8976 Wellington Road
Manassas, VA 20109

February 19, 2016

Alex G. Czuhanich
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau E, 12th Floor
625 Broadway
Albany, New York 12233-7017

Re: Installation and Performance Monitoring Report – Area A Pilot SVE System
Former IBM East Fishkill Facility
Hopewell Junction, New York
EPA ID No. NYD00707901

Dear Mr. Czuhanich:

The enclosed letter report presents the performance monitoring results of a pilot soil vapor extraction system installed within Remediation Area A at the Former IBM East Fishkill Facility in Hopewell Junction, New York. This letter report addresses the operating period from May through October 2015. IBM has shut down the system for the cold weather months and intends to re-start operations in April 2016.

If you have any questions or wish to discuss the document, please contact me at (703) 257-2583.

Sincerely yours,

Dean W. Chartrand

Dean W. Chartrand
Program Manager
Corporate Environmental Affairs

Enclosure: Installation and Performance Monitoring Report – Area A Pilot SVE System

cc:	Gary Marone	Global Foundries	(via email)
	Jayne Ulrich	Global Foundries	(via email)
	Seth Soos	Sanborn Head and Associates	(via email)
	Bradley Green	Sanborn Head and Associates	(via email)
	David Shea	Sanborn Head and Associates	(via email)

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Building Trust. Engineering Success.

Dean Chartrand
IBM Corporate Environmental Affairs
8976 Wellington Road
Manassas, Virginia 20109

February 19, 2016
File No. 62999.02

Re: Installation and Performance Monitoring Report – Area A Pilot SVE System
Former IBM East Fishkill Facility
Hopewell Junction, New York

Dear Mr. Chartrand:

This letter presents the performance monitoring results of a pilot soil vapor extraction (SVE) system installed and operated in 2015 to address the presence of volatile organic compounds (VOCs), primarily tetrachloroethene (PCE), in soil vapor located in Remediation Area A (Area A) at the former IBM East Fishkill facility (the site). A site location plan is provided as Figure 1, and the location of the Area A SVE system is shown on Figure 2.

As communicated to the New York State Department of Environmental Conservation (NYSDEC) in an October 15, 2014 letter, IBM elected to conduct SVE testing using a network of existing wells located north of the linkway between Buildings 308 and 310. The purpose of this testing was to assess the potential for increasing subsurface contaminant mass removal from a portion of the historical source area. The following sections document the results of this work.

SOIL VAPOR EXTRACTION PILOT SYSTEM DESIGN

This section presents the design of the Area A pilot SVE system for VOC source removal, including a system description, process flow diagram, and system location and safeguards.

System Description

The Area A pilot SVE system consists of six soil vapor extraction wells, and a vacuum blower and treatment system that are housed in a shipping container located along the east side of B310, within Area A, as shown on Figure 3. The SVE wells (SDV-1, 3, 5, 6, 7, 8) are screened in the lower portion of the soil fill at a depth of approximately 7.5 to 10 feet below ground surface (bgs). In addition, subsurface vacuum monitoring point couplets (VMP-S/D) were installed at the locations shown on Figure 3 to monitor vacuum response at about 5 feet (S) and 10 feet (D) bgs. Depth to groundwater is approximately 10 to 12 feet bgs subject to natural variations of several feet depending on annual precipitation and recharge.

Exhibit 1 shows a schematic/process flow diagram of the system, which includes a vapor-liquid separator, two vapor-phase granular activated carbon (GAC) vessels for removal of VOCs from extracted vapor, and a regenerative vacuum blower.

