SOURCE WATER ASSESSMENT

for

Fort Detrick
Water Treatment Plant

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TABLE OF CONTENTS

EXECUTIVE SUMMARY i

1.0 BACKGROUND 1

2.0 INTRODUCTION 1
A. Description of Surface Water Supply Sources 2
B. Water Supply Development 2

3.0 RESULTS OF SITE VISIT(S) 3
Concerns and Site Observations 3

4.0 WATERSHED CHARACTERIZATION 3
Source Water Assessment Area Delineation Method (Surface Water) 3
General Characteristics 4
Land Use Characteristics 4
Table 4. Land Use Distribution in the Monocacy River Watershed 4
Localized Characteristics 4
Subwatersheds 5
Maps – Monocacy – Intake and Double Pipe Creek 6
Piney – Alloway and Toms Creek 7
Marsh Creek 8

5.0 SIGNIFICANT SOURCES OF CONTAMINATION 9
Non-Point Pollution Sources 9
Point Source Concerns 9
Transportation Related Concerns 10
Land Use Planning Concerns 10
Table 5. Land Use Planning Concerns in Watershed Land Development in the Monocacy River Watershed 10

6.0 REVIEW OF WATER QUALITY DATA 11
Existing Plant Data 11
Turbidity 11
Table 6.1. Fort Detrick Plant Raw Water Turbidity 2001 – 2004 12
Fecal Coliform and Protozoa 12
Table 6.2. Storm Event #1. Cryptosporidium Results 13
Table 6.3. Storm Event #2. Cryptosporidium Results 13
Table 6.4. Storm Event #3. Cryptosporidium Results 13

Table 6.5. Storm Event #4. Cryptosporidium Results 13
Figure 6-1: Fort Detrick – Raw Water Coliform – Coliform Counts Below the Detection Limit are Plotted at ½ of the Detection Limit 14
Figure 6-2: Coliform as a Function of a Three Day Rainfall Total Ending the Day of the Coliform Sample 15
Inorganic Compounds (IOCs) 16
Table 6.6. Testing Results for IOCs in Finished Water 16
Synthetic Organic Compounds (SOCs) 17
Table 6.7. Testing Results for SOCs in Finished Water 17
Volatile Organic Compounds (VOCs) 18
Table 6.8. Quarterly Average Concentrations of DBPs from 2002 through 2004 19
Table 6.9. Annual Average Concentrations of DBPs from 2002 through 2004 19
DNR Watershed Data 19
Table 6.10. Statistical Summary Data from Monocacy River Basin 20

7.0 SUSCEPTIBILITY ANALYSIS 21
Turbidity and Sediment 21
Inorganic Compounds 21
Synthetic Organic Compounds (SOCs) 21
Disinfection Byproducts 22
Table 7.1. Disinfection Byproducts MCLs 22
Table 7.2. Required Removal of TOC by Enchanced Coagulation for Plants Using Conventional Treatment 23
Table 7.3. Fort Detrick TOC Removal for 2004 23
Microbial Contaminants 24
Consistency with Clean Water Act Findings 24

8.0 RECOMMENDATIONS FOR SOURCE WATER PROTECTION PLAN .24

REFERENCES 26

OTHER SOURCES OF DATA 26

FIGURES 27
Figure 3-A. Monocacy Intake – City of Frederick Major Subwatersheds, Towns, and Transportation

EXECUTIVE SUMMARY

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment programs to evaluate the safety of all public drinking water systems. A Source Water Assessment (SWA) is a process of evaluating the vulnerability of a source of public drinking water supply to contamination. This SWA was completed for the Monocacy River, the source of water supply for Fort Detrick Water Treatment Plant. This report does not address the effectiveness of the treatment processes of removing contaminants.

The Monocacy River is the largest Maryland tributary to the Potomac River and forms by confluence of Rock Creek and Marsh Creek at the Pennsylvania-Maryland State line 25 miles north of Frederick, Maryland. The river flows for 57.1 miles generally in a southerly direction across the entire width of the State to the Potomac River. Fort Detrick's intake is located approximately 17 miles upstream of the mouth near Maryland Route 26. The water enters the treatment plant through a bank river intake, flows to a wetwell and then is pumped to the treatment plant.

The source water protection area for Fort Detrick intake encompasses approximately 700 square miles of mixed land use with predominantly cropland (54%) and forested land (27%). Approximately 75% of the watershed is located in Maryland's Frederick and Carroll counties and 25% is in the state of Pennsylvania.

Potential sources of contamination for Monocacy River watershed include point and non point sources, including transportation, agriculture, on-site septic systems and runoff from developed areas. There are three major and several minor wastewater treatment plants (WWTPs) located in the Monocacy River Source Water Assessment Area. The total daily average flow from all major and minor WWTPs is approximately 7.4 million gallons per day (MGD). Under low flow conditions (7 day once in ten (10) year occurrence frequency), the discharges account for 27% of the river flow.

The susceptibility analysis indicates that turbidity, disinfection by product precursors and pathogenic microorganisms are the contaminants of most concern. Sampling for cryptosporidium (a pathogenic protozoa) in the Monocacy River indicates that highest concentrations were found during stormwater events. Elevated fecal coliform concentrations were also often, but not exclusively, associated with rainfall events. Nutrient enrichment, algal blooms and natural organic matter all contribute to reactive of disinfection by products precursors. High turbidity levels are associated with erosion and transport of sediment during storm flows.

Section 8.0 of this report lists specific recommendations for consideration in developing a source water protection plan. Providing critical information for implementing a source water protection program for Monocacy River is the ultimate goal of this assessment.

1.0 BACKGROUND

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment programs to evaluate the potential for contaminants to affect the sources of all public drinking water systems. A Source Water Assessment (SWA) follows a process for evaluating the susceptibility of a public drinking water supply to contamination. The assessment does not address the treatment processes or the storage and distribution of the water system, which are covered under separate provisions of the Safe Drinking Water Act. The Maryland Department of the Environment (MDE) is the lead state agency in this SWA effort.

There are three main steps in the assessment process: (1) delineating the watershed drainage area that is likely to contribute to the drinking water supply, (2) identifying potential contaminants within that area and (3) assessing the vulnerability of the system to those contaminants. This document reflects all of the information gathered and analyzed required by those three steps. MDE looked at many factors to determine the susceptibility of this water supply to contamination, including the size and type of water system, available water quality data, the characteristics of the potential contaminants, and the capacity of the natural environment to attenuate any risk.

Maryland has more than 3,800 public drinking water systems. Approximately 50 of Maryland's public drinking water systems obtain their water from surface supplies, either from a reservoir or directly from a river. The remaining systems use ground water sources. Maryland's Source Water Assessment Plan was submitted to the Environmental Protection Agency (EPA) in February 1999, and received final acceptance by the EPA in November 1999. A copy of the plan can be obtained at MDE's website, www.mde.state.md.us, or by calling the Water Supply Program at 410-537-3714.

2.0 INTRODUCTION

Fort Detrick is a military installation devoted to medical research and deployment, communications, and a civilian cancer research facility. The installation is located in the central Frederick County, west of US 15 and north of US 40. The installation is divided into two separate parts, a 0.64 square mile area west of Rocky Springs Road and a 1.25 square mile area between Yellow Springs Road and Opossumtown Pike.

The Fort Detrick water system is owned and operated by the Department of the Army and serves an estimated population of 7,500 people, most of whom do not live on site. The Fort Detrick's six million gallons per day (6.0 MGD) capacity plant withdraws water directly from the Monocacy River approximately 100 yards down stream of the City of Frederick's intake.

A. Description of Surface Water Supply Sources

The Monocacy River is the largest Maryland tributary to the Potomac River and forms by confluence of Rock Creek and Marsh Creek at the Pennsylvania-Maryland state line 25 miles north of Frederick, Maryland. The river flows for 57.1 miles generally in a southerly direction across the entire width of the State to the Potomac River near Dickerson, Maryland. The City and Fort Detrick intakes are located approximately 17 miles upstream from the mouth near Maryland Route 26.

The Monocacy watershed, a sub-basin of the Middle Potomac River basin, encompasses 774 square miles (476,200 acres), 75% of which is in the state of Maryland and 25% is in the state of Pennsylvania. The area of watershed above Fort Frederick's intake encompasses approximately 700 sq. miles (448,000 acres). The major tributaries of the Monocacy River above the Fort's intake are: Tom's Creek, Marsh Creek, Tuscarora Creek, Fishing Creek, Big Pipe, Little Pipe Creek, Piney Alloway Creek, and Israel Creek. The Monocacy River, which meanders through the Frederick Valley in a wide, shallow riverbed, is a slow flowing river with an average drop of 2.8 feet/mile from the Maryland-Pennsylvania border to its mouth.

