MULRY AND CRESSWELL ENVIRONMENTAL, INC.

Shunk Street Sewer Remediation Project

Sun Belmont Terminal
Passyunk Avenue
Philadelphia, PA

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I) Introduction

The Sun Company (R&M), Sun, Belmont Marketing Terminal is a truck petroleum loading facility adjacent to Sun's Philadelphia refinery. The Belmont Terminal is located on the south side of Passyunk Avenue at the intersection of 26th Street in South Philadelphia (see Figure I).

A City of Philadelphia combined storm and sanitary sewer line, the Shunk Street sewer, crosses the Terminal property in an approximately east - west direction and crosses under Passyunk Ave. in the vicinity of the Terminal main gate (see Figure II). The sewer was installed in the early 1900's and is reported thirteen feet in diameter constructed of brick. The top of the sewer is estimated to be approximately twenty feet below the current grade of the terminal parking lots and extends to approximately thirty-three feet below this grade. The dimensions of the excavation in which the sewer was constructed, the methods of excavation employed and the nature and extent of fill used in restoring the sewer excavation are not known. In response to reports of hydrocarbon odors in the sewer and a visual inspection of the sewer line under the Terminal property, conducted by the City of Philadelphia Water Department, which reported hydrocarbon infiltration to the sewer line in this area, Sun contracted Mulry and Cresswell Environmental, Inc. (MCE) to conduct a subsurface investigation of the area.

Between 13 and 19 November 1997 MCE in conjunction with B.L. Myers Bros., Inc., a Pennsylvania certified and licensed drilling company installed seventeen borings on the Terminal property along the Shunk Street sewer, both north and south of the sewer line. As part of delineation project, fourteen observation (monitoring) wells and five recovery wells were installed (see Figure III). Pumping tests were performed on three wells and vacuum extraction tests were performed on two wells.

The methods and results of the investigation along the Shunk Street sewer line on the Belmont Terminal property were presented in a report entitled "Free Product Delineation Along the Shunk Street Sewer", generated by MCE on 23 January 1998.

Subsequent to review of the Delineation Report, Sun authorized the installation of a combined groundwater and separate phase hydrocarbon recovery and soil vapor extraction remediation system. The system was installed as per the Remediation System Work Plan, contained in Appendix A, and in accordance with the engineering plans and specifications developed for Sun by Resource Control Corporation. A copy of the plans and specifications, marked up to represent actual system components, as built, are attached as Appendix B.

II) Remediation System Description

The remediation system is comprised of three basic elements: separate phase product recovery; groundwater recovery, treatment and discharge; and soil vapor extraction and treatment. Based on liquid level gauging in site wells and pumping test results, automated separate phase hydrocarbon recovery was targeted for wells RW1, RW4 and RW15. Groundwater pumping was targeted for wells: RW1; RW4; RW6; RW7 and RW15. Soil vapor extraction was targeted for wells: 3, 10, 12, 13, 16, 18, 19, and 20.

Separate phase hydrocarbons are recovered via electric submersible pumps with down-hole float controls. Recovered product is pumped through sub-grade dual wall PVC pipe through individual well flow totalizing meters to a one thousand-gallon double wall storage tank located in the remediation equipment shed. The storage tank is equipped with a high level shut off float.

Groundwater is pumped from electric submersible pumps through sub-grade PVC pipe, through totalizing flow meters to an oil water separator in the equipment shed. High level sensors in the separator control a transfer pump which pumps effluent water through sub-grade cast iron pipe to a City of Philadelphia Water department sanitary sewer junction manhole under permit. A copy of the permit and conditions of discharge are contained in Appendix C.

Soil vapors are extracted and treated via a VR 3 internal combustion unit. This unit is a computer controlled eight-cylinder gasoline engine, which employs the engine vacuum to draw soil gas from the wells through sub-grade PVC piping. Propane make up fuel is mixed by the control computer as needed to maintain efficient combustion. A second VR unit has been deployed to the site but has not been operational pending the completion of reprogramming of the control unit being conducted by the manufacturer at the time of this writing. It is intended to remove the VR(s) from this site and conduct soil vapor extraction via two 5 horse power positive displacement blowers when hydrocarbon concentrations in the extracted soil gas reduce to a level where the VRs no longer are cost effective to operate. This determination will be based on the hydrocarbon concentration in the extracted soil gas and the rate of propane consumption.

III) System Start-up and Shake Down

The VR unit was activated on the 14th of September and the product recovery and groundwater pumps were activated on 18 September 1998.

Operation and monitoring activities conducted from the start-up of the system through the end of calendar year 1998 consisted of weekly site visits to collect data. check operating equipment status and effect repairs where possible. Data collection consisted of gauging liquid levels in all accessible wells, recording flow totalizer readings for all water and product pumps, recording VR operating data (running hours, manifold vacuum, BTU content of soil gas, etc.), recording propane tank levels, and recording any noteworthy miscellaneous observations or conditions.

A) Groundwater Recovery

As previously described, submersible water pumps were deployed in RWs 1, 4, 6, 7, and 15 and pumping was initiated on 18 September 1998. Flow totals for each well are presented in Table I. As displayed on the table, the pump in RW 1 operated continuously from start-up in mid September through the end of the reporting period, December1998. An estimated total of 505,456 gallons of groundwater were pumped from this well at an average rate of 4814 gallons per day (GPD) or approximately 3.3 gallons per minute (gpm). The flow totalizing meter for this well ceased functioning on 29 October 1998 and was replaced on 29 December 1998. Although the manufacturer claims the flow meter is suitable for applications where dissolved hydrocarbons are present, this meter and others failed to operate. Replacement meters were on back order with the vendor and replacements were not always possible in a timely manner.

As with RW 1, the flow meter in RW 4 failed but much sooner after start-up. The meter for RW 4 was inoperable from 22 September until it was replaced on 4 December 1998. Estimated flow from this well was a total of 8085 gallons for the reporting period at approximately 77 GPD (0.05 gpm). This well by far produces the least amount of groundwater even though the static water level in this well is anomalously high when compared to surrounding wells. It is suspected that the high static water levels measured in RW 4 are not due to groundwater but are due to localized mounding from an unidentified local source. The low yield from this well indicates whatever the source of groundwater mounding in this area under static conditions; it is a minor volume of water.

With the exception of the first two weeks of December, the pump and flow meter in RW 6 operated continuously throughout the reporting period. The reduced flow in early December was due to a rupture of the polyethylene water line from the submersible pump to the sub-grade PVC plumbing in the well head road box. As with the flow meters, the polyethylene line seems to be prone to failure at this site. This well produced the largest yield of all pumping wells with a total of 623175 gallons pumped at a rate of approximately 5935 GPD (4.1 gpm).

The pump and flow meter in RW 7 operated continuously throughout the reporting period without failure. A total of 272,895 gallons of groundwater were pumped from this well at an average rate of 2599 GPD (1.8 gpm).

The pump, flow meter, pump controls and plumbing in RW 15 were in continual need of repair or replacement. The flow meter for this stream failed after four days of operation and the pump control probe protective sleeves (PVC) became soft and distorted after approximately one month of deployment in the well. Replacement components and materials are being investigated. It is estimated during the time the water pump functioned in RW 15, a total of 15810 gallons of groundwater was pumped at an average rate of 930 GPD (0.65 gpm).

B) Water Table Fluctuation in Response to Pumping

Hydrographs for the pumping (recovery) wells and observation wells are attached as Figure V. All hydrographs except the plot for OW 19 depict falling liquid levels throughout the report period. For all other observation wells, coincidental with increasing product thickness, water table elevations declined over the report period. The magnitude and rate of decline in individual wells varied somewhat, however a comparison of slopes of the depths to water plots on the hydrographs leads to three classifications:

- Very shallow slope, between 0.004 and 0.006; these wells may be somewhat influenced by pumping or all decline in water elevation may be due to static water table decline; these wells are TW 5, TW 8, TW 9, OW 11 and OW 14;
- Slopes greater than 0.006, these wells are pumping wells or wells influenced by pumping and in addition to the recovery wells include observation wells TW 3 and, OWs 2, 12, 13, 16, 17, 18, and 20;
- An increase in water levels over the period, which was only observed in OW 19.

Due to the general (background) decline in water levels through the period, pumping influence in the wells with shallow sloped decline in water levels may be masked. Monitoring during future recharge periods will be helpful in making this determination.

C) Water Table Elevations

A series of water table elevation plots for the period from before pumping was initiated, static conditions, through December 1998 are attached as Figures VI - X. The specific dates of the plots are:

- 21 August, 1998, Figure VI, prior to initiation of pumping;
- 23 September, 1998, Figure VII, after approximately one week of pumping;
- 1 October, 1998, Figure VIII, after approximately two weeks of pumping;
- 20 November, 1998, Figure IX, after approximately two months of pumping;
- 18 December 1998, Figure X, after approximately three months of pumping.

As mentioned above, this entire period was marked by little to no precipitation resulting in regional water table elevation decline. Although the above referenced plots depict a reduction in water elevation in most wells over the period, it is difficult to separate background decline in water table elevations from those attributable to pumping from the recover wells. What can be attributed to pumping is the generation of cones of depression around the recovery wells, specifically RWs 1, 4 and 7. In addition in the overall lowering of the water table across the site, a slight deflection of the water table gradient north of the sewer line, is evident from August through December. In August, prior to initiation of pumping, the gradient north of the sewer line, west of OW20, was to the west with a magnitude of approximately 05%. East of OW 20, the gradient was to the south. In subsequent months, as pumping influences proliferated, the westerly gradient observed north of the sewer, west of OW 20, was gradually diverted in a more southerly direction, towards RW 1. In the absence of pumping from RW 15, the gradient in the western most portion of the site, remains in a more westerly direction.

IV) Product Recovery

Product recoveries by well and total volume are displayed in Table III. As presented in the table, a total of 21,649 gallons of separate phase product was recovered during the report period, from start up in mid September through the end of December 1998. The vast majority of the recovery was from RW 1, 18,879 gallons. The product recovery from RW 15 was 2590 gallons through 27 October, after which time the pump controllers were inoperable.

For the wells where separate phase is routinely measured, apparent separate phase product thickness plots are attached as Figure XI. As depicted on these charts, product thickness increased in almost all wells coincidental with the observed decline in water table elevation. With the exception of OW 19, no reduction in product thickness, potentially attributable to product recovery was observed. Product thickness in OW 19 decreased over the period.

Five site wells, TWs 5, 8 and 9 and OWs 11 and 14 have never been measured as containing separate phase product. Separate phase has not been measured in any well north of the sewer line (TWs 5, 8 and 9) at any time prior to or during operation of the pumping equipment, nor has separate phase been observed at the eastern extremity of the site (OWs 11 and 14).

The product recovery pump in RW 1 has had to be replaced several times since September. Conversations with the manufacture's recommended pump repair personnel suggests the pump failure is likely due to continuos operation at back pressure (pipe friction head) that taxes the pump capacity.

V) Vapor Extraction

Soil gas (vapor) is extracted from wells: 3, 10, 12, 13, 16, 18, 19, and 20 via a "VR 3" vapor extraction unit, which is a computer controlled internal combustion engine which utilizes the engine vacuum to extract soil gas from the connected wells. The unit was manufactured by a company that is no longer in business and retrofitted with new controls (computer) by a second company, RSI, Inc. Two units were deployed to the site with similar retrofitted components. One VR has operated without serious interruption since start-up on 14 September 1998. In spite of replacement of several key components, including the control computer, the second unit has not yet been made operational. Currently the second unit is waiting for an influent gas stream regulator from RSI. Due to the elevated concentration of hydrocarbon in the soil gas, little to no measurable vacuum has been exerted on the wells. As soil vapor extraction continues it is expected that the hydrocarbon concentration in the soil gas will decrease, the flow of soil gas will increase and the vacuum on the wells will also increase.

Table IV presents the operational data for the VR unit from start-up in September through the end of December 1998. This table also contains an estimation of the equivalent of 5800 gallons of gasoline as having been recovered via soil vapor extraction. This estimate is based on several assumptions and is useful for tracking the efficacy of the soil vapor extraction system. This estimate should not be considered a quantitative record.

VI) Summary

Groundwater pumping from the recovery wells (RWs 1, 4, 6, 7 and for a brief period 15) on the Belmont Terminal property, along the south side of the Shunk Street Sewer, has influenced the water table in the area of the sewer. The groundwater gradient on the eastern portion of the site is to the south, towards the recovery wells and not towards the sewer. The gradient on the western portion of the site has been slightly deflected from a westerly direction to a southwestern direction. Longer and more continuous operation of the groundwater pumping system will steepen the southern gradient, continue to lower the water table around the sewer and further deflect the gradient on the western portion of the site to the south. Cones of depression have been established around the pumping wells and separate phase product has been successfully recovered from RWs 1, RW 15, and to a lesser extent, RW 4. A total of approximately 1,425,421 gallons of groundwater were pumped treated and discharged to the Philadelphia Water Department sanitary sewer system. Approximately 21,650 gallons of separate phase hydrocarbons, reported to be gasoline, have been recovered from start-up in mid September through the end of December 1998.

Soil vapor extraction via a single VR unit has removed the approximate equivalent of 5800 gallons of gasoline to through the end of December 1998. Efforts are ongoing to bring a second VR unit online to increase hydrocarbon recovery and increase subsurface vacuum at the vapor extraction wells and hopefully in the backfill of the sewer.

Based on the estimates above, approximately 27,450 gallons of gasoline were recovered from mid September through the end of December 1998.

TABLE I: Belmont Terminal Shunk Street Sewer Remediation System Water Pump Totalizer Readings

	RW 1		RW 4		RW 6		RW 7		RW 15	
Date	Total	Avg. GPD	Total	Avg. GPD	Total	Avg. GPD	Total	Avg. GPD	Total	Avg. GPD
17-Sep-98	0		115		2827		428		0	
18-Sep-98	488	488	280	165	14045	11218	1938	1510	866	866
21-Sep-98	4921	1478	873	198	38484	8146	5574	1212	3851	995
22-Sep-98	7184	2263	873*		40514	2030	7326	1752	3851*	
23-Sep-98	10623	3439			48250	7736	8640	1314	3851*	
24-Sep-98	11085	462			49634	1384	8863	223	3851*	
25-Sep-98	14746	3661			58856	9222	11050	2187	3851*	
28-Sep-98	20761	2005			85175	8773	16301	1750	3851*	
29-Sep-98	24299	3538			94014	8839	19105	2804	3851*	
30-Sep-98	29600	5301			106713	12699	22254	3149	3851*	
1-Oct-98	35331	5731			118554	11841	25008	2754	3851*	
5-Oct-98	52299	4242			136334	4445	29283	1069	3851**	
13-Oct-98	106652	6794			197555	7653	44132	1856		
19-Oct-98	146788	6689			246969	8236	56616	2081		
27-Oct-98	192546	5720			337943	11372	79726	2889		
29-Oct-98	192557	6			359640	10849	86889	3582		
2-Nov-98	192548	0			431280	17910	107720	5208		
13-Nov-98	192558	1			474072	3890	131210	2135		
20-Nov-98	192557	0			523300	7033	153786	3225		
25-Nov-98	192550	-1			555308	6402	169832	3209		
4-Dec-98	192550	0	108	12	555318	1	194809	2775		
11-Dec-98	192559	1	357	36	555318	0	219609	3543		
18-Dec-98	192559	0	566	30	591361	5149	242256	3235		
29-Dec-98	192559	0	784	20	611274	1810	267728	2316		
Avg. GPD	4814		Avg. GPD	77	Avg. GPD	5935	Avg. GPD	2599	Avg. GPD	930

Estimated Discharge 17 Sep through 31 Dec 98

RW 1	505456	RW 4	8085	RW 6	623175	RW 7	272895	RW 15	15810

Total Estimated Discharge (gal.) from All Wells 17 Sep - 31 Dec 1998= 1425421

* Flow meter inoperable, water pump running.

** Water pump removed from well.

Product RecoveryTotals

Table II: Liquid Level Measurements and Water Table Elevations

TW 3

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	28.56	28.40	0.16	99.56	71.00	71.11
17-Dec-97	28.14	27.54	0.60	98.79	70.65	71.06
21-Aug-98	28.60	27.51	1.09	32.86	4.26	5.00
18-Sep-98	28.70	27.66	1.04	32.86	4.16	4.87
21-Sep-98	28.80	27.64	1.16	32.86	4.06	4.85
22-Sep-98	28.83	27.64	1.19	32.86	4.03	4.84
23-Sep-98	28.91	27.77	1.14	32.86	3.95	4.73
25-Sep-98	28.92	27.78	1.14	32.86	3.94	4.72
28-Sep-98	28.90	27.71	1.19	32.86	3.96	4.77
29-Sep-98	29.06	27.85	1.21	32.86	3.80	4.62
30-Sep-98	29.05	27.83	1.22	32.86	3.81	4.64
1-Oct-98	29.03	27.83	1.20	32.86	3.83	4.65
5-Oct-98	28.92	27.77	1.15	32.86	3.94	4.72
13-Oct-98	29.06	27.88	1.18	32.86	3.80	4.60
19-Oct-98	29.01	27.83	1.18	32.86	3.85	4.65
20-Nov-98	29.46	28.08	1.38	32.86	3.40	4.34
25-Nov-98	29.76	28.15	1.61	32.86	3.10	4.19
4-Dec-98	29.55	28.08	1.47	32.86	3.31	4.31
11-Dec-98	29.61	28.15	1.46	32.86	3.25	4.24
18-Dec-98	29.73	28.25	1.48	32.86	3.13	4.14
29-Dec-98	29.69	28.16	1.53	32.86	3.17	4.21

TW 5

Date	Depth to Water	DTP	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	31.13	-	0.00	103.02	71.89	71.89
17-Dec-97	27.72	-	0.00	99.57	71.85	71.85
21-Aug-98	27.54	-	0.00	33.13	5.59	5.59
18-Sep-98	27.87	-	0.00	33.13	5.26	5.26
21-Sep-98	27.80	-	0.00	33.13	5.33	5.33
22-Sep-98	27.80	-	0.00	33.13	5.33	5.33
25-Sep-98	27.96	-	0.00	33.13	5.17	5.17
28-Sep-98	27.88	-	0.00	33.13	5.25	5.25
29-Sep-98	28.05	-	0.00	33.13	5.08	5.08
30-Sep-98	28.03	-	0.00	33.13	5.10	5.10
1-Oct-98	28.04	-	0.00	33.13	5.09	5.09
5-Oct-98	27.93	-	0.00	33.13	5.20	5.20
13-Oct-98	28.09	-	0.00	33.13	5.04	5.04
19-Oct-98	27.98	-	0.00	33.13	5.15	5.15
20-Nov-98	28.28	-	0.00	33.13	4.85	4.85
25-Nov-98	28.35	-	0.00	33.13	4.78	4.78
4-Dec-98	28.26	-	0.00	33.13	4.87	4.87
11-Dec-98	28.34	-	0.00	33.13	4.79	4.79
18-Dec-98	28.45	-	0.00	33.13	4.68	4.68
29-Dec-98	28.38	-	0.00	33.13	4.75	4.75

TW 8

Date	Depth to Water	DTP	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	26.95	-	0.00	97.82	70.87	70.87
17-Dec-97	26.00	-	0.00	96.83	70.83	70.83
21-Aug-98	26.08	-	0.00	31.12	5.04	5.04
18-Sep-98	26.26	-	0.00	31.12	4.86	4.86
21-Sep-98	26.24	-	0.00	31.12	4.88	4.88
22-Sep-98	26.28	-	0.00	31.12	4.84	4.84
23-Sep-98	26.40	-	0.00	31.12	4.72	4.72
25-Sep-98	26.43	-	0.00	31.12	4.69	4.69
28-Sep-98	26.43	-	0.00	31.12	4.69	4.69
29-Sep-98	26.49	-	0.00	31.12	4.63	4.63
30-Sep-98	26.45	-	0.00	31.12	4.67	4.67
1-Oct-98	26.49	-	0.00	31.12	4.63	4.63
5-Oct-98	26.40	-	0.00	31.12	4.72	4.72
13-Oct-98	26.40	-	0.00	31.12	4.72	4.72
19-Oct-98	26.40	-	0.00	31.12	4.72	4.72
20-Nov-98	26.75	-	0.00	31.12	4.37	4.37
25-Nov-98	26.78	-	0.00	31.12	4.34	4.34
4-Dec-98	26.75	-	0.00	31.12	4.37	4.37
11-Dec-98	26.80	-	0.00	31.12	4.32	4.32
18-Dec-98	26.92	-	0.00	31.12	4.20	4.20
29-Dec-98	26.81	-	0.00	31.12	4.31	4.31

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

TW 9

Date	Depth to Water	DTP	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	28.69	-	0.00	100.47	71.78	71.78
17-Dec-97	27.75	-	0.00	99.47	71.72	71.72
18-Sep-98	28.06	-	0.00	33.14	5.08	5.08
21-Sep-98	27.97	-	0.00	33.14	5.17	5.17
22-Sep-98	27.97	-	0.00	33.14	5.17	5.17
23-Sep-98	28.15	-	0.00	33.14	4.99	4.99
25-Sep-98	28.14	-	0.00	33.14	5.00	5.00
28-Sep-98	28.05	-	0.00	33.14	5.09	5.09
29-Sep-98	28.18	-	0.00	33.14	4.96	4.96
30-Sep-98	28.19	-	0.00	33.14	4.95	4.95
1-Oct-98	28.17	-	0.00	33.14	4.97	4.97
5-Oct-98	28.11	-	0.00	33.14	5.03	5.03
13-Oct-98	28.28	-	0.00	33.14	4.86	4.86
19-Oct-98	29.40	-	0.00	33.14	3.74	3.74
20-Nov-98	28.43	-	0.00	33.14	4.71	4.71
25-Nov-98	28.57	-	0.00	33.14	4.57	4.57
4-Dec-98	28.43	-	0.00	33.14	4.71	4.71
11-Dec-98	28.45	-	0.00	33.14	4.69	4.69
18-Dec-98	28.58	-	0.00	33.14	4.56	4.56
29-Dec-98	28.52	-	0.00	33.14	4.62	4.62

TW 10

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	26.97	26.89	0.08	97.64	70.67	70.72
17-Dec-97	26.48	26.29	0.19	97.04	70.56	70.69
21-Aug-98	27.88	25.91	1.97	31.19	3.31	4.65
18-Sep-98	28.08	26.04	2.04	31.19	3.11	4.50
21-Sep-98	27.91	26.05	1.86	31.19	3.28	4.54
22-Sep-98	27.97	26.1	1.87	31.19	3.22	4.49
23-Sep-98	28.12	26.18	1.94	31.19	3.07	4.39
25-Sep-98	28.17	26.23	1.94	31.19	3.02	4.34
28-Sep-98	28.10	26.22	1.88	31.19	3.09	4.37
29-Sep-98	28.24	26.28	1.96	31.19	2.95	4.28
30-Sep-98	28.16	26.25	1.91	31.19	3.03	4.33
1-Oct-98	28.21	26.28	1.93	31.19	2.98	4.29
5-Oct-98	27.95	26.2	1.75	31.19	3.24	4.43
19-Oct-98	27.95	26.2	1.75	31.19	3.24	4.43
20-Nov-98	28.43	26.51	1.92	31.19	2.76	4.07
25-Nov-98	28.52	26.53	1.99	31.19	2.67	4.02
4-Dec-98	28.58	26.47	2.11	31.19	2.61	4.04
29-Dec-98	28.65	26.51	2.14	31.19	2.54	4.00

