Silica and Silicates for Activation:

1. Daniel Nunez, Regenesis
2. Silicon dioxide, sodium silicate (silica, silica gel, silicate/RegenOx™ Part B - Activator Complex, Petrocleanze™, PersulfOx™):
3. MSDS & Technical Data Sheet - Attached
4. Number of Field-scale Applications to Date: 1,500+ sites in US and Canada and 148 in California.
5. Case Studies – Attached
6. Silica and silicates are the active ingredients as catalysts in the RegenOx and PersulfOx products. The RegenOx product, which employs silica and silicates (RegenOx Part B), has been approved since 2010 under the general LA WDR permit. It has been in the market for approximately 8 years, and is shown by extensive case studies to be effective for contaminant oxidation. Compared with other ISCO chemistries (e.g. Fenton's reagent and alkaline-activated persulfate) the silica/silicate activator system is relatively safer and easier to apply in the field.

RegenOx® – Part B (Activator Complex)

Material Safety Data Sheet (MSDS)

Last Revised: June 4, 2010

Section 1 – Supplier Information and Material Identification

Supplier:

REGENESIS

1011 Calle Sombra
San Clemente, CA 92673
Telephone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Description:	A mixture of sodium silicate solution, silica gel and ferrous sulfate
Chemical Family:	Inorganic Chemicals
Trade Name:	RegenOx® – Part B (Activator Complex)
Product Use:	Used for environmental remediation of contaminated soils and groundwater

Section 2 – Chemical Information/Other Designations

CAS No.	Chemical
1344-09-8	Silicic Acid, Sodium Salt, Sodium Silicate
63231-67-4	Silica Gel
7720-78-7	Ferrous Sulfate
7732-18-5	Water

Section 3 – Physical Data

Form:	Liquid
Color:	Blue/Green
Odor:	Odorless
Melting Point:	NA
Boiling Point:	NA
Flammability/Flash Point:	NA
Vapor Pressure:	NA

Section 3 – Physical Data (cont)

Specific Gravity	1.39 g/cm^3
Solubility:	Miscible
Viscosity:	NA
pH (3% solution):	11
Hazardous Decomposition Products:	Oxides of carbon and silicon may be formed when heated to decomposition.

Section 4 – Reactivity Data

Stability:	Stable under normal conditions.
Conditions to Avoid:	None.
Incompatibility:	Avoid hydrogen fluoride, fluorine, oxygen difluoride, chlorine trifluoride, strong acids, strong bases, oxidizers, aluminum, fiberglass, copper, brass, zinc, and galvanized containers.

Section 5 – Regulations

TSCA Inventory Listed:	Yes

CERCLA Hazardous Substance (40 CFR Part 302)

Listed Substance:	*No*
Unlisted Substance:	*Yes*

SARA, Title III, Sections 302/303 (40 CFR Part 355) – Emergency Planning and Notification

Extremely Hazardous Substance:	No

SARA, Title III, Sections 311/312 (40 CFR Part 370) – Hazardous Chemical Reporting: Community Right-To-Know

Hazard Category:	Acute

SARA, Title III, Sections 313 (40 CFR Part 372) – Toxic Chemical Release Reporting: Community Right-To-Know

Extremely Hazardous Substance:	No

Section 6 – Protective Measures, Storage and Handling

Technical Protective Measures

Storage:	Keep in a tightly closed container (steel or plastic) and store in a cool, well ventilated area away from all incompatible materials (acids, reactive metals, and ammonium salts). Store in a dry location away from heat above 60 degrees C and colder than 10 degrees C. Do not store in aluminum, fiberglass, copper, brass, zinc or galvanized containers.
Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing spray mist. Use with adequate ventilation. Do not use product if it is brownish-yellow in color.

Personal Protective Equipment (PPE)

Engineering Controls:	General room ventilation is required if used indoors. Local exhaust ventilation, process enclosures or other engineering controls may be needed to maintain airborne levels below recommended exposure limits. Safety shower and eyewash station should be within direct access.
Respiratory Protection:	Use NIOSH-approved dust and mist respirator where spray mist exists. Respirators should be used in accordance with 29 CFR 1910.134.
Hand Protection:	Wear chemical resistant gloves.
Eye Protection:	Wear chemical safety goggles. A full face shield may be worn in lieu of safety goggles.
Skin Protection:	Try to avoid skin contact with this product. Gloves and protective clothing should be worn during use.
Other:	
Protection Against Fire & Explosion:	Product is non-explosive and non-combustible.

Section 7 – Hazards Identification

Potential Health Effects	
Inhalation:	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath, and irritations to mucous membranes, nose and throat.
Eye Contact:	Causes irritation, redness and pain.
Skin Contact:	Causes irritation. Symptoms include redness, itching and pain.
Ingestion:	May cause irritation to mouth, esophagus, and stomach.

Section 8 – Measures in Case of Accidents and Fire

After Spillage/Leakage (small):	Mop up and neutralize liquid, then discharge to sewer in accordance with local, state and federal regulations.
After Spillage/Leakage (large):	Keep unnecessary personnel away; isolate hazard area and do not allow entrance into the affected area. Do not touch or walk through spilled material. Stop leak if possible without risking injury. Prevent runoff from entering into storm sewers and ditches that lead to natural waterways. Isolate the material if at all possible. Sand or earth may be used to contain the spill. If containment is not possible, neutralize the contaminated area and flush with large quantities of water.
Extinguishing Media:	Material is compatible with all extinguishing media.
Further Information:	
First Aid	
Eye Contact:	Flush eyes with running water for at least 15 minutes with eyelids held open. Seek a specialist.
Inhalation:	Remove affected person to fresh air. Give artificial respiration if individual is not breathing. If breathing is difficult, give oxygen. Seek medical attention if the effects persist.
Ingestion:	If the individual is conscious and not convulsing, give two-four cups of water to dilute the chemical and seek medical attention immediately. **<u>DO NOT</u>** induce vomiting.
Skin Contact:	Wash affected areas with soap and a mild detergent and large amounts of water. Remove contaminated clothing and shoes.

Section 9 – Accidental Release Measures

Precautions:

PPE:	Wear chemical goggles, body-covering protective clothing, chemical resistant gloves, and rubber boots (see Section 6).
Environmental Hazards:	Sinks and mixes with water. High pH of this material may be harmful to aquatic life. Only water will evaporate from a spill of this material.
Cleanup Methods:	Pick-up and place in an appropriate container for reclamation or disposal. US regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities.

Section 10 – Information on Toxicology

Toxicity Data

Sodium Silicate:	When tested for primary eye irritation potential according to OECD Guidelines, Section 405, a similar sodium silicate solution produced corneal, iridal and conjunctival irritation. Some eye irritation was still present 14 days after treatment, although the average primary irritation score has declined from 29.7 after 1 day to 4.0 after 14 days. When tested for primary skin irritation potential, a similar sodium silicate solution produced irritation with a primary irritation index of 3 to abraded skin and 0 to intact skin. Human experience confirms that irritation occurs when sodium silicates get on clothes at the collar, cuffs, or other areas where abrasion may exist. The acute oral toxicity of this product has not been tested.
Ferrous Sulfate:	LD50 Oral (rat): 319 mg/kg not a suspected carcinogen.

Section 11 – Information on Ecology

Ecology Data

Ecotoxicological Information:	Based on 100% solid sodium silicate, a 96 hour median tolerance for fish of 2,320 mg/l; a 96 hour median tolerance for water fleas of 247 mg/L; a 96 hour median tolerance for snail eggs of 632 mg/L; and a 96 hour median tolerance for Amphipoda of 160 mg/L.

Section 12 – Disposal Considerations

Waste Disposal Method

Waste Treatment:	Neutralize and landfill solids in an approved waste facility operated by an authorized contactor in compliance with local regulations.
Package (Pail) Treatment:	The empty and clean containers are to be recycled or disposed of in conformity with local regulations.

Section 13 – Shipping/Transport Information

D.O.T.	This product is not regulated as a hazardous material so there are no restrictions.

Section 14 – Other Information

HMIS® Rating	Health – 2 (moderate)	Reactivity – 0 (none)
	Flammability – 0 (none)	Lab PPE – goggles, gloves, and lab coat
	Contact – 1 (slight)	

HMIS® is a registered trademark of the National Painting and Coating Association.

Section 15 – Further Information

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

RegenOx® – PetroCleanze™

Material Safety Data Sheet (MSDS)

Last Revised: April 29, 2011

Section 1 – Supplier Information and Material Identification

Supplier:

REGENESIS
1011 Calle Sombra
San Clemente, CA 92673
Telephone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Description:	A mixture of sodium silicate solution, sodium hydroxide, sodium tripoly-phosphate and ferrous sulfate.
Chemical Family:	Inorganic Chemicals
Trade Name:	RegenOx® PetroCleanze™ (Activator Complex)
Product Use:	Used for environmental remediation of contaminated soils and groundwater.

Section 2 – Chemical Information/Other Designations

CAS No.	**Chemical**
1344-09-8	Silicic Acid, Sodium Salt, Sodium Silicate
7720-78-7	Ferrous Sulfate
1310-73-2	Sodium Hydroxide
7758-29-4	Sodium Tripolyphosphate

Section 3 – Physical Data

Form:	Semi Viscous Liquid
Color:	Dark Green to Black
Odor:	Odorless
Melting Point:	NA
Boiling Point:	NA
Flammability/Flash Point:	NA
Vapor Pressure:	NA

Section 3 – Physical Data (cont)

Density	1.1 – 1.3 g/cm^3
Solubility:	Miscible
pH (3% solution):	13

Section 4 – Hazards Identification

Corrosive:	May cause burns. Harmful by inhalation, in contact with skin and if swallowed. Casues skin and eye irritation. Causes irritation to mouth, esophagus and stomach if swallowed. In case of accident or if you feel unwell, seek medial advice. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of water. If swallowed, do not induce vomiting, give plenty of water. Never give anything by mouth to an unconscious person. Wear suitable protective clothing, gloves, eye/face protection. Spilled material is very slippery.

Section 5 – Reactivity Data

Stability:	Stable under normal conditions
Conditions to Avoid:	None.
Incompatibility:	Avoid hydrogen fluoride, fluorine, oxygen difluoride, chlorine trifluoride, strong acids, strong bases, oxidizers, aluminum, fiberglass, copper, brass, zinc, and galvanized containers.

Section 6 – Protective Measures, Storage and Handling

Technical Protective Measures

Storage:	Keep in a tightly closed container (steel or plastic) and store in a cool, well ventilated area away from all incompatible materials (acids, reactive metals, and ammonium salts). Store in a dry location away from heat above 60 degrees C and colder than 10 degrees C. Do not store in aluminum, fiberglass, copper, brass, zinc or galvanized containers.
Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing spray mist. Use with adequate ventilation. Do not use product if it is brownish-yellow in color.

Personal Protective Equipment (PPE)

Engineering Controls:	General room ventilation is required if used indoors. Local exhaust ventilation, process enclosures or other engineering controls may be needed to maintain airborne levels below recommended exposure limits. Safety shower and eyewash station should be within direct access.
Respiratory Protection:	Use NIOSH-approved dust and mist respirator where spray mist exists. Respirators should be used in accordance with 29 CFR 1910.134.
Hand Protection:	Wear chemical resistant gloves.
Eye Protection:	Wear chemical safety goggles. A full face shield may be worn in lieu of safety goggles.
Skin Protection:	Try to avoid skin contact with this product. Gloves and protective clothing should be worn during use.
Other:	
Protection Against Fire & Explosion:	Product is non-explosive and non-combustible.

Section 7 – Measures in Case of Accidents and Fire

Spill or Leakage:	Keep unnecessary personnel away; isolate hazard area and do not allow entrance into the affected area. Do not touch or walk through spilled material. Stop leak if possible without risking injury. Prevent runoof from entering into storm sewers and ditches that lead to natural waterways. Isolate the material if at all possible. Sand or earth may be used to contain the spill. If containment is not possible, nuetralize the contaminated area and flush with large quantites of water.
Extinguishing Media:	Material is compatible with all extinguishing media. The following protective equipment for fire fighters is recommended when this material is present in the area of a fire: chemical googles, body-covering protective clothing, chemical resistant gloves and rubber boots.

