SOURCE WATER ASSESSMENT

for

Lake Linganore Water Treatment Plant
Frederick County

Prepared by
Maryland Department of the Environment
Water Management Administration
Water Supply Program
April 2005

MDE

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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

The Lake Linganore water system is owned and operated by Frederick County Department of Public Works and serves Lake Linganore and Spring Ridge Planned Unit Developments (PUDs) with an estimated population of 13,200 people. The Lake Linganore water system's service area is generally located in the central part of Frederick County and is part of New Market Region Comprehensive Plan. Currently, the raw water is supplied by surface water from Lake Linganore, constructed in 1972 as a 833,000,000 gallon reservoir, formed by flooding Linganore Creek. The County withdraws water directly from Lake Linganore and the City of Frederick intake is located on Linganore Creek approximately 1 ½ miles downstream of the dam.

Almost 75% of the County's water system customers receive treated water from surface water supplies, specifically the Potomac River and Lake Linganore. The remaining 25% of the customers receive water from wells (Frederick County Bureau of Water and Sewer, Annual Water-Quality Report). The Potomac River Source Water Assessment for Frederick County's New Design Road water treatment plant is completed under a separate report.

A. Description of Surface Water Supply Source

Lake Linganore is an impoundment located near the City of Frederick in Frederick County, Maryland (Figure 1). The impoundment, which is owned by the Lake Linganore Association, lies on Linganore Creek, a tributary of Monocacy River. An earthen dam was installed in 1972 to create the lake for the purpose of water supply and for recreational use. According to the Phase I Dam Inspection Report which was prepared for the U.S. Army Corps of Engineers (1980), the lake covered 215 acres at the normal pool elevation of 308 feet above mean sea level with volume of 2,700 acre feet. The lake is approximately 3.7 miles long with maximum depth of 40 feet and average depth of 12 feet and it is the largest impoundment in Frederick County.

The watershed above the intake is approximately 81 square miles of mixed land use, primarily in Frederick County, but extends a short distance into Carroll County.

Lake Linganore lies in the Piedmont physiological province. The soils immediately surrounding the lake are Manor-Liganore-Montalto (USDA: Soil Conservation Service, 1960). The Montalto soils are deep, well drained, and fine textured while the Manor and Liganore are generally shallow to very shallow, excessively drained, immature, or skeletal. The outer watershed area is comprised of soils of the Duffield-Hagerstown Association. These soils are well drained soils developed from limestone. The area surrounding Lake Linganore, like the rest of Frederick County, has a humid, temperate climate with an average temperature of 50°F and an average precipitation range between 44 and 46 inches.

B. Water Supply Development

The County's Linganore/Spring Ridge water system is dependent on a 2.0 million gallons per day (MGD) water treatment plant, which started operation in 1993. The plant is equipped with two Trident Microfloc 420A package plants, each consisting of an upflow clarification chamber with absorption media and mixed media filter. The raw water intake structure which was constructed in 1999, is located in the lake with three levels of intake lines. The three intake lines are located at elevations of 294.62, 287.19 and 280.19 feet above mean sea level respectively. The valves on each line control the level of intake when the reservoir pool level drops during the periods of drought. Raw water flows by gravity, through an 18-inch line by using control valves to withdraw from different reservoir levels to the plant's raw water basin. From the basin, water pumps by one of the two pumps to the head of the plant. Alum and chlorine are added prior to an in-line static mixers. If needed, carbon, lime and polymer can be added here 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.

A summary of site visits' findings and discussions is as follows:

Concerns and Site Observations

In addition to looking at the intake and immediate land along Lake Linganore, multiple visits were made to survey the watershed of Lake Linganore and its tributaries. The observed land use characteristics were compared with the Maryland Department of Planning's 2000 land use data and document. Meetings with plant operators and Lake Linganore Association officials were held to discuss concerns regarding the potential or known sources of contamination to the source water. The list below reflects plant operators, Lake Linganore Association members' concerns and MDE site observations:

- Frederick County's 30-inch sewer is located adjacent to Lake Linganore and runs parallel to the raw water intake line with less than 10 feet of separation distance.
- A sewer line above Lake Linganore has experienced some leakage in the past.
- Geese migration and activities around Lake Linganore.
- Sedimentation and siltation are the major concerns. A limited scope bathymetric study to determine the storage volume of the Lake at spillway elevation and loss of storage compared to the original design was completed by a consulting engineering firm in 2002. The report is attached in Appendix A.

- Lake Linganore Association members expressed concerns that under existing local regulations the watershed is not protected and is subject to development and other land use changes.
- Algea bloom during summer months and high turbidity during storms are the concerns expressed by the plant operators.

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 source water protection area for Lake Linganore intake encompasses approximately 81 square miles (52,000 acres) of mixed land use with predominantly cropland and forested land. The entire watershed is located in Frederick County with a small portion extending into Carroll County (Figure 3).

Land Use Characteristics
Based on the Maryland Department of Planning's 2000 land use data, the land use distribution in Lake Linganore Watershed is summarized as shown below:

Table 1. 2000 Land Use Data

Land Use	Total Area in Acres	Percent of Total Watershed
Low Density Residential	5816.9	11.2
Medium-High Residential	1930.1	3.7
Commercial/Industrial	416.2	0.8
Parks & Golf Courses	217.8	0.4
Cropland	25198.3	48.6
Pasture	3519.2	6.8
Forest	14314.4	27.6
Open Water	223.3	0.4
Wetlands	46.1	0.1

Table 1 continued

Concentrated Agriculture	142.8	0.3
Total	51825.1	100.0

Localized Characteristics
At the location of the County's intake, the topography of the surrounding area consists of steep slopes with only a gravel road leading to the intake's concrete valve box. The Lake Linganore development covers approximately 3,730 acres of land with an ultimate potential of 8,200 housing units surrounding the lake with swimming beaches and boat access ramps (Figure 1).

5.0 SIGNIFICANT SOURCES OF CONTAMINATION

Non-Point Concerns
According to 2000 Department of Planning land use data, 55.4% of the watershed is used for agricultural purposes (48.6% cropland, 6.8% pasture). Land used to grow crops can be a source of nutrients (from fertilizer), synthetic organic compounds (herbicides) and sediment load. If manure is used as a source of fertilizer for row crops then these fields in crop production can also release pathogens and organic carbon to the surrounding streams following rain events. Pastures used to graze livestock can be sources of nutrients and pathogenic protozoa, viruses and bacteria from animal waste. The predominate soils within the source protection area are from Manor-Glenelg and Manor-Linganore-Urbana series. The Manor soils, which dominate in these soil series, are fairly shallow and skeletal. Erosion throughout the region can create problems and careful farm management is important (New Market Region Plan, October 1993).

While less than 15% of the watershed is listed as residential, there are areas of concern based on their size and location:

Lake Linganore at Eaglehead, a Planned Unit Development (PUD) community, is located between I-70 and Gas House Pike and is approximately 3,730 acres. The PUD and surrounding area consist of a mixture of housing types including single family, villa and apartment units planned around Lake Linganore and five smaller lakes. In 1993, the population of Lake Linganore at Eaglehead was approximately 3,700 persons with an ultimate potential of 8,200 units and a population of 20,000-25,000 persons.

Another large Planned Unit Development is the Spring Ridge PUD located southwest of Lake Linganore, on both sides of I-70 and west of Quinn Road. In the area north of I-70, approximately half of this housing development is located within the watershed of Lake Linganore and includes a mixture of single family, townhouse and multi-family units. In 1993, the population of Spring Ridge was approximately 940 persons with an ultimate population expected to be approximately 4,600 persons in over 1,500 housing units (Frederick County New Market Region Plan, October 1993).

Because of the close proximity of the above residential areas to Lake Linganore and high population density, pollution due to non-point runoff from this large housing development can be a major concern.

In addition to the above residential areas, there are two incorporated municipalities, the Towns of New Market, Mount Airy, two unincorporated communities, New London and Libertytown and there are several rural subdivisions and housing developments in the watershed with on-site septic systems.

Point Source Concerns

The only point source of pollution located in Lake Linganore watershed is the Libertytown Wastewater Treatment Plant. This facility, NPDES Permit MD0060577 is operated by Frederick County Division of Utilities and Solid Waste Management. Treated effluent is discharged into Town Branch, upper stream reaches of Linganore Creek. The Libertytown service area is approximately 0.5 square miles, encompassing the unincorporated community of Libertytown located at the intersection of M26 and 75. The community has a current population of 526. The Libertytown Wastewater Treatment Plant was built by the County in 1986 with a capacity of 50,000 GPD. It treats an average flow of 30,000 GPD. The projected population of Libertytown is expected to be 1,050 by the year 2010. The County is in the process of replacing this wastewater treatment plant with a new sewage pump station. The wastewater from the community of Libertytown will be pumped to the nearby sewer interceptor and treated in Frederick County's Wastewater Treatment Plant outside of the watershed.

Currently, the maximum permitted discharge is 50,000 gallons per day, with effluent limits of BOD_5 average monthly of 30 mg/l total suspended solid monthly average of 30 mg/l, and the concentration of fecal coliforms of 200 MPN per 100/mililiter.

Transportation Related Concerns

Major roads in the Linganore Creek source water protection area include: Route 75 extending from the southern to northern boundaries of the watershed; Route 26 runs along the northern boundary for most of the watershed; and sections of Route 31 and Route 27 also located within the watershed boundary. There are also numerous secondary roads and residential access roads throughout the watershed. Concentration of residential access roads with heavy traffic within Lake Linganore at Eaglehead and lack of proper stormwater management practices in some areas of the development can expedite further siltation of Lake Linganore.

The following is a list of local roads in the watershed which are adjacent to and/or cross the tributaries and may be of concerns for spills: Boyers Mill Road (bridge over Lake Linganore), Gas House Pike (bridge over Linganore Creek), Old Annapolis Road, Woodville Road and Buffalo Road (See Figure 2).

Land Use Planning Concerns

A comparison between 1990 and 2000 Maryland DOP land use data shows changes in watershed land development. Land use percentages are shown below:

Table 2. Land Use Planning Concerns

Land Use	Percent of Watershed in 1990	Percent of Watershed in 2000	CHANGE:
Residential	6.2	14.9	**+ 8.7**
Industrial/Commercial	1.4	0.8	**- 0.6**
Urban Public Lands	0.6	0.4	**- 0.2**
Cropland	58.0	48.6	**- 9.4**
Pasture	7.6	6.8	**- 0.8**
Forest	25.4	27.6	**+ 2.2**
Open Water	0.3	0.4	**+ 0.1**
Wetlands	NA	0.1	**0.1**
Concentrated Agriculture	0.6	0.3	**- 0.3**

Note: Black = increase; Red = decrease

The most significant changes are the increase in residential land use and decrease of agricultural (cropland and pasture) land use over the past ten years in Lake Linganore watershed. This land use trend is also seen in the rest of Frederick County. A significant percentage of the land slated for new development on the south side of Lake Linganore, however, is currently forested and potential residential or commercial developments of large tracts of forested land in the watershed threatens the water quality in streams and Lake Linganore.

6.0 REVIEW OF WATER QUALITY DATA

Several sources of water quality data were reviewed for Lake Linganore source water assessment areas. These include MDE Water Supply Program's database for safe drinking water contaminants and monthly operating reports for Frederick County Water Treatment Plant, Frederick County Health Department, United States Geological Survey, MD Department of Natural Resources, and Lake Linganore Association and health department bacteriological data.

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

Frederick County is required to perform water quality tests on the drinking water it produces 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. Other plant data included in the Monthly Operating Report (MOR) reflects the quality of treated (finished) water. All contaminants detects from plant data (finished) and the year 2000 raw water turbidity and pH for each plant are listed below.

Raw Water Turbidity and pH

Our review of Frederick County monthly operating reports from January 2000 to December 2000 indicates that the average monthly turbidity of the raw water fluctuates from 5.0 NTU to 31.7 NTU. The highest value recorded in 2000 was 113 NTU. The average pH of the raw water is from 7.3 to 8.1 and within the 6.5 – 8.5 range as recommended by secondary standard for drinking water. Below is a list of turbidity and pH values (monthly average, maximum and minimum) for Lake Linganore raw water during the year 2000.