TW 11

Date	Depth to Water	DTP	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	28.36	-	0.00	99.94	71.58	71.58
17-Dec-97	28.40	-	0.00	99.94	71.54	71.54
21-Aug-98	28.33	-	0.00	33.43	5.10	5.10
18-Sep-98	28.45	-	0.00	33.43	4.98	4.98
21-Sep-98	28.42	-	0.00	33.43	5.01	5.01
22-Sep-98	28.41	-	0.00	33.43	5.02	5.02
23-Sep-98	28.55	-	0.00	33.43	4.88	4.88
25-Sep-98	28.53	-	0.00	33.43	4.90	4.90
28-Sep-98	28.49	-	0.00	33.43	4.94	4.94
29-Sep-98	28.59	-	0.00	33.43	4.84	4.84
30-Sep-98	28.59	-	0.00	33.43	4.84	4.84
1-Oct-98	28.59	-	0.00	33.43	4.84	4.84
5-Oct-98	28.55	-	0.00	33.43	4.88	4.88
13-Oct-98	28.64	-	0.00	33.43	4.79	4.79
19-Oct-98	28.59	-	0.00	33.43	4.84	4.84
20-Nov-98	28.81	-	0.00	33.43	4.62	4.62
25-Nov-98	28.87	-	0.00	33.43	4.56	4.56
4-Dec-98	28.82	-	0.00	33.43	4.61	4.61
11-Dec-98	28.87	-	0.00	33.43	4.56	4.56
18-Dec-98	28.97	-	0.00	33.43	4.46	4.46
29-Dec-98	28.91	-	0.00	33.43	4.52	4.52

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

OW 2

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	27.37	27.30	0.07	99.17	71.80	71.85
17-Dec-97	27.31	27.30	0.01	99.17	71.86	71.87
21-Aug-98	27.88	27.06	0.82	32.70	4.82	5.38
18-Sep-98	28.15	27.30	0.85	32.70	4.55	5.13
21-Sep-98	28.04	27.22	0.82	32.70	4.66	5.22
22-Sep-98	28.16	27.22	0.94	32.70	4.54	5.18
23-Sep-98	28.30	27.38	0.92	32.70	4.40	5.03
25-Sep-98	28.39	27.29	1.10	32.70	4.31	5.06
28-Sep-98	28.28	27.85	0.43	32.70	4.42	4.71
29-Sep-98	28.42	27.46	0.96	32.70	4.28	4.93
30-Sep-98	28.39	27.43	0.96	32.70	4.31	4.96
1-Oct-98	28.44	27.43	1.01	32.70	4.26	4.95
5-Oct-98	28.36	27.33	1.03	32.70	4.34	5.04
13-Oct-98	28.59	27.44	1.15	32.70	4.11	4.89
19-Oct-98	28.53	27.37	1.16	32.70	4.17	4.96
20-Nov-98	28.92	27.64	1.28	32.70	3.78	4.65
25-Nov-98	28.97	27.70	1.27	32.70	3.73	4.59
4-Dec-98	28.96	27.62	1.34	32.70	3.74	4.65
11-Dec-98	28.98	27.68	1.30	32.70	3.72	4.60
18-Dec-98	29.10	27.82	1.28	32.70	3.60	4.47
29-Dec-98	29.08	27.70	1.38	32.70	3.62	4.56

OW 12

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	26.86	25.81	1.05	96.93	70.07	70.78
17-Dec-97	26.94	25.84	1.10	96.93	69.99	70.74
21-Aug-98	27.22	25.83	1.39	31.18	3.96	4.91
18-Sep-98	27.65	25.99	1.66	31.18	3.53	4.66
21-Sep-98	27.32	25.98	1.34	31.18	3.86	4.77
22-Sep-98	27.46	26.10	1.36	31.18	3.72	4.64
23-Sep-98	27.58	26.20	1.38	31.18	3.60	4.54
25-Sep-98	27.70	26.20	1.50	31.18	3.48	4.50
28-Sep-98	27.72	26.13	1.59	31.18	3.46	4.54
29-Sep-98	27.78	26.24	1.54	31.18	3.40	4.45
30-Sep-98	27.78	26.21	1.57	31.18	3.40	4.47
1-Oct-98	28.01	26.29	1.72	31.18	3.17	4.34
5-Oct-98	27.44	26.13	1.31	31.18	3.74	4.63
13-Oct-98	27.44	26.13	1.31	31.18	3.74	4.63
19-Oct-98	27.37	26.60	0.77	31.18	3.81	4.33
20-Nov-98	28.16	26.49	1.67	31.18	3.02	4.16
25-Nov-98	28.38	26.38	2.00	31.18	2.80	4.16
4-Dec-98	28.48	26.42	2.06	31.18	2.70	4.10
11-Dec-98	28.25	26.46	1.79	31.18	2.93	4.15
18-Dec-98	28.64	26.50	2.14	31.18	2.54	4.00
29-Dec-98	28.35	26.47	1.88	31.18	2.83	4.11

OW 13

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	27.93	27.74	0.19	99.48	71.55	71.68
17-Dec-97	28.80	27.52	1.28	99.48	70.68	71.55
21-Aug-98	28.70	27.61	1.09	33.26	4.56	5.30
18-Sep-98	29.07	27.84	1.23	33.26	4.19	5.03
21-Sep-98	28.90	27.74	1.16	33.26	4.36	5.15
22-Sep-98	28.96	27.76	1.20	33.26	4.30	5.12
23-Sep-98	29.08	27.95	1.13	33.26	4.18	4.95
25-Sep-98	29.09	27.96	1.13	33.26	4.17	4.94
28-Sep-98	29.12	27.85	1.27	33.26	4.14	5.00
29-Sep-98	29.18	28.04	1.14	33.26	4.08	4.86
30-Sep-98	29.21	28.01	1.20	33.26	4.05	4.87
1-Oct-98	29.25	28.01	1.24	33.26	4.01	4.85
5-Oct-98	29.20	27.84	1.36	33.26	4.06	4.98
13-Oct-98	29.38	28.04	1.34	33.26	3.88	4.79
19-Oct-98	29.40	27.92	1.48	33.26	3.86	4.87
20-Nov-98	29.65	28.17	1.48	33.26	3.61	4.62
25-Nov-98	29.69	28.22	1.47	33.26	3.57	4.57
4-Dec-98	29.62	28.13	1.49	33.26	3.64	4.65
11-Dec-98	29.64	28.22	1.42	33.26	3.62	4.59
18-Dec-98	29.78	28.35	1.43	33.26	3.48	4.45
29-Dec-98	29.75	28.24	1.51	33.26	3.51	4.54

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

OW 14

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	28.35	-	0.00	99.75	71.40	71.40
17-Dec-97	28.45	-	0.00	99.75	71.30	71.30
21-Aug-98	28.33	-	0.00	33.26	4.93	4.93
18-Sep-98	28.67	-	0.00	33.26	4.59	4.59
21-Sep-98	28.43	-	0.00	33.26	4.83	4.83
22-Sep-98	28.42	-	0.00	33.26	4.84	4.84
23-Sep-98	28.71	-	0.00	33.26	4.55	4.55
25-Sep-98	28.67	-	0.00	33.26	4.59	4.59
28-Sep-98	28.46	-	0.00	33.26	4.80	4.80
29-Sep-98	28.83	-	0.00	33.26	4.43	4.43
30-Sep-98	28.80	-	0.00	33.26	4.46	4.46
1-Oct-98	28.82	-	0.00	33.26	4.44	4.44
5-Oct-98	28.82	-	0.00	33.26	4.44	4.44
13-Oct-98	28.88	-	0.00	33.26	4.38	4.38
19-Oct-98	28.58	-	0.00	33.26	4.68	4.68
20-Nov-98	28.89	-	0.00	33.26	4.37	4.37
25-Nov-98	28.96	-	0.00	33.26	4.30	4.30
4-Dec-98	28.84	-	0.00	33.26	4.42	4.42
11-Dec-98	28.90	-	0.00	33.26	4.36	4.36
18-Dec-98	29.04	-	0.00	33.26	4.22	4.22
29-Dec-98	28.94	-	0.00	33.26	4.32	4.32

OW 16

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
17-Dec-97	27.43	26.90	0.53	94.14	66.71	67.07
21-Aug-98	27.82	26.86	0.96	32.37	4.55	5.20
18-Sep-98	28.15	26.98	1.17	32.37	4.22	5.02
21-Sep-98	28.03	27.01	1.02	32.37	4.34	5.03
22-Sep-98	28.11	27.02	1.09	32.37	4.26	5.00
23-Sep-98	28.40	27.14	1.26	32.37	3.97	4.83
25-Sep-98	28.52	27.15	1.37	32.37	3.85	4.78
28-Sep-98	28.35	27.09	1.26	32.37	4.02	4.88
29-Sep-98	28.30	27.19	1.11	32.37	4.07	4.82
30-Sep-98	28.25	27.18	1.07	32.37	4.12	4.85
1-Oct-98	28.34	27.21	1.13	32.37	4.03	4.80
5-Oct-98	28.14	27.15	0.99	32.37	4.23	4.90
13-Oct-98	28.32	27.32	1.00	32.37	4.05	4.73
19-Oct-98	28.17	27.22	0.95	32.37	4.20	4.85
20-Nov-98	28.50	27.47	1.03	32.37	3.87	4.57
25-Nov-98	28.75	27.51	1.24	32.37	3.62	4.46
4-Dec-98	28.71	27.44	1.27	32.37	3.66	4.52
18-Dec-98	28.91	27.59	1.32	32.37	3.46	4.36
29-Dec-98	28.80	27.49	1.31	32.37	3.57	4.46

OW 17

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
17-Dec-97	26.13	26.10	0.03	95.31	69.18	69.20
21-Aug-98	26.42	26.13	0.29	30.99	4.57	4.77
18-Sep-98	27.06	26.21	0.85	30.99	3.93	4.51
21-Sep-98	26.95	26.18	0.77	30.99	4.04	4.56
22-Sep-98	26.95	26.19	0.76	30.99	4.04	4.56
23-Sep-98	27.38	26.25	1.13	30.99	3.61	4.38
25-Sep-98	27.73	26.25	1.48	30.99	3.26	4.27
28-Sep-98	27.51	26.34	1.17	30.99	3.48	4.28
29-Sep-98	27.55	26.28	1.27	30.99	3.44	4.30
30-Sep-98	27.45	26.26	1.19	30.99	3.54	4.35
1-Oct-98	27.59	26.30	1.29	30.99	3.40	4.28
5-Oct-98	27.44	26.30	1.14	30.99	3.55	4.33
13-Oct-98	27.73	26.35	1.38	30.99	3.26	4.20
19-Oct-98	27.55	26.33	1.22	30.99	3.44	4.27
20-Nov-98	28.05	26.48	1.57	30.99	2.94	4.01
25-Nov-98	28.25	26.55	1.70	30.99	2.74	3.90
4-Dec-98	28.13	26.54	1.59	30.99	2.86	3.94
11-Dec-98	28.15	26.59	1.56	30.99	2.84	3.90
18-Dec-98	28.28	26.72	1.56	30.99	2.71	3.77
29-Dec-98	28.17	26.53	1.64	30.99	2.82	3.94

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

OW 18

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	27.44	27.34	0.10	31.79	4.35	4.42
18-Sep-98	27.54	27.51	0.03	31.79	4.25	4.27
21-Sep-98	27.50	27.42	0.08	31.79	4.29	4.34
22-Sep-98	27.52	27.40	0.12	31.79	4.27	4.35
23-Sep-98	27.58	27.44	0.14	31.79	4.21	4.31
25-Sep-98	27.82	27.62	0.20	31.79	3.97	4.11
28-Sep-98	27.98	27.59	0.39	31.79	3.81	4.08
29-Sep-98	27.94	27.48	0.46	31.79	3.85	4.16
30-Sep-98	27.93	27.41	0.52	31.79	3.86	4.21
1-Oct-98	28.08	27.40	0.68	31.79	3.71	4.17
5-Oct-98	28.06	27.42	0.64	31.79	3.73	4.17
13-Oct-98	28.24	27.41	0.83	31.79	3.55	4.11
19-Oct-98	28.31	27.41	0.90	31.79	3.48	4.09
20-Nov-98	28.76	27.50	1.26	31.79	3.03	3.89
25-Nov-98	28.89	27.55	1.34	31.79	2.90	3.81
4-Dec-98	28.06	27.48	0.58	31.79	3.73	4.12
11-Dec-98	29.06	27.56	1.50	31.79	2.73	3.75
18-Dec-98	29.08	27.61	1.47	31.79	2.71	3.71
29-Dec-98	29.08	27.57	1.51	31.79	2.71	3.74

OW 19

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	27.02	26.23	0.79	31.95	4.93	5.47
18-Sep-98	26.52	26.35	0.17	31.95	5.43	5.55
25-Sep-98	27.68	26.19	1.49	31.95	4.27	5.28
28-Sep-98	26.70	26.41	0.29	31.95	5.25	5.45
29-Sep-98	26.79	26.57	0.22	31.95	5.16	5.31
30-Sep-98	26.78	26.59	0.19	31.95	5.17	5.30
1-Oct-98	26.78	26.54	0.24	31.95	5.17	5.33
5-Oct-98	26.74	26.49	0.25	31.95	5.21	5.38
13-Oct-98	26.93	26.78	0.15	31.95	5.02	5.12
19-Oct-98	26.82	26.65	0.17	31.95	5.13	5.25
20-Nov-98	26.40	26.39	0.01	31.95	5.55	5.56
25-Nov-98	26.15	26.06	0.09	31.95	5.80	5.86
4-Dec-98	26.38	26.35	0.03	31.95	5.57	5.59
11-Dec-98	26.13	25.99	0.14	31.95	5.82	5.92
18-Dec-98	26.17	26.14	0.03	31.95	5.78	5.80
29-Dec-98	26.08	26.06	0.02	31.95	5.87	5.88

OW 20

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	26.88	26.48	0.40	32.86	5.98	6.25
18-Sep-98	26.63	26.54	0.09	32.86	6.23	6.29
21-Sep-98	26.67	26.50	0.17	32.86	6.19	6.31
22-Sep-98	26.67	26.58	0.09	32.86	6.19	6.25
23-Sep-98	26.79	26.63	0.16	32.86	6.07	6.18
25-Sep-98	26.91	26.63	0.28	32.86	5.95	6.14
28-Sep-98	26.87	26.61	0.26	32.86	5.99	6.17
29-Sep-98	27.08	26.71	0.37	32.86	5.78	6.03
30-Sep-98	27.16	26.71	0.45	32.86	5.70	6.01
1-Oct-98	27.15	26.69	0.46	32.86	5.71	6.02
5-Oct-98	27.20	26.67	0.53	32.86	5.66	6.02
13-Oct-98	27.29	26.73	0.56	32.86	5.57	5.95
19-Oct-98	27.17	26.68	0.49	32.86	5.69	6.02
20-Nov-98	28.23	27.16	1.07	32.86	4.63	5.36
25-Nov-98	28.23	27.17	1.06	32.86	4.63	5.35
4-Dec-98	28.22	27.18	1.04	32.86	4.64	5.35
11-Dec-98	28.23	27.33	0.90	32.86	4.63	5.24
18-Dec-98	28.22	27.44	0.78	32.86	4.64	5.17
29-Dec-98	28.24	27.43	0.81	32.86	4.62	5.17

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

RW 1

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	26.72	25.16	1.56	30.50	3.78	4.84
18-Sep-98	29.40	26.56	2.84	30.50	1.10	3.03
21-Sep-98	26.89	25.30	1.59	30.50	3.61	4.69
22-Sep-98	30.80	26.05	4.75	30.50	-0.30	2.93
23-Sep-98	29.45	25.95	3.50	30.50	1.05	3.43
25-Sep-98	29.30	25.55	3.75	30.50	1.20	3.75
28-Sep-98	29.50	25.70	3.80	30.50	1.00	3.58
29-Sep-98	29.30	25.90	3.40	30.50	1.20	3.51
30-Sep-98	29.60	25.60	4.00	30.50	0.90	3.62
1-Oct-98	29.60	25.60	4.00	30.50	0.90	3.62
5-Oct-98	30.95	26.65	4.30	30.50	-0.45	2.47
13-Oct-98	30.10	27.10	3.00	30.50	0.40	2.44
19-Oct-98	30.15	26.65	3.50	30.50	0.35	2.73
20-Nov-98	29.85	26.05	3.80	30.50	0.65	3.23
25-Nov-98	28.25	25.70	2.55	30.50	2.25	3.98
4-Dec-98	29.91	26.03	3.88	30.50	0.59	3.23
11-Dec-98	28.10	25.68	2.42	30.50	2.40	4.05
18-Dec-98	28.95	25.75	3.20	30.50	1.55	3.73
29-Dec-98	29.70	25.70	4.00	30.50	0.80	3.52

RW 4

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	12.60	12.58	0.02	31.42	18.82	18.83
18-Sep-98	25.10	24.90	0.20	31.42	6.32	6.46
21-Sep-98	29.50	11.05	18.45	31.42	1.92	14.47
22-Sep-98	27.56	27.04	0.52	31.42	3.86	4.21
23-Sep-98	28.08	27.20	0.88	31.42	3.34	3.94
25-Sep-98	26.00	25.15	0.85	31.42	5.42	6.00
28-Sep-98	25.40	24.10	1.30	31.42	6.02	6.90
29-Sep-98	25.33	24.82	0.51	31.42	6.09	6.44
30-Sep-98	25.50	25.00	0.50	31.42	5.92	6.26
1-Oct-98	26.90	26.20	0.70	31.42	4.52	5.00
5-Oct-98	16.23	13.70	2.53	31.42	15.19	16.91
13-Oct-98	26.98	26.33	0.65	31.42	4.44	4.88
19-Oct-98	26.84	26.24	0.60	31.42	4.58	4.99
20-Nov-98	27.87	27.30	0.57	31.42	3.55	3.94
25-Nov-98	27.50	26.95	0.55	31.42	3.92	4.29
4-Dec-98	28.15	27.61	0.54	31.42	3.27	3.64
11-Dec-98	28.10	27.60	0.50	31.42	3.32	3.66
18-Dec-98	26.85	26.18	0.67	31.42	4.57	5.03
29-Dec-98	27.52	27.07	0.45	31.42	3.90	4.21

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;
CWTE: WTE corrected forseperate phase hydrocarbon thickness.

Table II: Liquid Level Measurements and Water Table Elevations

RW 6

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	26.88		0.00	98.58	71.70	71.70
17-Dec-97	26.92		0.00	98.58	71.66	71.66
21-Aug-98	26.80		0.00	32.11	5.31	5.31
18-Sep-98	29.85		0.00	32.11	2.26	2.26
21-Sep-98	26.98		0.00	32.11	5.13	5.13
22-Sep-98	27.75		0.00	32.11	4.36	4.36
23-Sep-98	29.50		0.00	32.11	2.61	2.61
25-Sep-98	29.32		0.00	32.11	2.79	2.79
28-Sep-98	30.65		0.00	32.11	1.46	1.46
29-Sep-98	30.80		0.00	32.11	1.31	1.31
30-Sep-98	30.70		0.00	32.11	1.41	1.41
1-Oct-98	30.50		0.00	32.11	1.61	1.61
5-Oct-98	27.13		0.00	32.11	4.98	4.98
13-Oct-98	30.95		0.00	32.11	1.16	1.16
19-Oct-98	31.00		0.00	32.11	1.11	1.11
20-Nov-98	31.17	28.52	0.00	32.11	0.94	0.94
25-Nov-98	29.68	26.90	0.00	32.11	2.43	2.43
4-Dec-98	27.22		0.00	32.11	4.89	4.89
11-Dec-98	27.30		0.00	32.11	4.81	4.81
18-Dec-98	30.98	27.98	0.00	32.11	1.13	1.13
29-Dec-98	30.68	27.53	0.00	32.11	1.43	1.43

RW 7

Date	Depth t Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
21-Aug-98	24.07		0.00	29.18	5.11	5.11
18-Sep-98	30.15		0.00	29.18	-0.97	-0.97
21-Sep-98	24.04		0.00	29.18	5.14	5.14
22-Sep-98	24.41		0.00	29.18	4.77	4.77
23-Sep-98	24.55		0.00	29.18	4.63	4.63
25-Sep-98	32.45		0.00	29.18	-3.27	-3.27
28-Sep-98	25.05		0.00	29.18	4.13	4.13
29-Sep-98	28.30		0.00	29.18	0.88	0.88
30-Sep-98	29.40		0.00	29.18	-0.22	-0.22
1-Oct-98	29.35		0.00	29.18	-0.17	-0.17
5-Oct-98	24.18		0.00	29.18	5.00	5.00
13-Oct-98	24.67		0.00	29.18	4.51	4.51
19-Oct-98	24.60		0.00	29.18	4.58	4.58
20-Nov-98	28.68	27.5	0.00	29.18	0.50	0.50
25-Nov-98	28.05	26.3	0.00	29.18	1.13	1.13
4-Dec-98	28.70	25.15	0.00	29.18	0.48	0.48
11-Dec-98	28.10	24.22	0.00	29.18	1.08	1.08
18-Dec-98	28.13	24.65	0.00	29.18	1.05	1.05
29-Dec-98	28.65	25.6	0.00	29.18	0.53	0.53

RW 15

Date	Depth to Water	Depth to Product	PT	Casing Elev.	WTE.	CWTE
25-Nov-97	28.10	26.81	1.29	97.43	69.33	70.21
17-Dec-97	27.99	26.86	1.13	97.43	69.44	70.21
21-Aug-98	28.18	26.69	1.49	31.45	3.27	4.28
18-Sep-98	29.69	28.12	1.57	31.45	1.76	2.83
21-Sep-98	28.44	26.75	1.69	31.45	3.01	4.16
22-Sep-98	27.98	26.75	1.23	31.45	3.47	4.31
23-Sep-98	28.66	26.84	1.82	31.45	2.79	4.03
25-Sep-98	28.95	28.40	0.55	31.45	2.50	2.87
28-Sep-98	28.80	28.30	0.50	31.45	2.65	2.99
29-Sep-98	27.40	26.85	0.55	31.45	4.05	4.42
30-Sep-98	27.28	26.82	0.46	31.45	4.17	4.48
1-Oct-98	27.20	26.90	0.30	31.45	4.25	4.45
5-Oct-98	28.68	26.89	1.79	31.45	2.77	3.99
13-Oct-98	28.41	26.87	1.54	31.45	3.04	4.09
19-Oct-98	28.79	26.92	1.87	31.45	2.66	3.93
20-Nov-98	29.13	27.08	2.05	31.45	2.32	3.71
25-Nov-98	29.35	27.09	2.26	31.45	2.10	3.64
4-Dec-98	29.17	27.05	2.12	31.45	2.28	3.72
11-Dec-98	29.20	27.14	2.06	31.45	2.25	3.65
18-Dec-98	29.45	27.20	2.25	31.45	2.00	3.53
29-Dec-98	29.15	27.10	2.05	31.45	2.30	3.69

DTW: Depth to water;DTP: depth to product; WTE: water table elevation;

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ENVIRONMENTAL, INC.

TABLE III

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation Project
Product Recovery

Product RecoveryTotals

Date	RW 1	RW 4	RW 15
17-Sep-98	7	0	0
18-Sep-98	79	0	33
21-Sep-98	931	0	91
22-Sep-98	1200	14	91
23-Sep-98	1445	30	91
24-Sep-98	1484	33	91
25-Sep-98	1686	50	262
28-Sep-98	2178	84	589
29-Sep-98	2320	86	743
30-Sep-98	2502	10	747
1-Oct-98	2588	17	747
5-Oct-98	2292	29	2589
13-Oct-98	5940	69	2590
19-Oct-98	8279	81	2590
27-Oct-98	10649	101	2590
2-Nov-98	11927	111	
6-Nov-98	11982	117	
13-Nov-98	14090	129	
20-Nov-98	15889	140	
25-Nov-98	16716	147	
4-Dec-98	17327	157	
11-Dec-98	17766	164	
18-Dec-98	18328	171	
29-Dec-98	18879	180	

Total through December 1998 21649 gallons

MULRY AND CRESSWELL
ENVIRONMENTAL, INC.