First Aid:

Eye Contact:	Flush eyes with running water for at least 15 minutes with eyelids held open. Seek a medical specialist.
Inhalation:	Remove affected person to fresh air. Give artifical respiration if individual is not Breathing. If breathing is difficult, give oxygen. Seek medical attention.
Ingestion:	If the individual is conscious and not convulsing, give two-four cups of water to dilute the chemical and seek medical attention immediately. DO NOT induce vomiting. Seek medical attention.
Skin Contact:	Wash affected areas with soap and a large amount of water. Remove contaminated clothing and shoes.

Section 8 – Accidental Release Measures

Personal Protection:	Wear chemical goggles, body-covering protective clothing, chemical resistant gloves and rubber boats.
Environmental Hazards:	Material sinks when mixed with water. High pH of this material is harmful to aquatic life. Only water will evaporate from a spill of this material.
Small Spill Cleanup:	Mop and neutralize liquid and discharge to sewer in accordance with federal, state and local regulations.
Large Spill Cleanup:	Keep unnecessary personnel away; isolate hazard area and do not allow entrance into the affected area. Do not touch or walk through spilled material. Stop leak if possible without risking injury. Prevent run off from entering into storm drains and ditches that lead to natural waterways. Isolate the material if at all possible. Sand or earth may be used to contain the spill. If containment is not possible, nuetralize the contaminated area and

flush with large quantites of water.

Section 9 – Information on Toxicology

Toxicity Data

Sodium Silicate:	When tested for primary eye irritation potential according to OECD Guidelines, Section 405, a similar sodium silicate solution produced corneal, iridal and conjunctival irritation. Some eye irritation was still present 14 days after treatment, although the average primary irritation score has declined from 29.7 after 1 day to 4.0 after 14 days. When tested for primary skin irritation potential, a similar sodium silicate solution produced irritation with a primary irritation index of 3 to abraded skin and 0 to intact skin. Human experience confirms that irritation occurs when sodium silicates get on clothes at the collar, cuffs, or other areas where abrasion may exist. The acute oral toxicity of this product has not been tested. In a study of rats fed sodium silicate in drinking water for three months, at 200, 600 and 1800 ppm, changes were reported in the blood chemistry of some animals, but no speifec changes to the organs of the animals due to sodium silicate administraton were observed in any of the dosage groups. Another study reported adverse effects to the kidneys of dogs fed sodium silicate in their diet at 2.4g/kg/day for 4 weeks, whereas rats fed the same dosage did not develop any treatment-related effects. Decreased numbers of births and survival to weaning was reported for rats fed sodium silicate in their drinking water at 600 and 1200 ppm.
Ferrous Sulfate:	LD50 Oral (rat): 319 mg/kg; not a suspected carcinogen.
Sodium Hydroxide:	Irritation data: skin, rabbit: 500 mg/24H severe; eye rabbit: 50 ug/24H severe. Investigated as a mutagen. Not a known carcinogen. No environmental toxicity found or determined.
Sodium Tripolyphosphate:	Harmful if swallowed, inhaled or absorbed through skin. Causes severe irritation. Material is irritating to mucous membranes and upper respiratory tract. Symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea and vomiting. To the best of our knowledge the chemical, physical and toxicological properties have not

been thoroughly investigated.

Section 10 – Information on Ecology

Ecotoxicological Information:	Based on 100% solid sodium silicate, a 96 hour median tolerance for fish of 2,320 mg/l; a 96 hour median tolerance for water fleas of 247 mg/L; a 96 hour median tolerance for snail eggs of 632 mg/L; and a 96 hour median tolerance for Amphipoda of 160 mg/L.

Section 11 – Regulations

TSCA Inventory Listed:	Yes
CERCLA Hazardous Substance (40 CFR Part 302)	
Listed Substance:	No
Unlisted substance:	Yes
SARA Title III, Sections 302/303 (40 CFR Part 355) Emergency Planning Notification	
Extremely Hazardous Substance:	No
SARA Title III, Sections 311/312 (40 CFR Part 370) Community Right-to-Know	
Acute: Yes	**Chronic: Yes**
SARA Title III, Sections 313 (40 CFR Part 372) Toxic Chemical Release Reporting	
Community Right-to-Know	
Extremely Hazardous Substance:	**No**

Section 12 – Disposal Considerations

Waste Disposal Method

Waste Treatment:	Neutralize and landfill solids in an approved waste facility operated by An authorized contactor in compliance with local regulations.
Package Treatment:	The empty and clean containers are to be recycled or disposed of in conformity with local regulations.

Section 13 – Shipping/Transport Information

USDOT:	Hazard Class 8 Corrosive Substance
Proper Shipping Name:	Corrosive liquid, basic, inorganic, n.o.s.
UN/NA:	UN3266
Packing Group:	PGIII

Section 14 – Other Information

HMIS Rating:	Health 3, Flammability 0, Reactivity 1, Contact 1.
Label Hazard Warning:	Danger! Corrosive. May be harmful if swallowed. Harmful in inhaled. Causes burns to any area of contact. Reacts with water, acids and other materials.

Section 15 – Further Information

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

PersulfOx

Material Safety Data Sheet (MSDS)

Last Revised: February 8, 2013

Section 1 – Supplier Information and Material Identification

Supplier:

REGENESIS
1011 Calle Sombra
San Clemente, CA 92673
Telephone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Synonyms:	A mixture of Sodium Persulfate [$Na_2S_2O_8$] and Sodium Silicate [Na_2SiO_3].
Chemical Family:	Inorganic Chemicals
Trade Name:	PersulfOx™
Product Use:	Used to remediate contaminated soil and groundwater (environmental remediation applications)

Section 2 – Chemical Information/Other Designations

CAS No.	Chemical	Percentage
7775-27-1	Sodium Persulfate	90%
1344-09-8	Sodium Silicate	10%

Section 3 – Physical Data

Form:	Solid, free-flowing powder
Color:	White
Odor:	Odorless
Melting Point:	NA
Boiling Point:	NA
Flammability/Flash Point:	Non-combustible
Vapor Pressure:	NA
Bulk Density:	NA
Viscosity:	NA
pH (10% solution):	≈ 7.0 – 11.5 @ 25 °C
Decomposition Temperature:	Decomposition will occur upon heating.

Section 4 – Reactivity Data

Stability:	Stable under normal conditions. Stability decreases in the presence of heat, moisture and/or contamination.
Conditions to Avoid/Incompatibility:	Acids, alkalis, halides (fluorides, chlorides, bromides and iodides), Combustible materials, most metals and heavy metals, oxidizable materials, other oxidizers, reducing agents, cleaners, and organic or carbon containing compounds, moisture, heat, flame. Contact with incompatible materials can result in a material decomposition or other uncontrolled reactions.
Hazardous Decomposition Products:	Oxygen that supports combustion and oxides of sulfur.
Polymerization	Will not occur

Section 5 – Regulations

UNITED STATES

SARA TITLE III (SUPERFUND ADMENDMENTS AND REAUTHORIZATION ACT)

Section 302 Extremely Hazardous Substances (40 CFR 335, Appendix A):	N/A
Section 311 Hazard Categories (40 CFR 370):	Fire Hazard, Immediate (Acute) Health Hazard
Section 312 Threshold Planning Quantity (40 CFR 370):	The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None
Section 313 Reportable Ingredients (40 CFR 372):	Not Listed

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA Designation & Reportable Quantities (RQ) (40 CFR 302.4):	Unlisted, RQ = 100 lbs., Ignitability

Section 6 – Protective Measures, Storage and Handling

Technical Protective Measures

Storage:

Oxidizer. Store in a cool, clean, and well ventilated area away from all sources of ignition and out of the direct sunlight. Store in a dry location away from heat and in temperatures less than 40 ˚C.

Keep away from incompatible materials and keep lids tightly closed. Do not store in improperly labeled containers.

Protect from moisture. Do not store near combustible materials. Keep containers well sealed.

Store separately from reducing materials. Avoid contamination which may lead to decomposition.

Handling:

Avoid contact with eyes, skin and clothing. Use with adequate ventilation. Wear respiratory protection if ventilation is inadequate or not available. Use eye and skin protection. Use clean plastic or stainless steel scoops only.

Do not swallow. Avoid breathing vapors, mists or dust. Do not eat, drink or smoke in the work area. Wash hands thoroughly after handling.

Label containers and keep them tightly closed when not in use.

Personal Protective Equipment (PPE)

Engineering Controls:

General room ventilation is required if used indoors. Local exhaust ventilation, process enclosures or other engineering controls may be needed to maintain airborne levels below recommended exposure limits. Avoid creating dust or mists. Maintain adequate ventilation at all times. Do not use in confined areas. Keep levels below recommended exposure limits. To determine actual exposure limits, monitoring should be performed on a routine basis. General use of persulfates will generate thermal and pressure regimes which need to mitigated during application as a precautionary measure.

Respiratory Protection:

Use NIOSH(P100) approved respirator when airborne dust is expected.

Exposure Limit

0.1 mg/m^3 (TWA) - ACGIH

Hand Protection:

Wear chemical resistant gloves (neoprene, rubber, or PVC). Thoroughly wash the outside of gloves with soap and water prior to removal.

Section 6 – Protective Measures, Storage and Handling (cont)

Eye Protection:	Wear chemical safety goggles. A full face shield may be worn in lieu of safety goggles.
Skin Protection:	Try to avoid skin contact with this product. Chemical resistant gloves (neoprene, PVC or rubber) and protective clothing should be worn during use.
Protection Against Fire & Explosion:	Product is non-explosive. In case of fire, evacuate all non-essential personnel, wear protective clothing and a self-contained breathing apparatus, stay upwind of fire, and use water to spray cool fire-exposed containers. Presence of water accelerates decomposition.

Section 7 – Hazards Identification

Potential Health Effects

Inhalation:	May be harmful and irritating.
Eye Contact:	Non-irritating (rabbit)
Skin Contact:	Non-irritating (rabbit)
Ingestion:	May be harmful if swallowed (vomiting and diarrhea).
Target Organs:	Eyes, skin, respiratory passages

Section 8 – Measures in Case of Accidents and Fire

After Spillage/Leakage:	Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to regulatory agencies procedures.
Extinguishing Media:	Water; Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect on decomposing persulfates. Wear full protective clothing and self contained breathing apparatus.

First Aid

Eye Contact:	Flush eyes with running water for at least 15 minutes with eyelids held open. Seek a specialist.
Inhalation:	Remove affected person to fresh air. Seek medical attention if the effects persist.
Ingestion:	Rinse mouth with water, give two-four cups of water to dilute the chemical and seek medical attention immediately. Never give anything by mouth to an unconscious person. **Do Not** induce vomiting.
Skin Contact:	Wash affected areas with soap and a mild detergent and large amounts of water. Seek medical attention if irritation occurs or persists.

Notes to Medical Doctor: This product has low oral toxicity and is not irritating to the eyes and skin. Flooding of exposed areas with water is suggested, but gastric lavage or emesis induction for ingestions must consider possible aggravation of esophageal injury and the expected absence of system effects. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

Section 9 – Accidental Release Measures

Precautions:

Cleanup Methods:	Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to local regulatory agencies procedures.

Section 10 – Information on Toxicology

Toxicity Data

Oral LD_{50} (rat):	895 mg/kg
Dermal LD_{50} (rabbit):	> 10 g/kg
Inhalation LD_{50} (rat):	5.1 mg/kg

Section 11 – Information on Ecology

Ecotoxicological Information

Bluegill sunfish, 96-hour LC_{50} = 771 mg/L

Rainbow trout, 96-hour LC_{50} = 163 mg/L

Daphnia, 48-hour LC_{50} = 133 mg/L

Grass shrimp, 96-hour LC_{50} = 519 mg/L

Biotic Degradation: N/A.

Section 12 – Disposal Considerations

Waste Disposal Method: Dispose of in an approved waste facility operated by an authorized contactor in compliance with local, state and federal regulations.

