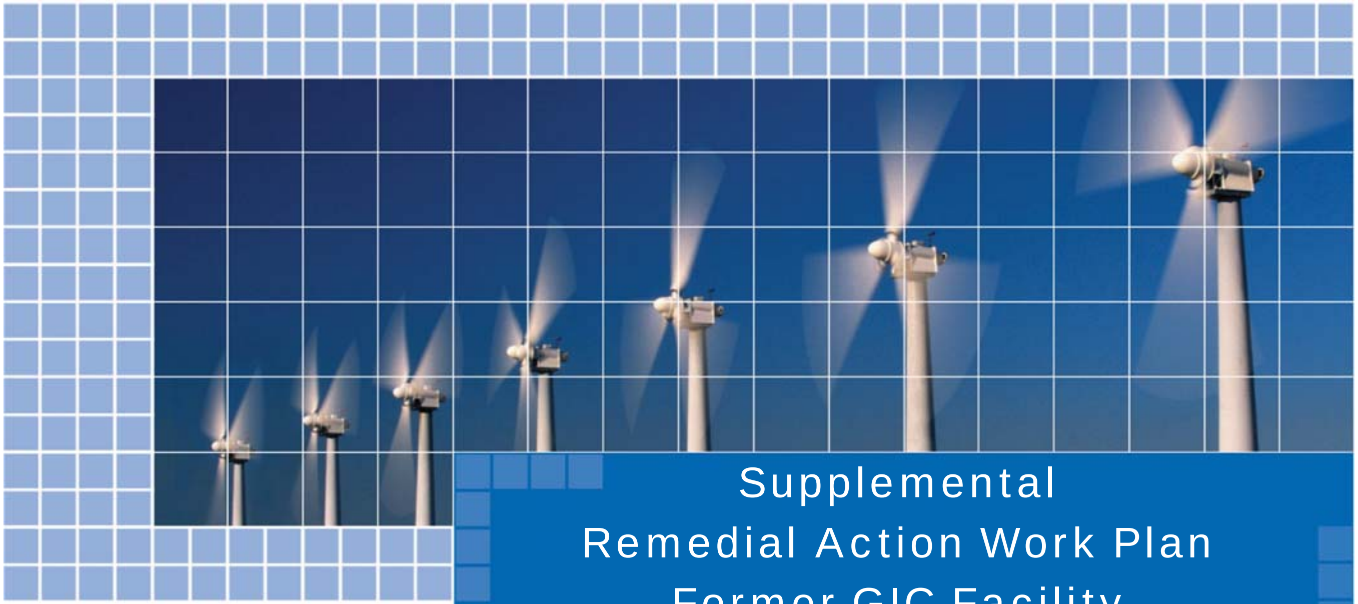

Supplemental Remedial Action Work Plan Former GIC Facility Sherburne, New York

August 10, 2009

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"I certify that the Supplemental Remedial Action Work Plan, Former GIC Facility, Sherburne, New York dated August 10, 2009 was completed personally by me and by a person under my direct supervision.

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1 Introduction

WSP Engineering of New York, P.C., on behalf of Vishay GSI, Inc. (VGSI), has prepared this supplemental remedial action work plan for the former General Instrument Corporation (GIC) site in Sherburne, New York. The supplemental action is being undertaken to enhance the current groundwater treatment system at the site, a permeable reactive barrier (PRB) installed in 1997 to address chlorinated volatile organic compounds (CVOCs) in groundwater. Analytical and groundwater elevation data collected during performance monitoring events and during investigations beginning in 2004 suggest that the system is not performing as intended. The supplemental remedial action is designed to address the CVOCs that remain upgradient of the PRB and ensure that the original objectives of the 1994 Record of Decision (ROD) for the site are met.

The supplemental remedial action plan is based primarily on the site-specific data contained within the Pre-Design and Remedial Alternatives Report, which was submitted to the New York State Department of Environmental Conservation (NYSDEC) on January 6, 2009. The report included WSP Engineering's remedial alternatives evaluation and recommendations for the supplemental remedy. The selected treatment, enhanced biological attenuation (i.e., bioremediation), was proposed for the northern end of the study area where the investigations indicated the most significant mass of CVOCs are located. The NYSDEC approved the proposed enhanced bioremediation remedy with the stipulation that the supplemental treatment also include areas along the southern terminus of the PRB. WSP Engineering has included the southern treatment area in this plan.

All of the proposed remedial activities will be performed in accordance with the procedures outlined in the approved Preliminary Evaluation of Supplemental Remedial Alternatives and Pre-Design Work Plan, dated November 30, 2007, and the methods listed in WSP Engineering's standard operating procedures (SOPs; Appendix A). The proposed bioremediation injection activities will be conducted under a U.S. Environmental Protection Agency (EPA) underground injection control (UIC) permit, which is currently pending. A copy of the UIC permit application, completed on June 5, 2009, is included in Appendix B.

1.1 WORK PLAN ORGANIZATION

The plan is presented in six parts. Section 2 presents a brief background of the site with a focus on the sequence of events that led to the proposed supplemental remedy, including a review of the pre-design results. Sections 3 and 4 review the technical and regulatory approach for the action and Section 5 outlines the scope of work, including the remedy design. Section 6 presents the proposed performance monitoring of the remedy and includes the schedules for sample collection. Section 7 discusses the reporting and the schedules for implementing the supplemental remedial action and achieving compliance with the applicable groundwater standards.

2 Background

In 2004, WSP Engineering performed a technical evaluation of the PRB treatment system at the former GIC facility. The performance of the barrier, which had been installed by Stearns and Wheler, LLC (S&W) of Cazenovia, New York, in 1997, was under increased scrutiny beginning in 2001 after shifts in the groundwater flow pattern and distribution of CVOCs were noted in the semiannual groundwater monitoring data. WSP Engineering, at the request of VGSI, reviewed the groundwater data generated by S&W during the 2002 groundwater monitoring events and developed a conceptual site model (CSM), which was later validated by groundwater data collected by WSP Engineering in the spring of 2004. The data suggested that the groundwater flow pattern had been altered by the PRB and the CVOCs might be bypassing the barrier; however, the data set did not include enough groundwater monitoring wells to fully evaluate the flow patterns and the extent of affected groundwater.

WSP Engineering installed nine additional groundwater monitoring wells, MW-31 through MW-39, in November 2005 to further evaluate the flow of affected groundwater around the barrier and update the CSM (Figure 1). The wells, positioned along the northern and southern ends of the barrier (i.e., along the northern and southern flow lines around the ends of the barrier), were sampled in December 2005 as part of the semiannual groundwater monitoring event. The data confirmed that the groundwater flow pattern had been altered by the PRB, which appeared to have a lower relative permeability than the surrounding water-bearing unit (the PRB permeability should be greater than the surrounding unit). The result was the formation of a slight groundwater mound east (upgradient) of the treatment system that appeared to be diverting a portion of the groundwater plume around the barrier. Groundwater quality data from the wells indicated some systematic decrease of CVOC concentrations along the flow lines, though the concentrations near the ends and further downgradient of the barrier were one to two orders of magnitude below those samples from the area around P-8 and MW-17 where the highest concentrations of CVOCs were consistently detected (i.e., the core of the plume; Figure 1). The data suggested that, while the PRB was not performing exactly as designed, the bulk of the untreated CVOCs had not flowed around the ends of the barrier and instead remained upgradient of the treatment system.

2.1 PRE-DESIGN INVESTIGATION AND REMEDIAL ALTERNATIVES EVALUATION

While the findings of the 2005 investigations indicated that the area of affected groundwater had not changed significantly, the performance of the PRB remained problematic. The perturbation in the groundwater flow field demonstrated that the barrier was not as effective at treating the affected groundwater as designed by S&W. Rather than risk exacerbating conditions at the site, and to address the NYSDEC’s ongoing concerns, VGSI elected to evaluate remedial alternatives that could be used to augment the performance of the PRB.

The initial assessment of technologies identified several potentially-applicable remedial alternatives; however, only three, bioremediation barriers, chemical oxidation, and bioremediation, met the screening criteria and were considered as possible remedial alternatives for the site. The evaluation qualitatively assessed the technical feasibility, overall cost, and likelihood of success of each alternative given the conditions at the site, which were based primarily on the 2005 groundwater investigation and the results of the semiannual PRB performance monitoring plan. These data, while sufficient to monitor the PRB performance and highlight the groundwater flow and extent of CVOCs for the site as a whole, were insufficient to determine the bounds of CVOCs between the wells, particularly in the likely treatment areas. WSP Engineering also identified several other remedy-specific data gaps (e.g., the potential for natural or enhanced attenuation) that needed to be addressed to complete the analysis and select the appropriate remedy.

In the summer of 2008, WSP Engineering conducted a series of investigations at the site to obtain the design-level information necessary to complete the remedial alternatives evaluation. The activities included an *in situ* groundwater investigation to define the likely treatment area within the CVOC-affected groundwater delineated by the monitoring well network; an intrinsic properties investigation and slug testing to further characterize the water-bearing zone within the likely treatment areas; and a site-wide natural attenuation and bioremediation amenability evaluation to assess the ambient water conditions (via the collection of monitored natural attenuation [MNA] indicators and a compound-specific isotope analysis) and microbial ecology (via biological traps) that could be potentially exploited for the supplemental remedy.

The results of the *in situ* groundwater investigation revealed that the relatively high concentrations of CVOCs detected in samples from wells MW-17 and P-8, in the historic core of the source plume are limited in extent (Figure 2). Samples from the 20 *in situ* sample locations, designated IS-1 through IS-20, indicated no significant concentrations of CVOCs in the former source area and only relatively moderate (directly upgradient of MW-17 and P-8) to low (downgradient of the two wells along the northern flow line) concentrations of CVOCs in a discrete area around the core of the plume. Of particular note was the lack of substantial CVOC mass along the northern flow line supporting the interpretation that the amount of affected groundwater bypassing the barrier is relatively low.

The bioremediation and natural attenuation evaluation results revealed that the CVOCs detected in and around MW-17 and P-8, including the points along the northern flow line upgradient of the barrier, were dominated by dechlorination breakdown products, such as 1,2-dichloroethene (1,2-DCE) and vinyl chloride (Figure 2). Analysis of the specific ratios of isomers and the compound-specific isotope analysis (CSIA) of the CVOCS further indicated that the compounds had biodegraded from the parent compound, trichloroethene (TCE), most likely, based on the biological trap data, through metabolization by the microbial dechlorinators *dehalococoides spp., desulfuromonas spp.,* and *dehalobacter spp.* The lack of appreciable amounts of the dechlorination end products (i.e., ethane and ethene) and the results of the CSIA suggested that the dechlorination was stalled, probably due to the lack of soluble organic carbon to act as an electron donor; however, in areas where fuel oil, an alternate source of carbon, had been released on the main site the bioremediation appeared to be complete. These data suggest that bioremediation could be enhanced through the addition of an appropriate electron donor.

WSP Engineering revisited the remedial alternatives evaluation after completing the pre-design investigation and analysis and, based on the data, selected bioremediation as the most appropriate supplemental remedy for the site. The other remedial alternatives under consideration, *in situ* chemical oxidation and bioremediation barriers, were not feasible due to the obstacles at the site (including the railroad between the main site and MW-17) and the heterogeneity of the soil (a major finding of the investigation), both of which would have limited contact between an oxidant and the CVOCs; and the lack of significant groundwater movement around the PRB making timely treatment using bioremediation barrier technology unlikely (Figure 1). The proposed supplemental remedy was submitted as part of the recommendations of the pre-design investigation and was later approved by the NYSDEC in a letter, dated May 1, 2009.

3 Technical Approach

Very few organic compounds are recalcitrant to biological degradation. In most cases, given the appropriate conditions, VOCs, including chlorinated compounds, are readily metabolized by microbes that are often already present in the water-bearing zone. Bioremediation as a remedial technology involves the manipulation of those conditions, typically through the introduction (via fixed or temporary injectors) of an electron donor or receptor, to promote the biologically-mediated degradation of the organic compounds. The process, in essence, enhances the biological attenuation potential already present in most groundwater systems.

Three key factors are necessary to sustain microbial degradation of organic compounds: a healthy and sufficiently robust population of the appropriate microbial species; macronutrients, such as nitrogen, phosphorus, or potassium; and either an electron donor (anaerobic reduction-oxidation [redox] conditions) or electron receptor (aerobic redox conditions) to act as a substrate for the biochemical reactions. In practice, macronutrients in the water-bearing zone are rarely, if ever, limiting factors for microbial growth and the mere presence of the dechlorinating microorganisms is generally sufficient to indicate that the required thermodynamic conditions exist (though they may not be optimum) and that enhanced biodegradation is possible. The addition of an appropriate electron donor or acceptor substrate is usually enough to adjust the thermodynamic conditions (through the consumption of competing terminal electron processes) and spur the growth of the organisms that are already present in the water-bearing zone.

3.1 BIOREMEDIATION AMENDMENT COMPOSITION AND SELECTION

Enhancing the reductive dechlorination potential is a two-step process. The main driver for the dechlorination is the application of an electron donor source such as emulsified vegetable oil, carbohydrates, or fatty acids. Some of the dechlorinators can use these carbon sources directly (e.g., *dehalobactor spp.* can metabolize volatile fatty acids), though the number of dechlorinating organisms with this capability are few and the metabolization is restricted to short fatty acid chains and simple carbohydrates with little or no persistence in the subsurface. Most of the dechlorinating organisms rely on other microbes to break the large molecules into smaller molecules. Chlorodegraders such as *dehalococcoides spp*., for example, the only known microbe that can reductively degrade tetrachloroethene and TCE to ethene, use hydrogen as an electron donor and, thus, rely on other microbes to ferment the carbon sources to produce the hydrogen.

Selecting a suitable amendment formulation for the specific site characteristics is critical to ensuring the appropriate balance of readily available simple carbon sources and more complex electron donor molecules which persist within the treatment area. Volatile fatty acid amendments, such as lactate, offer a readily bio-available source of fermentable carbon. Lactate, however, is water soluble and is immediately available to and quickly consumed by a wide range of “non-target’ microbes. Indeed, the data collected from the lactate-baited biological traps used in the pre-design investigation showed little response by the microbial phylum *Firmicutes,* ubiquitous fermenters, primarily because non-target microbes likely consumed the lactate early in the test.

Longer chain fatty acids, in contrast, offer higher hydrogen yields than shorter chained acids and increased longevity in the subsurface. The difficulty with fatty acids, however, is their bioavailability for the fermenters. The carbon within these compounds, often introduced as free fatty acids (e.g. oleic acid) or volatile fatty acid esters, must breakdown in the environment (via hydrolysis or microbial degradation) before the carbon becomes available (as lactic acid) to the fermenting microbes. Depending upon the specific formulations used, and the population of esterase and lipase producing microbes, the degradation can occur over months or years. This can be advantageous at sites like the former GIC site where soil heterogeneities will likely slow the desorption of CVOCs from the soil matrix to the groundwater (under the induced concentration gradient) to the rate of diffusion.

WSP Engineering evaluated several potentially-applicable commercial bioremediation products before selecting 3-D MicroEmulsion (3DME), manufactured by Regenesis, Limited, of San Clemente, California, as the most appropriate bioremediation amendment for the site. The amendment, which is a newly-patented form of hydrogen release compound (HRC), has several advantages that make it particularly well suited for use at the former GIC facility. First, the product capitalizes on the differing carbon bio-availabilities of the carbon sources by combining the immediately available organic acids with the more persistent fatty acids and fatty acid esters (as polylactate esters). The result is a hybrid compound with a release profile that generates an immediate “boost” to the fermenting organisms via free lactate followed by a slower, time-released flow of fermentable carbon beyond the first few months after application as the fatty acids break down in the environment. The commercial HRC, in its original form, has been in use since 1999 and has been demonstrated to be effective at stimulating reductive dechlorination at a wide variety of sites around the country.

Where 3DME differs from the original HRC is in its application. HRC is a low-volume viscous fluid with the consistency of honey, which gives the compound a limited radius of influence around each injection location and a positional stability that is advantageous in some applications. The reformulation of HRC as 3DME, in contrast, is a high volume application that can be mixed in concentrations ranging from 10:1 to 50:1 with potable water (volume to volume), depending upon the application. This allows greater flexibility in the application design and spacing (more dilute mixtures travel further in groundwater when injected) and aids, due to its reduced viscosity, in the injection of the material into the subsurface. The injectate also contains a patented emulsifying agent that creates micelles (described by Regenesis as a microemulsion) that allow the reagent to flow into the spore spaces within the water-bearing zone (via the injection pressure and, later, to a limited extent, by advection) until the product has coated most of the soil surfaces within the radius of influence. The greater distribution increases the treatment potential for the area beneath the New York Susquehanna and Western (NYS&W) railroad bed directly upgradient of the core of the plume (see treatment area description below) and was an important consideration in the selection process.

4 Supplemental Remedial Action

The 1994 ROD issued by the NYSDEC stated that the remediation goals for the site with respect to the offsite groundwater were:

- mitigate the impacts of contaminated groundwater to the environment
- provide for attainment of all standards, criteria, and guidelines for groundwater quality limits of the area of concern (AOC)

The AOC, as specified by the ROD, included the source area at the former GIC facility (i.e., the northwest corner of the property directly west of the former plating room) and the area west of the facility hydraulically upgradient of the current location of the PRB; and the west field between the PRB and downgradient wells MW-20 and MW-21 (Figure 1). This description was subsequently refined by the NYSDEC, as detailed in a December 1994 response letter prepared by the agency and included in the responsiveness summary portion of the ROD, stating that the treatment approach for the PRB was designed to separate the affected groundwater downgradient of the source into two plumes. Affected groundwater lying between the source area and the PRB was designated as the source area plume. This area contained the highest concentrations of CVOCs and was the target of the treatment provided by the barrier.

Affected groundwater located downgradient (west) of the PRB treatment area was designated by the NYSDEC as the west field plume (Figure 1). Concentrations of CVOCs within this portion of the AOC were significantly lower that the source area and did not warrant “active treatment.” Instead, the CVOCs were anticipated to attenuate to groundwater standards after the loading of the source are plume was reduced. One of the major findings of the pre-design investigation was that no significant mass of CVOCs has migrated around the barrier from the source plume to the west field plume. These results, along with data from the semiannual groundwater sampling program, show the concentrations in the west field have decreased over time, indicating that that the conditions originally set forth in the ROD are still present at the site.

WSP Engineering’s approach to the proposed supplemental treatment, as outlined in the Preliminary Evaluation of Supplemental Remedial Alternatives and Pre-Design Work Plan, dated November 30, 2007, is in keeping with the original intent of the ROD. That is, the supplemental remedy is designed to reduce, in combination with treatment provided by the PRB and natural attenuation, the concentrations of CVOCs detected in groundwater upgradient of the barrier to the concentrations outlined in Draft Addendum to the Division of Water Technical and Operational Guidance Series No. 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS; Title 6 of the New York Code of Rules and Regulations, Part 703.5). This includes, based on the pre-design data, a primary treatment area in and around MW-17 and P-8 and a secondary treatment area near the southern end of the PRB as requested by the NYSDEC (Figure 1). These areas are detailed in Section 5.1 below. While it is possible that some areas outside of the proposed injection zones, including those along the edges or directly downgradient of the PRB along the northern and southern flow lines, will be treated incidentally, no active treatment will be performed downgradient of the PRB in the west field plume.

5 Scope of Work

WSP Engineering has identified two supplemental treatment zones at the site where the 3DME amendment will be delivered using a grid pattern of temporary direct-push injectors. The northern or primary treatment zone is based on the *in situ* results from the pre-design investigation and groundwater well data collected during the same event or during the semiannual groundwater sampling event that immediately preceded the investigation. The bounds for the treatment area were determined by comparing the investigation results against the TOGS evaluation criteria with the injectors positioned to deliver the amendment in areas where the CVOC concentrations significantly[1] exceed the evaluation criteria. The pre-design investigation activities did not include *in situ* sampling at the southern end of the PRB where the NYSDEC requested additional treatment, thus no high resolution sampling data was available to delineate the injection zone. Instead, WSP Engineering relied on the well data collected during the PRB semiannual groundwater monitoring data from the three wells, MW-22, MW-31, and MW-32, located at the southern terminus of the barrier to position the treatment grid (Figure 1). The treatment area was designed to encompass the area between all three wells along the probable flow line extending beyond the PRB rather than limit the treatment to the areas directly around each well. This conservative approach was selected to ensure treatment of the CVOCs within the southern flow line. Details of the proposed treatment areas are presented in the Remedy Design and Implementation section below.

