District of Columbia
Water Quality
Monitoring and Assessment Strategy

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District of Columbia
Department of Health
Environmental Health Administration
Bureau of Environmental Quality
Water Quality Division

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ADB	Assessment Database
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BPWWTP	Blue Plains Waster Water Treatment Plant
CBP	Chesapeake Bay Program
C&O	Chesapeake and Ohio
CIMS	Chesapeake Information Management System
CPP	Continuing Planning Process
CRL	Central Regional Laboratory
CSGWPP	Comprehensive State Ground Water Protection Program
CSO	Combined Sewer Overflow
D.C.	District of Columbia
DCRA	Department of Consumer and Regulatory Affairs
DCSS	District of Columbia Stream Survey
DES	Department of Environmental Services
DO	Dissolved Oxygen
DOH	Department of Health
EHA	Environmental Health Administration
ELB	Environmental Laboratory Branch
EPA	Environmental Protection Agency
GWPP	Ground Water Protection Program
IBI	Index of Biotic Integrity
ICPRB	Interstate Commission on the Potomac River Basin
LID	Low Impact Development
MBSS	Maryland Biological Stream Survey
MS4	Municipal Separate Storm Sewer System
MWCOG	Metropolitan Washington Council of Governments
NPDES	National Pollution Discharge Elimination System
QA	Quality Assurance
QC	Quality Control
SAS	Statistical Analysis System
SIM	STORET Interface Module
SOP	Standard Operation Procedure Monitoring Branch
SRBC	Susquehanna River Basin Commission
STORET	STOrage and RETrieval
SWQS	Surface Water Quality Standards
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VIMS	Virginia Institute for Marine Sciences
WLF	WQMB Laboratory Facility
WPCA	Water Pollution Control Act

WQD	Water Quality Division
WQMB	Water Quality Monitoring Branch
WQMP	Water Quality Monitoring Program
WQS	Water Quality Standards

ELEMENTS OF THE DISTRICT OF COLUMBIA'S MONITORING PROGRAM STRATEGY

Monitoring Program Strategy

History

The District of Columbia assumed responsibility for the quality of its ambient waters with the passage of the federal Clean Water Act of 1971 and the establishment of Home Rule in 1973. These responsibilities included development of state water quality standards, assessment of its ambient waters, assignment of designated beneficial uses, and the determination of water quality standard compliance via monitoring. In January 1985, the District Council passed the District of Columbia Water Pollution Control Act (WPCA) giving the statutory authority to control pollution in its waters to the Department of Consumer and Regulatory Affairs (DCRA). In 1995 the D.C. Control Board deemed the environmental protection responsibilities of DCRA to be health-related and transferred the environmental and other DCRA units to the newly created D.C. Department of Health (DOH). The transfer was effective in 1998.

Before the 1960's various federal and local agencies had sporadically monitored D.C. waters since the turn of the century. These early monitoring activities focused primarily on detecting waterborne infectious diseases. During those years, no agency made a long-term consistent monitoring effort.

In the early 1960's the District of Columbia began an ambient monitoring fixed-station network. Parameters monitored included dissolved oxygen (DO), temperature, conductivity, pH and coliform bacteria. However, it was not until the late 1970's, under the direction of the Department of Environmental Service (DES), that D.C. began a comprehensive water quality monitoring program (WQMP) that included nutrient analyses. The program concentrated its monitoring effort on the Potomac and Anacostia rivers primarily in response to the impact of point source discharges from regional sewage treatment plants on river water quality, particularly Blue Plains Waste Water Treatment Plant (BPWWTP). The program also looked at the impact of overflows from the city's combined sewer overflow system.

In 1982 the District of Columbia's Water Pollution Control Program developed a "Monitoring Program Five Year Plan" as a component of their quality assurance program plan (see "The District of Columbia Ambient Monitoring Strategy", 1988). The five year plan called for three types of monitoring: (1)fixed station monitoring; (2) continuous monitoring (DO, temperature); and (3) high close interval frequency sampling (DO, temperature, pH and conductivity). The current monitoring network is a result of modifications to that plan.

The network design underwent another revision in 1983 to include more water chemistry stations on the Anacostia and the deletion of selected stations on the Potomac. In the case of the Potomac, D.C. determined that the variability in water quality between stations was not great enough to justify the number of stations sampled. A similar conclusion was made concerning transect stations. Sampling time constraints and limits on the number of samples that could be processed at the Environmental Protection Agency's (EPA) Central Regional Laboratory (CRL) further supported these deletions.

In turn, the city began to take a closer look at the water quality of the Anacostia River. Within the District of Columbia monitoring data showed that the Anacostia water quality suffered from periods of hypoxia because of high biological oxygen demand (BOD) load from combined sewer overflows (CSOs). About 70 percent of the city's CSOs discharge to the Anacostia River. The tidal Anacostia also receives a high sediment load from upstream sources in Maryland. These pollution concerns prompted D.C. to add four more chemistry stations to its Anacostia network.

The program also turned its attention to the city's smaller streams, most of which had never been monitored. In 1982, the program conducted a study to assess the water quality and the restoration and/or maintenance needs of most of the tributaries to the Potomac and Anacostia rivers. This was a preliminary investigation. The study evaluated each stream for the following factors: width, depth, flow, bottom sediment, storm sewer entry, aquatic organisms, and occurrence of channelization. The study reported on access for potential sampling, access for public recreation, and trash. It also presented possible remedial actions that might be needed to rectify any problems. In 1983, WQMP began monitoring these tributaries for water quality on a monthly basis to determine degree of support of designated beneficial uses.

<u>Current</u>

The current District of Columbia Water Quality Monitoring Program strategy is to establish a monitoring framework to properly manage the city’s water resources. The strategy includes statements of the Water Quality Monitoring Program’s goals and objectives. It also provides descriptions of water and biological sampling programs already in place as well as programs planned to accomplish the stated goals and objectives.

The District of Columbia’s monitoring program strategy encompasses all the waterbodies of the city. The results generated by the monitoring program provide managers with sound information on how to best approach new efforts to improve D.C.’s water quality, as well as determine the designated use attainment of D.C. waters on the individual and overall basis, based on criteria set in the Water Quality Standards.

It is the plan of the District of Columbia to remove deficiencies in the monitoring program before 2014. The Water Quality Division (WQD) has developed a timeline of events to address each deficiency and how WQD plans to correct or lessen the effects of the deficiency. In addition, timeline includes WQD accomplishments and milestones. Because of the location of the District of Columbia between Maryland and Virginia, in as much as is possible, WQD will also engage both states in D.C.’s efforts to protect and restore our shared waters.

Projected Timeline & Highlights

The projected timeline and highlights for the WQD are as follows:

2004 -Pennsylvania Susquehanna River Basin Commission (SRBC) became a partner in the Potomac River split sampling.
-WQD produced its first Integrated Report.
-EPA issued a final National Pollution Discharge Elimination System (NPDES) to the District of Columbia Government authorizing discharges from municipal separate storm sewer system (MS4) to the Potomac and Anacostia Rivers, and tributaries in accordance with the city's Storm Water Management Plan.
-D.C. has several intensive survey studies being conducted on the Anacostia and Potomac rivers.
-WQD is beginning to scan all field data sheets to be stored in WQD files in a pdf format.
-Data generated for Hydrolabs will be formatted for monthly entry into WQD database.
-WQD began using methodology in the "Stressors Identification Guidance Document" to determine causes/sources of impairment to D.C. waters.
-Three new YSI ® sonde units were purchased for water quality monitoring purposes.
-Three new stereo microscopes and pairs of tweezers were purchased for benthic macroinvertebrate assessments.
-WQD staff conducted the triennial review of the Water Quality Standards required by the Water Pollution Control Act and the Federal Clean Water Act.
-WQD completed the regulatory process and technical revisions to the Water Quality Standards that include: revising numeric criteria for over 100 constituents, adding 34 new constituents, revising numeric criteria consistent with Chesapeake Bay criteria, adding new definitions, updating references, typographical and clarification corrections.
-WQD staff is currently revision D.C.'s continuing planning process (CPP) for water quality management planning.
-TMDLs have been developed to address impairments in Rock Creek, the Potomac River and its tributaries.
-WQD has undertaken several monitoring and modeling initiatives to develop TMDLs for pH and toxics in the Potomac River.
-Multi-year plans have been initiated or are underway to develop a next generation Chesapeake Bay Model that will address various issues and emerging concepts, and toxics in the Potomac River.

2005 -WQD might establish a continuous monitoring site at the Washington Ship Channel as proposed.
-WQD will begin discussions on how to best approach developing the programmatic evaluation, including contact neighboring states to found out how they developed their evaluations.
-WQD will produce its first District of Columbia Stream Survey (DCSS) report.
-Reports generated by WQD will begin to be available on WQD website.