Section 13 – Shipping/Transport Information

D.O.T. Shipping Name:	Oxidizing Solid, n.o.s. (a mixture of Sodium persulfate, sodium metasilicate and silicon dioxide)
UN Number:	UN 1479
Hazard Class:	5.1 (Oxidizer)
Labels:	5.1 (Oxidizer)
Packaging Group:	III

Section 14 – Other Information

HMIS® Rating	Health – 1 (Slight)	Physical Hazard – 1 (Slight)
	Flammability – 0 (None)	Lab PPE – goggles, gloves, apron, dust respirator

HMIS® is a registered trademark of the National Painting and Coating Association.

NFPA	Health – 1 (Slight)	Reactivity – 1 (Slight)
	Flammability – 0 (None)	Special - Oxidizer

Section 15 – Further Information

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

Treadwell&Rollo
A LANGAN COMPANY

Project Manager: David Dixon, PG
555 Montgomery Street / Suite 1300 / San Francisco, CA
www.treadwellrollo.com

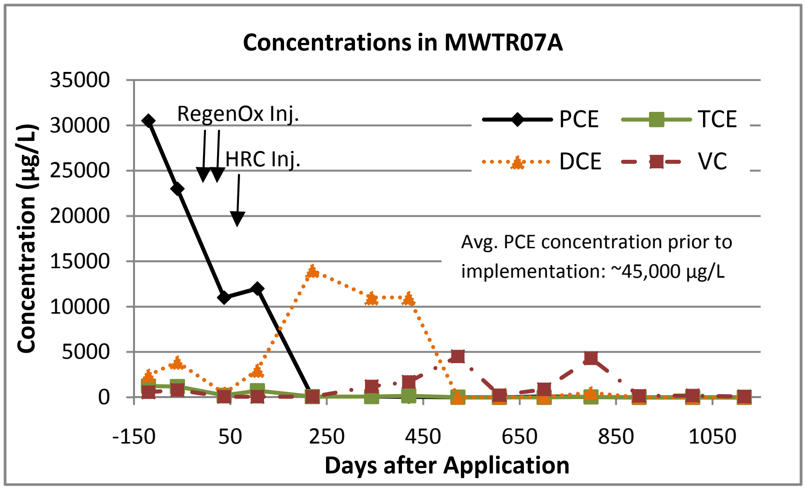
Chlorinated Solvents in Tight Clay Soils Treated beneath Active Manufacturing Building

Project Summary

Operations at an active manufacturing facility resulted in total chlorinated solvent (CVOCs) contamination up to ~35,000 micrograms per liter (µg/L) within groundwater and soils. The surrounding soils consisted of tight clays known as "bay mud" which can limit the options for a successful cleanup. To reduce the high chlorinated solvent concentrations and to eventually allow for on-going bioremediation, a combined approach involving *in situ* chemical oxidation (ISCO) using RegenOx® and enhanced anaerobic bioremediation (EAB) using Hydrogen Release Compound (HRC®) was chosen. This would allow for a safe application beneath the active facility and eliminate expensive installation of machinery and continuing extraction events.

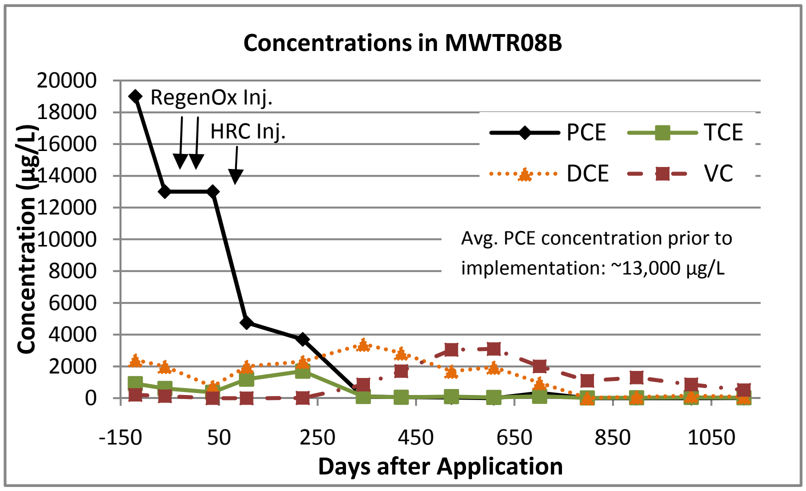
Figure 1. ISCO Injection using RegenOx beneath On-Site Building

- RegenOx and HRC applied beneath active on-site structure using direct-push technology (Figure 1)
- PCE concentrations reduced to the cleanup goals within ~1 year of the application
- Redox conditions established within a few months of the HRC injection
- Site Closure attained from the regulatory agency



Concentrations in MWTR07A

Avg. PCE concentration prior to implementation: ~45,000 µg/L



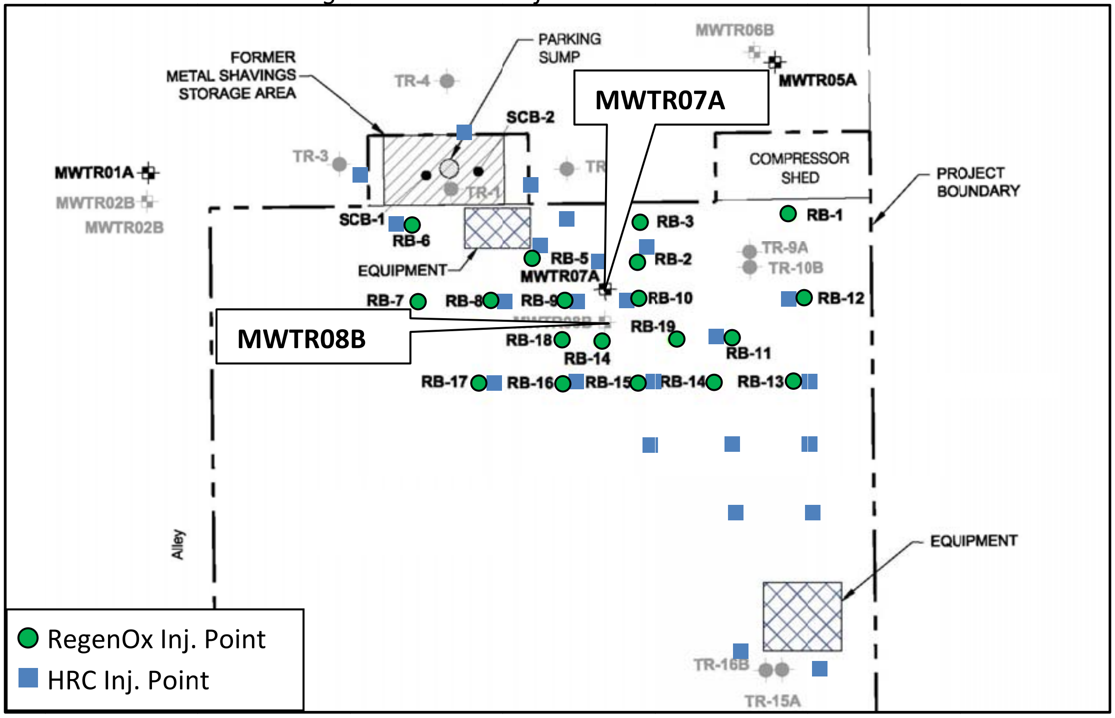
Concentrations in MWTR08B

Avg. PCE concentration prior to implementation: ~13,000 µg/L

Remedial Approach

A grid injection design was implemented across the source area from 5 – 22 feet below ground surface. A total of 10,200 pounds of RegenOx were applied during two injection events in October 2006. Approximately two months later, a total of 3,030 pounds of HRC were injected via 24 injection points.

RegenOx and HRC Injection Point Locations



Results

The RegenOx injections reduced chlorinated solvent concentrations by half within one month. A transition from chemical oxidation into bioremediation was established following the HRC injection and was evidenced by an increase in Fe^{2+}, a reduced ORP and low concentrations of dissolved oxygen. As concentrations of DCE and VC declined, an increase in ethene of up to 3.9 mg/L was observed indicating that reductive dechlorination was occurring. The remediation program reduced PCE concentrations in groundwater to below the reporting limits within one year. Three years of post-remediation monitoring has shown continuing biological degradation occurring within groundwater.

Cost Analysis

The life-cycle cost to remediate the site is shown in Chart 1. RegenOx and HRC product cost resulted in 19% of the total project cost of remediation. Total implementation costs were $140,000.

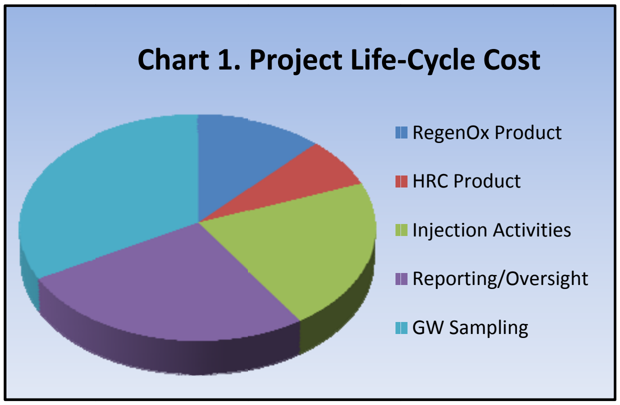


Chart 1. Project Life-Cycle Cost

THE REYNOLDS GROUP
a California corporation

RegenOx™ Application Treats TPHg, BTEX and MTBE and achieves NFA from LA RWQCB

Introduction

Culver City, CA
Four leaking underground storage tanks (LUSTs) ranging in size from 12,000 to 20,000 gallons were discovered at a former service station during a site investigation in 1998. Initial groundwater samples contained elevated levels of total petroleum hydrocarbons as gasoline (TPHg), benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl tert-butyl ether (MTBE) above the maximum contaminant levels (MCLs). A resulting contaminant plume covered more than 6,000 square feet and reached concentrations of 52,000 parts per billion (ppb) TPHg, 10,000 ppb BTEX, and 7,000 ppb MTBE.

Figure 1. RegenOx Material On-Site

Remediation Activities

Soil Excavation
In 2000, excavation activities removed the four LUSTs, fuel dispensers and fuel product lines. A total of 312 tons of hydrocarbon-impacted soil was excavated, removed from the site and replaced with clean backfill.

In-Situ Chemical Oxidation (ISCO)
In December 2005, an ISCO pilot test was performed to assess the ability of RegenOx™ to treat petroleum hydrocarbons in an impacted area of deep groundwater (~40 feet bgs). RegenOx was applied around well EW1 which was located within the former LUST area (Figure 2).

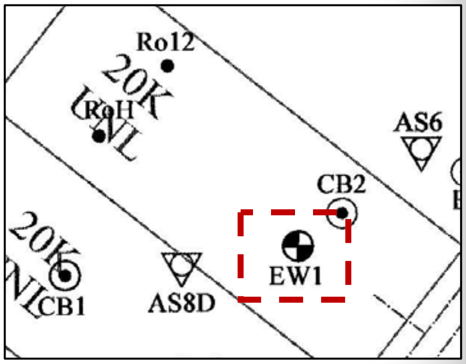


Figure 2. Pilot Test Well EW1 Located within a Former LUST Area

RegenOx is chemical oxidation technology, manufactured by Regenesis, that rapidly destroys contaminants through powerful chemical reactions. It directly oxidizes contaminants while a catalytic component generates oxidizing free radicals to destroy the target compounds. RegenOx treats the saturated and vadose zones and can allow for on-going biological reduction.

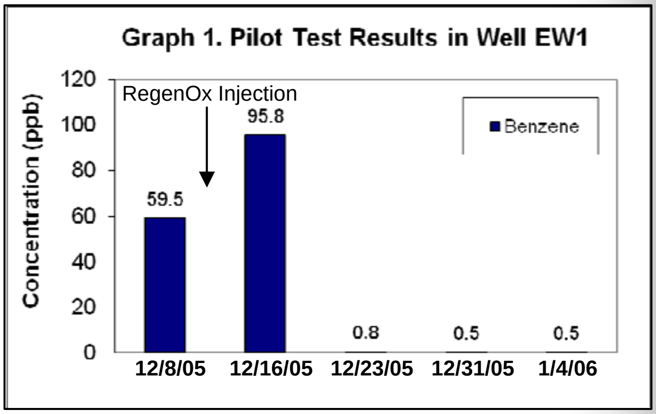
Following the RegenOx injection, desorption of residual contamination from the soil occurred causing a temporary spike in concentrations (Graph 1). A persistent decline followed as the chemical oxidation reactions reduced concentrations in TPHg, BTEX and MTBE by 63%-99%.