A conservative approach was also adopted with respect to the injection grids in each zone. Although the selected amendment can be diluted up to 50:1 with potable water for distribution over a larger radius of influence, WSP Engineering selected a concentration of 27:1 for the amendment and a delivery grid pattern with 10 foot spacing. This design was selected to increase the probability of amendment saturation of the treatment zones, including those areas where heterogeneities exist in the soil profile (a description of the soil profile within the two treatment areas is presented in Section 5.1). Injection volumes will be consistent among the proposed injectors except for those along the NYS&W railroad property. Additional amendment will be introduced in the adjoining injectors to effect treatment below the rail ballast where injectors cannot be installed. A description of the dose calculations and the delivery volumes is presented below.

5.1 REMEDY DESIGN AND IMPLEMENTATION

The northern and southern treatment zones along with the injection volumes, rates and methods are discussed in the following section and presented in detail in the design drawings prepared for the supplemental remedial action (Appendix C). The design drawings include:

- Sheet 1: Title Sheet
- Sheet 2: Site Plan
- Sheet 3: Cross Sections A-A and B-B
- Sheet 4: Enhanced Biological Attenuation Plan – Northern Injection Area
- Sheet 5: Enhanced Biological Attenuation Plan – Southern Injection Area

Sheet 2 presents a site plan similar to Figure 2 with the additional of the two proposed treatment areas outlined with respect to the PRB. Sheet 3 provides simplified versions of the geologic cross sections of the two treatment zones showing the average water table elevation and the lower silt-clay unit that forms

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[1] Several areas evaluated as part of the pre-design investigation, such as those near locations IS-2 and IS-18, where 1,1-dichloroethane (1,1-DCA) exceeded the evaluation criterion, and IS-9, where *cis*-1,2-DCE was above the evaluation criterion, were not included in the injection zone (Figure 2). Concentrations at these locations, while technically exceedances, are only slightly above the evaluation criteria and, thus, do not warrant active treatment.

the bottom of the treatment area, and sheets 4 and 5 show in detail the injector layout for each treatment zone. The design drawings include notes specific to implementing the injection program and will be used by WSP Engineering personnel and our subcontractors when performing the supplemental remedial action.

5.1.1 Treatment Zones

The proposed treatment zones together cover approximately 14,800[2] square feet (ft^2) and are concentrated at the two ends of the PRB. The northern injection zone, which constitutes the majority (11,800 ft^2) of the proposed treatment area, includes 108 of the 138 proposed injectors and is designed to address the CVOCs in the core of the plume (Sheets 2 and 4). Fifty-nine of the injectors, designated IN-1 through IN-59, will be installed in a 10-foot by 10-foot spaced grid extending from the edge of the NYS&W railroad ballast north and westward towards the PRB. These injectors will allow delivery of the amendment in the areas directly adjacent to wells MW-17 and P-8 just west of the rail line and near *in situ* points IS-6 and IS-7 where substantial concentrations of CVOCs were detected (Figure 2). Two extensions of the grid, one to the north (i.e., injectors IN-60 through IN-81) and one to the south (i.e., injectors IN-82 through IN-90) will ensure treatment of the CVOCs detected in groundwater adjacent to the MW-17 and P-8 area, particularly along the flow line around the northern edge of the PRB. A minimum offset distance of 20 feet was used to protect against injectate fouling the PRB.

Also included in the northern injection zone are two additional treatment areas directly east (1,400 ft^2 total) and south (400 ft^2) of the main grid. Injectors IN-91 through IN-104 will be installed in a 10x10 grid pattern between the former GIC main building and the edge of the NYS&W railroad ballast (Sheet 4). This area was selected to treat the CVOCs detected near IS-19, which is directly upgradient of P-8 and MW-17. The second, smaller addition to the northern treatment area includes only four injectors, designated IN-105 through IN-108. These injectors were spaced approximately 10 feet apart around *in situ* location IS-12 where CVOC concentrations were detected above the evaluation criteria.

The southern injection zone is located near the southern terminus of the PRB and is designed to treat the CVOCs migrating around the southern tip of the barrier as requested by the NYSDEC. Thirty injectors, designated IN-109 through IN-138, will be installed in a 10-foot by 10-foot L-shaped grid extending from monitoring well MW-22 near the southern tip of the PRB south and then west towards monitoring well MW-32 covering approximately 3,000 ft^2 (Sheet 5). The proposed grid encompasses all three wells and the space between them to ensure treatment of any CVOCs that may be flowing around the PRB.

5.1.2 Treatment Zone Geology and Hydrogeology

Treatment for both the northern and southern areas will be restricted to the uppermost water-bearing unit at the site. The unit, which is the same interval the PRB was designed to treat, is generally characterized by fine-grained overbank deposits with coarse-grained sand and gravel splays typical of the floodplain deposits that flank the nearby Chenango River. In the northern treatment zone, the upper 5 to 8 feet of the unit, based on boring logs from the area, consists predominately of organic-rich, yellowish-brown to olive brown silt or sandy silt with minor amounts of gravel and clay (Sheet 3). Saturated conditions are typically encountered within this layer 3 to 5 feet below ground surface (bgs). Underlying the silt and clay interval is 10 to 12 feet of (saturated) olive brown well to poorly-graded coarse gravel with varying amounts of silt and sand silty and sandy gravel. The gravel is often rounded to well-rounded, weakly stratified with alternating layers of gravelly silt and gravely sand, and is relatively tranmissive with an estimated radial hydraulic conductivity of 8.8E-03 centimeters per second (cm/s; 24.8 feet per day

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[2] The total treatment area was determined by multiplying the number of injectors (138) by the expected radius of influence around each point (10 feet by 10 feet). Additional treatment area (1000 ft^2) was included in the calculation to cover those areas beneath the NYS&W where injectors cannot be installed, but additional amendment is being added to the adjacent injectors. See Amendment Dose and Delivery Section below for additional detail.

[ft/day])[3]. The southern treatment zone has a similar soil profile, though with a slightly thinner (4 to 6 feet) layer of silt and clay overlying a silty and sandy gravel layer that appears to thin from about 17 feet thick near MW-22 to approximately 9 feet at downgradient well MW-32. The estimated radial hydraulic conductivity for the southern treatment area is 7.1E-03 cm/s (20.1 ft/day).

The gravel layer in both treatment zones is underlain by dense, dark grey silty clay, which marks the base of the upper water-bearing zone. This interval ranges in depth from about 13 feet bgs near MW-17 to approximately 17 feet bgs at MW-22 and is the same strata into which the PRB was keyed during its construction. The estimated hydraulic conductivity for the silty clay ranges from 1.7E-06 to 2.6E-06 cm/s (4.8E-03 to 7.3E-03 ft/day)[4]. For the purposes of the amendment dose and delivery calculations, the thickness of the treatment areas was estimated at 16 feet based on the maximum depth the underlying silty clay layer at the base of the upper water-bearing unit and the average water table depth across the site of 4 feet bgs[5]

5.1.3 Amendment Dose and Delivery Volume

The delivery concentration, or dose, of the 3DME amendment (typically expressed as a volume per cubic yard of aquifer material to be treated) is calculated by comparing the hydrogen release capacity of the solution to the hydrogen demand required by the dechlorinators to attenuate the dissolved and sorbed CVOCs; the demand from competing reactions (e.g., dissolved oxygen); and microbial demand safety factor (typically 3 times the stoicheiometric value). These data, most of which were collected as part of the pre-design investigation, were provided directly to the vendor (Regenesis) for the dose determination. Based on these data, Regenesis calculated that approximately 878 gallons of 3DME concentrate would be required to satisfy the demand for the proposed 14,800 ft^2 treatment zone (combined northern and southern treatment areas; Table 1). This estimate, when expressed at the minimum (base) dilution of 10:1, translates to approximately 9,660 gallons (80,566 pounds) of emulsion, or approximately 1.1 gallons of emulsion per cubic yard (gal/yd^3) of aquifer material (based on a 16 foot treatment thickness). This loading rate is in the expected range (based on WSP Engineering's experience at other sites) of 0.9 to 1.2 gal/yd^3.

Delivery volume calculations use the base 10:1 dose estimate and an approximation of the pore volume within the treatment zones to determine the injectate dilution. The desired pore volume replacement rate for high volume amendment applications like 3DME, based WSP Engineering's experience, is between 5 and 10 percent. This is an empirical number that is not intrinsic to the treatment but, rather, a proxy that is used to estimate the amount of (diluted) amendment necessary to ensure the proper dose is distributed over the entire radius of influence around each injector. Lower volumes, because of the tortuous flow path around the soil matrix and other vagaries associated with injecting fluid into an aquifer, may simply not have enough volume to force the amendment to the most distant parts of the radius of influence.

WSP Engineering determined, based on the volume of the treatment area and an estimated effective porosity of 0.2, that the base dilution rate of 10:1 (i.e., the 878 gallons mixed to approximately 9,660 gallons) would not achieve the desired pore replacement rate. The base 10:1 dilution would yield a replacement rate of only 2.7 percent of the 354,301 gallons calculated for the total treatment area pore volume (Table 1). To boost the pore replacement rate, WSP Engineering increased the amendment

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[3] Minimum average estimated radial hydraulic conductivity based on slug tests performed on monitoring wells MW-17 in the northern treatment area and MW-34 near the southern treatment area. See the *Pre-design and Supplemental Remedial Alternatives Report*, dated January 6, 2009, for additional information for additional information on the hydraulic conductivity estimates.

[4] Estimates based on Hazen's Power Law using grain size analyses from soil samples collected from the silty clay layer. See the *Additional Groundwater Investigation Report*, dated August 30, 2006, for additional information.

[5] Average water table elevation within the two treatment areas based on the depth-to-water measurements collected during the PRB semiannual groundwater monitoring events between June 2004 and June 2009.

dilution from 10:1 to 27:1 by adding 15,140 gallons of additional potable water. The new amendment volume, approximately 24,800 gallons, gives an estimated pore replacement rate of about 7 percent, which is well within the target range. This translates to a per-point injection volume, with the exception of the points lining the railroad in the northern treatment area, of 168 gallons of the 27:1 emulsion.

The per-point injection volume will be consistent across both treatment zones with the exception of the northern area where the NYS&W railroad bisects the treatment grid (Sheet 4). The tracks and ballast, due to the minimum drilling offsets specified by the NYS&W right-of-entry permit, leaves an approximately 30-foot wide strip where no injectors can be installed. This gap is of particular concern near in-situ locations IS-19 east of the tracks and IS-8 west of the rail line where significant concentrations of CVOCs were detected (Figure 2). WSP Engineering believes that these CVOCs, particularly those at IS-8, represent the upgradient edge of the plume detected in and around MW-17 and P-8 and likely extends beneath the rail line. The concentrations detected on both sides of the rail line indicate that treatment beneath the structure is warranted.

To effect treatment below the obstacle, WSP Engineering is proposing to inject the adjacent borings, both upgradient and downgradient, with an additional volume of 3DME equivalent to the amount that would have been injected in the area were the tracks not present. The gap between the two areas of the grid is approximately 30 feet wide. Treating this area would likely have required two additional rows of five north-south oriented points (10 points total) positioned between the two existing grids near points IS-8 and IS-19 (Sheet 4). The amendment that would have been injected in these theoretical points were simply moved to the adjacent points to either side of the tracks resulting in a proposed doubling of the injection volume (336 gallons of emulsion) for points IN-36, IN-45, IN-53, IN-59, and IN-86 to the west and IN-91 through IN-95 to the east. Although this will likely still leave a small (approximately 10 feet wide) “gap”, WSP Engineering believes that the conservative dosing of the 3DME amendment (i.e., including a safety factor of 3) and conservative application (replacing 7-percent of the pore volume), will distribute the 3DME into the gap under the tracks resulting in continuous treatment between the two grids.

5.1.4 Pre-treatment Clearing and Survey

Both the northern and southern ends of the PRB and the areas adjacent to the NYS&W rail line are heavily vegetated with grasses, scrub brush, and small-diameter trees and are not suitable for vehicular traffic. To facilitate drill rig access and delivery of the amendment, the proposed treatment zones will be grubbed by a local, licensed contractor. Woody debris removed from the work areas will be disposed of offsite.

The treatment areas will be surveyed by a New York-certified land surveyor after the work areas have been grubbed before beginning work to ensure the injector locations are clearly identified. All injector locations will be marked with a white stake or pin flag, as appropriate. WSP Engineering will re-survey any locations that are significantly adjusted in the field due to buried utilities or other obstacles encountered during the injector installation.

5.1.5 Amendment Preparation and Delivery

The 3DME product is manufactured as a concentrated liquid and is shipped to the site in 4.25-gallon (32 pound) pails. The product will be mixed (after homogenizing the product in the pail with a drill-mounted jiffy mixer, or equivalent) to the appropriate dilution onsite using a small (approximately 300-gallon) portable poly batch tank fitted with a high-speed centrifugal pump (e.g., a trash pump), which is necessary to supply the shearing necessary to generate the emulsion. Batches will be limited to approximately 250 gallons or less. Potable water will be supplied through the permitted use of a Town of Sherburne fire hydrant and delivered to the work area via tanker truck. The mixed solution will be transferred from the batch tank to the injectors via a second pump, such as a Monyo® progressive cavity pump outfitted with a valved discharge bypass loop returning to the pump feed tank (or equivalent; rated to 150 to 200 pounds per square inch [psi] and 3 gallons per minute, minimum), and 1-inch inside diameter (ID) flexible hosing. Detailed installation instructions provided by Regenesis are included in Appendix D and are summarized on Sheets 4 and 5. Material Safety Data Sheets for the 3DME product are presented in Appendix E.

Injections will proceed from the delivery points along the outer edge of each grid pattern to ensure product saturation within the treatment zone. The injectate will be delivered to the subsurface using a direct-push drill rig equipped with 4 or 5-foot-long, 1.25-inch ID drilling rods fitted with a Geoprobe® pressure-activated injection probe tip, an expendable drive tip, or other appropriate delivery device; and, if necessary, a membrane interface probe expansion bulb (or equivalent) to minimize the amount of short-circuiting between the borehole and the drilling rods. The product will be delivered, in accordance with the delivery schedule outlined on Sheets 4 and 5 from the top down in approximately 4-foot depth intervals (i.e., 8, 12, as 16 feet bgs) as the rods are advanced into the soil.

The injectate will be introduced into the subsurface at the lowest feasible pressure. The objective of this approach is to limit the generation of fractures in the water-bearing unit, which can lead to preferential flow paths[6] and uneven distribution of the liquid amendment. The initial pressure for the injections will be set at 110 percent of the theoretical breakout pressure: approximately 1.9 psi at the uppermost injection interval 8 feet bgs; 3.8 psi at the intermediate delivery depth of 12 feet bgs; and 5.7 psi at the lowermost injection interval of 16 feet bgs. If a minimum flow rate of 2 gallon per minute (gpm) is not achieved after 5 minutes, the injection pressure will be gradually increased at a rate of approximately 5 pounds psi (gauge) per minute until the minimum flow rate of 2 gpm is achieved. If delivery of the amendment fluid to any of the individual depth intervals is not successful (as determined by the onsite engineer) due to limited flow, the amendment fluid will be added to the next interval in the same boring or, if the probe is at the deepest injection interval, then to an adjacent boring at the same depth interval. Amendment fluid from eliminated points (due to underground obstacles or other unforeseen access issues) will be spread evenly among the adjacent borings.

WSP Engineering may elect, based on the injection rates and the discretion of the onsite engineer, to install additional borings within the 10-foot grid spacing to verify the distribution of the amendment fluid. Saturated soil samples from these borings will be collected using the same direct-push drill rig equipped with a 4 or 5-foot long macro-core soil sampler fitted with an acetate liner. Upon retrieval of the sampler, the acetate will be sliced open and the soil samples examined visually for evidence of the 3DME solution. The onsite engineer may, based on these results, adjust the dilution or the grid spacing if the 3DME solution is not present in the sample to ensure uniform distribution throughout the treatment area. The dose of the amendment fluid, however, will not be changed.

At the conclusion of the injection activities, each injector boring will be backfilled with bentonite and the surface restored to match the surrounding grade. The sample position will be marked with white paint or a wooden stake for later re-location (if necessary) by a New York-certified land surveyor.

5.2 INVESTIGATION-DERIVED WASTE

Investigation-derived waste generated during the injection and subsequent sampling activities, including residual soil cuttings, purge water, and decontamination rinsate, will be placed in DOT-approved 55-gallon steel drums and staged onsite for later offsite disposal.

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[6] WSP Engineering may also, at the discretion of the onsite engineer, install inflatable, down-hole packers in existing groundwater monitoring wells within the treatment area to prevent short-circuiting.

6 Performance Monitoring

The performance of the supplemental remedy will be monitored using wells within the existing PRB groundwater monitoring well network. Three monitoring wells, P-8, MW-17, and MW-34 will be used to monitor the groundwater quality and conditions in the northern treatment area with three additional wells, MW-22, MW-31, and MW-32 used to monitor the southern treatment zone (Sheets 4 and 5). All six wells will continue to serve as monitoring points for the PRB performance in addition to their role in demonstrating the efficacy of the supplemental remedy.

Two sampling schedules, quarterly (for the first year after injection) and semiannually, will be established to collect the data necessary to demonstrate the effectiveness of the treatment program. The split schedules were adopted to allow for monitoring of those parameters that are expected to change rapidly (e.g., the microbial population and CVOC concentrations) without incurring the additional costs for collecting data that does not need to be assessed as frequently (e.g., CSIA). For logistical purposes, the semiannual sampling program and every other quarterly sampling event will be aligned with the current PRB performance monitoring program. This will further limit the manpower, equipment, and overall expense of collecting the data and allow the analytical samples collected from the permeable diffusion bag (PDB) samplers to serve as water quality samples for both the PRB and supplemental treatment programs. The details for each sampling program and the reporting guidelines are outlined below.

6.1 QUARTERLY SAMPLING

Biological and water quality samples will be collected on a quarterly basis for the first year of the post-treatment monitoring to verify that the injectate has had the intended effect and document the expected rapid changes in the microbial community and CVOC concentrations during the first few months after injection. One Bio-Trap Sampler® (bio-trap) similar to the control (i.e., non-baited or un-amended) traps used for the pre-design investigation will be deployed in a representative well within each treatment zone. The traps will be suspended within the screened interval of the monitoring well with the same Teflon-coated steel line used for the PDB samplers and allowed to incubate over the period between sampling events (i.e., approximately 90 days[7]). Recovered traps will be placed in separate Ziploc bags (to prevent cross-contamination), packed on ice, and shipped to Microbial Insights, Inc., of Rockford, Tennessee, for species-level identification of key microbial dechlorinators via quantitative polymerase chain reaction analysis and general characterization and health of classes of microbes by phospholipid fatty acid analysis. All of the samples will be handled and shipped in accordance with WSP Engineering's SOP 20.

Quarterly groundwater samples that fall outside of the semiannual schedule will be collected from the six designated treatment monitoring wells using the same PDB samplers[8] and techniques[9] used to monitor the performance of the PRB. Retrieved PDB samplers will be sliced open at one end using scissors decontaminated with non-phosphate soap and tap water and the contents poured into the appropriate laboratory-supplied, pre-cleaned sample vials. The samples will then be labeled, packed on ice, and shipped by overnight carrier to TestAmerica Laboratories, Inc., of Buffalo, New York, for analysis of VOCs using EPA Method 8260. All of the samples will be handled and shipped in accordance with WSP Engineering's SOP 20.

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[7] The minimum incubation time for the bio-trap samplers, according to the laboratory, Microbial Insights, Inc., is approximately 30 days; however, incubation times can be extended to as long as 120 days with no detrimental effects.

[8] Columbia Analytical Services' 24-inch-long, 1.25-inch-diameter, heat-sealed, low density polyethylene PDB samplers.

[9] The PDBs will be deployed and collected in accordance with the methods outlined in a letter to the NYSDEC from WSP Engineering, dated November 16, 2006, and in the User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells (Vroblesky, 2001)

WSP Engineering will re-evaluate whether additional bio-trap or quarterly sampling is warranted after the first year of monitoring. Any proposed changes or extensions in the monitoring plan will be submitted to the NYSDEC for approval as part of the recommendations included in the semiannual report (see reporting section below). If continued quarterly sampling is not warranted, bio-trap data will be collected on a semiannual basis after the first year.

6.2 SEMIANNUAL SAMPLING

In addition to the quarterly sampling, WSP Engineering will implement a semiannual supplemental remedial action monitoring plan that includes the collection of MNA and CSIA samples to evaluate the geochemical environment after the addition of the 3DME amendment and track the anticipated breakdown of the chlorinated compounds through their isotopic fractionation. Both types of samples will be collected using low flow sampling techniques, the same as those used in the pre-design investigation, in accordance with SOP 3b (Appendix A) and the EPA Low Flow (Minimal Drawdown) Groundwater Sampling Procedures (1996). Groundwater will be retrieved from each well using a gas-driven bladder pump positioned near the midpoint of the screened interval. The extracted groundwater will be monitored using water quality meters and a flow-through cell for temperature, specific conductance, dissolved oxygen, pH, oxygen-reduction potential, and turbidity. Once the parameters stabilize, the groundwater will be placed in laboratory-supplied glassware, packed on ice, and shipped to Microseeps, Inc., of Pittsburgh, Pennsylvania, for analysis of the MNA indicators including dissolved gasses carbon dioxide, ethane, methane by EPA Method AM20GAX; inorganic compounds alkalinity (as calcium carbonate) by EPA Method SM2320B, chloride, nitrate, and sulfate by EPA Method 9056, ferrous iron by EPA 7199 (modified), sulfide by EPA Method SM4500-S-F; dissolved organic carbon by EPA Method 9060: and the CSIA by method number AM-24-DL-C. All of the samples will be handled and shipped in accordance with WSP Engineering's SOP 20.