-TMDL Implementation Plans for the Anacostia and Potomac River and Rock Creek subwatersheds will be submitted to EPA.
-WQD's first Annual Report, Storm Water Implementation Plan, and Discharge Monitoring Report will be submitted to EPA.
-WQD will begin its rotating basin monitoring.

2006 -D.C. will conduct a fish tissue study for the purpose of updating current fish advisory.
-The WQD's Field & Laboratory Standard Operating Procedures and Quality Assurance Protocols will be updated.

2008 -DCSS report will include reference streams from both Maryland and Virginia.
-Comprehensive State Ground Water Protection Program (CSGWPP) will develop mechanisms for groundwater data collection, accessibility and utilization.
-WQD will submit its first draft programmatic evaluation to EPA
-The WQD's Field & Laboratory Standard Operating Procedures and Quality Assurance Protocols will be available in pdf format.

2009 -CSGWPP will develop ground water indicators and pollution source inventories.

2013 -WQD will review its current monitor strategy and update as necessary.

2014 -If necessary, WQD will submit and updated monitoring strategy.

Monitoring Objectives

The WQD has incorporated monitoring objectives that are essential to generating efficient, effective and accurate data to assist management in its decision making. WQD's monitoring objectives include but are not limited to the goals and objectives of the Clean Water Act.

The goal of WQD's Water Quality Monitoring Program (WQMP) is to generate a reliable scientific water quality data base to aid in future management decisions concerning:

a. protection of D.C. waters and aquatic resources from environmental pollutants and physical degradation; and
b. protection of the public from potential hazards arising from polluted water

To achieve this goal WQD collects data to:

a. characterize annual base line water quality conditions;
b. identify long-term seasonal and/or spatial trends in water quality and morphology;
c. locate and describe water quality and hydrologic problem areas;
d. identify potential water pollution problems;
e. evaluate planned and implemented water pollution control activities;
f. characterize life use support based on biological, chemical and physical/habitat assessments;

g. share water samples and life use support information with neighboring states to compare results;
h. identify causes and sources of water quality impairments;
i. identify impaired waters;
j. assess the condition of all waters in D.C.;
k. determine effectiveness of non-point source program and projects;
l. determine environmental effectiveness of voluntary and required pollution control programs;
m. identify and define the scope of emerging issues and/or threats to the health of the city's waters and the public;
n. review and revise water quality standards;
o. develop total maximum daily loads (TMDLs) and;
p. determine water quality standards attainment.

The goal will be accomplished through the following actions:
a. maintenance of a monitoring network to systematically measure and record the water quality, biologic and morphologic conditions;
b. response to water quality emergencies, i.e., fish kill, oil spill, identification of the source of contamination, and evaluation of the extent of damage;
c. establishment and maintenance of a data management system for efficient use and dissemination of gathered information;
d. establishment of the mechanisms to periodically evaluate and modify (to increase overall effectiveness), if necessary, the established monitoring program;
e. performance of special water quality monitoring studies to better understand specific river and streams reaches ; and
f. establishment of a network with neighboring states to exchange information and innovative ideas to improve the quality of information being produced.

Monitoring Design

The District of Columbia's Water Quality Monitoring Program (WQMP) focuses on the surface waters, including the Potomac River and Anacostia River estuaries and the smaller streams. The estuaries are monitored for mainly physical and chemical water quality parameters. Diurnal monitoring allows the WQD to discern any temporal trends in estaurine water quality, and subsequently provides more reliable data for dissolved oxygen (DO) modeling. The tributaries are monitored for biological, chemical, physical/habitat and morphological conditions.

To assess the surface waters of the District of Columbia the Water Quality Division (WQD) employs four types of monitoring: (1) fixed station, (2) continuous monitoring station, (3) intensive and screening-level monitoring, and (4) rotating basin monitoring. The criteria and indicators used to determine whether the narrative and numeric criteria for each designated use support are defined in the Core and Supplemental *Water Quality Indicators* section.

River transects of *in situ* water quality data logger profiles are also conducted.

Ground water in the District of Columbia is not monitored on the same basis as surface water. Ground water protection activities are guided by the continued development of the Comprehensive State Ground Water Protection Program (CSGWPP). Among the main components of the CSGWPP, is the development of mechanisms for ground water data collection, accessibility and utilization. Other pertinent elements of the CSGWPP include the development of ground water indicators and the preparation of a pollution sources inventory. These elements and the coordination of ground water protection activities within state and federal agencies/programs promoted by the CSGWPP, constitute aspects of some of the indispensable elements in the assessment of the ground water quality. The agencies/programs identified in this effort include the State Voluntary Cleanup Program, the Department of Public Works-Metropolitan Police Department Environmental Crimes Unit Program, EHA's Underground Storage Tank Division, Toxic Substances Division and Hazardous Wastes Division, and the National Capital Planning Commission's Geographic Information Systems Consortium.

The District of Columbia relies on the Potomac River for its public drinking water supply. This reliance has placed the focus for ambient water quality protection primarily on surface water. However, the District also seeks to protect ground water as a public and/or private raw drinking water source especially in the event of an emergency. Although their exact locations remain undisclosed, four domestic wells have been reported to the Water Quality Division (WQD) within the last three years in a variety of areas in the District (The Palisades, Watts Branch, Fort Totten and northwest DC). Presumably, these wells are the wells Johnston mentioned as existing, but they were not catalogued in his report (Johnston, 1961). Ground water is also protected for other beneficial purposes such as irrigation, firefighting or geothermal heating/cooling. Further, as contaminants entrained in ground water discharge to surface water bodies they may pollute the water column and impact the ecosystems. Regulatory oversight must be exercised over anthropogenic activities and/or pollutant sources to prevent such occurrences.

In order to protect the ground water within the District, efforts have been made to characterize and monitor the ground water, develop and implement protective policies and regulations as well as identify and regulate sources of contamination to this resource.

Fixed Station Approach and Rationale

The District of Columbia's fixed station monitoring network was designed to assess the long-term water quality trends in the water column in response to different control strategies. The sampling schedule which is based on a calendar year is developed in advance in cooperation with MWCOG Regional Monitoring Committee. All monitoring activities are conducted by

WQMB personnel. The estuary stations include 7 Potomac River stations and 12 Anacostia River stations. The remaining 39 stations are found on Rock Creek, the Chesapeake and Ohio (C&O) Canal, the Washington Ship Channel, the Tidal Basin, Kingman Lake, and other smaller streams throughout the city. At the request of regional water quality modelers for verification of the Potomac estuary model and MWCOG's tidal Anacostia model, three Potomac and three Anacostia River stations are monitored twice a month from March to October.

During the warmer months when temperatures are high, the river can become hypoxic because of high BOD and sediment oxygen demand, primarily the result of combined sewer overflows. To monitor this potential problem, physical, *in situ* parameters are profiled at all river water chemistry stations, nine months of the year, February to October. These parameters are temperature, DO, pH and conductivity.

Quarterly, WQMB collects and sub-splits a surface water sample from the Potomac River at station PMS10, Key Bridge in Georgetown. The split sample is distributed to Virginia's Department of Environmental Quality (Virginia Consolidated Laboratory Services), Maryland's Department of the Environment, Old Dominion University, Virginia Institute for Marine Sciences (VIMS), Occoquan Laboratory, United States Geological Survey (USGS), Pennsylvania Susquehanna River Basin Commission (SRBC) and Fairfax County Department of Public Works for the purpose of comparing data generated on the Potomac River. WQMB collects monthly surface water samples for chemical analysis at seven stations on the Potomac River, twelve stations on the Anacostia River, three stations on Watts Branch, two stations each on Rock Creek, C&O Canal, Kingman Lake and one station on the Tidal Basin and Hickey Run. All of the small tributary stations are water chemistry stations. Bacteriological conditions (fecal and total coliform bacteria) on the Potomac estuary stations and on the larger tributaries (fecal coliform only) are monitored monthly. The small tributaries are monitored for fecal coliform only, quarterly. WQMB samples all water chemistry stations, quarterly for heavy metals analysis.

Since the sampling schedule for the estuary stations is developed in advance, the data gathered does not target storm runoff that could contribute a significant portion of pollutant runoff. Data gathered from this network is supplemented with fish tissue sample analysis and surveys that target sediment, stormwater and similar media.

Continuous Monitoring Approach and Rationale

The Water Quality Division began monitoring the Anacostia River continuously in 1997. Hourly readings are taken seven days a week. Currently there are four continuous monitoring sites, three on the Anacostia river and one on the Potomac river. In 2005 there will be an additional monitoring site at the Washington Ship Channel. Use support/impairment decisions are made based on the results from the four types of monitoring using the criteria mentioned in the Core and Supplemental Water Quality Indicators section.

The Anacostia and Potomac rivers diurnal stations are continuously monitored for *in situ* physical water quality parameters (Table 1). There is a proposal to establish a continuous monitoring station for the Washington Ship Channel in 2005. The locations for the current and proposed continuous monitoring stations are in Table 2.

