CSXT RIVER STREET DERAILMENT PROJECT
EHC-O™ INJECTION WORK PLAN
480 RIVER STREET
ROCHESTER, NEW YORK

May 28, 2007

Prepared for:
CSX Transportation, Inc.
500 Water Street, J-275
Jacksonville, FL 32202

Submitted to:
New York State Department of Environmental Conservation
Region 8
6274 East Avon-Lima Road
Avon, New York 14414

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1.0 INTRODUCTION

On behalf of CSX Transportation, Inc. (CSXT), AMEC Earth and Environmental, Inc. (AMEC) has prepared this EHC-O™ injection work plan. The work plan will detail the proposed scope of work to inject and monitor the EHC-O™ bioremediation amendment which will address the residual methylene chloride and acetone soil impacts at the River Street Derailment, Rochester, NY site (Site) in both the saturated and unsaturated zones. The work plan has been prepared in conjunction with Adventus Americas, Inc. (AAI), the EHC-O™ technology provider.

2.0 BACKGROUND

On December 23, 2001 at 3:40 p.m., a CSXT train derailed in Rochester, New York, north of the Latta Road and River Street intersection. As a result of the derailment, diesel (3,000 gallons (gal)), acetone (14,000 gal) and methylene chloride (16,000 gal) were released to the surrounding area including the Genesee River.

An interim remedial measures (IRM) work plan for impacted soils and groundwater was developed and implemented in the summer of 2002. The IRM activities included the excavation and disposal of approximately 1,700 tons of petroleum impacted soil, 28,000 tons of methylene chloride and/or acetone impacted soils, and the removal and disposal of 1.4 million gallons of impacted water. The 2002 IRM activities were successful in removing all of the petroleum impacted soil and the vast majority of the methylene chloride and acetone containing soils from the affected properties.

Following these IRM activities, a subsurface investigation was conducted over the course of several months in the summer of 2004 to determine to what extent, if any, residual impacts remained in the subsurface. This included a soil gas survey, dense non-aqueous phase liquid (DNAPL) sampling, soil sampling and groundwater sampling.

To further evaluate the presence of residual chemicals of concern (COC) concentrations in subsurface soils at the Site, AMEC implemented a three stage investigation conducted in October 2006, November 2006 and January 2007. The investigation was implemented to confirm the presence, or lack there of, residuals in Site soils since the 2002 IRM and August 2004 samples were evaluated.

3.0 RESIDUAL IMPACTS

Based on analytical data collected during the IRM and 2004 subsurface investigation activities, three areas of concern (AOCs) were initially identified as having residual concentrations of methylene chloride and acetone that exceeded the identified site-specific cleanup levels.

The initial on-land AOCs that exceeded the New York State Department of Environmental Conservation Technical and Administrative Guidance Memorandum 4046 Recommended Soil Clean-up Objectives (TAGM 4046 RSCOs) were: (1) Soils in the vicinity of the CSXT railroad tracks (Tracks AOC); (2) soils located in the north end of the Tapecon parking lot (N. Tapecon AOC); and (3) soils in an area on the City of Rochester property (East AOC).

A further evaluation of the Site's on-land residuals was conducted in the fall 2006 and winter 2007 through a focused supplemental subsurface investigation. The investigation was conducted by collecting soil samples at each of the locations where either CSXT or the City had identified residual COCs during the IRM or the 2004 subsurface investigation activities detailed above. Soil was collected at 36 locations from the depths where residuals were previously identified.

Review of the analytical data generated during this supplemental subsurface investigation determined that significant attenuation of the residual COCs occurred and likely continues. Various natural processes have effectively reduced the concentrations of residual COCs in the Track and East AOCs in half and eliminated the residual COCs in the N. Tapecon AOC.

The AOCs and the associated residual sample locations are illustrated on **Figure 1**.

4.0 CLEANUP CRITERIA

Soil and groundwater analytical results for the COCs generated during the various Site IRM actions were evaluated against site-specific cleanup levels derived from the two potentially applicable standards, criteria, and guidance (SCGs): NYSDEC TAGM 4046 RSCOs; and the NYSDEC Division of Water Technical and Operational Guidance Series 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Concentrations (TOGS 1.1.1).

The NYSDEC TOGS 1.1.1 identifies a guidance concentration of 50 micrograms per liter (µg/L) for acetone and a water quality standard concentration of 5 µg/L for methylene chloride. Since completion of the IRMs, there have been no exceedances of the applicable TOGS 1.1.1 groundwater quality standards and guidance.

As detailed above, during the initial IRM activities, residual COC concentrations were compared to the RSCOs as established by the applicable TAGM 4046 guidance document. The NYSDEC TAGM 4046 identifies RSCOs above the water table for acetone and methylene chloride of 200 micrograms per kilogram (µg/kg) and of 100 µg/kg for respectively and calculated RSCOs of 44 ug/kg and 40 ug/kg, respectively below the groundwater table. The results of the IRM confirmation sampling, the 2004 subsurface investigation and the 2006/2007 supplemental subsurface investigation sampling indicate that exceedances of the applicable TAGM 4046 RSCOs remain.

Soil analytical results generated during the injection program will also be evaluated against the Soil Cleanup Objectives (SCOs) detailed in Table 375-6.8 of the newly amended 6 NYCRR Part 375. Although the SCOs have been challenged in court, unless and until voided, they are the relevant and appropriate criteria to be considered. Table 375-6.8 sets forth the SCOs which are protective of public health for unrestricted and restricted use, protective of groundwater quality and protective of ecological resources. However, the protection of groundwater quality SCOs are not relevant and appropriate because the IRM removed the source of contamination, the area is served by public water, and there has not been an exceedance of the applicable groundwater quality standards and guidance since the completion of the IRM. In addition, because the soils containing the COCs are not accessible to wildlife, the protection of ecological resources SCOs are not relevant and appropriate.

As detailed in Table 375-6.8(a), the Protection of Public Health – Residential SCOs (Residential SCOs) for acetone is 100,000 ug/kg and for methylene chloride is 51,000 ug/kg. The protection of Public Health – Restricted Residential Use SCOs (Restricted Residential SCOs), which is applicable to multi-family housing, is 100,000 ug/kg for both acetone and methylene chloride. The SCOs for Protection of Public Health – Commercial (Commercial SCOs) for both acetone and methylene chloride is 500,000 ug/kg.

5.0 BENCH SCALE STUDY

In April through June of 2006, a bench scale study was conducted to evaluate the effectiveness of EHC™ (anaerobic biodegradation) and EHC-O™ (aerobic biodegradation) amendments mixed into representative soils collected from the Site. Both COCs are anaerobic and aerobic biodegradation pathways. The study was conducted at the laboratories of Adventus Americas, Inc. (AAI) in Mississauga, Ontario, Canada. The study included spiking of sub-average concentration samples collected from the site to better approximate the residual COC concentrations observed. The amendments were added to the groundwater and both the saturated and unsaturated soils. Degradation of the COCs was observed in four sampling events spread over 70 days. The objective was to determine whether the anaerobic or aerobic pathways for degradation of the COCs could be optimized.

Results from the test were mixed. AAI reported a decrease in COC concentrations in both the saturated and unsaturated control samples that did not contain any amendment. The decrease in the control soils was observed and was most likely the result of the soils being handled during collection and spiking, thereby being altered from their natural state exposing additional surface area, introducing oxygen, and possibly activating slow or dormant microbes.

AAI observed a decrease in COC concentrations in saturated soils that was faster and more complete than the decrease observed in the control indicating that the EHC™/EHC-O™ compounds were working effectively in the saturated zone. However, the unsaturated soils had similar results to those observed in the controls, with no major advantage observed for either amendment.

Overall, the results of this study identified that the EHC-O™ amendment would be able to treat acetone and methylene chloride in the saturated zone and potentially the unsaturated zone. The most significant difference in the saturated and unsaturated tests was the presence of higher moisture in the former.

6.0 EHC-O™ TECHNOLOGY

EHC-O™ is an integrated source of oxygen; major-, minor-, and micro-nutrients; and a pH buffering agent. This unique combination of materials facilitates the aerobic bioremediation of various organic and inorganic compounds including the COCs, impacting soils, sediment or groundwater. EHC-O™ will significantly stimulate the catabolic activity of the indigenous microflora, thereby accelerating the rate of constituent removal.

The amendment is supplied in 30 or 35 pound (lb) pails as a powder which can be mixed with soil or slurried in water. Application techniques vary widely depending on specific site conditions. For this remedial event, the application method selected will be injection of the amendment as a slurry directly into the subsurface utilizing Geoprobe® direct push technology. In specific locations, injection depths close to the surface may not allow direct push injection without surfacing of the amendment. In those instances, the ECH-O™ amendment may be surface applied or added as a thin slurry through a temporary injection pipe. **Appendix A** contains manufacturer literature on EHC-O™.

7.0 TREATMENT ZONES AND ESTIMATED MASS OF EHC-O™

To address the remaining residual subsurface COCs the work will be implemented in two main components; a blanket injection of the amendment between GP-6 and GP-9 which incorporates the center of the Track Excavation including GP-5 and SB-11/BT-2; and focused injections at areas GP-1, GP-2, GP-13, GP-24, GP-29, GP-30, GP-32, GP-34, GP-37 and GP-38 as detailed on the attached **Figure 2**.

Various methodologies to apply the amendment were considered, including soil mixing, injection through a well network using existing wells and newly installed wells, injection through horizontal wells, and direct push injection. Only direct push injection allowed for application at a specific depth, the ability to complete the injection without significantly impacting rail and vehicular traffic, and permitted the selection of injection point locations around utilities. The projected number of injection points and pounds of product required are presented below.

Injection Point Details

Location	# of Injection Points	Pounds of EHC-O™
Track AOC	29	10,990
East AOC	4	1,675
Totals	**33**	**12,665**

The quantity of the injection points is based on a conservative radius of influence of 20 feet. Approximately 4,600 gallons of water will be required for preparing the 25 percent solids slurry of EHC-O™.

8.0 HEALTH AND SAFETY

AMEC has an established Health and Safety Plan (HASP) for this site and will prepare a Job Safety Analysis (JSA) for the pilot study that will be added to the HASP as an addendum. A copy of the JSA has been included with this work plan as **Appendix B** along with the EHC-O™ Material Safety Data Sheet (MSDS) as **Appendix C.**

9.0 FIELD ACTIVITIES

The attached **Figure 2** illustrates the 33 injection locations. The injections points that are concentrated in the area of SB-11 will be placed approximately 10' apart in all directions. Several of these locations will also focus on the unsaturated zone. The prescribed volume of slurry will be injected into each of the locations and dependant upon site conditions either saturated and or unsaturated soil layers will be targeted within each location.

The slurry will be prepared in the pails in which the ECH-O™ powder is shipped utilizing a portable mixer and a generator to power the equipment. Once the desired consistency of the slurry (25% solids) has been achieved, the material will be poured into the hopper of a GS 1000 high pressure grout pump (manufactured by Geoprobe®). The pump will then send the slurry material through the rod string to the desired depth. The injection and slurry preparation will be completed by Zebra Environmental Corp. (Zebra), a highly experienced amendment injection specialist, using a fully equipped vehicle mounted direct push unit.

