8976 *Wellington Road*
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July 23, 2019

Jessica LaClair
Project Manager
Division of Environmental Remediation, Remedial Bureau E
New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7014

Subject: Revised RCRA Facility Investigation Work Plan, Building 322 Area of Concern (Operable Unit 7)

Reference: Corrective Measures Program
Former IBM East Fishkill Facility
Hopewell Junction, New York
NYSDEC Part 373 Permit 3-1323-0025-00249-0
EPA ID No. NYD000707901

Dear Ms. LaClair:

Enclosed for your review, is the revised RCRA Facility Investigation (RFI) Work Plan for the Building 322 (B/322) Area of Concern (AOC) at the Former IBM East Fishkill Facility in Hopewell Junctionl, New York (Site). In a letter dated July 9, 2019, NYSDEC provided comments on the original April 30, 2019 Work Plan, requesting a resubmittal. On behalf of IBM, Groundwater Sciences Corporation submitted draft revisions in a July 15, 2019 e-mail. NYSDEC provided comments to the draft revisions on July 15, 2019. This revised Work Plan addresses the above mentioned comments.

If you have any questions, please contact me at (703) 257-2583.

Sincerely,
International Business Machines Corporation

Dean W. Chartrand
Program Manager
Corporate Environmental Affairs

cc: J. Kenney, NYSDOH
G. Marone, Global Foundries
M. Buckley, iPark
C. Monheit, iPark
D. Bergmann, Groundwater Sciences

RCRA FACILITY INVESTIGATION WORK PLAN
BUILDING 322 AREA OF CONCERN (OPERABLE UNIT 7)

FORMER IBM EAST FISHKILL FACILITY
TOWN OF EAST FISHKILL, DUTCHESS COUNTY, NEW YORK

NYSDEC Site No. 314054, EPA ID No. NYD000707901

Prepared for:

IBM Corporate Environmental Affairs
8976 Wellington Road
Manassas, Virginia 20109

April 30, 2019
Revised July 23, 2019

Prepared by:

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Professional Geologist Certification
RCRA Facility Investigation Work Plan
Building 322 Area of Concern (Operable Unit 7)

Former IBM East Fishkill Facility
Town of East Fishkill, Dutchess County, New York
NYSDEC Site No. 314054, EPA ID No. NYD000707901

April 30, 2019
Revised: July 23, 2019

As the person with primary responsibility for the performance of the geological services and activities associated with the captioned work plan, I certify that I have reviewed the document titled *"RCRA Facility Investigation Work Plan, Building 322 Area of Concern (Operable Unit 7), Former IBM East Fishkill Facility, Town of East Fishkill, Dutchess County, New York, NYSDEC Site No. 314054, EPA ID No. NYD000707901"*. This work plan was originally dated April 30, 2019, was revised July 23, 2019 and was prepared by Groundwater Sciences, P.C. (GSPC) and Groundwater Sciences Corporation (GSC) for IBM Corporation.

As a professional geologist licensed in the State of New York, I certify that the associated geological services and this work plan have been prepared under my direct supervision while working as agent for GSPC. To the best of my knowledge; all such information contained in this work plan is complete and accurate.

This work plan bears the seal of a professional geologist; no alterations may be made to the information contained in this report unless made in accordance with Title 8, Article 145, Section 7209 of New York State Education Law.

STATE OF NEW YORK
DOROTHY A. BERGMANN
No. 000477-1
LICENSED PROFESSIONAL GEOLOGIST

Signature: ______________________ Date: 7/23/2019

Name: Dorothy A. Bergmann

License No: 00477

State: New York

Table of Contents

Figures

Plates

Appendices

1 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan has been prepared by Groundwater Sciences Corporation (GSC) at the request of IBM Corporation (IBM) for the Building 322 (B/322) Area of Concern (AOC) / Operable Unit 7 (OU7) at the former IBM East Fishkill Facility in East Fishkill, New York (Site). The B/322 AOC (OU7) is one of eight operable units being remediated as part of the Site's RCRA Corrective Action (CA) program which is regulated by the New York State Department of Environmental Conservation (NYSDEC) under a New York State Part 373 RCRA permit (NYSDEC Site No. 314054, EPA ID No. NYD000707901). The Site is currently owned by GLOBALFOUNDRIES U.S. 2LLC (GF), i.Park East Fishkill LLC, and i.Park East Fishkill I LLC but IBM has maintained responsibility for implementation of the Site's RCRA CA program under the permit. The B/322 AOC (OU7) is located in the central portion of the Site, within property owned by GF. The primary constituents of concern that remain in the B/322 AOC consist of volatile organic compounds (VOCs), including tetrachloroethene (PCE), Freon® TF, and their associated breakdown products.

In 2018, GF began redevelopment activities that include demolition of the northern two-thirds of B/322 leaving a small telephone panel room and associated structures in the southern portion of the building. According to GF, the demolished portion of B/322 will be used for additional parking and roadway areas. The demolition work is projected to be completed near the middle of 2019. The NYSDEC has requested that IBM conduct an investigation in the former area of B/322 to assess whether additional corrective measures could be performed to address the remaining recalcitrant VOC presence in the B/322 AOC (OU7).

1.1 Purpose

The purpose of the RFI described in this work plan is intended to collect data of sufficient quantity and quality to further refine the nature and extent of the VOC presence in the B/322 AOC (OU7) portion of the Site. Depending on the findings of the RFI, the data may also be used to evaluate whether additional corrective measures should be implemented in the B322 AOC (OU7).

1.2 Organization of Work Plan

The remainder of this work plan is organized in seven additional sections as follows. Section 2 presents pertinent background information and Section 3 presents the objectives, scope and rationale for the proposed investigation work. Section 4 presents the proposed field activities plan. Sections 5 and 6 present the QA/QC Plan and Health and Safety Plans, respectively. Section 7 presents a schedule for performing and reporting on these activities. A list of references is presented in Section 8.

2 BACKGROUND

This section provides an overview of pertinent background information concerning the location of the Site and the B/322 AOC, B/322 AOC hydrogeologic conditions, a summary of previous investigations and corrective actions in the B322 AOC, and a brief description of the nature and extent of the VOC presence in B/322 AOC groundwater based on groundwater sampling conducted during the second quarter of 2018.

2.1 Site and B/322 AOC Location

The Site is located in south-central Dutchess County within the Town of East Fishkill, New York. The location of the Site relative to regional ground surface topography and drainage features is shown on the topographic base map provided as **Figure 2-1**. The Site is bounded on the north by New York State Route 52, on the east by Lime Kiln Road, on the south by Interstate 84 (I-84) and the I-84 interchange at Lime Kiln Road, and on the west by high voltage power lines owned by Consolidated Edison Company of New York and natural gas lines owned by Central Hudson Gas & Electric Corporation. On July 1, 2015 the Site was acquired by GF. In 2017, the Site was subdivided into eight lots as shown on **Plate 2-1**. On September 1, 2017 National Resources, also doing business as i.Park East Fishkill LLC and i.Park East Fishkill I LLC, purchased lots 2, 3, 4, 6, 7, and 8, with lots 1 and 5 remaining as GF property. The B/322 AOC is located in Lot 5, comprising the area of B/322 and nearby areas to the east and west where VOCs are present in shallow groundwater.

2.2 Hydrogeologic Conditions in the Area of B/322

Listed in descending order, the geologic strata in the area of B/322 includes:

- Soil fill – consisting of a mixture of sand and gravel with lesser amounts of silt/clay and/or cobbles/boulders.
- Late-glacial and post-glacial alluvium – consisting of a complex sequence of interbedded sandy silt, silty sand, sand, and sand & gravel.
- Glaciolacustrine silt & clay – consisting of silt with lesser amounts of clay, sand, and trace amounts of gravel, commonly well-stratified.

- Ice-contact and glaciofluvial outwash deposits – consisting of poorly- to well-sorted sand and gravel with lesser to trace amounts of silt, clay, cobbles and boulders.
- Glacial till – dense to very dense, heterogeneous mixture of clay, silt, sand, and gravel with cobbles and boulders.
- Bedrock – Dolostone interbedded with lesser amounts of shale, siltstone, and sandstone.

Where saturated, the late-glacial and post-glacial alluvium constitutes the uppermost water bearing zone. In the area of B/322, this upper water bearing zone is unconfined and perched on the fine-grained soils of the glaciolacustine silt & clay. The glaciolacustrine silt & clay serves as an aquitard perching infiltration of precipitation and limiting downward vertical advection through the silt & clay. Due to bedrock production well withdrawals, some of the soil beneath the glaciolacustrine silt & clay in the area of B/322 is unsaturated, with the next level of saturation for the deeper water bearing zone residing in the lower portion of the outwash, the glacial till, and/or the fractured bedrock.

As shown on **Figure 2-2**, groundwater in the perched upper water bearing zone ("Soil Groundwater") flows both southerly and westerly. The majority of groundwater in the area of B/322 flows in a southerly direction towards Building 323 (B/323) and ultimately recharges the deeper overburden and bedrock at the limit of the silt & clay aquitard. The remaining groundwater in the area of B/322 flows in a more westerly direction towards a wetland area drained by Gildersleeve Brook. As shown on **Figure 2-3**, Gildersleeve Brook flows in a northwest direction near the western Site boundary and continues to flow outside the limits of the Site in a north to northwest direction before discharging into Fishkill Creek.

2.3 Previous Investigations and Corrective Actions

Beginning in the late 1970s, the Site has been the subject of numerous and extensive environmental investigations focused on characterizing hydrogeologic Site conditions and defining the nature and extent of contamination. Results of these investigations identified the presence of VOCs in soil and groundwater in certain areas of the Site. In response to the discovery of VOCs, IBM implemented Corrective Action in the form of soil removals and operation of groundwater extraction and treatment systems. From 1981 to 1995, these Corrective Action activities were conducted under an Order on Consent with the NYSDEC. Beginning in 1995, these Corrective Action activities have been conducted under a 6 NYCRR Part 373 permit. Over the past four decades, results of CA activities have resulted in substantial reductions in the VOC presence across the Site, including the B/322 AOC (OU7).

Soil and groundwater RFIs were performed in the B/322 AOC (OU7) in the mid-1990s. The soil RFI focused on areas of potential releases near solid waste management units (SWMUs) in the area of B/322 and the B/322-B/320 linkway. Results of the soil RFI activities did not confirm the presence of VOCs in soil exterior to buildings and structures in the vicinity of B/322 (WF Cosulich, February 1998). Results of the groundwater RFI activities indicated the presence of separate groundwater plumes in overburden (soil) and bedrock where VOCs have been detected above applicable 6NYCRR Part 703 New York State Groundwater Quality Standards. Both plumes appear to originate northeast of B/322, in the former area of solvent and waste solvent underground storage tanks (USTs) generally located between the former B/322-B/320 linkway and support Building B/320C (**Figure 2-2**). The shallow VOC plume in soil extends to the southwest beneath B/322, while the deeper VOC plume in bedrock extends to the northwest, towards bedrock production well PW-1.

The groundwater RFI revealed a potential pathway for human exposure associated with future discharge of a minor component of groundwater flow, transporting VOCs towards Gildersleeve Brook. Although the groundwater data did not suggest discharge of VOCs to the brook at the time of the RFI, there was a potential for low concentrations of VOCs to reach wet areas bordering the brook in the future.

According to SHPC (September 1998),

> "based on the findings of the CMS Task I screening, and in consideration of IBM's risk management preferences, IBM proposed voluntary implementation of groundwater migration control/management in the interest of streamlining the more broad-based, time consuming CMS process and in consideration of: the potential gains in expeditiously implementing the groundwater migration control in arresting further VOC migration toward the brook; the relative potential technical and administrative simplicity of implementation; and positive IBM experience in management of groundwater containment systems."

IBM implemented a pump and treat system for the western portion of the B/322 overburden plume in 2000. The B/322 groundwater extraction system included three overburden extraction wells (GW-612, GW-617 and GW-618), with one backup available (GW-613). Locations of the four extraction wells are shown on **Figure 2-2**. Extraction wells GW-612, GW-613, and GW-617 were installed to capture perched groundwater in the overburden in the area of West Drive to eliminate the potential migration of VOCs toward the Gildersleeve Brook. Extraction well GW-618 was installed with the goal of remediating a localized presence of dichlorodifluoromethane (Freon® 12) near the wetland area surrounding Gildersleeve Brook. The extracted groundwater from wells GW-612, GW-613, GW-617, and GW-618 was piped to the facility's Water Pollution Control Facility where it was combined with sanitary and treated industrial wastewater, treated, and discharged under a State Pollution Discharge Elimination System (SPDES) permit to the Gildersleeve Brook.

In September 2013, a Final Statement of Basis (FSB) that selected the Final Corrective Measures to protect overburden and bedrock groundwater at the Site was developed by the NYSDEC, in consultation with the New York State Department of Health (NYSDOH). The FSB was incorporated into the Part 373 permit and became effective on April 16, 2014. According to the FSB, the shallow VOC plume in soil comprises the B/322 AOC (OU7) portion of the Site, while the deeper VOC plume in bedrock is part of the Bedrock Remediation Area (OU2) portion of the Site.

In January 2014, NYSDEC approved a three-year shutdown test of extraction well GW-618 after sampling of GW-618 and other nearby wells indicated applicable New York State Groundwater Quality Standards (NYSGQS) had not been exceeded in groundwater samples in more than eight years. In July 2015, NYSDEC approved a two-year shutdown test of extraction wells GW-612, GW-613, and GW-617 after sampling of those wells and other wells in the B/322 AOC (OU7) indicated significant declines in the magnitude and lateral extent of the VOC plume in the perched groundwater. Results of both shutdown tests indicated no significant changes under non-pumping conditions in the area of GW-618 and the leading edge of the VOC plume near wells GW-612, GW-613, and GW-617. In July 2018, NYSDEC agreed with the findings of the two shutdown tests and approved the permanent shutdown of the four extractions wells.

2.4 Nature and Extent of VOCs in B/322 AOC Groundwater

As listed in the FSB, chemicals of concern in the B/322 AOC (OU7) include: PCE, trichloroethene (TCE), cis-1,2-dichloroethene (c12DCE), Freon® TF, and Freon® 123. **Plate 2-2** provides five maps with postings of concentrations for these chemicals of concern, based on analysis of groundwater samples collected in April/May 2018. Isoconcentration contours for groundwater concentrations above the NYSGWS of 5 micrograms per liter (µg/L) are also shown where applicable. As indicated by the contour maps, the analysis of groundwater samples collected in the B/322 AOC (OU7) during the second quarter of 2018 only detected PCE, TCE, and Freon® TF above the NYSGWS. Exceedances of the NYSGWS for PCE and Freon® TF appear to be limited to the area of well 735, near the northeast corner of B/322, whereas exceedances of the NYSGWS for TCE appear to extend from the area of well 735 towards the portion of the parking lot area west of B/322 in the area of wells 768 and 769.

3 OBJECTIVES, SCOPE AND RATIONALE

The objective of this RFI Work Plan is to obtain chemical and physical data of sufficient quality and quantity to further refine the nature and extent of the VOC presence in groundwater and soil within the B/322 AOC (OU7) portion of the Site. The data collected may also be used to evaluate whether additional corrective measures should be implemented in the B322 AOC (OU7).

The scope of this Work Plan consists of a multi-phased program of field explorations and testing whereby the results of the initial field explorations are reviewed and used to support the scope of the subsequent phases of the work. The scope and technical rationale for each field exploration and testing phase is provided as follows:

- Phase 1 - An initial soil vapor sampling survey to collect screening-level data to assess VOC vapor concentrations in the upper portion of the vadose zone beneath the demolished portion of B/322, in areas of the apparent groundwater plume origin, northeast of B/322, and in areas of the groundwater plume front extending west of B/322.

- Phase 2 – A series of four Membrane Interface Probe (MIP) transects oriented roughly perpendicular to groundwater flow to obtain screening-level data regarding VOC presence in the vadose zone and saturated zone. The transect locations will be selected based on a combination of the findings of the soil vapor sampling survey and the results of recent groundwater monitoring in the B/322 AOC (OU7).

- Phase 3 – Soil and groundwater sampling probes at up to fifteen locations where VOCs were detected by the MIP transects. The soil sampling will provide additional data concerning vadose zone and saturated zone soil gradation and allow for fixed-base analytical laboratory analyses for VOCs to quantify the screening-level MIP results. The groundwater sampling will assist in refining the magnitude and lateral extent of the VOC plumes remaining in the B/322 AOC (OU7). At least one soil sample from the vadose zone and one soil sample from the saturated zone will be collected for VOC analysis from each soil boring. The soil sample depths selected for VOC analysis will be based on the findings of the soil vapor sampling survey and the MIP transects. Upon completion of the soil sampling, one groundwater grab sample will also be collected for VOC analysis for each soil boring.

- Phase 4 – Installation of up to three groundwater monitoring wells in the VOC plume area to provide long-term water level and water quality monitoring locations to further define the remaining VOC plumes in groundwater in the B/322 AOC (OU7). The need for additional monitoring wells will be assessed as part of the review of the Phase 3 exploration and testing data. If completed, the monitoring well locations would be selected based on results of the Phase 3 soil and groundwater sampling probes to supplement existing monitoring wells in the area of B/322. Water level monitoring and groundwater sampling of these newly installed wells would be completed as part of a broader groundwater monitoring round for the B/322 AOC (OU7).

4 FIELD ACTIVITIES PLAN

This section describes the field activities that will be performed as part of the RFI. Overall, the field activities include an initial utility review followed by up to four phases of field explorations and testing. Results of the field activities will produce data of sufficient quantity and quality to further refine the VOC presence in the B/322 AOC (OU7) and, if warranted, support development and screening of additional corrective measures to address the remaining VOC presence. Detailed descriptions of field investigation procedures are provided in **Appendices A through D**.

4.1 Utility Review

A review for the possible presence of subsurface utilities will be performed in the area of the proposed field explorations. The utility review will include coordination with GF to obtain and review available subsurface utility plans and screening for the possible presence of subsurface utilities using electrical conductivity and ground penetrating radar (GPR) geophysical survey methods. The results of the geophysical utility review surveys will be marked in the field and reviewed with GF utility personnel.

4.2 Soil Vapor Sampling Survey

A soil vapor sampling survey will be performed using hydraulically-driven direct-push probes advanced to a depth of 6.5 feet below ground surface (bgs). As shown on **Figure 4-1**, a total of approximately 45 soil vapor probes will be performed with the soil vapor sampling probe spacing ranging from about 70 to 100 feet apart in the area of the PCE plume in groundwater and the former footprint of B/322. The proposed locations shown on **Figure 4-1** will be adjusted in the field based on results of the utility review activities and accessibility constraints imposed by Site features or GF operations.

