D.C. DEPARTMENT OF HEALTH

Environmental Health Administration
Bureau of Environmental Quality
Water Quality Division

DISTRICT OF COLUMBIA

FINAL
TOTAL MAXIMUM DAILY LOADS

FOR

METALS

IN

ROCK CREEK

FEBRUARY 2004

Government of the
District of Columbia
Anthony A. Williams, Mayor

DISTRICT OF COLUMBIA

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1.0 Introduction

1.1 TMDL Definition and Regulatory Information

In 1996, the District of Columbia (DC) submitted the Total Maximum Daily Load (TMDL) Priority list and Report to EPA containing a list of waters that do not or are not expected to meet water quality standards as required by Sections 303(d)(1)(A) and 303(d)(1)(B) of the Clean Water Act (CWA):

> *Each state shall identify those waters within its boundaries for which the effluent limitations required by section 301(b)(1)(A) and section 301(b)(1)(B) are not stringent enough to implement any water quality standards applicable to such waters. The state shall establish a priority ranking for such waters taking into account the severity of the pollution and the uses to be made of such waters*
>
> *Each state shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the administrator identifies under section 304(a)(2) as suitable for such calculations. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between the effluent limitations and water quality.*

The Section 303(d) list of impaired waters was revised in 2002 based on additional water quality data and contains an updated priority list that is used to determine the order in which TMDLs will be completed. By following the TMDL process, states can establish water-quality based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of their water resources (EPA, 1991).

1.2 Rock Creek Watershed Location

Rock Creek flows through Montgomery County, Maryland, and the northwest portion of Washington, DC, to join with the Potomac River. The watershed is 76.5 square miles with 15.9 square miles in DC or approximately 21 percent in DC and 79 percent in Maryland (USGS, 2002). The Rock Creek basin is part of the Middle Potomac-Anacostia-Occoquan watershed (Hydrologic Unit Code 02070010).

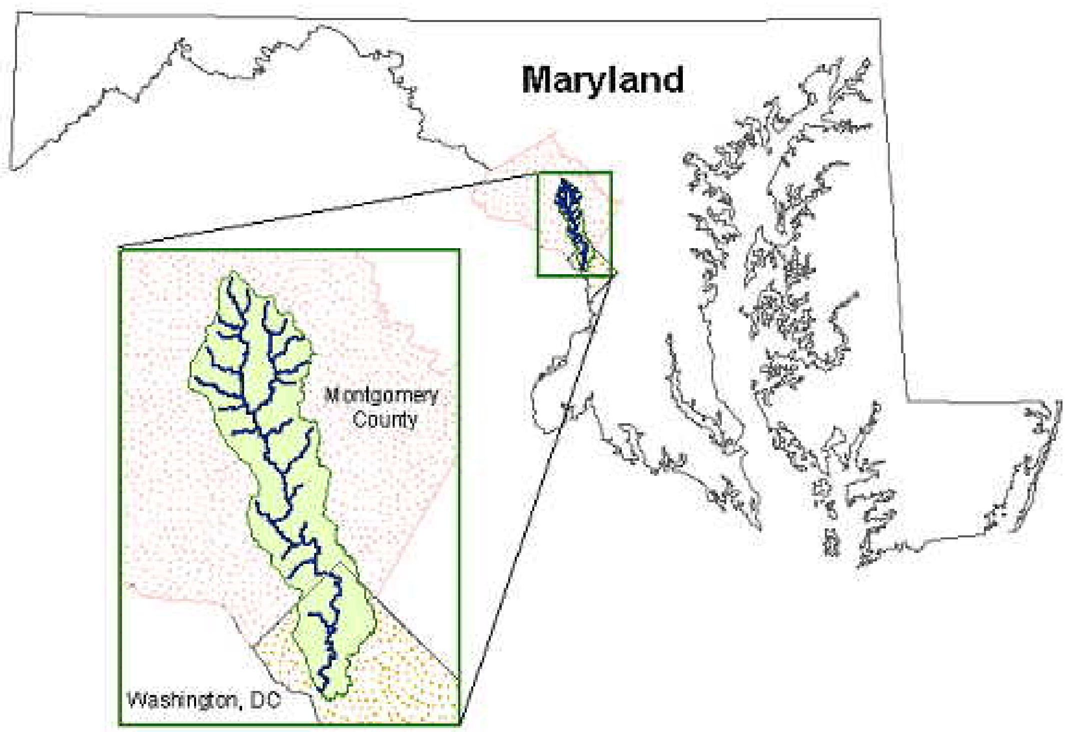

Figure 1-1: Location of Rock Creek Watershed

1.3 Impairment Listing

The District of Columbia's Section 303(d) list of impaired waters divides Rock Creek into two segments: Upper Rock Creek (DCRCR00R_02) and Lower Rock Creek (DCRCR00R_01). Lower Rock Creek is 3.6 miles long and extends from the confluence of Rock Creek and the Potomac River in Georgetown to the National Zoo below the Pierce Mill Dam. Lower Rock Creek is designated as a "special water of the District of Columbia" under the District of Columbia Water Quality Standards (WQS). Upper Rock Creek is 5.9 miles long and extends from Pierce Mill Dam to the District/Maryland line. DC's 1998 Section 303(d) list for the Rock Creek watershed is shown in Table 1-1 and the water bodies are presented in Figure 1-2.

Table 1-1: District of Columbia 303(d) Listings for Rock Creek

Waterbody ID	Waterbody	Pollutant Categories Causing Impairment	Priority Ranking
DCRCR00R_02	Upper Rock Creek	Organics, Bacteria, and Metals	Medium
DCRCR00R_01	Lower Rock Creek	Organics, Bacteria, and Metals	Medium
DCTSO01R	Soapstone Creek	Organics	Low
DCTBR01R	Broad Branch	Organics	Low
DCTDO01R	Dumbarton Oaks	Organics	Low
DCTFE01R	Fenwick Branch	Organics	Low
DCTKV01R	Klingle Valley Creek	Organics	Low
DCTLU01R	Luzon Branch	Organics	Low
DCTMH01R	Melvin Hazen Valley	Organics	Low
DCTNS01R	Normanstone Creek	Organics	Low
DCTPI01R	Pinehurst Branch	Organics	Low
DCTPO01R	Portal Branch	Organics	Low
DCTPY01R	Piney Branch	Organics, Metals	Low

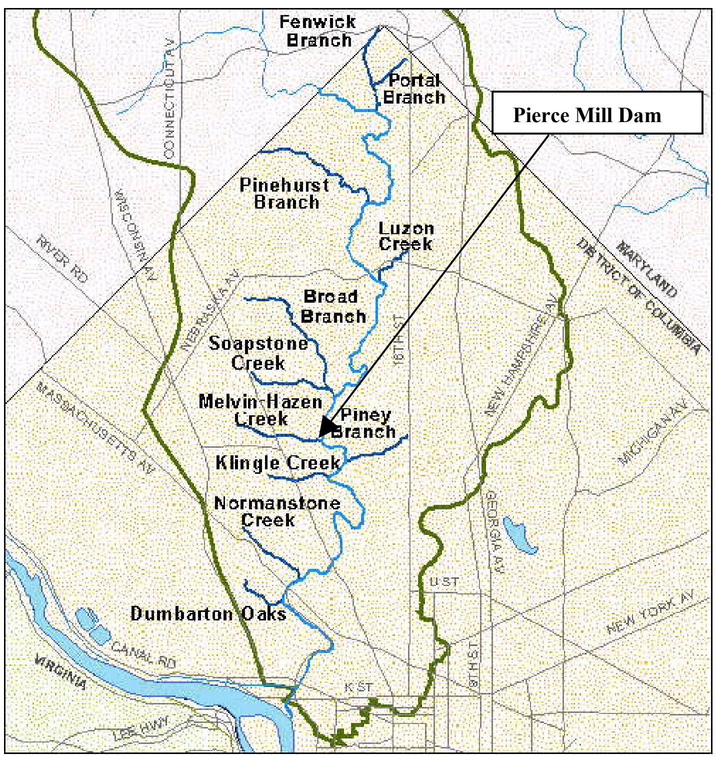

Figure 1-2: Rock Creek and its Impaired Tributaries

1.4 Pollutants of Concern

The District of Columbia's Section 303(d) list does not specifically identify the organics and metals impairing Rock Creek's water quality. Organics and metals are broad ranging pollutant groups. A general lack of data in the Rock Creek watershed required that fish tissue and sediment analysis in the Anacostia River serve as the basis for the selection of the pollutants of concern. Table 1-2 lists the metals and organics identified as pollutants of concern for the Rock Creek watershed.

Table 1-2: Pollutants of Concern for the Rock Creek Watershed TMDLs

Metals	Cadmium	Copper
	Chromium	Mercury
	Lead	Arsenic
	Nickel	Zinc
	Selenium	
Organics	Chlordane	Total Polychlorinated Biphenyls (TPCBs)
	DDT	Total Polynuclear Aromatic Hydrocarbons
	Dieldrin	Mirex
	Heptachlorepoxide	Endosulfane (II)
	Gamma - BHC	Hexachlorobenzene
	Endrin	

Analysis of available water quality data, as presented in the data analysis memorandum (LTI, 2003a), suggested the need for a limited number of TMDLs. Many of the pollutants of concern most likely do not contribute to the impairment of Rock Creek or they have been banned and future loadings of these pollutants of concern should be minimal. It was decided that TMDLs were required for lead, zinc, and mercury while insufficient data to determine whether or not TMDLs were required for cadmium and copper.

A wet weather monitoring program was implemented to determine whether or not cadmium and copper TMDLs are required. During all sampling events, concentrations of cadmium were significantly below all existing water quality standards. However, copper concentrations found within Rock Creek indicated possible violations of water quality standards.

1.5 Other TMDLs

Concurrent with these TMDLs, the District developed TMDLs for Rock Creek tributaries for organics and metals. Metals include arsenic, copper, lead, and zinc. Organics include Chlordane, DDD, DDE, DDT, Dieldrin, Heptachlor, Epoxde, and various PAHs. Only Piney Branch required TMDLs for metals. All tributaries required TMDLs for organics.

2.0 Beneficial Uses and Applicable Water Quality Standards

2.1 Designated Uses

Surface water beneficial uses and water quality standards are contained in the Title 21, District of Columbia Municipal Regulations (DCMR), Chapter 11.

> *Section 1101.1 states:*
>
> *For the purposes of water quality standards, the surface waters of the district shall be classified on the basis of their (i) current uses and (ii) future uses to which the waters will be restored. The categories of beneficial uses for the surface waters of the district shall be as follows:*

Categories of Uses Which Determine Water Quality Standards	Classes of Water
Primary Contact Recreation	A
Secondary Contact Recreation and Aesthetic Enjoyment	B
Protection &Propagation of Fish, Shellfish and Wildlife	C
Protection of Human Health Related to Consumption of Fish and Shellfish	D
Navigation	E

Rock Creek and its tributaries are designated for uses for all classes of waters. Lower and Upper Rock Creek do not support their overall use designations. Primary and Secondary Contact Recreation are not supported while Aquatic Life support is partially supported. Fish consumption (use D) is not supported based on a public health advisory issued in 1994 by the DC Commissioner of Health. The advisory urges banning consumption of channel catfish, carp, or eels caught in the District's stretches of the Potomac and Anacostia rivers. Since Rock Creek is a tributary of the Potomac River, fish may migrate from the river into the tributary, thereby extending this advisory into Rock Creek. The only fully supported use for Lower and Upper Rock Creek is Navigation (Use E).

Possible pollutant sources for Lower Rock Creek are combined sewer outfalls (CSOs) and urban storm water runoff. Habitat modification and stream bank destabilization are considered pollutant sources for Upper Rock Creek in addition to CSOs and urban runoff (DOH, 2002).

2.2 Applicable Water Quality Standards

The Water Quality Standards of the District of Columbia include narrative and numeric criteria written to protect existing and designated uses. Class C, protection and propagation of fish, shellfish, and wildlife, criteria apply to all the metals of interest and include two numeric criteria. The Criteria Maximum Concentration (CMC) is the acute criterion that estimates the highest concentration of a pollutant in surface water to which an aquatic community can be briefly exposed without resulting in an unacceptable effect. The Criteria Continuous Concentration (CCC) is the chronic criterion that estimates the highest concentration of a pollutant in surface water to which an aquatic community can be indefinitely exposed without resulting in an unacceptable effect. In freshwater, it is important to note that Class C criteria for most metals are expressed as a function of hardness in the water column. Class D, protection of human health related to consumption of fish and shellfish, is applicable for mercury. The Class C and Class D water quality standards for the District of Columbia are presented in Table 2-1.

Table 2-1:Water Quality Standards for Metals in the District of Columbia (ug/L)

Metals	Criteria for Classes		
	Class C		Class D
	Criteria Maximum (CMC) Concentration (CCC) Four-Day Average - ug/L	Criteria Continuous (CCC) Concentration (CMC) One-Hour Average - ug/L	30-Day Average - ug/L (Risk Level 10^{-6})
Copper - Dissolved	18.6	12.3	NA
Lead - Dissolved	71.63	2.79	NA
Zinc - Dissolved	124.1	113.3	NA
Mercury - Total Recoverable	0.012	2.4	0.15

The water quality criteria for copper, lead, and zinc are hardness dependent. The Rock Creek criteria shown are based on a hardness of 110 mg/L as $CaCO_3$ and the tributaries are based on 140 mg/L as $CaCO_3$ from DC DOH monitoring data. Tributary TMDLs are discussed in Section 1.5.

3.0 Watershed Characterization

3.1 Background

The Rock Creek watershed is located in central Maryland and the northwest portion of the District of Columbia. The entire watershed covers approximately 76.5 square miles and the stream runs approximately 33 miles from its source in Laytonsville, Maryland, to the Potomac River. Approximately 15.9 square miles are within DC and nine miles of Rock Creek (USGS, 2002). Within the District, Rock Creek is in Rock Creek Park, an urban park maintained by the National Park Service. The Park is approximately 9.3 miles long and up to one mile wide, containing 1,754 acres. The Park is about 17 percent of the Rock Creek watershed within the District.

A large majority of the watershed is located within the upland section of the Piedmont Physiographic providence above the Fall Line with only eight percent of the watershed in the Atlantic Coastal Plain.

The District of Columbia Water and Sewer Authority (DCWASA) operates combined, sanitary, and storm sewers systems in the District of Columbia. A total of 28 combined sewer outfalls are located in the watershed with the largest outfall located at 17 St. NW and Piney Branch Parkway (Piney Branch Outfall). Over 130 storm water sewers drain to the watershed. Figure 3-1 displays the locations of known outfalls.

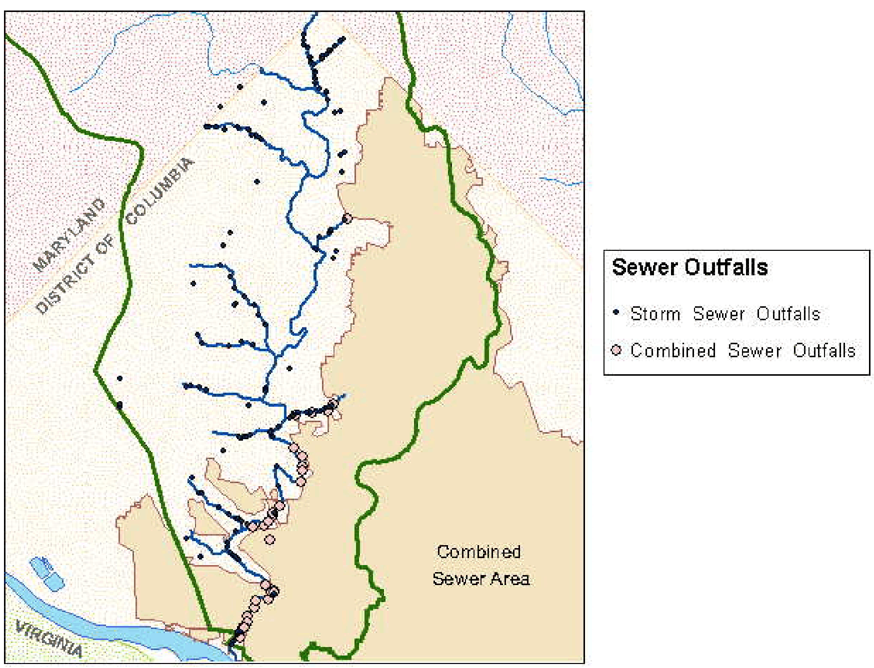

Figure 3-1: Sewer Outfalls in the Rock Creek Watershed

WASA developed, and submitted to EPA, the July 2002 Long Term Control Plan (LTCP) for controlling CSOs, which is expected to provide a significant improvement in the quality of DC surface waters. The plan is designed to minimize the amount of polluted water discharged to the receiving waters, allowing these waters to meet the designated uses stipulated in the WQS. LTCP projects in the Rock Creek watershed include:

- Separate Luzon Valley Drainage Area (completed)
- Separate selected CSOs
- Build a 9.5-million gallon storage tunnel for the Piney Branch CSO
- Perform monitoring at selected CSOs and, if necessary, perform regulator improvements and connect the main interceptor to the planned Potomac storage tunnel.

