UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

AUG 2 4 1999

Honorable Jane T. Nishida
Secretary, Maryland Department of the Environment
2500 Broening Highway
Baltimore, Maryland 21224

Dear Secretary Nishida:

The Environmental Protection Agency (EPA), Region III has reviewed the report "Total Maximum Daily Loads (TMDLs) of Phosphorus and Sediments to Urieville Community Lake, Kent County, MD" and Technical Memorandum entitled "Significant Nonpoint Phosphorus and Sediment Sources in the Urieville Lake Watershed" which were submitted by the Maryland Department of Environment (MDE) on June 24, 1999. Pursuant to 40 CFR Section 130.7(d), EPA is approving the Urieville TMDLs. Urieville Lake is listed on Maryland's 1998 list of water quality limited segments pursuant to Section 303(d) of the Clean Water Act as part of the Middle Chester River (02-13-05-09). These TMDLs are designed to satisfy the water quality standards and designated uses of Urieville Lake only. Impairments in the remainder of the Chester River Watershed are not addressed by these TMDLs.

The definition of Load Allocation (LA) in 40 CFR Section 130.2(g) states, in part, that "Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading." Further, a wasteload allocation (WLA), according to 40 CFR Section 130.2(h), is "The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation." In addition, a TMDL is defined in 40 CFR Section 130.2(I) as "The sum of the individual WLAs for point sources and LAs for nonpoint sources and natural background."

The TMDL report submitted by Maryland did not include land use-based LAs for nonpoint sources. However, the supporting documentation provided with the TMDL report, specifically the Technical Memorandum provides one allocation scenario. EPA relied upon this information in reviewing and approving the TMDL submittal and in preparing our approval rational which is enclosed. We expect that for the future TMDLs, the Technical Memorandum will be included in any public notice of the TMDLs.

EPA has determined that the TMDLs and Technical Memorandum are consistent with the regulations and requirements of 40 CFR Section 130 (see enclosed Decision Rationale). Pursuant to 40 CFR Sections 130.6 and 130.7(d)(2), these TMDLs and the supporting documentation, including the Technical Memorandum, should be incorporated into Maryland's current water quality management plan. Furthermore, EPA has authority to object to issuance of a National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with WLAs established by these TMDLs. EPA expects that any NPDES permits issued in the Urieville Lake watershed will be consistent with the WLA of zero for phosphorus and sediments. These changes should be documented in the TMDL document as well as in the permit Fact Sheet.

If you have any questions or concerns, please contact me at 215-814-2050 or Tom Henry at 215-814-5752.

Sincerely,

Thomas J. Maslany, Director
Water Protection Division

Enclosure

Decision Rationale

Total Maximum Daily Loads of Phosphorus and Sediments to Urieville Community Lake, Kent County, MD

I. Introduction

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the Total Maximum Daily Loads (TMDLs) of Phosphorus and Sediments to Urieville Community Lake in Kent County, Maryland submitted for final Agency review on June 24, 1999. Our rationale is based on the TMDL, Technical Memorandum, and other information provided in the submittal document to determine if the TMDL meets the 8 regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs includes a margin of safety.
7) The TMDLs has been subject to public participation.
8) There is reasonable assurance that the TMDLs can be met.

The Technical Memorandum, *Significant Nonpoint Phosphorus and Sediment Sources in the Urieville Lake Watershed, Kent County, Maryland* submitted by the Maryland Department of the Environment, specifically allocates phosphorus or sediment to each of the three contributing sub-watersheds. The allocations are based on instream monitoring data collected from each contributing tributary of the three sub-watersheds and are representative of annual average conditions. The instream data was collected as part of the 1996 study of Urieville Lake performed by the Maryland Department of Natural Resources. Each individual sub-watershed load allocation represents yearly allowable loads of phosphorus and sediments and considers both natural and human induced conditions.

II. Summary

Urieville Lake[1] was originally constructed prior to the Revolutionary War to serve as a mill pond. The small, Y-shaped impoundment lies on Morgan Creek, a tributary of the Middle

---

[1] Urieville Lake is located in Kent County near the town of Kennedyville.

