FINAL

Comment Response Document
Regarding the Total Maximum Daily Loads (TMDLs) of Phosphorus and Sediments for Liberty Reservoir, Baltimore and Carroll Counties, Maryland

The Maryland Department of the Environment (MDE) has conducted a public review of the proposed TMDLs of phosphorus and sediments for Liberty Reservoir. The public comment period was open from August 15, 2012 through September 13, 2012. MDE received three sets of written comments.

The commentors, their affiliations, the date comments were submitted, and the numbered references to the comments submitted are identified below. In the pages that follow, comments are summarized and listed with MDE's response.

List of Commentors

Author	Affiliation	Date	Comment Number
John Grace	Maryland Department of the Environment – Water Supply Program	September 12, 2012	1 – 6
Hugh Murphy	Carroll County Department of Land Use, Planning, and Development	September 12, 2012	7 - 27
Steve Stewart	Baltimore County Department of Environmental Protection and Sustainability	September 13, 2012	28 - 34

Comments and Responses

1. The commentor says that when comparing Table Two, which presents the individual model land-use classification acres within the Liberty Reservoir watershed, with Tables 5 and 13, the baseline and TMDL phosphorus load distributions, respectively, it would appear that nurseries have a very high loading rate, given the small number of nursery acres within the watershed. The commentor continues by saying that it is not wise to require such a significant reduction, 2,672 pounds per year (lbs/yr), from nurseries, unless specific data is available for nursery operations within the watershed, which demonstrates that they are a significant contributor of phosphorus to the reservoir.

   Response: The response to this comment provides general background to the responses to Comments #3, #4, #5, and #6 as well, which also refer to nurseries.

   According to the Chesapeake Bay Program (CBP), the nursery land-use category represents container nurseries. Container nurseries are characterized by (1) a high density of plants (10-100 plants/square meter); (2) high nutrient applications rates (350-1000 pounds per acre per year (lbs/acre/yr) of nitrogen and 100-300 lbs/acre/yr of phosphorus); and (3) low rates of nutrient utilization (10-30%). Based on these factors, CBP set a target phosphorus loading rate for calibration purposes of 85 lbs/acre/yr for this category across the Chesapeake Bay. The actual calibrated rate may differ, and it is also impacted by the application of regional factors and Best Management Practices (BMPs). CBP's justification for nursery loading rates, including references to the literature, can be found in US EPA (2010), as referenced at the end of this document.

At this time, there is no further information to refute the current nursery loads. However, the treatment of nurseries in the CBP Phase 5 (CBP P5) watershed model may be revised in the near future, provided that new information becomes available. The watershed model is currently under review as part of the Chesapeake Bay TMDL midpoint assessment and the development of the Phase III Watershed Implementation Plan (WIP) scheduled for 2017. MDE is also planning on explicitly incorporating the phosphorus and sediment reduction goals for Liberty Reservoir and four other major drinking water reservoirs into the State's Phase III WIP, which will facilitate meeting the final Chesapeake Bay TMDL nutrient and sediment reduction goals by 2025. Any improvements made in the CBP P5 watershed model can also be incorporated in the phosphorus and sediment reduction goals for Liberty Reservoir.

2. The commentor says that MDE's Water Supply Program has no issue with the total estimated phosphorus loading to Liberty Reservoir, since the watershed and water quality models were calibrated using water quality data collected within the reservoir.

   Response: MDE's Science Services Administration (SSA) appreciates the Water Supply Program's concurrence with the total estimated phosphorus loading to Liberty Reservoir.

3. The commentor says that according to Table Two of the TMDL report, which presents the individual land-use classification acres within the Liberty Reservoir watershed, there are 152 acres of nursery within the watershed, which equates to 0.9% of the total watershed area. However, the baseline phosphorus load from nurseries within the watershed is estimated to be 10,149 lbs/yr, which equates to 13.4% of the total baseline phosphorus load to the reservoir. The commentor then asks how realistic it is to assume that less than 1% of the watershed area accounts for 13.4% of the total phosphorus load to the reservoir. Furthermore, if the nursery loading is over-estimated and nurseries really do not contribute 13.4% of the total watershed phosphorus load, the commentor asks if the required reduction of 2,672 lbs/yr could ever actually be achieved.

   Response: Please see response to Comment #1. It should also be noted that the total TMDL represents the phosphorus load compatible with water quality standards. It is independent of the allocation of loads among sources. As stated in the Nonpoint Source Technical Memorandum, the state of Maryland "reserves the right to allocate the phosphorus TMDL among different sources in any manner that is reasonably calculated to protect the designated uses of Liberty Reservoir from nutrient-related impacts."

4. The commentor describes how MDE's Water Supply Program calculated an event mean phosphorus concentration for nurseries within the Liberty Reservoir watershed using the nursery acres and phosphorus loads in the TMDL analysis, average annual precipitation data for Baltimore and Carroll Counties, and stream gauge data for the North Branch Patapsco River. The commentor downloaded average annual flow data for the steam gauge on the

North Branch Patapsco River at the town of Cedarhurst. The average annual flow for the North Branch Patapsco River at Cedarhurst is 64.89 cubic feet per second (ft^3/s). The drainage area above the stream gauge at Cedarhurst is 56.6 square miles (mi^2). After converting the average annual stream flow in ft^3/s to a total stream discharge per year in cubic feet (ft^3/yr) and dividing by the drainage area upstream of the stream gauge, converted to square feet (ft^2), produces a mean annual areal discharge of 1.3 feet/year (ft/yr), which equates to 15.56 inches per year (in/yr). The average annual precipitation for Baltimore and Carroll Counties is 43 in/yr. Thus, 15.56 in/yr of the total 43 in/yr of rainfall runs off from the watershed into the streams feeding Liberty Reservoir. Using an annual runoff of 15.6 in/yr, the commentor was then able to calculate an event mean phosphorus concentration for nurseries. The commentor multiplied the total nursery area in the watershed, 152 acres, by the total annual runoff, 15.6 in/yr, yielding 2,371 acre-inches, which equates to 64,372,630 gallons per year, or 176,363 gallons per day, or 0.176 millions of gallons per day (MGD). Next, the commentor converted the total phosphorus baseline loading of 10,149 lbs/yr to a daily value, which came out to equal 27.8 pounds per day (lbs/day). Finally, using the following formula: [pollutant load (lbs/day)] = [flow (MGD)] x [pollutant concentration in milligrams per liter (mg/l)] x [conversion factor], the commentor calculated the event mean phosphorus concentration for nurseries within the reservoir watershed to be 18.9 mg/l.