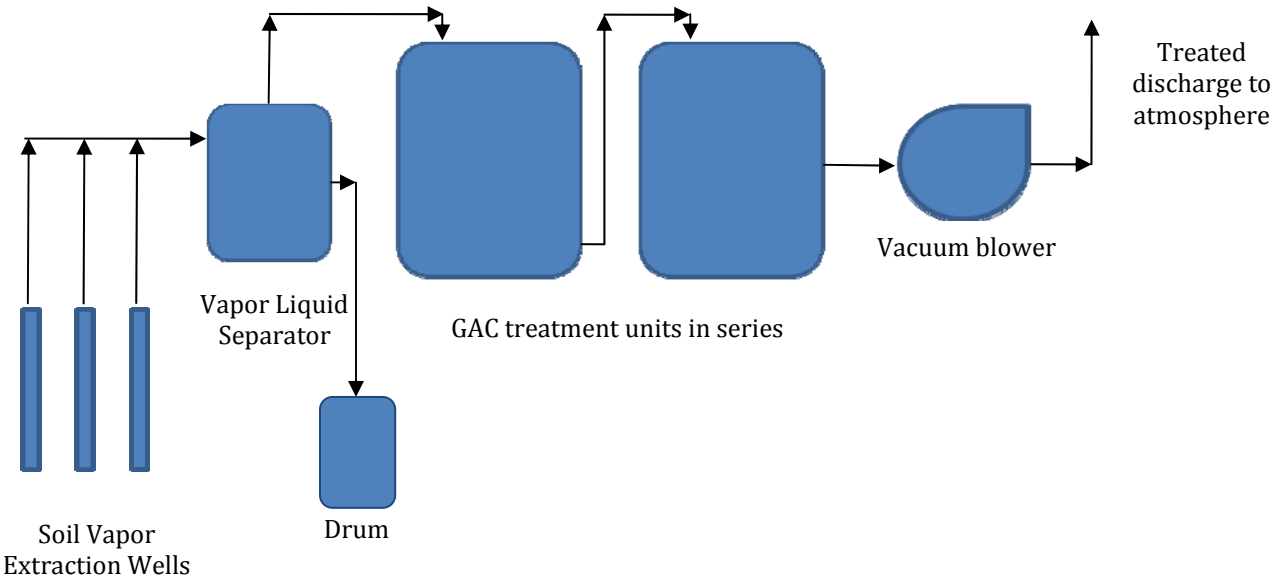

Exhibit 1 –Vapor Extraction System Process Flow Diagram

In operation, soil vapor is withdrawn from the vapor extraction wells and conveyed to the extraction and treatment equipment through polyvinyl chloride (PVC) hose connected to a common PVC pipe manifold. Within the equipment enclosure, the vapor stream passes through the vapor-liquid separator (VLS) to remove any free moisture, and then is treated through two GAC vessels connected in a lead-lag series configuration. Free moisture that accumulates in the VLS is periodically pumped into a drum and transported to the Area A groundwater extraction and treatment system for treatment. Vacuum is generated by a regenerative vacuum blower (7.5 horsepower FPZ, Inc. Model K08-MS) located downstream of the GAC vessels such that the VOC-containing vapors and the GAC are maintained under vacuum conditions during operation. The treated vapor passes through the vacuum blower and is exhausted to the atmosphere through a stack extending above the enclosure roofline. The locations of the extraction wells, header manifold, and equipment enclosure are shown on Figure 3.

System Location and Safeguards

The vapor extraction and treatment equipment is installed in a lockable shipping container that was placed within a locked chain-link fence within Area A. The system includes the following engineering design and operational safeguards to protect personnel health and safety and prevent equipment damage during system operation, maintenance shutdowns, or potential system malfunction:

- The vacuum blower is downstream of the GAC units such that VOC-containing vapors and the GAC units are maintained under a vacuum condition during operation.

- The positive pressure discharge from the vacuum blower contains only treated vapor and is piped to an exhaust stack that is installed through the roof of the enclosure.

- The enclosure is equipped with a ventilation system, such that the equipment area will be ventilated during maintenance shut downs, including when the GAC vessels are changed out.

- The system is equipped with several sensors and alarms (e.g., low vacuum, high temperature) that will automatically shut down the system and send notifications to appropriate site personnel if operating conditions are outside of their preset range.

SOIL VAPOR EXTRACTION PILOT STARTUP

The Area A SVE and treatment system was installed during the second quarter of 2015 and put into operation on May 13, 2015. This section summarizes the startup activities, including target operating conditions, monitoring results, and VOC mass removal during the 2015 operating period.

Target Operating Conditions

During startup of the SVE system, various combinations of extraction wells were put into operation to identify which grouping of wells resulted in the largest area of subsurface vacuum influence, and the highest contaminant mass removal rate, while operating within the blower's normal range of operating conditions. The combination of extraction wells that best met these objectives was SDV-5, SDV-6, and SDV-7. Based on initial startup observations, the target vacuum applied to these wells was approximately 40 inches of water column (in. wc), which resulted in an approximate combined flow rate of 160 cubic feet per minute (cfm). This applied vacuum provided a reasonable balance among vapor flow rate, vacuum influence, and the efficient operating range of blower capability.

The remaining extraction wells (SDV-1, SVD-3, and SDV-8) remain connected to the SVE system, but are valved off. The combination of operating extraction wells may be adjusted based on results of future system monitoring.