The soil vapor samples will be collected using a temporary soil vapor monitoring point. Samples will be collected into 1-liter SUMMA®-type canisters equipped with 30-minute flow controllers (equivalent to a sampling rate of about 27 milliliters (ml) per minute – assuming a sampling volume of 800 ml). For soil vapor sampling probe locations within the former footprint of B/322, the concrete slab will be pre-cored prior to performance of the direct-push probes.

The soil vapor probe samples will be analyzed for VOCs by EPA-Method TO-15. Details concerning the soil vapor probe sampling procedures, along with field sampling forms are included in **Appendix A**.

4.3 MIP Screening of Vadose Zone and Saturated Zone

Membrane Interface Probe (MIP) technology will be used to collect screening level data regarding the presence of VOCs in the vadose and saturated zones in the area of Building 322. The MIP is a direct-push downhole tool that produces continuous vertical profile logs of VOC chemistry and physical properties in the vadose and saturated zones. It locates VOCs *in-situ* by heating the soils and groundwater adjacent to the probe at about 120 degrees C, thereby increasing the volatility of the target compounds. The vapor phase diffuses across a hydrophobic membrane above the heating element and into a closed, inert gas loop. The carrier gas transports the vapors to a laboratory-grade gas chromatograph housed at the surface and equipped with both an electron-capture detector (ECD) and a photoionization detector (PID). The PID provides qualitative identification of aromatic VOCs and the ECD provides qualitative identification of chlorinated VOCs such as PCE. Soil conductivity and temperature are also measured by the MIP and the conductivity logs can be compared to the chemical logs to better understand where the VOCs are present relative to the known geologic and hydrologic units. The continuous vertical profiles generated from each direct-push borehole are used to develop cross-sectional profiles of the subsurface.

As shown on **Figure 4-2**, a total of approximately 30 direct-push MIP boreholes will be drilled along four transects oriented roughly perpendicular to groundwater flow and the remaining VOC plumes. The direct-push MIP boreholes will be advanced on 25-foot spacings (In general, the minimum borehole spacing will be 25 feet, but this spacing may be increased as real-time chemistry data is generated in the field). MIP Transect #1 will run through the former area of solvent and waste solvent USTs, northeast of B/322. In an effort to limit the potential for downward migration of VOCs, vertical penetration of the MIPs will cease at depths where PID readings begin to decrease following exceedance of the maximum 15-volts on the ECD.

MIP Transect #2, consisting of approximately eight MIP boreholes, will extend across the PCE, TCE, and Freon® TF plumes in proximity to well 735. MIP Transects #3 and #4 also consist of approximately eight MIP boreholes and extend across the PCE and TCE plumes at locations further downgradient from the apparent plume origin, northeast of B/322. The proposed locations of these four transects and the spacing of the MIP boreholes along each transect will be reassessed after the receipt of the soil vapor survey results.

Unless terminated due to the ECD maximum criteria described above, continuous vertical MIP profiles will be generated for the MIP boreholes from the surface down to the lacustrine silt & clay (approximately 25 to 30 feet bgs) that is believed to form that base of the shallow unconfined water-bearing unit. The cross-sectional view of chemical distribution generated by the MIPs will help to define the characteristics of the remaining VOC plumes emanating from the former area of solvent and waste solvent USTs. Results of the MIP screening will be used as a basis for selecting locations for soil and groundwater sampling probes. The number and location of soil and groundwater sampling probes will be determined after an evaluation of the MIP screening level data.

4.4 Soil and Groundwater Sampling Probes

Soil and groundwater sampling probes will be performed at up to fifteen locations where VOCs were detected by the MIP transects. Results of the MIP screening will be used as a basis for selecting locations for soil and groundwater sampling probes. The soil sampling will provide additional data concerning vadose zone and saturated zone soil gradation and allow for fixed-base analytical laboratory analyses for VOCs to quantify the screening-level MIP results. The groundwater sampling will assist in refining the magnitude and lateral extent of the VOC plumes remaining in the B/322 AOC (OU7).

The sampling probes will be advanced using hydraulically-driven direct-push drilling techniques. The soil samples will be collected into single-use disposable plastic tubes using a Geoprobe® Macrocore or Dual-Tube sampler. The soil samples will be screened in the field using a PID and logged by a GSC geologist. On the basis of the field screening and field logging of the soil gradation, one vadose zone soil sample and one saturated zone soil sample will be selected for VOC analysis by a fixed-based analytical laboratory using EPA Method 8260. The remaining soil samples will be placed in glass jars and retained for possible fraction of organic carbon (foc) analyses and gradation analyses. Details concerning the soil drilling methods, sampling procedures, field screening procedures, and analytical methods are included in **Appendix B**.

4.5 Soil Borings, Well Installations, and Groundwater Monitoring

Depending upon the findings of the MIP screening and the soil and groundwater sampling, up to three groundwater monitoring wells may be installed to supplement the existing monitoring well network in the B/322 AOC (OU7). The purpose of the new wells would be to provide long-term water level and water quality monitoring locations to further define the remaining VOC plumes in groundwater in the B/322 AOC (OU7).

Soil borings with continuous split-spoon sampling would be advanced using 4-1/4-inch inner diameter (I.D.) hollow-stem auger drilling techniques. Soil samples would be screened in the field using a PID via jar headspace analysis techniques. Upon completion of the borings, nominal two-inch diameter monitoring wells would be installed. The monitoring well installations would provide for assessment further assessment of lateral hydraulic gradients, confirm and further refine the nature and extent of VOC presence, and provide locations for long-term monitoring of remedial progress. Procedures developed to guide performance of the soil borings, soil sampling, jar headspace analysis, monitoring well installations, and monitoring well development are described in **Appendix C**.

A location and elevation survey of the newly installed monitoring wells would be performed by a land surveyor license in the State of New York. Consistent with previous Site surveys, the wells would be surveyed relative to the Site's coordinate system. The locations would be surveyed to the nearest 0.1 foot and reference point elevations would be surveyed to the nearest 0.01 foot.

Water level monitoring and groundwater sampling of these newly installed wells would be completed as part of a broader groundwater monitoring round for the B/322 AOC (OU7). The groundwater levels would be measured using an electronic water level measurement device capable of measuring in increments of 0.01 feet. The existing and newly installation monitoring wells would be sampled and analyzed for VOCs by EPA Method 8260. The samples would also be screened in the field for pH, temperature, specific conductance. Groundwater sampling and analysis procedures are described in **Appendix D**.

5 QUALITY ASSURANCE / QUALITY CONTROL

Quality assurance and quality control (QA/QC) will be performed in accordance with Module II, Appendix II-A of the Site's 6 NYCRR Part 373 Permit, which specifies data requirements for RCRA Analytical Data Submitted to the New York State Department of Environmental Conservation.

5.1 Project Organization

IBM's project manager for this investigation will be Dean W. Chartrand, Program Manager with IBM Corporate Environmental Affairs. Groundwater Sciences Corporation (GSC) will perform the investigation work. GSC's project team will include Robert C. Watson, P.G., who will serve as Project Director. He will be assisted by C. Edward Stoner, P.G., Project Manager; Dorothy A Bergmann P.G., Quality Assurance Officer; and Stephen M. Fisher, P.G., Assistant Project Manager. The resumes of these GSC individuals are presented in **Appendix E**.

The geophysical surveys will be performed by GSC subcontractor, Advanced Geological Services (AGS) of Malvern, Pennsylvania. The contractor for soil vapor probes, direct-push MIP logging, direct-push soil and groundwater sampling probes, and soil borings with monitoring well installations will be Cascade Drilling of Albany, New York. Surveying services will be provided by the Chazen Companies of Poughkeepsie, New York, a New York State licensed surveyor.

5.2 Laboratories

Fixed-base analytical services will be provided by Eurofins Lancaster Labs Environmental of Lancaster, Pennsylvania. Lancaster Laboratories is NYSDOH ELAP CLP-certified. The reporting level for the soil and groundwater analyses will be NYSDEC Analytical Services Protocol (ASP) Category B deliverables, and the data will be evaluated according to the NYSDEC Division of Environmental Remediation (DER) Data Usability Summary Report (DUSR) guidelines. These DUSR guidelines are described in Section 5.4.

5.3 Standard Operating Procedures

Standard Operating Procedures (SOPs) for soil vapor sampling, MIP screening, soil and groundwater sampling, monitoring well construction, decontamination procedures, field instruments, and field screening methods are presented in **Appendices A through D**.

5.4 Data Usability Summary Reports

The Data Usability Summary Report (DUSR) provides a thorough evaluation of analytical data without the costly and time consuming process of third party data validation. The primary objective of a DUSR is to determine whether the data, as presented, meets the site/project specific criteria for data quality and data use.

The DUSR will be prepared by the project's Quality Assurance Officer, Dorothy A. Bergmann P.G., who is capable of conducting a full data validation and holds a certificate in Organic Data Validation from Westchester Community College in a course sponsored by EPA Region 2 and NYSDEC. Ms. Bergmann holds Bachelors and Master's Degrees in Geology, and has completed 20 credit hours in chemistry coursework at the undergraduate and graduate levels. She has over 30 years of experience in environmental sampling, data analysis, review, and validation at six RCRA and state Superfund sites in New York State.

The DUSR will be prepared based on a review of a full NYSDEC ASP Category B or a USEPA CLP deliverables package. During the course of this review the following questions will be answered:

1. Is the data package complete as defined under the requirements for the NYSDEC ASP Category B or USEPA CLP deliverables?

2. Have all holding times been met?

3. Do all the QC data (i.e., blanks, instrument tunings, calibration standards, calibration verifications, surrogate recoveries, spike recoveries, replicate analyses, laboratory controls and sample data) fall within the protocol required limits and specifications?

4. Have all of the data been generated using established and agreed upon analytical protocols?

5. Does an evaluation of the raw data confirm the results provided in the data summary sheets and quality control verification forms?

6. Have the correct data qualifiers been used?

Once the data package has been reviewed and the questions listed above have been answered, the DUSR will proceed to a description of the samples and analytical parameters. Data deficiencies, analytical protocol deviations, and quality control problems will be identified and their effect on the data will be discussed. The DUSR will also include recommendations on resampling and/or reanalysis. All data qualifications must be documented in accordance with NYSDEC ASP guidelines.

If the DUSR and the data deliverables package indicate significant problems with some or all of the data in the package, the data will be either rejected or validated to determine whether it can be used. In some cases, the data may be usable for screening purposes only.

6 HEALTH AND SAFETY PLANS

A Site-Specific Health & Safety and a Community Air Monitoring Plan have been prepared to address potential health and safety issues for field investigation workers and potential exposures to VOCs in air for field investigation workers and third parties at the Site.

6.1 Site-Specific Health & Safety Plan

Potential health and safety issues are addressed in a Site-Specific Health & Safety Plan (HASP). The HASP addresses field activities, including geophysical surveys, soil vapor sampling, MIP logging, soil and groundwater probe sampling, drilling and well installations, and groundwater monitoring. The HASP will be reviewed by all workers prior to commencement of field activities.

6.2 Community Air Monitoring Plan

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for VOCs and particulates (i.e., dust) at the downwind perimeter of the designated work area when certain activities are in progress at the Site. The area of the investigation is covered by the former B/322 concrete floor slab, and asphalt-paved parking and roadway areas, so particulates are not contaminants of concern. The intent of the CAMP is to provide a measure of protection for the downwind community (i.e., off-Site receptors and on-Site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative work activities. The nearest off-site businesses and residences are at least a quarter-mile away and the expected VOC exposures are such that impacts to the downwind community are expected to be negligible. The CAMP will also help to confirm that work activities do not spread contamination off-Site through the air. In addition to the CAMP, simple, common-sense measures will be used to keep VOCs, dust, and odors at a minimum around the work. The implementation of the CAMP will rely on a hierarchy of conditions as described below.

During the RFI Work Plan field activities, the CAMP will consist of real-time air monitoring for VOCs. Screening for the potential presence of VOCs in air will be performed outside of the designated work area at the start of each workday and periodically thereafter to establish background conditions. Monitoring for VOCs will be performed at the perimeter of the immediate work area (i.e., the exclusion zone, contaminant reduction zone, and support zone) during ground intrusive activities, such as the soil vapor sampling probes, MIPs, soil and groundwater sampling probes, soil borings and monitoring well installations. Proposed air monitoring locations are shown on Figure 6-1. As shown on the figure, the proposed air monitoring locations include five air monitoring locations around the perimeter of the work area, designated as A through E. Background air monitoring will be performed at an apparent “upwind” location a minimum of 100 feet from the work area.

The air monitoring will be performed using a photoionization detector (PID) equipped with an 11.7 or 10.6 electron-volt (eV) lamp. The PID will be calibrated at least daily for an appropriate surrogate to trichloroethene and will be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below. Periodic monitoring will be conducted at intervals of at least every 15 minutes in the active work zone of the RFI activities described in this Work Plan. Increased monitoring, corrective actions to abate emissions, and/or work shutdown may be required in the event that concentrations are measured at levels in access of the action levels specified below.

If the ambient air concentration of total organic vapors at the apparent downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities will resume with continued monitoring. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind from the exclusion zone or half the distance to the nearest potential receptor, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average. If the organic vapor level exceeds 25 ppm at the perimeter of the work area, work activities will be halted until corrective actions are completed to abate the emissions. NYSDEC and NYSDOH will be notified of any work shutdowns due to the results of the air monitoring. Instantaneous readings and 15-minute readings will be recorded and transmitted to NYSDEC and NYSDOH at the end of each week or the end of each RFI work phase, whichever duration is shorter.

7 REPORTING AND SCHEDULE

The total time for completing the RFI of the B/322 AOC (OU7) is projected to be six months from the start of utility review and field activities coordination through submittal of an RFI report. This projected timeframe assumes:

- The field activities described in this work plan are completed in about ten weeks, including: one week for the soil vapor sampling and two weeks for analytical laboratory analyses of the soil vapor samples; one week of MIP logging and two weeks to develop cross-sectional visualizations of the MIP data; one week of soil and groundwater sampling probes and two weeks of analytical laboratory analyses of the soil and groundwater grab samples; and one week for monitoring well installations and B/322 AOC groundwater monitoring.

- The analytical laboratory analyses of the B/322 AOC groundwater samples, data validation, and data compilation and review activities are completed within two months.

- RFI report preparation, including preparation of DUSRs, will be completed in six weeks.

Assuming GF demolition activities are completed by the end of June 2019, the RFI field activities would be completed during July and August 2019 and the data analysis and reporting would be completed by the end of 2019. IBM with keep the NYSDEC and NYSDOH informed of the progress of the RFI field activities, data analysis, and report preparation during monthly telephone conference calls/status meetings.

8 REFERENCES

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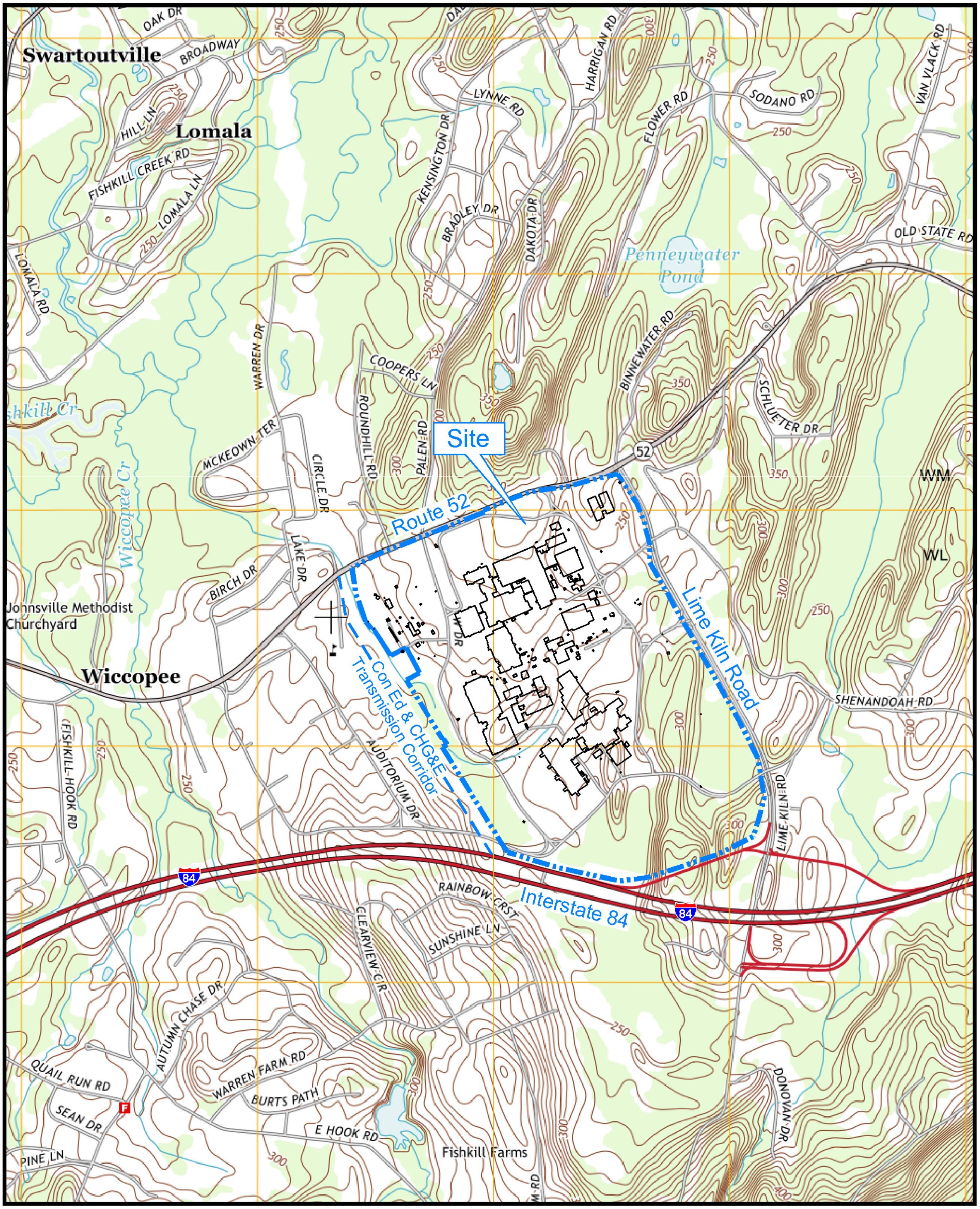


