FINAL
INTERIM REMEDIAL MEASURE WORK PLAN
STANDARD MOTOR PRODUCTS, INC. SITE
(Site No. 2-41-016)
Long Island City, Queens, New York

Prepared for

Standard Motor Products, Inc.
37-18 Northern Boulevard
Long Island City, New York 11101

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Contents

List of Tables

List of Figures

List of Appendices

Acronyms

AWS	air/water separator
BTEX	benzene, toluene, ethylbenzene, and xylenes
CDM	Camp Dresser & McKee Inc.
cfm	cubic feet per minute
CRT	constant rate test
CVOC	chlorinated volatile organic compound
FS	feasibility Study
HOA	hand/off/auto
hp	horsepower
HVAC	heating, ventilation, and air conditioning
IRM	interim remedial measure
lb	pound
LPGAC	liquid-phase granular activated carbon
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OD	outer diameter
OM&M	operation, maintenance, and monitoring
P&ID	process and instrumentation diagram
PID	photo-ionization detector
PLC	programmable logic controller
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
RI	remedial investigation
ROI	radius of influence
rpm	rotations per minute
SB	sub-slab monitoring point
SMP	Standard Motor Products, Inc.
SSDS	sub-slab depressurization system
SVE	soil vapor extraction
TEFC	totally-enclosed fan-cooled
VOC	volatile organic compound
VPGAC	vapor-phase granular activated carbon
"WC	inches water column

Section 1
Introduction

Camp Dresser & McKee Inc. (CDM) is submitting on behalf of Standard Motor Products, Inc. (SMP) this Final Interim Remedial Measure Work Plan in accordance with the New York State Department of Environmental Conservation (NYSDEC) direction during the September 11, 2008 Feasibility Study (FS) scoping meeting. This work plan describes the pre-design field testing and basis of design of the Interim Remedial Measure (IRM) for the SMP Site located at 37-18 Northern Boulevard in Long Island City, New York (herein referred to as the "Site").

1.1 Site Background

The SMP property is located at 37-18 Northern Boulevard in Long Island City, New York (Figure 1-1). The property contains a large, six-story, industrial building with approximately 42,000 square feet per floor. The building occupies most of the property. A narrow strip of land on the south side of the property contains a loading dock and a dirt access path for vehicles. Contamination has been identified in the soil adjacent to the loading dock. Thus, the Site includes the SMP building and the adjacent strip of land where contamination has been identified.

Investigations at the Site have identified chlorinated volatile organic compound (CVOC) contamination in saturated soils and groundwater beneath the Site. Benzene, toluene, ethylbenzene, and xylene (BTEX) contamination was also identified in the groundwater. The BTEX contamination is not believed to be related to operations at the Site, and is likely part of a plume originating from the gas station immediately to the east of the Site. The most recent investigation identified elevated volatile organic compound (VOC) concentrations in the sub-slab and soil gas samples above the New York State Department of Health (NYSDOH) air matrix guidelines. As a result, an IRM was proposed to the NYSDEC and NYSDOH during the FS scoping meeting on September 11, 2008 and is presented as a vapor alternative in the Final FS Report submitted to NYSDEC and NYSDOH on February 6, 2009 (CDM 2009a). The IRM will include the installation of a sub-slab depressurization system (SSDS) to mitigate sub-slab vapors under the on-site building. Detailed descriptions of the Site history and previous investigations are included in the Final Comprehensive Remedial Investigation (RI) Report, dated February 6, 2009 (CDM 2009b).

1.2 Scope and Objectives

This work plan has been developed to provide a performance-based design description and implementation plan for the IRM, which includes the installation of a SSDS at the Site. Additionally, this work plan may be used as part of the bid solicitation scope of work for the system and installation. The Operation, Maintenance, and Monitoring (OM&M) plan will be developed separately following construction of the SSDS.

The overall objective of the IRM is to eliminate any potential pathway of direct human contact with soil vapor contaminants through vapor intrusion that may occur in the future. This engineering control is being implemented to prevent exposure to contaminated soil vapor until the soil vapor meets NYSDOH guidance. The objective will be accomplished by the operation of a SSDS, which will create a negative pressure gradient across the building basement's slab (i.e., a lower pressure beneath the slab than above the slab). This negative pressure gradient is achieved by extracting soil vapor from beneath the slab. Following installation and initial operation of the SSDS, long-term monitoring will be performed to support engineering control efforts, providing an understanding of changes in contaminant concentrations, degradation, and distribution over time.

1.3 Work Plan Organization

The work plan is structured as follows:

Section 1: Introduction. This section summarizes the Site background information, describes of the project scope and objectives, and presents the organization of this work plan.

Section 2: Radius of Influence (ROI) Pilot Test. This section describes the pre-design ROI pilot test performed at the Site. The section also discusses the results of the test and their use in design of the SSDS.

Section 3: Basis of Design. This section discusses the design rationale, including the development of performance goals and design criteria. The section also describes the extraction system and vapor treatment process. This basis for design provides details on primary equipment and materials, installation configuration, and initial operation of the system.

Section 4: References. This section documents the references cited in the work plan.

Section 2
Radius of Influence Pilot Test

CDM conducted pilot testing at the Site from November 17-19, 2008. The primary objective of the test was to determine the flow characteristics of the sub-slab soils and observe the achievable ROI. Observations and data gathered during the pilot test were used as a basis for the full-scale SSDS design.

2.1 Test Procedure

The pilot test consisted of the following activities:

- November 17 – mobilize and begin setup
- November 18 – complete setup, step test, and begin constant rate test
- November 19 – conclude constant rate test, breakdown, and demobilize

Project-dedicated field log books and monitoring sheets were maintained by the field engineer overseeing the pilot test. Copies of the log book entries are included in Appendix A. Photographs of the pilot test are included in Appendix B.

2.1.1 Setup

The test was carried out using one vapor extraction sump (ES01) and was monitored at ten existing sub-slab monitoring points (SBs) and seven new SBs (SB17-SB23). The extraction sump and new SBs were installed as part of the pilot test field event. Figure 2-1 shows the locations of the extraction sump and SBs. The extraction sump was constructed by cutting a 12-inch diameter hole in the slab, which is six inches thick, and excavating sub-slab soils to a depth of 36 inches. A 24-inch length of 0.050-inch slot, 6-inch diameter stainless steel screen was placed in the pit and joined using a Fernco fitting to a 4-inch diameter polyvinyl chloride (PVC) riser pipe. The annular space was backfilled with Filpro #4 well gravel and sealed at the surface with cement. Each SB was constructed by drilling a 3/8-inch hole through the floor to a depth of approximately three inches beneath the slab. Loose sub-slab soil was vacuumed from the hole prior to inserting a ¼-inch outer diameter (OD) stainless steel tubing into the hole. The tubing was attached to a female Swagelok quick-connect fitting at the floor surface, and the upper annular space was sealed using anchoring cement. The extraction sump and SB construction details are shown on Figures 2-2 and 2-3.

A schematic showing the pilot system configuration is shown on Figure 2-4. Four-inch and two-inch diameter PVC pipe was used to connect ES01 to a blower skid containing two 2.5-horsepower (hp) regenerative blowers piped in parallel. A drain was installed at the low point in the pipe to collect condensed water from the extracted soil vapor. The effluent from the blowers was passed through a vapor-phase granular activated carbon (VPGAC) drum to remove VOC contaminants prior to discharge to the atmosphere. The blower skid was equipped with a dilution valve to control the vacuum applied at ES01 by varying the amount of atmospheric air drawn in by the blowers. The blowers were capable of being operated individually or together for additional control of the applied vacuum.

A magnehelic vacuum gauge was installed at ES01, and a magnehelic pressure gauge was installed on the blower effluent prior to the VPGAC drum. An annubar was installed to measure the dynamic pressure (correlates to velocity) of the soil vapor removed from ES01. To measure the temperature and low-velocity flows not detectable by the annubar, a thermal anemometer was also installed. Sample ports were placed at ES01 and the discharge stack to monitor VOC concentrations at these locations during the test. During the test, a vacuum pump was used to remove vapor from ES01 for VOC measurement. All VOC concentration measurements, including those in the breathing zone, were made using a MiniRAE 2000 photo-ionization detector (PID), which is capable of measuring total VOC concentrations ranging from 0.1 part-per-million (ppm) to 9,999 ppm.

2.1.2 Step Testing

Step testing was conducted to determine the effect of applied vacuum on the vapor flowrate and ROI. By adjusting the opening of the dilution valve, the level of applied vacuum was varied. Eight steps were conducted at increasing levels of applied vacuum. During each step, the process was allowed to stabilize prior to recording the following data and observations:

- Applied vacuum at ES01
- Velocity of soil vapor
- Temperature of soil vapor
- VOC concentration at ES01
- Pressure at VPGAC drum influent
- VOC concentration at the discharge stack
- Pressure gradient at each SB

Pressure gradients were primarily measured using an Omniguard III unit capable of measuring differential pressures from -0.250 inches water column (" WC) to 0.250" WC with a resolution of 0.001" WC. When the differential pressure exceeded 0.25" WC, a Dwyer digital manometer was used. This instrument is capable of measuring higher differential pressures to a resolution of 0.1" WC.

2.1.3 Constant Rate Testing

Following step testing, a constant rate test (CRT) was conducted with both blowers on and the dilution valve fully closed (maximum applied vacuum). The system was operated under these conditions overnight to observe ROI and flow characteristics over a longer period. The gas-fired ceiling heaters in the basement were turned off for this portion of the test. System parameters/data (see list in Section 2.1.2) were recorded at the beginning and end of the CRT. Additionally, Omniguard III units were used to continuously log pressure differential at SB04 and SB22 at five minute intervals. The pressure differential at each SB was measured approximately one hour following conclusion of the CRT (blowers off).

2.2 Test Results

Field monitoring data are presented on Table 2-1.

2.2.1 Vapor Flow Characteristics

Step tests were conducted at applied vacuum levels ranging from -1.8″ WC (Step 1) to -20.9″ WC (Step 8). Figure 2-5 shows the relationship between the applied vacuum at ES01 and the resulting vapor flowrate. As expected, the vapor flowrate rose steadily as the applied vacuum was increased. Vapor flowrates observed during the test varied from 19 cubic feet per minute (cfm) (Step 1) to 240 cfm (Step 8). The sub-slab soil observed when installing ES01 was predominantly sand, which likely contributes to the high vapor flowrates achieved.

VOC concentrations in the extracted vapor are shown on Table 2-1. Measurements ranged from 5.9 to 193 ppm during step testing; the final measurement collected at the end of the CRT was 423 ppm. For comparison purposes, pre-test VOC concentrations in the headspace of ES01 ranged from 1,350 to >9,999 ppm. VPGAC effluent (stack) VOC concentrations ranged from 0.0 to 2.0 ppm during step testing; the concentration at the end of the CRT was 16.5 ppm.

2.2.2 ROI

For sub-slab depressurization system, ROI is best determined by observation of pressure differential across the slab. A negative pressure differential (lower pressure beneath the slab than above the slab) prevents sub-slab vapor from entering the building space. SB pressure differential measurements are shown on Table 2-1. Appendix C contains series of charts depicting the relationship between each SB's distance from ES01 and its differential pressure. As expected, the charts show that the degree of influence decreases with increasing distance from ES01. These charts show that negative pressure differential was maintained up to 137 feet from ES01 for applied vacuum levels of -11.3″ WC and higher (Steps 6, 7, and 8).

For a SSDS to be effective at mitigating vapor intrusion, the recommended minimum level of negative pressure differential is -0.003″ WC. However, for design purposes a safety factor is required to account for varying field conditions such as proximity to footings, vaults, exterior walls, and staircases; soil heterogeneity; slab integrity; and future changes in heating, ventilation, and air conditioning (HVAC) conditions. Thus, a safety factor of five is applied to arrive at a design ROI defined by -0.015″ WC. The ROI achieved during the pilot test ranged from approximately 10 feet (-1.8″ WC applied vacuum) to approximately 90 feet (-20.9″ WC).

2.2.3 Other Observations

Additional observations were made that are relevant to the design of the full-scale SSDS.

2.2.3.1 HVAC Effects

The basement does not have an advanced HVAC system. The gas-fired ceiling heaters were operated during the step test to create "worst-case scenario" conditions. The heaters were turned off overnight for the CRT. Based on field observations, it is not believed that this had any effect on the performance of the pilot system. The basement is not a sealed space; there are openings at several exhaust vents which would serve to keep the test area of the basement at atmospheric pressure.

2.2.3.2 Slab Condition

Several cracks, anchoring holes, vaults, and other imperfections exist in the slab. These can serve as "short-circuit" pathways where interior air preferentially flows to the sub-slab space, reducing the effectiveness of sub-slab depressurization. Prior to initiating the pilot test, many of these were plugged using cement to enhance the performance of the pilot system.

2.2.3.3 Condensate Generation

Approximately 3-5 gallons of condensate was generated during the pilot test. Most of this was generated overnight during the CRT, when the outdoor temperature was approximately 30˚F.

2.2.3.4 Influence Uniformity

Although the vacuum influence was relatively uniform with respect to distance from ES01, there were some anomalies. The most notable anomaly is that SB01, SB04, SB12, SB13, SB16, and SB23 consistently had lower differential pressure (less influence) than would be expected given the general trends observed on the charts in Appendix C. With the exception of SB01, all of these monitoring points were located along the north wall of the building. It is believed the reduced influence along this wall is due to proximity to the subway tunnels that run under Northern Boulevard, directly north of the building.

Additionally, the influence at monitoring points along the north wall was observed to be highly variable relative to the influence at other monitoring points. The variations were observed as sudden swings in the differential pressure coinciding with the audible passing of a subway train. This phenomenon is confirmed by Figures 2-6 and 2-7, which present the data logs from overnight monitoring of SB04 and SB22. These two points are approximately the same distance from ES01 (64 feet), but SB04 is located along the north wall, whereas SB22 is not. Figure 2-6 shows the differential pressure variation at the two points from approximately 7:00 to 8:00 PM on November 18; it can be seen that the pressure swings at SB04 are generally wider than those at SB22. Figure 2-7 shows the differential pressure at SB04 from approximately 7:00 PM on November 18 to 8:00 AM on November 19; the chart shows that the size of the pressure swings was lower during the middle of the night, when subway traffic is significantly reduced. Overnight data at SB22 is not available due to a power failure of the logger attached to this point.

2.3 Conclusions and Recommendations

The following list summarizes the conclusions from the pilot test and recommendations for full-scale SSDS design and implementation:

- SSDS will be effective for mitigating vapor intrusion at the Site. The sandy sub-slab soil at the Site allow for significant sub-slab influence and high vapor flowrates.

- Influence is reduced and highly variable near the north wall. The design should account for this by the placement and/or spacing of extraction points in this area.

- VPGAC is an effective treatment technology for removing VOCs from the extracted vapor.

- The design should include provisions to address condensate from the extracted vapor. Pipe runs should be sloped to drain to the extraction points where possible, and outdoor pipes should be well insulated. Pipe elevation should be closely monitored during construction to ensure dips are not created where condensate could collect. The design should include an air/water separator and treatment/disposal options for collected water.

- It is recommended that 60 feet be used as the design ROI. Based on pilot test data, this will result in an applied vacuum of approximately -10 to -15" WC, and a vapor flow of 125 to 175 cfm per extraction sump.

- The spacing/placement of extraction sumps should take into account subway tunnel effects on the north side of the building.

- To reduce potential short circuiting, the design should include some level of sealing for imperfections in the slab, including existing unused vaults.

- Design and construction of the SSDS should incorporate operational flexibility. A flexible system can be easily adjusted to address any variations in sub-surface conditions, building space modifications, or performance impact from future remedial activities (e.g., air sparging). This will reduce or eliminate the need for costly system modifications and/or performance monitoring in the future.

Section 3
Basis of Design

The design basis presented in this section is meant to provide the performance requirements and general specifications for the full-scale SSDS at the Site. It is not intended to comprise a detailed design with detailed drawings and specifications. It is recommended that bidders be required to include a detailed technical proposal. The technical proposals should be reviewed by the engineer to ensure each bidder's complete technical understanding of design intent and verify that the technical approach will fulfill the performance goals specified herein.

3.1 Site Plan and Piping Layout

Based on the recommended 60-foot ROI (see Section 2.3), a site plan was developed to present the proposed extraction sump locations. The site plan is shown on Figure 3-1. The design includes nine extraction sumps. Three are located in the narrower western portion of the building, which has not exhibited elevated VOC concentrations in the sub-slab vapor. The other six sumps are located in the wider eastern portion of the building, where elevated VOC concentrations have been detected in sub-slab vapor. The sumps in this area are more closely spaced to create more overlap in area of influence. Three of the sumps are installed along the north wall to address variability and modulating vacuum influence caused by trains passing through the adjacent subway tunnels (see Section 2.2.3.4). Due to the relatively long trenches required for ES08 and ES09, SMP may consider the option of moving these sumps closer to the north wall and installing two additional sumps in this area near the south wall. This configuration would reduce the length of trench required. These four sumps could be operated at a lower level applied vacuum due to the closer spacing.

Figure 3-1 also shows the proposed piping layout, including the dimensions for each pipe run. Pipe sizing and friction loss calculations are included in Appendix D. Vapor extraction pipe and fittings will be socket-weld Schedule 40 PVC, and connections will be made using PVC primer and cement. The pipe material is subject to change based on a thorough review of local code regulations and is subject to approval by the local building department. Above-slab pipe will be supported from the ceiling. The proposed piping layout may be modified in the field as necessary to avoid existing obstructions. Dips in pipe runs will be avoided to eliminate the collection of condensate in low spots, and pipes will have a 0.5% minimum pitch toward extraction sumps where possible, and in other cases, a 0.5% minimum pitch toward the air/water separator inlet (see Section 3.3.3).

3.2 Extraction Sumps and Trenching

Extraction sumps will be constructed as shown on Figure 3-2. This design is the same as utilized during the pilot test with the exception of the below-slab effluent trenching. The effluent pipe from each sump will follow a trench to the nearest wall, where a riser pipe will bring the extracted vapor to the trunk line at the ceiling. Each riser pipe will be equipped with a sample port, vacuum gauge, and a butterfly valve for precisely controlling the applied vacuum at each sump. Figure 3-2 shows a typical trench construction. Below slab pipe will have a 0.5% minimum pitch toward the extraction sump.

3.3 Extraction and Treatment System

A single system will be used to extract and treat vapor from the sumps. The process & instrumentation diagram (P&ID) for the system is presented on Figure 3-3. The major pieces of equipment are described in detail in this section. Data sheets for recommended equipment are included in Appendix E.

3.3.1 Blowers

The system will include two rotary lobe-type blowers (Roots URAI 711 or equal). The blowers will be equipped with silencers at the influent and effluent, and the blower units will be surrounded with an acoustical enclosure to reduce nuisance noise exposure to building occupants.

Each blower will be capable of approximately 970 cfm at 1 pound/square inch (psi) (combined vacuum and back pressure) when operated at 1400 rotations per minute (rpm). The anticipated operating conditions of each blower are:

- 1-2 psi
- 800-1,000 cfm

The use of two blowers provides the flexibility to operate the SSDS with one blower if the targeted sub-slab influence is attained with less applied vacuum and vapor flow. In this case, the second blower will serve as a backup, which would be used to prevent system downtime if the first blower requires servicing. If higher applied vacuums are required to achieve complete influence, both blowers may be used. The system will be equipped with a dilution valve equipped with an inlet filter that will be used for rough control of applied vacuum. Each blower will be driven by a 20 hp totally-enclosed fan-cooled (TEFC) motor coupled to drive the blower at 1400 rotations per minute (rpm). The use of indirect-drive blowers will permit easy modification of the drive ratio/motors in the future if more or less applied vacuum is needed. At anticipated operating conditions, the temperature rise across the blowers will be less than 30˚F. Blower curves for the Roots URAI 711 are included with the data sheet in Appendix E.

3.3.2 VPGAC Unit

The effluent from the blowers will be treated with a VPGAC adsorber (Calgon HFVS2000 or equal) to remove VOCs prior to atmospheric discharge. The VPGAC unit will be box-type, top-load carbon steel rated for a maximum flow of 2,000 cfm and pressure-rated to a minimum of 3 psi. The unit will contain 2,000 pounds (lbs) of carbon. The pressure drop across the unit will be less than 15" WC at a flowrate of 2,000 cfm. The vessel will be equipped with a pressure relief valve to vent pressure in the event of an emergency.

3.3.3 Air/Water Separator (AWS)

An air/water separator will be used to remove entrained moisture in the extracted vapor stream. This will prevent moisture from entering blowers and VPGAC units. The AWS will have a minimum volume of 60 gallons and be rated for a flow of up to 2,000 cfm and at least -50" WC vacuum. It will be constructed of aluminum or other corrosion resistant material. The AWS will be equipped with a sight glass and low, high, and high-high level sensors. The volume of water storage capacity between the low and high level sensors will be a minimum of 10 gallons. A condensate transfer pump (March MDK-MT3 or equal) will be required to pump accumulated condensate from the AWS. The pump curve for the March MDK-MT3 is included with the data sheet in Appendix E.

3.3.4 Liquid Phase Granular Activated Carbon (LPGAC) Unit

The water effluent from the AWS will require treatment with LPGAC prior to surface discharge to the south yard. The LPGAC unit (Carbonair PC1 or equal) will be rated for a maximum flow of 10 gallons/minute (gpm) and hold a minimum of 90 lbs carbon. Drum-type LPGAC units will not be used. A pressure drop curve for the Carbonair PC1 is included in Appendix E with the data sheet.

3.3.5 Process Instrumentation and Control

The process instrumentation required for the SSDS is shown on Figure 3-3.

3.3.5.1 Control Panel

The SSDS will be managed from a single control panel. The panel will include hand/off/auto (HOA) switches for each blower motor and the pump. It will also display indicator lights for the following conditions:

1) Blower motor #1 running
2) Blower motor #2 running
3) Pump running
4) High-high level fault in AWS
5) High vacuum fault at blower #1 inlet
6) High vacuum fault at blower #2 inlet
7) High temperature fault at blower #1 outlet
8) High temperature fault at blower #2 outlet
9) High pressure fault at blower #1 outlet
10) High pressure fault at blower #2 outlet
11) Low pressure fault at combined blower outlet
12) Low flow (differential pressure) fault at combined blower outlet

The control panel will have separate reset buttons to clear faults associated with conditions #4-#12.

3.3.5.2 Programmable Logic Controller (PLC)

The system will be equipped with a PLC, audible alarm, and autodialer. The PLC will be programmed to sound the audible alarm and dial the system operator on detection of any condition #4-#12 (see Section 3.3.5.1).

Each blower and pump has a HOA switch. When a switch is set to the "hand" position, the corresponding piece of equipment will start immediately. When a switch is set to the "off" position, the corresponding piece of equipment will remain shutdown. When a switch is set to the "auto" position, control of the corresponding equipment will be transferred to the PLC.

In "auto" mode, the pump will start on detection of high level condition in the AWS. The pump will stop on detection of low level condition in the AWS.

In "auto" mode, Blower #1 will start. The blower will shut down on detection of any of the following conditions (see Section 3.3.5.1): #4, #5, #7, #9, #11, #12.

In "auto" mode, Blower #2 will start. The blower will shut down on detection of any of the following conditions (see Section 3.3.5.1): #4, #6, #8, #10, #11, #12.

The PLC will not acknowledge fault conditions #11 or #12 unless at least one blower has been running for 10 seconds.

3.3.6 Insulation and Heat Tracing

The AWS, LPGAC adsorber, and water piping between them will be insulated and heat traced to prevent freezing during the winter. Heat tracing will also be required for both units and the water piping between them. Operation of the heat tracing system will be by manual control only.

3.3.7 General

The system will be located in the eastern covered portion of the loading dock on the south side of the building (see Figure 3-1). Installation and hookup of all equipment and materials will be performed according to the manufacturers' instructions. The blower motors, blowers, AWS, condensate transfer pump, and LPGAC adsorber will be mounted to a single pre-fabricated steel skid. The skid will include additional space for the installation of a third blower that may be required in the future to support soil vapor extraction (SVE) activities at the Site. With the exception of the VPGAC adsorber, all equipment and the control panel will be located inside of a lockable weatherproof enclosure to provide security and protect the system from the elements. The enclosure will include a passive louvers and a fan controlled by a thermostat to provide ventilation as required to exhaust heat.

Calculations were performed to determine whether explosion-proof equipment would be required. These calculations are provided in Appendix D. Explosion-proof equipment is generally recommended only if a compound's anticipated concentration in the vapor is 10% or more of the compound's lower explosive limit (LEL). The results of the calculations indicate that all compounds (and their sum) are below this threshold. Explosion-proof equipment will not be required.

