ALTERNATIVES ANALYSIS REPORT
CRUSHER ROAD SITE
NYSDEC ERP SITE NO. B00185-03
TOWN OF BEDFORD, NEW YORK

Prepared For

Town of Bedford

March 2012

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March 30, 2012

Mr. John Benvegna
Leggette, Brashears & Graham, Inc.
110 Corporate Park Drive, Suite 112
White Plains, NY 10604

RE: Alternatives Analysis Report
Crusher Road Site
NYSDEC ERP Site No. B00185-03
Town of Bedford, New York

Dear Mr. Benvegna:

LBG Engineering Services, P.C. (LBGES) was retained by Leggette, Brashears & Graham, Inc. to review the above-referenced Alternative Analysis Report for consistency with applicable regulatory requirements. The review has been completed and the following certification is provided:

I, William K. Beckman, certify that I am currently a NY State registered professional engineer as defined in 6 NYCRR Part 375 and that this Alternatives Analysis Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Very truly yours,

LBG ENGINEERING SERVICES, P.C.

William K. Beckman

STATE OF NEW YORK
WILLIAM KARL BECKMAN
063219-1
LICENSED PROFESSIONAL ENGINEER

William K. Beckman, P.E.
President

WKB:cmm
cc: NYSDEC
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TOWN OF BEDFORD, NEW YORK

INTRODUCTION

Scope and Purpose

The following remedial Alternatives Analysis (AA) is being completed on behalf of the Town of Bedford, New York by Leggette, Brashears & Graham, Inc. (LBG) for the Crusher Road Site, New York State Department of Environmental Conservation (NYSDEC) Environmental Restoration Program Site No. B00185-03 (the Site). A Remedial Investigation (RI) completed in June 2011 identified contamination on and off the Site that requires remedial action to protect public health and the environment. The investigation results were presented in a Draft Remedial Investigation Report (RIR) submitted in September 2011. The AA is being completed to identify potential remedial alternatives for the Site and affected offsite areas, and to determine those considered most appropriate for meeting Remedial Action Objectives (RAOs).

The AA is a preliminary step in the development of a Record of Decision (ROD) which, based on the AA, will select the final remedial alternatives for the Site. The RAOs for any final remedy implemented at the Site are to be protective of public health and the environment, given the intended Site use. The ability of alternatives to meet the RAOs is determined by an evaluation against various screening criteria. The selected remedy will be one which, to the extent practicable, best meets the screening criteria.

Site History

A complete site history is presented in the RIR and is incorporated herein by reference. The following is a brief summary of that information.

The Site is located on Crusher Road off New York State (NYS) Route 22 in the Town of Bedford, Westchester County, New York (figure 1). The Site is situated on property owned by the Town of Bedford and consists of three parcels totaling 13.1 acres. For the past

50 years, the Town has used the property as a satellite storage area for the Town Highway Department.

Adjacent to the Site on three sides is a 102-acre parcel of undeveloped land owned by Old Post Holdings LLC. This property was formerly the site of a gravel mining operation. It is undeveloped with the exception of six man-made ponds that were created when the former gravel pits filled with groundwater (figure 2). Several environmental investigations, including one completed by the NYSDEC in 2001, showed the presence of the solvent tetrachloroethylene (PCE) (also known as perchloroethylene) in groundwater samples collected from the Crusher Road site and the southwest portion of the Old Post Holdings property. The investigations indicate that the Crusher Road site was the likely source.

The Crusher Road Site was accepted into the State Environmental Restoration Program (ERP) in June 2003 and the Site was designated Site No. B00185-03. The adjacent Old Post Holdings property is considered an impacted, offsite property and is referred to hereafter as "offsite".

Geology and Hydrogeology

A complete description of site geology and hydrogeology is presented in the RIR and is incorporated herein by reference. The following is a summary of that information.

The Town of Bedford, including the Site and adjacent offsite property, lie in the Manhattan Prong of the New England physiographic province. The Site is located within the Mianus River Valley and is approximately 750 feet west of the Mianus River. The offsite property is bounded by the river along its eastern property line. The Mianus River flows to the north and is the main drainage feature for the drainage basin within which both the Site and offsite properties lie.

The unconsolidated sediments beneath the Site and offsite areas are glacial in origin and consist primarily of stratified drift. Onsite drilling activities confirmed the unconsolidated material is comprised primarily of fine sand with some silt and gravel. Previous investigations indicate these sediments can be as much as 100 feet thick. Bedrock beneath the Site is mapped as the Fordham Gneiss and the depth to bedrock ranges between 40 and 100 ft bg (feet below grade). Groundwater beneath the Site occurs in both the unconsolidated glacial sediments and the underlying bedrock. The depth to groundwater on and offsite ranges between 3 and 23 ft bg.

The direction of groundwater flow is southeast towards the Mianus River (figure 3). The Mianus River is a topographic low point with grade elevations at 350 feet msl (mean sea level), according to the USGS topographic quadrangle map for Mount Kisco, New York (figure 1). Land surface elevations on either side of the river are higher relative to the river, indicating that groundwater on both sides flows towards it, and that the river is a groundwater discharge point. This is confirmed by groundwater elevation data from the RI, which show an upward groundwater gradient at the river. Groundwater elevations measured in Well Cluster CW-5 during the RI ranged between 353.14 and 353.34 feet msl, which are slightly more than 3 feet above the elevation of the river. Well Cluster CW-5 is approximately 100 feet from the river and the groundwater flow gradient across the site ranged between 0.01 and 0.004 feet per foot (figure 3). Using this data, the groundwater elevation at the river was extrapolated to be no more than a foot lower then what was measured in the wells at CW-5, which was still 2 feet above the river elevation of 350 feet. An upward gradient at the river confirms groundwater from both sides of the river is converging at and discharging to the river, and that the river is a hydraulic barrier.

NATURE AND EXTENT OF CONTAMINATION

The Crusher Road RI was completed in two phases between 2007 and 2011. The purpose of the RI was to define the nature and extent of contamination beneath the Site and the adjacent offsite property, and to provide sufficient data for the development of remedial alternatives. The scope of the RI included the following:

- soil and groundwater sampling;
- surface water and sediment sampling;
- potable well sampling;
- indoor air and sub-slab vapor sampling;
- monitor well installation and formation sampling;

- water level monitoring and permeability testing; and
- fish and wildlife resource assessment.

The RI results were presented in a draft report dated September 2011. The report was conditionally approved by the NYSDEC on December 12, 2011. A summary of detected contaminants of concern by media is presented in table 1. Based on the RI results, the nature and extent of contamination is defined as follows.

Soil

Soil sampling results confirmed the presence of a source area on the Crusher Road Site and that PCE is the primary contaminant of concern. PCE was detected in 5 out of 20 samples (from 20 locations) at concentrations ranging from 8 to 1,100 ug/kg (micrograms per kilogram). These 5 samples were collected from between 0 and 8 ft bg, which was the top of the water table, from 5 different borings. None of the detected PCE concentrations exceeded the 6 NYCRR part 375-6.8 Unrestricted Use Soil Cleanup Objectives (SCOs) or the Protection of Groundwater SCOs (see table below). In addition, none of the known PCE degradation products, trichloroethylene (TCE), cis-1,2 dichloroethylene (DCE) or vinyl chloride (VC) were detected in any of the samples.

Although PCE was not detected above the SCOs, the results indicate a PCE source area onsite. Considering the initial release was between 10 and 20 years old at the time of the sampling, it is expected that concentrations in the soil have decreased over that time. The 5 borings in which PCE was detected are located within close proximity to each other, in an area that measures approximately 50 x 25 feet or 1,250 sq. ft. (square feet) [figure 4]. PCE was not detected in soil samples from any of the 15 borings immediately upgradient and downgradient of that area. These results are consistent with historical groundwater data which show PCE concentrations downgradient of this area, but not upgradient. No other contaminants of concern including semivolatile organics, metals, pesticides or polychlorinated biphenols (PCBs) were identified in the source area. The table below summarizes contaminant of concern detections in the soil during the RI.

Contaminants of Concern	Concentration Range Detected (ug/kg)	Unrestricted Use SCO (ug/kg)	Unrestricted Use SCO Exceedances	Protection of Groundwater SCO (ug/kg)	Protection of Groundwater SCO Exceedances
PCE	Not Detected – 1,100	1,300	0 out of 20	1,300	0 out of 20
TCE	Not Detected	470	0 out of 20	470	0 out of 20
DCE	Not Detected	250	0 out of 20	250	0 out of 20
VC	Not Detected	20	0 out of 20	20	0 out of 20

ug/kg – micrograms per kilogram
SCO – Soil Cleanup Objective 6 NYCRR Part 375 Subpart 375-6

Groundwater

Based on the RI results, the dissolved groundwater contaminant plume extends approximately 900 feet east–southeast from the source area to the Mianus River and ranges between 150 and 450 feet wide. Vertically the plume extends to the bottom of the unconsolidated aquifer, which in the area of investigation ranges between 40 and 95 ft bg. In general the highest concentrations occur within 300 feet of the source area, between 20 and 60 ft bg, and they decrease with distance. Concentrations detected in three samples, collected onsite in 2008 from vertical profile borings, exceeded 1,500 ug/l (micrograms per liter), which is 1-percent of the aqueous solubility of PCE (table 2). These results indicate the potential that Dense Non-Aqueous Phase Liquids (DNAPLs) may be present in the sediments below the water table in those areas. The greatest potential for occurrence, based on the vertical profiling data, is between 10 and 20 ft bg (5-15 feet below the water table) within the source area, which covers approximately 1,250 sq. ft.

In comparison to historical monitor well data, the vertical and horizontal distribution of monitor well detections in 2011 was consistent and the PCE concentrations were lower. Wells which were not contaminated in previous sampling events have remained unaffected and the highest concentrations have been detected in the same wells and at the same depths (table 3). Several impacted wells do show new occurrences or increased concentrations of breakdown products TCE, DCE and VC, which is consistent with the natural degradation of PCE.

Groundwater samples from two bedrock wells within the plume (C-180 and B-110) show no impact to the underlying bedrock aquifer. In addition, groundwater samples collected from three residential supply wells, located on the east side of the Mianus River, showed no impact from PCE or any of its degradation products. As a result, site contaminants are not believed to have migrated beyond the Mianus River, which as stated is a hydraulic barrier with groundwater on both sides flowing towards and discharging to it. These data indicate that the plume has maintained its general location along the southern end of the offsite property, east–southeast of the source area (figure 5).

The table below summarizes contaminant of concern detections in groundwater during the RI. Two geologic cross sections showing PCE concentrations in groundwater through the plume area are presented on figures 6, 7 and 8.

Contaminants of Concern	Concentration Range Detected (ug/l)	GWQS (ug/l)	Frequency Exceeding GWQS
PCE	Not Detected – 4,100	5	49 out of 136 or 36%
TCE	Not Detected – 100	5	9 out of 136 or 6.6%
DCE	Not Detected – 27	5	5 out of 136 or 3.7%
VC	Not Detected – 8	2	1 out of 136 or 0.7%

ug/l – micrograms per liter
GWQS – Groundwater Quality Standard

Surface Water and Sediments

As shown in the summary tables below, neither PCE nor any of its degradation products were detected in surface water or sediment samples collected from the Mianus River and 5 ponds on the downgradient offsite property.

Surface Water

Contaminants of Concern	Concentration Range Detected (ug/l)	SWQS or Guidance (ug/l)	Frequency Exceeding SWQS or Guidance
PCE	Not Detected	1	0 out of 6
TCE	Not Detected	5	0 out of 6
DCE	Not Detected	5	0 out of 6
VC	Not Detected	0.3	0 out of 6

ug/l – micrograms per liter
SWQS – Surface Water Quality Standard

Sediments

Contaminants of Concern	Concentration Range Detected (ug/kg)	Unrestricted Use SCO (ug/kg)	Unrestricted Use SCO Exceedances	Protection of Ecological Resources SCO (ug/kg)	Protection of Ecological Resources SCO Exceedances (ug/kg)
PCE	Not Detected	1,300	0 out of 6	2,000	0 out of 6
TCE	Not Detected	470	0 out of 6	2,000	0 out of 6
DCE	Not Detected	250	0 out of 6	No Standard	NA
VC	Not Detected	20	0 out of 6	No Standard	NA

ug/kg – micrograms per kilogram
SCO – Soil Cleanup Objective 6 NYCRR Part 375 Subpart 375-6

Soil Vapor

As shown in the summary table below, neither PCE nor any of its degradation products were detected in the indoor air or sub-slab vapor samples collected during the RI from the on-site DPW Garage building. This is consistent with the fact that the building is located upgradient of the source area. No other buildings currently exist onsite or on the adjacent offsite property.

Contaminants of Concern	Concentration Range Detected (ug/m^3)	NYSDOH Indoor Air Guidance Value (ug/m^3)	Frequency Exceeding Guidance Value
PCE	Not Detected	100	0 out of 3
TCE	Not Detected	5	0 out of 3
DCE	Not Detected	No Standard or Guidance	Not Applicable
VC	Not Detected	No Standard or Guidance	Not Applicable

ug/m^3 - micrograms per cubic meter

REMEDIAL ACTION OBJECTIVES

RAOs are specific clean-up objectives for the purpose of ensuring the protection of public health and the environment from contaminated media. The objectives are developed based on applicable Standards, Criteria and Guidance (SCGs) for the contaminated media at the Site. The SCGs used in development of the RAOs for this site include the following:

- 6 NYCRR Part 375, Subpart 375-6 Remedial Program Soil Cleanup Objectives;
- 6 NYCRR Part 703 Surface Water and Groundwater Quality Standards;
- NYSDEC Division of Water Technical and Operational Guidance Series 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998;
- NYSDEC DER-10/Technical Guidance for Site Investigation and Remediation, May 3, 2010;
- NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006; and,
- NYSDEC DER-15/Presumptive/Proven Remedial Technologies, February 27, 2007.