Portion of the Hopewell Junction, NY
7.5-minute USGS Quadrangle
(The National Map US Topo, 2013)
Latitude/Longitude: 41°32'27"N, 73°49'28"W (41.540714, -73.824185)

N

Scale
0 1000' 2000'

Figure 2-1

Former IBM East Fishkill Facility

Site Location Map

GROUNDWATER SCIENCES CORPORATION

95007-044-F2 / 03-06-19

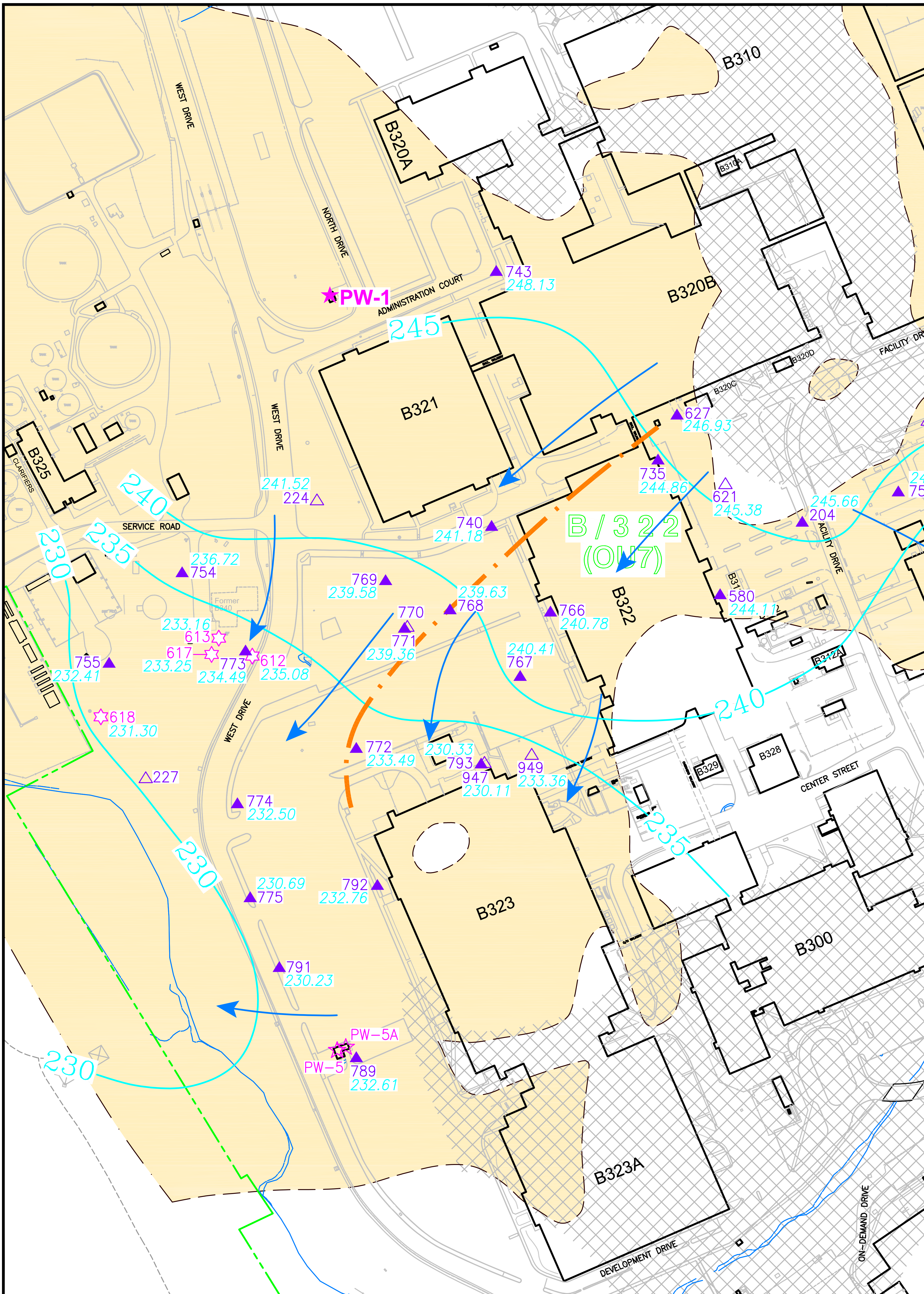


Figure 2-2

LEGEND

- Former IBM East Fishkill Facility Property Line
- GMP Soil Monitoring Well
- GMP Soil Monitoring Well (for groundwater elevations only)
- Bedrock Extraction Well
- Inactive Bedrock Extraction Well
- Inactive Shallow Extraction Well
- OU - Operable Unit
- 220 - Contour of Constant Potentiometric Head (feet amsl)
- 233.25 - Groundwater Elevation (feet amsl)
- Generalized Direction of Groundwater Flow
- Groundwater Divide
- Extent of Clay Mapping
- Extent of Glaciolacustrine Clay
- Inferred Areas of No Saturated Soil (approx.)

N

Scale
0 100' 200'

Former IBM East Fishkill Facility

Elevation Contour Map
Soil Groundwater Table
December 10, 2018 (GMP Wells)

DRAWN BY: MHM	DATE: 12/21/18	DRAWING NO.
CHECKED & APPROVED BY: CES		95007-102-N2

GROUNDWATER SCIENCES CORPORATION

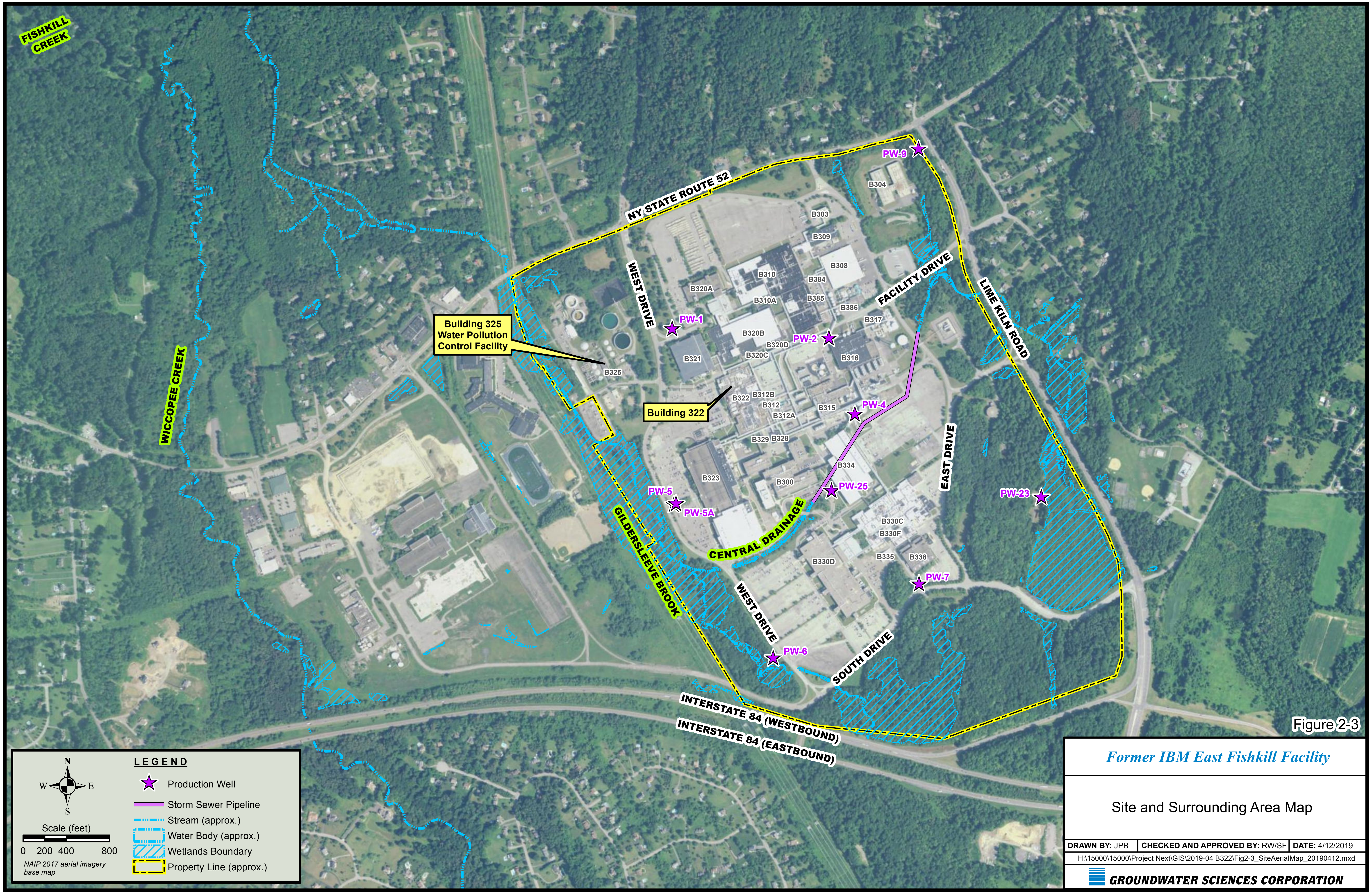


Figure 2-3

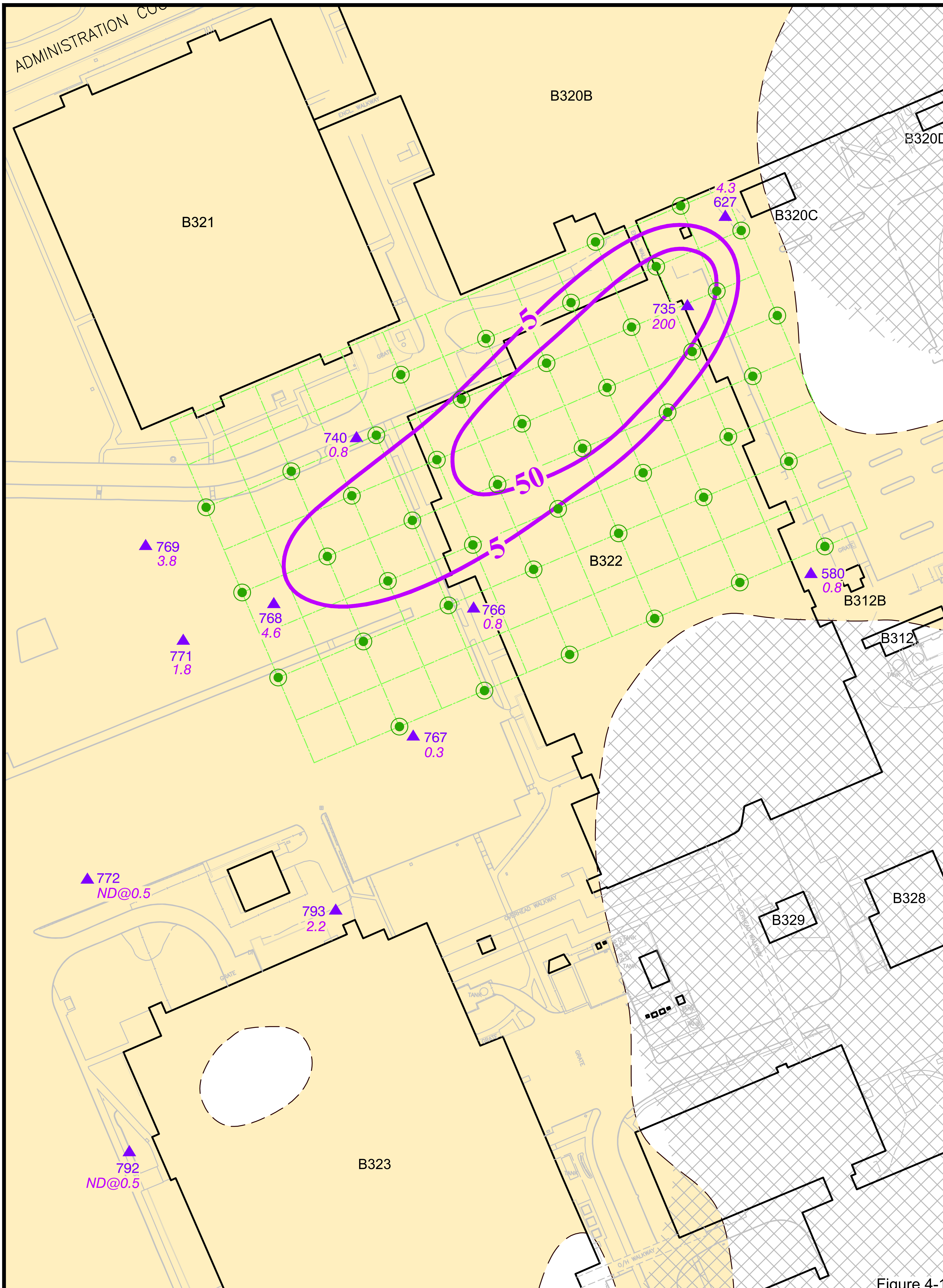
Former IBM East Fishkill Facility

Site and Surrounding Area Map

DRAWN BY: JPB | CHECKED AND APPROVED BY: RW/SF | DATE: 4/12/2019

H:\15000\15000\Project Next\GIS\2019-04 B322\Fig2-3_SiteAerialMap_20190412.mxd

GROUNDWATER SCIENCES CORPORATION



LEGEND

- Former IBM East Fishkill Facility Property Line
- Former Structure
- GMP Soil Monitoring Well
- Proposed Soil Vapor Sampling Probe

OU - Operable Unit

PCE - Tetrachloroethene

5 - PCE Concentration Contour (µg/l)

49 - PCE Concentration (µg/l; April 9-May 4, 2018)

ND@"X" - Not Detected at Laboratory Detection Limit "X"

- Extent of Clay Mapping
- Extent of Glaciolacustrine Clay (East Complex only) (Approximate)
- Inferred Areas of No Saturated Soil

Approximate N

Scale

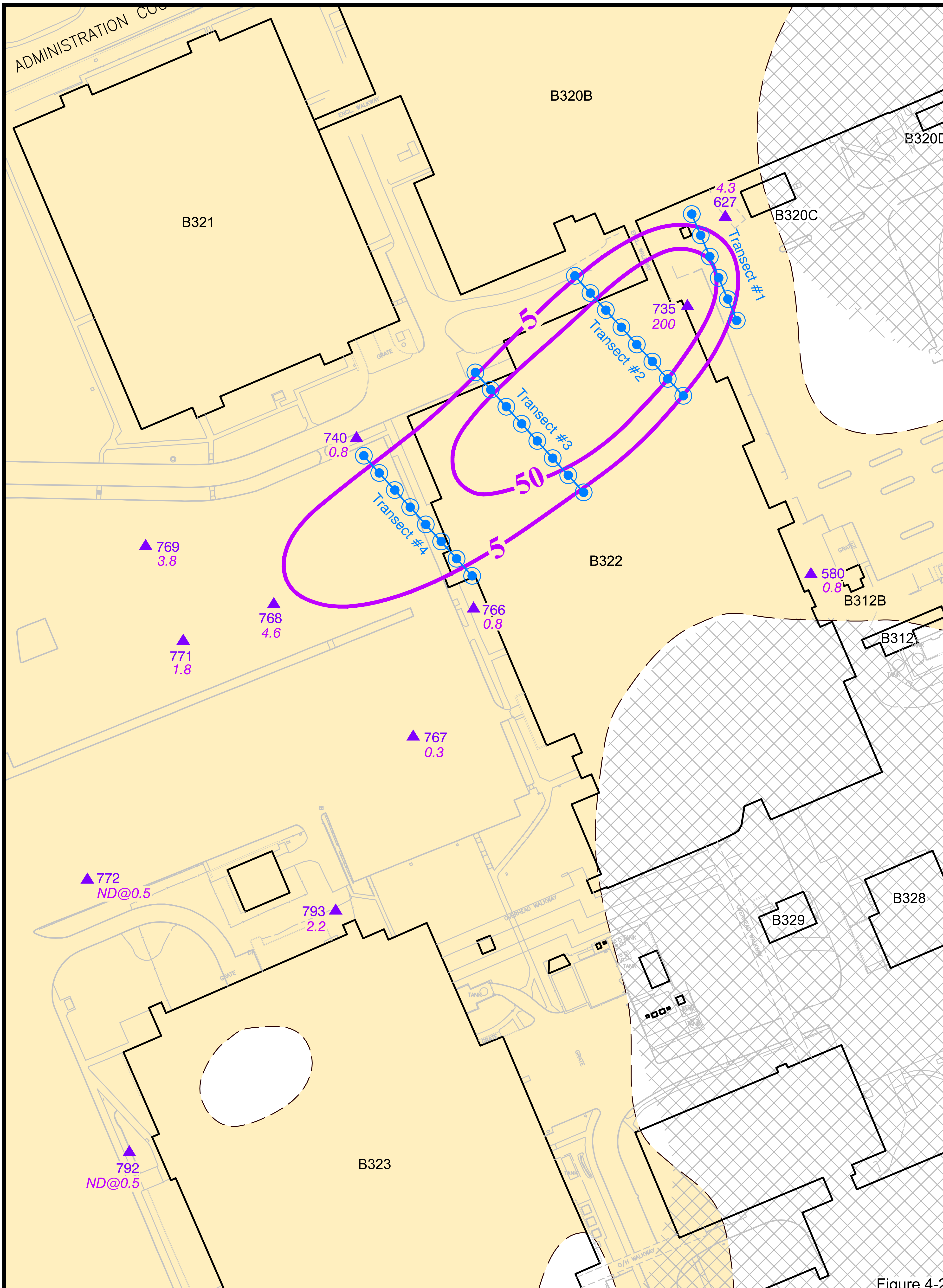
0 50' 100'

Former IBM East Fishkill Facility

Proposed Soil Vapor Sampling Probe Location Map

DRAWN BY: MHM/JPB	DATE: 4/12/19	DRAWING NO. 15000-027-A1
CHECKED & APPROVED BY: CES/RCW		

GROUNDWATER SCIENCES CORPORATION



LEGEND

- Former IBM East Fishkill Facility Property Line
- Former Structure
- GMP Soil Monitoring Well
- Proposed Membrane Interface Probe

OU - Operable Unit

PCE - Tetrachloroethene

5 - PCE Concentration Contour (µg/l)

49 - PCE Concentration (µg/l; April 9-May 4, 2018)

ND@"X" - Not Detected at Laboratory Detection Limit "X"

- Extent of Clay Mapping
- Extent of Glaciolacustrine Clay (East Complex only) (Approximate)
- Inferred Areas of No Saturated Soil

