Design Document

Groundwater
Interim Remedial Measure (IRM)
In-Situ Chemical Oxidation (ISCO)

Brownfield Cleanup Program
Former Griffin Technology Site
Farmington, New York

BCP Site # C835008

May 2008

S&W
REDEVELOPMENT

GROUNDWATER IRM DESIGN
BCP SITE No. C835008
FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON, NEW YORK

Prepared for

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SECTION 1 – INTRODUCTION

This Design Document presents technical plans for implementing an in-situ chemical oxidation (ISCO) system as an Interim Remedial Measure (IRM) for groundwater contamination, at 6132 Victor Manchester Road in Ontario County, New York (the *site* – see Figures 1-1 and 1-2). The site is owned by SW Victor Manchester, LLC (Applicant), and was accepted into the New York State Brownfield Cleanup Program (BCP) by the New York State Department of Environmental Conservation (NYSDEC). A Brownfield Cleanup Agreement (BCA) has been executed requiring the applicant, as a Volunteer, to implement a site remedy that adequately protects human health and the environment.

As part of a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC) (BCA No. C835008), SW Victor Manchester LLC (the Applicant and Owner) plans to remediate the site to support future commercial use. Based on the nature and extent of contamination and the contemplated future use of the site, a Track 4 remedial approach is being sought which would allow for institutional and engineering controls to meet Remedial Action Objectives (RAOs) for the site, which include protection of human health and the environment.

Consistent with the proposed commercial end use, a strategy to achieve Track 4 RAOs has been proposed by the Applicant:

- In Situ Groundwater Treatment to decrease the volatile organic compounds (VOCs) contaminant mass in the upper bedrock groundwater zone.
- Engineering Controls to be defined in a Site Management Plan (See Section 5.9) and Environmental Easement. These controls will be based on previous site investigation findings, the results of the ISCO IRM, additional data that will be collected to further characterize soil, and an evaluation of soil vapor intrusion (SVI) potential. Following further soil characterization, evaluation of SVI potential, and post-IRM (ISCO) sampling, occupied buildings may require sub slab vapor barriers, or sub-slab depressurization systems (SSDS), if it is determined necessary to mitigate potential future SVI.
- Institutional Controls will be included in an Environmental Easement (EE) filed with the County Clerk's office that will prohibit the use of groundwater at the site without proper treatment and approval by NYSDEC and the New York State

Department of Health (NYSDOH). The EE will also include restrictions on the end use for commercial development without prior approval from NYSDEC/NYSDOH.

The Applicant has prepared a Groundwater Interim Remedial Measure (IRM) Work Plan [S&W Redevelopment of North America, LLC (SWRNA), April 2008] and is prepared to proceed with the groundwater component of the overall remediation strategy as an IRM. This Groundwater IRM Design Document describes in detail the approach to implement an ISCO system.

Before a final remedy can be selected for the site, additional data will be collected for soil and the potential for soil vapor intrusion will be evaluated, as previously indicated. The implementation approach for the final remedy will be described in a separate Remedial Work Plan (RWP) that will be submitted for NYSDEC acceptance after the groundwater IRM is implemented and additional site characterization data is collected. To that end, the groundwater IRM approach will provide additional soil data requested by NYSDEC. A separate Supplemental Soil Investigation Work Plan has been submitted to NYSDEC for acceptance, and the results of that investigation will be provided to NYSDEC as part of the RWP.

The site specific technical plans contained herein describe the installation, operation, and performance monitoring of the ISCO groundwater IRM. Once accepted by the NYSDEC, the groundwater IRM will be implemented in accordance with this IRM Design Document, and the Quality Assurance Project Plan (QAPP) provided as Appendix A. In addition, work will be conducted in accordance with the following documents appended to the Groundwater IRM Work Plan:

- Health and Safety Plan
- Community Air Monitoring Plan

SECTION 2 - PROJECT OVERVIEW

The groundwater IRM by ISCO will provide contaminant mass reduction at the site, thereby reducing the potential for future exposure to site contaminants both on site and off site via groundwater and soil vapor.

2.1 - NATURE AND EXTENT OF CONTAMINATION

Chlorinated volatile organic compounds (Cl-VOCs) are present in site groundwater above Class GA groundwater quality standards. The detected groundwater contaminants include trichloroethene (TCE), 1,1,1-trichloroethane (TCA), dichloroethene (DCE), and vinyl chloride (VC). TCE and TCA were believed to be present in wastewater that was released onto the ground outside the western door of the site building from approximately 1975 until 1986. The contaminated wastewater evidently migrated downward through the soil in the release area and into the groundwater, where it subsequently migrated away from the release area, towards the southwest, in the direction of groundwater flow.

Seventeen (17) groundwater monitoring wells, including nine (9) located downgradient of the site, have horizontally and vertically delineated a groundwater plume that extends southwest of the site, affecting both overburden and bedrock. The majority of impact at the site is in the upper weathered bedrock zone. Figure 2-1 shows the extent of groundwater contamination at the site with respect to TCE, based on July 2006 analytical data.

Analytical data indicates that the groundwater contamination has naturally degraded since its release, based on the presence of DCE and vinyl chloride which are degradation products of TCE and TCA.

Analytical results for forty three (43) soil samples collected from this area produced two (2) soil samples with contaminant levels above existing Part 375 soil cleanup objectives for unrestricted site use and for the protection of groundwater (BB&L, July 1991; URS/Woodward-Clyde, June 1999). Additional soil sampling will be conducted at the site, including the source area and below the site building, in accordance with a Supplemental Soil Investigation Work Plan (SWRNA, April 2008) following NYSDEC approval.

2.2 - SITE HYDROGEOLOGY

Overburden at the site consists of a heterogeneous mixture of brown silt, sand, and clay, which is believed to be glacial till. Silt appears to be the primary soil component, with varying amounts of sand and clay.

Overburden thickness increases across the site from north to south. In the northern portion of the site overburden is less than 5 feet thick, and in the southern portion of the site it approaches 20 feet thick. Further to the south, overburden is approximately 30 feet thick adjacent to Beaver Creek.

Bedrock at the site consists of dolomite. The bedrock surface is weathered and described as "soft", based on auger penetration. The bedrock surface dips to the south/southwest. Fractures were identified in bedrock cores, and some exhibited iron (orange) and manganese (black) staining. Most of the fractures appeared to be free of mineral deposits.

Overburden groundwater flows to the south/southwest in the vicinity of the site. Bedrock groundwater flows generally southwest across the site, but off site there appears to be a flow component that diverges to the west/southwest, due to an anomalously low water level in one of the bedrock monitoring wells (MW-7D) southwest of the site.

Vertical hydraulic gradients have been measured upward in certain monitoring well couplets and downward in others.

Hydraulic conductivity of the overburden, as estimated from slug tests, is on the order of 10^{-3} cm/sec. For bedrock, the conductivity varies from 10^{-3} cm/sec to 10^{-2} cm/sec. The variation in bedrock hydraulic conductivity likely reflects the presence of fracture zones that create localized areas of relatively high hydraulic conductivity. This variation in water transmitting capability for bedrock may also account for the observed differences in the vertical gradients from one location to the next.

2.3 PREVIOUS INTERIM REMEDIAL MEASURE

A groundwater recovery system was implemented at the site in 1997, in accordance with a 1996 IRM Work Plan (Woodward-Clyde, 1996). Three (3) recovery wells screened in bedrock across the overburden/bedrock interface began operating in 1997, and a fourth recovery well went into operation in 1999. However, concentrations of the contaminants of concern still exceed Class GA groundwater quality standards, and it appears that the recovery system has reached its performance limits.

2.4 IRM GOALS

The overall remediation goal for the site is to protect human health and the environment from site-related contamination, in a manner that supports redevelopment and reuse of the site to the benefit of the community. The remedial strategy will focus on eliminating or reducing human health exposure to site contamination. Under current site conditions, there are no complete, or potentially complete, fish or wildlife exposure pathways for this site.

In order to achieve site remediation goals, the following Remedial Action Objectives (RAOs) have been proposed (Groundwater IRM Work Plan, SWRNA April 2008).

- Eliminate, or reduce to the extent practicable, potential on-site chlorinated hydrocarbon impacts to shallow and deep groundwater;
- Eliminate, or reduce to the extent practicable, human exposure to site groundwater through ingestion;
- Eliminate, or reduce to the extent practicable, chlorinated VOC contamination in shallow groundwater to mitigate potential human exposure to volatile organic vapors that may migrate into future site structures;

The groundwater IRM will focus on eliminating or reducing human health exposure to site contamination relative to groundwater contamination that presently exists, as well as soil vapor contamination that may potentially result from groundwater contamiantion.

To address the groundwater and soil vapor RAOs, an in-situ chemical oxidation (ISCO) system will be installed as an IRM to treat groundwater contamination by chemical oxidation processes. By reducing the contaminant mass at the site, this system will permanently reduce the potential for future migration of, and exposure to, site contaminants. The basis of design and the conceptual approach to implement the ISCO groundwater treatment system were initially outlined in the Groundwater IRM Work Plan. This IRM Design Document provides a more detailed discussion of the ISCO system design.

SECTION 3 - EVALUATION OF REMEDIAL APPROACH

The aim of the ISCO groundwater IRM will be to treat groundwater in the region of the overburden/bedrock interface, targeting primarily the upper 15 feet of the weathered bedrock zone where the majority of groundwater contamination resides. Two general areas of the site will be targeted, including the source area along the west side of the site building, where the Cl-VOC contaminants had been historically released at the ground surface, and along the south and portions of the west property boundaries, which are downgradient of the source area. An in-situ chemical oxidation (ISCO) system will be installed that injects potassium permanganate ($KMnO_4$) solution into the upper weathered bedrock groundwater zone, to destroy organic contaminants.

Potassium permanganate oxidation breaks the carbon bonds of the Cl-VOC molecules, producing non-toxic reaction by-products that include carbon dioxide, manganese dioxide solids, potassium, and chloride. The following equation is an example chemical reaction for the oxidation of TCE (C_2HCl_3) using $KMnO_4$:

$$2KMnO_4 + C_2HCl_3 \Rightarrow 2CO_2 + 2MnO_2(s) + 2K^+ + 3Cl^- + H^+$$

Potassium permanganate is a strong oxidant, and the above reaction is thermodynamically favorable. The effectiveness of ISCO as a technology strongly depends on the ability of the injection system to deliver the oxidant to the contamination. Once introduced into the target treatment zone, chemical oxidants are dispersed by advective groundwater flow. For this site, the oxidant will also follow fracture-flow paths in the weathered bedrock zone to reach the groundwater contaminants.

Ideally, the oxidant concentrations are sustained from the point of delivery until the oxidants contact the contaminants. However, the concentrations of oxidant may decrease by dilution through mixing with subsurface pore water, and as they are consumed by ancillary chemical reactions unrelated to the target contaminants. This loss of oxidant due to reactions with non-target compounds is referred to as the natural oxidant demand (NOD).

3.1 BENCH SCALE TEST

Carus Chemical Company performed a bench test of aquifer material from the site in January 2008 to determine the permanganate soil/site groundwater oxidant demand (PSOD). The permanganate demand is the amount of permanganate consumed in a given amount of time. Natural soil and rock typically contain reduced minerals that may consume oxidants such as potassium permanganate that are injected into the matrix. It is therefore essential to measure the oxidant demand of the aquifer matrix to estimate the proper potassium permanganate dose.

Because the ISCO approach will primarily target the upper weathered bedrock zone, the bench tests were conducted on broken rock material retrieved from shallow bedrock cores from the site. The bedrock samples were broken into small pieces by the laboratory analyst (> 1 gram), and placed in reaction vessels in which potassium permanganate solutions were added.

Tests were run at three different permanganate strengths (low does, medium dose, high dose). This was done to measure the how the reaction rate increases as the permanganate strength increased. Because the rate of oxidant consumption may increase as the permanganate dose increases, there may be a loss of reaction efficiency at higher doses.

The bench test results are expressed as permanganate soil oxidant demand (PSOD), as presented below:

Permanganate Concentrations	PSOD (per 48 hours)
2.8 g/kg (low dose)	1 g/kg
13.9 g/kg (medium dose)	1.8 g/kg
27.8 g/kg (high dose)	1.8 g/kg

The measured PSOD indicates the grams of permanganate consumed per Kg dry weight of soil/rock at the indicated dosages over a 48-hour period. Overall, the soil and groundwater samples had a low demand in all three scenarios, indicating that ISCO with permanganate is a workable remedy with respect to PSOD.

Because the aquifer matrix is composed of rock, and due to the standard test methods employed, the measured PSOD is likely to overstate the actual, or effective, PSOD. The rock samples collected from cores had to be broken into small pieces (less than one gram) to enable bench testing. This significantly increased the reaction surface area of the rock matrix. In addition, it is standard procedure to invert the sample vessel once during the 48 hour test, which agitates the sample and increases reactivity. Although this is standard procedure, it produces a conservative estimate of PSOD that typically exceeds the actual in-field value. Based on empirical observations from numerous test sites, Carus has indicated that the *effective* PSOD is typically 10 to 20 percent of the measured PSOD from bench tests (personal communication). For the type of fractured rock matrix at this site, it is reasonable to anticipate that the effective PSOD will not significantly exceed 0.18 g/Kg.

3.2 PILOT TEST

A pilot test was done in January 2008 to provide specific hydraulic information to provide a basis for system design, including radius of influence (ROI), travel time, mounding, and injection flow rates. Approximately 425 gallons of a 2 percent potassium permanganate solution were introduced into groundwater monitoring well MW-2S over two days (January 30 – 31, 2008). Although the Groundwater IRM Work Plan had indicated approximately 1,000 gallons would be injected during the pilot test, below-freezing weather conditions reduced the solubility of the solution and the effectiveness of injection equipment such that a smaller quantity was injected at a slightly lower concentration.

3.2.1 STUDY DESIGN

Figure 3-1 shows the orientation of pilot test observation wells (OW-1, OW-2, OW-3, OW-4, ROW-1, and ROW-2) with respect to pilot test injection well MW-2S. Travel time and the effective ROI were estimated by examining the color of water samples collected from six observation wells (OW-1, OW-2, OW-3, OW-4, ROW-1, and ROW-2), which were installed at distances of approximately 10 feet (OW-1 and OW-3), 15 feet (ROW-1 and ROW-2), and 20 feet (OW-2 and OW-4) away from MW-2S.