Response: The event mean concentration (EMC) calculated for nurseries by the commentor is in agreement with the target loading rate used by CBP for this land use. The target phosphorus loading rate is 85 lbs/acre/yr across the Chesapeake Bay watershed. This is one to two orders of magnitude higher than other sources. Please also see the response to Comment #1.

5. The commentor asks if there is observed data from nurseries in the watershed that supports the estimated phosphorus loadings within the model.

   Response: Please see response to Comment #1. CBP’s justification for nursery loading rates can be found in US EPA (2010).

6. The commentor requests that the event mean phosphorus concentrations be added to the baseline phosphorus load distribution table in the TMDL report (i.e., Table Five), since many people are better able to understand pollutant concentrations contextually, as opposed to pollutant loadings at a watershed scale.

   Response: Calculating and comparing event mean concentrations (EMCs) is a useful way of evaluating the nutrient impacts from various sources. TMDLs, Load Allocations (LAs), and Wasteload Allocations (WLAs), however, are expressed in terms of loads. The relative impact of pollutant sources on water quality in the reservoir is better understood in terms of loads. Knowing that the EMC of source A is twice as great as source B does not tell you how much source A contributes to the observed concentrations in the reservoir, but knowing that source A contributes twice the load as source B does tell you that the contribution of source A is twice as great as source B. This assumes that the sources contribute the same relative amounts of the different forms of phosphorus, so that the fate and transport of total phosphorus from all sources is roughly the same.

7. The commentor says that Carroll County government will be held responsible for the regulated urban allocations of the TMDL via its Phase I National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit. The commentor continues, however, and says that the process by which MDE has identified the impairing substance and quantified the necessary, regulatory enforceable criteria is based on several conservative assumptions, computer modeling simulations, statistical interpretations, and professional judgements. Therefore, the commentor asks if MDE can explain how the uncertainty inherent in the TMDL development process relates to the strict numerical criteria that the County will be held responsible for.

   Response: The commentor is correct in stating that Carroll County government will be held responsible for the individual NPDES Stormwater WLA (SW-WLA) and associated reductions assigned to the County's Phase I MS4 permit area (see the point source Technical Memorandum to the TMDL entitled *Significant Phosphorus and Sediment Point Sources in the Liberty Reservoir Watershed*). As per the latest round of Phase I MS4 permits, the County will need to develop a SW-WLA implementation plan and also demonstrate "progress towards achieving" the SW-WLA. MDE has developed a guidance document to assist the local Phase I MS4 jurisdictions in developing their SW-WLA implementation plans, which is entitled *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits* (MDE 2011). This guidance document is available on MDE's website at http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/Documents/NPDES%20Draft%20Guidance%206_14.pdf. MDE's Science Services and Water Management Administrations are continually working together to further refine this guidance, which outlines several different tools and methods available for assisting the counties in developing their implementation plans and tracking progress towards achieving SW-WLAs. One of the main tools MDE proposes using in the guidance document is Maryland's Assessment and Scenario Tool (MAST), an online tool for estimating nutrient and sediment loads consistent with the CBP Phase 5.3.2 (CBP P532) watershed model.

   The commentor is correct in that MDE applied conservative assumptions within the TMDL to err on the side of water quality protection, as is described in the MOS. Relative to the "strict numerical criteria that the County will be held responsible for," the requirements of MDE's revised Phase I MS4 permits and development of SW-WLA implementation plans take into consideration the uncertainty surrounding water quality models. Thus, the uncertainty involved in TMDL development for the Liberty Reservoir should not confound the issue of TMDL achievement and demonstrating progress from the perspective of the permitted entities within the watershed.

8. The commentor says that, as per the TMDL documentation, the water quality goal for the Liberty Reservoir sediment TMDL is to increase the useful life of the reservoir for water supply purposes by preserving storage capacity. Thus, the commentor first asks what the

current actual rate of sedimentation is within the reservoir, and then asks if a quantitative sedimentation rate will be used in the future to assess compliance with the sediment TMDL.

Response: The sedimentation rate of 0.21 in/yr shown in Table 10 of the TMDL report is the best estimate of current sediment rates. It is based on the 2001 bathymetric survey conducted by the Maryland Geological Survey. Sedimentation rates are usually calculated over decades, so it is not unusual that a more recent survey hasn't been performed. Therefore, a quantitative sedimentation rate will not be used to assess the achievement of and progress towards the sediment TMDL. Rather, MDE would recommend tracking progress towards achieving the sediment TMDL using the estimated reduction ratios applied within the TMDL between phosphorus and sediments. Subsequently, the County can estimate sediment reduction from planned implementation practices designed to achieve the required phosphorus reduction. Please also see the response to Comment #7 for further details regarding TMDL/SW-WLA compliance for Phase I MS4s.

9. The commentor says that the water quality goals of the Liberty Reservoir phosphorus TMDL are to reduce high chlorophyll-α (Chl-a) concentrations associated with excessive algal blooms and to increase dissolved oxygen (DO) concentrations to levels that are supportive of the reservoir's designated use. The commentor then goes on to say that the DO monitoring data indicate that the applicable criteria are being met, however, the Chl-a data are not presented in a context whereby they are applied to their applicable state-adopted numeric criteria. Thus, based on the empirical data presented within the TMDL collected within the reservoir, the commentor asks MDE to explain why a TMDL is being developed. Furthermore, the commentor asks why the Chl-a data was presented in such a manner.