Based on the results of the RI performed at the Site and the identified SCGs, the following RAOs have been identified for this Site.

Soil

RAOs for Public Health Protection

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of or exposure to, contaminants volatilizing from contaminated soil.

RAOs for Environmental Protection

- Prevent migration of contaminants that would result in groundwater or surface water contamination.
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain.
- Remove/treat to the extent practicable residual PCE source material in onsite soil below the water table to mitigate ongoing impacts to groundwater.

Soil Vapor

RAOs for Public Health Protection

- Prevent inhalation of or exposure to, contaminants volatilizing from contaminated soil or groundwater.
- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at a site.

Groundwater

RAOs for Public Health Protection

- Mitigate to the extent practicable potential human exposure pathways for groundwater containing site related contaminants at concentrations exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

RAOs for Environmental Protection

- Remediate the groundwater aquifer, to the extent practicable, to comply with applicable SCGs by reducing the concentrations of residual PCE and associated breakdown products.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

REMEDIAL ALTERNATIVES

This section lists and describes several potential remedial alternatives available for the contaminated media identified onsite and offsite, based on the stated RAOs and applicable SCGs. This includes presumptive and proven remedial technologies for the contaminants of concern and site conditions per NYSDEC DER-15/Presumptive/Proven Remedial Technologies, February 27, 2007. Presumptive/proven technologies are those which have been proven to be feasible and cost effective for the type of site and contaminants in question.

Onsite

- No Action;
- Institutional Controls;
- Engineered Controls; and,
- Monitored Natural Attenuation (MNA).

No Action

The No Action alternative would consider no further measures to remediate, control or monitor impacted soil or groundwater onsite. Applicable guidance requires that the No Action alternative be considered as a baseline option. For the unsaturated soils this is a viable alternative as there were no SCG exceedances. For soil below the water table and groundwater, this option would not be consistent with the RAOs for the protection of public health and the environment.

Institutional Controls

Institutional controls would include administrative measures in the form of deed restrictions, zoning changes and/or environmental easements. These measures would limit future land use options and restrict groundwater use to prevent human exposure to affected media. As the Site is a Town owned property implementing institutional controls is a viable option. Institutional controls would be consistent with the RAOs for the protection of human health, but not with those for protection of the environment as they do not remove or treat the contamination. As a result they would not reduce contaminant toxicity, mobility or volume.

Engineered Controls

Engineered controls include designed remedies geared towards physical removal and/or treatment of impacted media to reduce contaminant mass. Some engineered options for the Site include soil excavation with offsite treatment and disposal, groundwater pump and treat, air sparging with soil vapor extraction and, insitu chemical and/or biological treatment. These options either transfer the contaminant mass from one media to another allowing for ex situ treatment, or treat the contamination insitu. Removing and/or reducing contaminant mass is consistent with site RAOs for the protection of public health and the environment. All of the above remedies are presumptive/proven remedial technologies.

Monitored Natural Attenuation (MNA)

MNA combines comprehensive monitoring with natural contaminant degradation. Under this alternative, contaminants are allowed to attenuate or degrade over time through various naturally occurring chemical, physical or biological processes without any human interaction to reduce contaminant mass. The ability of this approach to be effective is dependent on the nature of the contaminants and having environmental conditions conducive to natural degradation. Because MNA does not involve any active remediation, it is generally not considered an effective strategy for addressing source area contamination. MNA is most effective at remediating residual contamination once the contaminant source has been removed or remediated by other means.

Offsite

- No Action;
- Engineered Controls; and,
- Monitored Natural Attenuation (MNA).

Institutional Controls are not being considered for an offsite alternative as the NYSDEC has indicated they will not endorse a remedy that includes institutional controls on the offsite property.

No Action

As with onsite, the No Action alternative would consider no further measures to remediate, control or monitor impacted groundwater offsite. Applicable guidance requires that the No Action alternative be considered as a baseline option. Considering offsite groundwater contains contaminant concentrations above applicable SCGs, this option would not be consistent with the RAOs for the protection of public health and the environment.

Engineered Controls

Engineered controls include designed remedies geared towards physical removal and/or treatment of impacted media to reduce contaminant mass. Some options under this alternative for offsite include groundwater pump and treat, air sparging with soil vapor extraction and treatment and, insitu chemical and/or biological treatment. Removing and/or reducing contaminant mass is consistent with Site RAOs for the protection of public health and the environment. All of the above remedies are presumptive/ proven remedial technologies.

Monitored Natural Attenuation

MNA for offsite would be the same as that described above for onsite. Data from the RI suggests that natural contaminant degradation is occurring in offsite groundwater and there are no source areas on the offsite property.

ALTERNATIVES ANALYSIS

This section evaluates the identified remedial alternatives against the criteria below for determining effectiveness and implementability for onsite and offsite.

- protection of human health and the environment;
- applicable standards, criteria and guidance (SCG);
- short-term effectiveness and impacts;
- long-term effectiveness and permanence;
- reduction of toxicity, mobility or volume;
- implementability/cost effectiveness; and,
- current and future land use.

Remedial actions that are not deemed technically or practicably feasible, or which are not consistent with the Site RAOs will be eliminated from further evaluation. Those remedial actions that are determined to be most appropriate for the remedial action objectives and Site conditions will be retained and considered for final alternative selection. Both the Site and adjacent offsite property are zoned residential, although neither is currently used for that purpose. The potential future use of both sites for residential development will be considered in the evaluation. The RI identified onsite soil below the water table and groundwater and offsite groundwater as media containing contaminants of concern above applicable SCGs.

Onsite

No Action

Under the No Action response alternative, no additional work would be undertaken to improve soil or groundwater quality. While shallow soil in the source area is in compliance with applicable criteria, deeper soils and groundwater are not. The potential presence of DNAPL in the saturated soil onsite means there could be a continuing source of impact to onsite and offsite groundwater, which is a source of water supply in this area. Relative to the screening criteria, this alternative would not be protective of human health or the environment and would not be compliant with SCGs, which require source removal and treatment. Some reduction of toxicity, mobility and volume may occur naturally over the long-term. However, based on the historical and current contaminant concentrations as presented in the RI, this would not be a very effective long-term solution. As a result, this option would not be compliant with the Site RAOs.

Institutional Controls

Onsite Institutional Controls including zoning changes, deed restrictions and/or environmental easements would prevent human exposure to impacted soil and groundwater onsite. However, similar to the No Action alternative, this option would do nothing to eliminate or treat the source of contamination, which has impacted an offsite property, and therefore would not result in any significant reduction of toxicity, mobility or volume. As a result, this option would not be protective of the environment which is not consistent with the Site RAOs.

Engineered Controls

Engineered Controls identified for onsite include soil excavation with offsite treatment and disposal, groundwater pump and treat, air sparging with soil vapor extraction and, insitu chemical and/or biological treatment. As presumptive/proven remedial technologies they have essentially been pre-screened against the criteria noted above for determining effectiveness and implementability. As a result these remedies would be consistent with the site RAOs. Due to certain site specific conditions however, some of these technologies may be more technically feasible then others. Soil contamination onsite potentially exists in the form of DNAPL at depths between 10 and 20 ft bg (5-15 feet below the water table) over an area of approximately 1,250 sq. ft. Excavation of this material would require shoring and dewatering to depths greater then the anticipated excavation depth of 20 feet. Dewatering would have to include onsite treatment and disposal of pumped groundwater and would be a continuous, 24-hour per day operation for the duration of the excavation.

Onsite groundwater contamination is present at depths of up to 85 feet below the water table (90 ft bg) with some of the higher concentrations between 55 and 75 feet below the water table. Soil vapor extraction alone is not an effective remedy for saturated soils, which is where there is a potential for DNAPL on this site. Air sparging for groundwater treatment is known to have limited effectiveness at depths greater than 50 feet below the water table. There is also a risk that air sparging could push contaminated groundwater, and possibly DNAPL, into areas currently not impacted. Forcing high pressure air through the formation could cause groundwater mounding, pushing groundwater against the natural gradient. Careful spacing of sparging points and limiting the air injection pressures would mitigate the potential for these conditions to occur, but could also limit the systems effectiveness.

Insitu Chemical Oxidation would be expected to cause a temporary increase in dissolved contaminant concentrations as it degrades the potential DNAPL source and the primary dissolved contaminant, PCE. The increased dissolved concentrations would move down gradient with the direction of groundwater flow. Generally a second Chemical Oxidation treatment and or bioremediation, which provides longer term treatment, are employed to address concentration increases from the initial treatment.

Monitored Natural Attenuation

As stated above, MNA combines comprehensive monitoring and natural contaminant degradation without any human interaction. However, the potential for the presence of DNAPL and the high contaminant concentrations onsite constitute a continuing source. Applicable SCGs require the removal and/or treatment to the extent practicable of source area contamination including DNAPL. As a result, MNA alone would not be an effective remedial strategy for onsite contamination and would not be compliant with site RAOs or SCGs.

Offsite

No Action

Under the No Action response alternative, no additional work would be undertaken to improve groundwater quality or address plume migration. Due to the potential use of offsite groundwater for potable supplies and the potential for plume migration, this alternative would not be protective of human health or the environment based on the current contaminant concentrations. Historical groundwater data show that contaminant concentrations have declined over the last 15 years. However, contaminant concentrations in offsite groundwater are still well above standards in some locations, indicating that No Action is not an effective long-term strategy under the current conditions.

Engineered Controls

Engineered Controls identified for offsite include groundwater pump and treat, air sparging with soil vapor extraction and, insitu chemical and/or biological treatment. As presumptive/proven remedial technologies, these technologies have been pre-screened against the criteria noted above for determining effectiveness and implementability and would be consistent with the RAOs for this site. Due to certain site specific conditions however, some of these technologies may be more technically feasible then others. Offsite groundwater contamination is present at depths of up to 85 feet below the water table with some of the higher concentrations occurring in wells between 60 and 80 feet deep. As stated previously, air sparging for groundwater treatment has limited effectiveness at depths greater then 50 feet below the water table. As a result, air sparging with soil vapor extraction would not be technically appropriate for addressing residual offsite groundwater contamination. The offsite area is also currently undeveloped with no existing infrastructure and the area of the plume is located within a Town Regulated wetland buffer zone. In addition this property is owned and controlled by a third party. These conditions would make construction of an engineered remedy such as a pump and treat system challenging.

Monitored Natural Attenuation

MNA combines comprehensive monitoring and natural contaminant degradation without any human interaction. Historical data and data from the RI, including decreasing PCE concentrations and the presence of the breakdown products TCE, DCE and VC, suggest that natural contaminant degradation is occurring in offsite groundwater. This is further supported by the presence of indicator parameters including methane, sulfate, nitrate, iron and carbon dioxide, which were detected in offsite groundwater during the RI (table 4). A comparison of plume data from 1999 and 2011 (figure 5) also shows that the plume's position has not changed significantly over the last 13 years. These data indicate that once the PCE source area on the Site is remediated, offsite conditions are conducive to MNA and natural degradation of residual contamination in groundwater.

REMEDIAL ALTERNATIVES ASSESSMENT

This section presents specific remedial alternatives and costs for onsite and offsite media based on the alternatives analysis above and the ability of the various options to meet the screening criteria including; protection of human health and the environment; compliance SCGs; short-term effectiveness and impacts; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume of contaminated material; implementability; cost effectiveness and land use. All present worth costs assume a 2-percent discount factor and implementation of the remedies in 2013.

Alternative I – No Action

Onsite and Offsite – No Action

Cost Estimate:

Capital Costs:	$	0
Monitoring Costs:	$	0
Alternative I Total Cost:	**$**	**0**
Present Worth Cost	**$**	**0**

In accordance with applicable guidance, evaluation of the No Action Alternative is required as a baseline alternative. Under this alternative no action would be taken onsite or offsite to remove or treat source area contamination or impacted groundwater.

Evaluation

This alternative would not offer any protection of human health or the environment and would not be compliant with site RAOs. Over the long-term this alternative may reduce contaminant toxicity, mobility, and volume. However, monitoring would be necessary to verify natural attenuation is occurring. In addition, without active remediation of the source area, it is unlikely that a reduction of contaminant mass to acceptable levels would be achieved naturally in the near future, given the current concentrations. No action makes this alternative easily implementable and while there are no associated costs or short-term impacts, it would not be considered an effective remedy as no action would be taken to prevent future exposures or impacts. This alternative is also not likely to receive community acceptance as it does not provide any protection of public health or the environment.

Alternative II – Insitu Chemical Oxidation/Bioremediation/Monitored Natural Attenuation

Onsite Remedy

Soil and Groundwater: Insitu chemical oxidation and bioremediation applied via multi-level injection; 5 years of semiannual post treatment groundwater monitoring.

Offsite Remedy

Groundwater: MNA with 5 years of semiannual groundwater monitoring.

