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September 14, 2005

Mr. Richard Brazell
NYSDEC – Region 7
615 Erie Boulevard
W. Syracuse, NY 13204-2400

Subject: Buckeye, Alaskan and Dreyfus/Stratus Terminals
Lysander (Cold Springs), New York
NYSDEC Spill No. 89-04923
PIN No. 99528

Dear Mr. Brazell,

Enclosed please find the final Remedial Alternatives and Pilot Test Report for the above referenced site. The report includes a description of the remedial alternatives considered for the Cold Springs Terminals and subsequent pilot testing conducted in November, 2004.

The proposed remedial design includes soil vapor extraction and product recovery via 67 remedial wells and groundwater extraction/depression via three horizontal wells. Aztech recommends that the services of an outside consultant versed in LNAPL/groundwater flow modeling and horizontal well design be employed in assisting with design and implementation of the groundwater depression system recommended therein. A scope of work is attached hereto detailing the services we believe that the outside consultant should be able to offer the project. Additionally, after installation of the groundwater depression system is completed, Aztech recommends operating the system for a period of time sufficient to evaluate its performance at the site. Operational data collected during this time period will be used to determine the appropriate depth and spacing for additional horizontal wells, if warranted, and to properly size equipment for a final water treatment system.

If you have any questions regarding the information presented in the report, please contact either Fil Fina, Mary Passaretti or myself at (518) 584-5122 at your convenience.

We appreciate the opportunity to work with you on this project.

Sincerely,
AZTECH TECHNOLOGIES, INC.

Randy Hoose

Randolph H. Hoose, P.G.
Sr. Hydrogeologist

Mary Passaretti, M.S.
President

Attachments: Consultant Scope of Work for Cold Springs Remediation Project
Remedial Alternatives and Pilot Test Report

Scope of Work for Cold Springs Remediation Project

Cold Springs Terminals, Lysander NY

Objectives:

[a] To design a groundwater depression system, using horizontal wells, for installation in the soils beneath the Cold Springs Terminals and [b] to evaluate the potential of the groundwater depression system to enhance the removal of LNAPL and dissolved-phase contamination by various remedial methods.

Deliverables:

[1] After a review of existing data for the site, the consultant should provide Aztech with recommendations for additional data necessary to complete the project requirements. At a minimum, this should include the number, locations and depths of soil samples to be collected and analyzed via sieve analysis. Results of the sieve analysis will be provided to the consultant to assist in the determination of the proper screen slot size for the horizontal wells.

[2] A preliminary report on the groundwater flow system beneath the Terminals including:

- A review of recent pump testing conducted by Aztech to aid in the development of a groundwater flow model for the site;
- The groundwater flow model should be able to evaluate the effect of installing one or more horizontal wells at various depths and in various orientations on the capture of the LNAPL via vertical wells;
- The groundwater flow model should be able to evaluate the production of LNAPL over time by the optimal placement/orientation of the horizontal wells;
- The groundwater flow model should be able to provide specifications for the location, optimal depth of placement and orientation for the horizontal wells;
- The groundwater flow model should be able to estimate the production of LNAPL via vertical wells and groundwater via horizontal wells under a variety of conditions.
- Design specifications for the horizontal boring technique, drilling fluids, screen length and slot size, sand pack, development, method of groundwater extraction and pump placement of the horizontal wells.

[3] After installation and preliminary testing of the horizontal wells, a second report should be prepared that will include the following:

- An analysis of the data collected during preliminary testing of the groundwater depression/LNAPL recovery system
- Recommendations concerning the need for modifications to the groundwater depression/LNAPL recovery system (if warranted) and recommendations regarding operation of the groundwater depression/LNAPL recovery system;
- A simulation of surfactant flooding, as a means of polishing, to remove remaining LNAPL beneath the water table and estimation of costs of implementation;
- A simulation of enhanced soil vapor extraction to remove remaining LNAPL in the vadose zone and estimation of costs of implementation.

Requirements:

The consultant must have demonstrable experience in modeling multi-phase flow of LNAPL, water, and air, and have the capability of using such computer programs or simulators for the design of well fields to remove LNAPL. Furthermore, the consultant should be able to incorporate horizontal wells into the design and simulate the LNAPL movement in three-dimensions. Because surfactant flooding is being considered for removal of the residual LNAPL, it would be advantageous if the consultant has experience with modeling and implementation of surfactant-enhanced LNAPL removal as well.

Remedial Alternatives and Pilot Test Report

SUBJECT SITE:

Cold Springs Terminals
Hillside Drive
Lysander (Cold Springs)
Onondaga County, New York

NYSDEC Spill No. 89-04923
PIN # 99528

PREPARED BY:

Aztech Technologies, Inc.
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518-584-5122
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September, 2005

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INTRODUCTION

Aztech Technologies, Inc., on behalf of the New York State Department of Environmental Conservation (NYSDEC), has prepared this report in order to present the results of pilot testing conducted at the Cold Springs Terminals located on Hillside Drive in the Town of Lysander, Onondaga County, New York (**Figure 1**). The pilot testing presented herein was conducted in order to evaluate and propose an appropriate remedial technology to reduce the presence of liquid phase hydrocarbons, as well as residual petroleum hydrocarbon compounds in soil and groundwater beneath the site.

Site Description and Background

The site is located on the north shore of the Seneca River, approximately 1.25 miles north of the northern end of Onondaga Lake. The site consists of three (3) Petroleum Bulk Storage (PBS) facilities: the Buckeye pipeline facility on the north side of Hillside Drive, and, the Alaskan and Dreyfus/Stratus facilities on the south side of Hillside Drive.

The Buckeye facility is located topographically higher than the Alaskan and Dreyfus/Stratus terminals. Prior to 1989, when the aboveground PBS tanks (ASTs) were razed, the Buckeye facility transferred petroleum products from their pipeline, which crosses under the Seneca River, to their facility via underground product lines. The product lines were routed to the Buckeye facility via an easement between the Alaskan and Dreyfus/Stratus terminals. The Buckeye facility is currently vacant and overgrown; the only visible evidences of former PBS activities at this site are the remaining footprints of the old ASTs, as well as the site fencing and secondary containment berms. Presently, both the Alaskan and Dreyfus/Stratus terminals are active PBS facilities adjacent to the north shore of the Seneca River. Site features, including the existing monitoring well network, are included on the site map (**Figure 2**).

The topography immediate to the site generally rises approximately 30 feet on the north side of Hillside Drive. As such, the Buckeye facility is topographically upgradient of the Alaskan and Dreyfus/Stratus Terminals. The topography south of Hillside Drive is generally flat across both the Alaskan and Stratus/Dreyfus terminals, and then drops down to the Seneca River. The properties to the north and east of the site are privately owned with a few residences; west of the site is a Cemetery. The east-flowing Seneca River bounds the site to the south.

Drilling Program

Based on our review of the existing data for the site, Aztech proposed the installation of two (2) pilot test wells, and associated monitoring points, in the southeast quadrant of the Buckeye property. These pilot test wells were installed in proximity to existing monitoring wells BMW-14 and MW-C. One of the pilot test wells was installed to facilitate soil vapor extraction (SVE-PTW) while the other pilot test well was installed in order to facilitate groundwater extraction (GWE-PTW). The installation of the pilot test wells was completed in October, 2004.

Well SVE-PTW was installed to a depth of 20-feet below grade and was screened in the interval from 5.0-feet to 20-feet below grade. Well GWE-PTW was installed to a total depth of 22-feet below grade and was screened in the interval extending from 7.0-feet to 22-feet below grade. The soil boring/well completion logs for the pilot test wells are included in **Appendix A**.

Site Stratigraphy and Hydrogeology

Observations made during previous investigations at the site indicate soil textures ranging from silt and clay, to silt to fine-grained sand. Several wells advanced to approximately 30-feet below grade (+/-) on the Buckeye property encountered dense red clay and/or red shale bedrock at depth. Additionally, some fine- to medium-grained gravel was encountered. Observations made during the installation of the pilot test wells (SVE-PTW and GWE-PTW) indicate that a surficial layer of silt, that gradually coarsens to well sorted fine- to medium-grained sand with depth, underlies the southeastern portion of the Buckeye property.

Static groundwater elevations, obtained on November 2, 2004 prior to pilot testing, indicate that groundwater is encountered on the site at depth ranging from approximately 6.0-feet to 29-feet below grade. In general, depth to groundwater increases with horizontal distance from the Seneca River. As such, groundwater is encountered on the Alaskan and Dreyfus/Stratus terminals at depths ranging from 6.0- to 15-feet below grade and, from 15- to 29-feet below grade on the Buckeye property. As shown in the groundwater contour map presented as **Figure 3**, groundwater flow beneath the Buckeye property is a subdued reflection of surface topography with groundwater movement from north to south at a hydraulic gradient of 0.09 ft/ft (as measured between wells BMW-2 and MP-5) beneath the Buckeye facility. In the southern portion of the Buckeye property and beneath the Alaskan and Dreyfus/Stratus facilities, the groundwater elevations indicate that the hydraulic gradient becomes very shallow and that the groundwater configuration becomes distorted. In fact, the configuration of the 87.50-foot groundwater elevation contour presented in Figure 3 suggests that groundwater movement from the southeastern quadrant of the Dreyfus/Stratus terminal is generally toward an east-northeasterly trending trough. Within this trough, the hydraulic gradient (as measured between wells BMW-4 and AMW-3) is 0.003 ft/ft. This trough/distortion in the 87.50-foot groundwater elevation contour may be related to the presence of measurable quantities of free-phase petroleum product beneath much of the Alaskan and Dreyfus/Stratus Facilities. The distribution (and measured thickness) of free-phase product on November 4, 2004 is shown in **Figure 4**.

REMEDIAL ALTERNATIVES

Several remedial approaches were given consideration based on the distribution of free and dissolved -phase petroleum hydrocarbons throughout the terminals area and the stratigraphy of the subsurface. Consideration was also given to the logistics of implementing the various remedial approaches and the fact that the Alaskan and Stratus/Dreyfus terminals are active facilities. Each of the remedial approaches considered appears to have its own specific benefit as well as its own set of logistical difficulties from the standpoint of effectiveness, implementation, cost or any combination thereof. The following is a summary of the remedial approaches considered.

Excavation

Excavation would be accomplished using track-mounted excavation equipment. In order for a complete removal for impacted soil, the facility would first have to be razed, then excavated and the facility rebuilt. Additionally, it is likely that excavation would require sidewall support via proper sloping and shoring with sheet piles. Additionally, the subsurface would likely need to be dewatered (adjacent to a river) before and during excavation activities. The primary benefit to excavation would be removal of source area soil and free-phase product from the site. However, excavation would be cost-prohibitive and, as such, is not considered a realistic remedial option for the Cold Springs site.

In-Situ Chemical Oxidation

In-situ chemical oxidation would be accomplished by installing the appropriate infrastructure, consisting of wells and a distribution manifold(s) in order to introduce chemical oxidant to impacted soil and groundwater. The primary benefit to in-situ chemical oxidation would be complete destruction of petroleum hydrocarbons in soil and groundwater. However, storage and handling of chemicals required by the process as well as the risk of an uncontrolled exothermic reaction in the presence of free-product might have serious consequences. Based on the risk of an uncontrolled exothermic reaction in the presence of free-product and the fact that the site is an active bulk petroleum storage facility, in-situ chemical oxidation is not considered a realistic remedial option for the Cold Springs site.

In-Situ Bioremediation

In-situ bioremediation would be accomplished by installing the appropriate infrastructure, consisting of wells and a distribution manifold(s) in order to introduce nutrients to impacted soil and groundwater. The primary benefit to in-situ bioremediation is that it can be a cost effective means to enhance naturally occurring biological activity to reduce concentrations of petroleum hydrocarbon compounds in soil and groundwater. However, this is a very non-aggressive remedial approach that could take tens (or hundreds) of years to reach completion. The actual duration of remedial efforts is dependant on the mass of petroleum hydrocarbons and the availability of oxygen or other electron receptors, and the rate of the reaction. Based on the high mass of petroleum hydrocarbons beneath the site and the number of years anticipated for this approach to be completed, in-situ bioremediation is not considered a realistic remedial option for the Cold Springs site. It can, however, be considered as a polishing mechanism after completing a more aggressive remedial approach for the site.

Air/Bio-Sparging

Air/bio-sparging are both accomplished by installing the appropriate infrastructure (consisting of wells and a distribution manifold) in order to introduce atmospheric air below the water table. Bio sparging involves injecting air at a pressure sufficient to push groundwater out of the sparge well so that compresses air can be “bubbled” into the subsurface. The primary benefit to bio sparging is that it helps to enhance naturally occurring biological activity by increasing the amount of oxygen in the subsurface. Air sparging is a more aggressive approach whereby atmospheric air is rapidly introduced into the subsurface under pressure. The goal of air sparging is to physically agitate the groundwater so that petroleum hydrocarbons are transferred from the aqueous phase to the gaseous phase. As such, mass is transferred from the groundwater to the vadose zone. However, in the absence of simultaneous soil vapor extraction, mass transferred to the vadose zone will eventually re-dissolve into percolating precipitation via recharge and serve as a continual source of petroleum hydrocarbon compounds to groundwater. While air sparging and bio sparging are more aggressive than in-situ bioremediation, they are not considered a realistic remedial option based on the duration of time anticipated for remedial activities to be completed. They can, however, be considered as a polishing mechanism after completing a more aggressive remedial approach for the site.

Free-Product Recovery

Free-product recovery is accomplished via installation of electric or pneumatic product recovery pumps in strategically placed wells to maximize the area from which product can be recovered. The benefit of product recovery is that it can rapidly remove a great mass of petroleum hydrocarbons in a relatively short period of time and can lower the overall cost of simultaneous and/or subsequent remedial technologies. However, in the absence of other remedial technologies, free-product recovery will not address residual petroleum hydrocarbons in soil held by capillary forces or dissolved in groundwater. Installation of infrastructure, such as product recovery wells, electrical/pneumatic supply lines and product return lines, can be challenging and expensive, but efficient well placement and infrastructure design can help to minimize those costs. Free-product recovery is considered a feasible remedial technology for the Cold Springs Terminals.

Groundwater Extraction and Treatment

Groundwater extraction (GWE) can be accomplished via installation GWE pumps in strategically placed vertical or horizontal wells to capture groundwater containing concentrations of dissolved petroleum hydrocarbon compounds. The benefit of GWE is that further migration of impacted groundwater can be minimized and/or eliminated using a proper configuration of GWE wells. By itself, GWE can control further impact from the site to the environment. The use of GWE to depress the water table beneath an area of free-phase product can help to make free-product recovery efforts more efficient. Depressing the water table can also increase the amount of vadose zone and thereby isolate impacted soil from the water table. Thus, further addition of mass to groundwater can be minimized or eliminated. However, in the absence of other remedial technologies, GWE will not address residual petroleum hydrocarbons in the vadose zone. Installation of infrastructure, such as GWE recovery wells, electrical/pneumatic supply lines and groundwater return lines, can be challenging and expensive, but efficient well placement and infrastructure design can help to minimize those costs.

After the groundwater is extracted, it is typically treated via air stripping, followed by polishing with liquid phase granular activated carbon. Treatment via air stripping typically presents several challenges based on the fact that the extracted groundwater is brought to the surface, and both the temperature and water chemistry is changed. These changes in temperature and/or water chemistry can result in the formation of precipitates that can further complicate operation and maintenance of the groundwater treatment system. Additional challenges are presented by frigid conditions in the cold winter months. However, in spite of the challenges presented, GWE and treatment is considered a feasible remedial technology for the Cold Springs Terminals.

Surfactant Flushing

Surfactant flushing is accomplished by introducing a liquid surfactant to the soil and groundwater that physically removes hydrocarbons held by capillary forces from the soil. The surfactant accomplishes this by increasing the solubility of the hydrocarbons in water. The hydrocarbons are subsequently collected via strategically placed groundwater extraction wells. The benefit of surfactant flushing is that it addresses residual hydrocarbons above and below the water table. Additionally, since implementation of GWE is also required in order to capture the surfactant solubilized hydrocarbons, further migration of impacted groundwater from the site can be minimized and/or eliminated using a proper configuration of GWE wells. The proper configuration and design of the infrastructure required to introduce the surfactant and to extract the surfactant/hydrocarbon/groundwater mixture is determined via computer modeling. Additionally, installation of the infrastructure (injection wells, distribution manifold(s), extraction wells, electrical/pneumatic supply lines and groundwater return lines) can be challenging and expensive, but efficient well placement and infrastructure design/construction can help to minimize those costs.

After the mixture of hydrocarbons/groundwater is extracted, it chemically treated in order to separate the hydrocarbons from the aqueous phase. Hydrocarbons are stored and ultimately recycled; the aqueous phase is treated via air stripping and liquid phase GAC. As previously indicated, treatment via air stripping presents several challenges based on the fact that the temperature and water chemistry is changed and, the additional challenges presented in the cold winter months. However, in spite of the challenges presented, surfactant flushing appears to be a feasible remedial technology for the Cold Springs Terminals.

Soil Vapor Extraction

Soil Vapor Extraction (SVE) can be accomplished by connecting a vacuum blower to several strategically placed/constructed wells to remove soil vapors from the vadose zone. The wells are attached to the blower via either above ground or below ground piping. The benefit of SVE is that, given the right set of soil conditions, petroleum hydrocarbons can be removed from impacted soil above the water table. As such, SVE can help to minimize and/or eliminate these vadose zone soils as a further source to introduce mass to groundwater. However, in the absence of other remedial technologies, SVE cannot address mass within and below the water table.

After the soil vapor is extracted from the ground, it must meet SVE system benzene emission limits as set forth by NYSDEC. That emission limit is 0.022 pounds of benzene per hour of discharge via an effluent stack at 30 feet above the ground. In the event that benzene limits are exceeded, treatment of the effluent via GAC or thermal/catalytic oxidation will be necessary. The addition of thermal/catalytic oxidation increases the infrastructure and routine maintenance required for operation of the system. SVE is considered a feasible remedial technology for the Cold Springs Terminals.

Total Fluids Extraction

Total Fluids Extraction (TFE) is a process by which all fluids (typically groundwater and soil vapor) are extracted via small diameter drop tubes in several strategically placed remedial wells. TFE systems are not typically designed for the removal of free-product. Remedial wells are connected to a vacuum blower via below grade piping buried to a depth sufficient to prevent freezing. Alternatively, piping can be run above ground and heat traced as appropriate.

Fluids extracted by the system are conveyed to a series of separators where the gaseous and aqueous phases are separated. Further separation of the aqueous phase and free-product are also required. Product is temporarily stored in a separate vessel; extracted groundwater is treated via air stripping and/or liquid phase GAC; and, the vapor component will likely require thermal/catalytic oxidation prior to discharge.

The benefit of TFE is that all fluids are extracted from each well by a vacuum applied to the small diameter drop tube. As such, the down-well components are simple and low maintenance. TFE also serves to dewater each well, not only lowering the overall water table at the site, but also creating low spots in the water table where free-phase product can accumulate and be extracted from the subsurface. Once dewatered, the vacuum blower will be able to remove soil vapors from the newly created vadose zone and remove residual hydrocarbons that would otherwise be a continual source below the water table. The drawbacks to TFE include the fact that it is a technology that typically requires high horsepower electrical motors to drive the vacuum blower(s). TFE is also best applied to dewater soil to a depth of 15 feet below grade or less. It can be applied at greater depths, but its efficiency decreases rapidly below 15 feet. Additionally, TFE is most appropriate when applied to low permeability/low water producing soil. At the present time, the stratigraphy below 12-feet is not well documented on the Alaskan and/or Stratus/Dreyfus terminals in proximity to the Seneca River. While TFE is a technology that might be able to be applied at this site, TFE is not considered the best remedial approach for the Cold Springs site.

Discussion of Remedial Alternatives

After evaluating the various remedial alternatives, it appears that no single remedial approach presents an effective remedial scenario by itself. Rather, simultaneous implementation of two or more approaches will provide the most efficient remedial scenario. For example, SVE in the absence of GWE will be of limited benefit. However, implementing GWE in order to dewater the subsurface and create additional vadose zone from which additional soil vapors can be withdrawn, will provide a more efficient remedial approach than using GWE or SVE alone. Likewise, free-product recovery prior to implementing surfactant flushing will help to increase the efficiency of the surfactant flushing. Additionally, surfactant flushing would require installation of infrastructure for GWE and treatment.

PILOT TESTING

After determining that remedial technologies utilizing free-product recovery, GWE and/or SVE provide the most feasible alternatives for the site, pilot testing was conducted in order to further investigate the subsurface. Pilot testing was performed in order to estimate the air and water permeability of the soil underlying the site. This would help to further evaluate whether remedial technologies that included SVE and/or GWE were feasible and effective for reducing the occurrence and distribution of free-phase petroleum product in the subsurface. In particular, the pilot testing would help to evaluate whether these technologies would help to reduce the concentrations of petroleum hydrocarbon- compounds from soil pore spaces both above and below the water table. Pilot testing was conducted by extracting soil vapors only from well SVE-

PTW and groundwater only from well GWE-PTW. Changes in the measured thickness of free-phase petroleum hydrocarbons in response to GWE were also monitored during the testing. The data obtained from the pilot testing was used to develop a conceptual design and approach for implementing remedial activities on the site.

Methodology

The pilot testing was conducted using the two (2) wells (SVE-PTW and GWE-PTW) installed specifically for conducting the pilot test (Figure 2). The SVE component of the pilot testing was conducted using a positive displacement blower to facilitate extraction of soil vapors from the tested well. The GWE component of the pilot testing was conducted via an electric submersible pump that was installed to dewater the tested well. The general approach was to initially conduct SVE pilot testing in the absence of groundwater extraction, then, to conduct GWE pilot testing for approximately 24-hours (in the absence of SVE). Pilot testing was completed with simultaneous GWE/SVE testing.

SVE pilot testing is typically conducted by first determining the maximum flow rate/vacuum that can be applied to the tested well without drawing groundwater out of the well. After determining the maximum wellhead vacuum, the test is subsequently conducted by extracting soil vapors from the tested well at a fixed flow rate that is proportional to approximately one-third (1/3) the maximum wellhead vacuum. This initial step is conducted until the vacuum induced into the vadose zone reaches a steady-state condition. Once a steady state condition is reached, the flow rate/vacuum applied to the tested well is increased, and the vacuum is monitored in the vadose zone until steady state is reached again. This procedure is repeated until the flow rate/vacuum applied to the tested well is maximized.

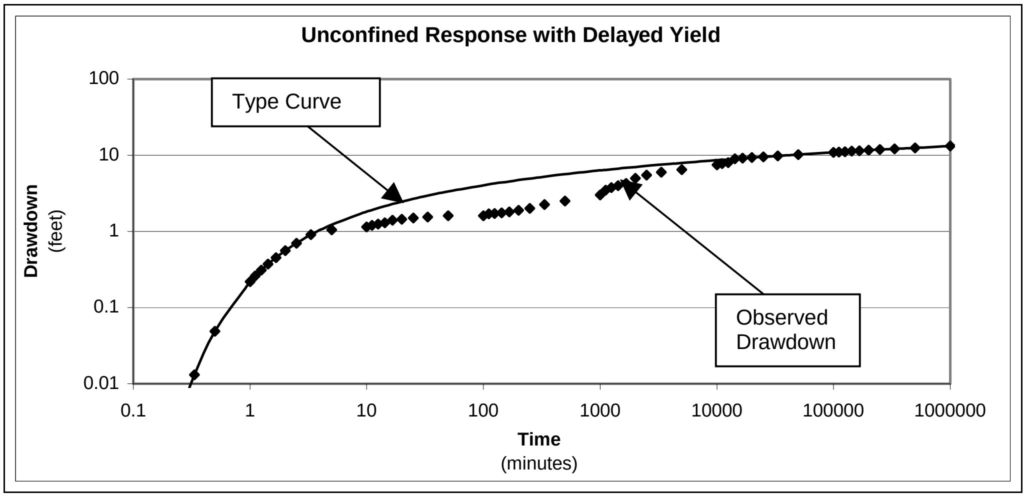
Upon completion, the data collected during the SVE component of the test are reduced and graphically represented by plotting the vacuum recorded in the observation points versus their distance from the tested well. These vacuum distribution plots are prepared for each flow rate tested. A best-fit line is drawn through the data on each vacuum distribution plot in order to determine the effective radius of influence (ROI) at that flow rate. The effective ROI is considered to be that distance where 0.1-inches of water column vacuum (H2O) can be induced into the subsurface at a particular flow rate/vacuum setting.

Prior to commencing with the GWE component of the pilot test, a complete round of depth to water measurements representing static groundwater conditions is obtained. Groundwater elevations are subsequently monitored during the test, and at the end of the test. Upon completing the pilot testing, the static and end of test water levels are used to prepare groundwater contour maps. The data collected during the test are also reduced in order to evaluate the type of water-bearing unit being tested (i.e. confined; semi-confined or, unconfined) and, also, to estimate the transmissivity of the subsurface.

Transmissivity is the product of a soils hydraulic conductivity (k) and its full saturated thickness (b). Hydraulic conductivity is a measure of a soils ability to transmit a volume of viscous fluid, over a given time period, through a two-dimensional planar surface. Hydraulic conductivity values are typically given in units of cubic feet per day (ft^3/day) per square foot (ft^2) of soil material (ft^3/day/ft^2). After cancellation of like units, hydraulic conductivity values are represented as feet per day (ft/day). Transmissivity is a measure of the amount of water that can be transmitted horizontally by the full saturated thickness of a soil under a hydraulic gradient (i) of one (1.0). Transmissivity values are typically given as a volume per unit of time [(ft^3/day, for example) per foot (ft) of saturated thickness]. After cancellation of like units, transmissivity values are represented as feet squared per day (ft^2/day).

Groundwater extraction data obtained during the pilot testing were initially evaluated in order to select appropriate methods of data analysis. This was done by correcting the depth to water data for recharge related to precipitation events before and during the testing activities, then plotting the corrected drawdown data on log-log graph paper. The resulting logarithmic plots were compared to the typical time-drawdown curves presented in "Analysis and Evaluation of Pumping Test Data" (Kruseman and de Ridder, 1983 – page 20) in order to evaluate the type of aquifer response observed during the GWE portion of the pilot test. Azech's understanding of the site prior to GWE testing suggested that the drawdown data collected from nearby monitoring wells would be that of an unconfined aquifer with the possibility of delayed yield noted. The observed drawdown data collected from the GWE testing, when plotted logarithmically, suggested either a semi-confined response or, an unconfined response with varying degrees of delayed yield noted in several monitoring wells.

As shown in the chart below, the initial response of an unconfined aquifer to GWE is that the drawdown observed in nearby monitoring wells generally follows the typical response of a confined aquifer, as shown by the type curve developed by Theis. During this initial response, the water is released from storage by compaction of the aquifer matrix and expansion of the water. During this early time period, the transmissivity can be determined using the Theis method. After a sufficient period of time has elapsed (in the example below, at approximately 7.0 minutes), the observed drawdown begins to deviate from the type curve. During this segment of the curve, the slope of the observed drawdown data decreases. This is because gravity drainage of the inter-granular porosity is occurring (i.e. delayed yield), which temporarily acts as a recharge boundary. As the duration of pumping continues the effect of delayed yield decreases and, eventually, equalizes with the rate of decline of the water table. In fact, if sufficient time is allowed for pumping to continue, the effect of delayed yield decreases completely and the observed drawdown data returns to the Theis type curve.



Based on the drawdown data collected during the GWE testing, the double logarithmic plots suggest that one of the data analysis methods developed for an unconfined system with delayed yield is appropriate for the analysis of the data collected from the GWE testing at the site. As such, the method developed by Boulton (1963) was used to evaluate the drawdown data collected during the GWE testing.

