SVE/SP PILOT STUDY REPORT

WORK ASSIGNMENT C007540-4.1

FORMER KLINK COSMO CLEANERS SITE
GREENPOINT/EAST WILLIAMSBURG
INDUSTRIAL AREA

SITE NO. 224130
KINGS (C) NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Basil Seggos, Acting Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
Remedial Bureau B

URS Corporation
257 West Genesee Street, Suite 400
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March 2016

SOIL VAPOR EXTRACTION / AIR SPARGE PILOT STUDY REPORT

FOR THE

FORMER KLINK COSMO CLEANERS SITE

EAST WILLIAMSBURG INDUSTRIAL AREA

SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
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REMEDIAL BUREAU B
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PREPARED BY:

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MARCH 2016

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1.0 INTRODUCTION

URS conducted a soil vapor extraction / air sparge (SVE/SP) pilot study at the former Klink Cosmo Cleaners Site (Site No. 224121) in Brooklyn, New York, between November 16th and 19th, 2015. This report summarizes the results of the pilot study, and assesses the effectiveness of SVE/SP as a viable remedial alternative for treating subsurface contaminants.

1.1 Objectives

The objectives of the SVE Pilot Study were to:

- Demonstrate mass reduction of tetrachloroethene (PCE) and trichloroethene (TCE) and estimate PCE and TCE mass removal rates via semi-quantitative and quantitative means.
- Develop SVE design parameter values including radius of influence (ROI), intrinsic permeability (k_i), locations and depths of extraction wells, system and extraction flow rates, and vacuum pressures.

The objectives of the SP Pilot Study were to:

- Develop SP design parameter values, locations and depths of sparge wells, including air injection flow rates and pressures.

2.0 PILOT PROGRAM

The pilot study was conducted between November 16th through 19th, 2015, along the south side of Richardson Street near the intersection of Vandervoort Avenue. Step and constant rate tests were performed at various vacuum pressures to determine its impact on the formation. The pilot study generally followed the procedures provided in the New York State Department of Environmental Protection (NYSDEC) approved SVE/SP Pilot Study Work Plan, dated September 2015 (included in Attachment A as a compact disk). Deviations to the approved plan are presented in Sections 3.1 and 3.2.

As part of the pilot study, two SVE wells (4-inch diameter), three SP wells (2-inch diameter), and four pairs of soil vacuum observation wells (OWs, 1-inch diameter) were constructed. The locations of the pilot study wells are shown on Figure 1. Boring logs and well construction diagrams for these wells are provided in Attachment A.

A trailer mounted SVE/SP treatment system (Unit 75), rented from ProAct Services Corporation of Southbury, Connecticut and was used for the pilot study. Components of the SVE/SP treatment system included:

- SVE – a 15 horsepower (HP) rotary claw blower, capable of 300 actual cubic feet per minute (acfm) with a maximum vacuum of 23 inches of mercury (Hg)

- SVE vacuum manifold equipped with vacuum and flow indicators, throttling valves, hoses and cam-lock connectors

- SP – a 15 HP rotary claw blower, capable of 125 standard cubic feet per minute (scfm) at 22 pounds per square inch (psi)

- SP manifold equipped with pressure and flow indicators, throttling valves, hoses and cam-lock connectors

A vapor-phase carbon adsorption system, installed outside near the treatment unit, was used to treat collected soil vapors prior to discharge to the atmosphere. The vapor phase system consisted of two parallel trains of two 200 pound (lb) 55-gallon drums constructed in series, with sampling points. Evoqua Water Technologies of Elizabeth, New Jersey provided the vapor phase carbon drums.

The treatment unit required a three-phase 230V, 200A electrical service. This was provided by a commercial 75 kilowatt (kW) trailer-mounted diesel generator rented from a local vendor. A plan view of the treatment system, equipment specifications, piping and instrumentation diagrams (P&IDs) for the SVE and SP systems are included in Attachment A.

2.1 SVE Scope of Work

A series of fifteen 30-minute stepped-vacuum tests were to be performed at various pressures followed by a 2-hour constant-vacuum test at the maximum achievable vacuum pressure. The stepped-vacuum testing was to be performed on well SVE-1 first, SVE-2 second, and finally, SVE-1 and SVE-2 simultaneously, until the maximum obtainable vacuum pressure was achieved (design maximum vacuum was 23 inches Hg).

The constant-rate test was to be performed on wells SVE-1 and SVE-2 simultaneously, at the maximum achievable vacuum pressure.

Soil vapor samples were to be collected in summa canisters before carbon treatment at the beginning and end of each stepped and constant flow rate test for laboratory analysis to quantitatively determine contaminant removal.

The planned sequence for conducting the SVE pilot study is detailed in the SVE/SP Pilot Study Work Plan. Because of system operating issues and time constraints not all sequences were performed.

2.2 SP Scope of Work

The SP pilot study was to be conducted following the SVE pilot study. A series of twenty-six 30-minute stepped-flow rate tests were to be performed at various air flow rates followed by a 2-hour constant-rate test at a single flow rate. Air was to be introduced through SP wells while SVE-1 and SVE-2 were both operating simultaneously at their maximum achievable vacuums.

Air sparge was to be initially applied in one SP well at a time. SP-1 was to be applied first, followed by SP-2, and then SP-3. Air sparge was then to be applied to two wells at a time. Wells SP-1 and SP-2 were to be applied first, followed by SP-1 and SP-3, and then SP-2 and SP-3. Finally, air sparge was to be introduced through wells SP-1, SP-2, and SP-3 simultaneously.

Constant-flow rate air sparge testing was to be performed through SP wells SP-1, SP-2, and SP-3 simultaneously while wells SVE-1 and SVE-2 were simultaneously operating at their maximum achievable vacuum pressures.

The planned sequence for conducting the SP pilot study is detailed in the SVE/SP Pilot Study Work Plan. Because of health/safety concerns for employees working in the adjacent building, time constraints, system operating issues, and unknown radius of influence created by the SVE system, not all sequences were performed.

3.0 PILOT STUDY

URS mobilized to the site on Monday, November 16th, 2015. The treatment unit was set up on the south side of Richardson Street between monitoring wells DEC-031 and DEC-044D. An initial start-up and shortened SVE step test was conducted at SVE-2 beginning at 1720 hours to see how the unit performed. Following set up, step tests were performed by incrementally raising the vacuum pressure by opening the valve at the vacuum manifold. Data collected during the pilot study that was used in the calculations is presented in Attachment B – SVE/SP Pilot Study Calculations.

3.1 SVE Pilot Study Procedures

Field data collected during the pilot study is presented in Table 1 – Pilot Study Field Data Summary. A total of five SVE step tests (Tests 1, 2, 3, 9, and 10) were performed. Test 1 was conducted at SVE-1 between 1930 and 2210 on November 16th. The initial test, performed on SVE-2 at 1720 on November 16th, appears as Test 2 in Table 1.2 - Pilot Study Field Data Summary. Test 3, performed on SVE-2 on November 16th was conducted between 2225 and 0044 (November 17). Tests 9 and 10, conducted on November 19th, were performed on SVE-1 and SVE-2, respectively.

During these tests, vacuum pressures were increased four times by throttling the valve inside the treatment system's vacuum manifold. Vacuum pressure measured inside the treatment unit at the vacuum extraction manifold that induced a vacuum at the SVE wells ranged between 2 inches Hg to 7.5 inches Hg (the maximum achievable vacuum) depending on the SVE well location and combined operation. The maximum vacuum pressure observed at the vacuum extraction manifold was well under the rated maximum value (23 inches Hg) of the SVE blower; possibly due to leaking hoses, piping, manifold connections and/or constraints attributed to the stratigraphy of the formation.

During the SVE tests, four rounds of data were collected at 10 to 12 minute intervals. Vacuum pressures were monitored and recorded inside the treatment unit at the vacuum extraction manifold, extraction wells (SVE-1 & SVE-2), observation wells (OW-1, OW-1D, OW-

2, OW-2D, OW-3, OW-3D, OW-4, & OW-4D), and monitoring wells (DEC-31, DEC-44, & DEC-141).

The volume of air extracted (standard cubic feet per minute – scfm) was also recorded during each monitoring interval. A planned step test with SVE-1 and SVE-2 was not performed as the throttling valve used to bring the vacuum pressure up incrementally could not be adjusted in small enough increments to balance the system and accurately record vacuum pressures; even while manipulating the make-up air.

Constant rate tests (Tests 7 and 11) were performed with SVE-1 and SVE-2 under full vacuum. Data were collected at approximately10-minute intervals only during Test 11. No incremental gauge readings were collected during Test 7 a purge run prior to initiating SP. Gauge readings were only collected at the beginning and end of Test 7 for use in the mass removal estimate.

While conducting the constant rate test on November 18, 2015, vacuum pressures at SVE-1 ranged from 2.5 to 3 inches Hg and from 0.5 to 2 inches Hg in SVE-2. During the constant rate test performed on November 19, 2015, the vacuum pressures in SVE-1 ranged from 1.25 to 1.5 inches Hg and from 2.5 to 2.75 inches Hg in SVE-2.

Summa canisters were collected near the beginning and end of each test, shipped to Pace Analytical Services, Inc. of Melville, NY, and analyzed for volatile organic compounds (VOCs) following USEPA Method TO-15.

Analytical data collected during the pilot study are presented in Table 2 – Soil Vapor Extraction Pilot Test Analytical Data. Semi-quantitative measurements of VOCs in the extracted soil gas were also made periodically with a photoionization detector (PID) and flame ionization detector (FID). PID/FID readings are provided on Table 1 – Pilot Study Field Data Summary.

3.2 SP Pilot Study Procedures

Three air sparge step-tests (Tests 4, 5 and 6) were performed on November 17th. Step tests were performed with SP-2 (Test 4) and SP-3 (Test 5) online separately and then SP-2 and SP-3 together (Test 6). At the time of the SP study, the capture zone (radius of influence) provided by operating SVE-1 and SVE-2 at their maximum capacity was unknown. As such, SP-1 was not brought online due to its proximity to the source area (northeast corner of the warehouse building) and health/safety concerns regarding potential fugitive PCE and TCE vapors entering the adjacent warehouse building affecting workers.

During the step tests, the air flow rates (scfm) were to be increased incrementally by 25 scfm every 30 minutes by opening the valve inside the treatment system's air supply manifold until the maximum flow rate produced by the compressor (125 scfm at 22 psi) was achieved. Four rounds of data were to be collected at each interval. As such, flow rates were to range between 25 and 125 scfm during each interval for each of the step tests. However, the air sparge compressor could not be adjusted to achieve the planned sequences.

The step test with SP-2 and SP-3 (Test 4 and Test 5) operating separately was not performed as the throttling valve used to increase the air flow could not be adjusted in small enough increments to balance the system and accurately record flow rate; even while manipulating the make-up air. As such, Tests 4 and 5 were conducted using approximately the same air flow rate.

The step test using both SP-2 and SP-3 (Test 6) was somewhat successful as the air flow rate was able to be raised evenly in increments of 5 to 10 scfm. However, pressure readings in the SP wells did not provide sufficient data for use in the calculations. It is unlikely that steady-state conditions were achieved during the pilot study.

The constant rate test was performed on November 18th with SP-2 and SP-3 (Test 8) operating together. Data was collected at approximately 10 minute intervals.

Summa canisters were collected near the beginning and end of each test, shipped to Pace Analytical Services, Inc. of Melville, NY, and analyzed for volatile organic compounds (VOCs) following USEPA Method TO-15.

Semi-quantitative measurements of VOCs in the extracted soil gas were also made periodically with a PID and FID. PID/FID readings are provided on Table 1.

4.0 CALCULATIONS

Calculations were performed to determine the following parameters:

- Mass reduction of PCE and TCE
- PCE and TCE mass removal rates
- ROI created by the SVE system
- Intrinsic permeability
- SVE well extraction rates
- SVE well vacuum pressures
- SP injection flow rates
- SP injection pressures

Each parameter is discussed in further detail in the paragraphs below. The data, rationale, and references used to calculate mass removal rates, ROI, k_i, flow rates and pressures are presented in Attachment B.

4.1 <u>Mass Reduction</u>

The mass of VOCs removed during the Pilot Study was calculated quantitatively based on the concentration of VOCs detected at the beginning and end of each test (Table 2), the average flow rate (Table 1), and operating duration recorded during each of the 11 tests (Table 1).

Table 3 – Estimate of Mass Removed during the Pilot Test provides a summary of the data and calculation used to determine the volume of VOCs removed during each of the 11 tests. The total mass removed over the 1476 minutes the treatment unit was operated was 5.13 pounds. The rate of removal = (5.13 lb / 1476 mins) x (60 min/hr) = 0.21 lb/hr, or 5 lb/day.

The percentage of PCE and TCE existing in the average total VOC concentration was calculated for each of the 11 tests and used to determine their mass reduction and mass removal rates. The mass of PCE removed during the pilot study was 5.1 lbs and the mass of TCE removed was 0.017 lbs.

The rate of removal was 4.95 pound/day (or 0.21 lb/hour) for PCE and 0.016 lb/day (or 6.8 x 10^{-4} lb/hour) for TCE. Removal rates are anticipated to decrease over time as contaminant mass is reduced.

Removal rates for VOCs increased approximately 5.9% when the SP system was online as shown on Table 3.

4.2 Radius of Influence (ROI)

The ROI is the furthest distance from the extraction well that soil and soil gas can be successfully treated by SVE. It is determined by placing a vacuum on the extraction well and measuring the vacuum that is achieved in nearby monitoring points, and then extrapolating the distance to a point where there is a slight vacuum. For the purposes of the calculation (Table 4 in Attachment B), the pressure at the farthest ROI distance was set at 1% of the vacuum pressure measured in the operating SVE wells.

Average ROIs, using SVE-1 as the extraction well, range between 31.3 ft to 31.9 ft. The average ROI induced by SVE-1 is approximately 32 ft. Average ROIs, using SVE-2 as the extraction well, range between 37.3 ft to 38.9 ft. The average ROI induced by SVE-2 is approximately 38 ft.

The vacuum contours shown on Figure 2 in Attachment B (SVE-1 operating at 45 inches H_2O) indicate that the ROI extends approximately 64 feet to the west and at least 26 feet to the east with a vacuum pressure of 0.75 inches H_2O at the fringe of the ROI. Figure 3 in Attachment B (SVE-2 operating at 39.5 inches H_2O) indicates that the ROI extends approximately 39 feet to the west and 66 feet to the east with a vacuum pressure of 1 inches H_2O at the fringe of the ROI. If the contours were extrapolated to reflect the 1% SVE well vacuum pressures used in the calculations the line would significantly extend the ROI in both cases.

A graphical estimate was developed in an attempt to predict the limits of the ROI based on gauge readings and distances from the SVE wells. The shaded data presented on Tables 1.9 and 1.10 was used to graphically determine the ROI created by SVE-1 and SVE-2, respectively. Vacuum gauge readings (inches H_2O – y axis) collected from the vacuum pressure monitoring wells (SVE, OW, and DEC wells) were plotted on a semi-log graph with the distance from the extraction well to the monitoring wells (x-axis). Graphically, the ROI is the intersection of the regressed vacuum distribution line, plotted exponentially, and the distance where the vacuum approaches atmospheric conditions. A horizontal line that reflects 1% of the vacuum observed in the extraction well was selected as the point where the vacuum in the formation approaches atmospheric conditions. As shown on the graphs the ROI created by SVE-1 (Figure 2) ranges between 65 and 75 feet and the ROI created by SVE-2 (Figure 3) ranges between 90 and 143 feet.

Based on the vacuum gauge pressure contours presented on Figures 2 and 3 in Attachment B, the calculated values shown in Table 4 in Attachment B, and graphs presented on Figures 2 and 3, URS believes that the ROI developed while operating the SVE system was at least 40 feet.

4.3 Intrinsic Permeability (k_i)

The intrinsic permeability is the measurement for the ability of fluids (groundwater and air) to pass through soils, and is typically used as an indicator to determine the effectiveness of SVE. Intrinsic permeability is a function of soil properties only, whereas hydraulic conductivity is a function of both soil and fluid properties. Using the hydraulic conductivity values provided in the Remedial Investigation Phase II Report, and as shown in Attachment B, k_i was calculated to be 5.55×10^{-8} cm^2. This corresponds to the permeability expected for fill, sand, gravel, and a sandy silt layer observed in the formation above the water table and corresponds to an environment that would be conducive to SVE remediation.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the location of the contaminant source, the nature and extent of contamination, and results of the pilot study, SVE is the preferred remedial technology for source contaminant reduction and URS recommends that it should be evaluated further in combination with other technologies, as part of a feasibility study prepared for this site.

5.2 Recommendations

5.2.1 Conceptual Design Layout for Source Perimeter Treatment

Figure 4 provides a conceptual design layout of SVE and SP wells for treating the contaminant source along the perimeter of the warehouse building. The following paragraphs and Attachment B provide the basis, assumptions, calculations and references used to develop the conceptual design.

5.2.2 Recommended Locations and Depths of Extraction Wells

Based on an ROI of 40 feet, four additional extraction wells will be installed on the sidewalk adjacent to the former Klink Cosmo building to remediate the source area. One of the additional extraction wells will be installed near the intersection of Richardson Street and Vandervoort Avenue, two additional extraction wells will be installed south of the intersection approximately 40 feet away from each other, and the remaining additional extraction well will be installed on Richardson Street between a SVE-1 and SVE-2, drilled on an approximately 15-degree angle to extend beneath the warehouse building (extending approximately 20 feet from the building perimeter). Figure 4 provides the locations of the existing and proposed extraction wells.

The screened interval of the new extraction wells will be increased from 10 to 15 feet as discussed in Attachment B.

5.2.3 Extraction Well Flow Rates

The total treatment area encompassed by the six SVE wells will total approximately 19,175 ft^2 (see Figure 4). Groundwater exists approximately 32 feet below grade. As such the treatment volume is 613,600 cubic feet (ft^3). At a soil porosity of 0.24 and extracting at least two pore volumes per day the vacuum extraction rate is 213 ft^3/ minute.

Assuming that the subsurface conditions are relatively homogenous, each SVE well will be designed to have an extraction flow rate of approximately 35 scfm. At 35 scfm per well, the total extraction rate would be 210 scfm.

5.2.4 Determination of Extraction Well Vacuum

The intrinsic permeability of $5.55x10^{-8}$ cm^2 was used to determine the vacuum pressure at the SVE wells. As shown in Table 5 (Attachment B), the vacuum in the extraction wells should be at least 50.2 inches H_2O.

5.2.5 Air Sparge Flow Rate

As described in Attachment B, the SP system should consist of eight 2-inch diameter wells spaced between 15 to 20 feet. A 3 foot screen length should be used for design of the additional sparge wells since subsurface conditions are relatively uniform in the treatment zone.

Assuming a one pore exchange rate and an SVE extraction rate equal to two times the sparging injection rate, the air sparging flow rate is 100 ft^3/ minute.

Operation of the air sparge system can vary from having all eight wells online or pulsing the system with a few wells online at one time. With all eight wells online, the air sparging rate per well would be 12.5 ft^3/ minute

5.2.6 Sparging Air Pressure

The data shows that the contamination was detected approximately 40 below ground surface (bgs) in wells the shallow aquifer to a maximum of approximately 80 feet bgs the deep aquifer. The air sparging pressure should be maintained between the minimum pressure necessary to induce flow and the pressure at which fracturing occurs. Because contaminants exist in both the shallow and deep aquifers beneath the site, air should be injected in two different zones.

As shown in Attachment B, an acceptable pressure range for the shallow aquifer is 5.4 to 32.8 psig. Injection pressures in the deep aquifer range between 22.6 and 62.0 psig. This exceeds the acceptable pressure range provided in the reference documents.

If the well screen is placed at 75 feet bgs, at the midpoint of DEC-031D, P_{min} would be 18.3 psig and $P_{fracture}$ would be 54.8 psig. The range of P_{min} for treating the shallow and deep aquifer is 5.4 to 18.3 psi (top of screen for deep aquifer set at 75 feet bgs). This is in the range of acceptable values for air sparge pressure. Actual operation of the air sparge system would warrant treatment of the shallow and deep aquifer to be conducted separately due to the fracture pressure when treating the shallow aquifer.

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.1 - PILOT STUDY FIELD DATA SUMMARY

Well: **SVE-1 Stepped Rate Test**
Date: 11/16/2015
Personnel: MG, JL

Test 1

Time	Flow Rates	Vacuums / Pressures														PID Readings		Temperature	
	Manifold To Extraction Well SVE-1	At Extraction Well SVE-1	Manifold To Well SVE-1	At OW-1	At OW-1D	AS-2 At OW-4	AS-2 At OW-4D	At OW-3	At OW-3D	At OW-2	At OW-2D	At DEC-44	At DEC-141	At DEC-31	At SVE-2	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	Ambient Air Before Carbon
Units	(scfm)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)	(ppm)	(°F)	(°F)
1930	58	-2	-2	0	0	0	0	-0.2	0	0	0	0	0	0	-0.2	>1000	1	60	55
1940	58	-2.5	-2	0	0	0	-0.2	-0.2	-0.5	0	0	-0.2	0	0	-0.2			60	55
1950	59	-2.5	-2	0	0	0	-0.2	-0.2	0	0	-0.2	-0.2	0	0	0			60	55
2000	59	-2.5	-2	0	0	0	-0.2	-0.2	-0.2	0	-0.2	0	0	0	0			60	55
2010	60	-2	-2	0	0	0	-0.2	-0.2	-0.2	0	0	-0.2	0	0	-0.2			60	55
2012	60	-3	-4	0	0	0	-0.25	0	0	0	0	0	0	0	0			60	55
2022	60	-3	-4	0	0	0	0	-0.2	0	0	-0.2	0	0	0	-0.2			60	55
2032	60	-3	-4	0	0	0	-0.2	0	0	0	-0.25	0	0	0	-0.2			60	55
2042	60	-3.5	-4	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0			60	55
2044	60	-4	-6	0	0	0	-0.25	0	0	0	-0.2	0	0	0	0			60	55
2054	62	-4	-6	0	0	0	-0.2	0	0	0	-0.2	0	0	0	0			60	55
2104	61	-4	-6	0	0	0	-0.2	-0.2	0	-0.2	0	0	0	0	0			60	55
2114	60	-4	-6	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0			60	55
2116	60	-4.5	-7.5	0	0	0	-0.2	-0.2	0	0	-0.2	0	0	0	0			60	55
2126	61	-4.5	-7.5	0	0	0	-0.2	0	0	0	-0.2	0	0	0	0				55
2136	61	-4	-7.5	0	0	0	0	-0.2	0	0	-0.2	0	0	0	0				55
2210	60	-4.5	-7	0	0	0	0	0	0	0	-0.2	0	0	0	0				55
^ Lost Power																			
Run Time																			
(min)																			
160																			
Average	60																		

Klink Cosmo - Soil Vapor Extraction Pilot Test
Tables 1.2 & 1.3 - PILOT STUDY FIELD DATA SUMMARY

Test 2

Time	Flow Rates	Vacuums / Pressures														PID Readings		Temperature	
	Manifold To Extraction Well SVE-2	At Extraction Well SVE-2	Manifold to Well SVE-2	At OW-1	At OW-1D	AS-2 At OW-4	AS-2 At OW-4D	At OW-3	At OW-3D	At OW-2	At OW-2D	At DEC-44	At DEC-141	At DEC-31	At SVE-1	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-2	Ambient Air Before Carbon
Units	(scfm)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)	(ppm)	(°F)	(°F)
1720	33	-2	-2.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0			52	50
1749	38	-3.5	-2	0	0	0	-0.2	-1.5	0	0	0	0	0	0	0		723	60	50
1815	70	-0.4	-2	0	0	0	-0.2	-2	0	0	0	0	0	0	0			60	50
1826	70	-0.3	-2	0	0	0	-0.2	-2	0	0	0	0	0	0	-0.2	>1000	2/	60	50
1835	75	-0.4	-3	0	0	0	-0.2	-2	0	0	0	0	0	0	-0.2			60	50
1844	75	-0.3	-4.5	0	0	0	-0.2	-2.5	0	0	0	0	0	0	-0.2			60	50
Run Time																			
(min)																			
84																			
Average	60																		

Test 3

RESTART SYSTEM FOR SVE -2 STEP TEST																			
2225	70	-2	-1.5	0	0	0	-0.2	-0.2	0	-0.2	0	0	0	0	0				50
2235	70	-2	-1.5	0	0	0	-0.25	0	0	0	0	0	0	0	0				
2245	70	0	-1.5	0	0	0	-0.25	-0.2	0	-0.2	0	0	0	0	0				
2255	70	-0.2	-1.5	0	0	0	-0.2	0	0	-0.2	-0.2	0	0	0	-0.2				
2300	68	-0.2	-2.5	0	0	0	-0.2	0	0	0	-0.2	0	0	0	-0.2				
2310	70	-0.2	-2.5	0	0	0	0	0	0	0	0	0	0	0	0				
2320	70	0	-2.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2330	70	-0.2	-2.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2335	71	-0.2	-3.5	0	0	0	0	0	0	0	0	0	0	0	0				
2345	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2355	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2405	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2410	70	-0.2	-4.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2420	69	-0.2	-4.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2430		-0.2	-4.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0				
2444	69	-0.2	-4.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0				
Run Time																			
(min)																			
139																			
Average	70																		

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.4 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

NOTES:	SVE-2 on @ Max Throttle	1019 reset	1131 shutdown
	0945 shutdown	1031 shutdown and reset	1136 shutdown
	0952 reset	1037 shutdown	1221 shutdown
	1014 shutdown	1038 reset	1237 stop

Well: **SP-2 Stepped Rate Test**
Date: 11/17/2015
Personnel: MG, JL

Test 4

Time	Flow Rates		Vacuums / Pressures																		Temperature		
	Manifold To SP-2 Well	Manifold To SVE-2	Manifold To Air Sparge SP-2	At Well SVE-2	AS-2	Manifold To SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Ambient Before Carbon
Units	(scfm)	(scfm)	(psi)	(in Hg)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)	(ppm)	(°F)	(°F)	(°F)
930	20	63	13.5	-2.5	0.5	-2.7	0	0	-2	-0.5	-1	0	0	-2	-1	-1	0	0	>15000/-	0	45	45	55
956	24	60	12.5	-0.5	0	-3.5	0	0	-1	0	-1	-0.5	-0.5	-1.5	-0.75	-0.75	0	0	>15000/-	0	45	45	55
1005	26	60	12	-2.5	0	-4	0	0	-1	0	-1	0	-0.5	-1.5	-0.5	-0.75	0	0	>15000/-	0	45	45	55
1015	21	60	11.5	-2.5	0.5	-4	0	0	-1	0	-1	0	-0.5	-2	-0.75	-1	0	0	>15000/-	0	45	45	55
1027	40	60	14.5	-2.5	0	-4	0	0	-1	0	-0.5	0	-0.5	-2	-1	-1	0	0	>15000/-	0	45	45	55
1035	40	60	11	-2.5		-4.5	0	0	-0.75	0	SP-2 PVC/FERNCO slipped off					-0.5	0	1040 glued new			45	45	55
1123	40	61	17.5	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1.5	0	0	-/315	0	45	47	55
1132	43	60	17	-2.5	0	-4	NA	NA	-1	-0.5	-1	-1	-0.5	-1.5	-0.5	-1.5	NA	-0.5	NA	NA	45	46	55
1139	40	60	19	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1	0	0	>15000/574	0	45	46	55
1215	70	60	26.5	-2.5	0	-4	0	0	-0.75	0	-1	-1	-0.5	-1.75	-0.75	-1	0	0	-/680	0	45	46	55
1234	80	60	23.5	-2.5	0	-4	NA	NA	-0.75	0	-1.5	-1	-0.5	-1.75	-0.5	-1	NA	0	>15000/650	0	45	46	55
1237	Stopped System																						
Run Time																							
(min)																							
187																							
Average	40	60																					

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.5 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

Well: **SP-3 Stepped Rate Test**
Date: 11/17/2015
Personnel MG, JL

NOTES: Compressor shut off @ > 40 scfm - Max limit of formation
Tried increasing flow but motor repeatedly cut out
Per final sample w/summa can at 540pm
21 psi @ SP-3 manifold during sample

Shut down @ 4:03 pm for installation of sample tap
Restart at 4:15 pm
Shut down @ 5:45 pm
Retool for SP-2 & SP-3

Test 5

Time	Flow Rates		Vacuums / Pressures																						Temperature		
Units	Manifold To SP-3 (scfm)	Manifold To SVE-2 (scfm)	At SP-2 (psi)	Manifold To SP-3 (psi)	At SP-3 (psi)	Back Gauge (psi)	Manifold To SVE-2 (in Hg)	At SVE-2 (Hg)	At OW-1 (in Hg)	At OW-1D (in Hg)	At OW-2 (in Hg)	At OW-2D (in Hg)	At OW-3 (in Hg)	At OW-3D (in Hg)	AS-2 At OW-4 (in Hg)	AS-2 At OW-4D (in Hg)	At DEC-44 (in Hg)	At SVE-1 (in Hg)	At DEC-31 (in Hg)	At DEC-141 (in Hg)	Trains A & B Before Carbon PID/FID (ppm)		Trains A & B After Carbon (PID/FID) (ppm)		At SVE-1 (°F)	At SVE-2 (°F)	Ambient Before Carbon (°F)
1532	16	60	0.5	15	3		-4	-2.5	0	-0.5	-1	0	-1	-0.5	-0.5	-1.75	-1	-0.5	-0.25	0	890	50	800	540	48	49	45
1542	18	60	0	16	3		-4	-2.5	0	-0.75	-1.5	0	-1	0	-0.25	-1.75	-1	-1	-0.25	0	NA	NA	NA	0	48	49	45
1550	18	60	0	15	3		-4.5	-2.5	0	-0.5	-1	0	-1.5	0	0	-1.75	-1.5	-0.5	-0.25	0	NA	NA	NA	0	48	49	45
1555	18	60	0	14.5	3		-4.5	-2.75	0	-0.5	-1	0	-1	-0.25	-0.25	-1.75	-1.5	-0.75	-0.25	-0.25	805	685	850	0	48	49	45
1603	System shut down due to high pressure																										
1615	30	61	0	24	2.5		-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.25	-0.25	-2	-1.5	-1.5	-0.25	0	490	490	0	0	48	49	45
1625	30	61	0	16	2.6	18.5	-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.5	-0.25	-1.75	-1.5	-1	-0.5	0	470	320	0	0	48	49	45
1639	30	62	0	15	2.6	20	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	415	0	0	48	49	45
1645	30	61	0	14.5	2.6	21.5	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	1700	0	0	49	49	45
1650	40	60	0	18.5	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1.25	-0.5	0	420	1900	0	0	48	48	45
1657	41	61		18	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	-0.25	620	740	0	0	48	48	45
1703	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.5	-0.5	-1.5	-0.25	0	-1.5	-1.5	-1	-0.5	0	470	610	0	0	48	48	45
1709	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.25	-0.5	-1	-0.25	0	-1.5	-1	-1	-0.5	0	680	720	0	0	47	49	45
1730	40	System shut down due to high pressure																									
1740	21	Restarted system to collect sample																									
1745	21	Collected sample & shutdown system																									
Average	29	61																									

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.6 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

NOTES: Summa collected at 2020
SVE on max throttle

Well: **SP-2 & SP-3**
Date: 11/17/2015
Personnel: David Coulter, Mike Gutman, John Lysiak

Test 6

Time	Flow Rates			Vacuums / Pressures																			PID Readings			Temperature		
	Manifold To SP Wells (scfm)		Manifold To SVE-2 (scfm)	Manifold To SP Wells (psi)		Manifold To Well SVE-2	Outside At Air Sparge Wells (psi)		Back Gauge	At Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)	At SVE-1	At SVE-2	Ambient Before Carbon
Units	SP-2	SP-3		SP-2	SP-3	(in Hg)	SP-2	SP-3	(psi)	(Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)	(°F)	(°F)	(°F)
1800	10	10	62	8.9	14	-4.5	0.5	2.5	14	-2.25	0	0	-1	-0.5	-0.5	0	-0.5	-1	-0.5	-1	-0.5	0	620	480	0	45	48	45
1819	10	10	61	9.5	12.5	-4.5	0.5	3	14	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	720	560	0	45	47	45
1830	10	10	61	9	11.5	-5	1	3	13.5	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-2	-0.5	-0.5	-0.5	0	710		0	45	48	45
1837	10	10	63	9	11	-5	0.5	3	13.5	-2.25	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	710	530	0	45	48	45
1845	15	15	62	9	12	-5	0.5	3	16	-2.5	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	740	516	0	45	48	45
1853	15	15	63	9	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	800	680	0	45	48	44
1902	15	15	63	8.5	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	720	590	0	45	50	44
1906	15	15	62	8.5	11	-5	0.5	3	16	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-0.5	-0.5	0	840	700	0	45	49	44
1915	20	20	62	9	12.5	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	0	-1.5	-0.5	-0.5	-0.5	0	780	725	0	45	49	45
1921	20	20	63	8.5	12	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	820	780	0	45	49	45
1928	20	20	62	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	850	748	0	45	48	44
1934	20	20	63	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.75	-0.75	-1	-0.5	0	840	730	0	45	49	41
1940	25	25	63	8.5	12.5	-5	0.5	3	18	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.75	-1	-0.5	0	770	620	0	45	48	44
1945	25	25	62	8.5	12.5	-5	0.5	3	18	-2.75	0	0	-0.5	-0.5	-1	0	-0.5	-1.5	-0.5	-1	-0.5	0	700	570	0	45	48	43
1950	25	25	63	8.5	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	750	530	0	45	47	43
1954	25	25	62	8	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	740	530	0	45	47	43
2003	35	35	62	9.5	15	-4.5	0.5	3	20.75	-3	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	800	590	0	45	48	43
2008	35	35	62	9.5	15	-4.5	0.5	3.5	20.6	-3	0	0	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	850	640	0	45	48	43
2014	35	35	63	9	15.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.1	850	640	0	45	48	43
2019	35	35	62	9	14.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	-0.25	-0.75	-0.1	-0.5	-1.5	-0.5	-1	-0.5	-0.1				45	48	43
Run Time (Min)																												
139																												
Average	21	21	62.3																									

Klink Cosmo - Soil Vapor Extraction Pilot Test
Tables 1.7 & 1.8 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

NOTES: Gauge calibration not low enough
Max Vac 0 w/ both SVE 1 &2 at Max Flow

Well: **SVE-1 & SVE-2 Constant Rate Test**
Date: 11/18/2015 6:54 Purging SVE-1 and SVE-2
Personnel: MG, JL Purge duration at Max Flow = 2010-1854 = 76 Minutes (Test 7)

Tests 7 & 8

Time	Flow Rates / Pressures								Vacuums / Pressures														PID Readings				Temperature		
	Manifold To SP-1		Manifold To SP-2		At Extraction Well SVE-1	Manifold to Well SVE-1	Manifold to Well SVE-2	At Well SVE-2	At AS-3	At AS-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)		At SVE-1	At SVE-2	Ambient
Units	(scfm)	(psi)	(scfm)	(psi)	(in Hg)	(scfm)	(scfm)	(in Hg)	(psi)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)		(°F)	(°F)	(°F)
2010	27		28		-2.5	70	61	-0.5	0	0	0	-0.5	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	0	490	350			57	60	57
2044	35	11	35	8	-2.5	70	60	-0.5	0	0	-0.25	0	-0.5	0	-0.5	-0.5	0	-2	-0.5	-0.5	0	900	1014			58	60	59
2054	35	11	35	8	-3	69	60	-2	0	0	-0.5	0.25	-0.5	0	-0.25	0	-0.5	-1	-0.5	-0.5	-1.5	900	1013			60	60	60
2104	36	10.5	35	7	-3	70	61	-2	0	0	-0.5	0.5	0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	1140	960			60	60	60
2114	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0	-0.5	-0.25	-0.5	-0.25	0	-2	-0.5	-0.5	-2.5					60	60	60
2124	36	10.5	35	8	-3	69	61	-2	0	0	0	0.25	-0.25	0	-0.25	0	-0.25	-1.5	-0.25	-0.5	-2.5	1015	900			60	60	60
2134	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0.25	-0.5	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	900	800			60	60	60
2144	37	10.5	35	7.5	-2.75	69	61	-2	0	0	-0.5	0	-0.25	-0.25	-0.5	-0.25	-0.25	-2	-0.5	-0.5	-2.5	800	1300			60	60	60
2154	36	10.5	35	7.5	-2.75	70	60	-2	0	0	-0.25	0	-0.25	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	1500			60	60	60
2204	37	10.5	35	8	-3	70	61	-2	0	0	-0.25	0	-0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	940			60	60	60
2214	37	10.5	35	7.5	-2.75	70	61	-2	0	0	0	0	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	-1.5	880	1480			60	60	60
2224	37	10.5	34	7.5	-2.5	69	60	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-1.5	870	1100			60	60	60
2234	37	10.5	35	7.5	-2.75	67	61	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.75	-1.75	-0.5	-0.5	-1.5	950	1450			61	60	60
2244	45	12	45	9		70	61																					
Run Time																												
(min)																												
154																												
Average	36		35			70	61																					

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.9 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

NOTES: Collected summa @ 1033

Well: **SVE-1 Stepped Rate Test**
Date: 11/19/2015
Personnel: DC, MG, JL, GK

Test 9

Time	Flow Rates	Vacuums / Pressures																PID Readings			Temperature		
	Manifold To Extraction Well SVE-1	At Extraction Well SVE-1	Manifold to Well SVE-1	At OW-1	At OW-1D	AS-2 At OW-4	AS-2 At OW-4D	At OW-3	At OW-3D	At OW-2	At OW-2D	At DEC-44	At DEC-141	At DEC-31	At SVE-2	SP-2	SP-3	Before Carbon PID/FID		After Carbon (PID/FID)	Before Carbon	After Carbon	Ambient Carbon
Units	(scfm)	(in H_2O)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in Hg)	(in H_2O)	(in Hg)	(in Hg)	(in Hg/ H_2O)	(in H_2O)	(Hg)	(Hg)	(ppm)		(ppm)	(°F)	(°F)	(°F)
1007	67	-8	-1.5	0	-1	0	-0.5	0	0	-0.25	-1.5	0	-1	0	0	0	0				65	64	64
1017	66	-30.5	-1.5	0	-1.5	0	-0.75	-0.5	-0.5	-0.25	-2	0	-1.25	0	-0.5	0	0				65	64	64
1027	67	-30.5	-1.5	0	-1.5	0	-0.75	-0.5	-0.5	-0.25	-2	0	-1.5	0	-0.5	0	0	890	634	0	65	64	64
1037	66	-30.5	-1.5	0	-1.5	0	-0.8	-0.5	-0.5	-0.25	-5	-0.25	-1.5	0	-1	0	0	1150	940	0	65	64	64
1047	68	-35	-3	0	-2	0	-1	-0.5	-0.75	-0.1	-2.2	0	-1.6	0	-0.6	0	0	1080	1213	0	65	65	64
1057	68	-34	-3	0	-1.75	0	-1	-0.5	-0.8	-0.1	-2.1	0	-1.5	0 -1.5	-0.6	0	0	1020	1213	0	70	65	64
1107	67	-33.5	-3	-0.1	-2	0	-1.5	-0.5	-0.8	0	-2.2	0	-1.5	0 -1.5	-1.6	0	0	1100	1410		70	65	65
				EVERYTHING FORWARD IS IN INCHES H_2O																			
	(scfm)	(in H_2O)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)						
1117	68	-32	-3	-1.5	-2	-1	-1	-0.8	-0.5	-2.1	-2.2	-0.5	-1.5	-1.6	-0.6	0	0	1170	1300		70	66	65
1127	69	-39.5	-4.5	-1.6	-2.1	-1.1	-1.6	-0.5	-0.8	-2.25	-2.3	-0.5	-1.5	-1.6	-0.75	0	0	1110	1320		69	66	64
1137	69	-39.5	-4.5	-1.75	-2.2	-1.1	-1.1	-0.6	-1	-2.4	-2.25	-0.75	-1.5	-1.75	-0.75	0	0	1100	1320		69	65	63
1147	68	-39.5	-4.5	-1.6	-2.1	-1	-1.1	-0.6	-0.9	-2.3	-2.5	-0.7	-1.6	-1.6	-0.75	0	0	1100	1370		69	65	63
1157	68	-39.5	-4.5	-1.6	-2.1	-1.2	-1	-0.6	-0.9	-2.4	-2.4	-0.7	-1.5	-1.6	-0.75	0	0	1180	1420		69	66	63
1202	69	-45	-6.25	-1.8	-2.5	-1.4	-1.3	-0.7	-1	-2.5	-2.5	-0.75	-1.6	-1.75	-0.75	0	0	1220	1470				
1212	69	-45	-6.25	-1.9	-2.4	-1.5	-1.4	-0.75	-1	-3.1	-2.5	-0.8	-1.7	-1.9	-0.9	0	0	1200	1560		90	80	63
1222	68	-45	-6.25	-1.7	-2.3	-1.4	-1.3	-0.6	-1	-3.1	-3.2	-0.75	-1.75	-1.8	-0.75	0	0	1210	1420		90	81	64
1232	68	-45	-6.25	-1.75	-2.5	-1.3	-1.4	-0.75	-1	-3.1	-3.1	-0.75	-1.75	-1.9	-0.75	0	0	1250	1530		89	80	64
																				FINAL -->	95	85	
Run Time																							
(Min)																							
145																							
Average	68.4																						

NOTE: Shaded data, the last reading of the increment, was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions.
Data used in the 4 and 5 series ofcalculation tables.

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.10 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: **SVE-2 Stepped Rate Test** NOTES: All well readings in H_2O
Date: 11/19/2015
Personnel: MG, JL **Test 10**

Time	Flow Rates	Vacuums / Pressures																PID Readings			Temperature		
Units	Manifold To Extraction Well SVE-2 (scfm)	At Extraction Well SVE-2 (in H_2O)	Manifold to Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	AS-2 At OW-4 (in H_2O)	AS-2 At OW-4D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At DEC-44 (in H_2O)	At DEC-141 (in H_2O)	At DEC-31 (in H_2O)	At SVE-1 (in Hg)	SP-2	SP-3	Before Carbon PID/FID (ppm)		After Carbon (PID/FID) (ppm)	Before Carbon (°F)	After Carbon (°F)	Ambient Carbon (°F)
1245	60	-19	-1.5	-0.75	-0.75	-1.4	-1.3	-1.2	-1.6	-2.3	-2.5	-0.9	-1.6	-1	-0.5	0	0	620	698	0	97	87	61
1255	60	-19	-1.5	-0.75	-0.9	-1.5	-1.25	-1.1	-1.4	-2.4	-2.5	-0.9	-1.5	-0.8	-0.5	0	0	606	590	0	98	87	62
1305	60	-19	-1.5	-0.75	-0.75	-1.4	-1.4	-1.1	-1.5	-2.4	-2.6	-0.9	-1.6	-0.75	-0.5	0	0	570	690	0	103	89	61
1315	60	-19	-1.5	-0.75	-0.75	-1.2	-1.25	-1.3	-1.6	-2.5	-2.5	-1	-1.6	-0.75	-0.5	0	0	560	642	0	104	90	61
1317	60	-26	-3	-0.8	-0.8	-1.5	-1.75	-1.6	-2	-2.6	-3	-1	-2	-0.8	-0.6	0	0	530	795	0	105	90	62
1327	60	-26.5	-3	-1	-0.9	-1.6	-1.7	-1.7	-2.1	-2.6	-2.7	-1.25	-2	-0.9	-0.6	0	0	500	770	0	105	90	63
1337	60	-27	-3	-1	-1.1	-1.6	-1.7	-1.6	-2	-2.6	-2.7	-1.7	-2	-0.9	-0.6	0	0	490	780	0	105	90	62
1343	61	-27	-3	-1	-1	-1.75	-1.6	-1.75	-2	-2.6	-2.7	-1.4	-2.1	-1	-0.6	0	0	450	630	0	105	90	63
1345	60	-34.5	-4.5	-1	-1.25	-2	-2.1	-2	-2.25	-2.9	-3.1	-1.25	-2.4	-1	-0.7	0	0	430	550	0	104	92	64
1355	60	-34.5	-4.5	-1	-1.1	-2.1	-2.1	-2	-2.4	-2.9	-3.1	-1.4	-2.5	-1	-0.6	0	0	380	670	0	105	92	62
1405	61	-34.5	-4.5	-1	-1.25	-2.1	-2.2	-2	-2.4	-2.8	-3.1	-1.4	-2.4	-1	-0.6	0	0	360	580	0	100	90	62
1415	61	-34.5	-4.5	-1.1	-1.1	-2	-2.1	-2	-2.4	-2.8	-3.1	-1.4	-2.4	-2.5	-0.6	0	0	380	560	0	85	87	62
1416	60	-39.5	-5.5	-2.5	-2.6	-2.3	-2.25	-2.3	-2.5	-3	-3.1	-1.5	-2.5	-2.5	-0.75	0	0	390	790	0	97	95	62
1426	61	-39.5	-5.5	-2.5	-2.5	-2.2	-2.25	-2.4	-2.5	-3	-3.1	-1.6	-2.5	-2.4	-0.75	0	0	380	450	0	97	95	61
1436	61	-39.5	-5.5	-2.5	-2.5	-2.5	-2.3	-2.25	-2.4	-3.1	-3.3	-1.5	-2.6	-2.4	-0.75	0	0	370	400	0	100	92	62
1446	61	-39.5	-5.5	-2.6	-2.5	-2.25	-2.4	-2.3	-2.4	-3	-3.25	-1.4	-2.5	-2.4	-0.75	0	0	370	400	0	100	95	62
Run Time (min)																							
121																							
Average	60.4																						

NOTE: Shaded data, the last reading of the increment, was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions.
Data used in the 4 and 5 series ofcalculation tables.

Klink Cosmo - Soil Vapor Extraction Pilot Test
Table 1.11 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: SVE-1 & SVE-2 **Constant Rate Test**
Date: 11/19/2015
Personnel: MG, JL **Test 11**

Time	Flow Rates		Vacuums / Pressures															PID Readings			Temperature		
	Manifold to Extraction Well SVE-1	Manifold to Well SVE-2	At Extraction Well SVE-1	Manifold to Well SVE-1	At Extraction Well SVE-2	Manifold to Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)	Before Carbon	After Carbon	Ambient
Units	(scfm)	(scfm)	(in H_2O)	(in Hg)	(in H_2O)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)		(ppm)	(^oF)	(^oF)	(^oF)
1450	69	61	-21	-1.5	-24.5	-2.5	-3.1	-3.6	-3.5	-3.6	-2.1	-2.1	-2.4	-2.5	-0.9	-3.1	-2.5	720	730	0	100	92	62
1500	67	61	-21.1	-1.5	-24.5	-2.5	-3.3	-3.6	-3.6	-3.7	-2.2	-2.1	-2.6	-2.4	-1.5	-3.1	-2.5	630	800		97	92	62
1510	68	61	-21.1	-1.5	-24.5	-2.5	-3.25	-3.5	-3.5	-3.75	-2.1	-2.1	-2.3	-2.4	-1.4	-3.1	-2.5	940	840		90	95	62
1520	66	61	-21.1	-1.5	-24.5	-2.5	-3.4	-3.5	-3.5	-3.6	-2.1	-2.1	-2.5	-2.5	-1.4	-3.25	-2.5	900	710		95	90	62
1530	70	60	-21.1	-1.5	-24.5	-2.75	-3.2	-3.4	-3.5	-3.6	-2.1	-2.1	-2.4	-2.5	-1.4	-3.25	-2.5	900	710		95	90	62
1540	70	61	-21.1	-1.5	-24.5	-2.75	-3.4	-3.5	-3.6	-3.6	-2	-2	-2.4	-2.5	-1.4	-3.2	-2.5	780	800		95	90	62
1550	68	61	-21.1	-1.4	-24.5	-2.5	-3.1	-3.6	-3.1	-3.7	-2.1	-2.1	-2.4	-2.5	-1.4	-3.1	-2.5	840	920		95	90	62
1600	68	61	-21.1	-1.25	-24.5	-2.5	-3.4	-3.5	-3.5	-3.6	-2.1	-2.1	-2.25	-2.4	-1.3	-3.25	-2.5	700	1100		90	89	62
1610	68	61	-21.1	-1.25	-24.5	-2.5	-3.25	-3.6	-3.5	-3.6	-2	-2.1	-2.5	-2.5	-1.4	-3.1	-2.5	850	1280		92	87	62
1618	68	61	-21.1	-1.25	-24.5	-2.5	-3	-3.5	-3.6	-3.5	-2.1	-2.1	-2.4	-2.6	-1.6	-3.25	-2.5				100	90	62
Run Time (Min)																							
138																							
Average	68.2	61.9																					

Table 2 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits

		Test 1		Test 2		Test 3	
Location ID		**SVE-01**	**SVE-01**	**SVE-02**	**SVE-02**	**SVE-02**	**SVE-02**
Sample ID		**SVE-01-START**	**SVE-01-END**	**SVE-02-START-R1**	**SVE-02-END-R1**	**SVE-02-START-R2**	**SVE-02-END-R2**
Matrix		**Soil Gas**	**Soil Gas**	**Soil Gas**	**Soil Gas**	**Soil Gas**	**Soil Gas**
Depth Interval (ft)		-	-	-	-	-	-
Date Sampled		**11/16/15**	**11/16/15**	**11/16/15**	**11/16/15**	**11/16/15**	**11/17/15**
Parameter	**Units**				(2-2)	(3-3)	(4-4)
Volatile Organic Compounds							
1,2-Dichloroethene (cis)	µg/M³	5,960	6,520	1,430	666 J	952 J	1,190 J
Acetone	µg/M³	6,560		18,400	3,760	1880	
Carbon tetrachloride	µg/M³	554 J					
Chloroform	µg/M³		703J	293 J			
Methyl ethyl ketone (2-Butanone)	µg/M³	7,390	3,080	22,200	3,930	2020	743 J
Tetrachloroethene	µg/M³	1,420,000 D	1,610,000 D	550,000 D	718,000 D	773,000 D	848,000 D
Toluene	µg/M³						
Trichloroethene	µg/M³	8,430	9,800	3,160	1,480	2580	3290
Total VOCs	µg/M³	1,448,894	1,630,103	595,483	727,836	780,432	853,223
Average Total VOCs	**µg/M³**	**1,539,499**		**661,660**		**816,828**	
PID / FID Measurements	**ppm**						

Flags assigned during chemistry validation are shown.

Table 2 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 4		Test 5			Test 6	
		SVE-02/AS-02	SVE-02/AS-02	SVE-02/AS-03	SVE-02/AS-03	SVE-02/AS-03	SVE02/SP02/SP03	SVE02/AS02/AS03
Location ID		SVE-02/AS-02 START	SVE-02/AS-02 END	SVE-02/AS-03A START	SVE-02/AS-03B START	SVE-02/AS-03 END	SVE-02/SP-02/SP-03 START	SVE-02/AS-02/AS-03 END
Sample ID		Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-	-	-	-	-
Depth Interval (ft)		11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15
Date Sampled	**Units**		(2-2)		(2-2)	(3-3)		
Volatile Organic Compounds								
1,2-Dichloroethene (cis)	µg/M³	1,430 J	1,520	1,670	1,310	1,470	2,050	412 J
Acetone	µg/M³			812				
Carbon tetrachloride	µg/M³							
Chloroform	µg/M³			527 J	410 J	469 J	674	
Methyl ethyl ketone (2-Butanone)	µg/M³	708 J	708 J	602 J	301 J			
Tetrachloroethene	µg/M³	1,520,000 D	975,000 D	1,020,000 D	647,000 D	670,000 D	1,210,000 D	301,000 D
Toluene	µg/M³					610	1,990	
Trichloroethene	µg/M³	3,870	3,350	3,870	2,970	3,390	5,090	946
Total VOCs	µg/M³	1,526,008	980,578	1,027,481	651,991	675,939	1,219,804	302,358
Average Total VOCs	**µg/M³**	**1,253,293**		**785,137**			**761,081**	
PID / FID Measurements	**ppm**			**890 / 50**	**490 / 490**	**680 / 720**	**620 / 480**	**850 / 640**

Flags assigned during chemistry validation are shown.

Table 2 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 7	Test 8	
		SVE-01/SVE-02	SVE1&2/AS2&3	SVE1&2/AS2&3
Location ID		SVE-01/SV-02 PRE SPARGE	SVE-01/SV-02/AS-02/AS-03 START	SVE-01/SV-02/AS-02/AS-03 END
Sample ID		Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-
Depth Interval (ft)		11/18/15	11/18/15	11/18/15
Date Sampled	**Units**			(2-2)
Volatile Organic Compounds				
1,2-Dichloroethene (cis)	µg/M³	698 J	730 J	603 J
Acetone	µg/M³			
Carbon tetrachloride	µg/M³			
Chloroform	µg/M³			
Methyl ethyl ketone (2-Butanone)	µg/M³			
Tetrachloroethene	µg/M³	348,000 D	366,000 D	421,000 D
Toluene	µg/M³		542 J	
Trichloroethene	µg/M³	1,030	1,250	946
Total VOCs	µg/M³	349,728	368,522	422,549
Average Total VOCs	**µg/M³**	**349,728**	**395,536**	
PID / FID Measurements	**ppm**		**490 / 350**	**950 / 1450**

Flags assigned during chemistry validation are shown.

Table 2 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 9		Test 10		Test 11	
		SVE-01	SVE-01	SVE-02	SVE-02	SVE-01/SVE-02	SVE-01/SVE-02
Location ID		SVE-01 START	SVE-01 END	SVE-02 START	SVE-02 END	SVE-01/SVE-02 START	SVE-01/SVE-02 END
Sample ID		Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-	-	-	-
Depth Interval (ft)		11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15
Date Sampled	Units		(2-2)		(2-2)	(2-2)	(3-3)
Volatile Organic Compounds							
1,2-Dichloroethene (cis)	µg/M³	983	888			539 J	571 J
Acetone	µg/M³						
Carbon tetrachloride	µg/M³						
Chloroform	µg/M³						
Methyl ethyl ketone (2-Butanone)	µg/M³						
Tetrachloroethene	µg/M³	846,000 D	529,000 D	372,000 D	253,000 D	468,000 D	416,000 D
Toluene	µg/M³						
Trichloroethene	µg/M³	1550	1380	688 J	731 J	1070	946
Total VOCs	**µg/M³**	848533	531268	372688	253731	469609	417517
Average Total VOCs	**µg/M³**	**689901**		**313209.5**		**443563**	
PID / FID Measurements	**ppm**	**890 / 634**	**1250 / 1530**	**620 / 700**	**370 / 400**	**720 / 730**	**850 /1280**

Flags assigned during chemistry validation are shown.

Klink Cosmo - Pilot Study
Table 3 - Estimate of Detectable VOC Mass Removal During Soil Vapor Extraction Pilot Test

Date	Test No.	Average VOC Concentration ($\mu g/M^3$)	Average System Flowrate (CFM)	Operating Duration (Min)	Mass Removed (Lbs)	Removal Rate (Lbs/Min)
11/16/2015	1	1,539,499	60	160	0.9235	0.0058
11/16/2015	2	661,660	60	84	0.2084	0.0025
11/16/2015	3	816,828	70	139	0.4966	0.0036
11/17/2015	4	1,253,293	60	187	0.8787	0.0047
11/17/2015	5	785,137	60	133	0.3915	0.0029
11/17/2015	6	761,081	62	139	0.4099	0.0030
11/18/2015	7	349,728	131	76	0.2176	0.0029
11/18/2015	8	395,536	131	154	0.4986	0.0032
11/19/2015	9	689,901	68	145	0.4251	0.0029
11/19/2015	10	313,209	60	121	0.1421	0.0012
11/19/2015	11	443,563	140	138	0.5355	0.0039
			Total	**1476**	**5.1274**	

Mass Removed = ((Average Concentration($\mu g/M^3$))*(g/1,000,000 μg)*(M^3/35.315 Ft^3)*((Average Flowrate(Ft^3/Min))*((Operating Duration (Min))*(Lb/453.16 g)

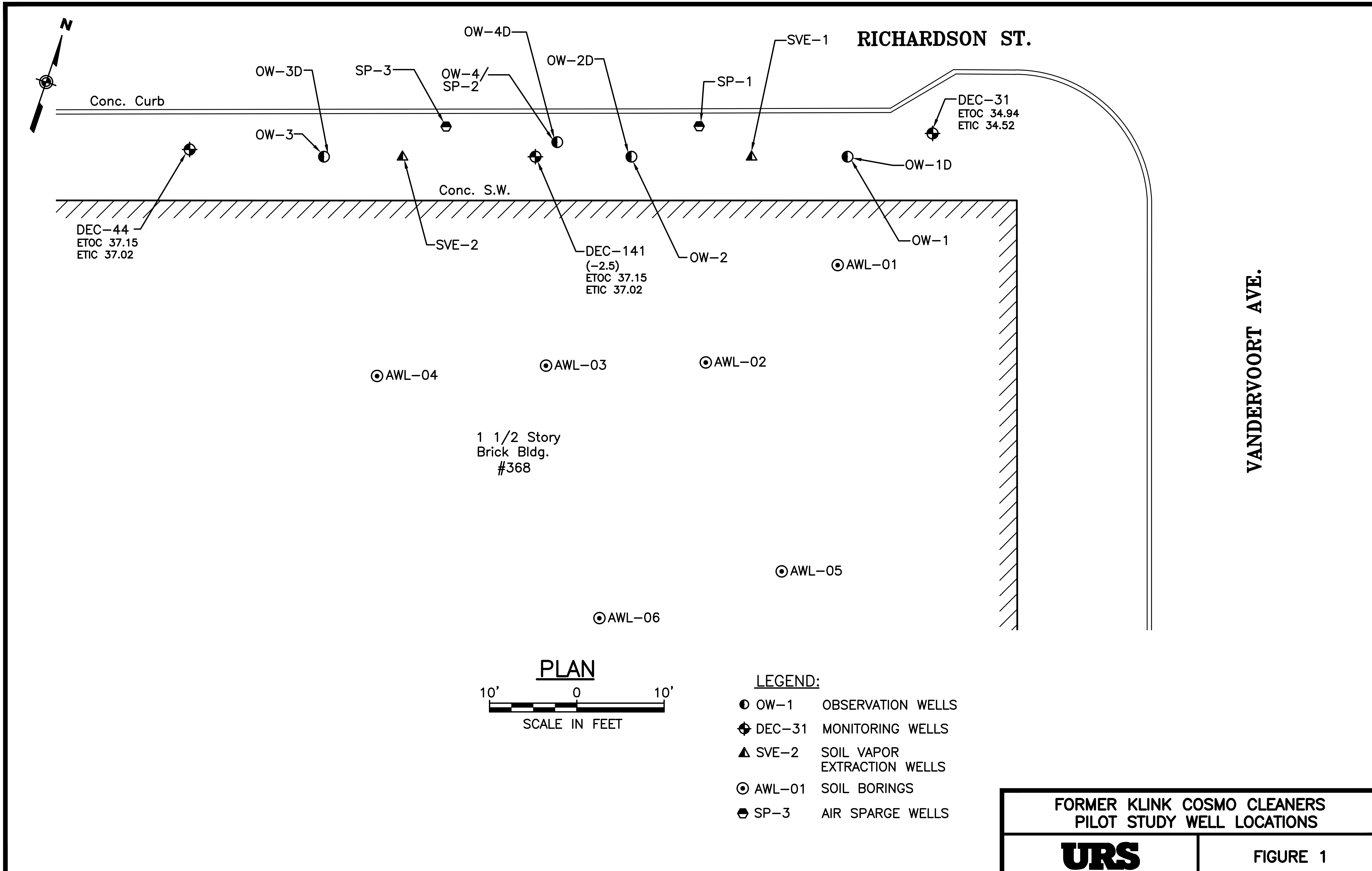
Average Emission Rate = Mass Removed / Operating Duration = 0.0035 Lbs/Min
0.2084 Lbs/Hr
5.0023 Lbs/Day

Average Removal Rate using SVE Only (Tests 1, 2, 3, 7, 9, 10, 11) = (0.0058+0.0025+0.0036+0.0029+0.0029+0.0012+0.0039)/7
= 0.00326 lbs/min

Average Removal Rate using SVE & SP (Tests 4, 5, 6, 8) = (0.0047+0.0029+0.0030+0.0032)/4
= 0.00345 lbs/min

Increase with SP Online = (0.00345-0.00326/0.00326) *100%
= 5.9%

If the removal rate from Test 1 (initial slug of VOCs removed) is eliminated, the increase with SP online is 22.5%

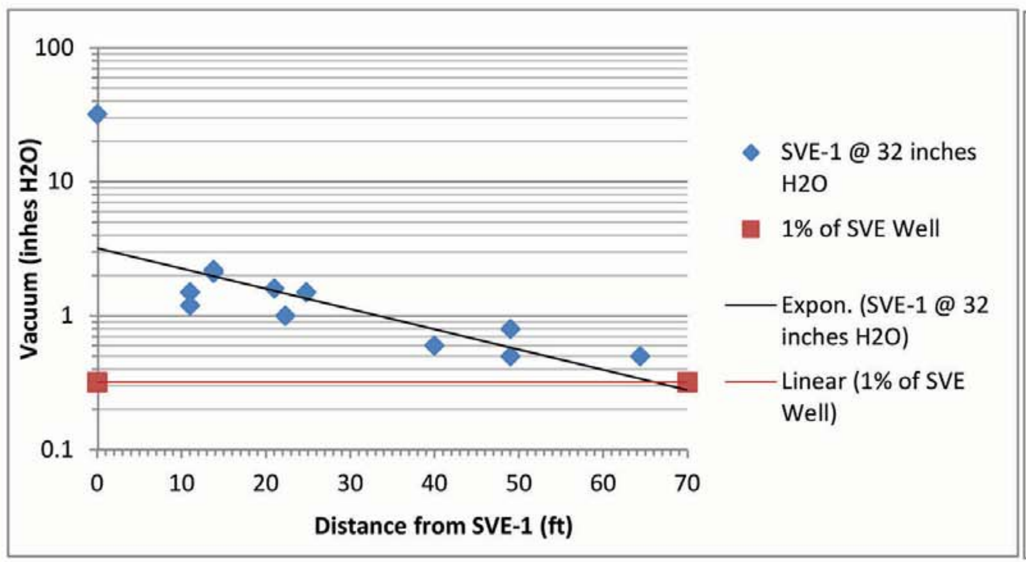


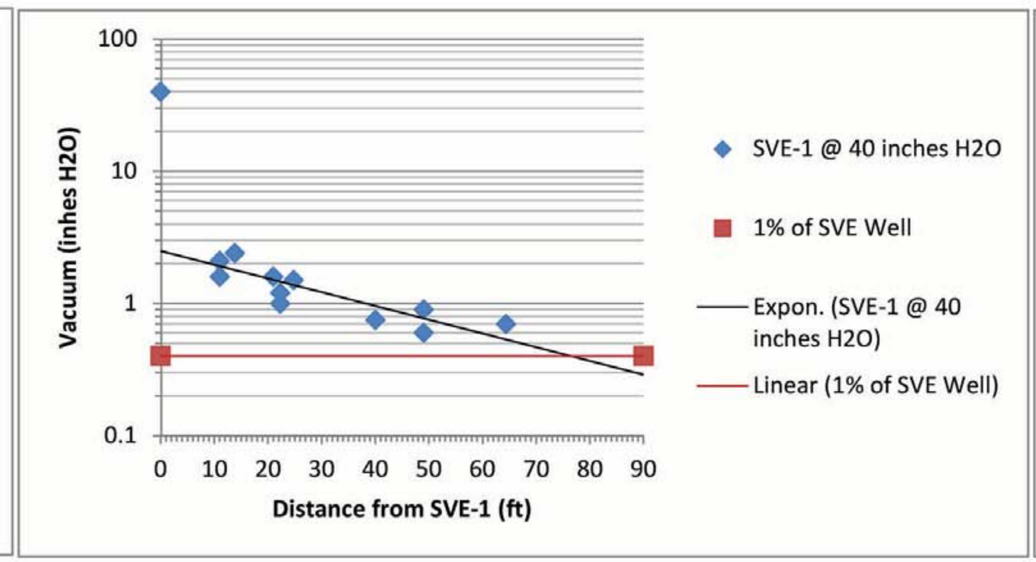
J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 1.dwg 3/18/16 – 2 RAL

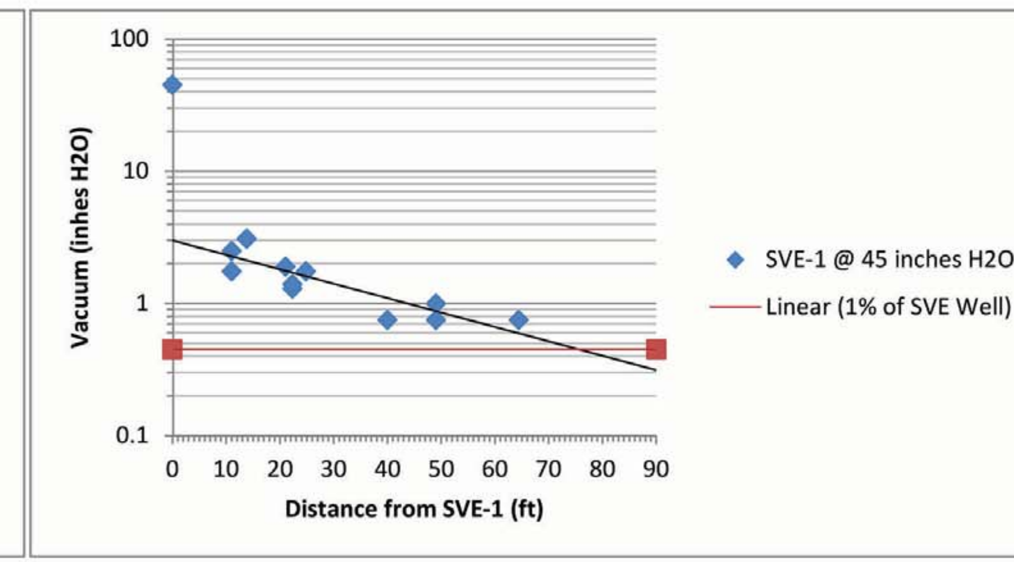
Determination of Radius of Influence (Graphical Estimate)
Klink Cosmo - Soil Vapor Extraction Pilot Study

SVE-1 Monitoring Locations

Monitoring Points	Screened Interval (ft bgs)	Distance from SVE-1 (ft)	SVE-1 at 30.5 in H_2O (in H_2O)	SVE-1 at 32 in H_2O (in H_2O)	SVE-1 at 40 in H_2O (in H_2O)	SVE-1 at 45 in H_2O (in H_2O)
OW-1	7 - 17	11	0	1.5	1.6	1.75
OW-1D	20 - 30	11	1.5	1.2	2.1	2.5
OW-2	7 - 17	13.8	3.4	2.1	2.4	3.1
OW-2D	20 - 30	13.8	5	2.2	2.4	3.1
OW-3	7 - 17	49	0.5	0.8	0.6	0.75
OW-3D	20 - 30	49	0.5	0.5	0.9	1
OW-4	7 - 17	22.3	0	1	1.2	1.3
OW-4D	20 - 30	22.3	0.8	1	1	1.4
DEC-31	30 - 45	21	0	1.6	1.6	1.9
DEC-44	30 - 45	64.4	3.4	0.5	0.7	0.75
DEC-141	29 - 44	24.8	1.5	1.5	1.5	1.75
SVE-2	17 - 27	40	1	0.6	0.75	0.75
SVE-1	17 - 27	0	30.5	32	40	45







