III. Summary of the Effects of Dredging and CDF Disposal on Air Quality

A. Introduction

As part of the hot spot remedial action, an extensive air monitoring program was designed and implemented to monitor the potential impacts of the cleanup on ambient air quality, and to ensure the protection of site workers and nearby residents from unacceptable levels of airborne PCBs. Previous studies had indicated locally elevated airborne PCB levels in the vicinity of the hot spots (ranging from 196 to 471 ng/m^3 at low tide, NUS 1986), as well as that dredging and disposal activities can promote airborne PCB releases (Ebasco, 1990). As discussed further below, the sampling plan included multiple stations at both the dredging and CDF storage area, and originally focused on potential impacts from the incinerator as well (USACE, 1991).

Due to the very high degree of public concern about the dredging operations, airborne PCB data was made available to the public on a quick turn-around basis. This data was reviewed with the public regularly throughout the duration of the project. A series of airborne PCB action levels were utilized which called for assessments, operational changes or, in the worst case, cessation of operations in the event of elevated airborne PCB levels.

B. Methods

Monitoring stations

Although the incineration component of the remedy was ultimately terminated, ambient monitoring stations originally intended for the assessment of air quality impacts from incineration were retained. Other ambient stations were added to ease public concerns about dredging. The final configuration of monitoring stations is shown in Figure 3-1, and consisted of 6 stations in the dredging area, 6 stations in the immediate CDF area and 4 stations covering offsite areas around the CDF.

The locations of the dredge area stations reflect the predominant southwesterly wind direction during summer, in which higher degrees of PCB volatilization are expected. Logistical issues with the air sampling equipment (i.e., utilities, security, access) also played a role in determining station locations. Duplicate stations were co-located at stations 3 and 13 to provide assessments of overall data quality.

With the exemption of stations 3 and 3D, the samplers were installed on wooden platforms at the breathing zone level approximately 6 feet above the ground. Stations 3 and 3D were located approximately 10 feet above the ground, due to a wind

SOURCE: Base map adapted from USGS 7.5 min series maps(1:25,000), New Bedford North, MA. quad, dated 1979

Figure 3-1. Location of Ambient Air Monitoring Sites New Bedford Harbor Hot Spot Dredging Remedy screen around the CDF in this area. Station 4 was moved on 5/22/95 to the office trailer area, and was redesignated station 17.

Meteorological monitoring

A meteorological monitoring station was located in the CDF area, and included instrumentation for continuous recording of wind speed, wind direction, standard deviation of wind direction, temperature at 2 and 10 m and the difference between the two, precipitation, relative humidity, barometric pressure, and solar radiation. These parameters were recorded for the duration of the dredging program, and the results were used to determine which monitoring stations were upwind or downwind on any given day, and as aids in the overall interpretation of the airborne PCB results.

Sampling program

In order to characterize impacts from the dredging operations, 8-hour integrated samples were collected from stations 11 through 16 and at station 10 on days in which dredging or intrusive activity occurred. The 8-hour period was centered around the high tide during which the dredging activity occurred. For characterization of impacts from the CDF, the six CDF stations were sampled over a 24-hour period twice per week, and the three other off-site stations (7, 8 and 9) were similarly sampled once per week. The days of the week in which sampling occurred at these nine stations were rotated to avoid potential bias from offsite urban activities.

The type of air samplers used were General Metals Works model GPS-1. The sampler contained a quartz glass fiber filter for the removal of particulate-bound PCBs, followed by a sorbent polyurethane foam (PUF)/"XAD" resin plug for the collection of vapor-phase PCBs. Ambient air was drawn through the filter and sorbent plug at a rate of approximately 9 cfm, as monitored using a calibrated magnehelic gauge. After sampling was completed, both the filter and PUF plug were removed and sent for laboratory analysis.

All ambient air monitoring and analysis was performed using a modified version of EPA Method TO-4, "Determination of Oganochlorine Pesticides and Polychlorinated Biphenyls in Ambient Air." The analysis for PCBs was performed using a modified version of the Aroclor-specific EPA method 608. The method was modified so that it was consistent with prior studies, and so that it provided a conservative estimate of airborne PCBs, as follows:

- 4 peak identification for Aroclors 1016, 1242, 1254 and 1260
- external standards for Aroclor 1016 and 1254
- analysis using a packed column

Some initial work focused on congener-specific as opposed to Aroclor-specific airborne PCB analysis, but non-PCB airborne interferants were found to bias the sample results unacceptably high (Virag et al., 1996).

Action Levels

A series of action levels was established prior to the start of remedial operations to manage potential air impacts from the remedial operations. These action levels are presented in Table 3-1. If the airborne PCB monitoring data were to exceed the various action levels (i.e., 50, 500 or 1,000 ng/m^3), then changes in operations or addition of engineering controls were to be implemented as appropriate. During the preliminary stages of the remedial action, in order to further minimize potential air impacts, an additional control measure was added for the dredge area: if any airborne PCB value for stations 11 through 16 were above the 1,000 ng/m^3 level, the dredging operations would be shut down until levels could be lowered. These action levels were built into the remedial action contract, so that EPA and the Corps had clear authority to manage the remedial contractor's activities as appropriate.

For perspective, the dredge area shut-down level, 1,000 ng/m^3 or 1 ug/m^3 for total Aroclors, is the same level as the NIOSH REL for individual Aroclors (NIOSH, 1994). This NIOSH REL is 500 times lower than the lowest Aroclor-specific OSHA PEL (Occupational Safety and Health Administration permissible exposure level) (NIOSH, 1994).

C. Results and Discussion

A summary of the air data collected from March 11, 1994 to September 5, 1995, the last day of dredging, is shown on Table 3-2. The complete air data base is attached in Appendix B. As presented in Table 3-2, of the 4,041 total samples, 1,063 (26%) exceeded the 50 ng/m^3 action level, 49 (1%) exceeded the 500 ng/m^3 action level, and 10 (0.25%) exceeded the 1,000 ng/m^3 action level, including two occasions in which levels at both station 3 and the co-located station 3D were above the 1,000 ng/m^3 criteria.

All but one of the 10 exceedances of the 1,000 ng/m^3 action level occurred at CDF monitoring station 3 or 3D. This station was the closest of all CDF stations to the stored dredged material, approximately 50 ft away. Due to these occasionally elevated levels, engineering controls were implemented at the CDF to minimize airborne PCB levels. These controls included maintenance of a ponded water layer over the dredged sediment, placement of a floating plastic cover on this ponded water layer, and implementation of a sprinkler system to cool this black colored cover as a way to minimize temperature dependent volatilization of the PCBs.

Table 3-1. Airborne PCB Action Levels and Corrective Measures

Case	Air Concentration	Action
1.	50 ng/m^3 measured in any one sampling event	Contractor shall notify the Contracting Officer and provide an explanation of why the elevated ambient concentration was observed.
2.	50 ng/m^3 measured in two or more consecutive sampling events	Contractor shall take action outlined for Case 1 above and propose operational changes to control emissions.
3.	50 ng/m^3 measured in more than 50% of ten consecutive sampling events (i.e., 5 out of 10)	The Contractor shall take action outlined above for Case 2 and shall develop and present to the Contracting Officer a plan to provide physical emission controls and contingencies.
4.	0.5 ug/m^3 measured in any one sampling event	Contractor shall notify the Contracting Officer, provide an explanation of why the elevated ambient concentration was observed and be prepared to take immediate operational changes to control emissions.
5.	1.0 ug/m^3 measured in any one sampling event	Contractor shall take the action outlined in Case 4 above and shall be prepared to implement immediate physical emission controls and contingencies (e.g., vapor suppression foams).

Table 3-2. Summary of Airborne PCB Sampling Results
New Bedford Harbor Hot Spot Dredging Remedy

SAMPLE LOCATION	TOTAL # OF SAMPLES COLLECTED	AVERAGE CONC. (NG/M3)	ACTION LEVEL EXCEEDENCES >50 ng/m3	>500 ng/m3	>1000ng/m3
ON-SITE					
1	204	33.19	37	0	0
2	204	44.18	55	0	0
3	200	180.11	107	22	7
3D	161	147.70	87	9	2
4	131	14.04	6	0	0
5	162	20.06	18	0	0
6	206	51.98	68	0	0
17	30	52.29	13	0	0
NEAR SITE					
7	86	9.45	0	0	0
8	94	8.45	0	0	0
9	94	14.92	11	0	0
DREDGE					
10	311	29.17	52	0	0
11	313	174.12	251	12	1
12	313	28.69	50	0	0
13	313	80.99	143	4	0
13D	282	77.54	121	2	0
14	314	11.16	13	0	0
15	313	23.08	28	0	0
16	310	10.09	3	0	0
TOTAL					
	4041		1063	49	10

NOTE: SUMMARY OF DATA FROM 03/11/94 TO 09/05/95

The one dredge area exceedance of the 1,000 ng/m^3 action level also occurred at the closest dredge area station, station 11, approximately 30 ft away from the most contaminated hot spot area. This exceedance occurred on April 25, 1994, the day before actual dredging began, during initial deployment of various dredging-related equipment. This one dredge area exceedance is attributed to poor performance of silt curtains that were initially planned to help minimize sediment resuspension. Use of the silt curtains around the dredge was abandoned as a result of these initial findings.

Other operational changes were made as well in order to minimize airborne PCB levels in the dredge area, including a) decreasing the sweep speed of the cutterhead, b) modification of the dredging sequence so that the most contaminated areas were dredged during the winter, and c) initiation of night time dredging during the summer months to minimize the influence of temperature and solar radiation on the volatilization of any PCBs that migrated to the water surface as a result of dredging.

PCBs in the vapor phase

Importantly, although the monitoring protocol called for the reporting of total PCBs as opposed to differentiating between particulate-bound and vapor phase PCBs, we believe that the vast majority of airborne PCBs were in the vapor phase. This is due to the nature of the remedial operations (creation of dust that would carry attached PCBs was not a characteristic of this site nor this remedy), the seasonality of the airborne PCB levels (levels were much higher in summer than in winter), and the low molecular weight Aroclor typically identified during the sampling program (see next paragraph). One sample from station 3 did differentiate the PCB mass associated with the filter from that associated with the sorbent plug portion of the air sampler: the results (1.3 ug/filter, 368 ug/plug; Virag et al., 1996) are consistent with the conclusion that airborne PCBs were largely in the vapor phase.

The specific Aroclor typically identified during the sampling program was Aroclor 1016. Aroclor 1016 contains mostly tri-chlorinated PCB congeners, and no congeners greater than the tetra-chlorinated group (Table 3-3). The lighter molecular weight, predominating congeners of Aroclor 1016 have higher vapor pressures than the more chlorinated isomers (Table 3-4), and would thus be expected to evaporate more readily. Aroclor 1016 was by far the most prevalent Aroclor identified during the sampling program: on average, Aroclor 1016 accounted for 99.74 to 100% of the total PCBs reported for each sampling station (Weston, 1997).

In terms of other factors that affected airborne PCB levels, Virag et al. (1996) found that wind direction, wind speed, air temperature and solar radiation all played a statistically significant role in detected PCB concentration.

Table 3-3. Typical percent composition of some commercial PCB mixtures

	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Clophen A 30	Clophen A 60	Kanechlor 300	Kanechlor 400	Kanechlor 500
Mono-CBs	2	1	—	—	—	—	—	—	—	—
Di-CBs	19	13	1	—	—	20	—	17	3	—
Tri-CBs	57	45	21	1	—	52	—	60	33	5
Tetra-CBs	22	31	49	15	—	22	1	23	44	26
Penta-CBs	—	10	27	53	12	3	16	1	16	55
Hexa-CBs	—	—	2	26	42	1	51	—	5	13
Hepta-CBs	—	—	—	4	38	—	28	—	—	—
Octa-CBs	—	—	—	—	7	—	4	—	—	—
Nona-CBs	—	—	—	—	1	—	—	—	—	—
Deca-CB	—	—	—	—	—	—	—	—	—	—

Source: USEPA, 1996a (originally adapted from Silberhorn et al., 1990, and ATSDR, 1995)

Table 3-4. Vapor pressures of some PCB congeners

	congener IUPAC No.	subcooled liquid vapor pressure at 25 °C (Torr)
biphenyl	0	2.8×10^{-2}
2-chlorobiphenyl	1	1.9×10^{-2}
3-chlorobiphenyl	2	7.5×10^{-3}
4-chlorobiphenyl	3	6.8×10^{-3}
2,2′-dichlorobiphenyl	4	4.5×10^{-3}
2,4-dichlorobiphenyl	7	1.9×10^{-3}
4,4′-dichlorobiphenyl	15	6.0×10^{-4}
2,4,4′-trichlorobiphenyl	28	1.8×10^{-4}
2,4,5-trichlorobiphenyl	29	3.3×10^{-4}
2,4′,5-trichlorobiphenyl	31	2.1×10^{-4}
2′,3,4-trichlorobiphenyl	33	1.4×10^{-4}
2,2′,3,5′-tetrachlorobiphenyl	44	8.8×10^{-5}
2,2′,4,4′-tetrachlorobiphenyl	47	8.9×10^{-5}
2,2′,3,5′,6-pentachlorobiphenyl	95	4.7×10^{-5}
2,3,3′,4′,6-pentachlorobiphenyl	110	1.9×10^{-5}
2,3,4,5,6-pentachlorobiphenyl	116	1.7×10^{-5}

Source: Anderson and Hites, 1996

D. Conclusions

The extensive air monitoring program implemented for the hot spot dredging and interim storage operations revealed occasionally elevated airborne PCB levels. Most of the exceedances of the 500 and 1,000 ng/m^3 action levels occurred at the CDF area as opposed to the dredge area, and no such exceedances occurred in the months of September through February.

Operational practices and engineering controls served to minimize airborne levels, to an extent that no exceedances of the 1,000 ng/m^3 dredge area shut down level occurred once dredging actually began. Control of airborne PCB emissions did contribute, however, to a slower rate of dredging and thus a longer project duration.

A number of important operational lessons were learned as a result of this project that can be applied to the next phase of remedial dredging planned for the harbor (USEPA, 1996b). These include a) silt curtains should not be used around the dredge(s), b) even though sediment PCB levels will be lower, some form of emissions control at the CDFs will most likely be required if similar airborne PCB action levels are employed, and c) airborne PCB monitoring need not be as frequent during winter as in summer. Also, given the $1.3 million cost of this monitoring program, alternative air monitoring technologies should be reviewed for appropriateness and cost-effectiveness for future dredging operations.

Finally, the comprehensive nature of the air monitoring program clearly demonstrated that migration of PCBs via the air pathway does occur, especially during warmer temperatures. Characterization or cleanup at other PCB-contaminated sites should therefor include an effective airborne PCB monitoring program.

IV. Summary of the Effects of CDF Effluent on Water Quality

A. Introduction

Since one of the primary operational goals of the hot spot dredging project was to minimize sediment resuspension, large volumes of water were "codredged" (i.e., high operating vacuums were used on the dredge) as one of several engineering controls to minimize sediment resuspension. This section summarizes the treatment operations for this dredged water, including a discussion of the effluent limitations employed and an analysis of the chemical and biological effects of the treated discharge on the receiving waters.

