Clean Charles 2005 Water Quality Report
2001 Core Monitoring Program
November 2002

Prepared By

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1.0 EXECUTIVE SUMMARY

Purpose and Scope

In 1995, the U.S. Environmental Protection Agency - New England (EPA) established the Clean Charles 2005 Initiative to restore the Charles River Basin to a swimmable and fishable condition by Earth Day in the year 2005. The ongoing initiative incorporates a comprehensive approach for improving water quality through: Combined Sewer Overflow (CSO) controls, illicit sanitary connection removals, stormwater management, public outreach, education, monitoring, enforcement and technical assistance.

In 1998, EPA's Office of Environmental Measurement and Evaluation (OEME) initiated the Clean Charles 2005 Core Monitoring Program that will continue until 2005. The purpose of the program is to track water quality improvements in the Charles River Basin (defined as the section between the Watertown Dam and the New Charles River Dam) and to identify where further pollution reductions or remediation actions are necessary to meet the Clean Charles 2005 Initiative goals. The program is designed to sample during the summer months that coincide with peak recreational uses.

The program monitors twelve "Core" stations. Ten stations are located in the Basin, one station is located on the upstream side of the Watertown Dam and another is located immediately downstream of the South Natick Dam (to establish upstream boundary conditions). Five of the ten sampling stations are located in priority resource areas, which are identified as potential wading and swimming locations. Six of the twelve stations are monitored during wet weather conditions.

In the year 2001, the following parameters were measured: dissolved oxygen, temperature, pH, specific conductance, turbidity, clarity, transmissivity, chlorophyll a, total organic carbon, total suspended solids, apparent and true color, nutrients, bacteria, and dissolved metals. In 2001, additional monitoring was conducted to define the extent of the salt wedge and to monitor select bacteria "Hot Spots". The detailed results from these two projects will be presented in the annual comprehensive 2001 Core Monitoring Program report.

Conclusions of the 2001 Core Monitoring Program

The conclusions below summarize the 2001 Core Monitoring Program data and use these data to evaluate the water quality conditions from 1998 to 2001. **No short-term trends were observed from the past four years of data. Water quality was influenced by yearly fluctuations in weather and river flows, making short-term trends difficult to determine.** These data will provide a baseline for determining long-term trends. With the exception of lower flows beginning in mid September, the sampling season daily average flows at the Waltham gauging station were generally between 1998 and 1999 flow levels. In 1998, the summer conditions were generally wetter with correspondingly higher flows; in 1999, summer conditions were drier with correspondingly lower flows; and in 2000, summer flows were generally between 1998 and 1999 flow levels.

Three dry weather and two wet weather events were sampled from July to September. Comparing these data to the past three years' data revealed no definitive trends. The four years of data show the section near the mouth of the River (Mass Ave. Bridge to the New Charles River Dam, excluding the Pond at the Esplanade) met the swimming standards more often than any other part of the Basin.

Clarity, Color and Transmissivity

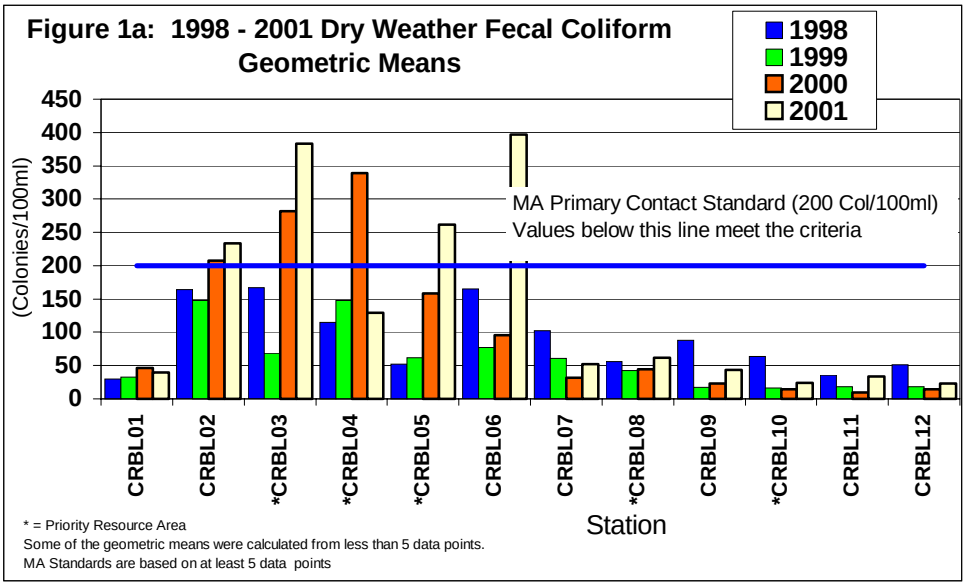
Water clarity was directly measured in the field using a Secchi disk. Mean Secchi disk readings were similar to those collected in previous years. The greatest clarity was recorded near the mouth of the Basin (from just upstream of the Longfellow Bridge to the New Charles River Dam) during the first two sampling events (July 9 and August 7). During both events, the four stations at the mouth of the Basin, met the four foot swimming criteria. The data from the sampling events following August 7 showed a decrease in water clarity when compared to the data from the first two sampling events.

True and apparent color were highest in July and decreased throughout the summer. Mean color values were similar to values from the previous three years. As identified in a previous report (EPA 1999), it appears that part of the color was associated with particulate matter. This implies that controlling algae growth and preventing particulates from being discharged could enhance the clarity of the water and help achieve the bathing beach visibility criteria.

Transmissivity was added to the parameter list in 2001 as an additional measurement of water clarity. The greatest transmissivity was recorded near the mouth of the Basin. The lowest transmissivity was consistently recorded in the Pond at the Esplanade. The transmissivity measurements correlated well with Secchi disk measurements.

Bacteria

Fecal coliform concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12), which was typical of the data collected during the previous three years. Stations CRBL09 - CRBL10 met the swimming criteria[1] of less than 200 colonies/100 ml during all sampling events. The dry weather geometric means[2] were higher at stations CRBL02, CRBL03, CRBL05, and CRBL06 when compared to previous years' geometric means[2] (Figure 1a). At the other eight stations the dry weather geometric means[2] were similar to those collected during previous years.



The highest wet weather concentration was recorded at the Watertown Dam (CRBL02). As in past years this

[1]The Massachusetts fecal coliform swimming criteria of less than 200 colonies/100ml is actually based on a geometric mean of five samples or more. For this report, individual concentrations were compared to this criteria.

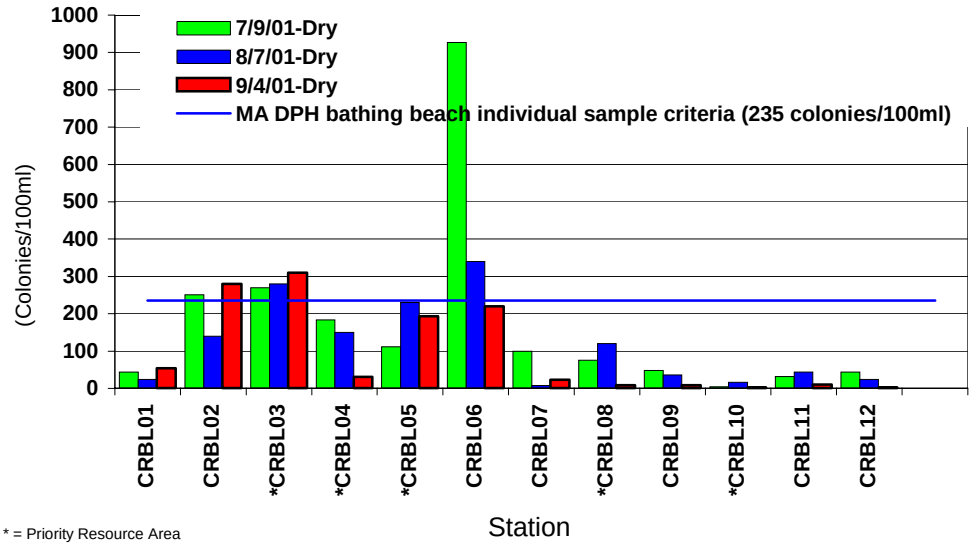
[2]Some of the dry weather geometric means were calculated from less than five data points, the actual criteria is based on a geometric mean of five samples or more.

station continued to exhibit high concentrations during wet weather.

During dry weather, approximately 35% of the core monitoring samples exceeded the fecal coliform swimming criteria[1] (compared to 23% in 2000, 8% in 1999, and 17% in 1998). There were no identified reasons for this increase in dry weather exceedances. During wet weather, approximately 44% of the fecal coliform samples exceeded the criteria[1] (compared to 63% in 2000 and 50% in 1999).

E. coli bacteria was sampled during three dry weather sampling events. As observed with fecal coliform measurements, the E. coli concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). All samples collected at these stations were below the single sample criteria of 235 colonies/100ml[3]. Seven of the samples, collected at the other stations, (19 % of all samples, compared to 35% in 1998) exceeded this criteria (Figure 2a).

Figure 2a: Dry Weather E.coli Counts



Dissolved Oxygen (DO) and pH

Massachusetts has established DO criteria[4] for class B waters. One of the two stations where continuous DO data were collected, recorded three hours of data not meeting the criteria. This station was located immediately downstream of the BU Bridge. No DO violations were recorded from the manual measurements collected during the eight sampling events (compared to 0% in 2000, 3% in 1999, and 0% in 1998). No DO violations were recorded from surface measurements during the salt wedge monitoring although numerous DO violations and anoxia were observed at lower depths.

Violations of pH were recorded throughout the basin at each of the three pH continuous monitoring stations. The hours of recorded violations occurred in the afternoon and evening on August 8 and coincided with super-saturated DO conditions. The data from all the dry and wet weather manual measurements showed pH violated the criteria twelve times or approximately 18% of all field measurements (compared to 20% in 2000 and 8% in 1999, and 4% in 1998). All except one of the violations were greater than 8.3 and occurred downstream of the Mass Ave. Bridge. The one exception occurred upstream of the South Natick dam and

[3] The Massachusetts DPH E. coli Bathing Beach criteria for as single sample is less than or equal to 235 colonies/100ml. The geometric mean criteria is less than or equal to 126 colonies/100ml and is based on a geometric mean of the most recent five samples within the same bathing season (this criteria was not evaluated in this report).

[4] The Massachusetts water quality criteria for Class B water for DO is $\geq$ 5 mg/l and $\geq$60% saturation and for pH is between 6.5 and 8.3.

was 6.4. Violations of pH were also recorded in the salt wedge monitoring during August and September.

Nutrients

Phosphorus was the most significant nutrient in this system. Elevated phosphorus concentrations at many of the sampling stations indicated highly eutrophic conditions. Each station recorded the highest concentration during the July sampling event. Mean dry weather total phosphorus concentrations at most stations were less than 1998 levels and similar to the means over the past two years. At the South Natick Dam, the dry weather data showed a reduction in the total phosphorus when compared to data collected over the past three years. Except for two stations, the highest concentrations for ammonia and nitrate+nitrite were recorded during the July sampling event.

Metals

Copper was the only metal that exceeded the acute Ambient Water Quality Criteria (AWQC). The two exceedances occurred at the Magazine Beach station. Copper and lead were the only metals that exceeded the chronic AWQC. In addition to the acute AWQC exceedance, copper exceeded the chronic AWQC twice. The exceedances occurred at the Herter East Park and Community Boating Stations. The lead chronic AWQC was exceeded sixteen times. Twelve of the exceedances occurred during the July sampling event and the remainders occurred during the August sampling event. Lead exceedances occurred 33% of the time during dry weather (compared to 27% in 2000 and 8% in 1999) and 0% of the time during wet weather (compared to 25% in 2000 and 72% in 1999). There were no identified reasons for these yearly changes. The other measured priority pollutants metals (arsenic, cadmium, chromium, mercury, nickel, selenium, silver, and zinc) did not exceed the AWQC.

