



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER PROTECTION AND LAND REUSE
REMEDIATION DIVISION
860-424-3705

General Permit for In Situ Groundwater Remediation: Chemical Oxidation

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General Permit for In Situ Groundwater Remediation: Chemical Oxidation

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General Permit for In Situ Groundwater Remediation: Chemical Oxidation

Section 1. Authority

This general permit is issued under the authority of sections 22a-133z, 22a-430, 22a-430b, and 22a-454(e) of the Connecticut General Statutes (CGS).

Section 2. Definitions

The definitions of terms used in this general permit shall be the same as the definitions contained in sections 22a-430-3(a) and 22a-133k-1(a) of the Regulations of Connecticut State Agencies (RCSA). In addition, as used in this general permit:

“Approval of registration” means an approval of registration issued by the commissioner under this general permit;

“Area of concern” is a location or area where hazardous waste and/or hazardous substances (including petroleum products) have been or may have been used, stored, treated, handled, disposed, spilled, and/or released to the environment;

“Authorized activity” means any activity authorized by this general permit;

“Borehole” means a bored, drilled, or driven shaft or hole, extending below the ground surface, that may or may not intersect the water table or yield recoverable water;

“Certificate of coverage” means a document issued by the department acknowledging that a particular activity for which a registration was submitted to the department is authorized pursuant to this general permit;

“Chemical oxidant” means any substance that oxidizes another substance, being itself reduced in the process, including permanganates, persulfides, peroxides, percarbonates and ozone, and combinations thereof;

“Coastal boundary” means the boundary described in section 22a-94(b) of the Connecticut General Statutes;

“Coastal water” means coastal waters as defined by section 22a-93 of the Connecticut General Statutes;

“Commissioner” means commissioner as defined by section 22a-2(b) of the Connecticut General Statutes;

“Conceptual site model” or *“CSM”* means a representation of an environmental system, incorporating information about a chemical’s release, fate, transport mechanisms and pathways, and any potential receptors, that is used as a tool for understanding and for explaining to others the basis and rationale for the site investigation and the conclusions drawn about the environmental conditions at a site;

“Constituent of concern” or *“COC”* means a component, breakdown product, or derivative of a substance that may be found in the environment as a result of a release or discharge, or a reaction caused by such a release or discharge;

“Day” means the calendar day;

“Department” or *“DEEP”* means the Connecticut Department of Energy and Environmental Protection;

“Discharge” means discharge as defined in section 22a-423 of the Connecticut General Statutes and also includes, for the purposes of this general permit, the injection or emplacement of substances on or below the ground surface, above or below the water table, that are intended to react with or dissolve into the waters of the state to affect their chemical properties or react with pollutants in the water or soil, and shall also include the substances generated within an expected zone of influence as the result of expectable reactions of such injected or emplaced substances with groundwater, pollutants, and naturally occurring substances in soil and groundwater;

“Discharge monitoring well” means a monitoring well used for evaluation of the quality of groundwater that may be affected by activities authorized by this general permit;

“Emplacement” means the physical introduction on or below the ground surface of a substance, by any means, either permanently or temporarily;

“Endangered or threatened species” means endangered or threatened species as defined by section 26-304 of the Connecticut General Statutes;

“Fluid” means fluid as defined in section 22a-430-8(a) of the Regulations of Connecticut State Agencies;

“Free product” means free product as defined in section 22a-449(d)-101 of the Regulations of Connecticut State Agencies;

“Groundwater” means groundwater as defined in section 22a-133k-1 of the Regulations of Connecticut State Agencies;

“Heating oil” means petroleum fuel that is typically used in the operation of heating equipment, boilers, or furnaces, including but not limited to fuel oil of various grades;

“Heating oil tank” means a tank, and its associated fill and distribution lines, that is or was used to store heating oil for consumptive use, usually containing # 2 grade fuel oil at a residential, institutional or retail-commercial property;

“Individual permit” means a permit issued to a named permittee under sections 22a-430 or 22a-454 of the Connecticut General Statutes;

“Infiltration structure” means a structure, excavation or other facility designed to allow liquids to percolate into the underlying soil without overflow and to mix with the groundwater;

“Injection” means injection as defined in section 22a-430-8(a) of the Regulations of Connecticut State Agencies;

“Inland wetlands” means wetlands as defined by section 22a-38 of the Connecticut General Statutes;

“Leaching system” means a structure, excavation or other facility designed to allow sewage or other liquids to percolate into the underlying soil without overflow and to mix with the groundwater;

“Licensed Environmental Professional” or *“LEP”* means an environmental professional licensed pursuant to the requirements of section 22a-133v of the Connecticut General Statutes;

“Monitoring well” means a well designed and used to obtain representative samples of groundwater for evaluation of groundwater quality;

“Municipality” means a city, town, or borough of the state;

“Permittee” means any person who or municipality which has filed a registration and to whom or to which the commissioner has provided a certificate of coverage or has issued an approval of registration;

“Person” means person as defined by section 22a-2(c) of the Connecticut General Statutes;

“Professional Engineer” or *“P.E.”* means a professional engineer licensed by the Connecticut Department of Consumer Protection;

“Petroleum” means petroleum as defined in section 22a-449a of the Connecticut General Statutes;

“Petroleum fuel” means a petroleum product produced for use as fuel, usually for heating or transportation, including but not limited to gasoline, jet fuel, diesel fuel, and heating oil, excluding petroleum products produced for use as lubricants or solvents, and excluding fuels blended with solvents or wastes or over twenty percent (20%) non-petroleum in origin;

“Pollution” means pollution as defined in section 22a-423 of the Connecticut General Statutes;

“Public water supply well” means a water supply well that is a source of drinking water supply for a public water system, as defined in section 19-13-B102 of the Regulations of Connecticut State Agencies;

“Registrant” means a person who or municipality which files a registration pursuant to Section 4 of this general permit;

“Registration” means a registration form filed with the commissioner pursuant to Section 4 of this general permit, including any fees, supplemental documents, and certifications as specified in Section 4 of this general permit;

“Residential property” means real property with a house, apartment, trailer, mobile home, condominium or other structure, composed of up to four residential units, solely occupied by individuals as a dwelling;

“Retail-commercial property” means real property that is not residential property, has been primarily used for sale or distribution of goods or services or institutional purposes, and has not been used as a location for industrial or commercial manufacturing or repair.

“Site” means geographically contiguous land or water on which an authorized activity takes place or on which an activity for which authorization is sought under this general permit is proposed to take place, and includes, for the purposes of this general permit, consideration as a single site of contiguous parcels and associated roads and rights of way, even if owned by different persons, which are located over a single free product or groundwater pollution plume;

“Source of drinking water supply” means active source of supply, as defined in section 19-13-B102 of the Regulations of Connecticut State Agencies;

“Source water area” means an area of land, delineated by the state, that contributes water to a source of drinking water supply, whether the source is groundwater, surface water, or both;

“Supervised remediation site” means a site at which remediation is being conducted:

- i) in accordance with sections 22a-133x, 22a-133y, 22a-134a, or 32-9mm of the Connecticut General Statutes,
- ii) under sections 22a-449(c)-105(h) or 22a 449(d)-106 of the Regulations of Connecticut State Agencies, or

iii) to achieve compliance with an order of the commissioner issued pursuant to section 22a-432 of the Connecticut General Statutes;

“*Surface water classification*” means the water quality classification for a surface water body, as established in accordance with the water quality standards adopted pursuant to section 22a-426 of the Connecticut General Statutes;

“*Tank*” means tank as defined in section 22a-449(d)-101 of the Regulations of Connecticut State Agencies, and also including, but not limited to, any associated fill and distribution lines;

“*Tidal wetland*” means wetland as defined in section 22a-29 of the Connecticut General Statutes;

“*Total petroleum hydrocarbons*” or “*TPH*” means the reported results of an analysis conducted using the Connecticut Extractable Total Petroleum Hydrocarbons test, or other methodology approved by the commissioner to determine the concentration of gross oil or hydrocarbon in a substance or material;

“*Underground source of drinking water*” means underground source of drinking water as defined in section 22a-430-8 of the Regulations of Connecticut State Agencies;

“*Unprotected subsurface structure*” means a metal structure, such as a tank, pipe or conduit, that is below the ground surface, in contact with the soil, and not protected from corrosion by either an applied dielectric coating or a cathodic protection system, or any other structure that may come into contact with groundwater containing substances that could affect the structure’s integrity;

“*Watercourse*” means watercourse as defined in section 22a-38 of the Connecticut General Statutes;

“*Water supply well*” means water supply well as defined in section 19-13-B51b of the Regulations of Connecticut State Agencies; and

“*Well*” means well as defined in section 22a-430-8(a) of the Regulations of Connecticut State Agencies.

Section 3. Authorization Under This General Permit

(a) *Eligible Activities*

Provided the requirements of Section 3 of this general permit are satisfied, this general permit authorizes, except as limited by Section 5 of this general permit, the introduction at a single site of chemical oxidants and necessary supplemental substances into soil or groundwater to remediate pollution in situ through chemical oxidation, as follows:

- (1) Emplacement of chemical oxidants and associated substances, in solid, powdered, or any fluid form, in an open excavation resulting from removal of a tank or polluted soil, to remediate soil or groundwater polluted by *petroleum fuel*;
- (2) Injection or emplacement of chemical oxidants and associated substances, in solid, powdered, or any fluid form, on or below the ground surface at one or more points, infiltration structures, wells, or boreholes that are in an area of *petroleum fuel* pollution, or up-gradient or down-gradient from such area, to remediate soil or groundwater polluted by *petroleum fuel*, sources of such pollution, or to limit the migration of such pollution;
- (3) Discharge of chemical oxidants and associated substances, in solid, powdered, or any fluid form, in open excavations or on or below the ground surface by any means at one or more points, infiltration structures, wells, or boreholes that are in an area of

pollution, or up- or down-gradient from such area, to remediate soil or groundwater polluted by *polyaromatic hydrocarbons or halogenated or non-halogenated organic solvents*, or sources of such pollution, or to limit the migration of such pollution;

- (4) Discharge of chemical oxidants and associated substances, in solid, powdered, or any fluid form, in open excavations or on or below the ground surface by any means at one or more points, infiltration structures, wells, or boreholes that are in an area of pollution, or up- or down-gradient from such area, to remediate soil or groundwater polluted by *substances amenable to chemical oxidation that are not included in sections 3(a)(1) through 3(a)(3) of this general permit*, or sources of such pollution, or to limit the migration of such pollution; and
- (5) Ancillary short term discharge into groundwater of substances demonstrated necessary to maintain a condition facilitating continued use as intended of any well, borehole, or infiltration structure used for introduction of substances pursuant to Sections 3(a)(1) through 3(a)(4) of this general permit, at any time during the implementation of such other activities.

Generation, and subsequent presence in water within the zone of influence, of chemical intermediates, daughter- by- and end- products, and metabolic byproducts associated with the authorized activities, mobilization into groundwater within the zone of influence of natural materials due to the authorized activities, deposition in the aquifer of residues associated with the authorized activity are all authorized within the zone of influence, and discharge of atmospheric air or potable water as necessary for delivery of the authorized substances to the subsurface is also authorized.

Any discharge of water, substance or material into the waters of the state other than those specified in this section is not authorized by this general permit, and any person who or municipality which initiates, creates, originates or maintains such discharge must first apply for and obtain authorization under section 22a-430 or 22a-430b of the Connecticut General Statutes.

(b) Requirements for Authorization

This general permit authorizes the activities listed in Section 3(a) of this general permit provided the requirements of this subsection of this general permit are met.

(1) Registration

A completed registration with respect to such discharge (see Section 4 of this general permit), including all applicable fees, shall have been filed with the commissioner.

(2) Coastal Area Management

Such activities shall be consistent with all applicable goals and policies in section 22a-92 of the Connecticut General Statutes, and shall not cause adverse impacts to coastal resources as defined in section 22a-93 of the Connecticut General Statutes.

(3) Endangered and Threatened Species

Such activities shall not threaten the continued existence of any species listed pursuant to section 26-306 of the Connecticut General Statutes as endangered, threatened, or species of special concern and shall not result in the destruction or adverse modification of habitat essential to such species.

(4) **Aquifer Protection**

Such activities, if located within an aquifer protection area as mapped under section 22a-354b of the Connecticut General Statutes, shall comply with regulations adopted pursuant to section 22a-354i of the Connecticut General Statutes.

(5) **Conservation and Preservation Restrictions**

If activities are on or may affect property subject to a conservation or preservation restriction, proof of written notice to the holder of such restriction of the proposed activity's registration pursuant to this general permit or a letter from the holder of such restriction verifying that the proposed activity is in compliance with the terms of the restriction shall have been provided to the commissioner.

(6) **Wetlands and Watercourses**

Such activities shall cause only minimal adverse impacts on the environment, including, without limitation, watercourses, coastal waters, inland wetlands, tidal wetlands, and fish and wildlife habitat.

(7) **Flood Hazards**

Such activities shall not cause or contribute to flooding or flood hazard, permanently obstruct a floodway, or interfere with federal, state, or local flood management efforts; and such activities comply with the National Flood Insurance Program requirements.

