SOURCE WATER ASSESSMENT

for

Freedom District Water System

Prepared by
Maryland Department of the Environment
Water Management Administration
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EXECUTIVE SUMMARY

The 1996 Safe Drinking Water Act Amendments require each state to develop and implement source water assessment programs to evaluate the potential for contaminants to affect the sources of all public drinking water systems. The Freedom District water system's raw water source is Liberty Reservoir, which is also one of three reservoirs that serve the Baltimore Metropolitan area. A Source Water Assessment for Liberty Reservoir was completed by Gannett Fleming, Inc. in April 2003 for Maryland Department of the Environment (MDE) and the City of Baltimore. (See Appendix A) The assessment report describes the watershed characteristics, maps, potential sources of contamination, reviews water quality data from the reservoirs, analyzed the susceptibility of the source and makes recommendations for a source water protection plan. The Liberty report should be considered as an integral part of the source water assessment for the Freedom District Water Treatment Plant.

Freedom District water withdrawals from Liberty Reservoir vary depending on the demand for water. The water treatment plant treats an average of 2.2 million gallons per day. The Carroll County Commissioners have an agreement with the City of Baltimore that authorizes the County to withdraw an average of 2.4 mgd and a maximum of 90 million gallons over a 30-day period (3.0 mgd).

The susceptibility of the Freedom District watershed is very similar to that described in the Liberty Reservoir Watershed Assessment report. Based on water quality data from the operation of the Freedom District water plant and the Liberty Reservoir watershed assessment, the water supply for Freedom District is susceptible to dissolved solids, chlorides, disinfection by-product precursors, nutrients (particularly phosphorus), and spills in the tributaries feeding the reservoir. Like all surface water sources, protozoas, viruses and bacteria and turbidity are significant concerns.

In addition to the recommendations listed in the Liberty Reservoir Watershed Assessment, specific recommendations regarding watershed management particularly relevant to the location of the Freedom District intake are explained in Section 9 of this report and should be considered for implementation.

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. The assessment does not address the treatment process 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 for the Freedom District's surface water source (Liberty Reservoir). The assessment of the County's ground water source (Fairhaven well) is covered in a separate report. MDE looked at many factors to determine the vulnerability 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 DEVELOPMENT OF WATER SUPPLY

The Freedom District water system's service area is located in southeastern Carroll County and covers approximately 9,167 acres which include the Town of Sykesville (Carroll County Master Plan for Water and Sewerage). Carroll County owns and operates Freedom District Water Treatment Plant serving an estimated population of 23,000 people.

The Freedom District water plant is located at the end of Oakland Road near the eastern bank of Liberty Reservoir. This facility treats water from Liberty Reservoir, which is owned by Baltimore City. The plant was constructed in 1969 and upgraded in 1978 and 1996. With a design capacity of 3.0 million gallons per day (mgd), the plant operates 24 hours per day, treating an average of 2.2 mgd. Treatment consists of coagulation, solids contact clarification, continuous backwash filter, diatomaceous earth filtration and disinfection. The water treatment plant is connected to an extensive distribution network to serve the entire service area.

3.0 DESCRIPTION OF SURFACE SOURCE

The raw water source is Liberty Reservoir, which is owned by the City of Baltimore. The Carroll County Commissioners have an agreement with the City of Baltimore to purchase water for the Freedom District area from the Liberty Reservoir water supply. This agreement authorizes the County to withdraw an average of 2.4 million gallons per day (mgd) and a maximum of 90 million gallons over a 30-day period (3.0 mgd).

Liberty Reservoir is located on the North Branch of the Patapsco River on the boundary between Baltimore and Carroll counties. It collects water from a 163.8 square mile watershed that includes eastern Carroll County and southwestern Baltimore County (Gannett Fleming, Inc., 2003).

Liberty Reservoir is also one of the main sources of water supply for the City of Baltimore's water treatment plants. Together with Prettyboy and Loch Raven reservoirs, Liberty Reservoir provides water for about 1.8 million people living in Baltimore City and Anne Arundel, Baltimore, Carroll, Harford and Howard counties. A source water assessment for Liberty Reservoir was completed by Gannett Fleming, Inc. in April, 2003 for MDE and the City of Baltimore. A copy of the assessment report that includes information regarding watershed characterization, potential sources of contamination, review of water quality data, susceptibility analysis and recommendations for a source water protection plan is attached and should be considered as an integral part of the source water assessment for the Freedom District Water Treatment Plant. Additional water quality data (raw and finished water from the water treatment) was reviewed to complete this assessment.