MW-2S is a 2-inch diameter PVC water table well installed primarily in the upper weathered zone of the dolomite bedrock that underlies the site. It is 14.1 feet deep (below ground surface – "bgs"). Each of the observation wells is constructed of 1-inch diameter PVC. The screen intervals of the observation wells, and depth to groundwater prior to the start of the pilot test, are indicated below:

Well I.D.	Screen Interval	Depth to Water
OW-1	1.5 - 4 ft bgs	3.97 ft below top of PVC
OW-2	1.5 - 4 ft bgs	4.47 ft below top of PVC
OW-3	1.5 – 4.5 ft bgs	4.74 ft below top of PVC
OW-4	1.5 – 4.5 ft bgs	3.94 ft below top of PVC
ROW-1	7.5 – 16 ft bgs	6.44 ft below top of PVC
ROW-2	7 – 15.5 ft bgs	6.54 ft below top of PVC

During installation of the observation wells (OW-1, -2, -3, -4) it was determined that bedrock in the area of MW-2S is less than 4.5 feet bgs. Rock observation wells ROW-1 (15 feet west) and ROW-2 (15 feet south) were installed in bedrock, screened across a zone of vertical fractures. Vertical fractures were observed in ROW-1 between 7 and 9 feet bgs, and in ROW-2 between 12.5 and 14.5 feet bgs.

The permanganate compound introduced at MW-2S was provided by Carus Chemical Company. The permanganate solution was prepared on site, by mixing approximately 80 pounds of powdered potassium permanganate with approximately 425 gallons of water. This solution was introduced into MW-2S in two equal batches (i.e. ~ 212 gallons per batch), on January 30 and January 31, 2008, respectively. The injection period for each of the two episodes was 2 to 3 hours, or approximately 1.5 gallons per minute (gpm).

3.2.2 PERMANGANATE BREAKTHROUGH

The ROI was verified when water samples from the observation wells turned purple, as occurs when permanganate is mixed with water. On the first day of injection, it took approximately one hour to observe breakthrough at ROW-1, fifteen feet away from MW-2S, after approximately 75 to 100 gallons of permanganate solution had been delivered to

MW-2S. Breakthrough at ROW-2 was observed after 2.5 hours, after 175 gallons had been introduced.

On the second day, approximately 20 hours after injection the previous day had stopped, and prior to injecting any additional permanganate solution, groundwater at ROW-1 was still purple, but groundwater from ROW-2 was clear. Groundwater at ROW-2 turned purple after approximately 130 gallons of solution was injected, approximately 90 minutes after injection was resumed. Mounding of less than 12-inches was observed in the injection well.

Five days after injection, on February 5, 2008, groundwater in ROW-1 was still purple, and groundwater in ROW-2 was clear. None of the other monitoring wells and recovery wells on site contained purple. In the injection well (MW-2S) groundwater had a faint pink color, indicating a small amount of potassium permanganate was still present.

The fact that clear water was observed in ROW-2 indicates either that all of the permanganate had been consumed, or that the permanganate solution had migrated beyond ROW-2. The latter possibility may be more likely than the former, because purple was still evident in ROW-1 after five days. This means that the permanganate in ROW-1 had not been entirely consumed, indicating that the contaminant levels and oxidant demand of the aquifer were not sufficient to consume the permanganate over that time.

From the above observations, an ROI of approximately 20 feet is estimated for the design. On a localized scale (such as within 15 feet from the injection well) it is expected that variability in flow rates may exceed variability in chemical oxidation rates. This is because the degree of anisotropy due to fractures is likely to be greater in a dolostone aquifer than the degree of chemical variability of the dolostone on a small scale. Based on this assumption it is concluded that the permanganate had migrated beyond ROW-2, and is still purple as it is in ROW-1.

3.2.3 GROUNDWATER FLOW HYDRAULICS

As previously noted, there was minimal evidence of groundwater mounding during that pilot test. The groundwater elevation at MW-2S increased by less than 1 foot, and there was no measurable change in groundwater elevation in any of the observation wells or other site monitoring wells during the test.

No permanganate solution was observed in the shallow observation wells installed above bedrock (OW-1, -2, -3, & -4), which suggests that in the vicinity of MW-2S overburden is not a significant water bearing unit. The well screen for MW-2S extends slightly above the soil/bedrock interface, so the absence of permanganate in overburden wells OW-1 through -4 indicates that virtually all of the permanganate was delivered to the upper weathered bedrock zone.

3.2.4 PILOT STUDY CONCLUSIONS

The results of the pilot study indicate an ROI of at least 15 feet can be achieved by injection of potassium permanganate solution. The ROI is likely to be greater than 15 feet based on the fact that observation well ROW-2 no longer contained permanganate one week after the pilot test injection. At this location, the permanganate solution had apparently migrated some distance beyond the observation well. It seems unlikely that the absence of purple color at ROW-2 after one week is an indication that permanganate solution had been completely consumed, because purple groundwater was still very apparent at ROW-1, and there is no reason to think the groundwater in these two wells is subject to significantly different oxidant demands.

PSOD analysis of rock matrix material indicates a fairly low oxidant demand (1.8 g/Kg at high dose). The actual demand is probably much less, and not likely more than 0.18 g/Kg, for previously noted reasons.

The results also indicate that permanganate oxidation reactions are still effective after at least one week, based on the deep purple color still observed at observation well ROW-1.

SECTION 4 – IRM IMPLEMENTATION APPROACH

The ISCO IRM approach for this site will apply necessary oxidant mass in a single injection event. The design of the ISCO system utilizes oxidant demand results from bench-scale oxidation testing, together with empirical observations from the field-scale pilot test, so that one injection event is sufficient to meet remedial objectives. Following ISCO implementation, post-implementation groundwater sampling will occur, in accordance with a Site Management Plan (SMP – see Section 5.9), to monitor ISCO effectiveness.

The IRM approach will involve an array of seventeen (17) injection wells that will be manifolded in five groups consisting of two to four injection wells each. A 3 percent potassium permanganate solution will be injected sequentially into each of the five groups of injection wells.

The ISCO dosage will be aimed at destroying 100% of the contamination by a single injection of potassium permanganate solution, in order to reach RAOs. The site specific cleanup goal for groundwater shall be the New York State Groundwater Standards. If this cannot be achieved, the groundwater cleanup goal shall be cleanup to the extent practicable of the groundwater remediation technology. Low-level asymptotic conditions and bulk contaminant removal shall be used to consider the need for further remediation.

The effectiveness of ISCO will be measured, after implementation is complete, as a percentage of the contamination that is actually destroyed.

4.1 INJECTION SYSTEM

4.1.1 INJECTION & OBSERVATION WELL LOCATIONS

The proposed layout of the injection well array is based on an assumed 20-foot ROI. In reality, the pilot test has indicated the ROI is likely to be greater than 20 feet, as indicated by the purple groundwater color in site monitoring wells one week after the test. For design purposes, a conservative 20-foot ROI will be assumed.

Figure 4-1 depicts a network of seventeen (17) injection wells (IW-1 through IW-17) based on a 40 foot grid. The shaded area on the figure, encompassing approximately 45,000 square feet, is the target treatment area, which was presented in the Groundwater IRM Work Plan as greater than 10 µg/L (ppm) TCE. The proposed injection wells will include seven (7) across the contaminant source area west of the site building (IW-1 through IW-6, and IW-15), which is the core of the groundwater contamination plume. Ten (10) additional downgradient injection wells will be positioned downgradient or cross gradient of the contaminant source area (IW-7 through IW-14, IW-16, IW-17), including six that will be located in proximity to the western and southern downgradient site boundaries (IW-11, -12, -13, -14, -16, -17). Note that three of the existing site monitoring wells – MW-2S, MW-5S and MW-5D – will be used as injection wells IW-15, -16, and -17, respectively.

Observation wells will be installed within and downgradient of the injection well array (Figure 4-1) to monitor the effectiveness of the ISCO injection. Five (5) observation wells will be installed (OW-1 through OW-5), and four (4) existing wells will also be used as observation wells: MW-3, MW-4, RW-1, and RW-2.

A SWRNA hydrogeologist will be present during installation of the injection and observation wells, to record field observations, including photoionization detector (PID) readings of soil samples.

All of the injection and observation wells will be surveyed after installation to a known point of reference and their top of casing (PVC) elevations will be measured.

4.1.2 INJECTION & OBSERVATION WELL DESIGN

Previous site investigation data have indicated groundwater contamination exists primarily in the upper weathered bedrock zone, which the results of the pilot test indicate is the principal water bearing zone at the site. It is therefore proposed that the injection and observations wells be screened in the upper 15 feet of bedrock to target the contamination zone and maximize the dispersion of the potassium permanganate. A design schematic for a typical injection/observation well is shown as Figure 4-2.

Hydraulic evidence from the pilot test indicates the upper weather bedrock is an appropriate target interval for ISCO injection. Pilot test overburden observation wells installed above the top of bedrock contained very little groundwater throughout the test, and there was no evidence of permanganate breakthrough. Conversely, permanganate breakthrough was observed in bedrock observation wells screened ten feet into the upper bedrock zone several hours after injection began at well MW-2S. The pilot test confirms that the upper weathered bedrock, which contains the majority of groundwater contamination, is also the principal water-bearing unit at this site, and ISCO treatment will target this zone.

The total depth of the injection/observation wells is expected to range from approximately 20 feet to 35 feet bgs across the site, depending on bedrock depth. Near the west side of the building, in the contaminant source area, the depth to bedrock is less than 5 feet bgs in most places. The depth to bedrock increases away from the source area to the west and south.

The injection wells will be installed using 6 ¼ inch inside diameter hollow stem augers, which will be drilled at least one foot into the upper weathered bedrock. Drilling will continue by coring 15 feet into rock using an H-bit, within which a 4-inch diameter schedule 40 PVC well will be placed, with 0.01 slot well screen. The well screen will extend up from the bottom of the borehole to the top of bedrock.

The observation wells will be installed using 4 ¼ inch inside diameter hollow stem augers, and will be constructed of 2-inch diameter PVC. Drilling and construction methods will be otherwise the same as those used for the injection well installation.

The annular space of the borehole will be filled with #3 silica sand from the bottom of the borehole to at least 2 feet above the top of the well screen. At least two feet of bentonite pellets will be placed above the sand filter pack, and the remaining space will be backfilled with a grout/Portland cement mixture. The wells will be secured with locking stick-up protective iron casings. The top of the PVC riser will be threaded, with screw-on PVC caps, to provide easy connection with remediation system components.

4.1.3 SOIL SAMPLING AND ANALYSIS

Previous soil sampling efforts do not indicate significant soil contamination exists in the source area, west of the site building, relative to Part 375 soil cleanup objectives (SCOs). Only two (2) samples in 43 analyzed contained contaminants above (SCOs) for unrestricted use. Additional soil samples will be collected to characterize soils beyond the source area at the same time as the injection/observation wells are installed.

Soil boring locations from which samples will be collected are shown on Figure 4-3. At each soil boring location, soil samples will be screened with a PID. A soil sample will be taken from two (2) discrete intervals from each boring, including: (1) the upper six inches (1/2 foot) immediately below any ground cover (i.e. pavement, vegetation, gravel fill, etc), and (2) from either the soil/bedrock interface, or the water table interface, based on field evidence of potential contamination (visual, odor, and PID). If field evidence is inconclusive the second soil sample will be collected from the soil/bedrock interface.

The soil samples will be analyzed for target compound list (TCL) volatile organic compounds (method 8260), semivolatile organic compounds (method 8270), pesticides (method 8081), PCBs (method 8082), and target analyte list (TAL) metals (methods 6010, 7470, and 7471).

4.2 - PERMANGANATE DOSAGE

The amount of permanganate solution required to meet RAOs is based on the mass of permanganate required to destroy the estimated contamination mass, plus the estimated effective permanganate soil oxidant demand (effective PSOD). Table 4-1, provided by Carus Corporation, provides a conservative estimate of the mass of potassium permanganate required to destroy TCE contamination at the site, taking into account the PSOD for the aquifer matrix.

The target area is conservatively estimated at 45,000 square feet. The target injection zone thickness is 15 feet, and an effective porosity of 25 percent is assumed. The total treatment volume is therefore approximately 1.2 million gallons.

The mass of contamination is conservatively estimated within this volume, by assuming the entire volume contains the maximum TCE concentration detected in July 2006: 2,100 μg/L in MW-2S. By this approach the target mass of TCE at the site is approximately 22 pounds (~ 10 Kg).

Accounting for the effective PSOD, the amount of potassium permanganate required to destroy 22 pounds of TCE is approximately 13,500 pounds.

To create a 3 percent permanganate solution, 52,000 gallons of water is required. Divided evenly among the 17 proposed injection wells, each well will receive approximately 2,900 gallons of solution. At a target flow rate of 4 gpm, approximately 12 hours would be required to deliver permanganate solution to each injection well. The injection wells are to be manifolded into groups of two to four wells, and it is estimated that the total injection can be completed in two weeks.

4.3 - FEED SYSTEM COMPONENTS

As indicated above, the injection wells will be manifolded in groups of two to four wells each, so that permanganate solution will be injected into multiple wells at a time. One injection episode will therefore consist of four sequential injections conducted at each bundled group of injection wells.

Potassium permanganate solution will be fed to each of the four groups of injection wells via a system that will be engineered to carefully control injection rates. The manifold system will include valves on each line to control solution feed rates dependent on the capacity of each injection well. The following is a schedule of basic feed system equipment that will be used.