(8) **Sources of Drinking Water**

Such activities shall not affect an underground source of drinking water or a watercourse, or any tributary thereto, which is or contributes to a source of drinking water supply; unless the discharge is necessary and appropriate to remediate groundwater pollution and its sources and, to the maximum extent practical, the discharge does not impair public health or the environment.

(9) **Water Diversions**

Any activity involving a groundwater withdrawal of greater than 50,000 gallons per day shall have in effect a valid license issued by the Commissioner pursuant to sections 22a-6 and 22a-368 or 22a-378a of the Connecticut General Statutes, or be exempt pursuant to section 22a-377(b)-1(a) of the Regulations of Connecticut State Agencies.

(10) **Local Authorizations**

Any local authorizations required for such activities shall have been obtained.

(c) ***Geographic Area***

This general permit applies throughout the State of Connecticut.

(d) ***Effective Date and Expiration Date of this General Permit***

This general permit is effective on the date it is issued by the commissioner and expires ten years from such date of issuance. Post-discharge monitoring and reporting requirements of

this general permit applicable to an authorized activity at a site shall remain in effect after expiration of this general permit except as approved by the commissioner.

(e) ***Authorization and Effective Date for Eligible Activities***

(1) **Authorization by Approval of Registration**

- (A) A commissioner's approval of registration is always required to authorize eligible activities (except that additional phases of activity may be authorized under Section 3(e)(4) of this general permit), and the effective date is the day of issuance of such approval of registration, when such activities will occur or will cause a zone of influence:
- (i) within an area with a groundwater quality classification of GAA;
 - (ii) within an identified aquifer protection area;
 - (iii) within a public water supply well source water area;
 - (iv) on land owned by an owner or operator of a public water supply that is defined as class I or class II water company land pursuant to section 25-37c of the Connecticut General Statutes; or
 - (v) on or below the surface of the bedrock, or within two feet above such surface.
- (B) Any other eligible activity pursuant to Sections 3(a)(1) through 3(a)(4) of this general permit requires a commissioner's approval of registration, except as authorized pursuant to Sections 3(e)(2) through 3(e)(4) of this general permit.

(2) **Authorization by Certificate of Coverage**

Except for an activity in an area referenced in Sections 3(e)(1)(A)(i) through 3(e)(1)(A)(v) of this general permit, the following eligible activities are authorized by the commissioner's issuance of a certificate of coverage (except that additional phases of activity may be authorized under Section 3(e)(4) of this general permit), and the effective date is the day of issuance of such certificate of coverage:

- (A) Activities referenced in Sections 3(a)(1) through 3(a)(3) of this general permit at a *supervised remediation site*; however, if the activity or location is referenced in Sections 3(e)(2)(A)(i) through 3(e)(2)(A)(v) immediately below, then an approval of registration is required pursuant to Section 3(e)(1)(B) of this general permit:
- (i) any activity that is only permissible with the commissioner's approval pursuant to Section 5(a)(11)(B) of this general permit.
 - (ii) activity using surfactants to mobilize non-aqueous phase product for chemical oxidation, or emplacement of chemical oxidants in areas where surfactants have previously been emplaced;
 - (iii) activity using hydrogen peroxide, ozone or perozone as a chemical oxidant;
 - (iv) any activity occurring or creating an expected zone of influence within 1,000 feet of a public water supply well, or within 200 feet of any other water supply well; and

- (v) any activity occurring or creating an expected zone of influence in locations where any of the following conditions are present:
 - 1) the water table is less than fifteen (15) feet above the surface of the bedrock,
 - 2) the aquifer permeability is less than 10^{-4} cm/sec (.28 ft/day),
 - 3) an existing groundwater or soil vapor control system being operated to control migration of pollution to receptors is within twenty-five (25) feet of the expected zone of influence,
 - 4) a coastal water, tidal or inland wetland, or watercourse is within twenty-five (25) feet, of the expected zone of influence, or
 - 5) an underground utility, unprotected subsurface structure, or basement is within twenty-five (25) feet of the expected zone of influence; and
- (B) Activities referenced in Sections 3(a)(1), and 3(a)(2) of this general permit at a site polluted solely by a release of *heating oil* from a tank with a capacity of less than 2,100 gallons, *provided that*:
 - (i) the proposed discharge does not total more than xxx pounds of oxygen supplied within any thirty (30) day period, and
 - (ii) the activity is not listed in Sections 3(e)(2)(A)(i) through 3(e)(2)(A)(v) of this general permit.
- (3) **Reserved**
- (4) **Authorization of Additional Phases of Activity**
 - (A) Except as may be authorized pursuant to Sections 3(e)(4)(B) through 3(e)(4)(D) of this general permit, any additional phase(s) of implementation for activity authorized pursuant to this general permit, including scale-up of project scope from an authorized pilot study, is(are) authorized upon the date the commissioner approves in writing a work plan for such additional phase(s) of activity submitted pursuant to Sections 5(c)(3)(C) or 5(a)(9) of this general permit.
 - (B) At supervised remediation sites, or at residential or retail-commercial sites where a release associated with a heating oil tank with a capacity of less than 2100 gallons is or had been present, implementation of planned additional phases of activity pursuant to Sections 3(a)(1) through 3(a)(3) of this general permit that are substantially identical to a previous authorized phase, with either similar or smaller amount(s) of discharged substance(s), is authorized without an additional submittal or written approval *provided that*:
 - (i) there is no increase in either the amount of substance injected for the phase, by more than ten percent, or the extent of the expected zone of influence, by more than ten feet, when compared to the amount and extent described for a phase in the registration or an approved modification;
 - (ii) a notice that an additional phase will be implemented is submitted to the commissioner, on a form prescribed by the commissioner, not later than seven (7) days prior to the proposed discharge phase, identifying

- the date(s) of proposed discharge and the amount of substance(s) to be discharged in the phase to be implemented;
- (iii) no notifications pursuant to Section 5(d) of this general permit were necessary as a result of implementation of previous phases of authorized activity; and
 - (iv) periodic reports are submitted pursuant to Section 5(c)(2) and 5(c)(4)(C)(ii) of this general permit.
- (C) Additional planned episodic discharge phases of activity to remediate pollution pursuant to Sections 3(a)(1) through 3(a)(3) of this general permit, where the discharge specifications of each phase are determined through review of the results of a previous phase, and additional unplanned recurrences of an authorized activity, are authorized without a written approval thirty (30) days after the commissioner's receipt of a work plan modification for the additional phase submitted pursuant to Section 5(c)(3)(C)(i) of this general permit, *provided that*:
- (i) there is no change in type of activity or substance;
 - (ii) the work plan modification identifies the amount of substance(s) to be discharged in the phase to be implemented, and any changes in the distribution or delivery specifications from the prior phase;
 - (iii) the work plan modification includes a certification that the monitoring and performance results of the previous phase were incorporated in the design of the current phase;
 - (iv) if the proposed recurrence is unplanned, there is no increase in either the amount of substance injected for the phase or the extent of the expected zone of influence when compared to the amount and extent described for a phase in the registration or an approved modification
 - (iv) if the recurrence was planned, there is no increase in either the amount of substance injected for the phase, by more than twenty five percent (25%), or the extent of the zone of influence, by more than fifteen (15) feet, when compared to the amount and extent described for a phase in the registration or, if greater, in a work plan modification for a previous phase approved pursuant to Section 3(e)(4)(A) of this general permit;
 - (v) no notifications pursuant to Section 5(d) of this general permit were necessary as a result of implementation of previous phases of authorized activity; and
 - (vi) the work plan is not modified or disapproved by the commissioner in writing within thirty days of receipt by the department.
- (D) Additional planned recurring intermittent discharge phases of activity to establish and maintain a subsurface condition to remediate pollution pursuant to Sections 3(a)(1) through 3(a)(3) of this general permit, are pre-authorized upon initial authorization of activity pursuant to this general permit where discharge specifications and recurrence scheduling rationale for such phases are described in the registration, or an approved modified work plan, and otherwise are authorized without a written approval thirty (30) days after receipt of a proposed work plan modification pursuant to Section 5(a)(9)(C) or 5(c)(3)(C) of this general permit, *provided that*:

- (i) there is no change in type of activity or substance;
 - (ii) periodic reports are submitted pursuant to Section 5(c)(3)(C)(ii) of this general permit; and
 - (iii) there is no increase in either the amount of substance injected for the phase, by more than ten percent, or the extent of the zone of influence, by more than ten feet, when compared to the amount and extent described for a phase in the registration or an approved modification;
 - (iv) no notifications pursuant to Section 5(d) of this general permit were necessary as a result of implementation of previous phases of authorized activity; and
 - (v) if more than ninety (90) days has elapsed from the previous phase, and no work plan modification is necessary, a notice that an additional phase will be implemented is submitted to the commissioner, not later than seven (7) days prior to the proposed discharge phase, identifying the date(s) of proposed discharge and the amount of substance to be discharged in the phase to be implemented.
- (5) Any activity pursuant to Section 3(a)(5) of this general permit to maintain a condition facilitating continued remediation activity already authorized pursuant to this general permit is authorized upon the date the commissioner approves a work plan for such activity submitted pursuant to Section 5(c)(3)(D) of this general permit, *however*:
- (A) for activity at supervised remediation sites not subject to the restrictions listed in section 3(e)(1)(A) of this general permit, such activity shall be authorized thirty (30) days after receipt by the department of a work plan submitted pursuant to Section 5(c)(3)(D) of this general permit unless the work plan is modified or disapproved by the commissioner in writing within thirty days of receipt by the department;
 - (B) if activity pursuant to Section 3(a)(5) of this general permit is expected to be necessary and specifications meeting the requirements of Section 5(c)(3)(D) of this general permit are included in the work plan submitted with the registration, such activity is authorized upon authorization of the primary remediation activity pursuant to this general permit, *provided that* the department is notified seven (7) days in advance of the date of implementation of activity pursuant to Section 3(a)(5); and
 - (C) if activity pursuant to Section 3(a)(5) of this general permit will be a recurrence of a previous discharge authorized pursuant to this general permit such activity shall be authorized seven (7) days after notification to the department of the date the recurrence is proposed to be implemented.
- (6) Any authorization of activity effective pursuant to Section 3(e) of this general permit also authorizes generation, and subsequent presence in water within the area of authorized activity, of chemical and metabolic intermediate- and by-products associated with the authorized activity.

(f) *Expiration of Authorization for Eligible Activities*

Authorization of discharge activity pursuant to section 3(e) of this general permit shall, unless otherwise approved by the commissioner, expire three (3) years from the effective

date of authorization of discharge activity or the date of expiration of this general permit, whichever is earlier, unless a request for extension of authorization, describing the reason an extension is needed, an update of the site conditions report, and a modified work plan and monitoring plan are submitted to the commissioner for review and approval not less than thirty (30) days prior to the expiration of authorization to discharge. After expiration of the active discharge authorization monitoring requirements of this permit shall remain in effect, and may be modified as permissible pursuant to this general permit.

(g) *Revocation of an Individual Permit*

If an activity meets the requirements of authorization of this general permit and such activity is presently authorized by an individual permit, the existing individual permit may be revoked by the commissioner upon a written request by the permittee. If the commissioner revokes such individual permit in writing, such revocation shall take effect on the effective date of authorization of such activity by this general permit, however post-discharge monitoring and reporting obligations of such individual permit shall remain in effect unless explicitly revoked by the commissioner in writing.

(h) *Issuance of an Individual Permit*

If the commissioner issues an individual permit authorizing an activity authorized pursuant to this general permit, this general permit shall cease to authorize active discharge activity beginning on the date such individual permit is issued, however monitoring and reporting obligations of this general permit shall remain in effect unless explicitly revoked by the commissioner in writing or superseded in the individual permit.

Section 4. Registration Requirements

(a) *Who Must File a Registration*

Any person seeking, under the authority of this general permit, to introduce chemical oxidants and necessary supplemental substances into soil, groundwater, or an open excavation to remediate pollution shall file with the commissioner:

- (1) The applicable fee as specified in Section 4(c)(1) of this general permit,
- (2) A complete and accurate registration form meeting the requirements of Section 4(c)(2) of this general permit,
- (3) Supporting documents as specified in Section 4(c)(3) of this general permit, and
- (4) Certifications to meet the requirements of Section 4(c)(4) of this general permit.

(b) *Scope of Registration*

A registrant shall submit one registration form for all activities taking place at a single site, as defined in this general permit, for which the registrant seeks authorization under this general permit. Activities taking place on more than a single parcel may not be consolidated on one registration form unless they are associated with remediation of a single pollution release.

(c) **Contents of Registration**

(1) **Fees**

- (A) Except as provided in Sections 4(c)(1)(B) and 4(c)(1)(C) of this general permit, the registration fee of \$TBD shall be submitted with a registration form.
- (B) Fees required pursuant to this general permit are reduced to half (1/2) the fee required if the registrant or the property owner of the primary parcel is a municipality.
- (C) Fees required by this general permit are waived for any activity addressing pollution originating from a single family residence.
- (D) A registration shall not be deemed complete and the subject discharge or activity shall not be authorized by this general permit unless the registration fee has been paid in full.
- (E) The registration fee shall be paid by check or money order payable to the **Department of Energy and Environmental Protection**.
- (F) The registration fee is non-refundable.