   Response: The Chl-a data are not collected at a frequency that allows the calculation of a 30-day rolling average, or, for that matter, a statistically robust 90th percentile over a growing season; the sample size is simply too small. Accordingly, the data are presented (in Appendix A) in the form of a time series at each station and in tabular form to display peaks by month and year. These are appropriate methods of visually presenting the observed chl-a data in a meaningful context. Taken in its entirety, the dataset is sufficient for model calibration. Once calibrated, the model produces simulated chl-a values at a much more frequent time-step, which is sufficient for the computation of the rolling average and percentile analysis as described. This is a widely-recognized and acceptable means of using a water quality model and is in keeping with the basic principles of environmental modeling.

   The occurrence and persistence of chl-a concentrations over 10 micrograms per liter (µg/l), with spikes over 30 µg/l, preclude any data analysis that would support a determination that the reservoir is not impaired by nutrients; hence, it cannot be removed from Category 5 of Maryland's *Integrated Report of Surface Water Quality* and a TMDL is therefore required to address this impairment. Please also refer to the response to Comment #11 for more discussion on this matter.

10. The commentor references how MDE applies a 30-day moving average of concentrations $\leq$ 10 µg/l and/or 90th percentile concentrations < 30 µg/l as the water quality criteria for Chl-a.

The commentor then asks if this criteria is codified, and if so requests that MDE send the reference to the county.

Response: The criteria to which the commentor refers are codified in the Code of Maryland Regulations (COMAR) and may be found at the following website under section H, Criteria for Public Water Supply Reservoirs: http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.02.03-3.htm (COMAR 2012a).

11. The commentor references Section 2.3.7 of the TMDL report, which describes the Chl-a water quality criteria exceedances as "regular" and "frequent". The commentor then asks if MDE can define these terms and subsequently direct the county to the appropriate data.

    Response: As explained in Section 3.0 of the TMDL report, MDE considers Chla concentrations in reservoirs excessive and likely to interfere with designated uses, in violation of Maryland's narrative water quality standards, if (1) the 90^{th} percentile instantaneous Chla concentration exceeds 30 µg/l or (2) a 30-day moving average concentration exceeds10 µg/l. As Section 3.0 explains, a concentration of 10 µg/l approximately represents the boundary between mesotrophic and eutrophic conditions on the Carlson Trophic Index and Chla concentration exceeding 30 µg/l are associated with a shift in the algal assemblage to blue-green algae.

    The report does not say that water quality criteria exceedances occur "regularly" and "frequently" in Liberty Reservoir. There is not sufficient data to determine a 30-day moving average. The report does say that Chla concentrations above 10 µg/l occur "regularly" and that Chla concentrations above 30 µg/l occur "frequently". The terms "regularly" and "frequently" are not used in any technical sense, but their meaning can be understood by examining Table A-1 in Appendix A of the main TMDL report. As Table A-1 shows, concentrations above 30 µg/l do not occur every year, but at a frequency of approximately once every three years. Concentrations above 10 µg/l generally occur every season and even every month in the summer months. The persistence of Chla concentrations above 10 µg/l in the summer months prevent the removal of Liberty Reservoir from Category 5 of Maryland's *Integrated Report of Surface Water Quality* (ie., the list of water bodies requiring TMDLs). The maximum daily observed Chla concentrations are presented for each Baltimore City Department of Public Works (BCDPW) monitoring station in the reservoir in Figures A-25 through A-28.

12. The commentor says that the TMDL represents a future scenario wherein there will be no phosphorus related impacts to the aquatic health of the reservoir. The commentor then asks how phosphorus related impacts to the reservoir will be measured, and subsequently, will this method represent how TMDL compliance is assessed.

    Response: Please see responses to Comments #7 and #8 regarding TMDL achievement and demonstrating progress towards the TMDL relative to phosphorus loads, reductions from future management practices, and required SW-WLAs and associated reductions. Additionally, the assessment of phosphorus-related impacts on reservoir water quality and impairment status will be complemented by regular, ongoing monitoring by Baltimore City. As described in section 2.3 of the main TMDL report, BCDPW regularly samples four different stations within the reservoir for temperature, DO, Chla, and other water quality parameters at various 5-10 foot depth intervals. In concert with efforts to track phosphorus- and sediment-loading mitigation measures as described above and in the referenced comment responses, these monitoring data will be used to assess whether or not water quality standards, relative to phosphorus-related impacts, are being met within the reservoir.

13. In regards to the land-use data applied within the TMDL, the commentor asks how the urban footprint was “extensively modified,” as described within the TMDL. Furthermore, the commentor asks what assumptions were made in order to capture sub-divisions that are smaller than the pixel resolution of the Chesapeake Bay Land-Cover Dataset (CBLCD). Was this process peer-reviewed by objective experts to ensure its applicability? What was done to capture forested areas that are smaller than the pixel resolution of the CBLCD? Lastly, the commentor asks why MDE refined certain categories of the land-use data.

    Response: As per Section 2.1.1 of the main TMDL report, the urban footprint in the 2006 Chesapeake Bay Land-Cover Dataset (CBLCD) was "extensively modified" via reclassifications using NAVTEQ roads data and institutional area polygons. These reclassifications were based on the proximity of underlying pixels to these areas, applying different methods for determining the spatial thresholds to these features as per rural residential areas adjacent to the secondary road-network and suburban residential subdivisions. In terms of pixel resolution, the CBLCD has a resolution of 30 meters x 30 meters, which equates to a total area of 900 squares meters, or approximately 0.2 acres. Thus, resolution is not an issue in terms of accurately delineating residential sub-divisions. Rather, the reclassification techniques are meant to correct for the algorithms applied in classifying the raw Landsat imagery, which result from the spectral confusion of similar land-cover types (i.e., the similar spectral properties of turf grass, or pervious urban lands, vs. pasture). No reclassification techniques were applied to more accurately classify forested lands, because forest is a "left-over" in the final tabular CBP P532 watershed model land-use, after the incorporation of the agricultural census data; therefore, the most important function of the CBLCD, relative to informing the final watershed model land-use, is determining urban acres per land-river segment. For full methods and reclassification techniques applied in the modifying the 2006 CBLCD urban foot-print, which were extensively peer reviewed, please refer to the memorandum from the USGS's Chesapeake Bay Program's Office entitled *Methods for Estimating Past, Present, and Future Developed Land Uses in the Chesapeake Bay Watershed Phase 5.3* (USGS 2010).