3.3.8 Testing, Startup, and Operation

After installation and hookup of the SSDS is complete, the extraction and treatment system will be tested. The flow control valves at the extraction sumps will be closed, and the dilution air valve will be opened to test the system with atmospheric air. The blowers will be run individually and then together to verify proper operation of the system. Potable water will be used to test operation of the AWS, condensate transfer pump, and LPGAC unit. Any leaks and malfunctioning equipment/instrumentation will be repaired at this time.

Once the system has passed testing, startup activities will begin under the supervision of the field engineer. During startup activities, sub-slab vacuum influence will be monitored at existing monitoring points. Additional monitoring points may be installed (see Figure 3-2) as necessary to verify the extent of influence. Startup activities will continue until achievement of -0.015" WC pressure gradient across the slab is confirmed throughout the basement area. Starting with all extraction sump flow control valves and dilution valve fully open, one blower will be switched on. The dilution valve will be incrementally closed until applied vacuum is observed at the extraction sumps. If necessary, the second blower will switched on. With the direction of the supervising engineer, further adjustments may be made, including:

- Adjustment of the individual extraction sump flow control valves
- Adjustment of the dilution air valve
- Modification of the blower drive ratios

If the target level of influence cannot be achieved by the above methods, additional extraction sumps may be installed at the direction of the supervising engineer.

Beginning with the commencement of startup activities, influent and effluent samples will be collected daily at the VPGAC and LPGAC units to confirm effective operation of the carbon units. Samples will be collected weekly for the following three weeks to provide a baseline for future evaluation of the SSDS performance.

The SSDS installation subcontractor will be responsible for preparation of OM&M manual, which will be the governing document for long-term operation of the SSDS. The SSDS subcontractor will also be responsible for preparation of a system "as-built" report that contains all "as-built" drawings and a detailed account of start-up activities.

3.4 Permitting

In addition to any applicable local permits, permits may be required from NYSDEC for the air and water discharges. The construction/installation contractor will be responsible for preparing applications for any required permits. Prior to submittal to the permitting authority, all applications will be reviewed by the supervising engineer.

Section 4
References

Camp Dresser and McKee Inc. (CDM). 2009a. *Final Feasibility Study Report, Standard Motor Products, Inc Site.* February 6.

Camp Dresser and McKee Inc. (CDM). 2009b. *Final Comprehensive Remedial Investigation Report, Standard Motor Products, Inc Site.* February 6.

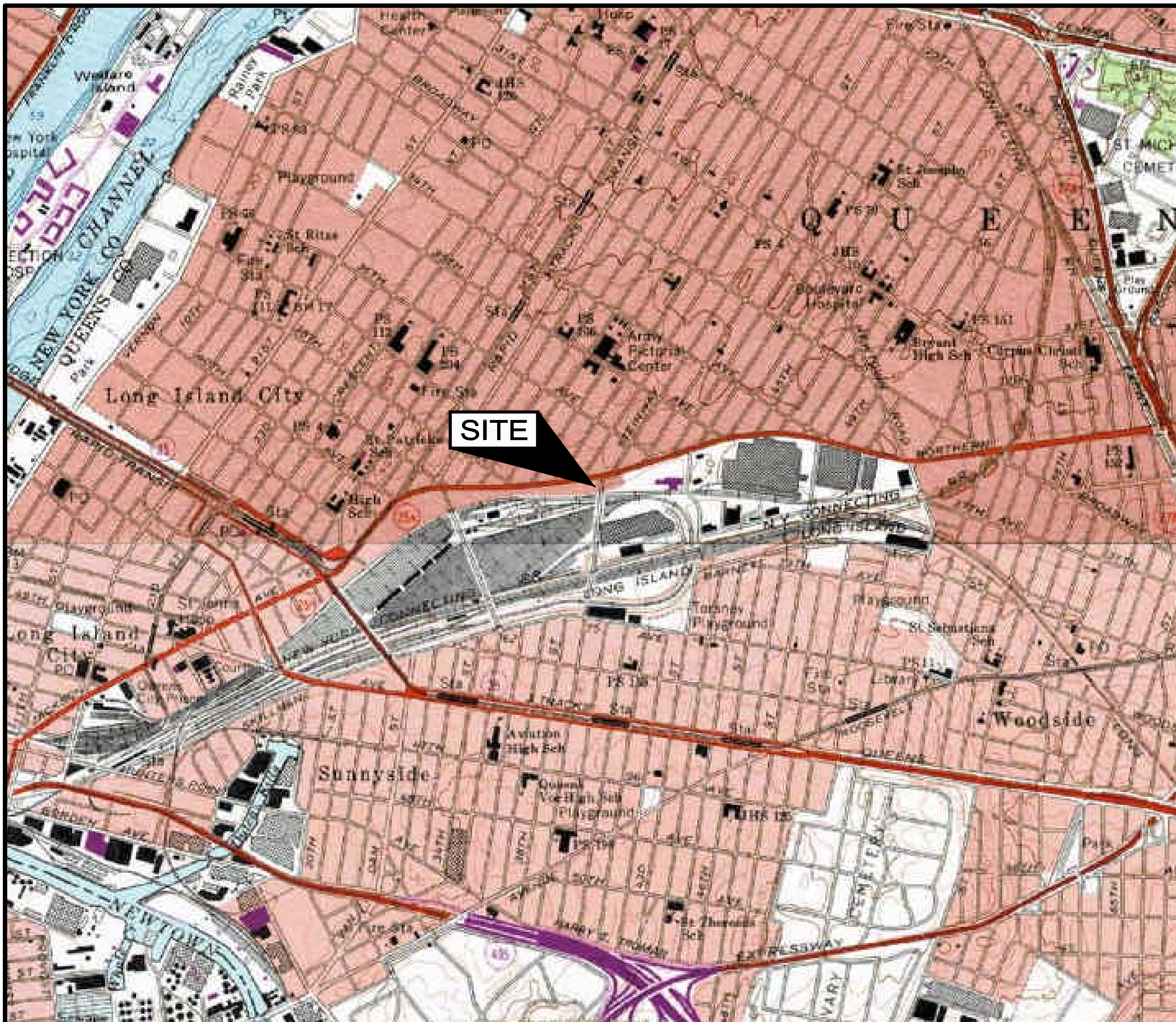
Tables

Table 2-1
Field Monitoring Data
Standard Motor Products
ROI Testing

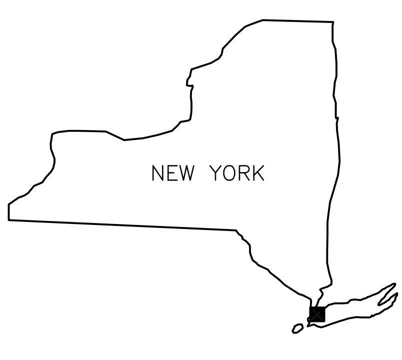
Date		11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/18/2008	11/19/2008	11/19/2008	11/19/2008
Time		11:10[1]	11:50	12:30	13:50	14:30[5]	14:50	16:00	16:45	17:40	18:10	7:35	8:05	9:10[8]
ES01 Vacuum (in. WC)		NA	-1.8	-2.5	-4.5	-6.7	-7.0	-8.9	-11.3	-17.0	-21.0	-20.8	NR	NA
ES01 Flowrate (ft/min)		NA	830[2]	1300[2]	2110[2]	3060[2]	3280[2]	900[6]	1100[6]	1590[6]	1910[6]	2040[6,7]	1920[6]	NA
Vapor Temperature (˚F)		NA	66	67	66	64	67	61	59	57	56	59	NR	NA
Annubar ΔP (in. WC)		NA	0.1	0.2	0.2	0.5	0.5	1.15	1.95	4.0	6.7	6.7	NR	NA
ES01 Flow[9] (cfm)		NA	19	30	48	70	75	99	128	185	240	240	NR	NA
ES-1 PID Reading (ppm)		1350	193	9.3	5.9	7.2	8.5	7.3	19.7	81.0	76.0	423	NR	NR
GAC PID Reading (ppm)		NA	0.8	0.3	0.0	NR	NR	0.8	1.0	0.5	2.0	16.5	NR	NA
GAC Inlet Pressure (in. WC)		NA	1.0	1.8	1.8	NR	NR	7.0	3.4	2.4	2.1	1.8	NR	NA
Sub-Slab Monitoring Point Vacuum (inches WC)	SB01	0.014	-0.003	-0.002	-0.004	NR	-0.004	-0.007	-0.017	-0.026	-0.034	-0.029	NR	0.000
	SB03	0.010	-0.032	-0.059	-0.107	NR	-0.173	-0.229	<-0.250	<-0.250	<-0.250	<-0.250	NR	0.000
	SB04	0.016	0.014	0.006	0.000	NR	-0.003	-0.011	-0.007	-0.043	-0.052	-0.052	NR	0.006
	SB05	0.010	-0.004	-0.015	-0.015	NR	-0.025	-0.033	-0.036	-0.063	-0.079	-0.071	NR	-0.001
	SB06	0.014	-0.010	-0.162	<-0.250[4]	NR	<-0.250	<-0.250	-0.400	-0.800	-1.150	-1.000	NR	0.005
	SB07	0.009	0.000	-0.008	-0.008	NR	-0.009	-0.008	-0.012	-0.011	-0.011	-0.009	NR	-0.010
	SB08	0.010	-0.005	-0.018	-0.018	NR	-0.023	-0.022	-0.028	-0.048	-0.054	-0.056	NR	-0.016
	SB11	0.023	-0.006	-0.013	-0.028	NR	-0.050	-0.074	-0.093	-0.157	-0.209	-0.190	NR	0.000
	SB12	0.010	0.050	0.020	0.010	NR	0.018	0.014	-0.015	-0.003	0.000	-0.002	NR	0.003
	SB13	0.010	0.019	0.005	0.021	NR	0.005	0.002	-0.025	-0.001	0.000	-0.006	NR	0.002
	SB16	0.016	0.030	0.021	0.001	NR	0.008	-0.007	-0.004	-0.028	-0.043	-0.035	NR	0.011
	SB17	0.015	-1.300	-1.450	-3.050	NR	-5.100	-6.400	-8.200	-12.400	-14.800	-14.800	NR	0.001
	SB18	0.014	-0.180	-0.248	<-0.250	NR	-0.350	-0.650	-0.800	-1.500	-1.800	-1.800	NR	0.000
	SB19	0.008	NR[3]	-0.072	-0.117	NR	-0.202	<-0.250	<-0.250	<-0.250	<-0.250	-0.246	NR	0.000
	SB20	0.012	-0.007	-0.017	-0.022	NR	-0.040	-0.056	-0.068	-0.111	-0.152	-0.130	NR	0.000
	SB21	0.014	0.000	-0.017	-0.024	NR	-0.037	-0.054	-0.065	-0.085	-0.109	-0.101	NR	0.000
	SB22	0.016	0.000	-0.017	-0.019	NR	-0.030	-0.036	-0.038	-0.061	-0.064	-0.065	NR	-0.011
	SB23	0.016	NR[3]	0.000	-0.004	NR	-0.008	-0.012	-0.016	-0.038	-0.055	-0.040	NR	0.003

Notes:
1. Round collected prior to system startup. Pressure values were recorded immediately after attaching quick connects (i.e., they were not allowed to stabilize). System startup at 11:45 with one blower on.
2. Velocity measured in 2" schedule 40 PVC.
3. No reading collected. Anchoring cement at these probes was still setting.
4. The vacuum was too high to be measured with the Omniguard unit and too low to get a reliable reading with the Dwyer digital manometer.
5. The second blower was turned on at 14:30.
6. Velocity measured in 4" schedule 40 PVC.
7. Suspected high reading due to thermal mass of anemometer.
8. System shut down at 08:10. Readings collected approximately 1 hour after shutdown.
9. Flowrates up to 75 cfm were calculated from the anemometer velocity data. Flowrates above 75 cfm were calcuted from the annubar differential pressure data.

Figures



SOURCE: USGS 7.5 MINUTE SERIES
TOPOGRAPHIC QUADRANGLE 1979
CENTRAL PARK, N.Y. – N.J.
CONTOUR INTERVAL = 10'

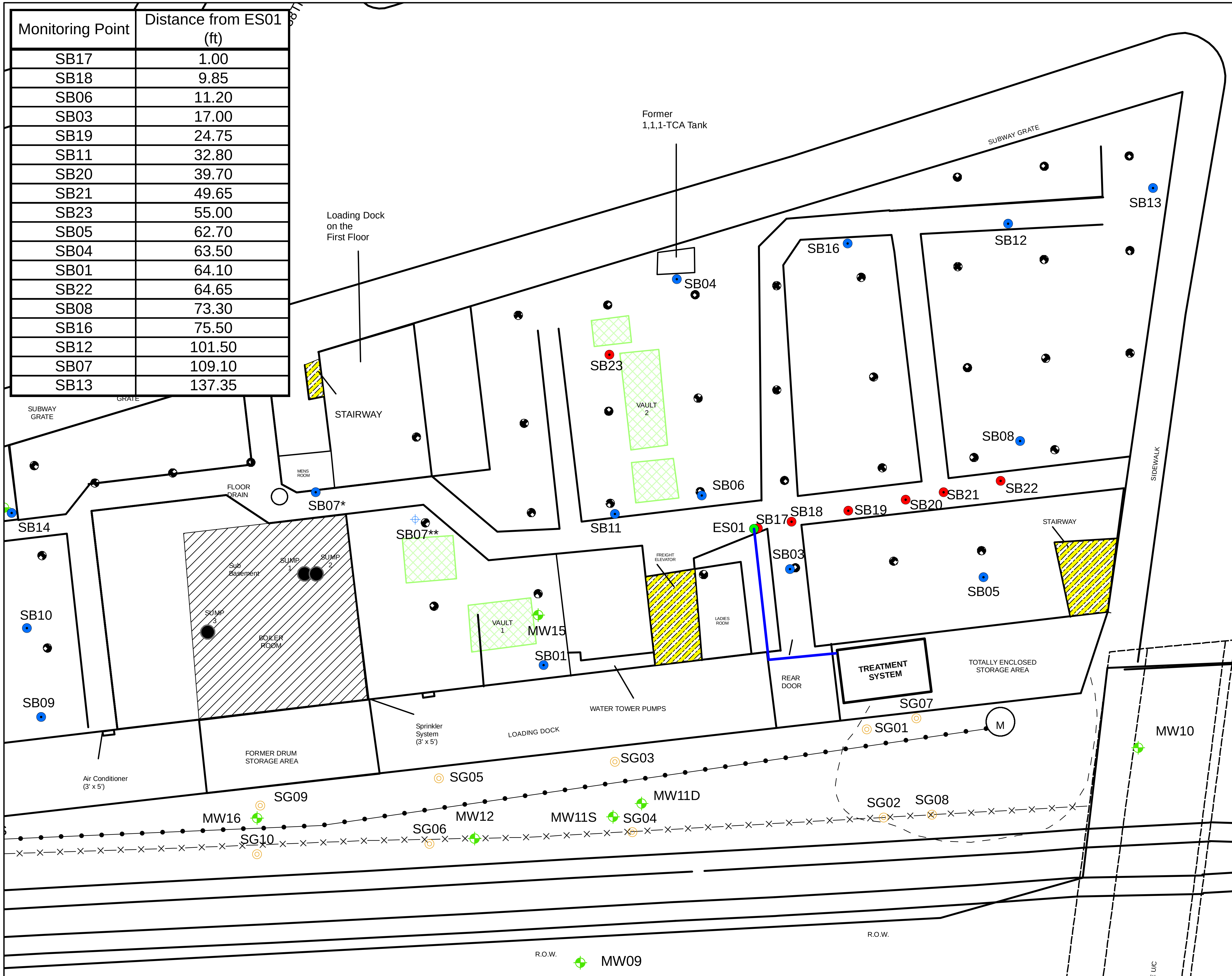


QUADRANGLE LOCATION

DRAFTED BY: W.G.S. (N.J.)	SITE LOCATION
CHECKED BY:	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK
REVIEWED BY:	
NORTH	CDM

SCALE IN FEET	DATE	FIGURE
0 — 2000	1-29-04	1-1

Monitoring Point	Distance from ES01 (ft)
SB17	1.00
SB18	9.85
SB06	11.20
SB03	17.00
SB19	24.75
SB11	32.80
SB20	39.70
SB21	49.65
SB23	55.00
SB05	62.70
SB04	63.50
SB01	64.10
SB22	64.65
SB08	73.30
SB16	75.50
SB12	101.50
SB07	109.10
SB13	137.35



MONITORING WELL (MW)

SUB-SLAB (SB) SAMPLE LOCATION

SOIL GAS (SG) SAMPLE LOCATION

(M) SEWER MANHOLE (APPROX 12' DEEP)

(D) APPROX LOCATION OF DRAIN SPOUT

R.O.W. RIGHT OF WAY

SUPPORT COLUMN

X—X—X FENCE LINE

UNDERGROUND STORM SEWER

APPROX. VICINITY OF PREVIOUSLY EXCAVATED SOILS

RECESS EQUIPMENT PAD/VAULT

PROPOSED EXTRACTION LOCATION

PROPOSED NEW MONITORING LOCATION

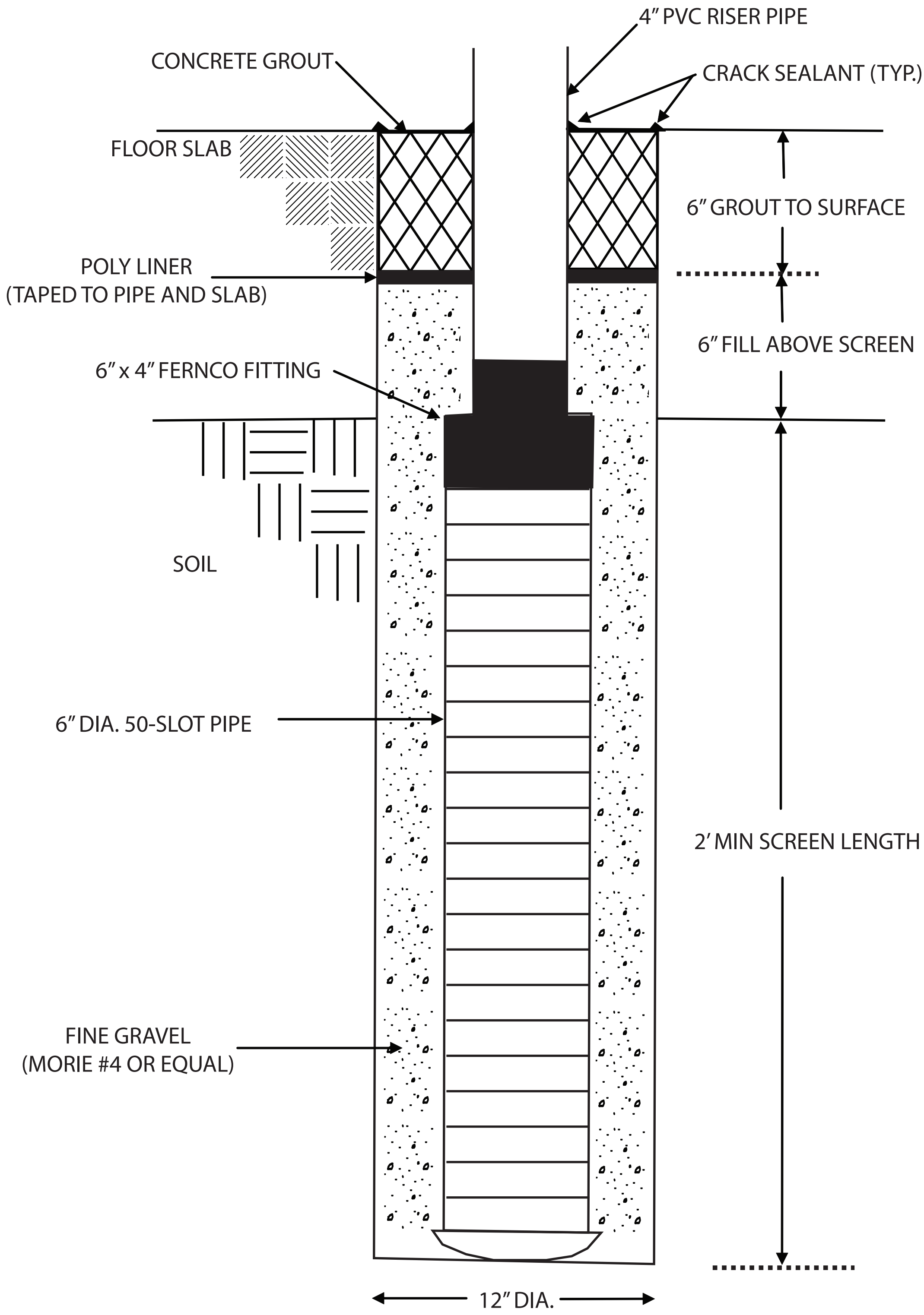
PROPOSED EXISTING MONITORING LOCATION

PVC PIPING

NOTES:
SB07* - AIR SAMPLE
SB07** - SOIL/GW SAMPLE

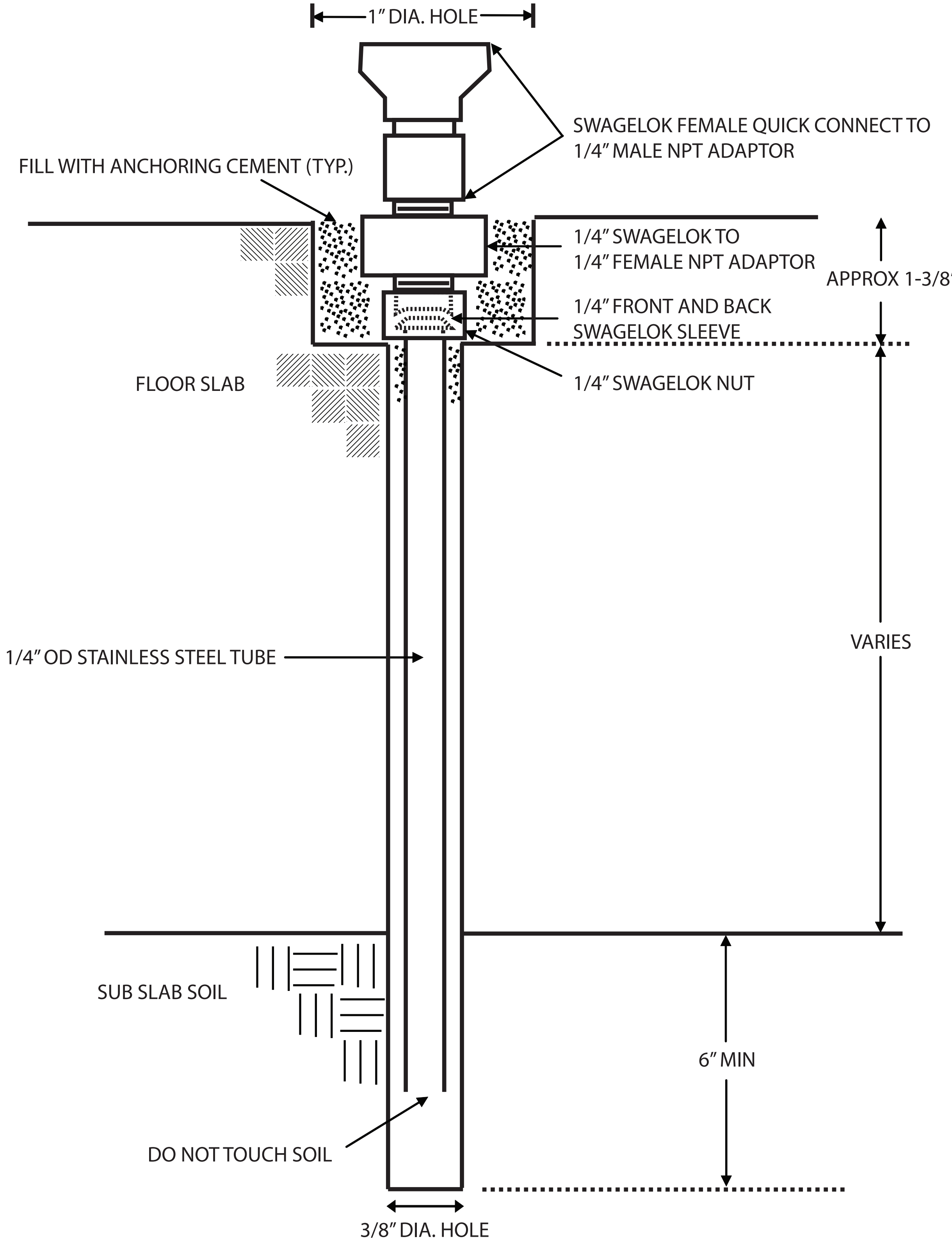
DRAFTED BY: CJ	RADIUS OF INFLUENCE PILOT TEST PLAN VIEW
CHECKED BY: JVB	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK
REVIEWED BY: MW	CDM