(2) **Registration Form**

A registration shall be filed on forms prescribed and provided by the commissioner and shall include, but not be limited to, the following:

Registrant and Contact Information

- (A) Legal name, address, and telephone number of the registrant and, if the registrant is not the owner of property on which the subject activity is to take place, the registrant's relationship to such owner(s);
- (B) Legal name, address, and telephone number of the owner(s) of the property(ies) on which the subject activity is to take place;
- (C) Legal name, address, and telephone number of the registrant's attorney or other representative, if applicable;
- (D) Legal name, address, and telephone number of any consultant(s) or engineer(s) retained by the registrant to prepare the registration or to design, construct, or supervise the subject activity;

Site Information

- (E) Name, location, street address, and town of the site, and, if the site includes multiple parcels, a list of all parcels where activity is proposed or where groundwater quality may be affected (as delineated by the zone of influence), providing such parcels are associated with remediation of a single pollution release;
- (F) A statement whether the primary parcel of the site is or is not a residential or retail-commercial property as defined in this general permit and, if so, whether it is a single family residential property;

Site Setting

- (G) A statement whether the area where the subject activity, zone of influence, or access and support activity will occur is or is not, in whole or in part, within the coastal boundary, upon Indian lands, subject to a conservation or preservation restriction, in essential habitat of an endangered or threatened species, or in an area identified on the department's map depicting Natural Diversity Data Base locales;
- (H) A statement whether the area where the subject activity, zone of influence, or access and support activity will occur is or is not within 100 feet of any watercourse, coastal water, inland wetland, or tidal wetland; within any identified floodplain; or within stream channel encroachment lines established pursuant to section 22a-342 of the Connecticut General Statutes;
- (I) The name and surface water classification, pursuant to section 22a-426 of the Connecticut General Statutes, of the nearest surface water downgradient from the area where the subject activity will occur and its distance from the zone of influence;
- (J) A statement whether the area of proposed activity or zone of influence is or is not within one mile of any public water supply well;

Site Character

- (K) A statement whether the primary parcel of the site is or is not undergoing remediation being conducted in accordance with:
 - (i) sections 22a-133x, 22a-133y, or 22a-134a of the Connecticut General Statutes,
 - (ii) sections 22a-449(c)-105(h) or 22a-449(d)-106 of the Regulations of Connecticut State Agencies,
 - (iii) a brownfield redevelopment program, including section 32-9mm of the Connecticut General Statutes, or
 - (iv) an order of the commissioner issued pursuant to section 22a-432 of the Connecticut General Statutes;
- (L) A statement, including any DEEP ID numbers, as to whether the area where the subject activity, zone of influence, or access and support activity will occur is or is not on a parcel(s):
 - (i) regulated under Subtitle C of the Federal Resource Conservation and Recovery Act (RCRA), as amended, under section 22a-454 of the Connecticut General Statutes, or section 22a-449(c) of the Regulations of Connecticut State Agencies,
 - (ii) regulated under Subtitle D of the Federal Resource Conservation and Recovery Act (RCRA), as amended, or under section 22a-208 of the Connecticut General Statutes,
 - (iii) regulated under Subtitle I of the Federal Resource Conservation and Recovery Act (RCRA), as amended, or under section 22a-449d of the Connecticut General Statutes, or
 - (iv) subject to a discharge permit, other than a stormwater discharge permit, issued under section 22a-430 of the Connecticut General Statutes;

Site Proximity to Water Supplies

- (M) A statement whether the subject activity or zone of influence will or will not occur at a location within an identified aquifer protection area, or within a public drinking water source water area, or will occur on land owned by an operator of a public water supply system;
- (N) The groundwater classification(s), pursuant to section 22a-426 of the Connecticut General Statutes, of the area where the subject activity or zone of influence will occur;
- (O) A statement whether the subject activity or zone of influence will or will not occur within 1,000 feet of a public water supply well, or within 500 feet of any other water supply well, and a list of all public water supply wells located within 1,000 feet and all other water supply wells located within 500 feet of the subject activity zone of influence;

Site Setting Mitigation Measures

- (P) A summary of the measures that will be taken to prevent adverse impact of the proposed activity as it may affect compliance with Sections 3(b)(2) through 3(b)(8) of this general permit, affect receptors identified pursuant to Sections 4(c)(2)(G) through (J), (M) and (O) of this general permit, or affect compliance with programs identified pursuant to Section 4(c)(2)(L) of this general permit, and a summary of any measures proposed to identify and correct any adverse impact that does occur;

Site Conditions

- (Q) Identification of whether the subject activity or zone of influence will or will not occur at a location where the following sensitive site conditions exist:
 - (i) the water table is less than 15 feet above the bedrock surface,
 - (ii) a soil vapor control system or groundwater pumping system is operating to reduce potential human or environmental exposure to pollutants,
 - (iii) a leaching system is located within 25 feet,
 - (iv) a coastal water, tidal or inland wetland, or watercourse is located within 25 feet,
 - (v) an underground utility, unprotected subsurface structure, or basement is located within 25 feet, or
 - (vi) an occupied structure is located within 25 feet and volatile organic chemicals or gasoline are present;
- (R) A description of the evidence that pollution is present on the site, and a statement that mobile free product petroleum fuel is not present or has been removed to the maximum extent technically practicable from the area of proposed activity, taking into consideration soil and site characteristics, and that any other mobile non-aqueous phase substance has been removed to the extent feasible, taking into consideration soil and site characteristics and cost;

Activity Mitigation Measures

- (S) A summary of operational and design measures for the proposed activity that will limit adverse impact affecting the sensitive site conditions identified pursuant to Sections 4(c)(2)(Q) and 4(c)(2)(R) of this general permit, human

health and safety on the site, or compliance with the operating conditions listed in section 5(a) of this general permit, and a summary of monitoring and response measures to identify and mitigate impact;

Other Information

- (T) Full-sized original United States Geological Survey (USGS) quadrangle map(s) or an 8 inch by 11 inch copy of the relevant portion(s) of such maps, with the quadrangle name(s) and numbers(s) identified and with a scale of 1:24,000, showing the exact location of the site, the area within a one mile radius of the site, mapped location of any boundaries or features associated with information listed in Sections 4(c)(2)(G) through 4(c)(2)(J) and 4(c)(2)(M) through 4(c)(2)(O) of this general permit and within one mile of the site; and
- (U) If the subject activity is an existing activity, the date it began and the date it is expected to end, and any departmental permit or authorization number; if the subject activity is a new activity, the date the registrant intends to initiate the activity and the date it is expected to end.

(3) Required Supporting Documents

(A) *Site Conditions Report*

A site conditions report shall describe the environmental conditions resulting in the necessity of the proposed discharge to remediate soil or groundwater pollution, and those conditions potentially affecting or affected by such discharge.

- (i) If the site is residential or retail-commercial property with only a heating oil release originating on the site, the site conditions report shall include, at a minimum:
 - 1) a description of the origin and character of the petroleum release, and all details (construction, size, depth, age, etc.) of any associated tanks or release pathways;
 - 2) an identification (“site review”) of any historical releases of pollution, non-residential or non-retail uses, or importation of fill at the site;
 - 3) a description of any remediation conducted to date to prevent further releases or remove free product, polluted soil, or polluted groundwater;
 - 4) a summary of available information regarding hydrogeology, groundwater flow, and groundwater quality, including a discussion of data gaps that may affect design or monitoring of the remedial activity and how they will be resolved during work plan implementation; and
 - 5) an identification of potential discharge migration pathways and receptors that may be affected by the proposed discharge.
- (ii) If the site is not solely residential or retail commercial property or has any release other than heating oil, the site conditions report shall

include a description of the conceptual site model and conditions relative to the activity proposed, including at a minimum:

- 1) the origin and character of the petroleum or other pollutant release and all details of any associated tanks or other materials management physical plant features;
- 2) a review, to the extent that the proposed activity may be affected, of current and past activities at and uses of the site, identification of any potential pollutants other than petroleum that may be present as a result of releases due to such activity or use or due to importation of polluted fill, and identification and description of specific areas of concern, other than the target pollution, that may be affected by or could affect the proposed activity;
- 3) a description of any remediation conducted to date to prevent further releases or remove free product, polluted soil, or polluted groundwater;
- 4) a description of the hydrogeology, groundwater flow and soil and groundwater quality at the site and its variability, including depths to water table and bedrock, and, for soil and groundwater within the proposed discharge area, basic chemical quality data identified in the conceptual site model as important for design or monitoring of the proposed activity or listed in Appendix I of this general permit for the substances proposed to be discharged ;
- 5) a delineation of the extent of polluted soil, free product, and groundwater pollution present;
- 6) an identification of potential pollution migration pathways and receptors that may be affected by the proposed discharge; and
- 7) a discussion of data gaps that may affect design or monitoring of the remedial activity and how they will be resolved during work plan implementation.

- (iii) For all sites, if a site is identified as subject to any of the authorities in Section 4(c)(2)(L) of this general permit, excluding those subject only to section 22a-449(d)-106 of the Regulations of Connecticut State Agencies, or if the site review or site conditions report determines there are potential pollutants other than petroleum fuel, volatile organic chemicals, or polyaromatic hydrocarbons, the site conditions report shall include:

A listing of constituents of concern, based on either pre-existing characterization or monitoring data, knowledge of systems and processes at the site, or a minimum of two screening analyses each of the soil and groundwater within the area of proposed activity and zone of influence, to determine if any constituents listed in Appendix B to section 22a-430-4 of the Regulations of Connecticut State Agencies are present above concentrations occurring naturally in the environment.

(B) *Site Plan*

A site plan and cross sections shall, for the entire area of proposed activity and zone of influence, depict, at a minimum:

- (i) the site and parcel boundaries;
- (ii) the location of the subject activity, including staging and support areas;
- (iii) the location, on the site or off-site but within 100 feet of the proposed activity or zone of influence, of structures, paved areas, water supply wells, leaching systems, known wetlands boundaries, floodplains, watercourses, and existing tanks (including pipelines, and fill and dispenser locations) or other materials management physical plant features, drains, utilities and other structures, along with notes of any installed corrosion protection on any underground structures;
- (iv) the location of the pollution to be remediated, its source location, the area of any prior remedial activity, and the current extent and concentration distribution of pollution in soil and groundwater, including the distribution of any residual non-aqueous phase product identified;
- (v) the location of any other area of concern identified pursuant to the requirement of Section 4(c)(3)(A) of this general permit;
- (vi) the locations of all existing and proposed wells and other data points;
- (vii) the inferred direction of groundwater flow, including vertical components;
- (viii) the location and expected zone of influence of each specific point where substances will be emplaced on or below the ground surface, and the resultant composite zone of influence.
- (ix) the location of all potentially affected receptors and migration pathways, both under existing conditions and those that are predicted to be created by the proposed activity; and
- (x) all proposed monitoring locations for the proposed activity.

(C) *Work Plan*

A work plan shall describe all activities planned for the introduction of substances on or below the ground surface at the location for which a registration is submitted, including, at a minimum:

- (i) a description of the technology selected for the remediation project, the rationale for its selection, and the remedial project goals for the proposed activity;
- (ii) information regarding the exact substance(s) to be introduced, including any additives, activators, amendments or supplements proposed to be used, and the rationale for their necessity and, if the substances are not listed in Appendix I of this general permit, also include identification of all chemical constituents of the substances, material safety data sheets (MSDSs), an identification of potential impurities present in the substance, an evaluation of byproducts and residuals that may be produced due to the use of the substances at the site and the potential effects of these impurities or produced substances on human health and the environment or the long term

aquifer condition, and a list of proposed monitoring parameters to evaluate the substance's effects;

- (iii) evaluation, based on the conceptual site model and any requirements identified for substances listed in Appendix I to this general permit, of the interaction between the proposed substance(s) to be emplaced and the location's target pollution, aquifer matrix and groundwater, and also any non-target pollutants identified as present, identification of end- intermediate- and by-products that may be produced, and any residuals that may remain in the aquifer or groundwater, and discussion of how any adverse interaction will be mitigated and monitored;
- (iv) results of any design studies, treatability studies, bench scale studies, or pilot studies conducted to gather information to design the proposed action, or an explanation of why no such studies were necessary;
- (v) details of the concentration and amount of substance(s) to be used, including the total amount of each substance that will be discharged during each discharge phase, the data and calculations used to determine the amount(s), the proposed distribution relative to the pollution to be remediated, and a description of the detailed emplacement locations and depths, and their expected zones of influence;
- (vi) a description of specific emplacement mechanisms, including proposed concentrations, volumes, injection pressures and flow rates, and a discussion of how these activities will be monitored at the discharge point(s);
- (vii) details of the procedures for material storage and handling, including procedures for reagent handling, mixing, measurement, applicable controls and alarms, and methods for disposal of excess or off-specification material;
- (viii) site safety procedures, including identification of applicable OSHA requirements (note that the department does not explicitly review or approve OSHA mandated safety plans), measures to prevent public access, and measures to ensure that no threats to public safety or health result from the proposed activity, and to identify and mitigate any that do;
- (ix) contingency procedures, including spill management procedures, actions to take in response to observations during active emplacement, and actions to take in response to monitoring results;
- (x) additional information and design specifications to meet substance specific requirements in Appendix I of this general permit and to demonstrate that any proposed activities identified in Section 5(a)(11)(B) of this general permit are protective of human health and the environment and may be approved by the commissioner pursuant to this general permit; and
- (xi) for multi-phased discharges either:

- 1) a description of the target aquifer geochemical condition and specifications for a phased recurring discharge to establish and maintain such condition, along with a fixed recurrence schedule or methodology for determining when the next phase is required, and also a methodology for periodically evaluating the appropriateness or effectiveness of the discharge, or
- 2) a description of the decision criteria to be used for episodic results-based remediation phases to establish the specifics of the subsequent phase of discharge based on monitoring of the results of the previous phase.