Table 3. Linganore Plant Raw Water Turbidity and pH for 2000

Date	Average Monthly Value		Maximum / Month		Minimum / Month	
	Turb. NTU	PH	Turb. NTU	pH	Turb. NTU	pH
January	7.8	7.7	11	7.8	4.0	7.6
February	15.3	7.6	72	7.8	2.0	7.4
March	21.4	7.8	104	8.5	7.0	7.4
April	12.5	8.1	47	8.8	5.0	7.6
May	5.3	7.7	10	9.1	3.0	7.2
June	7.0	7.3	10	7.5	5.0	7.2
July	7.2	7.3	9	7.4	5.0	7.2
August	7.0	7.4	9	7.5	5.0	7.3
September	7.8	7.4	12	7.6	5.0	7.3
October	5.0	7.7	8	8.1	3.0	7.3
November	6.4	7.9	10	8.2	3.0	7.6
December	31.7	7.9	113	8.4	3.0	7.3
	Avg. Turb/Year NTU **11.2**	Avg. pH year **7.65**	Highest Turb. In Year 2000 **113**	Highest pH Year 2000 **9.1**	Lowest Turb. **2.0**	Lowest pH **7.2**

Inorganic Compounds (IOCs)

Linganore plant regularly tests for the presence of nitrate and other inorganic compounds in finished drinking water. Below is a summary of testing results for IOCs detected in finished water. All data is expressed in milligrams per liter (mg/l). Fluorides added during the treatment process; therefore, levels are not reflective of raw water conditions. Twenty-three samples detected nitrate since 1993, none exceeded 50% of the MCL. The highest nitrate value reported (4.2 mg/l) was from the most recent sample collected in February of 2004.

Table 4. Inorganic Compounds (IOCs) from Lake Linganore

Contaminant	Sample Date	Result	Units	MCL
ARSENIC	03/28/1995	0.001	mg/L	0.01
BARIUM	03/28/1995	0.03	mg/L	2
BARIUM	03/12/1997	0.03	mg/L	2
BARIUM	05/28/1999	0.028	mg/L	2
BARIUM	08/18/2000	0.025	mg/L	2
BARIUM	05/16/2001	0.025	mg/L	2
BARIUM	06/26/2002	0.0271	mg/L	2
BARIUM	06/09/2003	0.0241	mg/L	2
BARIUM	05/19/2004	0.0313	mg/L	2
CHROMIUM	03/28/1995	0.003	mg/L	0.1
CHROMIUM	05/19/2004	0.0021	mg/L	0.1
FLUORIDE	03/28/1995	0.9	mg/L	4
FLUORIDE	05/22/1995	0.97	mg/L	4
FLUORIDE	05/29/1996	0.68	mg/L	4
FLUORIDE	09/08/1996	0.97	mg/L	4
FLUORIDE	03/12/1997	0.78	mg/L	4
FLUORIDE	06/30/1997	0.97	mg/L	4
FLUORIDE	05/04/1998	0.99	mg/L	4
FLUORIDE	05/28/1999	0.9	mg/L	4
FLUORIDE	08/18/2000	0.8	mg/L	4
FLUORIDE	05/16/2001	0.76	mg/L	4
FLUORIDE	08/07/2001	1.19	mg/L	4
FLUORIDE	04/30/2002	1.18	mg/L	4
FLUORIDE	06/26/2002	1.11	mg/L	4
FLUORIDE	04/22/2003	0.72	mg/L	4
FLUORIDE	06/09/2003	1.05	mg/L	4
FLUORIDE	05/19/2004	1.02	mg/L	4
NITRATE	03/02/1993	3.2	mg/L	10
NITRATE	05/13/1993	3	mg/L	10

Table 4 continued

NITRATE	08/30/1993	0.9	mg/L	10
NITRATE	10/21/1993	1.2	mg/L	10
NITRATE	03/28/1995	2.8	mg/L	10
NITRATE	05/22/1995	1.9	mg/L	10
NITRATE	05/31/1995	2	mg/L	10
NITRATE	11/15/1995	1.6	mg/L	10
NITRATE	02/27/1996	3.2	mg/L	10
NITRATE	09/08/1996	2.5	mg/L	10
NITRATE	01/28/1997	3.9	mg/L	10
NITRATE	06/30/1997	2	mg/L	10
NITRATE	01/07/1998	2.7	mg/L	10
NITRATE	05/04/1998	2.7	mg/L	10
NITRATE	02/10/1999	2.8	mg/L	10
NITRATE	02/09/2000	3.5	mg/L	10
NITRATE	01/24/2001	3.3	mg/L	10
NITRATE	08/07/2001	0.4	mg/L	10
NITRATE	01/30/2002	2	mg/L	10
NITRATE	04/30/2002	0.7	mg/L	10
NITRATE	02/28/2003	2.5	mg/L	10
NITRATE	04/22/2003	2.6	mg/L	10
NITRATE	02/05/2004	4.2	mg/L	10
NITRITE	05/22/1995	0.002	mg/L	1
NITRITE	05/31/1995	0.01	mg/L	1
NITRITE	09/08/1996	0.002	mg/L	1
NITRITE	04/30/2002	0.002	mg/L	1
SODIUM	03/12/1997	6.4	mg/L	*
SODIUM	06/30/1997	6.6	mg/L	
SODIUM	05/04/1998	6	mg/L	
SODIUM	08/18/2000	6.6	mg/L	
SODIUM	05/16/2001	6.9	mg/L	
SODIUM	08/07/2001	7.14	mg/L	
SODIUM	04/30/2002	8.72	mg/L	
SODIUM	06/26/2002	8.05	mg/L	
SODIUM	04/22/2003	8.15	mg/L	
SODIUM	06/09/2003	5.67	mg/L	
SODIUM	05/19/2004	7.4	mg/L	
SULFATE	03/15/1994	32	mg/L	250**
SULFATE	06/21/1994	16	mg/L	250**

Table 4 continued

SULFATE	09/26/1994	16	mg/L	250**
SULFATE	12/20/1994	20	mg/L	250**
SULFATE	03/06/1995	12	mg/L	250**
SULFATE	05/22/1995	12.58	mg/L	250**
SULFATE	05/31/1995	12.58	mg/L	250**
SULFATE	05/29/1996	11	mg/L	250**
SULFATE	09/08/1996	19.1	mg/L	250**
SULFATE	06/30/1997	13.1	mg/L	250**
SULFATE	05/04/1998	12.7	mg/L	250**
SULFATE	08/18/2000	12	mg/L	250**
SULFATE	05/16/2001	11.9	mg/L	250**
SULFATE	08/07/2001	16.8	mg/L	250**
SULFATE	04/30/2002	30.9	mg/L	250**
SULFATE	06/26/2002	22.2	mg/L	250**
SULFATE	06/09/2003	34.5	mg/L	250**
SULFATE	05/19/2004	28	mg/L	250**

*EPA advisory for persons sensitive to salty taste between 30-60 ppm.
**secondary standard

Radionuclides

No radionuclides were found in finished water at levels at or above 50% of established MCLs. Gross alpha emissions were reported as detectable and gross beta emissions are less than 10% of the screening level of 50 picocuries per liter.

Synthetic Organic Compounds (SOCs)

SOC samples are collected by Frederick County and MDE. Below is a summary of SOCs detected for years 1993-2004. All data is expressed in micrograms per liter (µg/l). Atrazine, a commonly used agricultural herbicide, was detected 19 times during these years, three times above 50% of the maximum contaminant level. A detailed discussion of the atrazine findings will be covered in the susceptibility analysis. No other compounds were detected at levels greater than 50% of the maximum contaminant levels.

Table 5. Synthetic Organic Compounds (SOCs)
Lake Linganore Creek Source

Contaminant	Sample Date	Result	Units	MCL
2,4-D	05/11/04	0.16	µg/l	70
ATRAZINE	06/21/94	0.6	µg/l	3

Table 5 continued

ATRAZINE	09/26/94	0.1	µg/l	3
ATRAZINE	12/12/94	0.1	µg/l	3
ATRAZINE	05/15/95	0.73	µg/l	3
ATRAZINE	05/21/96	2	µg/l	3
ATRAZINE	06/20/96	3.5	µg/l	3
ATRAZINE	07/24/96	2.9	µg/l	3
ATRAZINE	06/30/97	0.51	µg/l	3
ATRAZINE	05/06/98	0.49	µg/l	3
ATRAZINE	07/13/98	0.55	µg/l	3
ATRAZINE	05/10/00	0.12	µg/l	3
ATRAZINE	07/19/00	0.42	µg/l	3
ATRAZINE	07/11/01	0.17	µg/l	3
ATRAZINE	06/26/02	0.432	µg/l	3
ATRAZINE	08/07/02	0.32	µg/l	3
ATRAZINE	06/09/03	0.7	µg/l	3
ATRAZINE	07/16/03	0.02	µg/l	3
ATRAZINE	05/19/04	0.2	µg/l	3
ATRAZINE	07/28/04	0.1	µg/l	3
DALAPON	04/19/99	0.65	µg/l	200
DALAPON	08/17/99	0.59	µg/l	200
DALAPON	05/31/00	0.1	µg/l	200
DALAPON	08/07/01	0.34	µg/l	200
DI(2-ETHYLHEXYL) ADIPATE	05/31/00	0.8	µg/l	400
DI(2-ETHYLHEXYL) ADIPATE	05/16/01	1.8	µg/l	400
DI(2-ETHYLHEXYL) ADIPATE	08/07/01	0.5	µg/l	400
DI(2-ETHYLHEXYL) PHTHALATE	05/22/95	1.78	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	05/04/98	1.03	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	04/19/99	0.5	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	08/17/99	0.7	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	05/31/00	1.3	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	05/31/00	1.5	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	08/07/01	1.6	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	04/30/02	1.1	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	04/22/03	0.6	µg/l	6
DI(2-ETHYLHEXYL) PHTHALATE	05/11/04	0.5	µg/l	6
METHOXYCHLOR	05/06/98	0.16	µg/l	40
METOLACHLOR	06/21/94	0.8	µg/l	
METOLACHLOR	06/26/02	0.143	µg/l	
SIMAZINE	06/20/96	0.4	µg/l	4
SIMAZINE	07/19/00	0.23	µg/l	4
SIMAZINE	06/26/02	0.21	µg/l	4
SIMAZINE	08/07/02	0.14	µg/l	4

Volatile Organic Compounds (VOCs)/Disinfection Byproduct

No volatile organic compounds other than disinfection by-products were detected in the finished water leaving Linganore Water Treatment Plant. Compliance with the disinfection by-product standards is determined by levels in the distribution system. Levels of disinfection by products in the distribution exceed 50% of the recently established MCLs for total trihalomethanes (80 µg/l) and haloacetic acids (60 µg/l). In 2004, levels of haloacetic acids in the distribution system were in excess of the maximum contaminant levels.

Frederick County has been monitoring disinfection byproducts (DBPs) in the distribution system to monitor compliance with Stage 1 Disinfectants and Disinfection Byproduct Rule (DBPR). The DBPs are total trihalomethanes (TTHMs) and haloacetic acids (HAA). The sum of the concentration of four compounds chloroform, bromochloromethane, dibromochloromethane, and bromoform comprise TTHM and the sum of five compounds mono-, di-, and tri-chloroacetic acids, and mono- and di-bromoacetic acids comprise HAAs. The THM and HAA values for annual and quarterly concentrations are presented in Table 6 and Table 7.

Table 6. Annual Concentrations of Disinfection Byproducts in Lake Linganore Distribution System (all sample locations[1]) All values reported in micrograms per liter (µg/l).

	THM			HAA		
Year	**Average**	**Max**	**Min**	**Average**	**Max**	**Min**
2002	60.48	93.9	29.1	42.31	55.1	30.3
2003	58.01	141.7	19.0	59.58	177.0	16.2
2004	46.54	84.2		67.79	119.8	37.3
Total	53.80	141.7		59.87	177.0	16.2

[1]Based on samples from four locations: 6540 Twin Lake Drive, 6114 Samuel Road, 7007 Clubhouse Circle, 6135 Field Crest Drive.

Table 7. Quarterly Average Concentrations of Disinfection Byproducts in the Distribution System. All values reported in micrograms per liter (µg/l).

	THM			HAA		
Quarter	**Average**	**Max**	**Min**	**Average**	**Max**	**Min**
1	34.78	80.6	-	50.06	119.8	16.2
2	49.82	84.2	24.8	65.94	177.0	22.3
3	82.93	141.7	41.2	66.77	120.0	33.9
4	58.11	85.8	35.1	43.60	51.0	35.2
Total	53.80	141.7		59.87	177.0	16.2

In addition, total organic carbon (TOC) is used as a surrogate for precursors DBPPs. TOC has been monitored in the raw and treated water. The TOC values by quarter are shown in Table 8 below. The highest TOC values are found during the third quarter where there is a greater likelihood of more biological activity (algal growth) within the reservoir. It is also during this quarter that the highest average concentration of HAA was measured over the last three years.

