CBP/TRS-327-20

Nontidal Wetland Creation, Rehabilitation and Enhancement

Recommendations of the Wetland Expert Panel for the nitrogen, phosphorus and sediment effectiveness estimates for nontidal wetland best management practices (BMPs)

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Chesapeake Bay Program
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Executive Summary

The Wetland Workgroup approved the formation of this expert panel to evaluate the effectiveness of nontidal wetland best management practices (BMPs) to reduce loads of nitrogen, phosphorus and sediment to the Chesapeake Bay. This panel was formed to expand on the CBP-approved report by a previous Wetland Expert Panel that clarified the wetland restoration BMP and established two nontidal wetland land uses in the Phase 6 Chesapeake Bay Watershed Model (WEP, 2016).

The current panel first convened in November 2017 and deliberated its approach and recommendations over the subsequent months. This report describes the panel's recommendations for review, feedback and approval under the Chesapeake Bay Program's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, or "BMP Review Protocol."

The panel's recommended efficiency values for nitrogen, phosphorus and sediment are summarized in Table ES-1. As described in sections 4 and 5 of this report, the panel considered multiple lines of reasoning to arrive at these recommended estimates, including: multiple conceptual models; an updated literature review; an expert elicitation survey of panel members, and; functional assessment data of created and natural wetlands.

Table ES-1. Summary of removal efficiencies for nontidal wetland creation, rehabilitation and enhancement

Wetland BMP Type	TN (%)	TP (%)	TSS (%)
Restoration[1]	42	40	31
Creation	30	33	27
Rehabilitation	16	22	19
Enhancement	Not recommended		

[1] *The wetland restoration efficiencies are provided for reference and the values are from WEP (2016).*

The expert panel worked diligently to articulate BMP efficiencies for wetland creation, rehabilitation and enhancement with respect to the available literature and the CBP-approved wetland restoration BMP. As with wetland restoration, the recommended wetland creation BMP is simulated as a land use change that also reduces upland loads using the above efficiency value. The recommended wetland rehabilitation BMP is not a land use change, but the efficiency is applied to upland land uses. Further details for how the BMPs will be reported for progress runs and simulated in the Watershed Model are provided in Appendix B. As explained in section 5, the panel recommends that wetland enhancement should not be a BMP for purposes of achieving nutrient and sediment reduction targets under the TMDL, as simulated in the Watershed Model.

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Introduction

The modern history of human activities across a 64,000 square mile watershed has dramatically shifted the ecosystem structure of the Chesapeake Bay, thus leading to the decline of many iconic species and habitats, including blue crabs, submerged aquatic vegetation, wetlands and oyster beds. In 2014, the Chesapeake Bay Program (CBP) partnership committed to the fundamental goal of restoring the Bay ecosystem health in the Chesapeake Bay Watershed Agreement.

The CBP partnership, a multi-agency partnership led by the six Bay states and the District of Columbia, identified healthy wetlands as a critical element of a restored Bay watershed. Since colonialization, more than 70 percent of historic wetlands were lost by drainage or infill. During the 18th and 19th Centuries the extensive construction of mill dams, combined with agricultural cultivation practices of the time, led to extensive deposition of legacy sediment, particularly in floodplain areas of the Piedmont region within the CBW. Substantial historic floodplain wetlands were lost by burial under this legacy sediment. Most of the drainage impacts occurred during the twentieth century, when the vital role of wetlands for providing water quality and habitat benefits remained undervalued, and the demands of regional (and global) population growth, combined with modern technology and public works ditch and drainage projects, led to rapid agricultural and urban intensification. The most extensive losses from active ditching and filling occurred in the Coastal Plain, where proximity to water and highly tillable lands naturally led to a concentration of human activities. The 2014 Watershed Agreement acknowledged the significance of these losses by establishing wetland restoration as a fundamental objective to a more comprehensive Bay watershed restoration goal. Partners committed to "create or reestablish 85,000 acres of tidal and nontidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025." These targets represent approximately 10 percent of the original wetland extent across the region. Identified management strategies include wetland restoration, rehabilitation, enhancement, and creation. Importantly, conservation of existing wetlands (approximately 2 million acres) also is essential to achieving the Bay Program's broader restoration goals.

There are two spatial scales at which decision-makers require guidance for advancing the CBP's wetlands goal. First, the Chesapeake Bay Total Maximum Daily Load (TMDL) requires state agencies and their local partners to detail watershed implementation plans (WIPs) for achieving the regulated nutrient and sediment load reduction targets. Planning agencies must outline the type and extent of best management practice (BMP) implementation intended to meet the reduction targets. Local and state decision making will reflect an assessment of opportunity as well as cost. The expected cumulative benefits of wetland management are therefore compared to other BMPs and with consideration to other planning priorities. Ideal decision support would include an inventory of wetland management opportunities that details hydrologic function, current condition assessment, expected water quality and habitat benefits, and cost. However, this information is not necessarily available in all cases. Generally, managers should consider where in the project area (e.g., county or watershed) BMP practices can provide the greatest overall benefits.

At the field-scale, restoration managers working with landowners must consider current site conditions and the cause of degradation to identify appropriate locations and techniques for wetland management. Further, the techniques applied to a wetland BMP (e.g., levee breach, ditch plugs, and landscape grading), should consider design specifications such as the number, size, area, and timing of interventions to carefully target and optimize wetland ecosystem services. While a simple intervention, such as a levee breach to restore floodplain hydrology can be used, frequently a combination of techniques, including revegetation, invasive species control, and soil remediation or enhancement, are used to achieve a more holistic restoration. In developing these designs, restoration managers must work with landowners to address additional concerns including maintenance requirements and costs. Collectively, all these factors will influence the techniques incorporated into wetland BMP design, which in turn, will impact the potential water quality improvement at the site.

The reporting of wetland acreage restored or created will be important for tracking progress toward CBP's broader restoration goals. To receive credit toward the established wetland and water quality targets, implemented site-scale designs must be inventoried and evaluated by state and local municipalities for reporting to the CBP. Ideally, this accounting system will account for a range of wetland management actions. Accordingly, CBP state and local municipalities need guidance to classify the field technique(s) applied as one of the four established CBP wetland management categories (i.e., restoration, rehabilitation, enhancement, or creation).

In 2016, the CBP partnership approved recommendations from a Wetland Expert Panel to define a wetland land use and four categories of BMPs as part of the Phase 6 Chesapeake Bay Watershed Model (CBWM). Currently, natural wetlands are assigned the lowest land use loading rate, equal to the forest land use in the Phase 6 CBWM, while pollutant load reductions were approved for the wetland restoration BMP. However, three of the four categories – creation, enhancement and rehabilitation – required further evaluation. The 2016 Panel recommended a follow-up panel to evaluate these additional BMP techniques for inclusion in the CBP watershed model and also encouraged the partnership to review the current modeling framework to evaluate more fully the retention benefits associated with natural wetlands.

1. Charge and membership of the expert panel

The Chesapeake Bay Program's Wetland Workgroup approved the charge for the current panel in June 2017. Through its Cooperative Agreement with the Chesapeake Bay Program office (CBPO), Virginia Tech selected the proposal submitted by the Center for Watershed Protection that identified expert panelists and a statement of work to fulfill the charge by the Wetland Workgroup. Following some adjustments in response to feedback from the CBP partnership, the panel membership listed in Table 1 was approved by the Wetland Workgroup in September 2017. The panel convened for its first conference call in November 2017 and met 14 times via conference call and twice in-person from November 2017 through June 2019.

Panelist	Affiliation
Neely L. Law, PhD, Panel Chair	The Center for Watershed Protection
Kathleen Boomer, PhD	Foundation for Food and Agriculture Research (formerly with The Nature Conservancy)
Jeanne Christie	Christie Consulting Services LLC (formerly with Association of State Wetland Managers)
Greg Noe, PhD	U.S. Geological Survey
Erin McLaughlin	Maryland DNR
Solange Filoso, PhD	Chesapeake Biological Lab

Denise Wardrop, PhD, PE	Penn State
Scott Jackson	University of Massachusetts
Steve Strano	NRCS
Rob Roseen, PhD, PE, D.WRE	Waterstone Engineering
Ralph Spagnolo	EPA Region 3

The full panel charge and scope of work is included as Appendix A. As with the previous Wetland Expert Panel that concluded in 2016 (described below), this current panel and report are focused on voluntary wetland activities that can be tracked and reported toward TMDL progress. Compensatory wetland mitigation is outside the purview of this panel and is not creditable for Chesapeake Bay TMDL purposes.