(D) *Monitoring Plan*

A monitoring plan shall describe a monitoring program that is based on the conceptual site model and meets the requirements of Section 5(b) of this general permit, incorporates the substance-specific requirements for substances listed in Appendix I of this general permit, monitors the remediation process and performance of any discharge delivery system, and documents the effect, if any, of the proposed activity on the waters of the state.

Such plan shall include, at a minimum:

- (i) identification of water supply wells within 75 feet of the proposed activity or zone of influence, or otherwise proposed or required to be monitored pursuant to this general permit, and specifics of the well and water system construction;
- (ii) identification of environmental receptors other than water supply wells that will be monitored because they may be affected by the proposed activity or are otherwise proposed or required to be monitored pursuant to this general permit, and the objectives of the proposed monitoring;
- (iii) identification of proposed discharge monitoring wells outside the expected zone of influence, their hydrogeologic relationship to such zone; the specifics of their construction, and the rationale for their inclusion in the monitoring program;
- (iv) Identification of monitoring wells within the expected zone of influence, and activity monitoring at discharge points and, for all monitoring wells, the specifics of their construction, the rationale for their inclusion in the monitoring program, and the objective of the proposed monitoring;
- (v) a description of how any discharge that is active at a specific location for more than 24 hours or is pressurized greater than two times atmospheric pressure will be evaluated for its effects on the hydrogeologic flow regime and its conformance with the zone of influence identified in the registration;
- (vi) a list of project-specific constituents of concern, including parameters specific to the substance proposed for discharge, the pollutant present, and those based on the substance specific requirements listed in Appendix I of this general permit and on the results of any site

specific evaluations conducted in fulfillment of Sections 4(c)(3)(A)(iii) and 4(c)(3)(C) of this general permit, and a proposed project-specific monitoring parameter list, which may vary based on monitoring location and objective, and which includes the rationale for inclusion or exclusion from the monitoring program of each constituent of concern;

- (vii) a description of sampling and analysis procedures, and the sampling schedule to be used; and
- (viii) a description of the data evaluation procedures to be used in drawing conclusions from the monitoring data consistent with the objectives of the monitoring program and requirements of this general permit.

(4) **Certifications**

(A) The registration shall include the signature of the registrant(s) and of the individual or individuals responsible for actually preparing the registration, each of whom shall certify in writing as follows:

(i) "I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that, based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I certify that this general permit registration is on complete and accurate forms as prescribed by the commissioner without alteration of their text. I understand that a false statement made in the submitted information may be punishable as a criminal offense, in accordance with section 22a-6 of the Connecticut General Statutes, pursuant to section 53a-157b of the Connecticut General Statutes, and in accordance with any other applicable statute."

and (ii) "I certify that I have read the *General Permit for In Situ Groundwater Remediation: Chemical Oxidation* issued by the Connecticut Commissioner of Energy and Environmental Protection; that the activities which are the subject of this registration are eligible for authorization under such permit; that if such activities commenced prior to the issuance of such permit, all applicable requirements of such permit are being met; and that a functioning and effective system is in place to assure that all such requirements are met so long as the activities which are the subject of this registration continue."

(B) A Verification, set forth below, signed by a P.E. or LEP, is required.

Verification:

(i) "I verify that I have thoroughly and completely reviewed the: site conditions report, including the past and present uses of the site and fill history; site plan; work plan; and monitoring plan; and, if applicable, results of screening samples included with this registration and any other site characterization samples. I verify, based on such review and on my professional judgment, that any constituent of concern list includes all non-petroleum potential pollutants present in the area of proposed activity or zone of influence and that the proposed activities are based on an

appropriate site characterization consistent with prevailing standards and guidelines. I also verify that I have thoroughly and completely reviewed the proposed activities and, based on such review and on my professional judgment, I verify that the proposed activities are necessary and the activity design, development specifications, and implementation procedures are appropriate to remediate the pollution present at the area of the site where activity is proposed, and the oversight and monitoring provisions, and contingency measures, all described in the work plan and/or monitoring plan, are consistent with prevailing standards and guidelines, and the proposed activities are not expected to cause changes in groundwater or surface water quality beyond the designated zone of influence, are not expected to adversely affect any identified underground source of drinking water supply or water supply well, and are not expected to adversely affect any underground utilities, underground structures or leaching fields. I also verify that, in my professional judgment, the proposed work plan and monitoring plan are sufficient to identify any unpredicted adverse effects, and provide a mechanism such that the activity will be stopped and such effects mitigated.”

and (ii) “I am aware that any professional services rendered pursuant to this general permit shall conform to the applicable rules of professional conduct of the Regulations of Connecticut State Agencies (for P.E.s section 20-300-12(a) and for LEPs section 22a-133v-6). I am also aware that there are significant penalties for false statements in this verification, including the possibility of fine and imprisonment for knowingly making false statements”.

(d) *Where to File a Registration and Other Related Documents*

(1) A registration shall be filed with the commissioner at the following address:

CENTRAL PERMIT PROCESSING UNIT
DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
79 ELM STREET
HARTFORD, CT 06106-5127

(2) If the proposed activity or zone of influence is within any part of an aquifer protection area, an area of the state with a groundwater Water Quality Classification of GAA, or a public drinking water source water area, or if the proposed activity is on land owned by an owner or operator of a public water supply, a duplicate or certified copy of the registration filed with the department, including attached supporting documents, shall be filed with the Department of Public Health at the following address:

DRINKING WATER SECTION
DEPARTMENT OF PUBLIC HEALTH
410 CAPITOL AVENUE - MS #51 WAT
P.O. BOX 340308
HARTFORD, CT 06134-0308

(3) If the proposed activity or zone of influence is within 200 feet of any water supply well pumping over ten (10) gallons per minute, or within seventy-five (75) feet of any other water supply well, a duplicate or certified copy of the registration form

filed with the department, without any attachments, shall be filed with the local Director of Health.

(e) Additional Information

The commissioner may require a registrant to submit additional information, which the commissioner reasonably deems necessary to evaluate the consistency of the subject activity with the requirements for authorization under this general permit.

(f) Action by Commissioner

- (1) The commissioner may reject without prejudice a registration if it is determined that it does not satisfy the requirements of Section 4(c) of this general permit or more than thirty (30) days have elapsed since the commissioner requested that the registrant submit additional information or the required fee and the registrant has not submitted such information or fee. Any registration re-filed after such a rejection shall be accompanied by the fee specified in Section 4(c)(1) of this general permit.
- (2) The commissioner may disapprove a registration if it is found that the subject activity is inconsistent with the requirements for authorization under Section 3 of this general permit, or for any other reason provided by law.
- (3) Disapproval of a registration under this subsection shall constitute notice to the registrant that the subject activity may not lawfully be conducted or maintained without the issuance of an individual permit.
- (4) The commissioner may approve a registration pursuant to this general permit, or may issue a certificate of coverage in lieu of an approval, when an approval is not required pursuant to Section 3(e)(1) of this general permit.
- (5) The commissioner may approve a registration with reasonable conditions, in lieu of either disapproval or issuance of a certificate of coverage pursuant to this general permit. If the commissioner approves a registration with conditions, the permittee shall be bound by such conditions as if they were a part of this general permit.
- (6) Rejection, disapproval, or approval of a registration shall be in writing.

Section 5. Conditions of This General Permit

The permittee shall at all times meet the requirements for authorization set forth in Section 3 of this general permit. In addition, a permittee shall ensure that activities authorized by this general permit are conducted in accordance with this Section and Section 6 of this general permit.

(a) Operating Conditions

- (1) Authorized activities shall be conducted in accordance with the work plan submitted with the registration, and, if applicable, any approved modification, or conditions in an approval of registration issued pursuant to this general permit, and shall be under the supervision of a P.E. or LEP.
- (2) Activities authorized under this general permit shall not occur without the written consent of all property owner(s) whose property intersects the zone of influence. A summary of consent status for all parcels within the zone of influence shall be included in the registration submitted pursuant to Section 4 of this general permit if the registrant is not the property owner(s). Such consent is not required for public rights of way that are within the zone of influence but not otherwise an area of

activity pursuant to this general permit, provided subsurface utilities in such rights of way are identified as a sensitive site condition and evaluated pursuant to this general permit.

- (3) The local director of health, local fire marshal, and any abutting property owners within twenty-five (25) feet of the anticipated zone of influence, shall be notified of the nature of the proposed activity, at least forty-eight (48) hours before a discharge into an open excavation. All abutting property owners, the local director of health and the local fire marshal shall be notified in writing or by other methods acceptable to the commissioner at least fifteen (15) days before initiation of any other authorized activity. Such notices shall provide the name and telephone number of a point of contact who is knowledgeable of the proposed activity. A summary of notification activity and example copies of any written notifications shall be included in the first report submitted to the commissioner pursuant to Section 5(c)(3) of this general permit.
- (4) The authorized substances shall be discharged in a manner that ensures that to the extent possible there will be contact with groundwater in sufficient quantity to stimulate dispersal through the zone of influence and in a manner that minimizes potential outward migration of pollution from the area where it is already present.
- (5) Activities authorized pursuant to Sections 3(a)(1) through 3(a)(4) of this general permit, unless otherwise approved by the commissioner, shall not occur until any mobile petroleum fuel free product present has been removed to the maximum extent technically practicable, taking into consideration soil and site characteristics, and any other mobile non-aqueous phase liquid has been removed to the extent feasible, taking into consideration soil and site characteristics and cost.
- (6) Activities pursuant to this general permit shall not occur unless there is qualitative or quantitative *evidence of a release* of polluting substances amenable to treatment by oxidation in the area where the discharge is proposed to occur or expected to affect groundwater quality.
- (7) Substances authorized for discharge pursuant to this general permit shall not be discharged, injected, or emplaced into, or within fifteen (15) feet of, any well designated as a discharge monitoring well in the registration or by the commissioner in an approval of registration, except as site conditions dictate and technical justification is included in the monitoring plan, or any well explicitly excluded by any approval of registration issued pursuant to this general permit.
- (8) If *short term discharge* of treatment chemicals pursuant to Section 3(a)(5) of this general permit is needed to maintain a condition facilitating the continued implementation of other activities pursuant to this general permit such activity shall not occur unless specifically authorized pursuant to section 3(e)(5) of this general permit.
- (9) If *phased activity* is proposed pursuant to this general permit, including scale-up of project scope from an authorized pilot study:
 - (A) the implementation, monitoring and results of each phase shall be evaluated and used as appropriate to inform the design and implementation of subsequent phases;
 - (B) reports of such evaluation shall be submitted as specified in Section 5(c)(3)(C) of this general permit and such reports may include proposed

modifications to the discharge specifications for a phase in the work plan and monitoring plan originally submitted with the registration;

- (C) The permittee may submit to the Commissioner a work plan modification to change for subsequent discharge phases the specific details of discharge procedures, change the schedule for periodic discharges, increase the number of remediation phases proposed, increase the duration of time during which discharge is authorized, increase the amount, volume or concentration of substance(s) proposed for each discrete discharge above the amount(s) specified in the registration or any approved work plan modification, or increase the proposed zone of influence.
- (D) For each specific phase, any change in type of activity or substance and any significant increases in either the amount of substances discharged (an increase of 10% or greater) or the zone of influence of the discharge (an expansion greater than ten feet), in comparison to the specifications in the registration or any previously approved modification, may not be implemented until reviewed and approved by the commissioner pursuant to Section 3(e)(4) of this general permit.

(10) **Discharge Limits**

- (A) Hydrogen peroxide solutions discharged pursuant to this general permit shall not exceed a concentration of fifteen percent (15%).
- (B) Ozone enriched air introduced to the subsurface pursuant to this general permit shall not exceed ten percent (10%) ozone.
- (C) No other discharge shall exceed 125 percent (125%) of the volume or concentration proposed in the work plan, and any volume or concentration deviations shall not result in an increase of the total amount of substance discharged during a remediation phase over the amount authorized.