6.3 QUALITY ASSURANCE/QUALITY CONTROL

Field quality assurance/quality control procedures for the proposed quarterly and semiannual sampling activities will be performed in accordance with the current PRB monitoring program and the procedures outlined in the Preliminary Evaluation of Supplemental Remedial Alternatives and Pre-Design Work Plan, dated November 30, 2007. The procedures include the collection and analysis of duplicate groundwater samples, matrix spike and matrix spike duplicates (MS/MSDs), equipment rinsate blanks, and trip blanks. The duplicate groundwater samples will be analyzed with the other samples to evaluate the reproducibility of the sample collection and analytical procedures, and the MS/MSD samples will be collected to evaluate the effect of the groundwater matrix on the analytical protocol. The equipment rinsate blanks will be collected by pouring analyte-free water over the decontaminated sampling equipment. The rinsate blank is used to determine if contaminants are being inadvertently introduced from the sampling equipment or by the decontamination procedures. Finally, a trip blank will accompany the sample containers from the laboratory to the field and the samples from the field to the laboratory. The trip blank is used to assess cross-contamination during transit. Quality assurance and quality control samples will be collected during the proposed activities in accordance with WSP Engineering's SOP 21 (Appendix A).

7 Reporting and Scheduling

The results of the proposed quarterly and semiannual supplemental remedy monitoring program will be integrated with the current PRB groundwater monitoring program reports schedule, which are presented to the NYSDEC on a semiannual basis. Results from samples collected during the off-cycle quarterly program will be held and presented in the following semiannual report. The documents will include, at a minimum:

- a summary of the supplemental remedial action activities (first report after treatment only)
- groundwater quality data, including the laboratory results
- groundwater flow data
- geochemistry data and the CSIA results
- microbial ecology data
- an evaluation of the efficacy of the supplemental action within the context of the current remedy
- recommendations for additional actions, modifications of the sampling program, or other changes, if any

WSP Engineering believes the combining reporting for the two monitoring programs is appropriate given that the proposed scope of work is meant to enhance the current groundwater treatment system and will provide the NYSDEC with a snapshot of the overall treatment of CVOCs at the site.

7.1 COMPLIANCE WITH STANDARDS, CRITERIA, AND GUIDELINES

WSP Engineering anticipates, based on experience at other sites, that site-related CVOC concentrations within the two treatment zones will be significantly reduced approximately 18 months after implementing the supplemental remedy and that the areas will be in compliance with TOGS 36 to 60 months after the initial injection. The treatment will be monitored according to the schedule proposed above with the efficacy of the supplemental action reviewed formally after 24 months. Additional bioremediation treatments may be considered if the data suggest that the 3DME has been consumed (current longevity projections from Regenesis and a review of literature suggest the maximum longevity of 3DME ranges between 18 and 36 months). Other remedial technologies may also be considered after 24 months, particularly if the data do not show significant reductions trending towards the TOGS evaluation criteria.

7.2 SCHEDULE FOR SUPPLEMENTAL REMEDIAL ACTION

WSP Engineering has renewed the site access and lease agreements with the owner of the adjacent farm land, updated our permit application with the NYS&W, and submitted a Class V UIC permit application with the EPA. Permits have also been negotiated with the Town of Sherburne for use of the fire hydrant and WSP Engineering has already selected an appropriate subcontractor for the fluid installation. WSP Engineering anticipates that all of the appropriate permits will be in place by mid August 2009.

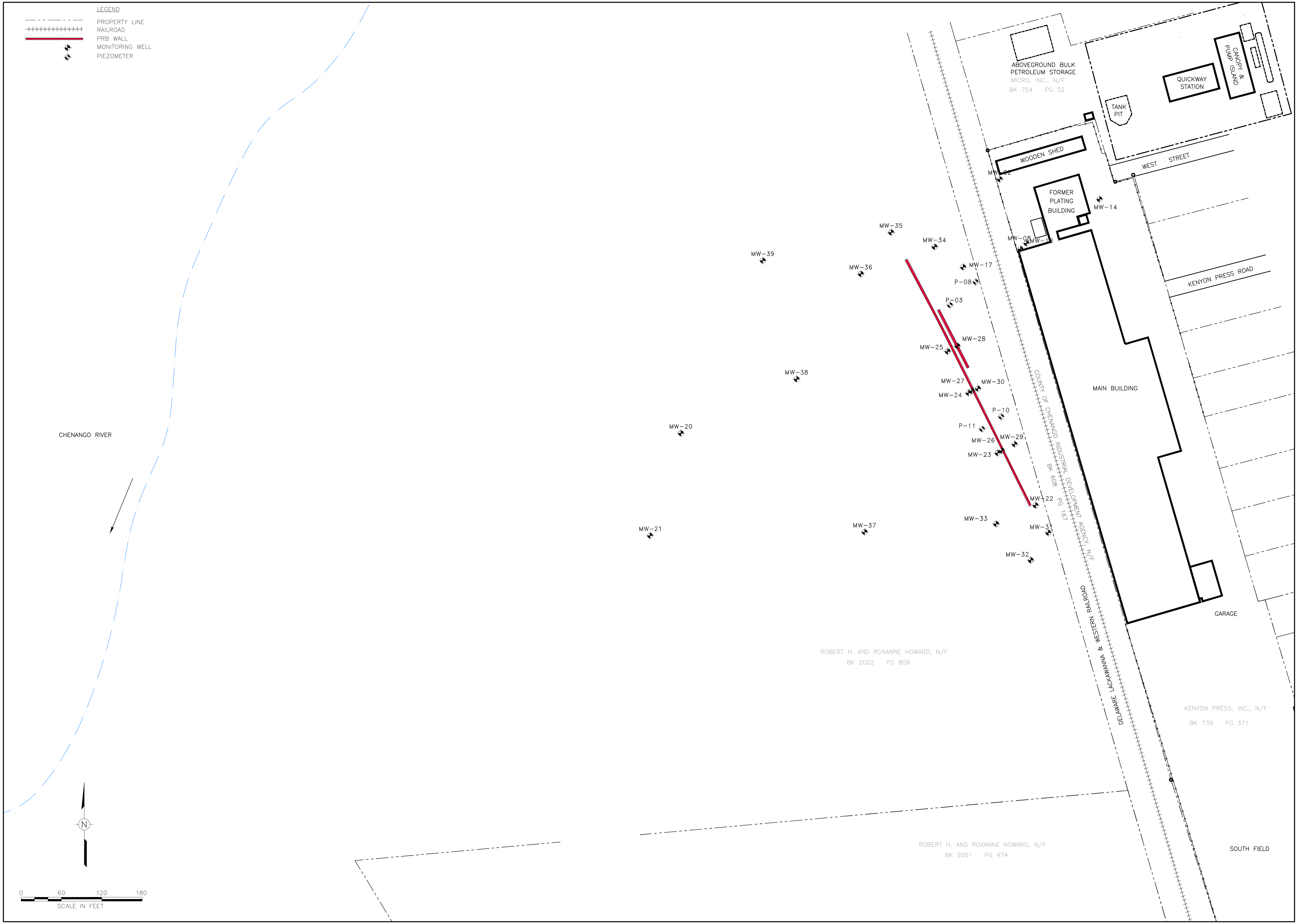
The supplemental remedial action activities will begin, pending subcontractor availability and weather conditions, within 6 weeks of receiving approval from the NYSDEC (assuming all permits have been completed). The work will likely require about 15 days to accomplish, and bio-traps will be set in the selected wells as soon as the injection activities are completed.

Acronyms and Symbols

3DME™	Regenesis 3-D Microemulsion™
AOC	area of concern
bgs	below ground surface
CID	casing inside diameter
cm/s	centimeters per second
CSIA	compound specific isotype analysis
CSIA	compound-specific isotope analysis
CSM	conceptual site model
CVOCs	chlorinated volatile organic compounds
DCE	dichloroethene
DNAPLs	dense non-aqueous phase liquids
DTW	depth to water
Eh	oxidation potential meter
EPA	U.S. Environmental Protection Agency
ft/day	feet per day
ft^2	square feet
gal/min	gallon per minute
gal/yd^3	gallons per cubic yard
GIC	General Instrument Corporation
gpm	gallons per minute
HRC	hydrogen release compound
ID	inside diameter
LNAPLs	light non-aqueous phase liquids
MNA	monitored natural attenuation
MS/MSD	matrix spike and matrix spike duplicate
NYS&W	New York, Susquehanna, and Western Railroad
NYSDEC	New York State Department of Environmental Conservation
PDB	passive diffusion bag sampler
PID	photoionization detector
POC	purgeable organic carbon
POX	purgeable organic halogens
PPE	Personal protective equipment
PRB	permeable reactive barrier

QA/QC	Quality Assurance/Quality Control
Redox	reduction/oxidation
ROD	record of decision
S&W	Stearns and Wheler, LLC
SOPs	Standard Operating Procedures
TCE	trichloroethene
TD	total depth
TOC	Total organic carbons
TOGS	Draft Addendum to the Division of Water Technical and Operational Guidance Series No. 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations
UIC	underground injection control
VGSI	Vishay GSI, Inc.
VOCs	volatile organic compounds

Figures



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SITE LAYOUT

FORMER GENERAL INSTRUMENT CORPORATON SITE
SHERBURNE, NEW YORK
PREPARED FOR
MORRIS, DOWNING & SHERRED, LLP
NEWTON, NEW JERSEY

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

FIGURE 1

Drawing Number
14899236

LEGEND

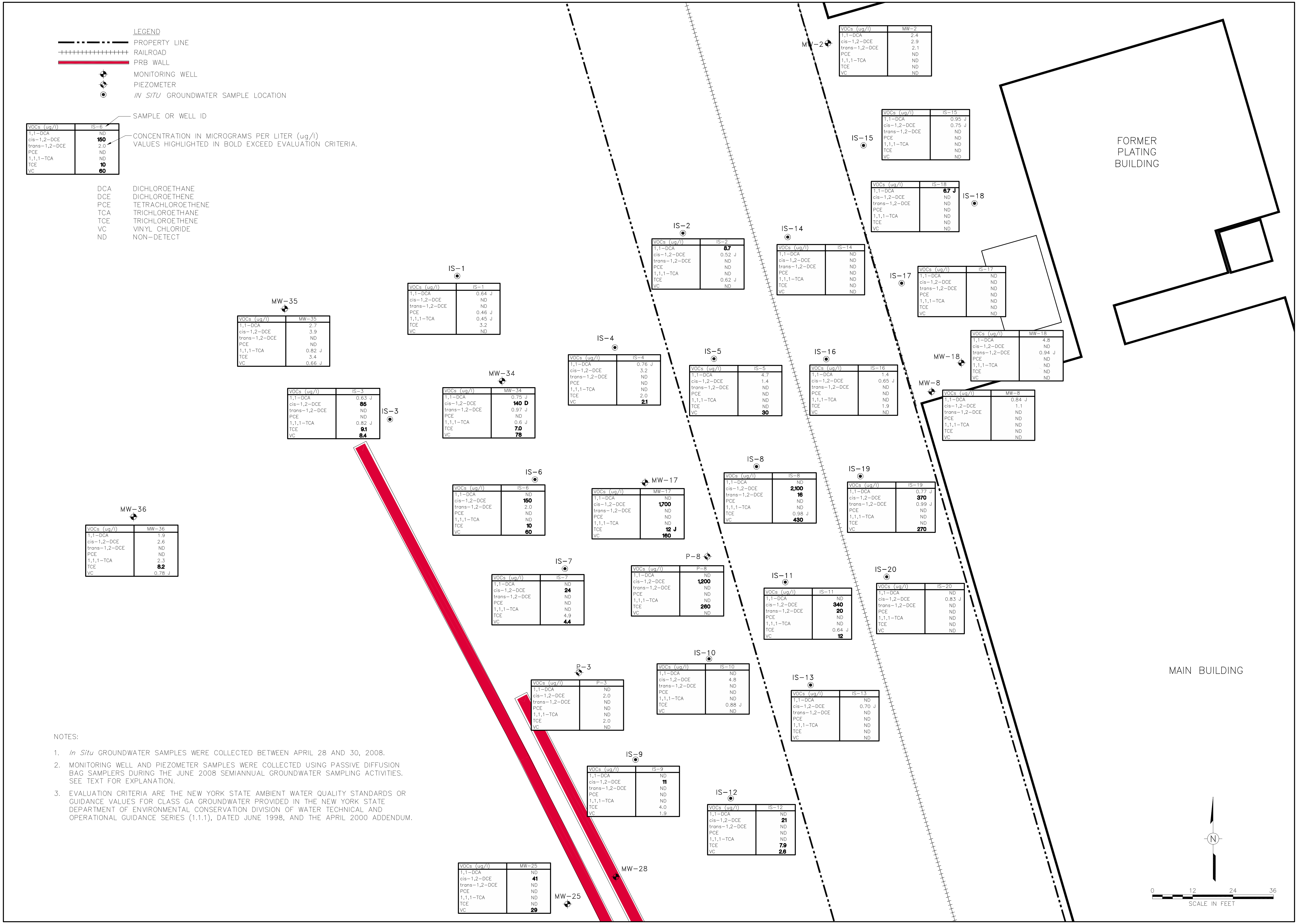
▬ · · ▬ · · ▬	PROPERTY LINE
┼┼┼┼┼┼┼┼	RAILROAD
🟥	PRB WALL
⊕	MONITORING WELL
⊕	PIEZOMETER
⊙	*IN SITU* GROUNDWATER SAMPLE LOCATION

VOCs (ug/l)	IS-6
1,1-DCA	ND
cis-1,2-DCE	**150**
trans-1,2-DCE	2.0
PCE	ND
1,1,1-TCA	ND
TCE	**10**
VC	**60**

SAMPLE OR WELL ID

CONCENTRATION IN MICROGRAMS PER LITER (ug/l)
VALUES HIGHLIGHTED IN BOLD EXCEED EVALUATION CRITERIA.

DCA	DICHLOROETHANE
DCE	DICHLOROETHENE
PCE	TETRACHLOROETHENE
TCA	TRICHLOROETHANE
TCE	TRICHLOROETHENE
VC	VINYL CHLORIDE
ND	NON-DETECT



VOCs (ug/l)	MW-2
1,1-DCA	2.4
cis-1,2-DCE	2.9
trans-1,2-DCE	2.1
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-15
1,1-DCA	0.95 J
cis-1,2-DCE	0.75 J
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-18
1,1-DCA	**6.7 J**
cis-1,2-DCE	ND
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-2
1,1-DCA	**8.7**
cis-1,2-DCE	0.52 J
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	0.62 J
VC	ND

VOCs (ug/l)	IS-14
1,1-DCA	ND
cis-1,2-DCE	ND
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-17
1,1-DCA	ND
cis-1,2-DCE	ND
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-1
1,1-DCA	0.64 J
cis-1,2-DCE	ND
trans-1,2-DCE	ND
PCE	0.46 J
1,1,1-TCA	0.45 J
TCE	3.2
VC	ND

VOCs (ug/l)	MW-35
1,1-DCA	2.7
cis-1,2-DCE	3.9
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	0.82 J
TCE	3.4
VC	0.66 J

VOCs (ug/l)	IS-4
1,1-DCA	0.76 J
cis-1,2-DCE	3.2
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	2.0
VC	**2.1**

VOCs (ug/l)	IS-5
1,1-DCA	4.7
cis-1,2-DCE	1.4
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	**30**

VOCs (ug/l)	IS-16
1,1-DCA	1.4
cis-1,2-DCE	0.65 J
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	1.9
VC	ND

VOCs (ug/l)	MW-18
1,1-DCA	4.8
cis-1,2-DCE	ND
trans-1,2-DCE	0.94 J
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	MW-8
1,1-DCA	0.84 J
cis-1,2-DCE	1.1
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-3
1,1-DCA	0.63 J
cis-1,2-DCE	**85**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	0.82 J
TCE	**9.1**
VC	**8.4**

VOCs (ug/l)	MW-34
1,1-DCA	0.75 J
cis-1,2-DCE	**140 D**
trans-1,2-DCE	0.97 J
PCE	ND
1,1,1-TCA	0.6 J
TCE	**7.0**
VC	**78**

VOCs (ug/l)	IS-6
1,1-DCA	ND
cis-1,2-DCE	**150**
trans-1,2-DCE	2.0
PCE	ND
1,1,1-TCA	ND
TCE	**10**
VC	**60**

VOCs (ug/l)	MW-17
1,1-DCA	ND
cis-1,2-DCE	**1,700**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	**12 J**
VC	**160**

VOCs (ug/l)	IS-8
1,1-DCA	ND
cis-1,2-DCE	**2,100**
trans-1,2-DCE	**16**
PCE	ND
1,1,1-TCA	ND
TCE	0.98 J
VC	**430**

VOCs (ug/l)	IS-19
1,1-DCA	0.77 J
cis-1,2-DCE	**370**
trans-1,2-DCE	0.99 J
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	**270**

VOCs (ug/l)	MW-36
1,1-DCA	1.9
cis-1,2-DCE	2.6
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	2.3
TCE	**8.2**
VC	0.78 J

VOCs (ug/l)	IS-7
1,1-DCA	ND
cis-1,2-DCE	**24**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	4.9
VC	**4.4**

VOCs (ug/l)	P-8
1,1-DCA	ND
cis-1,2-DCE	**1,200**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	**260**
VC	ND

VOCs (ug/l)	IS-11
1,1-DCA	ND
cis-1,2-DCE	**340**
trans-1,2-DCE	**20**
PCE	ND
1,1,1-TCA	ND
TCE	0.64 J
VC	**12**

VOCs (ug/l)	IS-20
1,1-DCA	ND
cis-1,2-DCE	0.83 J
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-10
1,1-DCA	ND
cis-1,2-DCE	4.8
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	0.88 J
VC	ND

VOCs (ug/l)	P-3
1,1-DCA	ND
cis-1,2-DCE	2.0
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	2.0
VC	ND

VOCs (ug/l)	IS-13
1,1-DCA	ND
cis-1,2-DCE	0.70 J
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	ND

VOCs (ug/l)	IS-9
1,1-DCA	ND
cis-1,2-DCE	**11**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	4.0
VC	1.9

VOCs (ug/l)	IS-12
1,1-DCA	ND
cis-1,2-DCE	**21**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	**7.9**
VC	**2.6**

VOCs (ug/l)	MW-25
1,1-DCA	ND
cis-1,2-DCE	**41**
trans-1,2-DCE	ND
PCE	ND
1,1,1-TCA	ND
TCE	ND
VC	**29**

NOTES:

1. *In Situ* GROUNDWATER SAMPLES WERE COLLECTED BETWEEN APRIL 28 AND 30, 2008.
2. MONITORING WELL AND PIEZOMETER SAMPLES WERE COLLECTED USING PASSIVE DIFFUSION BAG SAMPLERS DURING THE JUNE 2008 SEMIANNUAL GROUNDWATER SAMPLING ACTIVITIES. SEE TEXT FOR EXPLANATION.
3. EVALUATION CRITERIA ARE THE NEW YORK STATE AMBIENT WATER QUALITY STANDARDS OR GUIDANCE VALUES FOR CLASS GA GROUNDWATER PROVIDED IN THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION DIVISION OF WATER TECHNICAL AND OPERATIONAL GUIDANCE SERIES (1.1.1), DATED JUNE 1998, AND THE APRIL 2000 ADDENDUM.