Table IV

Sun Belmont Terminal, 2700 Passyunk Ave., Phil., PA
Shunk Street Remediation Project

Belmont Terminal Hydrocarbon Recovery Via Soil Vapor Extracti

Date	Hours	Vacuum	Air Flow	Well Flow	Fuel flow	BTUs
21-Sep-98	167	18.8	75	7	6	297,000
23-Sep-98	212	19.1	65	14	12	293,000
25-Sep-98	260	19	75	11	6	298,800
28-Sep-98	338	18.5	71	13	6	307,500
01-Oct-98		18.9	74	15	8	344,500
05-Oct-98		19.6	82	56	12	313,000
13-Oct-98	675	19.4	90	50	12	330,000
19-Oct-98	818		83	41	12	350,000
2-Nov-98						320,000
6-Nov-98						310,000
13-Nov-98						322,400
20-Nov-98	1429					329,000
25-Nov-98						354,000
4-Dec-98	1769					374,400
11-Dec-98	1936					333,000
18-Dec-98						387,000
29-Dec-98	2341					315,600

Average BTU/hr	328188
Average Lb/Hr as Gasoline (20,500 BTU/lb)	16.0091822
Average Gallons/Hr as Gasoline (123,000 BTU/gallon)	2.66819703 @ 3.9024
Hours Run	2174
Gallons Removed This Period	**5800**

MULRY AND CRESSWELL
ENVIRONMENTAL, INC.

FIGURE I
SITE LOCATION
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

SCALE IN FEET
0 2000 4000

SOURCE: USGS PHILADELPHIA, PA.
QUADRANGLE 1967
PHOTOREVISED 1985.

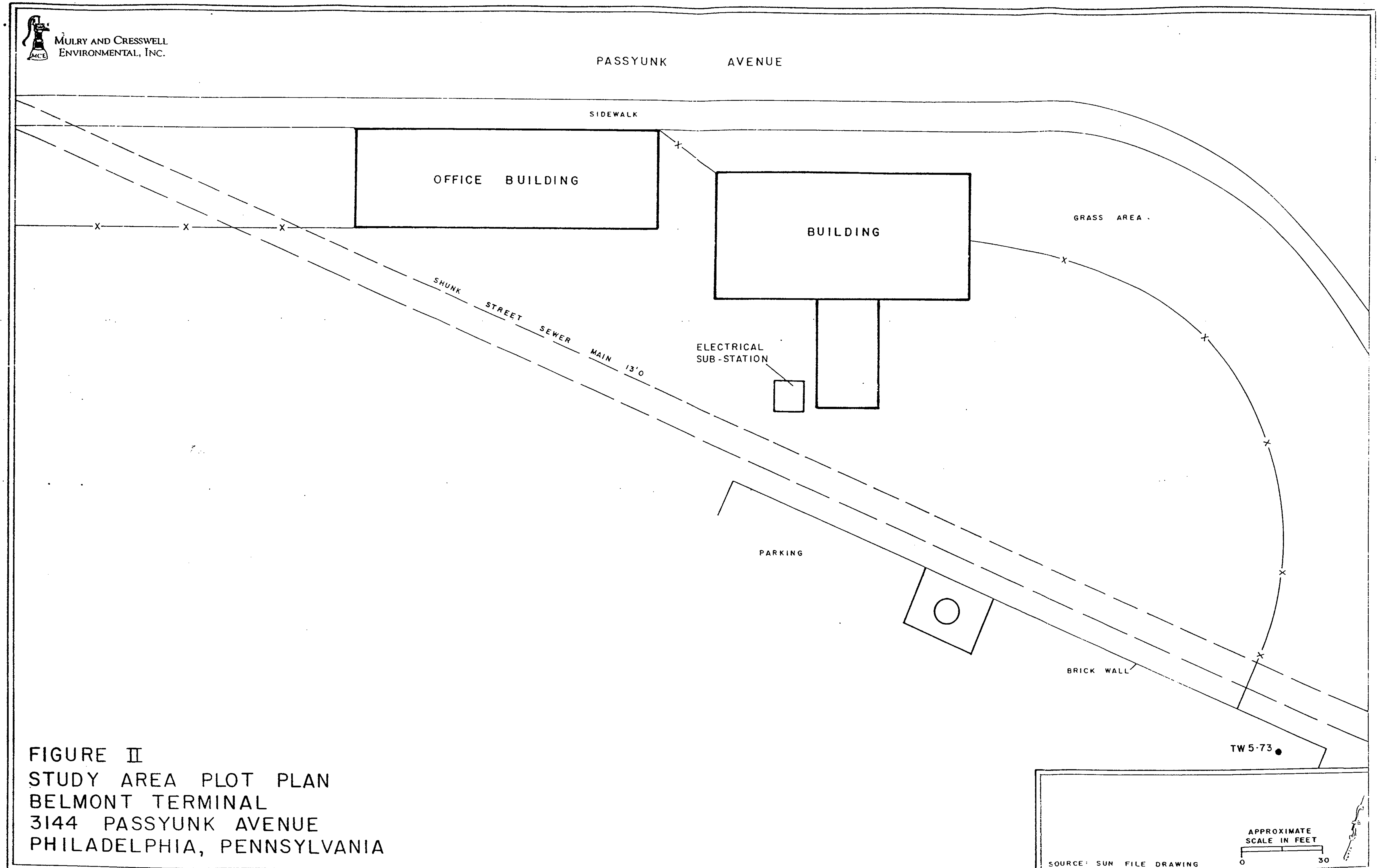


FIGURE II
STUDY AREA PLOT PLAN
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

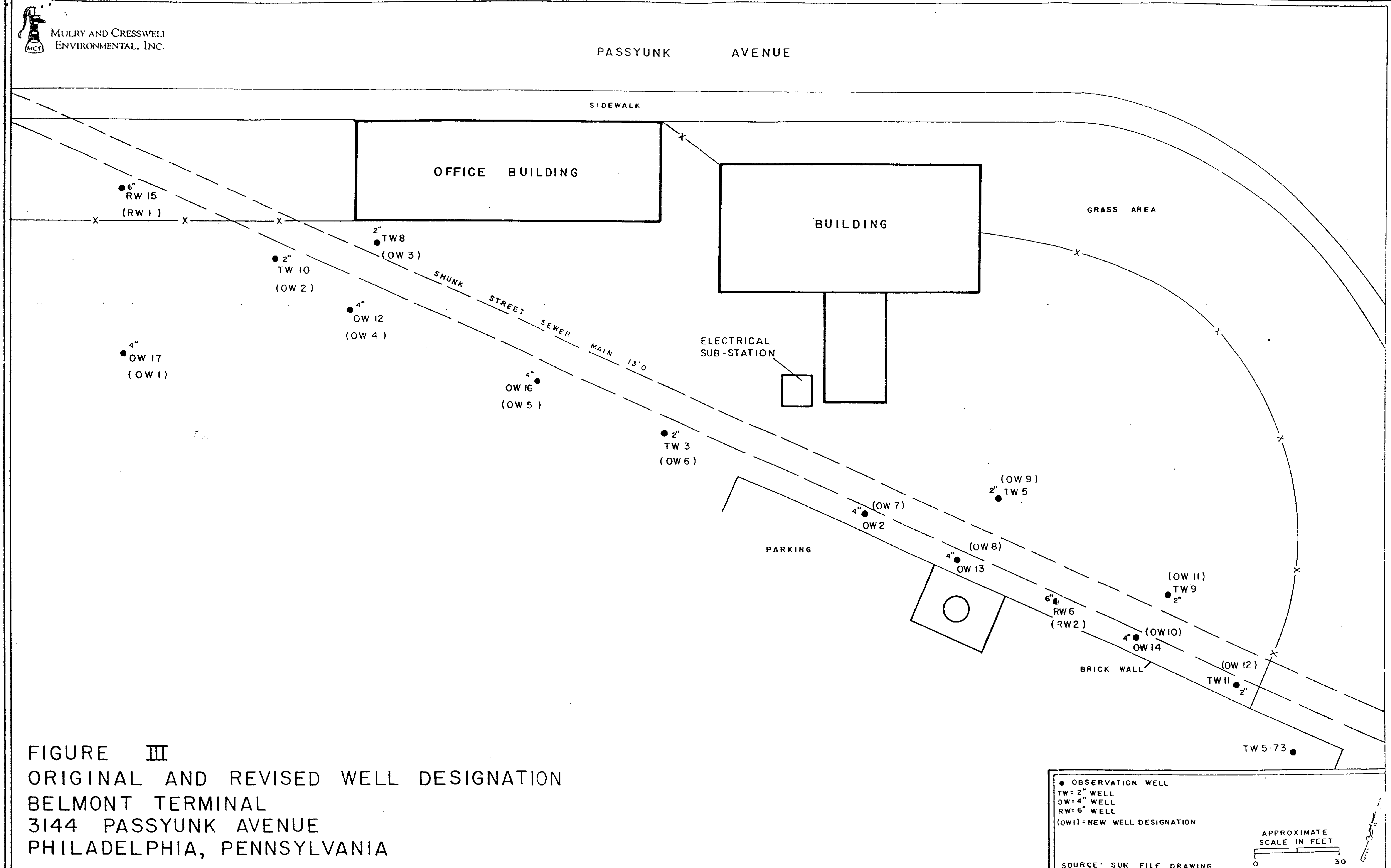


FIGURE III
ORIGINAL AND REVISED WELL DESIGNATION
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

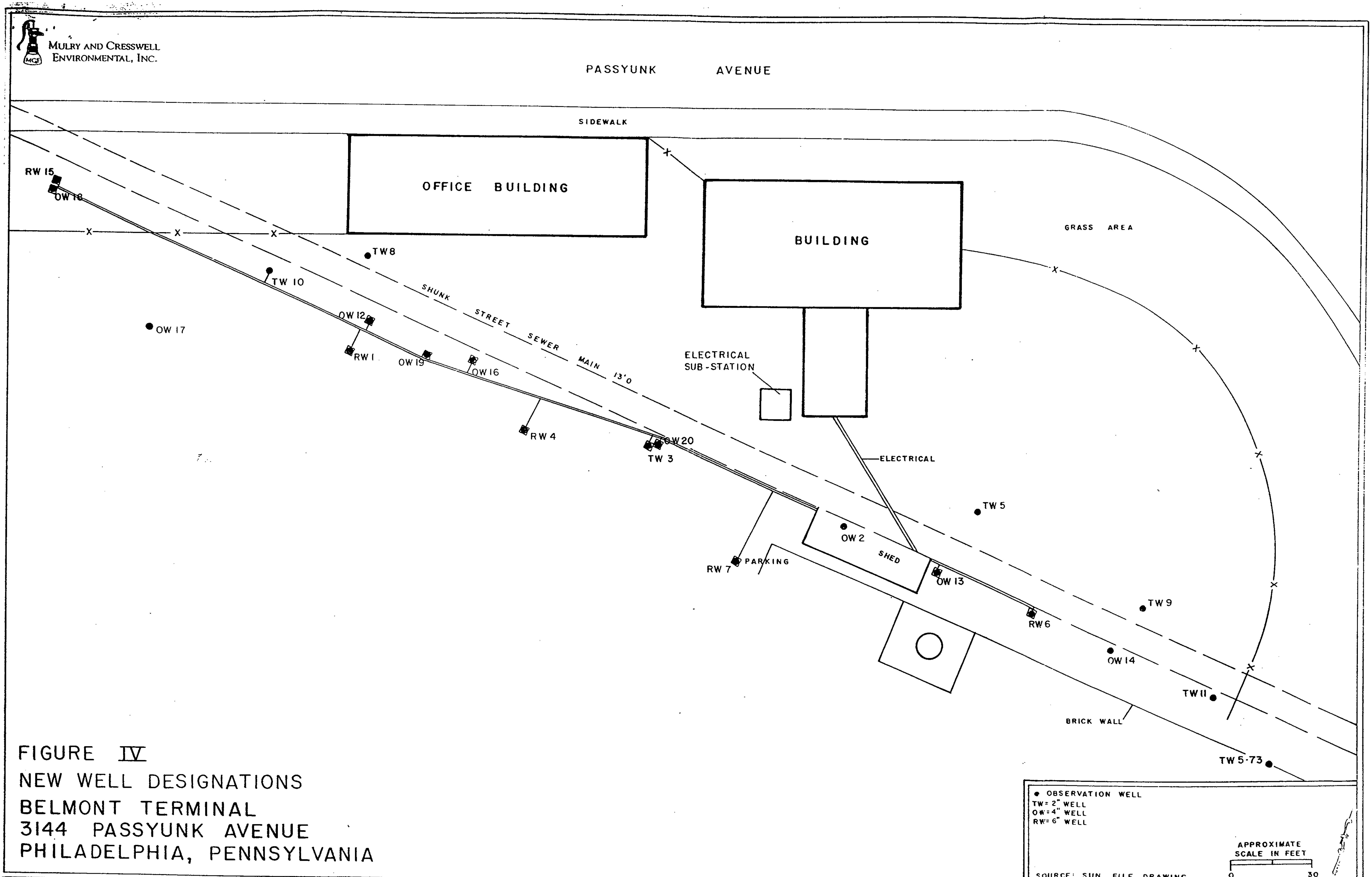
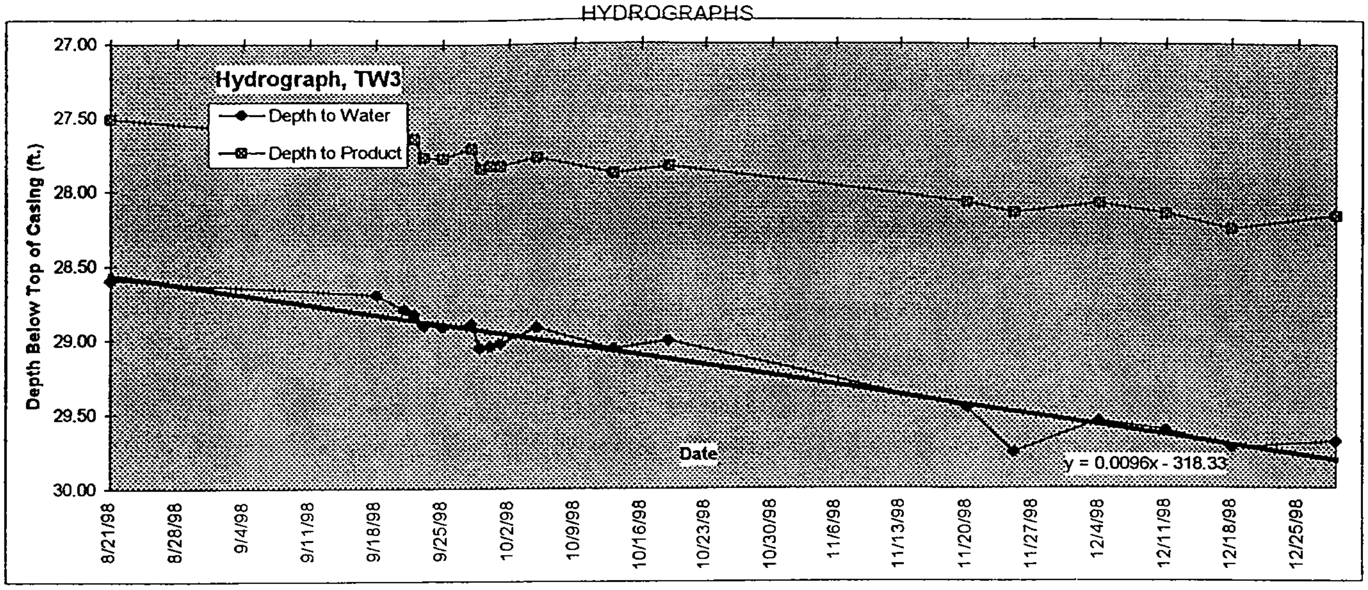
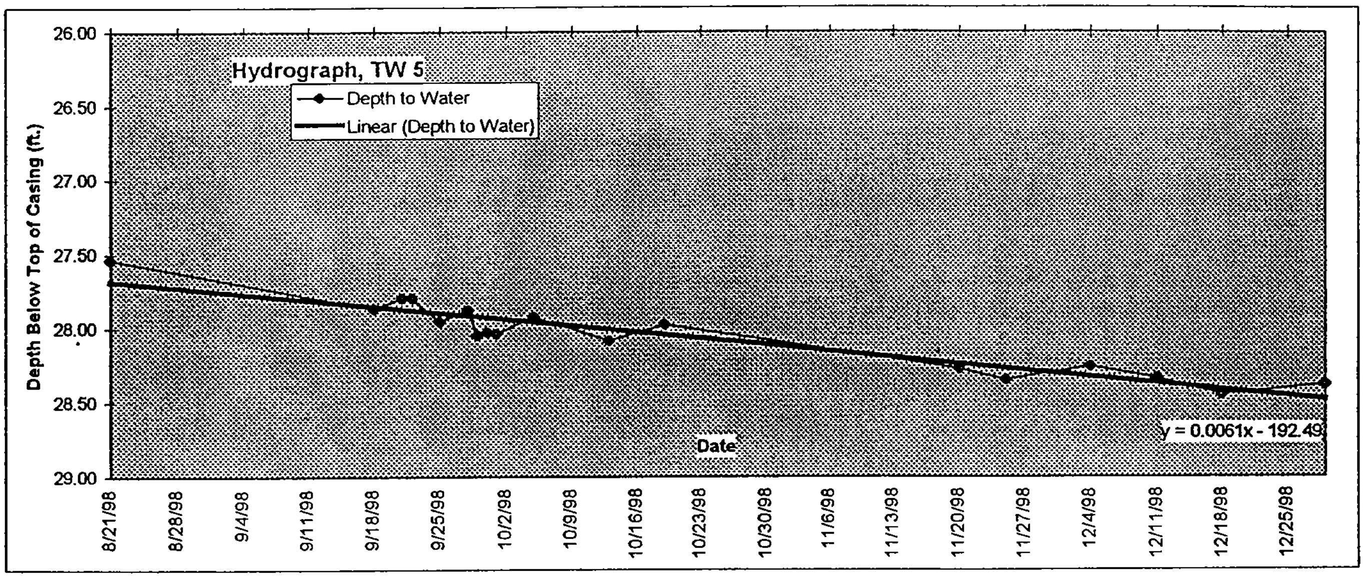


FIGURE IV
NEW WELL DESIGNATIONS
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





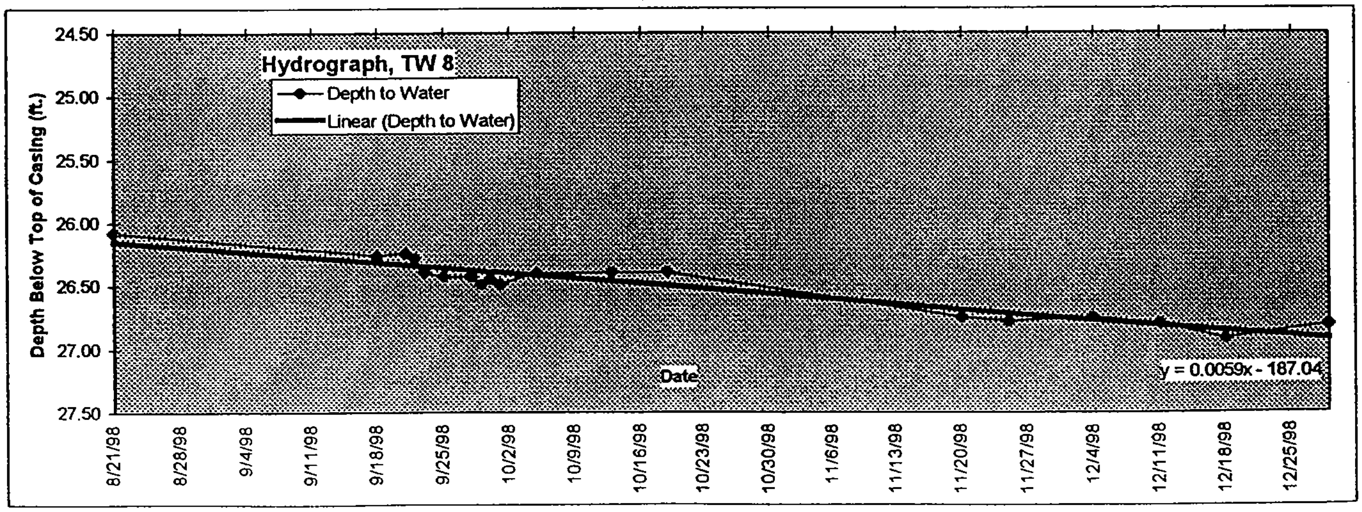
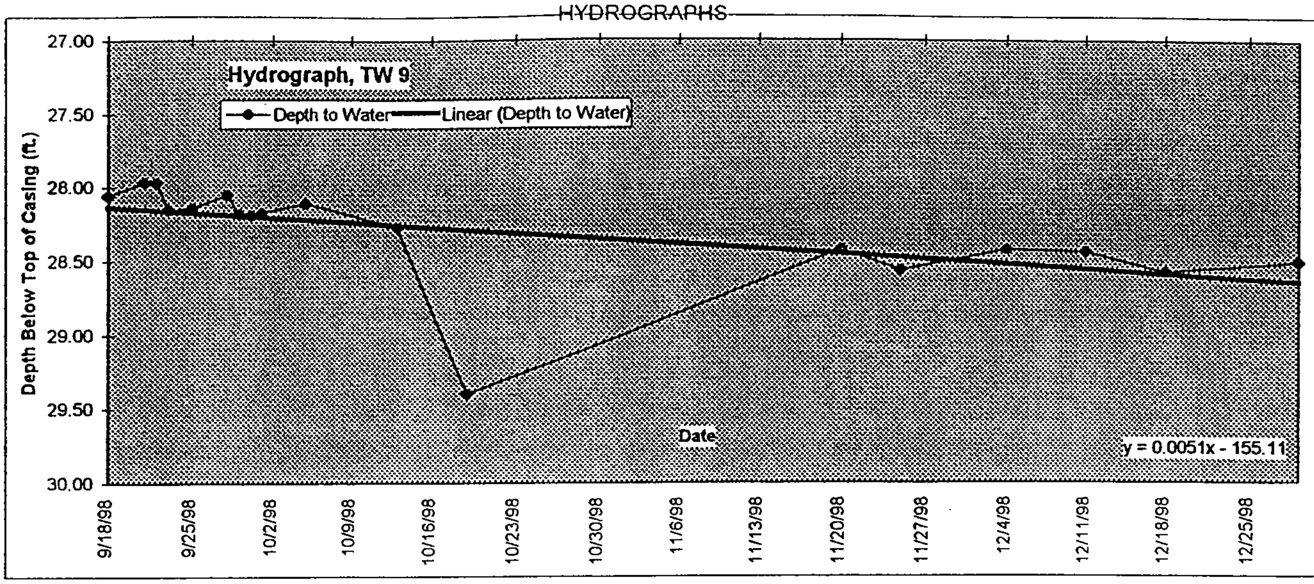
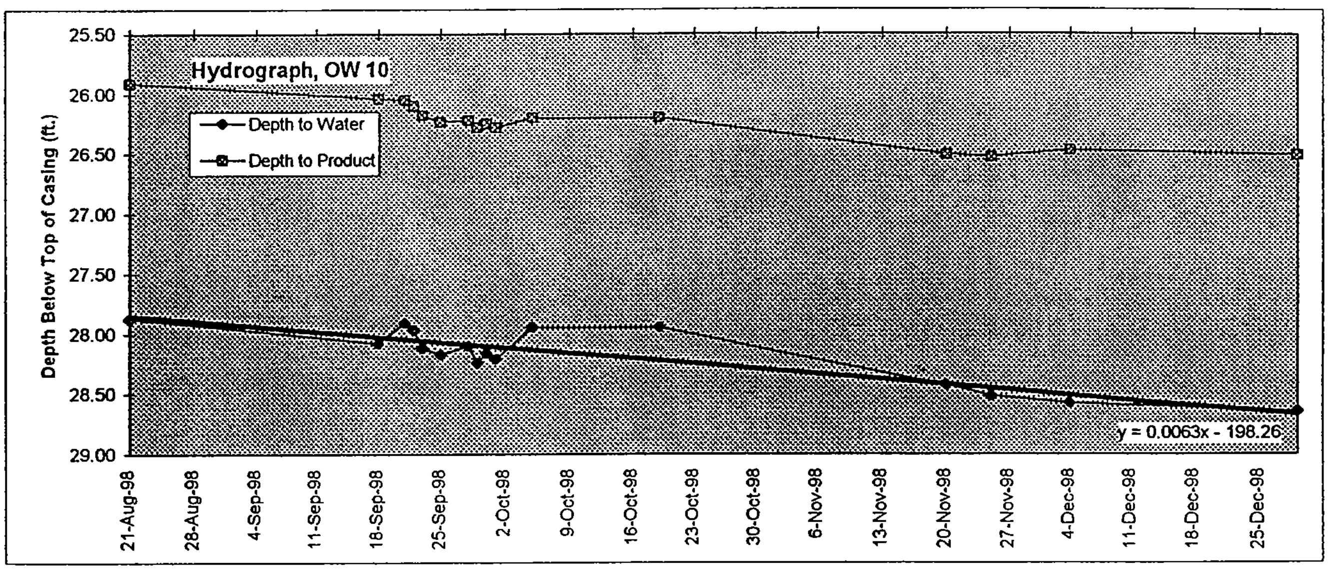