Table 8. Quarterly Average Concentrations of Source and Treated Total Organic Carbon and Percent Removed (2001 through 2004) at the Lake Linganore Water Treatment Plant

Quarter	Source TOC (mg/l)			Treated TOC (mg/l)			Percent Removal TOC		
	Average	Max	Min	Average	Max	Min	Average	Max	Min
Jan – Mar	2.47	4.25	0.91	1.61	2.70	0.57	34%	48%	7%
Apr – Jun	3.21	5.17	1.45	2.12	3.00	1.10	33%	52%	18%
Jul – Sep	3.94	7.29	2.63	2.41	3.87	1.64	36%	72%	17%
Oct - Dec	3.33	5.43	1.37	2.20	3.54	0.85	33%	47%	21%
All Data	3.28	7.29	0.91	2.11	3.87	0.57	34%	72%	7%

The Disinfection Byproducts Rule (DBPR) requires that water systems serving 10,000 or more persons must comply with the rule's provisions beginning December 2001. The rule establishes MCLs 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 in Table 9:

Total 9. MCLs for the Stage 1 DBPR

Total Trihalomethanes (TTHMs)	80 µg/l
Haloacetic Acids (HAAs)	60 µg/l
Bromate	60 µg/l
Chlorite	1.0 µg/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 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 Table 10.

Table 10. Total Organic Carbon Removal Requirements

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%

Review of the TOC data collected by Frederick County from 2002 through 2004 indicates that the treatment process usually removes the required percentage of TOC from the Linganore Creek raw water.

Protozoa and Fecal Coliform

Lake Linganore Association operates several bathing beaches around the lake in accordance with the County Health Department permit. Review and analysis of the data from the County Health Department, Lake Linganore Association, and data from Frederick County Department of Public Works since 1991 reveals that fecal coliform counts exceeded the 200 MPN per 100 ml on several occasions. A total of 267 sample results from various sites at Lake Linganore were analyzed to determine the values of the minimum, maximum, and geometric mean of the existing data. The range of the values are: minimum from 1.5 to 20, maximum from 1,100 to 240,000 and geometric mean from 46.8 to 988.6.

MDE, with cooperation of Frederick County water treatment operators, completed a two-year bacteriological monitoring program. The raw water samples were collected bi-weekly and tested for fecal coliform and E.Coli. A summary of monthly average, maximum and minimum concentrations of Fecal Coliform from March 2001 to December 2002 is shown in Table 11. Results from the intake sampling show a high level of variability but with most values below the state water quality standard of 200 mpn for fecal coliform that was in effect at the time of the sampling.

Table 11. Monthly Summary of Lake Linganore Intake Results for Fecal Coliform

Month	Fecal Coliform (MPN)		
	Average	Maximum	Minimum
Mar-01	9.0	30	2
Apr-01	196.0	800	2
May-01	11.6	50	2
Jun-01			
Aug-01	6.8	17	2
Sep-01	753.0	3,000	2
Oct-01	12.2	30	2
Nov-01	50.8	170	7
Dec-01	120.0	180	50

Jan-02	4.6	13	2
Feb-02	2.5	4	2
Mar-02	227.0	900	2
Apr-02	7.3	23	2
May-02	38.6	80	2
Jun-02	71.0	170	2
Jul-02	3.2	8	2
Nov-02	377.2	1,100	26
Dec-02	1,678.0	5,000	11
Total	160.1	5,000	2

Table 11 continued

MDE completed a three-year study to determine the occurrence and concentrations of Cryptosporidium oocysts in selected intakes along the Potomac River and in smaller water supply watershed tributaries. Cryptosporidium is a water-borne parasite that has been implicated in water-borne disease outbreaks in drinking water. Linganore Creek was selected as one of the sample sites in MDE's study. As part of this study, samples were collected for baseflow and stormflow from Linganore Creek at Gas House Pike upstream of the reservoir. All four baseflow sample results show negative for Cryptosporidium at Linganore Creek sampling site. Stormflow samples were taken during pre-storm, peak and post storm events. From the total of 12 samples, eight samples tested positive and four tested negative for Cryptosporidium. The data shown in Tables 12-15 are the sample results during each stormflow event. The data clearly shows the effect of increased runoff on the levels of Cryptosporidium observed.

Table 12. Storm Event #1 Cryptosporidium Results

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample date	09/25/2001	09/25/2001	09/26/2001
Oocysts/Liter	Negative	29	3
Total Number	Negative	327	37
Viable/Infectious	NA	V	V

NA = Not Viable; All samples were 3-gallons

Table 13. Storm Event #2 Cryptosporidium Results

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample date	01/24/2002	01/24/2002	01/25/2002
Oocysts/Liter	Negative	21	2
Total Number	Negative	241	24
Viable/Infectious	NA	V	V

NA = Not Viable; All samples were 3-gallons

Table 14. Storm Event #3 Cryptosporidium Results

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample date	03/18/2002	03/18/2002	03/19/2002
Oocysts/Liter	Negative	24	2
Total Number	Negative	271	23
Viable/Infectious	NA	V	V

NA = Not Viable; All samples were 3-gallons

Table 15. Storm Event #4 Cryptosporidium Results

Sampling Sequence	Pre-Storm	Peak-Storm	Post-Storm
Sample date	06/13/2002	06/13/2002	06/14/2002
Oocysts/Liter	Negative	15	1
Total Number	Negative	173	12
Viable/Infectious	NA	V	V

NA = Not Viable; All samples were 3-gallons

7.0 SUSCEPTIBILITY ANALYSIS

Each class of contaminants with significant levels reported in Chapter 6.0 were further analyzed based on the potential they have of contaminating the Lake Linganore and Frederick County water intake. This analysis identified suspected sources, evaluated the natural conditions that may decrease or increase the likelihood of contaminant reaching the intake, and evaluate the impacts that future changes within the watershed may have on the susceptibility of the water intake.

Turbidity and Sediment

The average raw water turbidity in the Lake Linganore Treatment Plant during the year 2000 was approximately 11.2 NTU; the highest monthly average turbidity of 31.7 NTU was recorded during the month of December, 2000. High levels of turbidity in Lake Linganore can result from storm events (rainfall) and snowmelt. The sediment loads into Lake Linganore are severe because of the steps slopes and erodible soils concurrent with the residential development surrounding some of the lake and the high percentage of agricultural land in the watershed. A limited scope bathymetric survey was performed by a consulting engineering firm to estimate the amount of sedimentation that has occurred in Lake Linganore since it was constructed. The study also estimated the remaining reservoir capacity and the feasibility and cost options for restoring the lake capacity. The report concluded that the lake has lost approximately 13% of its capacity in the 27 years between the dam construction year of 1972 and 1999. A copy of Siltation and Capacity Report prepared by Whitman, Requardt & Associates, LLP, December 2002, is included in Appendix A.

Future land use changes in the Lake Linganore watershed could increase the turbidity contamination. Most of the watershed is privately owned and development of forested land will increase the amount of exposed surfaces that can lead to increased erosion. Lake Linganore is susceptible to elevated turbidity.

Inorganic Compounds

All inorganic compounds except phosphorous are discussed in this section. All the inorganic compounds (IOCs) that have been detected are below the maximum contaminant level in the finished water from Lake Linganore Water Treatment Plant. Nitrate was the most common IOC detected but no results exceeded 50% of the Maximum Contaminant Level (MCL). Nitrates can enter the water supply via ground water and surface runoff. Fertilizer losses, leachate from septic tanks and animal waste are considered sources of nitrates. If the amount of livestock, fertilizer usage and conversion of forested lands to residential development using on-site disposal increases, then nitrate concentration will increase in the future. Nitrate is not considered a threat to the Lake Linganore water supply at the present time.

Very low levels of other inorganic compounds have been detected in the finished water leaving Lake Linganore Water Treatment Plant (Table 4). None have been greater than 50% of the respective MCL. Lake Linganore is not susceptible to IOCs.

Total Phosphorus

Since phosphorus is the limiting nutrient for algae growth in Lake Linganore, phosphorus reduction is needed to reduce eutrophication stresses on the reservoir system. A reduction in algae levels is expected to lead to lower levels of reactive organic carbon and consequently lower levels of disinfection byproducts in the treated water. Phosphorus is the eleventh most abundant mineral in the earth's crust; fresh water phosphorus exists in either particulate phase or a dissolved phase. Particulate matter includes living and dead plankton, precipitate of phosphorus, phosphorus absorbed to particulates and amorphous phosphorus. The dissolved phase includes inorganic phosphorus (generally in the soluble orthophosphate form), organic phosphorus excreted by organisms, and macromolecular colloidal phosphorus. External sources of phosphorus include agricultural and urban runoff, wastewater effluents and runoff from forested land. A comparison between phosphorus loading (in terms of pounds per acre per year) from the discharge of the Libertytown Wastewater Plant and agricultural land in the watershed revealed that the contribution from the wastewater plant is rather insignificant compared to agricultural activities in the watershed (Chesapeake Model DNR). Farming practices would have to be adopted to either reduce fertilizer applications or to reduce runoff from fertilized land to reduce phosphorus loading. The contribution of phosphorus from land in residential development has not been quantified.

According to the Total Maximum Daily Loads' (TMDLs) report prepared by MDE for Lake Linganore (December 2002) the major water quality problems of Lake Linganore were associated with high phosphorus and high sediment loads.

The water quality goal of these TMDLs is to reduce long-term phosphorus and sediment loads to acceptable levels consistent with the physical characteristics of Lake Linganore. This reduced loading rate is predicted to resolve excess algal problems and maintain a dissolved oxygen concentration above the State's water quality standard. The TMDL for phosphorus was determined using an empirical method known as the Vollenweider Relationship. Because the reduction of sediments is a component of controlling external phosphorus loads, a sediment loading rate consistent with narrative water quality criteria is predicted to be achieved.

The average annual TMDL for phosphorus is 5,288 lbs/yr. There is one point source in the Lake Linganore basin. Consequently, the allocation is partitioned between nonpoint sources, the point source and the margin of safety. For sediments, the TMDL is established to achieve a loading rate consistent with the uses of the lake, as a result of the proposed control of phosphorus. This loading rate is estimated to result in preserving about 48% - 79% of the lake's design volume over a period of 40 years.

Synthetic Organic Compounds (SOCs)

There are several SOC detects at the Lake Linganore plant, but all results are less than 50% of MCL, with the exception of three samples of atrazine (Table 5). The MCL for atrazineis 3 micrograms per liter (μg/l). The highest concentrations were from 1996, with all results in the past 5 years less than 0.7 μg/l. Atrazine has been documented to enter streams and rivers in Maryland following springtime herbicide application. Atrazine is water soluble, and residues on soil, vegetation or other surfaces can be easily carried by runoff into streams. The highest concentrations in Lake Linganore intake were measured in late spring and early summer. A review of Maryland Pesticide Statistics for the past decade indicates that the usage of atrazine in Frederick County is declining. This reduction is due to both a declining number of acres in row crop production and a reduction in the allowed application rates. Therefore given the changing land use it is likely that atrazine concentration will continue to decrease in the future. Lake Linganore is therefore not susceptible to SOCs.

Disinfection Byproducts

Trihalomethanes (THMs) and haloacetic acids (HAAs) both exceeded 50% of the MCL and in 2004 HAAs were in excess of maximum contaminant levels in the distribution system. Organic carbon compounds in the raw water contributed by the elevated HAAs by reacting with chlorine in the treatment plant and distribution system.

The amount and type of organic matter in Lake Linganore is due to the contribution of organic carbon from the watershed and the production of algae from nutrients delivered by the watershed to the lake. Watershed sources of organic carbon include decying vegetation (leaves), airborne deposition, soil erosion and animal wastes.

Due to the nature of the watershed, the biological status of the reservoir (in-reservoir process "algae blooms" and decomposition of aquatic plants) and occasionally high sample concentrations of HAA and THM, the Lake Linganore water system is susceptible to disinfection byproducts.

Microbiological Contaminants
The consistent presence of fecal coliform bacteria in Lake Linganore indicates its susceptibility to pathogenic microorganisms. The fecal coliform data from different sources, summarized in Section 6.0 Review of Water Quality Data, shows that counts periodically exceeded the previous state standard of 200 MPN/l00 ml. Three sampling locations: Ben's Branch, Linganore Creek and Nightingale Beach test results from June 1992-September 2001show the highest geometric mean value of 602, 988 and 355 MPN/100 ml respectively.

Giardia and *cryptosporidium* are fairly common in surface water and associated with human and animal waste, including livestock, horses, pets, birds and various wildlife species such as deer, raccoons, opossums, rabbits, rats and squirrels. Young calves infected with *cryptosporidium* are significant sources of very high levels of *cryptosporidium*, particularly if they have direct access to streams. The management of livestock waste, including limiting the access of livestock from flowing streams would reduce the susceptibility of this water supply to pathogenic protozoas. Like most all surface water supplies, the water intake is susceptible to contamination by *giardia*, *cryptosporidium* and other pathogens. Sampling data indicates that highest fecal and *cryptosporidium* levels are associated with the peak periods of stormwater runoff (see Tables 12, 13, 14. 15). Sampling locations indicate that high levels are present prior to entering the reservoir, thus indicating that watershed sources, especially agricultural lands, are likely to be the most significant.

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 Frederick County's Lake Linganore 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 each source.