NOTE: Shaded vacuum gauge data from Table 1.9 was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

FORMER KLINK COSMO
CLEANERS SITE
SVE-1 GRAPHICAL DETERMINATION OF ROI

URS

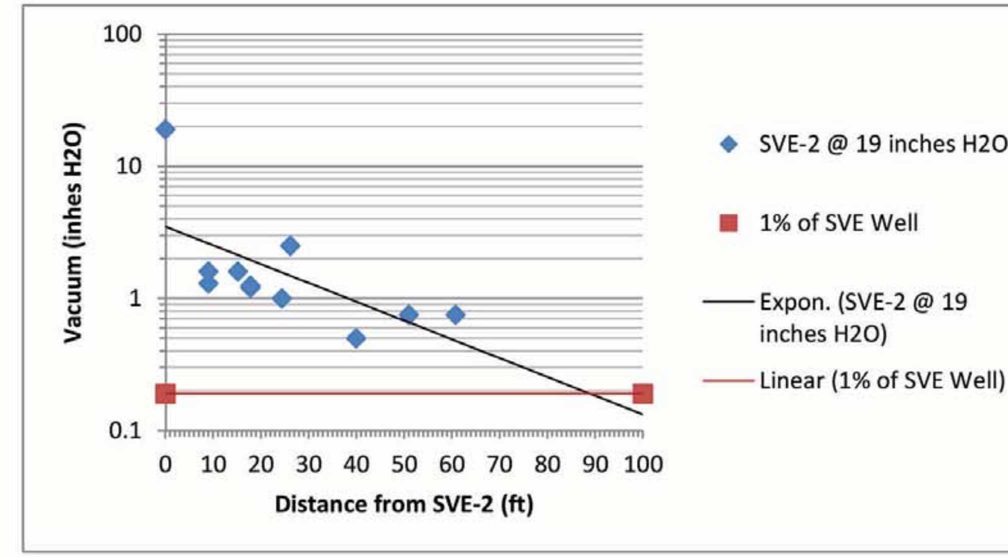
FIGURE 2

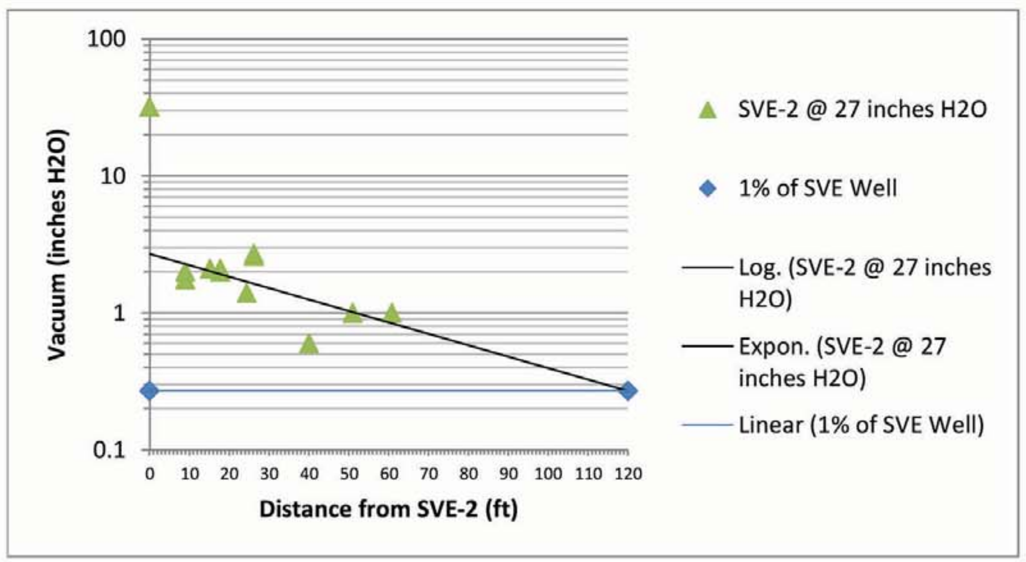
AG21093-11176390.031616-GCM

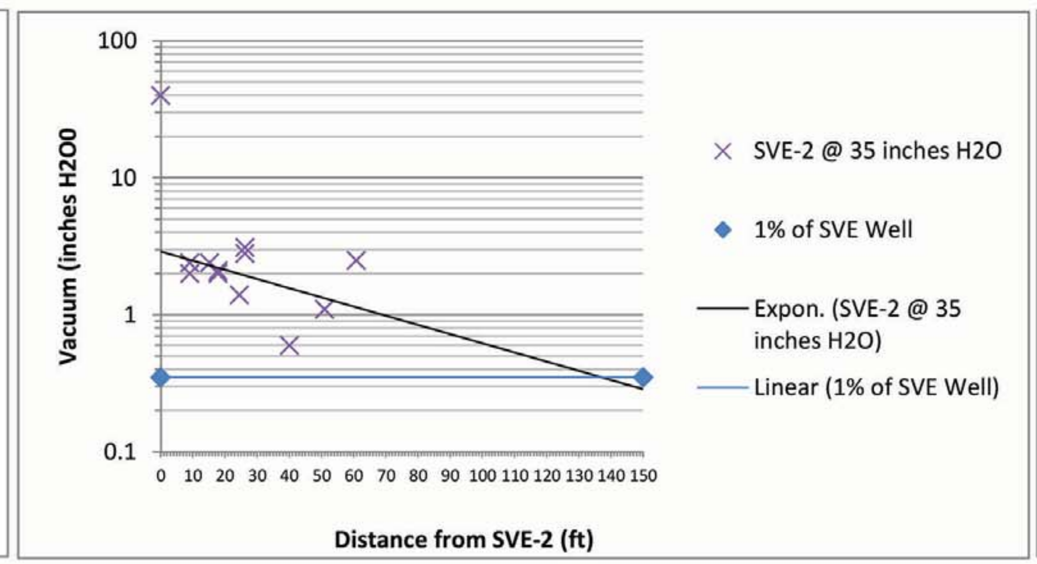
Determination of Radius of Influence (Graphical Estimate)
Klink Cosmo - Soil Vapor Extraction Pilot Study

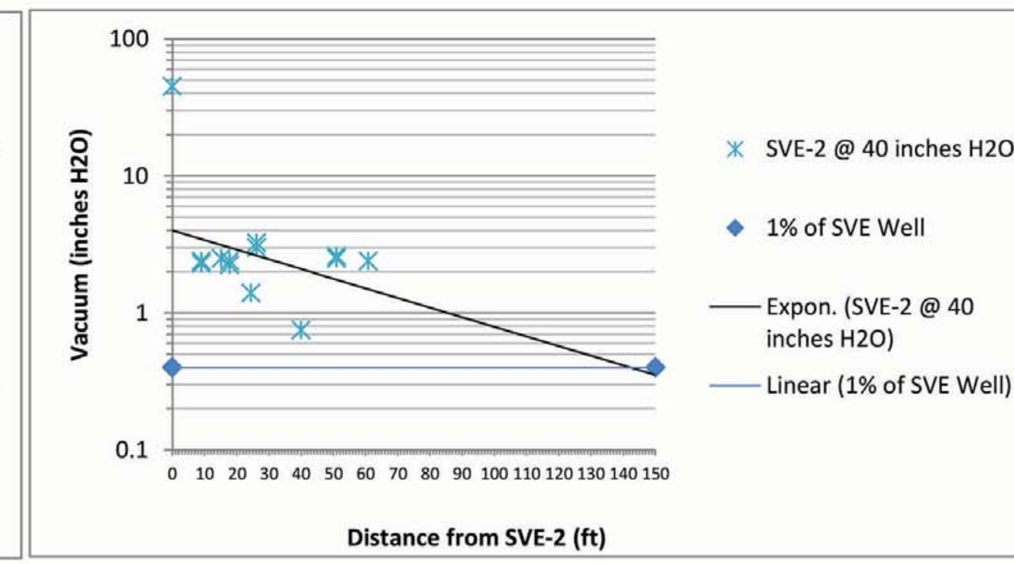
SVE-2 Monitoring Locations

Monitoring Points	Screened Interval (ft bgs)	Distance from SVE-2 (ft)	SVE-2 at 19 in H_2O (in H_2O)	SVE-2 at 27 in H_2O (in H_2O)	SVE-2 at 35 in H_2O (in H_2O)	SVE-2 at 40 in H_2O (in H_2O)
OW-1	7 - 17	51	0.75	1	1.1	2.6
OW-1D	20 - 30	51	0.75	1	1.1	2.5
OW-2	7 - 17	26.2	2.5	2.6	2.8	3
OW-2D	20 - 30	26.2	2.5	2.7	3.1	3.25
OW-3	7 - 17	9	1.3	1.75	2	2.3
OW-3D	20 - 30	9	1.6	2	2.4	2.4
OW-4	7 - 17	17.8	1.2	2	2	2.25
OW-4D	20 - 30	17.8	1.25	2.1	2.1	2.4
DEC-31	30 - 45	60.8	0.75	1	2.5	2.4
DEC-44	30 - 45	24.4	1	1.4	1.4	1.4
DEC-141	29 - 44	15.2	1.6	2.1	2.4	2.5
SVE-1	17 - 27	40	0.5	0.6	0.6	0.75
SVE-2	17 - 27	0	19	32	40	45









NOTE: Shaded vacuum gauge data from Table 1.10 was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

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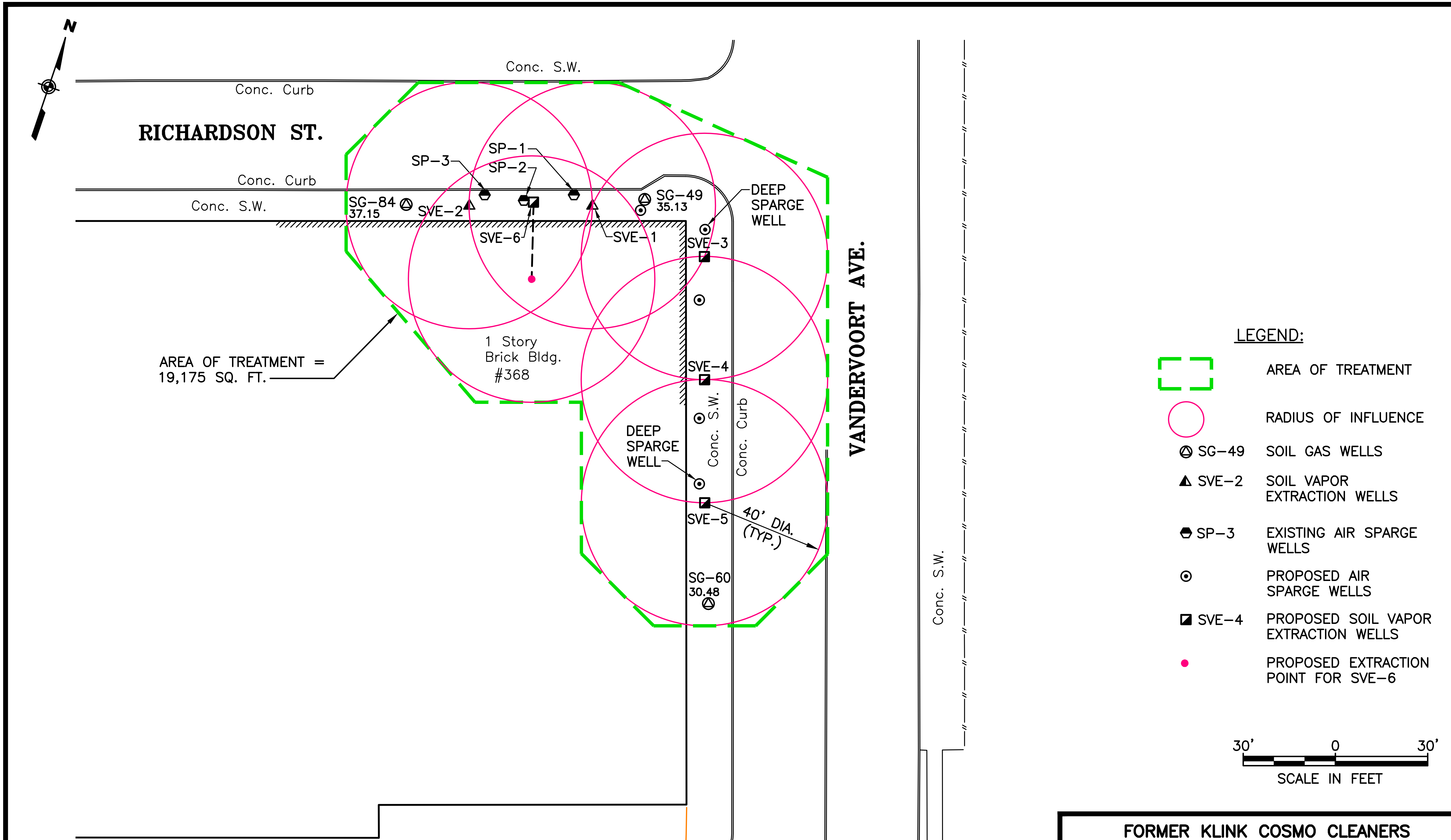
FORMER KLINK COSMO
CLEANERS SITE
SVE-2 GRAPHICAL DETERMINATION OF ROI

URS

FIGURE 3



PLAN

FORMER KLINK COSMO CLEANERS
CONCEPTUAL DESIGN FOR
PERIMETER SOURCE TREATMENT

URS

FIGURE 4

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\CONCEPTUAL DESIGN\FIGURE 4.dwg 3/24/16 - 2 RAL

ATTACHMENT A

SVE/SP PILOT STUDY WORK PLAN

SVE/SP PILOT STUDY WORK PLAN

WORK ASSIGNMENT C007540-4.1

FORMER KLINK COSMO CLEANERS SITE **SITE NO. 224130**
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA **KINGS (C), NY**

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Joseph Martens, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B

URS Corporation
257 West Genesee Street, Suite 400
Buffalo, New York 14202

G4766

Final
September 2015

SVE/SP PILOT STUDY WORK PLAN

FOR THE

FORMER KLINK COSMO CLEANERS SITE

EAST WILLIAMSBURG INDUSTRIAL AREA

SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B
WORK ASSIGNMENT NUMBER C007540-4.1

PREPARED BY:

URS CORPORATION
257 WEST GENESEE STREET, SUITE 400
BUFFALO, NY 14202

SEPTEMBER 2015

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TABLES
(Following Text)

FIGURES
(Following Tables)

ATTACHMENTS

(Following Figures)

LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
DOT	Department of Transportation
FID	flame ionization detector
FS	feasibility study
HP	horsepower
IDW	investigation derived waste
in Hg	inches of mercury
k	intrinsic permeability
kW	kilowatt
NYCDOB	New York City Department of Buildings
NYCDOT	New York City Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
OW	Observation Wells
PCE	tetrachloroethene or perchloroethene or tetrachloroethylene or perchloroethylene
PID	photoionization detector
P&ID	piping and instrumentation diagram
psi	pounds per square inch
ROI	Radius of Influence
scfm	standard cubic feet per minute
SP	Air Sparge
SCGs	Standards, Criteria, and Guidance
SVE	Soil Vapor Extraction
TCE	trichloroethene or trichloroethylene
$\mu g/m^3$	micrograms per cubic meter
µg/L	micrograms per liter (parts per billion)
VC	vinyl chloride
VOCs	volatile organic compounds
WA	work assignment

1.0 INTRODUCTION

Chlorinated solvents including tetrachloroethene (PCE) and trichloroethene (TCE) have been detected in soil vapor, soil, and groundwater samples at concentrations significantly above New York State Standards, Criteria, and Guidance (SCGs) values in the vicinity of the Former Klink Cosmo Cleaners Site, in Brooklyn NY (Site). The remedial action goal for the Site is to eliminate or mitigate all significant threats to human health and/or the environment, to the extent practicable, caused by the release of PCE from the former onsite dry cleaners.

In accordance with Task 5 of Amendment Request #1 to Work Assignment (WA) # C007540-4.1 and as stated in our April 28, 2015 correspondence to the New York State Department of Environmental Conservation (NYSDEC), included as Attachment A, URS will perform a pilot study adjacent to the Site to obtain data that will be used to evaluate and assess the effectiveness of soil vapor extraction (SVE) and air sparge (SP) technologies to remediate and mitigate contaminants at the Site. This data will also be used to develop full-scale treatment for further consideration in the feasibility study (FS) along with other remedial alternatives. This document presents the work plan for the pilot study.

2.0 BACKGROUND

The Former Klink Cosmo Cleaners Site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, New York. The Site is located within the Meeker Avenue Plume Trackdown Site (NYSDEC Site Number 224121) investigation area. Data gathered during investigations at the Meeker Avenue Plume Trackdown Site, between May 2007 and July 2009, and a groundwater sampling event in November 2009, indicated that a source of groundwater contamination was originating near the buildings housing the Former Klink Cosmo Cleaners, which was located at 368 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). In January 2009, the above mentioned source of groundwater contamination was listed as a Class 2 Inactive Hazardous Waste Disposal Site (Site Number 224130). A site location map is presented in Figure 1.

Groundwater is approximately 32 feet below ground surface (bgs). Analytical data collected from soil vapor implants (SG-049, SG-058, SG-084, and SG-085), monitoring wells (DEC-031, DEC-031D, DEC-031TC, DEC-044, and DEC-044D), and soil borings (SB-15, SB-16, SB-18, and SB-22) were evaluated and used to select the area where the pilot study will be performed. The pilot study will be conducted along the south side of Richardson Street near the intersection of Vandervort Avenue between monitoring wells DEC-031 and DEC-044D. Three SP, two SVE, and four pairs of soil vacuum monitoring points [i.e., observation wells (OW)] were constructed in April 2015 as part of the pilot study program. A site plan showing the pilot study program wells is presented as Figure 2. Well construction diagrams are included in Attachment B. Soil boring logs are included in Attachment C.

3.0 RATIONALE

SVE/SP is a proven technology for effectively reducing concentrations of volatile organic compounds (VOCs) in groundwater, such as the PCE and TCE present at this site. The locations of the wells installed for the pilot study program were selected based on the contaminant levels in the soil vapor and groundwater.

Elevated concentrations of PCE and TCE were detected at monitoring wells DEC-031 and DEC-044, which are adjacent to the site and screened from 30 to 45 feet bgs. To mitigate the potential migration of PCE and TCE during the pilot study, the sparge wells were installed in areas where lower dissolved concentrations of PCE and TCE are present compared to DEC-031. The dissolved phase contaminants are believed to extend below 45 feet bgs. The sparge wells are screened from 57 to 60 feet bgs to introduce air 15 feet below the screened interval of monitoring wells DEC-031 and DEC-044.

The SVE wells are screened from 17 to 27 feet bgs. They have been set 5 feet above the water table to minimize entrainment of water into the treatment system.

The observation wells were installed at variable distances from the SVE wells, depending on which SVE well is online, to adequately determine the radius of influence (ROI) in the formation. The ROI is the furthest distance from an extraction well that soil and soil vapor can effectively be treated by SVE. It is determined by placing a vacuum on an extraction well, measuring the vacuum that is achieved in nearby monitoring points, and then projecting the distance where the well no longer has an influence. The observation wells were installed in pairs with one well extending 17 feet bgs and the second well extending 30 feet bgs. The shallow observation well is screened from 7 feet to 17 feet bgs. The deep observation well is screened from 20 feet to 30 feet bgs. The well pairs will be used to determine the effect of depth on the ROI. VOC concentrations will be measured with a photoionization detector (PID) during SVE and air sparging.

Intrinsic permeability (k) is the measure of a soil's ability to transmit fluids (i.e. groundwater and air) and is typically used as an indicator for the effectiveness of SVE remediation. Data collected during the pilot test will be used to determine the intrinsic permeability.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 Soil Vapor

Soil vapor samples were collected to the north and northeast of the Former Klink Cosmo Cleaners Site during the Site Characterization Phase VI Field Investigation conducted in June 2011. In general, the concentrations found within the area of the Former Klink Cosmo Cleaners Site showed no discernible trend as compared to previously sampled locations. Concentrations at some locations were different from the previous sampling events by up to three orders of magnitude. For example, SG-042 was sampled in June 2011 and a PCE concentration of 803,000 micrograms per cubic meter ($\mu g/m^3$) was detected. When this location was re-sampled on September 29, 2011, a concentration of 540 $\mu g/m^3$ was detected. Soil vapor sample locations are shown on Figure 3.

4.2 Soil

There have been no exceedances for Unrestricted Use or Protection of Groundwater Soil Cleanup Objectives in soil samples collected from soil borings or monitoring well borings along the perimeter of the Former Klink Cosmo Cleaners Site.

4.3 Groundwater

PCE and its degradation compounds were detected in numerous groundwater monitoring wells in both the shallow and deep groundwater as well as in downgradient top of clay monitoring wells. Results of the Phase II Former Klink Cosmo Cleaner Site Remedial Investigation (URS, November 2012) indicate high concentrations of PCE were detected at DEC-031 in the shallow groundwater at a concentration of 5,800 micrograms per liter (µg/L); and downgradient of the site to the northeast in DEC-014R at a concentration of 46,000 µg/L; DEC-029/029D/029TC had concentrations of 4,400, 27 and 4,400 µg/L, respectively; DEC-007/007D had concentrations of 1,400 and 400 µg/L, respectively, and DEC-006D/006DD had concentrations of 8,000 and 440 µg/L, respectively; to the north DEC-008 had a concentration of 3,000 µg/L, and DEC-028 had a concentration of 3,100 µg/L. TCE and cis-1, 2-DCE were generally detected above criteria where PCE was detected. Vinyl chloride (VC) was detected above criteria only in DEC-009 (36 µg/L). Benzene, toluene, ethyl benzene, and xylene (BTEX) and/or fuel-related compounds were generally not detected within the Former Klink Cosmo Cleaners Site. Monitoring well locations are shown on Figure 4.

Based upon the observed concentrations of VOCs in groundwater, a dissolved chlorinated solvent plume appears to originate at the Klink Cosmo Site. The horizontal extent of chlorinated solvents has been mostly delineated. It appears that the chlorinated solvents in the shallow and deep overburden have higher concentrations of PCE immediately north and east of the Klink Cosmo site. The extent of PCE has a larger footprint in the shallow groundwater compared to the deep groundwater and appears to be moving to the northeast and comingles with the dissolved chlorinated solvent plume originating within the nearby ACME Steel Areas. The horizontal extent of PCE impacted groundwater in the deep overburden near the top of the Raritan Formation has not been fully been delineated. The impacted groundwater appears to be migrating to the northeast and extends into the ACME Steel Areas in the vicinity the intersection of Porter Avenue and Lombardy Street. The vertical extent of PCE and TCE impacted groundwater was determined to extend down to the top of the Raritan Formation; however, it is not expected to migrate below the top of the Raritan Formation, approximately 110 feet bgs, due to its vast areal extent and low permeability.

5.0 GOALS/OBJECTIVES

5.1 Soil Vapor Extraction

The primary objectives of the SVE Pilot Test are:

- Demonstrate PCE and TCE mass reduction and estimate PCE and TCE mass removal rates via semi-quantitative and quantitative means.
- Develop full-scale SVE design parameter values, including ROI, locations and depths of extraction wells, intrinsic permeability, system and wellhead flowrates, and vacuum pressures.

5.2 Air Sparge

The primary objectives of the Air Sparge Pilot Test are:

- Determine the most effective configuration for contaminant removal using a combination of SVE and air sparge wells.
- Develop full-scale air sparge design parameter values, locations and depths of sparge wells, including system and wellhead flowrates and pressures.

6.0 SOIL VAPOR EXTRACTION SYSTEM CONSTRUCTION

The wellheads of the SVE, observation, and air sparge wells installed in April 2015 and existing groundwater monitoring wells will be modified as shown on Figures 5 through 7 for the Pilot Study. The wells will be connected to the SVE system via 2-inch hoses and camlock fittings. There are sufficient vacuum ports in the SVE system to accommodate each SVE well.

The SVE system is a trailer-mounted dual-phase vacuum extraction unit. It includes a 15 horsepower (HP) vacuum pump that is rated at a maximum vacuum of 23 inches of mercury (in Hg). The system is equipped with a knockout tank, oil/water separator, air stripper, bag filters, and granular activated carbon for extracted groundwater. The system will be rented from ProAct Services Corporation in Southbury, Connecticut (to be confirmed). Two sets of two, 55-gallon drums of vapor-phase carbon will be connected in parallel to the vacuum pump discharge to treat collected soil vapor prior to discharge to the atmosphere. Each pair of 55-gallon drums is connected in series (lead/lag configuration). Mass removal calculations indicate that approximately 160 pounds of PCE and TCE will be removed and treated during the pilot study (calculations presented in Attachment D). However, there is always uncertainty regarding the behavior of the subsurface formation, potential for extracting more concentrated vapors near the source area, and the possibility of treating other VOCs. As such, four spare drums will be kept onsite for insertion into the treatment stream in the event of breakthrough is detected after the lead carbon adsorber; at which point the lag adsorber will be moved to the lead position and an unused spare adsorber will be placed in the lag position.

The spent carbon adsorber will be taken offsite for proper recycling/disposal. Carbonair will provide the vapor phase carbon drums (to be confirmed).

A plan view of the SVE system appears in Figure 8. A piping and instrumentation diagram (P&ID) for the SVE system appears in Figure 9. Electrical power will be supplied from a commercial 75 kilowatt (kW) trailer-mounted diesel generator rented from a local vendor. The SVE Unit requires three-phase 230V, 200A power. A complete SVE Pilot Test Equipment and Materials List and the specifications for the SVE system are included in Attachment D.

7.0 AIR SPARGE SYSTEM CONSTRUCTION

The air sparge wellheads will be modified as shown in Detail A on Figure 7 for the Pilot Study. The wells will be connected to the Air Sparge system via 1-inch hoses and camlock fittings. There are sufficient blower ports in the air sparge system to accommodate each air sparge well.

The Air Sparge system consists of a trailer-mounted blower unit. It is housed in the same trailer as the SVE system. The 15 HP blower is rated at a maximum flow of 125 standard cubic feet per minute (scfm) at 22 pounds per square inch (psi). A P&ID for the air sparge unit appears in Figure 10. Electrical power will be supplied from the same commercial 75 kW trailer-mounted diesel generator as the SVE system. A complete Air Sparge Pilot Test Equipment and Materials List and the specifications for the blower unit are included in Attachment E.

8.0 SOIL VAPOR EXTRACTION PILOT STUDY PROCEDURES

The soil vapor extraction pilot study will be conducted over a 12-hour period after the SVE/Air Sparge trailer has been mobilized to the site and connected to the SVE wellheads.

8.1 <u>Monitoring Requirements</u>

VOC levels, flowrate, vacuum, and VOC concentrations will be monitored during the pilot study before carbon treatment. Vacuum will be monitored at the observation wells and select monitoring wells during the pilot study. Data will be recorded on the field forms in Attachment F.

Summa canisters of soil vapor will also be collected before carbon treatment at the beginning and end of each stepped-rate test and constant rate test for laboratory analysis to allow a quantitative analysis of contaminant removal to be performed.

8.2 Sequence of Operation

A series of 30 minute stepped-rate tests will be performed at various vacuums followed by a 2-hour constant-rate test at the maximum achievable vacuum. The stepped-rate testing will be performed on well SVE-1 first, SVE-2 second, and finally, SVE-1 and SVE-2 simultaneously, until the maximum obtainable vacuum pressure is achieved (design maximum vacuum is 23 in Hg). For the purposes of this study, we have conservatively planned for a total of 15 individual stepped-rate tests. Constant-rate testing will be performed on wells SVE-1 and SVE-2 simultaneously. The steps of each phase of testing are summarized in Table 1 and are described in detail below.

8.2.1 Stepped-Rate Testing

Step 1 Mobilize the generator and ProAct Unit 75 SVE/Air Sparge trailer to the site and make electrical connections with the assistance of the ProAct Representative (provider of SVE/Air Sparge trailer to be confirmed).

Step 2 Modify the wellheads at soil vapor extraction wells SVE-1 and SVE-2 as shown in Detail B on Figure 7. Modify the wellheads at observation wells OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D as shown in Detail C on Figure 7. Modify the wellheads at monitoring wells DEC-044, DEC-044D, DEC-031, DEC-031D as shown in Detail D on Figure 7. Make 2-inch diameter camlock connections with hoses at SVE-1 and SVE-2 and run the hoses to two separate ports at the SVE manifold inside of the trailer. Make the camlock connections at the piping manifold inside the trailer.

Step 3 Open the valve at the SVE manifold that leads to soil vapor extraction well SVE-1. Turn on vacuum pump VLR-500 and throttle the valve at the port on the SVE manifold leading to SVE-1 until the gauge there reads 5 in Hg. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 4 Measure the flowrate at the flowmeter at the SVE manifold that leads to soil vapor extraction well SVE-1. Record it on the field form in Attachment F. Repeat every 10 minutes. Measure the flowrate at the flowmeter after the vapor-phase activated carbon vessels. Record it on the field form in Attachment F. Repeat every 10 minutes.

Step 5 Measure the vacuum on the gauges at wells SVE-1, OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D and gauges at the SVE manifold. Measure the temperature at SVE-1 and after the vacuum pump. Record the data on the field form in Attachment F. Repeat every 10 minutes.

Step 6 Connect the combination photoionization/flame ionization detector (PID/FID) to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 7 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 8 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-1 until the gauge there reads 10 in Hg.

Step 9 Repeat steps 4 through 7.

Step 10 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-1 until the gauge there reads 15 in Hg.

Step 11 Repeat steps 4 through 7.

Step 12 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-1 until the gauge there reads 20 in Hg.

Step 13 Repeat steps 4 through 7.

Step 14 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-1 to maximize the vacuum pressure (design maximum vacuum is 23 in Hg).

Step 15 Repeat steps 4 through 7.

Step 16 After the readings are taken at 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off vacuum pump VLR-500. Close the valve at the SVE manifold that leads to soil vapor extraction well SVE-1. Open the valve at the SVE manifold that leads to soil vapor extraction well SVE-2.

Step 17 Turn on vacuum pump VLR-500 and throttle the valve at the port on the SVE manifold leading to SVE-2 until the gauge there reads 5 in Hg. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 18 Measure the flowrate at the flowmeter at the SVE manifold that leads to soil vapor extraction well SVE-2. Record it on the field form in Attachment F. Repeat every 10 minutes. Measure the flowrate at the flowmeter after the vapor-phase activated carbon vessels. Record it on the field form in Attachment F. Repeat every 10 minutes.

Step 19 Measure the vacuum on the gauges at wells SVE-2, OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D. Measure the temperature at SVE-2 and after the vacuum pump. Record the data on the field form in Attachment F. Repeat every 10 minutes.

Step 20 Connect the combination PID/FID to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 21 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 22 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-2 until the gauge there reads 10 in Hg.

Step 23 Repeat steps 18 through 21.

Step 24 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-2 until the gauge there reads 15 in Hg.

Step 25 Repeat steps 18 through 21.

Step 26 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-2 until the gauge there reads 20 in Hg.

Step 27 Repeat steps 18 through 21.

Step 28 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SVE manifold leading to SVE-2 to maximize the vacuum pressure (design maximum vacuum is 23 in Hg).

Step 29 Repeat steps 18 through 21.

Step 30 After the readings are taken at 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off vacuum pump VLR-500. Open the valve at the SVE manifold that leads to soil vapor extraction well SVE-1.

Step 31 Turn on vacuum pump VLR-500 and throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until the gauges at each port read 5 in Hg. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 32 Measure the flowrates at the flowmeters at the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Record them on the field form in Attachment F. Repeat every 10 minutes. Measure the flowrate at the flowmeter after the vapor-phase activated carbon vessels. Record it on the field form in Attachment F. Repeat every 10 minutes.

Step 33 Measure the vacuum on the gauges at wells SVE-1, SVE-2, OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D. Measure the temperature at SVE-1, SVE-2 and after the vacuum pump. Record the data on the field form in Attachment F. Repeat every 10 minutes.

Step 34 Connect the combination photoionization/flame ionization detector (PID/FID) to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 35 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 36 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until the gauges at each port read 10 in Hg.

Step 37 Repeat steps 32 through 35.

Step 38 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until the gauges at each port read 15 in Hg.

Step 39 Repeat steps 32 through 35.

Step 40 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until the gauges at each port read 20 in Hg.

Step 41 Repeat steps 32 through 35.

Step 42 After readings are taken at 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 to maximize the vacuum pressure (design maximum vacuum is 23 in Hg).

Step 43 Repeat steps 32 through 35.

Step 44 After the readings are taken at 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off vacuum pump VLR-500. Close the valves at the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Prepare for constant-rate testing.

8.2.2 Constant-Rate Testing

Step 1 Open the valves at the SVE manifold that lead to soil vapor extraction well SVE-1 and SVE-2.

Turn on vacuum pump VLR-500 and throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 to maximize the vacuum pressure (each gauge approximately reads 23 in Hg). Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 2 Measure the flowrates at the flowmeters at the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Record them on the field form in Attachment F. Measure the flowrate at the flowmeter after the vapor-phase activated carbon vessels. Record it on the field form in Attachment F.

Step 3 Measure the vacuum on the gauges at wells SVE-1, SVE-2, OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D. Measure the temperature at SVE-1, SVE-2 and after the vacuum pump. Record the data on the field form in Attachment F.

Step 4 Connect the combination PID/FID to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F.

Step 5 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment F. Repeat every 10 minutes.

Step 6 Repeat steps 2 through 5 every 10 minutes.

Step 7 After 120 minutes, connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 8 Turn off vacuum pump VLR-500. Close the valves at the ports on the SVE manifold that lead to wells SVE-1 and SVE-2. Prepare for air sparge testing.

9.0 AIR SPARGE PILOT STUDY PROCEDURES

The air sparge pilot study will be conducted over a 22-hour period after the SVE pilot testing.

9.1 Monitoring Requirements

VOC levels, flowrate, vacuum, and VOC concentrations will be monitored during the pilot study at the SVE wells and before carbon treatment. Pressure and flowrate will be measured at the SP wells. Pressure/vacuum will be monitored at the observation wells and select groundwater monitoring wells during the pilot study. Data will be recorded on the field forms in Attachment G.

Summa canisters of soil vapor will also be collected before carbon treatment at the beginning and end of each stepped-rate test and constant rate test for laboratory analysis to allow a quantitative analysis of contaminant removal to be performed.

9.2 Sequence of Operation

A series of 30 minute stepped-rate tests will be performed at various flowrates followed by a 2-hour constant-rate test at a single flowrate. The testing will be completed over one, 24-hour period. Air sparge will be introduced while SVE-1 and SVE-2 are simultaneously under maximum vacuum. Air sparge will initially be applied in one SP well at a time. SP-1 will be applied first, followed by SP-2, and then SP-3. Air sparge will then be applied two wells at a time. Wells SP-1 and SP-2 will be applied first, followed by SP-1 and SP-3, and then SP-2 and SP-3. Finally, air sparge will be introduced through wells SP-1, SP-2, and SP-3 simultaneously. For the purposes of this study, we have conservatively planned for a total of 26 individual stepped-rate tests. Constant-rate air sparge testing will be performed through SP wells SP-1, SP-2, and SP-3 simultaneously while wells SVE-1 and SVE-2 are simultaneously under maximum vacuum. The steps of each phase of testing are summarized in Table 2 and are described in detail below.

The stepped-rate testing will be performed on well SVE-1 first, SVE-2 second, and finally, SVE-1 and SVE-2 simultaneously, until the maximum obtainable vacuum pressure is achieved (design maximum vacuum is 23 in Hg). Constant-rate testing will be performed on wells SVE-1 and SVE-2 simultaneously.

9.2.1 Stepped - Rate Testing

Step 1 Make 1-inch diameter camlock connections with hoses at SP-1, SP-2, and SP-3 and run the hoses to three, separate ports at the SP manifold inside of the trailer. Make the camlock connections at the piping manifold.

Step 2 Open the valve at the SVE manifold that leads to soil vapor extraction well SVE-1. Open the valve at the SVE manifold that leads to soil vapor extraction well SVE-2. Turn on vacuum pump VLR-500 and throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until the gauges at each port read the maximum obtainable value observed during the SVE testing.

Step 3 Turn on air compressor DLR-250 and throttle the valve at the port on the SP manifold leading to SP-1 until the flowmeter there reads 25 scfm. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 4 Measure the pressure at the gauge at the SP manifold that leads to air sparge well SP-1. Record it on the field form in Attachment G.

Step 5 Measure the flowrate at the flowmeter at the SP manifold and after the vapor-phase activated carbon vessels. Record it on the field form in Attachment G.

Step 6 Measure the vacuum on the gauges at wells SVE-1 and SVE-2. Record them on the field form in Attachment G. Measure the pressure/vacuum on the gauges OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D. Measure the temperature at SVE-1, SVE-2 and after the vacuum pump. Record the data on the field form in Attachment G.

Step 7 Connect the combination PID/FID to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment G.

Step 8 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment G. Repeat every 10 minutes.

Step 9 Repeat steps 4 through 8 every 10 minutes.

Step 10 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-1 until the flowmeter reads 50 scfm. Repeat step 9.

Step 11 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-1 until the flowmeter reads 75 scfm. Repeat step 9.

Step 12 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-1 until the flowmeter reads 100 scfm. Repeat step 9.

Step 13 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-1 until the flowmeter reads 125 scfm. Repeat step 9.

Step 14 After 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valve at the SP manifold that leads to air sparge well SP-1. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valve at the SP manifold that leads to air sparge well SP-2.

Step 15 Repeat step 2.

Step 16 Turn on air compressor DLR-250 and throttle the valve at the port on the SP manifold leading to SP-2 until the flowmeter reads 25 scfm. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. Repeat steps 5 through 8.

Step 17 Measure the pressure at the gauge at the SP manifold that leads to air sparge well SP-2. Record it on the field form in Attachment G.

Step 18 Repeat steps 5 through 8 and 17 every 10 minutes.

Step 19 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-2 until the flowmeter reads 50 scfm and repeat step 18. Repeat step 18.

Step 20 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-2 until the flowmeter there reads 75 scfm. Repeat step 18.

Step 21 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-2 until the flowmeter reads 100 scfm. Repeat step 18

Step 22 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-2 until the flowmeter reads 125 scfm. Repeat step 18.

Step 23 After 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valve at the SP manifold that leads to air sparge well SP-2. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valve at the SP manifold that leads to air sparge well SP-3.

Step 24 Repeat step 2.

Step 25 Turn on air compressor DLR-250 and throttle the valve at the port on the SP manifold leading to SP-3 until the flowmeter reads 25 scfm. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 26 Measure the pressure at the gauge at the SP manifold that leads to air sparge well SP-3. Record it on the field form in Attachment G.

Step 27 Repeat steps 5 through 8 and 26 every 10 minutes.

Step 28 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-3 until the flowmeter reads 50 scfm. Repeat step 27.

Step 29 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-3 until the flowmeter reads 75 scfm. Repeat step 27.

Step 30 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-3 until the flowmeter reads 100 scfm. Repeat step 27.

Step 31 After 30 minutes (recording 4 rounds of data), throttle the valve at the port on the SP manifold leading to SP-3 until the flowmeter reads 125 scfm. Repeat step 27.

Step 32 After 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valve at the SP manifold that leads to air sparge well SP-3. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valves at the SP manifold that lead to air sparge wells SP-1 and SP-2.

Step 33 Repeat step 2.

Step 34 Turn on air compressor DLR-250 and throttle the valves at the ports on the SP manifold leading to SP-1 and SP-2 until the flowmeters at each port read 25 scfm.

Step 35 Measure the pressure at the gauges at the SP manifold that lead to air sparge wells SP-1 and SP-2. Record it on the field form in Attachment G.

Step 36 Repeat steps 5 through 8 and 35 every 10 minutes.

Step 37 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-1 and SP-2 until the flowmeters at each port read 50 scfm. Repeat step 36.

Step 38 After readings are taken at 30 minutes, throttle the valves at the ports on the SP manifold leading to SP-1 and SP-2 until the flowmeters at each port read approximately 62.5 scfm. Repeat step 36.

Step 39 After 30 minutes (recording 4 rounds of data), turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valves at the SP manifold that lead to air sparge wells SP-1 and SP-2. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valves at the SP manifold that lead to air sparge wells SP-1 and SP-3.

Step 40 Repeat step 2.

Step 41 Turn on air compressor DLR-250 and throttle the valves at the ports on the SP manifold leading to SP-1 and SP-3 until the flowmeters at each port read 25 scfm.

Step 42 Measure the pressure at the gauges at the SP manifold that lead to air sparge wells SP-1 and SP-3. Record it on the field form in Attachment G.

Step 43 Repeat steps 5 through 8 and 42 every 10 minutes

Step 44 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-1 and SP-3 until the flowmeters at each port read 50 scfm. Repeat step 43.

Step 45 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-1 and SP-3 until the flowmeters at each port read approximately 62.5 scfm. Repeat step 43.

Step 46 After 30 minutes (recording 4 rounds of data), turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valves at the SP manifold that lead to air sparge wells SP-1 and SP-3. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valves at the SP manifold that lead to air sparge wells SP-2 and SP-3.

Step 47 Repeat step 2.

Step 48 Turn on air compressor DLR-250 and throttle the valves at the ports on the SP manifold leading to SP-2 and SP-3 until the flowmeters at each port read 25 scfm.

Step 49 Measure the pressure at the gauges at the SP manifold that lead to air sparge wells SP-2 and SP-3. Record it on the field form in Attachment G.

Step 50 Repeat steps 5 through 8 and 49 every 10 minutes.

Step 51 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-2 and SP-3 until the flowmeters at each port read 50 scfm. Repeat step 50.

Step 52 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-2 and SP-3 until the flowmeters at each port read approximately 62.5 scfm. Repeat step 50.

Step 53 After 30 minutes (recording 4 rounds of data), turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valves at the SP manifold that leads to air sparge wells SP-2 and SP-3. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Open the valves at the SP manifold that lead to air sparge wells SP-1, SP-2, and SP-3.

Step 54 Repeat step 2.

Step 55 Turn on air compressor DLR-250 and throttle the valves at the ports on the SP manifold leading to SP-1, SP-2, and SP-3 until the flowmeters at each port read 25 scfm. Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 56 Measure the pressure at the gauges at the SP manifold that lead to air sparge wells SP-1, SP-2, and SP-3. Record it on the field form in Attachment G.

Step 57 Repeat steps 5 through 8 and 56 every 10 minutes.

Step 58 After 30 minutes (recording 4 rounds of data), throttle the valves at the ports on the SP manifold leading to SP-1, SP-2, and SP-3 until the flowmeters at each port read approximately 42 scfm. Repeat step 57.

Step 59 After 30 minutes (recording 4 rounds of data), connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis. After collecting the sample turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valves at the SP manifold that leads to air sparge wells SP-1, SP-2, and SP-3. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Prepare for constant-rate testing.

9.2.2 Constant - Rate Testing

Step 1 Open the valves at the SVE manifold that lead to soil vapor extraction well SVE-1 and SVE-2.

Step 2 Turn on vacuum pump VLR-500 and throttle the valves at the ports on the SVE manifold leading to SVE-1 and SVE-2 until maximum vacuum pressure is obtained in both legs.

Step 3 Turn on air compressor DLR-250 Open the valves at the SP manifold that lead to air sparge wells SP-1, SP-2, and SP-3 and throttle the valves at the ports on the SP manifold leading to SP-1, SP-2, and SP-3 until the flowmeters at each port read a maximum flowrate of approximately 42 scfm.

Step 4 Connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 5 Measure the pressure at the gauges at the SP manifold that lead to air sparge wells SP-1, SP-2, and SP-3. Record it on the field form in Attachment G.

Step 6 Measure the flowrate at the flowmeters at the SP manifold and after the vapor-phase activated carbon vessels. Record it on the field form in Attachment G.

Step 7 Measure the vacuum on the gauges at the SVE manifold and at wells SVE-1 and SVE-2. Record them on the field form in Attachment G.

Step 8 Measure the pressure/vacuum on the gauges OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, OW-4D, DEC-044, DEC-044D, DEC-031, and DEC-031D. Record them on the field form in Attachment G.

Step 9 Connect the combination PID/FID to the sample port immediately before the vapor-phase activated carbon vessels using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment G.

Step 10 Connect the combination PID/FID to the sample port in between each the vapor-phase activated carbon trains (vessels connected in series) using Tygon® tubing. Open the valve at the sample port. Measure the VOC concentration in both PID mode and FID mode. Record them on the field form in Attachment G. Repeat every 10 minutes.

Step 12 Repeat steps 5 through 10 every 10 minutes.

Step 14 After 120 minutes, connect a summa canister to the sample port immediately before the vapor phase carbon vessels using Tygon® tubing and collect a vapor sample by opening the sample port valve. Transport the sample canister to an analytical laboratory for analysis.

Step 15 Turn off the air compressor DLR-250 first, followed by the vacuum pump VLR-500. Close the valves at the SP manifold that leads to air sparge wells SP-1, SP-2, and SP-3. Close the valves on the SVE manifold that lead to soil vapor extraction wells SVE-1 and SVE-2. Prepare for demobilization.

10.0 SUBCONTRACTORS

ProAct Services Corporation in Southbury, Connecticut will be subcontracted to provide the SVE/SP unit (to be confirmed). Catalog cuts of equipment are presented in Attachment D.

Con-Test Laboratories, Inc. will be subcontracted to provide analytical services for the vapor samples and waste characterization sampling, if required.

Pine Environmental Services will be subcontracted to provide the combination FID/PID.

Carbonair will provide eight 250 pound vapor phase activated carbon canisters (GPC 3.85), and will transport and dispose of spent vapor phase carbon canisters (to be confirmed). Catalog cuts of equipment are presented in Attachment D.

GT Power Systems, Inc. will be subcontracted to provide and transport the electrical generator, and two temporary exterior portable light towers. Catalog cuts of equipment are presented in Attachment D.

Johnny on the Spot, Inc. will provide the portable temporary fencing Attachment D.

AARCO Environmental Services will be subcontracted to transport and dispose of waste materials generated during the pilot test.

11.0 HEALTH AND SAFETY PLAN

A health and safety plan has been prepared for the site and will be stored in the SVE/SP trailer during the pilot test.

12.0 PERMITTING

A New York City Department of Transportation (NYCDOT) permit will be required prior to commencing the pilot study.

13.0 INVESTIGATION DERIVED WASTES (IDW)

All IDW including personal protective equipment, entrained groundwater, etc., will be contained in DOT-approved containers with tight fitting lids. Provisions for the proper handling, testing, and disposal of IDW materials will be arranged prior to commencement of field activities. Filled containers will be removed from the Site on a daily basis.

14.0 CONCLUSIONS/ RECOMMENDATIONS

A SVE/SP Pilot Study Report will be developed to present the procedures used for the stepped-rate and constant-rate tests. The report will include a summary of our findings, recommendations and conclusions. Data collected during the study will be used to determine the following:

- If SVE/SP is effective for removing VOC constituents and should be developed further as part of a feasibility study.
- The optimum extraction rate and vacuum pressure

- Determine the radius of influence created under optimum conditions
- Removal rates of VOC constituents
- The intrinsic permeability of the media
- The most effective configuration for removing VOC constituents using a combination of SVE and air sparge wells. Locations, depths, diameters, and screen lengths for SVE and SP wells will be identified.
- Full-scale SVE design parameters values, including equipment sizing, system and wellhead flowrates, vacuum, and pressures.

TABLES

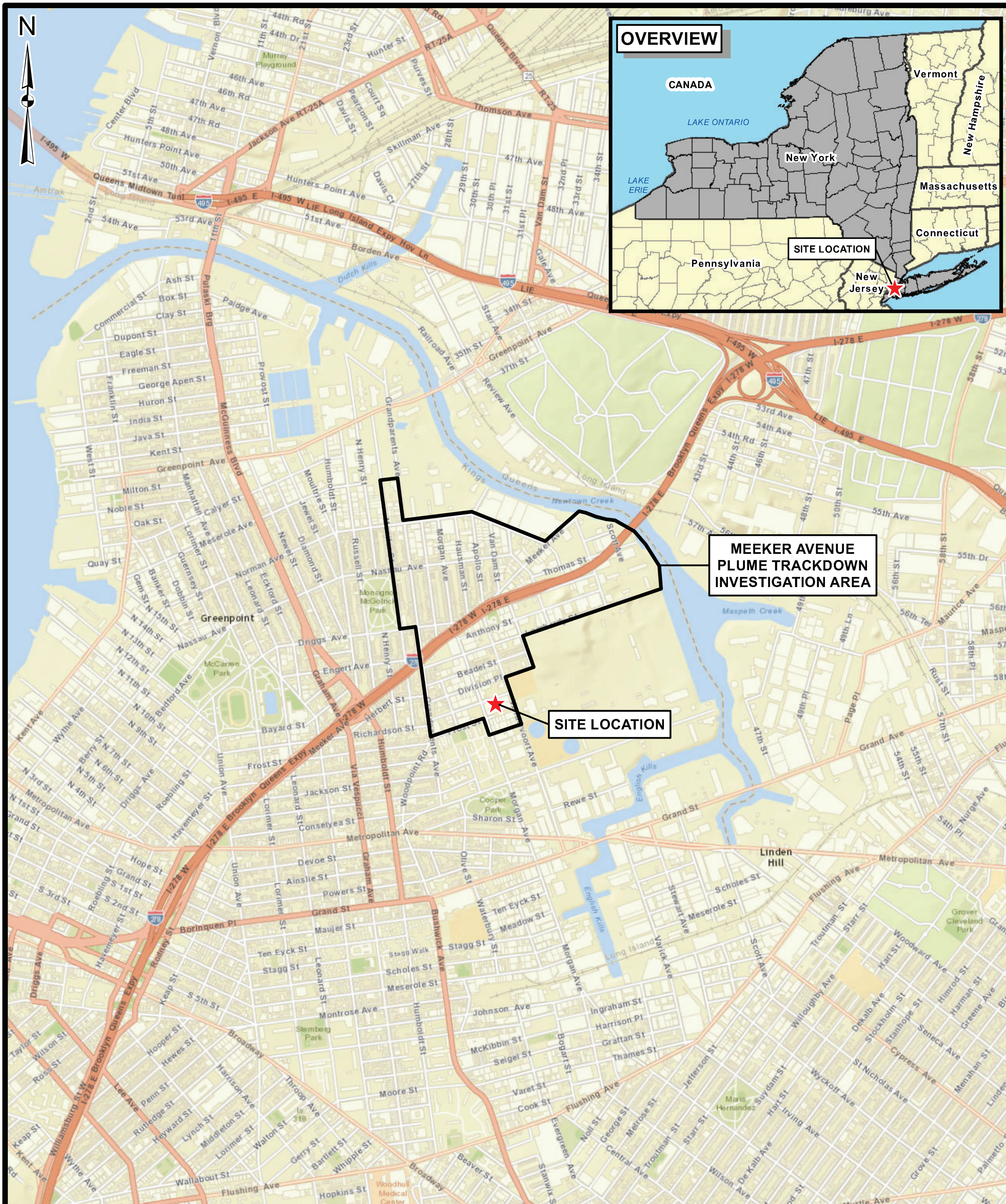
Table 1 - Soil Vapor Extraction Testing Summary

Sequence No.	Extraction Well SVE-1	Extraction Well SVE-2	Target Vacuum (in Hg)	Air Sample Summa Canisters
1	X		5	X
2	X		10	
3	X		15	
4	X		20	
5	X		maximum	X
6		X	5	X
7		X	10	
8		X	15	
9		X	20	
10		X	maximum	X
11	X	X	5	X
12	X	X	10	
13	X	X	15	
14	X	X	20	
15	X	X	maximum	X
16 (Constant Rate)	X	X	maximum	XX

Table 2 - Air Sparge Testing Summary

Sequence No.	Air Sparge Well-SP-1 Target Flowrate (scfm)	Air Sparge Well-SP-2 Target Flowrate (scfm)	Air Sparge Well-SP-3 Target Flowrate (scfm)	Air Sample Summa Canisters
1	25			X
2	50			
3	75			
4	100			
5	125			X
6		25		X
7		50		
8		75		
9		100		
10		125		X
11			25	X
12			50	
13			75	
14			100	
15			125	X
16	25	25		
17	50	50		
18	62.5	62.5		
19	25		25	
20	50		50	
21	62.5		62.5	
22		25	25	
23		50	50	
24		62.5	62.5	
25	25	25	25	X
26	42	42	42	X
27 (Constant Rate)	42	42	42	XX

FIGURES



Source: ESRI World Street Map

2,000 0 2,000 Feet

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FORMER KLINK COSMO CLEANERS SITE
SITE LOCATION

FIGURE 1

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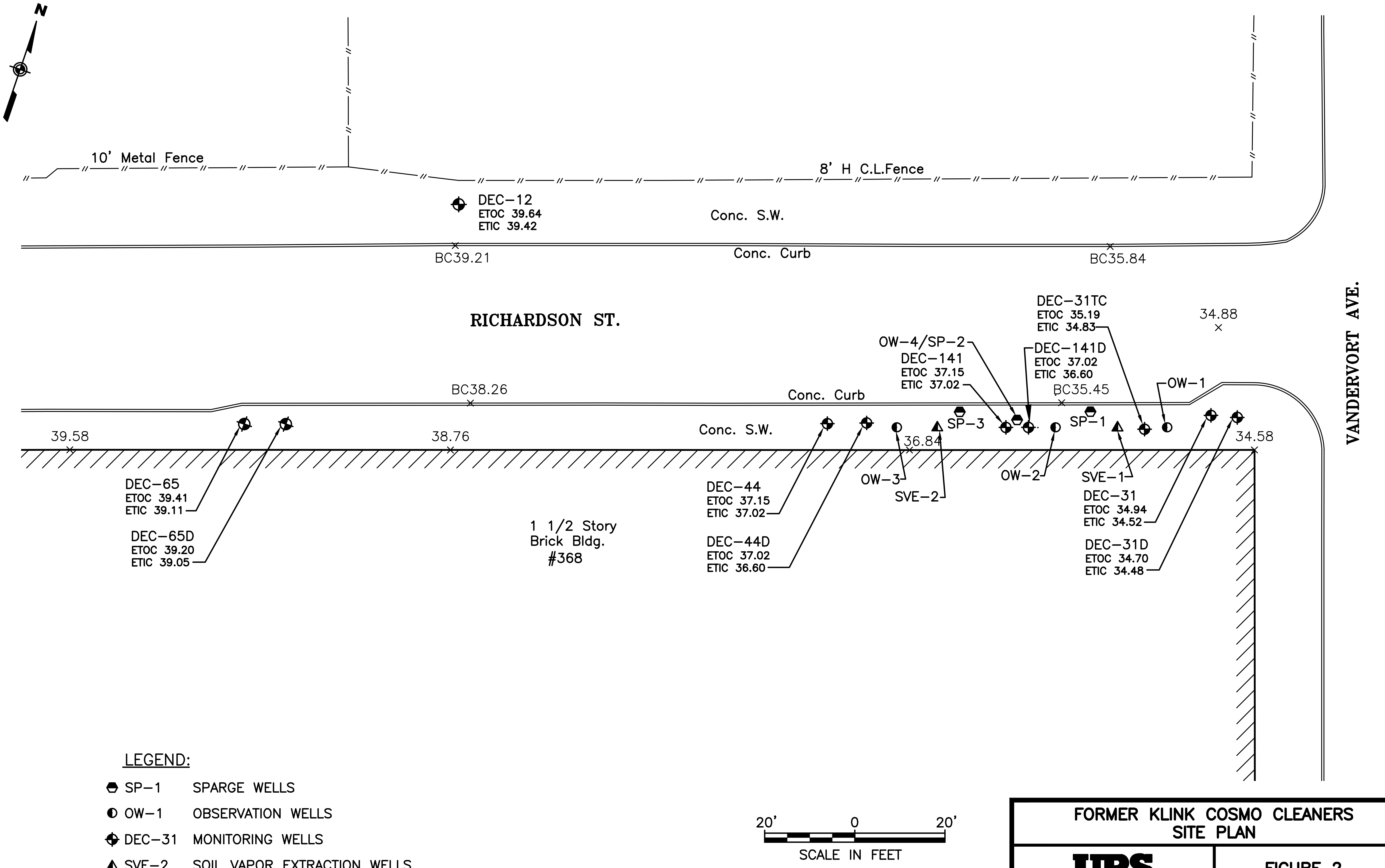

FORMER KLINK COSMO CLEANERS
SITE PLAN

URS

FIGURE 2

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Legend

▲ NYSDEC Soil Vapor Implant

NOTE: Units are in μg/m^3

SOURCE: Bing Maps Aerial (c) 2010 Microsoft Corporation

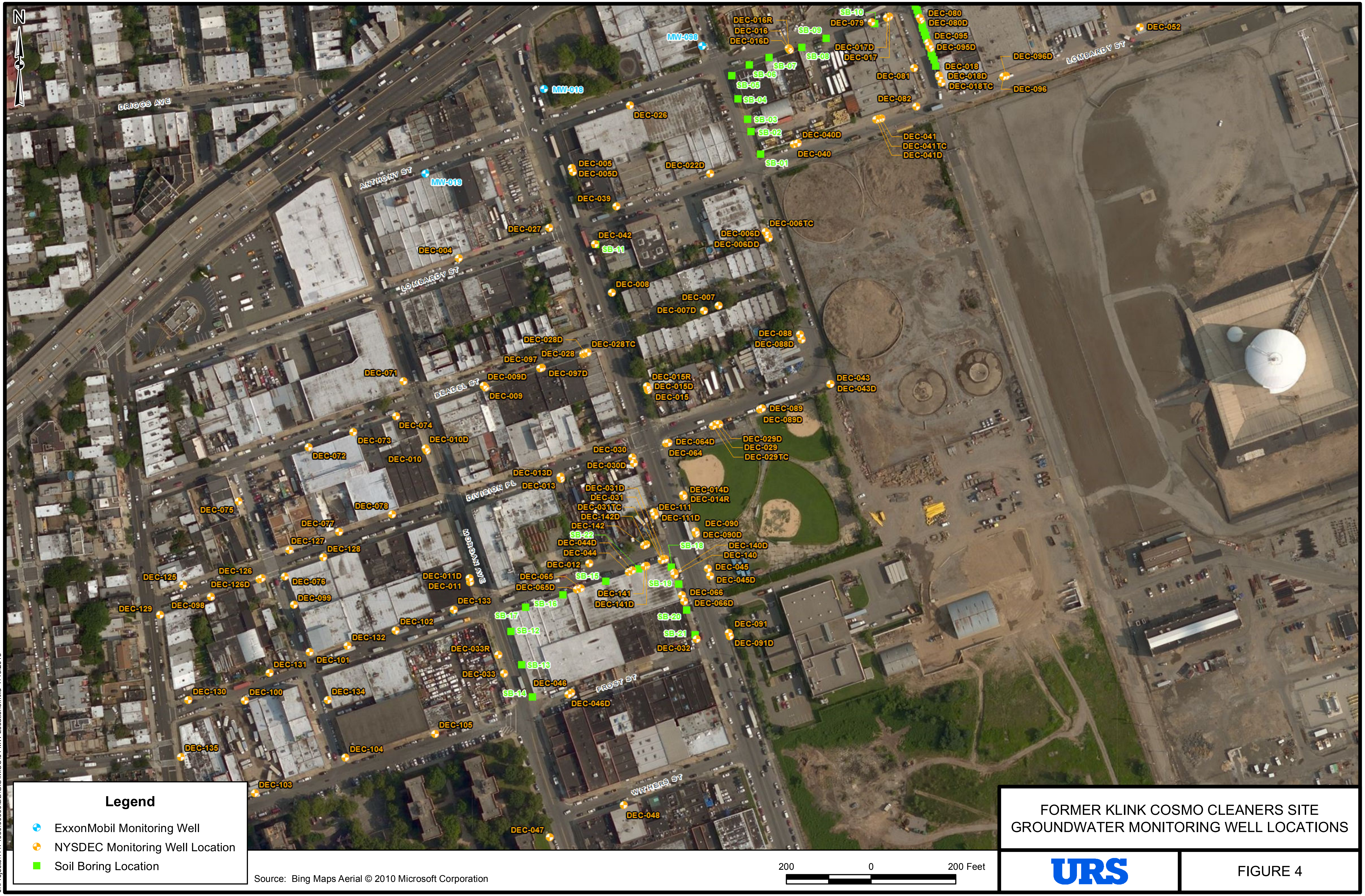
200 0 200 Feet

FORMER KLINK COSMO CLEANERS SITE
SC PHASE I - III & VI CONCENTRATIONS OF
PCE AND TCE IN SOIL VAPOR

URS

FIGURE 3

J:\Projects\11174989.00000\DB\GIS\MISC\KlinkCosmo\03 SG PCE and TCE.mxd 6/16/2015 MDL



FORMER KLINK COSMO CLEANERS SITE
GROUNDWATER MONITORING WELL LOCATIONS

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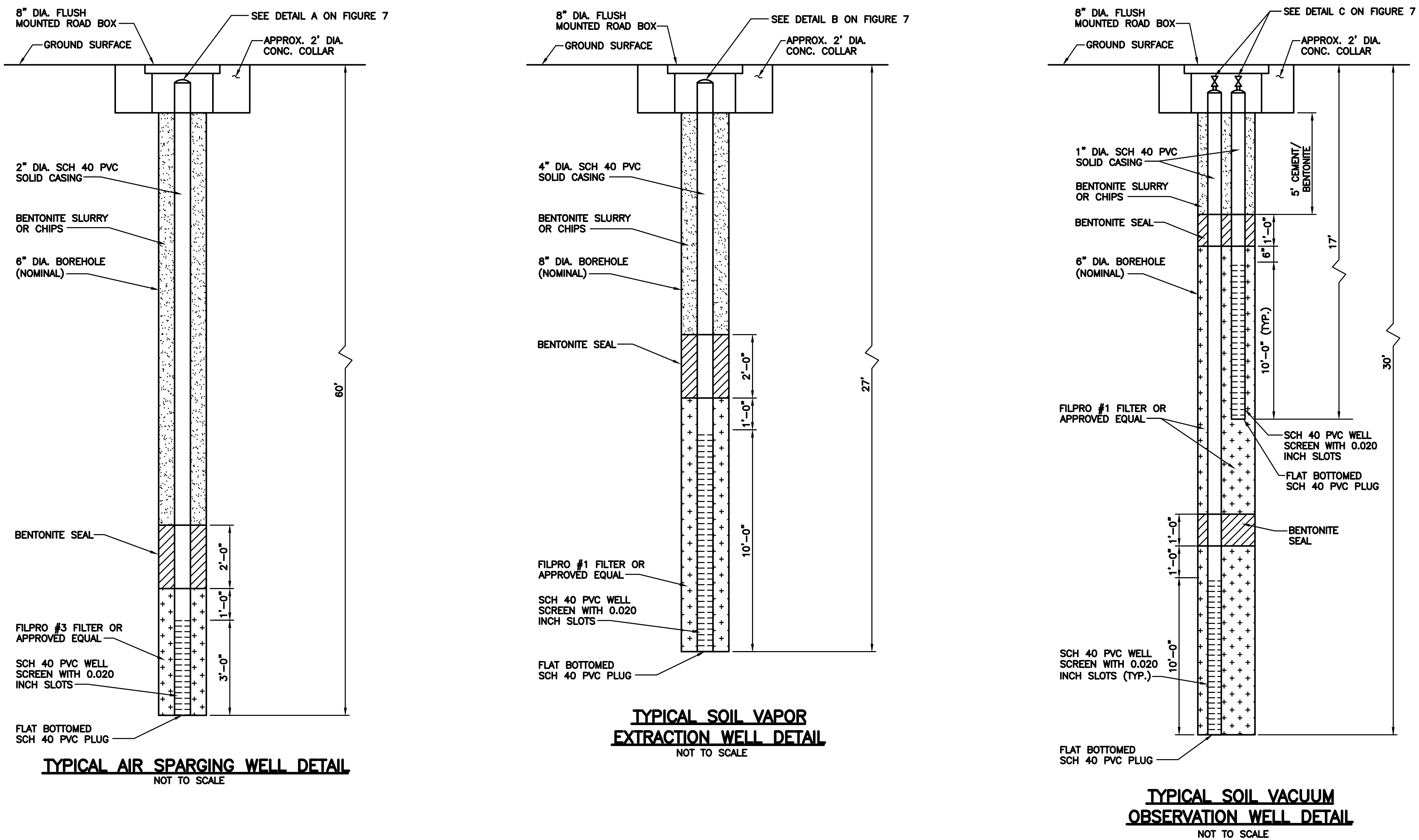
FIGURE 4

J:\Projects\11174989.00000\DB\GIS\MISC\04 MW Locations.mxd 7/10/2015



FORMER KLINK COSMO CLEANERS SITE
PILOT STUDY WELL DETAILS–SHEET 1 OF 3

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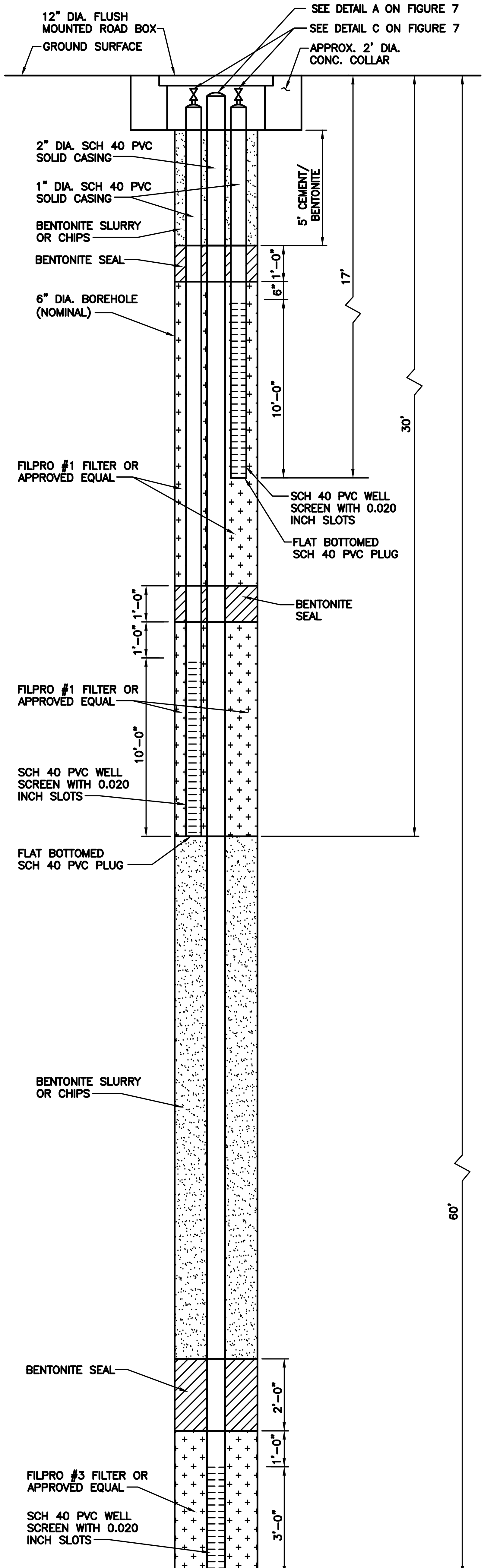
FIGURE 5