Chester River in the Upper Eastern Shore Tributary Basin[2]. As a result of the Lake Water Quality Assessment Project (MDE, 1993), the Middle Chester River Watershed was listed on the Clean Water Act (CWA) Section 303(d) list of water quality impaired waterbodies. The primary reason for listing this watershed was the water quality impairments as demonstrated by excessive sedimentation, seasonal algal blooms, excessive plant growth, foul odors and low dissolved oxygen concentrations which caused violations of the designated uses[3] of Urieville Lake. Sediment and nutrients were listed as the causes of impairment. In 1996, the Maryland Department of Natural Resources (DNR) published the Phase I study of Urieville Lake which documents the impairments and describes the potential sources and causes of the impairment. In addition, a lake management plan to correct these problems and restore the lake to its designated uses (recreation potential) was to be developed. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the State where technology-based and other required controls did not provide for attainment of water quality standards.

MDE developed TMDLs to address the excessive sedimentation and nutrient enrichment Urieville Lake is currently experiencing. These TMDLs are designed to satisfy the water quality standards and designated uses of Urieville Lake only. Impairments in the remainder of the Chester River watershed are not addressed by these TMDLs. Maryland has interpreted its narrative water quality standards in order to determine an appropriate endpoint for the TMDL. The sediment TMDL is designed to restore the designated uses of Urieville Lake through the control of sediment delivery to the lake and will result in only a 24% loss of lake volume due to sediment over 40 years. In order to control nutrient enrichment in Urieville Lake to restore designated uses, a phosphorus TMDL was developed by MDE predicated on the identification of phosphorus as the limiting nutrient[4]. The phosphorus TMDL is designed to control nuisance seasonal algae blooms, excessive plant growth, and foul odors. In addition, MDE links the control of phosphorus loading to the attainment of the dissolved oxygen water quality standard in the surface waters[5] of the lake. EPA believes that these endpoints are acceptable for deriving the phosphorus and sediment TMDLs. Table 1 below summarizes the phosphorus and sediment TMDLs.

Table 1, Phosphorus and Sediment TMDL summary

---

[2] The Chester River Sub-Basin is listed as sub-basin 02-13-05. Urieville Lake is considered part of segment 02-13-05-09 (Middle Chester River) from the 1996 305(b) report.

[3] The Code of Maryland Regulations (COMAR) at Section 26.08.02.07 list the designated uses of Urieville Lake as Use I-Water Contact Recreation, and Protection of Aquatic Life.

[4] Diagnostic/Feasibility Study, Urieville Community Lake (Kent County, Maryland), October 1996, Maryland Department of Natural Resources Fisheries Service.

[5] Maryland has provided an interpretation regarding how the dissolved oxygen water quality standard applies to lakes in a June 17, 1999 letter to Tom Henry, EPA from Robert Summers, MDE. The dissolved oxygen water quality criterion only applies to the well-mixed surface layers of lakes.

Parameter	Rate	TMDL	WLA	LA	MOS
Phosphorus	**(lbs/yr)**	509	0	458	51
	(lbs/day)	1.39	0	1.25	0.14
Sediment	**(tons/yr)**	89.2	0	89.2	Implicit
	(tons/day)	0.24	0	0.23	Implicit

It is important to point out that the TMDLs of phosphorus and sediment are based on the assumption that dredging of Urieville Lake will be performed to restore the lake to 1955 conditions. Due to the use of the Vollenweider Approach to determine the TMDL of phosphorus, and consequently the TMDL of sediment, EPA believes that dredging is necessary to assure that the water quality standards and designated uses of Urieville Lake will be achieved and maintained. Furthermore, Maryland states that "Restoration of Urieville Lake to its full recreational potential may require the removal of sediments and nutrients which sustain the growth of excessive aquatic vegetation."[6] Maryland DNR's Engineering and Construction Division proposes mechanical dredging of the lake in the Diagnostic/Feasibility report (DNR, 1996), thus providing reasonable assurance that dredging will be performed.

III. Discussion of Regulatory Conditions

EPA finds that Maryland has provided sufficient information to meet all of the 8 basic requirements for establishing phosphorus and sediment TMDLs for Urieville Lake. EPA therefore approves the TMDLs, Technical Memorandum, and supporting documentation for phosphorus and sediment in Urieville Lake. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to implement the applicable water quality standards

Maryland does not currently have numeric water quality standards for nutrients (phosphorus and nitrogen) or sediments. Therefore, Maryland utilized its General Water Quality Criteria[7] and the Vollenweider Approach[8] to establish an endpoint for phosphorus such that the designated uses of Urieville Lake are restored. Utilizing the total phosphorus loading from the Clean Lakes Phase I study of Urieville Lake (DNR, October, 1996), a current areal annual phosphorus load of 10.2 g/m^2 per year was calculated. The current areal phosphorus loading rate

[6] Id., See footnote 4

[7] The Code of Maryland Regulations at Section 26.08.02.03B(5)(a).