NORTH	SCALE IN FEET 0 20	DATE	FIGURE
		12-05-08	2-1



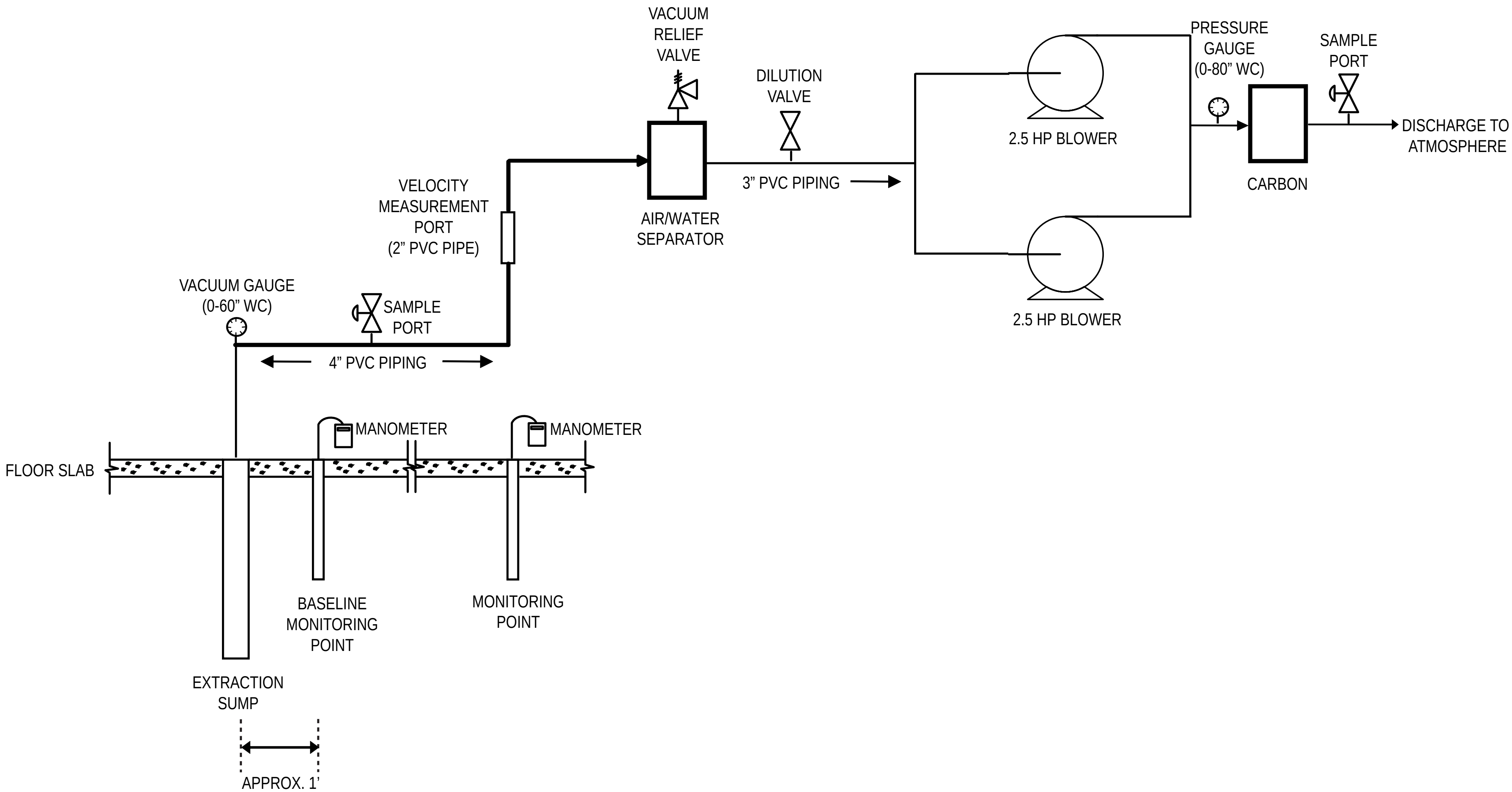
DRAFTED BY: CJ	PILOT TEST EXTRACTION SUMP DETAIL
CHECKED BY: JVB	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK
REVIEWED BY: MW	CDM

SCALE	DATE	FIGURE
NTS	11-6-08	2-2



DRAFTED BY: CJ	PILOT TEST MONITORING POINT DETAIL
CHECKED BY: JVB	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK
REVIEWED BY:	CDM

SCALE	DATE	FIGURE
NTS	10-24-08	2-3



LEGEND:

4" PVC PIPING

3" PVC PIPING

DRAFTED BY: CJ	PILOT TEST PROCESS FLOW DIAGRAM
CHECKED BY: JVB	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK
REVIEWED BY: MW	CDM

SCALE	DATE	FIGURE
NTS	11-06-08	2-4

Figure 2-5
Pilot Test - Flow Rate vs. Applied Vacuum
Standard Motor Products, Inc. Site
Long Island City, New York

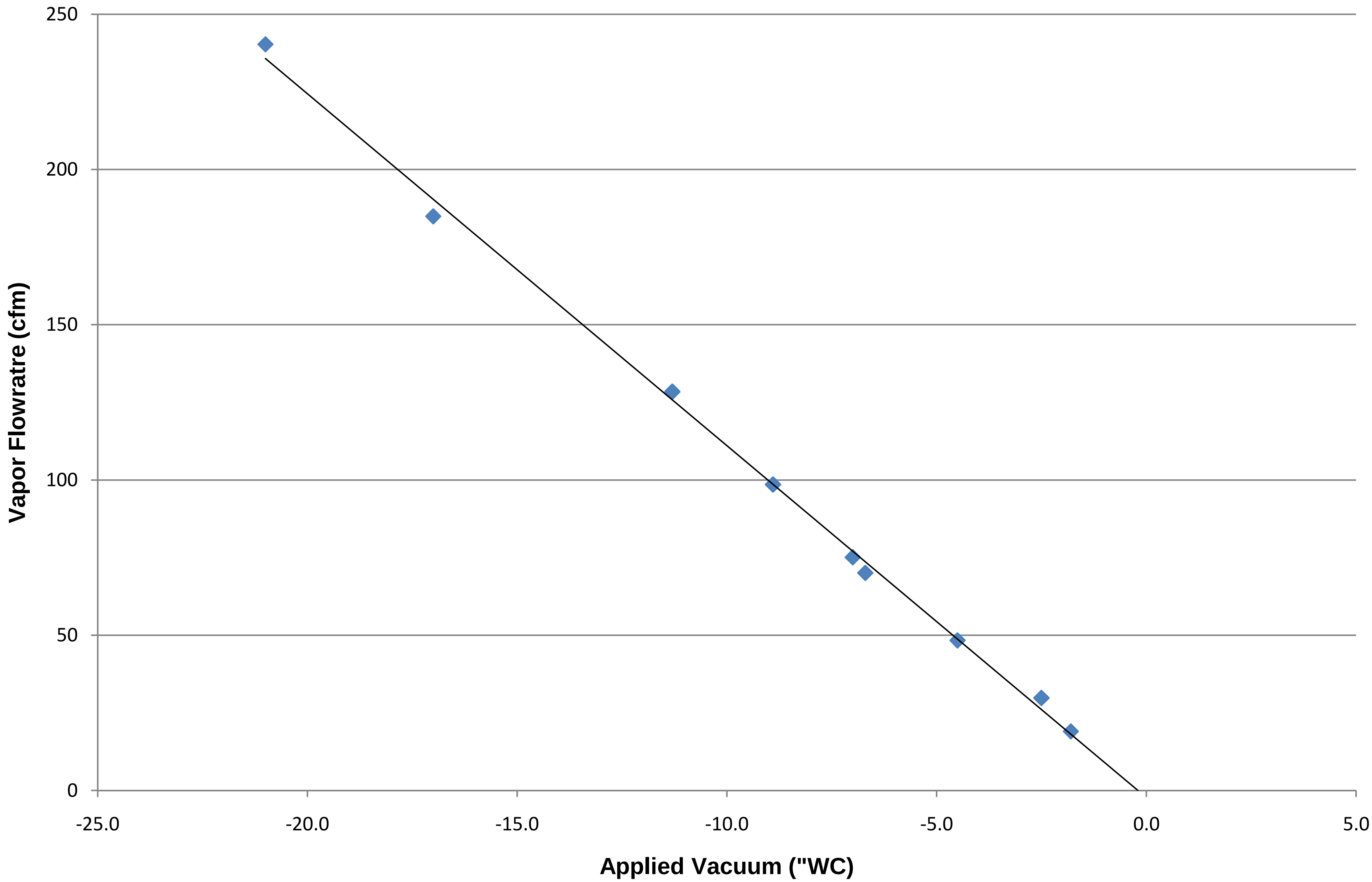


Figure 2-6
Pilot Test - Comparison of Pressure Variation at SB04 and SB22
Standard Motor Products, Inc. Site
Long Island City, New York

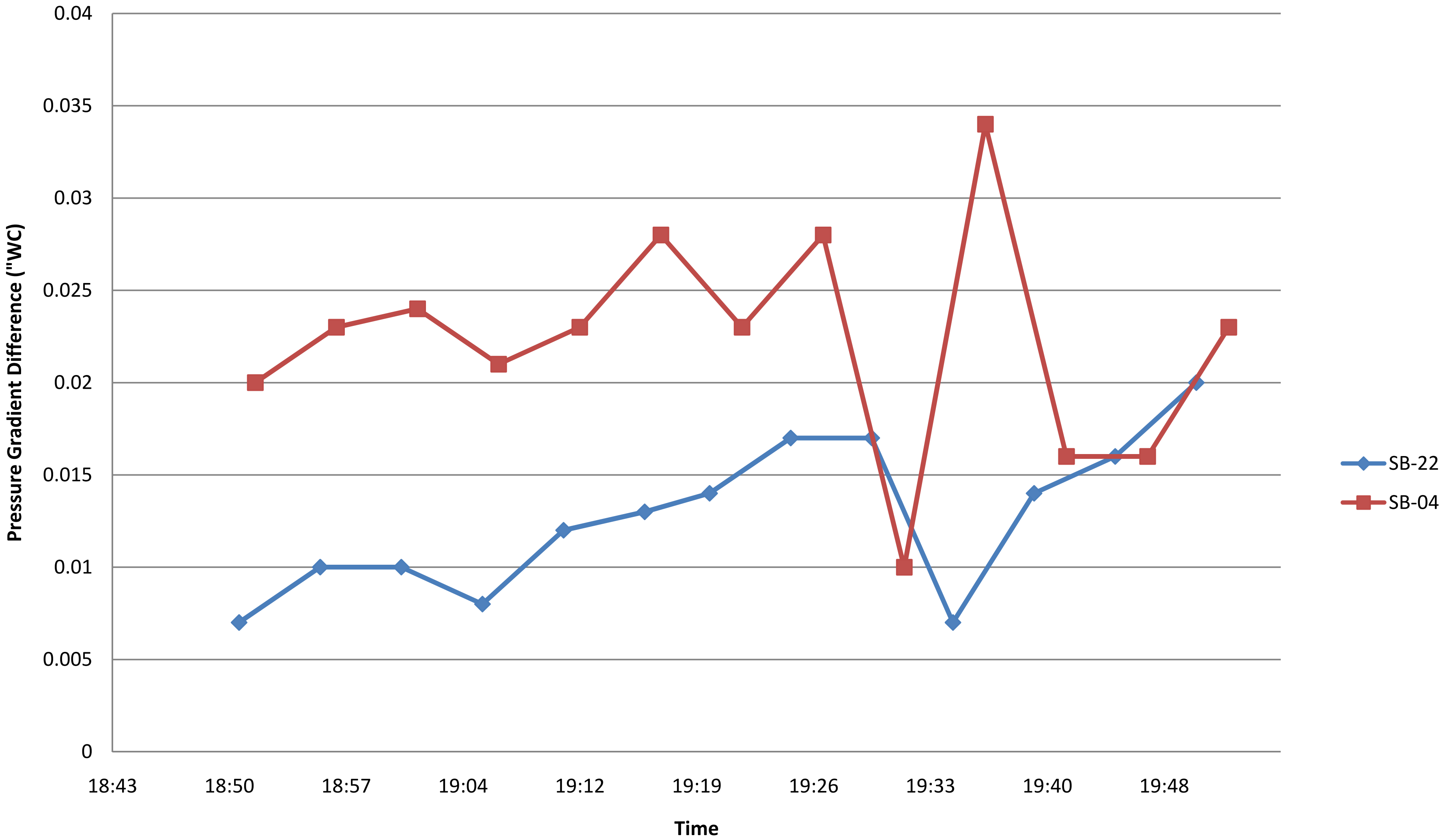
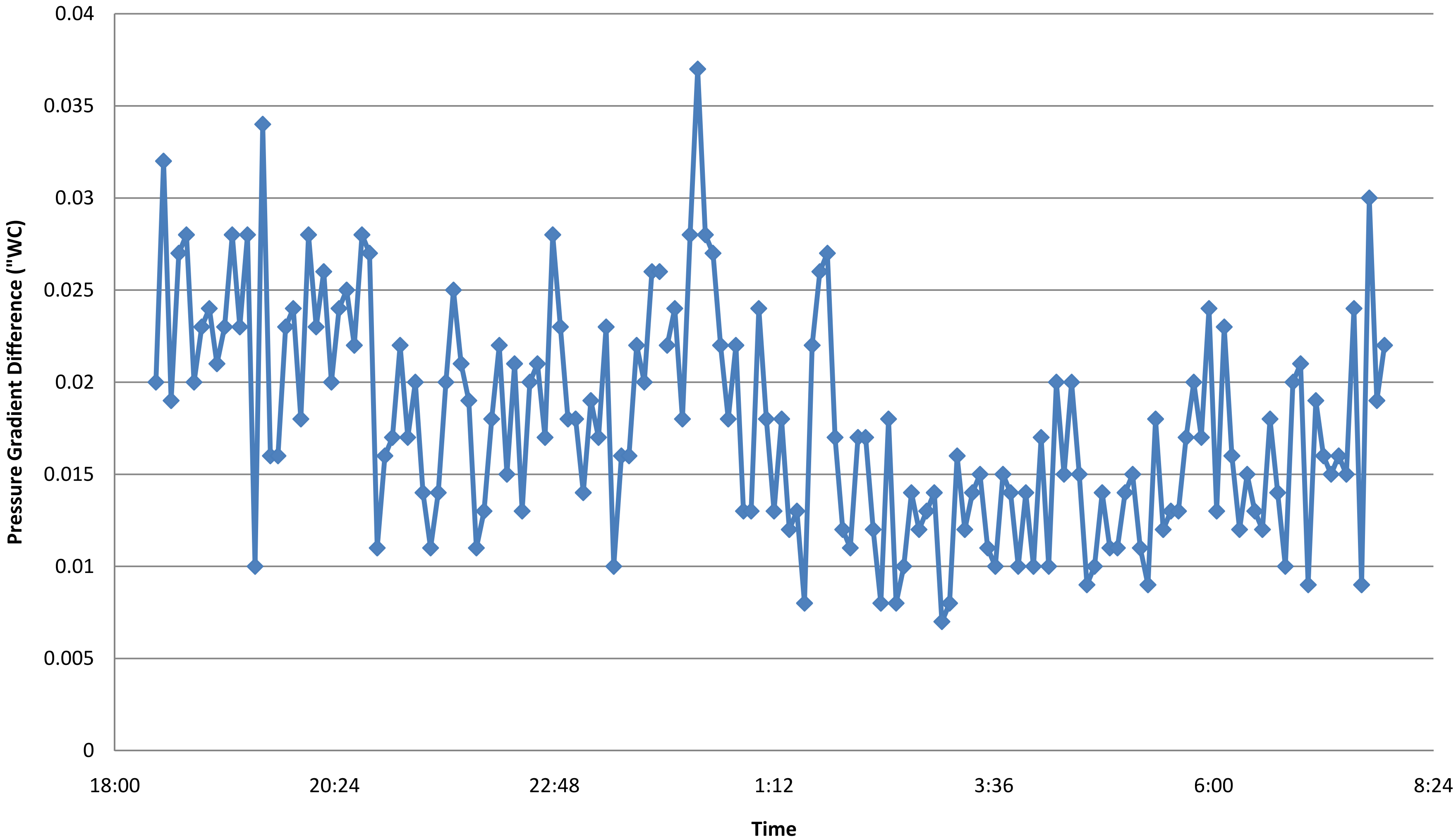
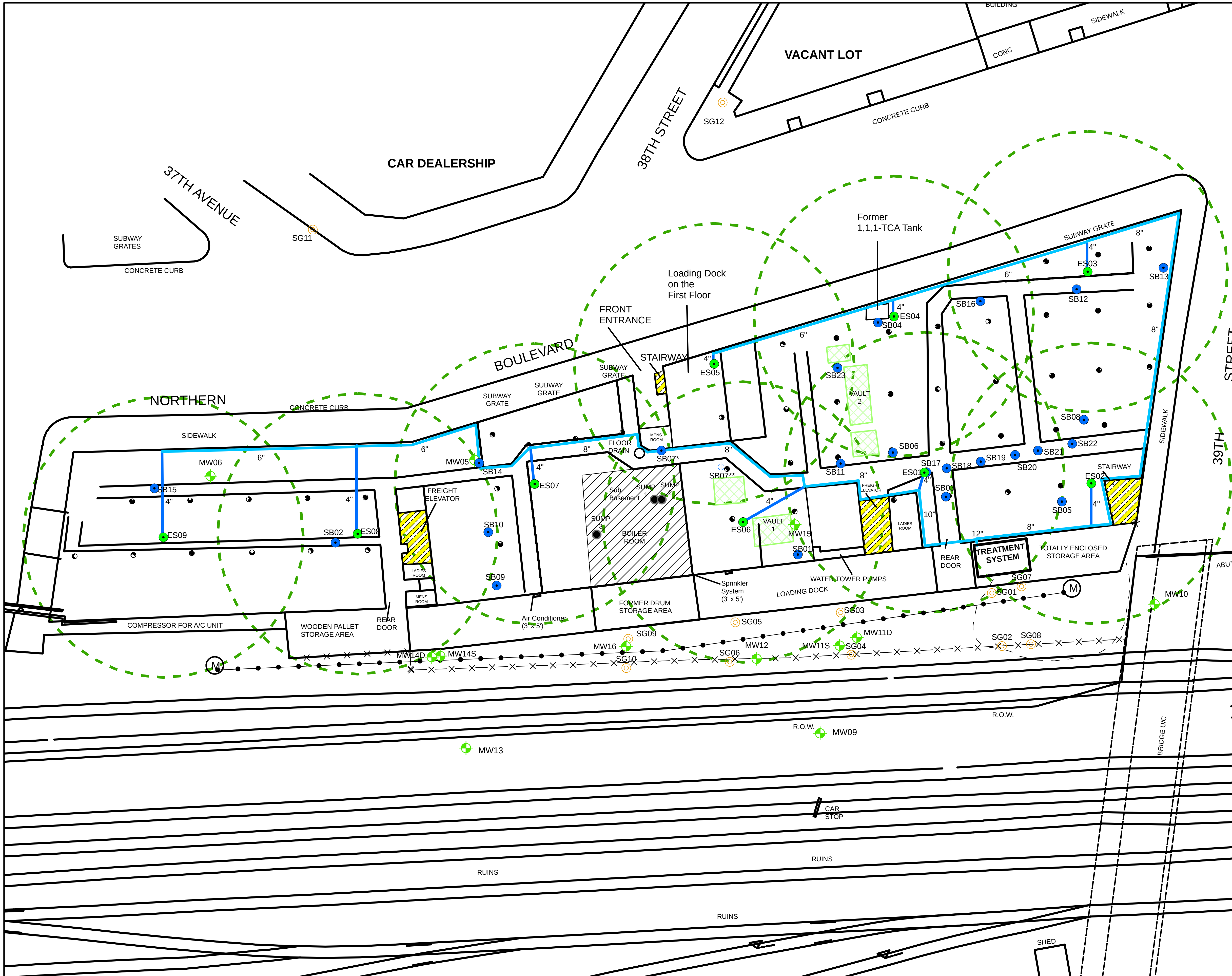


Figure 2-7
Pilot Test - Pressure Gradient Variation Log at SB22
Standard Motor Products, Inc. Site
Long Island City, New York





MONITORING WELL (MW)

SUB-SLAB (SB) SAMPLE LOCATION

SOIL GAS (SG) SAMPLE LOCATION

SEWER MANHOLE (APPROX 12' DEEP)

APPROX LOCATION OF DRAIN SPOUT

R.O.W. RIGHT OF WAY

SUPPORT COLUMN

FENCE LINE

UNDERGROUND STORM SEWER

APPROX. VICINITY OF PREVIOUSLY EXCAVATED SOILS

RECESS EQUIPMENT PAD/VAULT

PROPOSED EXTRACTION LOCATION

PROPOSED EXISTING MONITORING LOCATION

EXTRACTION POINT RADIUS OF INFLUENCE

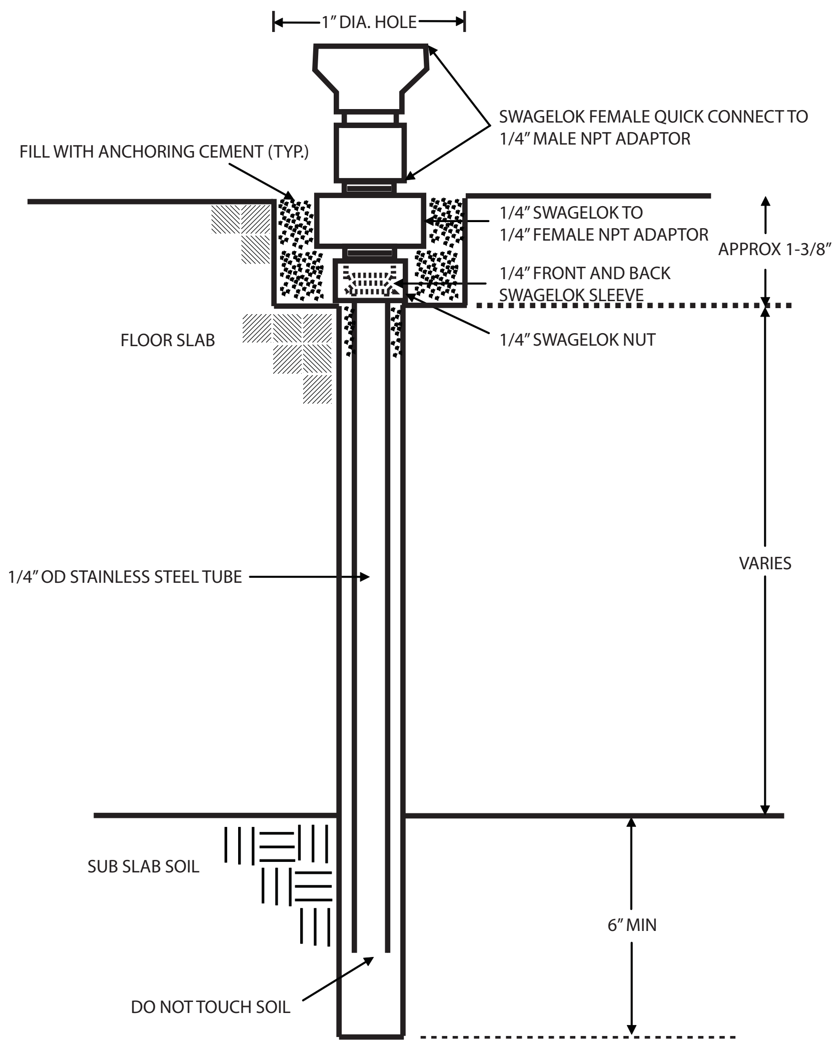
6" OVERHEAD 6" PIPING

4" EXTRACTION POINT EXCAVATION FOR 4" PIPING

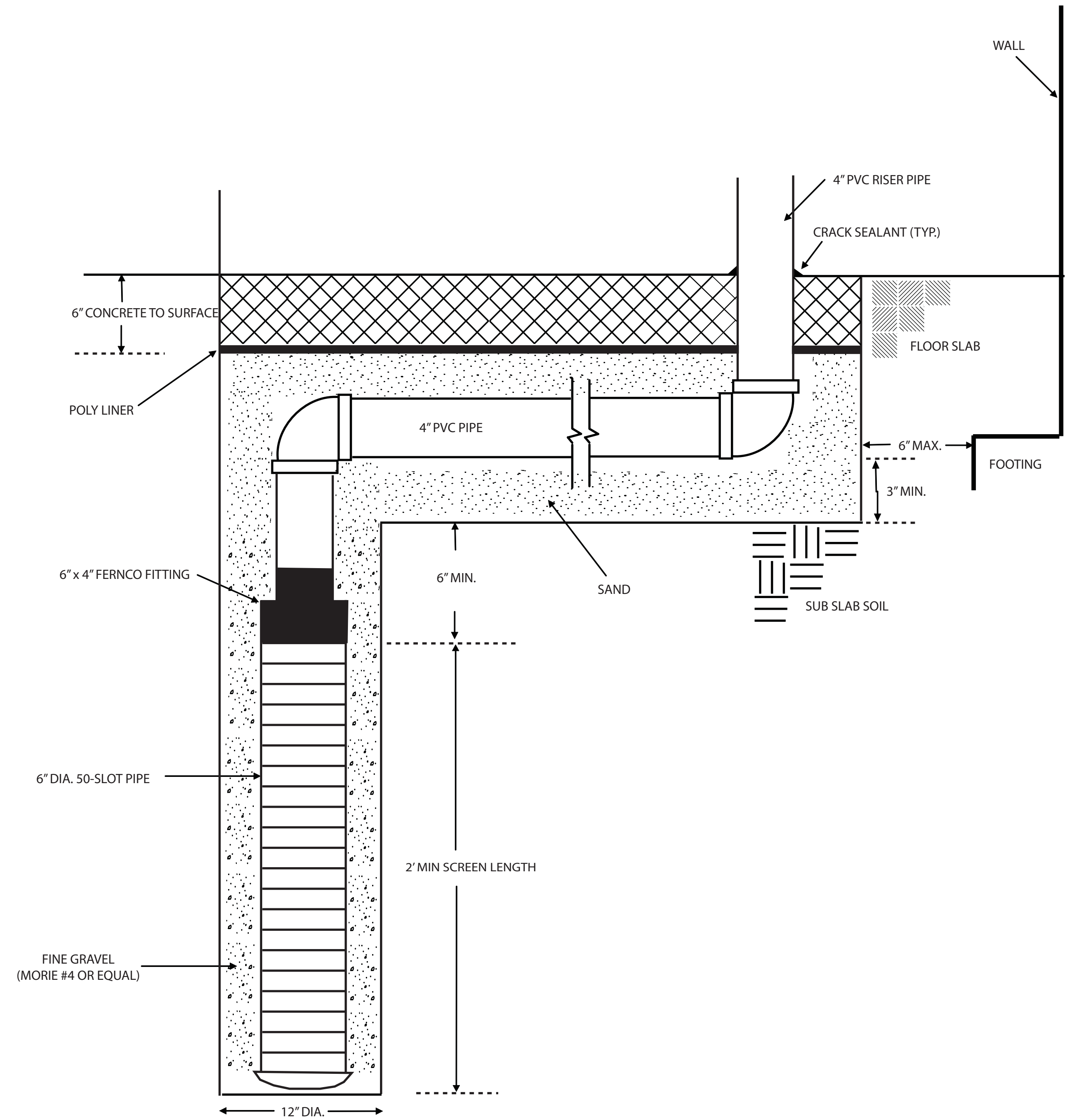
NOTES:
1. SB07* - AIR SAMPLE LOCATION
SB07** - SOIL/GW SAMPLE LOCATION
2. PIPING FROM THE GROUND TO CEILING IS 4" PIPING.

