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ENVIRONMENTAL
ENGINEERS & SCIENTISTS

Final

~~Draft~~ Work Plan

Field Trial of the EnviroMetal Process General Instrument Corporation Sherburne, NY

January 1995

DRAFT WORK PLAN FOR FIELD TRIAL OF THE ENVIROMETAL PROCESS

Prepared for

GENERAL INSTRUMENT CORPORATION

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CHAPTER 1

INTRODUCTION

1.1 PROJECT DESCRIPTION

This document is a work plan for conducting a pilot-scale field trial of the EnviroMetal Process as part of a permeable reaction wall/funnel-and-gate system for remediation of a dissolved plume of chlorinated organics which has been transported with the groundwater from the former General Instrument Corporation (GIC) site in Sherburne, NY to the area known as the West Field. Included in the field trial will be construction of the pilot scale in-situ treatment system, followed by six months of monitoring. Accompanying this monitoring will be groundwater modeling activities which will allow evaluation of this process with the focus on determining the application of such a system for full-scale remediation of the contaminant plume at the site.

1.2 PURPOSE OF WORK PLAN

The purpose of this work plan is to document the hydrogeologic and engineering basis for the design of the treatment system, to describe in detail the materials used and methods to construct the system, and to present the subsequent field monitoring program which will be undertaken to both evaluate the ability of the EnviroMetal Process/funnel-and-gate system to degrade the chlorinated organics in the plume and provide sufficient data such that a full-scale system could be designed for the site. Using the results from this study, a cost analysis will be performed to allow comparison with more conventional groundwater treatment methods.

1.3 ACCOMPANYING DOCUMENTS

Accompanying this work plan as appendices are the following:

- Specifications for materials used to construct the treatment system (Appendix A).
- Specifications for installation of Waterloo barrier containment system (Appendix A).
- Construction plans (Appendix A).

- Rationale for Suggested Design and Monitoring Program, prepared by EnviroMetal Technologies, Inc. (Appendix B).

- Site-specific draft Quality Assurance Project Plan (QAPP), prepared by PRC Environmental Management, Inc. for the project's inclusion as part of the USEPA SITE Program (Appendix C).

- Site-specific Health and Safety Plan (Appendix D).

CHAPTER 2

SITE BACKGROUND INFORMATION

2.1 SITE DESCRIPTION

General Instrument Corporation (GIC) owned and operated a manufacturing and plating facility on TACO Street in Sherburne, NY from 1968 until 1983. The facility was operated by others from 1947 until 1968. Site-related environmental impacts were discovered during the plant closure, which led to the site's being listed as a Class 2 site on the *New York State Registry of Inactive Hazardous Waste Sites.* A Remedial Investigation/Feasibility Study (RI/FS) has been completed for the site. During the investigation, a plume of dissolved chlorinated solvents was found to originate on the former GIC site and has been transported by natural processes to adjacent property, known as the West Field. The following subsections describe the impacted properties and the extent of the contamination which has been found associated with this dissolved groundwater plume.

A. **Former TACO Property.** The former TACO facility was used to plate antennas and manufacture electronics parts. The 5.5-acre site borders agricultural fields on the west, residential and light commercial property on the east and south, and a petroleum bulk storage facility (bulk plant) on the north. Access to the site is from the east (Route 12) via what is now Kenyon Press Road, formerly TACO Street. Figure 2-1 illustrates the location of the site in the Village of Sherburne. Figure 2-2 illustrates the orientation of the buildings at the site.

The facility consists of a 75,000 square foot main building, previously used for manufacturing, warehousing, and administration; a 4,900 square foot plating building, formerly used for applying metal plating material and for degreasing; a 1,600 square foot garage used as a maintenance shop; and a 2,800 square foot wooden shed used to store machinery and material. The area directly east of the plating building is a parking lot and, as such, is paved.

B. **West Field.** Adjacent to the western side of the former GIC site is agricultural property known as the West Field. Separating the former TACO property and the agricultural property are railroad tracks. The West Field is used for growing crops (corn and oats), which are used as feed for dairy cattle. Access to the property is by the farm access roads from East State Street, near the Chenango River. There are no utilities on the property.

The contaminant plume extends into the West Field toward the Chenango River as shown in Figure 2-3. The soil in the field is of the Hamblin type, as classified by the SCS, and the field is moderately well drained.

2.2 SOURCE OF PLUME

During the RI, the soil under and in the vicinity of the former plating building was identified as a source of chlorinated hydrocarbons which resulted from the industrial activity which occurred during the plant operation. Some of the contaminants probably entered the saturated soil through the building's floor drain system, which was used to collect rinse water from the cleaning of aluminum antennas and associated parts. Concentrations of contaminants in soil beyond the perimeter of the building can be attributed to separate spills and releases of chemicals in that area, and also from vapor phase migration. Once contaminants are introduced into the saturated soil, dissolved phase transport in the direction of groundwater flow contributes to the movement of the contaminants with the groundwater, thereby constituting the dissolved groundwater plume.

2.3 CONTAMINANTS OF CONCERN

Four monitoring wells have been installed to date in the West Field to allow for sampling of the dissolved plume. Table 2-1 presents the concentrations of organics determined in samples from these wells in 1993. The contaminants of concern in the plume are the chlorinated organics trichloroethylene (TCE) and both isomeric forms of 1,2-dichloroethylene (1,2-DCE). Vinyl chloride has been detected in samples from Wells MW-17 and MW-19 at much lower concentrations than that found for TCE and 1,2-DCE. 1,1,1-trichloroethane (TCA) was also detected in samples from all four wells, also at much lower concentrations than that found for TCE and 1,2-DCE. Total concentrations of volatile organics (VOCs) ranged from 820 $\mu g/l$ in groundwater from MW-19 to 50 $\mu g/l$ in samples from MW-20.

2.4 AQUIFER CHARACTERISTICS

The surficial geology at the site consists of the modern alluvial sand and gravel associated with the Chenango River and its smaller tributary streams. The alluvium varies in thickness from 5 to 15 feet across the site and is underlain by glacial lake clays.

A conceptual model of subsurface stratigraphy was complied from well logs in the Chenango Valley by McNish and Randall in 1982. The model suggests that two separate overburden aquifers exist in the valley. A quarternary sand and gravel aquifer which is less than 15 feet thick in the shallow subsurface, and a deeper quarternary sand and gravel aquifer which is separated from the shallow aquifer by a layer of impermeable glacial silts and clays which is up to 300 feet thick. Figure 2-4 presents a geologic cross-section across the site. For location of monitoring wells, refer to Figure 2-5.

The water table is approximately 4 feet below the ground surface of the site. Groundwater flow is predominantly easy to west across the site, with a southwesterly component to flow at the north end of the site. Slug tests were conducted on the monitoring wells to approximate the hydraulic conductivity of the upper shallow aquifer. Seepage velocity, V, is the linear rate of groundwater flow in a horizontal direction in the aquifer. It is calculated from the hydraulic conductivity according to the following equation:

$$V = KI/n$$

where:

K = Hydraulic conductivity
I = Gradient
n = Porosity

Seepage velocity was calculated for minimum conditions (25 percent porosity) and maximum conditions (50 percent porosity). Average seepage velocity for minimum conditions was, therefore, calculated to be 42 ft/year and 85 feet/year for maximum conditions.

2.5 LOCATION OF PILOT STUDY

The proposed location of the pilot-scale field test is in the vicinity of MW-19. This location was chosen for the following reasons:

1. Water used for laboratory evaluation of the EnviroMetal process was obtained from this well. Therefore, all data concerning expected reaction half-lives for the contaminants of concern in the Sherburne dissolved plume is related to the concentration ratios found in the groundwater at this location.

2. This location is on the outer limits of the crop areas of the West Field. Presumably, this location should have the least amount of impact on the current farming operations.

2.6 CONTAMINANT ATTENUATION MODELING

The groundwater solute transport model MOC, developed by the USGS, was used to examine the natural attenuation of the plume left untreated downgradient of the in-situ treatment system. The objective of this modeling was to get an estimate of the extent that solvent contamination will be dispersed and degraded over time once the full-scale remediation effort has begun.

The USGS MOC model is a two-dimensional model widely used throughout the environmental industry (e.g., Anderson and Wang, 1992) and is well validated. The shallow aquifer was modeled as a homogeneous aquifer using a plan view model domain of 1,800 feet parallel to groundwater flow by 1,000 feet perpendicular to groundwater flow. The untreated plume was given the rectangular shape illustrated in Figure 2-6. The model assumed a constant hydraulic gradient to the Chenango River, and coefficients of hydrodynamic dispersion on the order of meters, consistent with the length of the flow paths the solutes will travel to the river. The river was considered as a constant head flow boundary. It was also assumed that the groundwater system is at steady state.

Four simulations were undertaken for this exercise, as indicated below:

Simulation	K_d	Bulk Density	Retardation	Half-life
Run 1	0	0	0	0
Run 2	0.13	1.6	2.04	0
Run 3	0.13	1.6	2.04	2 years
Run 4	0.13	1.6	2.04	20 years

To be conservative, no input for dilution due to recharge was included.

The first run was used to determine the worst-case scenario (no retardation, dilution, or degradation). Thus, all attenuation is due to dispersion. The results are that the plume travels as a slug toward the Chenango River, with approximately 20 years required before the slug reaches the river. At that time, advection would reduce the contaminant concentrations to a maximum of about 300 to 400 ppb (see Figure 2-7).

The second simulation included literature-based values for the distribution coefficient, K_d, the bulk density, and resultant retardation factor (R) based on analysis of a TCE plume in an unconfined sand and gravel aquifer in California (Avon and Bredehoeft, 1989). The results of the simulation again showed the plume to move toward the river as a slug; however, the time to reach the river is approximately 30 years. At that time, the peak concentration would reduce to between 200 and 300 ppb (see Figure 2-8).

Simulations 3 and 4 were identical to Simulation 2, with the addition of degradation. A degradation half-life of two years was input into Run 3. This assumption is based on literature reported half-lives ranging from 88 to 339 days (Barbee, 1994) to 95 months (Howard, et.al., 1991). In Run 4, the half-life was increased by an order of magnitude to 20 years. It is likely that by this time the aquifer microbes have become acclimated and actual degradation half-lives would lie somewhere between these two values. Using the short half-life, the maximum contaminant concentration was found to be approximately 50 ppb (see Figure 2-9), and the VOCs would appear to be completely attenuated in 15 years. The slower half-life indicates that the plume would still reach the river. However, migration would take 40 years and the maximum concentrations would be only 50 to 100 ppb (see Figure 2-10).

This modeling was performed only as an exercise to estimate the time frame for natural attenuation of the untreated plume. Because extensive contaminant concentration data is not available from monitoring wells in the West Field, calibration cannot be attempted at this time. However, conservative assumptions were used in an attempt to evaluate the effects of simple processes, such as retardation, dispersion, and degradation on the plume. The results indicate that somewhere between 10 and 30 years are required for the untreated portion of the plume to reach groundwater standards. Because recharge (dilution) also may have a significant impact on the plume concentrations over time, the time frame is considered an upward bound. Likely dilution effects, especially in the spring, will result in attenuation of the maximum concentrations in a shorter time frame being required.

TABLE 2-1

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
(September 1993 Results Only)

Compound		Concentration (µg/l) Monitoring Wells MW-17	MW-19	MW-19D	MW-20	MW-21
Vinyl chloride	1993-1					
	1993-2	7.5	14	23		
1,2-dichloroethene	1993-1					
	1993-2					
1,1-dichloroethane	1993-1				5	12
	1993-2	3	4	4	4	19
1,2-dichloroethene (total)	1993-1	34	278		10	152
	1993-2			1		
Chloroform	1993-1					
	1993-2					
1,1,1-trichloroethane	1993-1	28	13		12	40
	1993-2	27	21	13	10	30
Trichloroethene	1993-1	57	529		23	479
	1993-2	73.2	220	414	28	334
Summary:						
Total volatiles	1993-1	119	820	0	50	683
	1993-2	111	259	456	42	383

Notes: Samples split with NYSDEC prior to analysis. First value is NYSDEC's lab result; second is Stearns & Wheler's lab result.

MW-19D refers to duplicate sample at MW-19, taken for QA/QC purposes.

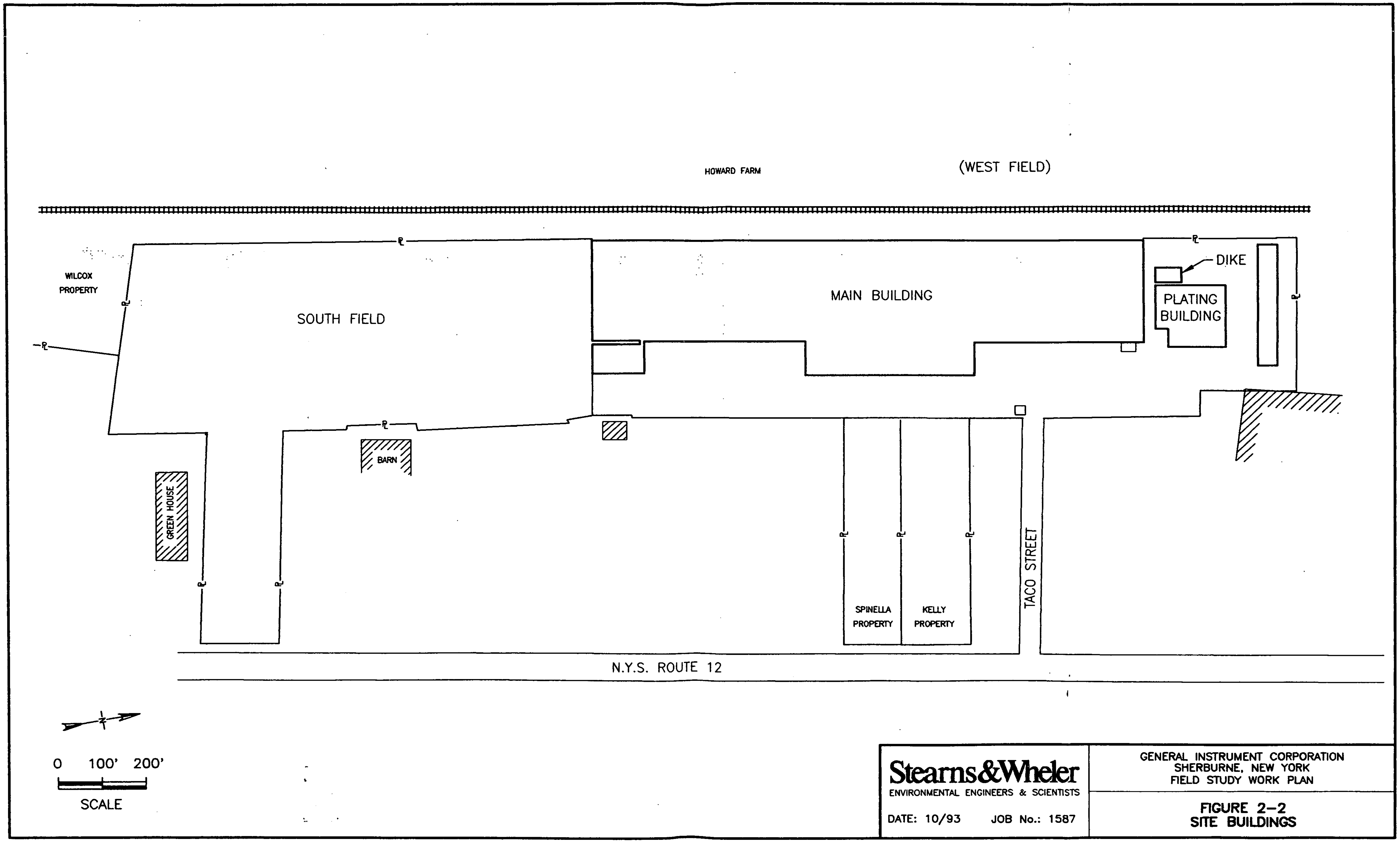
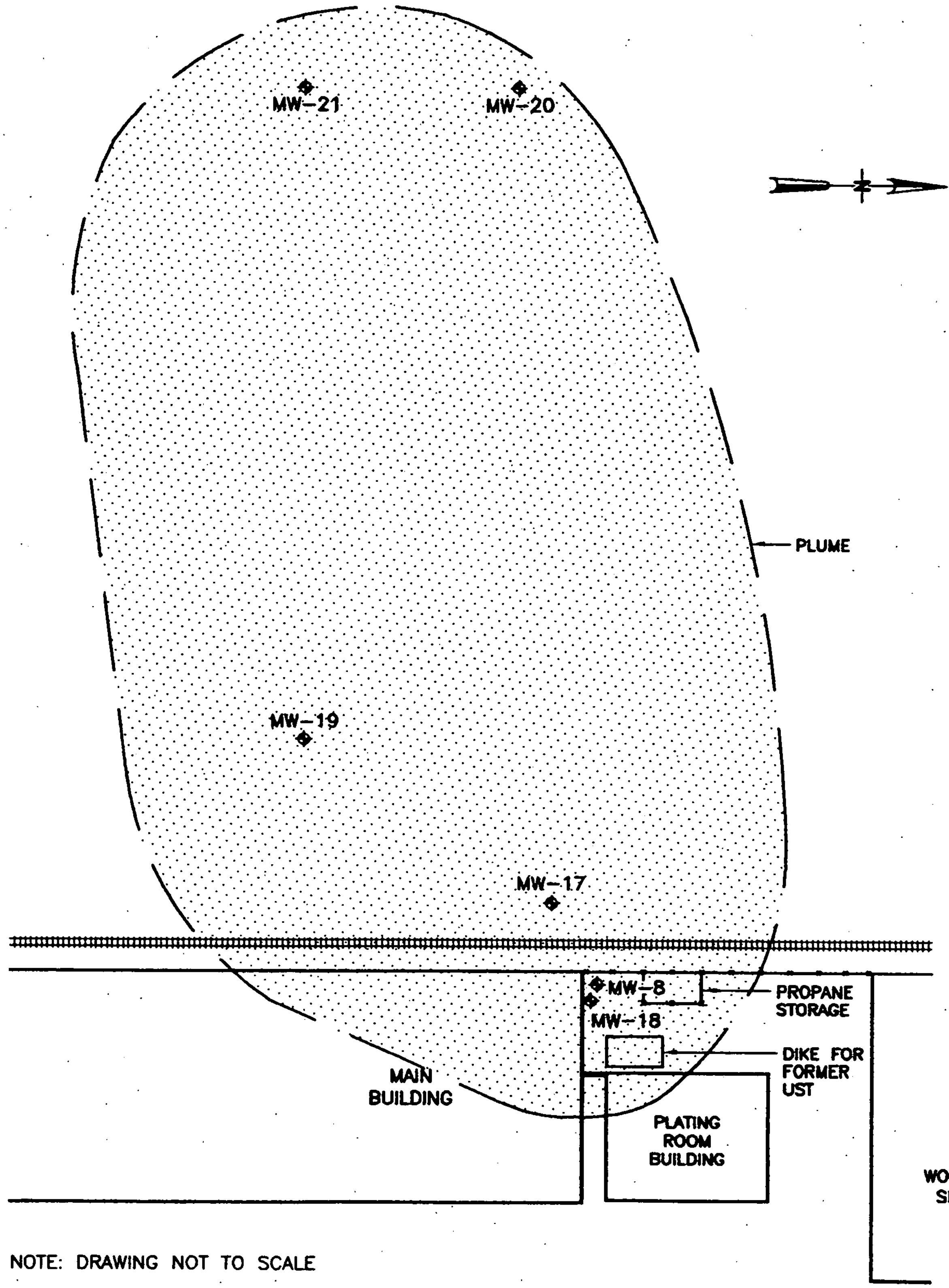


FIGURE 2–2
SITE BUILDINGS



NOTE: DRAWING NOT TO SCALE

Stearns&Wheler ENVIRONMENTAL ENGINEERS & SCIENTISTS	GENERAL INSTRUMENT CORPORATION SHERBURNE. NEW YORK FIELD STUDY WORK PLAN
DATE: 10/94 JOB No.: 1587	FIGURE 2-3 LOCATION OF CONTAMINANT PLUME

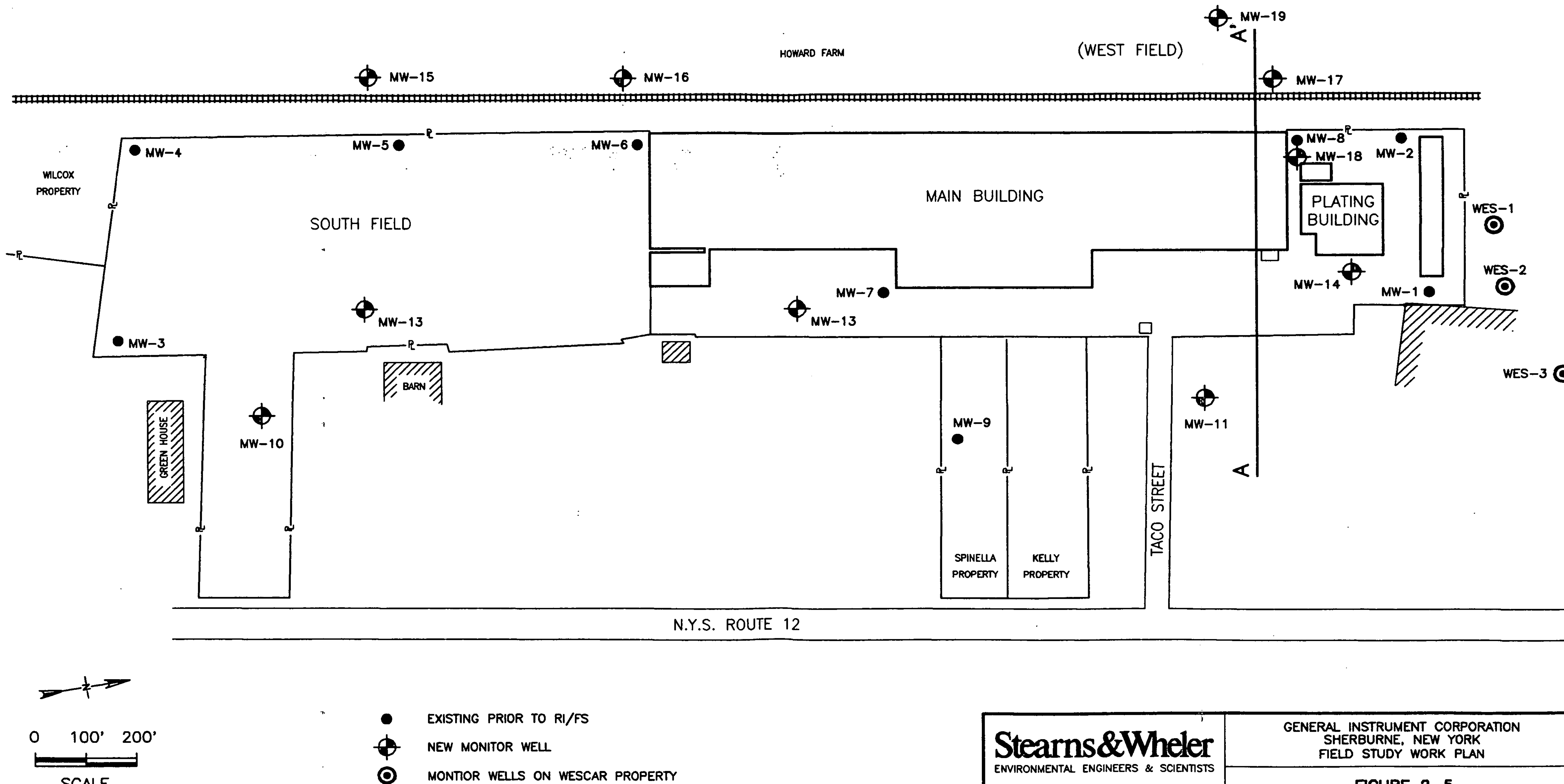


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FIGURE 2-5
LOCATION OF MONITORING WELLS

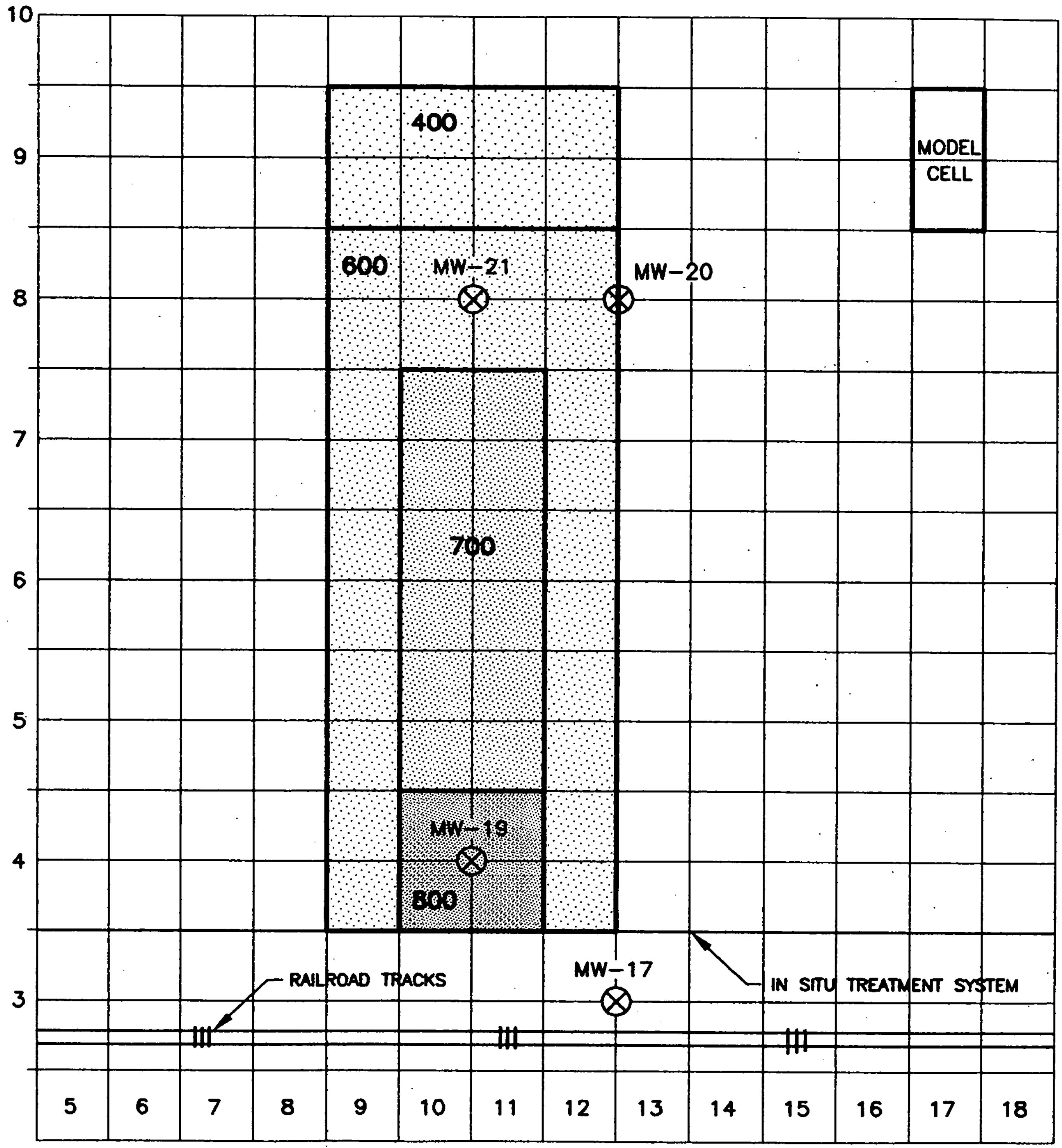

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FIGURE 2-6
PLUME ATTENUATION MODELING:
UNTREATED PLUME

CASE 1:
Kd = 0
Retardation = 0
Half-life = 0

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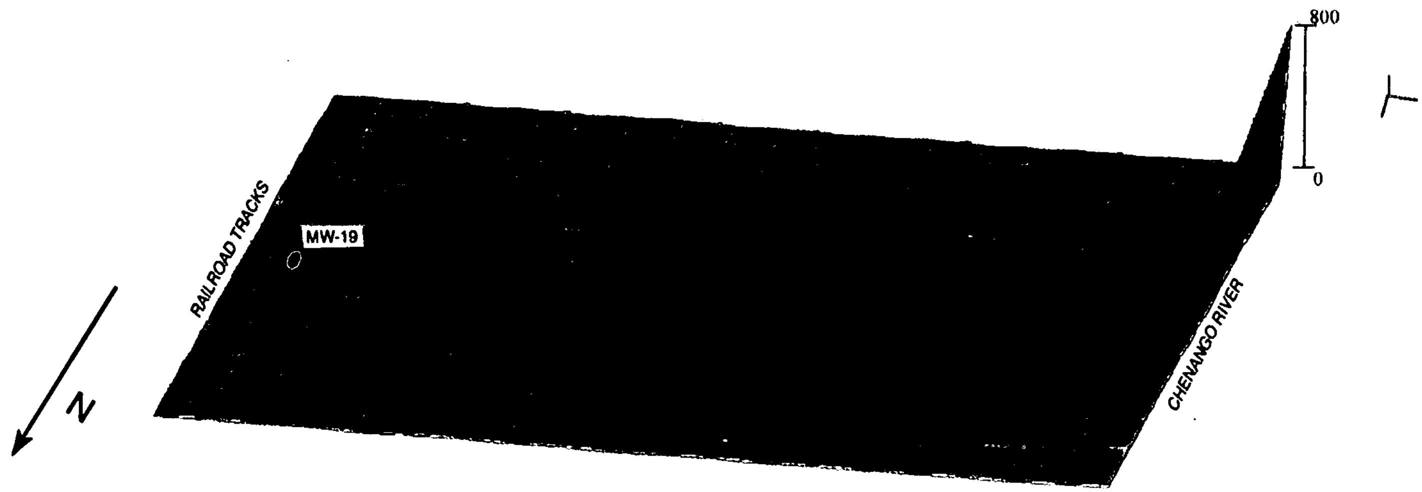
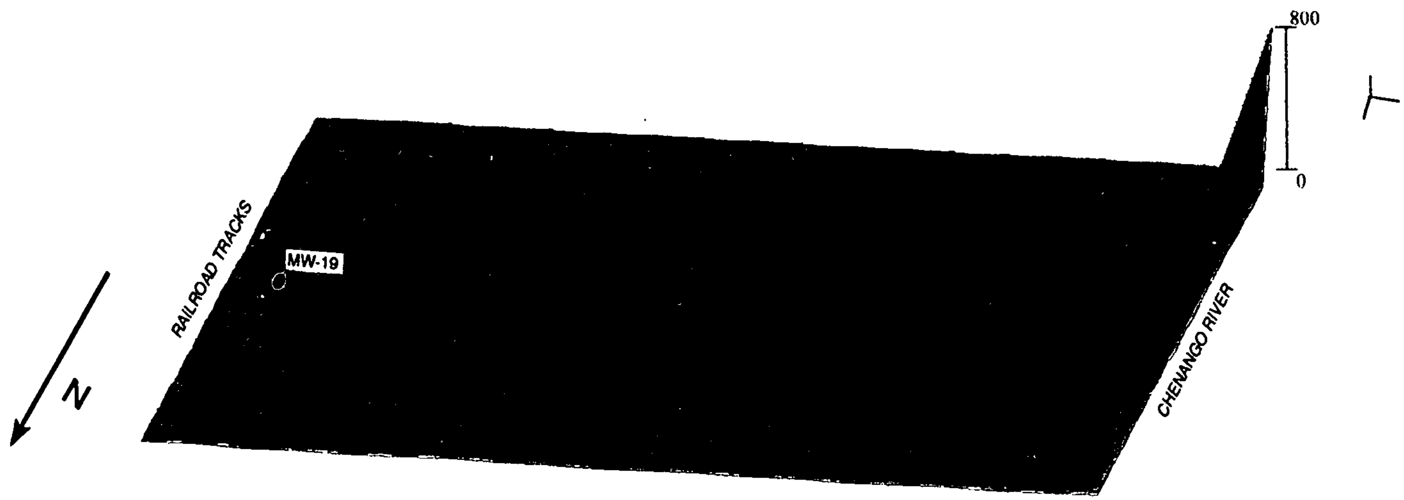
FIGURE 2–7
CASE 1: EXTENT OF PLUME IN 20 YEARS



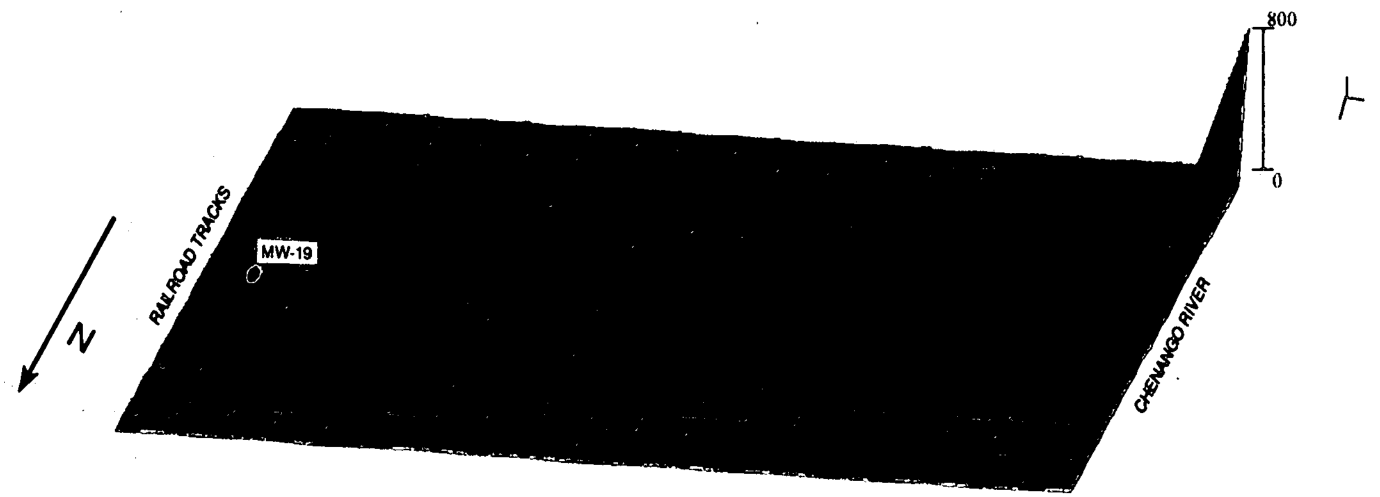
CASE 2:
Kd = 0.13
Retardation = 2.04
Half-life = 0