[8] The Vollenweider Approach (1968) is a simple empirical model which uses a linear relationship between phosphorus loading and the ratio of the lake's mean depth to hydraulic residence time to establish the lake's eutrophication status.

and the ratio of the mean depth to the hydraulic residence time were used to classify Urieville Lake as eutrophic according to the Vollenweider loading plots. The endpoint of the phosphorus TMDL was identified as reducing the areal phosphorus loading to achieve a mesotrophic designation according to the loading plots. MDE indicates that a mesotrophic status will support the designated uses of Urieville Lake. The areal phosphorus loading was reduced to 1.7 g/m^2 per year which represents the upper level of the mesotrophic zone based on the lake characteristics. This areal loading rate was then converted into 509 pounds per year for consistency with the TMDL process. Thus, implementation of the TMDL will result in an 85% reduction of phosphorus loading to the lake.

Although nutrients, both nitrogen and phosphorus, are listed as the cause of impairment in Urieville Lake, a TMDL of phosphorus was developed to control seasonal algae blooms, excessive plant growth, and foul odors because phosphorus is often the major nutrient in shortest supply and is frequently a prime determinate of the total biomass[9]. Phosphorus is also the most effectively controlled using existing engineering technology and land use management[10]. Maryland DNR identified phosphorus as the limiting nutrient in Urieville Lake during the Clean Lakes Phase I study (1996).

Lake eutrophication is both a natural and culturally-induced phenomenon. Natural eutrophication is a slow, largely irreversible process associated with the gradual accumulation of organic matter and sediments in lake basins. Cultural eutrophication is an often rapid, possibly reversible process of nutrient enrichment and high biomass production stimulated by cultural activities causing nutrient transport to lakes[11]. Lakes are considered to undergo a process of "aging" which can be characterized by the trophic status as oligotrophic, mesotrophic, or eutrophic. Oligotrophic lakes are normally associated with deep lakes which have relatively high levels of dissolved oxygen throughout the year, bottom sediments typically contain small amounts of organic matter, chemical water quality is good, and aquatic populations are both productive and diverse. Mesotrophic lakes are characterized by intermediate levels of biological productivity and diversity, slightly reduced dissolved oxygen levels, and generally have adequate water quality to support designated uses. However, there is a recognition that these lakes are naturally or culturally moving towards a eutrophic state. Lakes which are classified as eutrophic typically exhibit high levels of organic matter, both suspended in the water column and in the upper portions of sediments. Biological productivity is high, often indicated by seasonal algae blooms and excessive aquatic plant growth. Dissolved oxygen concentrations are low, and may reach extreme levels during critical periods. In addition, water quality is often poor resulting in

---

[9] Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients, 1980, EPA 440/5-80-011.

[10] Id.

[11] Id.

violations of the designated uses[12]. The following table illustrates typical water quality variables of these three trophic designations.

Table 2, Trophic-state classification and typical variables

	Trophic-state		
Variable	**Oligotrophic**	**Mesotrophic**	**Eutrophic**
Total phosphorus (ug/l P L^{-1})	<10	10-20	>20
Chlorophyll-a (ug/l Chl-a L^{-1})	<4	4-10	>10
Secchi-disk depth (m)	<4	2-4	<2
Hypolimnion oxygen (% saturation)	>80	10-80	<10

MDE has chosen to control phosphorus loading to achieve a mesotrophic status and support the designated uses in Urieville Lake. These levels result in an 85% reduction to current phosphorus loading rates and will restore the designated uses and general water quality of the lake. EPA provides the following calculations to confirm the in-lake phosphorus and chlorophyll-a concentrations which would result from the phosphorus TMDL. All equations are derived from *Principles of Surface Water Quality Modeling and Control, Thomann and Mueller, 1987.*

1) <u>Relationship of areal phosphorus loading to in-lake phosphorus concentration</u>