DRAFTED BY: CJ	**SUB-SLAB DEPRESSURIZATION LAYOUT**
CHECKED BY: JVB	**STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK**
REVIEWED BY: MW	CDM

NORTH	SCALE IN FEET 0 40	DATE 12-23-08	FIGURE 3-1

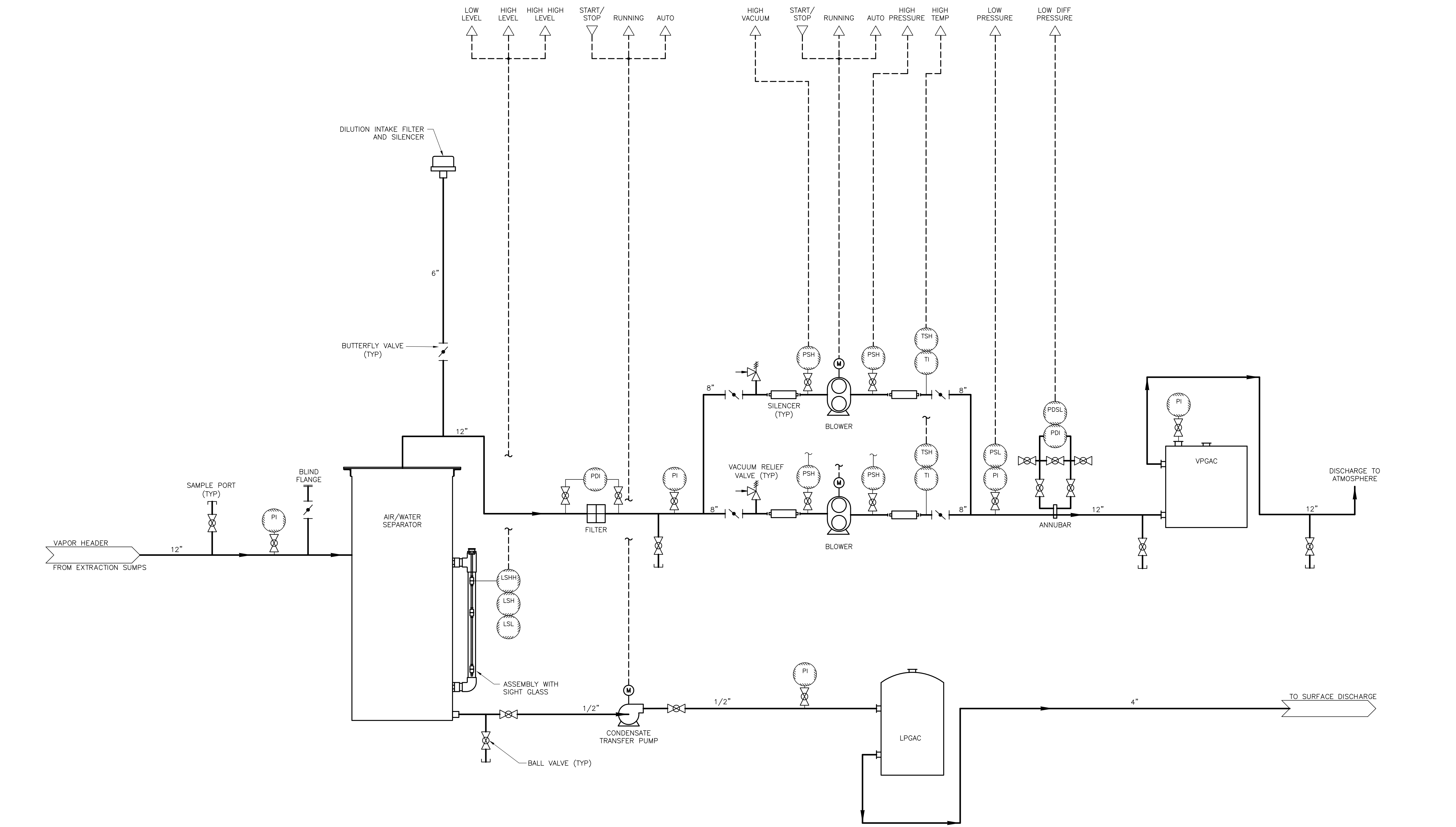


MONITORING POINT DETAIL (TYP.)



EXTRACTION SUMP DETAIL (TYP.)

DRAFTED BY: CJ	MONITORING POINT AND EXTRACTION SUMP DETAILS		
CHECKED BY: JVB	STANDARD MOTOR PRODUCTS, INC. SITE LONG ISLAND CITY, NEW YORK		
REVIEWED BY: MW	CDM		
	SCALE	DATE	FIGURE
	NTS	12-17-08	3-2



STANDARD MOTOR PRODUCTS, INC.
37-18 NORTHERN BOULEVARD
LONG ISLAND CITY, NEW YORK

FIGURE 3-3
PROCESS & INSTRUMENTATION DIAGRAM
INTERIM REMEDIAL MEASURE WORK PLAN
DECEMBER 2008

CDM Camp Dresser & McKee Inc.

Appendix A
Pilot Test Log Book Copies

ROI TESTING

1245 Josh VanBogaert (JVB) onsite. Prior to arriving, loaded truck at warehouse, picked up generator.
Weather: 40's, sunny
Jim + Jay Deinhart (CCI) already on site. David (SMP) onsite.
- Markout ES-1 and SB17-23.
- J+J work on drilling for SB's and coring ES-1. JVB marked out existing SBs. CANNOT FIND SB-11.
- Chris Wendt (SMP) stops in to check out ES installation.
- Prepare swagelok fittings.
1400 Dick Flannigan (DF), CCI onsite. Begin prepping KO tank, securing generator, and installing piping.
1500 Realize KO tank is rotted at bottom. Will build catch drain (PVC) instead.

JVB 11/17/08

ROI TESTING

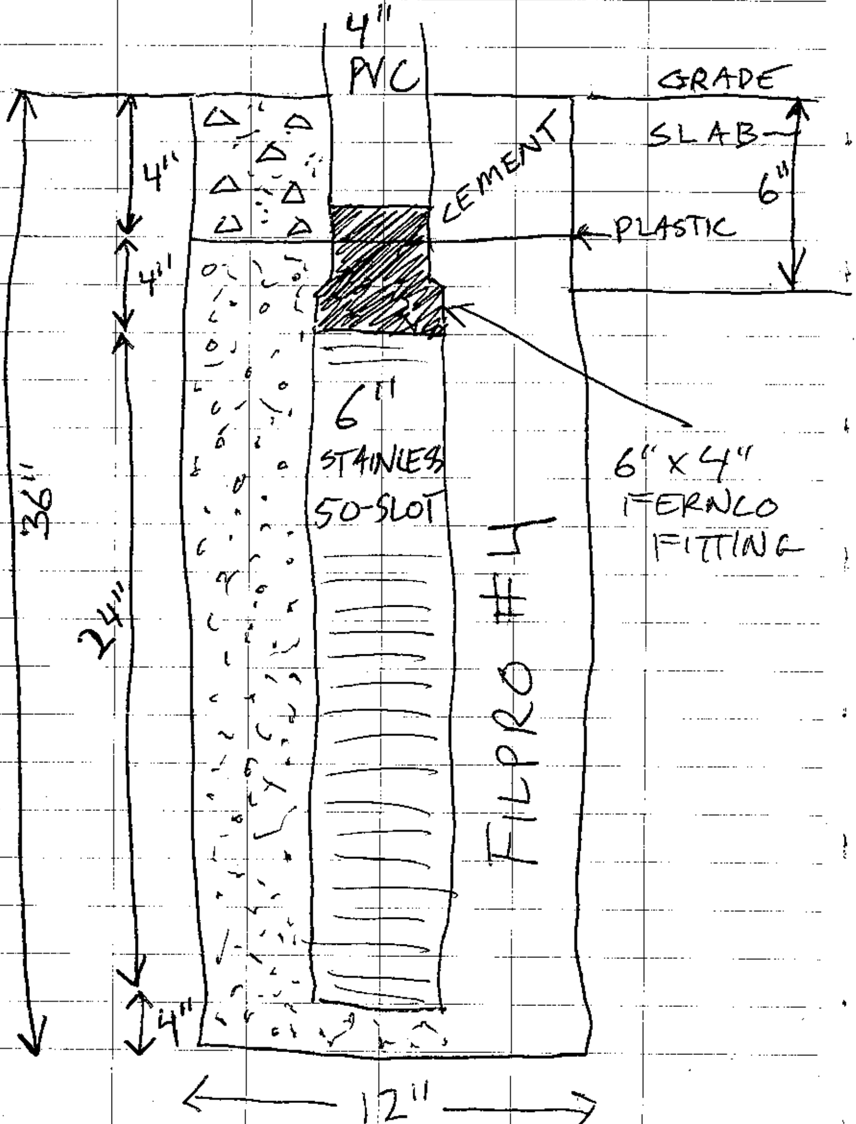
Finish ES-1 as shown on next page (P.70). Attach female QC's to all existing SBs. Unable to install probes in new SB holes (no time).
ALL OFFSITE @ 1800.
NOTE: Gas-fired ceiling heaters on all day

JVB 11/17/08

SMP | IRM | 11-17-08

ROI TESTING

ES-1 CONSTRUCTION



SMP | IRM | 11-18-08

ROI TESTING

0730 JVB onsite. J & JD, DF already onsite. Jay hooking up effluent piping & GAC. Jim setting new SBs with Hilti anchoring adhesive.
JVB calibrate Mini Rae SN# R9576 from Ashtead Rental. Fresh air reading = 0.0 ppm. Reading on 100 ppm Isobutylene = 100.0 ppm.
Breathing zone = 0.0 - 0.1 ppm.
Reading ~ 8" into ES-1 = >9999 ppm (immediately after uncapping.
WEATHER: ~40F, clear, 60% humidity. Barometric pressure = 30.02"
Finish setup, install press/vac gauges, sample points, annubar, anemometer.
1145 Start test. ~1 blower only. Conduct 1st step @ ~17 cfm, -1.8" WC (ES-1)

JVB 11/18/08

ROI TESTING

1150 1st round readings
1225 2nd step ≈ ~~30 cfm~~ 28 cfm +
-2.5" WC
1230 2nd round readings
Breathing zone PID = 0.0 ppm
1330 3rd step @ 46 cfm + 4.5 "WC
Randy Kullmann, Maria Watt,
Christine Judias (all CDM) +
Sean Bollers (NYSDEC) onsite
1430 4th step @ 71 cfm, -7.0" WC } 2nd blower
1450 Collect readings 4th step.
NOTE: Annubar + anemometer both
installed in 2" SCH 40 PVC. At
1520, turned dilution valve down,
maxxed out anemometer at 4000
fpm. Switched anemometer only
to 4" SCH PVC. (now outside)
1530 Conduct 5th test @ 78 cfm
and -8.9 " WC
1610 Close dilution valve to 6th step
1645 Collect readings. 96 cfm, -11.3 "WC
17:10 Conduct 7th step 134 cfm @
-17.0" WC.
17:30 Collect readings @ 7th step

JRB 11-18-08

ROI TESTING

Note - SB-19, 23 are loose.
Caulk to seal
1750 Close dilution valve fully,
both blowers on.
1810 Final readings @ 8th step
-21.0" WC + 160 cfm
Measure dist. from ES-1 to
all SBs using measuring tape.
Note: SB22 was installed
@ ~65' from ES1 (instead of 85')
Surveyed floor elevations.
1830 Prior to leaving, set
date/time on loggers and
program to record every 5
minutes. Hookup to SB-22
and SB-04. Both are ~65'
from ES-1. SB-04 is also
along N wall, which has
been difficult to influence +
had erratic readings (maybe
due to subway trains coming
through N of the building)
Turned heat OFF before
leaving. Offsite 1835.

JRB
11-18-08

SMP ~~IAR~~ IRM 11-18-08
ROI TESTING

Monitoring pt	Dist. to ES-1 (ft)
SB-17	1
SB-18	9.85
SB-03	17.0
SB-06	11.2
SB-19	24.75
SB-11	32.8
SB-20	39.7
SB-21	49.65
SB-23	55.0
SB-05	62.7
SB-04	63.5
SB-22	64.65
SB-08	73.3
SB-16	75.5
SB-12	101.5
SB-07	109.1
SB-13	137.35
SB-01	Couldn't measure

JVB 11/18/08

SMP IRM 11-19-08
ROI TESTING

0715 JVB onsite. J+JD, DF already onsite.
Weather ~30°F. Clear. Heat still off. System running. Basement still warm (~55-60F)
0735 Collect round of readings. Flowrate ~same as 11/18 1800 (8th step.) Vacuum level ~same @ -20.8 "WC (ES-1). Calibrate PID. Calibration reading 103ppm. Vapor sample from ES-1 = 423 ppm.
0810 System shutdown.
0815 Check water trap. Multiple gallons (~2-3 gallons) of water drain out.
Start breaking down piping, etc.
0830 ~~Markout~~ Measure triangulation measurements for SB-23, SB-22, + ES-1 for future location. See figure markup for measurements

JVB 11/19/08

SMP IRM 11-19-08
ROI TESTING

0910 Collect round of measurements ~1 hour after shutdown. See field monitoring sheet for details.
0930 Chip out concrete seal plug at ES-1. Cut riser pipe, cap below slab grade, and backfill with cement to grade
1000 Finish cleanup, remove female QCs, cap SBs. Sweep
1030 JVB, DF offsite to return generator, CDM warehouse items, and truck.

JVB 11-19-08

Appendix B
Pilot Test Photos

Appendix B - Photographs

Photo 1: Discharge and Stack

Photo 2: Blower Influent and Effluent

Photo 3: Vapor Piping and VPGAC Adsorber

Photo 4: Dilution Valve

Photo 5: Blower Skid

Photo 6: Pipe Penetration from Outside

Photo 7: Pipe Penetration from Inside

Photo 8: Thermal Anemometer Velocity Measurement

Photo 9: Annubar Installation

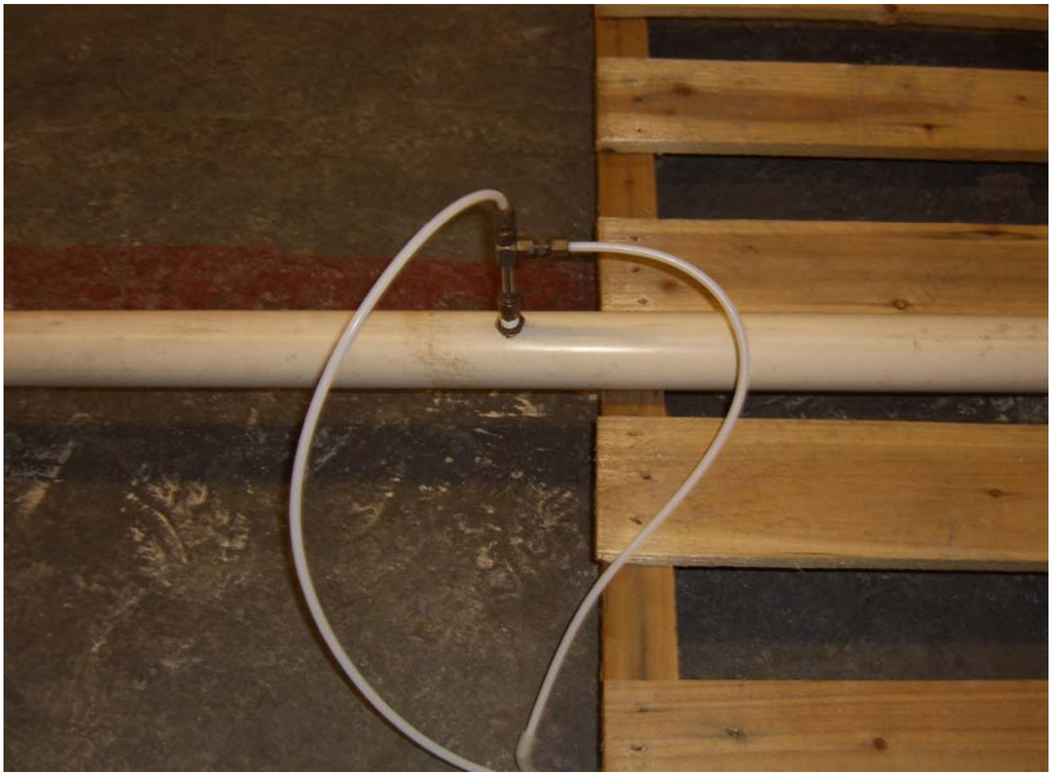
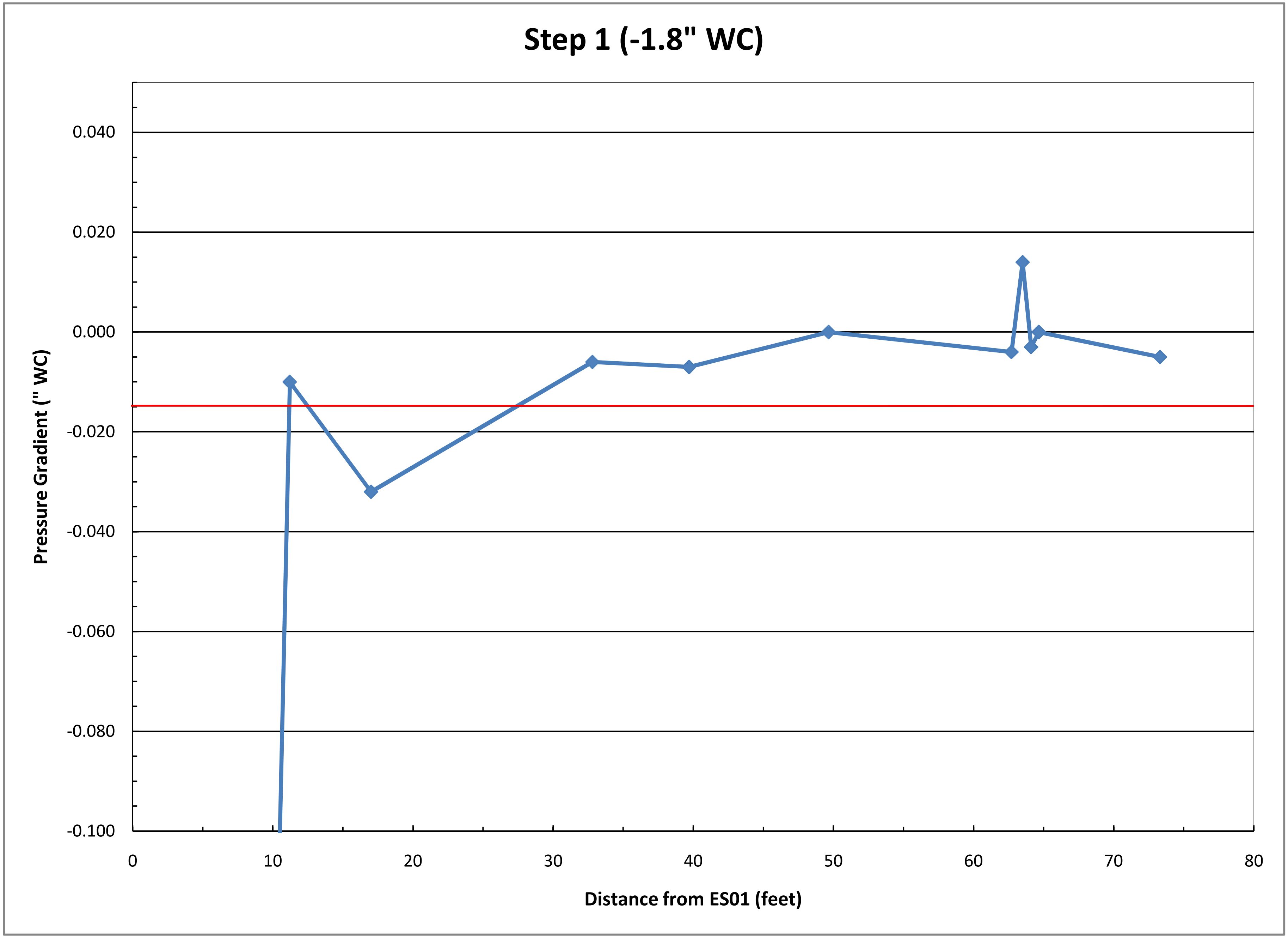
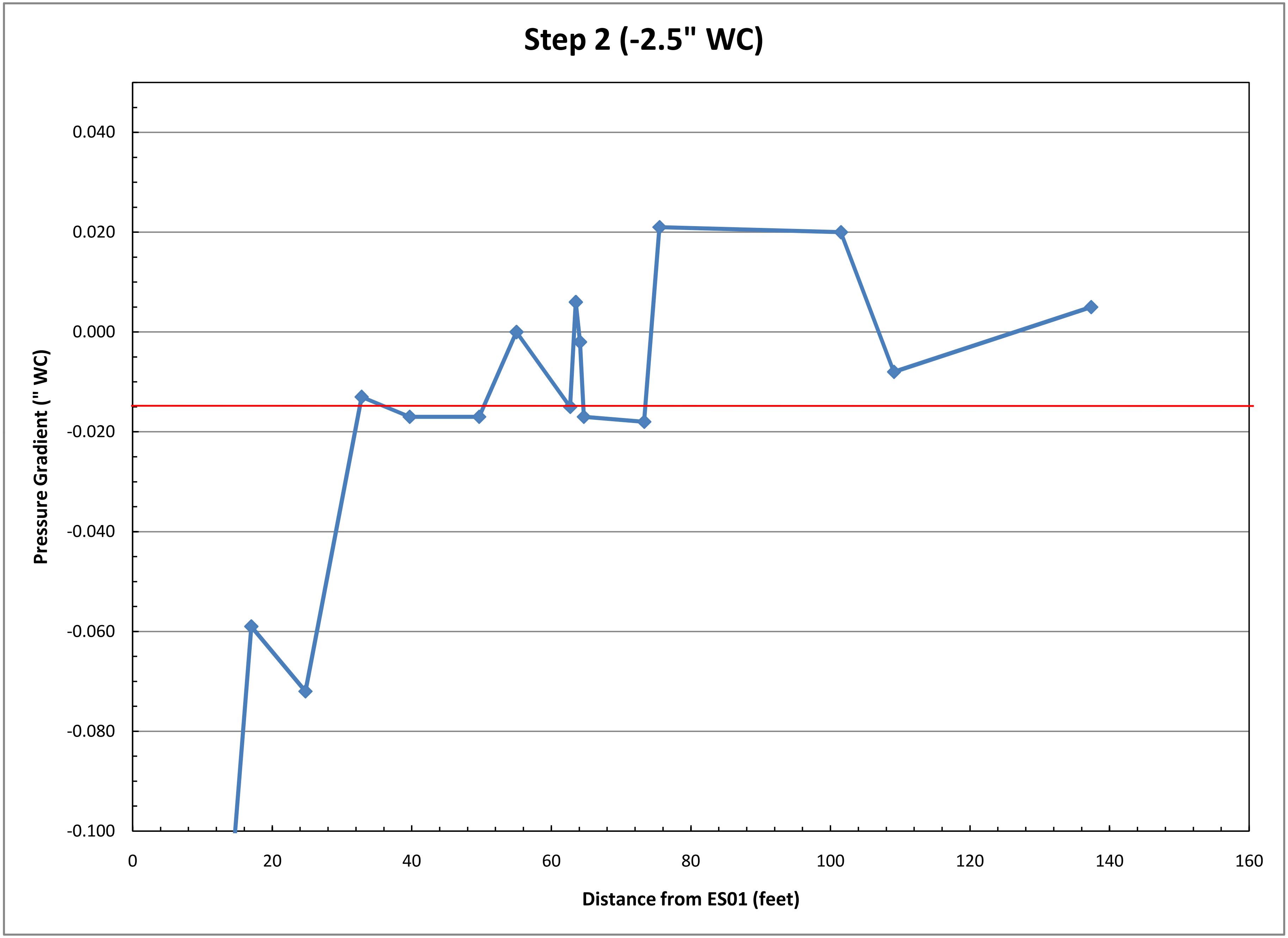