Table 1. RegenOx™ Pilot Application – Well EW1

RegenOx Applied	2,000 lbs
Depth to GW	~40 feet
Injection Points	8
Injection Spacing	6 feet
Application Rate	40 lbs/ft

Table 2. Pilot Application Results – Well EW1

	Pre-Pilot	Post-Pilot	Reduction
TPHg	4,956	199	**96%**
BTEX	330	2	**99%**
MTBE	440	165	**63%**



In-Situ Chemical Oxidation (ISCO) – Groundwater Full-Scale

The success of the pilot test led to a full-scale application of RegenOx in December 2006. The direct-push injection was focused near wells EW-1, EW-4, MW-2, and MW-3 (Figure 3). RegenOx was applied over three injection events (12/1/06, 12/29/06, 1/5/07). Using field parameter measurements and field observations, the inferred radius of influence from the RegenOx injections was approximately 15-20 feet.

Table 3. RegenOx™ Full-Scale Application

RegenOx Applied	12,420 lbs
Depth to GW	~40 feet
Injection Points	30
Treatment Thickness	14 feet
Application Rate	40 lbs/ft

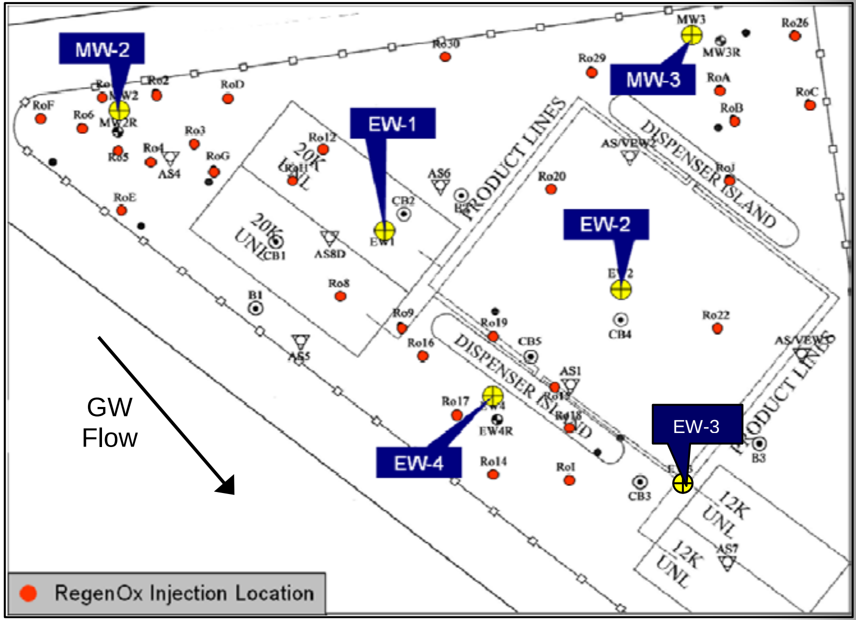


Figure 3. Full-Scale Application of RegenOx

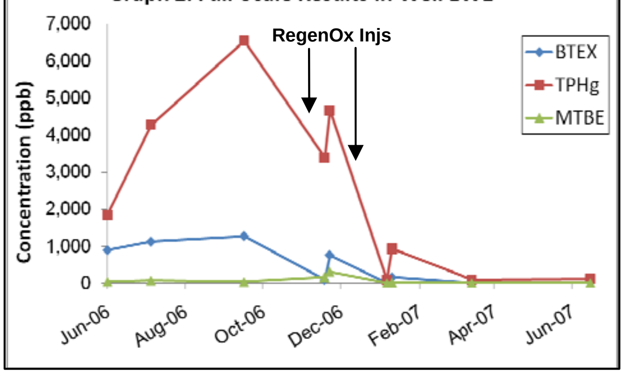
TPHg Concentrations

In wells EW-1, EW-4, MW-2 and MW-3, concentrations of TPHg reached between 6,000 and 35,500 ppb (Graphs 2 & 3). Contaminant concentrations rapidly declined following the series of RegenOx applications and were reduced by 62%-86% after only 8 weeks of treatment. Concentrations in non-target wells EW-2 and EW-3 reduced to approximately 100 ppb (Table 4).

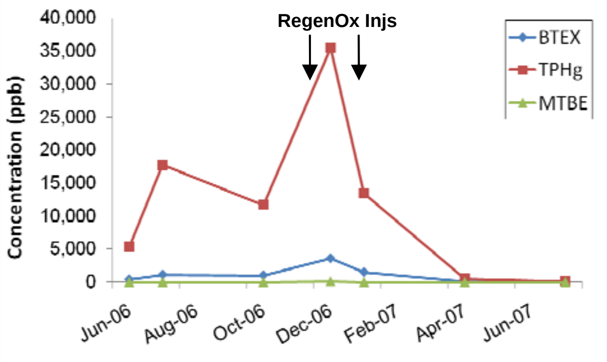
Benzene & MTBE Concentrations

Total BTEX was most significant in wells EW-1 and MW-2 at concentrations of 1,270 ppb and 1,025 ppb, respectively. Across the treatment area, benzene levels exceeded the cleanup goal (5 ppb) as concentrations reached 136 ppb (MW-2) prior to the RegenOx applications. Within approximately 2 months of the initial injection, benzene levels were reduced by 50% across the site and **continued to decline reaching non-detect levels in all wells within 4 months.** Due to desorption, MTBE concentration reached 4,458 ppb following the RegenOx injections. Within 3 months, concentrations were reduced by 99% to <3.0 ppb in all wells. A No Further Action letter was issued by the Los Angeles Regional Water Quality Control Board in August 2007.

Graph 2. Full-Scale Results in Well EW1

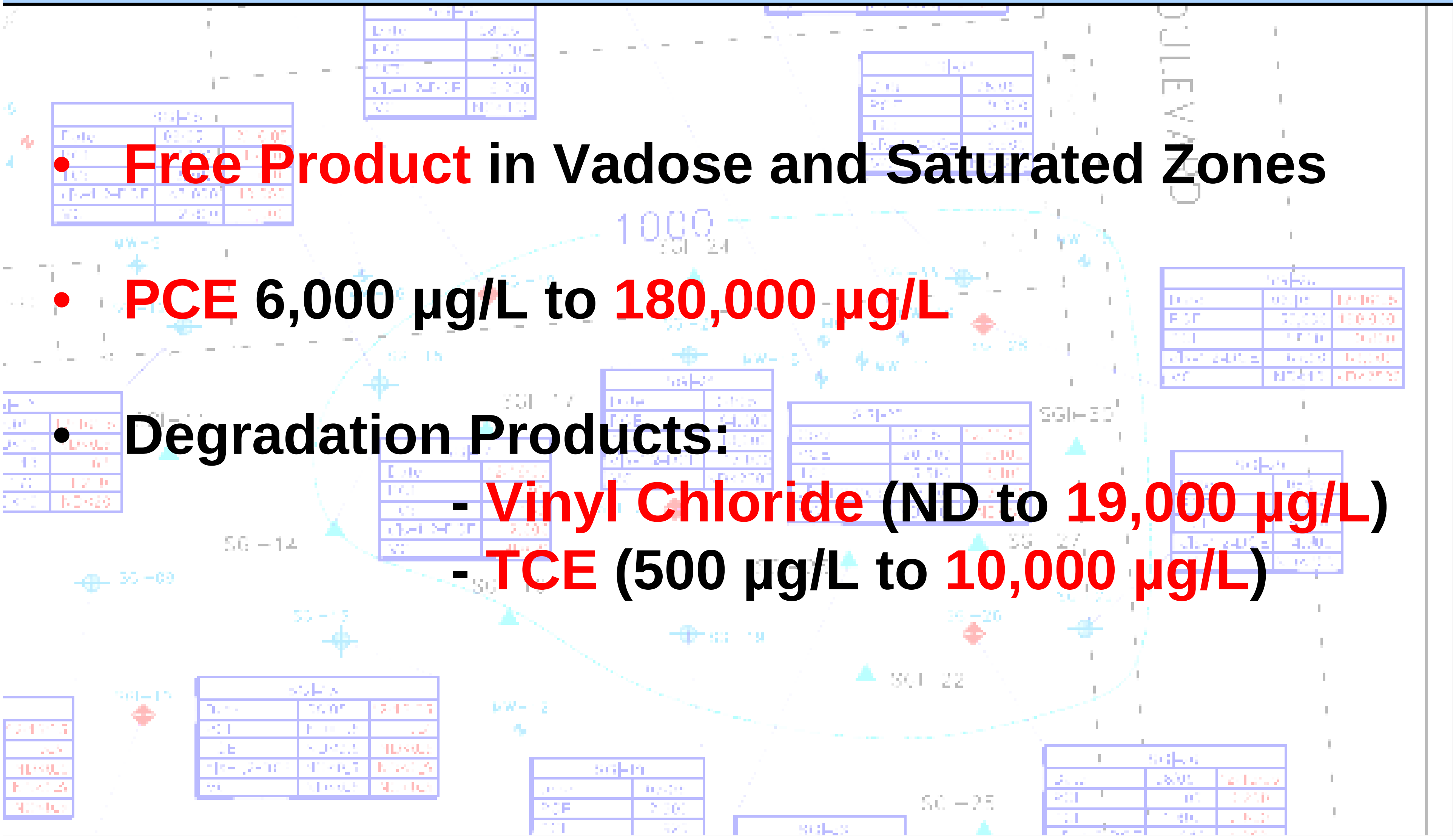


Graph 3. Full-Scale Results in Well MW2



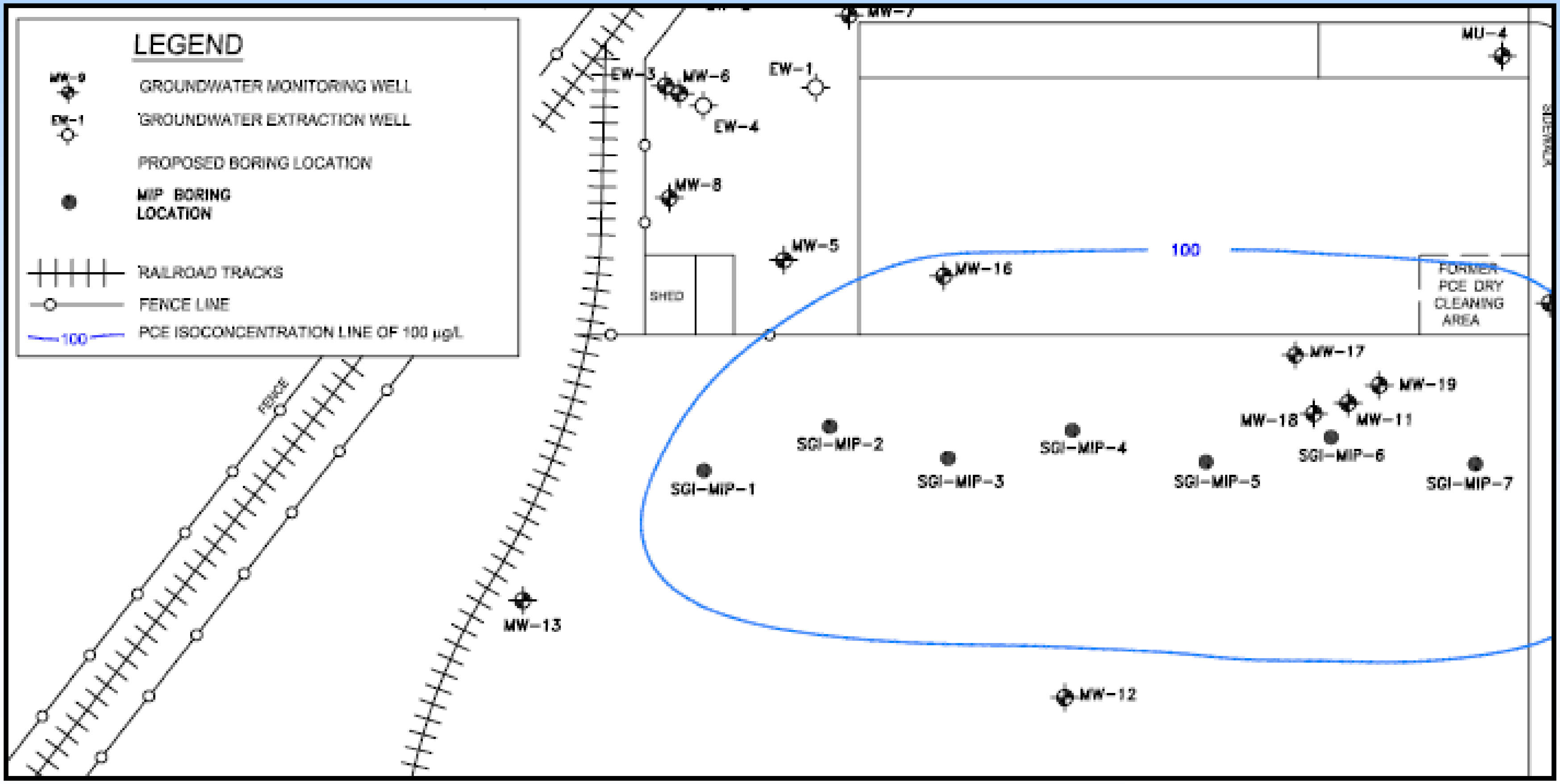
RegenOx Application on a Industrial Dry Cleaner in California

