# Hurricane Lake, West Virginia

## Total Maximum Daily Loads
## for
## Phosphorous, Sediment, and Iron

**Established by**
**The Environmental Protection Agency, Region III**

**September 30, 1998**

# TOTAL MAXIMUM DAILY LOADS
# HURRICANE LAKE, WEST VIRGINIA

## Introduction

The West Virginia Division of Environmental Protection (DEP) listed Hurricane Lake (stream code #K(L)-22-(1)) on its 1996 Section 303(d) list due to nutrients, siltation, and metals from domestic sewage, construction, and urban runoff. The Total Maximum Daily Loads (TMDLs) presented here address these three pollutants.

To develop this TMDL, EPA used two computer models. First, the Hydrologic Simulation Program Fortran (HSPF) was used to simulate the runoff of pollutants from the watershed, the delivery of those pollutants to the stream channels, and the routing of the pollutants to the lake. Second, the Environmental Fluid Dynamics Code (EFDC) was used to simulate the transport and fate of the pollutants once they were delivered to the lake. The models were then run with reduced pollutant loads until water quality standards were met.

EPA is establishing a TMDL for phosphorous to address the nutrient impairment. Based on previous studies of Hurricane Lake and similar lakes in West Virginia, EPA determined that phosphorous is the limiting nutrient[1] in the lake, and thus a TMDL for phosphorous, in lieu of other nutrients, is adequate to control the eutrophication problem. For siltation, EPA is establishing a TMDL for the amount of sediment that enters the lake. For metals, EPA is establishing a TMDL for Iron, as this particular metal is the one metal that has been shown to violate state water quality criteria in Hurricane Lake. Table 1 summarizes the TMDLs and the component wasteload (WLA) and load allocations (LA) needed to meet the TMDL.

Table 1. Summary of TMDL (kg/day)[a]

| PARAMETER | WLA | LA[b] | MOS | TMDL |
|---|---|---|---|---|
| Phosphorous | 0 | 1.28 | implicit | 1.28 |
| Sediment | 0 | 6293.82 | implicit | 6293.82 |
| Iron | 0 | 15.89 | implicit | 15.89 |

TABLE NOTES:

a. The TMDL technical development report expresses the sediment loads on an annual basis. For the purpose of this table, and consistency with previous TMDLs, EPA has divided those values by 365 days to arrive at daily loads.

[1]Algae require inorganic carbon, nitrogen, phosphorous, silica, and various trace elements in the presence of light in order to grow. The ratio of these nutrients to each other falls into a known range depending on the age of the algae and species composition. If the quantity any one of the nutrients is too low, falling outside the range of ratios, the algae will not grow. In other words, a single nutrient—known as the limiting nutrient—can control algae growth.

b. The load allocation is the sum of the loads from several categories of nonpoint sources. The separate allocations are shown below in the discussion of WLAs and LAs.

EPA developed this TMDL consistent with statutory and regulatory requirements and EPA policy and guidance. The Hurricane Lake TMDL addresses the following seven regulatory elements:

**1. Water quality standards.**

These TMDLs ensure that Burches Run Lake will meet the applicable water quality criteria for nutrients, siltation, and iron thus ensuring that the water supports its designated use. West Virginia has only narrative criteria related to nutrients and siltation. West Virginia has a numeric water quality criteria for iron of 1.5 mg/l, which applies to Category A waters (public water supply) such as Hurricane Lake.

For the nutrient TMDL, EPA has elected to use chlorophyl-a as a surrogate indicator of eutrophication. A value of 15 $\mu$g/l, which represents the low end of a range of published acceptable values, was selected as the specific endpoint. The phosphorous load, therefore, was reduced to the point where chlorophyl-*a* was below 15 $\mu$g/l. The endpoint for the iron TMDL is the numeric criteria: 1.5 mg/l.

Selecting an endpoint to represent attainment of standards for siltation is more difficult. Impoundments such as Hurricane Run Lake, by their nature, are subject to siltation. The challenge is to select a rate of siltation that is reasonable, recognizing that a significant amount of siltation is inevitable. For this TMDL, EPA determined, based on best professional judgement, that an appropriate indicator of standards attainment was a sedimentation rate that would result in 30% of the average reservoir depth being preserved (70% reduced) after 40 years. At the existing rate of siltation, 70% of the remaining capacity would be reduced in only 32 years. Because the lake is already severely impacted by siltation—the mean depth is a mere 1.08 meters—preserving 30% of the remaining depth would require reducing siltation by a full 62%. EPA is not confident that such a significant reduction is feasible and has therefore developed this sediment TMDL with the assumption that the sediment load reductions will be accompanied by lake-wide dredging. Assuming the lake is dredged to an average depth of 2.0 meters, the allocations included in this TMDL will ensure that the indicator of water quality standards attainment—preservation of 30% of the depth after 40 years—will be met.

EPA believes the TMDLs and the associated pollutant reductions are reasonable and implementable. A number of best management practices—both structural and non-structural—can significantly reduce pollutant loads. On agricultural lands, for instance, maintained vegetated buffer strips along stream channels (in this case, the tributaries draining to Hurricane Lake) have been shown to capture a significant amount of sediment. The vegetation also helps reduce stream bank erosion. Recent estimates of the trap efficiency of buffer strips range from 70% to 90%.[2] Many of the same management practices that reduce sediment loss also reduce phosphorous and iron because a large proportion of these pollutants are bound to soil particles. On agricultural lands, terracing, contouring, and conservation tillage have been reported to reduce sediment-associated phosphorous by 50% to 90%.[3] Similar reductions in iron can be expected.