1.1. Additional context for the expert panel – Summary of Previous Wetland Expert Panel (WEP)

A Wetlands Expert Panel (WEP) was convened in 2014 to provide recommendations on how natural wetlands and implementation of wetland BMPs should be represented in the Phase 6 Chesapeake Bay Watershed Model (CBWM). This panel provided recommendations to the Chesapeake Bay Program in a 2016 report (WEP, 2016). The panel recognized that natural wetlands provide important water quality and habitat benefits and that restored wetlands are designed to reestablish natural wetland function. The panel also unanimously agreed that wetland water quality benefits strongly depend upon wetland type, which is greatly influenced by a site’s hydrogeologic setting and its hydrologic connectivity to upgradient sources of nutrients and sediments. Results of a literature review were consistent with other meta-analyses indicating that wetlands have highly variable capacity to protect regional water quality by sequestering excess nutrients and sediment. Reported differences were attributed not only to site-specific conditions of a wetland but also the connectivity to up-gradient contaminant sources. Consequently, the WEP (2016) developed a simplified framework to estimate expected retention benefits based on location and expected wetland setting and retention capacity. First, information about the physiographic setting and its influence on the distribution of wetlands and wetland types, as well as hydrologic connectivity were considered to estimate the typical acreage of intensive human activity in a wetland’s local contributing area, as a basis for estimating typical nutrient and sediment loads. Second, retention efficiencies were prescribed to represent degradation in wetland environments, based on measurements reported in peer-reviewed literature, including natural and restored wetlands, within and outside of the Chesapeake Bay watershed in both floodplain and non-floodplain landscape settings (see Table 9, in WEP 2016). Because of the large variability in reported retention estimates, and as only a few of these studies provided enough information to stratify data based on location or wetland condition, mean values of these data were used as the prescribed average, annual retention rates of Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) (42%, 40% and 31%, respectively). The wetland restoration BMP, as a land use change, also received additional load reductions that account for the treatment of upland area loads. The WEP (2016) recommendations were consistent with the Chesapeake Bay Program credit framework, which in general uses a ratio of upland acres treated to BMP area to quantify this additional load reduction. Importantly, the WEP (2016) recommendations explicitly did not consider wetland condition or the consequences of different wetland management strategies, including creation, rehabilitation and enhancement. The watershed model currently assumes rehabilitation, creation and enhancement wetland management practices have equal potential (i.e., ratio of 1:1) to provide regional water quality benefits.

2. Natural Wetlands in the Phase 6 Watershed Model

The Phase 6 Watershed Model (Figure 1) is a management tool designed to simulate the effect of jurisdictions' management actions on nutrient and sediment loads delivered to the Bay. An integrated estuarine model then simulates water quality responses based on predicted watershed discharge. Time series data of land uses, BMP implementation, animal populations and other factors are simulated in the Model history and the Model is calibrated to monitored loads from River Input Monitoring (RIM) stations from 1985-2014. Thanks to the efforts of the previous WEP, nontidal wetlands were included as a land use in the Phase 6 CBWM, which means that acres of wetlands through time were included in the calibration. Nutrient and sediment loading rates for these wetlands the same as forests were applied. Also similar to forest land cover, additional retention capacity was implicitly captured through the calibration process.

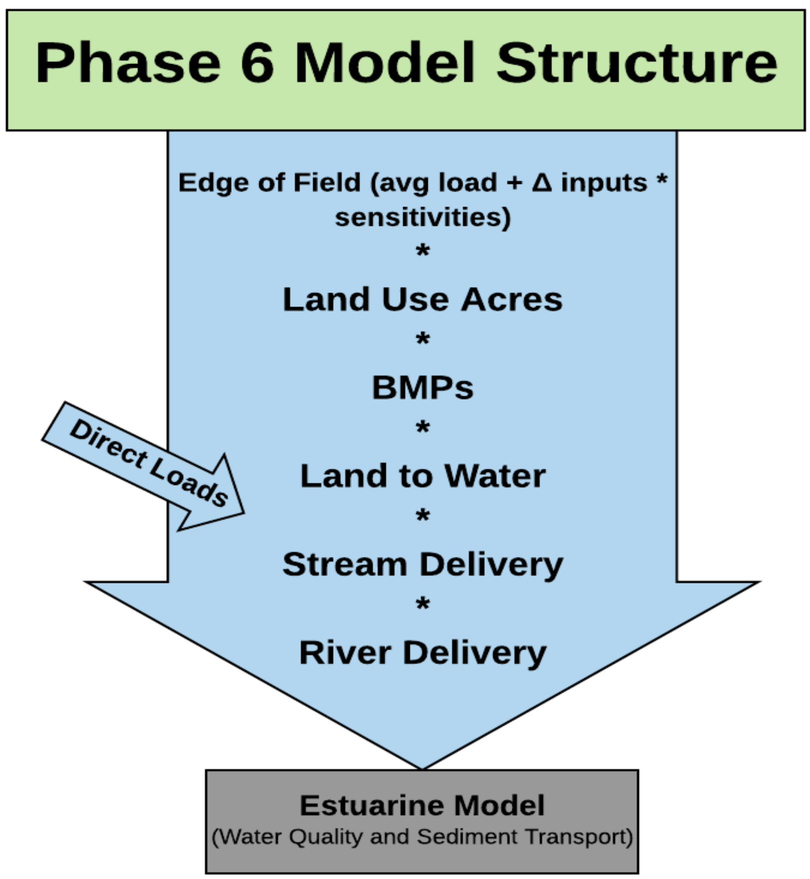

Figure 1. Overall structure of the Phase 6 Chesapeake Bay Watershed Model

Land-to-water factors

As stated in the Phase 6 CBWM documentation, land-to-water (L2W) factors "account for spatial differences in loads due to physical watershed characteristics. L2W factors do not add or subtract to the loads over the entire Chesapeake Bay watershed, but instead represent the spatial variance of nutrient transport." SPARROW (SPAtially Referenced Regressions On Watershed attributes) modeling by USGS sought to explain the spatial variance of nutrient transport and the specific details are described in Chapter 7 of the CBWM documentation. For purposes here, it should be noted that the CBP modeling team explained to the previous WEP that L2W factors accounted for the effect of existing wetlands in the landscape. The panel's report reflected this point and supported future research into the matter (page 47, WEP 2016):

> "…While the land-to-water factors in the Phase 6 Watershed Model are understood to implicitly capture the effect of existing wetlands in the landscape through the model calibration, the partnership may wish to apply a distinct factor in the model to account for the retention and treatment effects of existing wetlands. Their inclusion as land uses will be a basis for potentially simulating their contribution in the future. Though the Panel was unable to make a recommendation for a distinct loading rate or retention factor for existing wetlands at this time due to a dearth of science on wetland load contributions, it is recommended that future research using SPARROW or other tools be used to inform the partnership in the future."

To reiterate, L2W factors do not change the overall loads, but they reflect variability based on landscape characteristics. The factors used in the SPARROW modeling to establish L2W factors for nitrogen and phosphorus are summarized in Table 1.

Table 1 - Summary of factors used to inform land-to-water factors for Nitrogen and Phosphorus

Nitrogen	**Phosphorus**
Mean EVI (enhanced vegetation index)*	Soil erodibility*
Mean soil available water capacity	% well-drained soils
Groundwater recharge	% area in Coastal Plain*
Piedmont carbonate	Mean annual precipitation*
* Dropped from final calculation of L2W factors as the land uses account for vegetation	*Dropped from final calculation of L2W factors because sensitivities and Δinputs already account for these factors (see Figure 1)

L2W factors can also be understood as "delivery variation factors" or DVFs, as described in Chapter 7 of the CBWM documentation. As noted above, there is no effect on overall loads, because the L2W factors were centered on an average of 1.0. They were broken into the four global land use categories (developed, cropland, pasture, natural) and calculated for Nitrogen (N) and Phosphorus (P) at the land-river-segment scale. For N, the DVF ranged from approximately 0.42 to 2.3 for the Natural category; for P it ranged from 0.6 to 1.18 for Natural (wetland land uses are part of the Natural category).

