Port Jervis Former MGP Site

Orange and Rockland Utilities, Inc.

REMEDIAL DESIGN

Port Jervis, New York

November 2017

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Orange and Rockland Utilities, Inc.
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I, Kevin W. Jay, certify that I am currently a NYS registered professional engineer or Qualified Environmental Professional as defined in 6 NYCRR Part 375 and that this Remedial Design was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

Prepared for:

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1 INTRODUCTION

On behalf of Orange and Rockland Utilities, Inc., (O&R), Arcadis of New York, Inc. (Arcadis) has prepared this Remedial Design (RD) to install and operate a combined Air Sparge (AS)/Soil Vapor Extraction (SVE) remediation system at the O&R former manufactured gas plant (MGP) site in Port Jervis, New York (**Figure 1**). This RD is based on findings of an AS/SVE Pilot Test as specified in the Arcadis Air Sparging Pilot Test Summary Report dated August 1, 2017. The system is designed to remediate adsorbed-phase and dissolved-phase hydrocarbon impacts present at the site. The RD provides details on the proposed remedial system design, installation, operation and performance monitoring. The AS/SVE system is designed to intercept the dissolved-phase plume and prevent further migration of the constituents of concern (COC). This document has been prepared for New York State Department of Environmental Conservation (NYSDEC) review and approval before proceeding with the implementation of the proposed remedy.

2 REMEDIAL DESIGN

A combined AS/SVE system will be installed and operated to intercept the dissolved-phase plume at the site. Details on the system layout, design and operation are provided in the following sections. The proposed design has been prepared using conservative estimates for air sparging and soil vapor extraction radii of influence and other parameters for the subsurface conditions based on pilot testing results.

2.1 Remediation System Conceptual Design

2.1.1 Summary of Technology and Governing Principals

2.1.1.1 Air Sparge

AS systems introduce ambient air into the saturated zone typically via the use of an air sparge compressor. The physical action of the sparged air rising through the subsurface (groundwater and soil) promotes the volatilization of dissolved- and adsorbed-phase petroleum hydrocarbons into the soil vapor. Typically, air sparge systems are used in conjunction with SVE systems so that the sparged vapors can be recovered from the subsurface. In addition to volatilization, air sparging increases the dissolved oxygen in the groundwater and promotes aerobic degradation of hydrocarbons. Air sparging is most effective at removing volatile dissolved-phase compounds in a relatively homogeneous permeable aquifer matrix. As discussed in the *Air Sparging Pilot Test Summary* (Arcadis, 2017), AS is considered an appropriate remedial technology for the site and was shown to be effective during pilot testing activities.

2.1.1.2 Soil Vapor Extraction

SVE is a commonly used remediation technique for the treatment of vapor phase and adsorbed-phase petroleum hydrocarbons in the vadose zone. SVE systems apply vacuum to extraction wells to allow for the recovery of soil vapor from unsaturated soils. As air moves through soil in the vadose zone, volatile organic compounds (VOCs), including adsorbed-phase hydrocarbons, are transferred into the vapor stream for recovery. Overall, SVE systems have been proven effective for compounds which have high vapor pressures (>1 millimeter of mercury) and/or that are aerobically biodegradable. As groundwater levels fluctuate, SVE can remediate the petroleum hydrocarbons that are exposed in the capillary fringe as well.

The contaminant mass at the site consists mainly of VOCs associated with petroleum hydrocarbons which have relatively high vapor pressures. As demonstrated during the pilot test, the site conditions are favorable for the application of SVE technology to extract vapor and hydrocarbons from the subsurface created during air sparging.

2.1.2 Pilot Testing

Arcadis completed an AS/SVE pilot test at the site on June 6 and 7, 2017. Pilot testing was completed on shallow AS well AS-1S and deep AS well AS-1D. Soil vapor was extracted from SVE-1 during applicable steps. Pilot testing results were summarized in the *Air Sparging Pilot Test Summary* (Arcadis, 2017) that was submitted to the NYSDEC on August 1, 2017. The results demonstrated that AS/SVE can be used effectively to remediate petroleum hydrocarbon impacts and support the following conclusions regarding the full-scale AS/SVE design.

- A combination of deep and shallow AS wells will be required to cover the vertical extent of impacts.
- Low level (less than 5 ppmv) well headspace detections were observed in building sub-slab monitoring points MP-1 and MP-2.
- An increase in well headspace photoionization detector (PID) readings during AS indicate a need for SVE in addition to AS.
- When SVE was implemented during air sparging, a decrease in well headspace readings in the monitoring wells was observed, indicating a successful capture of vapors.
- A conservative SVE and AS radius of influence (ROI) of 17 feet was assumed during the design of the full-scale well network.

2.1.3 Air Sparge System Layout and Design

The proposed air sparge system consists of sixteen wells (AS-1S, AS-1D, AS-2S, AS-2D, AS-3S, AS-3D, AS-4S, AS-4D, AS-5S, AS-5D, AS-6S, AS-6D, AS-7S, AS-7D, AS-8S, and AS-8D). The locations of the proposed air sparge wells are shown on **Figure 2**. The 17-foot ROI used to develop the air sparge well network layout is based on an assumed 45° cone of sparge influence, extending outward from the top of the sparge well screen to water table surface, which pilot testing results indicate is appropriate for the formation.

The proposed air sparge system well network consists of both shallow and deep wells. Sparge wells AS-1S and AS-1D were installed prior to the pilot test, and construction details are documented in the *Air Sparging Pilot Test Summary* (Arcadis, 2017). The remaining fourteen AS wells will be installed in seven 8-inch boreholes (a deep and shallow AS well will be nested in each of the boreholes) and will be constructed of 2-inch ID, Schedule 40 PVC casing with 2-foot long, 0.02-inch-slotted wire-wrapped stainless-steel screens. The shallow air sparge wells will be installed to a depth of 40 feet bgs while the deep wells will be installed to a depth of 60 feet bgs. Silica sand filter pack (#1) will be installed in the annular space surrounding the well screen to a depth of approximately 2-feet above the top of the screen. A 2-foot thick layer of hydrated bentonite pellet seal will be installed above the sand filter pack. The remaining annular space surrounding the well casing will be filled with a cement grout seal to approximately 4 feet below grade. The boring will then be completed with sand to allow for lateral system piping connections. AS wells will be completed at the surface within a flush-mounted curb box. **Figure 3** provides details illustrating the construction of a typical AS well and wellhead completion. The layout and design of the proposed air sparge well network and construction of the individual wells may change based on field conditions.

Based on pilot test data, Arcadis has assumed for design purposes that each AS well will operate at a steady-state airflow rate of between 5 and 20 scfm and a pressure of 10-25 pounds per square inch (psi). The design wellhead pressure range was also selected to be below the formation fracture pressure of the deep AS wells, which is calculated to be approximately 36.6 psi based on available site data, as documented in **Appendix A**. The formation fracture pressure of the shallow AS wells was calculated to be approximately 23.1 psi based on available site data, as documented in **Appendix A**. Separate air sparge manifolds will be constructed to control flow and pressure into the shallow and deep air sparge points. The shallow AS well manifold will be plumbed with a pressure regulator to limit the pressure going into the shallow AS wells so not to exceed the formation fracture pressure. The air sparge compressor and other system equipment will be sized to operate within these wellhead pressures and airflow rate ranges. A process and instrumentation diagram for the AS system that will be installed at the site is illustrated in **Figure 5**.

The AS system will be interlocked with the SVE system, so that it will shut down if the SVE system shuts down to prevent air sparging from continuing without vapor recovery.

