4.0 FINDINGS

4.1 Introduction

This section provides a discussion of the chemical compounds and other MGP residuals identified in on-site and off-site areas based on the supplemental field program data. Where appropriate, data from the initial field program, as well as historical data, has been used in conjunction with supplemental data to provide a more comprehensive understanding with respect to the nature and extent of MGP-related chemical compounds and residuals associated with the site.

Consistent with the initial field program completed in the Fall of 2000, environmental samples collected as part of the supplemental field program from on-site locations have been grouped into what is referred to as the "On-site Field Investigation Program," and samples collected from off-site locations have been grouped into what is referred to as the "Off-site Field Investigation Program." However, consistent with the initial field program, the On-site Field Investigation includes "off-site" samples collected adjacent to the Bay Shore Site as far south as Union Boulevard. The Off-site Field Investigation Program includes all other off-site locations.

Drawing 2A presents the surveyed locations of all completed on-site and adjacent off-site sample locations along with the approximate locations of former MGP structures located on the site. **Drawing 2B** presents the location of all off-site sample locations. Sample locations related to the Watchogue Creek/Crum's Brook area are provided on **Figure 2-1**. Locations where private groundwater well and air samples were collected are shown on **Figure 2-2**. **Appendix C** contains data tables summarizing the analytical results of all samples collected during the supplemental field investigation. The total concentrations of all detected BTEX compounds for each sample location, as well as the total concentrations of all detected PAHs and carcinogenic PAHs (CaPAHs) for each sample location are also provided in the data summary tables. In addition, **Appendix E** summarizes all total BTEX and total PAH data for subsurface soil samples collected as part of the initial field program, as well as prior studies, and contains data tables summarizing the analytical results of all groundwater samples collected during the same investigations.

The assessment of the presence of chemicals in the environment was performed using sample analytical results and the visual observations and physical descriptions of recovered sample media. In the case of groundwater, upgradient groundwater quality was compared to downgradient quality. In the case of metals in soil, values were compared to typical metals concentrations observed within eastern United States soils (see **Table 4-1**). When relevant, data generated under this investigation was compared to data generated during prior investigations in order to assess any trends in the reduction or migration of chemical constituents.

In addition, the analytical results associated with the supplemental field program were compared to NYSDEC regulatory standards, criteria and guidance values (SCGs) for *screening* purposes. The analytical data tables provided in **Appendix C** include a column for SCGs including those presented in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4046 for soil and the Class GA groundwater standards and guidance values provided in the NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 for groundwater. In addition, SCGs for surface water are from TOGS 1.1.1 and SCGs for surface water sediment were obtained from the NYSDEC Division of Fish, Wildlife and Marine Resources document entitled, “Technical Guidance for Screening Contaminated Sediments.” Concentrations of chemical constituents that exceeded the SCGs are bracketed on the data tables. Also, **Tables 4-2** through **4-10** summarize the concentration range, frequency of exceedances of SCGs and the specific SCG for chemical constituents typically associated with former MGP sites.

The following terminology and descriptions were used to describe the visual and olfactory observations made during the field investigation, as well as to describe the nature of the observed materials.

TABLE 4-1
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TYPICAL BACKGROUND CONCENTRATIONS OF METALS IN SOIL

Metals	Background Levels - Eastern USA (mg/kg)
Aluminum	7,000 - 100,000
Antimony	< 1 - 8.8
Arsenic	< 0.1 - 73
Barium	10 - 1,500
Beryllium	< 1 - 7
Cadmium	-
Calcium	100 - 280,000
Chromium	1 - 1,000
Cobalt	< 0.3 - 70
Copper	< 1 - 700
Iron	100 - 100,000
Lead	< 10 - 300
Magnesium	50 - 50,000
Manganese	< 2 - 7,000
Mercury	0.01 - 3.4
Nickel	< 5 - 700
Potassium	50 - 37,000
Selenium	< 0.1 - 3.9
Silver	-
Sodium	500 - 50,000
Thallium	-
Vanadium	< 7 - 300
Zinc	< 5 - 2,900

NOTES:

From: H.T. Shacklette and J.G. Boerngen, USGS Professional Paper 1270, 1984

- : Not established.

TABLE 4-2
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES
DETECTED IN BAY SHORE SITE AND ADJACENT OFF-SITE AREAS
SURFACE AND SUBSURFACE SOIL AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPM)	CONCENTRATION RANGE (PPM)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Surface Soil	**PCBs**	Aroclor 1260	1	ND to 4.7	2 of 7	BBSS-30(0-6")
		Aroclor 1254	1	ND	0 of 7	NA
		Aroclor 1221	1	ND	0 of 7	NA
		Aroclor 1232	1	ND	0 of 7	NA
		Aroclor 1248	1	ND	0 of 7	NA
		Aroclor 1016	1	ND	0 of 7	NA
		Aroclor 1242	1	ND	0 of 7	NA
Subsurface Soil	**VOCs**	Benzene	0.06	ND to 1,200	27 of 175	BBTP-04(5-6)
		Toluene	1.5	ND to 1,600	18 of 175	BBTP-04(5-6)
		Ethylbenzene	5.5	ND to 370	52 of 175	BBSB-49(9-10)
		Total Xylenes	1.2	ND to 2,500	72 of 175	BBTP-04(5-6)
	PAHs	Benzo(a)pyrene *	0.061	ND to 860	103 of 175	BBTP-04(5-6)
		Dibenzo(a,h)anthracene *	0.014	ND to 6.6	48 of 175	BBSB-43(0-2)
		Benzo(a)anthracene *	0.224	ND to 1,000	98 of 175	BBTP-04(5-6)
		Indeno(1,2,3-cd)pyrene *	3.2	ND to 280	34 of 175	BBTP-04(5-6)
		Benzo(b)fluoranthene *	1.1	ND to 580	77 of 175	BBTP-04(5-6)
		Benzo(k)fluoranthene *	1.1	ND to 260	52 of 175	BBTP-04(5-6)
		Chrysene *	0.4	ND to 1,000	100 of 175	BBTP-04(5-6)
		Naphthalene	13	ND to 20,000	73 of 175	BBTP-04(5-6)
		2-Methylnaphthalene	36.4	ND to 8,700	68 of 175	BBTP-04(5-6)
		Acenapthylene	41	ND to 2,500	25 of 175	BBTP-04(5-6)
		Acenapthene	50	ND to 440	20 of 175	BBTP-04(5-6)
		Dibenzofuran	6.2	ND to 270	22 of 175	BBTP-04(5-6)
		Fluorene	50	ND to 2,000	28 of 175	BBTP-04(5-6)

TABLE 4-2 (continued)
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES
DETECTED IN BAY SHORE SITE AND ADJACENT OFF-SITE AREAS
SURFACE AND SUBSURFACE SOIL AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPM)	CONCENTRATION RANGE (PPM)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Subsurface Soil (cont.)		Phenanthrene	50	ND to 5,600	52 of 175	BBTP-04(5-6)
		Anthracene	50	ND to 1,300	25 of 175	BBTP-04(5-6)
		Fluoranthene	50	ND to 1,500	23 of 175	BBTP-04(5-6)
		Pyrene	50	ND to 2,700	34 of 175	BBTP-04(5-6)
		Benzo(ghi)perylene	50	ND to 350	4 of 175	BBTP-04(5-6)
		Total CaPAHs	10	ND to 3,980	74 of 175	BBTP-04(5-6)
		Total PAHs	500 [1]	ND to 49,340	43 of 175	BBTP-04(5-6)

Notes:

SCGs: NYSDEC TAGM 4046 dated January 1994
NA: Not applicable
ND: Non-detect
* Carcinogenic PAH (CaPAH)
[1] SCG is for Total SVOCs

TABLE 4-3
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Groundwater	**VOCs**	Benzene	1	ND to 4,100	60 of 159	BBGP-68(8-12)
		Toluene	5	ND to 5,600	49 of 159	MW-05S
		Ethylbenzene	5	ND to 13,000	74 of 159	BBMW-23S
		Total Xylenes	5	ND to 19,000	101 of 159	BBMW-23S
	PAHs	Benzo(a)pyrene *	NA	ND to 7,600	NA	BBGP-72(64-68)
		Dibenzo(a,h)anthracene *	NA	ND to 4	NA	BBMW-06ST
		Benzo(a)anthracene *	0.002	ND to 14,000	50 of 157	BBGP-72(64-68)
		Indeno(1,2,3-cd)pyrene *	0.002	ND to 10	21 of 157	BBMW-06ST MW-05D
		Benzo(b)fluoranthene *	0.002	ND to 5,200	36 of 157	BBGP-72(64-68)
		Benzo(k)fluoranthene *	0.002	ND to 21	18 of 157	BBGP-70(9-13)
		Chrysene *	0.002	ND to 13,000	48 of 157	BBGP-72(64-68)
		Naphthalene	10	ND to 340,000	95 of 157	BBGP-72(64-68)
		2-Methylnaphthalene	NA	ND to 180,000	NA	BBGP-72(64-68)
		Acenapthylene	NA	ND to 64,000	NA	BBGP-72(64-68)
		Acenapthene	20	ND to 6,600	50 of 157	BBGP-72(64-68)
		Dibenzofuran	NA	ND to 3,900	NA	BBGP-72(64-68)
		Fluorene	50	ND to 31,000	49 of 157	BBGP-72(64-68)
		Phenanthrene	50	ND to 80,000	61 of 157	BBGP-72(64-68)
		Anthracene	50	ND to 26,000	24 of 157	BBGP-72(64-68)
		Fluoranthene	50	ND to 22,000	19 of 157	BBGP-72(64-68)
		Pyrene	50	ND to 30,000	25 of 157	BBGP-72(64-68)
		Benzo(ghi)perylene	NA	ND to 51	NA	BBGP-69(9-13)
		Total CaPAHs	NA	ND to 39,800	NA	BBGP-72(64-68)
		Total PAHs	NA	ND to 823,300	NA	BBGP-72(64-68)

Notes:

SCGs: NYSDEC Class GA Groundwater Standards/Guidelines

NA: Not applicable

ND: Non-detect

*: Carcinogenic PAH (CaPAH)

TABLE 4-4
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN BAY SHORE WEST PARCEL/BRIGHTWATERS YARD SUBSURFACE SOIL AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPM)	CONCENTRATION RANGE (PPM)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Subsurface Soil	**VOCs**	Benzene	0.06	ND to 0.077	1 of 58	BBSB-93(6-8)
		Toluene	1.5	ND to 0.95	0 of 58	BBSB-96(8-10)
		Ethylbenzene	5.5	ND to 7.8	2 of 58	BBSB-96(8-10)
		Total Xylenes	1.2	ND to 54	6 of 58	BBSB-71(9-11)
	PAHs	Benzo(a)pyrene *	0.061	ND to 44	6 of 58	BBSB-78(0-2)
		Dibenzo(a,h)anthracene *	0.014	ND to 5.2	3 of 58	BBSB-78(0-2)
		Benzo(a)anthracene *	0.224	ND to 51	3 of 58	BBSB-78(0-2)
		Indeno(1,2,3-cd)pyrene *	3.2	ND to 15	1 of 58	BBSB-78(0-2)
		Benzo(b)fluoranthene *	1.1	ND to 41	1 of 58	BBSB-78(0-2)
		Benzo(k)fluoranthene *	1.1	ND to 15	2 of 58	BBSB-78(0-2)
		Chrysene *	0.4	ND to 53	2 of 58	BBSB-78(0-2)
		Naphthalene	13	ND to 130	1 of 58	BBSB-78(0-2)
		2-Methylnaphthalene	36.4	ND to 130	1 of 58	BBSB-78(0-2)
		Acenapthylene	41	ND to 31	0 of 58	BBSB-78(0-2)
		Acenapthene	50	ND to 9.5	0 of 58	BBSB-78(0-2)
		Dibenzofuran	6.2	ND to 6.5	1 of 58	BBSB-78(0-2)
		Fluorene	50	ND to 52	1 of 58	BBSB-78(0-2)
		Phenanthrene	50	ND to 160	1 of 58	BBSB-78(0-2)
		Anthracene	50	ND to 32	0 of 58	BBSB-78(0-2)
		Fluoranthene	50	ND to 61	1 of 58	BBSB-78(0-2)
		Pyrene	50	ND to 120	1 of 58	BBSB-78(0-2)
		Benzo(ghi)perylene	50	ND to 17	0 of 58	BBSB-78(0-2)
		Total CaPAHs	10	ND to 224.2	1 of 58	BBSB-78(0-2)
		Total PAHs	500 [1]	ND to 973.2	1 of 58	BBSB-78(0-2)

Notes:

SCGs: NYSDEC TAGM 4046 dated January 1994

NA: Not applicable

ND: Non-detect

* Carcinogenic PAH (CaPAH)

[1] SCG is for Total SVOCs

TABLE 4-5
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN BAY SHORE WEST PARCEL/BRIGHTWATERS YARD GROUNDWATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Groundwater	**VOCs**	Benzene	1	ND to 11	2 of 12	BBGP-85(6-10)
		Toluene	5	ND	0 of 12	NA
		Ethylbenzene	5	ND to 2,500	5 of 12	BBGP-86(6-10)
		Total Xylenes	5	ND to 19,000	5 of 12	BBGP-86(6-10)
	PAHs	Benzo(a)pyrene *	NA	ND to 1	NA	BBMW-13D
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.002	ND to 2	1 of 12	BBMW-13D
		Indeno(1,2,3-cd)pyrene *	0.002	ND	0 of 12	NA
		Benzo(b)fluoranthene *	0.002	ND to 1	1 of 12	BBMW-13D
		Benzo(k)fluoranthene *	0.002	ND	0 of 12	NA
		Chrysene *	0.002	ND to 2	1 of 12	BBMW-13D
		Naphthalene	10	ND to 700	5 of 12	BBGP-86(6-10)
		2-Methylnaphthalene	NA	ND to 36	NA	BBGP-85(6-10)
		Acenapthylene	NA	ND to 2	NA	MW-03S BBGP-88(8-12)
		Acenapthene	20	ND to 1	0 of 12	BBGP-88(8-12)
		Dibenzofuran	NA	ND	NA	NA
		Fluorene	50	ND to 2	0 of 12	BBGP-88(8-12)
		Phenanthrene	50	ND to 15	0 of 12	BBMW-13D
		Anthracene	50	ND to 1	0 of 12	BBGP-88(8-12)
		Fluoranthene	50	ND to 5	0 of 12	BBMW-13D
		Pyrene	50	ND to 9	0 of 12	BBMW-13D
		Benzo(ghi)perylene	NA	ND	NA	NA
		Total CaPAHs	NA	ND to 6	NA	BBMW-13D
		Total PAHs	NA	ND to 732	NA	BBGP-86(6-10)

Notes:

SCGs: NYSDEC Class GA Groundwater Standards/Guidelines

NA: Not applicable

ND: Non-detect

*: Carcinogenic PAH (CaPAH)

TABLE 4-6
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN OFF-SITE GROUNDWATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Groundwater	**VOCs**	Benzene	1	ND to 980	67 of 116	BBGP-79(22-26)
		Toluene	5	ND to 1,600	35 of 116	BBGP-75(64-68)
		Ethylbenzene	5	ND to 2,700	54 of 116	BBGP-75(16-20)
		Total Xylenes	5	ND to 3,700	65 of 116	BBGP-75(16-20)
	PAHs	Benzo(a)pyrene *	NA	ND	NA	NA
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.002	ND	0 of 116	NA
		Indeno(1,2,3-cd)pyrene *	0.002	ND	0 of 116	NA
		Benzo(b)fluoranthene *	0.002	ND	0 of 116	NA
		Benzo(k)fluoranthene *	0.002	ND	0 of 116	NA
		Chrysene *	0.002	ND	0 of 116	NA
		Naphthalene	10	ND to 8,000	66 of 116	BBMW-01I
		2-Methylnaphthalene	NA	ND to 1,100	NA	BBGP-76(40-44) BBMW-01I
		Acenapthylene	NA	ND to 450	NA	BBMW-01I
		Acenapthene	20	ND to 240	31 of 116	BBGP-75(16-20)
		Dibenzofuran	NA	ND to 9	NA	BBGP-83(26-30)
		Fluorene	50	ND to 100	25 of 116	BBGP-82(26-30)
		Phenanthrene	50	ND to 100	23 of 116	BBGP-82(26-30)
		Anthracene	50	ND to 32	0 of 116	BBGP-77(60-64)
		Fluoranthene	50	ND to 4	0 of 116	BBGP-75(16-20)
		Pyrene	50	ND to 4	0 of 116	BBGP-75(16-20)
		Benzo(ghi)perylene	NA	ND	NA	NA
		Total CaPAHs	NA	ND	NA	NA
		Total PAHs	NA	ND to 9,720	NA	BBMW-01I

Notes:

SCGs: NYSDEC Class GA Groundwater Standards/Guidelines

NA: Not applicable

ND: Non-detect

*: Carcinogenic PAH (CaPAH)

TABLE 4-7
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN O-CO-NEE POND SURFACE WATER SEDIMENT AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPM)	CONCENTRATION RANGE (PPM)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Surface Water Sediment	**VOCs**	Benzene	0.021	ND	0 of 12	NA
		Toluene	0.037	ND	0 of 12	NA
		Ethylbenzene	0.018	ND	0 of 12	NA
		Total Xylenes	0.069	ND to 0.006	0 of 12	BWSD-04(0-6)
	PAHs	Benzo(a)pyrene *	NA	ND to 4.6	NA	BWSD-04(0-6)
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.009	ND to 3.9	3 of 12	BWSD-04(0-6)
		Indeno(1,2,3-cd)pyrene *	NA	ND to 2.6	NA	BWSD-04(0-6)
		Benzo(b)fluoranthene *	NA	ND to 7.2	NA	BWSD-04(0-6)
		Benzo(k)fluoranthene *	NA	ND to 4.5	NA	BWSD-04(0-6)
		Chrysene *	NA	ND to 7.1	NA	BWSD-04(0-6)
		Naphthalene	0.023	ND	0 of 12	NA
		2-Methylnaphthalene	0.026	ND	0 of 12	NA
		Acenapthylene	NA	ND	NA	NA
		Acenapthene	NA	ND	NA	NA
		Dibenzofuran	NA	ND	NA	NA
		Fluorene	0.006	ND	0 of 12	NA
		Phenanthrene	NA	ND to 5	NA	BWSD-04(0-6)
		Anthracene	0.08	ND	0 of 12	NA
		Fluoranthene	NA	ND to 10	NA	BWSD-04(0-6)
		Pyrene	0.721	ND to 12	5 of 12	BWSD-04(0-6)
		Benzo(ghi)perylene	NA	ND	NA	NA
		Total CaPAHs	NA	ND to 29.9	NA	BWSD-04(0-6)
		Total PAHs	NA	ND to 56.9	NA	BWSD-04(0-6)

Notes:

SCGs: NYSDEC Class C freshwater, benthic aquatic life chronic toxicity, based on total organic carbon of 0.075%

NA: Not applicable

ND: Non-detect

* Carcinogenic PAH (CaPAH)

TABLE 4-8
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN O-CO-NEE POND SURFACE WATER AND PORE WATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs^1 (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Pore Water	**VOCs**	Benzene	1	ND to 170	1 of 6	BWPW-03
		Toluene	5	ND	0 of 6	NA
		Ethylbenzene	5	ND to 3	0 of 6	BWPW-03
		Total Xylenes	5	ND to 4	0 of 6	BWPW-03
	PAHs	Benzo(a)pyrene *	NA	ND	NA	NA
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.002	ND	0 of 6	NA
		Indeno(1,2,3-cd)pyrene *	0.002	ND	0 of 6	NA
		Benzo(b)fluoranthene *	0.002	ND	0 of 6	NA
		Benzo(k)fluoranthene *	0.002	ND	0 of 6	NA
		Chrysene *	0.002	ND	0 of 6	NA
		Naphthalene	10	ND to 2	0 of 6	BWPW-02
		2-Methylnaphthalene	NA	ND	NA	NA
		Acenapthylene	NA	ND	NA	NA
		Acenapthene	20	ND	0 of 6	NA
		Dibenzofuran	NA	ND	NA	NA
		Fluorene	50	ND	0 of 6	NA
		Phenanthrene	50	ND	0 of 6	NA
		Anthracene	50	ND	0 of 6	NA
		Fluoranthene	50	ND	0 of 6	NA
		Pyrene	50	ND	0 of 6	NA
		Benzo(ghi)perylene	NA	ND	NA	NA
		Total CaPAHs	NA	ND	NA	NA
		Total PAHs	NA	ND to 2	NA	BWPW-02

TABLE 4-8 (continued)
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN O-CO-NEE POND SURFACE WATER AND PORE WATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs^2 (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Surface Water	**VOCs**	Benzene	210	ND	0 of 11	NA
		Toluene	100	ND	0 of 11	NA
		Ethylbenzene	17	ND	0 of 11	NA
		Total Xylenes	65	ND to 1	0 of 11	BWSW-01(B)
	PAHs	Benzo(a)pyrene *	NA	ND to 3	NA	BWSW-05(B)
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.03	ND to 2	2 of 11	BWSW-05(B)
		Indeno(1,2,3-cd)pyrene *	NA	ND to 2	NA	BWSW-05(B)
		Benzo(b)fluoranthene *	NA	ND to 5	NA	BWSW-05(B)
		Benzo(k)fluoranthene *	NA	ND to 3	NA	BWSW-05(B)
		Chrysene *	NA	ND to 4	NA	BWSW-05(B)
		Naphthalene	13	ND	0 of 11	NA
		2-Methylnaphthalene	4.7	ND	0 of 11	NA
		Acenapthylene	NA	ND	NA	NA
		Acenapthene	5.3	ND	0 of 11	NA
		Dibenzofuran	NA	ND	NA	NA
		Fluorene	NA	ND	NA	NA
		Phenanthrene	5	ND to 3	0 of 11	BWSW-05(B)
		Anthracene	3.8	ND	0 of 11	NA
		Fluoranthene	NA	ND to 6	NA	BWSW-05(B)
		Pyrene	4.6	ND to 6	1 of 11	BWSW-05(B)
		Benzo(ghi)perylene	NA	ND	NA	NA
		Total CaPAHs	NA	ND to 19	NA	BWSW-05(B)
		Total PAHs	NA	ND to 34	NA	BWSW-05(B)

Notes:

[1]: NYSDEC Class GA Groundwater Standards/Guidelines
[2]: NYSDEC Class C Surface Water Standards/Guidelines
NA: Not applicable
ND: Non-detect
*: Carcinogenic PAH (CaPAH)

TABLE 4-9
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN WATCHOGUE CREEK/CRUM'S BROOK SUBSURFACE SOIL AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPM)	CONCENTRATION RANGE (PPM)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Subsurface Soil	**VOCs**	Benzene	0.06	ND to 0.006	0 of 66	WCSB-38(4-6)
		Toluene	1.5	ND to 0.18	0 of 66	WCSB-39(8-10)
		Ethylbenzene	5.5	ND to 1.6	0 of 66	WCSB-39(8-10)
		Total Xylenes	1.2	ND to 6.6	3 of 66	WCSB-39(8-10)
	PAHs	Benzo(a)pyrene *	0.061	ND to 81	17 of 56	WCSB-49(4-6)
		Dibenzo(a,h)anthracene *	0.014	ND to 8.6	15 of 66	WCSB-49(4-6)
		Benzo(a)anthracene *	0.224	ND to 86	16 of 66	WCSB-49(4-6)
		Indeno(1,2,3-cd)pyrene *	3.2	ND to 33	3 of 66	WCSB-49(4-6)
		Benzo(b)fluoranthene *	1.1	ND to 96	14 of 66	WCSB-49(4-6)
		Benzo(k)fluoranthene *	1.1	ND to 45	13 of 66	WCSB-49(4-6)
		Chrysene *	0.4	ND to 83	16 of 66	WCSB-49(4-6)
		Naphthalene	13	ND to 80	6 of 66	WCSB-37(8-10)
		2-Methylnaphthalene	36.4	ND to 89	4 of 66	WCSB-37(8-10)
		Acenapthylene	41	ND to 33	0 of 66	WCSB-52(10-12)
		Acenapthene	50	ND to 120	3 of 66	WCSB-52(10-12)
		Dibenzofuran	6.2	ND to 35	3 of 66	WCSB-49(4-6)
		Fluorene	50	ND to 140	3 of 66	WCSB-52(10-12)
		Phenanthrene	50	ND to 440	10 of 66	WCSB-52(10-12)
		Anthracene	50	ND to 130	4 of 66	WCSB-52(10-12)
		Fluoranthene	50	ND to 200	3 of 66	WCSB-49(4-6)
		Pyrene	50	ND to 180	4 of 66	WCSB-49(4-6)
		Benzo(ghi)perylene	50	ND to 32	0 of 66	WCSB-49(4-6)
		Total CaPAHs	10	ND to 432.6	14 of 66	WCSB-49(4-6)
		Total PAHs	500 [1]	ND to 1,354.1	5 of 66	WCSB-52(10-12)

Notes:

SCGs: NYSDEC TAGM 4046 dated January 1994

NA: Not applicable

ND: Non-detect

* Carcinogenic PAH (CaPAH)

[1] SCG is for Total SVOCs

TABLE 4-10
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CHEMICAL CONSTITUENTS TYPICALLY ASSOCIATED WITH FORMER MGP SITES DETECTED IN WATCHOGUE CREEK/CRUM'S BROOK GROUNDWATER AND COMPARISON TO NYSDEC SCGs

MEDIA	CLASS	CHEMICAL CONSTITUENT	SCGs (PPB)	CONCENTRATION RANGE (PPB)	FREQUENCY OF EXCEEDING SCG	SAMPLE EXHIBITING MAXIMUM CONCENTRATION
Groundwater	**VOCs**	Benzene	1	ND to 8	5 of 43	WCGP-10D(5-9)
		Toluene	5	ND to 11	1 of 43	WCGP-14(4.5-8.5)
		Ethylbenzene	5	ND to 350	4 of 43	WCGP-14(4.5-8.5)
		Total Xylenes	5	ND to 550	4 of 43	WCGP-14(4.5-8.5)
	PAHs	Benzo(a)pyrene *	NA	ND to 7	NA	WCGP-15(18-22)
		Dibenzo(a,h)anthracene *	NA	ND	NA	NA
		Benzo(a)anthracene *	0.002	ND to 17	15 of 43	WCGP-15(18-22)
		Indeno(1,2,3-cd)pyrene *	0.002	ND to 2	2 of 43	WCGP-15(18-22) WCGP-16(2-6)
		Benzo(b)fluoranthene *	0.002	ND to 5	4 of 43	WCGP-15(18-22)
		Benzo(k)fluoranthene *	0.002	ND to 2	2 of 43	WCGP-15(18-22)
		Chrysene *	0.002	ND to 17	15 of 43	WCGP-15(18-22)
		Naphthalene	10	ND to 1,800	9 of 43	WCGP-14(4.5-8.5)
		2-Methylnaphthalene	NA	ND to 620	NA	WCGP-14(4.5-8.5)
		Acenapthylene	NA	ND to 110	NA	WCGP-15(18-22) WCGP-17(28-32)
		Acenapthene	20	ND to 300	6 of 43	WCGP-14(4.5-8.5)
		Dibenzofuran	NA	ND to 10	NA	WCGP-15(18-22) WCGP-15(4-8)
		Fluorene	50	ND to 89	4 of 43	WCGP-15(18-22)
		Phenanthrene	50	ND to 210	9 of 43	WCGP-15(18-22)
		Anthracene	50	ND to 169	2 of 43	WCGP-15(70-74)
		Fluoranthene	50	ND to 30	0 of 43	WCGP-15(18-22)
		Pyrene	50	ND to 47	0 of 43	WCGP-15(18-22)
		Benzo(ghi)perylene	NA	ND to 2	NA	WCGP-15(18-22) WCGP-16(2-6)
		Total CaPAHs	NA	ND to 50	NA	WCGP-15(18-22)
		Total PAHs	NA	ND to 3,015	NA	WCGP-14(4.5-8.5)

Notes:

SCGs: NYSDEC Class GA Groundwater Standards/Guidelines

NA: Not applicable

ND: Non-detect

*: Carcinogenic PAH (CaPAH)

- **Nonaqueous phase liquid (NAPL):** NAPL is a liquid that does not readily dissolve in water and can exist as a separate fluid phase. Tar and oil released in a soil/water environment will behave as a NAPL. NAPLs are subdivided into two types, those that are lighter than water (light nonaqueous phase liquid or LNAPL) and those with a density greater than water (dense nonaqueous phase liquid or DNAPL). Being lighter than water, LNAPLs will float on water. A common example of an LNAPL would be gasoline or oil floating on water. DNAPLs, being denser than water, would tend to sink through water. Though examples of DNAPLs in everyday life are not very common, an analogy to a DNAPL in water would be an oil and vinegar salad dressing where, in this case, the vinegar represents the DNAPL and the oil represents the water. When the oil and vinegar mixture is shaken, it is momentarily mixed as an emulsion. However, after settling, the oil, being lighter than the vinegar, floats to the top of the container whereas the vinegar (representing the DNAPL) settles to the bottom as a separate phase layer.

- **Saturated:** The entire pore space of the soil matrix for a given soil sample was "filled" with a NAPL. The characteristics of the observed NAPL were used in the description (i.e., tar-saturated or petroleum-saturated).

- **Blebs:** Observed discrete sphericals or pockets of NAPL within a soil or groundwater sample. The characteristics of the observed NAPL were used in the description (i.e., tar blebs or petroleum blebs).

- **Stained:** The soil sample exhibited a discoloration not associated with natural processes. The color of the observed stain was used and if the characteristics of the staining material were discernible, they were also noted (i.e., tar-stained or petroleum-stained).

- **Sheen:** The iridescence observed within a soil sample or the surface of a groundwater sample created by the presence of small quantities of NAPL.

- **Odor:** If an odor was present, it was described based on its relative intensity and characteristics. Relative odor intensity was described using terms such as strong, moderate and faint. Descriptive terms such as tar-like, naphthalene-like, hydrocarbon-like or petroleum-like odors were also used when such determinations could be made.

- **MGP Tar:** MGP tar is a byproduct of the manufactured gas process and is typically comprised of a broad spectrum of hydrocarbon compounds including BTEX compounds, PAHs and phenols. However, it should be noted that elevated concentrations of phenols have generally not been encountered in association with investigations being conducted by KeySpan at its former MGP sites. MGP tar can be encountered in a solid, semi-solid or liquid state. Similar to petroleum, MGP tar does not readily dissolve in water and will exist as a NAPL when released in a soil/water environment.

BTEX compounds were the principal VOCs detected in samples and are the common VOCs associated with tar. Semivolatile organic compounds (SVOCs) were also detected at the site with PAHs being the common subset of SVOCs in tar. For purposes of this report, PAHs include the compounds listed below.

- 2-Methylnaphthalene
- Benzo(b)fluoranthene
- Fluorene
- Acenaphthene
- Benzo(g,h,i)perylene
- Indeno(1,2,3-c,d)pyrene
- Acenaphthylene
- Benzo(k)fluoranthene
- Naphthalene
- Anthracene
- Chrysene
- Phenanthrene
- Benzo(a)anthracene
- Dibenzo(a,h)anthracene
- Pyrene
- Benzo(a)pyrene
- Fluoranthene
- Dibenzofuran

Of these PAHs, the following constituents are considered carcinogenic PAHs by EPA.

- Benzo(a)anthracene
- Dibenzo(a,h)anthracene
- Benzo(a)pyrene
- Benzo(k)fluoranthene
- Indeno(1,2,3-cd)pyrene
- Benzo(b)fluoranthene
- Chrysene

The analytical results of this investigation and previous investigations are discussed relative to the presence of total BTEX and total PAHs.

4.2 On-Site Investigation

Consistent with the Supplemental Field Investigation Work Plan and the operable unit designations discussed in **Section 1.5**, the on-site field program has been further divided into the following areas:

- Bay Shore Site and adjacent off-site locations (Operable Unit 1)
- The Bay Shore West Parcel (Operable Unit 1)
- The Bay Shore West Storage Lot Parcel (Operable Unit 3)

4.2.1 Bay Shore Site and Adjacent Off-site Locations (Operable Unit 1)

4.2.1.1 - Surface Soil

A total of seven surface soil samples were collected at the Bay Shore site. Surface soil samples BBSS-30, 31, 32 and 38 were collected from the southwest corner of the site near the southern end of the former Generator House, in order to delineate the presence of PCBs identified in surface soil sample BBSS-09 collected during the initial field program. In addition, BBSS-33 was collected approximately 130 feet north of this area in order to determine if the source of the PCBs identified at BBSS-09 was a former electrical transformer located in this area. Samples BBSS-36 and BBSS-37 were collected from the northwest corner of the site in the vicinity of the active electrical substation located adjacent to the site.

The analytical results for PCBs in the samples collected are summarized in **Table C-1**. In the vicinity of BBSS-09, PCBs were detected at concentrations that ranged from 0.10 mg/kg in BBSS-31 to 4.7 mg/kg in BBSS-30. PCBs were detected at a concentration of 0.17 mg/kg at BBSS-33 located in the vicinity of the former Transformer. Aroclor-1260 was the only PCB compound detected in the above samples. PCBs were not detected above the Contract Required Detection Limit (CRDL) of 0.03 mg/kg in BBSS-36 and BBSS-37.

4.2.1.2 - Subsurface Soil

A total of 39 soil borings and probes were completed at the Bay Shore Site and adjoining areas with a total of 170 subsurface soil samples selected for chemical analysis, including BTEX, PAHs and petroleum fingerprint. The objectives of the soil boring program included:

- Further delineate the presence of BTEX and PAHs in subsurface soil in source areas identified during the initial field program;
- Define the vertical and areal extent of NAPL within suspected source areas; and
- Define the nature and extent of off-site NAPL migration downgradient of the Bay Shore Site.

In addition, 14 test pits were completed within the site with a total of 16 subsurface soil samples selected for analysis. The objectives of the test pits included:

- Observe shallow subsurface conditions;
- Determine if LNAPL is present at or near the water table; and
- Locate and identify subsurface MGP structures and foundations.

Analytical results for BTEX and PAHs in subsurface soil samples collected from soil borings are summarized in **Tables C-2** and **C-3** and analytical results for petroleum fingerprint/total petroleum hydrocarbons (TPH) are summarized in **Table C-4**. The analytical results for subsurface soil samples collected from test pits for BTEX, PAHs and petroleum fingerprint/TPH are summarized in **Tables C-5** through **C-7**.

BTEX

Table 4-11 summarizes data related to subsurface soil samples collected from on-site and adjacent off-site locations which exhibited the highest total BTEX and total PAH concentrations along with the approximate location of each sample with respect to former MGP structures/ features where appropriate. The table also includes PID measurements and lists any significant

TABLE 4-11

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS SUBSURFACE SOIL SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Boring and Sample Depth)	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location (in Relation to Former MGP Structure and/or Site)	PID (ppm)	Field Description of Recovered Sample
BBSB-37 (12-14')	0.2	2,075.6	Within eastern portion of Oxide Bed and adjacent to northern portion of Purifiers. Downgradient of Cesspool.	282.0	Black staining, NAPL saturated, strong naphthalene-like odor
BBSB-40 (0-2')	872.0	2,326.0	Between 100,000 cu. ft. Gas Holder and Former 0.5 Million cu. ft. Relief Gas Holder. Downgradient of Former 2 Million cu. ft. Main Storage Gas Holder.	203.0	Black staining w/strong naphthalene-like odor in top 3", black staining w/faint naphthalene-like odor in bottom 2"
BBSB-44 (4-6')	0.0	2,448.1	Outside southeast portion of Former 0.5 Million cu. ft. Relief Gas Holder.	99.5	Black banding, tar staining, moderate naphthalene like odor
BBSB-49 (4-6')	924.0	2,809.0	Within Tar Seperators. Downgradient of Demulsifier Pump House.	2,000+	Black staining, NAPL saturated, heavy hydrocarbon-like and naphthalene-like odors
BBSB-49 (9-10')	744.0	3,241.2	Within Tar Seperators. Downgradient of Demulsifier Pump House.	1,100.0	Black staining, heavy hydrocarbon-like odor
BBSB-52 (1-3')	469.0	1,775.0	Between Centrifix Pit and 75,000 gallon Tar Tank. Downgradient of Demulsifier Pump House.	900.0	Heavy staining, hydrocarbon-like odor
BBSB-53 (6-8')	617.0	519.4	In vicinity of Catch Basin, Drip House and Blow Down Tank. Downgradient of Tar Settling Tanks.	800.0	Heavy black staining, heavy hydrocarbon-like odor
BBSB-58 (6-8')	859.1	759.1	Within Generator House in the vicinity of Tar Well. Downgradient of Oil Unload Tank.	650.0	Heavy black staining, heavy hydrocarbon-like odor
BBSB-63 (34-36')	27.4	4,932.0	Adjacent to southern portion of Compressor House. Downgradient of Compressor House.	475.0	Heavy staining-NAPL saturated w/tar from 33.5-35.5', heavy naphthalene-like odor
BBSB-66 (36-37')	20.1	3,051.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	232.0	Saturated w/tar - flowable, naphthalene-like odor

TABLE 4-11 (continued)

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS SUBSURFACE SOIL SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Boring and Sample Depth)	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location (in Relation to Former MGP Structure and/or Site)	PID (ppm)	Field Description of Recovered Sample
BBSB-66 (53-54')	77.0	5,538.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	250.0	Black tar saturated band from 53-53.5', sheen, strong naphthalene-like odor
BBSB-81 (36-38')	0.6	2,633.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	150.0	Intermittant heavy staining, heavy naphthalene-like odor
BBSB-81 (69-71')	250.0	4,075.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	800.0	NAPL saturated at 70.5', heavy naphthalene-like odor
BBSB-82 (69-71')	167.8	11,009.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	433.0	Black-brown staining, sheen, hydrocarbon-like odor from 69-70.5'
BBSB-86 (15-17')	514.8	725.1	Within eastern portion of Compressor House. Downgradient of 54,000 cu. ft. Gas Holder & Heavy Oil Tank.	300.0	Blue staining, tar/oil lenses at 15.5' and 16.5', hydrocarbon-like odor
BBTP-03 (5-6')	287.0	10,997.0	Partially within Cesspool, in the vicininty of Former 2 Million cu. ft. Main Storage Gas Holder. Downgradient of Concrete Basin Cooling Coils.	254.0	Saturated w/flowing tar, moderate tar-like odor
BBTP-04 (5-6')	5,510.0	49,340.0	Outside eastern portion of Former 0.5 Million cu. ft. Relief Gas Holder. Downgradient of Former 2 Million cu. ft. Main Storage Gas Holder.	685.0	Saturated w/tar, strong naphthalene-like odor
BBTP-08 (6-7')	660.0	20,270.0	In vicinity of Tar Separators and Effluent Water Treatment House. Downgradient of Demulsifier Pump House.	150.0	Solidified tar chunks, naphthalene-like odor
BBTP-09 (7-8')	581.0	1,002.7	In vicinity of Tar Settling Tanks, Centrifix Pit and Catch Basin. Downgradient of Meter House.	940.0	Heavy black tar staining, strong naphthalene/tar-like odor
BBTP-10 (5-7')	636.0	594.2	Partially within Boiler House, Drip House and 54,000 cu. ft. Gas Holder & Heavy Oil Tank. Downgradient of Gas Condenser Cooler.	784.0	Black staining, strong tar/hydrocarbon-like odor

field observations noted for the samples. Also, note that **Section 4.2.1.4** provides additional details regarding the nature and extent of NAPL in subsurface soil.

As presented in **Table 4-11**, with regard to the supplemental field program, the maximum total BTEX concentration of 5,510.0 mg/kg was detected in subsurface soil sample BBTP-04 (5 to 6 feet) collected immediately to the north of the former Naphthalene Scrubber and west of the former Relief Holder. This sample consisted of tar-saturated soil and produced a PID reading of 685.0 ppm. In addition, sample BBTP-04 (5 to 6 feet), which was collected as part of the initial field program from a location approximately 20 feet north of soil boring BBSB-11, exhibited a total BTEX concentration of 41,100.0 mg/kg. This particular sample represents the highest concentration of BTEX detected in subsurface soil samples collected as part of the initial field program. In general, the highest total BTEX concentrations were observed west of the former Relief Holder (BBTP-04 and BBSB-40) and within the area of the former Tar Separator/Effluent Treatment House (BBSB-49, BBTP-08 and BBTP-09). In addition, soil sample BBSB-58 (6 to 8 feet) exhibited a total BTEX concentration of 859.1 mg/kg. BBSB-58 was completed adjacent to the former Tar Well located in the southwestern portion of the Bay Shore site. Consistent with the initial field program findings, samples containing the highest total BTEX concentrations were collected from shallow subsurface soil (less than 12 feet below grade) and exhibited heavy tar staining and/or tar/NAPL-saturated conditions. At most on-site locations, BTEX concentrations decrease rapidly with increasing depth. However, at a number of off-site borings completed during the supplemental field program immediately downgradient of the site, BTEX was detected at deeper soil intervals including:

Sample ID	Total BTEX Concentration (mg/kg)
BBSB-66 (53 to 54 feet)	77.0
BBSB-81 (69 to 71 feet)	250.0
BBSB-82 (69 to 71 feet)	167.8

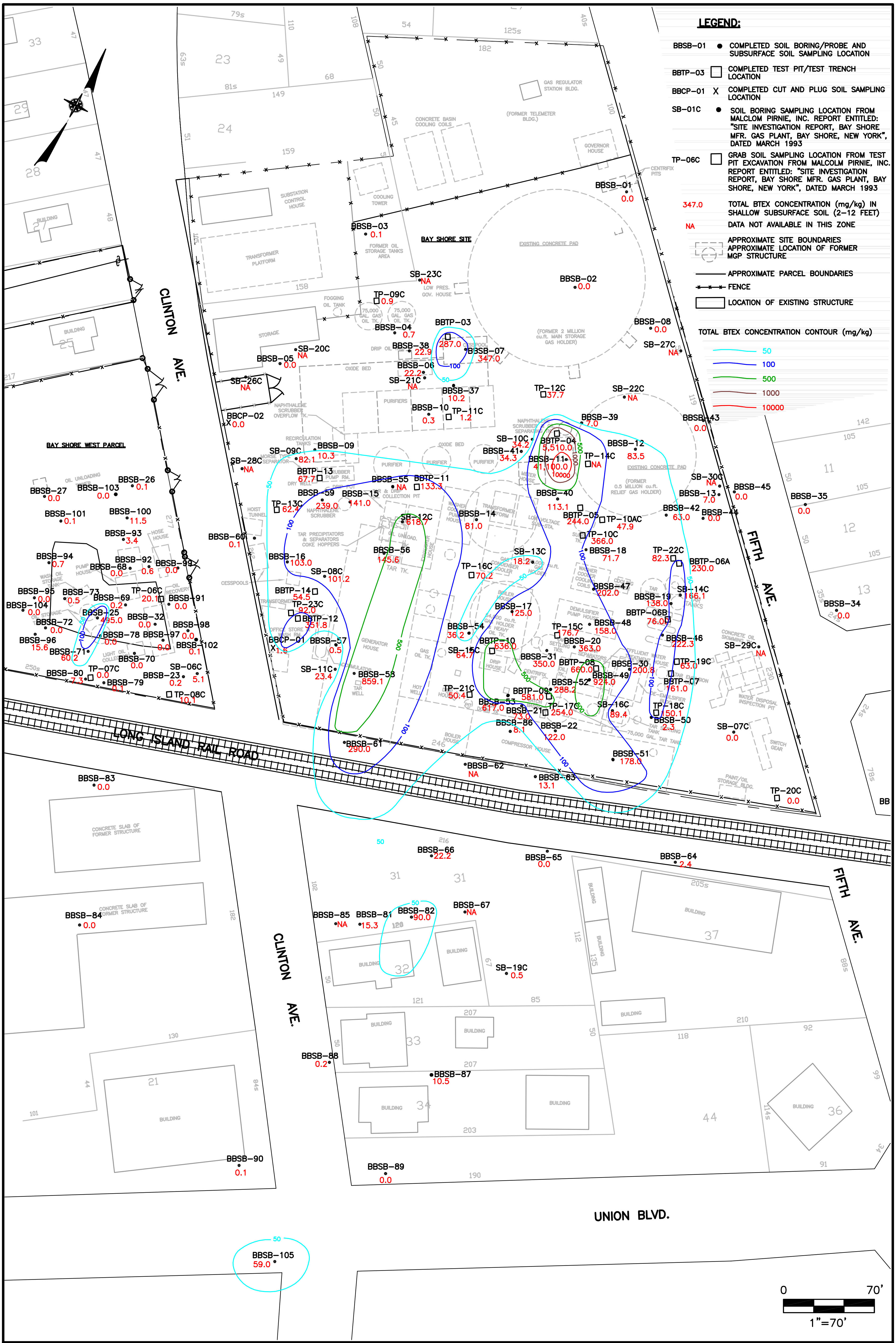
The deeper samples listed above also exhibited tar staining and/or tar/NAPL-saturated conditions.

The total BTEX observed in the samples listed in **Table 4-11** are comprised predominantly of ethylbenzene and xylenes. An exception to this distribution was observed in soil boring BBSB-49 located within the former Tar Separator in the southeast portion of the site. Soil in this boring contained elevated concentrations of toluene in addition to the ethylbenzene and xylenes. This and similar exceptions may reflect a unique source material or varying degrees of weathering of the material in the vicinity of these borings.

Figures 4-1 through **4-3** depict total BTEX concentrations in subsurface soil at on-site and adjacent off-site sample locations. The figures are based on soil data generated from the supplemental field program, the initial field program completed in the Fall of 2000, the cut and plug IRM conducted in the Winter of 1999, as well as the Malcolm Pirnie investigation conducted in 1992. Details concerning the 1992 Malcolm Pirnie investigation, as well as the cut and plug IRM are presented in the April 2002 RI report. The data used for **Figure 4-1** is based on the analytical results of subsurface soil samples collected at shallow depths ranging from 2 to 12 feet bgs, and includes the groundwater interface encountered between 6 and 8 feet bgs at on-site locations. The data used for **Figure 4-2** is based on the analytical results of subsurface soil samples collected at intermediate depths ranging from 12 to 32 feet bgs. The data used for **Figure 4-3** is based on the analytical results of subsurface soil samples collected from deep intervals at depths greater than 32 feet bgs. It is important to note that at sample locations where more than one sample within a given depth range was analyzed for BTEX, the highest concentration detected was utilized in developing **Figures 4-1** through **4-3**.

Based on a review of these figures and the supporting data, the following are noteworthy observations.

1. With the exception of the former Cesspool area located immediately southwest of the former Main Gas Holder, subsurface soil in the northern third of the Bay Shore Site does not contain elevated levels of BTEX. In fact, total BTEX concentrations in this area do not exceed 0.92 mg/kg. In addition, it appears that subsurface soil in the southeastern portion of the Bay Shore Site does not contain BTEX compounds.