14. The commentor states that the baseline phosphorus and sediment loads within the TMDL are estimated using the CBP land-use based model populated with 2001 land-use data, modified 2006 land-cover data (modified to better estimate the extent of urban lands), precipitation and meteorological data from 1991-2000, BMPs from 2009, and data for Confined Animal Feeding Operations (CAFOs) from 2009. The commentor continues by saying that empirical data for the water quality metrics in both the reservoir and watershed are available; however, MDE still used the modeled data, despite its uncertainty. The commentor concludes by

asking MDE to explain why they used modeled data over empirical data to estimate the baseline loads.

Response: Baseline loads for the Liberty Reservoir TMDLs are edge-of-stream (EOS) loads from the CBP P532 watershed model 2009 Progress Scenario. The 2009 Progress Scenario represents 2009 land-use and the 2009 level of BMP implementation. It is simulated over the rainfall period of 1991-2000 to obtain an accurate representation of long-term loading rates under a variety of hydrological conditions. This scenario was selected to represent the baseline phosphorus loads in the watershed, since it provides the closest approximation of current watershed land-use and management conditions and considers long-term hydrologic variation.

The Liberty Reservoir phosphorus and sediment TMDLs use a physical process model [i.e., the CBP P532 Hydrologic Simulation Program Fortran (HSPF)]. Empirical data tends to be sparse and does not account for the underlying physical processes occurring in the watershed. Even though, as the commentor states, phosphorus concentrations are monitored at several locations in the Liberty Reservoir watershed, a strictly empirical model that applies this data would not include the aforementioned underlying physical processes, such as daily precipitation, evapotranspiration, infiltration, etc., which are included within the CBP P32 HSPF watershed model. The HSPF model also models phosphorus dynamic processes. The application of the HSPF model is therefore considered a much more defensible approach to developing the TMDL than the application of a strictly empirical model. Furthermore, a strictly empirical model does not allow for load estimations from individual source sectors within the watershed (i.e., urban and agricultural land-uses), whereas the HSPF model does. This allows for the estimation of Load (LAs) and Wasteload Allocations (WLAs) within the TMDL.

The CBP P532 HSPF model does apply the empirical data, which the commentor makes reference to (i.e., the measured phosphorus concentrations from monitoring data) for model calibration. CBP P532 model calibration (i.e., the Calibration Scenario) confirms the validity of using the EOS loads from the CBP P532 watershed model in all the Liberty Reservoir TMDL model scenarios (See Sections 4.2 and 4.3 of the main TMDL report for further details). Specifically, the Calibration Scenario uses a refined version of the CBP P532 watershed model (see response to Comment #16) to simulate input loads to the CE-QUAL-W2 (W2) water quality model of Liberty Reservoir. As part of the development of the refined model, the loads from the model were compared to, and were in agreement with, average annual loads estimated with the United States Geological Survey (USGS) regression model LOADEST at three locations in the Liberty Reservoir watershed.

The City of Baltimore performs storm and ambient water quality monitoring at three USGS gages in the watershed: (1) the North Branch of the Patapsco River at Cedarhurst (01586000), Beaver Run near Finksburg (01586210), and Morgan Run near Louisville (01586610). Water quality data and daily flows at these stations were used to estimate LOADEST regression equations relating loads to flow, time, and seasonality. These three watersheds account for three-fifths of the total watershed area draining to Liberty Reservoir.

In aggregate, the average annual EOS loads from the refined CBP P532 watershed model matched the average annual loads from LOADEST, except for the estimated sediment loads. Average annual sediment loads from the refined CBP P532 model were on average low compared to LOADEST estimates, but within the confidence interval for the LOADEST average annual loads. The refined CBP P532 model sediment loads did agree, however, with independent estimates of average annual sediment loads calculated from the results of the Maryland Geological Survey's (MGS) bathymetric study of Liberty Reservoir. Section Three of the modeling report, *Modeling Framework for Simulating Hydrodynamics and Water Quality in Liberty Reservoir* (ICPRB 2012), provides further details on the use of observed data in LOADEST and use of LOADEST to validate the EOS loads from the Phase 5 Watershed Model.

Because the sediment TMDL is based on the required phosphorus reduction, the comparison of the refined CBP P532 sediment loads to LOADEST or any other estimate is not as relevant for model validity as the comparison of phosphorus loads. Therefore, because the phosphorus loads from the refined CBP P532 model matched the LOADEST loads, and the refined CBP P532 sediment loads were within the confidence interval of the LOADEST loads and were in agreement with MGS's bathymetry mapping, use of the refined CBP P532 model for the TMDL was justified. This also provided justification for the use of the CBP P532 2009 Progress Scenario phosphorus and sediment loads to represent the baseline conditions.

The phosphorus loads from the refined CBP P532 watershed model of the Liberty Reservoir watershed were used as inputs to the W2 water quality model of Liberty Reservoir. Model parameters were calibrated by comparing simulated total phosphorus concentrations in the reservoir with monitoring data from the reservoir. The calibration demonstrates that the phosphorus loads in the Calibration Scenario are compatible with observed phosphorus concentrations in the reservoir. Thus, the model output matches the empirical data and thus is calibrated. There are no observations of sediment concentrations in Liberty Reservoir, however. Therefore, the modeled sediment loads are strictly based on CBP P532 loading estimates. The sediment TMDL, however, is based on the required reductions in phosphorus loads from the baseline condition and the estimated relationship between phosphorus and sediment reductions (based on scientific literature), because phosphorus binds to sediments; thus, the lack of sediment observations in the reservoir has no bearing on the calculated sediment TMDL.