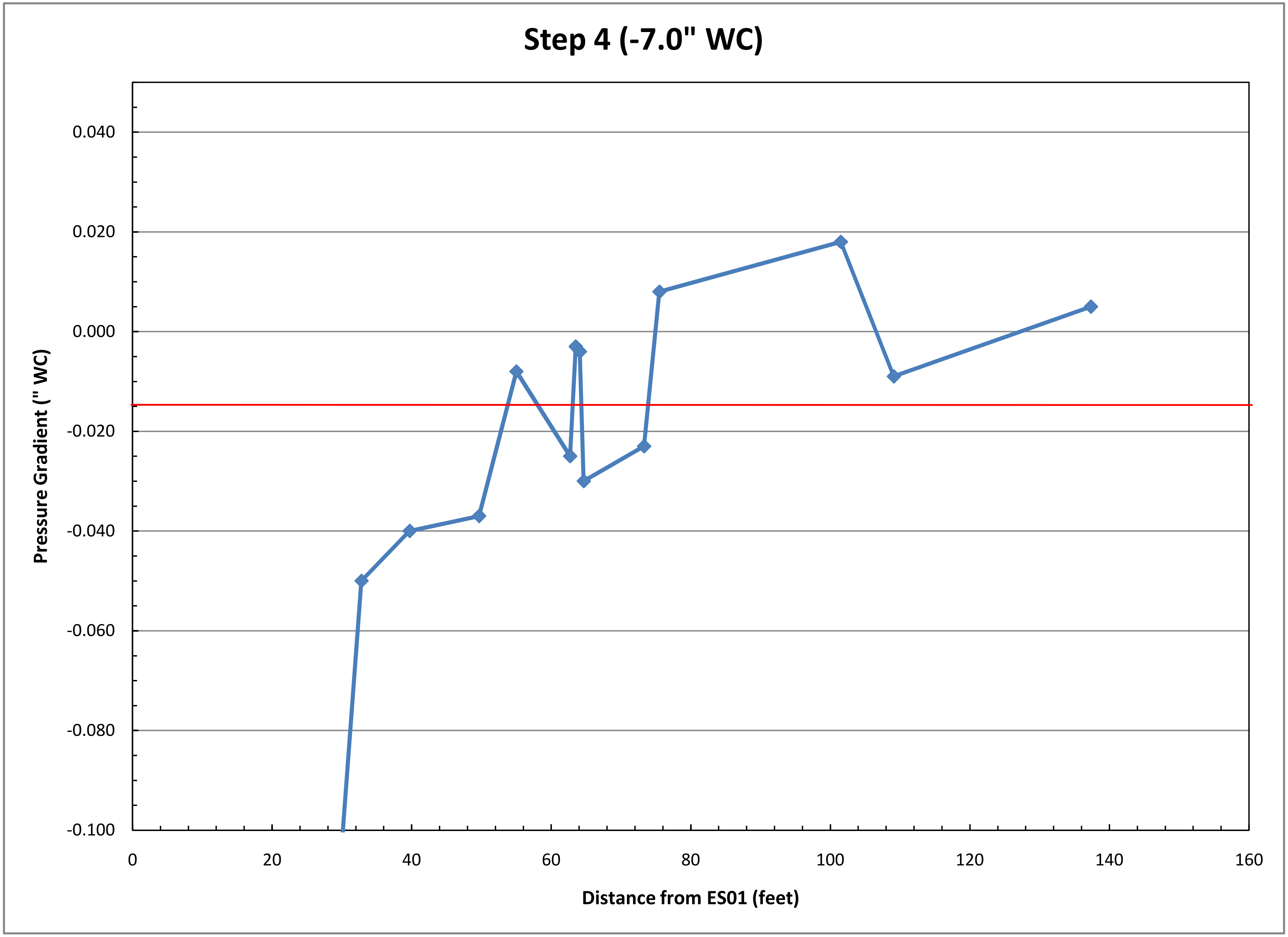
Photo 10: Extraction Sump

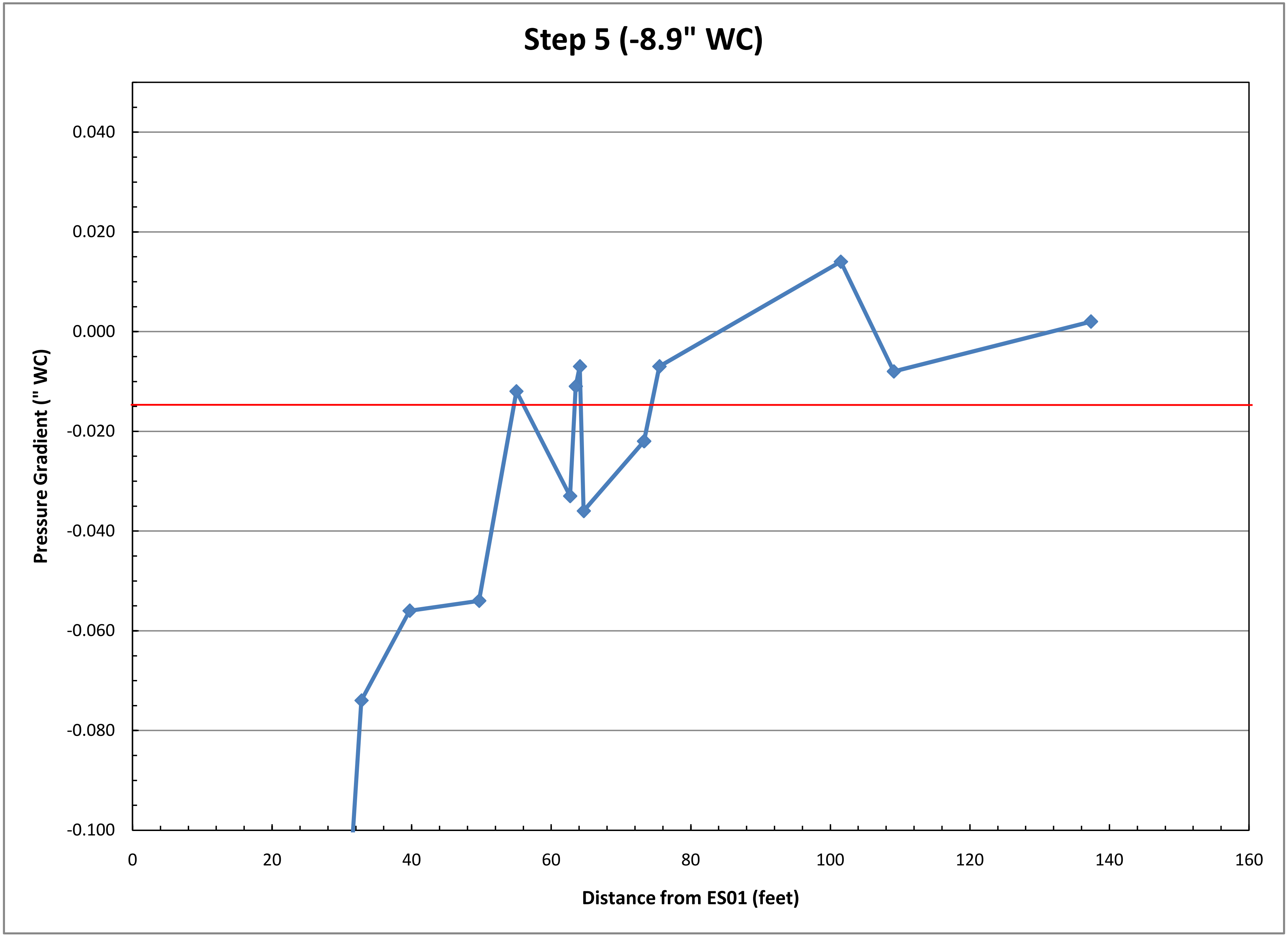
Appendix C
Step Test Pressure Gradient vs. Distance Charts


Step 1 (-1.8" WC)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
10
20
30
40
50
60
70
80
Distance from ES01 (feet)

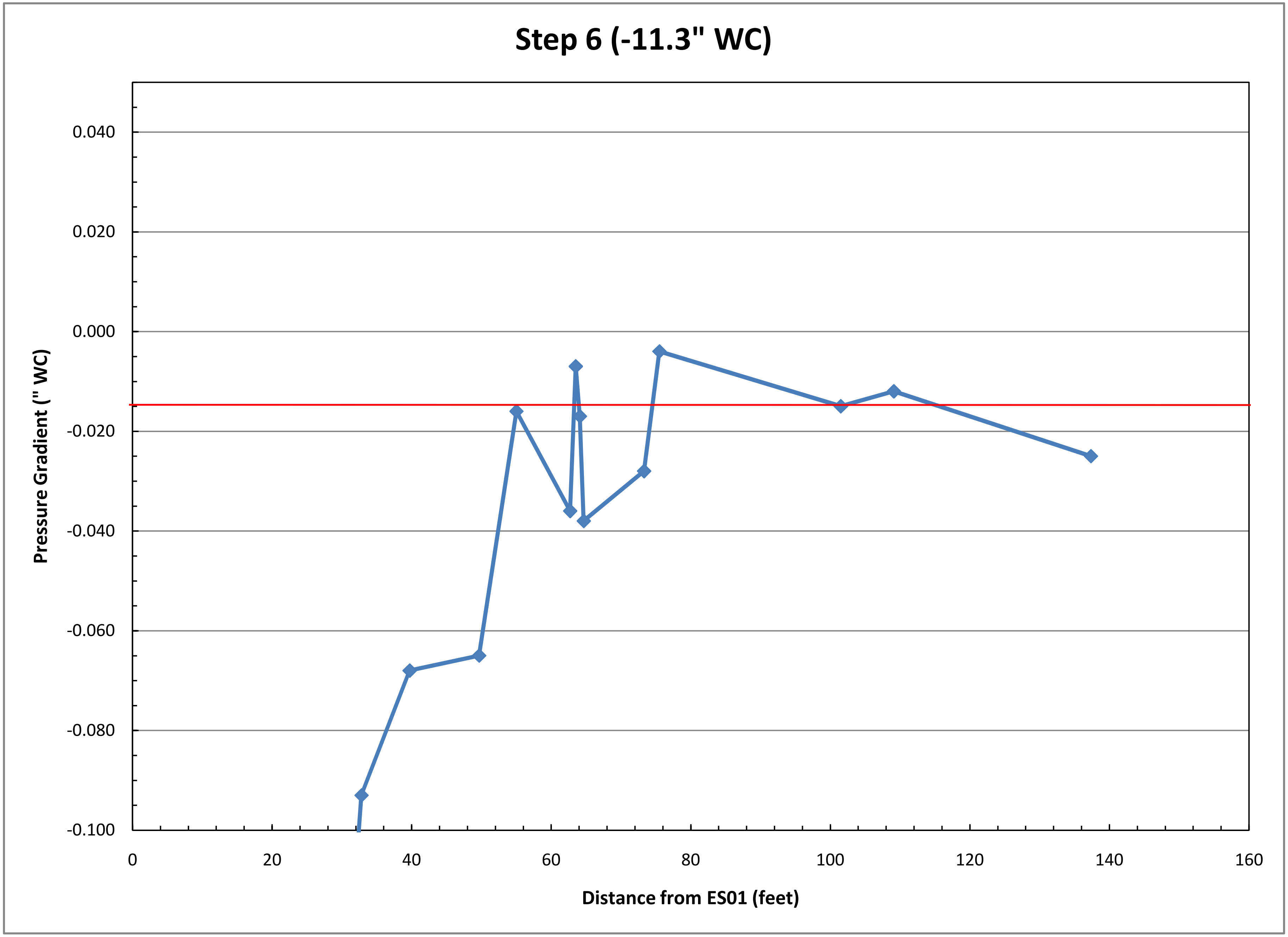

Step 2 (-2.5" WC)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)


Step 3 (-4.5" WC)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)

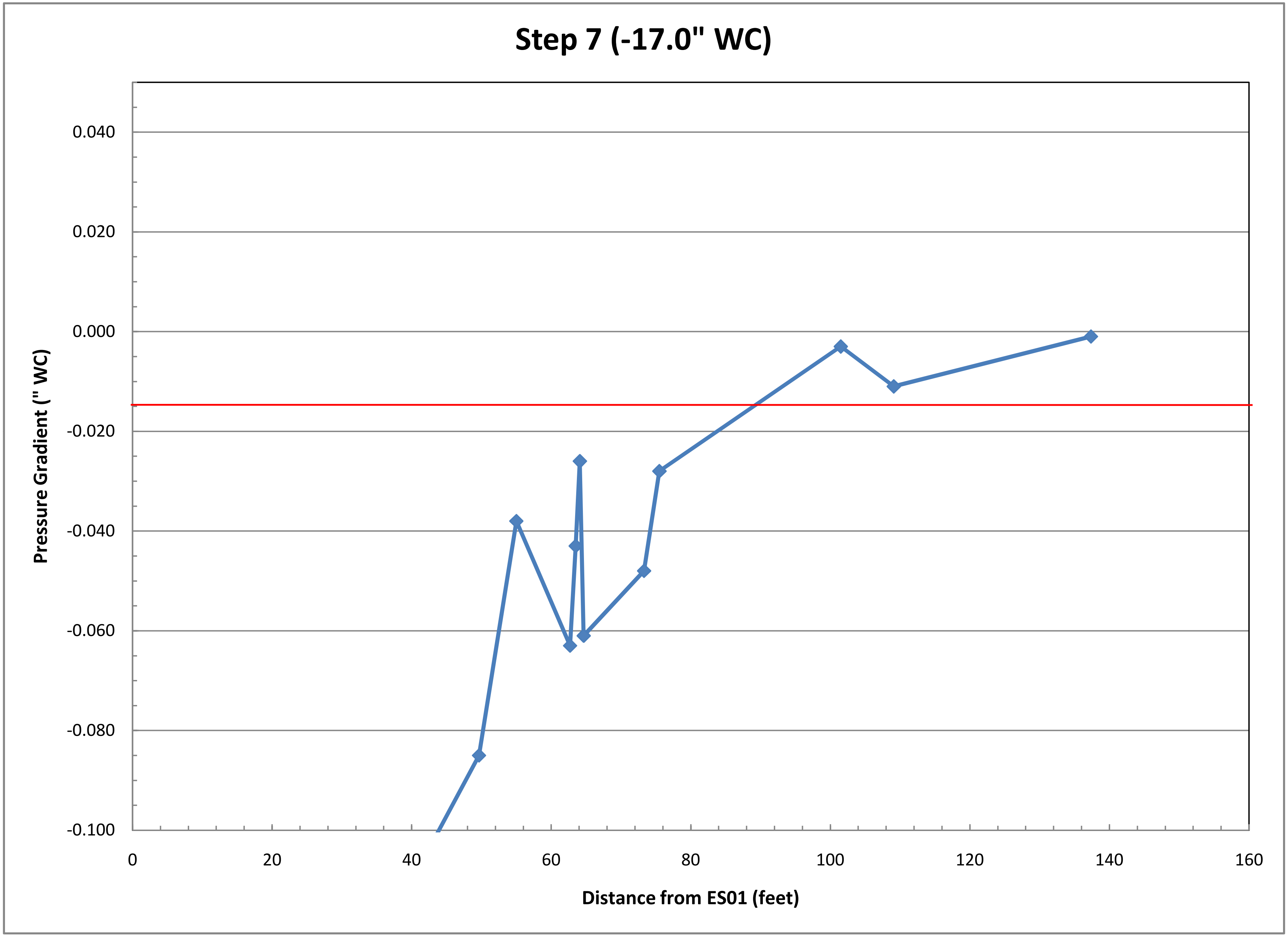

Step 4 (-7.0" WC)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)



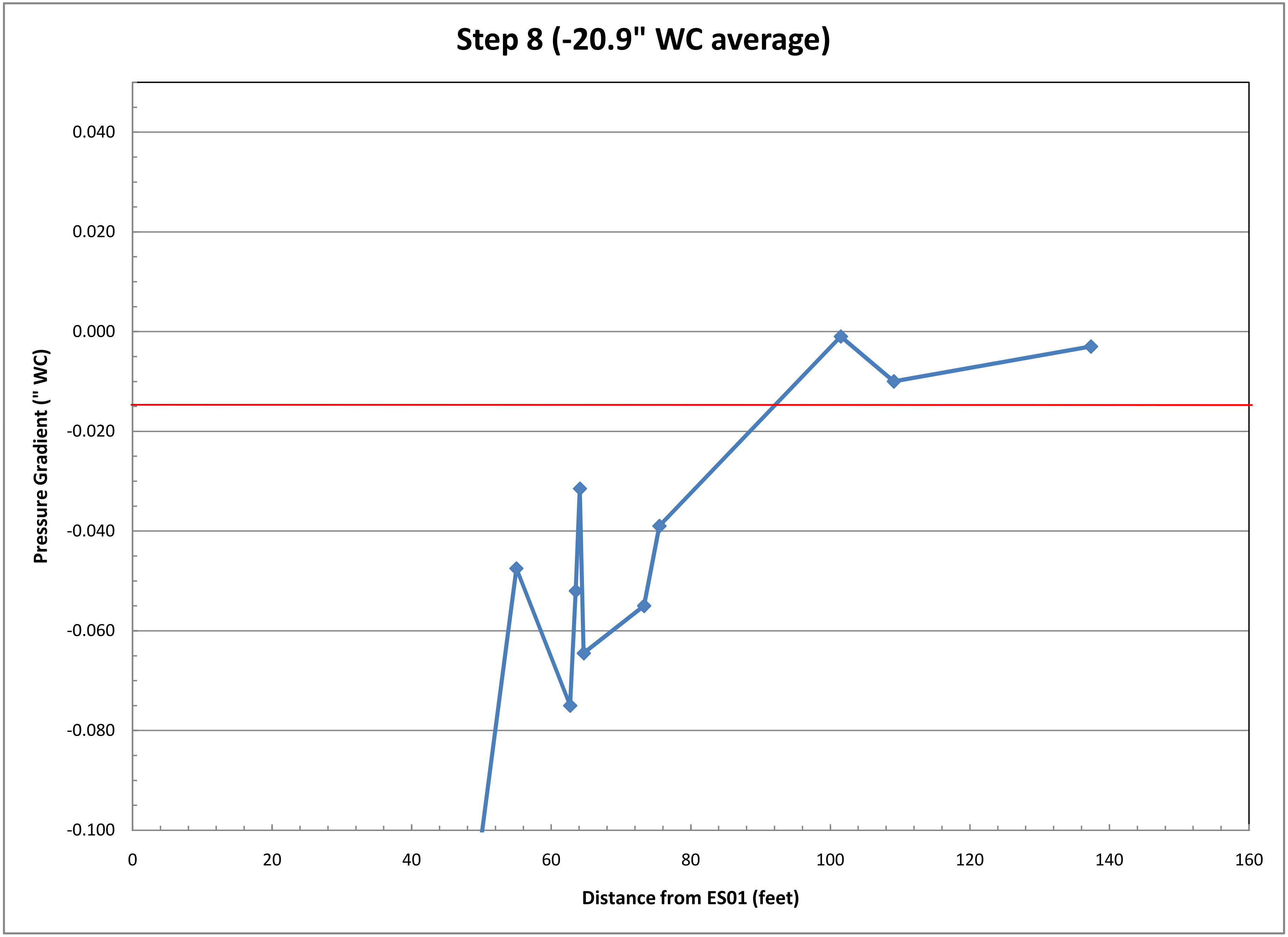
Step 5 (-8.9" WC)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)



Step 6 (-11.3" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
Pressure Gradient (" WC)
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)



Step 7 (-17.0" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
Pressure Gradient (" WC)
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)


Step 8 (-20.9" WC average)
Pressure Gradient (" WC)
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
0
20
40
60
80
100
120
140
160
Distance from ES01 (feet)

Appendix D
Calculations

- Pipe Sizing
- Friction Loss
- Lower Explosive Limit

Pipe Sizing

Pipe Sizing Calculations | **Done by: JVB** | **Checked by: CJ**
Date: 12-16-08 | **Date: 12-16-08**

Goal:

1. Calculate pipe sizes for the vapor extraction piping/duct.

Assumptions:

1. Vapor lines: Target between 1200 and 2100 ft/min, 20 to 35 ft/sec   Hard limit max of 3000 ft/min=50 ft/sec.
2. Normal vapor flow is 125-175 cfm per sump, max of 250 cfm.