The Monocacy River watershed is located in Piedmont and Blue Ridge Provinces. The rock formation that influences the river basin's geological history is intensely metamorphosed, or highly compact and crystalline. Three rock types are found in the western division: the Frederick Valley Region, the Triassic Upland Region and the Piedmont Upland Region. The lower part of the basin, the Frederick Valley Region, is characterized by easily erodible sedimentary rocks that have deep soils, shallow banked streams and gently rolling topography. Piedmont Upland Region contains more metamorphic material. In the river's upper watershed, the Triassic Upland Region has harder rock materials overlaying the softer limestones. This latter geological phenomenon has created some shallow, highly erodible soils (Maryland Scenic River Report, The Monocacy River Scenic River Local Advisory Board, May 1990).

B. Water Supply Development

The Fort Detrick water system consists of 4.25 MGD conventional water treatment plant, built in the 1940's with later addition and modifications. Conventional treatment includes coagulation, flash mixing, floeculation, sedimentation, filtration, and disinfection. The plant operates 24 hours a day and treats an average 1.3 MGD. An eight-foot wide inlet canal (with bars) and wet well provide flooded suction for the raw water pumps in the pump station. Raw water flows through a traveling screen which operates 15

minutes every two hours and pumps to the treatment plant. The treated water is pumped about two miles from the plant to the Fort Detrick distribution system. Chlorine, alum, sodium aluminate and powdered activated carbon are added to aid the treatment processes.

3.0 RESULTS OF SITE VISIT(S)

Water Supply Program personnel conducted a site survey of Frederick County water sources and other raw water facilities in order to accomplish the following tasks:

- To collect information regarding the locations of raw water sources and intakes by using Global Positioning System (GPS) equipment.
- To determine the general condition and structural integrity of intakes and other raw water facilities.
- To discuss source water issues and concerns with the County water system operators.
- To conduct a windshield survey of the watershed and to document potential problem areas. Additional tours of the watersheds were taken on follow-up visits.

Concerns and Site Observations

- The intake of Fort Detrick Water Treatment Plant is located on the bank of the Monocacy River consisting of a concrete channel with bar screen. A dyke (stone) was created in the river to direct the water to the intake during the periods of low flow.
- Six drying beds are located uphill of the intake, flooding or heavy rainstorms may cause sludge to enter the river from the drying beds.
- The sewer line and pump station upstream of the intake have experienced leakage in the past.
- Water treatment plant operators expressed concerns that possible discharges from a stone quarry cause elevated pH during the summer months.

4.0 WATERSHED CHARACTERIZATION

Source Water Assessment Area Delineation Method (Surface Water)

An important aspect of the source water assessment process is to delineate the watershed area that contributes to the source of drinking water. A source water protection area is defined as the whole watershed area upstream from a water plant's intake (MDE, 1999). Delineation of the source water area was performed by using ESRI's Arc View Geographic Information Software (GIS), utilizing existing GIS data, and by collecting location data using a Global Positioning System (GPS). GPS point locations were taken at the water source intake and differentially corrected (for an accuracy of +/-2 meters) at MDE. Once the intake location was established, the contributing area was delineated based on existing

Maryland Department of Natural Resources digital watershed data and Maryland State Highway Administration digital stream coverage. Digital USGS 7.5 topographical maps were also used to perform "heads up" digitizing, or editing, or watershed boundaries.

General Characteristics

The drainage area above the City of Frederick and Fort Detrick intakes on the Monocacy River encompasses approximately 700 square miles 448,000 acres of mixed land use with over 60% of cropland and pasture. Forested land, making up about 27% of the watershed, is the next most prevalent land cover. About 75% of the source protection area is located in Frederick and Carroll Counties of Maryland and 25% of the watershed is located in Adams County, Pennsylvania. Most of the forested land is located at higher elevation in the western part of the watershed and some wooded areas extend along the river corridor.

Land Use Characteristics

According to the Maryland Department of Planning's 1997 land use data, the following table shows the land use distribution in the Monocacy River watershed.

Table 4. Land Use Distribution in the Monocacy River Watershed.

Land Use	Total Area in Acres	Percent of Total Watershed
Residential	22967.49	7.6%
Commercial	2621.319	0.9%
Industrial	374.96	0.1%
Mining	914.398	0.3%
Urban Public Lands	764.165	0.3%
Cropland	164715.2	54.2%
Pasture	25464.178	8.4%
Orchards	1350.806	0.4%
Forest	82961.33	27.3%
Open Water	125.824	< 0.1%
Barren Land	53.374	< 0.1%
Concentrated Agriculture	1639.013	0.5%

Localized Characteristics

Fort Detrick does not own and maintain land in the watershed except a small portion of land around the intake structure and water treatment plant. The source protection area covers ten municipalities in Frederick and Carroll Counties of Maryland and two municipalities in Pennsylvania as listed below:

Maryland		Pennsylvania
Emittsburg	Union Bridge	Gettysburg
Frederick	Uniontown	Littlestown
New Windsor	Walkersville	
Taneytown	Westminster	
Thurmont	Woodsboro	

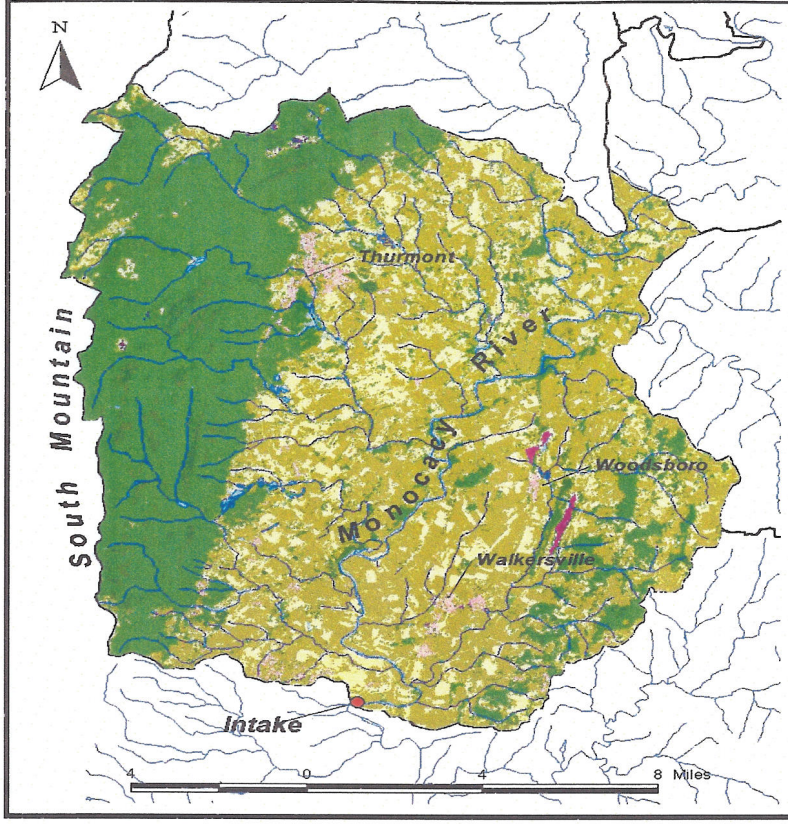
U.S. Highway 15 and State Highways 194, 26 and 140 are the major transportation corridors in the watershed.

Subwatersheds

Maryland Source Water Assessment Plan states that larger source water protection areas will be segmented into smaller subwatersheds to provide better assessment and identify watersheds of concern. The Monocacy watershed was segmented into five subwatersheds for this assessment. These subwatersheds are similar to the Maryland Department of Natural Resources (MD-DNR) 12 digit hydrologic unit codes. They were based on MD-DNR data and were edited by digital topographic maps. The following pages depict the five subwatersheds in the Monocacy River source water protection area.