Stearns&Wheler ENVIRONMENTAL ENGINEERS & SCIENTISTS	GENERAL INSTRUMENT CORPORATION SHERBURNE. NEW YORK FIELD STUDY WORK PLAN
DATE: 10/94 JOB No.: 1587	FIGURE 2-8 CASE 2: EXTENT OF PLUME IN 30 YEARS



CASE 3:
Kd = 0.13
Retardation = 2.04
Half-life = 2 years

Stearns&Wheler ENVIRONMENTAL ENGINEERS & SCIENTISTS	GENERAL INSTRUMENT CORPORATION SHERBURNE, NEW YORK FIELD STUDY WORK PLAN
DATE: 10/94 JOB No.: 1587	FIGURE 2-9 CASE 3: EXTENT OF PLUME IN 15 YEARS



CASE 4:
Kd = 0.13
Retardation = 2.04
Half-life = 20 years

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FIGURE 2-10
CASE 4: EXTENT OF PLUME
IN 40 YEARS

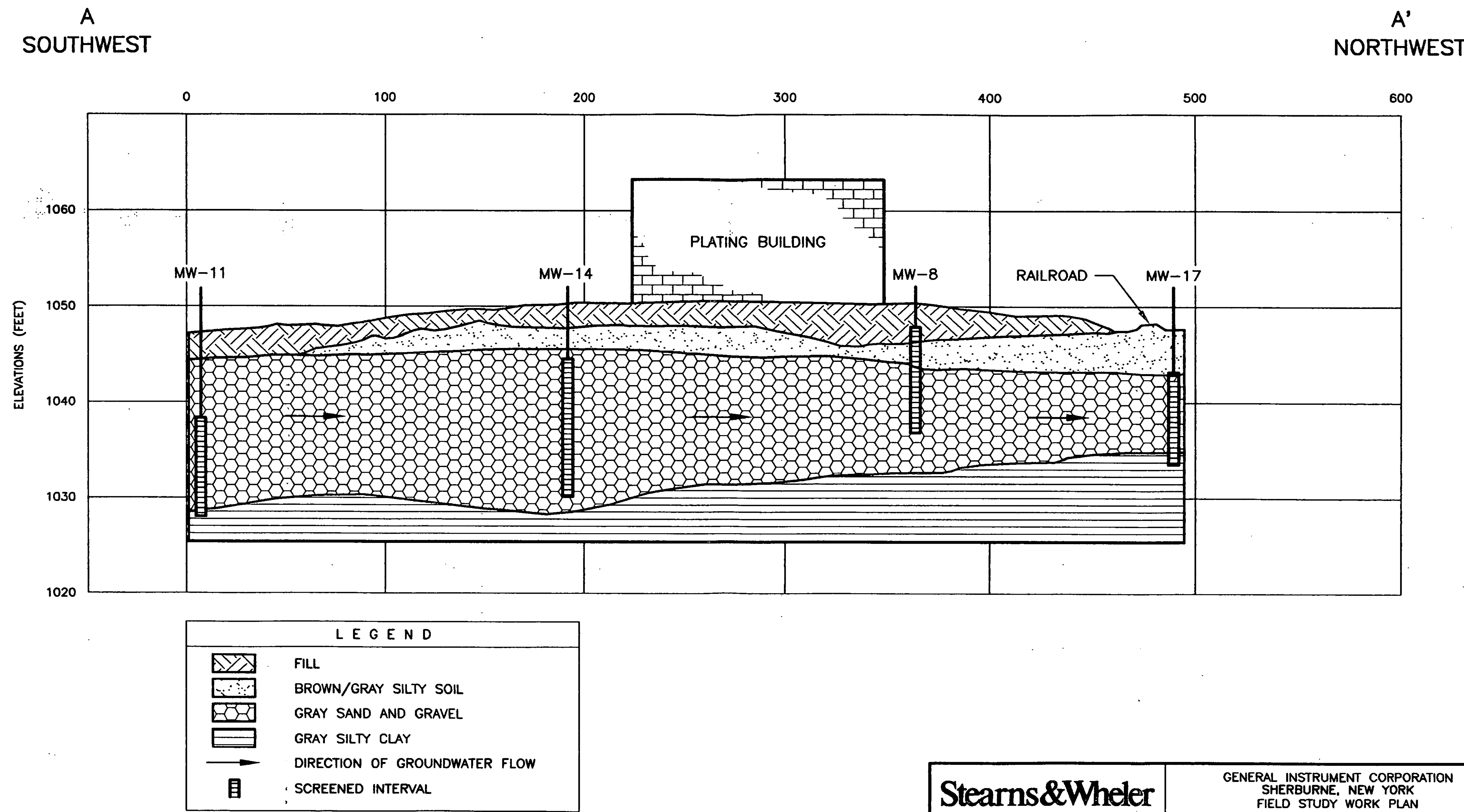

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FIGURE 2-4
CROSS-SECTION A-A'
(SEE FIGURE 2-5 FOR LOCATION)

CHAPTER 3

PROCESS DESCRIPTION

3.1 ENVIROMETAL PROCESS

Developed at the Waterloo Centre for Groundwater Research in Canada, the EnviroMetal Process uses elemental iron to promote the reductive dehalogenation of dissolved halogenated organic compounds in groundwater. The preferred application of the process is as an in-situ permeable reaction wall. The wall consists of a porous medium containing granular iron which degrades the dissolved contaminants as the groundwater flows naturally through the wall. Laboratory (batch and column studies) and field testing has shown that this process has the ability to degrade contaminants faster than the natural rates of abiotic and biotic degradation. Because the compounds are actually degraded, this method of remediation does not result in the transfer of the contaminants from the water to another medium, such as air or activated carbon, which occurs with the more commonly used pump and treat remedial options.

Although the EnviroMetal process rapidly dechlorinates most chlorinated hydrocarbons, it does not appear to degrade dichloromethane (DCM) and 1,2-dichloroethane (1,2-DCA). This should not impact its potential effectiveness at the GIC Sherburne site, as neither of these compounds were found in the groundwater in appreciable amounts. However, it would affect the ability of the process to achieve groundwater standards at a site where these chemicals are the primary contaminants of concern, or are breakdown products resulting from dechlorination of site contaminants.

A. **Reaction Kinetics.** Reduced forms of iron, and potentially other transition metals, have the ability to act as electron donors thereby promoting the reduction of organic compounds (Gillham and O'Hannesin, 1992). However, at the present, the exact mechanism for this electron transfer is not known. Besides providing this necessary electron transfer, the metals also are able to induce the highly reducing conditions required to cause the dehalogenation of many aliphatic compounds. The rate of dechlorination appears to be a first order reaction and is highly sensitive to the ratio of the mass of iron to the solution volume. Although the dehalogenation is somewhat sequential in nature, any intermediate chlorinated compounds are subsequently degraded. Much of the parent compound seems to degrade completely at a rapid rate. Any chlorinated breakdown products which may occur also subsequently degrade.

As stated above, the degradative process is electrochemical in nature, resulting in oxidation of iron and reductive dechlorination of the organic compounds. Sampling programs conducted as part of laboratory evaluations of this process have observed pH increases and the formation of hydrogen, which indicate that hydrolysis of water is taking place during the reaction. Laboratory studies have also been conducted which confirm the process is abiotic in nature. For example, batch tests conducted with iron and the organics in the presence of sodium azide, an effective biocide, have resulted in the same degradation rates as those conducted without the biocide (Gillham and O'Hannesin, 1992; and Gillham, O'Hannesin and Orth, 1993).

B. **Possible Reaction Byproducts.** End products of the dehalogenation reactions are aliphatic hydrocarbons. Studies have indicated methane and ethane to be the primary products of TCE degradation (Orth, 1992). The effects of these end products on groundwater quality are expected to be minimal. For example, a plume concentration of 500 μg/l corresponds to only 3.8×10^{-6} moles of TCE. If a 1:1 ratio of TCE degraded to ethane formed is assumed, this will only result in 114 μg/l of ethane in the groundwater. Neither methane or ethane have a promulgated groundwater standard (MCL) or a drinking water guidance concentration (MCLG). While both ethane and methane are soluble in water, both compounds are readily degraded, with theoretical oxygen demands of 3.73 and 3.99 for ethane and methane, respectively. It is also well documented that the mixed microbial populations present in soil readily degrade both of the hydrocarbons to form cell mass and carbon dioxide. Several species of *Pseudomonas* bacteria are known to use methane as their primary food source, forming methanol, formaldehyde and cell mass. The methanol is subsequently broken down by complimentary bacteria, such as *Flavobacterium* sp., *Acinetobacter* sp., and *Hyphomicrobium* sp. (Bailey and Ollis, 1977; and Chapelle, F.H., 1992). Although this occurs in an aerobic environment, methane is known to be degraded in an anaerobic environment, as well. The mechanism for this anaerobic degradation is not known, but similar biodegradation of higher weight hydrocarbons (including ethane) by mixtures of autotroph is known to occur readily (Chapelle, F.H., 1992).

C. **Reaction Induced Inorganic Changes.** Because the degradation is electrochemical in nature, changes in inorganic parameters occur along with the dehalogenation of the organic compounds (Gillham and O'Hannesin, 1992). The oxidation of iron, which provides the electrons for the reductive dehalogenation, results in the formation of Fe^{+2} ions. At the same time, electrolysis of water occurs, resulting in generation of hydrogen gas and OH^- ions. As the pH of the groundwater increases, bicarbonate ions present in the groundwater are converted to carbonate ions to buffer the increased pH. Carbonate ions, then readily combine with soluble cations present in the groundwater (iron, magnesium, and calcium) to form mineral carbonate precipitates. This potentially can result in plugging, over time, of the permeable reaction wall, or coating of the reactive iron particles' surface.

3.2 BENCH-SCALE TESTING WITH GROUNDWATER FROM SHERBURNE SITE

In November 1993, 26 liters of groundwater was collected from MW-19 and shipped to the Groundwater Research Centre at the University of Waterloo for laboratory column testing as part of a feasibility evaluation of the ability of the EnviroMetal Process to degrade the contaminants present in the plume at the GIC site in Sherburne. The following paragraphs summarize the results of this bench-scale testing.

A. **Groundwater Quality as Tested.** Groundwater was shipped in separate 1-liter glass bottles to the University of Waterloo. Analytical quantification performed at the university found concentrations of organics in the separate containers to contain from 40 to 150 ppb of trichloroethene (TCE), 30 to 90 ppb cis-1,2-dichloroethene (cDCE), 5 to 10 ppb of 1,1,1-trichloroethane (TCA), and low levels (less than 5 ppb) of tetrachloroethene (PCE) and vinyl chloride (VC). These concentrations approximate the levels of organics found in samples from MW-19 during the RI field work (see Table 2-1).

The alkalinity of the groundwater shipped to the university ranged from 199 to 243 mg/l. It was found to be low in dissolved potassium (2 mg/l) and magnesium (12 to 13 mg/l) and contained approximately 75 mg/l of dissolved calcium.

B. **Laboratory Testing Configuration.** One reactive column, 50 cm long and 3.8 cm in diameter, constructed of plexiglass, was used for the bench-scale testing. The column was filled with 100 percent granular iron. The column was configured with sampling at the influent, effluent, and at seven sampling ports located along the length of the column (see Figure 3-1). Prior to introduction of groundwater from the site, the column was flushed with carbon dioxide to avoid air entrapment during wetting the column. Several pore volumes of deionized water were also flushed through the column prior to introduction of site groundwater.

Two experiments were conducted with the groundwater from the site. One used a groundwater flow velocity of 20 cm/day (0.7 ft/day), and the other used a flow velocity of 102 cm/day (3.4 ft/day). The column was sampled over time until steady state concentration profiles were achieved. During each experiment samples from the influent and effluent were analyzed for inorganic and organic analytes, Eh, and pH. Samples from the seven sampling ports were analyzed for only organics, Eh and pH.

C. **VOC Degradation Rates.** All VOCs present in the groundwater degraded quickly at both flow rates using the 100 percent iron column, with steady state conditions being used to calculate degradation half-lives for TCE of 0.5 and 0.2 hours, at flow rates of 0.7 ft/day and 3.4 ft/day, respectively. Half-lives calculated for cDCE were 1.5 and 3.9 hours at the two flow rates. The half life for TCA was calculated at three hours ar the 0.7 ft/day velocity. The half lives for VC were calculated to be 5.5 hours and 2.1 hours at the two flow rates.

D. **Inorganic Results.** As expected, calcium, magnesium, and alkalinity concentrations in the groundwater decreased while the groundwater flowed through the column containing reactive iron. At the same time, the concentration of dissolved iron in the groundwater increased. The observed decreases in calcium and magnesium are due to precipitation of calcium and magnesium carbonates, as a result of the conversion of bicarbonate ions to carbonate ions as the buffering capacity of the groundwater is exhausted. Once the pH reached 9.2, iron hydroxide precipitated as well as the carbonate. Prior to that pH, dissolved iron precipitated as siderite ($FeCO_3$), although to a lesser extent than calcium and magnesium.

3.3 FUNNEL-AND-GATE SYSTEM

The funnel-and-gate system for in-situ treatment of contaminated groundwater consists of low permeability cutoff walls ("funnels') constructed with gaps ("gates") between the subsurface walls. The gaps consist of high permeability material which act as in-situ reactors that are able to destroy or detoxify contaminants in the groundwater. The cutoff walls modify the groundwater flow pattern such that the flow is primarily through the gate sections. The preferred approach of the funnel and gate system is as a passive remediation system, requiring minimal maintenance over the lifetime of the project. The system offers an alternative to pump and treat systems, which require power and long-term maintenance. Another benefit of such a system over conventional groundwater pump and treat systems is that an in-situ funnel and gate system does not involve treating large volumes of groundwater with low concentrations of contaminants.

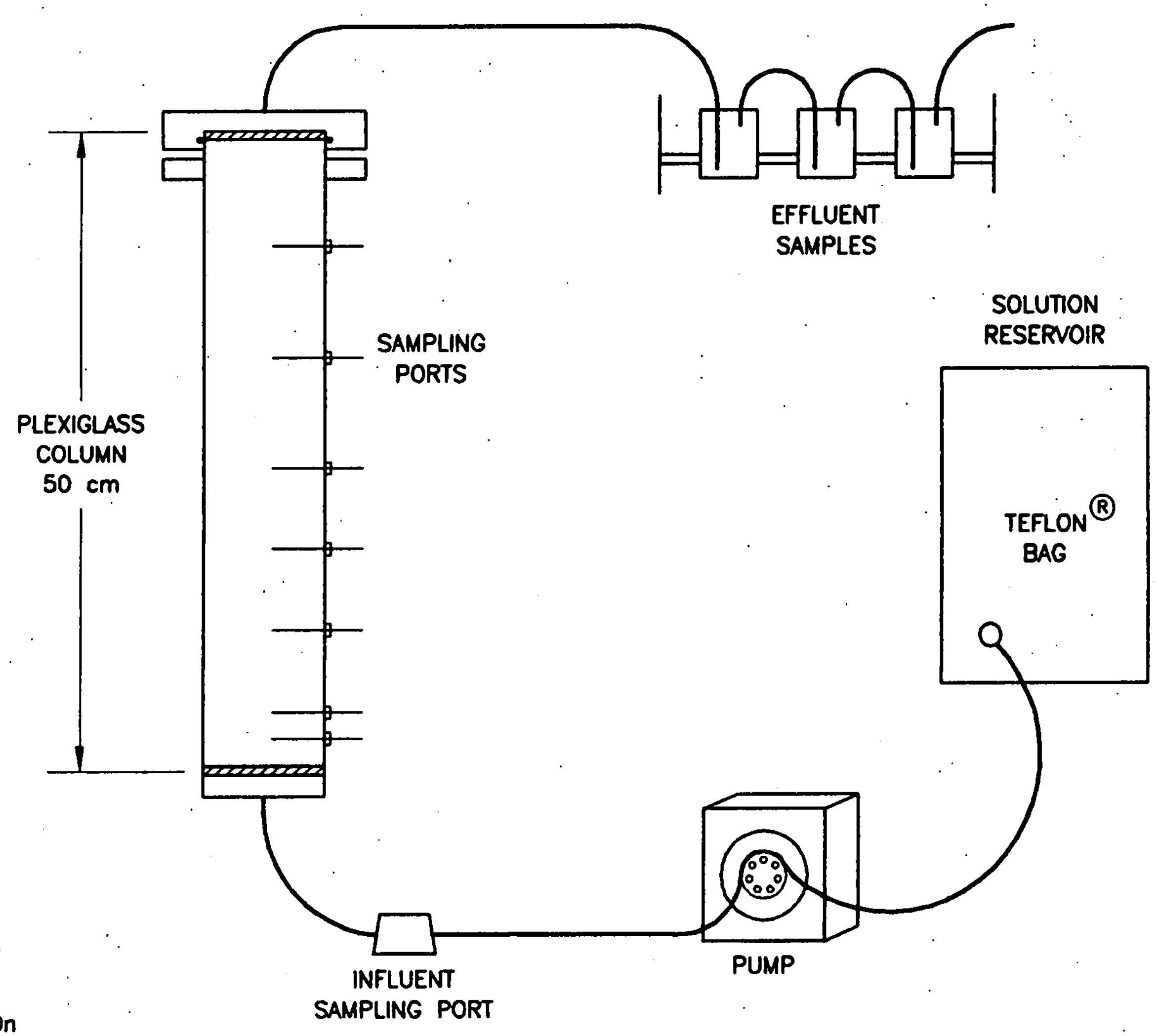
A. **Cutoff Walls.** Besides the type of in-situ reactor used in a funnel-and-gate remediation system, the other component of such a system is the cutoff walls that form the funnel (Starr and

Cherry, 1994). In general, the type of cutoff walls used are not critical; however, the material must not be able to become dislodged or degraded with time. More important, the installation contractor must not plug the gate, or permeable, section during construction of the funnel. For that reason, sealable joint sheet piling is one option for the funnel material. The material should also be sufficiently impermeable with respect to the natural aquifer material and the material in the gate.

B. **System Hydraulics.** The advantage to using a funnel and gate system is that a smaller size reactor can be used for treating a given plume. However, during design of such a system, many factors must be balanced. The funnel and gate must be designed so that the capture zone overlaps the entire area of plume which requires treatment. The residence time of this groundwater in the treatment zone must also be sufficient to achieve effluent concentration goals. Finally, the number of funnel and gate units must be low enough to be cost effective.

Groundwater modeling undertaken to simulate a surficial sand and gravel aquifer at the Borden site has illustrated that a treatment zone with hydraulic conductivity one order of magnitude higher than the natural material will result in a capture zone equal to, or slightly greater than, the treatment zone width (Starr and Cherry, 1994). If cutoff walls are added to the side of the zone (with conductivity 10,000 times less than the aquifer material), the capture zone increases significantly.

Modeling must be undertaken for each site to determine the impacts on design of the site's aquifer properties when combined with the permeabilities of both the treatment zone and cutoff walls.



Based On
Schematic Provided By
enviro**metal**
technologies
inc.

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FIGURE 3-1
SHEMATIC:
LABORATORY COLUMN TEST

CHAPTER 4

FIELD TEST PROJECT OBJECTIVES

The primary objective to be accomplished by the pilot field test is to determine the application of the EnviroMetal Process for in-situ treatment of groundwater which has migrated from the GIC Sherburne, New York site. More specifically, the objectives of this pilot-scale field test are as follows:

1. To evaluate the rate of VOC degradation under field conditions.

2. To evaluate the effects of inorganic geochemical changes on the field performance of the technology, with specific emphasis on the extent and effects of any mineral precipitation.

3. To evaluate the effects of the in situ installation on existing groundwater flow patterns and compare the measured effects to the modeling results used for design of the pilot system.

4. To obtain the necessary data to conduct a cost analysis for evaluation of a full scale system for treatment of the entire plume width with the EnviroMetal process as part of a funnel and gate treatment system.

5. To obtain the necessary engineering and hydrogeologic data to design a full scale system for treatment of the plume.

6. To determine whether any reaction byproducts will affect groundwater quality downstream of the process.

7. To evaluate the possibility of biodegradation and the implications to system operation if biodegradation is contributing to the measured degradation of the VOCs.

CHAPTER 5

DESIGN OF IN-SITU PILOT SYSTEM

5.1 ENVIROMETAL PROCESS GATE

The following sections describe the basis for design of the permeable reaction wall ("gate") portion of the in-situ pilot treatment zone. The reaction zone was designed based on the expected influent contaminant concentrations, the measured half-lives from the laboratory evaluation of the EnviroMetal Process, established effluent concentration goals equal to New York State groundwater standards, and projected groundwater flow rates based on slug test results from MW-17. The data was then modeled to evaluate different funnel and gate geometries, with resultant sizing of the permeable reaction wall.

A. **Design Contaminant Concentrations.** Contaminant concentrations in samples from monitoring well MW-19 were found to be approximately 529 µg/l TCE, 278 µg/l 1,2-DCE, 23 µg/l VC, 4 µg/l, 1,1-Dichloroethane (1,1-DCA), and 13 µg/l of 1,1,1-TCA when sampled in September 1993. However, in 1992, a groundwater sample collected from a temporary probe (1A) installed in the West Field in the vicinity of where MW-19 was subsequently located was found to contain 5,650 µg/l of 1,2-DCE and 288 µg/l TCE. An additional sample from a temporary Probe 2A, located adjacent to Probe 1A, was found to have lower concentrations of TCE and 1,2-DCE, but had 220 µg/l of VC. These samples were only intended to be used as a screening tool in order to locate additional monitoring wells. In order to be conservative, however, the higher concentrations of TCE and 1,2-DCE, as well as the higher concentration of VC from Probe 2A, were assumed to be the design influent concentrations of contaminants for the pilot-scale treatment system.

B. **Degradation Half-Lives.** The bench-scale treatability testing (discussed in Chapter 3) determined degradation half-lives for TCE, c-DCE, and VC to be 0.2 hours, 3.9 hours, and 2.1 hours, respectively. Half-lives calculated for TCA and PCE during laboratory column testing were 3 hours and 0.5 hours, respectively. These results were used as required design half-lives for the pilot-scale system.

C. **Required Residence Time.** Between six and seven half-lives are required in order to degrade an influent TCE concentration of 529 μg/l to New York State MCL of 5 μg/l. The required residence time to degrade TCE is, therefore, calculated to be 1.3 hours (6.5 x 0.2 hr). Using the half-life of 3.9 hours for c-DCE results in 10 half lives required for degradation of 5650 μg/l, or 39 hours. For design of the system with respect to degradation of VC, allowance was made for degradation of additional VC which could result from the degradation of the TCE and c-DCE. Assuming 1 percent of TCE and c-DCE results in formation of VC, the total influent concentration becomes 280 μg/l. Using the laboratory VC degradation half-life of 2.1 hours, then results in a calculated residence time of 15 hours (between seven and eight half-lives). Total required residence time in the pilot system is, therefore, the sum of the individual residence times for each compound, assuming sequential degradation of each compound. Total treatment system residence time is, therefore, calculated at 55 hours, or 2.3 days. Further basis for the design residence time is included in the Rationale for Suggested Design and Monitoring Program, included as Appendix B.

It should also be noted that this residence time calculation is based on the observed half-lives from the laboratory evaluation. It appears that temperature does not have a significant effect on reaction rate (Matheson & Tratnyek, in publication), so this is a valid assumption.

D. **Groundwater Modeling Results.** The groundwater flow model FLOWPATH was used to examine the effect of installation of a "funnel and gate" in-situ treatment zone on existing groundwater flow patterns in the field west of the facility buildings. The main objective of this modeling exercise was to determine the residence time of groundwater in an in-situ permeable treatment zone (or gate), given existing aquifer characteristics and the installation of impermeable "funnels" and a permeable "gate" of given dimensions. The width of the upgradient plume which could be captured and treated by the in-situ system was also evaluated. Details of the assumptions and software used in the model are presented in Appendix B.

Two pilot-scale funnel and gate designs were simulated for this system. The first design as shown in Appendix B, Figure 1, consists of a square central permeable treatment zone of iron 3.5 feet on a side (perpendicular to flow) flanked by 15 feet of sheet piling on either side. The size of the treatment zone was based on an initial estimate of the length of treatment zone which would provide the residence time needed, given the anticipated increase in groundwater velocity. The reactive iron in the center section is separated from the aquifer material both on the upgradient and downgradient sides by a section of pea gravel. The pea gravel acts to reduce the effects of high conductivity zones present in the aquifer upgradient of the gate by spreading this flow vertically, and also provides a location for installation of monitoring wells.

Because a significant portion of the cost associated with the installation of a pilot-scale funnel and gate involves the cost of equipment mobilization and construction, the cost and feasibility of increasing the permeable treatment zone width were examined with the goal of increasing the width of plume treated by the pilot-scale installation. This case was modeled using the same aquifer and 100 percent iron properties, and increased width of the gate from 3.5 feet to both 10 and 20 feet perpendicular to flow.

Results of the model runs are summarized in the following table.

Gate Width (ft)	Width of Plume Captured (ft)	Distance Groundwater Levels Affected Upgradient (ft)	Residence Time in Central Treatment Zone (days)
3.5	12	±20 to 25	2(1)
10	21	±20 to 25	3(2)
20	32	±25	4 to 5(1)

(1) 3.5 feet thick.
(2) 3 feet thick.

Figure 2 in Appendix B shows the capture zone upgradient of a 10-foot wide permeable gate containing 100 percent iron. Residence times in the reactive iron zone were determined using the approach discussed in detail in Appendix B. For the 3.5-foot square iron zone, a minimum residence time in the reactive zone of about two days was determined from the particle tracking routine. This increased to three days for the 10-foot wide by 3-foot thick gate, and to about four or five days for the widest (20 feet wide by 3.5 feet thick) gate. Upgradient "capture zone" widths of about 12 feet, 21 feet, and 32 feet were determined for 3.5-foot wide, 10-foot wide, and 20-foot wide gates, respectively.

E. **Design Safety Factor.** Based on the results of the groundwater modeling, the size of the reactive gate section for the pilot-scale system has been selected to be 10 feet wide by 3 feet thick (perpendicular to groundwater flow), resulting in a residence time of approximately three days. Because of the nature of the reaction, selection of a safety factor for the pilot system design is uncertain. However, this design will allow for an additional 0.7 days of retention time beyond what has been calculated for the maximum contaminant concentrations detected in samples from the West field, or approximately four additional half-lives for degradation of c-DCE which exhibited the longest degradation half-life during the laboratory evaluation of the process using Sherburne groundwater. Since, c-DCE concentrations in samples from the monitoring wells have been approximately one order of magnitude lower than the c-DCE concentration used for design of the system, treatment system residence times should be adequate. An additional discussion of why the design is believed to be conservative is presented in Appendix B. Figure 5-1 illustrates the resultant design of the treatment system.

F. **Reactive Iron Fill Material.** The reactive iron material consists of finely ground iron which has been put through a furnace to remove impurities such as oils which result from the grinding process. The iron particle sizes range from 0.09 inches to 0.0059 inches. Appendix A includes specifications for the reactive iron material. The iron weighs approximately 170 lb/cu.ft. loose, and 200 lb/cu.ft. packed. Measured porosity is 0.4 to 0.45.

G. **Purpose of Gravel.** As illustrated in Figure 5-1, the reactive iron in the center section of the "gate" is separated from the aquifer material on both upgradient and downgradient sides by a section of standard pea gravel. The purpose of the gravel is to reduce the effects of any high conductivity zones present in the aquifer upgradient of the gate by spreading this flow vertically. The gravel also provides a location for installation of compliance monitoring wells and piezometers.

5.2 SHEET PILE FUNNEL

The funnel portion of the pilot scale field test will be constructed of sheet piling. Sheet piling will also be used to shore the sides of the trench for construction of the "gate." The following sections describe the design of the funnel system and the materials of construction.

A. **Sealable Sheet Piling.** A new type of barrier containment wall will be used as part of the pilot scale funnel and gate system. The Waterloo barrier system uses specially designed steel sheet piling with interlocking joints which incorporate a cavity which can be filled with grout. Normally, sheet piling is designed for strength, not watertightness. However, when the cavities in the joints between each individual sheet piling are sealed, the permeability of the final grouted barrier can approach 1×10^{-8} cm/sec. Specifications for the sheet piling are presented in Appendix A.

The cavities for the sheet piling barrier joints can be formed several ways. The cavity can be formed as part of the sheet piling itself, when the piling is manufactured. Alternatively, standard Z-type sheet piling can be used, and a steel "L" section can be attached in the field. Once the sheet piling is driven into the overburden, the cavities are flushed out and inspected to verify that the sheet piling was not damaged during the construction process. The joints are then flushed out and the grout is pumped in from the bottom up to form the seal. Because the potential leak paths through the barrier are limited to the joints between the individual sections of the sheet piling, the joints are the focus of the quality control procedure.

B. **Funnel Cutoff Walls and Orientation.** As shown in Figure 5-1, the pilot system will consist of a 10 foot wide gate (permeable reaction wall) flanked by 15 foot long cut-off walls. The funnel and gate system will be oriented perpendicular to the direction of groundwater flow, in what is believed to be the center of the plume. Groundwater flow modeling performed to predict the capture zone of the pilot unit estimated a capture zone approximately 21 feet wide.

5.3 DESIGN MODIFICATIONS TO ALLOW IN-SITU RENOVATION OF GATE

During the laboratory evaluation of the EnviroMetal process (which was performed with groundwater from the Sherburne site), it appeared that 0.4 to 1.1 mmole of iron carbonate precipitate formed during the column testing procedure. Additional amounts of precipitation in the form of iron hydroxide along with calcium and magnesium carbonate were also estimated to have occurred. Much of this precipitation could occur in the reactive media and cause porosity losses, as well as fouling of the surface area of the reactive iron particles. Based on results from the laboratory evaluation, it was calculated that porosity losses could amount to as much as 7.5 percent of the original porosity each year. This, in turn, could have a significant impact on long-term operation of a "funnel and gate" system. Options, then, for continued operation of the system include replacement of the reactive media, or flushing the system with a material which will dissolve the precipitates. Because the inorganic precipitates are soluble in acid, a first option for renovation would use the compliance and process monitoring points installed in the gravel "diffuser" on the upgradient side of the treatment zone for addition of acid which could possibly dissolve the precipitates, while not dissolving the reactive iron itself. If this does not sufficiently restore the porosity of the reactive material, then the media will have to be physically replaced on a regular basis.

5.4 DESIGN MODIFICATIONS TO ALLOW IN-SITU AIR SPARGING

If porosity losses due to precipitation of inorganics are significant, or if analysis of groundwater sampling data indicates the system, using reative iron only, cannot be designed to meet New York State cleanup goals, consideration will be given to reconfiguring the system as an air sparging system. Additional “wells” screened only in the lowest foot of the aquifer located in the gravel zone of the "gate" sections will be used for addition of air to promote in-situ air stripping, or air sparging. If air sparging is required, the wells could be joined by a manifold and connected to a blower for the air addition. However, because the compounds of concern are not readily degraded by soil microbes, an additional horizontal PVC screened pipe may be required for extraction of soil gas vapors resulting from the stripping of the chlorinated VOCs from the groundwater. The horizontal piping will need to be connected to solid piping and a vacuum pump. Figure 5-2 illustrates the additional piping which would be necessary should the system be operated as an air sparging system.

The field test system will be constructed with the two additional sparging wells in place. If the results of the pilot test indicate that the permeable reaction wall system cannot be constructed economically to meet effluent goals established by the NYSDEC, or that the reactive iron alone cannot meet cleanup goals, the horizontal vapor extraction well will be added. Once in place, a pilot test will be undertaken to evaluate the use of air sparging in a funnel and gate system to meet treatment goals.