Vapor/Air Lines

Line Description	q (CFM)			Pipe/Duct ID (IN)	a (FT^2)	v (FT/SEC)			Selected pipe/tube/duct	Vacuum Loss (IWG/100 FT)			
	Min Norm	Max Norm	MAX			Min Norm	Max Norm	MAX		Min Norm	Max Norm	MAX	
1 sump	125	175	250	3.998	0.08714	24	33	48	4" SCH 40 PVC	1.07	2.08	3.82	
1 sump	125	175	250	6.031	0.19828	11	15	21	6" SCH 40 PVC	0.13	0.26	0.45	
2 sumps	250	350	500	6.031	0.19828	21	29	42	6" SCH 40 PVC	0.50	0.96	1.95	2 sumps
3 sumps	375	525	750	7.942	0.34385	18	25	36	8" SCH 40 PVC	0.24	0.48	0.89	3
4 sumps	500	700	1000	7.942	0.34385	24	34	48	8" SCH 40 PVC	0.43	0.81	1.69	4
5 sumps	625	875	1250	9.976	0.54253	19	27	38	10" SCH 40 PVC	0.22	0.40	0.81	5
6 sumps	750	1050	1500	9.976	0.54253	23	32	46	10" SCH 40 PVC	0.29	0.58	1.15	6
7 sumps	875	1225	1750	11.889	0.77054	19	26	38	12" SCH 40 PVC	0.17	0.31	0.58	7
8 sumps	1000	1400	2000	11.889	0.77054	22	30	43	12" SCH 40 PVC	0.21	0.39	0.75	8
9 sumps	1125	1575	2250	11.889	0.77054	24	34	49	12" SCH 40 PVC	0.26	0.51	0.96	9

L/s	59	83	118	102	mm	7	10	15	m/s	8.7	17	31.2	Pa/m
	59	83	118	153		3	4	6		1.1	2.1	3.7	
	118	165	236	153		6	9	13		4.1	7.8	15.9	
	177	248	354	202		6	8	11		2	3.9	7.3	
	236	330	472	202		7	10	15		3.5	6.6	13.8	
	295	413	590	253		6	8	12		1.8	3.3	6.6	
	354	495	708	253		7	10	14		2.4	4.7	9.4	
	413	578	825	302		6	8	12		1.4	2.5	4.7	
	472	660	943	302		7	9	13		1.7	3.2	6.1	
	531	743	1061	302		7	10	15		2.1	4.2	7.8	

Fig. 55.2 Friction loss of air in straight ducts.
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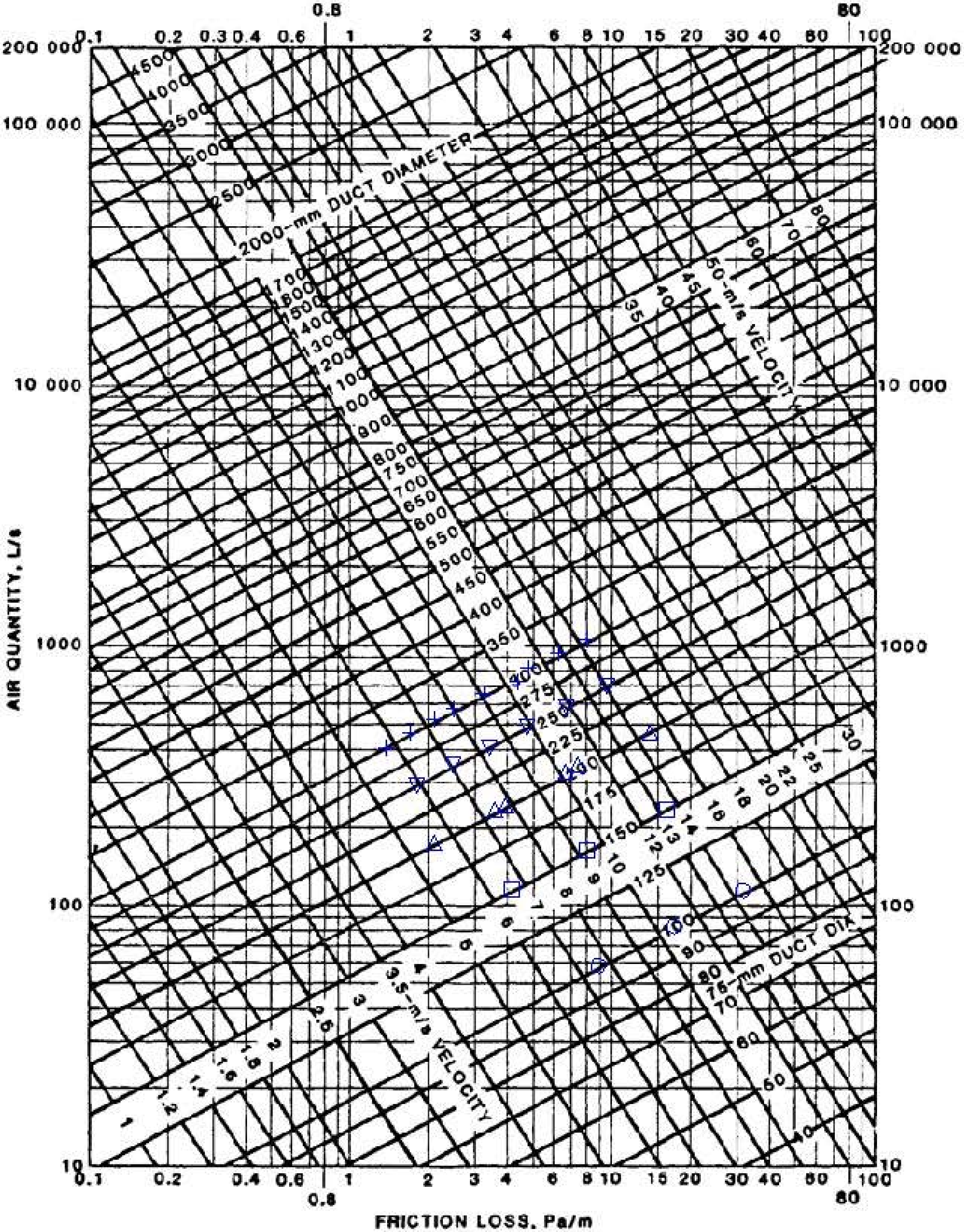


4" Pipe

Friction loss [Pa/m]	Air quantity [L/s]
8.717	59.45
16.96	83.4
31.23	115.2

6" Pipe

Friction loss [Pa/m]	Air quantity [L/s]
4.081	118.0
7.813	165.5
15.94	235.9

8' Pipe

Friction loss [Pa/m]	Air quantity [L/s]
2.049	177.7
3.516	235.9
3.862	247.4
6.58	331.1
7.341	355.5
13.84	471.9

10" Pipe

Friction loss [Pa/m]	Air quantity [L/s]
1.752	294.3
2.434	355.5
3.329	412.8
4.661	494.9
6.58	588.7
9.355	710.8

12" Pipe

Friction loss [Pa/m]	Air quantity [L/s]
1.353	412.8
1.672	471.9
2.065	531.4
2.453	579.2
3.2	662.4
4.243	745.4
4.697	825.8
6.131	944.0
7.813	1062.0

Mechanical Engineers' Handbook (2nd Edition)

Friction Loss

Pressure Loss Calculations | **Done by:** CJ | **Checked by:** JVB
Date: 12/17/2008 | **Date:** 12/17/08

Goal:

1. Calculate pressure loss for the vapor extraction piping at "worst case" scenario.
   (i.e., from furthest extraction sump to where the combined header exits the basement wall at the extraction system).

Assumptions:

1. Normal vapor flow is 175 cfm per sump.
2. Air temperature at 60°F, so the specific weight is 0.07636 lb/ft^3.
3. The ceiling is 10 ft high.

Line Description	q (CFM)	Pipe/Duct ID (IN)	a (FT^2)	v (FT/SEC)	Selected pipe/tube/duct	Vacuum Loss (IWG/100 FT)	Length (FT)	Minor Loss Coefficient (ξ)	Vacuum Loss (IWG)
1 sump	175	3.998	0.08714	33	4" SCH 40 PVC	2.08	48.5		1.010
3 90° bend	175	3.998	0.08714	33	4" SCH 40 PVC			1.3	0.997
1 enlargement	175	n/a	n/a	33	n/a			0	0.000
1 sump	175	3.998	0.08714	33	6" SCH 40 PVC	0.26	83		0.216
1 Tee	175	6.031	0.19828	15	6" SCH 40 PVC			0.3	0.015
2 sumps	350	6.031	0.19828	29	6" SCH 40 PVC	0.96	96		0.917
1 minor bend	350	6.031	0.19828	29	6" SCH 40 PVC			0.025	0.005
2 90° bend	350	6.031	0.19828	29	6" SCH 40 PVC			1.3	0.514
2 45° bend	350	6.031	0.19828	29	6" SCH 40 PVC			0.5	0.198
1 enlargement	350	n/a	n/a	29	n/a			0.18	0.035
1 Tee	175	3.998	0.08714	33	4" SCH 40 PVC			0.3	0.077
3 sumps	525	7.942	0.34385	25	8" SCH 40 PVC	0.48	133		0.635
2 90° bend	525	7.942	0.34385	25	8" SCH 40 PVC			1.3	0.384
4 45° bend	525	7.942	0.34385	25	8" SCH 40 PVC			0.5	0.296
1 Tee	525	7.942	0.34385	25	8" SCH 40 PVC			0.3	0.044
4 sumps	700	7.942	0.34385	34	8" SCH 40 PVC	0.81	56		0.453
3 90° bend	700	7.942	0.34385	34	8" SCH 40 PVC			1.3	1.025
1 enlargement	700	n/a	n/a	34	n/a			0.13	0.035
1 Tee	175	3.998	0.08714	33	4" SCH 40 PVC			0.3	0.077
5 sumps	875	9.976	0.54253	27	10" SCH 40 PVC	0.40	47		0.190
1 90° bend	875	9.976	0.54253	27	10" SCH 40 PVC			1.3	0.214
1 enlargement	875	n/a	n/a	27	n/a			0.09	0.015
1 Tee	875	9.976	0.54253	27	10" SCH 40 PVC			0.3	0.049
								TOTAL	7.336

Lower Explosive Limit

Vapor Standard Motor Products Inc.	"WORST CASE" Explosive Vapor Calculation for volatile compounds in water						
PARAMETER: CONTAMINANT	Maximum Concentr'n in site water (ug/l)	Water Solubility mg/l	Vapor Pressure (torr)	Henry's Law Constant (atm m3/mol)	Lower Explosive Limit % of air	Saturation Concentr'n in Air (ppm)	Saturation Concentr'n in Air % of LEL
Acetone	21.	1.E+6	231.	3.97E-05	2.6	.01	0.0
Benzene	410.	600.	95.2	5.55E-03	1.3	28.41	0.2
Carbon Disulfide	1.6	1,190.	358.	1.44E-02	1.3	.3	0.0
Carbon Tetrachloride		793.	115.	2.76E-02	1000		
Chlorobenzene	.85	498.	12.	3.77E-03	1.3	.03	0.0
Chloroform	7.1	7,950.	197.	3.67E-03	1000	.22	0.0
1-2, Dichlorobenzene	9.9	156.	1.36	1.90E-03	2.2	.13	0.0
1-4,Dichlorobenzene	2.	76.	1.	2.40E-03	2.2	.03	0.0
1,1-Dichloroethane	2,300.	5,060.	227.	5.62E-03	5.4	130.62	0.2
1,2-Dichloroethane		8,524.	78.9	1.18E-03	6.2		
1,1-Dichloroethene	13.	2,250.	600.	2.61E-02	6.5	3.5	0.0
1,2-Dichloroethene	1,700.	3,500.	201.	4.08E-03	9.7	71.55	0.1
Ethyl Benzene	1,800.	169.	9.6	7.88E-03	1	133.6	1.3
Ethyl Chloride		5,680.	1,010.	1.11E-02	3.8		
Methyl Chloride		5,320.	4,300.	8.82E-03	8.1		
Methyl Ethyl Ketone	11.	223,000.	95.3	5.69E-05	1.4	.01	0.0
Methylene Chloride	150.	13,000.	435.	3.25E-03	14	5.74	0.0
Naphthalene	260.	31.7	.082	4.83E-04	0.9	.98	0.0
Propane		62.4	7,150.	.707	2.2		
Styrene		310.	6.4	2.75E-03	1.1		
Tetrachloroethane		2,960.	4.62	3.76E-04	1000		
Tetrachloroethylene	92.	200.	18.6	1.77E-02	1000	9.82	0.0
Toluene	640.	526.	28.4	6.64E-03	1.2	46.12	0.4
1,1,1-Trichloroethane	3,100.	1,500.	124.	1.72E-02	8	399.67	0.5
Trichloroethylene	2,300.	1,100.	69.	9.85E-03	8	172.43	0.2
Vinyl Chloride	41.	8,800.	2,980.	2.78E-02	3.6	18.24	0.1
Xylenes	6,000.	168.	8.	6.68E-03	1	377.51	3.8
	18,859.45				Total Vapor	1,398.91	
					% of LEL for the mixture		6.8

Appendix E
Equipment Data Sheets and Information

- Roots URAI 711 Blower
- Calgon HFVS2000 VPGAC Unit
- March MDK-MT3 Pump
- Carbonair PC1 LPGAC Unit

Roots URAI 711 Blower

SPECIFICATIONS

ROOTS™ UNIVERSAL RAI® Rotary Positive Displacement Blowers

Frames 22 thru 718

BASIC BLOWER DESCRIPTION

Universal RAI blowers are heavy duty blowers designed with detachable rugged steel mounting feet that permit easy in-field adaptability to either vertical or horizontal installation requirements.

Because of the detachable mounting feet, these units can be easily adapted to any of four drive shaft positions - right hand, left hand, bottom or top. The compact, sturdy design is engineered for continuous service when operated in accordance with speed and pressure ratings.

The basic model consists of a cast iron casing and cast iron involute impellers. Carburized and ground alloy steel spur timing gears are secured to the steel shafts with a taper mounting and locknut. Oversized antifriction bearings are used, with a cylindrical roller bearing at the drive shaft to withstand V-belt pull. The Universal RAI features thrust control, with splash oil lube on the gear end and grease lube on the drive end. After standard tests, the unit is sprayed with a protective paint and boxed or placed on skids.

Available accessories include driver, relief valve, inlet and discharge silencers, inlet filter, check valve, extended base, v-belt or flexible coupling and drive guards.

STRONGEST WARRANTY IN THE INDUSTRY

ROOTS™ Universal RAI® blowers are warranted for two years plus an additional 6 months for shipping and construction where required. ROOTS synthetic oil assures top performance and warranty acceptance for lubricants.

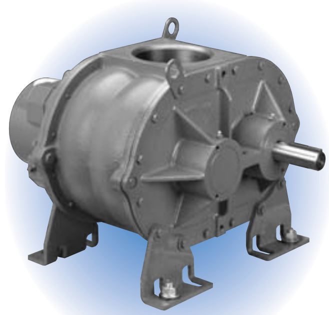
Vertical Drive End

DESIGN AND CONSTRUCTION FEATURES

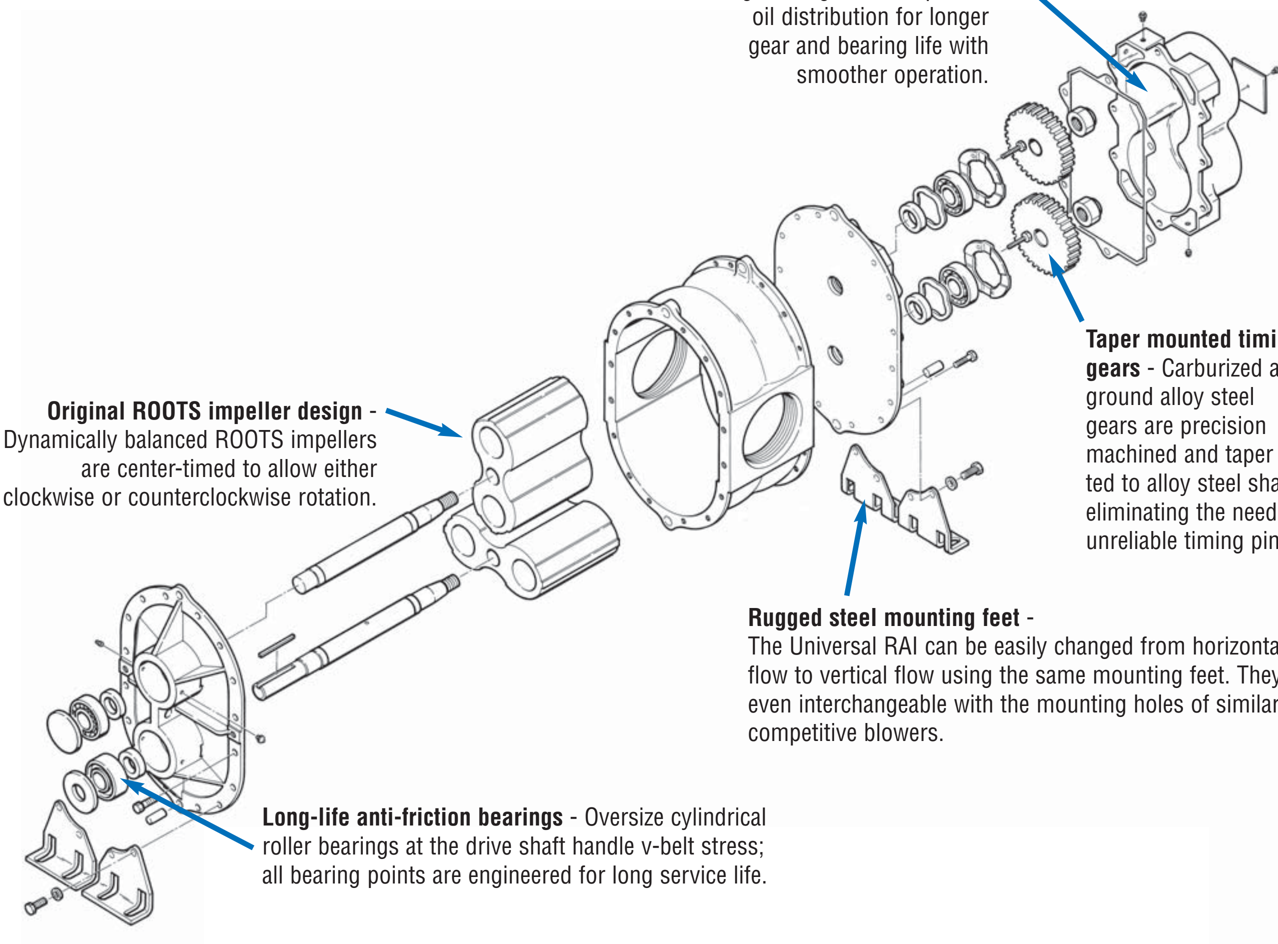
- Steel detachable mounting feet
- Rigid one-piece cast iron casing
- Anti-friction bearings
- Thrust control
- Splash oil lubricated spur timing gears
- Connections in standard pipe sizes
- Balanced, precision machined bi-lobe impellers
- Ground steel shafts

Vertical Gear End

Horizontal Gear End



Horizontal Drive End



Exclusive gearbox design - "Figure 8" gearbox improves oil distribution for longer gear and bearing life with smoother operation.

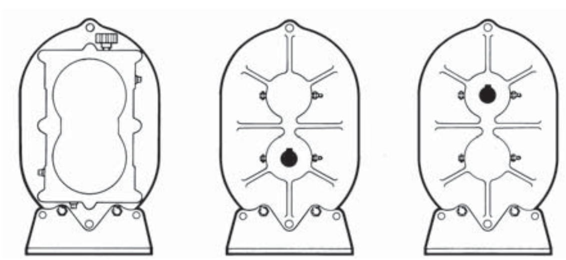
Original ROOTS impeller design - Dynamically balanced ROOTS impellers are center-timed to allow either clockwise or counterclockwise rotation.

Taper mounted timing gears - Carburized and ground alloy steel gears are precision machined and taper fitted to alloy steel shafts, eliminating the need for unreliable timing pins.

Rugged steel mounting feet - The Universal RAI can be easily changed from horizontal flow to vertical flow using the same mounting feet. They're even interchangeable with the mounting holes of similar competitive blowers.

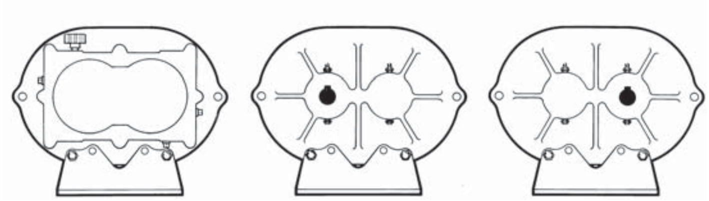
Long-life anti-friction bearings - Oversize cylindrical roller bearings at the drive shaft handle v-belt stress; all bearing points are engineered for long service life.

Versatile mounting - You can mount the Universal RAI in multiple positions to accommodate your specific needs. With your choice of 17 frame sizes, there's a URAI that fits right into your OEM or replacement application.



Vertical Gear End | **Drive Shaft Bottom** | **Drive Shaft on Top**

Vertical Mounting (Horizontal Air Flow)

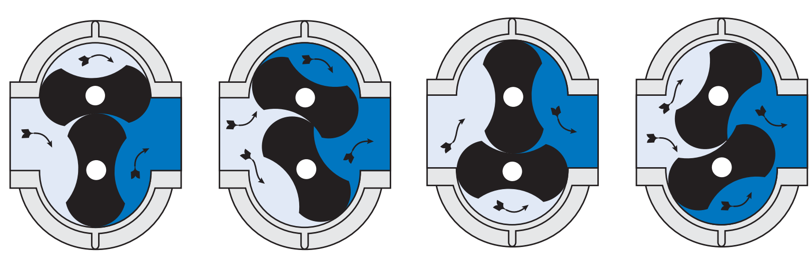


Horizontal Gear End | **Drive Shaft on Left** | **Drive Shaft on Right**

Horizontal Mounting (Vertical Air Flow)

BI-LOBE OPERATING PRINCIPLE

Two figure-eight lobe impellers mounted on parallel shafts rotate in opposite directions. As each impeller passes the blower inlet, it traps a finite volume of air and carries it around the case to the blower outlet, where the air is discharged. With constant speed operation, the displaced volume is essentially the same regardless of pressure, temperature or barometric pressure. Timing gears control the relative position of the impellers to each other and maintain small but finite clearances. This allows operation without lubrication being required inside the lobe cavity.

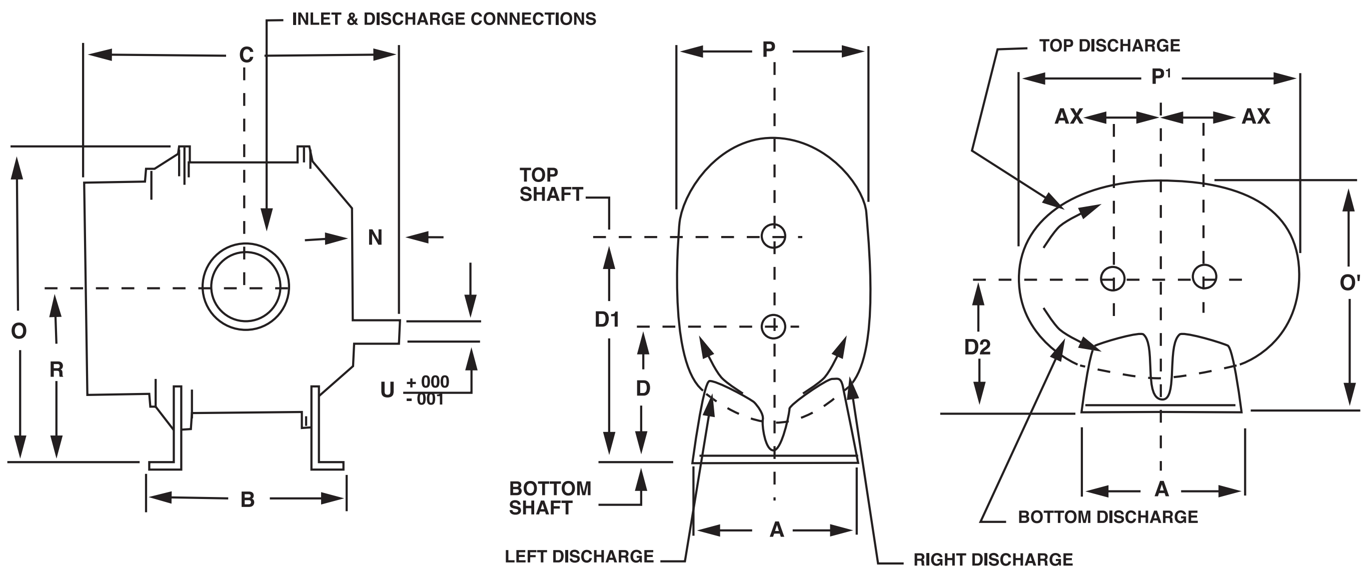


URAI BLOWER PERFORMANCE

Frame Size	Speed RPM	1 PSI		6 PSI		7 PSI		10 PSI		12 PSI		13 PSI		14 PSI		15 PSI		Max. Vacuum		
		CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	“HGV	CFM	BHP
	1160	10	0.1															4	6	0.2
22	3600	49	0.3	38	1.6	36	1.8	32	2.6	29	3.1							14	28	1.8
	5275	76	0.5	64	2.4	63	2.7	59	3.8	56	4.6							15	53	2.8
	1160	24	0.2															6	12	0.5
24	3600	102	0.6	83	3.1	81	3.6											14	69	3.5
	5275	156	0.9	137	4.6	135	5.4											15	119	5.5
	1160	40	0.2	21	1.4	19	1.6											10	18	1.1
32	2800	113	0.6	95	3.4	93	3.9	86	5.6	82	6.7	81	7.2	79	7.8	77	8.3	15	78	4.1
	3600	149	0.9	131	4.4	129	5.2	122	7.3	118	8.7	117	9.4	115	10.1	113	10.8	16	110	5.3
	1160	55	0.3	31	1.9	28	2.2											10	27	1.5
33	2800	156	0.9	132	4.6	129	5.4	120	7.7	116	9.2							14	113	5.2
	3600	205	1.2	181	6.1	178	7.0	170	9.9	165	11.9							15	159	7.3
	1160	95	0.5	61	3.1	57	3.6											10	55	2.5
36	2800	262	1.5	229	7.7	224	8.9											12	213	7.5
	3600	344	2.1	310	10.1	306	11.7											15	278	12.1
	860	38	0.2	18	1.4	15	1.6											8	19	0.9
42	1760	92	0.5	72	2.8	69	3.3	62	4.7	58	5.6							14	56	3.2
	3600	204	1.4	183	6.1	181	7.1	173	9.9	169	11.8	167	12.8	165	13.7	163	14.7	16	160	7.7
	860	79	0.5	42	2.7	37	3.2											8	46	1.8
45	1760	188	1.0	151	5.7	146	6.6	133	9.4									12	134	5.5
	3600	410	2.7	374	12.2	369	14.1	356	19.8									16	332	15.4
	860	105	0.6	59	3.6	53	4.2											8	63	2.4
47	1760	249	1.3	203	7.5	196	8.7											12	181	7.3
	3600	542	3.5	496	16.1	490	18.6											15	452	19.1
	700	72	0.4	42	2.4	38	2.8											10	36	2.0
53	1760	211	1.2	181	6.3	177	7.3	167	10.3	160	12.3	157	13.3	155	14.4			14	158	7.1
	2850	355	2.5	325	10.7	321	12.3	310	17.2	304	20.5	301	22.1	298	23.8	295	25.4	16	291	13.4
	700	123	0.7	78	4.1	72	4.7											10	70	3.3
56	1760	358	2.0	312	10.5	306	12.2	290	17.3	280	20.6	276	22.3					14	276	11.8
	2850	598	4.0	553	17.7	547	20.5	531	28.7	521	34.2	517.0	37.0					16	501	22.4
	700	187	1.0	130	5.9													8	135	3.9
59	1760	529	2.9	472	15.3	464	17.8											12	445	14.9
	2850	881	5.9	824	26.0	816	30.0											15	770	30.8
	700	140	0.8	93	4.5	86	5.3	70	7.5									12	71	4.4
65	1760	400	2.4	353	11.9	347	13.8	330	19.4	320	23.2	316	25.1	311	27.0	307	28.9	16	300	15.2
	2350	546	3.8	499	16.4	492	19.0	475	26.5	466	31.6	461	34.1	457	36.6	452	39.1	16	445	25.6
	700	224	1.2	149	7.3	139	8.5											10	135	5.9
68	1760	643	3.7	567	18.9	557	21.9	530	31.0	515	37.0	507	40.1	500	43.1			15	495	22.7
	2350	876	5.6	801	25.9	790	29.9	763	42.1	748	50.2	740	54.2	733	58.3			16	715	32.8
	700	420	2.3	279	13.6	260	15.9											8	292	8.9
615	1760	1205	6.6	1063	34.9	1044	40.6											12	997	33.9
	2350	1641	9.7	1500	47.6	1481	55.2											14	1389	53.4
	575	192	1.1	134	6.1	126	7.1	105	10.2									12	117	6.0
76	1400	527	3.0	468	15.4	460	17.8	439	25.3	427	30.2	421	32.7	415	35.1	410	37.6	16	413	19.7
	2050	790	5.3	731	23.4	723	27.0	702	37.9	690	45.1	684	48.7	679	52.4	673	56.0	16	674	29.5
	575	362	1.9	271	11.1	258	13.0	226	18.6									12	228	10.9
711	1400	970	5.2	880	27.7	867	32.2	835	45.7									15	793	33.5
	2050	1450	8.8	1359	41.8	1347	48.4	1315	68.2									16	1256	53.1
	575	600	3.1	470	18.1													10	446	14.8
718	1400	1590	8.1	1460	44.8													12	1398	43.6
	2050	2370	13.3	2240	66.9													12	2178	64.7

Notes:
1. Performance based on inlet air at standard pressure of 14.7 psia, standard temperature of 68° F, and specific gravity of 1.0.
2. Vacuum ratings based on inlet air at standard temperature of 68°F, discharge pressure of 30” Hg and specific gravity of 1.0.