MONOCACY - INTAKE

Total Area = **205** square miles

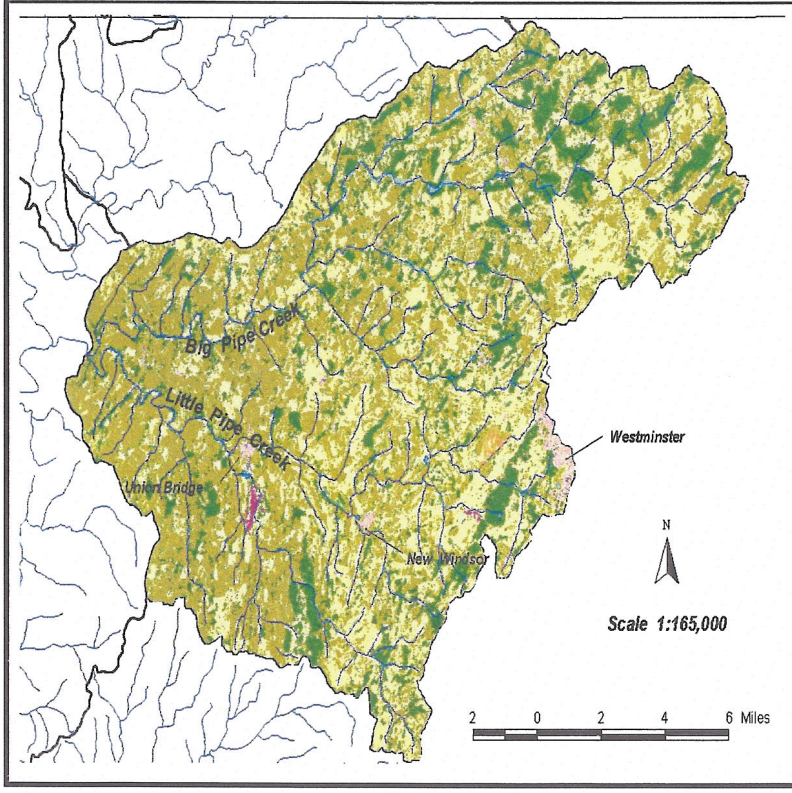


Land Use	Total Acres	% Watershed
Open Water	977	0.8
Residential	1556	1.2
Commercial/Industrial	219	0.2
Pasture/Hay	44906	34.5
Cropland	28608	22
Forested	52132	40.1
Wetlands	1416	1.1
Mined or Abandoned	226	0.2
Transitional	86	0.1
Total:	130126	100

This is the largest subwatershed in the basin and contains the greatest amount of land used for agriculture. Approximately 40% of the watershed is forested and lies in the higher elevation extending from northwest to southwest of the subwatershed. U.S.Highway 15 crosses through the western part of this sub-basin.

DOUBLE PIPE CREEK

Total Area = **191** square miles

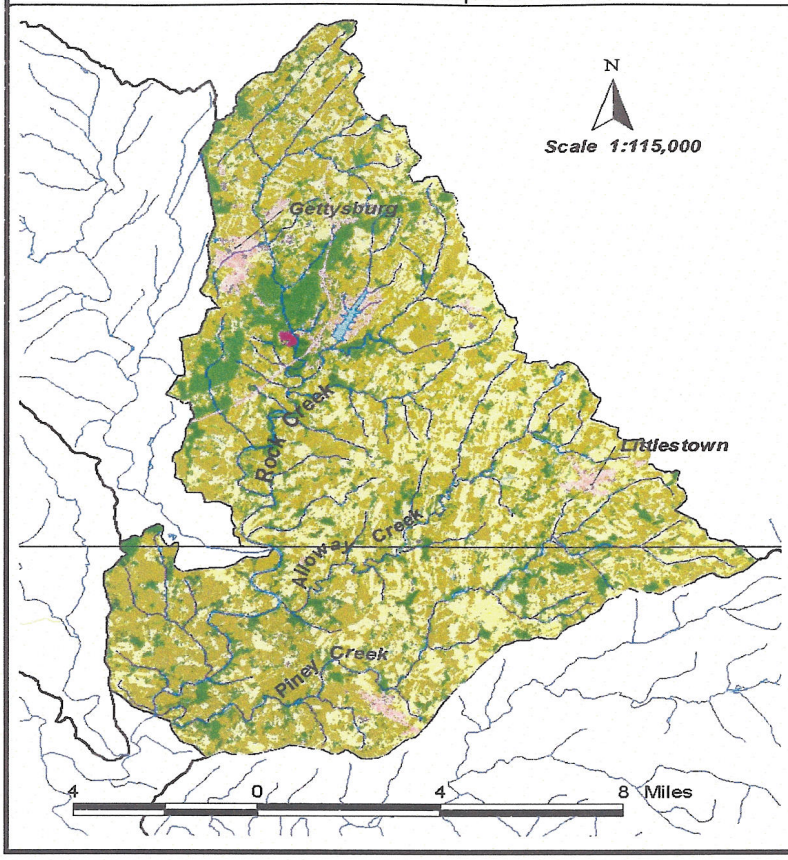


Land Use	Total Acres	% Watershed
Open Water	478	0.4
Residential	1223	1
Commercial/Industrial	139	0.1
Pasture/Hay	42995	35.5
Cropland	52865	43.7
Urban Parkland	187	0.2
Forested	21721	17.9
Wetlands	1306	1.1
Mined or Abandoned	163	0.1
Totals:	121076	100

This subwatershed has two main tributaries, Big Pipe Creek and Little Pipe Creek. Almost 80% of the land is used for pasture and cropland. A portion of the City of Westminster and Towns of New Windsor and Union Bridge are located in this sub-basin.

PINEY - ALLOWAY

Total Area = **137.5** square miles

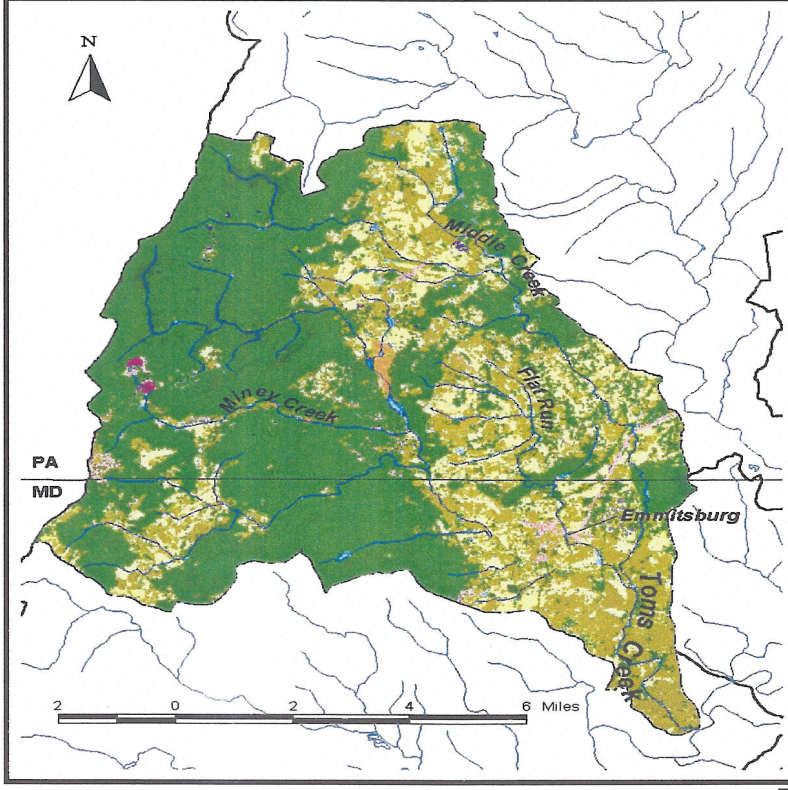


Land Use	Total Acres	% Watershed
Open Water	599	0.7
Residential	2373	2.7
Commercial/Industrial	404	0.5
Pasture/Hay	30990	35.6
Cropland	35564	40.8
Forested	15973	18.3
Wetlands	1192	1.4
Mined or Abandoned	69	0.1
Total:	87164	100

Two municipalities in Pennsylvania, the City of Gettysburg and City of Littlestown, are located in this subwatershed. One municipality in Maryland, the City of Taneytown, is located along Piney Creek. With approximately 2,777 acres of residential and commercial land, this sub-basin contains the highest percentage of urban area compared to the other basins. Agriculture is predominant land use in this subwatershed covering approximately 76% of Piney Alloway watersheds.