4.0 RESULTS OF SITE VISITS

Water Supply Program conducted a site survey of the Freedom District water sources and other facilities in order to accomplish the following tasks:

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

4.1 Intake Integrity/Description

The water treatment plant receives water by way of a floating surface water intake on Liberty Reservoir. Raw water is pumped through two 300-foot long, ten-inch diameter pipes; both are supported by sixteen pairs of spherical floats. Two pumps are located submerged within a stainless steel enclosure, and the level of the intake is adjusted by adding a section of pipe (manually) as needed. The two 10-inch ductile iron pipes with flexible joint were installed in 1969. There were no apparent problems noted during our site visit. Two submersible pumps with a capacity of 75 Horse Power (HP) and 50 HP respectively, were in good working

condition. According to the operators, the 50 HP pump was to be upgraded to 75 HP in order to keep up with high water demands. The spherical floats (buoys) are replaced when necessary.

4.2 Operator Concerns and Field Observations

Algae blooms during late summer months is one of the major concerns of the operators. The levels of the intake pumps require adjustment during periods of aquatic growth in the reservoir. High algae counts greatly reduce the efficiency of the treatment system and can lead to objectionable tastes and odors. Trihalomethane (THM) levels in the distribution system during the summer and fall were occasionally higher than the maximum contaminant level (MCL) due to the higher level of disinfection byproduct precursors and/or warmer temperatures. Because compliance with the standard is based on running annual averages, the high individual sample results have not resulted in MCL violations. Manganese levels in the raw water also lead to increased operational expense and decreased plant efficiency.

Water treatment plants' clarifier sludge and spent backwash water flow into a sludge lagoon. Supernatant from the lagoon is pumped to a settler, whereas solids are pumped to a filter press. Filtrate from the press goes to the settler. Filtrate from the settler flows back to Liberty Reservoir. Solids from the press and from the settler are hauled to a landfill. At the location where the filtrate discharges back to the reservoir, bank erosion causes additional sediment to flow into the reservoir.

An on-site septic system is located above the intake at the vicinity of the water plant to collect wastewater from floor drains and other building facilities. In the same area a 2,000 gallon above ground fuel tank for an emergency generator is installed without a containment structure.

5.0 WATERSHED CHARACTERIZATION

Please refer to Liberty Reservoir Source Water Assessment.

6.0 POTENTIAL SOURCES OF CONTAMINATION

Please refer to Liberty Reservoir Source Water Assessment.

Any potential contamination sources along Route 26 and any potential sources within the small drainage basins that feed into the southern most portion of Liberty Reservoir are downstream of the Freedom District intake. While included in the Liberty Reservoir Source Water Assessment, they do not apply to the Freedom District intake.

7.0 REVIEW OF WATER QUALITY DATA

In addition to an extensive water quality data review conducted by Gannett Fleming, Inc. for Liberty Reservoir Watershed Assessment, Section 7 (Appendix A), Freedom District Water Treatment Plant's data are also reviewed and summarized as below.

7.1 Existing Plant Data

Carroll County is required to perform water quality tests on the drinking water produced from Freedom District plant in order to ensure compliance with the EPA's Safe Drinking Water Act (SDWA) requirements. The County 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. The County also participated in the sampling of its raw water for fecal coliform and e.coli. Other plant data included in the Monthly Operating Report (MOR) reflect the quality of treated (finished) water. Detects from the plant data (finished water) and the raw water turbidity and pH for years 2001 and 2002 are discussed below.

7.1.1 Raw Water Turbidity and pH

Review of turbidity of pH of raw water at the water treatment plant during years of 2001 and 2002 indicates that the reservoir turbidity is consistently below 2.0 nephelometric turbidity units (NTU). This consistently low turbidity reflects the benefit of the reservoir as a treatment zone prior to the intake. The pH of the reservoir is relatively stable. However, the increased pH observed during the growing season is indicative of the effect from algal and aquatic growth. The average value of 2001 and 2002 is 7.96 which is within the 6.5-8.5 secondary standard for drinking water.

Below is a summary of Average, Maximum and Minimum values for turbidity and pH during the years 2001 and 2002.