J:\Projects\11176390\CAD\Pilot test work plan #1\PILOT TEST WORK PLAN 1.dwg 7/13/15 – 2 RAL



SP-2/OW-4 SOIL VACUUM OBSERVATION WELL & AIR SPARGING WELL DETAIL

NOT TO SCALE

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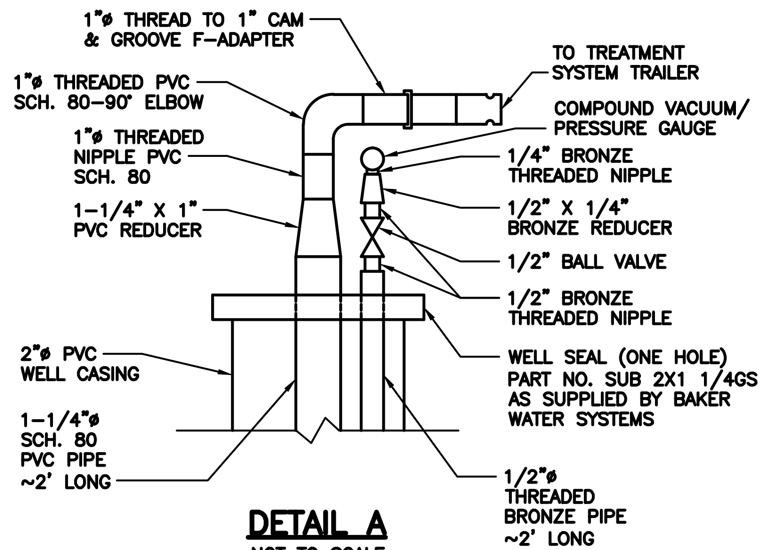
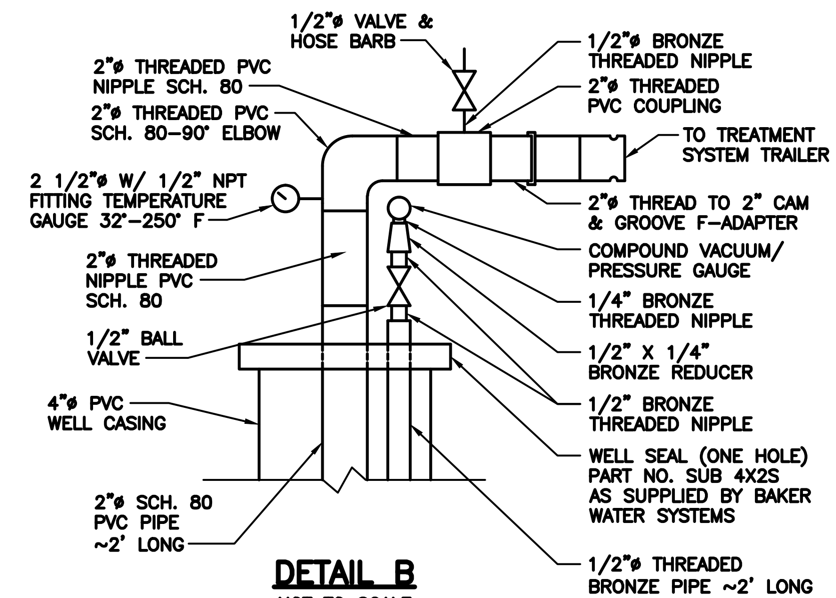
PILOT STUDY WELL DETAILS–SHEET 2 OF 3

URS

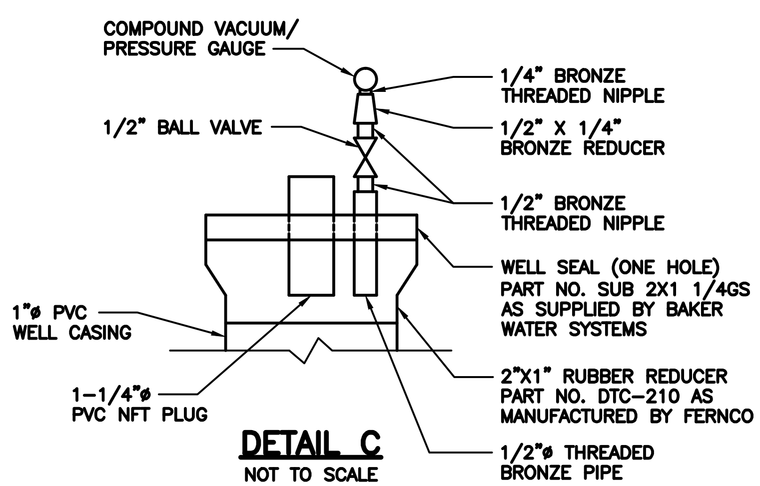
FIGURE 6



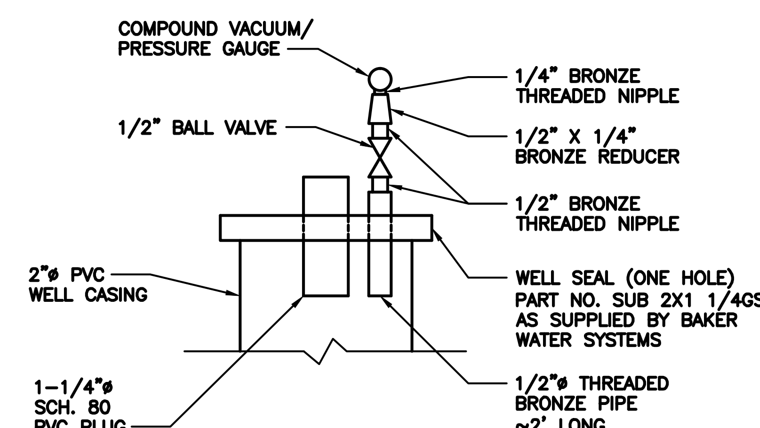
DETAIL A
NOT TO SCALE



DETAIL B
NOT TO SCALE



DETAIL C
NOT TO SCALE



DETAIL D
MONITORING WELL HEAD DETAIL
NOT TO SCALE

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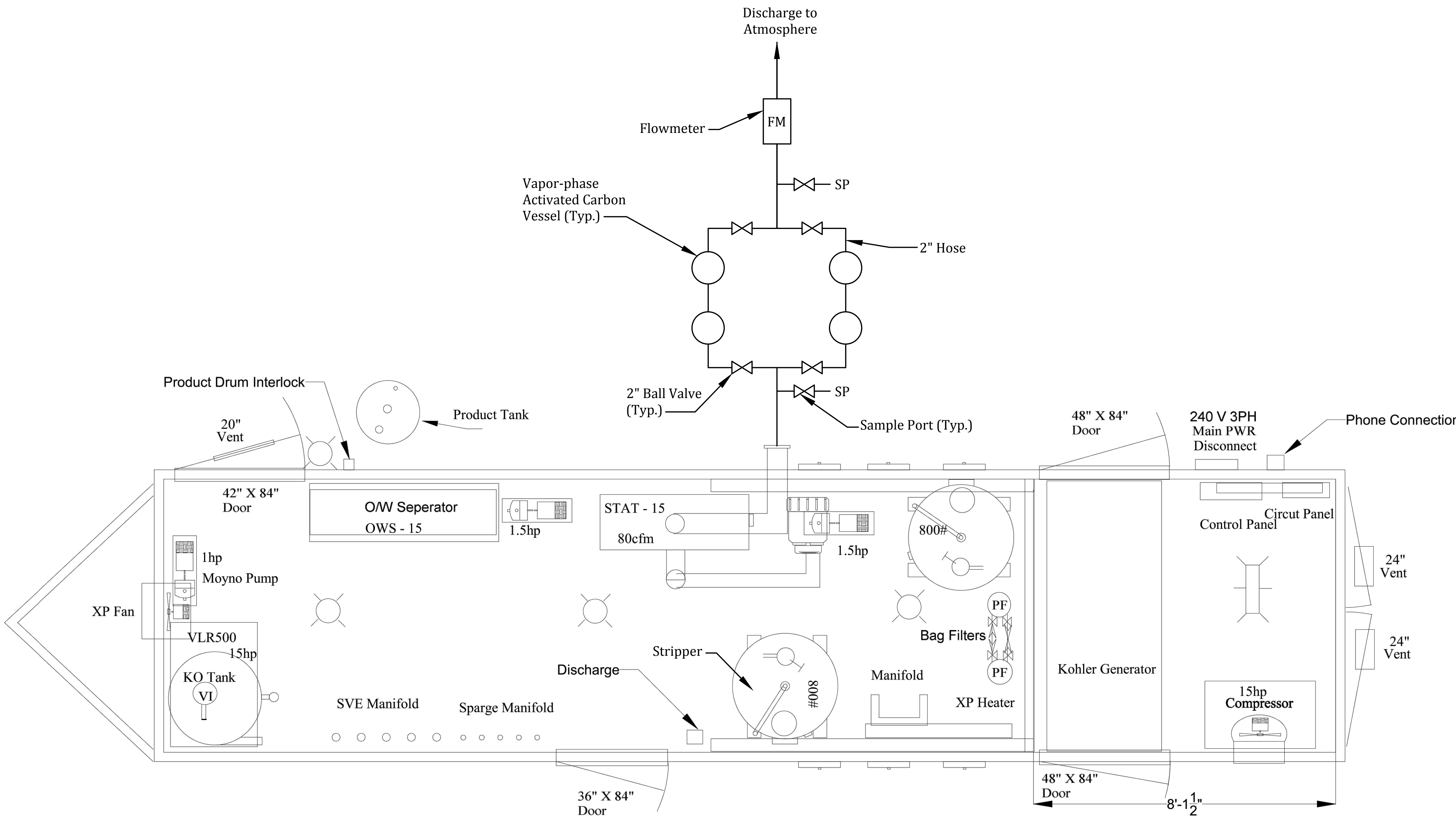
PILOT STUDY WELL DETAILS–SHEET 3 OF 3

URS

FIGURE 7

J:\Projects\11176390\CAD\Pilot test work plan #1\PILOT TEST WORK PLAN 1.dwg 7/29/15 - 2 RAL



FORMER KLINK COSMO CLEANERS SITE
SVE/AIR SPARGE UNIT PLAN VIEW

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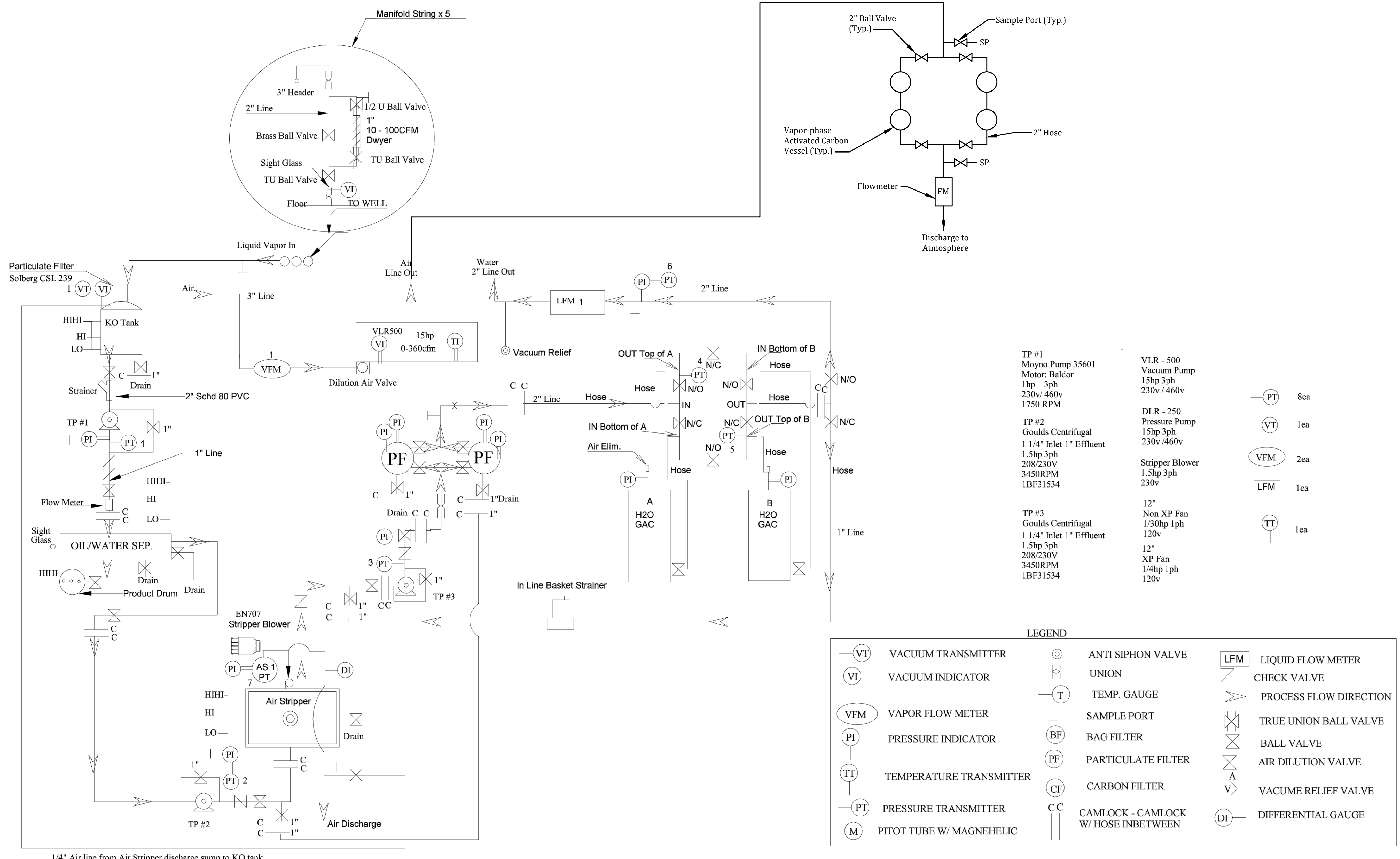
FIGURE 8

J:\Projects\11176390\CAD\Pilot test work plan #1\FIGURE 8.dwg 7/13/15 - 2 RAL

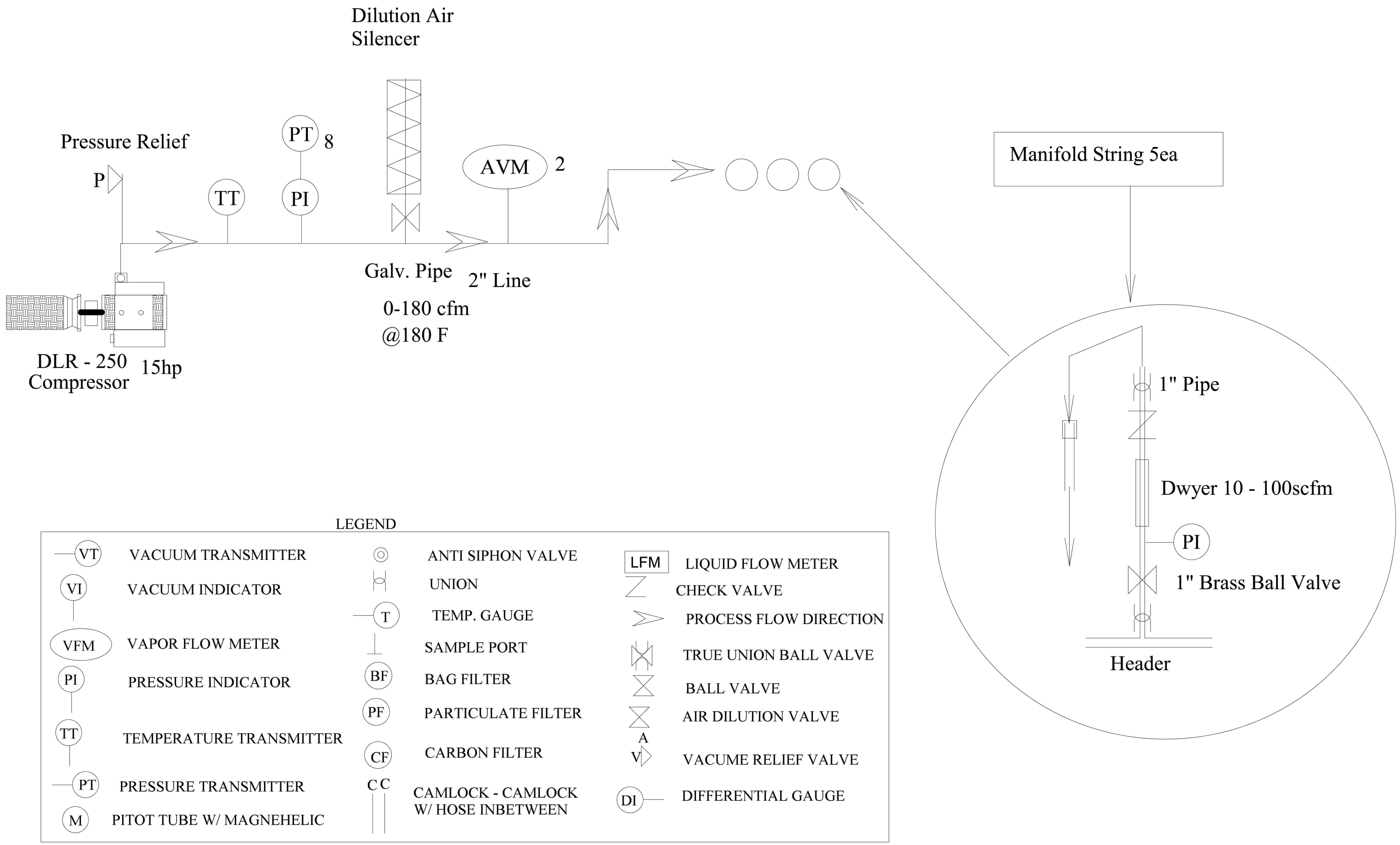


FORMER KLINK COSMO CLEANERS SITE
SVE UNIT P&ID

URS

FIGURE 9

J:\Projects\11176390\CAD\Pilot test work plan #1\FIGURE 9.dwg 7/13/15 - 2 RAL



FORMER KLINK COSMO CLEANERS SITE
AIR SPARGE UNIT P&ID

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FIGURE 10

J:\Projects\11176390\CAD\Pilot test work plan #1\FIGURE 10.dwg 7/13/15 - 2 RAL

ATTACHMENT A

APRIL 28, 2015

NYSDEC CORRESPONDENCE

April 28, 2015

Ms. David Harrington, P.E.
Project Manager
New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway
Albany, NY 12233-7010

RE: NYSDEC Standby Contract C007540
Former Klink Cosmo Cleaners, Site No. 224130
Soil Vapor Extraction / Air Sparge Pilot Study Well Locations and Design
WA # C007540-4.1

Introduction and Background

Chlorinated solvents including tetrachloroethene (PCE) and trichloroethene (TCE) have been detected in soil vapor, soil, and groundwater samples at concentrations significantly above New York State Standards, Criteria, and Guidance (SCGs) values in the vicinity of the former Klink Cosmo Cleaner Site, in Brooklyn NY (Site). The remedial action goal for the Site is to eliminate or mitigate all significant threats to human health and/or the environment, to the extent practicable, caused by contaminants present due to the release of PCE from the former dry cleaners onsite. In order to meet this goal, remedial action objectives (RAOs) have been established to protect human health and the environment. These RAOs provide the basis for selecting appropriate technologies and developing remedial alternatives. RAOs were established on the basis of contaminated media, SCGs for the site (especially Part 375 soil cleanup objectives), the results of Phase 2 of the Klink Cosmo Remedial Investigation (URS, December, 2011), and the qualitative human health exposure assessment.

Media	For:	Remedial Action Objectives
Soil Vapor/ Outdoor Air	Public Health Protection	o Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings and/or outdoor air.
Groundwater	Public Health Protection	o Prevent human exposure (ingestion, contact with, or inhalation of volatiles) to contaminated groundwater;
	Environmental Protection	o Remove the source of groundwater contamination, and o Restore groundwater aquifer to pre-release conditions, to the extent possible.

In accordance with Task 5 of Amendment Request #1 to Work Assignment (WA) # C007540-4.1, URS will perform a pilot study adjacent to the Site to obtain data that will be used to evaluate and assess the effectiveness of soil vapor extraction (SVE) and air sparge (AS) technologies to remediate and mitigate the contaminants at the Site. This data will also be used to develop full-scale treatment for further consideration in the FS along with other remedial alternatives.

Groundwater is approximately 32 feet below ground surface (bgs). Analytical data collected from soil vapor implants (SG-49, SG-58, SG-84, and SG-85), monitoring wells (DEC-31, DEC-31D, DEC-031TC, DEC-44, and DEC-44D), and soil borings (SB-15, SB-16, SB-18, and SB-22) were evaluated and used to determine the area that the pilot study will be performed. The pilot study will be conducted along the south side of Richardson Street near the intersection of Vandervort Avenue between monitoring wells clusters DEC-31 and DEC-44D. Three air sparge (SP), two SVE, and four pairs of soil vacuum monitoring point [i.e., observation wells (OW)] will be constructed as part of the pilot study program. Locations of these wells and two additional monitoring wells (DEC-141 and DEC-141D) were selected based on contaminant levels in the soil vapors and groundwater. Actual locations were determined in the field during the week of April 13th, 2015 and are presented on Figure 1.

All well locations will be cleared to 5 feet bgs using a Vac-Tron© prior to drilling to confirm the absence of any buried utilities. Figure 2 presents an elevation of the proposed SP, SVE, and OW pairs in relation to the existing and proposed (DEC-141 and DEC-141D) monitoring wells. Geologic strata used to size the well screens and filter material is also presented on Figure 2. Figure 3 presents construction details for air sparge, soil vapor extraction, and observation wells. Figure 4 presents a detail for the combination sparge (SP-2) / observation (OW-4 and OW-4D) well cluster.

Air Sparge Wells

Two 6-inch diameter boreholes will be advanced 60 feet bgs, approximately 28 feet below the groundwater surface, using sonic drilling methods. Soils will be screened using a photoionization detector (PID). A third AS/ combination OW well cluster will also be installed and the details are presented in a separate section below. Up to two soil samples will be collected from each boring from the areas exhibiting the highest PID readings for analysis of Target Compound List (TCL) volatile organic compounds (VOCs). Two sparge wells (SP-1 and SP-3) will be constructed to a depth of 60 feet below grade. The wells will be constructed with 2-inch diameter schedule 40 polyvinylchloride (PVC) screens in the bottom 3 feet of each solid PVC riser. The filter pack surrounding the 20-slot well screen shall be FilPro #3 or an approved equal. The filter pack will extend approximately 1 foot above the well screen. Bentonite chips will be placed approximately 2 feet above the filter pack. A bentonite slurry mixture or bentonite chips will extend upward from the filter pack to grade. An 8-inch diameter flush mounted well box will be installed to protect the well.

Soil Vapor Extraction Wells

Two 8-inch diameter boreholes will be advanced to approximately 27 feet bgs, approximately 5 feet above the water table, using sonic drilling methods. Soils will be screened using a PID. Up to two soil samples will be collected from each boring from the areas exhibiting the highest PID readings for analysis of TCL VOCs. The SVE wells will be constructed with 4-inch diameter schedule 40 PVC screens in the bottom 10 feet of each solid PVC riser. The filter pack surrounding the 20-slot well screen shall be FilPro #1 or an approved equal. The filter pack will extend approximately 1 foot above the well screen. Bentonite pellets or chips will be placed 2 feet above the filter pack. A bentonite slurry mixture or bentonite chips will extend upward from the filter pack to grade. An 8-inch diameter flush mounted well box will be installed to protect the well.

Soil Vacuum monitoring Points/Observation Wells

Three 6-inch diameter boreholes will be advanced to approximately 30 feet bgs, approximately 2 feet above the groundwater surface, using sonic drilling methods. Soils will be screened using a PID. Up to two soil samples will be collected from each boring from the areas exhibiting the highest PID readings for analysis of TCL VOCs. Three observation well pairs (OW-1, OW-1D, OW-2, OW-2D, and OW-3, OW-3D) will be constructed side by side in the same borehole extending to different depths. The shallower observation wells (OW-1, OW-2, and OW-3) will extend approximately 17 feet bgs while the deep wells (OW-1D, OW-2D, and OW-3D) will extend to approximately 30 feet bgs. The wells will be constructed with 1-inch diameter schedule 40 PVC screens in the bottom 10 feet of each solid PVC riser. The filter pack surrounding the 20-slot well screen shall be FilPro #1 or an approved equal. The filter pack will extend approximately 1 foot above the well screens at the deeper wells and 6-inches above the well screen at the shallower wells. Bentonite chips will be placed 1 foot above the filter pack in the deeper and shallower wells. A cement/bentonite mixture will extend upward from the filter pack to grade. An 8-inch diameter flush mounted well box will be installed to protect the well pairs.

Air Sparge/ Soil Vacuum Monitoring Points - Observation Well Cluster

A 6-inch diameter borehole will be advanced 60 feet bgs, approximately 28 feet below the groundwater surface, using sonic drilling methods. Soils will be screened using a photoionization detector (PID). Up to two soil samples will be collected from the areas exhibiting the highest PID readings for analysis of TCL VOCs. Sparge well SP-2 will be constructed to a depth of 60 feet bgs. The well will be constructed with 2-inch diameter schedule 40 PVC screen in the bottom 3 feet of the solid PVC riser. The filter pack surrounding the 20-slot well screen shall be FilPro #3 or an approved equal. The filter pack will extend approximately 1 foot above the well screen. Bentonite chips will be placed approximately 2 feet above the filter pack. A cement/bentonite mixture will extend upward from the filter pack to 30 feet bgs.

Observation well pair OW-4 and OW-4D will be constructed on each side of SP-2 in the same borehole. OW-4 will extend 17 feet bgs and OW-4D will extend 30 feet bgs. The OWs will be constructed with 1-inch diameter schedule 40 PVC screens in the bottom 10 feet of each solid PVC riser. The filter pack surrounding the 20-slot well screen shall be FilPro #1 or an approved equal. The filter pack will extend approximately 1foot above the well screens at OW-4D and 6-inches above the well screen at OW-4. Bentonite chips will be placed approximately 1 foot above the filter packs in both OW-4 and OW-4D. A bentonite slurry mixture or bentonite chips will extend upward from the filter pack above OW-4 to grade. A 12-inch diameter flush mounted well box will be installed over SP-2, OW-4, and OW-4D to protect the well cluster.

Development of Air Sparge Wells

SP-1, SP-2, and SP-3 will be developed a minimum of 24 hours following their completion. Approximately 100 gallons of development water will be removed from each well and drummed for testing and disposal offsite.

Disposal of IDW

All investigation derived wastes (IDW) including personal protective equipment, soil cuttings, development water, etc. must be contained in DOT-approved containers with tight fitting lids. Provisions for the proper handling, testing, and disposal of IDW materials will be arranged prior to commencement of field activities. Filled containers will be removed from the Site on a daily basis.

PILOT STUDY WELL CONSTRUCTION SUMMARY

Well ID	Design Materials	Screen Size	Filter Pack	Screen Depth Setting (Ft bgs)	Curb Box Ø (In)	Well Location Rationale
SP-1	2"Ø Sch.40 PVC	0.020" slot	FilPro #3	57 - 60	8	Highest PCE & TCE levels in groundwater at DEC-31 & DEC-44, screened 30-45' bgs. Did not want to sparge at highest concentration (DEC-31) to mitigate migration of PCE & TCE during Pilot Study. Dissolved-phase is believed to extend deeper than 45' bgs. Introduce air 15' below screen interval (normally 10-15' below contaminants).
SP-2	2"Ø Sch.40 PVC	0.020" slot	FilPro #3	57 - 60	8	
SP-3	2"Ø Sch.40 PVC	0.020" slot	FilPro #3	57 - 60	12	
SVE-1	4"Ø Sch.40 PVC	0.020" slot	FilPro #1	17 - 27	8	Soil vapor samples collected ~ 8' bgs within the fine/med sand strata from Implant Wells. SVE well screens set 5' above water table to minimize entrainment of water into treatment system.
SVE-2	4"Ø Sch.40 PVC	0.020" slot	FilPro #1	17 - 27	8	
OW-1	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	7 - 17	8	OW pairs will be installed ~ 9', 12', 14', 18', and 26' away from the SVE wells. Should be able to determine the radius of influence (ROI) in the formation with these intervals. Should also be able to determine how the ROI changes at depth as OW pairs will extend 7-17' bgs and 20-30' bgs. PID readings will also be collected to determine VOC concentrations at depth during soil vapor extraction and while air sparging.
OW-1D	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	20 - 30	8	
OW-2	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	7 - 17	8	
OW-2D	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	20 - 30	8	
OW-3	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	7 - 17	8	
OW-3D	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	20 - 30	8	
OW-4	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	7 - 17	12	
OW-4D	1"Ø Sch.40 PVC	0.020" slot	FilPro #1	20 - 30	12	

Pilot Study Implementation

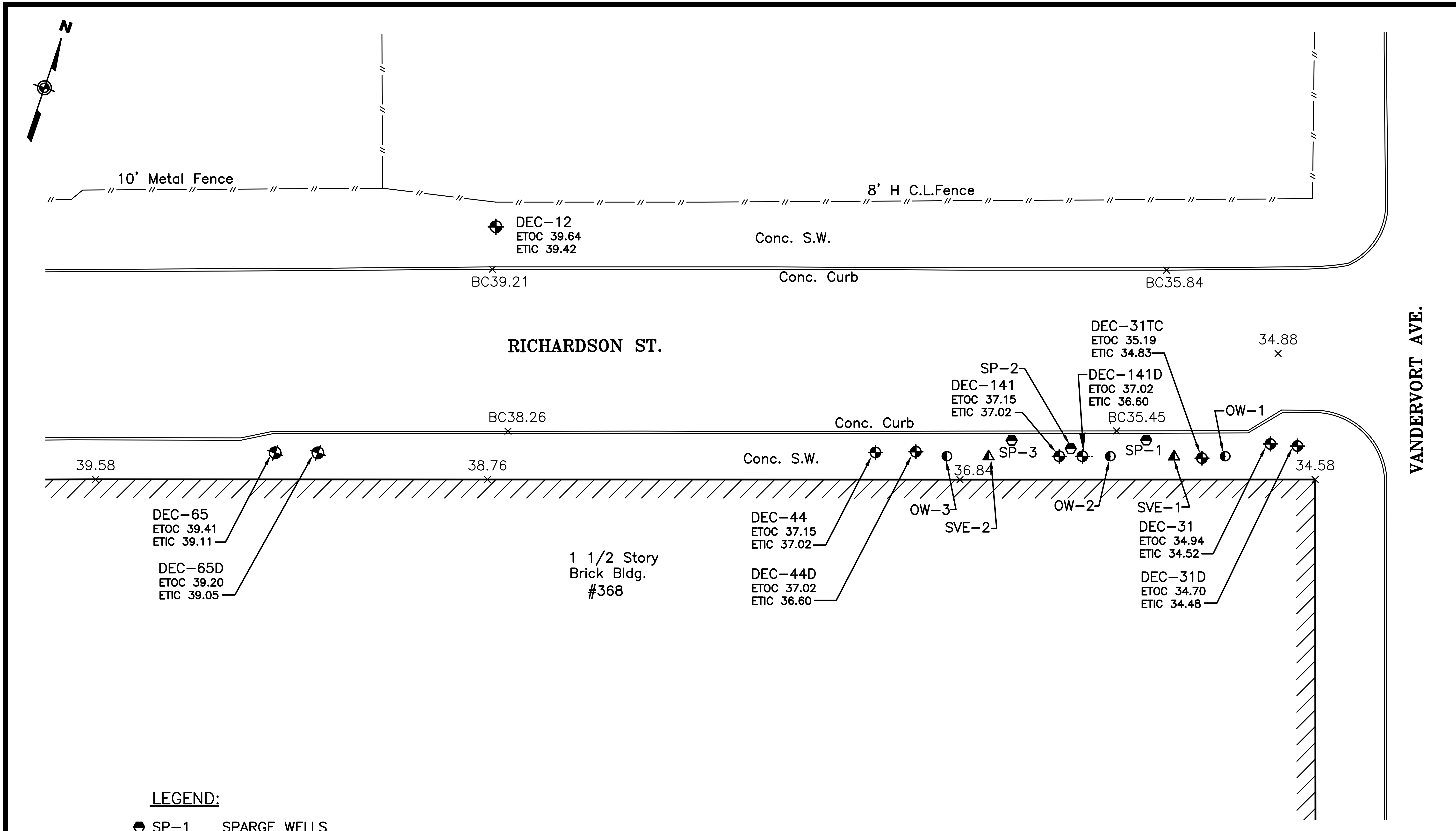
A Work Plan for the pilot study implementation will be submitted separately.

We appreciate the opportunity to serve the Department on this interesting and challenging project. If you should have any questions, please contact me.

Sincerely,

Michael Gutmann
Project Manager

cc: John Lysiak, URS
Mark Lang, P.E., VP, URS
File 11176390 (WA-1)



FORMER KLINK COSMO CLEANERS
SITE PLAN

URS

FIGURE 1

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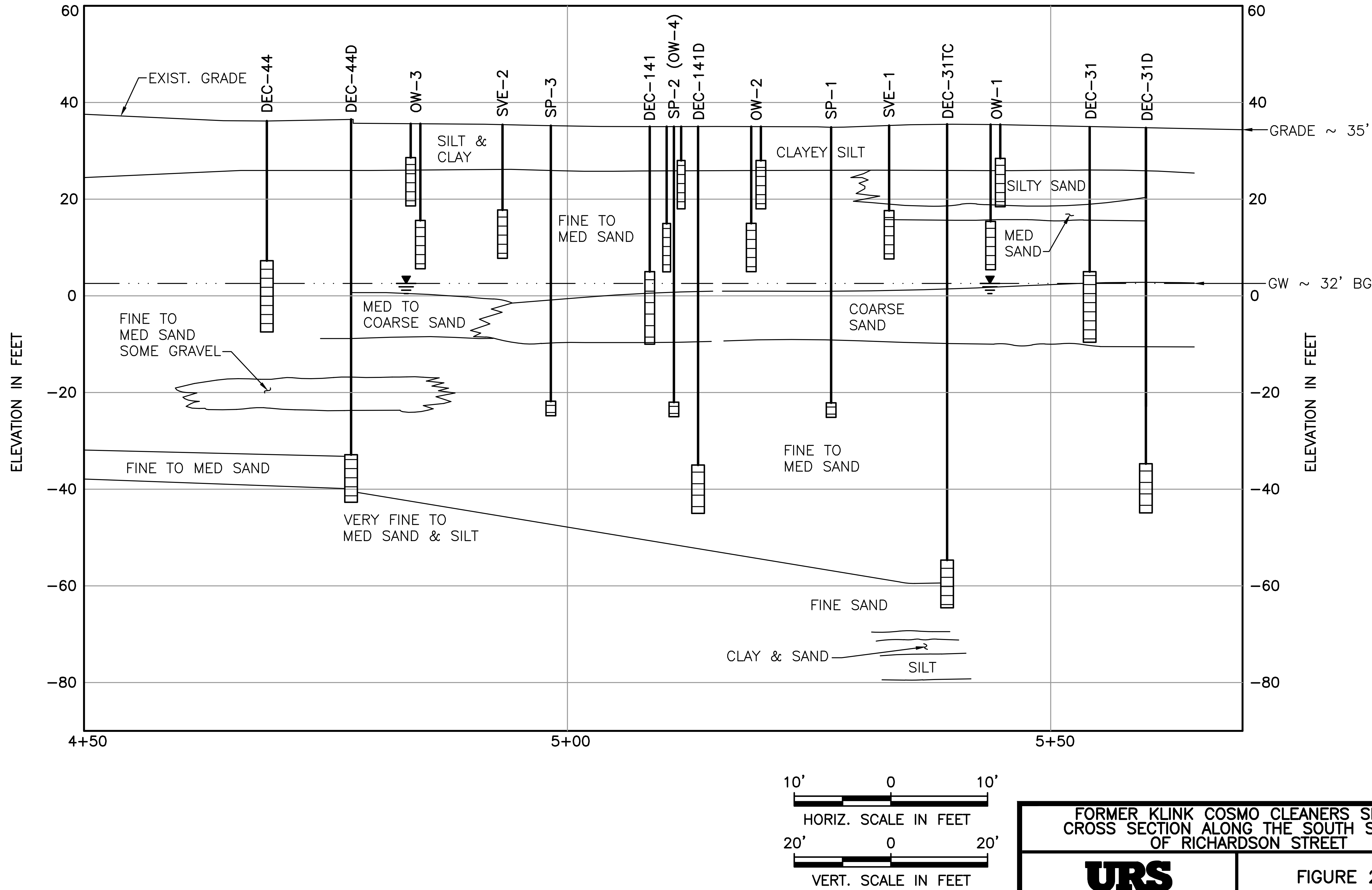
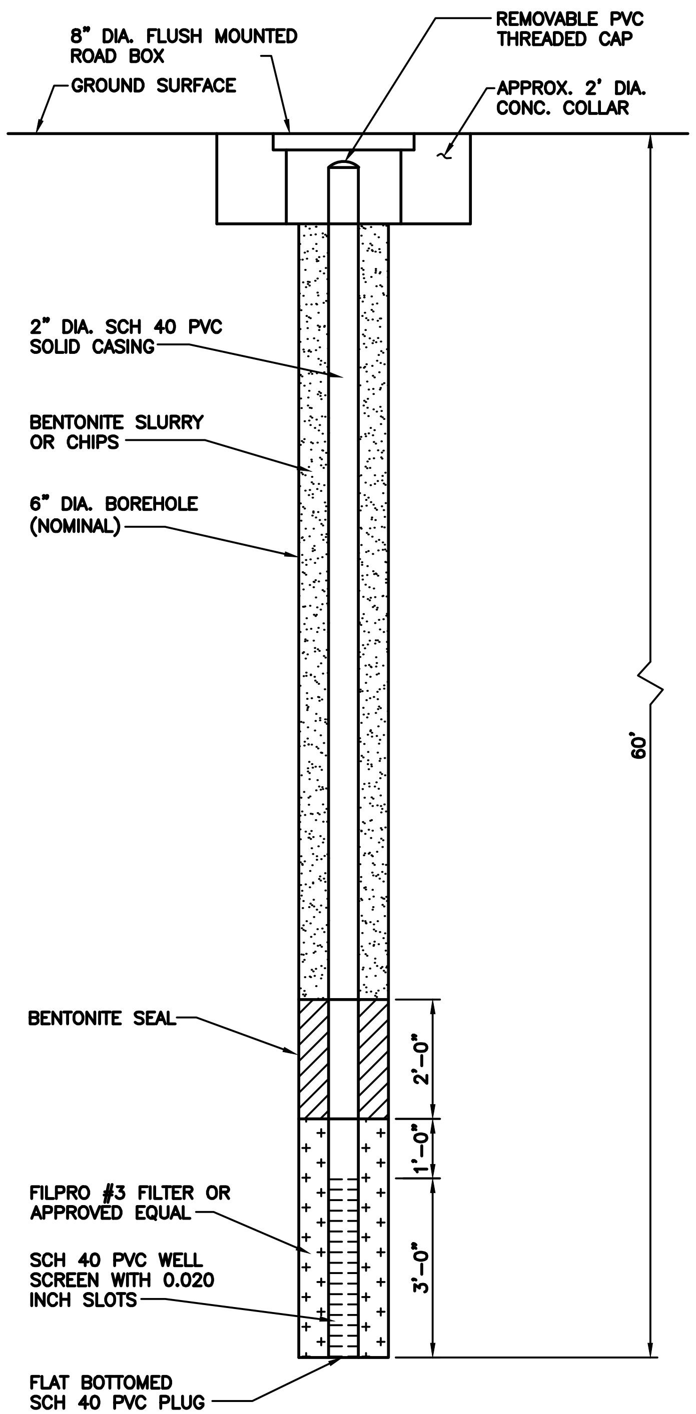


FORMER KLINK COSMO CLEANERS SITE
CROSS SECTION ALONG THE SOUTH SIDE
OF RICHARDSON STREET

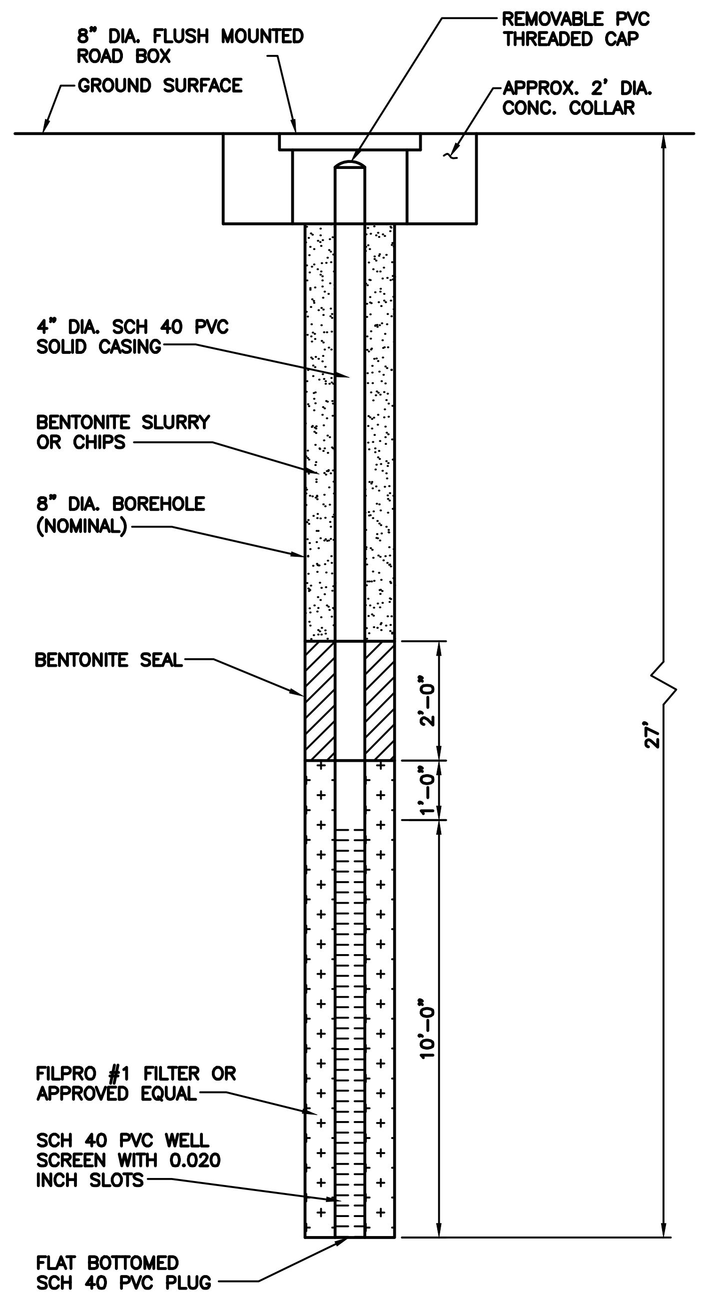
URS

FIGURE 2

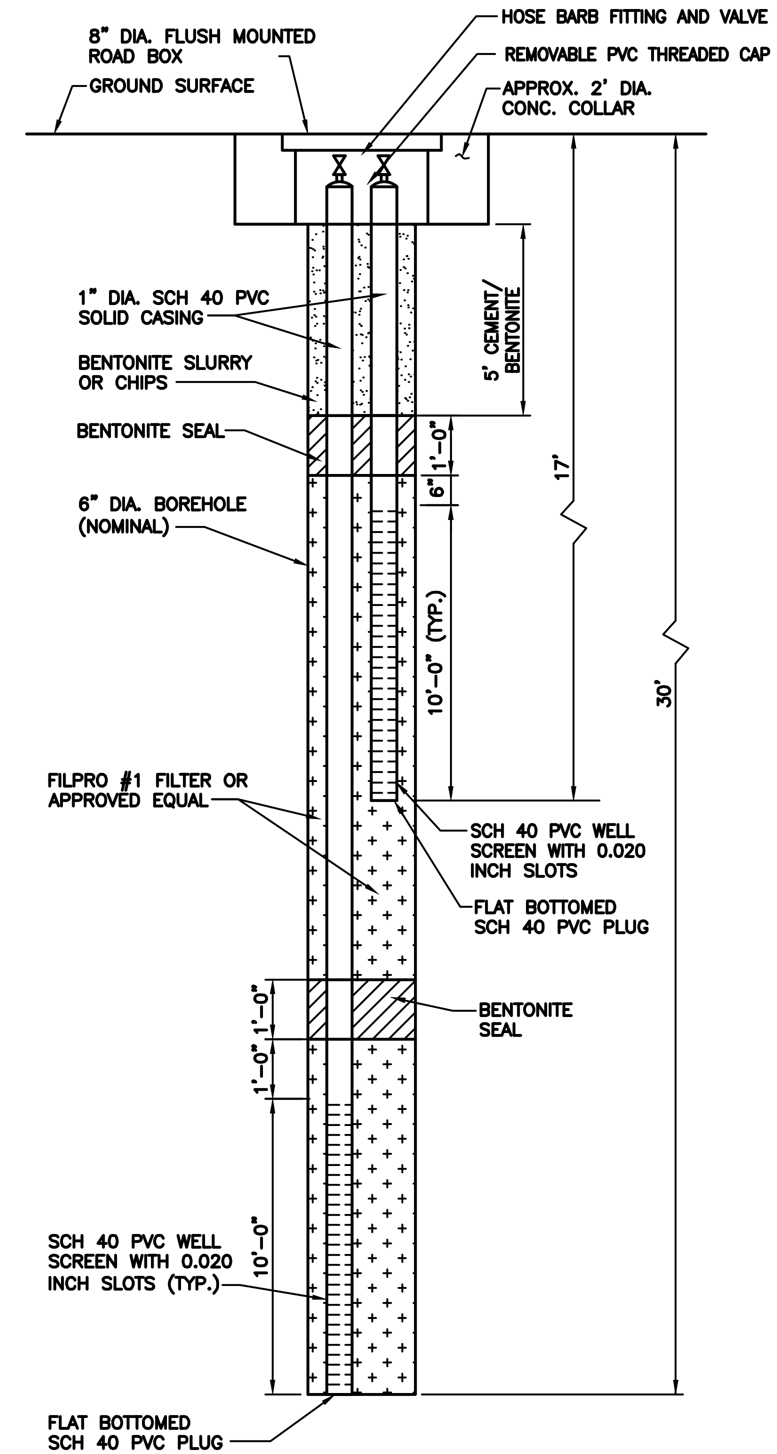
J:\Projects\11176390\CAD\KLINK COSMO CROSS SECTION.dwg 4/28/15 - 2 RAL



TYPICAL AIR SPARGING WELL DETAIL
NOT TO SCALE



TYPICAL SOIL VAPOR EXTRACTION WELL DETAIL
NOT TO SCALE



TYPICAL SOIL VACUUM MONITORING POINT DETAIL
NOT TO SCALE

FORMER KLINK COSMO CLEANERS SITE
PILOT STUDY WELL DETAILS

URS

FIGURE 3

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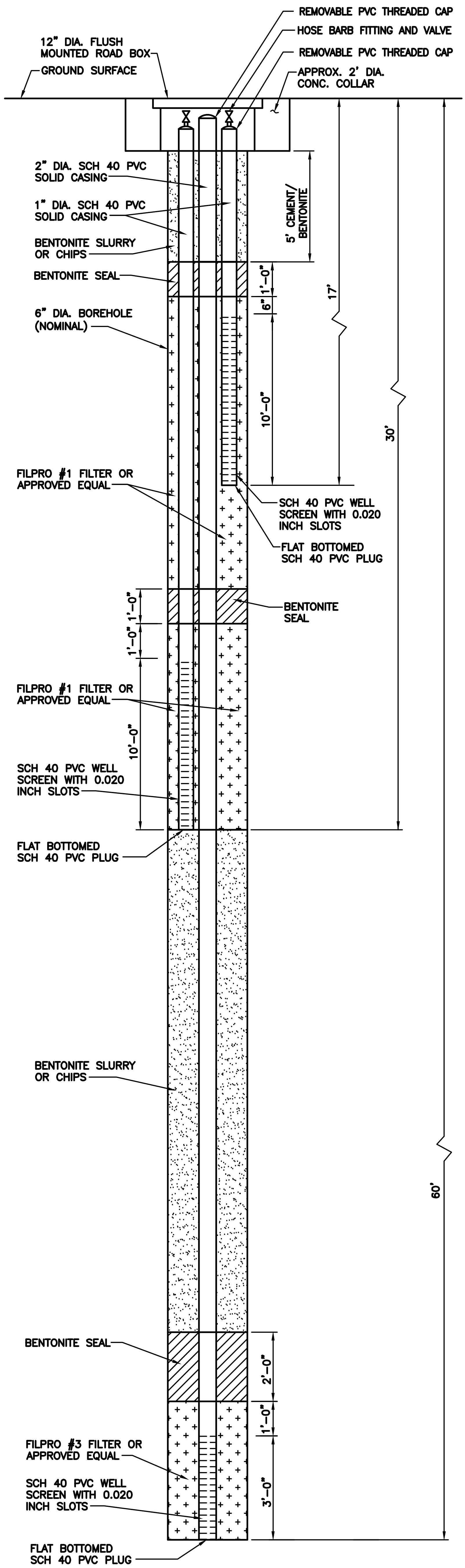

TYPICAL SOIL VACUUM MONITORING POINT & AIR SPARGING WELL DETAIL

NOT TO SCALE

FORMER KLINK COSMO CLEANERS SITE
PILOT STUDY WELL DETAILS

URS

FIGURE 4

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ATTACHMENT B

WELL CONSTRUCTION DIAGRAMS

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

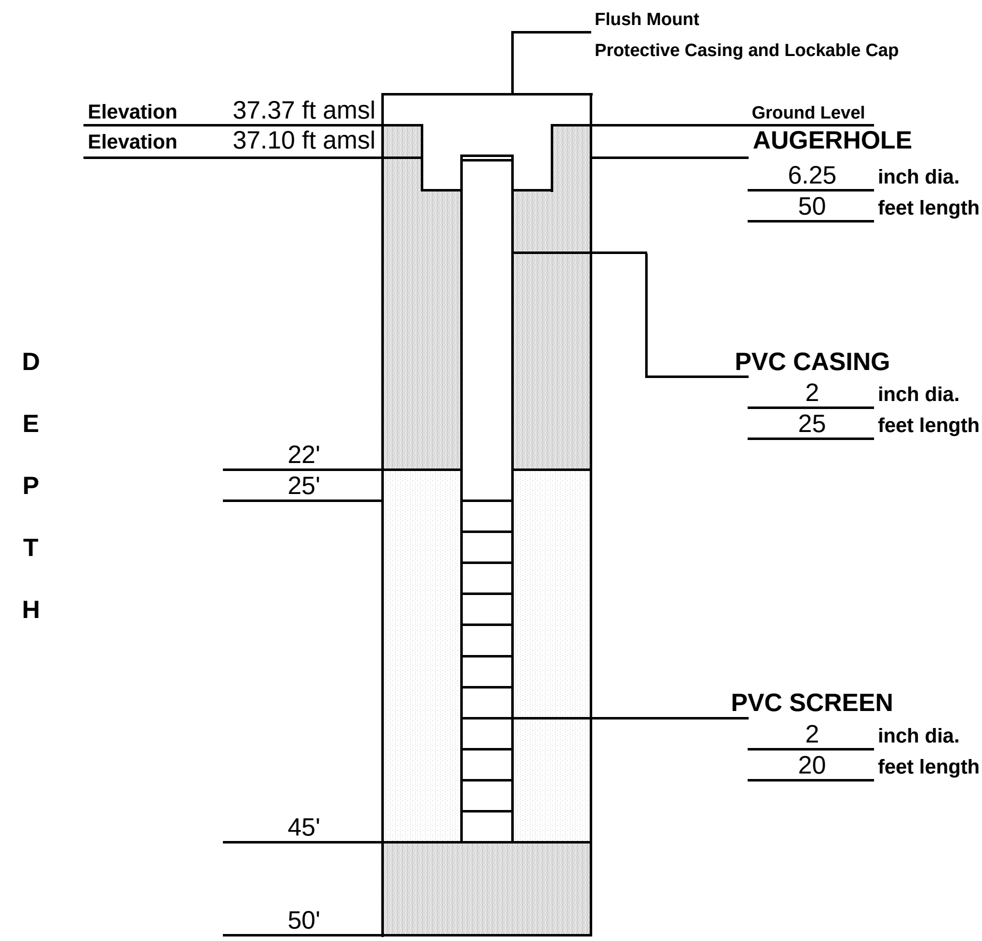
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/13/15 - 4/21/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL		*SCREEN MATERIAL*		*FILTER MATERIAL*			
Surface:	Steel grade box	**Type:**	2" PVC	**Type:**	#2 Sand	**Setting:**	22 - 45'
				SEAL MATERIAL			
Riser:	2" PVC	**Slot Size:**	.020"	**Type:**	Bentonite	**Setting:**	1 - 22' and 45-50'

COMMENTS:

LEGEND

- Bentonite Chip Seal
- Bentonite Pellet Seal
- Silica Sandpack

Client: NYSDEC	**Former Klink Cosmo Cleaners**	**Project No.:** 11176390.00005
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** DEC-033R

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

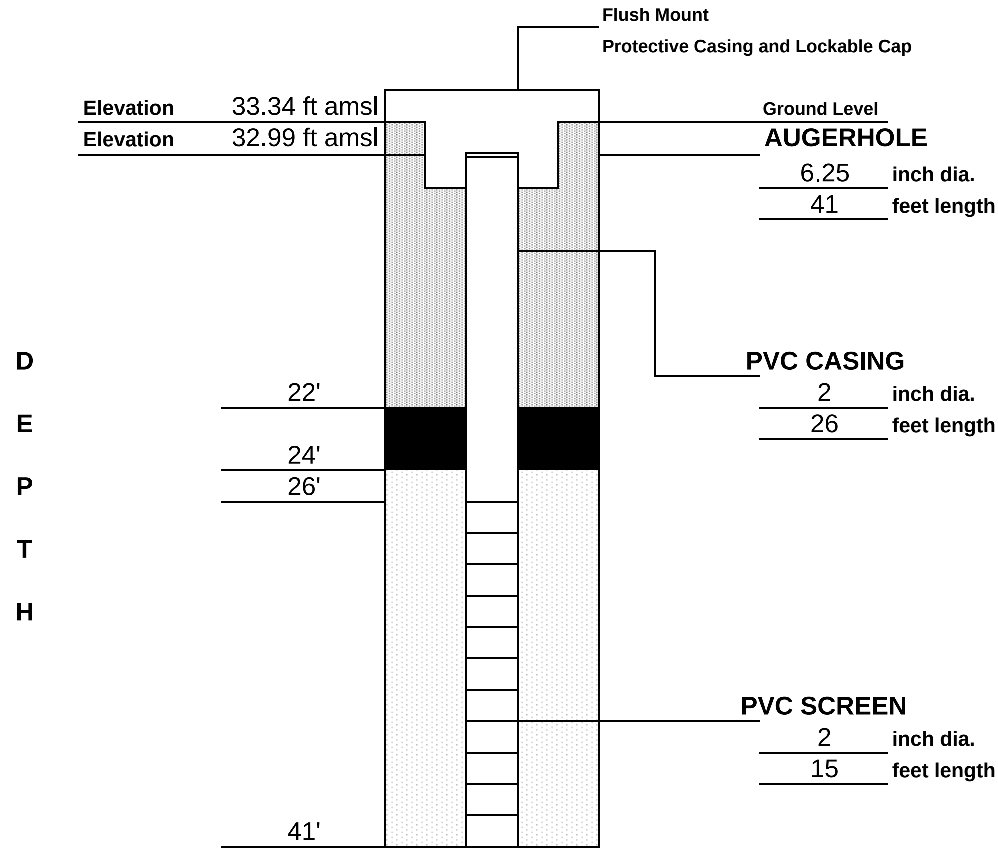
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/13/15 - 4/17/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL		SCREEN MATERIAL	
Surface:	Steel grade box	**Type:**	2" PVC
Riser:	2" PVC	**Slot Size:**	.020"

FILTER MATERIAL

Type: #2 Sand **Setting:** 24-41'

SEAL MATERIAL

Type: Bentonite pellets 22-24'
Bentonite slurry 3-22'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** **DEC-140**

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

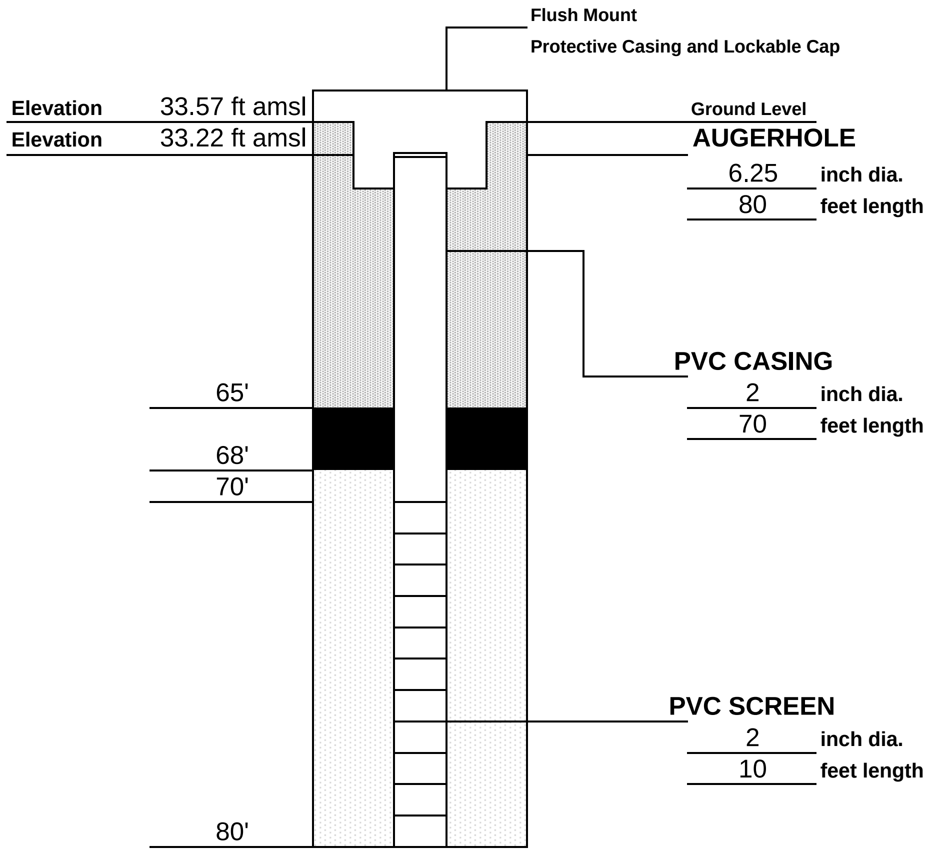
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/13/15 - 4/16/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL		SCREEN MATERIAL		FILTER MATERIAL
Surface:	Steel grade box	**Type:**	2" PVC	**Type:** #2 Sand **Setting:** 68-80'
Riser:	2" PVC	**Slot Size:**	.020"	

SEAL MATERIAL

Type: Bentonite pellets 65-68'
Bentonite slurry 2-65'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** **DEC-140D**

DRILLING SUMMARY

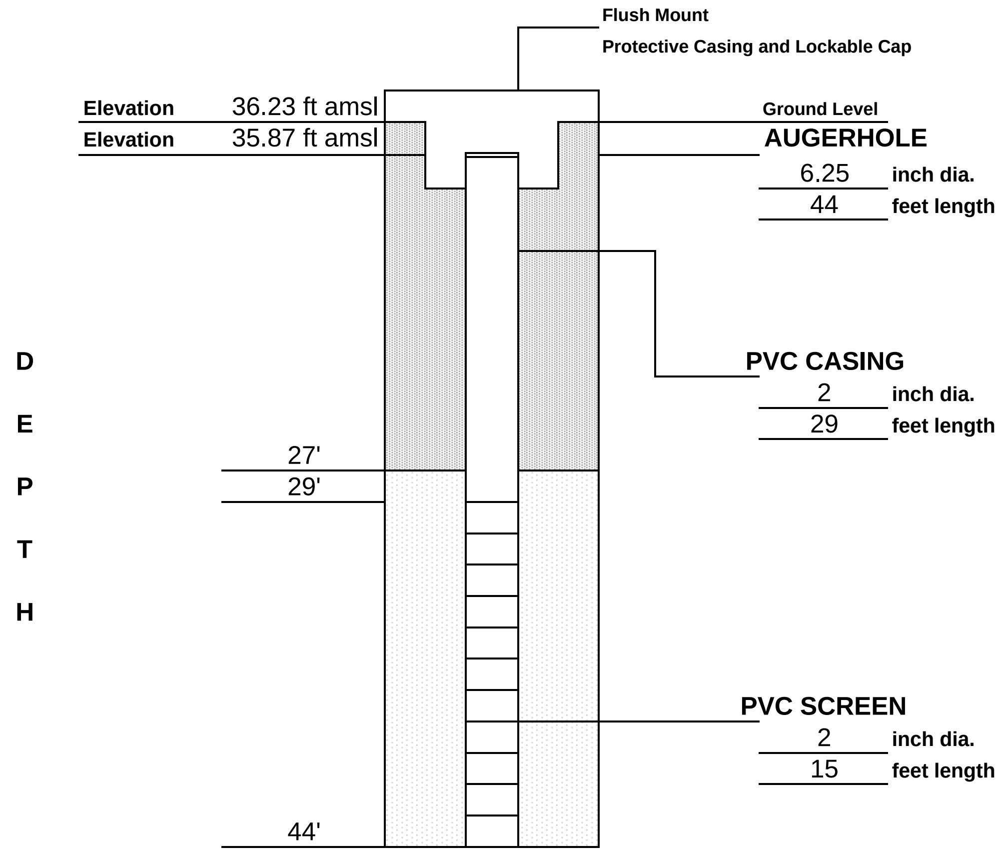
Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/14/15 - 4/21/15



GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description

WELL DESIGN

CASING MATERIAL		SCREEN MATERIAL		FILTER MATERIAL
Surface:	Steel grade box	**Type:**	2" PVC	**Type:** #2 Sand **Setting:** 27-44'
				SEAL MATERIAL
Riser:	2" PVC	**Slot Size:**	.020"	**Type:** Bentonite chips 1-27'

COMMENTS:

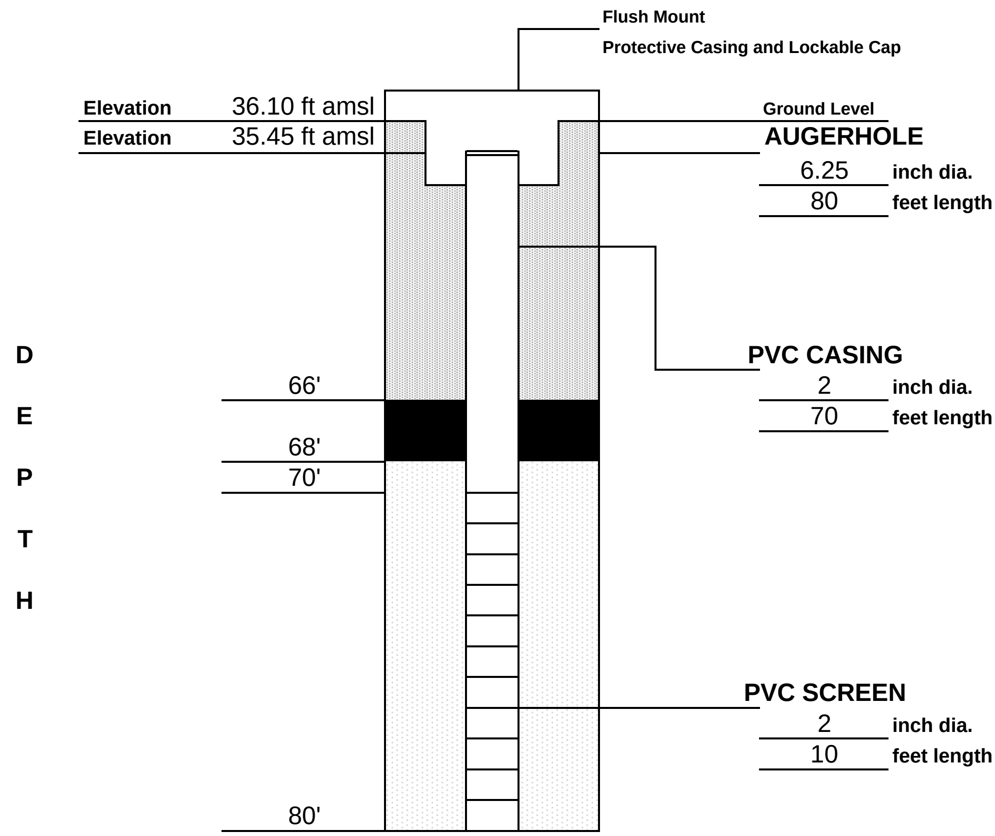
LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** **DEC-141**

DRILLING SUMMARY

Geologist: John Boyd
Drilling Company: Glacier Drilling Co.
Driller: Mark Schock
Rig Make/Model: 8140LS Sonic Rig
Date: 4/14/15 - 4/20/15



GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description

WELL DESIGN

CASING MATERIAL		SCREEN MATERIAL		FILTER MATERIAL
Surface:	Steel grade box	**Type:**	2" PVC	**Type:** #2 Sand **Setting:** 68-80'
Riser:	2" PVC	**Slot Size:**	.020"	**SEAL MATERIAL** **Type:** Bentonite pellets 66-68'; Bentonite slurry 3-66'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: NYSDEC	**Former Klink Cosmo Cleaners**	**Project No.:** 11176390.00005
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** DEC-141D

DRILLING SUMMARY

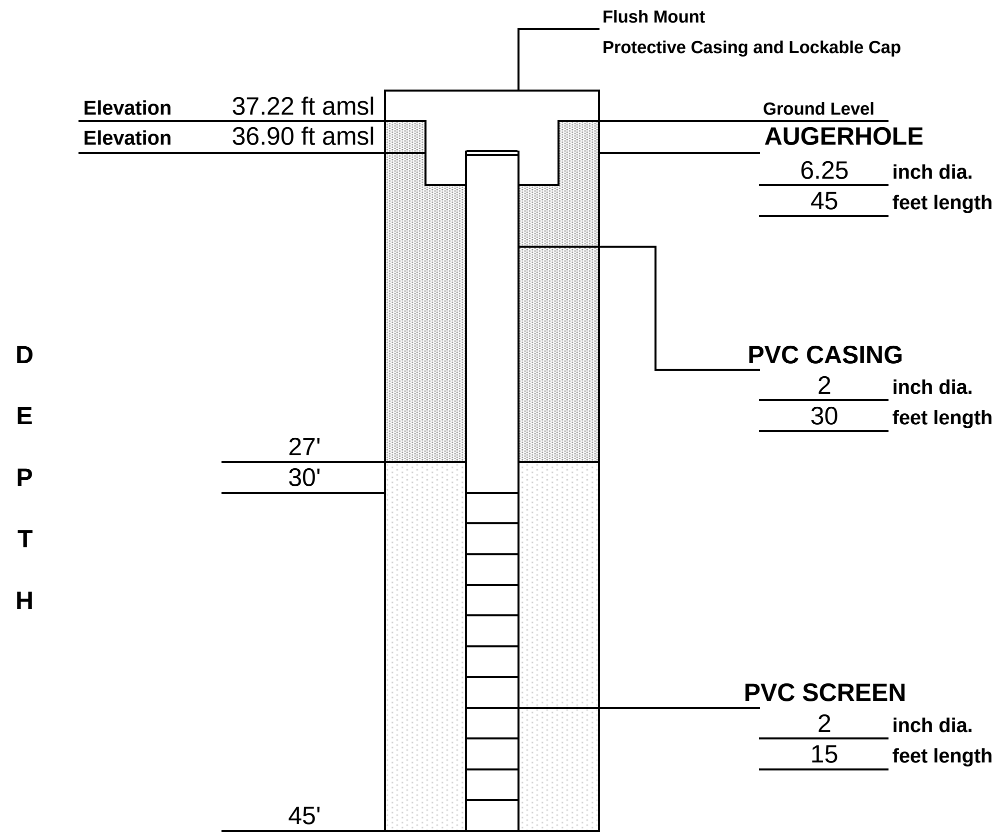
Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/13/15 - 4/15/15



GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description

WELL DESIGN

CASING MATERIAL		SCREEN MATERIAL		FILTER MATERIAL
Surface:	Steel grade box	**Type:**	2" PVC	**Type:** #2 Sand **Setting:** 27-45'
				SEAL MATERIAL
Riser:	2" PVC	**Slot Size:**	.020"	**Type:** Bentonite chips 1-27'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: NYSDEC	**Former Klink Cosmo Cleaners**	**Project No.:** 11176390.00005
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** DEC-142

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

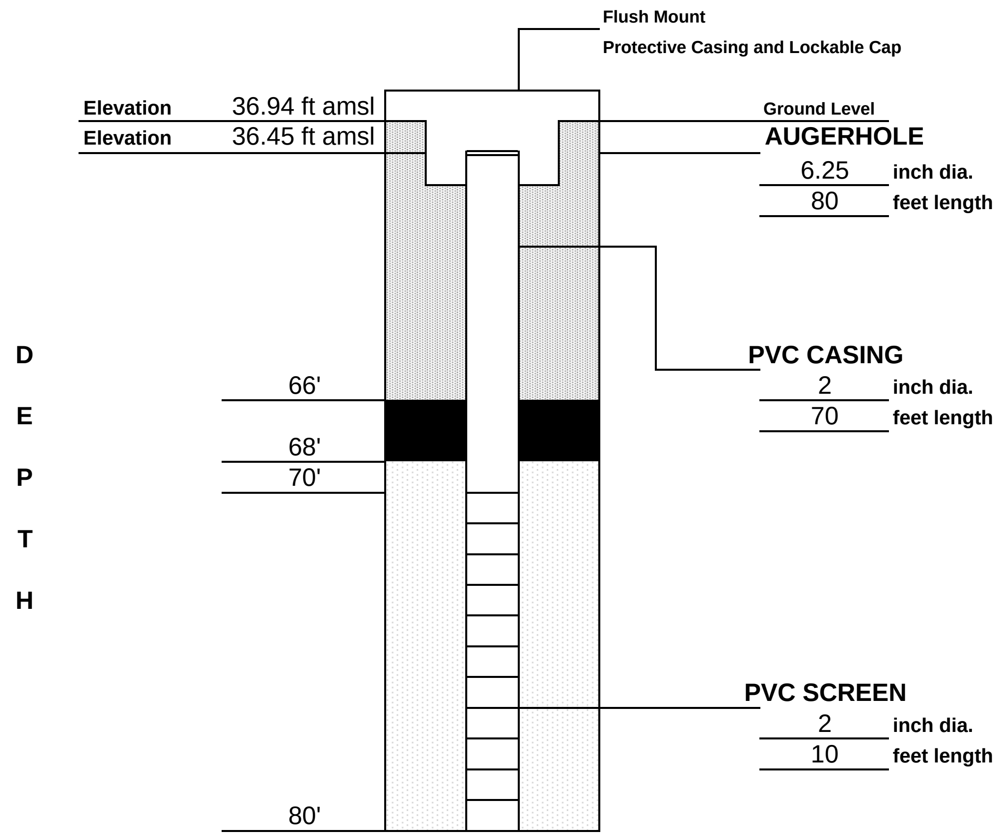
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/13/15 - 4/15/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Type:** 2" PVC	**Type:** #2 Sand **Setting:** 68-80'
		SEAL MATERIAL
Riser: 2" PVC	**Slot Size:** .020"	**Type:** Bentonite pellets 66-68' Bentonite slurry 3-66'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** **DEC-142D**

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

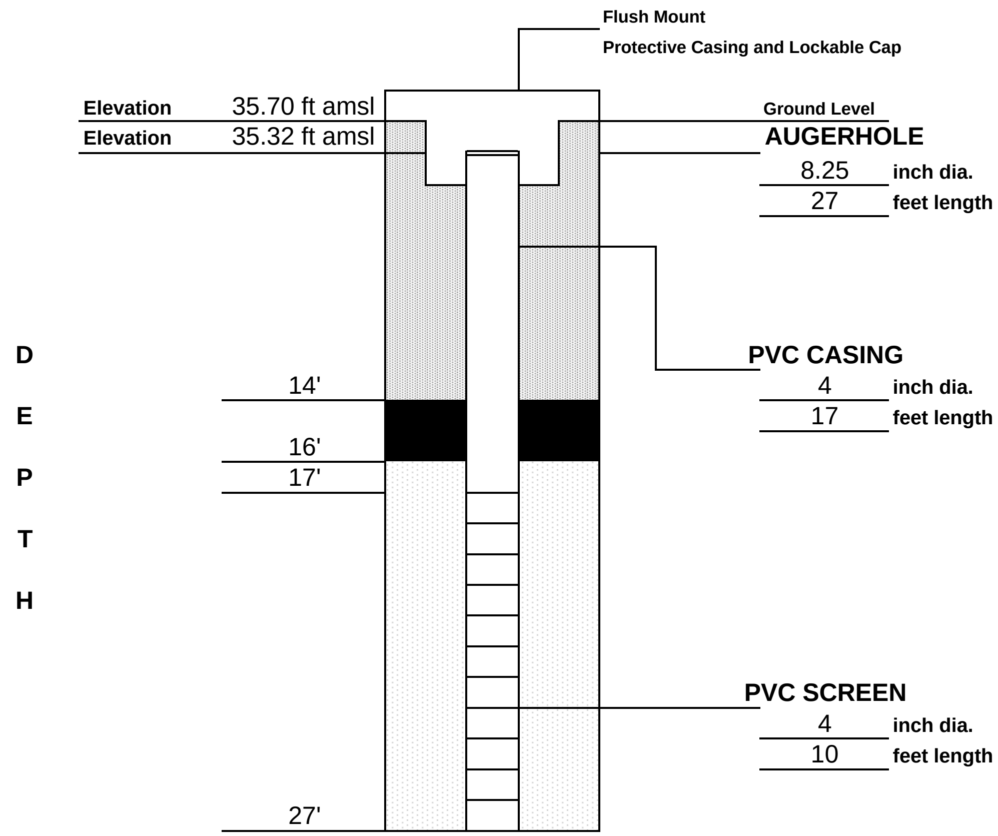
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/15/15 - 4/29/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description

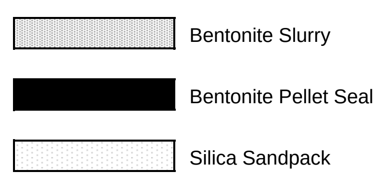


WELL DESIGN

CASING MATERIAL		*SCREEN MATERIAL*		*FILTER MATERIAL*			
Surface:	Steel grade box	**Type:**	4" PVC	**Type:**	#1 Sand	**Setting:**	16-27'
Riser:	4" PVC	**Slot Size:**	.020"	*SEAL MATERIAL*			
				Type:	Bentonite pellets 14-16' Bentonite slurry 1-14'		

COMMENTS:

LEGEND



Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**SOIL VAPOR EXTRACTION WELL CONSTRUCTION DETAILS**	**Well Number:** **SVE-01**

DRILLING SUMMARY

Geologist: John Boyd

Drilling Company: Glacier Drilling Co.