2.0 BACKGROUND

The Charles River watershed is located in eastern Massachusetts and drains 311 square miles from a total of 24 cities and towns. Designated as a Massachusetts class B water, the Charles is the longest river in the state and meanders 80 miles from its headwaters at Echo Lake in Hopkinton to its outlet in Boston Harbor. From Echo Lake to the Watertown Dam, the River flows over many dams and drops approximately 340 feet. From the Watertown Dam to the New Charles River Dam in Boston, the River is primarily flat water (EPA 1997). This section, referred to as "the Basin", is the most urbanized part of the River and is used extensively by rowers, sailors and anglers. A Metropolitan District Commission (MDC) park encompasses the banks of the River and creates excellent outdoor recreational opportunities with its open space and bicycle paths.

The lower basin (defined as the section between the Boston University Bridge and the New Charles River Dam), once a tidal estuary, is now a large impoundment. During low flow conditions of the summer, the basin consists of fresh water overlying a wedge of saltwater. Sea walls define a major portion of the banks and shoreline of this section.

The Charles River shows the effects of pollution and physical alteration that has occurred over the past century. The water quality in the Basin is influenced by point sources, storm water runoff and CSO's. An EPA survey identified over 100 outfall pipes in the Basin (EPA 1996).

3.0 INTRODUCTION

In 1995, EPA established the Clean Charles 2005 Initiative, with a taskforce and numerous subcommittees, to restore the Charles River to a swimmable and fishable condition by Earth Day in the year 2005. The Initiative's strategy was developed to provide a comprehensive approach for improving water quality through CSO controls, removal of illicit sanitary connections, stormwater management planning and implementation, public outreach, education, monitoring, enforcement and technical assistance.

In 1998, EPA's Office of Environmental Measurement and Evaluation (OEME) implemented a water quality monitoring program (Core Monitoring Program) in the Charles River that will continue until at least 2005. EPA and its partners on the Taskforce's water quality subcommittee developed a study design to track improvements in the Charles River Basin and to identify where further pollution reductions or remediation actions were necessary to meet the swimmable and fishable goals. Members of the subcommittee included EPA-New England, U.S. Geological Survey (USGS), U.S. Army Corps of Engineers - New England District (ACE), Massachusetts Executive Office of Environmental Affairs (EOEA), Massachusetts Department of Environmental Protection (DEP), Massachusetts Department of Environmental Management (DEM), Massachusetts Water Resources Authority (MWRA), Boston Water and Sewer Commission (BWS), Charles River Watershed Association (CRWA) and the MDC. In addition to the Core Monitoring Program, EPA and its partners continue to support other water quality studies in the Charles River to further identify impairment areas and to evaluate storm water management techniques.

EPA's Core Monitoring Program was designed to sample twelve stations during three dry weather periods and six (of the twelve) stations during three different wet weather events. The monitoring was focused in the Boston and Cambridge areas of the River during peak recreational usage in July, August and September. To establish a boundary condition, one station was located immediately downstream from the South Natick Dam or 30.5 miles upstream from the Watertown Dam. One station was located above the Watertown Dam and the other ten stations were located in the Basin. Five of these ten sampling stations were located in priority resource areas (potential wading and swimming locations). The project map (Figure 1) shows the locations of the: dry and wet weather fixed sampling stations, priority resource areas, CSO's, and stormwater discharge pipes. Table 1 describes the stations monitored in 2001.

The 1998 monitoring program included measurements of dissolved oxygen (DO), temperature, pH, specific conductance, chlorophyll a, total organic carbon (TOC), total suspended solids (TSS), apparent color, clarity, turbidity, nutrients, bacteria and total metals. Chronic toxicity was also tested during dry weather conditions. In 1999, dissolved metals and true color were added to the analyte list. Dissolved metals were added to better assess the metals concentration in relationship to the AWQC, which are based on the dissolved metals fraction. True color was added to help determine the causes of reduced clarity. In 2000, the analyte list was unchanged.

In 2001, transmissivity was added as an additional measurement of water clarity. In addition, E. coli bacteria was added and enterococcus bacteria was discontinued. This modification was made to reflect the changes to the Massachusetts Department of Public Health (DPH) Minimum Standards for Bathing Beaches regulations, which allowed the use of E. coli bacteria for determining compliance in freshwater.

Table 1: Sampling Station Description

PRIMARY CORE MONITORING STATION DESCRIPTIONS	STATION #
Downstream of S. Natick Dam	CRBL01
Upstream of Watertown Dam	CRBL02 WW
Daly Field, 10 m off south bank	**CRBL03**
Herter East Park, 10 m off south bank	**CRBL04**
Magazine Beach, 10 m off north bank	**CRBL05 WW**
Downstream of BU Bridge, main stem	CRBL06 WW
Downstream of Stony Brook & Mass Ave, 10 m off South shore	CRBL07 WW
Pond at Esplanade	**CRBL08**
Upstream of Longfellow Bridge, Cam. side	CRBL09 WW
Community boating area	**CRBL10**
Between Longfellow Bridge & Old Dam	CRBL11 WW
Upstream of Railroad Bridge	CRBL12
SUPPLEMENTAL SAMPLING STATIONS DESCRIPTION	
30 m downstream of BU Bridge, center channel	CRBUBR
Cheese Cake Brook near mouth of the Charles River	CHEE01
Laundry Brook near mouth of the Charles River	LAUD01
Hyde Brook at mouth of Charles River	HYDE01
Faneuil Brook at USGS Sampling Station	FANE02
Sawins Brook near mouth at Charles River	SAW01
Upstream pipe at drainage area #76, (California Rd Across from California Pk, Newtown)	CR76L
Downstream Pipe at drainage area #76	CR76R
Outfall in front of Perkins school (across from Daly Field)	CRPES
Pipe discharging to Sawins Brook between Arlington and Elm St	SAPIP
Sawins Brook (~40 meters downstream of Elm St)	SAUPS

Bold = Priority resource area station

WW = Wet weather sampling station

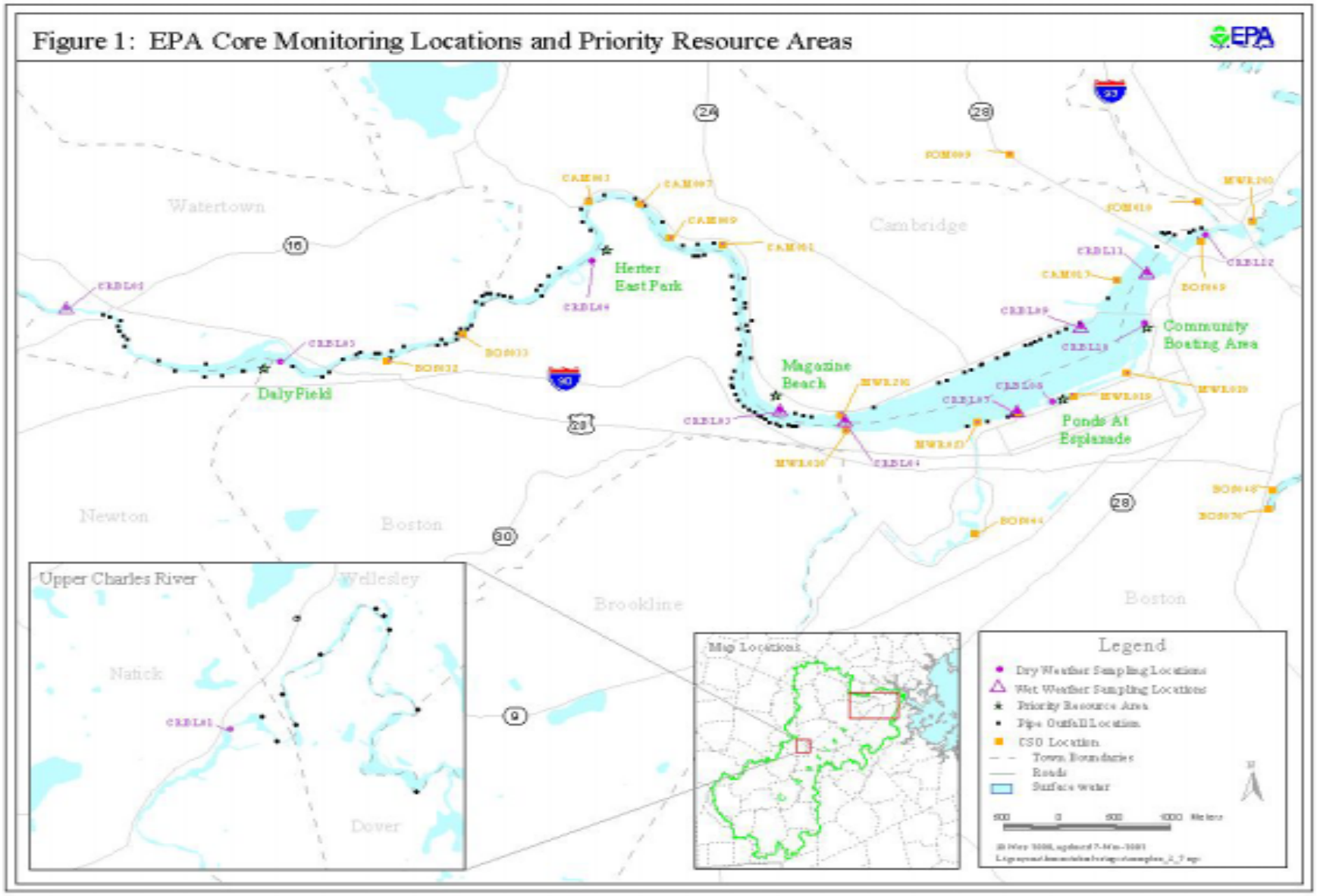


Figure 1: EPA Core Monitoring Locations and Priority Resource Areas
EPA
Watertown
Cambridge
Newton
Boston
Brookline
Natick
Wellesley
Dover
Herter
East Park
Daly Field
Magazine
Beach
Ponds At
Esplanade
Community
Boating Area
Upper Charles River
Map Location
Legend
Dry Weather Sampling Locations
Wet Weather Sampling Locations
Priority Resource Area
Pipe Outfall Location
CSO Location
Town Boundaries
Roads
Surface Water

4.0 PROJECT DESCRIPTION

Sampling was conducted during three dry weather periods and two wet weather events from July through September 2001. Dry weather sampling days were preplanned for the months of July, August, and September. The dry weather sampling goal was to sample on days that were preceded by three days during which a total of less than 0.20 inches of rain had fallen. Dry weather sampling was conducted on July 9, August 7, and September 4. These three dry weather sampling events and the two pre-storm sampling events met the dry weather sampling goal.

The approach for each wet weather event was to sample six stations during four storm periods; pre-storm, first flush, peak flow and post-storm. The pre-storm was sampled before the rain began. The first flush sampling began when the rain became steady and one hour after the measured stage in the Laundry Brook culvert increased by at least 0.5 inches. The peak flow sampling began when rain intensity peaked and the stage reading was greatest in the Laundry Brook culvert. In previous sampling years, it was identified that peak rain intensity coincides with maximum stage or peak flow in Laundry Brook (EPA 2001). Post-storm sampling occurred when the rain ceased and the flow at Laundry Brook returned to near pre-storm conditions.