Ultimately, while the retention or removal of nutrients or sediments by existing natural wetlands are not explicitly accounted for in the Model the same way that N, P and sediment may be retained by a wetland BMP, any removal or loss of wetlands will increase delivered loads in the Model, as every other simulated land use has a higher loading rate, except Forest, which is equal to wetlands. Additionally, if natural wetlands are lost, then it is reasonable to expect that monitored loads will not decrease as expected due to management actions, which will increase the level of effort needed to meet water quality standards. If there is available science to explicitly simulate wetlands as part of the L2W factors, it could be incorporated in future iterations of the CBWM, but this panel did not have the data or resources to address that research need on its own.

Phase 6 Wetland Land Uses

Nontidal wetlands have two land uses in the Watershed Model based on the WEP (2016) recommendations. Tidal wetlands are represented in the Estuarine Model and do not have a land use in the Watershed Model. The appropriate excerpt from Chapter 5 of the Model Documentation describing wetlands in the Phase 6 land use dataset is copied here for accuracy:

> The National Wetlands Inventory (NWI) served as the starting point for defining the universe of mapped wetlands. In all areas outside Virginia, the Chesapeake Conservancy and University of Vermont mapped additional emergent wetlands if visible in the NAIP imagery and they adjusted the boundaries of NWI wetlands if it were obvious that they have changed (e.g., a former wetland which is now covered by a house and lawn). In Pennsylvania, additional wetlands were mapped by the Upper Susquehanna Coalition and University of Vermont. County-wide wetlands were mapped using an object-based image analysis (OBIA) which combined regression models of hydrogeologic variables with LIDAR-derived terrain variables, high resolution aerial imagery, and land cover data. Woody wetlands were predicted by landscape wetness, surface elevation, climate, and poorly drained soils. Emergent wetlands were predicted by landscape wetness, topographic dissection, landscape roughness, and forest cover. A full description is contained in Appendix 5.X: A LiDAR-aided hydrogeologic modeling and object-based wetland mapping approach for Pennsylvania.
>
> Tidal wetlands were classified using three methods: 1) identifying all wetlands classified as marine and estuarine wetland systems (E2EM, ESFO, W2SS) according to the NWI Wetlands and Deepwater Habitats Classification chart (https://www.fws.gov/wetlands/Documents/Wetlands-and-Deepwater-HabitatsClassification-chart.pdf); 2) identifying palustrine wetlands with water regime modifiers associated with tidal hydrological conditions (e.g., saltwater tidal or freshwater tidal: PEM, PFO, PSS); 3) identifying wetlands that could be influenced by tidal characteristics/processes by having an elevation less than or equal to 2 meters above sea level according to the Bay elevation apparent in the 10m-resolution National Elevation Dataset (Ator et al. 2003).
>
> Floodplain wetlands were mapped by first creating a map of floodplains based on Federal Emergency Management Agency's (FEMA) Digital Flood Insurance Rate Maps in the National Flood Hazard Layer and Natural Resources Conservation Service's (NRCS) Soil Survey Geographic database (SSURGO). The primary soil attributes used to identify potential floodplains include: flooding frequency (annual probability > 1%), fluvial origins (e.g., fluvents, fluventic aquicambids, fluvaquents), and floodplain geomorphic characteristics (e.g., floodplains, floodplain steps, floodplain playa), and presence of water.

All NWI and other mapped wetlands that did not qualify as tidal or floodplain wetlands were classified as "other". Most of these would be considered isolated and/or headwater wetlands.

Based on the draft-final Phase 6 Watershed Model, there are approximately 1.3 million acres of the two nontidal wetland land uses throughout the Bay watershed (approximately 3 percent of the 64,000 mi^2 watershed area). In comparison, there are approximately 1.6 million acres of impervious surfaces (roads, buildings and other), 2.6 million acres of turf grass land uses,[1] 2 million acres of pasture, and 4 million acres of (non-hay) cropland.[2]

3. Definitions and terms used in the report

Best Management Practice (BMP): For purposes here, a BMP is a management action or conservation practice as defined by the Chesapeake Bay Program (CBP), e.g., Wetland Restoration, Wetland Creation, Wetland Rehabilitation and Wetland Enhancement. Definitions of wetland BMPs are provided in Table 2.

Constructed (stormwater) wetland: Engineered shallow marsh areas that are designed and constructed to treat stormwater. These often incorporate small permanent pools and/or extended detention storage to achieve the full water quality volume treatment. A wetland for stormwater purposes in developed areas should be reported under the existing CBP-approved urban BMP "Wet Ponds and Wetlands" or as a stormwater treatment component of a retrofit or performance standard project. In an agriculture context, constructed wetland structures that treat or capture barnyard runoff as part of a treatment train may be eligible under the Agricultural Stormwater Management BMP.

Degraded wetland: The term "degraded" can be subjective based on the focus of the assessment. For purposes of this report, "degraded wetland" refers to a wetland area where impacts to hydrology, soils, or vegetation impede the wetland's ability to function. Assessment methods can be used to determine whether a particular resource is degraded, based on the chosen threshold(s). Best professional judgment may also be used to identify degraded resources in situations where appropriate assessment methods are not available. The assessment may not be limited to water quality. Specific thresholds or assessment methods are outside the scope of this panel and will be set based on the applicable local, state or federal guidance or regulations. An example wetland conditions assessment is provided in Section 6 of the report as part of qualifying conditions.

Efficiency (Net): A net efficiency, or "lift" is defined to express the percent improvement in nutrient and sediment reduction provided by a wetland BMP. The net efficiency is defined by the difference in the output nutrient and sediment loads pre- and post-treatment and expressed as a percentage. (see Appendix D for a more complete description).

Net Improvement: Similar definition as net efficiency.

Post-Treatment Efficiency: The difference in inflow and outflow pollutant load or concentrations of a BMP after construction or implementation of the practice is complete. Typically, this efficiency is based

[1] Acreage of impervious surfaces and turfgrass do not include tree canopy over impervious or tree canopy over turfgrass.
[2] Base conditions report downloaded from CAST for 2013 Progress with Allocation Air. Accessed Nov. 9, 2017.

on surface measurements, however groundwater loads may impact the overall performance of a BMP as well.

Practice: A general reference to a management action or conservation practice (i.e., not CBP-specific).

Pre-Treatment Efficiency (Baseline or Existing Condition): The difference in inflow and outflow pollutant load or concentrations of an existing natural wetland, whether the wetland is fully functional or degraded. Typically, this efficiency is based on surface measurements; however, groundwater loads may impact the overall performance of a BMP as well.

Technique: Design strategies used to restore, create, rehabilitate, or enhance wetland conditions, typically as an intervention or action that alters the hydrology, vegetation or soils. One or more techniques may be applied as part of a single BMP. While techniques may be implemented individually as a basic approach to address a singular component of a wetland for enhancement, more frequently they will be implemented collectively as a more comprehensive approach to restore wetland structure and functions. Section 6 of the report provides more detail discussion of techniques used to implement wetland BMPs.

Wetland BMPs – see Table 2 for definitions applicable to the scope of the WEP. Additional information to further distinguish amongst the wetland BMP types is provided in Section 6.

4. Methods, Results and Key Findings to Inform the Development of Recommendations for Wetland Rehabilitation, Enhancement and Creation BMPs

The panel recognized the limitations of traditional literature reviews to evaluate wetland water quality benefits as highlighted by WEP (2016), and therefore, the panel explored a variety of methods to build on the previous panel's work as well as leverage and integrate the expertise provided by the current panel. A 'multiple lines of evidence' approach to build consensus was adopted by the current panel that considered the strengths and comparability of results from the following methods. These included: 1) a preliminary conceptual modeling exercise to direct data synthesis and interpretation; 2) a literature review to build on the data developed by the first WEP; 3) a follow-up conceptual modeling exercise to integrate and advance findings from the literature review and early discussions; 4) an expert elicitation to derive retention efficiencies based on a synthesis of panelists' expert-based estimates and 5) analysis of the Riparia Reference Wetland Database (Brooks et al., 2016) in the Commonwealth of Pennsylvania. Individually, no singular method provided a definitive result or consensus to quantify the water quality benefits of wetland BMPs. Rather, these approaches provided an opportunity to examine wetlands from a variety of different perspectives to either validate results or examine why results diverged from a general expectation or trend.