These LTCP elements are expected to reduce CSO events from 30 per year to less than one event per year on Rock Creek. During the study period used for the LTCP, an estimated 52 million gallons/year of CSO overflow volume discharged into Rock Creek. After the plan is implemented, it is anticipated that the annual CSO volume will be 5 million gallons/year, a reduction of over 90 percent (DCWASA, 2002).

3.2 Land Use

The entire basin is heavily urbanized, with a total population of over 450,000 and a population density of 5,964 people per square mile based on the 2000 US Census data. The DC portion of the watershed has a population of over 200,000 with a population density of 11,412 people per square mile. The upper portion of the watershed was previously used for agricultural purposes but it is now developing into a suburban area. The lower portion of the watershed has long been urbanized including the District of Columbia and its inner suburbs. Table 3-1 shows the breakdown of the land uses in the District and Maryland.

Table 3-1: Land Use in the Rock Creek Watershed (acres)

	Water/ Wetland	**Low Intensity Residential**	**High Intensity Residential/ Commercial/Industrial**	**Forest/ Grassland**	**Agriculture**
District of Columbia	1	9,980	1,402	201	384
Maryland	895	7,620	3,270	15,287	10,853
Total	896	17,600	4,672	15,488	10,304

(USGS, 2002)

Residential land uses dominate the Rock Creek watershed. In the northern portion of the watershed there still is some agricultural activity intermixed with low intensity housing. Commercial and industrial uses follow the main arterials that intersect the watershed. Finally, the parkland associated with Rock Creek Park occupies a section of forest and grassland in the middle of watershed as seen in Figure 3-2.

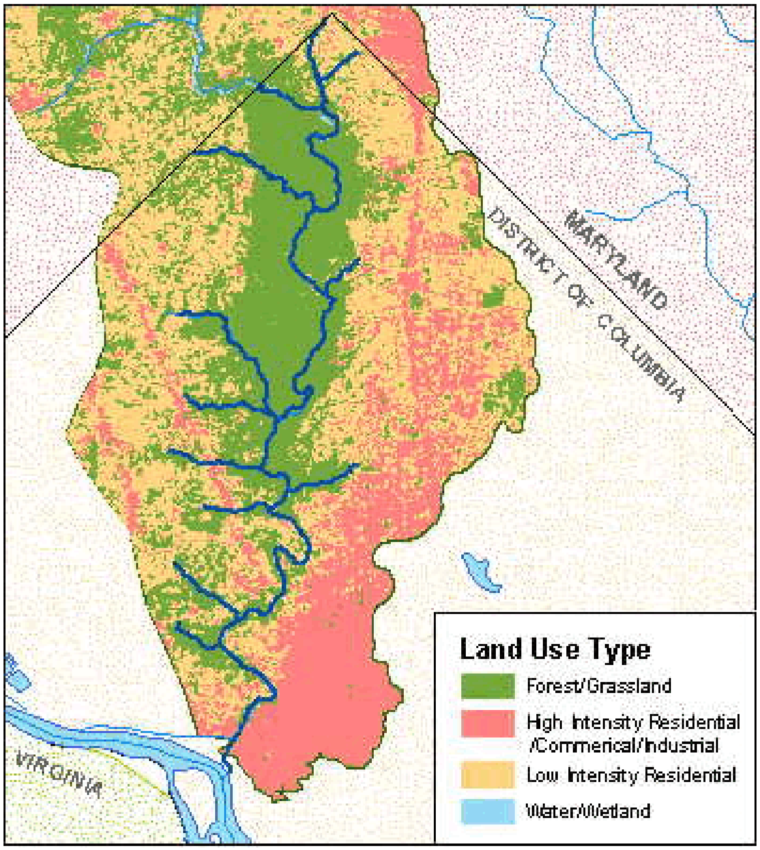

Figure 3-2: Land Uses in the DC portion of the Rock Creek Watershed

3.3 Streamflow

The heavily urbanized nature of the Rock Creek watershed makes it susceptible to the episodic nature of rainfall and runoff. As part of the formulation of the DC WASA LTCP (2002), a statistical analysis of the rainfall records from Ronald Reagan National Airport was performed. The analysis identified a dry year, a wet year, and an average rainfall year, which are the consecutive years 1988, 1989, and 1990. The flow for these representative years was used in the modeling for the TMDLs. The average flow based on the USGS gage at Sherrill Drive (USGS 01648000) is presented for the representative years in Table 3-2.

Table 3-2: Total Precipitation and Average Flow Data

Year	Total Precipitation (in)	Days of Precipitation	Average Flow in Rock Creek (cfs)
1988	31.7	107	56.6
1989	50.3	128	81.8
1990	40.8	127	77.9

3.4 Climate

The climate of the Rock Creek watershed is a moderate Mid-Atlantic climate. Winters are generally mild and summers are warm and humid. Weather conditions during spring and fall are variable. The coldest months are January and February. The warmest time occurs in late July and early August. During the spring, summer, and fall the area can experience sudden thunderstorms that bring large bursts of intense rainfall and occasional hail.

4.0 Available Data

4.1 Data Sources

To support the calculation and analysis of the TMDL components, various data sources have been compiled. The *Data Report for the Washington, DC Portion of the Rock Creek Watershed Total Maximum Daily Load Calculation* (LTI, 2003b) presented the assorted geospatial and monitoring data sources available, a summary of this information is given in Table 4-1 and Table 4-2.

Table 4-1: Geospatial Data Available for the Rock Creek TMDLs

Data Type	Dataset
Hydrography	Reach File Version 1.0 (RF1) National Hydrography Dataset (NHD) Interstate Commission on the Potomac River (ICPRB) GPS derived stream
Topography	20 m contour file from WASA CSO LTCP National Elevation Dataset (NED)
Jurisdictional	US Census County TIGER file DC boundary from Metropolitan Washington Council of Governments State boundaries from ESRI 2002 data CD-ROM Federal Highway Administration National Highway Planning Network
Soil	STATSGO
Land Use and Land Cover	National Land Cover Data (NLCD)
Combined Sewer System Outfalls	WASA LTCP
Storm Sewer System Outfalls	WASA LTCP
Industrial and Commercial Facilities	Storm water Phase II Permit Application

Table 4-2: Monitoring Data Available for the Rock Creek TMDLs

Data Type	Dataset
Hydrology	USGS Stream Flow Data from USGS Gaging Station 1648000 ROCK CREEK AT SHERRILL DRIVE WASHINGTON, DC
Water Column - Constituent Concentrations	WASA LTCP MS4 Storm Water Monitoring USGS Water Quality Baseline Study
Sediment - Constituent Concentrations	Limno-Tech Sediment Study USGS Water Quality Baseline Study
Bioassessment	Banta Study 1992-1993 DC DOH Study 1997-1998

As part of the DC WASA LTCP, a monitoring program was established to characterize the existing sewer system. City-wide, the monitoring plan included four rain gages, 14 combined sewer system flow monitors and automatic samplers at four combined sewer outfalls. Three flow meters and two automatic samplers for the separate storm water system were used for monitoring. The automatic sampling point activated when a wet weather induced event occurred. The Piney Branch combined sewer overflow point is the only automatic monitoring point located in the Rock Creek watershed. Samples taken during wet weather events were analyzed for conventional pollutants and metals for a total of six events. Manual samples were taken during two events to measure 127 priority pollutants. The other sampling points in the District of Columbia provide valuable information describing the chemical composition of the flow in the combined and separate storm water sewers.

The 1995 draft storm water permit created by PEER consultants also generated storm water monitoring data. The monitoring program chose six sample points located around DC at storm water outfalls. A group of 12 chemicals was monitored on three different occasions. Three monitoring points are located in the Rock Creek watershed. In 2003, the District of Columbia monitored storm water outfalls at five locations within the Rock Creek watershed for mercury, lead, copper, and zinc. The results of this monitoring study provided another set of data to characterize the impacts of storm water.

In 1999, the USGS developed a sampling program to provide the park managers of Rock Creek Park with a water quality baseline for future management plans. Samples were taken at a total of seven locations along Rock Creek. Initial samples were taken from five sites from June 23, 1999 to June 25, 1999. Later from February 1999 to September 2000, 16 samples were taken at one site creating a temporal survey of this site. Finally, three sites were used to collect bed-sediment samples. Pesticides, field parameters, nutrients, metals, and organic compounds were assessed during the study.

Limno-Tech, Inc. (LTI) performed a sediment survey of priority pollutants in the District for the Interstate Commission on the Potomac River Basin in fall 1989. The goal of the survey was to identify areas likely to be influenced by point sources and the typical levels of contamination throughout the city's waterways. From October 11-13, 1989, a total of 28 samples were taken at select sites throughout the city. Two sampling sites were located along the main stem of Rock Creek. The top six inches of the sediment cores were analyzed for a large range of organic and metal priority pollutants (Eco Logic, 1990).

The DC Department of Health Environmental (DOH), Health Administration Water Quality Division is responsible for the city's water quality control program, water quality monitoring program, and the environmental laboratory. The division maintains various water quality monitoring stations throughout the city. Four stations are located in the Rock Creek watershed, though only two have any significant data.

4.2 Technical Approach

To determine the loading capacity and estimate the existing copper, lead, and zinc loads, a model of Rock Creek was developed. This model was based on previous SWMM models of Rock Creek constructed for the DC WASA LTCP (2002) and the District of Columbia Bacteria TMDLs in Rock Creek. The model predicts hourly concentrations of total metal which were converted to dissolved concentrations using a partition coefficient. These results were then compared to the applicable water quality standards to determine an appropriate TMDL. A more detailed description of the modeling approach, as applied to the copper TMDL, along with equations and specific values used in the model can be found in Appendix A of this TMDL report. The Rock Creek copper model was calibrated using the detailed sampling data collected by LTI from July to October 2003. Estimates of copper loads to Rock Creek and the TMDL were determined using the three-year representative period detailed in Section 3.3 of this report.

Using the same model framework, a model of Rock Creek for mercury was developed. This SWMM model for mercury used the same segmentation, transport parameters, and flows used in the copper, zinc, and lead models. Mercury concentrations were calculated based upon available monitoring data and atmospheric deposition modeling. A more detailed description of the modeling approach along with the equations and specific values used in the Rock Creek mercury model can be found in Appendix B.

5.0 Copper TMDL

5.1 Source Assessment

Copper can enter the environment through various mining releases and factories that produce or use copper metal or copper compounds. Other sources of copper are domestic wastewater, combustion of fossil fuels and wastes, wood products production, phosphate fertilizer production, and natural sources (for example, windblown dust, from native soils, volcanoes, decaying vegetation, forest fires, and sea spray). Since there are no major agricultural or manufacturing sources of copper in the Rock Creek watershed, natural sources and by-products of a modern urban environment contribute to the levels of copper in the watershed. Urban sources can enter the waterbody both from point and nonpoint junctions.

The hydrologic cycle and other natural phenomena transport and contain metals. Atmospheric deposition is a possible source of copper. Copper can escape from the atmosphere as a particle or dissolved in rain water. Copper is also a naturally occurring component of soil. A study by the Maryland Department of Environment characterized the natural background concentrations of numerous chemicals in Maryland. In this study, Maryland was split into three regions based upon age, chemistry, and geologic structure of each area. Soil samples were collected in each region and analyzed for copper. The results were averaged by region, and the final soil concentrations of copper range from 12 ug/g to 42 ug/g (MDE, 2001).

Storm water and nonpoint sources are potential contributors of copper in the DC portion of the watershed. Rain and snow events create runoff that collect copper from a diffuse group of sources and transports it to Rock Creek. The possible nonpoint sources of copper include automotive parts and buildings. A study by Davis et. al. (2001) of metal concentrations in runoff from an idealized watershed concluded that copper came from brake wear, followed by runoff from siding. Brick and wood sidings produced higher copper concentrations than concrete, metal, or vinyl sidings. Another source is runoff from roofs. Davis found that commercial and institutional roofs produced higher copper concentrations compared to residential roofs. This may be because copper trims and rain gutters are often used in commercial and institutional roofs. Since the Rock Creek watershed is highly urbanized, one can assume that these sources are very common.

A database of industrial and commercial facilities, obtained from the WASA pre-treatment program, provides a list of potential contributors to nonpoint pollution. The database organizes industries by their Standard Industrial Classification (SIC) code. Automotive, wood production, and carwashes were selected as industries that may have contributed to copper pollution and their location in the watershed at the time of the facilities survey are shown in Figure 5-1.

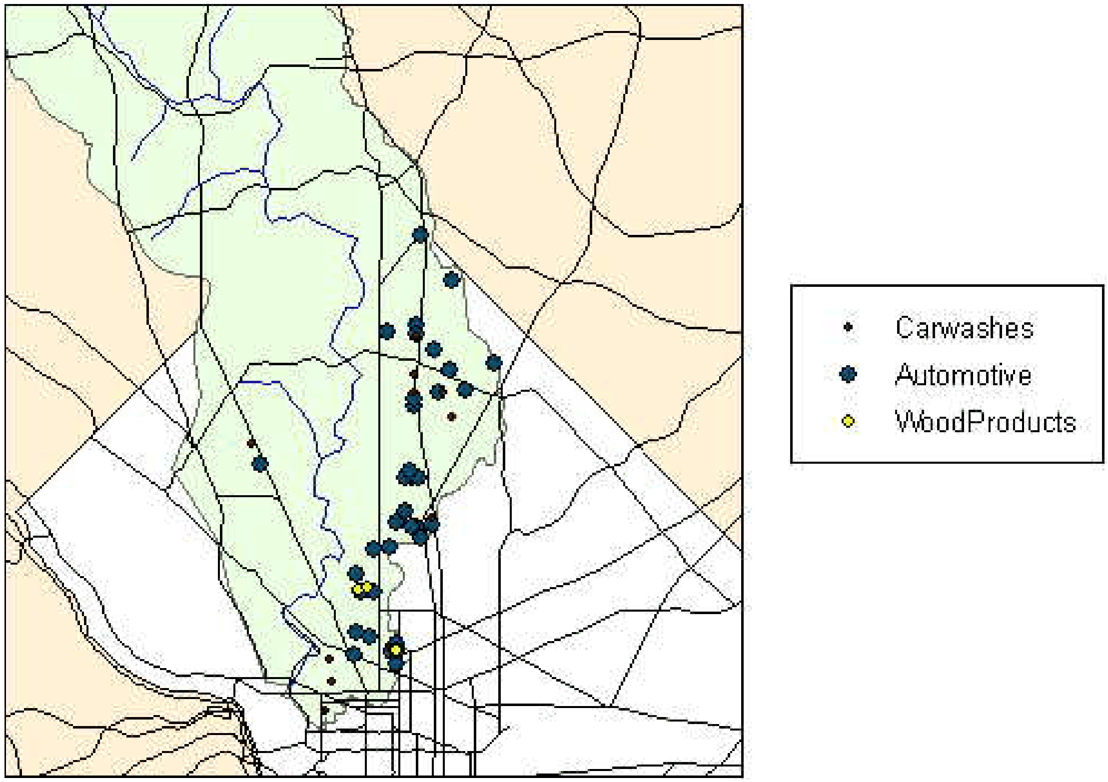

Figure 5-1: Possible Sources of Copper Pollution

Storm water and combined sewer system outfalls are potential point sources for copper in the DC portion of the watershed. There are 28 CSOs and roughly 130 storm sewers discharging to Rock Creek and its tributaries. The combined sewers are concentrated in the eastern part of the watershed as shown in Figure 3-1. The largest CSO discharges to Piney Branch.