Approximate N

Scale

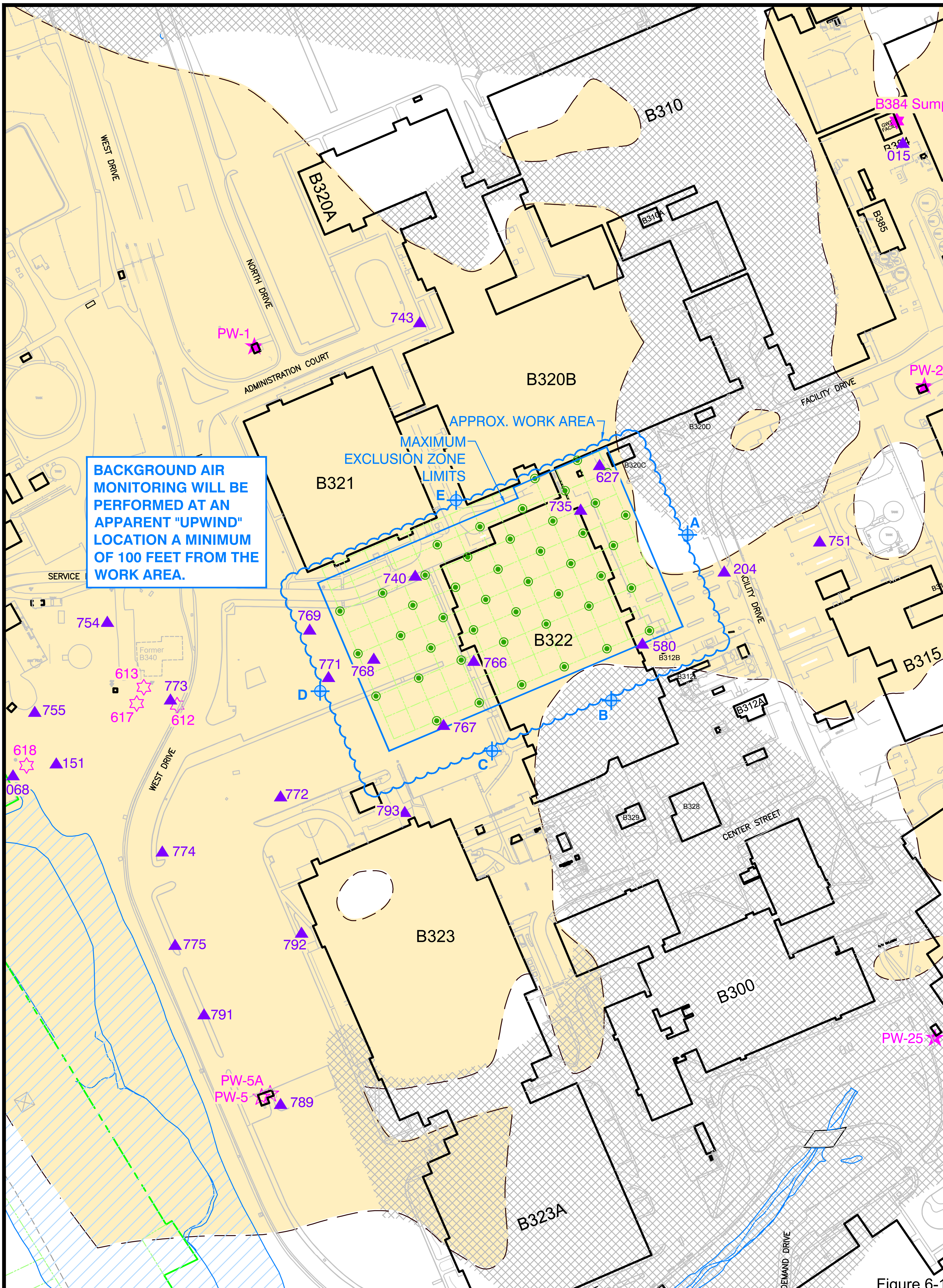
0 50' 100'

Former IBM East Fishkill Facility

Proposed Membrane Interface Probe Location Map

DRAWN BY: MHM/JPB	DATE: 4/12/19	DRAWING NO.
CHECKED & APPROVED BY: CES/RCW		15000-027-A2

GROUNDWATER SCIENCES CORPORATION



LEGEND

- Former IBM East Fishkill Facility Property Line
- Former Structure
- GMP Soil Monitoring Well
- Proposed Soil Vapor Sampling Probe
- Proposed Air Monitoring Location

OU - Operable Unit

- Extent of Clay Mapping
- Extent of Glaciolacustrine Clay (East Complex only) (Approximate)
- Inferred Areas of No Saturated Soil

Approximate N

Scale 0 50' 100'

Former IBM East Fishkill Facility

Proposed Air Monitoring Location Map

DRAWN BY: JPB	DATE: 7/19/19	DRAWING NO. 15000-027-B1
CHECKED & APPROVED BY: CES/RCW		

GROUNDWATER SCIENCES CORPORATION

GlobalFoundries (~145 acres)		
Lot 1	(45.64 acres)	GlobalFoundries U.S 2 LLC
Lot 5	(98.94 acres)	GlobalFoundries U.S 2 LLC

i.Park (~290 acres)		
Lot 2	(48.34 acres)	i.Park East Fishkill I LLC
Lot 3	(23.85 acres)	i.Park East Fishkill I LLC
Lot 4	(13.72 acres)	i.Park East Fishkill LLC
Lot 6	(56.19 acres)	i.Park East Fishkill LLC
Lot 7	(85.05 acres)	i.Park East Fishkill LLC
Lot 8	(59.40 acres)	i.Park East Fishkill LLC
Building 303		
Building 309		

Notes:

Lot 2 Reversionary Clause - Buildings 303 and 309: In the event GlobalFoundries or its successors ceases to exist or operate the chip fab or the need for hazard waste collection is eliminated, then said portion of Lot 5 containing Buildings 303 and 309 shall revert to Lot 2 owner or its successors.

Lot 4 Reversionary Clause - Bulk Storage Tanks: In the event GlobalFoundries or its succesors ceases to exist or operate the chip fab or the need for hydrogen gas is eliminated, then said portion of Lot 5 east of East Drive containing hydrogen tanks shall revert to Lot 4 owner or its successors.

LEGEND

- Former IBM East Fishkill Site Property Line
- Subdivision (GlobalFoundries U.S. 2 LLC)
- Subdivision (i.Park East Fishkill LLC)
- Subdivision (i.Park East Fishkill I LLC)
- Right-of-Way
- Fee Road

Irrevocable Offer of Cession and Dedication of Fee Roads:

South Drive	(Deed doc 02 2017 5782)
Fee Road IV and Fee Road VI	(Deed doc 02 2017 5783)
Fee Roads I, II, III and V	(Deed doc 02 2017 5784)

Plate 2-1

Former IBM East Fishkill Facility

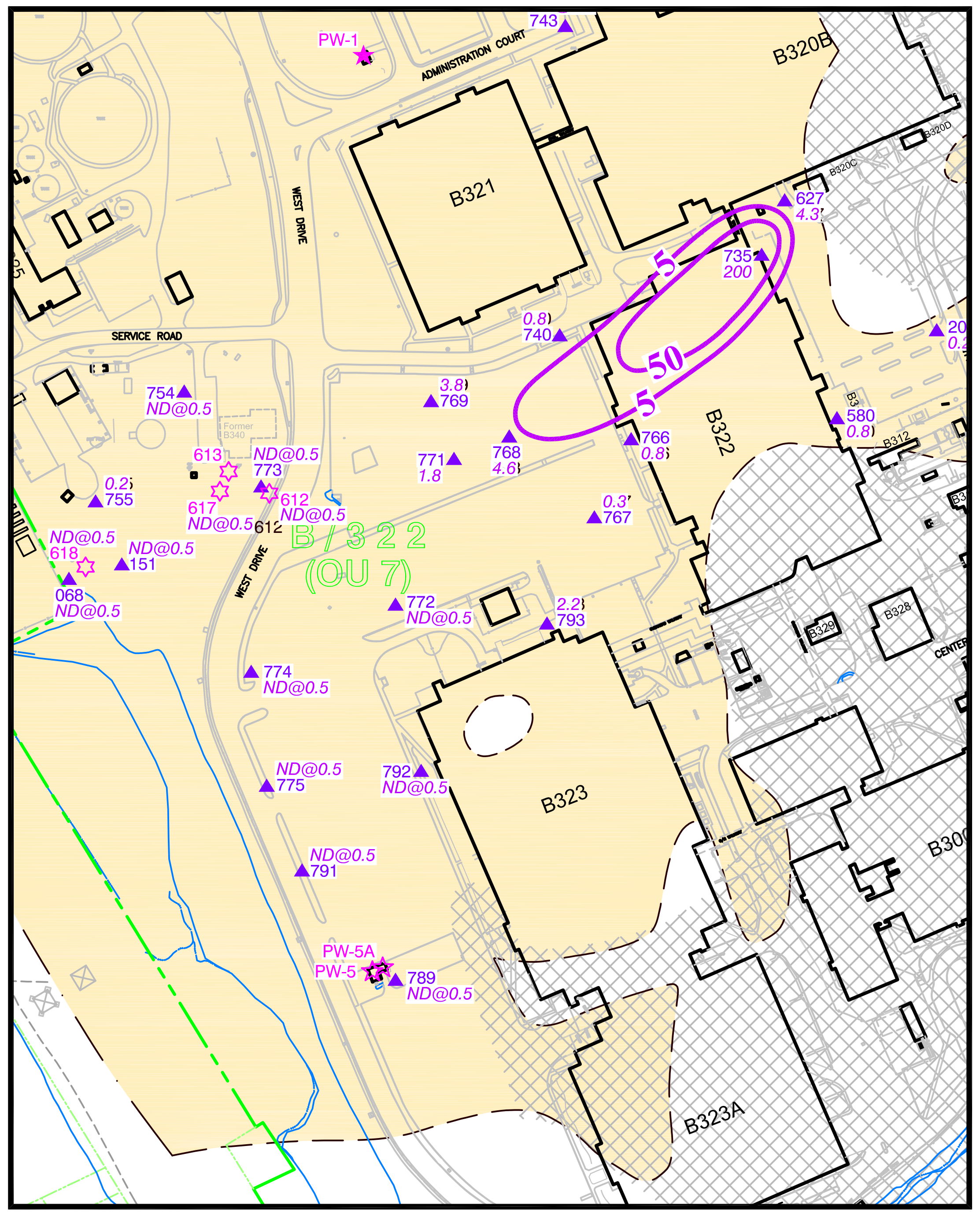
Site Subdivision Map

DRAWN BY: MHM	DATE: 4/11/19	DRAWING NO.
CHECKED & APPROVED BY: CES		95007-140-A1e

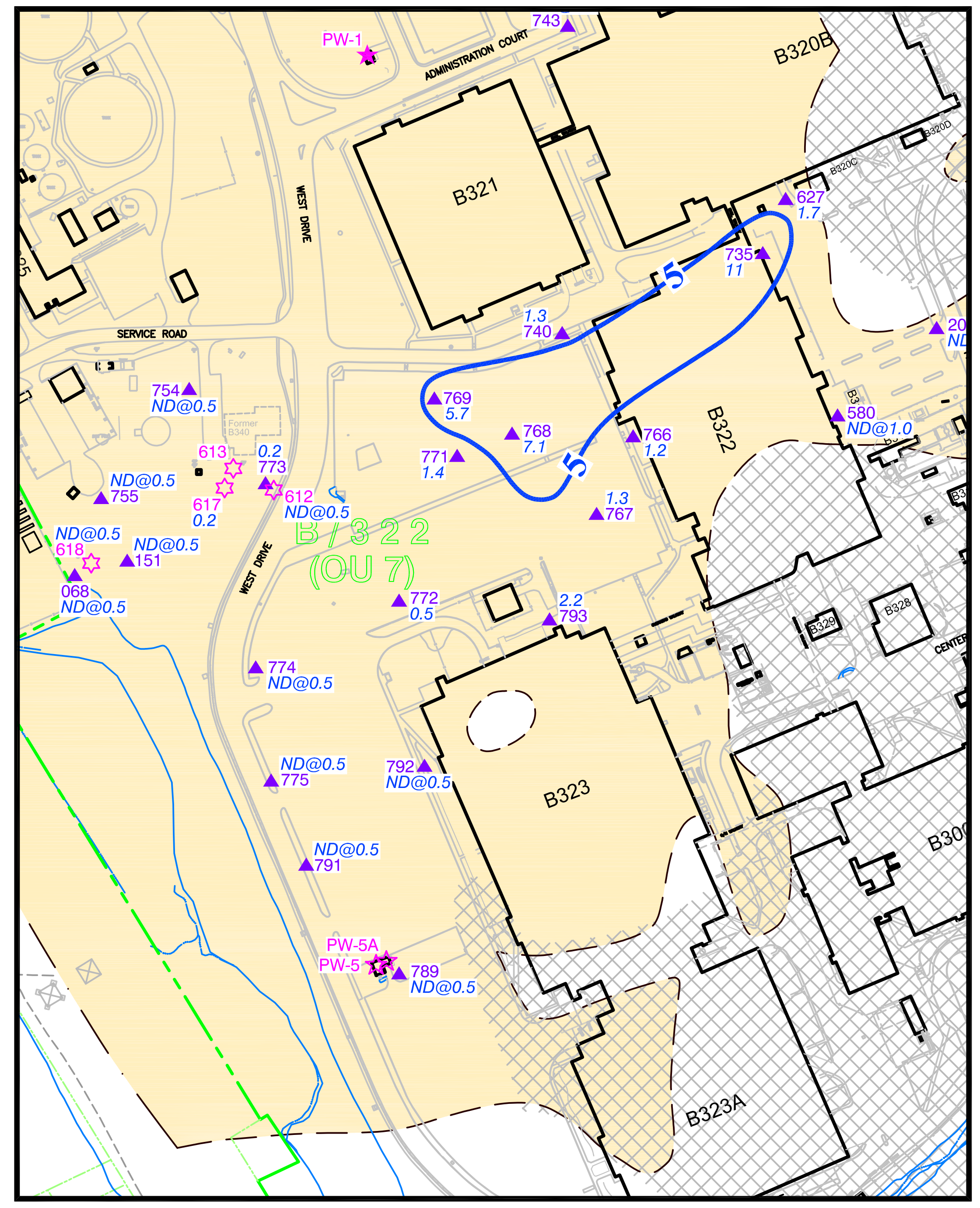
GROUNDWATER SCIENCES CORPORATION

Scale 0 200' 400'

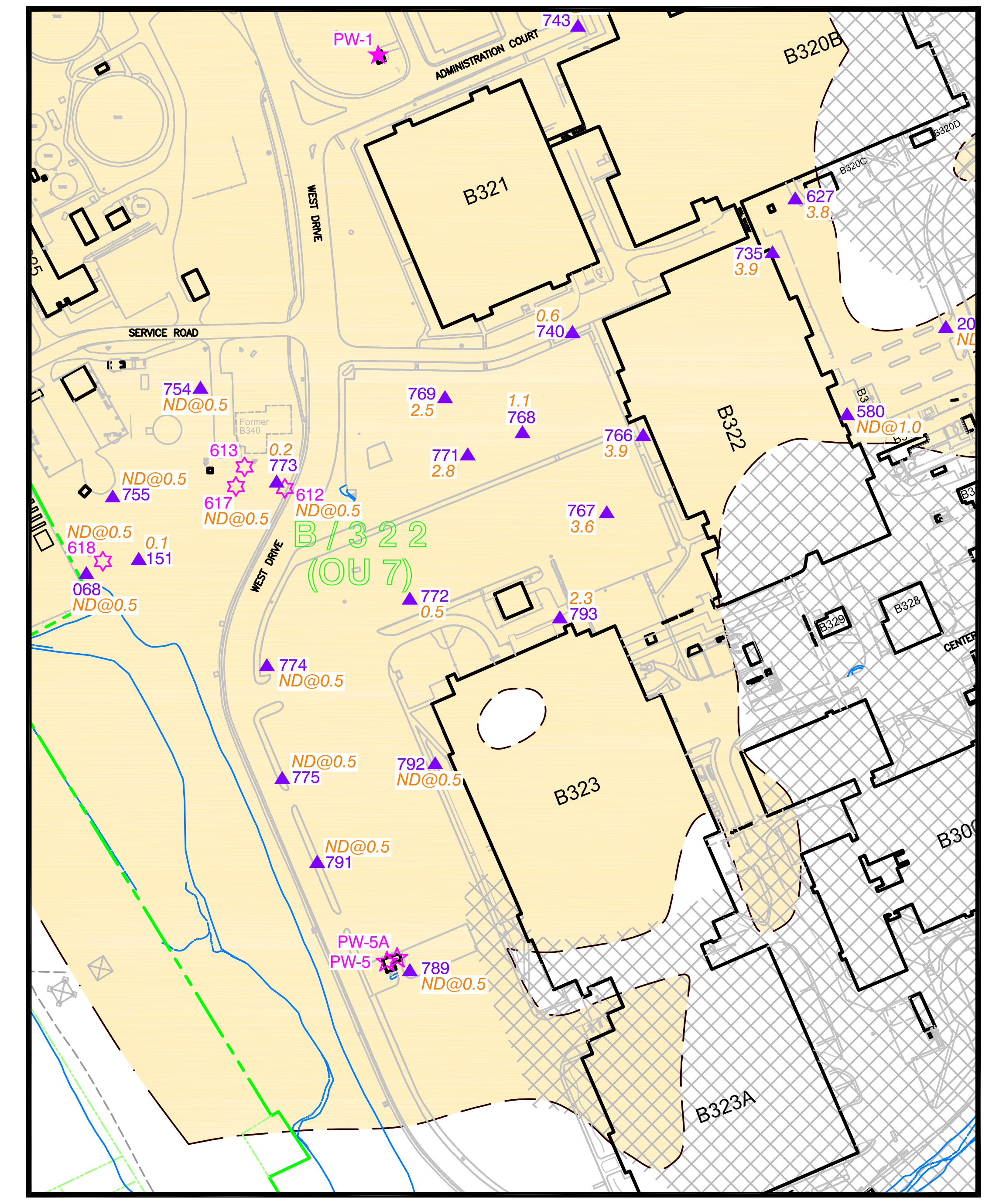
Site Basemap: Chazen Engineering, Land Surveying & Landscape Architecture Co., D.P.C., Poughkeepsie, NY (XBASE-SVY_51421-00.dwg, 8/10/15); Parcels: XSUBD_51539-00.dwg
Offsite Basemap: "Groundwater Monitoring Basemap", IBM East Fishkill Facility (9718new.dwg, original date 12/21/98).