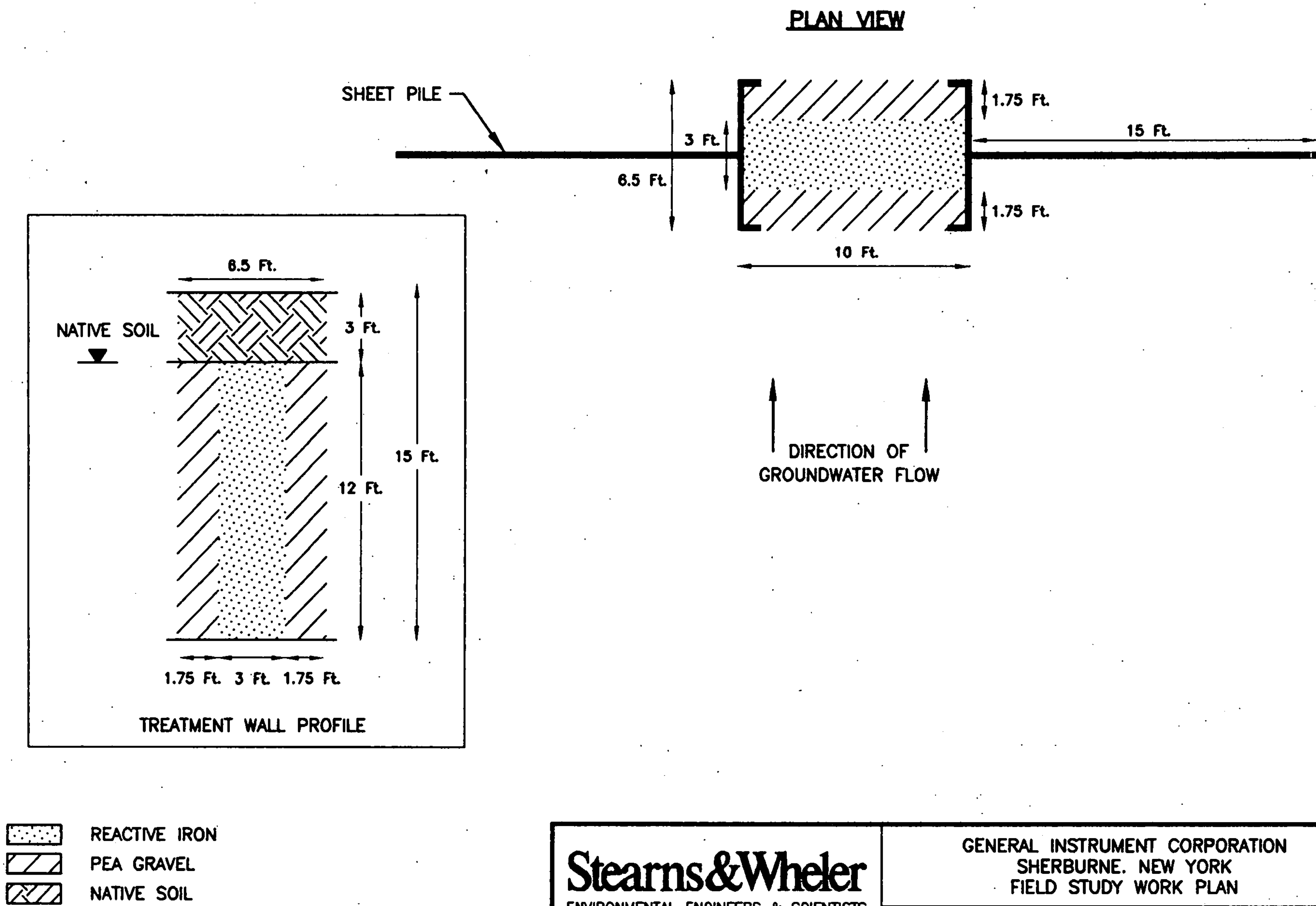

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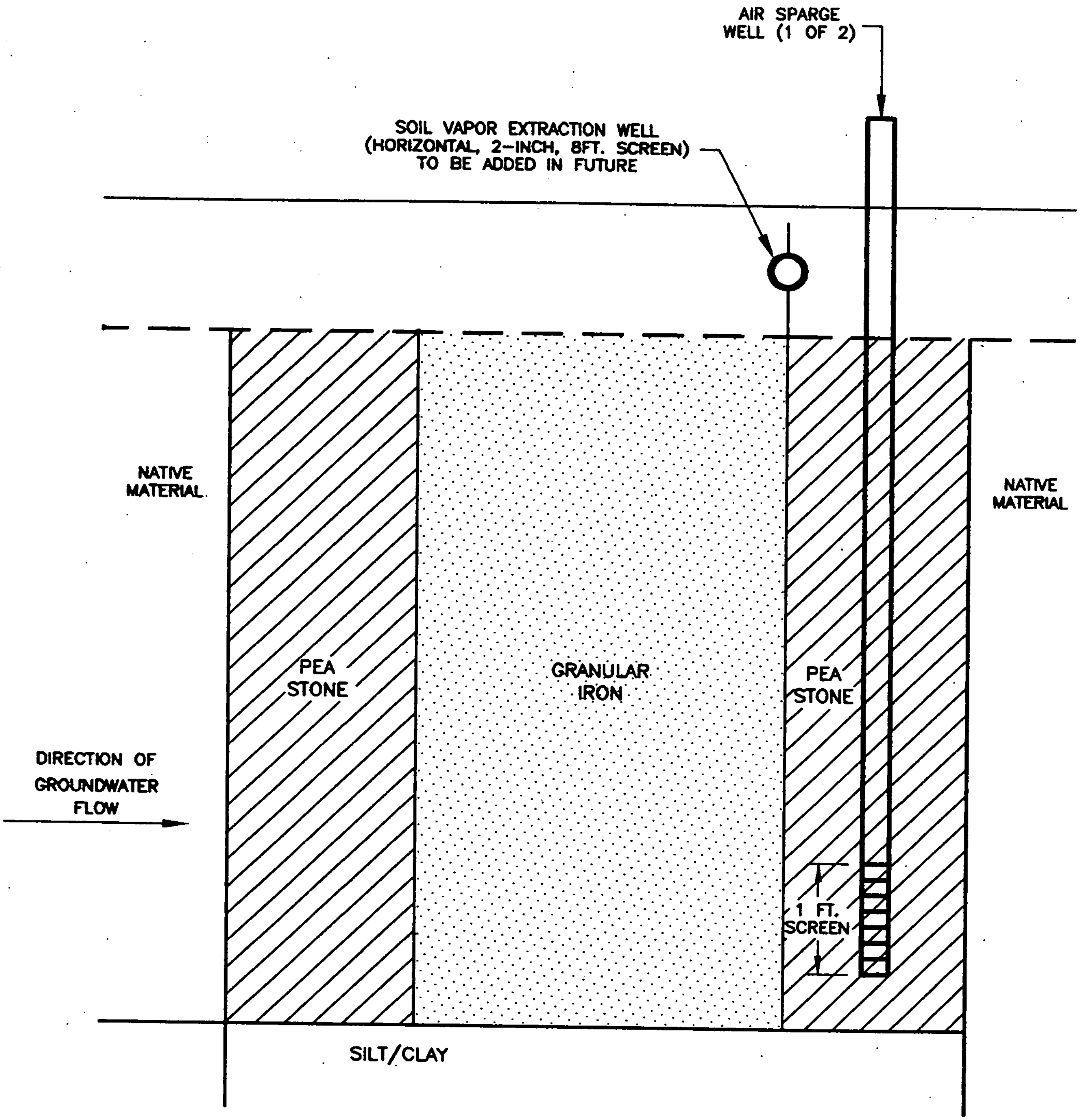
FIGURE 5-1
PILOT SYSTEM SCHEMATIC



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DATE: 10/94 JOB No.: 1587	FIGURE 5-2 MODIFICATIONS TO SYSTEM FOR AIR SPARGING

CHAPTER 6

TREATMENT SYSTEM INSTALLATION/CONSTRUCTION

6.1 LOCATION OF TREATMENT SYSTEM

The pilot-scale treatment system will be located approximately 50 feet to the north of existing Monitoring Well MW-19, as shown in Figure 6-1. As stated in Chapter 2, this location was chosen as a compromise between a location at the extreme downgradient extent of the plume, which would mitigate all areas of dissolved contamination; and a location in the vicinity of the source area, which then permits continuing use of the entire West Field for agricultural purposes. The location chosen (near MW-19) allows for treatment for the most impacted portions of the plume (groundwater with total VOCs approaching 1 ppm), with natural processes of biodegradation and dispersion contributing to further degradation of the remaining low concentrations of contaminants in the portion of the plume which does not pass through the treatment system.

6.2 ADDITIONAL FIELD TASKS

Prior to installation of the pilot-scale treatment system, additional field tasks are warranted, as discussed in the following paragraphs.

Additional borings will be installed to verify the elevation of the impermeable clay layer which forms the base of the shallow sand and gravel aquifer in the vicinity of the pilot test. Three borings will be advanced in the locations shown in Figure 6-2 using a hollow-stem auger. Continuous samples will be taken with a split spoon and examined in the field by a Stearns & Wheler geologist to determine the depth of the clay layer, and to verify the surface of the layer is indeed horizontal. Boring logs will be prepared for the sheet pile supplier and installation contractor.

Soil samples from the upper 4 feet of overburden will be sent from each of the borings for laboratory quantification of total VOCs by USEPA Method (SW-846) 8260. If the laboratory results indicate VOC concentrations are less than regulatory levels, the material will be determined to be nonhazardous. As such, the unsaturated soil will be able to be used as fill material to cover the permeable reaction wall (iron and gravel) portion of the pilot system. Boring logs will be be prepared for the sheet pile supplier and installation contractor. During the field work, Monitoring Wells MW-19, MW-20, and MW-21 will be surveyed and groundwater elevations will be taken to verify the hydraulic gradient in the West Field. Finally, slug tests will be conducted in MW-19 to verify hydraulic conductivity of the formation in the vicinity of the funnel and gate system. The results of the survey and slug testing will be used to verify input parameters used for the groundwater flow modeling which was the basis of design of the system.

6.3 MOBILIZATION OF EQUIPMENT

A designated staging area will be established at the site, as indicated in Figure 6-3. All materials required for construction of the pilot-scale system (reactive iron, pea stone, and sheet piling) will be staged in this area. A separate portion of the same area will be used to stage soil excavated from the trench prior to off-site disposal and/or use as fill. A decontamination area will also be established for decontamination of equipment used during construction.

The reactive iron will be shipped to the site in either 3,000-pound bags or 1,000-pound barrels from the manufacturer's facility in Ohio. The selection of bags or barrels will be decided once the contractor has been selected. Once the iron has arrived at the site, it will be stored on pallets in the staging area and covered with 10 mil polyethylene sheeting until it can be placed in the permeable reaction wall. The sheet piling installation contractor will mobilize all necessary pile driving equipment and excavation equipment to the site. Slurry Systems, Inc., the licensed sealable sheet piling installation contractor, will mobilize the necessary sheet pile grouting/sealing equipment to the site from their headquarters in Indiana.

A source of water will be required for the sheet pile sealing (grouting) operations. Because public water is not available in this location, it is now assumed a tank truck will be used to provide water at sufficient pressure for the grouting operation. Portable tanks will be brought to the site to contain all wastewater from grouting operations and any groundwater resulting from dewatering during construction of the treatment system.

6.4 INSTALLATION OF SHEET PILING TO FORM "GATE"

Initially, sheet piling will be used to form the four sides of a "rectangular box" which will be excavated by the contractor and filled with the reactive iron and pea stone. The individual sections, including rolled corners and T-sections, will be set in place prior to commencement of driving.

This is required to enable the last corner to fit properly. The sheet piling will be driven by the installation contractor to an approximately 20-foot depth as shown on the drawings. This will allow the bottom 4 feet of sheet piling to be driven into the impermeable silty clay layer which forms the base of the shallow aquifer. Allowable tolerances for installation of the sheet pile are listed in the specifications included in Appendix A. Procedures for installation of the sheet piling are also listed in the specifications included in Appendix A, including procedures for monitoring that joints remain free from debris. Once in place, the joints on the sides of the rectangle will be sealed with bentonite grout.

6.5 EXCAVATION OF SHEET PILE "BOX"

Once the sheet piling has been installed, forming the rectangular "box" for the permeable treatment zone, the installation contractor will excavate the native material from inside the rectangle formed by the sheet piling. The native material will be removed to the depth of the impermeable silty clay layer. The exposed piling will be shored as necessary to prevent collapse from hydrostatic pressure. Non-hazardous excavated material will be staged on polyethylene sheeting, covered with a double layer of the sheeting, with ballast as necessary. Unsaturated soils will be staged separately from the material excavated from below the groundwater table, to be available for fill material as needed. Saturated materials will be placed directly in roll-off containers for storage prior to transportation to a disposal facility. It is expected that the sealed sheet piling will be tight enough to prevent excessive groundwater from seeping through the joints into the relatively small trench during the excavation operation. However, the installation contractor will provide equipment for dewatering, as necessary, to allow efficient removal of native material from below the natural water table. All groundwater recovered during dewatering operations is expected to be contaminated and will be stored in temporary on-site tanks or drums to allow for treatment and characterization prior to discharge or disposal. Treatment, characterization, and disposal plans are discussed in Chapter 10, Residuals Management.

Once the native material has been excavated from the rectangular sheet piling enclosure, the reactive iron and pea stone will be filled in the trench to the dimensions indicated on the plans (Appendix A) and as indicated in Figure 6-4. Prior to this fill operation, the bottom portion of the exavation will be covered with standard filter fabric to prevent fines being carried into the iron and pea stone. At the same time as the fill operation is conducted, the process and compliance monitoring wells and the air sparging wells will be installed in the treatment system. Temporary sheeting will be used to separate the gravel from the iron during this fill operation. The iron material and pea stone will be filled to approximately 1 foot above the normal groundwater level (3 feet below the ground surface). Unsaturated, native material will be used to complete filling of the trench to match the site grade. Once the media is in place, the temporary sheet piling on the two 10-foot sides will be removed, thereby allowing groundwater flow through the permeable reaction wall, or "gate." Any undamaged sheet piling removed from the reactive wall sections will then be used, along with new sections of piling as needed, to form the extensions to the cutoff walls, resulting in 15-foot cutoff walls on either side of the permeable zone as shown in Figure 6-4, and in the drawings in Appendix A. All sheet piling joints will be sealed once the cutoff walls are in place. Properties of the grouts to be used are included in Appendix A.

6.6 SYSTEM MODIFICATIONS TO ALLOW AIR SPARGING AND MONITORING

Monitoring wells will be installed in the pea stone sections of the permeable reactive wall during the fill operations. These wells will be used for compliance and technology evaluation purposes. Three wells will be installed in both the upgradient and downgradient pea gravel sections of the "gate" as shown in the construction drawings (Appendix A) and Figure 6-5. Each well will consist of nominal 2-inch PVC well screen and will be screened the entire depth of the pea stone. The contractor will take measures to install the wells vertical during the same time the pea stone is being filled in the system. Each monitoring point (compliance or process) will extend approximately 2 feet above ground and will be flagged to allow identification during the winter. Three 2-inch PVC wells will also be installed in the reactive iron section during the backfill operations. Each well will be screened the entire depth of the iron.

In order to provide an alternative treatment method in the gate, two additional sections of slotted 2-inch PVC piping will be installed in the gravel envelope downgradient of the reactive iron as shown in Figure 6-6 and the Contract Drawings (Appendix A). This slotted pipe will only be screened in the lower foot of the aquifer and will extend above ground, where it will be capped and secured by the contractor. This additional piping will serve as air injection ports for the air sparging process, to be utilized only if the results of the field test indicate the reactive iron system cannot be designed to meet cleanup goals. Vapor extraction piping will also be installed as part of the air sparging system. Should air sparging be required, a trench in the native material will be hand excavated to a depth of 24 inches. A 3-inch layer of sand will be filled in the bottom of the trench with an 8-foot length of PVC well screen lain over the sand. One end of the piping will be capped, with the other attached to a vertical section of solid PVC piping. The native material will then be used as fill for the trench and the vertical PVC piping will be used as the vapor extraction portion of an air sparging system.

6.7 CONSTRUCTION OF "FUNNEL"

As stated in Section 6.5, after the rectangular trench is filled with iron, pea gravel, and finally, native material, and the well installation and sparge/vapor extraction piping is in place, the sheet piling on the 10-foot sides of the gate will be removed by the contractor. Undamaged sections will then be used to extend the cutoff walls to a final width of 15 feet on either side of the "gate" section, as shown in Figure 6-4 and the Contract Drawings (Appendix A). New sheet piling will be used if sections are damaged.

The sheet piling will be driven according to the process outlined in the specifications, with joint QA/QC being provided by Slurry Systems, Inc., a licensed Waterloo barrier sealing contractor. Joints in the cutoff walls and in the piling which forms the sides of the reactive permeable wall will then be grouted following the steps outlined in the specifications (Appendix A). All joint sealing will also be done by Slurry Systems, Inc. following the sheet piling vendor's guidelines and QA/QC procedures. The piling vendor reports that the finished joints should then have permeability of less than $<10^{-7}$ cm/sec.

6.8 MONITORING WELL AND PIEZOMETER CONSTRUCTION

Monitoring wells and piezometers will be installed in the locations indicated in Figure 6-5. Monitoring wells will be of two types. Two compliance monitoring wells will be installed in the gravel sections of the treatment system, one upgradient and one downgradient. One additional monitoring well will be installed in the native material 5 feet downgradient of the pilot system.

Process monitoring wells will also be installed within the treatment system, as follows:

- Two installed upgradient in pea stone.
- Two installed downgradient in pea stone.
- Three installed within the reactive iron zone.

All wells in the gravel and iron portions of the treatment system will be placed during the gravel and iron filling operations. The monitoring wells will all be constructed of 2-inch PVC with screen length equal to the depth of the iron media. Piezometers screened across the water table will be installed in the native material for water level measurements only.

6.9 SITE SECURITY

A fence will be emplaced around the pilot-scale facility location, and equipment/material staging areas to prevent unauthorized access to the site during the construction activities. Once the system construction is complete and all monitoring wells and piezometers are in place, the fence will be reconfigured, as necessary, to protect the integrity of the pilot-scale treatment system and associated monitoring locations.

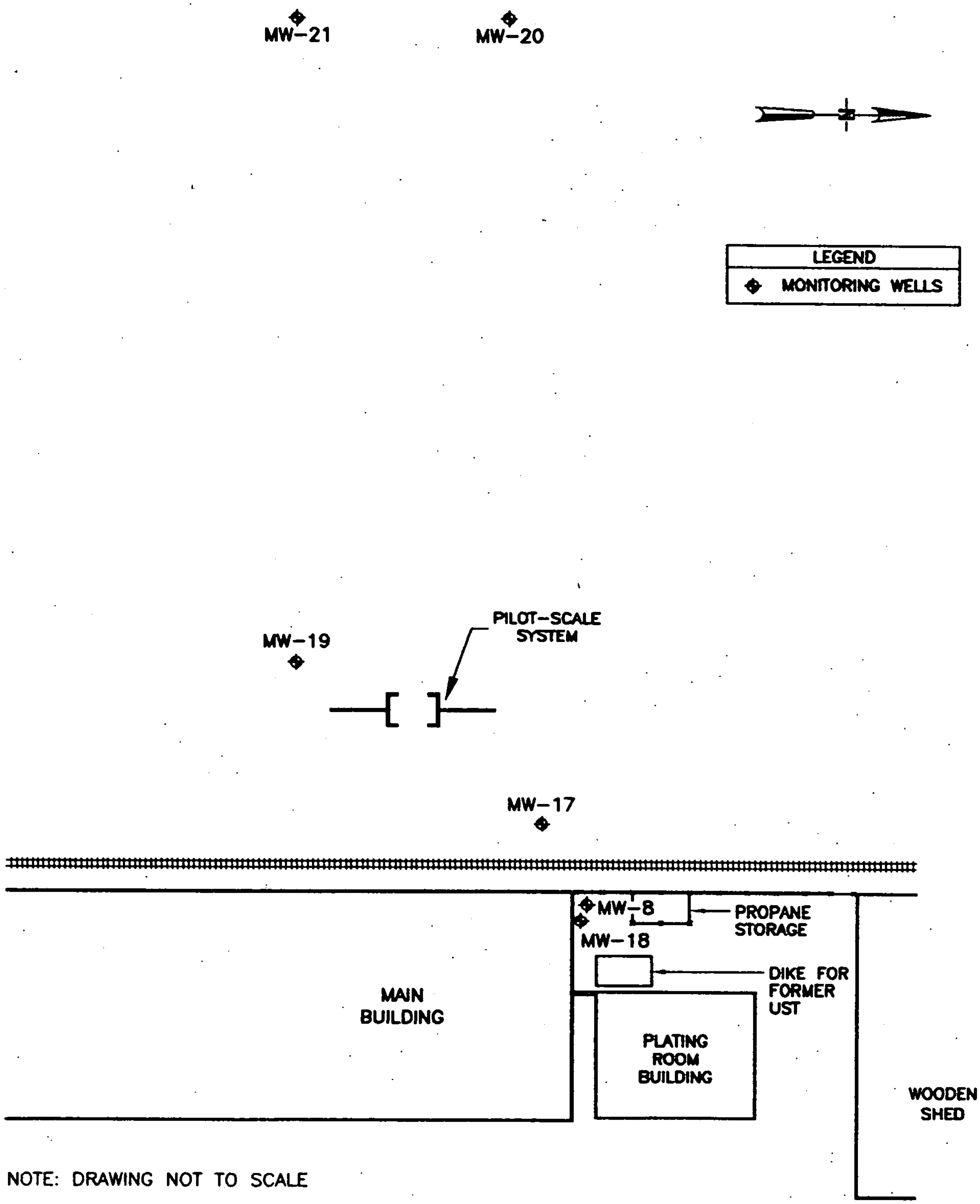

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FIGURE 6-1
LOCATION OF
PILOT SYSTEM

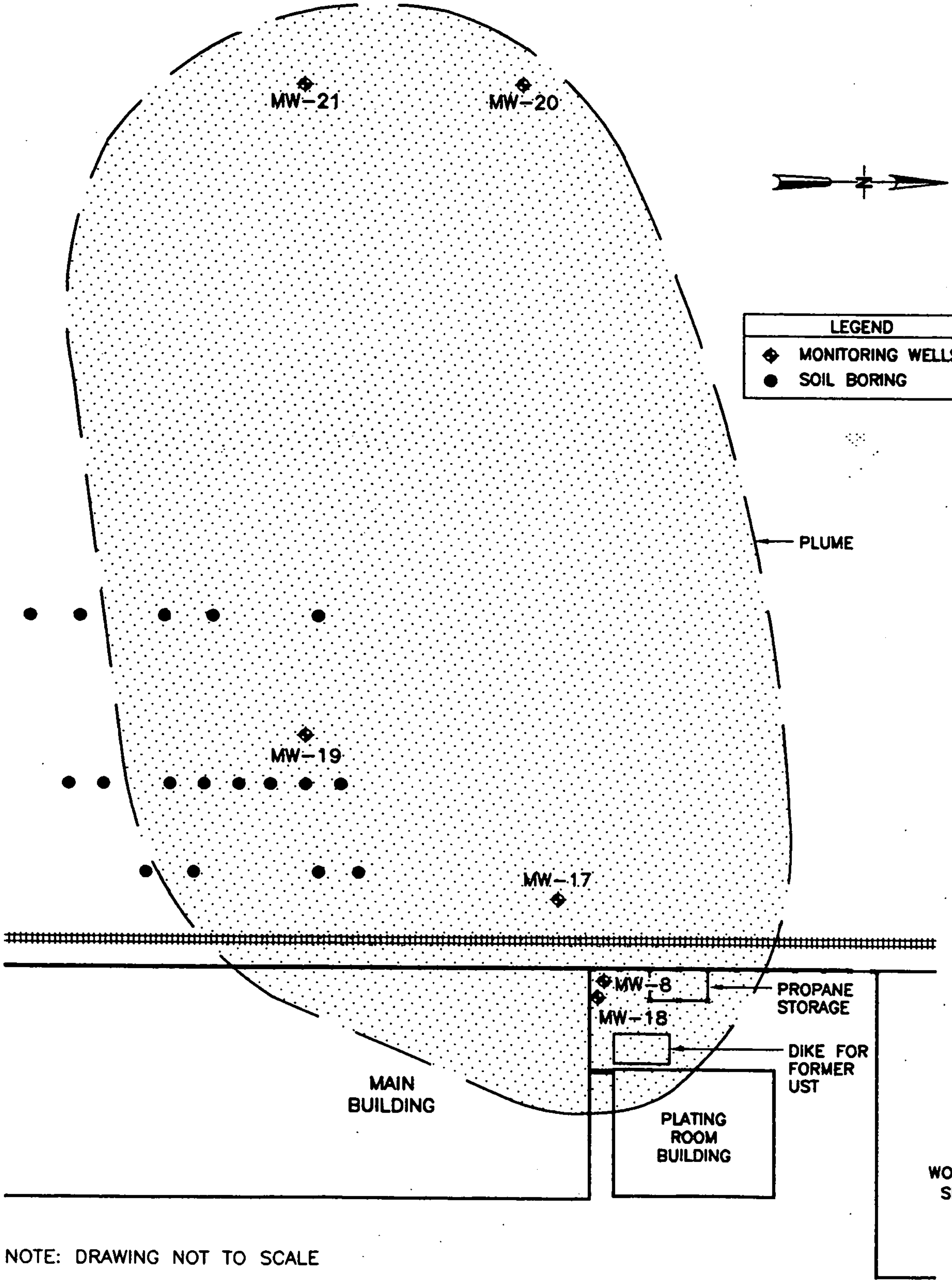

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FIGURE 6-2
LOCATION OF
ADDITIONAL BORINGS

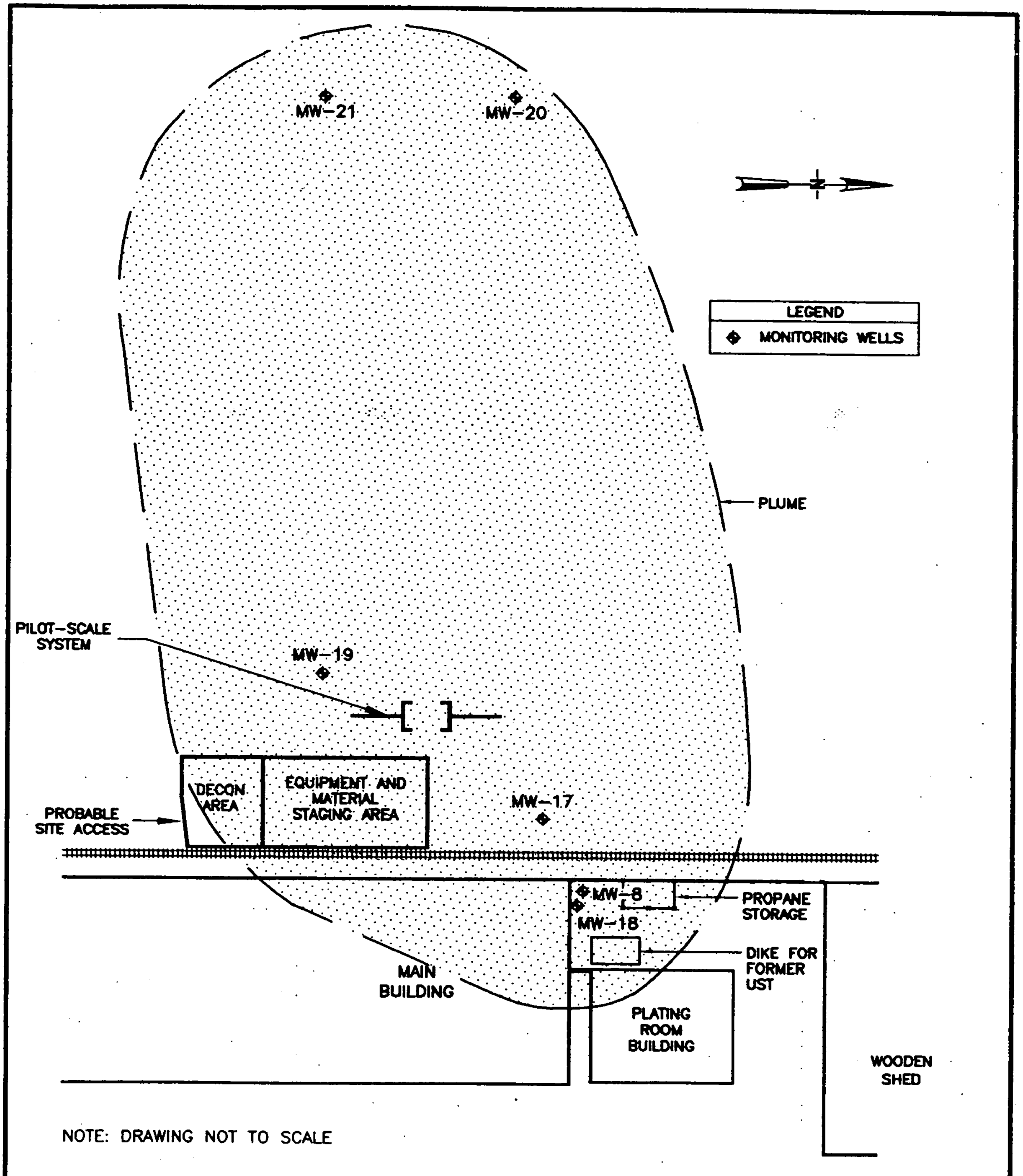

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FIGURE 6-3
LOCATION OF
STAGING AREAS

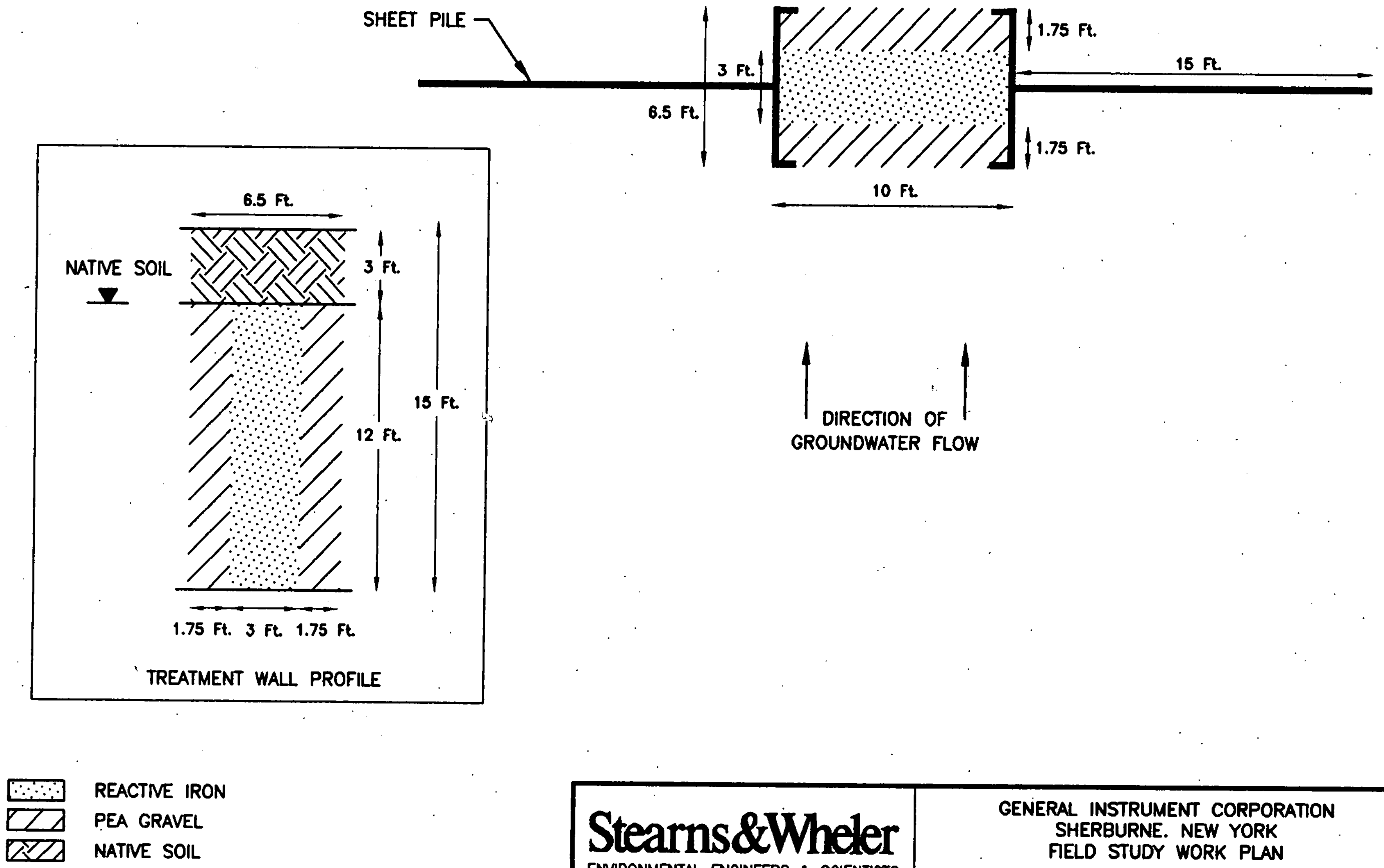

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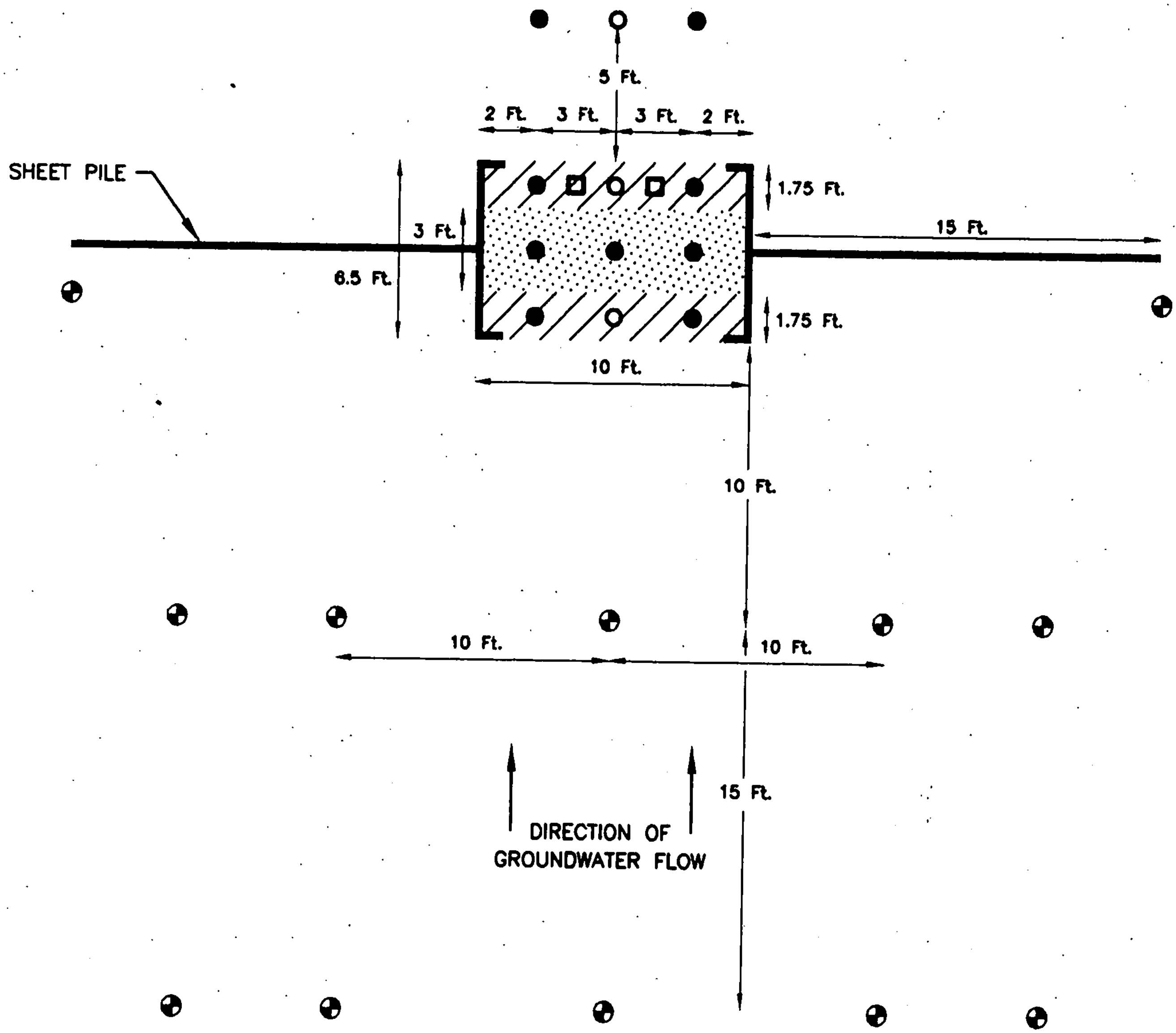
FIGURE 6-4
CONCEPTUAL DESIGN
PILOT SCALE TREATMENT SYSTEM



○ COMPLIANCE MONITORING WELLS
◑ WATER LEVEL PIEZOMETERS
● "PROCESS" MONITORING WELLS
□ AIR SPARGING WELLS

REACTIVE IRON
PEA GRAVEL

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FIGURE 6–5
LOCATION OF
MONITORING POINTS

CHAPTER 7

MONITORING PROGRAM

7.1 MONITORING PROGRAM

Attached as appendices to this work plan are the Rationale for Suggested Design and Monitoring Program of the Pilot-Scale Field Trial, prepared by EnviroMetal Technologies, Inc.; and the USEPA SITE Program QAPP, prepared by PRC Environmental Management, Inc. These two reports detail the choice of the monitoring well and piezometer locations and the sampling program which will be undertaken during this field study of the EnviroMetal Process used for in-situ treatment of the plume at Sherburne. All analytical methods and sampling procedures are detailed in the QAPP. For clarification, Table 7-1 presents a summary of the monitoring program which will be conducted, including sampling parameters, locations, frequency, and purpose for each analysis or test.