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





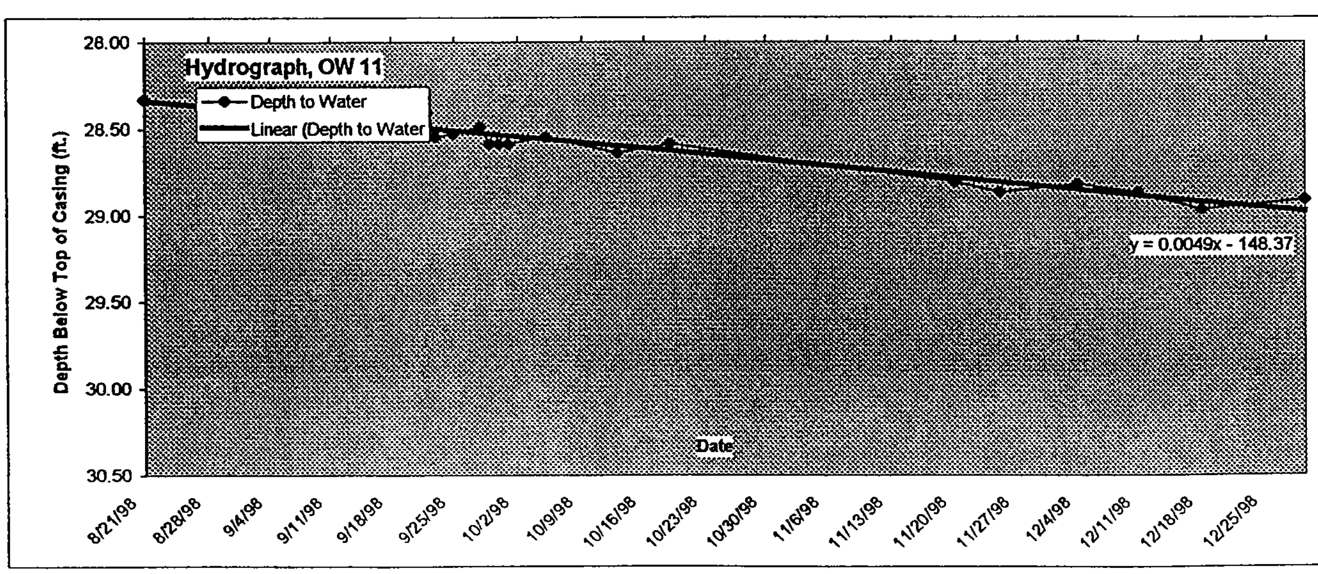
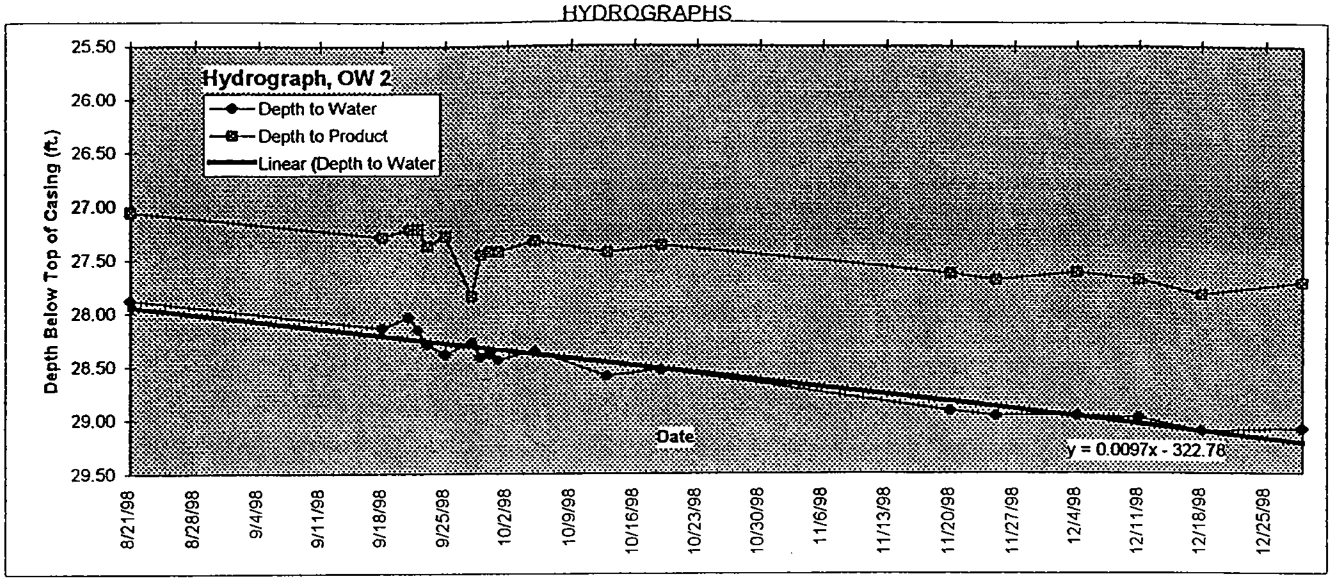
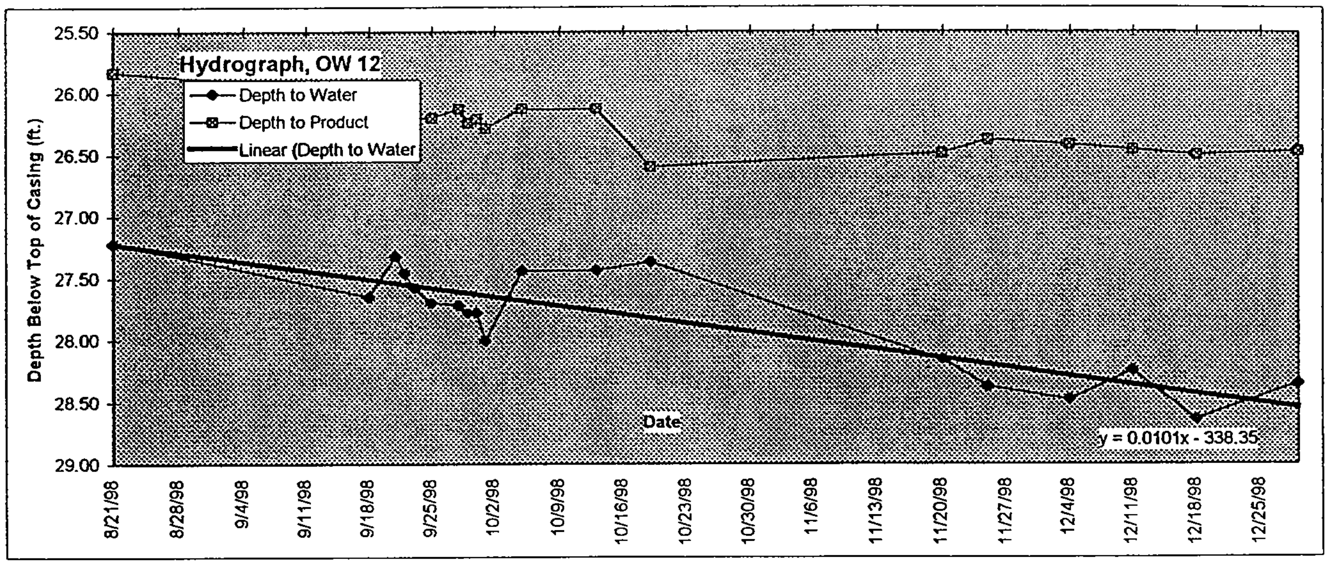


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





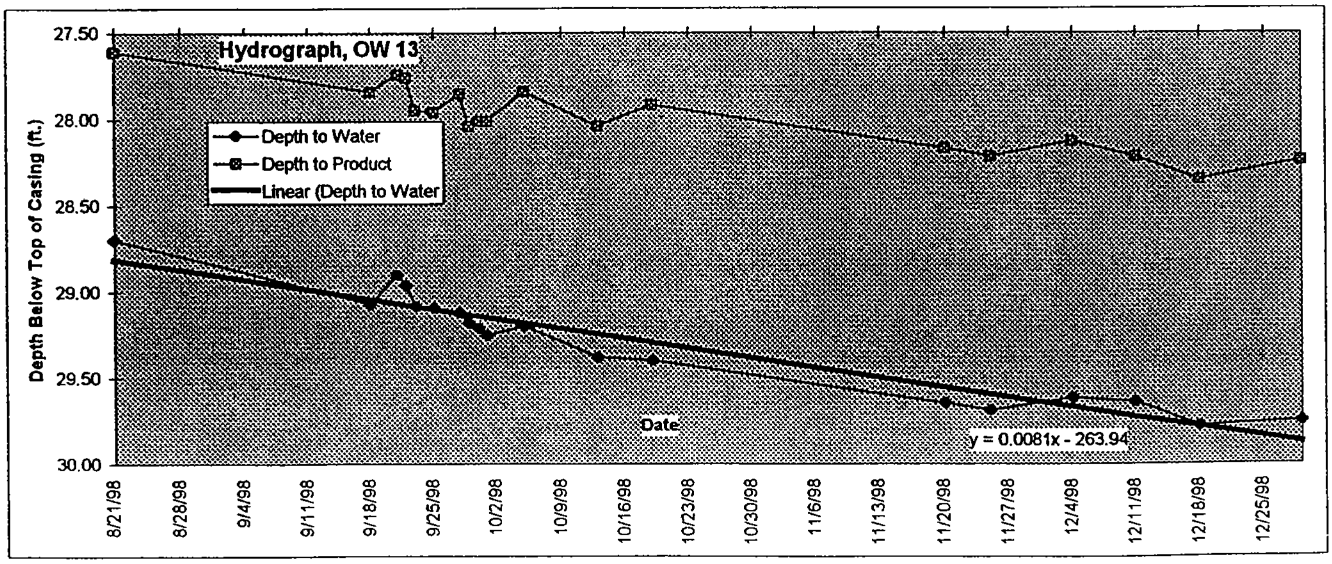
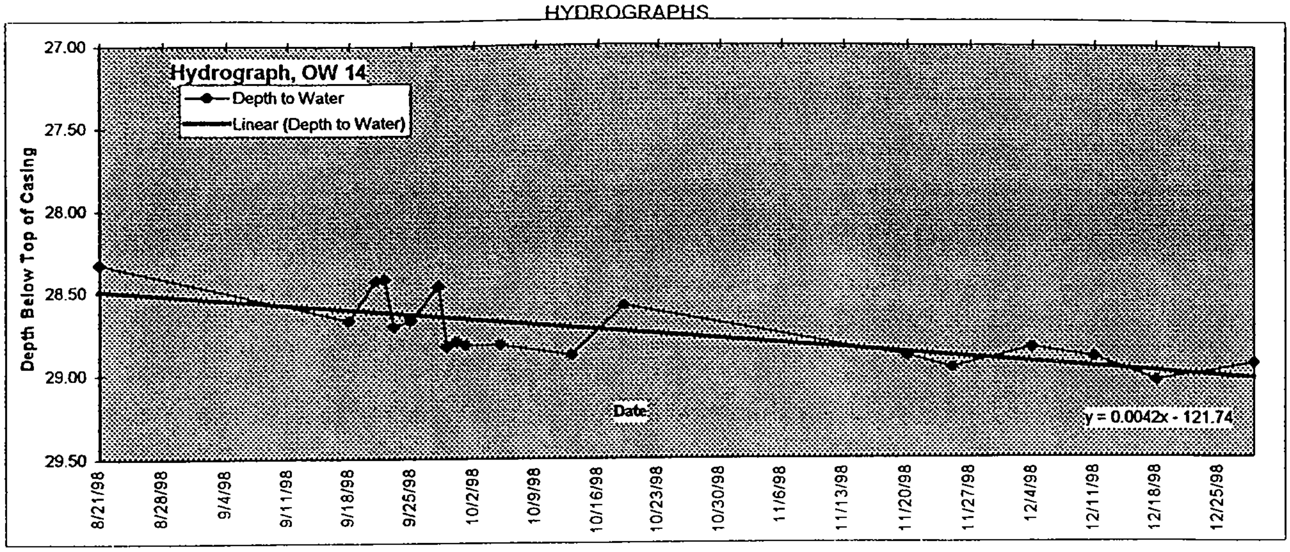
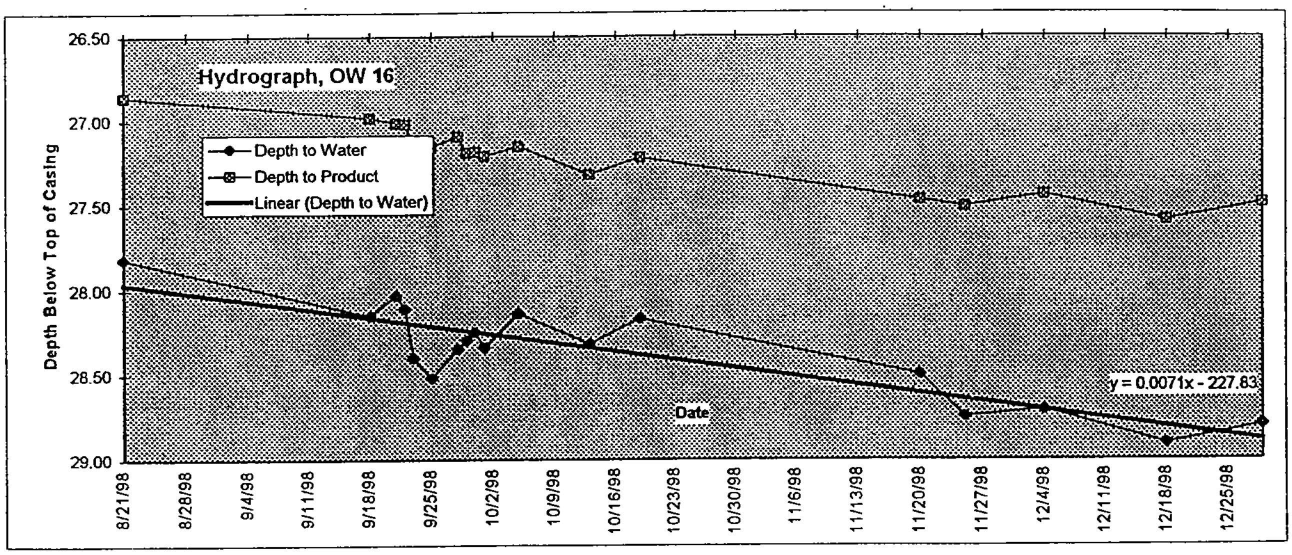


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





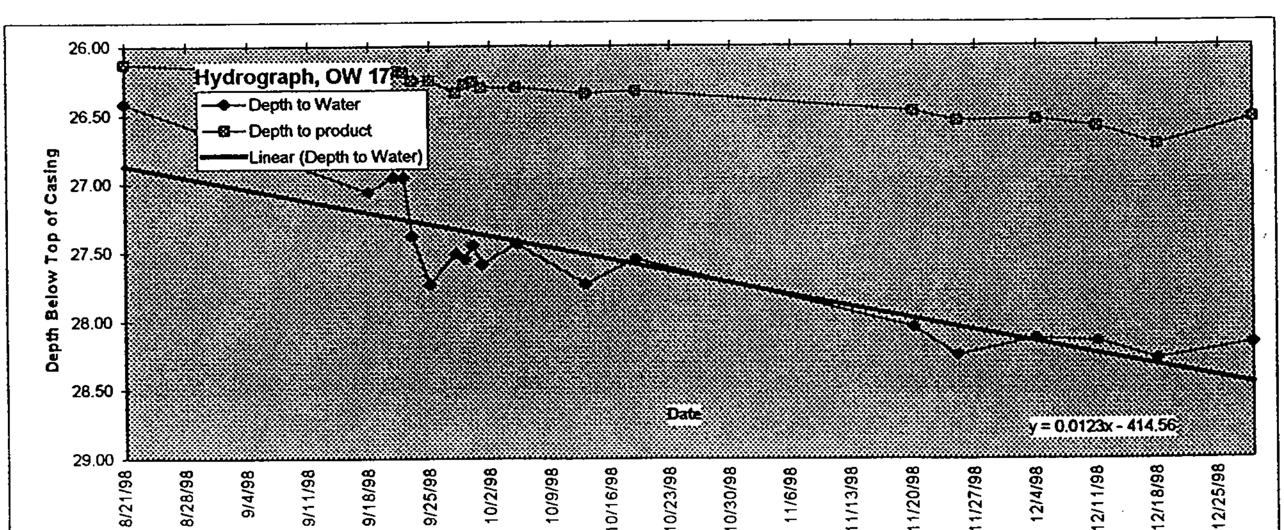
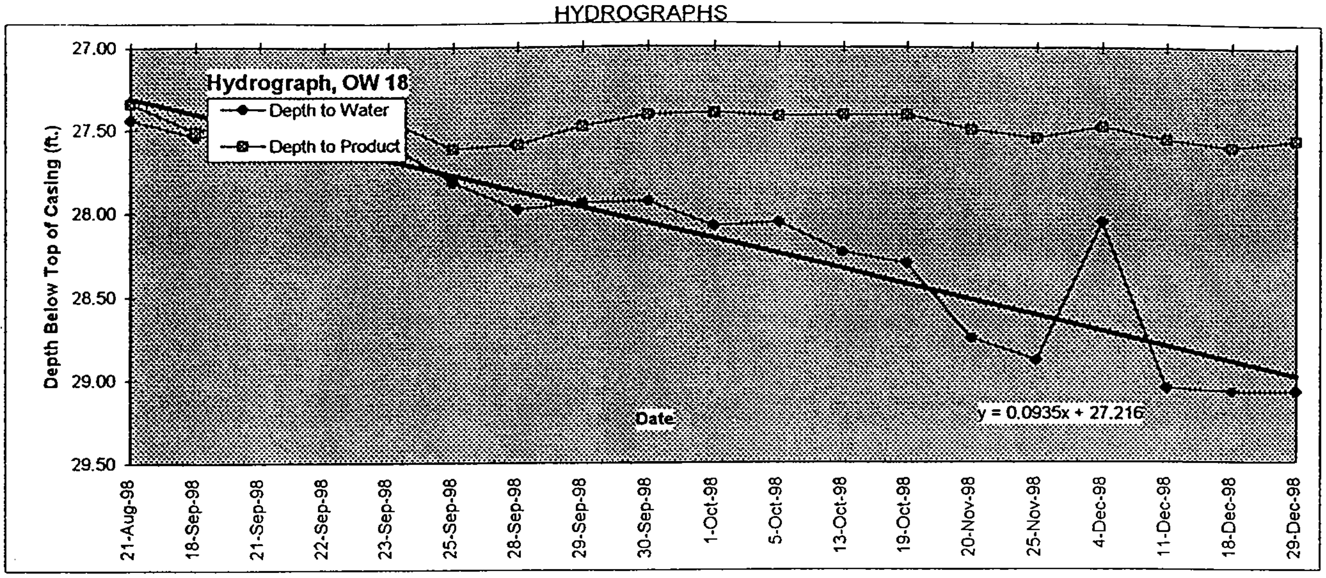
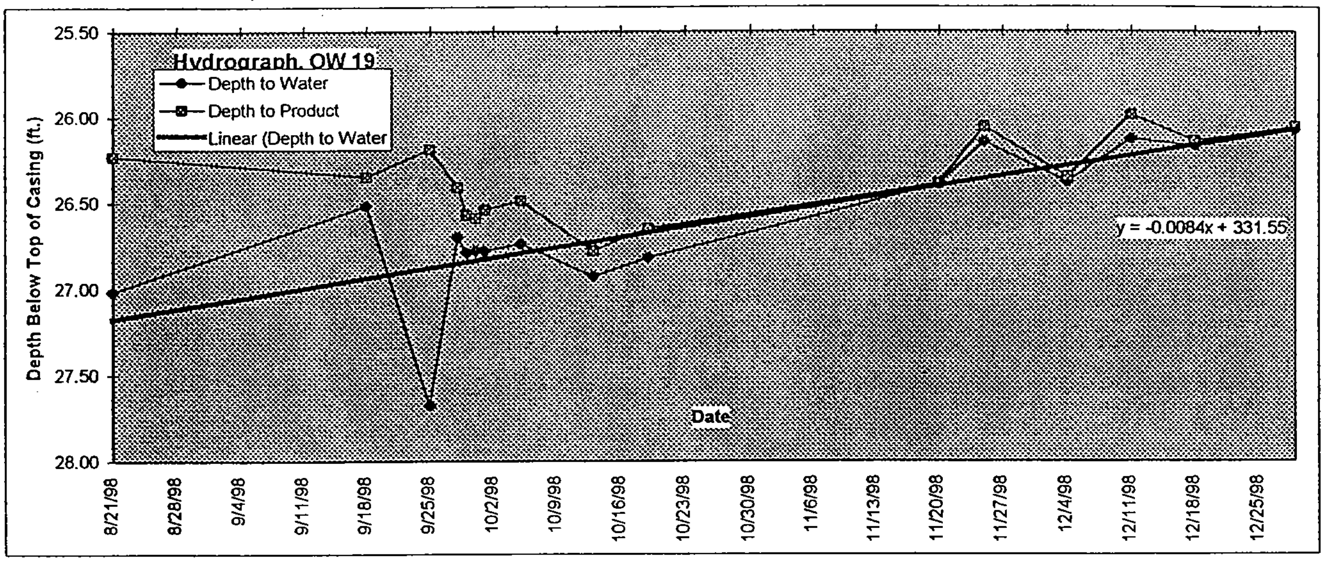