TOMS CREEK

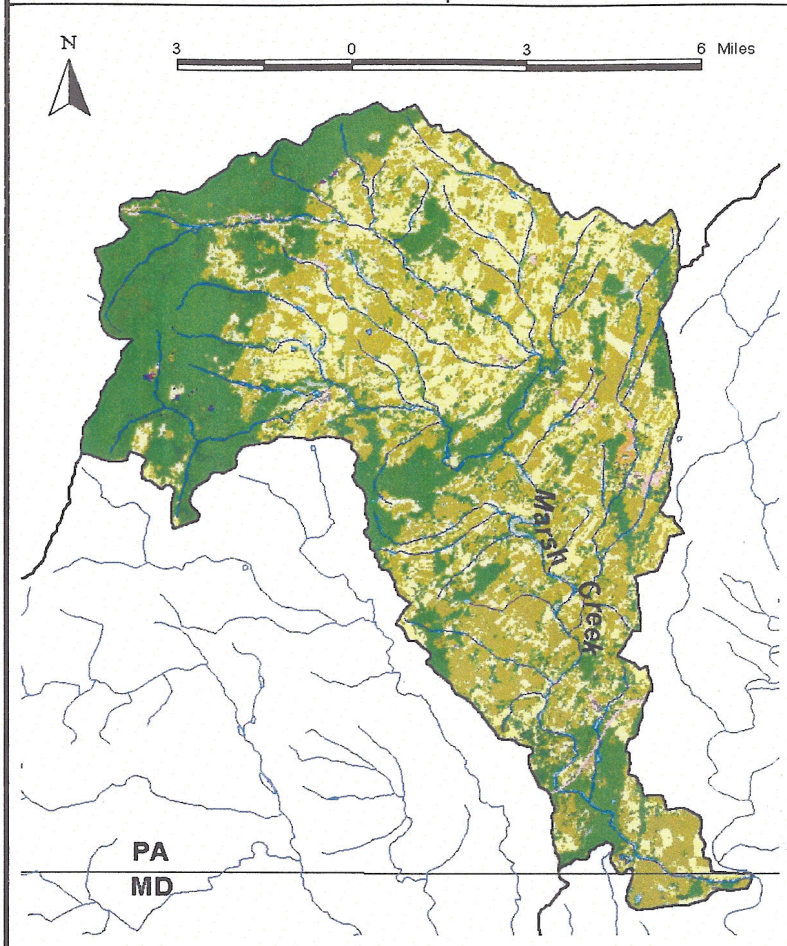
Total Area = **89** square miles



Land Use	Total Acres	% Watershed
Open Water	255	0.5
Residential	735	1.3
Commercial/Industrial	133	0.2
Pasture/Hay	9569	17
Cropland	11452	20.4
Urban Parkland	170	0.3
Forested	33214	59.1
Wetlands	532	0.9
Mined or Abandoned	54	0.1
Transitional	72	0.1
Total:	56185	100

With over 59% of forested land, this watershed is the most forested of the subwatersheds. The Town of Emmitsburg, Maryland is the only major municipality in this sub-basin. Over 50% of the watershed is within the southern part of Adams County, Pennsylvania.

MARSH CREEK	Land Use	Total Acres	% Watershed
Total Area = **80** square miles	Open Water	288	0.6
	Residential	448	0.9
	Commercial/Industrial	97	0.2
	Pasture/Hay	13577	26.7
	Cropland	16054	31.5
	Urban Parkland	59	0.1
	Forested	19271	37.9
	Wetlands	1054	2.1
	Transitional	48	0.1
	Total:	50896	100



The Marsh Creek subwatershed is the smallest in the basin. Marsh Creek and Rock Creek form the headwater of the Monocacy River and are located in Pennsylvania. The City of Gettysburg obtains its water from Marsh Creek. Water quality sampling station taken from the Monocacy River downstream of the confluence of Marsh Creek and Rock Creek indicate good water quality from these streams.

5.0 SIGNIFICANT SOURCES OF CONTAMINATION

Non-Point Pollution Sources

According to 1997 DOP land use data, 62.6% of the watershed is used for agricultural purposes (54.2% cropland, 8.4% pasture). As described above, land used to grow crops can be a source of nutrients (from fertilizer), synthetic organic compounds (from herbicides), and sediment load. Pastures used to graze livestock can be sources of nutrients and pathogenic protozoa, and viruses and bacteria from animal waste. Compared to most of the upper Potomac River, the Monocacy is more enriched in nutrients due to extensive agriculture and higher human and animal populations. High nutrient levels in the Monocacy River increase the growth of blue-green algae, a plant that thrives in a nutrient enriched environment. The decaying matter, as algae dies, decreases the availability of oxygen in the river, and algae growth increases the total organic carbon in the water. The reaction of organic carbon with disinfectants used in the water treatment process results in the production of disinfection-by-products in the treated water.

With 8.6% urban land use (7.6% residential, 0.9% commercial, 0.1% industrial) combined with 62.6% of the agricultural area in the watershed, sedimentation is another serious problem of the Monocacy River. On a per acre basis, the Monocacy watershed contributes sediment at more than twice the rate of all other watersheds draining into the Potomac upriver of Point of Rocks. The Monocacy also has numerous bends that may trap sediment over a period of time. This physiographic phenomenon possibly allows for a great deal of sediment to be stored in the river system (Monocacy. Scenic River Study & Management Plan, 1990).

The most common herbicides found in water samples used on row crops are atrazine, simazine and metalachlor. Levels are higher in late spring due to runoff events. Non-point sources of pathogenic organisms include urban and residential lands as well as pasture land. Runoff events carry the organisms to the river and higher levels would be expected following such storms.

Point Source Concerns

There are three major plants (WWTP), and several minor wastewater treatment plants (WWTP) that are located in the Monocacy River Source Water Assessment Area (SWAA). The three major plants include Westminster, Thurmont, and Gettysburg Municipal Authority. The total daily average flow from these three plants is 5.1 MGD. The total average daily discharge from all major and minor municipal wastewater treatment plants is approximately 7.4 MGD.

The flow of the Monocacy River near Fort Detrick's intake under low flow conditions (7 day once in 10 year occurrence) is 40.5 cubic feet per second (CFS),

or 26 MGD. Therefore, under low flow conditions treated effluent comprises approximately 27% of the river flow.

All of these major and minor facilities require Maryland or Pennsylvania discharge permits or NPDES permits to satisfy the regulatory requirements of the National Pollutant Discharge Elimination System (NPDES) established under the Federal Clean Water Act. Each discharge permit specifies limits for water quality criteria specific to the designated uses of the receiving surface water stream. The Monocacy River and tributaries in the SWAA are designated as USE IV-P-recreational trout waters and water supply. These facilities are regulated for total suspended solids, biochemical oxygen demand, phosphorous, total nitrogen, pH, dissolved oxygen and fecal coliform bacteria but are not directly regulated for the control of disinfectant resistant *giardia* and *cryptosporidium*, or pharmaceutical chemicals. Review of State compliance data indicates that currently the facilities are in compliance with the NPDES permits requirements. If a facility does not comply with the permit requirements, an enforcement action to correct the problem will be issued by the State.

Transportation Related Concerns

Major roads in the Monocacy River source water protection area include U.S. Route 15 extending from the south to the northern boundaries of the watershed, and a section of U.S. 30 in the northern most portion of the watershed. State Routes 194, 140 and 26 are also located in the watershed. The highest volumes of traffic occur on U.S. Highway 15 which crosses the Monocacy River's major tributaries at several locations. In addition to roads, there is also an extensive network of railways that cross and are adjacent to tributaries for considerable distances and may be of concern for spills. (See Fig. 3-A for location of transportation corridors).

Land Use Planning Concerns

A comparison between 1990 and 1997 Maryland DOP land use data shows changes in watershed land development. Land use percentages are shown below:

Table 5. Land Use Planning Concerns in Watershed Land Development in the Monocacy River Watershed

Land Use	Percent of Watershed in 1990	Percent of Watershed in 1997
Residential	5.4%	7.6%
Commercial	0.7%	0.9%
Industrial	< 0.1%	0.1%
Mining	0.3%	0.3%
Urban Public Lands	0.2%	0.3%
Cropland	55.2%	54.2%
Pasture	9.2%	8.4%
Orchards	0.4%	0.4%

Table 5 continued.

Forest	27.8%	27.3%
Open Water	0.1%	< 0.1%
Barren Land	0.1%	< 0.1%
Concentrated Agriculture	0.6%	0.5%

Trends in the Monocacy River's watershed land use are similar to trends in the rest of Frederick County. The increase in residential development is the most significant land use change over the period of seven years in the watershed and remains a main land use concern. Over 75% of the watershed is located in Maryland's Frederick and Carroll Counties. The Comprehensive Plan for Frederick County and Carroll County's Master Plan are planning tools that provide direction for accommodating desirable growth while maintaining the quality of life. An understanding of existing local land use and water resources management plan and related State and federal programs is an important component of the source water protection program.

6.0 REVIEW OF WATER QUALITY DATA

Several sources of water quality data were reviewed for all of the three source water assessment areas. These include MDE Water Supply Program's database for safe drinking water contaminants and monthly operating reports for the Fort Detrick Water Treatment Plant, Frederick County Health Department, United States Geological Survey and MD Department of Natural Resources.