2.1.4 Soil Vapor Extraction System Layout and Design

The SVE system will consist of six proposed SVE wells (SVE-1, SVE-2, SVE-3, SVE-4, SVE-5, and SVE-6) at the locations shown on **Figure 2**. This system layout was developed to provide coverage across the anticipated AS treatment area. The 17-foot SVE ROI used in the design represents a conservative estimate based on pilot test data.

Extraction well SVE-1 was installed prior to the pilot test, and construction details are documented in the *Air Sparging Pilot Test Summary* (Arcadis, 2017). The remaining five SVE wells will be constructed of 4-inch inner-diameter (ID), Schedule 40 PVC casing with 10-foot-long, 0.02-inch standard machine-slotted screens, screened from approximately 5 to 15 feet below ground surface (bgs). Silica sand filter pack (#1) will be installed in the annular space surrounding the well screen to a depth of approximately 1 foot above the top of the screen. A 2-foot thick layer of hydrated bentonite pellet seal will be installed above the sand filter pack. The remaining annular space surrounding the well casing will be filled with sand to facilitate the installation of lateral system piping to the well. SVE wells will be completed at the surface within a flush-mounted traffic vault. **Figure 3** provides typical construction details for the remaining five proposed SVE wells that will be installed at the site. The layout and design of the proposed extraction well network and construction of the individual wells may change based on field conditions.

Based on the pilot test data, Arcadis has designed the soil vapor extraction portion of the system to operate at a wellhead vacuum of approximately 55 inches of water column (in. w.c.) and a flow rate of approximately 60 standard cubic feet per minute (scfm) per extraction well. A process and instrumentation diagram (P&ID) for the SVE system that will be installed at the site is provided on **Figure 4**.

Data from the pilot test indicated that concentrations of individual constituents in the SVE effluent were below the laboratory detection limits; therefore, a Division of Air Resources – 1 (DAR-1) model was not prepared to evaluate the need for vapor treatment prior to discharging to the atmosphere. It should be noted that dissolved phase benzene concentrations are higher west of the pilot test location, near MW-24 and MW-25. Since benzene is generally the main driver for requiring vapor treatment, during full-scale system start-up activities, including the operation of remediation wells in the vicinity of MW-24 and MW-25, an additional vapor sample will be collected and a DAR-1 model will be prepared using system operational data to re-evaluate the need for vapor treatment on the SVE system.

2.1.5 System Layout and Design

Blowers and other system equipment will be housed in a system enclosure building/trailer that will be located on site at the approximate location illustrated on **Figure 2**. A diagram of a typical AS/SVE system enclosure that will be used at this site is provided as **Figure 6**. Actual system enclosure specifications will be provided by the selected equipment vendor during procurement activities.

Piping between the AS and SVE wellheads and the system enclosure will be installed below-grade in trenches with the exception of the initial piping from the system enclosure which will exit the side of the building and connect to stub up piping prior to penetrating the subsurface. A proposed system trenching layout is illustrated on **Figure 2**. Individual air and vacuum lines will be extended from the system enclosure to each of the AS and SVE wells, allowing for simple modifications/ optimization of the system. Above grade compressed air supply lines will be constructed with 1-inch diameter Schedule 40 painted steel pipe. Above grade SVE lines will be constructed with 3-inch diameter, painted Schedule 40 PVC. All below grade compressed air supply lines will be constructed with 1-inch diameter, HDPE piping. The compressed air lines will transition to steel piping prior to daylighting above grade. Below grade SVE lines will be constructed with 3-inch diameter, Schedule 40 PVC. A headloss evaluation was completed for all subsurface piping to select optimal piping diameters. The headloss calculations are included in **Table 1**.

The system will be equipped with telemetry that will alert operations and maintenance personnel of any alarm conditions or other anomalies in system operation that require attention.

2.2 System Installation and Operation

2.2.1 System Startup

After the AS/SVE wells and associated trenching/piping are installed, the various components of the AS/SVE system will be transported to the site, assembled and connected to the piping in preparation for system startup.

Prior to startup, groundwater samples will be collected to establish baseline conditions within the proposed target zone. During the system startup phase, the full-scale system will be brought online and run through a series of operational tests. Field personnel will be on site during the initial startup period to monitor system operating parameters (i.e., vacuum strength, air flow, pressure, and VOC content of influent vapors). Startup measurements will be used to optimize the system and make any adjustments necessary such that the system operates as designed.

Field personnel will collect an influent air sample for laboratory analysis after the full-scale system is brought online and system readings have stabilized. The influent sample will be collected from a sample port located on the pressurized side of the system after the blower. The sample will be collected using a Tedlar® Bag, and be sent to a New York State Department of Health (NYSDOH)-certified laboratory to be analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX) and C4-C10 hydrocarbons via United States Environmental Protection Agency (USEPA) Method 18/25. Air analytical data will be used to calibrate total VOC concentrations measured in the field with the PID readings by confirming air analytical data is consistent with field PID readings and to provide concentrations of individual constituents. The analytical data will be used to run the DAR-1 model with full-scale system operation data and confirm if vapor treatment is needed.

In addition to BTEX and C4-C10 hydrocarbons, the initial influent air sample will be analyzed for polycyclic aromatic hydrocarbons (PAHs) to evaluate concentrations of these individual compounds within the vapor stream. These analyses will ensure compliance with the DAR-1 regulations. If the concentrations of these constituents are non-detect during the sampling, then they will be eliminated from any subsequent air sampling events. In addition, and within a month of system startup, groundwater samples will be collected to further evaluate subsurface conditions.

After startup operations are completed and the system is running at the desired operational settings, the standard system operation phase will begin.

2.2.2 Standard Operation, Maintenance, and Monitoring

Following remedial system startup activities, routine operation, maintenance, and monitoring (OM&M) activities will commence. OM&M personnel will perform any routine maintenance, complete adjustments as needed and collect the following system performance monitoring data:

- pressure, temperature, and air flow readings at the system enclosure for both components of the system, AS and SVE
- VOC concentrations (by PID) of the SVE system influent vapor stream
- system operating time
- flow rate, temperature, pressure and VOC concentrations (by PID) at the SVE wellheads routinely to help optimize the system operation
- flow rate and pressure readings at the AS wellheads routinely to help optimize the system operation

System components will be maintained in accordance with the manufacturer’s guidance and equipment manuals.

Influent air samples will be collected via Tedlar® bag as needed, based on significant increases in field PID readings and historical calibration between PID readings and individual constituent concentrations. Samples will be submitted to a NYSDOH-certified laboratory for analysis of BTEX and C4-C10 hydrocarbons via USEPA Method 18/25 and PAHs and SVOCs if applicable. The results of the air samples collected during system operation will confirm the applicability of the DAR-1 model and conformity to state regulations.

The data recorded during the monthly O&M visits will be used to estimate the hydrocarbon mass recovery rate and evaluate the system performance. When the data suggest that mass recovery is becoming asymptotic, Arcadis will take steps to try and optimize system performance and increase mass recovery.

In addition to system monitoring, groundwater monitoring will be conducted to evaluate the effectiveness of the remediation system. Groundwater samples will be collected from upgradient and downgradient monitoring wells as remediation progresses. Groundwater samples may be analyzed for VOCs and SVOCs as well as geochemical parameters such as phosphate, sulfate, and nitrate to aid in evaluating the influence the remedy is having on the subsurface and assist in optimizing operation.