5.2 Copper-Specific Data

5.2.1 Data Sources

To support the source analysis for copper impairment in the Rock Creek watershed, five data sources were available as discussed in Section 4.1. Four of the five data sources are the results of studies performed to analyze specific problems and issues in the watershed. The distribution and data available from each site are shown in Figure 5-2 and Figure 5-3.

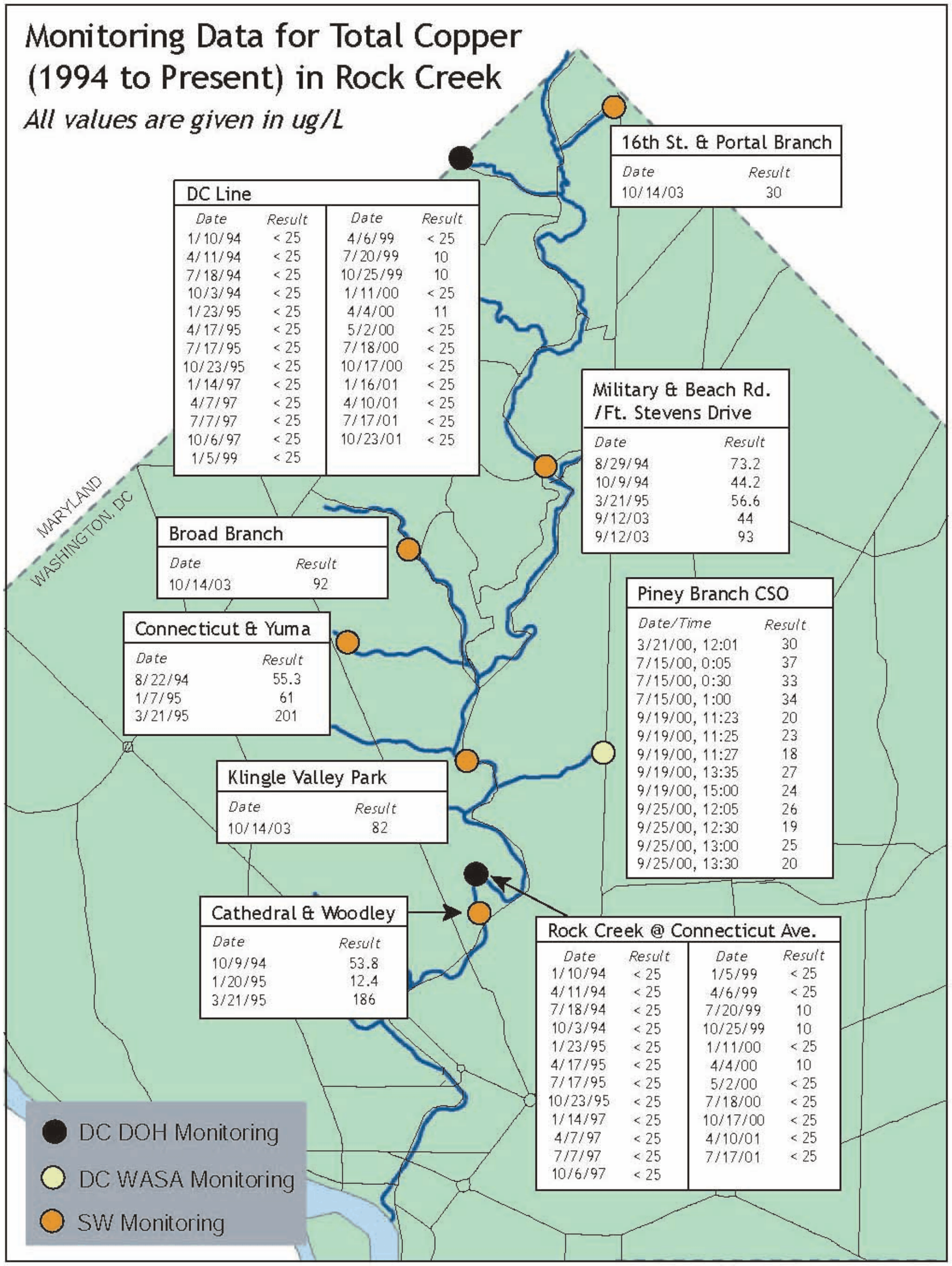

Figure 5-2: Water Column Monitoring Data for Total Copper

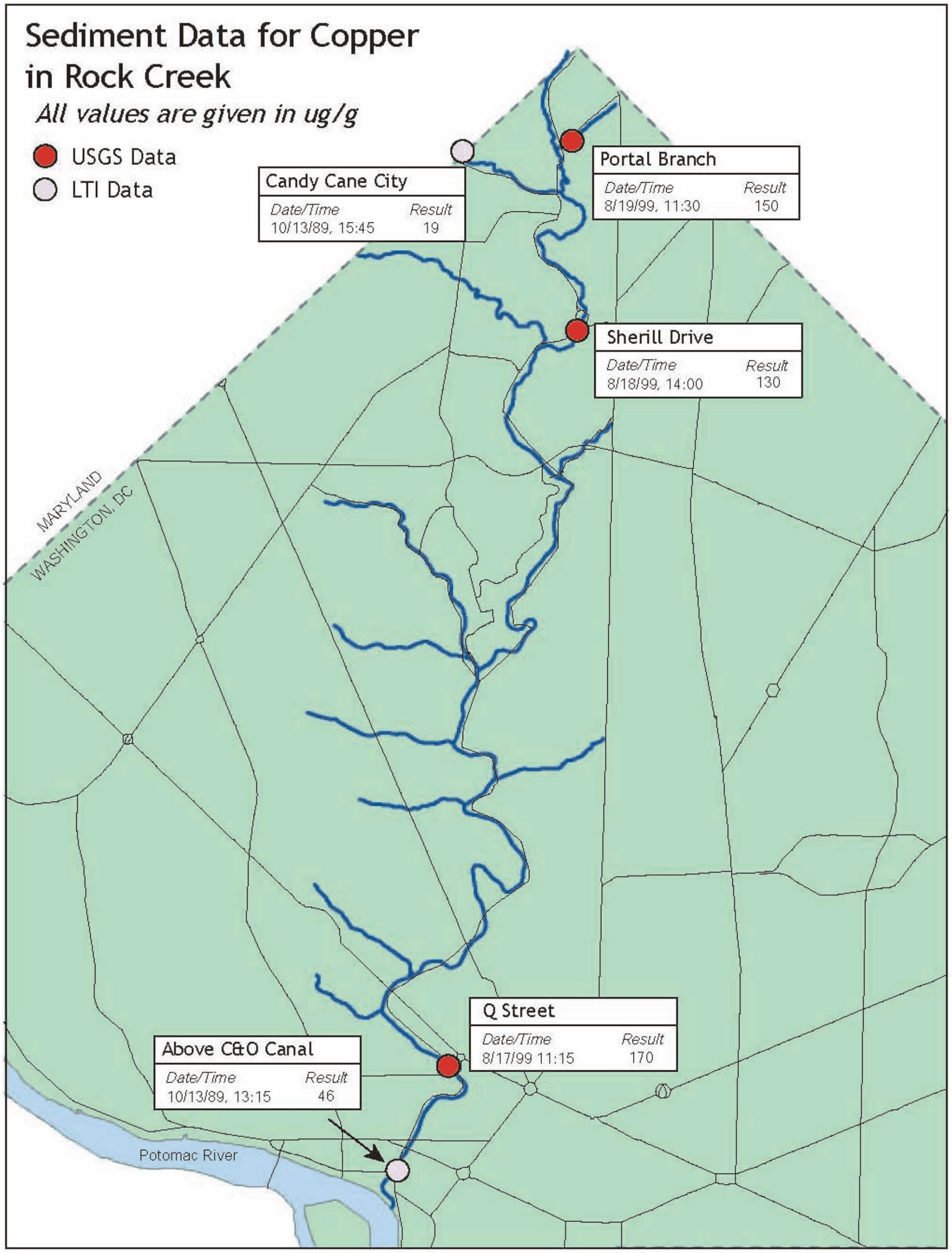

Figure 5-3: Sediment Data for Copper in Rock Creek

5.2.2 Copper Specific Data Collected

To support the development of the copper TMDL, water column monitoring was performed by Limno-Tech, Inc. during the summer and fall of 2003. The monitoring program was implemented to assess the impact of storm water runoff, CSOs, and background loadings from Maryland on the water quality of Rock Creek in the District of Columbia. The major objective of the monitoring effort was to develop a more complete dataset of cadmium and copper readings using lower detection limits. Total and dissolved copper samples were taken at two sites, one near the DC border with Maryland and the other closer to the confluence of Rock Creek and the Potomac River as shown in Figure 5-4.

Figure 5-4: LTI Sampling Locations and USGS Gage Locations in Rock Creek

A total of five wet weather events and three dry weather events were sampled. Wet weather sampling occurred when the rainfall total was greater than 0.5 inches and it had not rained significantly (greater than 0.1 inch) in the past 72 hours. The time at which the initial sample was taken was considered time zero. A total of four samples were taken at each location during the first six hours of the storm. Samples were then taken 12, 24, and 48 hours after the sampling began. For each sampling site, a total of seven samples were taken per wet weather event.

Dry weather sampling occurred when the sampling event was preceded by 72 hours without precipitation. One sample was taken at both sites for each dry weather sampling event. A total of six dry weather samples were collected. Figure 5-5 shows the flow at the USGS gaging station and Figure 5-6 shows the total and dissolved copper measured for the first storm event. A summary of all the storm events is shown in Table 5-1 and Table 5-2.

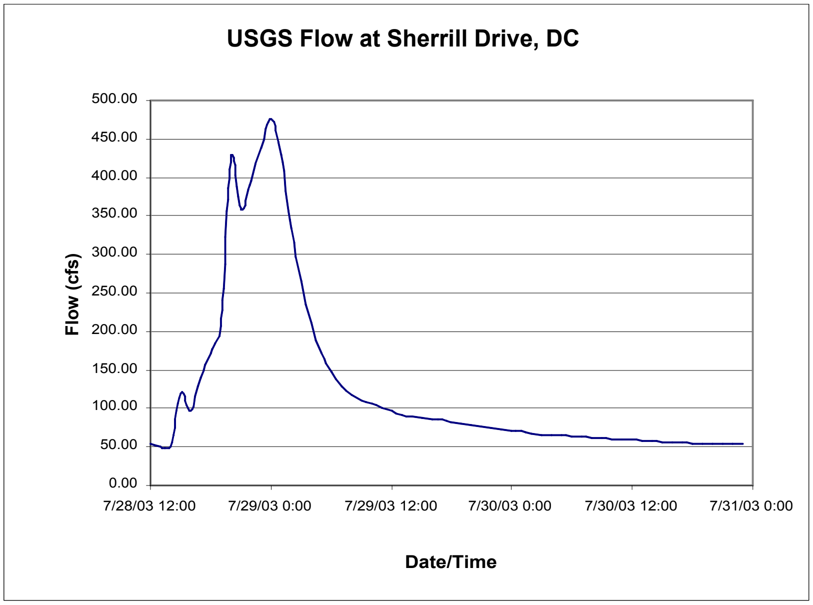

Figure 5-5: Flow at the USGS Sherrill Drive Monitoring Station

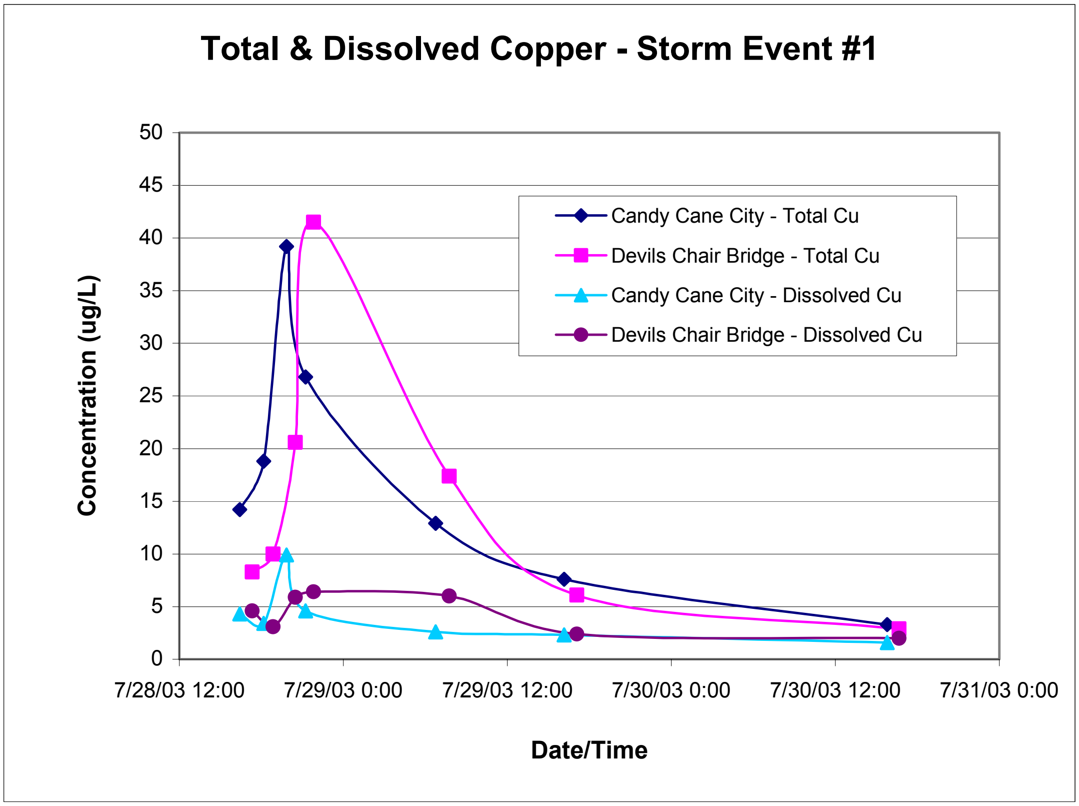

Figure 5-6: Measured Copper Levels from Storm Event #1

Table 5-1: Summary of Total Copper Monitoring

Storm Event	Median	Maximum		Minimum	
		Value (ug/L)	Time	Value (ug/L)	Time
Candy Cane City					
1	14.2	39.2	7/28/03 19:50	3.3	7/30/03 15:48
2	6.8	32.2	8/11/03 17:10	3.3	8/13/03 15:45
3	18	35.1	8/26/03 19:10	5.5	8/27/03 16:30
4	14.8	35	9/12/03 20:40	2.9	9/14/03 15:45
5	18.5	48.2	10/14/03 22:45	2.7	10/16/03 15:35
Devils Chair Bridge					
1	10	41.5	7/28/03 19:50	2.9	7/30/03 15:48
2	10.4	29.6	8/11/03 18:45	3.4	8/13/03 16:45
3	35.7	45.7	8/27/03 0:05	5.9	8/28/03 16:50
4	16.3	25.2	9/12/03 23:59	4	9/14/03 16:30
5	13.3	49.3	10/14/03 23:20	3.6	10/16/03 16:30

Table 5-2: Summary of Dissolved Copper Monitoring

Storm Event	Median	Maximum		Minimum	
		Value (ug/L)	Time	Value (ug/L)	Time
Candy Cane City					
1	3.4	9.9	7/28/03 21:50	1.6	7/30/03 16:40
2	3.9	13.7	8/11/03 17:10	2.8	8/13/03 15:45
3	5.6	7.4	8/27/03 7:25	4.2	8/26/03 20:40
4	6.1	11.2	9/12/03 16:20	2.4	9/14/03 15:45
5	4.5	5.9	10/15/03 0:30	2.2	10/16/03 15:35
Devils Chair Bridge					
1	4.6	2.9	7/28/03 21:50	2	7/30/03 16:40
2	4.2	9.2	8/11/03 21:50	3	8/13/03 16:45
3	6.1	12.7	8/26/03 22:40	3.9	8/28/03 16:50
4	5.9	9.3	9/12/03 19:50	3	9/14/03 16:30
5	5.3	8.9	10/15/03 1:30	2.3	10/16/03 16:30

Available copper data includes:

Total Copper

- All water column samples by DC DOH were less than 25 ug/L (48 data points),
- Piney Branch CSO values are between 18 to 37 ug/L (13 data points from the DC WASA LTCP),
- Storm water data ranges from 12 to 201 ug/L (14 data points from 1995 and 2003), and LTI 2003 sampling data ranges from 3 to 48 ug/L (70 points).