OUTLINE DRAWING & DIMENSIONS



VERTICAL CONFIGURATION

HORIZONTAL CONFIGURATION

Universal RAI® Blower Dimensions

Frame Size	A	B	C	Drive Shaft Location D	D1	D2	N	O	O1	P	P1	R	U	Keyway	Inlet & Disch. Dia.	AX	Approx. Net Wt. (lbs.)
22	5.13	5.00	9.75	3.75	6.25	3.75	2.50	9.63	6.88	6.25	9.25	5.00	.625	.188 x .094	1.0 NPT	1.25	32
24	5.13	7.00	11.75	3.75	6.25	3.75	2.50	9.63	6.88	6.25	9.25	5.00	.625	.188 x .094	2.0 NPT	1.25	43
32	7.25	6.75	11.25	5.00	8.50	5.00	2.44	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	1.25 NPT	1.75	69
33	7.25	7.63	12.13	5.00	8.50	5.00	2.44	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	2.0 NPT	1.75	74
36	7.25	10.00	14.63	5.00	8.50	5.00	2.56	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	2.5 NPT	1.75	102
42	8.00	7.25	13.00	6.25	10.25	6.25	3.18	15.06	10.63	8.75	13.63	8.25	.875	.188 x .094	1.5 NPT	2.00	88
45	8.00	10.00	15.50	6.25	10.25	6.25	2.94	15.06	10.63	8.75	13.63	8.25	.875	.188 x .094	2.5 NPT	2.00	109
47	8.00	11.75	17.63	6.25	10.25	6.25	3.31	15.06	10.50	8.50	13.63	8.25	.875	.188 x .094	3.0 NPT	2.00	128
53	10.50	8.38	15.38	6.25	11.25	6.75	3.68	17.38	11.88	10.25	17.25	8.75	1.125	.250 x .125	2.5 NPT	2.50	143
56	10.50	11.00	18.00	6.25	11.25	6.75	3.38	17.38	12.25	11.00	17.25	8.75	1.125	.250 x .125	4.0 NPT	2.50	170
59	10.50	14.00	21.18	6.25	11.25	6.75	3.88	17.38	12.25	11.00	17.25	8.75	1.125	.250 x .125	4.0 NPT	2.50	204
65	11.00*	10.00	18.38	8.75	14.75	8.75	3.56	21.63	15.13	12.75	19.75	11.75	1.375	.312 x .156	3.0 NPT	3.00	245
68	11.00*	13.00	21.38	8.75	14.75	8.75	3.69	21.63	15.13	12.75	19.75	11.75	1.375	.312 x .156	5.0 NPT	3.00	285
615	11.00*	20.00	28.38	8.75	14.75	8.75	3.69	21.63	16.25	15.00	19.75	11.75	1.375	.312 x .156	6.0 FLG	3.00	425
76	14.00**	11.75	19.94	11.00	18.00	11.00	4.06	26.13	20.69	19.38	23.25	14.50	1.562	.375 x .188	4.0 NPT	3.50	400
711	14.00**	16.75	25.19	11.00	18.00	11.00	4.31	26.13	19.50	17.00	23.25	14.50	1.562	.375 x .188	6.0 FLG	3.50	530
718	14.00**	23.75	32.19	11.00	18.00	11.00	4.31	26.13	19.50	17.00	23.25	14.50	1.562	.375 x .188	8.0 FLG	3.50	650

*17.00 in horizontal configuration
**21.00 in horizontal configuration

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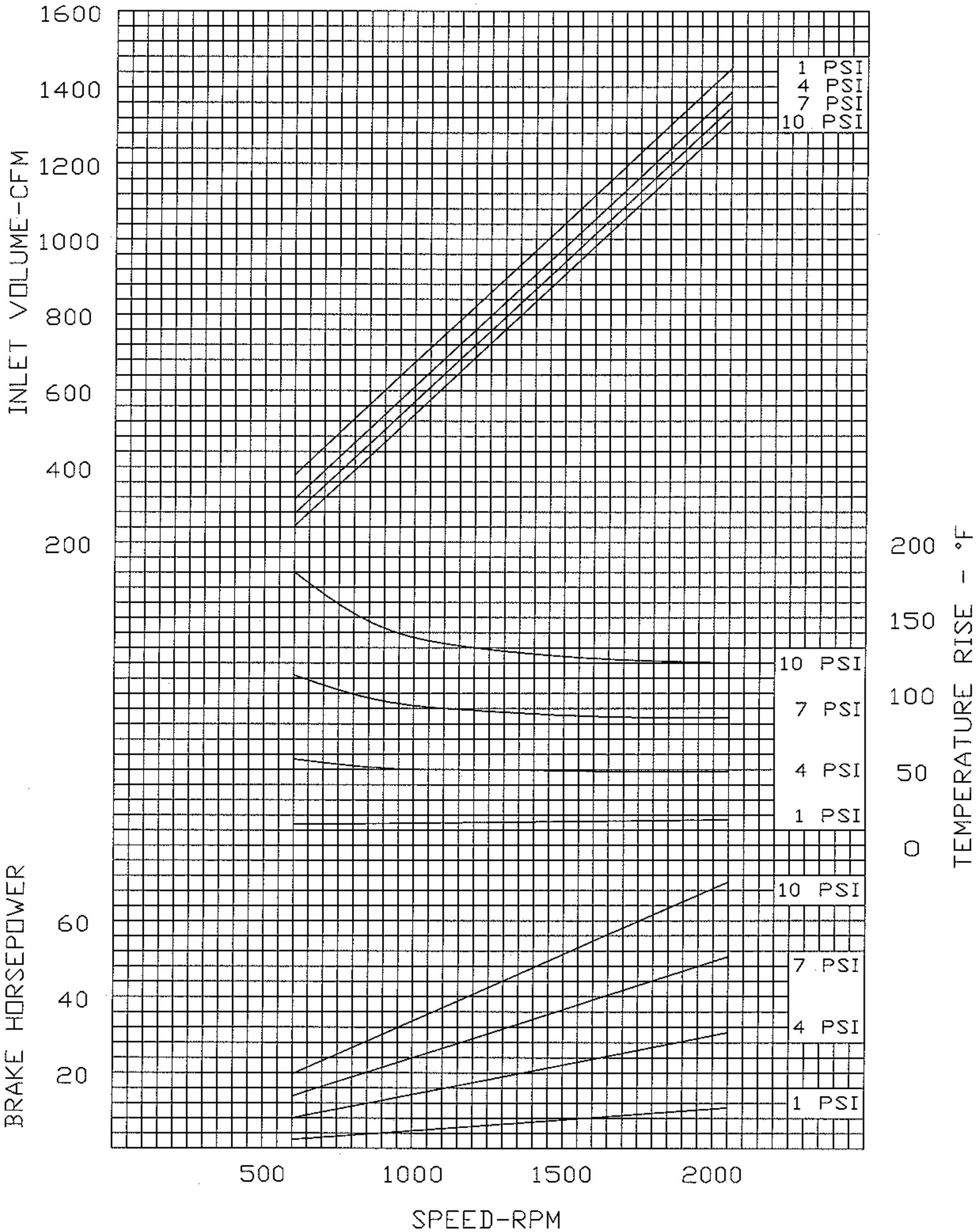
FRAME 711 UNIVERSAL RAI BLOWER
MAXIMUM PRESSURE RISE=10 PSI
MAXIMUM SPEED=2050 RPM



/PARTS2/CRVE

PC-12-711

Calgon HFVS2000 VPGAC Unit

CALGON
CALGON CARBON CORPORATION

Making Water and Air Safer and Cleaner

HIGH FLOW VENTSORB®

Emission Control Unit

Description

Calgon Carbon Corporation's High Flow VENTSORB® (HFVS) emission control units were developed to utilize granular activated carbon to treat air/vapor containing VOC emissions from a variety of applications at industrial, commercial, or remedial sites.

There are four sizes available to treat airflows up to 3,000 cfm. These units are designed to allow selection of the optimum size to economically solve air treatment needs. The units are constructed with features that allow for ease of installation and operation.

The HFVS units are available in four sizes: 500 cfm, 1,000 cfm, 2,000 cfm, and 3,000 cfm. The units are constructed of carbon steel with an internal epoxy lining and external coating.

Specification and Standard Features

Vessel Material:	Carbon Steel
Vessel Lining:	Epoxy
Vessel Exterior:	Epoxy
Manway:	One (1) 20" diameter manway on top of the unit for GAC loading with Buna-N Gasket
Temperature Rating:	Maximum continuous operating temperature 140°F, with excursions to 200°F
Pressure Rating:	3 psig
Vacuum Rating:	HFVS not rated for vacuum
Underdrain:	Style: False Bottom
Drain:	1/2" Plugged Drain Coupling
Connection:	Flanged Inlet/Outlet Nozzles, drilled to ANSI 150 lb. pattern

Model	Maximum Air Flow Capacity cfm	Carbon Capacity pounds	Shipping Weight pounds
HFVS500	500	500	1,100
HFVS1000	1,000	1,000	2,000
HFVS2000	2,000	2,000	3,700
HFVS3000	3,000	3,000	5,500

Features and Benefits

Easy to Install

The HFVS is fitted with supports for ease of off-loading and positioning near the emission source using a fork truck.

Ready to Use

The units are delivered pre-loaded with GAC to minimize labor costs for set-up.

Optimum Design

The HFVS units are designed to optimize the amount of GAC installed in each unit taking into consideration the air flow requirements, available space, and low system pressure drop.

Reusable Unit

When the GAC in the HFVS is spent and cannot remove additional contaminants, it can be easily removed and refilled using the large 20" diameter manway installed on top of the unit.

Corrosion Resistant

The HFVS units are constructed of epoxy lined and painted carbon steel with a stainless steel bed support.

Effective Treatment of a Wide Variety of Contaminants

The HFVS can be filled with different types of GAC to provide treatment tailored to specific requirements.

Continuous Treatment

The HFVS unit works 24 hours per day to remove contaminants from air emissions regardless of fluctuations of air flow rate.

Flexibility to Meet a Variety of Needs

The HFVS unit requires relatively little space. When necessary, the units can be installed side by side then piped for either series or parallel operation.

Equipment and Systems

Visit our website at **www.calgoncarbon.com**, or call 800-422-7266 to learn more about our complete range of products and services, and obtain local contact information.

HIGH FLOW VENTSORB®

Emission Control Unit

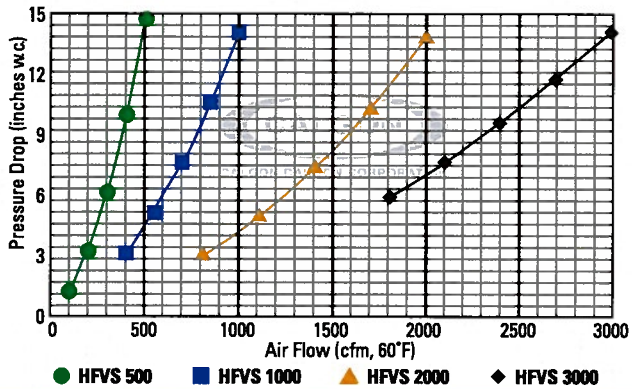
HFVS Installation

The HFVS units are shipped ready for installation. The unit can be moved using a fork truck and should be placed as near as possible to the emission source. After placement, remove the manway and check that the GAC is level (it may shift during shipment).

Connect from the emission source to the bottom inlet connection on the HFVS using flexible hose, lightweight ductwork, or pipe. Connect the discharge piping to the upper outlet connection.

The maximum recommended airflow is listed in the Specifications section of this bulletin. If higher flows are required, another unit should be added in parallel. The unit operates upflow, so high airflow rates above the maximum listed could expand the bed, causing premature breakthrough.

HFVS Series Vapor Adsorber
AP4-60 Pellet Carbon



Pressure drop is based on using AP4-60 type carbon, which is a 4mm pellet. For other types of GAC, the pressure drop should be adjusted. For BPL® 4x10, multiply the pressure drop by 1.5. For VPR 4x10, multiply the pressure drop by 1.6.

Special Considerations

When the HFVS is used to control vapors from an organic solvent storage tank, the following precautions are recommended:

- A safety relief valve must be provided. This protects the storage tank should the HFVS become plugged or blocked in any fashion. Such a vent would open in this emergency situation, thereby relieving pressure.
- Under appropriate conditions a flame arrestor and/or a backflow preventer must be installed as shown. This prevents backflow of air when the storage tank is empty.
- Pre-wetting the carbon helps dissipate excessive heat that may be caused by high organic concentrations (>0.5 to 1 Vol%).

When the HFVS is used to control organic emissions from air strippers or other high moisture sources, Calgon Carbon recommends that humidity in the air stream be reduced to less than 50%. Lower humidity optimizes adsorption capacity of the GAC. Also, a condensate drain trap should be installed on the drain connection to carry away any moisture that collects in the unit.

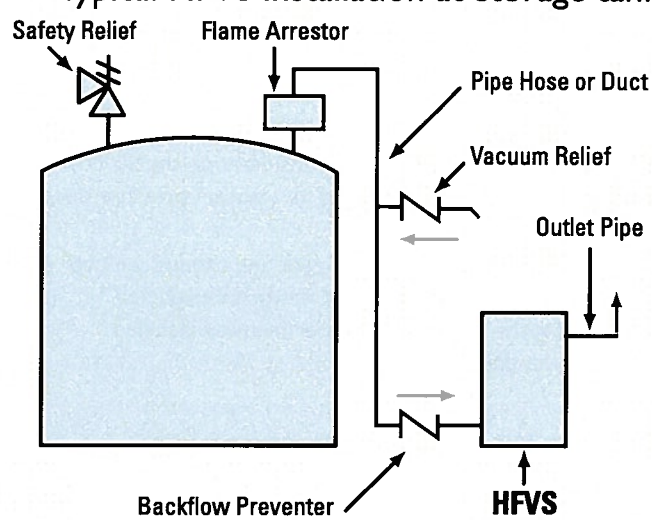
Carbon Replacement

For an estimate of carbon bed life, contact your local sales representative.

When it has been determined that the carbon is spent (no longer adsorbs the target compounds), it is time to replace the carbon. Follow these steps to replace the spent carbon with fresh carbon.

1. Isolate the HFVS by either disconnecting the ductwork or by closing the inlet and outlet valves.
2. Open the manway and remove the spent carbon by vacuuming or by bucket to the appropriate storage containers. If the unit must be entered to access spent carbon, take the appropriate safety measures for confined space entry. Refer to the safety message on this bulletin.
3. When all the spent carbon is removed, inspect the bed support for signs of damage.
4. Refill the unit with fresh carbon by loading it through the manway. After each bag is loaded into the vessel, level the surface using a rake or similar device.
5. Replace the manway and reconnect the ductwork.

Typical HFVS Installation at Storage tank



ES-EB1027-1004

HIGH FLOW VENTSORB®

Emission Control Unit

Spent Carbon Return

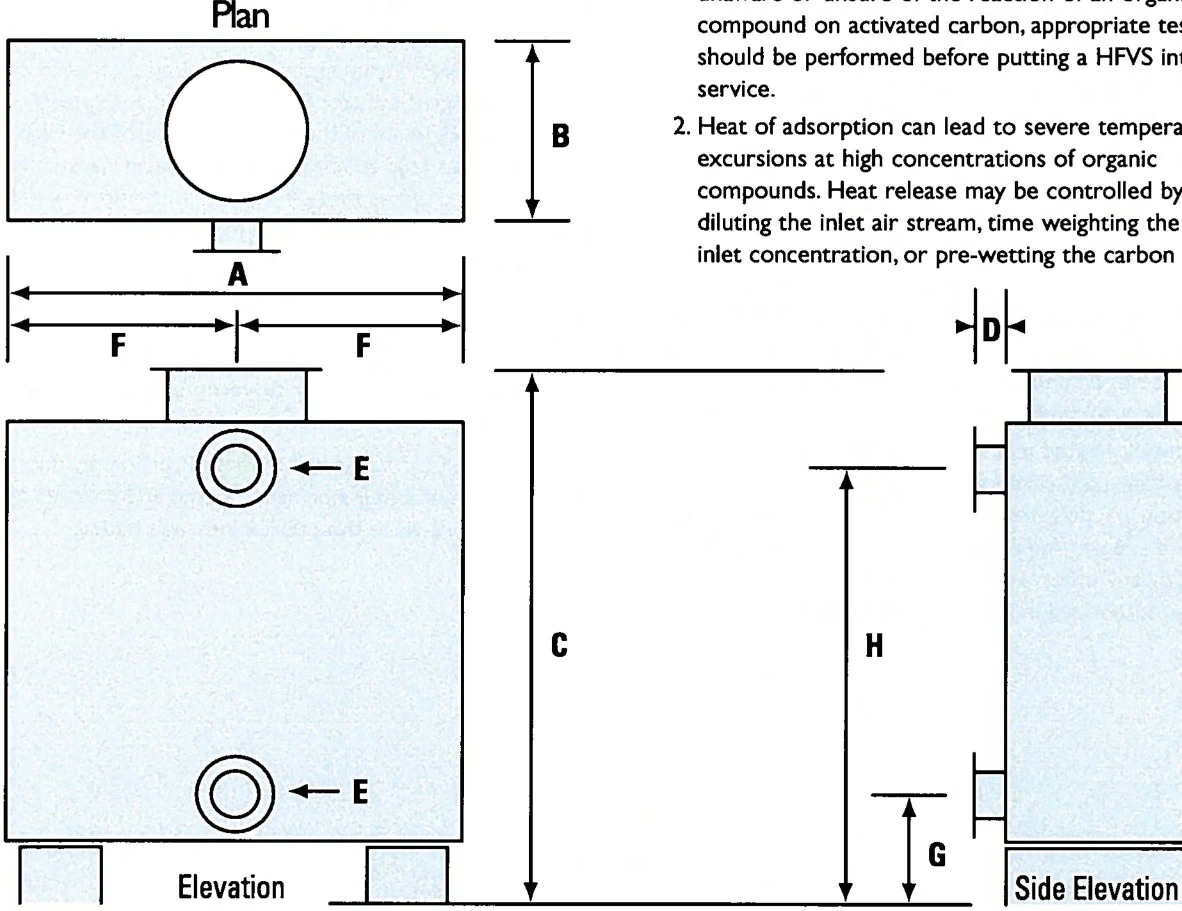
Spent carbon can be returned to Calgon Carbon for reactivation after the carbon acceptance procedure is complete. Contact your local representative for detailed instructions and to arrange for carbon acceptance testing. It is recommended that you start the carbon acceptance testing before change-out to minimize handling of the spent carbon. This should be done when ordering fresh carbon.

Saftey Considerations

While complying with recommended installation instructions, operators should also be aware of these additional heat related safety considerations:

1. When GAC adsorbs some types of chemical compounds, such as those in the ketone, aldehyde, organic acid, or organic sulfur families, the chemical may react on the carbon surface causing severe exotherm or temperature excursions. If you are unaware or unsure of the reaction of an organic compound on activated carbon, appropriate tests should be performed before putting a HFVS into service.
2. Heat of adsorption can lead to severe temperature excursions at high concentrations of organic compounds. Heat release may be controlled by diluting the inlet air stream, time weighting the inlet concentration, or pre-wetting the carbon bed.

HFVS Dimensional Data



HFVS Dimensional Data								
	Width	Depth	Canister Height	Nozzle Length	Inlet/Outlet Nozzle Diameter	Nozzle Position	Inlet Nozzle Height	Outlet Nozzle Height
Model	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
HFVS 500	36″	24″	66″	3″	6″	18″	10″	57 5/16″
HFVS 1000	45″	39″	68″	3″	8″	22 1/2″	10″	58 5/16″
HFVS 2000	72″	48″	76″	3″	12″	36″	11 1/2″	64 3/8″
HFVS 3000	72″	72″	79″	3″	14″	36″	12 1/2″	67″

HIGH FLOW VENTSORB®

Emission Control Unit

Warranty

Calgon Carbon Corporation (Seller) warrants that the High Flow VENTSORB® sold shall be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. This warranty does not apply to problems associated with normal wear and tear, improper maintenance, negligence, misuse, or the failure to operate in strict accordance with the operating and maintenance plan provided. For those items provided by, but not directly manufactured by the Seller, the manufacturer's warranty shall apply provided warranty coverage exceeds that which is provided by the Seller. All other warranties, either express or implied, are hereby disclaimed including, but not limited to, the warranty of merchantability and fitness for a particular purpose.

Seller warrants that any/all activated carbon provided hereunder shall conform to the specifications for such grade as published from time to time by the Seller. There are no warranties made with regard to the activated carbon or equipment to be sold hereunder other than those contained in this paragraph or stated elsewhere in the proposal. All other warranties, either express or implied, are hereby disclaimed including, but not limited to, the warranty of merchantability and fitness for a particular purpose.

This warranty is limited to the replacement and/or repair by the Seller of any part, parts or material, which in the Seller's determination are defective. This warranty does not cover any charges by the Buyer for replacement of parts, adjustments or repairs, or any other work unless such charges shall be assumed or authorized in advance in writing by the Seller.

Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all Federal and State requirements.

Limitation of Liability

Seller's liability and the Purchaser's exclusive remedy for any cause of action arising out of purchase and use of the High Flow VENTSORB® including, but not limited to, breach of warranty, negligence and/or indemnification, is expressly limited to a maximum of the purchase price of the High Flow VENTSORB® as sold. All claims of whatsoever nature shall be deemed waived unless made in writing within forty-five (45) days of the occurrence giving rise to the claim. In no event shall the Seller for any reason or pursuant to any provision of these warranties be liable for incidental or consequential damages, or damages in excess of the purchase price of the High Flow VENTSORB®, nor shall the Seller be liable for loss of profits or fines imposed by Governmental agencies.

Calgon Carbon Corporation's activated carbon products and services are continuously being improved and changes may have taken place since this publications was issued.