(11) **Prohibitions**

- (A) Activities authorized under this general permit shall not cause:
 - (i) atmospheric oxygen or ozone concentrations to be enriched within fifty (50) feet of any fuel dispensing or use area;
 - (ii) explosive gasses to accumulate at levels above ten percent (10%) of the lower explosive limit in any confined space or basement;
 - (iii) corrosion or other degradation of subsurface infrastructure present within the zone of influence.
 - (iv) volatile organic chemicals to migrate into indoor air in occupied structures;
 - (v) the water table to rise within two feet of the ground surface
 - (vi) groundwater to enter into any occupied basement;
 - (vii) a release of chemical oxidants directly to surface water;
 - (viii) discharge into a storm-water drainage system that discharges to surface water unless such discharge is contained and removed for proper disposal; or

- (ix) disruption of the operation of any existing soil vapor control system or groundwater pumping system that is installed and operated to protect human health or the environment.
- (B) The following activities shall not occur without prior written authorization of the activity pursuant to Section (3)(e) of this general permit:
 - (i) injections using pressures greater than three (3) times atmospheric pressure;
 - (ii) discharge of greater than fifty percent (50%) of the pore volume in the zone of influence;
 - (iii) hydraulic or pneumatic fracturing of aquifer materials to enhance permeability or chemical contact;
 - (iv) operation of active pumped withdrawal of groundwater to establish and maintain the zone of influence;
 - (v) a discharge that incorporates recirculation of groundwater that is affected by the discharged substance or by pollution, even if treated; and
 - (vi) discharge of ozone, perozone or catalyzed hydrogen peroxide in the absence of operation of a soil vapor control system capable of capturing vapors migrating as a result of the discharge effects.
- (12) The permittee shall have the responsibility to make notifications and file reports required under this general permit. The permittee shall also have the responsibility to make notifications, file reports, and implement contingency actions as specified in any work plan or monitoring plan applicable to activity authorized pursuant to this general permit. In addition, the permittee shall make any monitoring results or data available to the commissioner upon request.

(b) Monitoring Requirements

(1) Monitoring Objectives and Locations

- (A) The permittee shall establish a perimeter network of discharge monitoring wells, placed at appropriate locations and depths, to be sampled to determine if there any effects of the discharge authorized by this general permit outside the zone of influence defined in the registration.
- (B) The permittee shall, through monitoring discharge points and sampling discharge monitoring wells within the defined zone of influence, establish a process monitoring program to ensure activity authorized by this general permit is implemented and proceeds as proposed in the work plan and to determine the effects of the discharge on the groundwater within the zone of influence.
- (C) Potable water supply wells within seventy-five (75) feet of the authorized activity or zone of influence shall be sampled and analyzed for the parameters specified in Section 5(b)(3)(C) of this general permit to determine if there is any effect of the discharge authorized by this general permit.

- (D) Potable water supply wells more than seventy five (75) feet but within 500 feet of the expected zone of influence of activities pursuant to Sections 3(a)(1) through 3(a)(3) of this general permit shall, unless otherwise approved by the commissioner, be sampled and analyzed for the parameters specified in Section 5(b)(3)(C) of this general permit to determine if there is any effect of the discharge authorized by this general permit if:
- (i) the authorized activity is in an area where the water table is within fifteen (15) feet of the bedrock surface,
 - (ii) the well is a public water supply well,
 - (iii) mobile free product or non-aqueous phase liquids have not been removed to meet the requirement of Section 5(a)(5) of this general permit but the commissioner has authorized the proposed discharge activity,
 - (iv) groundwater analyses within the zone of influence determines the concentration of any individual chlorinated volatile organic solvent prior to initiation of a discharge pursuant to this general permit is greater than 1,000 ug/l, or
 - (v) sampling the well is proposed in the monitoring plan, or required in any approval of registration by the commissioner.
- (E) Potable water supply wells within 500 feet of activities pursuant to Section 3(a)(4) of this general permit or the expected zone of influence of such activities shall, unless otherwise approved by the commissioner, be sampled and analyzed for the parameters specified in Section 5(b)(3)(C) of this general permit to determine if there is any effect of the discharge authorized by this general permit.
- (F) The permittee shall establish a monitoring program, including field observations, field parameter measurements, and chemical analyses, to identify if the discharge authorized by this general permit has an effect on environmental receptors other than potable water supply wells, including but not limited to surface water, stormwater systems, soil gas and indoor air quality.
- (G) If storm-water management drains are present within 25 feet of the zone of influence they shall, at a minimum, be visually inspected periodically for any flow associated with the authorized discharge during the active discharge period and the following calendar day.
- (H) The permittee shall establish and conduct, consistent with prevailing standards and guidelines, a monitoring program, including field observations, field parameter measurements, and chemical analyses, to determine that any active control systems, including pumping wells to control groundwater flow and soil vapor control systems, 1) if designed or used to meet requirements of this general permit, operate as proposed in the work plan or 2) if preexisting

protections for human health and the environment, continue to adequately meet the designed protection objective.

- (I) Downgradient monitoring wells, when required pursuant to this general permit, shall be installed at a location and depth that monitors a point that is not further from the identified zone of influence than the distance groundwater travels in six (6) months, based on hydrogeologic evaluation of the site, unless the proposed monitoring frequency and duration in the monitoring plan are adjusted, based on the site hydrogeologic analysis, from those specified in Section 5(b)(2) of this general permit.

(2) **Monitoring Frequency and Duration**

Monitoring of activities pursuant to Section 5(b) of this general permit, unless required otherwise by Appendix I of this general permit, otherwise increased or modified in an approval by the commissioner, increased in a monitoring plan based on the conceptual site model, or otherwise required through Section 5(d) or modified by Section 5(b)(5) of this general permit, shall be conducted at least once prior to initiation of activity pursuant to this general permit (“baseline conditions”) and then as follows:

- (A) Monitoring of activities pursuant to Sections 5(b)(1)(A) and 5(b)(1)(F) of this general permit shall at a minimum be conducted:
 - (i) for field observations and field determined parameters:
 - daily during the first week of active discharge then
 - weekly for the remaining period of active discharge,
 - monthly for the first quarter after active discharge has ended, and
 - quarterly thereafter for a period of eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of anticipated chemical activity, whichever is later, and
 - (ii) for laboratory determined parameters:
 - once during the first and third weeks of active discharge then
 - monthly for the remaining period of active discharge, and
 - quarterly thereafter for a period of eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of anticipated chemical activity, whichever is later.
- (B) Monitoring of activities pursuant to Sections 5(b)(1)(B) of this general permit shall at a minimum be conducted:
 - (i) for field observations and field determined parameters:
 - daily during the first week of active discharge then
 - weekly for the remaining period of active discharge, and
 - quarterly thereafter for a period of eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of chemical activity, whichever is later, and
 - (ii) for laboratory determined parameters:
 - monthly for the first quarter of active discharge, and

- quarterly thereafter until eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of chemical activity, whichever is later.
- (C) Water supply well monitoring that is required pursuant to Sections 5(b)(1)(C) through 5(b)(1)(E) of this general permit shall at a minimum be conducted:
- (i) for field observations and field determined parameters:
 - once during the first and third weeks of active discharge then
 - monthly for the remainder of the quarter, and
 - quarterly thereafter for a period of eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of chemical activity, whichever is later, and
 - (ii) for laboratory determined parameters:
 - monthly for the first quarter of active discharge, and
 - quarterly thereafter until eighteen (18) months after either cessation of active discharge, injection, or emplacement or end of chemical activity, whichever is later.
- (D) If monitoring conducted outside the zone of influence or monitoring of drinking water supply wells or other environmental receptors determines that these monitoring locations show any effects of the discharge, monitoring of the affected locations shall continue for a minimum period of one year after such effects are no longer detected.
- (E) If monitoring conducted within the zone of influence determines that groundwater standards in Appendix C, D or E to sections 22a-133k-1 to 3 of the Regulations of Connecticut State Agencies or any chemical specific limit listed in Appendix I of this general permit are exceeded due to the authorized discharge, monitoring of the affected locations shall continue for a minimum period of one year after such effects are no longer above the criteria. This requirement does not apply to constituents that baseline monitoring has documented as similarly above the specified comparison criteria prior to the authorized discharge.
- (F) Monitoring of activities pursuant to Section 3(a)(5) of this general permit shall be as specified in the work plan submitted with the registration or a supplemental work plan submitted pursuant to Section 5(c)(3)(D) of this general permit, or as such monitoring is otherwise increased or modified in an approval by the commissioner pursuant to Section 3(e)(5) of this general permit.
- (G) Monitoring that is required more than ninety (90) days after initiation of authorized activity may be conducted concurrently with any quarterly monitoring schedule already established for the site.
- (H) Water supply well monitoring that is required pursuant to Sections 5(b)(1)(D) and 5(b)(1)(E) of this general permit shall also be conducted once one year after the end of monitoring required pursuant to Section 5(b)(2)(C) of this general permit, or as such monitoring is otherwise increased or modified in an approval by the commissioner, or increased in a monitoring plan.

(3) **Monitoring Parameters**

(A) Monitoring conducted outside the zone of influence and monitoring of environmental receptors to meet the requirements of sections 5(b)(1)(A) and 5(b)(1)(F) respectively shall, unless otherwise approved by the commissioner, include at a minimum sampling and analysis for the following:

- (i) field measurements, which shall be taken and reported in a log to be submitted with laboratory analysis:
 - Oxidation-reduction Potential (ORP),
 - Conductivity,
 - pH,
 - Temperature,
 - Water Surface Elevation; and
- (ii) contaminant constituents of concern associated with the pollution being remediated;
- (iii) chemical specific indicator parameters identified in Appendix I of this general permit; and
- (iv) if results of monitoring identify that there is an effect of the discharge at a location, subsequent monitoring at that location shall include any additional project-specific constituents of concern identified in fulfillment of the requirement of Sections 4(c)(3)(A)(iii) and 4(c)(3)(C) of this general permit, or listed in Appendix I of this general permit, and included in the project-specific monitoring parameter list in a monitoring plan developed pursuant to Section 4(c)(3)(D)(vi) of this general permit, and any additional monitoring parameter required in any approval of registration, using appropriate methods consistent with Section 5(b)(4) of this general permit.

(B) Monitoring conducted within the zone of influence to meet the requirements of section 5(b)(1)(B) of this general permit shall, unless otherwise approved by the commissioner, include at a minimum sampling and analysis for the following:

- (i) field measurements:
 - Oxidation-Reduction Potential (ORP),
 - Conductivity,
 - pH,
 - Temperature,
 - Water Surface Elevation;
- (ii) general operational parameters:
 - Injection pressure,
 - Injection flow rate,
 - Injectant concentration;
- (iii) chemical specific parameters identified in Appendix I of this general permit; and
- (iv) any additional project-specific constituents of concern identified in fulfillment of the requirement of Sections 4(c)(3)(A)(iii) and 4(c)(3)(C)

of this general permit, and included in the project-specific monitoring parameter list in a monitoring plan developed pursuant to Section 4(c)(3)(D)(vi) of this general permit, and any additional monitoring parameter required in any approval of registration, using appropriate methods consistent with Section 5(b)(4) of this general permit.

- (C) Potable water supply wells required to be sampled pursuant to sections 5(b)(1)(C) through 5(b)(1)(E) of this general permit shall be sampled and analyzed for the following:
 - (i) field measurements, which shall be taken and reported in a log to be submitted with laboratory analysis:
 - Oxidation-reduction Potential (ORP),
 - Conductivity,
 - pH;
 - (ii) contaminant constituents of concern associated with the pollution being remediated; and
 - (iii) any additional project-specific constituents of concern identified in fulfillment of the requirement of Sections 4(c)(3)(A)(iii) and 4(c)(3)(C) of this general permit, or listed in Appendix I of this general permit, and included in the project-specific monitoring parameter list in a monitoring plan developed pursuant to Section 4(c)(3)(D)(vi) of this general permit, and any additional monitoring parameter required in any approval of registration, using appropriate methods consistent with Section 5(b)(4) of this general permit.
- (D) Sampling conducted to meet the requirements of section 5(b)(1)(G) of this general permit shall use appropriate methods consistent with section 5(b)(4) of this general permit and shall be for parameters identified as appropriate to monitor the discharge or its effects on groundwater in the work plan submitted pursuant to section 5(c)(3)(D) of this general permit, or as otherwise approved by the commissioner pursuant to section 3(e)(5) of this general permit.:
- (E) Monitoring conducted to meet the requirements of sections 5(b)(1)(H) of this general permit shall use appropriate methods consistent with section 5(b)(4) of this general permit and shall be for parameters that are, consistent with prevailing standards and guidelines, appropriate to monitor the function of the control system to meet the specifications in the work plan submitted pursuant to section 4(c)(3)(C) of this general permit, or as otherwise approved by the commissioner pursuant to section 3(e) of this general permit.:

(4) Sampling and Analysis Requirements

- (A) All discharge monitoring wells identified in the monitoring plan submitted with the registration, or in any approval of registration issued pursuant to this general permit, shall be installed at least seven (7) days prior to the first sampling required pursuant to Sections 5(b)(2)(A) and 5(b)(2)(B) of this general permit.

- (B) All sampling and analyses required to monitor activities authorized by this general permit shall, unless otherwise specified in this general permit, comply with the following requirements:
 - (i) all samples collected to monitor groundwater impacts shall be grab samples composed solely of groundwater representative of the subject groundwater, and shall be collected in a manner consistent with prevailing standards and guidelines;
 - (ii) laboratory analyses, and the reporting of such analyses, shall be conducted by a laboratory certified by the Connecticut Department of Public Health, and analyses shall be performed using methods consistent with Connecticut's Reasonable Confidence Protocols or methodologies that contain a level of quality control and documentation at least equivalent to the reasonable confidence protocols; and
 - (iii) monitoring required by this general permit for temperature, dissolved oxygen, dissolved carbon dioxide, pH, conductivity, turbidity, oxidation-reduction potential, or other field-measured parameters shall be conducted in the field using field test kits or electronic probes as appropriate.
- (C) The permittee shall periodically calibrate and perform maintenance on all monitoring and field equipment used to monitor the groundwater, as required under this general permit, at intervals that will ensure the accuracy of measurements, and shall document such calibration in field logs.