Dissolved Copper:

- LTI 2003 sampling data ranges from 1.6 to 13.7 ug/L (70 points).

Sediment Concentration:

- The highest sediment sample collected by LTI in the 1989 study was 170 ug/g.

5.3 Allocation Analysis

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background, or upstream levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

TMDL = 3 WLAs + 3 LAs + MOS (+ upstream loads)

5.3.1 TMDL Endpoint Determination

The two numeric Class C criteria for copper shown in Table 2-1 for Rock Creek are dependent on the insteam hardness and are calculated using the following equations:

$$CCC: e^{(0.8545[\ln(hardness)]-1.465)}$$
$$CMC: e^{(0.9422[\ln(hardness)]-1.464)}$$

where: *CMC* and the *CCC* are total copper concentrations in micrograms per liter (ug/L),
exp is the base e exponential function,
ln is the natural logarithm function, and
hardness is measured in milligrams per liter (mg/L) as calcium carbonate, $CaCO_3$.

Dissolved copper CCC and CMC values are calculated according to the District's Water Quality Standards, Section 1105.10, using conversion factors contained in Table 2 at 60 FR 22231 (1995). Table 5-3 shows how the dissolved copper criterion vary with hardness.

Table 5-3: District of Columbia Copper Criteria

Hardness (mg/L)	**Dissolved Copper**	
	CCC (ug/L)	CMC (ug/L)
25	3.47	4.61
50	6.28	8.86
75	8.88	12.98
100	11.35	17.02
125	13.74	21.00
150	16.05	24.93
175	18.31	28.83
200	20.52	32.70
225	22.70	36.53

Using data collected in Rock Creek from 1984 to 2000, the 50^{th} percentile hardness value was calculated to be 110 mg/L as $CaCO_3$. At a hardness of 110 mg/L of $CaCO_3$, the CCC is 12.3 ug/L and the CMC is 18.6 ug/L.

5.3.2 Margin of Safety

An implicit MOS was included in TMDL development through application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions, and through the use of conservative assumptions in model calibration and scenario development. In addition to this implicit MOS, a five percent explicit MOS was used to account for the differences between modeled and monitored data. Monitored data were not a continuous time series and may not have captured the full range of instream conditions that occurred during the simulation period. The explicit five percent MOS also accounts for those cases where monitored data may not have captured the full range of instream conditions.

5.3.3 Seasonal Variation/Critical Conditions

By applying the Rock Creek copper model for the three-year period from 1988 to 1990, a wide variety of seasonal variations and critical conditions were estimated. At no point during this three-year period does the model exceed the CCC or CMC for dissolved copper.

5.4 Existing Conditions

As described in Appendix A, under existing conditions, the Rock Creek copper model does not exceed the CCC or the CMC at any time during the three-year period modeled. Figure 5-7 shows the instream dissolved copper concentrations for the three-year period compared to the criteria, *i.e.*, CCC = 12.3 ug/L and CMC = 18.6 ug/L.

Figure 5-8 shows a portion of the plot with an expanded time scale to show that although the daily peaks may exceed the four-day CCC criterion of 12.3 ug/L level, the four-day level is not exceeded for four days.

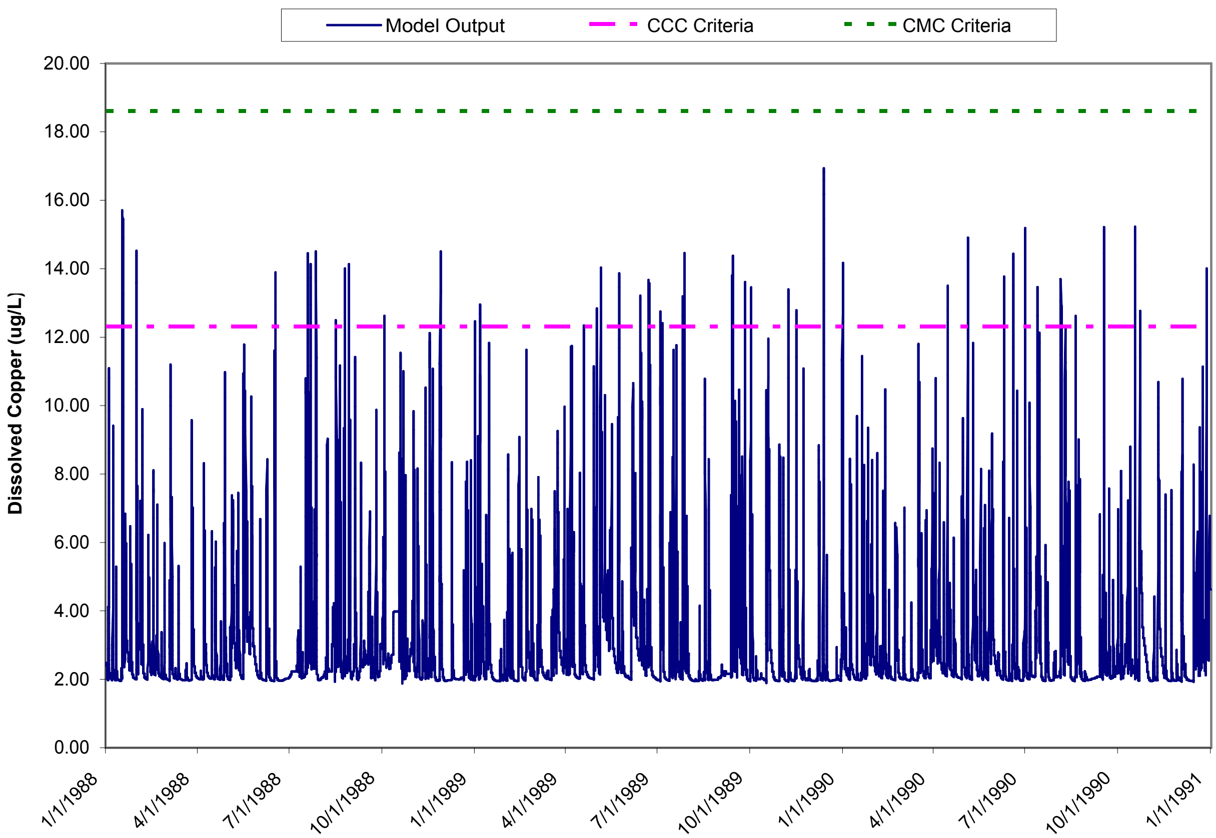

Figure 5-7: Three-Year Model Results for Dissolved Copper

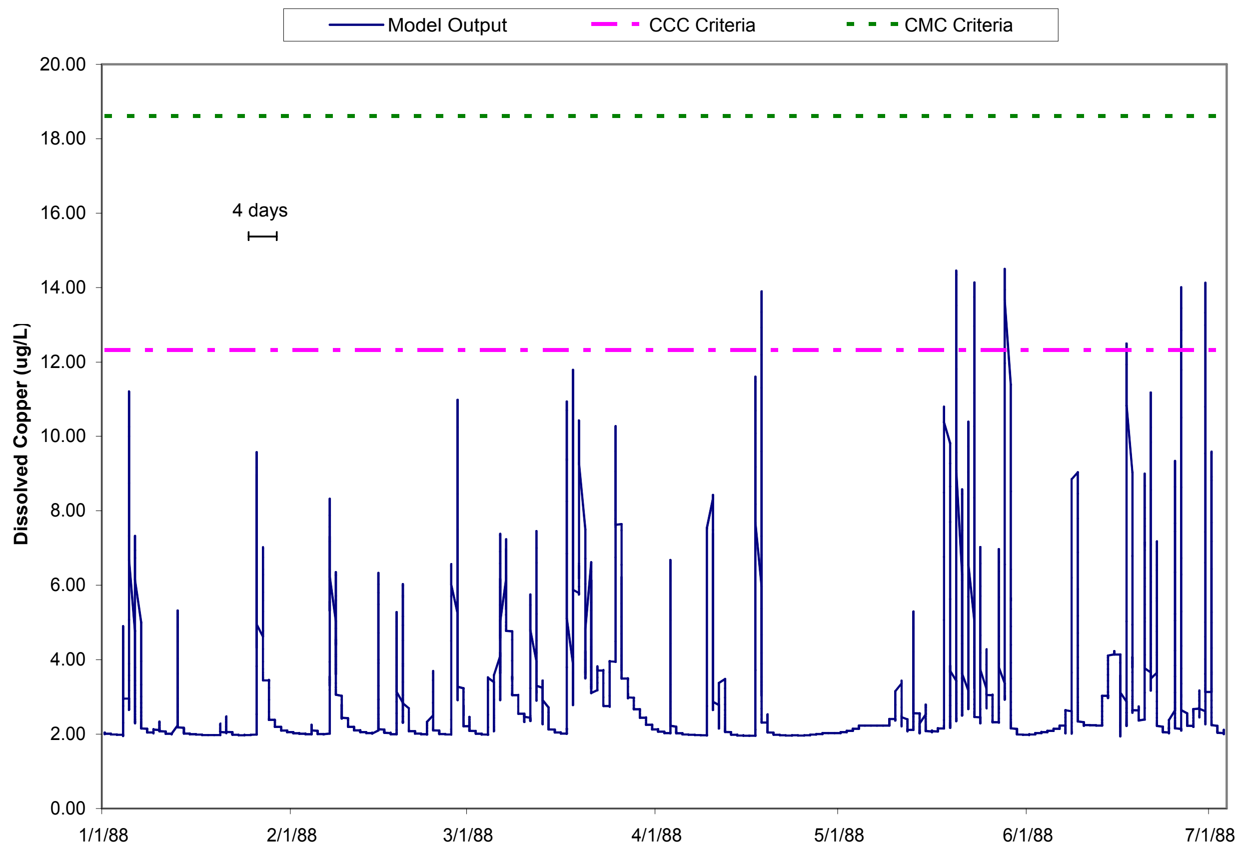

Figure 5-8: Six-month Model Results for Dissolved Copper Compared to the TMDL Endpoint

5.5 TMDLs

The TMDLs are based upon the existing conditions shown in Table 5-4. The values given in Table 5-4 are separated by category. The categories include waste load allocations (WLA), load allocations (LA), upstream loads, and tributary loads. For each tributary except Piney Branch, the entire load to the tributary is separate storm water. In Piney Branch the load is composed of both CSO and storm water load. It is important to notice that the TMDL is given as a loading of total copper not dissolved copper. The District's water quality standards require that specific effluent limits be in terms of total metals even when the actual criteria are for dissolved metals.

Table 5-4: Existing Average Annual Total Copper Loads in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	1,867.15	Upstream	2,638.31
CSO	0.00	CSO	2.64
Separate Storm Water	155.60	Separate Storm Water	149.67
Direct Storm Runoff	1.74	Direct Storm Runoff	1.30
Pinehurst Branch	84.57	Piney Branch	31.86
Broad Branch	221.77	Klingle Run	98.49
Soapstone Branch	112.77		
Luzon Valley	194.72		
Total	2,638.31	**Total**	2,922.26

The TMDL for copper is given in Table 5-5. This includes all of the categories in Table 5-4 with the addition of a category for margin of safety.

Table 5-5: TMDL for Total Copper in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	1,773.79	Upstream	2,506.40
CSO - WLA	0.0	CSO - WLA	2.50
Separate Storm Water - WLA	147.82	Separate Storm Water - WLA	142.19
Direct Storm Runoff - LA	1.66	Direct Storm Runoff - LA	1.24
Pinehurst Branch	80.34	Piney Branch	30.26
Broad Branch	210.68	Klingle Run	93.56
Soapstone Branch	107.13		
Luzon Valley	184.98		
5% MOS	131.91	5% MOS	146.11
Total	2,638.31	**Total**	2,922.26

6.0 Zinc TMDL

6.1 Source Assessment

Zinc is one of the most common elements in the earth's crust. However, most zinc enters the environment as the result of human activities such as mining, steel production, coal burning, and burning of wastes. Zinc ore is commonly used in plating iron or other metals so that they do not rust or corrode. The product is often referred to as galvanized metal.

Atmospheric deposition is another source of zinc. Zinc can escape from the atmosphere as a particle or dissolved in rain water. A study by the Maryland Department of Environment characterized the natural background concentrations of numerous chemicals in Maryland. Zinc is present in the soil with concentrations between 63 ug/g and 73 ug/g (MDE, 2001).

Storm water and nonpoint sources are potential contributors of zinc in the DC portion of the watershed. Rain and snow events create runoff that collect zinc from a diffuse group of sources and transport the constituent to Rock Creek. The possible nonpoint sources of zinc include buildings and automotive parts. A study by Davis et. al. (2001) of metal concentrations in runoff concluded that the majority of input of zinc came from siding. Brick, painted wood and concrete sidings produced higher zinc concentrations than metal, unpainted wood, or vinyl sidings. The runoff from roofs both residential and industrial produced zinc concentrations an order or two magnitude greater than the other metals studied. Automobile tires and engine oil are also other possible sources of zinc. Zinc additives are placed in motor oil to protect the engine. When rain comes in contact with older vehicles, zinc is washed off into the environment.

A database of industrial and commercial facilities, obtained from the WASA pre-treatment program, provides a list of potential contributors. The database organizes industries by their SIC code. Hospitals, colleges, universities, automotive, and carwashes were selected as industries that may have contributed to zinc pollution and their location in the watershed at the time of the survey are shown in Figure 6-1.

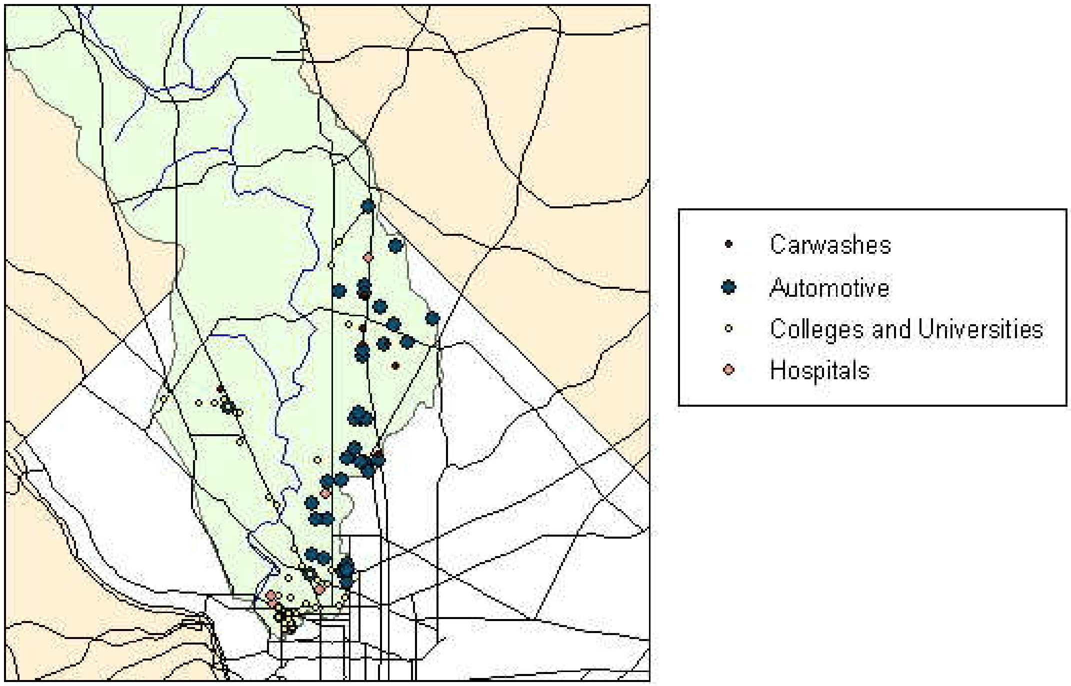

Figure 6-1: Possible Sources of Zinc Pollution

Storm water and combined sewer system outfalls are potential point sources for zinc in the DC portion of the watershed. There are 28 CSOs and roughly 130 storm sewers discharging to the Rock Creek and its tributaries. The combined sewers are concentrated in the eastern part of the watershed as shown in Figure 3-1. The largest CSO discharges to Piney Branch.