TABLE 1
WATER QUALITY PARAMETERS

Physical	Chemical	Biological	Metals
Temperature*	Ammonia	Phytoplankton	Arsenic
Dissolved Oxygen*	Nitrate	Mesozooplankton	Cadmium
pH*	Nitrite	Microzooplankton	Chromium
Specific Conductivity*	OPO_4	Fecal Coliform	Copper
Secchi depth*	Alkalinity	Total Coliform	Iron
Total Suspended Solids	Hardness	Phaeophytin A	Mercury
Turbidity	5-day BOD		Lead
Chlorophyll a			Selenium
			Zinc

* in situ parameters

TABLE 2
CONTINUOUS MONITORING LOCATIONS ON THE ANACOSTIA AND POTOMAC RIVERS AND THE WASHINGTON SHIP CHANNEL

Station Name and ID	Year Monitoring Began	Location
Middle Anacostia River ANA13	1997	Located off the Conrail Bridge just upriver from the Pennsylvania Avenue Bridge
Upper Anacostia River ANA01	2000	Located off the New York Avenue Bridge at the D.C. - Maryland border
Lower Anacostia River ANA21	2000	Located off the South Capitol Street Bridge
Upper Potomac River PMS 10	2003	Located below the Francis Scott Key Bridge on the Georgetown side of the river
Washington Ship Channel PWC01	2005 proposed	Located below Hero's Bridge at the north end of the Washington Ship Channel

Intensive and Screening-Level Monitoring Approach and Rationale

The Water Quality Division is conducting total maximum daily load studies (TMDL) studies on the streams in D.C. The purpose of screening-level monitoring is to find the sources and causes of impairment to the flora and fauna of D.C. waterbodies. The TMDL studies will be conducted over a number of years and will be in conjunction with the MS4 studies. The 2004 303(d) List, from the 2004 Integrated Report has initiation dates for TMDL studies for various waterbodies in the District of Columbia. All existing TMDLs are available through EPA Region III at http://www.epa.gov/OWOW/tmdl/index.html.

In August 2004 EPA issued a final National Pollution Discharge Elimination System (NPDES) permit to the District of Columbia government authorizing discharges from the municipal separate storm sewer system (MS4) to the Potomac River, Anacostia River, and tributaries in accordance with the city's Storm Water Management Plan. To meet new requirements of the MS4 permit D.C. is scheduled to submit a TMDL Implementation Plan covering the Anacostia River subwatershed to EPA by February 2005. The first Annual Report, Storm Water Implementation Plan, and Discharge Monitoring Report will be due to EPA in August 2005, in addition to the TMDL Implementation Plan covering the Rock Creek subwatershed.

The MS4 permit and its supporting documents are available through EPA Region III at http://www.epa.gov/reg3wapd/npdes/index.htm.

The District of Columbia funds, through Federal monies allocated under the Clean Water Act, studies on water and water-related issues that are of concern to the District of Columbia. Local non-profit organizations and universities conduct research projects with the cooperation of WQMB. Table 3 has projects completed and scheduled for the waterbodies of the District of Columbia. The District of Columbia will continue to sponsor such projects when a particular e quality of the waters of the District of Columbia.

TABLE 3
INTENSIVE STUDIES: TARGET AREAS AND COMPLETION DATES

Intensive Study	**Year completed or scheduled to be completed**
Nutrient Flux Estimations from Sediment in the Anacostia River	2005
Assessment of the Water Quality of the Tidal Potomac River in Washington, DC: Trace Metals and Organic Contaminants	2007
Distribution of Sediment-Bound Chemical Contaminants on Deep Cores from the Tidal Potomac River in the District of Columbia	2006
Taxonomic Identification of Phytoplankton and Zooplankton Samples from the Anacostia and Potomac River	2006

Intensive Study	Year completed or scheduled to be completed
Fecal Coliform and Genetic Typing Monitoring Survey from the Anacostia and Potomac Rivers and Rock Creek	2005
Toxics Monitoring and Loading Estimates from Lower Beaverdam Creek	2005
Toxics Screening in the District of Columbia Stormwater System	2006
Development of a Two Dimensional Toxics Model	2005
Developing a Model Framework for Fecal Coliform, Toxics and pH TMDLs	2005
Investigation of Varying Shear Stress on the Natural Sediment Beds of the Anacostia River	2006
Anacostia River Stormwater Monitoring	2005
Fish Tissue Study (Fish Advisory)	2006

Fish tissue studies are apart of the intensive surveys. Depending what types of chemicals and levels that are present in the fish tissue, using EPA's Fish Risk Guidance, WQD can determine if the protection of human health related to consumption of fish and shellfish designated use is supported. The designated use for each waterbody in the District of Columbia can be found in the D.C. Water Quality Standards (WQS). The next fish tissue study for the District of Columbia is planned for 2006.

Rotating Basin Approach and Rationale

Waterbodies will be monitored for identified TMDL pollutants on a rotating watershed basis in addition to the normally scheduled ambient monitoring, to attempt to determine the source and extent of pollution in the city's waterbodies. The rotation is Anacostia watershed, Rock Creek watershed and Potomac watershed. Monitoring for this purpose will start in 2005.

Water Quality Indicators

The WQMB uses a tiered monitoring approach that includes a core set of baseline indicators selected to represent each applicable designated life use (Table 4), plus supplemental indicators selected according to site specific or project specific decision criteria. The designated use for each waterbody in the District of Columbia can be found in the D.C. Water Quality Standards (http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/pdf/WQ_Standards03.shtm).

TABLE 4
DESIGNATED USE INDICATORS

Designated Use	Indicators Used to Determine Use Support
Primary Contact Recreation (Class A)	Pathogens
Secondary Contact Recreation (Class B)	Pathogens
Protection & Propagation of Fish, Shellfish and Wildlife (Class C)	Stream Survey Assessment (benthic macroinvertebrates, fish assessment, ambient monitoring and habitat assessment)
Protection of Human Health Related to Consumption of Fish and Shellfish (Class D)	Fish Risk Assessment (intensive level screening)
Navigation (Class E)	Submerged manmade objects that pose a hazard to users

To help to compare D.C. water quality and national water quality, the District of Columbia applies national criteria, where possible, in determining use support of its waterbodies. However, a modified version of the criteria established by EPA had to be used in certain use support decisions because D.C. did not collect the data as specified in the national criteria. For example, in many cases D.C. collected monitoring data less frequently than indicated by EPA criteria. The majority of monitoring stations are only sampled once-a-month. The District of Columbia, therefore, had to modify the criteria for determining primary and secondary contact recreation (Class A and B) as well as aquatic life use determinations using physical/chemical data to accommodate the sampling frequency.

In most cases, D.C. relies on biological/habitat data, instead of chemical/physical standards, to make aquatic life use (Class C) decisions. When streams with both conventional pollutant data and biological data are available, the biological data are the overriding factor in aquatic life use support decisions.
Aquatic life use support is based on the relationship between observed stream biological condition as compared to the reference stream condition producing a percent of reference stream biological condition. This scale rates “impaired” at 0-79%, and “non-impaired at 80-100%” of reference condition. U.S. EPA 305(b) guidelines on criteria for aquatic life use support classification recommend designation of “not supporting” if impairment exists, and “fully supporting” if no impairment exists. Piedmont and Coastal Plain tributaries were assessed using reference condition data from Montgomery and Prince George’s Counties, Maryland. During the 2005-2006 assessment D.C. will also employ reference streams from Virginia. Figure 1 gives sampling location for the Piedmont and Coastal Plain tributaries.

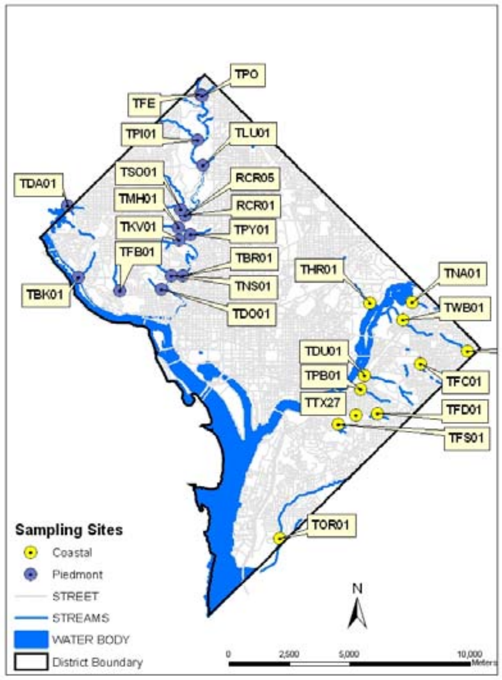

Figure 1: Sampling Stations for Piedmont and Coastal Plain Tributaries.