$p=W/q+v_s$ (pg. 410, eq. 7.5)
p=in-lake P conc (mg/l)
W=areal P loading rate ($g/m^2/yr$)
q=overflow rate (m/yr)
v_s=net loss rate (m/yr)

$q=H/t_d$ (pg. 410, example 7.1)
t_d=residence time (yrs)
H=depth (m)

$v_s=k_s/H$ (pg. 405, eq. 7.2b)
k_s=overall loss rate of P (yr^{-1})

$k_s=10/H$ (pg. 405, eq. 7.8)

$k_s=10/1.87\ m = 5.35\ yr^{-1}$

$v_s= 5.35/1\ .87\ m = 2.86\ m/yr$

---

[12] Technical Guidance Manual for Performing Waste Load Allocations, Book IV, Lakes and Impoundments, Chapter 2, Nutrient/Eutrophication Impacts, EPA 440/14-84-019.

$q = 1.87\ m/0.0145\ yr = 128.96\ m/yr$

$p = 1.7 g/m^2/yr\ /\ 128.96\ m/yr + 2.86\ m/yr = 0.0129\ mg/l$ or $12.9\ ug/l$

According to these calculations, the TMDL for phosphorus will result in an in-lake phosphorus concentration of 13ug/l, which is within the mesotrophic state range.

2) <u>Relationship of in-lake phosphorus concentration to chlorophyll-a concentration</u>

$log_{10}(chl\text{-}a) = 0.807(log_{10}(p)) - 0.194$ (pg. 412, eq. 7.18a)
(p)=in-lake phosphorus concentration

$chl\text{-}a = 5.03\ ug/l$

An in-lake phosphorus concentration of 13 ug/l from the phosphorus TMDL results in an estimated chlorophyll-a concentration of 5 ug/l. Again, this chlorophyll-a value is within the mesotrophic state range.

Calculations of the secchi depth and percent saturation of oxygen in the hypolimnion are not possible due to the shallow depth of the lake and lack of data. These variables are not critical, as both the in-lake phosphorus concentration and chlorophyll-a concentration are well within the range of mesotrophic conditions.

Maryland also identified violations of the numeric dissolved oxygen water quality criterion in the waters of Urieville Lake which contributed to the non-attainment of designated uses and possible fish kills. The State has developed a link in order to demonstrate that achieving this level of phosphorus loading will result in attainment of the dissolved oxygen water quality standard throughout the well-mixed surface waters. This link is based on determining the lakewide dissolved oxygen concentration resulting from the phosphorus TMDL. This calculation is based on factors[13] specific to Urieville Lake which were observed during the Clean Lakes Phase I study. In addition, the diurnal dissolved oxygen fluctuation based on the average photosynthetic dissolved oxygen production and the light attenuation factor is calculated to ensure that the dissolved oxygen water quality criterion of 5 mg/l is met at all times in the lake.

1) <u>Calculation of lakewide dissolved oxygen concentration</u>

$$c = (Q/(Q + k_l A))c_{in} + (k_l A/(Q + k_l A))c_s - (V{*}K_d/(Q + k_l A))L - (S_b A/(Q + k_l A))$$

---

[13] These factors include lake discharge, volume and area, lake Carbonaceous Biochemical Oxygen Demand and Sediment Oxygen Demand as well as contributing tributary effects.

Q=lake discharge=28,624 m^3/d

$(Q + k_l A) = 147{,}273\ m^3/day$

k_l=D.O. transfer rate=0.87 m/d
k_d=effective deoxygenation rate 0.3/d
L=ambient lakewide CBOD=2mg/l
A=area=136,379 m^2
V=volume=149,254 m^3
S_b=SOD rate=0.92 g/m^2/d
c_{in}=flow-weighted average ambient levels of DO of 3 tributaries flowing into lake=6.78 mg/l
c_s=D.O saturation at 30°C and zero(0) chlorinity=7.559 mg/l (Thomann and Mueller, 1987)

A) *Temperature adjustment for deoxygenation rate at 30°C*

$$(k_d)_T = (k_d)_{20} * 1.047^{T-20}$$
$$(k_d)_{30} = (0.2/d) * 1.047^{30-20}$$
$$(k_d)_{30} = 0.3/d$$