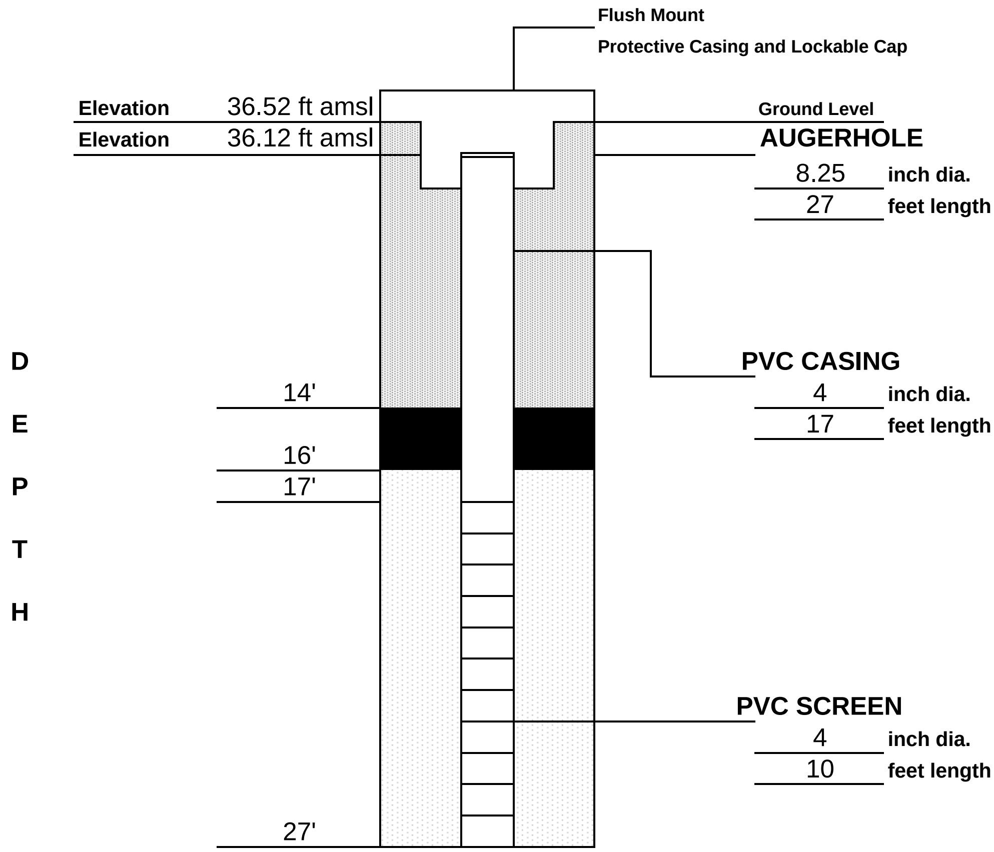
Driller: Mark Schock

Rig Make/Model: 8140LS Sonic Rig

Date: 4/15/15 - 4/29/15

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL		*SCREEN MATERIAL*		*FILTER MATERIAL*
Surface:	Steel grade box	**Type:**	4" PVC	**Type:** #1 Sand **Setting:** 16-27'
				SEAL MATERIAL
Riser:	4" PVC	**Slot Size:**	.020"	**Type:** Bentonite pellets 14-16' Bentonite slurry 1-14'

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**SOIL VAPOR EXTRACTION WELL CONSTRUCTION DETAILS**	**Well Number:** **SVE-02**

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

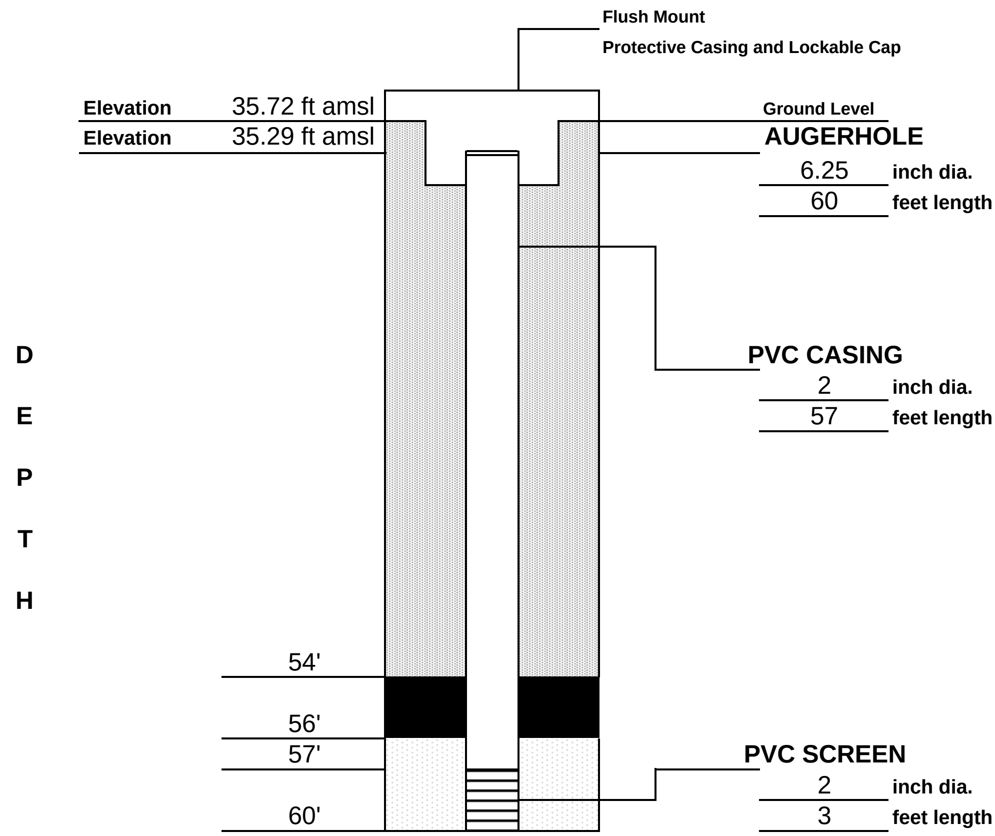
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/23/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL		***SCREEN MATERIAL***		***FILTER MATERIAL***			
Surface:	Steel grade box	**Type:**	2" PVC	**Type:**	#3 Sand	**Setting:**	56-60'
				SEAL MATERIAL			
Riser:	2" PVC	**Slot Size:**	.020"	**Type:**	Bentonite pellets 54-56' Bentonite slurry 1-54'		

COMMENTS:

LEGEND

- Bentonite Slurry
- Bentonite Pellet Seal
- Silica Sandpack

Client: NYSDEC	**Former Klink Cosmo Cleaners**	**Project No.:** 11176390.00005
URS Corporation	**AIR SPARGE WELL CONSTRUCTION DETAILS**	**Well Number:** AS-01

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

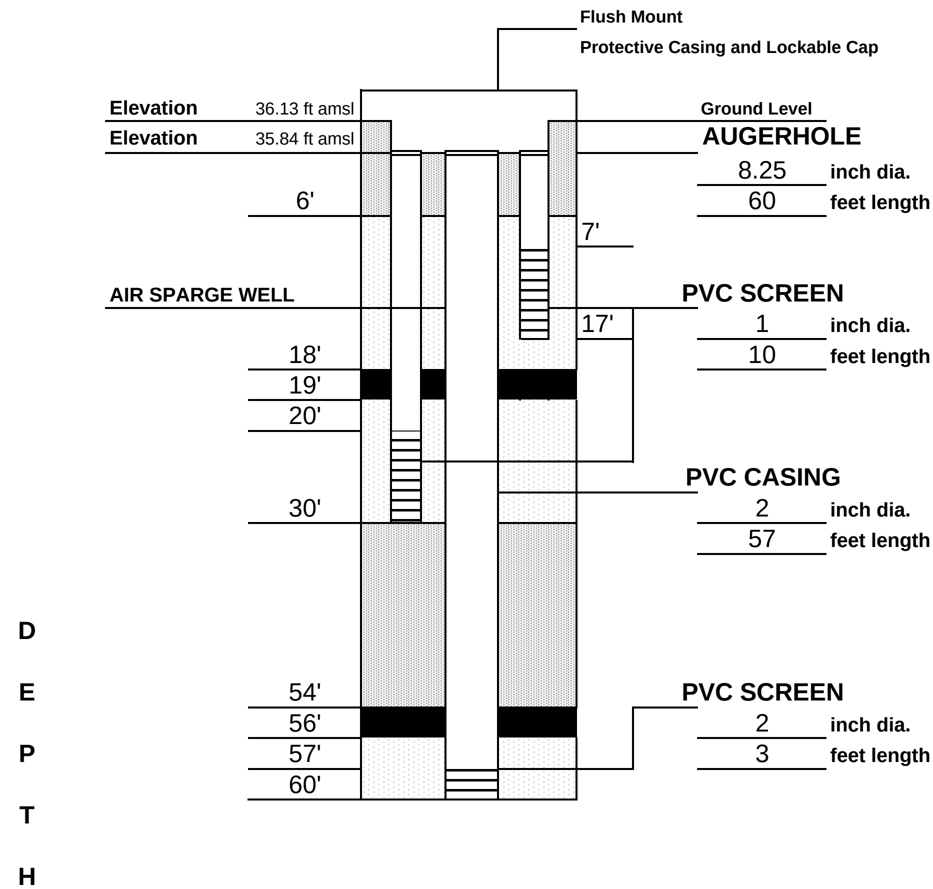
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/27/2015 and 4/28/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Air Sparge Well:** 2" PVC	**AS-02:** No. 3 sand **OW-04:** No. 1 sand
Air Sparge Well: 2" PVC	**Observation Well:** 1" PVC	***SEAL MATERIAL*** **Type:**
Observation Well: 1" PVC	**Slot Size:** .020"	Bentonite pellets 18-19' and 54-56' Bentonite chips 1-6' and 30-54'

COMMENTS:

LEGEND

- Bentonite Chip Seal
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**AIR SPARGE & OBSERVATION WELL CONSTRUCTION DETAILS**	**Well Number:** **SP-02 & OW-04**

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

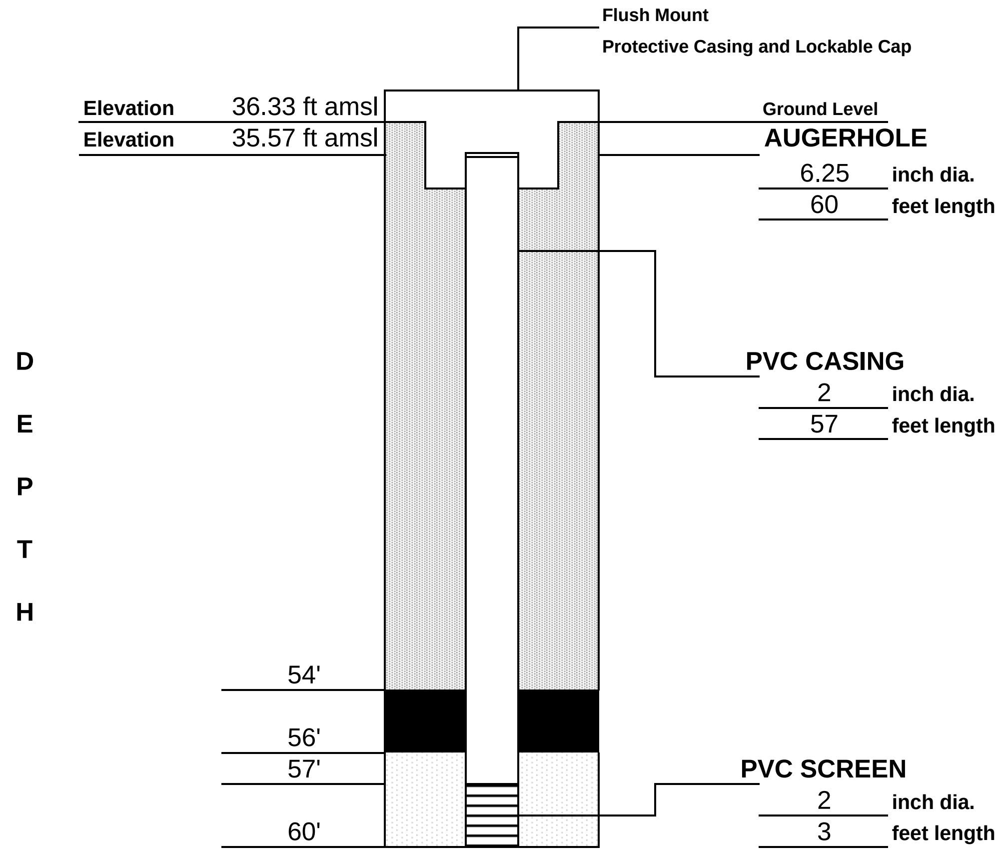
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/27/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description

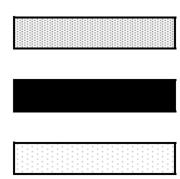


WELL DESIGN

CASING MATERIAL		*SCREEN MATERIAL*		*FILTER MATERIAL*
Surface:	Steel grade box	**Type:**	2" PVC	**Type:** #3 Sand **Setting:** 56-60'
				SEAL MATERIAL
Riser:	2" PVC	**Slot Size:**	.020"	**Type:** Bentonite pellets 54-56' Bentonite slurry 1-54'

COMMENTS:

LEGEND



Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**AIR SPARGE WELL CONSTRUCTION DETAILS**	**Well Number:** **SP-03**

DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

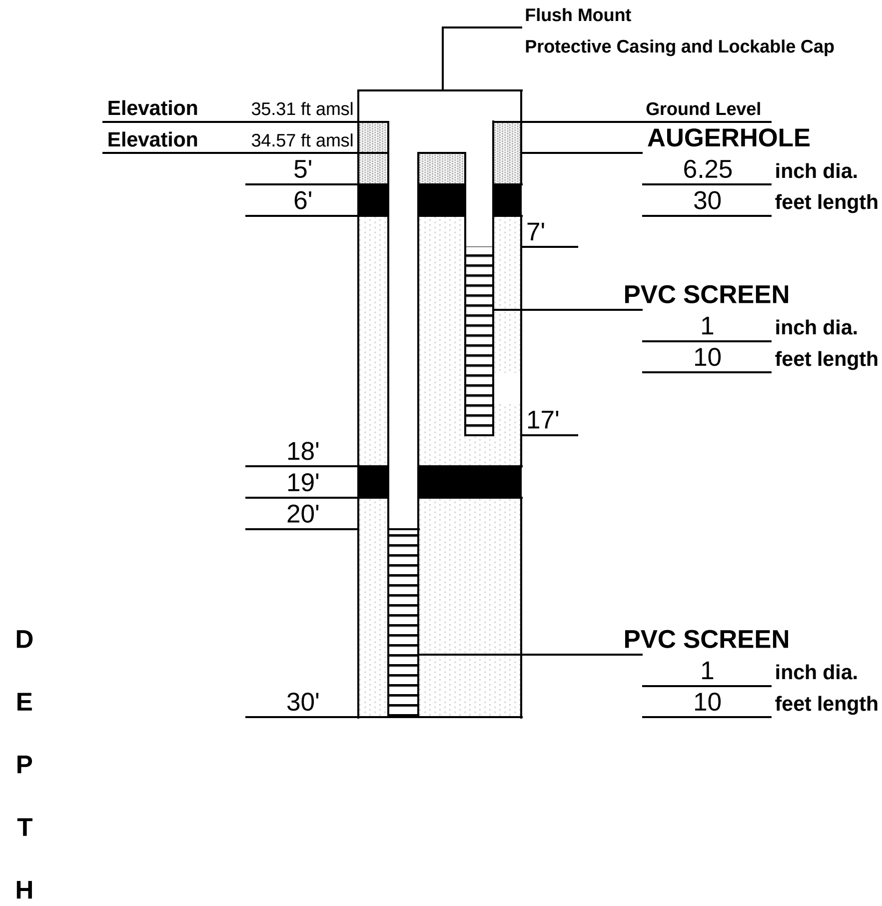
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/22/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Observation Well:** 1" PVC	**Type:** No. 1 sand 6-18' and 19-30'
		SEAL MATERIAL
Riser: 1" PVC	**Slot Size:** .020"	**Type:** Bentonite pellets 5-6' and 18-19'; Bentonite chips 2-5'

COMMENTS:

LEGEND

- Bentonite Chip Seal
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**OBSERVATION WELL CONSTRUCTION DETAILS**	**Well Number:** **OW-01**

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DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

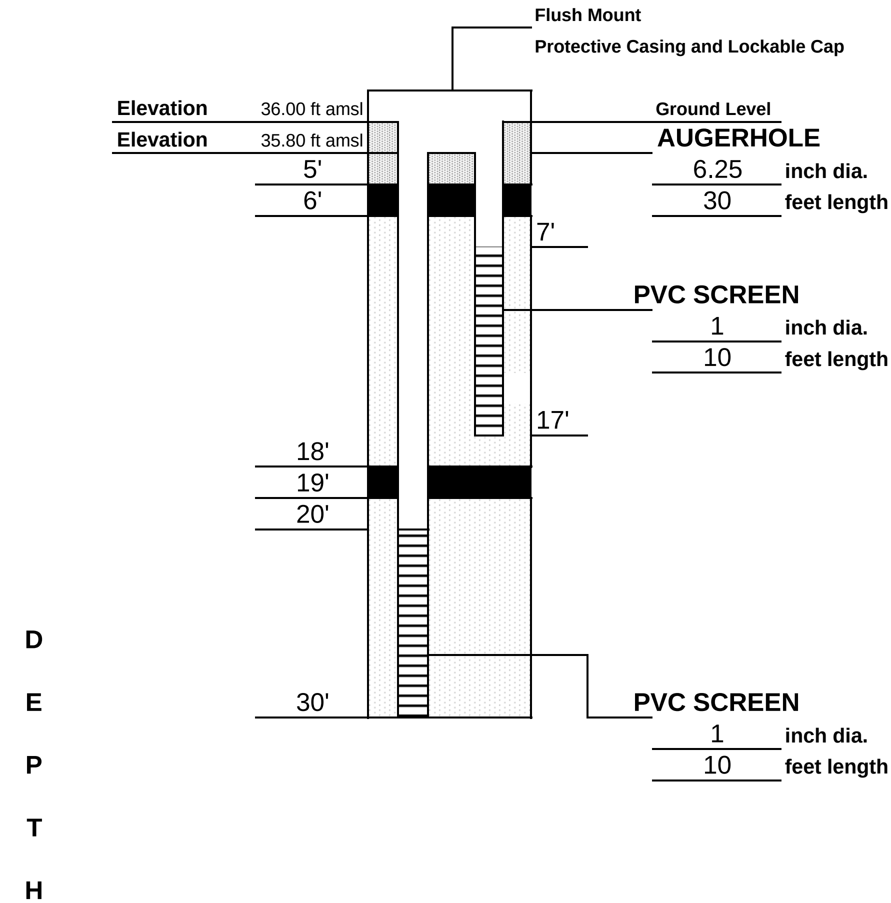
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/22/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Observation Well:** 1" PVC	**Type:** No. 1 sand 6-18' and 19-30'
Riser: 1" PVC	**Slot Size:** .020"	***SEAL MATERIAL*** **Type:** Bentonite pellets 5-6' and 18-19'; Bentonite chips 2-5'

COMMENTS:

LEGEND

- Bentonite Chip Seal
- Bentonite Pellet Seal
- Silica Sandpack

Client: **NYSDEC**	**Former Klink Cosmo Cleaners**	**Project No.:** **11176390.00005**
URS Corporation	**OBSERVATION WELL CONSTRUCTION DETAILS**	**Well Number:** **OW-02**

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DRILLING SUMMARY

Geologist:
John Boyd

Drilling Company:
Glacier Drilling Co.

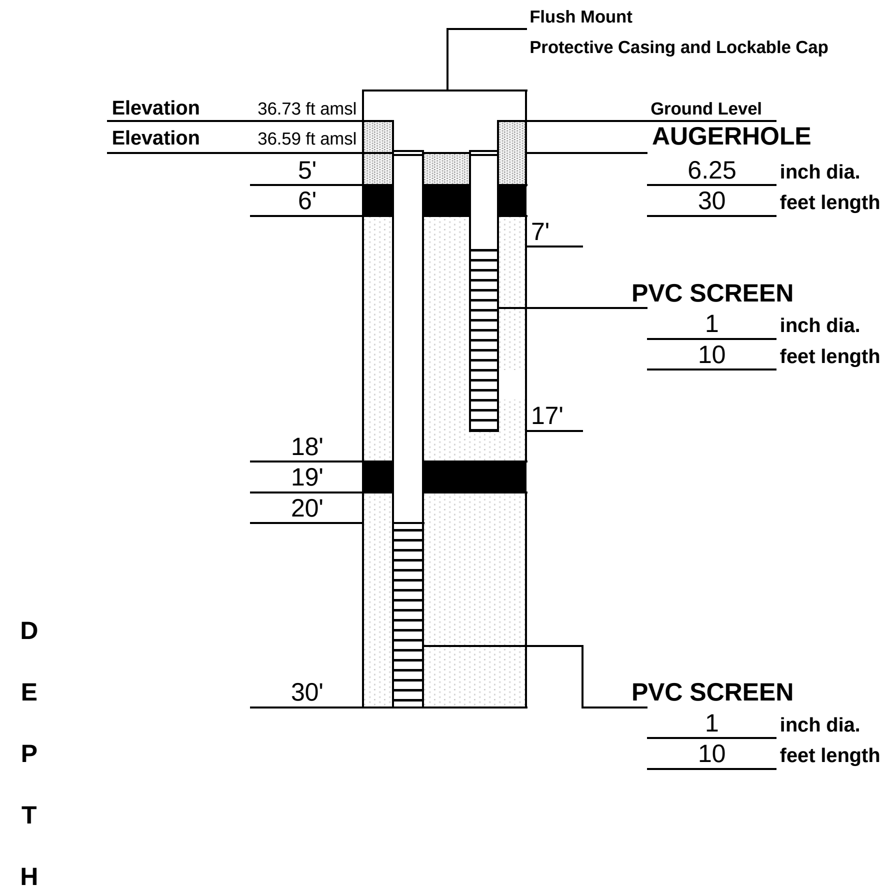
Driller:
Mark Schock

Rig Make/Model:
8140LS Sonic Rig

Date:
4/24/2015

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Observation Well:** 1" PVC	**Type:** No. 1 sand 6-18' and 19-30'
Riser: 1" PVC	**Slot Size:** .020"	***SEAL MATERIAL*** **Type:** Bentonite pellets 5-6' and 18-19'; Bentonite chips 2-5'

COMMENTS:

LEGEND

- Bentonite Chip Seal
- Bentonite Pellet Seal
- Silica Sandpack

Client: NYSDEC	**Former Klink Cosmo Cleaners**	**Project No.:** 11176390.00005
URS Corporation	**OBSERVATION WELL CONSTRUCTION DETAILS**	**Well Number:** OW-03

ATTACHMENT C

SOIL BORING LOGS

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-140
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 1
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201730.751 EASTING: 1001917.916
	GROUND ELEVATION: 33.34 ft amsl
	DATE STARTED: 4/13/15
	DATE FINISHED: 4/17/15
	DRILLER: Mark Schock
	GEOLOGIST: J. Boyd
	REVIEWED BY: T. Burmeier

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE
DATE	TIME	LEVEL	TYPE	TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							0-41' stratigraphic profile described on log for DEC-140D.			
-5										
-10										
-15										
-20										
-25										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-140 (31-31.5).

BORING NO. : DEC-140

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-140D
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 3
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201736.719 EASTING: 1001915.797

GROUNDWATER: 30.92 ft bgs					CAS.	SAMPLER	CORE	TUBE	GROUND ELEVATION:	33.57 ft amsl
DATE	TIME	LEVEL	TYPE	TYPE					DATE STARTED:	4/13/15
				DIA.					DATE FINISHED:	4/16/15
				WT.					DRILLER:	Mark Schock
				FALL					GEOLOGIST:	J. Boyd
				* POCKET PENETROMETER READING					REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0				100	Gray	Hard	Concrete		0.0	Vactron cleared boring 0-5.0'
					Light brown	Medium dense	Medium to coarse SAND, some fine to medium gravel and cinders (fill).	FILL		
							Fine to coarse SAND and SILT, trace fine gravel (fill).	FILL		
							Fine to medium SAND, some to trace silt and fine to medium gravel.	SW		
-5		1		100	Brown				1.8	Moist
									4.6	
									7.3	
							SILT and fine to medium SAND, trace fine to medium gravel.	SM	13.6	
									0.9	
							Cobble			
-10		2		80					0.8	
							Fine to coarse SAND, some fine to medium gravel, trace fine sand.	SW	0.3	
									0.1	
									0.2	
							Cobble			
-15										
						Dense	Fine to medium SAND, some silt and fine to medium gravel.	SW	1.6	
									0.4	
									0.5	
									0.7	
-20		3		80					0.5	
									15.8	
						Loose	Fine to medium SAND.	SW	5.1	
									5.9	
									4.3	
-25									39.2	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil samples DEC-140D (4-4.5), DEC-140D (8.5-9') and DEC-140D (25-26').

BORING NO. : DEC-140D

URS Corporation

TEST BORING LOG

BORING NO. : DEC-140D

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. : 11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									26.6	
									5.1	
									4.7	
							Fine to medium SAND, some coarse sand and fine gravel, trace silt.	SW	4.5	Very moist
-30		4					No Recovery			Wet
-35										
-40		5		50			Fine to medium SAND, trace to some coarse sand and fine to medium gravel.	SW	0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-45									0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-50		6		100					0.3	
									0.7	
									1.1	
									0.5	
									0.6	
-55									0.8	
									0.4	
									0.5	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing. Collected soil samples DEC-140D (4-4.5), DEC-140D (8.5-9') and DEC-140D (25-26').

BORING NO. : DEC-140D

URS Corporation

TEST BORING LOG

PROJECT: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-140D
CLIENT: New York State Department of Environmental Conservation	SHEET: 3 OF 3
	JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									0.2	
									0.2	
-60		7		100					0.0	
									0.1	
									0.0	
									0.0	
					Yellow brown				0.0	
-65									0.0	
							Medium to coarse SAND, some to trace fine sand and fine to medium gravel.	SW	0.0	
									0.0	
									0.0	
									0.0	
-70		8		100					0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-75									0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-80							Boring completed at 80 ft bgs.			
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil samples DEC-140D (4-4.5), DEC-140D (8.5-9') and DEC-140D (25-26').

BORING NO. : DEC-140D

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-141
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 1
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201750.786 EASTING: 1001846.149

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE		
									GROUND ELEVATION:	36.23 ft amsl
DATE	TIME	LEVEL	TYPE	TYPE					DATE STARTED:	4/14/15
				DIA.					DATE FINISHED:	4/21/15
				WT.					DRILLER:	Mark Schock
				FALL					GEOLOGIST:	J. Boyd
				* POCKET PENETROMETER READING					REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							0-44' stratigraphic profile described on log for DEC-141D.			
-5										
-10										
-15										
-20										
-25										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-141D
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 3
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201752.260 EASTING: 1001850.879

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE		
DATE	TIME	LEVEL	TYPE	TYPE					GROUND ELEVATION:	36.10 ft amsl
				DIA.					DATE STARTED:	4/14/15
				WT.					DATE FINISHED:	4/20/15
				FALL					DRILLER:	Mark Schock
				* POCKET PENETROMETER READING					GEOLOGIST:	J. Boyd
									REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0		1		100	Gray	Hard	Concrete			
					Brown	Medium dense	Fine to medium SAND, some silt and fine to medium gravel (fill).	FILL	0.0	Moist
							SILT, some fine to medium sand, trace coarse sand and fine gravel (fill).	FILL	0.6	
-5		2		100	Dark brown		SILT and fine to medium SAND, some fine to medium gravel, trace cobbles.	SM	0.4	
									0.5	
					Brown				0.7	
					Light brown				2.3	
									2.0	
-10		3		100					0.1	
									0.2	
						Loose	Fine to medium SAND, trace fine to medium gravel.	SW	0.5	
		4		86	Brown				0.0	
									5.7	
-15							SILT and fine to medium SAND, some fine to medium gravel, trace cobbles.	SM	3.8	
									3.5	
									5.7	
									6.1	
									10.6	
-20		5		100			Fine to medium SAND, some silt and fine to medium gravel.	GM	3.2	
									3.3	
									3.1	
									2.2	
									2.1	
-25		6		100					0.8	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-141D (33-45')

URS Corporation

TEST BORING LOG

BORING NO. : DEC-141D

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									0.8	
							Fine to medium SAND, some coarse sand and fine gravel.		2.0	
								SW	2.1	
							Medium to coarse SAND and fine to medium gravel, trace to some fine sand.	GW	0.6	
-30		7		60					2.1	
									2.2	
									6.8	
									25.9	Wet
							Fine to medium SAND, trace fine gravel and silt.		8.4	
-35								SW	8.3	
							No recovery	SW		
-40		8		50			Medium to coarse SAND and fine to medium GRAVEL.	SW	0.0	
-45							Fine to medium SAND, trace to some fine sand and fine gravel.	GM	0.0	
-50		9		60					0.3	
						Medium dense	Fine to medium SAND, some silt, trace coarse sand and fine gravel.	SW	0.3	
						Loose	Medium to coarse SAND, some fine sand and fine gravel.	SW	0.3	
									0.2	
									0.2	
-55									0.1	
							No recovery			

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-141D (33-45')

URS Corporation

TEST BORING LOG

BORING NO. : DEC-141D

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 3 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
-60		10		100			Medium to coarse SAND, some fine sand and fine gravel.		0.0	
							Medium SAND, trace fine to medium gravel.	SP	0.0	
									0.0	
									0.0	
							Fine to medium SAND, some fine to medium gravel, trace silt.	SW	0.0	
-65									0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-70		11		100					0.0	
									0.0	
									0.0	
					Dark brown		Fine to coarse SAND and fine to medium GRAVEL, trace silt.	GW	0.0	
									0.0	
-75					Brown				0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-80							Boring completed at 80 ft bgs.			
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-141D (33-45')

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-142
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 1
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201801.075 EASTING: 1001845.34

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE
DATE	TIME	LEVEL	TYPE	TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

GROUND ELEVATION:	37.22 ft amsl
DATE STARTED:	4/13/15
DATE FINISHED:	4/15/15
DRILLER:	Mark Schock
GEOLOGIST:	J. Boyd
REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							0-45' stratigraphic profile described on log for DEC-142D.			
-5										
-10										
-15										
-20										
-25										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.

URS Corporation

TEST BORING LOG

BORING NO. :	DEC-142D
PROJECT/PROJECT LOCATION:	Former Klink Cosmo Cleaners - Pilot Study
SHEET:	1 OF 3
CLIENT:	New York State Department of Environmental Conservation
JOB NO. :	11176390.00005
BORING CONTRACTOR:	Glacier Drilling
NORTHING:	201802.744
EASTING:	1001850.364
GROUNDWATER:	36 ft bgs
GROUND ELEVATION:	36.94 ft amsl
DATE STARTED:	4/13/15
DATE FINISHED:	4/15/15
DRILLER:	Mark Schock
GEOLOGIST:	J. Boyd
REVIEWED BY:	T. Burmeier

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0		1		100	Dark brown	Medium dense	SILT, some fine to medium sand, trace glass, roots and fine gravel (FILL).	FILL	0.0	Moist
					Light brown		Fine to medium SAND, some silt, tracefine gravel and cobbles (FILL).	FILL	0.0	
-5		2		90	Brown		Fine to medium SAND and SILT, some fine gravel.	SM	0.0	
							Fine to coarse SAND, and fine gravel, some silt, trace medium gravel.	SW	0.0	
-10		3		100			Fine to medium SAND, some coarse sand, fine gravel, silt and cobbles.	SW	0.0	
									0.0	
-15		4		100					0.0	
									0.0	
		5		100					0.0	
							Medium to coarse SAND, some to trace fine sand, fine to medium gravel, trace silt	SW	0.0	
-20		6		100					0.1	
									0.7	
									2.9	
									0.5	
-25		7		80					0.4	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-142D (36-36.5').

URS Corporation

TEST BORING LOG

PROJECT: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : DEC-142D
CLIENT: New York State Department of Environmental Conservation	SHEET: 2 OF 3
	JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									0.4	
									1.0	
									0.8	
									0.7	
-30		8		100		Loose			2.0	
									0.7	
									1.3	
									2.2	
									1.3	
-35									8.9	
									0.8	Wet
									0.5	
									1.0	
									1.1	
-40		9		80			Fine to medium SAND, some to trace coarse sand and fine gravel.	SW	1.2	
									1.0	
									3.2	
									0.6	
									0.2	
-45									0.1	
							Fine to medium SAND.	SW	0.1	
									0.1	
									0.1	
									0.1	
-50		10		100					0.0	
							Fine to medium SAND, some coarse sand and rounded fine gravel.	SW	0.0	
									0.0	
									0.0	
									0.0	
-55									0.0	
									0.0	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing. Collected soil sample DEC-142D (36-36.5').

BORING NO. : DEC-142D

URS Corporation

TEST BORING LOG

BORING NO. : DEC-142D

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 3 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
-60		11		100	Yellow brown		Fine to medium SAND, trace fine gravel.	SW	0.0	
									0.0	
									0.0	
							Fine to coarse SAND, some to trace fine to medium gravel and silt.	SW	0.0	
									0.0	
-65									0.0	
									0.0	
									0.0	
					Brown				0.0	
									0.0	
-70		12		100					0.0	
									0.0	
									0.0	
									0.0	
									0.0	
-75									0.0	
									0.0	
									0.0	
									0.0	
							Fine to medium SAND.	SW	0.0	
-80							Boring completed at 80 ft bgs.			
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample DEC-142D (36-36.5').

BORING NO. : DEC-142D

URS Corporation

TEST BORING LOG

BORING NO.: OW-1	
PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	SHEET: 1 OF 2
CLIENT: New York State Department of Environmental Conservation	JOB NO.: 11176390.00005
BORING CONTRACTOR: Glacier Drilling	NORTHING: 201762.620 EASTING: 1001880.897
GROUNDWATER: Not Encountered	GROUND ELEVATION: 35.31 ft amsl
	DATE STARTED: 4/22/15
	DATE FINISHED: 4/22/15
	DRILLER: Mark Schock
	GEOLOGIST: J. Boyd
	REVIEWED BY: T. Burmeier

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			
-5		1		100	Brown	Medium dense	Fine to medium SAND, some silt, trace fine to medium gravel. Cobble 9-10'.	GM	6.1	Moist
									5.1	
									6.3	
									17.8	

-10		2		100					11.3	
						Loose	Fine to medium SAND, some silt and fine to medium gravel, trace cobbles.	GM	12.4	
									10.1	
									9.1	
							Fine to coarse SAND, some fine to medium gravel. Cobble 15-16'.	SW	9.6	
-15									---	
		3		100			Fine SAND	SP	8.8	
							Fine to coarse SAND and fine to medium gravel, some to trace silt.	SW	18.3	
									2.4	
									8.7	
-20		4		100					2.9	
									4.2	
									3.4	
									3.2	
							Fine to medium SAND, some coarse sand and fine to medium gravel, trace to some silt.	SW	5.2	
-25		5		100					6.7	

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil samples OW-1 (8-9') and OW-1 (29-30').

BORING NO.: OW-1

URS Corporation

TEST BORING LOG

BORING NO. : OW-1

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 2

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									39.1	
									8.3	
									68.1	
							Medium SAND, trace coarse sand and fine gravel.	SP	286.5	
-30							Boring completed at 30 ft bgs.			
-35										
-40										
-45										
-50										
-55										

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil samples OW-1 (8-9') and OW-1 (29-30').

BORING NO. : OW-1

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO.: OW-2
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 2
	JOB NO.: 11176390.00005
BORING CONTRACTOR: Glacier Drilling	NORTHING: 201753.213 EASTING: 1001857.253
GROUNDWATER: Not Encountered	GROUND ELEVATION: 36.00 ft amsl
	DATE STARTED: 4/22/15
	DATE FINISHED: 4/22/15
	DRILLER: Mark Schock
	GEOLOGIST: J. Boyd
	REVIEWED BY: T. Burmeier

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			
-5		1		100	Brown	Medium dense	SILT and fine to medium SAND, some fine to medium gravel and coarse sand.	SM	3.1	Moist
									3.7	
							SILT, trace fine sand. Rock from 8-8.5' bgs.	ML	4.1	
		2		100					1.9	
						Loose	Medium to coarse SAND, some fine sand and fine to medium gravel.	SW	3.8	
-10							Fine to medium SAND, trace fine gravel.	SW	11.6	
		3		100					0.0	
							Medium to coarse SAND, some fine sand and fine to medium gravel, trace silt and cobbles. Rock 16-17' bgs.	SW	0.7	
									4.4	
									0.8	
-15		4		100					22.8	
									2.7	
							Fine to medium SAND, some fine to medium gravel, some to trace silt, trace cobbles.	SW	9.7	
									5.7	
									5.9	
-20		5		100					18.5	
									13.7	
									15.6	
									6.1	
									5.9	
-25		6		100					42.5	

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample OW-2 (25-26').

URS Corporation

TEST BORING LOG

BORING NO. : OW-2

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 2

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									30.5	
									26.0	
							Medium SAND, some to trace fine and coarse sand and fine gravel.	SP	14.2	
									11.9	
-30							Boring completed at 30 ft bgs.			
-35										
-40										
-45										
-50										
-55										

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing. Collected soil sample OW-2 (25-26').

BORING NO. : OW-2

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	**BORING NO. :** OW-3
	SHEET: 1 **OF** 2
CLIENT: New York State Department of Environmental Conservation	**JOB NO. :** 11176390.00005
BORING CONTRACTOR: Glacier Drilling	**NORTHING:** 201744.669 **EASTING:** 1001828.478
GROUNDWATER: Not Encountered	**GROUND ELEVATION:** 36.73 ft amsl
	DATE STARTED: 4/24/15
	DATE FINISHED: 4/24/15
	DRILLER: Mark Schock
	GEOLOGIST: J. Boyd
	REVIEWED BY: T. Burmeier

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			
-5		1		100	Brown	Medium dense	SILT and very fine SAND, trace fine gravel. Cobbles 6-7'.	ML	0.5	Moist
							Fine to medium SAND, some silt and fine to medium gravel.	SW	0.1	
									0.2	
						Loose			0.8	
-10		2		100					3.0	
									2.3	
							Medium to coarse SAND, some fine to medium gravel, trace silt.	SW	2.3	
							Fine to coarse SAND, some fine to medium grave, some to trace silt and cobbles. Cobble 14-16'.	SW	5.1	
		3		100						
-15										
		4		100					2.5	
									1.1	
									0.8	
									0.7	
-20		5		100					1.1	
					Red brown				1.0	
					Brown				0.9	
									1.6	
									1.3	
-25		6		100					1.0	

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing.

URS Corporation

TEST BORING LOG

BORING NO. : OW-3

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 2

CLIENT: New York State Department of Environmental Conservation

JOB NO. : 11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
							Fine to medium SAND, trace fine gravel.	SW	3.3	
									5.7	
									7.3	
									2.8	
-30							Boring completed at 30 ft bgs.			
-35										
-40										
-45										
-50										
-55										

COMMENTS: Boring advanced with GeoProbe 8140 LS Sonic drilling rig using 6" casing.

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SP-1
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 3
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201759.575 EASTING: 1001864.629
GROUNDWATER: 33 ft bgs	GROUND ELEVATION: 35.72 ft amsl

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DATE STARTED:	4/23/15
DATE FINISHED:	4/23/15
DRILLER:	Mark Schock
GEOLOGIST:	J. Boyd
REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			Moist
-5		1		100	Brown	Medium dense	SILT and fine to medium SAND, trace fine to medium gravel.	SM	15.1	
									3.3	
						Loose	Fine to medium SAND, some coarse sand, fine to medium gravel and silt, trace cobbles. Cobbles 12-13.5 and 15-18'.	SW	0.7	
									0.4	
									0.4	
-10		2		100					0.3	
									0.2	

									0.1	
									0.1	
-15		3		100					0.0	
									0.0	
									0.0	
		4		100			Fine to medium SAND,some fine to medium gravel, trace silt and cobbles.	SW	1.0	
									2.1	
-20									2.7	
									1.2	
									0.7	
									1.3	
						Medium dense	SILT. Faint PCE odor.	ML	96.2	
-25		5		100					20.2	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample AS-1 (24-25') and AS-1 (30-31').

BORING NO. : SP-1

URS Corporation

TEST BORING LOG

BORING NO. : SP-1

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
						Loose	Fine to medium SAND, some coarse sand and fine to medium gravel, trace to some silt and cobbles.	SW	18.3	
									1.2	
									2.0	
							Medium SAND, trace fine gravel.	SP	42.2	
-30									48.4	
									3.2	
									3.9	
							Medium to coarse SAND and fine to medium GRAVEL, trace silt and fine sand.	GW	1.8	Wet
									2.2	
-35		6		50			Medium SAND, some fine sand and fine gravel.	SW	2.0	
									3.2	
									0.7	
									3.1	
									3.4	
-40							Sample lost.		---	

-45		7		100			Fine to medium SAND, some to trace fine to medium gravel, trace coarse sand.	SW	6.9	
									17.4	
									5.3	
									1.0	
									0.6	
-50									0.4	
									0.4	
									0.7	
									0.8	
									0.8	
-55		8		100					0.1	
									0.2	
									0.2	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample AS-1 (24-25') and AS-1 (30-31').

URS Corporation

TEST BORING LOG

BORING NO. : SP-1

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 3 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									0.1	
									0.1	
-60		9							0.1	
									0.1	
							Coarse SAND and fine to medium GRAVEL, some fine to medium sand.	GW	0.1	
									0.1	
									0.1	
-65							Boring completed at 65 ft bgs.			
-70										
-75										
-80										
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample AS-1 (24-25') and AS-1 (30-31').

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SP-2
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 3
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
GROUNDWATER: 33 ft bgs	NORTHING: 201753.504 EASTING: 1001847.748
	GROUND ELEVATION: 36.13 ft amsl
	DATE STARTED: 4/27/15
	DATE FINISHED: 4/27/15
	DRILLER: Mark Schock
	GEOLOGIST: J. Boyd
	REVIEWED BY: T. Burmeier

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0						Medium dense	Vactron cleared boring 0-5'.			Moist
-5		1		100	Brown	Medium dense	SILT, some fine sand, trace fine gravel.	ML	3.6	
							Fine to medium SAND trace to some silt and fine to medium gravel and cobbles.	SW	3.3	
						Loose			1.1	
									1.1	
									3.6	
-10		2		100					3.7	
									1.8	
									5.1	
									3.7	
									3.4	
-15		3		100					3.5	
									2.2	
									5.4	
									7.1	
									5.8	
-20		4		100					9.5	
							Medium to coarse SAND, some fine sand and fine to medium gravel, trace cobbles.		3.3	
								SW	7.2	
							Fine to medium SAND. Faint PCE-like odor.	SW	32.6	
						Medium dense		SW	3.0	
-25		5		100			Fine to coarse SAND, some fine to medium gravel, trace silt and cobbles.		9.5	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 8" casing.
Collected soil sample AS-2 (28-29').

BORING NO. : SP-2

URS Corporation

TEST BORING LOG

BORING NO.: SP-2

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO.: 11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
						Loose	PCE-like odor.		1.7	
							Fine to medium SAND, trace fine gravel.	SW	60.3	
									42.9	
									11.1	
-30		6		30			Fine to coarse SAND, some fine to medium gravel and silt.	SW	10.4	
							Fine to medium SAND, some fine to medium gravel.	SW	2.7	
									2.2	
							Lost sample out of casing.		---	Wet

-35									---	

-40		7		50			Fine to medium SAND, some to trace fine to medium gravel.	SW	3.2	
									1.5	
									1.1	
									1.3	
									0.3	
-45							Lost sample out of casing.		---	

-50		8		100			Fine to medium SAND, trace fine gravel.	SW	1.7	
									1.2	
									1.0	
									4.0	
									2.8	
-55									0.6	
									0.2	
							Medium to coarse SAND, trace fine to medium gravel.	SW	0.1	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 8" casing. Collected soil sample AS-2 (28-29').

URS Corporation

TEST BORING LOG

BORING NO. : SP-2

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 3 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									0.0	
									0.0	
-60							Boring completed at 60 ft bgs.			
-65										
-70										
-75										
-80										
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 8" casing.
Collected soil sample AS-2 (28-29').

BORING NO. : SP-2

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SP-3
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 3
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201750.915 EASTING: 1001840.711

GROUNDWATER: 34 ft bgs					CAS.	SAMPLER	CORE	TUBE		
DATE	TIME	LEVEL	TYPE	TYPE					GROUND ELEVATION:	36.33 ft amsl
				DIA.					DATE STARTED:	4/27/15
				WT.					DATE FINISHED:	4/27/15
				FALL					DRILLER:	Mark Schock
									GEOLOGIST:	J. Boyd
				* POCKET PENETROMETER READING					REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			Moist
-5		1		100	Light brown	Medium dense	SILT, some fine sand, trace fine gravel.	ML	2.0	
					Brown	Loose	Fine to medium SAND, some silt, fine to medium gravel and cobbles.	GM	3.2	
									1.3	
									2.1	
									1.8	
-10		2		100			Fine to medium SAND, trace to some fine gravel and silt.	SW	4.5	
									6.7	
									2.4	
									0.6	
									0.2	
-15		3		100			with some cobbles 15-20' bgs.	SW	0.3	
									0.6	
									1.1	
									6.4	
									8.9	
-20		4		100			Fine to medium SAND, trace to some silt, fine to medium gravel and cobbles. PCE-like odor 23.5-25' bgs.	SW	14.6	
									1.6	
									2.8	
									6.0	
									22.2	
-25		5		100					10.3	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample AS-3 (34-35').

URS Corporation

TEST BORING LOG

BORING NO. : SP-3

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	SAMPLE NO.	BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
								1.5	
								14.4	
						Fine to medium SAND, trace fine gravel.	SW	9.1	
								24.9	
-30	6		100		Medium dense	Fine to medium SAND, trace to some silt, fine to medium gravel and cobbles.	SW	8.1	
					Loose			9.2	
								10.4	
								12.0	
						Fine to medium SAND, some fine and coarse sand, trace fine gravel.	SW	122.9	Wet
-35								113.6	
						Fine to medium SAND.	SW	2.7	
								2.8	
								8.8	
								6.3	
-40	7		50			Fine to medium SAND, trace fine gravel.	SW	0.0	
								0.1	
								0.1	
								1.2	
								0.3	
-45						Lost sample out of casing.		---	

-50	8		100			Fine to medium SAND, trace coarse sand and fine to medium gravel	SW	0.0	
								0.0	
								0.0	
								0.0	
								0.0	
-55								0.1	
								0.0	
								0.0	

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing.
Collected soil sample AS-3 (34-35').

URS Corporation

TEST BORING LOG

BORING NO. : SP-3

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 3 OF 3

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
							Medium to coarse SAND, trace fine to medium gravel.	SW	0.0 0.0	
-60							Boring completed at 60 ft bgs.			
-65										
-70										
-75										
-80										
-85										
-90										

COMMENTS: Boring advanced with a track-mounted GeoProbe 8140 LS Sonic drilling rig using 6" casing. Collected soil sample AS-3 (34-35').

BORING NO. : SP-3

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SVE-1
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 2
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201757.595 EASTING: 1001870.573
GROUNDWATER: Not Encountered	GROUND ELEVATION: 35.70 ft amsl

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DATE STARTED:	4/29/15
DATE FINISHED:	4/29/15
DRILLER:	Mark Schock
GEOLOGIST:	J. Boyd
REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0				100			Vactron cleared boring 0-5'.			
-5		1		100	Yellow brown	Medium dense	SILT and fine SAND, trace fine to medium gravel (fill). Cobble 8-8.5'.	FILL	28.2	Moist
									27.3	
									32.9	
		2		100	Brown				56.4	
						Loose	Fine to coarse SAND, trace to some silt and fine to medium gravel.	SW	15.1	
-10		3		100					6.0	
									15.5	
									7.2	
									9.6	
									5.3	
-15		4		100					4.1	
									8.3	
		5		100					3.6	
									13.3	
									15.5	
-20		6		100					86.9	
							Fine to medium SAND, trace fine gravel.	SW	166.7	
							Fine to medium SAND, some fine to medium gravel, trace silt and cobbles.	SW	86.0	
									362.0	
									211.3	
-25									167.7	

COMMENTS: Boring advanced withGeoProbe 8140 LS Sonic sdrilling rig using 6" casing.
Collected soil samples SVE-1 (8-9') and SVE-1 (23-24').

URS Corporation

TEST BORING LOG

PROJECT: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SVE-1
	SHEET: 2 OF 2
CLIENT: New York State Department of Environmental Conservation	JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
									120.2	
							Boring completed at 27 ft bgs.			
-30										
-35										
-40										
-45										
-50										
-55										

COMMENTS: Boring advanced withGeoProbe 8140 LS Sonic sdrilling rig using 6" casing.
Collected soil samples SVE-1 (8-9') and SVE-1 (23-24').

BORING NO. : SVE-1

URS Corporation

TEST BORING LOG

PROJECT/PROJECT LOCATION: Former Klink Cosmo Cleaners - Pilot Study	BORING NO. : SVE-2
CLIENT: New York State Department of Environmental Conservation	SHEET: 1 OF 2
BORING CONTRACTOR: Glacier Drilling	JOB NO. : 11176390.00005
	NORTHING: 201747.807 EASTING: 1001836.494
GROUNDWATER: Not Encountered	GROUND ELEVATION: 36.52 ft amsl

DATE	TIME	LEVEL	TYPE		CAS.	SAMPLER	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				
				* POCKET PENETROMETER READING				

DATE STARTED:	4/28/15
DATE FINISHED:	4/28/15
DRILLER:	Mark Schock
GEOLOGIST:	J. Boyd
REVIEWED BY:	T. Burmeier

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC% / RQD%	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
0							Vactron cleared boring 0-5'.			
-5		1		60	Brown	Medium dense	SILT and fine SAND, trace fine gravel (fill).	FILL	4.3	Moist
							Fine to coarse SAND, trace to some silt, fine to medium gravel and cobbles. Lost the 8-10' sample.	SW	5.7	
									1.5	
									--	
						Loose			--	
-10		2		100					0.3	
									1.7	
									1.4	
									0.9	
									0.8	
-15		3		100					1.7	
									5.4	
									3.0	
									2.0	
									3.4	
-20		4		100					2.2	
									2.8	
									3.4	
									4.7	
									4.9	
-25							Fine to medium SAND, some fine to	SW	5.1	

COMMENTS: Boring advanced withGeoProbe 8140 LS Sonic sdrilling rig using 6" casing.

BORING NO. : SVE-2

URS Corporation

TEST BORING LOG

BORING NO. : SVE-2

PROJECT: Former Klink Cosmo Cleaners - Pilot Study

SHEET: 2 OF 2

CLIENT: New York State Department of Environmental Conservation

JOB NO. :11176390.00005

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE BLOW COUNT	REC % / RQD %	COLOR	SOIL CONSISTENCY / ROCK HARDNESS	MATERIAL DESCRIPTION	USCS	PID	REMARKS
							medium gravel.		10.2	
							Boring completed at 27 ft bgs.			
-30										
-35										
-40										
-45										
-50										
-55										

COMMENTS: Boring advanced withGeoProbe 8140 LS Sonic sdrilling rig using 6" casing.

ATTACHMENT D

SVE PILOT TEST MATERIALS AND EQUIPMENT LIST AND SPECIFICATIONS

SVE Pilot Test Equipment List

One (1) Mobile Soil Vapor Extraction Unit

Eight (8) Vapor-Phase Activated Carbon Vessels (55-gallon/250 pound drums)

One (1) Combination Photoionization/Flame Ionization Detector

Three (3) Temperature gauges w/ ½-inch NPT fitting

Seventeen (17) Summa canisters

Four-Hundred (400) feet of 2-inch hose

Fourteen (14) compound vacuum/pressure gauges

Fourteen (14) ¼-inch bronze threaded nipples

Fourteen (14) ½-inch x ¼-inch bronze reducers

Fourteen (14) ½-inch ball valves

Twenty-eight (28) ½-inch bronze threaded nipples

Twelve (12) 2-inch diameter well seals

Twenty-eight (28) feet of ½-inch threaded bronze pipe

Twelve (12) 1-1/4-inch PVC NFT plugs

Eight (8) 2-inch x 1-inch rubber reducers

Two (2) 2-inch diameter thread to 2-inch cam and groove f-adapters

Two (2) 2-inch diameter threaded PVC couplings

Two (2) 2-inch diameter threaded PVC Schedule 80; 90-degree elbows

Two (2) ½-inch ball valves with hose barbs

Four (4) 2-inch diameter threaded PVC Schedule 80 nipples

Four (4) feet of 2-inch diameter Schedule 80 pipe

Two (2) 4-inch diameter well seals

C-VLR

zephyr

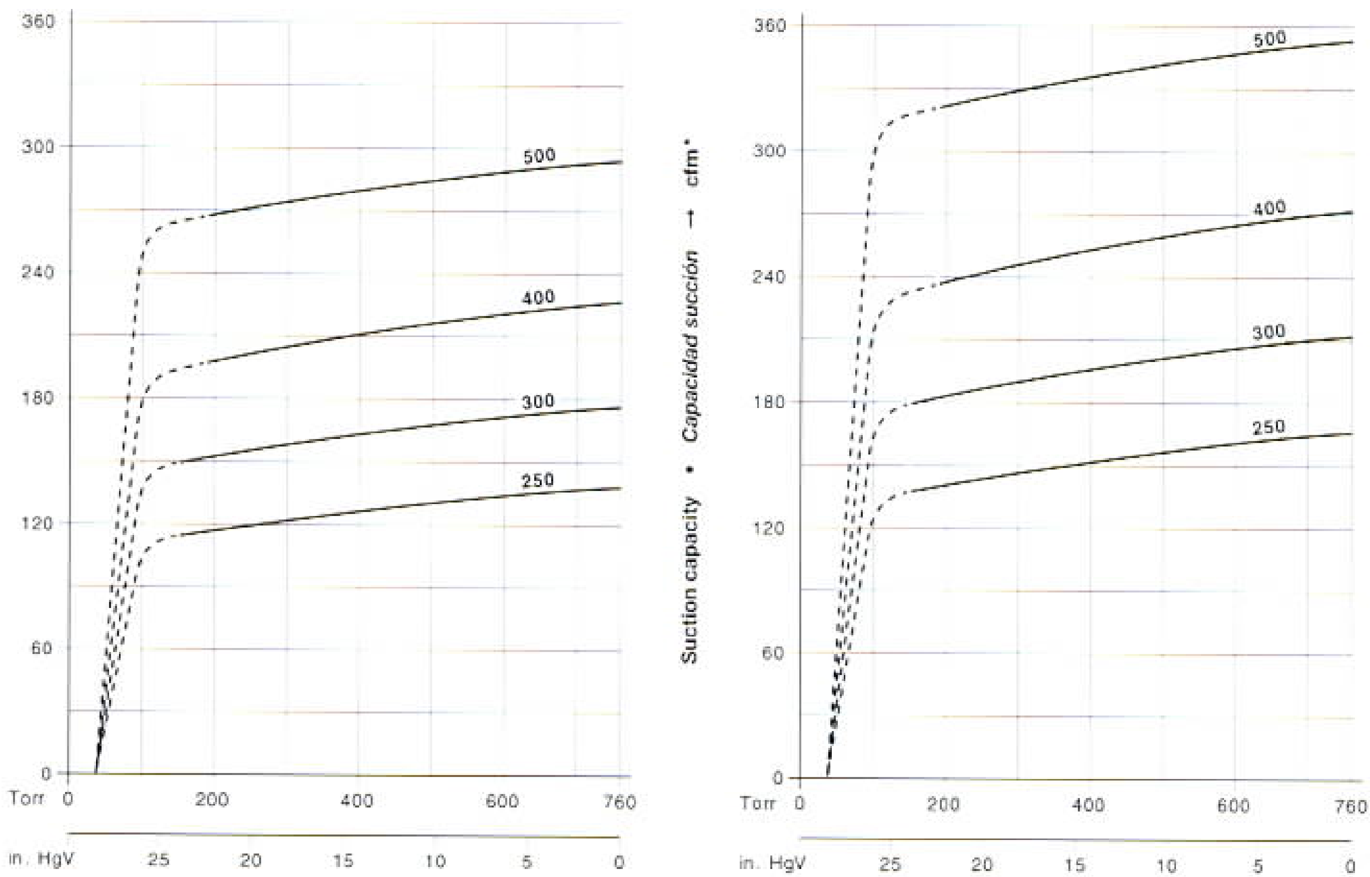
Elmo Rietschle
A Gardner Denver Product

C-VLR 250 | C-VLR 300 | C-VLR 400 | C-VLR 500

High efficiency, dry and contact free compression claw vacuum pump
Capacities ranging from 138 to 353 cfm.
The ultimate vacuum for continuous operation is 24 or 22.5 in. HgV.
Low maintenance. Integrated air cooling without additional cooling medium.

Bomba de vacío de garras altamente eficiente, de compactación en seco y sin contacto
Capacidades de 138 a 353 cfm.
El vacío absoluto para funcionamiento continuo es de 24 o 22.5 in. HgV.
Poco mantenimiento, refrigeración por aire integrada sin medios adicionales.