Biological Assessment

EPA water quality monitoring guidance encourages states to incorporate biological data into their programs and to use this information to evaluate life use attainability. The biological data collected by WQMB has been used in the assessments of the city's waterbodies.

The surface water monitoring program collects phytoplankton samples monthly at five Potomac stations, six Anacostia stations and five tributary stations. In addition, zooplankton tows are made at least once a month at two Potomac stations and one Anacostia station, from February to October. From February to June stations on the Potomac and Anacostia Rivers are sampled twice a month to provide added coverage during the fisheries spawning season. The protocol for zooplankton sampling was modified in 1993, with assistance from the Interstate Commission on the Potomac River Basin (ICPRB) technical staff, by using two different mesh size nets to account for mesoplankton and microplankton. The water column is now vertically, rather than horizontally, towed to account for stratified plankton at different depths. WQD's Environmental Laboratory Branch (ELB) conducts all bacterial sampling for total and fecal coliforms. Total coliforms and fecal coliforms are of major concern to the health of the city's waters. Most of the pathogens that enter the city's waterbodies are from CSO's. Streams that have a high occurrence and level of total coliform and fecal coliform have prevented most of the waterbodies from supporting its primary and secondary contact uses.

The biological assessment provides information for determining if the designated use for primary and secondary contact are supported. The biological assessment measures the frequency of occurrence and levels of both total coliforms and fecal coliforms in the city's streams and estuaries. The criteria for pathogens are found in Table 5.

TABLE 5
CRITERIA FOR USING CONVENTIONAL POLLUTANTS AND PATHOGENS WHEN MAKING USE SUPPORT DECISIONS

Support of Designated Use	Criteria for using Conventional Pollutants and Pathogens
Fully Supporting (F)	For any pollutant, standard exceeded in ≤ 10% of measurements. Pollutants not found at levels of concern.
Not Supporting (N)	For any one pollutant, standard exceeded in > 10% of measurements. Pollutants found at levels of concern.
Not Assessed (X)	Not assessed
Insufficient Information (I)	Data to determine if the designated use is fully supporting/not supporting is not available.

[1] Conventional pollutants are defined here as dissolved oxygen (DO), pH, and temperature.

Physical/Chemical Water Quality Assessment

All water quality monitoring is conducted by WQMB staff. The sampling schedule, based on the calendar year, has separate weeks and days assigned for the Anacostia and Potomac rivers was well as for the tributaries of the rivers. The water quality parameter measure can be found in Table 1. The criteria for conventional pollutants, temperature, dissolved oxygen, and pH are found in Table 5. Table 13 contains all the analytical water quality parameters. On a quarterly basis the WQMB collects and splits a water sample from the Potomac river with Virginia's Department of Environmental Quality, Maryland's Department of the Environment, Old Dominion University, Pennsylvania Susquehanna River Basin Commission (SRBC) and Fairfax County Department of Public Works for the purpose of comparing data generated in the Potomac River.

TABLE 6
ANACOSTIA AND POTOMAC RIVER WATER QUALITY MONITORING PARAMETERS AND THEIR FREQUENCY OF COLLECTION

STATION	SAMPLE TYPE	SAMPLE MATRIX	PHYSICAL[2]	CHEMICAL[2]	BIOLOGICAL[2, A]	METALS	SAMPLING FREQUENCY
PMS01	grab, *in situ*	S	*	ALL	no Z	**	monthly

STATION	SAMPLE TYPE	SAMPLE MATRIX	PHYSICAL[2]	CHEMICAL[2]	BIOLOGICAL[2, A]	METALS	SAMPLING FREQUENCY
PMS10	grab, *in situ*	S	*	ALL	no P	**	bimonthly[#]
PMS21	grab, *in situ*	S	*	ALL	no Z	**	bimonthly[#]
PMS29	grab, *in situ*	S	*	ALL	no Z	**	bimonthly[#]
PMS37	grab, *in situ*	S	*	ALL	ALL	**	monthly
PMS44	grab, *in situ*	S	*	ALL	no P, Z	**	monthly
PMS51	grab, *in situ*	S	*	ALL	no Z	**	monthly
PWC04	grab, *in situ*	S	*	ALL	no Z	**	monthly
ANA01	grab, *in situ*	S	*	ALL	no Z	**	bimonthly[#]
ANA05	grab, *in situ*	S	no C	ALL	no P, Z	NO	monthly
ANA08	grab, *in situ*	S	*	ALL	no P, Z	**	monthly
ANA11	grab, *in situ*	S	no C	ALL	no P, Z	NO	monthly
ANA13	*in situ*	S	*	--	--	--	diurnal
ANA14	grab, *in situ*	S	*	ALL	ALL	**	monthly
ANA19	grab, *in situ*	S	no C	ALL	no P, Z	NO	monthly
ANA21	grab, *in situ*	S	*	ALL	no Z	**	bimonthly[#]
ANA24	grab, *in situ*	S	no C	ALL	no P, Z	**	monthly
ANA29	grab, *in situ*	S	*	ALL	no Z	**	monthly
ANA30	grab, *in situ*	S	*	ALL	no P, Z	**	monthly
PTB01	grab, *in situ*	S	*	ALL	no Z	**	monthly
TCO01	grab, *in situ*	S	*	ALL	no Z	**	monthly
TCO06	grab, *in situ*	S	*	ALL	no Z	**	monthly
RCR01	grab, *in situ*	S	s	ALL	ALL	**	monthly
RCR09	grab, *in situ*	S	s	ALL	ALL	**	monthly
TWB01	grab, *in situ*	S	*	ALL	no P	**	monthly
TWB05	grab, *in situ*	S	*	ALL	no P	**	monthly

STATION	SAMPLE TYPE	SAMPLE MATRIX	PHYSICAL[2]	CHEMICAL[2]	BIOLOGICAL[2, A]	METALS	SAMPLING FREQUENCY
TWB06	grab, *in situ*	S	*	ALL	no P, Z	**	monthly
KNG01	grab, *in situ*	S	*	ALL	no Z	**	monthly
KNG02	grab, *in situ*	S	*	ALL	no Z	**	monthly
THR01	grab, *in situ*	S	*	ALL	noP	**	monthly

[1]: The latitude and longitude listed were determined manually. WQMB plans to use a newly acquired GPS to establish accurate readings for all stations monitored.
[2]: Physical, Chemical and Biological are described in the Water Quality Parameters Table (Table 1).
[A]: Only PMS stations are analyzed for total and fecal coliforms. All other stations are analyzed for fecal coliform only,
ALL: All associated parameters listed in Table1.
S: Surface water.
P: Phytoplankton.
Z: Zooplankton, Macroinvertebrate assessment
C: Coliform.
*: Collected monthly. Temperature, pH, conductivity and DO are profiled from April to October.
**: Collected quarterly.
[#]: Collected twice per month from March to October. Collected once per month the remaining months of the year.

TABLE 7
FREQUENCY TABLE OF TRIBUTARY MONITORING ASSESSMENT TYPES

Tributary Monitoring Station ID	Bio-assessment	Fish Assessment	Morphological Assessment	WQ Parameters[1,2]
Battery Kemble Creek -TBKH01	B	B	B	A
Broad Branch -TBRH01	B	B	B	A
Dalecarlia Tributary -TDAH01	B	B	B	A
Dumbarton Oaks -TDOH01	B	B	B	A
Fenwick Branch -TFEH01	B	B	B	A
Fort Chaplin Run -TFCH01	B	B	B	A
Fort Davis Tributary -TFDH01	B	B	B	A
Fort DuPont Creek -TDUH01	B	B	B	A
Fort Stanton Tributary-TFSH01	B	B	B	A
Foundry Branch-TFBH02	B	B	B	A
Hickey Run -THRH01	A	A	A	A
Klingle Valley -TKVH01	B	B	B	A

Tributary Monitoring Station ID	Bio-assessment	Fish Assessment	Morphological Assessment	WQ Parameters[1,2]
Luzon Branch -TLUH01	B	B	B	A
Melvin Hazen Valley Branch- TMHH01	B	B	B	A
Mills Creek -TMIH01	B	B	B	A
Nash Run -TNAH01	B	B	B	A
Normanstone Creek-TNSH01	B	B	B	A
Oxon Run -TORH01	B	B	B	A
Piney Branch -TPYH01	B	B	B	A
Popes Branch -TPBH01	B	B	B	A
Portal Branch -TPOH01	B	B	B	A
Upper Rock Creek -RCR05	A	A	A	A
Lower Rock Creek -RCRH09	A	A	A	A
Soapstone Creek -TSOH01	B	B	B	A
Texas Avenue Tributary -TTXH01	B	B	B	A
Upper Watts Branch -TWBH01	A	A	A	A
Lower Watts Branch- TWBH05	A	A	A	A
Lottsford Branch* -WEBR-201-R-2001	C	C	C	C
Back Branch A* -WEBR-105-R-2001	C	C	C	C
Mataponi Creek* -PAXM-211-R-2001	C	C	C	C
Back Branch B* -WEBR-111-R-2001	C	C	C	C
Burch Creek* -PISC-112-R-2001	C	C	C	C
Little Bennett Creek* -LMON-240-T-2000	C	C	C	C
Broad Run* -PROMO-202-R-2002	C	C	C	C
Hawling Creek* -RKGR-112-R-2002	C	C	C	C
Patuxent Creek* -BRIG-218-R-2000	C	C	C	C
Dry Seneca Creek* -SENE-211-R-2001	C	C	C	C