Flow rates into the CDF during periods of dredging (i.e., at high tide) varied between 1500 and 2100 gpm, with typically only 5% solids. The process of dredging and pumping the dredged material roughly one mile to the CDF via floating pipeline increased the concentration of PCBs and certain metals in the liquid phase by roughly one to two orders of magnitude. From CDF cell #1 the dredged water was decanted over a slide gate to cell #2, and from there pumped to a water treatment plant (Figure 4-1). Approximately 160 million gallons of decant water was treated during the 16 months of the project at an average rate of about 350 gpm. The treated effluent was discharged to the Acushnet River near the northeastern corner of the CDF. The overall goal of the water treatment process was to control and minimize the amount of contaminants discharged to the river.

B. Methods

Discharge limits

Discharge limitations for the hot spot water treatment plant were developed during the design phase of the project, and reflected performance testing of wastewater treatment technology and existing water quality conditions. The monthly average discharge limits are displayed in Figure 4-2, along with relevant EPA ambient water quality criteria (AWQC) and average background water quality conditions as measured at NBH-2, the Coggeshall Street bridge, to provide perspective. The daily maximum discharge limitations, which are not shown in Figure 4-2, were as follows: chromium - 12.8 ug/l; cadmium - 10.7 ug/l; lead -8.5 ug/l; copper - 14.9 ug/l; PCBs (defined for this project as the sum of Aroclors 1242 and 1254) - 1.3 ug/l.

Note that the background averages displayed in Figure 4-2 for lead (n=84), copper (n=84) and PCBs (n=111) reflect a large, four season data base collected in 1994 and 1995 during hot spot dredging, whereas those for chromium and cadmium reflect smaller data bases collected during the winter of 1988/1989. Collection of the more recent, larger data base for PCBs, copper and lead during

Figure 4-1. Areal Schematic of the Hot Spot CDF

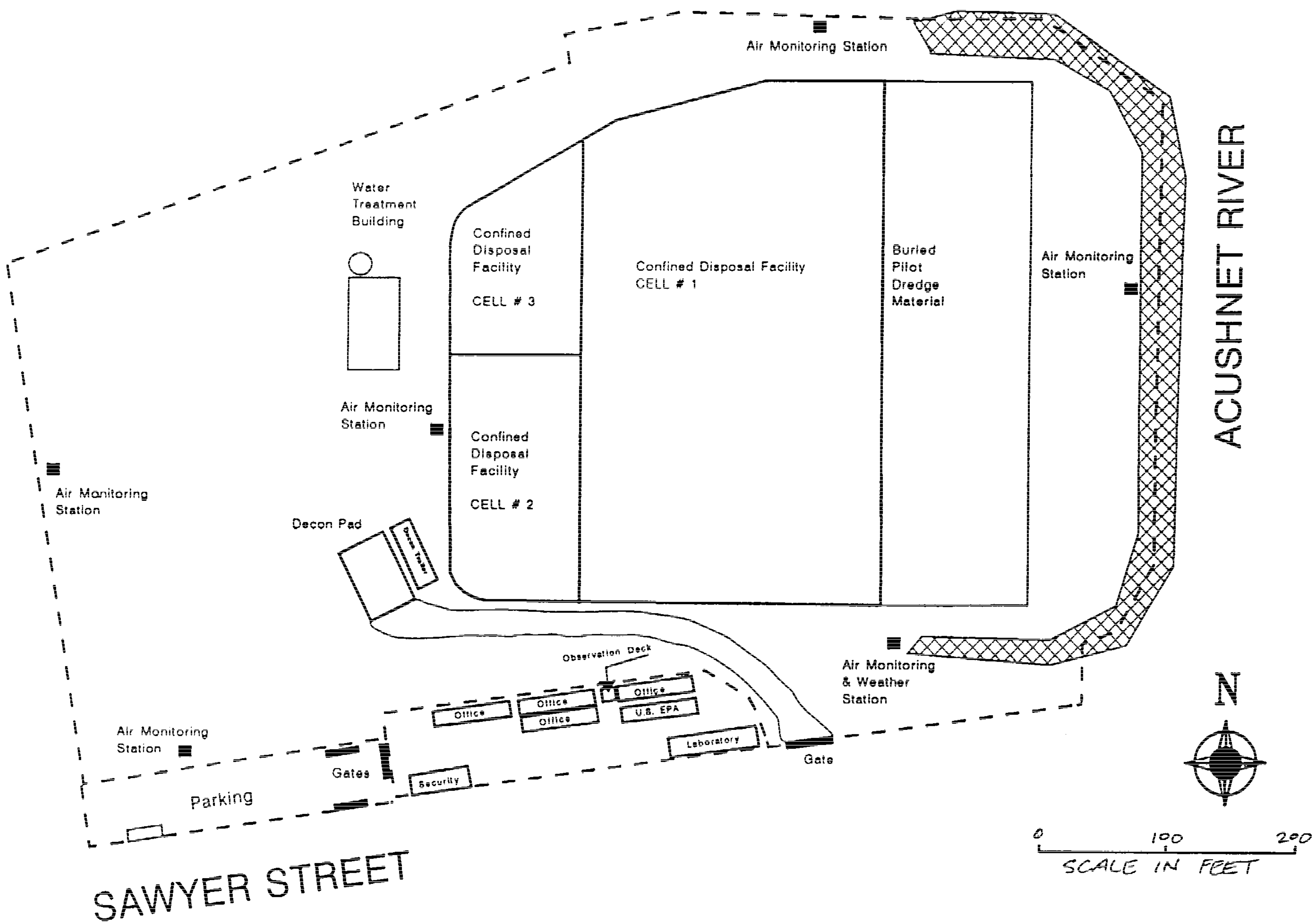
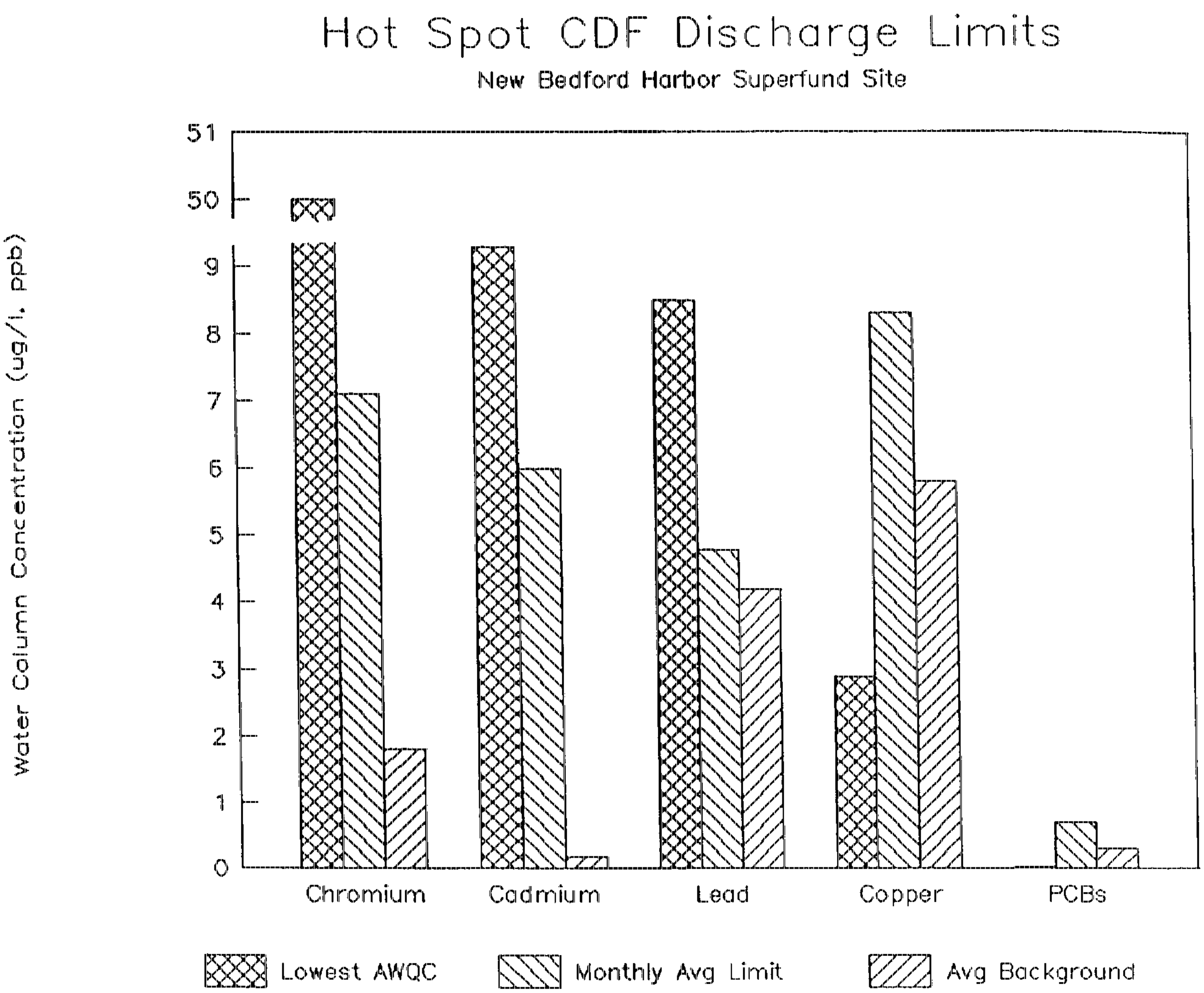


Figure 4-2


Hot Spot CDF Discharge Limits
New Bedford Harbor Superfund Site
Water Column Concentration (ug/l, ppb)
51
50
9
8
7
6
5
4
3
2
1
0
Chromium
Cadmium
Lead
Copper
PCBs
Lowest AWQC
Monthly Avg Limit
Avg Background

the hot spot dredging lowered the average "ambient" values compared to those previously calculated in 1988/1989. Thus the background values displayed in Figure 4-2 for chromium and cadmium may be biased high. Also, use of a single value to reflect background concentrations obviously does not reflect existing spatial and temporal variability, but is used here as a simplifying approach to provide the reader with a quick perspective of ambient water quality as measured at a central, well-mixed point in the harbor.

In summary, the monthly average discharge limitations for chromium, cadmium and lead were below marine chronic AWQC, setting very ecologically protective treatment criteria for these metals. For copper and PCBs, however, the monthly average limits were set above the chronic AWQC, reflecting the elevated, above-AWQC background levels of these substances and laboratory-based performance expectations of the treatment system. As discussed further below, the actual operational levels of copper and PCBs discharged were generally below ambient background levels.

Treatment methods

The treatment technologies used to obtain the hot spot discharge criteria included primary settling in cell #1, equalization in cell #2, flocculation, secondary settling in cell #3, sand filtration, polishing filtration and ultraviolet light/hydrogen peroxide treatment (Figure 4-3). The treatment plant was operated by staff from Metcalf & Eddy, Inc. a subcontractor to the Corps' prime contractor for the hot spot dredging, Perland Environmental Technologies, Inc.

Ambient impact monitoring

Finally, station NBH-7 was included in the monitoring effort for the evaluation of potential biological and chemical effects in the Acushnet River in the immediate vicinity of the CDF discharge. This monitoring station was included to provide the ability, in the event of unacceptable ecological effects detected during dredging, to differentiate between effects from the cutterhead and effects from the CDF discharge. As described in more detail in section II, the monitoring protocol for NBH-7 included analysis for PCBs, Cu and Pb, as well as toxicity testing using the sea urchin (Arbacia punctulata) sperm cell test, the seven day mysid (Mysidopsis bahia) survival test, and the red alga (Champia parvula) survival test.

C. Results and Discussion

Figures 4-4, 4-5, and 4-6 illustrate the actual levels of PCBs, Cu and Pb discharged (as monthly averages), along with the respective AWQC and background concentrations of these pollutants. Effluent quality was generally at or below background for these contaminants of most concern. PCBs and Cu stand out since their background concentrations are above AWQC by factors of about 10 and

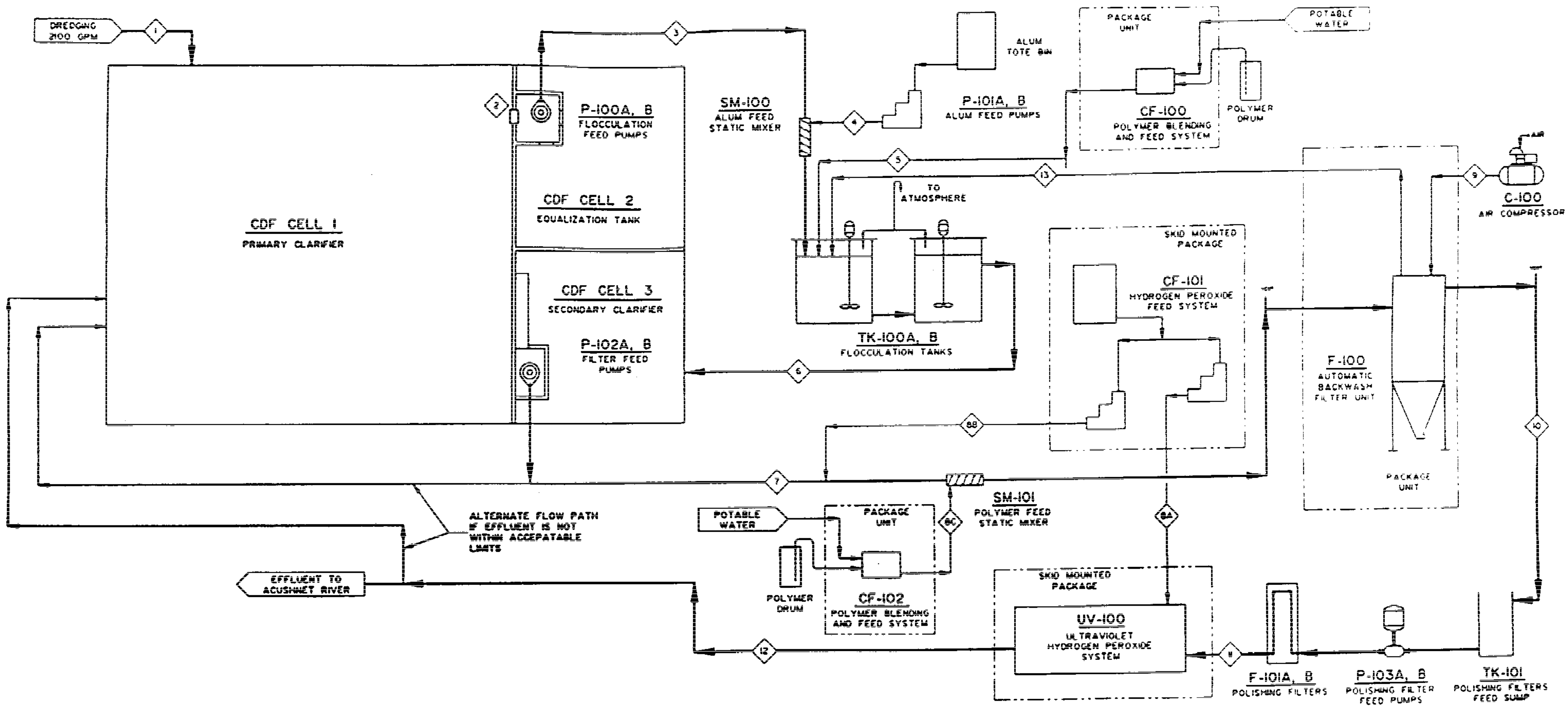


Figure 4-3
New Bedford Harbor Superfund Site
Water Treatment Plant Schematic
for the Hot Spot Dredging Project