	Turbidity (NTU)			pH		
Month	Average	Min	Max	Average	Min	Max
January	1.84	1.1	2.9	7.48	7.2	7.7
February	1.82	1.3	2.6	7.52	7.2	7.9
March	1.98	1.3	2.5	7.57	7.2	7.9
April	1.65	1.3	2.4	7.58	7.3	8.3
May	1.41	1.0	2.0	7.95	7.4	8.6
June	0.87	0.5	1.4	8.12	7.6	8.5
July	0.70	0.5	0.9	8.39	7.9	8.9
August	1.05	0.7	1.7	8.99	8.3	9.3
September	1.49	1.1	2.1	8.80	7.8	9.3
October	1.52	0.8	7.9	7.89	7.5	8.5
November	1.85	0.8	3.6	7.67	7.4	7.9
December	1.83	0.8	3.2	7.62	7.3	7.9
Overall	1.50	0.5	7.9	7.96	7.2	9.3

7.1.2 Inorganic Compounds (IOCs)

Freedom District Water Treatment Plant regularly tests for presence of nitrates and other inorganic compounds in finished drinking water. Below is a summary of testing results for IOCs detected in finished water. No IOCs exceeded 50% of any MCL in the treated or raw

water. Fluoride is added during the treatment process; therefore, levels are not reflective of raw water conditions.

Contaminant	Sample Date	Result Units	MCL
BARIUM	11/13/96	0.02 mg/L	2
BARIUM	10/20/99	0.02 mg/L	2
BARIUM	11/20/99	0.02 mg/L	2
BARIUM	9/22/00	0.022 mg/L	2
FLUORIDE	2/10/94	0.92 mg/L	4
FLUORIDE	6/1/95	1.8 mg/L	4
FLUORIDE	4/2/96	0.46 mg/L	4
FLUORIDE	11/13/96	1.2 mg/L	4
FLUORIDE	8/4/97	1.16 mg/L	4
FLUORIDE	5/12/98	0.8 mg/L	4
FLUORIDE	4/5/99	0.13 mg/L	4
FLUORIDE	10/20/99	1 mg/L	4
FLUORIDE	11/20/99	1 mg/L	4
FLUORIDE	9/22/00	0.8 mg/L	4
FLUORIDE	10/8/01	0.8 mg/L	4
FLUORIDE	12/10/01	0.78 mg/L	4
FLUORIDE	9/5/02	1 mg/L	4
FLUORIDE	9/25/02	0.98 mg/L	4
NITRATE	2/4/93	2.8 mg/L	10
NITRATE	10/11/93	4.76 mg/L	10
NITRATE	11/10/93	2.55 mg/L	10
NITRATE	1/5/94	2.56 mg/L	10
NITRATE	2/1/95	3.12 mg/L	10
NITRATE	6/8/95	2 mg/L	10
NITRATE	4/2/96	2.2 mg/L	10
NITRATE	9/18/96	3.1 mg/L	10
NITRATE	11/13/96	2 mg/L	10
NITRATE	8/4/97	2.5 mg/L	10
NITRATE	5/12/98	2.6 mg/L	10
NITRATE	12/17/98	1.8 mg/L	10
NITRATE	12/17/98	1.8 mg/L	10
NITRATE	4/5/99	0.95 mg/L	10
NITRATE	10/20/99	1.3 mg/L	10
NITRATE	11/20/99	1.3 mg/L	10
NITRATE	12/7/00	1.3 mg/L	10
NITRATE	10/8/01	1.3 mg/L	10
NITRATE	12/10/01	1.5 mg/L	10
NITRATE	9/25/02	0.6 mg/L	10
NITRATE	10/7/02	1.1 mg/L	10
NITRATE	10/7/02	1.1 mg/L	10
NITRATE	1/2/03	1.4 mg/L	10
NITRITE	6/8/95	0.002 mg/L	1
NITRITE	8/4/97	0.003 mg/L	1
SELENIUM	4/5/99	0.007 mg/L	0.05

SODIUM	11/13/96	10 mg/L
SODIUM	8/4/97	16.7 mg/L
SODIUM	5/12/98	15.4 mg/L
SODIUM	4/5/99	15 mg/L
SODIUM	10/20/99	11 mg/L
SODIUM	11/20/99	11 mg/L
SODIUM	9/22/00	12 mg/L
SODIUM	9/18/01	16 mg/L
SODIUM	12/10/01	16.9 mg/L
SODIUM	9/25/02	16.9 mg/L
SULFATE	6/1/95	5.5 mg/L
SULFATE	4/2/96	8.1 mg/L
SULFATE	8/4/97	7.2 mg/L
SULFATE	5/12/98	7.9 mg/L
SULFATE	4/5/99	14 mg/L
SULFATE	10/20/99	61 mg/L
SULFATE	9/22/00	10 mg/L