Potential system optimization measures may include:

- Deactivating extraction wells with low vapor-phase VOC concentrations, or AS wells located in areas which groundwater monitoring data, upgradient and downgradient, has indicated minimally impacted groundwater, which allows the system to focus on the wells operating in areas which groundwater monitoring indicates high concentrations of COCs.
- Changing the air flow rates and/or vacuum/pressure applied to SVE and AS wells
- Transitioning to a pulsed method of operation, where the system is repeatedly turned on and then off for specific periods of time (i.e., 4 hours on and 4 hours off) to allow hydrocarbon concentrations in groundwater to rebound, create turbulence within the subsurface, and to minimize preferential pathways
- If low vapor mass recovery is consistently observed at each extraction well and system influent, the system may transition to a biosparging approach which would consist of low sparging flow rates (less than 5 scfm) of ambient air used to maintain elevated dissolved oxygen concentrations to stimulate continued aerobic biodegradation. This will be evaluated by collecting dissolved oxygen (DO) readings at each extraction well during routine O&M activities and continued evaluation of groundwater monitoring data.

3 PERMITTING

Before beginning site activities, necessary permits (i.e., building and electrical permits) will be obtained from federal, state and local agencies having jurisdiction over aspects of the work. It will be determined after system startup if an air permit is required from the NYSDEC to operate the system by completing a DAR-1 model. If the discharge concentrations are below DAR-1 values, an air permit will not be obtained. Documentation proving compliance will be provided to the NYSDEC and other permitting entities as necessary. Building and electrical permits will be obtained as appropriate prior to the system and trenching installation.

4 SCHEDULE

An approximate implementation schedule is provided as **Table 2**. The schedule was developed based on an assumed review and approval timeframe for NYSDEC and the various state and local permitting agencies.

5 REFERENCES

Arcadis, 2017. *Air Sparging Pilot Test Summary*. Port Jervis Former MGP Site, City of Port Jervis, Orange County, New York. June 2017.

TABLES

Table 1
Headloss Calculations
Orange and Rockland Utilities, Inc.
Port Jervis Former MGP Site
City of Port Jervis, Orange County, New York

Well ID	Equivalent Length of Pipe (feet)	Friction Loss per Foot (in. w.c per foot)	Total Friction Loss (in. w.c.)
SVE-1	80	0.014	1.12
SVE-2	130	0.014	1.82
SVE-3	105	0.014	1.47
SVE-4	55	0.014	0.77
SVE-5	30	0.014	0.42
SVE-6	30	0.014	0.42
AS-1S	80	0.14	11.2
AS-1D	80	0.14	11.2
AS-2S	135	0.14	18.9
AS-2D	135	0.14	18.9
AS-3S	115	0.14	16.1
AS-3D	115	0.14	16.1
AS-4S	95	0.14	13.3
AS-4D	95	0.14	13.3
AS-5S	55	0.14	7.7
AS-5D	55	0.14	7.7
AS-6S	35	0.14	4.9
AS-6D	35	0.14	4.9
AS-7S	30	0.14	4.2
AS-7D	30	0.14	4.2
AS-8S	25	0.14	3.5
AS-8D	25	0.14	3.5

Note:
1 Assumed a max SVE flow rate of 60 scfm and 3" diameter pipe
2 Assumed a max AS flow rate of 15 scfm and 1" diamter pipe

Table 2
Tentative Implementation Schedule
Orange and Rockland Utilities, Inc.
Port Jervis Former MGP Site
City of Port Jervis, Orange County, New York

Task	Time (weeks)																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Receive NYSDEC Approval of RD																					
Permitting (Building, air, etc.)																					
Prepare Contractor Bid Specifications for Trenching & System Installation and System Fabrication																					
Bidding & Contractor Selection																					
Install SVE & AS Wells for Full-Scale System (Dependent on contractor availability)																					
Premobilization Activities (surveying, utility location, power drop, etc.)																					
Install System Trenching and Below Grade Piping (Dependent on contractor availability)																					
AS/SVE System Fabrication (Assume 6-8 weeks for fabrication after contract award to vendor)																					
AS/SVE System Mobilization and Installation																					
AS/SVE System Startup (Dependent on power drop)																					

Notes
Proposed schedule is subject to change based on actual NYSDEC and permitting agency review timeframes, power drop, contractor availability, weather and similar external factors.

FIGURES

LEGEND:

- PROPERTY LINE
- EDGE OF WATER (APPROXIMATE)
- EXISTING BUILDING
- EXISTING CHAIN-LINK FENCE
- EXISTING WOOD FENCE
- EXISTING WIRE FENCE
- EXISTING GUARDRAIL
- 36-INCH-DIAMETER STORM SEWER LINE (APPROXIMATE)
- INFERRED LIMITS OF GROUNDWATER IMPACTS
- MW14S — MONITORING WELL LOCATION
- PZ1 — PIEZOMETER LOCATION
- CMT WELL LOCATION
- SVE-1 — SOIL VAPOR EXTRACTION WELL
- AS-1S — AIR SPARGE WELL
- RW-05 — RECOVERY WELL

NOTES:

1. BASE MAP MODIFIED FROM DRAWINGS PORT_JERVIS_08.DWG AND FIG2-1_GW3-08.DWG PROVIDED BY AECOM AND BASED ON ELECTRONIC COPY OF SURVEY DRAWING NO. 100204, TITLED "SURVEY OF PROPERTY", DATED 03-25-10, PROVIDED BY BORBAS SURVEYING AND MAPPING, LLC.
2. HORIZONTAL DATUM IS THE NORTH AMERICAN DATUM OF 1983 (NAD 83) ; NEW YORK STATE PLANE EAST COORDINATE SYSTEM, IN U.S. SURVEY FEET. VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) .
3. ALL LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

0 80' 160'

GRAPHIC SCALE

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK

SITE LOCATION MAP

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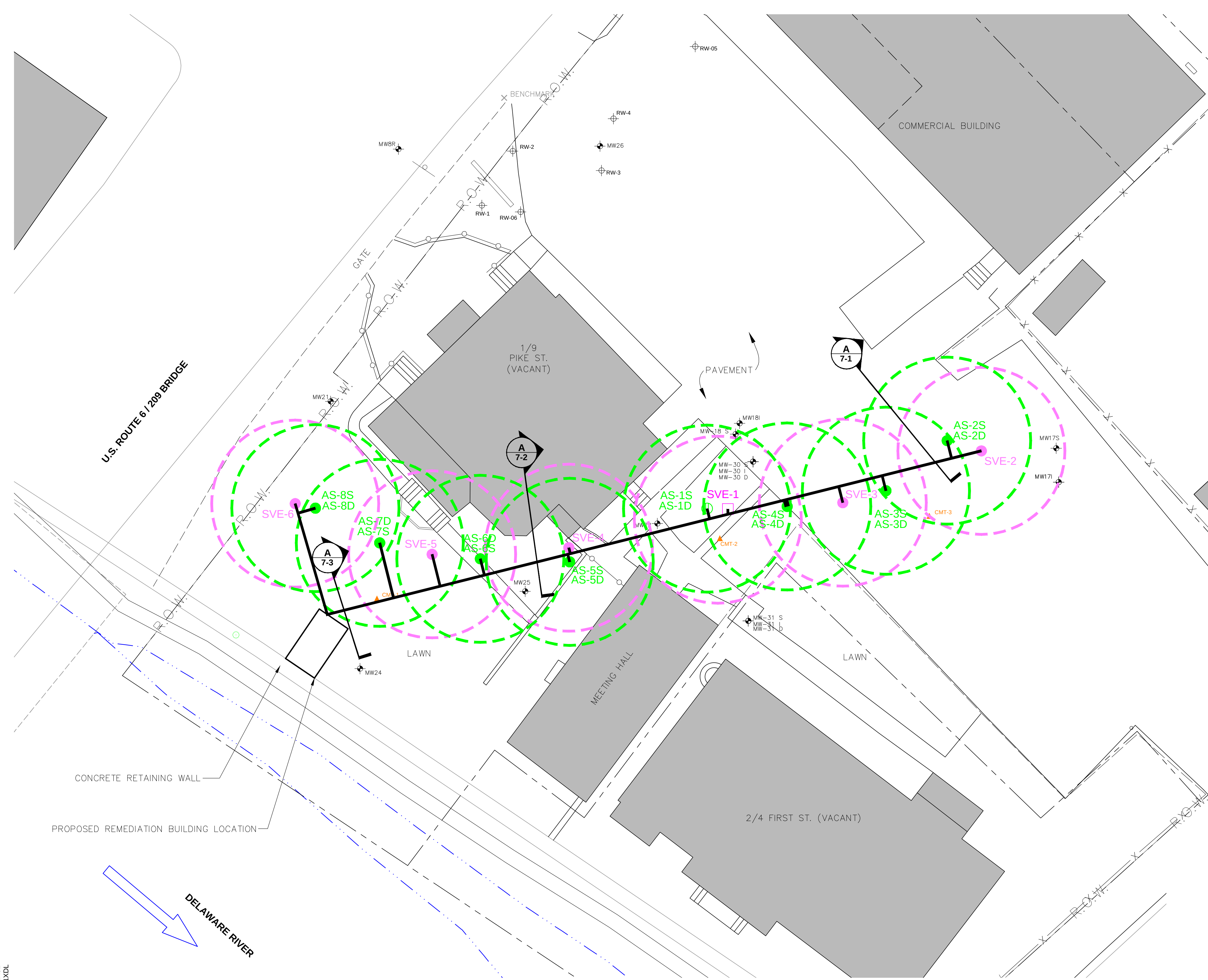
FIGURE 1