15. The commentor describes how the watershed model urban land-use consists of impervious and pervious classifications, the phosphorus and sediment loadings from which represent the permitted stormwater loads the county is responsible for. However, the commentor then states that the county's Phase I MS4 permit is only applicable to the "treated acreage" within the county and asks MDE for further clarification.

    Response: MDE is not certain what the commentor means in reference to the County's Phase I MS4 permit only applying to the "treated acreage" within the County. As per the

Phase I MS4 permits, permit coverage is for the entire county geographic area, covering all urban stormwater and urban land draining to a stormwater conveyance system within the County's boundaries, as long as the area is not covered under a separate NPDES stormwater permit. Also, relative to TMDLs and SW-WLAs, Maryland counties are required to develop implementation plans for all US Environmental Protection Agency (EPA) approved TMDLs/SW-WLAs, which must "demonstrate progress towards achieving" the assigned WLAs. Lastly, the County must treat 20% of all impervious surfaces covered under its permit that have little or no stormwater management. If by the permit only applying to the "treated acreage" within the county, the commentor is referring to this last permit stipulation, then MDE is in agreement with the commentor. Otherwise, the response to this comment outlines the major requirements as per the revised Phase I MS4 permits, which the commentor should take note of and possibly follow-up with MDE's stormwater management program for further details.

16. The commentor asks if the CBP P532 watershed model is designed to be implemented at the sub-Maryland 8-Digit (MD 8-Digit) watershed scale. If so, what was done to ensure that the model was calibrated properly?

    Response: Similar questions on the scale of the CBP P5 watershed model were raised by the Stakeholder Advisory Committee (STAC) for the Chesapeake Bay in January 2009. CBP's modeling subcommittee provided a response to the STAC, which indicates that the best approach in the development of local TMDLs would be to apply appropriate elements of the CBP P5 watershed model with augmentation from local data, specifically monitoring data, where available. This approach was done in the development of the Liberty Reservoir Phosphorus and Sediment TMDLs.

    For the Liberty Reservoir Phosphorus and Sediment TMDLs, a refined version of the CBP P532 model was developed to represent the input loads to the reservoir. One of the major refinements made was the spatial scale of the model. The Liberty Reservoir watershed was divided into eleven sub-watersheds. The modeled land-use from the CBP P532 watershed model was distributed among these sub-watersheds based on the land-cover distribution. The land-cover data applied was developed by the Regional Earth Science Applications Center (RESAC) at the University of Maryland.

    The refined CBP P532 model was then validated by comparing flows from the refined model with observed flows at USGS gages on the North Branch of the Patapsco River, Beaver Run, and Morgan Run and by comparing simulated phosphorus, sediment, nitrate, and ammonia loads with load estimates determined with the USGS LOADEST model. Please see the response to Comment #14 for further details. The comparison validated the use of the refined CBP P532 watershed model flows and EOS loads in TMDL development.

    Please see Section Three of the modeling report, *Modeling Framework for Simulating Hydrodynamics and Water Quality in Liberty Reservoir* (ICPRB 2012), for an extended discussion of the development of the original CBP P532 watershed model and the refined

CBP P532 watershed model of Liberty Reservoir, including how the land-use acres were determined for sub-watersheds and how the model was validated with LOADEST.

In addition to the spatial refinement of the CBP P32 watershed model via the incorporation of additional, local monitoring data, the CBP P532 watershed model river segments were delineated so as to represent Maryland's 8-digit watersheds. As part of its contribution to CBP P532 watershed model development, MDE collected monitoring data to calibrate the model at the scale of several MD 8-digit watersheds. MDE made the consistency of the scale of analysis among local TMDLs and between local TMDLs and the regional Chesapeake Bay TMDL a priority in CBP P532 model development.

17. The commentor asks if the TMDL scenario is representative of current conditions within the watershed, or if it would be possible that current water quality conditions in the reservoir mimic historical runoff (i.e., historic pollutant loading prior to the implementation of current management practices). The commentor also asks if the model can discern and account for the release of phosphorus from historic sediments to the reservoir's water column, which can contribute to algal blooms. Finally, the commentor asks MDE to elaborate on this topic.

    Response: Baseline Scenario loads include all BMP implementation accounted for in the Chesapeake Bay Program's 2009 Progress Scenario. The TMDL Scenario is independent of current or historical conditions. It represents the average annual phosphorus and sediment loads compatible with Liberty Reservoir supporting its designated uses. The reductions required under the TMDL allocations are relative to the Baseline Scenario loads and therefore represent reductions above and beyond the implementation of current management practices.

    The release of phosphorus from sediments in the reservoir is not simulated in the Liberty Reservoir W2 Model for three reasons. First, the observed phosphorus data do not show a pattern of increases in bottom phosphorus concentrations with the onset of anaerobic conditions. This is evident when contrasting the observed reservoir bottom phosphorus concentrations shown in Figure A-13 in Appendix A of the TMDL report with Figure A-17, the corresponding figure for ammonia, where releases from the sediment are evident from the seasonal pattern of bottom concentrations. Second, significant releases of phosphorus from the sediments occur only after nitrate is exhausted as an electron acceptor. Figures A-21 through A-23 in Appendix A of the TMDL report show that bottom nitrate concentrations generally remain above 1 milligram per liter (mg/l). These same patterns of observed concentrations of bottom phosphorus, ammonia, and nitrate are also apparent in Maryland's other large drinking water reservoirs: Prettyboy Reservoir, Loch Raven Reservoir, Triadelphia Reservoir, and Rocky Gorge Reservoir. The third reason for not simulating the release of phosphorus from sediments under anaerobic conditions is because an empirical study by Cornwell and Owens (2002), which attempted to measure the release of phosphate from sediment in Triadelphia Reservoir, found only modest releases of phosphorus at best under anaerobic conditions. Cornwell and Owens (2002) concluded that in general phosphorus remains tightly bound to sediments even under anaerobic conditions.

18. The commentor says that Section 3.8 of the modeling report indicates that half of the annual sediment load to the reservoir is from in-stream scour, but the model does not indicate that in-stream scour is a significant source of phosphorus to the reservoir. The commentor then asks how this was determined.