For the purposes of evaluating the ability of the system to meet New York State groundwater standards, only three monitoring wells will be needed. All other sampling locations (process monitoring wells and piezometers) are required for the technology demonstration evaluation conducted by PRC Environmental Management for the USEPA. Although the purpose of this additional monitoring data is to provide the USEPA with a statistical basis for determining the ability of the process to destroy dissolved halogenated compounds in groundwater in-situ, the data will be available in reports which will be submitted to the NYSDEC once data is validated and becomes available from the USEPA or its contractor.

7.2 EXTENT OF SAMPLING PROGRAM

The information in Appendix B indicates that approximately 20 to 30 pore volumes of flow are usually required to reach steady-state conditions in the reactive media during the laboratory column studies. This translates to 60 to 90 days of operation of the system required for steady-state conditions to be achieved in the pilot system, assuming a three-day residence time in the reactive iron media. Although the sampling program will begin during the first month of operation, the data obtained from this first sampling round will be used more to establish baseline conditions. The sampling program, then will continue for six months to allow representative evaluation of steady-state behavior of the operation of the pilot system in the field. Frequency of sampling and analyses will be as outlined in Table 7-1 and Appendices B and C.

7.3 QUALITY ASSURANCE/QUALITY CONTROL MEASURES

Appendix C, the QAPP for the USEPA SITE Program demonstration, details QA/QC measures which will be followed during the testing program.

steady-state behavior of the operation of the pilot system in the field. Frequency of sampling and analyses will be as outlined in Table 7-1 and Appendices B and C.

7.3 GROUNDWATER SAMPLING PROTOCOLS

Groundwater samples will be collected by PRC Environmental Management, Inc. (PRC) field personnel under contract to the USEPA. Samples will be collected according to PRC's Standard Operating Protocol (SOP) for groundwater sampling. Included in this SOP are procedures for purging monitoring wells prior to collection of samples. Each well will be purged a minimum of three well volumes prior to collection of samples for analytical quantitation.

7.4 QUALITY ASSURANCE/QUALITY CONTROL MEASURES

Appendix C, the QAPP for the USEPA SITE Program demonstration, details QA/QC measures which will be followed during the testing program.

TABLE 7-1
Field Study Sampling Program

Montioring Point	Location (Refer to Figure 6-)	Planned Analyses	Frequency	Purpose
Compliance Monitoring Wells	Upgradient, in Pea Stone	Total VOCs and Inorganics*	Monthly	Assess the ability of the system to meet NYS SCGs. Validate ground-water modeling
	Downgradient, in Pea Stone	Total VOCs and Inorganics*	Monthly	
	Downgradient in Native Material	Total VOCs and Inorganics*	Monthly	
	All wells	pH, Eh, Specific conductance, DO, temperature, water levels	Monthly	
	All wells in Pea Stone	Phospholipid Fatty Acids	**	Evaluate bioremediation affects
Process Evaluation Monitoring Wells	Upgradient, in Pea Stone	Total VOCs and Inorganics*	Monthly	Evaluate Process and validate groundwater model.
	Middle of Reaction Zone	Total VOCs and Inorganics*	Monthly	
	Downgradient, in Pea Stone	Total VOCs and Inorganics*	Monthly	
	Downgradient in Native Material	Total VOCs and Inorganics*	Monthly	
	All wells	pH, Eh, Specific conductance, DO, temperature, water levels	Monthly	
	All wells in Treatment System	Phospholipid Fatty Acids	**	Evaluate bioremediation affects
Piezometers	Upgradient	Groundwater elevations and Hydraulic Conductivity	Monthly	Validate groundwater model
	At ends of cut off walls	Groundwater elevations and Hydraulic Conductivity	Monthly	

* Inorganic parameters to be quantified include Ca+2, Mg+2, Na+, K+, Fe+2, Mn+2, Sulfate, Chloride, Bicarbonate, and Nitrate
** Frequency of testing will be at beginning of operation, after 3 months operation, and after 6 months of operation.
See Figure 6-5 for location of monitoring wells and piezometers.

CHAPTER 8

DATA ANALYSIS AND INTERPRETATION

8.1 OBSERVED DEGRADATION RATES

Concentrations of the contaminants of concern (VOCs) found in samples from the upgradient compliance monitoring well and the central well in the upgradient pea stone will be compared to concentrations of VOCs found in samples exiting the treatment area, to evaluate the actual degradation of the VOCs at field conditions. Concentrations of the contaminants will be plotted versus distance to approximate the concentration profiles achieved in the reaction wall. Degradation efficiency for each sampling event will be calculated according to the following equation:

$$\text{Efficiency} = \frac{C_i - C_f}{C_i} \times 100$$

At the same time, data will be available from the SITE Program to generate three-point curves of concentration versus distance at three locations in the gate section. This data will be used to statistically determine the destruction efficiency achieved in the reactive zone for the technology evaluation being simultaneously done during the field study.

8.2 GROUNDWATER QUALITY EXITING TREATMENT ZONE

Groundwater quality results for organic compounds in samples collected from the compliance monitoring well located in the downgradient gravel zone of the "gate" will be compared to New York State Standards, Criteria, or Guidance Levels (SCGs) to determine whether the process can achieve cleanup goals for the VOCs of concern at the site. If treatment to SCGs is not achieved, the plots of concentration versus distance will be used to determine whether the system could be designed with a larger treatment zone, and thereby longer groundwater residence time in the reaction zone, with resultant lower effluent VOC concentrations. Similarly, if non-detectable concentrations of volatiles are found exiting the treatment zone, the three-point curves obtained from the process monitoring wells could be used to design a correspondingly smaller reaction zone thickness, with corresponding shorter retention times.

Inorganic groundwater quality, as determined by concentrations of cations and anions listed in Appendices B and C and Table 7-1 will be evaluated in the two downgradient compliance monitoring wells. Results will be compared to New York State groundwater quality standards to determine if the inorganic changes which accompany the dehalogenation will cause an adverse impact on groundwater quality downgradient of the system. The concentration of inorganic compounds in the downgradient well installed in the native material will be of most concern when interpreting the ability of the system to meet groundwater standards, as it is assumed that pH and inorganic changes immediately exiting the treatment zone will be mitigated by the buffering capacity of the aquifer.

The concentrations of inorganic compounds in all monitoring wells (compliance and process) will be evaluated to determine the extent of precipitation occurring in the treatment zone. Field data will be compared to precipitation data gathered during the laboratory study. This evaluation of inorganic precipitation effects will allow a determination of potential porosity losses with time, which may affect the life of the treatment system. Photographs of the media at completion of the testing will be examined for visual indication of inorganic plugging.

8.3 VALIDATION OF MODELING

Groundwater levels will be measured each month in all monitoring wells and piezometers (see Table 7-1 and Figure 6-5). The purpose of the measurements will be to obtain data for validation of the groundwater flow modeling which was done as part of the pilot system design. The measurements will be used to evaluate the extent of plume capture of the entire pilot funnel-and-gate system. If the data from these measurements proves difficult to interpret, as outlined in Appendices B and C, point dilution tracer tests or downhole velocity meter measurements will be performed to identify the zone of capture.

8.4 EVALUATION OF BIODEGRADATION

Phospholipid fatty acid (PLFA) data from this testing will be undertaken at startup, after three months' operation, and at the completion of the six-month monitoring program. The data will aid in determination of the changes in composition, nutritional status, and physiological status of the microbial communities present in the system. Photographs of the media taken at the conclusion of the testing will be examined for visual evidence of biological fouling. Details of this testing are presented in the QAPP (Appendix C).

8.5 APPLICATION TO FULL-SCALE REMEDIATION

Results obtained from the six-month monitoring program, along with the calculated destruction efficiencies for each sampling event, will be used to determine the technical feasibility and cost effectiveness of constructing a full-scale system for treatment of the off-site plume at the Sherburne site. Technical feasibility will be primarily dependent on the ability of the system to meet New York State SCGs, along with the extent of plume capture achieved by the pilot-scale system. If groundwater contaminant concentrations are less than New York State MCLs, the contaminant profile curves plotted using data from the monitoring wells located within the treatment zone will be used to determine if the full-scale system could be designed with a smaller gate section or use less iron in the permeable fill of the gate section. Similarly, if groundwater contaminant MCLs are exceeded downgradient from the treatment system, the contaminant profiles will be used to increase the size of the treatment zone for the full-scale treatment system. Although additional pilot testing is not required for evaluating design of the full-scale system should residence times in the pilot test appear insufficient for degradation of the contaminant levels, agreement between the PRP, the state, and the designers (EnviroMetal Technologies and Stearns & Wheler) will be required prior to final design of the full-scale system.

Another aspect of technical feasibility will include an evaluation of the number of gates required to treat the entire width of the plume, based on the zone of capture measured during the field study. Similar to the modeling performed during the design of the pilot-scale system, groundwater modeling will be undertaken to examine the geometry of the funnel and gate system to determine the optimum geometry of a full-scale system for capture and treatment of the entire plume.

Once the optimum configuration of the full-scale system is determined, an estimate of the cost for constructing the system will be prepared.

CHAPTER 9

HEALTH AND SAFETY

9.1 PLAN AND PURPOSE

The purpose of the Health and Safety Plan (HSP) is to establish personnel protection standards and mandatory safety practices and procedures which must be followed during all phases of the field-scale testing at the General Instrument site. The plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies which may arise during the installation and monitoring of the funnel and gate system and installation of the monitoring points.

The requirements and provisions of this plan are mandatory for all phases of the field evaluation. All safety plans used by subcontractors must meet the requirements of the Stearns & Wheler HSP at a minimum. The plan must also be reviewed and understood by all personnel who participate in the site investigation. Guidelines of this HSP will be followed at all times during the installation/constructions activities, and during the monitoring activities throughout the entire course of the field evaluation at the General Instrument site.

The HSP is included as Appendix D to this Work Plan. In general terms, it describes the site, contamination associated with the dissolved plume in the West Field, and procedures to be implemented while on site and in the event of an accident. All Stearns & Wheler personnel assigned to the project are trained in accordance with the requirements of 29 CFR 1910.120 as they pertain to the construction and monitoring activities described in this work plan and Stearns & Wheler's company Health and Safety Program.

CHAPTER 10

RESIDUALS MANAGEMENT

Wastes generated during construction and monitoring of the field test and during any subsequent decommissioning activities will be sampled, analyzed, classified, and disposed of according to local, state, and federal regulations. Because this field test is being conducted as part if the USEPA SITE Program, a portion of the sampling, analyses, waste characterization, and disposal will be the responsibility of the USEPA through its SITE Program Contractor, PRC Management, Inc.

10.1 SOLID WASTES

The following solid wastes will be placed in 55-gallon drums:

- Discarded personnel protective equipment
- Well cuttings, boring cuttings, and driller's mud.
- Polyethylene tubing used for containment of decontamination water.
- Disposable bailers used to sample wells and piezometers.

The 55-gallon drums will be closed and labeled with the date and description of contents. The drums will be stored in the staging area prior to disposal.

Soil resulting from the construction of the "gate" section of the pilot treatment system will initially be placed on a double layer of 10 mil polyethylene sheeting and stockpiled in a roll-off on site. The pile or roll-off will be covered with 10 mil polyethylene sheeting prior to receiving sampling results for waste characterization. Once characterized, the material will be trucked to an appropriate facility for disposal.

10.2 DECONTAMINATION WATER, PURGE WATER, AND GROUNDWATER RECOVERED DURING CONSTRUCTION ACTIVITIES

Any groundwater recovered during dewatering activities associated with the construction of the pilot scale funnel and gate system will be stored in portable tanks or drums at a location acceptable to the current property owners. If tanks are used, the tanks will be covered once filled. Once construction activities have been completed, the recovered groundwater will be treated using activated carbon and stored prior to analytical verification of contaminant levels. Samples of this water will be analyzed for VOCs using USEPA Methods 601 and 602. Once the testing verifies groundwater concentrations meet New York State ambient water quality standards (TOGs 1.1.1), the groundwater will be discharged at a controlled rate to the West Field downgradient of the pilot-scale treatment system or to the storm sewers on the former GIC site.

Any groundwater used for the decontamination of personnel protective equipment, sampling equipment, piping, and drilling augers will also be drummed for on-site treatment or off-site disposal or treatment.

10.3 WATER FROM SHEET PILING GROUTING ACTIVITIES

Any excess water generated during the sealing of the sheet piling will be drummed, labeled, and stored on site until testing for appropriate classification is completed. At that time, the material will be transported to an appropriate disposal facility.

10.4 WASTES ARISING FROM DECOMMISSIONING

The pilot-scale system has been designed to be incorporated into a full-scale system which will be designed and implemented once results of the field evaluation are available. However, should the system not be chosen for use as part of the full-scale treatment system, the reactive iron will be removed, classified for disposal and/or reuse, and handled accordingly. Sheet piling which forms the cutoff walls will be removed and recycled.

CHAPTER 11

COMMUNITY RELATIONS

The pilot test was presented to the public in a hearing on September 22, 1994. The public meeting was required as part of the RI/FS process to allow concerned citizens to learn the results of the Final Feasibility Study and the alternatives presented in the Preliminary Remedial Action Plan (PRAP) prepared by the NYSDEC for the site. Because of this presentation, public comments on the pilot-scale test will be available concurrent with the work plan review. Once this work plan has been approved by the NYSDEC, two copies of the full document will be placed in the document repository in Sherburne, allowing interested parties an opportunity to examine the documents.

As part of the USEPA SITE Program, a Visitor's Day will be held allowing interested parties the opportunity to learn about the SITE Program, to view videos of the installation, and to review the vendor's claims for the technology. The current plan for the Visitor's Day is to combine the occasion with the Visitor's Day being planned for the ex-situ trial of the EnviroMetal Process at a New Jersey site. When plans for the Visitor's Day are complete, interested parties from the Village of Sherburne will be notified of the date and location.

Any information on the process and site prepared as handouts for the Visitor's Day will also be placed in the document repository in Sherburne for interested party review.

CHAPTER 12

REPORTING

12.1 INTERIM REPORTS

Status reports will be prepared bimonthly (once every two months) by Stearns & Wheler once preliminary review is completed and data is obtained from PRC Environmental Management, Inc. (PRC). The reports will be submitted to the NYSDEC once GIC has had the opportunity to review and approve the reports. Included in each report will be a summary of the data obtained during the two months of operation from the compliance and process monitoring wells. Concentrations of organic contaminants of concern and inorganics will be compared in the influent and effluent samples, with effluent concentrations compared to groundwater standards. Destruction efficiency will be calculated. Field parameters will be summarized, and water level elevations in all piezometers will be summarized in tabular form, as well as compared to the modeling results.

A description of conditions during the sampling events will be included, along with any changes in future operations or sampling frequency which may be required based on the results obtained to date.

12.2 FINAL REPORT

PRC will not conduct full data validation until all laboratory results from the six-month study are available. When the final validated data is available from PRC, Stearns & Wheler will prepare a final report. Included in the report will be a comparison of effluent groundwater quality achieved in the downgradient compliance monitoring wells with New York State SCGs. Destruction efficiency obtained during the test will be presented, along with three point curves illustrating the contaminant profiles through the treatment zone. The impact on required residence time for a full-scale system will be evaluated.

The summary report will include an evaluation of the data obtained from the field test with respect to each of the objectives for the field test presented in Chapter 4. Finally implications for design of the full-scale system will be discussed, along with a schedule for design and construction of the full-scale system, if appropriate and cost effective.

CHAPTER 13

SCHEDULE

The proposed schedule for implementation of this field test is as presented in Figure 13-1. Actual timing is dependent on public acceptance of this technology as part of the remedy for the Sherburne site and NYSDEC review and approval of the Work Plan. Sheet piling which meets the specifications presented in Appendix A is expected to be available for the project in October.

Prior to obtaining cost estimates from contractors for construction of the pilot-scale system, a pre-bid meeting will be held, including a visit to the site. The purpose of the meeting will be to discuss the requirements of the bidding documents, the protocols for performing the work, and conditions at the site. During the meeting, construction photos from EnviroMetal Technologies pilot systems in Borden, Ontario, and California will be examined. The pre-bid meeting will also allow the prospective installation contractor to assess the need for materials to allow adequate site access and the need for permanent decontamination facilities.

Prior to commencement of construction activities, a pre-construction meeting will be held at the site.

It should be noted that the final report prepared by PRC Environmental Management, Inc. on the technology evaluation is not expected to be available in draft form until at least two months after the monitoring program has been completed. Interim reports will be prepared at two-month intervals, once the validated data is available. However, design of a full-scale system will not be attempted until the SITE Program evalation report is final.

Figure 13-1
Proposed Pilot Test Schedule
Funnel and Gate Treatment Using EnviroMetal Process
General Instrument Company
Sherburne, NY Site

TASK		MONTHS 1	2	3	4	5	6	7	8	9	10
Public Meeting on PRAP-Approval	*										
Receipt of NYSDEC Approval	*										
Receipt of Property Owner Approval	*										
USEPA Approval of QAPP		■									
Install Borings/Survey Field/Slug Tests	X										
Pre-bid Meeting at Site	X										
Arrange for Contractor's Services		■									
Procure Equipment (Sheet Pile and Iron)		■									
PreConstruction Meeting at Site		X									
Mobilize Equipment to Site		■									
Install System, Wells, and Piezometers		■									
Operation and Monitoring			■	■	■	■	■	■			
Data Validation									■	■	
Report Preparation**									■	■	■
Visitor's Day (to be scheduled by PRC/EPA)				X							
BiMonthly Status Reports					X		X		X		
Final Report to NYSDEC											X
Final Report for EPA SITE Program											X

* Schedule begins once NYSDEC approval of Work Plan is obtained.
**Also assumes that bimonthly status reports will be prepared for GIC once sampling results are available from PRC. Once GIC approves the status reports, copies will be forwarded to NYSDEC.

CHAPTER 14

PROJECT MANAGEMENT AND STAFFING

This field investigation is being undertaken with two ultimate goals. First, it will serve as a treatability study to determine the efficacy of the EnviroMetal Process as a portion of a funnel-and-gate system for remediating the contaminated plume associated with the GIC Sherburne site. At the same time, it will serve as an evaluation and demonstration of the innovative process. To achieve this technology demonstration, the project is being conducted as part of the USEPA SITE Program. Because of the number of organizations involved in the project, a responsibility matrix is presented as Figure 14-1 which details the responsibilities of each of the groups associated with the project.

FIGURE 14-1
PROJECT RESPONSIBILITY MATRIX

ORGANIZATION	FINANCIAL	TECHNICAL	ADMINISTRATIVE
USEPA RREL	Costs for report preparation, site prep, visitors' day activities, demonstration waste disposal, sampling and analysis (via PRC,) installation of process monitoring wells.	Evaluate reports and data collected, QAPP, demonstration capsule, and innovative technology report	Coordinate between all parties involved.
EnviroMetal Technologies, Inc. (ETI)	None	Design of project & monitoring program, operating procedures, basis for sizing, and reaction chemistry to EPA RREL and PRC for report evaluation. Preparation of Field Study Work Plan w/ S&W Field oversight	Interface with WGC on Sealable Sheet Pile (joint seal) contractor Field Oversight
PRC Environmental Management, Inc. (PRC) SITE Team	Costs from budget for work assignment	Prepare reports (QAPP, PRC HASP, Demonstration capsule, and innovative technology evaluation report). Field oversight, visitors' day activities, demonstration waste disposal, groundwater sample collection and analysis. Review and analyze data. Preparation of SITE reports Arrange for waste disposal.	Support EPA in coordination efforts. Lead community relation activities. Work with ETI and Stearns & Wheler on set up and completion activities.
NYSDEC	None	Provide technical comments on the QAPP. Approval of test as part of remedial actions for site. Approval of Field Study Work Plan and Construction activities	Provide input on community relations activities.
General Instrument Corp. (GIC)	Capital costs for system, installation costs and mob/demob costs costs for compliance wells	Provide comments on QAPP, Review reports generated on system evaluation. Input on visitors' day activities.	Provide input on community relations activities. Agreements with current site owners.
Stearns & Wheler	None	Review of QAPP Preparation of Field Study Work Plan (w/ ETI) Design of full and pilot scale system, construction plans. Bimonthly reports for NYSDEC. Interface with all parties. Provide field oversight (OSHA trained field people)	Provide input on community relations activities. Any permit activities Negotiations with current site owners.

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APPENDIX A

MATERIAL SPECIFICATIONS AND INSTALLATION DRAWINGS

General Instrument Corporation
Sherburne, NY Site

Stearns & Wheler Project No. 1587

APPENDIX A

MATERIAL SPECIFICATIONS
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APPENDIX A

STEEL SHEET PILE BARRIER WALLS

PART 1 GENERAL

1.01 SCOPE

A. The work covered by this section consists of furnishing all plant, equipment, labor, and materials and performing all operations in connection with the installation of steel sheet pile barrier walls, including joint sealing procedures, in accordance with these Specifications and applicable drawings.

1.02 RELATED SECTIONS

A. Section 01300 - SUBMITTALS
B. Section 05500 - METAL FABRICATIONS

1.03 REFERENCES

A. The following American Society of Testing and Materials (ASTM) standards are of the current issue and form a part of this Specification to the extent indicated:

A 6 Structural Steel

A 328 Steel Sheet Piling

A 572 High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

A 668 Steel Forging, Carbon and Alloy, for General Industrial Use

B. The following American Welding Society (AWS) Standards are of the current issue and form a part of this Specification to the extent indicated.

D1.1 Structural Welding Code

1.04 SUBMITTALS

A. The Contractor shall submit descriptions of sheet piling driving equipment, shop drawings, material test reports, and sheet piling driving records to the Engineer and the NYSDEC for approval as required below:

1. Equipment Descriptions - Complete descriptions of sheet piling driving equipment, including hammers, extractors, protection caps, and other installation appurtenances,

shall be submitted for approval prior to commencement of work.

2. Shop Drawings - Shop drawings for sheet piling, including fabricated sections, shall show complete dimensions and details of piling, including mill test documentation and structural properties of piling sections to be used. Shop drawings shall also include details and dimensions of templates and other temporary guide structures for installing the piling and shall provide details of method of handling to prevent permanent deflection, distortion, or damage to the interlocks.

3. Pile Driving Plan which outlines detailed pile placement, driving sequence, splicing requirements and details, details and dimensions of templates and other temporary guide structures for installing and achieving verticality within 1 percent, quality control measures, joint preparation prior to sealing, grout materials, mixing, placement, and methods of handling to provide permanent deflection, distortion, or damage to the interlocks.

4. Driving Records - Records of the sheet piling driving operations shall be submitted after driving is completed. These records shall provide a system of identification which shows the disposition of approved piling in the work, date and time of driving, driving equipment performance data, piling penetration rate data, piling dimensions, top and bottom elevations, elevation of ground at point of pile penetration, rate of penetration in inches, minute, and detailed remarks concerning alignment and obstructions.

5. Submit qualification statement.

6. Proposed welding procedures and certification of welders.

1.05 QUALIFICATIONS

A. The sheet piling contractor shall be a company specializing in performing the work of this Section with a minimum of five years' documented experience.

B. The joint sealing Contractor shall provide documentation of being a Waterloo Barrier Inc. licensed installer or provide a subcontract agreement with a selected licensed installer to provide quality control for the sheet pile installation and provide joint sealing services.

C. All contractors working at the site must have all applicable hazardous waste certifications, as required by 40 CFR 1910.120, and have appropriate work experience dealing with hazardous waste (three-year minimum).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered to the site shall be in a new and undamaged condition and shall be accompanied by certified material test reports.

B. Sheet piling shall be stored and handled in the manner recommended by Waterloo Barrier, Inc. to prevent permanent deflection, distortion, or damage to the interlocks. Storage of sheet piling should also facilitate required inspection activities.

PART 2 PRODUCTS

2.01 MATERIALS

A. All steel sheet piling and accessories shall be new material and shall conform to the following specifications: ASTM A328.

B. Sheet piling, including special fabricated sections, shall be full length sections of the type and dimensions indicated on the drawings and shall have the properties equivalent to those listed in the PROPERTIES OF SECTIONS table at the end of this Appendix A.

C. Use standard rolled corners when available, otherwise, fabricated corners will be required.

D. Sheet piling sections shall be Designation WZ 75 and rolled corner sections shall be as manufactured by Canadian Metal Rolling Mills, or other approved manufacturer under license from Waterloo Barrier, Inc.

E. Sheet piling interlocks shall be reasonably free-sliding, allow a swing angle of at least 5 degrees when threaded, and shall maintain continuous interlocking when installed. Sheet piling shall be provided with standard lifting holes.

F. Fabricated sections of sheet piling shall conform to details shown on the Drawings, manufacturer's recommendations for fabricated sections, and to approved shop drawings.

2.02 ACCESSORIES

A. Foot plates and driving points shall be as shown on the Drawings and as recommended by Waterloo Barrier, Inc.

B. A foot plate shall be welded to the base of each female joint of the sealable sheet piling to prevent soil from entering the joint as the pile is driven into the ground. The fabrication and attachment of the foot plate shall be the responsibility of the Contractor. Exact dimensions of the foot plate shall be based on the final rolled sheet piles. Diagrams depicting the foot plate and welded configuration to the sheet pile are provided on Sheet 2 of the plans included as Appendix A. Waterloo Barrier, Inc. will provide the dimensions to the Contractor as soon as they become available. The Contractor shall make the necessary fabrication arrangement to assure manufacture of the plates does not delay the sheet pile installation.

If the Contractor chooses to drive sheet piles in doubles, a cone shall be employed to prevent soil from entering the mated (center) joint. The Contractor shall be responsible for the fabrication and installation of the cone for each paired sheet pile set. A diagram depicting the cone is provided on Sheet 2 of the attached plans; specific dimensions shall be based on actual dimensions of the final rolled sheet piles.

2.03 FABRICATION

A. All fabrication shall be as per shop drawings and shall be in accordance with the Ninth Edition of the AISC Manual of "Steel Construction."

2.04 COORDINATION

A. The Installation Contractor shall notify the Construction Manager at least five days prior to beginning pile driving operations at any location. This shall not relieve the Contractor of his responsibilities for performing the work in accordance with these Specifications and Contract Drawings.

2.05 QUALITY CONTROL

A. The Contractor is responsible for providing a Waterloo Barrier, Inc. licensed installer to act as Quality Control Observer during all phases of installation to assure proper alignment of piling.

B. Horizontal Alignment and Plumbness Tolerances - The maximum permissible horizontal tolerance in pile driving shall be a deviation of not more than 6 inches from the plan location indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Driving Hammers - Hammers shall be steam, air, or diesel drop, single acting, double acting, differential acting, or vibratory type. The driving energy of the hammers shall be between 8,750 and 16,000 foot-pounds for impact hammers and between 2,000 and 4,000 inch-pounds eccentric moment for vibratory hammers, as recommended by Waterloo Barrier, Inc., or their licensed installer for the piling weights and subsurface materials to be encountered.

B. Placing - Pilings locations as shown on the Drawings are approximate and should be field located when appropriate and as approved by the Engineer.

C. Sheet piles shall be handled in a manner which will not cause excessive bending stresses.

D. Pilings shall be placed vertical or plumb with out-of-plumbness not exceeding 1/16 inch per foot of length, and shall be placed as true to line as possible.

E. The Installation Contractor shall provide suitable temporary wales or guide structures to ensure that the piles are set and driven in correct alignment. A single template one-third the length of the sheets shall be used in placing each piling and the maximum spacing of templates shall not exceed 20 feet.

F. The joint of each sheet pile shall be visually inspected by the QA/QC observer prior to driving. Any foreign material shall be removed and damaged joints and/or sheet piles shall be replaced by the Installation Contractor.

G. The Installation Contractor shall replace or repair sheet piles which are damaged during driving.

H. Pilings properly placed and driven shall be interlocked throughout their length by the hook of each piling being griped by the hook and grip of an adjacent piling to form a continuous diaphragm throughout the length or run of piling wall.

I. Driving - Pilings shall be driven by the Installation Contractor with the proper size hammer and by approved methods to drive the piling to the design depths as shown on the Drawings and as not to subject the pilings to damage and to ensure proper interlocking throughout the lengths. Driving hammers shall be maintained in proper alignment during driving operations by use of leads or by guides attached to the hammer.

J. A protecting cap shall be employed in driving when using impact hammers to prevent damage to the tops of pilings. Pilings damaged during driving or driven out of interlock shall be removed and replaced.

K. The Installation Contractor shall prevent and correct any tendency of sheet piles to bend, twist or rotate, and to pull out of interlock. The integrity of each pile and interlocked joint must be maintained during and after driving.

L. The sheeting forming the enclosure for the in situ treatment shall be assembled totally above ground by the Installation Contractor before driving commences.

M. Top of pile at elevation of cut-off shall be within 2 inches of the specified alignment. Manipulation of piles to force them into position will not be permitted. Piles will be checked for heave by the QA/QC observer and the Engineer. Piles found to have heaved shall be redriven to the required point elevation.

N. Piles damaged or driven outside the above tolerances shall be replaced by the Installation Contractor. Any sheet pile ruptured in the interlock or otherwise damaged during driving shall be immediately pulled and replaced.

O. Piles shall be driven not deeper than 1 foot of the specified depths for each location. The Installation Contractor shall take necessary precautions to assure adjacent piles do not penetrate deeper during pile installation.

P. The Installation Contractor shall pull any sheet piling that are known to have pulled out of interlock or are suspected of having tip or interlock damage, as determined by the Quality Control Observer, for visual inspection before proceeding further.

Q. Splicing is permitted if shown on the Drawings or as approved by the Engineer.

R. Make splices using a full penetration weld or as otherwise directed by the Engineer for structural purposes.

S. Mark waterproof identification number clearly visible on each sheet pile within 2 feet of the top before driving is initiated.

T. When backfill operations for treatment cell enclosure are complete, six standard piles shall be removed from two sides of the enclosure as indicated on the plans. Upon removal, undamaged sections are to be redriven and sealed to form the cut-off walls of the finished plan view.

3.02 OBSTRUCTIONS

A. Should obstructions restrict driving a piling to the specified penetration, they should be removed or penetrated according to methods approved by Waterloo Barrier, Inc., the approved work plan for the field test, and the approved Site Health and Safety Plan.

3.03 JOINT SEALING

To be performed by a Waterloo Barrier, Inc. licensed installer.

A. Joint sealing shall not be performed adjacent to sheet pile installation within a radius of the length of sheet plus 10 feet from the sheet piling installation point.

B. After sheet piling has been installed in the ground, the Waterloo Barrier, Inc. licensed installer shall check all sealable cavities by probing with a tremie hose or pipe and then flushing with pressurized water or air to remove any remaining soil material.

C. During the flushing, a hose or pipe shall be inserted into the sealable cavity and advanced downward. The hose shall allow soil particles to travel up and out of the cavity. Any loose, oxidized material adhering to the interior wall of the sealable cavity must also be jetted clear. Removed water and soil shall be handled as specified in the approved work plan, Chapter 10, Section 10.3.

D. The flushing operation shall be considered complete when the hose has been passed to the base of the sealable cavity and the water or jet of air escaping from the top of the hole is reasonably clean. The flushing hose may then be removed from the cavity.

E. A tremie hose or tube for pressure injection of the sealant shall be inserted into the sealable cavity by the Waterloo Barrier, Inc. licensed installer. When the tube has reached the bottom of the hole, sealant injection shall begin. The hose shall be withdrawn progressively up the hole as the sealant fills the space below. Keep tremie nozzle at least 6 inches below rising surface of sealant.

F. The speed at which the injection tube is withdrawn must be carefully regulated to prevent trapping water bubbles within the sealant and to insure there is adequate sealant to fill the cavity.