LEGEND:

- PROPERTY LINE
- EDGE OF WATER (APPROXIMATE)
- EXISTING BUILDING
- EXISTING CHAIN-LINK FENCE
- EXISTING WOOD FENCE
- EXISTING WIRE FENCE
- EXISTING GUARDRAIL
- EXISTING SIGN
- MW14S MONITORING WELL LOCATION
- RW-06 RECOVERY WELL
- CMT WELL LOCATION
- PROPOSED SVE WELL AND ROI (17 FT)
- PROPOSED AS WELL AND ROI (17 FT)
- PROPOSED AS/SVE PIPING TRENCH
- SVE-1 SOIL VAPOR EXTRACTION WELL
- AIR SPARGE WELL

NOTES:

1. BASE MAP MODIFIED FROM DRAWINGS PORT_JERVIS_08.DWG AND FIG2-1_GW3-08.DWG PROVIDED BY AECOM AND BASED ON ELECTRONIC COPY OF SURVEY DRAWING NO. 100204, TITLED "SURVEY OF PROPERTY", DATED 03-25-10, PROVIDED BY BORBAS SURVEYING AND MAPPING, LLC.
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3. ALL LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

0 10' 20'
GRAPHIC SCALE

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK

PROPOSED TRENCHING LAYOUT PLAN

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FIGURE
2

CITY: SYRACUSE, NY DIV/GROUP: IMDV DB: G.STOWELL, K.DAVIS LD: G.STOWELL PIC:(Opt) PM:(Reqd) TM: T.HOWE LYR: ON=*;OFF=*REF*
I:\ENVCAD\WhitePlains-NY\RETURN-TO\Syracuse-NY\B0043021\0017\00001\DWG\43021B02.dwg LAYOUT: 2 SAVED: 8/25/2017 4:08 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 8/30/2017 3:27 PM BY: IAMICELI, KIMBERLY
XREFS: IMAGES: PROJECTNAME: ----
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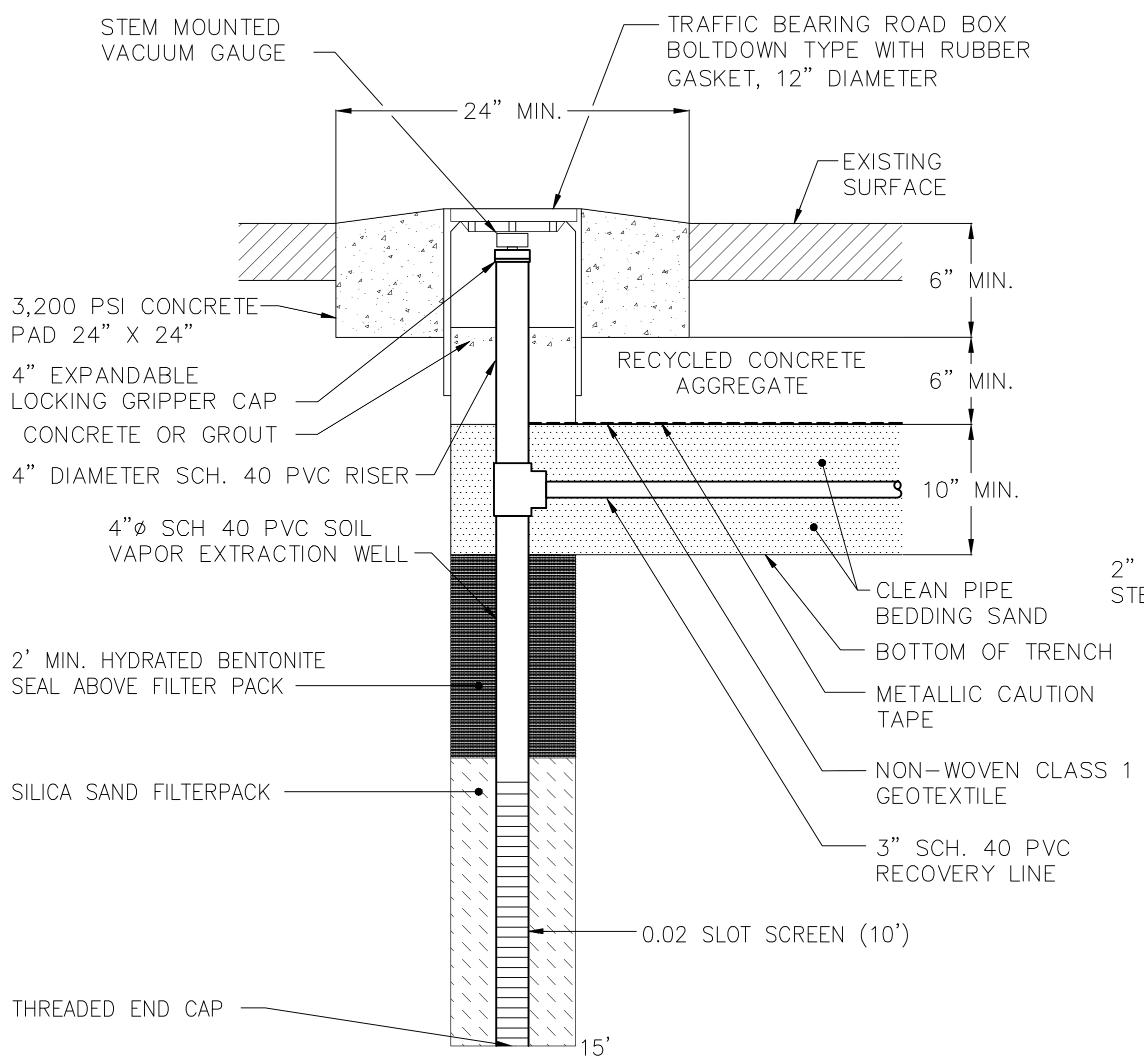
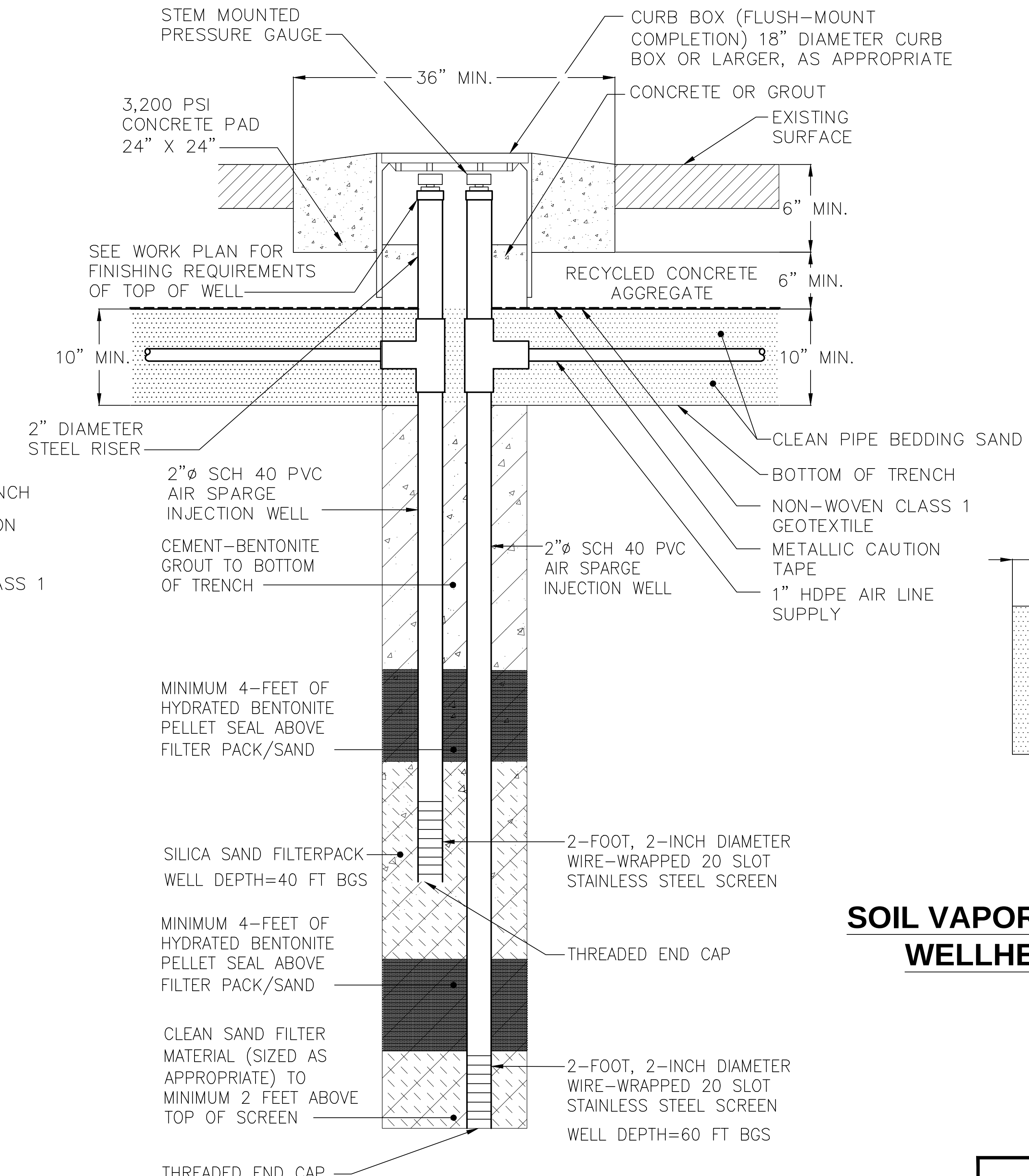
43021XDL