7.1.3 Synthetic Organic Compounds (SOCs)

Below is a summary of SOCs detected for the years 1993-2002. SOCs include herbicides, pesticides and other man-made organic compounds. Di(2-ethylhexyl) phthalate was the only SOC to exceed 50% of the maximum contaminant level (MCL). This contaminant was detected in laboratory blanks analyzed at the same time as the samples and is therefore not considered to be reflective of actual levels in the source water. Low levels (less than 1 ppb) of several herbicides (e.g., Atrazine and Simozine) reflect the runoff of residuals from their use on row crops within the watershed.

Contaminant	Date	Result Units	MCL
2,4,5-T	11/14/00	0.1 ug/L	
2,4-D	8/19/02	0.4 ug/L	70
ATRAZINE	1/31/02	0.19 ug/L	3
ATRAZINE	8/19/02	0.14 ug/L	3
DALAPON	6/1/95	0.122 ug/L	200
DALAPON	7/11/00	0.3 ug/L	200
DALAPON	7/11/00	0.3 ug/L	200
DI(2-ETHYLHEXYL) ADIPATE	6/1/95	2.74 ug/L	400
DI(2-ETHYLHEXYL) PHTHALATE	6/1/95	2.87 ug/L	6
DI(2-ETHYLHEXYL) PHTHALATE	8/4/97	0.56 ug/L	6
DI(2-ETHYLHEXYL) PHTHALATE	7/11/00	1 ug/L	6
DI(2-ETHYLHEXYL) PHTHALATE	7/11/00	3.1 ug/L	6
DI(2-ETHYLHEXYL) PHTHALATE	11/14/00	0.5 ug/L	6
ETHYLENE DIBROMIDE (EDB)	11/14/00	0.02 ug/L	0.05
PENTACHLOROPHENOL	11/14/00	0.02 ug/L	1
SIMAZINE	1/31/02	0.14 ug/L	4

7.1.4 Volatile Organic Compounds (VOCs)/Disinfection Byproducts (DBPs)

No volatile organic compounds other than disinfection byproducts were detected in the last ten years of monitoring finished water from the Freedom District Water Treatment Plant. Compliance with the Disinfection Byproduct Rule (DBPR) is determined by levels in the distribution system. Levels of disinfection byproducts in the distribution occasionally exceed the MCL for total THM (80 ug/l) and Haloacetic acids (HAA) (60 mg/l), as shown in the table below.

	THM (ug/l)				HAA (ug/l)			
Year	Average	Max	Min	Count	Average	Max	Min	Count
1999	57.85	95.9	22.6	17	29.09	64.7	9.0	17
2000	32.73	70.4	8.7	19	9.96	23.3	0.0	19
2002	38.00	85.9	9.3	42	29.46	108.3	3.2	40
2003	32.29	66.0	6.8	17	20.42	37.0	12.7	14
Total	39.47	95.9	6.8	95	23.87	108.3	0.0	90

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 matter (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:

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%

The Freedom District water plant source water alkalinity is often below 60 mg/l. Review of the TOC data collected by the Freedom District from 1999 through 2002 shown below indicates that the treatment process, on average, does not remove the required amount of 35% of source water TOC. The plant will therefore need to be optimized in order to comply with DBPR.