The first wet weather sampling event began on August 19. This storm, which started on August 20, produced less rain (0.18 inches of rainfall was recorded[1]) than was anticipated. Since this rain event did not meet the specified criteria (0.5 inches or greater within 24 hours) sampling was terminated after first flush samples were collected (Figure A-5). It should also be noted that during the three days prior to the first flush sampling a total of 0.09 inches of rain[1] was recorded. This rain occurred on August 17. The pre-storm sampling event on August 19 was considered representative of dry weather conditions since the rainfall amount was minimal and since during the previous 53 hours zero rainfall[1] occurred. A second wet weather sampling event was initiated on September 20. The associated storm dropped 0.55 inches of rainfall[1] (Figure A-4 in the appendix).

The parameters analysed during 2001 Core Monitoring Program are listed in Table 2. Except for the following notations, all parameters were measured during all sampling events. Transmissivity and E. coli were not measured during either of the wet weather sampling events. Secchi disk transparency was not measured during the September 21 wet weather event. True and apparent color were not measured during the September 4 dry weather event. During "Hot Spot" sampling only fecal coliform bacteria was measured. Dissolved oxygen, temperature, pH and specific conductance were the only parameters measured during the salt wedge monitoring. The EPA OEME's field staff conducted all the sampling and field measurements. Samples were analysed by OEME and contract laboratories.

Table 2: Parameters Analyzed During the 2001 Sampling Events

Field Measurements	Bacteria	Nutrients	Total Metal	Dissolved Metals	Other Parameters
dissolved oxygen, temperature, pH, specific conductance, turbidity, Secchi disk, transmissivity	fecal coliform E. coli.	total phosphorus(TP), ortho-phosphorus(OP), nitrate+nitrite(NO_2+NO_3), ammonia(NH_3)	Hg	Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Mg, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn	TSS, chlorophyll a, TOC, apparent + true color

[1] Rainfall data was collected in Watertown by USGS and are reported as preliminary data.

5.0 DATA ANALYSIS

The fourth year of the Core Monitoring Program was completed in 2001. These data will provide a baseline for determining long-term trends. Because the water quality was influenced by year-to-year fluctuations in weather and river flows, short-term trends could not be determined from the past four years of data. These data will provide a baseline for determining long-term trends. With the exception of lower flows beginning in mid September, the sampling season daily average flows at the Waltham gauging station were generally between 1998 and 1999 flow levels. In 1998, the summer conditions were generally wetter with correspondingly higher flows; in 1999, summer conditions were drier with correspondingly lower flows; and in 2000, the summer flows were generally between 1998 and 1999 flow levels. (Figure A-2).

Three dry weather and two wet weather events were sampled from July to September. Comparing these data to the past three years' data revealed no definitive trends. The four years of data show the section near the mouth of the River (Mass Ave. Bridge to the New Charles River Dam, excluding the Pond at the Esplanade) met the swimming standards more often than any other part of the Basin. Total phosphorus continues to be elevated throughout the system. Continued monitoring will help identify trends in the River.

5.1 Clarity, Apparent color, True color, TSS, Turbidity, TOC, Transmissivity and Chlorophyll a

Secchi disk was used to measure visibility/clarity. The Massachusetts Department of Health has recently amended the minimum standards for bathing beaches (105 CMR 445.00). The new standards amend the four foot numeric standard with a narrative standard. To maintain consistency with previous reports and the MA DEP primary contact recreational use criteria, Secchi disk measurements were compared to the four foot criteria.

Clarity could not be measured at the South Natick Dam (CRBL01) and Watertown Dam (CRBL02) because of the shallow water at these stations. Water clarity was directly measured in the field using a Secchi disk. The greatest clarity was recorded near the mouth of the Basin (from just upstream of the Longfellow Bridge to the New Charles River Dam; CRBL09- CRBL11) during the first two sampling events (July 9 and August 7). During both events, the four stations at the mouth of the Basin, met the four foot swimming criteria (Figure 2). The data from most stations data, following August 7, showed a decrease in water clarity when compared to the data from the first two sampling events.

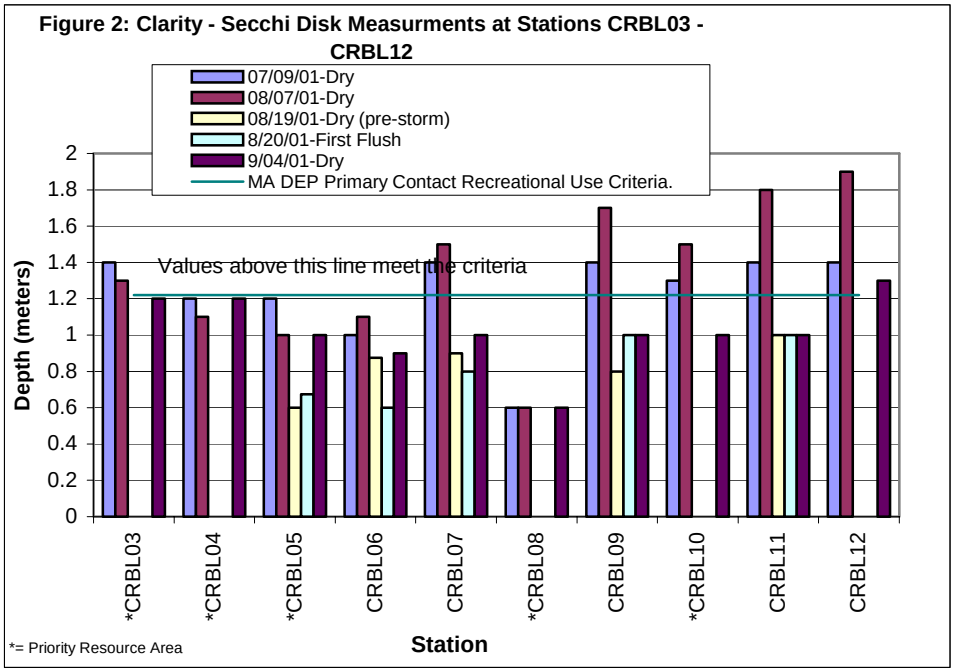


Figure 2: Clarity - Secchi Disk Measurments at Stations CRBL03 - CRBL12

The mean Secchi disk readings were similar to those collected in previous years. The means for 1998 to 2001 show water clarity improves closer to the mouth of the Basin

(Figure 3) and the lowest clarity readings were measured in the pond at the Esplanade (CRBL08).

Apparent color measures the color of the water which may contain suspended matter. Apparent color values were highest in July and decreased throughout the summer. This relationship was also evident in the data collected during 2000.

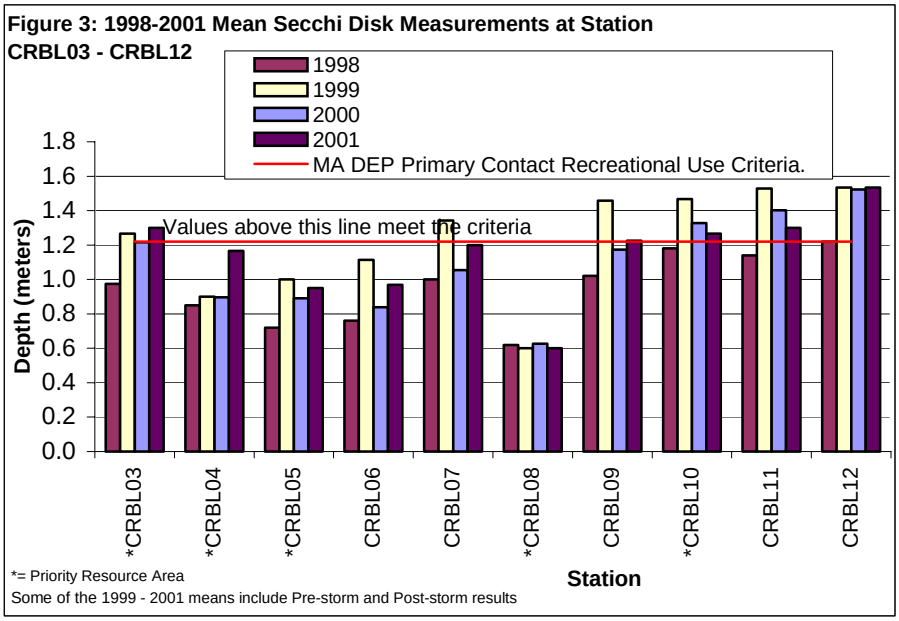


Figure 3: 1998-2001 Mean Secchi Disk Measurements at Station CRBL03 - CRBL12

True color measures the stain in the water after the suspended particulates have been removed by centrifuging.
As with apparent color, true color values were highest in July and decreased throughout the summer. True color was less than apparent color at each station. The true color mean value was 9% to 27% lower than the apparent color mean value. As identified in 1999 Core Monitoring Program Report (EPA 2000) it appears that part of the color was associated with suspended matter. This implies that reducing suspended matter and nutrients that stimulate algae growth could enhance the clarity of the water. Other sources of suspended matter include non-point, point sources (such as storm water and CSO's), resuspended bottom sediments, and other natural sources.

Total Suspended Solids measured in the water column were highest at station CRBL08 during the three dry weather events. Generally, TSS concentrations were higher during September compared to July and August. All measured TSS concentrations were less than the Massachusetts water quality standard (Table 3).

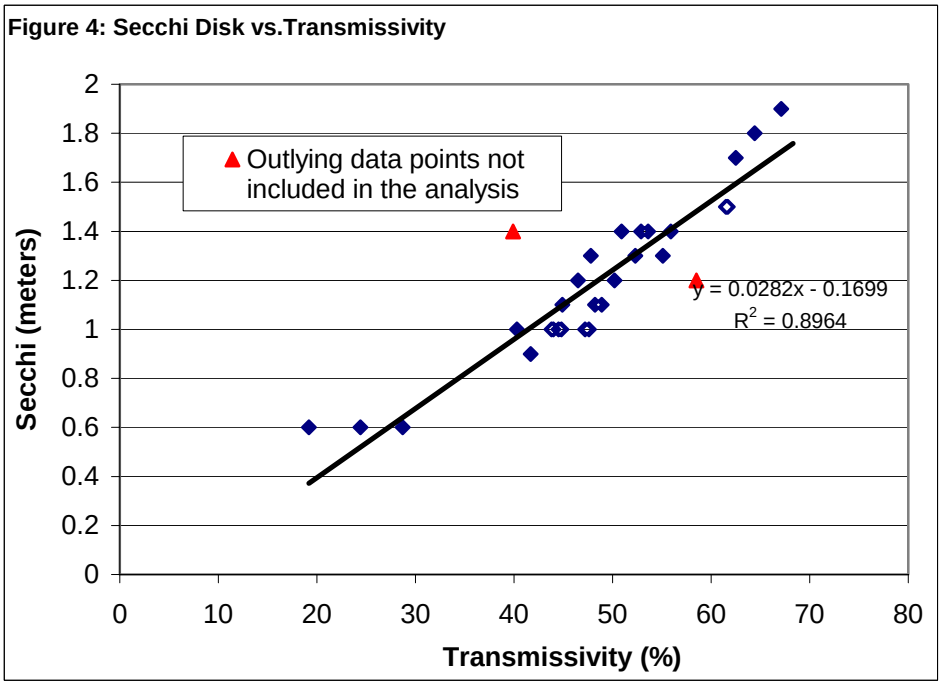


Figure 4: Secchi Disk vs.Transmissivity

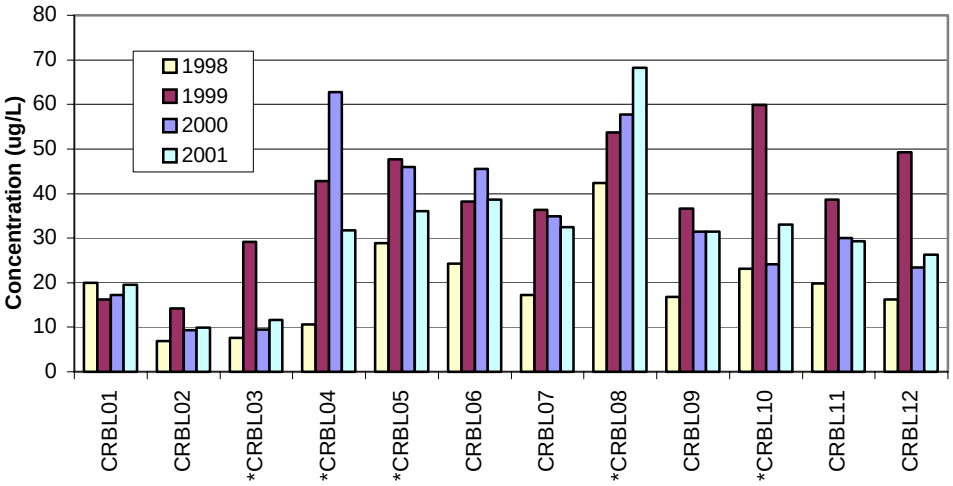
Turbidity and Total Organic Carbon (TOC) were additional measurements of suspended and dissolved matter in the water. As with TSS, the highest turbidity values recorded during the dry weather sampling events in July and September were at CRBL08. At each

station, the highest TOC values were recorded during the July sampling event. This was consistent with the data collected in 2000.