B) *Temperature adjustment for sediment oxygen demand rate at 30°C*

$$(S_B)_T = (S_B)_{20}(\theta)^{T-20}$$
$$(S_B)_T = 0.5\ g\ O_2/m^2/day * 1.065^{10}$$
$$(S_B)_T = 0.92\ g\ O^2/m^2/day$$

$$c = [(28{,}624\ m^3/d\ /\ 147{,}273\ m^3/d)6.78\ mg/l\ ] + [(118{,}649\ m^3/d\ /\ 147{,}273\ m^3/d)7.559\ mg/l\ ] - [(44{,}776\ m^3/d\ /\ 147{,}273\ m^3/d)2mg/l] - (125{,}468\ g/d\ /\ 147{,}273\ m^3/d)$$

$$c = 1.32\ mg\ O_2\ /\ l\text{-}day + 6.09\ mg\ O_2\ /\ l\text{-}day - 0.61\ mg\ O_2\ /\ l\text{-}day - 0.85\ mg\ O_2\ /\ l\text{-}day$$

$$c = 5.95\ mg\ O_2\ /\ l\text{-}day$$

The TMDL for phosphorus will result in a lakewide dissolved oxygen concentration of 5.95 mg/l, which exceeds the water criterion of 5 mg/l.

In addition to determining the lakewide dissolved oxygen concentration, Maryland also provided calculations to ensure that the diurnal dissolved oxygen concentration does not fall below the water quality criterion of 5 mg/l at any time. MDE has indicated that decreased levels of dissolved oxygen concentrations below the water quality criterion, including diurnal fluctuations, have contributed to fish kill events and disruptions in the lake's ecosystem balance.

1) Determine the average gross photosynthetic production of dissolved oxygen (p_a)

$$p_a = p_s(G(I_a))$$

p_s =light saturated D.O. production rate
$G(I_a)$ = light attenuation factor

$p_s = 0.25P$ P=chl-a in ug/l

$$G(I_a) = \frac{2.718f}{K_e H} \left[e^{-(\propto 1)} - e^{-(\propto 0)} \right]$$

$$-(\propto 1) = (I_a / I_s\, e^{(-K(e)Z)})$$

$$-(\propto 0) = (I_a / I_s)$$

f=photoperiod (0.6 day)
K_e = light extinction(1.04 m)
H=max depth (1.87 m)
I_a=solar radiation (500 langley/day)
I_s=saturation light intensity(350 langley/day)
Z=photosynthetic activity depth (0.914m)
$K(e)=K_e$

---

p_s= 0.25 * 10 ug/l chl-a[14]
p_s= 2.5 mg O_2/l-day

$-(\propto 1) = (500 \text{ langley/day} / 350 \text{ langley/day})*(e^{(-1.04\text{ m})(0.914\text{ m})})$
$-(\propto 1) = (1.42)*(0.39)$
$-(\propto 1) = 0.55$

$-(\propto 0) = (500 \text{ langley/day} / 350 \text{ langley/day})$
$-(\propto 0) = 1.42$

$$G(I_a) = \frac{2.718\ (0.6\text{ day})}{1.04\text{m}\ (1.87\text{m})} \left[e^{-0.55} - e^{-1.42} \right]$$

$$G(I_a) = \frac{1.63}{1.94} \left[0.58 - 0.24 \right]$$

$$G(I_a) = (0.84)*(0.34)$$

---

[14] MDE conservatively assumes a chlorophyll-a concentration of 10 ug/l, which is almost 2 times as much as the expected concentration of 5.03 ug/l resulting from the TMDL of phosphorus.

$G(I_a) = 0.29$

$p_a = (2.5 \text{ mg } O_2/\text{l-day})*(0.29)$
$p_a = 0.73 \text{ mg } O_2/\text{l-day}$

---

2) Estimate the diurnal dissolved oxygen range

$$\triangle c/p_a = \frac{(1 - e^{-k(a)*f*T})(1 - e^{-k(a)*T(1-f)})}{f*k_a(1 - e^{-k(a)*T})}$$

k(a)=k_a=reaeration coefficient=0.5 day
T=t=period=1 day

$$\triangle c/p_a = \frac{(1 - e^{-(0.5 \text{ day})(0.6 \text{ day})(1\text{day})})(1 - e^{-(0.5 \text{ day})(1 \text{ day})(1-0.6 \text{ day})})}{0.6 \text{ day}(0.5 \text{ day})(1 - e^{-(0.5 \text{ day})(1 \text{ day})})}$$