Quantity	Item Description
2	250 gallon polyethylene mixing totes
2	Pneumatic bladder pumps
2	2-point distribution manifolds
1	185 cfm compressor, 6 hp diesel
1	Self-priming centrifugal trash pump

4	1-inch diameter hose 20 feet in length (chemical grade)
2	2-inch diameter hose 100 ft in length (chemical grade)
2	2-inch diameter hose 5 ft in length (chemical grade)
1	Drum handler
1	Volumetric feed with venturi
1	600 ft of ¾-inch hose
40	330 pound drums of potassium permanganate (~13,500 lbs)
1	6,000 watt generator
5	12/3 extension chords

5.0 - SYSTEM OPERATION, MAINTENANCE & MONITORING

5.1- SYSTEM REQUIREMENTS

The volumetric helix requires a power source for operation. A variable speed drive consisting of a motor, controller, and control station determine the feed rate. The controller converts alternating current to direct current to drive the ¼ HP DC motor. The standard control panel consists of an ON-OFF switch and a speed adjusting potentiometer and operates on 115V 50/60 Hz AC current. The solution mixer has a ¼ HP DC motor and the pump is ¾ HP. The drum handler runs on a 12-volt DC battery which can be charged on a 120 volt system. One 40 amp generator can handle all four of these items. A separate optional generator will be used if necessary, in the event that work extends into nighttime hours, to power flood lights.

A potable water source will be obtained for use. The objective will be to secure water from the local Farmington Water District. NYSDEC will be notified of water arrangements for concurrence that the supply is suitable for the ISCO use.

5.2 EQUIPMENT SET-UP

The equipment and potassium permanganate drums will be delivered to the site via a shipping truck with a hydraulic lift. Ten pallets will be ordered for ISCO injection and each pallet will have four drums (1,320 pounds of potassium permanganate). The drums are made of heavy gauge steel to prevent damage and spills during handling and storage. The equipment will be mounted on wooden skids to eliminate the need for a fork lift to move the equipment around the site.

The volumetric helix feeder and venturi will be situated on the same skid and the pump will be mounted on a separate skid. The volumetric feeder will have a 1 ½ inch diameter helix with a maximum of 84 RPM. This helix can feed between 17.5 lbs and 350 lbs of potassium permanganate per hour. The permanganate solid will be fed to a 275 gallon dilution tank, and diluted to a 3% to 4% solution and mixed/agitated using compressed air.

All equipment will be stored outside. A tent may be used to protect equipment from the elements, but is not considered essential for equipment performance. A trailer, storage container, or the existing building will be used to house sampling equipment.

Unless a compelling need arises to inject during nighttime hours, all work will be done during daylight hours. Nighttime work, if any, will require adequate artificial lighting to maintain worker health and safety, and will also comply with local noise ordinances.

A 1-inch hose approximately 150 feet long, will be attached to the water supply tank and connected to the mix tank. A backflow preventer will be installed on the connection to prevent flow of the potassium permanganate solution into the tank. The volumetric feeder will be connected via an encased auger to the venturi. The mixer will be connected to the mix tank by a hose. Both the volumetric feeder and the mixer must be plugged into separate receptacles on the generator. The mix tank has three 2-inch orifices for removal of the potassium permanganate solution. One at the top of the tank for overflow and the other at the bottom to be used for flushing the permanganate solution. Both will drain into a bucket for collection and reuse. A 1-inch diameter hose will be connected to the third orifice and attach to the 20 gpm pump, which will then be attached to the distribution head. Four 100 foot 1-inch diameter hoses will be attached to the outputs on the distribution head for injection into the wells. This equipment schematic can be found on Figure 5-1.

Pre-Startup Procedure:

a. With screwdriver and small wrenches, check tightness of all setscrews and mounting screws.

b. Initial lubrication is made at factory; further lubrication before starting is not necessary.

c. Turn on water supply temporarily and check tightness of all piping connections.

5.3 SYSTEM START-UP

The helix feeder is volumetric, and gravimetric rate of feed varies widely from one chemical to the next. Therefore, calibration must be done at installation with the potassium permanganate. Since rate adjustment dial is approximately linear, it is only necessary to determine rate at the point near maximum rate setting. A linear calibration curve is desirable because they result in the best accuracy and precision. A plot of the calibration data and the fitted line should always be examined to check for outliers and to verify behavior of the feeder at a current setting with material inside.

Next, the potassium permanganate drum will be rolled from the pallet and placed on the battery operated drum handler by field personnel following the below directions:

Replace the solid plug on the hydraulic reservoir with the supplied breather cap for proper air venting before operating the drum handler. Remove the lid from a 330 lb. drum of potassium permanganate. Attach the stainless steel discharge cone to the drum with the bolt-on clamp provided. Before installing the cone, inspect the drum to insure the rim is round and free of defects such as indents, bends, etc. which will prevent the cone from seating properly. Locate the cone on the open drum being careful not to distort or misalign the gasket. Attach the locking ring to the cone and drum. Secure the locking ring in place with a nut & bolt. Make sure that the discharge iris valve is closed. Next, strap the drum to the lifting arms between the two center ribs of the drum and tighten the clamps with the ratchet handles. Once the drum is secured to the handler, press the raise switch to lift the drum and entire assembly off the ground. Roll the drum handler to the rear of the feeder. Press the raise button until the drum is approximately 4 feet off the ground. Next, press the rotate button to invert the drum and assembly. With the drum completely inverted, roll the drum handler and inverted drum over the inlet seal of the feeder. Take care to line up the discharge spout with the inlet seal. Once aligned, press the down button to lower the spout. This will engage the inlet seal. Set controls to the required feed rate.

Once the drum is attached, the water supply valve will be opened and water will flow into the tank at approximately 15 gpm. When 2 inches of water is in the tank, power on the mixer and slowly open the iris valve. Material in the hopper will flow by gravity into a rotating horizontal feed helix, which is chain-driven by a variable speed motor and gear reducer. As the feed helix rotates, it moves the material along the base of the hopper and out through the discharge spout. The feeder is equipped with an electromagnetic vibrator that provides cycled agitation to assist chemical flow to the feed screw. The vibrator is typically set to cycle 45 sec ff and 5 sec (or less) on while the feeder is operating. The feeder will auger the potassium permanganate into the 500 gallon mix tank at 150 pounds per hour creating a 2% solution. **Note: To prevent damage to the helix, be sure to shut off the feeder whenever the water supply to the mix tank is shut off.**

Fill the mix tank three quarters before beginning application. At this point, open the outlet from the mix tank, turn the pump on and beginning discharging the solution to the injection wells at a flow rate of 3 gpm (30 pounds of potassium permanganate per hour into each injection point).

The depth at which permanganate is introduced into the wells will be determined during the injection, and can be adjusted as necessary, to provide vertical distribution in the water column. In an effort to maintain similar flow rates and pressures at each injection point, wells that are equidistant from the equipment setup will be injected at the same time as follows:

Injection	Injection Well (IW) Numbers
1	1, 2, 4, 15
2	3, 5, 6 (close shut off valve to fourth application point)
3	10, 11, 16, 17
4	8, 9, 13, 14
5	7, 12 (close shut off valve to third and fourth application point)

5.4 DRUM HANDLER MAINTENANCE

Check the hydraulic fluid after every 40 hours of use. Three quarts of fluid is needed to operate the system properly. Check the voltmeter reading for adequate charge on the batteries. An overnight charge is usually sufficient to fully re-charge the battery. The lifting and rotator chain should be oiled periodically as needed. The nylon straps should be checked occasionally for wear and replaced as necessary. The chain guards can be temporarily removed to grease the rotator chain. The handler should be greased after every 100 hours of use.

- One grease point on each of the two front wheels.
- Two grease zerks on the front of the rotator.
- Eight grease points on the back plate (which rides up & down the mast).

5.5 HELIX FEEDER MAINTENANCE

Pull side & back covers off every three months and remove material that may have contaminated these areas. While covers are off, check all parts for wear and replace where necessary. Check all hardware for tightness and tighten where necessary. Ball bearing motors usually have lifetime lubrication requiring no attention for two years. In either case, the motors should be inspected and serviced at least once a year. The equipment supplier should perform this maintenance prior to delivery to the project site.

5.6 TROUBLESHOOTING

The following table describes briefly possible failures and their causes. No table can include all possible symptoms but the list below is a guide to areas for investigation.

Symptom	Possible Cause	Corrective Action
Motor not running	Supply power not on	Turn on
	Power switch failure	Replace
	Timer not operating	Repair or replace
	Motor overload tripped	Check motor, if motor is OK, then reset OL
	Defective motor	Replace
Helix not turning but motor is running	Defective gearbox (input shaft turns, output shaft does not)	Replace or repair gearbox making sure to thoroughly clean when repairing
	Sprockets in drive compartment are loose	Re-tighten setscrews on shaft flats
	Loose setscrew on helix	Align to shaft flat & re-tighten
	Torque limiter on main drive shaft is slipping	Determine cause of slippage & reset to 8 ft. pounds per instruction manual
Material being fed at a constant inaccurate rate	Feeder potentiometer not set correctly	Reset
	SCR Control Boards not functioning correctly	See SCR instruction manual

	Material flow problem	See material section
Material in hopper is rat holing or bridging	Vibrator not operating	Correct
	Vibrator amplitude set too low	Increase amplitude
	Improper feed application for material	Contact your local Carus representative
	Vibrator amplitude set too high	Decrease amplitude
Material in hopper is packing	Vibrator is not synchronized with on/off cycle of the feeder and is running when the feeder is off	Interlock the feeder with the feed cycle
	Improper feed application for material	Contact your local Carus representative
	Vibrator amplitude set too high	Decrease amplitude
Material in hopper is flooding	Material flooding from spout	Plug the spout before refilling the hopper
		Refill the hopper before completely empty
	Improper feeder application for material	Contact your local Carus representative

5.7 EQUIPMENT STORAGE

At the end of each injection event, the feed equipment will be emptied of all potassium permanganate solution. The unit will be emptied by operating the feeder until the hopper is empty. During the last injection event, every effort will be made to empty liquid potassium permanganate into the injection points by draining the solution from the tank of each individual hose. All solid and dissolved potassium permanganate will be removed from the dissolver/mix tank, all pumps, hoses and accessories. If residual solid material remains in any piece of equipment, it will be dissolved in water and neutralized. Any diluted permanganate solution that is generated during the equipment cleaning process will be neutralized using a reducing agent such as sodium bisulfite. The neutralization is achieved when the purple coloration has cleared. Clear rinse water may be discharged without special handling or treatment.

All equipment surfaces that may have residual potassium permanganate will be thoroughly cleaned. The equipment will be rinsed with water (inside and out) and allowed to dry before shipment. Wet rags will be used to wipe down the equipment and the rags will be thoroughly rinsed with copious amounts of water to wash away any visible purple. If not rinsed thoroughly, rags may become more concentrated with permanganate upon drying, increasing risk of spontaneous combustion. All valves shall be closed and hoses capped.

The equipment will be packaged by crating or palletizing and stretch-wrapped for return shipment. The crating, pallets, or packaging materials that the equipment was delivered in will be reused.

5.8 EFFECTIVENESS MONITORING

Effectiveness monitoring will be conducted before, during and after ISCO implementation. As previously noted, a Site Management Plan (Section 5.9) will be prepared, in accordance with the Remedial Work Plan, which will include provisions for post-implementation monitoring that will be conducted. The overall objective of effectiveness monitoring is to verify that ISCO implementation was carried out in accordance with design expectations, and has met or is likely to meet the remedial objectives for this site. This will be determined by the following measurements:

- Measuring flow rates/injection volumes during implementation
- Measuring the radius of influence around injection points based on the color of water samples taken from downgradient injection wells and monitoring wells
- Measuring contaminant levels in samples taken from adjacent observation wells before and after implementation
- Measuring indicator parameters (pH, Eh, specific conductance, turbidity, temperature) in samples taken from observation wells before, during, and after implementation

Part of the effectiveness monitoring program will involve collecting groundwater samples from nine (9) observation wells located within and adjacent to the injection well network and groundwater plume. Four of the proposed observation wells to be used for this purpose already exist at the site (MW-3, MW-4, RW-1, and RW-2). Five additional observation wells will be installed to supplement the existing wells (OW-1 through OW-5, see Figure 4-1). These observation wells will be installed in accordance with Section 4.1.2.

Groundwater samples will be analyzed by a New York State ELAP-certified laboratory, following Analytical Services Protocol (ASP). Laboratory reports will be provided by the laboratory as Category B analytical packages. The effectiveness monitoring program will include three main elements, as described below.

5.8.1 BASELINE MONITORING (PRE-IMPLEMENTATION)

The effectiveness monitoring program will begin prior to permanganate injection, to establish a pre-remediation baseline. The nine observation wells will be sampled for the following parameters:

- **VOCs**. Existing levels of VOC contamination have been measured in site soils and groundwater. VOCs are the contaminant of interest that will be destroyed by the application of chemical oxidant. Previous site investigation has determined that non-target organic compounds, such as semivolatile organic compounds (SVOCs), are not present to exert an oxygen demand on the chemical oxidant and therefore will not be analyzed.

- **Metals**. Groundwater samples will be collected for metals analysis from observation wells near the site boundary (OW-4, -5, -6, -7, -8, and -9). This will be done to enable monitoring of potential changes in metals concentrations that may occur following ISCO injection.

- **Chemical Oxygen Demand (COD)**. The COD for groundwater measures the amount of reduced (i.e. oxidizable) material dissolved in the water, and is an indicator of how much of the chemical oxidant may be consumed by parameters other than the target VOCs.

- **Total Organic Carbon (TOC)**. TOC analysis measures all forms of organic carbon is the groundwater, both natural and contaminant-related. Because natural organic carbon may consume the chemical oxidant as well as the target VOCs, it is important to measure it as a baseline parameter. In the majority of groundwater samples analyzed, TOC was less than 10 mg/L, which is not prohibitively high.

- **Field Parameters**. In addition to pH, field parameters will be measured, including Eh, specific conductance, dissolved oxygen, temperature, and turbidity.

5.8.2 IMPLEMENTATION PROCESS MONITORING

Process monitoring refers to system performance measurements during ISCO implementation – such as flow rates and injection volumes – along with monitoring of groundwater conditions that develop as a result of injection period of the chemical oxidant.

The flow rate of permanganate injection will be maintained by a flow meter. The flow meter will be observed during ISCO injection and adjusted as needed to maintain a flow rate of approximately 3 gallons per minute.

Groundwater monitoring will be provided by the nine observation wells located around the injection points within the target area for treatment. The groundwater monitoring program will determine the rate of migration and reaction of the chemical oxidant with site groundwater, and the radius of influence (ROI).