- Frederick County should become an active member of Lake Linganore source water protection committee group, interested in development and implementation of strategies to protect Lake Linganore as a drinking water source.
- Develop a formal or informal agreement to engage officials from different jurisdictions on a continuing basis.
- Encourage broad stakeholder participation, including home owners, farmers, developers and existing environmental groups.
- Establish clear and achievable goals, objectives and milestones to ensure the highest quality raw water. Some examples are listed below.
  - ✓ Implement recommendations of Lake Linganore Siltation and Capacity report of December 9, 2002 by Whitman, Requardt & Associates.
  - ✓ Develop a predictive model to relate the tributary nutrient loadings to the lake eutrophication, water quality parameters and algae dynamics.
  - ✓ Develop baseline information on pathogen contamination in main feeder streams and at different lake locations. Continue monitoring for fecal coliform and e.Coli.
  - ✓ Ensure that all farms with livestock have developed and are implementing best management practices for their animals. Addressing bare ground areas and areas where livestock (and particularly their young) have direct access to free flowing streams should be the highest priority for reducing the risk from pathogenic protozoans.
  - ✓ Keep track of water quality compliance violations and refer them to MDE.
  - ✓ Monitor the major tributaries for TOC and disinfection byproduct formation potential seasonally. Tributary monitoring may help pinpoint watersheds that are major precursor contributors.
  - ✓ The County should explore the possibility of acquiring land and conservation easements in sensitive watershed areas and along the feeder streams. Loan grants for the purchase of land or easements for the purpose of protecting water are available from MDE and through the Maryland Agricultural Preservation Funds.
  - ✓ Frederick County should periodically conduct its own detailed field survey of the watershed to ensure there are no new potential sources of contaminants.
  - ✓ In cooperation with Frederick City, conduct ongoing monitoring for algae and/or indicators of algae blooms, such as chlorophyla levels in Lake Linganore.
  - ✓ Monitor for phosphorus in major tributaries and in reservoir.

REFERENCES

City of Frederick Comprehensive Plan, Adopted August 17, 1995.

County, City and Lake Linganore and Regional Water System Agreement, December 2000.

Frederick County Comprehensive Plan, 1997, A Countywide Plan for Frederick County, Maryland.

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

MDE, *Total Maximum Daily Loads for Phosporus and Sediment of Lake Linganore, Frederick County, MD*, December 2002.

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.

New Market Region Plan, Adopted October 1993, Frederick County, Maryland.

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

U.S. Army Corps of Engineers, Baltimore District, 1980, Linganore Dam, Phase 1 Inspection Report.

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.

Whitman, Requardt & Associates, 1979, Lake Linganore Water Quality Study.

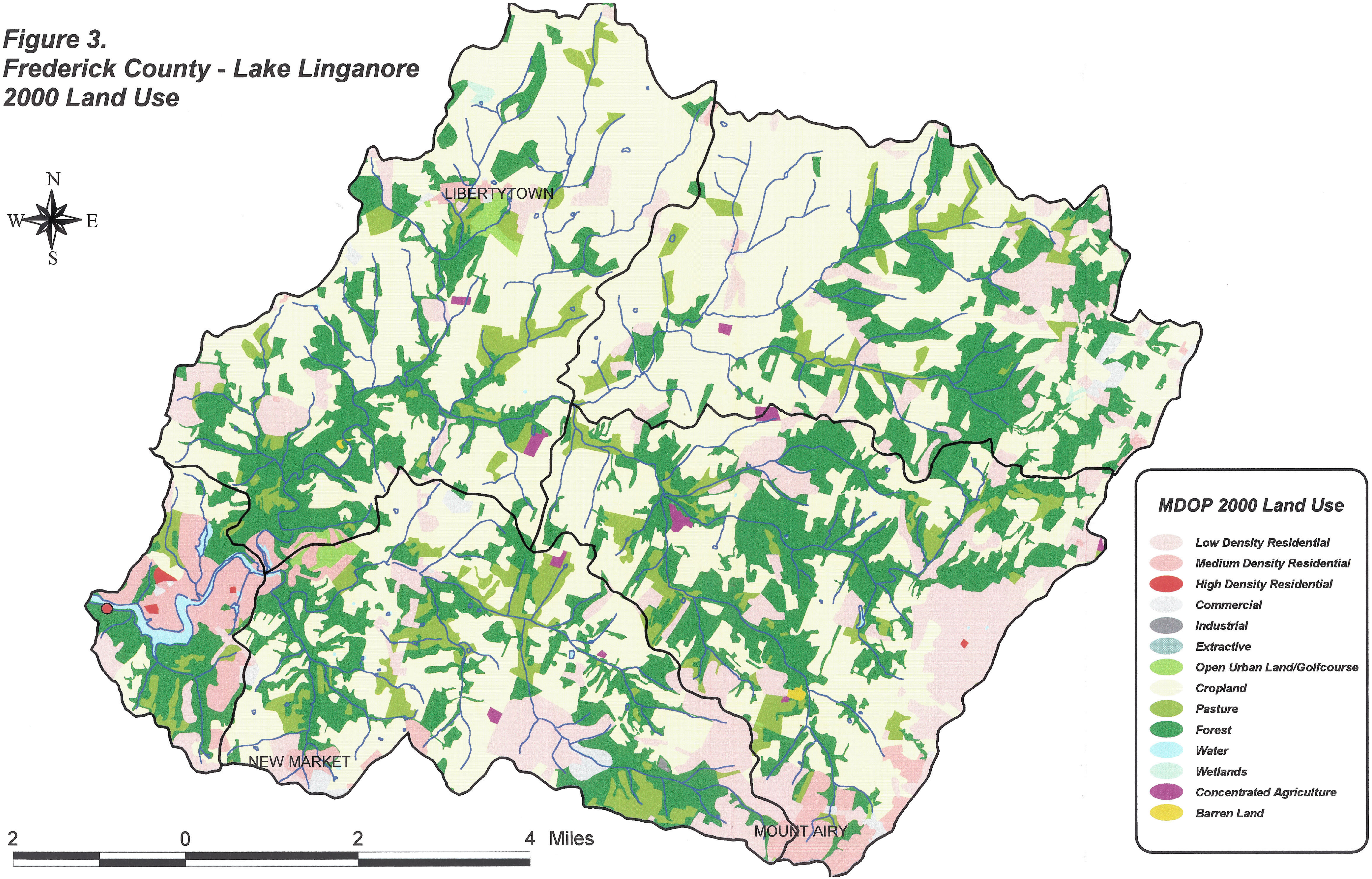
Whitman, Requardt & Associates, 2002 Lake Linganore Siltation & Capacity Report.

OTHER SOURCES OF DATA

- EPA's Guidance Manual for Source Water Assessments
- Maryland Department of Planning 2000, Frederick County Land-use Maps
- MDE NPDES Permits
- MDE Waste Management Sites Database
- MDE Water Appropriation and Use Permits
- MDE Water Supply Inspection Reports.
- MDE Water Supply Oracle Database.
- Frederick County Water Treatment Plant Monthly Operating Reports (MORs) and Self-Monitoring Reports

FIGURES

Figure 3.
Frederick County - Lake Linganore
2000 Land Use



APPENDIX

APPENDIX A

LAKE LINGANORE
Frederick County, MD

SILTATION & CAPACITY REPORT

December 9, 2002

Whitman, Requardt & Associates, LLP

Engineers Architects Planners

LAKE LINGANORE
SILTATION AND CAPACITY
REPORT

FREDERICK COUNTY, MARYLAND

December 9, 2002

Table of Contents

1. Introduction

Lake Linganore, in addition to its role as a recreational facility for the use of its owners, is also an important water supply reservoir in Frederick County, Maryland. Whitman, Requardt & Associates, LLP (WR&A) performed a siltation and capacity study of Lake Linganore, which is located approximately 5 miles east of the City of Frederick. The lake is privately owned by the Lake Linganore Association (LLA). Figure 1 (in the pocket) is a plan showing the lake. Figure 2 is a map of the lake and the surrounding area.

Frederick County withdraws water from the lake under a State water appropriation permit. The County is permitted to take from the lake an annual average of 1.2 million gallons per day (MGD) and a maximum daily use of 2.0 MGD. A minimum flow of at least 12 cubic feet per second, equal to 7.8 MGD, must be maintained past the dam. The City of Frederick is permitted to withdraw up to 6 MGD from Linganore Creek downstream of the dam.

Under the terms of the County, City and Lake Linganore, Regional Water System Agreement of December 14, 2000, Frederick City and Frederick County agreed to complete an engineering study to evaluate options to increase and/or restore lake volume including the evaluation of alternatives and costs associated with silt removal, increase in lake pool elevation and mitigation of ongoing siltation. This report documents the study results.

The purposes of this study are: (1) to estimate the amount of sedimentation that has occurred in Lake Linganore since it was constructed; (2) to estimate the remaining reservoir capacity; and (3) to evaluate the feasibility and costs of options for restoring the lake capacity. The options that were assessed are as follows: (1) dredging the lake sediments; (2) excavation of the lake sediments in a drained lake; and (3) raising the level of the lake with a rubber dam or combination of both. We have also suggested methods to control future sedimentation in the lake.

The scope of this project included a site inspection by boat, meetings and desktop analysis of lake sedimentation. This is a preliminary study; therefore drilling and testing were not part of the Scope of Work. WR&A surveyors and LLA cooperated in spot-checking lake depths on October 29, 2002. WR&A completed this study in accordance with its proposal dated October 29, 2001, under Frederick County Purchase Order No. 29624.

Lake Linganore was constructed in 1972. According to the Phase I Dam Inspection Report which was prepared for the U. S. Army Corps of Engineers (1980), the lake covered 215 acres at the normal pool elevation (El.) of 308 feet above mean sea level. The 1980 Phase I Dam Report used data from a USGS topographic map having 20-foot contours. Therefore, the 1980 estimate is less accurate than the estimates in this report, which are based on topographic mapping with 2-foot contours. El. 308 is the crest elevation of the ogee spillway at the dam.

WR&A

Base Map Source USGS Quadrangle- Walkersville

Approximate Scale 1" = 4,000'

Lake Linganore - Frederick County, Maryland

Siltation & Capacity Report

FIGURE 2

DATE: DECEMBER 2002

The drainage area of the lake is approximately 82 square miles. The land use is primarily agricultural, as shown on Figure 3, a watershed map. The intake for the County water treatment plant is approximately 1,000 feet upstream of the dam. The intake for the City water treatment plant is approximately 2 miles downstream of the dam.

2. Site Inspection

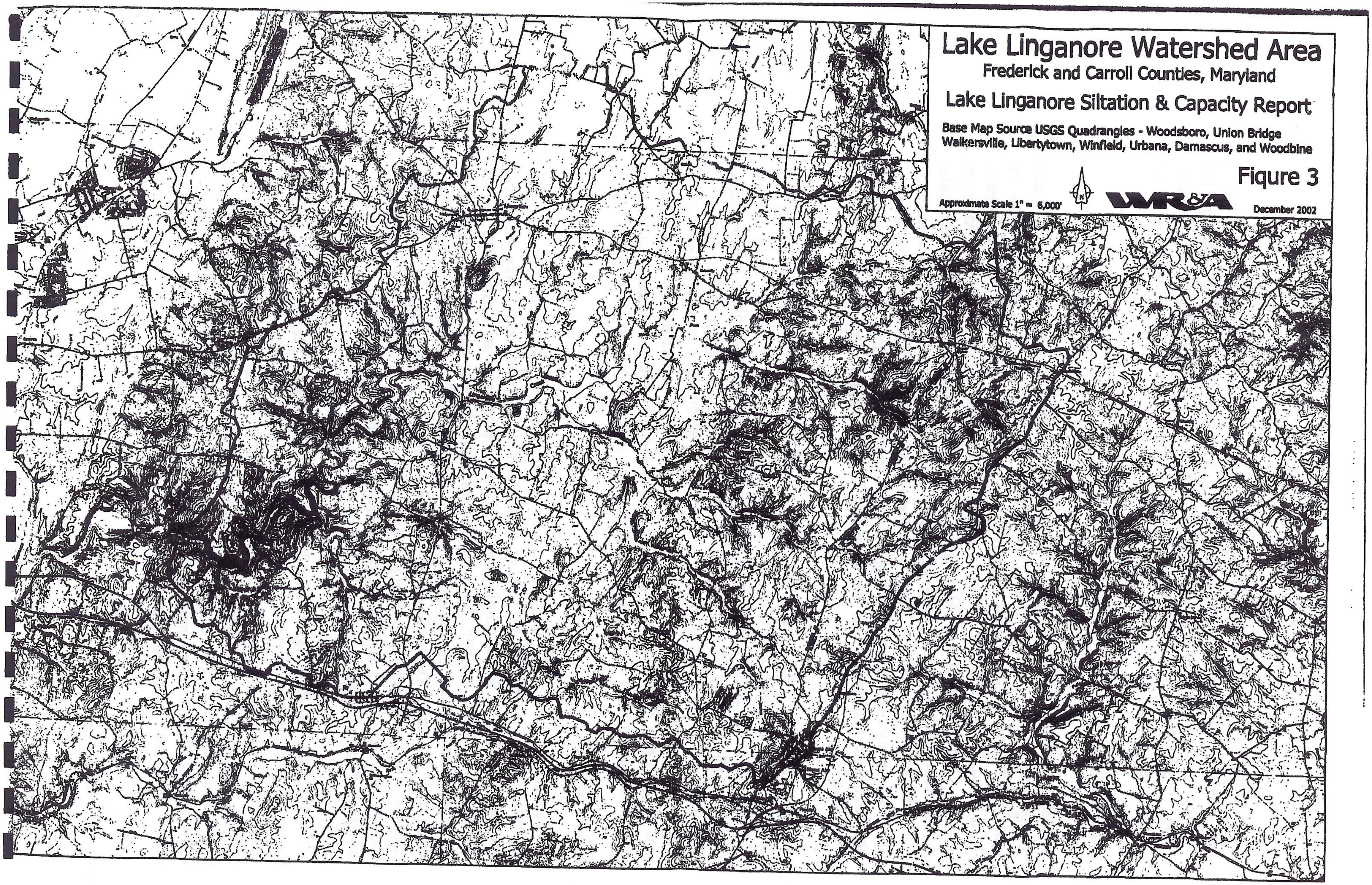
WR&A representatives visually inspected the extent of sedimentation in Lake Linganore using a small boat on March 19, 2002. The purpose was to qualitatively assess the extent of lake sedimentation. Downstream of the Boyers Mill Road Bridge, the lake bottom could not be touched with a 5-foot oar in most places. One exception was "Big Cove" along Eaglehead Road on the south side of the lake, where obvious progradation of a small sediment delta was observed. The tributary to the lake at Big Cove was choked with sediment ranging in size from silt to cobbles. Here, trees up to a few inches in diameter were growing in the sediment, indicating that the sediment deposit was several years old at the very least.

