

**CITY OF ROCHESTER  
WORK PLAN FOR  
CONTAMINANT REDUCTION ACTION  
Site Number B-00129-8  
1200 East Main Street  
Rochester, New York**

*Submitted to:*

New York State Department of Environmental Conservation

*Prepared by:*

Bergmann Associates, Inc.  
28 East Main Street  
200 First Federal Plaza  
Rochester, New York

**Bergmann Job No. 4453.02**

November 22, 2011



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## **1.0 INTRODUCTION**

The City of Rochester has retained Bergmann Associates, Inc. (Bergmann), for preparation of this work plan that presents the methods and procedures for a contaminant reduction action using chemical oxidation treatment at 1200 E. Main Street property (Site). The contaminant reduction action is proposed to reduce the Light Non-Aqueous Phase Liquid (LNAPL) petroleum product that is present in three monitoring wells prior to implementation of the remedial action described in the Record of Decision (ROD) that was approved in 2006 by the New York State Department of Environmental conservation (NYSDEC).

Previous attempts to recover and remove LNAPL (product) from monitoring wells with a vacuum truck have failed to reduce this condition. The remedial action requirements for this Site will be implemented in accordance with the ROD when levels of product observed are reduced or no longer present.

The current groundwater condition with measurable product is not favorable for implementation of the remedial action presented in the ROD. Bergmann recommends injection of RegenOx™ in treatment boreholes for In Situ chemical oxidation (ISCO) for product reduction. After this contaminant reduction action is completed the remedial action presented in the ROD may be implemented. This work plan was prepared based on the results of the investigations completed at the Site, Regenesys product information and our experience with application of oxygen release compounds for soil / groundwater remediation.

## **2.0 BACKGROUND**

On June 3, 2010, product was observed in four monitoring wells with approximate thickness of product measured as follows: MW-4 (0.16 ft.), MW-7 (0.12 ft.), MW-9 (0.50 ft.), and newly installed MW-15 (0.01 ft.). Product has been observed in Monitoring wells MW-4, MW-7, and MW-9 during previous groundwater gauging sampling events. It appears that product is located on top of the groundwater table within the bedrock formation or at the bottom of the overburden deposit based on the measurements from gauging and sampling events.

## **3.0 OBJECTIVE**

The objective of the proposed contaminant reduction action is to reduce the amount of product on the groundwater table at monitoring well locations where product has been observed.

## **4.0 SUBSURFACE PARAMETERS**

The following subsurface parameters were considered during the evaluation of chemical groundwater oxidation treatment using RegenOx™. The data used to determine the parameters was selected from monitoring well installation, field measurements within the groundwater system and with respect to the proposed treatment areas.

- Approximate Thickness of Overburden 14 ft.
- Approximate Saturated Thickness in Overburden 1.5 ft. to 2 ft.
- Approximate Depth to Groundwater in monitoring wells with product 16 ft.
- Shallowest Depth to Groundwater in monitoring wells 14 ft.



- Deepest Depth to Groundwater in monitoring wells 16.4 ft.
- Depth of Treatment area (injection zone) in bedrock 10.0 ft.
- Approximate Tons of bedrock in injection zone of Treatment Area No. 1 – 1,370Tons
- Approximate Tons of bedrock in injection zone of Treatment Area No. 2 – 362.6Tons
- Approximate Tons of bedrock in injection zone of Treatment Area No. 3 – 362.6Tons
- Maximum thickness of Product– 1.2 ft. (in monitoring well MW-9)
- Minimum thickness of Product – 0.01 ft.(in monitoring well MW-4)
- Approximate porosity of bedrock in the injection zone 35%

Note: each value above is approximate and the thickness of product measured in the well casing may be exaggerated due to capillary action.

The use of RegenOx™ as a chemical oxidant is feasible for the reduction of product based on the limited distribution and thickness of the observed product in Site monitoring wells. The fracture frequency is high to moderate in the top five feet of bedrock with a lower fracture frequency observed in bedrock core samples from 5 to 10 feet below the top of bedrock surface. Therefore, the treatment zone for the proposed contaminant reduction action is the upper ten feet of the bedrock formation.

## **5.0 SCOPE OF CHEMICAL OXIDATION TREATMENT USING RegenOx™**

Bergmann recommends application of RegenOx™ by injection for the contaminant reduction action at three treatment areas. Treatment Area 1 is approximately 45 ft. by 24 ft. by 10 ft. thick and is centered on monitoring well MW-9 and extends to MW-15. Treatment Area 2 is approximately 21 ft. by 12 ft. by 10 ft. thick and is centered on monitoring well MW-4. Treatment Area 3 is approximately 21 ft. by 12 ft. by 10 ft. thick and is centered on monitoring well MW-7. The locations of the treatment areas and approximate locations for proposed treatment boreholes are shown on Figure 1 – Contaminant Reduction Action Treatment Borehole Locations. The general scope for work elements to accomplish the contaminant reduction action is listed below:

- Present this scope of work to NYSDEC.
- Review RegenOx™ Calculations and Technical Information, see Appendix A - RegenOx™ Calculations and Technical Information
- Review of subsurface utilities/structures and their compatibility with RegenOx™.
- Layout initial RegenOx™ treatment boreholes in the field and contact underground utility stakeout.
- Perform first application of RegenOx™.
- Development of monitoring wells MW-4, MW-7, MW-9, and MW-15.
- Conduct field parameter monitoring and groundwater sampling from monitoring well locations MW-4, MW-7, MW-9, and MW-15 following a two week period after the RegenOx™



application. Field parameter monitoring will include: pH, temperature, dissolved oxygen, conductivity, and turbidity.