RegenOx: California dry cleaner



- **Free Product** **in Vadose and Saturated Zones**
- **PCE** **6,000 µg/L to** **180,000 µg/L**
- **Degradation Products:**
  - **Vinyl Chloride** **(ND to** **19,000 µg/L)**
  - **TCE** **(500 µg/L to** **10,000 µg/L)**

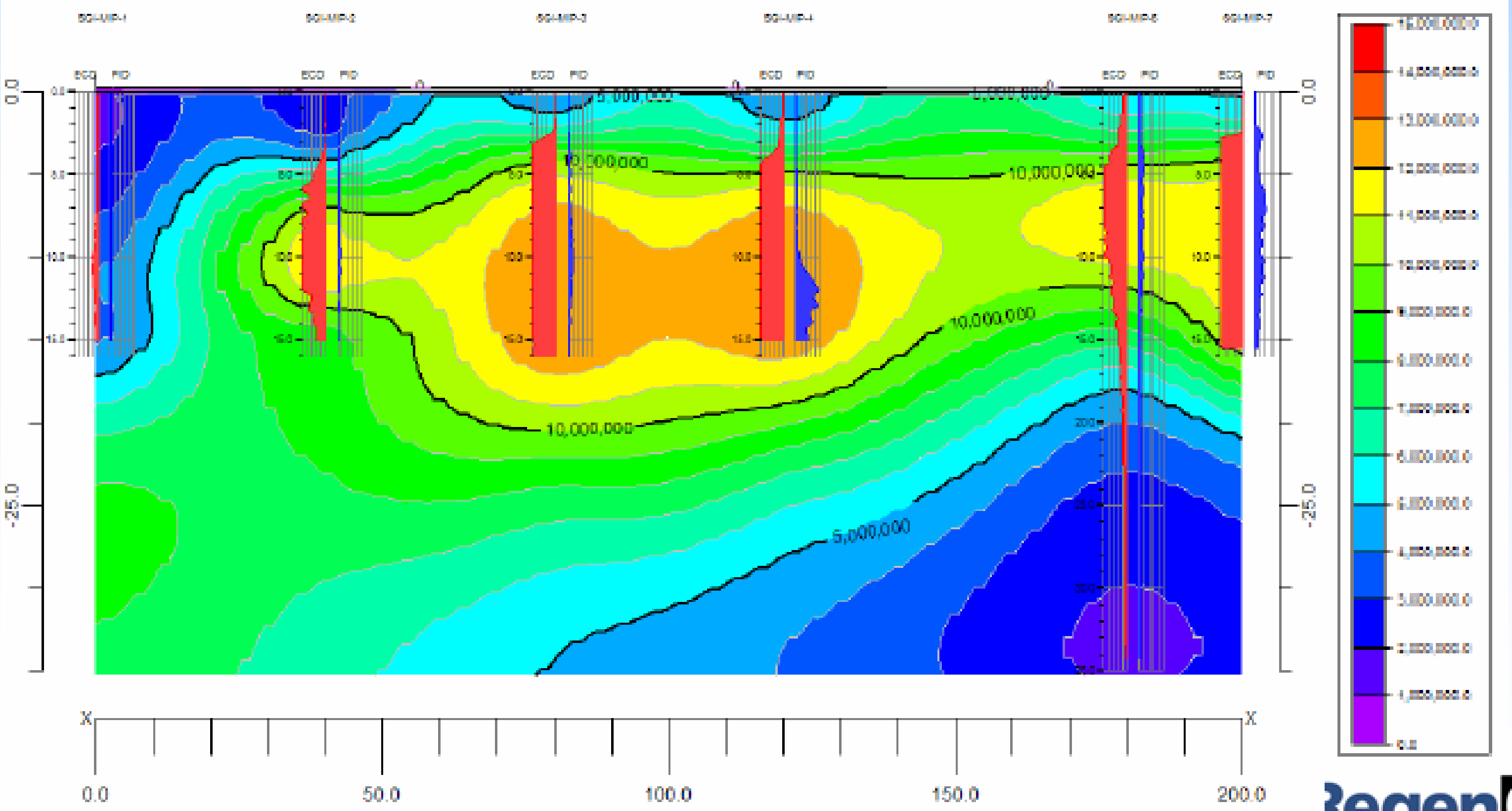
Membrane Interface Probe Characterization



CHEMICAL OXIDATION REDEFINED...

Membrane Interface Probe Characterization

ECD Cross Section with logs with ECD and PID



.RegenOx™

CHEMICAL OXIDATION REDEFINED...

Site Background

- Free Product Found in Vadose and Saturated Zones
- PCE Concentration as Range
  - 6 to 180 ppm
- Degradation Products
  - Vinyl Chloride (ND to 19 ppm)
  - TCE (0.5 to 10 ppm)

RegenOx Application on a Industrial Dry Cleaner in California

Treatment Area:

52,000 ft^2

Soil Type:

Sand/Silt/Fill

Groundwater Velocity:

5 ft/day

Depth to Groundwater:

8ft (perched)

Application Rate:

7 lbs/ft

Application Volume:

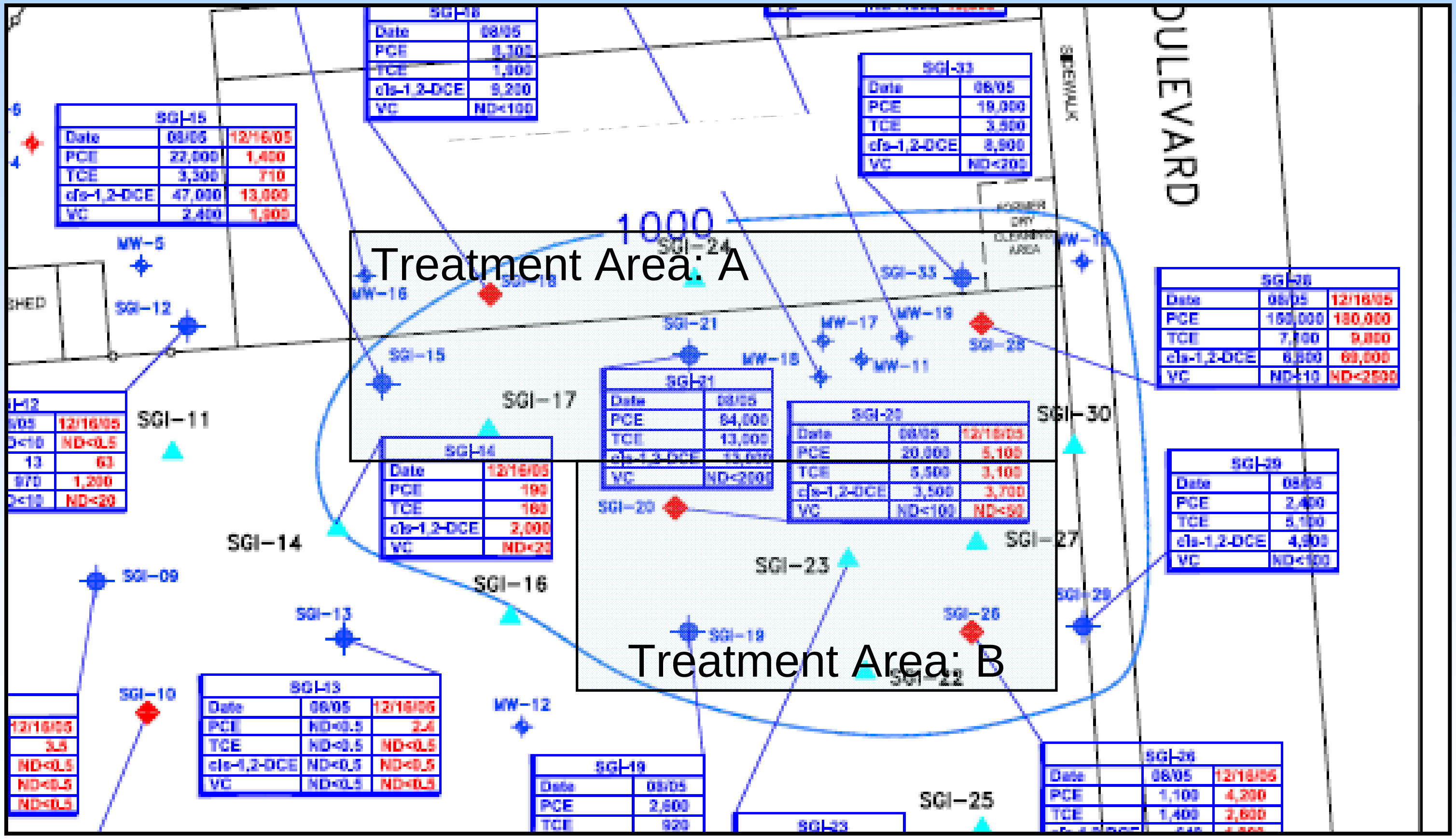
~13,500 Gal./injection

Injection Spacing:

15 ft

RegenOx™
CHEMICAL OXIDATION REDEFINED...

RegenOx Application on a Industrial Dry Cleaner in California



RegenOx™
CHEMICAL OXIDATION REDEFINED...