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX CONCENTRATIONS IN SHALLOW SUBSURFACE SOIL (2 TO 12 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-1

Dvirka
and
Bartilucci
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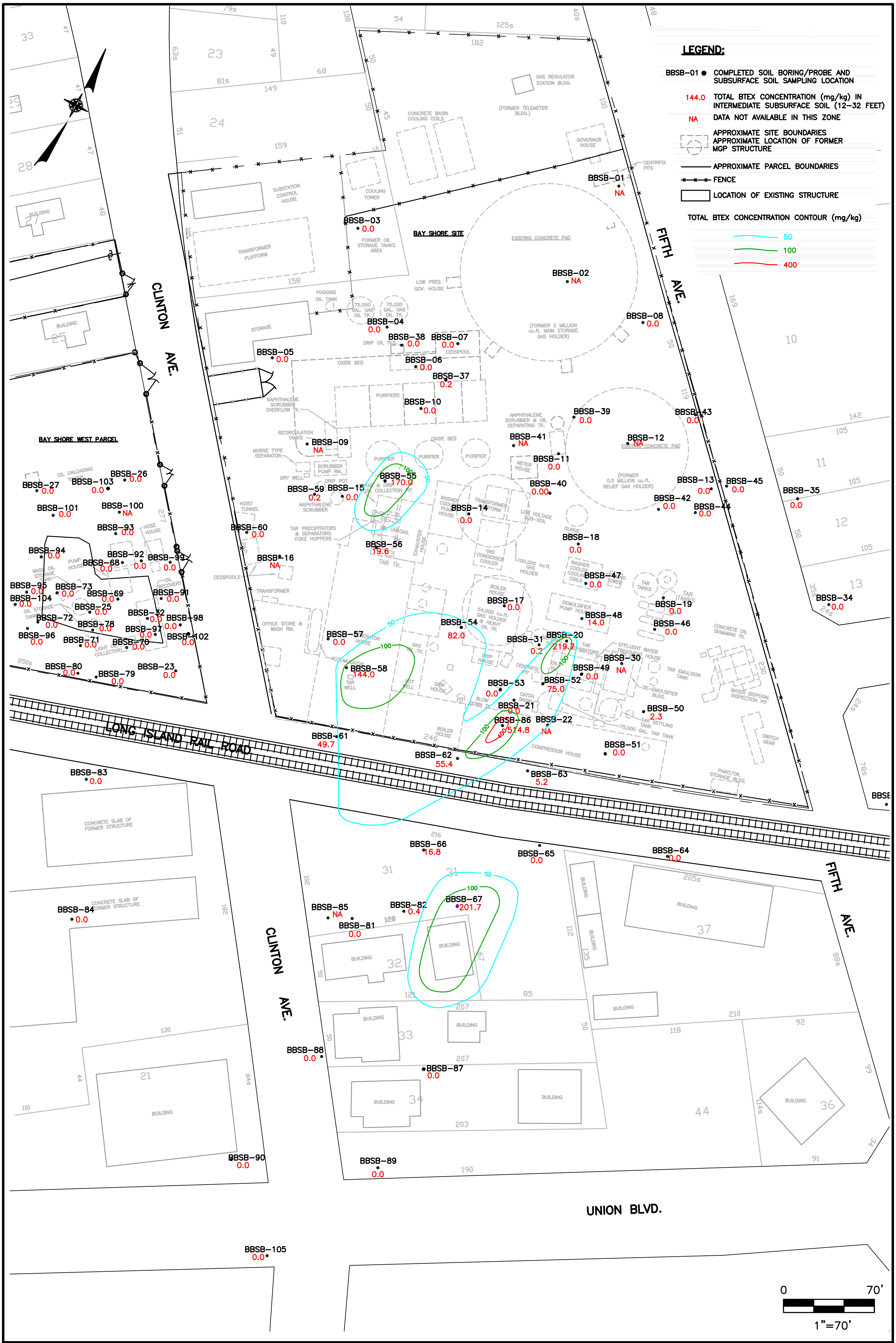

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

Dvirka and Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

TOTAL BTEX CONCENTRATIONS IN INTERMEDIATE SUBSURFACE SOIL (12 TO 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-2

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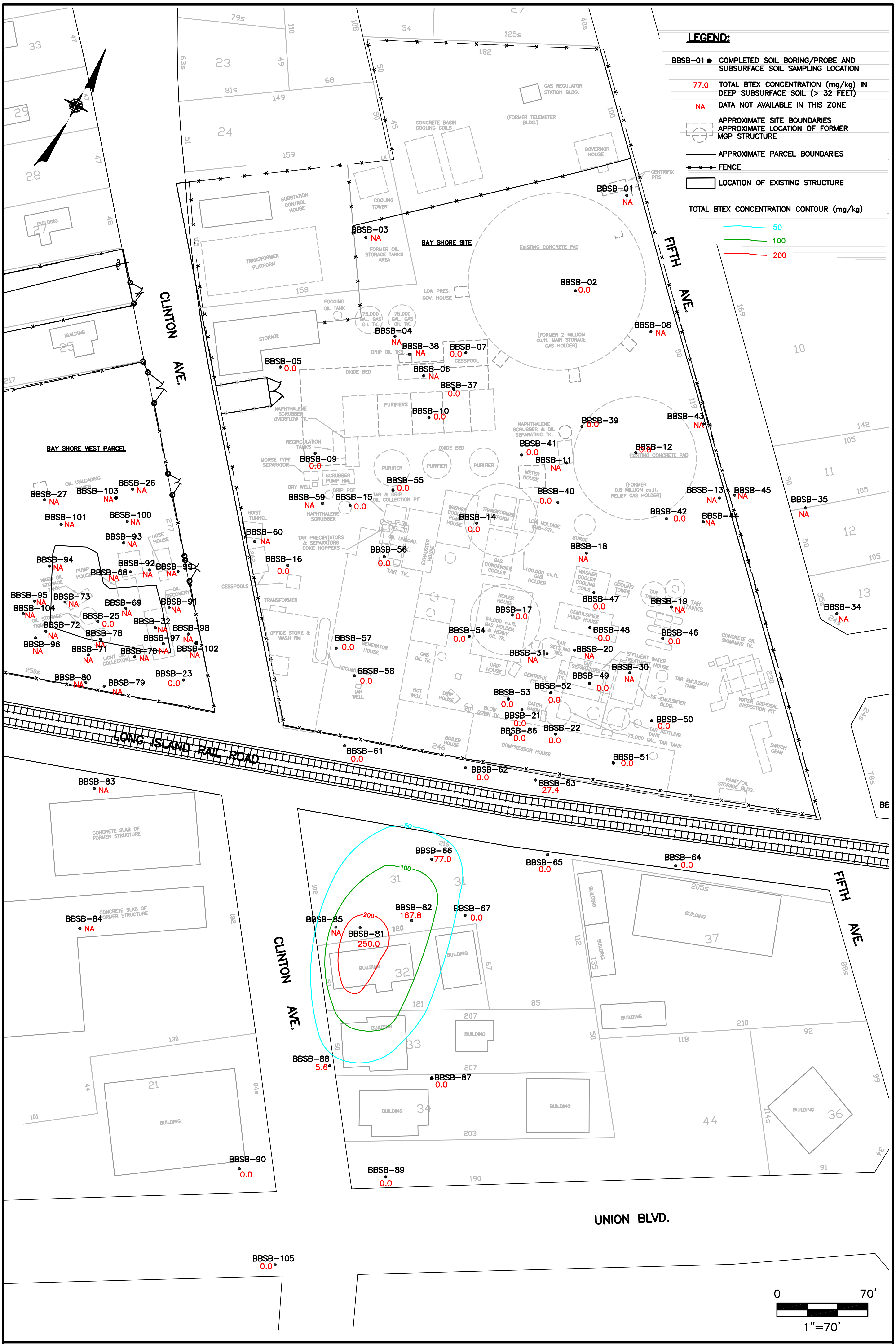

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BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX CONCENTRATIONS IN DEEP SUBSURFACE SOIL (> 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-3

Dvirka
and
Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

2. The highest concentrations of BTEX in subsurface soil are found in the shallow soil interval, southwest of the former Relief Holder and within the general vicinity of a former Naphthalene Scrubber. This area extends south to the former locations of the Effluent Water Treatment Facilities, Tar Separators and Tar Settling and Tar Holding Tanks. A second area of elevated BTEX in subsurface soil is present in the vicinity of the former Tar and Drip Oil Collecting Pits, as indicated by the analytical results for soil samples collected from Malcolm Pirnie soil boring SB-12C, which exhibited a total BTEX concentration of 618.7 mg/kg. In addition, shallow soil in the vicinity of the former Tar Well, which was located in the southwest corner of the site contained elevated total BTEX at a concentration of 859.1 mg/kg.

3. In the adjacent off-site areas south of the site, shallow subsurface soil contains relatively low BTEX concentrations with the exceptions of BBSB-61 (6 to 8 feet), which exhibited a total BTEX concentration of 290.0 mg/kg, and BBSB-82 (10 to 12 feet), which exhibited a total BTEX concentration of 90.0 mg/kg. In addition, BBSB-105 (8 to 10 feet), which is located approximately 410 feet south of the site, exhibited a total BTEX concentration of 59.0 mg/kg.

4. As shown on **Figure 4-2**, BTEX concentrations in intermediate subsurface soil (i.e., below a depth of 12 feet) at the majority of on-site locations are notably lower than those in shallow subsurface soil and are generally less than 100 mg/kg. Several exceptions to this observation include soil borings BBSB-55 located immediately north of the former Tar and Drip Oil Collection Pit, BBSB-58 located adjacent to the former Tar Well and borings BBSB-20 and BBSB-86, both completed within the vicinity of the former Tar Separator and Effluent Water Treatment House.

5. As shown on **Figure 4-3**, total BTEX concentrations in deep subsurface soil below a depth of 32 feet, are less than 0.03 mg/kg throughout the Bay Shore site. However, immediately downgradient of the site, BTEX was detected in deep subsurface soil, as indicated by soil samples BBSB-66 (53 to 54 feet) with a total BTEX concentration of 77.0 mg/kg, BBSB-82 (69 to 71 feet) with a total BTEX concentration of 167.8 mg/kg and BBSB-81 (69 to 71 feet) with a total BTEX concentration of 250.0 mg/kg. The detection and distribution of BTEX in deep subsurface soil off-site is consistent with field observations of tar/NAPL staining, as well as tar/NAPL at saturated levels within deep subsurface soil borings immediately downgradient of the Bay Shore site.

PAHs

Table 4-11 summarizes the analytical data of subsurface soil samples collected from on-site locations which exhibited the highest total PAH concentrations along with the approximate location of each sample in relation to former MGP structures/features where appropriate. The table also includes PID measurements and significant field observations noted for the samples.

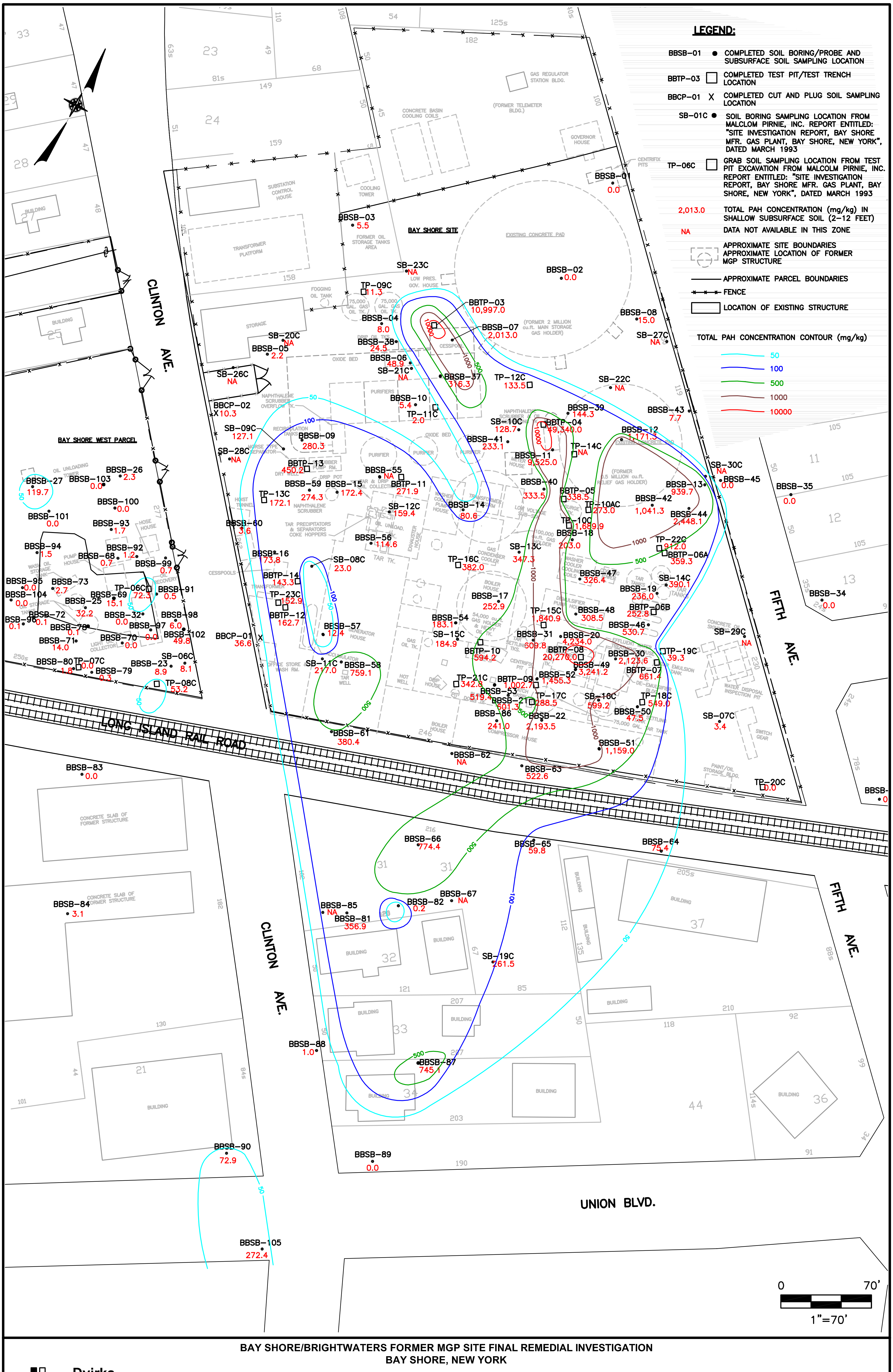
Also, note that **Section 4.2.1.4** provides additional detail as to the nature and extent of NAPL in subsurface soil.

As shown in **Table 4-11**, the maximum total PAH concentration observed in on-site subsurface soil was 49,340.0 mg/kg detected in soil sample BBTP-04 (5 to 6 feet), the same sample that contained the highest total BTEX concentration in subsurface soil collected as part of the supplemental field program. This sample was collected immediately north of the former Tar Scrubber located west of the former Relief Holder and is also located 20 feet north of BBSB-11, which contained the maximum total PAH concentration of 9,525.0 mg/kg detected in subsurface soil samples collected during the initial field program. In general, the highest PAH concentrations observed on-site were identified in shallow subsurface soil west and south of the former Relief Holder (BBTP-04), the former Tar Separator/Effluent Water Treatment House (BBTP-08 and BBSB-49) and the former Cesspool located west of the former Gas Holder (BBTP-03). Off-site to the south, a number of soil samples collected at depths greater than 50 feet exhibited PAHs, including:

Sample ID	Total BTEX Concentration (mg/kg)
BBSB-66 (53 to 54 feet)	5,538.0
BBSB-81 (69 to 71 feet)	4,075.0
BBSB-82 (69 to 71 feet)	11,009.0

The deeper samples listed above also exhibited tar staining and/or tar/NAPL-saturated conditions.

Figures 4-4 through **4-6** depict total PAH concentrations in subsurface soil at on-site and adjacent off-site sample locations. These figures are based on soil data generated from the supplemental field program completed in the Summer of 2002, the initial field program completed in the Fall of 2000, the cut and plug IRM conducted in the Winter of 1999, as well as the Malcolm Pirnie investigation conducted in 1992. Details of the 1992 Malcolm Pirnie investigation, as well as the cut and plug IRM, are presented in the April 2002 RI report. The



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL PAH CONCENTRATIONS IN SHALLOW SUBSURFACE SOIL (2 TO 12 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

Dvirka and Bartilucci
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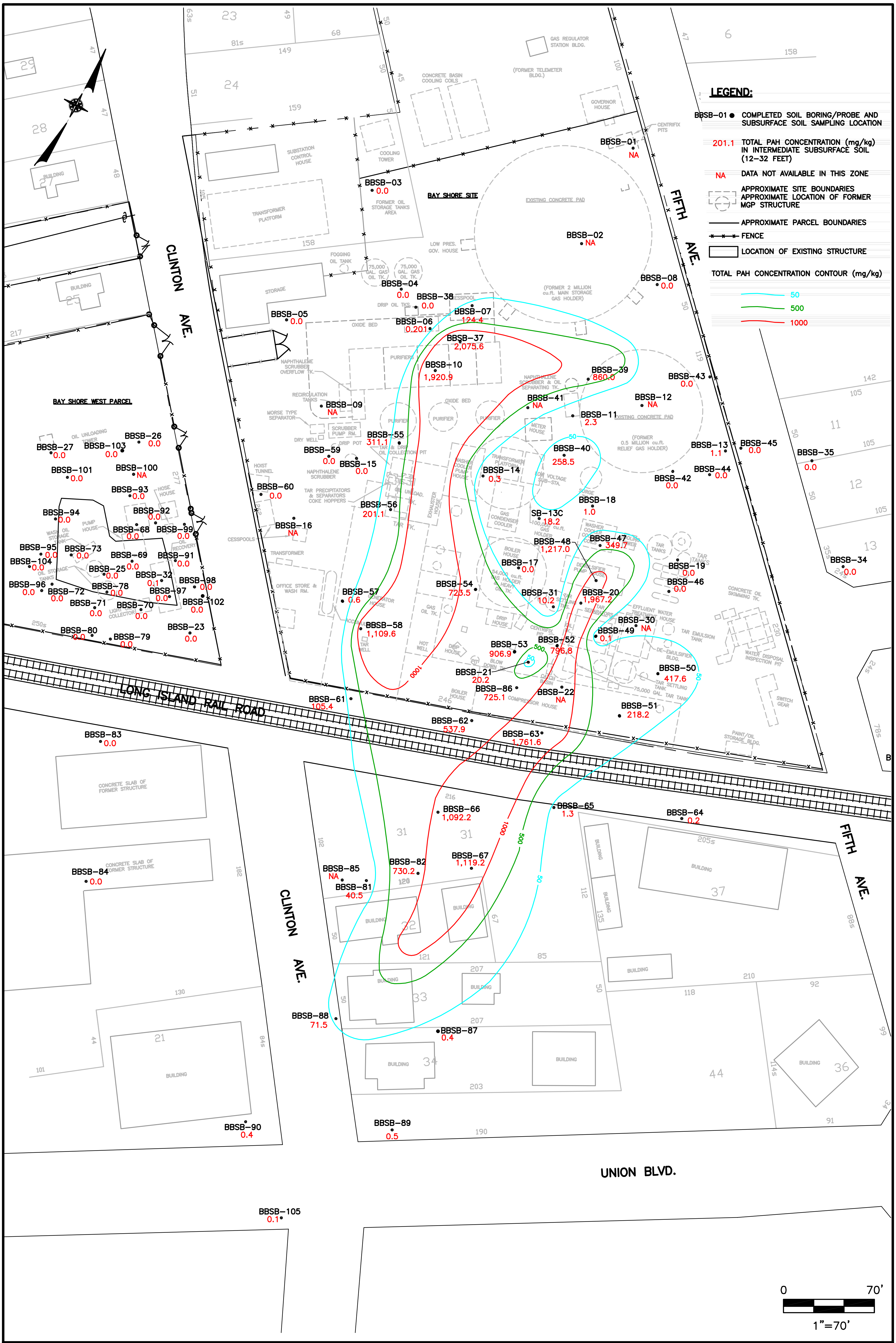
FIGURE 4-4

\\Nt4\CADwork\1620B12B\dwg\11X17\FIG-4D.dwg, 10/28/02 02:04:53 PM, APostyn



\\Nt4\CADwork\1620B12B\dwg\11X17\FIG-4E.dwg, 10/28/02 02:06:08 PM, APostyn

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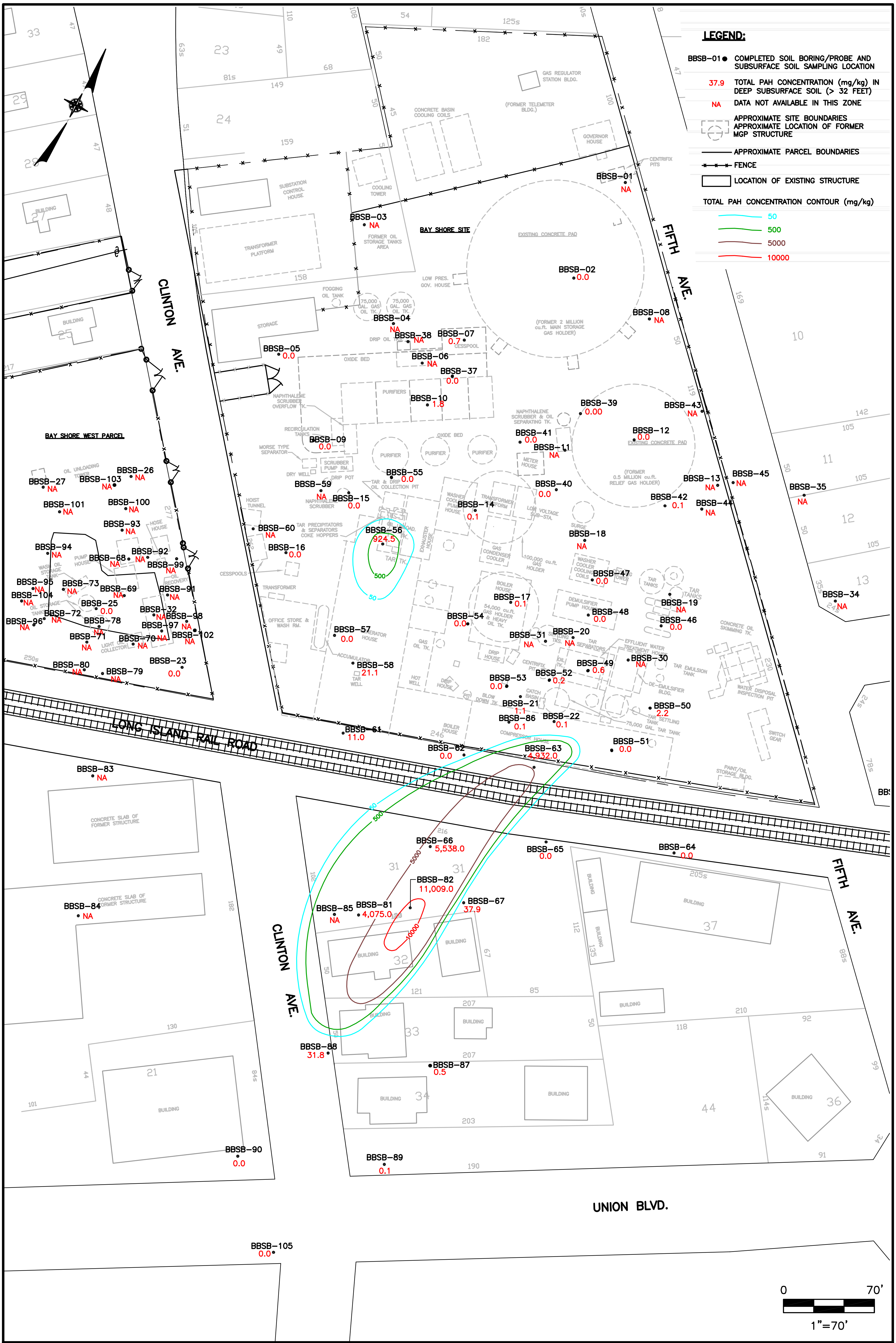
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL PAH CONCENTRATIONS IN INTERMEDIATE SUBSURFACE SOIL (12 TO 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-5



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL PAH CONCENTRATIONS IN DEEP SUBSURFACE SOIL (> 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-6

Dvirka
and
Bartilucci
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\\Nt4\CADwork\1620B12B\dwg\11X17\FIG-4F.dwg, 10/28/02 02:07:10 PM, APostyn data used for **Figure 4-4** is based on the analytical results of shallow subsurface soil samples collected at depths ranging from 2 to 12 feet bgs, and includes those soil samples that were collected at the groundwater interface, which was encountered between 6 and 8 feet bgs at on-site locations. The data used for **Figure 4-5** is based on the analytical results of subsurface soil samples collected from intermediate depths ranging from 12 to 32 feet bgs. The data used for **Figure 4-6** is based on the analytical results of subsurface soil samples collected at deep intervals greater than 32 feet bgs. It is important to note that at sample locations where more than one sample was analyzed within a given depth range for PAHs, the highest concentration detected was utilized in developing **Figures 4-4** through **4-6**.

Based on a review of these figures and the supporting data, the following are noteworthy observations.

1. The distribution of PAHs in subsurface soil is generally consistent with the pattern exhibited by total BTEX concentrations. Specifically, subsurface soil within the northern third of the Bay Shore Site does not exhibit elevated PAH concentrations. In this case, total PAH concentrations do not exceed 11.5 mg/kg. In addition, the subsurface soil within the southeastern corner of the site does not exhibit elevated PAH concentrations, with total PAH concentrations not exceeding 3.5 mg/kg. However, the former Cesspool, which is located southwest of the former Main Holder, contained elevated concentrations of PAHs. At this isolated location, total PAH concentrations of up to 10,997.0 mg/kg were detected at BBTP-03.

2. As shown on **Figure 4-4**, the highest concentrations of PAHs in shallow subsurface soil are found south and southwest of the former Relief Holder, as well as areas further south in the vicinity of the former Tar Settling Tanks, Tar Holding Tanks, Tar Separators and Effluent Water Treatment Facilities. In addition, the area to the southeast of the former Relief Holder appears to exhibit PAHs in shallow subsurface soil as indicated by samples collected from soil borings BBSB-13, BBSB-42 and BBSB-44. However, data for soil samples collected from soil boring BBSB-45 indicates that the area of shallow soil containing PAHs does not extend a significant distance off-site.

3. Shallow subsurface soil samples collected at or immediately below the water table from several soil borings located downgradient of the site, including BBSB-66, BBSB-81 and BBSB-87, exhibit total PAH concentrations ranging from 356.9 to 1,119.2 mg/kg. In addition, a total PAH concentration of 272.4 mg/kg was detected immediately below the water table at soil boring BBSB-105 located approximately 410 feet downgradient of the site.

4. **Figure 4-5** clearly indicates that PAH concentrations in soil samples collected from intermediate depths (i.e., below a depth of 12 feet) are significantly lower than those detected in shallow soil samples at the majority of on-site sample locations. However, PAHs remain present downgradient of the former Cesspool (BBSB-10 and BBSB-37), the former Naphthalene Scrubber southwest of the Relief Holder (BBSB-11) and in the vicinity of the former Tar Separators/Effluent Treatment House (BBSB-20, BBSB-21 and BBSB-31). Off-site and downgradient of the former Tar Separators/Effluent Treatment House, PAHs were detected in subsurface soil samples collected below a depth of 12 feet from soil borings BBSB-62, BBSB-63, BBSB-66, BBSB-67 and BBSB-82.

5. **Figure 4-6** indicates that, similar to total BTEX concentrations, the total PAH concentrations detected in deep subsurface soil (i.e., below a depth of 32 feet are relatively low, with total PAH concentrations not exceeding 2.0 mg/kg at most on-site locations. One exception was the detection of total PAHs at a concentration of 924.5 mg/kg in deep soil sample BBSB-56 (43 to 44 feet) located immediately downgradient of the former Tar and Drip Oil Collection Pit.

6. Soil borings completed immediately downgradient of the Bay Shore site contained elevated PAH concentrations in soil deeper than 32 feet including BBSB-83, BBSB-66, BBSB-81 and BBSB-82. The highest total PAH concentration observed in off-site soil was detected in BBSB-82 (69 to 71 feet) at a concentration of 11,009.0 mg/kg. The distribution of PAH concentrations in deep subsurface soil is consistent with field observations which indicated the presence of tar/NAPL stained and tar/NAPL saturated soil immediately downgradient of the Bay Shore Site and in subsurface soil at depths greater than 32 feet below grade.

Petroleum Fingerprint/TPH Analysis

The analytical results for the 13 subsurface soil samples selected for petroleum fingerprint/TPH analysis are summarized in **Tables C-4** and **C-7** for samples collected from soil borings and test pits, respectively. The TPH concentrations for soil boring samples ranged from 3,100.0 mg/kg in sample BBSB-47 (10 to 12 feet) to 34,000.0 mg/kg in sample BBSB-58 (6 to 8 feet). Soil boring BBSB-58 was located inside the former Generator House adjacent to the former Tar Well. As indicated in the boring log for this soil boring (**Appendix A**), soil in the interval exhibited visible tar staining, a strong hydrocarbon-like odor and PID measurements ranging up to 650 parts per million (ppm). It is noted that soil sample BBSB-58 (13 to 15 feet) exhibited a TPH concentration of 4,000.0 mg/kg.

The next highest TPH concentration was detected in soil sample BBSB-63 (6 to 8 feet) at 19,000.0 mg/kg. Soil boring BBSB-63 was located downgradient of the former Compressor House, between the southern site boundary and the LIRR right-of-way (ROW). As indicated in the boring log for this soil boring, soil in the interval sampled contained NAPL at saturated levels, staining, a tar-like odor and PID measurements ranging up to 600 parts per million (ppm). The TPH concentration for soil sample BBSB-63 (34 to 36 feet), the next deeper interval, was 9,000.0 mg/kg.

The TPH concentrations for test pit samples ranged from 8,400.0 mg/kg in test pit sample BBTP-11 (9 to 10 feet) to 490,000.0 mg/kg in test pit sample BBTP-10 (4-inch pipe). Test pit BBTP-11 was excavated in the central portion of the site in the vicinity of the former Oil Unloading Tank and Exhauster House. Test pit BBTP-10 was excavated in the south central portion of the site in the former 54,000 Cubic Foot Gas Holder and Heavy Oil Tank, Drip House and Boiler House. It is noted that as discussed above, soil boring BBSB-54 was also located near test pit BBTP-10; however, TPH concentrations in the soil boring were several orders of magnitude lower than that detected in the test pit sample.

Fingerprint analysis of the selected samples indicated that seven of the total of 13 samples collected were found to be most characteristic of “middle distillate” petroleum products, such as No. 2 fuel oil or diesel. The remaining six samples were found to be most characteristic of MGP tar. It is likely that the samples classified as middle distillate petroleum were associated with a petroleum based feedstock used in the MGP process and the samples classified as MGP tar were associated with various pyrogenic materials that were created as byproducts of the MGP process. However, the fingerprint analysis does not indicate a clear pattern as to the likely source of the MGP residuals present in subsurface soil at the Bay Shore site. Instead, the distribution of the soil exhibiting petroleum and MGP tar appear to be random and in a number of cases, samples collected from the same boring, but at different depths, vary in characteristics from petroleum to MGP tar.

4.2.1.3 – Groundwater

As part of the supplemental field program, a total of 20 groundwater probes were completed within the Bay Shore site and at adjacent off-site locations and 23 new groundwater monitoring wells were installed. All newly installed wells, along with all existing wells, were checked for NAPL and sampled. All groundwater samples were analyzed for BTEX and PAHs. In addition, several samples of NAPL collected from a number of adjacent off-site wells were selected for petroleum fingerprint analysis. The objectives of the well installation and groundwater sampling program included:

- Further delineate the presence of BTEX and groundwater in suspected source areas identified as part of the initial field program;
- Define the vertical and areal extent of NAPL within suspected source areas;
- Provide additional data as to the potential mobility and recoverability of identified NAPL;
- Define the nature and extent of off-site NAPL migration;
- Determine if site related chemicals have migrated vertically into the Magothy aquifer; and
- Obtain additional data needed to evaluate the potential applicability/effectiveness of various remedial technologies under a Remedial Action Plan (RAP).

BTEX and PAH results for groundwater samples collected from on-site and adjacent off-site monitoring wells are summarized in **Table C-8** and **Table C-9**, respectively. Petroleum fingerprint/TPH analytical results are presented in **Table C-10**. Analytical data for BTEX and PAHs in groundwater probe samples are presented in **Table C-11** and **Table C-12**, respectively.

Based on the hydrogeologic setting of the site, the groundwater chemical data has been grouped into three hydrogeologic zones including:

Shallow Groundwater

For the purpose of this investigation, the shallow groundwater zone has been defined as groundwater encountered from the water table to a depth of 26 feet bgs.

Intermediate Groundwater

The intermediate groundwater zone has been defined as groundwater from 26 to 50 feet bgs.

Deep Groundwater

The deep groundwater zone has been defined as groundwater between 50 and 80 feet bgs. The deep zone is located immediately above the low permeable Magothy formation sediments described in **Section 3.2**.

The following discussion presents the findings of the on-site groundwater sampling completed at the Bay Shore site and adjacent off-site locations as part of the supplemental field program.

BTEX

Table 4-12 summarizes on-site groundwater samples that exhibited the highest total BTEX and total PAH concentrations along with the approximate locations of these samples in relation to former MGP structures/features. The table also indicates any significant field observations noted in these samples. Additional detail as to the distribution of NAPL in groundwater is provided in **Section 4.2.1.4**.

As indicated in **Table 4-12**, the highest levels of BTEX were generally observed in shallow groundwater at or near the water table and within the southern half of the Bay Shore site and at off-site sample locations immediately downgradient of this area. However, during the

TABLE 4-12

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBGP-60 (8-12')	7,590.0	3,561.0	Between 100,000 cu. ft. Gas Holder and 54,000 cu. ft. Gas Holder & Heavy Oil Tank. Downgradient of 100,000 cu. ft. Gas Holder.	Sheen, strong naphthalene-like odor
BBGP-62 (8-12')	4,950.0	1,033.0	Within eastern portion of the Generator House. Downgradient of Morse Tar Seperator.	None
BBGP-64 (8-12')	7,170.0	3,127.0	Within Cesspool in eastern portion of site. Downgradient of Hoist Tunnel.	Heavy sheen, strong naphthalene-like odor
BBGP-65 (8-12')	13,150.0	3,531.0	Within Office Store & Wash Room. Downgradient of Transformer in eastern portion of site.	None
BBGP-66 (6-10')	331.0	6,084.0	Adjacent southern portion of Generator House. Downgradient of Generator House.	Light-moderate sheen, hydrocarbon-like odor
BBGP-66 (14-18')	6,420.0	3,436.0	Adjacent southern portion of Generator House. Downgradient of Generator House.	None
BBGP-67 (9-13')	7,020.0	5,754.0	Outside southwest corner of Compressor House. Downgradient of 54,000 cu. ft. Gas Holder & Heavy Oil Tank.	Sheen, hydrocarbon-like odor
BBGP-68 (8-12')	13,000.0	6,634.0	Outside southern portion of Compressor House. Downgradient of Compressor House.	None
BBGP-68 (32-36')	2,650.0	10,830.0	Adjacent to southern portion of Compressor House. Downgradient of Compressor House.	None
BBGP-69 (9-13')	1,308.0	9,954.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	Light sheen, hydrocarbon-like odor

TABLE 4-12 (continued)

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBGP-69 (20-24')	149.0	8,361.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	Light sheen, moderate naphthalene-like odor
BBGP-69 (34-38')	208.0	13,200.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	Moderate sheen, moderate naphthalene-like odor
BBGP-69 (40-44')	41.0	6,306.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	Light-moderate sheen, moderate naphthalene-like odor
BBGP-69 (56-60')	433.0	8,627.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	Light sheen, moderate naphthalene-like odor
BBGP-69 (71-75')	1,051.0	6,298.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	None
BBGP-70 (9-13')	5,910.0	4,011.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the eastern portion of Compressor House.	Heavy sheen, strong naphthalene-like odor
BBGP-70 (20-24')	34.0	9,520.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the eastern portion of Compressor House.	Sheen, moderate naphthalene-like odor
BBGP-72 (8-12')	3,736.0	2,277.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Sheen, hydrocarbon-like odor
BBGP-72 (16-20')	3,520.0	3,128.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Moderate sheen, hydrocarbon-like odor
BBGP-72 (40-44')	174.0	8,218.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Light sheen, strong naphthalene-like odor

TABLE 4-12 (continued)

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBGP-72 (56-60')	3,603.0	65,000.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Tar blebs, sheen, strong naphthalene-like odor
BBGP-72 (64-68')	9,660.0	823,300.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Tar blebs, sheen, strong naphthalene-like odor
BBGP-72 (71-75')	5,244.0	17,181.0	Within Clinton Avenue south of the railroad tracks. Approximately 233 ft. downgradient of site.	Tar blebs, sheen, strong naphthalene-like odor
BBGP-73 (32-36')	500.0	8,820.0	Within southeast corner of plot south of the railroad tracks and east of Clinton Avenue. Approximately 330 ft. downgradient of site.	None
BBGP-73 (40-44')	77.0	7,910.0	Within southeast corner of plot south of the railroad tracks and east of Clinton Avenue. Approximately 330 ft. downgradient of site.	None
BBGP-73 (72-76')	7,830.0	5,040.0	Within southeast corner of plot south of the railroad tracks and east of Clinton Avenue. Approximately 330 ft. downgradient of site.	Brown-gray discoloration, strong odor
BBGP-74 (16-20')	3,400.0	3,794.0	Directly on southern border of plot south of the railroad tracks and east of Clinton Avenue. Approximately 315 ft. downgradient of site.	None
BBGP-89 (7-11')	3,600.0	1,695.0	Directly on southern border of plot south of the railroad tracks and east of Clinton Avenue. Approximately 310 ft. downgradient of site.	None
BBGP-89 (16-20')	1,040.0	6,500.0	Directly on southern border of plot south of the railroad tracks and east of Clinton Avenue. Approximately 310 ft. downgradient of site.	None
BBMW-06ST (5-15')	6,352.0	2,073.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Compressor House.	Sheen, slight hydrocarbon-like odor

TABLE 4-12 (continued)
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBMW-06S (5-15')	4,723.0	2,784.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Compressor House.	Sheen, slight hydrocarbon-like odor
BBMW-14S (5-15')	9,200.0	3,064.0	Outside southern portion of Former 0.5 Million cu. ft. Relief Gas Holder. Downgradient of Former 0.5 Million cu. ft. Relief Gas Holder.	Small particles floating in water, strong hydrocarbon-like odor
BBMW-18S (6-16')	4,700.0	1,493.0	Within Office Store & Wash Room. Downgradient of Transformer in eastern portion of site.	None
BBMW-19S (10-20')	6,070.0	2,637.0	Within southern portion of Generator House. Downgradient of Scrubber Pump Room.	Light sheen, possible mild naphthalene-like odor
BBMW-20S (4-14')	15,140.0	2,248.0	Within Clinton Avenue south of the railroad tracks. Approximately 262 ft. downgradient of site.	Naphthtalene-like odor
BBMW-20I (35-45')	40.0	7,134.0	Within Clinton Avenue south of the railroad tracks. Approximately 262 ft. downgradient of site.	None
BBMW-20D (62-72')	3,505.0	14,594.0	Within Clinton Avenue south of the railroad tracks. Approximately 262 ft. downgradient of site.	5.3' of DNAPL, Tar blebs, moderate-strong naphthalene-like odor
BBMW-21S (7.5-17.5')	3,410.0	5,671.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	None
BBMW-21I (30-40')	236.0	9,444.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	1/4" product on bailer, moderate naphthalene-like odor
BBMW-21D (66.3-76.3')	3,140.0	9,016.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of the southern most Boiler House.	> 8' of product

TABLE 4-12 (continued)
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE SITE AND ADJACENT OFF-SITE AREAS GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBMW-22S (5-10')	13,610.0	3,954.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	Strong naphthalene-like odor
BBMW-22I (30-40')	36.0	8,810.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	None
BBMW-22D (64-74')	8,600.0	11,436.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	Tar blebs, moderate sheen, moderate naphthalene-like odor
BBMW-23S (5-15')	32,850.0	2,397.0	Within Plume approximately 410 ft. downgradient of site.	Naphthalene-like odor
MW-04S (4-14')	8,033.0	1,021.0	Within plot south of the railroad tracks and west of Clinton Avenue. Downgradient of the southeast corner of Bay Shore West Parcel.	None
MW-05S (4-14')	24,320.0	2,682.0	Within plot south of the railroad tracks and east of Clinton Avenue. Downgradient of Generator House.	Naphthalene-like odor
MW-07D (35-45')	94.0	4,813.0	In vicinity of 75,000 Gallon Tar Tank and Tar Seperators. Downgradient of Tar Separators.	1' of heavy black tar, very viscous, strong naphthalene-like odor
MW-08S (7-17')	5,200.0	1,100.0	Within northeast portion of Generator House. Downgradient of Scrubber Pump Room.	Black blobs, strong hydrocarbon-like odor

supplemental field program, the highest concentration of total BTEX in groundwater (32,850 ug/l) was detected in the sample collected from monitoring well BBMW-23S, which is located approximately 410 feet south of the site. This sample exhibited a naphthalene-like odor; however, NAPL was not observed. The second, third and fourth highest total BTEX concentrations detected in groundwater were 24,320 ug/l, 15,140 ug/l and 13,610 ug/l, detected in samples collected from off-site shallow monitoring wells MW-05S, BBMW-20S and BBMW-22S, respectively. These three samples exhibited a naphthalene-like odor. The highest total BTEX concentration in on-site groundwater was detected in monitoring well BBMW-14S at 9,200 ug/l. Monitoring well BBMW-14S is located southwest of the former Relief Holder. Groundwater sampling conducted as part of the initial field program also identified this on-site area as containing elevated levels of BTEX.

While the majority of samples exhibiting elevated BTEX concentrations were collected at or near the water table, several off-site samples collected from the deep groundwater zone also exhibited BTEX including:

Sample ID	**Total BTEX Concentration (ug/l)**
BBMW-22D	8,600
BBGP-72 (64 to 68 feet)	9,660
BBGP-73 (72 to 76 feet)	7,830

The three groundwater samples listed above exhibited visible tar blebs, sheens and a naphthalene-like odor. These findings are consistent with field observations which indicated that deep subsurface soil within these off-site areas contained tar staining and/or tar/NAPL-saturated conditions.

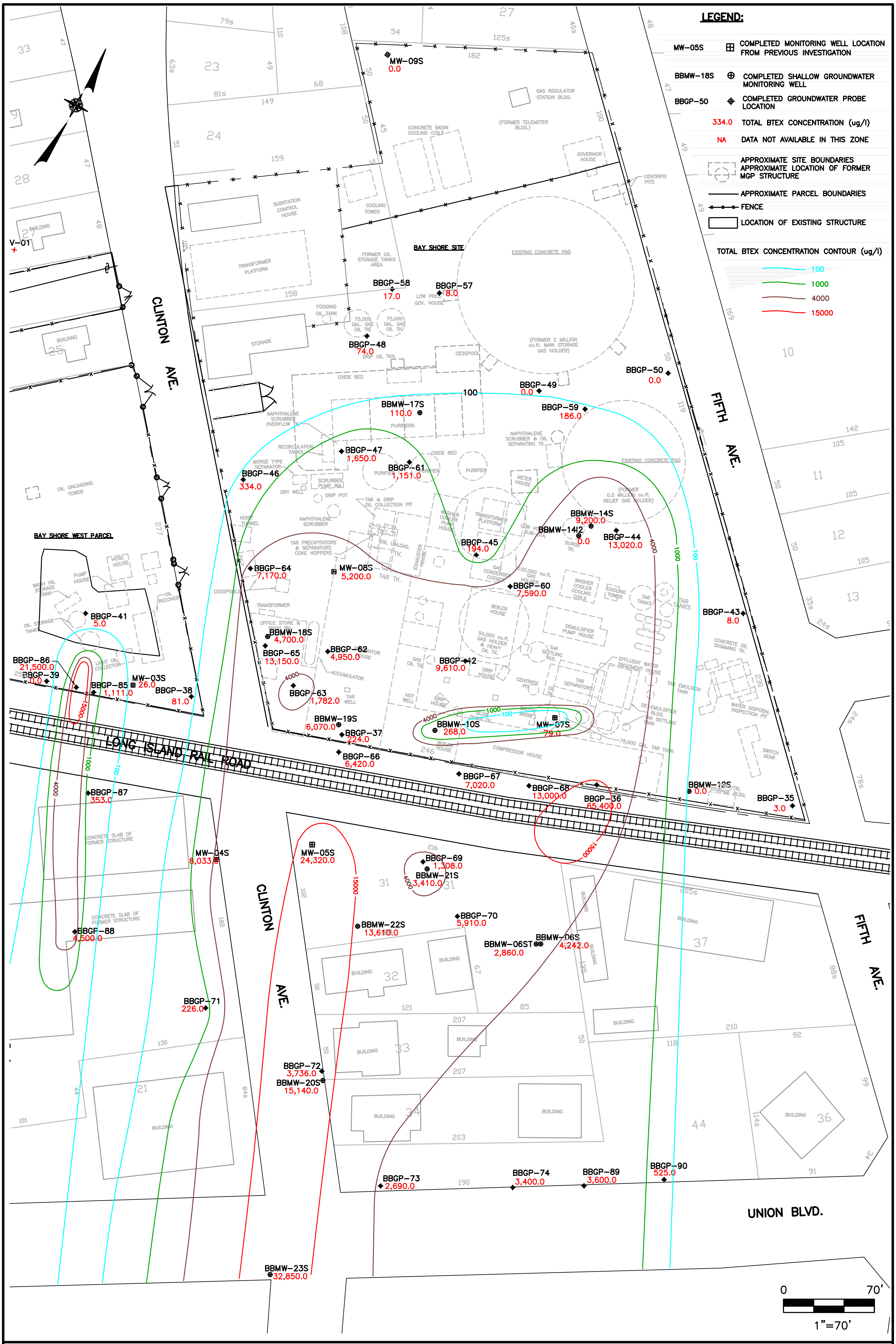
Analysis of the initial groundwater sample collected from deep monitoring well BBMW-05D2 screened within the Magothy aquifer indicated the presence of BTEX at a total concentration of 16 ug/l. However, further sampling of this well indicated nondetectable levels of BTEX.

Figures 4-7 through **4-9** depict total BTEX concentrations in groundwater collected from on-site and adjacent off-site sample locations. The data used for **Figure 4-7** is based on the analytical results of shallow groundwater samples collected from the water table (approximately 6 to 8 feet bgs) to a maximum depth of 26 feet bgs. The data used for **Figure 4-8** is based on the analytical results of groundwater samples collected from the intermediate groundwater zone ranging from 26 feet to 50 feet bgs. The data used for **Figure 4-9** is based on the analytical results of groundwater samples collected from the groundwater zone ranging from 50 feet to 80 feet bgs. Note that the data used in these figures was collected during the initial field program, as well as the supplemental field program, and as a result, the data set used in the graphics spans several years. However, all newly installed and existing monitoring wells were sampled as part of the supplemental field program, and, all monitoring well data presented on the figures is from this Spring 2002 sample round. Furthermore, all groundwater samples from BBGP-57 through BBGP-90 were collected during the Winter/Spring of 2002. Therefore, the majority of the data presented in these figures were collected in early 2002 and provide an accurate picture of total BTEX distribution within the Upper Glacial aquifer.

Based on a review of these figures and the supporting data, the following are noteworthy observations:

1. Consistent with subsurface soil data, a review of **Figure 4-7** indicates that shallow groundwater in the northern third of the Bay Shore site does not exhibit elevated BTEX concentrations. Total BTEX concentrations in this area do not exceed 100 ug/l. In addition, analytical data for samples collected from the southeast corner of the site also indicate that shallow groundwater in this area does not exhibit BTEX concentrations above 10 ug/l.