Subsurface Differential Pressure Monitoring Results

At the target operating conditions, the SVE system depressurized the subsurface as shown by the inferred vacuum isopleths at a depth of 5 feet bgs on Figure 4 and a depth of 10 feet bgs on Figure 5. Also shown on Figures 4 and 5 are the applied vacuum, air flow rate, and total VOC concentration measured with a photoionization detector (PID) at each extraction well on the first day of operation.

VOC Mass Removal and Treatment

The pilot SVE system successfully removed PCE source mass from the subsurface. To estimate the PCE mass removed by the system, process vapor samples were collected from the influent point of the GAC treatment train a total of eight times since startup. The plot in Exhibit 2 shows PCE concentrations versus time at the influent point of the GAC treatment

train. The initial PCE vapor concentrations were consistent with the levels of PCE in soil and groundwater in the SVE area that are the source of PCE in soil vapor. As expected, influent PCE concentrations demonstrate an exponential decline with a steep decrease after initial startup and subsequent minimal decrease over time thereafter, with the exception of the sample collected in October, which showed an increase of PCE influent concentration.

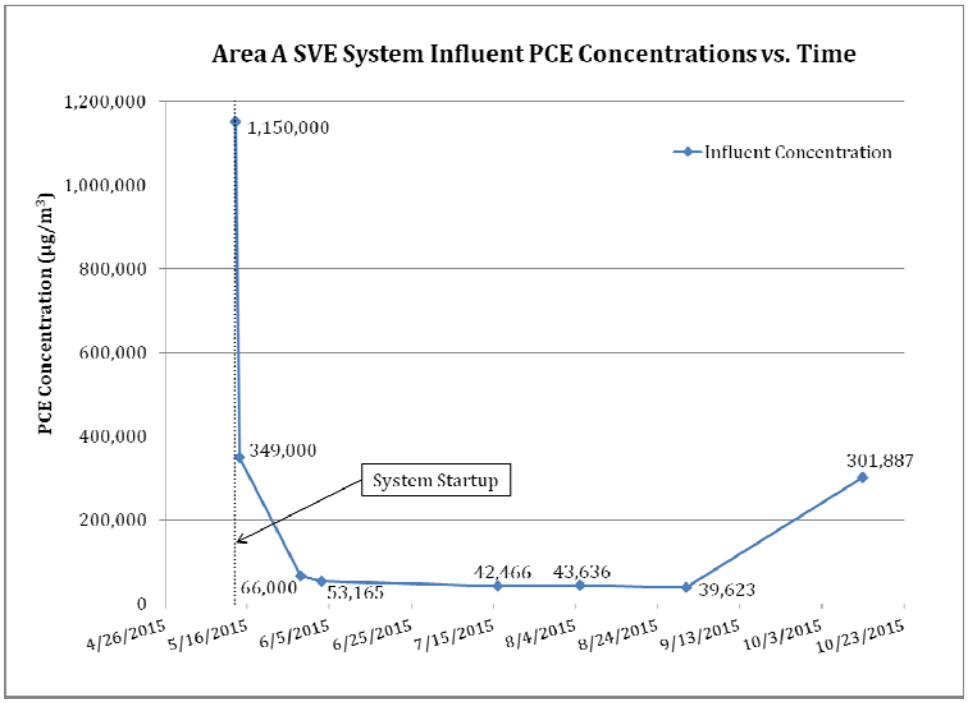

Exhibit 2: Area A Soil Vapor Extraction System Influent PCE Concentration vs. Time

Monitoring for VOC breakthrough of the lead and lag GAC units was conducted to determine when the GAC has been exhausted. Breakthrough is defined as having occurred when the lag unit PCE discharge concentration is 10% of the lead unit inlet concentration. When breakthrough is observed, both lead and lag units will be removed and replaced with vessels containing fresh GAC. The vessels containing spent GAC will be sent off-site for GAC reactivation or disposal. Breakthrough of the first GAC vessel was observed in the October 2015 sampling event, immediately prior to the system being shutdown for the colder months. During shutdown activities, the GAC vessels were transported off site for carbon reactivation or disposal. Vessels containing virgin GAC will be installed during system restart activities in April 2016.

The plot in Exhibit 3 shows PCE mass removal rates and cumulative mass removal during the 2015 operating period. The influent data and resulting mass removal calculations are shown on Table 1. A total of approximately 226 pounds of PCE were removed from May through October 2015.