(5) **Monitoring Exceptions**

- (A) In addition to the monitoring requirements specified in Sections 5(b)(1) through 5(b)(3) of this general permit, monitoring, including monitoring of discharge volume and concentration, proposed in any work plan or monitoring plan as a result of evaluation of the conceptual site model, shall be conducted as proposed in such documents, or as otherwise increased or modified in an approval of registration by the commissioner pursuant to Section 5(b)(5)(D) of this general permit.
- (B) If the authorized activity is chemical oxidant emplacement into open excavations resulting from removal of, or remediating a release from, tanks with a capacity of less than 2,100 gallons used to store heating oil:
 - (i) the monitoring requirements specified in Sections 5(b)(1)(A) and 5(b)(1)(B) of this general permit are not required unless otherwise specified in Appendix I of this general permit or in an approval of registration or work plan or monitoring plan, provided that any monitoring results that are collected shall be submitted in the report required by Section 5(c)(3)(B) or as otherwise required by Section 5(c)(4) of this general permit; and
 - (ii) any monitoring required by Sections 5(b)(1)(C) and 5(b)(1)(D) of this general permit shall be conducted initially on or before the day of discharge initiation, to establish "baseline conditions", bi-weekly for the first month, then monthly for the first quarter and then quarterly for one year, and then annually for the remaining monitoring period, or as otherwise increased or modified in an approval of registration or in a

work plan or monitoring plan. *However*, if no recoverable free product was present at any time prior to the authorized emplacement, such monitoring may be discontinued after the first year, or as otherwise extended or modified in an approval of registration or in a work plan or monitoring plan.

- (C) If the authorized activity is chemical oxidant injection or emplacement pursuant to Section 3(a)(2) of this general permit, at a site where a heating oil tank with a capacity equal to or smaller than 2,100 gallons is or had been present
- (i) the monitoring requirements specified in Section 5(b)(1)(A) may be met using monitoring wells installed and sampled to establish “baseline conditions” on or before the day of discharge initiation;
 - (ii) the monitoring requirements specified in Section 5(b)(1)(B) of this general permit are not required, for the first activity phase only, unless otherwise specified in Appendix I of this general permit or in an approval of registration or work plan or monitoring plan, provided that any monitoring results that are collected shall be submitted in the report required by Section 5(c)(3)(B) of this general permit; and
 - (iii) any monitoring required by Sections 5(b)(1)(C) and 5(b)(1)(D) of this general permit shall be conducted initially before discharge initiation, to establish baseline conditions, bi-weekly for the first month, then monthly for the first quarter and then quarterly for one year, and then annually for the remaining monitoring period, or as otherwise increased or modified in an approval of registration or in a work plan or monitoring plan. *However*, if no recoverable free product was present at any time prior to the authorized emplacement, monitoring required by Sections 5(b)(1)(C) and 5(b)(1)(D) of this general permit may be discontinued after two (2) years or as otherwise extended or modified in an approval of registration or in a work plan or monitoring plan.
- (D) The commissioner, when approving a registration, may increase, or modify the monitoring requirements specified in Section 5(b) of this general permit, or otherwise required at the site pursuant to this general permit, in order to protect human health or the environment. Such action by the commissioner may be taken for any proposed activity, in lieu of issuance of a certificate of coverage, even if an approval is not otherwise required pursuant to this general permit.

(c) **Reporting and Record Keeping Requirements**

- (1) Unless otherwise stated in this general permit, or otherwise specified in writing by the commissioner, notifications, plans, and reports required by this general permit, shall identify the permittee name, department assigned permit identification numbers, site name, site location, street address, and town, and shall be submitted to:

COORDINATOR – IN SITU GROUNDWATER REMEDIATION
REMEDICATION DIVISION – BUREAU OF WATER PROTECTION AND LAND REUSE
CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
79 ELM STREET
HARTFORD, CT 06106-5027

(2) **Report of Monitoring Data Evaluation**

The permittee shall submit, on a form prescribed by the commissioner, a summary review of the monitoring data relative to compliance with this general permit within sixty (60) days of the end of each sampling period. Monitoring analytical reports and field logs shall not be submitted with such summary unless required by the commissioner. However such data shall be incorporated in reports and notifications submitted pursuant to Sections 5(c)(3) and 5(d) of this general permit. Furthermore, field data shall be evaluated pursuant to Section 5(d) of this general permit within forty-eight (48) hours of collection, and the date and results of such evaluation shall be noted on the report of monitoring data evaluation form.

(3) **Other Required Reports**

Except as specified in Section 5(c)(4) of this general permit, the following plans/reports, prepared by the LEP or P.E. supervising the authorized activity pursuant to Section 5(a)(1) of this general permit, are required by this general permit:

- (A) A report of the site activities conducted in accordance with the work plan shall be submitted within ninety (90) days after the cessation of active discharge, except as waived for phased activity pursuant to Section 5(c)(3)(C) of this general permit;
- (B) A final report summarizing all site activity and monitoring shall be submitted within one hundred twenty (120) days after completion of all activity and post-discharge monitoring required pursuant to this general permit;
- (C) If phased activity pursuant to this general permit, including scale-up of project scope from an authorized pilot study, is proposed or determined by the permittee to be necessary, instead of the report required in Section 5(c)(3)(A) of this general permit the following reports are required, except as waived by Section 5(c)(4)(C) of this general permit:
 - (i) For unplanned recurring activity or planned episodic discharge phases where the discharge specifications of each phase are determined through review of the results of a previous phase the permittee shall submit not later than 180 days after the end of the discharge phase, or not less than thirty (30) days prior to the planned implementation date of the subsequent discharge phase, whichever is earlier, an evaluation report of the previous phase, including a summary of the discharged substances and amounts for the event, a summary of the discharge activity identifying any departures from the work plan, a summary of monitoring results, a supplement to the site conditions report as necessary to reflect changed conditions or additional information, a reevaluation of the conceptual site model and remedial design and progress, and recommendations for any modifications to the work plan or monitoring plan, including identified discharge locations and amounts for the next discharge phase; or
 - (ii) For planned recurring periodic discharge phases with specifications delineated in the registration or an approved modified work plan the permittee shall submit semiannual reports of discharge activity no later than sixty (60) days after the end of each six month period, with the first report due in the eighth month after the date of initial authorization

of the discharge pursuant to this general permit. Such reports shall include a summary of the discharged substances and amounts for the period, a summary of the discharge activity identifying any departures from the work plan, a summary of monitoring results, and a reevaluation of the conceptual site model and remedial design and progress, and may include recommendations for any modifications to the work plan or monitoring plan, including identified discharge locations and amounts for the next discharge periods.

- (D) If short term discharge of treatment chemicals, either at a single point in time or at defined recurrence intervals based on triggering conditions or elapsed time, is proposed pursuant to Section 3(a)(5) of this general permit to maintain a condition facilitating the continued implementation of other activities pursuant to this general permit, a report detailing why such discharge is needed, with identification of any recurrence trigger or interval, and including a supplemental work plan for such discharge and proposed monitoring shall be submitted for review and approval not less than thirty (30) days prior to the proposed discharge date, and such submittal shall be subject to review and approval as specified in Section 3(e)(5) of this general permit.

(4) Reporting Exceptions

- (A) For activities at supervised remediation sites, permittees are, except as otherwise specified in writing by the commissioner, not required to submit any report required under Sections 5(c)(3)(A) or 5(c)(3)(B) of this general permit, provided the information referenced in Sections 5(c)(3)(A) and 5(c)(3)(B) of this general permit is included in a Remedial Action Report submitted separately to the commissioner as required under the applicable remedial program. Notifications of certain conditions must be made in accordance with Section 5(d) of this general permit, and reports pursuant to Sections 5(c)(2) and 5(c)(3)(C), except as provided in Section 5(c)(4)(C), of this general permit are required.
- (B) For activities pursuant to this general permit which are to address pollution at a residential or retail-commercial location not a supervised remediation site where a heating oil tank with a capacity less than 2,100 gallons is or had been present, permittees are, except as otherwise specified in writing by the commissioner or in a work plan or monitoring plan, not required to submit reports pursuant to the requirements of Section 5(c)(3)(A) of this general permit, however the information referenced in Section 5(c)(3)(A) of this general permit shall be incorporated in the report submitted pursuant to Section 5(c)(3)(B) of this general permit. Notifications of certain conditions must be made in accordance with Section 5(d) of this general permit, and reports pursuant to Sections 5(c)(2) and 5(c)(3)(C), except as provided in Section 5(c)(4)(C), of this general permit are required.
- (C) For planned multi-phased activities pursuant to Sections 3(a)(1) through 3(a)(3) of this general permit at supervised remediation sites or at residential or retail-commercial sites with a release associated with a heating oil tank with a capacity of less than 2100 gallons is or had been present:
 - (i) reports pursuant to section 5(c)(3)(C) of this general permit are not required for additional phases of activity that are eligible to be authorized without written approval pursuant to Section 3(e)(4)(B) of

this general permit, unless the permittee seeks, for a subsequent phase, a change in the details of the work plan pursuant to Section 5(a)(9) of this general permit, *however*,

- (ii) the permittee shall, instead of the reports required in section 5(c)(3)(C) of this general permit, submit, not later than sixty (60) days after the anniversary of the effective date of discharge authorization, an annual report of the status of the discharge activity, including the number of phases of discharge, the number of days of active discharge for each phase, amount of substances discharged in each phase, aggregate amount of substances discharged, a summary of the discharge activity identifying any departures from the work plan, a summary of monitoring results, and a reevaluation of the conceptual site model and remedial design and progress, and may include recommendations for any modifications to the work plan or monitoring plan, including identified discharge locations and amounts for future phases.
- (5) Except as otherwise specified in writing by the commissioner, each analytical result of a groundwater sample taken and all data generated by any other monitoring, including field parameter monitoring, conducted under this general permit shall be retained at the subject site for at least five (5) years from the date such result or data was generated or received by the permittee, whichever is later. The commissioner may specify a longer retention period as reasonably deemed necessary upon written notice to the permittee stating the reasons for such longer period. If, during the required retention period, the commissioner, under chapter 446k of the Connecticut General Statutes, issues an order or commences a civil action against the permittee, such retention period shall be extended as necessary.
 - (6) The requirements of Section 5(c)(5) of this general permit for retention of records at the subject site are waived after all such information is included in a remedial action report submitted to the commissioner in accordance with the provisions of sections 22a-133x, 22a-133y, 22a-134a, or 32-9mm of the Connecticut General Statutes, sections 22a-449(c)-105(h) or 22a-449(d)-106 of the Regulations of Connecticut State Agencies, or an order of the commissioner issued pursuant to section 22a-432 of the Connecticut General Statutes, or after all such information is included in a final report submitted to the commissioner pursuant to Section 5(c)(3)(B) of this general permit. Other statutory or regulatory provisions requiring retention of records on site are unaltered.
 - (7) The requirements of Section 5(c)(5) of this general permit for retention of records at the subject site are waived for residential or retail-commercial properties, provided that the records are retained in the required manner at the place of business of the P.E. or LEP responsible for supervising the authorized activity under this general permit. Other statutory or regulatory provisions requiring retention of records on site are unaltered.
 - (8) In addition to the reporting requirements specified in Sections 5(c)(1) through 5(c)(4) of this general permit, the permittee shall submit reports as required by any approval of registration issued pursuant to this general permit.

(d) ***Notification and Mitigation of Certain Conditions***

- (1) When required, pursuant to this general permit or any approval, immediate or twenty-four (24) hour notification to the department shall be to the Remediation Division of the Bureau of Water Protection and Land Reuse at:

Phone Number: 860-424-3705 or

Telefax Number: 860-424-4057.

- (2) Notifications or reports required pursuant to this general permit Section or any approval, including any required follow-up written notifications, shall be submitted to:

COORDINATOR – IN SITU GROUNDWATER REMEDIATION
REMEDICATION DIVISION – BUREAU OF WATER PROTECTION AND LAND REUSE
CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
79 ELM STREET
HARTFORD, CT 06106-5027.

- (3) The department shall be notified within twenty-four (24) hours if field monitoring required pursuant to this general permit is not conducted at the specified time. If such notification is by telephone, a follow-up written notification shall be submitted within forty-eight (48) hours.
- (4) Written notifications and reports required by this general permit shall, unless otherwise specified by the commissioner, be in letter form and include, but not be limited to: the permittee name, department assigned permit identification numbers, site name, site location, street address, town, and date of certificate of coverage or approval of registration, if such certificate or approval was issued; monitoring location triggering notification or report, date(s) of sampling and analysis, monitored constituent(s) triggering notification or report, and reported concentration(s); a summary of any response action taken or planned; and the name and telephone number of a person the department may contact for further information.