Figure 4-4

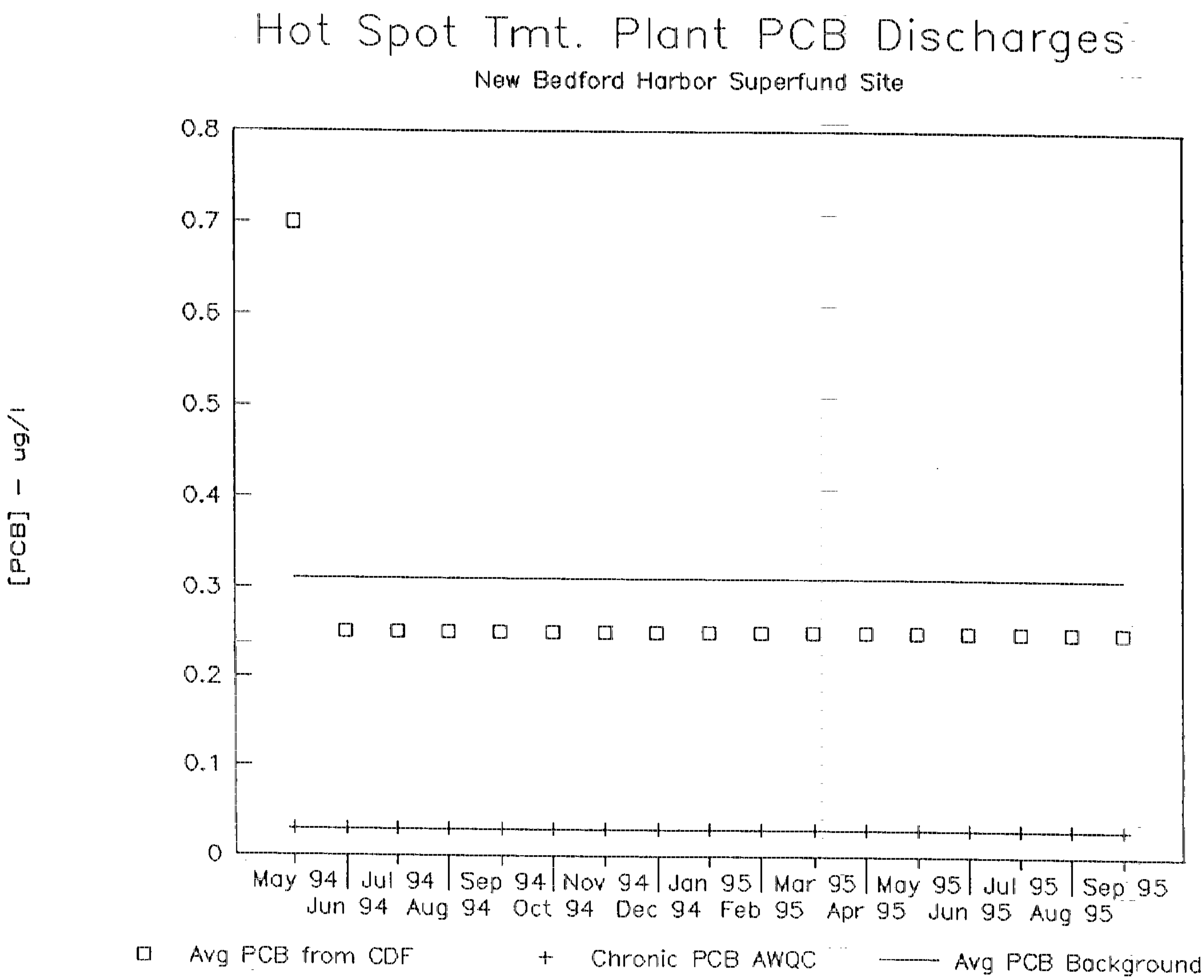

Hot Spot Tmt. Plant PCB Discharges
New Bedford Harbor Superfund Site
[PCB] – ug/l
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
May 94
Jun 94
Jul 94
Aug 94
Sep 94
Oct 94
Nov 94
Dec 94
Jan 95
Feb 95
Mar 95
Apr 95
May 95
Jun 95
Jul 95
Aug 95
Sep 95
Avg PCB from CDF
Chronic PCB AWQC
Avg PCB Background

Figure 4-5

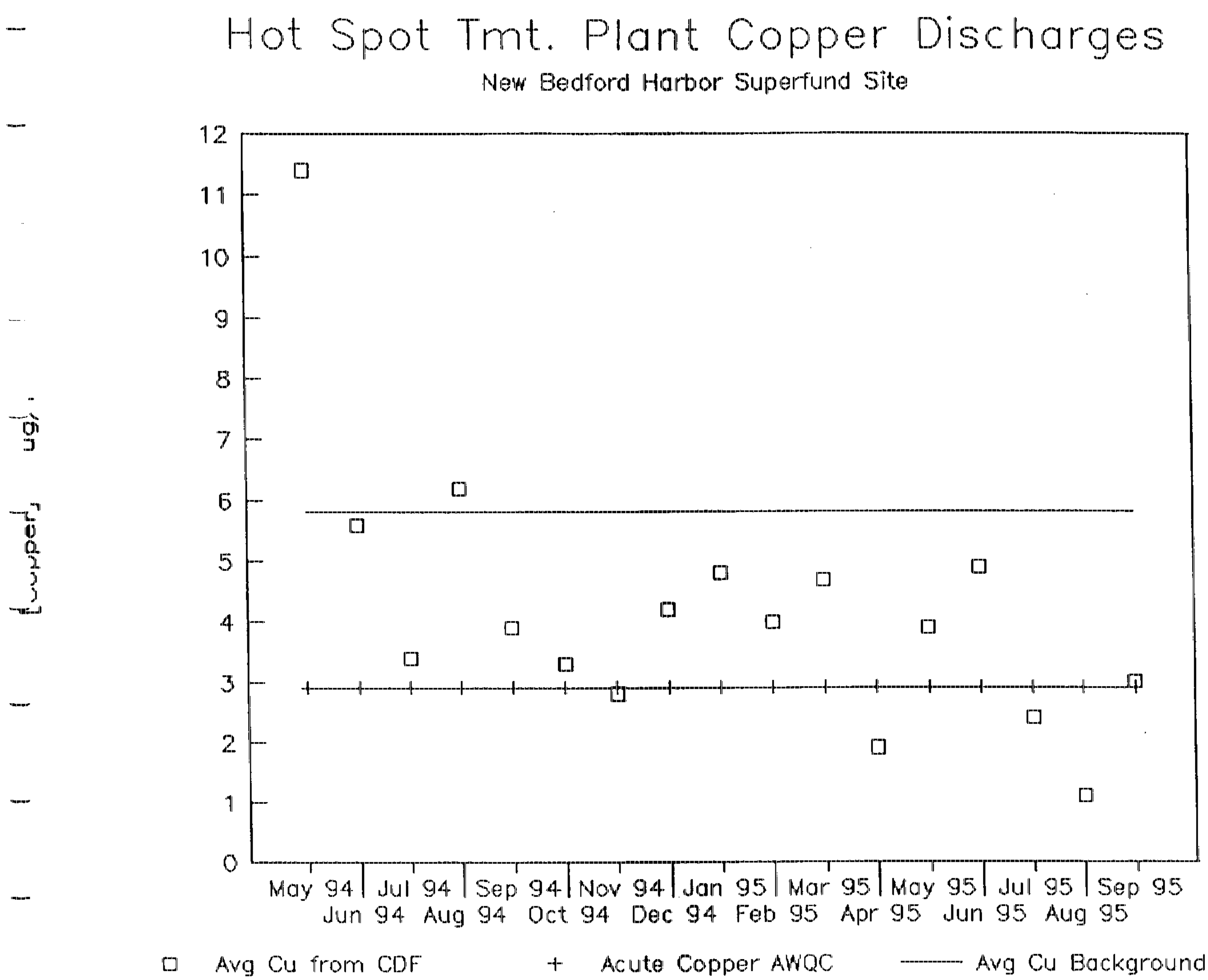
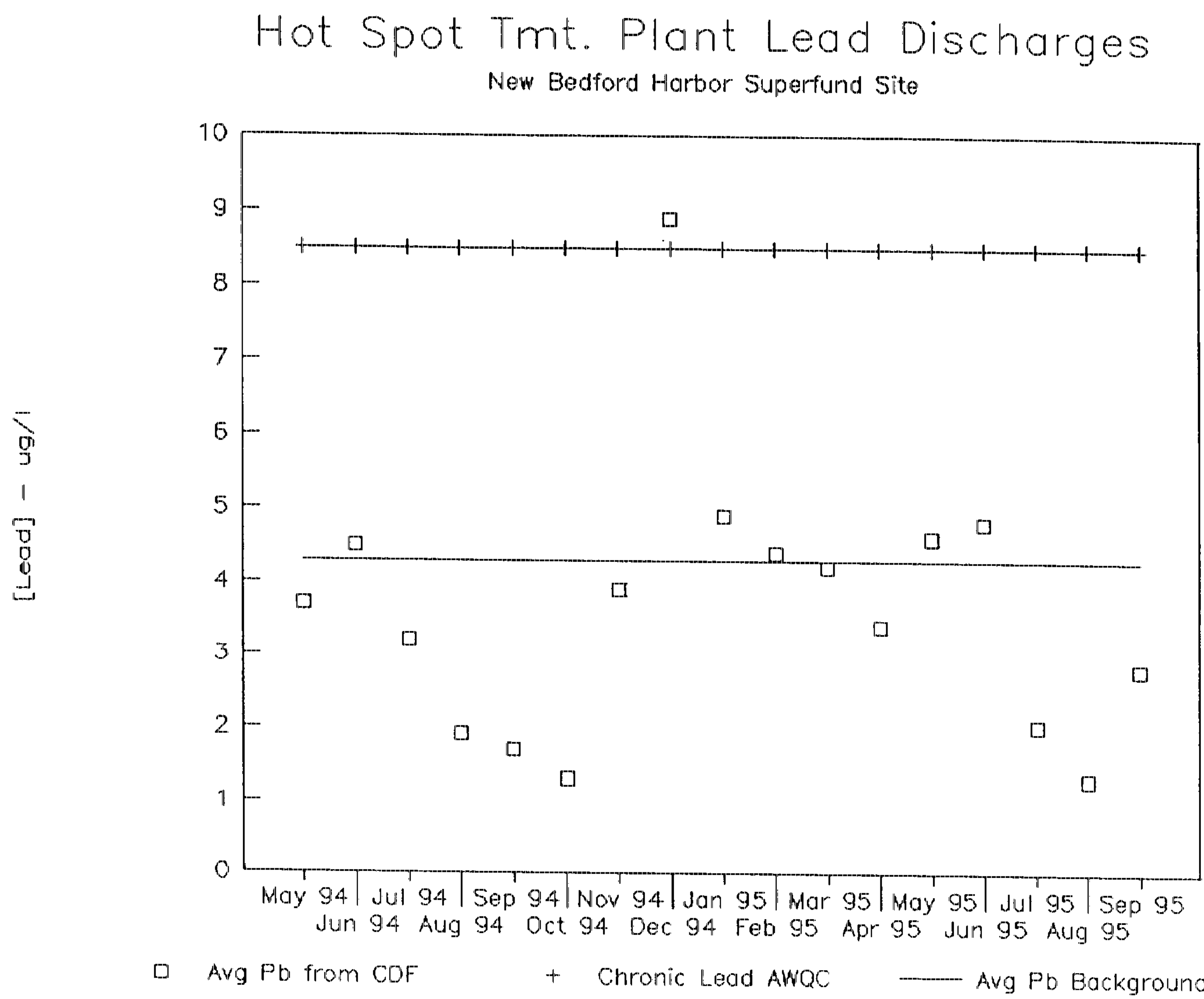

Hot Spot Tmt. Plant Copper Discharges
New Bedford Harbor Superfund Site
12
11
10
9
8
7
6
5
4
3
2
1
0
May 94
Jun 94
Jul 94
Aug 94
Sep 94
Oct 94
Nov 94
Dec 94
Jan 95
Feb 95
Mar 95
Apr 95
May 95
Jun 95
Jul 95
Aug 95
Sep 95
Avg Cu from CDF
Acute Copper AWQC
Avg Cu Background

Figure 4-6


Hot Spot Tmt. Plant Lead Discharges
New Bedford Harbor Superfund Site
[Lead] - ug/l
10
9
8
7
6
5
4
3
2
1
0
May 94
Jun 94
Jul 94
Aug 94
Sep 94
Oct 94
Nov 94
Dec 94
Jan 95
Feb 95
Mar 95
Apr 95
May 95
Jun 95
Jul 95
Aug 95
Sep 95
Avg Pb from CDF
Chronic Lead AWQC
Avg Pb Background

2, respectively. For Pb on the other hand, although some of the monthly average results are slightly above background, they are, with one minor exception, all below the chronic AWQC. The one exception occurred in December 1994, with an average discharge of 8.9 ug/l (n=13) versus a chronic AWQC of 8.5 ug/l. Since the background Pb level is roughly one-half that of the AWQC, this was not expected to cause adverse impacts due to available dilution in the receiving water and the minor nature of the exceedance. For Cd and Cr, although not displayed, neither the monthly average or daily maximum results ever exceeded chronic AWQC.

Regarding PCB compliance, PCBs were actually detected on only one occasion (5/27/94) at a reported concentration of 4.3 ug/l. Although this exceeded the daily limit of 1.3 ug/l, the monthly average limit of 0.71 ug/l was not exceeded. All other reported discharges were below the detection limit of 0.25 ug/l for both Aroclor 1242 and 1254. As a result, with the assumption that both of these Aroclors were present at one-half the detection limit, discharged PCB concentrations have been reported at 0.25 ug/l.

Regarding heavy metal compliance, the only monthly average limits exceeded were Cu in May 1994 (11.4 ug/l), and Pb in December 1994 (8.9 ug/l) and January 1995 (4.9 ug/l). The May 1994 Cu average and the December 1994 Pb average stand out as anomalies within the data set. The May 1994 Cu average may be due to plant start up, since Cu averages trended downward throughout the rest of the project (Figure 4-5). The December 1994 Pb average may be due to elevated lead levels in the sediment area being dredged at the time, or the fact that roughly half of the lead concentration during this time frame was in the soluble form (additional investigations into dissolved versus particulate Pb fractions were initiated to troubleshoot the Pb problem).

In terms of the in-stream biological effects from the CDF discharge, the aquatic toxicity testing data from NBH-7 demonstrated a lack of significant acute impact compared to control seawater from NBH-5, located approximately 12 km seaward in Buzzards Bay. Please refer to Appendix A for the specific results of the toxicity testing from this station.