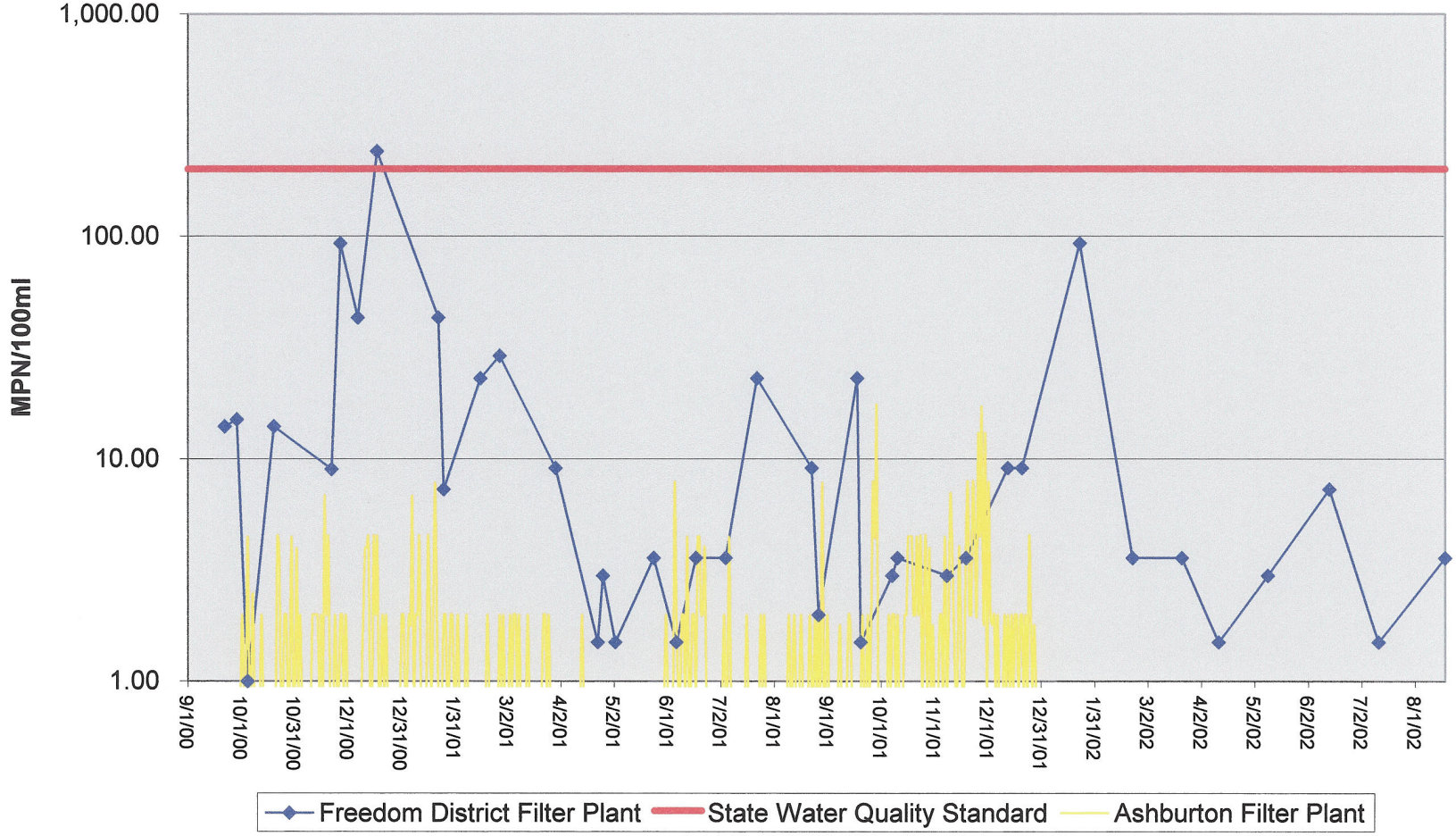
Quarterly Concentrations of Total Organic Carbon in Freedom District Distribution System from 1999 through 2003.

	Source TOC (mg/l)			Treated TOC (mg/l)			Percentage TOC Removed		
Quarter	Average	Max	Min	Average	Max	Min	Average	Max	Min
Jan - Mar	2.31	2.7	1.9	1.61	1.9	1.4	30%	46%	21%
Apr - Jun	2.32	3.1	1.7	1.53	2.1	1.1	33%	50%	19%
Jul - Sep	2.42	2.8	2.1	1.76	2.2	1.4	27%	39%	10%
Oct - Dec	2.58	3.2	1.9	1.5	2.1	0.9	42%	58%	23%
All Data	2.40	3.2	1.7	1.6	2.2	0.9	33%	58%	10%

7.1.5 Fecal Coliforms/E.Coli

Fecal coliform and E.Coli monitoring tests were performed on the raw water at Freedom District Plant on a bi-weekly basis starting in September of 2000. Figure 7.1 depicts fecal coliform concentration from September 2000 to December 2002. These levels are generally below Maryland's water quality standard of 200 colonies per 100 milliliters for source waters. The comparison of fecal coliform data between the City's intake and Freedom District intake from October 2000 to December 2001 indicates that the levels at the Ashburton Plant are lower than the Freedom District Plant. The higher concentration of fecal coliform at Freedom District may be associated with activities in subwatershed closer to this particular intake or additional removal provided by the reservoir between the two intakes. However, no attempt was made to correlate the data with subwatershed event.