REVISIONS

REV	DESCRIPTION		
△	Revised:	Chkd:	Appr.:
△2	Revised:	Chkd:	Appr.:
△3	Revised:	Chkd:	Appr.:

SEAL

DATE

DRAWN BY	JME
CHECKED	DB
APPROVED	

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APRIL 2008 *IN SITU* GROUNDWATER
RESULTS AND JUNE 2008 SEMIANNUAL
GROUNDWATER RESULTS
FORMER GENERAL INSTRUMENT CORPORATON SITE
SHERBURNE, NEW YORK
PREPARED FOR
MORRIS, DOWNING & SHERRED, LLP
NEWTON, NEW JERSEY

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

FIGURE 2

Drawing Number
14899239

Tables

Table 1

Amendment Dose and Delivery Volume Calculations
Former General Instrument Corporation Facility
Sherburne, New York

Characteristics and Design Assumptions	Quantity	Units	Notes
Area of application	14,800	square feet	a
Thickness of application	16	feet	b
Total porosity	0.3		c
Effective porosity	0.2		c
Dissolved contaminant mass	12	pounds	c, d
Adsorbed contaminant mass	17	pounds	c, d
Mass of competing electron acceptors	288	pounds	c, e

3DME Base Dose Calculations (Direct Push Application)	Quantity	Units	Notes
3DME concentrate	878	gallons	f
Water needed to make 10:1 base emulsion	8,782	gallons	
Volume of 10:1 base emulsion (minimum application volume)	9,660	gallons	g
Total concentrate mass	7,301	pounds	
Mass of 10:1 base emulsion	80,566	pounds	
Volume loading of 10:1 base emulsion	1.10	gallons/cubic yard	

3DME Delivery Volume Calculations	Quantity	Units	Notes
Volume of effective pore water	354,301	gallons	c
Emulsion effective pore volume replacement at base 10:1	2.7	percent	
Desired effective pore volume replacement	7.0	percent	h
Additional dilution water for desired replacement	15,141	gallons	
Total amendment volume	24,801		
New dilution ratio	27		
Number of delivery points	148	points	i
Delivery (27:1) Solution per point	168	gal	
Delivery (27:1) Solution per linear foot of injection	10.5	gal	

---

a/ Assumes 100 square feet per injector (138 total injectors; 13,800 square feet total) plus additional 1000 square feet beneath the New York Susquehanna & Western (NYS&W) railroad. See text for further explanation.

b/ Estimated treatment thickness based on soil logs and average groundwater elevation levels measured between June 2004 and June 2009.

c/ Data presented in the *Pre-Design and Supplemental Remedial Alternatives Report*, dated February 9, 2009.

d/ Vendor calculated value based on maximum concentrations of chlorinated volatile organic compounds trichlorethene (500 micrograms per liter [ug/l]), cis-1,2-dichloroethene (2,000 ug/l), and vinyl chloride (400 ug/l) detected in groundwater in the northern treatment area. Adsorbed value was estimated based on partitioning coefficients for the individual chlorinated species.

e/ Vendor calculated value based on the monitored natural attenuation data collected from select wells in the proposed treatment areas as part of the pre-design investigation. See text for further explanation.

f/ Vendor calculated loading (dose) rate for site based on stoicheiometry of contaminant mass, mass of competing electrons, and other site specific data.

g/ Base dose estimates are calculated using the minimum application dilution of 10 parts potable water to 1 part 3DME emulsion (i.e., 10:1 base emulsion). Base dose calculations do not reflect the delivery applications, which are typically more dilute. See Text for further explanation.

h/ Empirical pore volume replacement rate used with high-volume electron donors to determine approximate delivery volume. See text for further explanation.

i/ Includes 138 proposed injectors plus 10 additional to account for additional area beneath NYS&W rail line.

Appendix A – Standard Operating Procedures

Standard Operating Procedure – 3b

Groundwater Sampling Using Low – Flow Submersible Pump

Materials:

- Sampling notebook/Field log book
- Groundwater monitoring data log forms
- Well key
- Adjustable wrench or manhole wrench
- Photoionization detector (PID)
- Flashlight or mirror
- Electronic water level indicator
- pH, conductivity, temperature meter
- Oxidation potential meter (Eh)
- Dissolved oxygen meter
- Turbidity meter
- Sample bottles, sample tags or labels, indelible markers, and clear tape
- Appropriate power supply
- Redi-Flo 2 submersible pump (or equivalent) and Teflon® tubing
- Flow-through cell for pump or appropriate-sized beakers for meters
- Buckets or drum for water storage
- Pocket knife or scissors
- Level C or Level D Personal Protective Equipment
- Nitrile or latex gloves

Note: This SOP is only to be used if the applicable state of federal agency approves of purging and sampling groundwater using a submersible pump.

Procedure:

Verify locations of wells, media to be sampled, and parameters to be analyzed as specified in the sampling plan.

Prepare field log book with description of site, weather, participants, and other relevant observations (Refer to SOP-1)

As the following steps are completed, fill-in both front and back of the groundwater monitoring data log (Attachment 1 in SOP-1).

With the field personnel in Level D personal protective equipment, unless historical data, information, or suspicious warrants upgrading to Level C protective equipment, survey around the base of the well and wellhead with a PID; remove well cap, place probe of PID in wellhead, and record PID response in field book. Survey breathing zone to ensure that the level of personal protection is appropriate. Note observations on the groundwater monitoring data log. (See Site Health and Safety Plan for appropriate measuring techniques and upgrade requirements).

Inspect water surface in the well; use flashlight if necessary. Note any observable floating product and record observations in the field book.

Measure and record the extent of the top of the well riser above the ground. If well is a flush mount, measure and record the top of the well riser below the ground. Measure the casing (riser) inside diameter (CID) and record in inches. From the top of the riser, measure the depth (in feet) to water (DTW) with an electronic water level indicator and record on the groundwater monitoring data log. Static water level measurements must be recorded from the surveyor's mark at the top of the riser, if present. If no mark is present, mark a location with a metal file or indelible marker on the north side of the riser for future reference. Measure and record the total depth (TD, in feet) to the bottom of the well.

Check for light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs). Measure thickness with a oil/water interface probe in accordance with the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (November 1992).

Monitoring wells should be purged/sampled by starting with the upgradient (or clean wells) and proceeding downgradient (in the order from least to most contaminated wells) for the remaining monitoring wells.

If LNAPL was observed, carefully lower a bailer attached to an appropriate length of new nylon rope into the well and allow the bottom to sink 1 foot below the water surface to capture LNAPL only. Remove bailer and dispose of LNAPL appropriately. Record the quantity of LNAPL removed in the field book.

Place plastic sheeting around the wellhead. Carefully lower the pump into the well and place the pump intake in the center of the saturated screen interval, near the top of the well screen if the screen is submerged.

Begin purging the well at 0.2 to 0.5 L/min (0.05 to 0.13 gal/min). The water level should optimally be monitored continuously, but at a minimum, every 3 to 5 minutes during purging. Ideally, a steady flow rate should be maintained that results in a stabilized water level (less than 0.3 feet of variation). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. However, 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 ad the water level measured immediately after each adjustment.

If the recharge rate of the well is very low, care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. In these cases, purging should be interrupted before the water in the well reaches a level below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

During purging of the well, monitor the following geochemical parameters every 3 to 5 minutes: turbidity, dissolved oxygen, redox potential (Eh), temperature, specific conductance, and pH. In-line analyzers and continuous readout displays are highly recommended. The well is considered stabilized and ready for sample collection once turbidity, redox potential, and dissolved oxygen in in-line or downhole analyses of groundwater have stabilized within approximately 10% over at least two measurements – for example, over two successive measurements made three minutes apart. Turbidity should be less than 50 NTUs (decrease pumping rate to lower turbidity measurements). Dissolved oxygen and Eh must be obtained in a manner in which the sample is not exposed to air prior to the measurement. Other parameters may be taken in a clean container, such as a glass beaker.

If a well is purged to dryness before removing three well volumes, allow well to recharge and proceed to collect sample. If full recovery exceeds 2 hours, the well should be sampled as soon as sufficient volume is available or within a maximum of 3 hours from purging dry.

Collect groundwater samples after purging is completed. Collect the samples using the sampling pump operated at a maximum rate of 0.25 L/min (0.07 gal/min)(or to the rate of the purging activities) to avoid agitating the water. Sample first for VOCs, taking care to remove all air bubbles from the vial and minimize agitation. Collect remaining organic samples then inorganic samples.

The recommended order of sample collection is as follows:

In-field measurements (e.g., temperature, pH, Eh, specific conductance, dissolved oxygen, turbidity)
Volatile organic compounds (VOCs)
Purgeable organic carbon (POC)
Purgeable organic halogens (POX)
Total organic halogens (TOX)
Total organic carbon (TOC)
Extractable organics
Pesticides and herbicides
Total metals
Dissolved metals
Phenols
Cyanide
Sulfate and chloride
Nitrate and ammonia
Radionuclides

Affix a sample tag or label to each sample container and complete all required information (sample no., date, time, sampler’s initials, analysis, preservatives). Place clear tape over the tag or label. Record sample designation, date, time, and the sampler’s initials on the sample tracking form and in the field book. Complete chain-of-custody forms with appropriate sampling information.

Remove the pump and tubing from the well. Inspect the well for soundness of protective casing and surface ground seal. Record water color, suspended particulates, discoloration of casing, any unusual occurrences during sampling, and any pertinent weather details on the groundwater monitoring data log.

Thoroughly decontaminate all equipment used before proceeding to the next well. See SOP No. 16 for details on decontamination procedures. Discard used towels, tubing, gloves, etc., in a plastic bag. Refer to the Investigation Derived Waste Management Plan for the site for appropriate storage and disposal methods of these materials.

Standard Operating Procedure – 20

Sample Shipping Procedures

Materials:

- Suitable shipping container (e.g., plastic cooler or lab supplied styrofoam cooler)
- Chain-of-custody forms
- Custody seals
- WSP Engineering mailing labels
- Strapping, clear packing, or duct tape
- Ziploc® plastic bags
- Knife or scissors
- Permanent marker
- Latex or nitrile gloves
- Large plastic garbage bag
- Wet ice
- Bubble wrap or other packing material
- Universal sorbent materials
- Sample container custody seals (if required)
- Federal Express form (with WSP Engineering account number)
- Vermiculite (or commercially available cat litter)

Procedures:

For shipping purposes, samples are segregated into two classes; environmental samples and restricted articles (i.e., hazardous materials). Environmental samples can also be categorized based on expected or historical analyte levels (i.e., low or high). An environmental sample is one that is not defined as a hazardous material by the Department of Transportation (DOT, 49 CFR Part 171.8). The DOT defines a "hazardous material" as a substance which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Any material of a suspected hazardous nature, previously characterized as hazardous, or known to be hazardous is considered a restricted article.

In general, the two major concerns in shipping samples are protecting the samples from incidental breakage during shipment and complying with applicable DOT and courier requirements for restricted article shipments.

Protecting the samples from incidental breakage can be achieved using "common sense." All samples should be packed in a manner that will not allow them to freely move about in the cooler or shipping container. Glass surfaces should not be allowed to contact each other. When possible, repack the samples in the same materials that they were originally received in from the laboratory. Each container should be cushioned with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. Shipping hazardous materials should conform to the packaging, marking, labeling, and shipping instructions identified in 49 CFR Parts 172 & 173.

Environmental samples shall be packed for shipment using the following procedures:

1. Line the shipping container with a large, heavy-duty plastic garbage bag. Place universal sorbent materials (e.g., sorbent pads) between the cooler and the heavy-duty plastic bag. The amount of sorbent material should be sufficient to absorb the volume of wet ice and aqueous samples. If using a plastic cooler, securely tape the drain plug closed on the outside of the cooler.

2. Place 2-4 inches of bubble wrap or other packing material inside the heavy-duty plastic bag in the bottom of the cooler.

3. The sample packer should wear latex or nitrile gloves when handling the samples during the packing process.

4. Place the bottles in the cooler with sufficient space to allow for the addition of more bubble wrap or other packing material between the bottles. Large or heavy sample containers should be placed on the bottom of the cooler with lighter samples (i.e., VOAs) placed on top to eliminate breakage.

5. Place the "wet ice" inside two sealed heavy-duty zipper-style plastic bags and package the bags of ice on top of or between the samples. Pack enough ice in the cooler to chill the samples during transit. If the cooler is shipped on a Friday or Saturday for Monday delivery, double the amount of ice placed in the cooler (Monday delivery should be used only as a last resort). Fill all remaining space with bubble wrap or other packing material. Securely close and seal with tape the top of the heavy-duty plastic bag.

6. Place chain-of-custody form (and, if applicable, CLP traffic reports) into a Ziploc® plastic bag and affix to the cooler's inside lid, then close the cooler. Securely fasten the top of the cooler shut with tape. Place two signed and dated chain-of-custody seals on the top and sides of the cooler so that the cooler cannot be opened without breaking the seals.

7. Once cooler is sealed, shake test the cooler to make sure that there are no loose sample containers in the cooler. If loose samples are detected, open the cooler and repack the samples.

8. Using clear tape, affix a mailing label with WSP Engineering’s return address to the top of the cooler.

9. Ship samples via priority overnight express to the contracted analytical laboratory for next morning delivery. If applicable, check the appropriate box on the airbill for Saturday delivery.

10. Declare value of samples on the shipping form for insurance purposes. The declared value should reflect the cost to recollect the samples.

11. Record the tracking numbers from the Federal Express forms in the field notebook and on the chain of custody form. Also, retain the customer's copy of the Federal Express airbill.

Hazardous materials should be packed according to the above procedures with the following additions:

1. Place samples in individual Ziploc® plastic bags and secure with a plastic tie or tape.

2. Place samples in paint cans in a manner which would prevent bottle breakage (i.e., do not place glass against glass).

3. Place vermiculite or other absorbent packing material in the paint can around the samples. The amount of packing material used should be sufficient to absorb the entire contents of the sample if the container is broken during shipment.

4. Secure a lid to the paint can with can clips, and label the outside of the can with sample numbers and quantity. Mark the paint can with "This End Up" and arrow labels that indicate the proper upward position of the paint can.

5. Package the paint cans in DOT-authorized boxes or coolers, with appropriate DOT shipping labels and markings on two adjacent sides of the box or cooler.

6. Ship the restricted articles via overnight courier following the courier's documentation requirements. A special airbill must be completed for each shipment. Retain a copy of the airbill for WSP Engineering records and tracking purposes, if necessary.

Standard Operating Procedure – 21

Field Quality Assurance/Quality Control Samples

Materials:

Field logbook
Personal protective equipment (PPE)
Sample containers
Sample labels
Clear tape
Laboratory analyte free water
Clean or dedicated sampling equipment

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Select the appropriate glassware for the field Quality Assurance/Quality Control (QA/QC) samples. Refer to the WSP Engineering Standard Operating Procedure for Sample Container, Preservatives, and Holding Times to determine the appropriate bottles to use.

3. Field QA/QC samples include the following:

   trip blanks
   duplicate samples
   equipment blanks

4. Trip blanks should be provided by the analytical laboratory for all projects where samples are being collected for analysis of volatile organic compounds (VOCs). Trip blanks should accompany the sample bottles from the analytical laboratory to the site, accompany the sample containers at all times during the sampling event, and return to the laboratory with the sample containers. One trip blank should be submitted to the analytical laboratory with each shipment containing samples for VOC analysis. The trip blank should be analyzed only for VOCs.

5. One duplicate sample should be collected for every 20 samples of each matrix (e.g., soil and groundwater) collected during each sampling event. Duplicate samples of soil and other solid matrices should be collected by dividing the sample material in half and alternately filling the two sample bottle sets. Duplicate samples of groundwater and other aqueous matrices should be collected by alternately filling the two sample bottle sets from the same sampling vessel (e.g., bailer). The appropriate SOP should be followed for the collection of each sample type (soil, groundwater, sediment, sludge). Duplicate samples should be analyzed for all the analytes that are being analyzed for during the sampling event.

6. One equipment blank should be collected in the field at a rate of one per type of equipment per decontamination event not to exceed one per day. If dedicated sampling equipment is used, the equipment blanks should be prepared in the field before sampling begins. If field decontamination of sampling equipment is required, the equipment blanks should be prepared after the equipment has been used and field-decontaminated at least once. Equipment blanks should be prepared by filling or rinsing the precleaned equipment with analyte-free water and collecting the rinsate in the appropriate sample containers. The samples should be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Equipment blanks should be analyzed for all the analytes for which the environmental samples are being analyzed. Decontamination of the equipment following equipment blank procurement is not required.

All QA/QC samples should be submitted to the analytical laboratory with unique sample numbers. Therefore, the QA/QC samples should be labeled as separate environmental samples following the same numbering scheme used during that particular sampling event. However, the QA/QC samples should be clearly identified on WSP Engineering’s copy of the chain-of-custody form and in the field logbook.

Appendix B – Underground Injection Control Permit Application

Type or print all information. See reverse for instructions. OMB No. 2040-0042 Approval Expires 12/31/2011

INVENTORY OF INJECTION WELLS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF GROUND WATER AND DRINKING WATER

(This information is collected under the authority of the Safe Drinking Water Act)

1. DATE PREPARED *(Year, Month, Day)*: 09-06-04

2. FACILITY ID NUMBER:

PAPERWORK REDUCTION ACT NOTICE

The public reporting burden for this collection of information is estimated at about 0.5 hour per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, Director, Collection Strategies Division (2822), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW, Washington, DC 20460, and to the Office of Management and Budget, Paperwork Reduction Project, Washington, DC20503.

3. TRANSACTION TYPE *(Please mark one of the following)*

☐ Deletion ☑ First Time Entry
☐ Entry Change ☐ Replacement

4. FACILITY NAME AND LOCATION

A. NAME *(last, first, and middle initial)*: Former General Instrument Corporation

B. STREET ADDRESS/ROUTE NUMBER: 1 Kenyon Press Drive

C. LATITUDE

DEG	MIN	SEC
42	40	59 . 00

D. LONGITUDE

DEG	MIN	SEC
75	30	11 . 00

E. TOWNSHIP/RANGE

TOWNSHIP	RANGE	SECT	1/4 SECT

F. CITY/TOWN: Sherburne

G. STATE: NY

H. ZIP CODE: 13460

I. NUMERIC COUNTY CODE: 017

J. INDIAN LAND *(mark "x")*: ☐ Yes ☒ No

5. LEGAL CONTACT:

A. TYPE *(mark "x")*: ☐ Owner ☒ Operator

B. NAME *(last, first, and middle initial)*: Hooker, Todd M., Esquire

C. PHONE *(area code and number)*: (973) 383-2700

D. ORGANIZATION: Morris, Downing, and Sherred, LLP

E. STREET/P.O. BOX: One Main Street, PO Box 67

F. CITY/TOWN: Newton

G. STATE: NJ

H. ZIP CODE: 07860

I. OWNERSHIP *(mark "x")*

☒ PRIVATE ☐ PUBLIC ☐ SPECIFY OTHER
☐ STATE ☐ FEDERAL

6. WELL INFORMATION:

A. CLASS AND TYPE		B. NUMBER OF WELLS		C. TOTAL NUMBER OF WELLS	D. WELL OPERATION STATUS				
		COMM	NON-COMM		UC	AC	TA	PA	AN
5	B	0	134	134	134				
				0					
				0					
				0					
				0					
				0					
				0					

COMMENTS *(Optional)*:

Each UIC well will be a temporary injection point. Additional information regarding the site and proposed UIC wells are provided in Enclosure A.

KEY:

DEG = Degree
MIN = Minute
SEC = Second
SECT = Section
1/4 SECT = Quarter Section

COMM = Commercial
NON-COMM = Non-Commercial
AC = Active
UC = Under Construction
TA = Temporarily Abandoned
PA = Permanently Abandoned and Approved by State
AN = Permanently Abandoned and not Approved by State

SECTION 1. DATE PREPARED: Enter date in order of year, month, and day.

SECTION 2. FACILITY ID NUMBER: In the first two spaces, insert the appropriate U.S. Postal Service State Code. In the third space, insert one of the following one letter alphabetic identifiers:

D - DUNS Number,
G - GSA Number, or
S - State Facility Number.

In the remaining spaces, insert the appropriate nine digit DUNS, GSA, or State Facility Number. For example, A Federal facility (GSA - 123456789) located in Virginia would be entered as : VAG123456789.

SECTION 3. TRANSACTION TYPE: Place an "x" in the applicable box. See below for further instructions.

Deletion. Fill in the Facility ID Number.
First Time Entry. Fill in all the appropriate information.
Entry Change. Fill in the Facility ID Number and the information that has changed.
Replacement.

SECTION 4. FACILITY NAME AND LOCATION:

A. **Name.** Fill in the facility's official or legal name.
B. **Street Address.** Self Explanatory.
C. **Latitude.** Enter the facility's latitude (all latitudes assume North Except for American Samoa).
D. **Longitude.** Enter the facility's longitude (all longitudes assume West except Guam).
E. **Township/Range.** Fill in the complete township and range. The first 3 spaces are numerical and the fourth is a letter (N,S,E,W) specifying a compass direction. A township is North or South of the baseline, and a range is East or West of the principal meridian (e.g., 132N, 343W).
F. **City/Town.** Self Explanatory.
G. **State.** Insert the U.S. Postal Service State abbreviation.
H. **Zip Code.** Insert the five digit zip code plus any extension.

SECTION 4. FACILITY NAME & LOCATION (CONT'D.):

I. **Numeric County Code.** Insert the numeric county code from the Federal Information Processing Standards Publication (FIPS Pub 6-1) June 15, 1970, U.S. Department of Commerce, National Bureau of Standards. For Alaska, use the Census Division Code developed by the U.S. Census Bureau.
J. **Indian Land.** Mark an "x" in the appropriate box (Yes or No) to indicate if the facility is located on Indian land.