The slurry will be injected into the subsurface utilizing a direct push unit, which will advance the rods to pre-determined depths for each location to begin the injection process. The slurry will be injected across various depth intervals, as the target volume is reached for each specific layer the rods will be extracted to the next injection layer, continuing the process until the hole is complete. A layer is considered to be a 2 ft. soil thickness into which the amendment will be delivered. In specific locations, injection depths close to the surface may not allow direct push injection without surfacing of the amendment. In those instances, the ECH-O™ amendment may be surface applied or added as a thin slurry through a temporary injection pipe. The application method will be a field-made decision based on existing field conditions and observations made during the injection process. Included as **Table 1** are the EHC-O™ injection quantities and associated injection intervals.

All equipment will be decontaminated between injection points with Alconox and water.

10.0 SAMPLING AND MONITOIRNG

Baseline sampling will be conducted by advancing five soil borings within the primary Track AOC to provide analytical data on the methylene chloride and acetone soil concentrations prior to the EHC-O™ injection event. Prior to injection, soils will be evaluated in two-foot increments documenting soil type and field screening results for volatile organic compounds (VOCs) utilizing two photoionization detectors (PIDs) with different lamps. Two PIDs are being utilized to capture both COCs. Acetone has an ionization potential of 9.69eV and methylene chloride's is 11.32eV, detectable by PIDs with 10.6 eV and 11.7 eV lamps, respectively. The plan is to collect one sample from each four-foot interval. The collected sample will be the one that exhibits as many (but at least one) of the following characteristics as possible: highest PID reading; soil/groundwater interface; change in soil type; and/or visual signs of impacts. If the soil within a particular four-foot interval does not exhibit any of the characteristics detailed above, then sample selection will be at the discretion of the sampler. The five sample locations are identified on **Figure 2**.

Following the injection event, samples will be collected for the purpose of effectiveness monitoring. This will occur in the immediate vicinity of the initial baseline samples as detailed above. Sampling frequency will be a minimum of three times during the next twelve months. Assuming that the injection date is month one, these samples will be collected at months 3, 6 and 12. The proposed sampling frequency is detailed below in **Section 11**. The five soil borings will be advanced, each until the designed treatment zone is reached. Two samples will be collected per boring. One sample will be collected from the top two feet of the treatment zone and one soil sample will be collected from the bottom two feet of the treatment zone. A record will be kept of the exact depth of the soil interval sampled so that a corresponding sample can be taken of the same soil interval during each sampling event. Soil headspace screening of the samples will be conducted utilizing two PIDs as discussed above. Readings will be recorded on the boring logs and included in the report to be completed following the event. Samples will be analyzed for the COCs and total organic carbon (TOC).

Groundwater samples will be collected in accordance with the current quarterly monitoring plan implemented at the site. During those sampling events, water from four wells, MW-4, MW-6, MW-7 and MW-8, will be analyzed for total heterotrophic plate counts, total and dissolved iron, chloride, sulfate, and nitrate, in addition to the VOCs. During each quarterly groundwater monitoring event, the 14 monitoring wells will have field parameters (pH, oxidation reduction potential, dissolved oxygen, temperature, and conductivity) documented and evaluated. The purpose of these analyses will be to document desired changes in the subsurface environment.

All collected samples will be placed in laboratory-provided containers, sealed, labeled and placed on ice, until shipment to Severn Trent Laboratory (STL) in Amherst, New York. Samples will be shipped under proper chain-of-custody and either hand delivered or sent via courier to the lab. All applicable analytical methods and sampling protocols will be followed.

The effectiveness monitoring reports will be prepared to document the soil and groundwater monitoring events. The reports will include, but not be limited to, discussion of the field activities, copies of the field logs, a tabulated results summary comparing analytical data to the applicable NYSDEC TAGM 4046 RSCOs, NYSDEC TOGS 1.1.1 values and the relevant and appropriate Table 375-6.8 Residential SCOs. Also included for review will be groundwater contour maps and a complete copy of the laboratory reports.

11.0 INJECTION SCHEDULE

The current schedule for conducting the injection work plan is the first half of July 2007 unless otherwise directed by the NYSDEC.

Estimated Remediation Schedule

Event	**2007**						**2008**					
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Injection	**X**											
Monitoring			**GW/S**			**GW/S**			**GW**			**GW/S**

GW – Groundwater
S - Soil

12.0 QUALITY CONTROL / QUALITY ASSURANCE

A sample is the physical evidence collected from the site. Strict control over possession and integrity of the samples will be maintained by ensuring integrity of all sample containers, establishing and maintaining the record of custody, and ensuring that each sample is protected and preserved properly during shipment.

Field quality control checks will monitor the data quality as it is affected by field procedures and conditions. The degree of effort (number of check samples per total samples taken) is stated in this section for each category. All field quality control samples are submitted blind (no location identifiers on the label) to the laboratory.

A rinseate blank, a sample of rinse water from final decontamination of sampling equipment (split spoons, etc), will be collected and forwarded to the laboratory for analysis. This sample will provide a measure of the degree of sampling equipment decontamination and possible cross-contamination between locations. A minimum of one rinseate blank will be submitted for each analytical parameter.

Blind field duplicates (as opposed to duplicate containers full of sample intended as backup) are sequential or co-located grab samples that are collected to monitor laboratory precision. A minimum of 10% of the total number of samples will be taken and submitted for analysis.

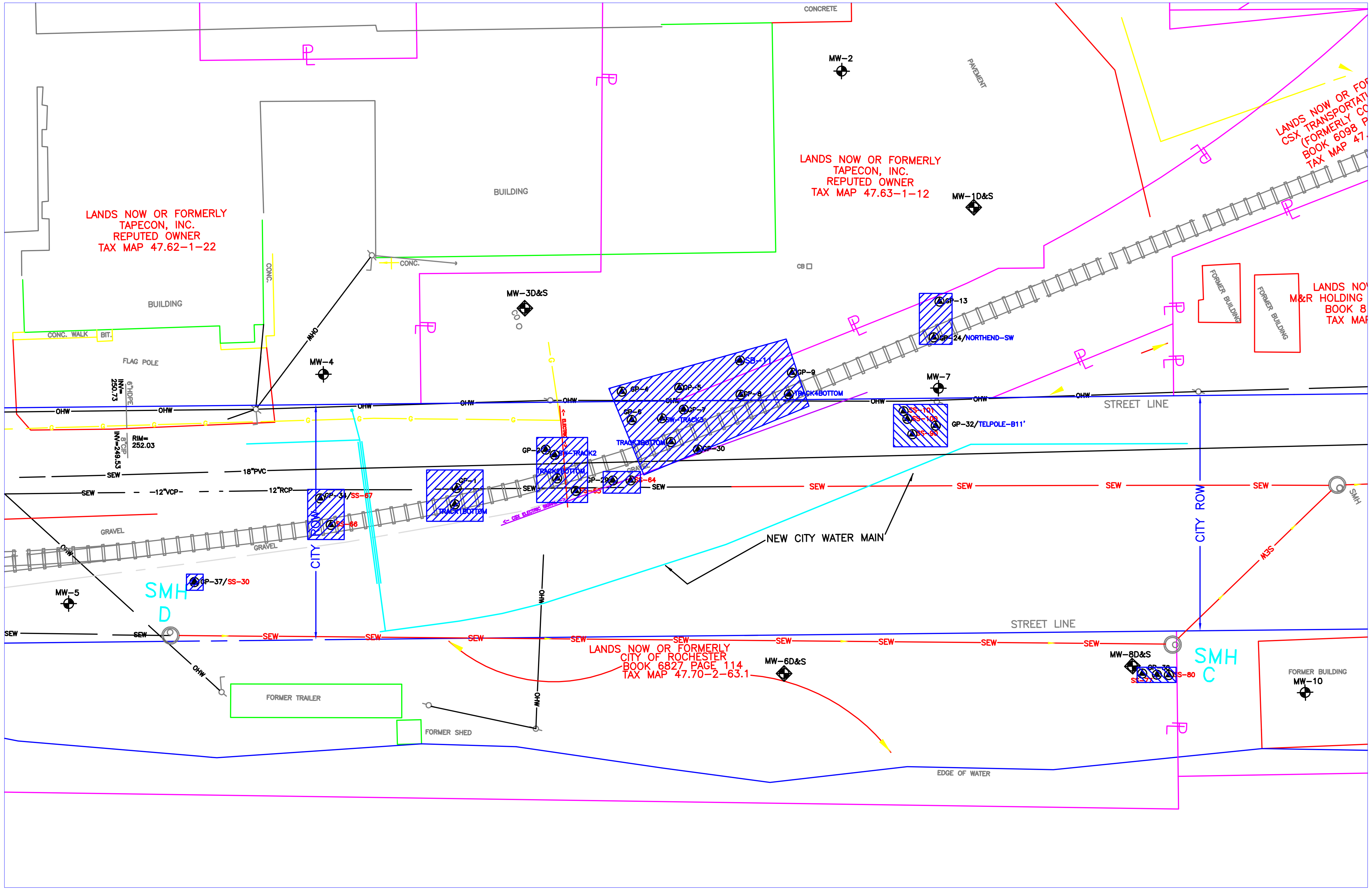
A trip blank sample of deionized water will be placed into a sample container at the laboratory and will accompany the containers and samples throughout the sampling process. These samples will provide a measure of the possible cross-contamination of samples through contact with the sample containers and through leaks or diffusion through the containers' caps. Trip blanks will only be analyzed for the COCs

The laboratory will generate quality control data in order to monitor reproducibility (precision) accuracy in samples submitted for analysis. The internal quality control checks to be routinely implemented by the lab include replicates, matrix-spiked samples, matrix spike duplicates, surrogate spikes, and method blanks.

13.0 EHC-O™ INJECTION REPORT

After the completion of the aforementioned activities, AMEC will prepare a report to document the activities conducted. The report will contain details of the injection event, identify actual monitoring and injection locations, provide the actual quantities of the EHC-O™ material injected per interval and per point, present the baseline soil and groundwater COC concentrations, evaluate the laboratory analytical results of the quarterly groundwater, and three soil sampling activities compared to the baseline data.

FIGURES



LEGEND

CB ☐	----- CATCH BASIN
—SEW—	----- UNDERGROUND SEWER LINE
—OHW—	----- OVERHEAD WIRES
— T —	----- UNDERGROUND TELEPHONE
TM 47.70-2-63.1	----- TAX MAP # (MAP-BLOCK-PARCEL)
ℙ	----- APPROXIMATE PROPERTY LINE
BM ⊕	----- BENCHMARK
⊕	----- SINGLE MONITORING WELL
◆	----- CLUSTERED MONITOIRNG WELL
▲ SS-#	----- CSXT IRM RESIDUAL LOCATION
▲ SS-#	----- COR IRM RESIDUAL SAMPLE
▲ GP-#	----- POST IRM RESIDUAL SAMPLING LOCATION
▨	----- TRACK AOC
▨	----- EAST AOC

MAP NOTES:

1) NORTH ORIENTATION IS BASED UPON THE NEW YORK STATE PLANE COORDINATE SYSTEM (NAD 83) ORIGINATING FROM RIGHT OF WAY MONUMENTS.

2) VERTICAL DATUM IS BASED ON THE CITY OF ROCHESTER DATUM. CONVERSION TO THE NORTH AMERICAN VERTICAL DATUM OF 1998 (NAVD 1998). CITY DATUM MINUS 1.71 FEET = NAVD 88.