- The results will be used to evaluate the groundwater quality to determine if a second application is required.
- Perform the second application of RegenOx™ approximately 2 to 4 weeks following the same installation and batch mix at the 11 borehole locations shown on Figure 1.

Collect groundwater samples for laboratory analysis with field parameter monitoring 90 days after the application. The following subsections present the RegenOx™ product information and detailed scope of work for this project.

## **6.0 APPLICATION OF RegenOx™**

RegenOx™ maximizes In Situ performance using a solid alkaline oxidant that employs a sodium percarbonate complex with a multi-part catalytic formula and an activator complex (a composition of ferrous salt embedded in a micro-scale catalyst gel). This product is delivered in two parts that are combined and injected into the subsurface using rotary drilling equipment. Once in the subsurface, the RegenOx™ produces an effective oxidation reaction without a violent exothermic reaction and is capable of treating a broad range of soil and groundwater contaminants including petroleum hydrocarbons. RegenOx™ will be applied as slurry into the injection zone in each treatment boreholes. The following sections present the methods and procedures for each phase of the proposed chemical oxidation using RegenOx™.

RegenOx™ application will oxidize the product in the treatment areas and will be applied using direct-injection techniques in temporarily cased treatment boreholes that will be installed using rotary drilling methods. The application process involves combining RegenOx™ Part A oxidizer with Part B activator in a water solution that is pumped into the injection zone of the treatment borehole under pressure. The injection zone includes the vertical zone of groundwater contamination of the top 10 feet of bedrock. The applied solution of RegenOx™ moves out of the injection zone and into the top of bedrock groundwater system. Upon direct contact with petroleum hydrocarbons, RegenOx™ produces a series of efficient oxidation reactions by a number of mechanisms including: surface mediated oxidation, direct oxidation and free radical oxidation. These reactions destroy a wide range of petroleum chemical compounds and reactions may be sustained for periods of up to 30 days from a single injection. RegenOx™ is safe for use in direct contact with underground utilities/infrastructure as it is non-corrosive and produces very low amounts of heat and pressure.

## **7.0 ENVIRONMENTAL SETTING**

The Site's physical setting is in a mixed commercial and residential area of the City of Rochester, New York. The Site is un-occupied and may be re-used for commercial retail developed. The ground surface topography in the vicinity of the Site is generally flat and the overburden groundwater flow is generally towards the south.

### **7.1 OVERBURDEN GEOLOGY**

The overburden at the site consists of urban fill soils underlying by a glacial till deposit. The uppermost water-bearing zone at the site occurs in the top of bedrock. The Silurian age LOCKPORT



DOLSTONE is the bedrock formation. The overburden deposits vary in thickness from approximately 12 feet to 15 feet. Previous investigations determined that groundwater in the top of bedrock occurs at depths ranging from approximately 11 to 15 feet below ground surface.

## **7.2 POTENTIAL RECEPTORS**

Underground utilities that are below the groundwater table may be considered potential receptors. However, impact due to utilities in the source area has been limited by the source area soil removal completed during March of 2010. The adjacent residential home is equipped with a sub-slab ventilation system to mitigate potential vapor intrusion issues. It should also be noted that concentrations of gasoline volatile organic compounds (VOCs) detected in the groundwater samples in monitoring wells near the Site property lines are generally non-detection or low parts per billion levels. It should be noted that installations of treatment boreholes (injection points) are not located immediately adjacent to the residence at 1214 East Main Street and the nearest proposed treatment borehole is approximately 48 feet from this residence.

## **8.0 RATIONALE**

The rationale for the proposed contaminant reduction action detailed in this work plan is based on the objectives for the action as well as the results of previous investigations. The procedures and methods detailed in this work plan will be implemented during the chemical oxidation treatment work. This work plan may be modified and revised in response to field conditions, locations of underground utilities, and groundwater monitoring results or other aspects that may not be evident at this time.

## **9.0 EVALUATION OF CHEMICAL OXIDATION**

RegenOx™ is a two part product (Part A is the oxidizer powder; Part B is the liquid activator). The composition of Part A is a mixture of sodium percarbonate [ $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$ ], sodium carbonate [ $\text{Na}_2\text{CO}_3$ ], sodium silicate and silica gel. The composition of Part B is a mixture of sodium silicate solution, silica gel and ferrous sulfate. The following benefits of chemical oxidation with RegenOx™ were evaluated for oxidation treatment of product and include:

- Rapid and sustained oxidation on petroleum chemical compounds
- Detergent-like, contaminant desorption effects
- Generates minimal heat and pressure
- Compatible with underground infrastructure
- Easily applied with rotary drilling equipment
- Destroys a broad range of contaminants
- Enhances subsequent bioremediation
- Avoids detrimental impacts to groundwater
- The action of oxidation lasts up to 30 days for each injection

Application of RegenOx™ by injection into treatment boreholes (injection points) is a feasible remedial technology for reduction of product in the upper 10 feet of the bedrock formation. Therefore, the targeted injection zone for the RegenOx™ treatment boreholes is the upper 10 feet of bedrock.

The desorption-surfactant like effect of RegenOx™ draws the contaminant off the groundwater surface and into solution (dissolved phase) like a detergent. Contaminants reach the catalytic surface





where localized free-radical generation occurs leading to efficient contaminant destruction as RegenOx™ is released into the groundwater. The primary oxidation mechanisms destroy petroleum chemical compounds in the subsurface upon contact with the RegenOx™ slurry (solution).