At the upper end of the lake in the Isles of Balmoral area, the channels were too shallow for the boat. The WR&A staff walked upstream to within sight of Gas House Pike at the north end of the lake area. Sediment accumulation is especially visible in the vicinity of the Isles of Balmoral at the upstream end of the lake. When the dam was completed in 1972, this area of the lake was deep enough to accommodate small boats. Today, the area is mostly impassable to small boats due to sand and silt bars. WR&A also performed a 1-day bathymetric survey of part of Lake Linganore, to spot-check lake depths on October 29, 2002.

3. Lake Capacity

All reservoirs formed by dams are subject to sediment inflow and deposition. WR&A has estimated the volume of sedimentation by comparing lake capacity curves derived from the original (pre-1972) lake topography and from 1999 aerial topography. In this method, the capacity corresponding to each elevation in the area-elevation data set is computed. The capacity difference between the two surveys is the estimated volume of sediment accumulation. This is a desktop analysis; it is not a direct measurement or field technique. Figure 4 is a schematic drawing showing the Lake Linganore storage volume. Figure 5 is a schematic drawing of Lake Linganore's capacity.

The topography of the original lake bottom was developed from pre-1972 aerial topography which was provided by Frederick County to WR&A. The exact date of the pre-1972 topography is not known, however it shows the stream valley that existed at the Lake Linganore site, before the Lake Linganore Dam was constructed in 1972. The original topography has a contour interval of 2 feet. The uncertainty associated with the pre-1972 topography is 1 foot of elevation, which is one-half the contour interval.


Lake Linganore Watershed Area
Frederick and Carroll Counties, Maryland
Lake Linganore Siltation & Capacity Report
Base Map Source USGS Quadrangles - Woodsboro, Union Bridge
Walkersville, Libertytown, Winfield, Urbana, Damascus, and Woodbine
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Approximate Scale 1" = 6,000'
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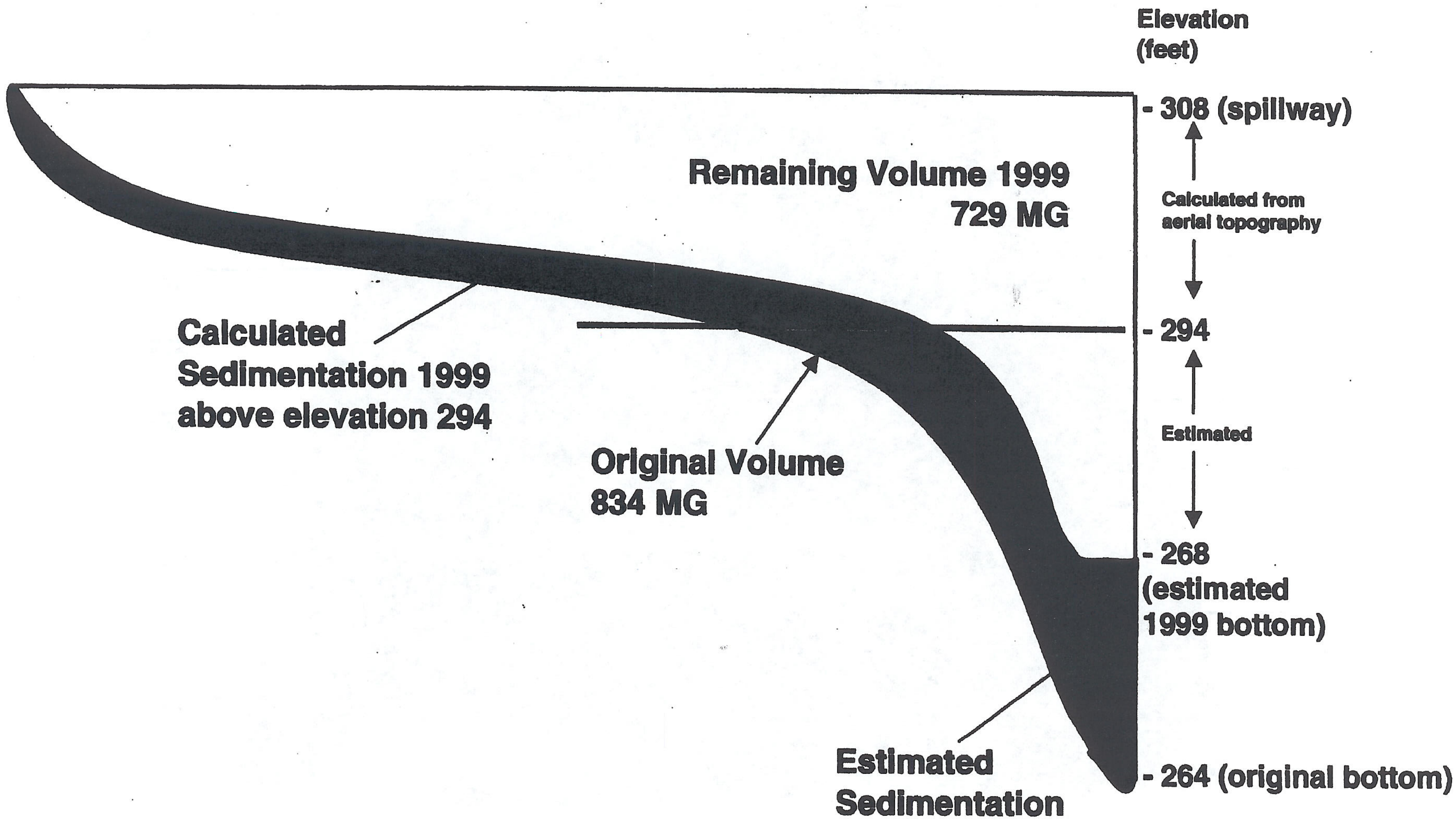
WR&A
December 2002

Lake Linganore Storage Volume

Figure 4



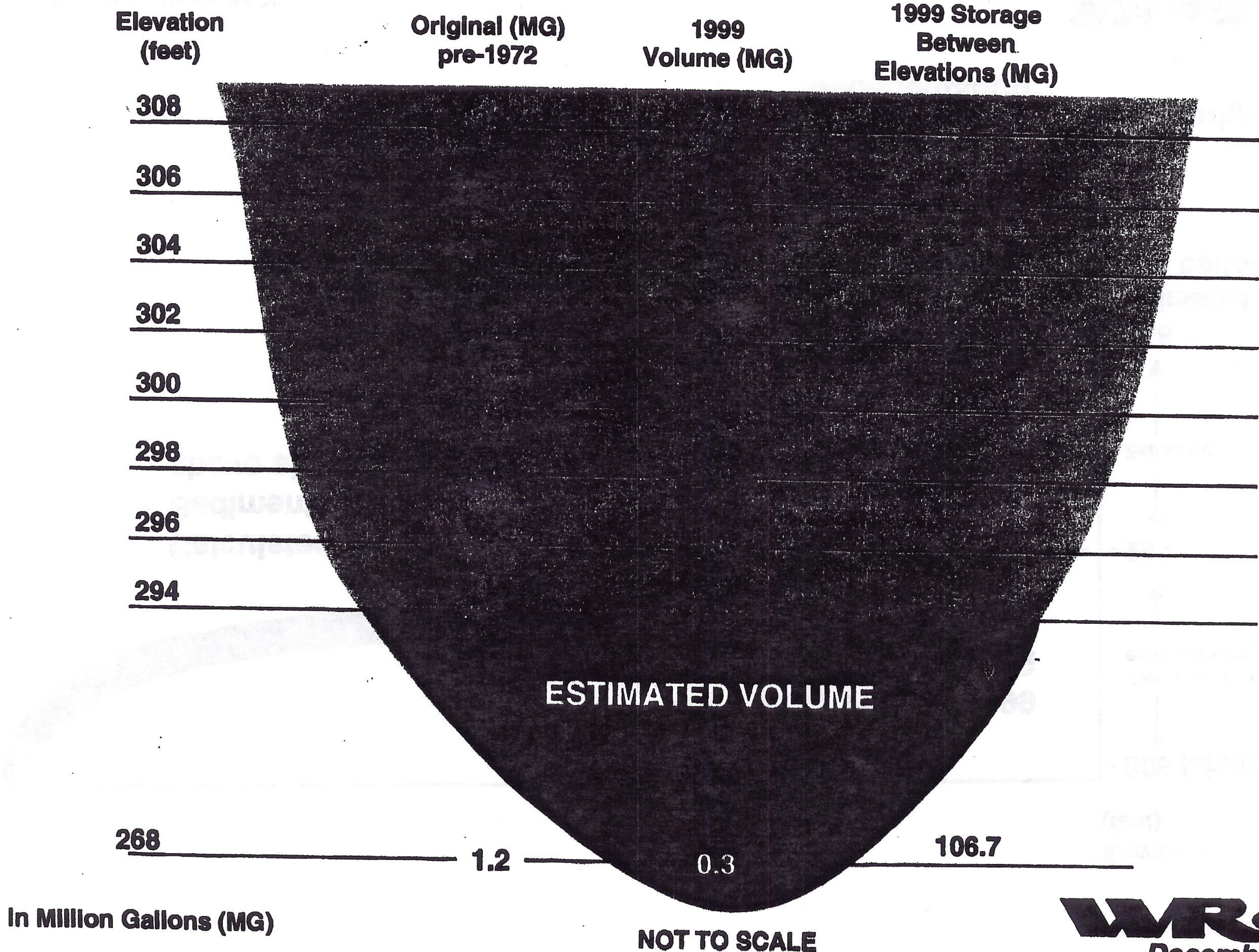
In Million Gallons (MG)

NOT TO SCALE

WR&A
December 2002

Lake Linganore Capacity

Figure 5



WR&A
December 2002

308
294
14

The topography of the lake bottom was also developed based on 1999 aerial topography. The aerial photographic survey was flown on May 1, 1999 by Wings Aerial Mapping Co. Inc. for LLA. The 1999 aerials were flown at a scale of 1 inch = 400 feet to take advantage of the lowered lake level (El. 292) at that time. The contour interval in the 1999 map is 2 feet. The scale of the 1999 topographic map is 1 inch = 50 feet, which is the same scale as the pre-1972 lake topography. Similar to the pre-development topography, the elevation uncertainty is 1 foot in the 1999 topography.

The vertical datum of the 1999 topography is NAVD 1988. The datum of the pre-1972 topographic map was not indicated on the map. However, comparison of land surface elevations on the pre-1972 topographic map, and the 1999 topographic map, indicates that the two maps used approximately the same elevation datum.

The lake capacity data obtained from the 1999 aerial topography is qualified to the extent that the capacity below elevation 294 was estimated. Given the lake level at the time of the flight, the 1999 aerial topography allowed for estimation of areas down to El. 292 only. The capacity below El. 294 was estimated by extrapolating the capacity curve, from El. 294 to El. 268. The elevation of 268 was estimated based on the results of a limited bathymetric survey performed on October 29, 2002.