6.2 Zinc-Specific Data

To support the source analysis for zinc impairment in the Rock Creek watershed, five data sources were available as discussed in Section 4.1. Four of the data sources are the results of studies performed to analyze specific problems and issues in the watershed. The distribution and data available from each site are shown in Figure 6-2 and Figure 6-3.

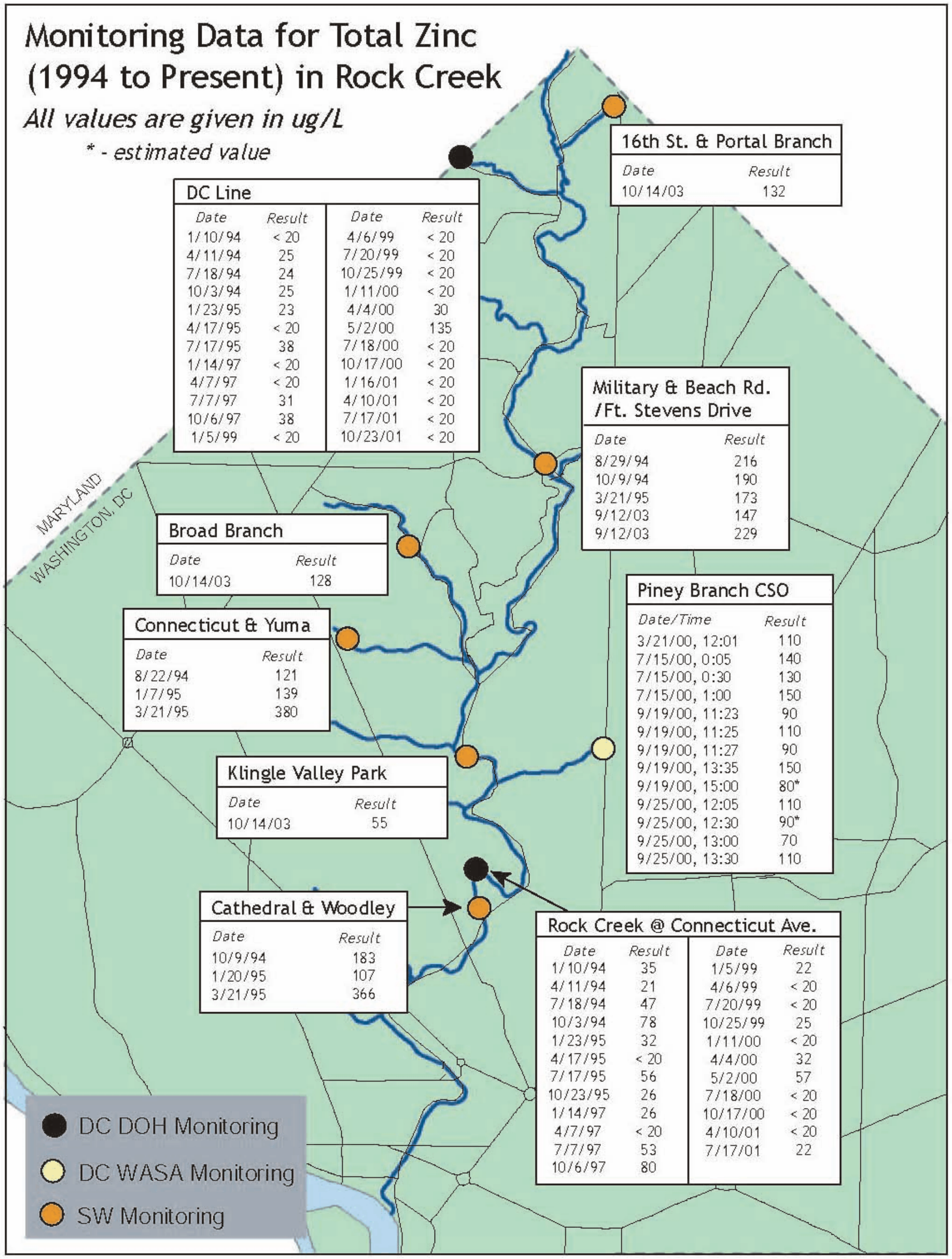

Figure 6-2: Water Column Monitoring Data for Total Zinc

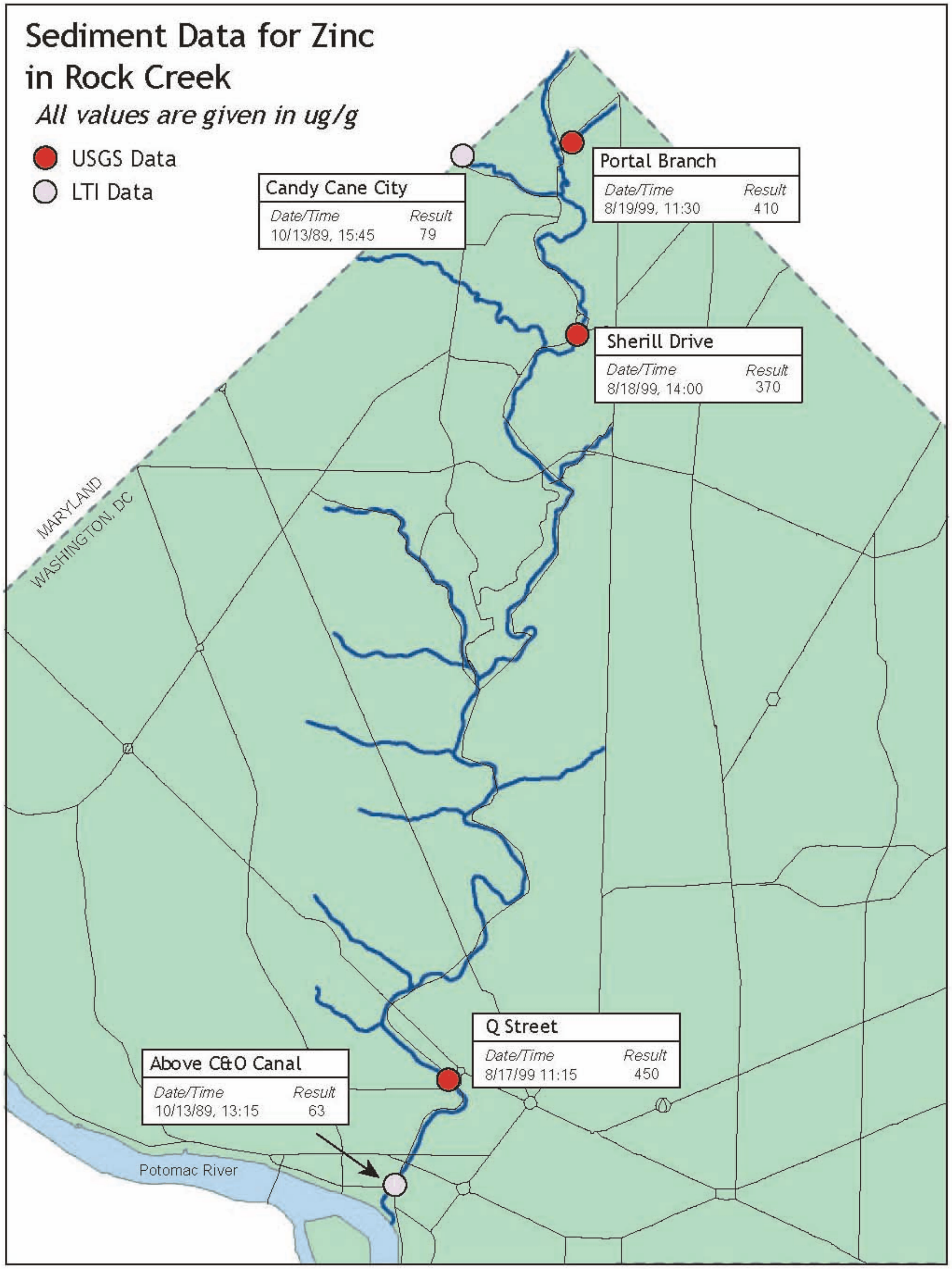

Figure 6-3: Sediment Data for Zinc in Rock Creek

Each of the studies listed earlier collected data for varying purposes. A total of 69 water samples and five sediment samples are available for the Rock Creek watershed. The sediment samples provided a quantifiable result for each sample. Approximately 32 percent of the water column samples had values under the detection limit. These samples may or may not have contained traces of zinc. However, they still may be used in the analysis of zinc levels in the water column.

Total Zinc

- Water column samples were variable. Many data points were below 20 ug/L, but some were samples as high as 135 ug/L (47 data points),
- Piney Branch CSO values were between 70 and 150 ug/L (13 data points), and
- SW data values ranged from 107 to 366 ug/L (9 data points).

Sediment Concentration = 63 ug/g to 73 ug/g

- The highest sediment sample collected was 450 ug/g.

To determine the loading capacity and estimate the existing zinc loads, the model of Rock Creek used for the copper TMDL was modified for zinc. A more detailed description of the modeling approach along with equations and specific values used in the model can be found in Appendix A of this TMDL report. Estimates of zinc loads to Rock Creek and the TMDL were determined using the three-year representative period detailed in Section 3.3 of this report.

6.3 Allocation Analysis

The TMDL is expressed as:

$$\text{TMDL} = 3\ \text{WLAs} + 3\ \text{LAs} + \text{MOS}\ (+\ \text{upstream loads})$$

6.3.1 TMDL Endpoint Determination

As with copper, two numeric Class C criteria for zinc apply for Rock Creek. Since the criteria are dependent on the hardness of the water column, they may be calculated using the following equations:

$$\text{CCC: } e^{(0.8473[\ln(\text{hardness})]+0.7614)}$$
$$\text{CMC: } e^{(0.8476[\ln(\text{hardness})]+0.8604)}$$

Dissolved zinc CCC and CMC values are calculated according to the District's water quality standards, Section 1105.10, using conversion factors contained in Table 2 at 60 FR 22231 (1995). The following table shows how the dissolved zinc criterion vary with hardness:

Table 6-1: District of Columbia Zinc Criteria

Hardness (mg/L)	**Dissolved Zinc**	
	CCC (ug/L)	CMC (ug/L)
25	32.29	35.36
50	58.09	63.61
75	81.90	89.69
100	104.51	114.45
125	126.26	138.27
150	147.35	161.36
175	167.91	183.88
200	188.02	205.91
225	207.76	227.52

At a hardness of 110 mg/L $CaCO_3$, the CCC is 113.3 ug/L and the CMC is 124.1 ug/L.

6.3.2 Margin of Safety

An implicit MOS was included in TMDL development through application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions, and through the use of conservative assumptions in model calibration and scenario development. In addition to this implicit MOS, a five percent explicit MOS was used to account for the differences between modeled and monitored data. Monitored data were not a continuous time series and may not have captured the full range of instream conditions that occurred during the simulation period. The explicit five percent MOS also accounts for those cases where monitored data may not have captured the full range of instream conditions.

6.3.3 Seasonal Variation/Critical Conditions

By applying the Rock Creek zinc model for the three-year period from 1988 to 1990, a wide variety of seasonal variations and critical conditions were estimated. At no point during this three-year period does the model exceed the CCC or CMC for dissolved zinc.

6.4 Existing Conditions

Under existing conditions, the Rock Creek zinc model does not exceed the CCC or the CMC at any time during the three-year period modeled. Therefore, the TMDL has been set based upon existing conditions. Figure 6-4 shows the instream dissolved zinc concentrations for the three-year period compared to the TMDL endpoint, *i.e.*, CCC = 113.3 ug/L and CMC = 124.1ug/L.

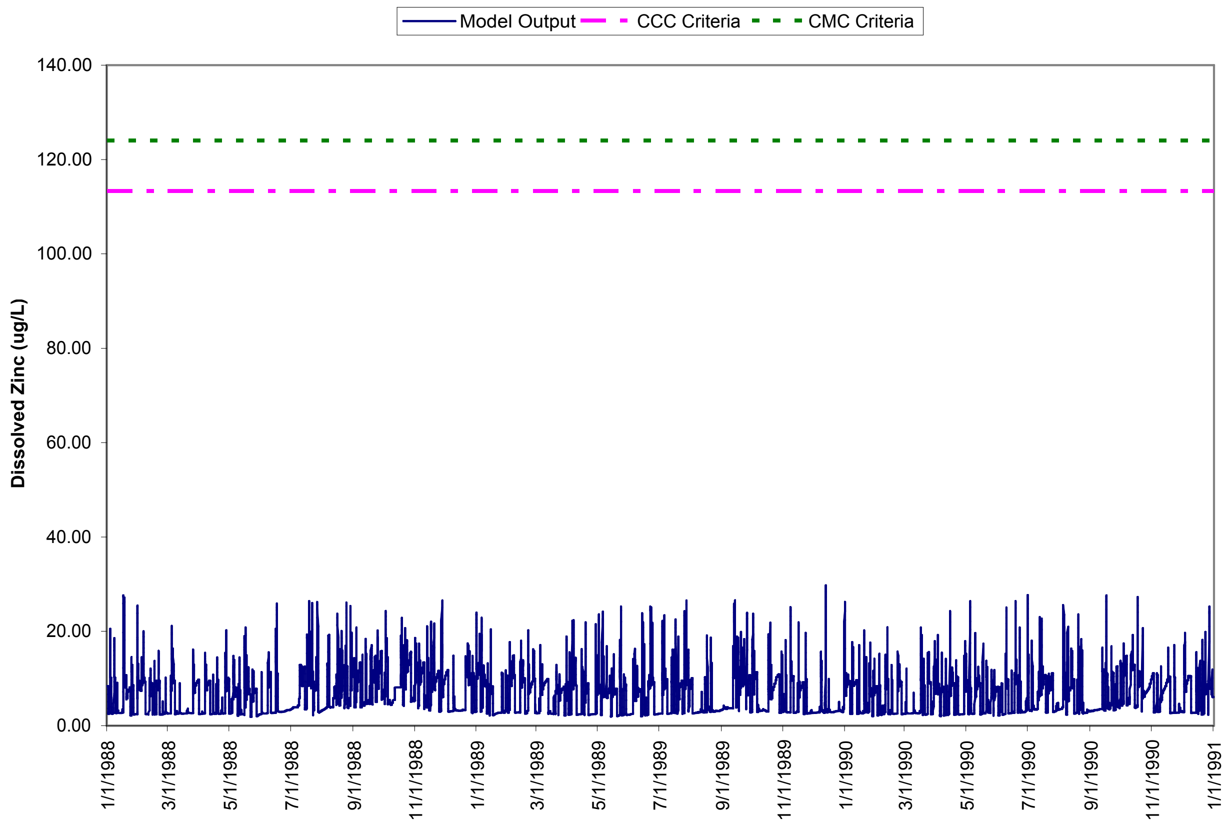

Figure 6-4: Three-year Model Results for Dissolved Zinc

6.5 TMDLs

The TMDLs are based upon the existing conditions shown in Table 6-2. The table presented follows the same structure as that developed for copper in Section 5.5. The TMDL is given as a loading of total zinc not dissolved zinc. The District of Columbia water quality standards require that effluent limits be in terms of total metals even when the actual criteria are for dissolved metals.

Table 6-2: Existing Average Annual Total Zinc Loads in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	4,438.30	Upstream	6,247.53
CSO	0.00	CSO	11.15
Separate Storm Water	365.04	Separate Storm Water	351.14
Direct Storm Runoff	4.09	Direct Storm Runoff	3.06
Pinehurst Branch	198.42	Piney Branch	91.12
Broad Branch	520.30	Klingle Run	231.05
Soapstone Branch	264.56		
Luzon Valley	456.84		
Total	6,247.53	**Total**	6,935.06

The TMDL for zinc is presented in Table 6-3. This includes all of the categories in Table 6-2 with the addition of a category for margin of safety.