SOIL VAPOR EXTRACTION WELL DETAIL

NOT TO SCALE

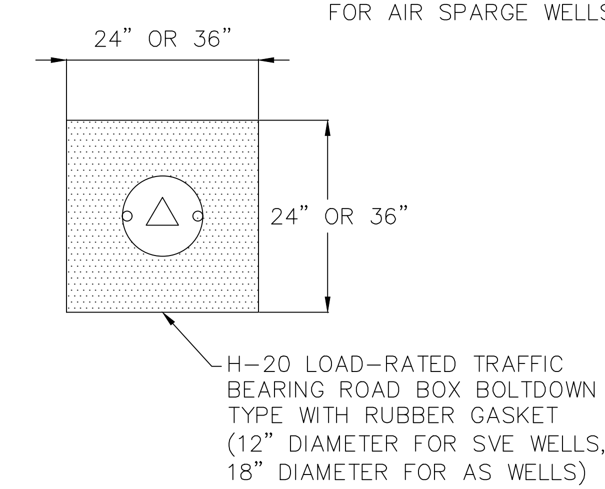


AIR SPARGE WELL DETAIL

NOT TO SCALE

NOTE:

1. 24" FOR SOIL VAPOR EXTRACTION WELLS AND 36" FOR AIR SPARGE WELLS.



SOIL VAPOR EXTRACTION/AIR SPARGE WELLHEAD MONUMENT DETAIL

NOT TO SCALE

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK

AIR SPARGE AND SOIL VAPOR EXTRACTION WELL DETAILS

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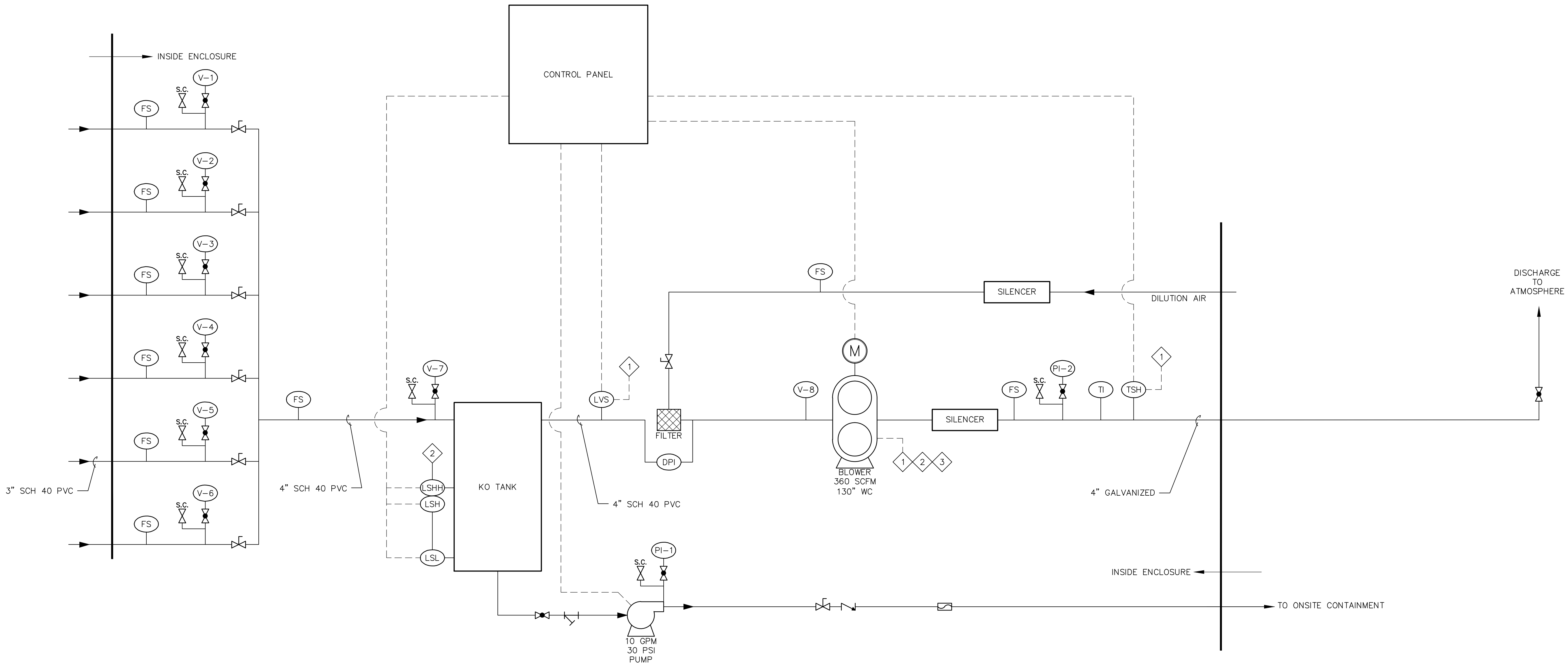
FIGURE