    Response: The version of the modeling report that was posted to MDE's webpage during the public review period reported this incorrectly and has now been revised and posted to MDE's webpage. As shown in Tables 5 and 7 of the TMDL report, for phosphorus and sediments respectively, in-stream scour is not a source category used to categorize either of these pollutants. This TMDL uses EOS loads from the refined CBP P532 watershed model to quantify the loads by source, and the contribution from in-stream scour is implicitly included in the land-use source sector loads (primarily urban impervious loadings) in the watershed model. In the CBP P532 watershed model, the EOS load represents the source load delivered to the represented river reaches in the model. In the case of the Liberty Reservoir watershed, the represented reach is the reservoir itself. Any in-stream scour in the tributaries to the reservoir is therefore included in the source loads

19. The commentor asks how sediment in the reservoir interferes with the designated use of the waterbody. Furthermore, the commentor asks if sediments are having a documented impact on fishing/recreation in the reservoir or the water supply/drinking water quality of the reservoir. Subsequently, the commentor asks if any documentation of these impacts could be made available for review.

    Response: The sedimentation of a reservoir designated as a public water supply decreases that reservoir's life-span and thus interferes with the water supply designated use of the waterbody. Liberty Reservoir was originally identified as impaired for sedimentation on the 1996/1998 303(d) List based on the best professional judgment of MDE scientists, primarily due to land-use conditions and expected sediment yields in the reservoir's watershed. Current bathymetry data collected by MGS indicate that sedimentation is occurring in the reservoir (See Section 2.3.8 of the main TMDL report), although at a lesser rate than other reservoirs within Maryland. In an effort to reduce the sedimentation rate, the sediment TMDL was established based on the required phosphorus reductions, taking into consideration phosphorus BMPs that do not influence sediment. This is a quantitative estimate of the narrative water quality standard for reservoir sedimentation and lnog-term impact on capacity and support of the designated use (see section 4.5.2 of the main TMDL report for details). Therefore, excess sediment loads are impairing the designated use of the reservoir as a water supply source.

20. The commentor states that the methodology applied in calculating the sediment TMDL for the reservoir is confusing. MDE calculated the sediment TMDL based on assumptions regarding the relationship between reductions in phosphorus loads and reductions in sediment loads (i.e., the ratio between the two), the sources of phosphorus reductions, and the relationship between phosphorus and sediment loading rates. Thus, the commentor asks how the county will be expected to report sediment loadings in the future to demonstrate compliance with the TMDL.

Response: The commentor is correct in that the Liberty Reservoir sediment TMDL is based on the calculated phosphorus TMDL, required reductions in phosphorus loads from the baseline condition, and the estimated relationship between phosphorus and sediment reductions (based on scientific literature). This method assumes that phosphorus binds to sediments. Details regarding the calculation of the sediment TMDL, per the phosphorus TMDL, can be found in Section 4.5.2 of the main TMDL report. Please also see the response to Comment #19.

In terms of tracking progress towards the sediment TMDL and compliance with the TMDL, please see the responses to Comments #7 and #8.

21. The commentor references MDE's description of the Calibration Scenario in Section 4.3.1 of the TMDL documentation, which says that the scenario represents "actual" phosphorus and sediment loads. The commentor subsequently asks how a model can provide actual pollutant loading data, and if the scenario represents a modeled simulation of what MDE estimates the "actual" phosphorus and sediment loads to be.

    Response: The refined CBP P532 watershed model is applied in the development of the Liberty Reservoir Phosphorus and Sediment TMDLs. The refined CBP P532 watershed model Calibration Scenario uses information consistent with the 2000 – 2005 time period. This includes land-use, precipitation, and temperature, and it is calibrated to observed flow (USGS gage data) and water quality data (observed phosphorus concentrations) from that time period. Therefore, the model Calibration Scenario represents "actual" phosphorus loads entering the reservoir from 2000 – 2005. Of the four scenarios used in the development of this TMDL, only the Calibration Scenario represents actual, historical loading rates.

    Please see the response to Comments #14 and 16 for further explanation of the methodology employed to represent loads in this TMDL.

22. The commentor says that atmospheric deposition is not considered part of the TMDL equation, but it is a source of phosphorus to the reservoir. Scientific literature indicates that atmospherically deposited phosphorus may account for 10-20% of total phosphorus loadings to waterbodies in the Mid-Atlantic region. The TMDL calculates atmospherically deposited phosphorus to account for 1.6% of the total phosphorus loading to the reservoir, which is far less than some other research indicates. The commentor then asks how MDE calculated the phosphorus loading from atmospheric deposition and what the potential implications on the detailed phosphorus loading per individual land-use classification/source sector in the analysis are.

    Response: The phosphorus loads from atmospheric deposition represent phosphorus deposited on open water only, which in this case is the Liberty Reservoir itself (i.e., the impoundment's surface). The surface area of the reservoir makes up about 3% of the area in the Liberty Reservoir watershed. Thus, it seems reasonable that the modeled loads from atmospheric deposition are small, in comparison to other source sectors. Phosphorus deposited on the land surface is assumed to be transported by wind from other land surfaces and therefore does not represent a net input to the watershed. Assumptions about the specific atmospheric loading rates for phosphorus in the CBP P532 watershed model can be found in Smullen, Taft, and Macknis (1982) and US EPA (2010).

23. The commentor asks how relevant an all forest scenario (i.e., natural conditions scenario) is for a watershed that drains to a reservoir, which was constructed in 1953, and how does the constructed reservoir influence the analysis of the "natural environment".

    Response: Low DO in the hypolimnion (bottom layer) of lakes and reservoirs is primarily a function of two factors: (1) the degree to which thermal stratification inhibits turbulent mixing and the transport of dissolved oxygen; and (2) the loading rate of diagenic material which drives sediment oxygen demand (SOD). MDE's interpretation of the DO criteria for reservoirs recognizes that low DO is the result of "natural conditions" if the first factor predominates. Specifically, COMAR states that in Use I-P waters, DO is not allowed to fall below 5.0 mg/l at any time, unless natural conditions result in lower DO concentrations (COMAR 2012b).