The information presented in this Section summarizes the development of a body of knowledge and information that informed the Panel's deliberations. The key findings provide a summary of salient discussion points to advance new, or build upon existing lines of evidence.

Table 2. CBP definitions of wetland best management practices and summary of decision ruled currently used in the CBP TMDL accounting framework.			
BMP Category /Applicable NRCS Practice Standard	**CBP Definition (for Phase 6 CBWM)**	**CBP will count the BMP acres as…**	**Operational Definitions**
Restoration Applicable NRCS Practice 657	Re-establish The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland.	Acreage gain *(toward Watershed Agreement outcome of 85,000 acre wetland gain <u>and</u> in Phase 6 annual progress runs)*	• No wetland currently exists • Hydric soils present • "Prior converted" • **Result**: Wetland acreage and functional gain
Creation Applicable NRCS Practice 658	Establish (or Create) The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site.	Acreage gain *(toward Watershed Agreement outcome of 85,000 acre wetland gain <u>and</u> in Phase 6 progress runs)*	• No wetland currently exists • Hydric soils not present • **Result**: Wetland acreage and functional gain
Enhancement Applicable NRCS Practice 659	Enhance The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).	Function gain *(toward 150,000 acre outcome <u>and</u> Phase 6 annual progress runs)*	• Wetland present • Some functions may be suboptimal • **Result**: Gain in wetland function
Rehabilitation May include some NRCS Code 657 practices.[3]	Rehabilitate The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland.	Function gain *(toward 150,000 acre outcome <u>and</u> Phase 6 annual progress runs)*	• Wetland present • Wetland conditions/functions degraded • **Result**: Gain in wetland function

Conceptual Modeling, Part I

The panel initially engaged in a series of discussions to develop conceptual models that describe the water quality benefits provided by restored, created, rehabilitated, and enhanced wetlands. The panel recognized other benefits provided by wetlands and wetland practices, and the tradeoffs that may occur but these are not reflected in the conceptual model(s) presented. Conceptual models "capture essential

[3] *Rehabilitated wetlands are a type of restoration according to NRCS definition.*

system components, relationships and their dynamics and provide a vehicle for building common understanding of complex modeling systems among researchers and stakeholders" (Liu *et al.*, 2008). When effectively applied, sharing non-software based, abstract descriptions of system dynamics through conceptual modeling can guide more informed data analyses than traditional approaches. The panel attempted to use conceptual modeling exercises to communicate ideas or hypotheses that might explain the wide range of water quality benefits reported in the wetlands literature. This approach was intended to capture expert insights as to the controlling factors that primarily influence wetland function (i.e., account for structural uncertainty), to provide a relative understanding of the different wetland BMP water quality performance, and to provide guidance on how best to expand and interpret the literature database.

As a starting point, the panel reviewed a conceptual model presented in Kreiling et al (2018) relating wetland condition to both disturbance and stream condition (Figure 2). The authors highlighted a threshold effect on wetland condition and the difficulty of restoring wetlands to their full functioning natural state. The panel explored whether Kreiling's model could be modified to capture key factors driving water quality benefits of different wetland conditions, including natural and restored wetlands, as well as created, rehabilitated, and enhanced wetlands. Figure 2 illustrates a set of hypotheses discussed using this conceptual model. For example, the panel considered the relative capacity of different wetland BMPs to provide water quality benefits as compared to a natural wetland. In general, it was hypothesized that restored wetlands have the greatest potential to provide water quality benefits comparable to natural wetlands, whereas created wetlands had the least potential. Rehabilitated and enhanced wetlands were believed to provide moderated benefits in comparison to the two other types of wetlands. Further, this conceptual model presented hypotheses how source loadings (i.e., source connection, watershed condition) and existing site conditions (i.e., level of disturbance) may affect wetland performance. Shared hypotheses discussed with the WEP included the following: 1) wetland BMPs cannot provide the same water quality benefits as natural wetlands, even in a similar state of degradation; 2) restored and rehabilitated wetlands have greater potential than enhanced or created wetlands to provide targeted water quality benefits; 3) wetland ecosystem functions are highest along undisturbed stream reaches in naturally vegetated catchments; however, 4) wetlands situated in catchments with more intensive human activities (e.g., agriculture) likely have greater potential to provide targeted water quality benefits because of connectivity to sources of excess nutrients and sediment.

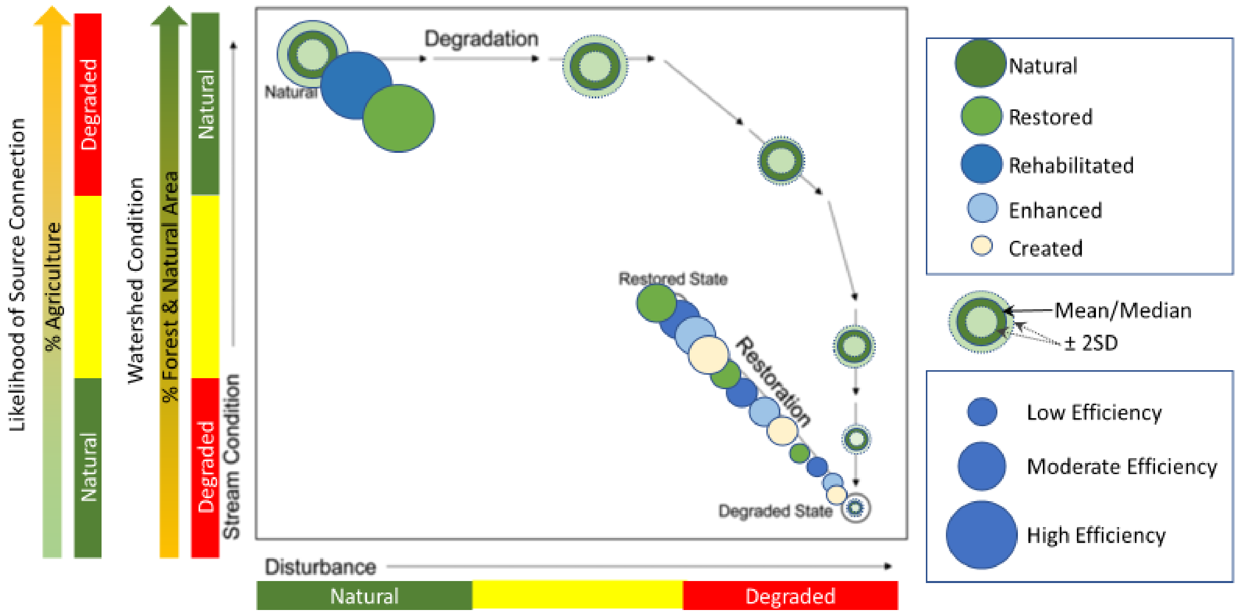

Figure 2 Example conceptual model shared with the panel to illustrate the relative performance of different wetland BMPs based on Kreiling et al (2018).

Key Findings

- The panel acknowledged the need to incorporate the performance of natural and restored wetlands to provide context for the evaluation of the other wetland BMPs.
- General agreement amongst the panel that a relative ranking of wetland BMPs may be valid, however, the conceptual model and literature reviewed was insufficient to reach consensus amongst the panel on a ranking amongst wetland restoration, creation, rehabilitation and enhancement; wetland enhancement was identified as the BMP to provide least net water quality benefit while natural, high-functioning, wetlands would provide the greatest benefit.
- The panel was not able to utilize the Kreiling model or modifications of it as a basis for advancing the panel's charge, in part, because they could not identify key drivers or more explicit processes affecting wetland water quality benefits as depicted by the conceptual model(s) along with supporting data that may be needed to more fully develop them
- The exercise was complicated by acknowledging wetland assessments reflect a wide range of concerns beyond water quality benefits (e.g., plant species diversity, carbon sequestration, water storage, flood protection, and wildlife habitat).

