To: Water Quality and Habitat Goal Implementation Teams
From: Pam Mason, VIMS, Panel Co-Chair
Ralph Spagnolo, EPA Region 3, Co-Chair
Jeremy Hanson, Virginia Tech, Coordinator
On behalf of the Wetlands Expert Panel
Re: Wetlands Land Use Classification for Phase 6.0 Watershed Model

Summary of recommended land uses and relative loading targets

The proposed land uses and relative land uses for nontidal wetlands in the Phase 6.0 Watershed Model are summarized in Table 1 below. It is the understanding of the panel that the Modeling Workgroup plans to transition tidal wetlands to the estuarine water quality model, and therefore a tidal wetlands land use and loading rate is not needed for the Phase 6 Watershed Model.[1, 2]

Table 1. Recommended land use classes and relative loading rates for nontidal wetlands in the Phase 6 Watershed Model

Proposed wetland land uses for Phase 6 Watershed Model	*Relative Loading Rate (TN)*	*Relative Loading Rate (TP)*	*Relative Loading Rate (Sediment)*
Palustrine Forested (PFO)	100% Forest	100% Forest	100% Forest
Palustrine Scrub-Shrub (PSS)	100% Forest	100% Forest	100% Forest
Palustrine Emergent (PEM)	100% Forest	100% Forest	100% Forest

Background

The Wetlands Expert Panel convened in Fall 2014 following approval of its charge and membership by the Wetlands Workgroup. A transition in panel coordination from The Center for Watershed Protection (CWP) to Virginia Tech resulted in delaying the panel's work from approximately February until May 2015 when Virginia Tech reconvened the panel. Subsequently, two panel Co-Chairs were selected and the panel worked to provide recommended land uses for the initial October 2015 Chesapeake Bay Watershed Model (CBWM) calibration by the end of August 2015.

The panel has arrived at a set of recommended land uses and relative loading rates for natural existing wetlands described in this memorandum. These recommendations only apply to land uses that will represent these natural nontidal wetlands within the Phase 6 CBWM, and do not represent recommended efficiencies or reductions associated with any wetland best management practices (BMPs) such as restoration, creation or enhancement. While these BMPs are a part of the panel's overall charge, they will be provided in a separate detailed report to be delivered at a later date in accordance to the WQGIT BMP Panel Protocol. Given the panel's situation and the

[1] The panel will work with the modeling team to determine how to apply and credit tidal wetland BMPs in the next version of the partnership modeling tools, but that issue is outside the scope of this current memo and will be addressed in the panel's subsequent full BMP report. However, it is likely that the reporting and crediting of tidal wetland BMPs would function similar to the recently approved Shoreline Management BMP, which reduces shoreline erosion loads that are part of the sediment transport model and not the Watershed Model.
[2] Some members of the panel may provide input to the CBPO modeling team as they build tidal wetlands into the next version of the modeling tools, but that effort falls under the purview of the Modeling Workgroup and CBPO modeling team, not this expert panel.

need to meet the Phase 6 CBWM development schedule, the panel is recommending these land uses and relative loading rates for approval by the Water Quality and Habitat GITs. These are simplified, standalone recommendations so the CBPO Modeling Team and Modeling Workgroup can proceed with the October 1st calibration with the inclusion of wetlands as a separate set of land uses. However, the panel is still assessing possible methods to calculate and apply reduction efficiencies for natural wetlands that would quantify the water quality services provided by wetlands as they treat runoff from surrounding landscapes.[3]

Justification for wetlands land uses

The National Wetlands Inventory (NWI) is available for the entire Chesapeake Bay Watershed and explicitly provides the information needed to map the proposed land uses for the Phase 6 CBWM. The NWI provides additional information for wetlands (such as vegetation type and hydrologic information) that can be potentially be used by the partnership for other purposes in the future, but the panel maintains the three general Palustrine classes in Table 1 are sufficient to distinguish existing nontidal wetlands in the watershed. While other potential classifications were discussed (e.g., tidal, nontidal, and isolated/depressional) it was determined that the best approach given available information was to mirror the NWI classifications. If approved by the partnership as new land uses by the end of August, CBPO staff have indicated to the panel that the wetland land uses can be ready in time for the October 2015 calibration.

Justification for suggested relative loading rate

While wetlands are generally a subject of thorough and widespread interest to researchers there are few studies that evaluate the loading rate of a wetland separately from surrounding land uses. This is due to the nature of wetlands as transition zones within their catchment, which means that any appropriate loading rate depends on the location of the particular wetland within their watershed. The panel agreed, therefore, that assigning loading rates similarly to those of other land uses would not reflect the multitude of studies that support the conceptual model that a wetland's water quality functions depend on the hydrogeologic setting and the nutrient/sediment load delivered to that wetland. Some limited loading rate data is summarized in this section, but due to the inherent nature of wetlands there is little purpose in establishing a unique base loading rate, whereas the real water quality impact is dependent on quantifying the wetland's function based on available information about relevant properties (e.g., location, vegetation type, hydroperiod, etc.).