    Of course, a reservoir is not a natural waterbody and there would not be a question of thermal stratification if the reservoir was not constructed. Therefore, it is necessary to ask the question of whether or not low DO would still occur in the hypolimnion of the reservoir under natural loading rates of diagenic material (i.e. the loading rates that would be associated with an all-forested watershed). Simulating whether low DO would persist with loading rates from an all-forested watershed is way of quantitatively testing whether thermal stratification is the dominant factor in the low DO concentrations observed in the hypolimnion. If DO violations persist in the hypolimnion in the all forest-scenario, then the loading rates under the TMDL are compatible with the interpretation of the DO criteria and water quality standards for reservoirs.

24. The commentor references Section 4.6 of the TMDL report, which says that equal reductions were applied to the current controllable loads from nonpoint sources. This appears to indicate that the reductions are based on the difference between the progress scenario and the E3 scenario. Thus, the commentor asks if the equal reduction equates to a percentage of the controllable load. The commentor then says that this methodology seems to result in a higher percent reduction from the county's portion of the TMDL (compared to other nonpoint sources), rather than being an equal reduction to all nonpoint sources. Finally, the commentor asks MDE to explain why this reduction strategy was applied.

    Response: The current controllable loads are defined as the difference between the CBP P532 2009 Progress Scenario and the CBP P532 E3 Scenario. An equal percent reduction was applied to the controllable loads; however, the reductions for the NPDES regulated stormwater source sector and CAFO source sector were not allowed to exceed 75% of the controllable load because this has been defined by MDE as the maximum feasible reduction for these source sectors. The reductions reported are relative to the total load, however, and not the controllable load. All other things being equal, a source sector will have a higher percent reduction of its total load if a higher percentage of its total load is controllable. The TMDL document has been revised to avoid future confusion regarding "equal reductions" and "equal percent reductions". The documentation now states that "equal percent reductions" were applied.

25. The commentor asks why the urban impervious and pervious loading rates were based on professional judgement and regression analysis. Furthermore, the commentor asks if there is insufficient data related to the loading rates of urban BMPs, pre and post-retrofit.

    Response: Professional judgement was a minimal factor in CBP's development of target loading rates for phosphorus and sediment from urban pervious and impervious land in the CBP P532 model. Phosphorus target loads for urban pervious and impervious land uses are based on median total phosphorus (TP) concentrations taken from a Pitt, et al. (2005) study of monitoring data collected by local jurisdictions as required by their MS4 permits. For TP, the median concentration was 0.27 mg/l. This value was multiplied by the simulated flow per acre to set the per acre phosphorus target loading rate.

    For the sediment target loading rates, CBP included the impact of increased peak flows in urban areas on in-stream scour. Peak stormflow tends to increase with increasing impervious area. CBP reviewed several studies of small urbanized watersheds, which had estimates of watershed loads, percent impervious cover, or urban land use type. From these studies, they calculated a regression equation relating watershed loads (lbs/ac/yr) to percent impervious cover. The intercept of this equation (at zero percent cover) was set as the target *edge-of-stream* EOS loading rate for pervious urban land. The loading rate at 100% impervious cover was set as the EOS loading rate for impervious urban land. In that way, the targeted EOS loading rate for any given watershed would be a function of impervious cover and would lie on the regression line. US EPA (2010) describes the development of urban sediment targets in more detail.

26. The commentor references the modeling report, which states that *edge-of-field* (EOF) erosion rates do not reflect BMPs or any soil conservation practices installed for restoration efforts, but a BMP factor was included in the model estimates. The commentor then asks how this BMP factor was calculated and what data was used to do so. Furthermore, is the factor applied to urban impervious and pervious land-uses? Finally, the commentor asks what methodology was applied to calculate these rates.

    Response: The calculation of EOF target erosion rates for urban pervious and impervious land is explained in the response to Comment #25.

    EOF target erosion rates for agricultural land-uses and forest land-uses were based on erosion rates determined by the Natural Resource Inventory (NRI). NRI is a statistical survey of land-use and natural resource conditions conducted by the Natural Resources Conservation Service (NRCS). Results from 1982 and 1987 surveys were used because they best represent erosion rates prior to the implementation of BMPs. The effect of BMP implementation is to reduce the erosion rate, or at least to reduce the amount of eroded sediment reaching the stream. BMP reductions are accounted for in the CBP P532 model by (1) tracking the number of acres treated with a specific BMP, and (2) identifying the reduction in phosphorus and sediment achieved by that specific BMP. BMP tracking is performed by state and federal agencies and coordinated by the CBP. The determination of BMP efficiencies is described in detail in US EPA (2010).

EOS sediment loads from the Baseline Scenario and Calibration Scenario include the effect of BMPs accounted for the CBP P532 watershed model. An EOS load from a land use is the product of (1) the EOF loading rate (on a per acre basis); (2) the acreage associated with that land use; (3) a delivery factor which takes into account the deposition of sediment in transport from field to stream; and (4) the reduction in sediment loads through BMP implementation. The documentation for the CBP P532 watershed model, *Chesapeake Bay Phase 5.3 Community Watershed Model* (US EPA 2010), discusses BMPs for all land uses represented in the CBP P532 watershed model.

27. The commentor says that Section 3.8 of the modeling report indicates that half of the annual sediment load to the reservoir is from in-stream scour, but the model does not indicate that in-stream sour is a significant source of phosphorus to the reservoir. The commentor then asks how this was determined.

    Response: Please see the response to comment #18.

28. The commentor asks if the average discharge of 20.0 cubic feet per second (ft^3/s) presented in Table 1 includes both water withdrawals and water that flows over the dam. If it includes both, the commentor asks MDE to partition the value between the two discharges.