**2. Waste load allocations and load allocations.**
The Permit Compliance System (PCS) database indicates one point source discharger in the watershed: the Hurricane water treatment plant. However, PCS contains no specific information about the permit, and the permit contains no effluent data. Further, The 1993 Clean Lakes report for Hurricane Lake identified no point sources in the watershed. Therefore, this facility was not included in the TMDL analysis, and the wasteload allocation is zero for all three pollutants.

The TMDL includes load allocations (LA) for the nonpoint sources. The overall load allocation is broken down into allocations from the most significant categories of nonpoint sources. Table 2 summarizes the LAs.

Table 2. Load Allocations and Needed Reductions (kg/day)

| SOURCE | PHOSPHOROUS | | SEDIMENT | | IRON | |
|---|---|---|---|---|---|---|
| | Allocation | % Reduction | Allocation | % Reduction | Allocation | % Reduction |
| Residential | 0.19 | 50 | 813.62 | 25 | 7.11 | 45 |
| Commercial/Industrial | 0.02 | 50 | 139.55 | 25 | 0.73 | 45 |
| Forest | 0.26 | 10 | 940.82 | 20 | 4.72 | 10 |
| Cropland/Pasture | 0.80 | 50 | 4399.56 | 33 | 3.32 | 0 |
| Barren | 0.00 | 0 | 0.27 | 0 | 0.003 | 10 |
| TOTAL LA | 1.28 | 45 | 6293.82 | 30 | 15.89 | 30 |

**3. Background pollutant contributions.**
Natural background is included as a component of the load allocations. The sediment loads associated with each land use category include the naturally occurring as well as human-induced contributions. The model was calibrated (i.e., adjusted so that the model predictions matched measured values) to water quality data that represents the cumulative impact from all sources—naturally-occurring and human-induced combined.

[2]Qui, Z. and T. Prato, 1998. Economic Evaluation of Riparian Buffers in an Agricultural Watershed. Journal of the American Water Resources Association, Vol. 34, No. 4, pp. 877-890.

[3]Illinois Environmental Protection Agency, 1986. Phosphorous: A Summary of Information regarding Lake Water Quality. IEPA/WPC/86-010.

**4. Critical conditions.**

There is no single critical condition for any of the three pollutants for which we have developed TMDLs. For nutrients, loads are highest during wet weather events that occur throughout a year. Nutrient impacts, however, are greatest during spring and summer when warm temperatures favor eutrophication. For siltation, the greatest amount of sediment is delivered to the lake during wet weather events. In terms of water quality, the sediment negatively impacts the lake regardless of when it is delivered. For iron, the water quality criteria can be violated during relatively dry periods due to sediment/water column interactions or during wet weather when tributary flows are high and bottom sediments of the lake are disturbed.

Considering the variability of critical conditions, the most meaningful and protective approach to protecting the water quality is to consider all conditions under which the pollutants are delivered and the water quality of the lake is impacted. The use of a continuous simulation model in developing this TMDL accounts for all possible critical conditions, both in terms of loading and water quality.

**5. Seasonal variations.**

These TMDLs appropriately consider seasonal variation. We have explicitly considered all seasonal variation by using a continuous simulation model that simulates loading and water quality throughout an entire year.

**6. Margin of safety.**

The Clean Water Act and federal regulations requires TMDLs to include a margin of safety (MOS) to take into account any lack of knowledge concerning the relationship between effluent limitations and water quality. EPA guidance suggests two approaches to satisfy the MOS requirement. First, it can be met implicitly by using conservative model assumptions to develop the allocations. Alternately, it can be met explicitly by allocating a portion of the allowable load to the MOS.

We have employed the implicit approach to satisfying the MOS requirement in these TMDLs by using conservative assumptions in the modeling process. First, the allocations and associated reductions are based on comparisons with the loads simulated for 1990, a relatively high-load year. By prescribing reductions based on a high-load year, we have ensured that water quality standards will be met in high-load years and, with a margin of safety, in typical years with lower loads. Second, as discussed in the technical report, the sediment trap efficiency of the lake was calculated through both the Brune method and by direct model simulation. The Brune method predicted trap efficiencies ranging from 32% to 58% while the model predicted 77%. In developing the TMDL for sediment, we used the higher trap efficiency—indicating a higher rate of siltation—as a way of increasing the margin of safety. Further, the modeled sedimentation rate is higher than that predicted during the earlier Clean Lakes Study of hurricane Lake. We've used the higher, modeled estimates to ensure a margin of safety.

**7. Public participation**

EPA published and requested comments on the proposed TMDLs on July 2, 1998 in the Charleston Gazette and six other newspapers across the state. EPA held a public meeting on July 16, 1998 in Parkersburg, West Virginia. In addition, EPA requested comments from United States Fish and Wildlife Service and no comments were received. EPA did not receive comments from any individuals or organizations specifically for Hurricane Lake.

FINAL AGENCY ACTION

W. Michael McCabe
Regional Administrator
EPA Region III

OCT 0 1 1998
Date