(5) **Supply Well Polluted Above Standards**

- (A) If post-baseline monitoring of any water supply well detects any constituents, not already identified as present at similar levels by baseline monitoring, above the standards in Appendix C to sections 22a-133k-1 to 3 of the Regulations of Connecticut State Agencies, above a maximum contaminant level applicable to public water supply systems for any contaminant listed in section 19-13-B102 of the Public Health Code, or above contaminant levels listed on the state drinking water action level list established pursuant to section 22a-471 of the Connecticut General Statutes, the permittee shall, within twenty-four (24) hours of receipt of the analytical results by the permittee or the permittee's consultant or engineer, verbally notify the department. The permittee shall also, within twenty-four (24) hours, provide written notification to the department, the owner of record of the property upon which any such water supply well is located, at least one occupant of each dwelling unit or business obtaining drinking water from such water supply well (except for community water supply systems), the local director of public health, and, if the affected well is a public water supply well, the Department of Public Health and the water system operator.

- (B) The permittee shall also, within forty-eight (48) hours, provide bottled water or another alternative supply of potable water, except for community water supply systems, and shall resample the affected supply well, and any other wells as may be required by the commissioner. The permittee shall, within five (5) days, provide to the department for review and approval a follow-up written report of the initial mitigation actions with recommendations for further actions. Any such additional proposed mitigation measures shall be implemented not later than seven (7) days after approval by the commissioner.
- (C) The requirements of subsection 5(d)(5)(A) of the general permit apply to the results of baseline monitoring of water supply wells when such baseline monitoring determines that a well is polluted above the comparison criteria and such pollution has not previously been reported to the department.

(6) Supply Well Affected

If post-baseline monitoring of a water supply well detects any monitored chemical constituents above twice the analytical reporting limit or, if higher, twenty-five percent (25%) greater than any established baseline condition for the water supply well, such detection or increase shall, unless otherwise specified by the commissioner in writing, be reported in writing to the department within seven (7) days of receipt of the analytical results by the permittee or the permittee's consultant or engineer.

The permittee shall, within fourteen (14) days after determining the presence of such detection or increase, resample any supply well so affected to confirm the detection or increase, and shall report such resampling results to the department within five (5) days of receipt of the analytical results by the permittee or the permittee's consultant or engineer. If such resampling confirms the supply well is affected, the report shall also include recommendations for further actions for the review and approval of the commissioner. Any such recommended actions shall be implemented not later than seven (7) days after approval by the commissioner.

The requirements of this section apply to results of baseline monitoring of water supply wells when such baseline monitoring determines that a well is polluted by organic chemical constituents above three times the analytical reporting limit or by naturally occurring chemical constituents above the greater of three times the expectable background concentration, three times the analytical reporting limit, or fifty percent (50%) of established water criteria identified in section 5(d)(5) of this general permit and such pollution has not previously been reported to the department.

(7) Field Parameter Results Show Change Outside the Zone of Influence

If post-baseline monitoring of discharge monitoring wells outside the zone of influence determines there is: a substantial change in oxidation reduction potential (Eh greater than 100 mv change from baseline conditions), a change in pH of more than two (2) standard units (in comparison to baseline conditions), or a change in water level of two feet that is not associated with a site-wide water level trend exhibited in other monitoring wells, such change shall be reported in writing to the department within forty-eight (48) hours of field sampling.

(8) Chemical Monitoring Results Show Change Outside the Zone of Influence

If post-baseline monitoring of discharge monitoring wells outside the zone of influence determines there is an increase in the concentration of: any discharged

substance being monitored, any identified project-specific constituent of concern, or a change in any inorganic or organic chemical greater than twenty-five percent (25%) over baseline conditions; or, for a site in an area where water supply wells are present within 500 feet downgradient or the groundwater classification is GA or GAA, any detection of such parameters above standards in appendix C to sections 22a-133k-1 to 3 of the Regulations of Connecticut State Agencies, such increase or detection shall, unless otherwise specified by the commissioner in writing, be reported in writing to the department within seven (7) days of receipt of the analytical results by the permittee or the permittee's consultant or engineer.

(9) **Other Notifications**

If monitoring of authorized activities determines the limits specified in Section 5(a)(10) of this general permit have been exceeded, or if monitoring determines that surface water, indoor air quality, or other monitored receptors are impacted by the authorized discharge, or if activity monitoring within the area of authorized activity and zone of influence determines the limits specified in Section 5(a)(10) of this general permit or the zone of influence identified in the registration may become exceeded or a potable water supply well or other receptor may become affected with continued discharge, the discharge, if active, shall immediately be discontinued and the commissioner shall immediately be notified of this determination and action.

The commissioner shall be notified immediately if there is an uncontrolled release of the substance being discharged, or if conditions indicate the need to implement contingency measures in the work plan intended to protect human health or the environment.

(10) **Response Actions for Notifications**

If the permittee notifies the commissioner of a condition pursuant to sections 5(d)(7) through 5(d)(9) of this general permit, the permittee shall immediately implement appropriate contingent measures as described in the work plan and take any other actions necessary to limit migration of pollutants or specified by the commissioner in response to such notification. The permittee shall, within five (5) days of the initial notification, provide follow-up written notification to the department, including a summary of the monitoring data and the initial actions taken, in accordance with Section 6(e) of this general permit. The permittee or the permittee's consultant or engineer shall, within fourteen (14) days of such determination, submit to the commissioner for review and approval a written evaluation of the condition with recommended changes to the work plan and additional measures to assess, monitor, and mitigate impact beyond the authorized zone of influence. Any such additional mitigation measures shall be implemented not later than seven (7) days after approval by the commissioner.

(11) Notifications and reports required by Sections 5(d)(5), 5(d)(6), and 5(d)(8) of this general permit may, as applicable, be identified as notifications required under section 22a-6u of the Connecticut General Statutes. They shall not meet the requirements of section 22a-6u of the Connecticut General Statutes unless they are specifically so identified and meet all requirements of section 22a-6u of the Connecticut General Statutes regarding notifying party and notification content.

(12) Reports of discharges, spills, or other releases shall independently be made as required pursuant to section 22a-450 of the Connecticut General Statutes and all associated regulations.

(e) ***No Remediation Assurance***

No provision of this general permit and no action or inaction by the commissioner shall be construed to constitute an assurance by the commissioner that any actions taken pursuant to this general permit will achieve remediation goals, result in compliance, or prevent or abate pollution; that monitoring approved for compliance with the requirements of this general permit will be sufficient to demonstrate that a release at a site has been remediated; or that monitoring results from wells located within the zone of influence will be accepted as representative samples for other uses of the monitoring data.

(f) ***No Product Endorsement***

No mention in Appendix I of this general permit, and no action or inaction by the commissioner, shall be construed to constitute an endorsement of specific brand-named, trademarked or proprietary chemicals or processes or a certification of their performance or full effectiveness and appropriateness for achieving the specific remediation goals of a proposed project.

Section 6. General Conditions

(a) ***Prevention of Pollution***

- (1) All substance handling and other implementation activities associated with the authorized discharge shall be conducted following best management practices.
- (2) Best management practices shall be implemented to ensure that no litter, debris, building materials or similar materials are discharged to the waters of the state or to the ground.
- (3) If activities authorized by this general permit create a potential for pollution due to the tracking or erosion of soil, erosion and sediment control measures shall be installed and maintained in compliance with the standards set forth in the “2002 Connecticut Guidelines for Soil Erosion and Sediment Control”, as revised, established pursuant to section 22a-328 of the Connecticut General Statutes.
- (4) All monitoring and discharge wells used or installed for the purpose of conducting activities under this general permit shall be properly abandoned in accordance with prevailing standards and guidelines and applicable State requirements when their use, including use for activities other than those conducted pursuant to this general permit, is no longer necessary.

(b) ***Waste Management***

Solid waste, including but not limited to contaminated soils or sludges, that may be generated as a result of the activities authorized by this general permit must be disposed of in accordance with applicable federal, state, and local law. Some or all of these wastes may be hazardous waste identified in accordance with Section 3001 of the Federal Resource Conservation and Recovery Act of 1976 (42 USC 6901 et seq.) or other wastes of special concern requiring department approval prior to disposal. It is the responsibility of the permittee to ensure that all wastes generated are properly identified and that all necessary department approvals are secured prior to disposal of such wastes.

(c) ***Regulations of Connecticut State Agencies Incorporated into this General Permit***

The permittee shall comply with all applicable law, including without limitation the following Regulations of Connecticut State Agencies:

(1) **Section 22a-430-3**

Subsection (b) General

- subparagraph (1)(D) and subdivisions (2), (3), (4) and (5)

Subsection (c) Inspection and entry

Subsection (d) Effect of a permit

- subdivisions (1) and (4)

Subsection (e) Duty to comply

Subsection (f) Proper operation and maintenance

Subsection (g) Sludge disposal

Subsection (h) Duty to Mitigate

Subsection (i) Facility modifications; Notification

- subdivisions (1) and (4)

Subsection (j) Monitoring, records and reporting requirements

- subdivisions (1), (5), (6), (8), (9), and (11)

(except subparagraphs (9)(A)(10 and 11), (9)(B), (9)(C), and 11(B))

Subsection (n) Enforcement

Subsection (o) Resource Conservation

Subsection (p) Spill Prevention and Control

Subsection (q) Instrumentation, Alarms, Flow Recorders

(2) **Section 22a-430-4**

Subsection (p) Permit revocation, denial or modification

Appendices

(3) **Section 22a-430-8**

Subsection (c) (regarding Class V injection wells)

Subsection (e) (regarding underground sources of drinking water)

(d) ***Reliance on Registration***

In evaluating a registration, the commissioner relies on information provided by the registrant. If such information proves to be false or incomplete, an authorization pursuant to this general permit may be suspended or revoked in accordance with law, and the commissioner may take any other legal action provided by law.

(e) ***Duty to Correct and Report Violations***

Upon learning of a violation of a condition of this general permit, a permittee shall immediately take all reasonable action to determine the cause of such violation, correct such violation and mitigate its results, prevent further such violation, and report in writing such violation and such corrective action to the commissioner within five (5) days of the permittee's learning of such violation. Such report shall be certified in accordance with Section 6(g) of this general permit.

(f) ***Duty to Provide Information***

If the commissioner requests any information pertinent to the authorized activities or to determine compliance with this general permit or with any approval of registration pursuant to this general permit, the permittee shall provide such information in writing

within thirty (30) days of such request. Such information shall be certified in accordance with Section 6(g) of this general permit.

(g) *Certification of Documents*

Any document, including but not limited to any notice, which is submitted to the commissioner under this general permit shall be signed by, as applicable, the registrant or the permittee in accordance with section 22a-430-3(b)(2) of the Regulations of Connecticut State Agencies, and by the individual or individuals responsible for actually preparing such document, each of whom shall certify in writing as follows:

“I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that, based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I understand that a false statement made in the submitted information may be punishable as a criminal offense, in accordance with section 22a-6 of the Connecticut General Statutes, pursuant to section 53a-157b of the Connecticut General Statutes, and in accordance with any other applicable statute.”

(h) *Date of Filing*

For purposes of this general permit, the date of filing with the commissioner of any document is the date such document is received by the commissioner. If any date specified in this general permit falls on a Saturday, Sunday, or legal holiday, such deadline shall be the next business day thereafter. The date of any notice by the Commissioner under this general permit, including but not limited to notice of approval or disapproval of any document or other action, shall be the date such notice is personally delivered or the date three days after it is mailed by the Commissioner, whichever is earlier.

(i) *False Statements*

Any false statement in any information submitted pursuant to this general permit may be punishable as a criminal offense, under section 22a-438 of the Connecticut General Statutes or, in accordance with section 22a-6 of the Connecticut General Statutes, pursuant to section 53a-157b of the Connecticut General Statutes, and in accordance with any other applicable statute.

(j) *Correction of Inaccuracies*

Within fifteen (15) days after the date a permittee becomes aware of a change in any of the information submitted pursuant to this general permit, or becomes aware that any such information is inaccurate or misleading, or that any relevant information has been omitted, such permittee shall correct the inaccurate or misleading information or supply the omitted information in writing to the commissioner. Such information shall be certified in accordance with Section 6(g) of this general permit. The provisions of this subsection shall apply both while a request for authorization under this general permit is pending and after such authorization becomes effective pursuant to Section 3(e) of this general permit.

(k) *Transfer of Authorization*

An authorization under this general permit is transferable only in accordance with the provisions of section 22a-60 of the Connecticut General Statutes.

(l) ***Other Applicable Law***

Nothing in this general permit shall relieve the permittee of the obligation to comply with any other applicable federal, state, and local law, including but not limited to the obligation to obtain any other authorizations required by such law.

(m) ***Other Rights***

This general permit is subject to and does not derogate any present or future rights or powers of the State of Connecticut and conveys no rights in real or personal property nor any exclusive privileges, and is subject to all public and private rights and to any federal, state, and local laws pertinent to the property or activity affected by such general permit. In conducting any activity authorized hereunder, the permittee shall not cause pollution, impairment, or destruction of the air, water, or other natural resources of this state. The issuance of this general permit shall not create any presumption that this general permit should or will be renewed.