Selection diagram • *Diagrama de selección* 50 Hz | 60 Hz

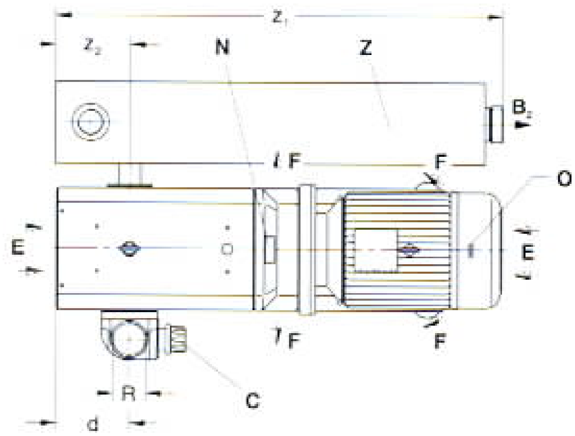


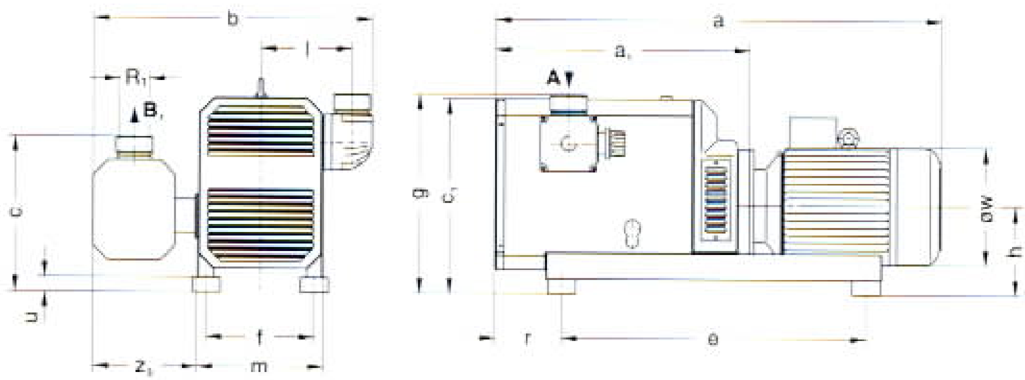
Suction pressure • *Presión succión* → Torr / in. HgV

C-VLR			250	300	400	500
Suction capacity *Capacidad succión*	cfm	50 Hz	138	177	227	294
		60 Hz	166	212	272	353
Ultimate vacuum max. *Vacío final máx.*			38 Torr - 28.44 in. HgV			
Ultimate vacuum continuous operation *Vacío final permanente*			150 Torr - 24.0 in. HgV		188 Torr - 22.5 in. HgV	
Rated voltage *Tensión asignada*	3~	50 Hz	230 / 400 V ± 10 %	400 / 690 V ± 10 %		
		60 Hz	208 - 230 / 460 V ± 10 %			
Motor rating *Potencia requerida*	kw	50 Hz	4.0	5.5	7.5	9.0
	hp	60 Hz	7.5	7.5	10	15
Full load amperage *Amperaje a carga plena*	A	50 Hz	14.4 / 8.3	11.0 / 6.4	15.0 / 8.7	19.0 / 11.0
		60 Hz	19 - 18 / 9.0	19 - 18 / 9.0	25 - 23 / 11.5	37.5 - 34 / 17
Speed *Velocidad*	rpm	50 Hz	2850			
		60 Hz	3450			
Average noise level *Nivel promedio de ruido*	dB(A) EN ISO 3744	50 Hz	76	77	82	82
		60 Hz	78	79	84	84
Weight *Peso*	lbs	50 Hz	470	580	728	840
		60 Hz	537	603	736	900
Oil capacity (gear) *Capacidad de aceite (engranaje)*	qt		0.75	0.75	0.75	0.75

Dimensions • *Dimensiones* [inches]

A	Vacuum connection • *Conexión de vacío*
B_1, B_2	Exhaust • *Escape* B_1 → C-VLR 100, 150 • B_2 → C-VLR 60, 251
C	Vacuum regulating valve • *Válvula reguladora de vacío*
E	Cooling air entry • *Entrada aire refrigerante*
F	Cooling air exit • *Salida aire refrigerante*
N	Data plate • *Placa de la unidad*
O	Rotation arrow • *Dirección de rotación*
Z	Exhaust silencer • Silenciador escape





C-VLR		60	100	150	251
a	50 Hz	24.61	26.02	32.52	34.88
	60 Hz	24.45	29.83	34.54	40.15
a_1	50 Hz	14.45	15.43	18.70	22.72
	60 Hz	14.45	17.29	20.62	24.63
b		16.97	21.26	20.98	25.00
c		11.22	9.80	11.77	11.57
c_1		11.61	14.17	14.76	14.76
d		9.61	3.62	2.28	2.56
e		9.65	17.32	15.04	15.04
f		6.30	8.66	6.30	6.30
g		16.22	14.53	15.31	17.09

C-VLR		60	100	150	251
h		6.10	5.91	6.50	6.50
l		6.33	7.17	7.05	8.39
m		6.46	10.24	10.16	10.16
r		4.21	3.03	4.57	8.58
u		0.79	0.59	1.18	1.18
øw	50 Hz	7.28	6.93	7.72	8.66
	60 Hz	7.05	6.62	8.50	10.62
z_1		12.01	25.98	25.98	43.07
z_2		2.36	3.94	3.94	6.30
z_3		4.72	7.28	7.28	10.24
R / R_1		1" NPT	1½" NPT	1½" NPT	2" NPT

Accessories • *Accesorios*

C-VLR			60	100	150	251
Non return valve *Válvula retención*	ZRK		25 (03)	40 (03)	40 (03)	50 (03)
Vacuum tight suction filter *Filtro de succión estanco al vacío*	ZVF	50 Hz	-	32 (54)	40 (53)	50 (53)
		60 Hz	-	40 (53)	40 (53)	50 (53)
Motor protection switch • *El guardamotor* Sound box • *Caja de sonido*	ZMS ZBZ		on request • *on pedido*			

cfm* Relates to pump inlet conditions • *se refiere a las condiciones de entrada de la bomba*

Curves, tables content (tolerance ±10%) refer to vacuum pump at normal operating temperature. • *Las curvas, las tablas (tolerancia ±10%) hacen referencia a una bomba de vacío a temperatura normal de funcionamiento.*

The motor dimensions as well as the full load amperage may vary because of different motor manufacturers. • *Las dimensiones de motor pueden variar para distintos fabricantes de motores.*

Technical information is subject to change without notice! • *La información técnica está sujeta a cambios sin previo aviso!*

Gardner Denver
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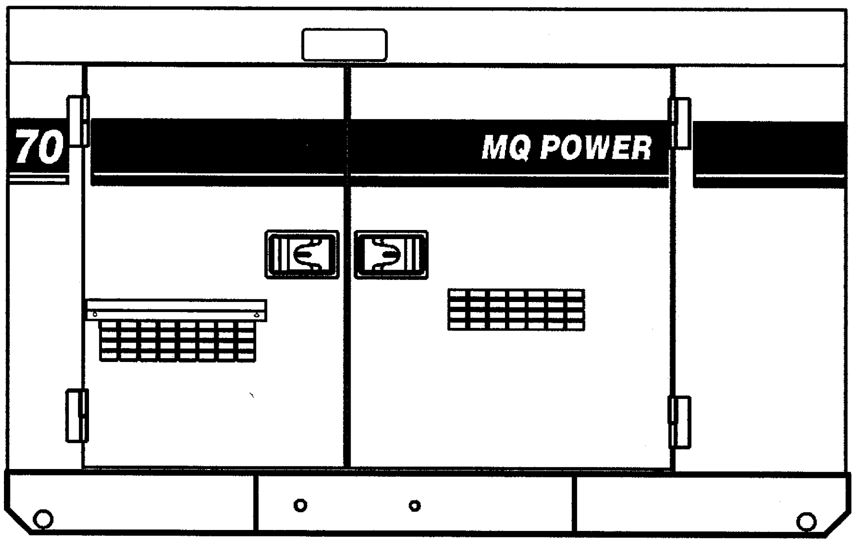
www.gd-elmorietschle.com

Edition: 1.4.2012 · D 880-1-US

DCA70SSI
WhisperWatt™ Series

WhisperWatt™ 70

Prime Rating: 56 kW (70 kVA)
Standby Rating: 59 kW (74 kVA)
60 Hertz



Standard Features

- **Heavy duty, 4-cycle, direct injection, turbocharged diesel engine** provides maximum reliability.
- **Brushless alternator** reduces service and maintenance requirements and meets temperature rise standards for Class F insulation systems.
- **Open delta alternator design** provides virtually unlimited excitation for maximum motor starting capability.
- **Automatic voltage regulator** (AVR) provides precise regulation.
- **Electronic Governor Control (Crystal Sync)** — maintains frequency to within ±0.25% from no load to full load.
- **Full load acceptance** of standby nameplate rating in one step (NFPA 110, para 5-13.2.6).
- **Sound attenuated, weather resistant, steel housing** provides ultra-silent operation at 65 dB(A) at 23 feet. Fully lockable enclosure allows safe unattended operation.
- **Integrated fuel tank** with direct reading fuel gauges are standard.
- **Seven-stage powder coat paint** provides durability and weather protection.
- **Simultaneous single and three phase power.**
- **Complete engine analog instrumentation** includes DC ammeter, oil pressure gauge, water temp. gauge, fuel level gauge, tachometer/hour meter, preheat indicator, and emergency shutdown monitors.
- **Complete generator analog instrumentation** includes voltage regulator control, ammeter phase selector switch, voltmeter phase selector switch, AC voltmeter, AC ammeter, frequency meter, panel light, and circuit breaker.
- **Automatic safety shutdown system** monitors the water temperature, engine oil pressure, overspeed and overcrank. Warning lights indicate abnormal conditions.
- **Automatic start/stop control** — automatically starts the generator set during a commercial power failure when used in conjunction with a transfer switch.
- **Complete power panel.** Fully covered; three-phase terminals and single phase receptacles allow fast and convenient hookup for most applications including temporary power boxes, tools and lighting equipment. All are NEMA standard.
- **Voltage selector switch** allows easy to change voltages as your applications require.
- **EPA emissions certified** - Tier 2 emissions compliant.

DCA70SSI
WhisperWatt™ Series

MQ POWER

Specifications

Generator Specifications

Design	Revolving field, self-ventilated, drip-proof, single bearing
No. of Poles	4-pole
Excitation	Brushless with AVR
Standby Output	58.8 Kw
Prime Output	56 Kw
Generator RPM	1800
Voltage — 1Ø	120/240
Voltage Regulation (No load to full load)	±1.0%
Power Factor	0.8
Frequency	60 Hz
Frequency Regulation: No Load to Full Load	3-5% under varying load from no load to 100% load
Frequency Regulation: Steady State	±0.5% of mean value for constant loads from no load to full load
Insulation	Class F
Sound Level dB(A) Full load at 23 feet	65

Engine Specifications

Make / Model	Isuzu/FF-4BG1T
Emissions	EPA Tier 2 Certified
Starting System	Electric
Design	4-cycle Water Cooled Direct injection Turbocharged
Displacement	264.2 in^3 (4329 cc)
No. cylinders	4
Bore x Stroke	105mm x 125mm
Gross Engine Power Output	98.6 bhp (73.5 KW)
BMEP	149 psi (1029 kPa)
Piston Speed	1476 ft/min (7.5 m/s)
Compression Ratio	18.0:1
Engine Speed	1800 rpm
Overspeed Limit	2100 rpm
Oil capacity	3.49 gal. (13.2L)
Battery	12V 80Ah x 1

Fuel System

Recommended Fuel	ASTM-D975-No.1 & No.2-D	
Maximum Fuel Flow (per hour)	30.4 gallons (115 liters)	
Maximum Inlet Restriction (Hg)	2.39 in. (60.8 mm)	
Fuel Tank Capacity	39.6 gallons (150 liters)	
Fuel Consumption	**gph**	**lph**
at full load	4.5	17.0
at 3/4 load	3.8	14.3
at 1/2 load	2.4	9.0
at 1/4 load	1.5	5.6

Cooling System

Fan Load	3.0 HP (2.2 KW)
Coolant Capacity (with radiator)	3.43 gallons (13.0 liters)
Coolant Flow Rate (per minute)	44 gallons (168 liters)
Heat Rejection to Coolant (per minute)	2502 Btu (2.64 MJ)
Heat Radiated to Room (per minute)	389 Btu (0.41 MJ)
Maximum Coolant Friction Head	7.6 psi (52.3 kPa)
Maximum Coolant Static Head	17 feet (5.3 meters)
Ambient Temperature Rating	104°F (40°C)

Air

Combustion Air	194 cfm (5.5m^3/min)
Maximum Air cleaner Restriction	29.5 in. H_2O (7.36 kPa)
Alternator Cooling Air	911 cfm (25.8m^3/min)
Radiator Cooling Air	3707 cfm (105m^3/min)

Exhaust System

Gas Flow (full load)	607 cfm (17.2 m^3/min)
Gas Temperature	993°F (534°C)
Maximum Back Pressure	53.5 in. H_2O (13.3 kPa)

Amperage

Rated Voltage	Maximum Amps
1Ø 120 Volt	155.5 Amps (4 wire)
1Ø 240 Volt	77.8 Amps (4 wire)
3Ø 240 Volt	168 Amps
3Ø 480 Volt	84 Amps
Main Line Circuit Breaker Rating	175 Amps
Over Current Relay Trip Set Point	84 Amps

Warranty*

Isuzu Engine

12 months from date of purchase or 1800 hours (whichever occurs first).

Generator

24 months from date of purchase or 2000 hours (whichever occurs first).

Trailer

12 months excluding normal wear items.

*Refer to the express written, one-year limited warranty sheet for additional information.

Generator is not intended for use in enclosed areas or where free flow of air is restricted.

Backfeed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device.

Specifications are subject to change without notice.

MQ POWER

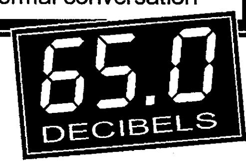
DCA70SSI

WhisperWatt™ Series

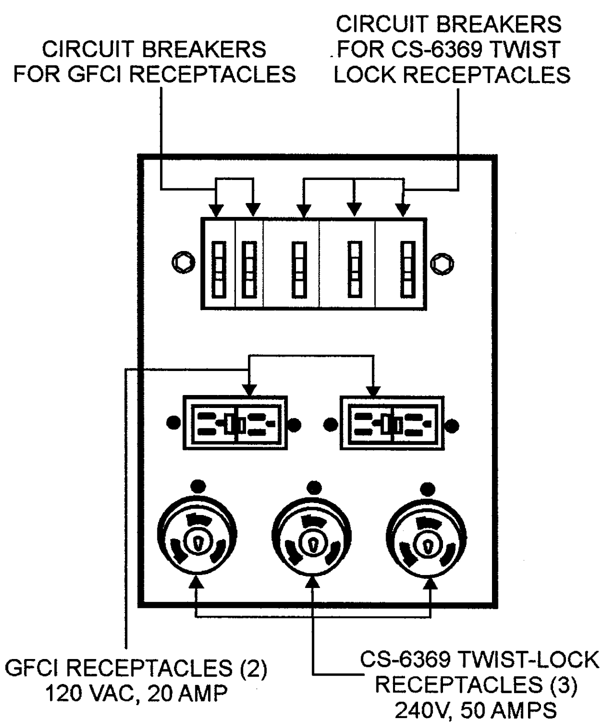
MQ POWER DECIBEL LEVELS

Our soundproof housing allows substantially lower operating noise levels than competitive designs. WhisperWatts are at home on construction sites, in residential neighborhoods, and at hospitals — just about anywhere.

- 90 — Subway / truck traffic
- 80 — Average city traffic
- 70 — Inside car at 60 mph
- — WhisperWatt at 23 feet
- 60 — Air conditioner at 20 feet
- 50 — Normal conversation



Generator Output Panel



Optional Generator Features

- ❑ **Battery charger** — provides fully automatic and self-adjusting charging to the generator's battery system.
- ❑ **Low coolant level shutdown** — provides protection from critically low coolant levels. Includes control panel warning light.
- ❑ **Jacket water heater** — for easy starting in cold weather climates.
- ❑ **Special batteries** — long life batteries provide extra engine cranking power.
- ❑ **Spring Isolaters** — provides extra vibration protection for standby applications.
- ❑ **Trailer mounted package** — highway legal trailer with electric or surge brakes with tandem axle configuration. Extra capacity fuel tanks are also available.

Optional Control Features

- ❑ **Emergency Stop Switch.**
- ❑ **Audible Alarm** — alerts operator of abnormal conditions.

Optional Fuel Cell Features

- ❑ **Trailer fuel tank** — a second fuel cell located in the trailer allows for extended run time.
- ❑ **Subbase fuel cells (single wall)** — Additional fuel cell for extended runtime operation.
  - ❑ 12 hours of minimum run time.
  - ❑ 24 hours of minimum run time.
- ❑ **Subbase fuel cells (double wall)** — Additional fuel cell for extended runtime operation. Contains a leak sensor, low fuel level switch, and a secondary containment tank. UL142 listed.
  - ❑ 12 hours of minimum run time.
  - ❑ 24 hours of minimum run time.

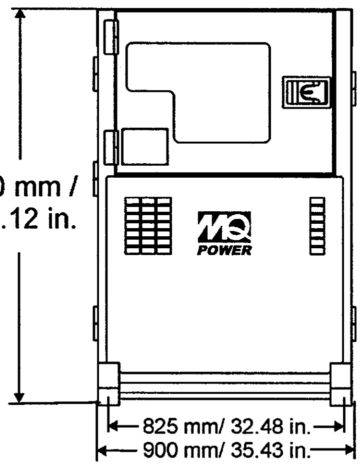
Optional Distribution Devices

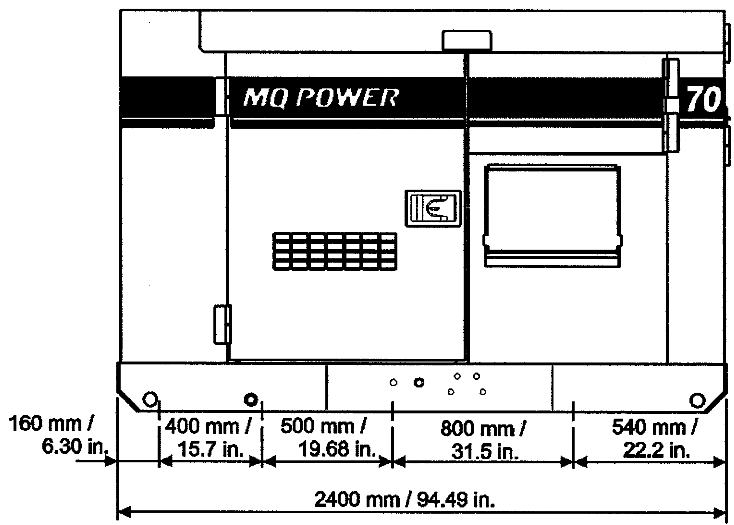
- ❑ **CamLok™ connectors**
- ❑ **Pin & sleeve connectors** — Appleton, Crouse-Hinds
- ❑ **AC output cable** — Type G, Type W

DCA70SSI

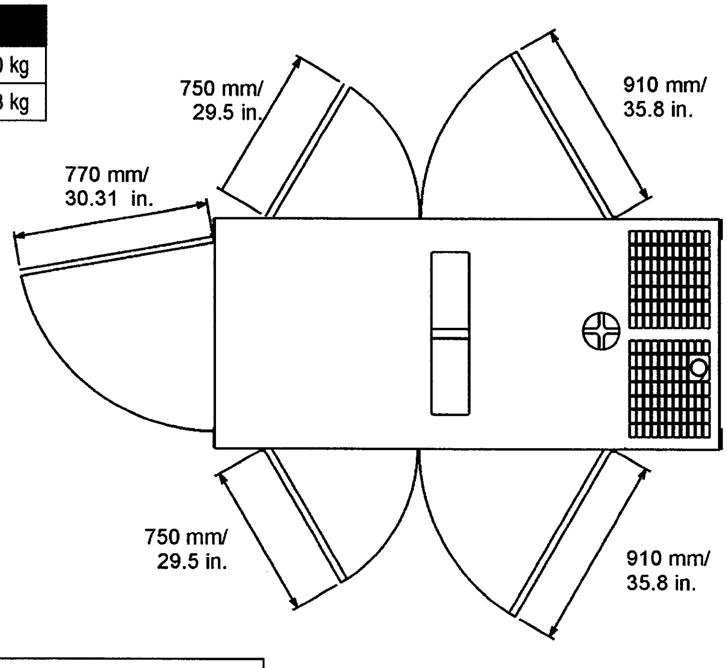
WhisperWatt™ Series

Dimensions





Weight	
Dry Weight	3087 lbs. / 1400 kg
Wet Weight	3425 lbs. / 1553 kg



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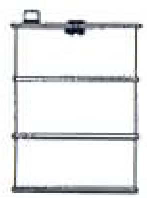
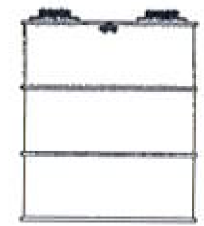
GPC Drum Series
Carbon Vessels

Carbonair's gas phase carbon adsorbers are designed to provide an efficient and economical means to control odor, toxic vapors, and corrosive gases. Several types of activated carbons are available for a variety of applications.

Specifications





Model	GPC 3	GPC 3H	GPC 3.85
Flow Range (cfm)	20 - 100	20 - 270	36 -360
Carbon Capacity (lb)	200	180	250
Vessel Diameter	2'	2'	2' -4"
Vessel Height	3' -0"	3'-0"	3' -6"
Bed Area (ft^2)	2.7	2.7	3.7
Empty Weight (lb)	65	65	100
Operating Weight (lb)	265	265	350
Influent Connection	2" FPT	4" FPT	4" FPT
Effluent Connection	2" FPT	4" FPT	4" FPT

Design Features
- **Drums meet UN standards**
- **Baked enamel exterior**
- **Epoxy-phenolic interior lining**

Options
- □ Influent/Effluent Sample and Pressure Taps
- □ Influent/Effluent ducting
- □ Humidity control
- □ Discharge stack
- □ Blowers
- □ Complete line of granular activated carbon

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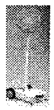


Larger Image

To get a quote, see bottom of page for options. All merchandises are sold at the store only.

Model:	PAL1250W2 OR PAL1250W4
CATALOG:	01-3405-

This item is also available for	
SALES	View Item

LIGHTING EQUIP.

Work Lights, 1250W
Work Light Towers, 1250W

PORT-A-LITE products help workers produce their highest quality work in concrete finishing, paving, masonry, roofing, excavation, mining, refineries, quarries, demolition, waterfronts, training sites and special events. Worldwide and domestic voltages available on request.

SPECIFICATIONS	
Make	Allmand
Model	PAL1250W2 OR PAL1250W4
AMPS	11
HEIGHT	Max Adju.10 ft/ (12 ft for PAL250W4)
TYPE	ELECTRIC
VOLTAGE	120
WATTS	1250/2500
WEIGHT	115 lbs (PAL1250W2)/225 lbs (PAL2500W4)

RELATED ITEM DOCUMENTS
To see specs click here

ADDITIONAL COMMENTS
Unit can be broken down to smaller components for easy transportation

RECOMMENDED SAFETY USE
Use a no. 10 or lower gauge electrical extension cord when distant from power source

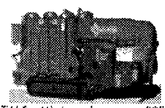
We Accept

To get a price
To receive a Quote via email, Sign-in where you can create multiple item lists, or if you prefer call us at 718-782-7887 and speak to a sales representative. Make sure you have the catalog number ready.
EMAIL THIS ITEM TO AN ASSOCIATE

Our Latest Additions

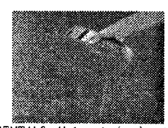
RENTALS - Mini Excavator

RENTALS - Track loaders



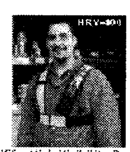
RENTALS - Mini spyder crane 295URW

SALES - Cut-N-Break K3000 saws

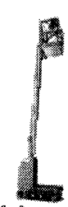


RENTALS - Hot spot pipe locator

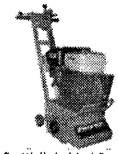
RENTALS - Plumbing camera, 125'



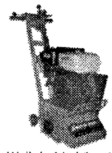
SUPPLIES - High Visibility Radio Vest



RENTALS - Personnel working platforms, 19 ft



RENTALS - Walk-behind Scarifier, 8", Gasoline



SALES - Walk-behind Scarifier, 8", Gasoline

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DIAN

SPECIFICATIONS ON PORT A LITE PRODUCTS

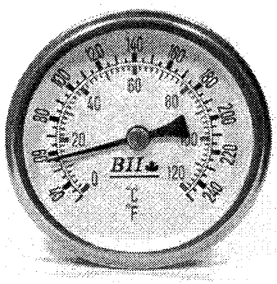
Models Available	MODEL NO.	Max. Adj. Height	Weight
	PAL 1250W2	10'	115 lbs.
	PAL 2500W4	12'	225 lbs.

MODEL PAL 1250W2

- Single 1250W SHO fixture, 120V/11A
- Fixture storage on base
- Lights adjust in all directions without tools
- Maximum adjustable height to 10 ft.

MODEL PAL 2500W4

- Two 1250 watt SHO fixtures, 120v/11A each
- Fixture storage on base
- Front wheel casters with brakes
- 10-in., ball bearing rear wheels
- Winch-up tower
- Maximum adjustable height to 12 ft..



1/2" NPT, 2.5" Face, Snap Well Thermometer

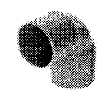
SKU: TW25-CB2-250-25 **Brand:** Boshart BOSHART INDUSTRIES

Read 6 Reviews | Write a Review

QTY	PRICE
	$18.10 / each
	$61.00 / box (5 units x $12.20)

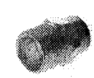
In Stock! Ships in 24-48 Hours (75 Available)

Others Also Bought



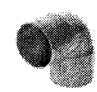
Cello WP7-12 - 3/4" Copper 90° Elbow
$0.77

In Stock!
(130775 Available)



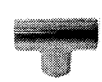
Cello WP4-12 - 3/4" Copper x Male Adapter
$1.16

In Stock!
(30138 Available)



Cello WP7-16 - 1" Copper 90° Elbow
$1.88

In Stock!
(30617 Available)



Cello WPT-12 - 3/4" CxCxC Tee
$1.42

In Stock!
(10313 Available)

Overview | Reviews 6 | Product Q & A 10

Resources

Product Overview

Specs

Dial Size:	2-1/2"
Connection Type:	1/2" NPT
Measures:	Fahrenheit Celsius
Temperature Range (F):	32°-250°F
Temperature Range:	0° to 120°C
Length (Inches):	1"
Min Temp (F):	32°F
Max Temp (F):	250°F
Accuracy:	+/- 2%
Application:	Temperature

Description for Boshart TW25-CB2-250-25

Features:

- 2-1/2" Dial
- General purpose industrial thermometer
- Coiled bi-metal element
- Bulb - Stem with detaching thermowell
- Accuracy : 2%
- Working Range 32-250°F Includes well
- 6 Bar Maximum Thermowell rating
- Aluminum Case / Acrylic Window
- Dual Scale °F & °C
- **Note: This product has a leaded brass thermowell. If your application requires a Stainless Steel Thermowell, order TW25-CB2-250-SS25**

JOHNNY ON THE SPOT LLC

Temporary Fencing for Construction Sites or Seasonal Businesses

Johnny On The Spot, leader in portable toilet rentals in NJ, NY and PA, now offers Temporary Fencing

NJ's finest portable restroom company now provides **Temporary Fencing** for security and safety at your construction site.

For Job Starts, choose the best *Temporary Fencing in NJ* and make it a one-stop with Johnny On The Spot.

- Choose from 6'X12' and 8'X10' surface mounted panels (all required hardware included) with or without sand bags, privacy screens and/or gates
- Our durable high-quality chain link fencing minimizes customer liability damage risk*
- Not sure what you need? One of our representatives will conduct a no cost inspection** of your site and advise you on the best **Temporary Fencing** solution for your unique situation

Our Temporary Fencing rentals save you money without sacrificing quality or service.

- Receive amazing bundle discounts on portable restrooms with *Temporary Fencing* at the same site!
- No long-term contracts for rentals; one month minimums with pay-as-you-go pricing means you never pay for more than you need - no lump sum quotes, no surprises
- Save money with a 15% discount on 12 month pre-paid rentals
- Fair rental policies: 50% final month rent refunded if fencing removed before the 15th
- Free site inspection/measurement performed by a Johnny On The Spot technician**

*No damage waiver offered on **Temporary Fencing**

**Free site inspection/measurement applies only if order is placed

Customers who use our **Temporary Fencing** also use:

- Standard Restrooms
- ADA Restrooms
- Portable Water Systems for Trailers

PDF Download the BROCHURE

Construction

- Standard Restroom
- Porta-Water System
- Temporary Fencing
- Deluxe Restroom
- Hi Rise Restrooms
- Hitch-N-Go Trailers
- ADA Accessible Restroom
- Wastewater Holding Tanks
- Other Restroom Solutions
- Lookout Guard Stations
- Liquid Waste Hauling, Pumping and Maintenance

Special Events

- Standard Restroom
- Celebrity Restroom
- Luxury Restroom Trailers
- ADA Accessible Restroom
- Hand Washing Solutions
- Barricade Fencing
- Temporary Fencing

Additional Services

- Non-Potable Water Supply
- Trash Receptacle Boxes
- Hand Sanitizer Stands
- Hi Rise Slings
- Containment Trays
- RV & Boat Waste Removal
- Restroom Attendants
- Baby Changing Stations

Former Klink Cosmo Site
Contaminant (PCE& TCE) Mass Removal During Pilot Study

Soil Vapor Concentrations in Area of Pilot Study

Well No.	PCE Soil Vapor Concentration (μg/M³) 6/2011	3/2012	Average	TCE Soil Vapor Concentration (μg/M³) 6/2011	3/2012	Average
SG-49	13100000	5140000	9120000	230000	70700	150350
SG-116		23600000	23600000		67600	67600
SG-84	282000	66200	174100	0	300	150
SG-58	176000	8800	92400	114	8.4	61.2
Average			**8246625**			**54540.3**

SVE-1 is approximately 30 feet east from the NE corner of the building
SVE-2 is approximately 70 feet east from the NE corner of the building
SG-116 is approximately 50 south of the NE corner of the building
SG-58 is approximately 220 feet east of the NE corner of the building

If we assume a radius of influence (ROI) of approximately 30 feet, SG-116 and SG-58 are well outside of our ROI.
Therefore, the concentrations at these monitoring points will not be used to determine carbon useage.

Contaminant Concentration to Determine Carbon Useage

Well No.	PCE Soil Vapor Concentration (μg/M³) 6/2011	3/2012	Average	TCE Soil Vapor Concentration (μg/M³) 6/2011	3/2012	Average
SG-49	13100000	5140000	9120000	230000	70700	150350
SG-84	282000	66200	174100	0	300	150
Average			**4647050**			**75250**

Anticipated Performance of Pilot Study

Parameter	Units	SVE Step Tests						
	inches HG	5	10	15	20	23		
SVE-1	SCFM	360	345	330	320	300		
PCE MW=166	Mass Recovered (lb/30 min)	3.133	3.003	2.872	2.785	2.611	14.404	(lbs)
TCE MW=131.4	Mass Recovered (lb/30 min)	0.051	0.049	0.047	0.045	0.042	0.233	(lbs)
Total Mass Removed during SVE-1 Step Test (~ 2 hours)							14.637	(lbs)

SVE Constant Rate Tests @ 300 SCFM

PCE MW=166	Mass Recovered (lb/120 min)	10.444	(lbs)
TCE MW=131.4	Mass Recovered (lb/120 min)	0.169	(lbs)
Total Mass Removed during SVE-1 & SVE -2 Constant Rate Test (~ 2 hours)		10.613	(lbs)

Total Mass Removed during SVE-1 Step Test (~ 2.5 hours)	14.637	(lbs)
Assume Step Test for SVE-2 will be the same as SVE-1 (~ 2.5 hours)	14.637	(lbs)
Assume SVE-1 and SVE-2 combined Step Test is the same as SVE-1 (~2.5 hours)	14.637	(lbs)
Total Mass Removed During Constant Rate Test (2 hours)	10.613	(lbs)
Total Mass Removed During SVE Pilot (over ~ 9.5 hours)	**54.524**	(lbs)

Anticipated Performance of Pilot Study

Parameter	Units	SP Step Tests @ 300 SCFM						
	inches HG	23	23	23	23	23		
SVE-1 & -2	SCFM	300	300	300	300	300		
SP Air Flow		25	50	75	100	125		
PCE MW=166	Mass Recovered (lb/30 min)	2.611	2.611	2.611	2.611	2.611	13.055	(lbs)
TCE MW=131.4	Mass Recovered (lb/30 min)	0.042	0.042	0.042	0.042	0.042	0.211	(lbs)
Total Mass Removed during SP-1 Step Test (~ 2.5 hours)							13.266	(lbs)

SP Constant Rate Tests @ 300 SCFM

PCE MW=166	Mass Recovered (lb/120 min)	10.444	(lbs)
TCE MW=131.4	Mass Recovered (lb/120 min)	0.169	(lbs)
Total Mass Removed during SP Constant Rate Test (~ 2 hours)		10.613	(lbs)

Total Mass Removed during SP-1 Step Test (~ 2.5 hours)	13.266	(lbs)
Assume SP-2 Step Test will yield the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Assume SP-3 Step Test will yield the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Assume SP-1 & SP-2 Combined Step Test will yield the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Assume SP-1 & SP-3 Combined Step Test will yield the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Assume SP-2 & SP-3 Combined Step Test will yield the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Assume SP-1, SP-2, & SP-3 Combined Step test is the same as SP-1 (~ 2.5 hours)	13.266	(lbs)
Total mass removed during SP-1, SP-2, SP-3 Constabt Rate Test (2 hours)	10.613	(lbs)
Total Mass Removed During SP Pilot (over ~ 19.5 hours)	**103.476**	(lbs)

Total Anticipated Mass Removal During Pilot Study	**157.999**	**(lbs)**

SVE Step Test - - Mass recovered/30 min. intervals = (μg/M³)(g/1000000 μg)*(M³/35.315 ft³)*(SCFM*60 mim/hr/2)/(453.59 g/lb)
SVE Constant Rate Test - - Mass recovered/120 min. intervals = (μg/M³)(g/1000000 μg)*(M³/35.315 ft³)*(SCFM*60 mim/hr*2)/(453.59 g/lb)

SP Step Test - - Mass recovered/30 min. intervals = (μg/M³)(g/1000000 μg)*(M³/35.315 ft³)*(SCFM*60 mim/hr/2)/(453.59 g/lb)
SP Constant Rate Test - - Mass recovered/120 min. intervals = (μg/M³)(g/1000000 μg)*(M³/35.315 ft³)*(SCFM*60 mim/hr*2)/(453.59 g/lb)

ATTACHMENT E

AIR SPARGE PILOT TEST MATERIALS AND EQUIPMENT LIST AND SPECIFICATIONS

AS Pilot Test Equipment List

One (1) Mobile Air Sparge Unit

Twenty-eight (28) Summa canisters

Six-Hundred (600) feet of 1-inch hose

Three (3) 1-inch diameter thread to 1-inch cam and groove f-adapters

Three (3) 1-inch diameter threaded PVC Schedule 80; 90-degree elbows

Three (3) 1-inch diameter threaded Schedule 80 PVC nipples

Three (3) 1-1/4-inch x 1-inch PVC reducers

Six (6) feet of 1-1/4-inch diameter Schedule 80 PVC pipe

Three (3) compound vacuum/pressure gauges

Three (3) ¼-inch bronze threaded nipples

Three (3) ½-inch x ¼-inch bronze reducers

Three (3) ½-inch ball valves

Six (6) ½-inch bronze threaded nipples

Three (3) 2-inch diameter well seals

Six (6) feet of ½-inch threaded bronze pipe

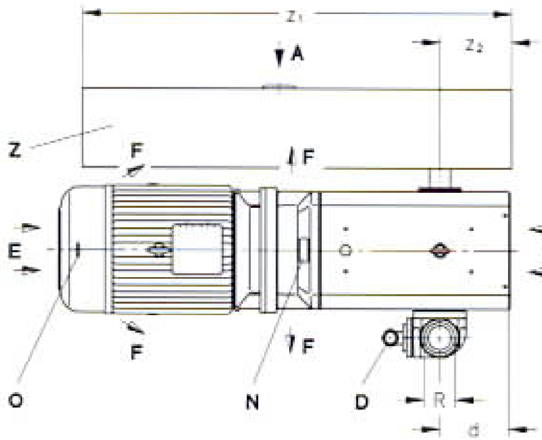
Rietschle
A Gardner Denver Product

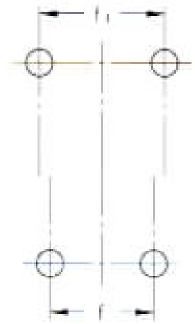
Compressors | Compresores | Compresseurs | Compressores

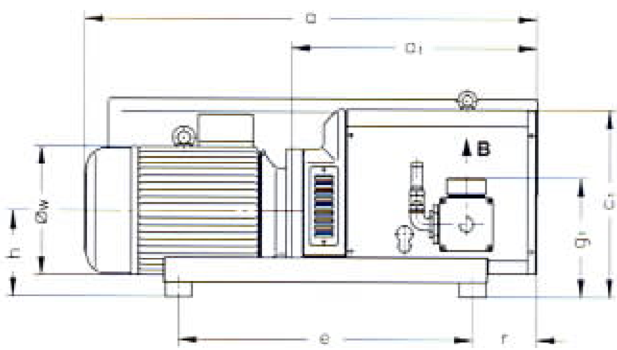
DLR

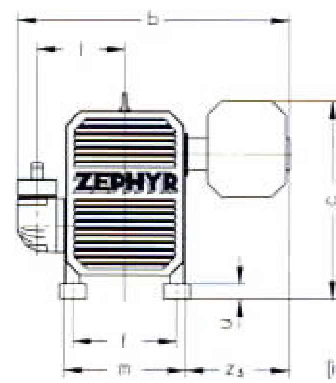
ZEPHYR

DLR 60
DLR 100
DLR 150
DLR 250
DLR 300
DLR 400
DLR 500









[inches]

A	Suction	Succión	Aspiration	Sucção
B	Pressure connection	Conexión presión	Raccord surpression	Conexão da pressão
D	Safety valve	Válvula seguridad	Clapet de sécurité	Válvula de segurança
E	Cooling air entry	Entrada aire refrigerante	Entrée air refroidissement	Entrada do ar refrigerante
F	Cooling air exit	Salida aire refrigerante	Sortie air refroidissement	Saída do ar refrigerante
N	Data plate	Placa fecha	Etiquette caractéristique	Placa da data
O	Rotation arrow	Dirección de rotación	Flèche sens rotation	Direção da rotação
Z	Inlet silencer	Silenciador entrada	Silencieux d'aspiration	Silenciador de entrada

DLR		60	100			150		250			300			400				500			
kw	50 Hz	3.0	3.0	4.0	5.5	7.5		7.5	11	-	7.5	11	15	11	15	18.5	22	15	18.5	22	30
hp	60 Hz	5.0	5.0	7.5	10	10	15	10	15	20	15	20	25	20	25	30	-	-	30	-	40
inches a	50 Hz	27.20	27.36	28.03	32.17	36.26		36.26	40.67	-	36.26	40.67	40.67	47.36	47.36	47.36	49.76	47.36	47.36	49.76	54.09
a	60 Hz	27.20	31.49	33.07	33.07	36.34	37.40	37.79	38.85	38.85	38.85	38.85	46.01	45.47	52.70	52.70	-	-	53.21	-	54.85
a_1	50 Hz	15.28	15.43	15.43	16.22	19.49		20.31	20.31	-	20.31	20.31	20.31	27.01	27.01	27.01	27.01	27.01	27.01	27.01	29.37
a_1	60 Hz	15.28	17.56	17.56	17.56	20.83		22.28	22.28	22.28	22.28	22.28	22.62	28.90	29.31	29.31	-	-	29.82	-	29.82
b		13.58	21.26			21.30		28.43			28.43			29.29				30.08			
c / c_1		- / 11.42	14.76 / 14.17			16.34/14.76		21.06 / 20.67			21.06 / 20.67			21.06 / 20.67				21.85 / 20.67			
d		2.36	3.62			20.83		3.94			3.39			7.76				7.76			
e		9.65	17.32			15.04		28.35			28.35			32.28				32.28			36.22
f		6.30	8.66			6.30		11.42			11.42			11.42				11.42			11.42
f_1	50 Hz	-	-			-		-			-			-				-			13.78
f_1	60 Hz	-	-			-		-			13.78			13.78				13.78			
g_1		11.61	8.23			12.76		11.54			11.54			13.07				13.07			
h		5.91	5.91			6.50		9.45			9.45			9.45				9.45			
l		5.43	7.17			7.09		9.25			9.25			9.65				9.65			
m		6.46	10.24			10.00		13.39			13.39			13.39				13.39			
r / u		4.21 / 0.59	3.03 / 0.59			4.56 / 1.18		4.37 / 1.57			4.37 / 1.57			7.05 / 1.57				7.05 / 1.57			
Øw	50 Hz	7.72	7.72	8.66	9.69	9.69		9.69	12.28		9.69	12.28		12.28				12.28		14.17	
Øw	60 Hz	7.87	7.88	9.57	9.57	9.57	11.47	9.57	11.47		11.47	11.47	15.30	11.47	15.30		-	-	15.30	-	16.88
z_1		-	25.59			25.59		39.37			39.37			39.37				47.24			
z_2 / z_3		-	3.94 / 7.68			3.94 / 7.68		3.15 / 10.63			3.15 / 10.63			3.15 / 10.63				7.87 / 11.42			
R		1" NPT	1¼" NPT			1½" NPT		2" NPT			2" NPT			3" NPT				3" NPT			

DA 881

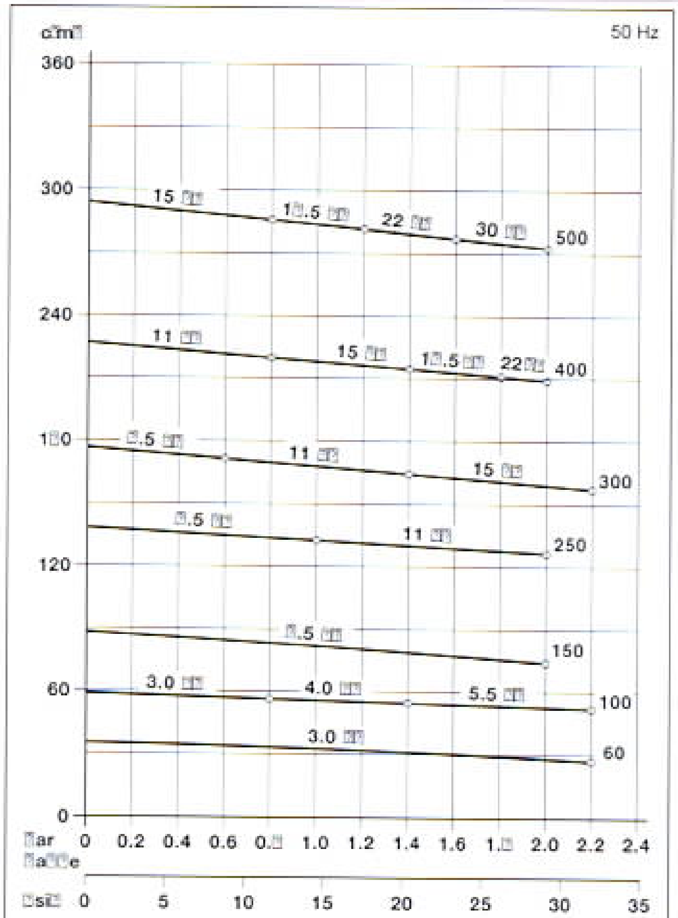
2.2.2004

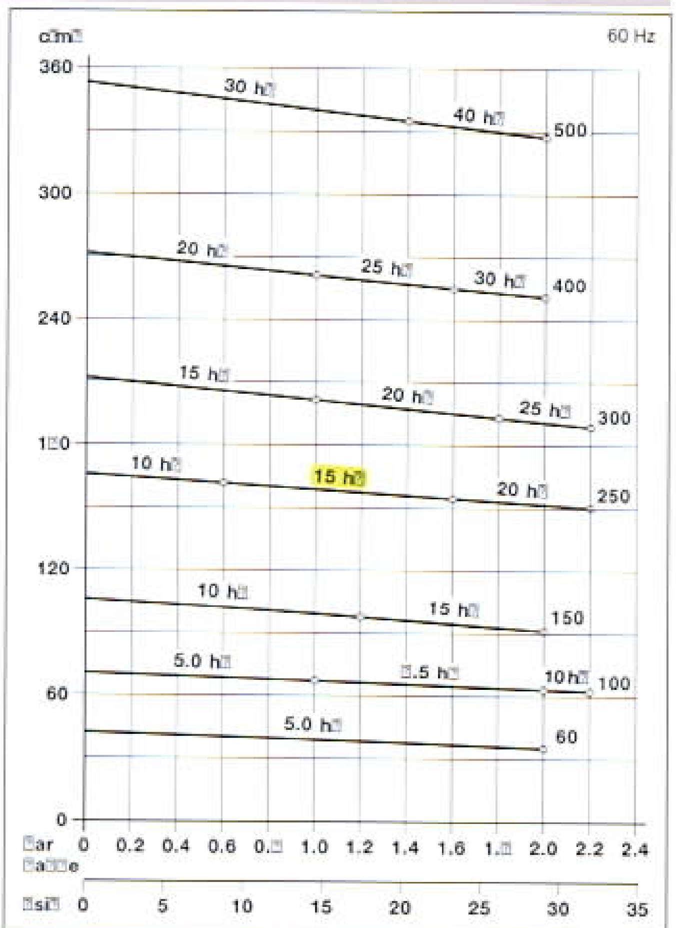
Rietschle Thomas Hanover Inc.
7222 Parkway Drive
HANOVER, MD 21076
USA
Fon 410 - 712 - 4100
Fax 410 - 712 - 4148
e-mail: sales@vacuumpumps.com
www.vacuumpumps.com

cfm	60 Hz	42.4	70.6			106		166			212			272				353			
psig	50 Hz	31.9	11.6	20.3	31.9	31.9		14.5	29.0	-	8.7	20.3	31.9	11.6	20.3	26.1	29.0	11.6	17.4	23.2	29.0
	60 Hz	29.0	14.5	29.0	31.9	17.4	29.0	8.7	23.2	31.9	14.5	26.1	31.9	14.5	23.2	29.0	-	-	20.3	-	29.0
3 ~	50 Hz	230/400V ± 10%			400/690V ± 10%																
	60 Hz	208-230/460V ± 10%								230/460V ± 10%											
kw	50 Hz	3.0	3.0	4.0	5.5	7.5		7.5	11	-	7.5	11	15	11	15	18.5	22	15	18.5	22	30
hp	60 Hz	5.0	5.0	7.5	10	10	15	10	15	20	15	20	25	20	25	30	-	-	30	-	40
rpm	50 Hz	2850																			
	60 Hz	3450																			
dB(A)	50 Hz	78	79			#		81			82			82				82			
	60 Hz	79	83			#		85			85			85				85			
lbs	50 Hz	143	232	243	287	331		551	611	-	571	631	664	785	820	873	975	906	933	1010	1125
	60 Hz	143	259	286	307	345	423	565	643	641	663	661	801	816	956	100	-	-	1079	-	1183
qt		0.4	0.5			0.6		0.9			0.9			0.9				0.9			

ZRZ	25	40	40	50	50	80	80
ZAF	25 (00)	40 (00)	40 (00)	50 (00)	50 (00)	80 (00)	80 (00)
ZDR	#	40	40	40	40	#	#
ZPD	-	-	-	300	300	400	500
ZMS / ZAD	#	#	#	#	#	#	#

cfm	Capacity	Capacidad	Volume engendré	Capacidade
psig	Excess pressure	Exceso de presión	Surpression	Pressão excessiva
3 ~	Motor version	Versión motor	Exécution moteur	Versão do motor
kw / hp	Motor rating	Datos motor	Puissance moteur	Potência do motor
rpm	Speed	Velocidad	Vitesse rotation	Velocidade
dB(A)	Average noise level	Nivel de ruido medio	Niveau sonore moyen	Nível médio de ruido
lbs	Weight	Peso	Poids	Peso
qt	Oil capacity (Gear)	Instrumentos capacidad aceite	Charge d'huile (Engrenage)	Engrenagem da capacidade do óleo
	Accessories	Accesorios	Accessoires	Acessórios
ZRZ	Non return leaf	Válvula retención	Clapet anti-retour	Válvula sem retorno
ZAF	Suction filter	Filtro succión	Filtre d'aspiration	Filtro de sucção
ZDR	Pressure regulating valve	Válvula reguladora de presión	Valve de réglage pression	Válvula de regulagem da pressão
ZPD	Pulsation silencer	Silenciador de pulsación	Absorbeur de pulsations	Silenciador de pulsação
ZMS	Motor starter	Arranque motor	Disjoncteur moteur	Arranque do motor
ZAD	Soft starter	Soft starter	Démarrage progressif	Soft starter
ZBZ	Sound box	Caja de sonido	Caisson insonorisant	Canópia





* Capacity refers to free air at 1 standard atmosphere and 20° C (68° F)./ La capacidad se refiere al aire libre a 1 atmosfera estandár de presión y a 20° C (68° F) de temperatura./ Le débit est mesuré à l'atmosphère de 1 bar (abs.) à 20° C (68° F)./ A capacidade refere-se ao ar livre a uma atmosfera padrão 1 e a 20° C (68° F).
Curves and tables refer to compressor at normal operating temperature./ Las curvas y las tablas se refieran al compresor a la temperatura normal de operación./ Les courbes et tableaux sont établies, compresseur à température de functionnement./ As curvas e tabelas referem-se ao compressor a temperatura normal de operação.
Technical information is subject to change without notice!/ La información técnica está sujeta a cambios sin previo aviso!/ Sous réserve de modification technique./ A informação técnica está sujeita a mudança sem aviso prévio!
The listed values for a, ø w and full load amperage may vary because of different motor manufacturers./ Los valores listados para a, ø w y para el amperaje de carga completa pueden variar para distintos fabicantes de motores./ Les dimensions a et ø w ainsi que l'ampérage peuvent différer des données indiquées ci-dessus, selon le fabricant du moteur./ Como variam os fabricantes de motores, poderá haver variação dos valores indicados para a, ø w e para uma amperagem da carga total.
on request # on pedido # sur demande # a pedido

ATTACHMENT F

SVE FIELD FORMS

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: SVE-1 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates		Vacuum/Pressure														PID Readings		Temperature	
	Manifold To Extraction Well	At Vapor Phase Carbon	At Extraction Well SVE-1	At Manifold to Well SVE-1	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	Before Carbon
Units	(scfm)	(scfm)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: SVE-2 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates		Vacuum/Pressure														PID Readings		Temperature	
	Manifold To Extraction Well	At Vapor Phase Carbon	At Extraction Well SVE-2	At Manifold to Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-2	Before Carbon
Units	(scfm)	(scfm)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: SVE-1 & SVE-2 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates		Vacuum/Pressure																PID Readings		Temperature		
	Manifold To Extraction Well	At Vapor Phase Carbon	At Extraction Well SVE-1	At Manifold to Well SVE-1	At Extraction Well SVE-2	At Manifold to Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Before Carbon
Units	(scfm)	(scfm)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)	(^oF)

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: SVE-1 & SVE-2 Constant Rate Test
Date:
Personnel:

Time	Flow Rates		Vacuum/Pressure																PID Readings		Temperature		
	Manifold To Extraction Well	At Vapor Phase Carbon	At Extraction Well SVE-1	At Manifold to Well SVE-1	At Extraction Well SVE-2	At Manifold to Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Before Carbon
Units	(scfm)	(scfm)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)	(^oF)

ATTACHMENT G

SP FIELD FORMS

Klink Cosmo - Air Sparge Pilot Test

Well: SP-1 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure																Temperature		
Units	Manifold To SP-1 Well (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Well SP-1 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-2 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure																Temperature		
Units	Manifold To SP-2 Well (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Well SP-2 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-3 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure																Temperature		
Units	Manifold To SP-3 Well (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Well SP-3 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-1 & SP-2 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure														PID Readings		Temperature		
	Manifold To SP Wells SP-1/SP-2	At Vapor Phase Carbon	At Air Sparge Wells SP-1/SP-2	Manifold At Well SVE-1	Manifold At Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Before Carbon
Units	(scfm)	(scfm)	(scfm)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)	(^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-1 & SP-3 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure														PID Readings		Temperature		
Units	Manifold To SP Wells SP-1/SP-3 (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Wells SP-1/SP-3 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-2 & SP-3 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure														PID Readings		Temperature		
Units	Manifold To SP Wells SP-2/SP-3 (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Wells SP-2/SP-3 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-1, SP-2 & SP-3 Stepped Rate Test
Date:
Personnel:

Time	Flow Rates			Vacuum/Pressure														PID Readings		Temperature		
Units	Manifold To SP Wells SP-1/SP-2/SP-3 (scfm)	At Vapor Phase Carbon (scfm)	At Air Sparge Wells SP-1/SP-2/SP-3 (scfm)	Manifold At Well SVE-1 (in Hg)	Manifold At Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-4 (in H_2O)	At OW-4D (in H_2O)	At DEC-44 (in H_2O)	At DEC-44D (in H_2O)	At DEC-31 (in H_2O)	At DEC-31D (in H_2O)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-1 (^oF)	At SVE-2 (^oF)	Before Carbon (^oF)

Klink Cosmo - Air Sparge Pilot Test

Well: SP-1, SP-2 & SP-3 Constant Rate Test
Date:
Personnel:

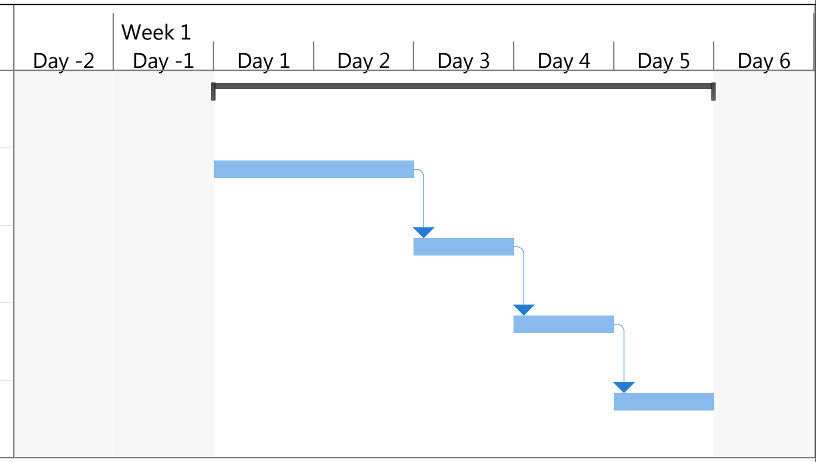
Time	Flow Rates			Vacuum/Pressure														PID Readings		Temperature		
	Manifold To SP Wells SP-1/SP-2/SP-3	At Vapor Phase Carbon	At Air Sparge Wells SP-1/SP-2/SP-3	Manifold At Well SVE-1	Manifold At Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	At OW-4	At OW-4D	At DEC-44	At DEC-44D	At DEC-31	At DEC-31D	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Before Carbon
Units	(scfm)	(scfm)	(scfm)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)	(ppm)	(^oF)	(^oF)	(^oF)

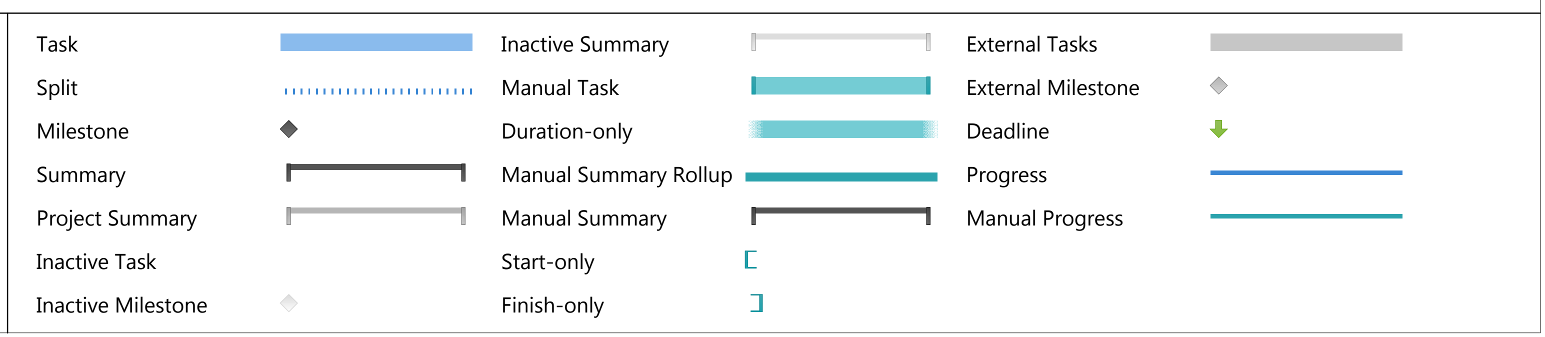
ATTACHMENT H

SCHEDULE

KLINK COSMO PILOT TEST SCHEDULE

ID	Task Name	Duration
1	**Klink Cosmo Pilot Test**	**5 days**
2	Mobilization	2 days
3	Soil Vapor Extraction Stepped and Constant-Rate Testing	1 day
4	Air Sparging Stepped and Constant-Rate Testing	1 day
5	Demobilization	1 day





ATTACHMENT B

SVE/SP PILOT STUDY CALCULATIONS

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

SVE/SP PILOT STUDY CALCULATIONS

WORK ASSIGNMENT C007540-4.1

FORMER KLINK COSMO CLEANERS SITE — SITE NO. 224130
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA — KINGS (C) NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Basil Seggos, Acting Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
Remedial Bureau B

URS Corporation
257 West Genesee Street, Suite 400
Buffalo, New York 14202

March 2016

SVE/SP PILOT TEST

MASS REMOVAL AND SVE RADIUS OF INFLUENCE CALCULATIONS

FOR THE

FORMER KLINK COSMO CLEANERS SITE

EAST WILLIAMSBURG INDUSTRIAL AREA

SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B
WORK ASSIGNMENT NUMBER C007540-4.1

PREPARED BY:

URS CORPORATION
257 WEST GENESEE STREET, SUITE 400
BUFFALO, NY 14202

MARCH 2016

URS

JOB NO.: 60413126

MADE BY: J. Lysiak **DATE:** 2/9/2016

CHECKED BY: JD **DATE:** 2/19/16

PROJECT: Klink Cosmo Pilot Study
SUBJECT: Determine VOC Mass Removal & Radius of Influence

Problem: Chlorinated solvents including tetrachloroethylene (PCE) and trichloroethylene (TCE) have been detected in soil vapor, soil, and groundwater samples at concentrations significantly above New York State SCG values in the vicinity of the Former Klink Cosmo Cleaners Site, in Brooklyn, NY. URS performed a soil vapor extraction/air sparge (SVE/AS) pilot study adjacent to the Site to obtain data that will be used to determine if this technology is suitable for further consideration as part of a feasibility study prepared for this Site.

Background: The Former Klink Cosmo Cleaners Site is located within the Meeker Avenue Plume Trackdown Site investigation area. Data gathered during investigations indicated that a source of groundwater contamination was originating near buildings formerly used by Klink Cosmo Cleaners. Adjacent to the Site, in the area where the pilot study was performed, PCE soil gas concentrations exceeded 13,000,000 micrograms per cubic meter ($\mu g/M^3$).

Objectives: The primary objectives of the SVE/AS Pilot Test were to:

- Demonstrate PCE and TCE mass reduction and estimate PCE and TCE mass removal rates
- Develop full-scale SVE design parameter values including radius of influence (ROI), locations and depths of extraction wells, intrinsic permeability (k_i), system and wellhead flowrates, and vacuum pressures.

Pilot Study: The pilot study was conducted from November 16 through 19, 2015, along the south side of Richardson Street near the intersection of Vandervort Avenue between monitoring wells DEC-031 and DEC-044D. The pilot study generally followed the procedures provided in the New York State Department of Environmental Protection (NYSDEC) approved *SVE/SP Pilot Study Work Plan* dated September 2015. Deviations to the approved plan are presented in the *Pilot Study Report*.

As part of the pilot study, two SVE wells (4-inch diameter), three AS wells (2-inch diameter), and four pairs of soil vacuum observation wells (OWs, 1-inch diameter) were constructed. Figure 1 provides the well locations.

A mobile trailer mounted SVE/AS treatment system (Unit 75), provided by ProAct Services Corporation of Southbury, Connecticut was used for the pilot test. Components of the SVE/AS treatment system include:

- SVE rotary claw blower, capable of 300 actual cubic feet per minute (acfm) and up to 22-inches of mercury (Hg)
- SVE vacuum manifold equipped with vacuum and flow indicators, throttling valves, and hoses

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- AS compressor, capable of 125 standard cubic feet per minute (scfm) at 22 psi
- AS manifold equipped with pressure and flow indicators, throttling valves, and hoses
- Two parallel trains of vapor phase carbon vessels, each containing two 200 pound drums construct in lead-lag configuration, with sampling points

---

SVE Pilot Test Procedures: Step and constant rate tests were performed at various vacuum pressures to determine its impact on the formation. Step tests were performed with only SVE-1 online, only SVE-2 online, and then both SVE-1 and SVE-2 online at the same time. During these step tests the vacuum pressures were increased four times by throttling the valve inside the treatment system's vacuum manifold. Vacuum pressure ranged between 2 inches of mercury (Hg) to 7.5 inches Hg (the maximum achievable vacuum) depending on the SVE well location and combined operation.

Four rounds of vacuum pressure measurements were collected at 10 to 12 minute intervals at each vacuum interval. Vacuum pressures were monitored and recorded inside the treatment unit at the vacuum manifold, extraction wells (SVE-1 & SVE-2), observation wells (OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, & OW-4D), and monitoring wells (DEC-31, DEC-44, & DEC-141). The locations of these wells are shown on Figure 1.

The volume of air extracted (standard cubic feet per minute – scfm) was also recorded during each monitoring interval. The step test with SVE-1 and SVE-2 was not performed as the throttling valve used to bring the vacuum pressure up incrementally could not be adjusted in small enough increments to balance the system and accurately record vacuum pressures; even while manipulating the make-up air.

The constant rate test was performed with SVE-1 and SVE-2 under full vacuum. Data were collected at approximately10 minute intervals. Vacuum pressures were monitored and recorded inside the treatment unit at the vacuum manifold, extraction wells (SVE-1 & SVE-2), observation wells (OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, & OW-4D), and monitoring wells (DEC-31, DEC-44, & DEC-141). The volume of air extracted (scfm) was also recorded during each monitoring interval. While conducting the constant rate test on November 18, 2015, vacuum pressures at SVE-1 ranged from 2.5 to 3 inches Hg and from 0.5 to 2 inches Hg in SVE-2. During the constant rate test performed on November 19, 2015, vacuum pressures in SVE-1 ranged from 1.25 to 1.5 inches Hg and 2.5 to 2.75 inches Hg in SVE-2.

JOB NO.: 60413126

MADE BY: J. Lysiak DATE: 2/9/2016

CHECKED BY: JAS DATE: 2/19/16

PROJECT: **Klink Cosmo Pilot Study**
SUBJECT: **Determine VOC Mass Removal & Radius of Influence**

Summa canisters were collected near the beginning and end of each test and analyzed for VOCs using USEPA Compendium Method TO-15.. Field data collected during pilot test is presented on Table 2 – Pilot Study Field Data Summary.

Data Usability: Data collected from each of the 11 tests were used to calculate the mass of VOCs removed. However due to equipment malfunctions and intermittent operation of the treatment unit, experienced during the first three days of the study, the ROI was based on field data collected the last day of the study (November 19, 2015 – Tests 9, 10, and 11). Figures 2, 3, and 4 present vacuum pressure readings collected in the field during the last day of the study. Contours presenting vacuum gauge readings were added to indicate the area influenced during the SVE-1 and SVE-2 step tests and constant rate test with SVE-1 and SVE-2 operating at the same time.

Assumptions:

- The treatment area surface is impermeable (i.e., no leakage or short circuiting)
- The stratigraphy of the formation is relatively homogeneous
- The formation has reached equilibrium (i.e., steady-state) during the pilot study
- Groundwater is at 32 feet bgs

1. Determination of Mass Removal

The total mass of VOCs removed during the Pilot Study can be calculated based on the following equation:

Mass Removed = Average Concentration x Average Flowrate x Operating Duration

Table 1 – Soil Vapor Extraction Pilot Test Analytical Data, is an Excel spreadsheet that presents the results of the samples collected during each of the 11 field tests. Only compounds that had detectable concentrations are included in Table 1. The spreadsheet calculates the average concentration for each test by summing the VOC concentrations, measured in $\mu g/M^3$, from each sample collected during that test divided by the number of test samples collected during that test.

Table 2 – Pilot Study Field Data Summary is an Excel spreadsheet that presents the field data collected during each of the 11 tests. The spreadsheet was also used to calculate the average flow rate induced by each extraction well by summing the flow flowrates (ft^3/min) recorded during each monitoring event and dividing it by the number of monitoring events.

JOB NO.: 60413126

MADE BY: J. Lysiak DATE: 2/9/2016

CHECKED BY: JDS DATE: 2/19/16

PROJECT: Klink Cosmo Pilot Study
SUBJECT: Determine VOC Mass Removal & Radius of Influence

Table 2 was also used to determine the operating duration. The start time and end time for each test is provided on the spreadsheets including lapses in operation. The difference between the end and start times for each test, including any intermittent lapses in operation, yields the operating duration (minutes).

Table 3 – Estimate of Mass Removed during the Soil Vapor Extraction Pilot Test, is an Excel spreadsheet that provides a summary of the data and calculation used to determine the volume of VOCs removed during each test.

As an example, data generated for Test 1 will be used to present the logic used to develop Table 3.

Mass Removed = Average Concentration x Average Flowrate x Operating Duration

Where:

Mass Removed (pounds – lb)

Average Concentration (μg/M³)

Average Flowrate (ft^3/min)

Operating Duration (min)

The average concentration was derived from data presented on Table 1. The sum of the detectable VOCs near the start of Test 1 was 1,448,894 μg/M³ and 1,630,103 μg/M³ near the end of Test 1. The average concentration of VOCs from samples collected near the start and end of Test 1 = (1,448,894 μg/M³ +1,630,103 μg/M³) / 2 = **1,539,499 μg/M³**.

The average flowrate was calculated by summing the flowrates (scfm or ft^3/minute) recorded on Table 2.1 during each monitoring event recorded during Test 1 and dividing it by the total number of monitoring events; (58+58+59+59+60+60+60+60+60+60+62+61+60+60+61+61+60) / 17 = 59.94 ft^3/min; say **60 ft^3/min.**

Also as shown on Table 2.1, Test 1 started at 1930 and ended at 2210, when the power was lost. As such, Test 1's operating duration is the difference between the start and end times = **160 minutes**.

The concentration units need to be converted from μg/M³ to lb/ft^3. Converting units: (1,539,499 μg/M³) x (g/1,000,000 μg) x (M³/35.315 ft³) x (lb/453.6 g) = **9.61×10^{-5} lb/ft^3.**

The mass of VOCs removed during Test 1 = (9.61×10^{-5} lb/ft^3) x (60 ft^3/min) x (160 min) = **0.92 lb**

The mass of VOCs removed during each of the 11 tests was calculated following the logic described for Test 1. As shown on Table 3, the total mass removed over the 1476 minutes the treatment unit was operated was 5.13

pounds. The rate of removal = (5.13 lb / 1476 mins) x (60 min/hr) = **0.21 lb/hr,** or (0.21 lb/hr) x 24 hr/day = **5 lb/day**.

The percentage that PCE and TCE existed in the average total VOC concentration was calculated for each of the 11 tests and used to determine their mass reduction and mass removal rates. The concentration of PCE near the start of Test 1 was 1,420,000 μg/M³ and 1,610,000 μg/M³ near the end of Test 1. The percentage that PCE existed in the average total VOC concentration = (1,420,000 μg/M³ + 1,610,000 μg/M³ /2 x (1/1,539,499 μg/M³) x 100% = 98.41%.

Likewise, the concentration of TCE near the start of Test 1 was 8,430 μg/M³ and 9,800 μg/M³ near the end of Test 1. The percentage that TCE existed in the average total VOC concentration = (8,430 μg/M³ + 9,800 μg/M³) /2 x (1/1,539,499 μg/M³) x 100% = 0.59%.

The average percentage that PCE and TCE existed in the total average VOC concentration was derived by adding the percent that each compound existed in the total average concentration for each test divided by 11 (the total number of tests. The average percentage that PCE was detected in the total average VOC concentration is (98.41+95.82+99.22+99.54+99.22+99.27+99.50+99.48+99.65+99.77+99.65)/ 11 x 100% = 99%.

Likewise, the average percentage that TCE was detected in the total average VOC concentration is (0.59+0.35+0.36+0.29+0.43+0.40+0.29+0.28+0.21+0.23+0.23) /11 x 100% = 0.33%.