The Boulton method was developed in order to evaluate pump test data collected from an unconfined system where delayed yield is observed. The method utilizes log-log plots of observed drawdown (on the vertical "Y" axis) vs. time (on the horizontal "X" axis), and matching that observed data to a family of "Boulton Type-Curves". The Boulton type-curves, which are included in **Appendix B**, are a series of type-curves (denoted as "r/B") that represent typical unconfined responses to pumping with delayed yield. The type-curves are bounded on each side by the Theis type-curve. The early (left hand) portion of the type-curves is a plot of the well function ($W(u_A)$) vs $1/u_A$; the late portion of the type-curves is also a plot of the well function ($W(u_Y)$ vs. $1/u_Y$) shifted to the right.

The data are evaluated by superimposing the observed drawdown data onto the Boulton type-curves and, while keeping the coordinate axes parallel, finding the type-curve on which as much as possible of the early time data will fall. Two match points (one for the early portion (A) of the data and one for the late portion (Y) of the data) are subsequently selected. The early match point is subsequently selected from the type curve (preferably where $W(u_A, r/B)$ and $1/u_A$ are equal to 1.0) and the corresponding drawdown ("s_A") and time ("t_A") are selected from the observed data. Likewise, a late match point is selected (preferably where $W(u_Y\ r/B)$ and $1/u_Y$ are equal to 1.0) and the corresponding drawdown ("s_Y") and time ("t_Y") are selected from the observed data. From the match points, the transmissivity (T) can be estimated via the relation:

$$T = \frac{Q}{4\,\pi\,s_A}\ W(u_A, r/B)$$

Where: T = Transmissivity (ft^2/day)
Q = Pumping Rate (ft^3/day)
s_A = Drawdown (ft) – determined from early match point
$W(u_A, r/B)$ = Well Function (preferably 1.0 from the match point selected)

The same equation can be used to determine the transmissivity based on the match point selected for the "late" observed drawdown data. There should be reasonable agreement between the transmissivity determined via the early and late observed drawdown data.

From the transmissivity, the hydraulic conductivity can be estimated through the relation:

$$K = T/b$$

Where: K = Hydraulic conductivity (ft/day)
T = Transmissivity (ft^2/day)
b = Saturated thickness (ft)

After determining the transmissivity, the storage coefficient (S_A) can be determined using the match point from the early observed drawdown data, and the specific yield (S_Y) can be determined from the late observed drawdown data. These are determined via the relation:

$$S_A = \frac{u_Y\ 4\ T\ t}{r^2}$$

Where: S_A = Storage Coefficient (early)
u_A = Early Match Point (preferably 1.0) determined from type-curve
T = Transmissivity (ft^2/day)
t_A = Time in days (determined from early match point)
r = radial distance from observation point to pumping well (feet)

The specific yield (S_Y) can be determined by inputting the values determined for u_Y and t_Y based on the match point selected for the "late" observed drawdown data.

The validity of the equations used to determine the transmissivity can be verified by calculating the effective coefficient of storage (γ) by the relation:

$$\gamma = 1 + \frac{S_Y}{S_A}$$

According to Kruseman and de Ridder, the above equation for transmissivity is valid if γ is greater than (>) 100. If γ is between 10 and 100 (i.e. $10 < \gamma < 100$), then the Boulton method is said to give a "good" approximation of the transmissivity.

Field Procedures

Pilot test data was collected over the period from November 2, 2004 through November 5, 2004. Three (3) pilot tests were conducted during this period. The first test included SVE only in order to evaluate the response of the subsurface under static groundwater conditions (Test-1). The second test involved GWE only for a period of 24 hours (Test-2). The third test involved a continuation of the GWE testing at well GWE-PTW and adding SVE to nearby well SVE-PTW for the remainder of the test (Test-3). Under these testing scenarios, the actual duration of the GWE component of the pilot testing was approximately 48-hours.

The following information was collected during the pilot testing: static depth to water and product thickness measurements from all wells at the site prior to start-up; observed vacuum/depth to water/product from selected monitoring wells (MP-5, MP-10, MP-15, BMW-14, MW-C, BMW-9, and SMW-12); air and/or groundwater flow rates from the tested wells, and; total VOC concentrations in the blower effluent. These data were collected over a time period that was sufficient to allow the vacuum induced into the vadose zone and flow rate at the test well to stabilize. Additionally, mass removal rates were calculated for each step of the SVE testing. Both pilot test wells (SVE-PTW and GWE-PTW) are located within approximately 5.0-feet of each other. A site map focused on the pilot test area is presented as **Figure 5**.

Test-1 was initiated by connecting the blower to well SVE-PTW and connecting vacuum gauges to selected monitoring wells. The following information was collected during the pilot test for estimating the ROI of the SVE component: wellhead vacuum at the tested well and observed vacuum at selected monitoring well locations; air flow rate from the tested well; and, total VOC concentrations in the blower effluent. These data were collected until the vacuum in the vadose zone and flow rate/vacuum at the test well had stabilized. Subsequent to stabilization, the flow rate/vacuum at the test well was increased incrementally until the maximum wellhead vacuum was reached.

Test-2 was initiated by installing an electric submersible pump in well GWE-PTW and setting the Hi/Lo controls to maintain the water level at approximately 16-feet below grade. Based on the static depth to water at approximately 10-feet below grade, the GWE component of Test-2 dropped the water table by approximately 6.0-feet in the tested well. Test-2 consisted of GWE only for approximately 24-hours. During that time period, depth to water and product measurements were collected in selected wells in order to estimate the hydraulic conductivity of the subsurface. Additionally, changes in product thickness in response to pumping were also monitored.

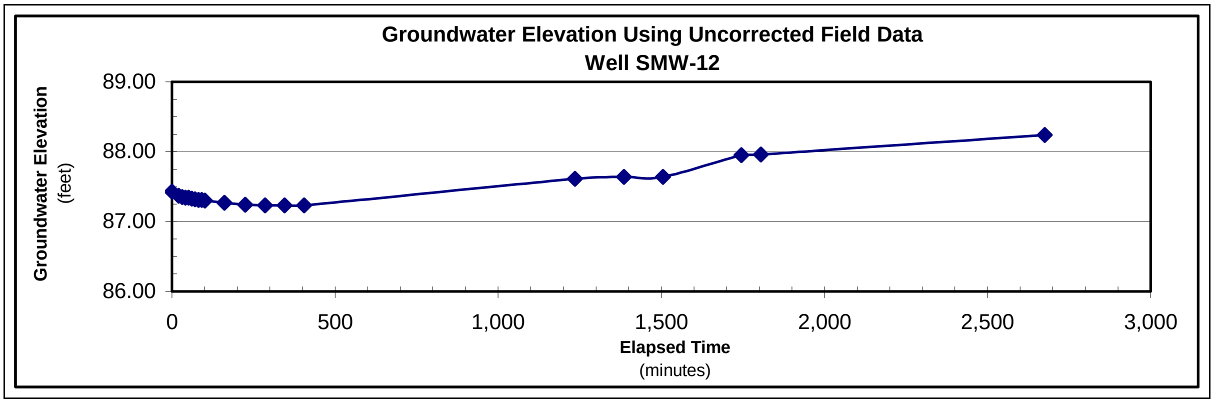
After approximately 24-hours had elapsed for Test-2 to be completed, Test-3 was initiated by activating SVE in nearby well SVE-PTW while continuing the GWE testing via well GWE-PTW. As with Test-1, the SVE component of Test-3 was conducted at various wellhead vacuum/flow rate configurations. During this test, wellhead vacuum at the tested well and observed vacuum at selected monitoring well locations; air flow rate from the tested well; and, total VOC concentrations in the blower effluent were monitored. Additionally, depth to water and product measurements continued to be collected in selected wells during until the pilot test was completed.

Results of Pilot Testing - Groundwater Extraction

The GWE component of the pilot testing was conducted on 4.0-inch inside diameter well GWE-PTW. The testing was initiated at 9:55 AM on November 3, 2004 and was terminated at 7:20 AM on November 5, 2004. The GWE component of the pilot test lasted for a total duration of 2,725 minutes. During that time period, a total of 1,110 gallons of groundwater were withdrawn from the subsurface. As such, the average yield for the GWE component of the test was 0.4 gallons per minute (GPM). Data collected during the GWE component of the pilot testing is included in Appendix B.

As indicated in Figure 3, the static groundwater elevation data collected on November 2, 2004 indicates groundwater flow beneath the Buckeye property from north to south at a hydraulic gradient of 0.09 ft/ft. The hydraulic gradient becomes very shallow beneath the Alaskan and Dreyfus/Stratus terminals and the groundwater configuration becomes distorted. This distortion may be related to the presence of measurable quantities of free-phase petroleum product in several wells within this area. A second set of static groundwater measurements was obtained on November 3, 2004 prior to commencing with the GWE component of the test. These measurements were used to prepare the static groundwater contour map for the pilot test area presented in **Figure 6**. The static groundwater contours shown in Figure 6, which are drawn at a smaller contour interval (0.5-feet) than presented in Figure 3 (2.5-feet), indicate the general movement of groundwater through this portion of the site prior to commencing with GWE on the morning of November 3. The static groundwater elevations suggest a generally east trending trough that appears to be centered about the pilot test wells.

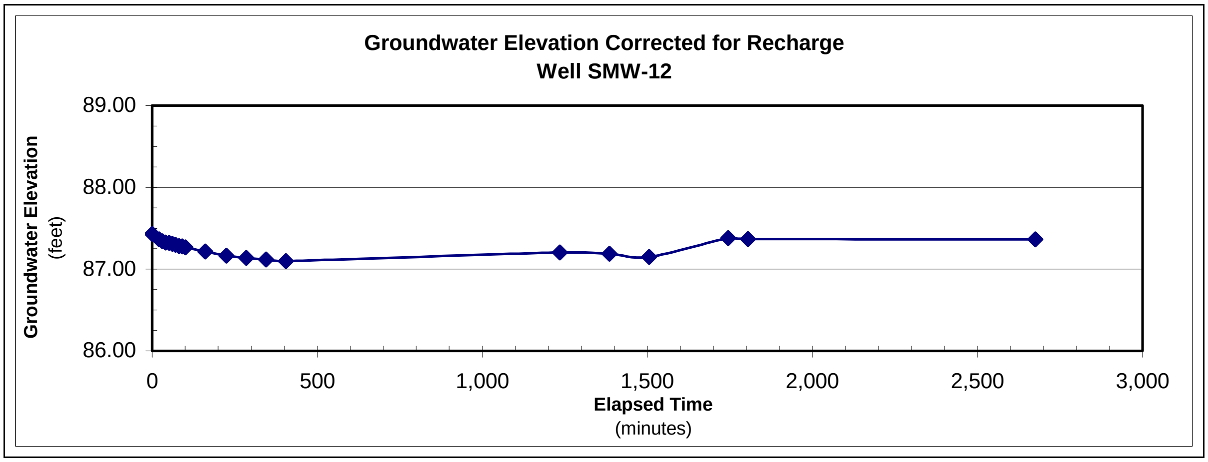
It is important to note that the pilot testing was conducted during a period of abundant rainfall. According to the National Weather Service, 0.34-inches of rainfall were recorded at the Hancock Airport in Syracuse during the week preceding the pilot test. This includes 0.16-inches on October 30, and 0.12-inches on November 1. On November 2, 0.36-inches of rainfall was recorded. Significant rainfall events of 0.39-inches and 0.36-inches were also recorded during the test on November 4, and November 5, respectively. An evaluation of the depth to water measurements obtained during the pilot test indicate that groundwater levels began to rise during the test. In fact, the depth to water measurements at 3:00 PM on November 4 (1,745 minutes into the test) indicate that groundwater elevations rose by as much as 2.30 feet (well BMW-2) up to that point in the test. This set of depth to water measurements (at 1,745 minutes into the test) was considered the "end of test" data set because a significant rainfall event was forecast for later that day. The chart below demonstrates the rising groundwater in a nearby monitoring well (SMW-12).



Based on the fact that the observed drawdown data at the end of the test were obscured by the rising groundwater elevations in response to the recent rainfall, the raw (uncorrected) field data were evaluated to identify the time into the test when the maximum drawdown was observed. This maximum drawdown was observed at 2:40 PM on November 4 (approximately 285 minutes into the test). The configuration of groundwater at the time the maximum drawdown was observed (based on the raw, uncorrected field data) is presented in Figure 7. The groundwater configuration shown indicates a cone of depression observed as a closed contour line (86.50) centered about the two pilot test wells. Additionally, the observed maximum drawdown (based on the raw, uncorrected field data at 285 minutes) is shown in Figure 8. It is interesting to note that the asymmetrical drawdown represented on Figure 8 suggests that a greater amount of drawdown was observed in wells located farther from well GWE-PTW than in wells located closer to well GWE-PTW. This may be related to partial penetration effects caused by the construction of well GWE-PTW, by heterogeneities in the subsurface or recharge.

After evaluating the raw field data to identify the time of the maximum observed drawdown, the depth to water data were evaluated in order to identify monitoring wells that indicated rising groundwater elevations during the course of the test. Based on their proximity to the pumping well, and the fact that they were not anticipated to be affected by pumping, the rise in groundwater elevation in 14 monitoring wells was averaged in order to develop a correction factor that could be applied to depth to water data collected during the test. The wells included in developing this correction factor are BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10. Based on the data collected during the test, the average rise in groundwater elevation in those monitoring wells over the 1,745 minutes between the start of pumping on November 3, 2004 and 3:00 pm on November 4, 2004 was 0.57-feet. As such, a correction factor of 0.0003267 feet per minute (ft/min) was applied to the drawdown data presented for the six wells (SVE-PTW, MP-5, MP-10, MP-15, MW-C and SME-12) closely monitored during the test. The intent of this correction factor is to remove the recharge observed in those wells and to extend the set of usable data collected during the pilot testing activities.

As shown in the chart below, the “corrected” groundwater elevations in well SMW-12 continue to decline until at least 400 minutes into the test. After 400 minutes, groundwater elevations generally stabilize (or rise slightly) until approximately 1,500 minutes into the test. Between 1,500 minutes, and 1,800 minutes, groundwater elevations rise (approximately 0.20-feet), and then stabilize out to 2,700 minutes. Comparing the groundwater elevations presented in the chart below with the “uncorrected” groundwater elevations presented in the chart above suggests that the correction applied to the data has helped to remove significant recharge effects. However, the fact that the “corrected” groundwater elevations continue to rise suggests that recharge effects have not been eliminated completely from the data set. As such, the amount of drawdown observed in the nearby monitoring wells may be less than would have been observed had recharge not occurred during the testing activities. Consequently, reduction of the pilot test data may suggest a higher transmissivity for the saturated soil underlying the site than would have been indicated had the test been conducted when recharge had not occurred.



After applying the correction to the observed drawdown data collected from wells SVE-PTW, MP-5, MP-10, MP-15, MW-C and SMW-12, the data were reduced to double logarithmic plots of observed drawdown vs. elapsed time, and the data superimposed over the Boulton Type-Curves. Match points were selected, and their coordinates were used in the aforementioned equations to calculate the transmissivity and storage coefficient from the data collected in each well. The Boulton plots and associated calculations are included in Appendix B; the match points selected for the data collected from each well are summarized in **Table 1**.

Table 1
Match Points of Observed Drawdown Data to Boulton Type Curves

Monitoring Well	Type Curve (r/B)	Early Match Point		Late Match Point		Distance (feet)
		Δs/log cycle (feet)	Time (minutes)	Δs/log cycle (feet)	Time (minutes)	
SVE-PTW	1.5	0.60	4.0	1.00	600	5.3
MP-5	2.0	0.60	2.5	0.75	450	5.3
MP-10	1.5	0.60	1.0	0.55	280	10
MP-15	2.0	0.45	15	0.35	200	15.3
MW-C	1.0	0.58	8.5	0.45	110	41.5
SMW-12	3.0	1.80	33	0.16	26	44.5

Notes:
Early match point (A) selected where $W(u_A, r/B)$ and $1/u_A = 1.0$
Late match point (Y) selected where $W(u_Y, r/B)$ and $1/u_Y = 1.0$
Discharge Q = 0.4 GPM (77 ft^3/day)

Using the match points indicated in Table 1, the transmissivity and storage coefficient were determined from the early and late match points for each well. As summarized below in **Table 2**, the transmissivities determined via the early data for five of the six monitoring wells (SVE-PTW, MP-5, MP-10, MP-15, MW-C) yield very consistent results. Using these five results, the average transmissivity is estimated at 10.96 ft^2/day. The range of transmissivity values for the late data is larger and less consistent than that of the early data, but with an average value of 11.32 ft^2/day, overall, the late data closely corroborates the transmissivity determined via the early data. Using the transmissivity value determined via the early drawdown data (10.96 ft^2/day) and an estimated saturated thickness of 12 feet, the hydraulic conductivity of the subsurface is estimated at 0.91 feet per day (ft/day) or 3.2×10^{-4} centimeters per second (cm/sec). This hydraulic conductivity value is consistent with the range of values published in Groundwater (Freeze and Cherry, 1979, Pg. 29) for silty sand. It is also important to note that the sequence of saturated materials in proximity to the pilot test wells appears to thicken laterally toward the Seneca River and, also, appears to coarsen with depth. As such, higher transmissivity and/or hydraulic conductivity values would be anticipated in proximity to the Seneca River. The transmissivity and storage coefficient values determined via the Boulton method are summarized below in Table 2.

Table 2
Transmissivity Values Determined via the Boulton Method

Monitoring Well	Early Match Point		Late Match Point		γ	Comment
	T (ft^2/day)	S	T (ft^2/day)	S		
SVE-PTW	10.2	0.00400	6.1	0.3637	91.9	“good” estimate
MP-5	10.2	0.00250	8.2	0.3649	146.9	method valid
MP-10	10.2	0.00029	11.2	0.0867	300.0	method valid
MP-15	13.6	0.00240	17.5	0.0415	18.3	“good” estimate
MW-C	10.6	0.00015	13.6	0.0024	17.6	“good” estimate
SMW-12	3.4	0.00016	38.3	0.0014	9.8	
Average Transmissivity (T)*	10.96	-	11.32	-	-	
Hydraulic Conductivity (ft/day)*	0.91	-	0.94	-	-	
Hydraulic Conductivity (cm/sec)*	3.2×10^{-4}	-	3.3×10^{-4}	-	-	

Notes:
S is dimensionless
Boulton method is valid if γ is > 100; Boulton provides a “good” estimate of transmissivity if $10 < \gamma < 100$
Discharge Q = 0.4 GPM (77 ft^3/day); Aquifer thickness (b) estimated at 12 feet in proximity to pilot test wells
* Averages based on results from wells SVE-PTW, MP-5, MP-10, MP-15 and MW-C; results for SMW-12 excluded.
K = Hydraulic conductivity determined via K = T/b

The hydraulic conductivity can subsequently be used, in conjunction with Darcy’s law, to determine the volume of groundwater flow through the site. Darcy’s law simply states that the volume of flow (Q) through a cross-sectional area of saturated media is the product of the dimensions of the cross sectional area (A), the hydraulic gradient (i) and the hydraulic conductivity (K).

Arithmetically, Darcy's Law can be expressed as:

$$Q = KiA$$

Where:
Q = Flow through cross-sectional area (ft^3/day)
K = Hydraulic Conductivity (ft/day)
i = Hydraulic gradient (dimensionless)
A = Cross-sectional area (ft^2)

Using the hydraulic conductivity determined by the pilot test (0.91 ft/day), the hydraulic gradient coming across the Buckeye property down to Hillside Drive (0.09 ft/ft), and assuming a saturated thickness of 12 feet (estimated saturated thickness in proximity to the pilot test wells), Darcy's Law predicts that the volume of groundwater flow across the approximately 1,000 foot length of the Alaskan and Dreyfus/Stratus facilities is 983 ft^3/day (7,351 gallons per day or 5.1GPM).

Capture Area and Hydraulic Control

The hydraulic conductivity determined via the Boulton Method (0.91 ft/day (3.2×10^{-4} cm/sec)) can also be used to estimate the width of the capture area for a pumping well given the rate of pumping.

The width of the capture area can be estimated by the relation:

$$\frac{Q}{2Kbi}$$

Where:
Q = Pumping rate (ft^3/day)
K = Hydraulic conductivity (ft/day)
b = Saturated thickness (ft)
i = Hydraulic gradient (dimensionless)

Using a saturated thickness of 12 feet, the shallow hydraulic gradient coming across the Buckeye Property down to Hillside Drive 0.09 ft/ft) and, the hydraulic conductivity estimated via the Boulton method (0.91 ft/day), the lateral width of the capture area for groundwater extraction wells completed in proximity to Hillside Drive and pumping at a rate of 0.4 GPM (77 ft^3/day), is 39 feet. It is important to note that this capture area width calculation is based on conditions anticipated in the area in proximity to the pilot test wells. It is likely that a pumping well installed in proximity to the Seneca River and pumping at that flow rate (0.4 GPM) would yield a smaller capture area based on the anticipated higher hydraulic conductivity and increased saturated thickness (i.e. higher transmissivity), in that portion of the site.

Product Thickness

One additional goal of the GWE component of the test was to evaluate whether lowering the water table would result in product thickness increasing in nearby monitoring wells. Based on the data collected at the time of maximum drawdown (285 minutes into the test), product was observed in three (3) wells where a measurable thickness was not noted prior to GWE testing. These wells include MP-5 (0.01 feet), MW-A (0.76 feet) and MW-B (0.57 feet). Additionally, product thickness increased in well MW-C from 0.16 feet (prior to testing) to 1.62-feet (at maximum drawdown) as a result of implementing GWE. Based on the observations recorded during the pilot test, product thickness appears to increase in response to GWE. The maximum drawdown observed in selected wells during the pilot test, as well as the changes in product thickness at the time of maximum drawdown, are summarized below in **Table 3**; the complete data set collected during the GWE component of pilot testing is included in Appendix B.

Table 3
Drawdown and Product Thickness Changes Observed During the Pilot Test

Observation Well ID	Distance from Pumping Well	Observed Drawdown	Product Thickness		
			@ Start of Test	@ Maximum Drawdown	Increase / (Decrease)
SVE-PTW	5.3	0.46	-	-	-
MP-5	5.3	0.21	-	0.01	0.01
MP-10	10.0	0.32	-	-	-
MP-15	15.3	0.12	-	-	-
MW-C	41.5	0.45	0.16	1.62	1.46
SMW-12	44.5	0.20	-	-	-
MW-B	59.8	0.35	-	0.57	0.57
MW-A	87.5	0.19	-	0.76	0.76

Notes:
All measurements in feet.
Test began with GWE from well GWE-PTW on November 3, 2004. Maximum drawdown observed @ 285 minutes into the test.

Discussion

The data presented herein for the GWE component of the pilot testing are representative of one single pump test event conducted during a period of several notable precipitation events. The drawdown data collected from wells in proximity to the GWE pilot test well, in addition to wells outside of the influence of the pilot test well, indicate that recharge was occurring during the GWE component of the pilot testing. An attempt was made to quantify the amount of recharge observed across the site in order to develop a single correction factor to be applied to those wells closely monitored for observed drawdown during the test. However, the variability in the amount of recharge observed in wells spatially distributed throughout the site suggests that the correction factor applied to the data may not be sufficient to completely remove recharge from the observed drawdown data. Likewise, the correction factor applied to the data may over compensate for recharge effects. In either case, the transmissivity values determined via the Boulton method are considered to be a reasonable estimate of site conditions in proximity to the pilot test wells. It should also be noted that the transmissivity of the subsurface might also be affected by the sites' proximity to the Seneca River.

A review of soil boring logs for monitoring wells distributed throughout the site did not identify any soil borings advanced to a depth sufficient to define the vertical extent of the water bearing silt and sand beneath either the Alaskan or Stratus terminals. As such, the actual saturated thickness of the unconsolidated sediments approaching (and adjacent-to) the Seneca River is unknown at this time. As indicated previously, the transmissivity of a water-bearing unit is the product of the hydraulic conductivity and the saturated thickness. An actual saturated thickness greater than the 12 feet assumed herein will result in a higher transmissivity and, as such, allow for a higher volume of water to be produced from each well. Additionally, a coarsening of the saturated sediments (i.e. increase in the hydraulic conductivity) in proximity to the river will also increase the transmissivity of the subsurface. In conclusion, development of any conceptual design for extracting groundwater from beneath the Alaskan and/or Stratus terminals should give consideration to possibly higher than anticipated well yield based on a coarsening and/or increasing saturated thickness (i.e. increased transmissivity) of the unconsolidated sediments in proximity to the Seneca River.

Results of Pilot Testing - Soil Vapor Extraction

The first SVE test was an SVE only test conducted on November 2. The test was conducted in three (3) steps by increasing the wellhead vacuum for each step. Step-1 was conducted at a water column (H_2O) vacuum of 25-inches (1.8-inches Hg) at the wellhead; Step-2 was conducted at a wellhead vacuum of 50-inches H_2O (3.7-inches Hg) and, Step-3 was conducted at a wellhead vacuum of 75-inches H_2O (5.5-inches Hg). The second SVE test was conducted on November 4, approximately 24-hours after commencing with GWE via nearby well GWE-PTW. The purpose of this second SVE test was to evaluate whether dewatering the subsurface increases the ROI and improves the efficiency of SVE. Step-1 was conducted at a wellhead vacuum of 30-inches H_2O; Step-2 was conducted at a wellhead vacuum of 60-inches H_2O (4.4-inches Hg) and, Step-3 was conducted at a wellhead vacuum of 80-inches H_2O (5.9-inches Hg). After completing the second SVE test, the wellhead vacuum was reduced to 40-inches H_2O (2.9-inches Hg), and the pilot test equipment operated overnight.

For each vacuum setting, the rate of soil vapor extraction was determined by obtaining air speed measurements of the blower effluent and bleed air introduced into the system. The volume of bleed air introduced was subtracted from the volume of air in the blower effluent in order to determine the volume of air extracted from the subsurface. Additionally, the concentration of total volatile organic compounds (VOCs) was screened using a photoionization detector (PID) during each step of each test. The data collected during the SVE component of the pilot testing are included in Appendix B.

The results of the first SVE test indicate that a sufficient vacuum was induced into the subsurface to generate an ROI in excess of 20 feet. During Step-1, the flow rate from well SVE-PTW was 7.7 cubic feet per minute (cfm) at a wellhead vacuum of 25-inches H_2O. The concentration of VOCs in the blower effluent was 257 parts per million (ppm). The mass removal rate associated with Step-1 is 16.07 pounds per day (lbs/day). During Step-2, the flow rate from the well was 15.7 cfm at a wellhead vacuum of 50-inches H_2O. The concentration of VOCs in the blower effluent increased to 396 ppm. The mass removal rate associated with Step-2 increased to 24.53 lbs/day. During Step-3, the flow rate from the well was 29.5 cfm at a wellhead vacuum of 75-inches H_2O. The concentration of VOCs in the blower effluent increased further to 437 ppm. The mass removal rate associated with Step-3 increased further to 25.16 lbs/day. Observed vacuum readings ranging from 0.16-inches H_2O (Step-1) to 0.40-inches H_2O (Step-3) were recorded in MP-15, located 20.3 feet from well SVE-PTW. The observed vacuum data collected during each step of the first SVE test suggest that an ROI of approximately 23 feet can reasonably be expected at any of the wellhead vacuum/flow rate configurations tested.

It is interesting to note that the ROI determined via each step of the first SVE test was essentially unchanged as the vacuum applied to the wellhead was increased. However, the flow rate of soil vapor recovered from well SVE-PTW increased as the wellhead vacuum was increased. It is also interesting to note that an observed vacuum was not recorded (i.e. 0.0-inches H_2O) at well GWE-PTW, located 5.3 feet from the tested well, at any time during the pilot testing activities reported herein. Additionally, the observed vacuum recorded at well MP-15, located 20.3 feet from the tested well, was consistently an order of magnitude higher than the observed vacuum in well BMW-14, located 16 feet from the tested well. This is likely related to heterogeneities in the subsurface.