[1] A water sample will be collected (annually or biennially) for physical and chemical water quality parameters as described in Table 2. Metals and fecal coliform samples will be collected quarterly.
[2] The sample matrix is surface water. The sample type is grab and *in situ* (where applicable). WQMB plans to use a newly acquired GPS to establish accurate latitude and longitude readings for the sites/stations monitored. Consequently, the water sample collection site and station id may change. Care should be exercised when

comparing data.
A- sampled once per year
B- sampled once every two years
C- sampled every five years
*- Maryland reference stream

Benthic Macroinvertebrate Assessment
The quality of data collected on the city's streams needed to be enhanced while, at the same time, limited monitoring resources used more efficiently. As the pre-scheduled, fixed-station network for monitoring did not provide a reliable representation of tributary water quality, a strategy was developed in 1995, to enhance data quality for D.C.'s small tributaries. The District of Columbia's tributary monitoring includes the use of standard physical/chemical water quality measurements in coordination with an annual multimetric biological/habitat assessment (Maryland Biological Stream Survey Protocols) and the establishment of permanent hydrogeomorphic reference survey sites (the Hydrologic Stream Classification and Assessment methodology), a morphologic stream classification and survey reference design. The larger and more significant tributaries are monitored yearly. While the smaller tributaries are monitored biannually.

In 2000 the District of Columbia adapted the Maryland Biological Stream Survey (MBSS) techniques to the District of Columbia Stream Survey (DCSS) to provide a high degree of impairment detection. The suite of metrics employed provides a basis for trend monitoring and prioritization of sites for more intensive evaluation.

Benthic sample collection is targeted in the riffle/run habitat areas of the stream. These areas are recognized as the most productive areas for benthic organisms in steam systems (EPA, 1989). The samples are composited and processed using DCSS field data sheets.

A 100-organism subsample is used when sorting the benthic collection. In D.C. streams that are severely impacted, 100 organisms may not be found.

All benthic macroinvertebrates are identified to the lowest positively identified taxonomic level in the lab and records of counts are kept in lab log books. A benthic macroinvertebrate library is also collected for referencing and further training in identification. The metrics used in the DCSS are defined in Table 8 below.

TABLE 8
DEFINITIONS OF DCSS BENTHIC METRICS

Category	Metric	Definition	Predicted Response to Increasing Perturbation
Taxa Richness	Total # Taxa	Measures the overall variety of the macroinvertebrate assemblage	Decrease

Category	Metric	Definition	Predicted Response to Increasing Perturbation
	# EPT Taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)	Decrease
	# Trichoptera Taxa	# of caddisfly taxa (usually genus of species level)	Decrease
	# Diptera Taxa	# of "true" fly taxa, which includes midges	Decrease
Composition Measures	% EPT	% of insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)	Decrease
	% Chironomidae	% of midge larvae	Increase
Tolerance/Intolerance Measures	Hilsenhoff Biotic Index	Uses tolerance values to weight abundance in an estimate of overall pollution. Originally designed to evaluate organic pollution	Increase
	% Dominant Taxon	Measures the dominance of the single most abundant taxon. Can be calculated as dominant 2, 3, 4, of 5 taxa	Increase
Feeding Measures	% Scrapers	% of the macrobenthos that scrape upon periphyton	Decrease
	% Gathers	% of macrobenthos that "gather"	Variable

Habitat Assessment

The primary factor controlling the biological potential of a stream is the quality of habitat in that stream. Determining habitat quality in a stream is essential to an accurate bioassessment as both are needed to make an evaluation (EPA, 1989). Habitat evaluations are completed on instream habitat, channel morphology and on structural features of the bank and riparian vegetation. The habitat evaluation conditions are broken down into the following parameters:

Substrate and Instream Cover
*bottom substrate and available cover
*embeddedness
*flow/velocity

Channel Morphology
*channel alteration
*bottom scouring and deposition
*pool/riffle, run/bend ration

Riparian and Bank Structure
*bank stability
*bank vegetation
*streamside cover

The separate parameters must be scored consistently by experienced field staff. Annual habitat referencing and coordination workshops will be attended by staff with other regional aquatic ecologist to assure accuracy. Scoring is completed on a DCSS field data sheet. The criteria for habitat are found in Table 9.

TABLE 9
CRITERIA FOR USING BENTHIC MACROINVERTEBRATE AND HABITAT ASSESSMENTS WHEN MAKING USE SUPPORT DECISIONS (CLASS C).

Support of Designated Use	Criteria for Using Benthic Macroinvertebrates and Habitat
Fully Supporting (F)	For any benthic macroinvertebrate or habitat that exceeded in ≤ 79% of the reference condition.
Not Supporting (N)	For any benthic macroinvertebrate or habitat that exceeded in > 79% of the reference condition.
Not Assessed (X)	Not assessed.
Insufficient Information (I)	Data to determine if the designated use is fully supporting/not supporting is not available.

The findings of the benthic macroinvertebrate assessment and habitat assessment provides vital information for determining if a stream supports its designated use of the protection and propagation of fish, shellfish and wildlife (aquatic life use). The raw data and results from DCSS are stored in WQD files in Excel format.

Fish Assessment

The bioassessment of fish is conducted using the MBSS techniques, which involve standardized field collections, species identification and enumeration, and community analyses using biological indices. The assessment is based primarily in the Index of Biotic Integrity (IBI) which can be used to measure the health of the fish community being studied (EPA, 1989). Table 10 gives the definitions for the metrics used in the DCSS fish assessment.

TABLE 10
METRICS USED FOR FISH ASSESSMENT

Metric	Definition	Predicted Response to Perturbation
# of Native Species	Total number of native fish species; adjusted for the	Decrease

# of Benthic Fish Species	# of fish species that reside primarily on the stream bottom	Decrease
% Tolerant Species	The percentage of individuals rated as tolerant to anthropogenic stressors	Increase
Biomass (g) per square meter	Total mass in grams of fish captured at a site, divided by the surface area	Decrease

To collect the samples electrofishing is employed. Electrofishing is considered the most common and effective method of fish collection in stream habitats (EPA, 1989). The fish community data collected through electrofishing should be representative of the fish community in all habitats, and therefore the sampling station should be representative of the entire stream reach. Although the results from the fish assessment are not used in the DCSS having this information is vital for establishing and tracking trends and changes in water quality.

A fish field collection data sheet is completed for each sampling segment with species, length, weight (if practical) and notes on abnormalities. Reference specimens of each species are preserved for permanent storage.

Fish tissue studies are included in the intensive surveys. Using EPA's Fish Risk Guidance, WQD can determine if the protection of human health related to consumption of fish and shellfish designated use is supported.

Fish consumption use determinations (Class D) are based on known fish consumption advisories in effect during the assessment period. Surface Water Quality Standards (SWQS) are not used to make fish consumption advisories from fish tissue contamination data collected. Fish tissue contamination data used to issue advisories are collected at stations located on the Anacostia and Potomac Rivers. If no barrier for fish movement exists, it is assumed that fish move freely to the smaller streams and other waterbodies. In addition, the EPA guidance on using fish advisories for Integrated Report categorizations indicated that fish and shellfish consumption advisories demonstrate non-attainment when the advisory is based on fish and shellfish tissue data (Table 11).

TABLE 11
CRITERIA FOR FISH CONSUMPTION USE SUPPORT CLASSIFICATION

Support of Designated Use	**Criteria for Fish Consumption**
Fully Supporting (F)	No fish/shellfish advisories or bans are in effect.
Not Supporting(N)	"No consumption" fish/shellfish advisory or ban in effect for general population, or a subpopulation that could be at potentially greater risk, for one or more fish species; commercial fishing/shellfishing ban in effect.

Support of Designated Use	Criteria for Fish Consumption
Not Assessed (X)	"Not assessed" is used when fish consumption is not a designated use for the waterbody.
Insufficient Information (I)	Data to determine if the designated use is fully supporting/not supporting is not available.

The District also determines overall use support for waterbodies with multiple uses according to EPA guidance. A waterbody fully supports its designated uses when **all** its uses are fully supported. When one or more uses are **not** supporting, then the waterbody is not supporting (Table 12).