Transmissivity was added to the parameter list in 2001 as an additional measurement of water clarity. Since the Core Monitoring Program only had one transmissometer and two sampling teams, transmissivity was not measured at station CRBL01 and CRBL02. Generally, the greatest transmissivity was recorded near the mouth of the Basin. The lowest transmissivity was consistently recorded in the Pond at the Esplanade. The transmissivity measurements correlated well with Secchi disk measurements and a four foot Secchi disk reading corresponds to an approximately 49% transmissivity (Figure 4).

Chlorophyll a was one of the parameters measured to assess eutrophication in the Basin. Because Massachusetts does not have numeric nutrient or chlorophyll a criteria for assessing eutrophication of lakes and rivers, the total phosphorus and chlorophyll a concentrations were compared to the State of Connecticut's Lake Trophic Classifications - Water Quality Standards[2]. More than 40% of the chlorophyll a samples collected in the Basin were considered highly eutrophic. Mean chlorophyll a concentrations were similar to the means for 2000. The 2001 means were between 1998 and 1999 mean values at ten of the twelve stations (Figure 5).

Figure 5: 1998-2001 Chlorophyll a Means



*= Priority Resource Area
Some of the means from 1999-2001 include Pre-storm and Post

[2] The Connecticut Water Quality Lake Trophic Classification Criteria during mid summer conditions for chlorophyll a: Oligotrophic (0 - 2 ug/l), Mesotrophic (2 - 15 ug/l), Eutrophic (15 - 30 ug/l), and Highly Eutrophic (>30 ug/l).

Table 3: Massachusetts Class B Surface Water Quality Standards and Guidelines for Warm Waters

Parameter	MA Surface Water Quality Standards (314 CMR 4.00) and Guidelines
Dissolved oxygen	≥ 5 mg/l and ≥ 60% saturation
Temperature	≤ 83°F (28.3°C) and ∆ 3°F (1.7°C) in Lakes, ∆ 5°F (2.8°C) in Rivers
pH	Between 6.5 and 8.3
Bacteria	See Table 4
Secchi disk depth	Lakes ≥ 1.2 meters (for primary contact recreation use support)
Solids	Narrative and TSS ≤ 25.0 mg/l (for aquatic life use support)
Color and turbidity	Narrative Standard
Nutrients	Narrative "Control of Eutrophication" Site Specific

5.2 Bacteria

The Massachusetts Department of Public Health (DPH) Minimum Standards for Bathing Beaches and the DEP Surface Water Quality Standards (314 CMR 4.00) establish maximum allowable bacteria criteria. These are summarized in Table 4.

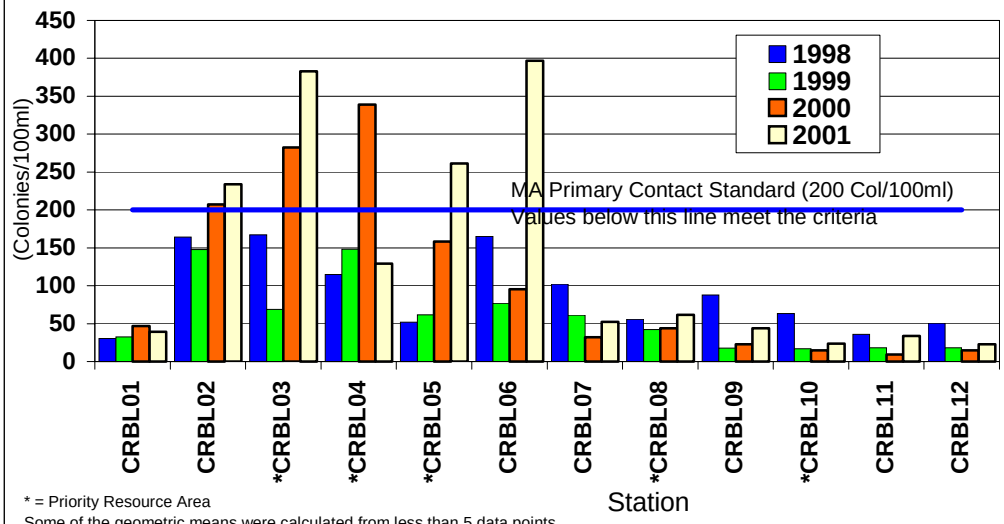
Table 4: Massachusetts Freshwater Bacteria Criteria

Indicator organism	MA DPH Minimum Criteria for Bathing Beaches (105 CMR 445.00)	MA DEP Surface Water Quality Standards (314 CMR 4.00) and water quality guidelines	
	Bathing beaches	Primary contact	Secondary contact
E. coli or	≤235 colonies/100ml and a geometric mean of most recent five samples ≤126 col/100ml	NA	NA
Enterococci	≤61 colonies/100ml and a geometric mean of most recent five samples≤33 col/100ml	NA	NA
Fecal coliform	NA	a geometric mean ≤200 col/100ml for ≥5 samples ≤400/100ml for not more than 10 % of the samples	a geometric mean ≤1000 col/100ml for ≥5 samples ≤2000/100ml for not more than 10 % of the samples
		≤400 col/100ml for <5 samples	≤2000 col/100ml for <5 samples

Note: NA = not applicable

Fecal coliform concentrations were measured during each sampling event. E. coli bacteria were measured during the three dry weather events. For the purpose of this report, the fecal coliform counts of individual samples were compared to the Massachusetts DEP geometric mean criteria of less than or equal to 200 colonies/100ml for primary contact recreation (swimming) and less than or equal to 1000 colonies/100ml for secondary contact recreation (boating).

Figure 6: 1998 - 2001 Dry Weather Fecal Coliform Geometric Means



* = Priority Resource Area
Some of the geometric means were calculated from less than 5 data points.
MA Standards are based on at least 5 data points

One dry weather sample collected downstream of the BU Bridge (CRBL06) and one wet weather sample collected upstream of the Watertown Dam (CRBL02) exceeded 1000 colonies/100ml. Approximately 35% of dry weather samples exceeded 200 colonies/100ml (compared to 23% in 2000). During wet weather conditions approximately 44% of the fecal coliform samples exceeded 200 colonies/100ml (compared to 63% in 2000). Fecal coliform concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12), which was typical of the data collected from 1998 to 2000.

Near the mouth of the Basin, dry weather geometric means[5] were similar to the values from 1998 to 2000 (Figure 6). In the upper part of the Basin, from Watertown Dam (CRBL02) to Magazine Beach (CRBL05), the dry weather geometric means[5] were generally higher than the values from 1998 to 2000 (Figure 6). The wet weather geometric means were calculated from only three data points. These values appear similar to that from previous years.

E. coli bacteria was sampled during three dry weather sampling events. As observed with fecal coliform measurements, the E. coli concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). All samples collected at these stations were below the single sample criteria of 235 colonies/100ml (Table 4). Seven of the samples, collected at other stations, (19 % of all samples, compared to 35% in 1998) exceeded this criterion.

5.3 Dissolved Oxygen and pH

Massachusetts has established criteria for class B waters for dissolved oxygen, pH, temperature, and turbidity (Table 3). To measure and evaluate these parameters, automated and manual in-situ measurement were

[5]Some of the dry weather geometric means were calculated from less than five data points, the actual criteria is based on a geometric mean of five samples or more.

made. One instrument was used to measure temperature, specific conductance, DO, pH, and turbidity. Data that did not meet the quality control criteria were not reported.

Automated instruments were deployed from August 6 to August 9 at three stations (Table A-1 and Figure A-1). The continuous monitoring data revealed several violations of the Massachusetts class B water quality criteria (Table 3). At one of the two stations (where validated continuous DO data were collected) there were three hours of recorded data that did not meet the DO criteria. This station was located immediately downstream of the BU Bridge (CRBUBR). The continuous monitoring data revealed pH violations throughout the basin at each of the three continuous monitoring stations (CRBL03, CRBUBR, CRBL09). On August 8, recorded violations occurred in the afternoon and evening which coincided with super-saturated DO conditions. In addition, CRBL09 exceeded the pH criteria during the afternoon and early evening hours of August 7. The temperature exceeded the warm water Class B criteria at each of the three continuous monitoring stations. At each of the three stations the highest temperatures were recorded on August 8. The highest fifteen-minute value was recorded at CRBL03 at 17:45 on August 8 and was 30.70 ^{o}C (87.26 ^{o}F).

Manual measurements for dissolved oxygen, pH, temperature, specific conductance, and turbidity were measured in-situ during each sampling day. No DO violations were recorded from the manual measurements collected during the eight sampling events (compared to 0% in 2000, 3% in 1999, and 0% in 1998). No DO violations were recorded from surface measurements during the salt wedge monitoring although numerous DO violations and anoxia were observed at lower depths. The data from all the dry and wet weather manual measurements showed pH violated the criteria twelve times or approximately 18% of all field measurements (compared to 20% in 2000 and 8% in 1999, and 4% in 1998). All except one of the violations were greater than 8.3 and occurred downstream of the Mass Ave. Bridge. The one exception occurred upstream of the South Natick dam and was 6.4. The eleven pH violations that were greater than the criteria had associated super-saturated DO concentration of greater than 115 %. Violations of pH were also recorded in the salt wedge monitoring during August and September. The cause of the elevated pH values was unable to be determined but may be, in part, due to the photosynthesis of algae and the uptake of carbon dioxide from the water. No instantaneous temperature measurements made during sample collection exceeded the warm water Class B criteria.