2. Consistent with the initial field program findings, shallow groundwater in the southern half of the site exhibited BTEX concentrations. The highest concentrations were observed in samples collected from areas southwest of the former Relief Holder, downgradient of the former 54,000 Cubic Foot Gas Holder/Heavy Oil Tank and downgradient of the former Tar and Drip Oil Collection Pit. In addition, BTEX compounds are present in groundwater downgradient of the former Tar Well located in the southwestern portion of the site. However, the most recent groundwater samples collected from shallow wells BBMW-10S and MW-07S located



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TOTAL BTEX CONCENTRATIONS IN SHALLOW GROUNDWATER (WATER TABLE TO 26 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-7

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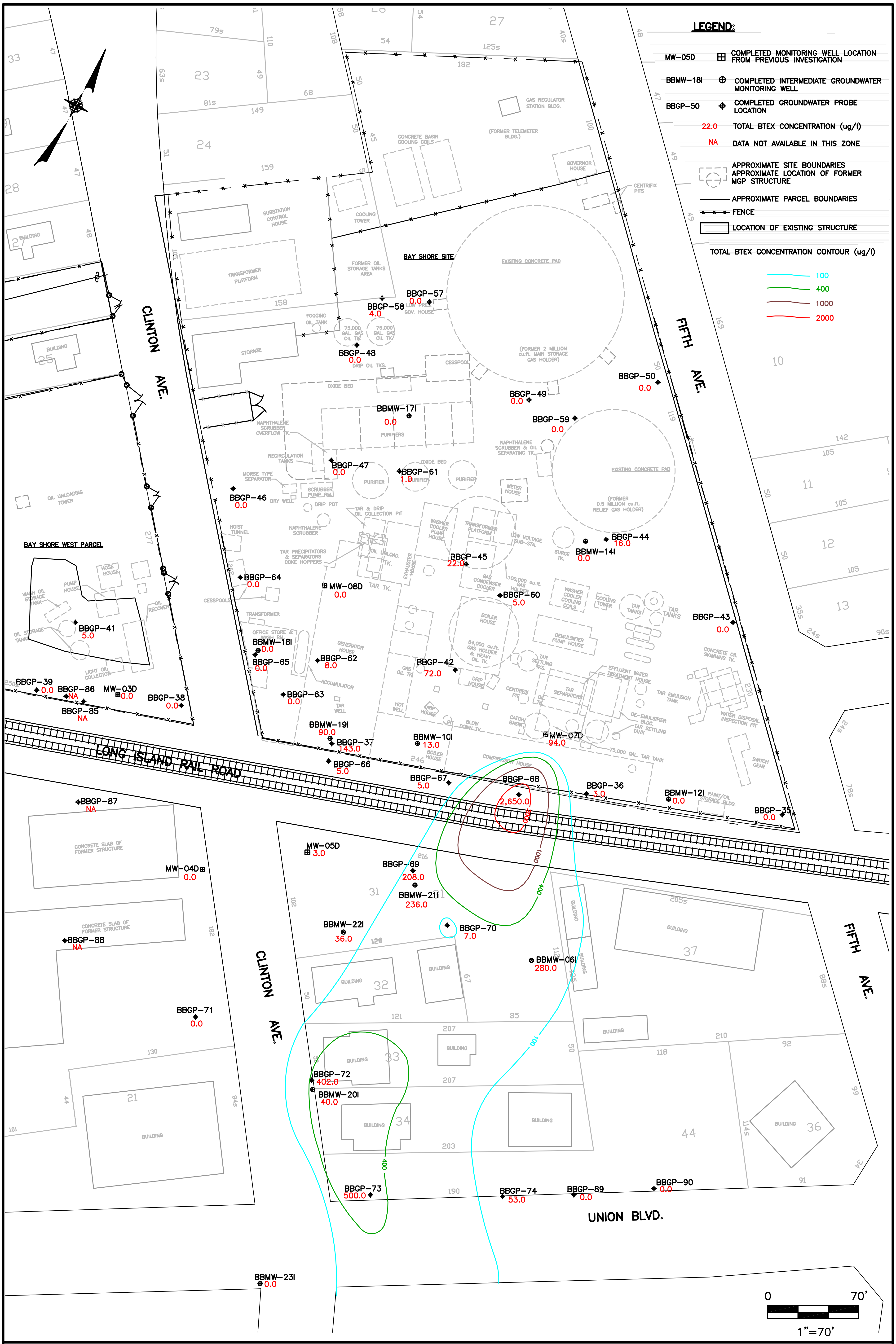
\\Nt4\CADwork\1620B12B\dwg\11X17\FIG-4M.dwg, 10/28/02 02:08:13 PM, APostyn



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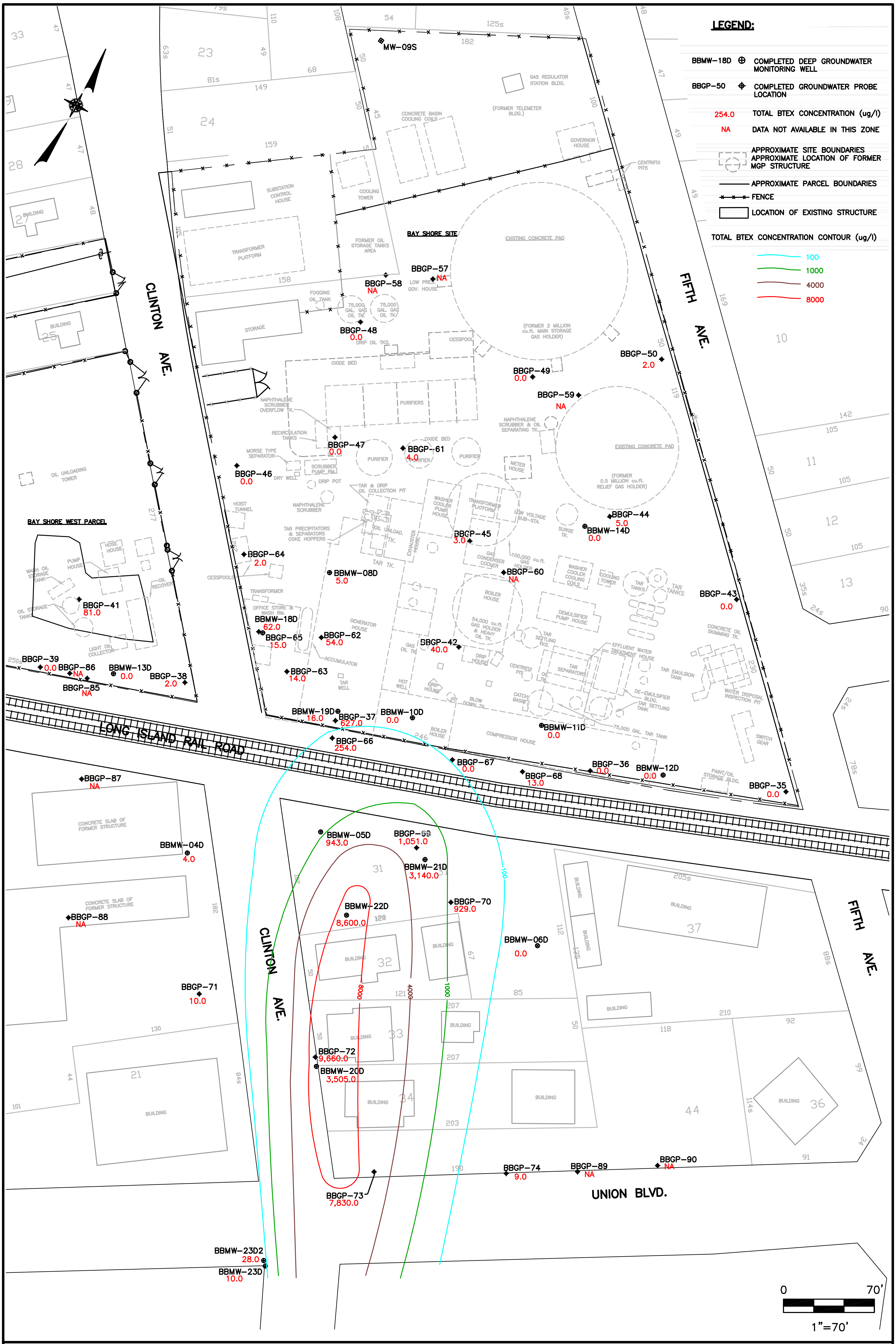
TOTAL BTEX CONCENTRATIONS IN INTERMEDIATE GROUNDWATER (26 TO 50 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-8

\\Nt4\CADwork\1620B12B\dwg\11X17\FIG-4N.dwg, 10/28/02 02:09:17 PM, APostyn



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TOTAL BTEX CONCENTRATIONS IN DEEP GROUNDWATER (50 TO 80 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-9

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and
Bartilucci
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\\Nf4\CADwork\1620B12B\dwg\11X17\FIG-4O.dwg, 10/28/02 02:10:10 PM, APostyn downgradient of the former Tar Separators/Effluent Treatment House exhibited relatively low total BTEX concentrations of 268 ug/l and 79 ug/l, respectively. As a result, **Figure 4-7** shows a zone of lower total BTEX in this location, though prior samples collected from this area exhibited significantly higher concentrations in the past. While the subsurface soil sample collected near the former Cesspool located southwest of the former Gas Holder contained elevated levels of BTEX, total BTEX concentrations for samples collected downgradient from this area in monitoring well BBMW-17S was only 110 ug/l.

3. **Figure 4-7** illustrates the fact that some of the highest total BTEX concentrations observed in shallow groundwater were collected from off-site locations including groundwater probes BBGP-67, BBGP-68 and BBGP-72, as well as monitoring wells MW-04S, MW-05S, BBMW-20S, BBMW-22S and BBMW-23S.

4. **Figure 4-8** indicates that groundwater in the intermediate zone is relatively free of BTEX throughout the Bay Shore site with total BTEX concentrations generally not exceeding 100 ug/l at most locations. This is consistent with subsurface soil data for the Bay Shore Site, which indicate that on-site soil below a depth of 32 feet does not exhibit total BTEX concentrations greater than 0.03 mg/kg. Off-site groundwater samples collected from the intermediate groundwater zone immediately downgradient of the site generally exhibited higher concentrations than on-site points, with a maximum total BTEX concentration of 2,650 ug/l detected at BBGP-68 (32 to 36 feet). However, farther downgradient, total BTEX concentrations appear to decrease in this zone with total BTEX concentrations not exceeding 500 ug/l.

5. Similar to the intermediate zone, the on-site deep groundwater zone contains little BTEX with the majority of deep on-site locations exhibiting nondetectable to trace levels of total BTEX (i.e., not exceeding 5 ug/l). However, samples collected along the southern property boundary contained higher levels of BTEX with a maximum total BTEX concentration of 627 ug/l detected at BBGP-37 (71 to 75 feet). As shown on **Figure 4-9**, deep groundwater samples collected from downgradient locations, including groundwater probe points BBGP-69, BBGP-70 and BBGP-72, as well as monitoring wells BBMW-20D, BBMW-21D and BBMW-22D, contained elevated BTEX concentrations. Subsurface soil in this adjacent off-site area also exhibited elevated levels of BTEX, as well as tar staining and tar/NAPL at saturated levels.

PAHs

Table 4-12 summarizes on-site groundwater samples that exhibited the highest total PAH concentrations along with the approximate locations of these samples in relation to former MGP structures/features where appropriate. The table also indicates any significant field observations noted in these samples. Additional detail as to the distribution of NAPL in groundwater is provided in **Section 4.2.1.4**.

A review of **Table 4-12** indicates that, unlike BTEX concentrations which were observed to be highest in shallow on-site groundwater, PAH concentrations detected in groundwater were observed to be highest in off-site groundwater samples collected from the deep and, to a lesser extent, intermediate groundwater zones. The highest total PAH concentrations detected in groundwater as part of the supplemental field program were observed at groundwater probe BBGP-72 located approximately 250 feet south of the site with total PAH concentrations of 823,300 ug/l at 64 to 68 feet, 65,000 ug/l at 56 to 60 feet and 17,181 ug/l at 71 to 75 feet. In addition, deep monitoring well BBMW-20D installed adjacent to groundwater probe BBGP-72 exhibited the fourth highest total PAH concentration of 14,594 ug/l. Note that all listed samples collected from this area exhibited tar blebs and sheens. A comparison of the PAH concentrations detected in groundwater samples collected from areas that also contained NAPL at saturated levels in soil with published solubility data for respective compounds, indicates that a number of the PAH compounds were detected at concentrations well above their maximum solubility in water. Based on this comparison, as well as field observations, the BTEX and PAH concentrations observed in groundwater within these areas do not represent true dissolved-phase concentrations, but are likely biased high due to the presence of NAPL in collected samples (i.e., sheens, separate phase layers and/or blebs).

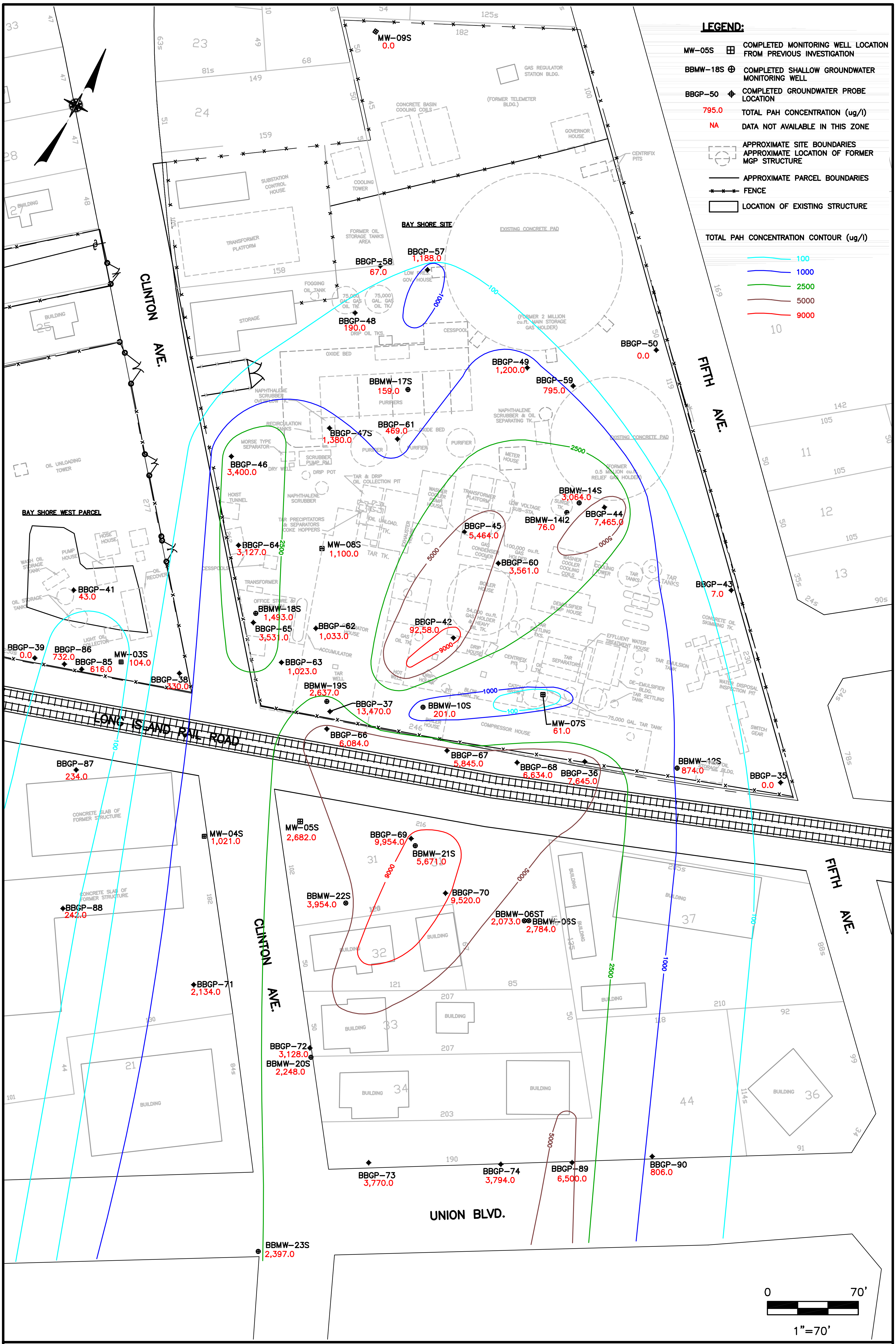
Consistent with the findings of the initial field program, the highest PAH concentrations detected at on-site sample locations were observed in the shallow groundwater zone, downgradient of the former Relief Holder (BBMW-14S and BBGP-44) within the vicinity of the former 54,000-gallon Cubic Foot Gas Holder/Heavy Oil Tank (BBGP-60) and downgradient of the former Tar and Drip Oil Collection Pit (BBGP-62, BBGP-66, BBMW-18S and MW-08S).

Analysis of the initial groundwater sample collected from deep monitoring well BBMW-05D2, screened in the Magothy formation, indicated a total PAH concentration of 147 ug/l. However, further sampling conducted at this well indicated nondetectable levels of PAHs.

Figures 4-10 through **4-12** depict total PAH concentrations in groundwater collected from on-site and adjacent off-site sample locations. The data used for **Figure 4-10** is based on the analytical results of groundwater samples collected from the water table (approximately 6 to 8 feet bgs) to a maximum depth of 26 feet bgs. The data used for **Figure 4-11** is based on the analytical results of groundwater samples collected from the intermediate groundwater zone ranging from 26 feet to 50 feet bgs. The data used for **Figure 4-12** is based on the analytical results of groundwater samples collected from the deep groundwater zone ranging from 50 feet to 80 feet bgs. Note that the data used in these figures was collected during the initial field program, as well as the supplemental field program, and as a result, the data set used in the graphics spans several years. However, all newly installed and existing monitoring wells were sampled as part of the supplemental field program, and all monitoring well data presented on the figures is from the Spring 2002 sampling program. Furthermore, all groundwater samples from BBGP-57 through BBGP-90 were collected during the winter/spring of 2002. Therefore, the majority of the data presented in these figures was collected in early 2002 and provide an accurate picture of the present total PAH distribution within the Upper Glacial aquifer.

Based on a review of these figures and the supporting data, the following are noteworthy observations:

1. **Figure 4-10** indicates that shallow groundwater in the northernmost third of the Bay Shore site is relatively free of elevated levels of PAHs, with total PAH concentrations not exceeding 200 ug/l in most samples. One anomaly is that PAHs were detected at a total concentration of 1,188 ug/l at BBGP-57 located west of the former Gas Holder. In addition, shallow groundwater in the southeastern corner of the Bay Shore site does not contain PAHs above 10 ug/l. Shallow groundwater at sample locations within the southern half of the site contains elevated PAHs, including BBGP-45 (5,464 ug/l), BBGP-44 (7,465 ug/l), BBGP-42 (9,258 ug/l) and BBGP-37 (13,470 ug/l). However, the most recent groundwater samples collected from shallow wells BBMW-10S and MW-07S located downgradient of the former Tar Separators/Effluent Treatment House exhibited relatively low total PAH concentrations of 201 ug/l and 61 ug/l, respectively. As a result, **Figure 4-10** shows a zone of lower total PAH in this location, though prior samples collected from this area exhibited significantly higher concentrations in the past. Downgradient of the Bay shore site, total PAHs were detected at a concentration of 2,397 ug/l in shallow groundwater at monitoring well BBMW-23S, which is located approximately 410 feet south of the site.



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TOTAL PAH CONCENTRATIONS IN SHALLOW GROUNDWATER (WATER TABLE TO 26 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-10

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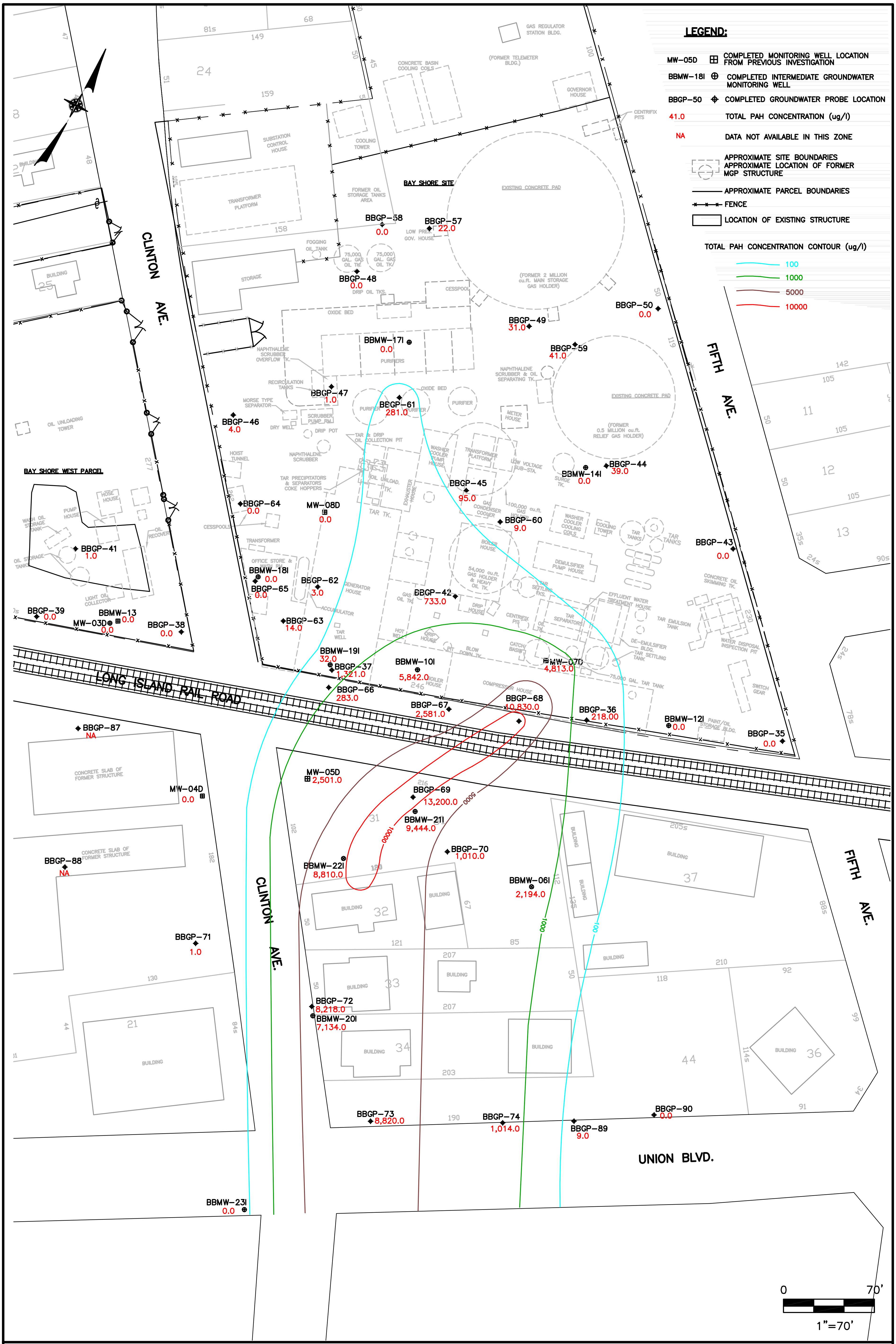

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TOTAL PAH CONCENTRATIONS IN INTERMEDIATE GROUNDWATER (26 TO 50 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-11

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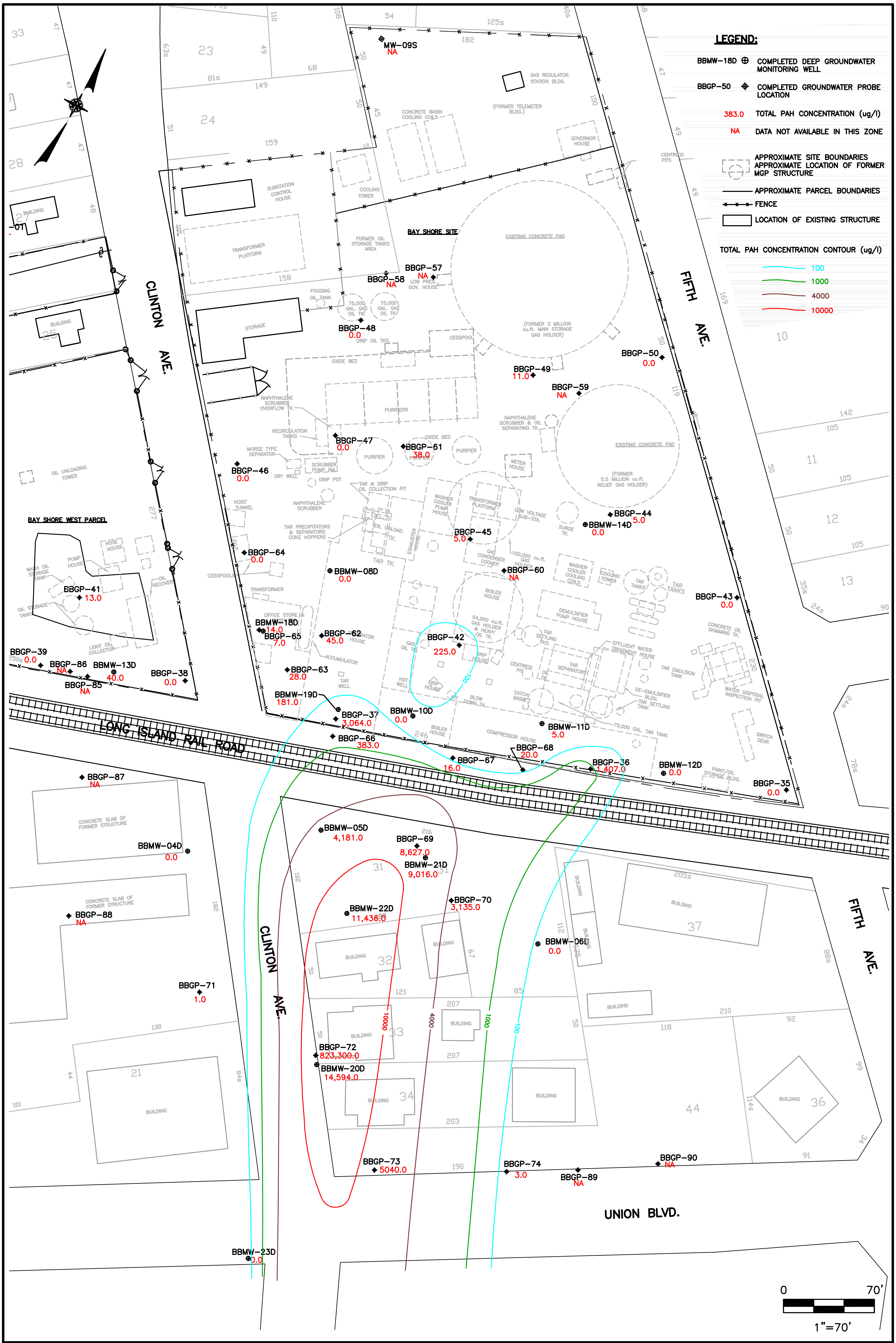

\\Nf4\CADwork\1620B12B\dwg\11X17\FIG-4R.dwg, 10/28/02 02:12:50 PM, APostyn

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TOTAL PAH CONCENTRATIONS IN DEEP GROUNDWATER (50 TO 80 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-12

2. **Figure 4-11** clearly indicates total PAH concentrations in groundwater in the intermediate zone (i.e., below a depth of 26 feet) at the majority of on-site locations did not exceed 300 ug/l throughout the northern two-thirds of the site. However, PAHs were detected in intermediate groundwater in the southernmost portion of the site and downgradient of the former 54,000 Cubic Foot Gas Holder/Heavy Oil Tank (BBGP-42 and BBMW-10I), as well as downgradient of the former Tar Separators/Effluent Treatment House as indicated by MW-07D. Immediately off-site and downgradient of these former structures, PAHs were detected in the samples from the intermediate groundwater zone at groundwater probes BBGP-67, BBGP-68, BBGP-69, BBGP-72 and BBGP-73, as well as monitoring wells BBMW-20I, BBMW-21I and BBMW-22I.

3. As illustrated on **Figure 4-12**, the deep groundwater zone within the Bay Shore site does not contain elevated levels of PAHs, with total PAH concentrations not exceeding 50 ug/l throughout the majority of the site. However, PAHs were detected in samples collected from the deep groundwater zone at locations along the southern property boundary of the site as indicated by samples collected from BBGP-36 and BBGP-37. As discussed previously, the highest total PAH concentrations observed in groundwater were actually collected from off-site locations within the deep groundwater zone, including groundwater probes BBGP-69, BBGP-70, BBGP-72 and BBGP-73, as well as monitoring wells BBMW-05D, BBMW-20D, BBMW-21D and BBMW-22D. The presence of PAHs in the deep groundwater zone is consistent with field observations indicating tar staining, as well as tar/NAPL at saturated conditions within deep subsurface soil immediately downgradient of the Bay Shore site.

Historical Total BTEX/PAH Concentrations at the Bay Shore Site

Changes in total BTEX and total PAH concentrations with time in monitoring wells MW-07S and MW-08S and 08D within the on-site groundwater plume are shown graphically on **Figures 4-13** through **4-15**. Similarly, groundwater data for monitoring wells MW-04S, MW-04D, MW-05S and MW-05D are plotted on **Figures 4-16** through **4-19** to evaluate conditions in the adjacent off-site areas of the plume immediately downgradient from the Bay Shore site. The wells used to evaluate possible trends in total BTEX and total PAH concentrations were selected based on their relative location to potential source areas, as well as the availability of analytical data from multiple sampling events at each well. Additionally, several of these wells have historically exhibited some of the highest total BTEX/PAH concentrations. Where appropriate, data from all wells in a monitoring well cluster were evaluated and all available data for a given well was utilized.

FIGURE 4-13
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CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
ON-SITE GROUNDWATER MONITORING WELL MW-07S

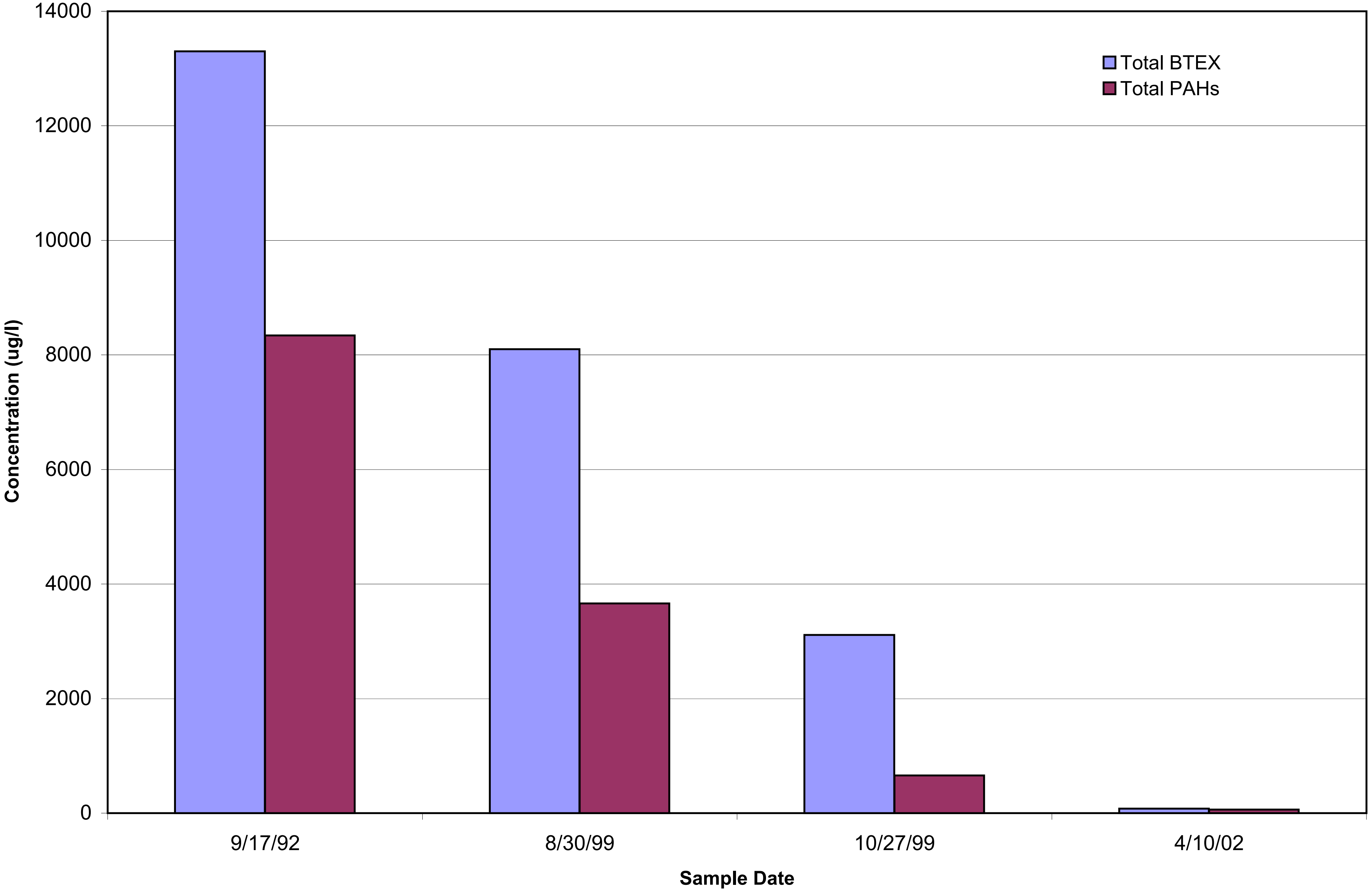

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FIGURE 4-14

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CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
ON-SITE GROUNDWATER MONITORING WELL MW-08S

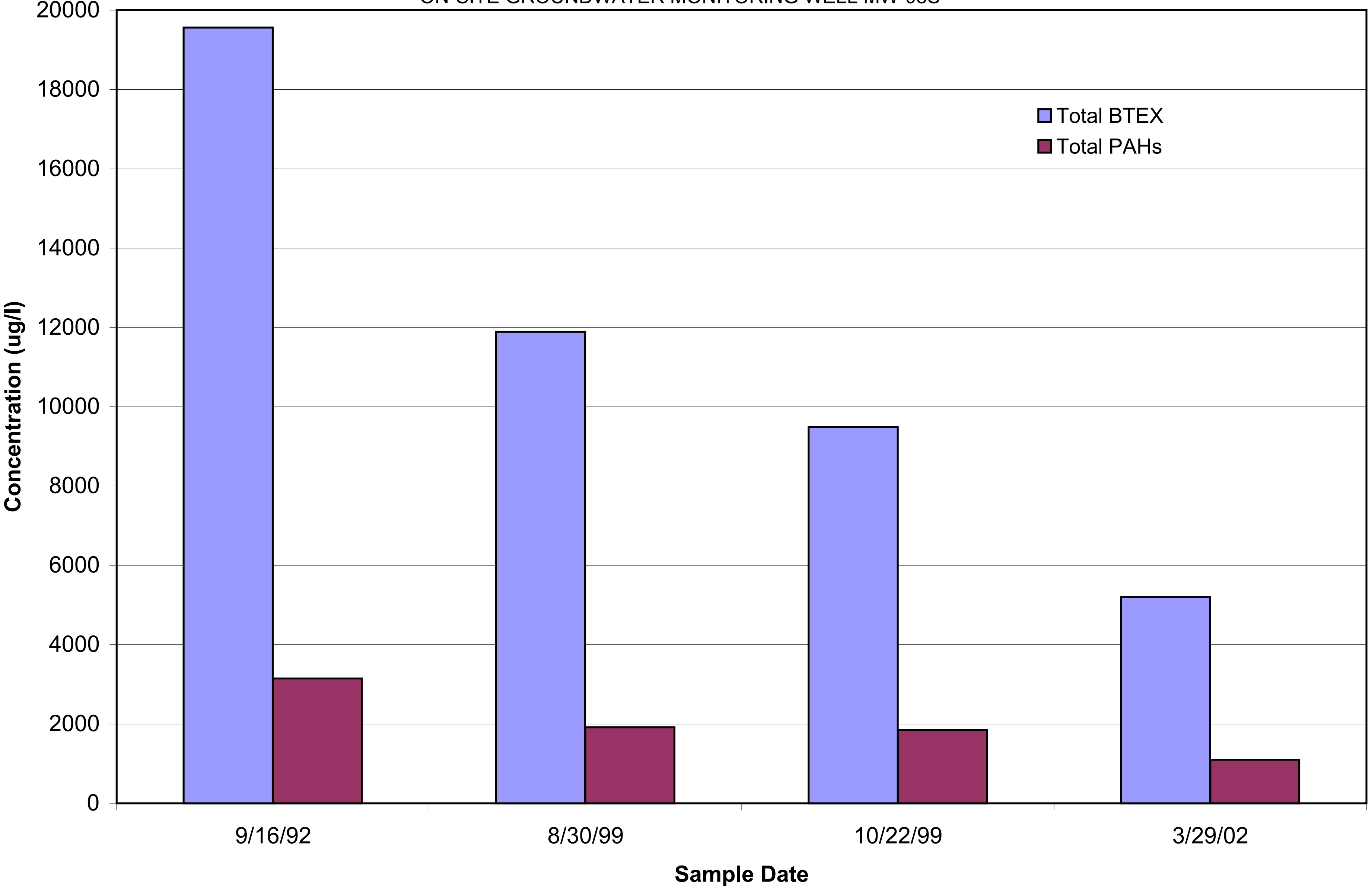

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FIGURE 4-15
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
ON-SITE GROUNDWATER MONITORING WELL MW-08D

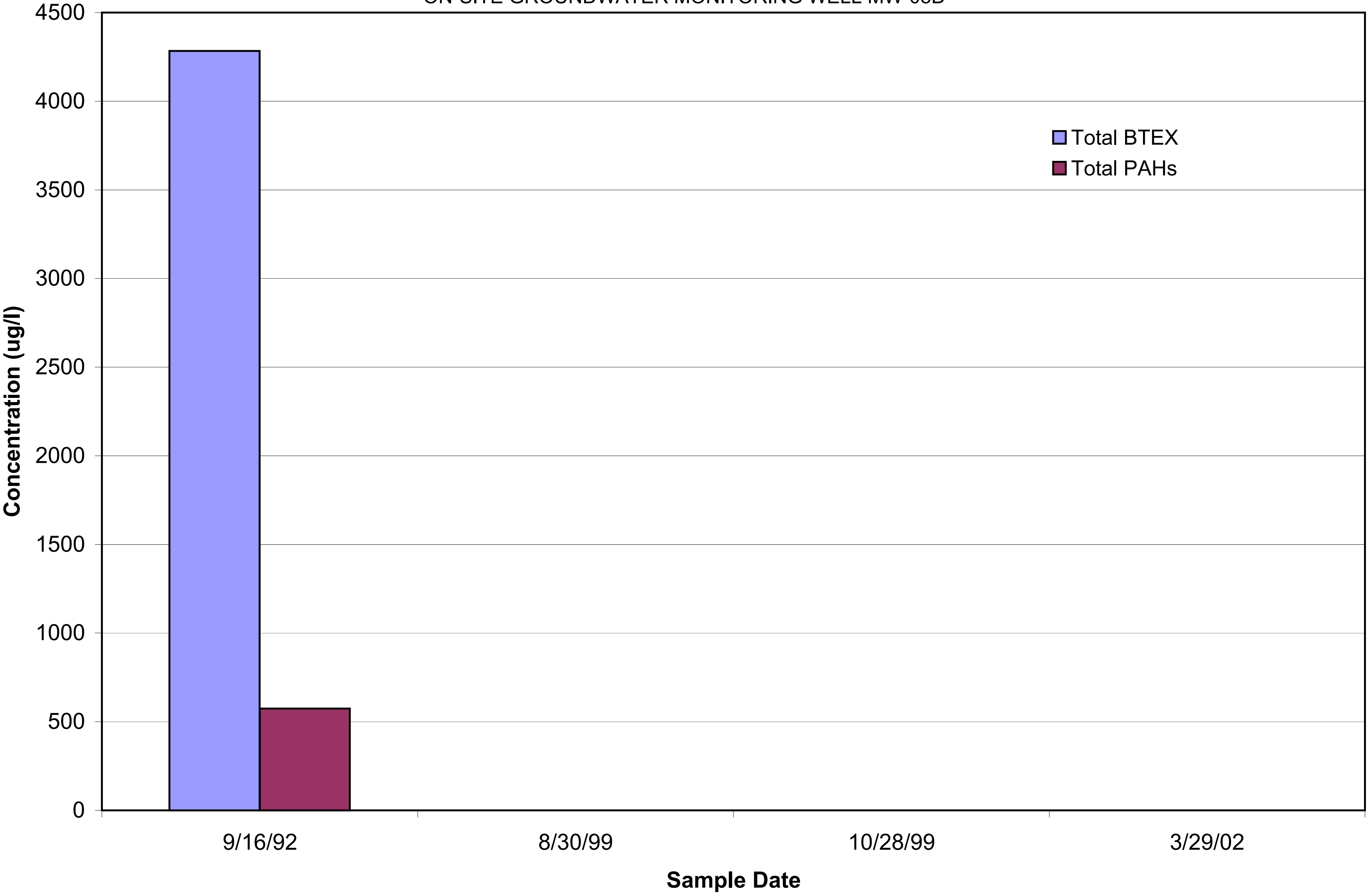

FIGURE 4-16
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN ADJACENT OFF-SITE GROUNDWATER MONITORING WELL MW-04S

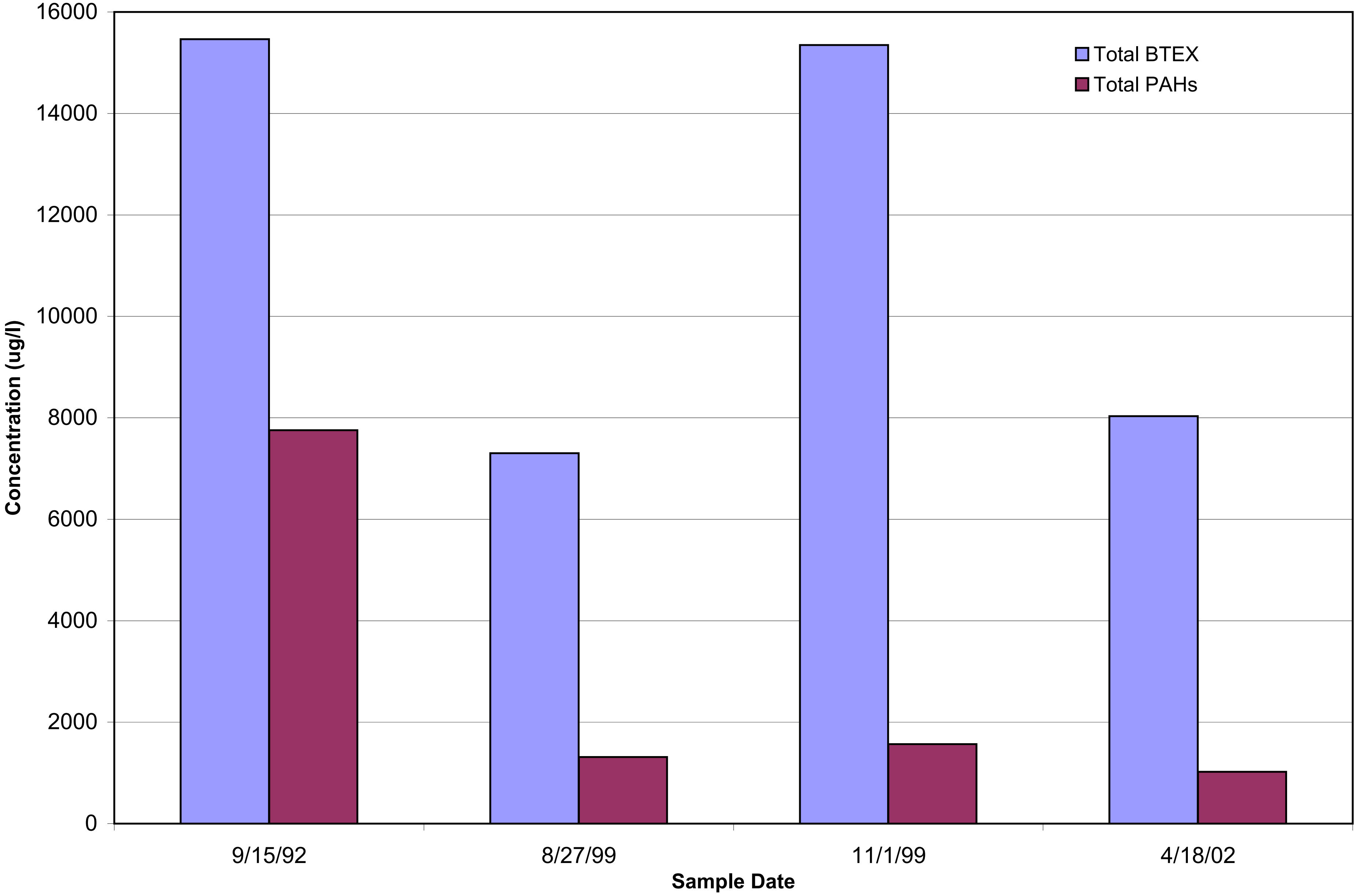

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FIGURE 4-17
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
ADJACENT OFF-SITE GROUNDWATER MONITORING WELL MW-04D

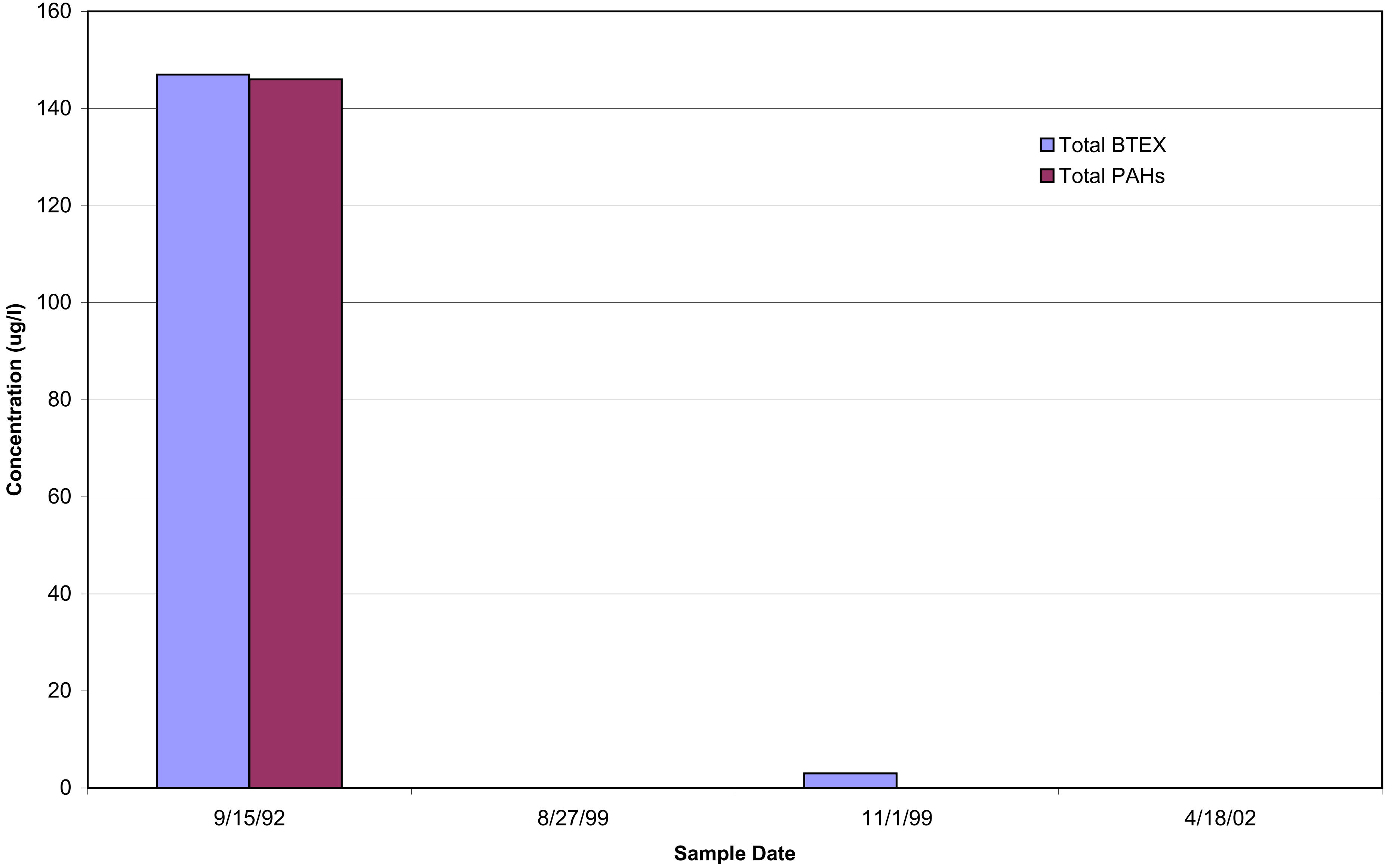

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FIGURE 4-18

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CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN ADJACENT OFF-SITE GROUNDWATER MONITORING WELL MW-05S

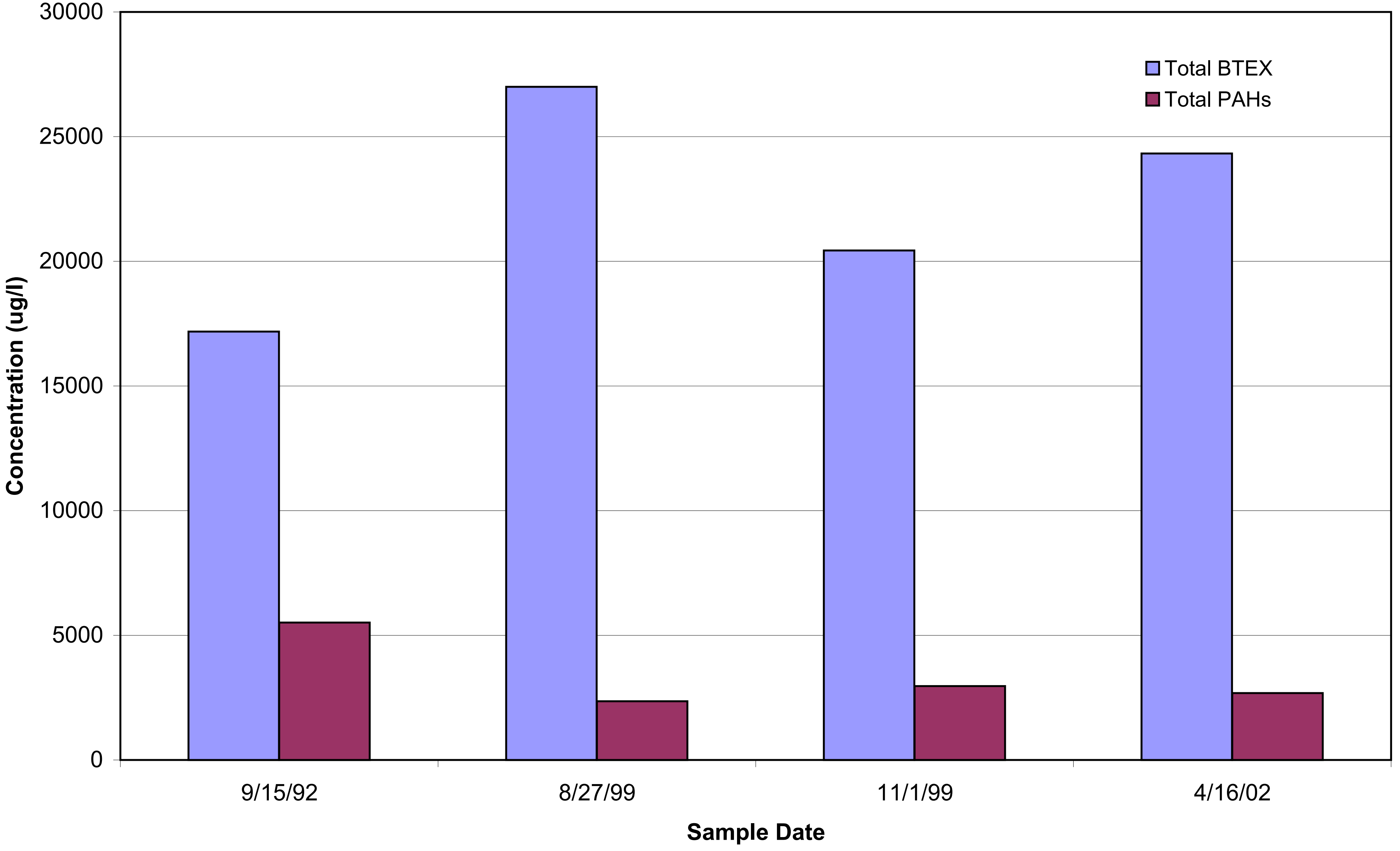

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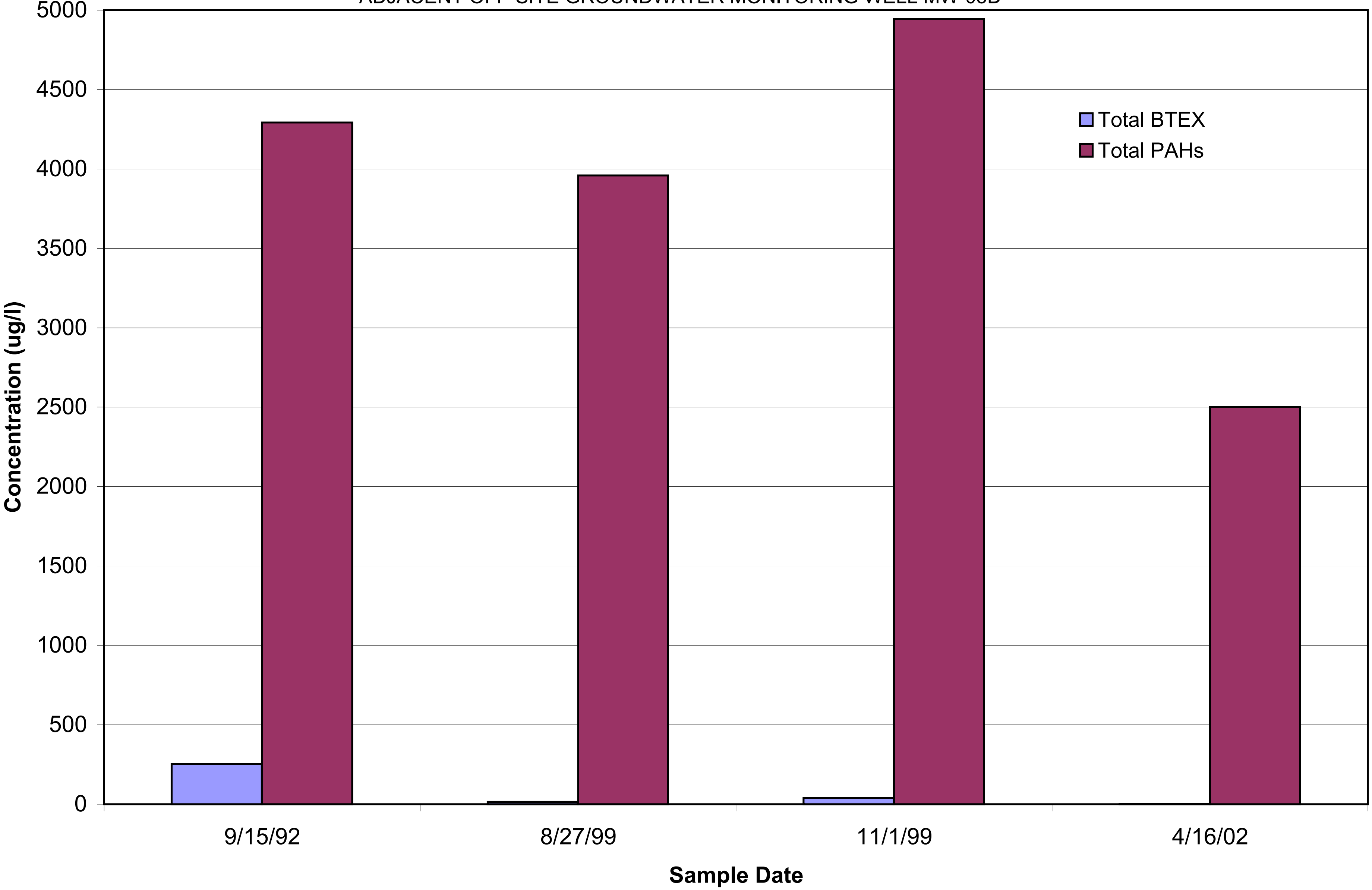
FIGURE 4-19
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
ADJACENT OFF-SITE GROUNDWATER MONITORING WELL MW-05D



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Historically, monitoring of the selected wells that were used to evaluate possible changes of BTEX and PAH concentrations in groundwater over time was not performed on a routine schedule. Accordingly, the trends presented in the graphs provide an overview of long-term changes in concentrations of these parameters over time. It is likely that BTEX and PAH concentrations in groundwater fluctuate in response to seasonal changes in water elevations produced by precipitation; however, no groundwater elevation and precipitation data is available for the historical monitoring events. Therefore, the influence of groundwater elevation on the observed fluctuations of total BTEX and total PAHs over time cannot be evaluated.