TABLE 12
CRITERIA FOR OVERALL USE SUPPORT CLASSIFICATION

Overall Designated Use for Multiple-Use Waterbodies	Criteria for Overall Use Support
Fully supporting (F)	All uses are fully supported.
Not supporting (N)	One or more uses are not supported.
Not Assessed (X)	Not assessed
Insufficient Information (I)	Data to determine if the designated use is fully supporting/not supporting is not available.

Quality Assurance

All WQD water samples are collected following strict written protocols based on EPA guidance in Standard Methods For the Examination of Water and Wastewater and the American Society for Testing and Materials Manual. The metals, chemical, filtered chlorophyll, and bacteriological samples are delivered by WQD staff to the EPA, Region III Central Regional Laboratory in Annapolis, MD, for analysis by WQD's Environmental Laboratory Branch (ELB) personnel. Quality assurance (QA) and quality control (QC) of the data generated at the ELB is the responsibility of ELB's QA Officer. Data received from ELB are assumed to meet standard QA requirements. Alkalinity, turbidity, and hardness analyses and chlorophyll filtration are conducted at the WQMB laboratory facility (WLF), located at the Blue Plains Waste Water Treatment Plant (BPWWTP), by WQD personnel. QA and QC of the data produced at the

WLF are the responsibility of the WQMB QA Officer. Private contractors perform biological (zooplankton and phytoplankton) identifications and counts. Separate QA/QC project plans for biological monitoring are submitted to EPA for approval.

Parameters that WQMB monitors are predominately those mandated by the District of Columbia's "Water Pollution Control Act" (DC WPCA). The act established water quality standards for D.C.'s ambient waters and set specific limits for acceptable levels of certain water quality parameters. To adequately assess water quality, when possible WQD managers require parameter methods with detection limits that are equal to or less than mandated numerical standards.

The Chesapeake Bay Program's management uses D.C.'s water quality data for modeling and watershed management purposes. The needs of the modelers, compatibility with other data bases in the Chesapeake Bay area, and the prevailing acceptable laboratory method available at reasonable costs, also have an impact on the data quality standards to which WQMP adhere.

The detection limits required by the District of Columbia's WQMB are listed in WQMB' s standard operating procedures (SOPs). For those parameters where there are no established detection limits, D.C. accepts the method detection limits currently available at a reasonable cost at ELB. To determine whether the data collected meets the expected quality, WQMB pursues a two-level QC effort, field and laboratory. Field instrumentation, principally *in situ* water quality instruments, are calibrated at the WQMB Laboratory Facility (WLF) before leaving for the field on the day of a sampling event. A calibration check is performed after each monitoring run using the same calibration solutions as the previous calibration to check for drift. Instruments used for analysis are also calibrated according to method and manufacturer's specifications. At ELB, analytical results are evaluated with standard reference material and by other mechanisms as is reflected in its QA documents.

WQMB collects co-located samples to detect the variability within the entire sampling system and to determine data precision. A co-located sample is collected during each monitoring run and is delivered with the other samples to ELB and WLF for analysis.

Accuracy and Precision

Laboratory quality control samples are used to determine accuracy and precision. QC samples will make up approximately 10% of the total number of analyses. Quality control samples for accuracy determination will make up 5% of the total number of samples analyzed. Laboratory duplicate samples are used to measure precision and generally make up 10% of the samples analyzed.

Using accuracy and precision data, standard deviations are calculated and used to prepare control charts. These control charts are drawn with "warning" and "out of control" limits which are used to plot and visually assess accuracy and precision data in each sample run (Table 13). Warning limits, corresponding to 95% confidence levels are located two standard deviations from the mean. Out of control limits corresponding to 99% confidence levels are located three standard deviations from the mean.

TABLE 13
ACCURACY AND PRECISION TABLE

Analytical Parameter	Analytical Method	Units	Accuracy	Precision
Nitrate & Nitrite	EPA(1979) 353.2 (colorimeter, automated cadmium reduction, diazotation)	mg/L	**	**
Nitrite	EPA(1979) 353.2 (automated diazotation)	mg/L	**	**
Ammonia	EPA(1979) 350.1 (colorimetric, automated phenate)	mg/L	**	**
Ortho-phosphorus (ortho-phosphate)	EPA(1979) 365.1 (colorimetric, automated ascorbic acid reduction)	mg/L	**	**
Biochemical Oxygen Demand (BOD(5))	St. Methods (19th ed.) 507 (dissolved oxygen depletion)	mg/L	**	**
Residue Non- filterable (TSS)	St. Methods (19th ed.) 209C (gravi-metric, 103-105 degree C post washing of residue)	mg/L	**	**
Chlorophyll "a"	(a)	µg/L	**	**
Phaeophytin "a"	(a)	µg/L	**	**
Coliform (total)	St. Methods (19th ed.) 908A (MPN, 5 tube, 3 dilution)	MPN/100mL	**	**
Coliform (fecal)	St. Methods (19th ed.) 908A (MPN, 5 tube, 3 dilution)	MPN/100mL	**	**
Hardness (total)	St. Methods (19th ed.) 314B (colorimetric, EDTA titration, manual)	mg/L	TBD	5 mg/L
Alkalinity ($CaCO_3$)	St. Methods (19th ed.) 403 (colorimetric, titration, manual)	mg/L	TBD	3 mg/L
Turbidity (NTU)	St. Methods (19th ed.) 214A (nephelometric)	NTU	±2% of full scale	±2% of full scale
Dissolved O_2,	Au/Ag polarographic cell (Clark) HSWQIM*	mg/L	±0.2 mg/L	not applicable
Cadmium (total)	Method 200.7, ICP (see note(b))	µg/L	**	**
Chromium (total)	Method 200.7, ICP (see note (b))	µg/L	**	**
Copper (total)	Method 200.7, ICP (see note(b))	µg/L	**	**
Iron (total)	Method 200.7 ICP (see note(b))	µg/L	**	**
Lead (total)	EPA (1979) 239.2 (AA furnace)	µg/L	**	**

Analytical Parameter	Analytical Method	Units	Accuracy	Precision
Mercury (total)	EPA (1979) 245.1 (cold vapor, automated)	µg/L	**	**
Zinc (total)	Method 200.7, ICP (see note(b))	µg/L	**	**
Arsenic (total)	EPA (1979) 206.2 (AA furnace)	µg/L	**	**
Selenium (total)	EPA (1979) 270.2 (AA furnace)	µg/L	**	**
Phytoplankton	(d)	#individuals/ mL	not applicable	not applicable
Zooplankton	(d)	# / m^3	not applicable	not applicable
Temperature	Linear thermistor network; HSWQIM*	°C	±0.15 °C	-5 to 50 °C
pH	Glass electrode: Ag/AgCl reference electrode pr.; HSWQIM*	pH units	±0.2 units	0 to 14 units
Secchi Depth	Secchi depth disk	m	not applicable	not applicable

(a) ASTM-WATER Post 31, ASTM Designation D3731-79, pages 1079-1083, "The status of Methods for the Analysis of Chlorophyll in Periphyton and Plankton": Weber, C.I., L.A. Fay, G.B. Collins, D. Rathke, J. Towbin, Env. and Plankton": Weber, C.I., L.A. Fay, G.B. Collins, D. Rathke, J. Towbin, Monitoring and Support Laboratory, U.S. EPA, Cincinnati, Ohio.
(b) The full text of method 200.7 "Inductively Coupled Plasma Emission spectrometric Method for Trace Element Analysis of Water and Wastes,"Inductively Coupled Plasma Emission Spectrometric Method for element Analysis of water and Wastes," is given in Appendix C of Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Proposed Rule, 40 CFR Part 136, Federal Register, Friday, October 26, 1984.
(c) UNESCO, 1965.
(d) Reduce the volume of the original water sample to about 50 mL. Take five 1 mL subsamples and count and identify species. Determine the reduces sample volume (RSV) by measuring the volume of sample after subsampling and adding five mL (for the 1 mL subsamples removed) to that value. Report counts as number of individuals.
* HSWQIM- Hydrolab (manufacturer) System Water Quality Instrumentation Manual
** information available upon request from ELB QA officer
EPA (1979) - Methods for Chemical analyses of Water and Wastes, EPA-600/4-79-020, Environmental Monitoring and Support Laboratory, Cincinnati, OH.
St. Methods (19th ed.)- Standard Methods for the Examination of Water and Wastewater, , 19th Edition 1995, American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, DC.
TBD: To be determined after statistical analysis of 25 data points

Representativeness

To obtain representative monitoring data for surface water, grab samples are taken for chemical analysis based on the project description. There are 58 network stations that are monitored biweekly or monthly. Field personnel are required to follow established SOPs for all activities associated with the project. SOPs include detailed information on sampling techniques, preservation and handling and corrective action to maintain the quality of the water samples collected.

Schedule of Tasks and Products

WQD has an on-going schedule of tasks and products that is determined in advance and submitted as part of the District of Columbia's annual grant application workplan to EPA (Table 14). The workplan contains those activities that WQD plans to complete in the grant year, i.e., ambient monitoring and sample analysis schedules, special surveys, data submission to STORET and the Chesapeake Bay Program, TMDL studies, NPDES permitting and water quality assessments.