G. The sealant used must be capable of penetrating into the potential leak paths, and have a low permeability to water. The sealant selected must also be resistant to chemical interaction and degradation when in contact with contaminated groundwater. The sealant will have a hydraulic conductivity of less than or equal to 1 x 10^{-7} cm/sec.

3.04 REJECTION

A. If rejected from the work because of deviation from location, plumbness requirements, excessive bending, twisting, or pulling out of interlock, or other reasons, Installation Contractor shall take suitable corrective action, including extracting, and furnishing and driving of replacement sheet piles, so that all sheet piles installed meet the requirements of this Specification.

B. The quality control observer will be responsible for determining the sheet piling has been installed in proper alignment, and rejecting the installation, if necessary.

PROPERTIES OF STEEL SHEET PILE SECTIONS

Nominal Web Thickness (In)	Section Modulus Per Lin Ft of Wall $(In)^3$	Weight Per Sq Ft of Wall (Lbs)	Weight Per Lin Ft of Piling (Lbs)	Radius of Gyration (In)	Moment of Inertia Per Lin Ft of Wall $(In)^4$	Nominal Width (In)
0.295	15.9	19.2	35.6	3.39	64.8	22.25

- END -

SPECIFICATIONS

REACTIVE IRON MATERIAL

This Section includes properties of reactive iron sand material used for fill material in permeable reaction wall portion of funnel and gate system. Reactive iron material to be furnished will be manufactured by Master Builders Technologies, Cleveland, OH. Refer to approved work plan, Chapter 6, Section 6.5, and approved construction plans.

Properties of Iron "Sand"

Specific Gravity, Helium Pycnometer	7.04 g/cm^3 (supplier value)
Bulk Unit Weight	170 lb/ft^3 loose, 200 lb/ft^3 packed (supplier values)
Bulk Void Fraction	50% loose, 42% packed (supplier values)

U.S. Sieve No.	(California Mill Run, % Passing)
4	100
8	100
16	81
30	47
50	19
100	7

Average Hydraulic Conductivity	5x10^{-2} cm/sec (laboratory permeameter test)
Measured Porosity	0.4 to 0.45 (laboratory column measurements)

*Only potential health and safety hazard is a small amount of nuisance dust.

SPECIFICATIONS

REMOVAL OF WATER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Providing equipment, materials and labor required to successfully complete the work included in this Section. All equipment shall be properly decontaminated before bringing to site.

B. Maintaining and operating pumps and related equipment, including standby equipment, of sufficient capacity to adequately perform dewatering as required by this Section. The Installation Contractor shall be responsible for any cleanup resulting from a leak or spill from any equipment or machinery supplies.

C. Lowering the groundwater table elevation.

D. Intercepting seepage from excavation slopes.

E. Controlling groundwater flow that may adversely affect excavation or construction activities.

F. Collecting, removing and disposing of all excess groundwater.

G. Collecting, removing, and disposing of all wastewater.

H. Removing and/or disposing of spoil, excess materials, equipment, trash and debris used for or resulting from the work included in this Section.

1.02 REGULATORY REQUIREMENTS

A. Conform to applicable local, state, and federal codes for legal disposal of water.

B. Temporary water supplies shall meet requirements of Local, State and Federal Regulatory Agencies.

C. Conform to applicable OSHA standards.

1.03 WELLPOINT DEWATERING SYSTEM

A. If wellpoint dewatering methods are proposed by Contractor, he shall prepare a plan of dewatering system for review and approval by Owner, Engineer and the NYSDEC. Review or comments by Owner and Engineer concerning the proposed plan shall not relieve Contractor of his responsibilities for dewatering his excavations in conformance with this Section of the Specifications. All water removed must be treated per Article 3.02F.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 PREPARATION

A. Review the Subsurface Investigation Report included in the RI report and become familiar with the groundwater conditions at the site. Allocate sufficient time and use appropriate procedures based on these conditions for dewatering excavations.

3.02 REMOVAL OF WATER

A. Assume responsibility for site, surface and subsurface drainage. Maintain such drainage as specified herein during the life of the contract.

B. Supply all supervision, labor, material, equipment, including standby equipment, necessary to maintain a dry excavation as may be necessary to construct the project.

C. Maintain groundwater level by methods which prevent loss of fines, which preserves the undisturbed state of subgrade soils and which sufficiently lowers the groundwater level in permeable strata at or below excavation and fill levels such that blowing or unstable conditions do not develop in the bottom or sides of excavation or fill areas.

D. Install all drains, ditching, sluiceways, pumping and bailing equipment, wicking, sumps, wells, well points, cutoff trenches, curtains, sheeting and all other equipment and structures necessary to create and maintain a dry excavation.

As part of any dewatering system, observation wells or piezometers shall be provided and installed, as required, to effectively and efficiently monitor drawdown to required levels.

E. The Installation Contractor shall take necessary measures to <u>not</u> contaminate fines by use of the Contractor's equipment.

F. Discharge water must be stored prior to activated carbon treatment (see Article 3.05) and analysis for contaminant levels. Samples of treated water will be collected for analysis using USEPA Methods 601 and 602. Once limits have been met, discharge water will be removed from the site to natural water courses, storm drains or channels, or through recharge to the West Field downgradient of the field test.

1. Large quantities of water shall not be discharged as overland flow.

2. Wastewater shall be disposed of in a manner satisfactory to the local Public Health Officer and the NYSDEC.

G. Dewatering operations shall cease when treatment system has been properly backfilled and compacted, and are safe from damage, flotation, settlement and displacement.

3.03 MAINTENANCE

A. Operate and maintain dewatering and removal operations on a 24-hour basis for the time required to complete that portion of the Work which requires dewatering prior to its construction and which requires protection from flotation or displacement of such Work until proper backfilling and compaction is completed.

3.04 REMOVAL

A. After groundwater levels have returned to elevations appropriate for conditions and time of year, without causing damage to the work, remove all dewatering equipment and related equipment from the site and restore site to original conditions or rehabilitate site to meet requirements of Contract Documents.

3.05 ACTIVATED CARBON TREATMENT SYSTEM

A. Figure A-1 illustrates the carbon adsorption system to be provided by the Installation Contractor and used for treatment of any groundwater recovered during dewatering activities associated with construction of the pilot-scale funnel and gate system.

B. Basis of Design

1. Carbon canisters by Carbtrol or other.

2. Manufacturer: Carbtrol. Model L-1

a. 200-lb. granular activated carbon.
b. Flow rates up to 10 gpm.
c. 24-inch diameter drums.
d. 36-inch height drums.
e. Shipping weight 250 lbs.
f. Inlet and outlet 1-1/4-inch NPT.
g. Heavy duty steel canister, double epoxy lined.

h. Chemically inert internal distribution and collection system.
i. Operating temperatures up to 200 degrees F.
j. Maximum operating pressure 10 psig.
k. Canister NYSDOT approved for handling as hazardous waste.

3. Sampling Location - Sampling valve provided as shown on piping schematic (Figure A-1).

4. Basis of Operation - Treatment is on batch basis. Procedure will follow these steps:

   a. Operator gauges tank before treatment.

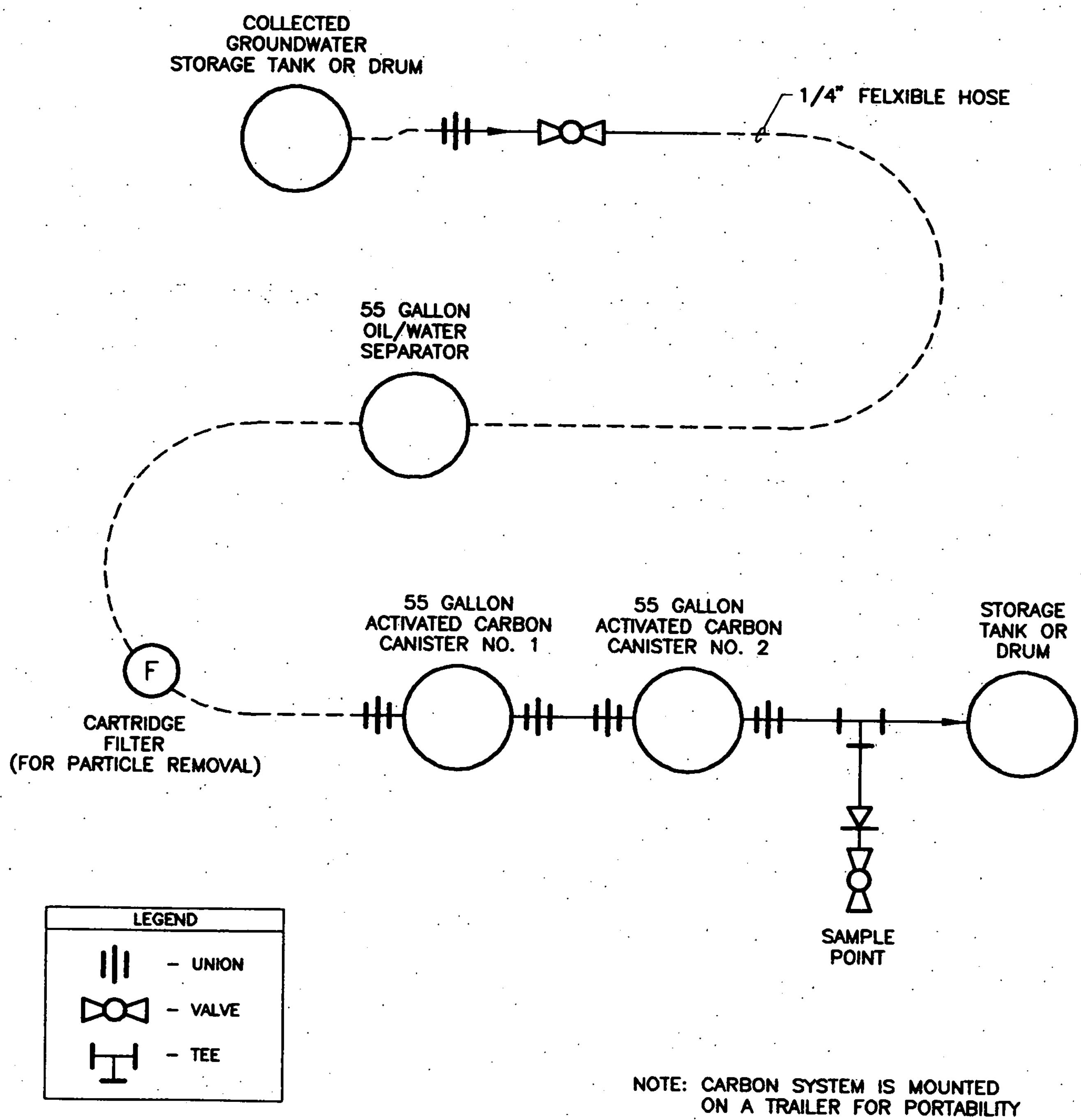
   b. Operating valves are opened to allow wastewater to flow through treatment system.

   c. Sample is taken at Sample Point A and analyzed for regulated constituents.

   d. Following treatment, operator gauges tank to determine volume treated.

   e. Carbon Canister No. 2 is provided for safety factor to prevent discharge of untreated wastewater in the event of "breakthrough" at Carbon Canister No. 1. Estimated volume of wastewater treated by one 55-gallon canister is 24,000 gallons.

END OF SECTION



Stearns & Wheler
ENVIRONMENTAL ENGINEERS & SCIENTISTS

DATE: 1/95 JOB No.: 1587

GENERAL INSTRUMENT CORPORATION
SHERBURNE, NEW YORK
FIELD STUDY WORK PLAN

FIGURE A-1
SCHEMATIC: CARBON ADSORPTION TREATMENT SYSTEM

SPECIFICATIONS

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities - Electricity, telephone service, water, and sanitary facilities.

B. Temporary Controls - Barriers, protection of the Work, water control and Pollution Controls.

C. Construction Facilities - Access roads, parking, and removal of utilities, facilities, and controls.

1.02 TEMPORARY UTILITIES

A. Electricity

1. Connect to existing power service. Power consumption shall not disrupt Owner's need for continuous service.

2. Owner will pay cost of energy used. Exercise measures to conserve energy. Provide separate metering and reimburse Owner for cost of energy used.

3. Provide and maintain adequate lighting for all operations in darkened work areas and at storage areas after dark for security purposes.

1.03 TELEPHONE SERVICE

A. Provide, maintain and pay for separate telephone service to Engineer's field office at time of project mobilization.

B. Engineer will pay for own service.

1.04 TEMPORARY WATER SERVICE

A. Provide and maintain suitable quality water service required for construction operations.

B. Owner will pay cost of water used. Exercise measures to conserve water.

C. Provide sufficient potable quality drinking water for workers at project site.

1.05 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required sanitary facilities and enclosures for use by all persons employed at the site. Existing facilities shall not be used.

B. Remove facilities from site at end of construction.

C. Facilities shall be maintained in conformance with applicable State Regulations and Local ordinances. Contents shall be removed and disposed of in satisfactory manner as occasion requires.

D. Enforce sanitary regulations amongst employees and take precautions against infectious diseases as deemed necessary. Isolate infected employee(s) and arrange for immediate removal of such person(s) from site.

1.06 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, and to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide protection for plant life designated to remain. Replace damaged plant life.

C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

D. Supplement barriers with suitable signs, railings, fencing and night lights, as necessary.

1.07 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion and damage to cultivated vegetation, plants, trees, shrubs, etc.

1.08 PROTECTION OF INSTALLED WORK

A. Protect installed Work from damage and deterioration due to floods driving rain, wind, snow storms or freezing temperatures; provide special protection where specified in individual specification Sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

C. Prohibit traffic over landscaped areas.

D. Owner reserves right to order that additional protective measures be taken beyond those proposed by Contractor, to safeguard the Work.

1.09 ACCESS ROADS

A. Provide and maintain temporary access roads to project site as follows:

1. Construct roads along designated rights-of-way to connect public thorough fare(s) with construction area.

2. Extend and relocate roads as work progress requires. Provide detours as necessary for unimpeded traffic flow.

3. Roads shall be free for use by all personnel involved in project, and be adequate for transportation of persons, materials, equipment and products to construction area.

4. Maintain roads in serviceable condition, free of obstructions, potholes, ponded water, debris, accumulated snow and ice, until completion of project or until permanent access roads are installed.

5. When no longer required, remove roads and restore disturbed areas to site owner's requirements as agreed to by Owner.

B. Designated existing on-site roads may be used for construction traffic.

1.10 PARKING

A. Construct temporary gravel surface parking areas to accommodate all construction personnel involved with project.

B. When site space is not adequate, provide additional off-site parking.

C. Designate one parking space for the Engineer and identify same with appropriate signs for each space.

1.11 PROGRESS CLEANING

A. Store unused tools and equipment at Contractor's yard or base of operations.

1.12 POLLUTION CONTROLS

A. Dust Control

1. Execute Work by methods to minimize raising dust from construction operations.

2. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

3. All dust control methods shall follow NYSDEC guidelines.

B. Erosion and Sediment Control

1. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas.

2. Minimize amount of bare soil exposed at one time.

3. Provide temporary measures such as berms, dikes, and drains, to regulate water flow and prevent soil erosion.

4. Periodically inspect earthwork in disturbed areas to detect evidence of erosion and sedimentation; promptly apply corrective measurer.

C. Noise Control

1. All construction equipment and tools exhibiting potential noise nuisance shall be provided with noise muffling devices.

2. Confine use of such equipment and tools during regular working hours.

D. Pollutants Control - Provide methods, means and facilities to prevent contamination of soil, water and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.13 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

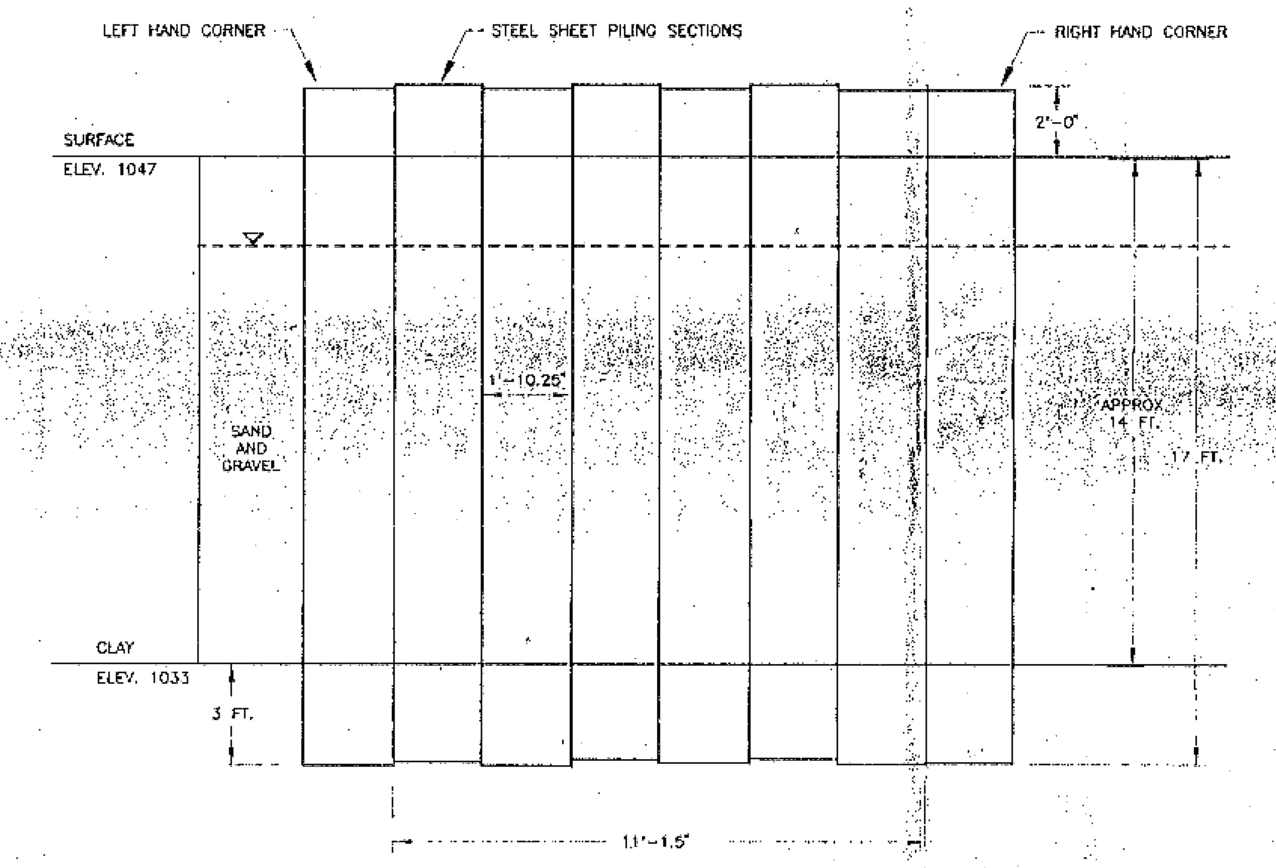
A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment.

B. Remove temporary controls, barriers, enclosures, etc. in concert with completion of those segments of Work which no longer require such measures.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

END OF SECTION

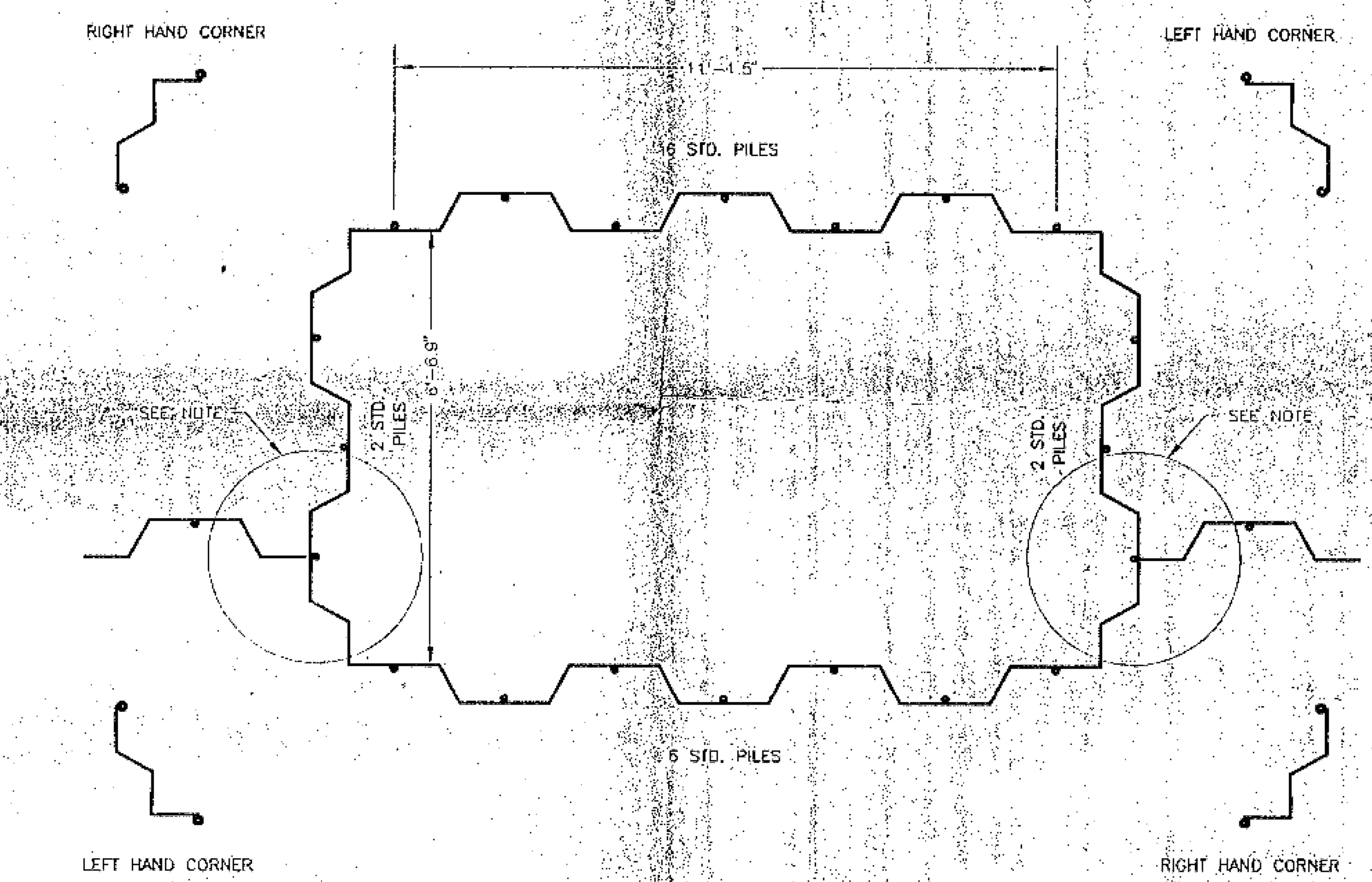


SECTION

SEE RI SUBSURFACE INVESTIGATION & BORING LOGS FROM PRE-CONSTRUCTION FIELD WORK

SYSTEM CROSS-SECTION – FINAL ELEVATIONS OF SHEET PILING

NOTE: SHEET PILING SECTIONS TO BE A MINIMUM OF 3 FT. INTO CLAY LAYER.



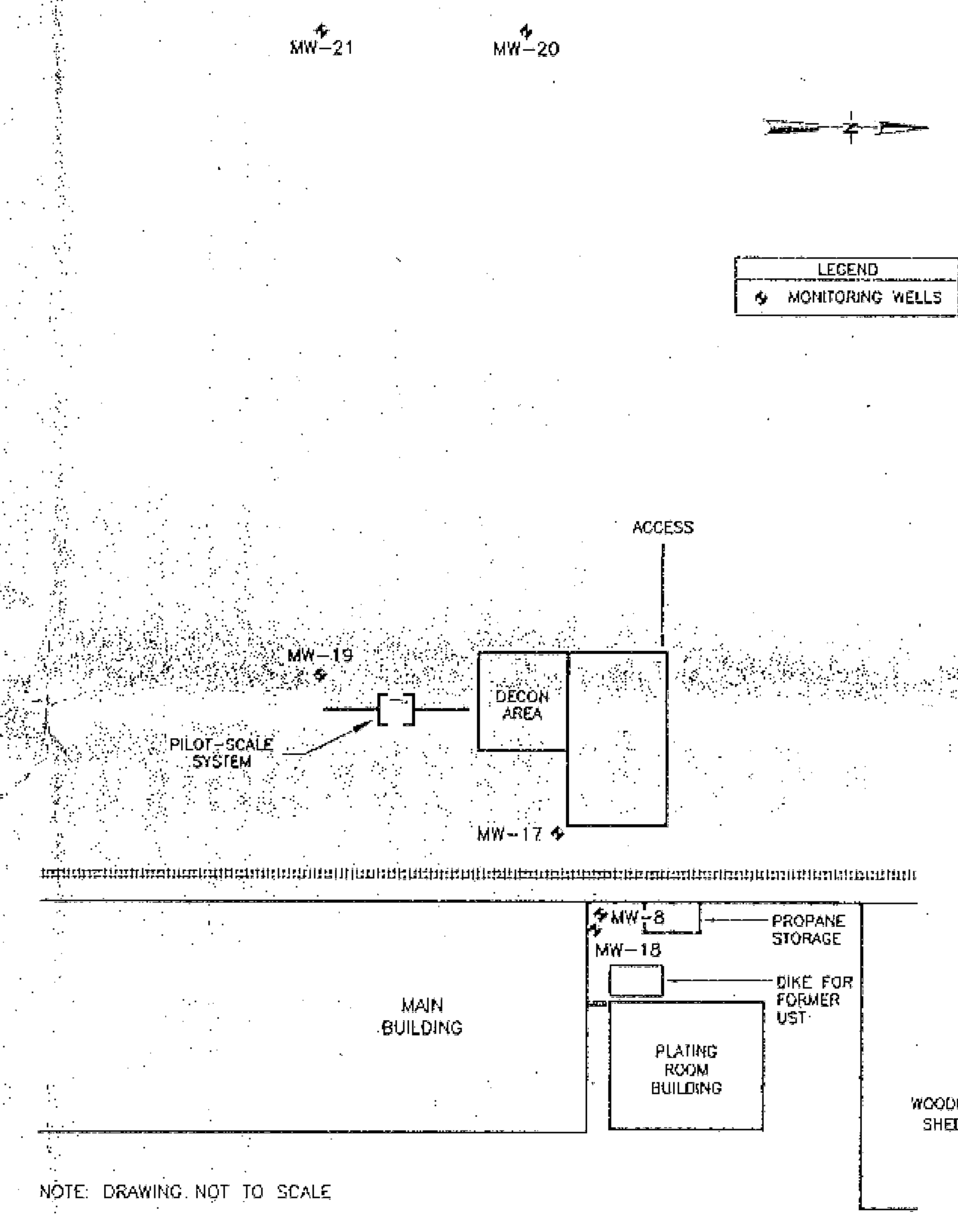
PLAN VIEW PILING LOCATION PRIOR TO EXCAVATION

MATERIAL LIST: (WZ75)

32 STANDARD PILES
2 STANDARD L.H.C.'s
2 STANDARD R.H.C.'s

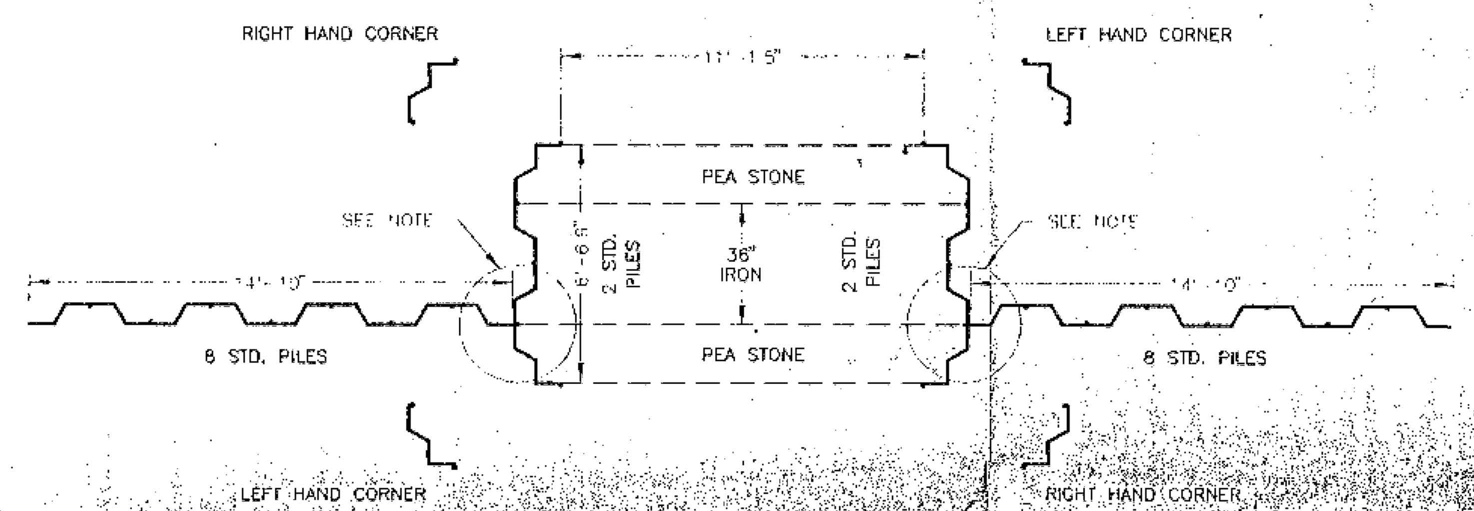
NOTE: "I" SECTIONS TO BE PROVIDED BY SHEET PILING SUPPLIER. DIMENSIONS IN FEET AND INCHES.

CONTRACTOR TO REMOVE 6 STANDARD PILES FROM BOTH 11'-1.5" SIDES WHEN IRON AND PEASTONE FILL OPERATION IS COMPLETED. SHEET PILING SECTIONS ARE TO BE REUSED FOR CUT OFF WALLS IN FINISHED PLAN VIEW.



NOTE: DRAWING NOT TO SCALE

LOCATION OF TREATMENT SYSTEM

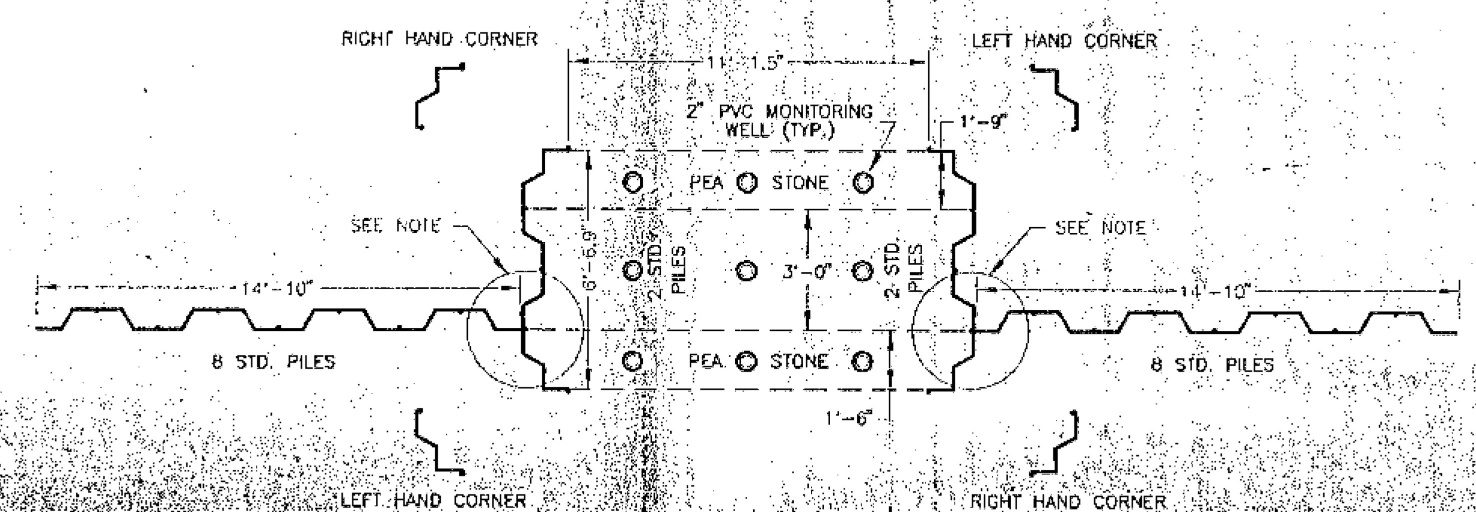


FINISHED PLAN VIEW

MATERIAL LIST: (WZ75)

20 STANDARD PILES
2 STANDARD L.H.C.'s
2 STANDARD R.H.C.'s

NOTE: "I" SECTIONS TO BE PROVIDED BY SHEET PILING SUPPLIER. DIMENSIONS IN FEET AND INCHES.



FINISHED PLAN VIEW WITH WELL LOCATIONS

MATERIAL LIST: (WZ75) (MINIMUM)

20 STANDARD PILES
2 STANDARD L.H.C.'s
2 STANDARD R.H.C.'s

NOTE: "I" SECTIONS TO BE PROVIDED BY SHEET PILING SUPPLIER. DIMENSIONS IN FEET AND INCHES.

NOTE: PROPOSED TREATMENT SYSTEM DIMENSIONS MAY BE MODIFIED DUE TO ANALYSIS OF FIELD SURVEY AND SLUG TEST DATA.

NOTES:

Underground facilities, structures, and utilities have been plotted from available surveys and records, and therefore their locations must be considered approximate only. There may be others, the existence of which is presently not known.

It is a violation of New York State Education Law for any person, unless acting under the direction of a licensed professional engineer, to alter an item on this drawing in any way. If an item is altered, the altering engineer shall affix to the item his/her seal and the notation "altered by" followed by his/her signature and the date of such alteration, and a specific description of the alteration.