Figure 7.1 - Fecal Coliform Measurements in Raw Water from LIberty - Values Below Detection Limit Are Plotted at 1/2 of the Detection Limit



7.2 Summary

The water quality data reviewed above and that presented in Section 7 of the Liberty Reservoir Watershed Assessment (particularly Figures 7.4a through 7.4e) reinforce the following:

a. The relatively stable turbidity and low concentration of coliform organisms demonstrates that the reservoir removes from the water column most of these contaminants (sediment and pathogens) while the water from the tributary streams traverses the length of the reservoir.
b. The high algal counts and chlorophylla levels in late summer and early fall (particularly in the top 20 feet of the reservoir) support the ongoing concern for the impact of algae on water treatment and potential for objectionable taste and odors. The presence of this aquatic growth is primarily controlled by the levels of phosphorus contributed by the watershed to the reservoir.
c. The high levels of disinfection byproducts during summer and late fall is associated with warmer temperatures and may also be related to more reactive precursors being present during this period. Additional study is needed to determine the organic compounds and their origins within the Liberty Reservoir and watershed. The prime suspects are decomposition of leaf litter and the compounds associated with increased algal growth as a result of nutrient enrichment.
d. Higher manganese levels are present at reservoir depths below 40 feet during late summer and early fall as this portion of the reservoir has lower levels of dissolved oxygen and therefore higher solubility of manganese. Elevated manganese adds additional treatment burden for the Freedom District Plant. Following turnover in late fall, manganese levels peak in December in the shallow waters.
e. One of the challenges for the operators of the Freedom District intake is to determine the optimum zone of most desirable waters. Elevated manganese in the deeper water and higher algal levels in the surficial water during late summer and early fall can result in the plant having to choose between two less desirable conditions. Drought conditions and any increase in phosphorus loadings would exacerbate this situation.

8.0 SUSCEPTIBILITY ANALYSIS

The susceptibility of the Freedom District watershed is very similar to that described in the Liberty Reservoir Watershed Assessment report (attached). Based on water quality data from Freedom District, in the reservoir and watershed characteristics, the water supply is not susceptible to volatile organic compounds, synthetic organic compounds or metals. All of the sections in Chapter 8 other than 8.10.2 and 8.10.3 apply to the Freedom District intake. In summary, the water supply for Freedom District is susceptible to:

a. An increasing trend of dissolved solids, chlorides at conductivity which has been shown through data analysis by the City of Baltimore to correlate with an increase in road miles within the tributaries watersheds (and therefore deduced to be related to road salt use).
b. Protozoas, viruses and bacteria and turbidity as are all surface sources. The reservoir, however, significantly reduces the susceptibility in comparison to water supplies withdrawn directly from free flowing streams.

c. Disinfection byproduct precursors; and
d. Nutrients, (particularly phosphorus) which are a primary threat to the reservoir; and
e. Spills in the tributaries feeding the reservoir. The intake, due to its location is likely to be more susceptible to spills in Morgan or Little Morgan Run subwatersheds.

9.0 RECOMMENDATIONS FOR SOURCE WATER PROTECTION PLAN

In addition to the recommendations listed in the Liberty Reservoir Watershed Assessment (attached), specific recommendations regarding watershed management for Freedom District intake are listed below:

- Carroll County's representative on the Reservoir Technical Group should work closely with Freedom District's water plant operators to address operators' concerns and discuss best management practices to ensure the production of safe drinking water.
- Continue to monitor for fecal coliform and E.Coli in the raw water.
- Road signs explaining to the public that they are entering a protected drinking water watershed is an effective way of keeping the relationship of land use and water quality in the public eye, and help in the event of a spill notification and response.
- Install rip raps and/or other engineering controls to repair and stop further bank erosion at the plant backwash area.
- Provide a containment structure for the above ground fuel tank located at the water plant site.
- Optimize plant's enhanced coagulation process in order to comply with Disinfection Byproducts Rule requirements.

10.0 ADDITIONAL REFERENCES

- MD Department of the Environment, Water Supply Program, MDE 1999. *Comprehensive Performance Evaluation (CPE) of the Freedom District Water Treatment Plant Report.*
- Carroll County Master Plan for Water Sewerage, Draft, June 2002.
- MDE Water Supply Program Inspection Reports.
- Freedom District Monthly Operating Reports (MORs) and Self-Monitoring Reports.
- MDE Water Supply Program database (PDWIS).