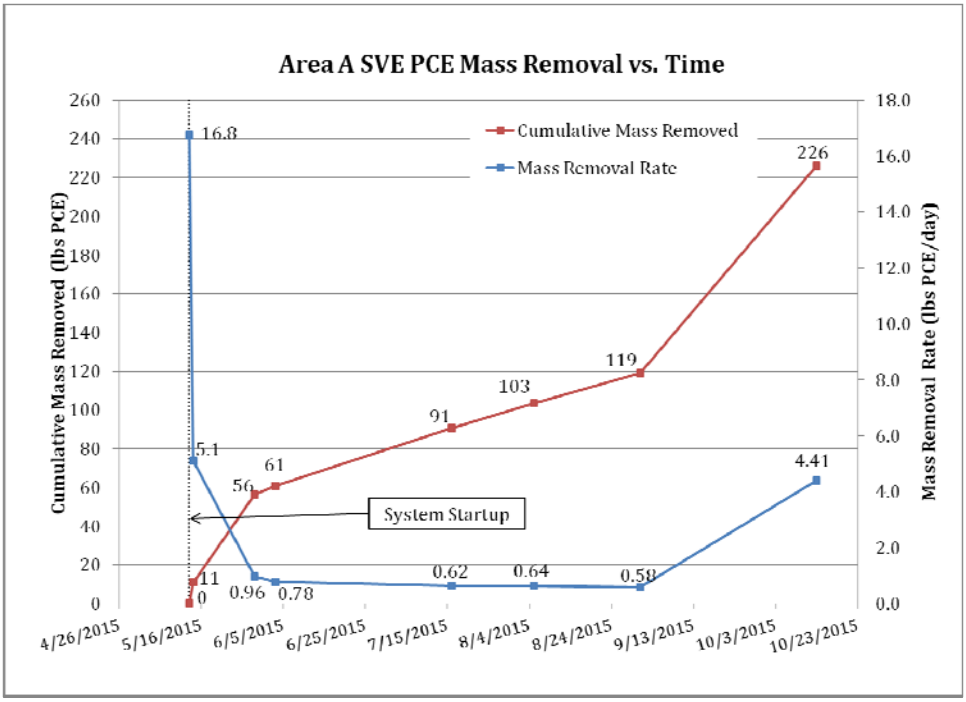

Exhibit 3: Area A Soil Vapor Extraction System PCE Mass Removal vs. Time

Future Operation

Because of the potential for excessive condensate generation and freezing in cold weather, IBM shut down the system and "winterized" it upon significant condensate generation and consistently freezing temperatures, which occurred by the end of October 2015. However, given the successful performance of the system, IBM intends to re-start the system in April 2016 and continue operations likely through October 2016. Future operations will be re-evaluated at that time.

During the operating months, bi-weekly operation and maintenance (O&M) visits will be conducted to ensure proper, continued operation. Vapor samples will be collected from the treatment train on a monthly basis to evaluate the system's effectiveness and determine when GAC changeouts are required. Based on observed influent concentrations, adjustments to the operating wells may be made in an effort to enhance contaminant mass removal.

CLOSING

The pilot SVE pilot system in Area A is meeting its design objectives of reducing PCE source mass in the unsaturated subsurface. During the 2015 operating period, the SVE system removed approximately 226 pounds of residual PCE source mass. Given these favorable results, IBM intends to re-start operations of the pilot SVE system in April 2016 after the cold weather months.

Should you have any questions regarding this report, please contact us.

Very truly yours,
SANBORN, HEAD ENGINEERING, P.C.

David Shea, P.E.
President
Sanborn Head Engineering, P.C.

Seth P. Soos
Senior Project Manager
Sanborn, Head & Associates, Inc.

JWC/SPS/DS: jwc

Encl. Table 1 Summary of VOC Mass Removal Results

Figure 1 Site Location Plan
Figure 2 Area A Pilot SVE System Location Plan
Figure 3 Area A Pilot SVE System Layout
Figure 4 Differential Pressure and Inferred Vacuum Isopleths 5 ft Depth
Figure 5 Differential Pressure and Inferred Vacuum Isopleths 10 ft Depth

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TABLE 1
Summary of VOC Mass Removal Results
Area A Pilot Soil Vapor Extraction System
Former IBM East Fishkill Facility
Hopewell Junction, New York