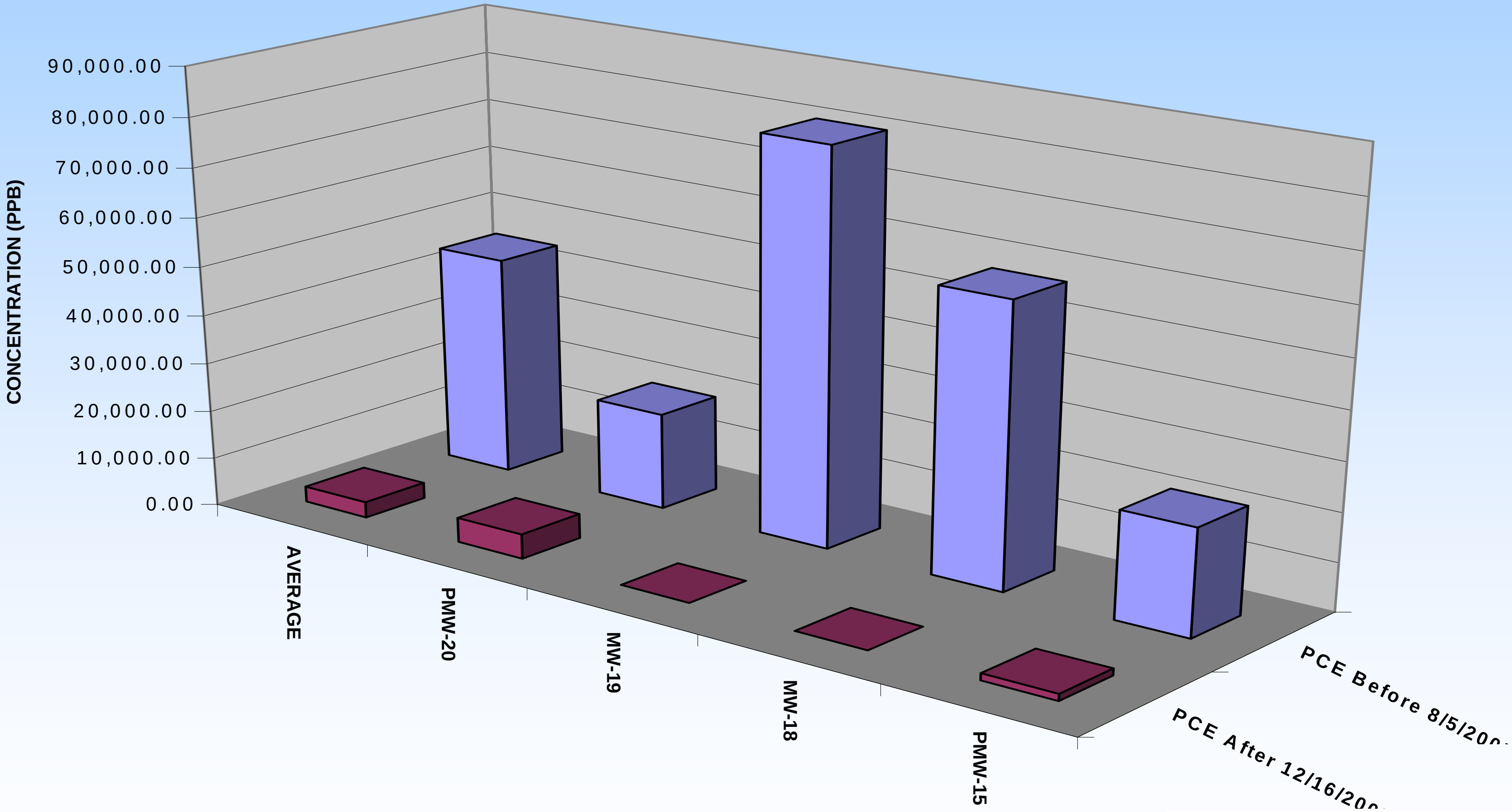
RegenOx Application on a Industrial Dry Cleaner in California

Direct Injection Through Pre-cut Holes in Concrete Floor

RegenOx™

CHEMICAL OXIDATION REDEFINED...

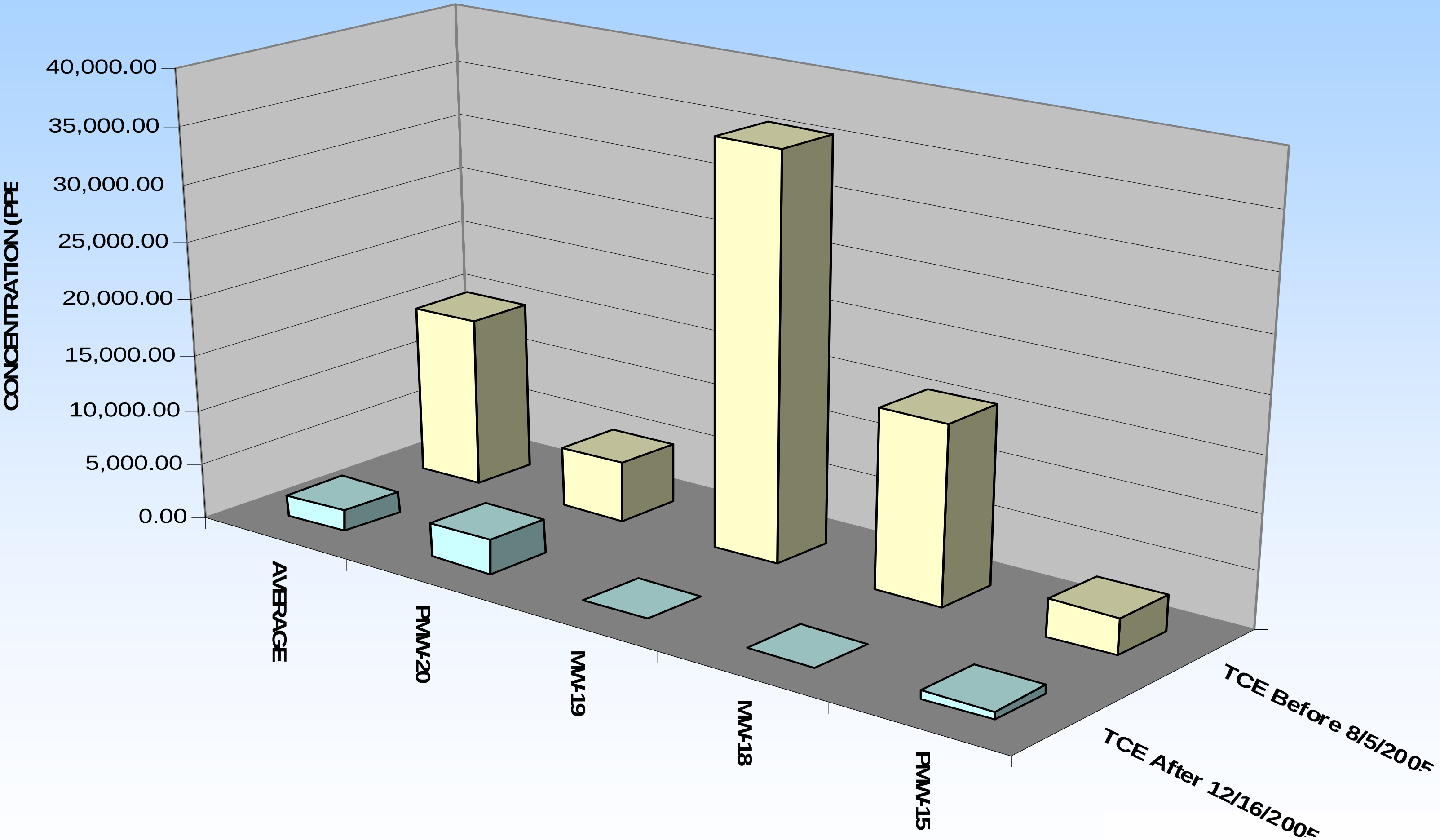
Remediation of High Levels of VOCs: 93% Reduction of PCE in 4 Months



RegenOx™

CHEMICAL OXIDATION REDEFINED...

Remediation of High Levels of VOCs: 88% Reduction of TCE in 4 Months



RegenOx™

CHEMICAL OXIDATION REDEFINED...

RegenOx Application on a Industrial Dry Cleaner in California

Conclusions:

- Effective degradation in the presence of Free Phase VOCs
- ~90% Contaminant reductions in a single application

RegenOx™

CHEMICAL OXIDATION REDEFINED...

Vadose Zone Treatment of Mixed Chlorinated and Petroleum Solvents Using In-Situ Chemical Oxidation Via Direct-Push and Soil Mixing Applications

CASE SUMMARY

Industrial Facility, Hollywood, CA

A mixed chlorinated and petroleum solvent contamination was detected in fill material throughout this 2-acre industrial property. Before a pending real estate transaction could be finalized, approximately 1 acre of the site required treatment for perchloroethene (PCE), naphthalene, and styrene in vadose zone soil. To achieve this, the engineering firm in charge of remediation selected chemical oxidation using RegenOx™ based on the product's proven effectiveness, low-cost, and handling safety.

TECHNOLOGY DESCRIPTION

RegenOx™ safely, effectively, and rapidly destroys a wide range of contaminants in both soil and groundwater. RegenOx™ is a solid alkaline oxidant built around a sodium percarbonate complex, which is activated using a proprietary, multi-part catalytic formula. The product is delivered to the treatment site in two parts. The two parts are combined and then added to subsurface soil (vadose or saturated zone) using direct-push and/or soil mixing equipment. RegenOx™ can also be added to excavations and soil piles using soil blending equipment. Once in contact with contaminated soil, RegenOx™ produces an effective oxidation reaction, comparable to that of Fenton's Reagent, without a violent exothermic hazard.

Soil requiring treatment at a large industrial facility near Los Angeles, CA

REMEDIATION APPROACH

The remediation objective at the Hollywood site was to reduce concentrations of chlorinated compound (PCE & TCE) and petroleum solvents (naphthalene & styrene) to below risk based closure levels.

Treatment by the in-situ mixing application of RegenOx™

- **Treatment Area:** 19,220 ft^3
- **Soil Type**: Consolidated Backfill
- **Groundwater Velocity:** NA (vadose zone)
- **Depth to Groundwater:** 14 ft
- **Application Type:**
  In-Situ Treatment via Direct-Push and Soil Mixing
- **Product**: RegenOx™
- **Quantity Applied:** 217,000 lbs
- **Average Application Rate:**
  Soil Mixing: 11 lbs/yd^3, Direct-Push: 8 lbs/ft

Phase I: Direct-Push Application

The first phase of remediation was performed using the direct-push application of RegenOx™ at the treatment site. The direct-push methodology uses specialized equipment to apply RegenOx™ to discrete areas of the subsurface without soil removal (i.e., *in situ*). Composite soil samples from various grid cells were taken before and after the treatment. Significant variation was seen in the contaminant concentrations before treatment, with the maximum concentrations of PCE at 140 ug/kg; naphthalene at 1200 ug/kg; and styrene at 400 ug/kg. Following the direct-push application of RegenOx™ the average PCE concentration, for example, was 4 ppb, a decrease of 86 percent. Similar results were seen for the petroleum solvents and other chlorinated volatile organic compounds (CVOCs) in the composite soil samples. However, despite the contaminant reductions achieved by the use of RegenOx™, it was determined that the direct-push application was too slow and inefficient for treatment of the entire site. Therefore, a different, more aggressive approach was implemented to maximize contact between RegenOx™ and the contaminated soil.

Phase II: In-Situ Soil Application

To complete the soil treatment, RegenOx™ was mechanically blended into the contaminated vadose soil using soil mixing equipment (shown below). RegenOx™ was added in an 8-percent solution and mixed throughout the soil. By maximizing contact between the RegenOx™ solution and the contaminated soil, approximately twice as much soil was treated per day in comparison to the amount treatable using the direct-push application.

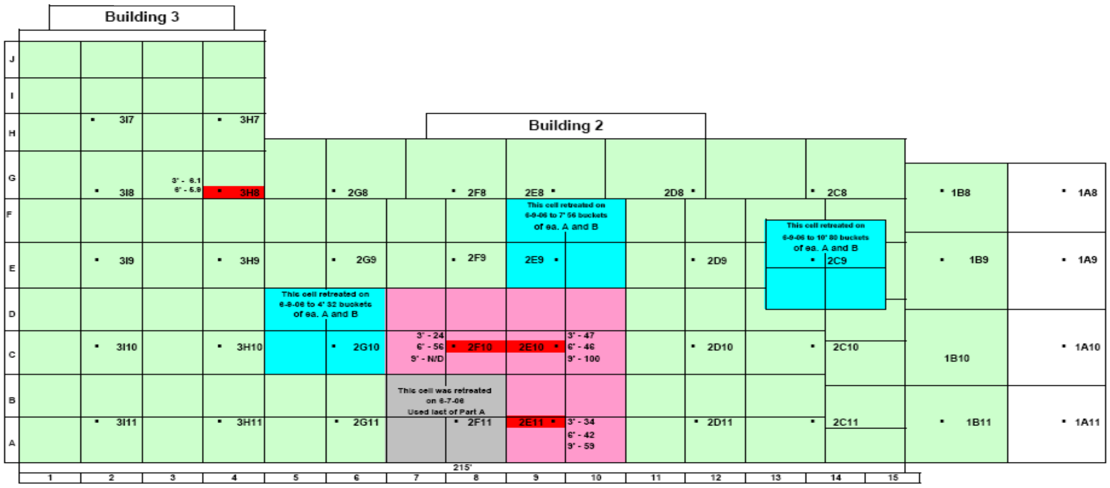
In-Situ Mixing of RegenOx™ On-Site

In-Situ Mixing Tool Head

Soil Mixing and Excavation Activities

Of the 111 grids treated with RegenOx™ (Figure 1), 83 required only one treatment (green), 12 required 2 treatments (blue), and 16 required more than 2 treatments (pink and gray).