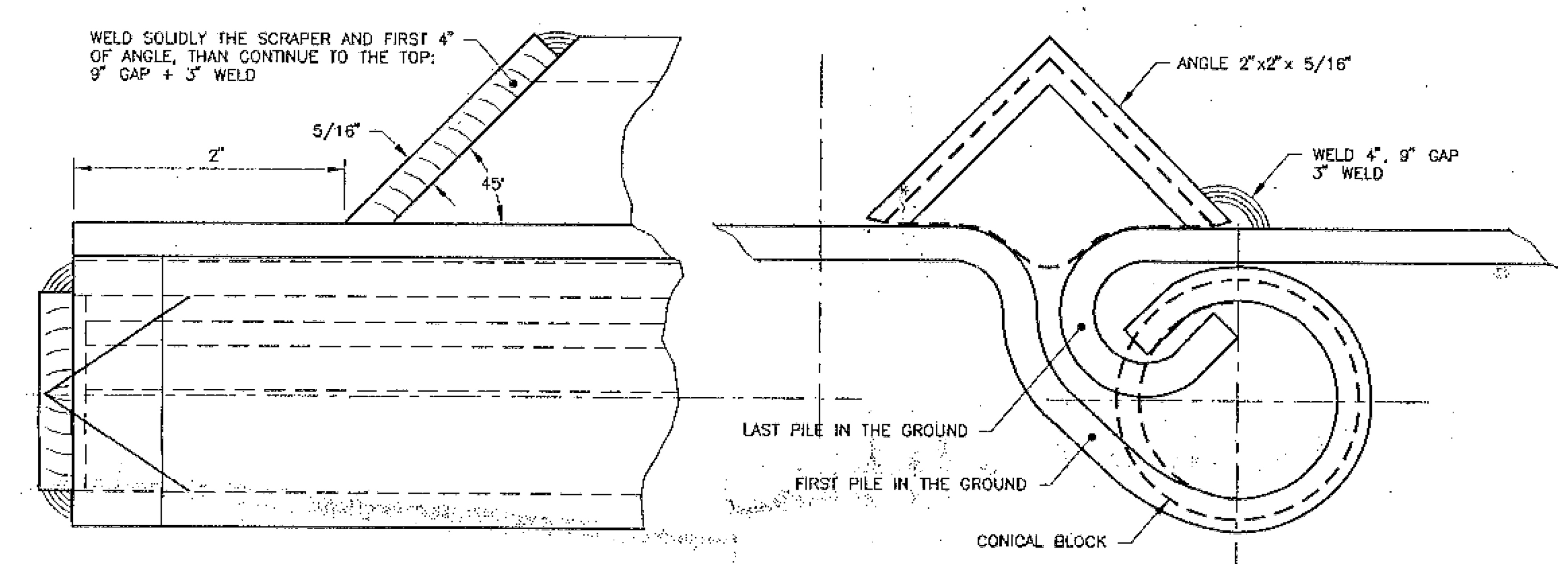
ISSUE NO.	DRAWN	DATE	CHECKED	DESIGNER	APPROVED	DATE
2	FOR CONSTRUCTION		DKC			
1	FOR APPROVAL					
	DW	10/94	DKC	DKC		

PROJECT SUPERVISOR / DEPARTMENT SUPERVISOR

Stearns&Wheler
ENVIRONMENTAL ENGINEERS & SCIENTISTS

SHERBURNE, NEW YORK
GENERAL INSTRUMENT CORPORATION
IN SITU TREATMENT SYSTEM
PLAN AND SECTIONS

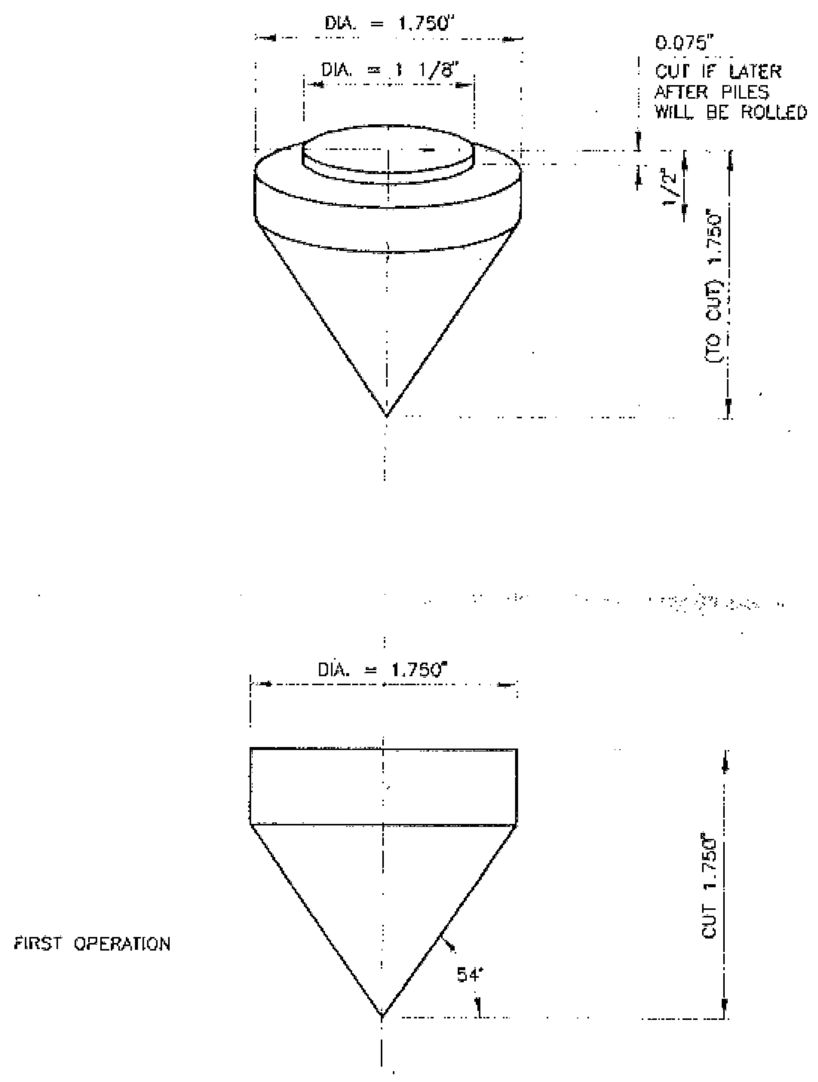
JOB NO. 1587 | CONTRACT 1 | SHEET 1 OF 2



NOTE:
ON THE FIRST PILE OF CLOSED CELL BLOCK THE BOTTOM OF OPEN CAVITY WITH CONICAL BLOCK.
THE LAST-CLOSING PILE HAS ON ONE SIDE REGULAR SCRAPER (SEE DETAIL) AND ON OTHER SIDE WELDED ANGLE.

DETAIL CLOSED CELL FROM WZ75 PILES (START & FINISH)

SCALE: 1:1

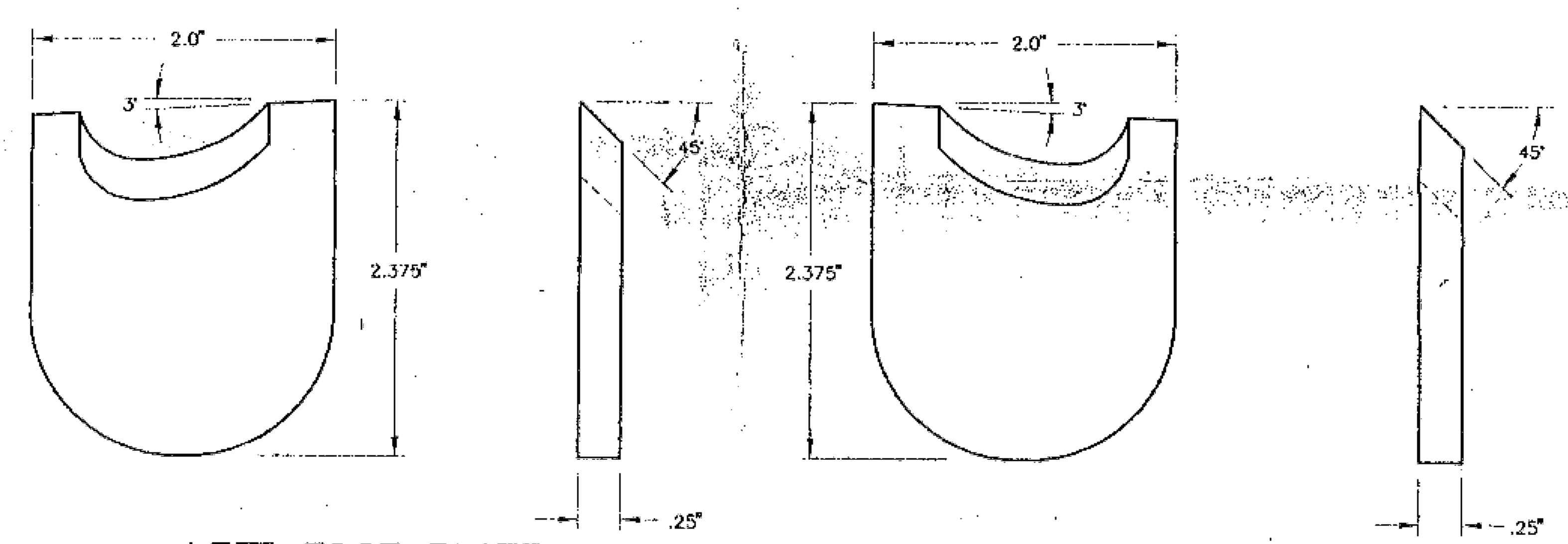


CONICAL BLOCK

SCALE: 1:1

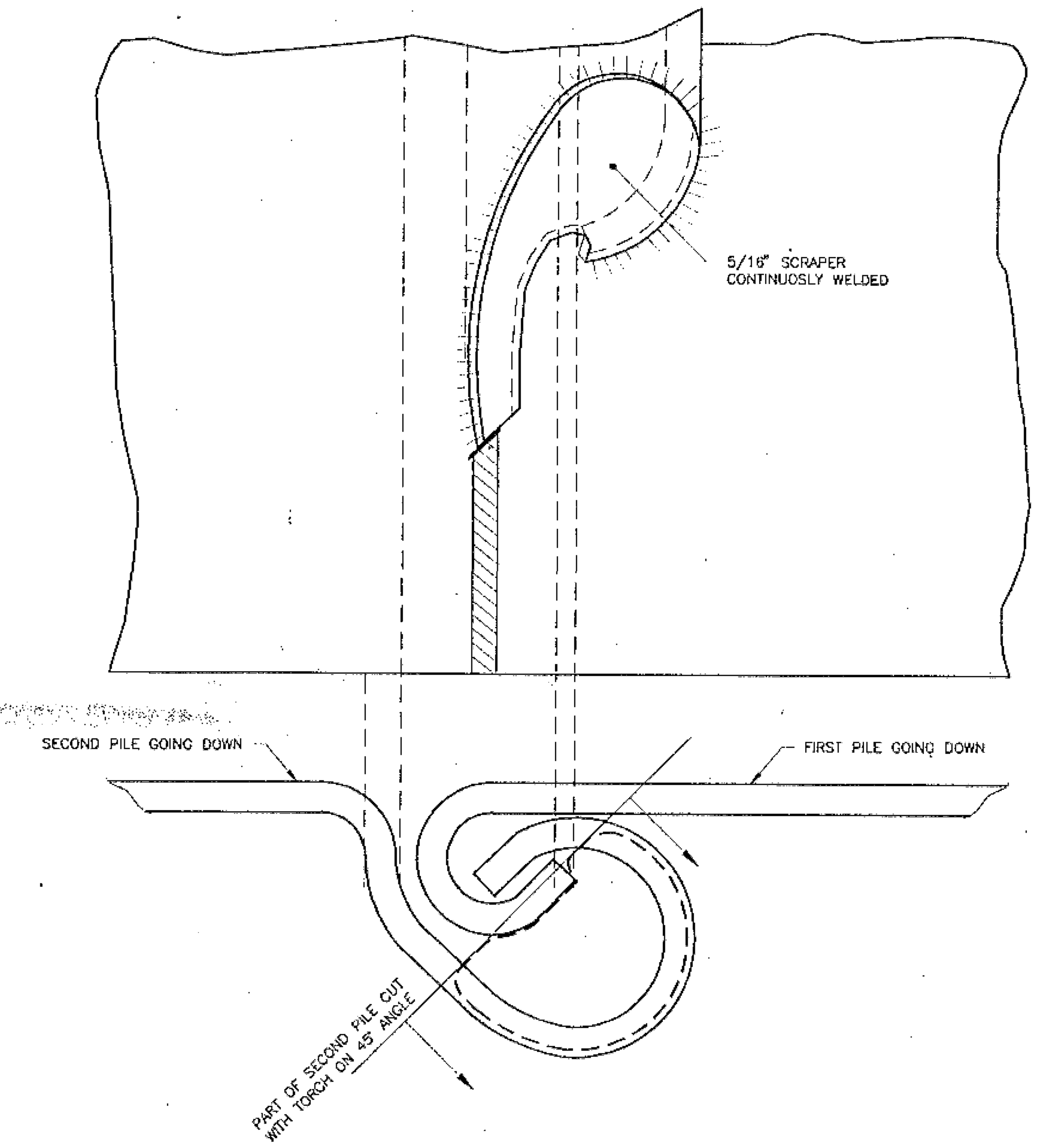
NOTES:
DIMENSIONS IN INCHES.
TO BE USED IF SHEET PILING IS TO BE DRIVEN IN PAIRS.

TO BE USED AS DRIVING POINT FOR INSTALLATION OF FIRST PILE.



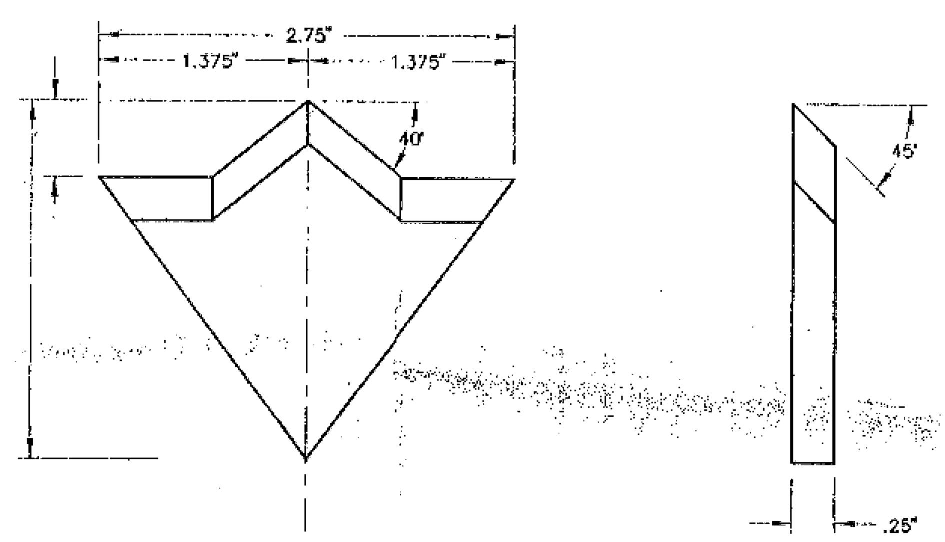
LEFT FOOT PLATE
FOR LEFT HANDED PILES

RIGHT FOOT PLATE
FOR RIGHT HANDED PILES



SCRAPER ON WZ75 PILES

SCALE: 1:1



FOOT PLATE TO BE USED FOR LAST PILE OF CLOSED CELL

DETAIL WATERLOO BARRIER – FOOT PLATES FOR WZ75 PILES

SCALE: 1:1

NOTES:

Underground facilities, structures, and utilities have been plotted from available surveys and records, and therefore their locations must be considered approximate only. There may be others, the existence of which is presently not known.

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ISSUE NO.	DRAWN	DATE	CHECKED	DESIGNER	APPROVED	DATE
2	FOR CONSTRUCTION		DKC		WJH	4/26/95
1	FOR APPROVAL: DW	10/94	DKC	DKC		

PROJECT SUPERVISOR Diane K. Clark DEPARTMENT SUPERVISOR

ISSUE NO.	DRAWN	DATE	CHECKED	DESIGNER	APPROVED	DATE

STATE OF NEW YORK · LICENSED PROFESSIONAL ENGINEER

Stearns&Wheler
ENVIRONMENTAL ENGINEERS & SCIENTISTS

SHERBURNE, NEW YORK
GENERAL INSTRUMENT CORPORATION

SEALABLE SHEET PILING DETAILS

JOB NO. 1587 CONTRACT 1 SHEET 2 OF 2

APPENDIX B

RATIONALE FOR SUGGESTED DESIGN AND MONITORING PROGRAM PILOT-SCALE TESTING FIELD TRIAL OF THE ENVIROMETAL PROCESS

Prepared by EnviroMetal Technologies, Inc.

Revised Draft
Rationale for Suggested Design and Monitoring Program
Pilot-Scale Field Trial of the EnviroMetal Process
General Instrument Corporation (GIC) Facility
Sherburne, New York

1.0 BACKGROUND

Bench-scale treatability studies of the EnviroMetal process (metal enhanced reductive dahalogenation) have shown that this technology can degrade the volatile compounds (VOCs) present in groundwater at the GIC facility, Sherburne, New York. Tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), vinyl chloride (VC) and 1,1,1-trichloroethane (TCA) were degraded in laboratory column studies which simulated conditions of groundwater flow. The rapid rates of degradation indicated that the technology could possibly be employed cost-effectively *in-situ* to remediate groundwater contamination at this site. The purpose of this field trial will be to confirm the technology's performance under field conditions, as outlined below.

2.0 OBJECTIVES

The objectives of the field trial are as follows:

i) to evaluate the rate of VOC degradation under field conditions;

ii) to evaluate the effects of inorganic geochemical changes on field performance of the technology, specifically the extent and effects of any mineral precipitation;

iii) to evaluate the effects of the *in-situ* installation on existing groundwater flow patterns;

iv) using data from (i), (ii), and (iii), together with the construction costs, to evaluate the feasibility and cost-effectiveness of this technology in remediating the entire plume; and

v) to develop design parameters for full-scale technology implementation.

3.0 RATIONALE FOR DESIGN

The design of the *in-situ* installation to be tested at the GIC facility (henceforth referred to as the "site") is based on the assumed concentrations of VOCs which will enter the treatment zone, the VOC degradation rates measured during the laboratory column tests, and the predicted groundwater velocity through the *in-situ* treatment zone based on a groundwater modeling study.

3.1 Required Residence Time

The assumed influent TCE, cDCE and VC concentrations given below have been specified by the NYSDEC. Using the appropriate degradation rate and water quality criterion for each VOC, the required residence time in reactive media (100% granular iron) can be determined, as shown below. The degradation rate is expressed in terms of the measured half-life of the contaminant (the time required to decrease the VOC concentration by 50%).

VOC	Initial Concentration (ppb)	Half-Life (hrs)	Required Residence Time (hrs)
TCA	96[a]	3.0	12.9
PCE	90[a]	0.5	2.1
TCE	529	0.2	1.3
cDCE	5,650	3.9	39.1
VC	220 + 60[b] = 280	2.1	15

[a] - data from well MW-17
[b] - assumes ±1% of (TCE + cDCE) will appear as VC.

From the above, it is likely that TCA, PCE, and TCE will degrade in the 39.1 hr residence time calculated for cDCE degradation. Although some VC degradation will likely occur concurrently with cDCE, this design takes the conservative approach of assuming no VC degradation will occur until the cDCE completely degrades. Therefore the total residence time assumed to be needed for VOC degradation in a reactive treatment zone is 39.1 + 15 = 54.1 hours, or 2.3 days.

3.2 Groundwater Modeling

3.2.1 Model Description

The groundwater flow model FLOWPATH was used to examine the effect of installation of a "funnel and gate" *in-situ* treatment zone on existing groundwater flow patterns in the field west of the facility buildings at the site. The main objective of this modeling exercise was to determine the residence time of groundwater in an *in-situ* permeable treatment zone (or gate), given existing aquifer characteristics and the installation of impermeable "funnels" and a permeable "gate" of given dimensions. The width of the upgradient aquifer captured and treated by the *in-situ* system was also evaluated.

FLOWPATH is a two-dimensional steady-state groundwater flow model which includes a particle tracking routine to calculate groundwater pathlines and travel times. The shallow aquifer at the site was modelled as a homogeneous aquifer using a plan-view model domain of 80 feet parallel to groundwater flow by 160 feet perpendicular to groundwater flow. The following aquifer characteristics were used as inputs into the model, based on hydrogeologic data from well MW-17 (the well nearest the proposed installation) supplied by Stearns & Wheler.

• hydraulic conductivity	102 ft/day ($3.6x10^{-2}$ cm/sec)
• horizonal gradient	0.002
• porosity	0.33

Two pilot-scale designs were simulated for this system. The first design as shown in Figure 1 consists of a square central permeable treatment zone of iron 3.5 feet on a side (perpendicular to flow) flanked by 15 feet of sheet piling on either side. The size of the treatment zone was based on an initial estimate of the length of treatment zone which would provide the residence time needed, given the anticipated increase in groundwater velocity. The reactive iron in the centre section is separated from the aquifer material both on the upgradient and downgradient sides by a section of pea gravel. The pea gravel acts to terminate the effects of any high conductivity zones present in the aquifer upgradient of the gate by spreading this flow vertically, and also provides a location for installation of monitoring wells.

A significant portion of the cost associated with the installation of a pilot-scale funnel and gate involves the cost of equipment mobilization and construction. We therefore examined the cost and feasibility of increasing the permeable treatment zone width with a goal of increasing the width of plume treated by the pilot-scale installation while not greatly increasing costs. We modelled this case using the same aquifer and 100% iron properties, and increased width of the gate (Figure 1) from 3.5 feet to both 10 and 20 feet perpendicular to flow.

The hydraulic conductivity of the pea gravel was assumed to be 2,830 ft/day (1 cm/sec), and values of hydraulic conductivity and porosity based on a number of laboratory tests were used for the reactive iron. For 100% iron, a hydraulic conductivity of 142 ft/day ($5x10^{-2}$ cm/sec) and a porosity of 0.40 were used. The sheet pile funnels were assigned a hydraulic conductivity of $2.8x10^{-3}$ ft/day ($1x10^{-6}$ cm/sec).

Results of the model runs are summarized in the following table.

Gate Width (ft)	Width of Plume Captured (ft)	Distance Groundwater Levels Affected Upgradient (ft)	Residence Time in Central Treatment Zone (days)
3.5	12	±20 to 25	2[a]
10	21	±20 to 25	3[b]
20	32	±25	4 to 5[a]

[a] - 3.5 feet thick
[b] - 3 feet thick

Figure 2 shows the capture zone upgradient of a 10 foot wide permeable gate containing 100% iron. Residence times in the reactive iron zone were determined using the approach shown in Figure 2. For the 3.5 foot square iron zone, a minimum residence time in the reactive zone of about 2 days was determined from the particle tracking routine. This increased to 3 days for the 10 foot wide, 3 foot thick gate and to about 4 to 5 days for the widest (20 foot wide x 3.5 feet thick) gate. Upgradient "capture zone" widths of about 12 feet, 21 feet and 32 feet were determined for 3.5 foot wide, 10 foot wide, and 20 foot wide gates respectively.

3.3 Recommended Design

A recommended design for the pilot-scale installation is shown in Figure 3. It consists of a 10 foot wide gate flanked by 15 feet of sheet piling on either side. The central reactive iron zone is 3 feet thick and flanked by about 1.75 feet of pea gravel on either side. Based on modeling results, this design should allow for 3 days of groundwater residence time in the reactive zone of the gate. The monitoring well network proposed for this system is also shown in Figure 3, and is described in Section 5.

Because of the nature of the reaction (i.e., a first order process) it is difficult to attribute a single numerical "safety factor" to this design. It is perhaps more appropriate to consider the following:

i) cDCE concentrations near the pilot-scale installation may be as much as an order of magnitude lower than the concentration used to determine the 2.3 day required residence time.

ii) Within the three day residence time in the 10 foot wide, 3 foot thick iron zone, double the 5,650 ppb cDCE concentration and any additional VC produced could be treated (degraded), if the degradation rates measured in the laboratory occur in the field.

iii) Degradation rates could decline by as much as 1.25 times those measured in the laboratory and state MCLs could still be met downgradient of the reactive zone, if the influent VOC concentrations discussed in Section 3.1 indeed occur, and 3 days residence time occurs in the reactive zone.

iv) relatively conservative (i.e., high) values of aquifer hydraulic conductivity and gradient were used to determine the residence times in the reactive zone. If lower values of these input parameters are used in the groundwater flow model, the residence time in the reactive zone increases.

Given the above, a three foot thickness of reactive iron should provide for adequate degradation of VOCs at the proposed location. In any event, field monitoring data will allow the various assumptions made in this design to be evaluated, as described in Section 5.0.

4.0 ASPECTS OF DESIGN DISCUSSED AT THE MEETING OF 7 JULY 1994

The following information is provided in response to questions posed by NYSDEC staff at our meeting of 7 July 1994.

4.1 Non-Halogenated Reaction Products

Based on research to date, the major end-products of the metal-enhanced degradation of chlorinated aliphatic compounds are ethene and ethane, with smaller amounts of methane and other non-chlorinated hydrocarbon gases. Information regarding the persistence and toxicity of ethane and ethene was requested at the meeting.

Ethane and ethene have very high solubilities in water (60.4 mg/L and 121 mg/L respectively at 20°C). Therefore there is little chance of dissolution of these gases from groundwater at the site, given initial VOC concentrations. Ethene and ethane are considered highly biodegradable in subsurface environments relative to chlorinated VOCs. It is anticipated that significant biodegradation of these compounds will occur within a few days of travel time in the aquifer downgradient of the gate.

Aqueous toxicity data for ethene and ethane are sparse as most toxicity measurements involving these compounds have examined the potential effects of gas phase. A brief review of the scientific literature produced the data contained in Appendix A. From these data, we expect no risk to human health to occur due to the production of ethane and ethene as a result of VOC degradation at the site.

4.2 Production of 1,2DCA From 1,1,1-TCA Degradation

As noted at the meeting, small amounts of 1,2-dichloroethane (1,2DCA) may be produced as a result of 1,1,1-trichloroethane (1,1,1TCA) degradation using this technology, and we have been unable to date to promote 1,2DCA degradation with the reactive iron to be used at the site. Fortunately, no 1,2DCA was detected above the method detection limit of 3.2 μg/L due to the degradation of 10 to 20 μg/L of 1,1,1TCA during the laboratory study. Given the above, and expected influent concentrations of 1,1,1TCA in the groundwater at the site (20 to 100 ppb); we expect that the production of 1,2DCA in concentrations exceeding the state MCL is unlikely. The possible production of 1,2DCA will be evaluated during the field trial.

4.3 "Funnel" Hydraulic conductivity

Questions were raised at the meeting regarding the hydraulic conductivity which could reasonably be expected to be obtained with the sealable sheet piling, and how this hydraulic conductivity related to the groundwater model results. Several tests of the sealable sheet piling at research sites in Ontario (Starr *et al.*, 1992) and at other facilities in the U.S. have indicated that the hydraulic conductivity of the sealable sheet piles ranges from 10^{-7} to 10^{-9} cm/sec. Given the shallow installation depth and aquifer materials present at this site, the contractor is confident that a hydraulic conductivity in this range can be achieved.

The groundwater model used to date incorporated a sheet piling hydraulic conductivity of 10^{-6} cm/sec, as described in Section 3.2. These results showed that the sheet piling will serve its purpose (i.e., to direct groundwater through the reactive zone or gate) even if the hydraulic conductivity is this high. Model results for another study showed that varying the funnel hydraulic conductivity between 10^{-6} and 10^{-8} cm/sec had no significant effect on upgradient capture zone width, or residence time in the reactive zone of the gate.

5.0 PROPOSED MONITORING PROGRAM

5.1 Monitoring Well Locations

We suggest that monitoring wells serving three somewhat distinct purposes be installed at the locations shown in Figure 4:

1. Two compliance monitoring wells, to satisfy the NYSDEC that VOC concentrations egressing the gate are meeting relevant water quality criteria. These wells would be screened across the total vertical length of the reactive zone. Results from the wells screened in the pea gravel on the upgradient and downgradient sides of the reactive zone will be compared to evaluate the degree of VOC remediation occurring. A third compliance monitoring well, installed 5 feet downgradient of the funnel and gate, will be used to evaluate the persistence of inorganic geochemical changes caused by the reaction (i.e., high pH, and possibly high dissolved iron) in the groundwater. It is thought that the pH of the groundwater will quickly decrease to "background" values downgradient of the reactive zone due to the buffering activity of the aquifer sediments.

2. "Process monitoring" wells would be installed in the gate and screened as described above. Data from these wells, together with the data from the compliance monitoring wells, would be used to generate 3 point curves of VOC concentration vs. distance profiles. These profiles, together with groundwater velocity measurements (see below) will allow VOC degradation rates to be calculated. Data from the wells in the middle of the reactive zone could also be used to evaluate the wall thickness needed in full-scale applications, if non-detectable levels are measured in the compliance monitors at the downgradient side of the reactive zone. Process monitors downgradient of the funnel and gate would be used to evaluate the persistence of inorganic changes in groundwater egressing the gate, as described above.

3. Piezometers which will monitor groundwater flow patterns upgradient of the gate. Groundwater level measurements from these wells will be used to evaluate the extent of groundwater mounding upgradient of the installation and the width of the aquifer captured by the system. Hydraulic conductivity tests will also be performed on these wells to obtain more information on aquifer characteristics. The wells will be

screened (using long screens) across the water table in the shallow aquifer. Water levels will also be taken in the compliance monitoring and process monitoring wells. These groundwater levels will be used to define the groundwater flow pattern in the vicinity of funnel and gate, permitting calculation of the horizontal groundwater velocity through the reactive zone. If these measurements produce an unusual and/or unexpected flow pattern, we suggest that velocity measurements also be made in individual wells using point dilution techniques and/or downhole velocity meters. References describing these techniques are given in Appendix B. Pending state approval, a tracer test using a conservative tracer such as bromide could also be used to evaluate groundwater flow patterns. Groundwater velocities and the capture zone width determined from the field data will be compared to groundwater model results to determine the accuracy of the model and therefore its usefulness in modeling full-scale technology application (i.e., multiple funnels and gates).

5.2 Sampling Program

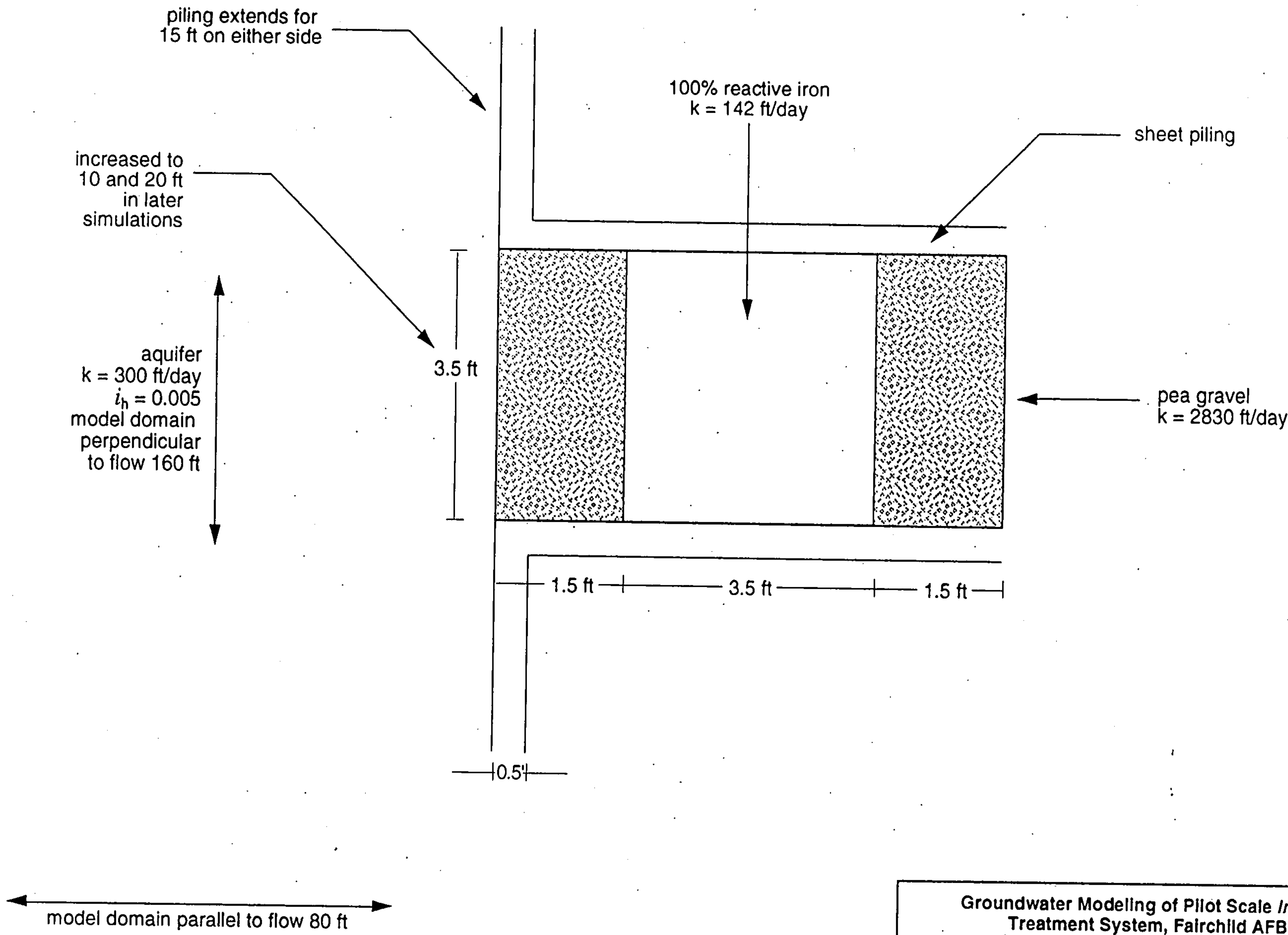
Usually 20 to 30 pore volumes of flow are required for steady-state conditions to be established in reactive media during laboratory studies. Given the calculated residence time of groundwater in the gate (about 3 days), it is likely that geochemical data gathered after two to three months of operation will be more representative of long-term performance than data obtained soon after the test is initiated. The test should run for a minimum of six months to adequately evaluate the field application of the technology..