D. Conclusions

The ecologically protective strategy of the dredging operations resulted in large volumes of water codredged along with the highly contaminated hot spot sediments. Successful design, construction and operation of the associated CDF and water treatment plant, however, combined to prevent adverse impacts as a result of the discharge of this water. Discharges of Pb, Cd and Cr were generally below chronic marine AWQC, and discharges of PCBs and Cu were generally below background (but above PCB and Cu AWQC). Moreover, the aquatic toxicity testing from station NBH-7 confirmed a lack of acute biological impacts as a result of the CDF discharge.

The hot spot water treatment experience provided valuable information for the planning and design of the much larger remedy for the upper and lower harbor (USEPA, 1996b), although more influent data would have been beneficial. The technology-based discharge limits for Pb, Cr and Cd, which were below chronic AWQC, were lower than theoretically necessary to protect marine organisms, although the treatment technology was appropriate for the reduction of other pollutants of concern. Ultimately, the protective nature of the water treatment operations cost approximately 0.025 $/gallon, including the construction and operation costs of the water treatment plant (but excluding those costs for the CDF itself). This cost will be partially offset, however, since the water treatment plant is planned for reuse as part of the remedy for the upper and lower harbor.

V. References

Anderson, P.N. and R.A. Hites. 1996. OH Radical Reactions: the Major Removal Pathway for Polychlorinated Biphenyls from the Atmosphere. Environ. Sci. Technol., 30, 1756-1763.

ATSDR (Agency for Toxic Substances and Disease Registry). 1995. Toxicological Profile for Polychlorinated Biphenyls. Atlanta: ATSDR, draft for public comment.

Bergen, B.J., W.G. Nelson and R.J. Pruell. 1993a. The bioaccumulation of PCB congeners in mussels deployed in New Bedford Harbor. Environmental Toxicology and Chemistry, 12, pp. 1671-1681.

Bergen, B.J., W.G. Nelson and R.J. Pruell. 1993b. The partitioning of PCB congeners in the water column of New Bedford Harbor. Environmental Science and Technology, 27, pp. 938-942.

Ebasco Services, Inc. (Ebasco). 1990. Final Air Monitoring Report: New Bedford Harbor Pilot Dredging and Disposal Study; prepared for USEPA under EPA Contract No. 68-01-7250; Work Assignment No. 04-1L43.

National Institute for Occupational Safety and Health (NIOSH). 1994. NIOSH Pocket Guide to Chemical Hazards; U.S. Department of Health and Human Services/Public Health Service/Centers for Disease Control and Prevention/NIOSH. June 1994.

Nelson, W.G. and D.J. Hansen. 1991. Development and use of site-specific chemical and biological criteria for assessing New Bedford Harbor Pilot Dredging Project. Environmental Management 15(1), pp. 105-112.

Nelson, W.G., R.J. Pruell and D.J. Hansen. 1994. Monitoring plan and decision criteria for remediation of the second operable unit ("Hot spot") at the New Bedford Harbor, MA, Superfund site. U.S. Environmental Protection Agency, Office of Research and Development, NHEERL, Atlantic Ecology Division, Narragansett, RI.

Nelson, W.G., B.J. Bergen and D.J. Cobb. 1995. Comparison of PCB and Trace Metal Bioaccumulation in the Blue Mussel, Mytilus edulis, and the Ribbed Mussel, Modiolus demissus, in New Bedford Harbor, MA. Environmental Toxicology and Chemistry, 14 (3), pp. 513-521.

Nelson, W.G. and T. Gleason. 1995. Deployment and retrieval of caged bivalves for environmental monitoring. Standard Operating Procedure # 1.02.002, U.S. Environmental Protection Agency, Office of Research and Development, NHEERL, Atlantic Ecology Division, Narragansett, RI.

Nelson, W.G., B.J. Bergen, S.J. Benyi, G. Morrison, R.A. Voyer, C.J. Strobel; S. Rego, G. Thursby and C.E. Pesch. 1996. New Bedford Harbor Long-Term Monitoring Assessment Report: Baseline Sampling. U.S. Environmental Protection Agency, National Health and Environmental Effects Reseach Laboratory, Atlantic Ecology Division, Narragansett, RI. EPA/600/R-96/097.

NUS Corporation (NUS). 1986. Draft Ambient Air Monitoring Program, Acushnet River Estuary, New Bedford, Massachusetts, Volume 1. February 1986.

Silberhorn, E.M.; Glauert, H.P.; and L.W. Robertson. 1990. Carcinogenicity of Polychlorinated Biphenyls: PCBs and PBBs. Crit. Rev. Toxicol. 20(6):439-496.

USACE. 1990. New Bedford Harbor Superfund Pilot Study, Evaluation of Dredging and Dredged Material Disposal; U.S. Army Corps of Engineers, New England Division. May 1990.

USACE. 1991. Specifications (for Construction Contract), Request for Proposal No. DACW45-92-R-0020, Hazardous Waste Cleanup, New Bedford Harbor/Hot Spot Operable Unit, New Bedford, Massachusetts. December 1991.

USEPA. 1990. Record of Decision Summary: New Bedford Harbor/Hot Spot Operable Unit, New Bedford, Massachusetts; U.S. Environmental Protection Agency, Region I. April 1990.

USEPA. 1996a. PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. Washington, DC. EPA/600/P-96/001F. September 1996.

USEPA. 1996b. Proposed Cleanup Plan, Upper & Lower New Bedford harbor, New Bedford, MA; U.S. Environmental Protection Agency Superfund Program, Region I. November 1996.

Virag, P., N. Feick, D. Hanes, M. Beaudoin and P. L'Heureux. 1996. Ambient Air Monitoring for PCBs at the New Bedford Harbor Superfund Site. Presented at the 89th Annual Meeting of the Air & Waste Management Association. June 1996.

Weston. 1997. Letter report from N. Feick (Roy F. Weston, Inc.) to M. Beaudoin (USACE) regarding airborne PCB data from the New Bedford Harbor air sampling program. September 24, 1997.

NEW BEDFORD HARBOR "HOT SPOT" MONITORING REPORT

Appendix A - Biological Data

Sea Urchin (*Arbacia puntulata*) Sperm Cell Test
Mysid (*Mysidopsis bahia*) Seven-day Survival and Growth Tests
Red Alga (*Champia parvula*) Survival and Repoduction Tests

NEW BEDFORD HARBOR HOT SPOT MONITORING

Biological Testing

SEA URCHIN SPERM CELL TEST

Dates		Percent Fertilization				
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
4/26/94	4/27/94	96	95	93	91	97
4/27/94	4/28/94	99	100	99	99	99
4/28/94	4/29/94	98	99	97	98	99
4/29/94	4/30/94	88	83	92	94	84
5/3/94	5/4/94	95	90	97	96	88
5/4/94	5/5/94	92	91	90	95	94
5/5/94	5/6/94	95	90	93	95	91
5/9/94	5/10/94	100	98	100	98	100
5/10/94	5/11/94	95	94	98	97	96
5/11/94	5/12/94			98		99
5/12/94	5/13/94	93	91	96	90	94
5/17/94	5/18/94			92	94	96
5/18/94	5/19/94	94	93	91	89	95
5/25/94	5/26/94	94	74	82	90	89
5/31/94	6/1/94	63	96	97	93	
6/1/94	6/2/94	74	78	80	78	85
6/6/94	6/7/94	98	98	98	99	97
6/7/94	6/8/94	83	92	84	91	93
6/8/94	6/9/94	79	94	89	96	89
6/10/94	6/11/94	90	93	91	92	97
6/13/94	6/14/94	98	99	99	100	97
6/15/94	6/16/94	92	97	99	97	98
6/16/94	6/17/94	96	95	98	98	97
6/21/94	6/22/94	94	89	91	91	97
6/29/94	6/30/94	93	84	90	86	96
6/30/94	7/1/94	93	85	88	90	92
7/14/94	7/15/94	97	94	93	93	95
7/21/94	7/22/94	95	95	93	90	95
7/22/94	7/23/94	84	92	92	86	90
8/18/94	8/19/94	96	96	95	97	91
8/30/94	8/31/94	98	95	90	94	97
8/31/94	9/1/94	92	94	90	96	95
9/6/94	9/7/94	85	91	92	88	93
9/7/94	9/8/94	91	95	96	96	94
9/12/94	9/13/94	100	99	99	100	99
9/15/94	9/16/94	98	100	97	97	97
9/20/94	9/21/94	93	95	95	96	93
9/21/94	9/22/94	86	91	92	87	92
9/26/94	9/27/94	97	99	97	98	97
9/28/94	9/29/94	91	95	95	94	91
10/3/94	10/4/94	96	96	98	97	97
10/12/94	10/13/94	95	96	95	93	98
10/13/94	10/14/94	96	96	99	94	96
10/18/94	10/19/94	93	94	96	95	96

NEW BEDFORD HARBOR HOT SPOT MONITORING						
Biological Testing						
SEA URCHIN SPERM CELL TEST (Continued)						
Dates		Percent Fertilization				
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
10/19/94	10/20/94	92	96	94	93	94
10/24/94	10/25/94	93	97	97	98	98
10/26/94	10/27/94	94	96	98	94	93
11/3/94	11/4/94	92	89	89	90	94
11/8/94	11/9/94	83	80	87	77	88
11/22/94	11/23/94	94	94	88	96	92
11/23/94	11/25/94	94	94	95	96	97
11/30/94	12/1/94	97	97	96	97	98
12/1/94	12/2/94	94	98	96	97	95
12/6/94	12/7/94	94	92	91	93	95
12/7/94	12/8/94	96	95	93	98	95
12/12/94	12/13/94	96	94	92	91	92
12/14/94	12/15/94	96	95	96	95	97
12/19/94	12/20/94	96	98	96	92	92
12/22/94	12/23/94	94	93	94	96	98
12/28/94	12/29/94	97	95	96	95	97
1/18/95	1/19/95	93	91	88	87	91
1/25/95	1/26/95	88	92	91	93	88
2/1/95	2/2/95	95	96	94	96	97
2/22/95	2/24/95	92	97	92	97	97
3/1/95	3/2/95	97	92	94	97	95
3/8/95	3/9/95	86	84	79	86	88
3/14/95	3/15/95	90	97	87	95	96
3/29/95	3/31/95	95	98	93	96	94
4/12/95	4/13/95	97	97	92	95	96
4/19/95	4/20/95	97	97	92	97	97
4/26/95	4/27/95	90	97	94	93	94
5/2/95	5/4/95	98	96	96	96	97
5/10/95	5/11/95	95	97	96	96	95
6/7/95	6/9/95	98	94	97	96	98
6/20/95	6/22/95	0	94	97	93	97
6/27/95	6/29/95	92	97	94	96	93
7/6/95	7/7/95	96	95	96	94	98
7/11/95	7/12/95	90	91	83	90	88
7/18/95	7/19/95	87	92	92	94	95
7/25/95	7/26/95	97	93	96	96	94
8/2/95	8/3/95	93	95	94	96	96
8/7/95	8/8/95	94	97	86	92	94
8/14/95	8/15/95	80	86	84	84	88
8/21/95	8/23/95	97	99	97	99	100
8/24/95	8/25/95	91	91	89	97	97
8/28/95	8/29/95	95	98	96	96	98
9/5/95	9/7/95	88	84	78	88	86

SEVEN DAY MYSID SURVIVAL (Percent)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
4/26-4/29	5/3/94	47.5	60	85	67.5	75
7/18-7/22	7/26/94	95	98	90	98	90
9/26-10/3	10/7/94	97.5	90	85	92.5	77.5
10/17-10/24	10/26/94	87.5	95	100	95	92.5
12/12-12/18	12/19/94	100	95	0	97.5	95
3/20-3/24	3/27/95	95	93	95	93	93
8/7-8/14	8/15/95	92.5	97.5	95	92.5	97.5

SEVEN DAY MYSID GROWTH (Dry wt. - mg.)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
4/26-4/29	5/3/94	0.50	1.03	1.18	1.16	1.12
7/18-7/22	7/26/94	1.80	1.82	1.65	1.48	1.73
9/26-10/3	10/7/94	0.42	0.43	0.41	0.37	0.40
12/12-12/18	12/19/94	1.29	1.17		1.31	1.37
3/20-3/24	3/27/95	0.47	0.38	0.39	0.39	0.45
8/7-8/14	8/15/95	0.39	0.37	0.37	0.37	0.33

NEW BEDFORD HARBOR HOT SPOT MONITORING						
Biological Testing (Continued)						
RED ALGA (Champia) SURVIVAL (Percent)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
4/26/94	4/27/94	100	100	100	100	100
4/27/94	4/28/94	100	100	100	100	100
4/28/94	4/29/94	100	100	100	100	100
4/29/94	4/30/94	100	100	100	100	100
5/3/94	5/4/94	100	100	100	100	100
5/4/94	5/5/94	100	100	100	100	66
5/5/94	5/6/94	100	100	100	100	50
5/9/94	5/10/94	100	100	100	100	100
5/10/94	5/11/94	100	100	100	100	100
5/11/94	5/12/94			100		100
5/12/94	5/13/94	100	100	100	100	100
5/17/94	5/18/94			100	100	100
5/18/94	5/19/94	100	100	100	100	100
5/25/94	5/26/94	100	100	100	100	100
5/26/94	5/27/94	100	100	100	100	100
5/31/94	6/1/94	100	100	100	100	75
6/1/94	6/2/94	100	100	100	100	100
6/6/94	6/7/94	100	100	100	100	75
6/7/94	6/8/94	100	100	100	100	75
6/8/94	6/9/94	100	100	100	100	100
6/15/94	6/16/94	100	100	100	100	100
6/16/94	6/17/94	100	100	100	100	100
6/21/94	6/22/94	100	100	100	100	100
6/29/94	6/30/94	100	100	100	100	100
6/30/94	7/1/94	75	75	50	100	45
7/21/94	7/22/94	100	100	100	100	100
7/22/94	7/23/94	50	100	100	100	100
8/9/94	8/10/94	100	75	75	50	10
8/11/94	8/12/94	100	100	100	100	0
8/17/94	8/19/94	75	100	75	50	0
8/30/94	8/31/94	0	0	0	0	0
8/31/94	9/1/94	0	0	0	0	0
9/6/94	9/8/94	50	100	100	100	10
9/7/94	9/9/94	100	50	0	0	70
9/12/94	9/14/94	100	100	100	100	100
9/15/94	9/16/94	100	0	100	0	0
9/20/94	9/21/94	100	100	100	75	100
9/21/94	9/22/94	100	100	100	100	75
9/26/94	9/27/94	100	100	100	100	100
9/28/94	9/29/94	100	100	50	100	50
10/3/94	10/4/94	100	100	100	100	75
10/18/94	10/19/94	100	100	100	100	100