## **10.0 INSTALLATION OF RegenOx™ TREATMENT BOREHOLES**

A total of 11 treatment boreholes are proposed for the initial application into the locations shown on Figure 1 and 11 treatment boreholes are proposed for the final (second) application of RegenOx™. Each treatment borehole will be advanced through the overburden soils with 4-1/4 in I.D. augers to the top of the bedrock surface. The augers will be removed and 4-inch I.D. flush joint casing will be installed through the overburden borehole and seated into the top of bedrock. A 3 7/8 inch O.D. roller bit will be used to flush soils from the flush joint casing (temporary casing). The remaining section of the treatment borehole will be advanced into the bedrock formation by drilling with a rock core barrel to a depth of approximately 10 feet into bedrock, see Figure 2 - Typical RegenOx™ Treatment Borehole Detail. The rock core sample is removed to complete the treatment borehole. A geologist will be responsible for logging the bedrock and making field recommendations regarding the completeness of the treatment borehole and changes for the RegenOx™ slurry batch, if required. The bedrock portion of the treatment borehole is approximately 3 inches in diameter and 10 feet in length. The overall depth of the treatment boreholes is approximately 25 feet. The treatment boreholes are to be installed on 9-foot centers at the approximate locations shown on Figure 1.

Soils removed from the boreholes during overburden drilling will be field screened with a photoionization detector (PID) for total organic vapors during the installation of the treatment boreholes. Soils that do not have elevated measurements above 10 parts per million (ppm) may be used as backfill for the treatment boreholes. Treatment boreholes will only be open for the time required to inject the RegenOx™ slurry. However, a temporary casing may be installed in a treatment borehole that does not accept the complete amount of RegenOx™ during the initial injection period. The remaining amount of RegenOx™ may be injected through the casing at a later time.

## **11.0 RegenOx™ SLURRY APPLICATION**

RegenOx™ will be mixed (batched) according to the manufacturer's specifications. RegenOx™ prepared in slurry will be directly applied into the subsurface in each of the treatment boreholes installed on 9 foot center spacing at the locations selected in the treatment areas. The proposed locations of the treatment boreholes are shown on the attached Figure 1. The second application, if required, will also include injection into 11 treatment boreholes using the same mixing and injection techniques. The second application will occur approximately 2 weeks after the initial application. During the time between applications the groundwater pH will be monitored and other parameters will be evaluated.

Approximately 10 lbs. of RegenOx™ Part A (oxidant) and 10 lbs. of Part B (Activator) will be combined in water for a 3% to 5% solution per foot of injection zone and pumped into the treatment boreholes through the drill steel rods and packer assembly. The rubber membrane of the packer will be inflated with 100 psi of nitrogen gas to seal the inside of the flush joint casing and top of bedrock interface. The injection zone (vertical injection area) is from approximately 13 feet to 23 feet. An estimate of approximately 2,640 lbs. of RegenOx™ (part A and part B combined) will be required for the first and second applications for a total of 5,280 lbs., see Appendix A. The RegenOx™ slurry level will be maintained at a level near the top of bedrock at each treatment borehole after the temporary steel flush joint casing is removed and prior to placement of backfill materials to ground surface. Non-





impacted soils generated for the treatment boreholes may be used as backfill and returned into the boreholes. If impacted soils are generated then they may not be used for backfill and will be managed in accordance with the requirements detailed in the ROD (drummed, labeled and transported off-site for landfill disposal).

The RegenOx™ slurry will be pumped into the injection zone per the methods below:

- Pre-measured quantity of RegenOx™ Oxidizer will be placed into the pre-measured volume of water to make the desired target % oxidant in solution. As a safety precaution the oxidizer should be poured into water. The water and oxidant will be mixed with a power drill and paint stirrer or other mechanical mixing device to ensure that the Oxidizer has dissolved in the water. The following slurry batches may be used:
  - 3% oxidant solution for every 10 lbs of oxidant and 10 lbs of activator (20 lbs total RegenOx™) with 38 gallons of water.
  - 4% oxidant solution for every 10 lbs of oxidant and 10 lbs of activator (20 lbs total RegenOx™) with 28 gallons of water.
  - 5% oxidant solution for every 10 lbs of oxidant and 10 lbs of activator (20 lbs total RegenOx™) with 22 gallons of water.
- An inflatable rubber packer will be placed into the top of rock borehole to seal the bedrock borehole during the injection of the RegenOx slurry through drill rods pipe that extends from the ground surface to the packer. The RegenOx™ slurry will be injected at approximately 1/2 psi to 3 psi until the amount per foot is injected. The estimated quantity of RegenOx per treatment borehole is 240 lbs.
- The flush joint steel casing will be removed and additional RegenOx™ slurry may be added by gravity tremie to a level that is approximately at the top of the bedrock formation to complete the injection of slurry in the treatment zone, if required.
- A temporary 2-inch diameter PVC casing may be placed in the borehole after the steel flush joint casing is removed. The bottom 10 foot section will be perforated to allow for additional RegenOx slurry to be added to the borehole by gravity tremie during the course of the injection process, if all of the slurry is not injected during the initial injection.
- The temporary PVC casing will be removed and the borehole backfilled to ground surface after the injection process is completed as detail in section 12.0.

## **12.0 BACKFILLING OF RegenOx™ TREATMENT BOREHOLES**

Each treatment borehole will be backfilled to the ground surface after the injection of RegenOx™ slurry is completed. The injection zone from approximately top of bedrock (approximately 14 feet) to the bottom of the treatment borehole (approximately 24 feet) will be backfilled with bentonite to seal the bedrock interval. The backfill from the bottom of the overburden to approximately 2 feet will consist of soils from the treatment borehole that did not indicate visual impacts or elevated Photoionization detector measurements above 10 part per million (ppm). If there is not enough soil from the installation of the borehole to complete the backfilling then bentonite will be installed for this



interval of the treatment borehole. The backfill from approximately 2 feet to ground surface feet will consist of concrete surface seal. See Figure 3 - Typical RegenOx™ Borehole Backfill Detail.