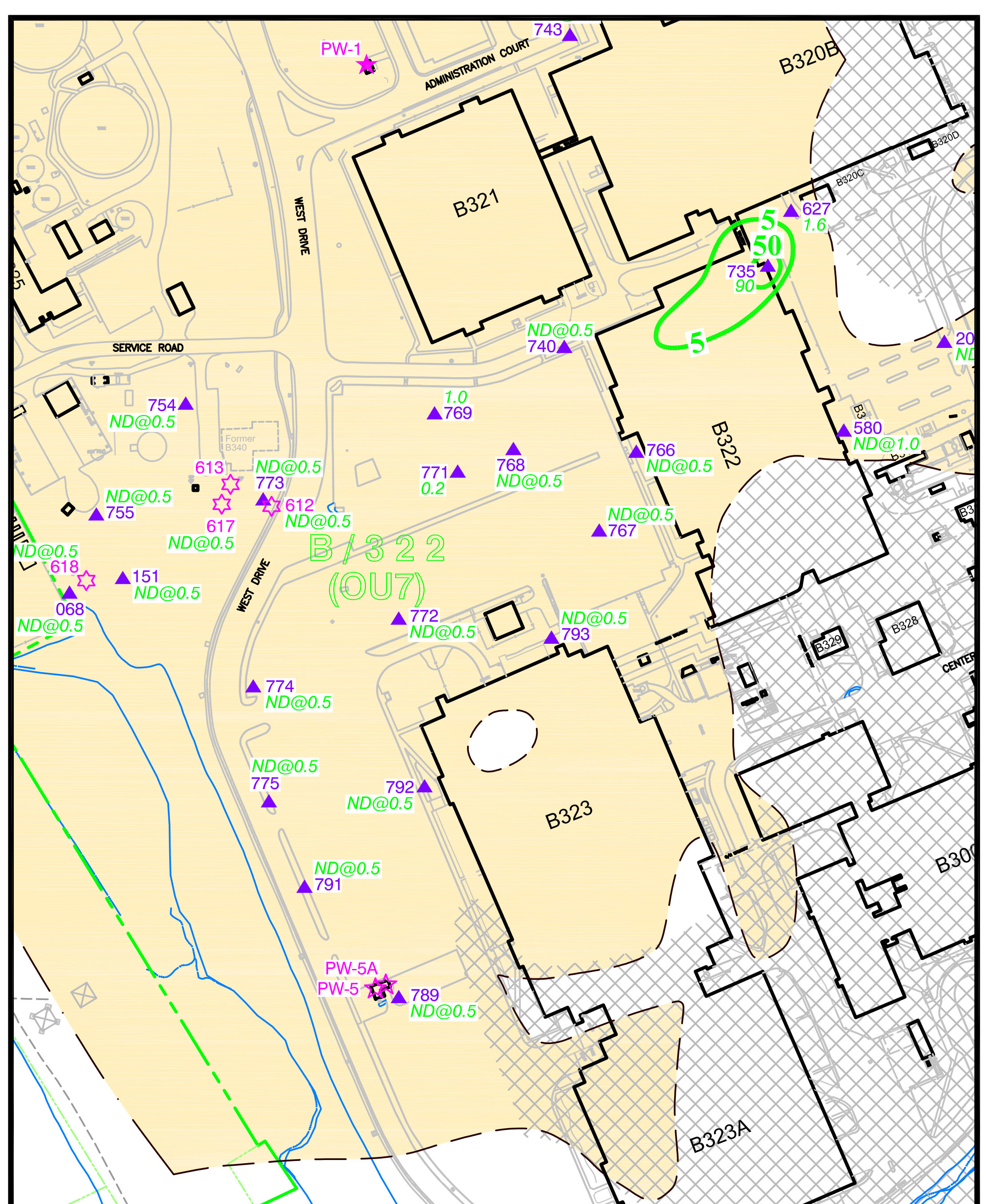
PCE



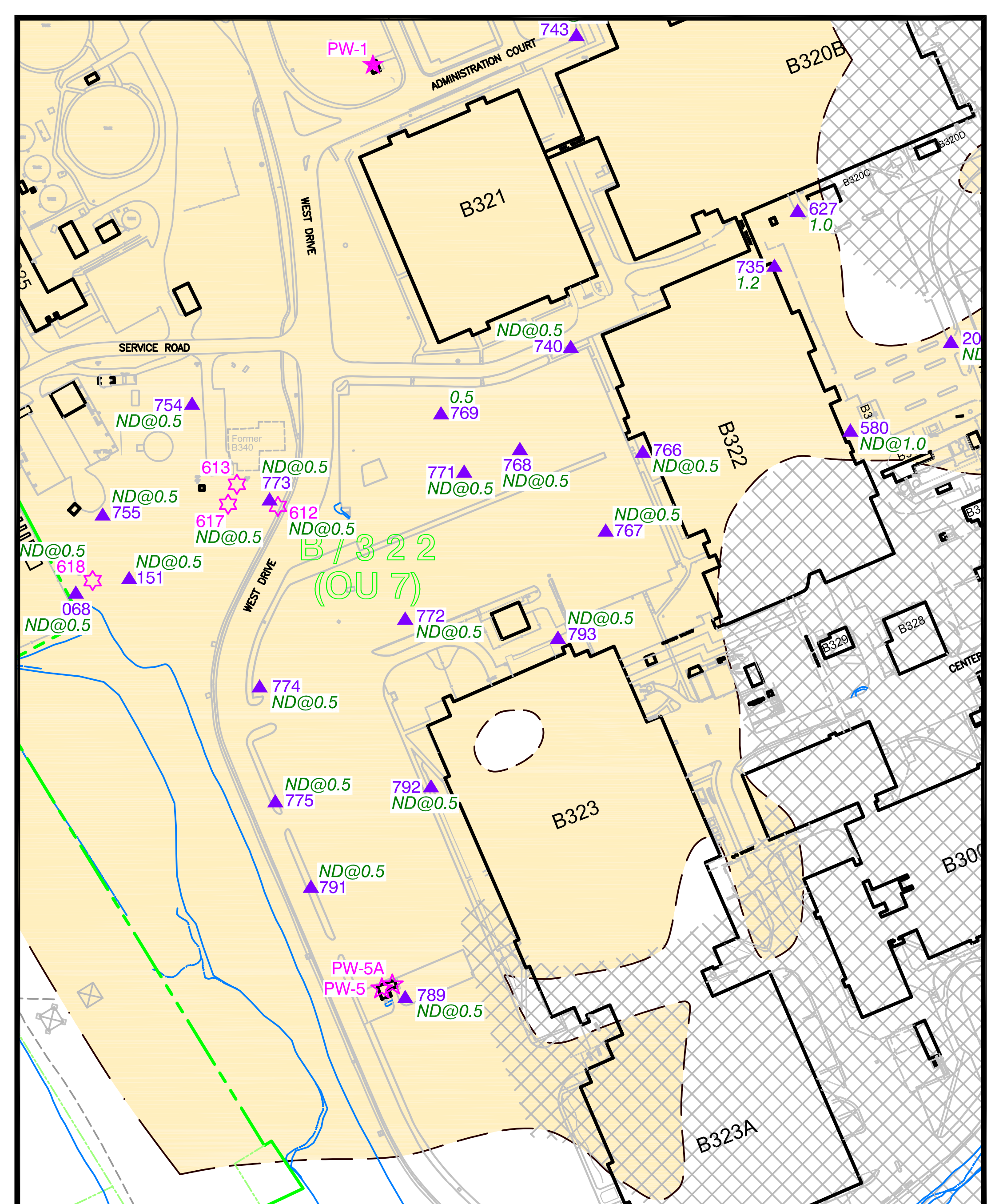
TCE



cis-1,2-DCE



Freon® TF



Freon® 123a

LEGEND

- Former IBM East Fishkill Facility Property Line
- GMP Soil Monitoring Well
- GMP Soil Monitoring Well (for groundwater elevations only)
- Bedrock Extraction Well
- Inactive Bedrock Extraction Well
- Inactive Shallow Extraction Well

OU - Operable Unit
PCE - Tetrachloroethene
TCE - Trichloroethene
cis-1,2-DCE - cis-1,2-Dichloroethene
Freon® TF - 1,1,2-Trichloro-1,2,2-Trifluoroethane
Freon® 123a - 1,2-Dichloro-1,2,2-Trifluoroethane

- Extent of Clay Mapping
- Extent of Glaciolacustrine Clay
- Inferred Areas of No Saturated Soil (approx.)

Samples collected April 9 through May 4, 2018.

Plate 2-2

Scale 0 150' 300'

Former IBM East Fishkill Facility

B322 Area Soil Groundwater Chemistry Comparison Map Second Quarter 2018

DRAWN BY: MHM	DATE: 4/11/19	DRAWING NO.
CHECKED & APPROVED BY: CES		95007-2Q2018_B322_5-up_1

GROUNDWATER SCIENCES CORPORATION

APPENDIX A: SOIL VAPOR PROBE SAMPLING PROCEDURES

Includes the following attachments:

Lab Reporting Limits

Soil Vapor Sampling Field Data Sheet

Chain of Custody Form

Field Screening Equipment Calibration Form

Appendix A

SOIL VAPOR SAMPLING PROCEDURES

April 30, 2019, Revised July 23, 2019

The overall data quality objectives of the soil vapor probe sampling is to adequately characterize soil vapor conditions with sufficient precision to allow for direct assessment of the presence or absence of volatile organic compounds (VOCs) in vadose zone soil and indirect assessment of the presence or absence of VOCs in groundwater. The data could also be used to assess the feasibility of certain remedial measures.

In general, soil vapor sampling will be performed by advancing a direct-push boring and by extracting a soil vapor sample from the probe. The soil vapor probe samples will be analyzed by a fixed-base laboratory. The procedures described in this document include: Direct-push borings, soil vapor probe sampling, soil vapor analysis, and field quality assurance sampling.

Direct-Push Borings

Soil vapor probes will be conducted using a hydraulically-driven direct-push boring machine. The borings will be advanced to a depth of approximately 7.0 feet below ground surface (bgs) using Geoprobe® 1.5 or 2.25-inch outer diameter (O.D.) steel rods. If probe refusal is encountered before 7.0 feet bgs, the probe will be reattempted within five feet of the initial probe location. For soil vapor sampling probe locations within the former footprint of Building 322, the concrete slab will be pre-cored prior to performance of the direct-push probes.

Temporaary Soil Vapor Point Installation and Sampling

After the steel rods have been advanced to the target depth, a temporary soil vapor monitoring point will be installed. Approximately 6 inches of sand will be placed at the bottom of the borehole. A 6-inch woven stainless steel screen will be attached to ¼-inch O.D. Telfon®-lined polyethylene tubing. The screen and tubing will be inserted to the target installation depth of 6.5 feet. Sand will be placed around the screen and approximately 6 to 12 inches above the screen. Bentonite grout or bentonite chips will extend from the top of the sand to the surface. The Geoprobe® rods will be steam cleaned between uses.

Sampling of each soil vapor point will commence no sooner than 24 hours after completion of the temporary soil vapor point. Each point will be purged of a minimum of one tubing volume or about 30 cubic centimeters (ccs) per 8 feet of tubing. Following purging, the soil vapor sample will be collected into a 1-liter SUMMA® canisters equipped with 30-minute flow controllers (equivalent to a sampling rate of about 27 mL/min – assuming a sampling volume of about 800 mL). The canisters will be connected to the tubing via a compression fitting. A detailed SUMMA® canister sampling procedure is provided in the following section.

Following collection of the soil vapor samples, a Tedlar® bag sample will be collected using a peristaltic pump and field screened for percent carbon dioxide, oxygen, and methane using a infrared gas analyzer. The soil vapor sampling rate for filling the Tedlar® bag should not exceed 200 milliliters per minute (mL/min) to limit the potential for infiltration of ambient air through cracks in pavement and/or shallow soil. Upon sampling completion soil vapor probe holes will be backfilled with bentonite and completed at the ground surface with either topsoil (grassed areas) or concrete (concrete sidewalk or paved areas).

Soil Vapor Probe SUMMA® Canister Sampling

SUMMA® canister sampling should be performed using the following steps outlined below:

1. Place the SUMMA® canister adjacent to the temporary sample point.

2. Record the SUMMA® canister serial number on the Sampling Field Data Sheet and Chain of Custody Form (COC Form).

3. Assign a Sampling Field ID and record this ID on the canister ID tag, Sampling Field Data Sheet, and COC Form.

4. Remove the brass plug from the canister fitting.

5. Install the pressure gauge with integrated metering valve on the canister valve fitting and tighten. Record the metering valve ID and /or other relevant information on the Sampling Field Data Sheet and COC Form (e.g. 30-minute valve; etc.)

6. Open and close the canister valve and record the gauge pressure on the Sampling Field Data Sheet and COC form. Confirm that the gauge pressure exceeds 25 inches Hg; if the pressure reads less than 25 inches Hg, remove the canister from service and begin again at Step 1 of this procedure.

7. Remove the brass plug from gauge fitting and store for later use.

8. Install the 2 micron particulate filter on the metering valve input fitting and tighten.

9. Connect the subsurface probe or implant to the end of the in-line particulate filter with $^1/_4$-inch Teflon® tubing and in-line stainless steel valve and in-line "T" using compression fittings.

10. Open the in-line valve and purge the Teflon® tubing between the subsurface probe and particulate filter using a graduated syringe. Closed the in-line valve and remove the syringe.

11. Open the canister valve to initiate sample collection. Record date and time of sample collection on Sampling Field Data Sheet and COC.

12. Upon completion of the sample collection period (e.g. 30 minutes); record the SUMMA® canister gauge pressure on the Sampling Field Data Sheet and COC Form.

13. Close the canister valve. Record the date and time of sample collection completion (valve closure) on the Sampling Field Data Sheet and COC Form.

14. Disconnect the Teflon® tubing and remove the particulate filter and pressure gauge with metering valve from the canister.

15. Reinstall the brass plug on the canister fitting and tighten.

Soil Vapor Analysis

Soil vapor probe samples and sub-slab soil vapor samples collected into SUMMA® canisters will be analyzed by a fixed-base analytical laboratory for VOCs by EPA Method TO-15. The soil vapor sample analyses will be performed by Eurofins Lancaster Labs Environmental (ELLE) of Lancaster, Pennsylvania. The specific compound list will include tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, Freon® TF, and Freon® 123. A list of ELLE's anticipated Method TO-15 reporting limits is attached.

Field Quality Assurance Samples

Field Quality Assurance samples collected as part of soil vapor sampling shall include field blanks and duplicate samples.

A field blank sample shall be collected to assess for the presence of VOCs due to ambient field conditions and sample collection procedures. The field blank samples shall consist of samples of ambient air that will be collected by filling a 1-liter SUMMA® canister equipped with a 30-minute flow controller. One field blank will be collected each day.

A duplicate soil vapor sample will be collected every twenty samples to assess laboratory precision. The duplicates shall be collected by filling multiple sampling containers simultaneously at the same location.

Field Documentation

Field documentation shall include Sampling Field Data Sheets, chain-of-custody forms, and field screening equipment calibration forms (see attached).

Sampling Field Data Sheets will be used to record specific information regarding the soil vapor samples including: locations, designations, types (SUMMA® canister), depths, purge volumes, collection times and rates, canister pressures, field screening results, and general comments such as weather conditions, noticeable odors, etc. Sample designations shall be based on sample type, vapor probe number, and date in accordance with the following:

- Sample type: Soil vapor (SV), field blank (FB), equipment blank (EB), and duplicate (DU)
- Vapor Probe Number
- Date of sample collection (year, month, day – YYYYMMDD)

A record shall be kept of field blanks and duplicate samples on the field data sheets.

A chain-of-custody will accompany the SUMMA® canister samples from the time of sample collection through laboratory analysis. The chain-of-custody record will, at a minimum, contain the following information: unique sample identification number, analysis requested, name of sample custodian, date and time of sample collection, SUMMA® canister start and stop pressures, date and time of sample receipt in laboratory, vacuum pressure of SUMMA® canisters upon receipt by the laboratory; signature(s) of person(s) relinquishing/receiving samples, and requested turnaround time. Information relating to the condition of samples upon receipt shall be written on the chain-of-custody form as a comment.

Eurofins Lancaster Labs Environmental
Method TO-15 (Air) Anticipated Reporting Limits

Analyte	Method Detection Limit (ppbv)	Limit of Quantitation (ppbv)	Method Detection Limit (ug/m3)	Limit of Quantitation (ug/m3)
cis-1,2-Dichloroethene	0.20	1.0	0.79	4.0
Freon 113	0.50	2.0	3.8	15
Freon 123a	0.20	0.50	1.3	3.1
Tetrachloroethene	0.20	1.0	1.4	6.8
trans-1,2-Dichloroethene	0.20	1.0	0.79	4.0
Trichloroethene	0.20	1.0	1.1	5.4
Vinyl Chloride	0.20	1.0	0.5	2.6

Soil Vapor Sampling Field Data Sheet

Project Name: | Project Number: | Date:

Project Location: | Sampling Personnel:

Sample Location	Sample Designation	Soil Vapor Probe or Sub-Slab Soil Gas Probe (CIRCLE ONE)	Sample Depth (ft bgs)	Sample Purge Vol. (ccs)	SUMMA® Can #	Sample Start Time	Sample Start Pressure (inches Hg)	Sample Stop Time	Sample Stop Pressure (inches Hg)	Approx Tedlar® Bag Purge Rate (mL/min)	PID (ppm)	FID (ppm)	% CO_2	% O_2	% CH_4	Comment #
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														
		SOIL VAPOR ----------------- SUB-SLAB														

Comments:

Summa Canister Field Test Data/Chain of Custody

eurofins

Lancaster Laboratories Environmental

For Eurofins Lancaster Laboratories Environmental use only

Acct. # ____________ Group # ____________ Sample # ____________________ Bottle Order (SCR) # ____________

Client Information	
Client	Account #
Project Name/#	
Project Manager	P.O. #
Sampler	Quote #
Name of state where samples were collected	

Turnaround Time Requested (TAT) (circle one)

Standard   Rush (specify) ____________

Data Package Required?		EDD Required?	
Yes	No	Yes	No

	Temperature (F)		Pressure ("Hg)	
	Start	Stop	Start	Stop
Ambient				
Maximum				
Minimum				

Analyses Requested

Sample Identification	Start Date/Time (24-hour clock)	Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO - 15	EPA 18 ☐ BTEX ☐ MTBE	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search	

Instructions/QC Requirements & Comments

EPA 25 (check one)

☐ C1 - C4   ☐ C2 - C10
☐ C1 - C10   ☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by:	Date/Time:	Canisters Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:

Gas Detection Monitor
Calibration Form

Model Name: ______________________________

Serial/Model No:___________________________ Rented From:_______________________________________

Calibration Date	Initials	Calibration Gas	Comments

APPENDIX B: SOIL AND GROUNDWATER SAMPLING PROBE PROCEDURES

Includes the following attachments:

Lab Reporting Limits

Boring Log

Chain of Custody Form

Field Screening Equipment Calibration Form

Appendix B

SOIL AND GROUNDWATER SAMPLING PROBE PROCEDURES

April 30, 2019, Revised July 23, 2019

The overall data quality objectives of the soil and groundwater sampling probes are to adequately characterize soil and groundwater conditions with sufficient precision to allow for direct assessment of the presence or absence of volatile organic compounds (VOCs) in vadose zone and saturated zone soil and direct assessment of the presence or absence of VOCs in groundwater. The data could also be used to assess the feasibility of certain remedial measures.