Water quality data for all three water sources will be compared with Maximum Contaminant Levels (MCLs) set by the U.S. Environmental Protection Agency to ensure safe drinking water. If the monitoring data is greater than 50% of a MCL for at least 10% of the time, a detailed susceptibility analysis will be performed for that contaminant and its potential sources.

Existing Plant Data

Fort Detrick is required to perform water quality tests on the drinking water produced from its water treatment plant in order to ensure compliance with the EPA's Safe Drinking Water Act (SDWA) requirements. Fort Detrick is also required to submit monthly operating reports to MDE's Water Supply Program, which includes daily testing of some raw water quality parameters such as turbidity (cloudiness of water), alkalinity,and pH. Other plant data included in the Monthly Operating Report (MOR) reflects the quality of treated (finished) water. All contaminant detects from plant data (finished) and the years 2001 through 2004 raw water turbidity for Fort Detrick's plant are listed below.

Turbidity

A review of raw water turbidity for the Fort Detrick plant shows that the river is subject to occasional periods of high turbidity usually following high intensity

rains. Below is a summary of maximum, minimum and average values for turbidity from January 2001 through August 2004.

Table 6.1. Fort Detrick Plant Raw Water Turbidity 2001 - 2004

Monthly Average Turbidity for the Period from January 2001 through August 2004			
Month	**Max**	**Min**	**Average**
Jan	114	2	54.9
Feb	96	2	23.1
Mar	586	2	25.8
Apr	228	3	16.4
May	235	4	22.7
Jun	589	0	35.4
Jul	172	3	14.2
Aug	162	2	19.9
Sep	592	4	29.8
Oct	163	2	15.1
Nov	216	2	14.2
Dec	348	2	28.4

Fecal Coliform and Protozoa

MDE with cooperation of Fort Detrick Water Treatment Plant operators began the raw water monitoring program starting in September 2000. The raw water collected weekly and tested for fecal and E.coli until September 2002. Figure 6.1 shows the results in Most Probable Numbers/100 ml from September 2000 through August 2004. A strong seasonal pattern was evident during the first two years of the sampling program when weekly samples were collected. Higher concentrations were evident in the spring and summer with lower levels in winter and fall. In addition, Figure 6.2 depicts the correlation between the levels of fecal coliform and the rainfall intensity. Higher levels of fecal coliform occurs when the rainfall exceeds 0.5 inches or more.

MDE has completed a 3-year study to determine the occurrence and concentration of *Cryptosporidium* oocysts in the Potomac River and tributaries. *Cryptosporidium* is a water-borne parasite that has been implicated in public health. The Monacy River at the vicinity of the City of Frederick intake, which is approximately 100 yards upstream of Fort Detrick's intake, was selected as one of the sample sites. As part of this study, samples were collected for base flow and stormflow events. A total of four base flow samples were tested; two samples dated August 27, 2001 and October 24, 2001 tested negative, but two samples dated September 25, 2001 and November 5, 2001 tested positive with 3 and 1 oocysts/liter respectively.

Stormflow samples were taken during pre-peak and post-storm events. From the total of ten samples, eight samples tested positive and two samples tested negative for *Cryptosporidium.* The data shown below are sample results during each storm event. Peak storm concentrations were approximately an order of magnitude greater than base flow concentrations.

Table 6.2. Storm Event #1. *Cryptosporidium* Results.

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample Date	8/13/2001	8/13/2001	8/13/2001
Oocyssts/liter	Negative	36	48
Total No.	Negative	410	540
Viable/Infectious	NV	I.Genotype II	I.Genotype II

NV – Not Viable V-Viable I-Infectious
All samples were 3 gallons.

Table 6.3. Storm Event #2. *Cryptosporidium* Results.

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample Date	9/24/2001	9/25/2001	9/25/2001
Oocyssts/liter	Negative	21	3
Total No.	Negative	240	31
Viable/Infectious		V	V

Table 6.4. Storm Event #3. *Cryptosporidium* Results.

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample Date	No Pre	3/4/2002	3/5/2002
Oocyssts/liter		28	2
Total No.		321	21
Viable/Infectious		V.Genotype 2	V

Table 6.5. Storm Event #4. *Cryptosporidium* Results.

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample Date	3/21/2002	3/22/2002	No Post
Oocyssts/liter	Negative	26	
Total No.	Negative	297	
Viable/Infectious		V.Genotype 2	

Figure 6-1: Fort Detrick - Raw Water Coliform - Coliform Counts Below the Detection Limit are Plotted at 1/2 of the Detection Limit

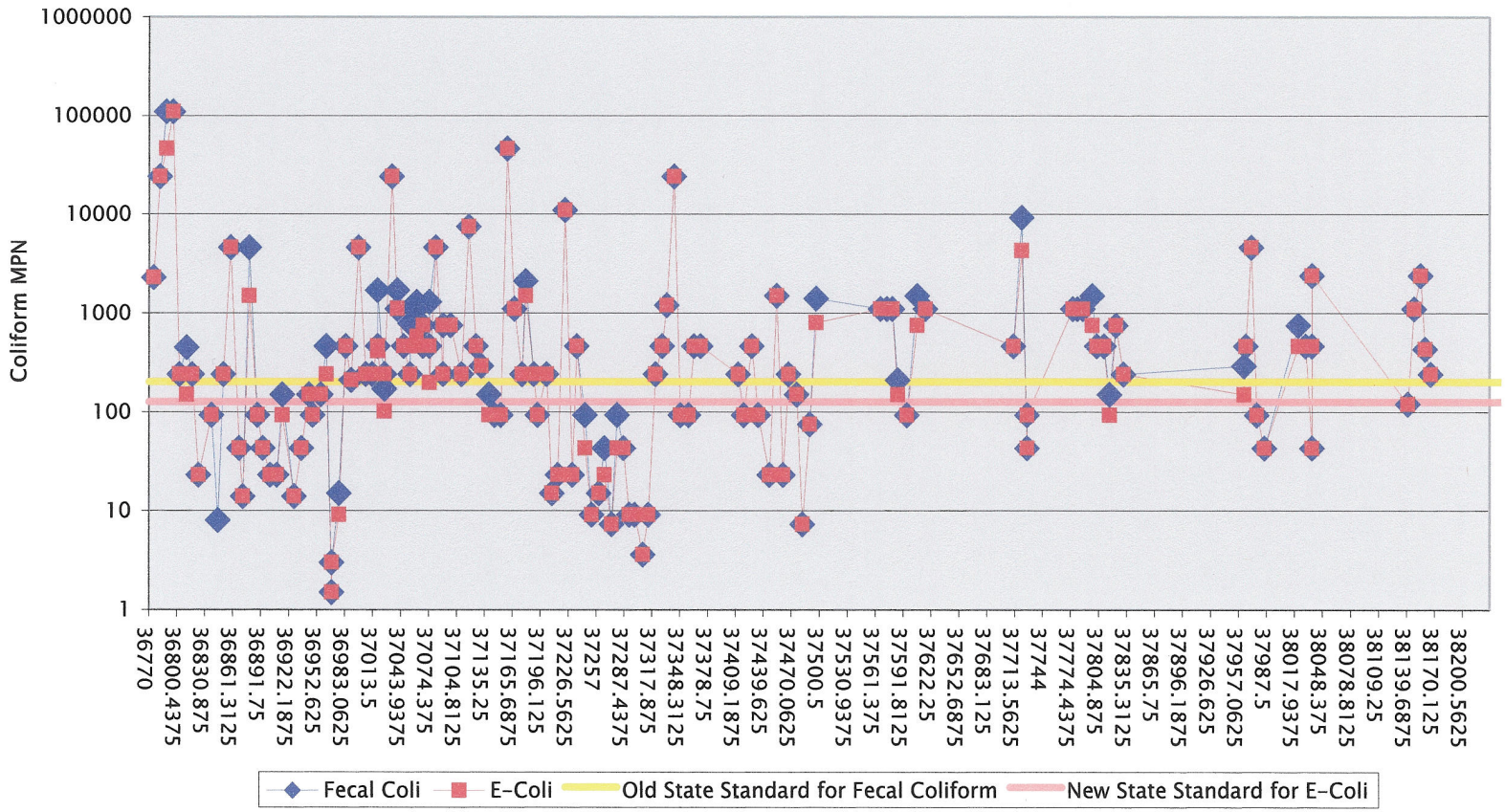
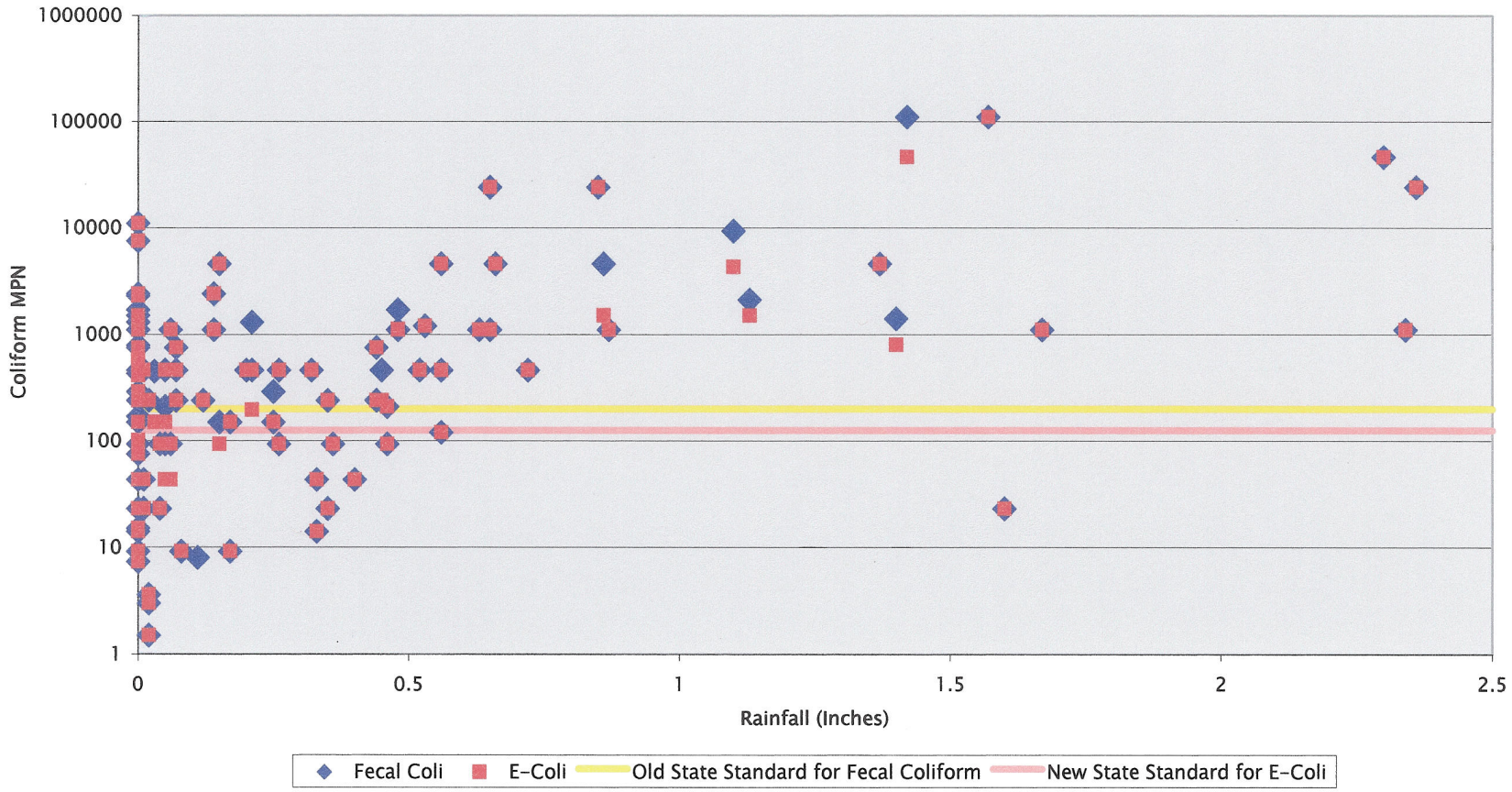