Section 7. Commissioner's Powers

(a) ***Abatement of Violations***

The commissioner may take any action provided by law to abate a violation of this general permit, including the commencement of proceedings to collect penalties for such violation. The commissioner may, by summary proceedings or otherwise and for any reason provided by law, including violation of this general permit, revoke a permittee's authorization hereunder in accordance with sections 22a-3a-2 through 22a-3a-6, inclusive, of the Regulations of Connecticut State Agencies. Nothing herein shall be construed to affect any remedy available to the commissioner by law.

(b) ***General Permit Revocation, Suspension, or Modification***

The commissioner may, for any reason provided by law, by summary proceedings or otherwise, revoke or suspend this general permit or modify it to establish any appropriate conditions, schedules of compliance, or other provisions which may be necessary to protect human health or the environment.

(c) ***Filing of an Individual Permit Application***

If the commissioner notifies a permittee in writing that such permittee must obtain an individual permit to continue lawfully conducting the activity authorized by this general permit, the permittee may continue conducting such activity only if the permittee files an application for an individual permit within sixty (60) days of receiving the commissioner's notice. While such application is pending before the commissioner, the permittee shall comply with the terms and conditions of this general permit and also those specified in any approval of registration. Nothing herein shall affect the commissioner's power to revoke a permittee's authorization under this general permit at any time.

Issued: _____

Macky McCleary, Deputy Commissioner

Hydrogen Peroxide

Substances: usually 8-20% H₂O₂ and 80-92% water. Standard 8% is formulated with an inorganic tin-based stabilizer for high stability and long term storage. Technical grade contains an organic based stabilizer.

Target Pollutants: less complex petroleum hydrocarbons (Eg. BTEX). Usually used for more shallow contamination

Function: Oxidant. It is particularly useful in chemical synthesis where the presence of inorganic residues is unacceptable. Its rapid decomposition can limit its effectiveness but its short persistence and high reactivity are good with the radius of influence is valued and when infrastructure above ground is present.

Associated Chemicals: It is often catalyzed with ferrous or ferric iron to produce hydroxyl radicals, which greatly increases its oxidative strength. An acidic iron solution can be injected before or after the injection of hydrogen peroxide if natural iron concentrations are too low. The reaction of iron catalyzed hydrogen peroxide oxidation is called a "Fenton's Reagent." In addition, pH adjustment using a strong acid such as sulfuric acid (H₂SO₄) or hydrochloric acid (HCl), is common since reactions of classic Fenton's Reagent is more rapid and efficient under low pH conditions (pH 2 to 4 is optimal).

Safety and Operational Considerations: Irritating to skin, eyes, nose, throat and lungs. It is exothermic and can increase temperatures of aquifers, as well as produce steam, reaction foam, and generate subsurface pressures in the treatment area capable of moving or cracking paved surfaces when used with hydrogen peroxide in the 10% to 12% concentration range. Heating of hydrogen peroxide may cause an explosion. Contact with combustible materials may cause fire. Causes severe burns. Harmful if inhaled or swallowed. Gas or vapor generation may increase migration potential for volatile organic chemicals, and process temperatures and pressures should be monitored. Local oxygen enrichment of air above the treatment zone may occur and should be monitored. Local fire marshal should be advised of project scope.

Delivery considerations: should be stored in vented containers. Hydrogen peroxide half-life in freshwater ranges from 8 hours to 20 days, in air from 10-20 hrs and in soils from minutes to hours depending upon microbiological activity and metal contaminants. At some concentrations is regulated under Homeland Security rules.

Byproducts: water and oxygen. This provides microbes with an oxygen source for further bioremediation of contaminants. If treating carbon-based compounds, carbon dioxide may be a byproduct as well as minor concentrations of nontoxic ions, salts and acids. If a iron catalysis is used, Fe(II) or Fe(III) may be a byproduct.

Residuals: Residual hydrogen peroxide not used in the oxidation process breaks down to water and oxygen in a matter of hours.

Monitoring requirements: Groundwater pH levels must be monitored. Monitoring is required for contaminant of concern, residuals associated with ingredients of ISCO and chemical byproducts. If petroleum hydrocarbons are contaminant of concern, then groundwater must be monitored for these contaminants. If the COC is a chlorinated solvent, then a significant amount of chlorine may be left as a byproduct and groundwater monitoring is necessary.

Sodium Persulfate

Substances: Sodium Persulfate

Target Pollutants: petroleum hydrocarbons and chlorinated compounds (eg. Chlorinated ethenes, chlorinated ethanes, chlorinated methanes, BTEX, MTBE, PAHs, 1,4-Dioxane, pesticides and petroleum hydrocarbons).

Function: a very strong oxidant that is more stable than hydrogen peroxide or ozone. It covers more area and stays in the ground longer. Its use may be preferred in areas beneath buildings because it does not generate gaseous byproducts. It may be used for deep or bedrock contamination because of density driven transport.

Associated Chemicals: Persulfate is often catalyzed by a chelated iron complex such as Fe-EDTA at a neutral pH to produce sulfate radicals that treat petroleum hydrocarbons and some chlorinated solvents. Heat, hydrogen peroxide and sodium hydroxide have also been used as activators for persulfate. The activator is chosen on an individual site basis.

Safety and Operational Considerations: Decomposes in storage under conditions of moisture (water/water vapor) and/or excessive heat causing release of oxides of sulfur and oxygen that supports combustion. Decomposition could form a high temperature melt. Irritating to eyes, nose, lungs, throat and skin upon contact. Store unopened in a cool, clean, dry place away from sources of heat.

Delivery Considerations: Use of persulfates in chemical reactions requires appropriate precautions and design considerations for pressure and thermal relief. Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated. Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

Byproducts: long lasting sulfate-reducing bacteria are left behind and continue to degrade contaminants.

Residuals: Sodium persulfate can remain in the subsurface for weeks.

Monitoring Requirements: must monitor for iron, manganese, pH, sodium, sulfates and dissolved solids in groundwater. Monitoring is required for contaminant of concern, residuals associated with ingredients of ISCO and chemical byproducts. If petroleum hydrocarbons are contaminant of concern, then groundwater must be monitored for these contaminants. If the COC is a chlorinated solvent, then a significant amount of chlorine may be left as a byproduct and groundwater monitoring is necessary.

Potassium Permanganate

Substances: Potassium permanganate

Target Pollutants: chlorinated solvents including TCE. Permanganate has a unique affinity for oxidizing organic compounds containing carbon-carbon double bonds, aldehyde groups or hydroxyl groups (such as alcohols and organic acids like phenol). Under most naturally occurring subsurface temperature and pH conditions, the carbon-carbon double bond of alkenes is broken and the unstable intermediates are converted to carbon dioxide through hydrolysis or further oxidation by the permanganate ion.

Function: oxidant. It lasts longer and can react in an environment with much higher pH compared to hydrogen peroxide. Permanganate oxidation involves a direct electron transfer unlike other oxidants. It can add oxygen, remove hydrogen or remove electrons from an element or compound. It oxidizes manganese and iron to manganese dioxide or iron oxide which can be easily removed from water with filters. Also can be used to oxidize hydrogen sulfide or arsenic.

Associated Chemicals: some chemical grades may contain heavy metal impurities such as chromium or cadmium at levels that may cause groundwater to exceed criteria.

Safety and Operational Considerations: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.

Delivery Considerations: Keep closed container in a cool, well-ventilated area. Separate from acids, alkalis, reducing agents and combustibles. It is shipped as powder and mixed with water. The pH range is critical in the speed of the oxidation reaction.

Byproducts: carbon dioxide, manganese dioxide, manganate which may be reduced to dissolved divalent manganese (Mn^{2+}) under low pH or redox conditions, chlorine gas or chloride salts. Chlorine gas reacts quickly with ground water to form hypochlorous acid ($HOCl$). This hypochlorous acid may react with methane to form trace concentrations of chloromethanes in the ground water immediately after treatment. However, this phenomenon is typically short lived as the subsurface conditions are converted to an oxidized state.

Residuals: Permanganate rapidly converts a wide range of chlorinated alkenes to carbon dioxide, water, and chloride ions. The permanganate is reduced to insoluble manganese dioxide during the reaction.

Monitoring Requirements: Monitoring is required for the contaminant of concern, residuals associated with ingredients of ISCO and all chemical byproducts. Evaluation of heavy metal concentration is necessary, and if the delivered concentration exceeds Groundwater Protection Criteria monitoring is necessary. If the contaminant of concern is a chlorinated solvent, then a significant amount of chlorine may be left as a byproduct and groundwater monitoring is necessary.

Sodium Permanganate

Substances: Sodium permanganate

Target Pollutants: chlorinated solvents, polyaromatic hydrocarbons, phenolics, organo-pesticides, and substituted aromatics. Permanganate has a unique affinity for oxidizing organic compounds containing carbon-carbon double bonds, aldehyde groups or hydroxyl groups (such as alcohols and organic acids like phenol). Under most naturally occurring subsurface temperature and pH conditions, the carbon-carbon double bond of alkenes is broken and the unstable intermediates are converted to carbon dioxide through hydrolysis or further oxidation by the permanganate ion.

Function: oxidant. Sodium permanganate can be used instead of potassium permanganate whenever the potassium ion cannot be tolerated. Permanganate oxidation involves a direct electron transfer unlike other oxidants. It can add oxygen, remove hydrogen or remove electrons from an element or compound. It oxidizes manganese and iron to manganese dioxide or iron oxide which can be easily removed from water with filters. Also can be used to oxidize hydrogen sulfide or arsenic.

Associated Chemicals: some chemical grades may contain heavy metal impurities such as chromium or cadmium at levels that may cause groundwater to exceed criteria.

Safety and Operational Considerations: Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material. It is explosive in contact with sulfuric acid or peroxides, or readily oxidizable substances.

Delivery Considerations: Keep closed container in a cool, well-ventilated area. Highly reactive with reducing agents, organic materials, metals, acids. Reactive with moisture.

Byproducts: carbon dioxide, manganese dioxide, manganate which may be reduced to dissolved divalent manganese (Mn^{2+}) under low pH or redox conditions, chlorine gas or chloride salts. Chlorine gas reacts quickly with ground water to form hypochlorous acid ($HOCl$). This hypochlorous acid may react with methane to form trace concentrations of chloromethanes in the ground water immediately after treatment. However, this phenomenon is typically short lived as the subsurface conditions are converted to an oxidized state.

Residuals: Permanganate rapidly converts a wide range of chlorinated alkenes to carbon dioxide, water, and chloride ions. The permanganate is reduced to insoluble manganese dioxide during the reaction.

Monitoring Requirements: Monitoring is required for the contaminant of concern, residuals associated with ingredients of ISCO and all chemical byproducts. Evaluation of heavy metal concentration is necessary, and if the delivered concentration exceeds Groundwater Protection Criteria monitoring is necessary. If the contaminant of concern is a chlorinated solvent, then a significant amount of chlorine may be left as a byproduct and groundwater monitoring is necessary. If petroleum hydrocarbons are contaminant of concern, then groundwater must be monitored for these contaminants.

Ozone

Substances: Gaseous ozone/trioxygen

Target Pollutants: volatile organic compounds (MTBE, BTEX, hydrocarbons, diesel fuel, TCE, pesticides, chlorinated solvents, aliphatic and polyaromatic hydrocarbons)

Function: Oxidant. It is the most powerful oxidizer available, capable of converting organic molecules to water and carbon dioxide.

Associated Chemicals: Advanced oxidation processes refer to when ozone is catalyzed by ultraviolet light, hydrogen peroxide or other oxidizers to increase its power by producing hydroxyl radicals.

Safety and Operational Considerations: Ozone is highly unstable and highly reactive. It is 12 times more soluble than oxygen in water and moves easily through soil. May irritate skin, eyes, or lungs if inhaled. Ozone may accelerate, even initiate, combustion, or cause explosions. Avoid contact with oxidizable substances. Ozone will readily react and spontaneously decompose under normal ambient temperatures. Gaseous delivery or gas or vapor generation may increase migration potential for volatile organic chemicals, and process temperatures and pressures should be monitored. Local oxygen enrichment of air above the treatment zone may occur and should be monitored.

Delivery Considerations: Generated on-site so all the ozone gas that is generated must be injected or destroying using an ozone destruction unit on the ozone generator. The ozone gas can be bubbled into closely spaced injection ports that release the bubbles into aquifers for remediation. The smaller the bubbles, the more surface area and the faster they can travel through small pore spaces. Pumping the ozone gas through specially designed ozone diffusers can produce micro-bubbles. The half-life of ozone is much shorter in water than in air. Increased temperature in either solvent decreases the half-life which can range anywhere from 20 minutes in water to 25 hours in dry air, maybe even less due to air circulation and humidity.

Byproducts: water, carbon dioxide, oxygen which may provide further bioremediation.

Residuals: No residual ozone. There may be residuals from contaminant of concern or other associated chemicals.

Monitoring Requirements: Monitoring is required for the contaminant of concern, residuals associated with ingredients of ISCO and all chemical byproducts. If the contaminant of concern is a chlorinated solvent, then a significant amount of chlorine may be left as a byproduct and groundwater monitoring is necessary. If petroleum hydrocarbons are contaminant of concern, then groundwater must be monitored for these contaminants.