3) UNDERGROUND FACILITIES, STRUCTURES AND UTILITIES HAVE BEEN PLOTTED FROM DATA OBTAINED BY FIELD SURVEY, PREVIOUS MAPS AND RECORDS, (AND PAROL TESTIMONY). THEREFORE THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHER UNDERGROUND UTILITIES, THE EXISTENCE OF WHICH ARE NOT KNOWN TO THE UNDERSIGNED. SIZE AND LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES MUST BE VERIFIED BY THE APPROPRIATE AUTHORITIES PRIOR TO ANY CONSTRUCTION.

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5) PLANIMETRIC FEATURES SHOWN HEREON ARE FROM FIELD SURVEY LOCATIONS IN CONJUNCTION WITH DIGITAL MAPPING PROVIDED BY IT CORPORATION ENTITLED "EXCAVATION AND CONSTRUCTION LAYOUT" DRAWING 834540-D2 DATED 01/07/02.

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1) "RIVER STREET, LATTA ROAD, LIGHTHOUSE STREET IMPROVEMENTS" NYSDOT PIN 4753.02 DATED APRIL 2001, PREPARED BY LABELLA ASSOCIATES, P.C. DRAWING NO.s: ROW-01, G-02.

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REV	D/M/Y	REVISION	DRN	CHK	APP	APP	APP	APP

ISS	D/M/Y	APP	ISSUED FOR
1	05/29/07	TPA	EHC-O INJ. WORK PLAN

APPROVED FOR CONSTRUCTION
CPM DM PM

PROJECT PHASE

PROJECT NO.

SCALE
1=40

	BY	D/M/Y
DSN.		
DRN.		

AREA

SUBJECT
SOIL RESIDUAL LOCATION MAP
EHC-O INJECTION WORK PLAN
CSXT RIVER STREET DERAILMENT
SITE ROCHESTER, NY

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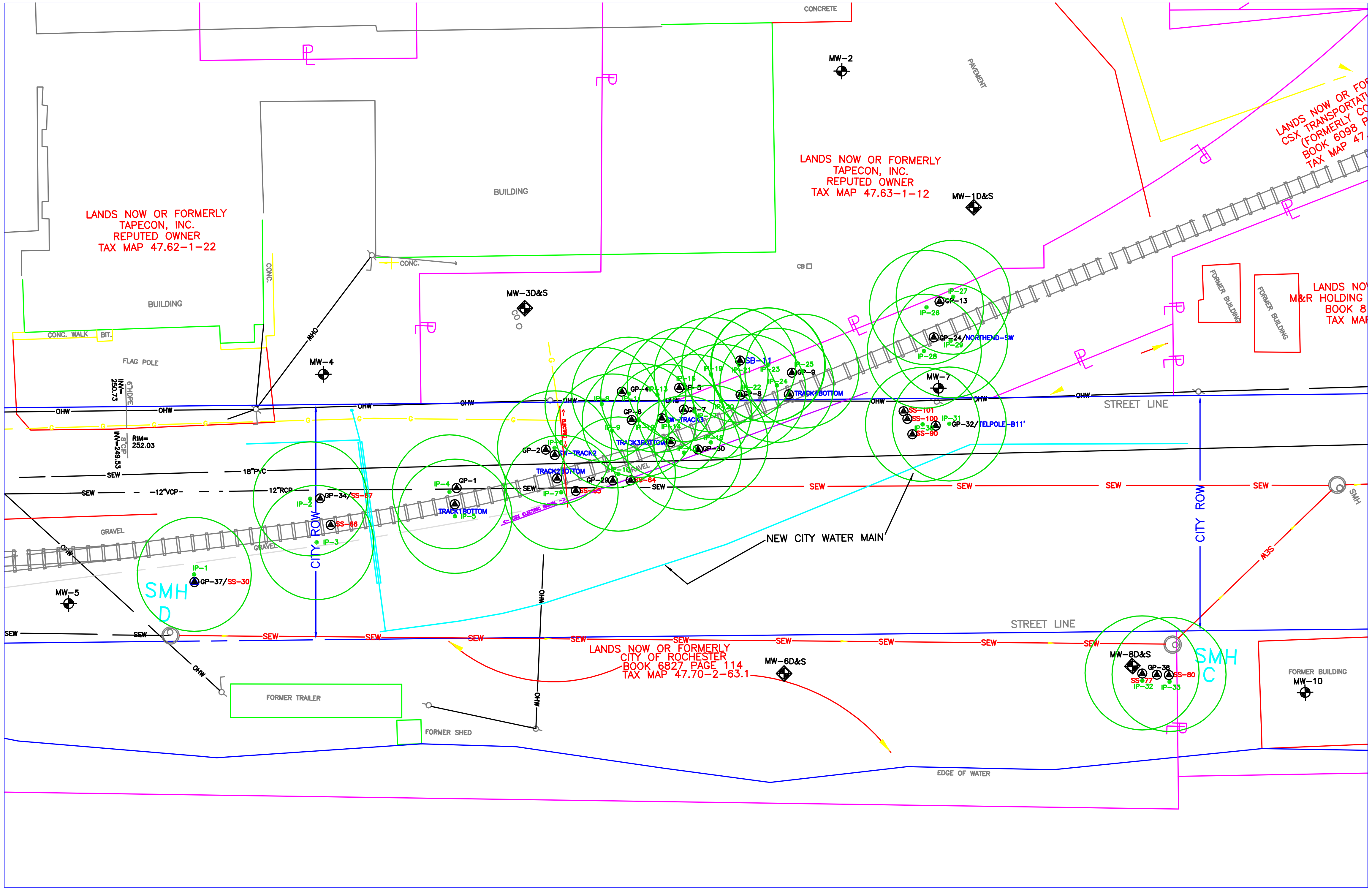
CLIENT DWG. NO.

DRAWING NO. FIGURE 1

REV. A



LEGEND

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—SEW—	-----	UNDERGROUND SEWER LINE
—OHW—	-----	OVERHEAD WIRES
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TM 47.70-2-63.1	-----	TAX MAP # (MAP-BLOCK-PARCEL)
ℙ	-----	APPROXIMATE PROPERTY LINE
BM ⊕	-----	BENCHMARK
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◆	-----	CLUSTERED MONITOIRNG WELL
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▲ SS-#	-----	COR IRM RESIDUAL SAMPLE
▲ GP-#	-----	POST IRM RESIDUAL SAMPLING LOCATION
● IP-#	-----	AMENDMENT INJECTION POINT
⊙	-----	AMENDMENT INJECTION POINT WITH ROI

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ISS	D/M/Y	APP	ISSUED FOR
1	05/29/07	TPA	EHC-O INJ. WORK PLAN

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CPM DM PM

PROJECT PHASE

PROJECT NO.

SCALE
1=40

	BY	D/M/Y
DSN.		
DRN.		

AREA

SUBJECT

EHC-O INJECTION LOCATIONS
EHC-O INJECTION WORK PLAN
CSXT RIVER STREET DERAILMENT
SITE ROCHESTER, NY

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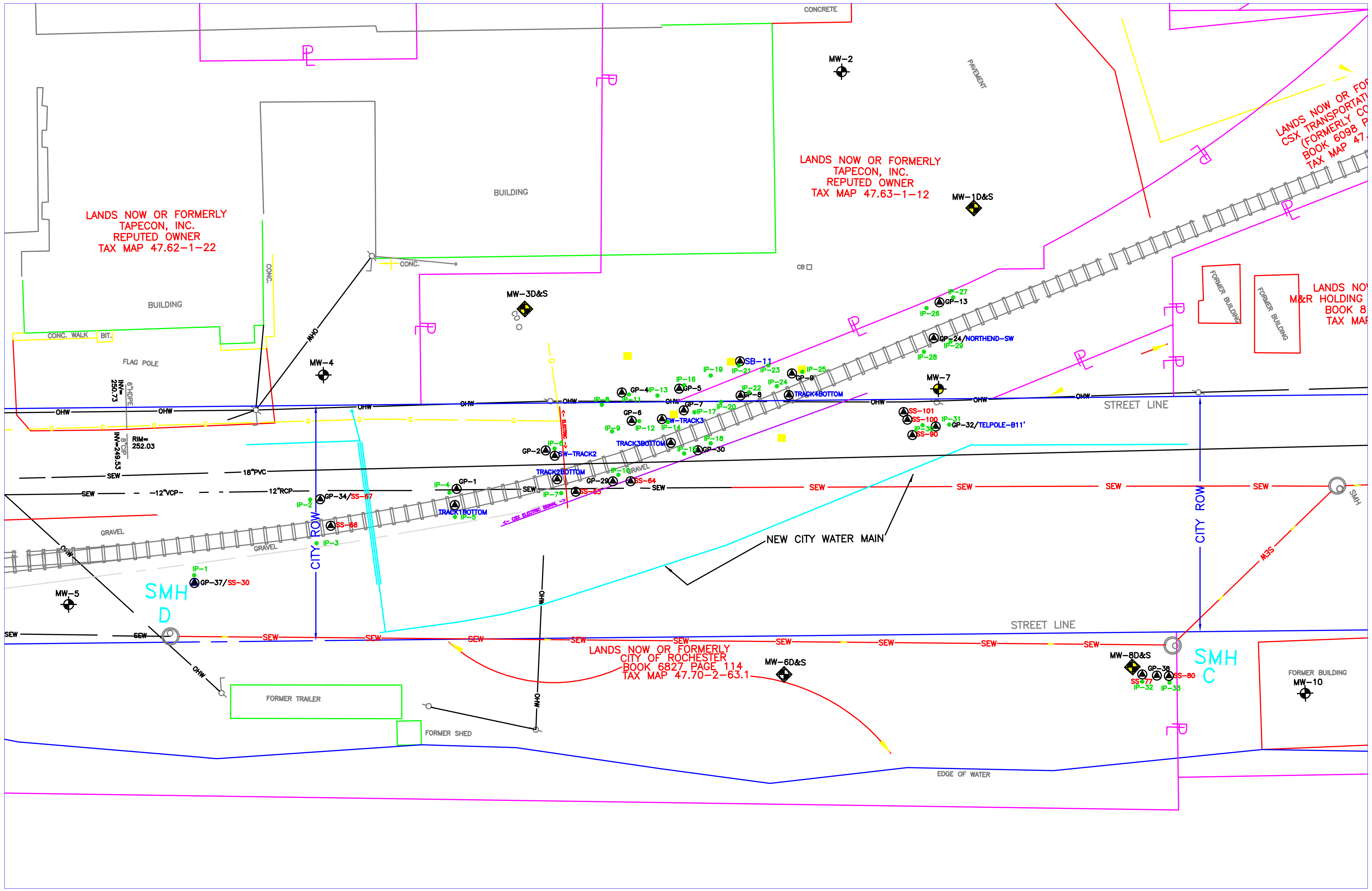
CLIENT DWG. NO.

DRAWING NO. FIGURE 2

REV. A



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🟨	----- EFFECTIVENESS SOIL MONITORING POINT
⊕ MW-#	----- EFFECTIVENESS GW MONITORING POINT

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APPROVED FOR CONSTRUCTION
CPM DM PM
PROJECT PHASE
PROJECT NO.
SCALE 1=40
BY D/M/Y
DSN.
DRN.

AREA

SUBJECT
EHC-O EFFECTIVENESS
MONITORING LOCATIONS
EHC-O INJECTION WORK PLAN
CSXT RIVER STREET DERAILMENT
SITE ROCHESTER, NY

amec

CLIENT DWG. NO.