Process monitoring will involve two rounds of field parameter measurements and groundwater sample collection from the observation wells. The first round will occur immediately following the last injection of permanganate at the fifth injection well group. The second round will occur two weeks thereafter. Each process monitoring event will include the above baselines parameters (i.e. VOCs, metals, TOC, COD, field parameters) to determine chemical changes in groundwater in the observation wells. Chemical observations will help verify the ROI of the injection wells.

Note that groundwater samples colored purple will not be analyzed, since they are unlikely to be representative. After purple groundwater samples are collected the presence of reactive permanganate will alter the samples' chemistry during holding time and prior to analysis.

5.8.3 POST-IMPLEMENTATION EFFECTIVENESS MONITORING

The above baseline and implementation process monitoring parameters will be monitored following ISCO implementation. The expected behavior of these parameters in response to the chemical oxidant is described below.

- **VOCs.** The ISCO system is designed to destroy 100 percent of the contaminant mass, with a remedial goal of Class GA groundwater quality standards. ISCO effectiveness will be measured in terms of the percent reduction in VOC levels. The remediation program may be determined complete if asymptotic conditions are reached and/or trends indicate the cleanup target will be achieved. Groundwater samples will be collected from observation wells to measure the reduction in contaminant levels.

- **Metals.** Certain metals may become more soluble following injection of potassium permanganate, and will therefore be sampled following ISCO injection. Groundwater samples will be collected from the same observations wells that were sampled for the pre-injection event (OW-4, -5, -6, -7, -8, and -9).

- **pH** may decrease slightly depending on how well buffered (i.e. resistant to changes in pH) the soil and groundwater is. A decline in pH at a monitoring well downgradient of an injection point would indicate that the monitoring well is within the radius of influence (ROI) of the injection point.

- **Eh.** Like pH, Eh is measured as a field parameter. Eh is a measure of the "redox state" of groundwater – whether it is oxidizing or reducing. Dispersion of the chemical oxidant will increase Eh.

- **Temperature.** A slight rise in groundwater temperature may signal exothermic reactions that occur as permanganate reacts with dissolved groundwater constituents.

- **Color.** As permanganate reacts with water it produces a pink or purple color. In many cases the color is clearly visible so that no colorometric instruments are needed to verify it. In any case, color will be monitored during the injection period to determine the ROI of the permanganate solution.

- **COD & TOC.** Both of these parameters would be expected to decrease in the ROI of the injection points, as the chemical oxidant consumes oxidizable material.

After the ISCO implementation is completed, post-implementation groundwater monitoring will be conducted, in accordance with a Site Management Plan that will be prepared for NYSDEC approval (see Section 5.9).

Post-implementation groundwater monitoring will begin three months following the completion of the ISCO injection. The nine ISCO observation wells will be sampled for for VOCs, pH, Eh, TOC, and COD. This will be done to verify that post-remediation rebound does not occur, to confirm that remediation is acceptable. A second post-implementation sampling event will occur six months following the ISCO implementation (i.e. three months following the first post-implementation sampling event), in accordance with the SMP. After the two post-implementation sampling events, a summary report of results will be presented to NYSDEC for review. The need for and duration/frequency of additional monitoring will be addressed in the summary report.

After the second post-remediation monitoring event, the percent of contaminant reduction will be determined by comparing the pre-remediation data (i.e. baseline data) and post-remediation groundwater analytical data. Pre-remediation average concentrations of total

VOCs and total chlorinated VOCs will be determined, respectively, for each of the observation wells at the site. In addition, an average concentration of total VOCs will be determined based on results from all of the observation wells to provide a site-wide pre-remediation estimate.

The pre-remediation averages for the individual observation wells will be compared to each round of post-remediation data for each well, to determine the apparent remediation progress, and the percent decline in groundwater concentrations at each well will be used to compute the percent reduction of contamination.

The site-wide pre-remediation averages for total VOCs will also be compared to the post-remediation site wide averages, based on data for the final post-remediation monitoring event.

5.9 SITE MANAGEMENT PLAN

Following implementation of the remedy, the requirements for the operation, maintenance, and certification of engineering controls will be described in a Site Management Plan (SMP) that will be incorporated into the site Environmental Easement (EE) as required under the BCA. The SMP will include a description of procedures to complete the post-implementation groundwater monitoring for ISCO effectiveness, and related reporting requirements to NYSDEC. The SMP will describe scenarios based on post-implementation data, and actions that may subsequently result. Three potential scenarios are anticipated:

> Scenario No. 1. Little or no pink/purple coloration is observed in certain observation wells over time following ISCO implementation, indicating that the permanganate solution may not have adequately dispersed. In this case, a subsequent injection episode(s) may occur in specific areas where dispersion has not yet occurred and/or may include the installation of additional injection wells to increase the potential for dispersion. This approach would utilize a specific injection well group or groups.
>
> Scenario No. 2: The analytical data for the two (2) post-implementation sampling events demonstrate that groundwater standards have been reached, or has reached

conditions and trends indicating it is likely to be achieved. In this case, no further action would be recommended, aside from continued quarterly monitoring for two additional quarters.

Scenario No. 3: The analytical data indicate that a substantial reduction in contamination has occurred but has not reached groundwater standards or reached conditions and trends indicating it is likely to be achieved, and there is indication that the potassium permanganate solution still resides in the injection and/or monitoring wells. In that case, it would be recommended that one or two additional quarterly monitoring event(s) be conducted to determine whether, given enough time, the permanganate injection may produce satisfactory results. If after the subsequent quarterly monitoring event(s), groundwater standards are not reached or trends indicate it is likely not to be achieved a subsequent injection episode could be conducted, including a repeat of the effectiveness monitoring program. The additional injection episode would focus on those wells or the areas where groundwater standards were not achieved or likely to be achieved.

The SMP will indicate that post-implementation injection episodes may utilize the entire injection well array, or specific injection wells where data indicates additional permanganate is needed. The need and approach for subsequent injections will be determined following the post-remediation monitoring after the initial injection and reviewed with the NYSDEC for their concurrence.

SECTION 6 – SCHEDULE

The following timeline is proposed implementing the remedial action, as set forth under the previously submitted Remedial Work Plan (SWRNA 2007), and including the in-situ remediation program described in this design document:

6.1 - IMPLEMENTATION

March 14, 2008 – Distribute Fact Sheet with 10-day notice
April 8 – May 5, 2008 – Install ISCO Injection/Observation Wells
May 20, 2008 – Five days notice given to NYSDEC of groundwater sampling event
May 27-30, 2008 – Collect baseline (pre-remediation) groundwater samples from ten (10) observation wells.
May 28-30, 2008 – Construction/installation of ISCO feed and delivery system.
June 2-6, 2008 – ISCO injection.
June 27, 2008 – Submit Final Engineering Report (FER) including Site Management Plan (SMP)

6.2 - POST-IMPLEMENTATION MONITORING

August 1, 2008 – complete 1st quarterly round of post-remediation groundwater sampling (following 5-day prior notification to NYSDEC)
November 1, 2008 – complete 2nd quarterly round of post-remediation groundwater sampling (following 5-day prior notification to NYSDEC)

FIGURES

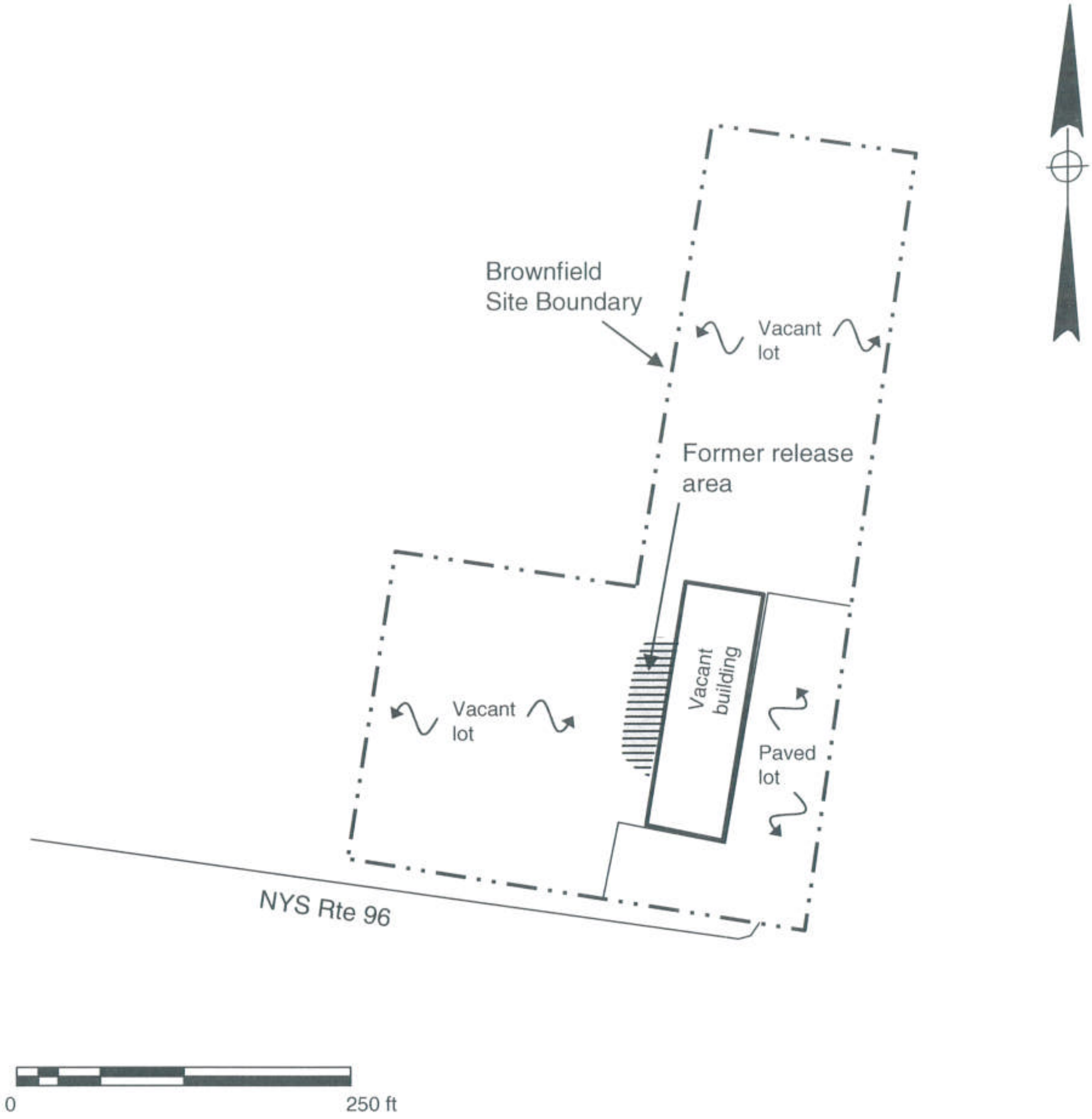
FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

S&W REDEVELOPMENT

Feb 2008

Proj No. B6003

FIGURE 1-1
SITE LOCATION



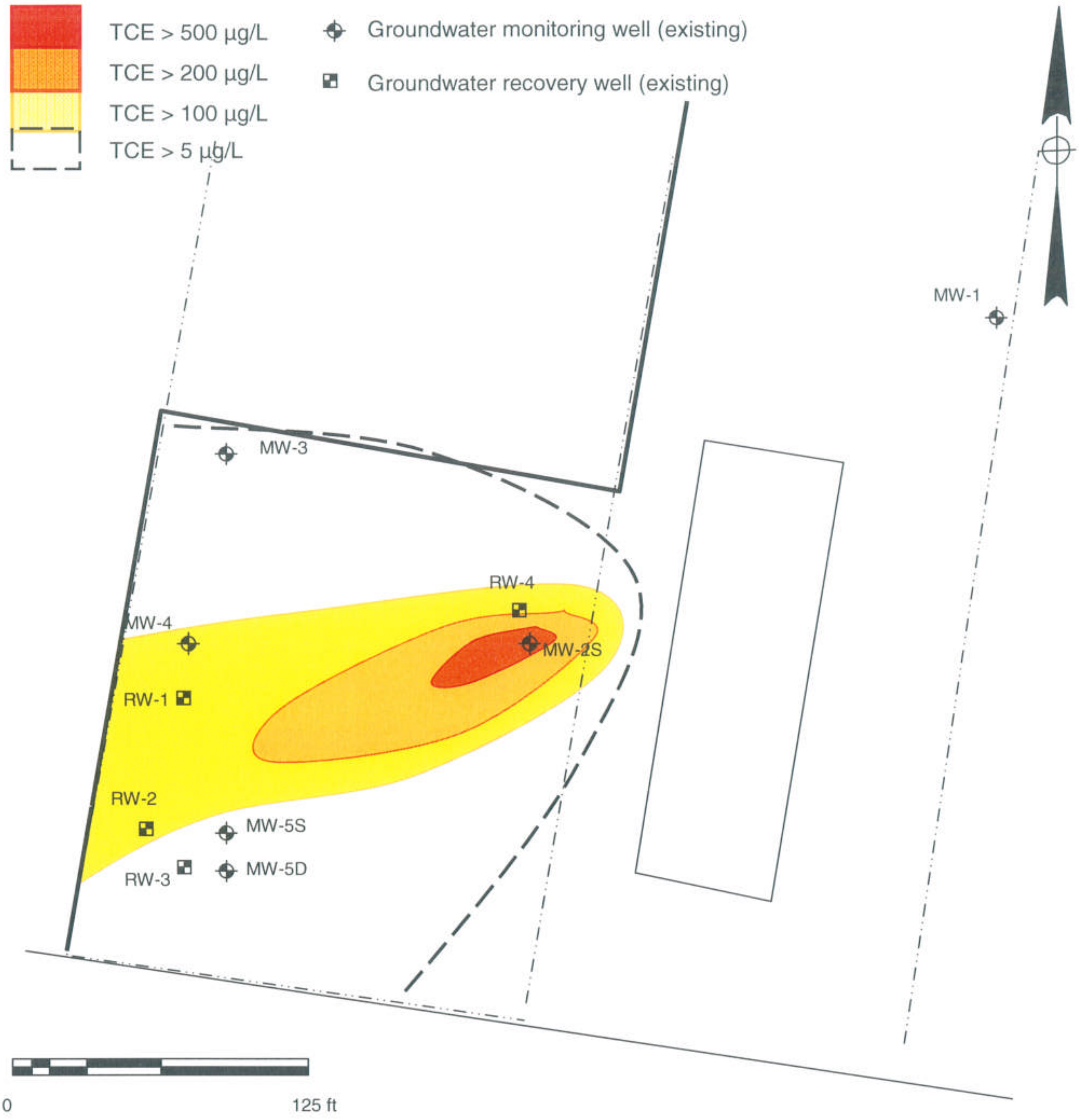
S&W
REDEVELOPMENT

Feb 2008

Proj No. B6003

FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

FIGURE 1-2
SITE LAYOUT



Data derived from
URS, Nov 2006 IRM
Annual Progress Report
(July 2006 Sampling
Event)