We suggest that the compliance monitoring wells and process monitoring wells be monitored monthly for the VOCs of concern, and the following inorganic parameters:

- Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Fe^{+2}, Mn^{+2}, SO_4^{-2}, Cl^{-}, HCO_3^{-}, NO_3^{-}

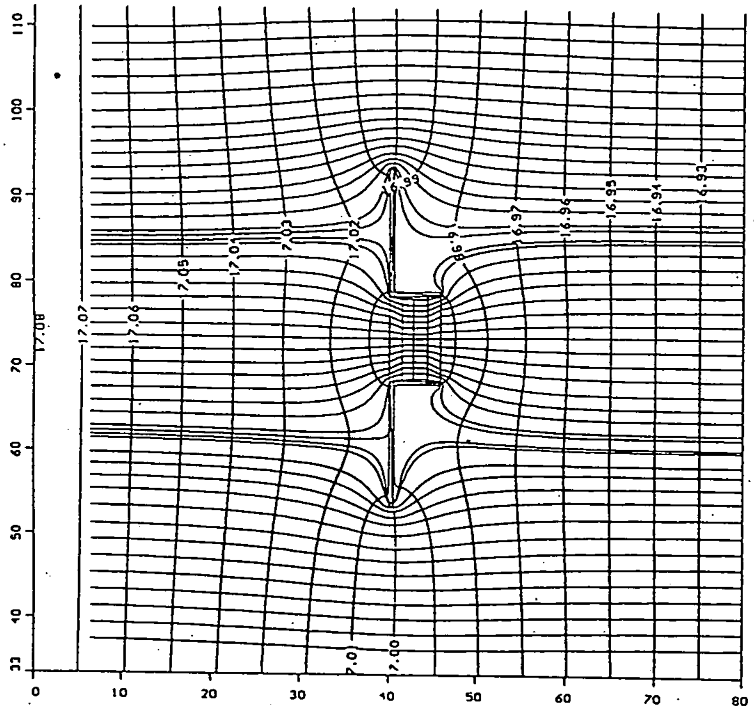
In addition, wells would be monitored biweekly for pH, Eh, specific conductance, dissolved oxygen and temperature (field measurements). The use of measured VOC concentrations to determine regulatory compliance and VOC degradation rates is described above. The inorganic data will be used to gauge the extent of mineral precipitation occurring in the reactive zone. In order to accurately evaluate groundwater level changes due to funnel and gate installation, we suggest that water levels in all wells be monitored every two weeks following construction.

If the budget of the SITE program permits, the nine wells in the reactive gate structure could be sampled for microbial populations using phospholipid/fatty acid analyses upon installation, after three months, and after six months. This analytical technique is described in more detail in Appendix C. These data would be used to evaluate the extent of biological activity in the reactive zone. Although results from other field trials have indicated that bacterial growth is not enhanced in the reactive iron, more data is necessary to better evaluate the potential for biofouling of the treatment zone.



Groundwater Modeling of Pilot Scale *In-situ* Treatment System, Fairchild AFB Base Case Material Properties		
envirometal technologies inc.	Figure 1	April 1994 Rev. 00

envirometal



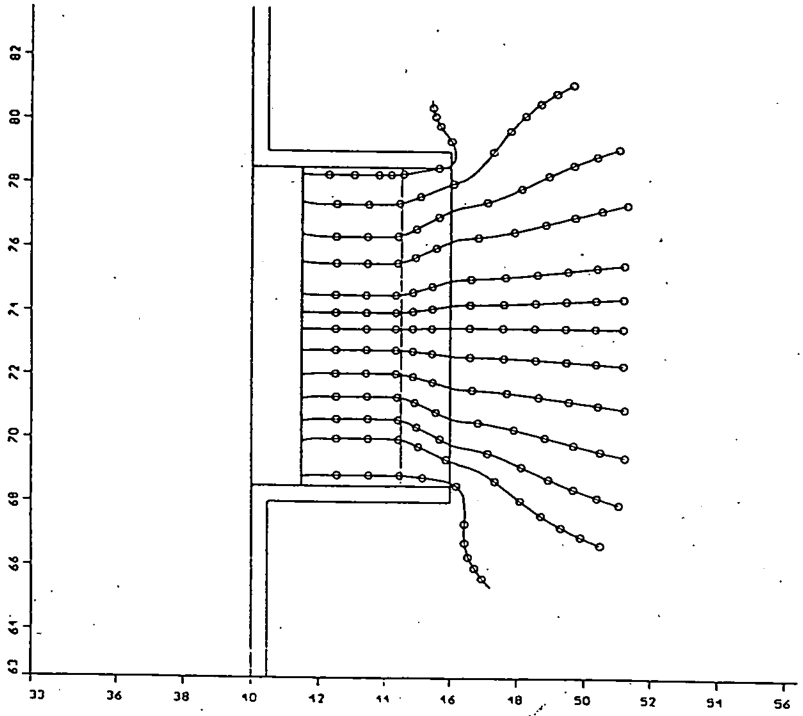
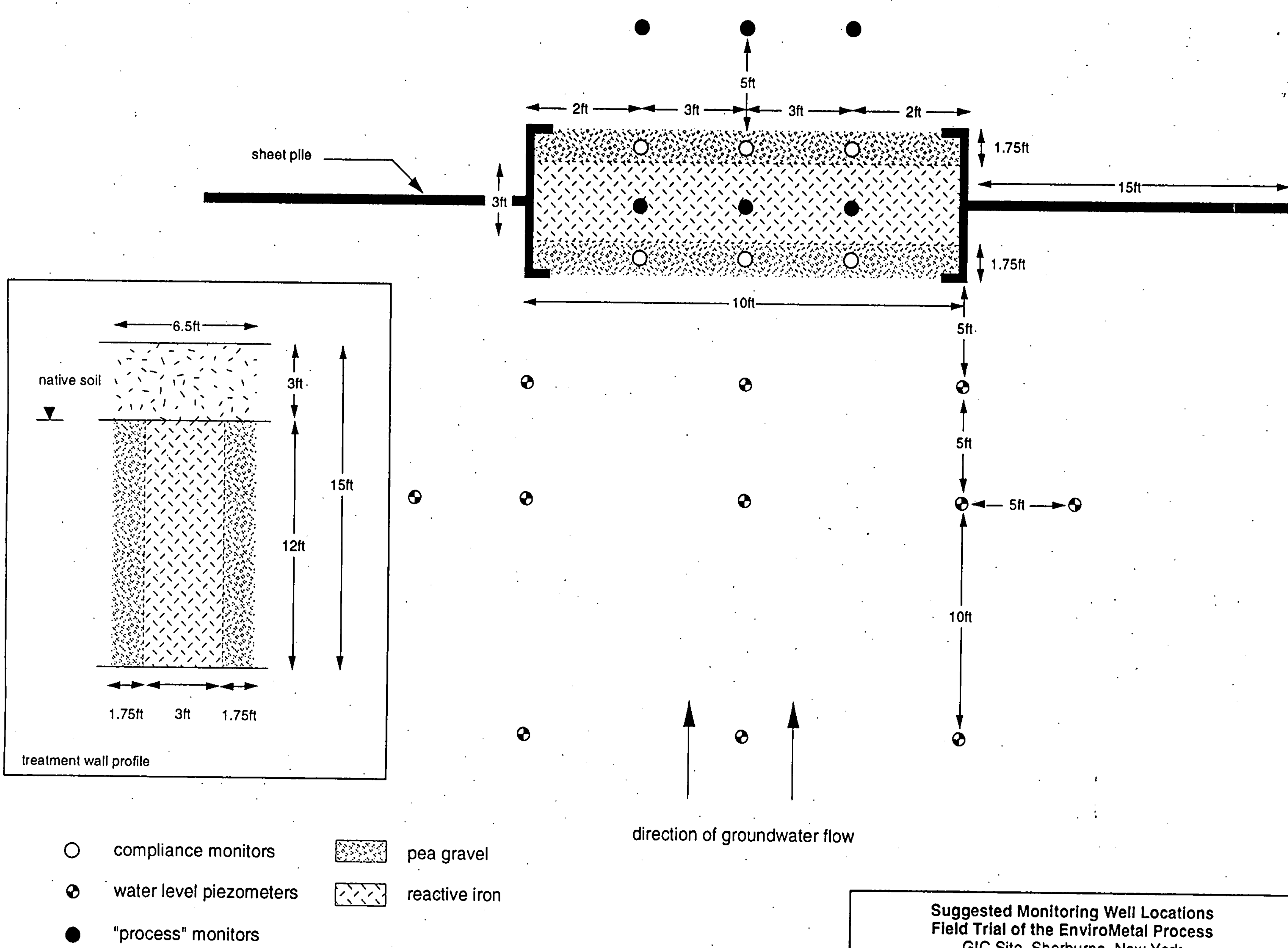


Figure 2 - Determination of residence time and upgradient treatment zone width, 10 foot wide gate, GIC facility. Pathlines determine treatment zone width (about 20-21 feet). Particles are released at the upgradient boundary of the central reactive zone, and their position is mrked at specific time intervals (in this case, 1, 2, 3, 3.5, 4, 5, 6, 7, 8, 9, 10 days)



Suggested Monitoring Well Locations
Field Trial of the EnviroMetal Process
GIC Site, Sherburne, New York

envirometal technologies inc.	Figure 3	June 1994 Rev. 00

envirometal

Appendix A - Data regarding ethene and ethane toxicity

Ethelyne

Aquatic Toxicity

-aquatic toxicity rating: TLm95 (95 % threshold limit) = 1,000 - 100 ppm
-no other data (due to volatility)

Human Toxicity

-mildly toxic by inhalation
-a high concentration can cause anesthesia, nacrosis, unconsciousness
-simple asphyxicant
-no significant physiological properties are reported for exposed workers
-minimum acute toxicity concentrations:
air health = $5.7x10^6$ ug/m^3;
water health = $8.6x10^7$ ug/l;
air ecology = 1.00 ug/m^3;
water ecology = 10^4 ug/l

Plant Toxicity

-phytotoxic
-ethylene is produced naturally by plants as a plant hormone
-0.04 ppm for 3 - 4 hrs is reported to cause leaf epinasty in tomato
-exposure to 0.001 ppm for 1 day has resulted in leaf epinasty in African marigold
-ethylene is the only hydrocarbon that should have adverse effects on vegetation in ambient
-concentrations of 1 ppm or less
-also exposure to 2 and 4 pm for 72 hrs produce growth retardation in *Narcissus* species

Environmental Quality Guidelines

-common air contaminant
-water pollution factor; organopletic limit = 0.5 mg/L

Ethane

Human Toxicity

-a simple asphyxiant, very flammable in gas form
-a narcotic in high concentrations
-biological effect man: no effect level < 50,000 ppm
-air pollution factor = 1 mg/cu m = 0.80 ppm, 1 pp = 1.25 mg/cu m
-BOD^{25} = 2.45
-ThOD = 3.73
-no significant physiological effects are reported for exposed workers
-ethane participates to a very limited extent in photooxidation reactions

Appendix B - References concerning in-situ velocity measurements

REFERENCES REGARDING *IN-SITU* GROUNDWATER VELOCITY MEASUREMENTS

Grisak, G.E., Merritt, W.F., and Williams, D.W. 1977. A fluoride borehole dilution apparatus for groundwater velocity measurements. Canadian Geotechnical Journal, v. 14, pp. 554-561.

Halevy, E., Moser, H., Zellhofer, O., and Zuber, A. 1967. Borehole dilution techniques: a critical review. Isotopes in Hydrology. IAEA, Vienna, pp. 531-564.

KVA Analytical Systems. 1989a. Groundwater Flowmeter System: Operations and Maintenance Manual, Model 40L Geoflo®.

KVA Analytical Systems. 1989b. Independent Verification of Heat Pulse Groundwater Flowmeter Results Through Long Term Observation and Tracer Tests on Superfund Sites. Technical Publication No. 92.

Melville, J.G., Molz, F.J., and Guven, O. 1985. Laboratory Investigation and Analysis of a Ground-Water Flowmeter. Ground Water, 23(4):486-494.

Nelson, D. 1991. Practical Handbook of Ground-Water Monitoring. Lewis Publishers Inc.

Appendix C - Description of phospholipid fatty acid analyses

Phospholipid Fatty Acid (PLFA) Analysis

Membrane phospholipids are found in all cellular membranes, have a rapid turnover in living cells, are rapidly hydrolysed on cell death, and are found in relatively constant proportions in bacterial cells in nature (White, 1988). Under conditions expected in natural microbial communities, bacteria contain relatively constant proportions of their biomass as phospholipids. Analysis of the phospholipid fatty acid (PLFA) content in a soil or water sample provides a more accurate measure of viable cellular biomass than classical microbiological methods (*i.e.*, culturing or direct cell counts) and measurement of other cellular components (*e.g.*, enzymes, ATP, muramic acid). Classical culturing methods (spread and pour plate, most probable number techniques) often lead to gross underestimation of the numbers of microorganisms since they rely on recovering soil and/or groundwater microorganisms which are viable and which can grow on the media selected for their cultivation. Typically, only 1 to 10% of the total biomass can be enumerated by culturing techniques. Direct counts are often overestimated by inclusion of non-viable bacteria. PLFA analysis provides a reproducible and cost-effective measure of the viable cellular biomass, without being subject to the limitations of classical techniques.

Measurement of the PLFA content of a soil or water sample also provides information on the:

- composition of the microbial community (*e.g.*, methanotrophs, methanogens, sulfate-reducers, iron-reducers, *actinomycetes*, Gram-positive, and Gram-negative organisms),
- content of respiratory quinones and diglycerides, ratios of anaerobic to aerobic microorganisms,
- nutritional status of a microbial community (balanced versus unbalanced growth), and
- physiological status of a microbial community (stress response to contamination and/or water availability).

The versatility of PLFA analysis makes this technique an extremely valuable tool for evaluating and monitoring microbiological conditions in water and soil. Water or groundwater samples are generally filtered through polycarbonate filters at the point of sample collection. The filter is frozen on dry ice to maintain the microbial conditions in the sample until its analysis. Similarly, soil samples can be frozen on dry ice immediately after collection to maintain the microbial conditions in the sample until its analysis. In the laboratory, total lipids are extracted from the frozen filters by a modification of the single-phase chloroform-methanol method of Bligh and Dyer (1959) (White *et al.*, 1979 and 1983). The lipids are separated on silicic acid columns and the PLFA fraction is collected and derivitized to phospholipid methyl-esters. The PLFA is then analyzed by gas chromatography/mass spectrometry (GC/MS).

PLFA analysis was pioneered by David White of the University of Tennessee in Knoxville, Tennessee. PLFA analysis is commercially available through Microbial Insights, Inc., in Knoxville, Tennessee.

Bligh, E.G. and W.J. Dyer. 1959. A rapid method of lipid extraction and purification. Can. J. Biochem. Physiol. 35:911-917.

Vestal, J.R. and D.C. White. Lipid analysis in microbial ecology. Quantitative approaches to the study of microbial communities. BioScience 39:535-541.

White, D.C., R.J. Bobbie, J.D. King, J. Nickels, and P. Amoe. 1979. Lipid analysis of sediments for microbial biomass and community structure. In: Litchfield CD & Seyfried PL (Eds) Methodology for Biomass Determinations and Microbial Activities in Sediments. ASTM STP 673. American Society for Testing Materials. pp. 87-103.

White, D.C., G.A. Smith, M.J. Gehron, J.H. Parker, R.H. Findlay, R.F. Martz, and H.L. Fredrickson. 1983. The ground water aquifer microbiota: biomass, community structure and nutritional status. Develop. Indust. Microbiol. 24:201-211.

White, D.C. 1988. Validation of quantitative analysis for microbial biomass, community structure, and metabolic activity. Arch. Hydrobiol. Beih. Ergebn. Limnol. 31:1-18.

APPENDIX C

USEPA SITE PROGRAM QAPP

APPENDIX D

SITE HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
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HEALTH AND SAFETY PLAN

Prepared for Field Work
to be Performed at
GENERAL INSTRUMENT CORPORATION
Sherburne, NY
Chenango County

Updated 10/6/94

EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. For emergency situations, contact should first be made with the site coordinator, who will notify emergency personnel, who will then contact the appropriate response teams. This emergency contacts list must be posted at the site.

	Phone Number
Contingency Contacts	
Nearest phone located at plant	(607) 674-4685
Fire Department	(607) 334-4747
Police	(607) 674-9770
County Sheriff	(607) 334-2000
Poison Control Center - Central New York	(315) 476-4766
Contract Physician (IMA)	(315) 478-1977
Stearns & Wheler Main Office	(315) 655-8161

Medical Emergency

Hospital name:	Chenango Memorial
Hospital address:	Norwich, NY
Hospital phone number:	(607) 335-4111

Directions to Hospital

Leave site and proceed south on Route 12; go through North Norwich and on to Norwich. Hospital is west side of road just inside village limits. One-way trip is about 15 miles.

Travel time from site: Approximately 20-25 minutes
Map to hospital (see next page)
Ambulance service: (607) 334-4747

Stearns & Wheler Contacts

Project Manager, T. Lawrence Hineline	(315) 655-8161
Site Health and Safety Contact, John Conklin	(315) 655-8161

RISK ANALYSIS

Chemical Hazards

The following substances are known to be present in groundwater from the West Field site. The following list indicates primary hazards, the source of substances identification on site, and the industrial or common use for the substance.

Substance	Hazard	Identification	Common Use
trichloroethylene	Liver	GW sample	Degreaser
1,1,1-trichloroethane	Lung, liver	GW sample	Degreaser
1,1 dichloroethane	Liver, kidney, CNS	GW sample	Solvent
Vinyl chloride	Liver	GW sample	Monomer
1,1,2 trichloroethane	Liver, kidney	GW sample	Solvent
tetrachloroethylene	Liver	GW sample	Solvent

CNS = Central nervous system

Physical Hazards

Possible heat stress or hypothermia hazards (see Preventive Health Monitoring, page HSP-4).

Personal Protective Requirements

Based on evaluation of potential hazards, the following levels of personal protection have been designated for the applicable work areas or tasks:

Location	Job Function	Level of Protection
Exclusion zone	Subsurface soil characterization	C or D
	Groundwater sampling	C or D
Contamination Reduction zone	Subsurface soil characterization	C or D
	Groundwater sampling	C or D

* Levels required for start of work at site; may be reduced if conditions permit. Level C protection will be used during trench excavation as long as breathing zone photoionization detector readings are between 5 and 20 ppm volatile organics. If readings are continuously under 5 ppm, level will be downgraded to D. PID monitoring will be continued and if readings greater than 5 ppm are recorded, Level C will be resumed as warranted.

Specific protective equipment for Levels C and D personal protection is listed on page HSP-5.

Action Levels

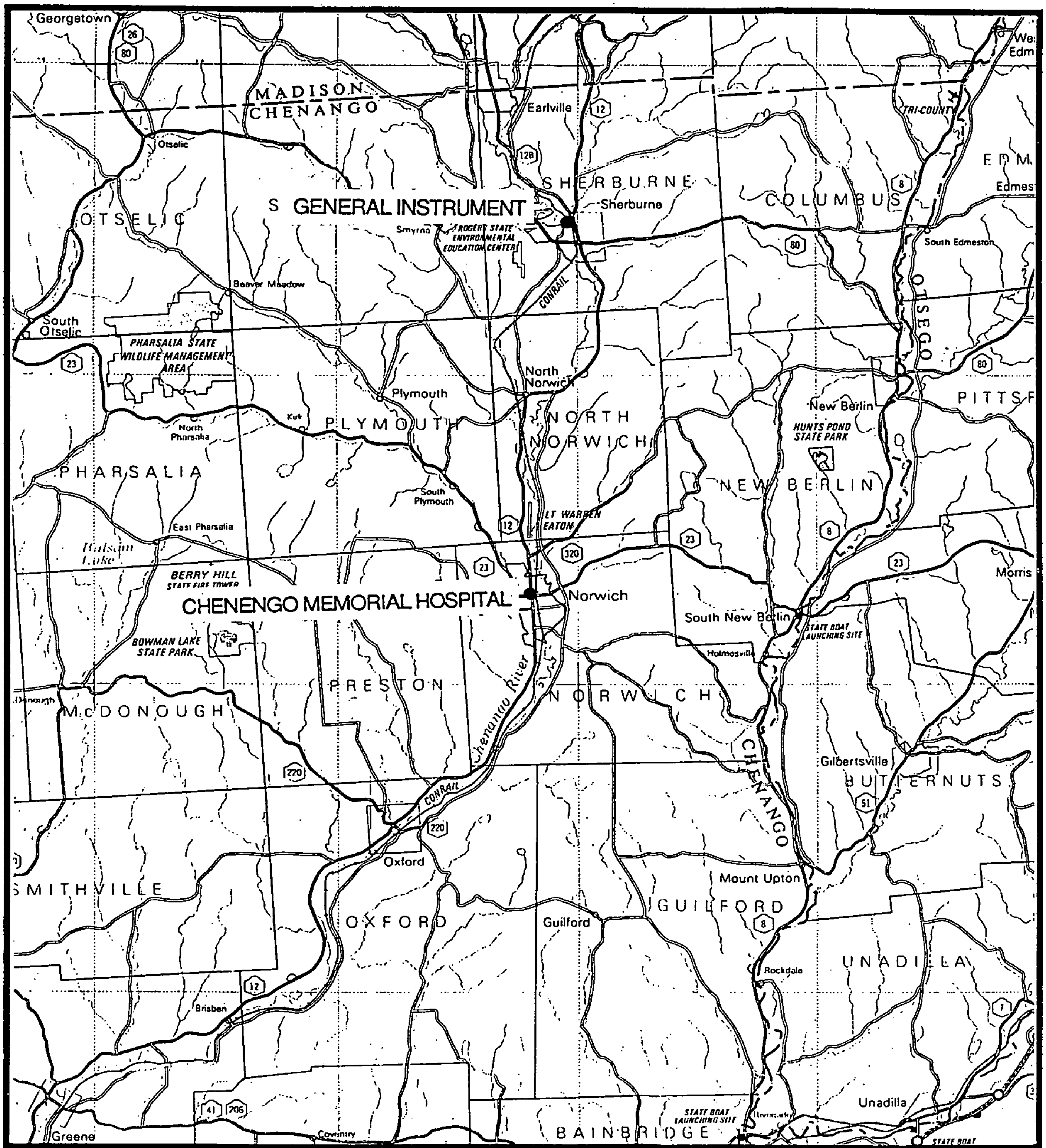
The following criteria should be used to determine appropriate action:

Volatile Organics (In the Breathing Zone)	Level of Respiratory Protection
0-5 ppm	Level D
5-20 ppm	Level C

Explosive Vapors (% Lower Explosive Limit)	Action
1-25	Use non-sparking tools
Over 25	Discontinue work and tank remedial action

Community Safety and Health

A preliminary review of prior site operations and lab analyses does not suggest that perimeter monitoring is warranted. All excavations and drilling activity will be continuously surveyed using a photoionization detector. Monitoring will be done in the breathing zone and in the excavated areas. In addition, perimeter air monitoring at the GIC property boundary with the railroad right-of-way will be conducted every 15 minutes during excavation activities.



HEALTH AND SAFETY PLAN

ROUTE TO CHENENGO MEMORIAL HOSPITAL, NORWICH, NEW YORK

APPROXIMATELY 12 MILES SOUTH ON NYS RT. 12

GENERAL HEALTH AND SAFETY POLICY

HEALTH AND SAFETY PLAN PURPOSE AND POLICY

The purpose of this safety plan is to establish personnel protection standards and mandatory safety practices and procedures for the General Instrument site. This plan assigns responsibilities, established standard operating procedures, and provides for contingencies which may arise during installation of the pilot system and subsequent monitoring activities.

The requirements and provisions of this plan are mandatory for all phases of the site investigation, and all Stearns & Wheler personnel shall abide by it. All safety plans used by subcontractors shall meet the requirements of the Stearns & Wheler safety plan as a minimum. This plan must be reviewed and understood by all personnel who participate in the field installation and monitoring activities. Guidelines of this safety plan will be followed at all times during the investigation of the General Instrument site.

PROJECT OUTLINE

Site Description

The General Instrument site is a former industrial facility that was used for antenna manufacture and research and development. The site has been designated a Class 2 inactive hazardous waste site due to the presence of metals and volatile organic compounds in the soil and groundwater. See Figure 1.

Hazardous Substance Identification

Hazardous substances encountered at this site in the West Field, are listed on Tables 1 and 2 of this section.

Scope of Work

Tasks to be performed by Stearns & Wheler at the General Instrument site include the following:

TABLE 1

TOXICOLOGICAL PROPERTIES OF CHEMICALS EXPECTED IN WEST FIELD

Chemical	TLV (ppm)	IDLH (ppm)	Symptoms of Acute Exposure
Trichloroethylene	50	200	Skin, eye irritation; cardiac failure
1,1,1-trichloroethane	350	1,000	Skin irritation, cardiac failure
1,1 dichloroethane	200	4,000	Headache, irritation, dizziness
Vinyl chloride	1	5	Skin damage by freezing
1,1,2 trichloroethane	10	500	Eye, nose, lung irritant
Tetrachloroethylene	50	200	Nausea, diarrhea

TLV = Threshold limit value.
IDLH = Immediately dangerous to life and health.

TABLE 2

PHYSICAL PROPERTIES OF CHEMICALS EXPECTED IN PLUME

Chemical	Vapor Pressure	Vapor Density	Odor Threshold (ppm)	Water Solubility @ 20°C (mg/l)
Trichloroethylene	100 mm @ 32C	4.35	28	1,100
1,1,1-trichloroethane	100 mm @ 20C	1.8	120	4,400
1,1 dichloroethane	234 mm @ 25C	3.44	NA	0.5 g/100 ml
Vinyl chloride	2600 mm @ 25C	2.15	3,000	1.1
1,1,2 trichloroethane	100 mm @ 20C	4.63	NA	4,500
Tetrachloroethylene	15.8 mm @ 22C	5.83	27	150

NA = Not available.

- Installation of monitoring wells.
- Collection of groundwater samples.
- Construction of in situ groundwater treatment system.

Project Team Organization

Table 3 describes the responsibilities of all on-site personnel. The names of principal on-site personnel associated with this project are delineated below:

Project Manager:	T. Lawrence Hineline
Field Team Leader:	Diane K. Clark
Site Safety Officer:	John Conklin

Individuals have been trained in first aid and hazardous waste safety procedures, and are experienced with the types of field work to be employed at the site.

SITE SECURITY PLAN

Purpose

The purpose of a site security plan is: 1) to establish procedures and define responsibilities for controlling access to the General Instrument site during trench installation activities, and 2) to prevent unauthorized access to the area. Site security will be achieved through a combination of organizational measures and physical site controls.

Site Security Organization Responsible Personnel

The individual primarily responsible for day-to-day site security will be the on-site Project Manager. The Project Manager will be responsible for the enforcement of site security and maintaining physical site security controls. The Project Manager will delegate responsibilities, providing support as needed, to implement and enforce the site security plan. All authorized personnel are responsible for assisting the project manager and implementing and enforcing the site security.

TABLE 3

ON-SITE PERSONNEL

Title	General Description	Responsibilities
Project Manager	Reports to upper-level management. Has authority to direct response operations.	- Prepares and organizes the background review of the situation, the work plan, the site safety plan, and the field team. - Obtains permission for site access and coordinates activities with appropriate officials. - Ensures that the work plan is completed and on schedule. - Briefs the field teams on their specific assignments. - Uses the Site Safety and Health Officer to ensure that safety and health requirements are met. - Prepares the final report and support files on the response activities. - Serves as the liaison with public officials.
Site Safety Officer	Advises the Project Manager on all aspects of health and safety on site. Stops work if any operation threatens worker or public health or safety.	- Periodically inspects protective clothing and equipment. - Ensures that protective clothing and equipment are properly stored and maintained. - Controls entry and exit at the access control points. - Coordinates safety and health program activities with the Project Safety Officer. - Confirms each team member's suitability for work based on a physician's recommendation. - Monitors the work parties for signs of stress, such as cold exposure, heat stress and fatigue. - Implements the site safety plan. - Verifies compliance with the site safety plan. - Conducts periodic inspections to determine if the site safety plan is being followed. - Enforces the "buddy system". - Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department and police department.

TABLE 3 (continued)

Title	General Description	Responsibilities
Site Safety Officer (continued)		- Notifies, when necessary, local public emergency officials. - Coordinates emergency medical care. - Sets up decontamination of all equipment, personnel and samples from the decontaminated areas. - Controls the decontamination of all equipment, personnel and samples from the contaminated areas. - Assures proper disposal of contaminated clothing and materials. - Ensures that all required equipment is available. - Advises medical personnel of potential exposures and consequences. - Notifies emergency response by telephone or radio in the event of an emergency.
Field Team Leader	Responsible for field team operations and safety.	- Manages field operations. - Executes the work plan and schedule. - Enforces safety procedures. - Coordinates with the Site Safety Officer in determining protection level. - Enforces site control. - Documents field activities and sample collection. - Serves as a liaison with public officials.
Work Team	Drillers, contractors, samplers. The work party must consist of two (2) people.	- Safely completes the on-site tasks required to fulfill the work plan. - Complies with site safety plan. - Notifies the Site Safety Officer or supervisor of suspected unsafe conditions.

Lines of Communication

The Project Manager will be responsible for ensuring that all individuals present at the site are familiar with all aspects and requirements of the site security plan. All concerns of on-site personnel regarding site security shall be brought to the attention of the Project Manager for resolution.

Authorized Personnel

The Project Manager is responsible for designating authorized personnel relative to site access. In general, authorized access will be limited to those individuals whose presence on the site is required in order to conduct work activities.

Non-Authorized Personnel

Non-authorized personnel seeking access to the site will be directed to the Project Manager for access consideration. Access permission will be granted on a case-by-case basis, taking into account safety and the need for access. All safety considerations, such as access, may be restricted to limited areas within the site. All non-authorized personnel must be accompanied by the Project Manager or designee of the Project Manager.

Enforcement of Site Security

All violations of site security shall be brought to the attention of the Project Manager by authorized personnel. The Project Manager will be responsible for stopping the violation and taking measures to prevent reoccurrence. The Project Manager will document all violations. If necessary, the Sherburne Police Department or County Sheriff will be requested to help enforce site security measures. The Project Manager will determine if involvement of law enforcement personnel is necessary.

PHYSICAL SITE SECURITY

Site Entry/Exit Procedures

All authorized personnel will be required to inform the Project Manager or delegate when they enter or exit the site so that a current record of site access is maintained. A daily sign-in/sign-out sheet may be used to document the time of entry and exit, the purpose of the visit, the location(s) visited within the site, and personnel contacted.

PREVENTIVE HEALTH MONITORING

Stearns & Wheler will utilize the services of a licensed occupational health physician with knowledge and/or experience in the hazards associated with the project to provide the medical examinations and surveillance specified herein. During field activities, the Site Safety Officer of each respective company will be responsible for monitoring temperature-related stress and exposure to potentially hazardous substances.

Medical Examination

Personnel involved in this operation will be provided with medical surveillance prior to participation in on-site operations and at 12-month intervals. The initial medical examination will include a complete medical and work history and a standard occupational physical; examination of all major organ systems; complete blood count with differential (CBC); and a SMAC/23 blood chemistry screen which includes calcium, phosphorus, glucose, uric acid, BUN, creatinine, albumin, SGPT, SGOT, LDH, globulin, A/G ratio, alkaline phosphatase, total protein, total bilirubin, triglyceride, cholesterol, and a creatinine/BUN ratio. Additionally, a pulmonary function test will be performed by trained personnel to record Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV 1.0). An audiogram and visual acuity measurement, including color perception, will be provided. The medical exam will be performed under the direction of a licensed occupational health physician. A medical certification as to fitness or unfitness for employment on this job, or any restrictions on his/her utilization that may be indicated, will be provided by the physician. This evaluation will be repeated as indicated by substandard performance or evidence of particular stress that is evident by injury or time loss illness on the part of an worker.

Site-Specific Training

The Site Safety Officer will be responsible for developing a site-specific occupational hazard training program and providing initial training to all Stearns & Wheler personnel that are to work at the site. Responsibilities of project personnel are outlined on Table 1. This training will include the following topics:

- Names of personnel responsible for site safety and health.
- Safety, health, and other hazards at the site.
- Proper use of personal protective equipment.
- Work practices by which the employee can minimize risk from hazards.
- Safe use of engineering controls and equipment on the site.
- Acute effects of compounds at the site.
- Decontamination procedures.

Protective Equipment

This section describes hazardous level classifications. Table 4 shows minimum equipment requirements necessary for the specified protection levels.

Regardless of level of protection, every field team should be equipped with a first aid kit including, but not limited to, bandages, compresses, tape, scissors, disinfectant and eyewash.

Level A

Level A protection should be worn when the highest available level of both respiratory, skin and eye contact protection is needed. While Level A provides the maximum available protection, it does not protect against all possible airborne or splash hazards. For example, suit materials may be rapidly permeable to certain chemicals in high air concentrations or heavy splashes.

Level B

Level B protection should be selected when the highest level of respiratory protection is needed, but cutaneous or percutaneous exposure to the small unprotected areas of the body (i.e., neck and back of head) is unlikely or where concentrations are known within acceptable exposure standards.

TABLE 4

HAZARD LEVEL VS. EQUIPMENT

	Level of Protection			
	A	B	C	D
Hard hat	X	X	X	X
Face shield/safety glasses			X	X
Boots	X	X	X	X
Inner gloves	X	X	X	
Outer gloves	X	X	X	
Work coveralls				X
Chemical-resistant coveralls			X	
Chemical-resistant suit		X		
Fully-encapsulating suit	X			
Air-purifying respirator			X	
SCBA/air-line respirator	X	X		
Two-way radio	X			

Level C

Level C protection should be selected when the type(s) and concentration(s) of respirable material is known or reasonably assumed to be not greater than the protection factors associated with air-purifying respirators; and if exposure to the few unprotected areas of the body (i.e., neck and back of head) is unlikely to cause harm. Continuous monitoring of site and/or individuals should be established to ensure this minimum protection level is still acceptable throughout the exposure.