Table 6-3: TMDL for Total Zinc in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	4,216.39	Upstream	5,935.16
CSO - WLA	0.0	CSO - WLA	10.59
Separate Storm Water - WLA	346.79	Separate Storm Water - WLA	333.58
Direct Storm Runoff - LA	3.88	Direct Storm Runoff - LA	2.91
Pinehurst Branch	188.49	Piney Branch	86.57
Broad Branch	494.28	Klingle Run	219.50
Soapstone Branch	251.33		
Luzon Valley	433.99		
5% MOS	312.38	5% MOS	346.75
Total	6,247.53	**Total**	6,935.06

7.0 Lead TMDL

7.1 Source Assessment

Lead is naturally found in small amounts in the earth's crust. One of its most important commercial uses is in the production of batteries. It is also used for ammunition production, in metal products, and scientific equipment. Before EPA banned use of leaded gasoline, most of the lead released in the U.S. came from car exhaust. Since the ban was put in place in 1996, the amount of lead released into the air has decreased but high levels of lead can still be measured in soil near roadways. In the environment, lead adheres strongly to soils and may remain in soil particles and water for many years. Lead compounds in water may combine with different chemicals depending on the acidity and temperature of the water.

Atmospheric deposition is one possible natural source of lead. Lead can escape from the atmosphere as a particle or dissolved in rainwater. A study by the Maryland Department of Environment characterized the natural background concentrations of numerous chemicals in Maryland. Lead is present in the soil with concentrations between 45 ug/g and 61 ug/g (MDE, 2001).

Storm water and other nonpoint sources are potential contributors of lead in the DC portion of the watershed. Rain and snow events create runoff that collect lead from a diffuse group of sources and transport the constituent to Rock Creek. As with other metals, possible nonpoint sources of lead include buildings. Davis' 2001 study of metal concentrations in runoff concluded that the majority of lead came from buildings. Brick and painted wood sidings produced higher lead concentrations than metal, unpainted wood, concrete, or vinyl sidings. Lead based paints used decades ago to paint building interiors and exteriors are another source. As the paint weathers, lead can be released as a particulate or dissolved by precipitation.

A database of industrial and commercial facilities, obtained from the WASA pre-treatment program, provides a list of potential contributors to nonpoint pollution. The database organizes industries by their SIC code. Hospitals, colleges, and universities were selected as industries that may have contributed to lead pollution and their location in the watershed at the time of the facilities survey are shown in Figure 7-1.

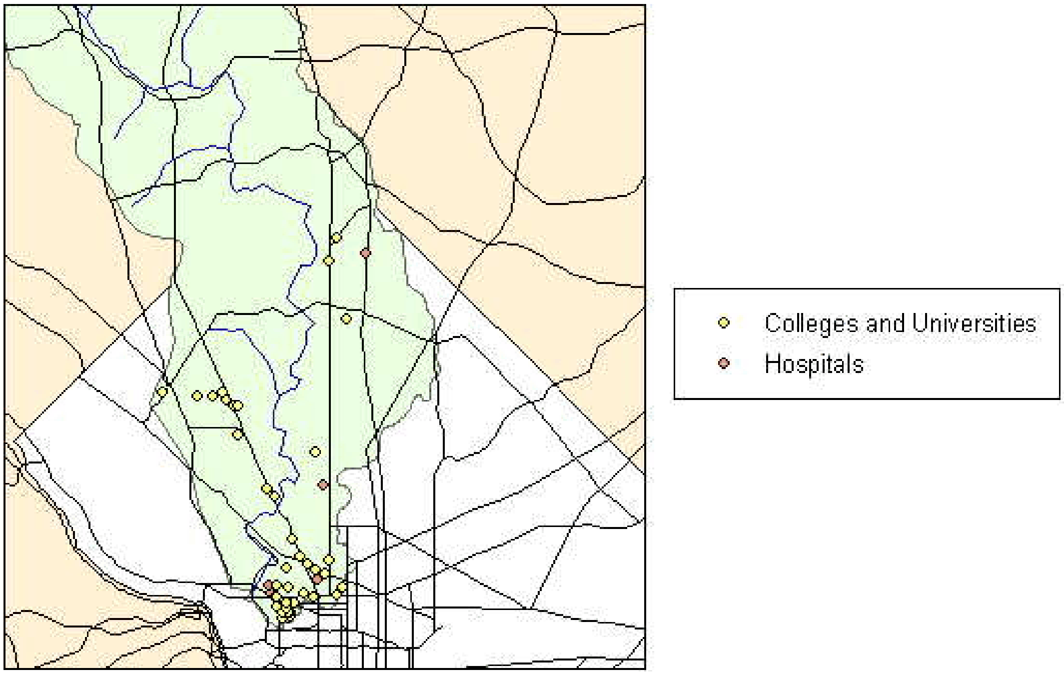

Figure 7-1: Possible Sources of Lead Pollution

Storm water and combined sewer system outfalls are potential point sources for lead in the DC portion of the watershed. There are 28 CSOs and roughly 130 storm sewers discharging to Rock Creek and its tributaries. The combined sewers are concentrated in the eastern part of the watershed as shown in Figure 3-1. The largest CSO discharges to Piney Branch.

7.2 Lead-Specific Data

To support the source analysis for lead impairment in the Rock Creek watershed, five diverse data sources were available as discussed in Section 4.1. Four of the data sources are the results of studies performed to analyze specific problems and issues in the watershed. The distribution and data available from each site are shown in Figure 7-2 and Figure 7-3.

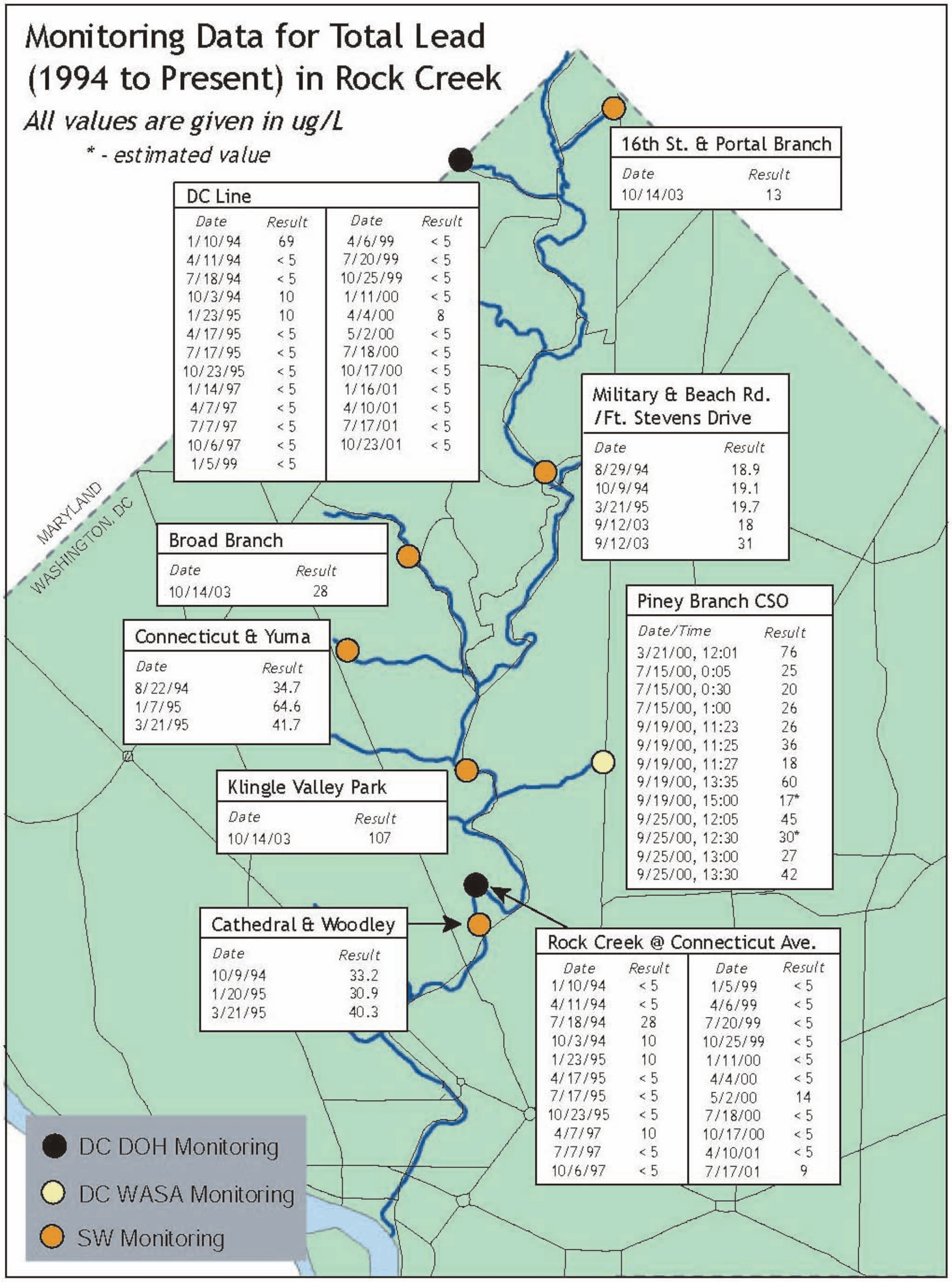

Figure 7-2: Water Column Monitoring Data for Total Lead

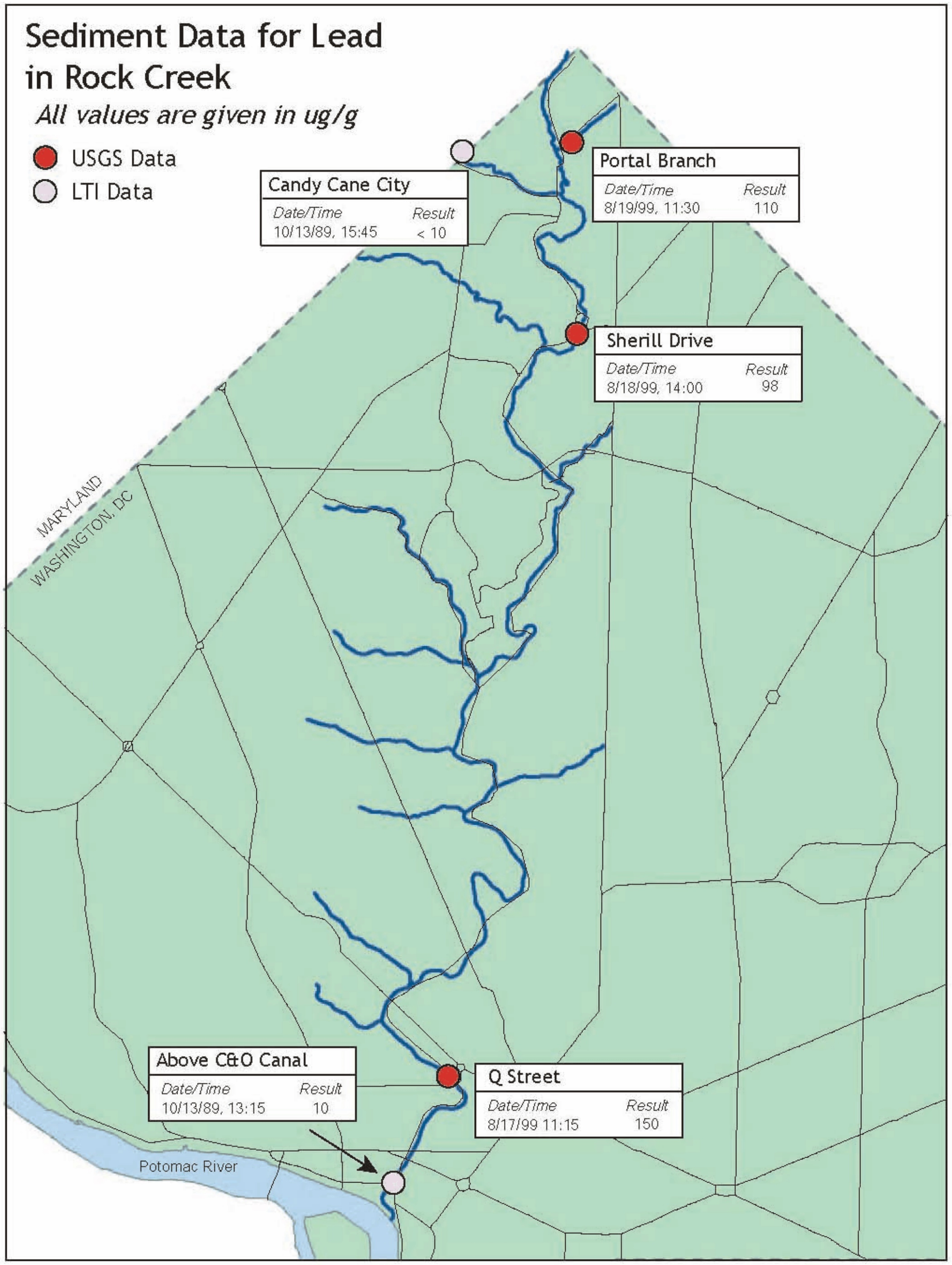

Figure 7-3: Sediment Data for Lead in Rock Creek

Each of the studies listed above collected data for varying purposes. A total of 69 water samples and five sediment samples are available for the Rock Creek watershed. Four of the sediment samples provided a quantifiable result while the remaining sample was below the detection limit. Approximately 54 percent of the water column samples had values under the detection limit. These samples may or may not have contained traces of lead. However, they still may be used in the analysis of lead levels in the water column.

Total Lead

- Most water column data is below 5 ug/L (37 data points), but there are some values between 5 and 69 ug/L (10 data points),
- CSO data from Piney Branch ranges from 17 to 76 ug/L (13 data points), and
- SW data ranges from 18 to 65 ug/L. (9 data points)

Sediment Concentration = 45 ug/g and 61 ug/g

- The highest sediment sample collected was 150 ug/g.

To determine the loading capacity and estimate the existing lead loads, the model of Rock Creek used for the zinc and copper TMDLs was modified for lead. A more detailed description of the modeling approach along with equations and specific values used in the model can be found in Appendix A of this TMDL report. Estimates of lead loads to Rock Creek and the TMDL were determined using the representative three-year period detailed in section 3.3 of this report.

7.3 Allocation Analysis

The TMDL is expressed as:

$$\text{TMDL} = 3\ \text{WLAs} + 3\ \text{LAs} + \text{MOS}\ (+\ \text{upstream loads})$$

7.3.1 TMDL Endpoint Determination

The two numeric Class C criteria for lead shown in Table 2-1 for Rock Creek are dependent on the instream hardness and are calculated using the following equations:

$$\text{CCC: } e^{(1.273[\ln(\text{hardness})]-4.705)}$$
$$\text{CMC: } e^{(1.273[\ln(\text{hardness})]-1.46)}$$

Dissolved lead CCC and CMC values are calculated according to the District's water quality standards, Section 1105.10, using conversion factors contained in Table 2 at 60 FR 22231 (1995). Table 7-1 shows how the dissolved lead criteria vary with hardness.

Table 7-1: District of Columbia Lead Criteria

Hardness (mg/L)	**Dissolved Lead**	
	CCC (ug/L)	CMC (ug/L)
25	0.54	13.88
50	1.17	30.14
75	1.84	47.15
100	2.52	64.58
125	3.21	82.27
150	3.90	100.13
175	4.60	118.10
200	5.31	136.14
225	6.01	154.23

At a hardness of 110 mg/L CaCO3, the CCC is 71.63 ug/L and the CMC is 2.79 ug/L.

7.3.2 Margin of Safety

An implicit MOS was included in TMDL development through application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions, and through the use of conservative assumptions in model calibration and scenario development. In addition to this implicit MOS, a five percent explicit MOS was used to account for the differences between modeled and monitored data. Monitored data were not a continuous time series and may not have captured the full range of instream conditions that occurred during the simulation period. The explicit five percent MOS also accounts for those cases where monitored data may not have captured the full range of instream conditions.