A review of **Figures 4-13** and **4-14** shows that the concentrations of total BTEX and total PAHs in on-site groundwater appear to have decreased since regular monitoring was initiated in September 1992. Specifically, the concentrations of total BTEX at well MW-07S decreased from 13,300 ug/l in September 1992 to 79 ug/l in April 2002. During this same period total PAHs decreased from 8,340 ug/l to 61 ug/l. Monitoring well MW-07S is located in the area of the former Tar Separators and former 75,000-gallon Tar Tank in the south-central portion of the site. Monitoring wells MW-08S and MW-08D are located adjacent to the northwestern end of the former Generator House and downgradient from the former Purifiers, Tar and Drip Oil Collection Tanks and Naphthalene Scrubber Overflow Tank. The concentrations of total BTEX and total PAHs appear to have decreased over time in samples collected from monitoring well MW-08S. However, the analytical results from the most recent sampling event in March 2002 detected total BTEX at 5,200 ug/l and total PAHs at 1,100 ug/l.

As shown on **Figures 4-16** and **4-18** the total BTEX concentrations in groundwater at monitoring wells MW-04S and MW-05S located in the adjacent off-site areas immediately south of the site have fluctuated between September 1992 and April 2002 with concentrations that ranged from 7,300 ug/l to 15,463 ug/l in well MW-04S and from 17,180 ug/l to 27,000 ug/l in well MW-05S. During this same monitoring period the concentrations of total PAHs have decreased to at or near the current levels which have remained relatively constant since August 1999. The trends exhibited by the total BTEX and total PAHs on these figures shows that, while there has been no net decrease in concentrations, the concentrations have not increased. As shown in **Figure 4-17**, since sampling of monitoring well MW-04D was initiated in September

1992, total BTEX was only detected at a concentration of 3 ug/l. It is noted that total PAHs predominate in the monitoring well MW-05D (**Figure 4-19**) with total BTEX being at very low concentrations. Accordingly, the plume in this area of the off-site is considered to be stable or in a steady state.

Petroleum Fingerprint/Specific Gravity/Viscosity Analysis

Analytical results for TPH and fuel fingerprint for monitoring well groundwater samples are summarized in **Table C-10**. Samples of DNAPL present in monitoring wells BBMW-21D and BBMW-22D were analyzed for fingerprint. Refer to **Section 4.2.1.4** for additional information on the DNAPL identified in these wells. The results of the fingerprint analyses showed that the type and distribution of PAHs that comprised the NAPL in these samples were typical of those produced by MGP by-products. Further environmental forensic analysis was performed on the two DNAPL samples collected from BBMW-21D and BBMW-22D. In addition, both samples were analyzed for specific gravity and viscosity. A copy of the forensic analysis report is provided as **Appendix D**. Based on this further analysis, it was determined that:

- The DNAPL collected from BBMW-21D contained a pyrogenic substance. Pyrogenic substances are complex mixtures of primarily hydrocarbons produced from organic matter subjected to high temperatures, but with insufficient oxygen for complete combustion. Pyrogenic materials are produced by fires, internal combustion engines, and furnaces. They also are formed when coke or gas are produced from coal or oil. Coal-tar based products, such as roofing, pavement sealers, waterproofing, pesticides, and some shampoos contain pyrogenic materials. The pattern of PAHs, especially the ratios of fluoranthene to pyrene and dibenzofuran to fluorine indicate that the pyrogenic material in this sample is MGP tar, probably from a carbureted water gas (CWG) process. The slightly reduced monocyclic aromatic hydrocarbon (MAH) concentrations relative to PAHs may be indicative of very mild weathering. In addition, the DNAPL from BBMW-21D was found to have a specific gravity of 1.07 indicating it is denser than water. The sample exhibited a kinematic viscosity at 25° Celsius (°C) of 39.1 centistokes (cSt). Water at 25°C has a kinematic viscosity of approximately 1.0 cSt.
- The DNAPL sample collected from BBMW-22D also contained a pyrogenic substance. The pattern and ratios of PAHs indicate that the pyrogenic material in this sample is MGP tar, probably CWG. The slightly reduced MAH concentrations

relative to PAHs may be indicative of very mild weathering. In addition, the DNAPL from BBMW-22D exhibited a specific gravity of 1.03 and a kinematic viscosity of 23.19 cSt.

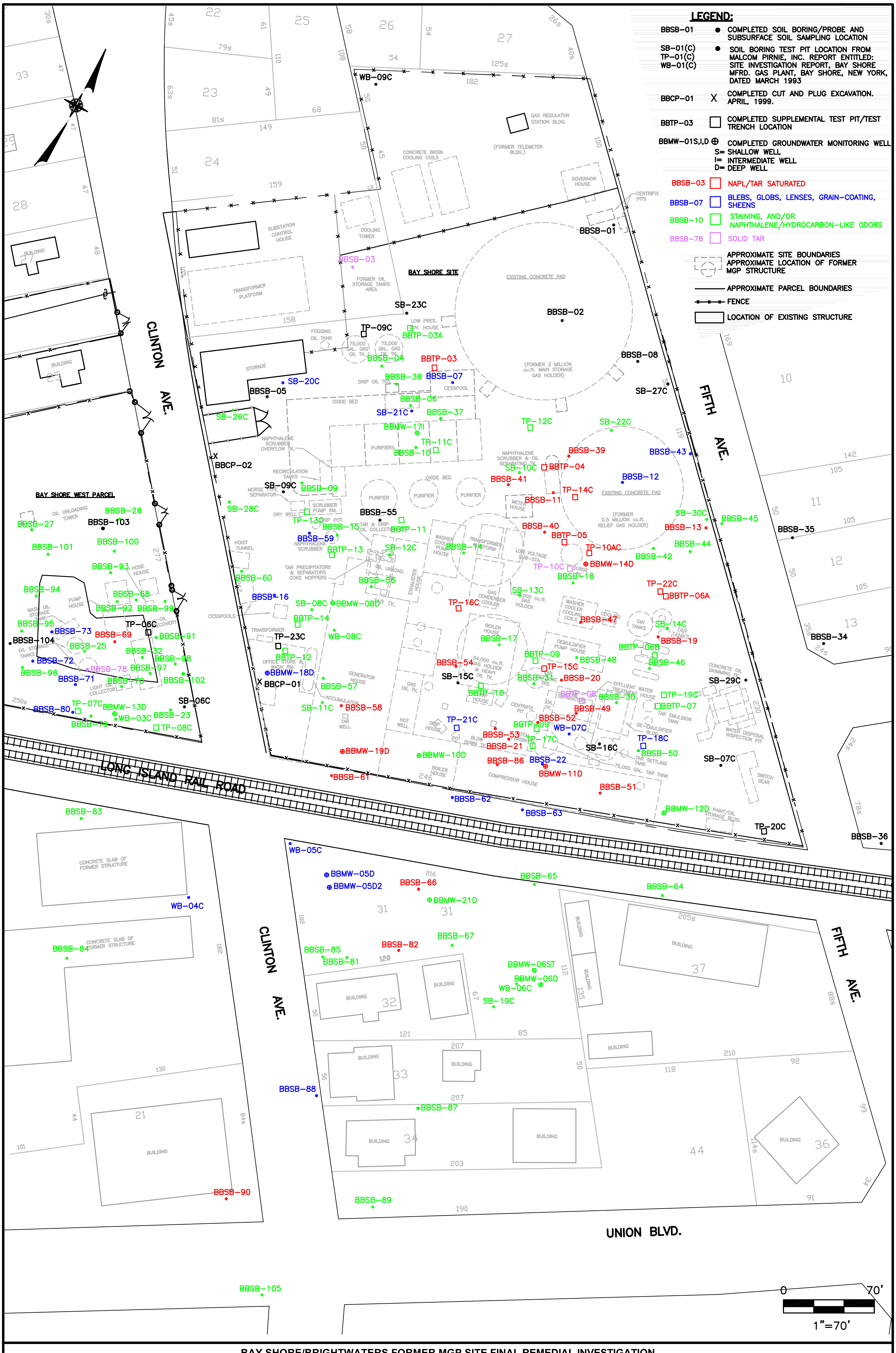
4.2.1.4 - Extent of NAPL

Figures 4-20 through **4-22** graphically depict the locations of soil borings and test pits completed as part of this remedial investigation, as well as prior studies where the following field observations were noted in subsurface soil: NAPL or tar-saturated conditions, blebs and lenses of NAPL; observations of soil grains coated by NAPL or tar; soil staining; soil with naphthalene/hydrocarbon-like odors; as well as areas of solid tar in the Bay Shore site, the Bay Shore West Parcel, and adjacent off-site areas. **Figures 4-20** through **4-22** also show where these conditions were encountered if one or more soil samples exhibited these physical conditions in the shallow (2 to 12 feet bgs), intermediate (12 to 32 feet bgs) and deep (greater than 32 feet deep) soil zones, respectively. In addition, **Drawings 4A** through **4C** graphically depict this same information vertically in geologic cross sections which run through the Bay Shore site and adjoining properties. All listed drawings are provided in map pockets at the end of this section.

Shallow Soil

Note that the shallow soil zone includes the groundwater interface located between 6 and 8 feet below grade at the Bay Shore site. As shown in **Figure 4-20**, NAPL and/or tar-saturated conditions were observed in shallow subsurface soil primarily within the vicinity of or adjacent to former MGP structures, including:

- Cesspool located west of the Main Storage Holder;
- The western half of the Relief Holder;
- Naphthalene Scrubber, Oil Separating Tank and Surge Tank located west of the Relief Holder;
- Washer Cooler Cooling Coils located south of the Relief Holder;



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FIELD OBSERVATIONS OF SHALLOW SUBSURFACE SOIL (2 TO 12 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-20

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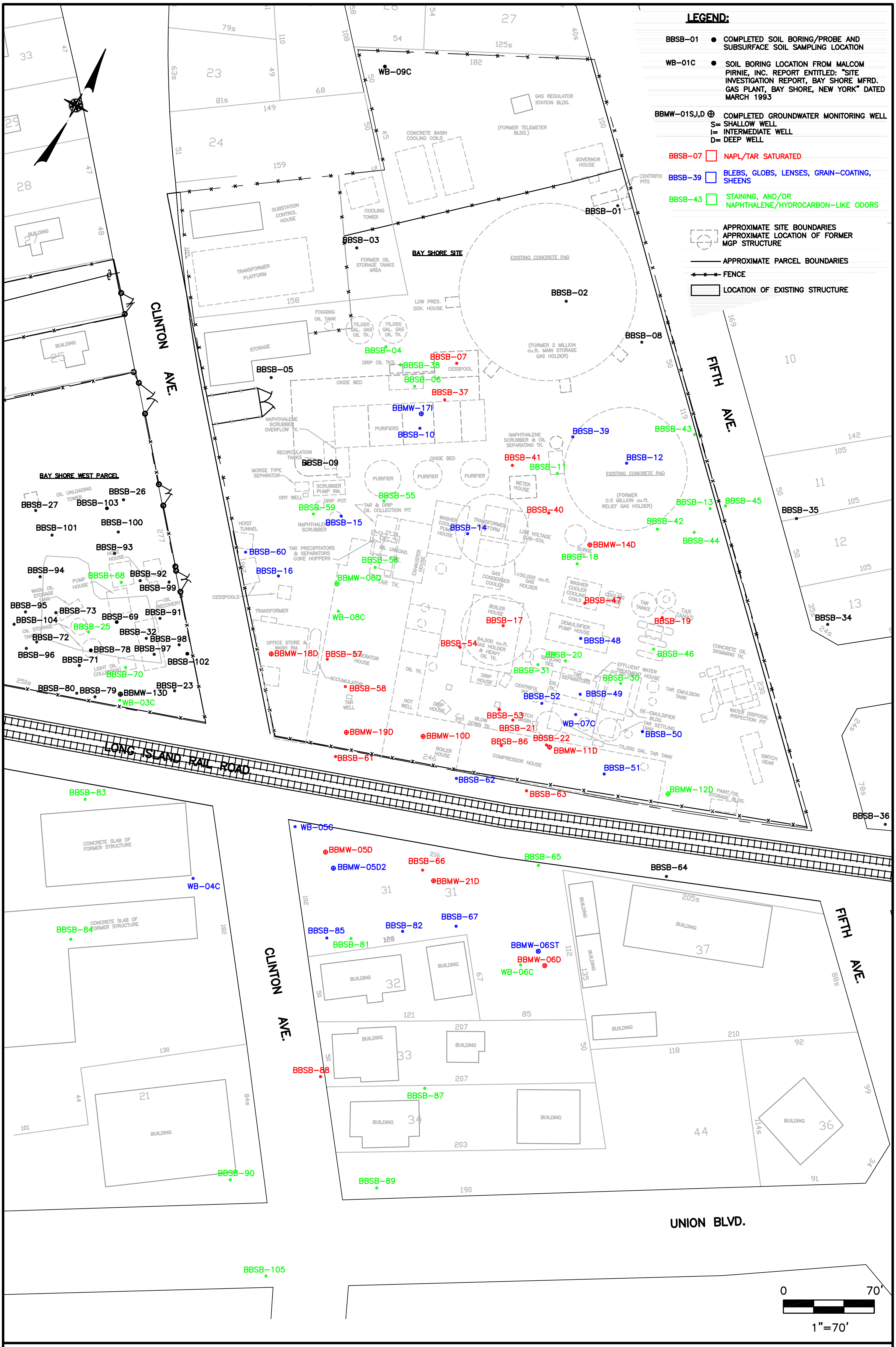
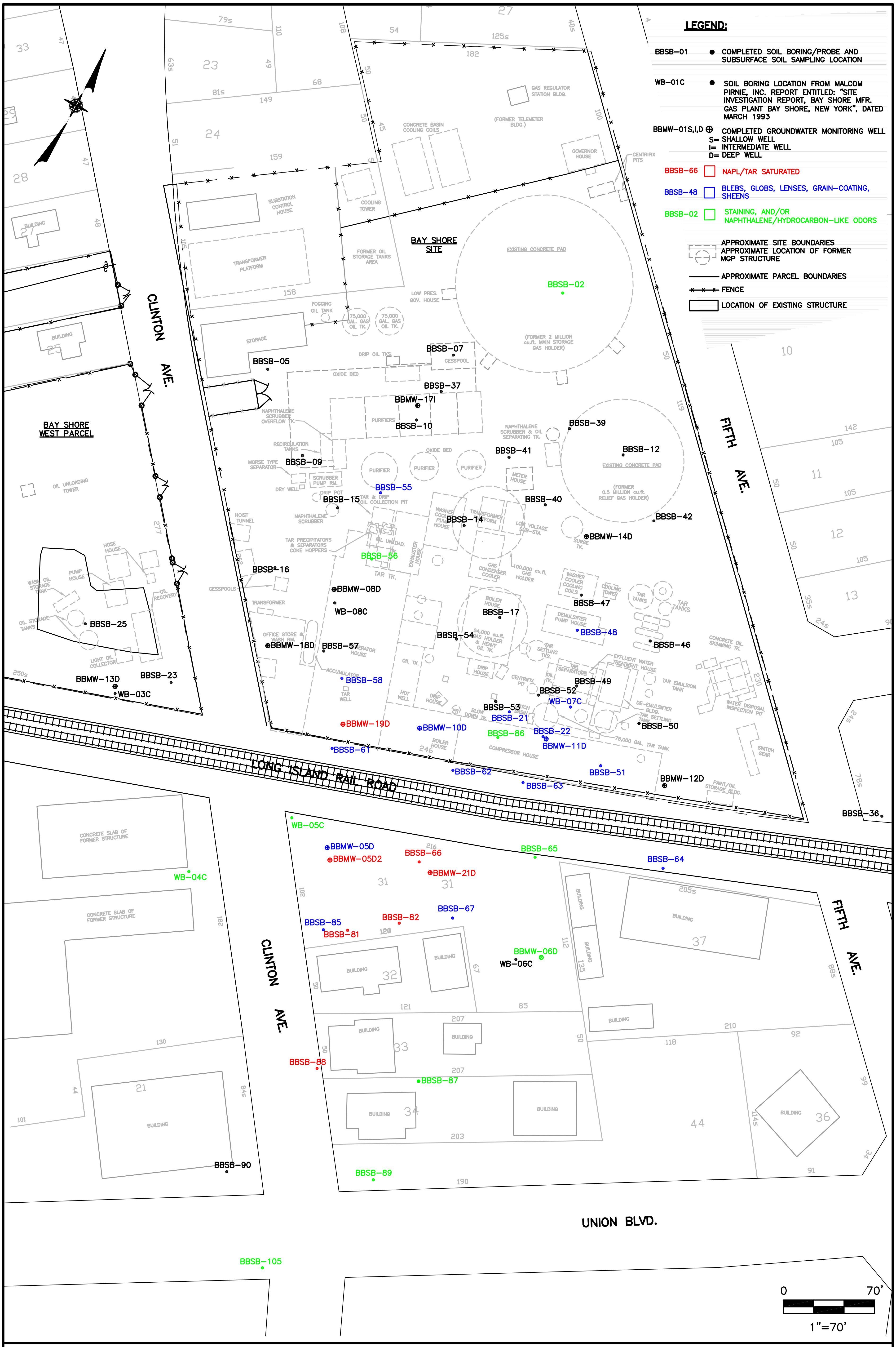


BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

FIELD OBSERVATIONS OF INTERMEDIATE SUBSURFACE SOIL (12 TO 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-21

Dvirka
and
Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.



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Dvirka and Bartilucci
CONSULTING ENGINEERS
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BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

FIELD OBSERVATIONS OF DEEP SUBSURFACE SOIL (> 32 FEET) AT THE BAY SHORE SITE, BAY SHORE WEST PARCEL AND ADJACENT OFF-SITE AREAS

FIGURE 4-22

- The Tar Separators, Tar Tanks and Effluent Water Treatment House located in the southern portion of the site;
- 54,000 cubic feet Gas Holder and Heavy Oil Tank; and
- Tar well located in the southern portion of the Generator House.

As described in **Section 4.2.1.2**, the areas in the vicinity of the former structures listed above generally exhibited the highest total BTEX and total PAH concentrations in shallow subsurface soil. Based on the presence of shallow NAPL/tar-saturated soil, as well as total BTEX and total PAH concentrations in subsurface soil, the former structures listed above are considered potential source areas. **Figure 4-20** also illustrates that, with the exception of the former Cesspool, the northernmost third of the Bay Shore site does not contain soil exhibiting NAPL or tar at saturated conditions. However, staining and/or odors were observed at a number of locations in this area of the site, including BBTP-03A, SB-26C, BBSB-04, BBSB-06 and BBSB-37.

Figure 4-20 also shows that, with the exception of soil boring BBSB-90, saturated NAPL in shallow subsurface soil in the adjacent off-site areas was generally restricted to the adjacent off-site area south of the site and north of Union Boulevard. Specifically, NAPL was detected in this area in soil borings BBSB-61, BBSB-82 and BBSB-86. Soil boring BBSB-61 was located immediately downgradient from the former Generator House and associated Tar Well. Soil borings BBSB-82 and 86 were located downgradient from the south-central portion of the site, which included the former Tar Separator and Effluent Water Treatment House listed above. In addition, soil exhibiting NAPL/tar blebs and sheens was noted in shallow soil collected from WB-05C, BBMW-05D and BBMW-05D2 which were also located immediately downgradient of the Bay Shore site and the 54,000 cubic foot Gas Holder and Heavy Oil Tank. While NAPL/tar-saturated conditions, NAPL/tar blebs and sheens were noted in the shallow soil zone at off-site locations, the geologic cross sections shown on **Drawings 4A** and **4B** clearly indicate that these conditions are observed at or below the water table.

Soil boring BBSB-90 was located at the northwest corner of the intersection of Union Boulevard and Clinton Avenue and immediately downgradient of an automotive repair shop.

Although saturated NAPL was noted in shallow soil at soil boring BBSB-90, it was described as gray and was accompanied with gray stained soil and a gasoline/hydrocarbon-like odor. Accordingly, the NAPL at BBSB-90 is attributed to an unknown off-site source, and is not considered to be related to former MGP operations at the site.

Intermediate Soil

Figure 4-21 depicts that the overall distribution of soil borings containing NAPL in the intermediate zone (i.e., from 12 to 32 feet bgs) is similar to that observed for NAPL in soil in the shallow zone. The majority of NAPL and/or tar-saturated soil was observed at intermediate depths in soil borings completed in the southern third of the site, west of the former Relief Holder and in the adjacent off-site areas immediately south (downgradient) of the site. In addition, NAPL-saturated soil was encountered in soil borings BBSB-07 and BBSB-37, completed in the vicinity of the former Cesspool located west of the former Gas Holder. **Figure 4-21** illustrates the fact that the majority of the soil borings exhibiting NAPL/tar-saturated conditions within the intermediate soil zone are located along the southern property boundary and adjacent downgradient areas. The north-south geologic cross-sections shown on **Drawings 4A** and **4B** illustrate the fact that soil in borings completed in the northern portion of the site shows little, if any, evidence of NAPL/tar-saturated conditions (with the exception of the area around the former Cesspool). However, further south, NAPL/tar-saturated conditions are more common and appear to be more frequently detected in the intermediate zone at the southern property boundary and in off-site adjacent downgradient locations.

Deep Soil

A review of **Figure 4-22** shows that saturated NAPL in the deep soil zone was only encountered in on-site soil borings BBMW-11D and BBMW-19D and in six soil borings in the adjacent off-site area including BBSB-66, BBSB-81, BBSB-82, BBSB-88, BBMW-21D and BBMW-05D2. Soil boring BBMW-11D was located in the south central portion of the Bay Shore Site immediately downgradient from the former Tar Separators and 75,000-gallon Tar Tank. Soil boring BBMW-19D was located in the southwestern portion of the site in the former

Generator House and near the former Tar Well. In addition, a number of soil borings completed in the southern portion of the site exhibited NAPL/tar blebs and sheens.

As indicated on **Figure 4-22**, with the exception of soil boring BBSB-88, all off-site soil borings that contained saturated NAPL in the deep soil zone were located in the northwestern corner of the adjacent off-site area. A review of cross sections provided on **Drawings 4A** and **4B** and logs for the soil borings that contained saturated NAPL/tar in the deeper zone, including BBSB-66, BBSB-81, BBSB-82, BBSB-88, BBMW-21D and BBMW-05D2, shows that the intervals where NAPL/tar was observed occurred intermittently between 32 feet bgs and the top of the low permeability sediments of the Magothy formation (approximately 72 feet bgs). While staining and odors were observed within the first several feet of the Magothy formation sediments, no evidence of NAPL/tar-saturated conditions was observed below the Glacial/Magothy formation interface, indicating that the low permeable nature of the Magothy formation is limiting the vertical migration of this material. The boring logs also showed that the presence of saturated NAPL was typically accompanied by the presence of naphthalene-like odors, moderate to heavy staining, and elevated PID readings.

Based on the discussion above the following summarizes the observed distribution of NAPL/tar-saturated soil at the site and adjacent areas:

- With the exception of the former Cesspool, no NAPL/tar was observed in the northern third of the site. This is expected as little, if any, operations of the former MGP took place in this portion of the site.
- Where detected, saturated NAPL/tar observed in subsurface soil in the central third of the site is generally limited to approximately 20-30 feet bgs. The sources of this relatively shallow NAPL/tar are former MGP structures.
- The occurrence of saturated NAPL/tar in deep soils (i.e., greater than 32 feet bgs) is generally limited to the southern third of the site and adjacent downgradient areas.
- The most extensive occurrence of NAPL/tar at saturated conditions in subsurface soil was observed within the southernmost third of the Bay Shore site and adjacent downgradient areas.
- The observed distribution of NAPL/tar in subsurface soil indicates a southerly migration of this material below the water table from on-site source areas primarily

located in the southernmost third of the site to downgradient areas. NAPL/tar migration appears to be predominantly horizontal in nature; however, in the vicinity of the southern property boundary, a significant downward vertical migration component is present. As a result, there appears to be a deep NAPL/tar zone located above the Glacial/Magothy formation interface from the property boundary to as far south as BBSB-88.

NAPL/Tar in Groundwater

Since the Summer of 1999, on-site and adjacent off-site monitoring wells have been periodically checked for LNAPL and DNAPL components within the screen zones. This was accomplished through the use of an oil/water interface probe as well as the use of a hand bailer to confirm the probe results. Based on measurements taken to date, there has been no measurable LNAPL noted within on-site or off-site monitoring wells. Furthermore, as part of the test pitting program conducted during the supplemental field program, each of the 14 test pits were excavated to a depth in which the water table was encountered in order to determine if LNAPL was present at or near the water table. At all 14 test pit locations no evidence of a separate phase LNAPL was observed.

As shown in **Table 4-12**, a measurable layer of DNAPL was detected in on-site monitoring well MW-07D and off-site monitoring wells BBMW-20D, BBMW-21D and BBMW-22D. The three off-site wells have 2-foot sumps, are located immediately downgradient of the Bay Shore site and are screened immediately above the Glacial/Magothy formation interface. MW-07D has a 0.5-foot sump on the end of the screen. DNAPL thicknesses ranged from a minimum of 2.5 feet detected in MW-07D to a maximum of 7.0 detected in BBMW-21D and BBMW-22D. The four monitoring wells are located in the same area identified as containing a deep NAPL/tar-saturated soil zone as described above. A sample of the DNAPL present in monitoring wells BBMW-21D and BBMW-22D was sent for petroleum fingerprint analysis, the results of which are discussed in **Section 4.2.1.3**.

4.2.2 Bay Shore West Parcel (Operable Unit 1)

4.2.2.1 - Subsurface Soil

As discussed in the April 2002 RI Report, a total BTEX concentration of 495 mg/kg was identified at BBSB-25 completed within the vicinity of the former Oil Storage Tanks located on the Bay Shore West Parcel. As part of the supplemental field program, a total of 25 soil probes were completed up to a depth of 26 feet bgs within and downgradient of the Bay Shore West Parcel in order to delineate the horizontal and vertical extent of BTEX identified in this area during the initial field program. A total of 59 subsurface soil samples were selected for BTEX and PAH analysis. Analytical results for BTEX and PAHs in subsurface soil samples collected from soil borings are summarized in **Tables C-13** and **C-14**, respectively, and analytical results for petroleum fingerprint are summarized in **Table C-15**. In addition, total BTEX and total PAH data associated with the collected samples are summarized on **Figures 4-1** through **4-6** referenced in **Section 4.2.1.2**.

BTEX

Six of the 59 samples collected from the Bay Shore West Parcel and analyzed as part of the supplemental field program exhibited a total BTEX concentration greater than 1.0 mg/kg with a maximum total BTEX concentration of 60.2 mg/kg detected at BBSB-71 (9 to 11 feet). As shown on **Figure 4-1**, BBSB-71 was located approximately 25 feet south of BBSB-25 completed during the initial field program. As shown on **Figure 4-2**, BTEX concentrations were found to be less than 0.1 mg/kg below a depth of 12 feet and in most locations were found to be nondetectable, indicating that BTEX present in subsurface soil within the Bay Shore West Parcel is limited to shallow soil. This is generally consistent with moderate to strong hydrocarbon-like odors and PID readings of up to 2,000 ppm in shallow soil at or immediately below the water table. However, odors and PID readings were significantly lower or absent below a depth of 12 feet at most locations.

PAHs

Twelve out of 59 soil samples collected from the Bay Shore West Parcel and analyzed as part of the supplemental field program exhibited total PAH concentrations greater than 10.0 mg/kg with the majority of these samples not exceeding 10.0 mg/kg total PAHs. The highest total PAH concentration of 973.0 mg/kg was detected in a sample collected from BBSB-78 from (0 to 2 feet). However, as shown in the boring log for BBSB-78, this sample contained a portion of hardened tar. As shown on **Figure 4-4**, the remaining total PAH concentrations observed within subsurface soil at the Bay Shore West Parcel did not exceed 120.0 mg/kg. Furthermore, **Figure 4-5** indicates total PAH concentrations below a depth of 12 feet were found to be nondetectable at virtually all locations consistent with BTEX concentrations.

4.2.2.2 - Groundwater

Groundwater quality was characterized through the collection and analysis of groundwater samples from six existing monitoring wells and six groundwater probes. BTEX and PAH results for groundwater samples collected from the monitoring wells are summarized in **Tables C-16** and **C-17**, respectively, and from the groundwater probe points are summarized in **Tables C-18** and **C-19**, respectively. In addition, total BTEX and total PAH concentrations in groundwater are summarized on **Figures 4-7** through **4-12**, referenced in **Section 4.2.1.3**.

BTEX

Table 4-13 summarizes the groundwater samples collected from the Bay Shore West Parcel site that exhibited the highest total BTEX and total PAH concentrations along with approximate locations of these samples in relation to former MGP structures/features where appropriate. The table also provides any significant field observations noted during the collection of these samples. Also note that additional detail as to the distribution of NAPL in groundwater is provided in **Section 4.2.1.4**.

TABLE 4-13
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

BAY SHORE WEST PARCEL GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)	Field Description of Recovered Sample
BBGP-85 (6-10')	1,111.0	616.0	Adjacent to fence along south side of Bay Shore West Parcel. Downgradient of Oil Storage Tanks.	None
BBGP-86 (6-10')	21,500.0	732.0	Adjacent to fence along south side of Bay Shore West Parcel. Downgradient of Oil Storage Tanks.	Light sheen, solvent-like odor
BBGP-88 (8-12')	4,500.0	242.0	Within L-shaped Concrete Slab of Former Structure south of the Long Island Railroad. Downgradient of Oil Storage Tanks.	None

As indicated in **Table 4-13**, the highest levels of total BTEX were observed in shallow groundwater at or near the water table and downgradient of former MGP structures which also coincided with elevated BTEX concentrations in subsurface soil, as described in **Section 4.2.2.1**. The highest total BTEX concentration of 21,500 ug/l was detected in groundwater probe sample BBGP-86 (6 to 10 feet) located directly downgradient of soil boring BBSB-25 and the former Oil Storage Tanks. During sampling, a light sheen was observed in the sample and solvent-like odors were detected. A total BTEX concentration of 1,111 ug/l was detected in groundwater probe sample BBGP-85 (6 to 10 feet), which was located in the vicinity of BBGP-86. No evidence of NAPL was detected in BBGP-85 during sampling. BTEX was also detected in samples collected in shallow groundwater at BBGP-87 and BBGP-88 both located downgradient of the Bay Shore West Parcel and south of the LIRR ROW at concentrations of 353 ug/l and 4,500 ug/l, respectively.

Based on a review of **Figures 4-7** through **4-9** and the supporting data, the following are noteworthy observations:

1. As shown on **Figure 4-7**, BTEX compounds were detected in groundwater collected from the approximate midpoint of the southern boundary of the Bay Shore West Parcel in groundwater probe locations BBGP-85 and 86 and along a downgradient flow path from these locations at groundwater probe points BBGP-87 and BBGP-88. These sample points are located downgradient of soil boring BBSB-25 at varying distances which exhibited a total BTEX concentration of 425.0 mg/kg in shallow subsurface soil.
2. BTEX compounds were primarily detected in the shallow groundwater zone. BTEX was only detected up to a concentration of 5 ug/l in the intermediate zone (**Figure 4-8**). Total BTEX was detected in the deep groundwater interval at groundwater probe locations BBGP-38 and BBGP-41 at concentrations of 2 ug/l and 81 ug/l, respectively (**Figure 4-9**).

Based on the direction of groundwater flow (refer to **Section 3.3**) and the location of the groundwater samples exhibiting the highest total BTEX concentrations, the likely source of BTEX compounds in groundwater at the Bay Shore West Parcel are the former Oil Storage Tanks.

PAHs

The data in **Table 4-13** shows that the highest concentration of total PAHs was detected in groundwater probe sample BBGP-86 (6 to 10 feet). As discussed above, a light sheen was observed and a solvent-like odor was detected in this sample during collection. Relatively low concentrations of PAHs were also detected in samples collected from groundwater probe locations BBGP-85, 87 and 88 at respective total PAH concentrations of 616 ug/l, 234 ug/l and 242 ug/l.

Based on a review of **Figures 4-10** through **4-12** and the supporting data, the following are noteworthy observations:

1. As shown on **Figure 4-10**, PAHs were detected in groundwater collected from the center of the southern boundary of the Bay Shore West Parcel in groundwater probe locations BBGP-85 and 86 and along a downgradient flow path from these locations at groundwater probe points BBGP-87 and BBGP-88. Again, these points are located downgradient of completed soil boring BBSB-25.
2. With only few exceptions, PAH compounds were generally detected only in shallow groundwater. PAHs were detected in the intermediate groundwater interval (**Figure 4-11**) in samples collected from probe point BBGP-41 at a concentration of 41 ug/l. PAHs were also detected in the deep groundwater interval at groundwater probe location BBGP-41 at a concentration of 13 ug/l and at monitoring well BBMW-13D at a concentration of 40 ug/l (**Figure 4-12**).

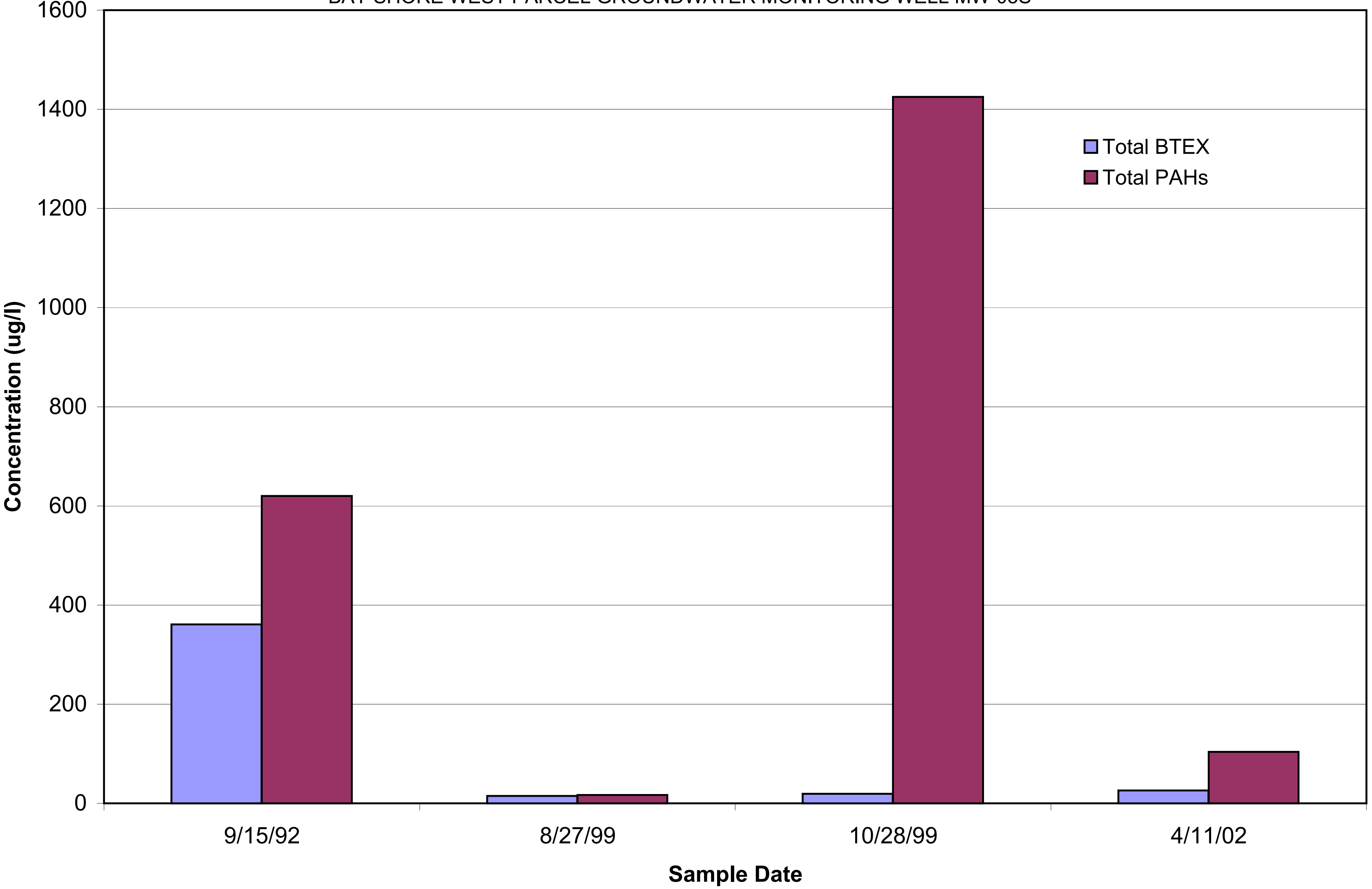
Based on the direction of groundwater flow (refer to **Section 3.3**) and the location of the groundwater samples exhibiting the highest total PAH concentrations, the likely sources of PAH compounds in groundwater at the Bay Shore West Parcel include the former Oil Storage Tanks.

Historical Total BTEX/PAH Concentrations at the Bay Shore West Parcel

Available groundwater data for monitoring well MW-03S, located along the southern property boundary of the Bay Shore West Parcel, is plotted on **Figure 4-23**. The data shown on **Figure 4-23** indicates that total BTEX concentrations have decreased to trace levels since September 1992 and total PAHs have not shown a consistent trend over that same time. As

FIGURE 4-23
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
BAY SHORE WEST PARCEL GROUNDWATER MONITORING WELL MW-03S



I:\1620 (KeySpan)\BAY SHORE_BRIGHTWATERS\Supplemental Investigation\SUPPLEMENTAL REPORT\Groundwater Trend Data

indicated on **Figure 4-23**, total BTEX and total PAHs were detected at low concentrations in groundwater samples collected in April 2002.

Petroleum Fingerprint/Specific Gravity/Viscosity Analysis

During the regrading of the Bay Shore West Parcel by KeySpan in the Spring of 2002, several sections of underground piping were removed from the subsurface. Several of the pipes contained a oil/water mixture that were drained, containerized and properly disposed of by KeySpan. Prior to the disposal of this material, a sample was collected for petroleum fingerprint analysis. In addition, the sample was analyzed for specific gravity and viscosity. A report summarizing the results of this analysis is provided in **Appendix D**. Based on the results of this analysis, it was determined that this sample contained pyrogenic and petrogenic substances. Pyrogenic substances are complex mixtures of primarily hydrocarbons produced from organic matter subjected to high temperatures, but with insufficient oxygen for complete combustion. Pyrogenic materials are produced by fires, internal combustion engines, and furnaces. They also are formed when coke or gas are produced from coal or oil. Coal-tar based products, such as roofing, pavement sealers, waterproofing, pesticides, and some shampoos contain pyrogenic materials. Petrogenic substances include crude oil and crude oil derivatives such as gasoline, heating oil, and asphalt. The petrogenic material in this sample eluted as an unresolved complex mixture (UCM or "hump") from approximately octane (C8 - 5 minutes) to nonacosane (C29 - 30 minutes) with a maximum at octadecane (C18 - 19 minutes). Examples of common petroleum products with these features include blended fuels such as No. 4 fuel oil as well as wash oil. The dominance of normal alkanes and the alkane/isoprenoid ratios indicate that this material is relatively unweathered. The combination of the pattern of PAHs, the high MAH concentrations and the petrogenic materials in this sample strongly suggest that this sample contains used wash oil. Wash oils were used in the gas purification process to remove tar volatiles from the gas stream. In addition, analysis of the oil portion of this sample determined the sample had a specific gravity of 0.98 indicating the material was slightly less dense than water. The sample exhibited a kinematic viscosity of 39.2 cSt.

4.2.2.3 - Extent of NAPL

The review of **Figures 4-20** through **4-22**, presented in **Section 4.2.1.4**, which summarize field observations indicates that evidence of NAPL/tar at saturated levels was only observed in shallow subsurface soil at BBSB-69. In addition, several soil borings exhibited NAPL/tar blebs and/or sheens including soil borings BBSB-71, BBSB-72, BBSB-73 and BBSB-80. These borings encompass the general area where BTEX and PAHs were observed in shallow subsurface soil and groundwater. Similar to distribution of total BTEX and total PAH concentrations in shallow soil and groundwater, evidence of NAPL in subsurface soil is minimal below a depth of 12 feet.

4.2.3 Bay Shore West Storage Lot (Operable Unit 3)

4.2.3.1 - Surface Soil

PAHs

Table C-20 summarizes the analytical results for PAHs in surface soil samples collected on the Bay Shore West Storage Lot Parcel. The results show that total PAHs were detected in samples BBSS-34 (0-6”) and BBSS-35 (0-6”) at respective concentrations of 17.2 mg/kg and 15.8 mg/kg. These relatively low concentrations are typical of surface soil in urban industrial environments such as exists at the Bay Shore West Storage Lot Parcel.

As shown on **Drawing 2A**, surface soil sample BBSS-34 was located along the central portion of the southern boundary of the Bay Shore West Storage Lot Parcel and BBSS-35 was located along the north-central boundary of this parcel.

4.3 Off-site Investigation (Operable Units 1 and 2)

4.3.1 Bay Shore Plume IRM Investigation

The objective of the IRM Investigation in the Bay Shore groundwater plume was to obtain additional stratigraphic, geotechnical and geochemical data within the plume. Similarly, groundwater samples were collected within the plume from both new and existing wells and from new groundwater probe points. The additional stratigraphic and geotechnical data and information were used in **Section 3.0 – Site Geology and Hydrogeology** to refine the model of the subsurface soil with particular emphasis on key aquifer characteristics and the location and configuration of low permeability layers, such as the top of the Upper Magothy Unit.

The soil and groundwater quality discussed below is used to define the vertical distribution of chemical constituents in soil and groundwater in the plume, evaluate the status of the plume (e.g., steady state, decreasing concentrations, etc.) and evaluate overall geochemical conditions in the aquifer. The geochemical data is also used to evaluate the occurrence of biodegradation of BTEX and PAHs in the plume as a potential component of an IRM.

4.3.1.1 - Subsurface Soil

As part of the Bay Shore Plume IRM Investigation, four soil borings, designated BBSB-74 through BBSB-77, were completed down the centerline of the Bay Shore plume in order to obtain additional stratigraphic data from this area. In addition, one sample, designated BBSB-76 (17 to 19 feet), was selected for analysis of BTEX and PAHs due to the presence of a slight hydrocarbon-like odor at this sample interval. The analytical results for BTEX and PAHs are summarized in **Tables C-21** and **C-22**, respectively.

BTEX

With the exception of benzene, BTEX compounds were not detected in soil sample BBSB-76 (17 to 19 feet). Benzene was detected at a concentration of 0.002 mg/kg.

PAHs

With the exception of phenanthrene, PAHs were not detected in subsurface soil sample BBSB-76 (17 to 19 feet). The concentration of phenanthrene was 0.042 mg/kg.

4.3.1.2 - Groundwater

As described in **Section 2.4**, the off-site groundwater investigation included the collection of samples from groundwater probes as well as the sampling of existing monitoring wells and monitoring wells installed as part of the supplemental field program. In addition to the routine MGP analytical parameters of BTEX and PAHs, geochemical parameters were analyzed and field parameters were measured. The analytical results for BTEX and PAHs in groundwater samples collected from monitoring wells are summarized in **Tables C-23** and **C-24**, and for samples collected from groundwater probe points are summarized in **Tables C-25** and **C-26**. The analytical results for geochemical and field parameters for samples collected from monitoring wells are summarized in **Tables C-27** and **C-28** and for samples collected from groundwater probe points are summarized in **Tables C-29** and **C-30**.

The BTEX and PAH data were used to further delineate the vertical and horizontal distribution of the Bay Shore groundwater plume. In addition, concentration of total BTEX/PAHs are used in this section to evaluate changes in concentrations over time. The trend evaluation is based on current and historical groundwater data for select wells. The geochemical parameters and field measurements were used to evaluate the overall geochemical conditions in the aquifer, with specific focus on evaluating the ability of the aquifer to support biodegradation and the effectiveness of biodegradation to reduce the mass of BTEX and PAHs in the Upper Glacial aquifer.

BTEX and PAHs

Table 4-14 summarizes the highest total BTEX and total PAH concentrations detected in the Bay Shore groundwater plume based on data from the supplemental field program. Note that consistent with the operable unit divisions discussed in **Section 1.5**, **Table 4-14** only includes groundwater samples collected from Operable Unit 2 which has Union Boulevard as its northern terminus. The discussion of BTEX and PAHs in groundwater north of Union Boulevard (Operable Unit 1) is presented in **Section 4.2.1.3**. **Table 4-12** summarizes the highest BTEX and PAH concentrations detected on the Bay Shore Site as well as off-site areas as far south as Union Boulevard. Comparison of **Table 4-12** with **Table 4-14** indicates that, in general, BTEX and PAHs are present at higher concentrations immediately downgradient of the Bay Shore Site (Operable Unit 1) compared to groundwater south of Union Boulevard. In addition, shallow groundwater immediately downgradient of the site exhibits the highest concentrations of BTEX and PAHs, whereas south of Union Boulevard the highest concentrations are generally found in the shallow as well as the intermediate groundwater zones.

A review of **Table 4-14** indicates the highest total BTEX concentrations observed in the Bay Shore plume were detected at groundwater probe BBGP-75 located approximately 800 feet downgradient of the Bay Shore Site, with total BTEX concentrations of 7,160 ug/l at 16 to 20 feet, 4,516 ug/l at 64 to 68 feet, and 4,310 ug/l at 32 to 36 feet. The highest total PAH concentration detected south of Union Boulevard (9,720 ug/l) was detected in the intermediate groundwater zone at well cluster BBMW-01 located approximately 550 feet south of the Bay Shore Site. However, the second, third and fourth highest total PAH concentrations in the Bay Shore plume were detected south of Montauk Highway, approximately 2,000 feet south of the Bay Shore Site, including BBGP-79 (32 to 36 feet) at 8,202 ug/l, BBGP-81 (26 to 30 feet) at 9,137 ug/l and BBGP-81 (36 to 40 feet) at 7,756 ug/l.