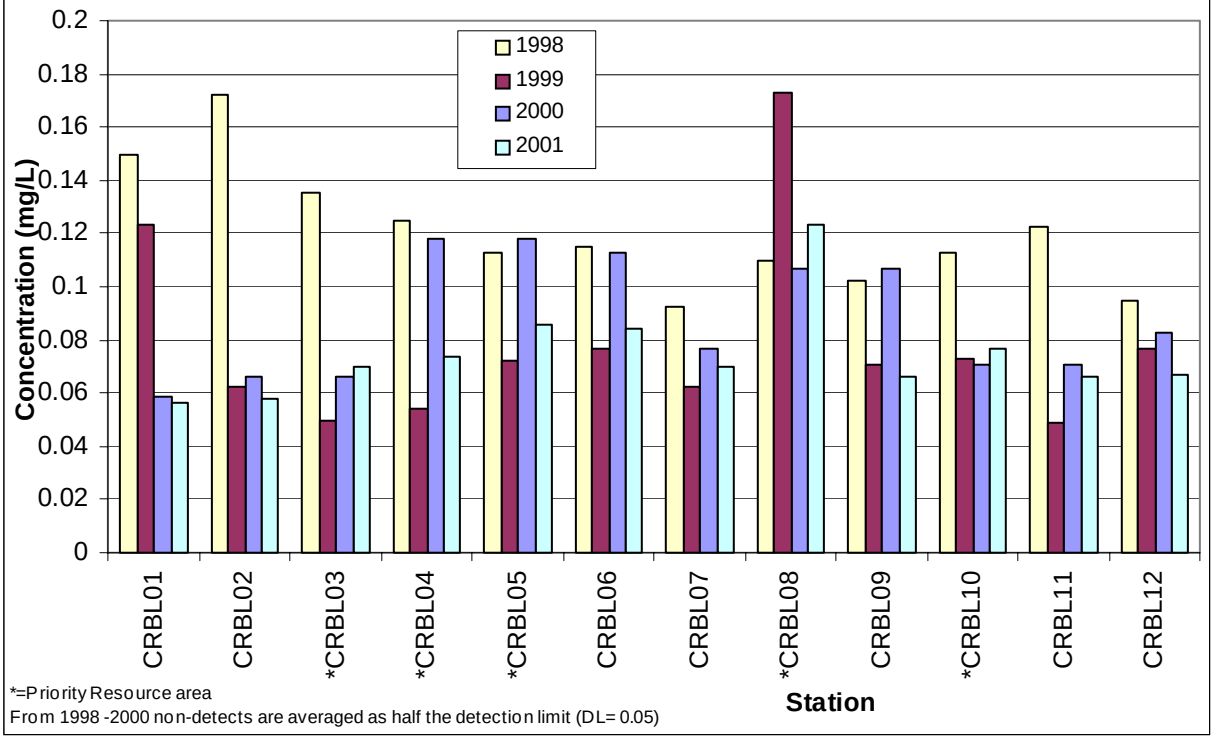
5.4 Nutrients

Nutrient analyses included measurements of total phosphorus, ortho-phosphorus, nitrate+nitrite and ammonia. Elevated phosphorus concentrations at many of the sampling stations indicated highly eutrophic conditions.

Each station recorded the highest concentration during the July sampling event. Mean dry weather total phosphorus concentrations at most stations were less than 1998 levels and similar to the means over the past two years (Figure 7). At the South Natick Dam, the dry weather data showed a reduction in the total phosphorus when compared to data collected over the past three years. Upstream point sources include wastewater treatment plants operated by: Charles River Pollution Control District, the Massachusetts Correctional Institute (MCI) in Norfolk, Wrentham State School, and the towns of Medfield and Milford. No direct correlation could be made between loading from the wastewater treatment plants and concentrations measured in the River[6].

[6] Wastewater treatment plant loadings data came from the facilities Discharge Monitoring Reports (DMR's)

Figure 7: 1998-2001 Total Phosphorus Dry Weather Arithmetic Means



Since Massachusetts uses a narrative site-specific water quality criteria for total phosphorus, measured concentrations were compared to Connecticut's numeric Lakes Trophic Classifications[7]. These classifications indicated that approximately 75% of the dry weather (compared to 80% in 2000 and 1999) total phosphorus concentrations were associated with highly eutrophic waters. Many of the ortho-phosphorus samples were reported as less than 8.15ug/l (not detected), although, as with total phosphorus each station recorded the highest concentration during the July sampling event

Except for two stations, the highest concentrations for ammonia and nitrate+nitrite were recorded during the July sampling event. Nitrate+nitrite (the total nitrate and nitrite) concentrations ranged from less than 0.023 mg/l (not detected) to 0.73 mg/l as nitrogen. Ammonia (as nitrogen) concentrations, ranged from less than 0.075 mg/l (not detected) to 0.321 mg/l.

5.5 Metals

Twenty-one elements were included in the dissolved metal analyses. In addition, total recoverable mercury was analyzed. Ten of these were EPA priority metals and have associated Ambient Water Quality Criteria (AWQC)[8]. Seven of these AWQC's were dependent on the water hardness. Hardness dependent AWQC

[7]The Connecticut Water Quality Lake Trophic Classification Criteria during the spring and summer conditions for total phosphorus are: Oligotrophic (0 - 0.010 mg/l), Mesotrophic (0.010 - 0.030 mg/l), Eutrophic (0.030 - 0.050 mg/l), and Highly Eutrophic (>0.050 mg/l).

[8]EPA:s Clean Water Act Section 304(a) Criteria for Priority toxic Pollutants (40 CFR Part 131.36)

were calculated using the hardness of the water at the time of sampling. The hardness was calculated using the dissolved fraction of calcium and magnesium. Except for mercury, all AWQC's were based on the dissolved metals fraction. Because only total recoverable mercury was measured, the AWQC's for mercury were converted to a total recoverable AWQC. The metals concentrations and the associated criteria are presented in Tables 5 and 6 for dry and wet weather, respectively. The concentrations of all the metals analyzed are presented in Appendix A.

Copper was the only metal that exceeded the acute AWQC. The two exceedances occurred at CRBL05 during a dry weather sampling event on July 9 and a wet weather first flush sampling event on September 21. Copper and lead were the only metals that exceeded the chronic AWQC. In addition, to the two acute AWQC exceedances, the copper chronic AWQC was exceeded twice. Both exceedances occurred at CRBL04 and CRBL10 on July 9. The lead chronic AWQC was exceeded a total of sixteen times. It was exceeded at every station on July 9 and at four stations on August 7. Overall the data appears similar to the data collected during previous years.

Table 5: Priority Pollutant Metals Dry Weather Concentrations and the Ambient Water Quality Criteria (AWQC)

STATION	Arsenic Conc. (ug/L)	Arsenic AWQC Acute (ug/L)	Arsenic AWQC Chronic (ug/L)	Cadmium Conc. (ug/L)	Cadmium AWQC Acute (ug/L)	Cadmium AWQC Chronic (ug/L)	Chromium Conc. (ug/L)	Chromium AWQC Acute (ug/L)	Chromium AWQC Chronic (ug/L)	Copper Conc. (ug/L)	Copper AWQC Acute (ug/L)	Copper AWQC Chronic (ug/L)	Lead Conc. (ug/L)	Lead AWQC Acute (ug/L)	Lead AWQC Chronic (ug/L)
Sampling was conducted on 7/9/01 (dry weather)															
CRBL01	0.62	340	150	ND (0.10)	1.6	1.1	1.5	270	35	2.3	6	4.1	1.70	24	0.9
CRBL02	0.82	340	150	ND (0.10)	2.0	1.3	1.7	322	42	3.4	7	4.9	3.00	30	1.2
CRBL03	0.78	340	150	ND (0.10)	2.0	1.3	1.7	322	42	3.1	7	4.9	3.00	30	1.2
CRBL04	0.87	340	150	ND (0.10)	2.0	1.3	1.7	324	42	6.6	7	5.0	4.00	30	1.2
CRBL05	0.95	340	150	ND (0.10)	2.0	1.3	1.7	324	42	28	7	5.0	6.70	30	1.2
CRBL06	0.99	340	150	ND (0.10)	2.0	1.4	1.8	326	42	4.4	7	5.0	5.60	31	1.2
CRBL07	1.00	340	150	ND (0.10)	2.1	1.4	1.9	331	43	4.3	7	5.1	6.60	31	1.2
CRBL08	1.50	340	150	ND (0.10)	2.0	1.3	1.6	324	42	5.0	7	5.0	18.00	30	1.2
CRBL09	1.20	340	150	ND (0.10)	2.1	1.4	1.8	339	44	5.1	7	5.2	6.40	32	1.3
CRBL10	1.30	340	150	ND (0.10)	2.3	1.5	1.8	359	47	5.7	8	5.5	6.20	35	1.4
CRBL11	1.20	340	150	ND (0.10)	2.3	1.5	1.8	361	47	5.6	8	5.6	6.10	35	1.4
CRBL12	1.60	340	150	ND (0.10)	3.5	1.9	2.2	488	64	7.7	11	7.6	6.10	53	2.0
Sampling was conducted on 8/7/01 (dry weather)															
CRBL01	ND (0.50)	340	150	ND (0.20)	2.6	1.6	1.0	393	51	2.4	9	6.1	0.47	39	1.5
CRBL02	0.80	340	150	ND (0.20)	2.8	1.7	1.2	412	54	2.8	9	6.4	0.91	42	1.6
CRBL03	0.82	340	150	ND (0.20)	3.0	1.7	0.7	432	56	3.4	10	6.7	1.10	45	1.7
CRBL04	0.77	340	150	ND (0.20)	3.0	1.8	1.1	434	57	3.1	10	6.7	1.00	45	1.8
CRBL05	0.86	340	150	ND (0.20)	2.7	1.6	1.3	399	52	4.0	9	6.2	0.90	40	1.6
CRBL06	0.96	340	150	ND (0.20)	2.8	1.7	1.1	412	54	4.3	9	6.4	1.20	42	1.6
CRBL07	1.20	340	150	ND (0.20)	3.4	1.9	1.2	479	62	5.0	11	7.5	2.20	51	2.0
CRBL08	1.40	340	150	ND (0.20)	3.6	2.0	1.8	501	65	4.3	12	7.8	5.60	54	2.1
CRBL09	1.20	340	150	ND (0.20)	3.6	2.0	1.5	501	65	5.0	12	7.8	2.30	54	2.1
CRBL10	1.30	340	150	ND (0.20)	3.9	2.1	1.9	528	69	6.2	12	8.3	2.20	58	2.3
CRBL11	1.40	340	150	ND (0.20)	4.3	2.2	1.8	571	74	6.9	14	9.0	2.10	65	2.5
CRBL12	1.30	340	150	ND (0.20)	3.9	2.1	1.6	532	69	4.2	12	8.3	2.40	59	2.3
Sampling was conducted on 8/19/01 (dry weather pre-storm)															
CRBL02	0.72	340	150	ND (0.20)	2.6	1.6	0.7	395	51	2.6	9	6.1	0.71	40	1.5
CRBL05	0.75	340	150	ND (0.20)	2.6	1.6	0.7	397	52	3.4	9	6.1	1.20	40	1.6
CRBL06	0.89	340	150	ND (0.20)	3.0	1.8	0.5	440	57	3.5	10	6.8	1.10	46	1.8
CRBL07	1.10	340	150	ND (0.20)	3.4	1.9	0.7	483	63	5.2	11	7.5	1.10	52	2.0
CRBL09	1.30	340	150	ND (0.20)	3.7	2.0	0.9	510	66	4.9	12	8.0	0.94	56	2.2
CRBL11	1.30	340	150	ND (0.20)	3.9	2.1	ND (0.50)	512	70	5.1	13	8.4	0.86	60	2.3
Sampling was conducted on 9/4/01 (dry weather)															
CRBL01	ND (0.5)	340	150	ND (0.2)	2.7	1.6	0.55	404	53	2.9	9	6.3	0.25	41	1.6
CRBL02	0.72	340	150	ND (0.2)	3.0	1.8	ND (0.5)	441	57	2.7	10	6.8	0.65	46	1.8
CRBL03	0.74	340	150	ND (0.2)	3.1	1.8	ND (0.5)	448	58	3.3	10	7.0	1.40	47	1.8
CRBL04	0.74	340	150	ND (0.2)	3.2	1.8	ND (0.5)	457	60	3.3	10	7.1	1.09	48	1.9
CRBL05	0.77	340	150	ND (0.2)	2.9	1.7	ND (0.5)	431	56	3.5	10	6.7	0.51	44	1.7
CRBL06	0.81	340	150	ND (0.2)	2.8	1.7	ND (0.5)	420	55	3.4	10	6.5	0.55	43	1.7
CRBL07	1.30	340	150	ND (0.2)	4.3	2.2	0.65	569	74	4.5	13	8.9	1.05	64	2.5
CRBL08	1.29	340	150	ND (0.2)	4.3	2.3	0.52	578	75	4.3	14	9.1	2.35	66	2.6
CRBL09	1.51	340	150	ND (0.2)	4.9	2.4	ND (0.5)	629	82	4.9	15	9.9	0.67	74	2.9
CRBL10	1.54	340	150	ND (0.2)	4.8	2.4	ND (0.5)	621	81	5.0	15	9.8	0.81	72	2.8
CRBL11	1.58	340	150	ND (0.2)	5.1	2.5	ND (0.5)	652	85	5.7	16	10.3	0.63	77	3.0
CRBL12	1.68	340	150	ND (0.2)	5.7	2.7	0.70	710	92	6.1	17	11.3	0.66	86	3.4

Note:

~ =Estimated data

ND = Not detected above the associated detection limit

Chronic '= Exceeds Chronic Criteria

Acute '= Exceeds Acute Criteria

Table 5: Priority Pollutant Metals Dry Weather Concentrations and the Ambient Water Quality Criteria (AWQC) Cont.