$\triangle c/ p_a = 0.39$
$\triangle c = 0.39*(p_a)$
$\triangle c = (0.39)*(0.73)$
$\triangle c = 0.29 \text{ mg } O_2/\text{l-day}$

Diurnal variations in dissolved oxygen concentrations are mainly due to photosynthesis and respiration of aquatic plants such as phytoplankton, aquatic weeds, or algae. Photosynthesis is the process by which plants utilize solar energy to convert simple inorganic nutrients into more complex organic molecules[15]. Due to the need for solar energy, photosynthesis only occurs during daylight hours and is represented by the following simplified equation:

$6CO_2$	+	$6H_2O$	<--------->	$C_6H_{12}O_6$	+	$6O_2$
(Carbon Dioxide)		(Water)		(Sugar)		(Oxygen)

In this reaction, photosynthesis is the conversion of carbon dioxide and water into sugar and oxygen such that there is a net gain of dissolved oxygen in the waterbody. Conversely, respiration and decomposition operate the process in reverse and convert sugar and oxygen into carbon dioxide and water resulting in a net loss of dissolved oxygen to the waterbody. Respiration and decomposition occur at all times and are not dependent on solar energy. Waterbodies exhibiting the typical diurnal variation of dissolved oxygen experience the daily

---

[15] Surface Water-Quality Modeling / Steven C. Chapra, 1997, page 347

maximum in mid-afternoon during which photosynthesis is the dominant mechanism and the daily minimum in the predawn hours during which respiration and decomposition have the greatest effect on dissolved oxygen and photosynthesis is not occurring.

The calculations above show that the expected diurnal dissolved oxygen range will increase or decrease 0.29 mg/l. Taking into consideration the expected lakewide dissolved oxygen concentration of 5.95 mg/l, the TMDL of phosphorus will result in an expected daily minimum of 5.66 mg/l and a daily maximum of 6.24 mg/l. Based on these calculations, the TMDL of phosphorus will assure that the dissolved water quality criterion of 5 mg/l is maintained.

The sediment TMDL endpoint was determined based on identifying an acceptable reservoir volume loss rate such that the designated uses of Urieville Lake are achieved and maintained. MDE determined that preserving 76% of the reservoir design volume (24% volume loss) over a period of 40 years supported this water quality objective. Sediment loading to Urieville Lake will be reduced 42% from a current rate of 155 tons per year to 89.2 tons per year.

The rationale for a 42% decrease in sediment loading is based on sediment/phosphorus control relationships from the Chesapeake Bay Program watershed modeling assumptions. When considering agricultural Best Management Practices (BMPs), a 1 to 1 control ratio can be expected. However, due to variation in the type of BMPs to be used in Urieville Lake watershed, Maryland uses a 0.5 to 1 ratio, which means that for each unit of phosphorus controlled, only ½ of the sediment unit will be controlled. Thus, BMPs which result in an 85% reduction in phosphorus loading will result in a 42% reduction in sediment loading.

Between the years of 1955 and 1995, Urieville Lake experienced a 42% loss of volume as a result of sedimentation at a rate of 155 tons per year. In order to estimate the expected loss in volume from the TMDL of 89.2 tons per year, Maryland computes the expected loss as follows:

$$\frac{\text{42\% loss of volume in 40 years}}{\text{155 tons per year}} = \frac{\text{X\% loss of volume in 40 years}}{\text{89.2 tons per year}}$$

This level of sedimentation and expected 24% loss of lake volume should result in the restoration of designated uses in Urieville Lake. Furthermore, the TMDL and expected 24% volume loss are based on the 1955 conditions[16]. EPA believes that this endpoint is acceptable and meets water quality standards.

2) The TMDLs include a total allowable load as well as individual waste load allocations and

[16] Maryland states that the TMDLs are developed under the assumption that the lake will be dredged to restore its approximate 1955 physical conditions.

load allocations.

Table 3, Summary of total allowable loads of phosphorus and sediments

	Phosphorus		**Sediment**	
	lbs/year	**lbs/day**	**tons/year**	**tons/day**
TMDL	509	1.39	89.2	0.24

A) Waste load Allocations

Maryland states that there are no point source discharge permits which have been issued in the Urieville Watershed. Therefore, the WLA is set at zero.