Using the extensive amount of groundwater quality data collected as part of the initial and supplemental field programs, six groundwater plume maps were prepared. They include shallow, intermediate and deep plume maps for both total BTEX and total PAH concentrations. Groundwater plume maps depicting total BTEX and total PAH concentrations are presented on

TABLE 4-14

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

OFF-SITE GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)
BBGP-75 (16-20')	7,160.0	1,959.0	On the corner of Cooper Lane and Clinton Avenue. Approximately 800 ft. downgradient of Bay Shore Site.
BBGP-75 (32-36')	4,310.0	3,954.0	On the corner of Cooper Lane and Clinton Avenue. Approximately 800 ft. downgradient of Bay Shore Site.
BBGP-75 (48-52')	432.0	6,027.0	On the corner of Cooper Lane and Clinton Avenue. Approximately 800 ft. downgradient of Bay Shore Site.
BBGP-75 (64-68')	4,516.0	7,300.0	On the corner of Cooper Lane and Clinton Avenue. Approximately 800 ft. downgradient of Bay Shore Site.
BBGP-76 (32-36')	1,142.0	6,171.0	In vicinity of the Jewish Center of Bay Shore, approximately 1, 200 ft. downgradient of Bay Shore Site.
BBGP-76 (40-44')	214.0	6,428.0	In vicinity of the Jewish Center of Bay Shore, approximately 1, 200 ft. downgradient of Bay Shore Site.
BBGP-76 (56-60')	672.0	6,588.0	In vicinity of the Jewish Center of Bay Shore, approximately 1, 200 ft. downgradient of Bay Shore Site.
BBGP-79 (32-36')	320.0	8,202.0	Within the Town of Islip, south of Montauk Highway. Approximately 1,970 ft. downgradient of Bay Shore Site.
BBGP-81 (26-30')	297.0	9,137.0	Within the Town of Islip, south of Montauk Highway. Approximately 2,250 ft. downgradient of Bay Shore Site.

TABLE 4-14 (continued)

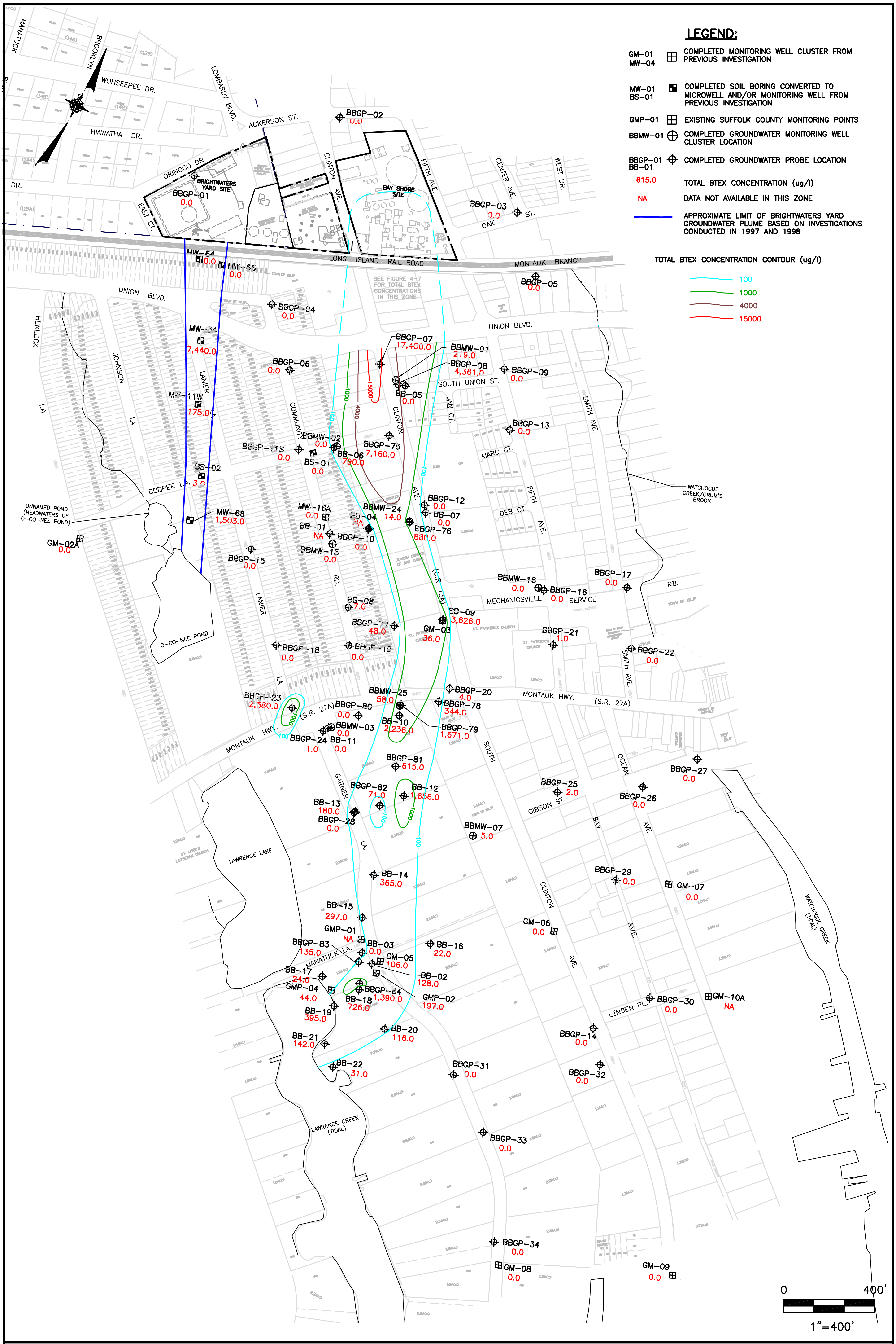
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

OFF-SITE GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe/Well No. and Sample Depth)	Total BTEX Concentration (ug/l)	Total PAH Concentration (ug/l)	Location (in Relation to Former MGP Structure and/or Site)
BBGP-81 (36-40')	105.0	7,756.0	Within the Town of Islip, south of Montauk Highway. Approximately 2,250 ft. downgradient of Bay Shore Site.
BBGP-82 (36-40')	224.0	6,401.0	Within the Town of Islip, south of Montauk Highway. Approximately 2,420 ft. downgradient of Bay Shore Site.
BBGP-83 (26-30')	236.0	6,171.0	Within the Town of Islip, south of Montauk Highway. Approximately 3,120 ft. downgradient of Bay Shore Site.
BBGP-84 (26-30')	435.0	7,000.0	Within the Town of Islip, south of Montauk Highway. Approximately 3,220 ft. downgradient of Bay Shore Site.
BBMW-01I (32-42')	222.0	9,720.0	In vicinity of Clinton Avenue, aproximately 550 ft. downgradient of Bay Shore Site.
BBMW-24I (32-42')	264.0	6,632.0	In vicinity of the Jewish Center of Bay Shore, approximately 1, 200 ft. downgradient of Bay Shore Site.
BBMW-24D (59.5-69.5')	1,102.0	7,412.0	In vicinity of the Jewish Center of Bay Shore, approximately 1, 200 ft. downgradient of Bay Shore Site.
BBMW-25I (25-35')	1,034.0	7,436.0	Within the Town of Islip, south of Montauk Highway. Approximately 1,970 ft. downgradient of Bay Shore Site.

Figures 4-24 through **4-29**. Both groundwater probe and monitoring well data were used to prepare these maps. The shallow interval is based on data from the water table to approximately 26 feet bgs, the intermediate interval includes data from approximately 26 to 50 feet bgs and the deep interval is approximately 50 feet to the lower limits of the Upper Glacial aquifer, approximately 80 feet bgs. In cases where more than one data point was available for a given location, such as if a monitoring well was installed near a groundwater probe location, the higher of the two concentrations was used to contour the plume in order to provide the most conservative estimate of the plume extent. Due to the highly variable nature of the concentrations found within and immediately downgradient of the site, it was necessary to use a nonlinear concentration contour interval when depicting chemical distribution. The six maps developed to graphically display the data provide an accurate picture of the BTEX and PAH distribution both in areal extent and vertical distribution within the Upper Glacial aquifer. **Drawing 4D** provides a vertical cross section of both the BTEX and PAH plumes with the estimated vertical extent of the plume being defined by the 100 ug/l interval. **Drawing 4D** is provided in the map pocket at the end of this section of the report.

Note that the data used in these graphics was collected during the initial field program as well as the supplemental field program, and as a result, the data set used in the graphics spans several years. However, all newly installed and existing monitoring wells were sampled as part of the supplemental field program, and, all monitoring well data presented on the graphics is from the Spring 2002 sample round. Furthermore, all groundwater samples from BBGP-74 through BBGP-84 were collected during the Winter/Spring of 2002. Therefore, the majority of the data presented in these graphics were collected in early 2002 and provide an accurate picture of total BTEX distribution within the Upper Glacial aquifer. Furthermore, the use of the 100 ug/l total BTEX and total PAH concentrations to define the estimated extent of the plume is not based on a specific regulatory guidance value or cleanup standard. However, we believe the use of the 100 ug/l contour interval is appropriate given upgradient groundwater has been shown to contain detectable levels of BTEX and PAHs from other sources. Additionally, as discussed in the April 2002 RI Report, there have been at least 17 petroleum spills documented as occurring downgradient of the Bay Shore Site between 1988 and 1999. Therefore, it is reasonable to



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX CONCENTRATIONS IN SHALLOW OFF-SITE GROUNDWATER (WATER TABLE TO 26 FEET)

FIGURE 4-24

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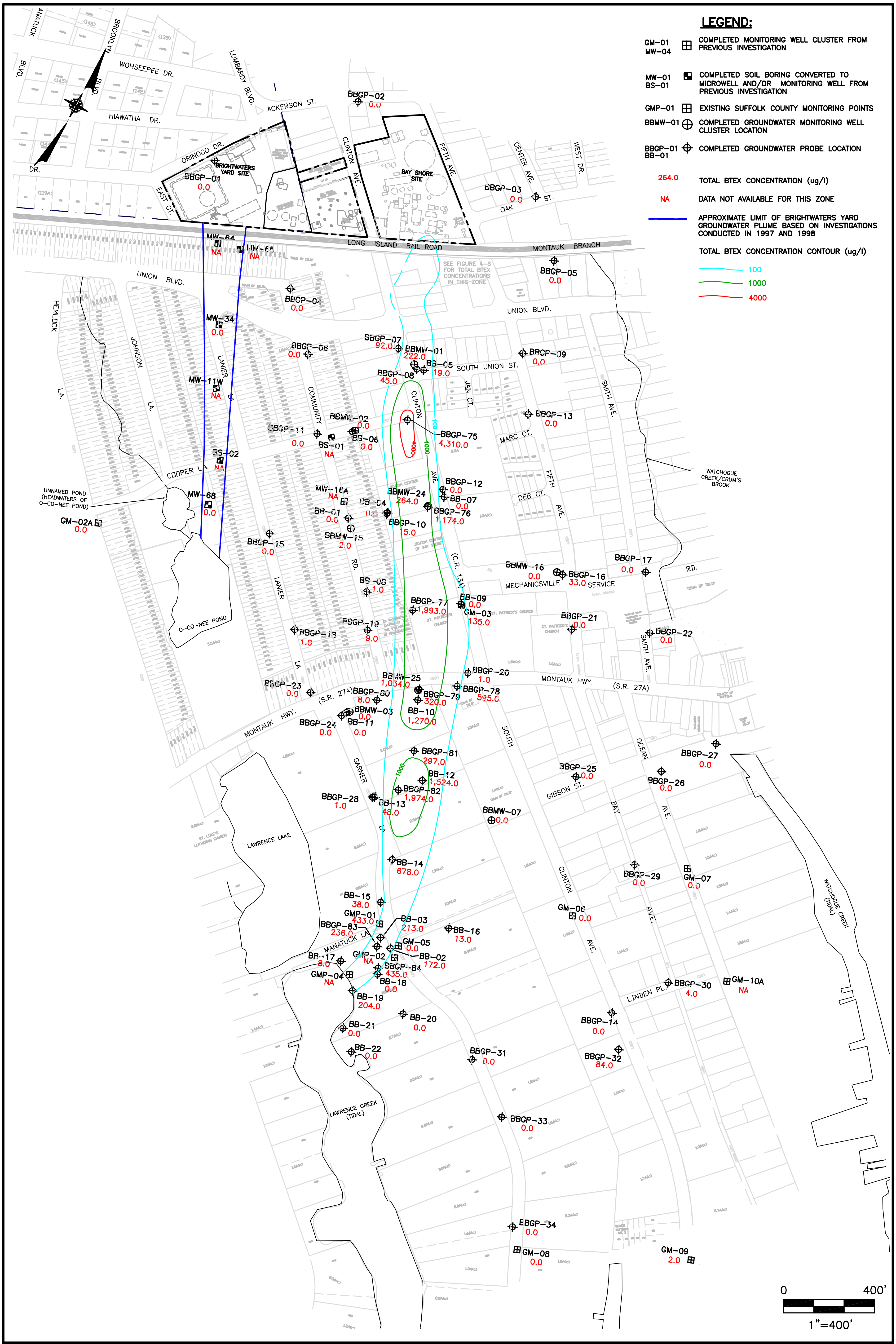

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX CONCENTRATIONS IN INTERMEDIATE OFF-SITE GROUNDWATER (26 TO 50 FEET)

FIGURE 4-25

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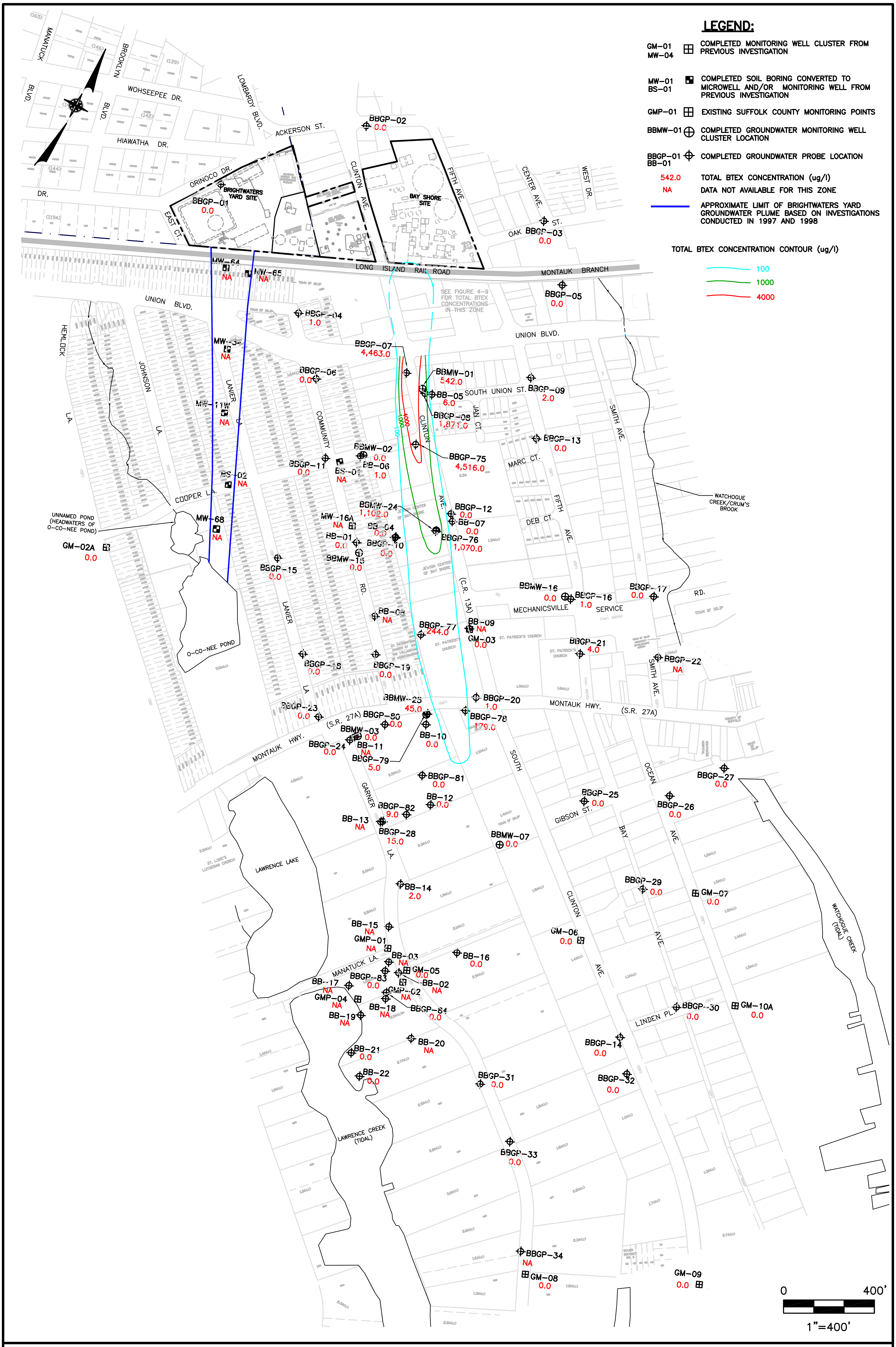

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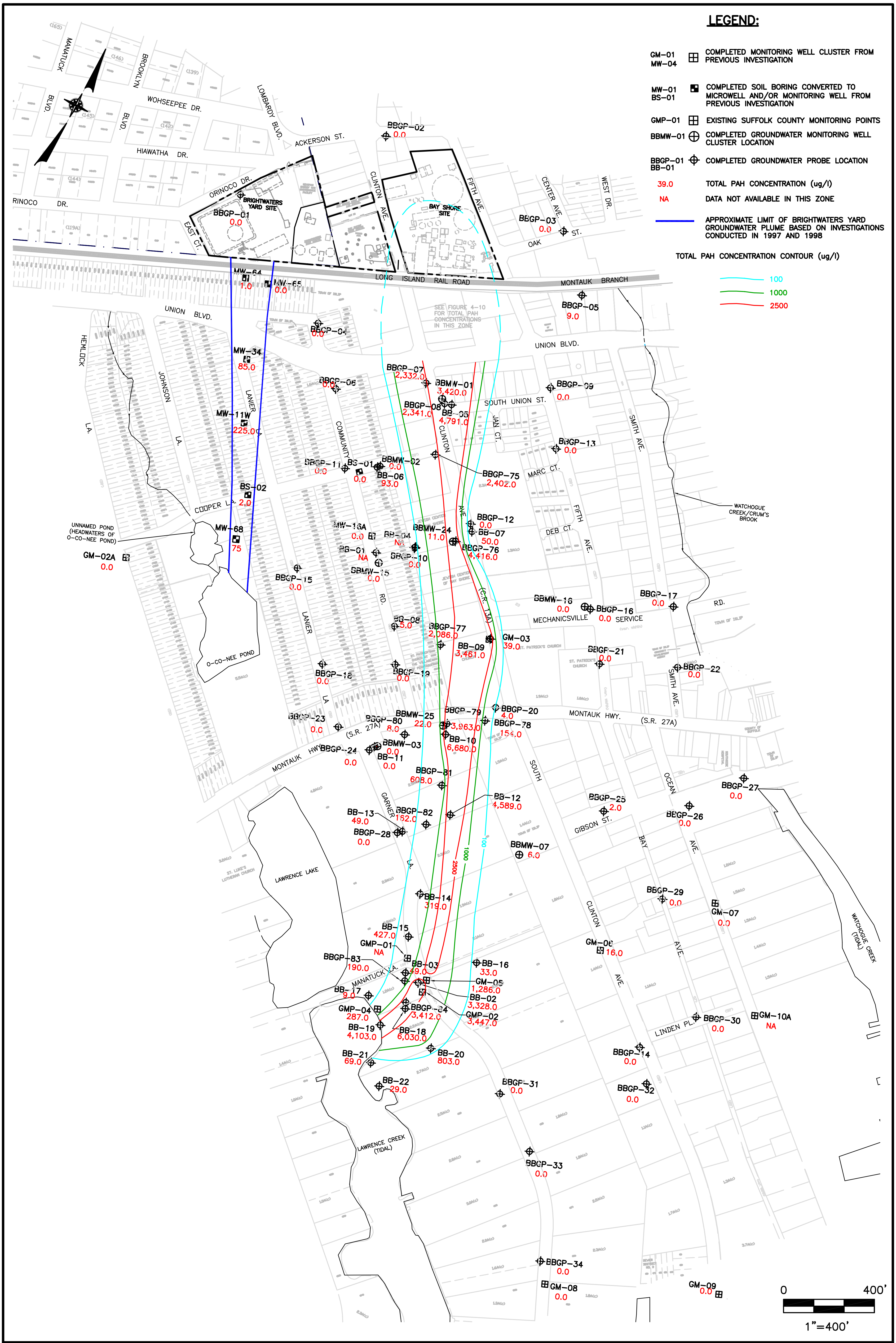
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX CONCENTRATIONS IN DEEP OFF-SITE GROUNDWATER (50 TO 80 FEET)

FIGURE 4-26



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL PAH CONCENTRATIONS IN SHALLOW OFF-SITE GROUNDWATER (WATER TABLE TO 26 FEET)

FIGURE 4-27

Dvirka
and
Bartilucci
CONSULTING ENGINEERS
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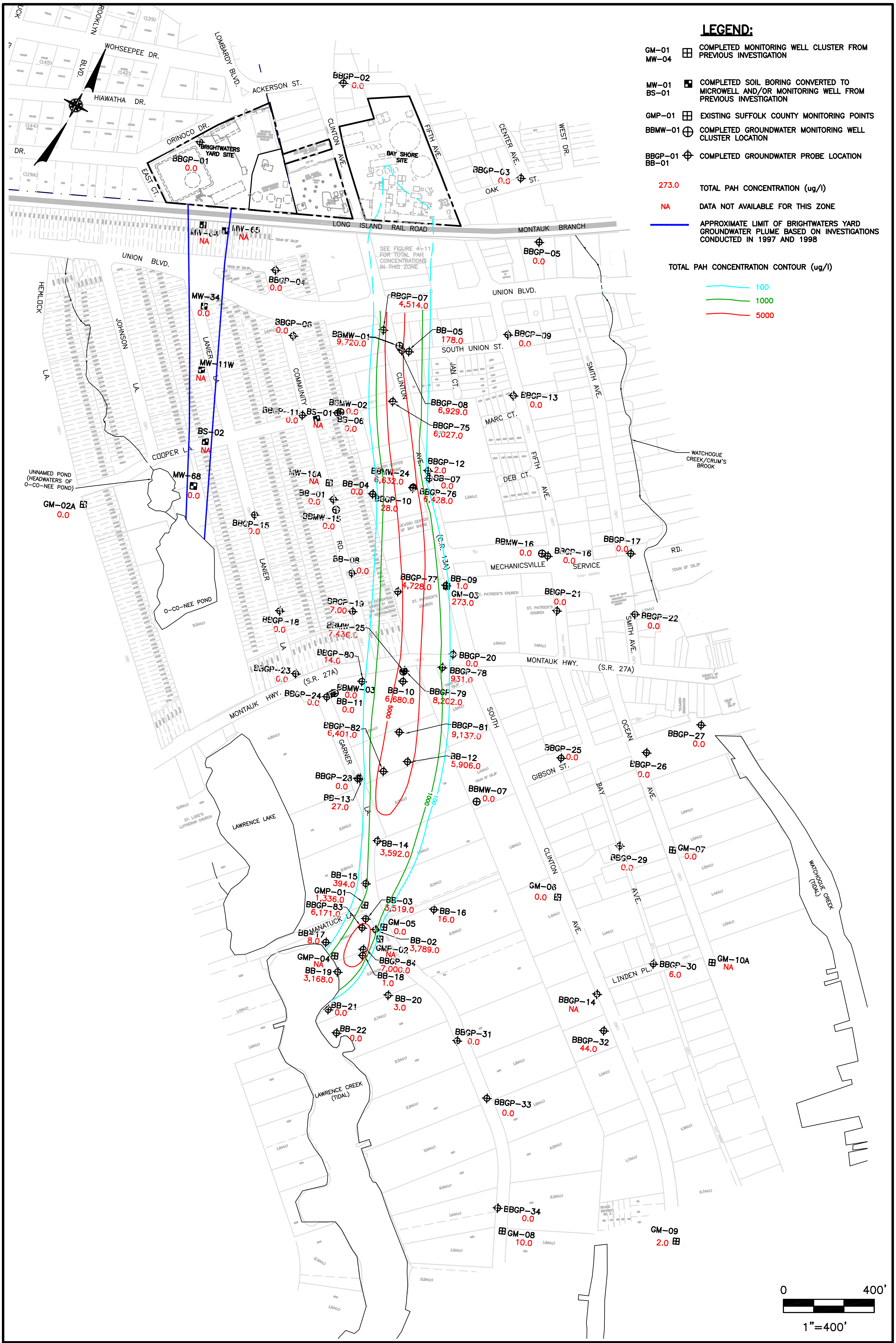
F:\1620B12B\dwg\11X17\FIG-4V.dwg, 01/02/03 01:51:43 PM, PMartorano



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

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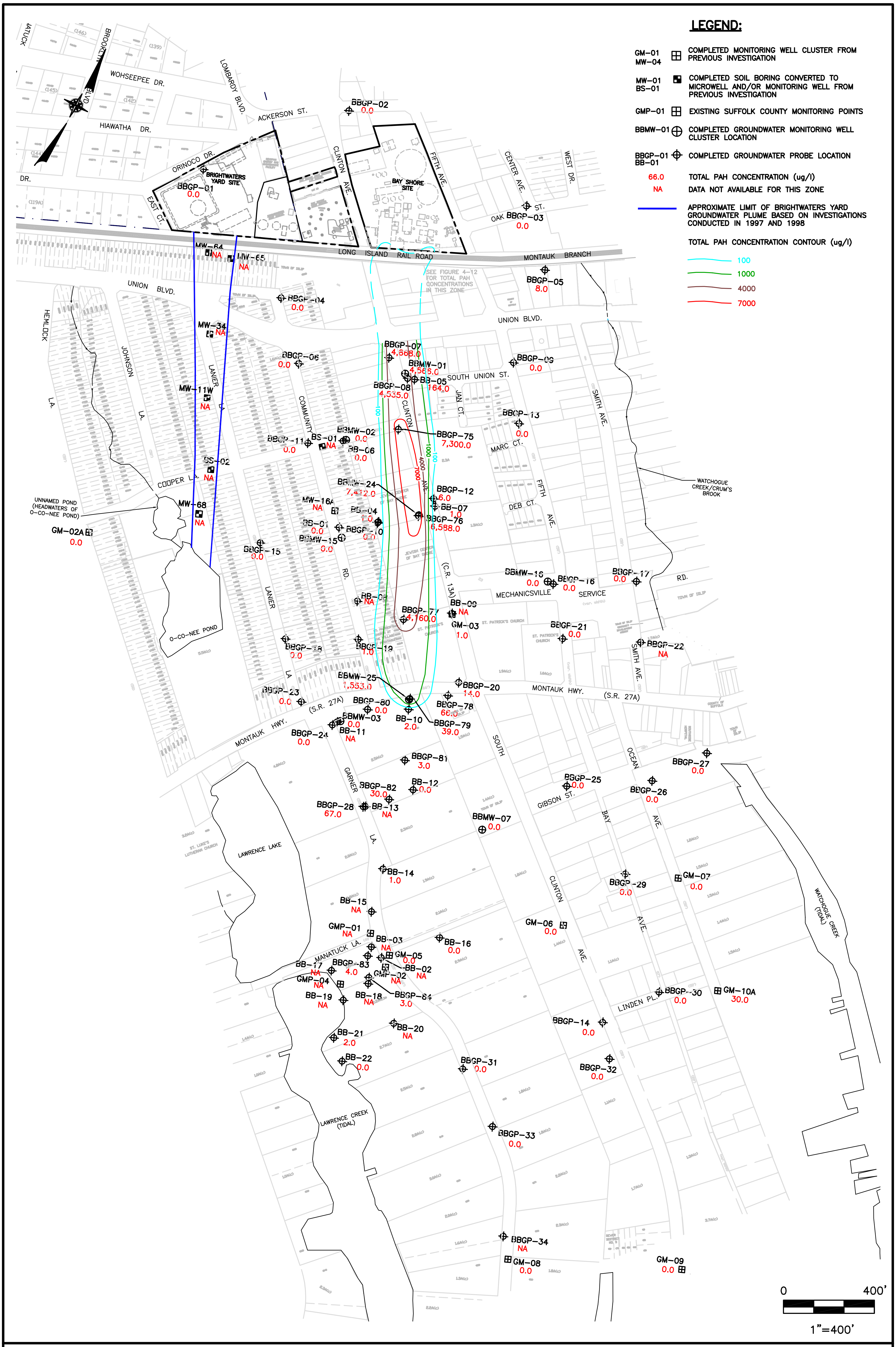
TOTAL PAH CONCENTRATIONS IN INTERMEDIATE OFF-SITE GROUNDWATER (26 TO 50 FEET)

FIGURE 4-28

F:\1620B12B\dwg\11X17\FIG-4W.dwg, 01/02/03 01:52:32 PM, PMartorano



BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL PAH CONCENTRATIONS IN DEEP OFF-SITE GROUNDWATER (50 TO 80 FEET)

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FIGURE 4-29

F:\1620B12B\dwg\11X17\FIG-4X.dwg, 01/02/03 01:53:18 PM, PMartorano assume that ambient groundwater not influenced by the Bay Shore Site may still exhibit detectable levels of BTEX and PAHs.

Based on the plume maps, the following observations are made with regard to BTEX and PAH concentrations:

1. The off-site plume represents the downgradient extension of the BTEX and PAH plume that originates on-site, as discussed in **Section 4.2.1.3**.
2. Although total BTEX and total PAHs were detected in groundwater samples collected from several downgradient wells and/or groundwater probe points, evidence of NAPL was not observed in any of the samples. Based on this data, the Bay Shore plume is comprised of dissolved phase BTEX and PAH compounds downgradient of Union Boulevard.
3. The highest total BTEX concentrations in the off-site plume were detected in the shallow and intermediate zones of the Upper Glacial Aquifer at groundwater probes BBGP-07 and BBGP-75 located 450 and 800 feet, respectively, downgradient of the site. In addition, the highest total BTEX concentrations detected in the deep groundwater zone were also detected in groundwater samples from these probes. A review of **Figure 4-24** indicates that BTEX compounds are present throughout the shallow groundwater interval along the center line of the plume with total BTEX concentrations ranging from 17,400 ug/l at BBGP-07 to 2,236 ug/l at BB-10, located approximately 50 feet south of Montauk Highway. Farther downgradient from BB-10, total BTEX concentrations decrease significantly within the shallow zone until approaching the plume discharge point located south of Manatuck Lane, where BTEX concentrations increase with a maximum total BTEX concentration of 1,390 ug/l detected at BBGP-84.
4. **Figure 4-27** shows total PAH concentrations down the center line of the Bay Shore plume in the shallow groundwater zone ranging from 2,332 ug/l at BB-07 located 450 feet from the site to a maximum of 6,680 ug/l detected at BB-10, again located 50 feet south of Montauk Highway (approximately 3,000 feet from the site), indicating PAH concentrations actually increase with increasing distance from the site as far downgradient as BB-10. Downgradient of BB-10, PAHs remain in the shallow groundwater zone with total PAH concentrations ranging from 608 ug/l at BBGP-81 to 4,103 ug/l at BB-19, located in the vicinity of the plume discharge point on Lawrence Creek.
5. While **Figures 4-24** and **4-27** indicate that BTEX and PAHs are present throughout much of the shallow groundwater zone, **Drawing 4D**, which consists of a cross-section through the approximate center line of the plume, provides a more detailed view of the vertical distribution of BTEX and PAHs. A review of **Drawing 4D** clearly illustrates the fact that while the shallow groundwater zone does contain levels

of BTEX and PAHs, the highest concentrations are actually observed at least 15 to 20 feet below grade within the plume south of Cooper Lane and, that groundwater samples collected at or near the water table exhibited nondetectable to low levels of BTEX and PAHs, not exceeding 60 ug/l in concentration.

6. As shown on **Figure 4-25**, the concentrations of total BTEX in the intermediate groundwater zone decrease rapidly from a concentration of 4,310 ug/l at groundwater probe point BBGP-75 located near the intersection of Cooper Lane and Clinton Avenue, to a maximum downgradient concentration of 435 ug/l at BBGP-84, which is located immediately upgradient of Lawrence Creek. Although the distribution of the PAHs plume shown on **Figure 4-28** is similar to that of BTEX (**Figure 4-25**), the concentrations of PAHs in the off-site groundwater plume remain elevated along a narrow band that extends the length of the plume, from the site and adjacent off-site areas to the discharge point at Lawrence Creek. As discussed previously, some of the highest total PAH concentrations detected in the Bay Shore plume were observed in the intermediate groundwater zone at groundwater probes BBGP-79 and BBGP-80 located south of Montauk Highway.

7. The BTEX and PAH plumes in the deep groundwater zone, as shown in **Figures 4-26** and **4-29**, respectively, end in the vicinity of Montauk Highway. The off-site concentrations of total BTEX decrease rapidly downgradient from over 4,000 ug/l, at groundwater probe point BBGP-07 located immediately south of Union Boulevard, to less than 200 ug/l south of Montauk highway. As shown on **Figure 4-29**, total PAHs remain along the plume center line in the deep groundwater zone ranging in concentration from a high of 4,868 ug/l at BBGP-07 to a low of 1,553 ug/l at BBMW-25 located on the south side of Montauk Highway. The deep BTEX and PAH Plumes appear to have migrated the least, with the downgradient limit, as defined by the 100 ug/l concentration contour, not extending significantly south of Montauk Highway. Furthermore, **Drawing 4D** illustrates the fact that the majority of the locations where total BTEX and PAHs were detected above 1,000 ug/l occur at the Upper Glacial/Magothy formation interface immediately downgradient of the Bay Shore Site. In addition, the geologic cross-sections provided as part of **Drawing 4D** indicate that the Upper Magothy formation consists primarily of low permeable clays. Due to the low permeable nature of this material, vertical migration of the Bay Shore plume is restricted, and impact to the Magothy aquifer is not expected. Low concentrations of BTEX and PAHs were detected in the initial sample collected from BBMW-05D2, screened below the low permeable clay of the Magothy formation. However, BTEX and PAHs were not detected in subsequent samples collected from this well. Therefore, the minimal impact detected in the initial round was not confirmed by subsequent sampling.

8. **Figure 4-24** depicts an area of BTEX outside of the defined Bay Shore plume centered around groundwater probe BBGP-23. Although groundwater probe sample BBGP-23 (9-13 feet) exhibited a total BTEX concentration of 2,580 ug/l and was generally located downgradient of the Bay Shore Site at the corner of Lanier Lane and Montauk Highway, it is not considered part of the Bay Shore plume. Based on the probe location, the observed distribution of BTEX and PAHs in groundwater

upgradient of this point and the determined groundwater flow directions, it is unlikely that the source of the BTEX observed at this location is associated with the Bay Shore Site. A review of state environmental databases, the findings of which are discussed in the April 2002 RI Report, indicate that a commercial business as well as a gasoline service station, both of which are located at the corner of Lanier Lane and Montauk Highway, have had documented gasoline and petroleum spills as recently as September of 1992.

9. **Figures 4-24** through **4-29** and **Drawing 4D** indicate that the Bay Shore plume is migrating with the natural flow of groundwater and discharging to the tidal portion of Lawrence Creek. The discharge zone appears to be a relatively narrow area along the northeastern shoreline of the tidal creek, roughly bounded by groundwater probe BB-17 to the north and groundwater probe BB-21 to the south, a distance of approximately 300 feet. Also, as discussed in the April 2002 RI Report, based on the analytical results of pore water samples collected from Lawrence Creek, BTEX and PAHs were detected in this relatively narrow portion of the tidal creek. This narrow discharge zone is illustrated on **Drawing 4D**. These findings are consistent with the findings of the SCDHS Lawrence Creek Investigation discussed in the April 2002 RI Report.

10. A review of **Figures 4-24** through **4-29** and **Drawing 4D** indicate that the overall Bay Shore BTEX/PAH plume is approximately 3,400 feet long extending from the southern property boundary of the Bay Shore Site to the discharge area within Lawrence Creek. At the site boundary, it is approximately 500 feet wide. A short distance downgradient, the plume appears to attain its maximum width of approximately 600 feet at or near Union Boulevard. Beyond Union Boulevard, the plume appears to gradually narrow with increasing distance from the site.

In addition, **Drawing 4E** indicates all off-site groundwater sample locations - groundwater probes and monitoring wells - at which groundwater samples were found to contain BTEX or PAH compounds that exceed NYSDEC Class GA groundwater standards. Note that the most recent sampling event was used to evaluate each monitoring well. **Drawing 4E** is provided in the map pocket at the end of this section of the report.

<u>Historical Total BTEX/PAHs in the Bay Shore Groundwater Plume</u>

Changes in total BTEX and total PAH concentrations with time in monitoring well cluster GM-03 (including S, I and D) and monitoring well GM-05S located in the middle and downgradient portions of the off-site Bay Shore groundwater plume, respectively, are shown graphically on **Figures 4-30** through **4-33**. It is noted that the early data (i.e., pre-September

FIGURE 4-30

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CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BAY SHORE PLUME GROUNDWATER MONITORING WELL GM-03S

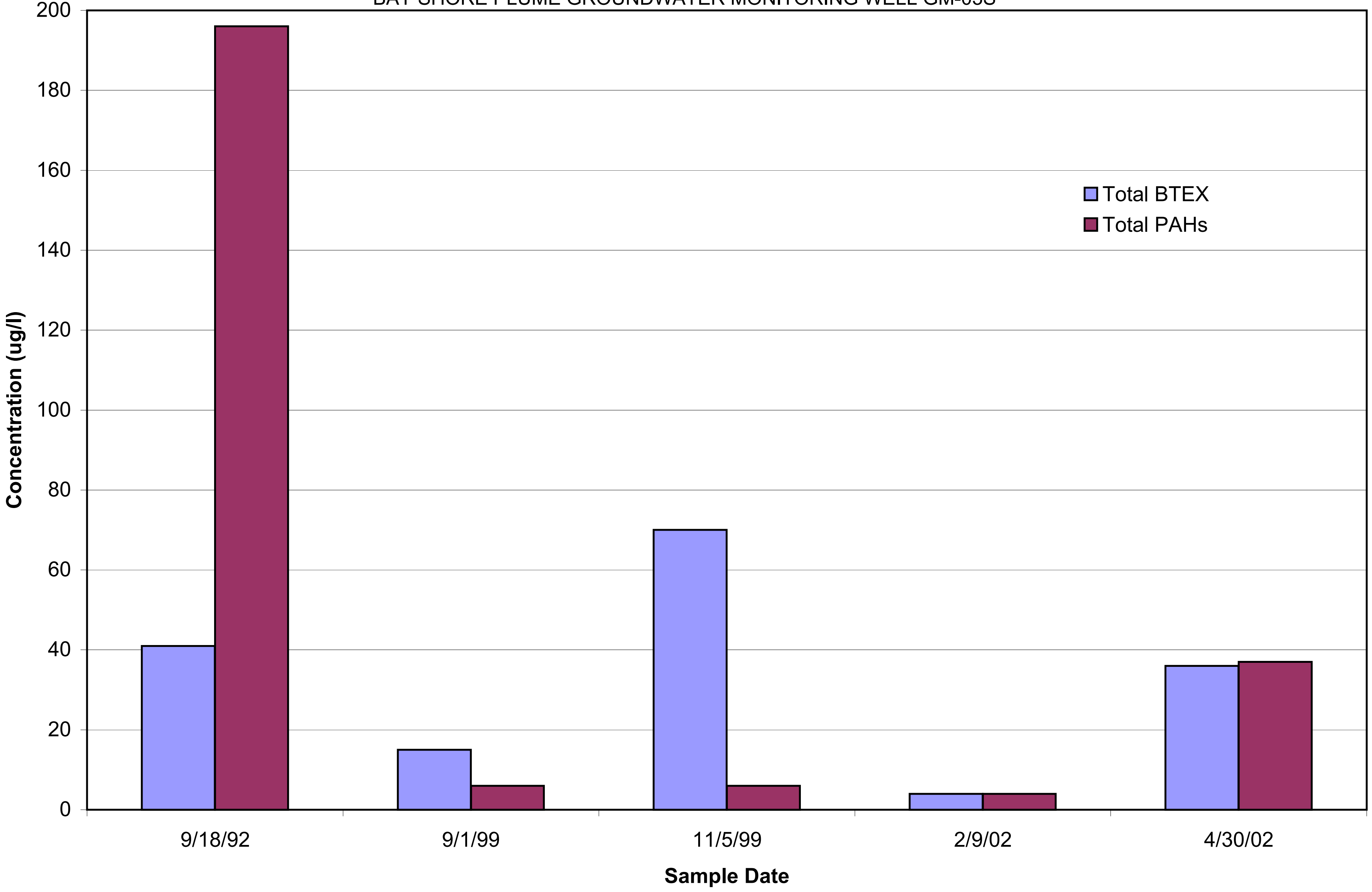

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FIGURE 4-31
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
BAY SHORE PLUME GROUNDWATER MONITORING WELL GM-03I

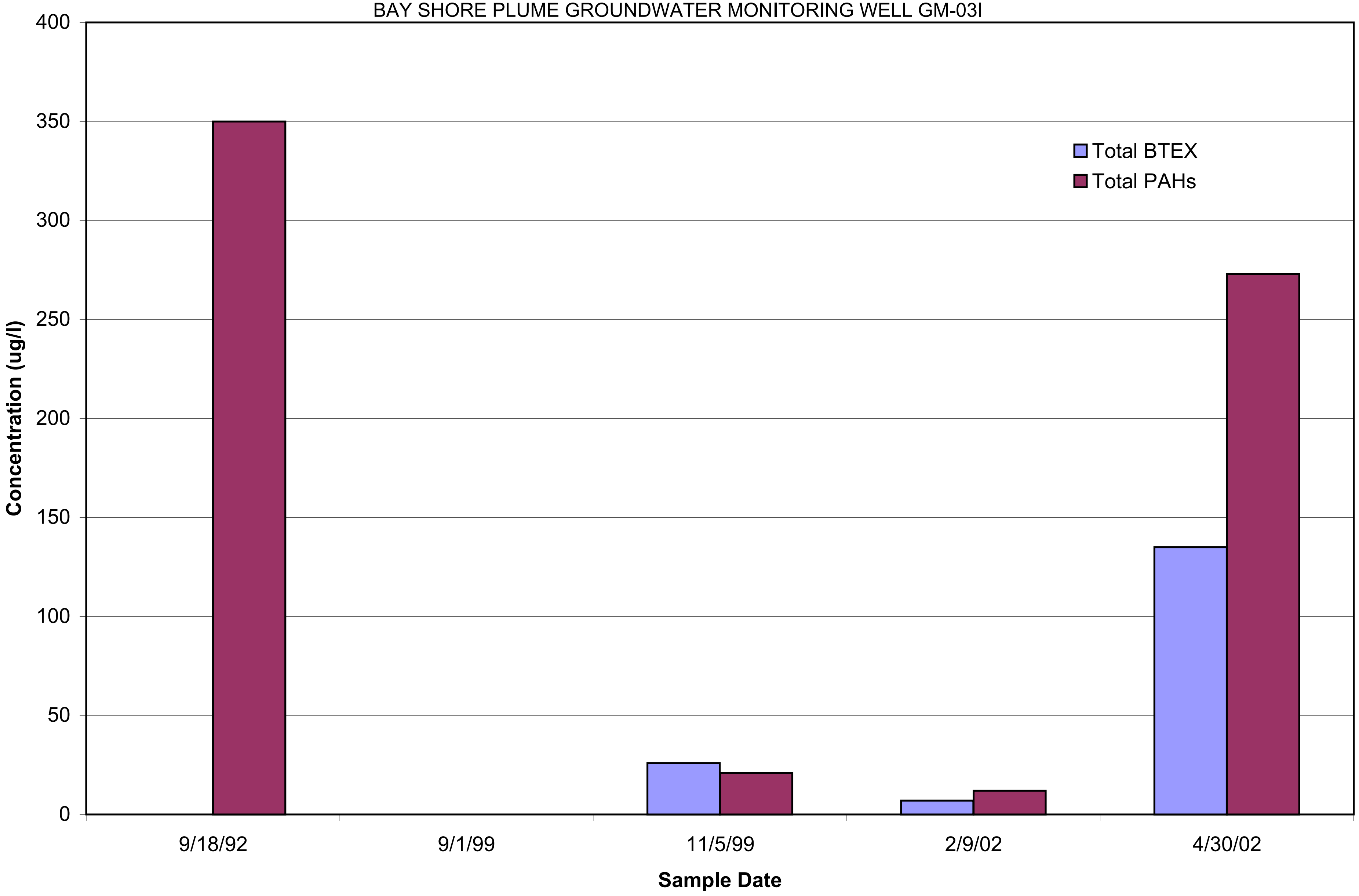

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FIGURE 4-32
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BAY SHORE PLUME GROUNDWATER MONITORING WELL GM-03D

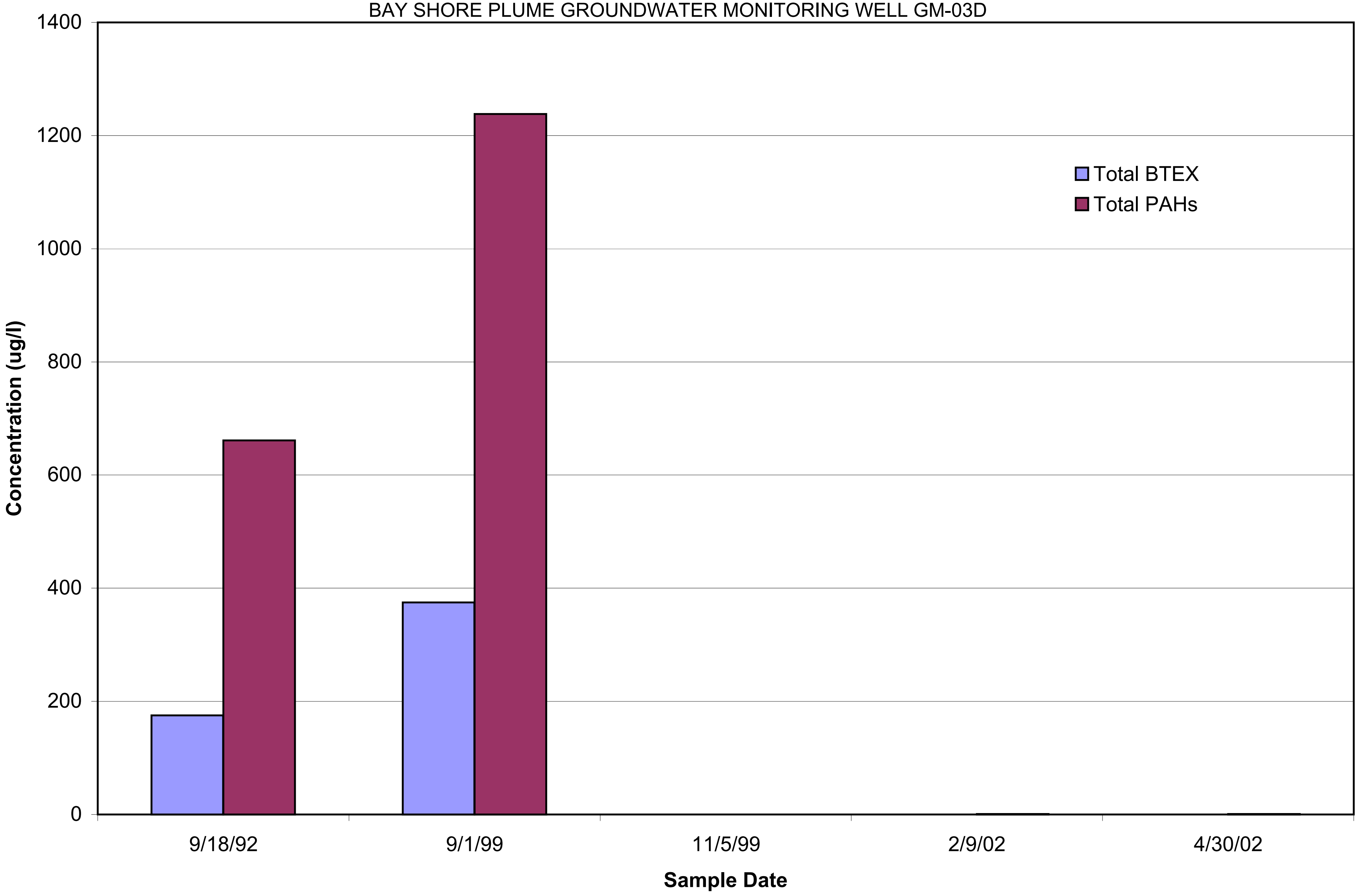
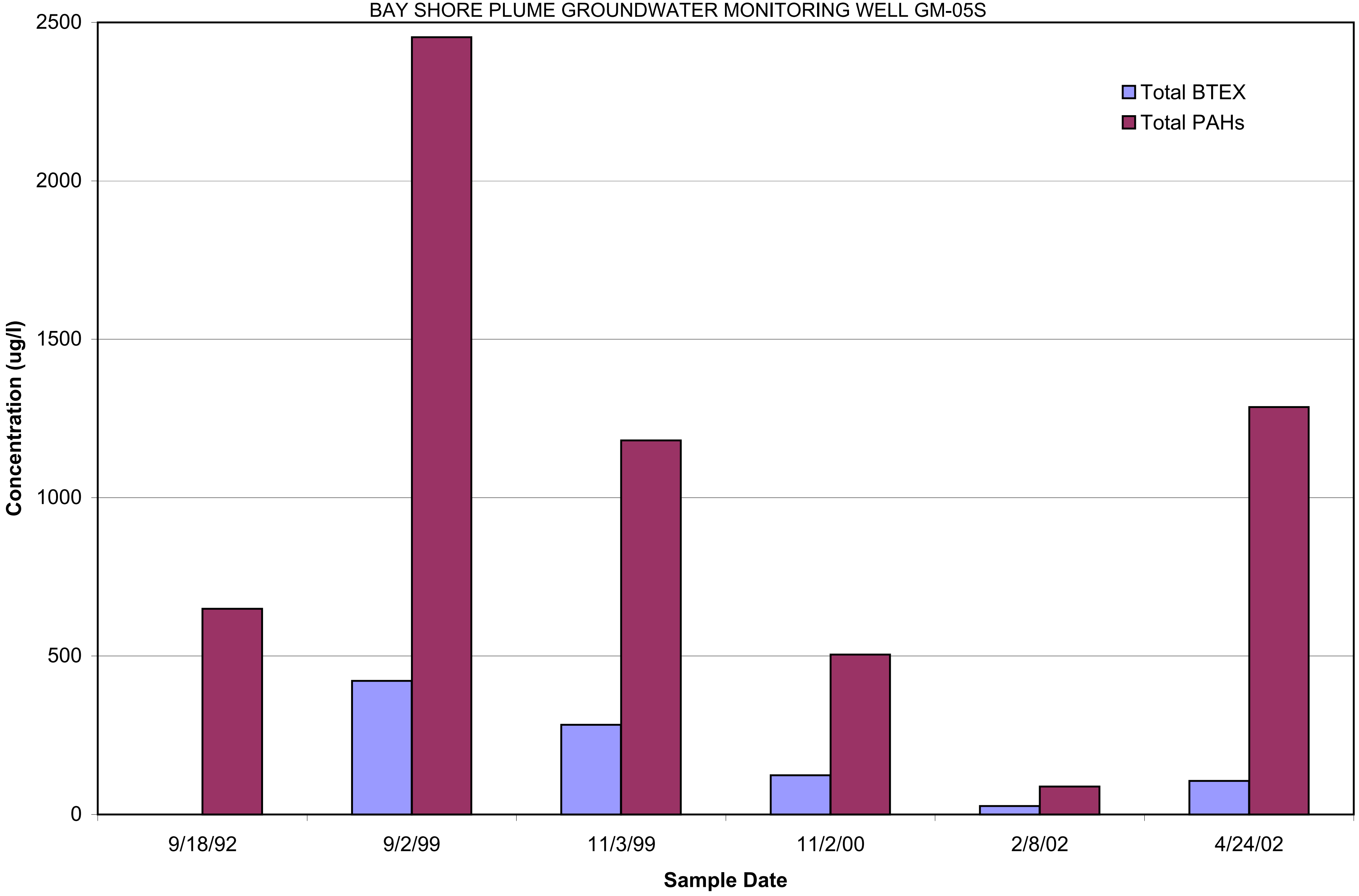


FIGURE 4-33
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BAY SHORE PLUME GROUNDWATER MONITORING WELL GM-05S



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1992) used to develop these figures is based on naphthalene only, as none of the other PAHs were analyzed in groundwater samples collected during the early sampling events. It is also noted that analysis of BTEX was not performed on samples collected from monitoring well GM-03S until September 1992. The wells used to evaluate possible trends in total BTEX and total PAH concentrations were selected based on their location relative to potential source areas, as well as the availability of analytical data from multiple sampling events at each well.