Literature Review

The Panel expanded and added to the literature review database developed by the WEP (2016) panel to summarize the data reported into different types of wetlands. The panel attempted to expand the existing database by identifying additional published observations of water quality benefits provided by restored and natural wetlands and extracting information that may help to differentiate amongst the wetland BMP types. Eight additional studies were added to the database. Appendix E provides a summary of the literature review database and key findings. Similar to the conclusions drawn by the WEP (2016), traditional statistical analyses indicated there is insufficient information in the reviewed literature to differentiate efficiencies amongst the different wetland BMP types. However, there was sufficient information to separate natural wetlands from wetland BMPs. These data were added to the database provided by WEP (2016) and the resulting distribution of TN, TP and TSS percent load reductions for all wetlands – natural and BMP. The summary includes studies reporting both concentrations and loads; however, the majority of the studies are based on loads that accounts for flow and concentrations entering and leaving wetlands[4].

Key Findings

- Since the WEP (2016) literature review was completed, several published meta-analyses (e.g. Land et al 2016) highlighted broader challenges to understanding the wide variation in water quality benefits. For example, wetland BMP definitions were inconsistent across different publications and also challenging to classify according BMP definitions used by NRCS and the Bay program. While a few studies may identify the type of wetland BMP, its operational definition with respect to the techniques used for the project made it often unclear. Variability in the design specifications further complicated comparisons across those studies which provided similar descriptions of restoration techniques. The CBP definitions are predominantly based on the federal (EPA/USACE) definitions for compensatory mitigation with some minor differences
    - Given the wide variety of monitoring methods and site settings, panel members found it difficult to align published wetland BMP descriptions with CBP or NRCS wetland BMP types. Often specific techniques were reported (e.g., levee excavations) without adequate description of pre-existing conditions or surrounding watershed conditions.
    - Comprehensive (i.e., holistic) wetland restorations that address hydrologic impacts and enhance hydric soil and vegetation composition were found to be more effective than simple or singular restoration techniques.

The eight studies were used to update Table 9 in the WEP (2016) report and are presented in Table 3 and Table 4 .

[4] A review of the database finds that the percent reductions from the studies reporting concentrations were similar to the load reductions reported in other studies, so they were included in the overall summary.

Table 3. Summary of literature review to update removal efficiencies for wetlands (n= number of studies). This is an update to Table 9 in WEP (2016).

Wetland Type	Vegetation Type	TN (% reduction)	TP (% reduction)	TSS (% reduction)
Headwater/Depressional	All	31.0 (10)	18.8 (16)	28.3 (6)
Floodplain	All	43.8 (22)	26.2 (15)	37.1 (11)
All, except constructed	Forest, mixed, and unknown	34.1 (21)	44.4 (45)	37.3 (11)
All, except constructed	Emergent	38.8 (22)	18.6 (16)	29.7 (8)
All	All	37.7 (57)	37.6 (88)	43.6 (24)
Chesapeake Bay only	All	26.0 (12)	23.9 (14)	24.4 (8)
All, except constructed	All	40.7 (40)	37.6 (61)	34.1 (19)

The data from the literature were further analyzed to separate retention efficiencies for natural and wetland BMPs; constructed wetlands were not included. A summary is provided in Table 4.

Table 4. Average Retention Efficiencies (%) for Natural and Wetland BMPs from the Literature Review, (n= number of studies).

Wetland Type	TN % (n)	TP % (n)	TSS % (n)
Natural wetlands	45 (15)	42 (17)	n/a
Wetland BMPs	39 (21)	42 (46)	43 (12)

Conceptual Modeling, Part II

Continued discussions to capture the Panel's understanding of factors affecting wetland water quality provisions resulted in a set of more detailed conceptual models to describe how or which bio-physical factors predominantly influence a wetland's water quality function. While these conceptual models did not explicitly consider any specific wetland classification system (i.e., HGM, Cowardin), factors common to these classifications may be reflected in the models discussed by the Panel (e.g., landscape position, hydrology, vegetation, soils). In contrast to the Kreiling-based model discussion, which focused on comparing retention among wetland BMP sites relative to stream and catchment conditions, this conversation focused on the mechanisms and conditions driving wetland capacity to provide water quality benefits. The summary of these hypotheses is outlined below, and graphical representations are included in Appendix F. A common thread throughout these discussions was the combined effects of a wetland's *capacity* and *opportunity*, which drive the functional potential of a wetland's water quality benefit. *Capacity* refers to the condition of the wetland (characteristics and size), whereas *opportunity* acknowledges the importance of location, including existing/surrounding site conditions (e.g. presence/absence of a wetland, existing land use/loadings). Each of these overarching components influence a wetland's hydrology, soil, vegetation condition, and biogeochemical functioning.

It is important to emphasize that these hypotheses represent potential explanations to the wide variability in observed water quality benefits (i.e., TN, TP, and TSS retention), and not current paradigms in wetland science. These statements are not conclusions drawn by the Panel, rather they have emerged based on review of the literature and Panel discussions. Like the Kreiling model-based discussion, this conversation revealed contrasting ideas among expert panelists to explain wetland function and uncertainties. Further, these hypotheses are not completely independent, which can complicate efforts to define a singular conceptual model or framework. Additionally, the Panel recognized and supported that the water quality benefits of a wetland are a function of hydrology, soils, and vegetation that may act singularly or in combination to affect the retention of nutrients and sediment. Results from this discussion emphasized a need to promote interdisciplinary, collaborative studies across institutions to refine our understanding of wetland ecosystem services across the Bay watershed.

Emerging Hypotheses to Explain Variability in Wetland TN, TP, and TSS Retention Capacity:

Emerging Hypotheses Set 1: Wetland Condition (Capacity)

This set of hypotheses explores how the extent of direct alteration of site conditions influences wetland water quality functions. The framework or context to evaluate the water quality functions of wetlands determines the relative improvement by the BMPs, as noted by the hypotheses described below. For example, the first two hypotheses suggest that the water quality function of a wetland can either rely on: 1) the presence of a (pre)existing wetland, or 2) the techniques implemented to optimize wetland function—irrespective of pre-existing wetland presence or conditions. The literature reviewed by the Panel and WEP (2016) is inconclusive to support any of the following hypotheses fully at this time.

1. *Natural Wetlands Maximize WQ Benefits*
   Natural wetlands have the greatest capacity to provide water quality benefits. Rehabilitated wetlands designed to manipulate natural wetlands may achieve comparable water quality benefits, especially over time (years) when natural ecosystem processes can reestablish. Enhanced wetlands designed solely to improve water quality benefits may increase nutrient and sediment retention, though perhaps not as much as rehabilitated wetlands designed to restore wetlands more holistically. It is also hypothesized that created wetlands are least likely to provide improvement in water quality benefits, with the assumption that the implementation of techniques are insufficient to promote the development of sustained natural wetland processes.

2. *Optimally Designed Wetland BMPs Maximize WQ Benefits*
   Because of the opportunity to improve natural processes through engineering, wetland BMPs may provide more effective nutrient and sediment retention compared to natural wetlands. However, these benefits may come at a cost to other targeted ecosystem benefits (e.g., preservation or enhanced establishment of rare wetland species) or be more singularly focused on water quality.

3. *Hydrologic Alteration is the Primary Influence on Wetland WQ Benefits*
   Hydrology is the master variable affecting soil development and the establishment and subsequent maintenance of wetland plant communities. Hydrologic alteration most notably influences wetland interception and retention capacity. Restoring a system's hydrology alone will ultimately improve nutrient and sediment retention capacity by facilitating the reestablishment of natural wetland soil biogeochemistry and hydrophytic vegetation dynamics (i.e., field-of-dreams hypothesis (Hilderbrand *et al.*, 2014)).

4. *Complexity of Biophysical Conditions is the Primary Influence on Wetland WQ Benefits*
   Multiple factors interactively influence wetland biogeochemistry and their resulting water quality benefits. Restoration designs must consider the extent of hydrologic alteration, soil compaction and oxidation, soil organic content, and loss of wetland vegetation to achieve maximum water quality function. Simple, form-based restoration typically "do[es] not achieve long-term project objectives with […] success" due largely "to the failure of most projects to take hydrology and natural processes into account." Successful restoration requires a holistic approach that addresses all aspects of human impacts on a system.