Figure 6-2: Coliform as a Function of a Three Day Rainfall Total Ending the Day of the Coliform Sample



Inorganic Compounds (IOCs)

Fort Detrick plant regularly tests for the presence of nitrate and other inorganic compounds. Below is a summary of testing results for IOCs detected in finished water. Fluoride is added during the treatment process; therefore, levels are not reflective of raw water conditions. No inorganic compounds exceeded MDE's criteria for a detailed susceptibility analysis.

Table 6.6. Testing Results for IOCs in Finished Water.

Contaminant Name	Sample Date	Result	MCL
BARIUM	08/02/1993	0.023	2
BARIUM	10/21/1993	0.28	2
BARIUM	06/28/1994	0.06	2
BARIUM	04/18/1995	0.023	2
BARIUM	04/22/1996	0.018	2
BARIUM	07/09/1996	0.043	2
BARIUM	07/19/2000	0.021	2
BARIUM	02/28/2001	0.025	2
BARIUM	11/25/2002	0.013	2
BARIUM	10/21/2003	0.026	2
BARIUM	04/12/2004	0.02	2
CALCIUM	07/09/1996	35.9	
CHLORIDE	07/09/1996	22	
CHROMIUM	06/28/1994	0.002	0.1
CHROMIUM	04/22/1996	0.001	0.1
COPPER	07/24/1995	0.006	1.3
FLUORIDE	08/02/1993	0.96	4
FLUORIDE	10/21/1993	1.05	4
FLUORIDE	06/28/1994	0.07	4
FLUORIDE	04/18/1995	0.05	4
FLUORIDE	07/19/2000	0.1	4
FLUORIDE	02/28/2001	0.1	4
LEAD	07/24/1995	0.003	0.015
MANGANESE	07/09/1996	0.018	
NITRATE	08/02/1993	3.6	10
NITRATE	10/21/1993	4.1	10
NITRATE	01/24/1994	5.2	10
NITRATE	05/02/1994	3.5	10
NITRATE	06/28/1994	2.9	10
NITRATE	02/07/1995	4	10
NITRATE	02/16/1995	4	10
NITRATE	04/18/1995	2.2	10
NITRATE	07/24/1995	1.6	10
NITRATE	04/22/1996	2	10
NITRATE	04/22/1996	2	10
NITRATE	07/09/1996	2.6	10
NITRATE	02/04/1997	3.1	10
NITRATE	01/21/1998	2.6	10
NITRATE	05/04/1998	1.7	10
NITRATE	03/23/1999	1.8	10
NITRATE	09/28/1999	3.2	10
NITRATE	03/23/2000	1.4	10

Table 6.6 continued

NITRATE	07/19/2000	2.3	10
NITRATE	02/28/2001	2.1	10
NITRATE	08/07/2001	2	10
NITRATE	03/20/2002	1.6	10
NITRATE	04/23/2002	0.9	10
NITRATE	11/25/2002	3.3	10
NITRATE	03/25/2003	2.5	10
NITRATE	04/22/2003	2	10
NITRATE	03/24/2004	1.8	10
NITRITE	02/07/1995	0.5	1
SELENIUM	10/21/1993	0.012	0.05
SODIUM	02/04/1997	12.2	
SODIUM	05/04/1998	8.9	
SODIUM	09/28/1999	15.3	
SODIUM	08/07/2001	14.3	
SODIUM	04/23/2002	13.7	
SODIUM	11/25/2002	11	
SODIUM	04/22/2003	11.1	
SODIUM	10/21/2003	12	
SODIUM	04/12/2004	11	
SULFATE	08/02/1993	37	
SULFATE	01/24/1994	33	
SULFATE	05/02/1994	43	
SULFATE	10/18/1994	44	
SULFATE	04/18/1995	36	
SULFATE	07/24/1995	39	
SULFATE	07/09/1996	42	
SULFATE	02/04/1997	38.1	
SULFATE	05/04/1998	39.3	
SULFATE	09/28/1999	42.1	
SULFATE	08/07/2001	35.2	
SULFATE	04/23/2002	45.6	
ZINC	07/09/1996	0.01	

Synthetic Organic Compounds (SOCs)

Samples are collected by MDE. Below is a summary of SOCs for the years 1995-2003, detected in finished water. Atrazine was detected eleven times during this period, none exceeding 50% of the maximum contaminant level. Di(2-ethylhexyl) Phthalate was detected twice exceeding 50% of MCL. A more detailed discussion of these findings will be covered in the susceptibility analysis.

Table 6.7. Testing Results for SOCs in Finished Water.