DRAWING NO. FIGURE 3

REV. 1

TABLES

TABLE 1
CALCULATED APPLICATION VOLUMES OF EHC-O
CSXT - RIVER STREET DERAILMENT PROJECT
ROCHESTER, NY

IP	Injection Depths (ft bgs)	Thickness (ft)	Area (sq.ft.)	Volume (cu.ft.)	Soil Mass (lb)	EHC-O Application Rate (%)	EHC-O Required (lb)	Water Required (gal)	EHC-O Slurry (gal)	
1	2-8	6	314	1,884	209,333	0.10	209	75	81	TRACK AOC
2	2-8	6	314	1,884	209,333	0.10	209	75	81	
3	2-8	6	314	1,884	209,333	0.10	209	75	81	
4	14-22	8	314	2,512	279,111	0.10	279	100	108	
5	5-22	17	314	5,338	593,111	0.10	593	213	230	
6a	0-3	3	314	942	104,667	0.10	105	38	41	
6b	14-22	8	314	2,512	279,111	0.10	279	100	108	
7	3-9	6	314	1,884	209,333	0.10	209	75	81	
8	6-16	10	314	3,140	348,889	0.10	349	125	136	
9	5-13	8	314	2,512	279,111	0.10	279	100	108	
10 a	4-6	2	314	628	69,778	0.10	70	25	27	
10 b	12-14	2	314	628	69,778	0.10	70	25	27	
11	6-16	10	314	3,140	348,889	0.10	349	125	136	
12	5-13	8	314	2,512	279,111	0.10	279	100	108	
13	2-17	15	314	4,710	523,333	0.10	523	188	203	
14	2-21	19	314	5,966	662,889	0.10	663	238	258	
15	6-19	13	314	4,082	453,556	0.10	454	163	176	
16	2-17	15	314	4,710	523,333	0.10	523	188	203	
17	2-21	19	314	5,966	662,889	0.10	663	238	258	
18	6-19	13	314	4,082	453,556	0.10	454	163	176	
19	2-17	15	314	4,710	523,333	0.10	523	188	203	
20	2-16	14	314	4,396	488,444	0.10	488	176	190	
21	2-17	15	314	4,710	523,333	0.10	523	188	203	
22	2-17	15	314	4,710	523,333	0.10	523	188	203	
23	2-17	15	314	4,710	523,333	0.10	523	188	203	
24	2-17	15	314	4,710	523,333	0.10	523	188	203	
25	2-12	10	314	3,140	348,889	0.10	349	125	136	
26	0.5-6	5.5	314	1,727	191,889	0.10	192	69	75	
27	0.5-6	5.5	314	1,727	191,889	0.10	192	69	75	
28	0.5-6	5.5	314	1,727	191,889	0.10	192	69	75	
29	0.5-6	5.5	314	1,727	191,889	0.10	192	69	75	
30	8-12	6	314	1,884	209,333	0.10	209	75	81	East AOC
31	8-12	6	314	1,884	209,333	0.10	209	75	81	
32	8-26	18	314	5,652	628,000	0.10	628	226	244	
33	8-26	18	314	5,652	628,000	0.10	628	226	244	

Project Total	**113,982**	**12,664,667**		**12,665**	**4,556**	**4,920**
Track AOC Total	**98,910**	**10,990,000**		**10,990**	**3,953**	**4,269**
East AOC Total	**15,072**	**1,674,667**		**1,675**	**602**	**651**

APPENDIX A

EHC Technology Overview - Field Applications

EHC™ Technology Overview

EHC technology describes a family of remediation products used for the *in situ* treatment of groundwater and saturated soil impacted by heavy metals and persistent organic compounds such as chlorinated solvents, pesticides and energetics. The technology is a modification of our DARAMEND® technology which has been used since 1992 to treat over 550,000 tons of similarly effected soil and sediment. Both EHC and DARAMEND are the subjects of numerous patents owned by Adventus Intellectual Properties, Inc. (Adventus).

EHC comes in a variety of formulations to meet the requirements unique to each site (**Photo 1**). Standard **EHC** is a solid material available in pellets, granules or powders. **EMC-L™** is a liquid formulation provided as a suspendable solid or an aqueous solution for easy application to existing wells or other networks. **EHC-M™** is specially prepared for treatment of heavy metals. **EHC-O™** contains a slow-release oxygen source for rapid removal of petroleum hydrocarbons and other compounds that are amenable to aerobic biodegradation processes.

Photo 1. Pictures of various EHC Formulations.

How the EHC Technology Works

EHC is a unique combination of controlled-release carbon and reduced metal (*e.g.*, zero valent iron [ZVI], aluminum or zinc) used for stimulating reductive dechlorination and enhanced bioremediation in a subsurface environment. Following placement of EHC into the saturated zone, a number of physical, chemical and microbiological processes combine to create strong reducing conditions that stimulate rapid and complete dechlorination reactions. The organic component of EHC (fibrous organic material) is nutrient rich, hydrophilic and has high surface area; thus, it is an ideal support for growth of bacteria in a groundwater environment. As they grow on EHC particle surfaces, indigenous heterotrophic bacteria consume dissolved oxygen thereby reducing the redox potential, or Eh. In addition, as the bacteria grow on the organic particles, they ferment carbon and release a variety of volatile fatty acids (acetic, propionic, butyric) which diffuse from the site of fermentation into the groundwater plume and serve as electron donors for other microbes, including dehalogenators and halorespiring species. Finally, the small ZVI or other reduced metal particles provide substantial reactive surface area that stimulates direct chemical dechlorination and an additional decrease in the redox potential of the groundwater via corrosion of the iron and chemical oxygen scavenging.

For chlorinated organic compounds, these physical, chemical and biological processes combine to create an extremely reduced environment that stimulates chemical and microbiological dechlorination of otherwise persistent compounds. Redox potentials as low as –600 mV are commonly observed in groundwater after EHC application. At these Eh levels, the organic constituents of interest (COI) are chemically unstable and they physically degrade. Hence, the technology is biologically based in that we rely on indigenous microbes to biodegrade the EHC carbon (refined plant materials), but EHC does not require the presence or activity of special or otherwise unique bacteria (*i.e.*, *Dehalococcoides* species are not required) for complete and effective remediation.

Potential Advantages of EHC Technology versus Other Potential Substrates

The unique combination of integrated controlled-release organic carbon and ZVI gives EHC powerful technical advantages over other materials that provide only carbon or only ZVI:

(1) Generation of significantly lowered reducing conditions leading to accelerated site closure ;

(2) Eliminates any requirement for specialty microorganisms or inoculants;

(3) Effective COI removal without accumulation of potentially problematic catabolites such as *cis*-1,2-dichloroethene (DCE), dichloromethane (DCM) or vinyl chloride (VC);

(4) Longer environmental life (from 12 to 60 months) as compared to other electron donors;

(5) Provision of plant-based major, minor and micronutrients that are essential to the activity of fastidious anaerobic bacteria involved in recognized dechlorination reactions; and

(6) Applicability to a wide range of target compounds (**Table 1**).

Composition of EHC

EHC products are available in a number of formulations specially selected for the unique situations found at every site. The primary active constituents of the EHC products are a combination of one or more of the following:

- controlled-release food-grade organic carbon (*e.g.* starches, cellulose, molasses, lecithin, soy, whey and /or other proteins). No animal products are used.
- oxygen-releasing compounds (*e.g.* calcium oxide or magnesium peroxide for EHC-O only).
- reducing compounds (*e.g.* zero valent iron, aluminum or zinc).

The proportion of each of these constituents depends on the type and concentration of the targeted COI. The MSDS for a typical EHC product is provided in **Appendix A**.

EHC-L is a water-soluble, liquid formulation specially designed for application to existing wells or hydraulic injection networks. Its unique mode of action does not require the presence of specialty microorganisms, nor will it result in the accumulation of potentially problematic catabolic intermediates (*e.g.*, DCE from PCE/TCE).

EHC-M is specially formulated for *in situ* immobilization of soluble metals via enhanced precipitation and adsorption reactions. The controlled-release feature of the carbon provides for extended longevity and greatly assists in maintaining very low redox conditions through simultaneous microbial consumption of the carbon and electron acceptors. Arsenic, for example, is precipitated through the production of iron arsenic sulfide minerals that are practically insoluble in groundwater.

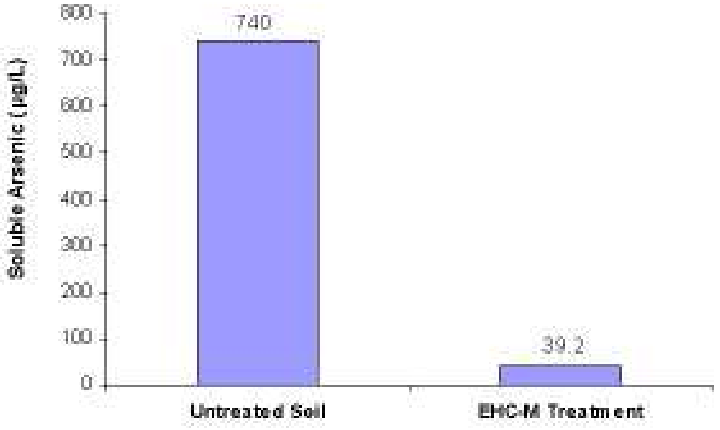

Figure 1. Reduced solubility of arsenic in soil as determined by TCLP analysis of treated soil.

EHC-M is well suited for treating environments co-impacted by heavy metals and chlorinated solvents

EHC-O contains an oxygen releasing component that provides a long-term source of dissolved oxygen. Native microorganisms utilize the dissolved oxygen as an electron acceptor, and the targeted contaminant serves as the electron donor resulting in its destruction. The organic carbon component of EHC provides trace micronutrients required for healthy growth and proliferation of the indigenous, naturally occurring microbial population.

Remedial Designs

EHC can be used for treatment of source areas and dissolved phase plumes. EHC has been employed at a number of sites to yield contiguous permeable reactive barriers (PRBs) as portayed in **Figure 2**. Injection of EHC into suspected source areas or dissolved plumes has also been performed to accelerate site remediation (**Figure 3**). The presence of any free phase hydrocarbon (LNAPL) or chlorinated hydrocarbon (DNAPL) is problematic; here alternative technologies such as *in situ* biogeochemical stabilization (ISBS) are likely more applicable to this problem (please see http://www.adventus.us/isbs.htm).

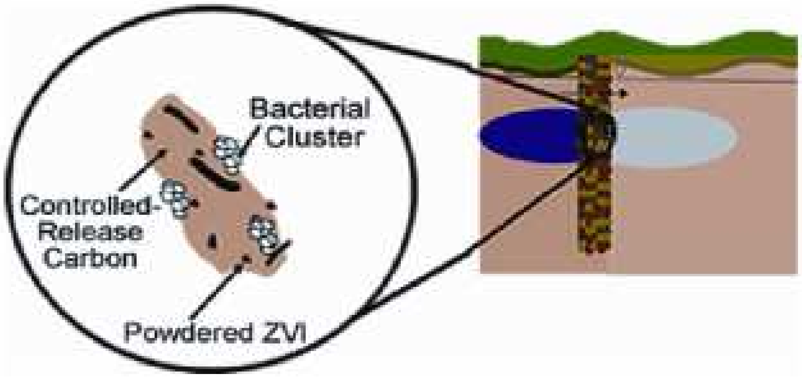

Figure 2. Schematic of PRB application.