B) Load Allocations

Maryland did provide adequate in-stream data from the tributaries in the TMDL report, but did not distribute the total load allocations for phosphorus and sediment to specific contributing tributaries in the TMDL report. Maryland included a gross load allocation of phosphorus and sediment for the TMDL which can be found in Table 1.

According to federal regulations at 40 CFR 130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished.

As noted above, Maryland did not provide a breakdown of the total allowable loads in the TMDL report, however, such a breakdown was provided in the Technical Memorandum. The TMDL is based on the phosphorus and sediment loading from the 3 tributaries to the lake. Despite the desire to allocate to individual land uses, the available data will only allow for allocating loads to each of the three tributaries. According to the Technical Memoranda, the specific load allocations for the TMDL are as follows:

Table 4, Summary of Tributary Load Allocations

Tributary Load Allocations				
Tributary	**Phosphorus Load (lbs/yr)**	**Percent of Load Allocation**	**Sediment Load (lbs/yr)**	**Percent of Load Allocation**
Central	104	22.7%	55.7	62.6%
Eastern	320	69.9%	26.8	30.1%
Western	34	7.4%	6.5	7.3%
Total LA	458	100%	89.0	100%

Allocation Scenarios

EPA realizes that the above breakout of the total loads for phosphorus and sediments to the tributaries is one allocation scenario. As implementation of the established TMDLs proceed or more detailed information becomes available, Maryland may find other combinations of tributary allocations that are more feasible and/or cost effective.

3) The TMDL considers the impacts of background pollutant contributions.

The State indicates that the model uses observed water quality data from the 3 contributing tributaries to estimate loading rates of both phosphorus and sediments, and therefore is representative of the impact from all sources, including naturally occurring background pollutant contributions. The 3 contributing tributaries represent the majority of the volume input to the lake and the assumption that the in-stream tributary measurements would effectively consider background pollutants is valid. The simple flow-in/flow-out comparison shown below in table 5 confirms this point.

Table 5, Flow in/Flow out Comparison for Urieville Lake

Flow-In		Flow-Out
Tributary	**Flow**	**Discharge Rate**
Eastern	5.06 ft^3/second	22.8 acre-feet/day
Western	5.7 ft^3/second	
Central	0.85 ft^3/second	
Total	1,003,104 ft^3/day	993,168 ft^3/day
1,003,104 ft^3/day/993,168 ft^3/day = 101%*		

* The discrepancy between flow-out and flow-in is attributed to evaporation and from problems associated with obtaining accurate stream flow measurements for the three tributaries.

4) The TMDLs consider critical environmental conditions

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for streamflow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Urieville Lake is protected during times when it is most vulnerable.

In terms of sediment and phosphorus, one critical condition occurs during precipitation events which cause an increase in loading of sediment and phosphorus to the lake. A separate critical period specific to phosphorus occurs during times when the lake experiences warmer temperatures which encourage algae growth. Negative water quality impacts from sedimentation occur on a continuing basis and can not be defined by a single, critical period.

Critical environmental conditions such as those described above are implicitly considered by the Vollenweider Approach. Sediment and phosphorus loads are given on a yearly basis and would effectively include precipitation events. The TMDLs also consider the increased water temperatures which may be experienced by this lake during summer months through the use of temperature values in the dissolved oxygen concentrations well in excess of any experienced during the Phase I study period.

5) The TMDLs consider seasonal environmental variations

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flow normally occurs during the colder period of winter and in early spring from snowmelt and spring rains, while seasonally low flow typically occurs during the warmer summer and early fall drought periods[17]. Consistent with our discussion regarding critical conditions, determining load allocations on a yearly basis will effectively consider seasonal environmental variations. The assumptions regarding increased temperature will also effectively capture seasonal variations.

6)The TMDLs include a Margin of Safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. Margins of safety may be implicit, built into the modeling process, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL.

MDE utilizes an explicit process for determining the margin of safety for the phosphorus TMDL by allocating 10% of the total allowable load to the margin of safety. In addition, certain implicit margins of safety, such as assuming a higher temperature than observed for use in the minimum dissolved oxygen calculations, are included in the phosphorus TMDL margin of safety. See footnote 12 for an additional margin of safety.