Level D

Level D is the basic work uniform and should be worn for all site operations. Level D protection should only be selected when sites are positively identified as having no toxic hazards. All protective clothing should meet applicable OSHA standards.

All personal protective equipment used during the course of this field investigation must meet the following applicable OSHA standards:

Type of Protection	Regulation	Source
Eye and face	29 CFR 1910.133	ANSI Z87.1-1968
Respiratory	29 CFR 1910.134	ANSI Z88.1-1980
Head	29 CFR 1910.135	ANSI Z89.1-1969
Foot	29 CFR 1910.136	ANSI Z41.1-1967

ANSI = American National Standards Institute

Level C respiratory protection consists of wearing a full-face air purifying respirator with compound specific cartridges. Both the respirator and chemical cartridges must be approved by NIOSH and MSHA.

Air purifying respirators cannot be used under the following conditions:

- Oxygen deficiency.
- IDLH concentration.
- High relative humidity.
- Contaminant levels exceed designated maximum use concentrations.

Individuals who use air purifying respirators must wear a respirator which has been successfully fitted to their faces. An improperly-fitted respirator provides little respiratory protection. In the event that organic vapor levels exceed the upper limit for Level C protection (20 ppm), all field personnel are to stop work while the Site Safety Officer consults with the Office Health and Safety Representative.

The Site Health and Safety Officer shall approve all personal protective equipment prior to initiating field activities.

Heat Stress

The use of protective equipment may create heat stress. Monitoring of personnel wearing impermeable clothing should commence when the ambient temperature is 70°F or above. Table 5 presents the suggested frequency for such monitoring. Monitoring frequency should increase as the ambient temperature increases or as slow recovery rates are observed. Heat stress monitoring should be performed by a person with a current first aid certification who is trained to recognize heat stress symptoms. For monitoring the body's recuperative abilities to excess heat, one or more of the following techniques will be used. Other methods for determining heat stress monitoring, such as the wet bulb globe temperature (WBGT) index from American Conference of Governmental Industrial Hygienist (ACGIH) TLV Booklet can be used.

To monitor the worker, measure:

1. Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

   - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one third and keep the rest period the same.

   - If the heart rate exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one third.

2. Oral temperature. Use a clinical thermometer (three minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

   - If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one third without changing the rest period.

TABLE 5

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS(1)

Adjusted Temperature(2)	Normal Work Ensemble(3)	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°- 32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)		After each 60 minutes of work
77.5°-82.5°C (25.3°-28.1°C)		After each 90 minutes of work
72.5°-77.5°C (22.5°C-25.3°C)		After each 120 minutes of work

(1) For work levels of 250 kilocalories/hour.

(2) Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows).

(3) A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

- If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following cycle by one third.

- Do not permit a worker to wear a semi-permeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

Prevention of Heat Stress

Proper training and preventive measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat-related illness. To avoid heat stress, the following steps should be taken:

1. Adjust work schedules.

    - Modify work/rest schedules according to monitoring requirements.

    - Mandate work slowdowns as needed.

    - Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.

2. Provide shelter (air conditioned, if possible) or shaded areas to protect personnel during rest periods.

3. Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., eight fluid ounces (0.23 liters) of water must be ingested for approximately every eight ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:

    - Maintain water temperature at 50° to 60°F (10° to 16.6°C).

- Provide small disposable cups that hold about 4 ounces (0.1 liter).

- Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.

- Urge workers to drink a cup or two every 15 to 20 minutes or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight. Urge workers to salt their food appropriately.

4. Train workers to recognize the symptoms of heat-related illnesses.

Cold-Related Illness

If work on this project begins in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Systemic cold exposure is referred to as hypothermia. Local cold exposure is generally labeled frostbite.

1. Hypothermia. Hypothermia is defined as a decrease in the patient core temperature below 96°F. The body temperature is normally maintained by a combination of central (brain and spinal cord) and peripheral (skin and muscle) activity. Interferences with any of these mechanisms can result in hypothermia, even in the absence of what normally is considered a "cold" ambient temperature. Symptoms of hypothermia include shivering, apathy, listlessness, sleepiness and unconsciousness.

2. Frostbite. Frostbite is both a general and medical term given to areas of local cold injury. Unlike systemic hypothermia, frostbite rarely occurs unless the ambient temperatures are less than freezing and usually less than 20°F. Symptoms of frostbite are a sudden blanching or whitening of the skin; the skin has a waxy or white appearance and is firm to the touch; tissues are cold, pale and solid.

Prevention of Cold-Related Illnesses

1. Educate worker to recognize the symptoms of frostbite and hypothermia.

2. Identify and limit known risk factors:

- Prohibit phenothiazine use.
- Identify/warn/limit beta blocker use.

3. Assure the availability of enclosed, heated environment on or adjacent to the site.

4. Assure the availability of dry changes of clothes.

5. Develop capability for temperature recording at the site.

6. Assure the availability of warm drinks.

Monitoring

Start (oral) temperature recording at job site:

1. At the Field Team Leader's discretion when suspicion is based on changes in worker's performance or mental status.

2. At worker's request.

3. As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind-chill less than 20°F or wind-chill less than 30°F with precipitation).

4. As a screening measure whenever any one worker on the site develops hypothermia.

Any person developing moderate hypothermia (a core temperature of 91°F) cannot return to work for 48 hours.

Air Monitoring Requirements

Initial site monitoring will be required utilizing Level D protection. Prior to performing site activities, ambient air monitoring will be performed and site work zones will be established. Periodic monitoring will be performed when:

1. A different type of operation is initiated (e.g., groundwater sampling as opposed to well installation or trench excavation).

2. The weather conditions change.

3. Work begins on a different portion of the site.

4. At 5-foot intervals during well installation.

A photoionization detector and explosimeter will be the monitoring instruments used on site. Continuous monitoring with an explosimeter will be conducted when drilling through refuse.

SITE WORK ZONES

To reduce the spread of hazardous materials by workers from the contaminated areas to the clean areas, zones will be delineated at the site where different types of operations will occur. The flow of personnel between the zones should be controlled. The establishment of work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in an emergency.

Exclusion Zone

The exclusion zone is an area where contamination does or could occur. An exclusion zone will be established for all drilling, groundwater, and trench excavation sampling activities. Access into the exclusion zone will be controlled to ensure that personnel entering the areas are wearing the proper protection (e.g., hard hat, gloves, Tyvek®, respirators). Unprotected onlookers should be located 50 feet upwind of the drilling.

Contamination Reduction Zone

This will be established by Site Safety Officer as a buffer zone between the exclusion zone and the support zone. Contamination reduction zone will contain the personnel and equipment decontamination station indicated below. The contamination reduction zone should always be located upwind of the exclusion zone in an area devoid of air contaminants.

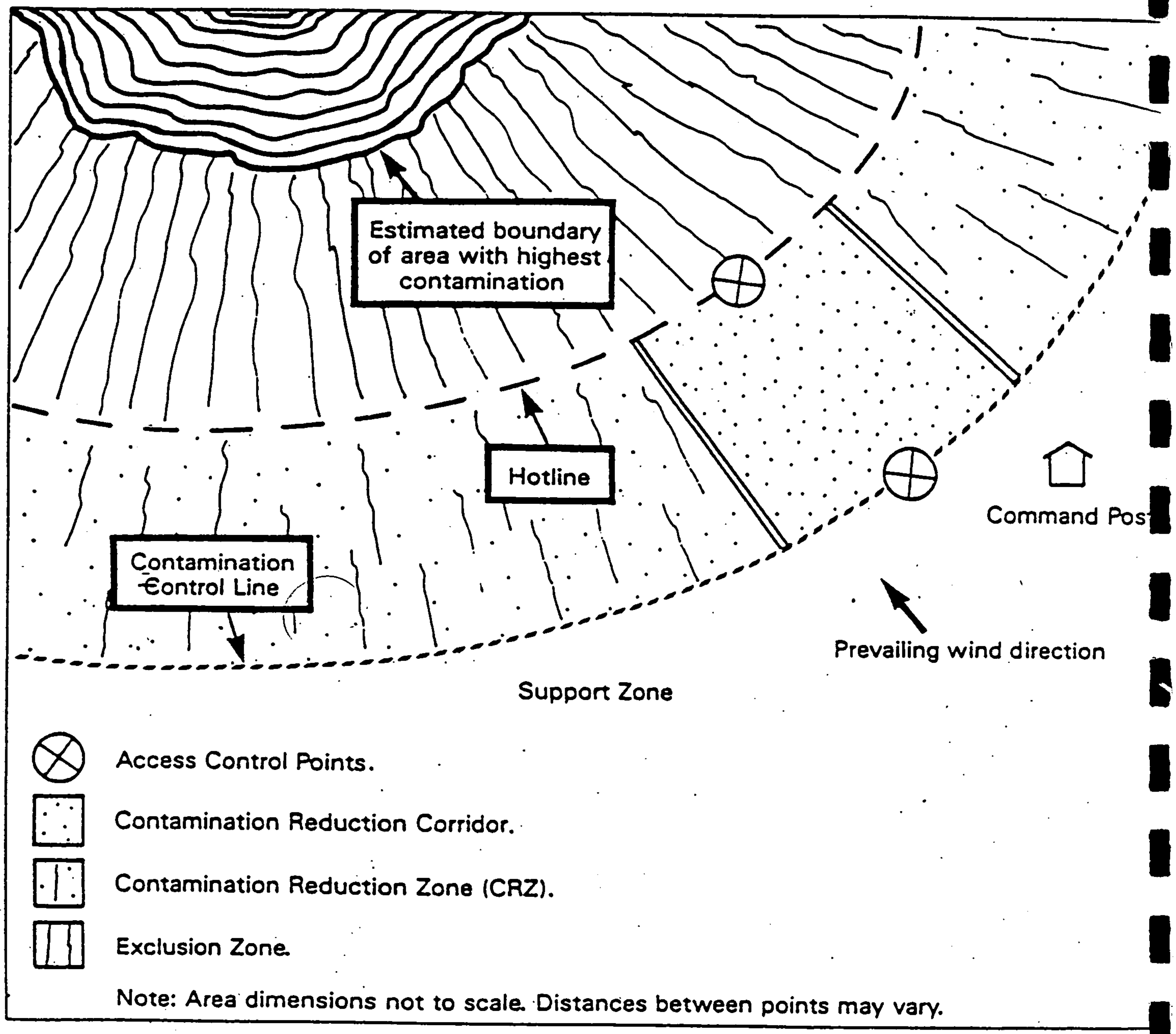


Figure 2

CONTAMINATION ZONES

Support Zone

The support zone will include the remaining areas of the job site. Break areas, operational direction and support facilities (to include supplies, equipment storage and maintenance areas) will be located in this area. No equipment or personnel will be permitted to enter the clean zone from the contamination reduction zone without passing through the personnel or equipment decontamination station. Eating, smoking and drinking will be allowed only in this area.

COMMUNICATION PROCEDURES

Because communications are extremely important and, at the same time, may be difficult due to background noise and personal protective equipment, both audio and visual signals have been established for on-site communication. Audio signals include verbal expression and equipment airhorns. Where equipment noise is a problem, radios which are certified and consequently safe for the situation of intended use will be used. Visual signals will be listed below. A telephone line or a mobile phone will be available for off-site communications. The following hand signals will be used:

Signal	Meaning
Hand gripping throat	Cannot breathe.
Gripping partner's wrist or both hands around waist	Leave area immediately.
Hands on top of head	Need assistance.
Thumbs up	Yes; I'm all right; I understand.
Thumbs down	No.

ACCIDENT PREVENTION

All field personnel will receive health and safety training prior to the initiation of any site activities. On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially-hazardous situations and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency. Before daily work assignments, regular meetings shall be held. Attendance at these meetings is mandatory. Attendance records will be maintained by the Site Health and Safety Coordinator. Discussion will include:

1. Tasks to be performed.

2. Time constraints (e.g., rest breaks, cartridge changes).

3. Hazards that may be encountered, including their effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals.

4. Work zone boundaries.

5. Emergency procedures.

6. PPE decontamination procedures.

Each site activity may present unique hazards which the field team should be vigilant.

SITE STANDARD OPERATING PROCEDURES

Standard operating procedures are developed and supplied in writing to the Project Manager before site activities commence. Operations will follow the regulations set forth in OSHA 29 CFR 1910 and 1926 as well as the USEPA Standard Operating Safety Guide, Field Standard Operating Procedures, and the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Manual for Hazardous Waste Site Activities. General standard operating procedures for the site are listed below. As the need for additional standard operating procedures are identified, the standard operating procedures will be developed and submitted to the Site, Health and Safety Officer for approval prior to implementation. General standard operating procedures personnel precautions:

1. Eating, drinking, gum chewing, tobacco, smoking or any practice that increase the probability of hand to mouth transfer and digestion of material is prohibited in any area designated "Contaminated."

2. Hands and face must be thoroughly washed upon leaving the work area.

3. Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

4. No facial hair which interferes with the satisfactory fit of the masked to face seal is allowed on personnel required to wear respirators.

5. Contact with contaminated or suspected contaminated surfaces will be avoided whenever possible. Do not walk through puddles, leachate, discolored surfaces, kneel on the ground, lean, sit, or place equipment on drums, containers, or on the ground.

6. Medicine and alcohol can worsen the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel at hazardous waste operations where the potential for adsorption, inhalation, or injestion of toxic substances exist, unless specifically approved by a qualified physician. Alcoholic beverages shall be avoided.

7. All personnel must adhere to the information contained in the Site Safety Plan.

8. Contact lens cannot be worn when respirator protection is required when the hazard of a splash exists.

9. Personnel will be made aware of symptoms for toxic chemicals on site and for heat and cold stress.

10. Respirators shall be clean and disinfected after each day's use or more often, if necessary.

11. Prior to donning, respirators will be inspected for worn or deteriorated parts. Emergency respirators and self-contained breathing apparatuses shall be inspected at least once a month and before and after each use.

12. Employees and site personnel shall provide documentation that they have passed a respirator fitness test program. Documents of the respirator fit tests shall be provided to the Site Safety and Health Officer.

GENERAL OPERATING PROCEDURES

1. All personnel going on site must be adequately trained and thoroughly briefed on anticipated hazards, equipment to be worn, safety practices to be followed, emergency procedures, and communications.

2. Any required respiratory protective devices and clothing must be worn by all personnel going into areas designated for wearing protective equipment.

3. Personnel on site must use the buddy system when wearing respirator protective equipment. As a minimum, a third person suitably equipped as a safety backup is required during extremely hazardous entries.

4. Visual contact must be maintained between buddies on site and safety personnel. Entry team members should remain close together to assist each other during emergencies.

5. During continual operation, on site workers in the "hot zone" act as safety backup to each other. Personnel in the "support zone" provide emergency assistance.

6. Personnel should practice unfamiliar operations prior to performing the actual procedure.

7. Entrance and exit locations must be designated an "Emergency Escape Routes" delineated.

8. Personnel and equipment in the contaminated area should be minimized and consistent with effective site operations.

9. Wind indicators visible to all personnel should be strategically located throughout the site.

10. Procedures for leaving a contaminated area must be planned and implemented prior to going on site. Work areas and decontamination procedures have been established and are based on expected site conditions.

11. Frequent and regular inspections of site operations will be conducted to insure compliance with the Site Health and Safety Plan. If any changes in operation occur, the Site Health and Safety Plan must be modified to reflect the change. The Site Health and Safety Officer is responsible for implementing changes to the Site Health and Safety Plan.

EXCAVATION ACTIVITIES PROCEDURES

Activities to be conducted by personnel in an excavation area will be performed in accordance with 29 CFR Part 1926, Subpart P excavations. The safety measures include, but are not limited to:

1. Removal or support of surface encumbrances.
2. Location of utilities and other underground installations.
3. Provisions of access and egress means.
4. Prevention of exposure to falling loads.
5. Establishment of a warning system for mobile equipment.
6. Provision of emergency rescue equipment.
7. Protection from hazards associated with water accumulation.
8. Provisions for the stability of adjacent structures.
9. Provisions of fall protection.
10. Protection of loose soil or rock.

Confined Space

Contractor is required to comply with Title 29 of the Code of Federal Regulations (CFR) Part 1910-146 and know all appropriate procedures and precautions to enter and exit confined spaces. Contractor shall develop and incorporate a confined space evaluation program; permit system; emergency procedures; and appropriate work practices, controls, and personal protective equipment in accordance with 29 CFR 1910-146 to properly enter a confined space.

Drilling and Construction Activities

Prior to any drilling or construction activity, efforts should be made to determine whether underground installations (i.e., telephone cables, sewer lines, fuel pipes, electrical lines, etc.) will be encountered and, if so, where these installations are located. The Field Team Leader must coordinate with the site owner or utility companies to locate underground utilities prior to performing drilling or construction activities. The Field Team Leader or Site Safety Officer will provide constant on-site observation of all subcontractors to encourage that they meet the health and safety requirements. If deficiencies are noted, work will be stopped and corrective action will be taken (e.g., retrain, purchase additional safety equipment). Reports of health and safety deficiencies and the correction action taken will be forwarded to the Project Manager. Periodic air monitoring will be performed by the Site Safety Officer to verify that proper personal protection is being utilized.

Sampling

The Site Safety Officer will ensure that entry into any exclusion zone is controlled to make certain that personnel entering this zone don the proper protective clothing. Periodic air monitoring will be conducted to determine whether atmospheric chemical conditions have changed from the initial air characterization. The Safety Officer will post the emergency phone numbers (phone numbers of the physicians, hospitals, ambulances, etc.) in a conspicuous place. The field team will be trained in emergency contingencies. Constant monitoring of field activities will be performed to verify compliance with the safety plan.

CONTINGENCY PLAN

Emergency Procedures

In the event that an emergency develops on site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

1. Any member of the field crew is involved in an accident or experiences any adverse effects of symptoms of exposure while on site.

2. A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

General emergency procedures and specific procedures for personal injury and chemical exposures are described in the Health and Safety Plan.

EVACUATION ROUTES AND PROCEDURES

All site personnel will be evacuated from the exclusion and contamination reduction zones if the Site Health and Safety Officer decides that their personal safety is in danger. If evacuation is necessary, personnel will be notified and the following procedures will apply:

- Evacuation will take place through normal contamination reduction corridor and the normal decontamination procedures will be followed.

- In the event that use of the normal contamination reduction corridor is deemed unsafe, evacuation will be through a designated emergency exit. Decontamination team personnel will proceed to the alternate exit immediately upon being advised by the Site Health and Safety Officer.

- Immediately upon completion of decontamination procedures, personnel will proceed to the assembly area adjacent to Project Manager's project coordination point.

- Personnel not requiring decontamination will proceed immediately to that area.

- Upon arriving to the Project Manager's coordination meeting, personnel must check in and remain in that area until advised otherwise.

- The buddy system should be followed throughout the evacuation procedures.

- First aid technicians must identify themselves to the Project Manager or the Site Health and Safety Officer upon arrival.

Chemical Exposure

If a member of the field crew demonstrates symptoms of chemical exposure, the procedures outlined below should be followed:

1. Another team member (buddy) should remove the individual from the immediate area of contamination. The buddy should communicate to the Field Team Leader (via two-way radio or hand signals) of the chemical exposure. The Field Team Leader should contact the appropriate emergency response agency.

2. Precautions should be taken to avoid exposure of other individuals to the chemical.

3. If the chemical is on the individual's clothing, the chemical should be neutralized or removed if it is safe to do so.

4. If the chemical has contacted the skin, the skin should be washed with copious amounts of water.

5. In case of eye contact, an emergency eyewash should be used. Eyes should be washed for at least 15 minutes.

6. All chemical exposure incidents must be reported in writing to the Office Health and Safety Representative. The Site Safety Officer or Field Team Leader is responsible for completing the accident report.

Personal Injury

In case of personal injury at the site, the following procedure should be followed:

1. Another team member (buddy) should signal the Field Team Leader (via two-way radio or hand signals) that an injury has occurred.

2. A field team member trained in first aid can administer treatment of an injured worker.

3. The victim should then be transported to the nearest hospital or medical center. If necessary, an ambulance should be called to transport the victim.

4. For less severe cases, the individual can be taken to the site dispensary (i.e., engineer's trailer office, plant infirmary, or field worker's vehicle equipped with first aid kit).

5. The Field Team Leader or Site Safety Officer is responsible for making certain that an accident report form is completed. This form is to be submitted to the Office Health and Safety Representative. Follow-up action should be taken to correct the situation that caused the accident.

Fire or Explosion

1. Notify paramedics and/or fire department as necessary.

2. Signal the evacuation procedure previously outlined and implement the entire procedure.

3. Isolate the area.

4. Stay upwind of any fire.

5. Keep area surrounding the problem source clear after the incident occurs.

6. Complete accident report form and distribute to appropriate personnel.

Smoking, eating, and the use of contact lenses or cosmetics will not be permitted on site.

Evacuation

1. The Field Team Leader will initiate evacuation procedures by signaling (via two-way radio or whistle) to leave the site.

2. All personnel in the work area should evacuate the area and meet in the common designated area.

3. All personnel suspected to be in or near the contract work area should be accounted for and the whereabouts of missing persons determined immediately.

4. Further instruction will then be given by the Field Team Leader.

DECONTAMINATION PROCEDURES

Personnel

To prevent harmful materials from being transferred into clean areas or from exposing unprotected workers, all field personnel exiting an area of potential contamination will undergo decontamination. The extent of decontamination depends on a number of factors, the most important being the type and concentration of the contaminant involved.

Soft-bristled scrub brushes and long handle brushes will be used to remove contaminants from personnel. Buckets of water or garden sprayers will be used for rinsing. Large plastic garbage bags will be used to store contaminated clothing (gloves, etc.) and equipment. Metal or plastic cans or drums will be used to store contaminated liquids. Washing and rinsing are done in combination with a sequential doffing of clothing starting at the first decon station with the most heavily contaminated article and progressing to the last station with the least contaminated article. Decontamination will be required for Level D activities. An exclusion zone will be established for drilling and Level C activities to prevent personnel from entering these areas without proper safety equipment (e.g., hard hat, steel-toe boots, respirators, etc.).

Decontamination procedures will be divided into 13 stations. Level C decontamination at all sites will consist of the following. Figures 3 and 4 illustrate typical Levels C and D and PPE decontamination steps.

Station 1: Segregated Equipment Drop

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross-contamination. Necessary equipment includes:

- Containers of various sizes
- Plastic liners

- Plastic drop cloths

Section 2: Suit/Safety Boot and Outer Glove Wash

Thoroughly wash chemically-resistant suit, safety boots and outer gloves. Scrub with long handle, soft bristle scrub brush and copious amounts of alconox/water solution. Necessary equipment includes:

- Container (30 gallon)
- Alconox/water solution
- Long handle, soft bristle scrub brushes
- Isopropanol

Station 3: Suit/Safety Boot and Outer Glove Rinse

Rinse off alconox/water solution using copious amounts of water. Repeat as many times as necessary. Necessary equipment includes:

- Container (30 gallon)
- Spray unit
- Water
- Long handle, soft bristle scrub brushes

Station 4: Outer Gloves Removal

Remove the outer gloves and deposit in individually-marked plastic bags. Necessary equipment includes:

- Plastic bag
- Bench or stool

Station 5: Canister or Mask Change

If a worker leaves the exclusion zone to change a canister (or mask), this is the last step in the decontamination procedures. The worker's canister is exchanged, new outer glove donned, and joints taped. Worker returns to duty. Otherwise the worker proceeds to Station 6. Necessary equipment includes:

- Canister (or mask)
- Tape
- Boot covers
- Gloves

Station 6: Safety Boot Removal

Remove safety boots and deposit in individually-marked plastic bags. Necessary equipment includes:

- Container (30 gallon)
- Plastic liners
- Bench or stool

Station 7: Removal of Chemically-Resistant Suit

With assistance of helper, remove suit. Deposit in container with plastic liner. Necessary equipment includes:

- Container (30 gallon)
- Chair
- Plastic liner

Station 8: Inner Glove Wash

Wash inner gloves with alconox/water solution that will not harm skin. Repeat as many times as necessary. Necessary equipment includes:

- Alconox/water solution
- Container
- Long handle, soft bristle brushes

Station 9: Inner Glove Rinse

Rinse inner gloves with water. Repeat as many times as necessary. Necessary equipment includes:

- Water
- Basin
- Small table

Station 10: Respirator Removal

Remove facepiece. Avoid touching face. Wash respirator in clean, sanitized solution. Allow to dry and deposit facepiece in plastic bag. Store in clean area. Necessary equipment includes:

- Plastic bags
- Sanitizing solution
- Cotton

Station 11: Inner Glove Removal

Remove inner gloves and deposit in container with plastic liner. Necessary equipment includes:

- Container
- Plastic liners

Station 12: Field Wash

Wash hands and face. Necessary equipment includes:

- Water
- Soap
- Tables
- Wash basins or buckets
- Clean towels

Station 13: Redress

If re-entering exclusion zone, put on clean field clothes (e.g., Tyvek^R , gloves, etc. Necessary equipment includes:

- Table
- Chairs
- Clothing

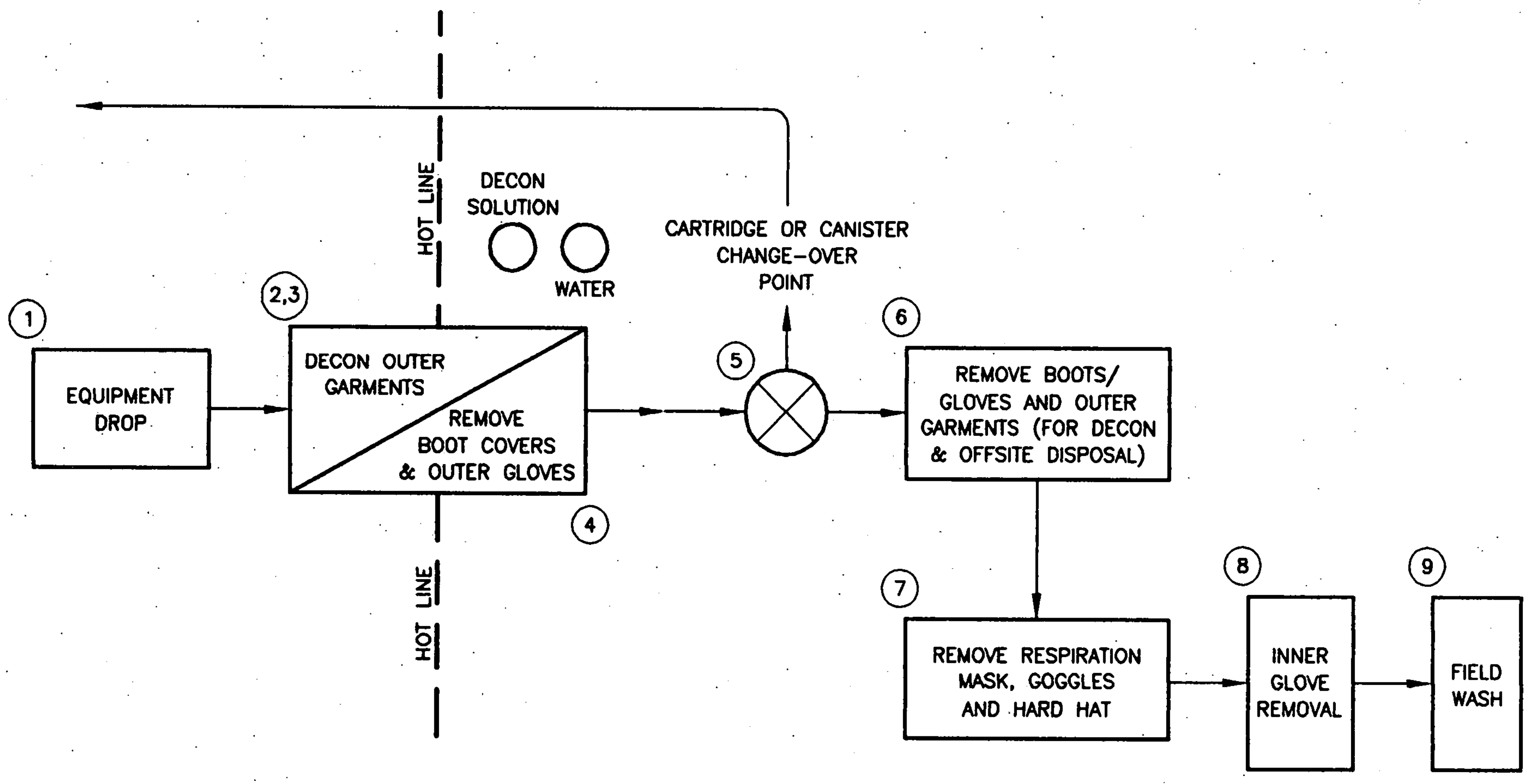
Modification can be made to the 13-station decontamination process depending upon the extent of contamination. The effectiveness of the decontamination process can be checked visually or by the use of a photoionization detector.

Personnel breaking for lunch will be required to wash hands and face prior to eating. Personnel should shower upon return to their hotels at the end of the work day.

Equipment

Excavating and trench construction equipment will be steam cleaned and decontaminated prior to moving to the site. Equipment will be steam cleaned to remove gross contamination and air dried before use.

All sampling equipment will be decontaminated prior to use at each sampling location. The methodology used to decontaminate sampling equipment is similar to that used for downhole equipment; the exception being that the first step, steam cleaning, is not necessary for decontaminating sampling equipment.

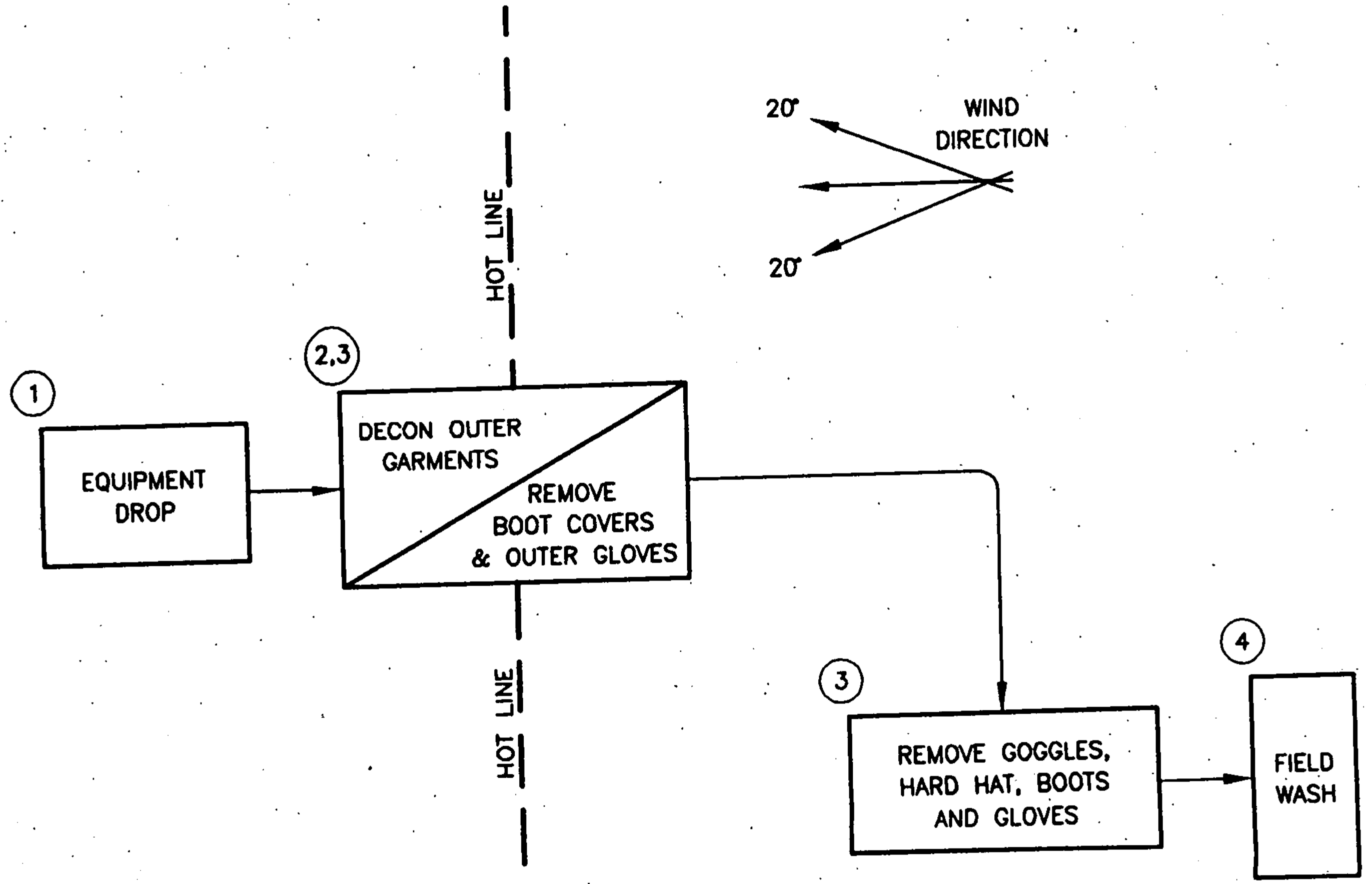


Stearns&Wheler
ENVIRONMENTAL ENGINEERS & SCIENTISTS

DATE: 8/94 JOB No.: 1587

GENERAL INSTRUMENT CORPORATION
SHERBURNE. NEW YORK
FIELD STUDY WORK PLAN – HSP

FIGURE 3
MINIMUM DECONTAMINATION LAYOUT
LEVEL C PROTECTION



Stearns&Wheler
ENVIRONMENTAL ENGINEERS & SCIENTISTS

DATE: 8/94 JOB No.: 1587

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FIGURE 4
MINIMUM DECONTAMINATION LAYOUT
LEVEL D PROTECTION