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





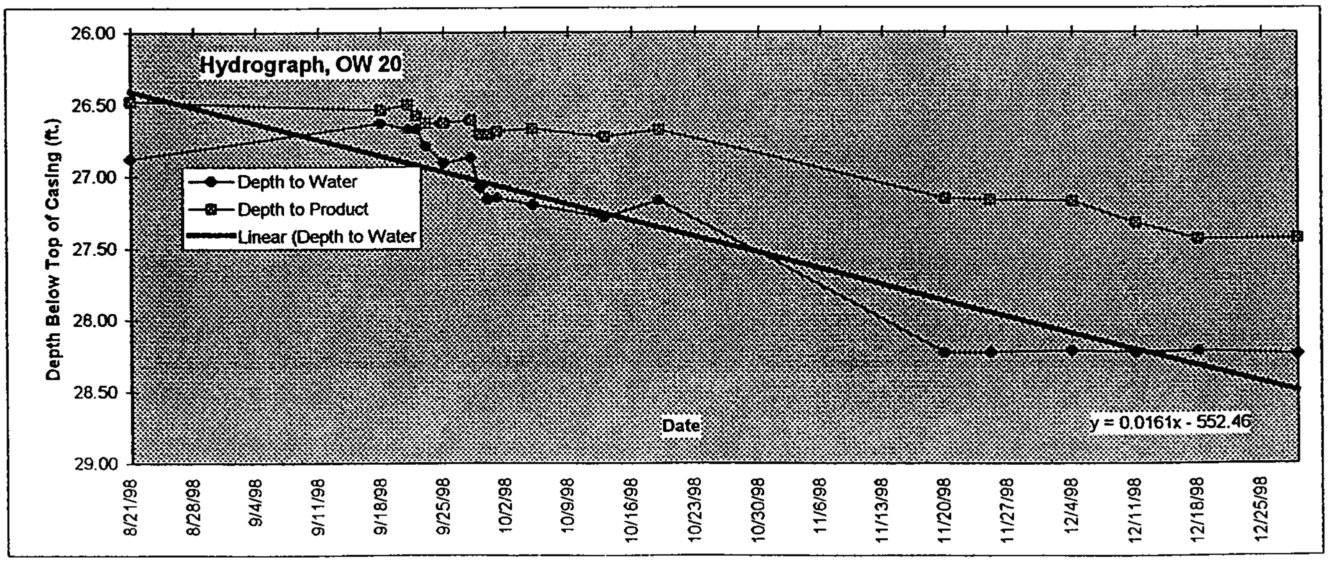
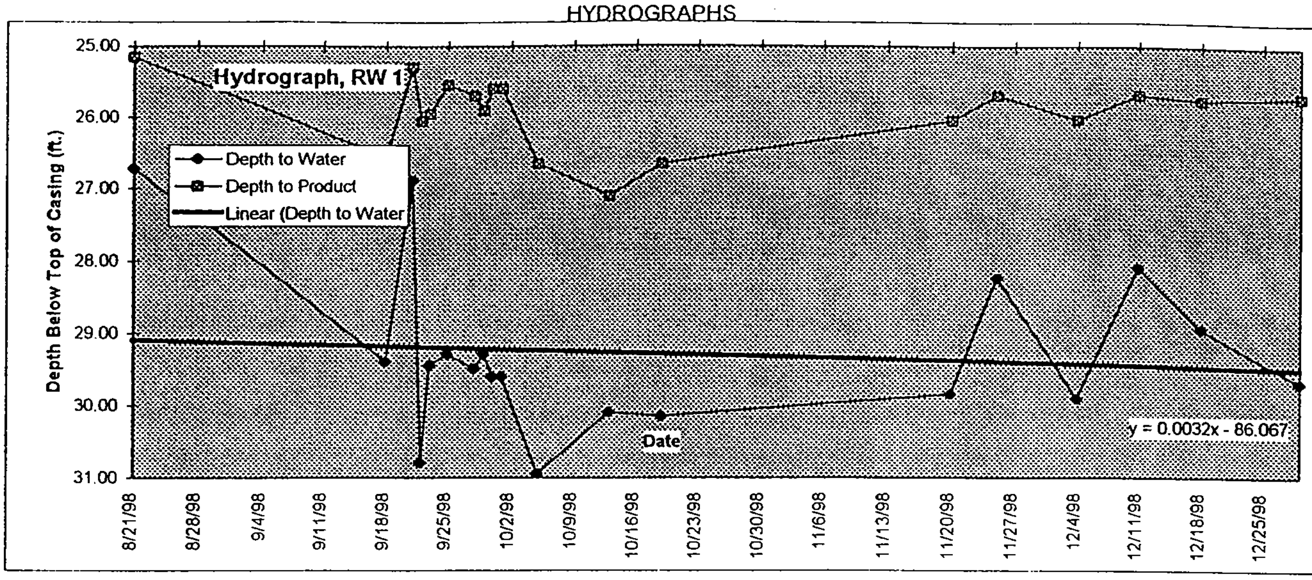
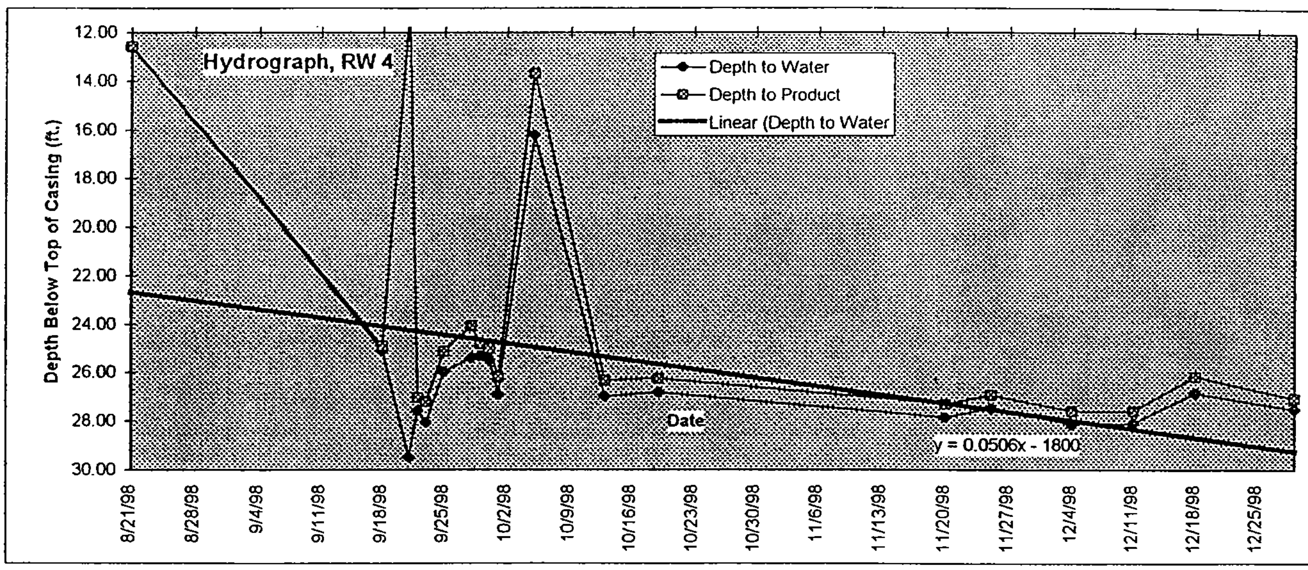


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





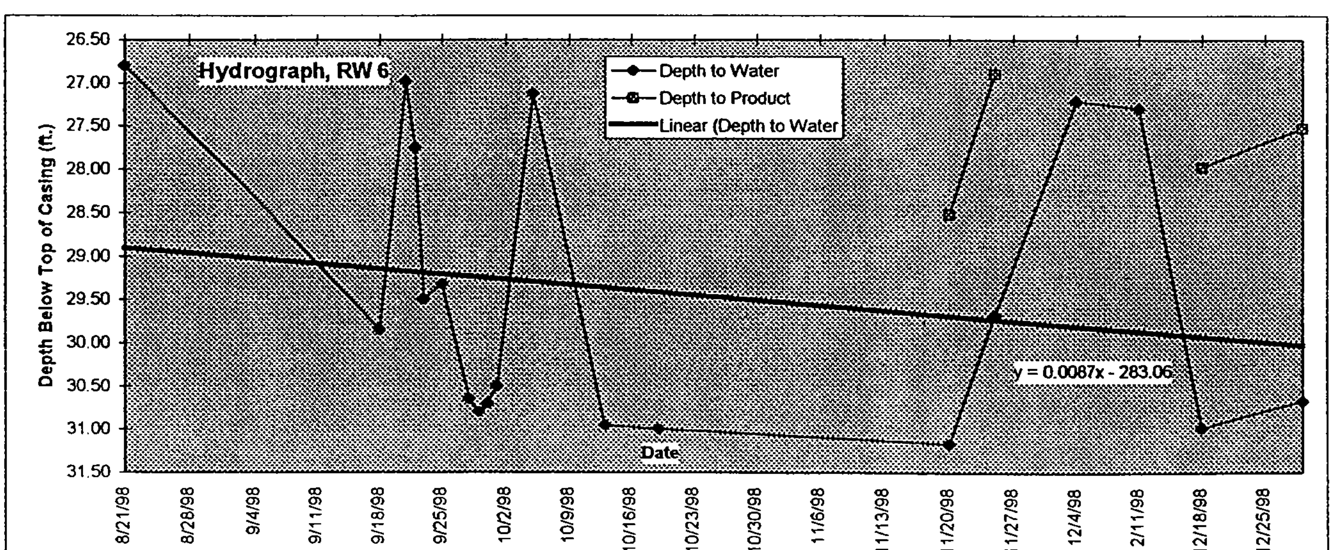
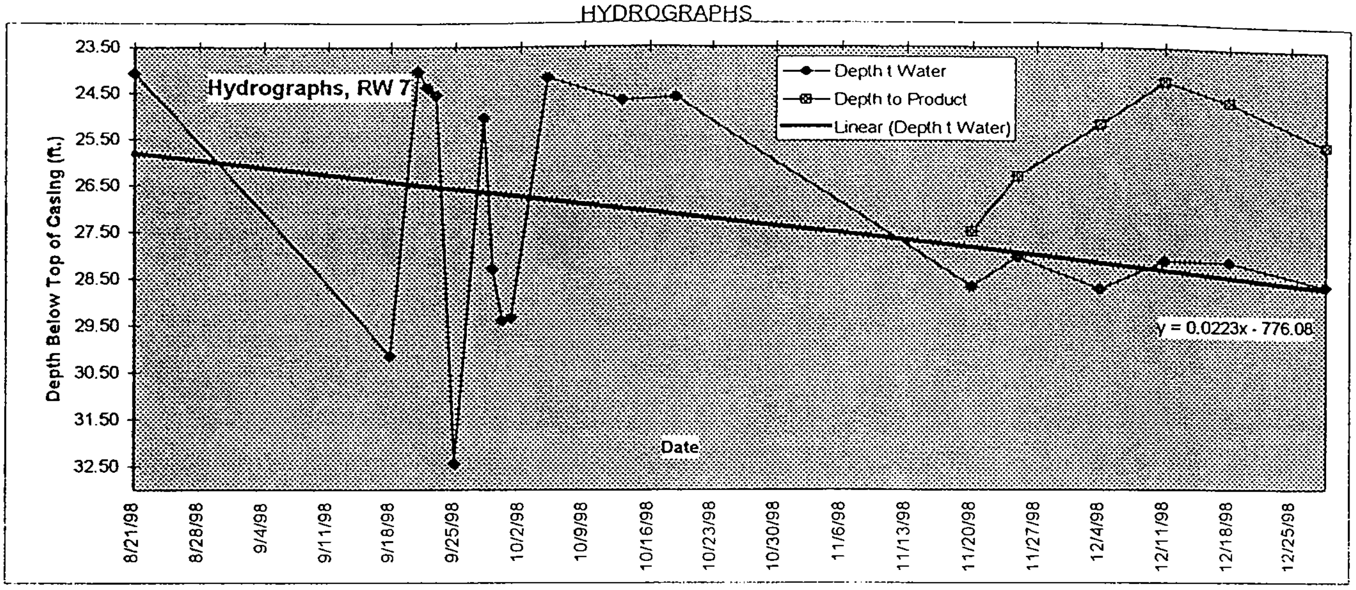
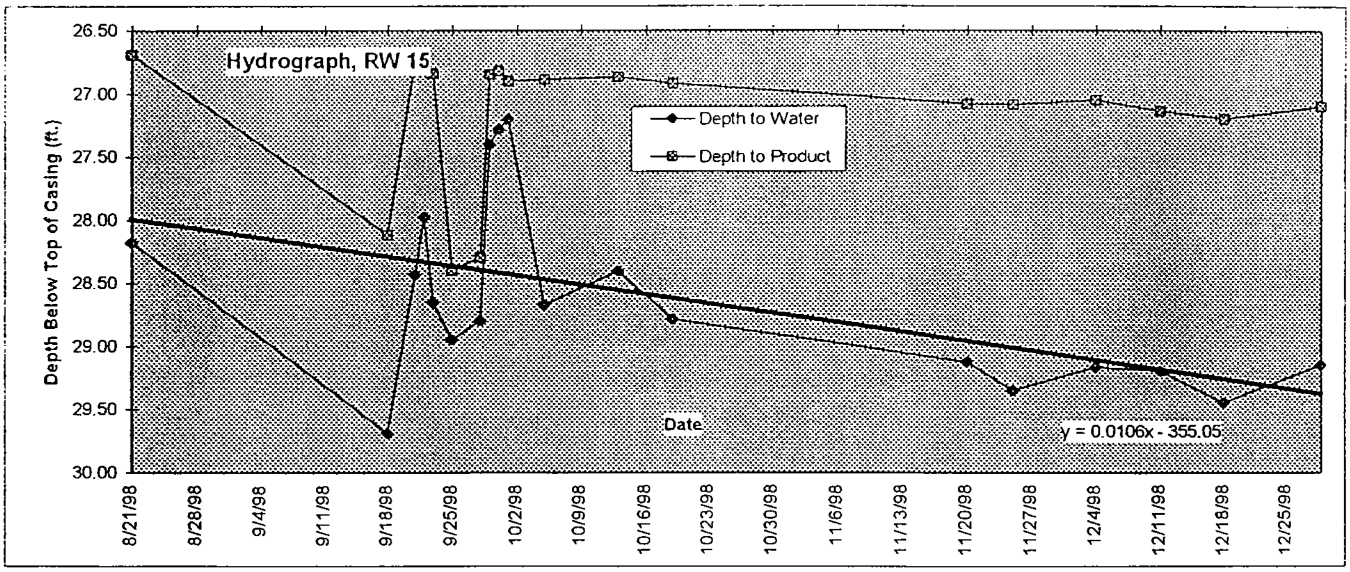


Figure V:

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.
Shunk Street Sewer Remediation project
HYDROGRAPHS





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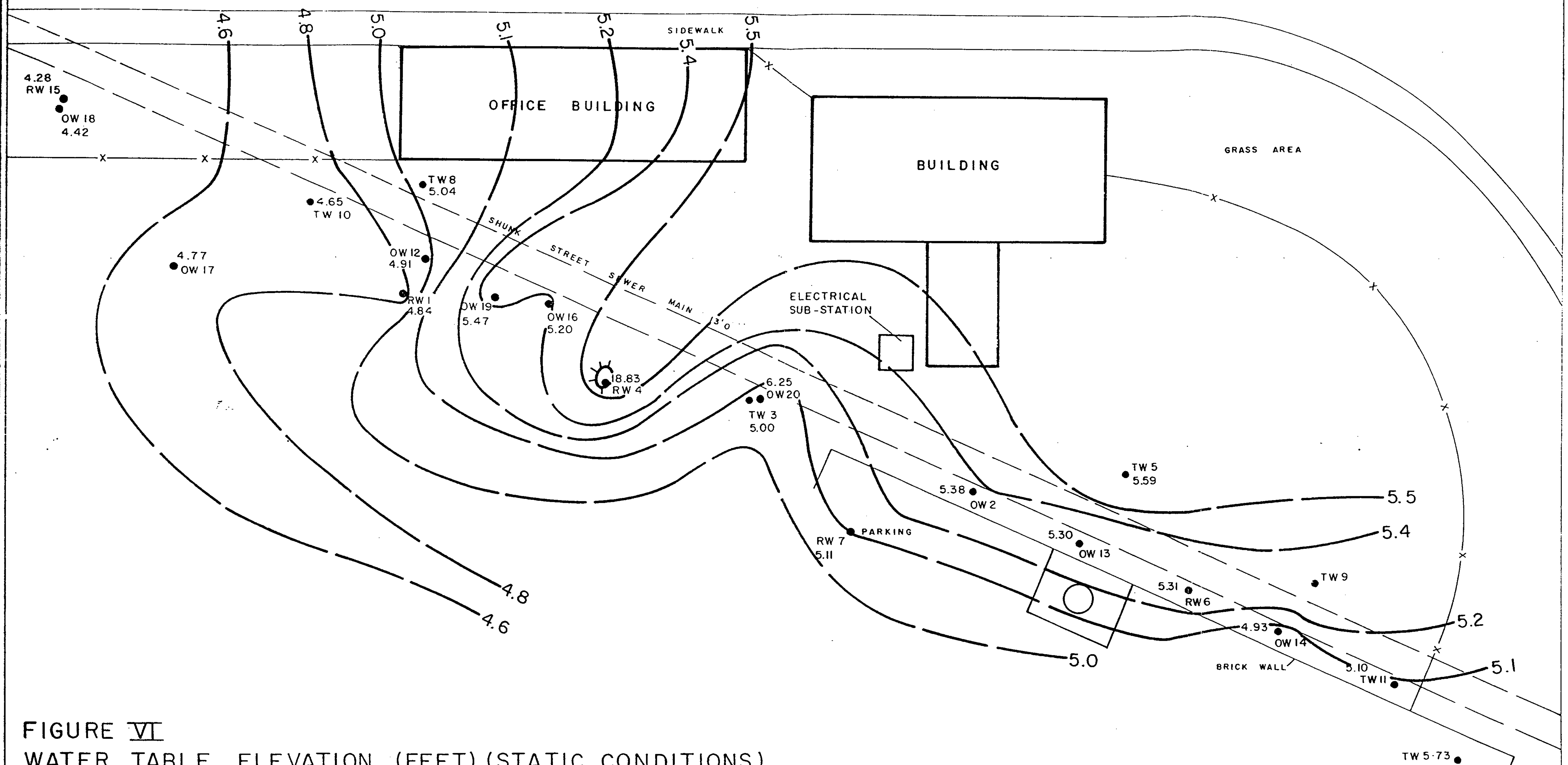


● OBSERVATION WELL
TW = 2" WELL
OW = 4" WELL
RW = 6" WELL

APPROXIMATE SCALE IN FEET
0 30

SOURCE: SUN FILE DRAWING

FIGURE VI
WATER TABLE ELEVATION (FEET) (STATIC CONDITIONS)
21 AUGUST 1998
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

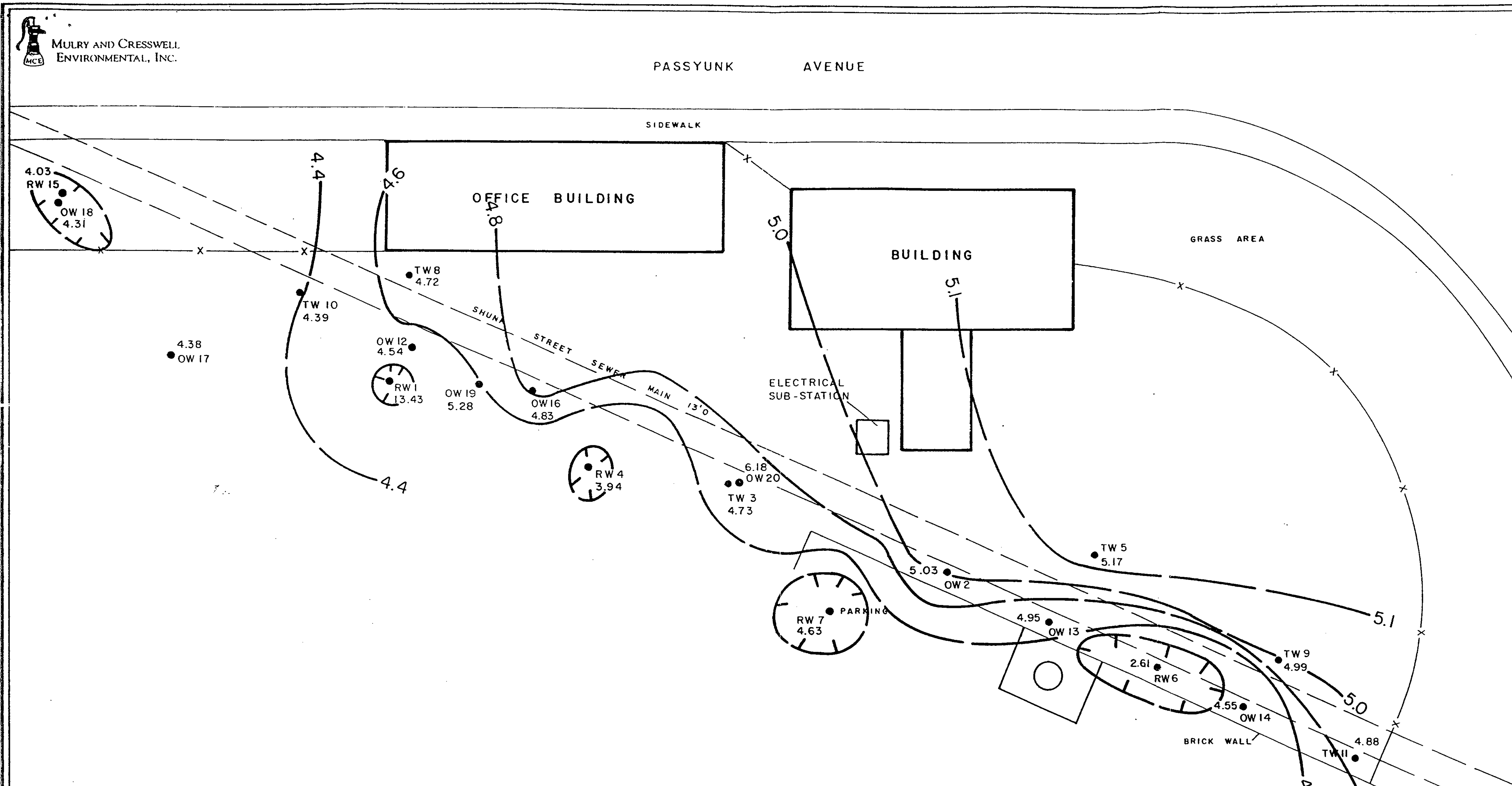


FIGURE VII
WATER TABLE ELEVATION (FEET) (PUMPING CONDITIONS)
23 SEPTEMBER 1998
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