In general, soil and groundwater sampling will be performed by advancing a direct-push boring and extracting a soil and a groundwater sample. The soil and groundwater samples will be analyzed by a fixed-base laboratory. The procedures described in this document include: Direct-push borings, soil sampling, groundwater sampling, soil and groundwater analysis, and field quality assurance sampling.

Direct-Push Borings and Soil Sampling

Soil borings will be advanced to the top of lacustrine silt using a hydraulically-driven direct-push boring machine. The soil samples will be collected into single-use disposable plastic tubes using steam-cleaned Geoprobe® Macrocore or Dual-Tube samplers assembled without lubricated threads. After each sample has been brought to the surface by the drilling contractor, it will be opened in the presence of the supervising geologist. The geologist will then screen the sample using photoionization detector (PID) by holding the detector wand over each sample as it is opened but prior to being otherwise physically disturbed. Elevated readings (above background) from the PID will be recorded on the field log. Where there is sufficient recovery, soil samples will then be collected from each Geoprobe® Macrocore or Dual-Tube sampler. These samples may include a sample for jar headspace analysis and a sample for possible laboratory analysis.

The length of recovery will be measured and recorded on the log, and the sample will be cut in half longitudinally using a clean stainless steel knife or single-use sterile plastic spatula designed for soil sampling. The sample will then be logged for lithology, texture, weathering, color, density, moisture, sample depth interval, penetration, and recovery, with descriptions following the

Modified Burmeister Classification System. If no sample is required for chemical or headspace analysis, the soil will be placed in a glass jar or sealable plastic bag, which will be individually labeled with the boring number, the depth interval of the sample, the date of collection, and the name or initials of the sampling personnel.

From each split-spoon sample for which a laboratory analysis may be required, a soil sample will be collected into 40-milliliter VOA vials provided by the analytical laboratory and labeled with the boring number, sample number, date collected, depth interval, and analyses requested. The soil samples will be placed in cooler with ice and shipped via chain-of-custody protocols to the analytical laboratory.

Procedure for Jar Headspace Analysis

For soil samples requiring a jar headspace analysis, each sample will be placed in an appropriately-sized glass jar such that one-half to two-thirds of the jar is filled with the soil sample, loosely packed, and the remainder is headspace. The top of the jar then will be covered with aluminum foil secured by a rubber band around the neck of the bottle, and will be allowed to stand at ambient temperature in the best available temperature-controlled space for a period of at least 15 minutes. As an alternative, the samples will be placed in a cooler or on ice to be removed within 24 hours and allowed to equilibrate to room temperature. The probe of the field survey instrument (PID or FID) will then be inserted through the aluminum foil to just above the surface of the soil. The initial reading on the field survey instrument will be noted and monitored for a period of at least five seconds, with the maximum concentration then being noted on the field log at the appropriate sample depth.

Groundwater Sampling within Direct-Push Borings

Upon completion of each direct-push boring, a groundwater grab sample will be obtained. The groundwater samples will be collected using a peristaltic pump and single-use polyethylene tubing. The samples will be collected into 40 milliliter (ml) VOA vials that are pre-preserved with hydrochloric acid. The sample vials will be provided by the analytical laboratory and labeled by the GSC geologist with the boring number, sample number, date collected, depth interval, and analysis requested. The groundwater samples will be placed in cooler with ice and shipped via chain-of-custody protocols to the analytical laboratory.

Analysis of Soil and Groundwater Samples

The soil and groundwater samples will be analyzed for volatile organic compounds by SW-846 Method 8260B. The sample analyses will be performed by Eurofins Lancaster Labs Environmental (ELLE) of Lancaster, Pennsylvania. The specific compound list will include tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, Freon® TF, and Freon® 123. ELLE's anticipated SW-846 Method 8260B reporting limits (Method Detection Limit and Limits of Quantitation) for the specified soil and groundwater analytes are attached.

Field Quality Assurance Samples

Field Quality Assurance samples collected as part of soil and groundwater sampling shall include trip blanks and equipment rinse blanks.

A trip blank sample shall be prepared by the analytical laboratory that will accompany the soil and groundwater grab sample containers and soil and groundwater samples from the time of sample container shipment from the laboratory through sample collection and laboratory receipt of the samples. The trip blanks will be collected to assess for the presence of VOCs due to ambient field conditions and sample shipment. One trip blank will be collected for each sample batch (sample cooler).

Equipment rinse blank samples shall be collected by pouring laboratory-grade deionized water over the cleaned downhole soil and groundwater sampling equipment and collecting the water into 40-ml VOA vials for VOC analysis. The equipment blank results will be used to assess for the presence of VOCs that could be associated with carry over from non-dedicated sampling equipment. At least one equipment blank sample shall be collected per every twenty soil samples and every ten groundwater samples.

Field Documentation

Field documentation shall include boring logs, chain-of-custody forms, and field screening equipment calibration forms (see attached). The field documentation logs and forms will be used to record specific information regarding the soil and groundwater samples including: locations, designations, depths, collection times, field screening results, and general comments such as weather conditions, noticeable odors, etc… Sample designations shall be based on sample type, soil boring number, soil sample depth, groundwater sample depth (end of polyethylene tubing) and date in accordance with the following:

- Sample type: Soil (S), groundwater (GW), trip blank (TB), and equipment blank (EB)
- Soil boring number
- Nominal soil sample depth (feet bgs) or nominal groundwater sample depth (feet bgs)
- Date of sample collection (year, month, day – YYYYMMDD)

Separate chain-of-custody forms will accompany the soil samples and groundwater samples from the time of sample collection through laboratory analysis. The chain-of-custody record will, at a minimum, contain the following information: unique sample identification number, analysis requested, name of sample custodian, date and time of sample collection, date and time of sample receipt in laboratory; signature(s) of person(s) relinquishing/receiving samples, and requested turnaround time. Information relating to the condition of samples upon receipt shall be written on the chain-of-custody form as a comment.

Eurofins Lancaster Labs Environmental
Method SW-846 8260C (Soil) Anticipated Reporting Limits

Parameter	Method Detection Limit (ug/kg)	Limit of Quantitation (ug/kg)
cis-1,2-Dichloroethene	0.5	5
Freon 113	0.6	10
Freon 123a	0.6	5
Tetrachloroethene	0.5	5
trans-1,2-Dichloroethene	0.5	5
Trichloroethene	0.5	5
Vinyl Chloride	0.6	5

Reporting Limits will change based on moisture content.

Eurofins Lancaster Labs Environmental
Method SW-846 8260C (Water) Anticipated Reporting Limits

Parameter	Method Detection Limit (ug/l)	Limit of Quantitation (ug/l)
cis-1,2-Dichloroethene	0.05	0.5
Freon 113	0.06	0.5
Freon 123a	0.06	0.5
Tetrachloroethene	0.06	0.5
trans-1,2-Dichloroethene	0.06	0.5
Trichloroethene	0.06	0.5
Vinyl Chloride	0.1	0.5

Reporting Limits based on 25 ml purge.

FIELD OPERATIONS REPORT Project No. ________	Total Depth ________ Depth to S.S. Refusal ________ Depth to Competent Bedrock ________ SWL (Date) ________ Screened Interval ________ Hole Diameter ________ Monitoring Tube ________ Elev., Ground Surface ________	Well No. ________ Driller ________ Logged by ________ Drilling Began ________ Drilling Completed ________ Well Const. Completed ________ Development Completed ________ Elev., T.O.C. ________

					SAMPLE DESCRIPTION	% Grn. Size					Graphic		
Depth	Blow Count	PID (ppm)	Recovery in.	Sample No./ Run No.	(USCS), Grn. Size, Color, Shape, texture, moistness, etc.	C	S	Sd	Gr	Other Notes	Lith.	Well Constr.	Depth

GROUNDWATER SCIENCES CORPORATION

IBM Chain of Custody

eurofins | Lancaster Laboratories Environmental

For Eurofins Lancaster Laboratories Environmental use only
Acct. # ______________ Group # ______________ Sample # ______________
Instructions on reverse side correspond with circled numbers.

COC # 019634

Client Information

Client	Acct #
Project Name/#	SSOW #
IBM PM	Project State
P.O. #	Sampler

For Compliance: ☐ Yes ☐ No

Check One:
☐ Routine Lab GW ☐ Routine GTF O&M
☐ Non-Routine Investigation ☐ Non-Routine Upgrades/Installs

OU: ______________________ (Endicott Non-Routine only)

Sample Identification	Collected Date	Collected Time	Grab	Composite	Matrix: ☐ Sediment ☐ Soil	☐ Ground ☐ Potable Water	☐ Surface ☐ NPDES Water	☐ Air ☐ Oil	Total # of Containers	Analyses Requested (Preservation Code)										For Lab Use Only / Remarks

For Lab Use Only
SCR#

Preservation Codes
H = HCl T = Thiosulfate
N = HNO_3 B = NaOH
S = H_2SO_4 O = Other

Remarks

Turnaround Time Requested (TAT) (please circle)
Standard Rush
(Rush TAT is subject to Lancaster Laboratories approval and surcharges.)
Date results are needed: ______________________
E-mail: ______________________

Relinquished by	Date	Time	Received by	Date	Time
Relinquished by	Date	Time	Received by	Date	Time
Relinquished by	Date	Time	Received by	Date	Time
Relinquished by	Date	Time	Received by	Date	Time

Data Package Options (please circle if required)

Type I (Validation/NJ Reg)	TX TRRP-13	NY ASP A
Type III (Reduced NJ)	MA MCP	NY ASP B
Type VI (Raw Data Only)	CT RCP	

SDG Complete? Yes No

Site-specific QC (MS/MSD/Dup)?
Yes No
(If yes, indicate QC sample and submit triplicate volume.)

Temperature upon receipt ________ °C

Eurofins Lancaster Laboratories Environmental, LLC • 2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300
The white copy should accompany samples to Eurofins Lancaster Laboratories Environmental. The yellow copy should be retained by the client.

7052 0417

Photoionization Detector
Calibration Form

Model Name:____

Serial/Model No:____________________________ Rented From:____

Calibration Date	**Initials**	**Calibration Gas**	**Comments**

APPENDIX C: SOIL BORING AND MONITORING WELL INSTALLATION PROCEDURES

C-1: Soil Boring and Monitoring Well Installation Procedure

C-2: Soil Sampling and Analysis Procedures

C-3: Well Development Procedure

Includes the following attachments:

Well Development Field Data Sheet

Appendix C-1

SOIL BORING & MONITORING WELL INSTALLATION PROCEDURE

April 30, 2019, Revised July 23, 2019

The following is a procedure for the drilling of soil borings for the collection of soil samples and the installation and development of groundwater monitoring wells constructed to monitor water levels and water quality in the soil.

Decontamination Procedures

The drilling equipment, tools, and well casing materials will be decontaminated to remove foreign materials, particularly petroleum-based products. All of the materials referenced above will be decontaminated prior to arrival at the site, and before being used in any well bore, by high pressure steam cleaning with super-heated water (above 100 degrees C). The drilling rig and other equipment or materials that come into contact with soil, water, or rock cuttings will also be decontaminated using this procedure before the rig is moved to the next well location and before it is demobilized. This steam cleaning and all other decontamination activities will be conducted at a decontamination area to be designated by IBM.

The decontamination pad consists of a bermed area lined with heavy-mil plastic such that the drilling rig and tools are cleaned inside the bermed area, and the decontamination water is contained by the berm. Field-generated decontamination water will be contained and treated on-Site at IBM's B/384 groundwater treatment facility.

All materials used to construct monitoring wells will be new and will be supplied in appropriate containers (e.g. bagged sand, not bulk sand). Electronic equipment (e.g. electronic water level measuring devices, pressure transducers) shall be decontaminated by washing with a laboratory-grade detergent-and-water solution, followed by an organic-free water rinse.

The threaded flush joint PVC or stainless steel pipe and screen used in constructing monitoring wells will be steam-cleaned immediately prior to use unless it is delivered in intact sealed plastic wrappings and is certified by the manufacturer to be factory-decontaminated for monitoring well use. All other materials used during well construction or monitoring (with the exception of sand and bentonite) will be decontaminated prior to being introduced to the well bore by the following procedure:

1. High pressure steam cleaning with super-heated water (over 100 degrees C) until equipment is hot to the touch and any visible contamination is removed. All water used shall be brought to the site from a municipal or private potable water supply designated by IBM.

2. Following steam cleaning, all materials will be handled only by personnel wearing nitrile or other chemical-resistant gloves. After being decontaminated, equipment will be handled such that it is not recontaminated prior to being used. This may involve placing on plastic, wrapping in plastic, or placing in similarly decontaminated containers.

All decontamination activities will be performed by, or directly supervised by, qualified technical or scientific personnel.

Monitoring Well Installation Procedure

The following procedure specifies procedures to be followed for the drilling and installation of soil monitoring wells in the project area.

Drilling

Drilling locations shall be selected on the basis of program objectives and the presence of buried and overhead utilities. Prior to drilling, all locations will be approved by IBM and/or the site owner with regard to utilities. New York's One-Call utility clearance hotline will be notified by the driller at least three working days in advance of drilling.

A truck-mounted hollow-stem auger drilling rig equipped with 8-inch O.D. and 4-1/4-inch I.D. augers and 2-inch or 3-inch O.D., two-foot-long split-spoon samplers typically will be used. Soil samples will be collected continuously as the well is being drilled in accordance with the soil sampling procedures as described in Appendix C-2. Blow counts from the standard penetration test will be recorded for each six-inch depth interval. After being advanced 2 feet by blows of 140-lb. hammer falling 30 inches (standard penetration test), the split spoon and sample will be removed and the augers will be advanced through the same 2-foot interval. In this way, only undisturbed soil samples will be collected.

Drilling will continue to the designated depth. Screen length will depend on the thickness of the soil aquifer and screen slot size will depend on a visual inspection and physical evaluation of the formation gradation.

Removal of Soil Cuttings at Drilling Locations

Cuttings generated during will drilling will be placed in drums, labeled, and stored at a designated location prior to disposal in accordance with IBM-approved disposal procedures.

Monitoring Well Construction

In the construction of all soil monitoring wells, a basic design will be followed to maintain uniformity. This basic soil monitoring well design includes the following elements:

1. Two-inch diameter, Schedule 40, threaded flush joint PVC screen (maximum length of 15 feet) and riser pipe.

2. Morie #00N silica sand pack and 20-slot (0.020-inch) screen size. (For screening fine-textured soil, e.g. silt, Morie #00 sand and 10-slot screens will be used.) The sand will be installed to a minimum of six inches but no more than 2 feet above the screen such that the entire monitoring interval (screen and sand pack) does not exceed 20 feet, unless approved by NYSDEC.

3. A minimum of one foot of bentonite chips/pellets, as appropriate, will extend to a level of at least two feet above the top of the sand pack.

4. Bentonite slurry (granular bentonite/water mix) to seal the remainder of the borehole to a depth of three feet from ground surface.

Variations on this basic design will be determined by the elevation of the static water level and soil characteristics.

Surface Completions

The surface soil around the outer casing will be excavated to a depth of at least one foot around the area of the outer casing. This excavation will be filled with concrete. The steel well casing or protector pipe, when installed and grouted, shall extend above the ground surface approximately 2.5 feet. Where site-specific activities prevent this type of standpipe completion or where the property owner does not want the well casing to extend above the ground surface, the riser pipe and outer casing (if present) shall be cut off below grade and placed inside a manhole. The area around the manhole will be excavated to a depth of at least one foot and will be filled with concrete. Where these flush-mount surface completions are required, an expanding water-tight locking plug will be installed on the PVC or stainless steel riser pipe inside the manhole to prevent surface water or contaminants from entering the well.

Supervision and Quality Control

Each drilling rig and its operators and crew will be supervised by a geologist. The geologist will maintain a record of the geologic materials encountered and the construction of the well. It is the responsibility of the geologist to select an appropriate well completion design and to ensure that the well is constructed according to these procedures. Additional responsibilities include measurement and recording of static water levels, field logging of soil returns and rock cuttings, and implementation of decontamination and health and safety procedures.

Appendix C-2

SOIL SAMPLING AND ANALYSIS PROCEDURES

April 30, 2019, Revised July 23, 2019

1. Procedure for Collecting Soil Samples

Soil samples will be recovered using steam-cleaned split-spoon samplers assembled without lubricated threads. After each sample has been brought to the surface by the drilling contractor, it will be opened in the presence of the supervising geologist. The geologist will then screen the sample using a photoionization detector (PID) by holding the detector wand over each split spoon as it is opened but prior to being otherwise physically disturbed. Elevated readings (above background) from the PID will be recorded on the field log. Where there is sufficient recovery, soil samples will then be collected from each split spoon sampler. These samples may include a sample for jar headspace analysis (Section 2).

The length of recovery will be measured and recorded on the log, and the sample will be cut in half longitudinally using a clean stainless steel knife or single-use sterile plastic spatula designed for soil sampling. The sample will then be logged for lithology, texture, weathering, color, density, moisture, sample depth interval, penetration, and recovery, with descriptions following the Modified Burmeister Classification System. If no sample is required for chemical or headspace analysis, the soil will be placed in a glass jar or sealable plastic bag, which will be individually labeled with the boring number, the depth interval of the sample, the date of collection, and the name or initials of the sampling personnel.

From each split-spoon sample for which a laboratory or jar headspace analysis may be required, a soil sample will be collected in accordance with Sections 2 and 3.