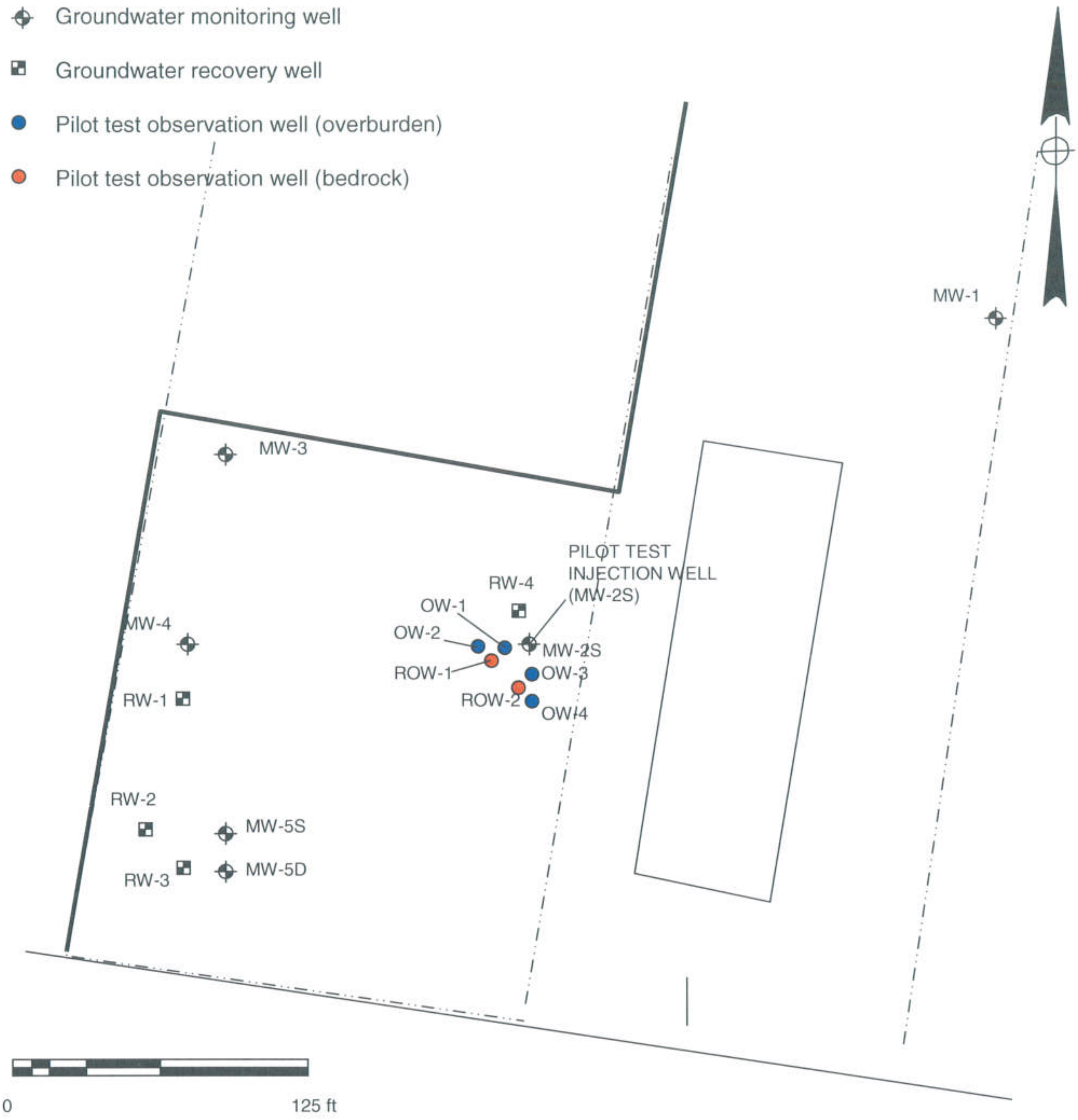
S&W
REDEVELOPMENT

Feb 2008

Proj No. B6003

FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

FIGURE 2-1
TCE (µg/L) IN BEDROCK
GROUNDWATER



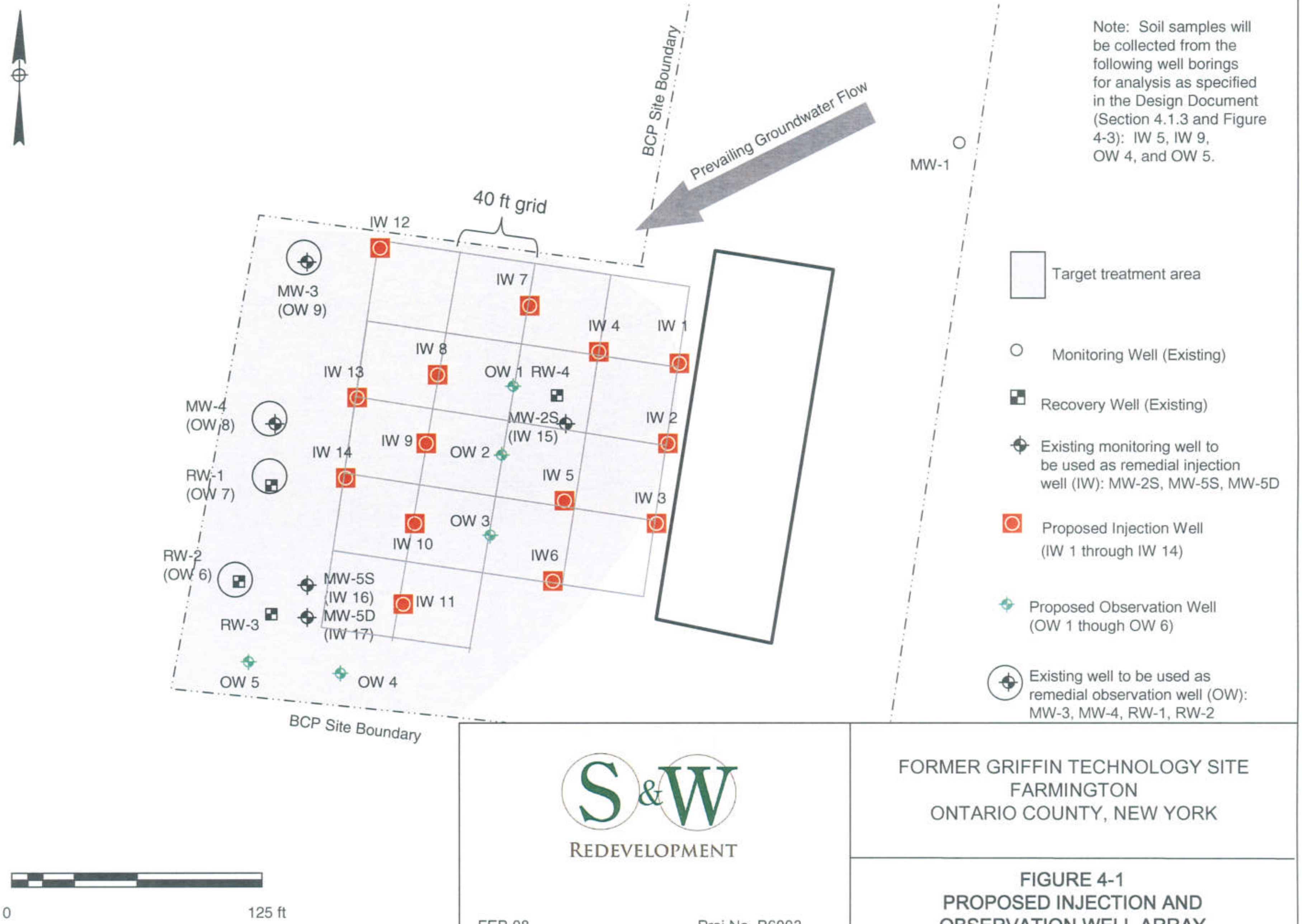
S&W
REDEVELOPMENT

Feb 2008

Proj No. B6003

FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

FIGURE 3-1
PILOT TEST APPROACH:
INJECTION & OBSERVATION WELLS



S&W REDEVELOPMENT

FEB 08

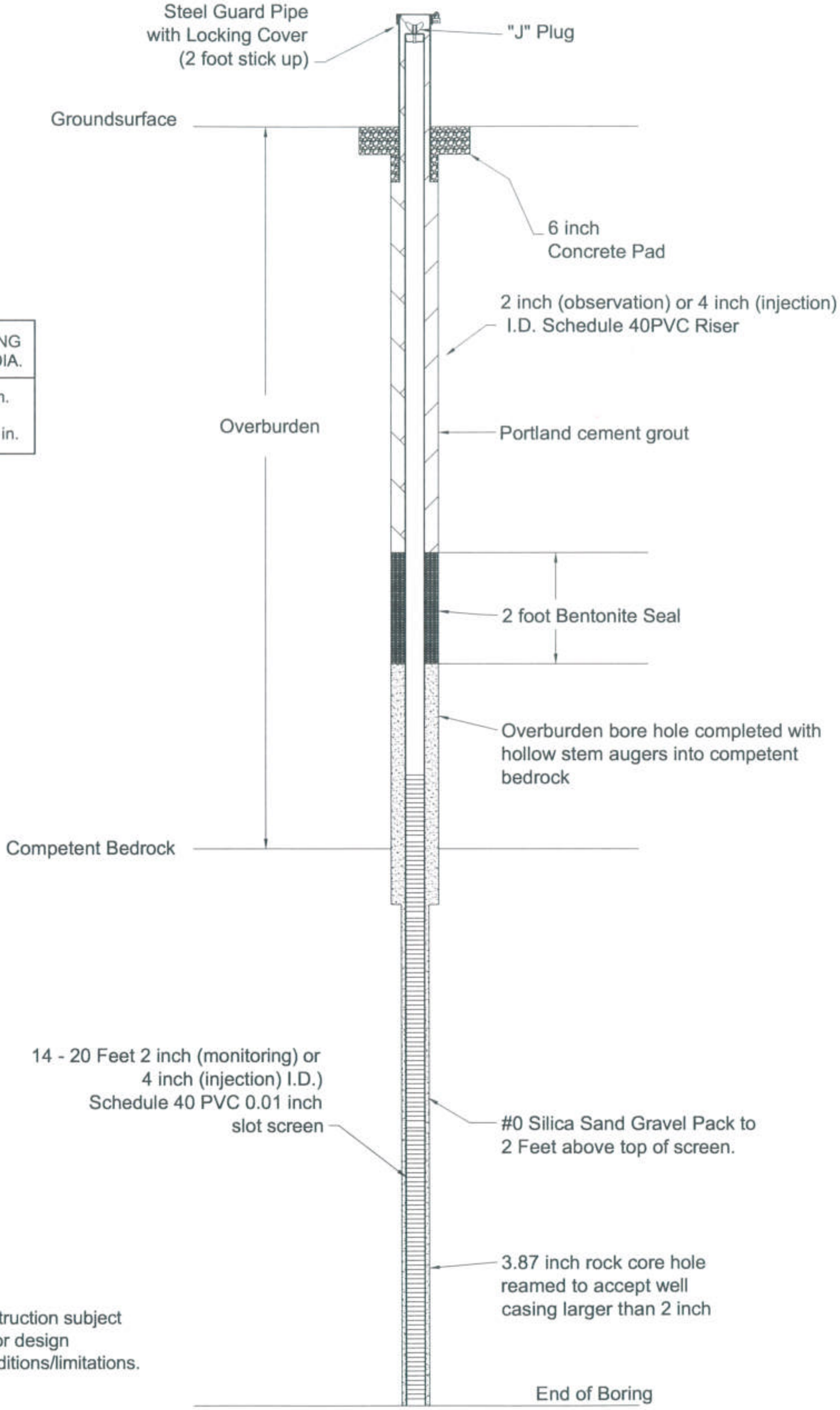
Proj No. B6003

FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

FIGURE 4-1
PROPOSED INJECTION AND
OBSERVATION WELL ARRAY

Note:
Well can also be completed flush with the ground surface.

CASING I.D. DIA.	AUGER I.D. DIA.	BORING I.D. DIA.
2 in.	4.25 in.	8.25 in.
4 in.	6.25 in.	10.25 in.



Note:
Idealized detail. Actual well construction subject to change due to regulatory and/or design requirements as well as field conditions/limitations.

Not to Scale

S&W
REDEVELOPMENT
Syracuse, New York

DATE:5/2008 JOB No.:B6003

Former Grifin Technology, BCP Site #C835008
6132 Victor-Manchester Road (Route 92)
Farmington, Ontario County, New York

Figure 4-2
Observation/Injection Well Detail

X-REF: NAMES?
2005/September/jlk
J:\PROJECTS\B-XXXX\B6000\B6003 - Griffin-Diebold\60 Remedial Action\Figures\InjectionMonitoring well detail.dwg

Note: Soil samples will be collected from the following well borings for analysis as specified in the Design Document (Section 4.1.3): IW 5, IW 9, OW 4, and OW 5.