● OBSERVATION WELL
TW= 2" WELL
OW= 4" WELL
RW= 6" WELL

APPROXIMATE SCALE IN FEET 0 30

SOURCE: SUN FILE DRAWING

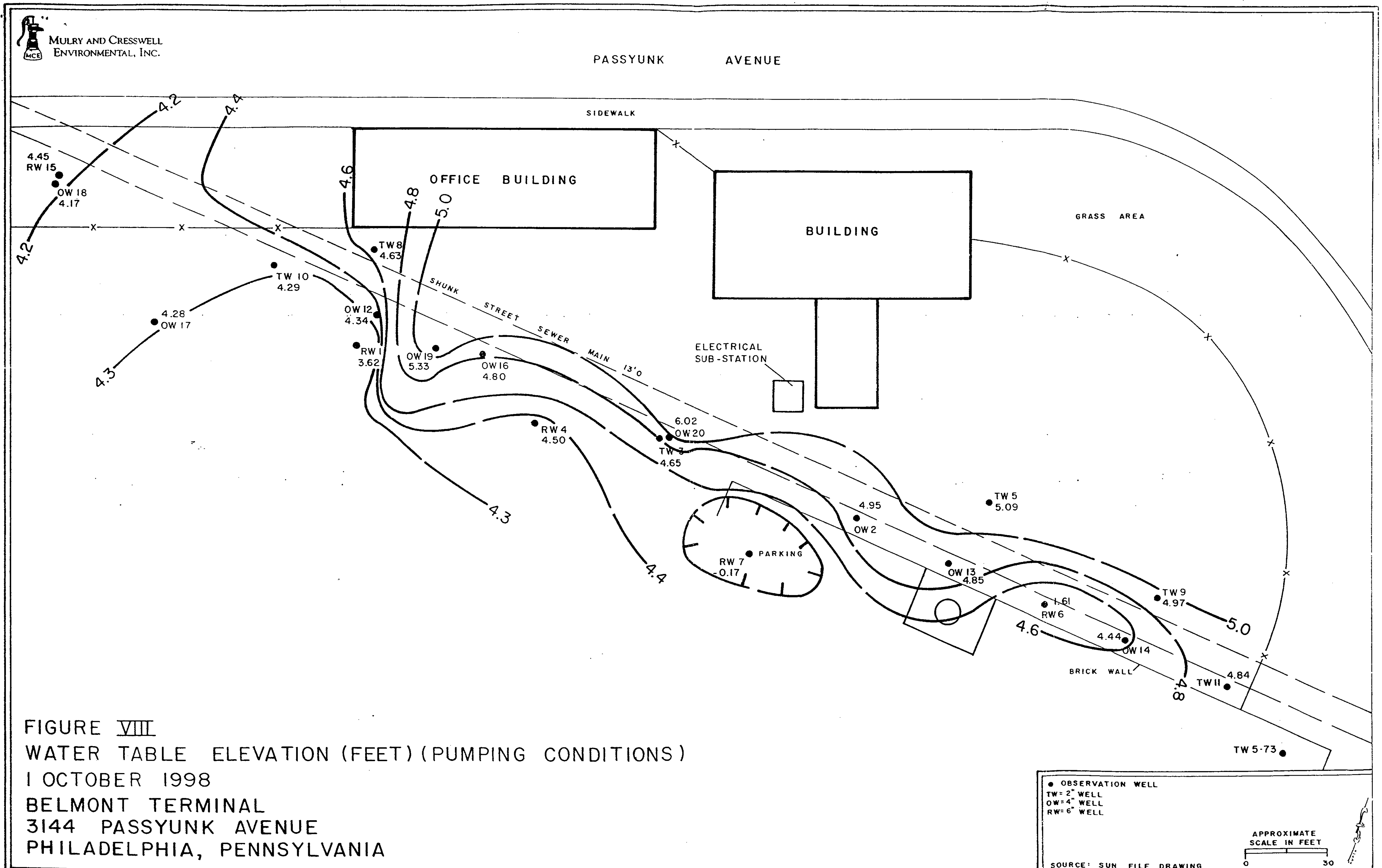


FIGURE VIII
WATER TABLE ELEVATION (FEET) (PUMPING CONDITIONS)
1 OCTOBER 1998
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

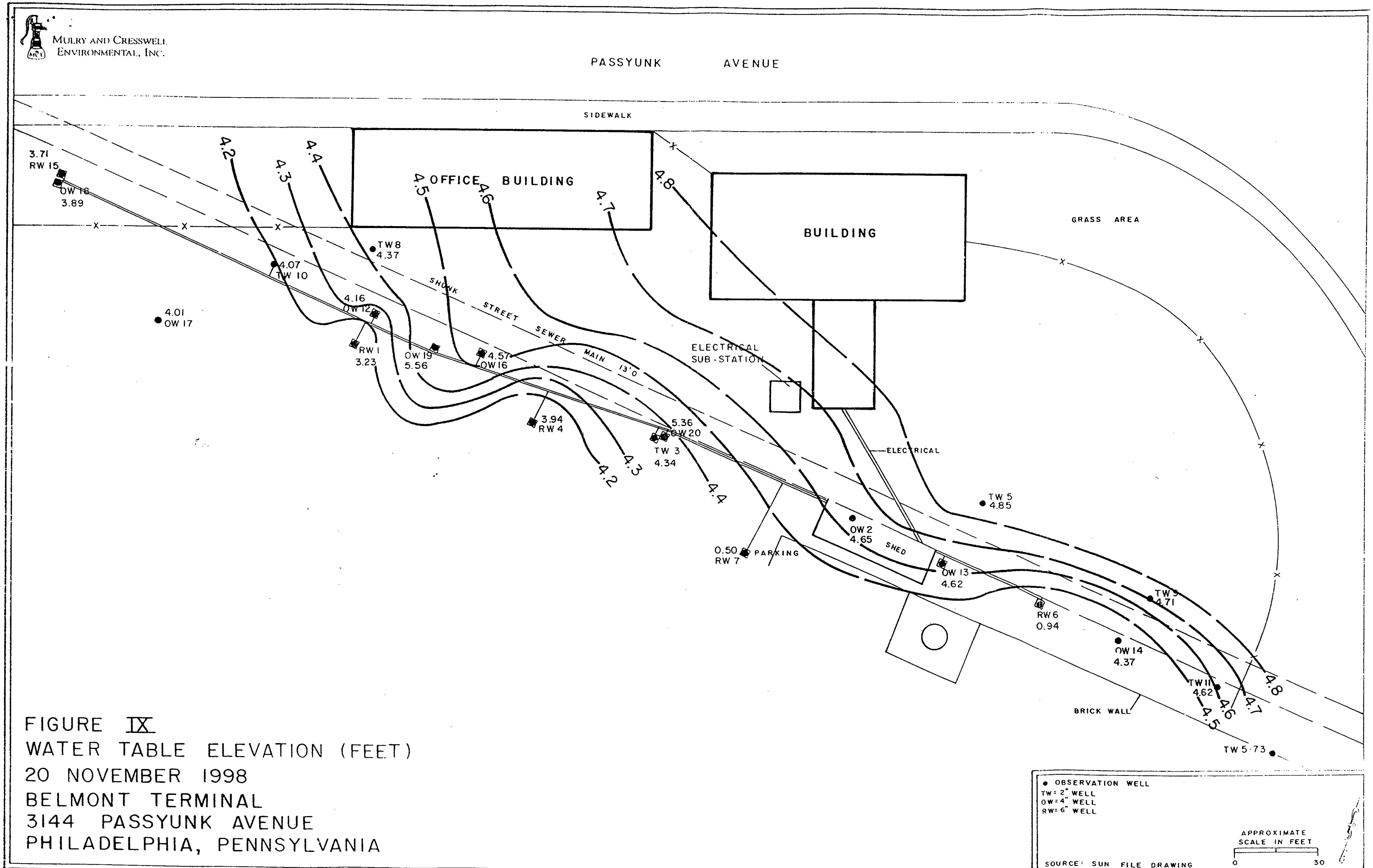


FIGURE IX
WATER TABLE ELEVATION (FEET)
20 NOVEMBER 1998
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

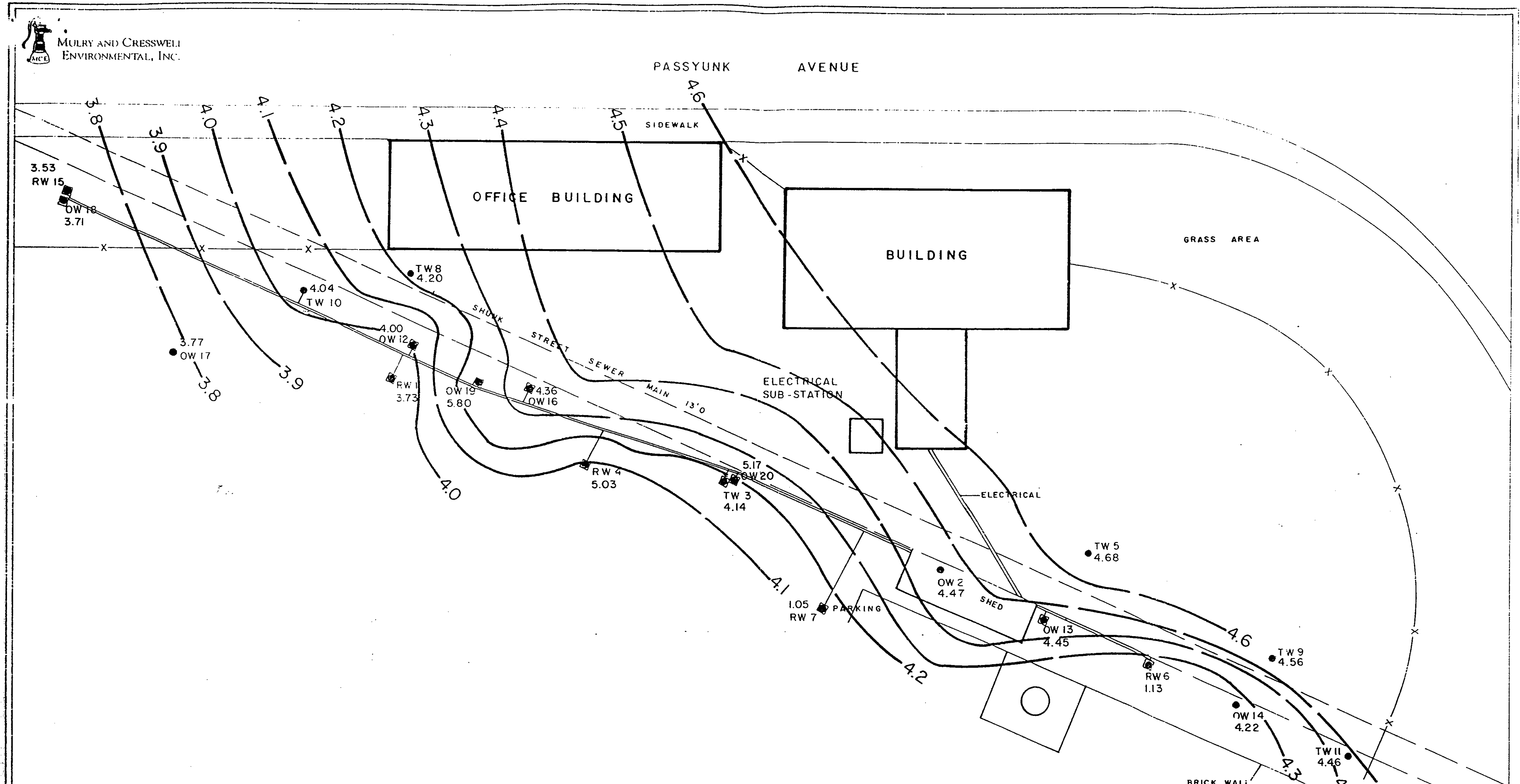


FIGURE X
WATER TABLE ELEVATION (FEET)
18 DECEMBER 1998
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

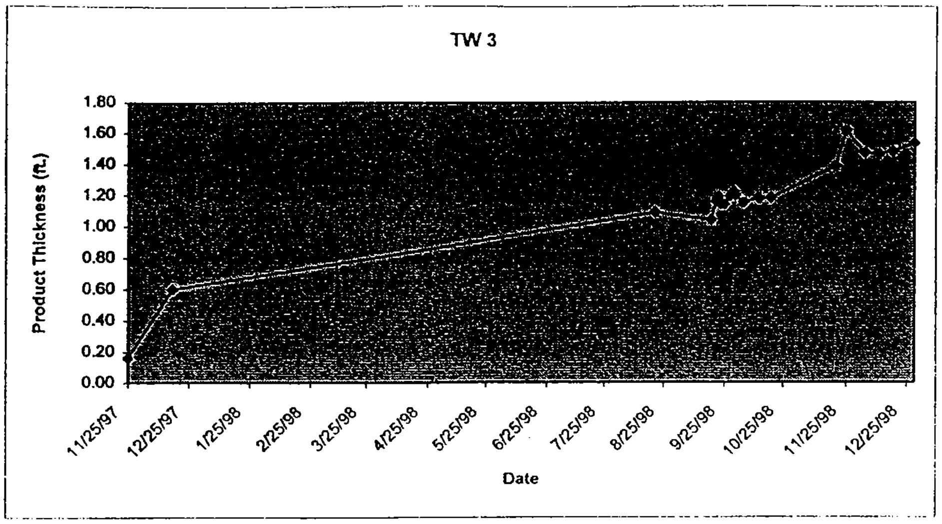
● OBSERVATION WELL
TW = 2" WELL
OW = 4" WELL
RW = 6" WELL

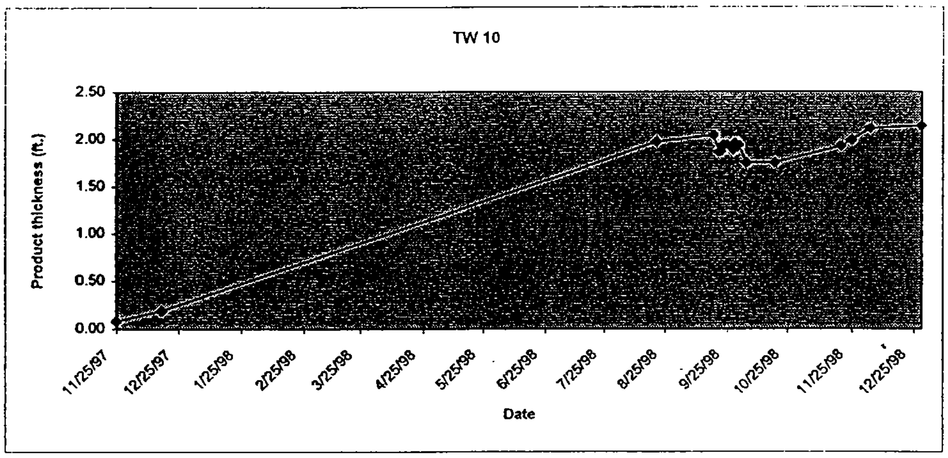
APPROXIMATE SCALE IN FEET
0 — 30

SOURCE: SUN FILE DRAWING

Figure XI

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.,
Shunk Street Sewer Remediation Project
Apparent product thickness (ft)





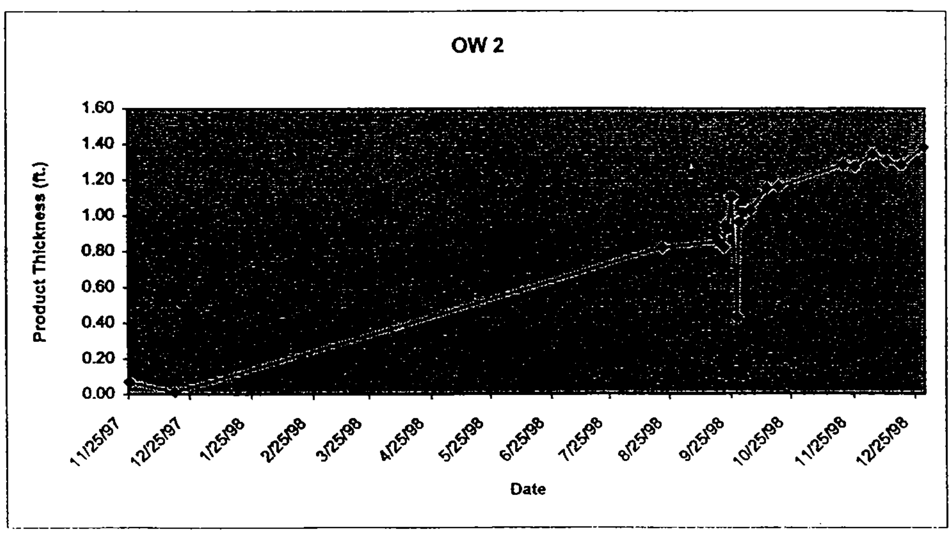
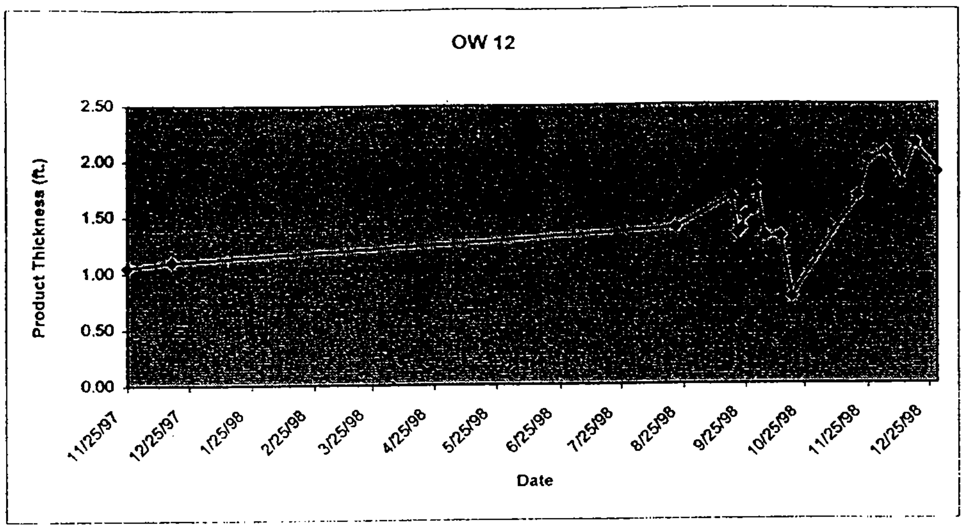
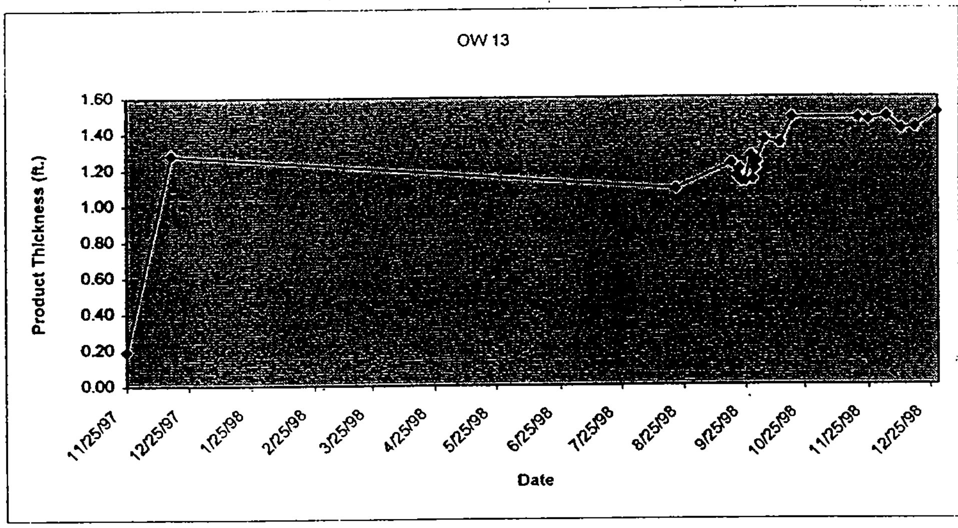


Figure XI

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.,
Shunk Street Sewer Remediation Project
Apparent product thickness (ft)





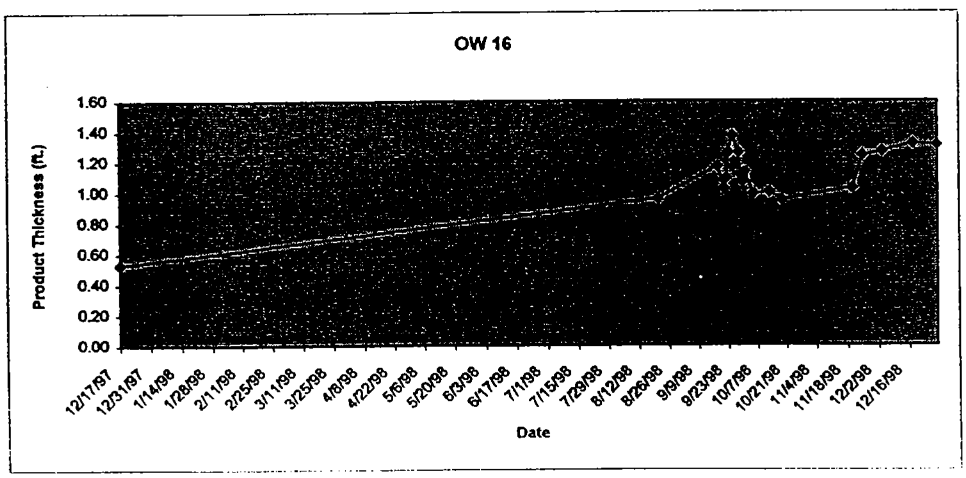
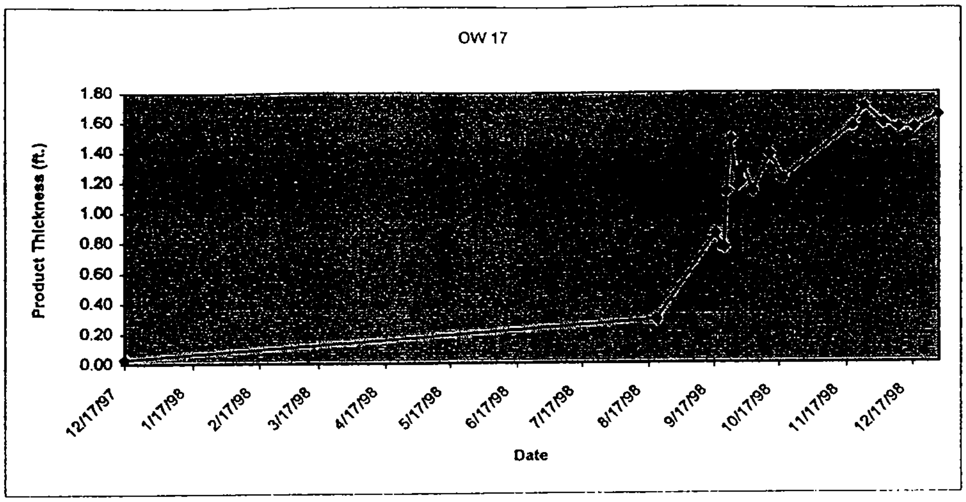
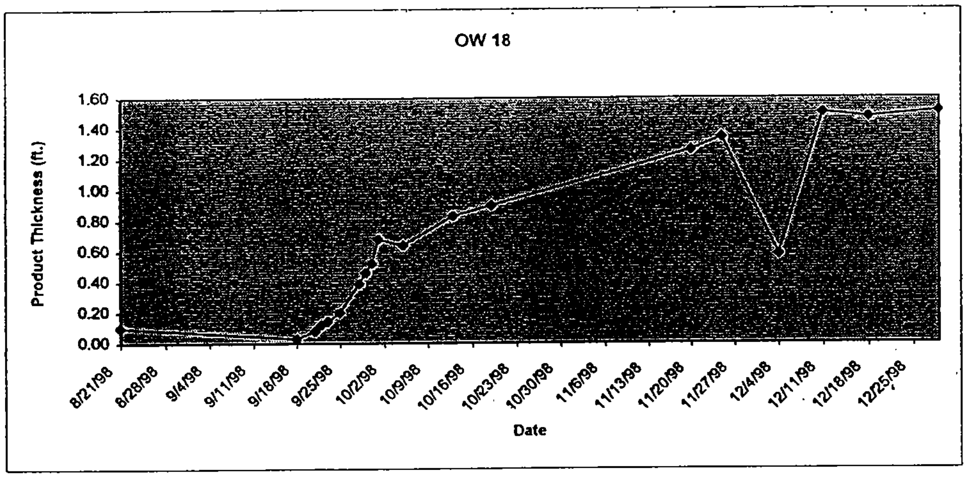


Figure XI

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.,
Shunk Street Sewer Remediation Project
Apparent product thickness (ft)