STATION	Mercury Conc. (ug/L)	Mercury AWQC Acute (ug/L)	Mercury AWQC Chronic (ug/L)	Nickel Conc. (ug/L)	Nickel AWQC Acute (ug/L)	Nickel AWQC Chronic (ug/L)	Selenium Conc. (ug/L)	Selenium AWQC Chronic (ug/L)	Silver Conc. (ug/L)	Silver AWQC Acute (ug/L)	Zinc Conc. (ug/L)	Zinc AWQC Acute (ug/L)	Zinc AWQC Chronic (ug/L)
Sampling was conducted on 7/9/01 (dry weather)													
CRBL01	0.0063	1.6	0.90	1.5	217	24.1	ND (2.5)	5	ND (0.10)	0.7	4.3	54	55
CRBL02	0.0105	1.6	0.90	1.6	260	28.8	ND (2.5)	5	ND (0.10)	1.0	4.3	65	66
CRBL03	0.0050	1.6	0.90	1.6	260	28.8	ND (2.5)	5	ND (0.10)	1.0	4.3	65	66
CRBL04	0.0054	1.6	0.90	1.7	262	29.0	ND (2.5)	5	ND (0.10)	1.1	6.5	65	66
CRBL05	0.0069	1.6	0.90	1.7	262	29.0	ND (2.5)	5	ND (0.10)	1.1	20	65	66
CRBL06	0.0083	1.6	0.90	1.7	263	29.2	ND (2.5)	5	ND (0.10)	1.1	5.4	66	66
CRBL07	0.0064	1.6	0.90	1.8	267	29.6	ND (2.5)	5	ND (0.10)	1.1	4.9	67	67
CRBL08	0.0083	1.6	0.90	2.0	261	29.0	ND (2.5)	5	ND (0.10)	1.1	4.0	65	66
CRBL09	0.0065	1.6	0.90	2.0	274	30.4	ND (2.5)	5	ND (0.10)	1.2	7.9	69	69
CRBL10	0.0060	1.6	0.90	2.0	290	32.2	ND (2.5)	5	ND (0.10)	1.3	6.8	73	73
CRBL11	0.0058	1.6	0.90	2.0	292	32.4	ND (2.5)	5	ND (0.10)	1.3	6.6	73	74
CRBL12	0.0071	1.6	0.90	2.0	399	44.3	ND (2.5)	5	ND (0.10)	2.5	7.2	100	101
Sampling was conducted on 8/7/01 (dry weather)													
CRBL01	0.0033	1.6	0.91	1.8	319	35.4	ND (1.0)	5	ND (0.20)	1.6	2.9	80	80
CRBL02	0.0025	1.6	0.91	1.8	335	37.2	ND (1.0)	5	ND (0.20)	1.7	3.5	84	84
CRBL03	0.0042	1.6	0.91	1.9	352	39.1	ND (1.0)	5	ND (0.20)	1.9	3.3	88	89
CRBL04	0.0049	1.6	0.91	2.0	354	39.3	ND (1.0)	5	ND (0.20)	2.0	3.1	89	89
CRBL05	0.0045	1.6	0.91	1.9	324	36.0	ND (1.0)	5	ND (0.20)	1.6	3.9	81	82
CRBL06	0.0054	1.6	0.91	2.0	335	37.2	ND (1.0)	5	ND (0.20)	1.7	5.4	84	84
CRBL07	0.0037	1.6	0.91	2.2	391	43.4	1.4	5	ND (0.20)	2.4	4.6	98	99
CRBL08	0.0077	1.6	0.91	2.0	410	45.5	1.6	5	ND (0.20)	2.6	2.0	103	103
CRBL09	0.0043	1.6	0.91	2.0	410	45.5	1.7	5	ND (0.20)	2.6	3.9	103	103
CRBL10	0.0039	1.6	0.91	2.1	433	48.1	1.7	5	ND (0.20)	2.9	4.2	108	109
CRBL11	0.0043	1.6	0.91	2.1	469	52.1	2.3	5	ND (0.20)	3.5	5.0	117	118
CRBL12	0.0032	1.6	0.91	2.2	436	48.5	1.7	5	ND (0.20)	3.0	4.5	109	110
Sampling was conducted on 8/19/01 (dry weather pre-storm)													
CRBL02	0.0045	1.6	0.91	1.8	321	35.6	ND (1.0)	5	ND (0.20)	1.6	3.2	80	81
CRBL05	0.0100	1.6	0.91	1.8	322	35.8	ND (1.0)	5	ND (0.20)	1.6	2.0	81	81
CRBL06	0.0052	1.6	0.91	1.9	359	39.9	1.0	5	ND (0.20)	2.0	ND (2.0)	90	91
CRBL07	0.0039	1.6	0.91	2.1	394	43.8	1.5	5	ND (0.20)	2.4	ND (2.0)	99	100
CRBL09	0.0043	1.6	0.91	2.1	418	46.4	2.1	5	ND (0.20)	2.7	2.1	105	105
CRBL11	0.0043	1.6	0.91	2.1	440	48.8	2.2	5	ND (0.20)	3.0	2.1	110	111
Sampling was conducted on 9/4/01 (dry weather)													
CRBL01	0.0031	1.6	0.91	1.8	328	36.4	ND (1.0)	5	ND (0.2)	1.7	ND (5.0)	82	83
CRBL02	0.0019	1.6	0.91	1.8	359	39.8	ND (1.0)	5	ND (0.2)	2.0	ND (5.0)	90	90
CRBL03	0.0051	1.6	0.91	1.8	366	40.6	ND (1.0)	5	ND (0.2)	2.1	ND (5.0)	92	92
CRBL04	0.0062	1.6	0.91	1.8	373	41.4	ND (1.0)	5	ND (0.2)	2.2	ND (5.0)	93	94
CRBL05	0.0064	1.6	0.91	1.8	351	39.0	ND (1.0)	5	ND (0.2)	1.9	ND (5.0)	88	89
CRBL06	0.0095	1.6	0.91	1.8	342	38.0	ND (1.0)	5	ND (0.2)	1.8	ND (5.0)	86	86
CRBL07	0.0056	1.6	0.91	1.9	468	51.9	2.0	5	ND (0.2)	3.4	ND (5.0)	117	118
CRBL08	0.0168	1.6	0.91	2.0	475	52.7	2.1	5	ND (0.2)	3.5	ND (5.0)	119	120
CRBL09	0.0100	1.6	0.91	1.9	518	57.6	2.5	5	ND (0.2)	4.2	ND (5.0)	130	131
CRBL10	0.0076	1.6	0.91	1.9	512	56.9	2.7	5	ND (0.2)	4.1	ND (5.0)	128	129
CRBL11	0.0070	1.6	0.91	1.9	539	59.8	2.9	5	ND (0.2)	4.6	ND (5.0)	135	136
CRBL12	0.0046	1.6	0.91	2.0	588	65.3	3.5	5	ND (0.2)	5.5	ND (5.0)	147	148

Note:

Except for Mercury, which is reported as Total Mercury, all metals concentrations and AWQC criteria are reported as dissolved metals.

~ =Estimated data

ND = Not detected above the associated detection limit

Chronic '= Exceeds Chronic Criteria

Acute '= Exceeds Acute Criteria

Table 6: Priority Pollutant Metals Wet Weather Concentrations and the Ambient Water Quality Criteria (AWQC

STATION	Arsenic Conc. (ug/L)	Arsenic AWQC Acute (ug/L)	Arsenic AWQC Chronic (ug/L)	Cadmium Conc. (ug/L)	Cadmium AWQC Acute (ug/L)	Cadmium AWQC Chronic (ug/L)	Chromium Conc. (ug/L)	Chromium AWQC Acute (ug/L)	Chromium AWQC Chronic (ug/L)	Copper Conc. (ug/L)	Copper AWQC Acute (ug/L)	Copper AWQC Chronic (ug/L)	Lead Conc. (ug/L)	Lead AWQC Acute (ug/L)	Lead AWQC Chronic (ug/L)
Sampling was conducted on 8/20/01 (wet weather first flush)															
CRBL02	0.64	340	150	ND (0.2)	2.6	1.6	0.60	395	51	2.7	9	6.1	0.70	40	1.5
CRBL05	0.73	340	150	ND (0.2)	2.7	1.6	ND (0.5)	401	52	3.7	9	6.2	1.20	40	1.6
CRBL06	0.81	340	150	ND (0.2)	2.7	1.6	ND (0.5)	401	52	3.0	9	6.2	1.30	40	1.6
CRBL07	1.00	340	150	ND (0.2)	3.2	1.8	0.70	454	59	3.5	10	7.1	0.99	48	1.9
CRBL09	1.20	340	150	ND (0.2)	3.7	2.0	0.60	514	67	6.9	12	8.0	1.30	56	2.2
CRBL11	1.20	340	150	ND (0.2)	3.7	2.0	0.70	516	67	4.6	12	8.1	0.83	57	2.2
Sampling was conducted on 9/20/01 (wet weather pre-storm)															
CRBL02	0.65	340	150	ND (0.2)	3.3	1.9	ND (0.5)	474	62	3.0	11	7.4	0.32	51	2.0
CRBL05	0.81	340	150	ND (0.2)	3.4	1.9	ND (0.5)	479	62	3.8	11	7.5	0.33	51	2.0
CRBL06	0.91	340	150	ND (0.2)	3.8	2.1	ND (0.5)	521	68	4.3	12	8.2	0.32	57	2.2
CRBL07	1.62	340	150	ND (0.2)	5.9	2.8	ND (0.5)	727	95	5.8	18	11.5	0.21	89	3.5
CRBL09	1.58	340	150	ND (0.2)	6.0	2.8	ND (0.5)	733	95	6.1	18	11.7	ND (0.2)	90	3.5
CRBL11	1.71	340	150	ND (0.2)	6.2	2.9	0.65	752	98	6.2	19	12.0	ND (0.2)	93	3.6
Sampling was conducted on 9/21/01 (wet weather first flush)															
CRBL02	0.63	340	150	ND (0.2)	3.2	1.8	ND (0.5)	455	59	3.4	10	7.1	0.42	48	1.9
CRBL05	0.74	340	150	ND (0.2)	3.4	1.9	ND (0.5)	483	63	12.0	11	7.5	0.40	52	2.0
CRBL06	0.79	340	150	ND (0.2)	3.5	2.0	0.66	491	64	4.4	11	7.7	0.31	53	2.1
CRBL07	1.50	340	150	ND (0.2)	5.5	2.7	0.55	688	90	5.8	17	10.9	ND (0.2)	83	3.2
CRBL09	1.60	340	150	ND (0.2)	6.3	2.9	ND (0.5)	764	99	6.3	19	12.2	ND (0.2)	95	3.7
CRBL11	1.60	340	150	ND (0.2)	6.2	2.9	0.70	754	98	6.9	19	12.0	0.26	93	3.6
Sampling was conducted on 9/24/01 (wet weather post-storm)															
CRBL02	0.60	340	150	ND (0.2)	3.2	1.8	ND (0.5)	457	59	3.2	10	7.1	0.30	48	1.9
CRBL05	0.80	340	150	ND (0.2)	3.4	1.9	ND (0.5)	483	63	4.8	11	7.5	0.30	52	2.0
CRBL06	0.80	340	150	ND (0.2)	3.5	2.0	ND (0.5)	491	64	5.0	11	7.7	0.40	53	2.1
CRBL07	1.30	340	150	ND (0.2)	4.9	2.5	ND (0.5)	632	82	5.8	15	10.0	0.30	74	2.9
CRBL09	1.50	340	150	ND (0.2)	5.6	2.7	ND (0.5)	699	91	6.4	17	11.1	ND (0.2)	85	3.3
CRBL11	1.70	340	150	ND (0.2)	5.8	2.8	0.60	717	93	7.4	18	11.4	ND (0.2)	88	3.4