### **13.0 GROUNDWATER SAMPLING AND PARAMETER MONITORING**

A post-application groundwater sampling event will occur approximately 2 weeks after the first application of RegenOx™. Groundwater sampling and parameter monitoring will be performed at monitoring wells MW-4, MW-7, MW-9, and MW-15. The results from this sampling event will be used to evaluate if a second application is required based on the thickness of product, concentrations of petroleum chemical compounds, the levels of pH in groundwater at these well locations. It is anticipated that petroleum chemical compounds in the dissolved phase groundwater may increase after the first application and would be further reduced after a second application. It is not possible to calculate the total amount of product in the subsurface using the current data from the site. However, it appears that the product distribution is limited and the relatively thin thickness suggests that the product thickness may be reduced after the first application. Subsequent to the second application a second groundwater sampling event will be performed approximately 90 days after the second application to evaluate the remaining concentrations of petroleum chemical compounds that will be remediated by implementation of the combined oxygen injection system with soil vapor extraction that is presented in the NYSDEC ROD.

### **14.0 CLASS V INJECTION WELL DOCUMENTATION**

The treatment boreholes (injection wells) are by definition type code 5X26 aquifer remediation related wells under the EPA Region 2 List of Class V Injection Well Types. The EPA Direct Implementation program requires at a minimum the following inventory information must be submitted for each Class V well:

- facility name and location
- name and address of legal contact
- ownership of facility
- nature and type of injection well(s); and operating status of injection well(s)

A list of all wells owned or operated along with the following information for each well is also required. (A single description of wells at a single facility with substantially the same characteristics is acceptable).

- Location of each well or project given by latitude and longitude to the nearest second
- Date of completion of each well;
- Identification and depth of the underground formation(s) into which each well is injecting
- Total depth of each well
- Construction narrative and schematic (both plan view and cross-sectional drawings)
- Nature of the injected fluids
- Average and maximum injection pressure at the wellhead
- Average and maximum injection rate
- Date of the last inspection

Since the wells are the same construction, injection depth /formation, and approximate depth the information and installation details for one of the injection wells may satisfy for the EPA Region 2



inventory requirements. The EPA program director may require other information believed necessary to protect underground sources of drinking water. EPA form OMB No. 2040-0042 must also be submitted as part of the required class V injection well inventory. See Appendix B – EPA Class V Injection Well Inventory Form.

## 15.0 HEALTH AND SAFETY

Upon combining RegenOx™ Part A and Part B, a mild exothermic reaction begins. This reaction results in minimal heat and pressure generation, allowing field application of RegenOx™ to be accomplished safely and without the use of highly specialized equipment or specialty contractors. As with all oxidants, proper health and safety procedures must be followed. Contractors shall follow Regenesys® safety guidance information for all aspects of storage and use of RegenOx™.

The requirements of the project health & safety plan and community air monitoring program (CAMP) will also be implemented during the drilling of treatment boreholes.

## 16.0 ANTICIPATED PROJECT SCHEDULE

The project should begin in November and will be completed by mid- December 2011. The following is the approximate timeframe for the project work.

<u>Project Task</u>	<u>Weeks</u>
• Install treatment boreholes and complete initial injections.....	2
• Groundwater sample event .....	2
• Period between RegenOx™ injections .....	2
• Second injection of RegenOx™ .....	2 to 4

Groundwater sample laboratory results will be provided to the NYSDEC approximately one month after the results are received and a progress report.