Using these average percentages, the total mass of PCE removed during the pilot study is 5.13 lb x 99% = 5.1 lbs. The total mass of TCE removed during the pilot study is 5.13 lb x 0.33% = 0.017 lbs.

The rate of removal for PCE is 5 lb/day x 99% = 4.95 pound/day (or 0.21 lb/hour) and the rate of removal for TCE is 5 lb/day x 0.33% = 0.016 lb/day (or 6.8×10^{-4} lb/hour).

2. Determination of Radius of Influence (ROI)

The ROI is the furthest distance from the extraction well that soil and soil gas can be successfully treated by SVE. It is determined by placing a vacuum on the extraction well and measuring the vacuum that is achieved in nearby monitoring points, and then extrapolating the distance to a point where there is no influence. For the purposes of this calculation, the pressure at the farthest ROI distance was set at 1% of the vacuum measured in the SVE wells.

The ROI (R_i) can be be calculated by solving the following equation for R_i:

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$Pr^2 - Pw^2 = (PRI^2 - Pw^2)\,(\ln(r/Rw)/\ln(Ri/Rw))$ *(Ref.1 – Eq. V.1.2)*

Data presented on Tables 2.9 and 2.10 is believed to be the most reliable and more closely reflects steady-state conditions when compared to other data. As shown on Tables 2.9 and 2.10 vacuum pressures were increased over four increments by throttling a valve inside the treatment unit. Four sets of data were collected, at approximately ten minute intervals, at each of the four increments. Data collected from the last round for each increment (shaded data) was used to estimate the ROI as it reflects the greatest amount of time that the formation had to reach steady-state conditions.

Calculated ROI Estimation:

The following equation was used to calculate the ROI.

$Pr^2 - Pw^2 = (PRI^2 - Pw^2)\,(\ln(r/Rw)/\ln(Ri/Rw))$ *(Ref.1 – Eq. V.1.2)*

Where:

Pr = Pressure at distance r from the extraction well (atm)

Pw = Pressure at the extraction well (atm)

PRI = Pressure at radius of influence (atm)

r = radial distance from extraction well monitoring point (ft)

Ri = Radius of influence (ft) – to be determined

Rw = Radius of extraction well (ft)

Vacuum pressure gauge readings collected at the monitoring points (SVE, OW, and DEC wells) during the last round of each increment on November 19, 2015 (shown on Tables 2.9 and 2.10 - shaded) were converted to atmospheric pressures (shown as Pr Values on the 4 series tables). This was done by multiplying the gauge vacuum pressure (inches H_2O) by (0.00246 atmospheres/ inch H_2O) then subtracting the result from 1 atmosphere. Vacuum pressure gauge readings collected at the SVE wells were also converted to atmospheric pressures (Pw) using the same calculation.

PRI pressure at the radius of influence was assumed to be 1% of the vacuum pressure at the SVE well; derived by multiplying the gauge reading at SVE ((inches H_2O) by (0.00246 atmospheres/ inch H_2O) and (0.01) then subtracting the result from 1 atmosphere.

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Tables 4.1 through 4.3 present the data and the results for calculating the ROI using SVE-1 as an extraction point at vacuum pressures of 32, 40, and 45 inches of H_2O, respectfully. Tables 4.4 through 4.7 present the data and the results for calculating the ROI using SVE-2 as an extraction point at vacuum pressures of 19, 27, 35, and 40 inches of H_2O, respectively.

Using the attached spreadsheets (series 4 tables – Calculation of ROI at SVEs) the above equation was solved for Ri. This was an iterative process. Various values of Ri were substituted in the equation until the right side of the equation approximately equaled the left side of the equation. As shown on the 4 series tables, an Ri was calculated for each of the eleven tests except for Test 1 where the vacuum pressure in SVE-1 was 30.5 inches H_2O.

Average ROIs, using SVE-1 as the extraction well, range between 31.3 ft to 31.9 ft. The average ROI induced by SVE-1 is approximately 32 ft.

Average ROIs, using SVE-2 as the extraction well, range between 37.3 ft to 38.9 ft. The average ROI induced by SVE-2 is approximately 38 ft.

ROIs extrapolated using data collected from the monitoring wells closest to the extraction wells (OW-1 and OW-2 for SVE-1 and OW-3 and OW-4 for SVE-2) provided the lowest ROIs. Conversely, ROIs extrapolated from data collected from monitoring wells the farthest from the extraction wells (DEC-44 for SVE-1 and DEC-31 for SVE-2) provided the greatest ROIs.

Eliminating OW-1 and OW-2 wells from the SVE-1 calculations raises the average ROI from 32 ft to 40 ft. The average ROI induced by SVE-2 is approximately 38 ft. Eliminating OW-3 and OW-4 data from the SVE-2 calculations, Tables 4.4 through 4.7, raises the average ROI from 38 ft to 48 ft.

The vacuum contours shown on Figures 2 (SVE-1 operating at 45 inches H_2O) indicate that the ROI extends approximately 64 feet to the west and at least 26 feet to the east with a vacuum pressure of 0.75 inches H_2O at the fringe of the ROI. Figure 3 (SVE-2 operating at 39.5 inches H_2O) indicates that the ROI extends approximately 39 feet to the west and 66 feet to the east with a vacuum pressure of 1 inches H_2O at the fringe of the ROI. The calculation used to estimate the ROI uses 1% of the vacuum pressure observed in the SVE well as the outer limit of the ROI. This would provide a vacuum pressure at the fringe of the ROI created by SVE-1 of 0.45 inches H_2O and 0.40 inches H_2O for SVE-2, extending the limits of the ROI in both cases.

Based on the vacuum pressure contours presented on Figures 2 and 3 and the calculated values, an ROI of 40 ft will be used to design the SVE/AS treatment system.

3. Preliminary Locations and Depths of Perimeter Source Area Extraction Wells

Since the treatment area in the warehouse building is not yet defined, we modeled the design criteria to provide treatment only around the perimeter of the source area (north-east section of the warehouse building). Based on an ROI of 40 feet, three additional extraction wells will be installed on the sidewalk adjacent to the former Klink Cosmo building to remediate the Site. One of the additional extraction wells will be installed near the intersection of Richardson Street and Vandervort Avenue and the remaining two extraction wells will be installed south of the intersection approximately 40 feet away from each other. Figure 5 provides the locations of the existing and proposed extraction wells.

The screened interval of the new extraction wells will be increased from 10 to 15 feet.

4. Determination of the Intrinsic Permeability (k)

The intrinsic permeability, the measurement for the ability of fluids to pass through soils, will be obtained from the definition of saturated hydraulic conductivity using the following equation:

$$K = k_i\,(\rho g)\,/\,\mu$$ *(Ref. 2 – Appendix D, Eq. D-1)*

Where:

K = Hydraulic Conductivity (cm/s)

k_i = Intrinsic Permeability (cm^2)

ρ = Fluid Density (g/cm^3)

g = Acceleration due to gravity (cm/sec^2)

μ = Viscosity of fluid (g/s-cm)

Air permeability and intrinsic permeability is expressed as:

$$k = k_i * k_{ra}$$ *(Ref.2 – Appendix D, Eq. D-2)*

Where:

k = Air Permeability (cm/s)

k_i = Intrinsic Permeability (cm^2)

k_{ra} = Relative Permeability to Air

$$k_{ra} = (1\text{-}S_e)^2 * (1\text{-}S_e^{\,2+\lambda/\lambda})$$ *(Ref.2 – Appendix D, Eq. D-3)*

Where:

Se = Effective Water Saturation

λ = Brooks-Corey Pore Size Distribution Index

The effective water saturation observed during the pilot test was 0.0. No moisture was detected in the piping or the treatment unit's knock-out tank. As such, $k_{ra} = 1$ and $k = k_i$.

With the estimate of water content, residual water saturation, capillary pressure head-saturation and saturated hydraulic conductivity, air permeability can be calculated as:

$$k_i = (1-S_e)^2 * (1-S_e^{\,2+\lambda/\lambda}) * (K\mu / \rho g)$$ *(Ref.2 – Appendix D, Eq. D-5)*

or $$k_i = K\mu / \rho g$$

The hydraulic conductivity in the shallow overburden soil ranged from 2.69 x10^{-5} to 4.77 x10^{-3} cm/s *(Ref. 3 - RI Phase II)*. The fluid density of water at 60°F is 0.9991 g/cm^3 and the viscosity of water at 60°F is 1.14x10^{-2} g/cm-s. Acceleration due to gravity is 980.6 cm/s^2 (9.806 m/s^2).

Using the upper and lower limits of hydraulic conductivities in the shallow overburdens soils, the intrinsic permeability are:

Using the upper K value $k_i = ((2.69 \times 10^{-5}\ \text{cm/s})\ (1.14\times 10^{-2}\ \text{g/cm-s}) / (0.9991\ \text{g/cm}^3)\ (980.6\ \text{cm/s}^2))$

$= 3.13 \times 10^{-10}\ \text{cm}^2$

Using the lower K value $k_i = ((4.77 \times 10^{-3}\ \text{cm/s})\ (1.14\times 10^{-2}\ \text{g/cm-s}) / (0.9991\ \text{g/cm}^3)\ (980.6\ \text{cm/s}^2))$

$= 5.55 \times 10^{-8}\ \text{cm}^2$

Intrinsic permeability ranges between 3.13 x10^{-10} cm^2 and 5.55 x10^{-8} cm^2.

5. Determination of Extraction Well Flowrates

The treatment area in the warehouse building is not yet defined. We modeled the design criteria to provide treatment only around the perimeter of the source area (north-east section of the warehouse building). Since the site has an impermeable cover the extraction flow rate can be calculated as (*based on Ref. 2 – Eq. 4-2)*

$$Q_v = \frac{Area \times bn_a}{t_{ex}}$$

Where:

Qv = volumetric flow rate at atmospheric pressure, to be determined.

Area = desired extent of treatment. The area to be treated is that created by the ROI (π*ROI^2) = 5,024 ft^2. The ROIs will intersect each other as the SVE wells will be spaced 40 apart. As such the total treatment area encompassed by the five SVE wells will total approximately 18,100 ft^2 (see Figure 5).

b = vadose zone thickness which represents distance from the surface to the water table; 32 feet.

n_a = air-filled porosity of the soil. The subsurface of the site is mainly comprised of fine, medium, and course sand, with some gravel. A clayey silt layer exists near the surface. For a poorly graded sand mixture, an average air-filled porosity of 0.24 was assumed. *(Reference 4)*

t_{ex} = time required for one pore volume exchange

An extraction rate of two pore volumes per day will be assumed. Therefore, t_{ex} = 12 hours = 720 minutes.

Substituting into the equation:

$$Q_v = \frac{(18{,}100\,ft^2)(32\,ft)(0.24)}{(720\,\text{min})} = 193\,ft^3/\text{min}$$

This will be the total flow rate from five extraction wells. Assuming that the subsurface conditions are relatively homogenous, the flow from the wells is assumed to be proportional to the length of screen in each well.

The screen length in the additional wells will be increased from 10 to 15 feet. The flow from each well is estimated to be:

(10 ft / 65 ft total)(193 scfm) = 30 scfm

(15 ft / 65 ft total)(193 scfm) = 45 scfm

To be conservative, all wells will be designed for an extraction flow rate of 45 scfm. SVE systems and controls are typically not precise enough to more accurately control the flow from individual wells. At 45 scfm per well, the total extraction rate is 225 scfm.

6. Determination of Extraction Well Vacuum

Ref. 1 (eq. V.1.5) presents the following equation that will be used to estimate well vacuum:

$$Q_w = H\left(\frac{\pi k}{\mu}\right)\left[\frac{P_w}{\ln(R_w / R_I)}\right]\left[1-\left(\frac{P_{RI}}{P_w}\right)^2\right]$$

(Ref.1 – Eq. V.1.5)

Where:

Q_w = flow rate from the well, assumed to be 45 scfm

H = the screened interval of the extraction well, assumed to be 15 ft screen

k = intrinsic permeability, calculated between 3.13×10^{-10} cm^2 and 5.55×10^{-8} cm^2

μ = viscosity of air, 0.0181 centipoise

P_W = absolute pressure at the extraction well, value to be determined (g/cm·s^2)

P_{RI} = absolute pressure at the ROI, assumed to be 0.5 inches H_2O

R_w = Radius of the vapor extraction well, 2 inches

R_I = Radius of influence where the vacuum is equal to 0.5 inches H_2O, assumed to be 40 ft

Converting units:

$Q_w = (45\text{ft}^3/\text{min})\ (\text{min}/60\ \text{s})\ (28{,}317\text{cm}^3/\text{ft}^3) = 21{,}238\ \text{cm}^3/\text{s}$

$H = (15\ \text{ft})\ (30.48\ \text{cm/ft}) = 457\ \text{cm}$

$\mu = (0.0181\ \text{centipoise})\ (0.01\ \text{g/cm s/centipoise}) = 1.81\text{x}10^{-4}\text{g/cm-s}$

$P_{RI} = 1.01\text{x}10^6\ \text{g/cm·s}^2 - (0.5\ \text{inches}\ H_2O)(\text{ft}/12\ \text{inches})(1.01\text{x}10^6\ \text{g/cm s}^2)\ /\ 33.91\ \text{ft}\ H_2O)$

$= 1{,}008{,}759\ \text{g/cm·s}^2$

$R_w = (2\ \text{inches})\ (2.54\text{cm/inch}) = 5.08\ \text{cm}$

$R_I = (40\ \text{ft})\ (30.94\ \text{cm/ft}) = 1{,}219\ \text{cm}$

The intrinsic permeability of $5.55\text{x}10^{-8}$ cm^2 was used to determine the pressure at the SVE well as it appears to be more in the range of acceptable published values for semi-pervious soils (mixture of sand, gravel silt, loam). (*Ref. 5– Wikipedia*).

$$21{,}238 = 457\left(\frac{3.14(5.55x10^{-8})}{1.81x10^{-4}}\right)\left[\frac{P_w}{\ln(5.08/1{,}219)}\right]\left[1-\left(\frac{1{,}008{,}759}{P_w}\right)^2\right]$$

Using the attached spreadsheet (Table 5 – SVE Well Vacuum) the above equation was used to solve for P_w; an iterative process. Various values of P_w were substituted in the equation until the right side of the equation approximately equaled the left side of the equation. As shown on Table 5 this yields a result of 885,100 g/cm·s^2. Now, converting back to vacuum: $1.010 x 10^6 - 885,100 = 124,900$ g/cm·s^2

Converting units: (124,900 g/cm·s^2) x (33.91 ft H_2O / $1.010 x 10^6$ g/cm·s^2) x (12 in. H_2O/ft) = 50.2inches H_2O The vacuum in the extraction wells will be at least 50.2 inches, say 50 inches H_2O.

7. SVE System – Conceptual Design

The design of the SVE system will be based on published values and equations for the estimation of SVE design parameters.

A total of five SVE wells will be used to remediate the area. As with the two existing SVE wells, the three additional wells will be constructed of 4-inch diameter slotted PVC and extend to a depth of approximately 27 feet below grade (approximately 5 feet above the water table) to minimize infiltration of water. Proposed well locations are shown on the Figure 5.

The screened interval of the new extraction wells will be increased from 10 to 15 feet.

Based on the above calculations, the design parameters for the SVE system are a total flow rate of 225 scfm and a vacuum of 250 inches H_2O.

URS

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MADE BY: J. Lysiak DATE: 2/9/2016

CHECKED BY: JMS DATE: 2/19/16

PROJECT: **Klink Cosmo Pilot Study**

SUBJECT: **Determine VOC Mass Removal & Radius of Influence**

References:

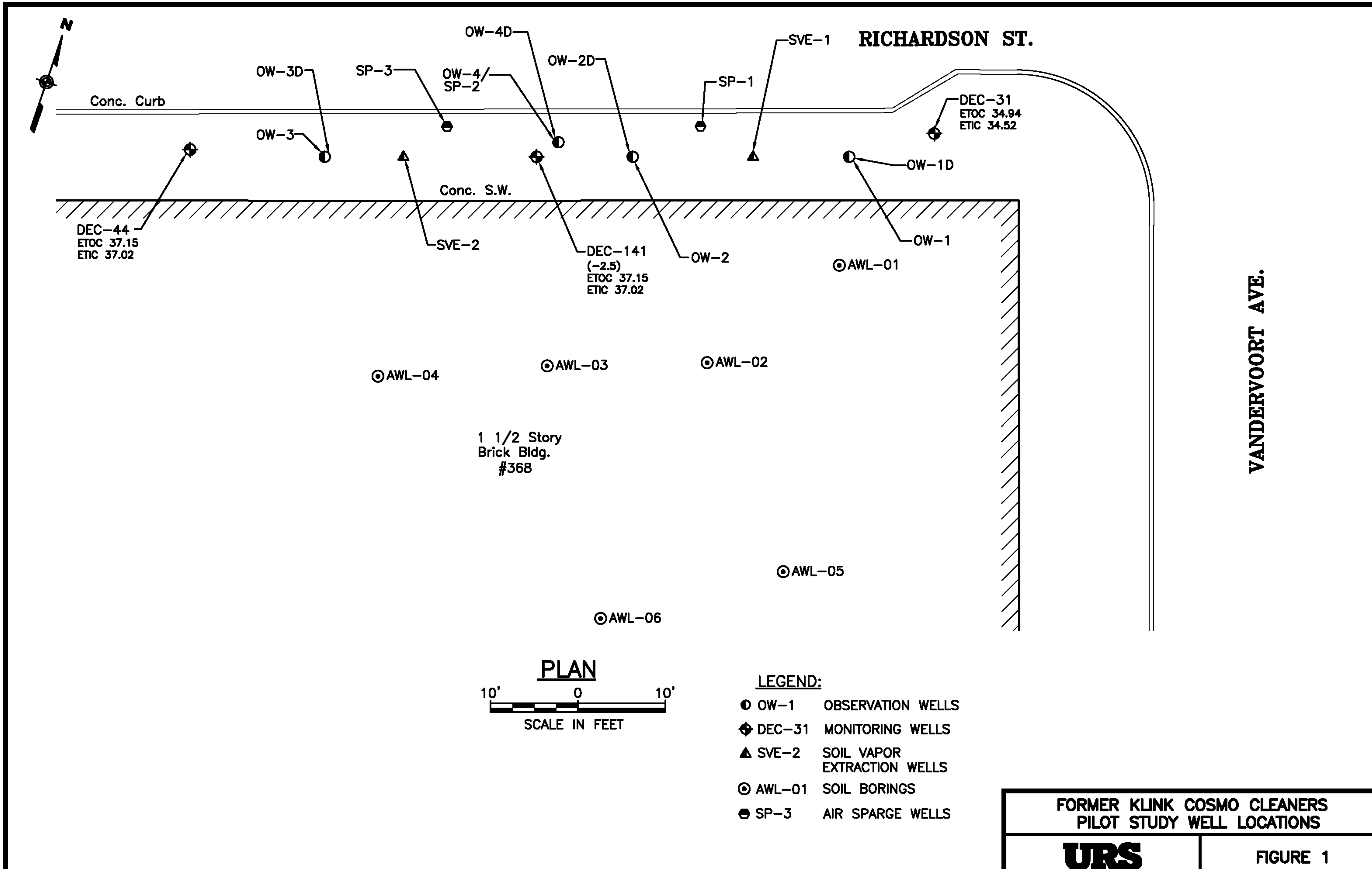
1. Practical Design Calculations for Groundwater and Soil Remediation, Jeff Kuo, PhD, PE, Lewis Publishers, 1999.

2. Soil Vapor Extraction and Bioventing, EM-1110-1-4001, US Army Corps of Engineers, June 3, 2002, Appendix D.

3. NYSDEC Phase II Remedial Investigation for the Former Klink Cosmo Cleaners Site, Site ID No. 224130, URS Corporation, November 2012.

4. Geotech Info - - Soil Porosity, updated November 18, 2013, http://www.geotechdata.info/parameter/soil-porosity.html

5. Wikipedia Permeability (earth sciences), Ranges of Common Intrinsic Permeabilities

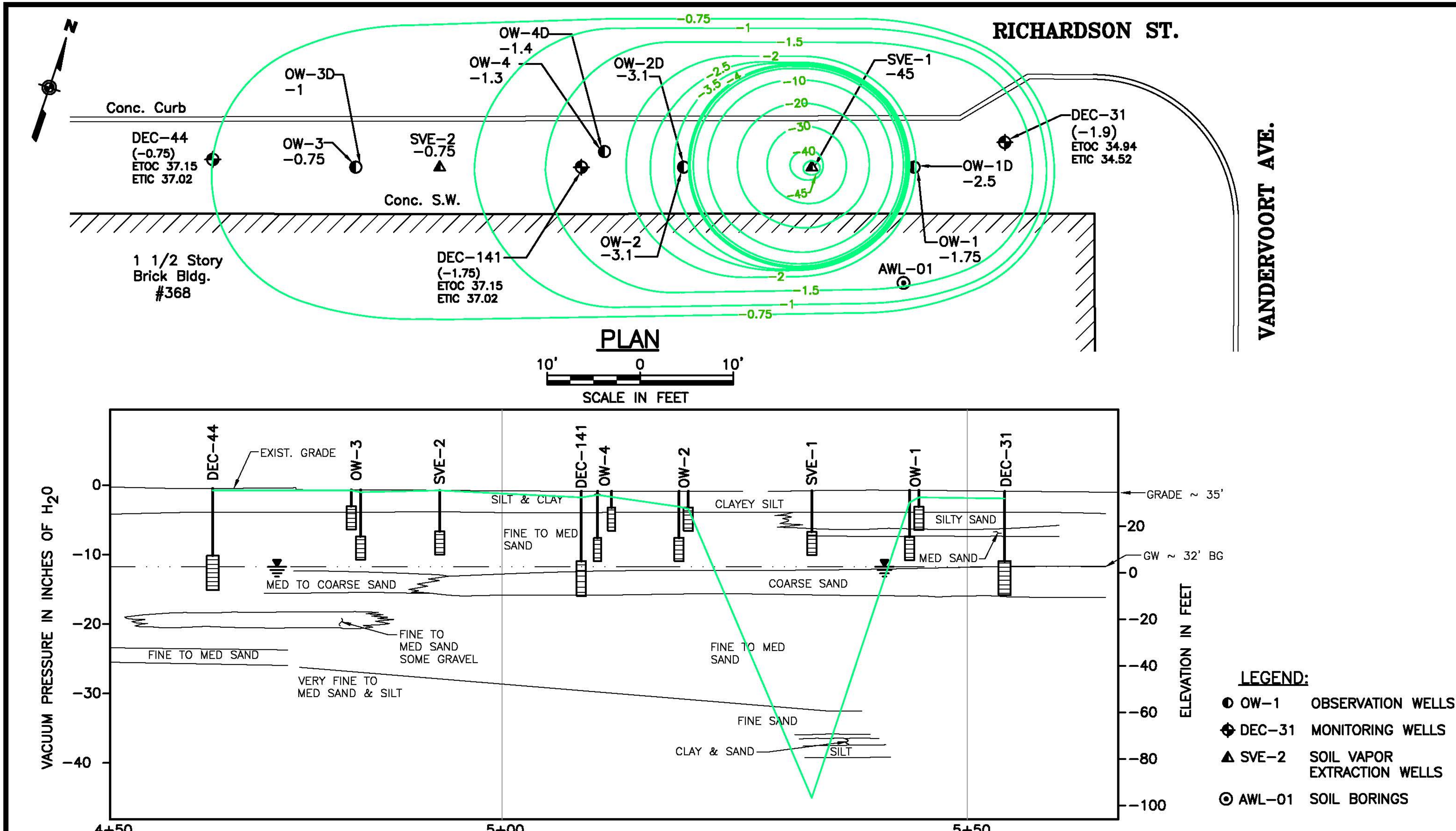


FORMER KLINK COSMO CLEANERS
PILOT STUDY WELL LOCATIONS

URS

FIGURE 1

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 1.dwg 3/18/16 - 2 RAL



FORMER KLINK COSMO CLEANERS
SVE-1 STEP TEST

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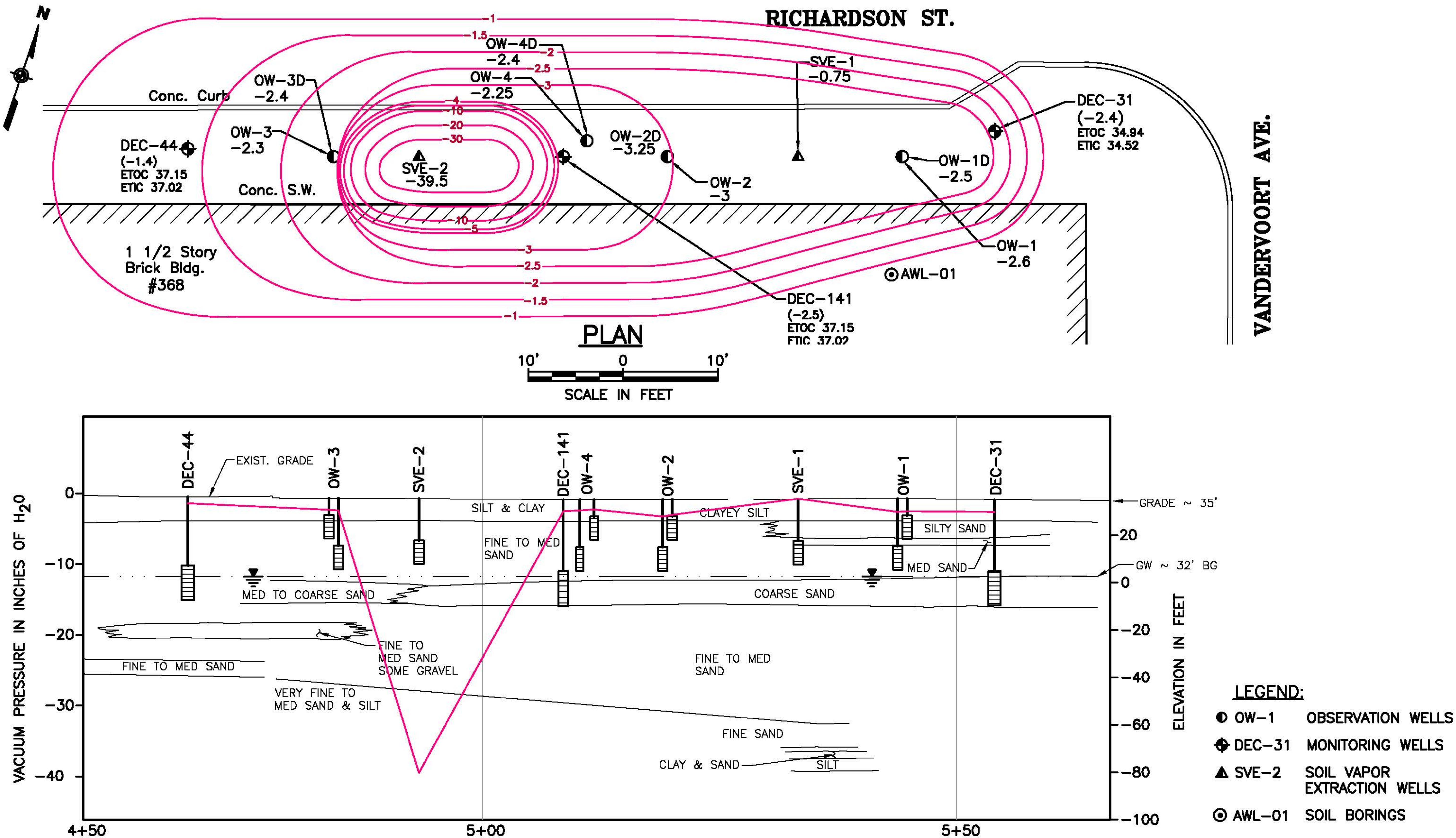
FIGURE 2

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 2.dwg 3/18/16 - 2 RAL



NOTE:

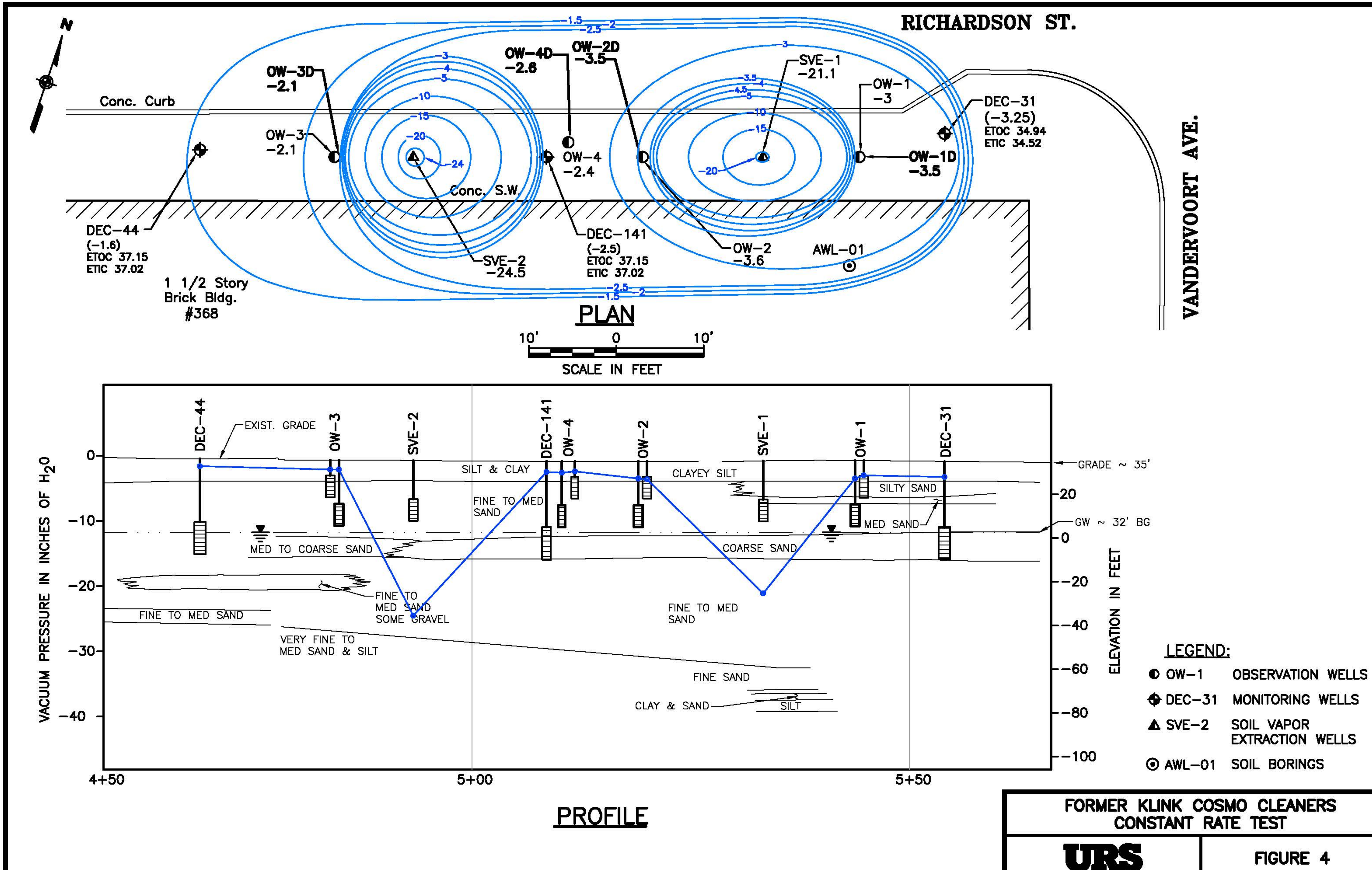
SVE-1 VACUUM NEGATED-
BELIEVED TO BE AN ANOMALY.

FORMER KLINK COSMO CLEANERS
SVE-2 STEP TEST

URS

FIGURE 3

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 3.dwg 2/24/16 - 2 RAL

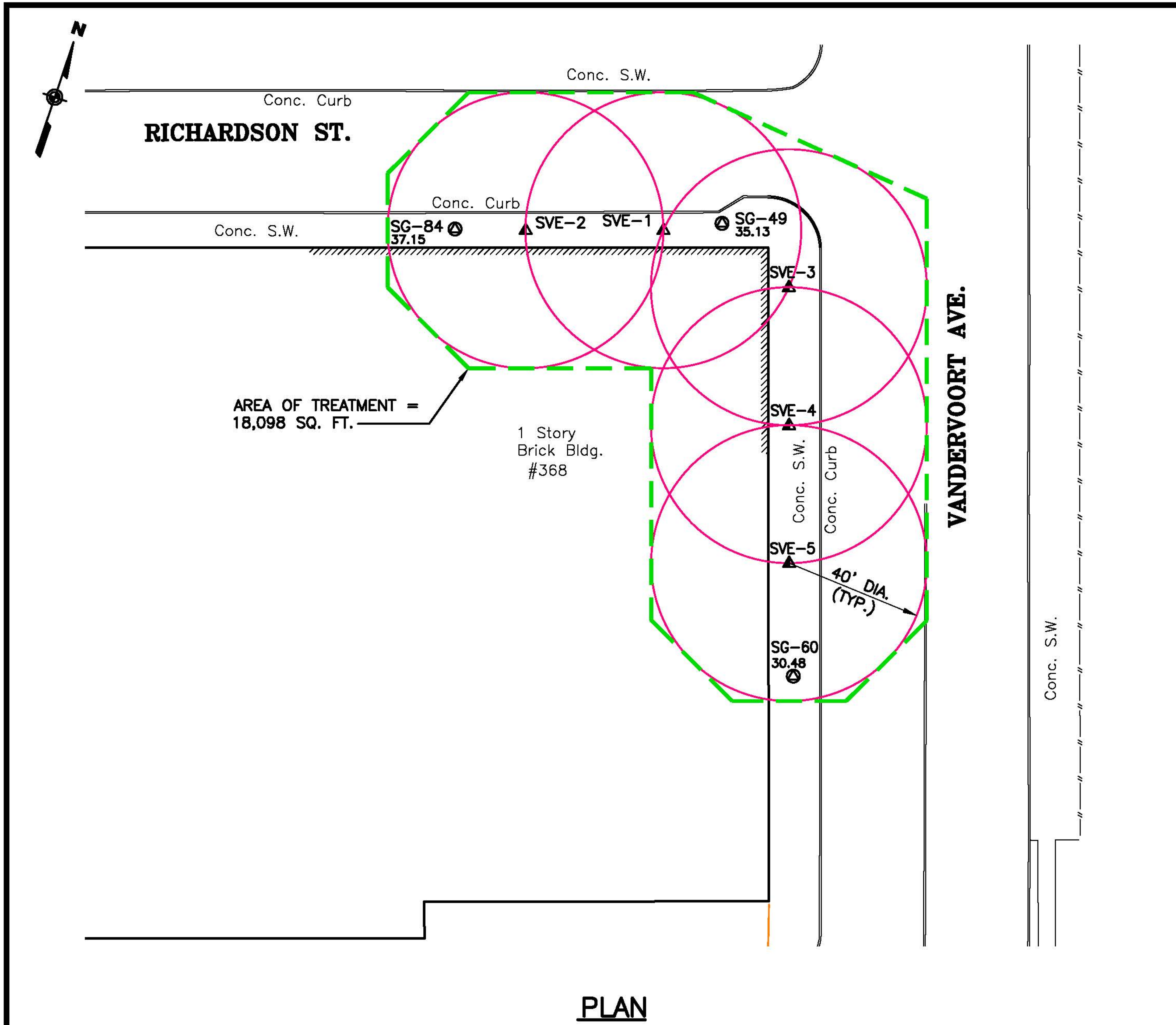


FORMER KLINK COSMO CLEANERS
CONSTANT RATE TEST

URS

FIGURE 4

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 4.dwg 3/18/16 - 2 RAL



FORMER KLINK COSMO CLEANERS
SOURCE AREA-PERIMETER
SVE WELL LOCATIONS

URS

FIGURE 5

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 5.dwg 2/29/16 - 2 RAL

Table 1 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits

		Test 1		Test 2		Test 3	
Location ID		SVE-01	SVE-01	SVE-02	SVE-02	SVE-02	SVE-02
Sample ID		SVE-01-START	SVE-01-END	SVE-02-START-R1	SVE-02-END-R1	SVE-02-START-R2	SVE-02-END-R2
Matrix		Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Depth Interval (ft)		-	-	-	-	-	-
Date Sampled		11/16/15	11/16/15	11/16/15	11/16/15	11/16/15	11/17/15
Parameter	**Units**				(2-2)	(3-3)	(4-4)
Volatile Organic Compounds							
1,2-Dichloroethene (cis)	µg/M³	5,960	6,520	1,430	666 J	952 J	1,190 J
Acetone	µg/M³	6,560		18,400	3,760	1880	
Carbon tetrachloride	µg/M³	554 J					
Chloroform	µg/M³		703J	293 J			
Methyl ethyl ketone (2-Butanone)	µg/M³	7,390	3,080	22,200	3,930	2020	743 J
Tetrachloroethene	µg/M³	1,420,000 D	1,610,000 D	550,000 D	718,000 D	773,000 D	848,000 D
Toluene	µg/M³						
Trichloroethene	µg/M³	8,430	9,800	3,160	1,480	2580	3290
Total VOCs	µg/M³	1,448,894	1,630,103	595,483	727,836	780,432	853,223
Average Total VOCs	**µg/M³**	**1,539,499**		**661,660**		**816,828**	
PID / FID Measurements	**ppm**						

Flags assigned during chemistry validation are shown.

Table 1 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 4		Test 5			Test 6	
		SVE-02/AS-02	SVE-02/AS-02	SVE-02/AS-03	SVE-02/AS-03	SVE-02/AS-03	SVE02/SP02/SP03	SVE02/AS02/AS03
Location ID		SVE-02/AS-02 START	SVE-02/AS-02 END	SVE-02/AS-03A START	SVE-02/AS-03B START	SVE-02/AS-03 END	SVE-02/SP-02/SP-03 START	SVE-02/AS-02/AS-03 END
Sample ID		Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-	-	-	-	-
Depth Interval (ft)		11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15	11/17/15
Date Sampled	**Units**		(2-2)		(2-2)	(3-3)		
Volatile Organic Compounds								
1,2-Dichloroethene (cis)	μg/M³	1,430 J	1,520	1,670	1,310	1,470	2,050	412 J
Acetone	μg/M³			812				
Carbon tetrachloride	μg/M³							
Chloroform	μg/M³			527 J	410 J	469 J	674	
Methyl ethyl ketone (2-Butanone)	μg/M³	708 J	708 J	602 J	301 J			
Tetrachloroethene	μg/M³	1,520,000 D	975,000 D	1,020,000 D	647,000 D	670,000 D	1,210,000 D	301,000 D
Toluene	μg/M³					610	1,990	
Trichloroethene	μg/M³	3,870	3,350	3,870	2,970	3,390	5,090	946
Total VOCs	μg/M³	1,526,008	980,578	1,027,481	651,991	675,939	1,219,804	302,358
Average Total VOCs	**μg/M³**	**1,253,293**		**785,137**			**761,081**	
PID / FID Measurements	**ppm**			**890 / 50**	**490 / 490**	**680 / 720**	**620 / 480**	**850 / 640**

Flags assigned during chemistry validation are shown.

Table 1 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 7	Test 8	
		SVE-01/SVE-02	SVE1&2/AS2&3	SVE1&2/AS2&3
Location ID		SVE-01/SV-02 PRE SPARGE	SVE-01/SV-02/AS-02/AS-03 START	SVE-01/SV-02/AS-02/AS-03 END
Sample ID		Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-
Depth Interval (ft)		11/18/15	11/18/15	11/18/15
Date Sampled	Units			(2-2)
Volatile Organic Compounds				
1,2-Dichloroethene (cis)	µg/M³	698 J	730 J	603 J
Acetone	µg/M³			
Carbon tetrachloride	µg/M³			
Chloroform	µg/M³			
Methyl ethyl ketone (2-Butanone)	µg/M³			
Tetrachloroethene	µg/M³	348,000 D	366,000 D	421,000 D
Toluene	µg/M³		542 J	
Trichloroethene	µg/M³	1,030	1,250	946
Total VOCs	µg/M³	349,728	368,522	422,549
Average Total VOCs	**µg/M³**	**349,728**	**395,536**	
PID / FID Measurements	**ppm**		**490 / 350**	**950 / 1450**

Flags assigned during chemistry validation are shown.

Table 1 Soil Vapor Extraction Pilot Test Analytical Data - Detections Over Laboratory Reporting Limits (Continued)

		Test 9		Test 10		Test 11	
		SVE-01	SVE-01	SVE-02	SVE-02	SVE-01/SVE-02	SVE-01/SVE-02
Location ID		SVE-01 START	SVE-01 END	SVE-02 START	SVE-02 END	SVE-01/SVE-02 START	SVE-01/SVE-02 END
Sample ID		Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Matrix		-	-	-	-	-	-
Depth Interval (ft)		11/19/15	11/19/15	11/19/15	11/19/15	11/19/15	11/19/15
Date Sampled	Units		(2-2)		(2-2)	(2-2)	(3-3)
Volatile Organic Compounds							
1,2-Dichloroethene (cis)	μg/M³	983	888			539 J	571 J
Acetone	μg/M³						
Carbon tetrachloride	μg/M³						
Chloroform	μg/M³						
Methyl ethyl ketone (2-Butanone)	μg/M³						
Tetrachloroethene	μg/M³	846,000 D	529,000 D	372,000 D	253,000 D	468,000 D	416,000 D
Toluene	μg/M³						
Trichloroethene	μg/M³	1550	1380	688 J	731 J	1070	946
Total VOCs	**μg/M³**	848533	531268	372688	253731	469609	417517
Average Total VOCs	**μg/M³**	**689901**		**313209.5**		**443563**	
PID / FID Measurements	**ppm**	**890 / 634**	**1250 / 1530**	**620 / 700**	**370 / 400**	**720 / 730**	**850 /1280**

Flags assigned during chemistry validation are shown.

Tables 2.2 & 2.3 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: **SVE-2 Stepped Rate Test**
Date: 11/16/2015
Personnel: MG, JL

NOTES:	shutdown		Lead 160, Lag 126
	Lead 145, Lag 135		

Test 2

Time	Flow Rates	Vacuums / Pressures														PID Readings		Temperature	
Units	Manifold To Extraction Well SVE-2 (scfm)	At Extraction Well SVE-2 (in Hg)	Manifold to Well SVE-2 (in Hg)	At OW-1 (in Hg)	At OW-1D (in Hg)	AS-2 At OW-4 (in Hg)	AS-2 At OW-4D (in Hg)	At OW-3 (in Hg)	At OW-3D (in Hg)	At OW-2 (in Hg)	At OW-2D (in Hg)	At DEC-44 (in Hg)	At DEC-141 (in Hg)	At DEC-31 (in Hg)	At SVE-1 (in Hg)	Before Carbon PID/FID (ppm)	After Carbon (PID/FID) (ppm)	At SVE-2 (°F)	Ambient Air Before Carbon (°F)
1720	33	-2	-2.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0			52	50
1749	38	-3.5	-2	0	0	0	-0.2	-1.5	0	0	0	0	0	0	0		723	60	50
1815	70	-0.4	-2	0	0	0	-0.2	-2	0	0	0	0	0	0	0			60	50
1826	70	-0.3	-2	0	0	0	-0.2	-2	0	0	0	0	0	0	-0.2	>1000	2/	60	50
1835	75	-0.4	-3	0	0	0	-0.2	-2	0	0	0	0	0	0	-0.2			60	50
1844	75	-0.3	-4.5	0	0	0	-0.2	-2.5	0	0	0	0	0	0	-0.2			60	50
Run Time																			
(min)																			
84																			
Average	60	-1.15	-2.7	0	0	0	-0.2	-1.7	0	0	0	0	0	0	-0.1			59	50

Test 3

RESTART SYSTEM FOR SVE -2 STEP TEST

2225	70	-2	-1.5	0	0	0	-0.2	-0.2	0	-0.2	0	0	0	0	0				50
2235	70	-2	-1.5	0	0	0	-0.25	0	0	0	0	0	0	0	0				
2245	70	0	-1.5	0	0	0	-0.25	-0.2	0	-0.2	0	0	0	0	0				
2255	70	-0.2	-1.5	0	0	0	-0.2	0	0	-0.2	-0.2	0	0	0	-0.2				
2300	68	-0.2	-2.5	0	0	0	-0.2	0	0	0	-0.2	0	0	0	-0.2				
2310	70	-0.2	-2.5	0	0	0	0	0	0	0	0	0	0	0	0				
2320	70	0	-2.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2330	70	-0.2	-2.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2335	71	-0.2	-3.5	0	0	0	0	0	0	0	0	0	0	0	0				
2345	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2355	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2405	70	0	-3.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2410	70	-0.2	-4.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2420	69	-0.2	-4.5	0	0	0	-0.2	0	0	0	0	0	0	0	0				
2430		-0.2	-4.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0				
2444	69	-0.2	-4.5	0	0	0	-0.2	-0.2	0	0	0	0	0	0	0				
Run Time																			
(min)																			
139																			
Average	70																		

Table 2.4 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

Well: **SP-2 Stepped Rate Test**
Date: 11/17/2015
Personnel: MG, JL

NOTES:

SVE-2 on @ Max Throttle	1019 reset	1131 shutdown
0945 shutdown	1031 shutdown and reset	1136 shutdown
0952 reset	1037 shutdown	1221 shutdown
1014 shutdown	1038 reset	1237 stop

Test 4

Time	Flow Rates		Vacuums / Pressures																		Temperature		
	Manifold To SP-2 Well	Manifold To SVE-2	Manifold To Air Sparge SP-2	At Well SVE-2	AS-2	Manifold To SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Ambient Before Carbon
Units	(scfm)	(scfm)	(psi)	(in Hg)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)	(ppm)	(°F)	(°F)	(°F)
930	20	63	13.5	-2.5	0.5	-2.7	0	0	-2	-0.5	-1	0	0	-2	-1	-1	0	0	>15000/-	0	45	45	55
956	24	60	12.5	-0.5	0	-3.5	0	0	-1	0	-1	-0.5	-0.5	-1.5	-0.75	-0.75	0	0	>15000/-	0	45	45	55
1005	26	60	12	-2.5	0	-4	0	0	-1	0	-1	0	-0.5	-1.5	-0.5	-0.75	0	0	>15000/-	0	45	45	55
1015	21	60	11.5	-2.5	0.5	-4	0	0	-1	0	-1	0	-0.5	-2	-0.75	-1	0	0	>15000/-	0	45	45	55
1027	40	60	14.5	-2.5	0	-4	0	0	-1	0	-0.5	0	-0.5	-2	-1	-1	0	0	>15000/-	0	45	45	55
1035	40	60	11	-2.5		-4.5	0	0	-0.75	0	SP-2 PVC/FERNCO slipped off					-0.5	0	1040 glued new			45	45	55
1123	40	61	17.5	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1.5	0	0	-/315	0	45	47	55
1132	43	60	17	-2.5	0	-4	NA	NA	-1	-0.5	-1	-1	-0.5	-1.5	-0.5	-1.5	NA	-0.5	NA	NA	45	46	55
1139	40	60	19	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1	0	0	>15000/574	0	45	46	55
1215	70	60	26.5	-2.5	0	-4	0	0	-0.75	0	-1	-1	-0.5	-1.75	-0.75	-1	0	0	>15000/680	0	45	46	55
1234	80	60	23.5	-2.5	0	-4	NA	NA	-0.75	0	-1.5	-1	-0.5	-1.75	-0.5	-1	NA	0	>15000/650	0	45	46	55
1237	Stopped System																						
Run Time																							
(min)																							
187																							
Average	40	60																					

Table 2.5 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

NOTES: Compressor shut off @ > 40 scfm - Max limit of formation
Tried increasing flow but motor repeatedly cut out
Per final sample w/suma can at 540pm
21 psi @ SP-3 manifold during sample

Shut down @ 4:03 pm for TAP
Restart at 4:15 pm
Shut down @ 5:45 pm
Retool for SP-2 & SP-3

Well: **SP-3 Stepped Rate Test**
Date: 11/17/2015
Personnel MG, JL

Test 5

Time	Flow Rates		Vacuums / Pressures																						Temperature		
	Manifold To SP-3	Manifold To SVE-2	At SP-2	Manifold To SP-3	At SP-3	Back Gauge	Manifold To SVE-2	At SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Trains A & B Before Carbon PID/FID		Trains A & B After Carbon (PID/FID)		At SVE-1	At SVE-2	Ambient Before Carbon
Units	(scfm)	(scfm)	(psi)	(psi)	(psi)	(psi)	(in Hg)	(Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)		(°F)	(°F)	(°F)
1532	16	60	0.5	15	3		-4	-2.5	0	-0.5	-1	0	-1	-0.5	-0.5	-1.75	-1	-0.5	-0.25	0	890	50	800	540	48	49	45
1542	18	60	0	16	3		-4	-2.5	0	-0.75	-1.5	0	-1	0	-0.25	-1.75	-1	-1	-0.25	0	NA	NA	NA	0	48	49	45
1550	18	60	0	15	3		-4.5	-2.5	0	-0.5	-1	0	-1.5	0	0	-1.75	-1.5	-0.5	-0.25	0	NA	NA	NA	0	48	49	45
1555	18	60	0	14.5	3		-4.5	-2.75	0	-0.5	-1	0	-1	-0.25	-0.25	-1.75	-1.5	-0.75	-0.25	-0.25	805	685	850	0	48	49	45
1603	System shut down due to high pressure																										
1615	30	61	0	24	2.5		-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.25	-0.25	-2	-1.5	-1.5	-0.25	0	490	490	0	0	48	49	45
1625	30	61	0	16	2.6	18.5	-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.5	-0.25	-1.75	-1.5	-1	-0.5	0	470	320	0	0	48	49	45
1639	30	62	0	15	2.6	20	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	415	0	0	48	49	45
1645	30	61	0	14.5	2.6	21.5	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	1700	0	0	49	49	45
1650	40	60	0	18.5	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1.25	-0.5	0	420	1900	0	0	48	48	45
1657	41	61		18	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	-0.25	620	740	0	0	48	48	45
1703	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.5	-0.5	-1.5	-0.25	0	-1.5	-1.5	-1	-0.5	0	470	610	0	0	48	48	45
1709	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.25	-0.5	-1	-0.25	0	-1.5	-1	-1	-0.5	0	680	720	0	0	47	49	45
1730	40	System shut down due to high pressure																									
1740	21	Restarted system to collect sample																									
1745	21	Collected sample & shutdown system																									
Average	29	61																									

Table 2.6 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Air Sparge Pilot Test

NOTES: Summa collected at 2020 800
SVE on max throttle 720

Well: **SP-2 & SP-3**
Date: 11/17/2015
Personnel: David Coulter, Mike Gutman, John Lysiak

Test 6

Time	Flow Rates			Vacuums / Pressures																			PID Readings			Temperature		
	Manifold To SP Wells (scfm)		Manifold To SVE-2 (scfm)	Manifold To SP Wells (psi)		Manifold To Well SVE-2 (in Hg)	Outside At Air Sparge Wells (psi)		Back Gauge (psi)	At Well SVE-2 (Hg)	At OW-1 (in Hg)	At OW-1D (in Hg)	At OW-2 (in Hg)	At OW-2D (in Hg)	At OW-3 (in Hg)	At OW-3D (in Hg)	AS-2 At OW-4 (in Hg)	AS-2 At OW-4D (in Hg)	At DEC-44 (in Hg)	At SVE-1 (in Hg)	At DEC-31 (in Hg)	At DEC-141 (in Hg)	Before Carbon PID/FID (ppm)		After Carbon (PID/FID) (ppm)	At SVE-1 (°F)	At SVE-2 (°F)	Ambient Before Carbon (°F)
Units	SP-2	SP-3		SP-2	SP-3		SP-2	SP-3																				
1800	10	10	62	8.9	14	-4.5	0.5	2.5	14	-2.25	0	0	-1	-0.5	-0.5	0	-0.5	-1	-0.5	-1	-0.5	0	620	480	0	45	48	45
1819	10	10	61	9.5	12.5	-4.5	0.5	3	14	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	720	560	0	45	47	45
1830	10	10	61	9	11.5	-5	1	3	13.5	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-2	-0.5	-0.5	-0.5	0	710		0	45	48	45
1837	10	10	63	9	11	-5	0.5	3	13.5	-2.25	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	710	530	0	45	48	45
1845	15	15	62	9	12	-5	0.5	3	16	-2.5	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	740	516	0	45	48	45
1853	15	15	63	9	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	800	680	0	45	48	44
1902	15	15	63	8.5	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	720	590	0	45	50	44
1906	15	15	62	8.5	11	-5	0.5	3	16	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-0.5	-0.5	0	840	700	0	45	49	44
1915	20	20	62	9	12.5	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	0	-1.5	-0.5	-0.5	-0.5	0	780	725	0	45	49	45
1921	20	20	63	8.5	12	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	820	780	0	45	49	45
1928	20	20	62	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	850	748	0	45	48	44
1934	20	20	63	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.75	-0.75	-1	-0.5	0	840	730	0	45	49	41
1940	25	25	63	8.5	12.5	-5	0.5	3	18	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.75	-1	-0.5	0	770	620	0	45	48	44
1945	25	25	62	8.5	12.5	-5	0.5	3	18	-2.75	0	0	-0.5	-0.5	-1	0	-0.5	-1.5	-0.5	-1	-0.5	0	700	570	0	45	48	43
1950	25	25	63	8.5	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	750	530	0	45	47	43
1954	25	25	62	8	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	740	530	0	45	47	43
2003	35	35	62	9.5	15	-4.5	0.5	3	20.75	-3	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	800	590	0	45	48	43
2008	35	35	62	9.5	15	-4.5	0.5	3.5	20.6	-3	0	0	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	850	640	0	45	48	43
2014	35	35	63	9	15.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.1	850	640	0	45	48	43
2019	35	35	62	9	14.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	-0.25	-0.75	-0.1	-0.5	-1.5	-0.5	-1	-0.5	-0.1				45	48	43
Run Time (Min)																												
139																												
Average	21	21	62.3																									

Tables 2.7 & 2.8 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

NOTES: Gauge calibration not low enough
Max Vac 0 w/ both SVE 1 &2 at Max Flow

Well: **SVE-1 & SVE-2** **Constant Rate Test**
Date: 11/18/2015 6:54 Purging SVE-1 and SVE-2
Personnel: MG, JL Purge duration at Max Flow = 2010-1854 = 76 Minutes (Test 7)

Tests 7 & 8

Time	Flow Rates / Pressures								Vacuums / Pressures													PID Readings				Temperature		
	Manifold To SP-1		Manifold To SP-2		At Extraction Well SVE-1	Manifold to Well SVE-1	Manifold to Well SVE-2	At Well SVE-2	At AS-3	At AS-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)		At SVE-1	At SVE-2	Ambient
Units	(scfm)	(psi)	(scfm)	(psi)	(in Hg)	(scfm)	(scfm)	(in Hg)	(psi)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)		(°F)	(°F)	(°F)
2010	27		28		-2.5	70	61	-0.5	0	0	0	-0.5	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	0	490	350			57	60	57
2044	35	11	35	8	-2.5	70	60	-0.5	0	0	-0.25	0	-0.5	0	-0.5	-0.5	0	-2	-0.5	-0.5	0	900	1014			58	60	59
2054	35	11	35	8	-3	69	60	-2	0	0	-0.5	0.25	-0.5	0	-0.25	0	-0.5	-1	-0.5	-0.5	-1.5	900	1013			60	60	60
2104	36	10.5	35	7	-3	70	61	-2	0	0	-0.5	0.5	0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	1140	960			60	60	60
2114	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0	-0.5	-0.25	-0.5	-0.25	0	-2	-0.5	-0.5	-2.5					60	60	60
2124	36	10.5	35	8	-3	69	61	-2	0	0	0	0.25	-0.25	0	-0.25	0	-0.25	-1.5	-0.25	-0.5	-2.5	1015	900			60	60	60
2134	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0.25	-0.5	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	900	800			60	60	60
2144	37	10.5	35	7.5	-2.75	69	61	-2	0	0	-0.5	0	-0.25	-0.25	-0.5	-0.25	-0.25	-2	-0.5	-0.5	-2.5	800	1300			60	60	60
2154	36	10.5	35	7.5	-2.75	70	60	-2	0	0	-0.25	0	-0.25	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	1500			60	60	60
2204	37	10.5	35	8	-3	70	61	-2	0	0	-0.25	0	-0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	940			60	60	60
2214	37	10.5	35	7.5	-2.75	70	61	-2	0	0	0	0	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	-1.5	880	1480			60	60	60
2224	37	10.5	34	7.5	-2.5	69	60	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-1.5	870	1100			60	60	60
2234	37	10.5	35	7.5	-2.75	67	61	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.75	-1.75	-0.5	-0.5	-1.5	950	1450			61	60	60
2244	45	12	45	9		70	61																					
Run Time																												
(min)																												
154																												
Average	36		35			70	61																					

Table 2.9 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

NOTES: Collected summa @ 1033

Well: **SVE-1 Stepped Rate Test**
Date: 11/19/2015
Personnel: DC, MG, JL, GK

Test 9

Time	Flow Rates	Vacuums / Pressures																PID Readings			Temperature		
	Manifold To Extraction Well SVE-1	At Extraction Well SVE-1	Manifold to Well SVE-1	At OW-1	At OW-1D	AS-2 At OW-4	AS-2 At OW-4D	At OW-3	At OW-3D	At OW-2	At OW-2D	At DEC-44	At DEC-141	At DEC-31	At SVE-2	SP-2	SP-3	Before Carbon PID/FID		After Carbon (PID/FID)	Before Carbon	After Carbon	Ambient Carbon
Units	(scfm)	(in H_2O)	(in Hg)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in Hg)	(in H_2O)	(in Hg)	(in Hg)	(in Hg/ H_2O)	(in H_2O)	(Hg)	(Hg)	(ppm)		(ppm)	(°F)	(°F)	(°F)
1007	67	-8	-1.5	0	-1	0	-0.5	0	0	-0.25	-1.5	0	-1	0	0	0	0				65	64	64
1017	66	-30.5	-1.5	0	-1.5	0	-0.75	-0.5	-0.5	-0.25	-2	0	-1.25	0	-0.5	0	0				65	64	64
1027	67	-30.5	-1.5	0	-1.5	0	-0.75	-0.5	-0.5	-0.25	-2	0	-1.5	0	-0.5	0	0	890	634	0	65	64	64
1037	66	-30.5	-1.5	0	-1.5	0	-0.8	-0.5	-0.5	-0.25	-5	-0.25	-1.5	0	-1	0	0	1150	940	0	65	64	64
1047	68	-35	-3	0	-2	0	-1	-0.5	-0.75	-0.1	-2.2	0	-1.6	0	-0.6	0	0	1080	1213	0	65	65	64
1057	68	-34	-3	0	-1.75	0	-1	-0.5	-0.8	-0.1	-2.1	0	-1.5	0 -1.5	-0.6	0	0	1020	1213	0	70	65	64
1107	67	-33.5	-3	-0.1	-2	0	-1.5	-0.5	-0.8	0	-2.2	0	-1.5	0 -1.5	-1.6	0	0	1100	1410		70	65	65
				EVERYTHING FORWARD IS IN INCHES H_2O																			
	(scfm)	(in H_2O)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)						
1117	68	-32	-3	-1.5	-2	-1	-1	-0.8	-0.5	-2.1	-2.2	-0.5	-1.5	-1.6	-0.6	0	0	1170	1300		70	66	65
1127	69	-39.5	-4.5	-1.6	-2.1	-1.1	-1.6	-0.5	-0.8	-2.25	-2.3	-0.5	-1.5	-1.6	-0.75	0	0	1110	1320		69	66	64
1137	69	-39.5	-4.5	-1.75	-2.2	-1.1	-1.1	-0.6	-1	-2.4	-2.25	-0.75	-1.5	-1.75	-0.75	0	0	1100	1320		69	65	63
1147	68	-39.5	-4.5	-1.6	-2.1	-1	-1.1	-0.6	-0.9	-2.3	-2.5	-0.7	-1.6	-1.6	-0.75	0	0	1100	1370		69	65	63
1157	68	-39.5	-4.5	-1.6	-2.1	-1.2	-1	-0.6	-0.9	-2.4	-2.4	-0.7	-1.5	-1.6	-0.75	0	0	1180	1420		69	66	63
1202	69	-45	-6.25	-1.8	-2.5	-1.4	-1.3	-0.7	-1	-2.5	-2.5	-0.75	-1.6	-1.75	-0.75	0	0	1220	1470				
1212	69	-45	-6.25	-1.9	-2.4	-1.5	-1.4	-0.75	-1	-3.1	-2.5	-0.8	-1.7	-1.9	-0.9	0	0	1200	1560		90	80	63
1222	68	-45	-6.25	-1.7	-2.3	-1.4	-1.3	-0.6	-1	-3.1	-3.2	-0.75	-1.75	-1.8	-0.75	0	0	1210	1420		90	81	64
1232	68	-45	-6.25	-1.75	-2.5	-1.3	-1.4	-0.75	-1	-3.1	-3.1	-0.75	-1.75	-1.9	-0.75	0	0	1250	1530		89	80	64
																				FINAL -->	95	85	
Run Time																							
(Min)																							
145																							
Average	68.4																						

Note: Shaded data, the last reading of the increment, was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady state conditions.
Data used in the 4 and 5 series of calculation tables.

Table 2.10 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: **SVE-2 Stepped Rate Test** NOTES: All readings in H_2O
Date: 11/19/2015
Personnel: MG, JL

Test 10

Time	Flow Rates	Vacuums / Pressures																PID Readings			Temperature		
Units	Manifold To Extraction Well SVE-2 (scfm)	At Extraction Well SVE-2 (in H_2O)	Manifold to Well SVE-2 (in Hg)	At OW-1 (in H_2O)	At OW-1D (in H_2O)	AS-2 At OW-4 (in H_2O)	AS-2 At OW-4D (in H_2O)	At OW-3 (in H_2O)	At OW-3D (in H_2O)	At OW-2 (in H_2O)	At OW-2D (in H_2O)	At DEC-44 (in H_2O)	At DEC-141 (in H_2O)	At DEC-31 (in H_2O)	At SVE-1 (in Hg)	SP-2	SP-3	Before Carbon PID/FID (ppm)		After Carbon (PID/FID) (ppm)	Before Carbon (°F)	After Carbon (°F)	Ambient Carbon (°F)
1245	60	-19	-1.5	-0.75	-0.75	-1.4	-1.3	-1.2	-1.6	-2.3	-2.5	-0.9	-1.6	-1	-0.5	0	0	620	698	0	97	87	61
1255	60	-19	-1.5	-0.75	-0.9	-1.5	-1.25	-1.1	-1.4	-2.4	-2.5	-0.9	-1.5	-0.8	-0.5	0	0	606	590	0	98	87	62
1305	60	-19	-1.5	-0.75	-0.75	-1.4	-1.4	-1.1	-1.5	-2.4	-2.6	-0.9	-1.6	-0.75	-0.5	0	0	570	690	0	103	89	61
1315	60	-19	-1.5	-0.75	-0.75	-1.2	-1.25	-1.3	-1.6	-2.5	-2.5	-1	-1.6	-0.75	-0.5	0	0	560	642	0	104	90	61
1317	60	-26	-3	-0.8	-0.8	-1.5	-1.75	-1.6	-2	-2.6	-3	-1	-2	-0.8	-0.6	0	0	530	795	0	105	90	62
1327	60	-26.5	-3	-1	-0.9	-1.6	-1.7	-1.7	-2.1	-2.6	-2.7	-1.25	-2	-0.9	-0.6	0	0	500	770	0	105	90	63
1337	60	-27	-3	-1	-1.1	-1.6	-1.7	-1.6	-2	-2.6	-2.7	-1.7	-2	-0.9	-0.6	0	0	490	780	0	105	90	62
1343	61	-27	-3	-1	-1	-1.75	-1.6	-1.75	-2	-2.6	-2.7	-1.4	-2.1	-1	-0.6	0	0	450	630	0	105	90	63
1345	60	-34.5	-4.5	-1	-1.25	-2	-2.1	-2	-2.25	-2.9	-3.1	-1.25	-2.4	-1	-0.7	0	0	430	550	0	104	92	64
1355	60	-34.5	-4.5	-1	-1.1	-2.1	-2.1	-2	-2.4	-2.9	-3.1	-1.4	-2.5	-1	-0.6	0	0	380	670	0	105	92	62
1405	61	-34.5	-4.5	-1	-1.25	-2.1	-2.2	-2	-2.4	-2.8	-3.1	-1.4	-2.4	-1	-0.6	0	0	360	580	0	100	90	62
1415	61	-34.5	-4.5	-1.1	-1.1	-2	-2.1	-2	-2.4	-2.8	-3.1	-1.4	-2.4	-2.5	-0.6	0	0	380	560	0	85	87	62
1416	60	-39.5	-5.5	-2.5	-2.6	-2.3	-2.25	-2.3	-2.5	-3	-3.1	-1.5	-2.5	-2.5	-0.75	0	0	390	790	0	97	95	62
1426	61	-39.5	-5.5	-2.5	-2.5	-2.2	-2.25	-2.4	-2.5	-3	-3.1	-1.6	-2.5	-2.4	-0.75	0	0	380	450	0	97	95	61
1436	61	-39.5	-5.5	-2.5	-2.5	-2.5	-2.3	-2.25	-2.4	-3.1	-3.3	-1.5	-2.6	-2.4	-0.75	0	0	370	400	0	100	92	62
1446	61	-39.5	-5.5	-2.6	-2.5	-2.25	-2.4	-2.3	-2.4	-3	-3.25	-1.4	-2.5	-2.4	-0.75	0	0	370	400	0	100	95	62
Run Time (min)																							
121																							
Average	60.4																						

Note: Shaded data, the last reading of the increment, was used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady state conditions.
Data used in the 4 and 5 series of calculation tables.