The results of the second SVE test indicate that after approximately 24 hours of GWE, both the flow rate and ROI associated with each step were larger than their corresponding step during the first SVE test. During Step-1, the flow rate from well SVE-PTW was 16.5 cfm at a wellhead vacuum of 30-inches H_2O. The concentration of VOCs in the blower effluent was 265 ppm, which corresponds to a mass removal rate of 13.29 lbs/day. During Step-2, the flow rate from the well was 24.6 cfm at a wellhead vacuum of 60-inches H_2O, and the concentration of VOCs in the blower effluent increased to 349 ppm. This corresponds to a mass removal rate of 17.96 lbs/day. During Step-3, the flow rate from the well was 31.2 cfm at a wellhead vacuum of 80-inches H_2O. The concentration of VOCs in the blower effluent increased further to 418 ppm, corresponding to a mass removal rate of 19.57 lbs/day. Observed vacuum readings ranging from 0.85-inches H_2O (Step-1) to 1.5-inches H_2O (Step-3) were recorded in MW-C, located 37 feet from the tested well. The observed vacuum data collected during each step of the second SVE test suggest that an ROI ranging from 30 feet to 37 feet can reasonably be expected at any of the wellhead vacuum/flow rate configurations tested while simultaneously extracting groundwater from the subsurface.

The results of the overnight SVE test indicate that a wellhead vacuum of 40-inches H_2O resulted in a flow of 15.7 cfm from the pilot test well. Observed vacuum readings ranging from 0.35-inches H_2O (well BMW-14) to 15.0-inches (well MP-5) were recorded. PID screening of the blower effluent indicated a total VOC concentration of 300 ppm, corresponding to a mass removal rate of 15.83 lbs/day. As with the observations made in the previous SVE tests, higher induced vacuums were recorded in well MW-C (located 37 feet from the tested well) than were recorded in well BMW-14 (located 16 feet from the tested well). The observed vacuum data collected during Test-3 suggest that an ROI in excess of 35 feet can reasonably be expected at a wellhead vacuum of 40-inches H_2O while simultaneously extracting groundwater from the subsurface. The results of the SVE pilot tests are summarized below in Table 4.

Table 4
Summary of Pilot Test Results – SVE Component

Test/Step	**Wellhead Vacuum** (inches H_2O)	**Flow Rate** (CFM)	**Observed ROI** (feet)	**Total VOC** (ppm)	Mass Removal Rate (lbs/day)
First / Step - 1	25	7.7	24	257	16.08
First / Step - 2	50	15.7	23	396	24.53
First / Step - 3	75	29.5	23	437	25.16
Second / Step - 1	30	16.5	30	265	13.29
Second / Step - 2	60	24.6	37	349	19.57
Second / Step - 3	80	31.2	37	418	17.96
Overnight	40	15.7	37+	305	15.53

Notes:
First SVE Test = SVE ONLY on 11-2-04
Second SVE Test = GWE/SVE on 11-4-04 after GWE for 24-hours
Overnight Test = GWE/SVE overnight 11-4-04 through 11-5-04

CONCEPTUAL DESIGN

The conceptual design for the remedial system proposed herein includes a combination of free-product recovery, soil vapor extraction, and groundwater recovery via horizontal wells. The general approach is to implement product recovery and SVE via several vertical wells distributed throughout each of the three (3) properties. In addition, GWE will be initiated via three (3) horizontal wells completed beneath the footprint of the Dreyfus/Stratus terminal. The purpose of the horizontal wells is to lower the water table beneath the site in order to increase the efficiency of product recovery efforts as well as increase the amount of vadose zone from which soil vapors can be withdrawn. Aztech proposes to operate these horizontal wells for a period of time sufficient to evaluate their effectiveness, as well as determine the optimal spacing for additional horizontal wells to be installed at a later date. Groundwater extracted from the horizontal wells will be treated via a temporary treatment system (i.e. portable air stripper with a granular activated carbon polish) until final specifications can be developed and implemented. The details of each aspect of the conceptual design are discussed herein.

Soil Vapor Extraction/Product Recovery

The primary mechanism for mass removal will be to implement product recovery accompanied by SVE via several strategically placed SVE/product recovery wells throughout each of the three properties. This includes vertical wells installed within the secondary containment areas of both active PBS facilities. Based on a wellhead vacuum of approximately 50-inches H_2O, the SVE component of each remedial well is anticipated to yield a flow of approximately 16 CFM and induce a conservatively estimated ROI of approximately 23-feet into the subsurface. A larger ROI is anticipated under operational conditions once the GWE component is activated via the horizontal pilot wells.

The distribution of SVE/product recovery wells shown on **Figure 9** is based on a 25-foot ROI for the SVE component of each operating remedial well. As shown on Figure 9, a total of 67 SVE/product recovery wells are proposed. The proposed well locations are based on the distribution of measurable free product identified in the “end of test” depth to product/water measurements collected on November 4, 2004. The historic distribution of free-product was also considered in the placement of several of the proposed remedial wells.

Based on the fact that the remedial wells will be in contact with free-phase product, it is recommended that they be constructed of 4.0-inch ID stainless steel wire wrapped screen (0.02-inch) and riser pipe. Available PID screening of soil encountered during the advancement of existing wells on the site indicated that total VOC concentrations as high as 1,300 ppm were recorded for soil from 10- to 12-feet below grade beneath the secondary containment footprint on the Dreyfus/Stratus terminal (well SMW-4). Based on the fact that groundwater is encountered at approximately 8.0-feet below grade, and total VOC concentrations in excess of 1,000 ppb are present below the water table at a depth of 12-feet below grade, it is recommended that the remedial wells be advanced to a depth sufficient to induce a vacuum throughout the column of impacted soil once it has been dewatered. As such, the total depth of the remedial wells beneath the secondary containment footprint on both active facilities is estimated at approximately 18-feet below grade. The actual depth and screened interval of each remedial well will be determined based, in part, on PID screening of the soil encountered at each location. The top of the well screen will not be installed any shallower than 3.0 feet below grade. This will allow for proper surface sealing of wells installed within the secondary containment areas and will also minimize the potential for short-circuiting of the SVE component to the surface.

The remedial equipment proposed for product recovery and SVE at this site includes pneumatic pumps, and ancillary equipment for product recovery, and a positive displacement blower(s) for SVE. Based on the volume of soil vapors anticipated from the SVE component of each active remedial well, the blower(s) should have the capability to move approximately 1,100 cfm while applying a wellhead vacuum of 50-inches H_2O (3.7-inches Hg) to each wellhead. Based on the fact that free product has been observed in several wells around the site, and the fact that total VOC concentrations during the pilot test were consistently in excess of 300 ppm, Aztech anticipates that mass removal rates will initially be in excess of 15 lbs/day for each active SVE well. As such, the soil vapors extracted from the ground will need to be treated prior to their discharge to the atmosphere. As such, treatment of the SVE effluent via a catalytic oxidizer (cat-ox) is recommended.

Each remedial well within and adjacent to the secondary containment areas will be interconnected via aboveground manifolding and air supply/product return lines. The manifolding and air supply/product return lines will extend back to a remedial equipment area via a horizontal borehole(s) that will extend from the north side of Hillside Drive and through the secondary containment wall on each active facility. The horizontal borehole through each secondary containment wall will be properly sealed/booted in order to maintain the integrity of each wall. SVE manifolding and air supply/product return lines for remedial wells outside of the secondary containment areas will extend back to the remedial equipment area underground via shallow trenching. The remedial equipment area is proposed in proximity to the pilot test wells in the southeast quadrant of the Buckeye property (Figure 9).

When the SVE/product recovery system becomes operational, each component of the system will be controlled with a programmable logic controller (PLC). The system will also be equipped with telemetry so that it can be accessed remotely via phone modem in order to verify the system status and make minor adjustments if necessary. A site visit will also be conducted on a monthly basis (at a minimum) so that various routine maintenance issues can be addressed. During each site visit, the overall vacuum and volume of air discharged by the SVE blower, and operation of the cat-ox unit will be evaluated. The concentration of total VOCs in the SVE effluent as well as the cat-ox effluent will also be monitored via PID screening. Additionally, the vacuum applied to specific wells will also be monitored and adjusted as appropriate in order to maintain the efficiency of the system. Induced vacuum will also be monitored in selected monitoring wells. The remedial system will be operated until mass removal rates decline and NYSDEC determines that concentrations of total VOCs in soil and groundwater are appropriate for active remedial efforts to be terminated.

Groundwater Extraction

The purpose of GWE at the site is to augment remedial efforts via SVE and product recovery. Based on previously existing PID screening of soil beneath the secondary containment footprint of the Dreyfus/Stratus terminal, as well as data collected during the recent pilot testing, the addition of GWE can: serve to increase the amount of vadose zone from which soil vapors can be withdrawn; increase the ROI in the subsurface induced by operating SVE equipment; induce the movement of free-product in the subsurface under the influence of gravity by creating low spots in the surface of the water table, and: locally reverse the flow of groundwater toward the Seneca River by inducing the flow of groundwater from the Seneca River toward the site. Thus, further flow of impacted groundwater and/or product discharge to the river can be reduced. In short, the addition of GWE will help to increase the efficiency and shorten the life of remedial efforts at the site.

Consideration was given to implementing a GWE system based on vertical wells. Consequently, the fact that the proposed remedial system would now need to convey groundwater (not only product and/or soil vapors) from the remedial wells back to the remedial equipment area requires that the GWE piping be installed in trenches approximately 4.0-feet below grade. Based on the distribution of remedial wells shown in Figure 9, the magnitude of this type of effort from within secondary containment areas and/or other portions of these active PBS facilities would logistically be very disruptive to their day-to-day operations. As such, Aztech believes that GWE via a series of horizontal wells installed beneath the footprint of both the Alaskan and Dreyfus/Stratus terminals is a less disruptive alternative to GWE via vertical wells. Based on the distance between Hillside Drive and the Seneca River, and the distribution of free-product beneath the site, Aztech estimates that each horizontal well will be constructed with approximately 200-feet of screen.

Based on the information obtained during the pilot testing, the flow rate from the pilot test well was 0.4 GPM and the hydraulic conductivity of the subsurface was determined to be 0.91 ft/day (3.2 x 10^{-4} cm/sec). However, based on the fact that a horizontal well will have significantly more saturated screen from which groundwater is derived, it is reasonable to expect that the yield from each horizontal well will be higher than the 0.4 GPM flow determined via pilot testing. Based on its similarity in geometry to that of a trench, a method for estimating the flow to a trench was used to estimate the flow to a horizontal well.

According to Groundwater and Wells (2nd edition, 1986. Page 741), the flow to a trench can be estimated by the relation:

$$Q = \frac{K\,(H^2-h^2)}{1055 \log R/r} + 2\,\frac{x\,K\,(H^2-h^2)}{2880\,L_o}$$

Where:
K = Hydraulic conductivity (gallons per day per foot^2 – GPD/ft^2)
H = Height of the water column above the trench bottom @ static (ft)
h = Height of water column above the trench bottom while pumping (ft)
R = Radius of cone of depression (ft)
r = radius of trench/horizontal well (ft)
x = Length of the trench (ft)
L_o = Distance from point of greatest drawdown to point of no drawdown (ft)

Using the following values for the above referenced variables, the flow to a single trench/horizontal well was estimated at 3.6 GPM when a hydraulic conductivity of 6.8 GPD/ft^2 (0.91 ft/day) is used.

Variables:
K = 6.8 GPD/ft^2 (0.91 ft/day)
H = 12 ft
h = 2.5 ft
R = 40 ft
r = 0.167 ft
x = 200 ft
L_o = 40 ft

Based on the fact that the actual performance of a horizontal well at this site is unknown at this time, Aztech recommends that three (3) horizontal wells be installed at the locations shown in **Figure 10** and that a long-term pilot study be conducted for a period of time sufficient to evaluate their performance. Based on a review of existing soil boring logs for the site, Aztech anticipates that the depth of the screened interval for these horizontal wells will be approximately 20-feet below grade in the area beneath the secondary containment footprint of the Stratus terminal. However, it is important to note that this depth may be increased (or decreased) depending on the stratigraphy and/or vertical distribution of petroleum hydrocarbon compounds in the soil underlying this portion of the site. It is also important to note that variability in the hydraulic conductivity toward the Seneca River could have a significant affect regarding the amount of groundwater produced by the horizontal wells. The separation distance between the horizontal wells (approximately 60 feet) was determined by the observations made during the pilot test where 0.1-feet of drawdown in response to pumping was inferred generally to the south during the pilot test (Figure 8).

The depth of the horizontal wells is estimated based on the fact that groundwater beneath the secondary containment footprint is encountered at approximately 8.0-feet below grade, and total VOC concentrations in excess of 1,000 ppb are present below the water table at a depth of 12-feet below grade (well SMW-4). Although the vertical limit of petroleum hydrocarbons in the soil beneath the water table is not known at this time, Aztech estimates that the most grossly impacted soil is present to an approximate depth of 18-feet below grade. As such, the initial remedial approach is to lower the water table to 18 feet below grade beneath the secondary containment footprint so that the SVE component of the remedial system can induce a vacuum throughout the column of impacted soil once it has been dewatered. As such, the horizontal wells are estimated to be installed at 20 feet below grade and be operated to maintain water levels at approximately 18-feet below grade. Schematic cross-sections representing the horizontal wells and the goal of their operation are presented in **Figure 11A** and **Figure 11B**. The actual depth below grade and screened interval of each horizontal well will be determined based on PID screening and the stratigraphy of the soil encountered at each remedial well location. The screened section of each horizontal well is anticipated to be approximately 200 feet in length.

After completing installation of the horizontal wells, Aztech recommends that a pilot study be conducted where groundwater is extracted from them over a one or two month time period. The groundwater extracted from the wells should be treated via a portable air stripper and polished via granular activated carbon. During this testing period, data will be collected that will help with determining the flow rate and magnitude/distribution of drawdown associated with their operation. This information will be used to evaluate whether additional horizontal wells are warranted and, if so, to determine the appropriate length, location, spacing and number of wells to be installed. Additionally, this information will help to properly size treatment equipment for the final groundwater extraction system.

As remedial efforts progress at the site, NYSDEC may wish to consider additional remedial options to further reduce residual petroleum hydrocarbon compounds. This includes in-situ bioremediation, bio-sparging or surfactant flushing to be implemented after the rate of mass removal from the site becomes diminished.

CONCLUSIONS

- The results of the pilot testing indicate that a combination of remedial technologies that include free-product recovery, SVE and GWE is a feasible and effective method for reducing concentrations of petroleum hydrocarbon compounds in soil and groundwater beneath the site.
- The results of the pilot testing also indicate that product thickness generally increases in nearby monitoring wells when GWE is initiated.
- The stratigraphic sequence that underlies the site consists of silt that gradually coarsens to well sorted fine- to medium-grained sand with depth. Fine- to medium-grained gravel and dense red clay and/or red shale bedrock was also encountered at a depth of approximately 30-feet below grade in some of the wells installed on the Buckeye property.
- The movement of groundwater beneath the Buckeye property is a subdued reflection of surface topography with groundwater movement at a hydraulic gradient of 0.09 ft/ft from north to south toward the Alaskan and Stratus/Dreyfus Terminals.
- The movement of groundwater beneath the Alaskan and Dreyfus/Stratus facilities becomes distorted into a trough and is likely related to the presence of measurable quantities of free-phase petroleum product. Within this trough, the hydraulic gradient is 0.003 ft/ft.
- The vertical saturated thickness in proximity to the pilot test wells is approximately 12 feet.
- The results of the SVE component of the pilot testing indicate that, in the absence of active groundwater extraction, an ROI of approximately 23 feet can reasonably be expected at wellhead vacuums ranging from 25-inches H_2O to 75-inches H_2O.
- The results of the SVE pilot testing indicate that after approximately 24 hours of GWE, both the flow rate and ROI associated with each wellhead vacuum increases when compared to a corresponding wellhead vacuum in the absence of active GWE.
- When actively extracting groundwater, SVE pilot testing indicates that an ROI ranging from 30-feet to 37-feet can reasonably be expected at wellhead vacuums ranging from 30-inches H_2O to 80-inches H_2O.
- Initial mass removal rates are anticipated to initially be in excess of 15 lbs/day for each active SVE well.
- Double logarithmic plots of observed drawdown vs. elapsed time suggest that the subsurface indicates an unconfined with delayed yield response to GWE.
- The results from the GWE component of the pilot testing estimate the hydraulic conductivity of the subsurface to be 0.91 ft/day (3.2×10^{-4} cm/sec) via the Boulton method.
- Using the hydraulic conductivity value determined via the Boulton method (0.91 ft/day (3.2×10^{-4} cm/sec)), a lateral capture area of 39 feet was estimated for a single well pumping at a rate of 0.4 GPM.
- It is important to note that the capture area width is based on conditions anticipated in the area in proximity to the pilot test wells. It is likely that a pumping well installed in proximity to the Seneca River would yield a much smaller capture area based on the anticipated higher hydraulic conductivity and increased saturated thickness (i.e. higher transmissivity) in that portion of the site.

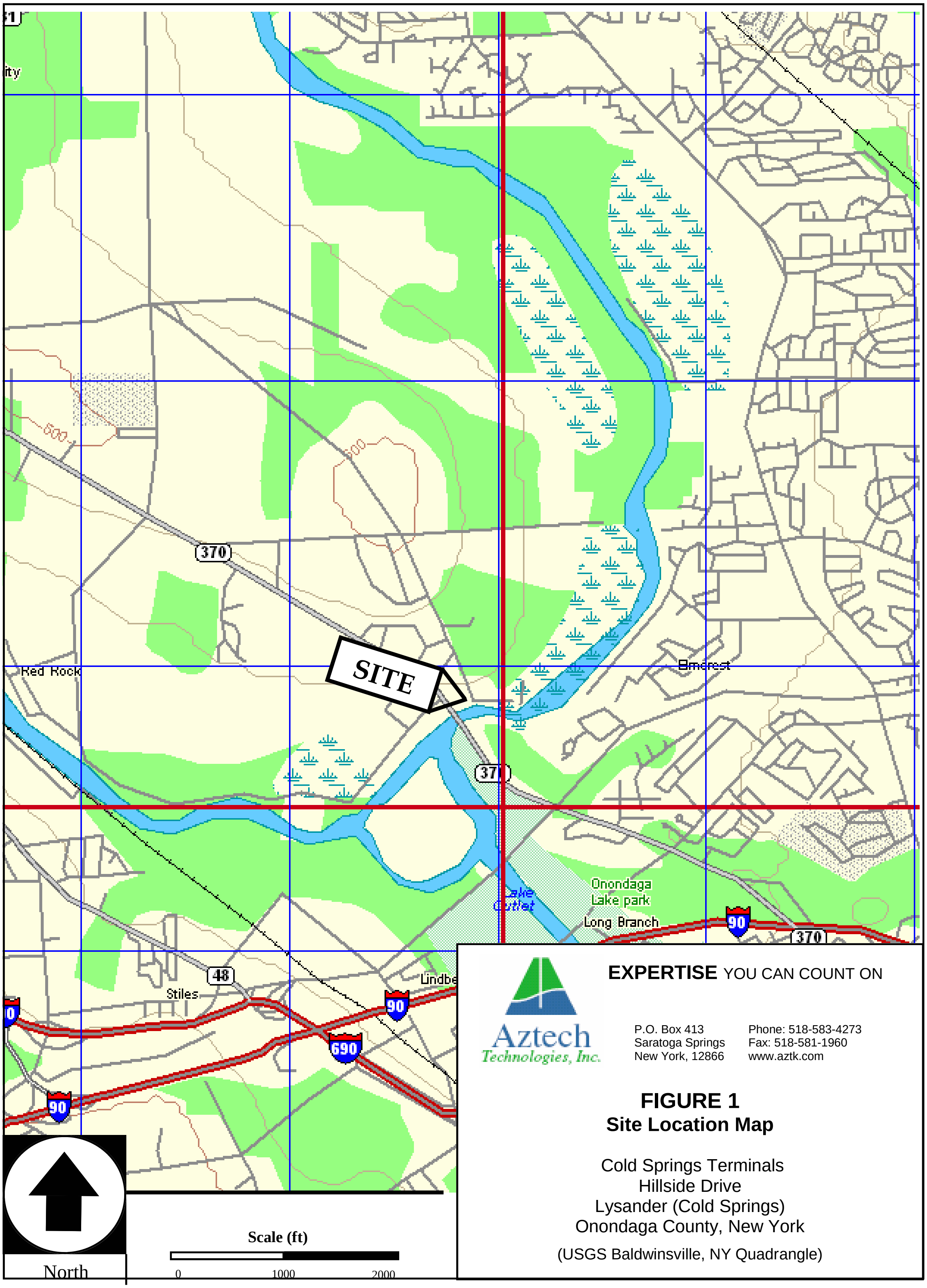
- The magnitude of the effort required for implementing GWE from within secondary containment areas and/or other portions of the Alaskan and Dreyfus/Stratus terminals would logistically be very disruptive to day-to-day operations. Therefore, consideration was given to dewatering beneath the Alaskan and Dreyfus/Stratus terminals via horizontal wells.
- Based on its similarity in geometry to that of a trench, the flow of groundwater to a trench at the site was estimated at approximately 3.6 GPM.

RECOMMENDATIONS

Based on the information gathered during the pilot testing, Aztech recommends that the conceptual design presented herein be implemented. This includes installation of approximately 67 SVE/product recovery wells and three (3) horizontal wells for dewatering. Specific recommendations are as follows:

- <u>Stainless Steel Well Materials:</u> Based on the fact that most of the proposed remedial wells will be in contact with free-product, the use of stainless steel well materials is recommended.
- <u>Soil Characterization:</u> Depth discrete soil samples should be collected from each remedial well location in order to evaluate the vertical extent of petroleum hydrocarbons in soil below the water table. This information will help to determine the depth to which the site should be dewatered, the depth of the SVE/product recovery wells, and help to determine the length and completion depth for the screened interval in the horizontal wells.
- <u>Sieve Analysis:</u> Based on the fact that depth discrete soil samples have not been collected at the anticipated completion depth for the horizontal wells, Aztech recommends that a minimum of eight (8) soil samples be collected from each of the Alaskan and Dreyfus/Stratus terminals (for a total of 16 samples) and be analyzed for grain size via sieve analysis. This information will help in selecting a proper screen size for the horizontal wells to be installed at the site.
- <u>Horizontal Well Pilot Study:</u> After installing the three proposed horizontal wells, a pilot study should be implemented to monitor the performance of the horizontal wells. Information will be collected to evaluate the need for additional horizontal wells and, to determine the appropriate length, location, spacing and number of wells to be installed. Additionally, this information will help to properly size treatment equipment for the final groundwater extraction system.

FIGURES



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New York, 12866

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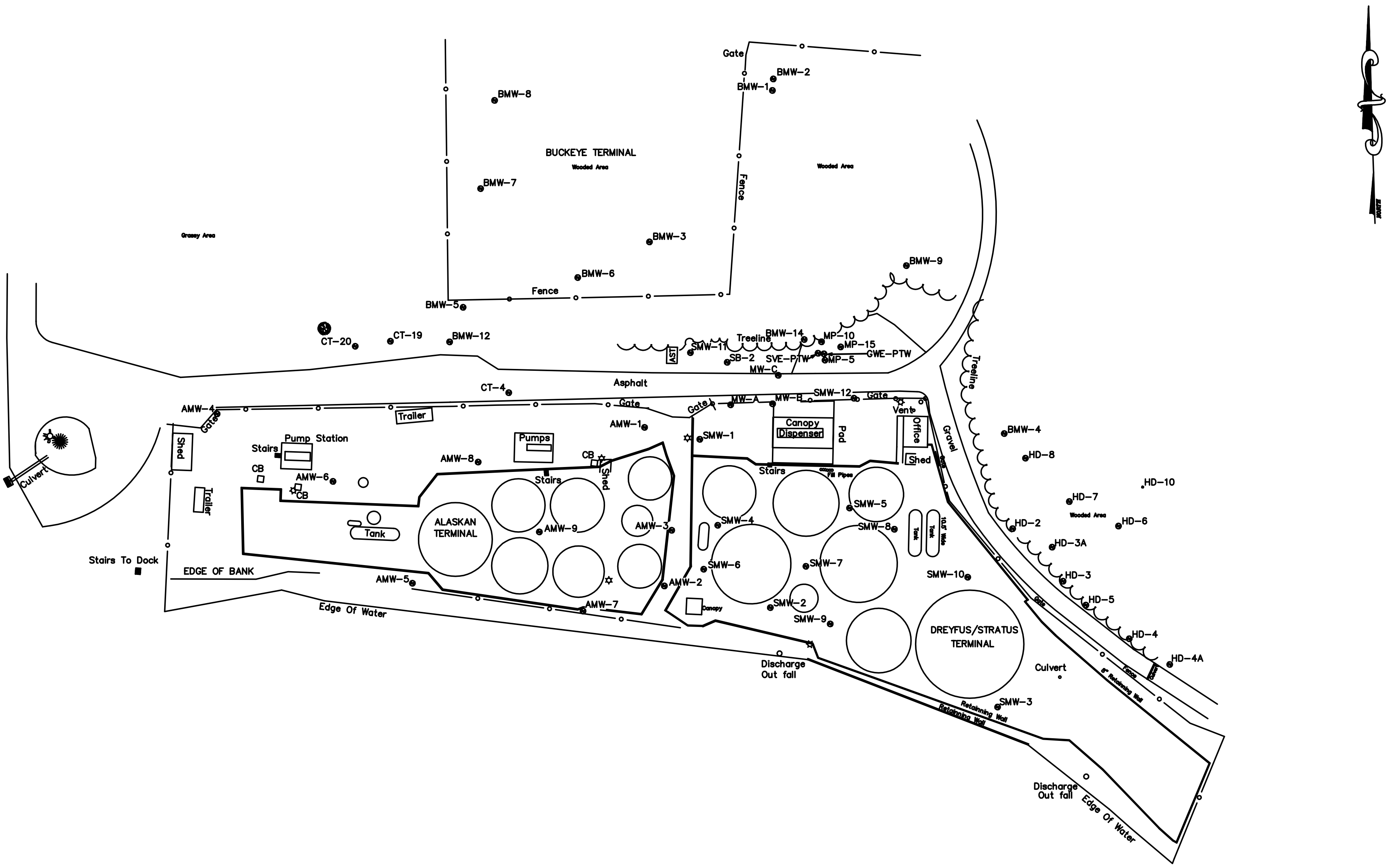
FIGURE 1
Site Location Map

Cold Springs Terminals
Hillside Drive
Lysander (Cold Springs)
Onondaga County, New York

(USGS Baldwinsville, NY Quadrangle)



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Lysander (Cold Springs), NY
NYSDEC Spill No. 89-09423 PIN No. 99528

FIGURE 2

DATE: 9-21-04

SCALE: 1" = 120'