Visit our website at **www.calgoncarbon.com**

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CALGON CARBON CORPORATION

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Chemviron Carbon

European Operations of Calgon Carbon Corporation
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B-7181 Feluy, Belgium
Tel: + 32 (0) 64 51 18 11
Fx: + 32 (0) 64 54 15 91

Your local office

ES-EB1027-1004

March MDK-MT3 Pump

MARCH PUMPS
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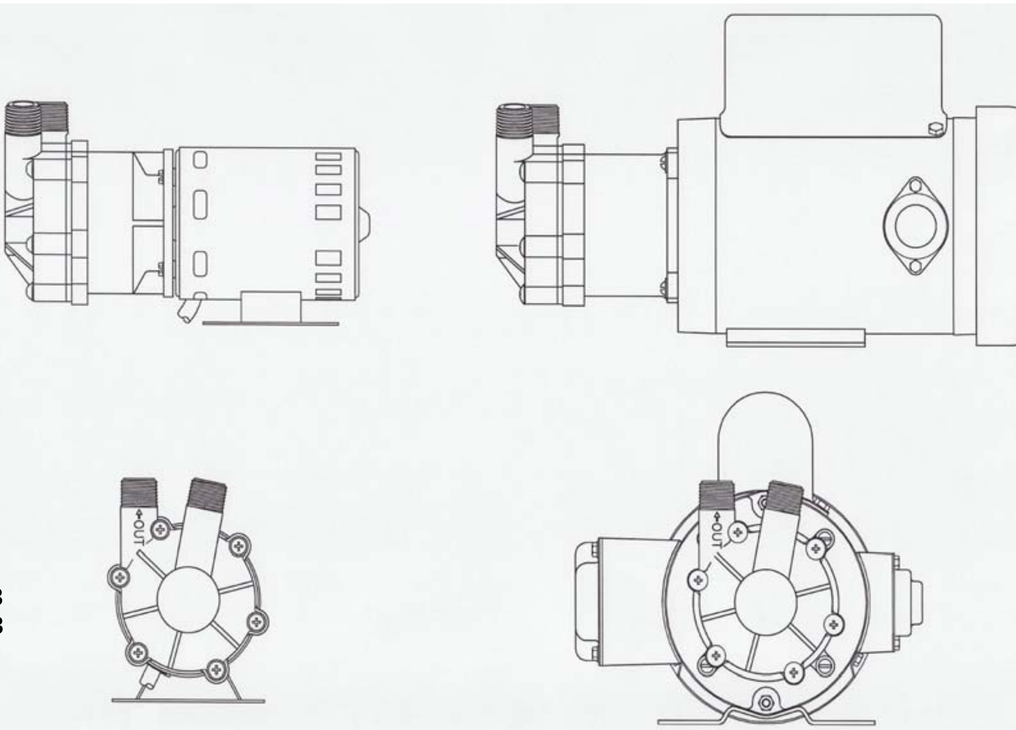
PHONE: (847) 729-5300 - FAX: (847) 729-7062
WWW.MARCHPUMP.COM

INSTRUCTIONS & REPAIR PARTS FOR MODELS
MDX-MT3, MDK-MT3, TE-MDX-MT3, TE-MDK-MT3

MODEL
MDX-MT3
MDK-MT3



MODEL
TE-MDX-MT3
TE-MDK-MT3

RATINGS & SPECIFICATIONS															
MODEL NO.	RPM @ 115v	MOTOR			DIMENSIONS			PSI GAGE	MAX HEAD	GALLONS PER MIN.					WEIGHT PACKED
		H.P.	WATTS	AMPS	HT.	WD.	LG.			1 FT.	3 FT.	6 FT.	9 FT.	15 FT.	
TE-MDX-MT3 TE-MDK-MT3	3450	1/15	130	.86/.43	7-1/4"	8-1/16"	12-1/2"	7.3	17 FT.	10.0	9.5	8.7	7.7	4.2	10 lbs.
MDX-MT3 MDK-MT3	3400	1/25	110	1.35	4-7/8"	3-3/4"	9-1/16"	7.0	16 FT.	8.0	7.2	6.4	5.5	2.0	6-1/2 lbs.

PUMP CONSTRUCTION & SERVICING

March "ORBITAL" Magnetic Drive Pumps eliminate the conventional shaft seals found in most pumps. This means that there is no rotating seal to wear and allow the liquid being pumped to leak out. There are only two areas in this type construction that rotate and could wear out. One area is the motor shaft and bearings. The second area is the impeller-magnet assembly rotating on a stationary spindle, and hence these are the only two areas where wearing can occur.

All parts can be easily serviced and replaced in the field if necessary with the use of a screwdriver. See the Repair Parts List for necessary replacement items.

All ratings are based on pumping water. Depending on the pumping conditions, some liquids heavier than water may cause the magnetic coupling to slip. Contact the factory if this occurs for special instructions. The inlet and outlet ports are ½" M.P.T. threads.

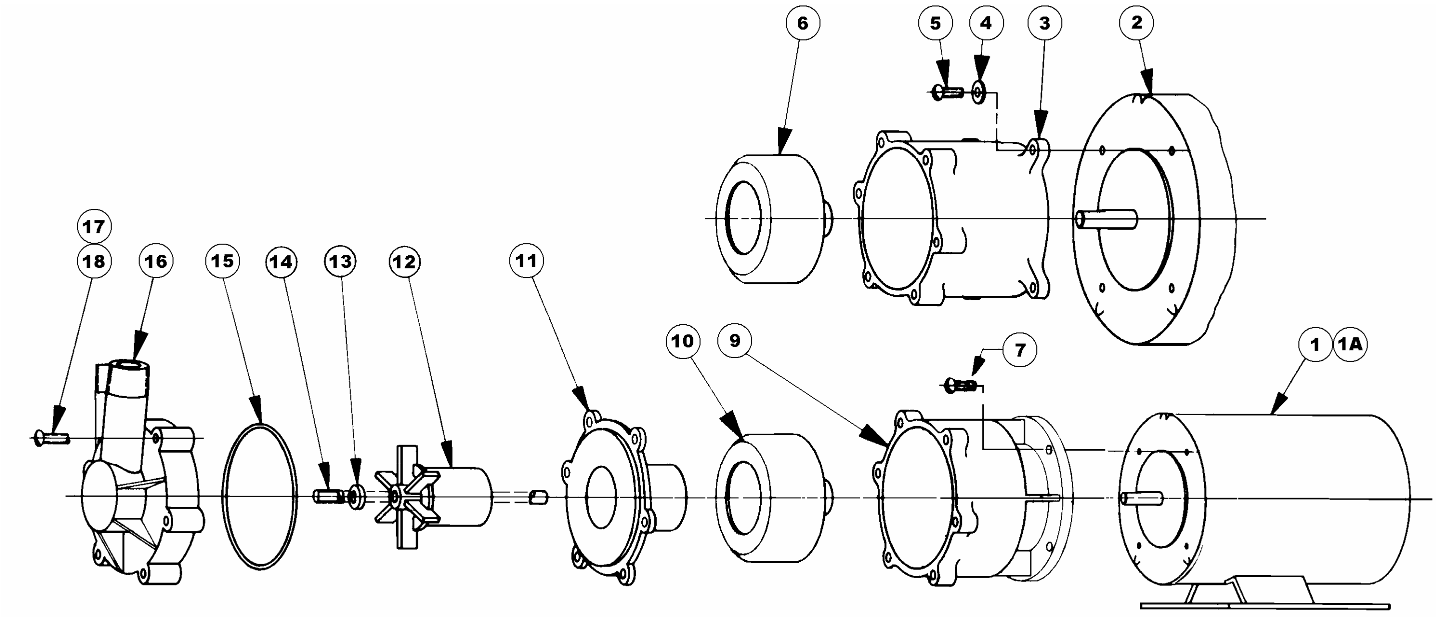
PUMP MATERIALS

The 3 plastic parts in contact with the liquid are molded out of Ryton®, or Kynar® Plastic. The motor bracket is molded out of glass filled Polypropylene on the TE-MDX-MT3, and black glass filled Noryl on the MDX-MT3. The "O" ring gasket is Viton® "A" rubber. The stationary spindle and thrust washer are chemical resistant ceramic. Contact the factory for other materials available on special order.

ELECTRICAL & OPERATION

The MDX-MT3 motor is open, fan-cooled, 115 volt, 50/60 cycle, 1 phase A.C.—230 volt motors are available.
The TE-MDX-MT3 motor is totally enclosed, 115/230 volt, 50/60 cycle, 1 phase A.C. Wiring instructions are located on the motor label. Both motors are U.L. recognized.

Pumps are not self priming and will not produce a suction lift and must be installed with a positive flooded suction. The pumps should not be run dry for more than 30 seconds as the plastic impeller will squeal and may bind on the stationary spindle.



REPAIR PARTS LIST				
ITEM	**DESCRIPTION**	**QTY.**	**PART NO.**	**USED IN**
1	Motor, 115 Volt, 50/60 Hz	1	0135-0114-1000	MDX-MT3 & MDK-MT3
1A	Motor, 230 Volt, 50/60 Hz	1	0135-0136-1000	MDX-MT3 & MDK-MT3
2	Motor, 115/230 Volt, 50/60 Hz Totally Enclosed	1	0135-0148-1000	TE-MDX-MT3 & TE-MDK-MT3
3	Motor Connecting Bracket	1	0135-0089-0100	TE-MDX-MT3 & TE-MDK-MT3
4	Washer #8	4	0135-0016-1000	TE-MDX-MT3 & TE-MDK-MT3
5	Screw #8-32 x 5/8"Lg	4	0618-0027-1000	TE-MDX-MT3 & TE-MDK-MT3
6	Drive Magnet Assembly	1	0130-0043-0300	TE-MDX-MT3 & TE-MDK-MT3
7	Screw #8-32 x 1/2"Lg	4	0135-0169-1000	MDX-MT3 & MDK-MT3
9	Motor Connecting Bracket	1	0135-0135-0100	MDX-MT3 & MDK-MT3
10	Drive Magnet Assembly	1	0130-0043-0100	MDX-MT3 & MDK-MT3
11A	Housing Rear (Ryton®)	1	0135-0087-1000	MDX-MT3 & TE-MDX-MT3
11B	Housing Rear (Kynar®)	1	0135-0153-1000	MDK-MT3 & TE-MDK-MT3
12A	Impeller Encapsulated Assembly (Ryton®)	1	0135-0113-0200	MDX-MT3 & TE-MDX-MT3
12B	Impeller Encapsulated Assembly (Kynar ®)	1	0135-0154-0200	MDK-MT3 & TE-MDK-MT3
13	Thrust Washer (Ceramic)	1	0130-0028-1000	ALL
14	Shaft (Ceramic)	1	0130-0024-1000	ALL
15	"O" Ring (Viton®)	1	0135-0046-1000	ALL
16A	Housing Front (Ryton®) ½" MPT	1	0135-0088-1000	MDX-MT3 & TE-MDX-MT3
16B	Housing Front (Kynar®) ½" MPT	1	0135-0152-1000	MDK-MT3 & TE-MDK-MT3
17A	Screw #10-32 x 1-1/8"Lg	6	0135-0181-1000	MDX-MT3 & MDK-MT3
17B	Screw #10-32 x 1-1/2"Lg	6	0823-0008-1000	TE-MDX-MT3 & TE-MDK-MT3
18	Washer #10	6	0150-0051-1000	MDX-MT3 & MDK-MT3

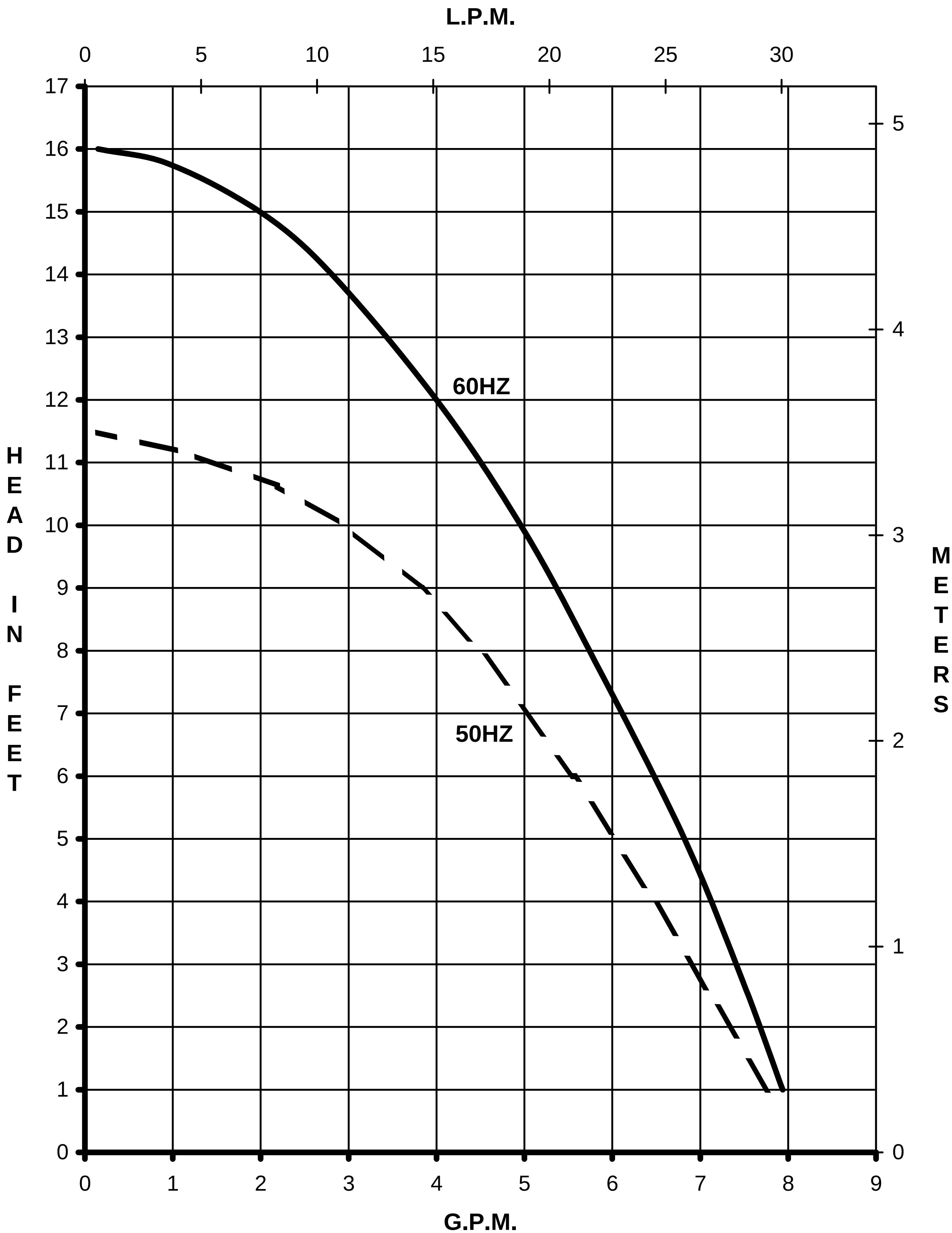
Contact factory for other materials and/or parts not listed.

LIMITED WARRANTY

March pumps are guaranteed only against defects in workmanship or materials for a period of one year from date of manufacture pumping water. On all other solutions, contact the factory for applicaton assistance. March Pump Application Worksheet 750-130-10 is available for additional warranty information.

MARCH PUMPS

MDX-MT3 (115V 50/60HZ) (230V 50/60HZ)
MDK-MT3 (115V 50/60HZ) (230V 50/60HZ)



Carbonair PC1 LPGAC Unit

Mobile Water Treatment Services

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Modeling and Design Services

STAT Low-Profile Air Strippers

COWS Oil/Water Separators

Used Equipment

IMP Customer Log In

Liquid Phase Granular Activated Carbon Filters

Carbonair's PC Series, MPC Series, and LPC Series liquid phase activated carbon filters are designed for the removal of dissolved contaminants from a liquid stream. With flow ranges up to 550 gpm and carbon capacities from 90 to 20,000 pounds, Carbonair can design a granular activated carbon system to meet your needs

Click here for specifications for our fiberglass PC Series, steel PC Series, MPC Series, and LPC Series of liquid phase carbon filters.

PC Series Activated Carbon Filters

Carbonair's PC Series activated carbon filters are designed and manufactured in accordance with engineering standards set forth by the American Society of Mechanical Engineers (ASME). The materials used in construction are in accordance with standards established by AWWA, FDA and EPA.

PC Series Carbon Filter Specifications

Model >	PC1	PC3	PC5	PC7	PC13	PC20	PC28	PC50	PC78
Diameter	1'-2"	2'-0"	2'-6"	3'	4'	5'	6'	8'	10'
Height (feet)	3'-4'	4'-11'	7'-3"	7'-7"	8'-4"	8'-5"	12'-5"	13'-3"	17'-7"
Bed Area (square feet)	1.1	2.4	4.9	7	12.6	19.5	28	50	78.5
Nominal Flow Rate (gpm)	10	20	50	75	100	150	250	300	550
Carbon Capacity (pounds)	90	250	500	1000	1500	2500	5000	10,000	20,000
Connections	1" NPT	1" NPT	2" FL	2" FL	2" FL	3" FL	4" FL	6" FL	6" FL
Design Pressure (psi)	150	150	90	90	90	75	75	75	75
Weight Empty (pounds)	23	80	780	980	1230	1800	3150	8100	10,900
Weight Loaded (pounds)	113	330	1280	1980	2730	4300	8150	18,100	30,900
Operating Weight (pounds)	290	805	2670	3670	6150	9200	17,450	40,600	75,600
Drained Weight (pounds)	225	650	1900	3230	4600	7400	14,400	30,520	55,750

Applications

We offer full service application support, from equipment sizing, carbon usage modeling, activated carbon analysis, on-site carbon change-out, filter exchange and spent carbon

Standard Features

- Reinforced fiberglass construction (PC1, 3, 5F, & PC7F)
- Polyethylene liner (PC1, 3, 5F, & PC7F)

recycling. Typical applications include:

- Groundwater remediation
- Wastewater filtration
- Drinking water treatment
- Temporary water treatment
- Underground tank clean-up
- Leachate treatment
- Spill clean-up

- Welded steel construction (PC5 through PC78)
- Double-coated corrosion resistant epoxy interior (PC5 through PC78)
- PVC or stainless steel internals
- Large carbon slurry lines (PC5 through PC78)
- Dual access ports (PC5 through PC78)

Optional Components

- External piping kits
- Flexible hose kits
- Pressure gauge/sample port kits
- Quick connect kits
- ASME stamped (steel vessels only)
- Automatic backwash controls

MPC Series Activated Carbon Filters

Carbonair's MPC Series activated carbon filters are high quality filters ideal for groundwater remediation, particularly in applications where the filters must be moved periodically.

MPC Series Activated Carbon Filter Specifications

Model >	MPC5	MPC7	MPC13	MPC20	MPC28
Diameter	30"	36"	48"	60"	72"
Height	7'-4"	7'-4"	7'-0"	7'-3"	9'-10"
Bed Area (sq ft)	4.91	7.07	12.57	19.63	28
Nominal Flow Rate (gpm)	50	75	100	150	250
Carbon Capacity (lbs)	500	1,000	1,500	2,500	5,000
Fittings (in, out)	2"	2"	2"	3"	4"
Design Pressure (psi)	90	90	90	75	75
Empty Weight (lbs)	780	980	1230	1800	3150
Loaded Weight (lbs)	1280	1980	2730	4300	8150
Operating Weight (lbs)	2675	3670	6150	9200	17,450
Spent & Drained Weight (lbs)	1900	3230	4600	7400	14,400

Standard Features

- Medium-pressure vessel
- Quick installation
- Welded steel construction
- 90 psi (75 MPC20 and MPC28) maximum design pressure
- 12" x 16" elliptical manway
- Fork tubes for easy lifting
- Bolt down lugs
- 3/4" drain coupling
- PVC hub and lateral distributor
- Polyamide epoxy interior lining
- Polyamide epoxy/urethane exterior finish

Optional Components

- External piping kit
- External sample/gauge kit
- Influent/Effluent quick connect kit
- Additional manway
- Influent/Effluent sample & pressure kit
- Quick connect industrial hose
- Sample ports
- Flow instrumentation
- Automatic backwash controls

LPC Series Activated Carbon Filters

Carbonair's LPC Series activated carbon filters are typically used in gravity discharge or low pressure water treatment applications. The materials used in construction are in accordance with standards established by AWWA, FDA and EPA.

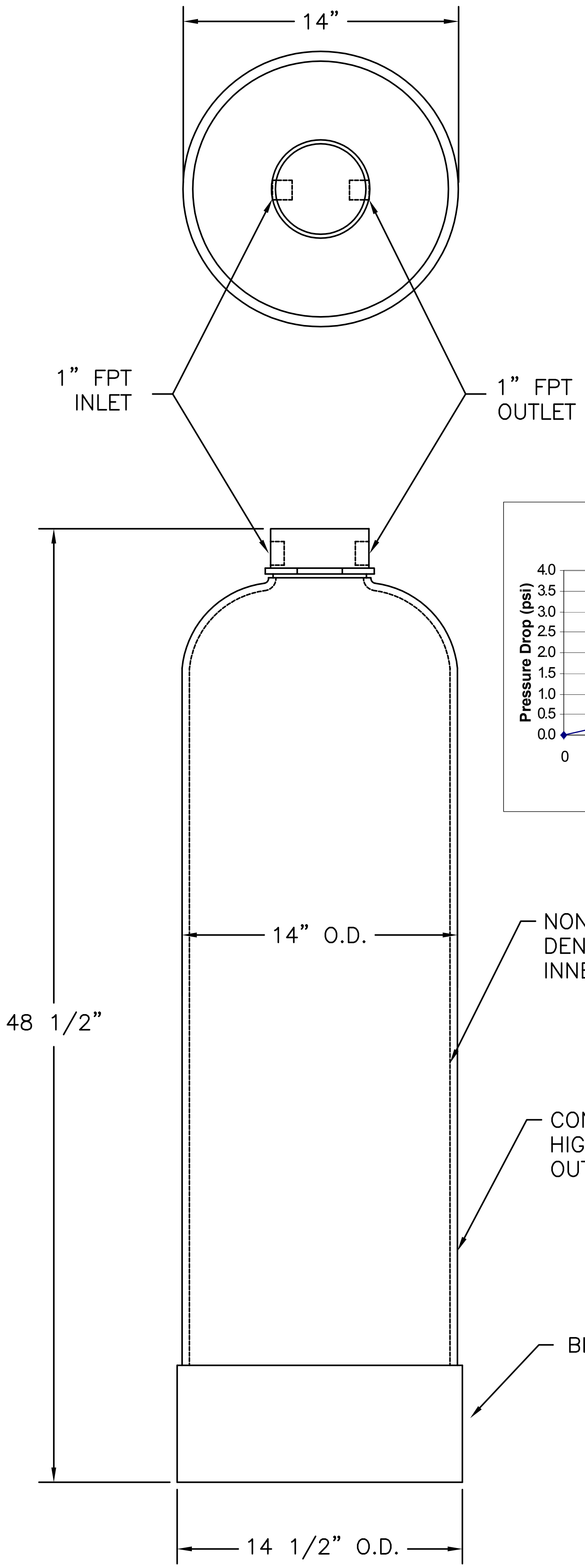
LPC Series Activated Carbon Filter Specifications

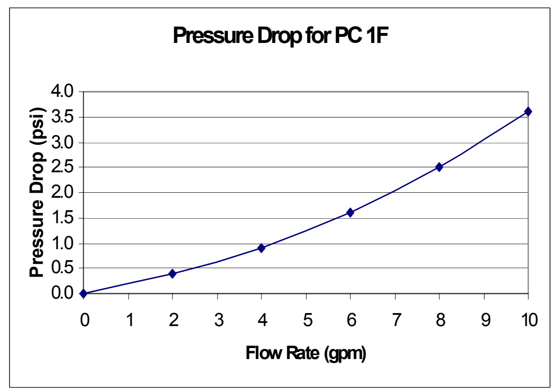
Model >	LPC3	LPC3.85
Diameter	24.5"	30"
Height	2.8'	3'-6"
Bed Area (sq feet)	2.6	3.68
Flow Range (gpm)	1-10	1-13
Carbon Capacity (pounds)	200	250
Fittings	1" NPT	1.5" NPT
Design Pressure (psi)	10	5
Empty Weight (pounds)	50	100
Loaded Weight (pounds)	250	350
Operating Weight (pounds)	423	725
Drained Weight (pounds)	355	600

Standard Features

- Low-pressure vessel
- 55-gallon steel drum (LPC3 and LPC3.85)
- Quick installation
- Welded steel construction
- 15 psi maximum design pressure

CARBON ADSORBER– LIQUID PHASE
PC–1F





Sales Drawing #107463
02/18/05