Cost Estimate:

Capital Costs:	$ 250,000
Monitoring Costs:	$ 175,000 ($35,000 per year for 5 years)
Alternative II Total Cost:	**$ 425,000**
Present Worth Cost:	**$ 414,107**

Alternative II combines Insitu Chemical Oxidation (ISCO) and Bioremediation for on-site treatment of soil and groundwater, with MNA for offsite groundwater. ISCO uses chemicals to destroy and degrade contaminants through reduction and oxidation, or redox reactions, which result in the transfer of electrons from one chemical to another. These reactions break carbon bonds and degrade organic compounds into different and smaller compounds. The ISCO treatment would target the higher concentration contaminants including any potential DNAPL that may be present in the source area soil. Following the ISCO treatment would be a bioremediation "polish" treatment designed to reduce contaminant concentrations to below regulatory levels. Post treatment and MNA monitoring would include semiannual groundwater sampling of select wells for site contaminants and MNA indicator parameters. The purpose of the monitoring would be to confirm treatment effectiveness and that onsite and offsite RAOs are being met.

For the ISCO portion of the alternative, the oxidizing agent would be RegenOx™ which is a proprietary solution of sodium percarbonate compound with a ferrous salt activator, embedded in a micro-scale catalyst gel manufactured by Regenesis. This system has very high activity and is capable of treating a broad range of soil and groundwater contaminants including chlorinated solvents like PCE. The percarbonate would be applied in a grid pattern through direct, multi-depth injections into the source area and surrounding formation by a Geoprobe or similar direct push method. This method would allow the treatment to be directly applied, vertically and horizontally, to the areas of highest contaminant concentration. The injections are anticipated to take between one and two weeks to complete. The ISCO treatment would be applied in two rounds between two and three months apart.

Approximately three months following the final ISCO treatment, one round of bioremediation injections would be applied to the same treatment area. The bioremediation product is also manufactured by Regenesis and is called 3-D MicroEmulsion. This product relies on the insitu metabolism of lactic acid, polylactate esters and fatty acid esters to degrade contaminants by reductive dechlorination through long-term electron donor release. Unlike the ISCO process, the 3-D MicroEmulsion product is self propagating enabling it to remain active and providing treatment for as long as three years. Following two rounds of ISCO treatments, the long-term activity of the 3-D MicroEmulsion is expected to reduce onsite contaminant concentrations to below regulatory levels within 5 years. This would be verified through 5 years of semiannual post remediation groundwater monitoring. A schematic diagram of an ISCO/ Bioremediation system is included in the Appendix.

The offsite portion of this alternative includes 5 years of MNA. Data from the RI suggests that conditions are favorable for natural degradation and that it is in fact occurring offsite. Treatment of the onsite source area is expected to eliminate the continuing source of contamination to offsite groundwater. In addition, the onsite ISCO and bioremediation treatments are expected to migrate onto the offsite property in groundwater, as the contamination did, providing some offsite treatment in the vicinity of the Site. The MNA would include semiannual sampling of select wells for site contaminants and MNA indicator parameters including but not limited to methane, dissolved oxygen and carbon dioxide.

Evaluation

Alternative II would be compliant with site RAOs as it provides for treatment of source area contamination and impacted groundwater and a reduction in toxicity, mobility and volume. The combination of ISCO and bioremediation would have minimal short-term environmental impact and no human exposure as all treatment is insitu and the direct push technology is minimally invasive. The ISCO and bioremediation injections would be completed over a period of six months. Long-term permanence is expected to result through the reduction of contaminant concentrations to below regulatory levels within 5 years. This alternative is also considered cost effective as onsite soil (below the water table) and groundwater would be treated simultaneously with the same method as opposed to having separate technologies for each media. Capital costs would be low as it does not require the purchase and installation of treatment equipment. Consequently, there would not be any ongoing equipment operation and maintenance costs. This option would also be easily implementable as it is minimally invasive and would not require the installation of any permanent wells, equipment or infrastructure to support the remedy onsite or offsite. This is expected to be viewed positively by the community as the adjacent offsite property is currently undeveloped and contains wetlands throughout the affected area. This alternative also would not require any trucking to remove contaminated material from the site thus minimizing disturbance to the surrounding, largely residential, community.

Alternative III – Insitu Chemical Oxidation and Bioremediation

Onsite Remedy

Soil and Groundwater: Insitu Chemical Oxidation and Bioremediation applied via multi-depth injection; 3 years of semiannual post treatment groundwater monitoring.

Offsite Remedy

Groundwater: Insitu Bioremediation applied via multi-depth injection; 3 years of semiannual post treatment groundwater monitoring.

Cost Estimate

Capital Costs:	$ 350,000
Monitoring Costs:	$ 105,000 ($35,000 per year for 3 years)
Alternative III Total Cost:	**$ 455,000**
Present Worth Cost:	**$ 450,417**

Alternative III is similar to Alternative II, the only difference being that bioremediation would be used as the offsite remedy in place of MNA. The bioremediation product would be the 3-D MicroEmulsion manufactured by Regenesis as described above. Under Alternative III the offsite bioremediation would be applied in conjunction with that for onsite, by the same method, after two onsite ISCO injections. The offsite injection points would be arranged in several, north–south lines orientated perpendicular to the long axis of the groundwater plume and the general direction of plume migration. This would create bioremediation treatment zones along the length of the offsite plume that would degrade contaminants as groundwater and the treatment solution migrate downgradient. As stated above, the 3-D MicroEmulsion product is self propagating and would be actively providing treatment for up to three years. After the treatments are applied, there would be 3 years of post treatment monitoring, onsite and offsite, to confirm the effectiveness of the remedy. A schematic diagram of an ISCO/ Bioremediation system is included in the Appendix.

Evaluation

Alternative III would be similar to Alternative II relative to meeting RAOs, and would also be expected to achieve a reduction of contaminants to below regulatory levels with minimal short-term impacts. However, Alternative III would provide treatment onsite and offsite as opposed to just onsite. As a result, there would be a greater likelihood of achieving acceptable regulatory levels in a shorter time frame offsite (estimated at 3 years). This Alternative would also be considered cost effective for the same reasons as Alternative II. Although the overall cost would be higher, the same treatment would be used for onsite and offsite and the offsite bioremediation would be combined with the onsite treatment, minimizing the additional cost. The end result is a shorter time frame to achieve applicable SCGs. Alternative III is also expected to be viewed favorably by the community as similar to Alternative II, it is easily implementable and provides treatment with minimal disturbance to the environment and surrounding community.

Alternative IV – Source Area Excavation/Insitu Chemical Oxidation and Bioremediation

Onsite Remedy

Soil: Source area dewatering and excavation (to 20 feet); offsite treatment and disposal of soil estimated at 900 tons; onsite treatment and disposal of dewatering effluent via airstripping and carbon filtration.

Groundwater: Insitu chemical oxidation and bioremediation applied via direct application and multi-depth injection; 3 years of semiannual post treatment groundwater monitoring.

Offsite Remedy

Groundwater: Insitu bioremediation applied via multi-depth injection and 3 years of semiannual post treatment groundwater monitoring.

Cost Estimate

Capital Costs: $ 900,000 (assumes classification of excavated soil as hazardous)

Monitoring Costs: $ 105,000 ($35,000 per year for 3 years)

Alternative IV Total Cost: $ 1,005,000

Present Worth Cost: $ 1,000,417

Alternative IV would include excavation and offsite disposal of the onsite source area soils, with ISCO and bioremediation for onsite groundwater and insitu bioremediation for offsite groundwater. The ISCO and bioremediation treatments would be the same as described in Alternatives II and III and would be implemented after excavation of the onsite source area.

The source area excavation would target sediments below the water table where there is a potential for DNAPL to be present. Based on data from the RI, the source area covers approximately 1,250 sq. ft. within a 50 x 25 foot area. The greatest likelihood of DNAPL occurrence is between 5 and 20 ft bg within the source area, which is also up to 15 feet below the water table. Due to the excavation depth, shoring would be required around the excavation perimeter and the area would have to be dewatered to enable removal of the contaminated sediments. The dewatering effluent would be treated onsite prior to disposal due to the contaminants in the groundwater. In order to determine the feasibility of dewatering to the desired depth and provide information for design of the dewatering and treatment systems, a pumping test would be conducted. The pumping test would require installation of a test well in the source area, which could later be used as a dewatering well.

The shoring would be installed with a pneumatic hammer to a depth of approximately 35 ft bg. This is due to the absence of any confining layers at shallower depths into which the bottoms of the shoring could be set. Once the shoring is set, dewatering wells would be installed within the shoring to approximately 35 ft bg. The dewatering wells would discharge to an onsite treatment system that would include airstripping and carbon filtration. Airstripping reduces contaminant mass by transferring the contamination from the liquid phase to the vapor phase. Due to the anticipated contamination levels, airstripping alone is not expected to be able to reduce the contaminants to levels suitable for onsite discharge. As a result the discharge would also be treated by carbon filtration. A schematic diagram of a source area excavation is included in the Appendix.

Once the source area has been dewatered to the desired depth, which would take several days, excavation of the contaminated sediments would begin. Approximately 700 cubic yards of sediments would be excavated and loaded directly onto trucks for offsite treatment and disposal. Due to the nature of the contaminant and the potential for the presence of DNAPL it has been assumed that excavated soil would have to be disposed of as a hazardous waste.

Upon completion of the excavation RegenOx™ ISCO (see Alternative II) would be added directly into the open excavation to treat onsite groundwater. After application of the

ISCO treatment the excavation would be backfilled, the dewatering system shut down and the shoring removed. Approximately two to three months after the ISCO application, onsite and offsite groundwater would be treated with one round of insitu bioremediation as described in Alternatives II and III. The bioremediation would treat groundwater for up to three years after application, degrading contaminants to below regulatory levels. The bioremediation would be followed with 3 years of post treatment, semiannual groundwater monitoring.

Evaluation

Alternative IV would meet site RAOs and would be expected to reduce site contaminants to below regulatory levels compliant with SCGs within 3 years. The excavation portion of the remedy would remove contaminated soil from the source area and treat or dispose of it offsite. Onsite and offsite groundwater would be treated insitu with ISCO and Bioremediation. This is protective of human health and the environment and would result in a reduction of contaminant mass, toxicity and volume. This remedy would have long-term effectiveness and permanence as contaminants would be removed from the site and destroyed insitu over time. In comparison to Alternatives II and III this alternative includes a physical removal and ex-situ portion to address the potential DNAPL in the source area as opposed to insitu treatment.

Alternative IV would not be as easily implementable as Alternatives II and III due to the excavation portion of the remedy. Because of the invasive nature of this option and the need to dewater and treat groundwater, a higher level of effort and coordination would be required to design and implement the remedy. There also would be multiple contractors needed to provide the equipment and labor for pre-design pump testing, shoring, excavating, dewatering, onsite groundwater treatment and, hazardous soil transportation and disposal. For these same reasons Alternative IV also would have a higher degree of short-term environmental impacts and potential for human exposure during implementation of the remedy. The excavation portion of the remedy would cause environmental disturbance onsite and result in bringing potentially hazardous waste and contaminated groundwater to the surface. The handling, transportation and treatment of this material would result in a potential for human exposure during the remedy. These potential exposures would be mitigated to the extent practicable through implementation of a site specific health and safety plan. The higher level of site activity, including increased truck traffic and a 24-hour a day dewatering operation, would also increase the potential for nuisance conditions in the surrounding neighborhood.

The costs for Alternative IV are higher than those for Alternatives II and III due to higher capital costs associated with the design and implementation of the excavation portion of the remedy, and the offsite disposal of potentially hazardous waste. Despite the higher cost, the estimated time frame for achieving SCGs is the same as that for lower cost Alternative III. This is because the excavation portion of the remedy, which accounts for the higher cost, only addresses the onsite source area and does not directly provide any treatment of the offsite groundwater plume.

Alternative V – Source Area Excavation/Groundwater Pump and Treat System

Onsite Remedy

Soil: Source area dewatering and excavation (to 20 feet); offsite treatment and disposal of soil estimated at 900 tons; onsite treatment and disposal of dewatering effluent via airstripping and carbon filtration.

Groundwater: Groundwater extraction and onsite treatment with airstripping and carbon filtration; 5 years of operation and semiannual groundwater monitoring.

Offsite Remedy

Groundwater: Groundwater extraction and treatment with airstripping and carbon filtration, as part of the onsite system; 5 years of operation and semiannual groundwater monitoring.

Cost Estimate

Capital Costs: $ 1,050,000 (assumes classification of excavated soil as hazardous)

Operation & Monitoring Costs: $ 375,000 ($75,000 per year for 5 years)

Alternative V Total Cost: $ 1,425,000

Present Worth Cost: $ 1,401,657

Alternative V would include excavation and offsite treatment of source area soil with a groundwater pump and treat system for treatment of onsite and offsite groundwater and 5 years of operation and monitoring. The source area excavation portion of the remedy would be the same as that described for Alternative IV.

Once the source area excavation is completed a groundwater pump and treat system would be designed and installed. The system would include 3 groundwater extraction wells with one onsite and two offsite. The onsite well would be located downgradient of the former source area and the offsite wells would be located in the vicinity of the "C" and "E" well clusters where offsite groundwater concentrations have historically been highest (table 3, figure 5). The well depths would vary and would target the depth of highest contaminant concentration at each location. Discharge from the extraction wells would be pumped, via below grade piping, to a treatment system located onsite in a shed or other type of temporary structure. Groundwater pumped through the system would be treated by airstripping and carbon filtration before being discharged onsite. The pump and treat system would be designed to operate continuously, 24 hours a day, until the contaminant levels in groundwater are compliant with applicable SCGs. The operation period of the system is anticipated to be 5 years. During operation the system would be checked monthly to perform any necessary maintenance and insure it is operating efficiently. Semiannual groundwater sampling would also be conducted during this period to monitor system effectiveness. A schematic diagram of a pump and treat system is included in the Appendix.