3



LEGEND

- RELIEF VALVE
- GATE VALVE
- SAMPLE CONNECTION/PORT
- CHECK VALVE
- BALL VALVE
- WYE STRAINER
- TOTALIZING FLOW METER
- FS PITOT TUBE FLOW SENSOR
- LVS LOW VAC SWITCH
- VPS VAPOR CONTROL SWITCH
- SV SOLENOID VALVE
- PI-1 PRESSURE INDICATOR 0-30 PSI
- DPI DIFFERENTIAL PRESSURE INDICATOR
- LSHH LEVEL SWITCH HIGH-HIGH LEVEL
- LSH LEVEL SWITCH HIGH LEVEL
- LSL LEVEL SWITCH LOW LEVEL
- TI TEMPERATURE INDICATOR 0-250
- PI-2 PRESSURE INDICATOR 0-30" WC
- V-1 VACUUM INDICATOR 0-30" HG
- TT TEMPERATURE TRANSMITTER
- FT FLOW TRANSMITTER
- THREE WAY VALVE

INTERLOCK SCHEDULE

1. LOW VACUUM ALARM (30" W.C.) – SHUT DOWN BLOWER SIGNAL ALARM
2. HIGH LEVEL ALARM – SHUT DOWN BLOWER SIGNAL ALARM
3. HIGH TEMPERATURE ALARM (200 F) – SHUT DOWN BLOWER SIGNAL ALARM

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK

SOIL VAPOR EXTRACTION SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

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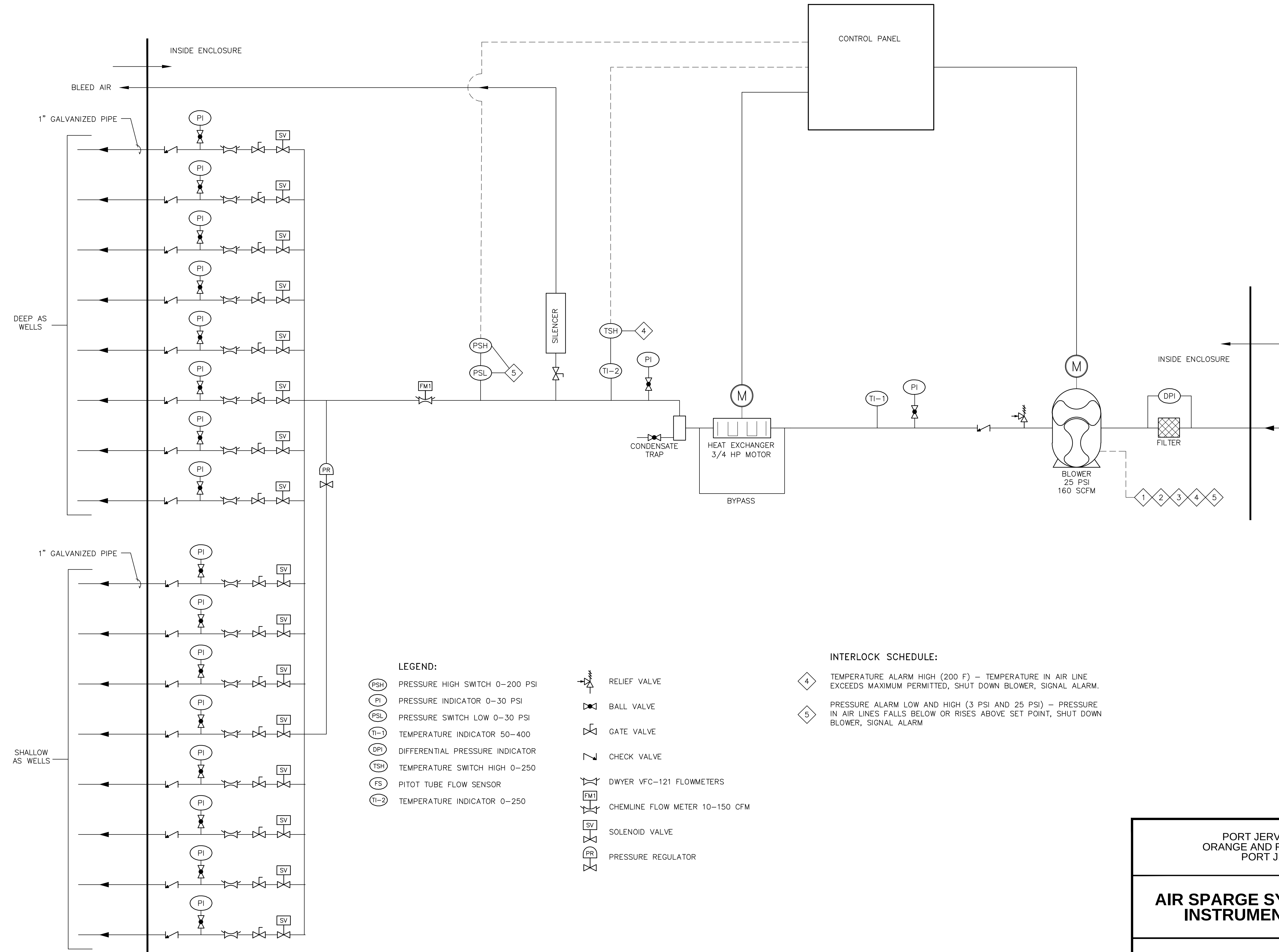
FIGURE
4



LEGEND:

- (PSH) PRESSURE HIGH SWITCH 0–200 PSI
- (PI) PRESSURE INDICATOR 0–30 PSI
- (PSL) PRESSURE SWITCH LOW 0–30 PSI
- (TI-1) TEMPERATURE INDICATOR 50–400
- (DPI) DIFFERENTIAL PRESSURE INDICATOR
- (TSH) TEMPERATURE SWITCH HIGH 0–250
- (FS) PITOT TUBE FLOW SENSOR
- (TI-2) TEMPERATURE INDICATOR 0–250
- RELIEF VALVE
- BALL VALVE
- GATE VALVE
- CHECK VALVE
- DWYER VFC-121 FLOWMETERS
- (FM1) CHEMLINE FLOW METER 10–150 CFM
- (SV) SOLENOID VALVE
- (PR) PRESSURE REGULATOR

INTERLOCK SCHEDULE:

- ⟨4⟩ TEMPERATURE ALARM HIGH (200 F) – TEMPERATURE IN AIR LINE EXCEEDS MAXIMUM PERMITTED, SHUT DOWN BLOWER, SIGNAL ALARM.
- ⟨5⟩ PRESSURE ALARM LOW AND HIGH (3 PSI AND 25 PSI) – PRESSURE IN AIR LINES FALLS BELOW OR RISES ABOVE SET POINT, SHUT DOWN BLOWER, SIGNAL ALARM