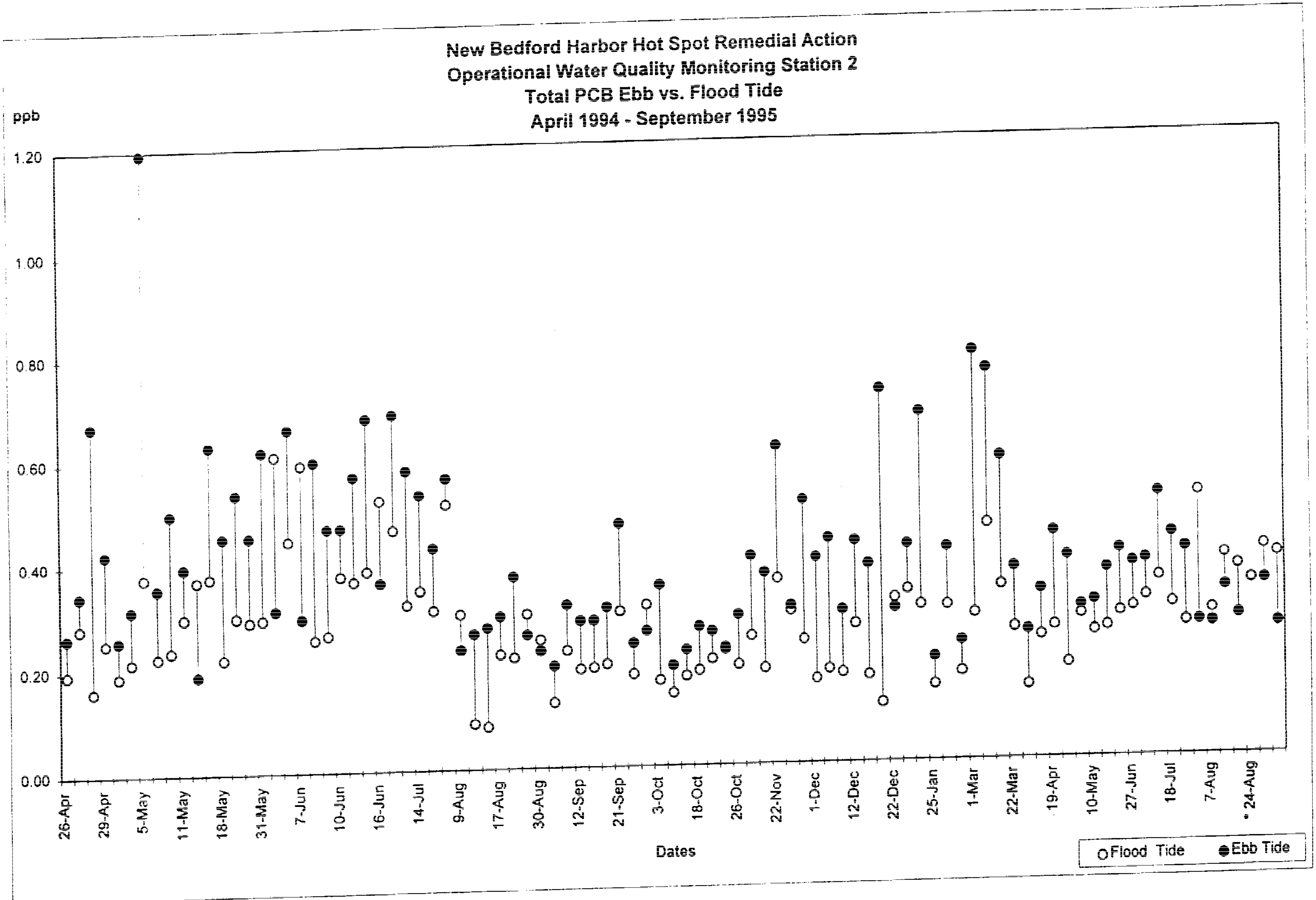
NEW BEDFORD HARBOR HOT SPOT MONITORING						
Biological Testing (Continued)						
RED ALGA (Champia) SURVIVAL (Percent)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
10/19/94	10/20/94	25	100	25	75	50
10/24/94	10/25/94	100	100	100	100	100
10/26/94	10/27/94	100	100	100	100	100
11/3/94	11/4/94	100	100	100	75	100
11/8/94	11/9/94	100	100	100	100	100
11/22/94	11/23/94	100	100	100	75	50
11/23/94	11/25/94	100	100	100	100	100
11/30/94	12/1/94	100	100	100	100	75
12/1/94	12/2/94	100	100	100	100	100
12/6/94	12/7/94	100	100	100	100	100
12/7/94	12/8/94	100	100	100	100	100
12/12/94	12/13/94	100	100	100	100	75
12/14/94	12/15/94	75	75	100	75	100
12/19/94	12/20/94	100	100	100	100	100
12/22/94	12/24/94	100	100	100	100	100
12/28/94	12/29/94	100	100	100	100	75
1/18/95	1/19/95	100	100	100	100	75
1/25/95	1/26/95	100	100	100	100	100
2/2/95	2/4/95	100	100	100	100	100
2/22/95	2/24/95	100	100	100	100	100
3/1/95	3/2/95	100	100	100	100	100
3/14/95	3/15/95	100	100	100	100	100
3/22/95	3/23/95	100	100	100	100	100
3/29/95	3/31/95	100	100	100	100	100
4/12/95	4/13/95	100	100	100	100	100
4/19/95	4/20/95	100	100	100	100	100
4/26/95	4/27/95	100	100	100	100	100
5/2/95	5/3/95	100	100	100	100	100
5/10/95	5/11/95	100	100	100	100	100
6/14/95	6/15/95	100	100	100	100	100
6/20/95	6/21/95	0	100	100	100	100
6/27/95	6/29/95	100	100	100	100	75
7/6/95	7/7/95	100	100	100	100	100
7/11/95	7/12/95	0	100	100	100	100
7/18/95	7/19/95	100	100	100	100	100
7/25/95	7/26/95	100	100	100	100	100
8/2/95	8/3/95	75	100	100	100	100
8/8/95	8/9/95	100	100	100	75	75
8/14/95	8/15/95	100	100	100	100	90
8/21/95	8/22/95	100	100	100	100	100
8/24/95	8/25/95	100	100	100	100	100
8/28/95	8/29/95	100	100	100	100	100
9/5/95	9/6/95	100	100	100	100	100

NEW BEDFORD HARBOR HOT SPOT MONITORING						
Biological Testing (Continued)						
RED ALGA (Champia) REPRODUCTION (# of Cystocarps)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
4/26/94	4/27/94	7.0	11.6	11.4	19.2	22.1
4/27/94	4/28/94	12.3	24.9	16.3	29.9	36.3
4/28/94	4/29/94	8.0	6.3	6.5	11.2	10.0
4/29/94	4/30/94	19.4	23.5	25.6	41.9	32.4
5/3/94	5/4/94	9.7	19.1	24.9	21.7	23.0
5/4/94	5/5/94	1.9	7.8	16.5	26.3	14.7
5/5/94	5/6/94	4.6	3.7	8.2	13.3	0.8
5/9/94	5/10/94	14.3	24.8	22.3	43.3	39.5
5/10/94	5/11/94	4.6	5.6	10.4	15.8	14.2
5/11/94	5/12/94			17.9		23.8
5/12/94	5/13/94	4.2	8.5	13.6	27.0	19.0
5/17/94	5/18/94			18.0	16.4	18.3
5/18/94	5/19/94	12.4	12.9	7.0	16.4	21.6
5/25/94	5/26/94	1.3	4.3	4.8	11.7	5.7
5/26/94	5/27/94	1.9	1.8	3.8	12.5	7.6
5/31/94	6/1/94	0.0	14.4	7.6	31.3	48.9
6/1/94	6/2/94	1.3	16.5	3.3	14.3	11.7
6/6/94	6/7/94	3.6	7.2	3.1	15.7	0.8
6/7/94	6/8/94	10.4	10.9	9.2	19.2	16.8
6/8/94	6/9/94	16.7	42.5	18.5	41.0	2.7
6/15/94	6/16/94	3.7	3.7	5.5	6.1	10.8
6/16/94	6/17/94	2.0	14.2	12.5	14.2	17.7
6/21/94	6/22/94	1.4	0.0	0.4	0.0	1.2
6/29/94	6/30/94	12.7	9.0	17.5	42.3	38.7
6/30/94	7/1/94	2.5	0.6	0.0	1.5	9.4
7/21/94	7/22/94	0.0	0.0	0.0	0.0	0.0
7/22/94	7/23/94	0.0	0.0	0.0	0.0	0.0
8/9/94	8/10/94	6.5	1.4	0.8	14.5	0.1
8/11/94	8/12/94	0.0	0.0	0.0	0.0	0.0
8/17/94	8/19/94	22.8	25.2	16.9	23.4	0.0
8/30/94	8/31/94	0	0	0	0	0
8/31/94	9/1/94	0	0	0	0	0
9/6/94	9/8/94	0	0	0	0	0
9/7/94	9/9/94	0	0	0	0	0
9/12/94	9/14/94	0	0	0	0	0
9/15/94	9/16/94	0	0	0	0	0
9/20/94	9/21/94	10.5	10.7	9.4	6.3	6.7
9/21/94	9/22/94	1.3	3.5	4.5	14.7	6.4
9/26/94	9/27/94	2.6	4.3	3.4	2.4	8.7
9/28/94	9/29/94	7.1	12.7	2.3	10.4	4.3
10/3/94	10/4/94	10.4	17.2	10.7	6.5	0.6
10/18/94	10/19/94	0.4	3.4	2.0	3.6	0.4

NEW BEDFORD HARBOR HOT SPOT MONITORING						
Biological Testing (Continued)						
RED ALGA (Champia) REPRODUCTION (# of Cystocarps)						
Date(s)						
Collected	Processed	NBH-1	NBH-7	NBH-2	NBH-4	NBH-5
10/19/94	10/20/94	0.0	6.2	0.0	14.3	8.6
10/24/94	10/25/94	3.5	5.2	6.7	15.5	24.1
10/26/94	10/27/94	3.9	3.2	8.9	9.8	10.8
11/3/94	11/4/94	4.7	13.9	16.3	32.6	33.0
11/8/94	11/9/94	5.4	18.9	17.4	33.0	35.7
11/22/94	11/23/94	2.6	8.6	6.5	38.5	30.3
11/23/94	11/25/94	6.0	4.8	5.7	10.4	10.9
11/30/94	12/1/94	0.0	2.9	7.3	16.1	24.2
12/1/94	12/2/94	13.2	12.8	13.6	22.7	27.3
12/6/94	12/7/94	11.7	11.1	12.5	31.8	32.9
12/7/94	12/8/94	10.8	20.1	17.7	33.6	41.8
12/12/94	12/13/94	22.9	17.8	0.0	21.8	29.3
12/14/94	12/15/94	2.2	2.3	2.5	11.8	7.7
12/19/94	12/20/94	1.8	2.3	1.9	5.1	2.8
12/22/94	12/24/94	3.0	2.7	4.5	7.5	3.1
12/28/94	12/29/94	2.0	7.6	15.1	7.8	3.9
1/18/95	1/19/95	3.9	2.9	0.2	2.3	8.9
1/25/95	1/26/95	44.5	37.9	41.8	53.6	67.1
2/2/95	2/4/95	17.5	20.3	16.3	47.3	30.3
2/22/95	2/24/95	0.0	0.0	0.0	0.1	0.3
3/1/95	3/2/95	3.3	1.8	1.4	19.7	17.9
3/14/95	3/15/95	7.6	6.5	10.6	16.1	6.5
3/22/95	3/23/95	22.9	15.2	24.2	19.0	31.7
3/29/95	3/31/95	4.1	8.3	4.4	9.3	12.0
4/12/95	4/13/95	22.9	15.2	24.2	19.0	31.7
4/19/95	4/20/95	8.1	13.7	7.3	23.9	39.0
4/26/95	4/27/95	9.5	32.2	12.3	27.0	27.0
5/2/95	5/3/95	32.5	20.3	27.1	41.6	34.6
5/10/95	5/11/95	26.3	22.5	14.0	23.2	22.8
6/14/95	6/15/95	0.1	0.1	0.0	0.1	0.9
6/20/95	6/21/95	0.0	16.8	18.1	34.8	31.7
6/27/95	6/29/95	48.1	76.8	67.4	57.3	36.9
7/6/95	7/7/95	40.3	39.1	17.3	56.0	65.4
7/11/95	7/12/95	0.0	27.6	22.5	54.4	58.4
7/18/95	7/19/95	17.1	21.6	17.0	30.9	46.1
7/25/95	7/26/95	16.1	20.9	35.0	28.1	22.8
8/2/95	8/3/95	5.3	15.5	17.6	20.8	20.5
8/8/95	8/9/95	12.7	17.5	17.3	12.5	0.4
8/14/95	8/15/95	31.1	23	29.9	24.9	18.1
8/21/95	8/22/95	18.8	22.7	14.2	7.6	20.2
8/24/95	8/25/95	37.1	31.4	39.7	45.7	24
8/28/95	8/29/95	22.8	19.9	17.1	23.9	19.4
9/5/95	9/6/95	0.75	2.15	1.45	6.1	7.6

APPENDIX C

PCB, COPPER AND LEAD WATER QUALITY DATA PRESENTED GRAPHICALLY



* No data for flood tide:

No dissolved data for 28-Apr-94

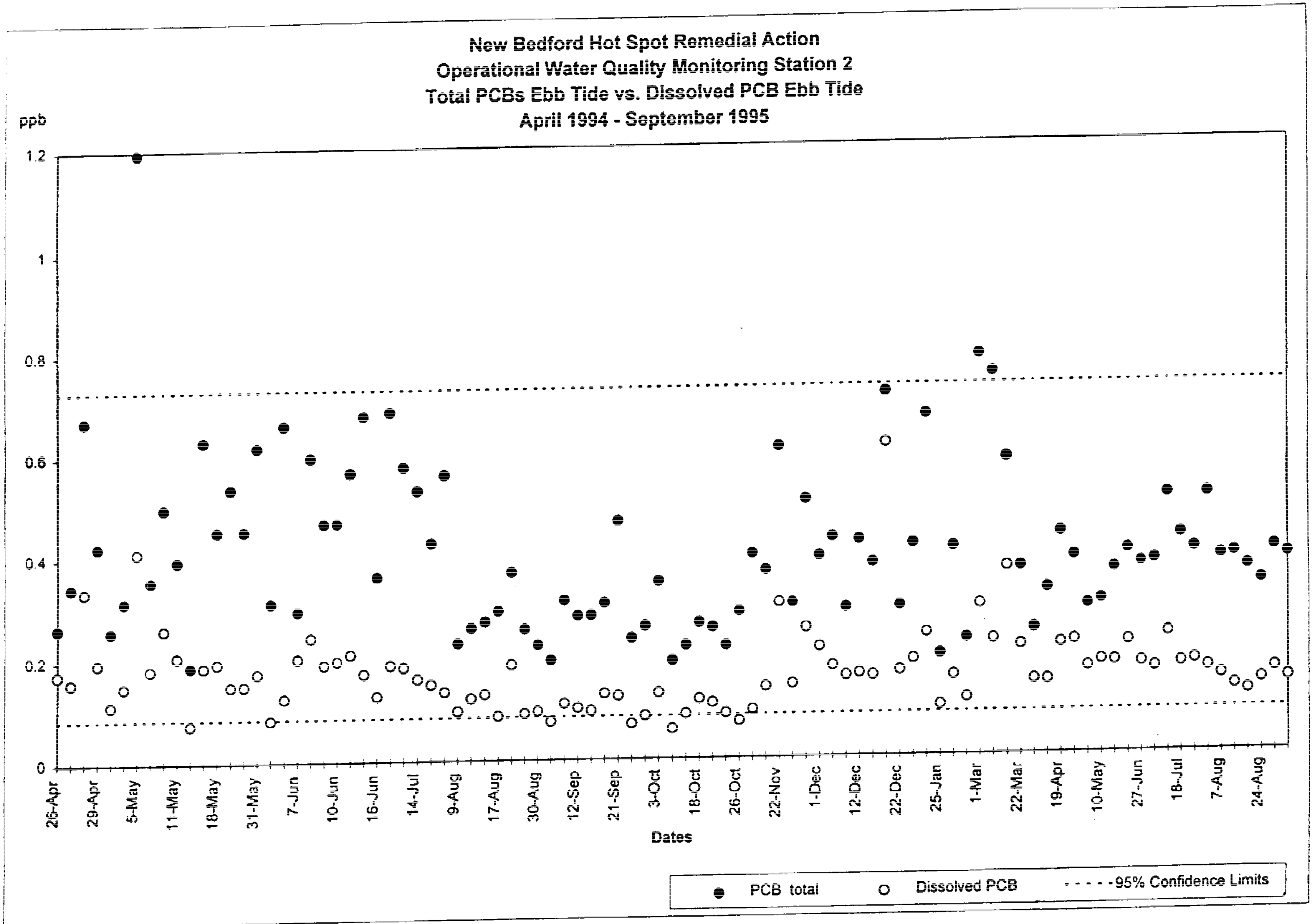
No particulate data for 10-Aug-94

No particulate data for 15-Aug-94

No flood samples taken on 24-Aug-95

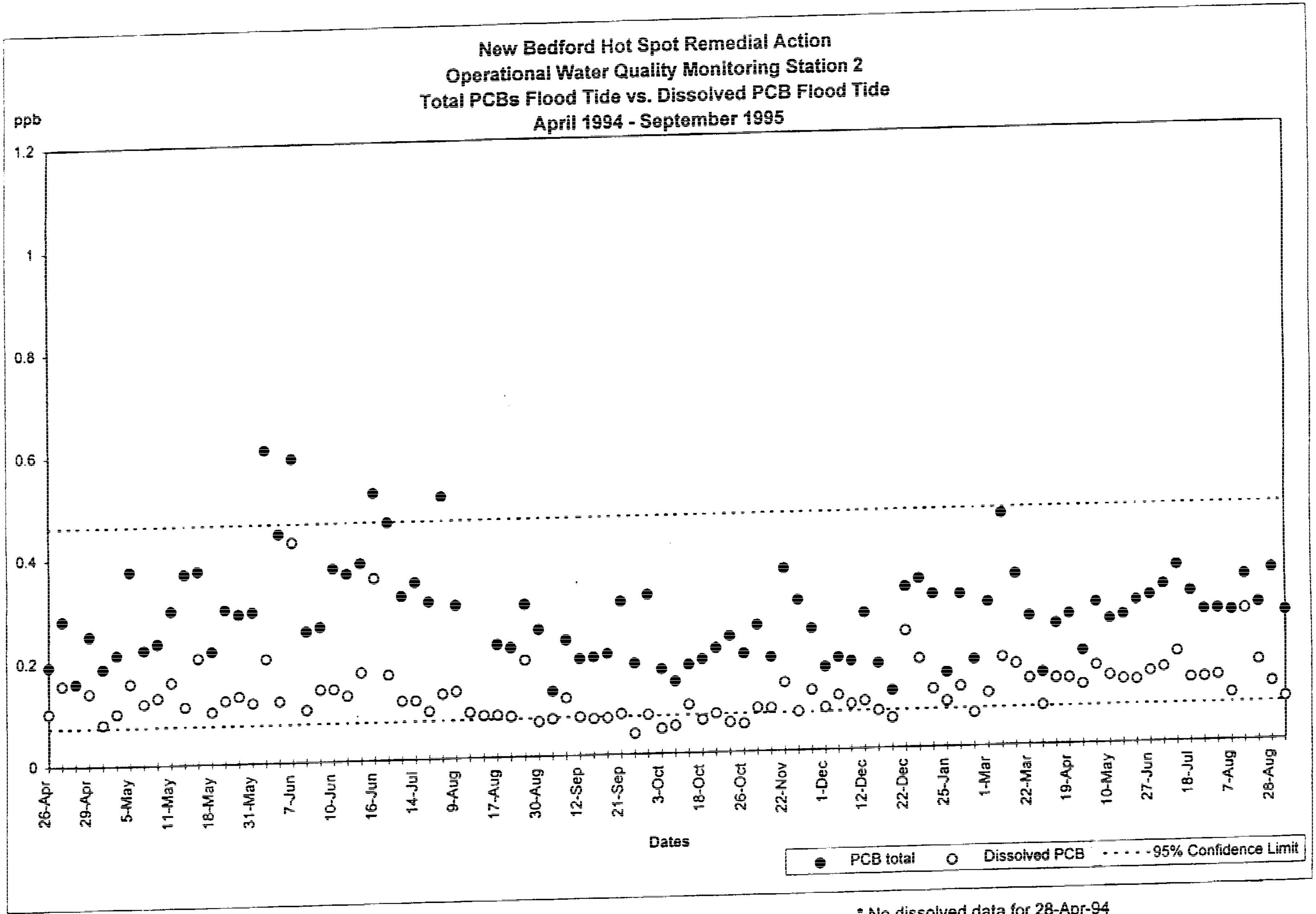
PCBEVF.XLS

3/14/97

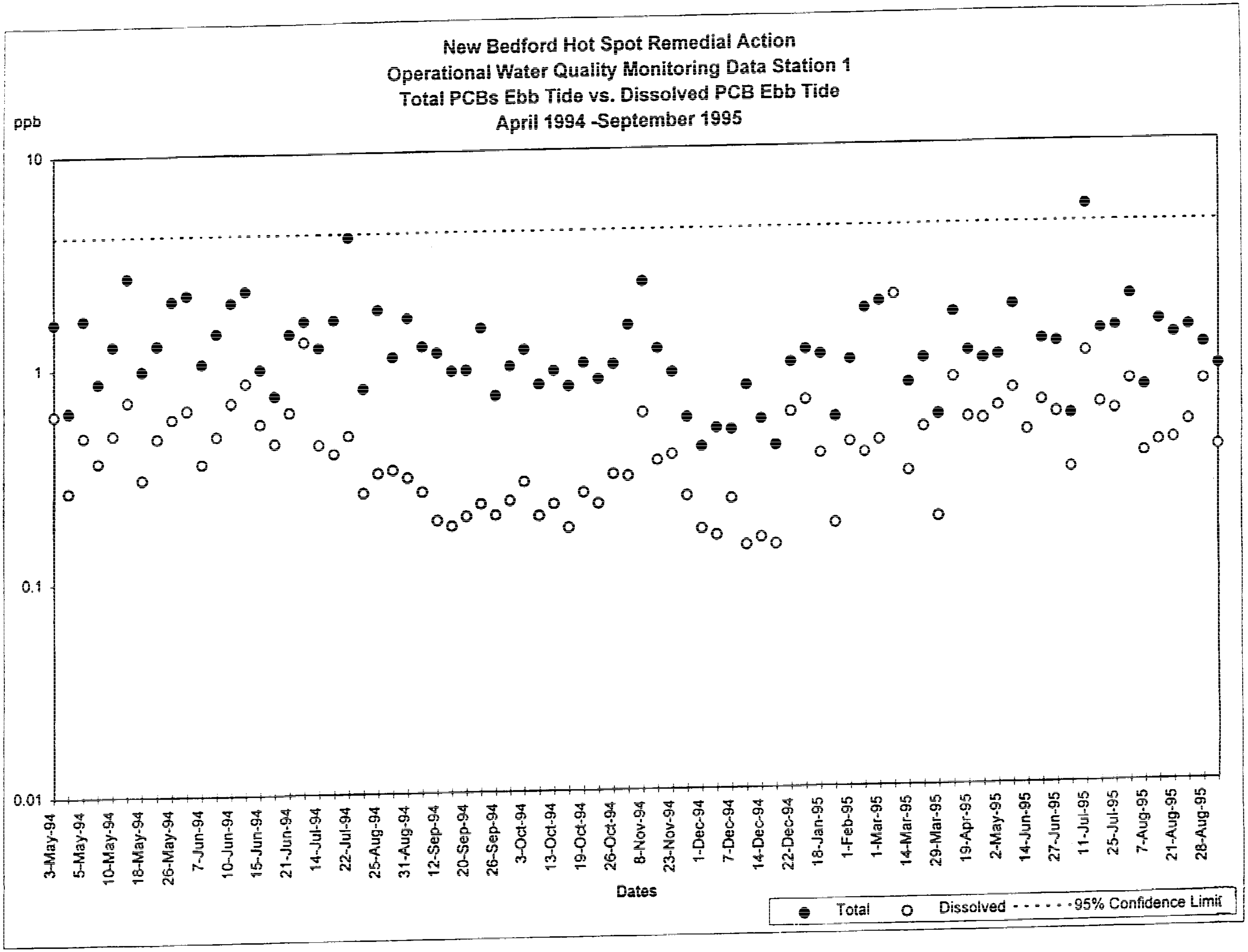


PCB_2.XLS

3/14/97



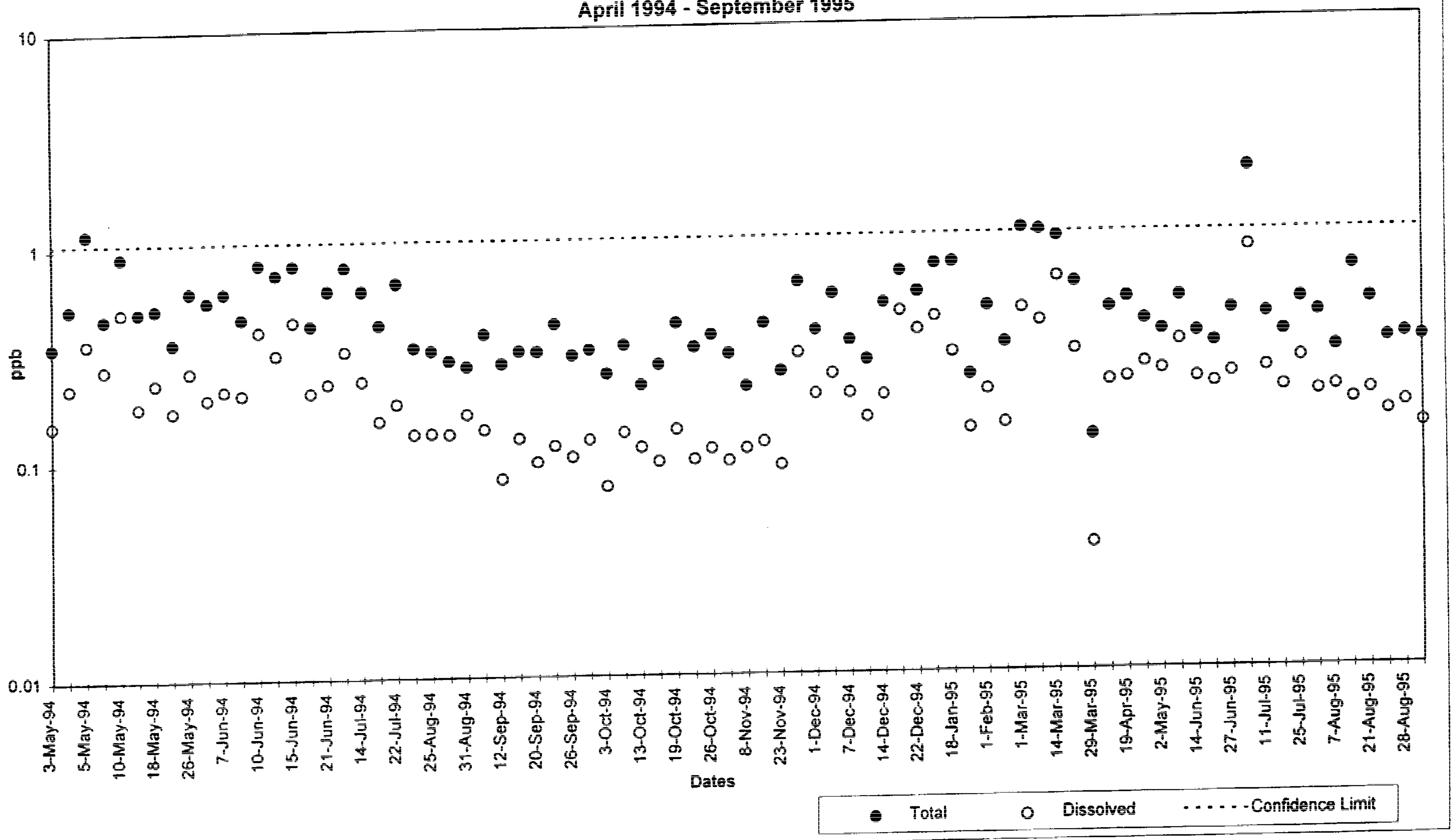
* No dissolved data for 28-Apr-94
* No particulate data for 10-Aug-94 and 15-Aug-94
* Flood tide samples not taken on 24-Aug-95