Evaluation

Alternative V would meet site RAOs and would be expected to reduce site contaminants to below regulatory levels compliant with SCGs. The excavation portion of the remedy would remove contaminated soil from the source area and treat and dispose of it offsite. Onsite and offsite groundwater would be treated through extraction and onsite treatment. The extraction wells would also provide a mechanism to control plume migration. This is protective of human health and the environment and would result in a reduction of contaminant mass, toxicity and volume. The remedy also would have long-term effectiveness and permanence as source area contamination would be removed from the site and residual groundwater contamination would be treated onsite over time.

Alternative V would be more difficult to implement then Alternatives II and III due to the excavation portion of the remedy. As described under Alternative IV above, the invasive nature of excavating and the need to dewater and treat groundwater onsite require a higher level of effort and coordination to design and implement the remedy. The pump and treat portion of Alternative V would also make it more difficult to implement in comparison to Alternative IV. This portion of the remedy involves construction of a treatment system and associated infrastructure, onsite and offsite that is expected to operate continuously for approximately 5 years. The offsite property is undeveloped and owned by a third party. The proposed wells would also be located in a wetland buffer zone. As a result, various agreements and approvals would be required to enable construction and operation of the remedy.

Similar to Alternative IV, Alternative V would have a greater short-term environmental impact and potential for human exposure and nuisance conditions during the remedy, in comparison to Alternatives II and III, due to the excavation activities (see discussion above). Alternative V would also have greater short-term impacts then Alternative IV due to construction of a pump and treat system. Construction of the system would include installing equipment and a temporary shed or building onsite and drilling permanent extraction wells onsite and offsite. Access roads would have to be constructed on the currently undeveloped offsite property (through a wetland buffer zone) to enable drilling of the wells and future operation and maintenance activities. To connect the offsite wells to the onsite system, trenches would have to be dug between each well and the system to run power, piping and well pump controls. The cost for Alternative V is the highest of all the alternatives due to the capital costs associated with implementation of the source area excavation and pump and treat system. In addition, Alternative V has higher operating and monitoring costs due to the 5 year operating period for the pump and treat system.

RECOMMENDATION OF PREFERRED ALTERNATIVE

Alternative III – Insitu Chemical Oxidation and Bioremediation

Based on evaluation of the five alternatives as described above, Alternative III is being recommended as the preferred alternative. Alternative III includes onsite and offsite treatment for all impacted media with the lowest cost, least potential for short-term environmental impacts and would be easily implementable. Alternative III would be expected to achieve the reduction of contaminants to below applicable SCGs on and offsite within three years of the completion of treatment. Alternatives IV and V also provide on and offsite treatment, but would be more difficult to implement with higher costs, greater short-term environmental impacts and no greater effectiveness. Alternatives IV and V would take as long or longer to achieve applicable SCGs and therefore would not be as cost effective as Alternative III.

Alternative II would only provide onsite treatment and would rely on MNA to reduce contaminant concentrations offsite. This remedy would be less expensive and also have minimal short-term impacts, but would have a longer time frame to achieve SCGs (5 years). Alternative III is preferred to Alternative II because it includes active offsite treatment with no greater short-term impacts. The higher costs in this case result in a more cost effective remedy as it is expected SCGs would be achieved within 3 years with Alternative III.

Alternative I is the least preferred as it does not provide any removal, treatment or protection of the public or environment from contamination and would not be expected to achieve applicable SCGs anytime in the near future.

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TABLES

TABLE 1

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC NO. B00185-03

Summary of Contaminated Media

Soil

Contaminants of Concern	Concentration Range Detected (ug/kg)	Unrestricted Use SCO (ug/kg)	Unrestricted Use SCO Exceedances	Protection of Groundwater SCO (ug/kg)	Protection of Groundwater SCO Exceedances
PCE	Not Detected – 1,100	1,300	0 out of 20	1,300	0 out of 20
TCE	Not Detected	470	0 out of 20	470	0 out of 20
DCE	Not Detected	250	0 out of 20	250	0 out of 20
VC	Not Detected	20	0 out of 20	20	0 out of 20

ug/kg – micrograms per kilogram
SCO – Soil Cleanup Objective, 6 NYCRR Part 375, Subpart 375-6

Groundwater

Contaminants of Concern	Concentration Range Detected (ug/l)	GWQS (ug/l)	Frequency Exceeding GWQS
PCE	Not Detected – 4,100	5	49 out of 136 or 36%
TCE	Not Detected – 100	5	9 out of 136 or 6.6%
DCE	Not Detected – 27	5	5 out of 136 or 3.7%
VC	Not Detected – 8	2	1 out of 136 or 0.7%

ug/l – micrograms per liter
GWQS – Ground Water Quality Standard

Surface Water

Contaminants of Concern	Concentration Range Detected (ug/l)	SWQS or Guidance (ug/l)	Frequency Exceeding SWQS or Guidance
PCE	Not Detected	1	0 out of 6
TCE	Not Detected	5	0 out of 6
DCE	Not Detected	5	0 out of 6
VC	Not Detected	0.3	0 out of 6

ug/l – micrograms per liter
SWQS – Surface Water Quality Standard

TABLE 1
(continued)

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC NO. B00185-03

Summary of Contaminated Media

Sediments

Contaminants of Concern	Concentration Range Detected (ug/kg)	Unrestricted Use SCO (ug/kg)	Unrestricted Use SCO Exceedances	Protection of Ecological Resources SCO (ug/kg)	Protection of Ecological Resources SCO Exceedances (ug/kg)
PCE	Not Detected	1,300	0 out of 6	2,000	0 out of 6
TCE	Not Detected	470	0 out of 6	2,000	0 out of 6
DCE	Not Detected	250	0 out of 6	No Standard	NA
VC	Not Detected	20	0 out of 6	No Standard	NA

ug/kg – micrograms per kilogram
SCO – Soil Cleanup Objective, 6 NYCRR Part 375, Subpart 375-6

Soil Vapor

Contaminants of Concern	Concentration Range Detected (ug/m^3)	NYSDOH Indoor Air Guidance Value (ug/m^3)	Frequency Exceeding Guidance Value
PCE	Not Detected	100	0 out of 3
TCE	Not Detected	5	0 out of 3
DCE	Not Detected	No Standard or Guidance	Not Applicable
VC	Not Detected	No Standard or Guidance	Not Applicable

ug/m^3 – micrograms per cubic meter

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TABLE 2

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC No. B00185-03

Groundwater Vertical Profile Sampling Results - Onsite
September and October 2008

VOCs by EPA Method 8260

Sample I.D. and depth in ft bg	Date	Concentration (ug/l) 1)						
		Tetrachloro-ethylene	Trichloro-ethylene	cis-1,2-Dichloroethylene	Acetone 2) 3)	Methylene Chloride 2)3)	Toluene	MTBE 4)
DPW-L1-A(20)	9/24/2008	< 5	< 5	< 5	11	5	< 5	< 5
DPW-L1-B(25)	9/24/2008	< 5	< 5	< 5	15	4	< 5	< 5
DPW-L1-B(45)	9/24/2008	< 5	< 5	< 5	20	4	< 5	< 5
DPW-L1-C(20)	9/24/2008	< 5	< 5	< 5	10	4	< 5	< 5
DPW-L1-C(40)	9/25/2008	< 5	< 5	< 5	9	4	< 5	3
DPW-L1-C(60)	9/25/2008	< 5	< 5	< 5	5	4	< 5	< 5
DPW-L1-C(80)	9/25/2008	< 5	< 5	< 5	7	4	< 5	< 5
DPW-L1-C(88)	9/25/2008	< 5	< 5	< 5	5	4	< 5	< 5
DPW-L2-A(40)	9/26/2008	< 5	< 5	< 5	23	4	< 5	< 5
DPW-L2-A(52)	9/26/2008	< 5	< 5	< 5	7	5	< 5	< 5
DPW-L2-B(40)	9/26/2008	2 2)	< 5	< 5	8	4	< 5	< 5
DPW-L2-B(60)	9/26/2008	< 5	< 5	< 5	5	5	< 5	< 5
DPW-L2-B(63)	9/26/2008	< 5	< 5	< 5	4	4	< 5	< 5
DPW-L2-C(20)	9/29/2008	3,600	< 5	< 5	150	120	< 5	< 5
DPW-L2-C(40)	9/29/2008	30	< 5	< 5	2	4	< 5	< 5
DPW-L2-C(60)	9/29/2008	67	< 5	< 5	4	3	< 5	< 5
DPW-L2-C(71)	9/29/2008	20	< 5	< 5	5	3	1 2)	< 5
DPW-L2-D(20)	9/30/2008	4,100	4 2)	< 5	4	3	< 5	< 5
DPW-L2-D(40)	9/30/2008	35	< 5	< 5	3	3	1 2)	3
DPW-L2-D(60)	9/30/2008	3	< 5	< 5	4	3	2 2)	< 5
DPW-L2-D(72)	9/30/2008	1 2)	< 5	< 5	5	4	1 2)	< 5
OS-L1-A(40)	10/1/2008	1	< 5	< 5	< 5	< 5	< 5	< 5
OS-L1-A(60)	10/1/2008	2,000	< 5	< 5	< 5	< 5	1 2)	3
OS-L1-A(80)	10/1/2008	160	< 5	< 5	3 2)	< 5	2 2)	< 5
OS-L1-A(92)	10/1/2008	95	< 5	< 5	1 2)	< 5	1 2)	< 5
TOGS GWQS 5)		**5**	**5**	**5**	**50**	**5**	**5**	**5**

1) - Micrograms per liter
2) - Estimated Values - detected below PQL
3) - Laboratory contaminant - analyte detected in associated batch method blank
4) - Methyl Tertiary Butyl Ether
5) - Technical & Operational Guidance Series Ground Water Quality Standards
< Less than - Indicates the minimum detectable level
Exceeds GWQS

TABLE 2 (continued)

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC No. B00185-03

Groundwater Vertical Profile Sampling Results - Offsite
September and October 2008

VOCs by EPA Method 8260

Sample I.D. and depth in ft bg	Date	Concentration (ug/l) 1)						
		Tetrachloro-ethylene	Trichloro-ethylene	cis-1,2-Dichloroethylene	Acetone 2)3)	Methylene Chloride 2)3)	Toluene	MTBE 4)
OS-L1-B(20)	10/10/2008	15	18	<5	3	4	2 2)	<5
OS-L1-B(40)	10/10/2008	630	8 2)	<25	19	20	<25	<25
OS-L1-B(60)	10/10/2008	1,000	6 2)	<25	23	21	<25	<25
OS-L1-B(80)	10/10/2008	290	3 2)	<25	7	8	2 2)	<10
OS-L1-B(88)	10/10/2008	250	1 2)	<10	7	8	<10	<10
OS-L1-C(20)	10/13/2008	<5	2 2)	<5	2	5	<5	<5
OS-L1-C(40)	10/13/2008	700	<25	<25	14	19	<25	<25
OS-L1-C(60)	10/13/2008	9	<5	<5	3	6	<5	<5
OS-L1-C(80)	10/13/2008	2 2)	<5	<5	<5	4	<5	<5
OS-L1-C(95)	10/13/2008	<5	<5	<5	5	5	3 2)	<5
OS-L1-D(20)	10/14/2008	<5	<5	<5	6	6	2 2)	<5
OS-L1-D(40)	10/14/2008	22	<5	<5	3	4	2 2)	<5
OS-L1-D(60)	10/14/2008	2 2)	<5	<5	4	6	1 2)	<5
OS-L1-D(68)	10/14/2008	<5	<5	<5	2	6	<5	<5
OS-L1-E(20)	10/9/2008	<5	<5	<5	4	5	2 2)	<5
OS-L1-E(40)	10/9/2008	<5	<5	<5	3	4	3 2)	<5
OS-L1-E(60)	10/9/2008	3 2)	<5	<5	2	4	<5	<5
OS-L1-E(65)	10/9/2008	3 2)	<5	<5	8	4	<5	<5
OS-L2-A(20)	10/2/2008	<5	<5	<5	8	3	2 2)	<5
OS-L2-A(50)	10/2/2008	<5	<5	<5	31	4	2 2)	<5
OS-L2-A(70)	10/2/2008	7	<5	<5	3	3	1 2)	<5
OS-L2-A(84)	10/2/2008	<5	<5	<5	5	3	2 2)	1 2)
OS-L2-B(20)	10/7/2008	<5	<5	<5	3	4	<5	<5
OS-L2-B(40)	10/7/2008	<5	<5	<5	5	5	<5	<5
OS-L2-B(60)	10/7/2008	31	<5	<5	2	4	<5	<5
OS-L2-B(66)	10/7/2008	2 2)	<5	<5	3	4	7	<5
OS-L2-C(20)	10/3/2008	<5	<5	<5	4	3	1 2)	<5
OS-L2-C(40)	10/3/2008	<5	<5	<5	4	3	2 2)	<5
OS-L2-C(70)	10/3/2008	120	<5	<5	5	3	2 2)	<5
OS-L2-C(83)	10/3/2008	8	<5	<5	4	3	4 2)	<5
OS-L2-D(20)	10/7/2008	<5	<5	<5	2	4	2 2)	<5
OS-L2-D(40)	10/8/2008	<5	<5	<5	3	4	<5	<5
OS-L2-D(60)	10/8/2008	56	2 2)	<5	3	4	4 2)	<5
OS-L2-D(80)	10/8/2008	200	3 2)	2 2)	5	8	3 2)	<5
OS-L2-D(88)	10/8/2008	38	<5	<5	3	4	3 2)	1 2)
TOGS GWQS 5)		**5**	**5**	**5**	**50**	**5**	**5**	**5**