Date	5/13/2015		5/14/2015				5/29/2015				6/3/2015			
Flow (scfm)	162		162				162				162			
Hours per Period (hrs)	0		24				360				120			
Cumulative Hours (hrs)	0		24				384				504			
Analyte	SSV Influent (µg/m³)	Mass Removal Rate (lb/day)	SSV Influent (µg/m³)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed (lb)	SSV Influent (µg/m³)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed (lb)	SSV Influent (µg/m³)	Mass Removal Rate	Mass/period (lb)	Cumulative Mass Removed (lb)
TOTAL CVOCs	1,152,190	16.78	350020	5.11	10.95	10.95	67,041	0.98	45.65	56.60	53,798	0.79	4.41	61.01
Trichloroethene	2,190	0.0	1,020	0.01	0.02	0.02	769	0.01	0.20	0.22	633	0.01	0.05	0.27
Tetrachloroethene	1,150,000	16.75	349,000	5.09	10.92	10.92	66,000	0.96	45.43	56.35	53,165	0.78	4.35	60.70
cis-1,2-Dichloroethene	ND	0.00	ND	0.00	0.00	0.00	272	0.00	0.03	0.03	NS	0.00	0.01	0.04
trans-1,2-Dichloroethene	ND	0.00	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00	NS	0.00	0.00	0.00
Vinyl chloride	ND	0.00	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00	NS	0.00	0.00	0.00

Date	7/16/2015				8/5/2015				8/31/2015				10/13/2015			
Flow (scfm)	162				162				162				162			
Hours per Period (hrs)	1032				480				624				1032			
Cumulative Hours (hrs)	1536				2016				2640				3672			
Analyte	SSV Influent (µg/m³)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed (lb)	SSV Influent (µg/m³)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed (lb)	SSV Influent (ug/m3)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed	SSV Influent (ug/m3)	Mass Removal Rate (lb/day)	Mass/period (lb)	Cumulative Mass Removed
TOTAL CVOCs	42,836	0.63	30.32	91.33	43,982	0.64	12.67	104.00	39,887	0.58	15.91	119.91	319,246	4.66	112.69	232.60
Trichloroethene	370	0.01	0.31	0.59	346	0.01	0.10	0.69	264	0.00	0.12	0.81	17,359	0.25	5.53	6.34
Tetrachloroethene	42,466	0.62	30.01	90.70	43,636	0.64	12.57	103.27	39,623	0.58	15.80	119.07	301,887	4.41	107.16	226.23
cis-1,2-Dichloroethene	NS	NA	NA	0.04	NS	NA	NA	0.04	NS	NA	NA	0.04	NS	NA	NA	0.04
trans-1,2-Dichloroethene	NS	NA	NA	0.00	NS	NA	NA	0.00	NS	NA	NA	0.00	NS	NA	NA	0.00
Vinyl chloride	NS	NA	NA	0.00	NS	NA	NA	0.00	NS	NA	NA	0.00	NS	NA	NA	0.00

Notes:
1. Samples collected on May 13, 14 and 29, 2015 were collected by Sanborn, Head & Associates, Inc. into 1.0-liter, stainless steel, pre-evacuated SUMMA® canisters. The samples were analyzed by Alpha Analytical of Westborough, Massachusetts for the project-specific list of volatile organic compounds (VOCs) by United States Protection Agency (USEPA) Method TO-15. Subsequent samples were collected over a 1-hour period using charcoal tube media samplers. The samples were analyzed by ALS Environmental of Rochester, New York in accordance with USEPA Method 18 Modified.

2. Analytical sample results were converted to mass removal rates (pounds per day) using a standard cubic foot per minute (scfm) flow calculated based on the applied blower vacuum, differential pressure, and post-carbon treatment temperature readings .

3. Abbreviations:
"CVOCs" chlorinated volatile organic compounds
"ND" analyte not detected above laboratory reporting limits
"NS" not sampled
"NA" not applicable