Figure 1. Grid Site Map with the Treatment Effectiveness Noted



Green:	Met criteria after one treatment
Blue:	Met criteria after two treatments
Pink/Gray:	Met criteria after multiple treatments

CONCLUSION

The mixed chlorinated and petroleum solvent soil contamination at the site was effectively reduced using RegenOx™ in both direct-push and soil mixing applications. At this site, however, soil mixing was the favored approach because it maximized contact between RegenOx™ and the contaminated soil, achieving more rapid treatment. In most of the treatment grids (74 percent), contaminant concentrations were reduced below the risk based cleanup goal for all the contaminants with a single application. Additional applications in all other treatment grids also achieved concentrations the risk based cleanup goal for all the contaminants. This remediation approach successfully treated nearly 18,000 yd^3 of soil within 30 days for approximately \$34/yd^3, which includes the costs for RegenOx™, the soil mixer, and support equipment. Using RegenOx™ and flexible application methods, the site was quickly and effectively remediated, allowing for the real estate transaction to be completed.

CONTACT

Suzi Rosen – Regenesis Southwest District Manager
949-366-8000 | srosen@regenesis.com

Consultant contact information available upon request. Please contact the Regenesis representative listed above.

Aqua Science Engineers, Inc.
ASE Consultants
ENVIRONMENTAL and ENGINEERING CONSULTING SERVICES

Chemical Oxidation of Petroleum Hydrocarbons via In Situ Soil Mixing

Summary

A former industrial facility in northern California contained two underground storage tanks (USTs) which were shown to be partially decayed during tank removal activities. Samples taken within the UST removal area indicated gasoline constituents benzene, toluene, ethylbenzene and xylenes (BTEX) at approximately 70 parts per million (ppm) in soil. Following soil and groundwater investigations, more than 2,100 tons of petroleum-impacted soil was excavated and transported off-site for disposal. An additional 8,000 cubic yards of soil was excavated and treated on-site. After excavation activities were completed, reassessment of the site was performed and resulted in a treatment area more extensive than previously investigated. Continued excavation was deemed too costly and a remedial strategy was sought to treat the remaining petroleum hydrocarbons on-site. A soil mixing design using RegenOx® in situ chemical oxidation and ORC Advanced® enhanced aerobic bioremediation was implemented.


Figure 1. Former Industrial Facility


Figure 2. RegenOx Material On-site


Figure 3. RegenOx Product Mixing

Remedial Strategy

RegenOx was used to target high concentration soil while ORC Advanced was applied to accelerate the aerobic bioremediation of any remaining petroleum hydrocarbons. RegenOx and ORC Advanced were mixed together with water and applied using a dual axis remediation blender provided by Lang Tool Co. A treatment cell map was designed with approximate amounts of material applied in each cell (Figure 4).

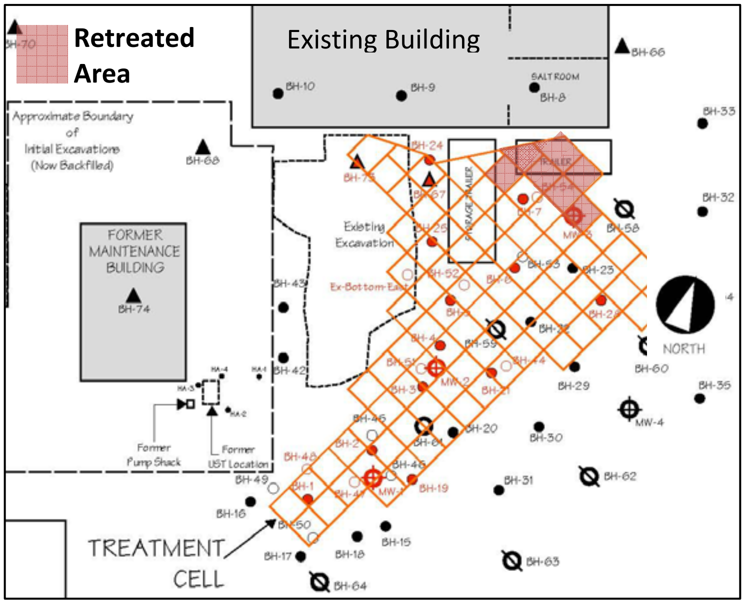


Figure 4. Treatment Cell Design and Retreated Area

- RegenOx – 79,620 lbs
- ORC Advanced – 4,800 lbs
- Soil Type – Silty clay
- 10ft x 10ft cells across 135,000 ft^2

Table 1. Remedial Goals (ppm)	
TPHg	180
Benzene	0.27
Toluene	9.3
Ethylbenzene	4.7
Xylenes	11

Figure 5. Dual Axis Head

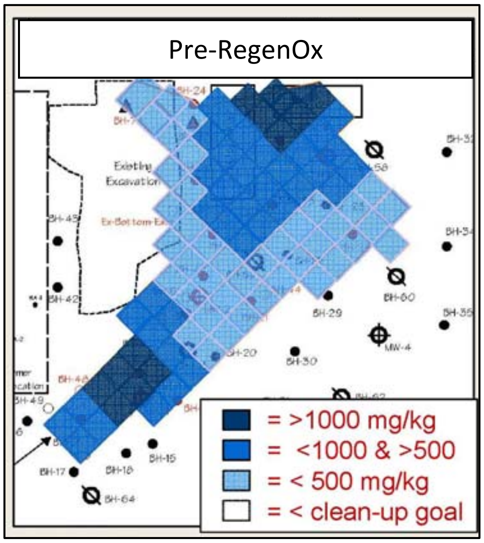
Figure 6. In Situ Mixing

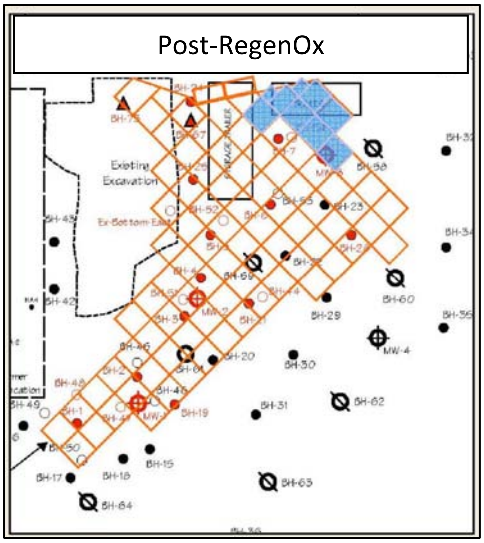
Figure 7. In Situ Mixing

Results

- Southern Area
    - TPHg declined by 2 orders of magnitude
    - BTEX reduced from 100 ppm to 2 ppm
    - Area remediated to below remedial goals
    - No groundwater was available to sample

- Northern Area
    - Retreatment of 7 cells (Figure 4)
    - Two cells remain elevated; highest concentrations at 440 ppm TPHg and 52 ppm BTEX
    - Groundwater TPHg concentrations declined by 80-90%
    - ORC Advanced anticipated to stimulate aerobic bioremediation of remaining contaminants





Conclusion

In situ soil mixing using a dual axis remediation blender successfully delivered RegenOx and ORC Advanced to the vadose zone approximately 5 to 20 feet below ground surface. Nearly 80% of the soil treatment area was successfully remediated using a combined chemical oxidation and aerobic bioremediation method. Reductions of TPHg in groundwater were variable, however, in the Northern area a decrease by as much as 80% was observed.

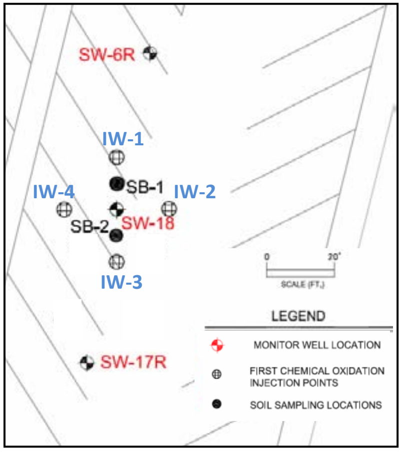
PetroCleanze™

COMBINING DESORPTION AND OXIDATION CHEMISTRY FOR HYDROCARBON MASS REMOVAL

CASE STUDY:SOIL BOUND BTEX TREATMENT AND ACTIVE REMEDIATION SYSTEM INTEGRATION

Purpose: The purpose of this pilot study was to demonstrate the feasibility of using PetroCleanze™ to desorb petroleum contaminants from the soil into the dissolved phase where they can then be treated by physical extraction or an active remediation system.

Figure 1. Site Map



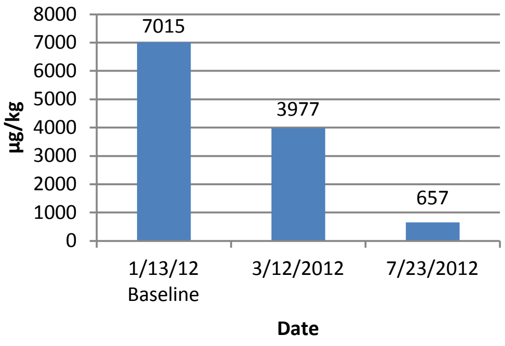
Background: A biosparge system was used at the site until groundwater concentrations dropped below cleanup target levels (approximately 2 years),then it was shut down. Rebound occurred during post-active remediation monitoring and groundwater concentrations increased above natural attenuation default concentrations. The observed increase in dissolved contaminant concentrations, combined with high organic vapor analyzer readings in saturated soil samples, and elevated fraction of organic carbon and total organic carbon concentrations in the soil, suggested petroleum contamination was likely absorbed to organics in saturated soils and was slowly desorbing into the groundwater. An approach was needed to liberate bound hydrocarbons for additional treatment using the biosparge system.

Pre-Injection Baseline Analytical: On January 12, 2012, baseline groundwater samples from monitoring wells SW-6R, -17R, and 18 (Figure 1) were collected for BTEX (benzene, toluene, ethylbenzene, xylene) and TRPH (total recoverable petroleum hydrocarbons) analysis (Figure 3, **4**). On January 13, 2012, two soil borings (SB-1 and SB-2) were completed and baseline soil samples were collected from 12-14 feet below land surface for BTEX analysis (Figure 2). Figure 2 shows the average soil BTEX concentration for SB-1 and SB-2 before and after PetroCleanze injection.

PetroCleanze Injection: On February 2-3, 2012, a total of 2,220 gallons of 5% solution of PetroCleanze was injected into four injection points surrounding SW-18. Each point received a total of 550 gallons of solution, including 220 lbs of RegenOx Part A, 240 lbs of PetroCleanze, and 500 gallons of water. The biosparge system was reactivated for the duration of the treatment event.

Post-Injection Analytical: On March 12, 2012 and July 10th, 2012, groundwater samples from groundwater monitor wells SW-6R, -17R, and -18 were collected for BTEX and TRPH analysis (Figure 3, 4). Also on March 13th and July 23rd, 2012, two soil borings (SB-1 and SB-2) were completed and soil samples were again collected for BTEX analysis (Figure 2).

Figure 2. Average Soil BTEX



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Results: Performance parameters were evaluated for SW-6R, -17R, and -18 and a marked increase in ORP values was observed in each of the three wells following the PetroCleanze injection indicating chemical oxidation activity. Additionally, the pH in wells SW-17R and -18 increased significantly, providing evidence that alkaline conditions resulted from the application of PetroCleanze. As anticipated, increases in TRPH and BTEX concentrations in the sampled wells were observed following PetroCleanze injection as compared to baseline (Figure 3, 4). SW-17R was slightly unique in that BTEX concentrations went down. When looking at the average soil BTEX concentration of the two soil samples (Figure 2) in January, March, and July 2012 (7,015, 3,977, and 657 µg/kg, respectively) there was a **43% reduction** between January and March and a **91% reduction** between January and July 2012 after continued biosparging treatment.