The original lake volume was also estimated in the Phase I Dam Inspection Report (1980) by Rummel, Klepper & Kahl. In that report, it was stated that "......no significant amount of sedimentation was noted." The 1980 data was based on USGS mapping which probably had a contour interval of 20 feet. Therefore the 1980 area-capacity data is less precise than estimates based on a contour interval of 2 feet. WR&A did not attempt to match volumes based on 2-foot contours, with volumes based on 20-foot contours.

Table 1 contains the capacity data for the lake. The table shows the total lake capacity at each elevation. Figure 6 contains the curves for the pre-1972 lake capacity, the 1999 lake capacity, and the Phase I Dam Report (less precise) capacity. Figure 7 is an enlargement of the part of Figure 6 that corresponds to the deeper part of the lake. The capacity curves show the total lake capacity for every 2 feet of lake water level.

In comparing the pre-1972 lake capacity with the 1999 capacity, it is apparent that the lake has lost 104.5 million gallons (MG) of reservoir capacity between the two surveys, at the normal lake level of El. 308. The original capacity was 833.7 MG. The 1999 capacity was 729.2 MG. The difference between these two quantities is a capacity of 104.5 MG, which is equivalent to 320 acre-feet of sediment. (An acre-foot is a unit of volume which represents a thickness of 1 foot over an area of 1 acre.) The lake has lost approximately 13% of its capacity in the 27 years between the dam construction year of 1972 and 1999.

TABLE 1: LAKE LINGANORE CAPACITY

Elevation (feet)	WR&A pre-1972 Capacity* (MG)	WR&A 1999 Capacity* (MG)	Phase I Dam Report Capacity** (MG)
312		1039.6	
310		877.6	1010.6
308 (spillway)	833.7	729.2	
306	712.2	600.0	
304	601.9	489.8	
302	501.7	394.7	
300	412.4	310.0	407.5
298	333.7	233.3	
296	263.2	165.6	
294	201.2	106.8	
292	149.0	57.1	
290	107.5	42.4	146.7
288	76.4	32.6	
286	54.8	24.5	
284	40.3	19.6	
282	29.8	13.0	
280	21.7	8.2	32.6
278	15.6	6.5	
276	11.2	3.3	
274	7.7	1.6	
272	4.9	1.0	
270	2.7	0.7	3.3
268	1.2	0.3	
266	0.3		

*data based on 2-ft topographic contours
** from Phase I Dam report (1980) which used 20-ft topographic contours

Capacity is the cumulative capacity at the corresponding lake elevation.

MG = million gallons

Figure 6 - Lake Linganore Capacity Curves
Frederick County, Md.

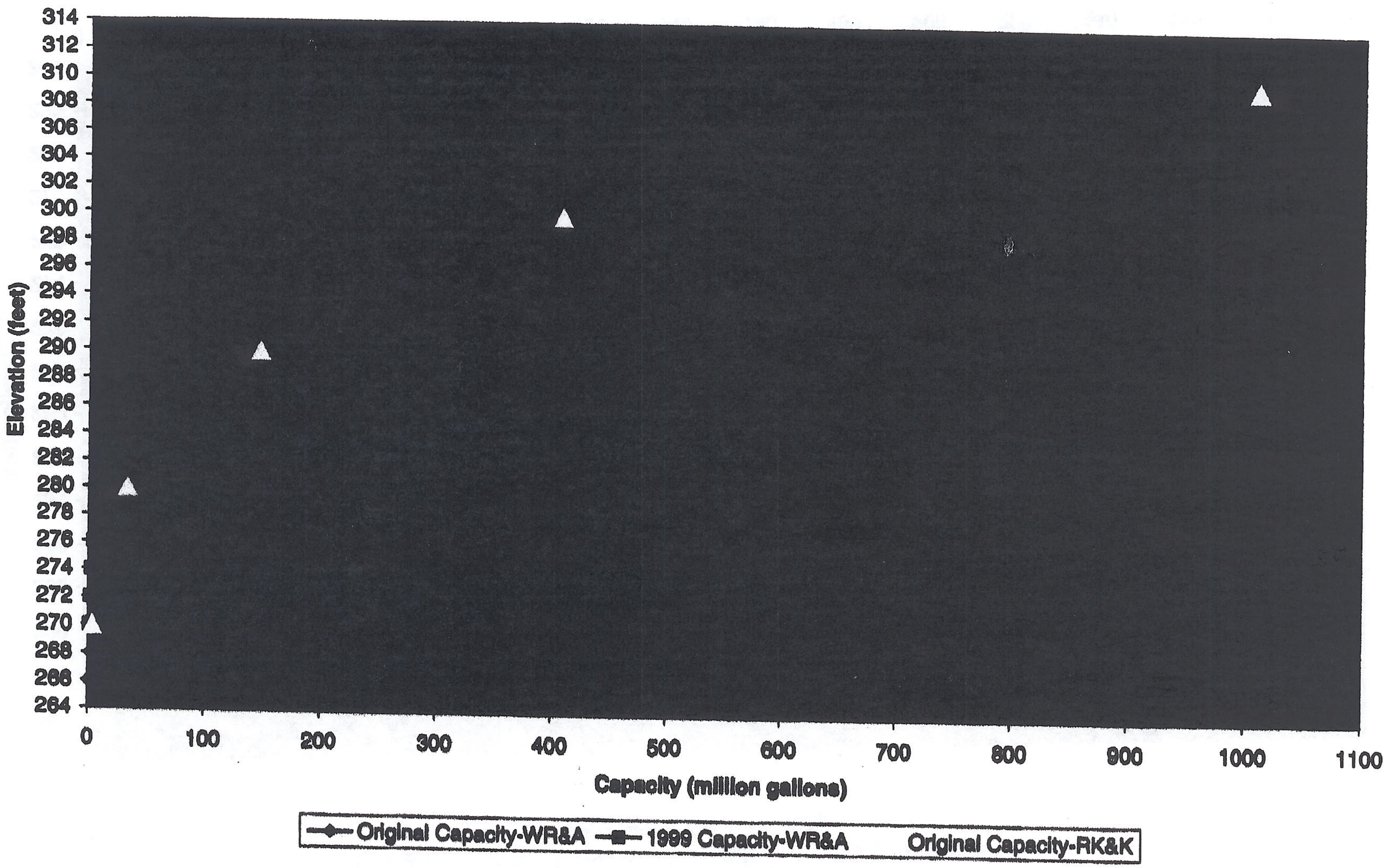
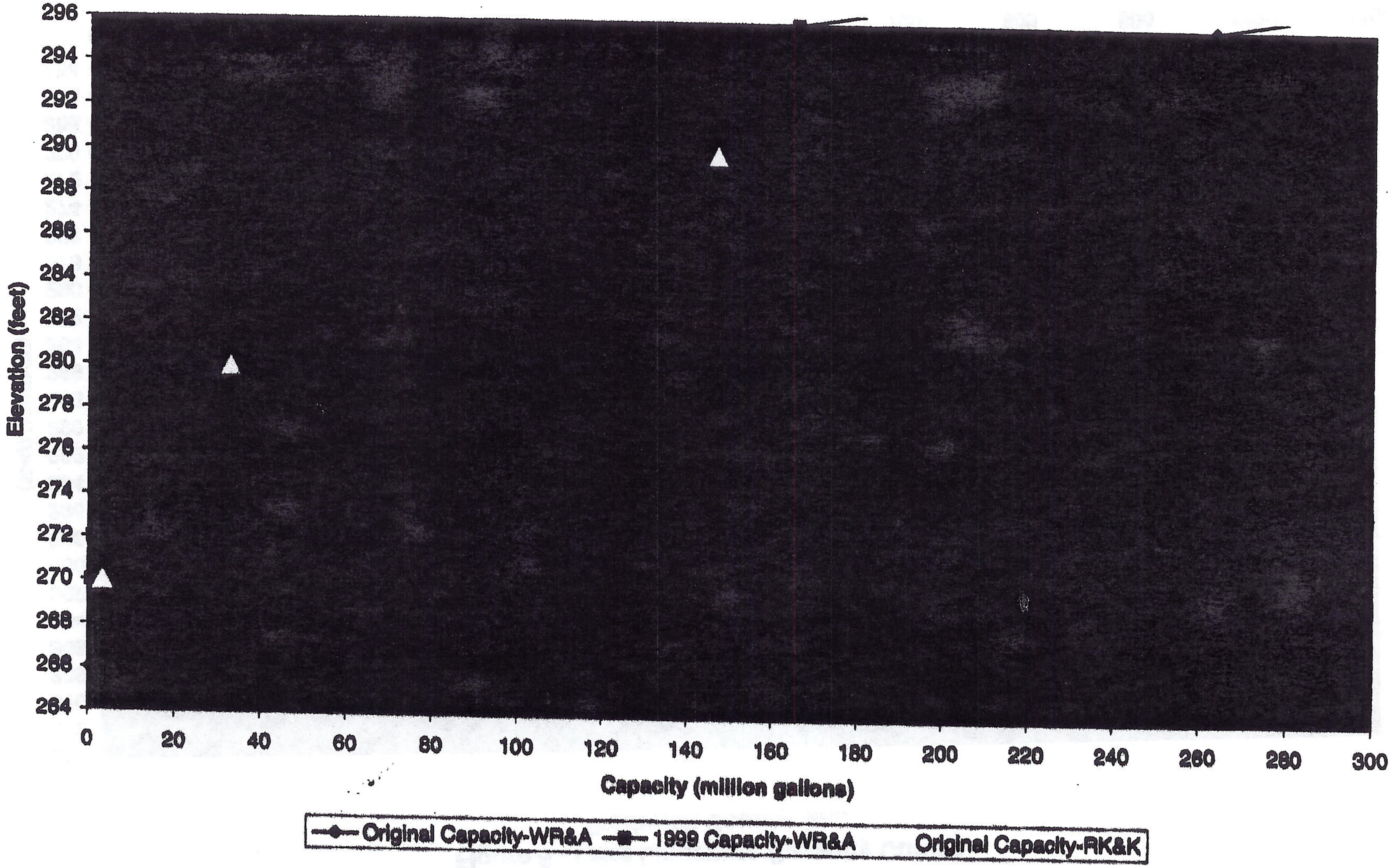


Figure 7 - Lake Linganore Capacity Curves (Enlargement)
Frederick County, Md.



WR&A used the best available data to estimate lake capacities. The mathematical uncertainties associated with the methods merit discussion. As noted earlier, the potential uncertainty associated with aerial topography is one-half the contour interval, which in this case is 1 foot uncertainty. The spot-checking of lake depths that was performed by WR&A and LLA on October 29, 2002, led us to revise our initial sedimentation estimate by approximately 2% from our September 2002 draft report. The spot-checking indicated that the current lake was deeper close to the dam than had been assumed in our earlier draft report calculations.

A factor that possibly impacted the computed capacities was calculation differences resulting from aerial topography development methods 30 years apart. In the 1970s, aerial topography was developed in a visual/manual fashion. Today it is developed digitally.

Another source of possible uncertainty in the computed lake capacities is the extrapolation which was necessary below El. 294 in the 1999 lake data. The total lake capacity below El. 294 is only approximately 8% of the total lake capacity at El. 308. Therefore, any uncertainty associated with the extrapolated portion of the lake volume would affect only 8% of the total lake volume. If the extrapolated portion varied by plus or minus 50%, then the total 1999 lake volume would vary by plus or minus 4%. We have high confidence in the 92% of the 1999 lake volume based on measured (not extrapolated) areas.

4. Options to Increase Lake Capacity

A. Dredging

The first option evaluated by WR&A for increasing the lake capacity is maintenance dredging to restore some of the original capacity of the lake. In general, lake dredging would benefit LLA residents to the extent that it would restore some of the lost lake volume and allow greater use of the lake. WR&A and LLA discussed dredging. LLA has indicated that it might buy a small dredge, remove 3 feet of sediments, and maintain the lake.

As noted earlier, we have estimated that 320 acre-feet of sediments have accumulated in Lake Linganore. This is equivalent to 512,000 cubic yards (cy) of sediment. If confined to the area of a football field, this volume of sediment would reach a height of approximately 242 feet. Using the data in Table 1, it is apparent that approximately 90% of this sedimentation (i.e. 463,000 cy) is present at El. 294 or higher. The zone of significant deposition above El. 294 is shown on Figure 1. Assuming two-thirds of the sediment above El. 294 would be hydraulically dredged from this zone, the dredge quantity is approximately 300,000 cy of sediment. This is the sediment volume used for cost estimation in this report. It is equivalent to approximately 188 acre-feet, or dredging 3 feet of sediments over a 63-acre portion of the lake. This would concentrate the dredging effort in approximately 30% of the lake area.