1) - Micrograms per liter
2) - Estimated Values - detected below PQL
3) - Laboratory contaminant - analyte detected in associated batch method blank
4) - Methyl Tertiary Butyl Ether
5) - Technical & Operational Guidance Series Ground Water Quality Standards
< Less than - Indicates the minimum detectable level
Exceeds GWQS

TABLE 2 (continued)

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC No. B00185-03

Groundwater Vertical Profile Sampling Results - Offsite
September and October 2008

VOCs by EPA Method 8260

Sample I.D. and depth in ft bg	Date	Concentration (ug/l) [1]						
		Tetrachloro-ethylene	Trichloro-ethylene	cis-1,2-Dichloroethylene	Acetone [2)3)]	Methylene Chloride [2)3)]	Toluene	MTBE [4)]
OS-L3-A(40)	10/16/2008	250	3[2)]	2[2)]	5	10	< 5	< 5
OS-L3-A(45)	10/15/2008	9	< 5	< 5	5	4	4[2)]	< 5
OS-L3-B(30)	10/15/2008	6	< 5	< 5	4	5	< 5	< 5
OS-L3-B(40)	10/15/2008	< 5	< 5	< 5	4	4	< 5	< 5
OS-L3-B(48)	10/15/2008	< 5	< 5	< 5	4	5	< 5	< 5
OS-L3-C(20)	10/15/2008	72	47	< 5	5	4	1[2)]	< 5
OS-L3-C(36)	10/15/2008	1[2)]	< 5	< 5	4	4	< 5	< 5
OS-L4-A(20)	10/17/2008	< 5	< 5	< 5	2	5	< 5	< 5
OS-L4-A(40)	10/17/2008	< 5	< 5	< 5	6	4	< 5	< 5
OS-L4-A(44)	10/17/2008	< 5	< 5	< 5	6	4	< 5	< 5
OS-L4-B(20)	10/17/2008	< 5	< 5	< 5	7	5	< 5	< 5
OS-L4-B(40)	10/17/2008	< 5	< 5	< 5	7	4	3[2)]	< 5
OS-L4-B(60)	10/17/2008	< 5	< 5	< 5	4	4	2[2)]	< 5
OS-L4-B(80)	10/17/2008	16	< 5	< 5	9	4	< 5	< 5
OS-L4-B(86)	10/17/2008	12	< 5	< 5	8	4	2[2)]	< 5
OS-GP-1(20)	10/20/2008	< 5	< 5	< 5	8	4	2[2)]	< 5
OS-GP-1(35)	10/20/2008	< 5	< 5	< 5	3	5	< 5	< 5
OS-GP-2(20)	10/21/2008	< 5	< 5	< 5	5	3	< 5	< 5
OS-GP-2(33)	10/21/2008	< 5	< 5	< 5	3	3	1[2)]	< 5
OS-GP-3(20)	10/22/2008	< 5	< 5	< 5	2	3	< 5	< 5
OS-GP-3(40)	10/22/2008	< 5	< 5	< 5	6	4	< 5	< 5
OS-GP-3(58)	10/22/2008	< 5	< 5	< 5	4	4	1[2)]	< 5
OS-GP-4(20)	10/22/2008	< 5	< 5	< 5	4	4	1[2)]	< 5
OS-GP-4(40)	10/23/2008	< 5	< 5	< 5	2	4	1[2)]	< 5
OS-GP-4(60)	10/23/2008	< 5	< 5	< 5	6	3	1[2)]	< 5
OS-GP-4(73)	10/23/2008	< 5	< 5	< 5	3	3	< 5	< 5
OS-GP-5(20)	10/23/2008	< 5	< 5	< 5	3	3	< 5	< 5
OS-GP-5(40)	10/23/2008	14	1[2)]	4[2)]	2	3	< 5	< 5
OS-GP-5(60)	10/23/2008	63	4[2)]	10	3	3	< 5	< 5
OS-GP-5(80)	10/23/2008	12	< 5	< 5	4	3	< 5	< 5
OS-GP-5(86)	10/23/2008	3[2)]	< 5	< 5	3	3	< 5	< 5
OS-GP-6(20)	10/24/2008	< 5	< 5	< 5	2	3	< 5	< 5
OS-GP-6(40)	10/24/2008	< 5	< 5	< 5	3	3	1[2)]	< 5
OS-GP-6(60)	10/24/2008	< 5	< 5	< 5	3	3	1[2)]	< 5
OS-GP-6(74)	10/24/2008	< 5	< 5	< 5	3	3	1[2)]	< 5
TOGS GWQS [5)]		**5**	**5**	**5**	**50**	**5**	**5**	**5**

1) - Micrograms per liter
2) - Estimated Values - detected below PQL
3) - Laboratory contaminant - analyte detected in associated batch method blank
4) - Methyl Tertiary Butyl Ether
5) - Technical & Operational Guidance Series Ground Water Quality Standards
< Less than - Indicates the minimum detectable level
Exceeds GWQS

LEGGETTE, BRASHEARS & GRAHAM, INC.

TABLE 3

TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC No. B00185-03

Historical Groundwater Quality Summary

VOCs by EPA Method 8260

Well I.D.	Date	Concentration (ug/l) 1)			
		Tetrachloroethene	Trichloroethene	cis-1,2 Dichloroethylene	Vinyl Chlloride
CW-1 (30)	3/22/2011	6.4	< 5.0	< 5.0	< 5.0
CW-1 (50)	3/22/2011	< 5.0	< 5.0	< 5.0	< 5.0
CW-1 (77)	3/22/2011	< 5.0	< 5.0	< 5.0	< 5.0
CW-2 (20)	3/22/2011	< 5.0	< 5.0	< 5.0	< 5.0
CW-2 (45)	3/22/2011	< 5.0	< 5.0	< 5.0	< 5.0
CW-3 (40)	3/21/2011	4.3 2)	< 5.0	< 5.0	< 5.0
CW-3 (60)	3/21/2011	4.1 2)	< 5.0	< 5.0	< 5.0
CW-3 (80)	3/21/2011	8.8	< 5.0	< 5.0	< 5.0
CW-4 (40)	3/21/2011	< 5.0	< 5.0	< 5.0	< 5.0
CW-4 (60)	3/21/2011	2.7 2)	< 5.0	< 5.0	< 5.0
CW-4 (80)	3/21/2011	17	< 5.0	< 5.0	< 5.0
CW-5 (40)	3/22/2011	13	1.0 2)	3.5 2)	3.5 2)
CW-5 (60)	3/22/2011	57	4.1 2)	8	8
CW-5 (80)	3/22/2011	5.4	< 5.0	< 5.0	< 5.0
B-20	10/10/2001	ND	ND	NA	NA
	3/20/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/25/2011	< 5.0	< 5.0	< 5.0	< 5.0
B-110	3/20/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/25/2011	< 5.0	< 5.0	< 5.0	< 5.0
C-60	3/30/1998	600	3.4	NA	NA
	5/4/1998	61	ND	NA	NA
	10/9/2001	790	ND	NA	NA
	3/20/2008	370	12	12	< 5.0
	3/25/2011	320	24	27	1.8 2)
C-180	3/20/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/25/2011	< 5.0	< 5.0	< 5.0	< 5.0
E-3	1/9/1998	180	ND	NA	NA
	2/6/1998	119	ND	NA	NA
	10/11/2001	550	ND	< 5.0	NA
	3/20/2008	590	< 5.0	< 5.0	< 5.0
	3/23/2011	260	12	13	2.2 2)
E-40	3/30/1998	8.9	NA	NA	NA
	5/4/1998	2.4	NA	NA	NA
	3/20/2008	40	< 5.0	< 5.0	< 5.0
	3/25/2011	28	5.2	< 5.0	< 5.0
E-90	3/26/1998	190	ND	NA	NA
	5/4/1998	93	ND	NA	NA
	10/11/2001	80	ND	NA	NA
	3/20/2008	320	< 5.0	< 5.0	< 5.0
	3/25/2011	47	100	1.7 2)	< 5.0
2-G	3/24/2008	< 5.0	< 5.0	< 5.0	< 5.0
3-G	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/23/2011	< 5.0	< 5.0	< 5.0	< 5.0
5-G	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
8-G	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/23/2011	< 5.0	< 5.0	< 5.0	< 5.0
9-G	3/21/2008	40	< 5.0	< 5.0	< 5.0
11-GL	3/20/2008	< 5.0	< 5.0	< 5.0	< 5.0
13-G	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
	3/23/2011	< 5.0	< 5.0	< 5.0	< 5.0
E-1	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
L1	3/21/2008	< 5.0	< 5.0	< 5.0	< 5.0
PW-1	3/24/2008	6	< 5.0	< 5.0	< 5.0
TOGS GWQS 3)		**5**	**5**	**5**	**5**

1) - Micrograms per liter
2) - Estimated Values - detected below PQL
3) - Technical & Operational Guidance Series Ground Water Quality Standards
ND - Not detected
NA - Not Available
< Less than - Indicates the Minimum Reporting Limit.
Exceeds GWQS

TABLE 4

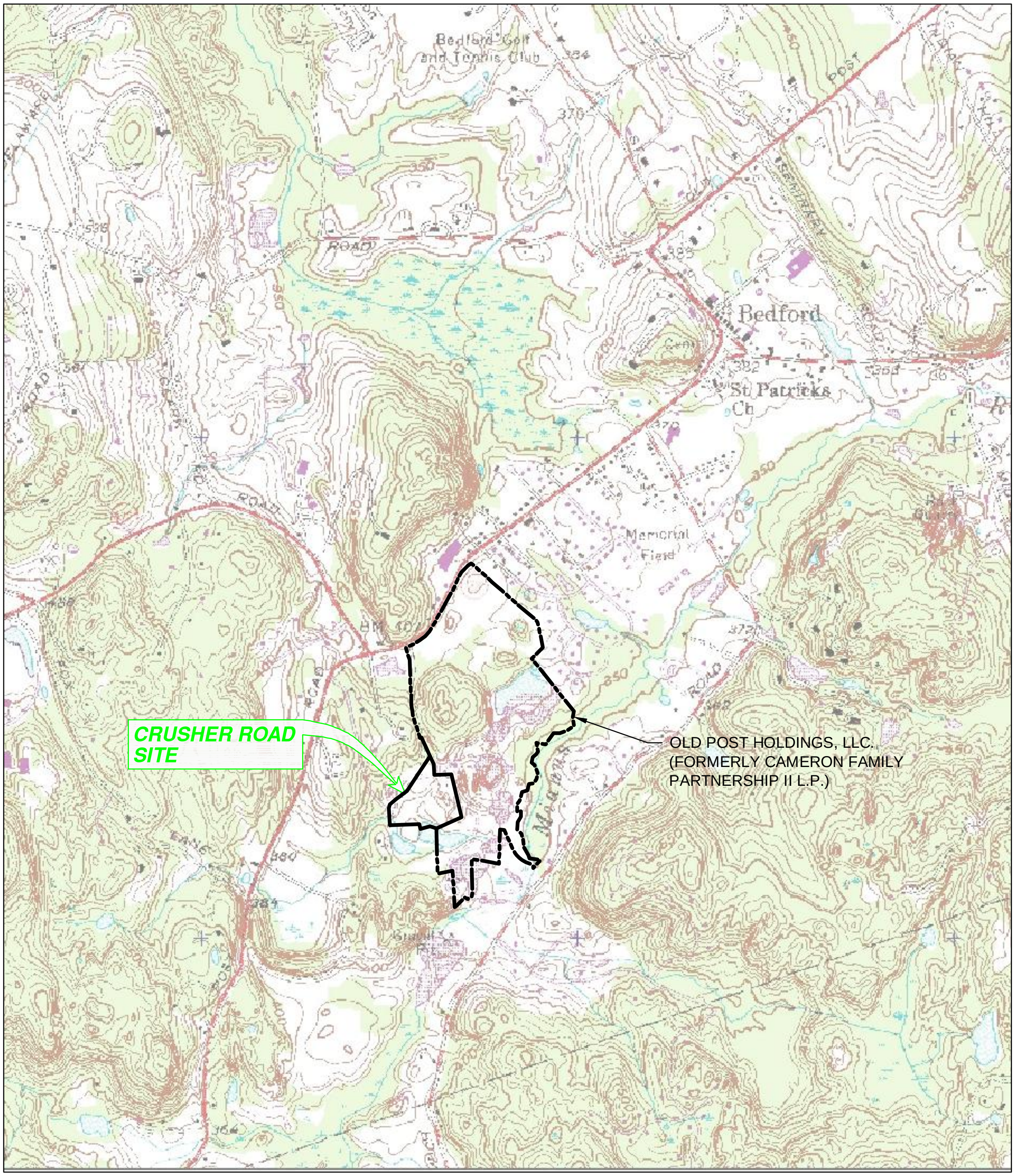
TOWN OF BEDFORD
CRUSHER ROAD SITE
WESTCHESTER COUNTY, NEW YORK
NYSDEC No. B00185-3

Summary of Groundwater Quality
Natural Attenuation Parameters
Collected March 22 and 23, 2011

Sample I.D.	Sulfate (mg/l) [1)]	Nitrate (mg/l)	Carbon Dioxide (mg/l)	Methane (ug/l)[2]	Total Iron (mg/l)
CW-1 (30)	62.5	3.64	13	< 10	223
CW-2 (45)	145	0.198	80	110	413
CW-5 (60)	49.2	0.772	38	78	7.95
E-3 (81)	74.8	1.78	80	3,200	0.962

1) Milligrams per liter
2) Micrograms per liter

FIGURES



NOTE:
BASE MAP ADAPTED FROM U.S.G.S. QUADRANGLE MAP MOUNT KISCO, N.Y.-CONN. -1971.