The data collected is used to determine the degree of support of the designated life uses assigned by the D.C. Water Pollution Control Act, and the fishable and swimmable uses of the federal Clean Water Act. Water quality assessments of waterbodies for their designated use is determined using D.C. Water Quality Standards. The data is also used to evaluate water pollution control activities such as CSO abatement and BPWWTP upgrades. Water quality data is processed for organizations, government agencies and individuals interested in learning more about District of Columbia waterbodies in the form of a 305(b) Report, a 303(d) List or an Integrated Report.

TABLE 14
SCHEDULE OF TASKS AND PRODUCTS

Task/Product	**Completion Date**
Field and Laboratory Preparation for Ambient Monitoring	Weekly according to sample collection schedule
Estuary and Tributary water sample collection	Monthly during grant year
Sample delivery to ELB and WQMB analysis area	Daily as per sample collection schedule
WQMB and ELB sample analysis	Within sample holding time
Potomac River Split Sampling project	Quarterly
Biological Monitoring	Seasonally
Fish Tissue Sampling	Biannual (contingent on availability of funds)
Tributary Field Assessment and Rapid Bioassessment	Seasonally as per sample collection schedule
Data Review	Weekly
Data Entry	Weekly
Data Verification	Weekly
Data Documentation	Weekly
Electronic Data Transfer (CBP, STORET, and the Public)	Quarterly

Project Operating Procedures

To ensure the integrity of the samples collected a variety of sample containers and preservation methods are required. Every effort is made to ensure that all samples are analyzed within their established holding times (Table 15). The data results from the analytical parameters found in Table 15 are downloaded into the STORET database, all except phyto- and zooplankton.

TABLE 15
PRESERVATION, HOLDING TIME AND CONTAINER REQUIREMENTS

ANALYTICAL PARAMETER	SAMPLE VOLUME[1]	RECOMMENDED CONTAINER	PRESERVATION METHOD	HOLDING TIME
TKN unfiltered	500	P, G	refrigerate add H_2SO_4 to pH<2	28 days at 4°C; pH<2 with H_2SO_4
Nitrate + Nitrite	200	P, G	add H_2SO_4 to pH<2, refrigerate	48 hours at4^{0}C; 28 days at 4^{0}C pH<2 with H_2SO_4
Nitrite	100	P, G	analyze as soon as possible or refrigerate	48 hours at 4^{0}C
Ammonia	500	P, G	analyze as soon as possible or add H_2SO_4 to pH<2, refrigerate	28 days at 4^{0}C, pH<2 with H_2SO_4 or 24housr at 4^{0}C
Total phosphorus	50	P, G	Refrigerate, add H_2SO_4 to pH<2	28 days at 4^{0}C; pH<2 with H_2SO_4
Total soluble phosphorus, filtered	50	P, G	Filter on site, refrigerate, add H_2SO_4 to pH<2	48 hours, 28 days at 4^{0}C; pH<2 with H_2SO_4
Ortho-phosphorus (ortho-phosphate)	50	P, G	Filter on site, refrigerate	48 hours at 4^{0}C
Biochemical oxygen demand (BOD-5)	1000	P, G	refrigerate	48 hours at 4^{0}C
Residue non- filterable (TSS)	100	P, G	refrigerate	7 days, 48 hours at 4^{0}C
Chlorophyll "a"	500	P, G	Cool, 4°C, protect from direct sunlight	6 hours at 4^{0}C for filtering; filters 30 days at-20^{0}C
Phaeophytin "a"	500	P, G	Cool, 4°C, protect from direct sunlight	6 hrs at4^{0}C filtering; filters 30 days at -20^{0}C
Coliform (total)	250	P	Cool, 4°C	6 hours at 4^{0}C; 10% $Na_2S_2O_3$; sterile container
Coliform (fecal)	250	P	Cool, 4°C	6 hours at 4^{0}C; 10% $Na_2S_2O_3$; sterile container
Hardness (total)	100	P, G	Cool, 4°C or add HNO_3 to pH<2	6 months. refrigerate
Alkalinity	100	P, G	Cool, 4°C, 24 hrs.	24 hours

ANALYTICAL PARAMETER	SAMPLE VOLUME[1]	RECOMMENDED CONTAINER	PRESERVATION METHOD	HOLDING TIME
Turbidity (NTU)	100	P, G	Cool, 4°C	Refrigerate in the dark up to 24 hours
Dissolved O2 , (Hydrolab)	--	NA	NA	NONE
Cadmium (total)	200	P, G	pH <2 with HNO_3	6 months at 4^0C; pH<2 with HNO_3
Chromium (total)	200	P, G	pH<2 with HNO_3	6 months at 4^0C; pH<2 with HNO_3
Copper (total)	200	P, G	pH<2 with HNO_3	6 month at 4^0C; pH<2 with HNO_3
Iron (total)	200	P, G	pH<2 with HNO_3	6 months at 4^0C; pH<2 with HNO_3
Lead (total)	200	P, G	pH<2 with HNO_3	6 months at 4^0C; pH<2 with HNO_3
Mercury (total)	500	P, G	pH<2 with HNO_3, refrigerate	28 days at 4^0C; pH<2 with HNO_3
Zinc (total)	200	P, G	pH<2 with HNO_3, refrigerate	6 months at 4^0C; pH<2 with HNO_3
Arsenic (total)	200	P, G	pH<2 with HNO_3, refrigerate	6 months at 4^0C; pH<2 with HNO_3
Selenium (total)	200	P, G	pH<2 with HNO_3, refrigerate	6 month at 4^0C; pH<2 with HNO_3
Phytoplankton	500	P, G	5 mL Acid-Lugol+ 3 mL Formalin, store in the dark	indefinitely; Lugol/formalin solution
Zooplankton	5 tows	P, G	5 mL Formalin/125 mL, store in the dark	indefinitely; formalin
Temperature	na	na	na	na
pH	na	na	na	na
Secchi depth	na	na	na	na

[1]Sample volume (mL) required.

P, G- (P)Plastic) or (G) glass. For metals, polyethylene with a polypropylene cap (no liner) is preferred.

Standard Operating Procedures

The standard operating procedures (SOPs) provides a consistent framework for the generation of analytical data in support of WQMP in the District of Columbia. Quality assurance and quality control represent the application of set procedures to assure reliable data are available for making responsible environmental management decisions about the city's waters. WQMP designed a SOP document, that is available on WQD files, to guide staff in preparing for and conducting field water quality sampling. Following the set procedures will result in data that is of known quality.

Volume I of the District of Columbia Water Quality Monitoring Program SOP is an integral supplement to EPA Central Regional Laboratory's (CRL) "Field SOP Quality Assurance Manual." CRL's field SOP was adopted in 1984 as the SOP for the WQMB. WQD files has a more up-to-date version of the SOP, that includes modifications, additions, and updates to CRL's field SOP. Other laboratory quality assurance/quality control and data management procedures used by WQD staff at CRL are also adopted by WQD as a component of its in-house SOP.

Volume II of the D.C. Water Quality Monitoring Program SOP contains copies of manuals for the various pieces of equipment WQD staff use to monitor the city's waters. The SOP is the result of substantial professional and technical effort. Monitoring staff review the SOP and become familiar with all of the applicable procedures before going into the field.

Data Management

Introduction

Reduction and validation procedures for environmental data are necessary to ensure that only accurate information is used. WQMB receives monitoring data from three sources:

- Directly from the field
- WQMB's laboratory facility at Blue Plains (WLF)
- WQD's Environmental Laboratory facility (ELB) located at CRL

The way data are reduced and validated depends on its source. Results are either manually transferred to specific data sheets or logbooks or, as with some Hydrolab data by electronic output and download. This year WQD is beginning to scan all field data sheets; they will be stored in pdf format. In addition, all data generated from Hydrolabs will be formatted for monthly entry in the WQD database. WQMB uses a variety of methods to validate the data. The data validation steps are described in the Data Validation section.

Field data that is generated from the District of Columbia Stream Survey is stored on WQD files in Excel format.

Data Reduction

Data reduction is the process of converting raw analytical numbers obtained from sample analysis into meaningful results. The analysts at WLF and ELB are responsible for data reduction at the laboratory level. Analysts use standard laboratory methods to convert raw analytical numbers into meaningful parameter values.

Field personnel are responsible for data generated in the field. Data generated *in situ* include the Hydrolab measurements of dissolved oxygen, temperature, pH, and conductivity. The

Hydrolab instrumentation reduces the information detected by its probes. Data generated are then stored in the Hydrolab's data logger for electronic download or manually recorded on field data sheets. Secchi depth is recorded manually on field sheets.