2. Procedure for Jar Headspace Analysis

For soil samples requiring a jar headspace analysis, each sample will be placed in an appropriately-sized glass jar such that one-half to two-thirds of the jar is filled with the soil sample, loosely packed, and the remainder is headspace. The top of the jar then will be covered with aluminum foil secured by a rubber band around the neck of the bottle, and will be allowed to stand at ambient temperature in the best available temperature-controlled space for a period of at least 15 minutes. As an alternative, the samples will be placed in a cooler or on ice to be removed within 24 hours and allowed to equilibrate to room temperature. The probe of the PID will then be inserted through the aluminum foil to just above the surface of the soil. The initial reading on the field survey instrument will be noted and monitored for a period of at least five seconds, with the maximum concentration then being noted on the field log at the appropriate sample depth.

Appendix C-3

WELL DEVELOPMENT PROCEDURE

April 30, 2019, Revised July 23, 2019

The primary purpose of well development is to remove fine formation particles, remove fluids introduced during drilling activities, and promote the exchange of groundwater from the formation into the well. Well development will be performed by one or more field services technicians, possibly with the assistance and oversight of a geologist. Information relating to well development will be recorded on a Well Development Field Data Sheet (attached). Upon completion of a well installation a determination of the amount of time to allow prior to initiating well development activities will be made by the Project Manager based on observations recorded during borehole advancement and well construction.

Specific development procedures are outline below.

1. Initial development to remove fines from the sand pack and surrounding formation will be performed using an inertial pump equipped with an appropriately sized surge block, or a PVC- or stainless-steel purge bailer. If an inertial pump is used, the position of the surge block will be varied through the entire screen length during this process.

2. Following this initial surging of the well, development will continue using a submersible pump, peristaltic pump, or an inertial pump. If an inertial pump is used, the surge block will be replaced with a simple check valve. The well will be stressed using one of these options until field parameters stabilize or at least ten well volumes are removed, whichever is longer. Conditions will be considered to have stabilized when:

    a. the discharge achieves visual clarity,

    b. the range in pH values for three consecutive well volumes is within 0.5 pH units,

    c. specific conductance is within 10% for three consecutive well volumes, and

    d. temperature is within 2 degrees C for three consecutive well volumes.

    Development water will be placed in containers, moved to a secure location, and transported for treatment at one of IBMs treatment facilities after well development.

3. Documentation regarding produced water clarity during initial surge block development and subsequent over pumping will be maintained on the Well Development Field Data Sheet. Observations regarding clarity will be recorded in the "Remarks & Clarity" column on this form.

Well Development Field Data Sheet

Well ______________________ Site ______________________________

Development Personnel __________________________ Pump Type _____________

Casing Diameter ____________ DTW __________ DTB ______________

Well Volume = _____________ gal/ft* x (DTB - DTW) ________ = _______ gal

x3 = _______ gal

x10 = _______ gal

Date	Time	WL (ft)	Flow Rate	Temp	pH	△pH (units)	Cond.	△Cond. (%)	Total Volume	Remarks & Clarity

*gal/ft: 1" = 0.041; 1.5" = 0.092; 2" = 0.163; 3" = 0.367; 4" = 0.65; 6" = 1.47; 8" = 2.61

or

gal/ft calculation: $(1/4d^2\pi h)$ x 7.4805 = ______ gal/ft (h = 1; d = diameter in feet)

Revised 8/25/95

APPENDIX D: GROUNDWATER SAMPLING AND ANALYSIS PROCEDURES

Includes the following attachments:

Field Sampling Data Sheet

Appendix D

GROUNDWATER SAMPLING AND ANALYSIS PROCEDURES

April 30, 2019, Revised July 23, 2019

This appendix presents detailed procedures for pre-sampling preparation and sample collection. Sample handling, documentation, field quality assurance sampling procedures and health and safety issues are also described. The organization of this information generally follows the order in which these tasks will be performed.

1 PREPARATION FOR SAMPLING

This section describes the procedures to be followed by field sampling personnel prior to the initiation of the sampling event. Sampling personnel will be trained in the use of the sampling plan, and a copy of the plan will be available to the samplers when performing field activities.

1.1 Equipment Procurement, Inspection, Calibration, and Maintenance

Prior to the sampling event, sampling equipment will be inspected to verify cleanliness and to ensure proper working order. Worn parts will be replaced prior to the sampling event and preventive maintenance of field measuring instruments and field sampling devices will be accomplished during the sampling event by daily inspection of these instruments and sampling devices.

Field parameter data (i.e., pH, Temperature, Specific Conductance, and Turbidity) will be collected using multiple field meters (Cole-Parmer®, Hydrolab®, or equivalent). Calibration activities will be recorded on a form and will be performed according to the manufacturer's instructions.

1.2 Procurement and Preparation of Sample Containers

Field personnel will collect samples in containers that are appropriate for the required the analytical methods. These containers, preservatives, and holding times will conform to the requirements of SW-846 and will be provided by the laboratory. Sample containers will be shipped directly from the laboratory using a delivery service, hand-delivered to the sampling team by laboratory personnel, or picked up at the laboratory by the sampling personnel.

For volatile organic compound (VOC) analyses glass 40 milliliter VOA vials are required. Preservation requirements for the VOC samples include: cool to 4°C ±2°C (7 day holding time); preserve with concentrated HCl or $NaHSO_4$ and cool to 4 degrees (14 day holding time). Sample preservation with hydrochloric acid or sodium bisulfate requires the following considerations:

1. If a sample effervesces upon collection, then a statement of this occurrence will be noted in the comments section of the field sampling data sheet.

2. If samples for volatile organic analysis are received by the laboratory with visible headspace (such as bubbles), then these samples will not be used for analysis unless they are the only samples available; a statement of this occurrence will be noted in the lab narrative. If this situation affects all of the sample containers for a particular sample, then the laboratory would immediately notify the sampling manager and the affected sample would be re-collected.

1.3 Storage and Handling of Sampling Gear

Sampling equipment will be stored in such a way and in such a place as to prevent contact with contaminated equipment or materials. Whenever possible, dedicated sampling equipment will be used to reduce the need for field decontamination of non-dedicated equipment. Purging and sampling equipment will be handled with gloved hands. These gloves will be changed following each activity that may contaminate them and, at a minimum, will be changed between wells being sampled.

1.4 Decontamination Procedures

The principal hazardous constituents being monitored in groundwater are primarily volatile organic compounds (VOCs); therefore, all non-dedicated purging and sampling devices will be decontaminated between uses. Dedicated purging and sampling equipment will be decontaminated prior to being placed in service, and whenever it is being removed for inspection and repair. Non-dedicated field measurement devices such as water level indicators or field screening meters will be decontaminated prior to obtaining a measurement in such a manner as to not damage the equipment. Delicate non-dedicated field equipment such as water level indicators and field meters will be decontaminated using the following procedure:

1. Wash the equipment with a non-phosphate detergent.

2. Rinse the equipment with tap water.

3. Rinse with deionized water or organic-free reagent water.

Equipment used for well purging and sampling will be decontaminated by high-pressure, high-temperature steam cleaning at the decontamination area, or by the alternate procedure described above.

1.5 Personal Protective Equipment/Health and Safety Measures

A Health and Safety Plan (HASP) has been prepared specifically for the Site. The HASP presents an assessment of chemical hazards identified through extensive and continuing sampling, and describes the personal protective equipment required for sampling personnel.

2 SAMPLING PROCEDURES

Specific sampling procedures, including water level measurement, monitoring well purging, purge water containment, sample collection, documentation, and shipping are discussed in this section. In addition to these tasks, a general check of well integrity and needed well maintenance will be performed each time a well is sampled.

2.1 Water Level Measurements

Depth to water will be measured and recorded on a Field Sampling Data Sheet (Section 2.5.1), and will also be entered into a spreadsheet that will calculate groundwater elevations. This water level data will be used to calculate hydraulic gradients, groundwater flow directions and sample purging information. Measurements will be obtained using an electronic water level measuring device and will be taken at the designated permanent surveyed reference point marked on each well casing. Typically, this surveyed reference point is identified as a notch, saw cut or series of drill holes in the well casing. Equipment used to measure these depths will be decontaminated prior to being placed in the well by the method described in Section 1.4 of this document.

Prior to purging and sampling, the static water level will be measured using the electronic water level measurement device with increments of 0.01 feet. This measurement will be recorded to the nearest 0.01 feet from the designated survey point.

2.2 Monitoring Well Purging

The appropriate purge volume for each well will be calculated based on water level measurement, reference well depth measurement, and well diameter. The depth to the bottom of the well as noted on the geologist's log will be used along with the measured depth to water for calculating the purge volume. All relevant information will be recorded on the Field Sampling Data Sheet (Section 2.5.1).

Well purging will be performed in a manner consistent with calculated well volumes and past recovery history or yield data. The intake structure of a purge device will be positioned in a manner that allows for the removal of all stagnant water from the well. Confirmation of the removal of all stagnant water will be accomplished by verifying the drawdown of the pump used for purging or by bailing from the top of the water column.

For purposes of determining the purging requirements, a "high-yield well" is defined as a well that can be purged of three well volumes in two hours or less. Such wells will be purged of three well volumes within two hours. All other wells ("low-yield wells"), will be evacuated to remove all water that can be removed using the most appropriate, practicable and feasible method of purging.

Monitoring wells will be purged using one of the following configurations or equivalent methods:

1. A self-priming variable-speed pump (i.e. peristaltic or low-flow submersible) equipped with Teflon®/silicone tubing. The Teflon® tubing is typically dedicated to the well whereas the silicone tubing is typically replaced with new tubing between purging events.

2. A bailer constructed of either PVC, Teflon® or stainless steel. This device may be either dedicated or non-dedicated. If non-dedicated, then it will be decontaminated between uses.

If any purging equipment is to be dedicated to the well, then it will be stored in the well or in a dedicated storage container (PVC canisters or plastic bags) between sampling rounds. All dedicated equipment that is not stored in the well will be fully cleaned and decontaminated between sampling events in accordance with the procedures outlined in Section 1.4.

Non-dedicated equipment and tubing not being used for collecting groundwater samples shall be removed from the well no later than 30 minutes following the end of purging.

2.3 Groundwater Containment/Disposal of Purge Water

Purge water will be contained and treated on-Site in the B/384 groundwater treatment facility.

2.4 Sample Collection

Sampling will begin within two hours after purging has been completed. Disposable surgical-type gloves or nitrile gloves (KleenGuard or similar) will be used for all sampling, regardless of the anticipated level of contamination. Gloves will be changed following each activity that may contaminate them and, at a minimum, between wells.

2.4.1 Sampling Order

Samples should be collected and containerized in the order of the parameter's stability or volatilization/reaction sensitivity. The collections order for groundwater parameters selected for testing is:

1. Volatile Organic Compounds;

2. Temperature, pH, Specific Conductance, and Turbidity

2.4.2 Sampling Techniques and Methods

During sampling efforts will be made to minimize physical alteration of samples and to prevent chemical cross-contamination during the sampling process. VOC samples will be transferred to sampling containers in such a way as to minimize agitation and aeration. To the extent practicable, the same type of sampling device will be used in wells of similar construction and yield characteristics. The following is a list of sampling equipment and techniques that may be used to collect groundwater samples:

1. Teflon® or stainless steel bailers equipped with double check valves and valved bottom emptying devices. The bailers will be lowered slowly into the water column so as to minimize agitation of the water column. After the sample is brought to the surface, it will be emptied into the sample container using the bottom emptying device.

2. A self-priming variable-speed pump (i.e. peristaltic or low-flow submersible) equipped with Teflon®/silicone tubing as described in Section 2.2. Samples for VOCs and dissolved gases will be collected using a bailer. Groundwater samples for other parameters will be collected directly from the discharge line of the pump with the flow rate adjusted until as slow and steady a flow as possible is achieved.

To ensure that a groundwater sample is representative, efforts will be made to minimize physical alteration of samples and to prevent chemical cross-contamination during the sampling process. VOC samples will be transferred to sampling containers in such a way as to minimize agitation and aeration.

2.4.3 Field Quality Assurance/Quality Control Samples

A QA/QC program will be followed in the field to ensure the reliability and validity of field data generated by this GMP. The field QA/QC program is based on the routine collection and analysis of three types of QC samples: trip blanks, duplicate samples, and equipment rinse blanks.

Trip blanks will be prepared prior to each sampling event. A trip blank will be prepared for each container (e.g., cooler) used to hold multiple groundwater samples collected during the course of the sampling event. The trip blank consists of two 40-ml bottles filled with organic-free water. These trip blanks will be transported with the other samples and equipment to locations visited for that day. The trip blanks will be analyzed for VOCs and will serve to detect contamination that may occur during transportation and storage.

Duplicate groundwater samples will be collected for routine samples. They will serve as a check on the validity of the sample, sampling technique, and laboratory precision. Duplicates will be collected at a minimum of five percent of all groundwater samples.

Equipment rinse blanks will be collected in the field by passing deionized water over non-dedicated, decontaminated equipment. These samples shall serve to confirm the effectiveness of decontamination procedures and shall be collected at least once per sampling round for each type of non-dedicated equipment (water level indicators, pumps, and bailers). Equipment rinse blanks shall be analyzed for the same VOCs as the groundwater samples from the plume monitoring wells. If deionized water not provided by the analytical laboratory is used for collecting equipment rinse blanks, then a sample of that deionized water shall be submitted to the laboratory for analysis once per sampling event.

A bottle filled with water will be placed in each cooler by the sampling personnel to serve as a temperature blank for each day of sampling. The temperature of this blank will be checked and recorded on the chain-of-custody form upon receipt of the samples by the laboratory. As an alternative, the laboratory may use an infrared measuring device to determine the temperature of the samples upon receipt.

All field QA/QC samples except temperature blanks will be included in the sampling database. Equipment rinse blanks and trip blanks will be recorded on index forms and will be noted on the chains of custody.

2.4.4 Measurement of Field Parameters

Field parameters (Temperature, pH, and Specific Conductance, and turbidity) will be determined using calibrated field meters (Hydrolab or equivalent and turbidity meter). These measurements will be taken in a container filled with fresh purge water at the surface. Once filled, the measurement probe will be submerged in the sample water and the reading will be recorded after the meter reading has stabilized. Field measurements will be recorded on the Field Sampling Data Sheet (Section 2.5.1).

2.5 Documentation, Labels, Storage, Shipment, and Chain of Custody

This section describes sample documentation, including the field data sheets, bottle labels, and chain-of-custody forms; and sample storage and shipment procedures from the time of sample collection until delivery to the laboratory.

2.5.1 Field Sampling Data Sheets and Sampling Log Book

All field documentation will be the responsibility of the designated field sampling custodian, who may be any one of the field sampling personnel. Field Sampling Data Sheets (sample attached) will be used to record specific information regarding the wells to be sampled during a particular sampling period. Specific information on these sheets will also be entered into an electronic database. The FSDSs may be bound, and preprinted, with sequentially numbered pages, and will be completed at the time of purging and sampling of each well. Each Field Sampling Data Sheet will record the following information:

- Well identification number;
- Sample identification number,
- Purge/sample date,
- Reference depth of well,
- Depth to water before and after purge,
- Purge volume,
- Purge time (start/stop),
- Purge rate,

- Sampling time (start/stop),
- Field parameters (temperature, pH, specific conductance),
- Physical condition of the well,
- Important field observations related to sample integrity,
- Names of sampling personnel,
- General description of weather conditions.

The Field Sampling Data Sheet will be signed and dated by the sampler and will also include the analytical laboratory to which the sample is being sent, the specific analyses requested, and the field parameters that were measured.

2.5.2 Chain of Custody

Signed COC forms shall accompany bottles from the laboratory and shall stay with the bottles (including QA/QC samples) until they have been returned to the laboratory. The COCs shall contain at least the following information:

- Client name and site location,
- Sample identification number,
- Sampler name and contact number,
- Date and time of sample collection,
- Type of sample (grab or composite),
- Number of sample containers,
- Preservatives (if any),
- Parameters requested or analytical method to be used,
- Signatures of persons involved in the chain-of-custody possession,
- Inclusive dates of possession,
- Special requests or comments.

2.5.3 Sample Numbering and Labeling

A unique sample identification numbering system will be used for all trip blanks, equipment rinse blanks, groundwater samples and duplicate samples. All containers from one sample will be labeled with this unique identification number. Samples will be labeled as follows:

2.5.3.1 Environmental Samples

XXYYMMDDZZZW where "XX" represents the sample type (groundwater (GW) or duplicate sample (NR); "YYMMDD" is the date the sample was collected (e.g., 190902 = September 2, 2019) and "W" is an optional identifier that can be used if more than one sample is collected at the same location on the same day.

2.5.3.2 Trip Blanks

ETZYMMDDMMDD where "E" designates the East Fishkill Site; "T" indicates the sample is a trip blank; "Z" designates the sampler identification, "Y" is the last digit of the year (e.g. 9 = 2019); and "MMDDMMDD" is the period for which the trip blank is valid (e.g. 09020903 is September 2 through September 3).

2.5.3.3 Equipment Rinse Blanks

EBYYMMDDZZZ where "EB" indicates the sample is an equipment rinse blank, "YYMMDD" is the date that the rinse blank was collected and "ZZZ" is number indicating what type of rinse blank collected (e.g. "303" is a water level indicator, "304" is non-dedicated pump, "305" is non-dedicated bailer).

Samples will be transferred in the field from the sampling equipment directly into the container specifically prepared for that analysis.

2.5.4 Sample Storage

In the field, samples will be kept in a cooler containing ice until such time as the samples can be refrigerated or received at the laboratory. Refrigerated samples will be maintained at 4 degrees C or lower. Samples shall be stored in heavy-duty coolers with ice. Once collected, samples shall remain in the coolers at all times in the field and during shipping except when the field technicians need to verify sample labels while completing the COC and FSDSs associated with that cooler.

2.5.5 Sample Shipment

Samples will be shipped via a commercial priority overnight delivery service or hand-delivered to the laboratory. In cases where samples leave the possession of the primary laboratory or sampling personnel (e.g., shipments for outside analysis), a custody seal shall be provided on the shipping container to ensure that the samples have not been disturbed during transport. Samples that are at all times in the possession of the field team or laboratory personnel shall not require custody seals on the coolers.