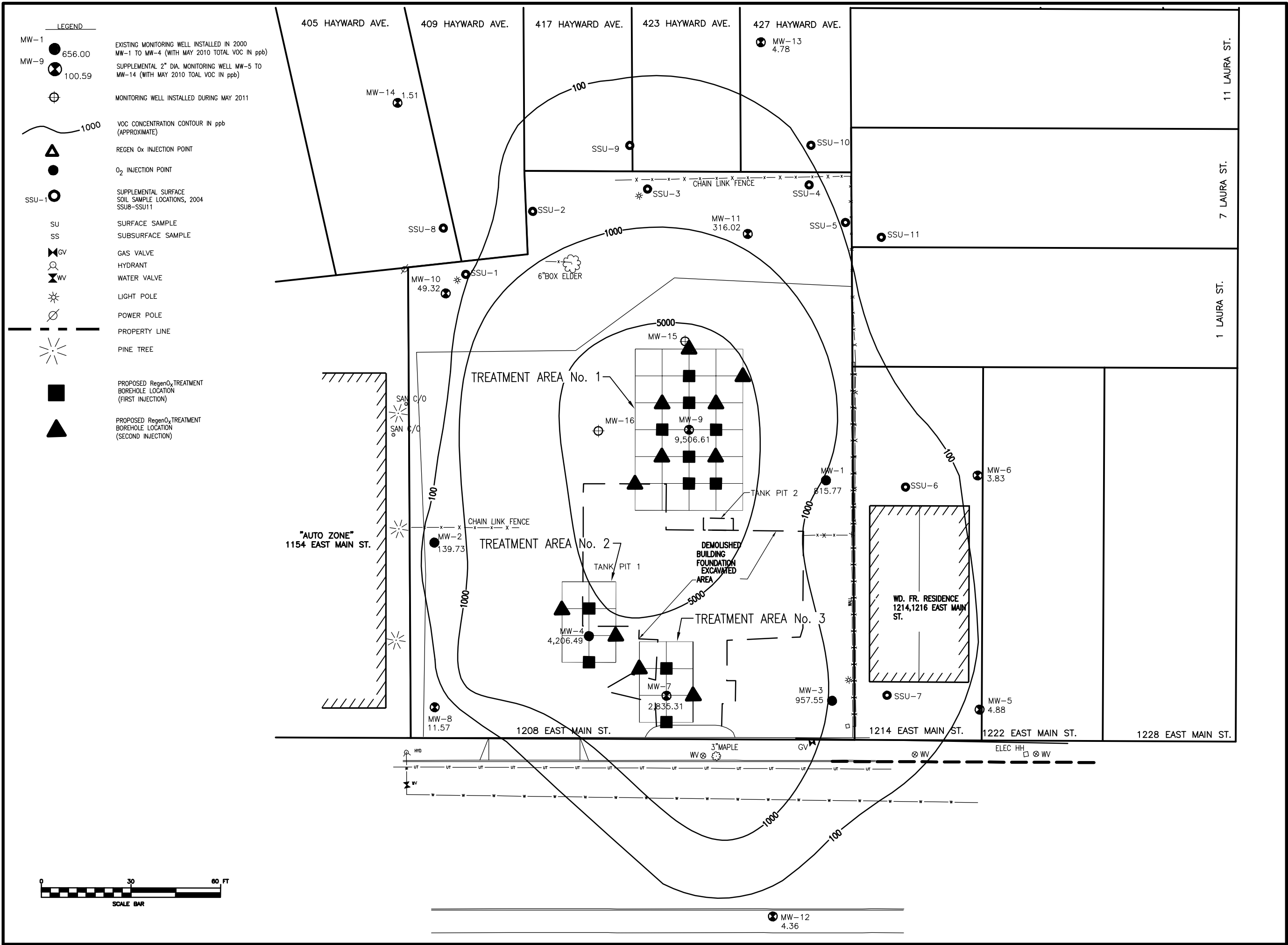
## 17.0 REFERENCES

Principles of Chemical Oxidation Technology for the Remediation of Groundwater and Soil, Design and application Manual V 3.0 Regenesys 2011.

Environmental Restoration Project Record of Decision 1200 East Main Street Site City of Rochester, Monroe County, New York Site Number B-00129-8 March 2006



## FIGURES



**CITY OF ROCHESTER**  
1200 EAST MAIN ST.  
ROCHESTER, NY  
14614

**REMEDIATION PROGRAM**



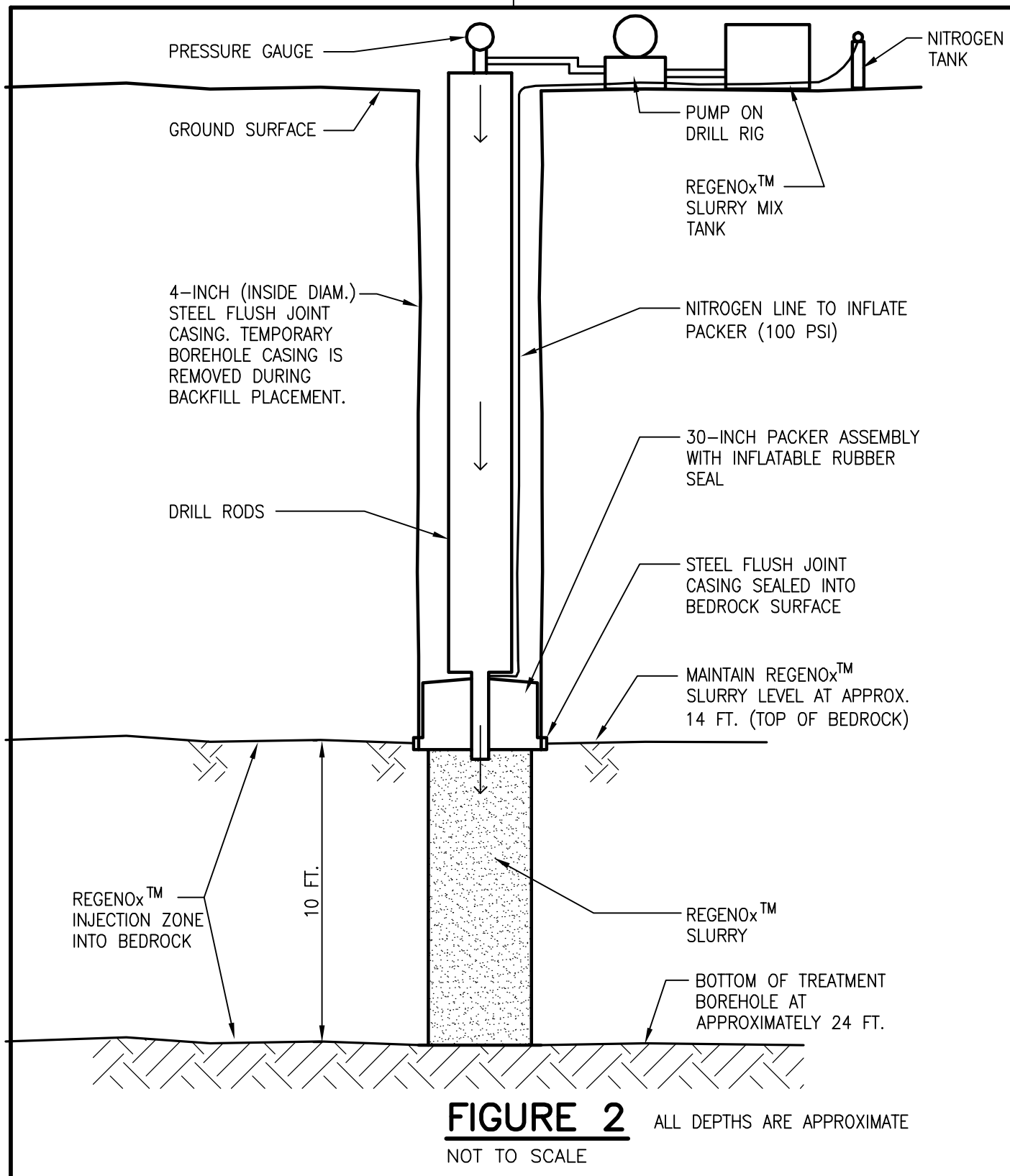
REVISIONS				
NO.	DATE	DESCRIPTION	REV.	CKD.