3/14/97

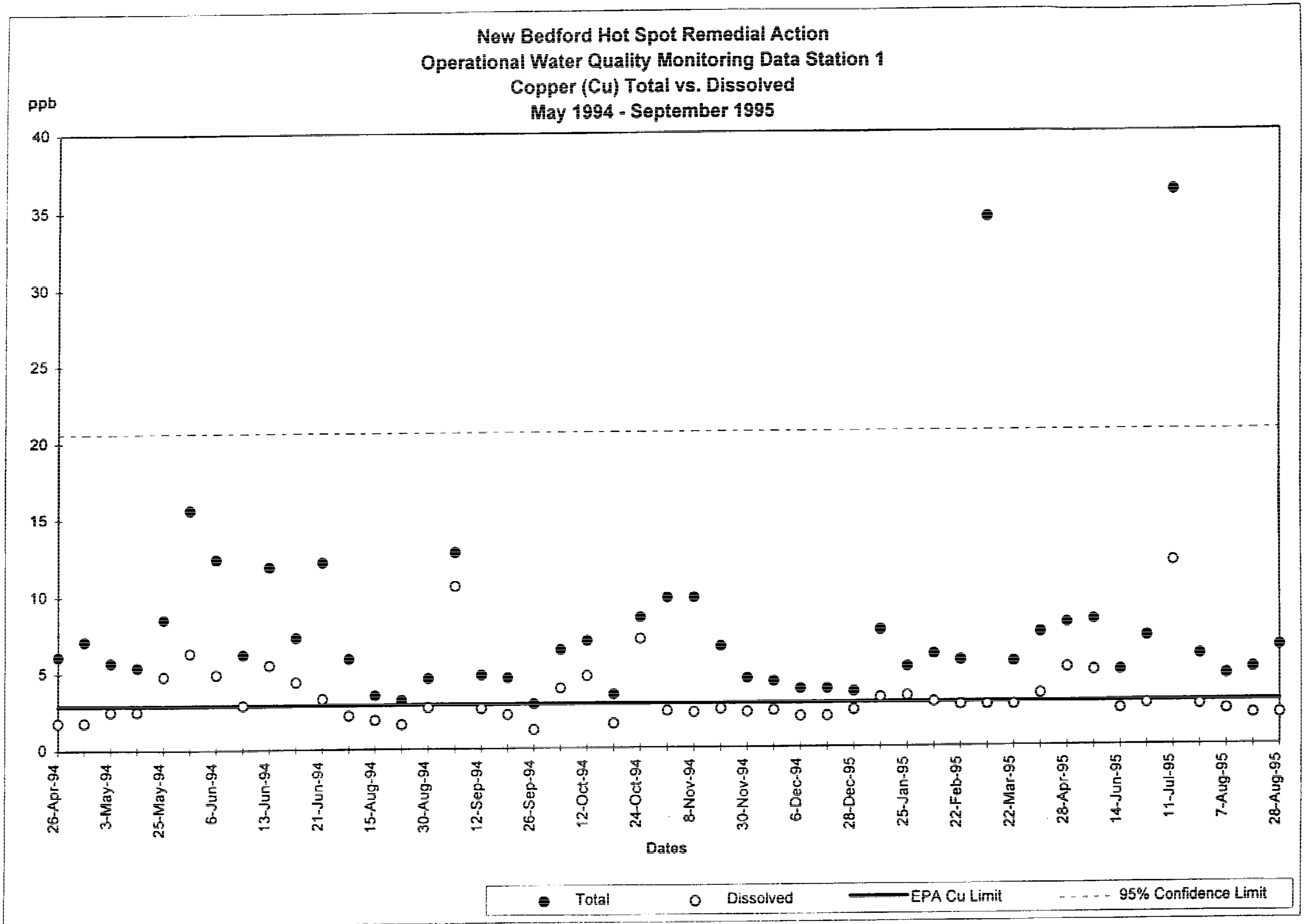
PCB_1.XLS

New Bedford Hot Spot Remedial Action
Operational Water Quality Monitoring Data Station 7
Total PCBs Ebb Tide vs. Dissolved PCB Ebb Tide
April 1994 - September 1995



3/14/97

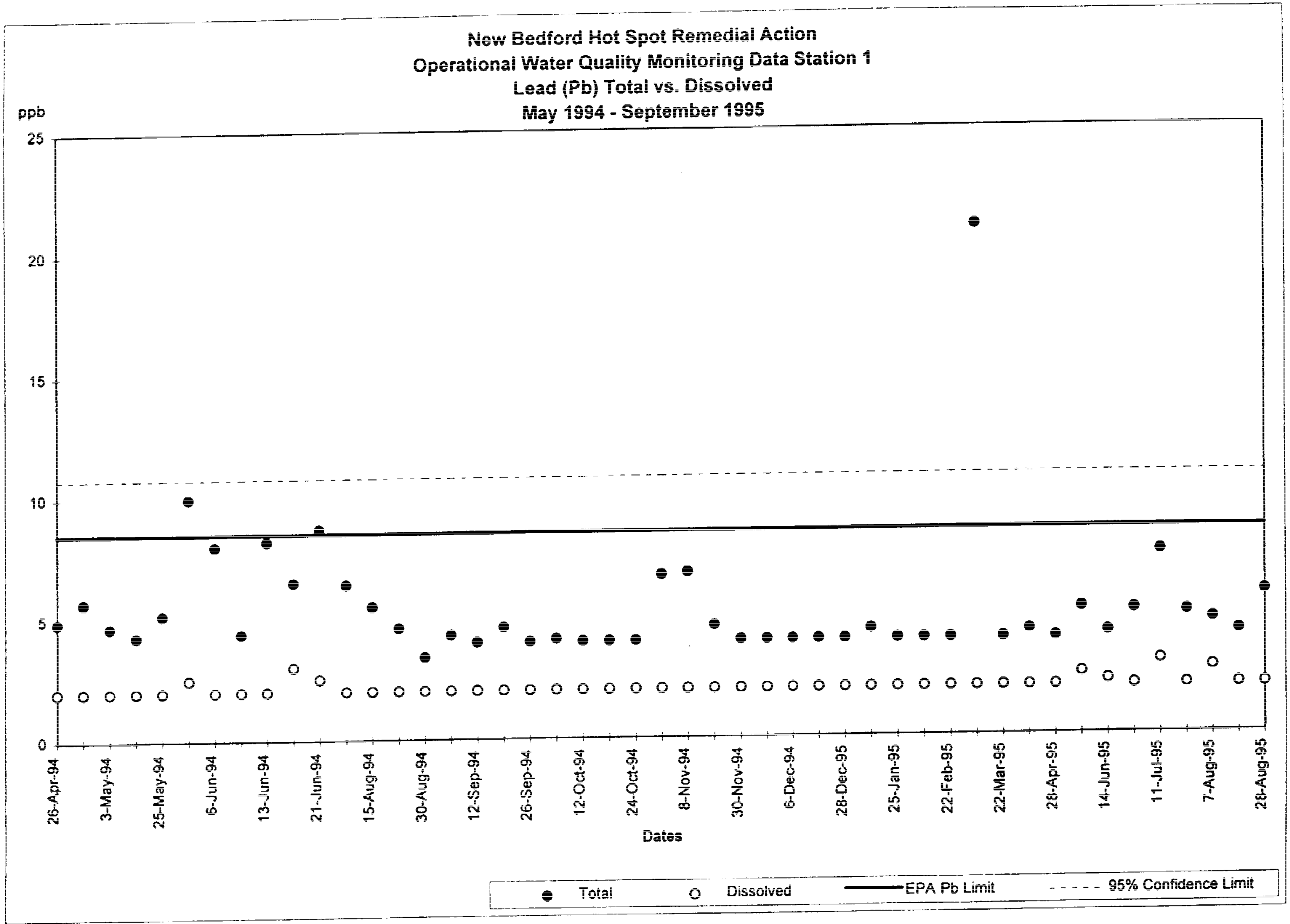
PCB_7.XLS



Note: EPA Cu limit 2.9 ppb

3/14/97

METALS_1.XLS

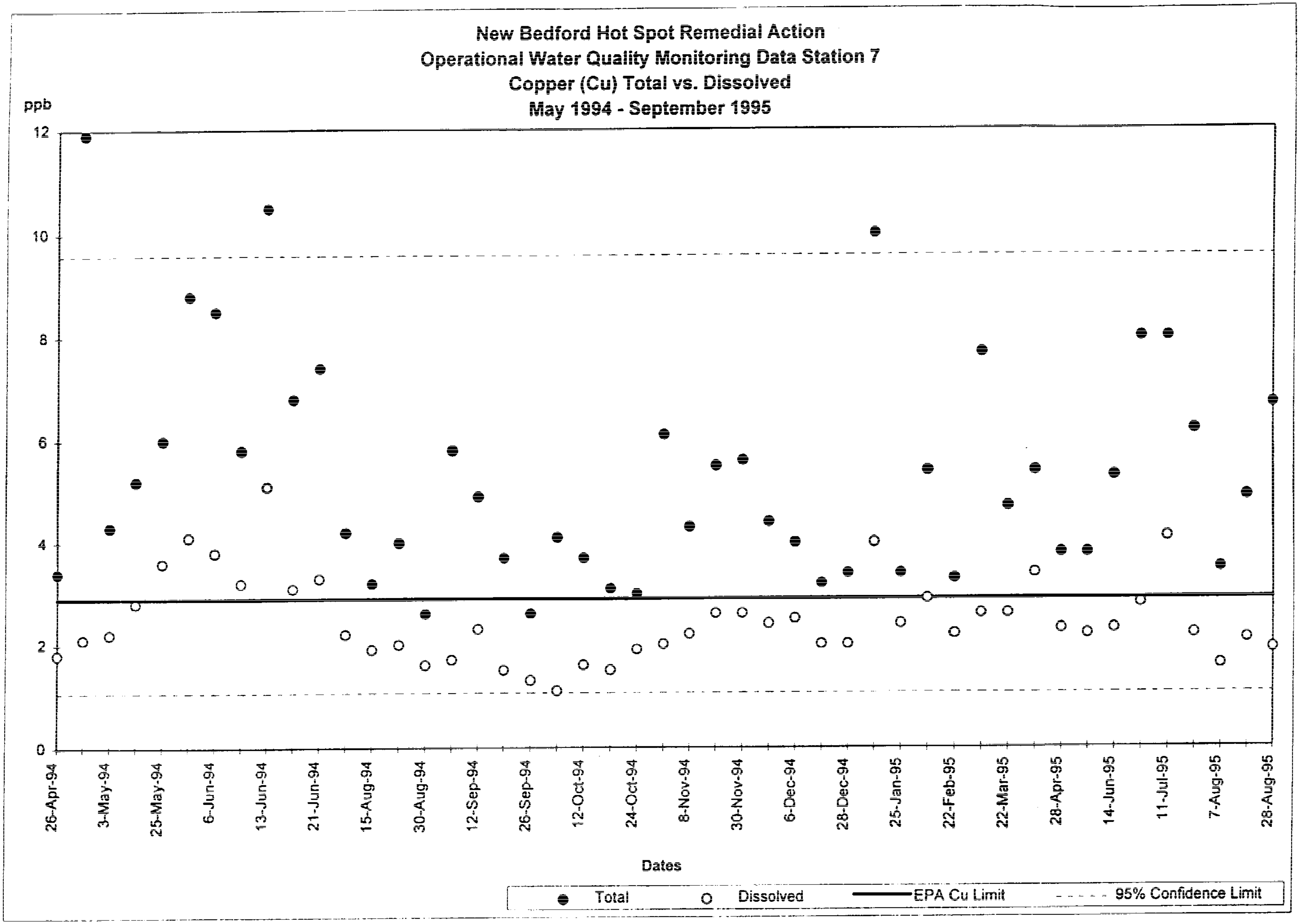


Note: EPA Pb limit 8.5 ppb

Note: When analyte was analyzed for but not detected, the detection limit (2 ppb) was reported.