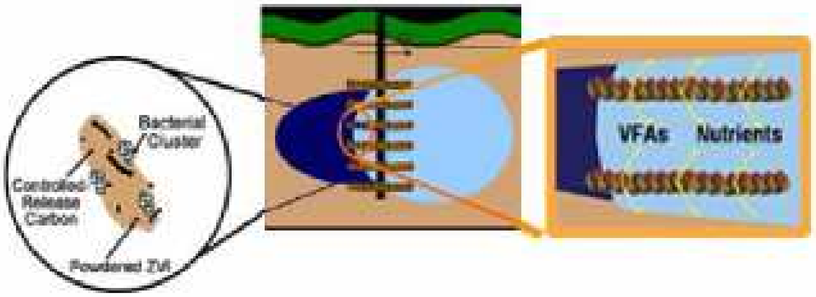

Figure 3. Schematic of source area treatment.

Implementation Methods

A variety of construction / implementation methods can be used to place EHC into a subsurface environment. The most effective delivery method will be determined by a number of site-specific lithological and hydrogeological features. Typical methods of subsurface installation are summarized below:

- backfill of a excavation
- backfill of a trench (*e.g.* PRB)
- injection from a direct-push drill rig
- injection using hydraulic fracturing
- injection using pneumatic fracturing and injection
- injection using high pressure jetting
- mechanical soil mixing

Excavation Fill

At a site in the southeast USA, EHC was mixed with sand (ratio of 9:1 by mass; *i.e.* 10% EHC) and placed in the bottom of an open excavation after most of the contaminated soils were removed (**Photo 2**). The EHC provided treatment of any residual contamination. An excavator was used to mix the EHC/sand and emplace the mixture into the opening. For larger scale excavations, pug mills and other mixing equipment could be used to mix the EHC and backfill material. Alternatively, the contaminated soil can be excavated, EHC can be mixed into the soils, and the soils amended with EHC can then be backfilled into the opening.

Photo 2. Picture of excavator leveling EHC and sand that were mixed together prior to placement into the excavated area.

Permeable Reactive Barrier (PRB)

A PRB is a continuous, *in situ* permeable treatment zone designed to intercept and remediate a contaminant plume. A PRB is typically constructed from 0.3 m to 2 m wide, and from 2 m to 35 m deep, and it usually extends across the width of the plume. Over 200 PRBs have been constructed using a variety of construction techniques. For trenches that are typically less than 5 m deep constructed in competent soils such as tight clays, an excavator can dig the trench, and the EHC plus sand or gravel can be placed into it using a loader as shown in **Photo 3.** For deeper trenches, or trenches in less competent soils, a biopolymer slurry can be used where a mixture of water and guar gum is pumped into the open trench to hold up the sidewalls. The biopolymer exerts hydraulic pressure and prevents the collapse of the trench as it is excavated. Another method, which is applicable to depths of 10 m, is to use a continuous one-pass trencher where a cutting chain digs the trench and simultaneously backfills it with a mixture of sand plus EHC.

Photo 3. Backfilling PRB after installation of EHC and sand in the trench; southern USA.

Hydraulic Injection Using Direct Push Technology (DPT)

For DPT, hollow pipes, or 'rods' are driven into the ground using a vibration or hammering technique. A low viscosity, aqueous slurry of EHC is prepared on site using a tank and a mixer or a pump. The slurry is then injected into the subsurface using an appropriate pump (up to 500 psi). A number of variations on this methodology can be used. In some cases, an expendable tip is driven into the ground to the bottom of the desired injection depth. The rods are then retracted upwards leaving the metallic tip in the ground. The slurry is then pumped into the ground as the rods are incrementally lifted upwards. Another method uses a pressure-activated tip, where injection holes are revealed once the pressure of the slurry in the rods is increased by forcing a spring to compress. **Figures 4** and **5** show pictures of EHC being applied at a site in the southeast USA using direct push technology.

Photo 4. Overall picture of equipment used to perform direct injection of EHC. The DPT rig is on left; the mixing tank is on right. EHC can be injected from bottom of the targeted zone to the top, or vice versa depending on site lithology and COI distribution.

Photo 5. Close-up of rod connected to a hose that is delivering EHC slurry into the subsurface.

Hydraulic Fracturing

Hydraulic fracturing involves the injection of a slurry or gel of EHC mixed with guar gum. The slurry is injected into the ground through drilling rods. One of the primary differences between hydraulic fracturing and DPT is that a fracture initiation step precedes the injection. This step involves physically creating an opening or slot at the injection point that is roughly shaped like a disc (see Figure 3). This fracture initiation step helps to initiate a fracture along which the injected slurry can follow. This promotes the slurry reaching much greater distances from the injection location.

Photograph 6 shows a picture of a hydraulic fracturing rig; **Photograph 7** shows a soil core that was taken after EHC injection, revealing a thick layer of injected slurry located approximately 3 m radially from the point of injection.

Photo 6. Photograph of hydraulic fracturing rig.

Photo 7. Photograph of soil core showing green layer of injected slurry.

Pneumatic Fracturing and Injection

This process uses gas to inject either dry EHC or a slurry of EHC into the subsurface down an open borehole. Depending on the formation, the gas may be used to first fracture the formation (*e.g.* rock or clays). The EHC is then fluidized in a gas stream (nitrogen is used where reducing conditions are to be maintained) and injected under pressure. This process can be used to inject EHC into rock as the pressure of the nitrogen will open up existing fractures and allow the EHC to be injected into them. This process can also be utilized in tight soils such as clays, where a distinct fracture typically opens. If applied to less consolidated materials, pneumatic fracturing of EHC yields a more uniform zone of mixed EHC and aquifer material.

High Pressure Jetting

High pressure jetting consists of the injection of water and EHC at very high pressures (up to 5,000 psi for example) to erode soil in the subsurface and mix it with the injected EHC. This process will create soil returns at the surface because of the erosion process. This approach provides very good mixing of contaminated soil with EHC, and will be particularly useful for injection into layers that are not thick, but are very deep.

Soil Mixing

Soil can be mechanically mixed with a number of different tools such as excavators, (**Photo 8**), large diameter augers or the 'Lang' tool. These technologies provide very good contact between the soil and the EHC and are of particular use for shallow impacts. Shallow soil mixing equipment can be used for depths up to 12 m and deep soil mixing can be used fro greater depths. This method is more applicable to treatment of shallower source zone contamination where higher concentrations of the COI exist.

Photo 8. Mixing Adventus amendments into sediments impacted by explosives.

Typical Results

Critical redox (Eh) calculations have been performed which indicate that a majority of the targeted COIs listed in Table 1 will be degraded in an environment reduced to <450 mV (**Table 2**). At a site in the southeast USA, the *in situ* subsurface (*ca.* 40 ft bgs) redox was reduced to <500 mV at distances at least 10 ft from the point of injection (**Figure 3**).

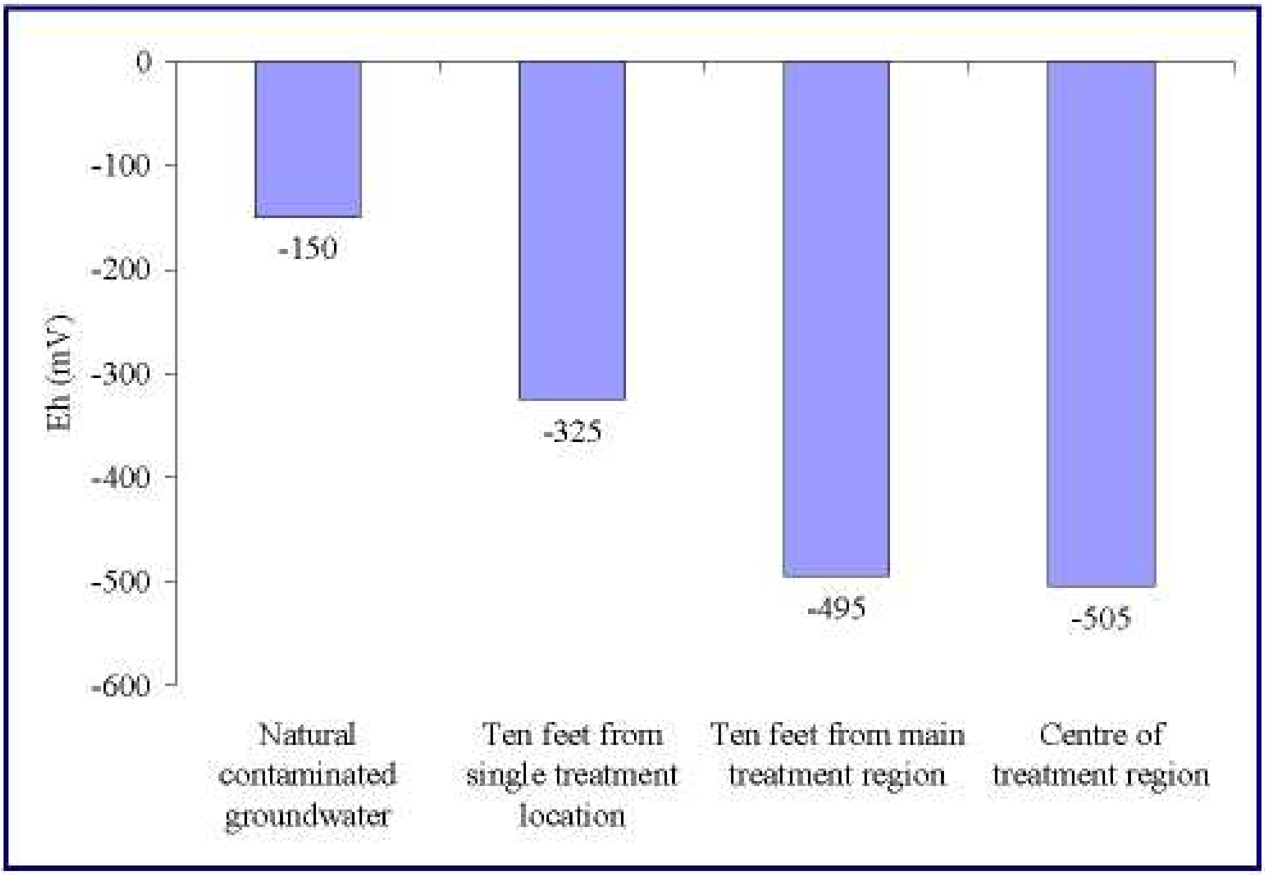

Figure 3. *In Situ* redox (Eh) following EHC injection

Because EHC creates such extremely reduced conditions, we do not observe the accumulation of potentially problematic intermediates such as DCE from PCE or TCE. Moreover, compounds typically resistant to biological or chemical reduction alone (*e.g.*, chloroethanes) are readily removed using the EHC technology **(Figure 4).**