A review of **Figure 4-30** indicates that naphthalene concentrations in monitoring well GM-03S (i.e., in the middle portion of the Bay Shore plume) have decreased from 800 ug/l in August 1978 to 37 ug/l in April 2000. As shown on **Figure 4-30**, analytical results for samples collected since September 1992 show that total BTEX has never been detected at concentrations exceeding 70 ug/l. The relatively minor fluctuations of total BTEX and total PAHs in this well indicate that the water quality in the middle portion of the plume is in a steady state.

A review of **Figures 4-31** and **4-32** for intermediate and deep wells in well cluster GM-03 indicate that, although total PAH concentrations in these wells initially increased, concentrations ultimately decreased to relatively low levels during the most recent sampling event.

The trends of total BTEX and total PAHs in monitoring well GM-05S (**Figure 4-33**) show that total BTEX concentrations in the downgradient area of the Bay Shore plume exhibited a net decrease, and total PAHs have had a period of decreasing concentrations ending with an increase during the most recent sampling round.

Geochemical Parameters and Field Measurements

The analytical results of the geochemical parameters and field measurements in groundwater are summarized in **Tables C-27** through **C-30**. The range of concentrations for each of the key geochemical and field parameters is summarized in **Table 4-15**. Discussions of the geochemical and field parameter analytical results are presented below in order of relevance to assessing the occurrence of biodegradation, followed by discussions of the geochemical

Table 4-15

SUMMARY OF GEOCHEMICAL AND FIELD PARAMETER ANALYTICAL RESULTS

Parameter	Units	Range	Location With Maximum Concentration
Carbon Dioxide	mg/l	ND – 240	BBGP-84 (6-10)
Microbial Plate Count	cfu/ml	ND – 200	BBGP-78 (6-10)
Dissolved Oxygen	mg/l	ND – 2.9	BBMW-03D
Total Iron	ug/l	ND – 53,400	BBGP-82 (26-30)
Ferrous Iron	ug/l	ND – 19,800	GMP-04
Dissolved Iron	ug/l	ND – 29,900	GMP-04
Total Manganese	ug/l	13.7 – 539,000	BBGP-81 (16-20)
Dissolved Manganese	ug/l	15.2 – 24,300	BBGP-77 (60-64)
Oxidation Reduction Potential (ORP)	(mV)	-493 – +77	BBGP-78 (6-10)
Ammonia	mg/l	ND – 3.80	BBGP-83 (16-20)
pH	S.U.	3.95 – 7.11	BBGP-83 (6-10)
Chloride	mg/l	ND – 270	BBGP-76 (16-20)
Chemical Oxygen Demand (COD)	mg/l	ND – 78	BBGP-75 (64-68)
Biochemical Oxygen Demand (BOD)	mg/l	ND – 32	BBGP-75 (16-20)
Orthophosphate	mg/l	ND – 0.78	BBGP-78 (6-10)

parameters that provide a gauge of overall geochemical conditions in the aquifer. The relevance of each geochemical parameter to the occurrence of biodegradation is discussed below as well. The graphs shown on **Figures 4-34** through **4-38** depict variations in geochemical parameter concentrations and/or field measurements relative to total BTEX and PAH concentrations and were developed to identify general correlations between the paired data. Specifically, the parameters shown on the graphs are used to support the evaluation of biodegradation of BTEX and/or PAHs in groundwater.

Heterotrophic Microbial Plate Count

The concentration and distribution of heterotrophic bacteria in groundwater provides an indication as to the relative amount of microbial activity occurring within an aquifer. The results for the plate counts as presented in **Tables C-27** and **C-29** showed that heterotrophic bacteria were detected at low concentrations in 19 of the 63 groundwater samples analyzed. The plate counts ranged from "nondetected" to 200 colony forming units per milliliter (cfu/ml), which was detected in groundwater probe sample BBGP-78 (6 to 10 feet). Total BTEX in this groundwater probe point sample was 42 ug/l. Although the presence and concentrations of total heterotrophic bacteria are lower than would be expected in an aquifer where active biodegradation is occurring, it is noted that these bacteria commonly reside on the aquifer matrix and are less prevalent suspended in groundwater. Accordingly, plate counts of water samples typically yield lower population totals as compared to those in soil samples collected from the saturated zone of the aquifer matrix. However, as discussed below, other geochemical indicators such as carbon dioxide and dissolved oxygen concentrations support the hypothesis that biodegradation of BTEX and PAHs is likely occurring in the Bay Shore groundwater plume.

Carbon Dioxide

Carbon dioxide is the primary byproduct of aerobic biodegradation and the concentration of this compound in groundwater is an indicator as to the relative amount of aerobic biodegradation occurring in an aquifer. As shown in **Tables C-27** and **C-29**, carbon dioxide (CO_2) was detected in 45 of the 60 water samples collected from probe points and nine of the 12

FIGURE 4-34
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TOTAL BTEX AND CARBON DIOXIDE CONCENTRATIONS VS. OFF-SITE GROUNDWATER SAMPLE LOCATIONS

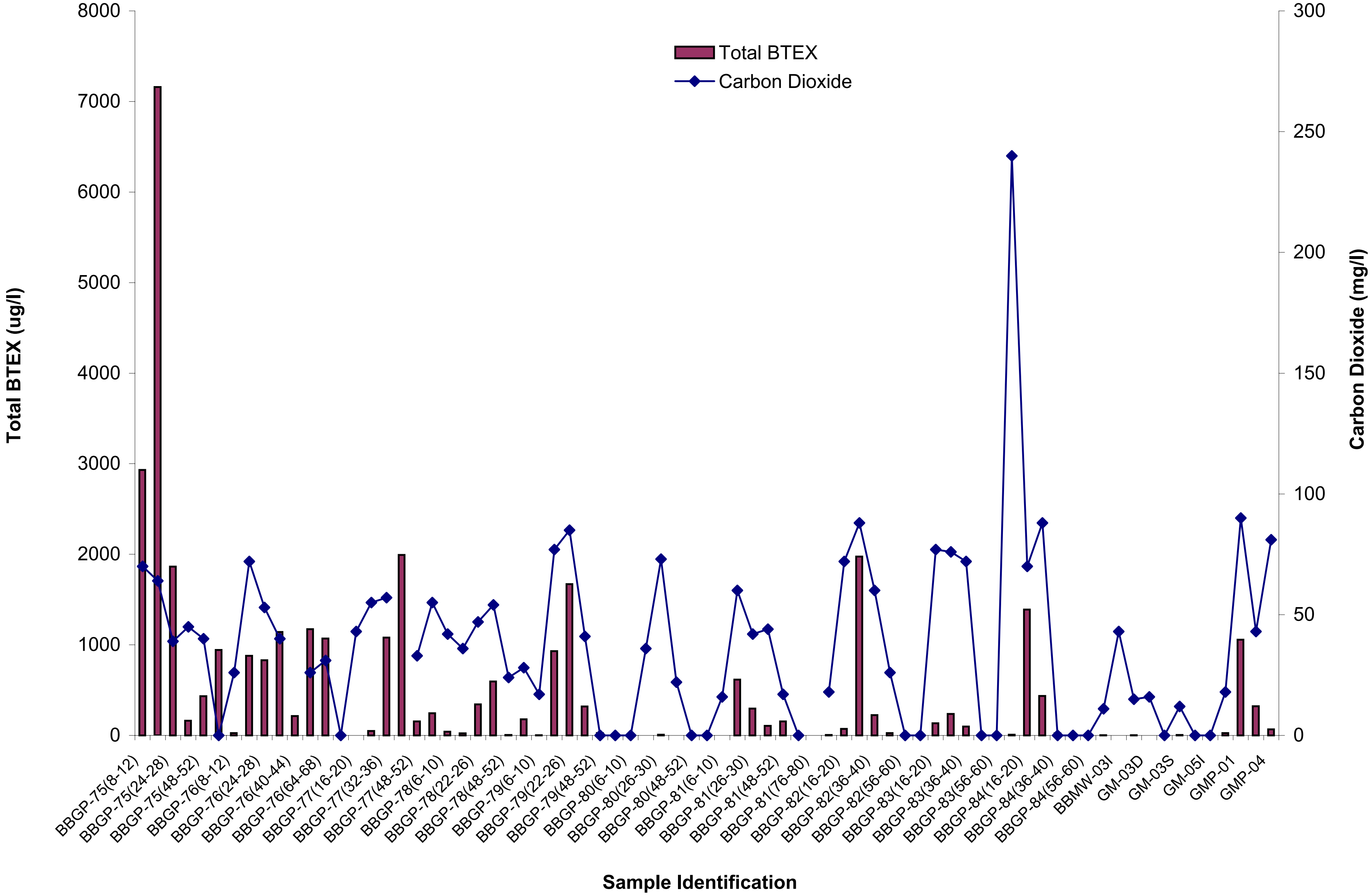

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FIGURE 4-35
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TOTAL BTEX AND DISSOLVED OXYGEN CONCENTRATIONS VS. OFF-SITE GROUNDWATER SAMPLE LOCATIONS

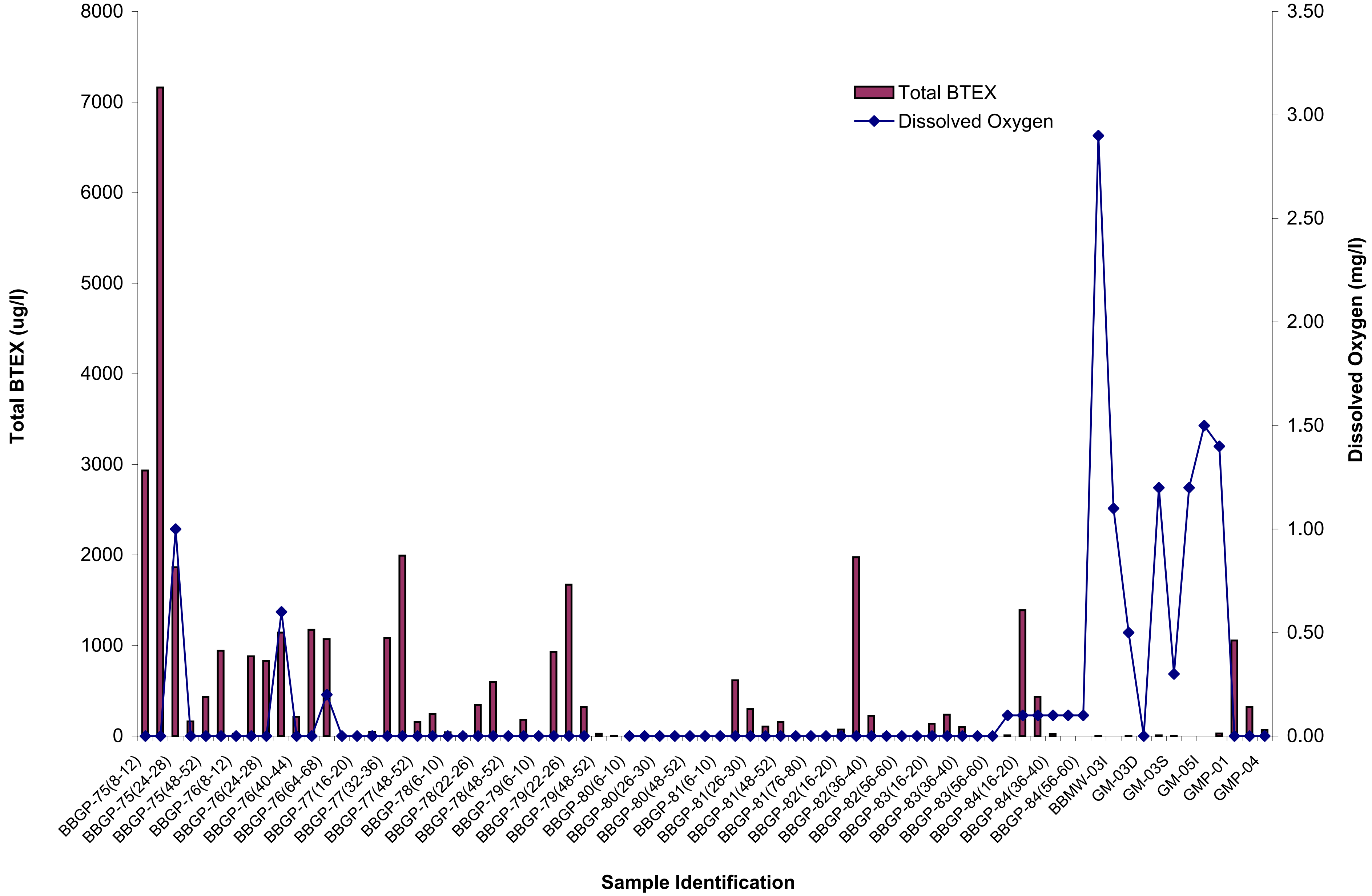

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FIGURE 4-36

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TOTAL BTEX AND FERROUS IRON CONCENTRATIONS VS. OFF-SITE GROUNDWATER SAMPLE LOCATIONS

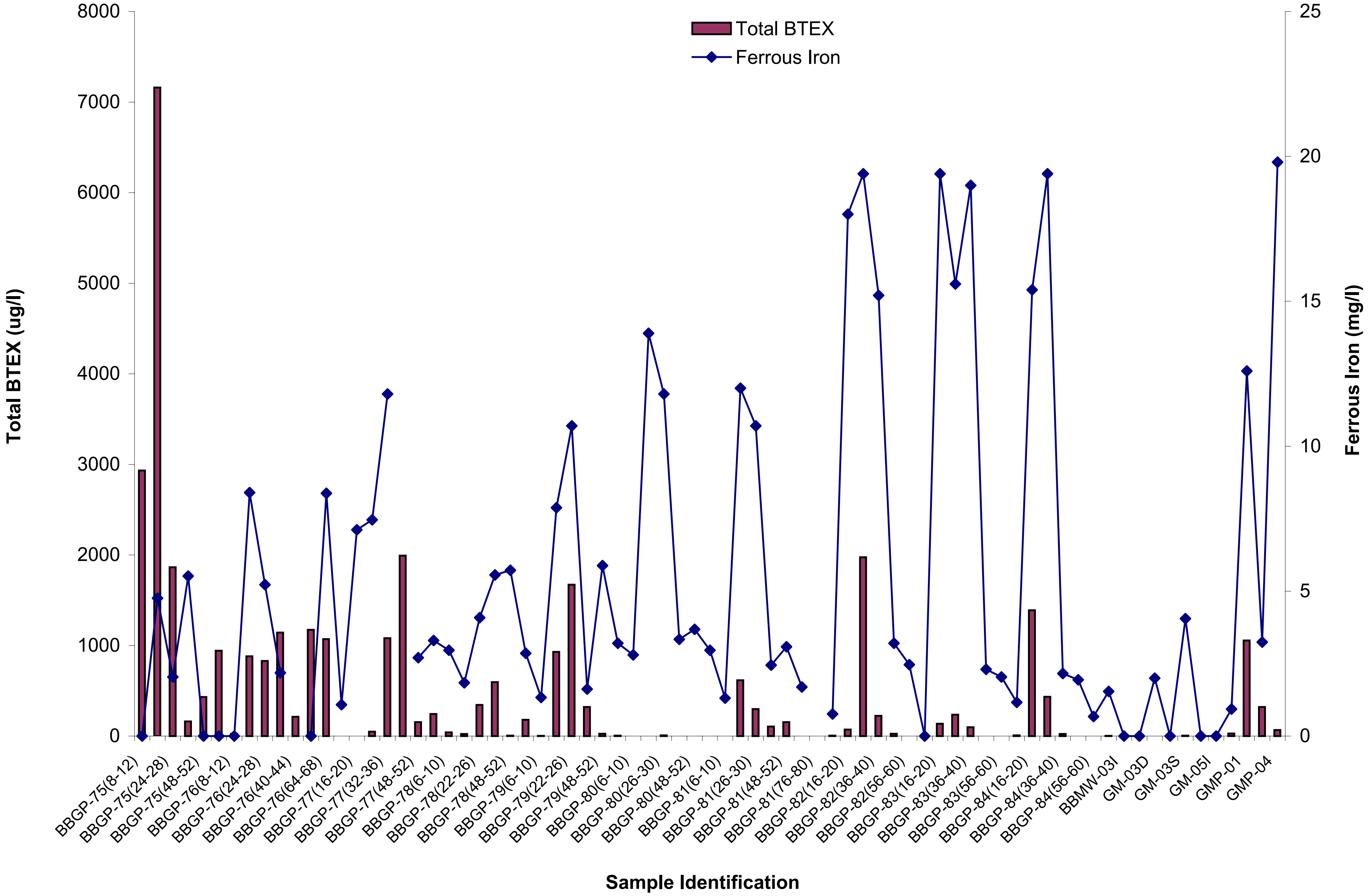

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FIGURE 4-37
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TOTAL BTEX AND DISSOLVED MANGANESE CONCENTRATIONS VS. OFF-SITE GROUNDWATER SAMPLE LOCATIONS

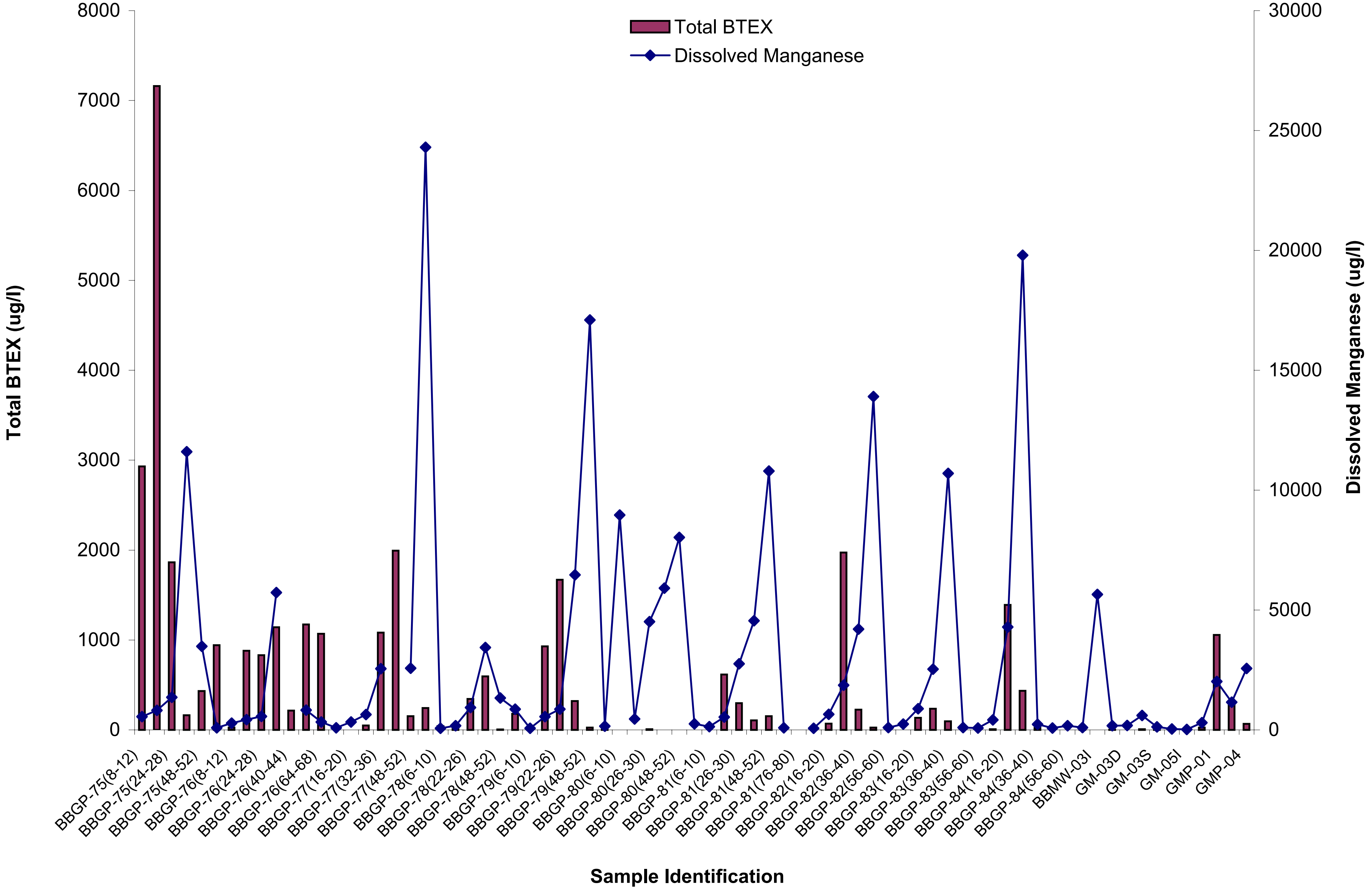

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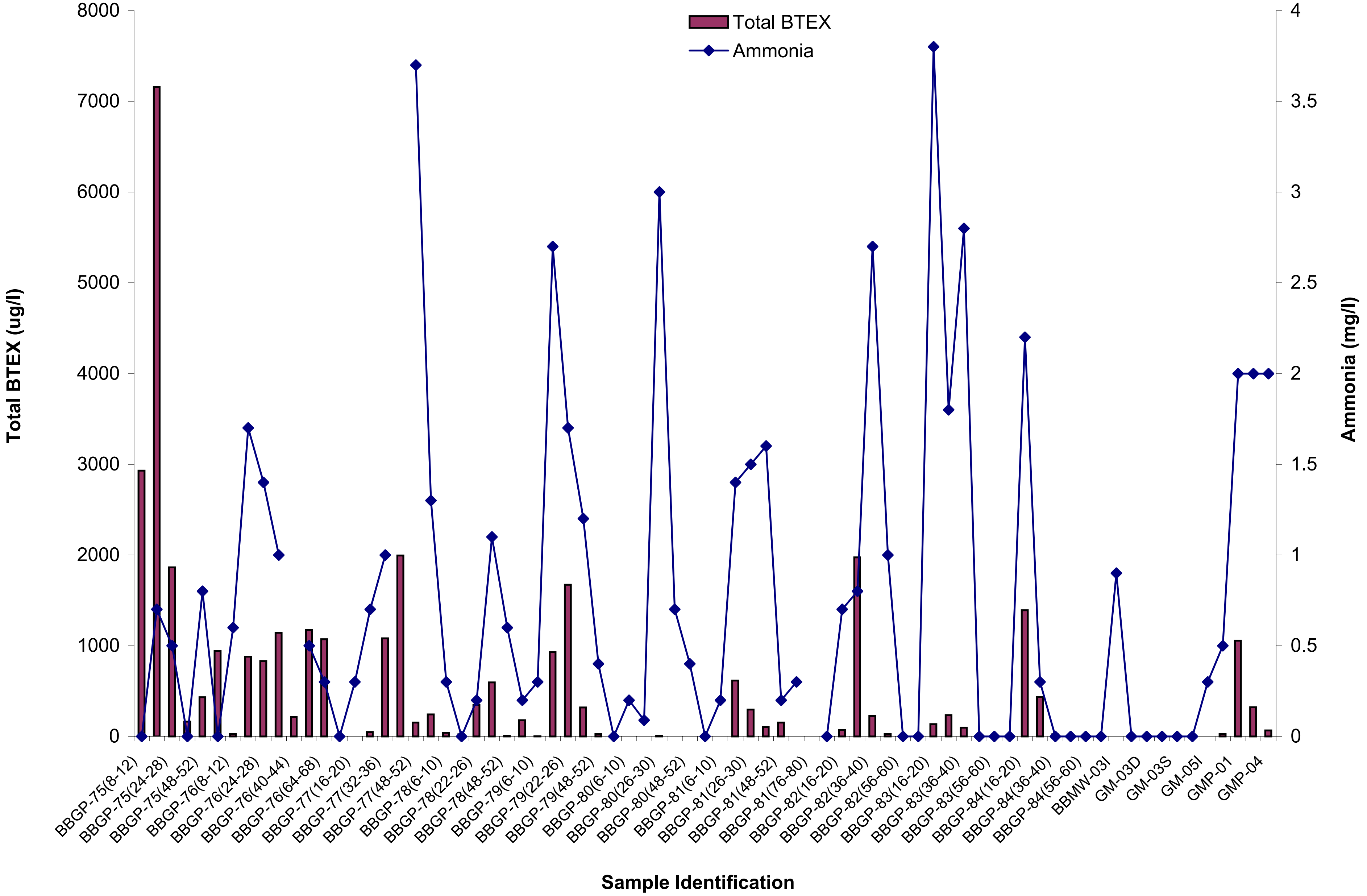
FIGURE 4-38
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

TOTAL BTEX AND AMMONIA CONCENTRATIONS VS. OFF-SITE GROUNDWATER SAMPLE LOCATIONS



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monitoring wells sampled. The concentrations ranged from less than the reported quantitation limit to 240 mg/l, as detected in groundwater probe sample BBGP-84 (6 to 10 feet). Concentrations of carbon dioxide are plotted versus total BTEX on **Figure 4-34**. With the exception of BBGP-75 (64 to 68 feet), carbon dioxide was detected in all samples that contained detectable concentrations of BTEX and or PAHs. Alternatively, no carbon dioxide is detected in samples that did not contain detectable BTEX and or PAHs. These correlations provide evidence that biodegradation of the BTEX and/or PAHs is occurring in the groundwater plume.

Dissolved Oxygen

The level of dissolved oxygen in groundwater provides an indication as to the predominant biological processes which are likely occurring within an aquifer. Concentrations of less than 0.5 mg/l generally indicate anaerobic conditions and concentrations above this generally indicate that aerobic conditions predominate (S. Suthersan). The analytical results presented in **Tables C-27** and **C-29** show that dissolved oxygen was detected in only sixteen of the 72 samples analyzed. Detectable levels of dissolved oxygen ranged from 0.1 mg/l to 2.9 mg/l. The maximum dissolved oxygen concentration of 2.9 mg/l was detected in sample BBMW-03D. At monitoring well cluster BBMW-03D, which is located outside the western plume boundary, concentrations of dissolved oxygen increase with depth. As shown on **Figure 4-35**, the five wells located at the downgradient end of the plume immediately upgradient from Lawrence Creek contained dissolved oxygen concentrations between 1 and 2 mg/l. This indicates that conditions at the leading edge of the plume are mildly aerobic. Dissolved oxygen concentrations in all other wells/probe points were 1.5 mg/l or less. The almost complete absence of dissolved oxygen is attributed to the consumption of oxygen during biodegradation of the BTEX and PAHs present in groundwater. As a result of the biodegradation, groundwater in the plume is predominated by anaerobic processes.

Oxidation - Reduction Potential

Similar to dissolved oxygen levels, oxidation-reduction potential (ORP) measurements provide an indication as to which biological processes predominate in an aquifer with negative

ORP measurements indicating generally anaerobic conditions and positive measurements indicating aerobic conditions. As shown in **Tables C-28** and **C-30**, the measurements of ORP in groundwater samples ranged from –493 millivolts (mV) in sample BBGP-78 (66 to 70 feet) to +77 mV in sample BBGP-78 (6 to 10 feet). The field measurements in **Tables C-28** and **C-30** show that the majority of the ORP measurements are negative, indicating that groundwater conditions in the Bay Shore plume are predominantly reducing and anaerobic.

Iron

Iron is a source of electrons used during biodegradation of organic substrates. During biodegradation iron is reduced to the ferrous, more soluble, form of iron. Ferrous iron is considerably more soluble than the oxidized form, or ferric iron. Accordingly, the presence of dissolved and or ferrous iron, in addition to other geochemical conditions, such as elevated dissolved carbon dioxide and reduced dissolved oxygen concentrations relative to background levels, is consistent with the occurrence of biodegradation. Dissolved iron concentration is used as an estimate or confirmation of ferrous iron.

Dissolved iron ranged from "nondetected" to 29,900 ug/l, which was detected in monitoring well GMP-04. Monitoring well GMP-04 is located at the most downgradient portion of the plume adjacent to Lawrence Creek, the discharge point for the Bay Shore plume. Similarly, analytical results for ferrous iron ranged from "nondetected" to 19,800 ug/l with the maximum concentration also occurring in monitoring well GMP-04. These analytical results from both analytical methods (i.e., for ferrous and dissolved iron) show that the highest concentrations of iron in solution were consistently detected in groundwater at monitoring well GMP-04. Total BTEX concentrations and ferrous iron are plotted by sample location on **Figure 4-36**. This plot indicates that ferrous iron concentrations are covariant with total BTEX concentrations. This means that ferrous iron concentrations are highest in groundwater containing BTEX and/or PAHs, and lowest where these chemical constituents were not detected. These correlations provide good evidence that iron is being used as an alternate electron acceptor to oxygen during anaerobic biodegradation processes. The increase in ferrous iron concentrations, shown as larger "spikes" on **Figure 4-36**, also shows that ferrous iron concentrations are generally higher in the relatively dilute downgradient portions of the plume and lower in the portions of the plume immediately downgradient from the site where BTEX and/or PAH compounds are more prevalent and occur at higher concentrations. As shown in **Tables C-27** and **C-29**, the maximum concentrations of ferrous iron appear to be approximately 20 mg/l, which suggests that the use of iron as an electron acceptor is limited. This may be due to the limited availability of iron in the aquifer.

As indicated in **Table 4-15**, total iron concentrations in the off-site plume ranged from not detected to 53,400 ug/l in groundwater probe sample BBGP-82 (26 to 30 feet). The absence of detectable iron was only observed in monitoring well BBMW-03I. Iron was detected in all other monitoring wells and groundwater probe points.

Manganese

The geochemical behavior of manganese is similar to that of iron, as described above. Accordingly, the reduced form of manganese is more soluble than the oxidized form. During biodegradation, manganese in the aquifer is reduced producing the more soluble manganous form.

Dissolved manganese concentrations ranged from 15.2 ug/l in monitoring well GM-05D to 24,300 ug/l in groundwater probe point BBGP-77 (60 to 64 feet). Monitoring well cluster GM-05 is located in the downgradient end of the plume immediately upgradient from Lawrence Creek. BTEX and PAHs were not detected in this well. Groundwater probe point BBGP-77 was located approximately midway between the site and Lawrence Creek. The concentrations of total BTEX and total PAHs in groundwater sample BBGP-77 (60 to 64 feet) were 244 ug/l and 4,011 ug/l, respectively.

In a parallel manner to iron, manganese is often used as an electron acceptor after the majority of available oxygen has been depleted. Total BTEX and dissolved manganese concentrations are plotted by sample location on **Figure 4-37**. This plot shows that dissolved manganese concentrations correlate directly with BTEX and PAH concentrations, where manganese concentrations are generally highest in groundwater with elevated BTEX and PAH concentrations.

Dissolved manganese was most frequently detected in groundwater with low to moderate concentrations of total BTEX and was present at the highest concentrations in groundwater samples collected from intermediate or deep wells. This increase in concentration with depth would suggest that manganese is utilized in the most reducing portions (i.e., the deepest portions of the aquifer) where total concentrations of total BTEX are moderate to low and dissolved oxygen would be expected to be naturally diminished.

Nutrients

Phosphorous (as orthophosphate) and nitrogen are key nutrients used by microbes in the subsurface to support growth and cell maintenance. Accordingly, these nutrients should be present at sufficient concentrations to support biodegradation of organic substrates.

Orthophosphate

Phosphorous (as orthophosphate) is a key nutrient used by microbes in the subsurface. Orthophosphate concentrations ranged from not detected to 0.78 mg/l, with the maximum concentration occurring in sample BBGP-78 (8 to 10 feet). Review of orthophosphate concentrations in **Tables C-27** and **C-29**, and corresponding total BTEX and/or PAH data in **Tables C-23** through **C-26** indicate that there is no apparent correlation between these chemical constituents and orthophosphate. According to Durant, et al. (1995), the ability to obtain and interpret the effect of phosphate concentrations on biodegradation rates or capacity is difficult, as it can readily complex with cations in the aquifer, such as calcium and iron. However, based on the absence of dissolved oxygen and the presence of metabolic by-products such as carbon dioxide, reduced forms of iron and manganese, the ability of the aquifer to support biodegradation does not appear to be limited by the relatively low phosphate concentrations in groundwater in the Bay Shore plume.

Ammonia

Ammonia is a reduced form of nitrogen that is produced in moderate to low pH and anaerobic conditions. During biodegradation, nitrate, a common component of groundwater, is used as an alternate electron acceptor. Therefore, relatively high concentrations of ammonia in groundwater is further evidence of anaerobic conditions.

Ammonia concentrations ranged from nondetected to 3.8 mg/l. In order to evaluate the behavior of ammonia in the plume, the concentrations of ammonia and total BTEX were plotted on **Figure 4-38** relative to sample locations. The plot indicates that ammonia concentrations, in general, are directly related to total BTEX concentrations. Without exception, ammonia concentrations are elevated in samples containing detected BTEX. This suggests that nitrogen, likely in the form of nitrate, is being used as an electron acceptor during anaerobic biodegradation of BTEX and PAHs in the aquifer. The reduced nitrogen resulting from this process is reacting with hydrogen to produce ammonia. The direct correlation of ammonia production with total BTEX concentrations indicates that sufficient nitrogen (likely as nitrate) is present in the aquifer to support biodegradation.

pH

As shown in **Tables C-28** and **C-30**, and as summarized in **Table 4-15**, values of pH ranged from 3.95 standard units (s.u.) to 7.11 s.u. According to Wiedemeir, et al. (1995), bacteria that typically degrade petroleum hydrocarbon compounds, such as BTEX and PAHs, prefer pHs from approximately 6 to 8 s.u.

Chloride

Chloride provides evidence of dechlorination of chlorinated hydrocarbons present in groundwater but may be also associated with road salting activities. As shown in **Tables C-27** and **C-29**, and as summarized in **Table 4-15**, where detected, chloride concentrations ranged from 11 mg/l in groundwater probe sample BBGP-78 (48 to 52 feet) to 270 mg/l in groundwater probe sample BBGP-76 (16 to 20 feet).

Chemical Oxygen Demand

Chemical Oxygen Demand (COD) is a measure of the portion of organic matter (including BTEX and PAHs) that can be readily oxidized by a strong oxidant. The concentrations of COD in groundwater samples collected in the plume, as shown in **Tables C-27** and **C-29**, and summarized in **Table 4-15**, ranged from not detected to a maximum of 78 mg/l in sample BBGP-75 (64 to 68 feet). Although COD was only detected in 24 of the 60 samples analyzed, the reported detection limit for this parameter was 30 mg/l, therefore, it is likely that COD is also present at concentrations below 30 mg/l in most, if not all, of the remaining samples analyzed. It is noted that the majority of the COD is attributed to naturally occurring organic materials with only minor contributions from the chemical constituents related to MGP residual materials in the subsurface.

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is defined as the mass of oxygen required by bacteria to metabolize decomposable organic compounds (including BTEX and PAHs) in a water or wastewater under aerobic conditions. The concentrations of BOD in groundwater, as shown in **Tables C-27** and **C-29**, and as summarized in **Table 4-15**, ranged from not detected to 32 mg/l, which was detected in sample BBGP-75 (16 to 20 feet). Biochemical oxygen demand is used here as an indication of the empirical maximum amount of oxygen that may be consumed by biochemical activity in groundwater. Specifically, in determining the necessary concentration of oxygen necessary to promote biochemical oxidation of target organic chemicals, such as BTEX, sufficient oxygen would be necessary to ensure that all forms of readily oxidizable organic materials are accommodated.

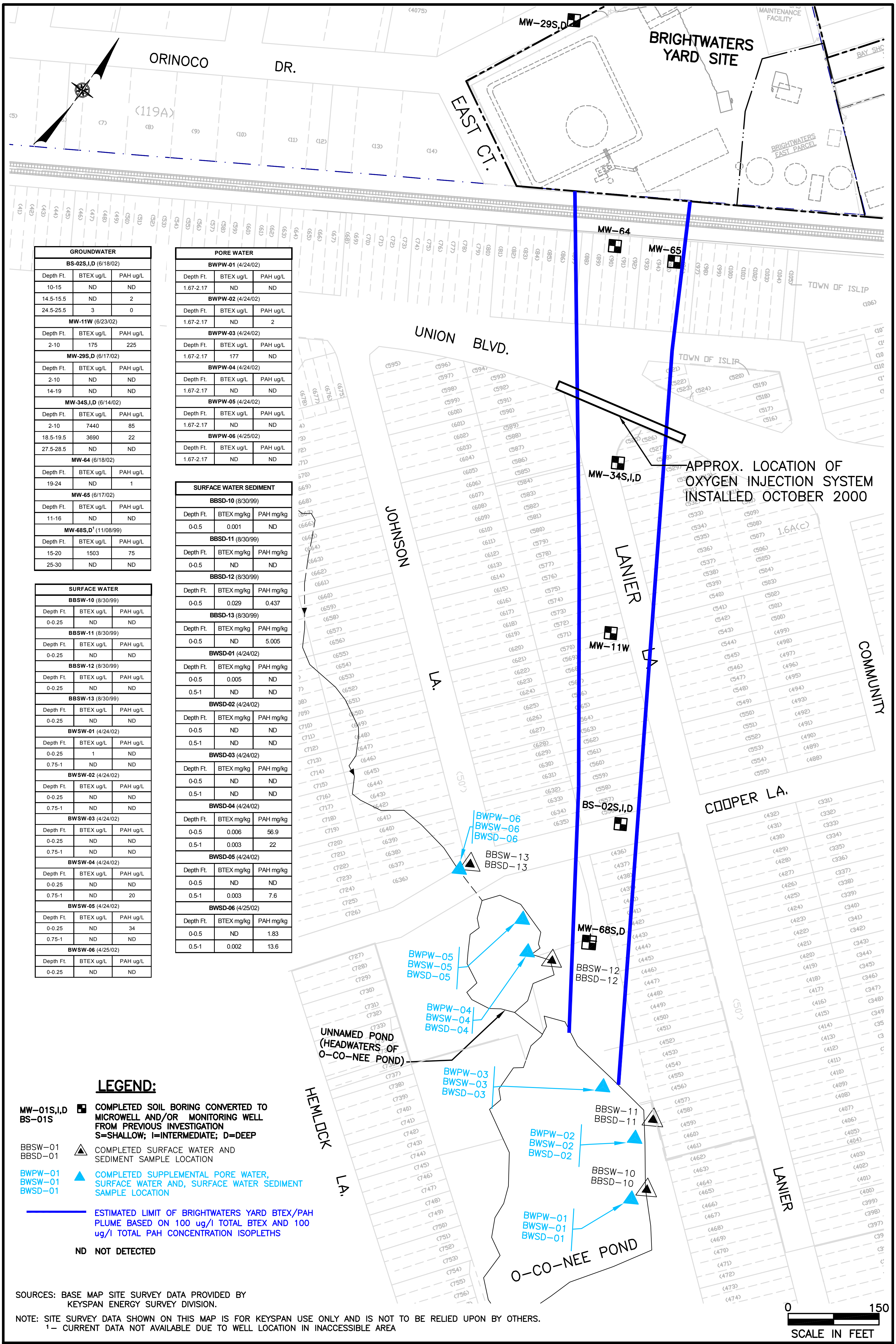
4.3.2 O-Co-Nee Pond Investigation (Operable Unit 3)

Investigations downgradient of the Brightwaters Yard conducted as part of the initial field program as well as prior work had defined a BTEX/PAH groundwater plume downgradient of the site. While the vertical and horizontal extent of the plume was sufficiently defined, additional data was needed to determine if the plume was discharging to a small surface water body called O-Co-Nee Pond located approximately 1,400 feet south of the site. Therefore, as part of the supplemental field program, additional surface water, surface water sediment and pore water samples were collected from this surface water body.

It should be noted that KeySpan is currently performing an Interim Remedial Measure (IRM) at the Brightwaters Yard. This IRM involves the mitigation of BTEX and PAHs present in the plume source area as well as in the off-site groundwater plume. The IRM includes the use of in-situ chemical oxidation technology and oxygen injection. The specific chemical oxidation process applied was the In-situ Oxidative Technologies, Inc. ISOTEC process. This IRM is one phase of the overall environmental improvements being implemented at the Bay Shore/Brightwaters former MGP site.

As part of this IRM, two series of oxygen injection wells were installed in September 2000. One system is located on the Brightwaters Yard property line adjacent to and parallel with the Long Island Railroad Right-of-Way. The other system is located off-site, perpendicular to the groundwater plume along the southern shoulder of Union Boulevard. The location of this system, relative to the plume, is depicted on **Figure 4-39**. The on-site system was installed for future use, and the off-site Union Boulevard system has been operational since its installation and is showing positive impacts at least 350 feet downgradient of the system. The system is still operational and is monitored on a monthly basis. Downgradient wells in the area are sampled quarterly and the status of the system is reported with this data to the NYSDEC.

To address the plume source areas, this IRM also included two large scale series of ISOTEC injections in the Brightwaters Yard and along the LIRR Right-of-Way. The injections were completed in May and September of 2001. On-site and downgradient well monitoring took



GROUNDWATER

Depth Ft.	BTEX ug/L	PAH ug/L
BS-02S,I,D (6/18/02)		
10-15	ND	ND
14.5-15.5	ND	2
24.5-25.5	3	0
MW-11W (6/23/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
2-10	175	225
MW-29S,D (6/17/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
2-10	ND	ND
14-19	ND	ND
MW-34S,I,D (6/14/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
2-10	7440	85
18.5-19.5	3690	22
27.5-28.5	ND	ND
MW-64 (6/18/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
19-24	ND	1
MW-65 (6/17/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
11-16	ND	ND
MW-68S,D[1] (11/08/99)		
Depth Ft.	BTEX ug/L	PAH ug/L
15-20	1503	75
25-30	ND	ND

SURFACE WATER

Depth Ft.	BTEX ug/L	PAH ug/L
BBSW-10 (8/30/99)		
0-0.25	ND	ND
BBSW-11 (8/30/99)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
BBSW-12 (8/30/99)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
BBSW-13 (8/30/99)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
BWSW-01 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	1	ND
0.75-1	ND	ND
BWSW-02 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
0.75-1	ND	ND
BWSW-03 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
0.75-1	ND	ND
BWSW-04 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND
0.75-1	ND	20
BWSW-05 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	34
0.75-1	ND	ND
BWSW-06 (4/25/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
0-0.25	ND	ND

PORE WATER

Depth Ft.	BTEX ug/L	PAH ug/L
BWPW-01 (4/24/02)		
1.67-2.17	ND	ND
BWPW-02 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
1.67-2.17	ND	2
BWPW-03 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
1.67-2.17	177	ND
BWPW-04 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
1.67-2.17	ND	ND
BWPW-05 (4/24/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
1.67-2.17	ND	ND
BWPW-06 (4/25/02)		
Depth Ft.	BTEX ug/L	PAH ug/L
1.67-2.17	ND	ND

SURFACE WATER SEDIMENT

Depth Ft.	BTEX mg/kg	PAH mg/kg
BBSD-10 (8/30/99)		
0-0.5	0.001	ND
BBSD-11 (8/30/99)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	ND
BBSD-12 (8/30/99)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	0.029	0.437
BBSD-13 (8/30/99)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	5.005
BWSD-01 (4/24/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	0.005	ND
0.5-1	ND	ND
BWSD-02 (4/24/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	ND
0.5-1	ND	ND
BWSD-03 (4/24/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	ND
0.5-1	ND	ND
BWSD-04 (4/24/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	0.006	56.9
0.5-1	0.003	22
BWSD-05 (4/24/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	ND
0.5-1	0.003	7.6
BWSD-06 (4/25/02)		
Depth Ft.	BTEX mg/kg	PAH mg/kg
0-0.5	ND	1.83
0.5-1	0.002	13.6

SOURCES: BASE MAP SITE SURVEY DATA PROVIDED BY KEYSPAN ENERGY SURVEY DIVISION.

NOTE: SITE SURVEY DATA SHOWN ON THIS MAP IS FOR KEYSPAN USE ONLY AND IS NOT TO BE RELIED UPON BY OTHERS.
[1] – CURRENT DATA NOT AVAILABLE DUE TO WELL LOCATION IN INACCESSIBLE AREA

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

Dvirka and Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

TOTAL BTEX AND PAH CONCENTRATIONS IN GROUNDWATER, SURFACE WATER, PORE WATER AND SURFACE WATER SEDIMENT FOR BRIGHTWATERS YARD PLUME AND O-CO-NEE POND

FIGURE 4-39

\\N4\CADwork\1620B12B\dwg\1620-BTEX-PAH.dwg, 10/28/02 03:47:02 PM, APostyn place at least monthly from the beginning of the IRM until January 2002. Groundwater monitoring has taken place quarterly from January 2002 until present, and is still ongoing. A supplemental investigation was performed in August 2002 in accordance with the "Supplemental Investigation Work Plan, Brightwaters Yard Groundwater Plume IRM," dated June 2002, that was approved by the NYSDEC. The purpose of the investigation was to:

- Better define the extent of BTEX and PAHs remaining in the Brightwaters Yard after completing the IRM;
- Provide a more definitive "before and after" BTEX/PAH concentration comparison for evaluating the IRM performance;
- Summarize the data collected to date on the IRM; and
- Recommend a course of action for additional remedial measures for the Brightwaters Yard.

A Supplemental IRM Investigation Report will be submitted to the NYSDEC in the first quarter of 2003 to document the results of this investigation and address the first three bulleted items mentioned above.

A Recommendations Report will immediately follow the Supplemental IRM Investigation to identify the extent of BTEX/PAHs remaining at the site and propose a conceptual plan detailing how these residual BTEX/PAHs will be mitigated. This document will begin a dialogue with the NYSDEC that will culminate with the development of a formal IRM Work Plan Addendum to remediate the remaining BTEX/PAHs identified at the Brightwaters Yard. While this process takes place, previously planned operations and maintenance will continue. These activities include: quarterly sampling of monitoring wells located within the Brightwaters Yard and downgradient throughout the groundwater plume, and monthly operation and maintenance of the Union Boulevard oxygen injection system.

As specified in the original IRM Work Plan dated June 2001, a Summary IRM Report will be prepared at the conclusion of the IRM project. The Report will be P.E. certified and stamped, attesting that the IRM was conducted in accordance with the IRM Work Plan. The report will include interim reports in the form of attachments, the results of field measurements and laboratory analyses, records pertinent to the performance and completion of the IRM project such as well abandonment records, summary evaluations of the components of the IRM, and project findings. The success of the IRM relative to the project objectives will be addressed in the summary report. Consideration will be given to the need for additional action as part of the overall site remedial program required under the Order on Consent.