SECTION 5. LEGAL CONTACT:

A. **Type.** Mark an "x" in the appropriate box to indicate the type of legal contact (Owner or Operator). For wells operated by lease, the operator is the legal contact.
B. **Name.** Self Explanatory.
C. **Phone.** Self Explanatory.
D. **Organization.** If the legal contact is an individual, give the name of the business organization to expedite mail distribution.
E. **Street/P.O. Box.** Self Explanatory.
F. **City/Town.** Self Explanatory.
G. **State.** Insert the U.S. Postal Service State abbreviation.
H. **Zip Code.** Insert the five digit zip code plus any extension.
I. **Ownership.** Place an "x" in the appropriate box to indicate ownership status.

SECTION 6. WELL INFORMATION:

A. **Class and Type.** Fill in the Class and Type of injection wells located at the listed facility. Use the most pertinent code (specified below) to accurately describe each type of injection well. For example, 2R for a Class II Enhanced Recovery Well, or 3M for a Class III Solution Mining Well, etc.
B. **Number of Commercial and Non-Commercial Wells.** Enter the total number of commercial and non-commercial wells for each Class/Type, as applicable.
C. **Total Number of Wells.** Enter the total number of injection wells for each specified Class/Type.
D. **Well Operation Status.** Enter the number of wells for each Class/Type under each operation status (see key on other side).

CLASS I Industrial, Municipal, and Radioactive Waste Disposal Wells used to inject waste below the lowermost Underground Source of Drinking Water (USDW).

TYPE	**1I**	Non-Hazardous Industrial Disposal Well.
	1M	Non-Hazardous Municipal Disposal Well.
	1H	Hazardous Waste Disposal Well injecting below the lowermost USDW.
	1R	Radioactive Waste Disposal Well.
	1X	Other Class I Wells.

CLASS II Oil and Gas Production and Storage Related Injection Wells.

TYPE	**2A**	Annular Disposal Well.
	2D	Produced Fluid Disposal Well.
	2H	Hydrocarbon Storage Well.
	2R	Enhanced Recovery Well.
	2X	Other Class II Wells.

CLASS III Special Process Injection Wells.

TYPE	**3G**	*In Situ* Gasification Well
	3M	Solution Mining Well.

CLASS III (CONT'D.)

TYPE	**3S**	Sulfur Mining Well by Frasch Process.
	3T	Geothermal Well.
	3U	Uranium Mining Well.
	3X	Other Class III Wells.

CLASS IV Wells that inject hazardous waste into/above USDWs.

TYPE	**4H**	Hazardous Facility Injection Well.
	4R	Remediation Well at RCRA or CERCLA site.

CLASS V Any Underground Injection Well not included in Classes I through IV.

TYPE	**5A**	Industrial Well.
	5B	Beneficial Use Well.
	5C	Fluid Return Well.
	5D	Sewage Treatment Effluent Well.
	5E	Cesspools (non-domestic).
	5F	Septic Systems.
	5G	Experimental Technology Well.
	5H	Drainage Well.
	5I	Mine Backfill Well.
	5J	Waste Discharge Well.

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Enclosure A

Narrative:

WSP Engineering of New York, P.C., has performed a series of environmental investigations at the former General Instrument Corporation (GIC) site, previously a television antenna and small electronics manufacturer, at 1 Kenyon Press Drive in Chenango County, Sherburne, New York (Figure 1). The investigations, begun in 2004, were focused on the performance of a permeable reactive barrier (PRB) groundwater treatment system installed downgradient of the site in 1997 to address chlorinated volatile organic compounds (VOCs), including tetrachloroethene (PCE) and trichloroethene (TCE), dissolved in the groundwater. Data from the investigations demonstrated that the PRB was not performing as designed and, thus, the site was out of compliance with the Order on Consent (#A701578810) signed by our client, Vishay GSI, Inc. (the corporate successor to GIC), and the New York State Department of Environmental Conservation in August 1989; and unlikely to meet the overall objectives outlined in the 1994 Record of Decision (ROD) for the groundwater remedy.

WSP Engineering determined that supplemental treatment was required to address the remaining chlorinated VOCs and meet the original objectives of the ROD. To that end, WSP Engineering proposed supplemental treatment activities that include the installation of up to 134 temporary delivery point locations (i.e., injection points) in two areas west (downgradient) of the former GIC property along the New York Susquehanna and Western (NYS&W) Railway property and the adjacent farm fields (privately owned by Mr. Robert Howard; Sheets 1 through 5). The temporary injection points, which will be used to deliver a water-based bioremediation compound (e.g., a microorganism growth compound; see below) to treat the groundwater, will be installed with a direct-push hydraulic drill rig (i.e., Geoprobe®, or equivalent) equipped with a 2-foot-long steel injection screen. The 2-inch diameter injection device will be advanced from the surface to a maximum depth of approximately 15 feet below the water table (i.e., approximately 20 feet below ground surface). Up to 65 gallons of bioremediation fluid will be injected into each point over the full extent (15 feet) of saturated soil as the device is removed from the ground. The liquid will be injected at low pressure (i.e., below the fracturing pressure) as to avoid undermining any surface structures. All of the work will be performed under the direction of a New York State-licensed Professional Engineer.

Once the bioremediation fluid has been injected into the subsurface, the injection device will be removed from the ground. The borehole will be backfilled with bentonite and the surface restored to match the surrounding material. No permanent injection wells will be installed. Monitoring of the treatment efficacy will be performed using the existing groundwater monitoring well network (Sheets 2 through 5). WSP Engineering may return to the site within 24 months to perform follow-up injections at approximately the same locations using the same techniques and bioremediation compound.

Site Detail:

Project Location:	42° 40' 59" N 75° 30' 11" W
Facility Name:	former General Instrument Corporation (currently owned and operated by a third party, Kenyon Press, an offset printer)
Facility Address:	1 Kenyon Press Drive, Sherburne, New York
Facility Type and History:	former manufacturing facility that produced and electroplated aluminum television antennas, antenna controllers, and other small electronics from the 1947 through 1983
Regulatory:	New York State Department of Environmental Conservation Inactive Hazardous Waste Site No. 7-09-010

Project Details:

Purpose:	enhanced bioremediation of chlorinated VOCs (primarily PCE and TCE) released to the groundwater during facility operations between 1947 and 1983
Treatment Areas:	two treatment areas positioned near the northern and southern ends of the PRB on NYS&W Railroad property (permits pending) and the adjacent farm fields owned by Mr. Robert Howard of Sherburne, NY
Geology and hydrogeology:	recent surficial deposits, including silt, sand, and gravel associated with the nearby Chenango River. Average depth to groundwater is 5 feet below ground surface.
Total Depth of Injectors:	20 feet below ground surface
Injection Interval:	approximately 5 to 20 feet below ground surface
Anticipated Injector Completion:	August 2009 (pending permit approval)

Injection Fluid:

Trade Name and Manufacturer:	3-D Microemulsion (3DME) by Regenesis, Ltd., of San Clemente, California (see attached company marketing information and material safety data sheet).
Description:	an electron donor solution consisting of esterified lactic acid and fatty acids designed to enhance

microbial-mediated reductive dechlorination of dissolved chlorinated VOCs in groundwater

Volume per Injection Point: 65 gallons of 3DME as a dilute 10:1 mixture (10 parts potable water to 1 part 3DME solution)

Appendix C – Design Drawings:

- Sheet 1 - Title Sheet
- Sheet 2 - Site Plan
- Sheet 3 - Cross Sections A-A and B-B
- Sheet 4 - Enhanced Biological Attenuation Plan - Northern Injection Area
- Sheet 5 - Enhanced Biological Attenuation Plan - Southern Injection Area

INDEX OF DRAWINGS

DRAWING NUMBER	SHEET NUMBER	DESCRIPTION
14899245	1	TITLE SHEET
14899246	2	SITE PLAN
14899247	3	CROSS SECTIONS A-A AND B-B
14899248	4	ENHANCED BIOLOGICAL ATTENUATION PLAN - NORTHERN INJECTION AREA
14899249	5	ENHANCED BIOLOGICAL ATTENUATION PLAN - SOUTHERN INJECTION AREA

ENHANCED BIOLOGICAL ATTENUATION - VOLUNTARY CLEANUP WORK PLAN

FORMER GENERAL INSTRUMENT CORPORATION SITE
SHERBURNE, NEW YORK

PREPARED FOR

MORRIS, DOWNING & SHERRED, LLP

REVISIONS

REV	DESCRIPTION		
1	Revised:	Chkd:	Appr.:
2	Revised:	Chkd:	Appr.:
3	Revised:	Chkd:	Appr.:

SEAL

DATE

DRAWN BY	EGC
CHECKED	
APPROVED	

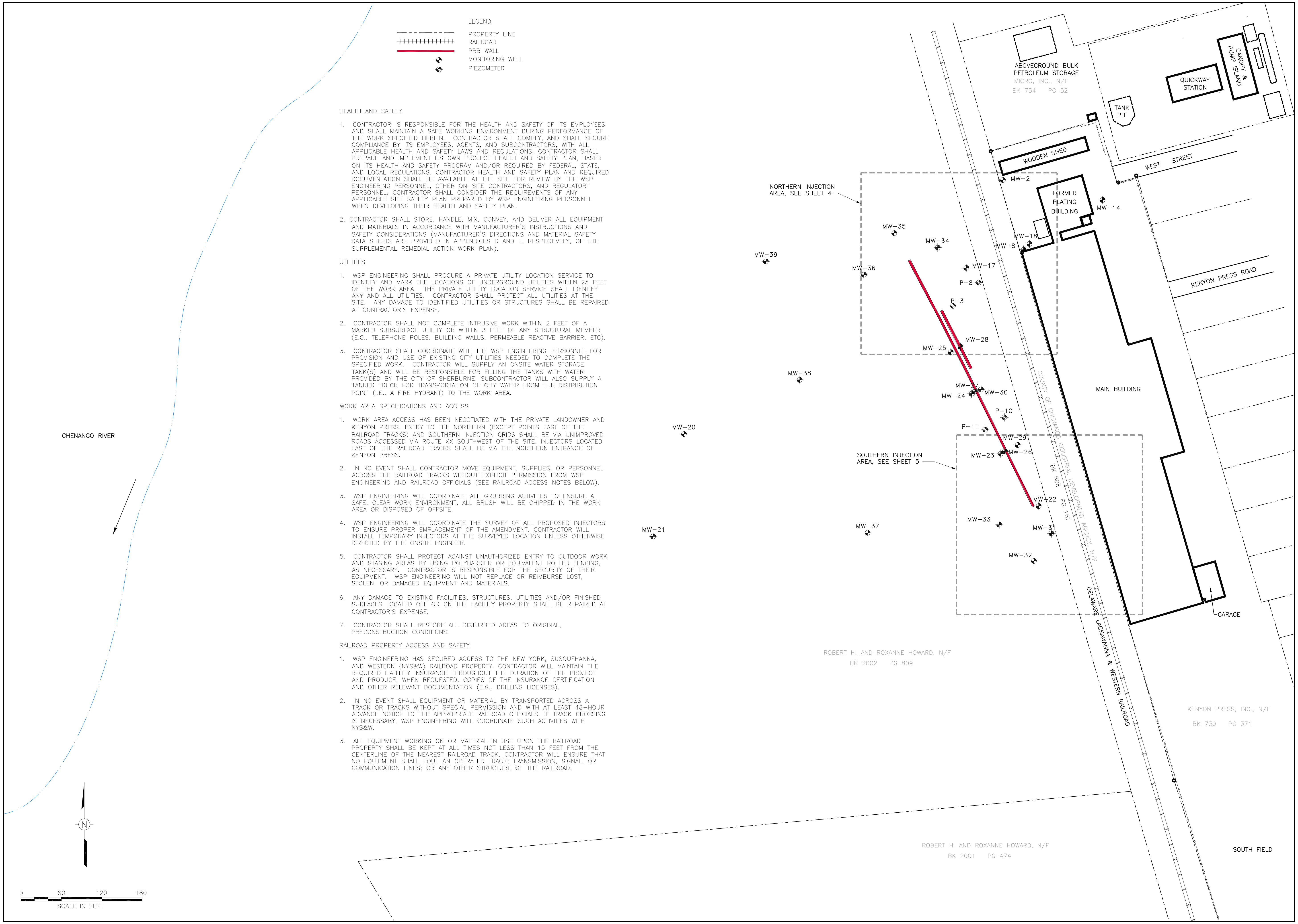
TITLE SHEET

FORMER GENERAL INSTRUMENT CORPORATION SITE
SHERBURNE, NEW YORK
PREPARED FOR
MORRIS, DOWNING & SHERRED, LLP

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

SHEET 1

Drawing Number
14899245



HEALTH AND SAFETY

1. CONTRACTOR IS RESPONSIBLE FOR THE HEALTH AND SAFETY OF ITS EMPLOYEES AND SHALL MAINTAIN A SAFE WORKING ENVIRONMENT DURING PERFORMANCE OF THE WORK SPECIFIED HEREIN. CONTRACTOR SHALL COMPLY, AND SHALL SECURE COMPLIANCE BY ITS EMPLOYEES, AGENTS, AND SUBCONTRACTORS, WITH ALL APPLICABLE HEALTH AND SAFETY LAWS AND REGULATIONS. CONTRACTOR SHALL PREPARE AND IMPLEMENT ITS OWN PROJECT HEALTH AND SAFETY PLAN, BASED ON ITS HEALTH AND SAFETY PROGRAM AND/OR REQUIRED BY FEDERAL, STATE, AND LOCAL REGULATIONS. CONTRACTOR HEALTH AND SAFETY PLAN AND REQUIRED DOCUMENTATION SHALL BE AVAILABLE AT THE SITE FOR REVIEW BY THE WSP ENGINEERING PERSONNEL, OTHER ON-SITE CONTRACTORS, AND REGULATORY PERSONNEL. CONTRACTOR SHALL CONSIDER THE REQUIREMENTS OF ANY APPLICABLE SITE SAFETY PLAN PREPARED BY WSP ENGINEERING PERSONNEL WHEN DEVELOPING THEIR HEALTH AND SAFETY PLAN.

2. CONTRACTOR SHALL STORE, HANDLE, MIX, CONVEY, AND DELIVER ALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SAFETY CONSIDERATIONS (MANUFACTURER'S DIRECTIONS AND MATERIAL SAFETY DATA SHEETS ARE PROVIDED IN APPENDICES D AND E, RESPECTIVELY, OF THE SUPPLEMENTAL REMEDIAL ACTION WORK PLAN).

UTILITIES

1. WSP ENGINEERING SHALL PROCURE A PRIVATE UTILITY LOCATION SERVICE TO IDENTIFY AND MARK THE LOCATIONS OF UNDERGROUND UTILITIES WITHIN 25 FEET OF THE WORK AREA. THE PRIVATE UTILITY LOCATION SERVICE SHALL IDENTIFY ANY AND ALL UTILITIES. CONTRACTOR SHALL PROTECT ALL UTILITIES AT THE SITE. ANY DAMAGE TO IDENTIFIED UTILITIES OR STRUCTURES SHALL BE REPAIRED AT CONTRACTOR'S EXPENSE.

2. CONTRACTOR SHALL NOT COMPLETE INTRUSIVE WORK WITHIN 2 FEET OF A MARKED SUBSURFACE UTILITY OR WITHIN 3 FEET OF ANY STRUCTURAL MEMBER (E.G., TELEPHONE POLES, BUILDING WALLS, PERMEABLE REACTIVE BARRIER, ETC).

3. CONTRACTOR SHALL COORDINATE WITH THE WSP ENGINEERING PERSONNEL FOR PROVISION AND USE OF EXISTING CITY UTILITIES NEEDED TO COMPLETE THE SPECIFIED WORK. CONTRACTOR WILL SUPPLY AN ONSITE WATER STORAGE TANK(S) AND WILL BE RESPONSIBLE FOR FILLING THE TANKS WITH WATER PROVIDED BY THE CITY OF SHERBURNE. SUBCONTRACTOR WILL ALSO SUPPLY A TANKER TRUCK FOR TRANSPORTATION OF CITY WATER FROM THE DISTRIBUTION POINT (I.E., A FIRE HYDRANT) TO THE WORK AREA.

WORK AREA SPECIFICATIONS AND ACCESS

1. WORK AREA ACCESS HAS BEEN NEGOTIATED WITH THE PRIVATE LANDOWNER AND KENYON PRESS. ENTRY TO THE NORTHERN (EXCEPT POINTS EAST OF THE RAILROAD TRACKS) AND SOUTHERN INJECTION GRIDS SHALL BE VIA UNIMPROVED ROADS ACCESSED VIA ROUTE XX SOUTHWEST OF THE SITE. INJECTORS LOCATED EAST OF THE RAILROAD TRACKS SHALL BE VIA THE NORTHERN ENTRANCE OF KENYON PRESS.

2. IN NO EVENT SHALL CONTRACTOR MOVE EQUIPMENT, SUPPLIES, OR PERSONNEL ACROSS THE RAILROAD TRACKS WITHOUT EXPLICIT PERMISSION FROM WSP ENGINEERING AND RAILROAD OFFICIALS (SEE RAILROAD ACCESS NOTES BELOW).

3. WSP ENGINEERING WILL COORDINATE ALL GRUBBING ACTIVITIES TO ENSURE A SAFE, CLEAR WORK ENVIRONMENT. ALL BRUSH WILL BE CHIPPED IN THE WORK AREA OR DISPOSED OF OFFSITE.

4. WSP ENGINEERING WILL COORDINATE THE SURVEY OF ALL PROPOSED INJECTORS TO ENSURE PROPER EMPLACEMENT OF THE AMENDMENT. CONTRACTOR WILL INSTALL TEMPORARY INJECTORS AT THE SURVEYED LOCATION UNLESS OTHERWISE DIRECTED BY THE ONSITE ENGINEER.

5. CONTRACTOR SHALL PROTECT AGAINST UNAUTHORIZED ENTRY TO OUTDOOR WORK AND STAGING AREAS BY USING POLYBARRIER OR EQUIVALENT ROLLED FENCING, AS NECESSARY. CONTRACTOR IS RESPONSIBLE FOR THE SECURITY OF THEIR EQUIPMENT. WSP ENGINEERING WILL NOT REPLACE OR REIMBURSE LOST, STOLEN, OR DAMAGED EQUIPMENT AND MATERIALS.

6. ANY DAMAGE TO EXISTING FACILITIES, STRUCTURES, UTILITIES AND/OR FINISHED SURFACES LOCATED OFF OR ON THE FACILITY PROPERTY SHALL BE REPAIRED AT CONTRACTOR'S EXPENSE.

7. CONTRACTOR SHALL RESTORE ALL DISTURBED AREAS TO ORIGINAL, PRECONSTRUCTION CONDITIONS.

RAILROAD PROPERTY ACCESS AND SAFETY

1. WSP ENGINEERING HAS SECURED ACCESS TO THE NEW YORK, SUSQUEHANNA, AND WESTERN (NYS&W) RAILROAD PROPERTY. CONTRACTOR WILL MAINTAIN THE REQUIRED LIABILITY INSURANCE THROUGHOUT THE DURATION OF THE PROJECT AND PRODUCE, WHEN REQUESTED, COPIES OF THE INSURANCE CERTIFICATION AND OTHER RELEVANT DOCUMENTATION (E.G., DRILLING LICENSES).

2. IN NO EVENT SHALL EQUIPMENT OR MATERIAL BY TRANSPORTED ACROSS A TRACK OR TRACKS WITHOUT SPECIAL PERMISSION AND WITH AT LEAST 48-HOUR ADVANCE NOTICE TO THE APPROPRIATE RAILROAD OFFICIALS. IF TRACK CROSSING IS NECESSARY, WSP ENGINEERING WILL COORDINATE SUCH ACTIVITIES WITH NYS&W.

3. ALL EQUIPMENT WORKING ON OR MATERIAL IN USE UPON THE RAILROAD PROPERTY SHALL BE KEPT AT ALL TIMES NOT LESS THAN 15 FEET FROM THE CENTERLINE OF THE NEAREST RAILROAD TRACK. CONTRACTOR WILL ENSURE THAT NO EQUIPMENT SHALL FOUL AN OPERATED TRACK; TRANSMISSION, SIGNAL, OR COMMUNICATION LINES; OR ANY OTHER STRUCTURE OF THE RAILROAD.