The most cost-effective dredging method would be hydraulic dredging and pumping sediment through pipes. The dredge spoils would be dewatered in basins by confined earthen dikes. This approach is preferred over the use of dewatering bags, or mechanical dewatering, which would be more expensive.

On October 15, 2002, WR&A discussed three possible dredging options on-site, with LLA and Mobile Dredging & Pumping Company. In the first dredging option, sediments would be piped to the 52-acre Isles of Balmoral area, where they would be deposited in dikes and dewatered. The potential spoils disposal area at the Isles of Balmoral is shown on Figure 1 and Figure 2. The dewatered sediments would be left in place.

Preliminary review of National Wetland Inventory maps and soil maps indicates that wetlands may exist in the Isles of Balmoral area, and they would be filled with dredge spoils. Under typical State and Federal permit procedures, such wetland filling would need to be mitigated by the construction of replacement wetlands. WR&A has estimated that the wetland mitigation costs would be approximately $45,000 per acre. The costs for the Isles of Balmoral option are estimated below, based on costs provided by Mobile Dredging and Pumping Company.

▪ Mobilization	$ 200,000
▪ Hydraulic Dredging, 188 acre-feet or 300,000 cy at $5.80/cy	1,740,000
▪ Wetland Mitigation: 20 acres x $45,000/acre	900,000
Subtotal	2,840,000
30% Contingency	852,000
20% Engineering/Administration	568,000
Total	~ $ 4,300,000

To accept 188 acre-feet of sediment, a 52-acre area would need to be filled 3.6 feet. The dredging would take approximately 2 years.

In the second dredging option, sediments would be piped to the Hamptons site for use as fill material. The Hamptons site is shown on Figure 1 and Figure 2. According to LLA, the owner of the Hamptons site has indicated that spoils disposal there may be possible. The Hamptons site is located north of Lake Linganore and east of Lake Merle. The entire Hamptons site is approximately 384 acres. The 300,000 cy of sediment could be placed at a thickness of approximately 2 feet over the preferred 100 acres of the Hamptons site. No wetland mitigation costs are expected in this option. The costs are estimated below.

▪ Mobilization	$ 200,000
▪ Hydraulic Dredging, 188 acre-feet or 300,000 cy at $7.00/cy	2,100,000
Subtotal	2,300,000
30% Contingency	690,000
20% Engineering/Administration	460,000
Total	**~$ 3,500,000**

In a third dredging option, sediments would be piped to the Big Cove area, which would serve as a temporary dewatering area for sediments. Big Cove is approximately 6 acres in size. After dewatering, sediments would be transported by truck to an off-site (undetermined) sediment disposal area via Eaglehead Drive. This option is not considered to be practical from a cost and permitting standpoint. Therefore, it has been dropped from consideration.

To consider the possibility of on-site dredge spoils disposal, WR&A estimated the capacity of the "Bowl" and "Pond", two Lake Linganore Association basins. Together, the two basins have a capacity of approximately 56,000 cy, which represents less than one-fifth of the estimated 300,000-cy spoils quantity. Therefore, the Bowl and Pond are not recommended for use as disposal areas at this time. They could be considered for use in future maintenance dredging operations.

The second dredging option, the Hamptons option, is the most cost-effective dredging option. This is due to the on-site disposal of the dewatered sediments and the absence of wetland mitigation costs for the Hamptons option.

A dredging contractor familiar with the Lake indicated that the dredging program described above could be continuously completed over an approximate 2-year period. Dredging costs could be phased.

The Lake Linganore Association collected six sediment samples from Lake Linganore on April 13, 2002. The samples were analyzed for volatile solids by the Frederick County Division of Utilities and Solid Waste Management Laboratory. The volatile solids test is an approximate measure of the amount of organic matter present. The results of the volatile solids tests are in the Appendix. The volatile solids ranged from 3.9 to 8.6 percent in the samples tested. No other quality data on the sediments is available.

For each acre-foot of sediment dredged, 326,000 gallons of lake capacity would be restored. The 188-acre-foot (300,000 cy) dredging program described above would restore approximately 61 MG of reservoir capacity to Lake Linganore. This is equivalent to the restoration of approximately 58% of the lake volume lost due to sedimentation since the dam was constructed in 1972.

Any dredging would require the disposal of dredge spoils under a Maryland Department of the Environment (MDE) permit. The work would also be subject to requirements of the Maryland Dam Safety Division, the Maryland Department of Natural Resources, and the U.S. Army Corps of Engineers. WR&A met with representatives of MDE and the U. S. Army Corps of Engineers on August 30, 2002 to discuss the permit requirements that would be associated with restoration of the lake capacity. MDE would require a Tidal Wetland License/Permit for the filling and dredging of open water and vegetated tidal wetlands. Due to wetland impacts, Corps of Engineers permits would also be required. Changing the reservoir volume also requires a Waterway Construction Permit for the dam. MDE and the Corps of Engineers indicated that dredging of the lake would be considered maintenance work to restore lake capacity.

After the lake capacity is restored to the extent possible by dredging, long-term sediment management will be needed. For long-term maintenance dredging, a forebay could be constructed at the location indicated on Figure 1. The forebay would accumulate a substantial portion of the sediment entering the lake in a confined area for removal. A rip rap weir could be constructed to create the forebay. The weir would need to allow residents' boats to pass over it. The advantage of the forebay is that it reduces water flow velocities and concentrates sediments in a relatively small zone for more practical sediment removal in the future. We estimate that the weir construction cost is $60,000. The cost of the forebay is essentially the cost of this weir.

A 23-acre forebay would extend from the rip rap weir to the Isles to Balmoral. An estimate of the sedimentation rate in the proposed forebay is 0.44 feet/year. This was estimated as follows: 320 acre-feet of sediment in approximately 30 years equals 11 acre-feet/year. If the annual sediment load were captured in a 23-acre forebay, the sedimentation in the forebay would be 11 acre-feet/year over 23 acres, which is approximately 0.5 foot/year. This is equivalent to approximately 18,000 cy of sediment entering the forebay per year. Approximately one foot of maintenance dredging would have to be performed every 2 years in the forebay in order to maintain the lake capacity that would be restored by the 3-foot dredging program described earlier.

The long-term forebay dredging could be performed by LLA if it purchased a dredging machine. Ellicott, a division of Baltimore Dredges, LLC (a leading dredge manufacturer) indicated that the cost of such a dredge would be approximately $300,000. The Bowl and Pond have the capacity for approximately 3 years of maintenance dredge spoils, and these basins could serve as interim disposal areas until a long-term sediment disposal site is selected for Lake Linganore. The initial cost of implementing the long-term maintenance dredging program in the forebay is estimated below.

▪ Purchase dredge/mobilization	$ 300,000
▪ Construct forebay	60,000
▪ Improve access	40,000
Subtotal	400,000
25% Contingency	100,000
20% Engineering/Administration	80,000
Total	**~$ 580,000**

The annual cost of maintenance dredging in the forebay is estimated below. Such dredging would restore approximately 3.7 MG to the lake each year.

▪ Hydraulic dredging into Bowl/Pond, 18,000 cy at 7.00/cy	$ 126,000	/year
Subtotal	126,000	
30% Contingency	37,800	
20% Engineering/Administration	25,200	
Total	**~$190,000**	**/year**

B. Emergency Excavation of Sediment

The County has requested that the option of emergency excavation of lake sediments be assessed. This could potentially be performed if the lake were intentionally dewatered or if drought caused the lake level to drop far below normal pool. Excavation of sediments would be performed with clamshell or excavator machinery. The excavation cost is estimated below.

▪ Excavation (including backhoe, front-end loader, on-site hauling, on-site road maintenance, dewatering, mobilization/demobilization): 300,000 cy at $10/cy	$ 3,000,000
▪ Hauling, 300,000 cy at $4.00/cy	1,200,000
▪ Placing/spreading materials, 300,000 cy at $1.30/cy	390,000
Subtotal	4,590,000
25% Contingency	1,147,500
20% Engineering/Administration	918,000
Total	**~$ 6,700,000**

Additional unquantified costs associated with the emergency excavation option include the cost of major access into and out of the reservoir and redirection of inlet water during excavation.

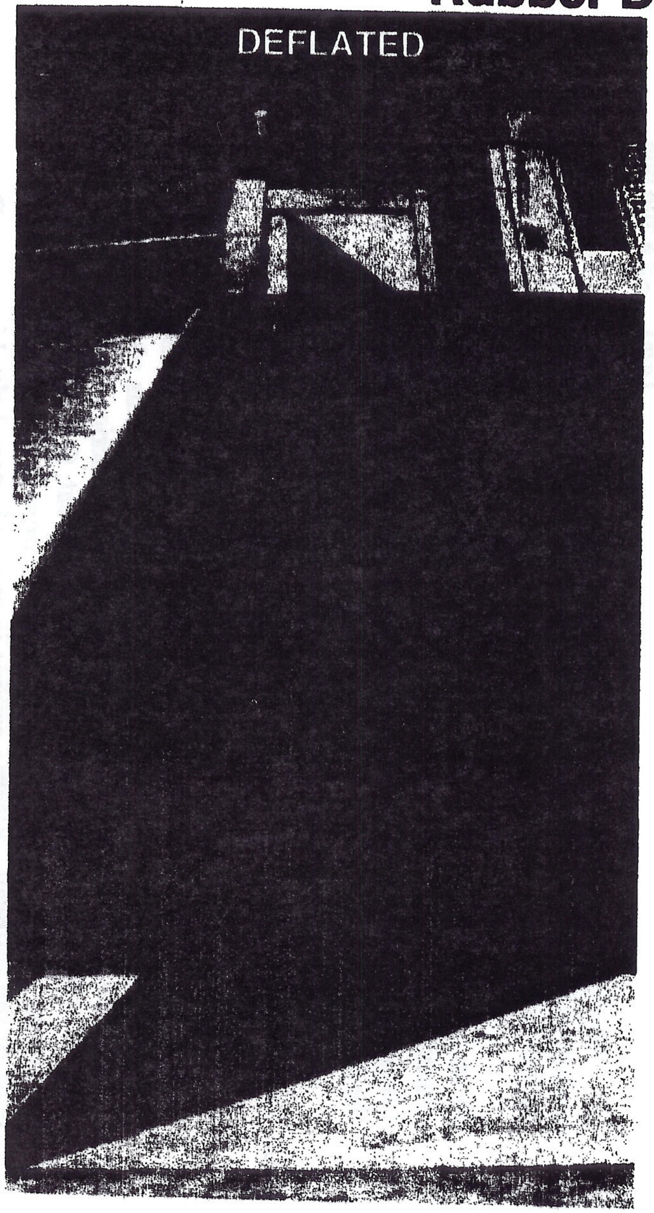
From a permit standpoint, excavation of the sediments from the lake would be considered maintenance work to restore the original capacity of Lake Linganore. The permit requirements would be similar to those described in the dredging option earlier in the report.

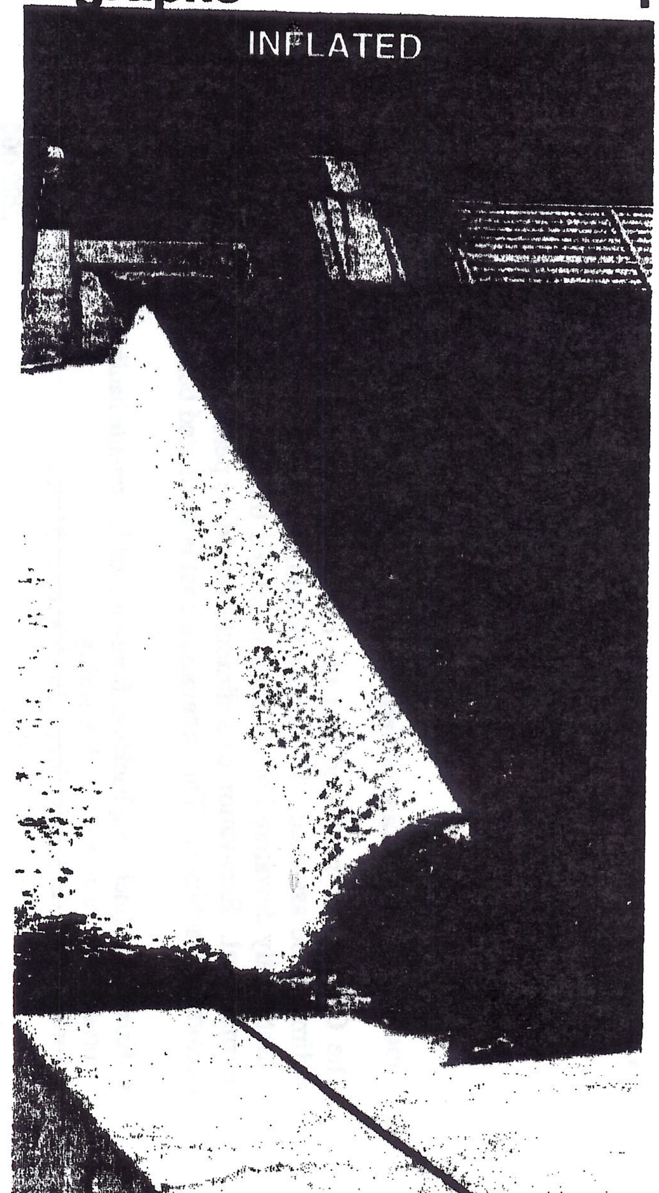
C. Raise Water Level

A third option for increasing the capacity of Lake Linganore which was evaluated by WR&A is to raise the water level. Rubber dams are frequently used to retrofit dams for this purpose. Figure 8 contains photographs of a rubber dam, and Figure 9 is an illustration of the interior of a typical rubber dam. A rubber dam is inflatable. In a flood event, the air may be let out of the rubber dam completely to release water from the lake and to lower the crest of the spillway. Electric service is available near Lake Linganore Dam for the air compressor and control systems.