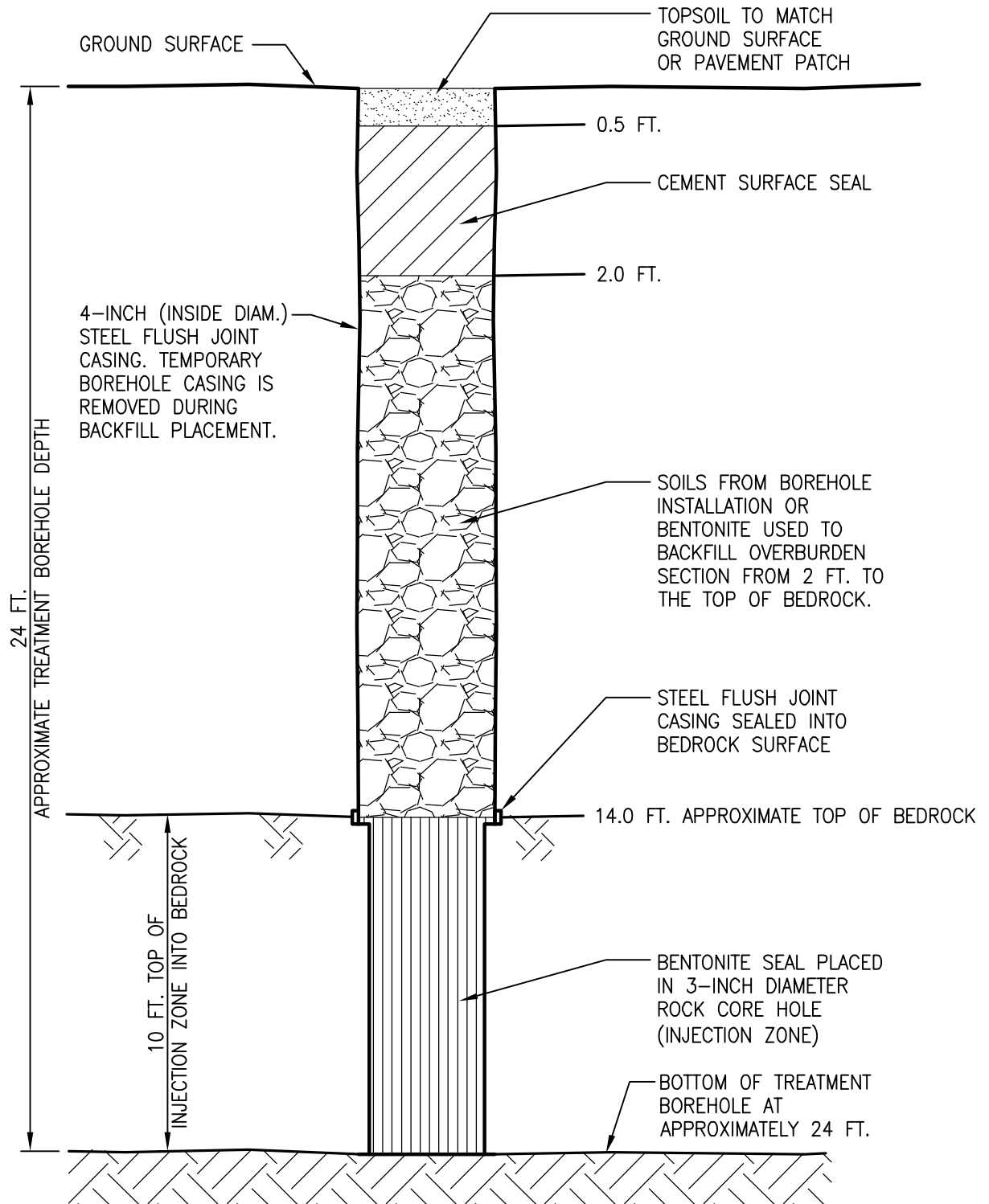
NOTE:  
Unauthorized alteration or addition to this drawing is a violation of the New York State Education Law Article 145, Section 7209.

**CONTAMINANT REDUCTION ACTION PROPOSED  
TREATMENT BOREHOLES  
FOR APPLICATION OF RegenO<sub>x</sub>™**

Project Manager:	GF
Designed by:	SD
Drawn by:	CD
Checked by:	SD
Date Issued:	JUNE 2011
Scale:	AS SHOWN
Date:	
Project Number:	4454.04
File Name:	W:\WR\jobs\COR\1200EastMain\Draws\FIG 3 2011.dwg
Drawing Number:	

**FIGURE 1**





**FIGURE 3**  
NOT TO SCALE

ALL DEPTHS AND THICKNESS  
ARE APPROXIMATE



## **APPENDIX A**



Consultant: Bergman

Number of RegenOx application (first, second, third, fourth . . . )

Is NAPL present? (yes or no)

Estimated Plume Requiring Treatment

Width of plume (intersecting gw flow direction)

Length of plume (parallel to gw flow direction)

Depth to contaminated zone

Thickness of contaminated zone

Nominal aquifer soil (gravel, sand, silty sand, silt, clay)

Total porosity

Hydraulic conductivity

Hydraulic gradient

Seepage velocity

Total Pore Volume

first			
no			
66	ft		
24	ft	1,584	ft <sup>2</sup>
3	ft	0.1	
12	ft		
bedrock		<-(not recognized, enter Kh or Vs below)	
0.2		Effective porosity:	0.2
0.6	ft/day		2.1E-04 cm/sec
0.05	ft/ft		
54.8	ft/yr		0.150 ft/day
3,802	ft <sup>3</sup>		28,440 gallons