    Response: The average discharge of 20 ft^3/s presented in Table 1 is intended to include only the water that flows over the dam. This has now been clarified in the document. The discharge is based on the downstream flow-by requirements for Liberty Reservoir. In contrast, water withdrawals average about 80 million gallons per day (MGD), or 125 ft^3/s (Weisberg et al. 1985).

29. The commentor says that the TMDL report cites the 1976 Baltimore County Soil Survey; however, a more recent soil survey is available for the county.

    Response: The actual analysis of soils was based on the recent State Soils Geographic (STATSGO) Database for Maryland. This geographic database is coarser than the county-level soil surveys, but contains the appropriate level of detail for this analysis. The 1976 Baltimore County Soil Survey is merely applied to provide a description of the Chester and Baile soil series (See Section 2.1 of the main TMDL report) and is not explicitly used in model development.

30. The commentor references how the land-use methodology for the TMDLs is based on the CBP P532 watershed model and subsequently asks if it was based on the most recent watershed model run (July 2011). The commentor says that there were changes to the urban

acres in the July 2011 model run compared to earlier model runs and asks if this is reflected in the Liberty Reservoir phosphorus and sediment TMDLs.

Response: The land-use applied in the TMDL comes from the CBP P532 watershed model. MDE is assuming that the change in urban acres the commentor is referring to are the changes between the CBP Phase 5.3.0 (CBP P530) watershed model and the CBP P532 watershed model, which was developed and finalized in 2011 for use in the Phase II WIPs. Assuming this to be correct, the model does reflect the changes in urban acres that the commentor refers to and thus reflects all changes made to the model before July 2011. More specifically, the land-use acres presented within the report are from the CBP P532 2009 Progress Scenario and therefore represent all potential management practices implemented prior to 2010 by localities that are represented within the model via a land-use conversion.

31. The commentor references the first footnote to Table 3 in the TMDL report, which indicates that two municipal water treatment plants (WTPs) within the watershed are not included in the analysis, since their discharge would represent a pass through condition. The water withdrawn from the stream system is presumably distributed as drinking water, and since there are no municipal wastewater treatment plants (WWTPs) in the watershed, the water is exported and not returned to the stream system. Finally, the commentor asks what the quantity of water withdrawn from the system is and if it should be accounted for in the model.

    Response: The quantity of water permitted to be withdrawn from the reservoir system from the Cranberry WTP is 1.838 MGD on an annual average basis and 3.0 MGD as a maximum daily limit. However, the plant has actually been withdrawing water on an average annual basis in the range of 1.73 MGD to 1.46 MGD over the past 3 years. The Freedom District WTP has an agreement with the City of Baltimore, since it withdraws water directly from the reservoir, to withdraw 4.2 MGD on average and 6.0 MGD during maximum monthly use. However, the plant has actually been withdrawing water on an annual average basis at a range of 2.03 MGD to 2.34 MGD.

    Water withdrawals from Cranberry WTP, which is located in the upstream, non-tidal portion of the Liberty Reservoir MD 8-Digit watershed, are not simulated in the model, but they only account for 1% of the average daily inflow to the reservoir. The withdrawals from the Freedom District WTP, which withdraws water directly from the reservoir, are implicitly included in the CE-QUAL-W2 simulation of the reservoir. In the W2 simulation, the reservoir is simulated using a single outflow time series to represent water withdrawals from the City of Baltimore and the Freedom District, as well as any discharge from the reservoir downstream to the North Branch of the Patapsco River. The outflow time series is calibrated on a daily basis against observed water elevation levels in the reservoir using a water balance calibration utility distributed with the CE-QUAL-W2 model. See the modeling report, *Modeling Framework for Simulating Hydrodynamics and Water Quality in Liberty Reservoir* (ICPRB 2012), for a discussion of the calibration of the water balance and reservoir outflows.

32. The commentor says that the last paragraph on page 42 in the Assurances of Implementation Section of the TMDL documentation, which discusses local WIPs, should be revised relative to tense. July 2012 has passed, and the Phase II WIP has been finalized.

    Response: The commentor is correct. The appropriate change in tense has been made to the referenced paragraph in the main TMDL report.

33. The commentor says that the paragraph in the Assurances of Implementation Section of the TMDL documentation regarding the Bay Restoration Fund is not applicable to the Liberty Reservoir watershed, since there are no WWTPs in the watershed, and upgrades to septic systems will not result in phosphorus and sediment load reductions.

    Response: The Bay Restoration Fund is also used to provide funding for the use of cover-crops by individual farmers. The referenced paragraph in the Assurance of Implementation Section of the main TMDL report has been revised to indicate that this is the only portion of BRF funding applicable to the Liberty Reservoir.

34. The commentor says that based on the Liberty Reservoir sediment TDML, the reservoir would lose 1% of its capacity after 40 years and 4% of its capacity after 100 years. Based on the documented capacity loss of the reservoir between 1953 and 2001 and projecting this forward, with no sediment TMDL, the capacity loss after 40 years would be 1.8%, and after 100 years, it would 4.6%. This difference between the baseline and TMDL conditions is not substantial at all, which raises the question as to whether or not the sediment TMDL was needed in the first place. There is no sediment TMDL associated with the Prettyboy Reservoir phosphorus TMDL, and the following statement is from the Gunpowder Reservoirs phosphorus and sediment TMDLs documentation:

    > “The annual percent capacity loss (volumetric reduction) rate in Loch Raven Reservoir, 0.13%, compares favorably with the national averages. The mean average capacity loss rate for comparably sized reservoirs is 0.43%; the median 0.27%”.

    The annual loss rate for Liberty is 0.05%, which is well below the national average.

    Response: Please see the response to comment #19. Currently, there is no quantitative criterion for reservoir sedimentation and capacity loss. It has been documented, however, that sedimentation is occurring in Liberty Reservoir (See Section 2.3.8 of the main TMDL report), although it is occurring at a much slower rate than Maryland’s other drinking water reservoirs. Because of this, the TMDL will be evaluated primarily on the basis of achieved phosphorus reductions, in comparison to the required phosphorus reductions, with a secondary evaluation of sediment loads, until a refined quantitative criterion is developed.

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