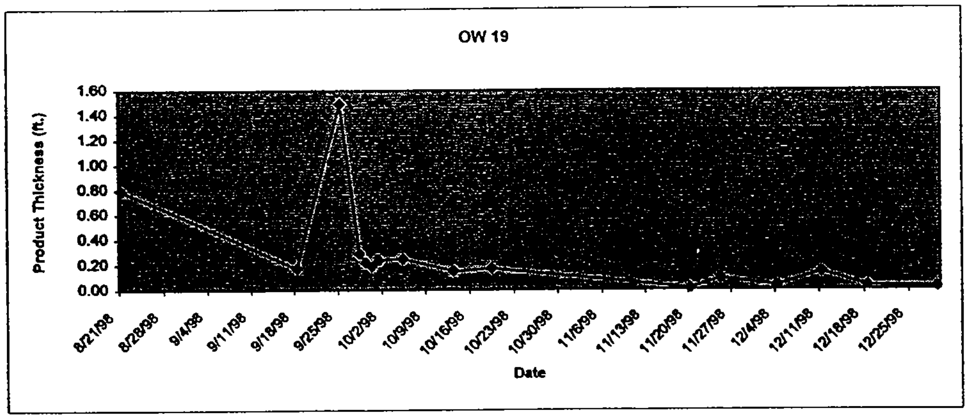
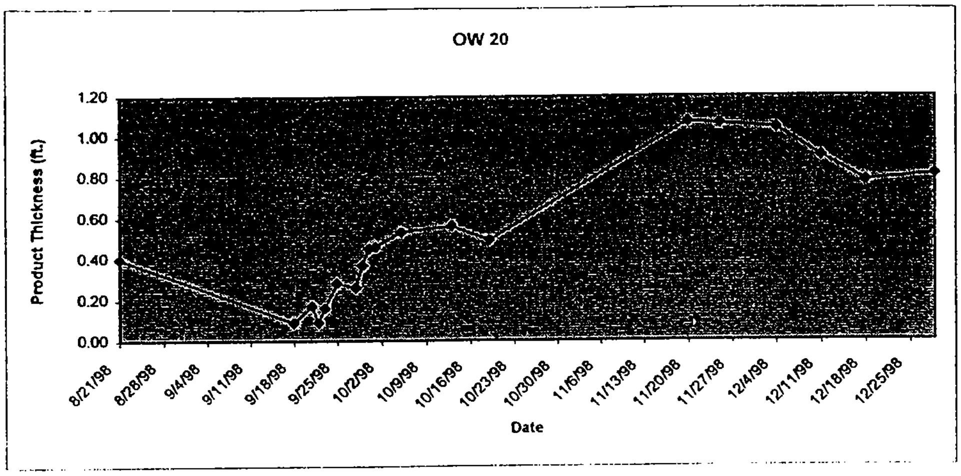
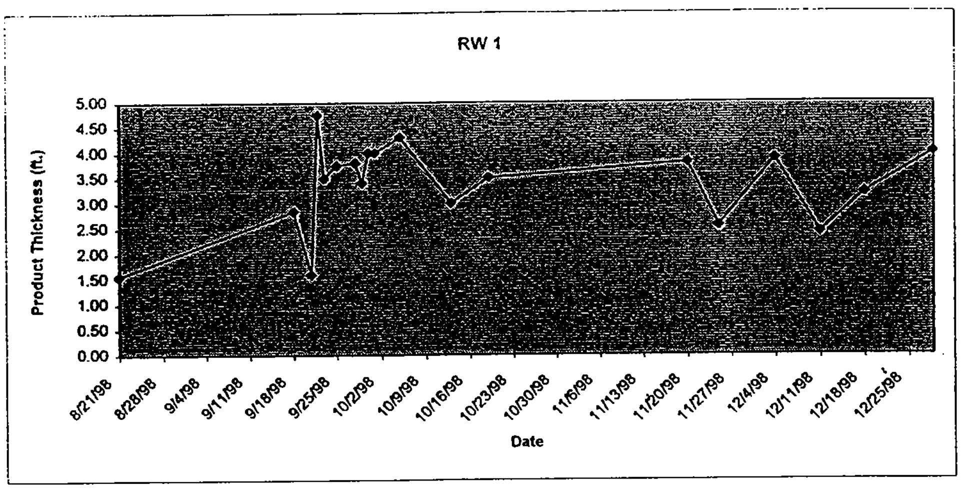


Figure XI

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.,
Shunk Street Sewer Remediation Project
Apparent product thickness (ft)





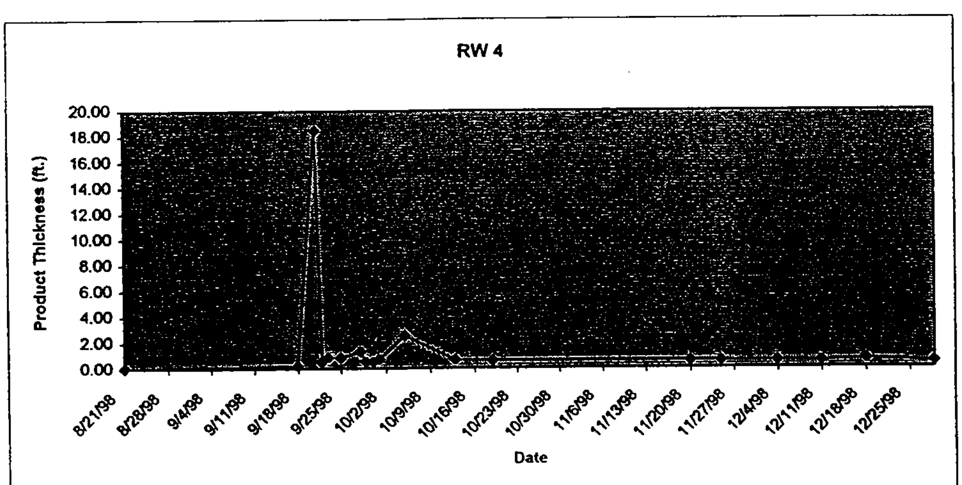
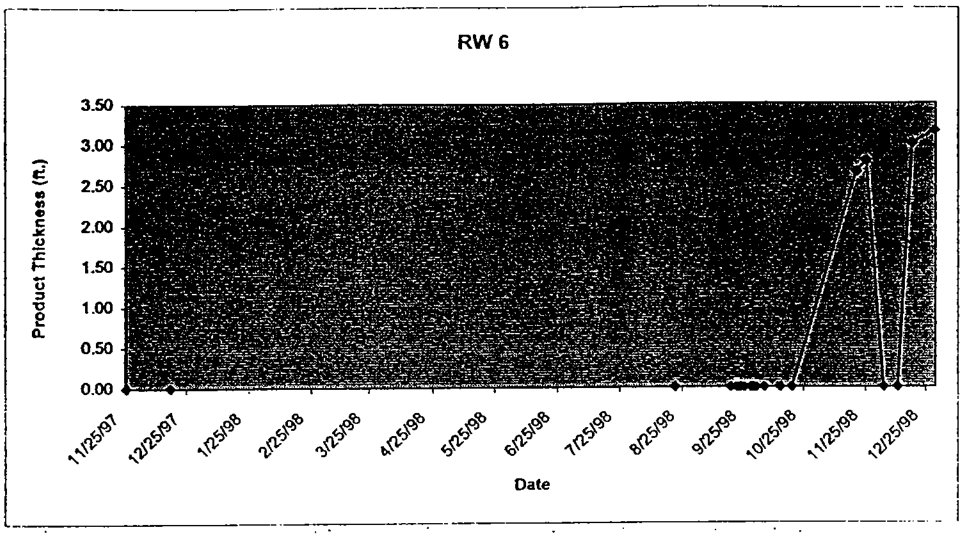
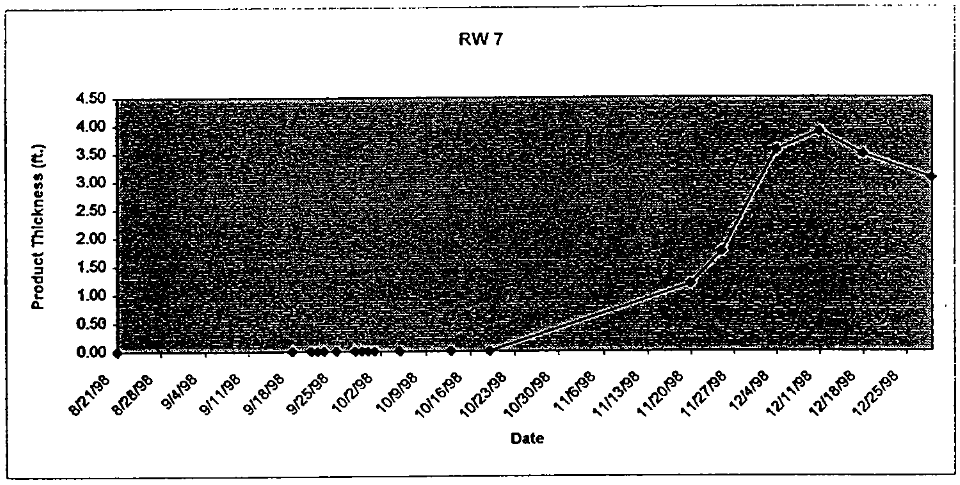
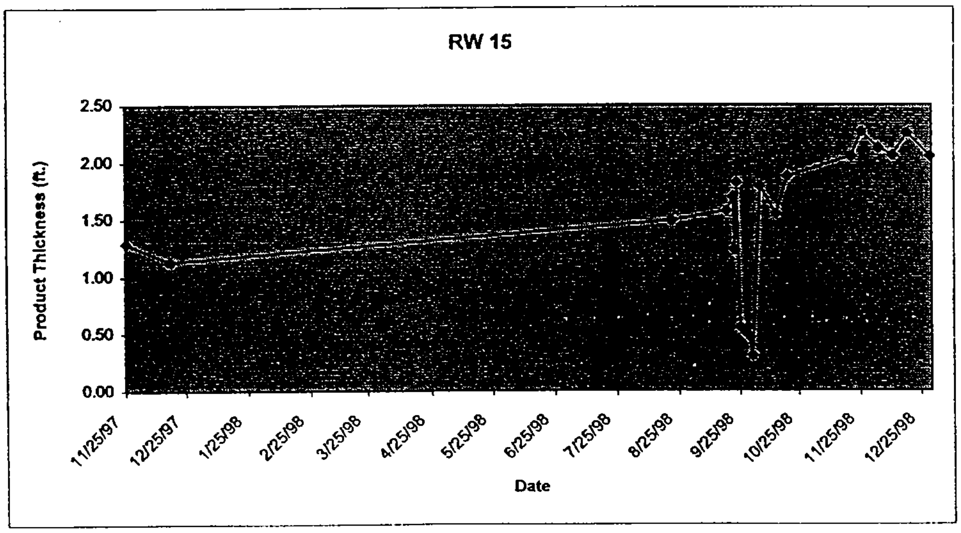


Figure XI

Sun Belmont Terminal, 2700 Passyunk Ave., Phil.,
Shunk Street Sewer Remediation Project
Apparent product thickness (ft)







Appendix A

Remediation System Work Plan

Remediation Work Plan Overview

The objective of site remediation is to mitigate hydrocarbon impacts to the City of Philadelphia Water Department's Shunk Street Sewer. Based on the results of a subsurface investigation and remediation testing as described in the "Free Product Delineation Along Shunk Street Sewer" report issued by Mulry and Cresswell Environmental, Inc., on 26 January 1998, it is probable that to successfully mitigate sewer impact, both liquid and vapor phase remediation efforts should be undertaken. Separate phase hydrocarbons are present on the water table south of the sewer line from RW 6 on the eastern portion of the site to the western property boundary at Passyunk Avenue. A comparison of the depths of the sewer line and static water in the site wells indicates the location of the sewer line coincides with a trough in the water table and the water table elevation along the sewer line intersects the line. The recharge of free product to site wells subsequent to bailing suggests liquid phase recovery will be expedient and efficient in removing hydrocarbons near the sewer line, especially if the separate phase hydrocarbons are collected in pumping cones of depression. In addition, vacuum extraction testing conducted on RW 6 indicates, by the proliferation of subsurface vacuum, that for the most part the sewer line is "tight" and is not open to the surrounding area to any great degree. For this reason, soil vapor extraction is also recommended as a means of removing vapor phase hydrocarbons that could potentially impact the sewer and to remove residual hydrocarbons absorbed in soils above the water table. The proposed remediation is therefore a combination of groundwater pumping with free product recovery and soil vapor extraction.

The flow rates and hydrocarbon concentrations in recovered groundwater and soil gas will decrease over time. During the early stages of soil vapor extraction, hydrocarbon concentrations in the soil gas may be above the lower explosive limit for an unknown period of time. When these concentrations are reduced, a different off gas treatment technology will undoubtedly be more cost effective than the technology originally employed. Similarly, initial groundwater contaminant concentrations will be higher than after several months of groundwater pumping and free product recovery rates will decrease over the same time period. For these reasons and also to allow for a margin of error in specifying a remedial strategy, it is proposed that the remedial design be flexible in the installation of an infrastructure (subsurface plumbing) steps. Initial groundwater recovery should be from the two six inch diameter wells already installed (RWs 6 and 15) with the capability of adding up to three additional recovery wells (RWs 1, 2 and 3) as depicted on the attached "Proposed

Remediation Schematic". Soil vapor extraction can be initiated utilizing VR units Sun already owns, or similar thermal or catalytic oxidizing units, which are ideally suited for this site. If and when the VR or similar units become ineffective due to decreased BTU content of the extracted soil gas, the design parameters for a replacement system will be known.

Groundwater Pumping and Free Product Recovery

From pumping tests conducted on three site wells, RWs 6 and 15 and OW 17, an initial pumping rate of approximately four to six gallons per minute (gpm) per pumping well is recommended. This flow is more than the anticipated sustained yield at this location but is expected to be necessary to dewater the sewer backfill. Static water levels along the sewer line are approximately twenty-six to twenty-eight feet below grade. The thirteen foot diameter sewer line is located approximately twenty to thirty-three feet below grade. The objective of groundwater pumping will be to create a hydraulic gradient away from the sewer line to the pumping well(s). Sustained yield is anticipated to be less than four gpm to maintain approximately thirteen feet of draw down in the pumping wells. Transmissivity and hydraulic conductivity calculated for pumping tests on RW 6 and OW 17 at the east and west ends, respectively, of the investigation area were in very close agreement, indicating similar pumping influences should be expected across the site.

The number of pumping wells employed will be dependent on how steep a gradient is needed to induce product migration away from the sewer. From the observed draw down during the two day pumping test on OW 17, the water level in RW 6, 60' from the pumping well dropped 0.88' and the level in OW 12, 80' from the pumping well dropped 0.33'. The two six inch wells, RWs 6 and 15, are approximately three hundred and sixty feet apart. It is unlikely that pumping these two wells alone will create a sufficient gradient to control the entire length of the sewer line. However because the greatest observed product thicknesses are on the west end of the property and the static water table gradient is towards the west, pumping these two wells may control the free product plume. Three additional recovery wells are proposed, spaced approximately equidistant between RWs 6 and 15, on approximately ninety foot intervals along the south side of the sewer line. The decision to initiate pumping from these wells will be deferred until pumping effects from RWs 6 and 15 are known. In the event all five recovery wells are employed for pumping, approximately one foot of draw down could be created between wells, creating a fairly steep gradient (≈ 10%) to the pumping wells. In this event, initial maximum flow rates are anticipated to be 20-30 gpm.

RW 15 should be fitted with a dual (water and product) pumping unit capable of pumping at least six gallons per minute. RW 6 should be fitted with a water pump only with the capability of adding an automated product pump if accumulations of product warrant. The additional pumping wells may or may not prove to be viable separate phase recovery points and should also be fitted with water pumps only until an evaluation of product recovery potential can be made.

Vapor Extraction

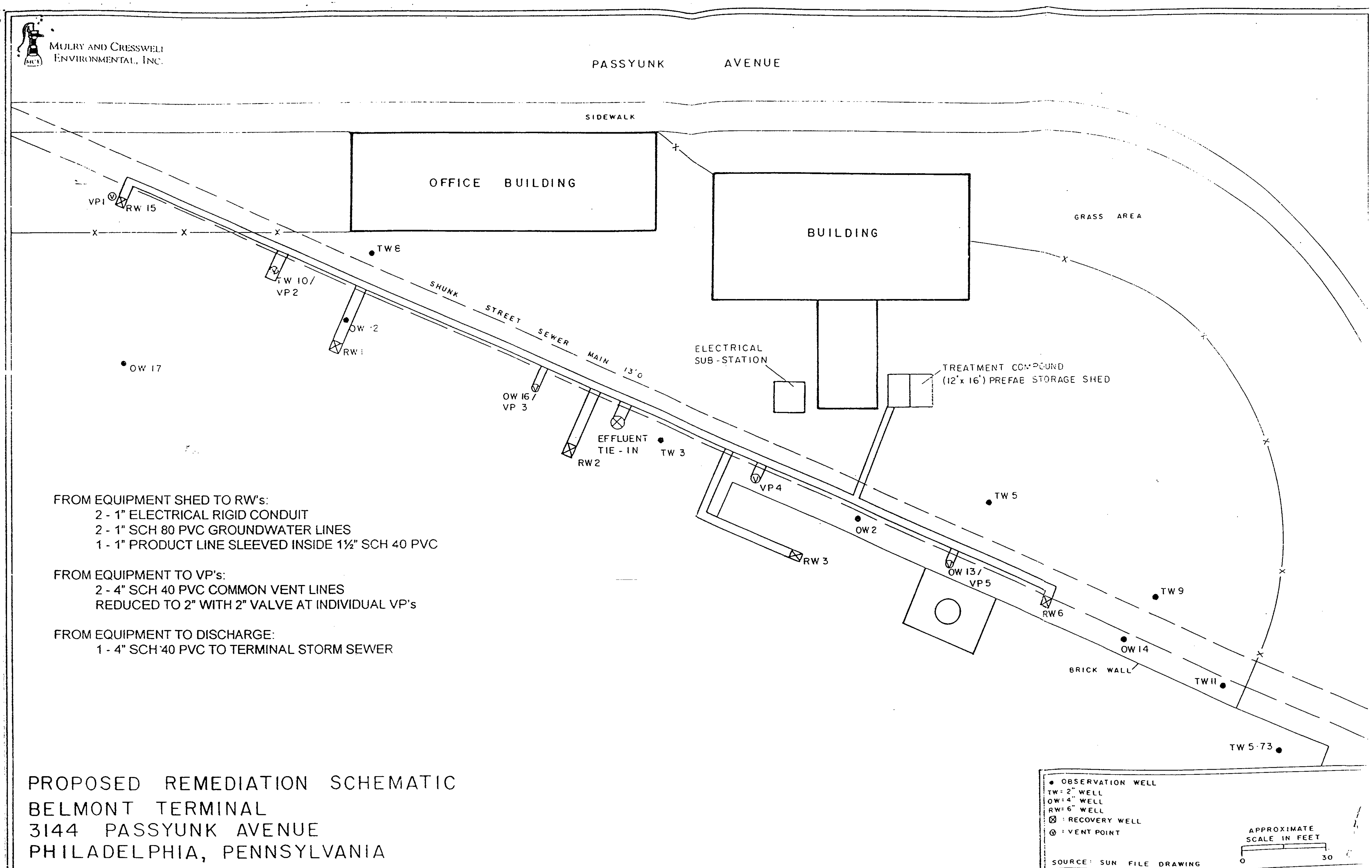
PID readings at well heads on the western portion of the site, OWs 16,17,12, RW 15 and TW 10, registered thousands of ppm_v. These concentrations are created by the available separate phase floating on the water table and should reduce rapidly as free product is removed. Until that occurs vapor phase concentrations in the extracted soil gas will be most efficiently treated by incineration or oxidation. Based on vapor extraction tests conducted on the site wells, to exert a vacuum of 0.5" H_2O over a fifty foot radius, a vacuum of approximately 75" H_2O will be needed at the extraction well head. The selection of 0.5" H_2O vacuum is conservative since vacuum as low as 0.1" H_2O is often sufficient to evaporate product from soil and theoretically, any negative pressure should prevent vapor migration into areas under atmospheric pressure, such as the sewer. To induce a vacuum of 0.5" H_2O over the length of the sewer line, five to six extraction wells spaced approximately eighty feet apart will be needed with a combined system vacuum of 375" to 450" H_2O, approximately 29" to 37" Hg. The corresponding flow rate of soil gas would be hundreds of CFM and require considerable expense to treat. For these reasons, it is recommended a self contained extraction/treatment unit, such as a VR unit be employed until initial soil vapor concentrations are reduced to a more steady state condition. Operational data collected from a VR unit can be analyzed to determine long range vapor recovery and treatment alternatives.

Infrastructure

Regardless of the number of pumping wells and vapor extraction points eventually put into operation, a central location for a treatment compound will need to be constructed. The treatment compound will house electrical panels, pump control panels and water and vapor treatment components. Water lines, vapor extraction lines and conduit will be extended from the treatment compound to the well heads and vapor extraction points. To minimize disruption to the terminal's operations, one trench will be dug from the treatment compound to directly over the sewer and from RW 6 west along the sewer to RW 15. A conceptual schematic diagram of a remediation system layout is attached. Water discharge lines (schedule 40 PVC, or 125 psi rated black polyethylene) should be buried at least two feet below grade in the trench from the Recovery wells. A water discharge manifold, as a substitute for individual discharge lines from each well may represent a cost saving, in which case the size of the line should take into consideration the maximum anticipated groundwater pumping rate (≈ 40 gpm). A product discharge line for potential future use should accompany each water discharge line as per the equipment manufacture's specification (usually small diameter ≈ 3/8"). One half inch or three quarter inch conduit to accommodate electrical power cord and control wiring for each pumping well will need to extend from the compound to the well heads, at a shallower depth than the liquid lines. Depending on the final discharge point selected, a discharge line (schedule 40 PVC) will need to be constructed between the treatment compound and the connection point to the refinery waste water treatment system. Vapor extraction lines will need to be run in the trench from the treatment compound to the recovery wells and vapor extraction points. Plastic pipe such as PVC and polyethylene are commonly employed for vapor extraction.

A competent engineering firm familiar with similar projects will be needed to determine the remediation system specifics and generate engineering drawings necessary to accomplish system construction.

A time line for the implementation of this remediation project is attached.