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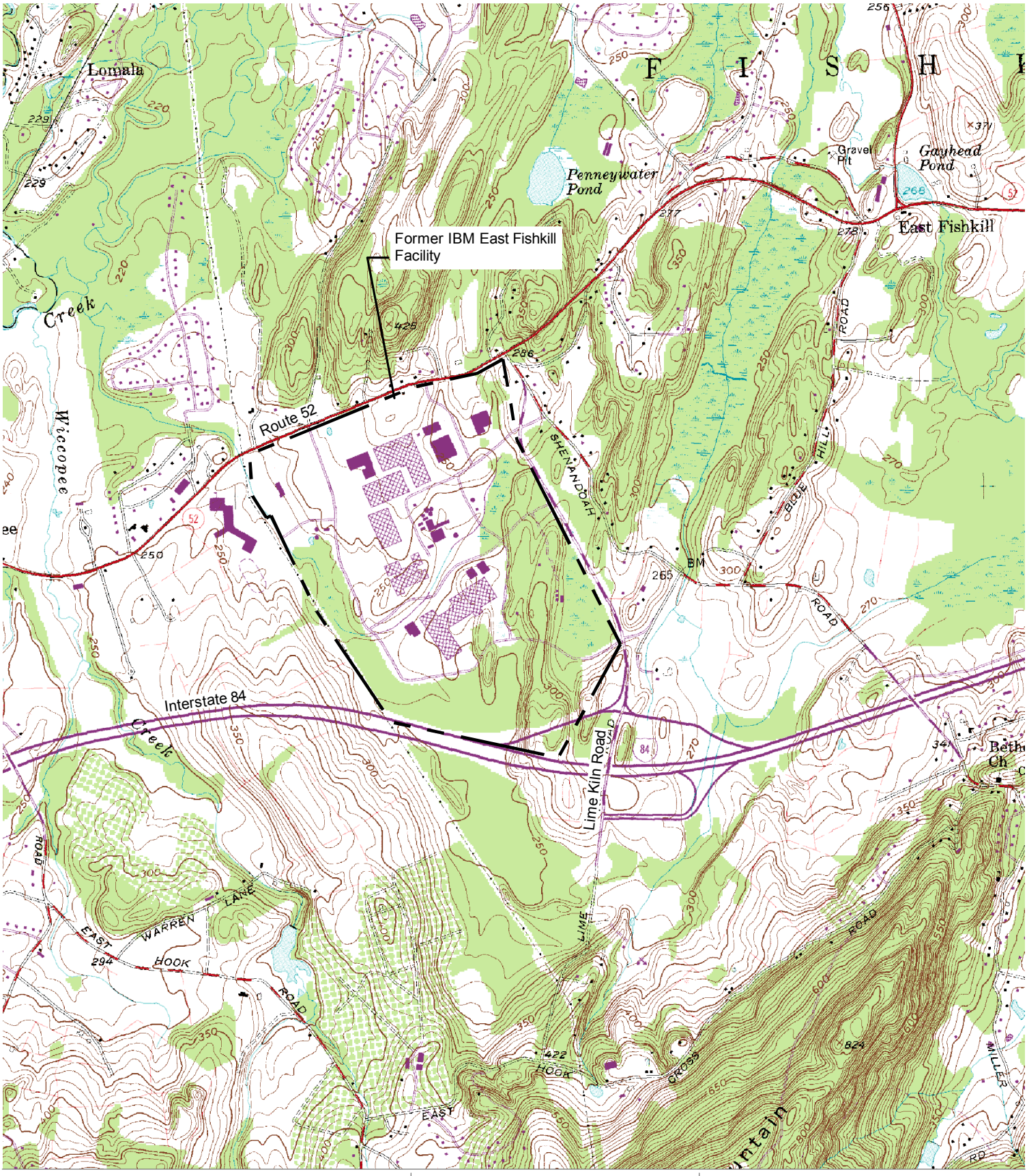

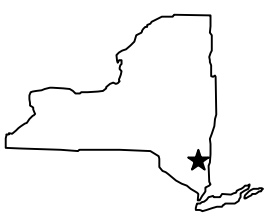

Notes:
Base map taken from 7.5 minute USGS Quadrangle Maps: Hopewell Junction, New York, Dated 1957, Photorevised in 1981.

Drawn By: E. Wright
Designed By: J. Corsello
Reviewed By: S. Soos / D. Shea
Project No: 2999.02
Date: February 2016

1,000' 0 2,000' Feet

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Figure 1

Site Location Plan

Installation and Startup Performance Monitoring Report - Area A Pilot Soil Vapor Extraction System

Former IBM East Fishkill Facility

Hopewell Junction, New York

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Figure 2

Area A Pilot SVE System Location Plan

Installation and Startup Performance Monitoring Report - Area A Pilot Soil Vapor Extraction System

Former IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: J. Corsello
Reviewed By: S. Soos / D. Shea
Project No: 2999.02
Date: February 2016

Figure Narrative

This figure shows the buildings at the former IBM East Fishkill facility. The location of the Area A Pilot SVE system is highlighted.