Figure 3. Total BTEX

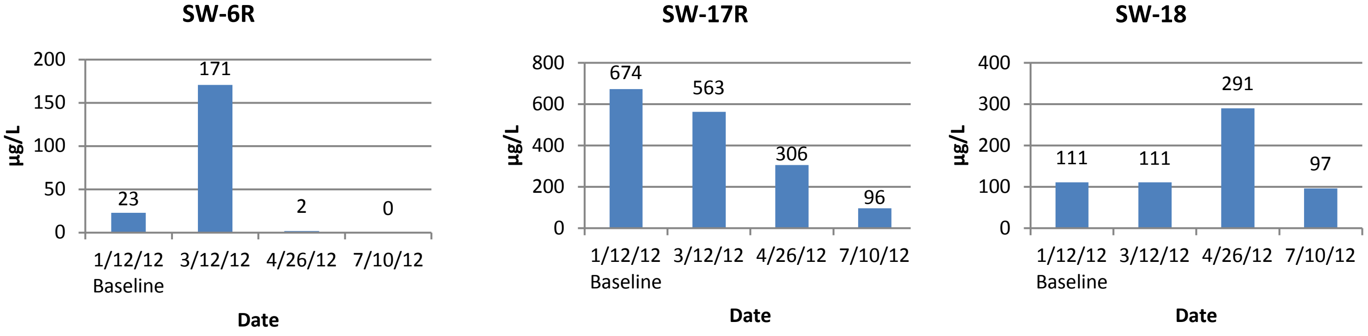
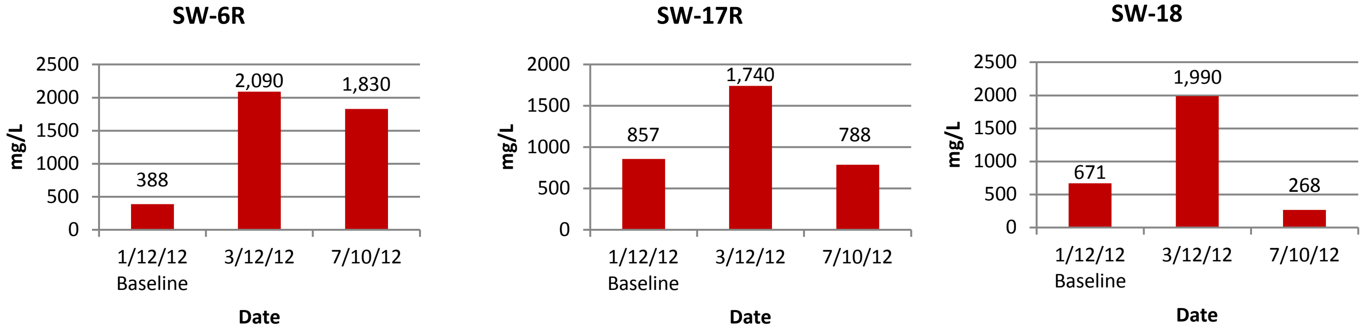

SW-6R
SW-17R
SW-18

Figure 4. TRPH


SW-6R
SW-17R
SW-18

Conclusion and Recommendations: The PetroCleanze application was successful and the material easily applied. Performance exceeded expectations as only one injection was needed to strip **91%** of the BTEX contamination from the soil into the dissolved phase. The reactivated biosparge system was able to treat the increased dissolved phase contaminants in the treatment area.

The current groundwater concentrations at the site are very low in key monitoring wells; therefore, the project does not require additional treatment at this time. However, should a change in contaminant concentration be observed at the site once active remediation has been ceased then additional treatment will be considered.

CASE SUMMARY: *IN SITU* CHEMICAL OXIDATION OF CHLORINATED SOLVENTS USING PERSULFOX™ AT AN INDUSTRIAL SITE

Overview: Chlorinated compounds were discovered in shallow groundwater at a former industrial site in Attleboro, Massachusetts. With total VOC concentrations as high as 85,000 ug/L in groundwater, a rapid and aggressive remediation approach was required. *In situ* chemical oxidation (ISCO) using PersulfOx™ - catalyzed persulfate was selected to treat a portion of the impacted area which was approximately 35' long x 35' wide x 15' deep and primarily comprised of sand. Three prescribed injections of ISCO using PersulfOx were performed over a 7- month period.

A 10% solution of PersulfOx in water was mixed and injected into a 10-foot treatment thickness using 3 injection wells within the vicinity of monitoring wells MW-16D, MW-16S and MW-8 (Fig.1).

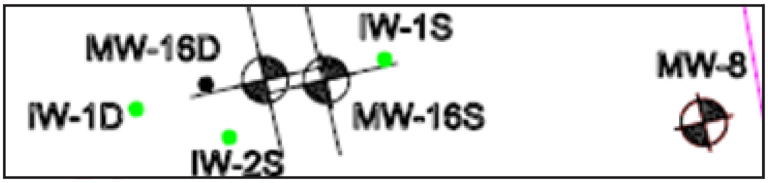


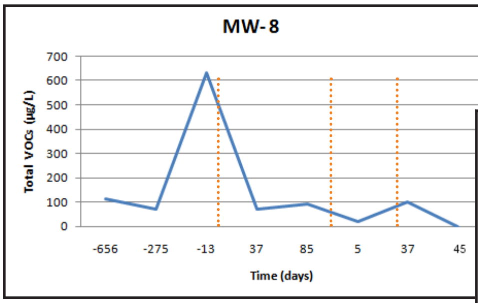
Figure 1. Injection wells and monitoring wells

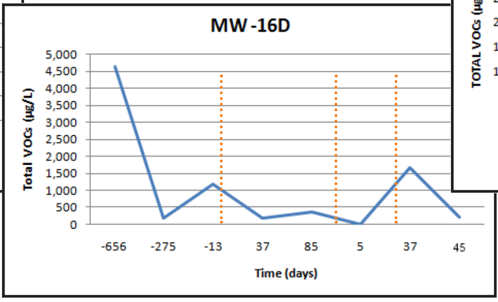
Results: After each PersulfOx application, an anticipated increase and subsequent decrease in VOCs (resulting from subsurface disturbance and contaminant desorption) was observed. After the 3 prescribed applications of PersulfOx, 2 of the treatment zone wells, MW-16D and MW-8, measured significant VOC removal, 81% and 99% respectively. Treatment zone well MW-16S (the most highly impacted—starting at 85,000 ug/L) showed a significant increase in VOCs after the first 2 injections (indicative of the liberation of soil bound mass). After the third application of PersulfOx, VOC concentrations in MW-16S were clearly decreasing (see figures below).

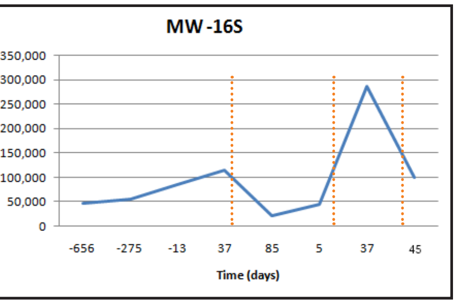
PersulfOx™

CATALYZED PERSULFATE

- PersulfOx is a persulfate based ISCO reagent that promotes rapid and sustained in situ oxidation of a wide-range of organic contaminants.
- This patented technology utilizes a unique catalytic surface on which oxidants and contaminants react in a process known as "surface mediated oxidation."
- PersulfOx also contains built-in activation which eliminates complex and potentially hazardous chemical addition required to achieve traditional persulfate activation.
- From a health and safety aspect, the use of PersulfOx alone is safer than traditional activation methods such as heat, chelated metals, hydrogen peroxide or base.
- If warranted, PersulfOx can also be activated through traditional means to achieve site remediation goals.







▬	VOC Concentrations
┈	PersulfOx Injection Events

For more information contact
Brian Snow of OHI Engineering at
bsnow@ohiengineering.com

REGENESIS

Advanced Technologies for Contaminated Site Remediation

CASE SUMMARY: PETROLEUM HYDROCARBON AND CHLORINATED SOLVENT TREATMENT USING PERSULFOX™ AT A FORMER SERVICE STATION

Overview: Petroleum hydrocarbons and chlorinated compounds were discovered in groundwater at a former gasoline service station/auto-repair facility. This redevelopment site, located in Bronx County, New York, previously housed an underground storage tank (UST) used for gasoline storage. Following the discovery of groundwater contamination in excess of NYSDEC groundwater protection standards, the UST and soils were removed to bedrock at a depth of 11 feet. Further monitoring revealed toluene and benzene contamination as well as tetrachloroethene (PCE) and trichloroethene (TCE) impacts from parts cleaning associated with the on-site auto-repair shop. Remedial action was required to restore site groundwater and make way for redevelopment and construction of a new building. In situ chemical oxidation (ISCO) using PersulfOx™ was chosen as the remediation approach.

The ISCO treatment system consisted of a series of pipes extending below the basement level of the existing slab for the specific purpose of delivering PersulfOx directly onto the bedrock surface. The pipes terminated into dispersion pits scraped into the bedrock allowing PersulfOx to pool and enter the fractures (Figure 1). The ISCO delivery system design allowed for multiple reagent applications as often as required to complete the remediation process.

Current trends in the available monitoring well data indicate significant reductions in total VOCs (Figure 2).

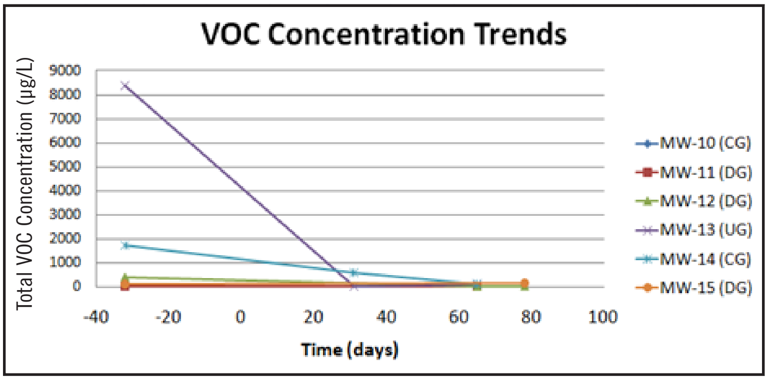


Figure 2. Total VOC concentrations decreased over time with the use of PersulfOx.

PersulfOx™

CATALYZED PERSULFATE

- PersulfOx is a persulfate based ISCO reagent that promotes rapid and sustained in situ oxidation of a wide-range of organic contaminants.
- This patented technology utilizes a unique catalytic surface on which oxidants and contaminants react in a process known as "surface mediated oxidation."
- PersulfOx also contains built-in activation which eliminates complex and potentially hazardous chemical addition required to achieve traditional persulfate activation.
- From a health and safety aspect, the use of PersulfOx alone is safer than traditional activation methods such as heat, chelated metals, hydrogen peroxide or base.
- If warranted, PersulfOx can also be activated through traditional means to achieve site remediation goals.

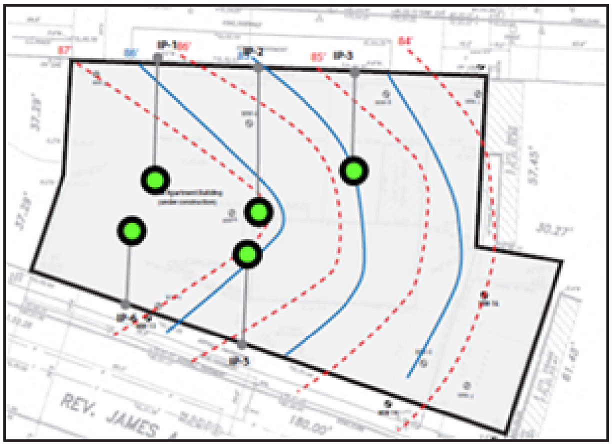


Figure 1. Site map with PersulfOx application trench and dispersion point locations (green dots)

For more information about this project or PersulfOx please contact Maureen Dooley of REGENESIS at mdooley@regenesis.com.