Sample Date	Contaminant Name	Result	Units	MCL	Is > 50% MCL?
05/22/1995	DALAPON	0.5	ug/L	200	
07/20/1998	DALAPON	0.26	ug/L	200	
05/04/1998	DALAPON	0.67	ug/L	200	
06/12/2000	DALAPON	2.34	ug/L	200	
06/12/2000	DALAPON	2.07	ug/L	200	

Table 6.7 continued

08/07/2001	DALAPON	0.58	ug/L	200	
04/22/2003	DALAPON	0.73	ug/L	200	
08/07/2001	DI(2-ETHYLHEXYL) ADIPATE	0.7	ug/L	400	
06/16/2003	SIMAZINE	0.14	ug/L	4	
07/28/2003	SIMAZINE	0.07	ug/L	4	
05/22/1995	DI(2-ETHYLHEXYL) PHTHALATE	1.24	ug/L	6	
07/18/1994	DI(2-ETHYLHEXYL) PHTHALATE	1.2	ug/L	6	
07/09/1996	DI(2-ETHYLHEXYL) PHTHALATE	0.8	ug/L	6	
06/12/2000	DI(2-ETHYLHEXYL) PHTHALATE	1	ug/L	6	
08/07/2001	DI(2-ETHYLHEXYL) PHTHALATE	5.5	ug/L	6	Yes
04/23/2002	DI(2-ETHYLHEXYL) PHTHALATE	3.5	ug/L	6	Yes
04/22/2003	DI(2-ETHYLHEXYL) PHTHALATE	1.2	ug/L	6	
07/18/1994	METOLACHLOR	0.2	ug/L		
07/09/1996	METOLACHLOR	0.4	ug/L		
07/24/1995	ATRAZINE	0.3	ug/L	3	
07/18/1994	ATRAZINE	0.1	ug/L	3	
05/02/1994	ATRAZINE	0.1	ug/L	3	
07/09/1996	ATRAZINE	0.5	ug/L	3	
05/04/1998	ATRAZINE	0.51	ug/L	3	
06/08/1999	ATRAZINE	0.27	ug/L	3	
07/23/2002	ATRAZINE	0.11	ug/L	3	
06/25/2002	ATRAZINE	0.49	ug/L	3	
06/16/2003	ATRAZINE	0.37	ug/L	3	
07/28/2003	ATRAZINE	0.26	ug/L	3	
06/16/2003	ATRAZINE	0.37	ug/L	3	
06/12/2000	2,4-D	0.23	ug/L	70	
04/22/2003	2,4,5-T	0.16	ug/L		
06/12/2000	PENTACHLOROPHE	0.05	ug/L	1	

Volatile Organic Compounds (VOCs)

No volatile organic compounds other than disinfection by-products were detected in the water leaving the Fort Detrick Water Treatment Plant. Compliance with the disinfection by-product rule is determined by levels in the distribution system. Data shown from distribution samples collected in 2002-2004 are shown below. These data indicate that changes will be needed at the Monocacy Plant for the facility to consistently meet the current standards of 80.0 Mg/L for total THM and 60.0 Mg/L for HAA at all locations.

Table 6.8. Quarterly Average Concentrations of DBPs from 2002 through 2004

Quarter	THM				HAA			
	Average	Max	Min	Count	Average	Max	Min	Count
Jan-Mar	19.30	27.48	11.11	2	31.22	63.92	11.95	3
Apr-Jun	44.81	63.60	27.00	6	21.02	36.20	11.60	3
Jul-Sep	86.44	174.42	48.70	5	51.15	65.35	33.20	3
Oct-Dec	94.22	113.45	74.99	2	53.33	53.43	53.23	2
Total	61.87	174.42	11.11	15	37.89	65.35	11.60	11

Table 6.9. Annual Average Concentrations of DBPs from 2002 through 2004

Year	THM				HAA			
	Average	Max	Min	Count	Average	Max	Min	Count
2002	78.02	174.42	27.48	4	46.88	63.92	15.25	4
2003	59.06	113.45	11.11	4	41.68	65.35	11.95	4
2004	54.26	76.90	27.00	7	20.87	33.20	11.60	3
Total	61.87	174.42	11.11	15	37.89	65.35	11.60	11

DNR Watershed Data

The Maryland Department of Natural Resources has collected monthly data for several parameters from three water quality sampling stations in the Monocacy River watershed from 1991 through 1996. The two stations are located on the main stem of the Monocacy River, Bridgeport Bridge on MD 97 and the Monocacy River bridge on Miggs Ford Road. The third station is located at Big Pipe Bridge on Biggs Ford Road. The following table is a statistical summary of data collected from each station from 1991-1996.

Table 6.10. Statistical Summary Data from Monocacy River Basin.

Station	Parameter	Minimum Concentration (mg/l)	Maximum Concentration (mg/l)	Avg. Concentration (mg/l)
MON0269 Monocacy River on Biggs Ford Road	Ammonia (NH4)	0.008	0.341	0.047
	Chlorophylla	0.199	20.783	2.090
	Dissolved Oxygen	5.500	14.780	9.739
	Phosphorous	0.007	0.412	0.081
	Nitrate	1.000	4.300	2.495
	Total Nitrogen	1.750	6.900	3.146
	Total Organic Carbon	1.890	9.280	4.418
MON0528 Monocacy River on MD Rt. 97	Ammonia (NH4)	0.008	0.302	0.052
	Chlorophylla	0.112	13.457	2.388
	Dissolved Oxygen	4.600	15.580	9.378
	Phosphorous	0.014	0.310	0.075
	Nitrate	0.020	4.700	1.503
	Total Nitrogen	0.070	6.000	2.179
	Total Organic Carbon	2.500	10.160	5.461
BPC0035 Big Pipe Bridge on Biggs Ford Rd.	Ammonia (NH4)	0.008	0.346	0.040
	Chlorophylla	0.199	99.281	6.286
	Dissolved Oxygen	6.390	14.790	10.203
	Phosphorous	0.004	0.646	0.052
	Nitrate	2.00	5.296	3.460
	Total Nitrogen	2.400	7.510	4.024
	Total Organic Carbon	1.390	14.640	3.467

7.0 SUSCEPTIBILITY ANALYSIS

Each class of contaminants that were detected in the water quality data have been analyzed to determine the potential they have to contaminate Fort Detrick's raw water sources. The analysis has identified suspected sources of contaminants, evaluated the natural condition of the watershed, increase or decrease the likelihood of a contaminant entering the raw water, and the impact that future changes may have on the susceptibility of Fort Detrick's water supply source (Monocacy River).

Turbidity and Sediment

Average monthly turbidity for the period from January 2001 through August 2004 fluctuated between 14.2 NTU and 54.9 NTU and the highest maximum of 592 NTU was recorded for the month of September. High levels of turbidity occur during rainfalls and snowmelts. Excessive turbidity can interfere with water treatment and can carry harmful microorganisms into drinking water supplies.

Sedimentation, the movement of solids such as soil, minerals and sand in water, is the most serious problem of the Monocacy River. The Monocacy River watershed contributes sediment at more than twice the rate of other land draining into the Potomac upriver of Point of Rock (Monocacy Scenic River Study and Management Plan, May 1990). Based on data collected at the plant's intake and by others, it is clear that Fort Detrick's intake is susceptible to excessive turbidity.

Inorganic Compounds

Several inorganic compounds (IOC) have been detected below the maximum contaminant level in finished water from the Monocacy River Water Treatment Plant. Nitrate was the most common IOC detected with only one result exceeding 50% of the MCL at a concentration of 5.2 PPM. Based on the available data, Fort Detrick's intake is not susceptible to inorganic compounds regulated under the Safe Drinking Water Act.

Synthetic Organic Compounds (SOCs)

There are several SOC detects at the Fort Detrick Water Treatment Plant, but all results are less than 50% of MCL, with the exception of di(2-ethylhexyl) Phthalate. Atrazine was the most common SOC detected but no results exceeded 50% of the MCL.

The two detections of di(2-ethylhexyl) Phthalate over 50% of the MCL were reported as unreliable on the lab sheet and was not detected in a subsequent sample. Its prevalence in plastics makes it a hard compound to sample and test. This compound was reported in corresponding laboratory blanks; therefore, reported quantities are not likely reflective of levels in the environment but rather laboratory artifacts.

Atrazine can enter the Monocacy River following springtime herbicide application. A review of triannual pesticide usage surveys compiled by the Maryland Department of Agriculture shows that the usage of atrazine has declined in Frederick County in the past ten years. Given the reduced usage rate and the steady conversion of cropland to residential land, it is unlikely that atrazine concentration will increase in the future. However, it is important to continue monitoring for atrazine concentration in finished water in order to track the trend of this compound in water supply. As no synthetic organic compounds were found at significant levels of concern, the water system is not considered susceptible to regular contamination of synthetic organic compounds. Given the significant amount of human activity in the watershed, it is quite conceivable that spills or intentioned discharge of organic contaminants may occur in the watershed and affect the water supply.