Data Validation

Once reduced, the QA Officer of each respective laboratory must verify that the data are correct. Data are validated through a series of quality control checks, screens, audits, qualifications, verifications and reviews. These procedures compare the generated data with established criteria to assure that the data are adequate for their intended uses. Laboratory data are verified by comparing quality control sample results with established parameter ranges for field blanks and duplicates. If data fall outside control limits, field records and other documentation are reviewed for any irregular conditions during sample collection and handling which may have affected the data. Results from the quality control procedures described above and documentation review are used to accept, qualify or reject data for later use.

WQMB validates Hydrolab data by calibrating the instrument against a set of known standards before deployment and performing post sampling measurements on the same standards. If data fall outside a specified range, field staff review the sampling run for any irregular conditions during sample collection and instrument handling which might have affected the data. Data are accepted or rejected based on field staff's best professional judgement. Data management staff also review all data before input to the data base.

Beyond the above steps, all data submitted to EPA STORET go through several parameter range-checking steps to detect data outliers. STORET requires these checks before final storage in it's data base.

The files are converted into Statistical Analysis System (SAS) data sets at CBP. They are checked through a range and error checking program before being finalized in the CBP CIMS (Chesapeake Information Management System) database. Water quality data is submitted to STORET through SIM (STORET INTERFACE MODULE). SIM is a data entry and validation tool that was designed to load large volumes of data into the STORET database. These special design data tables reside in the same Oracle form as the STORET database. The SIM application reads data in the form of common delimited text files into the SIM database. This process identifies any errors in the incoming file and allows the user to delete the data output from SIM, then correct the errors and resubmit the data until the data set are error free. When the process is complete, the user instructs the application to migrate the data from the SIM database into the STORET database.

Comparability

Comparability of the data depends on how samples are collected and handled in the field, and the uniformity of sample analysis and the validity of data reported. The requirements for sampling containers, sample preservation and holding times are followed to assure comparability in the samples collected.

Participation in the split sample program is another step taken to determine the comparability of the data collected. Quality control samples are conducted with a system of QA for the specific action taken to ensure that system performance is consistent with established limits. It is these actions which ensure accuracy, precision and comparability of results. To compare benthic macroinvertebrate data the WQD adapted the DCSS protocols to the Maryland Biological Stream Survey (MBSS) protocol; to have a point of reference across state lines.

Completeness

Completeness is a measure of valid data obtained compared to the amount that was expected under normal conditions. The data requirements of the project necessitate completeness. This WQMP strives to produce a data set that is 95% complete. Efforts to minimize factors, such as sample loss, breakage, inadequate storage and preservation which invalidate data is encouraged.

Causes/Sources of Impairment

To identify stressors in the field WQMB staff keeps a log of all causes and sources of impairment for each stream in the District of Columbia. The methodology for determining causes/sources impairment comes from the *"Stressor Identification Guidance Document"*, EPA 2002. The information is gathered from the guidance worksheet and inputted into the assessment database (ADB) to assist in further detailing which streams should be placed on the 303(d) List for TMDL studies.

Data Analysis

The WQD uses the D.C. SWQS as one way of evaluating its surface waters. The percentage of time a selected standard is out of compliance at a monitoring station or group of monitoring stations over a selected span of time determines whether a waterbody supports a particular use. Physical, chemical, bacterial data and biological data are also used. In cases where biological data and conventional pollutant data are available, biological data are the overriding factor in determining aquatic life use support. Fish consumption use determinations are based on known fish consumption advisories in effect during the assessment period, and not on water quality standards. To help to compare D.C. water quality and national water quality, the District of Columbia applies national criteria, where possible, in determining use support of its waterbodies. The criteria used to determine use support determinations can be found in the *Water Quality Indicators* section of this strategy.

Reporting

Historically WQD has submitted 305(b) reports in a timely fashion. The submission of 303(d) lists and the ADB database has been delayed during a number of reporting cycles. Limited staffing has been an ongoing hindrance to the reporting production of the District of Columbia. The WQD is making every effort to ensure that 303(d) list as well as the ADB data base submissions are timely.

For the 2003-2004 reporting cycle the WQD used the Integrated Report format for its biennial report. The Integrated Report includes the status on the health of all D.C. waterbodies (305(b)), a complete 303(d) list, with TMDL studies dates, and an updated ADB database.

WQMB plans to submit field and WQMB laboratory data every six months to EPA STORET, and CBPCC. Again, due to low quantity of staff the WQD has delays in submitting data to EPA STORET. Information being submitted to STORET will be up to date and continually current by January 2008.

The District of Columbia makes every effort to have all of the reporting information readily available to the public and state and federal agencies. To further ensure that WQD reports are accessible WQD is in the process of storing all informational reports including the Integrated Report 305(b), 303(d) list, 106 and other reports on the EHA website in a pdf format that will be available online. April 2005 is the projected date for reports being available online.

Programmatic Evaluation

The District of Columbia's Water Quality Division is in the process of devising a plan of action for the periodic reviews of each aspect of its monitoring program by EPA Region 3. The review process will aid in determining how well the program serves its water quality decision needs for all waters in the city. Below is a list of points that WQD will use as the framework for its program evaluation:

a. Written description of the Water Quality Monitoring Program.
b. Devise a plan to measure the effectiveness of the goals that have been set in the monitoring strategy and measure successes and failures at the end of each year.
c. Evaluate how WQD plans and manages projects.
d. Evaluate policy, procedures and special issues pertaining to the health of D.C. waters.
e. Develop a portfolio of lessons learned to continue to enhance the monitoring program.
f. Have evaluation done by EPA and select neighboring states, of the purpose of peer reviews.

During the 2005 calender year WQD will begin to document lessons learned in preparation for developing WQMB's programmatic evaluation. By the end of calendar year 2006 a draft of the programmatic evaluation will be in place.

General Support and Infrastructure

To fully develop and implement the District of Columbia's monitoring program can no longer survive on minimal resources. Below is a list of impediments to the success of the District of Columbia's monitoring program:

a. Additional Staff (for ADA database maintenance and ELB)
b. Laboratory Equipment (microscopes, digital scales, complete macroinvertebrate laboratory set-up at WQMB site, hydrolabs, water craft and various monitoring equipment for waterbody surveys)
c. Staff Training (in latest water quality monitoring techniques and information)

All of the impediments to the success to D.C.'s monitoring program can be alleviated through increased financial support. Table 16 prioritizes the needs of the District of Columbia monitoring program.

TABLE 16
DISTRICT OF COLUMBIA MONITORING PROGRAM NEEDS

Resource Needs or Technical Issue		**Purpose in Monitoring Program**
Highest Priority	Ground Water Research	The monitoring strategy cover all waters of the District of Columbia, but ground water has long since been neglected. Funding and staff are needed to continue with the development of ground water indicators, drilling wells and monitoring.
	Wetlands Research	Wetlands are an integral part of maintaining and improving water quality, and also is a type of water mentioned in the monitoring strategy. Additional staff and funding for equipment and training are needed to include wetlands in the WQD monitoring program.
	Fish Tissue Study	Fish tissues studies need to be done biennially to determine if Class D waters supports this designated use. Funding is needed to perform fish tissue analysis biennially, to have fish consumption determinations coincide with water quality assessments for biennial reporting.
	Ambient Monitoring	All of the criteria stated in the WQS need to be implemented to determine attainment or nonattainment for Class C waters. Funding and addition staff are needed to the WQD has sufficient personnel to cover all data collect and analysis needs.
	Sediment Research	To determine if the toxics found in the water column are from sediment or runoff.
	Intensive Surveys	For any areas of special interest to the District of Columbia that will facilitate efforts to improve water quality. Continued and increased funding is needed to continue contractual research to assist WQD with how to best improve the city's water quality.
	Training	To keep staff abreast of the latest trends in water quality assessments, modeling software, monitoring equipments and techniques. To determine what types of BMPs, LIDs and outreach and education should be installed/take place to target pollutant of concern.
Lowest Priority	Monitoring Equipment	To have the most accurate and technologically advanced equipment for more reliable results from testing.

Although WQD has listed its needs by priority, because of the revitalization of the District of

Columbia the city’s needs are ever-changing. WQD, in order to be a completely effective, must also be flexible enough to change focuses as needs arise. Therefore, WQD would suggest that the list of priorities may be updated. In the event of a change in focus WQD will reissue its priority of resource needs and technical resources.

Conclusion

Since the inception of the Water Quality Division there has been a need for increased funding to successfully carry out all tasks to improve the health of D.C. waters and the quality of life for its residents. The Water Quality Division provides the best possible service to the residents and waters of the District of Columbia with minimal resources, both staff and equipment.

The WQD has and will continue to make every effort to improve the WQMP. However, to ensure the success of D.C.’s monitoring program WQD must be able to overcome all the impediments to it’s success. It is the hope of the WQD that adequate funding and personnel can be secured to implement all the tasks outlined in the monitoring strategy.