Emerging Hypotheses Set 2: Wetland Location (Opportunity)

The location of a wetland largely determines wetland functions due to controls on hydrology and connectivity to contaminant sources (i.e., sources of excess nutrients and sediments).

1. *Hydrogeologic Setting is the Primary Influence on Wetland WQ Benefits*
   Variation in source waters and source water chemistry due to watershed position (e.g., headwater versus floodplain wetlands) and physiographic province (e.g., Ridge and Valley versus Coastal Plain), are the primarily influences on wetland function and the potential benefits of wetland BMPs to CBP water quality targets. The landscape setting ultimately influences hydroperiod characteristics. Further, biogeochemical functions cannot be determined without consideration of hydro-chemical characteristics of source waters, including the dissolved mineral content, pH, and redox condition of the wetland soils, as well as nutrient and suspended sediment loads.

2. *Hydrologic Connectivity to Up-Gradient Nutrient and Sediment Sources is the Primary Influence on Wetland WQ Benefits*
   Wetlands down-gradient from intensive land use activities that generate high volumes of excess nutrient and sediment loads have a greater opportunity to provide water quality benefits to regional waterways.

Expert Elicitation

While the earlier discussions provided opportunities for the panel to review peer-reviewed publications in the context of this panel's charge and to gain understanding of each other's perspective, there remained a great deal of uncertainty regarding how best to quantify and assign efficiencies to the different type of wetland BMPs. Given the limited availability of data to distinguish amongst the BMP types and the currently assigned efficiencies for wetland restoration BMPs, the panel used expert elicitation strategies to estimate the retention parameters based on integration of expertise from all panel members. Expert elicitation provides a scientifically-defensible method to solicit answers to questions in the absence of data based on the collective responses from experts in the field of study (Hemming et al 2018; Speirs-Bridge et al 2010).

This process is suitable for the panel as insufficient data is available to evaluate the three wetland BMPs (creation, rehabilitation, and enhancement) or conformity amongst the Panel to generate a framework or organizational principles to use available data. The purpose of the expert elicitation process was to solicit expert judgement to quantify the relative, average annual effectiveness for three wetland BMPs (creation, rehabilitation and enhancement) for TN, TP and TSS. The responses to the survey questions provided information to assess the degree or level of certainty or agreement associated with the responses. Expert judgement is based on an individual's knowledge, skills and/or experience related to wetlands, both natural or as a best management practice. The wetland restoration BMP and natural wetlands were included in the expert elicitation survey to provide a complete, relative assessment of all the wetland BMPs. However, it was communicated to the Panel that the current operational definitions for natural wetlands or wetland restoration BMP would not change as result of this process or part of the expert panel recommendations.

The expert elicitation survey included two rounds of surveys, with a review of the first round of survey results to clarify understanding of the questions that may affect an individual's response. The survey was re-issued with a revised wording and format of the questions to improve clarity and understanding of the questions and how the survey results would be used. Specifically, the second survey added questions that would enable results to define (quantify) a post-construction wetland BMP efficiency and a net improvement efficiency using both pre- and post-construction values. The results of the Round 2 Expert Elicitation survey were used to determine the percent efficiency pollutant load reductions, as a net efficiency or lift, for the four wetland BMPs: restoration, creation, rehabilitation and enhancement. A coefficient of variation, COV, was used to describe the relative measure of variation amongst the individual responses. The range in percent efficiency reductions (low and high estimates provided by the panel members) were adjusted by the confidence reported. Questions for the pollutant reduction performance of undisturbed, high-functioning natural wetlands and the wetland restoration BMP were included to provide context for the three other wetland BMPs, allowing for a relative ranking. The results provided for natural wetlands and the wetland restoration BMP would not be included as part of the Panel's recommendations on efficiency reductions, nor revise the wetland land use loading rates. However, recommendations may be provided as part of future research or management decisions for consideration by the Chesapeake Bay Program.

The complete results from the second round of surveys questions is provided in Appendix G.

Key Findings:

- There was greatest agreement amongst panel members for the post-treatment efficiencies for the four wetland BMPs compared to the pre-treatment condition.
- The survey responses showed a consistent relative ranking for the wetland BMPs for the pre- and post-treatment conditions for TN and TSS. The ordinal ranking for the BMPs post-treatment were similar. The EE found that the efficiency values for the post-construction wetland enhancement BMP had the greatest pollutant removal efficiency, and wetland restoration BMP had the lowest, followed by wetland creation. This ordinal ranking followed the assumption that sites for wetland rehabilitation and enhancement had some level of nutrient and sediment removal, e.g., hydric soils or vegetation. Therefore, the implementation of management actions/techniques added, or improved this function exceeding sites where no wetland currently existed.
- The ordinal ranking for the wetland BMPs reversed when the baseline condition of the wetland BMP site was considered to determine a net improvement efficiency. That is, the largest improvement in water quality function of wetland occurred for restoration and creation as it was assumed that little to no water quality benefits existed at the site prior to implementation (i.e., the biggest 'lift' occurred) (see Appendix D for additional description of net improvement efficiency).
- A summary of the Round 2 EE results is provided in Table 5.

Table 5. Wetland BMP TN, TP and TSS Efficiency Values Based on Round 2 Expert Elicitation Survey Results.

		Efficiency (%), expressed as a net improvement or "lift"		
Parameter	**BMP Type[1]**	**Mean (%)**	**COV[2]**	**Adapted Range[3] (%)**
TN	Restoration	32	0.48	0.9 – 57.6
	Creation	29.8	0.64	9.1 – 59.9
	Rehabilitation	21.0	0.55	-5.5 – 50.7
	Enhancement	17.5	0.85	-14.5 – 47.1
TP	Restoration	23.5	0.64	-11.0 – 49.0
	Creation	27.0	0.63	0.6 – 56.0
	Rehabilitation	22.8	0.50	-12.8 – 50.5
	Enhancement	25.6	0.80	-18.4 – 49.5
Sediment	Restoration	34.5	0.68	-3.6 – 49.0
	Creation	32.5	0.69	0.9 – 54.4
	Rehabilitation	20.8	0.63	-2.3 – 45.8
	Enhancement	17.3	0.93	-10.5 – 45.6

[1] The values for the wetland restoration BMP are the existing efficiencies as recommended by WEP(2016) and provided for context.

[2] COV is the coefficient of variation is used to describe the relative measure of variation amongst the individual responses

3 The adapted range takes into account the confidence associated with individual responses

Riparia Database Analysis

In support of the WEP process, data from Riparia (a research center located in the Department of Geography, Penn State University) was used to assess the relative water quality functional performance of a collection of natural and created wetlands across the Commonwealth of Pennsylvania. The Riparia Reference Wetland Database (Brooks et al., 2016) consists of 222 natural wetland sites that were originally established during the period of 1993-2003; many have been re-sampled on a 10-year interval since then. The uses of the dataset, background on its formation, and definitions of terms can be found in Brooks et al., 2016. The Pennsylvania Created Wetlands Dataset is the result of a research project by Naomi Gebo, and the majority of the sites (72) in the database are detailed in Gebo and Brooks, 2012; this study compared created wetland sites to the natural wetlands contained in the aforementioned database (additional sites were subsequently added to the database). Both datasets contain values across three sampling protocols, termed Level 1, 2, and 3. Level 1 is a Landscape Assessment, which utilizes digital geospatial data to give a rough approximation of expected condition of the site based on these parameters. Level 2 is termed a Rapid Assessment and supplements the Level 1 assessment with a short field visit that obtains data on the presence of various stressors of the site (e.g., evidence of eutrophication, sedimentation, invasive plants) and buffer characteristics. Level 3 involves a detailed field assessment that obtains information required to estimate various condition indicators (e.g. Floristic Quality Assessment Index, a plant-based Index of Biotic Integrity) and a suite of Hydrogeomorphic (HGM) Functional Assessments. Characteristics of the datasets are presented in Table 6.