4.3.2.1 - Groundwater

As discussed above, prior investigations had defined a groundwater plume downgradient of the Brightwaters Yard. The plume consists of dissolved-phase BTEX and PAH compounds originating from a source area located in the southwest corner of the site. This source area is associated with a petroleum-based MGP feedstock historically stored in this portion of the site. The plume has been determined to be approximately 200 feet wide at the site boundary and approximately 1,400 feet long.

Starting in March of 1999, KeySpan began routinely monitoring the Brightwaters Yard plume on a quarterly basis using a number of monitoring well clusters located down the plume centerline. **Figure 4-39** shows the location of each well cluster used in the monitoring program and the most recent BTEX/PAH concentration for each well, the majority being from the June 2002 sample round. In order to develop an understanding of changes in concentration of total BTEX/PAHs in groundwater over time, historical and current data were also evaluated as discussed below.

Changes in total BTEX and total PAH concentrations with time in monitoring wells MW-64, MW-65, MW-34S, MW-11W, BS-02S and MW-68S, which are located within the defined Brightwaters Yard groundwater plume, are shown graphically on **Figures 4-40** through **4-45**, respectively. The plots for monitoring wells MW-64 and MW-65 are used to show trends in water quality immediately downgradient from the Brightwaters Yard. The plots for monitoring wells MW-34S and MW-11W are used to show trends in water quality in the middle portion of the plume. The plots for monitoring wells MW-68S and BS-02S are used to show trends in water

FIGURE 4-40
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL MW-64

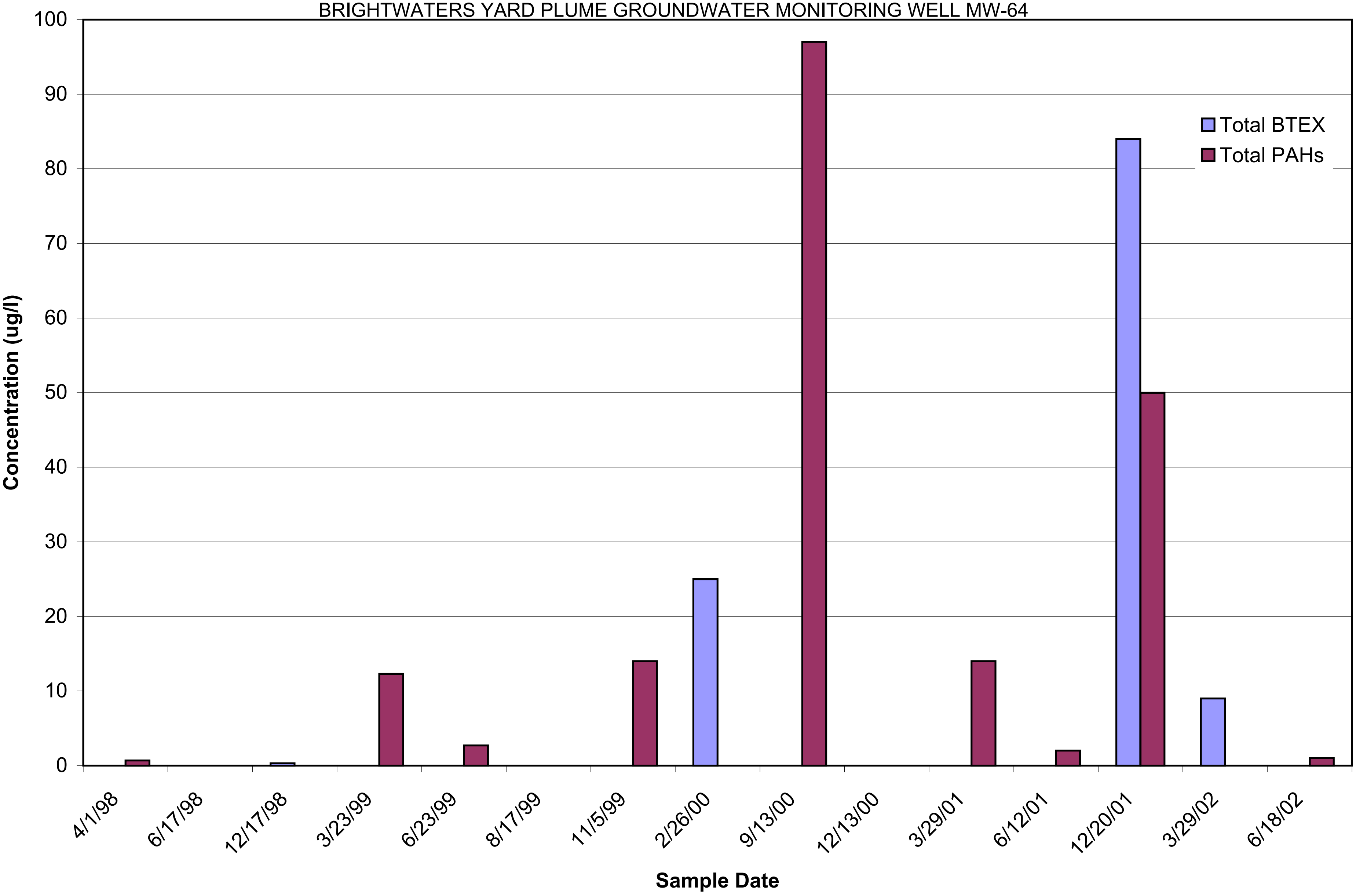


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FIGURE 4-41
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL MW-65

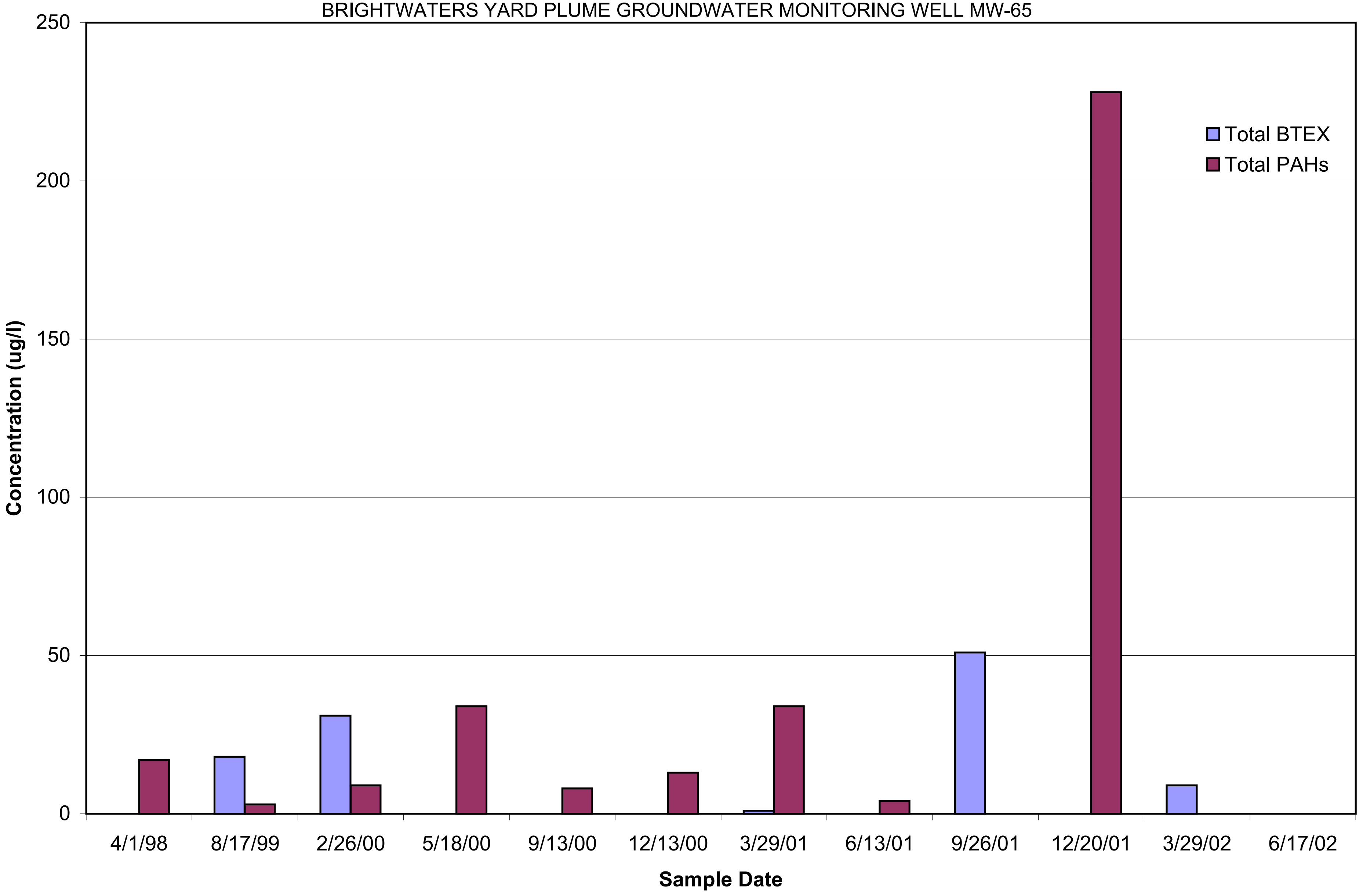

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FIGURE 4-42
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN
BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL MW-34S

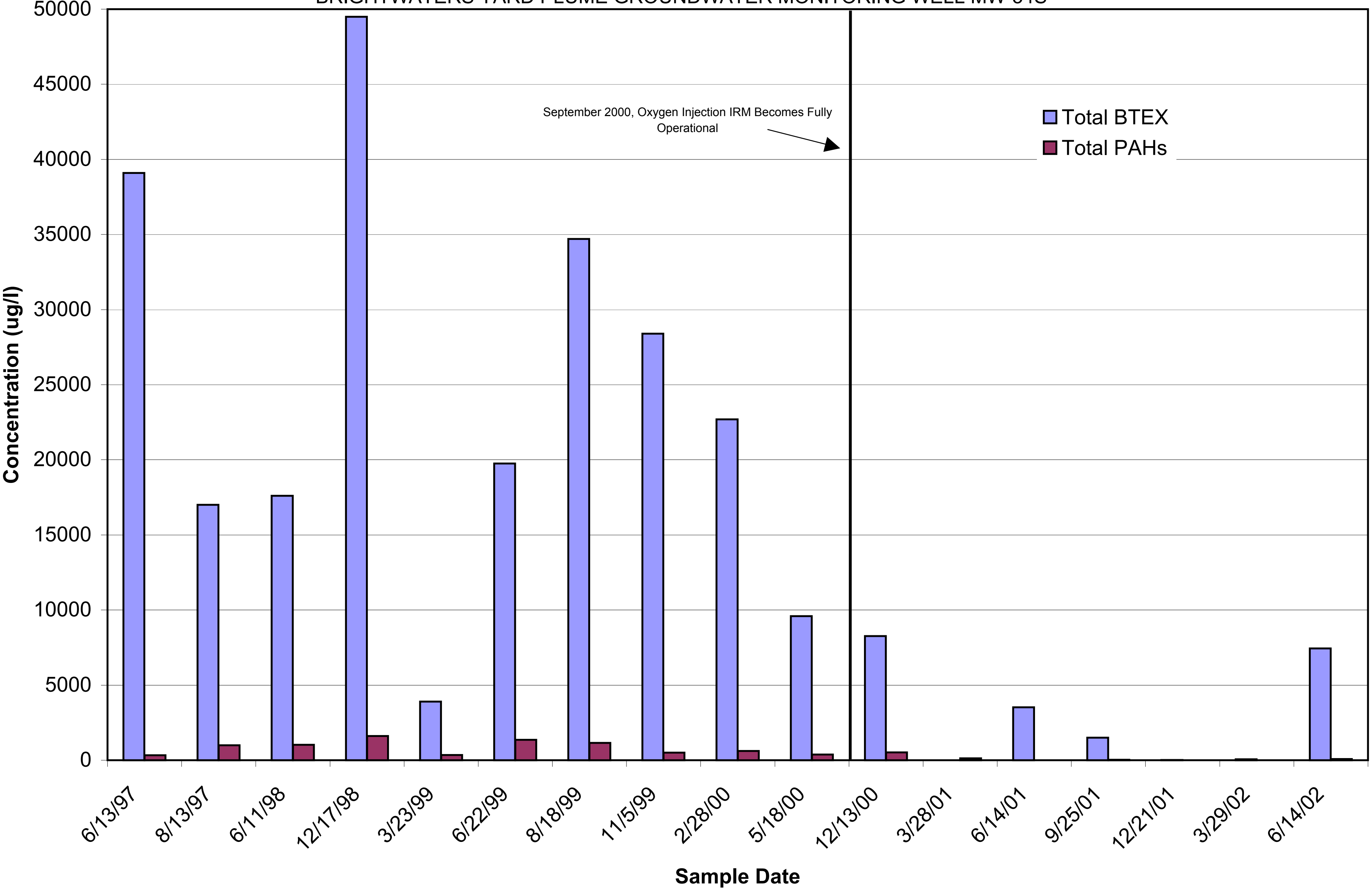

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FIGURE 4-43
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL MW-11W

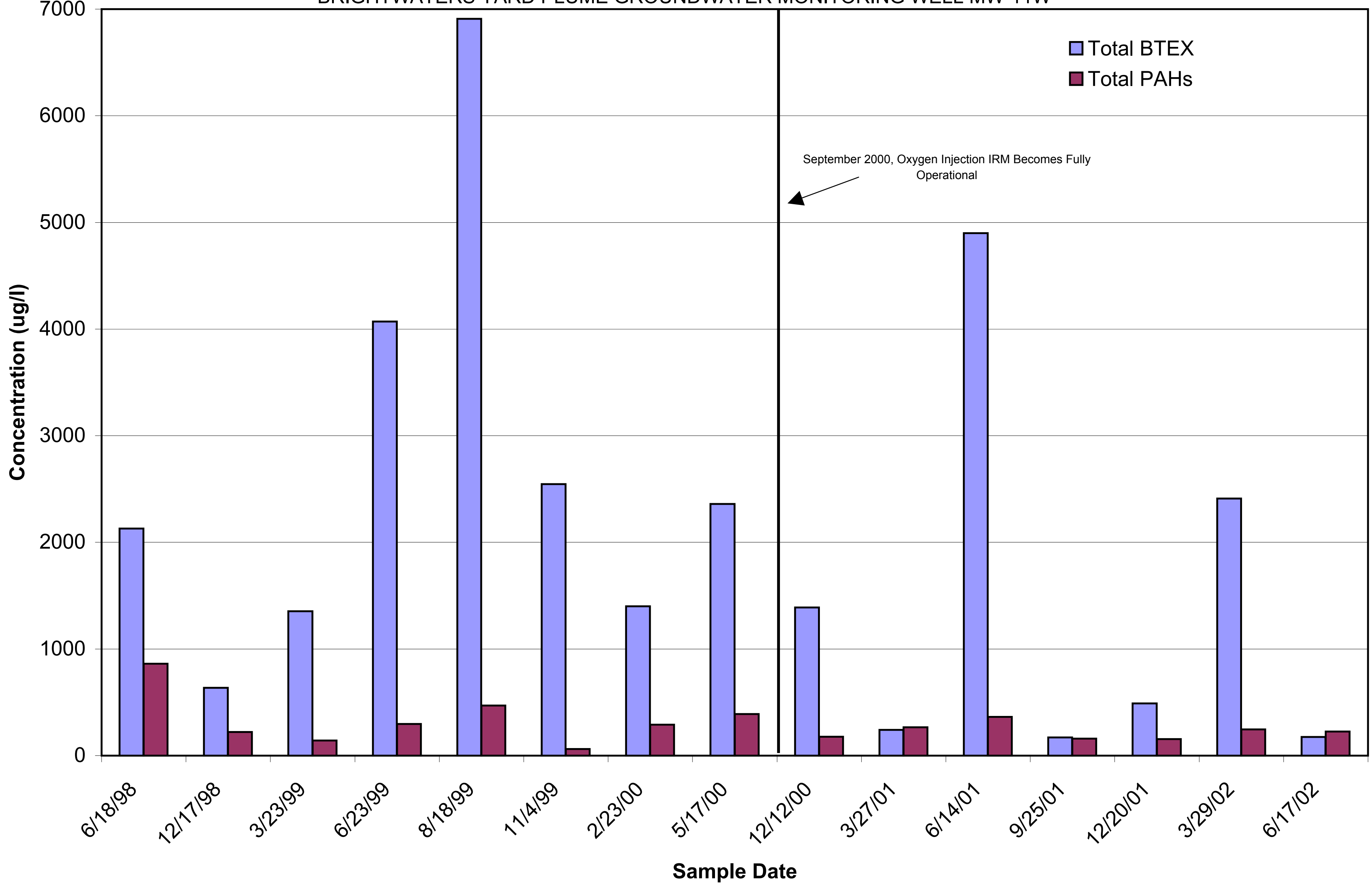

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FIGURE 4-44
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL BS-02S

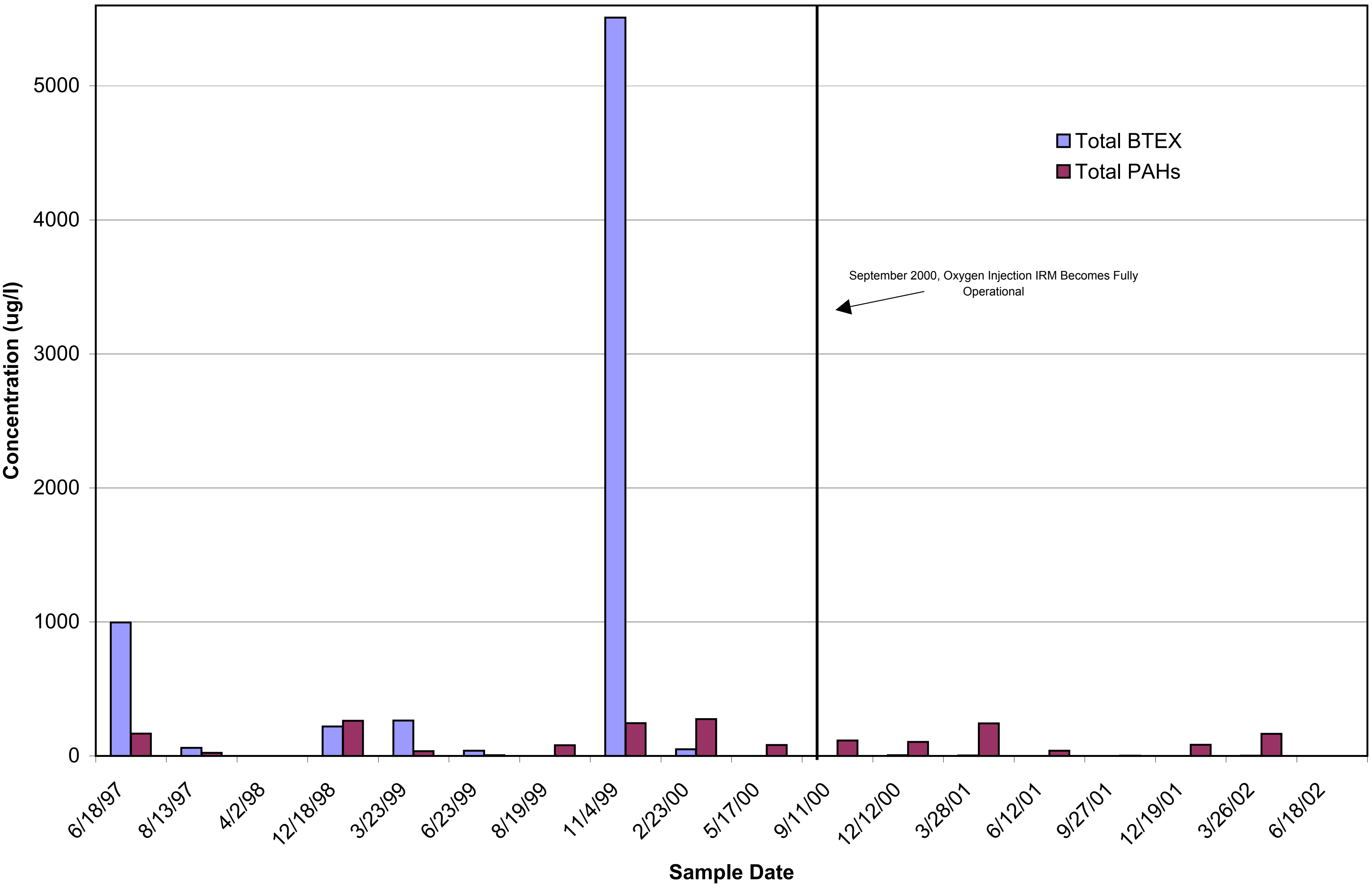
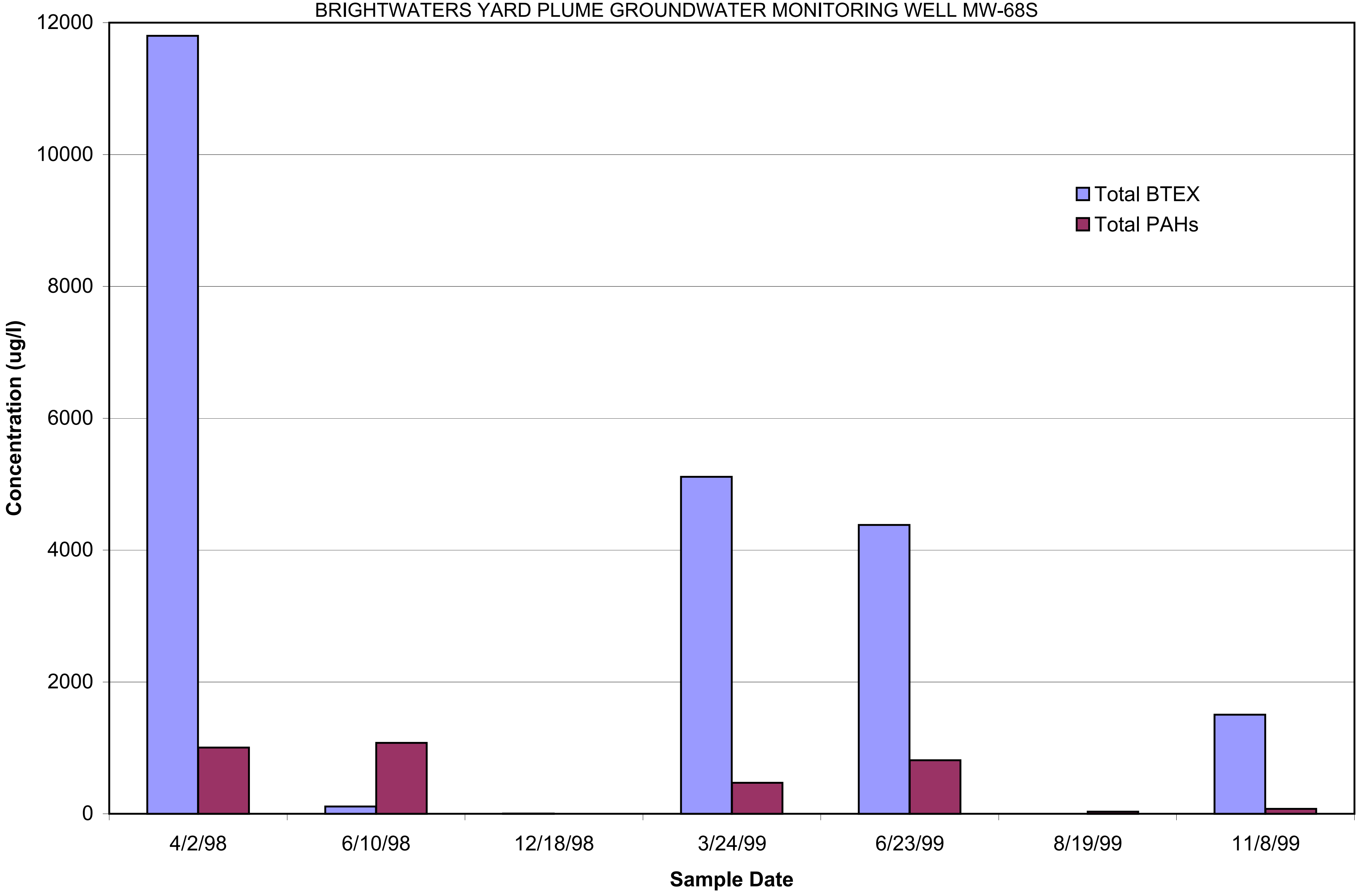


FIGURE 4-45
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

CHANGES OF TOTAL BTEX AND TOTAL PAH CONCENTRATIONS OVER TIME IN BRIGHTWATERS YARD PLUME GROUNDWATER MONITORING WELL MW-68S



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quality in downgradient areas of the plume. The wells used to evaluate the historical trend of total BTEX and total PAHs were selected based on their location relative to the source area and downgradient discharge point, as well as the availability of analytical data from multiple sampling events at each well. Where appropriate, data from all wells in a monitoring well cluster were evaluated. Note that a bold vertical line has been added to the figures, where appropriate, marking September 2000, the month in which the oxygen injection IRM discussed above became operational. Since monitoring wells MW-64 and MW-65 are located upgradient of the oxygen injection points, a bold vertical line has not been added to **Figures 4-40** and **4-41**. The line has also not been added to **Figure 4-45**, as monitoring well MW-68S has not been sampled since November 1999.

A review of **Figures 4-40** and **4-41** shows that total BTEX and total PAHs in the shallow groundwater at monitoring wells MW-64 and MW-65 have been detected at low concentrations intermittently since 1998. There is no predominant trend of increasing or decreasing concentrations. The graphs also show that concentrations of total BTEX and total PAHs for samples collected during 2002 from monitoring well MW-64 are near historical lows and that no BTEX or PAHs were detected in samples collected during the most recent sampling event in June 2002. Based on the trends presented, the concentrations of BTEX and PAHs in the plume immediately downgradient from the Brightwaters Yard site are not increasing and the plume is in an apparent steady state at this location.

A review of **Figures 4-42** and **4-43** shows that concentrations of total BTEX and total PAHs in the shallow groundwater in the middle portion of the plume, at monitoring wells MW-34S and MW-11W, respectively, exhibit an overall decreasing trend. As shown on **Figure 4-42**, since the oxygen injection IRM began operation in September 2000 immediately upgradient from monitoring well MW-34S, BTEX and PAH compounds decreased to relatively low concentrations until June 2002 when the concentration of total BTEX increased. Total PAHs in monitoring well MW-34S (**Figure 4-42**) have decreased to a concentration of 85 ug/l since oxygen injection was initiated and have remained at this low concentration. Due to its location approximately 350 feet downgradient from the injection transect, the concentrations of total BTEX and total PAHs in monitoring well MW-11W (**Figure 4-43**) showed a minimal response, if any, to the oxygen amendments. Despite its downgradient location, the concentration of BTEX and PAHs have decreased overall, with only two peaks of increased concentrations detected in samples collected during June 2001 and March 2002, respectively. It is noted that analytical results for the most recent sampling of the intermediate well MW-34I showed that total BTEX was detected at an elevated concentration of 3,690 ug/l. This is the first time that BTEX was detected in this well since August 1997. No BTEX has been detected in the deep well MW-34D since August 1997. With few exceptions since December 2000, PAHs have been either not detected or detected at trace concentrations in the wells of the MW-34 cluster.

A review of **Figures 4-44** and **4-45** shows that concentrations of total BTEX and total PAHs detected in the shallow groundwater at downgradient monitoring wells BS-02S and MW-68S have been sporadic since the first monitoring events at these locations, but have decreased overall.

4.3.2.2 - Pore Water

A total of six pore water samples were collected from the O-Co-Nee Pond within the suspected discharge area of the Brightwaters Yard groundwater plume. As discussed in **Section 2.4.2**, the pore water samples were collected immediately beneath the pond bottom using a 6-inch long stainless steel well screen. Each sample was analyzed for BTEX and PAHs. The BTEX results are summarized in **Table C-31** and the PAH results are summarized in **Table C-32**. The pore water sample locations are provided on **Drawing 2B,** as well as **Figure 4-39**.

BTEX

Analytical results for the BTEX compounds in pore water are summarized on **Figure 4-39**. The results show that BTEX was detected in one of the six pore water samples that were collected and analyzed. Total BTEX was detected in sample BWPW-03 at a concentration of 177 ug/l and consisted almost entirely of benzene, which was detected at a concentration of 170 ug/l.

PAHs

Of the PAHs analyzed, only naphthalene was detected in pore water sample BWPW-02 at a concentration of 2 ug/l. No other PAHs were detected in any of the other pore water samples.

4.3.2.3 - Surface Water

As discussed in **Section 2.4.2**, a total of 11 surface water samples were collected from O-Co-Nee Pond at six different locations with one sample collected immediately off the pond bottom and the second one approximately 12 inches off the pond bottom. Note that only one sample was collected from sample location BWSW-06 given the water was less than 6 inches deep at this location. All samples were analyzed for BTEX and PAHs with the results summarized in **Tables C-33** and **C-34**, respectively. Additionally, the total BTEX and total PAH concentrations are summarized on **Figure 4-39**.

BTEX

With the exception of xylene detected at a concentration of 1 ug/l in BWSW-01 (Bottom), BTEX compounds were not detected in the surface water samples.

PAHs

PAHs were detected in two of the 11 surface water samples. Concentrations for total PAHs were 20 ug/l in sample BWSW-04 (Bottom +12 inches) and 34 ug/l in sample BWSW-05 (bottom). The low concentrations of PAHs are typical for a surface water body that receives storm water from roadways and surrounding commercial and light industrial areas.

4.3.2.4 - Surface Water Sediment

As discussed in **Section 2.4.2**, a total of 12 sediment samples were collected from O-Co-Nee Pond at six locations with one sample collected from 0 to 6 inches below the pond bottom and one sample collected from 6 to 12 inches below the pond bottom. All samples were analyzed for BTEX, PAHs and total organic carbon (TOC), the results of which are summarized in **Tables C-35**, **C-36** and **C-37**, respectively.

BTEX

Trace concentrations of xylene were detected in 5 of the 12 surface water sediment samples ranging from 0.002 mg/kg in sample BWSD-06 (6 to 12 inches) to 0.006 mg/kg in sample BWSD-04 (0 to 6 inches). No other BTEX compounds were detected in any of the other surface water sediment samples.

PAHs

Relatively low concentrations of phenanthrene and/or pyrene were detected in five of the 12 surface water sediment samples. Concentrations of total PAHs, where detected, ranged from 1.8 mg/kg in sample BWSD-06 (0 to 6 inches) to 56.9 mg/kg in sample BWSD-04 (0 to 6 inches). PAHs were not detected in any of the other surface water sediment samples.

Total Organic Carbon

Total organic carbon was detected in all surface water sediments and ranged in concentration from 0.3 percent weight in sample BWSD-02 (6 to 12 inches) to 79 percent in sample BWSD-01 (0 to 6 inches). With the exception of samples from sample locations BWSD-02 and BWSD-03, which all had TOC less than 1.5 percent, all TOC was detected at concentrations greater than 10 percent. As shown on **Figure 4-39**, sample location BWSD-02 is located outside the discharge area and BWSD-03 was located in the area of O-Co-Nee Pond where the plume of dissolved chemical constituents from the Brightwaters site discharges. Due to the relatively low TOC concentrations in samples collected at BWSD-03, it is anticipated that the effect of organic carbon in the surface water sediments on the attenuation of the dissolved BTEX and or PAHs in the groundwater plume will be minor.

4.3.3 Watchogue Creek/Crum's Brook Investigation (Operable Unit 4)

As part of the initial field program, the headwaters of Watchogue Creek/Crum's Brook were investigated to evaluate potential migration of MGP-related materials from the Bay Shore Site to the headwaters area of Watchogue Creek. A former Cesspool located at the headwaters of Watchogue Creek was the historical discharge point for treated wastewater generated at the former MGP. Wastewater discharged to the creek flowed south to a small pond area, which was subsequently backfilled. Currently, the creek headwaters start immediately south of the LIRR property, located approximately 500 feet east of the former MGP site. The creek flows south under Union Boulevard, eventually discharging to the Great South Bay. The results of the initial field program indicated that soil, groundwater and surface water sediments contained detectable levels of BTEX and PAHs. In general, BTEX and PAH concentrations decreased rapidly with increasing depth. However, at several soil borings completed in the vicinity of the former Cesspool, the detectable concentrations of PAHs persisted at depths well below the water table. In these soil borings field observations of recovered soil included staining, sporadic blebs of NAPL and/or hydrocarbon and naphthalene odors. Additionally, groundwater samples collected in the vicinity of the borings that exhibited these conditions also contained detectable concentrations of BTEX and/or PAHs. It was determined that additional data was needed to advance the proposed IRM of the former cesspool area.

In addition, BTEX and PAHs were identified in shallow subsurface soil within the vicinity of a former pond located south of the former Cesspool. Based on the results of the initial field program, it was determined that additional data is necessary to advance the proposed IRM of the former pond area.

It should be noted that an IRM was performed from September to November of 2000 on the southern portion of Operable Unit 4, south of the former pond area, between Union

Boulevard and Mechanicsville Service Road. The objectives of this IRM were to remove sediments potentially containing MGP residual materials and to enhance the existing brook channel by improving its flow characteristics and aesthetics.

Specifically, Crum's Brook was improved over the approximate 1,400 feet long span between Union Boulevard and Mechanicsville Service Road (identified in green on **Figure 1-3**). The restoration provides a uniform, non-eroding stream cross section. Prior to improvement, a minimum of one (1) foot of sediment was excavated from the brook bed throughout the stream's width (as it existed at the time of remedial activities). To improve the flow characteristics of the brook, a nominal three (3) inch diameter stone lining underlain by filter fabric was installed in the brook invert to convey low flow conditions. The banks were cut to a consistent 2:1 slope and were overlain with erosion control matting and temporary winter rye grass to stabilize the banks during high flow events. Because the channel restoration work was completed in late fall (a non-optimum planting season) and construction activities were still scheduled to take place in support of the adjacent South Wind Village Development, no final landscaping was installed at the end of the field activities. Shrubs were installed during the fourth quarter of 2001, and a wildflower seed mix was determined unnecessary during the second quarter of 2002 due to the growth of natural vegetation already taking place. The "Final Summary Report for Crum's Brook Restoration, Area C Interim Remedial Measure in the Town of Islip, New York (OU-4B)" was submitted to the NYSDEC, NYSDOH and SCDHS on November 15, 2002.

The construction has improved the brook's flow characteristics and enhanced its aesthetics. The restored brook banks and adjacent upland area will provide an improved natural amenity that will be an asset to the community. The project has improved the quality of the habitat surrounding the brook, thereby supporting a more diverse mixture of plants and wildlife. KeySpan commenced with this aspect of the OU-4 remediation first, because proceeding with the restoration project as soon as possible met an important community goal in the construction of the adjacent South Wind Village Development.

4.3.3.1 - Surface Soil

BTEX and PAHs

One surface soil sample, designated WC-SOP, was collected adjacent to the former Standard Oil property located west of the former Cesspool. Analytical results for BTEX and PAHs in this sample are summarized in **Tables C-38** and **C-39**, respectively. The concentration of total BTEX detected in surface soil sample WC-SOP was 0.024 mg/kg and for total PAHs was 62.7 mg/kg.

Petroleum Fingerprint/TPH

TPH was detected at a concentration of 1,500.0 mg/kg in surface soil sample WC-SOP.

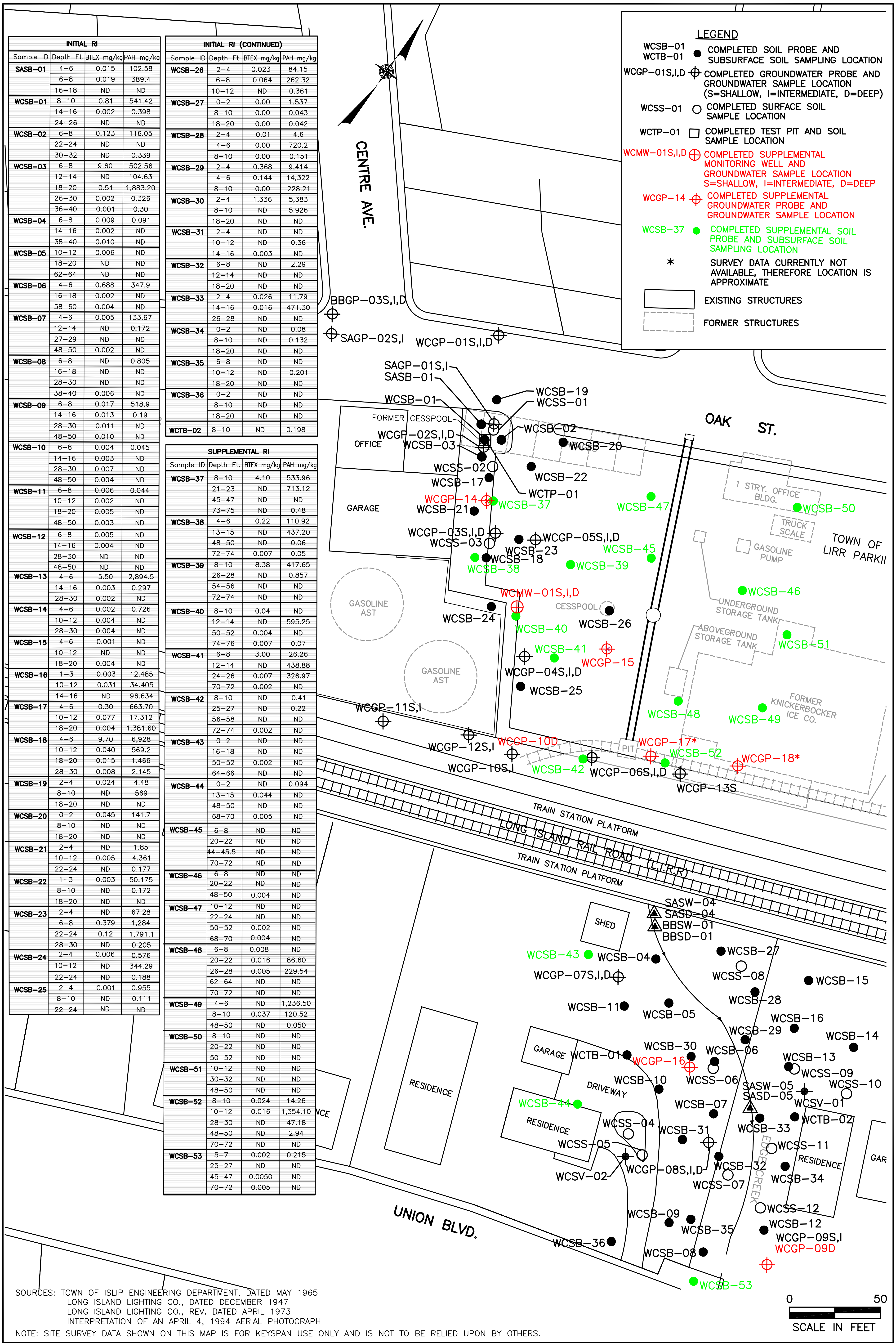
Metals

Metals were not detected above background concentrations in surface soil sample WC-SOP.

4.3.3.2 - Subsurface Soil

As part of the supplemental field program, a total of 14 soil borings were completed within the vicinity of the former Cesspool and 3 borings were completed within the former pond area, south of the LIRR tracks. A total of 66 subsurface soil samples were selected for analysis including BTEX and PAHs, the results of which are summarized in **Tables C-42** and **C-43**, respectively. Total BTEX and total PAH results are also summarized on **Figure 4-46**. In addition, three samples were selected for Petroleum Fingerprint/TPH analysis, summarized in **Table C-44**.

Table 4-16 summarizes data related to subsurface soil samples collected as part of the Watchogue Creek Investigation, which exhibited the highest total BTEX and total PAH



INITIAL RI

Sample ID	Depth Ft.	BTEX mg/kg	PAH mg/kg
SASB-01	4-6	0.015	102.58
	6-8	0.019	389.4
	16-18	ND	ND
WCSB-01	8-10	0.81	541.42
	14-16	0.002	0.398
	24-26	ND	ND
WCSB-02	6-8	0.123	116.05
	22-24	ND	ND
	30-32	ND	0.339
WCSB-03	6-8	9.60	502.56
	12-14	ND	104.63
	18-20	0.51	1,883.20
	26-30	0.002	0.326
	36-40	0.001	0.30
WCSB-04	6-8	0.009	0.091
	14-16	0.002	ND
	38-40	0.010	ND
WCSB-05	10-12	0.006	ND
	18-20	ND	ND
	62-64	ND	ND
WCSB-06	4-6	0.688	347.9
	16-18	0.002	ND
	58-60	0.004	ND
WCSB-07	4-6	0.005	133.67
	12-14	ND	0.172
	27-29	ND	ND
	48-50	0.002	ND
WCSB-08	6-8	ND	0.805
	16-18	ND	ND
	28-30	ND	ND
	38-40	0.006	ND
WCSB-09	6-8	0.017	518.9
	14-16	0.013	0.19
	28-30	0.011	ND
	48-50	0.010	ND
WCSB-10	6-8	0.004	0.045
	14-16	0.003	ND
	28-30	0.007	ND
	48-50	0.004	ND
WCSB-11	6-8	0.006	0.044
	10-12	0.002	ND
	18-20	0.005	ND
	48-50	0.003	ND
WCSB-12	6-8	0.005	ND
	14-16	0.004	ND
	28-30	ND	ND
	48-50	ND	ND
WCSB-13	4-6	5.50	2,894.5
	14-16	0.003	0.297
	28-30	0.002	ND
WCSB-14	4-6	0.002	0.726
	10-12	0.004	ND
	28-30	0.004	ND
WCSB-15	4-6	0.001	ND
	10-12	ND	ND
	18-20	0.004	ND
WCSB-16	1-3	0.003	12.485
	10-12	0.031	34.405
	14-16	ND	96.634
WCSB-17	4-6	0.30	663.70
	10-12	0.077	17.312
	18-20	0.004	1,381.60
WCSB-18	4-6	9.70	6,928
	10-12	0.040	569.2
	18-20	0.015	1.466
	28-30	0.008	2.145
WCSB-19	2-4	0.024	4.48
	8-10	ND	569
	18-20	ND	ND
WCSB-20	0-2	0.045	141.7
	8-10	ND	ND
	18-20	ND	ND
WCSB-21	2-4	ND	1.85
	10-12	0.005	4.361
	22-24	ND	0.177
WCSB-22	1-3	0.003	50.175
	8-10	ND	0.172
	18-20	ND	ND
WCSB-23	2-4	ND	67.28
	6-8	0.379	1,284
	22-24	0.12	1,791.1
	28-30	ND	0.205
WCSB-24	2-4	0.006	0.576
	10-12	ND	344.29
	22-24	ND	0.188
WCSB-25	2-4	0.001	0.955
	8-10	ND	0.111
	22-24	ND	ND

INITIAL RI (CONTINUED)

Sample ID	Depth Ft.	BTEX mg/kg	PAH mg/kg
WCSB-26	2-4	0.023	84.15
	6-8	0.064	262.32
	10-12	ND	0.361
WCSB-27	0-2	0.00	1.537
	8-10	0.00	0.043
	18-20	0.00	0.042
WCSB-28	2-4	0.01	4.6
	4-6	0.00	720.2
	8-10	0.00	0.151
WCSB-29	2-4	0.368	9,414
	4-6	0.144	14,322
	8-10	0.00	228.21
WCSB-30	2-4	1.336	5,383
	8-10	ND	5.926
	18-20	ND	ND
WCSB-31	2-4	ND	ND
	10-12	ND	0.36
	14-16	0.003	ND
WCSB-32	6-8	ND	2.29
	12-14	ND	ND
	18-20	ND	ND
WCSB-33	2-4	0.026	11.79
	14-16	0.016	471.30
	26-28	ND	ND
WCSB-34	0-2	ND	0.08
	8-10	ND	0.132
	18-20	ND	ND
WCSB-35	6-8	ND	ND
	10-12	ND	0.201
	18-20	ND	ND
WCSB-36	0-2	ND	ND
	8-10	ND	ND
	18-20	ND	ND
WCTB-02	8-10	ND	0.198

SUPPLEMENTAL RI

Sample ID	Depth Ft.	BTEX mg/kg	PAH mg/kg
WCSB-37	8-10	4.10	533.96
	21-23	ND	713.12
	45-47	ND	ND
	73-75	ND	0.48
WCSB-38	4-6	0.22	110.92
	13-15	ND	437.20
	48-50	ND	0.06
	72-74	0.007	0.05
WCSB-39	8-10	8.38	417.65
	26-28	ND	0.857
	54-56	ND	ND
	72-74	ND	ND
WCSB-40	8-10	0.04	ND
	12-14	ND	595.25
	50-52	0.004	ND
	74-76	0.007	0.07
WCSB-41	6-8	3.00	26.26
	12-14	ND	438.88
	24-26	0.007	326.97
	70-72	0.002	ND
WCSB-42	8-10	ND	0.41
	25-27	ND	0.22
	56-58	ND	ND
	72-74	0.002	ND
WCSB-43	0-2	ND	ND
	16-18	ND	ND
	50-52	0.002	ND
	64-66	ND	ND
WCSB-44	0-2	ND	0.094
	13-15	0.044	ND
	48-50	ND	ND
	68-70	0.005	ND
WCSB-45	6-8	ND	ND
	20-22	ND	ND
	44-45.5	ND	ND
	70-72	ND	ND
WCSB-46	6-8	ND	ND
	20-22	ND	ND
	48-50	0.004	ND
WCSB-47	10-12	ND	ND
	22-24	ND	ND
	50-52	0.002	ND
	68-70	0.004	ND
WCSB-48	6-8	0.008	ND
	20-22	0.016	86.60
	26-28	0.005	229.54
	62-64	ND	ND
	70-72	ND	ND
WCSB-49	4-6	ND	1,236.50
	8-10	0.037	120.52
	48-50	ND	0.050
WCSB-50	8-10	ND	ND
	20-22	ND	ND
	50-52	ND	ND
WCSB-51	10-12	ND	ND
	30-32	ND	ND
	48-50	ND	ND
WCSB-52	8-10	0.024	14.26
	10-12	0.016	1,354.10
	28-30	ND	47.18
	48-50	ND	2.94
	70-72	ND	ND
WCSB-53	5-7	0.002	0.215
	25-27	ND	ND
	45-47	0.0050	ND
	70-72	0.005	ND

SOURCES: TOWN OF ISLIP ENGINEERING DEPARTMENT, DATED MAY 1965
LONG ISLAND LIGHTING CO., DATED DECEMBER 1947
LONG ISLAND LIGHTING CO., REV. DATED APRIL 1973
INTERPRETATION OF AN APRIL 4, 1994 AERIAL PHOTOGRAPH

NOTE: SITE SURVEY DATA SHOWN ON THIS MAP IS FOR KEYSPAN USE ONLY AND IS NOT TO BE RELIED UPON BY OTHERS.

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

WATCHOGUE CREEK/CRUM'S BROOK IRM/INVESTIGATION
BTEX AND PAH CONCENTRATIONS IN SOIL

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 4-46

F:\1620B12C\BPC-SOIL.dwg, 10/25/02 04:40:54 PM, ACaniano

TABLE 4-16

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

WATCHOGUE CREEK/CRUM'S BROOK SUBSURFACE SOIL SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Boring and Sample Depth)	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location (in Relation to Former MGP Structure and/or Site)	PID (ppm)	Field Description of Recovered Sample
WCSB-37 (8-10')	4.1	534.0	Approximately 30 feet Downgradient of Former Cesspool.	12.1	Saturated w/NAPL, sheen, strong hydrocarbon-like odor
WCSB-37 (21-23')	0.0	713.1	Approximately 30 feet Downgradient of Former Cesspool.	0.3	Staining, sheen, slight hydrocarbon-like odor
WCSB-39 (8-10')	8.4	447.7	Approximately 85 feet Downgradient of Former Cesspool.	31.0	Tar staining and hydrocarbon-like odor
WCSB-40 (12-14')	0.0	595.3	Approximately 95 feet Downgradient of Former Cesspool.	6.0	Tar lenses at 12.7' and 13',
WCSB-49 (4-6')	0.0	1,236.5	Within Former Knickerbocker Ice Company. Downgradient of Truck Scale and Gas Pump	0.0	None
WCSB-52 (10-12')	0.0	1,354.1	Downgradient of Former Knickerbocker Ice Company and Above Ground Storage Tank	18.0	Tar staining and hydrocarbon-like odor from 9.5-11.5', sheen

concentrations along with the approximate location of each sample with respect to former MGP structures/features where appropriate. The table also includes PID measurements and lists any significant field observations noted for the samples.

Former Cesspool Area

As **Table 4-16** indicates, the maximum total BTEX concentration of 8.4 mg/kg was detected at WCSB-39 (8 to 10 feet) located approximately 80 feet downgradient of the former Cesspool. The maximum total BTEX concentration observed during the initial field program of 9.6 mg/kg was identified in BBSB-03 (6 to 8 feet), also located downgradient of the former Cesspool. Consistent with the initial field program findings, BTEX compounds were only detected at concentrations greater than 1.0 mg/kg in shallow subsurface soil no greater than 10 feet in depth. Below this depth, BTEX concentrations were found to be nondetectable or at trace concentrations of 0.05 mg/kg or less. The maximum total PAH concentrations detected in subsurface soil were observed in shallow subsurface soil within the vicinity of the former Knickerbocker Ice Company facility, including at WCSB-49 (4 to 6 feet) and WCSB-52 (10 to 12 feet) with total PAH concentrations of 1,236.5 mg/kg and 1,354.1 mg/kg, respectively. Petroleum fingerprint analysis indicates that the hydrocarbons present in the WCSB-49 (8 to 10 feet) sample were most characteristic of diesel fuel and motor oil. Similar to the initial field program findings, PAHs appear to be present up to 30 feet below grade in several locations with total PAHs up to 327.0 mg/kg. However, below this depth PAHs decrease in concentration with total PAHs not exceeding 3.0 mg/kg.