SITE MAP

LEGEND:
⊗ Monitoring Well

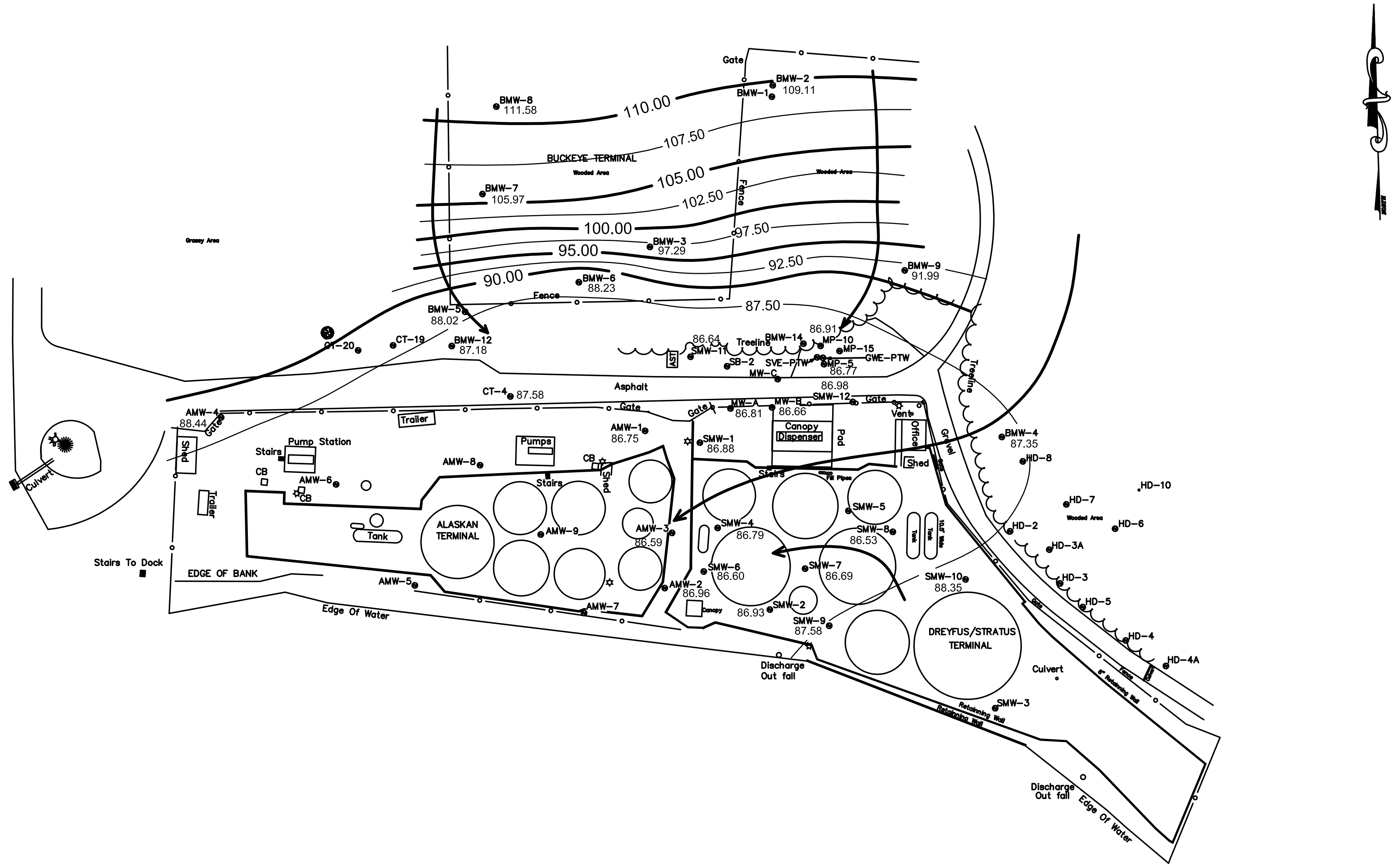

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FIGURE 3

DATE: 11-2-04

SCALE: 1" = 120'

Groundwater Contour Map
Static Conditions
November 2, 2004

LEGEND:
● Monitoring Well

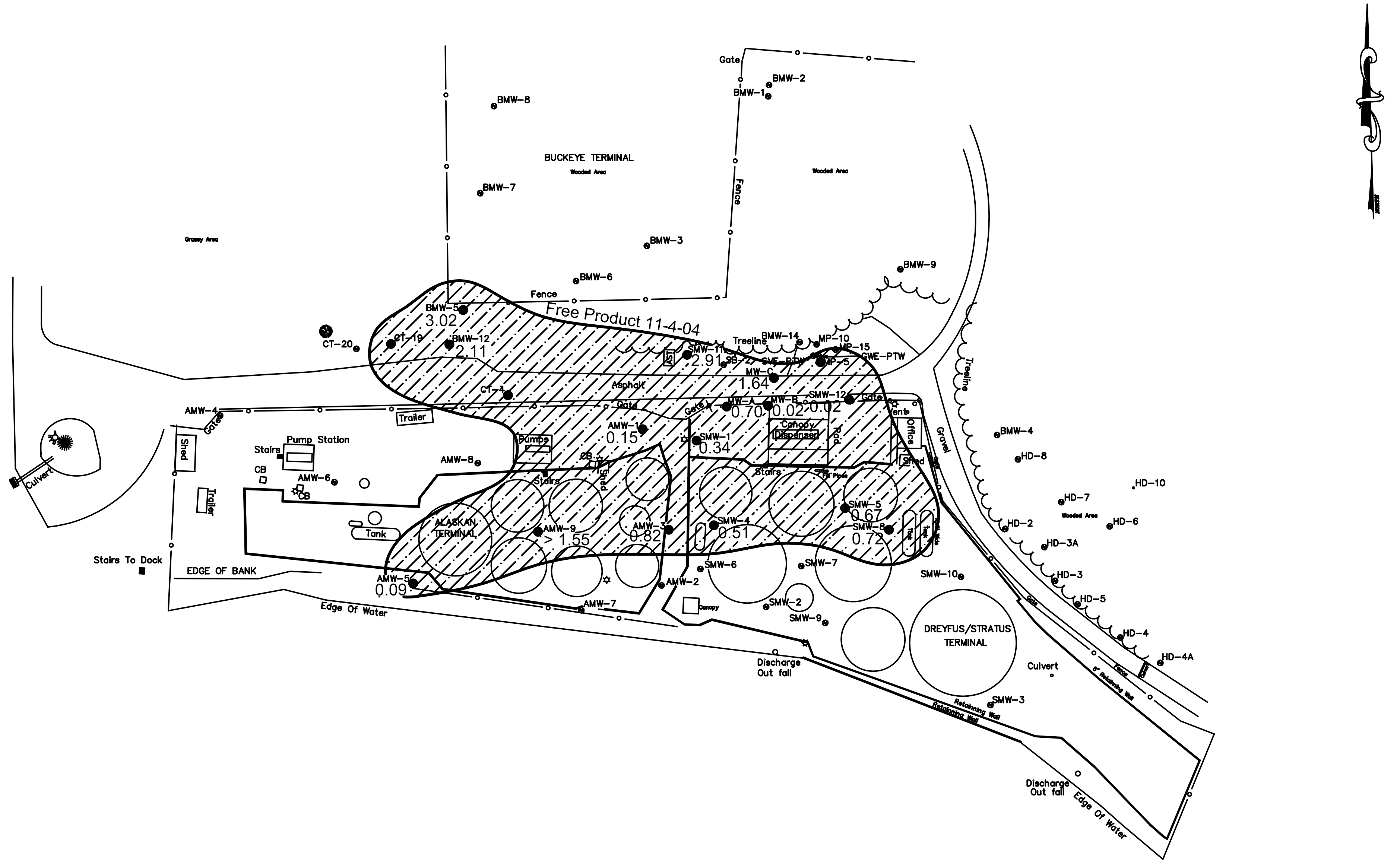

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FIGURE 4

DATE: 11-4-04

SCALE: 1" = 120'

Distribution of Free-Product

November 4, 2004

LEGEND:

● 1.64 Indicates well containing measured free-product and apparrent product thickness (feet)

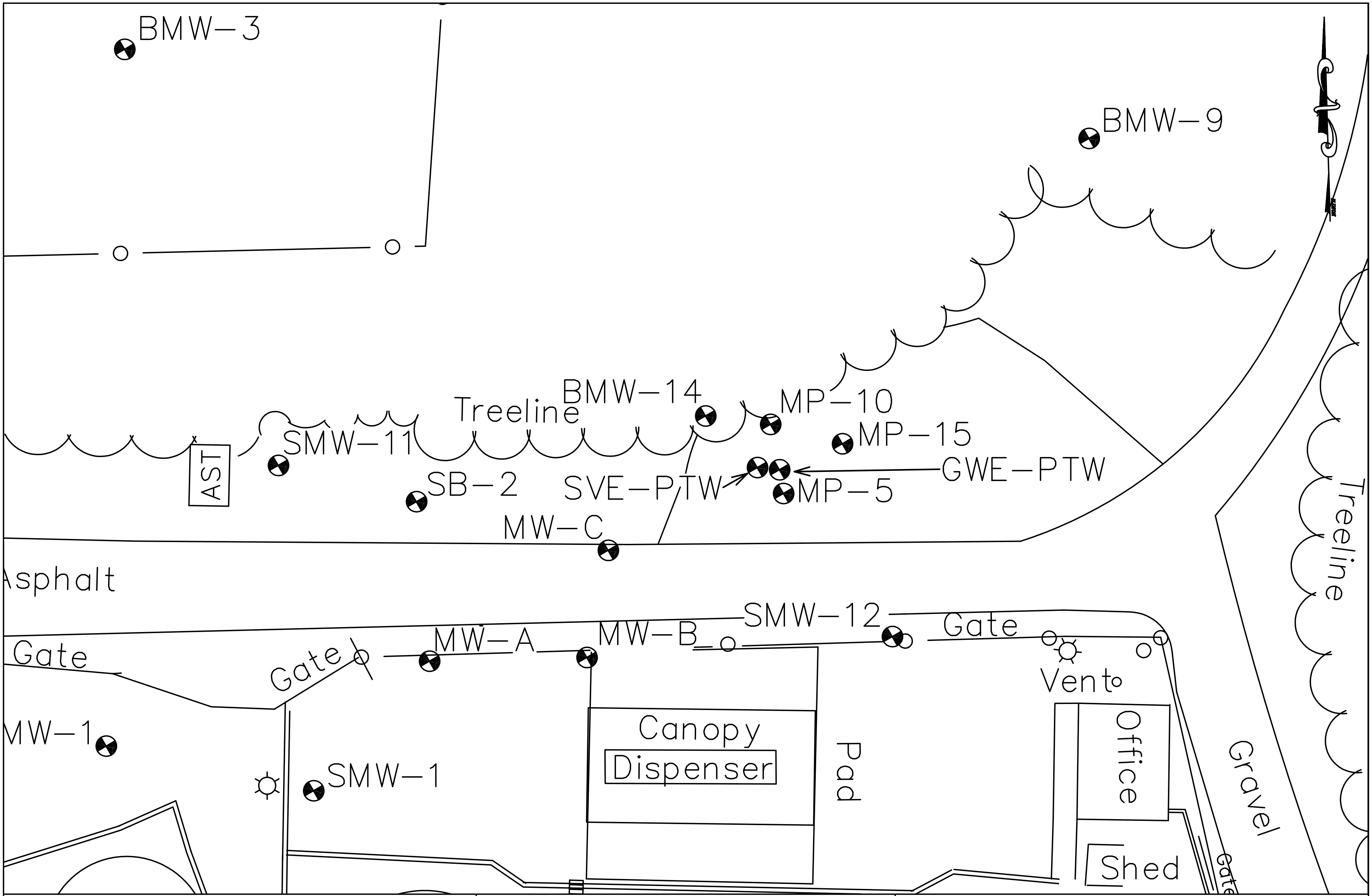

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FIGURE 5

DATE: 9-21-04

SCALE: 1" = 30'

Pilot Test Site Map

LEGEND:
⊗ **Monitoring Well**

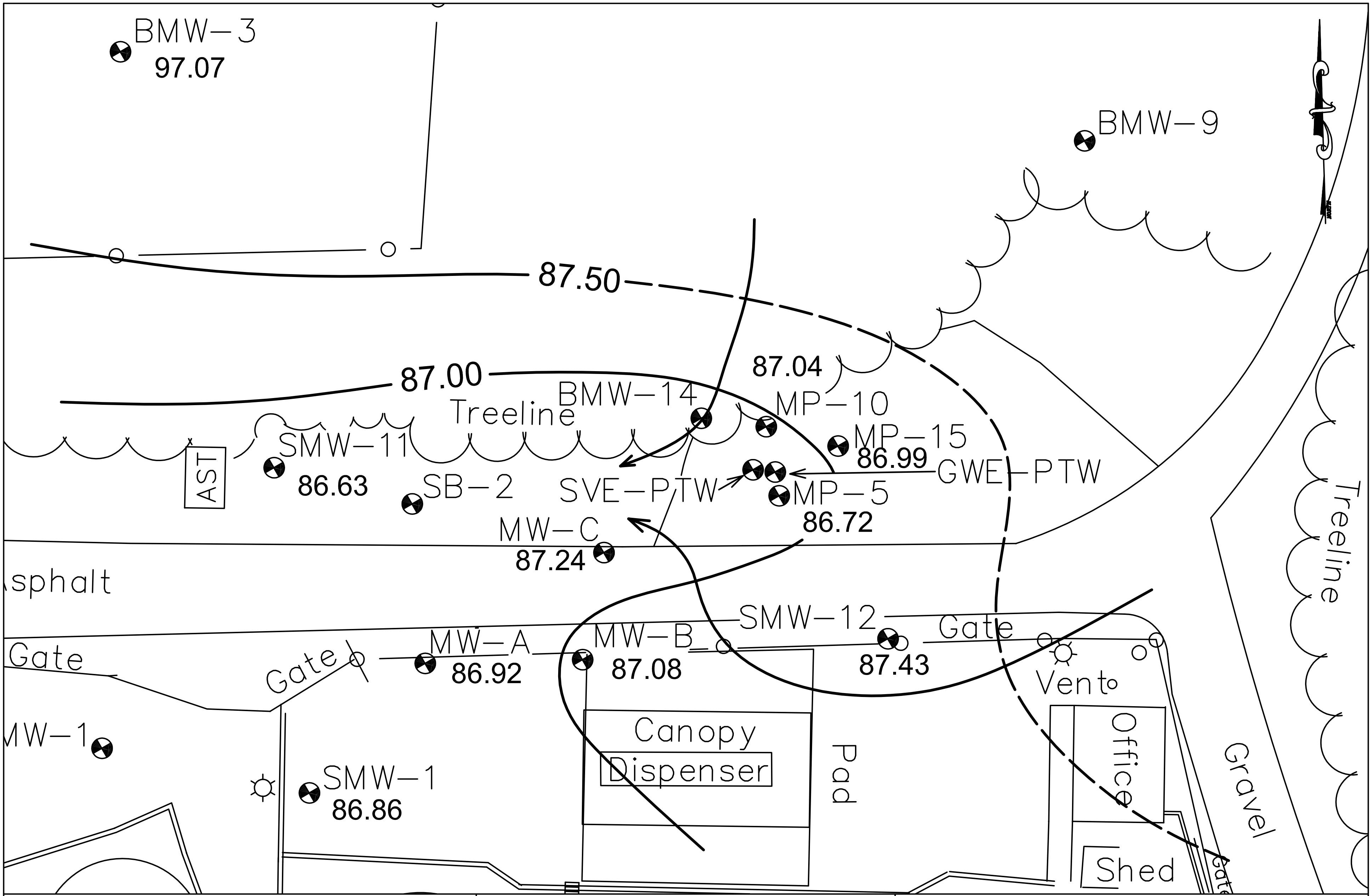

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FIGURE 6

DATE: 11-3-04

SCALE: 1" = 30'

Groundwater Contour Map Static Conditions Start of Test November 3, 2004

LEGEND:
● **Monitoring Well**

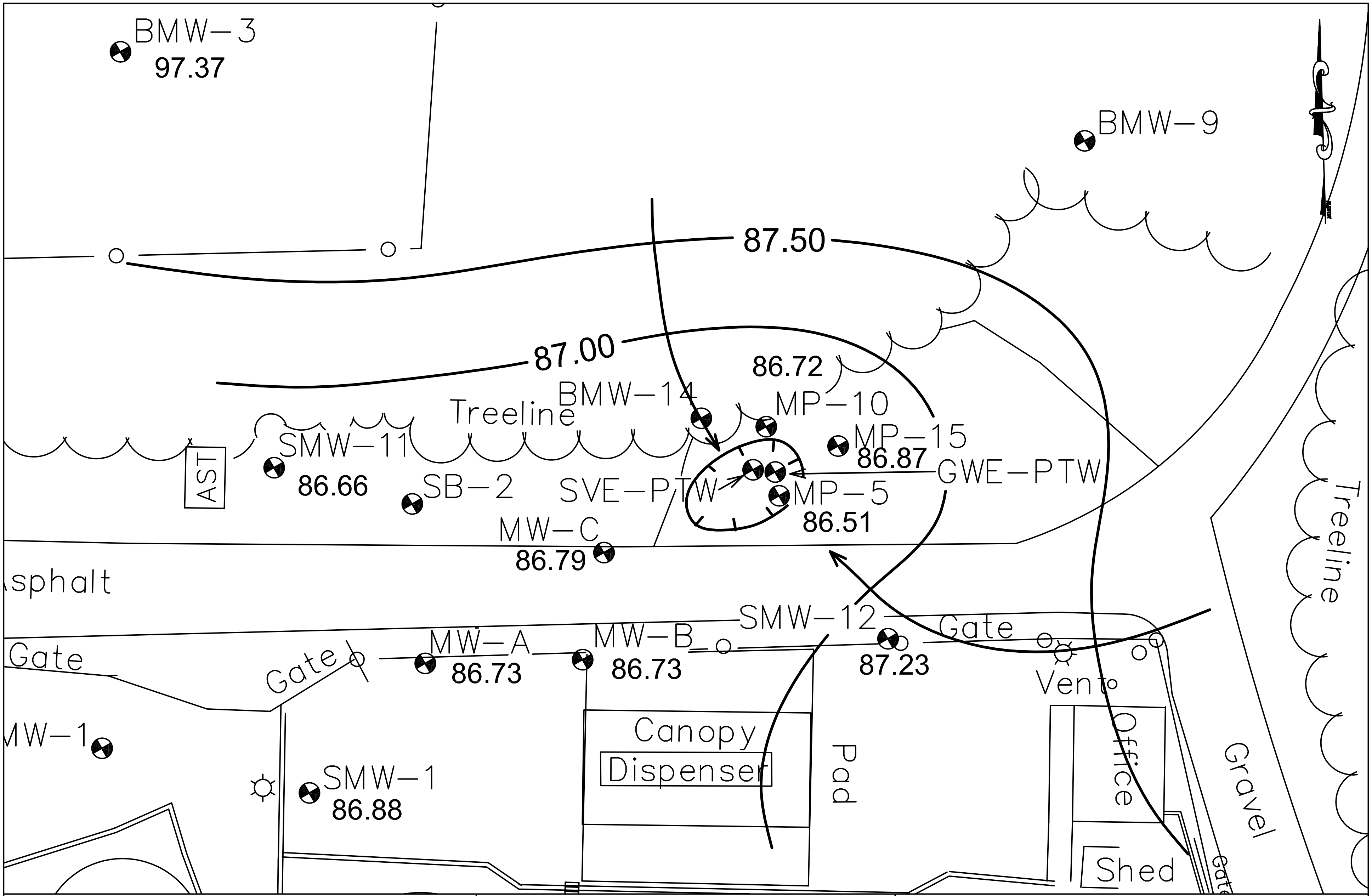

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FIGURE 7

DATE: 11-3-04

SCALE: 1" = 30'

Groundwater Contour Map
GWE at Maximum Drawdown
November 3, 2004

LEGEND:
● Monitoring Well

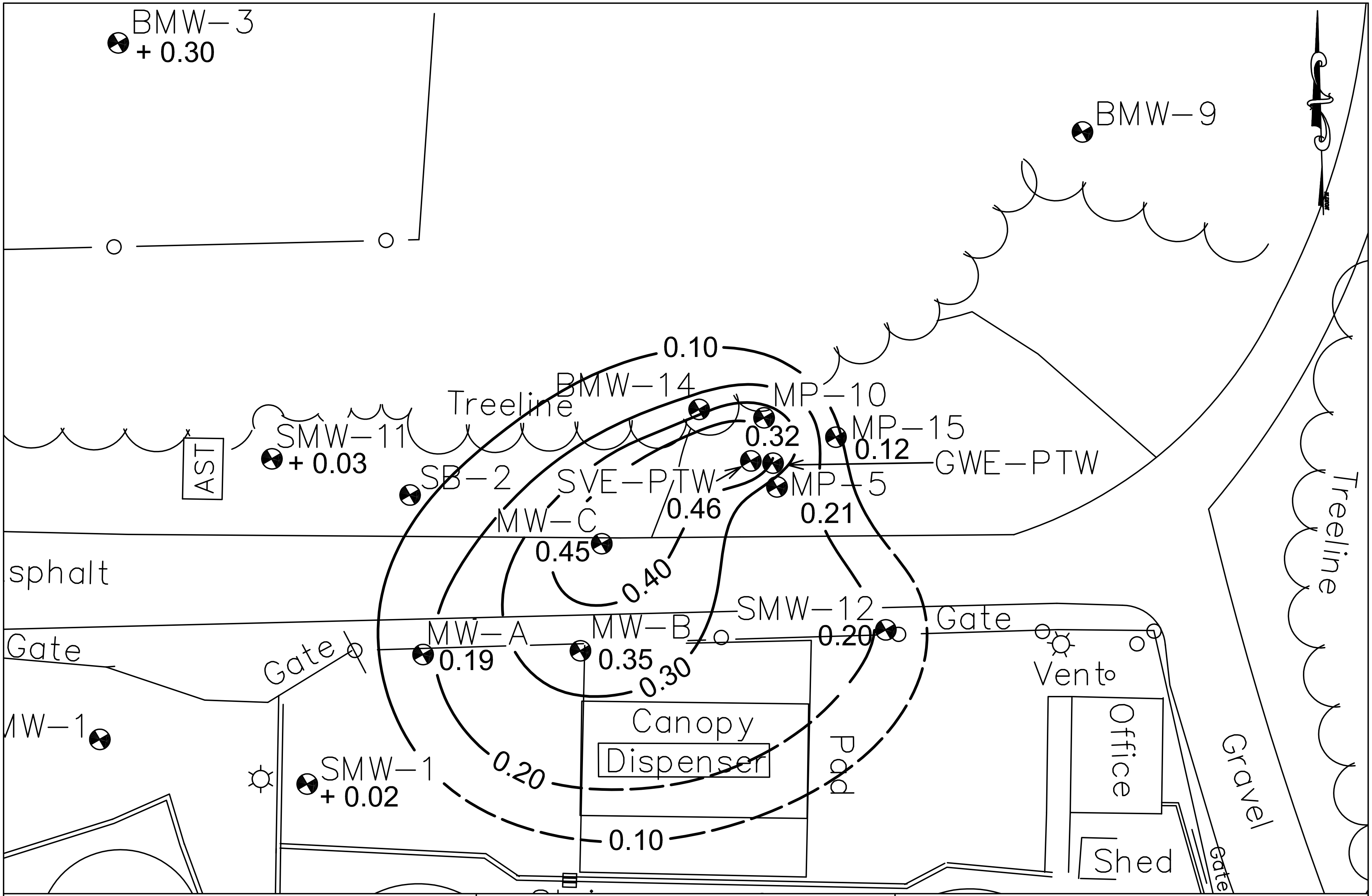

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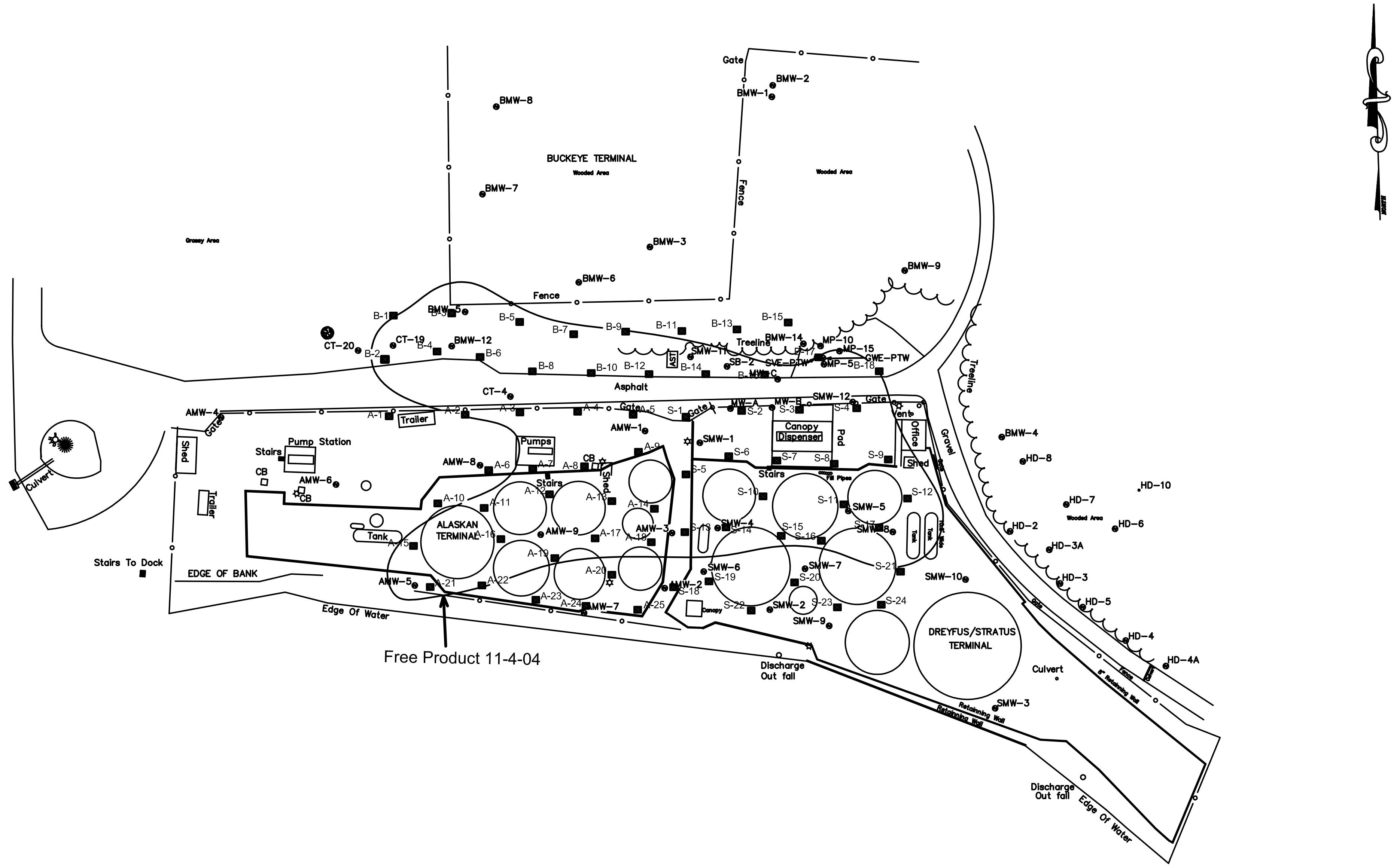
FIGURE 8

DATE: 11-3-04

SCALE: 1" = 30'

Maximum Observed Drawdown
November 3, 2004

LEGEND:
● **Monitoring Well**



Conceptual Design based on SVE only w/product recovery via pneumatic pumps (SVE-ROI = 25'+/-).
ROI increases to 35'+/- w/simultaneous groundwater extraction.