7.3.3 Seasonal Variation/Critical Conditions

By applying the Rock Creek lead model for the three-year period from 1988 to 1990, a wide variety of seasonal variations and critical conditions were estimated.

7.4 Existing Conditions

Under existing conditions, the Rock Creek lead model does not exceed the CMC at any time during the three-year period modeled. However, the model does predict that Rock Creek will exceed the CCC for dissolved lead. Figure 7-4 shows the instream dissolved lead concentrations for the three-year period compared to the TMDL endpoint, *i.e.*, CCC = 2.79 ug/L and CMC = 71.63 ug/L.

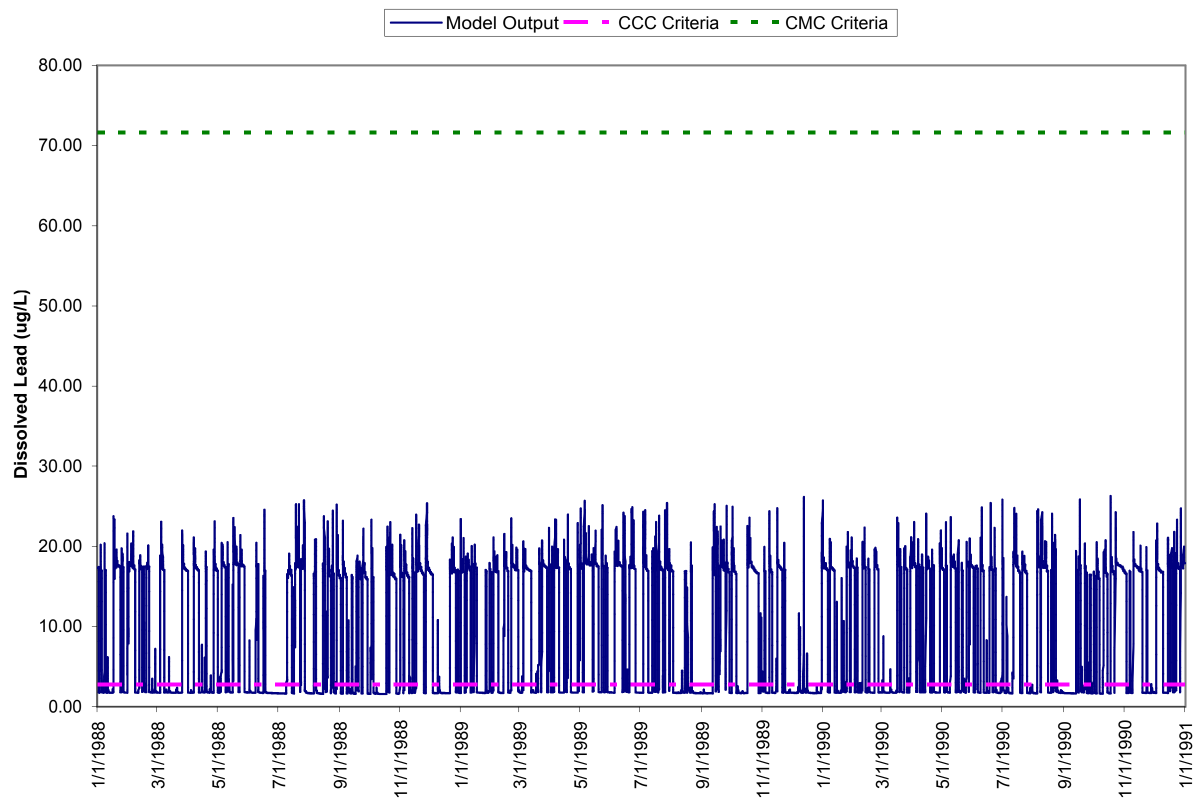

Figure 7-4: Three-year Model Results for Dissolved Lead

7.5 TMDLs

The TMDLs are based upon the existing conditions shown in Table 7-2. The table presented follows the same structure as that developed for copper in Section 5.5. The TMDL is given as a loading of total lead and not dissolved lead. The District of Columbia water quality standards require that effluent limits be in terms of total metals even when the actual criteria are for dissolved metals.

Table 7-2: Existing Average Annual Total Lead Loads in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	2,472.00	Upstream	2,827.93
CSO	0.00	CSO	3.55
Separate Storm Water	71.82	Separate Storm Water	69.08
Direct Storm Runoff	0.80	Direct Storm Runoff	0.60
Pinehurst Branch	39.03	Piney Branch	22.40
Broad Branch	102.36	Klingle Run	45.46
Soapstone Branch	52.05		
Luzon Valley	89.87		
Total	2,827.93	**Total**	2,969.01

Load reductions are needed for lead in Rock Creek. To meet the chronic standards during the entire three-year model simulation, the following load reductions were needed:

- CSO loads were reduced to match the load reductions specified in the LTCP. Through the provisions in the LTCP, the lead load will be reduced by 90 percent.
- All storm water loads (piped and direct runoff) were reduced by 86 percent. This was needed to prevent violations in the downstream segments of the Rock Creek model.
- Upstream loads were reduced by 86 percent. This was needed to prevent violations in the upstream segments of the Rock Creek model.

The TMDL for lead is given in Table 7-3. This includes all of the categories in Table 7-2 with the addition of a category for margin of safety.

Table 7-3: TMDL for Total Lead in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	328.78	Upstream	376.11
CSO - WLA	0.0	CSO - WLA	0.66
Separate Storm Water - WLA	9.55	Separate Storm Water - WLA	9.19
Direct Storm Runoff - LA	0.11	Direct Storm Runoff - LA	0.08
Pinehurst Branch	5.19	Piney Branch	1.88
Broad Branch	13.61	Klingle Run	6.05
Soapstone Branch	6.92		
Luzon Valley	11.95		
5% MOS	19.80	5% MOS	20.68
Total	395.91	**Total**	414.65

8.0 Mercury TMDL

8.1 Source Assessment

Mercury can enter the environment through various industrial activities including the production of chlorine gas and caustic soda. Mercury escapes into the environment from incinerators and travels over large distances until it is deposited. Thermometers and some electrical switches also contain mercury. Since there are no major industrial sources of mercury in the Rock Creek watershed, natural sources and by-products of the urban environment contribute to mercury in the watershed. Urban sources can enter the waterbody both from point and nonpoint junctions.

The hydrologic cycle and other natural phenomena transport and contain metals. Atmospheric deposition is a possible source of mercury. Mercury is also a naturally occurring component of soil. A study by the Maryland Department of Environment characterized the natural background concentrations of numerous chemicals in Maryland. In this study, Maryland was split into three regions based upon age, chemistry, and geologic structure of each area. Soil samples were collected in each region and analyzed for mercury. The results were averaged by region, and the final soil concentrations of mercury range from 0.14 ug/g to 0.51 ug/g (MDE, 2001).

Nonpoint sources are potential contributors of mercury in the DC portion of the watershed. Rain and snow events create runoff that collect mercury from a diffuse group of sources and transport mercury to Rock Creek. The possible nonpoint sources of mercury include dental facilities, areas with production of paper products, and mercury that has been deposited in the watershed.

A database of industrial and commercial facilities, obtained from the WASA pre-treatment program, provides a sense of possible contributors to nonpoint pollution. The database organizes industries by their SIC code. Dental Facilities and areas that produce paper products were selected as industries that may have contributed to mercury pollution and their location in the watershed at the time of the study are shown in Figure 8-1.

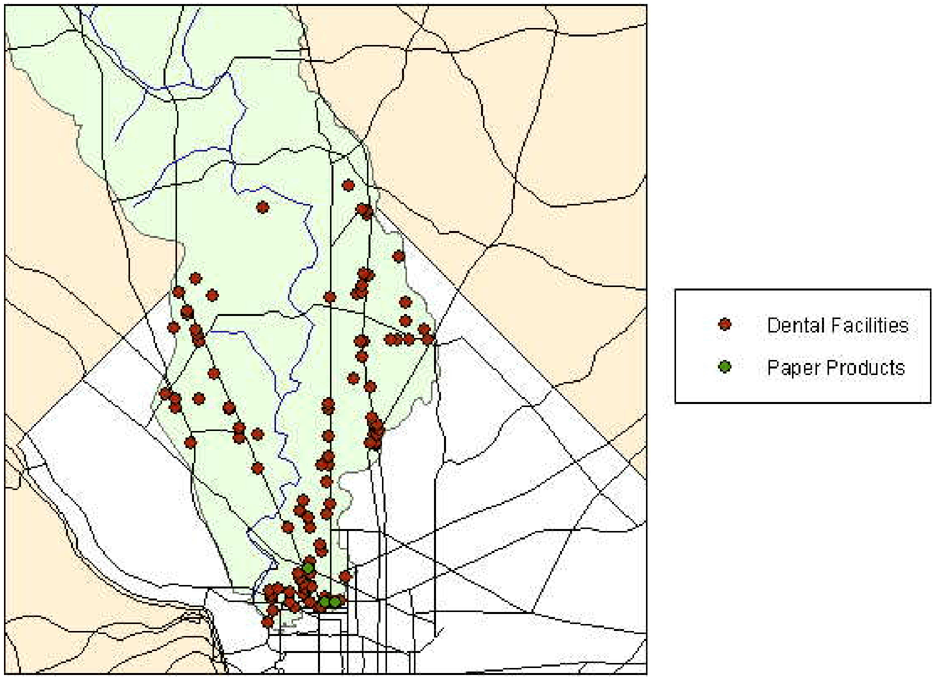

Figure 8-1: Possible Sources of Mercury Pollution

Storm water and combined sewer system outfalls are potential point sources for copper in the DC portion of the watershed. There are 28 CSOs and roughly 130 storm sewers discharging to the Rock Creek and its tributaries. The combined sewers are concentrated in the eastern part of the watershed as shown in Figure 3-1. The largest CSO discharges to Piney Branch.

8.2 Mercury-Specific Data

To support the source analysis for mercury impairment in the Rock Creek watershed, five diverse data sources were available. Four of the data sources are the results of studies performed to analyze specific problems and issues in the watershed. They include the DC WASA LTCP; the 1995 Storm water Permit Application; the USGS Water Quality Baseline Study of Rock Creek, Washington, DC; and a sediment study by Limno-Tech, Inc. in 1989. Another data source is data collected during routine sampling performed by DC DOH. The distribution and data available from each site are shown in Figure 8-2 and Figure 8-3.

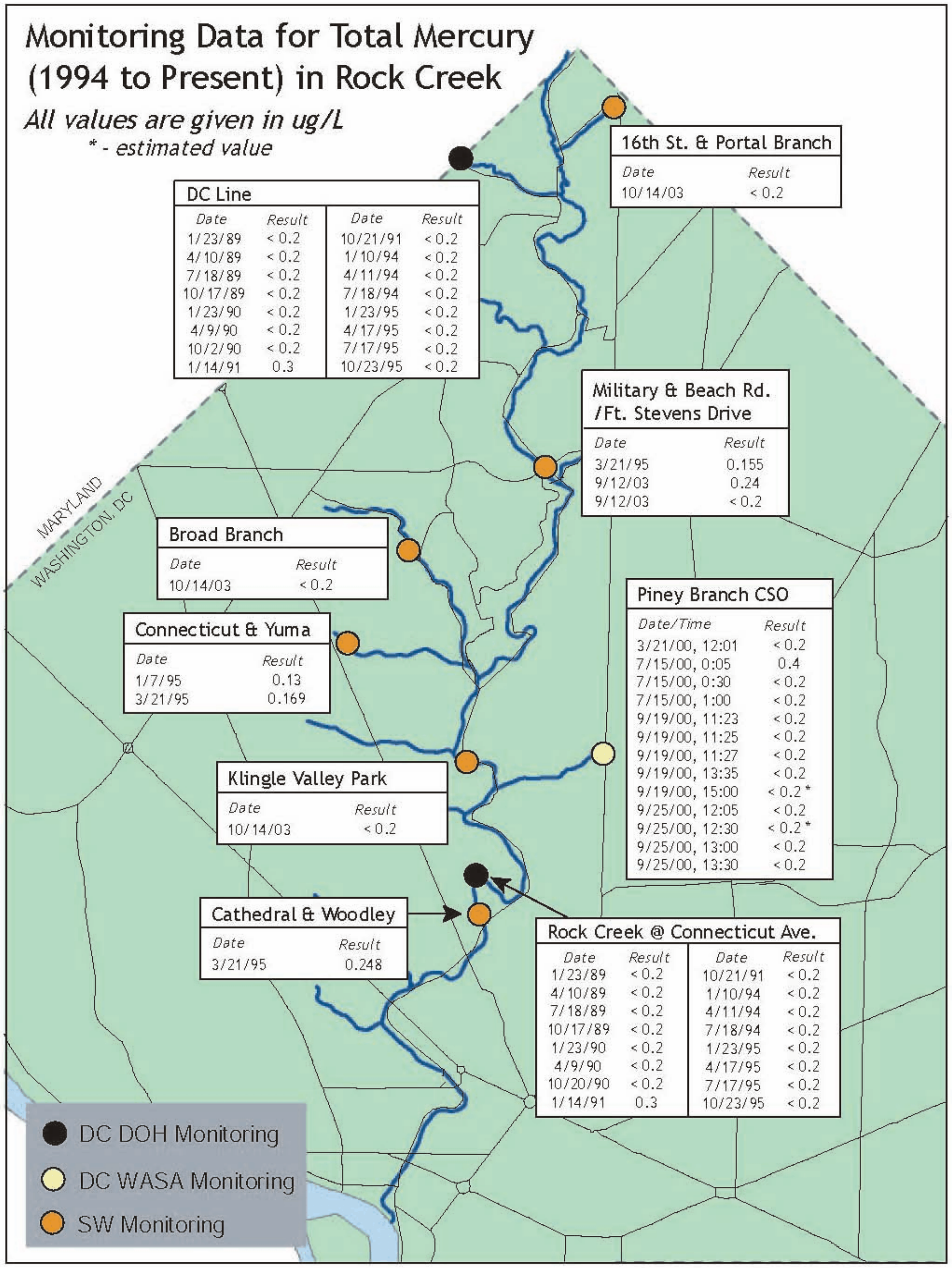

Figure 8-2: Water Column Monitoring Data for Mercury

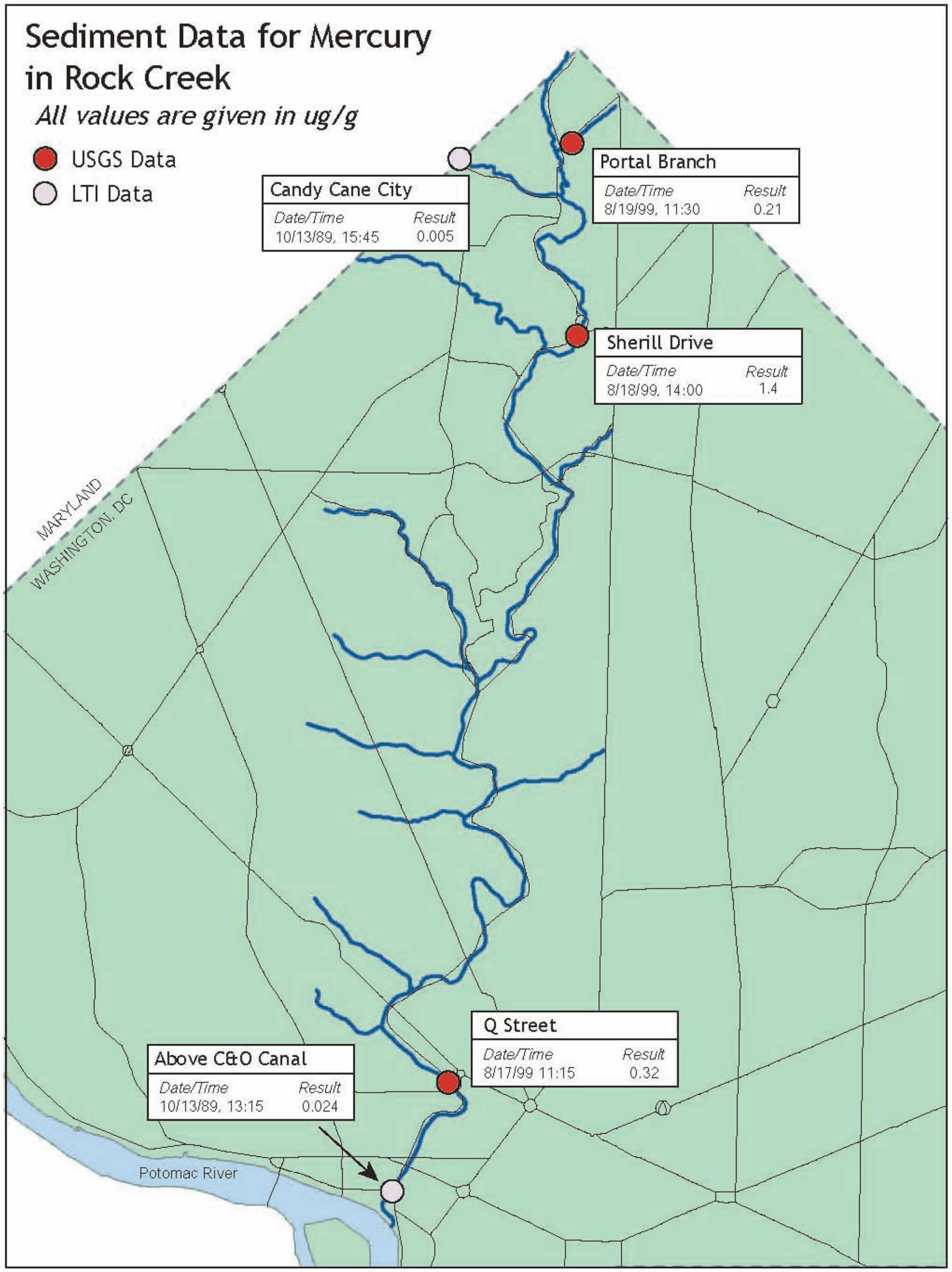

Figure 8-3: Sediment Data for Mercury in Rock Creek

A general summary of the data collected is given below.