Legend

— - - — Former IBM Property Line

Unlabeled features include wastewater treatment tanks, pump houses, trailers, and other structures and features not intended for human occupancy

B320B Indicates building number

Indicates the location of the Area A Pilot SVE system

N
W E
S

200' 100' 0 200' 400' Feet

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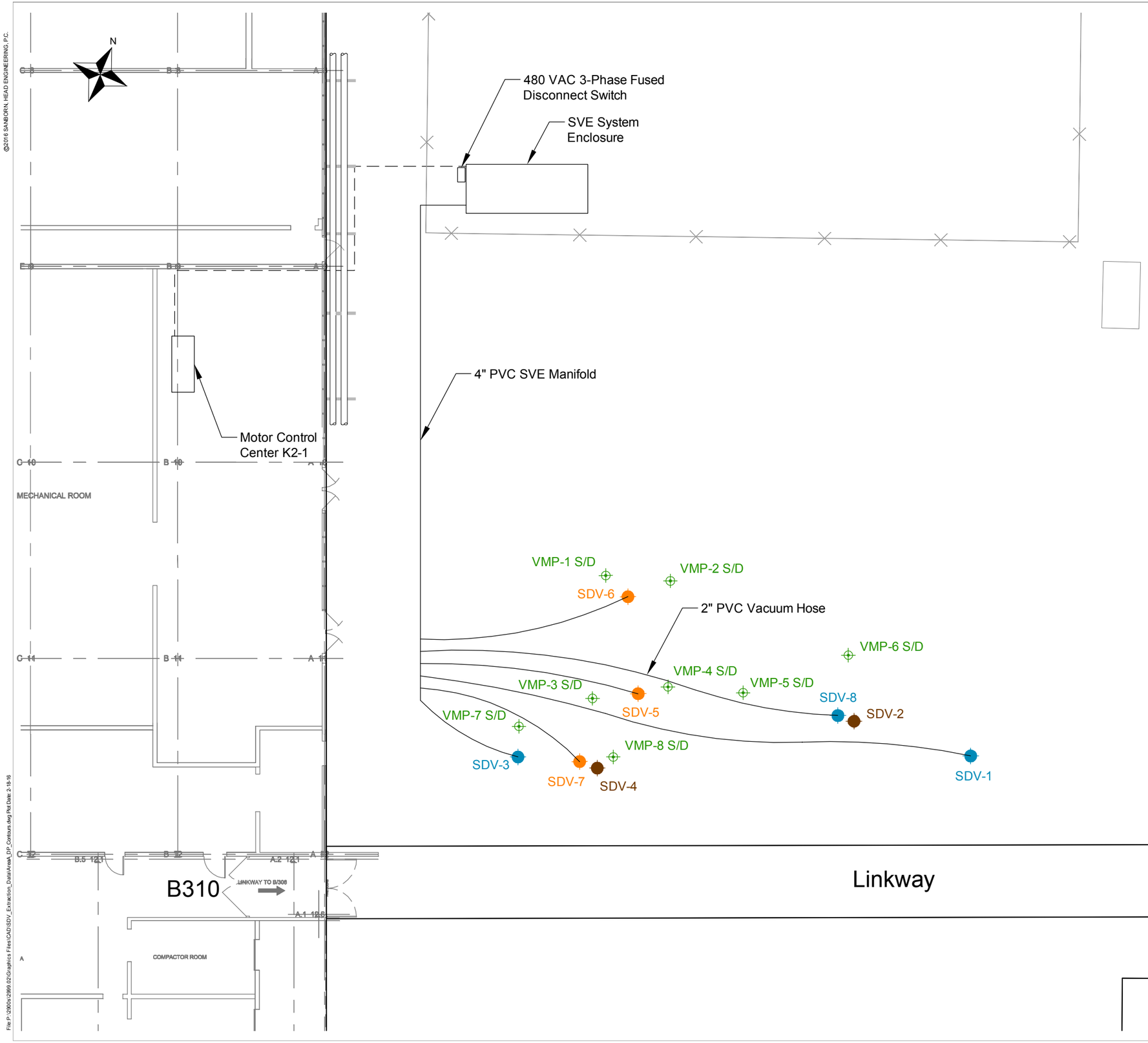

Figure 3

Area A Pilot SVE System Layout

Installation and Startup Performance Monitoring Report - Area A Pilot Soil Vapor Extraction System
Former IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: J. Corsello
Reviewed By: S. Soos / D. Shea
Project No: 2999.02
Date: February 2016

Figure Narrative

This figure shows the layout of the pilot SVE system in Area A. Refer to the legend for additional information.