Dissolved Phase Oxygen Demand:

Individual species that represent oxygen demand:

Benzene

Toluene

Ethylbenzene

Xylenes

Tetrachloroethene (PCE)

Trichloroethene (TCE)

cis-1,2-dichloroethene (DCE)

Vinyl Chloride (VC)

nap

TPH

Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
1.00	0.2	12.7	4
3.00	0.7	11.9	11
1.00	0.2	15.7	5
15.00	3.6	15.7	73
0.00	0.0	1.3	0
0.00	0.0	2.4	0
0.00	0.0	4.3	0
0.00	0.0	8.4	0
0.00	0.0	9.8	0
30.00	7.1	12.0	111

\* stoichiometries listed for petroleum hydrocarbons assume partial oxidation to biodegradable intermediates

Measures of total oxygen demand

Estimated total oxidant demand

Known total oxidant demand (from bench test)

10.00	g oxidant/kg soil	Total oxidant demand =	20,884	lbs
0.00	g oxidant/kg soil	Total oxidant demand =	0	lbs

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density

Fraction of organic carbon (foc)

(Estimated using sorbed phase = foc\*Koc\*Cgw)

(Adjust Koc as necessary to provide realistic estimates)

Individual species that represent oxygen demand:

Benzene

Toluene

Ethylbenzene

Xylenes

Tetrachloroethene (PCE)

Trichloroethene (TCE)

cis-1,2-dichloroethene (DCE)

Vinyl Chloride (VC)

nap

TPH

Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
123	0.12	0.3	12.7	4
267	0.80	1.7	11.9	26
327	0.33	0.7	15.7	14
298	4.47	9.3	15.7	191
371	0.00	0.0	1.3	0
122	0.00	0.0	2.4	0
80	0.00	0.0	4.3	0
2.5	0.00	0.0	8.4	0
1000	0.00	0.0	9.8	0
373	11.19	23.4	12.0	365

Summary of Estimated RegenOx Requirements

	Dissolved Phase Oxidant Dose (lbs)	Sorbed Phase Oxidant Dose (lbs)	RegenOx Safety Factor	Total RegenOx Oxidant Dose (lbs)	RegenOx Oxidant Cost
Stoichiometric Oxidant Dose	203	599	3.0	2,408	\$4,767
Known Total Oxidant Demand			100%	0	\$0
Oxidant material requirement			1%	2595	\$5,139

Required RegenOx oxidant quantity (in 30 lb increments) -----&gt;

2,610 lbs RegenOx oxidant

Delivery Design for RegenOx

Spacing within rows (ft)

# points per row

Spacing between rows (ft)

# of rows

Advective travel time bet. rows (days)

Number of points in grid

Oxidant application rate (lbs/ft)

Total RegenOx oxidant required

Total RegenOx activator required

15.0	ft
5	points/row
15.0	ft
2	rows
100	days
10	points
21.8	
2,610	lbs of RegenOx oxidant
2,610	lbs of RegenOx activator

Mixing Volume for Injections

Volume of pore space (effective)

Percent of pore space occupied by RegenOx solution

Amount of RegenOx activator required for injection

Amount of water required for injection

Percent oxidant in solution

Volume of water required per foot of injection

Amount of oxidant required per foot of injection

Amount of activator required per foot of injection

Total volume of solution injected per foot of injection

Radial influence (assuming 100% pore volume displacement)

Estimated efficiency factor

grams of oxidant per kg of soil

oxidant concentration

price per cubic yard of soil treated

3802	ft <sup>3</sup>
10%	
2,880	lbs
2,595	gallons
10.51%	
19.7	gallons
21.8	lbs
21.8	lbs
24.0	gallons
2.3	feet
0.75	
1.38	g/kg
12135	mg/L
\$0.00	

Project Summary

Number of RegenOx delivery points (adjust as necessary for site)

RegenOx oxidant application rate in lbs/ft (adjust as necessary for site)

RegenOx oxidant material requirement (lbs)

Number of 30 lb RegenOx oxidant buckets

RegenOx activator application rate in lbs/ft (adjust as necessary for site)

RegenOx activator material requirement

Number of 30 lb RegenOx activator buckets

Bulk RegenOx material requirement for single injection

Unit cost of RegenOx (per pound)

Total RegenOx material cost for single injection

Shipping and Tax Estimates

Sales Tax

rate: 0.00%

Total Material Cost

Shipping (call for amount)

Total Regenesix Material Cost

RegenOx Injection Cost Estimate (responsibility of customer to contract work)

Footage for each point = uncontaminated interval + RegenOx injection interval (ft)

Total length for direct push for project (ft)

Estimated daily installation rate (ft per day: 200 for push, 100 for drilling)

Estimated points per day (7 to 20 is typical for direct push)

Required number of days

Mob/demob cost for injection subcontractor

Daily rate for injection subcontractor

Total injection subcontractor cost for application

Total Install Cost (not including consultant, lab, etc.)