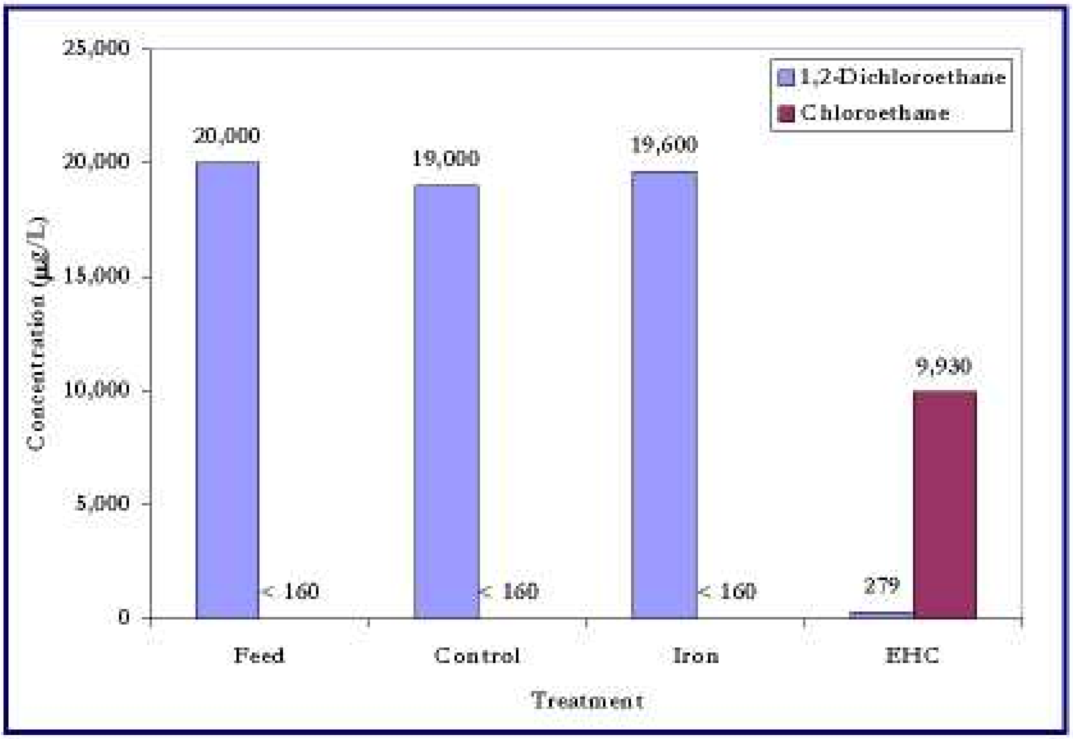

Figure 4. Effective removal of DCA during groundwater flow through a column packed with sand (control), iron and EHC.

NOTIFICATIONS:

The use of reduced metals for the purposes of treating organic contaminants in groundwater is the subject of numerous patents issued to the University of Waterloo and owned by Adventus Intellectual Property, Inc./ETI (www.eti.ca).

The combined use of an organic material plus reduced metals for the purposes of treating organic and inorganic contaminants in soil, sediment, water and groundwater is the subject of numerous patents issued to W.R. Grace & Company and owned by Adventus Intellectual Property, Inc. (www.adventus.us).

Adventus is obligated and committed to enforce its patent rights. The Patent Laws provide for punitive damages for the willful infringement of a patent in the form of treble damages and an assessment of the attorneys fees incurred by the patent owner in enforcing the patent (Title 35, United States Code, Section 284).

Adventus will continue to grant Patent licenses to end-users and installation contractors alike.

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TABLE 1 EHC TREATS THESE COMPOUNDS

Compound as Primary COI	EHC and EHC-L	EHC-M	EHC-O
Chlorinated Solvents			
Tetrachloroethylene (PCE)	X		
Trichloroethylene (TCE)	X		
cis 1,2-Dichloroethylene (*cis* DCE)	X		
trans 1,2-Dichloroethylene (*trans* DCE)	X		
1,1-Dichloroethene	X		
Vinyl Chloride	(x)		X
1,1,2,2-Tetrachloroethane (TeCA)	(x)		
1,1,1-Trichloroethane (TCA)	X		
Carbon Tetrachloride (CT)	X		
Chloroform (CF)	X		
Dichloromethane (DCM)	X		
Chloromethane (Methylene chloride)	X		
Pesticides			
Toxaphene	X		
Chlordane	X		
Dieldrin	X		
Pentachlorophenol	X		X
Energetics			
TNT	X		
DNT	X		
HMX	X		
RDX	X		
Perchlorate	X		
Heavy Metals		X	X
Petroleum Hydrocarbons			X

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Table 2 - Standard reduction potentials at 25^{0}C and pH 7 of selected organic and inorganic redox couples

Electron Acceptor	**Half-reaction of reductive transformations**		**□$G^{0'}$ (kJ/electron)**	**$E^{0'}$ (mV)**
1,1,1,2-TeCA	CCl_3-$CH_2Cl + 2e^-$	→ (1,1-)$C_2H_2Cl_2 + 2Cl^-$	-93.4	968
TeCA	$CHCl_2$-$CH_2Cl_2 + 2e^-$	→ *cis*-$C_2H_2Cl_2 + 2Cl^-$	-90.1	933
TeCA	$CHCl_2$-$CH_2Cl_2 + 2e^-$	→ *trans*-$C_2H_2Cl_2 + 2Cl^-$	-87.9	911
1,1,2-TCA	$CHCl_2$-$CH_2Cl + 2e^-$	→ $C_2H_3Cl + 2Cl^-$	-79.8	827
O_2	**$O_2 + 4H^+ + 4e^-$**	**→ $2H_2O$**	**-78.7**	**816**
1,2-DCA	CH_2Cl-$CH_2Cl + 2e^-$	→ $C_2H_4 + 2Cl^-$	-71.3	738
CT	$CCl_4 + H^+ + 2e^-$	→ $CHCl_3 + Cl^-$	-65.0	673
MnO_2	**$MnO_2 + HCO_3^- + 3H^+ + 2e^-$**	**→ $MnCO_3 + 4H_2O$**	**-58.9**	**610**
	$CCl_3F + H^+ + 2e^-$	→ $CHCl_2F + Cl^-$	-58.7	608
	CCl_2F-$CClF_2 + H^+ + 2e^-$	→ $CHClF$-$CClF_2 + Cl^-$	-55.7	577
PCE	$C_2Cl_4 + H^+ + 2e^-$	→ $C_2HCl_3 + Cl^-$	-55.4	574
1,1,1,2-TeCA	CCl_3-$CH_2Cl + H^+ + 2e^-$	→ $CHCl_2$-$CH_2Cl + Cl^-$	-54.2	562
TCA	CCl_3-$CH_3 + H^+ + 2e^-$	→ $CHCl_2$-$CH_3 + Cl^-$	-54.1	561
CF	$CHCl_3 + H^+ + 2e^-$	→ $CH_2Cl_2 + Cl^-$	-54.1	560
TCE	$C_2HCl_3 + H^+ + 2e^-$	→ *cis*-$C_2H_2Cl_2 + Cl^-$	-53.1	550
1,1,2-TCA	$CHCl_2$-$CH_2Cl + H^+ + 2e^-$	→ CH_2Cl-$CH_2Cl + Cl^-$	-51.9	538
	CCl_2F-$CClF_2 + H^+ + 2e^-$	→ CCl_2F-$CHF_2 + Cl^-$	-51.2	530
TCE	$C_2HCl_3 + H^+ + 2e^-$	→ *trans*-$C_2H_2Cl_2 + Cl^-$	-50.9	528
TCE	$C_2HCl_3 + H^+ + 2e^-$	→ 1,1-$C_2H_2Cl_2 + Cl^-$	-50.9	527
1,1,1,2-TeCA	CCl_3-$CH_2Cl + H^+ + 2e^-$	→ CCl_3-$CH_3 + Cl^-$	-49.9	517
1,1,2-TCA	$CHCl_2$-$CH_2Cl + H^+ + 2e^-$	→ $CHCl_2$-$CH_3 + Cl^-$	-49.8	516
TeCA	$CHCl_2$-$CHCl_2 + H^+ + 2e^-$	→ $CHCl_2$-$CH_2Cl + Cl^-$	-48.6	504
DCM	$CH_2Cl_2 + H^+ + 2e^-$	→ $CH_3Cl + Cl^-$	-47.6	493
CM	$CH_3Cl + H^+ + 2e^-$	→ $CH_4 + Cl^-$	-44.8	464
CA	$C_2H_5Cl + H^+ + 2e^-$	→ $C_2H_6 + Cl^-$	-44.6	462
	CF_3-$CCl_3 + H^+ + 2e^-$	→ CF_3-$CHCl_2 + Cl^-$	-43.6	452
VC	$C_2H_3Cl + H^+ + 2e^-$	→ $C_2H_4 + Cl^-$	-43.4	450
NO_3^-	**$NO_3^- + 2H^+ + 2e^-$**	**→ $NO_2^- + H_2O$**	**-41.7**	**432**
1,1-DCE	(1,1-)$C_2H_2Cl_2 + H^+ + 2e^-$	→ $C_2H_3Cl + Cl^-$	-40.6	420
trans-DCE	*trans*-$C_2H_2Cl_2 + H^+ + 2e^-$	→ $C_2H_3Cl + Cl^-$	-40.5	419
cis-DCE	*cis*-$C_2H_2Cl_2 + H^+ + 2e^-$	→ $C_2H_3Cl + Cl^-$	-38.3	397
1,1-DCA	$C_2H_4Cl_2 + H^+ + 2e^-$	→ $C_2H_5Cl + Cl^-$	-38.3	397
1,2-DCA	CH_2Cl-$CH_2Cl + H^+ + 2e^-$	→ $C_2H_5Cl + Cl^-$	-36.2	375
$Fe(OH)_3$	**$Fe(OH)_3 + 3H^+ + 2e^-$**	**→ $Fe^{2+} + 3H_2O$**	**-11.4**	**118**
SO_4^{2-}	**$SO_4^{2-} + 9H^+ + 8e^-$**	**→ $HS^- + 4H_2O$**	**+20.9**	**-217**
HCO_3^-	**$HCO_3^- + 9H^+ + 8e^-$**	**→ $CH_4 + 3H_2O$**	**+23.0**	**-238**

Calculated on the basis of data from Thauer et al. (1977), Dolfing and Harrison (1992), Dolfing and Janssen (1994) and Dolfing (2003), for $[Cl^-]$ = 1 mM.

Field Profile
EHC-O™

Rapid Site Closure Achieved within One Year Using EHC-O™

LUST Site, Kenosha, WI
Lead Consultant – STS Consultants, Ltd., Milwaukee WI

Summary

Site groundwater was impacted by petroleum volatile organic carbons (PVOCs) as a result of leaking underground storage tanks (LUSTs). The LUSTs were removed in the early 1970s, and in October 2004, STS Consultants, Ltd. treated the groundwater plume using an alternate oxygen-release compound. However, in Spring 2005, PVOCs were still detected at significant levels. To facilitate site closure, a second round of oxygen release compound injections was conducted in August 2005. But this time **EHC-O** was used as the source of slow-release oxygen due to its ability to supply oxygen plus inorganic nutrients and buffering capacity in a more cost effective manner (US$4.50/lb; US$9.90/kg for EHC-O). The primary PVOC concentrations were reduced by 99% within 1 month, and all compounds were below the State of Wisconsin's Groundwater Enforcement Standards (ES). A second sampling event, four months after the injections, showed additional reductions in PVOC levels and a "No further action" letter was issued on June 5, 2006 following only two sampling events.

The Challenge

Site groundwater was impacted with PVOCs up to levels of 2,300 ppb and the chemical oxygen demand measured between 36 and 90 ppm. The groundwater table was approximately 5 ft (1.5 m) bgs, and the impacts extended down to approximately 15 ft (4.6 m) bgs. The lithology consisted of silty clay with occasional trace gravel at the targeted treatment depth. The redox potential measured 21 mV and the pH was 6.65. The goal was to treat the PVOCs down to their respective groundwater quality standards within a timely manner in order to facilitate Site development.