REVISIONS

REV	DESCRIPTION
1	Revised: Chkd: Appr.:
2	Revised: Chkd: Appr.:
3	Revised: Chkd: Appr.:

SEAL

DATE

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SITE PLAN

FORMER GENERAL INSTRUMENT CORPORATION SITE
SHERBURNE, NEW YORK

PREPARED FOR

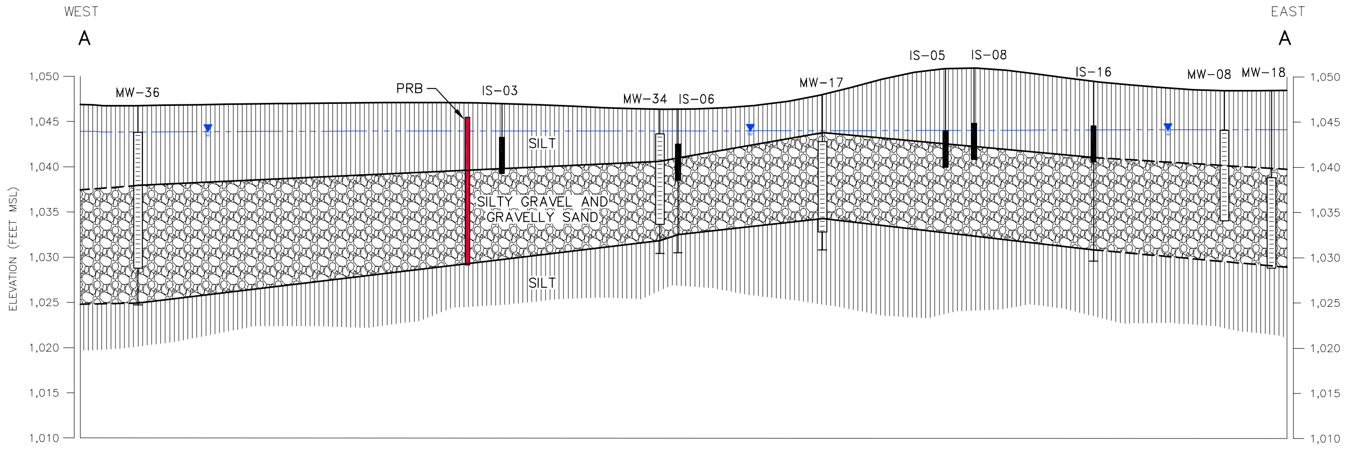
MORRIS, DOWNING & SHERRED, LLP

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

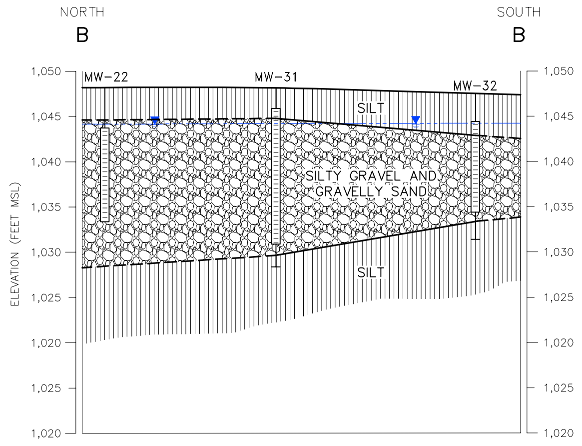
SHEET 2

Drawing Number
14899246

LEGEND
- IN SITU GROUNDWATER SAMPLE BORING PROFILE
- SCREEN–POINT SAMPLING INTERVAL
- SOIL SAMPLING INTERVAL
- MONITORING WELL PROFILE
- SCREENED INTERVAL
- SOIL SAMPLING INTERVAL
- INTERPRETED AVERAGE WATER TABLE (2004–2009)
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)



SECTION A–A

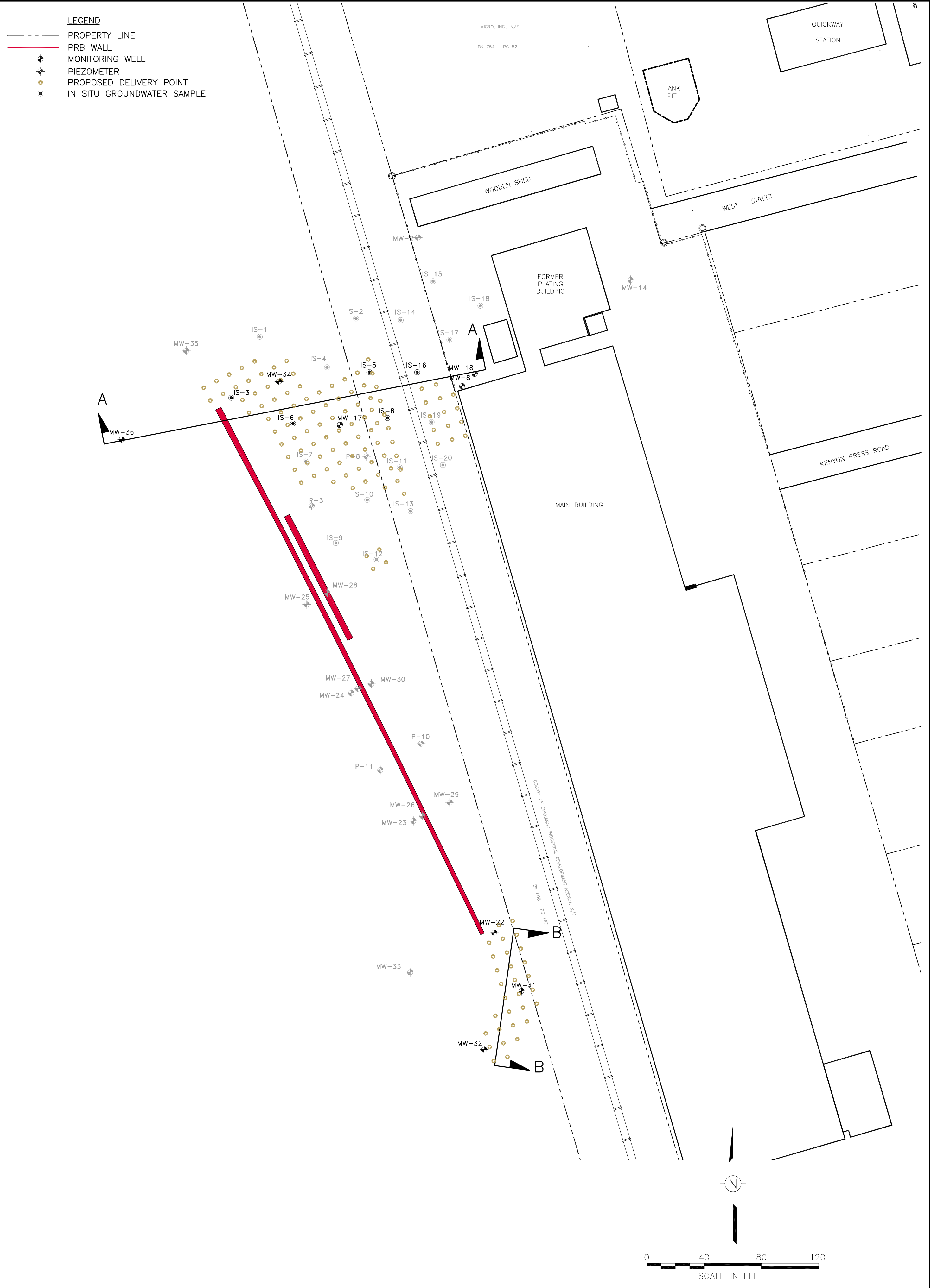


SECTION B–B

0 10 20
VERTICAL SCALE IN FEET

0 20 40
HORIZONTAL SCALE IN FEET

2:1 VERTICAL EXAGGERATION



REVISIONS

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CROSS SECTIONS A–A AND B–B

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WSP
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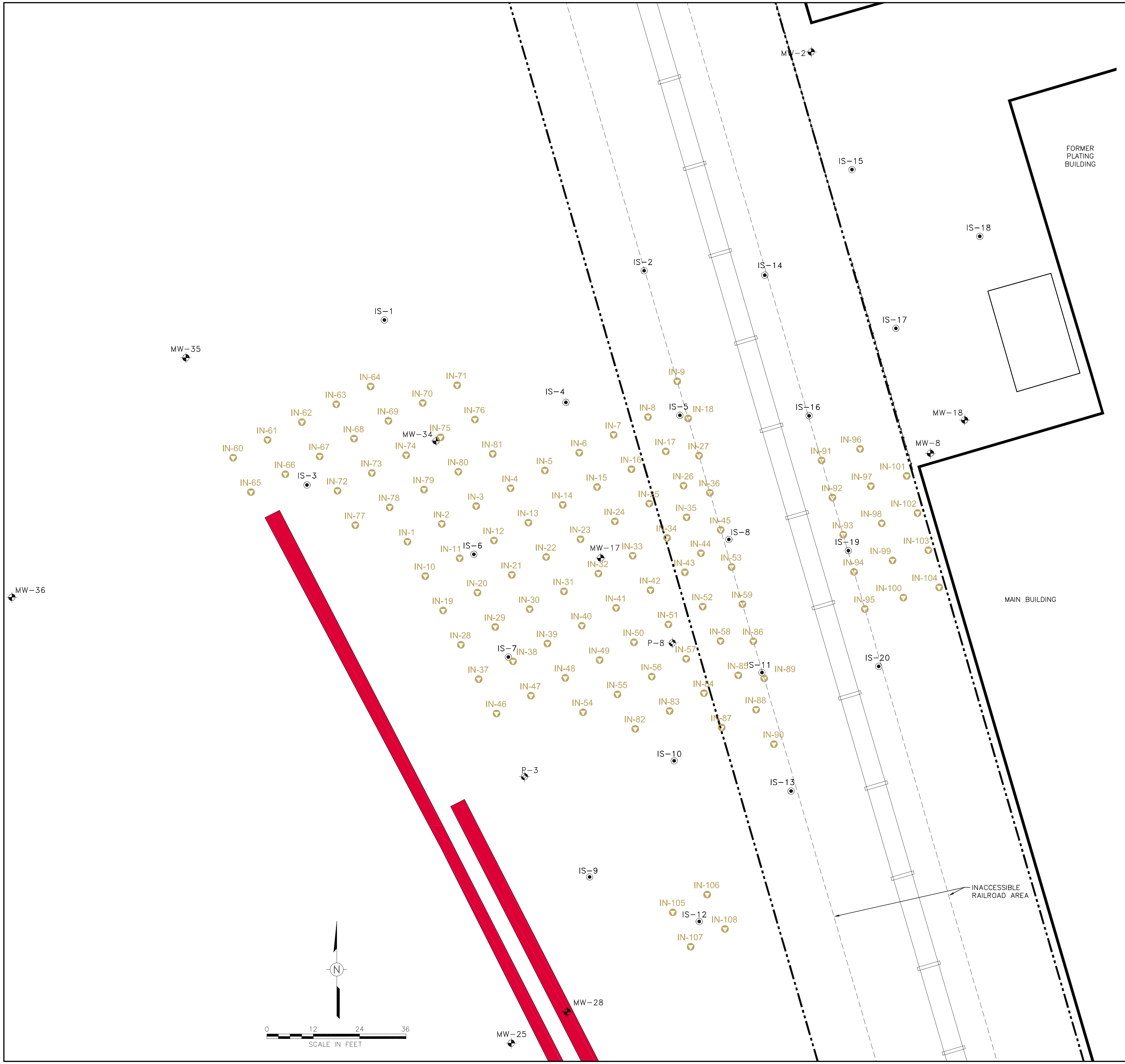
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

SHEET 3

Drawing Number
148992547



LEGEND

— · · — PROPERTY LINE
▬ PRB WALL
⊕ MONITORING WELL
⊕ PIEZOMETER
▽ PROPOSED DELIVERY POINT LOCATION (10 FOOT SPACING)

EQUIPMENT AND STORAGE

1. CONTRACTOR SHALL STAGE EQUIPMENT AND MATERIAL IN AREAS DESIGNATED BY WSP ENGINEERING PERSONNEL. CONTRACTOR SHALL PROTECT AGAINST UNAUTHORIZED ENTRY TO OUTDOOR WORK AND STAGING AREAS BY USING POLYBARRIER OR EQUIVALENT ROLLED FENCING, AS NECESSARY, OR DIRECTED BY WSP ENGINEERING PERSONNEL. CONTRACTOR IS RESPONSIBLE FOR THE SECURITY OF THEIR EQUIPMENT. WSP ENGINEERING PERSONNEL AND PROPERTY OWNER WILL NOT REPLACE OR REIMBURSE LOST, STOLEN, OR DAMAGED EQUIPMENT AND MATERIALS.

2. WSP ENGINEERING PERSONNEL SHALL PROVIDE GROUNDWATER REMEDIATION AMENDMENTS, ANALYTICAL SERVICES, AND GROUNDWATER SAMPLING EQUIPMENT FOR THE PROJECT.

3. CONTRACTOR SHALL PROVIDE ALL LABOR, EQUIPMENT, TOOLS, AND MATERIALS NECESSARY TO STORE, HANDLE, MIX, CONVEY, AND DELIVER THE REMEDIATION AMENDMENTS TO TWO POINT SIMULTANEOUSLY (USING A SINGLE GEOPROBE) TO THE SUBSURFACE AT A CUMULATIVE RATE OF 10 GPM (MAXIMUM: 5 GPM PER POINT)

4. CONTRACTOR SHALL STORE, HANDLE, MIX, CONVEY, AND DELIVER ALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SAFETY CONSIDERATIONS (MANUFACTURER'S DIRECTIONS AND MATERIAL SAFETY DATA SHEETS ARE PROVIDED IN APPENDICES D AND E, RESPECTIVELY, OF THE SUPPLEMENTAL REMEDIAL ACTION WORK PLAN).

INJECTION POINT LOCATIONS:

1. DELIVERY POINT LOCATIONS MAY BE MODIFIED IN THE FIELD AT DISCRETION WSP ENGINEERING PERSONNEL TO AVOID PROTECTED AREAS OR TO MAXIMIZE THE DISTANCE BETWEEN DELIVERY POINTS AND MONITORING WELLS. PROPOSED LOCATIONS WILL BE IDENTIFIED BY WSP ENGINEERING PERSONNEL AND/OR A SURVEYOR WITH MARKING PAINT, OR SIMILAR, BEFORE COMMENCEMENT OF WORK.

2. CONTRACTOR SHALL INSTALL WELL PACKS IN EXISTING MONITORING WELLS WITHIN 25 FEET OF A PROPOSED INJECTION POINT TO MINIMIZE SHORT–CICUITING. CONTRACTOR SHALL NOT INSTALL INJECTION POINTS WITHIN 3 FEET OF ANY EXISTING MONITORING WELL.

AMENDMENT FLUID COMPOSITION AND MIXING

1. CONTRACTOR SHALL MIX 3DME WITH WATER AT A MASS RATIO OF 27 PARTS WATER TO 1 PART 3DME. 3DME SHALL BE MIXED IN ACCORDANCE WITH REGENESIS MIXING INSTRUCTIONS (SEE APPENDIX D IN SUPPLEMENTAL REMEDIAL ACTION WORK PLAN).

2. IF AN ALTERNATE AMENDMENT FLUID IS USED THE CONTRACTOR WILL BE PROVIDED WITH DILUTION/RECONSTITUTION AND DELIVERY DOSE INSTRUCTIONS PRIOR TO MOBILIZATION TO THE SITE.

FLUID DELIVERY

1. CONTRACTOR SHALL COORDINATE ALL SUBSURFACE DELIVERY ACTIVITIES WITH WSP ENGINEERING PERSONNEL.

2. CONTRACTOR SHALL DELIVER THE VOLUME OF DILUTED 3DME TO EACH POINT IDENTIFIED ON THIS SHEET AND SHEET 5 IN ACCORDANCE WITH THE DELIVERY SCHEDULE ON THIS SHEET

3. TEMPORARY GEOPROBE (OR APPROVED EQUIVALENT) DRIVE POINT DELIVERY POINTS SHALL BE ADVANCED SEQUENTIALLY BEGINNING WITH THE POINTS LOCATED AT THE OUTER EDGE OF THE DELIVERY POINT GRID SHOWN ON THIS SHEET AND SHEET 5 AND FINISHING WITH THE POINTS LOCATED IN THE INTERIOR OF THE GRID.

4. A DELIVERY TOOL (SEE NOTE BELOW) SHALL BE ATTACHED TO THE BOTTOM OF THE 1.25" DIRECT PUSH RODS. A GEOPROBE® MEMBRANE INTERFACE PROBE EXPANSION BULB OR SIMILAR FRICTION REDUCING DEVICE SHALL BE USED AS NECESSARY TO MINIMIZE SHORT–CIRCUITING ALONG THE DRIVE POINT RODS.

5. WSP ENGINEERING MAY REQUIRE CONTRACTOR TO COLLECT DRILLING VERIFICATION SOIL OR GROUNDWATER SAMPLES WITHIN SELECTED GRIDS. WSP ENGINEERING PERSONNEL MAY ADJUST DELIVERY POINT LOCATIONS BASED ON DELIVERY VERIFICATION SAMPLES.

DELIVERY SEQUENCE

1. TOP DOWN DELIVERY USING A GEOPROBE® PRESSURE–ACTIVATED INJECTION PROBE (MODIFIED FOR LOW PRESSURE USE) OR SIMILAR WSP ENGINEERING APPROVED DEVICE IS PREFERRED. BOTTOM UP DELIVERY USING APPROVED INJECTION TOOLS OR EXPANDABLE DRIVE POINTS SHALL ONLY BE COMPLETED WITH WSP ENGINEERING APPROIVAL.

2. CONTRACTOR SHALL DELIVER THE TOTAL AMENDMENT VOLUME TO EACH DELIVERY POINT BASED ON THE DELIVERY VOLUME SCHEDULE, SUCH THAT, IT IS EQUALLY DISTRIBUTED ACROSSED THE AFFECTED SATURATED THICKNESS (APPROXIMATELY 4 TO 20 FEET BGS). UNLESS INSTRUCTED OTHERWISE BY WSP ENGINEERING PERSONNEL, ONE THIRD OF THE AMENDMENT VOLUME SHALL BE DELIVERED TO EACH OF THE 3 DEPTH INTERVALS: 8 FEET BGS, 12 FEET BGS, AND 16 FT BGS.

3. AMENDMENT FLUID SHALL BE DELIVERED TO THE SUBSURFACE THROUGH HOLLOW DRIVE POINT RODS UNDER THE LEAST AMOUNT OF PRESSURE PRACTICAL THAT ACHEIVES AN ACCEPTABLE DELIVERY RATE (2 TO 5 GPM).

4. AMENDMENT FLUID SHALL BE INTRODUCED AT THE INITIAL PRESSURE OF 110–PERCENT OF THE THEORETICAL BREAKOUT PRESSURE AS INDICATED IN THE BREAKOUT PRESSURE SCHEDULE BELOW OR AS DIRECTED BY WSP ENGINEERING PERSONNEL.

INJECTION INTERVAL (FT BGS)	110% DESIGN BREAKTHROUGH PRESSURE
8	1.9
12	3.8
16	5.7

5. IF DOWN–WELL FLOW OF 2 TO 5 GPM IS NOT ACHIEVED AFTER 5 MINUTES, THE DELIVERY PRESSURE MAY BE INCREASED SLOWLY UNTIL AN ACCEPTABLE FLOW RATE OF 2 TO 5 GPM IS ACHIEVED.

6. AFTER DELIVERING ONE THIRD OF THE AMENDMENT FLUID VOLUME INDICATED IN THE AMENDMENT FLUID DELIVERY NOTES, DOWN–WELL PUMPING SHALL BE DISCONTINUED.

7. THE DRIVE POINT SHALL BE ADVANCED OR RETRACTED AS APPROPRIATE TO THE NEXT DELIVERY INTERVAL AND THE DELIVERY SEQUENCE SHALL BE REPEATED UNTIL AMENDMENT FLUID HAS BEEN DELIVERED TO EACH INTERVAL.

8. IF DELIVERY TO ANY DEPTH INTERVAL IS NOT SUCCESSFUL THEN THE VOLUME NOT DELIVERED SHALL BE ADDED TO THE NEXT DELIVERY INTERVAL WITHIN THE SAME BORING. IF DELIVERY IN THE FINAL INTERVAL IS NOT SUCCESSFUL THEN THE VOLUME NOT DELIVERED SHALL BE ADDED TO THE FINAL INTERVAL AT AN ADJACENT LOCATION.