The following discussion is needed in order to fully explain the margins of safety used in the sediment TMDL. In determining the sediment TMDL, MDE considered 2 scenarios. The first involved utilizing the overall phosphorus TMDL (509 lbs/year) as the basis of the sediment TMDL. In order to achieve a phosphorus loading of 509 pounds per year, the current phosphorus loading rate of 3033.5 pounds per year would need to be reduced 83.23%.

(3033.5 lbs/year - 508.6 lbs/year) / 3033.5 lbs year = 0.8323 = 83.23%

Considering the BMPs currently or most likely used in the Urieville Lake watershed, a conservative sediment to phosphorus control ratio of 0.5 to 1 was determined based on Chesapeake Bay Program information. Applying this ratio to the 83.23% reduction to achieve a loading rate of 509 pounds per year, sediment loading would be reduced 41.61%. When applied to the current sediment loading rate of 155 tons per year, the sediment TMDL wold be 90.51 tons per year.

155 tons/year x 0.4161= 64.49 tons/year
155 tons/year - 64.49 tons/year = 90.51 tons/year

Scenario 2 involves utilizing the phosphorus load allocation of 458 pounds per year as the basis of the sediment TMDL. This allows for consideration of the explicit 10% phosphorus MOS and provides for an explicit/implicit relationship between the phosphorus and sediment TMDLs. In order to achieve a phosphorus loading rate of 458 pounds per year, the current loading rate of 3033.7 pounds per year would need to be reduced 84.91%.

---

[17] Section 2.3.3 of the Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (EPA 823-B-97-002, 1997).

(3033.5 lbs/year - 457.7 lbs/year) / 3033.5 lbs year = 0.8491 = 84.91%

Considering the BMPs currently or most likely used in Urieville Lake watershed, a sediment to phosphorus control ratio of 0.5 to 1 was determined based on Chesapeake Bay Program information. Applying this ratio to the 84.91% reduction needed to achieve a phosphorus loading rate of 458 pounds per year, the sediment loading rate to Urieville Lake would be reduced to 42.45%. When applied to the current sediment loading rate of 155 tons per year, the sediment TMDL would be 89.21 tons/year.

155 tons/year x 0.4245= 65.79 tons/year
155 tons/year - 65.79 tons/year = 89.21 tons/year

Maryland determined that scenario 2 would ensure that the water quality objective/endpoint of preserving 76% of the lake volume over 40 years would be met, which would also provide for the attainment of the designated uses of Urieville Lake.

As previously mentioned, scenario 2 also provides for an explicit/implicit relationship between the phosphorus and sediment TMDL. Scenario 1 results in a sediment TMDL of 90.52 tons per year while scenario 2 results in a sediment TMDL of 89.21 tons per year. The difference between these scenarios is 1.3 tons per year. Therefore, the explicit 10% phosphorus TMDL MOS results in an approximate 1.4% sediment TMDL MOS. Due to the manner in which the sediment TMDL was determined and the complicated relationship of explicit and implicit margins of safety within the context of these TMDLs, the 1.4% (1.3 tons per year) MOS can not be expressed or characterized as explicit. However, scenario 2 does impart some implicit conservatism to the sediment TMDL.

90.51 tons/year - 89.21 tons/year = 1.3 tons/year
1.3 tons/year / 89.21 tons/year = 0.014 = 1.4%

EPA believes that this combined explicit/implicit approach to account for margins of safety is acceptable in this situation.

7) There is reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. MDE states that reasonable assurance can be provided through implementation of the phosphorus reduction plan by three specific programs: 1) the Water Quality Improvement Act of 1998 (WQIA); 2) the Clean Water Action Plan of 1998 (CWAP); 3) and the States's Chesapeake Bay Agreement's Tributary Strategies for Nutrient Reduction. EPA believes that these programs will be able to provide the necessary tools for implementing the TMDLs and achieving water quality standards assuming the lake is dredged to 1955 physical conditions. As mentioned in the summary portion of this report, Maryland DNR's Engineering and Construction Division has proposed mechanical dredging of the lake, thus providing further reasonable assurance that the TMDLs will be met.

8) The TMDL has been subject to public participation.

The TMDLs of phosphorus and sediments to Urieville Community Lake were open for public comment from November 20, 1998 through December 20, 1998. Only one set of written comments was received by MDE, which was provided with the TMDL report along with responses from the State.