N

0 2000
SCALE IN FEET

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

SITE LOCATION MAP

DATE	REVISED	PREPARED BY:
		LEGGETTE, BRASHEARS & GRAHAM, INC.
		Professional Groundwater and Environmental Engineering Services
		110 Corporate Park Drive
		Suite 112
		White Plains, NY 10604
		(914) 694-5711

DRAWN:	MRV	CHECKED:	MD	DATE:	09/23/11	FIGURE:	1

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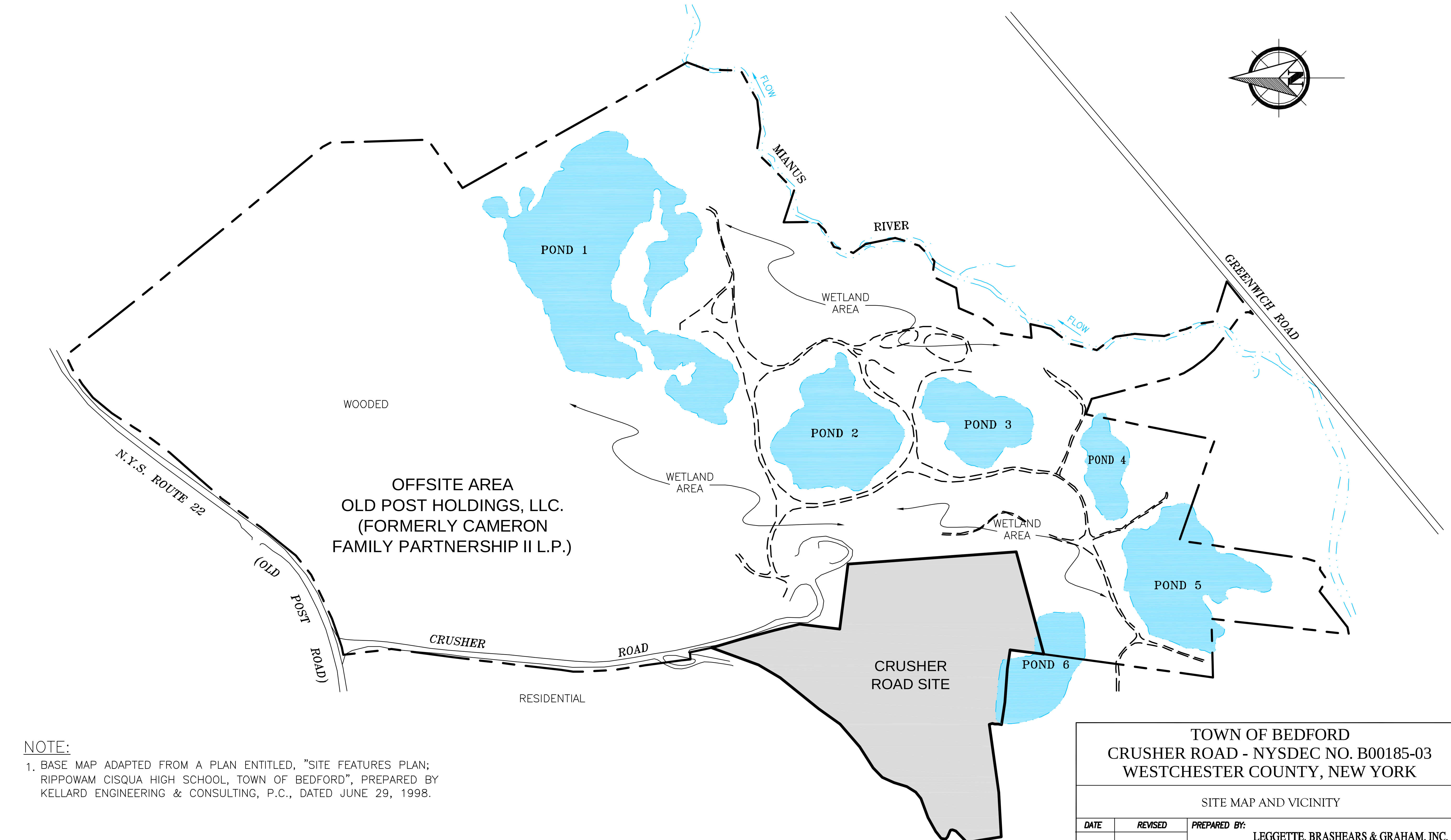

NOTE:

1. BASE MAP ADAPTED FROM A PLAN ENTITLED, "SITE FEATURES PLAN; RIPPOWAM CISQUA HIGH SCHOOL, TOWN OF BEDFORD", PREPARED BY KELLARD ENGINEERING & CONSULTING, P.C., DATED JUNE 29, 1998.

SOURCE: FIGURE CREATED FROM MAP PROVIDED BY GZA GEOENVIRONMENTAL OF NEW YORK, GZA PRELIMINARY SITE ASSESSMENT FEBRUARY 2002.

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

SITE MAP AND VICINITY

DATE	REVISED	PREPARED BY:
		LEGGETTE, BRASHEARS & GRAHAM, INC. Professional Groundwater and Environmental Engineering Services 110 Corporate Park Drive Suite 112 White Plains, NY 10604 (914) 694-5711

DRAWN: MRV | CHECKED: MD | DATE: 09/29/11 | FIGURE: 2

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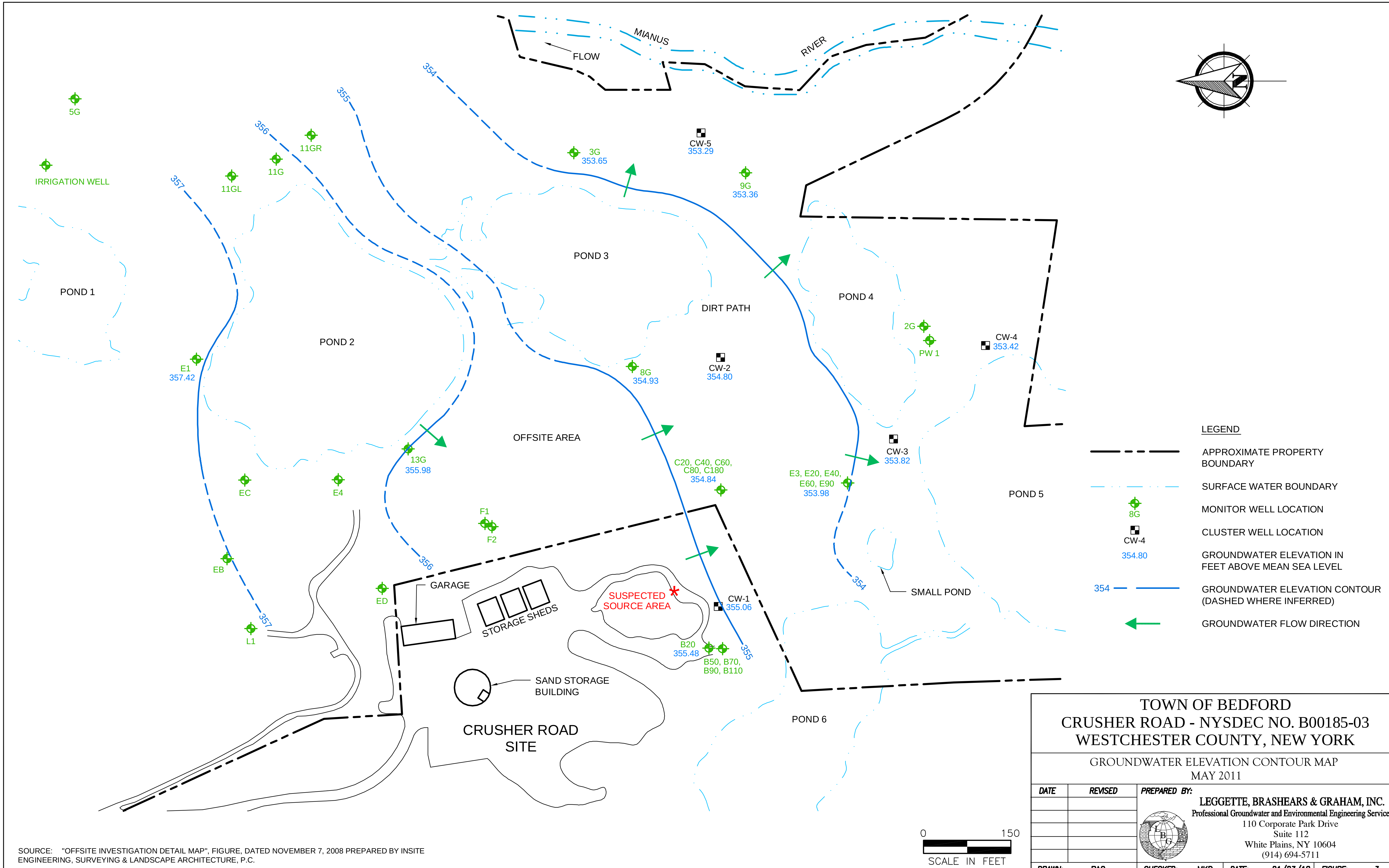

SOURCE: "OFFSITE INVESTIGATION DETAIL MAP", FIGURE, DATED NOVEMBER 7, 2008 PREPARED BY INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

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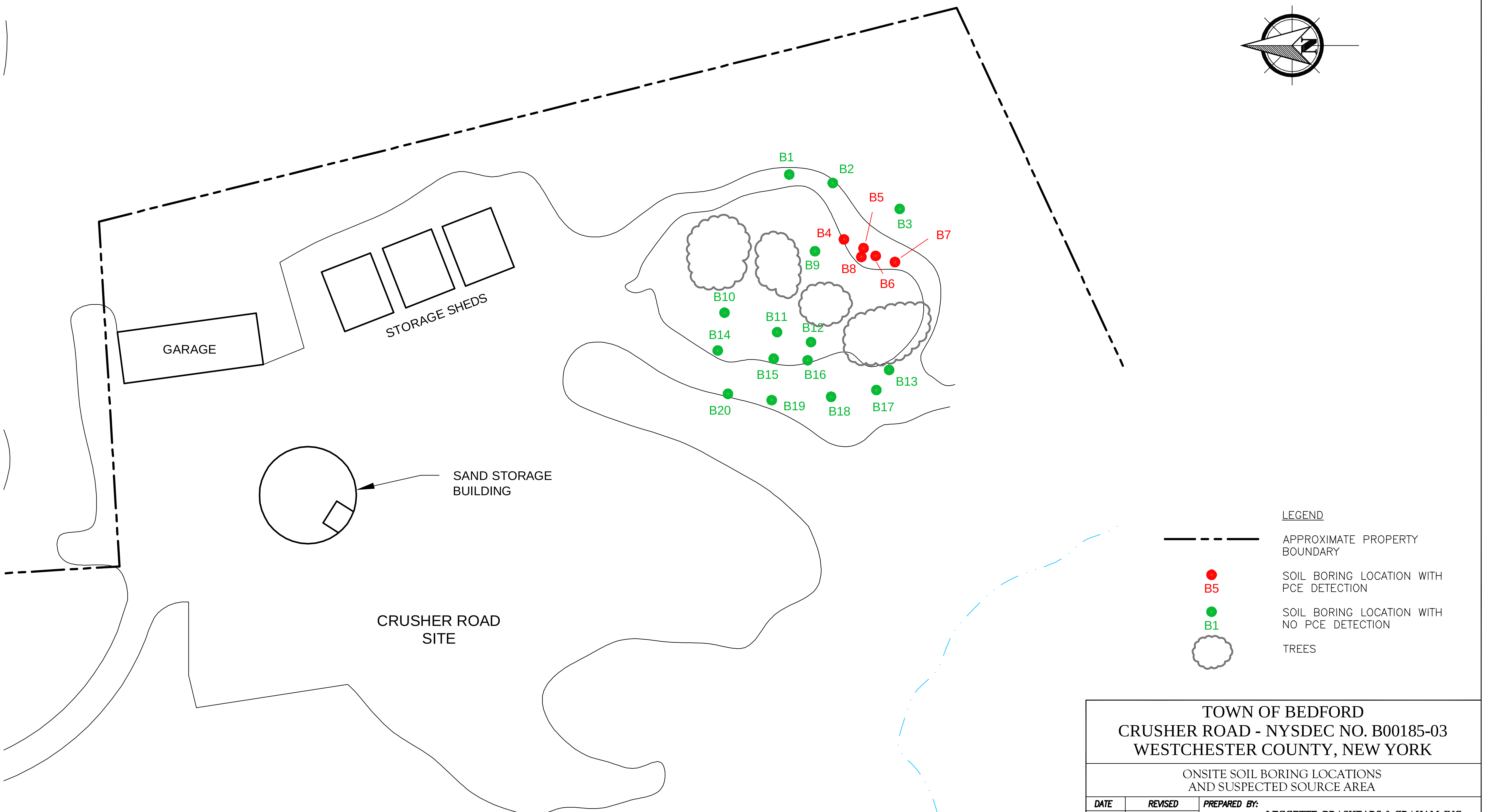

SOURCE: "OFFSITE INVESTIGATION DETAIL MAP", FIGURE, DATED NOVEMBER 7, 2008 PREPARED BY INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

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TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

ONSITE SOIL BORING LOCATIONS
AND SUSPECTED SOURCE AREA

DATE	REVISED

PREPARED BY:

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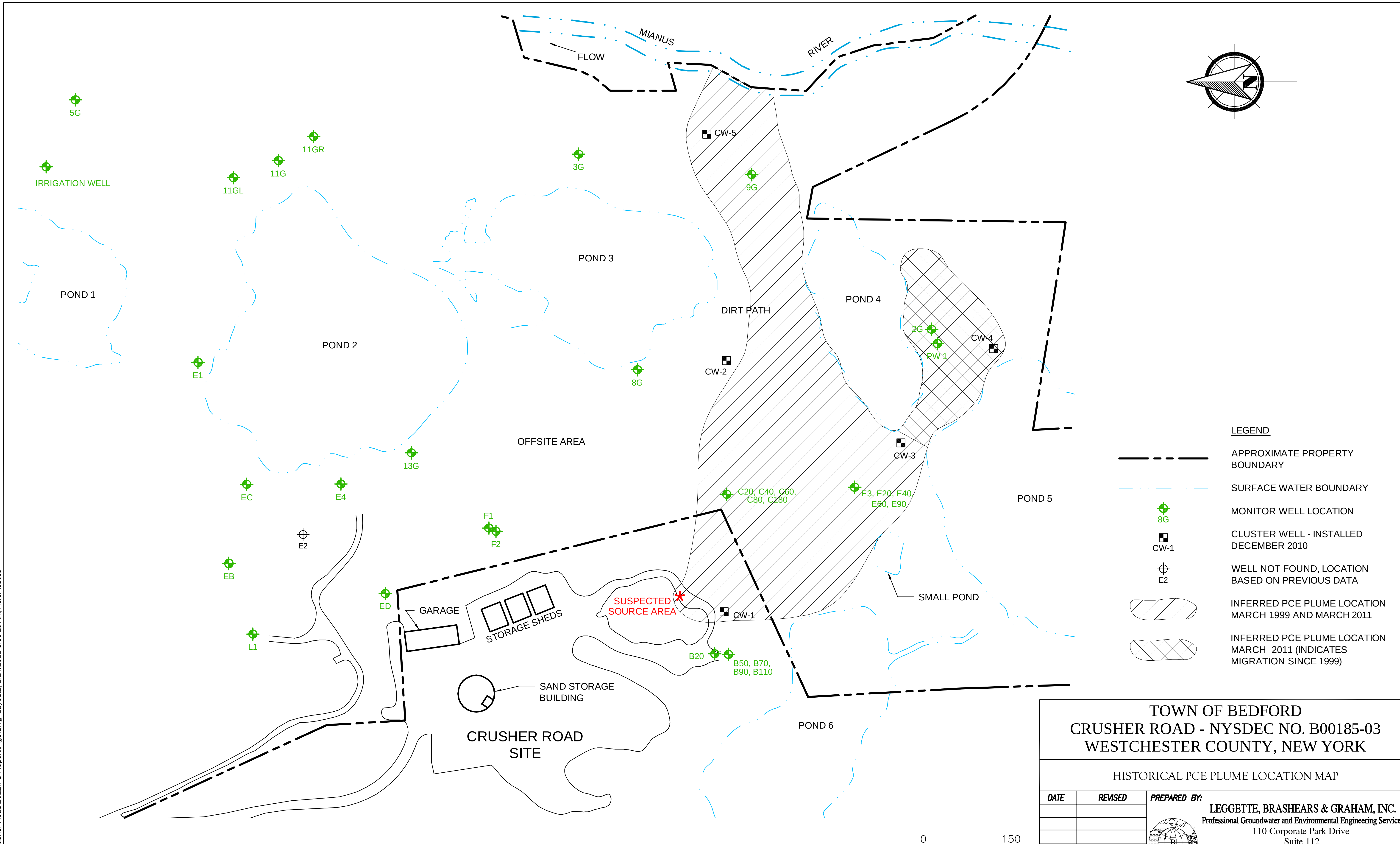
DRAWN:	RAC	CHECKED:	MKD	DATE:	01/23/12	FIGURE:	4



SOURCE:
"OFFSITE INVESTIGATION DETAIL MAP", FIGURE, DATED NOVEMBER 7, 2008 PREPARED BY INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

HISTORICAL PCE PLUME LOCATION MAP

DATE	REVISED

PREPARED BY:
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DRAWN: RAC | CHECKED: MKD | DATE: 01/23/12 | FIGURE: 5

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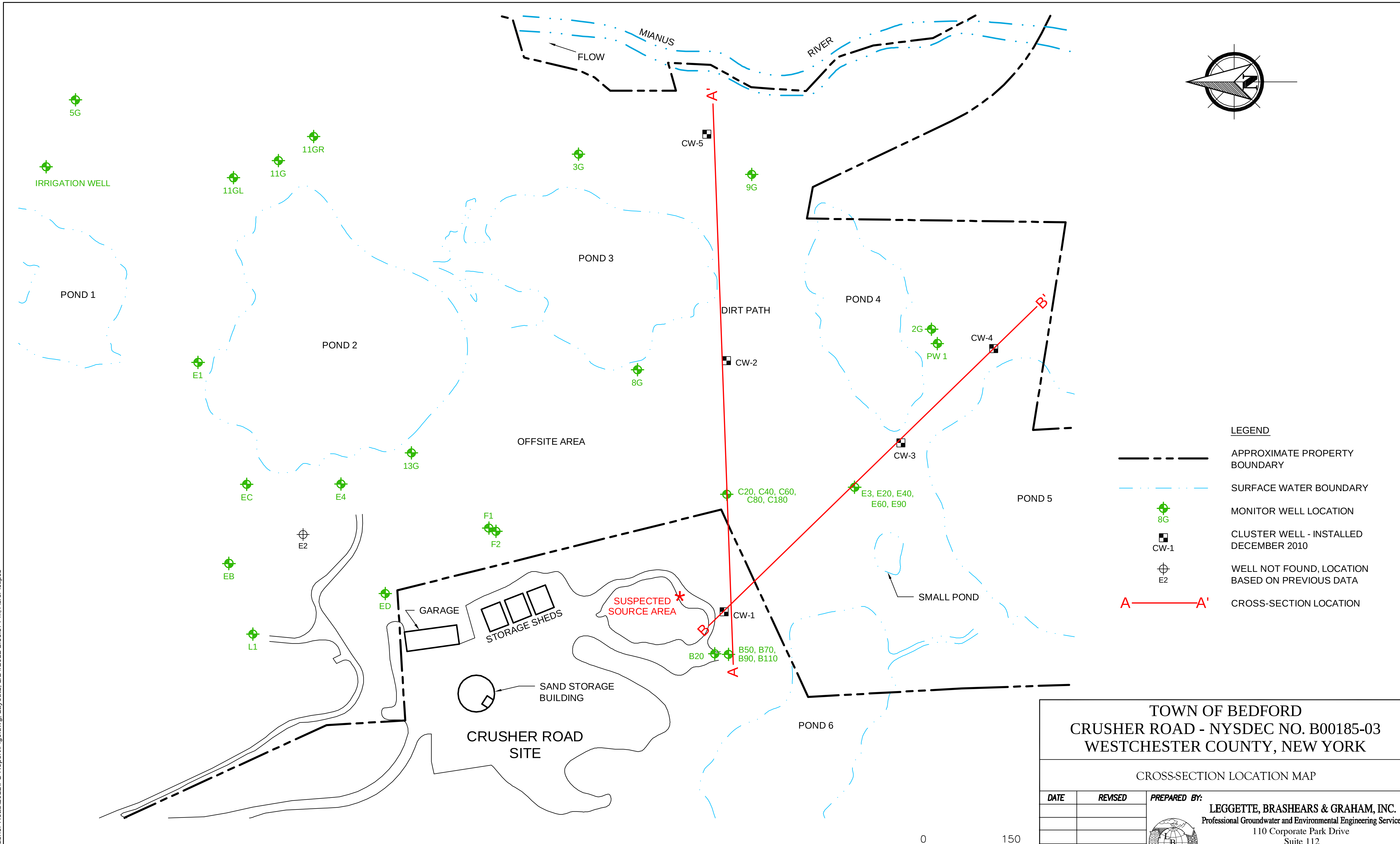

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SOURCE:
"OFFSITE INVESTIGATION DETAIL MAP", FIGURE, DATED NOVEMBER 7, 2008 PREPARED BY INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

CROSS-SECTION LOCATION MAP

DATE	REVISED

PREPARED BY:

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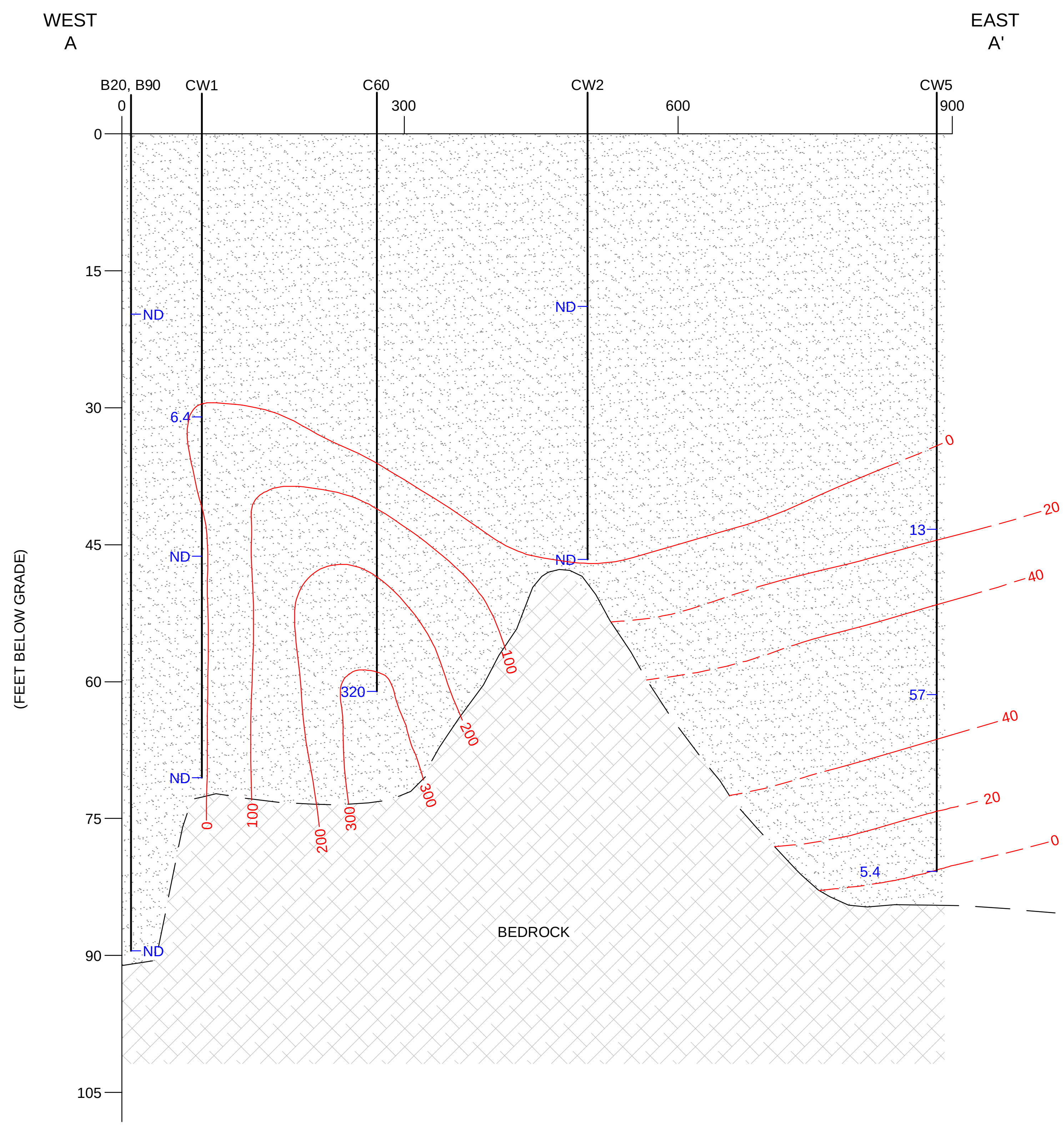
DRAWN: RAC | CHECKED: MKD | DATE: 01/23/12 | FIGURE: 6



LEGEND

(line symbol)	APPROXIMATE BEDROCK SURFACE
20	PCE ISO-CONCENTRATION INTERVAL (DASHED WHERE INFERRED)
320	PCE CONCENTRATION IN ug/L
ND	NOT DETECTED
(pattern)	FINE SAND WITH SOME SILT

0 150
HORIZONTAL SCALE IN FEET

0 15
VERTICAL SCALE IN FEET

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

PCE ISO-CONCENTRATIONS ALONG
CROSS-SECTION A-A' - MARCH 2011

DATE	REVISED

PREPARED BY:

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(914) 694-5711

DRAWN: RAC | CHECKED: MKD | DATE: 01/23/12 | FIGURE: 7

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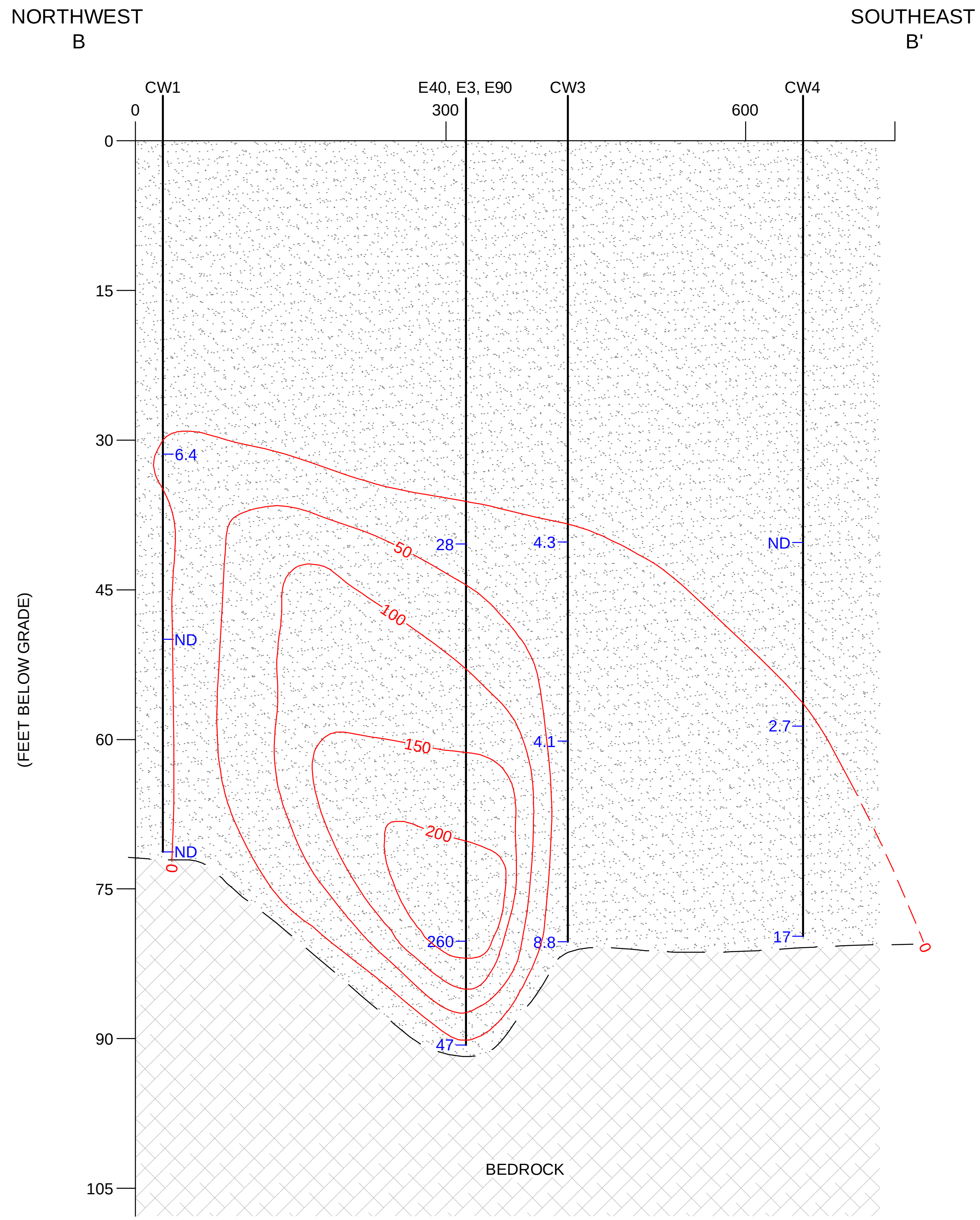

LEGEND

APPROXIMATE BEDROCK SURFACE

0 PCE ISO-CONCENTRATION INTERVAL (DASHED WHERE INFERRED)

260 PCE CONCENTRATION IN ug/L

ND NOT DETECTED

FINE SAND WITH SOME SILT

0 150
HORIZONTAL SCALE IN FEET

0 15
VERTICAL SCALE IN FEET

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

PCE ISO-CONCENTRATIONS ALONG
CROSS-SECTION B-B' - MARCH 2011

DATE	REVISED

PREPARED BY:
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Professional Groundwater and Environmental Engineering Services
110 Corporate Park Drive
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White Plains, NY 10604
(914) 694-5711

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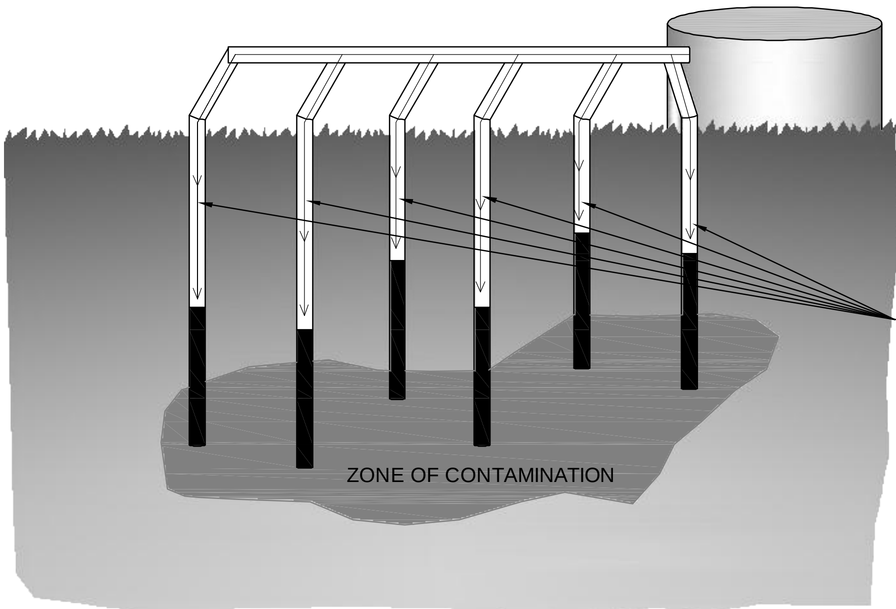
APPENDIX

SCHEMATIC DIAGRAM
IN-SITU CHEMICAL OXIDATION (ISCO)/BIOREMEDIATION



NOT TO SCALE

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

IN-SITU CHEMICAL OXIDATION (ISCO)/BIOREMEDIATION

DATE	REVISED	PREPARED BY:
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ADAPTED FROM:
NYSDEC DER-15, PRESUMPTIVE REMEDIAL TECHNOLOGIES
FOR NYS REMEDIAL PROGRAMS. APPENDIX VI

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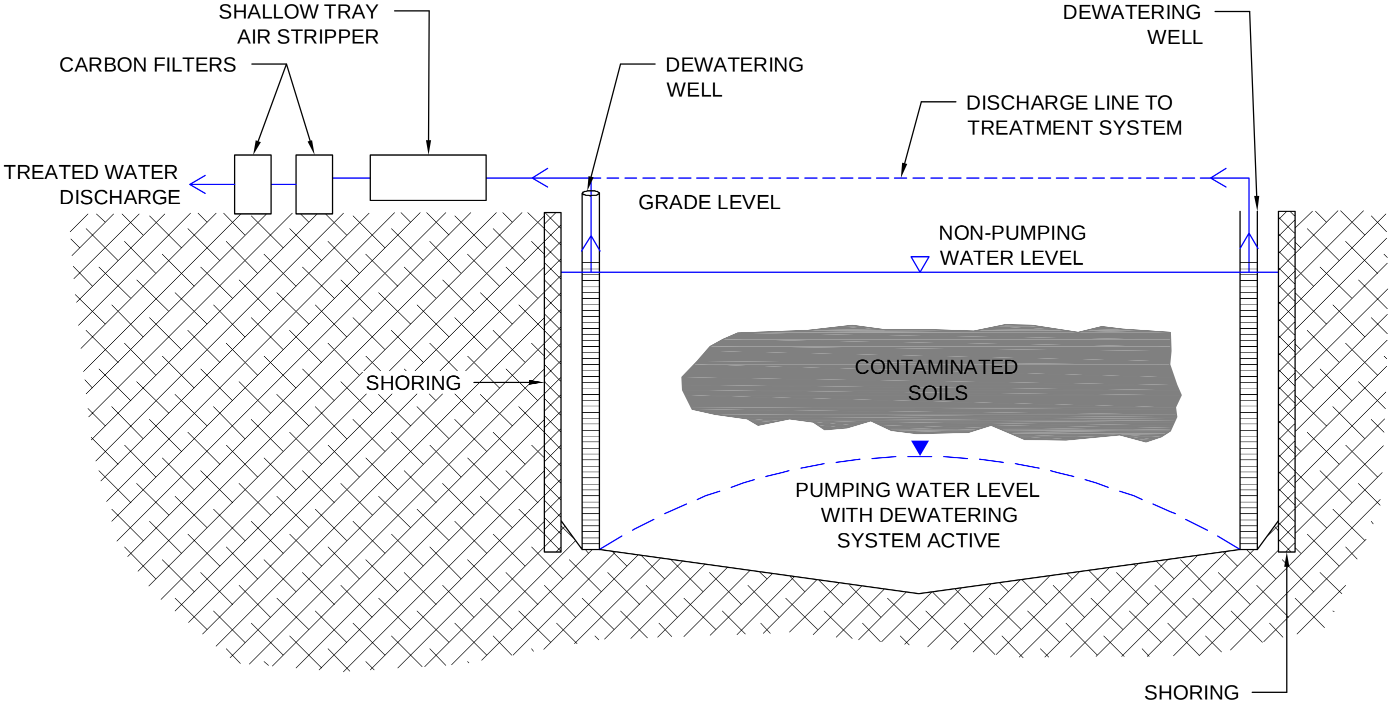
SCHEMATIC DIAGRAM
SOURCE AREA DEWATERING AND EXCAVATION



NOT TO SCALE

TOWN OF BEDFORD CRUSHER ROAD - NYSDEC NO. B00185-03 WESTCHESTER COUNTY, NEW YORK					
SOURCE AREA DEWATERING AND EXCAVATION					
DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM, INC. Professional Groundwater and Environmental Engineering Services 110 Corporate Park Drive Suite 112 White Plains, NY 10604 (914) 694-5711			
DRAWN: RAC		CHECKED: MD	DATE: 01/23/12	FIGURE: 2	

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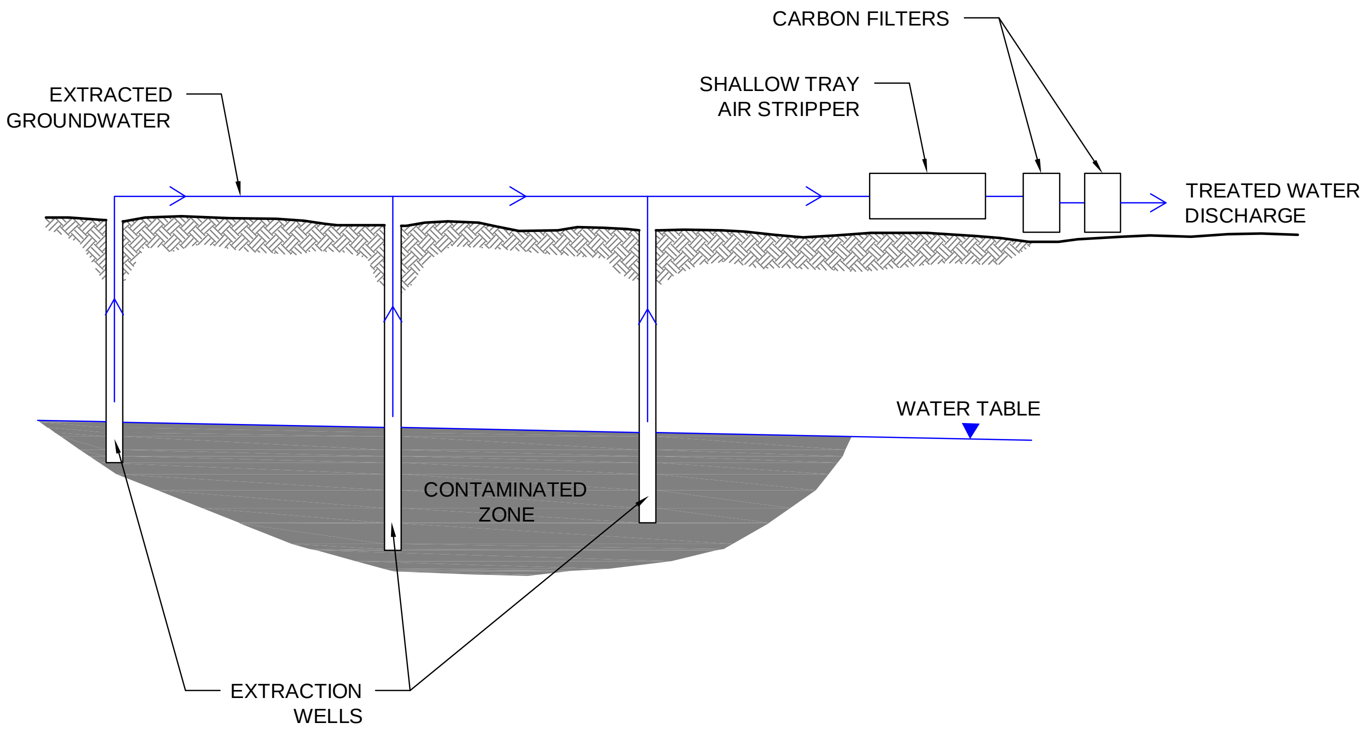
SCHEMATIC DIAGRAM
GROUNDWATER PUMP AND TREAT SYSTEM



NOT TO SCALE

TOWN OF BEDFORD
CRUSHER ROAD - NYSDEC NO. B00185-03
WESTCHESTER COUNTY, NEW YORK

GROUNDWATER PUMP AND TREAT SYSTEM

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
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(914) 694-5711

DRAWN:	RAC	CHECKED:	MD	DATE:	01/23/12	FIGURE:	3

ADAPTED FROM:
NYSDEC DER-15, PRESUMPTIVE REMEDIAL TECHNOLOGIES
FOR NYS REMEDIAL PROGRAMS. APPENDIX VII

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