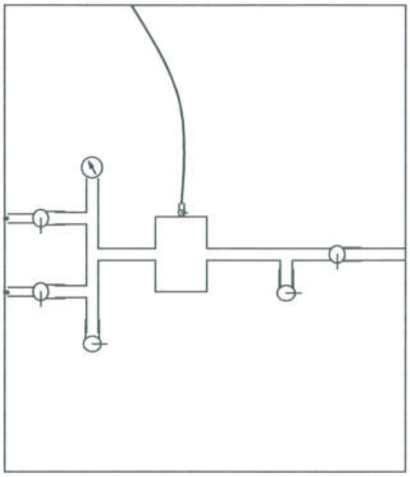
S&W REDEVELOPMENT

FEB 08

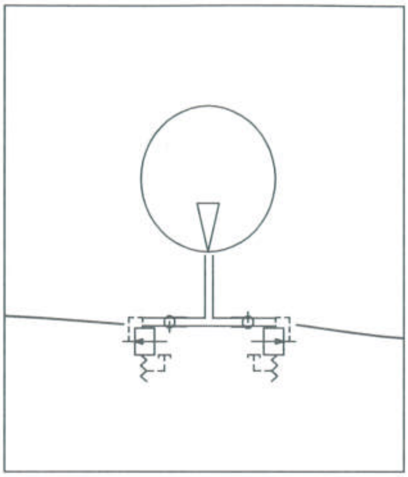
Proj No. B6003

FORMER GRIFFIN TECHNOLOGY SITE
FARMINGTON
ONTARIO COUNTY, NEW YORK

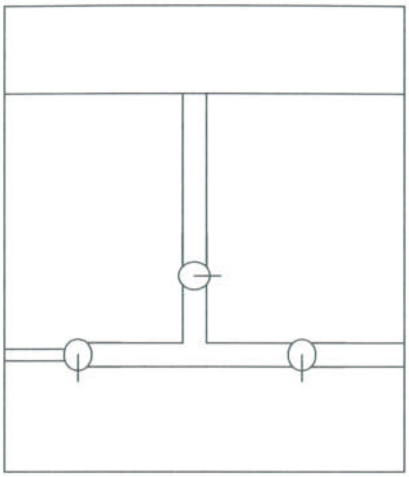
FIGURE 4-3
SOIL BORING ANALYTICAL PROGRAM



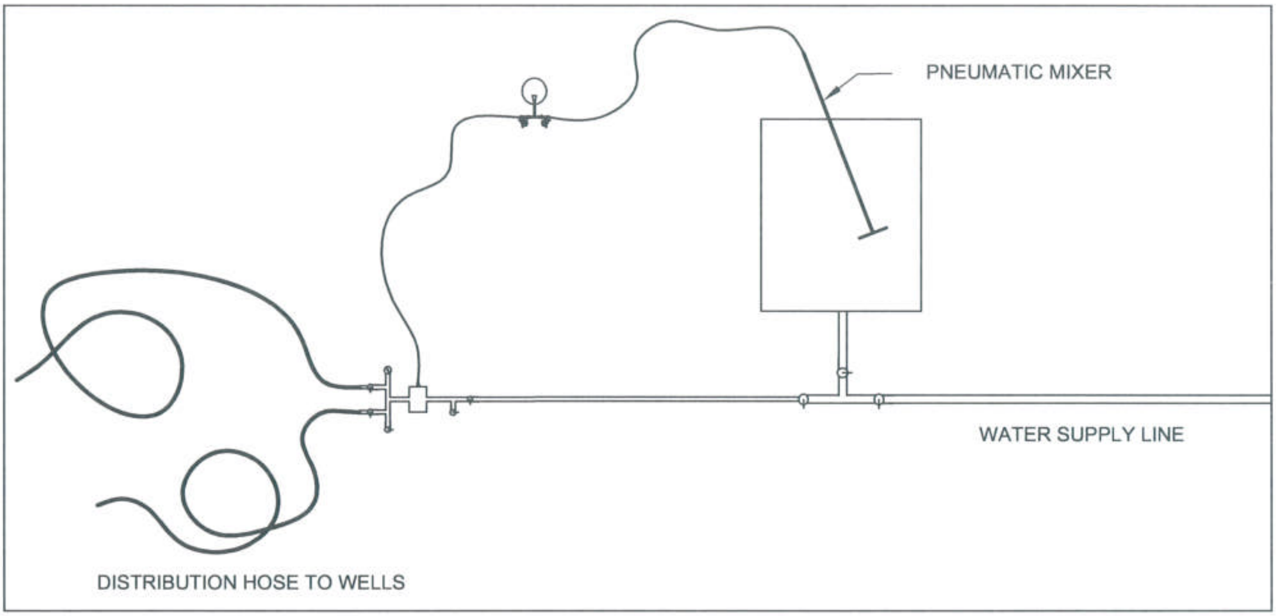
PNEUMATIC DIAPHRAM PUMP &
DISTRIBUTION MANIFOLD



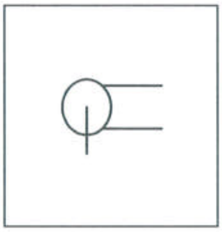
AIR COMPRESSOR &
DISTRIBUTION MANIFOLD



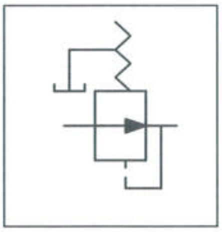
MIXING TANK MANIFOLD



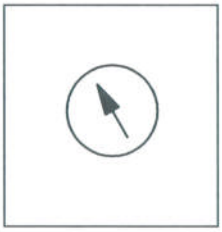
PERMANGANATE DISTRIBUTION SYSTEM



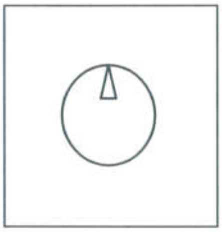
VALVE



PRESSURE CONTROL
VALVE



PRESSURE GAUGE



AIR COMPRESSOR

S&W
REDEVELOPMENT
Syracuse, New York

DATE:5/2008 JOB No.:B6003

Former Griffin Technology, BCP Site #C835008
6132 Victor–Manchester Road (Route 96)
Farmington, Ontario County, New York

Figure 5–1 Permanganate Solution
Pump System Schematic

X–REF: NAMES?
2008/Feb/Syr/jlk
J:\PROJECTS\B–XXXX\B6000\B6003 – Griffin–Diebold\60 Remedial Action\Figures\InjectionEquipSchem.dwg

TABLES

Table 4-1. Potassium Permanganate Dose Estimate. Former Diebold BCP Site. Remedial Design Document. February 2008.

Parameters	Units	Estimates	
*** Site Description ***			
Plume Length	Ft.	250	
Plume Width	Ft.	180	
Target Area	Sq. Ft.	45000	
Target Thickness	Ft.	15	
Total Volume	Cu. Yd.	25000	
Porosity	%	25	
Plume Total Pore Volume	Gal.	1262338	
Avg. Contaminant Conc.	ppm	2.1	* Maximum detection, July 2006
Mass of Contaminant	lb.	22.12284086	
PSOD	g/kg	1.8	
Effective PSOD %	10	0.18	
PSOD	lb/yd3	0.5346	Based on soil density of 2.97 lb/cubic yard
PSOD Oxidant Demand	lb	13365.00	
Avg. Stoichiometric Demand	lb/lb	2.4	
Contaminant Oxidant Demand	lb.	53.09481807	
Permanganate Required	lb.	**13,418**	

Above calculation matrix was provided by Carus Corporation.

Input estimates provided by S&W Redevelopment of North America, LLC

APPENDIX A –
QUALITY ASSURANCE PROJECT PLAN

Quality Assurance Project Plan

Former Diebold Facility
6132 victor Manchester Road
Farmington, New York

May 2008

S&W
REDEVELOPMENT

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SECTION 1

PROJECT DESCRIPTION

SW Victor Manchester, LLC (Applicant) has applied to the New York State Brownfield Cleanup Program (BCA) relative to property located at 6132 Victor Manchester Road, Farmington, in Ontario County, New York. The application was deemed eligible by the NYS Department of Environmental Conservation (NYSDEC) and a Brownfield Cleanup Agreement (BCA) was executed with a site designation of #C835008.

The applicant is a Volunteer and under the BCA is required to mitigate the potential exposure to contaminants at the site. Based on site investigation results and previous interim remedial actions completed at the site, and with the concurrence of the NYSDEC, the Applicant has developed an Interim Remedial Measure (IRM) Work Plan to address groundwater contamination.

This Quality Assurance Project Plan (QAPP) has been developed to establish the procedures and protocols for collection and laboratory analysis of samples associated with the implementation of the proposed groundwater IRM, as described in the IRM Work Plan.

SECTION 2

PROJECT ORGANIZATION

The organization of the key project management and field sampling teams, and areas of responsibility are shown presented below.

Project Principal	Damian J. Vanetti	Provide technical and administrative oversight and guidance throughout the project, assist in securing company resources, participate in technical review of deliverables, and attend key meetings as needed.
Principal Engineer	Brownfield Environmental Services, LLC (BES)	Provide technical guidance and review of reports, analytical data. Will have key involvement in screening and development of remedial alternatives.
Project Manager/Field Leader	Jeffrey L. Kiggins	Responsible for maintaining the day-to-day schedule for completing the fieldwork and deliverables according to budget, QA/QC, BCP requirements. Responsible for coordinating and directing field efforts of S&W staff and subcontractors
Project Scientist	Daniel P. Ours	Provide technical input relative to selection and implementation of field methods, technologies, and strategies for conducting work. Responsible for reviewing field results and analytical data and preparation of technical reports.

SECTION 3

QA/QC OBJECTIVES FOR MEASUREMENT OF DATA

In cases where NYSDOH ELAP Certification exists for a specific group or category of parameters, the laboratories performing analysis in connection with this project will have appropriate NYSDOH ELAP Certification. For analysis of samples where Analytical Service Protocol (ASP, June 2000) Category B deliverables are required, NYSDOH ELAP CLP certification is required.

Detection limits set by NYSDEC-ASP (June 2000) will be used for all sample analyses unless otherwise noted. If NYSDEC-ASP-dictated detection limits prove insufficient to assess project goals (i.e., comparison to drinking water standards or attainment of ARARs), then ASP Special Analytical Services (SAS) or other appropriate methods will be utilized.

The quality assurance/quality control objectives for all measurement data include completeness, representativeness, comparability, precision and accuracy.

COMPLETENESS

The analyses performed must be appropriate and inclusive. The parameters selected for analysis are chosen to meet the objectives of the study.

Completeness of the analyses will be assessed by comparing the number of parameters intended to be analyzed with the number of parameters successfully determined and validated. Data must meet QC acceptance criteria for 100 percent or more of requested determinations.

REPRESENTATIVENESS

Samples must be taken of the population and, where appropriate, the population will be characterized statistically to express the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process, or environmental condition.

Non-dedicated sampling devices will be cleaned between sampling points by washing and rinsing with Alconox or comparable detergent, followed by a rinse with distilled water. Specific cleaning techniques are described in the Field Sampling Procedure. Two types of blank samples will accompany each sample set where Target Compound List (TCL) volatiles are to be analyzed (water matrix only). A trip blank, consisting of a 40 ml VOA vial of organic-free water prepared by the laboratory, will accompany each set of sample bottles from the laboratory to the field and back. This bottle will remain sealed throughout the shipment and sampling process. This blank will be analyzed for TCL volatile organic compounds along with the groundwater samples to ensure that contamination with TCL volatile compounds has not occurred during the bottle preparation, shipment and sampling phase of the project. In order to check for contaminant carryover when non-dedicated sampling equipment is used, a rinsate blank will be submitted to the laboratory. This blank will also be analyzed for TCL volatile organic compounds. The TCL compounds are identified in the United States Environmental Protection Agency (USEPA) Contract Laboratory Program dated 7/85 or as periodically updated.

The analysis results obtained from the determination of identical parameters in field duplicate samples can be used to further assess the representativeness of the sample data.

COMPARABILITY

Consistency in the acquisition, preparation, handling and analysis of samples is necessary in order for the results to be compared where appropriate. Additionally, the results obtained from analyses of the samples will be compared with the results obtained in previous studies, if available.

To ensure the comparability of analytical results with those obtained in previous or future testing, all samples will be analyzed by NYSDEC-approved methods. The NYSDEC-ASP mandated holding times for various analyses will be strictly adhered to.

PRECISION AND ACCURACY

The validity of the data produced will be assessed for precision and accuracy. Analytical methods which will be used include gas chromatography/mass spectrometry (GC/MS), gas chromatography (GC), colorimetry, atomic spectroscopy, gravimetric and titrametric techniques. The following outlines the procedures for evaluating precision and accuracy, routine monitoring procedures, and corrective actions to maintain analytical quality control. All data evaluations will be consistent with NYSDEC-ASP procedures (June 2000). Data will be 100 percent compliant with NYSDEC-ASP requirements.

The number of duplicate, spiked and blank samples analyzed will be dependent upon the total number of samples of each matrix to be analyzed. The inclusion and frequency of analysis of trip blanks will be on the order of one per each sample delivery group. Samples to be analyzed for volatile organic compounds will be accompanied by trip blanks (water matrix).

Quality assurance audit samples will be prepared and submitted by the laboratory QA manager for each analytical procedure used. The degree of accuracy and the recovery of analyte to be expected for the analysis of QA samples and spiked samples is dependent upon the matrix, method of analysis, and compound or element being determined. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. The lower end of the analytical range for most analyses is generally accepted to be five times the detection limit. At or above this level, the determination and spike recoveries for metals in water samples will be expected to range from 75 to 125 percent. The recovery of organic surrogate compounds and matrix spiking compounds determined by GC/MS will be compared to the guidelines for recovery of individual compounds as established by the United States Environmental Protection Agency Contract Laboratory Program dated 7/85 or as periodically updated.

The quality of results obtained for inorganic ion and demand parameters will be assessed by comparison of QC data with laboratory control charts for each test.

SECTION 4

SAMPLING PROCEDURES

SAMPLING PROGRAM

The soil sampling program will include the collection of soil samples from split spoon sampling devices retrieved from soil borings. Groundwater samples will be collected from groundwater monitoring wells.

A. **Drilling/Sampling Procedures.** Test borings shall be completed using a combination of direct push and hollow stem auger drilling methods for overburden drilling, and rock coring methods for bedrock drilling, to specific approved target depth as directed in the field by the SWRNA geologist.