The Solution

In August 2005, a total of 450 lbs (205 kg) of EHC-O were introduced into 9 injection points at the hot spot area from 5 to 15 ft (1.5 to 4.6 m) bgs. The EHC-O powder was mixed with water on site into slurry (20% solids) using a handheld drill with mixing attachment and injected using direct push technology (Geoprobe grout system GS-1000 series). The injection points were spaced about 6 ft (1.8 m) apart to cover an area of approximately 20 ft x 20 ft (6 m x 6 m).

The Result

Figure 1 shows the concentration of PVOCs in groundwater before and after the EHC-O injection. Four weeks following the injection, six out of eight constituents of concern had decreased below the laboratory analytical detection limits. The concentration of the remaining PVOCs had also decreased significantly; the benzene concentration decreased by >99% (from 750 to 1.4 ppb) and the MTBE concentration decreased 88% (from 240 to 29 ppb). A second sampling event conducted 4 months following the injections confirmed the decreasing trend; benzene had decreased below the laboratory analytical detection limit and MTBE had decreased to 13 ppb. The total PVOC concentration decreased about 99% (from 2,290 to 13 ppb).

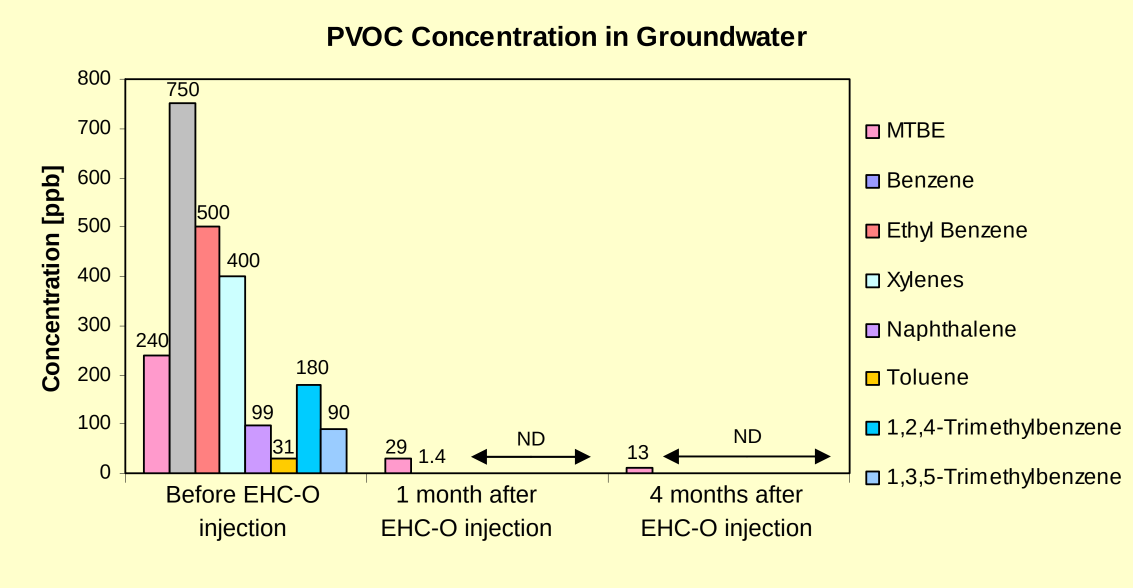

Figure 1: Concentrations of PVOC in groundwater before and after EHC-O injection.

The Timeline and Cost

- ❖ The EHC-O injection was completed in one day. Four weeks following the EHC-O additions the concentration of total PVOC decreased about 99%, and the concentrations of all constituents were below the State of Wisconsin's groundwater ES.
- ❖ The site was recommended for no further action within 4 months of switching to EHC-O technology and a "No further action" letter was issued on June 5, 2006 following only two sampling events (Appendix A). No further investigation or remedial action is necessary at the site.
- ❖ At US$4.50/lb (US$9.90/kg), the EHC-O product cost was US$0.50/ft^3 (US$18/m^3).

For more information, contact us by phone at 888.295.8661 or by email at info@adventus.us.

commerce.wi.gov
Wisconsin
Department of Commerce

ENVIRONMENTAL & REGULATORY SERVICES DIVISION
BUREAU OF PECFA
101 West Pleasant Street, Suite 100A
Milwaukee, Wisconsin 53212-3963
TDD #: (608) 264-8777
Fax #: (414) 220-5374
Jim Doyle, Governor
Mary P. Burke, Secretary

June 5, 2006

RECEIVED
JUN -7 2006
STS CONSULTANTS, LTD.
MILWAUKEE, WI 53224

Mr. Michael Zuckerman
Builders Bank of Chicago
1660 North La Salle Drive
Chicago, IL 60614

RE: **Conditional Case Closure**

Commerce # 53171-9999-71 DNR BRRTS # 03-30-113520
May Property, 1771 30th Street, Somers

Dear Mr. Zuckerman:

The Wisconsin Department of Commerce (Commerce) has reviewed the request for case closure prepared by your consultant, STS Consultants, Ltd., for the site referenced above. It is understood that residual soil contamination remains on site. Commerce has determined that this site does not pose a significant threat to the environment and human health. No further investigation or remedial action is necessary.

The following condition must be satisfied to obtain final closure:

- Groundwater monitoring wells MW-2R, MW-4 and MW-5 must be properly abandoned and the appropriate documentation forwarded to me at the letterhead address.

This letter serves as your written notice of "no further action." Timely filing of your final PECFA claim (if applicable) is encouraged. If your claim is not received within 120 days of the date of this letter, interest costs incurred after 60 days of the date of this letter will not be eligible for PECFA reimbursement.

Thank you for your efforts to protect Wisconsin's environment. If you have any questions, please contact me in writing at the letterhead address or by telephone at (414) 220-5361.

Sincerely,

Monica Weis

Monica L. Weis
Senior Hydrogeologist
Site Review Section

cc: Mr. Mark Mejac, STS Consultants, Ltd.

APPENDIX B

Job Safey Analysis (JSA)

EHC-O (oxidizing agent) Injection

Location	Date Prepared/Revisions	Team Members
480 River St. Rochester, NY	September 7, 2006	AMEC: Tim Ahrens, Jeff LaRock, Cris Schrader, Howard Miller

Personal Protective Equipment

Minimum PPE Requirements	Additional PPE Requirements (when noted in Remedy Section)
- Steel Toe Boots / Shoes - Safety Glasses w/Side Shields - Hard Hat - Bright orange shirt or vest (reflective clothing)	-Leather gloves when performing work with potential for hand injury -Full length pants and long sleeve shirts if working in vegetation. -DEET insect repellant if walking through heavy vegetation. -Sunscreen during summer -Two 20 pound fire extinguisher on ground in work area. -PVC Apron or Tyvek when handling EHC-O -PVC, neoprene or rubber gloves when handling EHC-O -Dust mask, or NIOSH approved respirator in dusty or unknown atmospheres or when exposures exceed limit values, when handling EHC-O -Chemical goggles and full face shield when handling EHC-O. -Safety shower or other means of emergency decon -Rubber Boots -Eye-wash Station

Subtask	Hazard	Remedy
1.Unloading EHC-O Containers	1a. Personal and/or property damage from vehicle movement	1a. Designate work area by placing cones around perimiter. 1a. When moving vehicles the following precautions must be taken: -equipment must be stowed and secured -a spotter must always be used. -the spotter must identify any surface obstructions/anomolies -audible warning signals must be used (horn or backing signal) -operator must yield to pedestrians 1a. Always know where all on-site vehicles are located.
	1b. Muscle strain or other injury from lifting heavy objects	1b. Do not attempt to lift anything that weighs more than 35 pounds. 1b. Use mechanical equipment such as lift gate to carry/lift 1b. Use proper lifting techniques; keep back straight and lift with arms and legs; keep load near body; avoid reaching 1b. Use leather gloves when handling containers.
2. Storing EHC-O	2a. Personal and/or property damage from Calcium Peroxide spills or reaction.	2a. Store EHC-O in designated storage containers only. - Use PVC, neoprene, or rubber gloves covered by leather gloves when handling containers. 2a. Maintain at least 50 feet from any combustable/flammable materials. 2a. No smoking on-site 2a. Keep EHC-O clear of metals such as water, acids, bases, salts of hevy metals, reducing agents, organic materials, flamable substances. 2a. Ensure MSDS is readily available and its location is known by all on-site personnel.
3. EHC-O Application	3a. Injury from sharp objects	3a. Leather gloves must be worn when handling/opening containers.
	3b. Personal and/or property damage from EHC-O	3b. Store EHC-O in designated storage containers only. 3b. Use PVC, neoprene or rubber gloves when handling EHC-O. 3b. Maintain at least 50 feet from any combustable/flammable materials. 3b. No smoking on-site 3b. Ensure MSDS is readily available and its location is known by all on-site personnel. 3b. When working with EHC-O, the following PPE must be worn: -PVC Apron or Tyvek -PVC, neoprene or rubber gloves when handling EHC-O -Dust mask or respirator, if required. -Chemical safety goggles and full face shield 3b.If windy, EHC-O must be watered lightly during application to suppress dust. 3b. All on-site personnel should stand up-wind of EHC-O when being mixed (or used in dry form). 3b. Non-essential personnel should stand up-wind and at least 25 feet from EHC-O application area.
	3c. Slip/Trip/Fall	3c. Group all equipment and waste in one designated area 3c. If tools not in use, return to storage

Job Safey Analysis (JSA)

EHC-O (oxidizing agent) Injection

Location	Date Prepared/Revisions	Team Members
480 River St. Rochester, NY	September 7, 2006	AMEC: Tim Ahrens, Jeff LaRock, Cris Schrader, Howard Miller

Personal Protective Equipment

Minimum PPE Requirements	Additional PPE Requirements (when noted in Remedy Section)
- Steel Toe Boots / Shoes - Safety Glasses w/Side Shields - Hard Hat - Bright orange shirt or vest (reflective clothing)	-Leather gloves when performing work with potential for hand injury -Full length pants and long sleeve shirts if working in vegetation. -DEET insect repellant if walking through heavy vegetation. -Sunscreen during summer -Two 20 pound fire extinguisher on ground in work area. -PVC Apron or Tyvek when handling EHC-O -PVC, neoprene or rubber gloves when handling EHC-O -Dust mask, or NIOSH approved respirator in dusty or unknown atmospheres or when exposures exceed limit values, when handling EHC-O -Chemical goggles and full face shield when handling EHC-O. -Safety shower or other means of emergency decon -Rubber Boots -Eye-wash Station

Subtask	Hazard	Remedy
		3c. Keep work area clear and orderly, identify those potential hazards with cones, flagging or signage
	3d. Personal injury/property damage from fire or explosion.	3d. Always have two 20 pound fire extinguishers available and within 25 feet of operations. 3d. See 2a
	3e. Personal injury/property damage from injecting	3e. Always ensure propper PPE is donned when mixing the reagent or adding to pump hopper, see 3b. 3e. Always monitor injection pressure to ensure it does not exceed manufature recommendations for the associated equipment. 3e. Inspect all equipment prior to using, also inspect tubing and hosing to ensure its integrity and there are no compromises. 3e. Ensure that there is operational equipment for emergency decon of personnel in event of reagent exposure.
4. Waste Management	4a. Personal injury from water splashing/chemical exposure	3a. When deconing containers and equipment, the following PPE must be worn in additon to the minimum PPE required above: -PVC Apron or Tyvek -Rubber Gloves -Chemical safety goggles and full face shield
	4b. Property damage from contaminants.	3b. Lay down impervious surface (such as >8-mil poly sheeting) during deconing and use wood blocks or sand bags to create a sump.
	4C. Waste Disposal	1j. Ensure that all all material is disposed of proprly, - General consturction debris is collected, containerized and disposed at a local landfill - Purge water or spoils are containerized, labled and disposed of according to State speciffic regulation.