Table 2.11 - PILOT STUDY FIELD DATA SUMMARY

Klink Cosmo - Soil Vapor Extraction Pilot Test

Well: **SVE-1 & SVE-2 Constant Rate Test**
Date: 11/19/2015
Personnel: MG, JL

Test 11

Time	Flow Rates		Vacuums / Pressures															PID Readings			Temperature		
	Manifold to Extraction Well SVE-1	Manifold to Well SVE-2	At Extraction Well SVE-1	Manifold to Well SVE-1	At Extraction Well SVE-2	Manifold to Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)	Before Carbon	After Carbon	Ambient
Units	(scfm)	(scfm)	(in H_2O)	(in Hg)	(in H_2O)	(in Hg)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(in H_2O)	(ppm)		(ppm)	(^oF)	(^oF)	(^oF)
1450	69	61	-21	-1.5	-24.5	-2.5	-3.1	-3.6	-3.5	-3.6	-2.1	-2.1	-2.4	-2.5	-0.9	-3.1	-2.5	720	730	0	100	92	62
1500	67	61	-21.1	-1.5	-24.5	-2.5	-3.3	-3.6	-3.6	-3.7	-2.2	-2.1	-2.6	-2.4	-1.5	-3.1	-2.5	630	800		97	92	62
1510	68	61	-21.1	-1.5	-24.5	-2.5	-3.25	-3.5	-3.5	-3.75	-2.1	-2.1	-2.3	-2.4	-1.4	-3.1	-2.5	940	840		90	95	62
1520	66	61	-21.1	-1.5	-24.5	-2.5	-3.4	-3.5	-3.5	-3.6	-2.1	-2.1	-2.5	-2.5	-1.4	-3.25	-2.5	900	710		95	90	62
1530	70	60	-21.1	-1.5	-24.5	-2.75	-3.2	-3.4	-3.5	-3.6	-2.1	-2.1	-2.4	-2.5	-1.4	-3.25	-2.5	900	710		95	90	62
1540	70	61	-21.1	-1.5	-24.5	-2.75	-3.4	-3.5	-3.6	-3.6	-2	-2	-2.4	-2.5	-1.4	-3.2	-2.5	780	800		95	90	62
1550	68	61	-21.1	-1.4	-24.5	-2.5	-3.1	-3.6	-3.1	-3.7	-2.1	-2.1	-2.4	-2.5	-1.4	-3.1	-2.5	840	920		95	90	62
1600	68	61	-21.1	-1.25	-24.5	-2.5	-3.4	-3.5	-3.5	-3.6	-2.1	-2.1	-2.25	-2.4	-1.3	-3.25	-2.5	700	1100		90	89	62
1610	68	61	-21.1	-1.25	-24.5	-2.5	-3.25	-3.6	-3.5	-3.6	-2	-2.1	-2.5	-2.5	-1.4	-3.1	-2.5	850	1280		92	87	62
1618	68	61	-21.1	-1.25	-24.5	-2.5	-3	-3.5	-3.6	-3.5	-2.1	-2.1	-2.4	-2.6	-1.6	-3.25	-2.5				100	90	62
Run Time (Min)																							
138																							
Average	68.2	61.9																					

Table 3 - Estimate of Mass Removed During Soil Vapor Extraction Pilot Test

Date	Test No.	Average VOC Concentration (µg/M³)	Average System Flowrate (CFM)	Operating Duration (Min)	Mass Removed (Lbs)
11/16/2015	1	1,539,499	60	160	0.9235
11/16/2015	2	661,660	60	84	0.2084
11/16/2015	3	816,828	70	139	0.4966
11/17/2015	4	1,253,293	60	187	0.8787
11/17/2015	5	785,137	60	133	0.3915
11/17/2015	6	761,081	62	139	0.4099
11/18/2015	7	349,728	131	76	0.2176
11/18/2015	8	395,536	131	154	0.4986
11/19/2015	9	689,901	68	145	0.4251
11/19/2015	10	313,209	60	121	0.1421
11/19/2015	11	443,563	140	138	0.5355
			Total	**1476**	**5.1274**

Mass Removed = (Average Concentration)*(g/1,000,000 µg)*(M³/35.315 Ft³)*(Average Flowrate)*(Operating Duration)*(Lb/453.16 g)

Average Emission Rate = Mass Removed / Operating Duration = 0.0035 Lbs/Min
0.2084 Lbs/Hr
5.0023 Lbs/Day

Table 4.1 - Calculation of ROI at SVE-1 @ 32 inches H2O

SVE-1 Monitoring Locations

Monitoring Points	r Distance from SVE-1 (ft)	Pr = Pressure at SVE-1: SVE-1 at 30.5 in H_2O (atm)	SVE-1 at 32 in H_2O (atm)	SVE-1 at 40 in H_2O (atm)	SVE-1 at 45 in H_2O (atm)	Pressure at SVE - 1 = 32": (Pr^2-Pw^2) ~	(Pri^2-Pw^2)*ln(r/Rw)/ln(Ri/Rw)	Ri (ft)
OW-1	11	1.0000	0.9963	0.9961	0.9957	0.1439	0.1439	13
OW-1D	11	0.9963	0.9970	0.9948	0.9939	0.1453	0.1452	12.5
OW-2	13.8	0.9916	0.9948	0.9941	0.9924	0.1409	0.1404	18.5
OW-2D	13.8	0.9877	0.9946	0.9941	0.9924	0.1404	0.1404	18.5
OW-3	49	0.9988	0.9980	0.9985	0.9982	0.1473	0.1479	52.5
OW-3D	49	0.9988	0.9988	0.9978	0.9975	0.1488	0.1481	52
OW-4	22.3	1.0000	0.9975	0.9970	0.9968	0.1463	0.1463	25
OW-4D	22.3	0.9980	0.9975	0.9975	0.9966	0.1463	0.1463	25
DEC-31	21	1.0000	0.9961	0.9961	0.9953	0.1434	0.1433	26
DEC-44	64.4	0.9916	0.9988	0.9983	0.9982	0.1488	0.1487	67
DEC-141	24.8	0.9963	0.9963	0.9963	0.9957	0.1439	0.1433	31
SVE-2	40	0.9975	0.9985	0.9982	0.9982	0.1483	0.1483	42
Pw (SVE-1)	0	0.9250	0.9213	0.9016	0.8893	0.0000		
Pri		0.9992	0.9992	0.9990	0.9989		**Average Ri (ft)**	**31.9**

1 inch H_2O = 0.00246 atmosphere

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.9 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

Table 4.2 - Calculation of ROI at SVE-1 @ 40 inches H2O

SVE-1 Monitoring Locations

Monitoring Points	r Distance from SVE-1 (ft)	Pr = Pressure at SVE-1: SVE-1 at 30.5 in H_2O (atm)	SVE-1 at 32 in H_2O (atm)	SVE-1 at 40 in H_2O (atm)	SVE-1 at 45 in H_2O (atm)	Pressure at SVE - 1 = 40": (Pr^2-Pw^2) ~	$(Pri^2-Pw^2)*ln(r/Rw)/ln(Ri/Rw)$	Ri (ft)
OW-1	11	1.0000	0.9963	0.9961	0.9957	0.1793	0.1781	13
OW-1D	11	0.9963	0.9970	0.9948	0.9939	0.1768	0.1765	13.5
OW-2	13.8	0.9916	0.9948	0.9941	0.9924	0.1753	0.1757	17.5
OW-2D	13.8	0.9877	0.9946	0.9941	0.9924	0.1753	0.1757	17.5
OW-3	49	0.9988	0.9980	0.9985	0.9982	0.1842	0.1842	50.5
OW-3D	49	0.9988	0.9988	0.9978	0.9975	0.1827	0.1829	52.5
OW-4	22.3	1.0000	0.9975	0.9970	0.9968	0.1812	0.1817	24.5
OW-4D	22.3	0.9980	0.9975	0.9975	0.9966	0.1822	0.1824	24
DEC-31	21	1.0000	0.9961	0.9961	0.9953	0.1793	0.1794	24.5
DEC-44	64.4	0.9916	0.9988	0.9983	0.9982	0.1837	0.1839	67
DEC-141	24.8	0.9963	0.9963	0.9963	0.9957	0.1798	0.1795	29
SVE-2	40	0.9975	0.9985	0.9982	0.9982	0.1834	0.1835	42
Pw (SVE-1)	0	0.9250	0.9213	0.9016	0.8893	0.0000		
Pri		0.9992	0.9992	0.9990	0.9989		**Average Ri (ft)**	**31.3**

1 inch H_2O = 0.00246 atmosphere

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.9 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reacl steady-state conditions under that increment setting

Table 4.3 - Calculation of ROI at SVE-1 @ 45 inches H2O

SVE-1 Monitoring Locations

Monitoring Points	r	Pr = Pressure at SVE-1				Pressure at SVE - 1 = 45"		Ri
	Distance from SVE- (ft)	SVE-1 at 30.5 in H_2O (atm)	SVE-1 at 32 in H_2O (atm)	SVE-1 at 40 in H_2O (atm)	SVE-1 at 45 in H_2O (atm)	$(Pr^2$-$Pw^2)$ ~	$(Pri^2$-$Pw^2)$*ln(r/Rw)/ln(Ri/Rw)	(ft)
OW-1	11	1.0000	0.9963	0.9961	0.9957	0.2006	0.2008	12.5
OW-1D	11	0.9963	0.9970	0.9948	0.9939	0.1969	0.1973	13.5
OW-2	13.8	0.9916	0.9948	0.9941	0.9924	0.1940	0.1930	19
OW-2D	13.8	0.9877	0.9946	0.9941	0.9924	0.1940	0.1941	18.5
OW-3	49	0.9988	0.9980	0.9985	0.9982	0.2055	0.2069	49
OW-3D	49	0.9988	0.9988	0.9978	0.9975	0.2042	0.2045	52.5
OW-4	22.3	1.0000	0.9975	0.9970	0.9968	0.2028	0.2022	25
OW-4D	22.3	0.9980	0.9975	0.9975	0.9966	0.2023	0.2022	25
DEC-31	21	1.0000	0.9961	0.9961	0.9953	0.1998	0.1997	25
DEC-44	64.4	0.9916	0.9988	0.9983	0.9982	0.2055	0.2056	67
DEC-141	24.8	0.9963	0.9963	0.9963	0.9957	0.2006	0.2007	29
SVE-2	40	0.9975	0.9985	0.9982	0.9982	0.2055	0.2042	43
Pw (SVE-1)	0	0.9250	0.9213	0.9016	0.8893	0.0000		
Pri		0.9992	0.9992	0.9990	0.9989		**Average Ri (ft)**	**31.6**

1 inch H_2O = 0.00246 atmosphere

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.9 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting

Table 4.4 - Calculation of ROI at SVE-2 @ 19 inches H2O

SVE-2 Monitoring Locations

Monitoring Points	r	Pr = Pressure at SVE-2				Pressure at SVE - 2 = 19"		Ri
	Distance from SVE-2 (ft)	SVE-2 at 19 in H_2O (atm)	SVE-2 at 27 in H_2O (atm)	SVE-2 at 35 in H_2O (atm)	SVE-2 at 40 in H_2O (atm)	(Pr^2-Pw^2) ~	$(Pri^2-Pw^2)*\ln(r/Rw)/\ln(Ri/Rw)$	(ft)
OW-1	51	0.9982	0.9975	0.9973	0.9936	0.0876	0.0879	60
OW-1D	51	0.9982	0.9975	0.9973	0.9939	0.0876	0.0879	60
OW-2	26.2	0.9939	0.9936	0.9931	0.9926	0.0790	0.0791	54
OW-2D	26.2	0.9939	0.9934	0.9924	0.9920	0.0790	0.0791	54
OW-3	9	0.9968	0.9957	0.9951	0.9943	0.0849	0.0843	12
OW-3D	9	0.9961	0.9951	0.9941	0.9941	0.0834	0.0843	12
OW-4	17.8	0.9970	0.9951	0.9951	0.9945	0.0854	0.0857	23
OW-4D	17.8	0.9969	0.9948	0.9948	0.9941	0.0852	0.0857	23
DEC-31	60.8	0.9982	0.9975	0.9939	0.9941	0.0876	0.0876	73
DEC-44	24.4	0.9975	0.9966	0.9966	0.9966	0.0864	0.0862	31
DEC-141	15.2	0.9961	0.9948	0.0059	0.9939	0.0834	0.0843	21
SVE-1	40	0.9988	0.9985	0.9985	0.9982	0.0888	0.0888	44
Pw (SVE-2)	0	0.9533	0.9336	0.9139	0.9016	0.0000		

Pw (SVE-2)		0.9533	0.9336	0.9139	0.9016		
Pri		0.9995	0.9993	0.9991	0.9990	**Average Ri (ft)**	**38.9**

1 inch H_2O = 0.00246 atmospheres

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

Table 5.3 - Calculation of ROI at SVE-1 @ 45 inches H2O

NOTE: Shaded data from Table 2.10 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

Table 4.5 - Calculation of ROI at SVE-2 @ 27 inches H2O

Monitoring Points	r Distance from SVE-2 (ft)	Pr = Pressure at SVE-2 SVE-2 at 19 in H_2O (atm)	SVE-2 at 27 in H_2O (atm)	SVE-2 at 35 in H_2O (atm)	SVE-2 at 40 in H_2O (atm)	Pressure at SVE - 2 = 27" (Pr^2-Pw^2) ~	(Pri^2-Pw^2)*ln(r/Rw)/ln(Ri/Rw)	Ri (ft)
OW-1	51	0.9982	0.9975	0.9973	0.9936	0.1235	0.1236	60
OW-1D	51	0.9982	0.9975	0.9973	0.9939	0.1235	0.1236	60
OW-2	26.2	0.9939	0.9936	0.9931	0.9926	0.1157	0.1158	43
OW-2D	26.2	0.9939	0.9934	0.9924	0.9920	0.1152	0.1153	44
OW-3	9	0.9968	0.9957	0.9951	0.9943	0.1198	0.1186	12
OW-3D	9	0.9961	0.9951	0.9941	0.9941	0.1186	0.1186	12
OW-4	17.8	0.9970	0.9951	0.9951	0.9945	0.1186	0.1185	25
OW-4D	17.8	0.9969	0.9948	0.9948	0.9941	0.1181	0.1185	25
DEC-31	60.8	0.9982	0.9975	0.9939	0.9941	0.1235	0.1236	72
DEC-44	24.4	0.9975	0.9966	0.9966	0.9966	0.1216	0.1213	31
DEC-141	15.2	0.9961	0.9948	0.0059	0.9939	0.1181	0.1186	21
SVE-1	40	0.9988	0.9985	0.9985	0.9982	0.1255	0.1254	43
Pw (SVE-2)	0	0.9533	0.9336	0.9139	0.9016	0.0000		

Pw (SVE-2)		0.9533	0.9336	0.9139	0.9016
Pri		0.9995	0.9993	0.9991	0.9990

Average Ri (ft)	**37.3**

1 inch H_2O = 0.00246 atmospheres

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.10 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

Table 4.6 - Calculation of ROI at SVE-2 @ 35 inches H2O

Monitoring Points	r Distance from SVE-2 (ft)	Pr = Pressure at SVE-2: SVE-2 at 19 in H_2O (atm)	SVE-2 at 27 in H_2O (atm)	SVE-2 at 35 in H_2O (atm)	SVE-2 at 40 in H_2O (atm)	Pressure at SVE - 2 = 35": (Pr^2-Pw^2) ~	$(Pri^2-Pw^2)*\ln(r/Rw)/\ln(Ri/Rw)$	Ri (ft)
OW-1	51	0.9982	0.9975	0.9973	0.9936	0.1594	0.1590	59
OW-1D	51	0.9982	0.9975	0.9973	0.9939	0.1594	0.1590	59
OW-2	26.2	0.9939	0.9936	0.9931	0.9926	0.1511	0.1512	39
OW-2D	26.2	0.9939	0.9934	0.9924	0.9920	0.1496	0.1498	41
OW-3	9	0.9968	0.9957	0.9951	0.9943	0.1550	0.1553	11
OW-3D	9	0.9961	0.9951	0.9941	0.9941	0.1530	0.1521	12
OW-4	17.8	0.9970	0.9951	0.9951	0.9945	0.1550	0.1546	23
OW-4D	17.8	0.9969	0.9948	0.9948	0.9941	0.1545	0.1546	23
DEC-31	60.8	0.9982	0.9975	0.9939	0.9941	0.1525	0.1529	90
DEC-44	24.4	0.9975	0.9966	0.9966	0.9966	0.1579	0.1576	29
DEC-141	15.2	0.9961	0.9948	0.9941	0.9939	0.1530	0.1537	20
SVE-1	40	0.9988	0.9985	0.9985	0.9982	0.1618	0.1616	42
Pw (SVE-2)	0	0.9533	0.9336	0.9139	0.9016	0.0000		

Pw (SVE-2)		0.9533	0.9336	0.9139	0.9016
Pri		0.9995	0.9993	0.9991	0.9990

Average Ri (ft)	**37.3**

1 inch H_2O = 0.00246 atmospheres

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.10 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

Table 4.7 - Calculation of ROI at SVE-2 @ 40inches H2O

Monitoring Points	r Distance from SVE- (ft)	Pr = Pressure at SVE-2: SVE-2 at 19 in H_2O (atm)	SVE-2 at 27 in H_2O (atm)	SVE-2 at 35 in H_2O (atm)	SVE-2 at 40 in H_2O (atm)	Pressure at SVE - 2 = 40": (Pr^2-Pw^2) ~	$(Pri^2-Pw^2)*\ln(r/Rw)/\ln(Ri/Rw)$	Ri (ft)
OW-1	51	0.9982	0.9975	0.9973	0.9936	0.1744	0.1742	73
OW-1D	51	0.9982	0.9975	0.9973	0.9939	0.1749	0.1746	72
OW-2	26.2	0.9939	0.9936	0.9931	0.9926	0.1724	0.1725	38
OW-2D	26.2	0.9939	0.9934	0.9924	0.9920	0.1712	0.1716	39
OW-3	9	0.9968	0.9957	0.9951	0.9943	0.1758	0.1763	11
OW-3D	9	0.9961	0.9951	0.9941	0.9941	0.1753	0.1763	11
OW-4	17.8	0.9970	0.9951	0.9951	0.9945	0.1761	0.1755	23
OW-4D	17.8	0.9969	0.9948	0.9948	0.9941	0.1753	0.1755	23
DEC-31	60.8	0.9982	0.9975	0.9939	0.9941	0.1753	0.1755	84
DEC-44	24.4	0.9975	0.9966	0.9966	0.9966	0.1802	0.1802	28
DEC-141	15.2	0.9961	0.9948	0.0059	0.9939	0.1749	0.1745	20
SVE-1	40	0.9988	0.9985	0.9985	0.9982	0.1834	0.1835	42
Pw (SVE-2)	0	0.9533	0.9336	0.9139	0.9016	0.0000		

Pw (SVE-2)		0.9533	0.9336	0.9139	0.9016
Pri		0.9995	0.9993	0.9991	0.9990

Average Ri (ft)	**38.7**

1 inch H_2O = 0.00246 atmospheres

$Pr^2 - Pw^2 = (Pri^2 - Pw^2) \ln(r/Rw) / \ln(Ri/Rw)$

Pr = Pressue at r from the well (atm)
Pw = Pressure at the extraction well (atm)
Pri = Pressure at the ROI = 1% of Pw (atm)
r = distance from the well (feet)
Ri = ROI (feet)
Rw = Extraction well radius = 2 inches

NOTE: Shaded data from Table 2.10 (Pr) was convert to atmospheres & used to determine the radius of influence as it reflects the greatest amount of time that the formation had to reach steady-state conditions under that increment setting.

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Table 5 - SVE Well Vacuum Calculation

$Q = H(\pi k/\mu)*((Pw/\ln(Rw/Ri))*((1-(Pri/Pw)^2)$

Q = Flowrate from well	45 scfm	21240	(cm^3/s)
H = Screen length of SVE well	15 ft	457.2	(cm)
k = Intrinsic permeability		5.55E-08	(cm^2)
μ = Viscosity of air		1.81E-04	(g/cm-s)
Pw = Pressure at SVE well	to be determined		(g/cm-s^2)
Rw = Radius of SVE well	2 inches	5.08	(cm)
Ri = Radius of influence	40 ft	1219.2	(cm)
Pri = Pressure at Ri assumed to be	0.5 inches H2O	1008759	(g/cm-s^2)

Solving for Pw

$21240 = H(\pi k/\mu)*((Pw/\ln(Rw/Ri))*((1-(Pri/Pw)^2)$

Revised Q=21240

	Resulting Q	Potential Pw	
	18,519	900000	
	21,280	884900	
	21,262	885000	
Very close to target Q	21,243	885100	(g/cm-s^2)

	atmospheric = 1010000	g/cm-s^2
Convert back to Vacuum Pressure	124900	g/cm-s^2
Convert to inches H2O	50.17207108	inches H2O
	4.181005923	ft H2O

REF. 1

Kuo, Jeff "Vadose zone soil remediation"
Practical Design Calculations for Groundwater and Soil Remediation
Boca Raton: CRC Press LLC,1999

chapter five

Vadose zone soil remediation

This chapter illustrates important design calculations for commonly used in situ and above-ground soil remediation techniques. The treatment processes covered include soil vapor extraction, soil bioremediation, soil washing, and low-temperature heating.

V.1 Soil vapor extraction

V.1.1 Introduction

Description of the soil venting process

Soil vapor extraction (SVE), also known as soil venting, in situ vacuum extraction, in situ volatilization, or soil vapor stripping, has become a very popular remediation technique for soil contaminated with VOCs. The process strips volatile organic constituents from contaminated soil by inducing an air flow through the contaminated zone. The air flow is created by a vacuum pump (often called a "blower") through a single well or network of wells.

As the soil vapor is swept away from the voids of the vadose zone, fresh air is naturally (through passive venting wells or air infiltration) or mechanically (through air injection wells) introduced and refills the voids. This flux of the fresh air will (1) disrupt the existing partition of the contaminants among the void, soil moisture, and soil grain surface by promoting volatilization of the adsorbed and dissolved phase of contaminants, (2) provide oxygen to indigenous microorganisms for biodegradation of the contaminants, and (3) carry away the toxic metabolic by-products generated from the biodegradation process. The extracted air is usually laden with VOCs and brought to the ground surface by the vacuum blower. Treatment of the extracted vapor is normally required. Design calculations for the VOC-laden air treatment are covered in Chapter seven.

Discussion. The actual concentration of the extracted vapor would be lower than 13,200 ppmV due to the fact that not all the air flows through the contaminated zone and that limitations of mass transfer were not considered in the above calculations.

V.1.3 Radius of influence and pressure profile

Selecting the number and locations of vapor extraction wells is one of the major tasks in design of in situ soil vapor extraction systems. The decisions are typically based on the radius of influence (R_I), which can be defined as the distance from the extraction well where the pressure drawdown is very small (P @ $R_I \sim 1$ atm). The most accurate and site-specific R_I values should be determined from steady-state pilot testing. The pressure drawdown data at the extraction well and the observation wells can be plotted as a function of the radial distance from the extraction well on a semilog plot to determine the R_I of that well. The approach is similar to the distance-drawdown method for aquifer tests, as described in Section II.3.3. The R_I is commonly chosen to be the distance where the pressure drawdown is less than 1% of the vacuum in the extraction well.

The field test data can also be analyzed by using the flow equations, which describe the subsurface air flow. The subsurface is usually heterogeneous, and the air flow through it can be very complex. As a simplified approximation, a flow equation was derived for a fully confined radial gas flow system in a permeable formation having uniform and constant properties.[3-6] References 3 through 6 are the basis for most of the sections on soil venting.

For the steady-state radial flow subject to the boundary conditions ($P = P_w$ @ $r = R_w$ and $P = P_{atm}$ @ $r = R_I$), the pressure distribution in the subsurface can be derived as

$$P_r^2 - P_w^2 = (P_{RI}^2 - P_w^2)\frac{\ln(r / R_w)}{\ln(R_1 / R_w)} \qquad \text{[Eq. V.1.2]}$$

P_r = pressure at a radial distance r from the vapor extraction well
P_w = pressure at the vapor extraction well
P_{RI} = pressure at the radius of influence (= atmospheric pressure or a preset value)
r = radial distance from the vapor extraction well
R_I = radius of influence where pressure is equal to a preset value
R_w = well radius of the vapor extraction well

Eq. V.1.2 can be used to determine the R_I of a vapor extraction well if the pressure drawdown data of the extraction well and a monitoring well (or data of two monitoring wells) are known. As shown, the flow rate and the permeability of the formation are not included in this equation. The R_I

where u_r is the vapor flow velocity at a radial distance "r" away from the well. The velocity at the wellbore, u_w, can be found by replacing r with R_w in the above equation as

$$u_w = \left(\frac{k}{2\mu}\right)\left[\frac{P_w}{R_w \ln(R_w / R_I)}\right]\left[1 - \left(\frac{P_{RI}}{P_w}\right)^2\right] \qquad \text{[Eq. V.1.4]}$$

The volumetric vapor flow rate entering the extraction well, Q_w, can then be found as

$$Q_w = 2\pi R_w u_w H$$
$$= H\left(\frac{\pi k}{\mu}\right)\left[\frac{P_w}{\ln(R_w / R_I)}\right]\left[1 - \left(\frac{P_{RI}}{P_w}\right)^2\right] \qquad \text{[Eq. V.1.5]}$$

where H is the perforation interval of the extraction well.

To convert the vapor flow rate entering the well to equivalent standard flow rates, Q_{atm} (where $P = P_{atm} = 1$ atm), the following relationship can be used

$$Q_{atm} = \left(\frac{P_{well}}{P_{atm}}\right) Q_{well} \qquad \text{[Eq. V.1.6]}$$

Example V.1.4A *Estimate the extracted vapor flow rate of a soil venting well*

A soil venting well was installed at a site. Determine the radius of influence of this soil venting well using the following information:

Pressure at the extraction well = 0.9 atm
Pressure at a monitoring well 30 ft away from the venting well = 0.95 atm
Diameter of the venting well = 4 in

Calculate the steady-state flow rate entering the well per unit well screen length, vapor flow rate in the well, and the vapor rate at the extraction pump discharge by using the following additional information:

Permeability of the formation = 1 Darcy
Well screen length = 20 ft
Viscosity of air = 0.018 centipoise
Temperature of the formation = 20°C

REF. 2

EM 1110-1-4001
3 June 2002

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ENGINEERING AND DESIGN

Soil Vapor Extraction and Bioventing

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Appendix D
Recommended Estimation Methods for Air Permeability

D-1. Introduction

Various methods used to estimate the air permeability of a given soil are summarized below. Air permeability estimates are required to predict or evaluate system performance using the available analytical and numerical models. Indirect, laboratory, and field methods for estimating air permeability are presented.

D-2. Indirect Method

Air permeability can be estimated as a function of saturated hydraulic conductivity. Intrinsic permeability can be obtained from the definition of saturated hydraulic conductivity as

$$k_i = \frac{K\mu}{\rho g} \qquad \text{D-1}$$

where

k_i = intrinsic permeability, [L^2]

K = saturated hydraulic conductivity, [L/T]

μ = dynamic viscosity of water, [M/L-T]

ρ = density of water, [M/L^3]

g = gravitational constant, [L/T^2]

a. The relationship between air permeability and intrinsic permeability is typically expressed as

$$k = k_i * k_{ra} \qquad \text{D-2}$$

where

k = air permeability

k_i = intrinsic permeability

μ_a = viscosity of air [$ML^{-1} T^{-1}$]

R_w = radius of test vent [L]

R_I = radius of pressure influence for test vent [L]

L = effective vent length [L]

k_a = estimated air permeability [L^2]

P_A = absolute atmospheric pressure [$ML^{-1} T^{-2}$]

(4) The target flow rate (Q_T) should be high enough to remove the number of soil pore volumes from the contaminated zone required by the final SVE/BV design. The volume of soil that receives the required number of soil volume exchanges in an acceptable timeframe is defined as "the zone of effective air exchange." Chapter 5 offers methods to estimate the necessary flow for various vent geometries. For example, if the target venting rate required to achieve sufficient removal of VOCs from a covered site with one vent were 3 soil pore volumes per day, then the target flow rate could be roughly estimated by

$$Q_T = \frac{3/\text{day} \cdot \pi R_E^2 \, b \, n_a}{1440 \, \text{min/day}} \tag{4-2}$$

where

R_E = extent of zone of effective air exchange of test vent (cm)

b = unsaturated zone thickness (cm)

n_a = effective (air-filled) soil porosity (dimensionless)

(5) The zone of effective air exchange for the vent is generally unknown; however, a range of 5 to 15 meters provides reasonable estimates for many cases. In general, shallow vents have less extensive areas of influence than deeper vents in similar soil and with similar surface and subsurface features. Further discussion of these concepts is found in paragraph 4-5*f*(20).

(6) Air permeabilities can be roughly estimated based on soil texture; estimated to within approximately an order of magnitude based on moisture retention curves and saturated hydraulic conductivities measured in similar materials; or measured in laboratory or field tests. Likewise, effective (air-filled) soil porosities can be estimated from soil texture and moisture, or determined from laboratory capillary pressure head-saturation tests.

(7) The test blower should be selected using the anticipated vacuum and flow levels. The blower should be selected so as to allow flexibility in accommodating some deviation in the site conditions.

REF. 3

PHASE II REMEDIAL INVESTIGATION

FOR THE

FORMER KLINK COSMO CLEANERS SITE

SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

REMEDIAL BUREAU B

WORK ASSIGNMENT NUMBER C007540-4

PREPARED BY:

URS CORPORATION

77 GOODELL STREET

BUFFALO, NEW YORK 14203

NOVEMBER 2012

DEC-045/045D, were slightly negative, or upwards (-0.002 to -0.007 ft/ft) based upon the water level information. Vertical hydraulic gradients in well pairs DEC-006D/006DD, DEC-007/007D, DEC-013/013D, DEC-030/030D, and DEC-044/044D were also upwards but were greater in magnitude (-0.012 to -0.017 ft/ft).

The vertical hydraulic gradients in top of Raritan Formation well triplets were similar in direction and magnitude during RI Phase II field activities. Vertical hydraulic gradients between the shallow and top of Raritan Formation wells at DEC-029/029TC and DEC-031/031TC were slightly negative or upwards (-0.002 to -0.006 ft/ft, respectively). Vertical hydraulic gradients between the deep and top of Raritan Formation wells at DEC-029D/029TC and DEC-031D/031TC were slightly positive or downwards (0.004 to 0.003 ft/ft, respectively).

3.6.1 Slug Test Results

Representative slug test results are presented on Table 3-3. Horizontal hydraulic conductivity values for the shallow overburden range from 2.69×10^{-5} cm/sec to 4.77×10^{-3} cm/sec. Horizontal hydraulic conductivity values for the deep overburden range from 9.74×10^{-3} cm/sec to 2.48×10^{-2} cm/sec.

3.7 Surface Water and Hydrology

The site slopes slightly to the east and south and is bounded by streets on the north, west and east. The surface of the site is entirely covered by buildings and/or pavement/sidewalks. There is a storm water drop inlet (DI) along Richardson Street near Vandervoort Avenue.

The nearest surface water body is Newtown Creek located approximately 2,500 feet northeast of the site. Newtown Creek is classified as a Class SD (marine waters) surface water body by the NYSDEC. The best usage of Class SD waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife survival. The classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements of primary and secondary contact recreation and fish propagation. While Newtown Creek may not be suitable for swimming and other recreational activities that involve human contact with surface water, individuals use Newtown Creek for fishing and boating. Water is not withdrawn from Newtown Creek for potable use. Numerous storm water drains from surrounding roadways and permitted Spill Discharge Elimination System (SPDES) outfalls discharge into Newtown Creek, including those discharging groundwater collected and treated on the nearby ExxonMobil remediation site.

REF. 4

Soil porosity

Geotechdata.info - Updated 18.11.2013

Soil porosity (n) is the ratio of the volume of voids to the total volume of the soil:

$n = (V_v) / V$

Where V_v is the volume of the voids (empty or filled with fluid), and V is the total volume of the soil.

Porosity is usually used in parallel with soil void ratio (e) , which is defined as the ratio of the volume of voids to the volume of solidsl. The posoity and the void ratio are inter-related as follows:

$e = n / (1-n)$ and $n = e / (1+e)$

The soil prosoity depends on the consistence and packing of the soil. It is directly affacted by compaction.

Typical values of soil porosity for different soils

Some typical values of soil porosity are given below for different USCS soil types at normally consolidated condition unless otherwise stated. These values should be used only as guidline for geotechnical problems; however, specific conition of each engineering problem often needs to be considered for an appropriate choice of geotechnical parameters.

Description	USCS	Porosity [-]			Reference
		min	max	Specific value	
Well graded gravel, sandy gravel, with little or no fines	GW	0.21	0.32		[1],
Poorly graded gravel, sandy gravel, with little or no fines	GP	0.21	0.32		[1],
Silty gravels, silty sandy gravels	GM	0.15	0.22		[1],
Gravel	(GW-GP)	0.23	0.38		[2],
Clayey gravels, clayey sandy gravels	GC	0.17	0.27		[1],
Glatial till, very mixed grained	(GC)	-	-	0.20	[4 cited in 5]
Well graded sands, gravelly sands, with little or no fines	SW	0.22	0.42		[1], [2],
Coarse sand	(SW)	0.26	0.43		[2],
Fine sand	(SW)	0.29	0.46		[2],
Poorly graded sands, gravelly sands, with little or no fines	SP	0.23	0.43		[1], [2],
Silty sands	SM	0.25	0.49		[1], [2],
Clayey sands	SC	0.15	0.37		[1],
Inorganic silts, silty or clayey fine sands, with slight plasticity	ML	0.21	0.56		[1],
Uniform inorganic silt	(ML)	0.29	0.52		[3],
Inorganic clays, silty clays, sandy clays of low plasticity	CL	0.29	0.41		[1],
Organic silts and organic silty clays of low plasticity	OL	0.42	0.68		[1], [3],
Silty or sandy clay	(CL-OL)	0.20	0.64		[3],
Inorganic silts of high plasticity	MH	0.53	0.68		[1],
Inorganic clays of high plasticity	CH	0.39	0.59		[1],
Soft glacial clay	-	-	-	0.55	[4 cited in 5]
Stiff glacial clay	-	-	-	0.38	[4 cited in 5]
Organic clays of high plasticity	OH	0.50	0.75		[1], [3],

Soft slightly organic clay	(OH-OL)	-	-	0.66	[4] cited in [5]
Peat and other highly organic soils	Pt	-	-		[4 cited in 5]
soft very organic clay	(Pt)	-	-	0.75	[4] cited in [5]

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2. Das, B., Advanced Soil Mechanics. Taylor & Francis, London & New York, 2008.
3. Hough, B., Basic soil engineering. Ronald Press Company, New York, 1969.
4. Terzaghi, K., Peck, R., and Mesri, G., Soil Mechanics in Engineering Practice. Wiley, New York, 1996.
5. Obrzud R. & Truty, A.THE HARDENING SOIL MODEL - A PRACTICAL GUIDEBOOK Z Soil.PC 100701 report, revised 31.01.2012

Citation :
Geotechdata.info, Soil void ratio, http://geotechdata.info/parameter/soil-void-ratio.html (as of November 16, 2013).

Other soil parameters

- » Angle of friction
- » Cohesion
- » Dry unit weight
- » Young's modulus
- » Void ratio
- » Soil Permeability coefficient
- » Soil porosity

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REF. 5

Permeability (earth sciences)

From Wikipedia, the free encyclopedia

Permeability in fluid mechanics and the earth sciences (commonly symbolized as κ, or k) is a measure of the ability of a porous material (often, a rock or an unconsolidated material) to allow fluids to pass through it.

The permeability of a medium is related to the porosity, but also to the shapes of the pores in the medium and their level of connectedness.

Contents

Permeability

Permeability is the property of rocks that is an indication of the ability for fluids (gas or liquid) to flow through rocks. High permeability will allow fluids to move rapidly through rocks. Permeability is affected by the pressure in a rock. The unit of measure is called the darcy, named after Henry Darcy (1803-1858). Sandstones may vary in permeability from less than one to over 50,000 millidarcys (md). Permeabilities are more commonly in the range of tens to hundreds of millidarcies. A rock with 25% porosity and a permeability of 1 md will not yield a significant flow of water. Such "tight" rocks are usually artificially stimulated (fractured or acidized) to create permeability and yield a flow.

Units

The SI unit for permeability is m^2. A practical unit for permeability is the *darcy* (d), or more commonly the *millidarcy* (md) (1 darcy $\approx 10^{-12} m^2$). The name is in honor to the French Engineer Henry Darcy who first described the flow of water through sand filters for potable water supply. Permeability values for sandstones range typically from a fraction of a *darcy* to several *darcys*. The unit of cm^2 is also sometimes used ($1\ cm^2 = 10^{-4}\ m^2 \approx 10^8$ d).

Applications

The concept of permeability is of importance in determining the flow characteristics of hydrocarbons in oil and gas reservoirs, and of groundwater in aquifers.

For a rock to be considered as an exploitable hydrocarbon reservoir without stimulation, its permeability must be greater than approximately 100 md (depending on the nature of the hydrocarbon - gas reservoirs with lower permeabilities are still exploitable because of the lower viscosity of gas with respect to oil). Rocks with permeabilities significantly lower than 100 md can form efficient *seals* (see petroleum geology). Unconsolidated sands may have permeabilities of over 5000 md.

The concept has also many practical applications outside of geology, for example in chemical engineering (e.g., filtration).

Description

Permeability is part of the proportionality constant in Darcy's law which relates discharge (flow rate) and fluid physical properties (e.g. viscosity), to a pressure gradient applied to the porous media:

$$v = \frac{\kappa}{\mu}\frac{\Delta P}{\Delta x}$$

Therefore:

$$\kappa = v\frac{\mu\Delta x}{\Delta P}$$

where:

v is the superficial fluid flow velocity through the medium (i.e., the average velocity calculated as if the fluid were the only phase present in the porous medium) (m/s)
κ is the permeability of a medium (m^2)
μ is the dynamic viscosity of the fluid (Pa·s)
ΔP is the applied pressure difference (Pa)
Δx is the thickness of the bed of the porous medium (m)

In naturally occurring materials, permeability values range over many orders of magnitude (see table below for an example of this range).

Relation to hydraulic conductivity

The proportionality constant specifically for the flow of water through a porous media is called the hydraulic conductivity; permeability is a portion of this, and is a property of the porous media only, not the fluid. Given the value of hydraulic conductivity for a subsurface system, the permeability can be calculated as follows:

$$\kappa = K\frac{\mu}{\rho g}$$

where

- κ is the permeability, m^2
- K is the hydraulic conductivity, m/s
- μ is the dynamic viscosity of the fluid, kg/(m·s)
- ρ is the density of the fluid, kg/m^3
- g is the acceleration due to gravity, m/s^2.

Determination

Permeability is typically determined in the lab by application of Darcy's law under steady state conditions or, more generally, by application of various solutions to the diffusion equation for unsteady flow conditions.[1]

Permeability needs to be measured, either directly (using Darcy's law), or through estimation using empirically derived formulas. However, for some simple models of porous media, permeability can be calculated (e.g., random close packing of identical spheres).

Permeability model based on conduit flow

Based on the Hagen–Poiseuille equation for viscous flow in a pipe, permeability can be expressed as:

$$\kappa_I = C \cdot d^2$$

where:

κ_I is the intrinsic permeability [length^2]
C is a dimensionless constant that is related to the configuration of the flow-paths
d is the average, or effective pore diameter [length].

Estimation of permeability distribution in subsurface reservoirs

Permeability distribution in subsurface reservoirs is typically estimated using inverse problem theory.[2]

Intrinsic and absolute permeability

The terms *intrinsic permeability* and *absolute permeability* states that the permeability value in question is an intensive property (not a spatial average of a heterogeneous block of material), that it is a function of the material structure only (and not of the fluid), and explicitly distinguishes the value from that of relative permeability.

Permeability to gases

Sometimes permeability to gases can be somewhat different that those for liquids in the same media. One difference is attributable to "slippage" of gas at the interface with the solid[3] when the gas mean free path is comparable to the pore size (about 0.01 to 0.1 μm at standard temperature and pressure). See also Knudsen diffusion and constrictivity. For example, measurement of permeability through sandstones and shales yielded values from $9.0\text{x}10^{-19}$ m^2 to $2.4\text{x}10^{-12}$ m^2 for water and between $1.7\text{x}10^{-17}$ m^2 to $2.6\text{x}10^{-12}$ m^2 for nitrogen gas.[4] Gas permeability of reservoir rock and source rock is important in petroleum engineering, when considering the optimal extraction of shale gas, tight gas, or coalbed methane.

Tensor permeability

To model permeability in anisotropic media, a permeability tensor is needed. Pressure can be applied in three directions, and for each direction, permeability can be measured (via Darcy's law in 3D) in three directions, thus leading to a 3 by 3 tensor. The tensor is realised using a 3 by 3 matrix being both symmetric and positive definite (SPD matrix):

- The tensor is symmetric by the Onsager reciprocal relations.

- The tensor is positive definite as the component of the flow parallel to the pressure drop is always in the same direction as the pressure drop.

The permeability tensor is always diagonalizable (being both symmetric and positive definite). The eigenvectors will yield the principal directions of flow, meaning the directions where flow is parallel to the pressure drop, and the eigenvalues representing the principal permeabilities.

Ranges of common intrinsic permeabilities

These values do not depend on the fluid properties; see the table derived from the same source for values of hydraulic conductivity, which are specific to the material through which the fluid is flowing.

Permeability	Pervious				Semi-Pervious				Impervious					
Unconsolidated Sand & Gravel	Well Sorted Gravel		Well Sorted Sand or Sand & Gravel			Very Fine Sand, Silt, Loess, Loam							
Unconsolidated Clay & Organic					Peat		Layered Clay			Unweathered Clay			
Consolidated Rocks	Highly Fractured Rocks				Oil Reservoir Rocks			Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite	
κ (cm^2)	0.001	0.0001	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}	10^{-15}
κ (millidarcy)	10^{+8}	10^{+7}	10^{+6}	10^{+5}	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001

Source: modified from Bear, 1972

See also

- Hydraulic conductivity
- Hydrogeology
- Permeation
- Petroleum geology
- Relative permeability
- Klinkenberg correction
- Electrical resistivity measurement of concrete

Footnotes

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References

SVE/SP PILOT TEST

AIR SPARGING CALCULATIONS

FOR THE

FORMER KLINK COSMO CLEANERS SITE

EAST WILLIAMSBURG INDUSTRIAL AREA

SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B
WORK ASSIGNMENT NUMBER C007540-4.1

PREPARED BY:

URS CORPORATION
257 WEST GENESEE STREET, SUITE 400
BUFFALO, NY 14202

MARCH 2016

MADE BY: J. Lysiak DATE: Feb. 17, 2016
CHECKED BY D. McCall DATE: Feb. 24, 2016

PROJECT: **Klink Cosmo**
SUBJECT: **Air Sparging Calculations**

1. Background and Purpose

Chlorinated solvents including tetrachloroethylene (PCE) and trichloroethylene (TCE) have been detected in soil vapor, soil, and groundwater samples at concentrations significantly above New York State SCG values in the vicinity of the Former Klink Cosmo Cleaners Site, in Brooklyn, NY.

URS performed a soil vapor extraction/air sparge (SVE/AS) pilot study at the Site to obtain data that will be used to determine if this technology is suitable for further consideration as part of a feasibility study prepared for this Site.

The purpose of this calculation is to determine preliminary design parameters for an air sparging system. These parameters include well spacing, well injection pressure, air injection rate and well construction parameters.

2. Source of Contamination

Data gathered during investigations indicated that a source of groundwater contamination was originating near buildings formerly used by Klink Cosmo Cleaners. Analytical results presented in the Phase III Remedial Investigation Report for the August 2015 sampling event had maximum PCE concentrations in the shallow groundwater at 3,600 μg/L (DEC-031) and 1,100 μg/L (DEC-140D) in the deep aquifer.

Based on the On-Site Phase III Remedial Investigation, the source of PCE contamination is an area of contaminated soil beneath the concrete floor in the north-eastern portion of the warehouse building.

3. Pilot Study

The pilot study was conducted from November 16 through 19, 2015, along the south side of Richardson Street near the intersection of Vandervort Avenue between monitoring wells DEC-031 and DEC-044D. The pilot study generally followed the procedures provided in the New York State Department of Environmental Protection (NYSDEC) approved SVE/SP Pilot Study Work Plan dated September 2015. Deviations to the approved plan are presented in the Pilot Study Report.

As part of the pilot study, two SVE wells (4-inch diameter), three AS wells (2-inch diameter), and four pairs of soil vacuum observation wells (OWs - shallow and deep, 1-inch diameter) were constructed. Figure 1 provides the well locations.

A mobile trailer mounted SVE/AS treatment system (Unit 75), provided by ProAct Services Corporation of Southbury, Connecticut was used for the pilot test. Components of the SVE/AS treatment system include:

- SVE rotary claw blower, capable of 300 actual cubic feet per minute (acfm) and up to 22 inches of mercury (Hg)
- SVE vacuum manifold equipped with vacuum and flow indicators, throttling valves, and hoses

- AS compressor, capable of 125 standard cubic feet per minute (scfm) at 22 psi
- AS manifold equipped with pressure and flow indicators, throttling valves, and hoses
- Two parallel trains of vapor phase carbon vessels, each containing two 200 pound drums construct in series, with sampling points

a. AS Pilot Test Procedures

Step and constant rate tests were to be performed at various air flowrates, under maximum SVE vacuum, to determine its impact on the formation. Step tests were performed with SP-2 and SP-3 online separately, and then together. The capture zone (radius of influence) provided by operating SVE-1 and SVE-2 at their maximum capacity was unknown. SP-1 was not brought online due to safety concerns regarding fugitive PCE and TCE vapors entering the adjacent building affecting workers. It should be noted that the area near SP-1 appears to be the closest sparge well to the most contaminated portion of the source area beneath the concrete floor slab in the north-eastern portion of the warehouse building.

During the step tests the air sparge flowrates (scfm) were to be increased incrementally by 25 scfm every 30 minute by opening the valve inside the treatment system's air supply manifold until the maximum flowrate produced by the compressor (125 scfm at 22 psi) was achieved. As such, air sparge flowrates were to range between 25 and 125 scfm during each of the step tests.

Four rounds of data were to be collected at each air flowrate interval. Data included: vacuum pressures inside the treatment unit at the vacuum manifold; at the extraction wells (SVE-1 & SVE-2); observation wells (OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, & OW-4D); and monitoring wells (DEC-31, DEC-44, & DEC-141). The volume of air extracted (scfm) was also to be recorded during each monitoring interval. The step test with SP-2 and SP-3 (Test 4 and Test 5) was not performed as the throttling valve used to increase the air flow could not be adjusted in small enough increments to balance the system and accurately record flowrate, even while manipulating the make-up air. As such, Tests 4 and 5 were conducted using approximately the same air flowrate.

The step test using both SP-2 and SP-3 was generally successful as the air flowrate was able to be raised evenly in increments of 5 to 10 scfm. However, pressure readings in the SP wells did not provide sufficient data for use in the calculations. It is unlikely that steady-state conditions were achieved during the pilot study.

The constant rate test was performed with SP-2 and SP-3 (Test 8). Data were collected at approximately 10 minute intervals. Vacuum pressures were monitored and recorded inside the treatment unit at the vacuum manifold, extraction wells (SVE-1 & SVE-2), observation wells (OW-1, OW-1D, OW-2, OW-2D, OW-3, OW-3D, OW-4, & OW-4D), and monitoring wells (DEC-31, DEC-44, & DEC-141). The flowrate of air introduced (scfm) was also recorded during each monitoring interval. Summa canisters were collected near the beginning and end of each test and analyzed for VOCs. Field data collected during pilot test is presented on Table 2 – Pilot Study Field Data Summary.

b. Data Usability

Because data collected from each of the 4 air sparge tests (Test 4, 5, 6 & 8) was not sufficient to design the air sparge system, the design will be based on published information from the references provided below. The flow- pressure relationship observed in Test 6 for SP-3 indicates a low value of air-entry pressure (see *Table 4.3 of Reference 2* - attached) suggesting that flow is predominantly occurring within macro-pores or that there was insufficient pressure provided by the equipment to indicate that the flow was predominately occurring within the matrix porosity (a well distributed airflow).

4. References

1. United States Environmental Protection Agency (USEPA). 1995. *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites, EPA 510-B-95-0-07,* May.
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5. Klink Cosmo, Draft Onsite Phase III Remedial Investigation, prepared by URS, January 2016

5. Design Criteria

The SVE calculation was based on a remediation area encompassing approximately 18,100 ft^2 extending down to the groundwater which ranges between 30 to 33 ft below ground surface (bgs). The same area will be used for the air sparge calculation (see Figure 2).

Design criteria have been developed based on information and guidance provided in the references cited in Section 4 as presented below.

PROJECT: **Klink Cosmo**
SUBJECT: **Air Sparging Calculations**

a. ZOI and Well Spacing

Parameter	Recommended Value or Range	Reference
Zone of Influence (ZOI)	5 ft for fine grained soils to 100 ft for course-grained soils	1
	5-25 ft typical, varies 0 to > 80 ft	2
Well Spacing	Based on ZOI	2
	15 ft, or more if economically impractical	3
	12-50 ft	4

There are many underground utilities along the sidewalk in the area where remediation will be conducted. If possible, a well spacing between 15 to 20 feet will be maintained for air sparging.

The stratigraphy in the upper aquifer consists mainly of medium to coarse sands while the stratigraphy in the lower aquifer is mainly comprised of fine to medium sands. This value is within the range of guidance values for well spacing (see Figure 3).

Since the treatment area in the warehouse building is not yet defined, we modeled the design criteria to provide treatment only around the perimeter of the source area (north-east section of the warehouse building). Using the 15 to 20 foot spacing for wells, and considering that 3 sparge wells already exist, approximately 6 additional sparge wells will be installed to remediate the area of contamination as shown in Figure 2.

b. Air Flow Rate

Air flow guidance values for the references cited are summarized below.

Parameter	Recommended Value or Range	Reference
Air Flow Rate	3-25 scfm per well typical	1
	1.3-40 scfm per well typical	2

The air flow rate for sparging is related to the air flow rate required to capture emissions from sparging by the SVE system. In accordance with USEPA guidance (Reference 1), a minimum of one pore volume per day should be extracted daily for effective remedial progress. According to USACOE guidance *(Reference 2)* the SVE extraction rate should be 2 to 4 times greater than the sparging air injection rate to establish sufficient capture zones.

Using the guidance cited in the previous paragraph, and assuming a one pore exchange rate and an SVE extraction rate equal to 2 times the sparging injection rate, the air sparging flow rate is calculated as follows:

Pore Volume (PV) = Area (A) x Depth to Water Table (d) x effective air porosity (n)

Where,

A = 18,100 square feet;
d = 33 feet; and
n = 0.24 (assumed – same value used in the SVE calculations)

then,

PV = 18,100 x 33 x 0.24 = 143,352 say 144,000 cubic feet

SVE Extraction Rate (ER) = 2 PV/day x day/1440 minutes
ER = 200 cubic feet per minute
Maximum Air Sparging Flow Rate = 200/2 = 100 cubic feet per minute

Operation of the air sparge system can vary from having all 11 wells online or pulsing the system with a few wells online at one time. With all 11 wells online,

Air Sparging Rate per Well = 100/9 = 11 cubic feet per minute

Assuming that the air sparging system will be operated in a pulse mode, with only 5 of the eleven wells operating at one time,

Air Sparging Rate per Well = 100/5 = 20 cubic feet per minute

The air sparging rate could range between 11 to 20 cubic feet per minute. This is within the range provided in the guidance documents.

c. Depth to Top of Screen

Guidance for depth to the top of screen is summarized below.

Parameter	Recommended Value or Range	Reference
Depth to Top of Screen	5 to 15 feet below contamination	1
	5 to 20 feet below the water table surface	2
	5 feet below the seasonal low water table	4

The data shows that the contamination was detected approximately 40 bgs in wells (DEC-031, DEC-044, DEC-065, DEC-066, DEC-141) the shallow aquifer to a maximum of approximately 80 feet bgs in (DEC-065D and DEC-140D) the deep aquifer. The lowest recorded water table elevation in wells in the treatment zone is approximately 33 feet bgs in DEC-031. *(Reference 5)*

Using the information provided in the paragraph above, the screens of the sparge wells will be installed at two different depths.

The ground elevation at DEC-031 is 34.99 ft. DEC-031 extends 45 ft below ground. The well is screened between 30 to 45 ft bgs. The lowest groundwater elevation recorded in DEC-031 was at elevation 1.76 ft (2/25/2013). The top of the screen in sparge wells that will be used to treat contaminants in the shallow aquifer will be set at approximately 45 ft bgs. This value is a minimum of 5 feet below contamination, and approximately 8 feet below the lowest recorded water elevation which is in compliance with the recommended values presented in the table above. *(Reference 5)*

The ground elevation at DEC-031D is 34.70 ft. DEC-031D extends 80 ft below ground. The well is screened between 70 to 80 ft bgs. The lowest groundwater elevation recorded in DEC-031 was at elevation 1.77 ft (2/25/2013). The top of the screen in sparge wells that will be used to treat contaminants in the deep aquifer will be set at approximately 85 ft bgs; 48 feet below the lowest recorded water elevation. *(Reference 5)*

d. Sparging Air Pressure

Sparging air pressure guidance values are summarized.

Parameter	Recommended Value or Range	Reference
Sparging Air Pressure	10-15 psig	1
	0.3 to 18 psig over hydrostatic pressure	2

The air sparging pressure should be maintained between the minimum pressure necessary to induce flow (P_{min}) and the pressure at which fracturing occurs ($P_{fracture}$):

$P_{min}\,(psig) = 0.43\,H + P_{packing} + P_{formation}$ *(Reference 3)*

$P_{fracture}\,(psig) = 0.73D$

Where:

H = depth of top of screen below the water table (ft)
D = depth of top of screen below ground surface (ft)

The sparging pressure is calculated based on the following assumptions: 1.) the highest seasonal water table surface recorded is approximately 33 feet bgs; and 2.) well screen is placed 45 feet bgs.

$P_{min}\,(psig) = 0.43\,H + P_{packing} + P_{formation}$

For treatment of the shallow aquifer:

$H = (45 - 33)\text{ ft} = 12\text{ ft}$

$P_{packing} + P_{formation} = 0.2$ psig for sandy formation *(Reference 3)*
$P_{min}\,(psig) = 0.43\,(12) + 0.2 = 5.4$ psig

and,

$P_{fracture}\,(psig) = 0.73D$
$P_{fracture}\,(psig) = 0.73\,(45) = 32.8$ psig

The acceptable pressure range based on the calculations for the shallow aquifer is 5.4 to 32.8 psig.

For treatment of the deep aquifer:

$H = (85 - 33)\text{ ft} = 52\text{ ft}$
$P_{min}\,(psig) = 0.43\,(52) + 0.2 = 22.56$ psig

and,

$P_{fracture}$ (psig) = 0.73D
$P_{fracture}$ (psig) = 0.73 (85) = 62.05 psig

This exceeds the acceptable pressure range provided in the reference documents. If the well screen is placed at 75 feet bgs, at the midpoint of DEC-031D, P_{min} would be 18.3 psig and $P_{fracture}$ would be 54.8 psig.

The range of P_{min} for treating the shallow and deep aquifer is 5.4 to 18.3 psi (top of screen for deep aquifer set at 75 feet bgs). This is in the range of acceptable values for air sparge pressure. Actual operation of the air sparge system may warrant that treatment of the shallow and deep aquifers to be conducted separately due to the fracture pressure when treating the shallow aquifer.

e. Well Diameter

Well diameter guidance values are summarized below.

Parameter	Recommended Value or Range	Reference
Well Diameter	1 to 4 inches	2
	2 inches or greater	4

The design will include 2-inch diameter wells. This diameter is within the range of values recommended by the references cited.

f. Screen Length

Guidance values for screen length are presented below.

Parameter	Recommended Value or Range	Reference
Screen Length	1 to 3 feet	1
	0.5 to 10 feet	2
	2 to 5 feet	4

A 3 foot screen length will be used for design of the additional sparge wells since subsurface conditions are relatively uniform in the treatment zone (fine to medium sands).

Klink Cosmo - Air Sparge Pilot Test

Well: **SP-2 Stepped Rate Test**
Date: 11/17/2015
Personnel: MG, JL

NOTES: SVE-2 on @ Max Throttle; 0945 shutdown; 0952 reset; 1014 shutdown; 1019 reset; 1031 shutdown and reset; 1037 shutdown; 1038 reset; 1131 shutdown; 1136 shutdown; 1221 shutdown; 1237 stop

Test 4

Time	Flow Rates		Vacuums / Pressures																	Temperature		
	Manifold To SP-2 Well	Manifold To SVE-2	Manifold To Air Sparge SP-2	At Well SVE-2	AS-2	Manifold To SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Before Carbon PID/FID	After Carbon (PID/FID)	At SVE-1	At SVE-2	Ambient Before Carbon
Units	(scfm)	(scfm)	(psi)	(in Hg)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)	(ppm)	(°F)	(°F)	(°F)
930	20	63	13.5	-2.5	0.5	-2.7	0	0	-2	-0.5	-1	0	0	-2	-1	-1	0	0	>15000/-	0	45	45	55
956	24	60	12.5	-0.5	0	-3.5	0	0	-1	0	-1	-0.5	-0.5	-1.5	-0.75	-0.75	0	0	>15000/-	0	45	45	55
1005	26	60	12	-2.5	0	-4	0	0	-1	0	-1	0	-0.5	-1.5	-0.5	-0.75	0	0	>15000/-	0	45	45	55
1015	21	60	11.5	-2.5	0.5	-4	0	0	-1	0	-1	0	-0.5	-2	-0.75	-1	0	0	>15000/-	0	45	45	55
1027	40	60	14.5	-2.5	0	-4	0	0	-1	0	-0.5	0	-0.5	-2	-1	-1	0	0	>15000/-	0	45	45	55
1035	40	60	11	-2.5		-4.5	0	0	-0.75	0	SP-2 PVC/FERNCO slipped off					-0.5	0	1040 glued new			45	45	55
1123	40	61	17.5	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1.5	0	0	-/315	0	45	47	55
1132	43	60	17	-2.5	0	-4	NA	NA	-1	-0.5	-1	-1	-0.5	-1.5	-0.5	-1.5	NA	-0.5	NA	NA	45	46	55
1139	40	60	19	-2.5	0	-4	0	0	-1	-0.5	-1	-1	-0.5	-1.5	-1	-1	0	0	>15000/574	0	45	46	55
1215	70	60	26.5	-2.5	0	-4	0	0	-0.75	0	-1	-1	-0.5	-1.75	-0.75	-1	0	0	-/680	0	45	46	55
1234	80	60	23.5	-2.5	0	-4	NA	NA	-0.75	0	-1.5	-1	-0.5	-1.75	-0.5	-1	NA	0	>15000/650	0	45	46	55
1237	Stopped System																						
Run Time																							
(min)																							
187																							
Average	40	60																					

Klink Cosmo - Air Sparge Pilot Test

Well: **SP-3 Stepped Rate Test**
Date: 11/17/2015
Personnel MG, JL

NOTES: Compressor shut off @ > 40 scfm - Max limit of formation
Tried increasing flow but motor repeatedly cut out
Per final sample w/summa can at 540pm
21 psi @ SP-3 manifold during sample

Shut down @ 4:03 pm for installation of sample tap
Restart at 4:15 pm
Shut down @ 5:45 pm
Retool for SP-2 & SP-3

Test 5

Time	Flow Rates		Vacuums / Pressures																							Temperature		
Units	Manifold To SP-3 (scfm)	Manifold To SVE-2 (scfm)	At SP-2 (psi)	Manifold To SP-3 (psi)	At SP-3 (psi)	Back Gauge (psi)	Manifold To SVE-2 (in Hg)	At SVE-2 (Hg)	At OW-1 (in Hg)	At OW-1D (in Hg)	At OW-2 (in Hg)	At OW-2D (in Hg)	At OW-3 (in Hg)	At OW-3D (in Hg)	AS-2 At OW-4 (in Hg)	AS-2 At OW-4D (in Hg)	At DEC-44 (in Hg)	At SVE-1 (in Hg)	At DEC-31 (in Hg)	At DEC-141 (in Hg)	Trains A & B Before Carbon PID/FID (ppm)		Trains A & B After Carbon (PID/FID) (ppm)		At SVE-1 (°F)	At SVE-2 (°F)	Ambient Before Carbon (°F)
1532	16	60	0.5	15	3		-4	-2.5	0	-0.5	-1	0	-1	-0.5	-0.5	-1.75	-1	-0.5	-0.25	0	890	50	800	540	48	49	45
1542	18	60	0	16	3		-4	-2.5	0	-0.75	-1.5	0	-1	0	-0.25	-1.75	-1	-1	-0.25	0	NA	NA	NA	0	48	49	45
1550	18	60	0	15	3		-4.5	-2.5	0	-0.5	-1	0	-1.5	0	0	-1.75	-1.5	-0.5	-0.25	0	NA	NA	NA	0	48	49	45
1555	18	60	0	14.5	3		-4.5	-2.75	0	-0.5	-1	0	-1	-0.25	-0.25	-1.75	-1.5	-0.75	-0.25	-0.25	805	685	850	0	48	49	45
1603	System shut down due to high pressure																										
1615	30	61	0	24	2.5		-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.25	-0.25	-2	-1.5	-1.5	-0.25	0	490	490	0	0	48	49	45
1625	30	61	0	16	2.6	18.5	-4.5	-2.5	0	-0.5	-1.5	0	-1	-0.5	-0.25	-1.75	-1.5	-1	-0.5	0	470	320	0	0	48	49	45
1639	30	62	0	15	2.6	20	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	415	0	0	48	49	45
1645	30	61	0	14.5	2.6	21.5	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	0	480	1700	0	0	49	49	45
1650	40	60	0	18.5	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1.25	-0.5	0	420	1900	0	0	48	48	45
1657	41	61		18	2.6	22	-5	-2.5	0	-0.5	-1.5	-0.5	-1.5	-0.25	0	-2	-1.5	-1	-0.5	-0.25	620	740	0	0	48	48	45
1703	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.5	-0.5	-1.5	-0.25	0	-1.5	-1.5	-1	-0.5	0	470	610	0	0	48	48	45
1709	40	61	0	17	3	22	-5	-2.5	0	-0.25	-1.25	-0.5	-1	-0.25	0	-1.5	-1	-1	-0.5	0	680	720	0	0	47	49	45
1730	40	System shut down due to high pressure																									
1740	21	Restarted system to collect sample																									
1745	21	Collected sample & shutdown system																									
Average	29	61																									

Klink Cosmo - Air Sparge Pilot Test

NOTES: Summa collected at 2020
SVE on max throttle

Well: SP-2 & SP-3
Date: 11/17/2015
Personnel: David Coulter, Mike Gutman, John Lysiak

Test 6

Time	Flow Rates			Vacuums / Pressures																			PID Readings			Temperature		
	Manifold To SP Wells (scfm)		Manifold To SVE-2 (scfm)	Manifold To SP Wells (psi)		Manifold To Well SVE-2	Outside At Air Sparge Wells (psi)		Back Gauge	At Well SVE-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At SVE-1	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)	At SVE-1	At SVE-2	Ambient Before Carbon
Units	SP-2	SP-3		SP-2	SP-3	(in Hg)	SP-2	SP-3	(psi)	(Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)	(°F)	(°F)	(°F)
1800	10	10	62	8.9	14	-4.5	0.5	2.5	14	-2.25	0	0	-1	-0.5	-0.5	0	-0.5	-1	-0.5	-1	-0.5	0	620	480	0	45	48	45
1819	10	10	61	9.5	12.5	-4.5	0.5	3	14	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	720	560	0	45	47	45
1830	10	10	61	9	11.5	-5	1	3	13.5	-2.25	0	0	-1.5	0	-0.5	0	-0.5	-2	-0.5	-0.5	-0.5	0	710		0	45	48	45
1837	10	10	63	9	11	-5	0.5	3	13.5	-2.25	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	710	530	0	45	48	45
1845	15	15	62	9	12	-5	0.5	3	16	-2.5	0	0	0	-0.5	-0.5	0	-0.5	-1	-0.5	-0.5	-0.5	0	740	516	0	45	48	45
1853	15	15	63	9	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	800	680	0	45	48	44
1902	15	15	63	8.5	11.5	-5	0.5	3	16	-2.25	0	0	0	-0.5	-0.75	0	-0.5	-1	-0.5	-0.5	-0.5	0	720	590	0	45	50	44
1906	15	15	62	8.5	11	-5	0.5	3	16	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-0.5	-0.5	0	840	700	0	45	49	44
1915	20	20	62	9	12.5	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	0	-1.5	-0.5	-0.5	-0.5	0	780	725	0	45	49	45
1921	20	20	63	8.5	12	-5	0.5	3	17	-2.25	0	0	-0.25	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	820	780	0	45	49	45
1928	20	20	62	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	0	850	748	0	45	48	44
1934	20	20	63	8.5	11.5	-5	0.5	3	17	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.75	-0.75	-1	-0.5	0	840	730	0	45	49	41
1940	25	25	63	8.5	12.5	-5	0.5	3	18	-2.5	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.75	-1	-0.5	0	770	620	0	45	48	44
1945	25	25	62	8.5	12.5	-5	0.5	3	18	-2.75	0	0	-0.5	-0.5	-1	0	-0.5	-1.5	-0.5	-1	-0.5	0	700	570	0	45	48	43
1950	25	25	63	8.5	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	750	530	0	45	47	43
1954	25	25	62	8	12.5	-5	0.5	3	18	-3	0	0	-0.5	0	-1	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	740	530	0	45	47	43
2003	35	35	62	9.5	15	-4.5	0.5	3	20.75	-3	0	0	-0.5	-0.5	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	800	590	0	45	48	43
2008	35	35	62	9.5	15	-4.5	0.5	3.5	20.6	-3	0	0	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.25	850	640	0	45	48	43
2014	35	35	63	9	15.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	0	-0.5	0	-0.5	-1.5	-0.5	-1	-0.5	-0.1	850	640	0	45	48	43
2019	35	35	62	9	14.5	-4.5	0.5	3.5	20.6	-3	0	-0.5	-0.5	-0.25	-0.75	-0.1	-0.5	-1.5	-0.5	-1	-0.5	-0.1				45	48	43
Run Time (Min)																												
139																												
Average	21	21	62.3																									

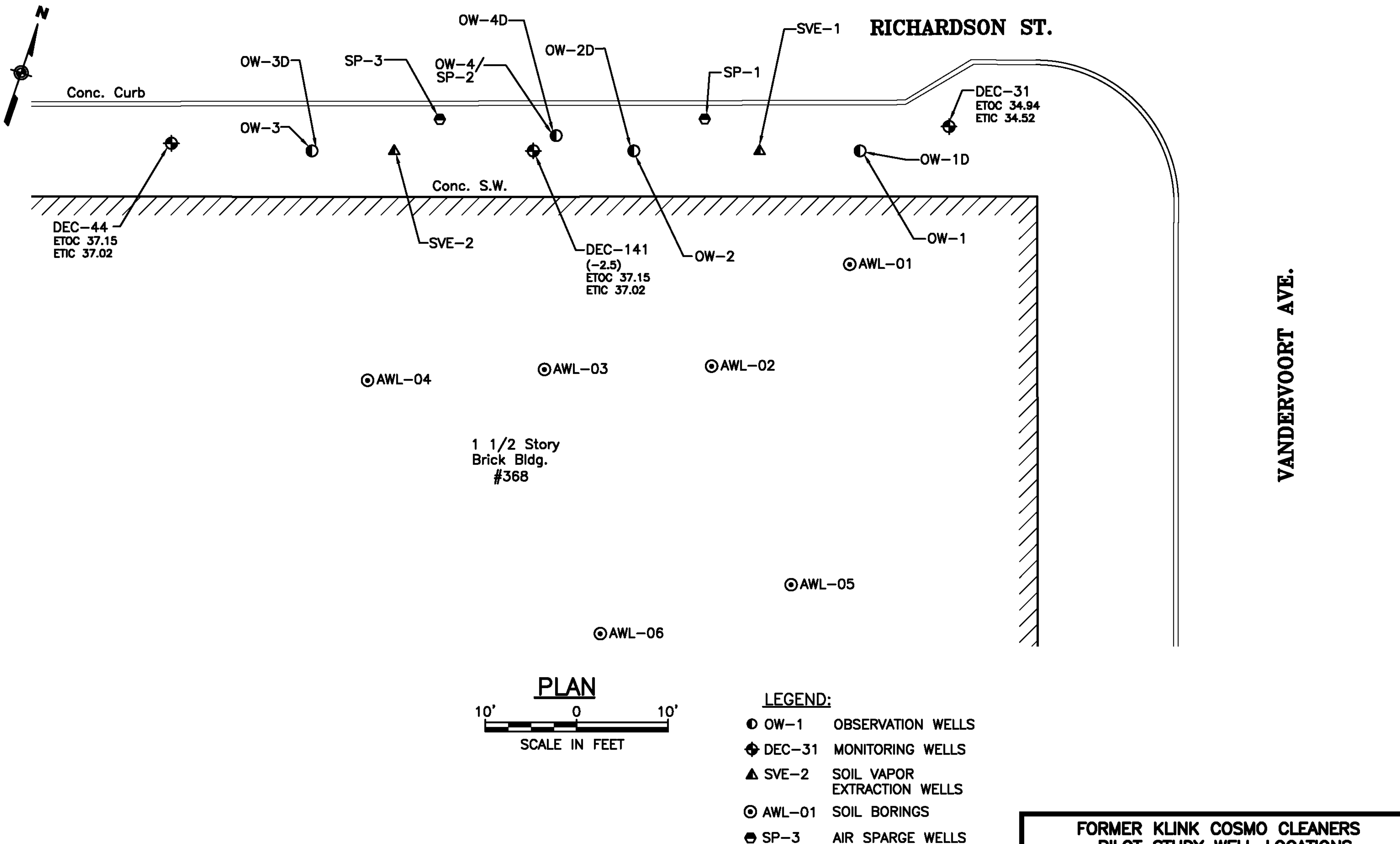
Klink Cosmo - Soil Vapor Extraction Pilot Test