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK

AIR SPARGE SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

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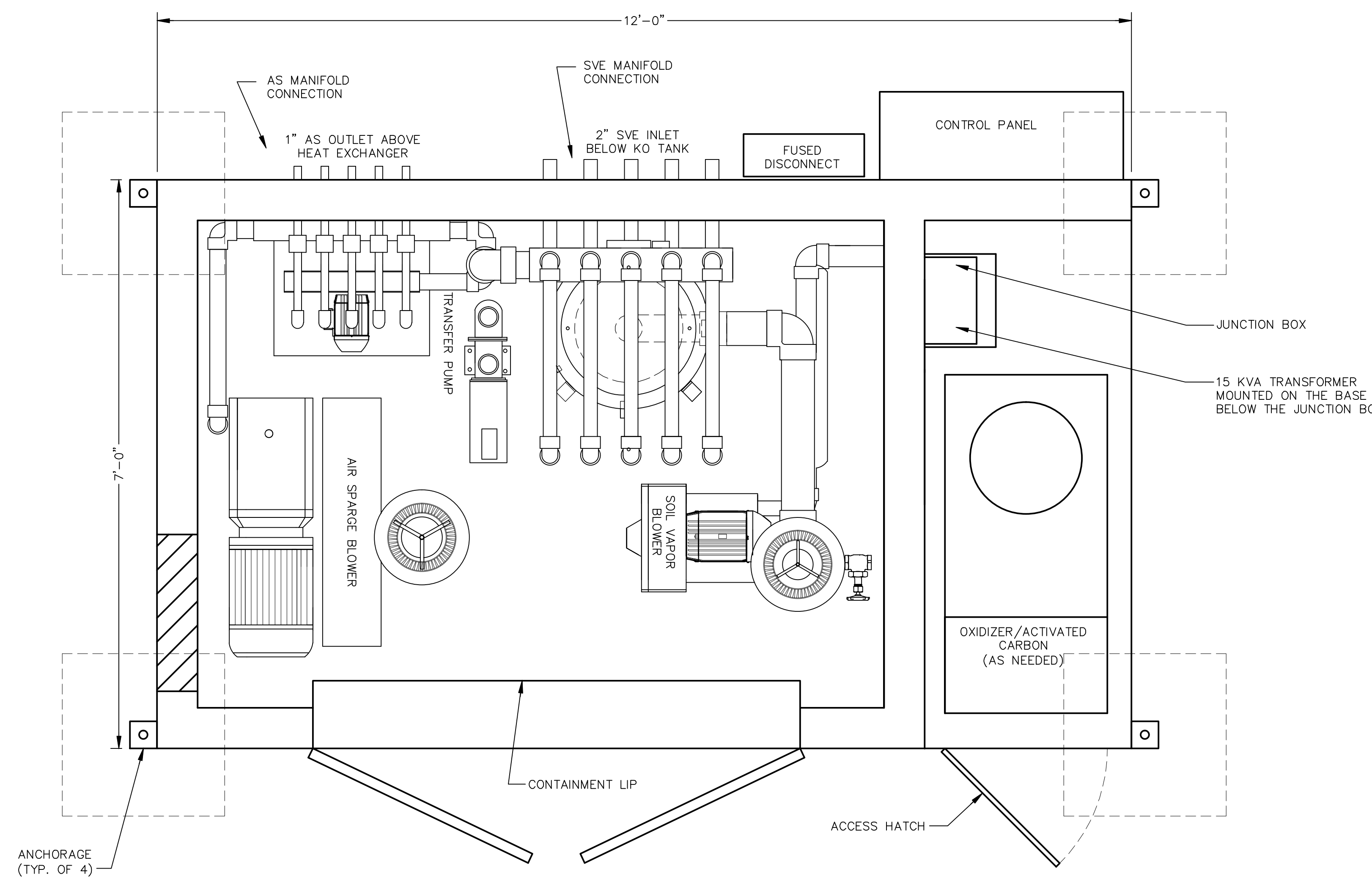
FIGURE
5

TYPICAL SYSTEM LAYOUT



PLAN

SCALE: 1"=1'-0"

NOTE:

1. ACTUAL TREATMENT SYSTEM DIMENSIONS AND LAYOUT WILL BE PROVIDED PRIOR TO IMPLEMENTATION.

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TYPICAL AIR SPARGE/SOIL VAPOR EXTRACTION TREATMENT SYSTEM ENCLOSURE

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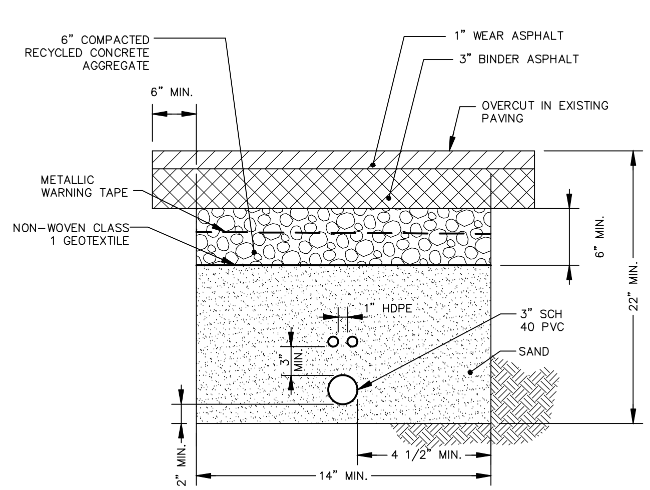
FIGURE 6

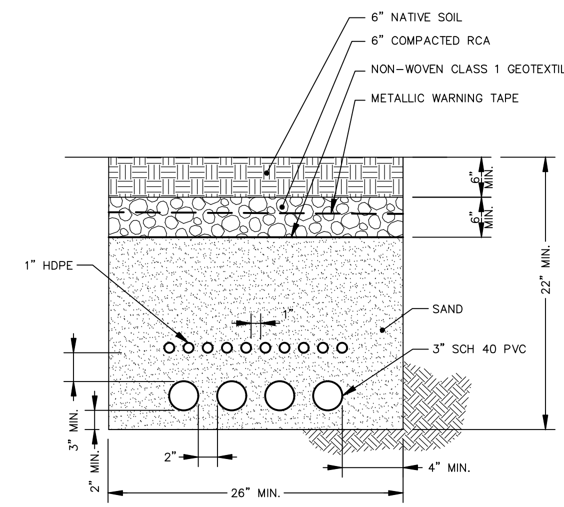


- MAIN TRENCH WILL BE A MINIMUM 22" DEEP BY 12" WIDE. PIPES WILL BE SURROUNDED BY CLEAN SAND BEDDING. SEE DIMENSIONS ABOVE.
- A NON-WOVEN GEOTEXTILE WILL BE PLACED ABOVE THE SAND. UPON WHICH A 6" THICK COMPACTED RCA WILL BE PLACED.
- BURIED UNDERGROUND WARNING TAPE MUST BE PLACED 6" BELOW GRADE AND ABOVE ALL PIPING.
- TRENCHES WILL BE COMPLETED TO WITH 3" OF BINDER AND 1" OF WEAR ASPHALT. SEAMS WILL BE SEALED.

A 7-1

AS/SVE PIPING TRENCH DETAILS

NOT TO SCALE

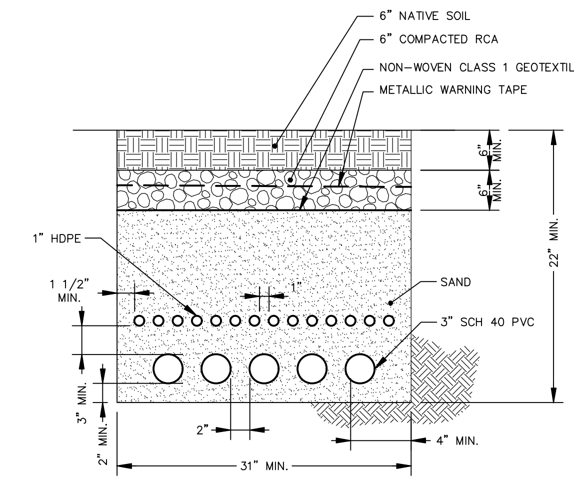


- MAIN TRENCH WILL BE A MINIMUM 22" DEEP BY 26" WIDE. PIPES WILL BE SURROUNDED BY CLEAN SAND BEDDING. SEE DIMENSIONS ABOVE.
- A NON-WOVEN GEOTEXTILE WILL BE PLACED ABOVE THE SAND. UPON WHICH A 6" THICK COMPACTED RCA WILL BE PLACED.
- BURIED UNDERGROUND WARNING TAPE MUST BE PLACED 6" BELOW GRADE AND ABOVE ALL PIPING.
- TRENCHES WILL BE COMPLETED TO SURFACE WITH 6" OF NATIVE SOIL BACKFILL AND SEEDED.

