

## **Sediment Study in Lake Linganore Watershed**

\*Excerpted from the Sediment, Phosphorus, Habitat,  
and Land Use in the Lake Linganore Watershed:  
A practical approach to assisting Frederick  
County in the TMDL Process  
by Alan Gellis Allen C Gellis [agellis@usgs.gov]

---

The Board of County Commissioners recently partnered with the U.S. Geological Survey to study Sediment, Phosphorus, Habitat, and Land Use in the Lake Linganore Watershed.

Lake Linganore, located in Frederick County, Maryland, was impounded in 1972 for the purposes of water supply and recreational use. The lake has been impacted by high sediment loads and associated phosphorus. Due to the excess sediment and nutrients, the Lake Linganore watershed is listed on the state list of impaired water bodies. As a result of being on this list, the state has set regulatory limits of phosphorus and sediment to the lake; these limits are known as Total Maximum Daily Loads, or TMDLs. The Lake Linganore TMDL was approved in May 2003 to reduce sediment and nutrients (Maryland Department of the Environment, 2002). The water quality goal of the TMDL is to reduce long-term phosphorus and sediment loadings to acceptable levels. Phosphorus is generally transported bound to suspended sediments in the water column. It is estimated that a 90% reduction in phosphorus loads would be necessary to meet the TMDL for phosphorus. Reduced sediment loading rates in Lake Linganore are expected to result in preserving about 48% - 79% of the lake's design volume over a period of 40 years (Maryland Department of the Environment, 2002). In order to reduce sediment and associated phosphorus loads to Lake Linganore, it is important to quantify sediment and phosphorous loadings, identify the significant sources of sediment and associated phosphorus to the lake, and develop strategies to monitor the success of management actions in reducing sediment and phosphorous.

The Linganore Reservoir plant has a water supply capacity to the City of Frederick of 6.0 million gallons per day. As a result of sediment problems in the receiving waters, the Lake's capacity was recognized as being compromised by sedimentation (City of Frederick, 2002). However, the storage capacity of the lake has never been adequately quantified. Without this knowledge, the amount of future storage lost by sedimentation and the useful life of the lake cannot be determined. This proposal incorporates an integrated design of determining Lake Linganore's sedimentation rate and storage capacity, with approaches to understand and identify the significant sources of sediment and associated phosphorus to the lake.

The Lake Linganore Watershed drains the Lower Monocacy River basin in the Piedmont Physiographic Province, the highest sediment-yielding region in the Chesapeake Bay Watershed (Gellis et al., 2005). The Monocacy River is a major tributary to the Potomac River that enters the Chesapeake Bay. The Bay is listed as an impaired water body with respect to sediment and excess nutrients. The Piedmont Physiographic Province is a

region that has gone through dramatic land-use change since European colonization and extending to the early 20<sup>th</sup> century, as forests were cleared for agriculture. Soil erosion that occurred during this land clearing was deposited in streams and behind mill ponds and can be identified in many stream banks as 'legacy sediment' (Walter and Merritts, 2008).

Land use in the 89 mi<sup>2</sup> Lake Linganore Watershed is 5% developed, 21% forested, and 70% agriculture (USGS, 2001 National Land Cover Data). Frederick County is in commuting distance to the metropolitan Washington DC area and is undergoing a second land-use change as forests and agriculture are converted to urban and suburban areas. Over the 1990's, the population of Frederick County increased 30% (45,000 persons) and impervious surfaces increased by almost 37%. From 2000 to 2005, Frederick County's population grew by the addition of 25,000 persons. Urban land-use conversion can also have a dramatic effect on runoff, stream flow, erosion, and sediment and phosphorus loadings. These two land conversions outlined above are typical for the Chesapeake Bay watershed and it is therefore important to document and understand the changes that occur to sediment and phosphorus dynamics so we can better understand the process and implement successful management strategies to reduce sediment and phosphorus loadings to the Bay.

In order to reduce sediment and phosphorous pollution in Lake Linganore, USGS will take a 3-step approach: (1) Identify the significant sources of sediment and phosphorous to Lake Linganore, (2) Develop and implement plans to reduce sediment and phosphorous to Lake Linganore, (3) Monitor the effectiveness of actions in reducing sediment and phosphorous.

The U.S. Geological Survey will assist Frederick County in this 3-step approach by:

- Determining sediment and phosphorous loadings into Lake Linganore, including identification of their sources, and their relation to land-use type.
- Conducting a bathymetric survey of Lake Linganore to determine the current storage capacity of Linganore and its sedimentation rate since closure in 1972.
- Developing management tools for Frederick County to assist in prioritizing and targeting areas to reduce sediment and phosphorous.
- Developing approaches to monitor the effectiveness of management actions to reduce sediment and phosphorous.

The data collected and interpreted by USGS will benefit Frederick County by:

- Determining the amount of storage capacity in Lake Linganore
- Determining the amount of sediment deposited in the Lake since closure and estimating the projected life of the reservoir,
- Providing a framework for future monitoring of sedimentation in Lake Linganore and its watershed
- Assisting in Frederick County's re-evaluation of the sediment and phosphorous TMDL through -
  - quantification of sediment and phosphorous loadings to the lake,
  - understanding the correlation of sediment to sorbed phosphorous

- a comparison of contributions of sediment and phosphorus from different land-use types.
- creation of maps showing significant sources of sediment and phosphorous which can be used by Frederick County to direct management actions,
- development of strategies to reduce sediment and phosphorous
- development of approaches to monitor the effectiveness of management actions to reduce sediment and phosphorous

The U.S. Geological Survey, through it's Chesapeake Bay Studies, is providing integrated science for improved understanding and management of the Chesapeake Bay ecosystem. Topics that are being addressed in the Lake Linganore and other focus watersheds are to:

- Understand the spatial processes affecting fate and transport of phosphorus and sediment to better target management actions.
- Assess and forecast changes in human activities and water quality to help evaluate management actions and future policies.
- Define the factors affecting the fish health and habitats in the watershed to develop management strategies.
- Provide implications and decision-support tools and analysis to enhance ecosystem management.

Products that will be generated from this study include: (1) phosphorous and sediment loads entering Lake Linganore, (2) maps showing areas in the watershed of high sediment and phosphorous loadings, (3) the amount of phosphorous sorbed onto the eroded sediment, (4) framework for a monitoring design of sediment and phosphorous, (5) bathymetric map of Lake Linganore, (6) a U.S. Geological Survey Publication, (7) several peer-reviewed journal articles, and (8) basic data. The USGS publication will be printed in January 2011. Journal articles will be published in 2011 and beyond.