Legend

SDV-2	Small diameter vapor well (2-in.) not connected to the pilot SVE system
SDV-5	Small diameter vapor well connected to the pilot SVE system currently in operation (screened 7.5 to 10 ft bgs)
SDV-3	Small diameter vapor well connected to the pilot SVE system currently not in operation (screened 7.5 to 10 ft bgs)
VMP-1 S/D	Multi-level vapor monitoring point (S = 5 ft bgs, D = 10 ft bgs)

8' 4' 0 8' 16' Feet

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Figure 4

Differential Pressure and Inferred Vacuum Isopleths 5 Ft Depth

Installation and Startup Performance Monitoring Report - Area A Pilot Soil Vapor Extraction System
Former IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: J. Corsello
Reviewed By: S. Soos / D. Shea
Project No: 2999.02
Date: February 2016

Figure Narrative

This figure shows measurements of differential pressure between ambient air and subsurface monitoring points in units of inches of water column at the noted depth interval. Negative values indicated subsurface pressures below atmospheric, or under vacuum, at the time of sampling.

Contours represent inferred apparent vacuum conditions observed during system startup monitoring conducted on May 13, 2015. Actual vacuum conditions include components of vertical flow and are likely more complex than shown. Other interpretations are possible.

Legend

- SDV-2 — Small diameter vapor well (2-in.) not connected to the pilot SVE system
- SDV-5 — Small diameter vapor well connected to the pilot SVE system currently in operation (screened 7.5 to 10 ft bgs)
- SDV-3 — Small diameter vapor well connected to the pilot SVE system currently not in operation (screened 7.5 to 10 ft bgs)
- VMP-1 S/D — Multi-level vapor monitoring point (S = 5 ft bgs, D = 10 ft bgs)
- -0.08 — Differential pressure measurement (in. wc)
- SDV-5 / 14.2 (cfm) / 39.9 (in. wc) / 318 (ppmv) — Extraction port / Flow rate (cu. ft. per min.) / Vacuum (extraction port) / PID concentration
- -1.0 — Differential pressure contour (inches of water column). Dashed where inferred.

Feet
8' 4' 0 8' 16'

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N

C 13 B 13 A 13

C 12 B 12 A 12

C 11 B 11 A 11

C 10 B 10 A 10

MECHANICAL ROOM

B310

LINKWAY TO B/308

COMPACTOR ROOM

G
EA

SVE System
Enclosure

SDV-6
13 (cfm)
40 (in. wc)
140 (ppmv)

SDV-5
14 (cfm)
40 (in. wc)
320 (ppmv)

SDV-7
90 (cfm)
36 (in. wc)
91 (ppmv)

-0.02

-1.00

-2.00

VMP-1 S/D
-2.9

VMP-2 S/D
-2.0

SDV-6

VMP-3 S/D
-0.48

VMP-4 S/D
-0.51

VMP-5 S/D
-0.09

VMP-6 S/D
-0.04

SDV-5

SDV-8

SDV-2

VMP-7 S/D
-0.43

SDV-3

VMP-8 S/D
-2.0

SDV-7

SDV-4

SDV-1

Linkway

B384

Figure 5

Differential Pressure and Inferred Vacuum Isopleths 10 Ft Depth

Installation and Startup Performance Monitoring Report - Area A Pilot Soil Vapor Extraction System
Former IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
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Figure Narrative

This figure shows measurements of differential pressure between ambient air and subsurface monitoring points in units of inches of water column at the noted depth interval. Negative values indicated subsurface pressures below atmospheric, or under vacuum, at the time of sampling.

Contours represent inferred apparent vacuum conditions observed during system startup monitoring conducted on May 13, 2015. Actual vacuum conditions include components of vertical flow and are likely more complex than shown. Other interpretations are possible.

Legend

- SDV-2 — Small diameter vapor well (2-in.) not connected to the pilot SVE system
- SDV-5 — Small diameter vapor well connected to the pilot SVE system currently in operation (screened 7.5 to 10 ft bgs)
- SDV-3 — Small diameter vapor well connected to the pilot SVE system currently not in operation (screened 7.5 to 10 ft bgs)
- VMP-1 S/D — Multi-level vapor monitoring point (S = 5 ft bgs, D = 10 ft bgs)
- -0.48 — Differential pressure measurement (in. wc)
- **SDV-5** / 14.2 (cfm) / 39.9 (in. wc) / 318 (ppmv) — Extraction port / Flow rate (cu. ft. per min.) / Vacuum (extraction port) / PID concentration
- -1.00 — Differential pressure contour (inches of water column). Dashed where inferred.

8' 4' 0 8' 16' Feet

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