9. AFTER DELIVERY, CONTRACTOR SHALL FILL THE INJECTION POINTS FROM THE BOREHOLE TERMINUS TO GRADE WITH BENTONITE GROUT.

AMENDMENT FLUID DELIVERY SCHEDULE

DELIVERY POINTS	TOTAL VOLUME (GAL)	INTERVAL VOLUME (GAL)
IN–1 TO IN–50	168	56
IN–36, IN–45, IN–53, IN–59 IN–86, IN–91, IN–95	336	112
REMAINING POINTS	168	56

REV	REVISIONS DESCRIPTION
	Revised: Chkd: Appr.:
	Revised: Chkd: Appr.:
	Revised: Chkd: Appr.:

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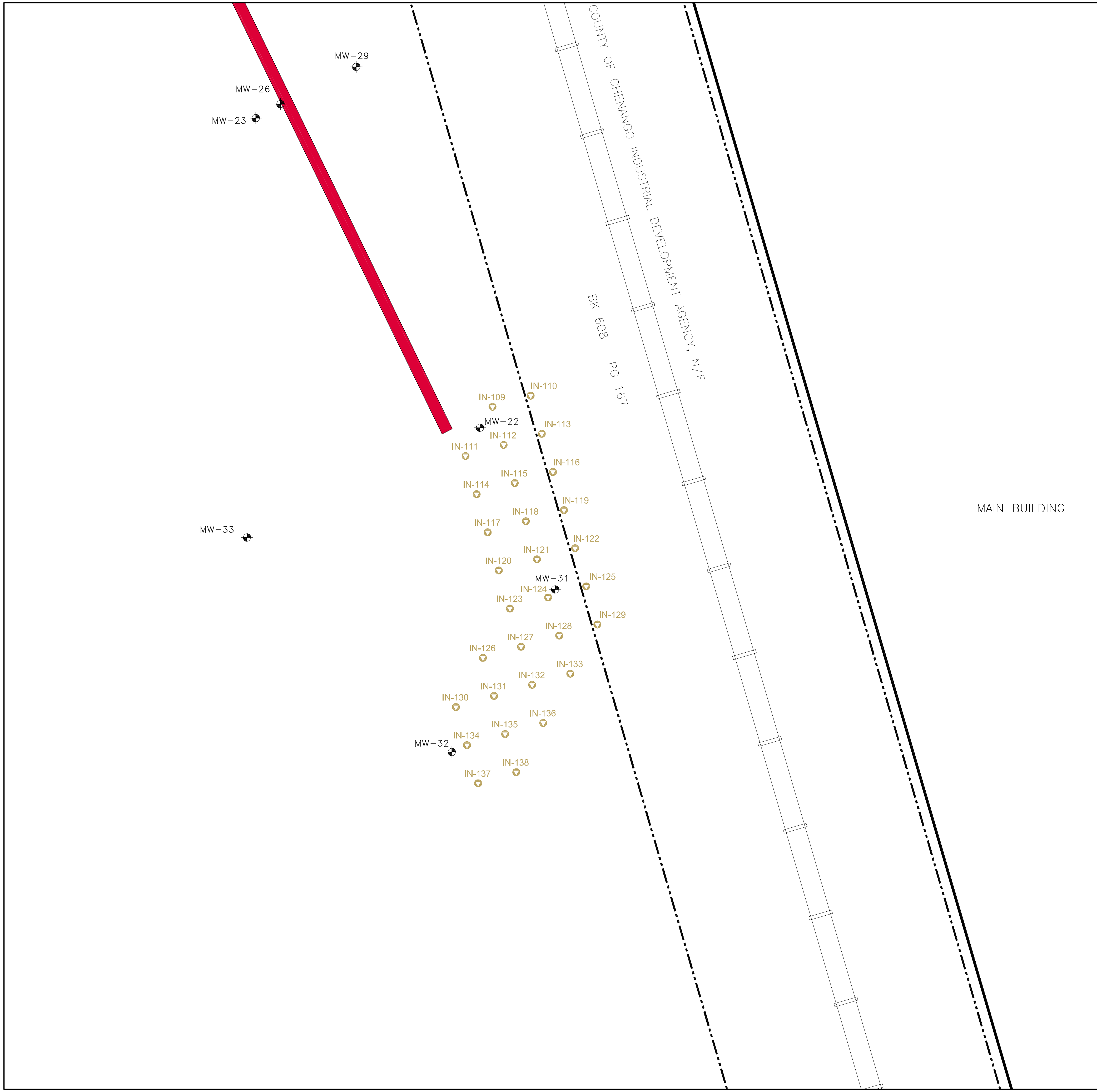
ENHANCED BIOLOGICAL ATTENUATION PLAN
NORTHERN INJECTION AREA
FORMER GENERAL INSTRUMENT CORPORATION SITE
SHERBURNE, NEW YORK
PREPARED FOR
MORRIS, DOWNING & SHERRED, LLP

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

SHEET 4

Drawing Number
14899248



LEGEND

—·—·—	PROPERTY LINE
┼┼┼┼┼┼	RAILROAD
🟥	PRB WALL
⊕	MONITORING WELL
⊕	PIEZOMETER
▼	PROPOSED DELIVERY POINT LOCATION (10 FOOT SPACING)

EQUIPMENT AND STORAGE

1. CONTRACTOR SHALL STAGE EQUIPMENT AND MATERIAL IN AREAS DESIGNATED BY WSP ENGINEERING PERSONNEL. CONTRACTOR SHALL PROTECT AGAINST UNAUTHORIZED ENTRY TO OUTDOOR WORK AND STAGING AREAS BY USING POLYBARRIER OR EQUIVALENT ROLLED FENCING, AS NECESSARY, OR DIRECTED BY WSP ENGINEERING PERSONNEL. CONTRACTOR IS RESPONSIBLE FOR THE SECURITY OF THEIR EQUIPMENT. WSP ENGINEERING PERSONNEL AND PROPERTY OWNER WILL NOT REPLACE OR REIMBURSE LOST, STOLEN, OR DAMAGED EQUIPMENT AND MATERIALS.
2. WSP ENGINEERING PERSONNEL SHALL PROVIDE GROUNDWATER REMEDIATION AMENDMENTS, ANALYTICAL SERVICES, AND GROUNDWATER SAMPLING EQUIPMENT FOR THE PROJECT.
3. CONTRACTOR SHALL PROVIDE ALL LABOR, EQUIPMENT, TOOLS, AND MATERIALS NECESSARY TO STORE, HANDLE, MIX, CONVEY, AND DELIVER THE REMEDIATION AMENDMENTS TO TWO POINT SIMULTANEOUSLY (USING A SINGLE GEOPROBE) TO THE SUBSURFACE AT A CUMULATIVE RATE OF 10 GPM (MAXIMUM: 5 GPM PER POINT)
4. CONTRACTOR SHALL STORE, HANDLE, MIX, CONVEY, AND DELIVER ALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SAFETY CONSIDERATIONS (MANUFACTURER'S DIRECTIONS AND MATERIAL SAFETY DATA SHEETS ARE PROVIDED IN APPENDICES D AND E, RESPECTIVELY, OF THE SUPPLEMENTAL REMEDIAL ACTION WORK PLAN).

INJECTION POINT LOCATIONS:

1. DELIVERY POINT LOCATIONS MAY BE MODIFIED IN THE FIELD AT DISCRETION WSP ENGINEERING PERSONNEL TO AVOID PROTECTED AREAS OR TO MAXIMIZE THE DISTANCE BETWEEN DELIVERY POINTS AND MONITORING WELLS. PROPOSED LOCATIONS WILL BE IDENTIFIED BY WSP ENGINEERING PERSONNEL AND/OR A SURVEYOR WITH MARKING PAINT, OR SIMILAR, BEFORE COMMENCEMENT OF WORK.
2. CONTRACTOR SHALL INSTALL WELL PACKS IN EXISTING MONITORING WELLS WITHIN 25 FEET OF A PROPOSED INJECTION POINT TO MINIMIZE SHORT-CICUITING. CONTRACTOR SHALL NOT INSTALL INJECTION POINTS WITHIN 3 FEET OF ANY EXISTING MONITORING WELL.

AMENDMENT FLUID COMPOSITION AND MIXING

1. CONTRACTOR SHALL MIX 3DME WITH WATER AT A MASS RATIO OF 27 PARTS WATER TO 1 PART 3DME. 3DME SHALL BE MIXED IN ACCORDANCE WITH REGENESIS MIXING INSTRUCTIONS (SEE APPENDIX D IN SUPPLEMENTAL REMEDIAL ACTION WORK PLAN).
2. IF AN ALTERNATE AMENDMENT FLUID IS USED THE CONTRACTOR WILL BE PROVIDED WITH DILUTION/RECONSTITUTION AND DELIVERY DOSE INSTRUCTIONS PRIOR TO MOBILIZATION TO THE SITE.

FLUID DELIVERY

1. CONTRACTOR SHALL COORDINATE ALL SUBSURFACE DELIVERY ACTIVITIES WITH WSP ENGINEERING PERSONNEL.
2. CONTRACTOR SHALL DELIVER THE VOLUME OF DILUTED 3DME TO EACH POINT IDENTIFIED ON THIS SHEET AND SHEET 5 IN ACCORDANCE WITH THE DELIVERY SCHEDULE ON THIS SHEET
3. TEMPORARY GEOPROBE (OR APPROVED EQUIVALENT) DRIVE POINT DELIVERY POINTS SHALL BE ADVANCED SEQUENTIALLY BEGINNING WITH THE POINTS LOCATED AT THE OUTER EDGE OF THE DELIVERY POINT GRID SHOWN ON THIS SHEET AND SHEET 5 AND FINISHING WITH THE POINTS LOCATED IN THE INTERIOR OF THE GRID.
4. A DELIVERY TOOL (SEE NOTE BELOW) SHALL BE ATTACHED TO THE BOTTOM OF THE 1.25" DIRECT PUSH RODS. A GEOPROBE® MEMBRANE INTERFACE PROBE EXPANSION BULB OR SIMILAR FRICTION REDUCING DEVICE SHALL BE USED AS NECESSARY TO MINIMIZE SHORT-CIRCUITING ALONG THE DRIVE POINT RODS.
5. WSP ENGINEERING MAY REQUIRE CONTRACTOR TO COLLECT DRILLING VERIFICATION SOIL OR GROUNDWATER SAMPLES WITHIN SELECTED GRIDS. WSP ENGINEERING PERSONNEL MAY ADJUST DELIVERY POINT LOCATIONS BASED ON DELIVERY VERIFICATION SAMPLES.

DELIVERY SEQUENCE

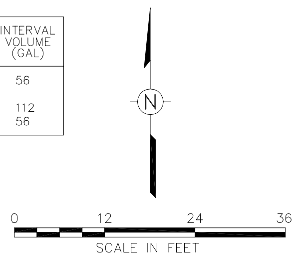
1. TOP DOWN DELIVERY USING A GEOPROBE® PRESSURE-ACTIVATED INJECTION PROBE (MODIFIED FOR LOW PRESSURE USE) OR SIMILAR WSP ENGINEERING APPROVED DEVICE IS PREFERRED. BOTTOM UP DELIVERY USING APPROVED INJECTION TOOLS OR EXPANDABLE DRIVE POINTS SHALL ONLY BE COMPLETED WITH WSP ENGINEERING APPROIVAL.
2. CONTRACTOR SHALL DELIVER THE TOTAL AMENDMENT VOLUME TO EACH DELIVERY POINT BASED ON THE DELIVERY VOLUME SCHEDULE, SUCH THAT, IT IS EQUALLY DISTRIBUTED ACROSSED THE AFFECTED SATURATED THICKNESS (APPROXIMATELY 4 TO 20 FEET BGS). UNLESS INSTRUCTED OTHERWISE BY WSP ENGINEERING PERSONNEL, ONE THIRD OF THE AMENDMENT VOLUME SHALL BE DELIVERED TO EACH OF THE 3 DEPTH INTERVALS: 8 FEET BGS, 12 FEET BGS, AND 16 FT BGS.
3. AMENDMENT FLUID SHALL BE DELIVERED TO THE SUBSURFACE THROUGH HOLLOW DRIVE POINT RODS UNDER THE LEAST AMOUNT OF PRESSURE PRACTICAL THAT ACHEIVES AN ACCEPTABLE DELIVERY RATE (2 TO 5 GPM).
4. AMENDMENT FLUID SHALL BE INTRODUCED AT THE INITIAL PRESSURE OF 110-PERCENT OF THE THEORETICAL BREAKOUT PRESSURE AS INDICATED IN THE BREAKOUT PRESSURE SCHEDULE BELOW OR AS DIRECTED BY WSP ENGINEERING PERSONNEL.

INJECTION INTERVAL (FT BGS)	110% DESIGN BREAKTHROUGH PRESSURE
8	1.9
12	3.8
16	5.7

5. IF DOWN-WELL FLOW OF 2 TO 5 GPM IS NOT ACHIEVED AFTER 5 MINUTES, THE DELIVERY PRESSURE MAY BE INCREASED SLOWLY UNTIL AN ACCEPTABLE FLOW RATE OF 2 TO 5 GPM IS ACHIEVED.
6. AFTER DELIVERING ONE THIRD OF THE AMENDMENT FLUID VOLUME INDICATED IN THE AMENDMENT FLUID DELIVERY NOTES, DOWN-WELL PUMPING SHALL BE DISCONTINUED.
7. THE DRIVE POINT SHALL BE ADVANCED OR RETRACTED AS APPROPRIATE TO THE NEXT DELIVERY INTERVAL AND THE DELIVERY SEQUENCE SHALL BE REPEATED UNTIL AMENDMENT FLUID HAS BEEN DELIVERED TO EACH INTERVAL.
8. IF DELIVERY TO ANY DEPTH INTERVAL IS NOT SUCCESSFUL THEN THE VOLUME NOT DELIVERED SHALL BE ADDED TO THE NEXT DELIVERY INTERVAL WITHIN THE SAME BORING. IF DELIVERY IN THE FINAL INTERVAL IS NOT SUCCESSFUL THEN THE VOLUME NOT DELIVERED SHALL BE ADDED TO THE FINAL INTERVAL AT AN ADJACENT LOCATION.
9. AFTER DELIVERY, CONTRACTOR SHALL FILL THE INJECTION POINTS FROM THE BOREHOLE TERMINUS TO GRADE WITH BENTONITE GROUT.

AMENDMENT FLUID DELIVERY SCHEDULE

DELIVERY POINTS	TOTAL VOLUME (GAL)	INTERVAL VOLUME (GAL)
IN-1 TO IN-50	168	56
IN-36, IN-45, IN-53, IN-59		
IN-86, IN-91, IN-95	336	112
REMAINING POINTS	168	56



REVISIONS

REV	DESCRIPTION		
1	Revised:	Chkd:	Appr.:
2	Revised:	Chkd:	Appr.:
3	Revised:	Chkd:	Appr.:

SEAL

DATE

DRAWN BY	EGC
CHECKED	
APPROVED	

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ENHANCED BIOLOGICAL ATTENUATION PLAN
SOUTHERN INJECTION AREA
FORMER GENERAL INSTRUMENT CORPORATION SITE
SHERBURNE, NEW YORK
PREPARED FOR
MORRIS, DOWNING & SHERRED, LLP

WSP
Engineering of
New York, P.C.
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

SHEET 5

Drawing Number
14899249

Appendix D – Manufacturers’ Installation Instructions

3-D Microemulsion (3DMe)™

INSTALLATION INSTRUCTIONS

High-Volume, Wide-Area, Micro-Emulsion Application

Introduction

3-D Microemulsion (3DMe)™, a form of HRC Advanced®, should ONLY be applied as a high-volume, micro-emulsion. In this form it offers greater physical distribution of the 3DMe material across a larger potential radius from a single injection point. The production of a 3DMe emulsion involves the on-site, volumetric mixing of 10 parts water with 1 part delivered 3DMe concentrate to form the injection-ready 3DMe micro-emulsion. This micro-emulsion suspension can then be injected directly or further diluted to a predetermined ratio of 3DMe to water. The following instructions provide details in the production and installation of the 3DMe micro-emulsion.

Material Overview Handling and Safety

3DMe concentrate is shipped and delivered in 4.25-gallon buckets. Each bucket has a gross weight of approximately 32 pounds. Each bucket contains 30 pounds of 3DMe concentrate (net weight) and a nominal volume of 3.7 gallons. At room temperature, 3DMe concentrate is a liquid material with a viscosity of approximately 500 centipoise, roughly the equivalent of pancake syrup. The viscosity of 3DMe is not temperature sensitive above 50 ºF (10 ºC). However, below 50 ºF the viscosity may increase significantly. If the user plans to apply the product in cold weather, consideration should be given to heating the material to above 60 ºF so that it can be easily handled. 3DMe concentrate should be stored in a warm, dry place that is protected from direct sunlight. It is common for stored 3DMe concentrate to settle somewhat in the bucket, a quick pre-mix stir by a hand held drill with a paint or "jiffy mixer" attachment will rapidly re-homogenize the material. 3DMe concentrate is non-toxic, however field personnel should take precautions while handling and applying the material. Field personnel should use appropriate personal protection equipment (PPE) including eye protection. Gloves should be used as appropriate based on the exposure duration and field conditions. A Material Safety Data Sheet is provided with each shipment. Personnel who operate field equipment during the installation process should have appropriate training, supervision, and experience and should review the MSDS prior to site operations.

Micro-Emulsion Production 3DMe to Water Ratio

3DMe concentrate should be mixed with water on a volume to volume (v/v) basis to produce a micro-emulsion starting at 10 parts water: 1 part 3DMe. Although micro-emulsions can be easily produced using greater water volumes than 10 parts, e.g. 20 to 50 parts water to 1 part 3DMe, the initial micro-emulsion should never be produced below a ratio of less than 10 parts water: 1 part 3DMe v/v. **WARNING: Do not attempt to produce a micro-emulsion at less than 10 parts water to 1 part 3DMe ratio v/v. This will produce an undesirable and unstable solution.**

The field production of 3DMe micro-emulsion is a very simple procedure; however, it is critical that the user follow the mixing directions outlined below. Never attempt to add water to the 3DMe as this will produce an undesirable and unstable large emulsion. Always add the 3DMe to a large volume of water.

As indicated previously the 10:1 ratio of water to 3DMe v/v is the minimum water ratio that can be used, a greater ratio (more dilute solution) can easily be achieved and is governed by: A) the volume of 3DMe required to treat the estimated contaminant mass, B) the pore volume in which the material is applied, C) the time available for installation (gallons/pump rate), and C) the estimated volume of 3DMe micro-emulsion that the target zone will accept over the time period allocated for installation.

Conceptually, although a higher volume of water to volume of 3DMe will produce a larger volume of the suspension, it will lower the concentration of 3DMe per gallon of solution. Thus, the benefit of using a high water/3DMe v/v ratio in order to affect a greater pore volume of the subsurface aquifer is offset by the dilution of the 3DMe per unit volume of suspension as well as by the limitations of the subsurface hydraulic conductivity and effective porosity (capacity of the aquifer to accept the volume of 3DMe micro-emulsion).

It is important that the user plan in advance the v/v 3DMe/water ratio to be employed at a project site. The resulting volume of solution will dictate the site water requirements and the time required for injection, etc. If upon injection of greater than 10:1 3DMe micro-emulsion, the subsurface does not readily accept the volume of solution as designed, the user can adjust downward the v/v water to 3DMe ratio until a more concentrated suspension is produced (this solution should never drop below the required 10 parts water:1 part 3DMe v/v production ratio). For more information on designing a 3DMe/water ratios to meet specific site conditions, please contact Regenesis Technical Services.

Direct Push Application Requirements

One of the best methods to deliver the 3DMe micro-emulsion into the subsurface is to pressure inject the solution through direct-push rods using hydraulic equipment, or to pressure inject/gravity feed the micro-emulsion into the dedicated injection wells. The use of low cost push points or temporary injection points allows the applier to more cost effectively distribute the 3DMe material across shallow sites by employing multiple points per site. In the case of treating deep aquifer sites, the use of the micro-emulsion applied via dedicated injection wells is likely to be the most cost effective remediation approach. Please note that this set of instructions is specific to direct-push equipment. Please contact Regenesis Technical Services to assist you with dedicated injection well applications.

In general, Regenesis strongly recommends application of the 3DMe micro-emulsion using an injection pump with a minimum delivery rate of three gallons per minute (gpm) and a pressure rating of between 150 to 200 pounds per square inch (psi). **Note: the <u>injection pump requirements are different than the requirements of the mixing pump</u> (see Mixing to Generate 3DMe Micro-emulsion).** High pressure, positive displacement pumps and progressive cavity pumps are appropriate for injecting 3DMe. For low permeability lithologies (clay, silt) higher pressure pumps (800-1600 psi) may be necessary, while for more permeable lithologies (gravel, sand) a lower pressure pump may be adequate. Examples of appropriate pumps are: Rupe Models 6-2200, 9-1500 and 9-1600 (positive displacement), Geoprobe® GS-2000 (positive displacement) and DP-800 (progressive cavity), Yamada (air diaphragm), Moyno (progressive cavity), and Wilden (air diaphragm). Delivery rate is a critical factor in managing installation time and costs. Generally, higher delivery rates (>6 gpm) are more cost effective for these types of applications but pump selection should be on a site specific basis and account for the volume of 3DMe solution and specific aquifer conditions present at the site.

The installation of the 3DMe micro-emulsion should span the entire vertical contaminated saturated thickness. If the vertical extent of the application is confined to a limited interval, then the micro-emulsion should be placed across a vertical zone extending a minimum of one-foot above and one-foot below the screened interval of monitoring wells that are being used to evaluate the performance of the project.