Job Safety Analysis (JSA)
Geoproing

Location	Date Prepared/Revisions	Team Members
480 River St. Rochester, NY	September 8, 2006	AMEC: Tim Ahrens, Jeff LaRock, Howard Miller, Cris Schrader

Personal Protective Equipment

Minimum PPE Requirements	Additional PPE Requirements (when noted in Remedy Section)
- Steel Toe Boots / Shoes - Safety Glasses w/Side Shields - Hard Hat - Bright orange shirt or vest (reflective clothing)	-Leather gloves when performing work with potential for hand injury -Full length pants and long sleeve shirts if working in vegetation. -DEET insect repellant if walking through heavy vegetation. -Sunscreen during summer -Two 20 pound fire extinguisher on ground in work area. -PVC Apron or Tyvek if potential to come in contact with impacted soils or water -Nitrile gloves when handling soils or groundwater -Rubber Boots or Boot Covers if potential to come in contact with impacted soils or water -First Aid Kit and Eye-wash Station

Subtask	Hazard	Remedy
Geoprobing	1a. Underground/Overhead Utilities	1a. Notify state speciffic Dig Safe Authority, patrol area with contractor for overhead utilities and underground utility markings, contact property owner for site speciffic clearance
	1b. Personal and/or property damage from vehicle movement	1b. Designate work area by placing cones around perimiter. 1b. When moving vehicles the following precautions must be taken: -equipment must be stowed and secured -a spotter must always be used. -the spotter must identify any surface obstructions/anomolies -audible warning signals must be used (horn or backing signal) -operator must yield to pedestrians 1b. Always know where all on-site vehicles are located.
	1c. Muscle strain or other injury from lifting heavy objects	1c. Do not attempt to lift anything that weighs more than 35 pounds. 1c. Use mechanical equipment such as lift gate to carry/lift 1c. Use proper lifting techniques; keep back straight and lift with arms and legs; keep load near body; avoid reaching 1c. Use leather gloves when handling containers.
	1d. High noise levels	1d. Use hearing protection, either ear plugs or muffs when noise level is greater than 85dBA.
	1e. Pinch points	1e. Identify and understand equipment and its moving parts. -ensure that guards are in place -wear proper gloves -deenergize equipment before maintenace
	1f. Slips Trips and Falls	1f. Keep work area clear and orderly, identify those potential hazards with cones, flagging or signage
	1g. Fire / Explosion	1g. No smoking on-site - Always have two 20 pound fire extinguishers available and within 25 feet of operations.
	1h. General Safety	1h. Ensure that all on-site personel have read and signed off on HASP and specifically reviewe JSA. - Ensure MSDS is readily available and its location is known by all on-site personnel. - Ensure all know Hospital location, site address, emergency numbers, and location of a site phone.
	1i. Equipment decontamination	1i. When deconning containers and equipment ensure propper PPE is worn including but not limited to water/chemcial proof gloves, splash apron or tyvek, face shield. - Lay down impervious surface (such as >10-mil poly sheeting) prevent runoff by using wood blocks or sandbags to create a sump.
	1j. Waste Disposal	1j. Ensure that all all material is disposed of proprly, - General consturction debris is collected, containerized and disposed at a local landfill - Purge water or spoils are containerized, labled and disposed of according to State speciffic regulation.
	1k. Property damage from contaminants.	3b. Lay down impervious surface (such as >10-mil poly sheeting) if storing impacted materials on the ground, prevent runoff by using wood blocking or sandbags.

APPENDIX C

1. PRODUCT IDENTIFICATION:

PRODUCT IDENTIFICATION:	EHC-O
PRODUCT USE:	Soil and water treatment.

MANUFACTURER:

Adventus Remediation Technologies Inc.
1345 Fewster Drive
Mississauga, Ontario
L4W 2A5

EMERGENCY PHONE:

Office Hours:	905-273-5374
After Hours:	416-457-9491

TRANSPORTATION OF DANGEROUS GOOD CLASSIFICATION:
Not Regulated

WHMIS CLASSIFICATION:
Not Controlled

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	Chemical Formula	CAS No.	Percentage
Calcium Peroxide	CaO_2	1305-79-9	45%-70%
Calcium Hydroxide	$Ca(OH)_2$	1305-62-0	10%-20%
Sodium, Calcium Aluminosilicate, Hydrated	$Ca_2(Na,K)_2Al_8Si_{28}O_{72}\ 24H_2O$	12172-10-3	20%-30%

3. PHYSICAL DATA

Appearance	White
Physical state	Solid
Odor threshold	None
Bulk Density	500~650g/L
Solubility in Water	Insoluble
pH	~11
Appearance	White
Decomposition Temperature	Self-accelerating decomposition with oxygen release starting from 275 degrees Celsius

4. HAZARDS IDENTIFICATION

Emergency overview

Oxidizing agent, contact with other material may cause fire. Under fire conditions this material may decompose and release oxygen that intensifies fire. This product also contains crystalline silica. Long tern exposure to hazardous levels of silica dusts can cause lung disease (silicosis). The World Health Organization had indicated that there is limited evidence that crystalline silica is carcinogenic to humans, but the NTP and OSHA have not classified this ingredient as carcinogenic.

Potential Health Effects:

- General……Irritating to mucous membrane and eyes.
- Inhalation……Irritating to respiratory tract. Long term inhalation of elevated levels may cause lung disease (silicosis).
- Eye contact……May cause irritation to the eyes; Risks of serious or permanent eye lesions.
- Skin contact……May cause skin irritation.
- Ingestion……Irritation of the mouth and throat with nausea and vomiting.

5. FIRST AID MEASURES

- Inhalation……Remove affected person to fresh air. Seek medical attention if effects persist.
- Eye contact……Flush eyes with running water for at least 15 minutes with eyelids held open. Seek specialist advice.
- Skin contact……Wash affected skin with soap and mild detergent and large amounts of water.
- Ingestion……If the person is conscious and not convulsing, give 2-4 cupfuls of water to dilute the chemical and seek medical attention immediately. Do not induce vomiting.

6. FIRE FIGHTING MEASURE

Flash Point

- Not applicable

Flammability

- Not applicable

Ignition Temperature

- Not applicable

Danger of Explosion

- Non-explosive

Extinguishing Media

- Water

Fire Hazards

- Oxidizer. Storage vessels involved in a fire may vent gas or rupture due to internal pressure. Damp material may decompose exothermically and ignite combustibles. Oxygen release due to exothermic decomposition may support combustion. May ignite other combustible materials. Avoid contact with incompatible materials such as heavy metals, reducing agents, acids, bases, combustible (wood, papers, cloths etc.) Thermal decomposition releases oxygen and heat. Pressure bursts may occur due to gas evolution. Pressurization if confined when heated or decomposing. Containers may burst violently.

Fire Fighting Measures

- Evacuate all non-essential personnel
- Wear protective clothing and self-contained breathing apparatus.
- Remain upwind of fire to avoid hazardous vapors and decomposition products.
- Use water spray to cool fire- exposed containers.

7. ACCIDENTAL RELEASE MEASURES

Spill Clean-up Procedure

- Oxidizer. Eliminate all sources of ignition. Evacuate unprotected personnel from equipment recommendations found in Section 9. Never exceed any occupational exposure limit.
- Shovel or sweep material into plastic bags or vented containers for disposal. Do not return spilled or contaminated material to inventory. Avoid making dust.
- Flush remaining area with water to remove trace residue and dispose of properly. Avoid direct discharge to sewers and surface waters. Notify authorities if entry occurs.
- Do not touch or walk through spilled material. Keep away from combustibles (wood, paper, oils, etc.). Do not return product to container because of risk of contamination.

8. HANDLING AND STORAGE

Storage

- Oxidizer. Store in a cool, well-ventilated area away from all source of ignition and out of direct sunlight. Store in a dry location away from heat.
- Keep away from incompatible materials. Keep containers tightly closed. Do not store in unlabeled or mislabeled containers.
- Protect from moisture. Do not store near combustible materials. Keep containers well sealed. Ensure pressure relief and adequate ventilation.
- Store separately from organics and reducing materials. Avoid contamination that may lead to decomposition.

Handling

- Avoid contact with eyes, skin, and clothing. Use with adequate ventilation.
- Do not swallow. Avoid breathing vapors, mists, or dust. Do not eat, drink, or smoke in work area.
- Prevent contact with combustible or organic materials.
- Label containers and keep them tightly closed when not in use.
- Wash thoroughly after handling.

9. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

- General room ventilation is required. Local exhaust ventilation, process enclosures or other engineers controls may be needed to maintain airborne levels below recommended exposure limits. Avoid creating dust or mist. Maintain adequate ventilation. Do not use in closed or confined spaces. Keep levels below exposure limits. To determine exposure limits, monitoring should be performed regularly.

Respiratory Protection

- For many condition, no respiratory protection may be needed; however, in dusty or unknown atmospheres or when exposures exceed limit values, wear a NIOSH approved respirator.

Eye/Face Protection

- Wear chemical safety goggles and a full face shield while handling this product.

Skin Protection

- Prevent contact with this product. Wear gloves and protective clothing depending on condition of use. Protective gloves: Chemical-resistant (Recommended materials: PVC, neoprene or rubber)

Other Protective Equipment

- Eye-wash station
- Safety shower
- Impervious clothing
- Rubber boots

General Hygiene Considerations

- Wash with soap and water before meal times and at the end of each work shift. Good manufacturing practices require gross amounts of any chemical removed from skin as soon as practical, especially before eating or smoking.

10. STABILITY AND REACTIVITY

Stability

- Stable under normal conditions

Condition to Avoid

- Water
- Acids
- Bases
- Salts of heavy metals
- Reducing agents
- Organic materials
- Flammable substances

Hazardous Decomposition Products

- Oxygen which supports combustion

11. TOXICOLOGICAL INFORMATION

- LD50 Oral: Min.2000 mg/kg, rat
- LD50 Dermal: Min. 2000mg/kg, rat
- LD50 Inhalation: Min. 4580 mg/kg, rat

12. ECOLOGICAL INFORMATION

Ecotoxicological Information

- Hazards for the environment is limited due to the product properties of no bioaccumulation, weak solubility and precipitation in aquatic environment.

Chemical Fate Information

- As indicated by chemical properties oxygen is released into the environment.

13. DISPOSAL CONSIDERATIONS

Waste Treatment

- Dispose of in an approved waste facility operated by an authorized contractor in compliance with local regulations.

Package Treatment

- The empty and clean containers are to be recycled or disposed of in conformity with local regulations.

14. TRANSPORT INFORMATION

- Proper Shipping Name: EHC-O
- Hazard Class: 5.1
- Labels: 5.1 (Oxidizer)
- Packing Group: II

15. REGULATORY INFORMATION

SARA Section	Yes
SARA (313) Chemicals	No
EPA TSCA Inventory	Appears
Canadian WHMIS Classification	C, D2B
Canadian DSL	Appears
EINECS Inventory	Appears

16. PREPARATION INFORMATION

Prepared By:	Geoff Bell Adventus Remediation Technologies Inc. 1345 Fewster Drive Mississauga, Ontario L4W 2A5	Date Prep./Rev: Print Date: Phone: Fax:	10/2/06 10/2/06 905-273-5374 905-273-4367