Former Pond Area and Watchogue Creek/Crum's Brook Headwaters

Three soil borings were completed in the former pond area in order to delineate the areal extent of BTEX/PAHs identified in this area as part of the initial field program. As shown on **Figure 4-46**, BTEX and PAHs did not exceed 0.25 mg/kg at all sample intervals selected for analysis.

4.3.3.3 - Groundwater

As part of the supplemental field program, five groundwater probes and one monitoring well cluster was installed within the former cesspool area. In addition, two groundwater probes and one monitoring well cluster were installed within the former pond area. A total of 43 groundwater samples were analyzed for BTEX and PAHs with the results for the monitoring wells presented in **Tables C-45** and **C-46**, and for groundwater probes in **Tables C-47** and **C-48**. In addition, total BTEX and PAH results are summarized on **Figure 4-47**.

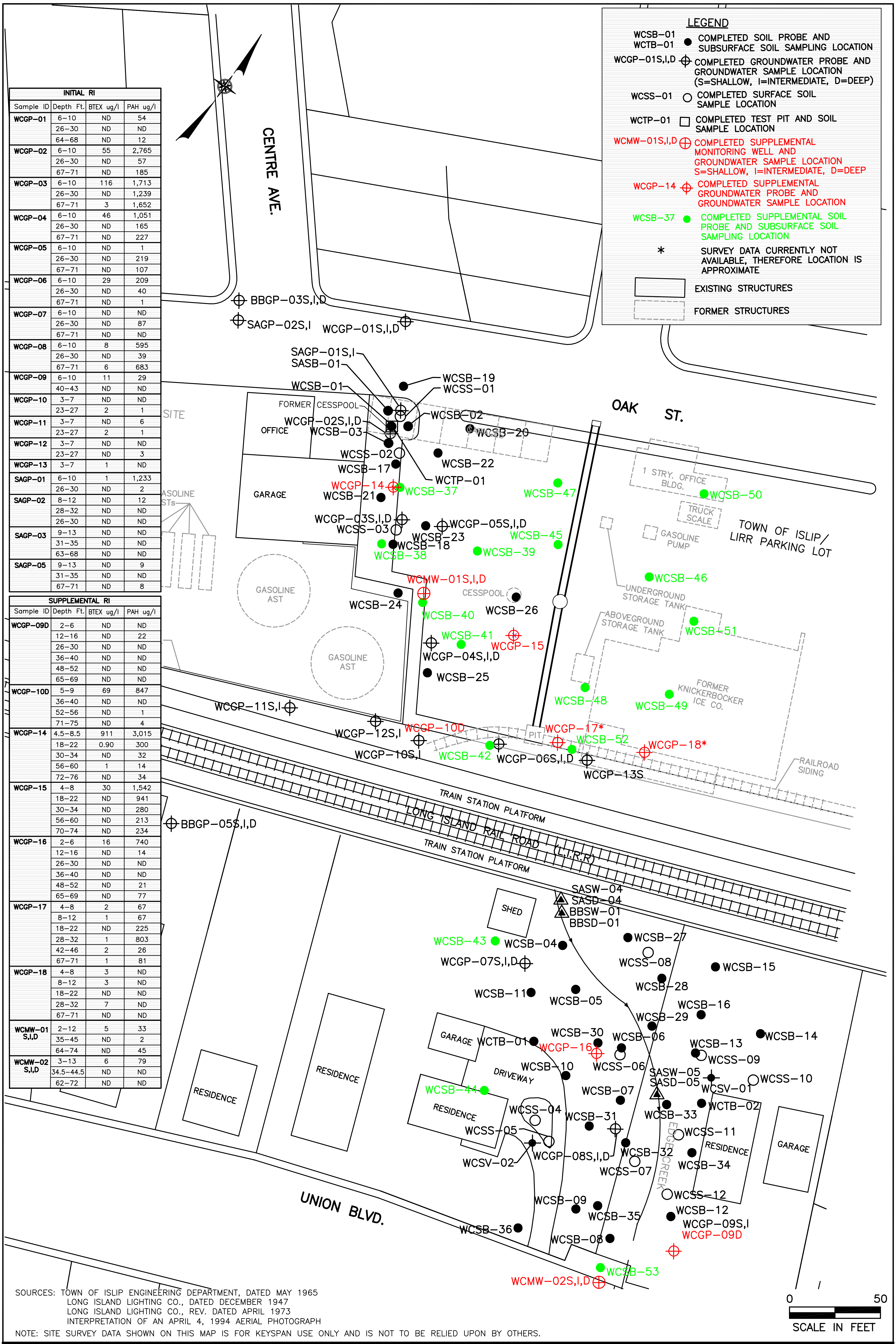
Table 4-17 summarizes groundwater samples that exhibited the highest total BTEX and total PAH concentrations along with the approximate locations of these samples in relation to former MGP structures/features. The table also indicates any significant field observations noted in these samples.

Former Cesspool Area

BTEX and PAH groundwater data is generally consistent with soil data with the highest BTEX and PAH concentrations observed within the former Cesspool and immediately downgradient in shallow groundwater. The maximum total BTEX and total PAH concentrations observed in this area were 911 ug/l and 3,015 ug/l, respectively, detected at WCGP-14 (4.5 to 8.5 feet). While the data does identify groundwater containing BTEX and PAH compounds immediately downgradient of the former Cesspool, concentrations decrease rapidly at most sample locations.

Former Pond Area and Watchogue Creek/Crum's Brook Headwaters

BTEX concentrations were below detection limits in 13 of the 15 groundwater samples. The remaining two samples exhibited total BTEX concentrations ranging from 5 ug/l to 16 ug/l. PAH compounds were detected in six of the 15 samples. Total PAH concentrations ranged from 22 ug/l to 740 ug/l. Based on these results, subsurface soil within the former pond area appears to be a minor source of BTEX and PAH compounds to groundwater.



INITIAL RI

Sample ID	Depth Ft.	BTEX ug/l	PAH ug/l
WCGP-01	6-10	ND	54
	26-30	ND	ND
	64-68	ND	12
WCGP-02	6-10	55	2,765
	26-30	ND	57
	67-71	ND	185
WCGP-03	6-10	116	1,713
	26-30	ND	1,239
	67-71	3	1,652
WCGP-04	6-10	46	1,051
	26-30	ND	165
	67-71	ND	227
WCGP-05	6-10	ND	1
	26-30	ND	219
	67-71	ND	107
WCGP-06	6-10	29	209
	26-30	ND	40
	67-71	ND	1
WCGP-07	6-10	ND	ND
	26-30	ND	87
	67-71	ND	ND
WCGP-08	6-10	8	595
	26-30	ND	39
	67-71	6	683
WCGP-09	6-10	11	29
	40-43	ND	ND
WCGP-10	3-7	ND	ND
	23-27	2	1
WCGP-11	3-7	ND	6
	23-27	2	1
WCGP-12	3-7	ND	ND
	23-27	ND	3
WCGP-13	3-7	1	ND
SAGP-01	6-10	1	1,233
	26-30	ND	2
SAGP-02	8-12	ND	12
	28-32	ND	ND
	26-30	ND	ND
SAGP-03	9-13	ND	ND
	31-35	ND	ND
	63-68	ND	ND
SAGP-05	9-13	ND	9
	31-35	ND	ND
	67-71	ND	8

SUPPLEMENTAL RI

Sample ID	Depth Ft.	BTEX ug/l	PAH ug/l
WCGP-09D	2-6	ND	ND
	12-16	ND	22
	26-30	ND	ND
	36-40	ND	ND
	48-52	ND	ND
	65-69	ND	ND
WCGP-10D	5-9	69	847
	36-40	ND	ND
	52-56	ND	1
	71-75	ND	4
WCGP-14	4.5-8.5	911	3,015
	18-22	0.90	300
	30-34	ND	32
	56-60	1	14
	72-76	ND	34
WCGP-15	4-8	30	1,542
	18-22	ND	941
	30-34	ND	280
	56-60	ND	213
	70-74	ND	234
WCGP-16	2-6	16	740
	12-16	ND	14
	26-30	ND	ND
	36-40	ND	ND
	48-52	ND	21
	65-69	ND	77
WCGP-17	4-8	2	67
	8-12	1	67
	18-22	ND	225
	28-32	1	803
	42-46	2	26
	67-71	1	81
WCGP-18	4-8	3	ND
	8-12	3	ND
	18-22	ND	ND
	28-32	7	ND
	67-71	ND	ND
WCMW-01 S,I,D	2-12	5	33
	35-45	ND	2
	64-74	ND	45
WCMW-02 S,I,D	3-13	6	79
	34.5-44.5	ND	ND
	62-72	ND	ND

LEGEND

WCSB-01 WCTB-01	●	COMPLETED SOIL PROBE AND SUBSURFACE SOIL SAMPLING LOCATION
WCGP-01S,I,D	⊕	COMPLETED GROUNDWATER PROBE AND GROUNDWATER SAMPLE LOCATION (S=SHALLOW, I=INTERMEDIATE, D=DEEP)
WCSS-01	○	COMPLETED SURFACE SOIL SAMPLE LOCATION
WCTP-01	□	COMPLETED TEST PIT AND SOIL SAMPLE LOCATION
WCMW-01S,I,D	⊕	COMPLETED SUPPLEMENTAL MONITORING WELL AND GROUNDWATER SAMPLE LOCATION S=SHALLOW, I=INTERMEDIATE, D=DEEP
WCGP-14	⊕	COMPLETED SUPPLEMENTAL GROUNDWATER PROBE AND GROUNDWATER SAMPLE LOCATION
WCSB-37	●	COMPLETED SUPPLEMENTAL SOIL PROBE AND SUBSURFACE SOIL SAMPLING LOCATION
	*	SURVEY DATA CURRENTLY NOT AVAILABLE, THEREFORE LOCATION IS APPROXIMATE
	▭	EXISTING STRUCTURES
	▭	FORMER STRUCTURES

SOURCES: TOWN OF ISLIP ENGINEERING DEPARTMENT, DATED MAY 1965
LONG ISLAND LIGHTING CO., DATED DECEMBER 1947
LONG ISLAND LIGHTING CO., REV. DATED APRIL 1973
INTERPRETATION OF AN APRIL 4, 1994 AERIAL PHOTOGRAPH

NOTE: SITE SURVEY DATA SHOWN ON THIS MAP IS FOR KEYSPAN USE ONLY AND IS NOT TO BE RELIED UPON BY OTHERS.

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

WATCHOGUE CREEK/CRUM'S BROOK IRM/INVESTIGATION
BTEX AND PAH CONCENTRATIONS IN GROUNDWATER

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 4-47

F:\1620B12C\BPC-GWATER.dwg, 10/25/02 04:45:11 PM, ACaniano

TABLE 4-17

BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

WATCHOGUE CREEK/CRUM'S BROOK GROUNDWATER SAMPLES EXHIBITING THE HIGHEST TOTAL BTEX AND TOTAL PAH CONCENTRATIONS

Sample ID (Probe No. and Sample Depth)	**Total BTEX Concentration (ug/l)**	**Total PAH Concentration (ug/l)**	**Location (in Relation to Former MGP Structure and/or Site)**	**Field Description of Recovered Sample**
WCGP-10D (5-9')	69.0	847.0	In vicinity of Raiilroad Siding and the southern most Gasoline AST.	None
WCGP-14 (4.5-8.5')	911.0	3,015.0	In vicinity of Garage and Office. Downgradient of Former Cesspool.	None
WCGP-15 (4-8')	30.0	1,542.0	In vicinity of Cesspool and Above Ground Storage Tank. Downgradient of Cesspool.	Oily, dark gray-black, odor
WCGP-15 (18-22')	0.0	941.0	In vicinity of Cesspool and Above Ground Storage Tank. Downgradient of Cesspool.	Sheen, hydrocarbon-like odor
WCGP-16 (2-6')	16.0	740.0	In vicinity of Driveway, south of the Railroad Tracks.	None
WCGP-17 (28-32')	1.0	803.0	Within Railroad Siding and downgradient of Above Ground Storage Tank.	sheen, mild hydrocarbon-like odor

4.3.4 Air and Private Well Sampling (Operable Units 2 and 3)

Since January 1999, KeySpan has collected air samples for chemical analysis from residential and commercial properties located downgradient of the Bay Shore/Brightwaters former MGP site. Analytical results for collected air samples are provided in **Table C-49**. In addition, two private wells identified downgradient of the former MGP site, based on the completed private well and basement survey (discussed under **Section 2.4.4**), were sampled. The analytical results of the samples are presented in **Table C-50** and **Table C-51**. Locations of properties in which air samples and private well samples were collected are shown on **Figure 2-2**.

4.3.4.1 - Air

Air sampling was conducted at 16 off-site locations during the remedial investigation. At one location, two rounds of sampling were conducted and at another location, three rounds of sampling were conducted. A total of 67 samples were collected and each sample was analyzed for 61 volatile organic compounds. Of these 67 samples, 27 were collected from inside homes/businesses, 23 were collected from basement/crawl spaces, and 17 were collected outside. The results, including frequency of detection, and the minimum and maximum detected concentrations for each compound, are summarized in **Tables 4-18**, **4-19** and **4-20**, for ambient air, basement/crawl space air and indoor (living/working space) air, respectively. The majority of the volatile organic compounds for which analysis was performed were not detected. Additionally, naphthalene, the compound most commonly associated with potential MGP impacts, was not detected in any of the samples. The analytical results obtained were reviewed by the NYSDOH and the detected compounds were found to be at acceptable levels.

4.3.4.2 - Private Well Groundwater

As discussed in **Section 2.4.6**, two private wells were identified and sampled downgradient of the Bay Shore/Brightwaters former MGP site. Groundwater samples were collected from the two wells and analyzed for VOCs and SVOCs. Sample PW-1 was collected

TABLE 4-18
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CONCENTRATIONS DETECTED IN OFF-SITE AMBIENT AIR SAMPLES

Analyte	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration
1,2,4-Trimethylbenzene	1/17	--	7.4
1,3,5-Trimethylbenzene	1/17	--	8.4
1,4-Dioxane	2/17	20.9	90.1
2-Butanone	7/17	13.3	94.4
2-Propanol	2/17	*	12.0
Acetone	14/17	6.2	57.0
Benzene	1/17	--	6.7
Carbon Disulfide	1/17	--	21.2
Chloromethane	5/17	2.0	2.9
Ethanol	10/17	7.7	180.9
Ethylbenzene	1/17	--	4.3
Freon 12	1/17	--	5.4
m,p-Xylenes	4/17	4.2	18.7
Methylene Chloride	8/17	4.2	7.6
Propylene	1/17	--	9.1
Tetrachloroethene	2/17	17.6	28.5
Tetrahydrofuran	1/17	--	10.9
Toluene	7/17	3.8	13.6
Trichloroethene	2/17	5.2	5.3

All units are in ug/m^3.

* Results essentially identical for each detected concentration.

TABLE 4-19
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CONCENTRATIONS DETECTED IN OFF-SITE BASEMENT/CRAWL SPACE AIR SAMPLES

Analyte	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration
1,1,1-Trichloroethane	1/23	--	7.1
1,2,4-Trimethylbenzene	4/23	3.6	12.3
1,2-Dichloropropane	1/23	--	4.6
2-Butanone	6/23	8.3	124
2-Propanol	7/23	9.3	3441
Acetone	21/23	8.1	570
Benzene	4/23	3.2	7.0
Carbon Disulfide	2/23	10.0	15.6
Chloroethane	3/23	2.6	22.4
Chloromethane	5/23	2.1	2.9
Ethanol	21/23	6.8	119
Ethylbenzene	2/23	4.3	6.1
Freon 11	2/23	21.4	25.8
Freon 12	6/23	3.3	59.3
Hexane	3/23	18.0	81.1
m,p-Xylenes	6/23	4.8	23.4
Methyl tert-butyl ehter	3/23	14.4	112
Methylene Chloride	15/23	3.5	25.4
o-Xylene	3/23	4.3	8.3
Styrene	1/23	--	3.1
Tetrachloroethene	8/23	8.1	16.3
Tetrahydrofuran	1/23	--	17.1
Toluene	16/23	3.5	41.4

All units are in ug/m^3.

TABLE 4-20
BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION

SUMMARY OF CONCENTRATIONS DETECTED IN OFF-SITE INDOOR (LIVING/WORKING SPACE) AIR SAMPLES

Analyte	Frequency of Detection *	Minimum Detected Concentration	Maximum Detected Concentration
1,2,4-Trimethylbenzene	4/27	4.9	12.3
1,2-Dichloropropane	1/27	--	3.3
1,4-Dioxane	1/27	--	15.1
2-Butanone	6/27	9.4	265
2-Propanol	15/27	7.6	4915
Acetone	26/27	10.2	474.8
Benzene	7/27	3.0	7.3
Carbon Disulfide	1/27	--	16.5
Chloroethane	2/27	4.5	8.7
Chloroform	1/27	--	4.3
Chloromethane	7/27	1.9	4.7
Ethanol	27/27	12.6	1583
Freon 11	4/27	6.7	43.3
Freon 12	5/27	4.2	109
Heptane	1/27	--	34.0
Hexane	1/27	--	24.3
m,p-Xylenes	9/27	4.3	10.4
Methyl tert-butyl ehter	1/27	--	18.7
Methylene Chloride	16/27	3.0	11.8
o-Xylene	1/27	--	4.8
Styrene	1/27	--	20.4
Tetrachloroethene	10/27	9.5	81.4
Toluene	23/27	2.8	26.8
Trichloroethene	1/27	--	5.9

All units are in ug/m^3.
*Total includes duplicate sample.

from the well located between O-Co-Nee Pond and the Bay Shore plume approximately 1,400 feet south of the site. Sample PW-2 was collected from the well located within the Brightwaters Yard plume boundary approximately 950 feet south of the Brightwaters Yard.

VOCs and SVOCs were not detected in sample PW-1, with the exception of methyl tert butyl ether (MTBE), at a concentration of 2 ug/l. MTBE is a common additive to gasoline. PW-1 was collected from a well that is currently used for irrigation purposes. A number of VOCs were detected in sample PW-2, with ethylbenzene exhibiting the highest concentration of 100 ug/l. SVOCs were detected as well, with naphthalene exhibiting the highest concentration of 23 ug/l. PW-2 was collected from a well that is currently not used as a source of water for any purpose and the pump and associated piping is currently inoperable.

KEY MAP
SHOWING CROSS−SECTION LINE
SCALE: 1"=200'

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CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

BAY SHORE/BRIGHTWATERS
FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

FIELD OBSERVATIONS OF SUBSURFACE SOIL DEPICTED VERTICALLY IN EXTENDED GEOLOGIC CROSS−SECTION A−A'

PROJECT NO.: 1620−B12C
DATE: JANUARY 2003
SCALE: AS SHOWN
DRAWING NO.: 4A

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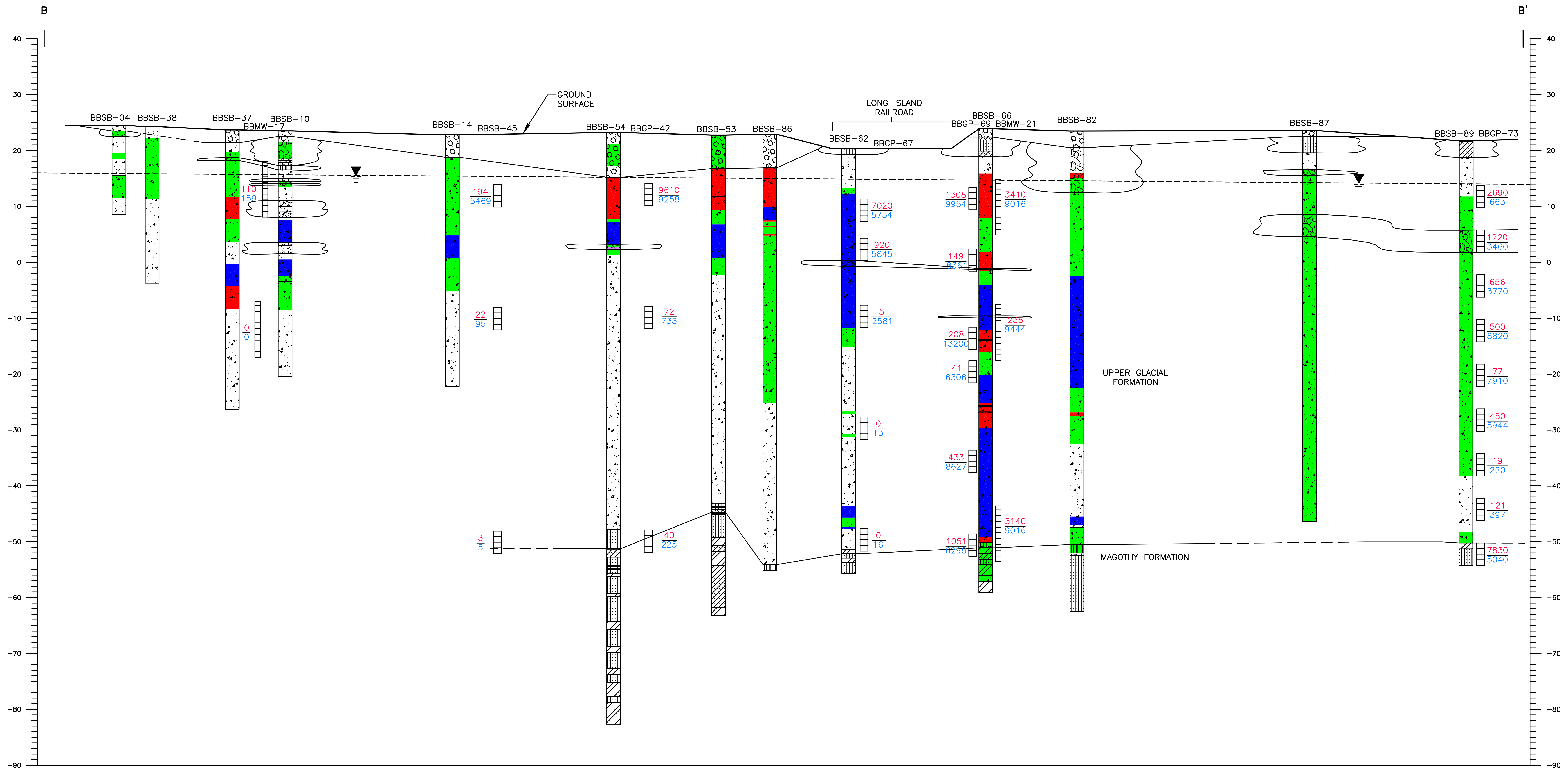
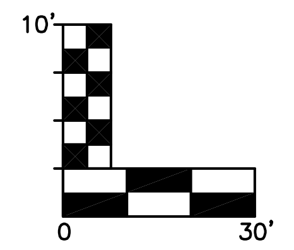
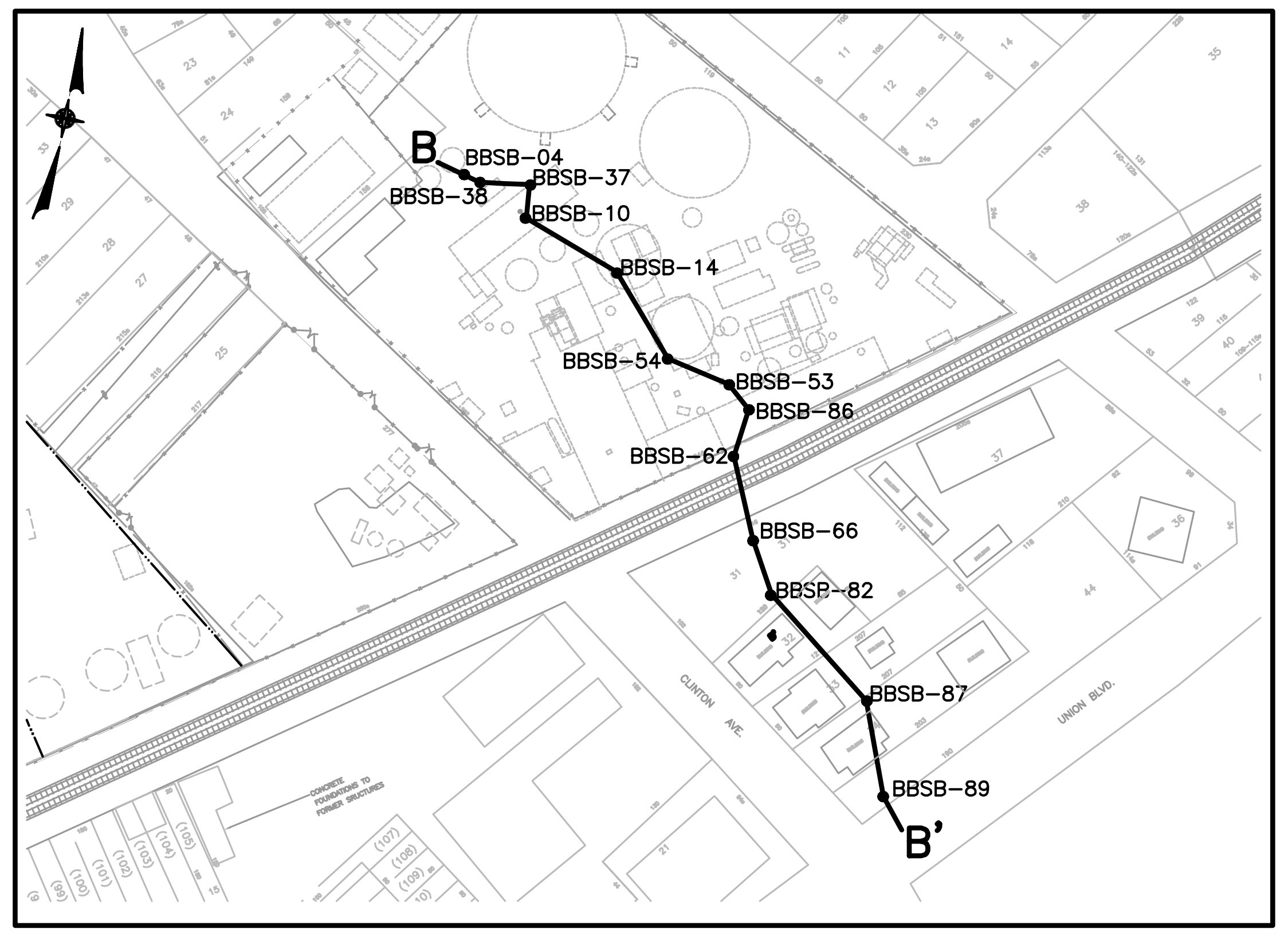


LEGEND

▨	FILL AND/OR TOPSOIL
▨	FINE, MED. TO COARSE SANDS TO FINE, MED. TO COARSE SANDS WITH GRAVEL
▥	SILT TO CLAY RICH SILT
▥	SILTY SAND TO SILT WITH SAND
▨	CLAY
▨	CLAY WITH SAND
▨	GRAVEL, GRAVEL WITH SAND
☐	MATERIAL NOT LOGGED
▥	SOIL BORING
▯	WELL SCREEN FOR MONITORING WELL CLUSTERS
▯	SAMPLING INTERVAL FOR GROUNDWATER PROBE
———	GROUND SURFACE
——— — — —	STRATAGRAPHIC CONTACT, DASHED WHERE INFERRED
- - - - ▼ -	ELEVATION OF WATER TABLE GIVEN IN FEET ABOVE MEAN SEA LEVEL
🟥	NAPL/TAR SATURATED
🟦	BLEBS, GLOBS, LENSES, GRAIN−COATING, SHEENS
🟩	STAINING, AND/OR NAPHTHALENE/HYDROCARBON−LIKE ODORS
🟪	SOLID TAR
433 8627	TOTAL BTEX (ug/L) TOTAL PAH (ug/L)





KEY MAP
SHOWING CROSS−SECTION LINE

SCALE:1"=150'

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BAY SHORE/BRIGHTWATERS
FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

FIELD OBSERVATIONS OF
SUBSURFACE SOIL DEPICTED
VERTICALLY IN
GEOLOGIC CROSS−SECTION
B−B'

PROJECT NO.: 1620−B12C
DATE: JANUARY 2003
SCALE: AS SHOWN
DRAWING NO.: 4B

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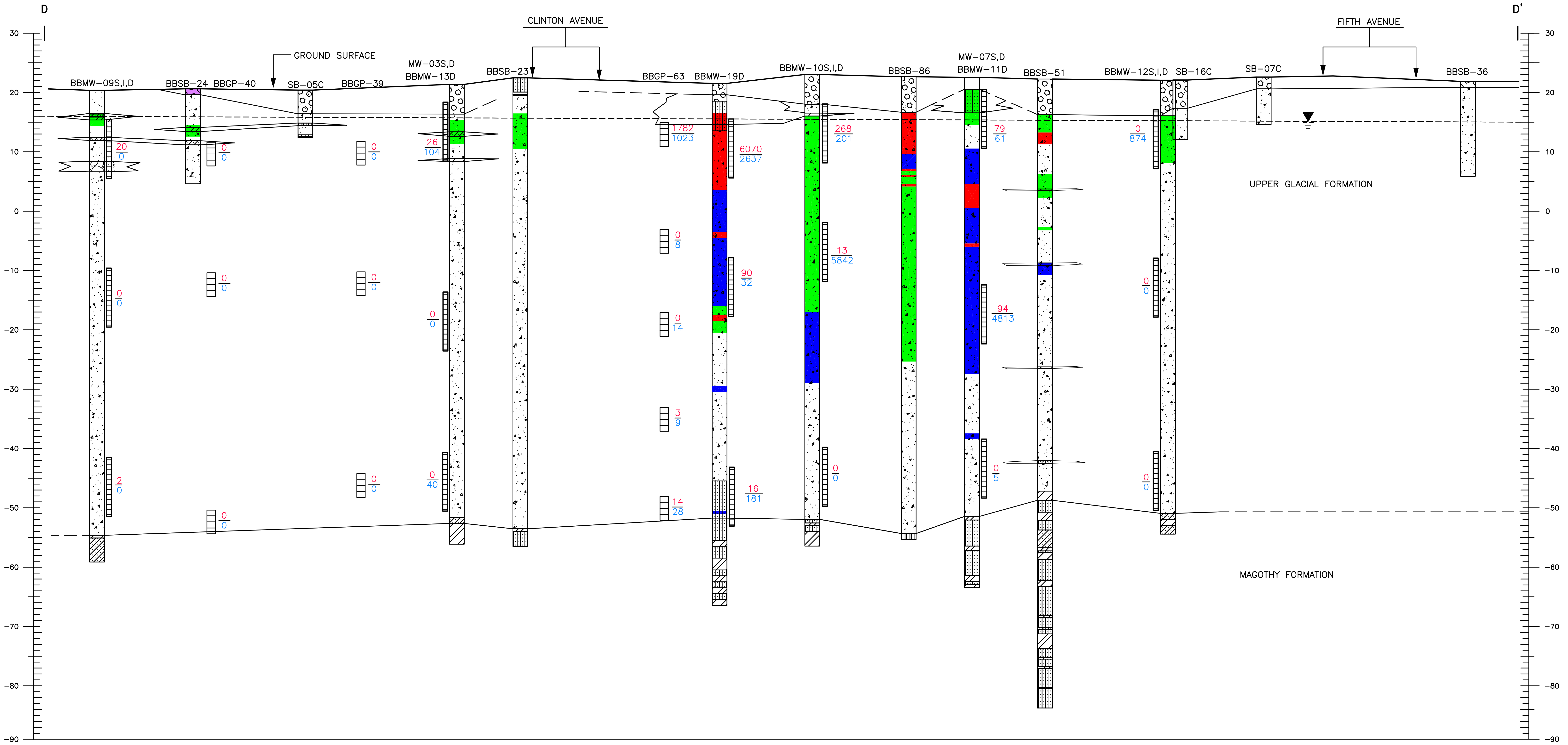


LEGEND

▨ FILL AND/OR TOPSOIL

▨ FINE, MED. TO COARSE SANDS TO FINE, MED. TO COARSE SANDS WITH GRAVEL

▥ SILT TO CLAY RICH SILT

▥ SILTY SAND TO SILT WITH SAND

▨ CLAY

▨ CLAY WITH SAND

▨ GRAVEL, GRAVEL WITH SAND

☐ MATERIAL NOT LOGGED

▥ SOIL BORING

▤ WELL SCREEN FOR MONITORING WELL CLUSTERS

▤ SAMPLING INTERVAL FOR GROUNDWATER PROBE

GROUND SURFACE

STRATAGRAPHIC CONTACT, DASHED WHERE INFERRED

ELEVATION OF WATER TABLE GIVEN IN FEET ABOVE MEAN SEA LEVEL

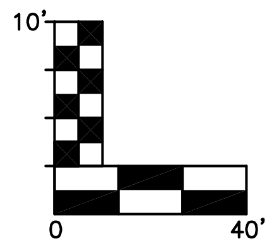
🟥 NAPL/TAR SATURATED

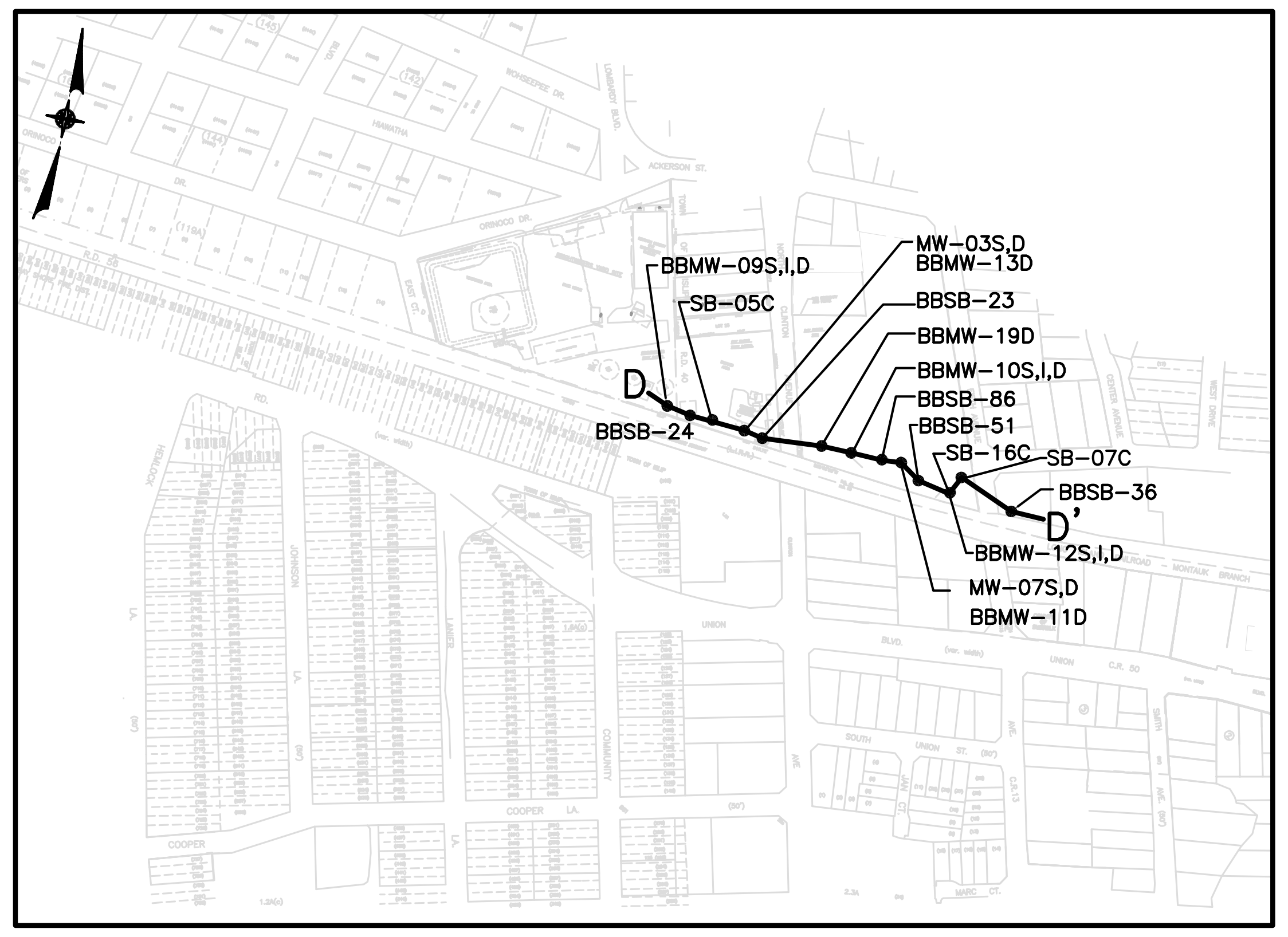
🟦 BLEBS, GLOBS, LENSES, GRAIN-COATING, SHEENS

🟩 STAINING, AND/OR NAPHTHALENE/HYDROCARBON-LIKE ODORS

🟪 SOLID TAR

79/61 TOTAL BTEX (ug/L) / TOTAL PAH (ug/L)





KEY MAP
SHOWING CROSS-SECTION LINE

SCALE:1"=400'

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BAY SHORE/BRIGHTWATERS
FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

FIELD OBSERVATIONS OF SUBSURFACE SOIL DEPICTED VERTICALLY IN GEOLOGIC CROSS-SECTION D-D'

PROJECT NO.: 1620-B12C
DATE: JANUARY 2003
SCALE: AS SHOWN
DRAWING NO.: 4C

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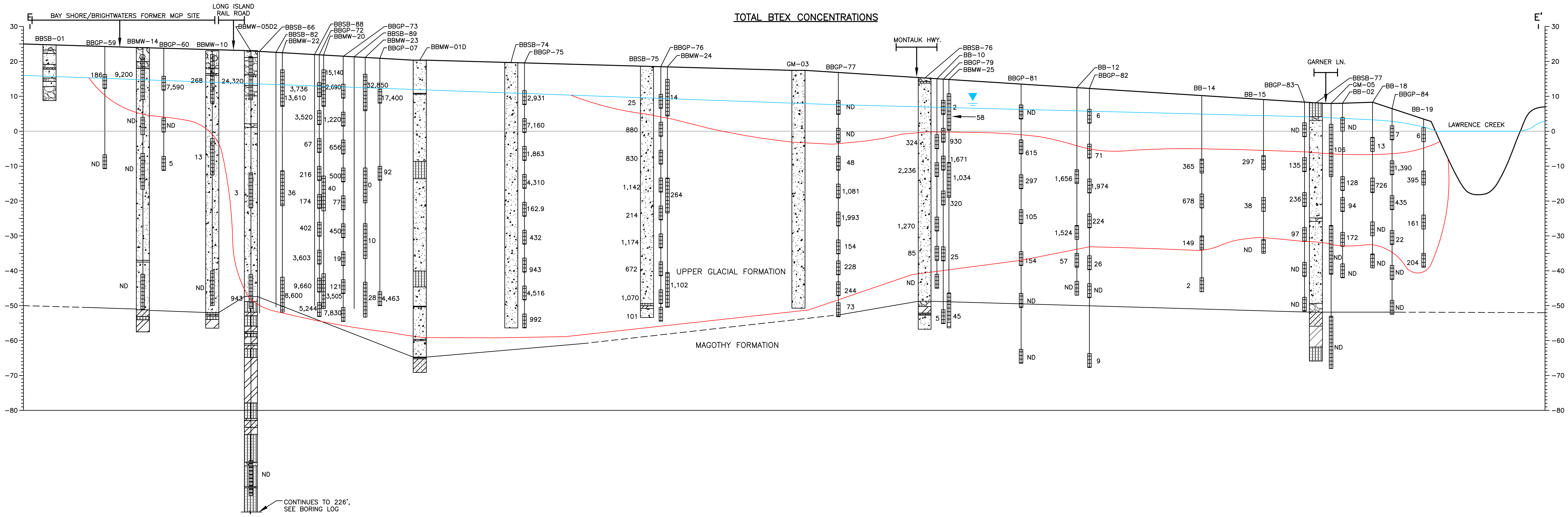
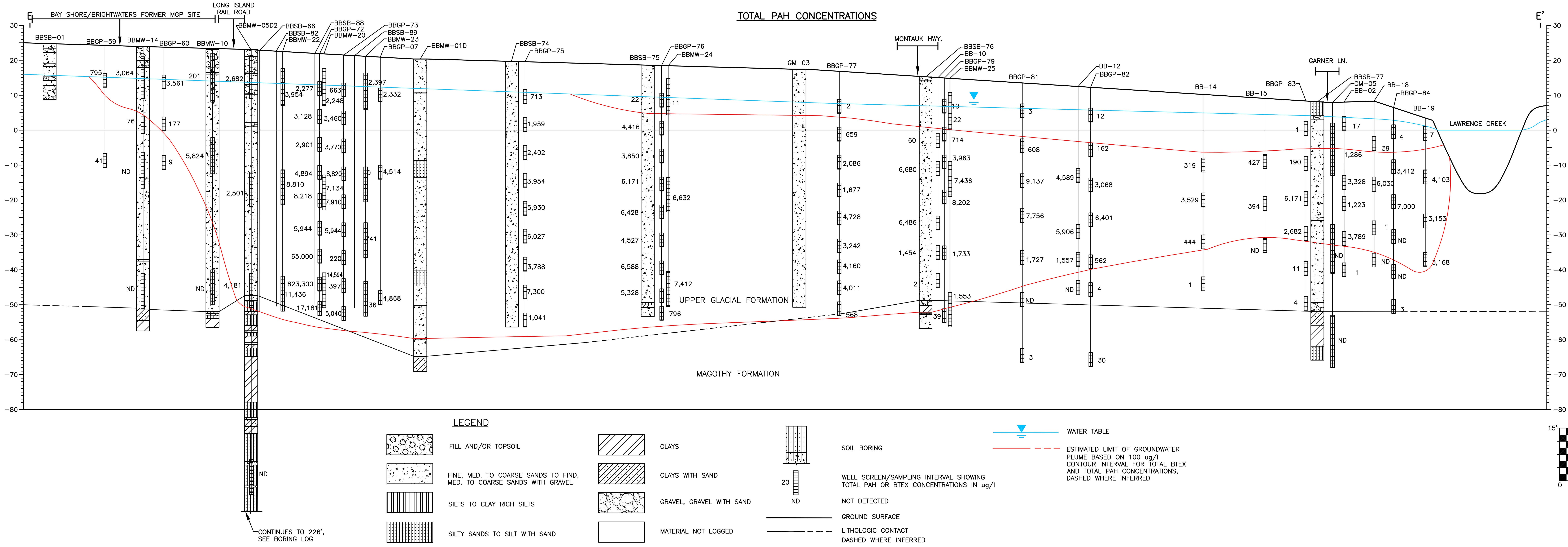


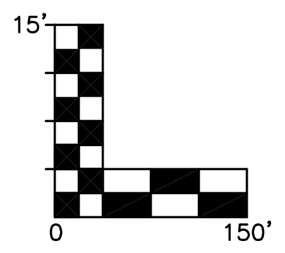


LEGEND

▨	FILL AND/OR TOPSOIL	▨	CLAYS	▥	SOIL BORING
▨	FINE, MED. TO COARSE SANDS TO FIND, MED. TO COARSE SANDS WITH GRAVEL	▨	CLAYS WITH SAND	20 ▯	WELL SCREEN/SAMPLING INTERVAL SHOWING TOTAL PAH OR BTEX CONCENTRATIONS IN ug/l
▥	SILTS TO CLAY RICH SILTS	▨	GRAVEL, GRAVEL WITH SAND	ND	NOT DETECTED
▦	SILTY SANDS TO SILT WITH SAND	☐	MATERIAL NOT LOGGED	———	GROUND SURFACE
				——— - - -	LITHOLOGIC CONTACT DASHED WHERE INFERRED

▼ WATER TABLE

——— - - - ESTIMATED LIMIT OF GROUNDWATER PLUME BASED ON 100 ug/l CONTOUR INTERVAL FOR TOTAL BTEX AND TOTAL PAH CONCENTRATIONS, DASHED WHERE INFERRED



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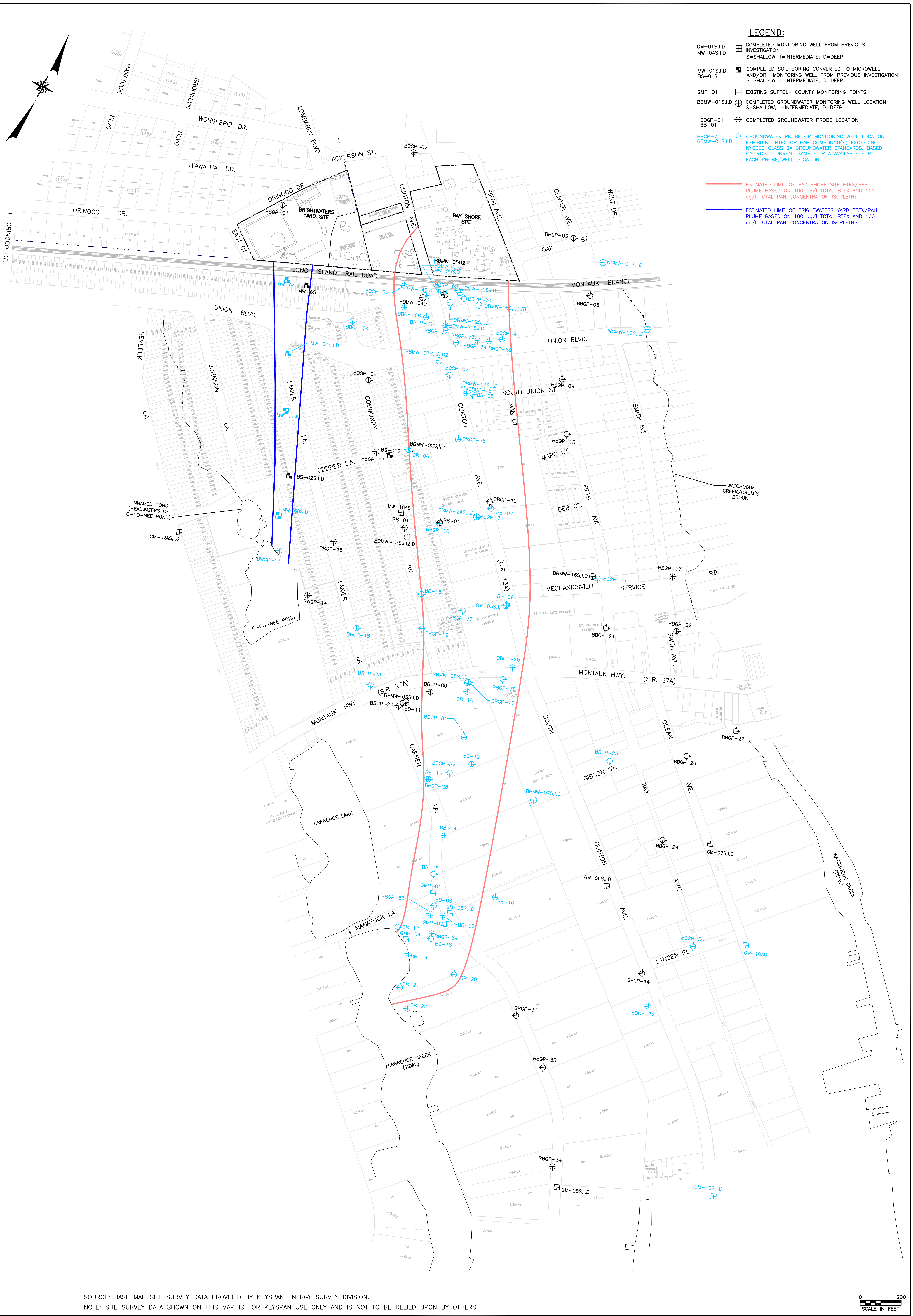
BAY SHORE/BRIGHTWATERS
FORMER MGP SITE FINAL REMEDIAL INVESTIGATION
BAY SHORE, NEW YORK

TOTAL BTEX AND PAH
CONCENTRATIONS IN GROUNDWATER
THROUGH BAY SHORE PLUME
CENTERLINE PLOTTED ON
NORTH–SOUTH GEOLOGIC
CROSS–SECTION E–E'

PROJECT NO: 1620-B
DATE: JANUARY 2003
SCALE: AS SHOWN
DRAWING NO. 4D



SOURCE: BASE MAP SITE SURVEY DATA PROVIDED BY KEYSPAN ENERGY SURVEY DIVISION.

NOTE: SITE SURVEY DATA SHOWN ON THIS MAP IS FOR KEYSPAN USE ONLY AND IS NOT TO BE RELIED UPON BY OTHERS

db **DVIRKA AND BARTILUCCI** CONSULTING ENGINEERS A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.	BAY SHORE/BRIGHTWATERS FORMER MGP SITE FINAL REMEDIAL INVESTIGATION BAY SHORE, NEW YORK	OFF–SITE GROUNDWATER SAMPLE LOCATIONS EXCEEDING NYSDEC CLASS GA GROUNDWATER STANDARDS FOR BTEX AND/OR PAHS	1620–B12C DATE: JANUARY 2003 SCALE: AS SHOWN	DRAWING NO. 4E

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