A preliminary literature review conducted for the panel by Tetra Tech found only two studies that attempted to define loading rates for wetland areas, neither of which were located in the Chesapeake Bay region. Baker et al. (2014) evaluated Barnegat Bay-Little Egg Harbor HUC14 watersheds and determined the export concentration for forest and wetlands combined was 1.17 mg/L for TN and 0.021 mg/L for TP. Similarly, Dodd et al. (1992) created nutrient budgets for the Albemarle-Pamlico Sound area; forest and wetlands were again considered as having the

[3]This continued analysis will compare results from a watershed-wide application of the first order kinetic equation to nontidal wetlands with the SPARROW model, which will allow the panel to better understand the kinetic equation's ability to explain expected nutrient and sediment reductions from nontidal wetlands (see Jordan et al 2003 and STAC 2008 for more about the first order kinetic equation). The results of the analysis have yet to be seen and reviewed by the panel, so this is a tentative direction that remains subject to deliberation by the panel. If that analysis yields defensible results that the panel believes should be incorporated into subsequent calibrations of the Phase 6 CBWM, the panel will detail that recommendation at an appropriate future time.

same loading rate, which Dodd et al. determined to be 2.08 lbs/ac/yr for TN and 0.12 lbs/ac/yr for TP. Neither study separated the loading from forest and wetland areas into distinct categories. No other studies were identified that provided a loading rate for wetlands as a uniform land use. However, the panel has concern that the literature review may have omitted pertinent research. Therefore, the recommended land uses and loading rates may be adjusted for the next calibration following further investigation and the inclusion of additional studies.

One study by Harrison et al. (2011) calculated the surface water and groundwater concentrations of TN and TP within wetlands, however, the export rates were not calculated. The wetlands, located near Baltimore, MD were two restored relic oxbow wetlands in an urban area and two reference forested floodplain wetlands. Across the restored oxbow wetlands, the groundwater concentrations for TN and TP, respectively, were 0.72 mg/l and 11.5 µg/L. The average at the forested floodplain wetlands were 0.37 mg/L and 114.7 µg/L for TN and TP, respectively. Surface water nutrient concentrations measured within the oxbow wetlands averaged 0.6 mg/L for TN and 24 µg/L for TP.

Considering the nature of wetlands (as described above) in combination with the limited data reviewed to date, and thus available to define a base loading rate, the panel agreed it is most reasonable to keep all wetland loading rates equivalent to the Phase 6 Forest land use, which is the lowest loading land use. Other Phase 6 land uses were less comparable and the lack of loading data in the literature reviewed to date did not meet the panel's burden of proof to distinguish the relative loading rate from Forest. As noted previously, the panel does feel that the services and functions provided by natural wetlands are understood well enough to quantify estimated reduction efficiencies, but that such analysis requires more time and, while it cannot be completed in time for the October 2015 calibration, it will be ready for subsequent calibrations. This additional reduction will represent the services wetlands provide in the overall landscape as they receive, trap, store and treat runoff from surrounding lands. To reiterate, however, the conceptual base loading rate from the wetland area itself could not be distinguished from Forest.

Given the importance of landscape position to wetland water quality function, the panel agreed to explore development of spatially-explicit retention efficiencies, rather than define wetland loading rates. Results could be applied, for example, by assigning a forest-based loading rate to each wetland acre, then adjusting the loading rate based on an overlay of assigned retention efficiencies, or perhaps by developing a spatially explicit algorithm to capture the interaction between up-gradient "contamination" and wetland landscape position. Assigning retention efficiencies within the model remains a challenging task for the panel, but they are regularly collaborating with CBPO staff as they continue their analysis. The recommended method for incorporating these wetland factors and functions into the CBWM will be provided in time for subsequent calibrations of the model. The panel acknowledges that following the October 2015 calibration there is no guarantee that potentially significant modeling changes can be incorporated into the final Phase 6 CBWM, but they will continue their analysis in good faith with the hope that their proposed methods will be a significant improvement to the representation of natural wetlands in the Watershed Model.

Caveats, uncertainty and future needs

Wetland processes that modify nutrient and sediment loads from the surrounding landscape are more informative for understanding the "load reduction" of a wetland than any estimated base loading rate. While the panel is recommending that the base TN, TP and TSS target loading rates for wetlands are set equivalent to forest for the initial Phase 6.0 CBWM calibration, the panel is still considering available methods to quantify the valuable water quality services that wetlands provide to surrounding landscapes (as described in footnote 3).