FROM EQUIPMENT SHED TO RW's:
- 2 - 1" ELECTRICAL RIGID CONDUIT
- 2 - 1" SCH 80 PVC GROUNDWATER LINES
- 1 - 1" PRODUCT LINE SLEEVED INSIDE 1½" SCH 40 PVC

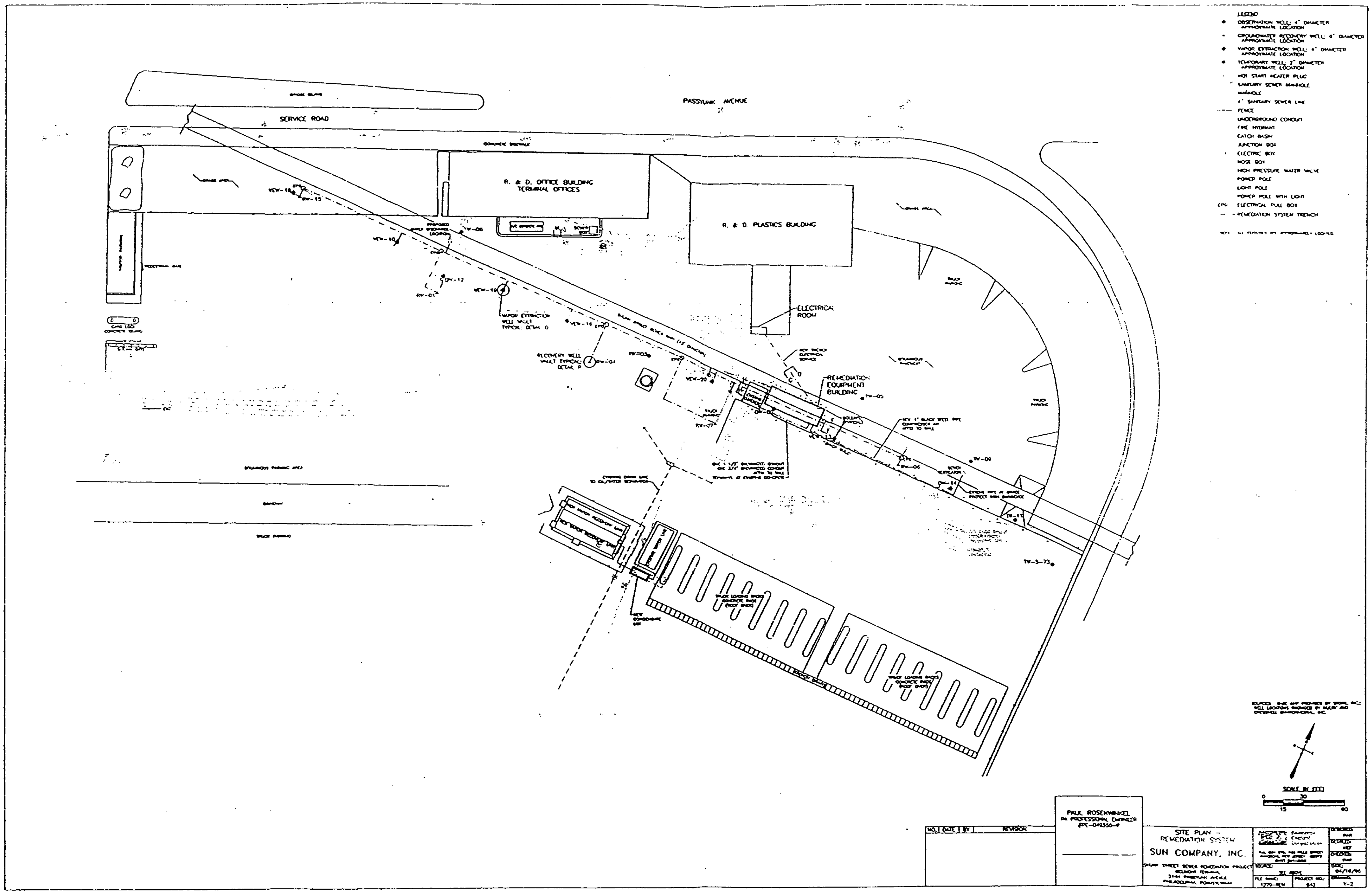
FROM EQUIPMENT TO VP's:
- 2 - 4" SCH 40 PVC COMMON VENT LINES REDUCED TO 2" WITH 2" VALVE AT INDIVIDUAL VP's

FROM EQUIPMENT TO DISCHARGE:
- 1 - 4" SCH 40 PVC TO TERMINAL STORM SEWER

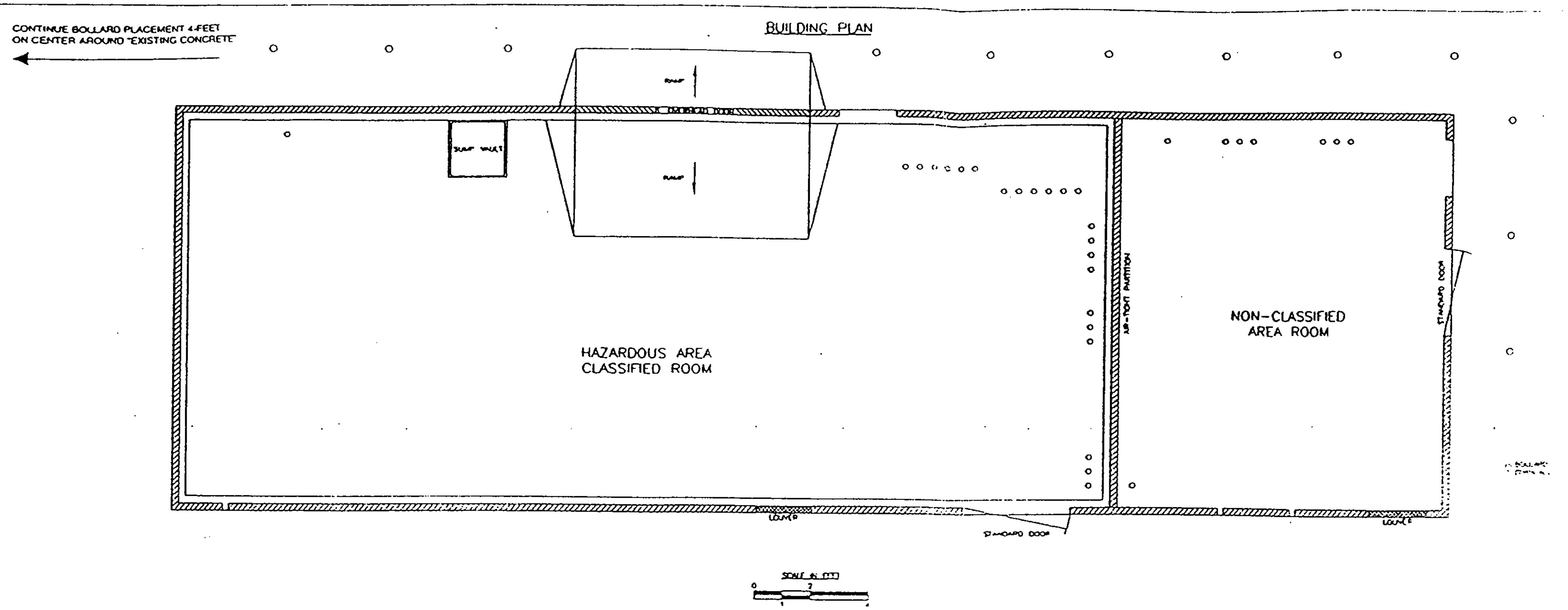
PROPOSED REMEDIATION SCHEMATIC
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

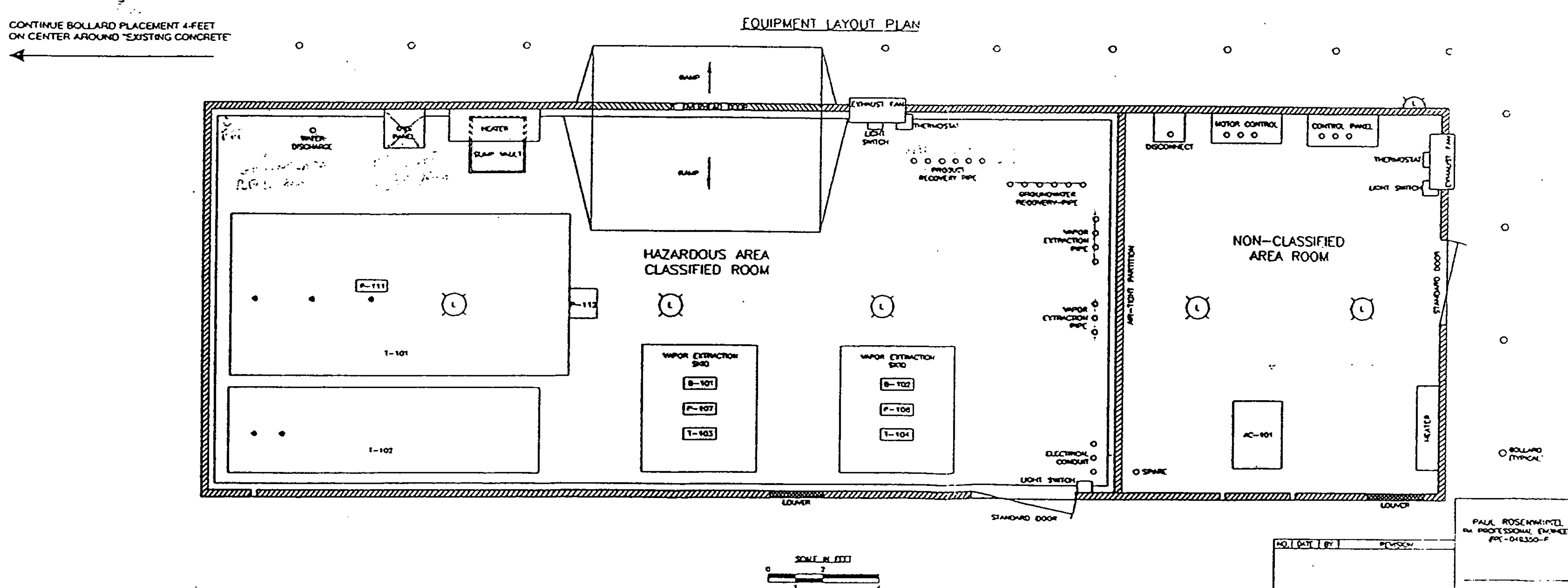
Appendix B

Remediation System As Built Diagrams and Drawings



PASSYUNK AVENUE
SERVICE ROAD
R. & D. OFFICE BUILDING
TERMINAL OFFICES
R. & D. PLASTICS BUILDING
ELECTRICAL ROOM
REMEDIATION EQUIPMENT BUILDING
VAPOR EXTRACTION WELL VAULT TYPICAL: DETAIL D
RECOVERY WELL VAULT TYPICAL: DETAIL P
TW-5-73
PAUL ROSENWINKEL
PA PROFESSIONAL ENGINEER
NO.
DATE
BY
REVISION
SITE PLAN –
REMEDIATION SYSTEM
SUN COMPANY, INC.
SCALE IN FEET
0
15
30
60
04/18/96
Y-2





PAUL ROSCHMANN(?)
PA PROFESSIONAL ENGINEER

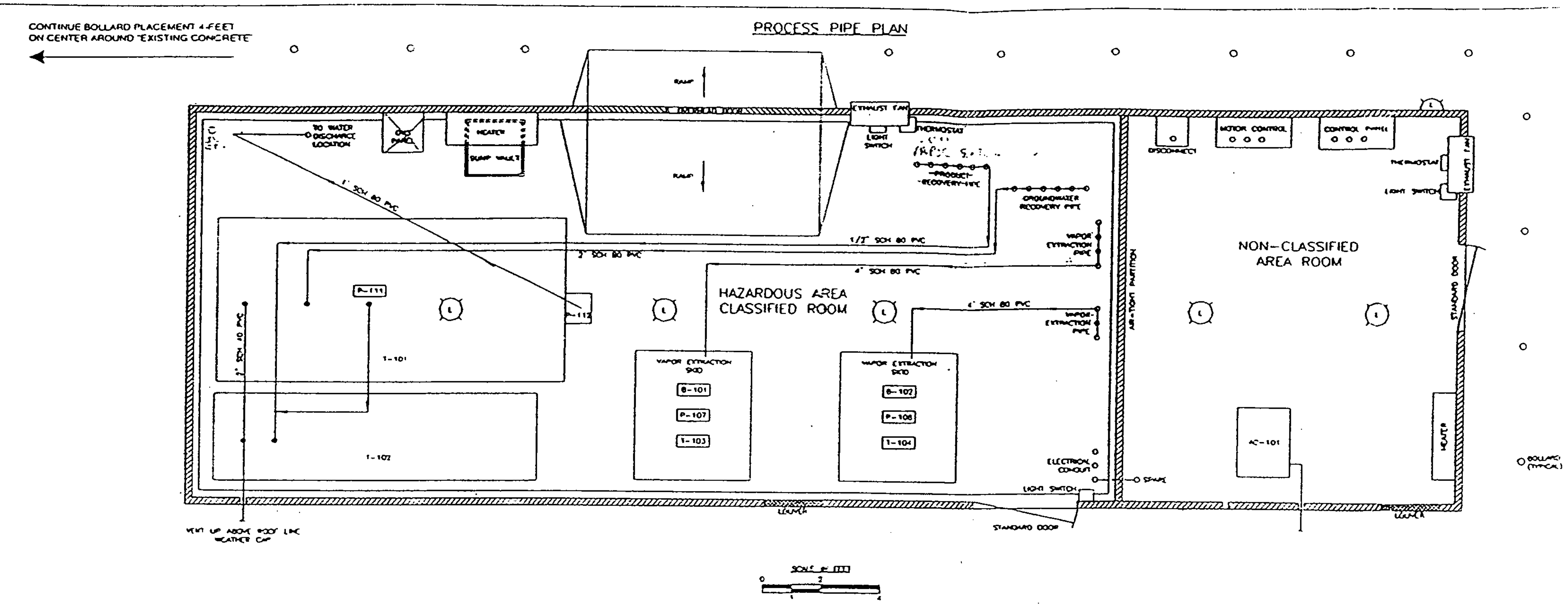
NO. | DATE | BY | REVISION

BUILDING LAYOUT PLANS

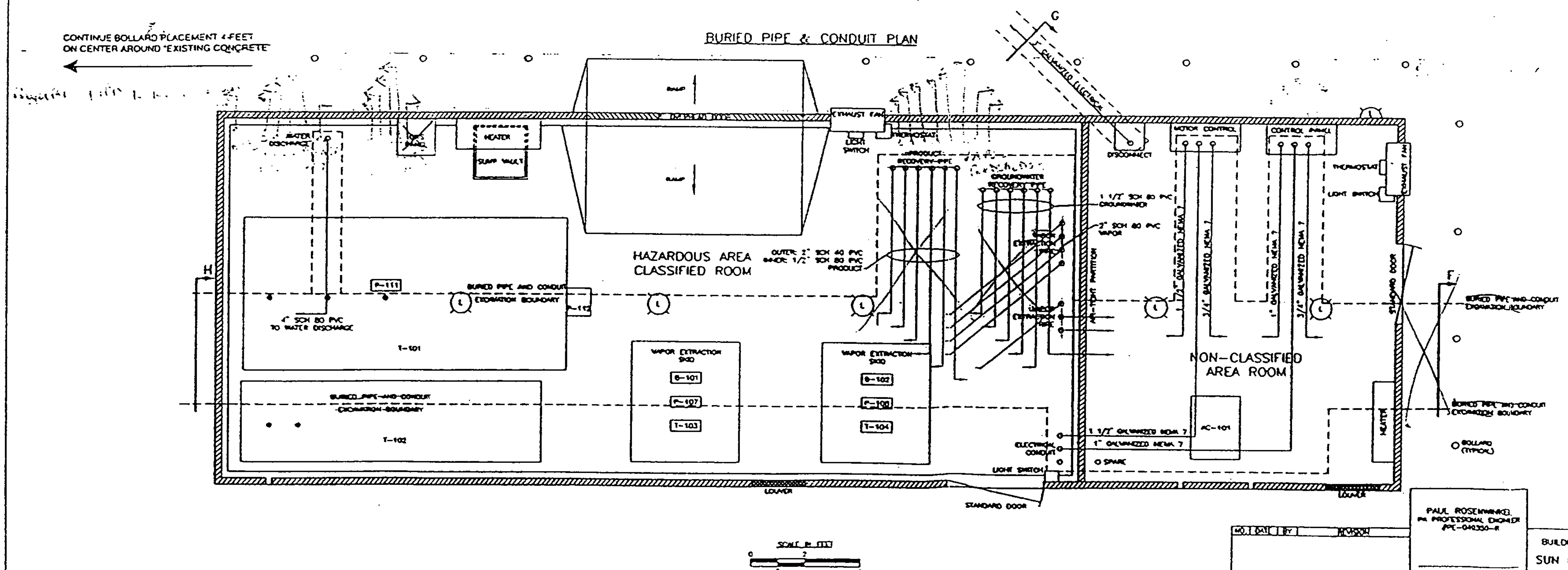
SUN COMPANY, INC.

PHILADELPHIA, PENNSYLVANIA

PROCESS PIPE PLAN



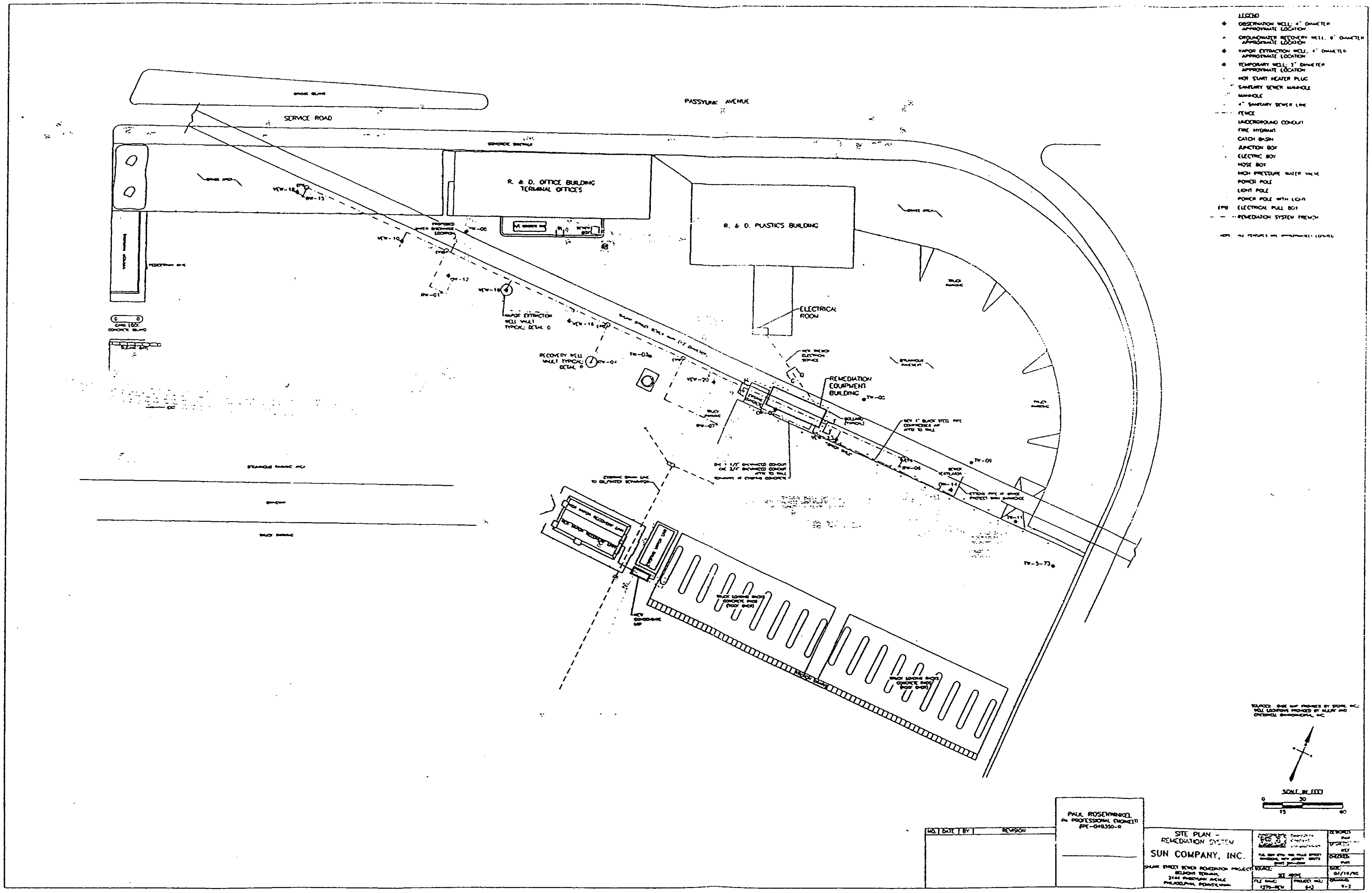
BURIED PIPE & CONDUIT PLAN



NO.	DATE	BY	REVISION

PAUL ROSENWINKEL
PA PROFESSIONAL ENGINEER
#PE-040350-R

BUILDING LAYOUT PLANS
SUN COMPANY, INC.


LEGEND
OBSERVATION WELL; 4" DIAMETER APPROXIMATE LOCATION
GROUNDWATER RECOVERY WELL, 6" DIAMETER APPROXIMATE LOCATION
VAPOR EXTRACTION WELL, 4" DIAMETER APPROXIMATE LOCATION
TEMPORARY WELL; 3" DIAMETER APPROXIMATE LOCATION
HOT START HEATER PLUG
SANITARY SEWER MANHOLE
MANHOLE
4" SANITARY SEWER LINE
FENCE
UNDERGROUND CONDUIT
FIRE HYDRANT
CATCH BASIN
JUNCTION BOX
ELECTRIC BOX
HOSE BOX
HIGH PRESSURE WATER VALVE
POWER POLE
LIGHT POLE
POWER POLE WITH LIGHT
EPB ELECTRICAL PULL BOX
REMEDIATION SYSTEM TRENCH
PASSYUNK AVENUE
SERVICE ROAD
R. & D. OFFICE BUILDING
TERMINAL OFFICES
R. & D. PLASTICS BUILDING
ELECTRICAL ROOM
REMEDIATION EQUIPMENT BUILDING
VAPOR EXTRACTION WELL VAULT TYPICAL DETAIL D
RECOVERY WELL VAULT TYPICAL DETAIL D
TRUCK LOADING RACKS CONCRETE PADS (ROOF SHED)
SCALE IN FEET
0 15 30 60
NO. DATE BY REVISION
PAUL ROSENWINKEL
PA PROFESSIONAL ENGINEER
SITE PLAN - REMEDIATION SYSTEM
SUN COMPANY, INC.
BELMONT TERMINAL
3144 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA
DATE: 04/16/90

Appendix C

City of Philadelphia Water Department Discharge Permit

Philadelphia
Water Department

The ARAMARK Tower
1101 Market Street
Philadelphia, Pennsylvania 19107-2994

Kumar Kishinchand, P.E.
Commissioner

June 16, 1998

Mr. Paul Rosenwinkel, P.E.
Project Manager
Resource Control Corporation
P.O. Box 579
Rancocas, NJ 08073-0579

Re: Request for permission to discharge treated groundwater
Sun Company, Inc.
Shunk Street Sewer Remediation Project
Belmont Terminal, 2700 W. Passyunk Ave., Phila., PA 19145

Dear Mr. Rosenwinkel:

We have reviewed the information submitted with your letter of May 19 concerning the project referred to above. Permission is hereby granted for the discharge of treated groundwater to the City of Philadelphia sanitary sewer system at the address indicated. Discharge must be made through an on-site connection to the City sanitary sewer. This discharge is subject to the City of Philadelphia Wastewater Control Regulations (WWCR), as well as the following conditions:

- BTEX must be no more than 40 mg/L.
- TPH must be no more than 100 mg/L.
- There is to be no floating layer or visible sheen on the wastewater discharged.
- Do not exceed 10 % of the lower explosive limit at the point of discharge to the City sewer.
- Extreme caution must be exercised to ensure that discharge is made to the sanitary sewer, as discharges to the storm sewer are prohibited.

- Exceedances of discharge limits must be reported in accordance with Section 3.3.7 of the WWCR.

The discharge is to be as indicated by the information submitted by you. Monitoring for the pollutant parameters listed above shall be performed once per month and analytical results shall be reported to this office semi-annually (in July for the period January through June, and in January for the period July through December), along with flow data for the relevant period and the certification statement required by Section 3.9 of the WWCR. A charge of $4.59 per thousand cubic feet will be assessed on the wastewater discharged.

This permission will expire five years from the date of this letter

Feel free to call me at 215-685-4910 with any questions or comments.

Sincerely,

Keith D. Houck
Assistant Manager, Industrial Waste Unit

Cc: J. Morrow, PWD / IWU