3 ANALYSIS OF GROUNDWATER SAMPLES

Groundwater samples will be analyzed for selected VOCs (tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, Freon® TF, and Freon® 123) by SW-846 Method 8260C by Eurofins Lancaster Laboratories Environmental (ELLE) of Lancaster, Pennsylvania. ELLE's anticipated SW-846 Method 8260C reporting limits (Method Detection Limit and Limits of Quantitation) for the selected analytes are attached in Appendix B. The detection limits and analytes shown on this table apply specifically to the primary analytical laboratory for groundwater (ELLE), although other laboratories typically are capable of achieving the listed detection limits and reporting the listed analytes.

Laboratory internal quality controls will conform to SW-846 requirements and are documented in the laboratory's Quality Assurance Project Plan.

164101

IBM EFK Field Sampling Data Sheet

Well No.: ____________ Date: ____/____/____ Personnel: ________________________

Purging

PID: | Background: ____________________ | Purging: __________________ | ☐ NA

Reference Depth to Bottom (DTB): ____________ Start: __________ Stop: ____________

Depth to Water (DTW): ______________________ Yields: ☐ Yes ☐ No

Target Volume: ______________________________ Contained: ☐ Yes ☐ No

ActualVolume: _______________________________ DTW after Purge: ___________________

Purge Method

		Rate	Equipment ID
☐ Bailer	☐ Peristaltic Pump	________________	________________
☐ Bladder Pump (BP)	☐ Packer	________________	________________
☐ Submersible Pump (SP)	☐ Dedicated	________________	________________

Sampling

Start: Stop:

ID: | | | | | | | | | | | | Dup ID: | | | | | | | | | | | | |

Method: ☐ Bailer ☐ SP ☐ BP ☐ Tap

Laboratory: ☐ Eurofins Lancaster Laboratories ☐ Other ______________________

Analyses Requested: ☐ 8260 ☐ 524.2 ☐ As ☐Cr ☐ Total Fluoride ☐ Other __________
☐ Filtered ☐ Unfiltered ____________________

Field Parameters

Date	Time	Temperature	pH	Sp. Cond.	Turbidity

Comments:

Signature: ____ Date: ___________________

QA/QC Review: ____ Review Date: ___________________

APPENDIX E: GROUNDWATER SCIENCES CORPORATION PROJECT TEAM RESUMES

DOROTHY A. BERGMANN, P.G.
Senior Associate and Hydrogeochemist

EDUCATION

Colgate University, Hamilton, New York: Bachelor of Arts, Geology (1985)
Northern Arizona University, Flagstaff, Arizona: Master of Science, Geology (1989)
Thesis and related research conducted in coordination with the Norwegian Institute for Water Research (NIVA) Project RAIN, Risdalsheia, Norway.

Continuing Education: vadose zone monitoring and sampling theory, soil gas sampling and analysis techniques, flow simulations, aquifer tests, validation of analytical chemistry data, quality assurance.

PROFESSIONAL REGISTRATIONS, CERTIFICATIONS, AND MEMBERSHIPS

Registered Professional Geologist: Kentucky, No. 1548 (1994 to 2003)
Registered Professional Geologist: New York, No. 477 (2018 to present)
New York State Division of Hazardous Waste Certified Organic Data Validator (1993)
New York State Division of Hazardous Waste Certified Inorganic Data Validator (1993)
Association of Ground Water Scientists and Engineers (National Ground Water Association)

EXPERIENCE

Ms. Bergmann has 30 years of professional experience implementing and managing environmental consulting projects in diverse hydrogeologic settings and is currently a Senior Associate at Groundwater Sciences Corporation.

Ms. Bergmann was hired by Groundwater Sciences Corporation in 1989 as an entry level Staff Scientist responsible primarily for field based data collection, well installation and data review and management. She was promoted to Hydrogeochemist in 1991, Senior Hydrogeochemist in 1997, Associate in 2002 and Senior Associate in 2008. Ms. Bergmann is responsible for the scientific development and training of consulting scientists, including training on database management, data analysis and scientific writing.

Ms. Bergmann has been active in remedial investigations and feasibility studies and is responsible for the overall environmental program for several large industrial sites. Her experience derives primarily from site investigations and subsequent remediation under RCRA, CERCLA, and the Clean Water Act in EPA Region 2 in the state New York with other site experience under various regulatory programs in New Jersey, Pennsylvania and Kentucky. Ms. Bergmann's experience includes soil, sediments, soil vapor and groundwater investigations and subsequent remediation. Many of these sites are large industrial facilities covering several hundred acres or more with at least 100 groundwater monitoring well installations and nearly all have been impacted by historical releases of chlorinated solvents. Ms. Bergmann has worked on sites in many geological settings, including formerly glaciated areas of the northeastern United States, fractured crystalline bedrock in southeastern New York and the coastal plain of New Jersey.

Ms. Bergmann has been responsible for development of comprehensive sampling/analysis and quality assurance project plans, has both directed and performed groundwater, surface water, soil, soil gas, sediment, sanitary, storm sewer and storage tank sampling according to USEPA protocols. Part of her experience involved the design, mobilization and operation of a field laboratory for on-site analysis of soil gas samples. She has designed, conducted and analyzed aquifer tests in a wide variety of geologic settings including slug tests to estimate hydraulic properties; step-drawdown tests to assess well potential and efficiency; constant-rate and constant-drawdown tests to determine hydraulic properties and; recovery tests to assess well performance and aquifer recharge. She has been responsible for well rehabilitation of production wells experiencing yield losses due to biological, mineral and debris fouling using both mechanical and chemical methods. She has analyzed and described hundreds of split spoon samples and is responsible for determining depositional environment, installing properly constructed monitoring wells and assessing construction of historical wells for the purpose of decommissioning. She has reviewed geophysical logs and determined rock type and formation from drill cores and cuttings. She has experience with hollow-stem auger, mud rotary, cable tool and air rotary drilling. She has managed the activities of drillers, surveyors, and general contractors in the field and is the company's corporate quality assurance and quality control officer.

Ms. Bergmann is principally responsible for both the Inorganic and Organic Data Validation for several RCRA Facility clients and as such has been designated as the Project Quality Assurance Officer (QAO) for those projects. As the QAO she participated in the development of the Quality Assurance Project Plan and sampling protocols currently approved for use by the state regulatory agency. She has supported the groundwater monitoring aspect for several Major Oil Storage Facility Permits and assisted with the development of a solids management protocol that applies to, but is not limited to, all soils excavations, storm water pollution prevention plan (SWPPP) concerns, concrete/asphalt construction activities, and other environmental related solids projects at a RCRA Facility. She is the principal author for multiple Site Management Plans developed under several regulatory frameworks for sites ranging from a 2 acre one-owner site with limited controls to a larger 400 acres multiple-parcel site with multiple institutional controls and multi-media engineering controls. She has also been designated Project Director for the Remedial Design / Remedial Action and Institutional Controls Implementation for a Region 2 NPL Superfund Site.

Ms. Bergmann has broad experience with many scientific software packages for data management, interpretation and presentation including: proprietary database management programs; USEPA's ProUCL for non-parametric statistical analysis of environmental chemistry data; USEPA's BIOCHLOR screening model for groundwater flow and remediation by natural attenuation; Capture (flow modeling) and; RockWare's RockWorks for 3-D visualization of complex geological environments.

STEPHEN M. FISHER, P.G.
Senior Hydrogeologist

EDUCATION

Mr. Fisher received his Bachelor of Science in Geology from Millersville University of Pennsylvania in 1988. His continuing education has included the NGWA Fracture Trace & Lineament Analysis Course, the NGWA Outdoor Action Conference, the NGWA Vadose Zone Monitoring Course, the NGWA Analysis and Design of Aquifer Tests Course, the NGWA Artificial Recharge Course, the University Consortium (Waterloo) DNAPL Site Characterization & Remediation Course, PCPG Courses, numerous Field Conferences of Pennsylvania Geologists, symposia on Appalachian Geomorphology, Maryland groundwater seminars, seminars on Pennsylvania Act 2 environmental regulations and municipal project funding, and other technical seminars, webinars, short courses, and computer software workshops.

PROFESSIONAL REGISTRATIONS, CERTIFICATIONS, AND MEMBERSHIPS

Registered Professional Geologist, Commonwealth of Pennsylvania - License Number 0222-G
Registered Professional Geologist, Commonwealth of Kentucky - License Number 1417
Registered Professional Geologist, State of Delaware - License Number S4-0001269
Registered professional Geologist, Commonwealth of Virginia – License Number 2801001856
Registered Professional Geologist, State of North Carolina – License Number 2336
Registered Professional Geologist, State of New York – License Number 353-1
Member, Association of Ground Water Scientists and Engineers
Life Member, Harrisburg Area Geological Society

SUMMARY OF EXPERIENCE

Since May 1988, Mr. Fisher has served as a staff geologist, hydrogeologist, and senior hydrogeologist with Groundwater Sciences Corporation. He has participated in numerous investigations, including environmental site assessments, underground storage tank investigations, water resource development projects, a coal surface mine reclamation study, and groundwater contamination investigations at manufacturing facilities and landfills, all in a variety of hydrogeologic settings. Mr. Fisher has also provided technical support and hearing testimony in support of legislation in the State of Maryland.

Mr. Fisher is extensively experienced in the management of municipal and commercial water supply development projects in Pennsylvania, Maryland, and New York. These projects typically involved well site selection, production well installation supervision, aquifer testing and analysis, watershed assessment, stream influence assessment. Additional related experience includes the directing and analysis of packer tests, geophysical surveys, wellhead protection area delineation, water budget analysis, water allocation assessments, well interference evaluation, supply well rehabilitation, report preparation and permit applications, and regulatory agency interaction. Mr. Fisher is also extensively experienced in the design, installation, and rehabilitation of screened extraction and injection wells in unconsolidated aquifers.

In addition, Mr. Fisher has been involved in the supervision of field activities and the analysis of data for numerous UST closures, leak impact assessments, and remediation projects. He has assisted remedial systems specialists and directed contractors with the installation, operation, and maintenance of vacuum extraction/air sparging systems and groundwater extraction and treatment systems at sites contaminated with petroleum products, pesticides, and VOCs. Mr. Fisher has conducted studies of groundwater quality, including mass-balance nitrate-nitrogen calculations and percolation tests for individual on-lot sewage for proposed single and multiple home developments and hydrogeologic assessments for Pennsylvania Act 537 Sewage Plan updates for a number of municipalities in south-central Pennsylvania.

While earning his Bachelor's Degree, Mr. Fisher worked as a hydrologic technician and scientific intern with the Water Resources Division of the United States Geological Survey and with the Pennsylvania Topographic & Geologic Survey. His responsibilities included assisting hydrogeologists with data collection and analysis for groundwater research projects throughout Pennsylvania.

C. EDWARD STONER, IV

Senior Hydrogeologist

EDUCATION

Mr. Stoner received his bachelor's degree cum laude in geology from Franklin and Marshall College in Lancaster, Pennsylvania in 1996. He received a Master of Science Degree in Geology from the University of Maryland at College Park in 1999, where he specialized in resistance to streamflow, stream morphology, and the evaluation of post-restoration stream hydraulics. While pursuing his graduate studies, he was also a research and teaching assistant.

PROFESSIONAL MEMBERSHIPS AND REGISTRATIONS

Geological Society of America – Member
National Ground Water Association – Member
40-Hour OSHA Hazardous Site Worker Training
Registered Professional Geologist: New York, No. 601-1
Registered Professional Geologist: North Carolina, No. 1943

EXPERIENCE

Since September 1999, Mr. Stoner has served as a staff geological scientist, hydrogeologist, and senior hydrogeologist at Groundwater Sciences Corporation. He has performed all aspects of field data acquisition and preparation, including collection of several hundred groundwater samples, soil samples, and water level measurements from monitoring wells at five RCRA sites in New York and New Jersey. He has also performed well installation and decommissioning at several RCRA sites in New York. Mr. Stoner is experienced with various aspects of environmental data management, including chemical and physical data. He is familiar with relational database concepts, manipulation of chemical data, and statistical evaluations using various software packages, including dBase, Lotus Approach, Excel, Lotus 123, Corel QuattroPro, and WQStat Plus. He has cross-referenced the information contained in field data sheets, laboratory reports, and chains of custody while reviewing such data for RCRA clients. Mr. Stoner has prepared corrective action status reports and evaluated groundwater monitoring well networks at RCRA sites in New York. Mr. Stoner has also created and implemented a monitoring plan to delineate third Unregulated Contaminant Monitoring Rule (UCMR 3) Per- and Polyfluoroalkyl Substances (PFAS) at a RCRA site. Designed and installed replacement for failed shallow groundwater extraction well

Mr. Stoner has analyzed and described hundreds of split spoon samples at several RCRA sites. Sediments were typical of glacial and post-glacial depositional environments common in New York State. He was responsible for determining depositional environment, installing properly constructed monitoring wells, and collecting samples used to determine residual Volatile Organic Compound (VOC) contaminant concentration in soils. Mr. Stoner has collected soil and rock cores used to quantify matrix diffusion effects on plume stability. He has experience with hollow stem auger, mud-rotary, cable tool, and dual-rotary drilling.

Mr. Stoner has supervised air-rotary drilling at several RCRA and EPA Superfund Sites. The work has included proper well installation and review of hundreds of samples from roughly one-thousand feet of drilling. Mr. Stoner has reviewed geophysical logs, determined rock type and Formation by reviewing hundreds of air-rotary derived rock chip samples, and collected structural measurements from outcrop as part of a detailed structural analysis on a site of over 200 acres. He has described and analyzed rock cores, with the observations used in evaluating contaminant migration and evaluating remedial alternatives.

ROBERT C. WATSON, P.G.
President

EDUCATION

Boston College, Chestnut Hill, MA (1986 to 1989); Master of Science, Geology and Geophysics
Honors: Pass with Distinction on Oral Comprehensive Exams
Geology Field Camp in Wyoming, University of Missouri-Columbia, Summer 1987

Bates College, Lewiston, ME (1982 to 1986); Bachelor of Science, Geology
Honors: High Honors in Geology
Geology Field Camp in Northern Appalachians of USA and Canada, Bates College, Spring 1984
Leave of Absence Junior Year – University of Massachusetts-Amherst, Fall 1984 to Spring 1985

PROFESSIONAL MEMBERSHIPS AND REGISTRATIONS

Professional Advisory Groups
PaDEP Cleanup Standards Scientific Advisory Board, Vapor Intrusion Subcommittee

Professional Associations
Air & Waste Management Association – Member
American Institute of Professional Geologists – Member
National Ground Water Association – Member
New York State Council of Professional Geologists – Member
Pennsylvania Council of Professional Geologists – Member

Professional Registrations and Certifications
Delaware, Professional Geologist – License Number S4-0001325
Indiana, Professional Geologist – License Number 2563
Kentucky, Professional Geologist – License Number 165577
Maine, Certified Geologist – License Number GE354
New Hampshire, Professional Geologist – License Number 406
New York, Professional Geologist – License Number 001208-1
North Carolina, Professional Geologist – License Number 2454
Pennsylvania, Professional Geologist – License Number PG004909
Virginia, Professional Geologist – License Number 2801002066

SUMMARY OF EXPERIENCE

Mr. Watson has about thirty years of professional experience in the implementation and management of environmental consulting projects conducted in a diversity of hydrogeologic settings throughout the United States, along with international project experience at sites in England, France, Japan, and Scotland. He has been responsible for work scope development, technical guidance, coordination, and management of environmental site assessments, remedial investigations, corrective measures studies, and feasibility studies at proposed commercial development sites, municipal and industrial landfill sites, underground storage tank removal sites, hazardous substance release sites, and petroleum release sites, including some CERCLA and RCRA sites with programs under EPA or State supervision. His experience includes detailed characterization of chlorinated solvent and petroleum hydrocarbon fate and transport to support vapor intrusion assessments and development and screening of soil and/or groundwater remedial alternatives. Mr. Watson has also managed public water supply feasibility, permitting, and development projects and has served as project geologist or technical consultant on many geotechnical engineering consulting projects that have involved detailed characterization of bedrock, including: bridge and hydroelectric dam foundation engineering projects, bedrock sewer and water supply tunnel design projects, and bedrock surface/structure evaluations for commercial development sites.

EMPLOYMENT HISTORY

Dates	Institution	Positions
2004 to Present	Groundwater Sciences Corporation Harrisburg, PA	Senior Hydrogeologist / Associate / Vice President (VP) / Executive VP / President
1995 to 2004	Sanborn, Head & Associates, Inc. Portland, ME	Project Manager / Senior Project Manager
1990 to 1995	GZA GeoEnvironmental, Inc., Portland, ME	Project Geologist / Assistant Project Manager
1989 to 1990	Delon Hampton & Associates, Washington, D.C.	Engineering Geology Field Inspector

PUBLICATIONS AND PRESENTATIONS

Heron, G., J. Bierschenk, R. Swift, R. Watson, and M. Kominek, 2016, Thermal DNAPL Source Zone Treatment Impact on a CVOC Plume, Groundwater Monitoring & Remediation Vol. 36, No. 1, pp. 26-37.

Watson, R.C., 2013, "2013 – The Year for Substantial Changes to PADEP Vapor Intrusion Guidance?", Pennsylvania Bar Institute, Environmental Law Forum, April 10, 2013.

Wang, G., R.M. Allen-King, S. Choung, G. Wang, S. Feenstra, R. Watson, and M. Kominek, 2013, A Practical Measurement Strategy to Estimate Nonlinear Chlorinated Solvent Sorption in Low foc Sediments, Groundwater Monitoring & Remediation Vol. 33, No. 1, pp. 87-96.

Watson, R., R.M. Allen-King, S. Choung, G. Wang, M. Kominek, and S. Feenstra, 2008, "Influence of Site-Specific Measurement of Perchloroethylene (PCE) Sorption on Remedial Decision-Making," Technical Session Presentation, Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle Memorial Institute, Monterey, California.

Carr, D.B., and R.C. Watson, 1996, "Pilot Testing and Design of Vacuum-Enhanced Recovery of Heavy Oil from Glacial Till," Poster Session, Fourth Conference on Lessons Learned in Remediation of Petroleum Contaminated Sites, Consulting Engineers of Maine and MDEP, Augusta, Maine.

Watson, R.C., and Skehan, J.W., 1989, "Evidence for West-Directed Alleghanian Thrusting in Northern Rhode Island," Technical Session Presentation, 24th Annual Meeting, Northeastern Section, Geological Society of America, New Brunswick, New Jersey, Abstracts with Programs, V. 21, No.2, p.74.

Watson, R.C., March 1986, "Lithological and Structural Relationships Within the East-Central Portion of the Poland 15' Quadrangle, Maine," Poster Session, Annual Spring Meeting, Geological Society of Maine, Abstracts with Programs, p.4.