Producing the 3DMe Micro-Emulsion

The application of 3DMe requires the creation of a micro-emulsion. Technically the optimal suspension is an 3DMe-in-water suspension containing micro-emulsions. Before beginning the mixing procedure the user should have in mind the desired water to 3DMe ratio v/v desired.

It is critical that the micro-emulsion be produced using a high-shear apparatus such as a high speed centrifugal pump. The shearing provided by the vanes in these types of pumps is sufficient to form and maintain a homogeneous milky emulsion. **<u>This pump will be a different pump than that used to inject the 3DMe micro-emulsion into the subsurface</u>.** If the user is uncertain as to requirements for the pump or the applicability of a certain pump, please contact Regenesis Technical Services. Regenesis typically suggests using a water trailer/pump apparatus commonly found at equipment rental facilities. Regenesis recommends using a Magnum Products LLC model MWT500 or equivalent water trailer (fitted with centrifugal recirculation pump). This "trash pump" or transfer pump is an ideal high shear pump and the water tank (400 gallons) serves as an excellent mixing tank.

<u>To ensure that proper micro-emulsion suspension is generated Regenesis suggests a two-step process that simply requires mixing at least 10 parts water to 1 part 3DMe concentrate using water at a temperature ≥ 60°F.</u>

Step 1) Regenesis recommends that the 3DMe concentrate in each bucket be re-homogenized using a drill equipped with a paint or "jiffy" mixer attachment as minor settling may have occurred during shipment.

Step 2) to calculate the volume of water necessary to produce a 10:1 v/v micro-emulsion, each bucket of 3DMe concentrate containing 3.7 gallons of material should be mixed with 37 gallons of water.

Example: 6 buckets x 3.7 gallons 3DMe concentrate/bucket yields a total of 22.2 gallons of 3DMe concentrate. Thus, a 10:1 v/v solution will require 222 gallons of water (22.2 gallons 3DMe concentrate x 10 gallons water yields 222 gallons of water). A nominal total volume micro-emulsion would result from the summation of the 3DMe concentrate volume (22.2 gallons) and the water volume (222 gallons). This yields a total fluids delivery volume of approximately 244 gallons.

The previously calculated water volume (222 gallons) should be transferred into an appropriately sized mixing tank. The water should be circulated by the high shear centrifugal pump and each of the six 3DMe buckets slowly poured into the tank. Each bucket of 3DMe concentrate should be poured at a slow rate (approx. 1 minute per bucket) and the contents of the tank continually recirculated using the high hear centrifugal pump. A period of 1-2 minutes should be allowed between addition of each subsequent bucket of 3DMe concentrate to allow the centrifugal pump to continue to shear and mix the water/3DMe concentrate. Upon addition of the entire volume of 3DMe concentrate the pump should remain on to allow the solution mixture to recirulate. The recirculation of the 3DMe micro-emulsion should continue until the material is injected to maintain micro-emulsion consistency.

Application of Micro-Emulsion Using Direct-Push Methods

1) Prior to the installation of the micro-emulsion, any surface or overhead impediments should be identified as well as the location of all underground structures. Underground structures include but are not limited to: utility lines, tanks, distribution piping, sewers, drains, and landscape irrigation systems.

2) The planned installation locations should be adjusted to account for all impediments and obstacles.

3) Pre-mark the installation locations, noting any points that may have different vertical application requirements or total depth.

4) Set up the direct-push unit over each specific point and follow the manufacturer's standard operating procedures (SOP). Care should be taken to assure that probe holes remain vertical.

5) For most applications, Regenesis suggests using drive rods with an O.D. of at least 1.25-inches and an I.D. of at least 0.625-inches I.D (Geoprobe or equivalent). However, the lithologic conditions at some sites may warrant the use of larger 2.125-inch O.D./1.5-inch I.D. drive rods.

6) The most typical type of sub-assembly currently being used is designed for 1.25-inch direct-push rods and is manufactured by Geoprobe. Other brands of drive rods can also be used but require the fabrication of a sub-assembly that allows for a connection between the pump and drive rod.

7) For mixing large volumes of the micro-emulsion, Regenesis recommends using a Magnum Products LLC model MWT500 water trailer (fitted with centrifugal recirculation pump) or equivalent unit. However, single large volume poly tanks are adequate. We suggest filling the tank with an appropriate quantity (e.g. from the example above 222 gallons) of water before start of mixing operations. The tank should be configured so that both a hose and a fire hydrant or larger water tank can be connected to it simultaneously and filled with water quickly and easily. This will dramatically reduce the time needed to fill the tank with mixing water.

8) Regenesis highly recommends preparing the micro-emulsion before pushing any drive rods into the subsurface. NOTE: it is best if the micro-emulsion is produced a single day application volumes.

9) After the micro-emulsion mixing/shearing step has been completed as described above, the micro-emulsion is ready to be applied. Check to see if a hose has already been attached to the inlet side of the centrifugal pump. If this has not been done, do so now.

10) If a non-water trailer tank is being used for mixing the micro-emulsion a stand alone centrifugal pump and hose system should be used for the shearing and mixing operations.

11) Advance drive rods through the ground surface, as necessary, following SOP.

12) Push the drive rod assembly with an expendable tip to the desired maximum depth. Regenesis suggests pre-counting the number of drive rods needed to reach depth prior to starting injection activities to avoid any miscalculations.

13) After the drive rods have been pushed to the desired depth, the rod assembly should be withdrawn three to six inches. The expendable tip can be dropped from the drive rods, following SOP.

14) If an injection tool is used instead of a direct-push rod with an expendable tip, the application of material can take place without any preliminary withdrawal of the rods.

15) In some cases, introduction of a large column of air may be problematic. This is particularly the case in deep injections (>50 ft) with large diameter rods (>1.5-inch O.D.). To prevent the injection of air into the aquifer during the application, fill the drive rods with 3DMe emulsion after they have been pushed to the desired depth and before the disposable tip has been dropped or before the injection tip is operational.

16) Transfer the appropriate quantity of the micro-emulsion from the water trailer to the working/application pump hopper or associated holding tank.

17) A volume check should be performed prior to the injection of the micro-emulsion. Determining the volume discharged per unit time/stroke using a graduated bucket and stopwatch or stroke counter.

18) Start the pump and use the graduated bucket to determine how many gallons of micro-emulsion are delivered each minute or stroke per unit volume.

19) Connect the 1.25-inch O.D., 1-inch I.D. delivery hose to the pump outlet and the appropriate sub-assembly. Circulate the micro-emulsion through the hose and the sub-assembly to displace any air present in the system.

20) Connect the sub-assembly to the drive rod. After confirming that all of the connections are secure, pump the micro-emulsion through the delivery system to displace any water or other fluids in the rods.

21) The pump engine RPM and hydraulic settings should remain constant throughout the day to maintain a constant discharge rate.

22) The material is now ready to be installed in the subsurface. Use the pumps discharge rate as calculated in step 18 to determine the withdrawal rate of the drive rods needed for the application.

23) Slowly withdraw the drive rods using Geoprobe Rod Grip or Pull Plate Assembly (Part AT1222-For 1.25-inch drive rods). While slowly withdrawing single lengths of drive rod (three or four feet), pump the pre-determined volume of micro-emulsion into the aquifer across the desired treatment interval.

24) Remove one or two sections of the drive rod at a time. The drive rod may contain some residual material so Regenesis suggests placing it in a clean, empty bucket and allowing the material to drain. Eventually, the material recovered in the bucket should be returned to the pump hopper for reuse.

25) Observe any indications of aquifer refusal such as “surfacing” around the injection rods or previously installed injection points. If aquifer acceptance appears to be low, allow enough time for the aquifer to equilibrate prior to removing the drive rod.

26) Repeat steps 19 through 25 until treatment of the entire contaminated vertical zone has been achieved.

27) Install an appropriate seal, such as bentonite, above the micro-emulsion injection zone. The seal should span across the entire vadose zone. Depending on soil conditions and local regulations, a bentonite seal using chips or pellets can be used. If the injection hole remains open more than three or four feet below the ground surface sand can be used to fill the hole and provide a base for the bentonite seal. The installation of an appropriate seal assures that

the micro-emulsion remains properly placed and prevents contaminant migration from the surface. If the micro-emulsion continues to "surface" up the direct-push borehole, an oversized disposable drive tip or wood plug/stake can be used to temporarily plug the hole until the aquifer equilibrates and the material stops surfacing.

28) Remove and clean the drive rods as necessary.

29) Finish the borehole at the surface as appropriate (concrete or asphalt cap, if necessary).

30) Periodically compare the pre- and post-injection discharge rates of the micro-emulsion in the pump hopper or holding tank using any pre-marked volume levels. If volume level indicators are not on the pumps hopper or holding tank use a pre-marked dipstick or alternatively temporary mark the hopper or holding tank with known quantities/volumes of water using a carpenter's grease pencil (Kiel crayon).

31) Move to the next probe point, repeating steps 11 through 29.

Helpful Hints

1) *Application in Cold Weather Settings*

As discussed in the Material Overview, Handling, and Safety section, cold weather tends to increase the viscosity of 3DMe as well as decrease the ease of micro-emulsion formation. To optimize an application in cold weather settings Regenesis recommends maintaining the 3DMe concentrate and the associated water at a temperature ≥60^{o}F (16^{o}C). The following procedures can be used to facilitate the production and installation of a 10:1 v/v 3DMe micro-emulsion.

- Raise and maintain the temperature of the HRC-A to at least 60°F (16°C) prior to mixing with water. A hot water bath can be used to heat up the 3DMe concentrate buckets. A Rubbermaid fiberglass Farm Trough Stock Tank (Model 4242-00-GRAY) has been used for this process. This trough can hold up to 16 buckets of 3DMe concentrate.
- Hot water (approximately 130-170°F or 54-77°C) should be added to the tank after the buckets of 3DMe have been placed inside. The hot water should be delivered from a heated pressure washer (Hotsy® Model No. 444 or equivalent) or steam cleaner unit.
- It is equally critical that a moderate water temperature (>60°F or 16^{o}C) be used in the production of the micro-emulsion. If on-site water supply is below 60^{o}F use a hot water or steam cleaner to generate a small volume (e.g. 5-10% of total water volume) of hot water (130–170^{o}F/54-77^{o}C). This small volume of hot water should be added to remaining cold water volume to raise the total volume temperature to >60^{o}F. When the 3DMe concentrate and water each reach a minimum temperature of 60°F or 16°C the two materials are ready for mixing.

- Upon achieving a minimum temperature of 60°F or 16°C (approximately 10-20 minutes). When the 3DMe and the associated water volumes have reached a minimum temperature of 60°F or 16°C (approximately 10-20 minutes) they are ready for mixing.

- In exceptionally harsh winter temperature settings use of a separate insulated pump containment structure and insulated delivery hoses may be necessary.

- Use a pump with a heater unit.
- Periodically check the temperature of the material in the hopper.
- Re-circulate the 3DMe micro-emulsion through the pump and hose to maintain temperature adequate temperatures.
- Care should be taken to avoid the re-circulation of material volumes that exceed the volume of the pump hopper or holding tank.

Table 1: Equipment Volume and 3DMe Micro-Emulsion Weight per Unit Length of Hose (Feet)

Equipment	Volume	Product Weight
1-inch OD; 0.625-inch ID hose (10 feet)	0.2 gallon	1.6 lbs.
1.25-inch OD; 0.625-inch ID drive rod (3 feet):	0.05 gallon	0.4 lbs.
1.25-inch OD; 0.625-inch ID drive rod (4 feet):	0.06 gallon	0.5 lbs.

2) *Pump Cleaning*

For best results, use a heated pressure washer to clean equipment and rods periodically throughout the day. Internal pump mechanisms and hoses can be easily cleaned by re-circulating a solution of hot water and a biodegradable cleaner such as Simple Green through the pump and delivery hose. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier’s standard procedures and local regulatory requirements.

NOTE:

Before using the Rupe Pump, check the following:

- Fuel level prior to engaging in pumping activities (it would be best to start with a full tank)
- Remote control/pump stroke counter LCD display [if no display is present, the electronic counter will need to be replaced (Grainger Stock No. 2A540)]

Monitor pump strokes by observing the proximity switches (these are located on the top of the piston).

3) *Bedrock Applications*

When contaminants are present in competent bedrock aquifers, the use of direct-push technology as a delivery method is not possible. *Regenesis is in the process of developing methods for applying 3DMe via boreholes drilled using conventional rotary techniques.* To develop the best installation strategy for a particular bedrock site, it is critical that our customers call the Technical Services department at Regenesis early in the design process.

The micro-emulsion can be applied into a bedrock aquifer in cased and uncased boreholes. The micro-emulsion can be delivered by simply filling the borehole without pressure or by using a single or straddle packer system to inject the material under pressure. Selection of the appropriate delivery method is predicated on site-specific conditions. The following issues should be considered in developing a delivery strategy:

- Is the aquifer's hydraulic conductivity controlled by fractures?
- Backfilling may be the better delivery method in massive, unfractured bedrock. This is particularly true in an aquifer setting with high permeability and little fracturing (such as that found in massive sandstone).
- Down-hole packer systems may be more advantageous in fractured bedrock aquifers.
    - In this case the fracture type, trends, and interconnections should be evaluated and identified.
- Are the injection wells and monitoring wells connected by the same fractures?
- Determine if it is likely that the injection zone is connected to the proposed monitoring points.
- If pressure injection via straddle packers is desired, consideration should be given to the well construction. Specific issues to be considered are:
    - Diameter of the uncased borehole (*will casing diameter allow a packer system to be used under high pressures*?).
    - Diameter of the casing (*same as above*).
    - Strength of the casing (*can it withstand the delivery pressures?*).
    - Length of screened interval (*screened intervals greater than 10 feet will require a straddle packer system*).

For further assistance or questions please contact Regenesis Technical Services at 949-366-8000.

3-D MicroEmulsion™
HRC ADVANCED®

Appendix E – Material Safety Data Sheets

3-D Microemulsion (3DMe)™

MATERIALS SAFETY DATA SHEET

Last Revised: March 26, 2007

Section 1 – Material Identification

Supplier:

REGENESIS

1011 Calle Sombra
San Clemente, CA 92673

Phone:	**949.366.8000**
Fax:	**949.366.8090**
E-mail:	**info@regenesis.com**

Chemical Name(s):	• Glycerides, di-, mono [2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxyl]-1-oxopropoxy]propanoates] • Propanoic acid, 2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxy]-1-oxopropoxy]-1,2,3-propanetriyl ester • Glycerol
Chemical Family:	**Organic Chemical**
Trade Name:	**3-D Microemulsion (3DMe)™**
Synonyms:	**HRC Advanced™ HRC-PED (Hydrogen Release Compound – Partitioning Electron Donor)**
Product Use:	**Used to remediate contaminated groundwater (environmental applications)**

Section 2 – Chemical Identification

<u>CAS#</u>	**<u>Chemical</u>**
823190-10-9	**HRC-PED**
61790-12-3 or **112-80-1**	**Fatty Acids (neutralized)**
201167-72-8	**Glycerol Tripolylactate**
56-81-5	**Glycerol**

Section 3 – Physical Data

Melting Point:	**Not Available (NA)**
Boiling Point:	**Not determined (ND)**
Flash Point:	**> 200 ºF using the Closed Cup method**
Density:	**0.9 -1.1 g/cc**
Solubility:	**Slightly soluble in acetone. Insoluble in water.**
Appearance:	**Amber semi-solid.**
Odor:	**Not detectable**
Vapor Pressure:	**None**

Section 4 – Fire and Explosion Hazard Data

Extinguishing Media:	**Use water spray, carbon dioxide, dry chemical powder or appropriate foam to extinguish fires.**

Water May be used to keep exposed containers cool.

For large quantities involved in a fire, one should wear full protective clothing and a NIOSH approved self contained breathing apparatus with full face piece operated in the pressure demand or positive pressure mode as for a situation where lack of oxygen and excess heat are present.

Section 5 – Toxicological Information

Acute Effects:	**May be harmful by inhalation, ingestion, or skin absorption. May cause irritation. To the best of our knowledge, the chemical, physical, and toxicological properties of the 3-D Microemulsion have not been investigated. Listed below are the toxicological information for glycerol, lactic acid and fatty acid.**	
RTECS#	**MA8050000** **Glycerol**	
Irritation Data:	**SKN-RBT 500 MG/24H MLD** **EYE-RBT 126 MG MLD** **EYE-RBT 500 MG/24H MLD**	**85JCAE-,207,1986** **BIOFX* 9-4/1970** **85JCAE-,207,1986**

Section 5 – Toxicological Information (cont)

Toxicity Data:	**ORL-MUS LD50:4090 MG/KG**	**FRZKAP (6),56,1977**
	SCU-RBT LD50:100 MG/KG	**NIIRDN 6,215,1982**
	ORL-RAT LD50:12,600 MG/KG	**FEPRA7 4,142,1945**
	IHL-RAT LC50: >570 MG/M3/1H	**BIOFX* 9-4/1970**
	IPR-RAT LD50: 4,420 MG/KG	**RCOCB8 56,125,1987**
	IVN-RAT LD50:5,566 MG/KG	**ARZNAD 26,1581,1976**
	IPR-MUS LD50: 8,700 MG/KG	**ARZNAD 26,1579,1978**
	SCU-MUS LD50:91 MG/KG	**NIIRDN 6,215,1982**
	IVN-MUS LD50:4,250 MG/KG	**JAPMA8 39,583,1950**
	ORL-RBT LD50: 27 MG/KG	**DMDJAP 31,276,1959**
	SKN-RBT LD50: >10 MG/KG	**BIOFX* 9-4/1970**
	IVN-RBT LD50: 53 MG/KG	**NIIRDN 6,215,1982**
	ORL-GPG LD50: 7,750 MG/KG	**JIHTAB 23,259,1941**

Target Organ Data: **Behavioral (headache), gastrointestinal (nausea or vomiting), Paternal effects (spermatogenesis, testes, epididymis, sperm duct), effects of fertility (male fertility index, post-implantation mortality).**

Only selected registry of toxic effects of chemical substances (RTECS) data is presented here. See actual entry in RTECS for complete information on lactic acid and glycerol.

Fatty Acids

Acute oral (rat) LD50 value for fatty acids is 10000 mg/kg. Aspiration of liquid may cause pneumonitis. Repeated dermal contact may cause skin sensitization.

Section 6 – Health Hazard Data

One should anticipate the potential for eye irritation and skin irritation with large scale exposure or in sensitive individuals. Product is not considered to be combustible. However, after prolonged contact with highly porous materials in the presence of excess heat, this product may spontaneously combust.

Handling: **Avoid continued contact with skin. Avoid contact with eyes.**

In any case of any exposure which elicits a response, a physician should be consulted immediately.

First Aid Procedures

Inhalation: **Remove to fresh air. If not breathing give artificial respiration. In case of labored breathing give oxygen. Call a physician.**

Ingestion: **No effects expected. Do not give anything to an unconscious person. Call a**

	physician immediately. DO NOT induce vomiting.

Section 6 – Health Hazard Data (cont)

Skin Contact:	Flush with plenty of water. Contaminated clothing may be washed or dry cleaned normally.
Eye Contact:	Wash eyes with plenty of water for at least 15 minutes lifting both upper and lower lids. Call a physician.

Section 7 – Reactivity Data

Conditions to Avoid:	Strong oxidizing agents, bases and acids
Hazardous Polymerization:	Will not occur.
Further Information:	Hydrolyses in water to form lactic acid, glycerol and fatty acids.
Hazardous Decomposition Products:	Thermal decomposition or combustion may produce carbon monoxide and/or carbon dioxide.

Section 8 – Spill, Leak or Accident Procedures

After Spillage or Leakage:	Neutralization is not required. The material is very slippery. Spills should be covered with an inert absorbent and then be placed in a container. Wash area thoroughly with water. Repeat these steps if slipperiness remains.
Disposal:	Laws and regulations for disposal vary widely by locality. Observe all applicable regulations and laws. This material may be disposed of in solid waste. Material is readily degradable and hydrolyses in several hours.

No requirement for a reportable quantity (CERCLA) of a spill is known.

Section 9 – Special Protection or Handling

Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass containers.

Protective Gloves:	Vinyl or Rubber
Eyes:	Splash Goggles or Full Face Shield. Area should have approved means of washing eyes.
Ventilation:	General exhaust.
Storage:	Store in cool, dry, ventilated area. Protect from incompatible materials.

Section 10 – Other Information

This material will degrade in the environment by hydrolysis to lactic acid, glycerol and fatty acids. Materials containing reactive chemicals should be used only by personnel with appropriate chemical training.

The information contained in this document is the best available to the supplier as of the time of writing. Some possible hazards have been determined by analogy to similar classes of material. No separate tests have been performed on the toxicity of this material. The items in this document are subject to change and clarification as more information becomes available.