Overburden drilling will commence using direct push methods (e.g. Georobe^{TM}) to refusal depth. Soil samples will be collected continuously at each drilling location, and selected soil samples will be containerized for laboratory analysis from designated locations acceptable to NYSDEC. Upon retrieval of the sampling barrel from the agreed locations, the collected samples shall be placed in glass jars and labeled, stored on site in an ice-filled cooler, and shipped to the appropriate testing laboratory or storage facility. Chain-of-custody procedures will be practiced following Section 15, EPA-600/4-82-029, Handbook for Sampling and Sample Preservation of Water and Waste Waters.

Hollow stem augers (6- ¼ inch inside auger diameter) will then be used to advance the boring into the upper weather bedrock zone, and create a seat for 6-inch casing, which will be grouted into the rock. After the grout has cured overnight, drilling will resume using a core barrel, attached at the bottom of a string of rods, which will be rotated and advanced through the grouted casing and a minimum of fifteen (15) feet into the underlying bedrock. Continuous core samples of rock material will be retrieved from the rock borings. Potable water will be used as needed to cool the cutting bit and carry cuttings to ground surface.

Following completion of coring activities, an air hammer (5-7/8 inch diameter) will ream out the hole to enable the placement of a 4-inch diameter PVC well. Air pressure will lift the cuttings to the surface.

Drill cuttings brought to the surface adjacent to each borehole will be screened with a PID. Cuttings will be taken to a designated area of the site where they will be staged on plastic. Cuttings will be analyzed as determined necessary to facilitate proper disposal.

A geologist will be on site during the drilling operations to fully describe each soil and rock sample retrieved from the borings. Overburden soil samples will be described following the New York State Soil Description Procedure. Bedrock cores will be examined for evidence of fracturing, and will be assigned rock quality designations (RQDs), which shall be defined as the sum total length of rock fragments greater than 4 inches, divided by the total core run length.

The drilling contractor will be responsible for obtaining accurate and representative samples, informing the geologist of changes in drilling pressure, keeping a separate general log of soils encountered including blow counts [i.e., the number of blows from a soil sampling drive weight (140 pounds)] required to drive the split-spoon sampler in 6-inch increments and installing monitoring wells to levels directed by the supervising geologist following specifications further outlined in this protocol.

B. Injection/Observation Well Completion. Injection wells will be installed to introduce a chemical oxidant into the approved groundwater treatment zone. Observation wells will be installed to collect groundwater samples in order to verify injection efficiency and contaminant degradation.

The screen interval for the injection and observation wells will include the upper fifteen (15) feet of bedrock, and extend approximately 1 to 2 feet above the soil/bedrock interface. The method for installing bedrock injection and observation wells will be to place the screen and riser assembly into the bore hole once the final approved boring depth is reached. At that time, a washed silica sand pack will be placed around the well screen, from the bottom of the well to approximately 2 to 3 feet above the top of well screen. Bentonite pellets will then be placed above the sand pack to create a seal that prevents surface infiltration from reaching the well screen. During placement of sand and bentonite pellets, frequent measurements will be made to check the height of the sand pack and thickness of bentonite layers by a weighted drop tape measure.

A protective steel casing shall be located over the standpipe extending 2 feet below grade and 2 to 3 feet above grade, secured by a Portland cement seal. The cement seal shall extend laterally at least 1 foot in all directions from the protective casing and shall slope gently away to drain water away from the well. A steel cap will be fitted on the protective casing. The cap shall be constructed so it may be secured with a steel lock.

C. **Well Development**. The injection and observation wells will be developed following installation by either pumping or bailing, the goal being to produce relatively sediment-free groundwater samples.

A submersible pump or dedicated bailer will be used to develop the wells. Pumping or bailing will continue for a minimum of10 well volumes, with the goal of reducing turbidity to below 50 NTUs, or until specific conductivity, pH, and temperature are stable (i.e., consecutive readings are within 10 percent with no overall upward or downward trends in measurements). Well development water will be screened with a photoionization detector (PID) and may be containerized based on evidence of contamination. Development water that requires containerization will be analyzed to determine a proper method for disposal.

D. Decontamination. All drilling equipment and associated tools including augers, drill rods, sampling equipment, wrenches and any other equipment or tools that have come in contact with contaminated materials will be decontaminated before any drilling on site begins, between each well, and prior to removing any equipment from the site. The preferred decontamination procedure will be to use a high pressure steam cleaner to remove soils and volatile organics from the equipment. The water used for this procedure will come from a controlled source, preferably a municipal drinking supply. Decontamination water and well development water will be screened in the field with a photoionization detector (PID) and may be containerized based on evidence of contamination. Any water that is containerized owing to field evidence of potential contamination will be sampled to determine the proper method of disposal.

E. Groundwater Sampling Program.

1. **Well Evacuation.** Prior to sampling a monitoring well, the static water level will be recorded and the wells evacuated to assure that the water in the well is truly representative of the groundwater. All well data will be recorded on a field sampling record. For shallow wells or deep wells with a relatively low static water level, evacuation will be accomplished by using a stainless steel or teflon bailer with a ball check valve at its lower end. A bladder may be used to evacuate the deeper wells at a rate of approximately 1 gpm. Water samples to be analyzed for volatile organics must be sampled by bailer.

2. **Sampling Procedure.** Groundwater samples for volatile organic compound (VOC) analysis will be collected using either stainless steel, teflon, or disposable polyethylene bailers with a ball check valve at the lower end. Incorporation of a check valve onto the bailers assures that a sample is representative of the depth to which the bailer is lowered. All samples will be removed from a depth just above the well screen to further assure a representative groundwater sample. Before and after sampling, the sampling device will be cleaned inside and out with soapy water, methanol, and then rinsed with distilled deionized water. Sampling procedures by bailer are summarized on Table 4.2.

Groundwater samples for parameters other than VOCs will be collected using a low stress (low flow) purge and sampling method, utilizing either a submersible bladder pump, or a peristaltic pump with dedicated tubing. The purpose of low stress purging and sampling is to collect groundwater samples from monitoring wells that are representative of groundwater conditions within a discrete vertical interval of the geologic formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown within the well casing, thereby drawing in water from immediately adjacent to the pump intake, and minimizing disturbance of sediments to produce a low turbidity sample. Sampling procedures by low-flow methods are summarized on Table 4.3.

In addition to water samples collected from the monitoring wells, two types of "blanks" will be collected and submitted to the chemical laboratory for analyses. The blanks will consist of 40 ml VOA vials, as follows:

a. **Trip Blank**. A trip blank will be prepared before the sample bottles are sent by the laboratory. It consists of a sample of distilled, deionized water which accompanies the other sample bottles into the field and back to the laboratory. A trip blank will be included with each shipment of samples where sampling and analysis for TCL volatiles is planned (water matrix only). The trip blank will be analyzed for TCL volatile organic compounds as a measure of the internal laboratory procedures and their effect on the results.

b. **Field (Wash) Blanks.** Field wash blanks are analyzed to check the effectiveness of decontamination. Each sample consists of distilled deionized water (prepared by the laboratory) poured through a decontaminated bailer or other sampling apparatus. It is usually collected as a last step in the decontamination procedure prior to sampling of a monitoring well. The wash blank can be analyzed for all or some of the compounds which the subsequent monitoring well sample is scheduled for.

SAMPLE PRESERVATION AND SHIPMENT

Since all bottles will contain the necessary preservatives as shown in Table 4.1, they need only be filled. The 40 ml VOA vials must be filled brim full with no air bubbles. The other bottles should be filled to within about 1 inch from the top.

The bottles will be sent from the laboratory in coolers which will be organized on a per site basis. Following sample collection, the bottles should be placed on ice in the shipping cooler. The samples will be cooled to 4°C, but not frozen.

Final packing and shipment of coolers will be performed in accordance with guidelines outlined in the "User's Guide to the CLP".

TABLE 4.1
SAMPLE CONTAINERIZATION

Analysis	EPA Method	Bottle Type and Size	No. of containers	Preservative	Holding Time
Soil					
TCL VOCs	8260	2 oz. glass soil jar	1	None	7 days until extraction 40 days after extraction
TCL SVOCs	8270	8 oz. glass soil jar	1	None	7 days until extraction 40 days after extraction
PCBs	8082	8 oz. glass soil jar	1	None	7 days until extraction 40 days after extraction
TAL Metals	6010 7471	8 oz. glass soil jar	1	None	6 months
Pesticides	8081A	8 oz. glass soil jar	1	None	7 days until extraction 40 days after extraction

All of the above except VOCs may be collected together in a single 8 oz. jar.

All containers must be labeled with the sample number, location, date, and time collected.

All samples must be chilled to 4°C (39.4°F).

Analysis	EPA Method	Bottle Type and Size	No. of containers	Preservative	Holding Time
Water					
TCL VOCs	8260	40 ml VOC vial	1	HCl	7 days until extraction 40 days after extraction
TAL Metals	6010 7470	500 ml plastic jar	1	HNO_3	6 months
Duplicate	One duplicate and one MS/MSD shall be collected for each parameter.				
MS/MSD	MS/MSD shall be labeled with the well number, location, date, and time of collection. Duplicate shall be identifed only as "Duplicate."				

SVOCs, PCBs, and Pesticides may be collected together in 3 1-liter amber bottles.

Duplicate will require three (3) additional 1-liter amber bottles.

All samples must be chilled to 4°C (39.4°F).

All containers except the duplicate must be labeled with the sample number, location, date, and time of collection.

TABLE 4.2

SAMPLING PROCEDURE FOR MONITORING WELLS USING BAILERS

1. Initial static water level recorded with an electric contact probe accurate to the nearest 0.1 foot.
2. Sampling device and electric contact probe decontaminated.
   - Sampling device and probe are rinsed with pesticide-grade methanol and distilled water.
   - Methanol is collected into a large funnel which empties into a five- gallon container.
3. Sampling device lowered into well.
   - Bailer lowered by dedicated PVC or polypropylene line.
4. Sample taken.
   - Sample is poured slowly from the open end of the bailer and the sample bottle tilted so that aeration and turbulence are minimized.
   - Duplicate sample is collected when appropriate.
5. Samples are capped, labeled and placed in laboratory coolers with ice packs or bagged ice.
6. All equipment is cleaned with successive rinses of pesticide-grade methanol and distilled water.
   - Dedicated line is disposed of or left at well site.
7. Equipment/wash blanks are collected when non-dedicated sampling equipment is used.
8. Chain-of-custody forms are completed in triplicate.
   - The original and one carbon copy are put into a zip-lock bag and placed into the cooler. The original will be returned following sample analysis.
   - A second carbon copy is kept on file.
9. Cooler is sealed with strapping tape and chain-of-custody seals to assure integrity and to prevent tampering of sample.

TABLE 4.3

SAMPLING PROCEDURE FOR MONITORING WELLS USING LOW-STESS (LOW-FLOW) METHODS

1. Initial static water level recorded with an electric contact probe accurate to the nearest 0.1 foot.

2. Sampling device is lowered into well. Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that well. Pump intake must be no less than 2 feet from the bottom of the well to prevent disturbance and resuspension of sediments which may be at the bottom of the well.

3. Measure water level again: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

4. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

5. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

+0.1 for pH
+3% for specific conductance (conductivity)
+10 mv for redox potential
+10% for DO and turbidity

6. Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

7. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

8. Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should

be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Groundwater purged from the well prior to sampling can be used for this purpose.

9. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

10. Measure and record well depth.

11. Close and lock the well.

12. Samples are capped, labeled and placed in laboratory coolers with ice packs or bagged ice.

13. All equipment is cleaned with successive rinses of pesticide-grade methanol and distilled water.
    - Dedicated line is disposed of or left at well site.

14. Equipment/wash blanks are collected when non-dedicated sampling equipment is used.

15. Chain-of-custody forms are completed in triplicate.
    - The original and one carbon copy are put into a zip-lock bag and placed into the cooler. The original will be returned following sample analysis.
    - A second carbon copy is kept on file.

16. Cooler is sealed with strapping tape and chain-of-custody seals to assure integrity and to prevent tampering of sample.

SECTION 5

SAMPLE CUSTODY

The program for sample custody and sample transfer is in compliance with the NYSDEC-ASP, as periodically updated. If samples may be needed for legal purposes, chain-of-custody procedures, as defined by NEIC Policies and Procedures (USEPA-330/9-78-001-R, Revised June 1988) will be used. Sample chain-of-custody is initiated by the laboratory with selection and preparation of the sample containers. To reduce the chance for error, the number of personnel handling the samples should be minimized.

FIELD SAMPLE CUSTODY

A chain-of-custody record accompanies the sample from initial sample container selection and preparation at the laboratory, shipment to the field for sample containment and preservation, and return to the laboratory. Two copies of this record follow the samples to the laboratory. The laboratory maintains one file copy and the completed original is returned to the site inspection team. Individual sample containers provided by the laboratory are used for shipping samples. The shipping containers are insulated and chemical or ice water is used to maintain samples at approximately 4°C until samples are returned and in the custody of the laboratory. All sample bottles within each shipping container are individually labeled and controlled. Samples are to be shipped to the laboratory within 24-48 hours of the day of collection.

Each sample shipping container is assigned a unique identification number by the laboratory. This number is recorded on the chain-of-custody record and is marked with indelible ink on the outside of the shipping container. The field sampler will indicate the sample designation/location number in the space provided on the appropriate chain-of-custody form for each sample collected. The shipping container is closed and a seal provided by the laboratory is affixed to the latch. This seal must be broken to open the container, and this indicates possible tampering if the seal is broken before receipt at the laboratory. The laboratory will contact the site investigation team leader and the sample will not be analyzed if tampering is apparent.

LABORATORY SAMPLE CUSTODY

The site investigation team leader or Project Quality Assurance Officer notifies the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped as well as the anticipated date of arrival.

The laboratory sample program meets the following criteria:

1. The laboratory has designated a sample custodian who is responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody.

2. Upon receipt of the samples, the custodian will check the original chain-of-custody documents and compare them with the labeled contents of each sample container for correctness and traceability. The sample custodian signs the chain-of-custody record and records the date and time received.