Table 6. Datasets used in the Riparia analysis.

Database	Classification System	Ecoregions	Level 1 Landscape Assessment	Level 2 Stressor Checklist and Buffer Characterization	Level 3 Intensive Condition and HGM Functional Assessment	Comments
PA Reference Sites (n=222)	HGM	Ridge & Valley; Appalachian Plateau, Unglaciated; Appalachian Plateau, Glaciated; Piedmont	Available	Available	Available	Includes **Reference Standard sites** in each category of ecoregion/HGM class. Sampled 1993-2003, with some sites re-sampled on a decade interval
PA Created Wetlands (n=107)	HGM	Ridge & Valley; Appalachian Plateau,Unglaciated; Appalachian Plateau, Glaciated; Piedmont	Available	Available	Available	Sampled in 2007/2008; sites ranged in age from 3 to 17 years since construction

The analysis for the WEP focused on three major HGM classes of wetlands, according to Brinson (1993). These included: Riverine (wetlands located along 4th order or greater streams/rivers), Headwater (wetlands occurring in the riparian areas on up to 3rd order streams), and Isolated Depressions. Fringing wetlands (those wetlands located on lakes and ponds) are excluded from the analysis because they occur primarily in highly-managed settings, e.g., farm ponds or recreational lakes, and thus do not generally represent naturally-occurring wetlands.

Reference, Reference Standard, and Created

The PA Reference Sites are composed of natural wetlands that cover the full range of condition and level of anthropogenic disturbance. A subset of sites are designated as Reference Standard. Reference Standard refers to conditions at the least, or minimally, impacted sites, thereby providing the potential to develop a quantitative description of the best available chemical, physical, and biological conditions in the wetland resource given the current state of the landscape. This conceptual framework and family of definitions is adaptable to any wetland type in any geographic setting; for example, a Reference Standard can be developed for Riverine wetlands in the Piedmont ecoregion.

Water Quality Functions

The analysis focused on the HGM Functional Models described in Gebo and Brooks (2012). The analysis focused on the water quality functions that include functional models F5, F6, F7 as shown in Table 7. The functional model scores provide a relative measure of function, rather than absolute. The scores range from a value of 0 to 1, where 0 represents the absence of that function and 1 would indicate that the function is at the maximal level for that wetland type.

Table 7. HGM Functional Models (from Gebo and Brooks 2012)

Function Number	Function Name	HGM Class
Hydrologic Functions		
1	Energy Dissipation/Short-term Surface Water Detention	Headwater Floodplain, Mainstem Floodplain, Slope
2	Long-term Surface Water Storage	Headwater Floodplain, Mainstem Floodplain
3	Maintain Characteristic Hydrology	Depression, Fringing, Slope
Biogeochemical Functions		
5	Removal of Imported Inorganic Nitrogen	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
6	Solute Adsorption Capacity	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
7	Retention of Inorganic Particulates	Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
8	Export of Organic Carbon	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
Biodiversity Functions		
9	Maintain Characteristic Native Plant Community Composition	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
10	Maintain Characteristic Detrital Biomass	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope
11	Vertebrate Community Structure and Composition	Depression, Fringing, Headwater Floodplain, Mainstem Floodplain, Slope

Application of the HGM Functional Model Scores

A method was developed to apply the HGM functional model scores using the Headwaters setting as the default values, combined with the updated literature review values (see Table 4) to estimate TN, TP and TSS efficiencies for the different wetland BMPs. See Appendix H for a complete description of the method and results.

To facilitate this analysis, a set of assumptions was applied.

1. It was assumed that the scores for the Reference wetlands in the Riparia database are representative of post-construction BMP wetland conditions for restoration and rehabilitation. Both of these wetland BMPs have similar outcomes according to the Chesapeake Bay definitions, where a restoration and rehabilitated wetland should result in the return or repair of wetland functions similar to a historic or natural wetland, respectively. As such, Table 8 presents the following wetland conditions assigned for the purposes of method development.

Table 8. Wetland condition assigned to wetlands in the Riparia database.

Wetland type	**Description**	**Condition**
Reference Standard	Existing wetlands in forested settings	Natural, undisturbed wetland
Reference	Existing wetlands in agricultural or urban settings	Approximate water quality functions of a restored or rehabilitated wetland
Created	Created wetlands	Created wetlands

2. Regardless of the method, the core data used are the mean HGM function model scores (0-1) represented by each wetland type.
3. The results using the Headwater Wetlands is used as a first approximation.
4. A net efficiency definition (Appendix D) is used. Where it is assumed that a restoration and created wetland have a pre-treatment of "0" as there is no wetland present. For the Pre-BMP Condition for Rehabilitation, it is assumed that the score is equivalent to the 10th percentile for Reference Wetlands. A sensitivity analysis and professional judgement was used to determine the 10th percentile.
5. Table 9 provides a summary of the data used for the Headwater wetlands using the HGM functional models and Riparia dataset.

Table 9. Mean Scores from the HGM Functional Assessment Models for Headwater Wetlands for Each Wetland Type

Wetland Type	Wetland BMP State Represented	Scores (Headwater Wetlands)		
		F5. Inorganic Nitrogen[2]	F6. Solute Adsorption[2]	F7. Inorganic Particulates
Reference	Post-BMP for Rehabilitation and Restoration	0.56	0.51	0.50
Created	Created	0.42	0.41	0.38
10th percentile for Reference Wetlands[1]	Pre-BMP Condition for Rehabilitation	0.41	0.24	0.24

[1] This value is estimated assuming a normal distribution, and the mean and standard deviation provided for each score.
[2] F5 and F6 refer to forms of TN or TP, which are likely bioavailable forms.

The scores from the HGM Functional Models (the HGM scores) were used to represent the ratio of performance for each wetland condition, then multiplied by the efficiency for wetland BMPs for TN, TP and TSS from the literature (Table 4). The resulting scaling Factors (see Table 6 in Appendix H) begin to indicate the relative condition for each wetland state. The scaling factors (F) were then be used to estimate a composite or average factor for each chemical parameter. Since each score represents a different wetland function, TN, TP and TSS are represented using different HGM function model scores, as follows:

- TN is the average of F5 (Inorganic Nitrogen Retention) and F7 (Inorganic Particulate Retention)
- TP is the average of F6 (Solute Adsorption) and F7 (Inorganic Particulate Retention)
- TSS is F7 (Inorganic Particulate Retention)

The resulting efficiencies are presented in Table 10 where the “lift” represent the net improvement or efficiency of the wetland BMP. It is important to note that the values presented in the table for wetland restoration are only applied for the purposes of the method and not recommended for the wetland restoration BMP in the Phase 6 Watershed Model. Values for the wetland enhancement BMP are not provided, given the recommendation by the Panel to exclude this BMP as an eligible management action for nutrient reductions for the Chesapeake Bay TMDL (see Section 5 of this report).

Table 10. Estimated Wetlands Efficiencies Using Scaling Factors for Wetland Creation and Rehabilitation.

	Wetland BMP Efficiency	***Parameter***		
		TN	***TP***	***TSS***
Restoration (**not the same as the numbers in the model**) Mean from our literature review database	*Pre-Restoration*	0%	0%	0%
	Post-Restoration	39%	42%	43%
	Lift	39%	42%	43%
Creation	*Pre-Creation*	0%	0%	0%
	Post-Creation Riparia Scaling of restored efficiency (ratio of Created to Reference)	30%	33%	35%
	Lift:	**30%**	**33%**	**35%**
Rehabilitation	*Pre-Rehabilitation Riparia Scaling (ratio of 10th percentile Reference to Mean of Reference)*	23%	20%	20%
	Post-Rehabilitation	39%	42%	43%
	Lift	**16%**	**22%**	**23%**

5. Recommendations for Nontidal wetland BMPs in the Phase 6 Watershed Model & Qualifying Conditions

The following recommendations are proposed to account for effects of wetland management strategy implementation and to refine the CBP6 TMDL modeling framework. The recommendations are based on a synthesis of the different approaches this panel explored to define and quantify wetland water quality benefits.