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FIGURE 9

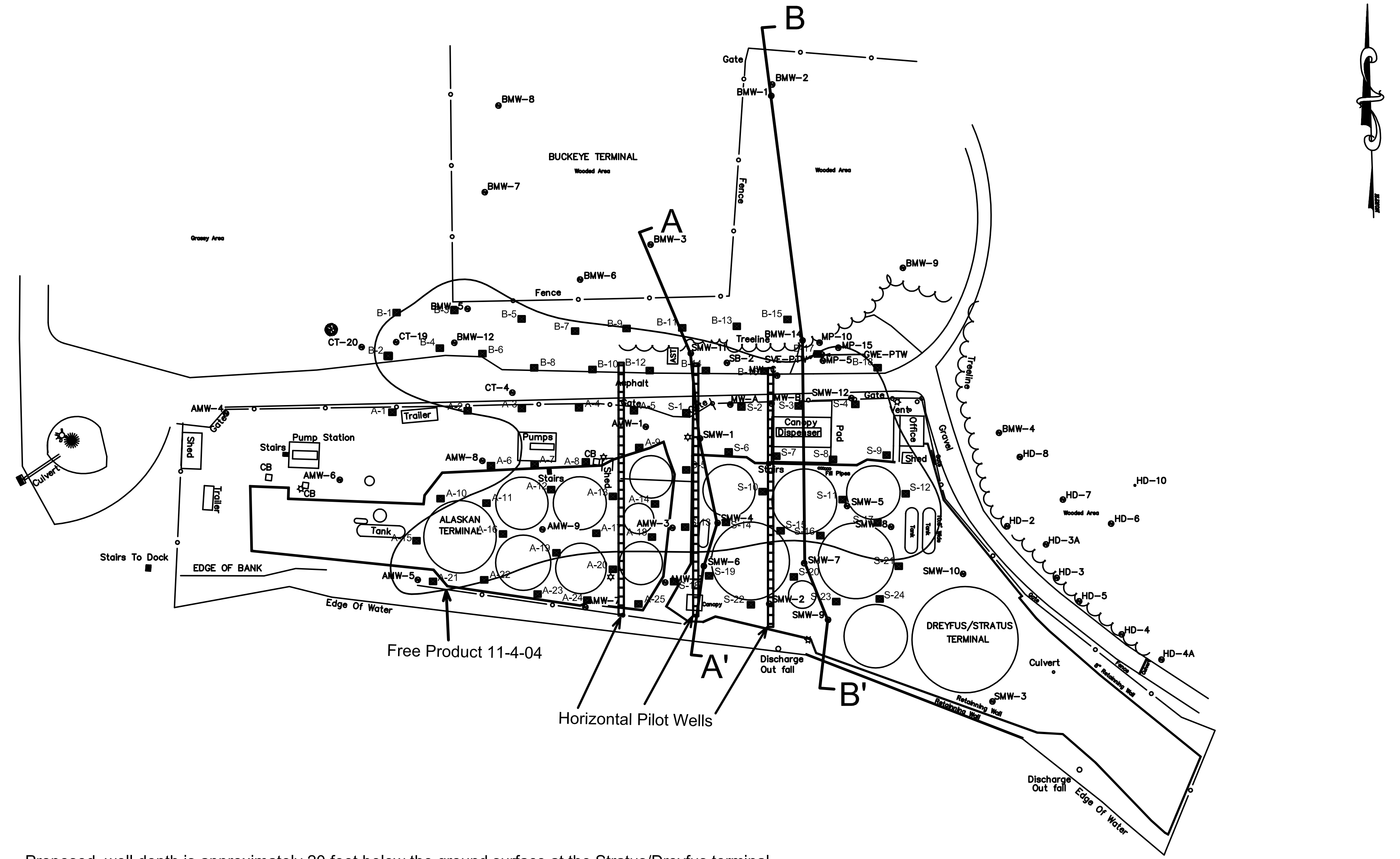
DATE: 12-20-04

SCALE: 1" = 120'

Conceptual Design SVE/Product Recovery

LEGEND:

A-19 ■ Proposed Product Recovery/SVE Remedial Well



Proposed well depth is approximately 20 feet below the ground surface at the Stratus/Dreyfus terminal
Approximate screened length of the horizontal wells is 200 feet.

A - A' and B - B' represent the line of cross-sections presented in Figure 11A and Figure 11B

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FIGURE 10

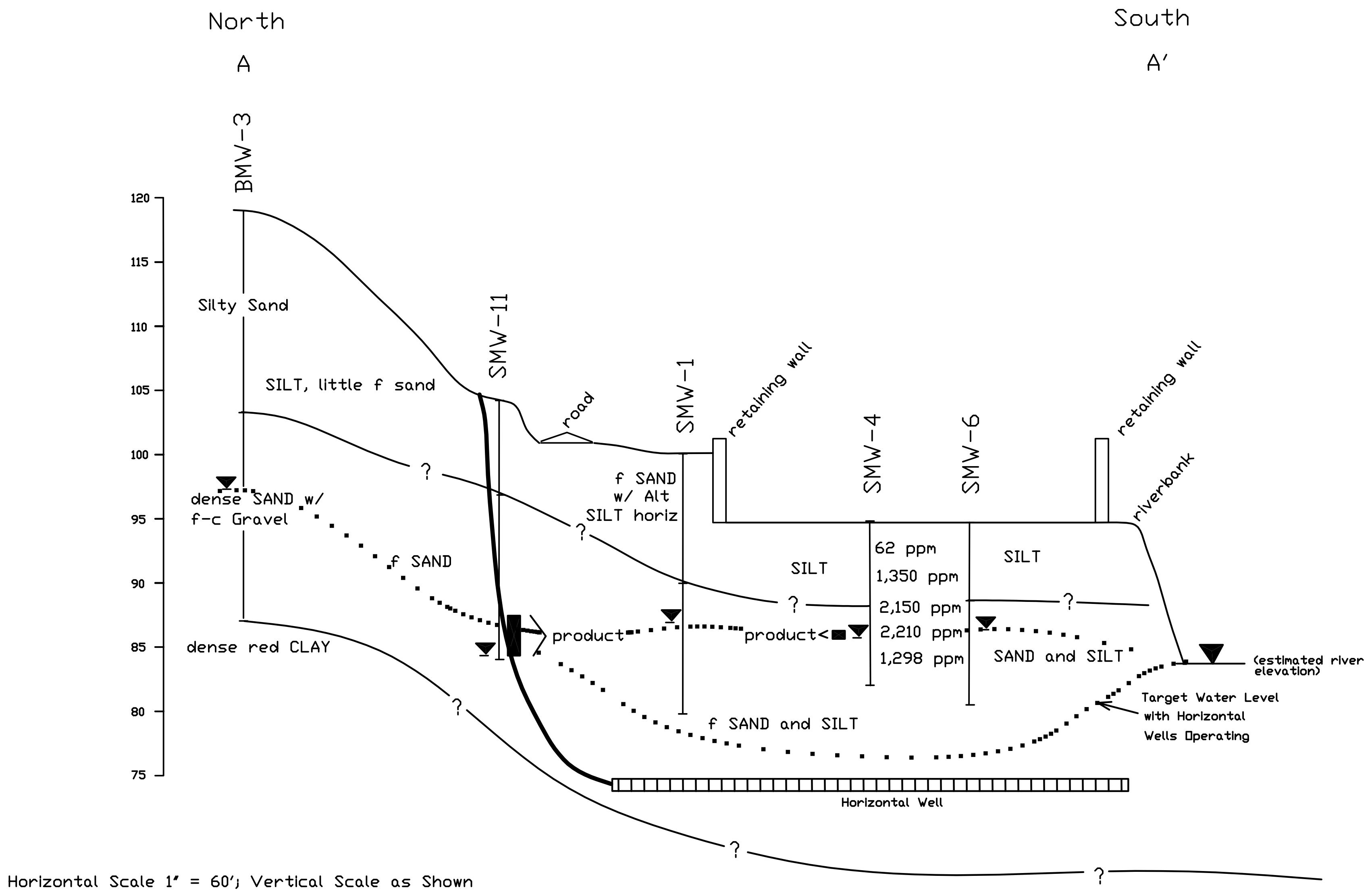
DATE: 12-20-04

SCALE: 1" = 120'

Conceptual Design Horizontal Pilot Wells

LEGEND:

A-19 ■ Proposed Product Recovery/SVE Remedial Well



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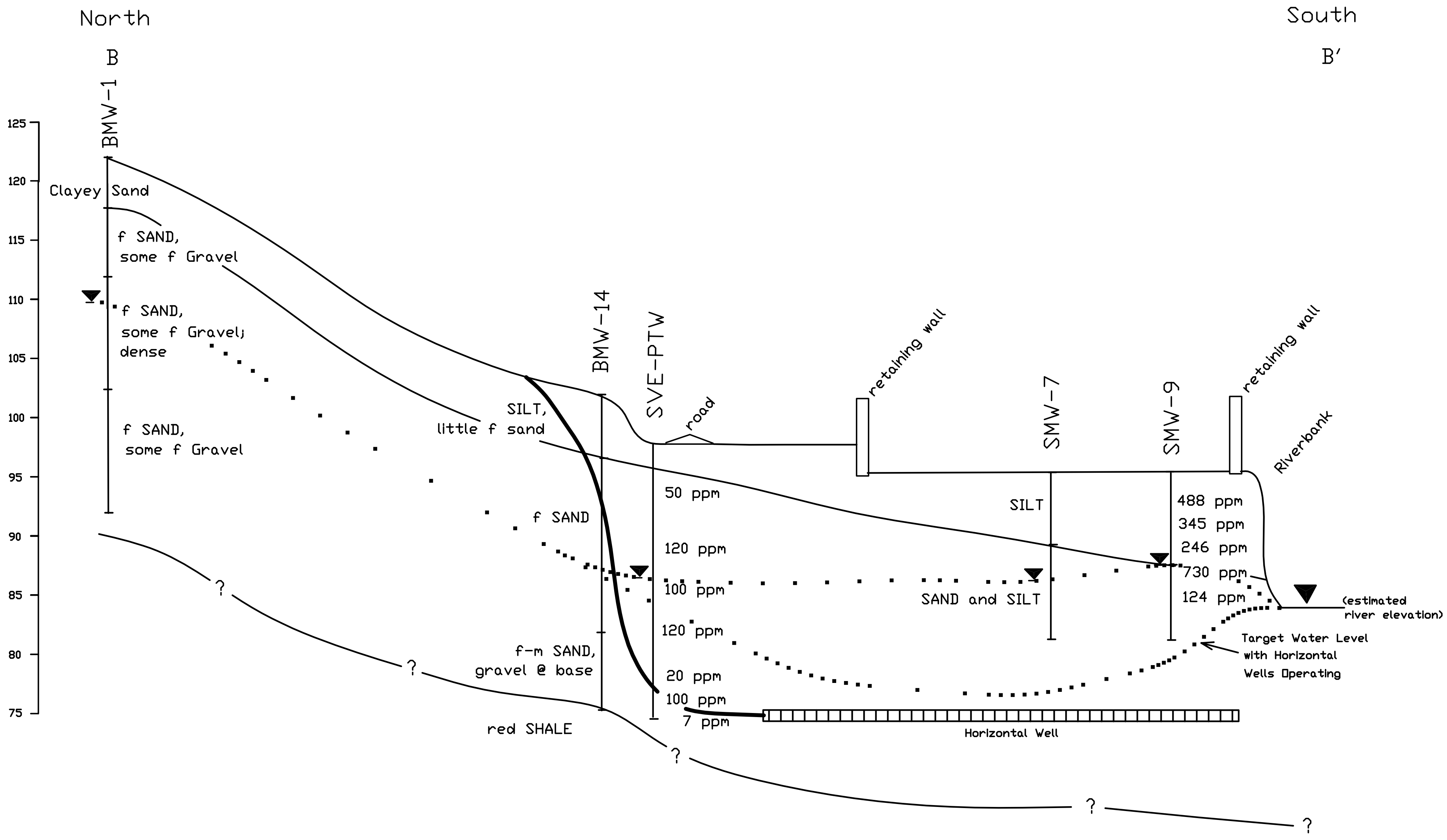
NYSDEC Spill No. 89-09423 PIN No. 99528

FIGURE 11A

DATE: 12-20-04
SCALE: 1" = 120'

Cross Section A - A'

LEGEND:
▼ Static GW Elevation 11-2-04
2,150 ppm = Total VOC concentration in soil - PID screening



Horizontal Scale 1" = 60'; Vertical Scale as Shown

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FIGURE 11B

DATE: 12-20-04

SCALE: 1" = 120'

Cross Section B - B'

LEGEND:

▼ Static GW Elevation 11-2-04

488 ppm = Total VOC concentration in soil - PID screening

APPENDIX A

SOIL BORING / WELL COMPLETION LOGS

Aztech Technologies, Inc.

P.O. Box 4515
Saratoga, NY 12866
(518) 584-5122

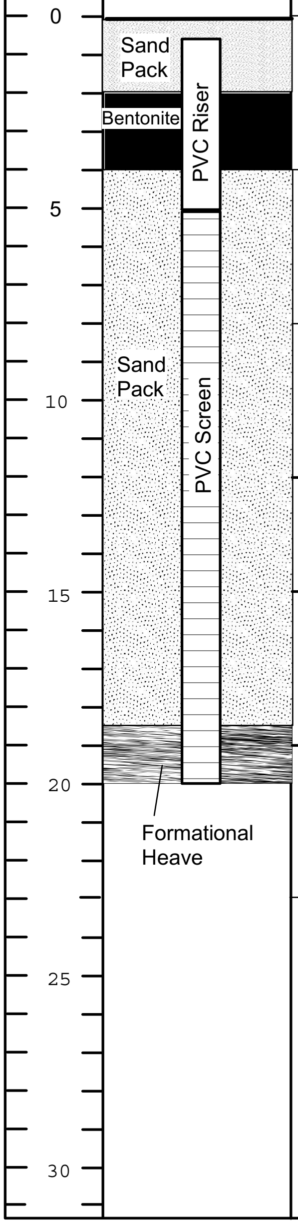
Page_____of_____

DRILLING LOG

Well/ Boring No. SVE-PTW

Client: NYSDEC
Locaion: Cold Springs Terminal
Phone No.:
Address:
Date Drilled: 10/20/04
Logged by: R. Hoose
Drilling Contractor: Aztech Technologies
Driller: C. DiNovo
Drilling Method: HSA/Direct Push
Total Depth of Hole: 20'/23'
Diameter: 10"
Screen: Dia.: 4.0" Length: 15.0' (5.0' - 20.0') Slot Size: 0.010"
Casing: Dia.: 4.0" Length: 5.0' (0.0-5.0') Type: PVC
Sand Pack: 4.0' - 18.5' Bentonite Seal: 2.0' - 4.0' Protective Casing: None

See Site Map



Sample Recovery	PID (ppm)
S-1: 0.0 - 4.0' REC: 1.0'/4.0'	2.0 @ 2.0' 50 @ 4.0'
S-2: 4.0 - 8.0' REC: 3.2'/4.0'	150 @ 5.0' 150 @ 6.5' 120 @ 8.0'
S-3: 8.0 - 12' REC: 2.5'/4.0'	110 @ 10' 100 @ 12'
S-4: 12' - 15' REC: 3.0'/3.0'	100 @ 13' 120 @ 15'
S-5: 15' - 19' REC: 3.0'/4.0'	40 @ 17' 20 @ 19'
S-6: 19' - 23' REC: 3.0'/4.0'	100 @ 21' 7.0 @ 23'

Description/ Soil Classification

0.0 - 2.0' (+/-) Brown to gray fine to coarse Sand, some Silt, some fine to coarse Gravel.
Sampler drove hard to ~2.0'
Dry; no odor
(GRAVEL and ROAD BASE)

2.0'

2.0' - 6.0' Brown to gray SILT.
Strong gasoline odor noted
Dry to damp
Becoming sandy @ ~ 6.0'
(SILT)

6.0'

6.0' - 12.0' Brown very, very fine SAND and SILT.
silt content gradually decreasing with depth
sand content gradually increasing with depth
▼ Groundwater encountered @ ~12'
(very fine SAND and SILT)

12.0'

12.0' - 19.0' Brown very fine to fine SAND, little SILT.
Sheen noted throughout 12' - 15' interval
Sheen not apparent below ~ 15'
Moderate gasoline odor noted
(fine SAND)

19.0'

19.0' - 22.6' Brown fine to medium (+) SAND, little silt.
Strong gasoline odor noted @ 21'
sand coarsens; little fine to coarse gravel noted from 22.2' - 22.6'.
(medium SAND)

22.6'

22.6' - EOB Brown fine SAND, little silt.
Mild gasoline odor noted @ 23'
(fine SAND)

23.0'

Sampled to 23', advanced hollow stem augers to 20'; installed 4.0" ID SVE pilot test well

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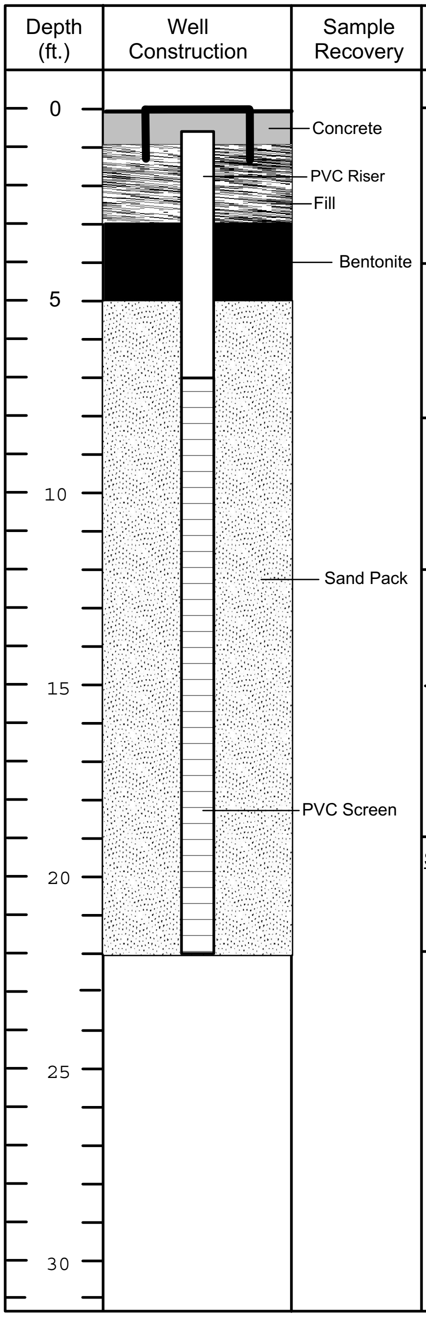
DRILLING LOG

Well/ Boring No. GWE-PTW

Client: NYSDEC
Locaion: Cold Springs Terminal
Phone No.:
Address:
Date Drilled: 4/19/04
Logged by: C. Post
Drilling Contractor: Aztech Technologies
Driller: C. DiNovo
Drilling Method: HSA
Total Depth of Hole: 22'
Diameter: 8-inch
Screen: Dia.: 4.0-inch Length: 15.0' - (7.0-22.0)' Slot Size: 0.020-slot
Casing: Dia.: 4.0-inch Length: 7.0' - (0.0-7.0)' Type: PVC
Sand Pack: (5.0-22.0)' Bentonite Seal: (3.0-5.0)' Protective Casing: Manhole

See Site Map



Sample Recovery		Description/ Soil Classification	
	S1: (0-4)'	0.0 - 0.5' Gravel and Road Base.	
		0.5' - 12.5' Brown Silt and Clay with trace of fine sand, moist.	0.5'
	S2: (4-8)'		
		Damp @ ~8.0'	
	S3: (8-12)'	Groundwater encountered while drilling. Becoming sandy @ ~ 12' (SILT and CLAY)	
	S4: (12-15)'	12.5' - 15.0' Brown to black fine Sand, some Silt, some Clay. (SAND/SILT/CLAY)	12.5'
	S5: (15-19)'	15.0' - 22.0' Fine to medium SAND, trace silt, trace clay.	15.0'
	S6: (19-22)'	some fine to medium gravel noted from 19.0' - 22.0' (fine to medium SAND)	
		Boring Terminated; installed 4.0" ID pilot test wel	22.0'

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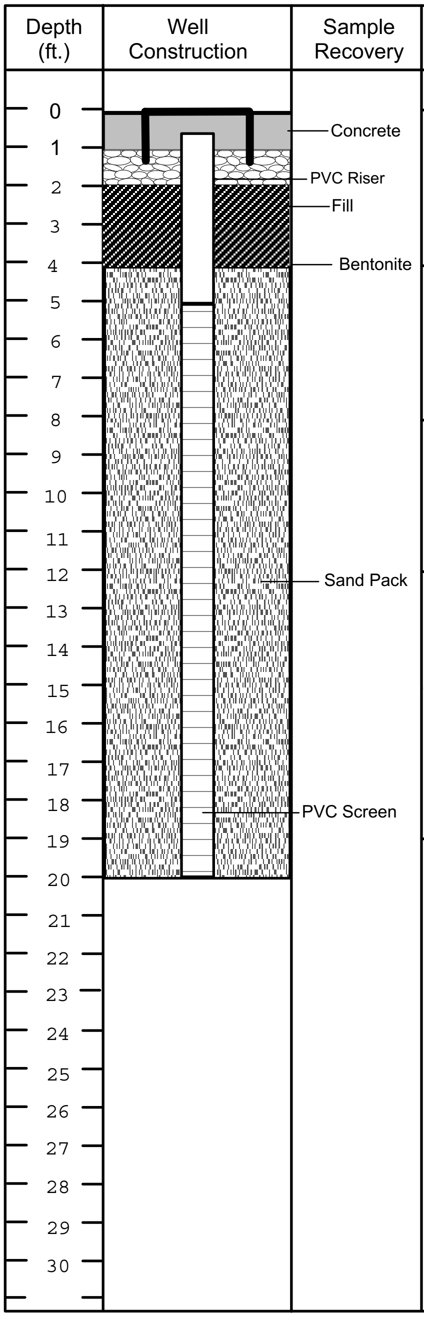
DRILLING LOG

Well/ Boring No. MP-5

Client: NYSDEC
Locaion: Cold Springs Terminal
Phone No.:
Address:
Date Drilled: 4/19/04
Logged by: C. Post
Drilling Contractor: Aztech Technologies
Driller: C. DiNovo
Drilling Method: HSA
Total Depth of Hole: 20'
Diameter: 4 1/4-inch
Screen: Dia.: 1.0-inch Length: 15.0' - (5.0-20.0)' Slot Size: 0.010-slot
Casing: Dia.: 1.0-inch Length: 5.0' - (0.0-5.0)' Type: PVC
Sand Pack: (5.0-20.0)' Bentonite Seal: (2.0-4.0)' Protective Casing: Manhole

See Site Map



	Description/ Soil Classification
S1: (0-4)'	(0-0.5)' - Gravel and Road Base. (0.5-4.0)' - Brown SILT and Clay with trace of fine-grained sand, moist.
S2: (4-8)'	(4.0-8.0)' - Brown SILT and Clay with trace of fine-grained sand, damp.
S3: (8-12)'	(8.0-10.0)' - Brown SILT and Clay with trace of fine-grained sand, damp. (10)' - Groundwater encountered while drilling. (10.0-12.0)' - Brown SILT and Clay with trace of fine-grained sand, wet.
S4: (12-15)'	(12.0-12.5)' - Transition to brown to black fine-grained SAND with some Silt and Clay. (12.5-15.0)' - Brown to black fine-grained SAND with some Silt and Clay.
S5: (15-19)'	(15.0-19.0)' - Fine to medium-grained SAND with traces of silt and clay.
S6: (19-20)'	(19.0-20.0)' - Fine to medium-grained SAND with Pebbles. (20)' - Boring Terminated. (20)'

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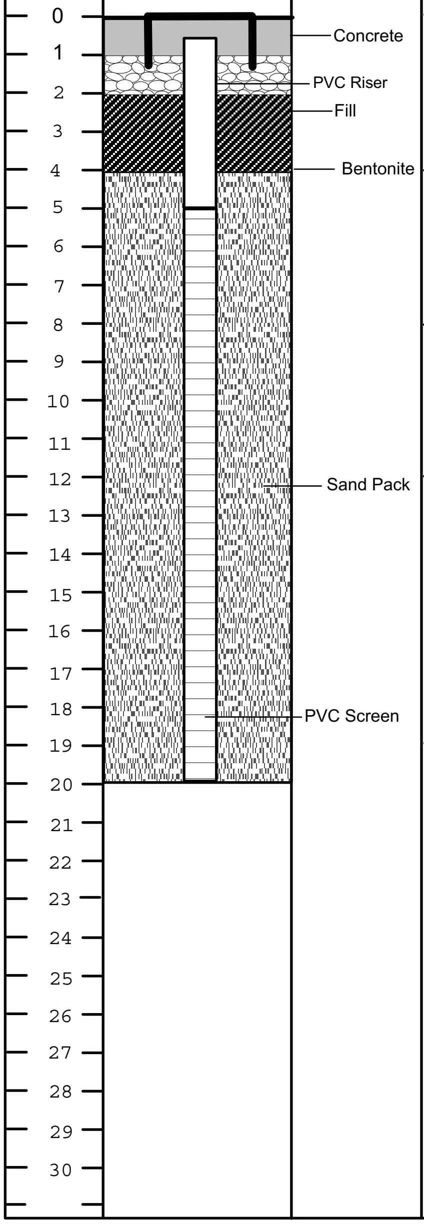
DRILLING LOG

Well/ Boring No. MP-10

Client: NYSDEC
Locaion: Cold Springs Terminal
Phone No.:
Address:
Date Drilled: 4/19/04
Logged by: C. Post
Drilling Contractor: Aztech Technologies
Driller: C. DiNovo
Drilling Method: HSA
Total Depth of Hole: 20'
Diameter: 4 1/4-inch
Screen: Dia.: 1.0-inch Length: 15.0' - (5.0-20.0)' Slot Size: 0.010-slot
Casing: Dia.: 1.0-inch Length: 5.0' - (0.0-5.0)' Type: PVC
Sand Pack: (5.0-20.0)' Bentonite Seal: (2.0-4.0)' Protective Casing: Manhole

See Site Map



Depth (ft.)	Well Construction	Sample Recovery		Description/ Soil Classification
			S1: (0-4)'	(0-0.5)' - Gravel and Road Base. (0.5-4.0)' - Brown SILT and Clay with trace of fine-grained sand, moist.
			S2: (4-8)'	(4.0-8.0)' - Brown SILT and Clay with trace of fine-grained sand, damp.
			S3: (8-12)'	(8.0-10.0)' - Brown SILT and Clay with trace of fine-grained sand, damp. (10)' - Groundwater encountered while drilling. (10.0-12.0)' - Brown SILT and Clay with trace of fine-grained sand, wet.
			S4: (12-15)'	(12.0-12.5)' - Transition to brown to black fine-grained SAND with some Silt and Clay. (12.5-15.0)' - Brown to black fine-grained SAND with some Silt and Clay.
			S5: (15-19)'	(15.0-19.0)' - Fine to medium-grained SAND with traces of silt and clay.
			S6: (19-20)'	(19.0-20.0)' - Fine to medium-grained SAND with Pebbles.
				(20)' - Boring Terminated. (20)'

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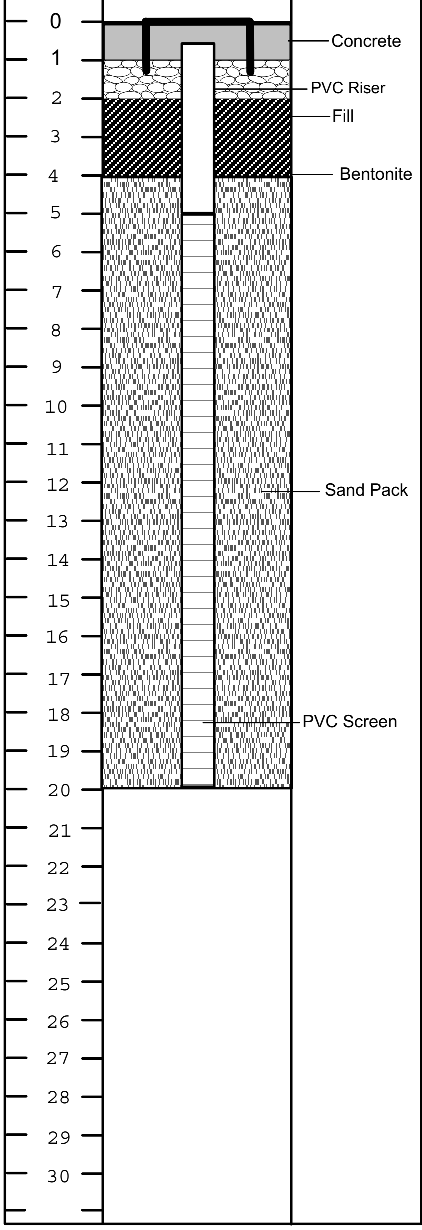
DRILLING LOG

Well/ Boring No. MP-15

Client: NYSDEC
Locaion: Cold Springs Terminal
Phone No.:
Address:
Date Drilled: 4/19/04
Logged by: C. Post
Drilling Contractor: Aztech Technologies
Driller: C. DiNovo
Drilling Method: HSA
Total Depth of Hole: 20'
Diameter: 4 1/4-inch
Screen: Dia.: 1.0-inch Length: 15.0' - (5.0-20.0)' Slot Size: 0.010-slot
Casing: Dia.: 1.0-inch Length: 5.0' - (0.0-5.0)' Type: PVC
Sand Pack: (5.0-20.0)' Bentonite Seal: (2.0-4.0)' Protective Casing: Manhole