3. Care is exercised to annotate any labeling or descriptive errors. In the event of discrepant documentation, the laboratory will immediately contact the site investigation team leader as part of the corrective action process. A qualitative assessment of each sample container is performed to note any anomalies, such as broken or leaking bottles. This assessment is recorded as part of the incoming chain-of-custody procedure.

4. The samples are stored in a secured area at a temperature of approximately 4°C until analyses are to commence.

5. A laboratory chain-of-custody record accompanies the sample or sample fraction through final analysis for control.
6. A copy of the chain-of-custody form will accompany the laboratory report and will become a permanent part of the project records.

FINAL EVIDENCE FILES

Final evidence files include all originals of laboratory reports and are maintained under documented control in a secure area.

A sample or an evidence file is under custody if:

- It is in your possession; it is in your view, after being in your possession.
- It was in your possession and you placed it in a secure area.
- It is in a designated secure area.

SECTION 6

CALIBRATION PROCEDURES

Instruments and equipment used to gather, generate or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the appropriate manufacturer's specifications or project specific requirements. The procedures for instrument calibration, calibration verification, and the frequency of calibrations are described in the NYSDEC-CLP. The calibration of instruments used for the determination of metals will be as described in the appropriate CLP standard operating procedures.

Calibration of other instruments required for measurements associated with these analyses will be in accordance with the manufacturer's recommendations and the standard operating procedures of the laboratory.

SECTION 7

ANALYTICAL PROCEDURES

Analytical procedures shall conform to the most recent revision of the NYSDEC-ASP and are summarized on Table 7.1. In the absence of USEPA or NYSDEC guidelines, appropriate procedures shall be submitted for approval by NYSDEC prior to use.

The procedures for the sample preparation and analysis for organic compounds are as specified in the NYSDEC-ASP. Analytical cleanups are mandatory where matrix interferences are noted. No sample shall be diluted any more than 1 to 5. The sample shall be either re-extracted, re-sonicated, re-stream distilled, etc. or be subjected to any one analytical cleanup noted in SW846 or a combination thereof. The analytical laboratory shall expend such effort and discretion to demonstrate good laboratory practice and demonstrate an attempt to best achieve the method detection limit.

VOLATILE ORGANICS (VOA)

The analytical procedure for volatile organic compounds (Table 7.1) is detailed in NYSDEC-ASP (Volume I, Section D-I). A measured portion of the sample is placed in the purge and trap apparatus and the sample analysis is performed by gas chromatography/mass spectrometry for the first round, by USEPA Method 8260. USEPA Methods 8010 or 8020 (gas chromatography with different detectors) will be used if subsequent rounds with lower limits of detection are warranted.

METALS

Groundwater and soil samples will be analyzed for the metals listed in Table 7.1. The detection limits for these metals are as specified in the NYSDEC-ASP, Section D-V. The instrument detection limits will be determined using calibration standards and procedures specified in the NYSDEC-ASP. The detection limits for individual samples may be higher due to the sample matrix. The procedures for these analyses will be as described in the NYSDEC-ASP.

The analyses for metals will be performed by atomic absorption spectroscopy (AAS) or inductively-coupled plasma emission spectroscopy (ICPES), as specified in the ASP with regard to AAS flame analysis.

SEMI-VOLATILE ORGANIC COMPOUNDS

The extraction and analytical procedures used for preparation of soil samples for the analysis of the TCL semi-volatile organic compounds are described in NYSDEC-ASP Volume I, Section D-III. USEPA Method 8270 will be used, plus tentatively identified compounds (TICs).

Instrument calibration, compound identification, and quantitation are performed as described in Section 6 of this document and in the NYSDEC-ASP.

PESTICIDE AND PCB COMPOUNDS

The sample preservation procedures for gas chromatography for pesticides and PCBs in soil will be as described in the NYSDEC-ASP methods (Section D-IV). The analysis of standard mixes, blanks and spiked samples will be performed at the prescribed frequency with adherence to the 72-hour requirement described in the method. USEPA MethodS 8081 AND 8082 will be used.

SITE SPECIFICITY OF ANALYSES

Work plans prepared for remedial investigation waste sites contain recommendations for the chemical parameters to be determined for each site. Thus, some or all of the referenced methods will apply to the analysis of samples collected at the individual waste sites. Analyses of Target Compound List (TCL) analytes will be performed on all samples.

TABLE 7-1

PROPOSED METHOD DETECTION LIMITS AND ANALYTICAL METHODS ASP INORGANICS, ASP VOLATILES, ASP SEMI-VOLATILES. ASP PESTICIDES, AND PCBS

Superfund Target Compound List (TCL) and Contract-Required Quantitation Limit

SECTION 1 - ASP INORGANICS

Method: NYSDEC-ASP, June 2000

PARAMETER		CONTRACT-REQUIRED DETECTION LEVEL* (µg/l)
1.	Aluminum	200
2.	Antimony	60
3.	Arsenic	10
4.	Barium	200
5.	Beryllium	5
6.	Cadmium	5
7.	Calcium	5000
8.	Chromium	10
9.	Cobalt	50
10.	Copper	25
11.	Iron	100
12.	Lead	3
13.	Magnesium	5000
14.	Manganese	15
15.	Mercury	0.2
16.	Nickel	40
17.	Potassium	5000
18.	Selenium	5
19.	Silver	10
20.	Sodium	5000
21.	Thallium	10
22.	Vanadium	50
23.	Zinc	20
24.	Cyanide	10

*Matrix: groundwater. For soil matrix, multiply CRDL by 100.

TABLE 7-1 (continued)

SECTION I - ASP ORGANICS
Method: NYSDEC-ASP, June 2000

	VOLATILE	PROPOSED METHOD DETECTION LIMITS (µg/l)*
1.	Chloromethane	1
2.	Bromomethane	1
3.	Vinyl chloride	1
4.	Chloroethane	1
5.	Methylene chloride	1
6.	Acetone	1
7.	Carbon disulfide	1
8.	1,1-Dichloroethylene	1
9.	1,1-Dichloroethane	1
10.	1,2-Dichloroethylene (total)	1
11.	Chloroform	1
12.	1,2-Dichloroethane	1
13.	2-Butanone	1
14.	1,1,1-Trichloroethane	1
15.	Carbon tetrachloride	1
16.	Bromodichloromethane	1
17.	1,1,2,2-Tetrachloroethane	1
18.	1,2-Dichloropropane	1
19.	cis-1,3-Dichloropropene	1
20.	Trichloroethene	1
21.	Dibromochloromethane	1
22.	1,1,2-Trichloroethane	1
23.	Benzene	1
24.	Trans-1,3-Dichloropropene	1
25.	Bromoform	1
26.	2-Hexanone	1
27.	4-Methyl-2-pentanone	1
28.	Tetrachloroethylene	1
29.	Toluene	1
30.	Chlorobenzene	1
31.	Ethylbenzene	1
32.	Styrene	1
33.	Total xylenes	1

*Quantitation limit for medium-level soil is 1200 µg/kg (wet weight basis).

TABLE 7-1 (continued)

SECTION I - ASP ORGANICS
Method: NYSDEC-ASP, June 2000

	SEMI-VOLATILES	CONTRACT-REQUIRED QUANTITATION LIMIT (µg/l)
34.	Phenol	10
35.	Bis(2-chloroethyl) ether	10
36.	2-Chlorophenol	10
37.	1,3-Dichlorobenzene	10
38.	1,4-Dichlorobenzene	10
39.	1,2-Dichlorobenzene	10
40.	2-Methylphenol	10
41.	2,2' oxybis(1-Chloropropane)	10
42.	4-Methylphenol	10
43.	N-Nitroso-dipropylamine	10
44.	Hexachloroethane	10
45.	Nitrobenzene	10
46.	Isophorone	10
47.	2-Nitrophenol	10
48.	2,4-Dimethylphenol	10
49.	bis(2-Chloroethoxy) methane	10
50.	2,4-Dichlorophenol	10
51.	1,2,4-Trichlorobenzene	10
52.	Naphthalene	10
53.	4-Chloroaniline	10
54.	Hexachlorobutadiene	10
55.	4-Chloro-3-methylphenol	10
56.	2-Methylnaphthalene	10
57.	Hexachlorocyclopentadiene	10
58.	2,4,6-Trichlorophenol	10
59.	2,4,5-Trichlorophenol	25
60.	2-Chloronaphthalene	10
61.	2-Nitroaniline	25
62.	Dimethyl phthalate	10
63.	Acenaphthylene	10
64.	2,6-Dinitrotoluene	10
65.	3-Nitroaniline	25
66.	Acenaphthene	10
67.	2,4-Dinitrophenol	25

TABLE 7-1 (continued)

SECTION I - ASP ORGANICS
Method: NYSDEC-ASP, June 2000

	SEMI-VOLATILES	**CONTRACT-REQUIRED QUANTITATION LIMIT (µg/l)**
68.	4-Nitrophenol	25
69.	Dibenzofuran	10
70.	Dinitrotoluene	10
71.	Diethylphthalate	10
72.	4-Chlorophenyl phenyl ether	10
73.	Fluorene	10
74.	4-Nitroanile	25
75.	4,6-Dinitro-2-methylphenol	25
76.	N-nitrosodiphenylamine	10
77.	4-Bromophenyl phenyl ether	10
78.	Hexachlorobenzene	10
79.	Pentachlorophenol	25
80.	Phenanthrene	10
81.	Anthracene	10
82.	Carbazole	10
83.	Di-n-butyl phthalate	10
84.	Fluoranthene	10
85.	Pyrene	10
86.	Butyl benzyl phthalate	10
87.	3,3'-Dichlorobenzidine	10
88.	Benz(a) anthracene	10
89.	Chrysene	10
90.	bis(2-ethylhexyl)phthalate	10
91.	Di-n-octyl phthalate	10
92.	Benzo(b)fluoranthene	10
93.	Benzo(k)fluoranthene	10
94.	Benzo(a)pyrene	10
95.	Indeno(1,2,3-cd)pyrene	10
96.	Dibenz(a,h)anthracene	10
97.	Benzo(g,h,i)perylene	10

TABLE 7-1 (continued)

SECTION I - ASP ORGANICS
Method: NYSDEC-ASP, June 2000

PESTICIDES/PCBS		CONTRACT-REQUIRED QUANTITATION LIMIT (µg/l)
98.	alpha-BHC	0.05
99.	beta-BHC	0.05
100.	delta-BHC	0.05
101.	gamma-BHC (lindane)	0.05
102.	Heptachlor	0.05
103.	Aldrin	0.05
104.	Heptachlor epoxide	0.05
105.	Endosulfan I	0.05
106.	Dieldrin	0.10
107.	4,4'-DDE	0.10
108.	Endrin	0.10
109.	Endosulfan II	0.10
110.	4,4'-DDD	0.10
111.	Endosulfan sulfate	0.10
112.	4,4'-DDT	0.10
113.	Methoxychlor	0.5
114.	Endrin ketone	0.10
115.	Endrin aldehyde	0.10
116.	alpha-Chlordane	0.05
117.	gamma-Chlordane	0.05
118.	Toxaphene	5.0
119.	AROCLOR-1016	1.0
120.	AROCLOR-1221	1.0
121.	AROCLOR-1232	1.0
122.	AROCLOR-1242	1.0
123.	AROCLOR-1248	1.0
124.	AROCLOR-1254	1.0
125.	AROCLOR-1260	1.0

SECTION 8

WASTE MANAGEMENT & SPILL PREVENTION

MISCELLANEOUS WASTE

Reasonable care will be taken to minimize waste materials requiring disposal. As described in QAPP Section 4, the proposed work may produce waste certain waste materials, including decontamination water, well development water, and soil/rock cuttings, which will be characterized for proper disposal.

Other miscellaneous waste materials as may be produced by the proposed work will be properly disposed of as either non-hazardous or hazardous waste as appropriate at permitted facilities. These materials include used personal protective equipment (PPE) and miscellaneous expendable materials (well construction materials, litter, etc.).

POTASSIUM PERMANGANATE HANDLING, STORAGE, AND SPILL PREVENTION

The chemical oxidant chosen to remediate site groundwater is potassium permanganate, which is a dry powder. It will be provided by Carus Chemical Company, and will be delivered to the site in USDOT-approved containers.

The containers will be stored inside the existing site building, in their closed shipping containers in a secure, dry area until ready for use. Per manufacturer's recommendation containers will be stored on the concrete floor as opposed to wooden palettes.

Dry potassium permanganate, if spilled on the floor in the storage area, will be swept or shoveled up immediately and transferred into a clean metal drum. Recovered permanganate may be reused for ISCO injection if it determined to be free of foreign material that might compromise its use. Otherwise, per manufacturer's specifications, spilled solid permanganate will be diluted with water until completely dissolved to form a solution. Permanganate solutions resulting from spills will be immediately neutralized as needed by applying neutralizing agents as discussed below.

Neutralizing agents will be kept on site and used as needed to immediately respond to any permanganate spills or releases as may occur during ISCO implementation. Carus Chemical Company has prescribed a number of ways to neutralize permanganate solutions to render it nonreactive. For small volumes of dissolved permanganate solution (approximately 5 gallons or less) a solution consisting of 3% hydrogen peroxide (3 parts by volume), mixed with water (3 parts) and white vinegar (4 parts) is an effective neutralizing agent. The peroxide/water/vinegar mixture may be added to the spilled permanganate solution until purple coloration is gone, signaling that the solution is no longer reactive.

For larger (> 10 gallon) releases of permanganate solution, sodium bisulfite ($NaHSO_3$) is an effective and fast neutralizing agent, applied directly to a liquid spill.

Small quantities of solid permanganate spilled on the ground will be immediately diluted with water until dissolved and neutralized if it is impracticable to shovel or sweep it into a container.

Contact equipment used for the implementation of ISCO, including, mixing tanks, pumps, hoses, buckets, and other containers which may contain residual liquid permanganate solution, will be thoroughly rinsed with neutralizing sodium bisulfite solution after implementation is complete, and prior to shipping off site. The neutralization and rinse process will be completed until no purple coloration is observed, which will signal that the solution has been neutralized. The rinse water produced from this process will also be neutralized such that no special containerization or disposal will be necessary.