Note:

Except for Mercury, which is reported as Total Mercury, all metals concentrations and AWQC criteria are reported as dissolved metals.

~ =Estimated data

ND = Not detected above the associated detection limit

Chronic '= Exceeds Chronic Criteria

Acute '= Exceeds Acute Criteria

Table 6: Priority Pollutant Metals Wet Weather Concentrations and the Ambient Water Quality Criteria (AWQC) Cont.

STATION	Mercury Conc. (ug/L)	Mercury AWQC Acute (ug/L)	Mercury AWQC Chronic (ug/L)	Nickel Conc. (ug/L)	Nickel AWQC Acute (ug/L)	Nickel AWQC Chronic (ug/L)	Selenium Conc. (ug/L)	Selenium AWQC Chronic (ug/L)	Silver Conc. (ug/L)	Silver AWQC Acute (ug/L)	Zinc Conc. (ug/L)	Zinc AWQC Acute (ug/L)	Zinc AWQC Chronic (ug/L)
Sampling was conducted on 8/20/01 (wet weather first flush)													
CRBL02	0.0032	1.6	0.91	1.8	321	36	ND (1.0)	5	ND (0.2)	1.6	3.1	80	81
CRBL05	0.0073	1.6	0.91	1.8	326	36	ND (1.0)	5	ND (0.2)	1.7	3.1	82	82
CRBL06	0.0121	1.6	0.91	1.8	326	36	ND (1.0)	5	ND (0.2)	1.7	2.5	82	82
CRBL07	0.0066	1.6	0.91	2.0	371	41	1.4	5	ND (0.2)	2.1	2.9	93	94
CRBL09	0.0047	1.6	0.91	2.1	421	47	1.8	5	ND (0.2)	2.8	4.4	105	106
CRBL11	0.0046	1.6	0.91	2.1	423	47	2.0	5	ND (0.2)	2.8	3.0	106	107
Sampling was conducted on 9/20/01 (wet weather pre-storm)													
CRBL02	0.0015	1.6	0.91	1.9	387	43	ND (1.0)	5	ND (0.2)	2.3	ND (5.0)	97	98
CRBL05	0.0100	1.6	0.91	1.9	392	44	ND (1.0)	5	ND (0.2)	2.4	ND (5.0)	98	99
CRBL06	0.0071	1.6	0.91	2.0	427	47	1.1	5	ND (0.2)	2.9	ND (5.0)	107	108
CRBL07	0.0062	1.6	0.91	2.1	602	67	3.3	5	ND (0.2)	5.7	ND (5.0)	151	152
CRBL09	0.0046	1.6	0.91	2.2	608	68	3.4	5	ND (0.2)	5.9	5.2	152	153
CRBL11	0.0040	1.6	0.91	2.2	624	69	3.7	5	ND (0.2)	6.2	ND (5.0)	156	157
Sampling was conducted on 9/21/01 (wet weather first flush)													
CRBL02	0.0026	1.6	0.91	2.0	371	41	ND (1.0)	5	ND (0.2)	2.1	ND (5.0)	93	94
CRBL05	0.0076	1.6	0.91	2.0	395	44	ND (1.0)	5	ND (0.2)	2.4	ND (5.0)	99	100
CRBL06	0.0078	1.6	0.91	2.1	402	45	ND (1.0)	5	ND (0.2)	2.5	ND (5.0)	100	101
CRBL07	0.0076	1.6	0.91	2.1	569	63	3.1	5	ND (0.2)	5.1	ND (5.0)	142	144
CRBL09	0.0049	1.6	0.91	2.2	634	71	3.5	5	ND (0.2)	6.4	ND (5.0)	159	160
CRBL11	0.0046	1.6	0.91	2.2	625	69	3.8	5	ND (0.2)	6.2	ND (5.0)	157	158
Sampling was conducted on 9/24/01 (wet weather post-storm)													
CRBL02	0.0018	1.6	0.91	1.8	373	41	ND (1.0)	5	ND (0.2)	2.2	ND (5.0)	93	94
CRBL05	0.0038	1.6	0.91	1.9	395	44	ND (1.0)	5	ND (0.2)	2.4	ND (5.0)	99	100
CRBL06	0.0049	1.6	0.91	1.9	402	45	ND (1.0)	5	ND (0.2)	2.5	ND (5.0)	100	101
CRBL07	0.0040	1.6	0.91	2.0	521	58	2.4	5	ND (0.2)	4.3	ND (5.0)	130	132
CRBL09	0.0032	1.6	0.91	2.0	578	64	3.0	5	ND (0.2)	5.3	ND (5.0)	145	146
CRBL11	0.0056	1.6	0.91	2.1	594	66	3.4	5	ND (0.2)	5.6	ND (5.0)	149	150

Note:

Except for Mercury, which is reported as Total Mercury, all metals concentrations and AWQC criteria are reported as dissolved metals.

~ =Estimated data

ND = Not detected above the associated detection limit

Chronic '= Exceeds Chronic Criteria

Acute '= Exceeds Acute Criteria

5.6 Salt Wedge Monitoring

On July 31, August 1, and September 11 depth profile measurements were made at selected stations in the Basin. Measurements were made for temperature, specific conductance, salinity, dissolved oxygen and pH. These measurements were conducted primarily to measure the depth and longitudinal profile of the halocline. These measurements were conducted to build on the work that USGS performed during 1998 and 1999 (USGS 2000). The profile data for July 31, August 1 and September 11 are presented in Table A-19, A-20, and A-21. The distribution and concentration of the haloclines for July 31, August 1 and September 11 are presented on Figure 8, 9 and 10, respectively. The halocline covered the largest area on September 11 (Figure 10). Bottom anoxic conditions were measured during each of the three sampling events.