See Site Map



Depth (ft.)	Well Construction	Sample Recovery		Description/ Soil Classification
				(0-0.5)' - Gravel and Road Base.
			S1: (0-4)'	(0.5-4.0)' - Brown SILT and Clay with trace of fine-grained sand, moist.
			S2: (4-8)'	(4.0-8.0)' - Brown SILT and Clay with trace of fine-grained sand, damp.
			S3: (8-12)'	(8.0-10.0)' - Brown SILT and Clay with trace of fine-grained sand, damp. (10)' - Groundwater encountered while drilling. (10.0-12.0)' - Brown SILT and Clay with trace of fine-grained sand, wet.
			S4: (12-15)'	(12.0-12.5)' - Transition to brown to black fine-grained SAND with some Silt and Clay. (12.5-15.0)' - Brown to black fine-grained SAND with some Silt and Clay.
			S5: (15-19)'	(15.0-19.0)' - Fine to medium-grained SAND with traces of silt and clay.
			S6: (19-20)'	(19.0-20.0)' - Fine to medium-grained SAND with Pebbles.
				(20)' - Boring Terminated. (20)'

APPENDIX B

PILOT TEST DATA

GWE COMPONENT

Data Collected During Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill # 89-04923; PIN No. 99528

11-2-04 Static Water Levels and Water Levels on 11-4-04 @ 1500 (1,745 minutes into test) Test Date: 11/3-5/04

Well ID	TOC	Static*				End of Test*				Total	Product Thickness
		DTP	DTW	Prod Thick	GW ELEV	DTP	DTW	Prod Thick	GW ELEV	Drawdown	increase (decrease)
Buckeye Terminal Wells											
GWE-PTW	98.01	-	11.22	-	86.79	NM	NM	NM	NM	-	-
SVE-PTW	98.07	-	11.24	-	86.83	NM	NM	NM	NM	-	-
MP-5**	97.81	10.99	11.18	0.19	86.77		9.98	-	87.83	-1.06	-
MP-10	98.12	-	11.21	-	86.91		11.05	-	87.07	-0.16	-
MP-15	97.66	-	10.67	-	86.99		10.03	-	87.63	-0.64	-
MW-C**	98.41	11.15	12.79	1.64	86.82	10.87	12.51	1.64	87.10	-0.28	0.00
BMW-1	122.21	-	11.98	-	110.23		10.50	-	111.71	**-1.48**	-
BMW-2	122.30	-	13.19	-	109.11		10.89	-	111.41	**-2.30**	-
BMW-3	119.05	-	21.76	-	97.29		21.64	-	97.41	**-0.12**	-
BMW-4	97.65	-	10.30	-	87.35		10.12	-	87.53	**-0.18**	-
BMW-5**	113.10	-	25.08	-	88.02	24.99	28.01	3.02	87.29	0.73	3.02
BMW-6	118.71	-	30.48	-	88.23		30.50	-	88.21	0.02	-
BMW-7	121.33	-	15.36	-	105.97		14.53	-	106.80	**-0.83**	-
BMW-8	123.79	-	12.21	-	111.58		11.33	-	112.46	**-0.88**	-
BMW-9	100.00	-	8.01	-	91.99	-	7.62	-	92.38	**-0.39**	-
BMW-12**	108.82	21.08	23.16	2.08	87.18	20.97	23.08	2.11	87.28	**-0.10**	0.03
BMW-14	102.38	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
SMW-11**	104.19	16.75	19.73	2.98	86.64	16.69	19.60	2.91	86.71	-0.07	-0.07
SB-2	103.61	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
CT-4**	103.20	15.61	15.65	0.04	87.58	15.51	-	> 0.14	< 87.55	> 0.03	> 0.10
CT-19	105.44	17.07	TD = 18.10	> 1.03	< 87.39	17.74	TD = 18.10	> 0.36	< 87.39	-	-
CT-20	105.50	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Alaskan Terminal Wells											
AMW-1**	100.82	14.06	14.11	0.05	86.75	13.95	14.10	0.15	86.83	**-0.08**	0.10
AMW-2	99.29	-	12.33	-	86.96		12.05		87.24	-0.28	-
AMW-3**	96.98	10.24	10.79	0.55	86.59	9.91	10.73	0.82	86.85	-0.26	0.27
AMW-4	101.94	-	13.50	-	88.44		13.55		88.39	0.05	-
AMW-5**		-	13.07	-	-13.07	12.85	12.94	0.09	-	-	0.09
AMW-6	100.52	-	> 13.13	-	< 87.39		> 13.13		< 87.39	-	-
AMW-7		-	12.80	-	-12.80		12.18		-12.18	-0.62	-
AMW-8	101.32	-	7.08	-	94.24	NM	NM	NM	NM	-	-
AMW-9		11.93	> 13.28	> 1.35	-	11.73	> 13.28	> 1.55	-	-	-

* Static DTW obtained on 11-2-04; End of test DTW obtained on 11-4-04 @ 1500 (1,745 minutes into test) prior to significant rainfall event.

** Corrected groundwater elevation determined by multiplying the apparent product thickness by 0.73 and subtracting the result from the measured depth to water.

Pilot Test:

Start @ 09:55 am 11-3-04. Meter reading 8,344 gallons.
End @ 07:20 am 11-5-04. Meter reading 9,454 gallons.

Test Duration: 2,725 minutes
Total Volume Pumped: 1,110 Gallons

Data Collected During Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill # 89-04923; PIN No. 99528

11-2-04 Static Water Levels and Water Levels on 11-4-04 @ 1500 (1,745 minutes into test)

Test Date: 11/3-5/04

Well ID	TOC	Static*				End of Test*				Total Drawdown	Change in Product Thickness
		DTP	DTW	Prod Thick	GW ELEV	DTP	DTW	Prod Thick	GW ELEV		
Stratus Terminal Wells											
MW-A**	100.11	13.29	13.31	0.02	86.81	13.07	13.77	0.70	86.85	-0.04	0.68
MW-B**	98.19	11.38	11.93	0.55	86.66	11.16	11.18	0.02	87.02	-0.36	-0.53
SMW-1**	99.97	-	13.09	-	86.88	12.92	13.26	0.34	86.96	-0.08	0.34
SMW-2	94.89	-	7.96	-	86.93	-	7.85	-	87.04	-0.11	-
SMW-3		-	7.66	-	-7.66	-	7.41	-	-7.41	-0.25	-
SMW-4**	95.05	8.29	8.78	0.49	86.63	8.14	8.65	0.51	86.77	-0.14	0.02
SMW-5**	94.87	7.97	8.39	0.42	86.79	7.74	8.41	0.67	86.95	-0.16	0.25
SMW-6	94.83	-	8.23	-	86.60	-	8.05	-	86.78	-0.18	-
SMW-7	95.53	-	8.84	-	86.69	-	8.68	-	86.85	-0.16	-
SMW-8**	95.11	8.44	8.97	0.53	86.53	8.03	8.75	0.72	86.89	-0.36	0.19
SMW-9	95.19	-	7.61	-	87.58	-	7.38	-	87.81	-0.23	-
SMW-10	96.06	-	7.71	-	88.35	-	7.40	-	88.66	-0.31	-
SMW-12**	97.32	-	10.34	-	86.98	9.63	9.65	0.02	87.68	-0.70	0.02

* Static depth to water measurements obtained on 11-2-04; End of test depth to water measurements obtained on 11-4-04 prior to significant rainfall event.

** Corrected groundwater elevation determined by multiplying the apparent product thickness by 0.73 and subtracting the result from the measured depth to water.

Pilot Test:

Start @ 09:55 am 11-3-04. Meter reading 8,344 gallons.
End @ 07:20 am 11-5-04. Meter reading 9,454 gallons.

Test Duration: 2,725 minutes
Total Volume Pumped: 1,110 Gallons

Data Collected During Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill # 89-04923; PIN No. 99528

Water Levels @ Test Start and Water Levels @ Maximum Drawdown

Test Date: 11/3-/5/04

Well ID	TOC	TEST START 11-3-04 @ 0955				DD 11-3-04 @ 1440				Total Drawdown	Product Thickness Increase - Decrease
		DTP	DTW	Prod Thick	GW ELEV	DTP	DTW	Prod Thick	GW ELEV		
GWE-PTW	98.01	-	11.18	-	86.83	NM	NM	NM	NM	-	-
SVE-PTW	98.07	-	11.15	-	86.92	-	11.61	-	86.46	0.46	-
MP-5	97.81	-	11.09	-	86.72	11.29	11.30	0.01	86.51	0.21	0.01
MP-10	98.12	-	11.08	-	87.04	-	11.40	-	86.72	0.32	-
MP-15	97.66	-	10.67	-	86.99	-	10.79	-	86.87	0.12	-
MW-C**	98.41	11.13	11.29	0.16	87.24	11.18	12.80	1.62	86.79	0.45	1.46
SMW-12	97.32	-	9.89	-	87.43	-	10.09	-	87.23	0.20	-
MW-A**	100.11	-	13.19	-	86.92	13.17	13.93	0.76	86.73	0.19	0.76
MW-B**	98.19	-	11.11	-	87.08	11.31	11.88	0.57	86.73	0.35	0.57
SMW-1**	99.97	13.01	13.39	0.38	86.86	12.99	13.35	0.36	86.88	-0.02	-0.02
SMW-2	94.89	-	7.93	-	86.96	-	7.93	-	86.96	0.00	-
SMW-11**	104.19	16.76	19.71	2.95	86.63	16.74	19.68	2.94	86.66	-0.03	-0.01
BMW-3	119.05	-	21.98	-	97.07	-	21.68	-	97.37	-0.30	-

* "Test Start" DTW obtained on 11-3-04 @ 0955; DD 11-3-04 DTW obtained 285 minutes into test and prior to significant rainfall event on 11-4-04.

** Corrected groundwater elevation determined by multiplying the apparent product thickness by 0.73 and subtracting the result from the measured depth to water.

Pilot Test:

Start @ 09:55 am 11-3-04. Meter reading 8,344 gallons.
End @ 07:20 am 11-5-04. Meter reading 9,454 gallons.

Test Duration: 2,725 minutes
Total Volume Pumped: 1,110 Gallons

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Pumping Well: GWE-PTW

Test Date: 11/3 - 5/04

Distance from Pumping Well:	5.3'	5.3'	10.0'	15.3'	41.5'	44.5'
Well ID	SVE-PTW	MP-5	MP-10	MP-15	MW-C	SMW-12
TOC Elev.	98.07	97.81	98.12	97.66	98.41	97.32
Meas Pt.						
Meas Pt. Elev.	98.07	97.81	98.12	97.66	98.41	97.32
Static DTW	11.15	11.09	11.08	10.67	11.17	9.89
Static Elev.	86.92	86.72	87.04	86.99	87.24	87.43
DTW 2 min	11.17	11.09	11.27	10.67	NM	NM
Elev. 2 min	86.90	86.72	86.85	86.99	NM	NM
DTW 4 min	11.25	11.20	11.33	10.68	NM	NM
Elev. 4 min	86.82	86.61	86.79	86.98	NM	NM
DTW 7 min	11.31	11.22	11.31	10.69	NM	NM
Elev. 7 min	86.76	86.59	86.81	71.00	NM	NM
DTW 9 min	11.33	11.21	11.31	10.70	NM	NM
Elev. 9 min	86.74	86.60	86.81	86.96	NM	NM
DTW 11 min	11.35	11.23	11.32	10.71	NM	NM
Elev. 11 min	86.72	86.58	86.80	86.95	NM	NM
DTW 21 min	11.48	11.26	11.34	10.74	11.17	9.95
Elev. 21 min	86.59	86.55	86.78	86.92	87.24	87.37
DTW 31 min	11.51	11.26	11.35	10.75	11.16	9.97
Elev. 31 min	86.56	86.55	86.77	86.91	87.25	87.35
DTW 41 min	11.54	11.27	11.36	10.75	11.16	9.98
Elev. 41 min	86.53	86.54	86.76	86.91	87.25	87.34
DTW 51 min	11.56	11.27	11.37	10.76	11.15	9.98
Elev. 51 min	86.51	86.54	86.75	86.90	87.26	87.34
DTW 61 min	11.57	11.28	11.37	10.76	11.57	9.99
Elev. 61 min	86.50	86.53	86.75	86.90	86.84	87.33
DTW 71 min	11.58	11.28	11.37	10.77	11.58	10.00
Elev. 71 min	86.49	86.53	86.75	86.89	86.83	87.32
DTW 81 min	11.58	11.28	11.37	10.77	11.59	10.01
Elev. 81 min	86.49	86.53	86.75	86.89	86.82	87.31
DTW 91 min	11.59	11.28	11.37	10.77	11.59	10.01
Elev. 91 min	86.48	86.53	86.75	86.89	86.82	87.31
DTW 101 min	11.59	11.28	11.38	10.77	11.59	10.02
Elev. 101 min	86.48	86.53	86.74	86.89	86.82	87.30
DTW 161 min	11.60	11.30	11.38	10.78	11.60	10.05
Elev. 161 min	86.47	86.51	86.74	86.88	86.81	87.27

0.48" RAIN on 11-1-04 & 11-2-04

Test started 11-3-04 @ 9:55 am
0.02" RAIN on 11-3-04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Pumping Well: GWE-PTW (continued) Test Date: 11/3 - 5/04

Well ID	SVE-PTW	MP-5	MP-10	MP-15	MW-C	SMW-12	
TOC Elev.	98.07	97.81	98.12	97.66	98.41	97.32	
DTW 225 min	11.60	11.28	11.38	10.78	11.62	10.08	
Elev. 225 min	86.47	86.53	86.74	86.88	86.79	87.24	
DTW 285 min	11.61	11.30	11.40	10.79	NM	10.09	
Elev. 285 min	86.46	86.51	86.72	86.87	NM	87.23	
DTW 345 min	11.61	11.28	11.39	10.79	NM	10.09	
Elev. 345 min	86.46	86.53	86.73	86.87	NM	87.23	
DTW 405 min	11.61	11.31	11.40	10.79	NM	10.09	
Elev. 405 min	86.46	86.50	86.72	86.87	NM	87.23	
DTW 1,235 min	11.58	11.25	11.37	11.75	NM	9.71	11-4-04 @ 6:30 am
Elev. 1,235 min	86.49	86.56	86.75	85.91	NM	87.61	
DTW 1,385 min	NM	10.64	11.31	10.62	NM	9.68	
Elev. 1,385 min	NM	87.17	86.81	87.04	NM	87.64	
DTW 1,505 min	NM	10.15	11.24	10.47	11.50	9.68	
Elev. 1,505 min	NM	87.66	86.88	87.19	86.91	87.64	
DTW 1,625 min	NM	9.96	11.19	10.45	11.50	NM	0.39" Rain begins in the afternoon of 11-4-04
Elev. 1,625 min	NM	87.85	86.93	87.21	86.91	NM	
DTW 1,745 min	NM	9.98	11.05	10.03	11.31	9.37	
Elev. 1,745 min	NM	87.83	87.07	87.63	87.10	87.95	
DTW 1,805 min	NM	10.13	10.97	10.04	11.44	9.36	
Elev. 1,805 min	NM	87.68	87.15	87.62	86.97	87.96	
DTW 2,675 min	NM	11.18	11.28	10.57	11.36	9.08	11-5-04 @ 6:30 am
Elev. 2,675 min	NM	86.63	86.84	87.09	87.05	88.24	
DTW 2,722 min	10.39	NM	NM	NM	NM	NM	11-5-04 @ 7:17 am; test ended 11-5-04 @ 7:20 am
Elev. 2,722 min	87.68	NM	NM	NM	NM	NM	
Observed Drawdown @ 285 min	0.46	0.21	0.32	0.12	0.45	0.20	
Total Observed Drawdown	-0.76	0.09	0.20	-0.10	0.19	-0.81	

<u>MP-5</u> - 0.01' apparent product thickness (APT) @ 225 - 405 minutes; 0.04' @ 1,235 minutes. DTW shown is not corrected for APT.

<u>MW-C</u> - APT ranges from 0.01' @ 21 minutes to 1.88' @ 2,675 minutes. DTW shown is corrected for APT.

<u>SMW-12</u> - 0.01' APT @ 1,235 & 1,385 minutes; 0.02' @ 1,505 minutes. DTW shown is not corrected for APT.

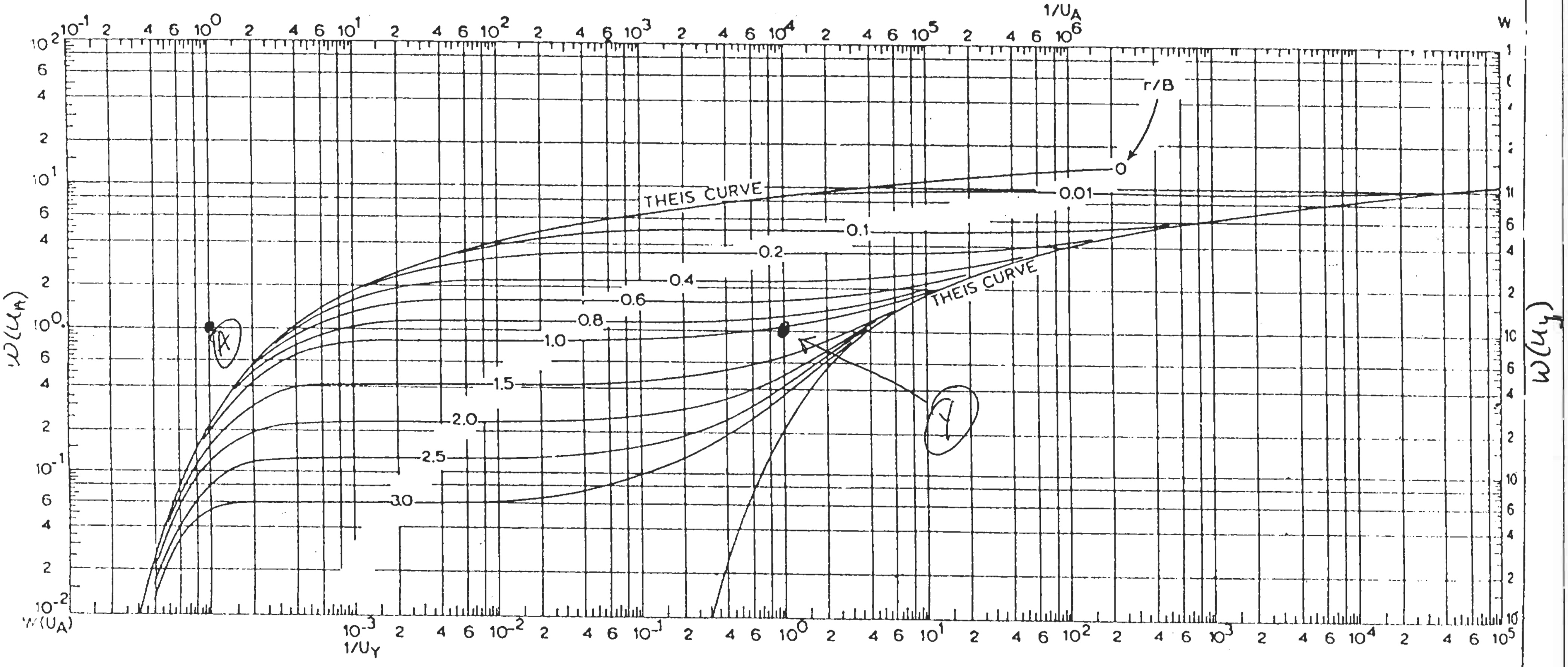


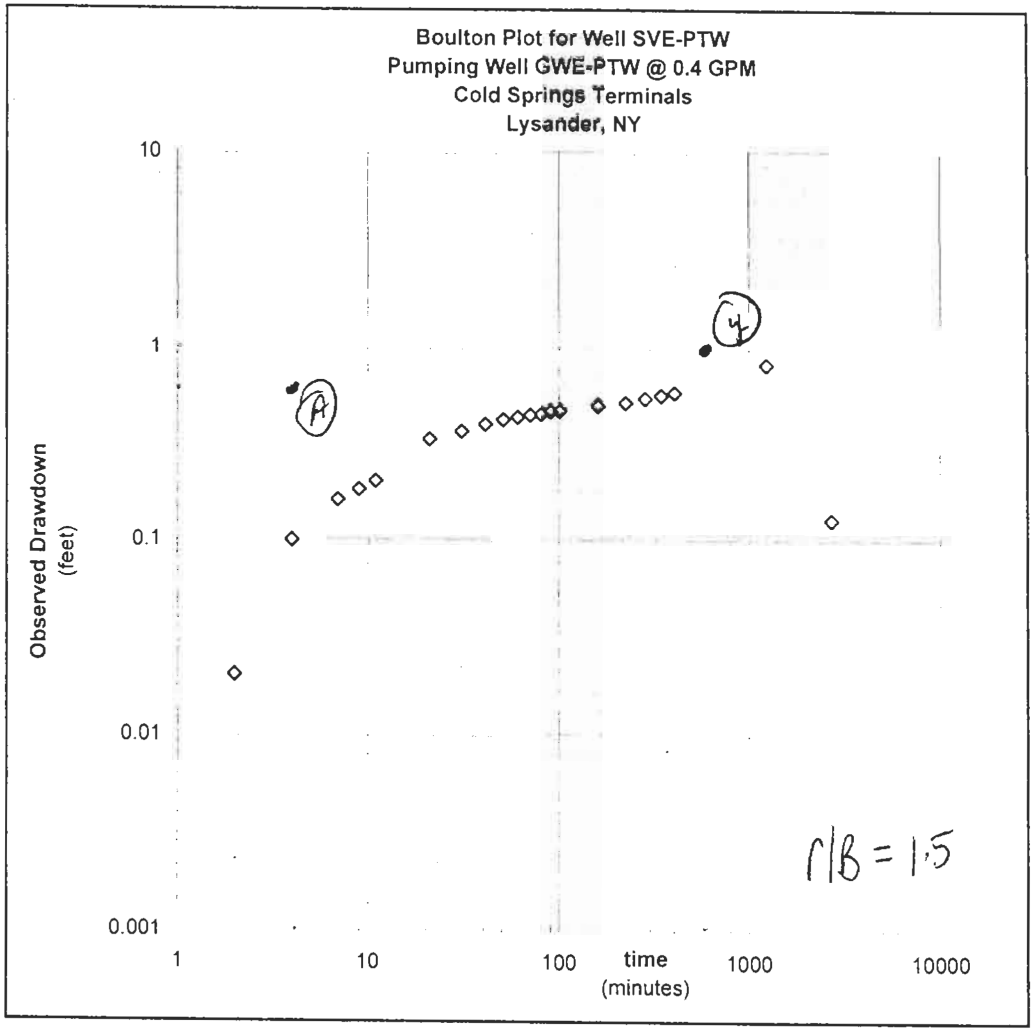
Fig. 32. Family of Boulton type curves: $W(u_A, r/B)$ versus $1/u_A$ and $W(u_Y, r/B)$ versus $1/u_Y$ for different values of r/B.

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well SVE-PTW

Time	DTW	Corr DTW	Corr DD
0	11.15	11.15	0.00
2	11.17	11.17	0.02
4	11.25	11.25	0.10
7	11.31	11.31	0.16
9	11.33	11.33	0.18
11	11.35	11.35	0.20
21	11.48	11.49	0.34
31	11.51	11.52	0.37
41	11.54	11.55	0.40
51	11.56	11.58	0.43
61	11.57	11.59	0.44
71	11.58	11.60	0.45
81	11.58	11.61	0.46
91	11.59	11.62	0.47
101	11.59	11.62	0.47
161	11.60	11.65	0.50
225	11.60	11.67	0.52
285	11.61	11.70	0.55
345	11.61	11.72	0.57
405	11.61	11.74	0.59
1,235	11.58	11.98	0.83
2,722	10.39	11.28	0.13

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



$Q = 77\ ft^3/d$

$r/B = 1.5$

$r = 5.3\ ft$

$w(u_A, r/B) = 1$

$1/u_A = 1$

$b = 12\ ft$

$w(u_y, r/B) = 1$

$1/u_y = 1$

Early Match Pt Ⓐ:

$s = 0.60\ ft$

$t = 4$ MINUTES

LATE Match Pt (y):

$s = 1.0\ ft$

$t = 600$ MINUTES

BOULTON CALCULATIONS
Well SVE-PW

Early (A):

$$T = \frac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \frac{77\ ft^3/d}{4(3.14)(0.6\ ft)}(1) = \frac{77\ ft^3/d}{7.536}$$

$$T = 10.22\ ft^2/d$$

$$T = Kb \Longrightarrow K = T/b = \frac{10.22}{12} = 0.85\ ft/d = 3.0 \times 10^{-4}\ cm/$$

$$S_A = \frac{u_A 4Tt}{r^2} = \frac{(1)(4)(10.22)(0.0028)}{5.3^2} = \frac{0.11356}{28.09} = 0.004$$

LATE (y):

$$T = \frac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \frac{77\ ft^3/d}{4(3.14)(1)}(1) = \frac{77\ ft^3/d}{12.56}$$

$$T = 6.13\ ft^2/d$$

$$T = Kb \Longrightarrow K = T/b = \frac{6.13}{12} = 0.51\ ft/d = 1.8 \times 10^{-4}\ cm/sec$$

$$S_y = \frac{u_y 4Tt}{r^2} = \frac{(1)(4)(6.13)(0.4167)}{5.3^2} = \frac{10.22}{28.09} = 0.3637$$

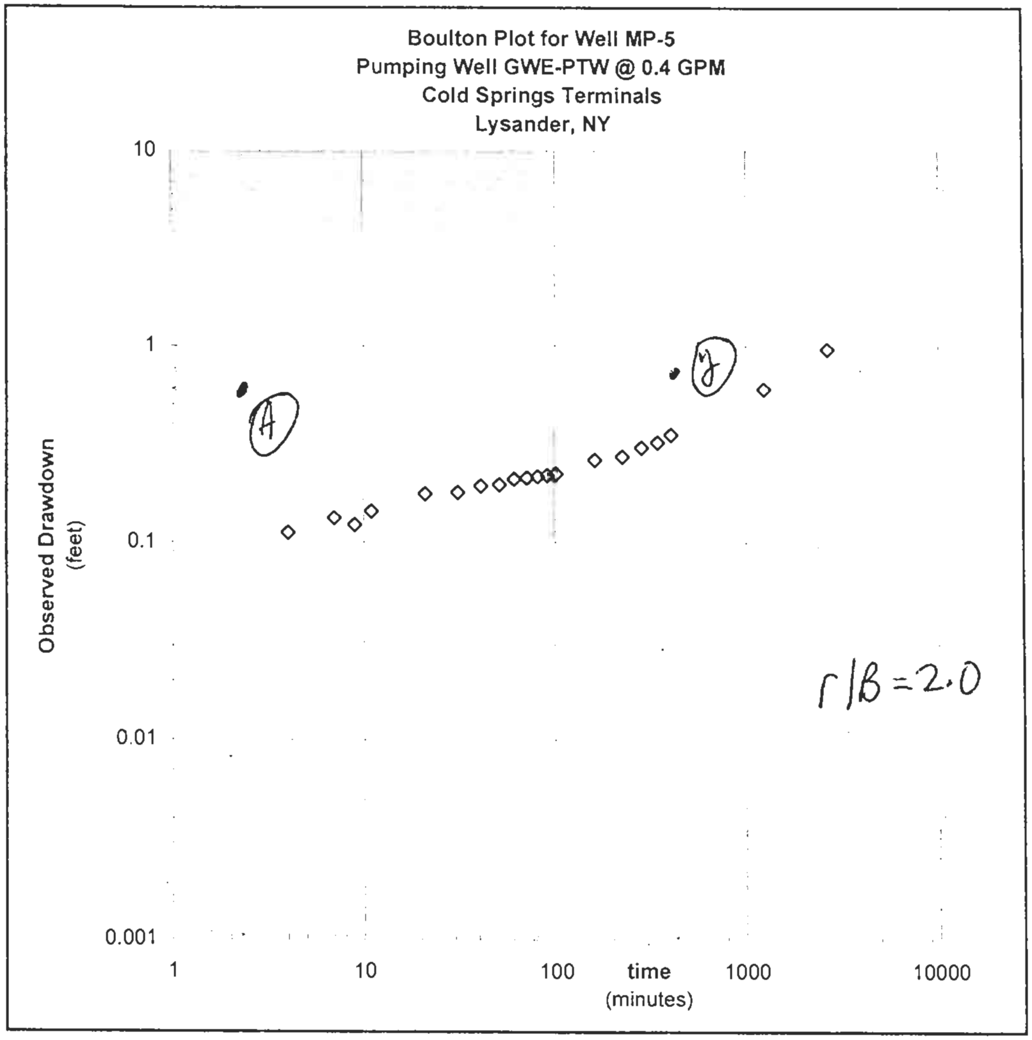
$$\eta = 1 + \frac{S_y}{S_A} = 1 + \frac{0.3637}{0.004} = 91.92$$