NOTES: Gauge calibration not low enough
Max Vac 0 w/ both SVE 1 &2 at Max Flow

Well: **SVE-1 & SVE-2 Constant Rate Test**
Date: 11/18/2015 6:54 Purging SVE-1 and SVE-2
Personnel: MG, JL Purge duration at Max Flow = 2010-1854 = 76 Minutes (Test 7)

Tests 7 & 8

Time	Flow Rates / Pressures								Vacuums / Pressures													PID Readings				Temperature		
	Manifold To SP-1		Manifold To SP-2		At Extraction Well SVE-1	Manifold to Well SVE-1	Manifold to Well SVE-2	At Well SVE-2	At AS-3	At AS-2	At OW-1	At OW-1D	At OW-2	At OW-2D	At OW-3	At OW-3D	AS-2 At OW-4	AS-2 At OW-4D	At DEC-44	At DEC-31	At DEC-141	Before Carbon PID/FID		After Carbon (PID/FID)		At SVE-1	At SVE-2	Ambient
Units	(scfm)	(psi)	(scfm)	(psi)	(in Hg)	(scfm)	(scfm)	(in Hg)	(psi)	(psi)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(in Hg)	(ppm)		(ppm)		(°F)	(°F)	(°F)
2010	27		28		-2.5	70	61	-0.5	0	0	0	-0.5	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	0	490	350			57	60	57
2044	35	11	35	8	-2.5	70	60	-0.5	0	0	-0.25	0	-0.5	0	-0.5	-0.5	0	-2	-0.5	-0.5	0	900	1014			58	60	59
2054	35	11	35	8	-3	69	60	-2	0	0	-0.5	0.25	-0.5	0	-0.25	0	-0.5	-1	-0.5	-0.5	-1.5	900	1013			60	60	60
2104	36	10.5	35	7	-3	70	61	-2	0	0	-0.5	0.5	0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	1140	960			60	60	60
2114	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0	-0.5	-0.25	-0.5	-0.25	0	-2	-0.5	-0.5	-2.5					60	60	60
2124	36	10.5	35	8	-3	69	61	-2	0	0	0	0.25	-0.25	0	-0.25	0	-0.25	-1.5	-0.25	-0.5	-2.5	1015	900			60	60	60
2134	36	10.5	35	8	-3	70	61	-2	0	0	-0.5	0.25	-0.5	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	900	800			60	60	60
2144	37	10.5	35	7.5	-2.75	69	61	-2	0	0	-0.5	0	-0.25	-0.25	-0.5	-0.25	-0.25	-2	-0.5	-0.5	-2.5	800	1300			60	60	60
2154	36	10.5	35	7.5	-2.75	70	60	-2	0	0	-0.25	0	-0.25	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	1500			60	60	60
2204	37	10.5	35	8	-3	70	61	-2	0	0	-0.25	0	-0.5	-0.25	-0.5	-0.25	-0.25	-1.75	-0.5	-0.5	-2.5	890	940			60	60	60
2214	37	10.5	35	7.5	-2.75	70	61	-2	0	0	0	0	-0.5	-0.25	-0.5	-0.25	-0.5	-1.75	-0.5	-0.5	-1.5	880	1480			60	60	60
2224	37	10.5	34	7.5	-2.5	69	60	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.25	-1.75	-0.5	-0.5	-1.5	870	1100			60	60	60
2234	37	10.5	35	7.5	-2.75	67	61	-2	0	0	0	0	-0.25	-0.25	-0.25	-0.25	-0.75	-1.75	-0.5	-0.5	-1.5	950	1450			61	60	60
2244	45	12	45	9		70	61																					
Run Time (min) 154																												
Average	36		35			70	61																					

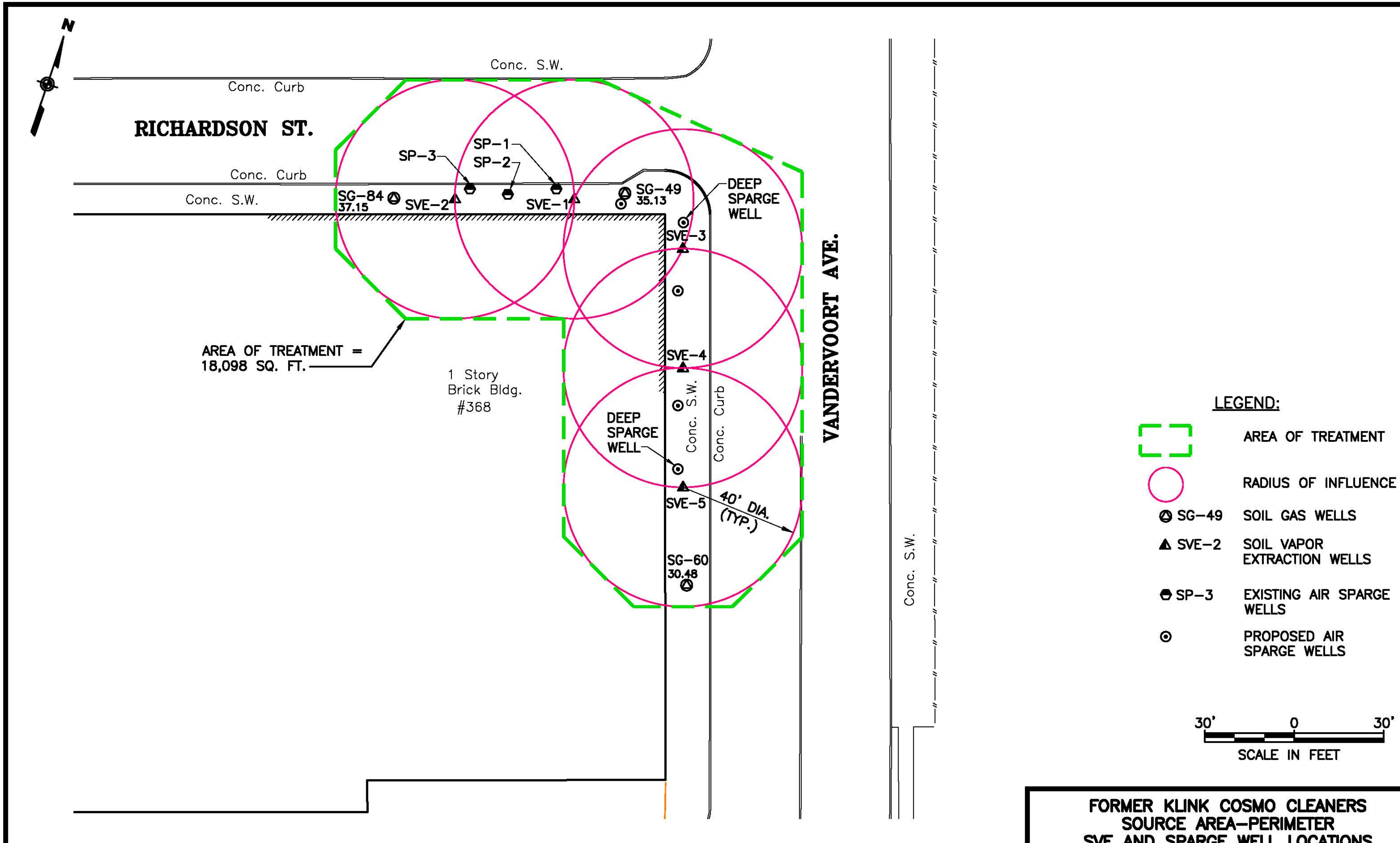


FORMER KLINK COSMO CLEANERS
PILOT STUDY WELL LOCATIONS

URS

FIGURE 1

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\FIGURE 1.dwg 3/18/16 - 2 RAL



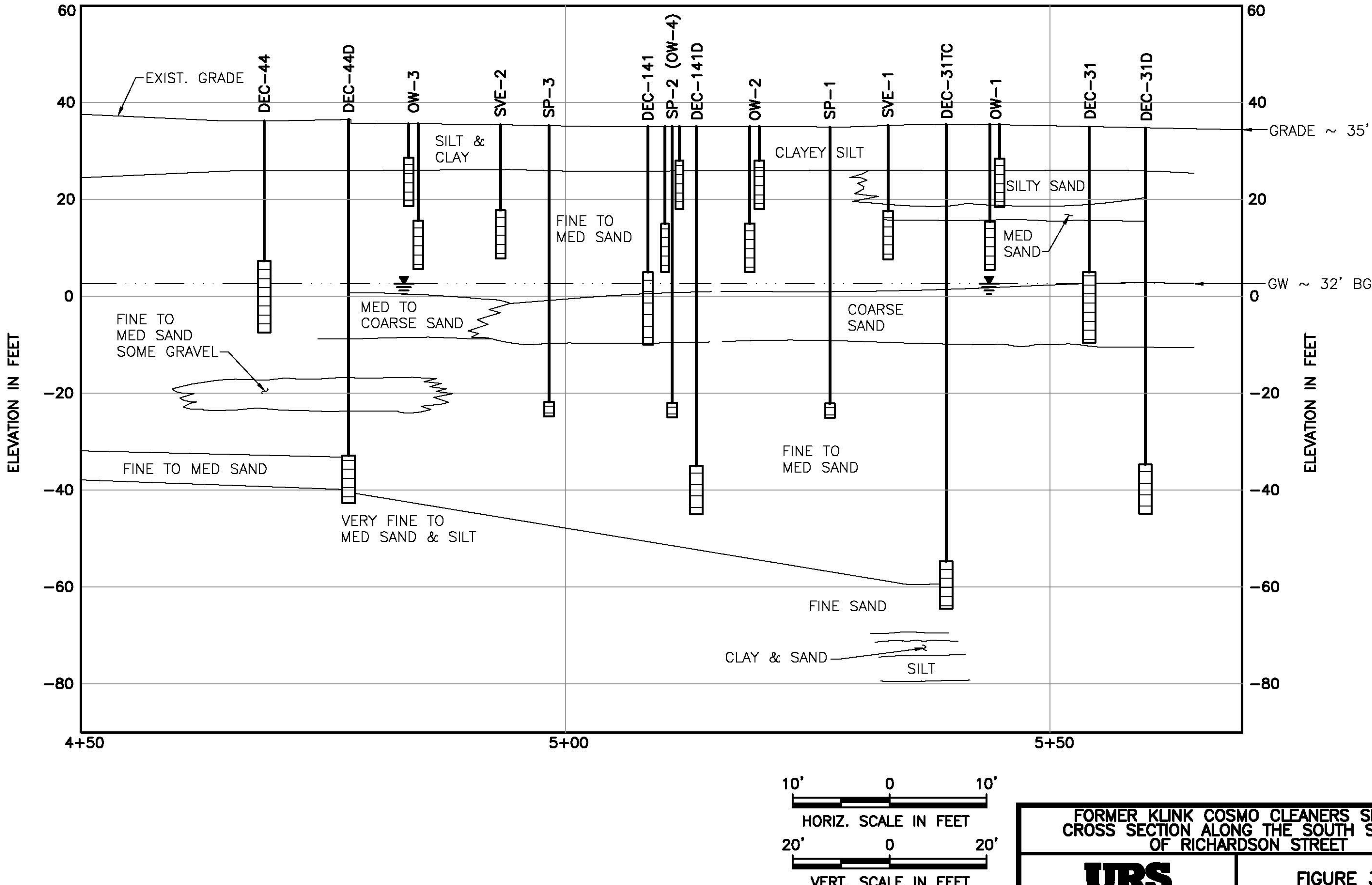
PLAN

FORMER KLINK COSMO CLEANERS
SOURCE AREA-PERIMETER
SVE AND SPARGE WELL LOCATIONS

URS

FIGURE 2

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\SPARGE REPORT\FIGURE 2.dwg 2/29/16 - 2 RAL



FORMER KLINK COSMO CLEANERS SITE
CROSS SECTION ALONG THE SOUTH SIDE
OF RICHARDSON STREET

URS

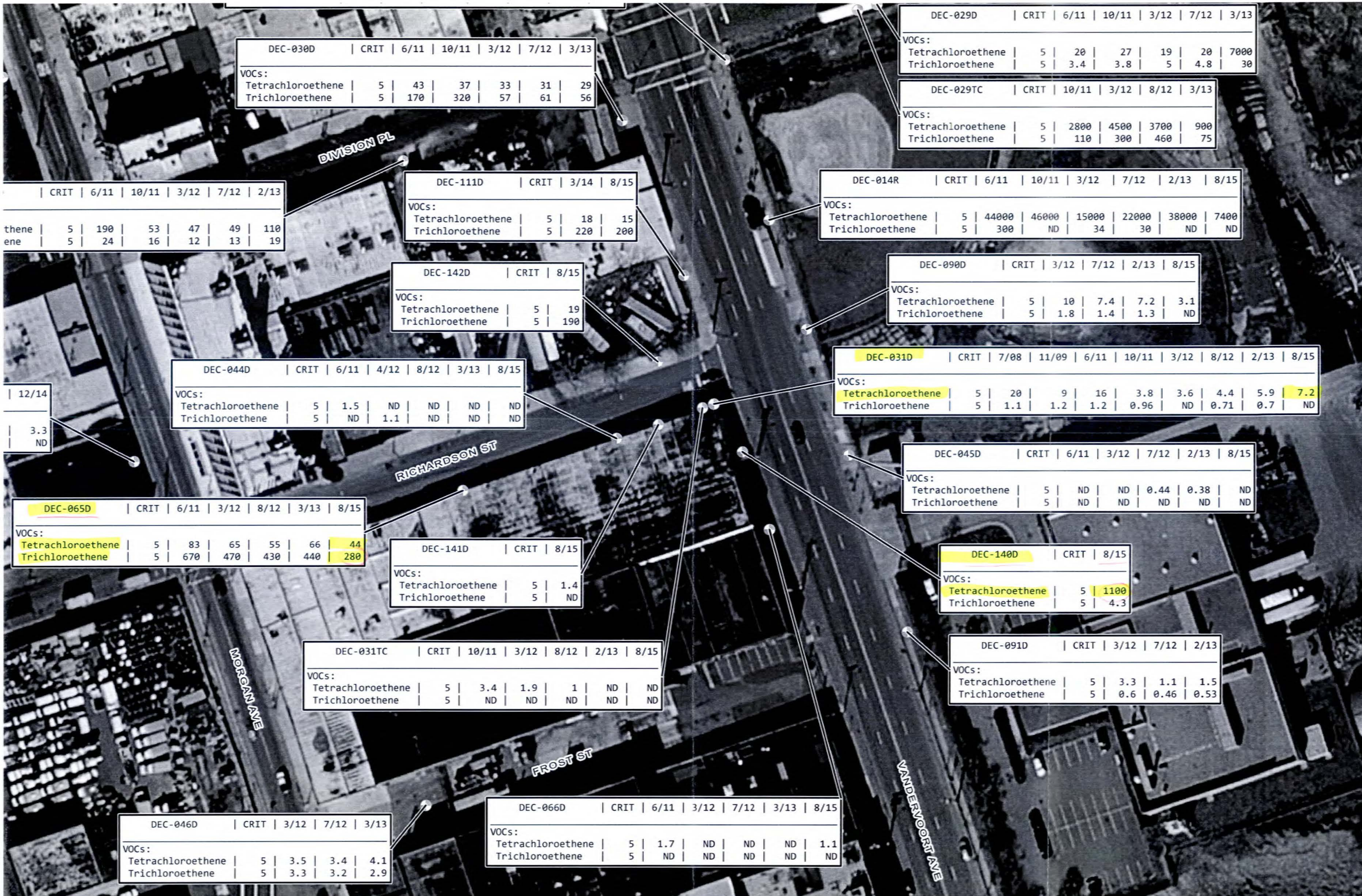
FIGURE 3

J:\Projects\11176390\CAD\Pilot test work plan #1\JAN 2016 SUBMISSION\SPARGE REPORT\FIGURE 3.dwg 2/24/16 - 2 RAL

ON-SITE
PHASE III
SHALLOW GW
MONITORING

PLATE 5-1

UNITS ug/l



DEC-029D	CRIT	6/11	10/11	3/12	7/12	3/13
VOCs:						
Tetrachloroethene	5	20	27	19	20	7000
Trichloroethene	5	3.4	3.8	5	4.8	30

DEC-030D	CRIT	6/11	10/11	3/12	7/12	3/13
VOCs:						
Tetrachloroethene	5	43	37	33	31	29
Trichloroethene	5	170	320	57	61	56

DEC-029TC	CRIT	10/11	3/12	8/12	3/13
VOCs:					
Tetrachloroethene	5	2800	4500	3700	900
Trichloroethene	5	110	300	460	75

	CRIT	6/11	10/11	3/12	7/12	2/13
thene	5	190	53	47	49	110
ene	5	24	16	12	13	19

DEC-111D	CRIT	3/14	8/15
VOCs:			
Tetrachloroethene	5	18	15
Trichloroethene	5	220	200

DEC-014R	CRIT	6/11	10/11	3/12	7/12	2/13	8/15
VOCs:							
Tetrachloroethene	5	44000	46000	15000	22000	38000	7400
Trichloroethene	5	300	ND	34	30	ND	ND

DEC-142D	CRIT	8/15
VOCs:		
Tetrachloroethene	5	19
Trichloroethene	5	190

DEC-090D	CRIT	3/12	7/12	2/13	8/15
VOCs:					
Tetrachloroethene	5	10	7.4	7.2	3.1
Trichloroethene	5	1.8	1.4	1.3	ND

DEC-044D	CRIT	6/11	4/12	8/12	3/13	8/15
VOCs:						
Tetrachloroethene	5	1.5	ND	ND	ND	ND
Trichloroethene	5	ND	1.1	ND	ND	ND

DEC-031D	CRIT	7/08	11/09	6/11	10/11	3/12	8/12	2/13	8/15
VOCs:									
Tetrachloroethene	5	20	9	16	3.8	3.6	4.4	5.9	7.2
Trichloroethene	5	1.1	1.2	1.2	0.96	ND	0.71	0.7	ND

	12/14
	3.3
	ND

DEC-045D	CRIT	6/11	3/12	7/12	2/13	8/15
VOCs:						
Tetrachloroethene	5	ND	ND	0.44	0.38	ND
Trichloroethene	5	ND	ND	ND	ND	ND

DEC-065D	CRIT	6/11	3/12	8/12	3/13	8/15
VOCs:						
Tetrachloroethene	5	83	65	55	66	44
Trichloroethene	5	670	470	430	440	280

DEC-141D	CRIT	8/15
VOCs:		
Tetrachloroethene	5	1.4
Trichloroethene	5	ND

DEC-140D	CRIT	8/15
VOCs:		
Tetrachloroethene	5	1100
Trichloroethene	5	4.3

DEC-031TC	CRIT	10/11	3/12	8/12	2/13	8/15
VOCs:						
Tetrachloroethene	5	3.4	1.9	1	ND	ND
Trichloroethene	5	ND	ND	ND	ND	ND

DEC-091D	CRIT	3/12	7/12	2/13
VOCs:				
Tetrachloroethene	5	3.3	1.1	1.5
Trichloroethene	5	0.6	0.46	0.53

DEC-066D	CRIT	6/11	3/12	7/12	3/13	8/15
VOCs:						
Tetrachloroethene	5	1.7	ND	ND	ND	1.1
Trichloroethene	5	ND	ND	ND	ND	ND

DEC-046D	CRIT	3/12	7/12	3/13
VOCs:				
Tetrachloroethene	5	3.5	3.4	4.1
Trichloroethene	5	3.3	3.2	2.9

ON-SITE PHASE III DEEP GW MONITORING (ug/l) PLATE 5-2

United States
Environmental Protection
Agency

Solid Waste And
Emergency Response
5403W

EPA 510-B-95-007
May 1995

REF. 1

EPA

How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites

A Guide for Corrective Action Plan Reviewers

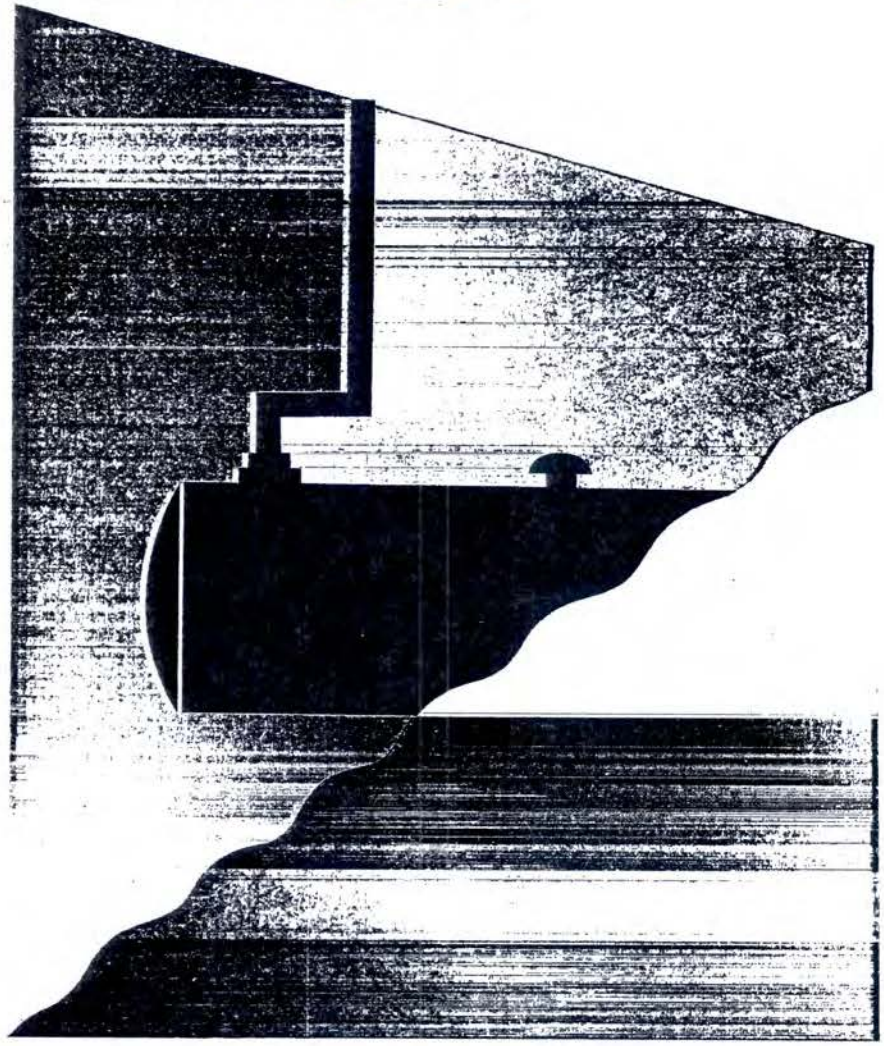


Exhibit VII-13
Pilot Test Data Objectives

Data Requirement	Source
SVE Test Portion (if necessary)	
SVE radius of influence (ROI)	Monitoring point pressure gauges
Wellhead and monitoring point vacuum	Well head pressure gauge
Initial contaminant vapor concentrations	SVE exhaust flame ionization detector (FID) readings (or other suitable detection device)
Initial hydraulic gradient	Water level tape at monitoring wells or pressure transducers and data logger
Air Sparging Test Portion	
Air sparging ROI	Monitoring point pressure gauge
Sparging rate	Compressor discharge flow gauge
Sparging vapor concentrations	Monitoring well and vapor point FID readings (or other suitable detection device)
Hydraulic gradient influence	Water level tape at monitoring wells or pressure transducers and data logger
Dissolved oxygen and carbon dioxide	Dissolved oxygen and carbon dioxide probes at monitoring wells
Combined Test (if necessary)	
Sparging/SVE capture rates	Pressure/flow gauges
Constituent vapor concentrations	Blower discharge and monitoring points

The ROI should be determined based on the results of pilot tests. One should be careful, however, when evaluating pilot test results because the measurement of air flow, increased dissolved oxygen, or the presence of air bubbles in a monitoring point can be falsely interpreted as an air flow zone that is thoroughly permeated with injected air. However, these observations may only represent localized sparging around sparsely distributed air flow channels. The ROI depends primarily on the hydraulic conductivity of the aquifer material in which sparging takes place. Other factors that affect the ROI include soil heterogeneities, and differences between lateral and vertical permeability of the soils. Generally, the design ROI can range from 5 feet for fine-grained soils to 100 feet for coarse-grained soils.

- *Sparging Air Flow Rate.* The sparging air flow rate required to provide sufficient air flow to enhance mass transfer is site-specific and will be determined via the pilot test. Typical air flow rates range from 3 to 25 standard cubic feet per minute (scfm) per injection well. Pulsing of the air flow (i.e., turning the system on and off at specified intervals) may provide better distribution and mixing of the air in the contaminated saturated zone, thereby allowing for greater contact with the dissolved phase contaminants. The vapor extraction system should have a greater flow capacity and greater area of influence than the air sparging system. The air sparging rate should vary between 20 percent and 80 percent of the soil vapor extraction flow rate.

- *Sparging Air Pressure* is the pressure at which air is injected into the saturated zone. The saturated zone requires pressures greater than the static water pressure (1 psi for every 2.3 ft of hydraulic head) and the head necessary to overcome capillary forces of the water in the soil pores near the injection point. A typical system will be operated at approximately 10 to 15 psig. Excessive pressure may cause fracturing of the soils and create permanent air channels that can significantly reduce air sparging effectiveness.

- *Initial Constituent Vapor Concentrations* are measured during pilot studies. They are used to estimate constituent mass removal rates and system operational time requirements and to determine whether treatment of extracted vapors will be required prior to atmospheric discharge or reinjection.

- *Required Final Dissolved Constituent Concentrations* in the saturated zone will determine which areas of the site require treatment and when air sparging system operations can be terminated. These levels are usually defined by state regulations as *remedial action levels*. In some states, these levels are determined on a site-specific basis using transport modeling and risk assessment.

- *Required Remedial Cleanup Time* may influence the design of the system. The designer may vary the spacing of the sparging wells to speed remediation to meet cleanup deadlines, if required.

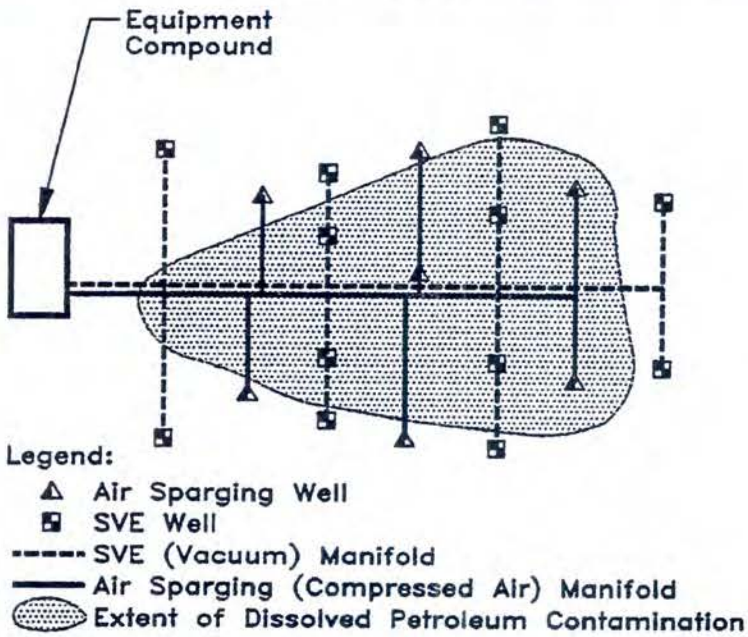
- *Saturated Zone Volume To Be Treated* is determined by state action levels or a site-specific risk assessment using site characterization data for the groundwater.

- *Pore Volume Calculations* are used along with extraction flow rate to determine the pore volume exchange rate. Some literature suggests that at a minimum one pore volume of soil vapor should be extracted daily for effective remedial progress.

- *Discharge Limitations And Monitoring Requirements* are usually established by state regulations but must be considered by designers of an air sparging system which uses SVE to ensure that monitoring ports are included in the system hardware. Discharge limitations imposed by state air quality regulations will determine whether offgas treatment is required.

- *Site Construction Limitations* (e.g., building locations, utilities, buried objects, residences) must be identified and considered in the design process.

Exhibit VII-17
Combined Air Sparging/SVE System Layout



Well Construction. The air sparging (injection) wells are generally constructed of 1 to 5 inch PVC or stainless steel pipe. The screened interval is normally from 1 to 3 feet and is generally set from 5 to 15 feet below the deepest extent of adsorbed contaminants. Setting the screen at a deeper interval requires higher pressures on the system but generally does not achieve higher sparge rates. Increased screened intervals do not improve system efficiency because air tends to exit at the top portion of the screen. Air sparging wells must be properly grouted to prevent short circuiting of the air. Horizontal injection wells should be designed and installed carefully to ensure that air exits from along the entire screen length. Perforated pipe, rather than well screening, is sometimes preferable. Exhibits VII-18 and VII-19 present typical vertical and horizontal air sparging well constructions, respectively.

Injection wells should be fitted with check valves to prevent potential line fouling caused by pressure in the saturated zone forcing water up the point when the system is shut down. Each air sparging well should also be equipped with a pressure gauge and flow regulator to enable adjustments in sparging air distribution. Refer to Chapter II: Soil Vapor Extraction for vapor extraction well details.

Exhibit VII-18
Typical Vertical Air Sparging Well Construction

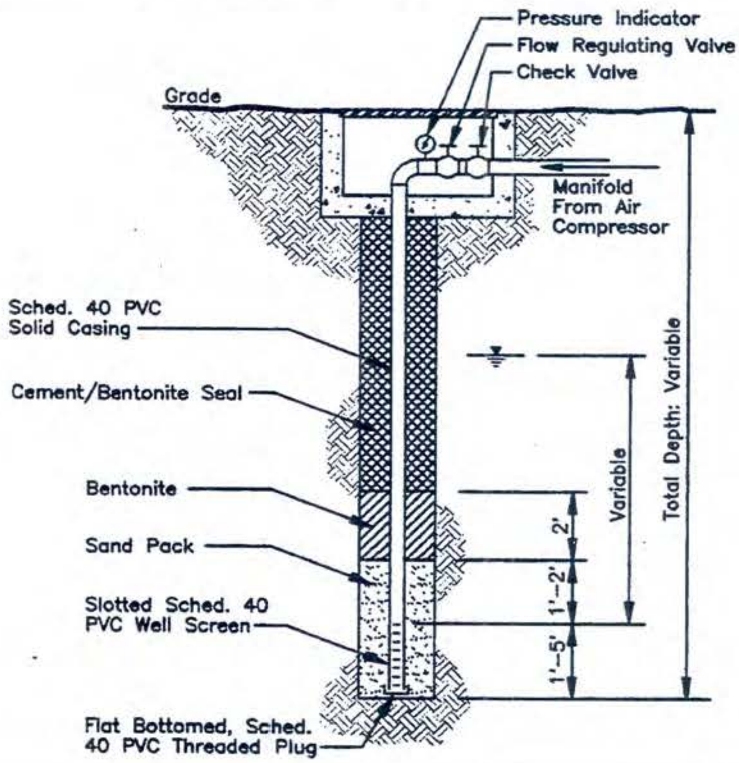
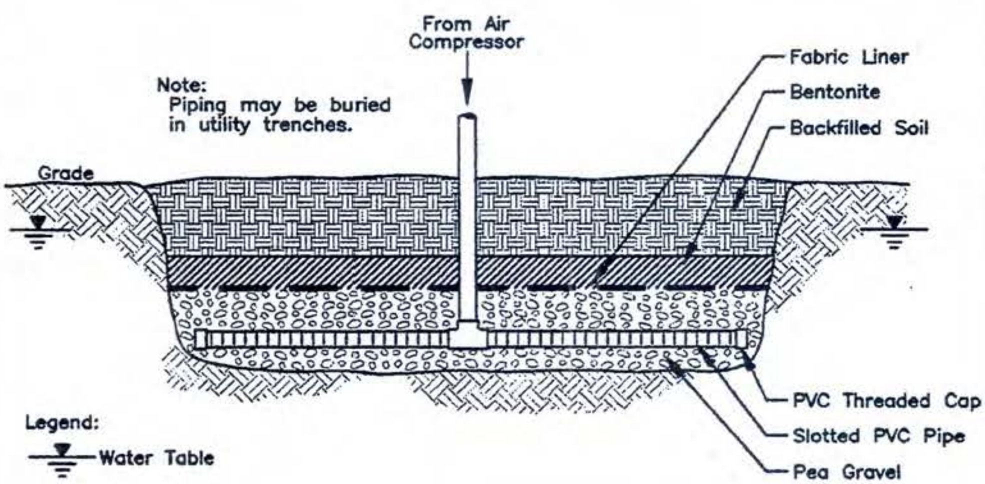


Exhibit VII-19
Typical Horizontal Air Sparging Well Construction



REF. 2

c. Biodegradation.

(1) There have been a number of discussions in the literature about whether air sparging operates primarily through volatilization or biodegradation. However, given the conceptual model described in Chapter 2, it is apparent that air sparging operates in both modes. Paragraphs 2-8b and 3-3e discuss many of the considerations that underlie biosparging design. In some instances, such as those sites affected by chlorinated solvents, the introduction of oxygen in air may not be sufficient to stimulate biodegradation of the target compounds if they are not readily degradable under aerobic conditions. Some form of conditioned air may be needed to promote in-situ biodegradation, or vapor-phase transport may be the only functioning removal mechanism.

(2) VOCs such as TCE, chloroform, cis- and trans-1,2-dichloroethene, and methylene chloride can be biologically co-oxidized during growth on a variety of substrates, including methane, propane, butane, and toluene (Norris 1994). Therefore, if the injected air can be conditioned with one or more of these of gases, chlorinated VOCs may be destroyed through both volatilization and biodegradation (Lombard et al. 1994).

5-3. Design Guidance—Subsurface

The mechanisms identified above provide a "general" basis for advancing the design. This chapter will provide more specific guidance for the subsurface design of IAS systems. There are many subsurface features that must be addressed during system design that are critical components of an effective IAS system. Systems should be designed to optimize volatilization and biodegradation processes and minimize adverse effects, such as uncontrolled migration of vapors or groundwater. Key features for design, along with typical ranges of values, are listed in Table 5-1. Each parameter has either been previously quantified or will be discussed in this chapter.

Table 5-1
Design Parameters for IAS Systems

Parameter	Typical Range[1]
Well diameter	2.5 to 10 cm (1 to 4 inches)
Well screen length	15 to 300 cm (0.5 to 10 ft)
Depth of top of well screen below water table	1.5 to 6 m (5 to 20 ft)
Air sparging flow rate	0.04 to 1.1 m^3/min (1.3 to 40 scfm)
Air sparging injection overpressure[2]	2 to 120 kPa (0.3 to 18 psig)
IAS ZOI	1.5 to 7.5 m (5 to 25 ft)

[1]Modified from Marley and Bruell (1995).
[2]Overpressure is injection pressure in excess of hydrostatic pressure, P_h.

REF. 3

AIR SPARGING DESIGN PARADIGM

by

Andrea Leeson, Paul C. Johnson, Richard L. Johnson, Catherine M. Vogel, Robert E. Hinchee, Michael Marley, Tom Peargin, Cristin L. Bruce, Illa L. Amerson, Christopher T. Coonfare, and Rick D. Gillespie, and David B. McWhorter

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505 King Avenue
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12 August 2002

Table 2. Sample Air Sparging Technology Screening Input Summary Table (cont.)

Semi-Quantitative Assessment of Feasibility – Calculations	
Approximate number of injection wells required if placed on close-spacings (i.e. using the "Standard" design approach prescribed 15-ft spacings) (cost prohibitive?)	20 (not cost-prohibitive)
Minimum economically-feasible injection well spacing (ft)	NA
$V_{soil} = L \times W \times D$ Volume of treatment zone (m^3)	800
$M_o = V_{soil} \times \rho_b \times C_{t,i} \times 10^{-6}$ kg/mg Initial mass of contaminant present (kg) *(not applicable for air sparging barrier treatment systems)*	1.4×10^4 (TPH) 420 (Benzene)
$Flux = U \times W \times D \times C_{w,i} \times 10^3$ L/m^3 $\times 10^{-6}$ kg/mg Contaminant flux to barrier (kg/d) *(only applicable for barrier treatment systems)*	NA
$R_{vc} = Q_{inject} \times C_{v,max} \times 10^{-6}$ kg/mg $\times$ 1,440 min/d maximum volatilization rate from within air channels (kg/d)	810 (TPH) 1.6 (Benzene)
$R_{Bc} = V_{soil} \times F \times \rho_b \times B \times 10^{-6}$ kg/mg Aerobic biodegradation rate from within air channels (kg/d)	0.3 to 3
$\tau_{min} = M_o \times 10^3$ g/kg $\times F \times V_{min}/Q_{inject} \times (1/1{,}440)$ d/min Minimum time necessary to achieve desired treatment in air channels by volatilization (d)	68
$R_{va} = Q_{inject} \times H \times C_{w,i} \times 10^{-6}$ kg/mg $\times$ 1,440 min/d Maximum volatilization rate from outside air channels due to water evaporation (kg/d)	4×10^{-4} (TPH) 8×10^{-5} (Benzene)
$R_{Bw} = V_{soil} \times \varphi \times O \times 10^3$ L/m^3 $\times 10^{-6}$ kg/mg $\times$ 0.33 kg-HC/kg-O_2 Estimated aerobic biodegradation rate in groundwater due to oxygen delivery to groundwater[5] (kg/d)	0.8 to 8
$R_{Bw} = V_{soil} \times \varphi \times O \times 10^3$ L/m^3 $\times 10^{-6}$ kg/mg $\times (C_{w,i}/9)$ Estimated initial volatilization rate from groundwater based on oxygen delivery rate estimate[6] (kg/d)	2.7 to 27 (TPH) 0.57 to 5.7 (Benzene)

[5]Assumes complete utilization of oxygen and complete mineralization of contaminant; assumes 3:1 oxygen/contaminant stoichiometry; [6]Assumes oxygen solubility in water is 9 mg/L, the driving force is the gradient in dissolved concentrations, and diffusion distances are similar for all chemicals.

followed by a case history in which the various pieces of the pilot test are combined to interpret what is occurring at the site and assess if air sparging is appropriate at the site.

5.2.1 Baseline Sampling (PT1)

Baseline sampling represents a critical step in the pilot test process. For several of the parameters, it is important to collect data prior to any air sparging activity to ensure that initial conditions are understood. In particular, those parameters include dissolved oxygen (DO) concentrations and any geophysical measurements (if geophysical tests are to be conducted as part of the pilot test). It is also important to collect baseline pressure transducer data with a data-logger. The pressure data should be collected for a sufficiently long period to assess diurnal changes in water level (e.g., tidal fluctuations) if they are believed to be a significant.

If an SVE system is to be used in conjunction with the air sparging system, then the SVE system should be operated for a period of time prior to air sparging startup primarily to ensure that the SVE system is operating properly to capture the initial high mass loading from air sparging. During this period, it may also be of interest to monitor SVE off-gas for the contaminants of interest in order to establish mass loading from volatilization from the vadose zone compared to volatilization from groundwater. Ideally, prior to initiating air sparging, the off-gas concentrations should have stabilized to the extent that changes in off-gas concentrations due to air sparging operation can be easily determined. In many cases it may be sufficient to monitor those off-gas concentrations with a hand-held field instrument, rather than requiring more sophisticated chromatographic analysis. If off-gas is regulated, regulatory requirements often will dictate which analytical method must be used.

If an SVE system is not part of the air sparging system, then soil gas concentrations (including both contaminant and oxygen concentrations) should be measured prior to air sparging startup. The initial contaminant concentration in the vadose zone can be used to calculate roughly contaminant mass removal from groundwater via volatilization (see Section 5.2.5). Initial oxygen concentrations are useful for measuring bioactivity in the vadose zone. Hand-held instruments should be appropriate for this since soil gas concentrations of contaminants are rarely regulated.

5.2.2 Air Injection Flowrate and Injection Pressure (PT2)

Prior to pilot test activities, it is important to evaluate the expected operating pressure for the air sparging system. This is important both for the selection of the correct air injection system and for the prevention of pneumatic fracturing of the aquifer. Outlined below is the general procedure for estimating the minimum pressure required to initiate sparging and the maximum pressures that should be exerted on the aquifer.

The operating pressure for an air sparging system will be determined by the depth of the air sparging well below the water table and the permeability of the aquifer. The minimum injection pressure necessary to induce flow (P_{min} [psig]) is given by:

$$P_{min}\,(\text{psig}) = 0.43\,H_h + P_{packing} + P_{formation} \tag{4}$$

The pressure at which fracturing of the aquifer can occur is given by:

$$P_{fracture}\,(\text{psig}) = 0.73\,D \tag{5}$$

Where H_h = depth below the water table to the top of the injection well screened section (e.g., the hydrostatic head) (ft); $P_{packing}$ and $P_{formation}$ = air entry pressures for the well annulus packing material and the formation (psig); and D = depth below ground surface to the top of the air injection well screened interval (ft).

For typical air sparging wells and applications, $P_{packing}$ and $P_{formation}$ are small compared to the contribution from the hydrostatic head (air entry pressures are generally <0.2 psig for sands, <0.4 psig for silts, but may be >1.5 psig in some clayey settings). At start-up, it is not unusual for users to exceed P_{min} by as much as 5 to 10 psig to initiate flow quickly. The injection pressure then generally declines to about P_{min} as steady flow conditions are approached. Pressures in excess of $P_{fracture}$ can cause fracturing of the formation; however, as the pressure drops off rapidly away from an injection point, the extent of fracturing in most cases is expected to be limited to the area immediately surrounding the well.

In general, it is recommended that oil-less compressors be used for the pilot test (even if it is not chosen for operation of the full air sparging system), because it eliminates uncertainties relating to air flowrate and potential overheating. Other pumps may be used for air injection, but the practitioner may experience more operational difficulties, depending on site conditions.

As part of the initial shakedown of the air sparging system, the air injection system must be tested. During this process, it is important to measure both the air flowrate and the injection pressure to ensure that neither P_{min} nor $P_{fracture}$ are exceeded at the required air flowrate. There are two general approaches for the initial introduction of air into the subsurface. The first is to include a "vent valve" in the injection air line. This valve should be fully open to begin the test and then be closed slowly while monitoring the increase in pressure and flowrate up to the desired flowrate. During this process, care should be taken not to exceed the upper pressure limit for the system (as determined by the calculations described above). In addition, if the air injection system requires some minimum airflow to provide cooling for the motor/pump, total air flow and system temperature should also be monitored.

A second approach for air sparging startup is to determine the maximum pressure for air injection and to include an in-line pressure regulator in the air injection line. (This approach is best suited to oil-less compressors that do not require airflow for cooling.) In this case, the pressure can be set at the air sparging well head and flow allowed to increase as air pathways in the aquifer become developed. In general, when using this approach it will be necessary to make adjustments in the system to achieve the desired flowrate.

It is desirable to begin the test with an air injection flowrate of 20 ft^3/min if possible. The air injection pressure at the on-set of flow should be recorded, as well as pressures every 5 to 10 min until the pressure and flow stabilize.

5.2.3 Groundwater Pressure Measurements During Air Sparging Startup and Shutdown (PT3)

Once the flow and pressure conditions for sparging have been established (PT2), groundwater pressures during air sparging startup and shutdown can be determined. The primary objective of this test is to assess the time required for airflow distribution to come to steady state. As discussed by Johnson et al. (2000a) (Appendix E), pressure measurements provide an easy and sensitive means of assessing if air sparging air is stratigraphically trapped below the water table. The pressure measurements can also provide a measure of site permeability, based on the magnitude of the response. In general terms, during air sparging startup groundwater pressures will increase because air is being pushed into the formation faster than the water can move away from the air sparging well. Typically, as long as the volume of air below the water table is increasing, the groundwater pressure will remain above pre-air sparging levels. As a result, the time required for groundwater pressure to return to pre-air sparging values is a good

REF. 4

Guidance for Design, Installation and Operation of In Situ Air Sparging Systems

RR-186 February 2015

Purpose

This is a guide to using *in situ* air sparging as a remediation technology. *In situ* air sparging is a process in which a gaseous medium (commonly air) is injected into groundwater through a system of wells. As the injected air rises to the water table, it can strip volatile organic compounds (VOCs) from groundwater and the capillary fringe. The process also oxygenates groundwater, enhancing the potential for biodegradation at sites with contaminants that degrade aerobically.

The Wisconsin DNR developed this guidance for environmental professionals who investigate contaminated sites and design remedial systems. Designing an *in situ* air sparging system is a multi-disciplinary process; the designer should have a working knowledge of geology, hydrogeology and basic engineering to design an effective system.

The majority of this guidance is intended for smaller VOC contaminated sites; however, some of the guidance is appropriate for larger sites. Designers may need to deviate from the guidance in some circumstances because each site has unique contaminants, access constraints, size, hydrogeology, and other characteristics.

If site-specific criteria or conditions require a cost-effective system design that differs from this guidance, it is the responsibility of the remediation system designer to propose an effective system to DNR.

Author/Contact

The original author of this document has left DNR. It was reviewed for accuracy by Gary A. Edelstein (608-267-7563) in November 2003 and again in February 2015.

Errata

This document includes errata and additional information prepared in August 1995.

1. The ERR Program is now called the Bureau for Remediation and Redevelopment or RR Program.
2. 2. The Bureau of Water Supply is now called the Drinking and Groundwater Bureau (or Program).
3. The Bureau of Air Management is now called the Air Management Bureau (or Program).
4. The 8/14/91 memo at the end of the document is still considered a current guideline for air injection at remediation sites even though there is no longer a special group of staff designated as LUST project managers. The guideline is directed to all RR staff that work on such sites.

Wisconsin Department of Natural Resources
P.O. Box 7921, Madison, WI 53707
dnr.wi.gov, search "brownfield"

4.0 Design and Installation of an Air Sparging System.

An in situ air sparging system consists of a number of components which are described in this section, beginning with a discussion of well placement and design. The discussion of design parameters includes well design, manifolds and blowers. Subsection 4.5 discusses other equipment that may or may not be used at sites, and the section concludes with a discussion of the information that should be submitted to the DNR.

4.1 Well Placement.

The air sparging well's zone of influence may be estimated by measuring one or more of the following:

- the change in water table elevation (upwelling);
- the use of gas tracers;
- measuring the change in dissolved oxygen (saturated zone);
- oxygen levels (unsaturated zone); and
- measuring the change in contaminant concentrations (saturated and/or unsaturated zone).

Note: The use of any tracers requires prior approval from the Bureau of Water Supply.

It is permissible to select a well placement configuration without scientifically determining a zone of influence at the site, provided that a relatively close well spacing is used. The department does not recommend a specific method to determine a zone of influence. Well spacing of 12 to 50 feet has generally been used, according to the literature. If well spacing is closer than 15 feet or farther than 30 feet, designers should include a justification in the work plan. Some designers use a grid pattern of sparging wells in the source area and other designers use a line of wells oriented perpendicular to the direction of groundwater flow. Some designers have used the same number of air sparging wells as air extraction wells in the soil venting system (if installed) and other designers use a significantly larger number of sparging wells than air extraction wells.

Under active air sparging, the lateral distribution of contaminants in the saturated zone may increase due to the convection currents discussed above in Subsection 2.1. Therefore, additional groundwater monitoring wells and air sparging wells may be necessary near the perimeter of the contaminated zone. If air sparging wells extend to the perimeter of the plume, groundwater extraction may not be necessary at some sites. If air sparging is only used in part of the plume, groundwater extraction will probably be necessary to capture any lateral migration that results from convection currents.

The system designer should use their professional judgement to space wells in a pattern that will effectively decontaminate the aquifer and capillary fringe at the site.

4.2 Well Design.

Figure 4-1 portrays a typical air sparging well design.

4.2.1 Drilling Methods and Soil Descriptions.

A hollow stem auger is the preferred drilling method, and the auger should be 4.25-inch inside diameter (or larger) for 2-inch diameter wells. The wells should be 2-inch diameter or larger so that conventional well development equipment can be used. Designers should justify using drilling methods other than hollow stem auger on a site-by-site basis in the work plan.

Continuous sampling by split spoon is recommended to characterize/verify the geologic conditions because the geological conditions must allow the air to rise to the water table. It is highly recommended that a hydrogeologist collect samples from above the seasonal, high water table to the base of the screened interval from a sufficient number of wells to verify the geologic characterization. A hydrogeologist as defined in NR 500.03 (64) or NR 600.03 (98) should describe the soil in detail. See Subsection 2.2.2 for soil description information.

4.2.2 Filter Pack.

Designers should select the filter pack for the well based on the average grain size of the geologic materials below the water table. Samples for grain size analysis should be tested prior to designing an air sparging system. A sieve analysis is usually sufficient for filter pack design (a hydrometer test is usually not needed).

The average grain size of the filter pack should be as close to the native soils as practical. Coarser materials should not be used for the filter pack, however, slightly finer-grained material may be used. If the filter pack's average grain size is larger than the native geologic materials, the filter pack may be more permeable than the native soil. While a highly permeable filter pack is an advantage in constructing wells for other uses (monitoring or extraction), a filter pack that has a significantly higher permeability than the surrounding formation will be a conduit for upward short circuiting of air in the depth interval between the bentonite seal and the top of the well screen. This reduces the lateral movement of air into the aquifer. If the filter pack is significantly smaller than the native soils, too much restriction to air flow results. Natural filter packs may be used in caving formations provided that the native materials do not have significant levels of fines that may accumulate within the well screens.

The filter pack should extend from the base of the well screen to a minimum of 1 to 2 feet above the screen.

4.2.3 Seals.

A bentonite seal that is 0.5 to 2 feet thick should be placed above the filter pack. The annular space seal (above the bentonite seal) should be constructed with either bentonite cement grout or bentonite. A tremie should be used to place grout when installing a seal below the water table. The surface seal should be constructed in a manner that complies with NR 141.

Designers should use a flush mount protective cover over the well, as described in NR 141 if the manifold is buried. If so, other fittings discussed in Subsections 4.2.5 and 4.3 can be installed under the manhole cover(s). If there is not enough physical space for these fittings under an NR 141-approved cover, a different air- and water-tight manhole can also be used.

4.2.4 Well Screen and Casing.

Air sparging transfers air through the well screen to the filter pack and then to the contaminated zone within the aquifer. Since the majority of the air flows out of the well screen near the top of the screen, designers should set the top of the well screen at the base of the contaminated groundwater plume under seasonal low conditions. At a minimum, the top of the screen should be set 5 feet below the seasonal low static water table. If different criteria are proposed for setting the screen depth, designers should include a justification in the workplan.

The pressure that is needed to inject air into the aquifer is higher than the pressure that is required to depress the static water level to the top of the screen. Since a number of wells are manifolded together on a common header, all wells on a manifold are essentially operated at an equal pressure. If the top of a well screen in one well within a system is installed closer to the water table than the other wells, most and possibly all of the air will pass through this shallower well. This happens because less pressure is needed to inject air to the top of the screen in that well. Designers may use throttle or solenoid valves to equalize air flow to the wells, as an alternative.

At sites where groundwater will not be extracted, it is recommended that designers estimate the exact depth at which each well will be installed by:

- drawing an accurate water table map;
- surveying the elevations of proposed air sparging well locations; and
- calculating the estimated depth of the water table for each well to determine the screened interval.

If groundwater is extracted, a cone of depression significantly changes the shape of the water table. Other devices such as solenoid valves (See Subsection 4.3) may be needed to compensate for varying screen depths caused by the drawdown.

Sites with seasonal variations in groundwater flow direction may also adversely impact the system design.

Example: A system that is designed for a site with natural groundwater flow toward the southwest. This site has higher water levels on the northeastern side of the site than the southwestern portion of the site. Later, the gradient shifts to a natural groundwater flow direction towards the southeast. The higher groundwater elevation will then be located in the northwest portion of the site.

In this situation, the increase in groundwater elevation on the western side of the site increases the pressure requirements in air sparging wells on the western part of the site relative to the eastern part of the site. If all wells are on a single common manifold, then the western wells will not inject as much air as the eastern wells.

In this case, the western side of the site receives less air (or possibly no air) from the air sparging wells, reducing overall system effectiveness. The use of throttle valves or solenoid valves may alleviate this situation (See Subsection 4.3).

The slot size should be appropriate to the filter pack size; filter pack sizing is discussed in Subsection 4.2.2. Since air readily passes through well screens, a small slot size usually is sufficient and underestimating the slot size (by a small margin) – relative to the filter pack – is usually acceptable.

A relatively short length of screen for a well, such as 2 to 5 feet is sufficient; some designers have proposed a 1-foot screen length. The well screen typically is a slotted pipe constructed of PVC or CPVC. Generally, the screen is flush threaded with schedule 40 or 80 pipe. A bottom plug is necessary. Designers should not use glued couplings and bottom plugs because they may adversely affect any groundwater samples from the wells.

In most cases, designers should use 2-inch well materials. If designers plan to use packers in the well at a later date to physically block off portions of a screen, other screen diameters (such as 4-inch) may also be used. In general, the screen diameter should not be smaller than 2 inches, because it is difficult to develop smaller diameter wells. The well casing and pipe schedule should be constructed of the same materials as the well screen. Drillers should install "O" rings or other seals and wrench all threaded casing joints tight to limit air leakage from the joints.

During well installation, the depth – from the top of casing or standpipe to the top of the screened interval – should be measured to 0.1 foot of accuracy.

4.2.5 Wellhead.

Designers should connect the wellhead to the manifold with a tee, which allows a threaded top cap to be attached. This configuration allows access to the well for bailers or water level measuring probes.

During the system installation, if the length of the well casing (or standpipe) is changed while connecting the well to the manifold, the change in elevation at the top of each well should be measured to 0.1 foot. Designers should adjust the well construction records to reflect any changes in the elevation at the top of the casing. The original casing measurement for each well is discussed in Subsection 4.2.4.

Wells should be surveyed to determine elevation if they are used for collecting groundwater samples or preparing a piezometric surface map (otherwise surveying for elevation is not necessary).

4.2.6 Development.

All wells should be developed to NR 141 standards to minimize fines that may accumulate in the screen. Water produced by well development should be handled in accordance with the DNR guidance on investigative wastes.

4.3 Manifold, Valves, and Instrumentation.

The manifold is typically buried underground; however, if land use and traffic patterns allow, the manifold may be installed above ground. If the manifold is buried, it may be installed at or below the frost level, or it may be installed just below the ground surface. If it is within the frost zone, it may need

REF. 5

NEW YORK
STATE OF
OPPORTUNITY

Department of Environmental Conservation

ON-SITE PHASE III REMEDIAL INVESTIGATION REPORT

WORK ASSIGNMENT C007540-4.1

FORMER KLINK COSMO CLEANERS SITE
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA

SITE NO. 224130
KINGS (C) NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Basil Seggos, Acting Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
Remedial Bureau B

URS Corporation
257 West Genesee Street Suite 400
Buffalo, New York 14202

DRAFT
January 2016

Location ID / Type	Northing	Easting	Ground Elevation (ft)	Casing Elevation (ft)	Meas.point (Riser)Elev.(ft)	Geol. Zone	Date / Time	Depth to Water (ft)	Water Elev. (ft)	Product Thick. (ft)	Corrected Water Elev. (ft)	Remark
DEC-031	201767.8547	1001889.641	34.99	34.94	34.52	A						
MNW							12/18/2007 0000	31.02	3.50	0.00		
MNW							7/14/2008 1333	31.17	3.35	0.00		
MNW							11/2/2009 0857	31.88	2.64	0.00		
MNW							6/20/2011 1102	31.85	2.67	0.00		
MNW							10/17/2011 0000	30.66	3.86	0.00		
MNW							3/29/2012 0735	32.45	2.07	0.00		
MNW							7/23/2012 0000	32.14	2.38	0.00		
MNW							2/25/2013 0000	32.76	1.76	0.00		
MNW							3/6/2014 0000	32.65	1.87	0.00		
MNW							12/12/2014 0000	32.26	2.26	0.00		
MNW							8/27/2015 0920	32.16	2.36	0.00		
MNW							12/7/2015 0000	32.57	1.95	Sheen		
DEC-031D	201768.9664	1001895.137	34.70	34.70	34.48	B						
MNW							7/14/2008 1334	31.11	3.37	0.00		
MNW							11/3/2009 1245	31.80	2.68	0.00		From purge log
MNW							6/20/2011 1102	31.72	2.76	0.00		
MNW							10/17/2011 0000	30.61	3.87	0.00		
MNW							3/29/2012 0736	32.40	2.08	0.00		
MNW							7/23/2012 0000	32.11	2.37	0.00		
MNW							2/25/2013 0000	32.71	1.77	0.00		
MNW							3/6/2014 0000	32.50	1.98	0.00		
MNW							12/12/2014 0000	32.02	2.46	0.00		
MNW							8/27/2015 1015	32.12	2.36	0.00		
MNW							12/7/2015 0000	32.52	1.96	0.01		
DEC-031TC	201765.771	1001886.31	35.19	35.19	34.83	B						
MNW							10/17/2011 0000	30.86	3.97	0.00		
MNW							3/29/2012 0735	32.83	2.00	0.00		
MNW							7/23/2012 0000	32.34	2.49	0.00		
MNW							2/25/2013 0000	32.73	2.10	0.00		
MNW							3/6/2014 0000	32.80	2.03	0.00		
MNW							12/12/2014 0000	32.40	2.43	0.00		No sounding
MNW							8/27/2015 1920	32.35	2.48	0.00		
MNW							12/7/2015 0000	32.75	2.08	Sheen		

NM - No Measurement

The value noted in the column labeled Specific Gravity is an assumed value for free product, if found.

Geologic Zone:

A	Shallow Unconfined Aquifer
B	Deep Unconfined Aquifer
P	Perched Zone

Type:

ASW	Air Sparging Well
MNW	Monitoring Well
OBW	Observation Well
RW	Recovery Well
VEW	Vapor Extraction Well

Location ID / Type	Northing	Easting	Ground Elevation (ft)	Casing Elevation (ft)	Meas.point (Riser)Elev.(ft)	Geol. Zone	Date / Time	Depth to Water (ft)	Water Elev. (ft)	Product Thick. (ft)	Corrected Water Elev. (ft)	Remark
DEC-140 MNW	201736.7186	1001915.797	33.57	33.57	33.22	A	8/25/2015 1610	30.61	2.61	0.00		
MNW							12/7/2015 0000	31.25	1.97	0.00		
DEC-140D MNW	201730.7509	1001917.916	33.34	33.34	32.99	B	8/25/2015 1750	30.87	2.12	0.00		
MNW							12/7/2015 0000	31.00	1.99	0.00		

NM - No Measurement

The value noted in the column labeled Specific Gravity is an assumed value for free product, if found.

Geologic Zone:

A	Shallow Unconfined Aquifer
B	Deep Unconfined Aquifer
P	Perched Zone

Type:

ASW	Air Sparging Well
MNW	Monitoring Well
OBW	Observation Well
RW	Recovery Well
VEW	Vapor Extraction Well

DRILLING SUMMARY

Geologist: A. Ledgerwood

Drilling Company:

Aquifer Drilling and Testing, Inc.

Driller: Jeremy Meyers

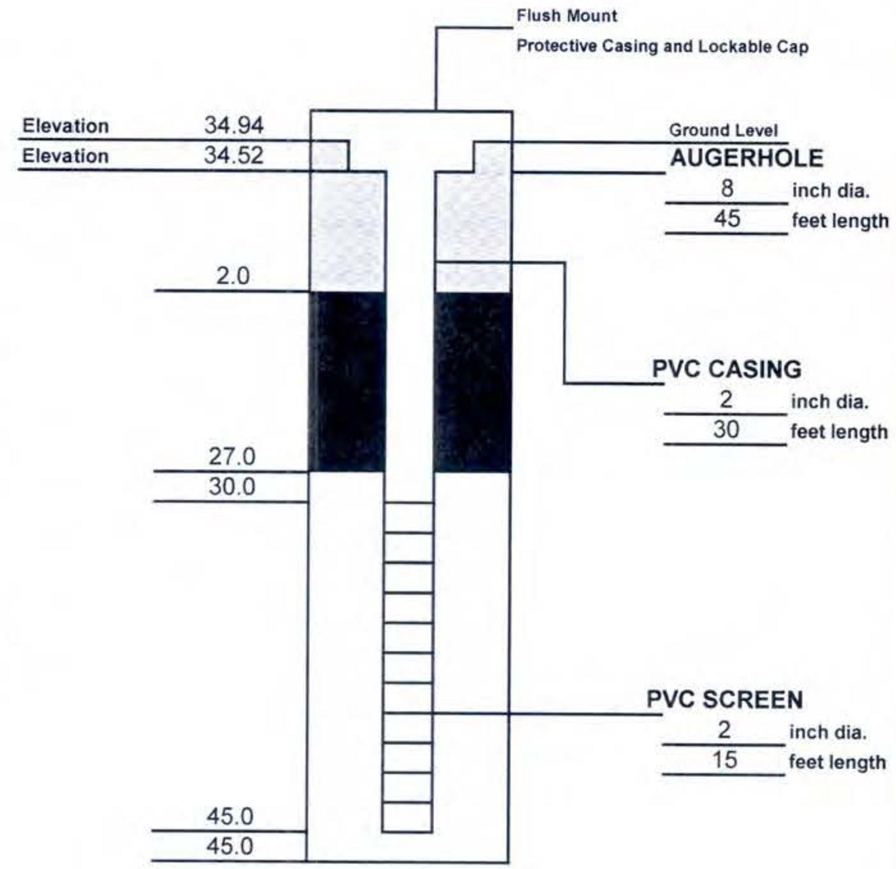
Rig Make/Model:
CME 55LC

Date:
11/21/2007

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description.

D E P T H (FT)



WELL DESIGN

CASING MATERIAL	SCREEN MATERIAL	FILTER MATERIAL
Surface: Steel grade box	**Type:** 2" PVC	Type: #2 Sand **Setting:** 27.0-45.0'
Monitor: 2" PVC	**Slot Size:** .020"	***SEAL MATERIAL*** Type: Bentonite **Setting:** 2.0-27.0'

COMMENTS:

LEGEND

- Cement/Bentonite Grout
- Bentonite Seal
- Silica Sandpack

Client: NYSDEC	**Location : Meeker Avenue Site**	**Project No.: 11174989.00002**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number: DEC-031**

J/11174989/Excel/Field Logs Nov 2007/Well Construction Logs Meeker Ave - Dec 2007

DRILLING SUMMARY

Geologist:
S. McCabe

Drilling Company:
Aquifer Drilling and Testing, Inc.

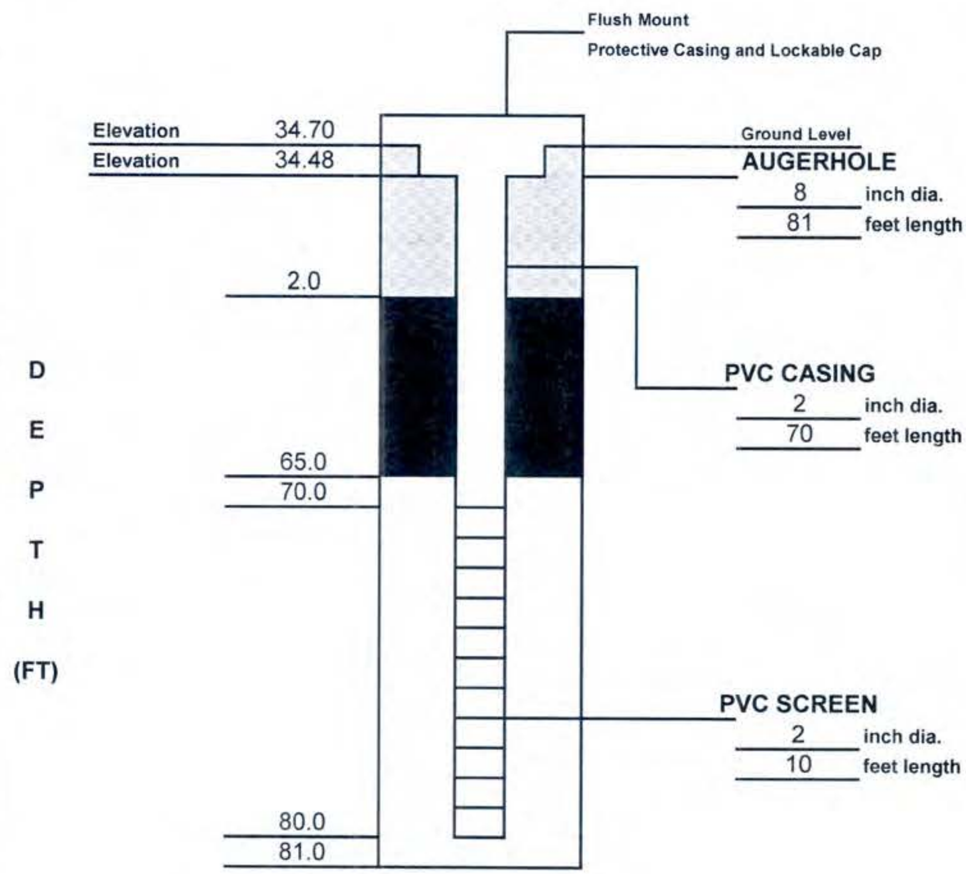
Driller:
Shawn Miller

Rig Make/Model:
CME-85

Date:
6/17/2008

GEOLOGIC LOG

Depth(ft.)	Description
	See Boring Log for Lithologic Description.



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface: Steel grade box	**Type:** 2" PVC	Type: #2 Sand **Setting:** 65.0-81.0'
		SEAL MATERIAL
Monitor: 2" PVC	**Slot Size:** .020"	Type: Bentonite **Setting:** 2.0-65.0'

COMMENTS:

LEGEND

- Cement/Bentonite Grout
- Bentonite Seal
- Silica Sandpack

Client: NYSDEC	**Location : Meeker Avenue Site**	**Project No.: 11174989.00002**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number: DEC-031D**

J/11174989/Excel/Field Logs Nov 2007/Well Construction - May 2008