Figure 8: Bottom Salinity Summary on July 13

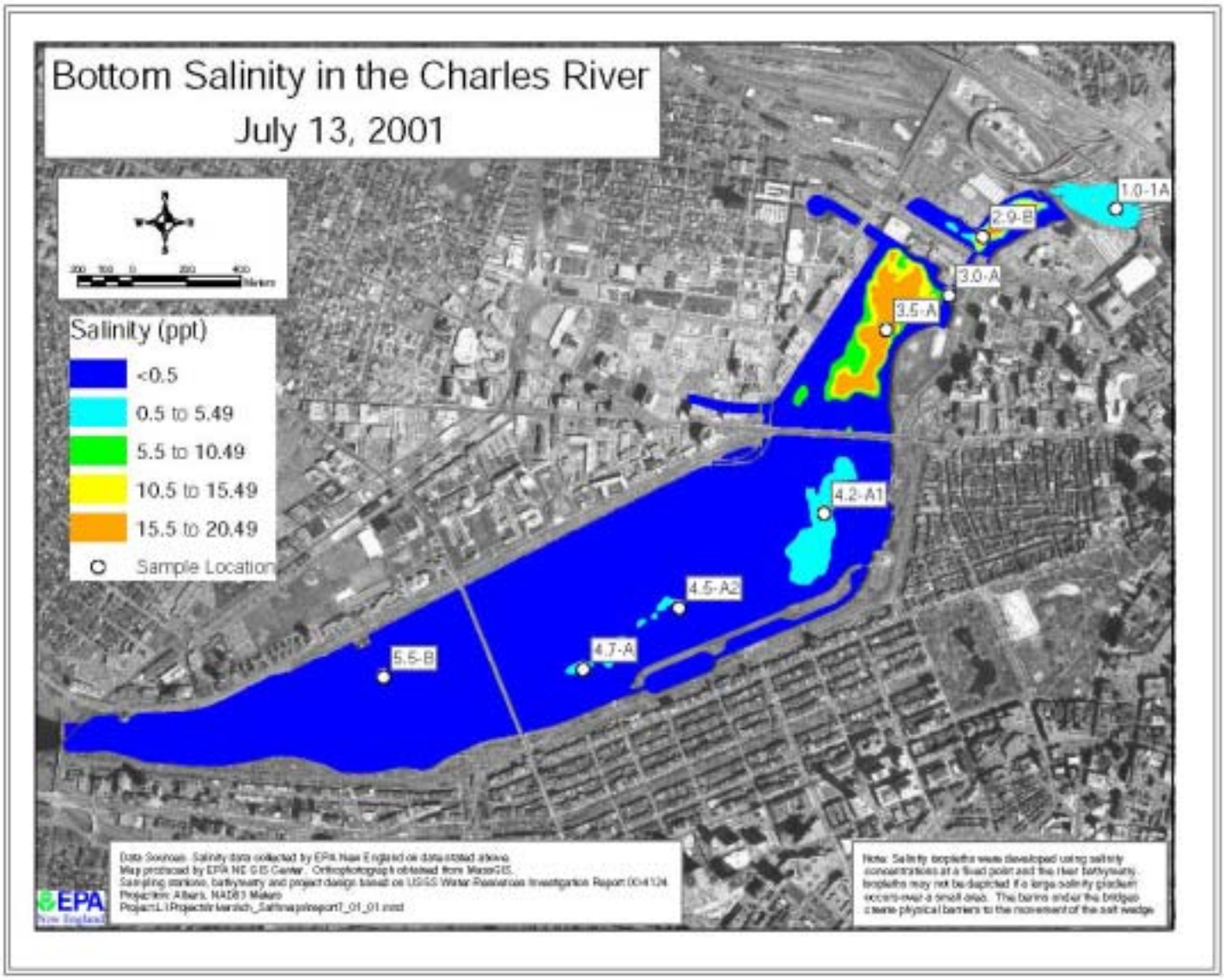


Figure 9: Bottom Salinity Summary on August 1

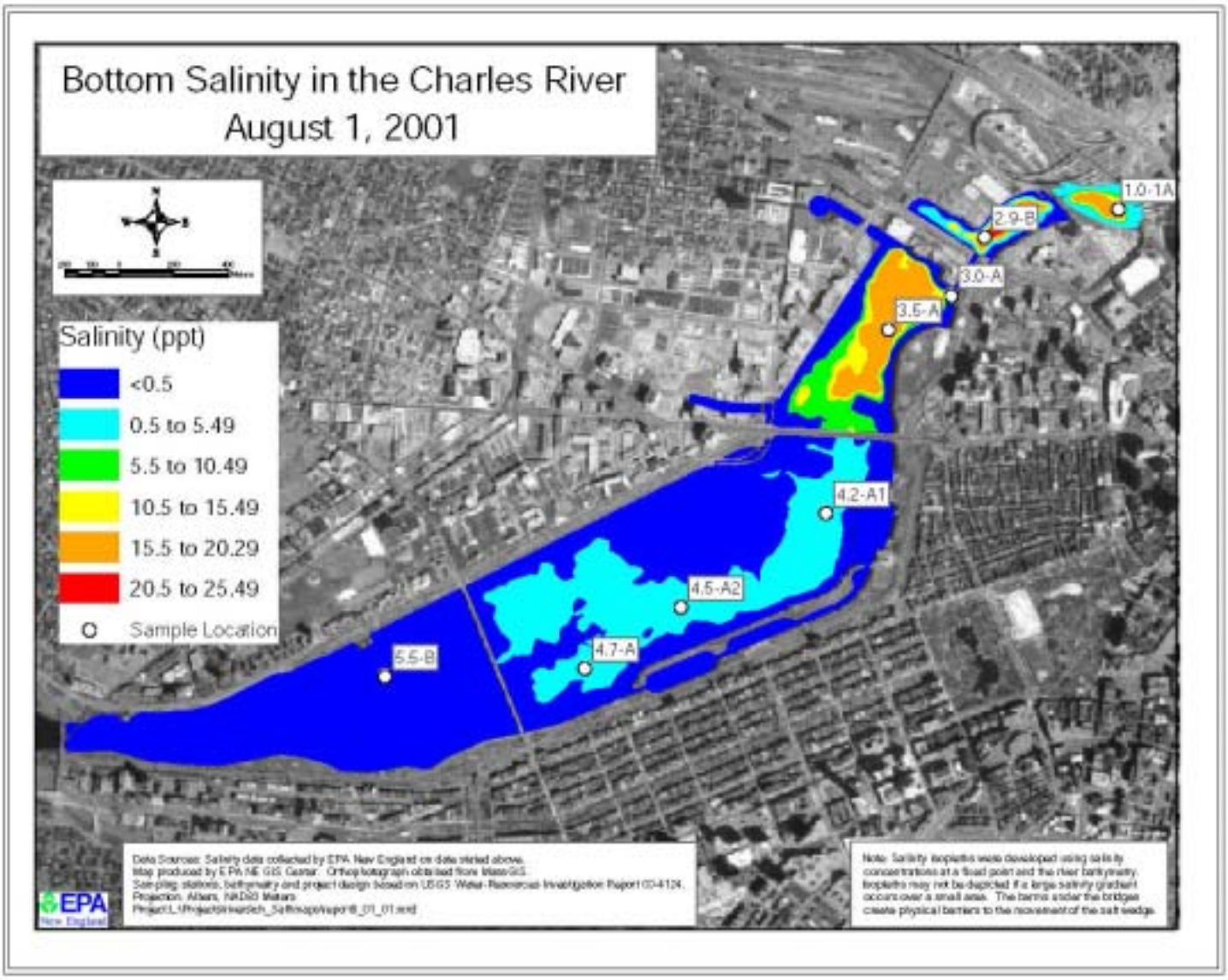
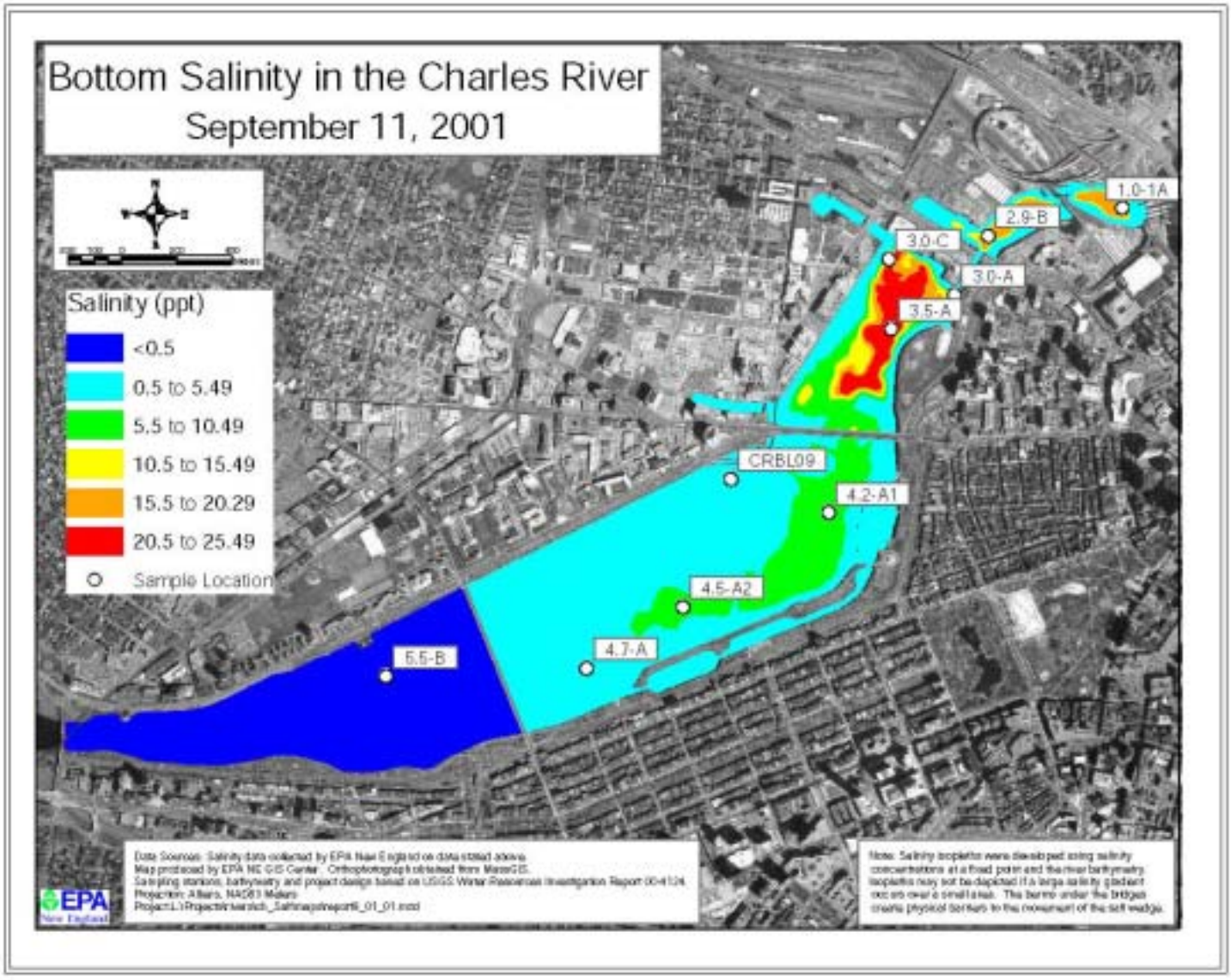


Figure 10: Bottom Salinity Summary on September 11



5.7 Data Usability

Quality control criteria were established for all data presented in this report. The criteria specify holding times, sample preservation, and precision and accuracy limits. Holding times were met for all samples. The quality control requirements for this project were documented in the Project Work/QA Plan - Charles River Clean 2005 Water Quality Study June 2,1999.

Duplicate field measurements (temperature, DO, pH, specific conductance, salinity, turbidity, and Secchi disk) were measured approximately fifty percent of the time. With the exception of one turbidity duplicate result, which recorded a relative percent difference of 69 percent, all duplicated relative percent differences were less than 10 percent. The Project Work/QA Plan did not specify goals for these parameters. There were criteria specified for post calibration checks that were performed after each sampling event to document instrument precision and accuracy. Field monitoring data that did not meet the established quality control criteria were not presented in this report. Field data that partially met the criteria were reported as estimated data and identified with a swung dash (~) preceding the value.

Chemistry data that partially met laboratory quality control criteria or concentrations that were less than the associated reporting limit were considered estimated values and identified with a swung dash (~) preceding the value. Field duplicate chemistry samples were collected during each of the eight core monitoring sampling events to evaluate sampling and analytical precision. The data not meeting the criteria are described below. Four of the 84 duplicate samples (excluding metals and field measurements) analyzed during the sampling events did not meet the precision quality control goal of less than 35 relative percent difference established in the Project Work/QA Plan. However, the project use of these data was not limited for the reason specified below. Three of the duplicate samples were for fecal coliform and one was for E. coli. All measured counts that recorded these variations were 100 colonies/100 ml or less. At these levels, large relative percent differences are common because of the of natural bacteria variability that exist in ambient water.

One of 176 duplicate samples for total and dissolved metals analyzed during the eleven sampling events did not meet the precision quality control goal of less than 35 relative percent difference. However, the project use of these data was not limited for this project for the reason specified below. The one duplicate sample collected on September 21, that did not meet the quality control goal was for manganese. The calculated relative percent difference for the duplicate sample was 49 percent. The review of the field and laboratory quality control data, samples showed no abnormalities.

For the chemistry analyses, trip blanks were used to evaluate any contamination caused by: the sample container, sample preservation, sampling method, and/or transportation to the laboratory. The trip blank, a bottle of ultra pure water, was collected prior to sampling and brought on the sampling trip. The non-metal sample trip blanks were collected during each dry weather sampling event. All the results for these samples were reported as not detected above the reporting limit, which indicates no reported contamination. The dissolved metals trip blank was filtered in the field and then preserved following the procedure specified for sample collection. Some of the dissolved metal blank values for copper and barium were above the reporting level. These blank values were all less than three times the lowest value reported for the station samples. Therefore, the use of the data was not limited for this report. No metal trip blank was collected for the August 19 pre-storm sampling event and contamination was evaluated using data collected during the other sampling events. This evaluation also indicates the use of the data was not limited for this report. The Appendix contains all the validated data for this report.

6.0 2002 STUDY DESIGN

In 2002, the monitoring program will change slightly to effectively build on the existing data and to address future monitoring needs. In the past, continuous monitoring was conducted in the Basin at numerous stations during different months of the summer. The results indicate few exceedances. Therefore, it was decided to discontinue continuous monitoring in 2002. If a need arises continuous monitoring will be added to future monitoring programs.

In 2002, EPA's Charles River Core Monitoring Program will be expanded to support water quality model development of the Basin. The model will ultimately be used in the development of a eutrophication Total Maximum Daily Load (TMDL) to address low dissolved oxygen levels, numerous aesthetic impairments resulting from algae blooms, and pH violations. The 2002 monitoring program will include; adding eight supplemental (TMDL) stations in the lower Basin, three additional surveys between June 1 and October 1, 2002, and adding Total Kjeldahl Nitrogen (TKN) and algal analysis to the parameter list.

In 2002, station CRBL08 will be relocated to the main stem of the Charles River (outside the Pond at the Esplanade). This new station will be identified as CRBLA8. This station will be relocated to better characterize water quality in the main-stem of the River. The previous monitoring data shows that the Pond at the Esplanade (CRBL08) has consistently poor water quality and it is currently unsuitable as a priority resource area.

Targeted pipe monitoring will continue in 2002 at identified hot spots in the Basin for fecal coliform and E. coli bacteria.

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