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well MP-5

Time	DTW	Corr DTW	Corr DD
0	11.09	11.09	0.00
2	11.09	11.09	0.00
4	11.20	11.20	0.11
7	11.22	11.22	0.13
9	11.21	11.21	0.12
11	11.23	11.23	0.14
21	11.26	11.27	0.18
31	11.26	11.27	0.18
41	11.27	11.28	0.19
51	11.27	11.29	0.20
61	11.28	11.30	0.21
71	11.28	11.30	0.21
81	11.28	11.31	0.22
91	11.28	11.31	0.22
101	11.28	11.31	0.22
161	11.30	11.35	0.26
225	11.29	11.36	0.27
285	11.30	11.39	0.30
345	11.30	11.41	0.32
405	11.31	11.44	0.35
1,235	11.29	11.69	0.60
1,385	10.64	11.09	
1,505	10.15	10.64	
1,625	9.96	10.49	
1,745	9.98	10.55	
1,805	10.13	10.72	
2,675	11.18	12.05	0.96

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



· Early Match Pt Ⓐ: $s = 0.60$ ft
$t = 2.5$ min

Late Match Pt Ⓨ:
$s = 0.75$ ft
$t = 450$ min

$r/B = 2.0$
$r = 5.3$ ft
$b = 12$ ft

$W(u_A, r/B) = 1$
$1/u_A = 1$
$W(u_y, r/B) = 1$

BOULTON Calculations
well MP-5

Early Ⓐ: $T = \dfrac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \dfrac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.60\ \text{ft})}(1) = \dfrac{77\ \text{ft}^3/\text{d}}{7.536\ \text{ft}}$

$T = 10.2\ \text{ft}^2/\text{d}$

$T = Kb \Rightarrow K = T/b = \dfrac{10.2\ \text{ft}^2/\text{d}}{12\ \text{ft}} = 0.85\ \text{ft/d} = 3.0 \times 10^{-4}\ \text{cm/sec}$

$S_A = \dfrac{u_A 4Tt}{r^2} = \dfrac{(1)(4)(10.2\ \text{ft}^2/\text{d})(0.0017)}{5.3^2\ \text{ft}} = \dfrac{0.06936}{28.09} = 0.0025$

Late ⓨ: $T = \dfrac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \dfrac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.75)}(1) = \dfrac{77\ \text{ft}^3/\text{d}}{9.42\ \text{ft}}$

$T = 8.2\ \text{ft}^2/\text{d}$

$T = Kb \Rightarrow K = T/b = \dfrac{8.2\ \text{ft}^2/\text{d}}{12} = 0.68\ \text{ft/d} = 2.4 \times 10^{-4}\ \text{cm/sec}$

$S_y = \dfrac{u_y 4Tt}{r^2} = \dfrac{(1)(4)(8.2\ \text{ft}^2/\text{d})(0.3125\ \text{d})}{5.3^2\ \text{ft}} = \dfrac{10.25}{28.09} = 0.3649$

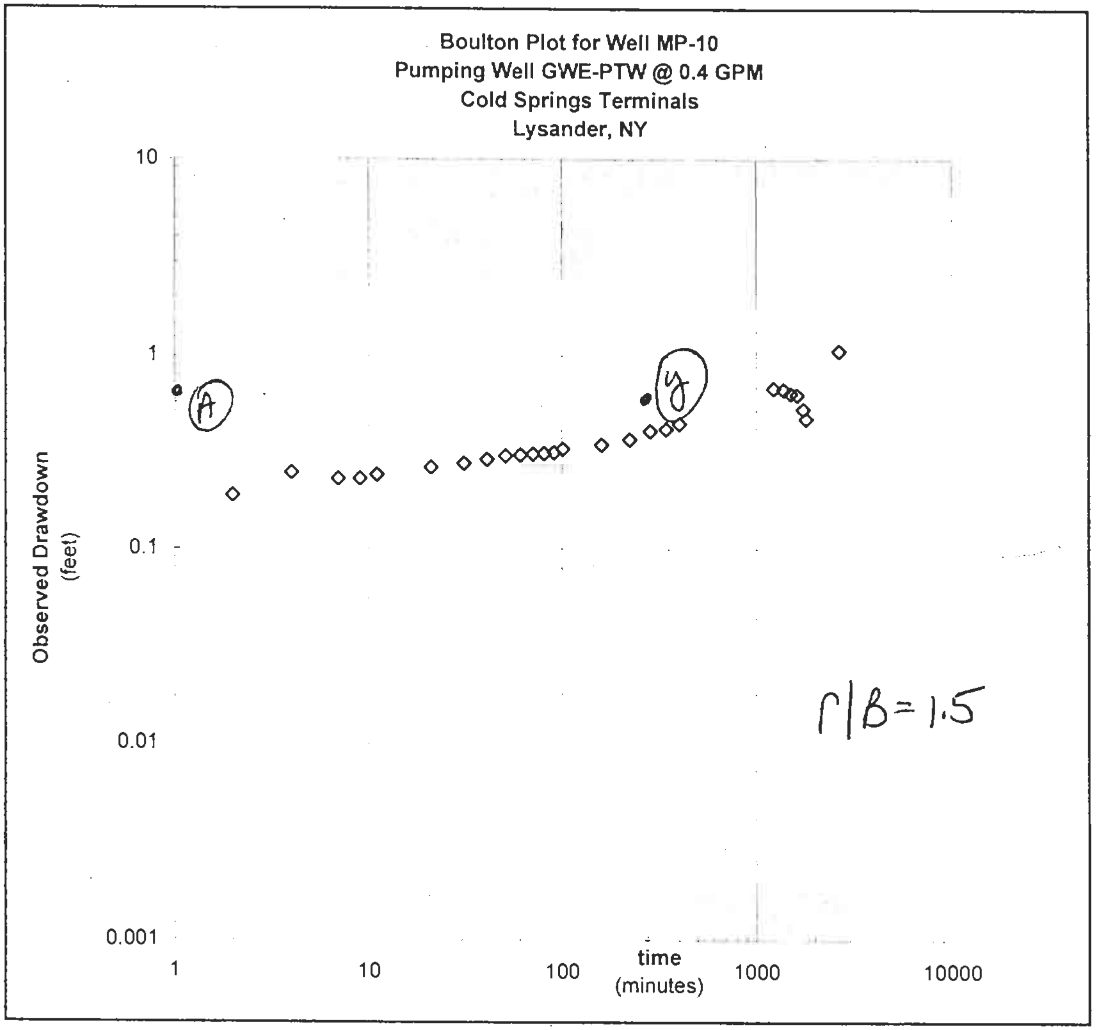
$\gamma = 1 + \dfrac{S_y}{S_A} = 1 + \dfrac{0.3649}{0.0025} = 146.9$

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well MP-10

Time	DTW	Corr DTW	Corr DD
0	11.08	11.08	0.00
2	11.27	11.27	0.19
4	11.33	11.33	0.25
7	11.31	11.31	0.23
9	11.31	11.31	0.23
11	11.32	11.32	0.24
21	11.34	11.35	0.27
31	11.35	11.36	0.28
41	11.36	11.37	0.29
51	11.37	11.39	0.31
61	11.37	11.39	0.31
71	11.37	11.39	0.31
81	11.37	11.40	0.32
91	11.37	11.40	0.32
101	11.38	11.41	0.33
161	11.38	11.43	0.35
225	11.38	11.45	0.37
285	11.40	11.49	0.41
345	11.39	11.50	0.42
405	11.40	11.53	0.45
1,235	11.37	11.77	0.69
1,385	11.31	11.76	0.68
1,505	11.24	11.73	0.65
1,625	11.19	11.72	0.64
1,745	11.05	11.62	0.54
1,805	10.97	11.56	0.48
2,675	11.28	12.15	1.07

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



Early Match Pt Ⓐ: S=0.6 ft
t = 1 MIN

LATE Match Pt Ⓨ:
s = 0.55 ft.
t = 280 MIN

r/B = 1.5
r = 10 ft
b = 12 ft

$w(u_A, r/B) = 1$
$1/u_A = 1$
$w(u_y, r/B) = 1$
$1/u_y = 1$

Boulton Calculations

well MP-10

Early Ⓐ: $$T = \frac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \frac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.6\,\text{ft})}(1) = \frac{77\ \text{ft}^3/\text{d}}{7.536\ \text{ft}}$$

$$T = 10.22\ \text{ft}^2/\text{d}$$

$$T = Kb \Rightarrow K = T/b = \frac{10.22\ \text{ft}^2/\text{d}}{12\ \text{ft}} = 0.85\ \text{ft}/\text{d} = 3.0\times10^{-4}\ \text{cm/sec}$$

$$S_A = \frac{u_A 4Tt}{r^2} = \frac{(1)(4)(10.22\ \text{ft}^2/\text{d})(0.0007)}{10^2\ \text{ft}} = \frac{0.0286}{100} = 0.00029$$

Late ⓨ: $$T = \frac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \frac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.55\,\text{ft})}(1) = \frac{77\ \text{ft}^3/\text{d}}{6.908\ \text{ft}} =$$

$$T = 11.15\ \text{ft}^2/\text{d}$$

$$T = Kb \Rightarrow K = T/b = \frac{11.15\ \text{ft}^2/\text{d}}{12} = 0.93\ \text{ft}/\text{d} = 3.3\times10^{-4}\ \text{cm/sec}$$

$$S_y = \frac{u_y 4Tt}{r^2} = \frac{(1)(4)(11.15)(0.19)}{10^2} = \frac{8.67}{100} = 0.08672$$

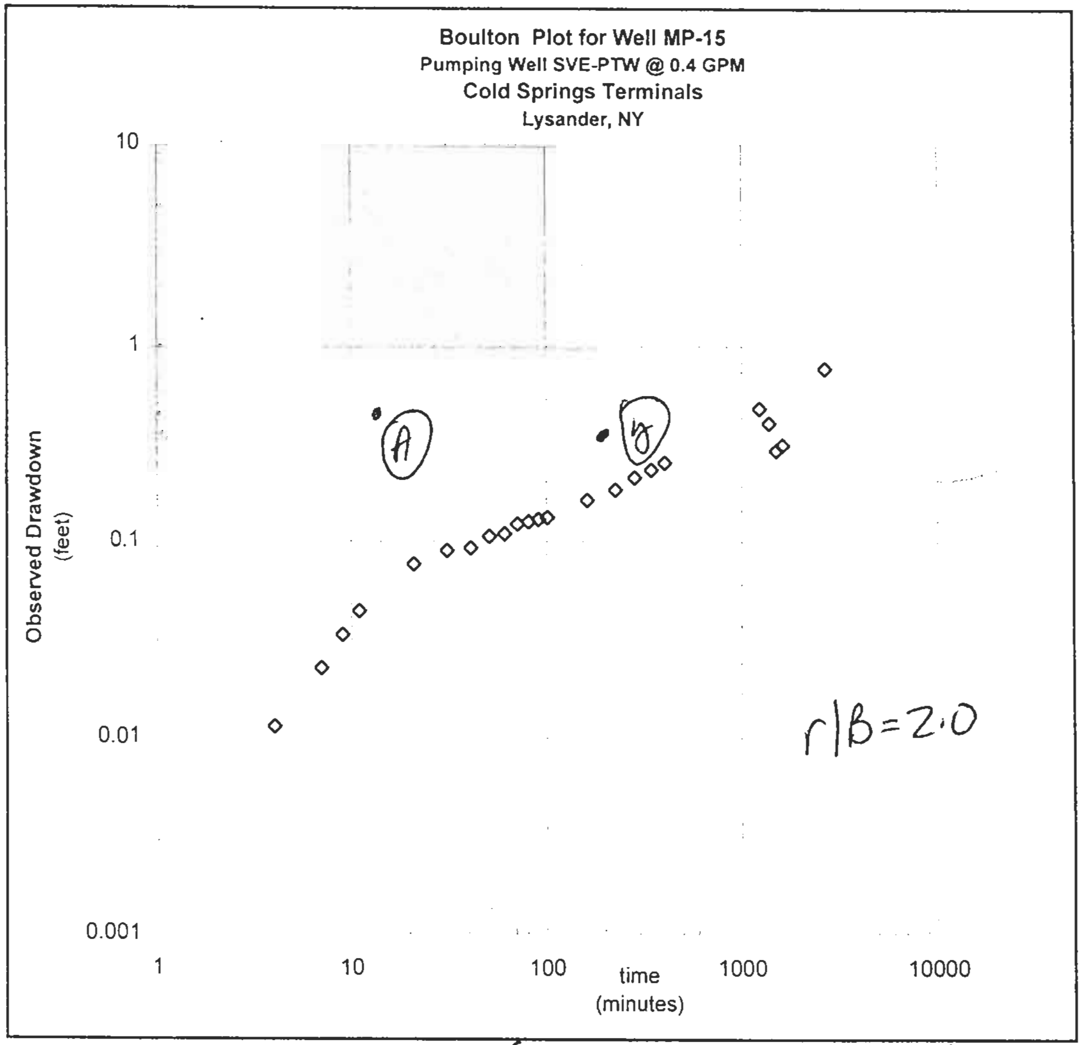
$$\eta = 1 + \frac{S_y}{S_A} = 1 + \frac{0.08672}{0.00029} = 300$$

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well MP-15

Time	DTW	Corr DTW	Corr DD
0	10.67	10.67	0.00
2	10.67	10.67	0.00
4	10.68	10.68	0.01
7	10.69	10.69	0.02
9	10.70	10.70	0.03
11	10.71	10.71	0.04
21	10.74	10.75	0.08
31	10.75	10.76	0.09
41	10.75	10.76	0.09
51	10.76	10.78	0.11
61	10.76	10.78	0.11
71	10.77	10.79	0.12
81	10.77	10.80	0.13
91	10.77	10.80	0.13
101	10.77	10.80	0.13
161	10.78	10.83	0.16
225	10.78	10.85	0.18
285	10.79	10.88	0.21
345	10.79	10.90	0.23
405	10.79	10.92	0.25
1,235	10.75	11.15	0.48
1,385	10.62	11.07	0.40
1,505	10.47	10.96	0.29
1,625	10.45	10.98	0.31
1,745	10.03	10.60	
1,805	10.04	10.63	
2,675	10.57	11.44	0.77

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



Early Match Pt. Ⓐ: $s = 0.45$ ft
$t = 15$ MIN

Late Match Pt ⓨ:
$s = 0.35$ ft
$t = 200$ MIN

$r/B = 2.0$
$r = 15.3$ ft
$b = 12$ ft

$W(u_A, r/B) = 1$
$1/u_A = 1$
$W(u_y, r/B) = 1$
$1/u_y = 1$

Boulton Calculations
Well MP-15

Early Ⓐ: $\frac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \frac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.45\ \text{ft})}(1) = \frac{77\ \text{ft}^3/\text{d}}{5.652}$

$T = 13.6\ \text{ft}^2/\text{d}$

$T = Kb \Rightarrow K = T/b = \frac{13.6\ \text{ft}^2/\text{d}}{12\ \text{ft}} = 1.13\ \text{ft/d} = 4.0 \times 10^{-4}\ \text{cm/sec}$

$S_A = \frac{u_A 4Tt}{r^2} = \frac{(1)(4)(13.6)(0.0104)}{15.3^2} = \frac{0.56576}{234.09} = 0.0024$

Late ⓨ: $T = \frac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \frac{77\ \text{ft}^3/\text{d}}{4(3.14)(0.35\ \text{ft})}(1) = \frac{77\ \text{ft}^3/\text{d}}{4.396\ \text{ft}}$

$T = 17.5\ \text{ft}^2/\text{d}$

$T = Kb \Rightarrow K = T/b = \frac{17.5\ \text{ft}^2/\text{d}}{12\ \text{ft}} = 1.46\ \text{ft/d} = 5.1 \times 10^{-4}\ \text{cm/sec}$

$S_y = \frac{u_y 4Tt}{r^2} = \frac{(1)(4)(17.5)(0.1389)}{15.3^2} = \frac{9.723}{234.09} = 0.0415$

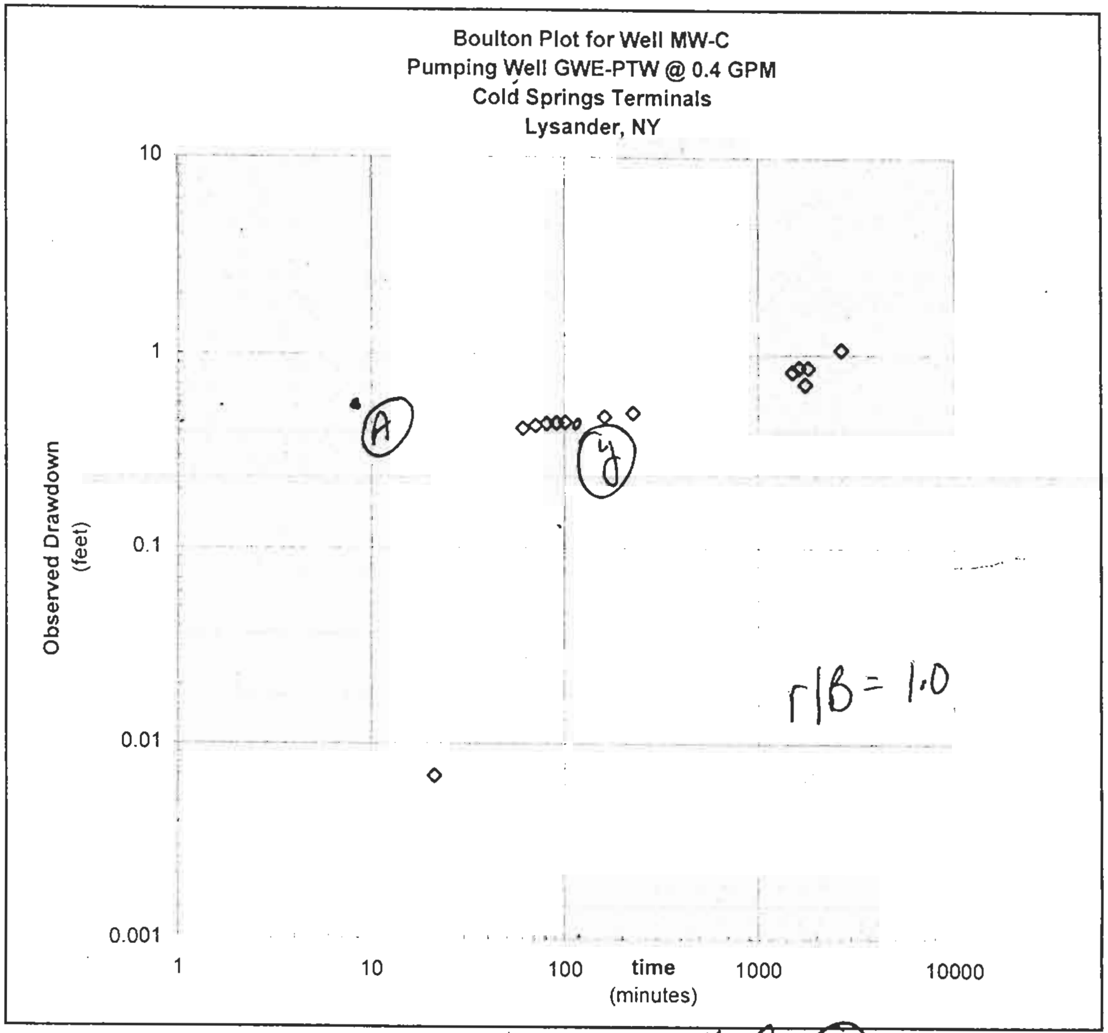
$\gamma = 1 + \frac{S_y}{S_A} = 1 + \frac{0.0415}{0.0024} = 18.3$

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well MW-C

Time	DTW	Corr DTW	Corr DD
0	11.17	11.17	0.00
21	11.17	11.18	0.01
31	11.16	11.17	
41	11.16	11.17	
51	11.15	11.17	
61	11.57	11.59	0.42
71	11.58	11.60	0.43
81	11.59	11.62	0.45
91	11.59	11.62	0.45
101	11.59	11.62	0.45
161	11.60	11.65	0.48
225	11.60	11.67	0.50
1,505	11.50	11.99	0.82
1,625	11.50	12.03	0.86
1,745	11.31	11.88	0.71
1,805	11.44	12.03	0.86
2,675	11.36	12.23	1.06

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



$r/b = 1.0$

$r = 41.5$ ft

$b = 12$ ft

$W(u_A, r/B) = 1$

$1/u_A = 1$

$W(u_y, r/B) = 1$

$1/u_y = 1$

Early Match Pt Ⓐ: $s = 0.58$ ft
$t = 8.5$ MIN

LATE Match Pt Ⓨ: $s = 0.45$ ft
$t = 110$ MIN

BoulTON CalculaTIONS
Well MW-C

Early Ⓐ: $T = \frac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \frac{77\ ft^3/d}{4(3.14)(0.58\ ft)}(1) = \frac{77\ ft^3/d}{7.2848}$

$T = 10.6\ ft^2/d$

$T = Kb \Longrightarrow K = T/b = \frac{10.6\ ft^2/d}{12\ ft} = 0.88\ ft/d = 3.1 \times 10^{-4}$ cm/sec

$S_A = \frac{u_A 4Tt}{r^2} = \frac{(1)(4)(10.6)(0.0059)}{41.5^2\ ft} = \frac{0.25}{1722.25} = 0.000145$

LaTE ⓨ: $T = \frac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \frac{77\ ft^3/d}{4(3.14)(0.45)}(1) = \frac{77\ ft^3/d}{5.652}$

$T = 13.6\ ft^2/d$

$T = Kb \Longrightarrow K = T/b = \frac{13.6\ ft^2/d}{12\ ft} = 1.13\ ft/d = 4.0 \times 10^{-4}$ cm/sec

$S_y = \frac{u_y 4Tt}{r^2} = \frac{(1)(4)(13.6)(0.0764)}{41.5^2\ ft} = \frac{4.1562}{1722.25} = 0.0024$

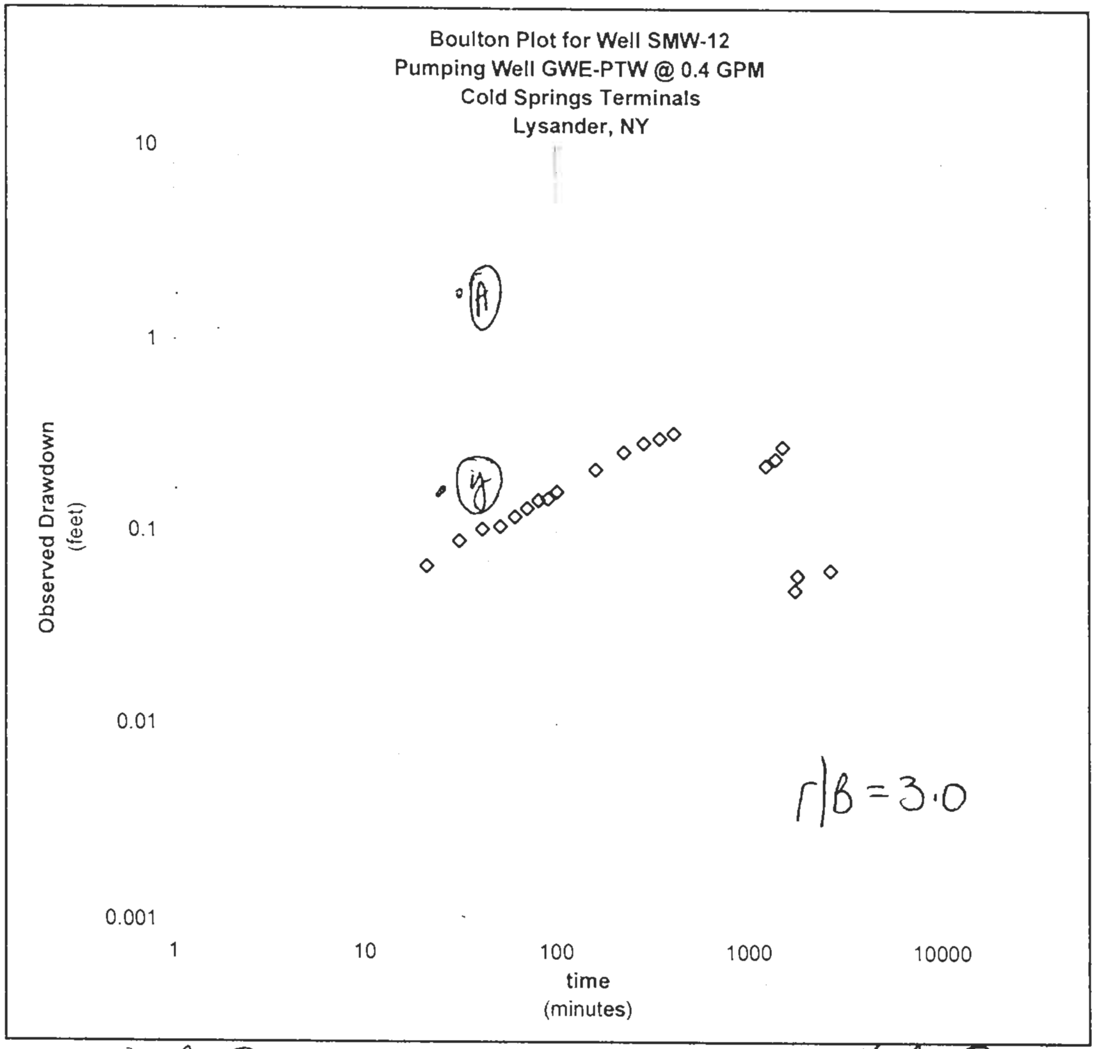
$\eta = 1 + \frac{S_y}{S_A} = 1 + \frac{0.0024}{0.000145} = 17.6$

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Well SMW-12

Time	DTW	Corr DTW	Corr DD
0	9.89	9.89	0.00
21	9.95	9.96	0.07
31	9.97	9.98	0.09
41	9.98	9.99	0.10
51	9.98	10.00	0.11
61	9.99	10.01	0.12
71	10.00	10.02	0.13
81	10.01	10.04	0.15
91	10.01	10.04	0.15
101	10.02	10.05	0.16
161	10.05	10.10	0.21
225	10.08	10.15	0.26
285	10.09	10.18	0.29
345	10.09	10.20	0.31
405	10.09	10.22	0.33
1,235	9.71	10.11	0.22
1,385	9.68	10.13	0.24
1,505	9.68	10.17	0.28
1,745	9.37	9.94	0.05
1,805	9.36	9.95	0.06
2,675	9.08	9.95	0.06

Data corrected for average recharge of 0.0003267 ft/min observed in wells BMW-1, BMW-2, BMW-3, BMW-4, BMW-7, BMW-8, BMW-9, AMW-7, SMW-2, SMW-3, SMW-6, SMW-7, SMW-9 and SMW-10 during pilot testing activities.