METALS_1.XLS

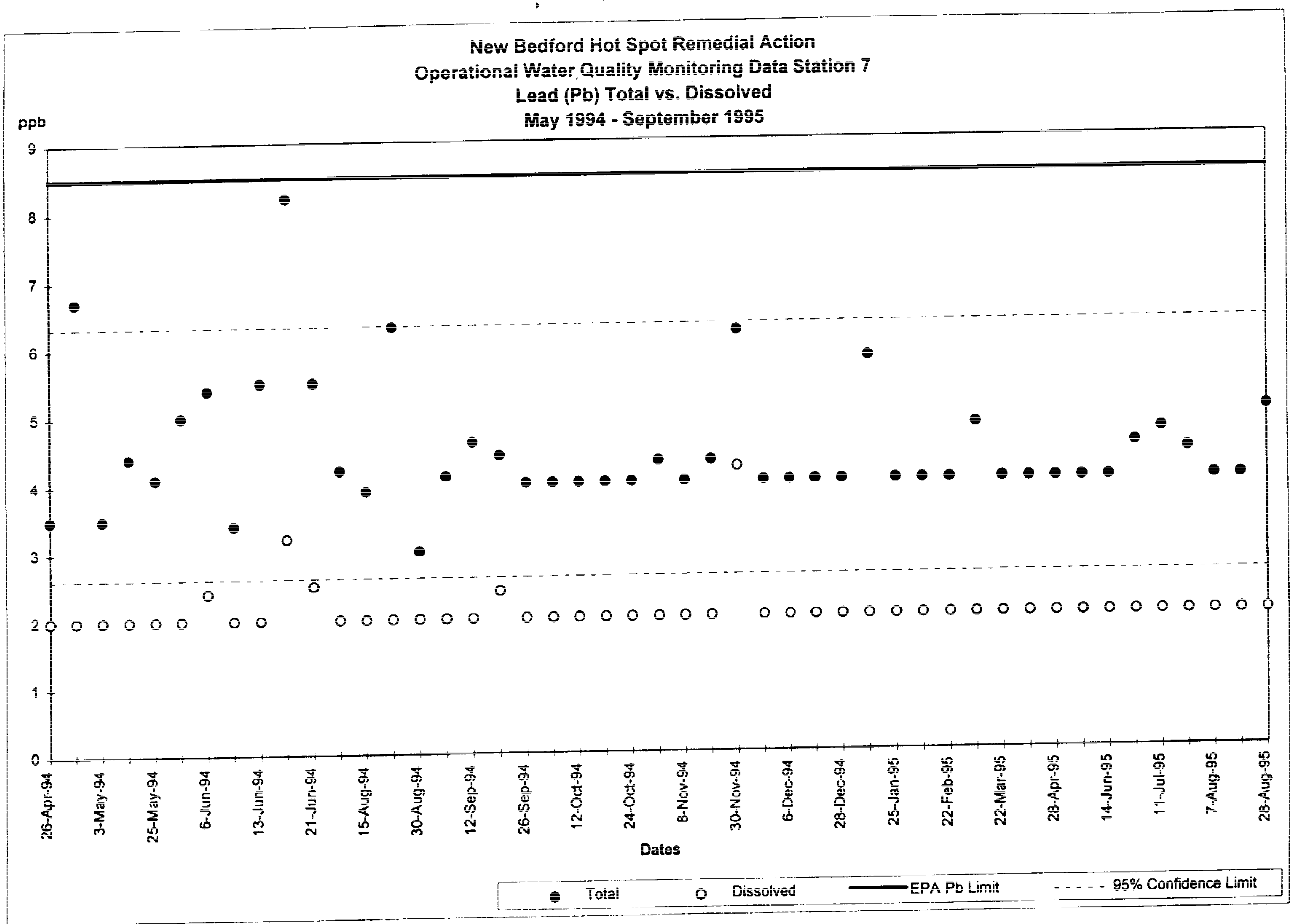
3/14/97



Note: EPA Cu limit 2.9 ppb

3/14/97

METALS_1.XLS

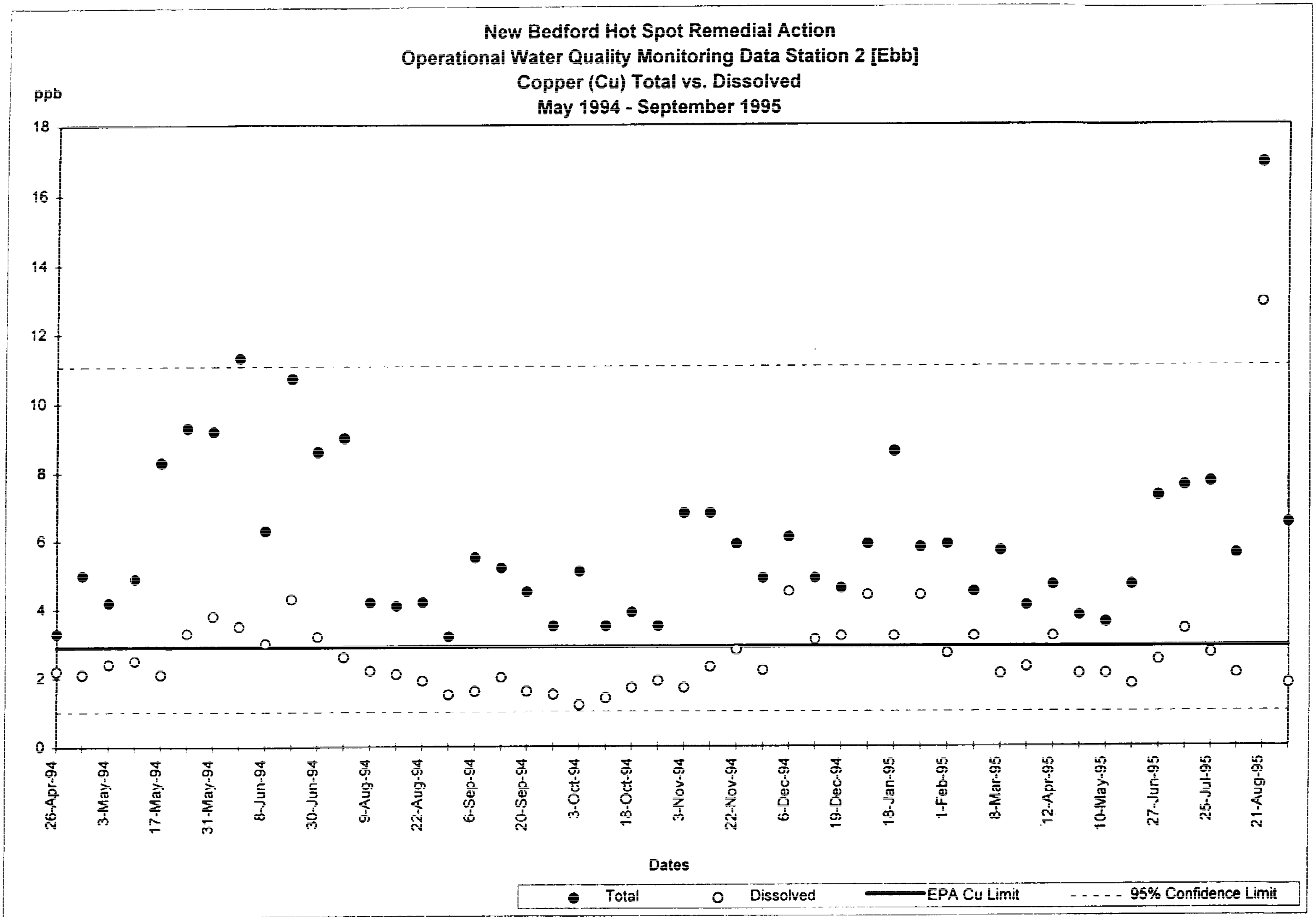


Note: EPA Pb limit 8.5 ppb

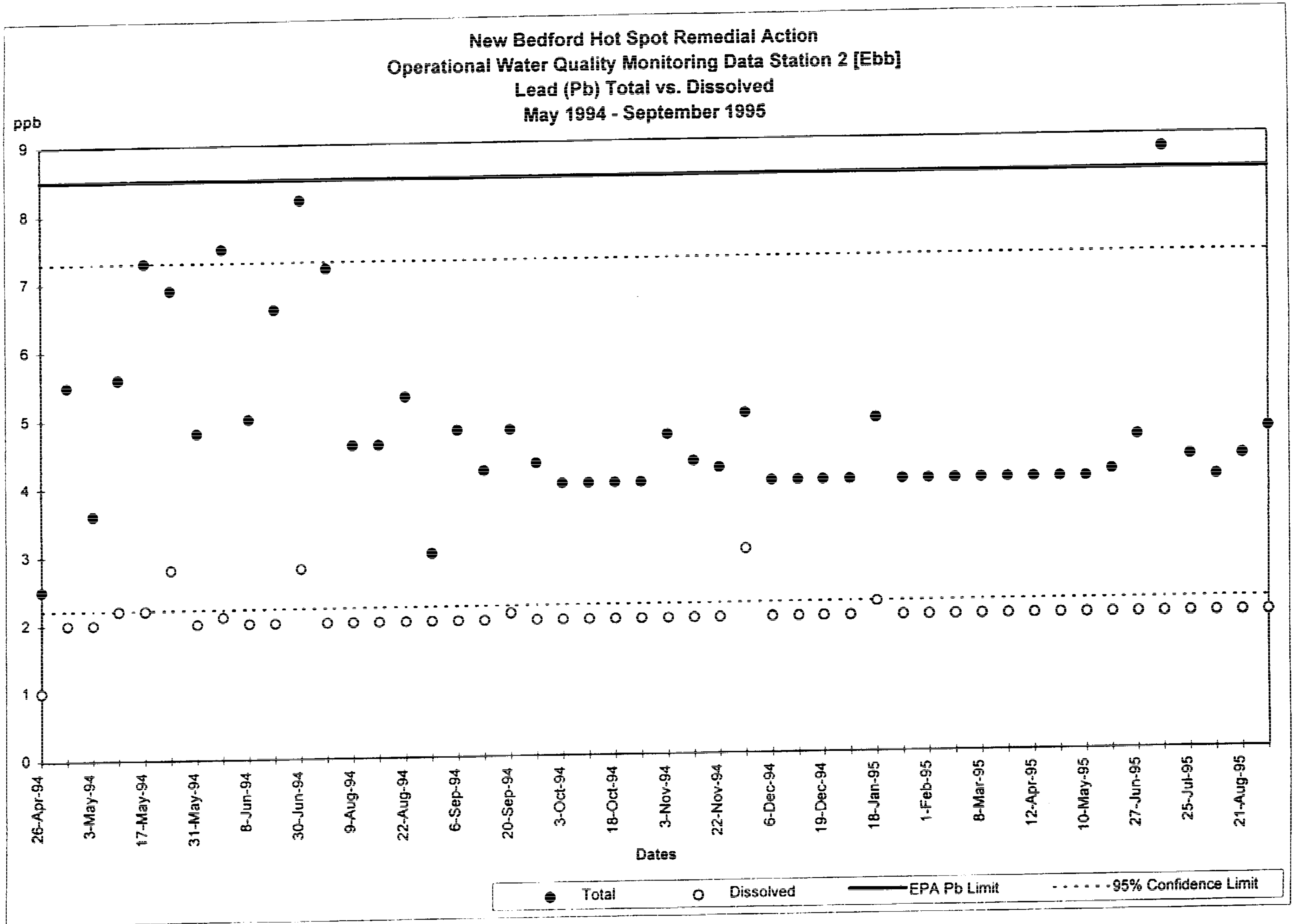
Note: When analyte was analyzed for but not detected, the detection limit (2 ppb) was reported.

METALS_1.XLS

3/14/97



Note: EPA Cu limit 2.9 ppb

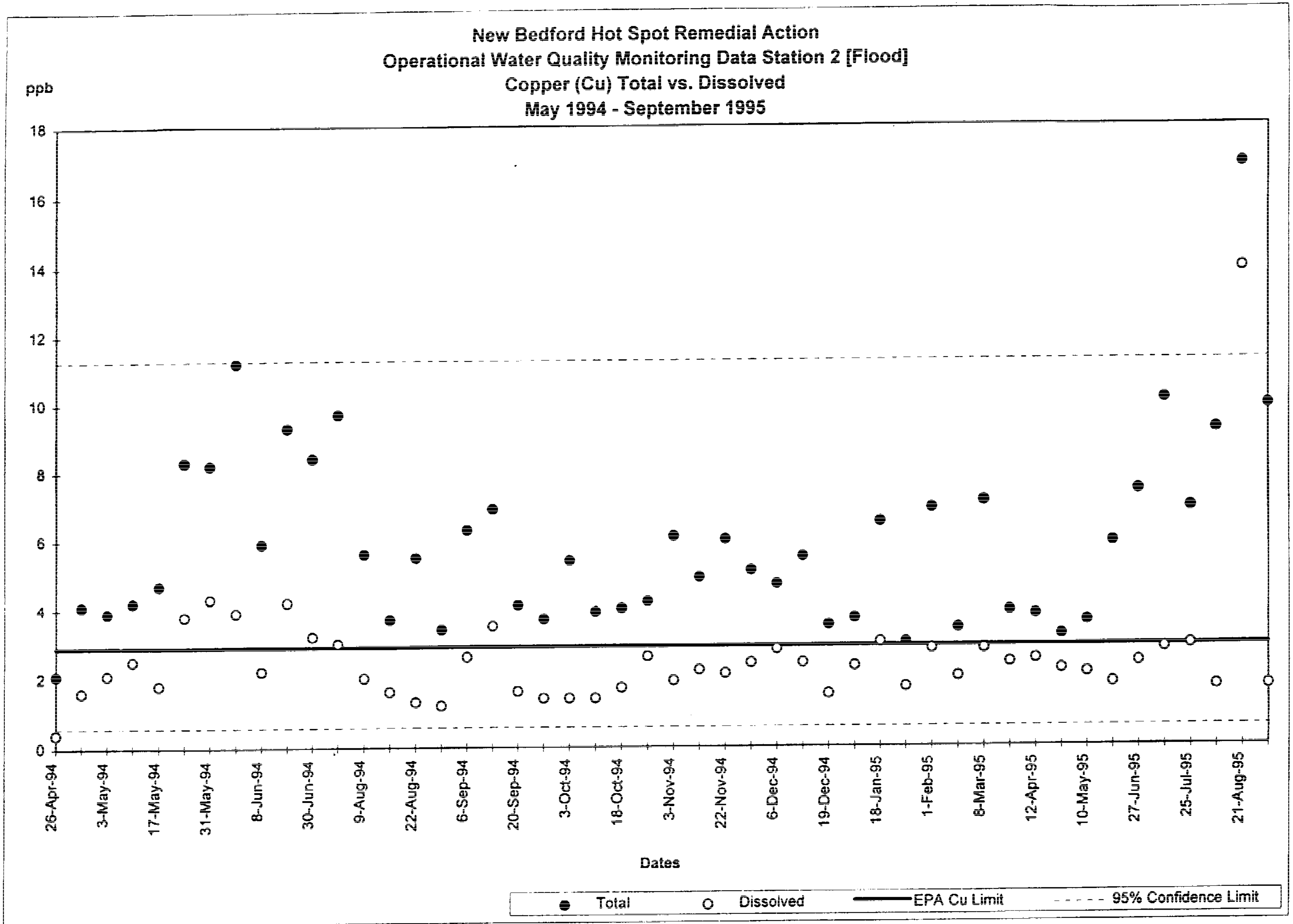


Note: EPA Pb limit 8.5 ppb

Note: When analyte was analyzed for but not detected, the detection limit (2 ppb) was reported.

METALS_1.XLS

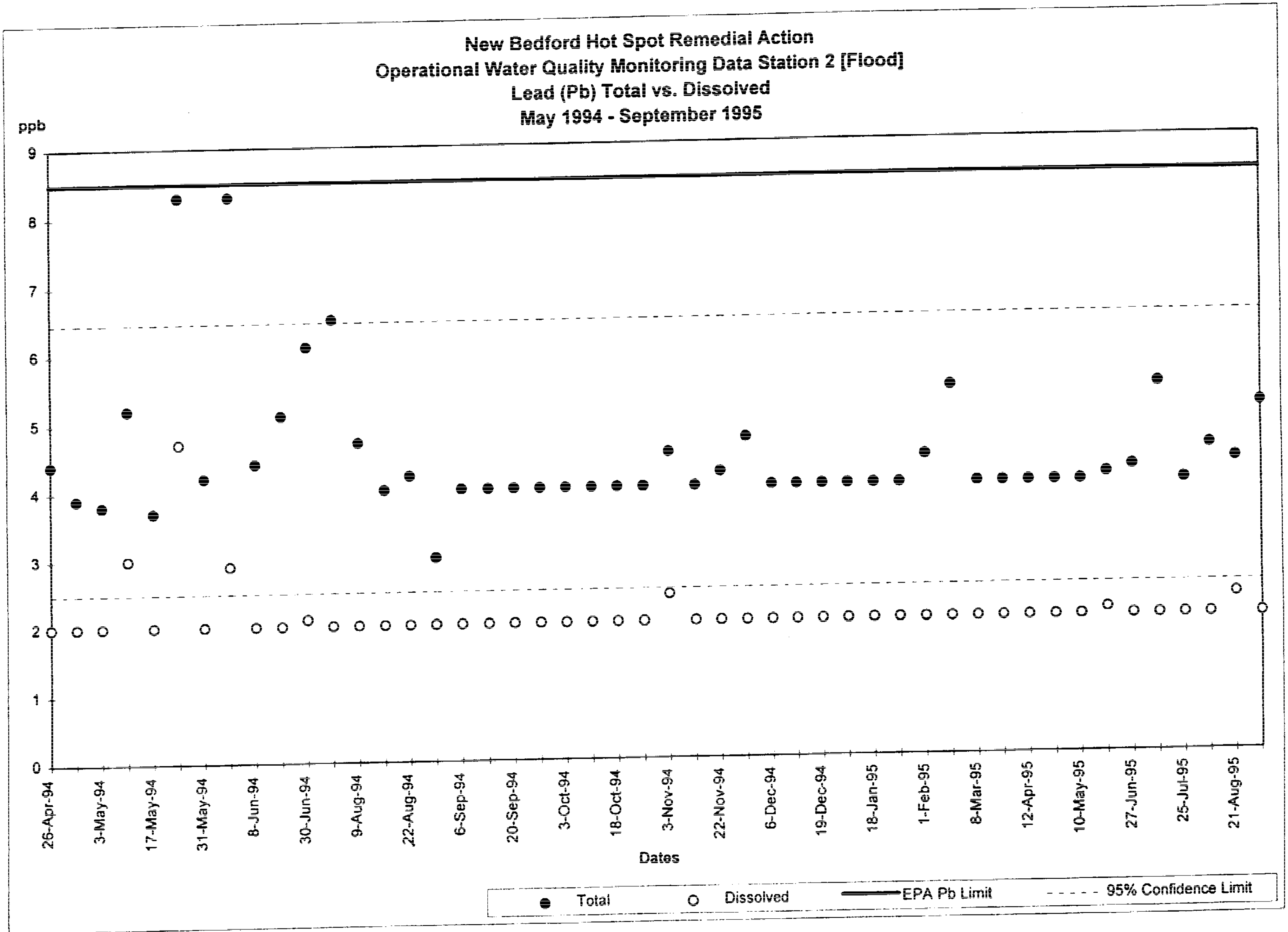
3/14/97



Note: EPA Cu limit 2.9 ppb

3/14/97

METALS_1.XLS



Note: EPA Pb limit 8.5 ppb

Note: When analyte was analyzed for but not detected, the detection limit (2 ppb) was reported.

METALS_1.XLS

3/14/97