The expert panel recognizes that wetland retention capacity depends on the hydrologic flux (be it ground- or surface waters or both) through a wetland system. Further, the relative importance of ground- and surface-waters has major implications to retention potential. For instance, groundwater dominated systems have ~~limited outflow and higher retention rates with~~ greater denitrification potential and therefore improved nitrogen removal capacity (Vidon & Hill 2006; Devito et al 1999). Whereas surface water dominated systems have greater potential to trap sediment and sediment-sorbed phosphorus. Biogeochemical processes are also related to the dominant vegetative community of the wetland. The majority of wetland studies assessing nutrient uptake and transformation have focused on emergent vegetated wetlands ~~(marshes)~~, while some work has included forested wetlands often as part of riparian buffers. These studies support consideration of a wetland classification scheme that creates the opportunity for attribution of different load reduction values by wetland hydrology and/or vegetated class. Accordingly, the panel agrees that wetlands have variable benefit or effect on downstream water quality and that the CBWM should explicitly capture this variation in water quality functions as this is expected to provide a more accurate sense of the cumulative effects of management actions and conditions in the watershed.

References

Baker, R.J., C.M. Wieben, R.G. Lathrop, and R.S. Nicholson. 2014. Concentrations, loads, and yields of total nitrogen and total phosphorus in the Barnegat Bay-Little Egg Harbor watershed, New Jersey, 1989–2011, at multiple spatial scales. *U.S. Geological Survey Scientific Investigations Report 2014–5072.* U.S. Geological Survey. Reston, VA.

Devito, K. J., Fitzgerald, D., Hill, A. R., & Aravena, R. (1999). Nitrate dynamics in relation to lithology and hydrologic flow path in a river riparian zone. *Journal of Environmental Quality*. 29(4), 1075–1084.

Dodd. R.C., G. McMahon, and S. Stichter. 1992. *Watershed Planning in the Albemarle-Pamlico Estuarine System. Report 1 – Annual Average Nutrient Budgets*. North Carolina Department of Environment, Health, and Natural Resources and U.S. Environmental Protection Agency, National Estuary Program.

Harrison, M.D., P.M. Groffman, P.M. Mayer, S.S. Kaushal, and T.A. Newcomer. 2011. Denitrification in alluvial wetlands in an urban landscape. *Journal of Environmental Quality*. 40:634-646.

Jordan, T.E., D.F. Whigham, K.H. Hofmockel, and M.A. Pittek. 2003. Nutrient and sediment removal by a restored wetland receiving agricultural runoff. *Journal of Environmental Quality*. 32:1534-1547.

STAC (Scientific and Technical Advisory Committee). 2008. *Quantifying the Role of Wetlands in Achieving Nutrient and Sediment Reductions in Chesapeake Bay*. Publication 08-006. Annapolis, MD.

Vidon, P. G., & Hill, A. R. (2006). A Landscape-Based Approach to Estimate Riparian Hydrological and Nitrate Removal Functions. *Journal of the American Water Resources Association*. 42(4), 1099–1112. http://doi.org/10.1111/j.1752-1688.2006.tb04516.x

Wetlands Expert Panel membership and other participants		
Name	*Role (post-CWP)*	*Organization*
Erin McLaughlin	Panel member	MD DNR, Wetland Work Group Co-Chair
Steve Strano	Panel member	NRCS
Judy Denver	Panel member	USGS - DE
Ken Staver	Panel member	Wye Research and Education Center
Kathy Boomer	Panel member	TNC
Pam Mason	Co-Chair	VIMS
Dave Davis	Panel member	VA DEQ
Jeff Hartranft	Panel member	PA DEP
Ralph Spagnolo	Co-Chair	USEPA Region 3
Jeff Thompson	Panel member	MDE
Tom Uybarreta	Panel member	USEPA Region 3
Quentin Stubbs	Panel member	USGS, CBPO
Rob Brooks	Panel member	Penn State
Dr. Jarrod Miller	Panel member	UMD Extension
Michelle Henicheck	Panel member	VA DEQ
Denise Clearwater	Panel member	MDE
Panel support		
Jeremy Hanson	Panel Coordinator	Virginia Tech, CBPO
Jennifer Greiner	HGIT Coordinator	USFWS, CBPO
Hannah Martin	Support	CRC, CBPO
Kyle Runion	Support	CRC, CBPO
Aileen Malloy	Support	Tetra Tech
Jeff Sweeney	CBPO Modeling and WTWG rep	EPA CBPO
David Wood	CBPO Modeling rep	CRC, CBPO
Peter Claggett	GIS Support	USGS, CBPO
Brian Benham	Va Tech Project Director	Virginia Tech
Additional panel guest participants: Ken Murin (PA DEP), Kristen Saacke-Blunk (AgWG Co-Chair), Anne Wakeford (WV DNR) Previous participants who contributed previously and are no longer active (post-CWP): Brian Needelman (UMD), Tom Jordan (SERC), and Robert Kratochvil (UMD)		