A 7-2

AS/SVE PIPING TRENCH DETAILS

NOT TO SCALE

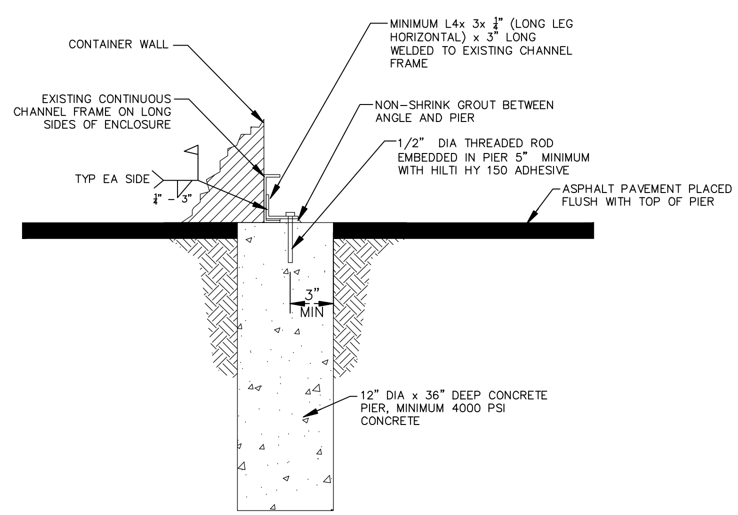


- MAIN TRENCH WILL BE A MINIMUM 22" DEEP BY 31" WIDE. PIPES WILL BE SURROUNDED BY CLEAN SAND BEDDING. SEE DIMENSIONS ABOVE.
- A NON-WOVEN GEOTEXTILE WILL BE PLACED ABOVE THE SAND. UPON WHICH A 6" THICK COMPACTED RCA WILL BE PLACED.
- BURIED UNDERGROUND WARNING TAPE MUST BE PLACED 6" BELOW GRADE AND ABOVE ALL PIPING.
- TRENCHES WILL BE COMPLETED TO SURFACE WITH 6" OF NATIVE SOIL BACKFILL AND SEEDED.

A 7-3

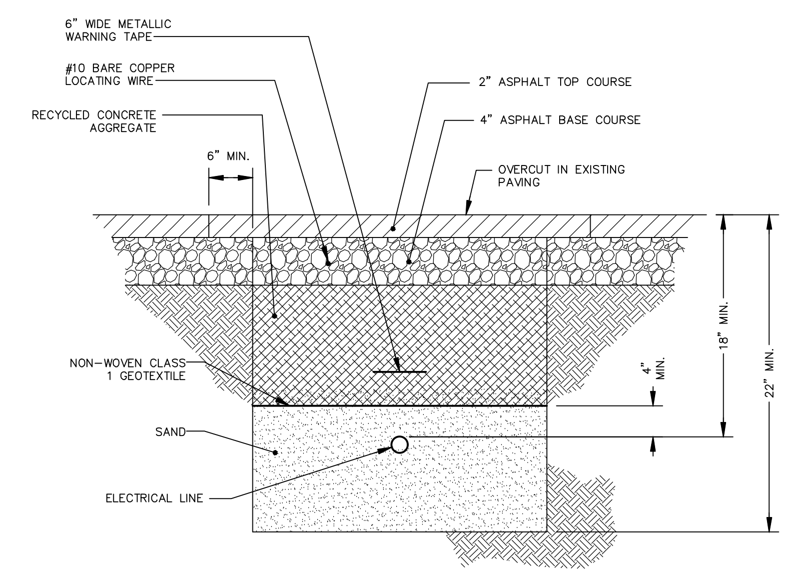
AS/SVE PIPING TRENCH DETAILS

NOT TO SCALE



EQUIPMENT ENCLOSURE ANCHORING DETAIL

NOT TO SCALE



ELECTRICAL LINE TRENCH DETAILS (IF NEEDED)

NOT TO SCALE

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TRENCHING AND ANCHOR DETAILS FOR AIR SPARGE / SOIL VAPOR EXTRACTION SYSTEM

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FIGURE 7

APPENDIX A

Fracture Pressure and Breakout Pressure Calculation

Appendix A
Air Sparge System Design Calculations

Estimated Formation Fracture Pressure

Equations

$P_F = P_{soil} + P_{water} = (d_s)(SG_s)(1-\theta)(\delta_w) + (d_s-d_{wt})(SG_w)(\theta)(\delta_w)$

where: P_{soil} = pressure component due to soil column

P_{water} = pressure component due to water column

d_s = depth from ground surface to top of well screen

SG_s = specific gravity of soil = 1.73 (assumed for sand and gravel mixture)

θ = soil porosity = 0.3 (assumed for sand and gravel mixture)

δ_w = specific weight of water = 64.2 lbf/ft^3

dwt = depth of static water table

SG_w = specific gravity of water = 1 (assumed)

Reference

USACE 2008. Engineering Design, In-Situ Air Sparging, EM 1110-1-4005, January 31, 2008.

Calculations

Air Sparge Well	Screen Int (ft bgs)	d_s (ft)	d_{wt} (ft)	SG_s	SG_w	θ	δ_w (lbf/ft^3)	P_{soil} (psi)	P_{water} (psi)	P_F (psi)
AS-1S through AS-8S	38-40	38	18.73	1.73	1	0.3	64.2	20.5	2.6	23.1
AS-1D through AS-8D	58-60	58	18.73	1.73	1	0.3	64.2	31.3	5.3	36.6

Average GW depth within air sparge treatment area for monitoring period of record (ft bgs) Ave per well

MW-18S	MW-18I	MW-22	MW-31S	MW-31I	MW-31D
19.07	18.88	19.05	18.52	18.45	18.52

MW-30S	MW-30I	MW-30D
18.81	18.71	18.56

Avgerage
18.73

Appendix A
Air Sparge System Design Calculations

Formation Break out Pressure Calculation

Equations

P_h =(D_w)*g*(ds-dwt)

where: P_h = hydrostatic pressure

d_s = depth from ground surface to top of well screen

D_w = Density of water= 1.94 slugs/ft^3

dwt = depth of static water table

g= gravity = 32.2 ft/s^2

Reference

USACE 2008. Engineering Design, In-Situ Air Sparging, EM 1110-1-4005, January 31, 2008.

Calculations

Air Sparge Well	Screen Int (ft bgs)	Dw (slugs/ft^3)	g (ft/s^2)	ds (ft)	dwt (ft)	P_h (psi)	Increases due to minor components[(1)] (psi)	P_h Final (psi)
AS-1S thru AS-8S	38-40	1.94	32.2	38	18.73	8.4	0.5	8.9
AS-1D thru AS-8D	58-60	1.94	32.2	58	18.73	17.0	0.5	17.5

Notes

(1) Minor components of breakout pressure include: piping friction losses, filterpack entry pressure, formation entry pressure.

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