Other Project Cost Estimates

Design

Permitting and reporting

Construction management

Groundwater monitoring and rpts

Other

Other

Other

Other

Total Project Cost

## **APPENDIX B**

<p>United States Environmental Protection Agency Office of Ground Water and Drinking Water Washington, DC 20460</p> <p><b>UIC Federal Reporting System</b> <b>Part III: Inspections</b> <b>Mechanical Integrity Testing</b> (This information is solicited under the authority of the Safe Drinking Water Act)</p>				<p><b>I. Name and Address of Reporting Agency</b></p> <p>United States Environmental Protection Agency</p>				
<p><b>II. Date Prepared (month, day, year)</b></p>		<p><b>III. State Contact (name, telephone no.)</b></p>		<p><b>IV. Reporting Period (month, year)</b></p> <p>From <u>October 31, 2011</u> To <u>December 31, 2011</u></p>				
				<p><b>Class and Type of Injection Wells</b></p>				
				I	II	III	IV	V
				SWD 2D	ER 2R	HC 2H		
<p><b>V.</b> Summary of Inspections</p>	Total Wells	A	Number of Wells Inspected					22
	Total Inspections	B	1. Number of Mechanical Integrity Tests (MIT) Witnessed					
			2. Number of Emergency Response or Complaint Response Inspections					
			3. Number of Well Constructions Witnessed				22	
			4. Number of Well Pluggings Witnessed				22	
			5. Number of Routine/Periodic Inspections					
<p><b>VI.</b> Summary of Mechanical Integrity  (MI)</p>	Total Wells	A	Number of Wells Tested or Evaluated for Mechanical Integrity (MI)					
	Total Wells	B	No. of Rule-Authorized Wells Tested/Evaluated for MI	Passed 2-part test				
				Failed 2-part test				
	For Significant Leak	C	1. Number of Annulus Pressure Monitoring Record Evaluations		Well Passed			
					Well Failed			
			2. No. of Casing/Tubing Pressure Tests		Well Passed			
					Well Failed			
			3. Number of Monitoring Record Evaluations		Well Passed			
					Well Failed			
			4. No. of Other Significant Leak Tests/Evaluations (Specify)		Well Passed			
					Well Failed			
	For Fluid Migration	D	1. Number of Cement Record Evaluations		Well Passed			
					Well Failed			
			2. Number of Temperature/Noise Log Tests		Well Passed			
					Well Failed			
			3. No. of Radioactive Tracer/Cement Bond Tests		Well Passed			
			Well Failed					
4. No. of Other Fluid Migration Tests/Evaluations (Specify)			Well Passed					
			Well Failed					
<p><b>VII.</b> Summary of Remedial Action</p>	Total Wells	A	Number of Wells with Remedial Action					22
	Total Remedial Actions	B	1. Number of Casing Repaired/Squeeze Cement Remedial Actions					
			2. Number of Tubing/Packer Remedial Actions				22	
			3. Number of Plugging/Abandonment Remedial Actions				22	
			4. Number of Other Remedial Actions (Specify)					

**VIII. Remarks/Ad Hoc Report** (Attach additional sheets)

**Certification**

I certify that the statements I have made on this form and all attachments thereto are true, accurate, and complete. I acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Signature and Typed or Printed Name and Title of Person Completing Form	Date	Telephone No.
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## Instructions and Definitions

(All reporting is cumulative, year to date, and begins with October 1.)

### Section V. Summary of Inspections

A complete inspection should include an assessment of: the well head, pressure and flow meters, pipeline connections, and any other equipment associated with the injection system; an inspection is complete only when a report has been filed with the regulating authority.

Item A: Enter under each well class the number of wells that have been inspected this year to date. These totals track the percentage of the injection well universe inspected each year. Enter a well only once each year.

Total Inspections: (This year to date)

Item 1: Enter under each well class the number of inspections to witness field Mechanical Integrity Tests. (At least 25% of MITs performed by operators each year should be witnessed.)

Item 2: Enter under each well class the number of inspections that have been in response to a problem reported to the regulating authority.

Item 3: Enter under each well class the number of inspections of well constructions or any preoperational activities.

Item 4: Enter under each well class the number of inspections of well pluggings or pluggings and abandonment.

Item 5: Enter under each well class the number of inspections that have been routine/periodic.

### Section VI. Summary of Mechanical Integrity

A complete MIT is composed of a test for significant leaks in the casing, tubing or packer and a test for significant fluid migration into a USDW through vertical channels adjacent to the well bore. An MIT consists of a field test on a well or an evaluation of a well's monitoring records (i.e., annulus pressure, etc.) or cement records. At a minimum, the mechanical integrity of a Class I, II, or III (solution mining of salt) well should be demonstrated at least once every five years during the life of the well.

Item A: Enter under each well class the number of wells that have had a complete MIT this year to date. These totals track the percentage of the injection well universe tested for MI each year. Enter a well only once each year.

Item B: Enter under the appropriate well class the number of rule authorized wells that have passed a complete MIT and the number that have failed a complete MIT this year to date.

Item C: Significant Leak Tests: (This year to date)

Item 1-4: Enter under each well class the number of times wells have passed or failed a field test/record evaluation for significant leaks (be specific).

Item D. Fluid Migration Tests: (This year to date)

Items 1-4: Enter under each well class the number of times wells have passed or failed a field test/record evaluation for fluid migration (be specific).

### Section VII. Summary of Remedial Action

A failure of mechanical integrity (MI) may occur at any time during the life of an injection well until it is plugged and abandoned in accordance with a preapproved plan. Failure may be identified during an inspection, a field test, an evaluation of well records, or during routine operation of a well. Remedial actions include additional permit conditions, monitoring or testing, or one of the actions specified below.

Item A: Enter under each well class the number of wells that have received remedial actions this year to date. This total tracks the percentage of the injection well universe that have received remedial action each year. Enter a well only once each year.

Total Remedial Actions: (This year to date)

Item 1-4: Enter under each well class the number of times that wells have received remedial action (be specific).

#### Paperwork Reduction Act

The public reporting and record keeping burden for this collection of information is estimated to average 5 hours per response. Burden means the total time, effort, or financial resource expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal Agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822), 1200 Pennsylvania Ave., NW., Washington, DC 20460. Include the OMB control number in any correspondence. Do not send the completed forms to this address.