Total Mercury

- All water column samples were less than 0.2 ug/L except for two values of 0.3 ug/L on 1/14/91 (32 data points),
- Piney Branch CSO values are below 0.2 ug/L except for two values of 0.4 ug/L (13 data points), and
- Storm water data values range from 0.13 to 0.248 ug/L (5 data points).

Sediment Concentration

- The highest sediment sample collected was 1.4 ug/g.

8.3 Allocation Analysis

The TMDL is expressed as:

$$\text{TMDL} = 3\ \text{WLAs} + 3\ \text{LAs} + \text{MOS}\ (+\ \text{upstream loads})$$

8.3.1 TMDL Endpoint Determination

The TMDL endpoint is set based on the water quality standards of the District of Columbia. A CCC of 0.012 ug/L, a CMC of 2.4 ug/L, and a class D standard of 0.15 ug/L are specified for mercury.

8.3.2 Margin of Safety

An implicit MOS was included in TMDL development through application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions, and through the use of conservative assumptions in model calibration and scenario development. In addition to this implicit MOS, a five percent explicit MOS was used to account for the differences between modeled and monitored data. Monitored data were not a continuous time series and may not have captured the full range of instream conditions that occurred during the simulation period. The explicit five percent MOS also accounts for those cases where monitored data may not have captured the full range of instream conditions.

8.3.3 Seasonal Variation/Critical Conditions

By applying the Rock Creek mercury model for the three-year period from 1988 to 1990, a wide variety of seasonal variations and critical conditions were estimated.

8.4 Existing Conditions

Under existing conditions, the Rock Creek mercury model does not exceed the CMC or Class D standard, but does exceed the CCC in all segments of the Rock Creek model. Figure 8-4 shows the instream dissolved zinc concentrations for the three-year period compared to the TMDL endpoint, *i.e.*, CCC = 0.012 ug/L, CMC = 2.4 ug/L, and a Class D standard of 0.15 ug/L.

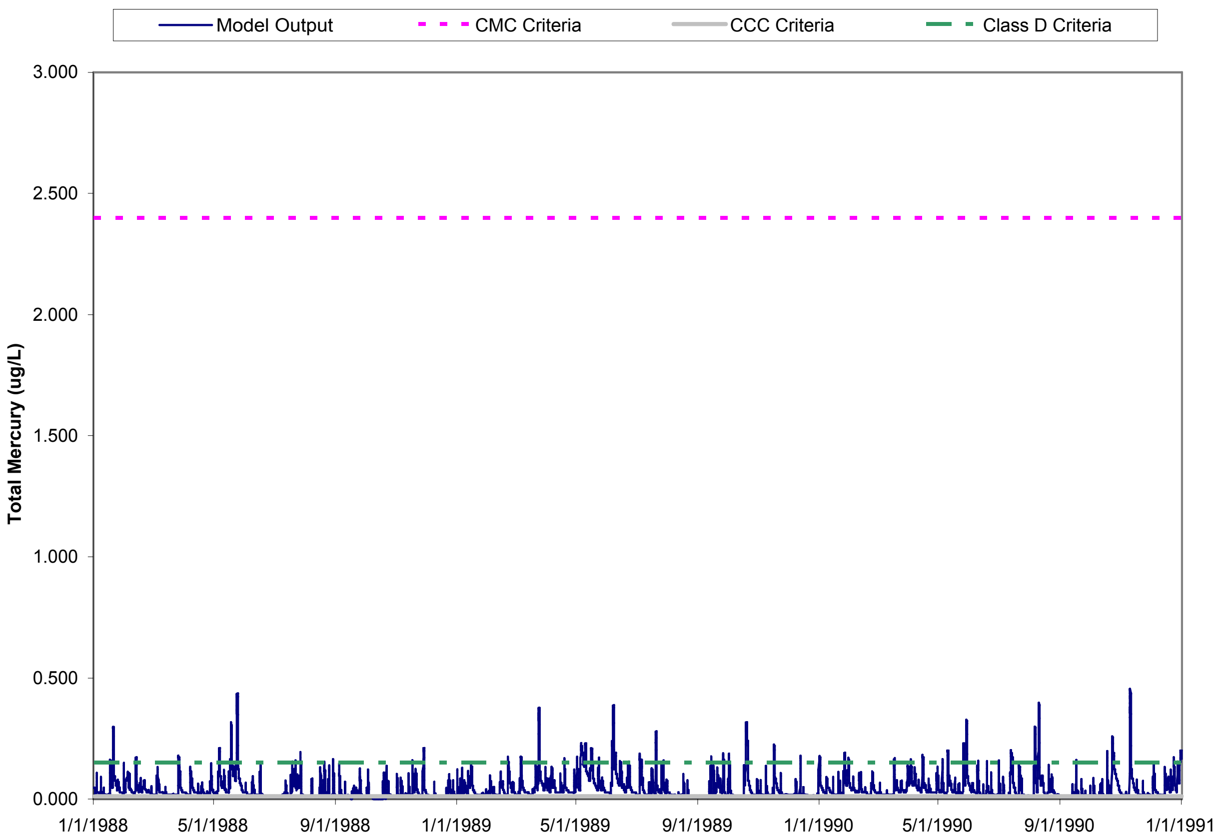

Figure 8-4: Three-year Model Results for Total Mercury

8.5 TMDLs

The TMDLs are based upon the existing conditions shown in Table 8-2. The table presented follows the same structure as that developed for copper in Section 5.5.

Table 8-2: Existing Average Annual Total Mercury Loads in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	14.37	Upstream	16.24
CSO	0.00	CSO	0.04
Separate Storm Water	0.38	Separate Storm Water	0.36
Direct Storm Runoff	< 0.01	Direct Storm Runoff	< 0.01
Pinehurst Branch	0.21	Piney Branch	0.19
Broad Branch	0.54	Klingle Run	0.24
Soapstone Branch	0.27		
Luzon Valley	0.47		
Total	16.24	**Total**	17.07

Load reductions are needed for mercury in Rock Creek. To meet the chronic standards during the entire three-year model simulation, the following load reductions were needed:

! CSO loads were reduced to match the load reductions specified in the LTCP. Through the provisions in the LTCP, the mercury load will be reduced by 90 percent.

! All storm water loads (piped and direct runoff) were reduced by 85 percent. This was needed to prevent violations in the downstream segments of the Rock Creek model.

! Upstream loads were reduced by 97 percent. This was needed to prevent violations in the upstream segments of the Rock Creek model.

The TMDL for mercury is given in Table 8-3. This includes all of the categories in Table 8-2 with the addition of a category for margin of safety.

Table 8-3: TMDL for Total Mercury in Rock Creek (pounds/year)

Upper Rock Creek		**Lower Rock Creek**	
Source	*Loading*	*Source*	*Loading*
Upstream	0.409	Upstream	0.682
CSO - WLA	0.0	CSO - WLA	0.008
Separate Storm Water - WLA	0.055	Separate Storm Water - WLA	0.053
Direct Storm Runoff - LA	0.001	Direct Storm Runoff - LA	< 0.001
Pinehurst Branch	0.030	Piney Branch	0.013
Broad Branch	0.078	Klingle Run	0.035
Soapstone Branch	0.040		
Luzon Valley	0.069		
5% MOS	0.036	5% MOS	0.041
Total	0.718	**Total**	0.832

9.0 **Reasonable Assurance**

9.1 Regional Activities

The District is a signatory to the Chesapeake Bay Agreement. On June 28, 2000, D.C. Mayor Anthony Williams, Maryland Governor Parris Glendening, U.S. EPA and others signed the new Chesapeake Bay Agreement. The goals of the agreement include:

> *Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health.*

and

> *By 2010, correct the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act.*

As part of the Chesapeake Bay commitments, the District of Columbia and Maryland are carrying out restoration of Rock Creek and its tributaries.

Federal lands encompass approximately 18 percent of the land inside DC, which contribute storm water flow to Rock Creek. DC DOH coordinates with the National Park Service in identifying and eliminating illicit discharges to Rock Creek and its tributaries. DC DOH continues to provide input to the Rock Creek Management Plan.

9.2 Source Controls

The District of Columbia has several programs in place to control the effects of CSOs and storm water runoff, and promote nonpoint source pollution prevention and control.

CSO Load Reductions

The DC WASA has developed a LTCP for the combined sewer system to reduce CSOs. The plan includes a storage system in Rock Creek to reduce a significant amount of CSOs. The CSO LTCP has been approved by DC DOH. The load reductions in this TMDL will depend on successful completion of the recommended control plan.

Storm Water Load Reductions

The District of Columbia Water Pollution Control Act (DC Law 5-188) authorizes the establishment of the District's Water Quality Standards (21 DCMR, Chapter 10) and the control of sources of pollution such as storm water management (21 DCMR, Chapter 5).
The DC DOH has an extensive storm water management, sediment, and erosion control program for construction activities. It also has a Nonpoint Source Management Plan to address the

reduction of nonpoint source pollution.

A number of activities to reduce pollutant runoff are carried out as part of the Municipal Separate Storm Sewer Permit for the District of Columbia. The most pertinent of these are contained in the storm water management plan. The plan provides additional mechanisms for achieving the load reductions needed.

Major currently operating programs in DC that reduce loads are as follows:

1. Street sweeping programs by the Department of Public Works.
2. Requirements for storm water treatment on all new development and earth disturbing activities such as road construction.
3. Regulatory programs restricting illegal discharges to storm sewers and enforcing the erosion control laws.
4. Environmental education and citizen outreach programs to reduce pollution causing activities.

9.3 Habitat Restoration

As part of the tidal fresh water system of the Bay, the waters of the District of Columbia constitute a special aquatic habitat. Numerous fish passage barriers have limited Rock Creek from hosting some native species. These obstacles are primarily constructed concrete spillways and sanitary sewers crossing Rock Creek that have been exposed as a result of bed scouring. As part of the Woodrow Wilson Bridge Project, the District of Columbia negotiated a plan for the mitigation of the fish passage barriers. The mitigation, currently underway, constitutes complete removal of structures at some sites or the construction of step-pools at other sites where structures are to remain for historic or utility reasons. Figure 9-1 shows the mitigation locations.

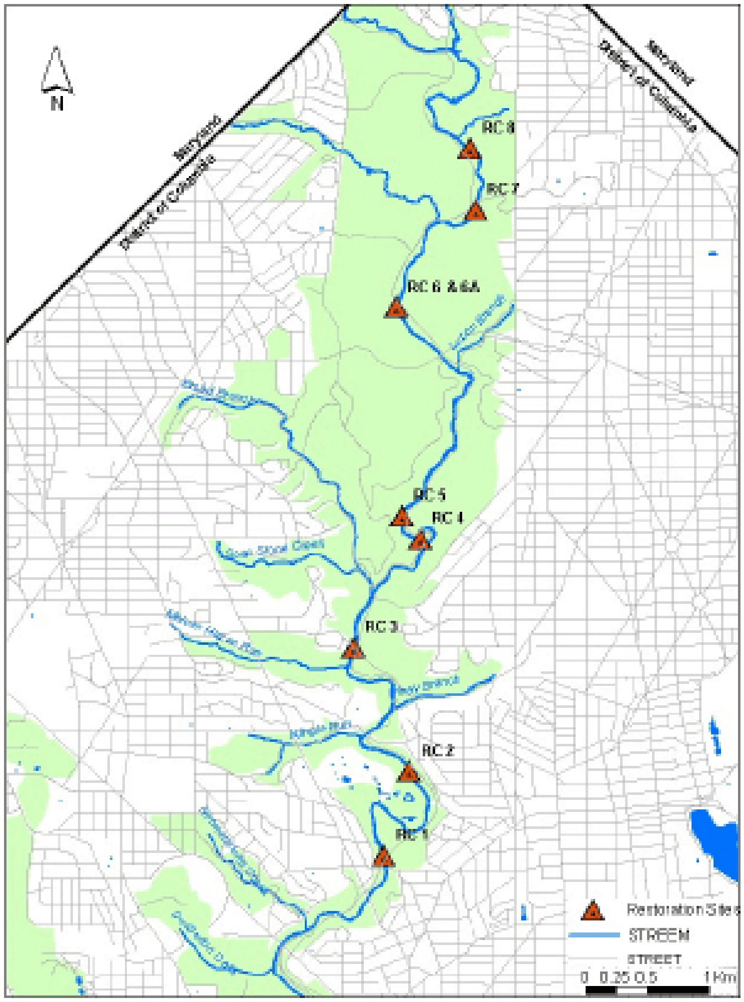

Figure 9-1: Rock Creek Fish Passage Restoration Sites

9.4 Monitoring

The DC Department of Health maintains an ambient monitoring network that includes the Potomac River, Anacostia River, and Rock Creek.

References

Banta, W.C. 1993. *Biological Water Quality of Surface Streams of the District of Columbia.* Occasional Publications, Department of Biology, American University, Washington DC 20016. Volume 2. No. 1.

Davis, A.P., Shokouhian, Mohammad, et. al. 2001. "Loading estimates of lead, copper, cadmium, and zinc in urban runoff from specific sources." *Chemosphere* 44 (2001): 997-1009.

District of Columbia, Department of Health (DOH). 2002. *District of Columbia 2002 Water Quality Report to U.S. EPA and Congress.* Washington, DC.

District of Columbia Water and Sewer Authority (DCWASA). 2002. *Combined Sewer System Long Term Control Plan.* Washington, DC.

Eco Logic. 1990. *Analysis of Priority Pollutants in Sediment from the Potomac River*. Rockwood, Ontario.

Limno-Tech, Inc. (LTI). 2003a. *An Evaluation of TMDL Options for Rock Creek.* Washington, DC.

LTI. 2003b. *Data Report for the Washington, DC Portion of the Rock Creek Watershed Total Maximum Daily Load Calculation*. Washington, DC.

Maryland Department of the Environment (MDE). 2001. *Cleanup Standards for Soil and Groundwater Interim Final Guidance.*

U.S. Environmental Protection Agency (EPA). 1991. *Guidance for Water Quality-based Decisions: The TMDL Process*. EPA-440/4-91-001. Prepared by Office of Water. Washington, DC.

U.S. Geological Survey (USGS). 2002. *Water Quality, Sediment Quality, and Stream-Channel Classification of Rock Creek, Washington, D.C., 1999-2000.* Water Resources Investigations Report 02-4067.