Rubber Dam Photographs

Figure 8

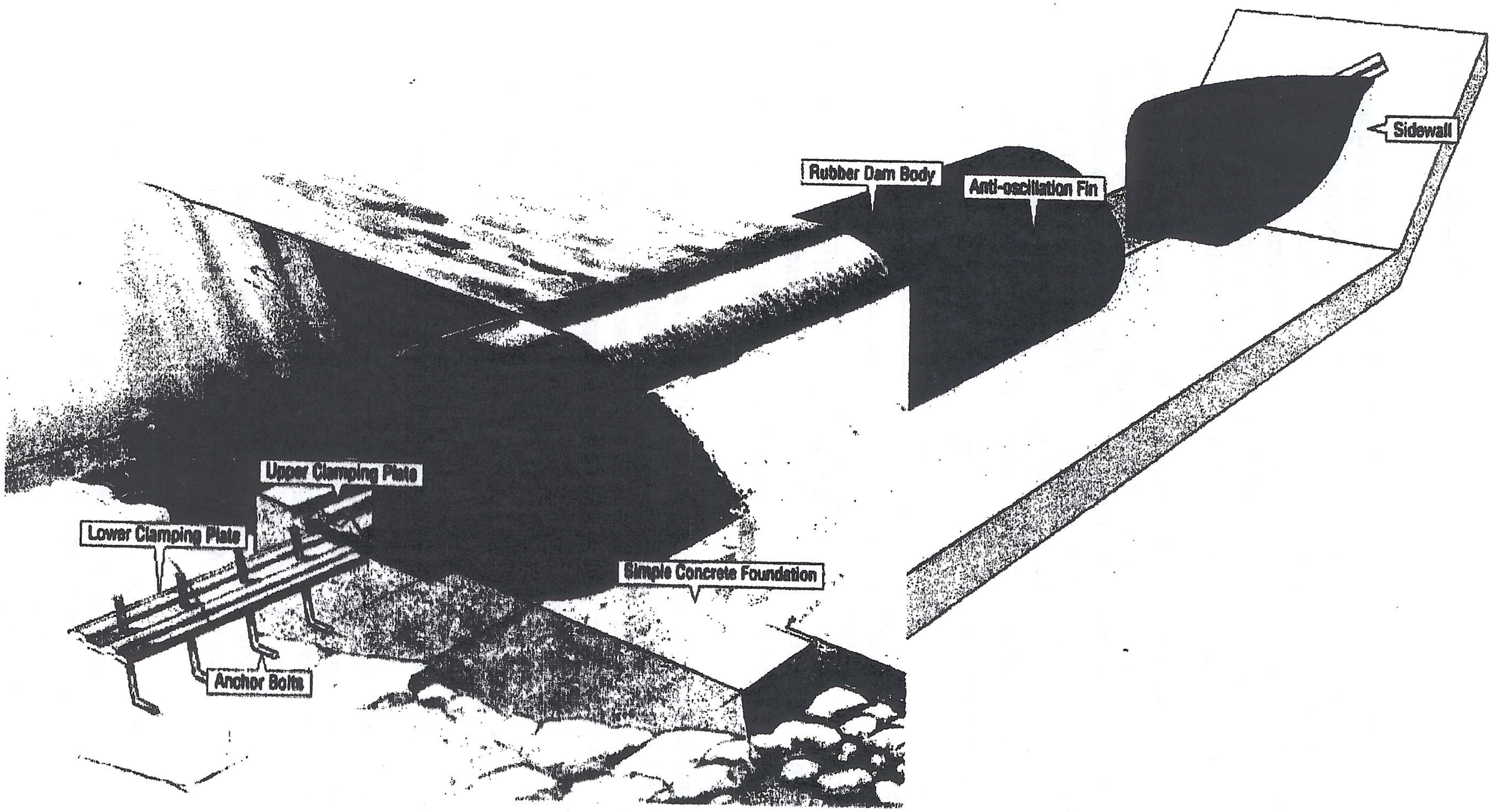




WR&A
December 2002

Typical Rubber Dam

Figure 9



WR&A
December 2002

WR&A met with a representative of the Dam Safety Division at MDE on March 4, 2002, to preliminarily discuss the rubber dam option. The response from MDE Dam Safety was generally favorable toward this option. MDE suggested cutting the existing spillway down and installing a rubber dam with a height of 2 to 3 feet. These improvements would require a hydraulic/hydrologic study, reconstruction of the spillway and installation of the rubber dam.

Although there are no rubber dams currently in use in Maryland, they have been successfully used in Pennsylvania, Virginia and New England. An example where a rubber dam has been successfully used is at Lake Manassas in Virginia. At Lake Manassas, the spillway crest was raised 5 feet with the installation of a rubber dam. The lake capacity was increased by approximately one billion gallons as a result of the rubber dam emplacement.

The installation of a rubber dam at Lake Linganore would need to be coordinated with ongoing dam repairs. Frederick County has indicated that the dam repair designers have been instructed to design wall repairs that do not prevent the installation of a rubber dam on the spillway.

If a rubber dam were installed, some wetlands surrounding the lake would be submerged. These wetlands were not identified by a formal wetland delineation, and their acreage was estimated with National Wetland Inventory maps and soil maps only. The following is a breakdown of the acres of wetlands that would be submerged for each foot of dam freeboard increase:

Dam Freeboard Increase (feet)	New Pool Elevation (feet)	Reservoir Capacity Added (MG)	Total Reservoir Capacity (MG)	Wetlands Submerged (Acres)
0	308	0	729	0
1	309	71	800	4.6
2	310	149	878	9.2
3	311	221	950	13.7

Increasing the dam freeboard would require a Nontidal Wetlands and Waterways Water Quality Certification. As noted earlier in the report, WR&A met with representatives of MDE and the U. S. Army Corps of Engineers on August 30, 2002 to discuss the permit requirements. The Corps indicated that no credit would be given for any new wetlands that would theoretically be created at the fringes of the lake, if the lake level were raised.

The Nontidal Wetlands and Waterways Division of MDE and the Corps of Engineers indicated that unlike dredging, the installation of a rubber dam would not be considered maintenance work to restore lake capacity. The impact on existing wetlands and streams would be relatively large. An alternatives analysis would need to be performed to assess the various means of meeting the water supply needs (e.g., a rubber dam at Lake Linganore, dredging at Lake Linganore, water from the Potomac River, ground water sources, etc.). It is estimated that this permit process would take two years or longer. The cost of raising the lake level with a rubber dam must include the potential costs of wetland mitigation. The estimated wetland mitigation cost is $45,000/acre. Wetland mitigation involves the construction of new wetlands to replace wetlands lost due to construction of the rubber dam.

WR&A obtained approximate costs for rubber dams from Bridgestone, a manufacturer of rubber dams. The estimated cost for a 2-foot high rubber dam on top of the existing ogee spillway is as follows:

2-ft rubber dam	$ 67,000
6x control system	$ 39,400
deflation override	$ 14,000
manufacturer adviser	$ 12,000
dam construction	$150,000
dam design	$100,000
possible wetland mitigation (9.2 acres)	$414,000
Subtotal	$796,400
30% Contingency	$238,920
20% Engineering/Administration	$159,280
Total	**~$1,200,000** for gain of 149 MG

For a 3-foot rubber dam, the estimated cost is as follows:

3-ft rubber dam	$87,000
6x control system	$39,400
deflation override	$14,000
manufacturer adviser	$12,000
dam construction	$150,000
dam design	$100,000
possible wetland mitigation (13.7 acres)	$616,500
Subtotal	$1,018,900
30% Contingency	$ 305,670
20% Engineering/Administration	203,780
Total	**~$1,500,000** for gain of 221 MG

Another issue relevant to raising the level of the dam is potential flooding of sewer interceptors, and shoreline facilities (e.g., docks) owned by Lake Linganore residents.

5. Conclusions and Recommendations

Whitman, Requardt & Associates, LLP performed a siltation and capacity study of Lake Linganore for the Frederick County Department of Public Works. We estimated the volume of sedimentation by comparing capacities based on the pre-1972 Lake Linganore topography, and 1999 aerial topography which was flown with the lake level lowered. The lake capacity decreased approximately 13% from its construction until 1999. The estimated amount of siltation is 320 acre-feet, or a loss of 104.5 MG at the normal pool elevation of 308 ft.

The costs of the options assessed in this report are summarized below.

Option for Increasing Lake Capacity	Cost ($ million)	Lake Capacity Added (Million Gallons)	Cost per Million Gallons
I. Dredging		61 MG	
A. Isles of Balmoral	$4.3M		$70,000
B. Hamptons	$3.5M		57,000
II. Emergency Excavation	$6.7M	61 MG	$110,000
III. Rubber Dam			
2-ft. Rubber Dam	$1.2M	149 MG	$8,000
3-ft. Rubber Dam	$1.5M	221 MG	$6,800
IV. Long-Term Maintenance			
Initial	$0.6M	--	--
Annual	$0.2M	3.7 MG/year	$54,000/year

A rubber dam on top of the existing ogee spillway to raise the lake level is the most cost-effective method of restoring reservoir capacity to Lake Linganore. Constructing a forebay and dredging the upper reaches of the lake will also restore capacity and provide long-term control of siltation of the reservoir. We are recommending a combined dredging and rubber dam retrofitting program in order to restore reservoir capacity to Lake Linganore. An added benefit of the forebay/dredging program is the implementation of a long-term program to manage sediment accumulation in Lake Linganore. A detailed bathymetric survey of the lake bottom as well as a thorough sediment sampling and testing program are recommended as part of any lake improvement program. An inventory of trails and other features that would potentially be impacted by raised reservoir levels should be performed as part of the dam studies.

APPENDIX

DIVISION OF UTILITIES AND SOLID WASTE MANAGEMENT

Frederick County, Maryland

118 North Market Street Frederick, Maryland 21701-5422 (301) 694-2078 FAX (301) 631-2349

LETTER OF TRANSMITTAL

October 28, 2002

TO:	Stephen L. Mogilnicki, WR&A	PROJECT	Lake Linganore Siltation Report

We are sending you: Two (1) copy of the Volatile Solids analysis of lake sediments

X	Herewith		Via Messenger		Under Separate Cover
	Via FAX [illegible]		Number of pages via Fax [illegible]		[illegible]

# OF COPIES		DESCRIPTION	ACTION
1		Lab Analysis	For Your use

***** CONFIDENTIALITY NOTICE *****

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REMARKS: **This analysis of samples collected by John Snow should be included in the lake siltation report. Should you have any questions regarding this information please feel free to contact Mark Schweitzer, supervisor of our environmental lab at 301-694-1597?**

DIVISION OF UTITLTIES AND SOLID WASTE MANAGEMENT

By: ______________________

Michael G. Marschner, Director

KLD:kld [D:\data\MS Word\FORMS\Tranmsittal Form.doc]

pc: One (1) enclosure:
Jim Reed (LLA)

Frederick County
Division of Utilities
and Solid Waste Management
Laboratory
(301) 694-1597
Maryland Cert # G-1044

Table 1 Results of Volatile Solids (VS) Analyses performed on samples collected from Lake Linganore on April 13, 2002 by John Snow. Analyses conducted using Standard Methods 2540E by JS.

Sample Description (GPS Coordinates)	Parameter	Results (% VS)	Date of Analysis
39.4152/77.3033	VS	8.2	4-25-02
39.4162/77.3014	VS	8.5	4-25-02
39.4164/73.3067	VS	6.0	4-25-02
39.4159/77.3073	VS	3.9	4-25-02
39.4223/77.2966	VS	7.5	4-25-02
39.4236/77.2936	VS	8.6	4-25-02

Prepared by: Mark A. Schwartz Date: 9-16-02

Whitman, Requardt & Associates, LLP

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