$r/B = 3.0$

$r = 44.5$ ft

$B = 12$ ft

$w(u_A, r/B) = 1$

$1/u_A = 1$

$w(u_y, r/B) = 1$

$1/u_y = 1$

Early Match Pt Ⓐ: $s = 1.8$ ft
$t = 33$ min

Late Match Pt ⓨ:
$s = 0.16$ ft
$t = 26$ min

BoulTON CalculaTIONS

Well SMW-12

Early Ⓐ: $T = \frac{Q}{4\pi s}\left(W(u_A, r/B)\right) = \frac{77 \text{ ft}^3/d}{4(3.14)(1.8)}(1) = \frac{77 \text{ ft}^3/d}{22.608}$

$T = 3.4 \text{ ft}^2/d$

$T = Kb \Rightarrow K = T/b = \frac{3.4 \text{ ft}^2/d}{12 \text{ ft}} = 0.28 \text{ ft}/d = 1.0 \times 10^{-4} \text{ cm/sec}$

$S_A = \frac{u_A 4Tt}{r^2} = \frac{(1)(4)(3.4)(0.0229)}{44.5^2} = \frac{0.3144}{1980.25} = 0.00016$

LaTE ⓨ: $T = \frac{Q}{4\pi s}\left(W(u_y, r/B)\right) = \frac{77 \text{ ft}^3/d}{4(3.14)(0.16)}(1) = \frac{77 \text{ ft}^3/d}{2.0096 \text{ ft}}$

$T = 38.3 \text{ ft}^2/d$

$T = Kb \Rightarrow K = T/b = \frac{38.3}{12} = 3.19 \text{ ft}/d = 1.1 \times 10^{-3} \text{ cm/sec}$

$S_y = \frac{u_y 4Tt}{r^2} = \frac{(1)(4)(38.3)(0.01806)}{44.5^2} = \frac{2.767}{1980.25} = 0.0014$

$\eta = 1 + \frac{S_y}{S_A} = 1 + \frac{0.0014}{0.00016} = 9.8$

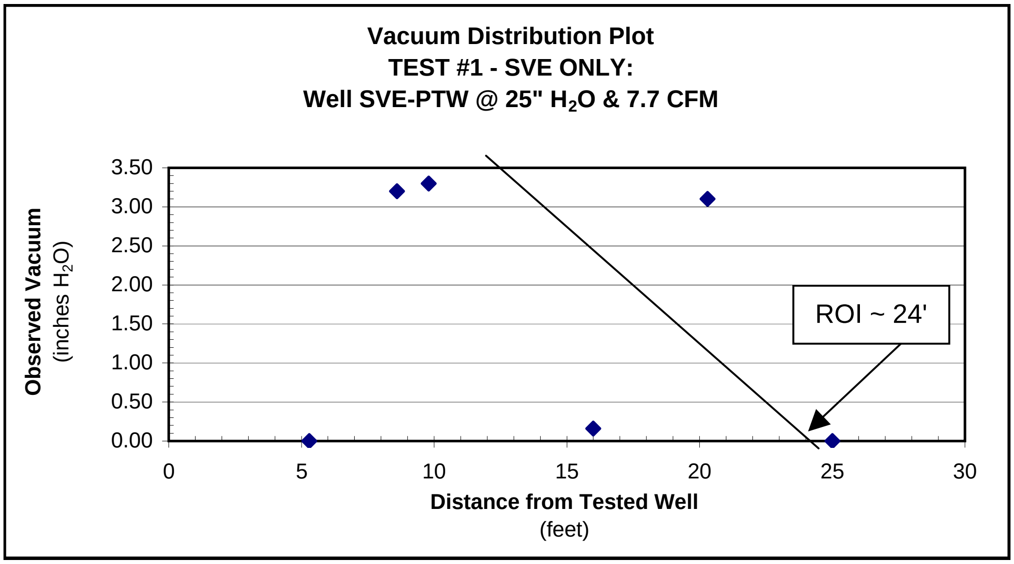
SVE COMPONENT

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE-PTW
Vacuum @ Wellhead: 25" H_2O (1.8" Hg)
Flow Rate from well: 7.7 CFM
Bleed Air (2"): 8,150 FPM; 179.3 CFM
Blower Effluent (4"): 2,150 FPM; 187 CFM
Effluent PID: 257 PPM

Observation Point	Distance	Observed Vacuum
GWE-PTW	5.3	0.00
MP-5	8.6	3.20
MP-10	9.8	3.30
BMW-14	16.0	0.16
MP-15	20.3	3.10
SB-25	25.0	0.00

SVE Only

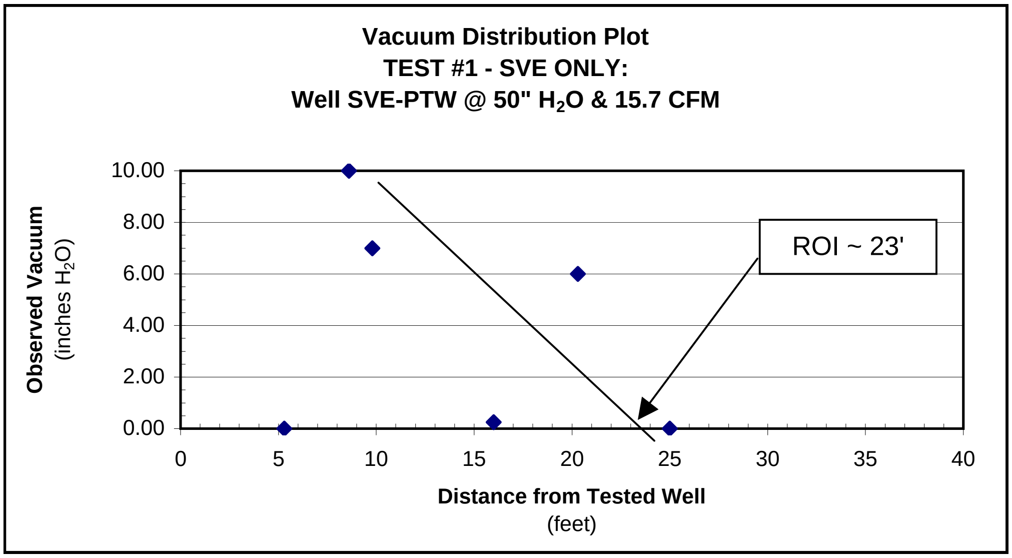


Test Date: 11/2/04

Tested Well: SVE-PTW
Vacuum @ Wellhead: 50" H_2O (3.7" Hg)
Flow Rate from well: 15.7 CFM
Bleed Air (2"): 7,710 FPM; 169.6 CFM
Blower Effluent (4"): 2,130 FPM; 185.3 CFM
Effluent PID: 396 PPM

Observation Point	Distance	Observed Vacuum
GWE-PTW	5.3	0.00
MP-5	8.6	10.00
MP-10	9.8	7.00
BMW-14	16.0	0.25
MP-15	20.3	6.00
SB-25	25.0	0.00

SVE Only



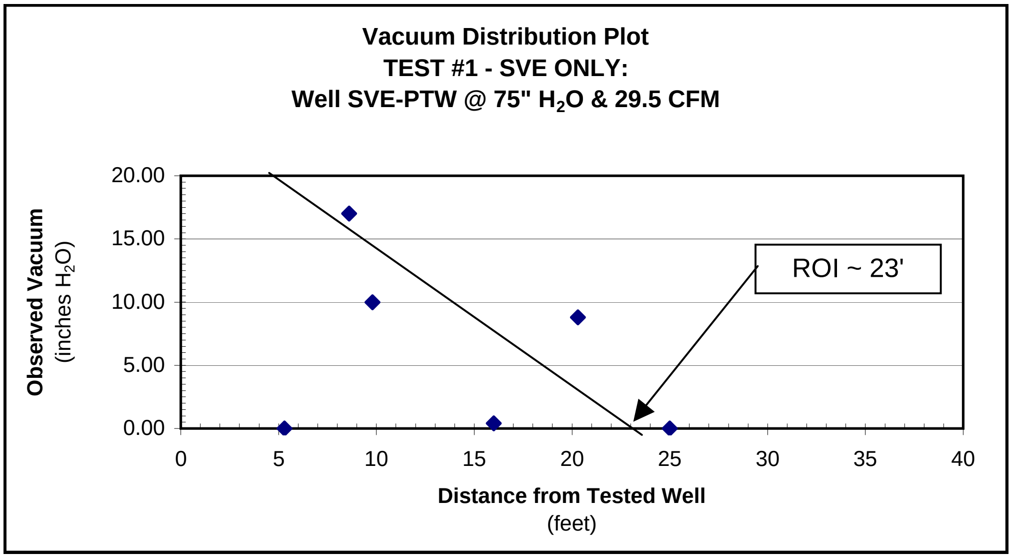
Test Date: 11/2/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE-PTW
Vacuum @ Wellhead: 75" H_2O (5.5" Hg)
Flow Rate from well: 29.5 CFM
Bleed Air (2"): 6,490 FPM; 142.8 CFM
Blower Effluent (4"): 1,980 FPM; 172.3 CFM
Effluent PID: 437 PPM

Observation Point	Distance	Observed Vacuum
GWE-PTW	5.3	0.00
MP-5	8.6	17.00
MP-10	9.8	10.00
BMW-14	16.0	0.40
MP-15	20.3	8.80
SB-25	25.0	0.00

SVE Only



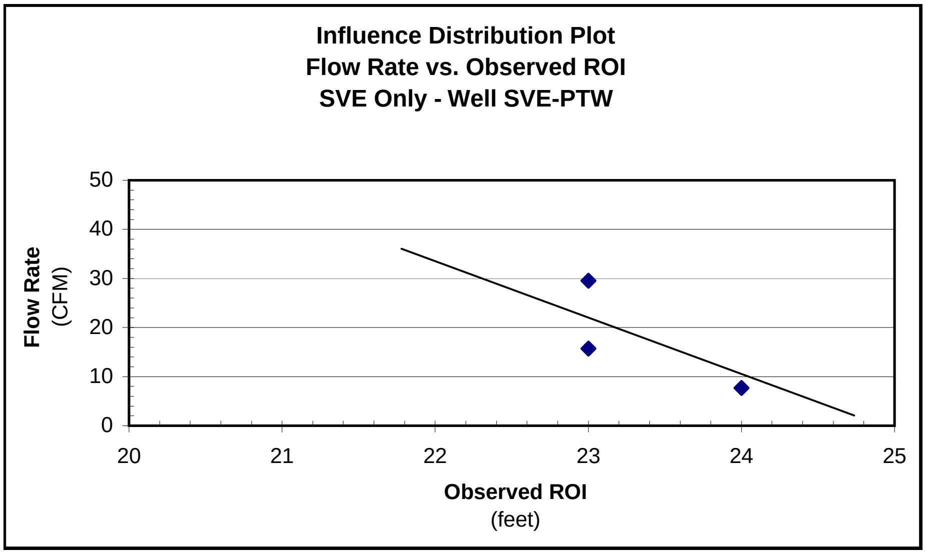
Test Date: 11/2/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE - PTW

Vacuum	Flow Rate	Observed ROI
25	7.7	24
50	15.7	23
75	29.5	23

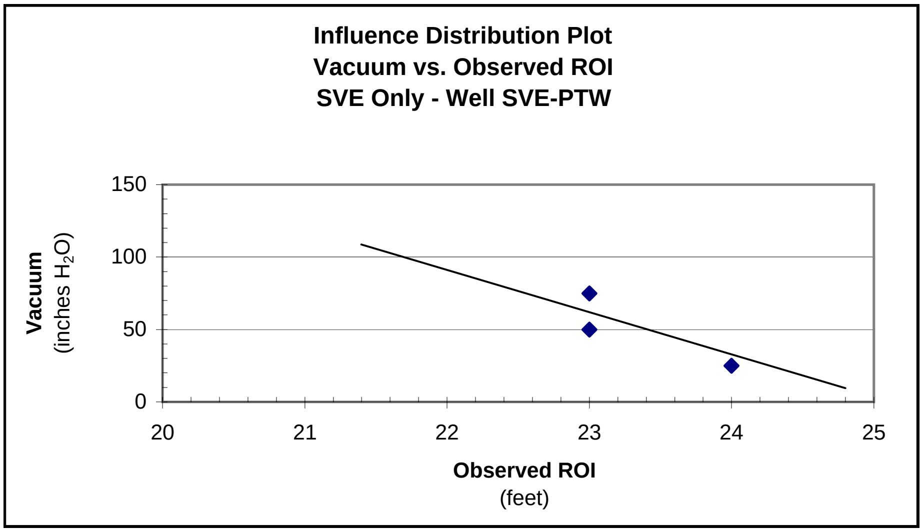
SVE Only



Test Date: 11/2/04

Vacuum	Flow Rate	Observed ROI
25	7.7	24
50	15.7	23
75	29.5	23

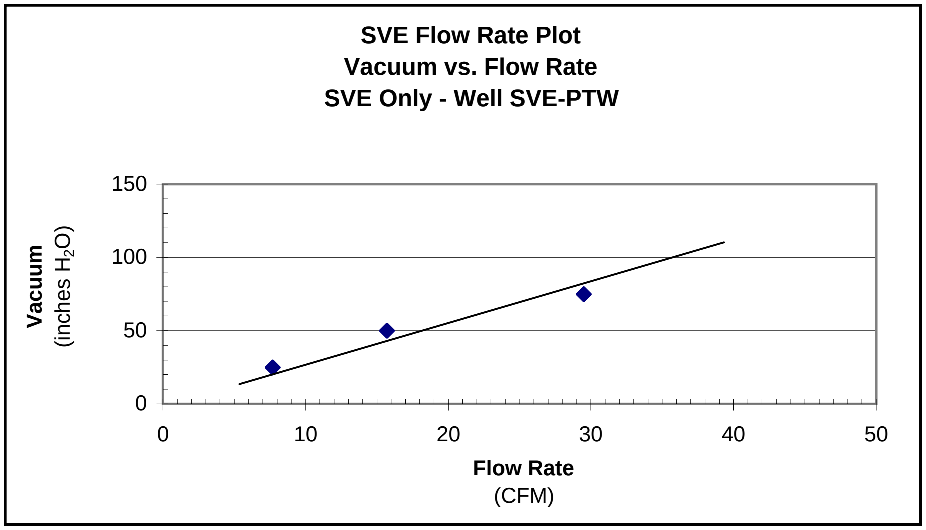
SVE Only



Test Date: 11/2/04

Vacuum	Flow Rate	Observed ROI
25	7.7	24
50	15.7	23
75	29.5	23

SVE Only



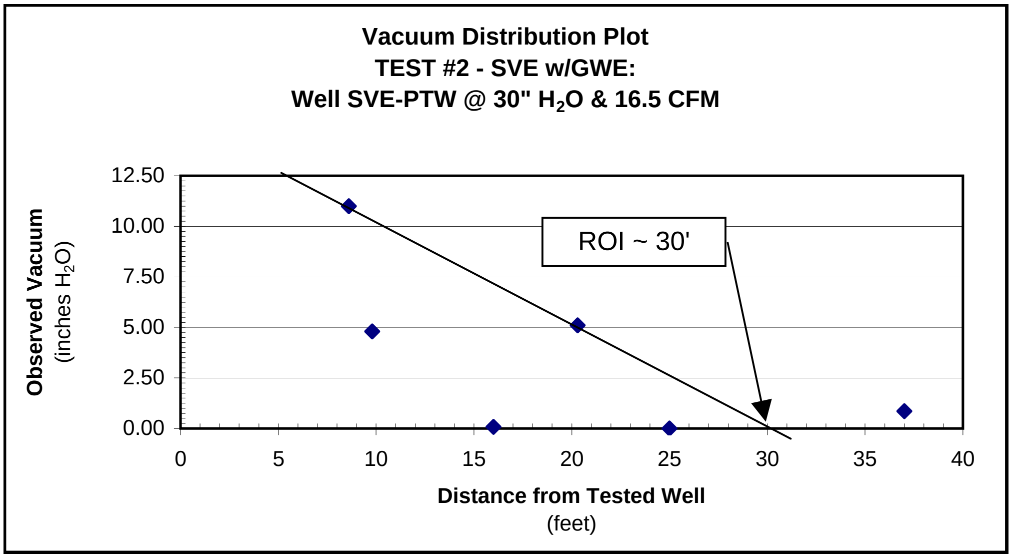
Test Date: 11/2/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE-PTW
Vacuum @ Wellhead: 30" H_2O (2.2" Hg)
Flow Rate from well: 16.5 CFM
Bleed Air (2"): 6,073 FPM; 133.6 CFM
Blower Effluent (4"): 1,725 FPM; 150.1 CFM
Effluent PID: 265 PPM

Observation Point	**Distance**	**Observed Vacuum**
MP-5	8.6	11.00
MP-10	9.8	4.80
MP-15	20.3	5.10
BMW-14	16.0	0.08
MW-C	37.0	0.85
SB-25	25.0	0.00

SVE w/GWE

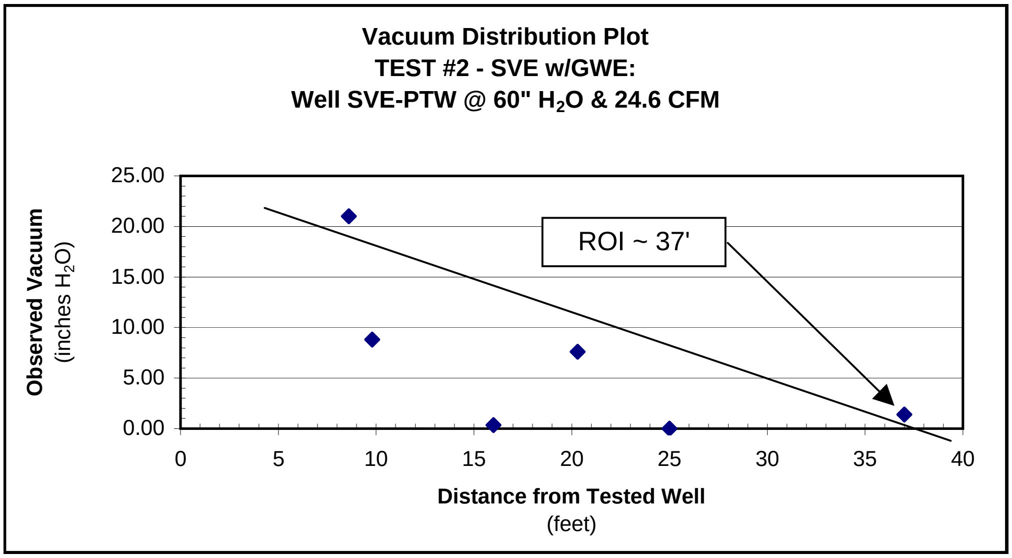


Test Date: 11/4/04

Tested Well: SVE-PTW
Vacuum @ Wellhead: 60" H_2O (4.4" Hg)
Flow Rate from well: 24.6 CFM
Bleed Air (2"): 5,880 FPM; 129.4 CFM
Blower Effluent (4"): 1,770 FPM; 154 CFM
Effluent PID: 349 PPM

Observation Point	**Distance**	**Observed Vacuum**
MP-5	8.6	21.00
MP-10	9.8	8.80
MP-15	20.3	7.60
BMW-14	16.0	0.35
MW-C	37.0	1.40
SB-25	25.0	0.00

SVE w/GWE



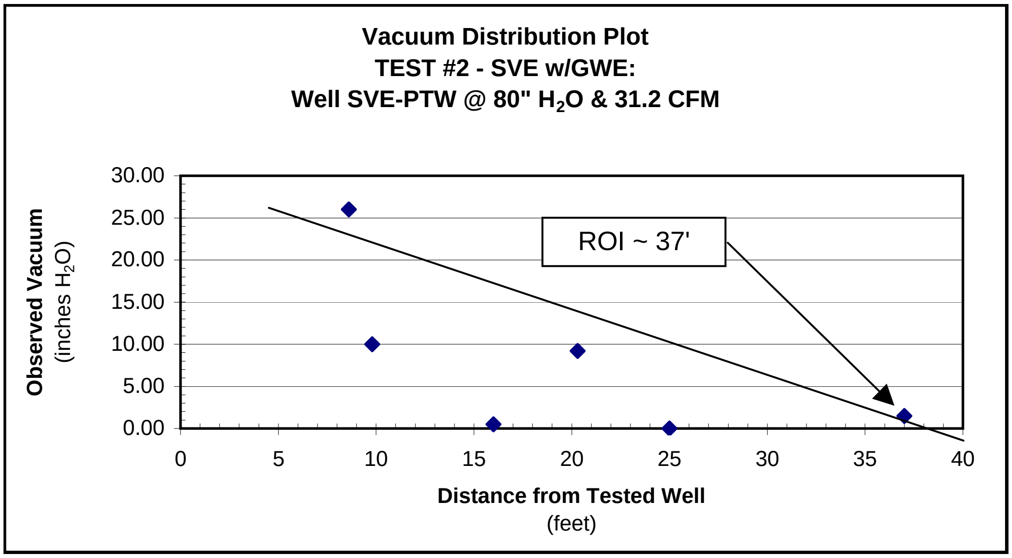
Test Date: 11/4/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE-PTW
Vacuum @ Wellhead: 80" H_2O (5.9" Hg)
Flow Rate from well: 31.2 CFM
Bleed Air (2"): 4,950 FPM; 108.9 CFM
Blower Effluent (4"): 1,610 FPM; 140.1 CFM
Effluent PID: 418 PPM

Observation Point	Distance	Observed Vacuum
MP-5	8.6	26.00
MP-10	9.8	10.00
MP-15	20.3	9.20
BMW-14	16.0	0.50
MW-C	37.0	1.50
SB-25	25.0	0.00

SVE w/GWE



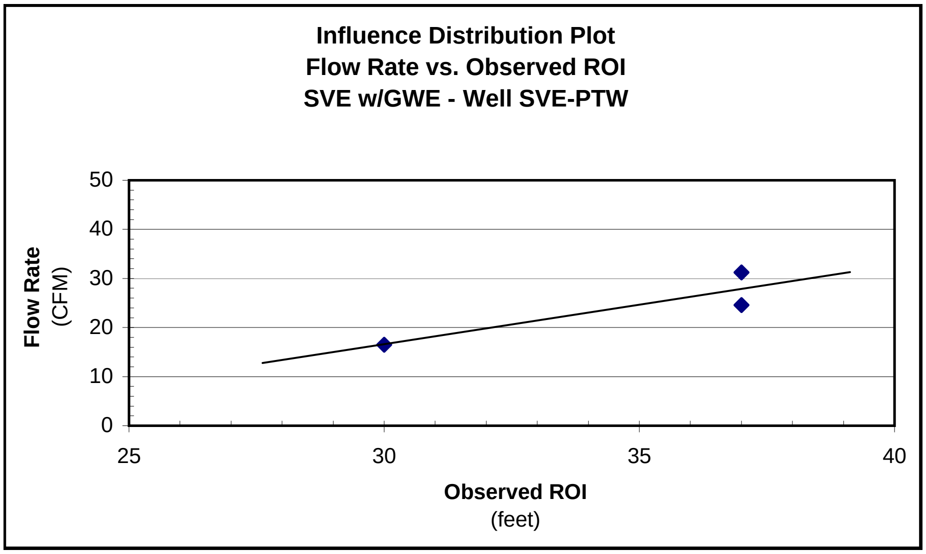
Test Date: 11/4/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Tested Well: SVE - PTW

Vacuum	Flow Rate	Observed ROI
30	16.5	30
60	24.6	37
80	31.2	37

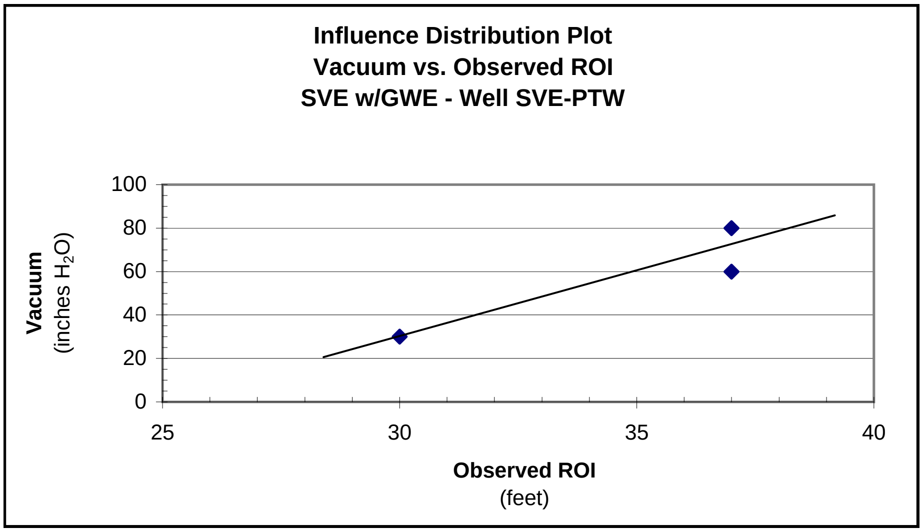
SVE w/GWE



Test Date: 11/4/04

Vacuum	Flow Rate	Observed ROI
30	16.5	30
60	24.6	37
80	31.2	37

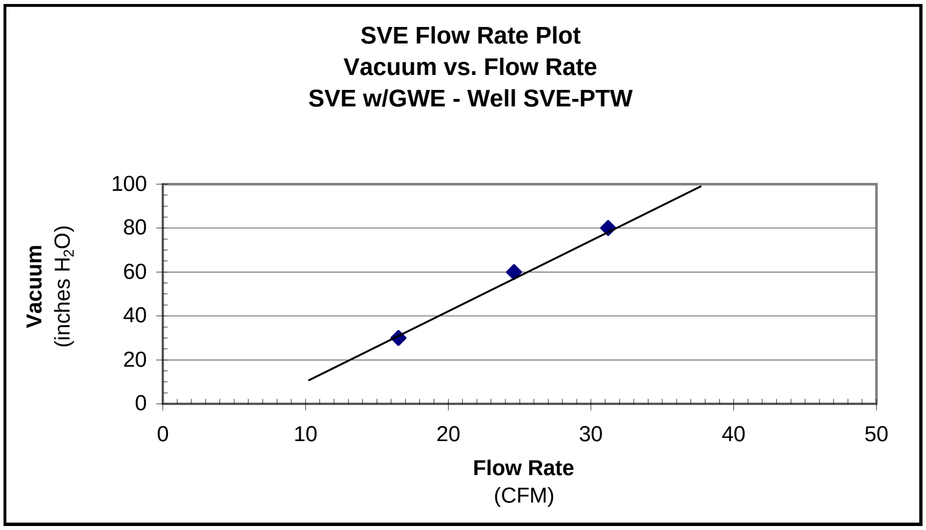
SVE w/GWE



Test Date: 11/4/04

Vacuum	Flow Rate	Observed ROI
30	16.5	30
60	24.6	37
80	31.2	37

SVE w/GWE



Test Date: 11/4/04

Data Collected During the Pilot Test
Cold Springs Terminals
Lysander, New York
NYSDEC Spill No. 89-04923; PIN No. 99528

Test Type	**Wellhead Vacuum**	**SVE System Flow Rate**			**SVE System Effluent**			
					Discharge	**VOC Recovery**		
		fpm	**cfm**	**m^3/day**	**ppm**	**mg/m^3**	**g/day**	**lbs/day**
SVE ONLY	25	2,150	188	7,649	257	952.61	7,286.91	16.0676
	50	2,130	186	7,578	396	1467.84	11,123.63	24.5276
	75	1,980	173	7,045	437	1619.81	11,410.86	25.1609
SVE w/GWE	30	1,725	151	6,137	265	982.27	6,028.46	13.2928
	40	1,780	155	6,333	300	1112.00	7,042.27	15.5282
	60	1,770	154	6,297	349	1293.63	8,146.49	17.9630
	80	1,610	140	5,728	418	1549.39	8,875.11	19.5696
						Stack Diameter:	4	inches