Disinfection Byproducts

Trihalomethanes (THMs) and Haloacetic acids (HAAs) both exceeded 50% of MCL from water treated at the Fort Detrick Plant. In some samples, concentrations were well in excess of maximum contaminant levels. The Disinfection Byproducts Rule (DBPR) establishes MCLs based on average concentrations for the most common and well-studied halogenated DBPs: total trihalomethane (TTHMs) and five of the nine haloacetic acids (HAAs) as well as bromate and chlorite. TTHM is defined as the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane; HAA is defined as the sum of mono-, di-, and trichloroaceticaeids, and mono- and dibromacetic acids. The MCLs for the disinfection byproducts are shown below:

Table 7.1. Disinfection Byproducts MCLs.

Total Trihalomethanes (TTHMs)	0.080 mg/l
Haloacetic Acids (HAAs)	0.060 mg/l
Bromate	0.060 mg/l
Chlorite	1.0 mg/l

In addition to MCLs, the DBPR requires the use of treatment techniques to reduce DBP precursors and to minimize the formation of unknown DBPs. It requires that a specific percentage of influent total organic carbon (TOC) be removed during treatment. The treatment technique uses TOC as a surrogate for natural organic natter (NOM), the precursor material for DBPs. A TOC concentration of greater than 2.0 mg/l in a system's raw water is the trigger for implementation of the treatment technique. Required removal of TOC by enhanced coagulation for plants using conventional treatment is shown in the table below:

Table 7.2. Required Removal of TOC by Enchanced Coagulation for Plants Using Conventional Treatment.

Source Water TOC (mg/l)	Source Water Alkalinity (mg/l as CaCo3)		
	0-60	>60 to 120	>120
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

We evaluated almost one year of data from the Fort Detrick water plant (from January 2004 to October 2004). As the average source water alkalinity was between 60 and 120 md/l, the plant removed the required percentage of TOC for most months (all but August and October). Fort Detrick should continue monitoring for TOC in the raw and finished water to optimize its operations for compliance with the DBP Rule.

Table 7.3. Fort Detrick TOC Removal for 2004.

Date	TOC (mg/L)		Percent Removal	Quarterly Average Removal
	Raw	Treated		
6-Jan-2004	3.1	1.3	58%	
24-Mar-2004	1.8	1.1	39%	48%
12-Apr-2004	1.7	1	41%	
4-May-2004	5	1.9	62%	
22-Jun-2004	2.3	1.5	35%	46%
12-Jul-2004	2.4	1.6	33%	
11-Aug-2004	2.5	2	20%	
27-Sep-2004	2.5	1.8	28%	27%
12-Oct-2004	2.1	1.9	10%	10%

Over 90% of the source water assessment area for the Monocacy River intake consists of agricultural and forested lands which are the major sources of THM precursors. The runoff from these areas contribute to the delivery of particulate and dissolved organic matter to the Monocacy River. A review of data collected by DNR from three quality sampling stations in the Monocacy River watershed indicates that the level of chlorophylla concentration is higher during the summer months. This is often related to algae growth due to nutrients enriched runoff from the watershed. Higher algae levels contribute to increased disinfection by product precursors and algae cells are significant contributors to THMs should they be reacted with chlorine prior to removal by filtration. The concentration of algae in fresh water is controlled by phosphorus. Therefore, the susceptibility of the Fort Detrick intake to disinfection by products is affected by both natural organic matter and phosphorus present in the Monocacy River.

Microbial Contaminants

The consistent presence of fecal coliform bacteria in the Monocacy River indicates susceptibility to pathogenic microorganisms. A sampling program being carried out by Fort Detrick for fecal bacteria shows that the values for the Monocacy River periodically exceeded the level of 200 MPN/100 ml as required by the previous State water quality standard for the Monocacy River. The new standard for the Monacacy River and other state-designated recreational trout and water supply sources is currently set for E.coli at 126 MPN/100 ml. As substantial numbers were found under various flow conditions, this probably reflects input from both point sources (sewage treatment plants) and non point sources (urban and agricultural runoff). Recent data is not available within the various subwatersheds of the Monocacy to identify differences in levels. Historical data in the Double Pipe Creek watershed indicates similar and higher levels than those measured at the Fort Detrick Plant. The upper Monocacy River mainstem was listed for impairment by fecal coliform bacteria based on data collected at two long-term monitoring stations from 1995 to 1999.

Giardia and *cryptosporidium* are fairly common in surface water and associated with human and animal waste, including cattle (particularly high numbers from infected young calfs), sheep, horses, birds, pets and various wildlife species such as deer, raccoons, opossums, rabbits, rats and squirrels. Like most all surface water supplies, the water intake is susceptible to contamination by *giardia, cryptosporidium* and other pathogens. Sampling data from MDE's study indicates that highest fecal and *cryptosporidium* levels are associated with stormwater runoff (See Tables 6.2, 6.3, 6.4 and 6.5).

Consistency with Clean Water Act Findings

The findings of this source water assessment are in general agreement with the impairments designated in the state's findings under the Clean Water Act. The Upper Monocacy River has been designated as impaired for excessive sediment, nutrients, pathogens and low biological integrity. Total Maximum Daily Loads (TMDLs) are being developed for the watershed to address these impairments.

8.0 RECOMMENDATIONS FOR SOURCE WATER PROTECTION PLAN

This report is compiled based on the existing and available data from several sources. It provides general information as a first step towards establishing and implementing source water protection plans for the Fort Detrick Monocacy source. Additional data may be needed to further understand the areas delineated for specific source protection goals. The following is a list of recommendations regarding watershed management for the Monocacy River Watershed above the City of Frederick and Fort Detrick intakes.

- Fort Detrick and the City of Frederick should participate in the Upper Potomac Tributary Team's regular meetings to introduce drinking water issues and concerns.

- Fort Detrick should become an active member of Potomac River Basin Drinking Water Source Protection Partnership, interested in development and implementation of strategies to protect Potomac River as drinking water source.
- Establish communication procedures with the wastewater treatment plants located above the two intakes to notify sewage overflow or other treatment problems concerning all of the major and minor plants in the watershed.
- Erect road signs in strategic locations to alert the public that they are entering a drinking water supply watershed.
- Continue monitoring for fecal coliform and E.coli for raw water.
- In cooperation with DNR, Frederick County and the City of Frederick, conduct ongoing monitoring for algae and/or indicators of algae bloom in the Monocacy River.
- Fort Detrick and the City of Frederick should periodically conduct their own detailed field survey of the watershed to ensure there are no new sources of contaminants.
- Work with Frederick County Soil Conservation District to develop projects to reduce pathogens and nutrients from animal waste from entering upstream tributaries. Stream fencing projects are particularly helpful.

- Fort Detrick should become an active member of Potomac River Basin Drinking Water Source Protection Partnership, interested in development and implementation of strategies to protect Potomac River as drinking water source.
- Establish communication procedures with the wastewater treatment plants located above the two intakes to notify sewage overflow or other treatment problems concerning all of the major and minor plants in the watershed.
- Erect road signs in strategic locations to alert the public that they are entering a drinking water supply watershed.
- Continue monitoring for fecal coliform and E.coli for raw water.
- In cooperation with DNR, Frederick County and the City of Frederick, conduct ongoing monitoring for algae and/or indicators of algae bloom in the Monocacy River.
- Fort Detrick and the City of Frederick should periodically conduct their own detailed field survey of the watershed to ensure there are no new sources of contaminants.
- Work with Frederick County Soil Conservation District to develop projects to reduce pathogens and nutrients from animal waste from entering upstream tributaries. Stream fencing projects are particularly helpful.

REFERENCES

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MDE, Water Supply Program, 1999, Maryland's Source Water Assessment Plan (SWAP).

Maryland Pesticide Statistics for 1997, 1994, 1991-1988 and 1985, Maryland Department of Agriculture.

Middle Potomac River Basin Environmental Assessment of Stream Conditions, December 1998, Maryland Department of Natural Resources (MDNR).

Monocacy River Scenic River Study and Management Plan, 1990.

Piney Alloway Creek's Targeted Watershed Project Summary Report, 1990-1997, August 1999, MDNR.

Water Quality Trends in Big Pipe Creek During the Double Pipe Creek Rural Clean Water Program, John L. McCoy and Robert M. Summers, Proceedings of National RCWP Symposium 1992.

OTHER SOURCES OF DATA

EPA's Guidance Manual for Source Water Assessments.
MDE NPDES Permits
MDE Waste Management Sites Database
MDE Water Supply Inspection Reports.
MDE Water Supply Oracle Database.
Fort Detrick Water Treatment Plant Monthly Operating Reports (MORs) and Self-Monitoring Reports.