Wetland Enhancement

The panel recommends that wetland enhancement should not be a BMP for purposes of achieving nutrient and sediment reduction targets under the TMDL, as simulated in the Watershed Model. The panel noted that wetland enhancement occurs to one or a few functions from a range of wetland functions. Typical enhancement projects are often not focused on water quality functions like nutrients or sediment retention. In some instances, management or treatment options associated with wetland enhancement could have an adverse impact on water quality, even though the intervention has a desirable outcome. For example, *Phragmites australis* control to enhance habitat value may reduce nutrient and sediment trapping as discussed by Bansal et al. (2019) that summarize the range of ecological services and disservices by this invasive plant. The panel agreed that the definition of wetland enhancement does not guarantee either a focus or effect on improved water quality benefits.

Further, the definition of enhancement may vary by jurisdiction or practitioner and presents challenges to adequately distinguish between wetland enhancement and rehabilitation BMPs in the literature. For example, invasive species management may be considered either enhancement or rehabilitation, depending on the degree and goals of the project. The Chesapeake Bay Program definition of a wetland enhancement BMP infers that the baseline condition is a relatively functional wetland (i.e., not a degraded wetland). The panel acknowledges there is ambiguity between wetland rehabilitation and wetland enhancement. The main consideration is that wetland rehabilitation is likely to address the wetland's degraded condition, whereas wetland enhancement may occur on wetlands that are generally considered functional. As such, it is this panel's professional judgment that wetlands that cannot reasonably be considered "degraded" by applicable thresholds and methods should not be targeted for management actions for nutrient and sediment reduction.

The panel further agreed that even when a wetland enhancement project is specifically designed to improve water quality, this could potentially be achieved at a detriment to habitat or other wetland functions. Such negative impacts to other functions may occur even if the project is designed and implemented properly, with oversight and permitting. The panel sees no practical methods for safeguarding against these potential losses in function, concluding that the most logical path is to remove the incentive for wetland enhancement as a BMP for nutrients and sediment reductions. Furthermore, the panel agrees that non-degraded wetlands should not be candidates for management actions if the sole purpose of those actions is nutrient or sediment reductions.

Finally, while the panel is not recommending wetland enhancement for TN, TP, or TSS benefits in the Watershed Model, this is not a judgment or disparagement of wetland enhancement as a practice. Indeed, wetland enhancement as a practice might be valuable for a number of management purposes, such as habitat for key species or control of invasive species. The panel acknowledges these potential benefits and encourages stakeholders to continue implementation of enhancement based on local or state needs and goals, but not as a tool to achieve nutrient and sediment targets under the TMDL. The other wetland BMPs (restoration, creation and rehabilitation) are still available to contribute to nutrient and sediment reduction targets.

Pollutant Removal Efficiencies Recommended for Wetland Creation and Rehabilitation

The panel reviewed the combined results of the literature review, expert elicitation and Riparia database method for TN, TP and TSS and provide the recommended pollutant removal efficiencies shown in Table 11 for wetland creation, rehabilitation and enhancement. The recommended values are based on a review of multiple data analyses as no single method or approach provided adequate information, nor garnered consensus amongst the panel on its own. The efficiency values represent a 'lift' in pollutant removal from the wetland BMP to reflect the pre-existing and post-treatment condition of the wetland, consistent with the efficiency definition adopted by the panel. An efficiency reduction for enhancement is not recommended given the panel's rationale provided in the previous section.

Table 11. Recommended pollutant removal efficiencies for wetland creation, rehabilitation and enhancement (expressed as a percent).

Wetland BMP Type	TN (%)	TP (%)	TSS (%)
Restoration[1]	42	40	31
Creation	30	33	27
Rehabilitation	16	22	19
Enhancement	Not recommended		

[1] The wetland restoration efficiencies are provided for reference and the values are from WEP (2016).

The recommended values are based on the criteria that the percent pollutant reduction for the wetland restoration BMP was set by the previous WEP and that there is a relative ranking of the wetland BMPs based on best professional judgement. Consequently, the wetland efficiencies (as "lift") for creation and rehabilitation would be less than restoration, and rehabilitation would be less than creation. The panel did recognize that site-specific and design considerations for wetland creation may result in a higher load reduction compared to a restoration BMP, however, the panel also acknowledged that the preexisting condition of a wetland restoration site may have greater potential for long-term sustainability.

A summary of the data used to inform the panel's recommendations is provided in Table 12. These results show the literature review, in general, provides higher efficiency values compared to the other two methods and the numbers established by WEP 2016 for the wetland restoration BMP. The Expert Elicitation results were similar to the results from Riparia database analyses for all three parameters. The panel recommended the efficiency numbers provided by the Riparia database be used, given the similarities with the Expert Elicitation results. Upon further evaluation of the literature review, the recommendation for TSS reduction required an additional decision point. The results in the literature review were heavily influenced by just a few studies and it was determined the average value from all publications reporting a TSS load reduction would be more representative (i.e., 36%) and was applied to the Riparia database analyses. That is, the 36% value was used to adjust the value in the Riparia database analysis from 35% to 27% as shown in Table 10.

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Table 12. Summary of pollutant removal efficiencies from multiple sources.

Wetland BMP Type	TN (%)	TP (%)	TSS (%)	Source	Note
Wetland BMPs	39	32	43[1]	Literature Review	Unable to differentiate amongst the different BMP types (see Table 4)
Creation	29.8	27	32.5	Expert Elicitation	Results from "Round 2" survey and represents "net efficiency" or "lift" (see Table 5)
Rehabilitation	21	22.8	20.8		
Creation	30	33	35	Riparia database analyses	See Table 10
Rehabilitation	16	22	23		
[1] *The average TSS percent reduction from all studies in the literature review databased is 36%*					

Upland Treated Acres

The panel was unable to reach consensus to apply the upland treated ratios recommended by the WEP (2016) for the wetland restoration BMP to the rehabilitation and creation wetland BMPs. The panel acknowledged the significance of landscape position and the influence of hydrologic connectivity and upland sources areas on the water quality function of BMPs. Many of the conceptual models discussed by the panel included these elements. However, similar to the challenges to quantify an efficiency value to differentiate amongst the wetland BMPs, the dearth of data to support the upland treated acres by the nine physiographic areas challenged the Panel to agree with the ratios recommended by the WEP (2016). The panel investigated data reported in the Riparia dataset along with a wetland database for the Nanticoke Watershed in Maryland and found insufficient information to support or build on the WEP (2016), or define alternative ratios to distinguish the performance of a wetland based on its location within the Chesapeake Bay watershed. Therefore, it is recommended by the Panel to report the drainage area of the wetland BMP as part of the water quality benefit (credit). If a drainage area for the wetland creation or rehabilitation BMP is not reported to the State agency, a default ratio will be applied for reporting to the Chesapeake Bay Program. A default 1:1 ratio will be applied to non-floodplain wetland creation and rehabilitation BMPs and a 1.5:1 for floodplain wetland creation and rehabilitation BMPs in acknowledgement of the influence of landscape position (flatter topography, lower in drainage area) and hydrological connectivity to upland sources on retention efficiency of a wetland. The Panel further recommends an upper limit for reported upland acres treated of 4:1 for non-floodplain wetland creation and rehabilitation and 6:1 for these wetland BMPs in the floodplain. These are the maximum ratios recommended by the WEP (2016).

5.1 Qualifying Conditions

The statements and procedures outlined in this Expert Panel Report are intended to supplement existing jurisdictional requirements, where established. The qualifying conditions do not affect any jurisdictional regulatory and other legal requirements. Each project should be assessed based on federal, state, and local regulatory requirements, according to best professional judgments in the field, and supported by benchmarks presented in state and federal guidance documents. It is recommended that wetland delineation should be conducted by a qualified professional in accordance with the USACE 1987 Wetland Delineation Manual (USACE, 1987) and applicable Regional Supplements for all potential Restoration or Rehabilitation projects (https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/reg_supp/).

In general, the intended outcome for all wetlands BMPs should result in a sustainable, functioning wetland that requires minimal, long-term intervention. It is recognized that site visits and maintenance are necessary in the initial years following installation to ensure the project's success. The location, to include consideration of hydrologic connectivity and landscape position, is central to achieving this outcome. The panel acknowledges that a single intervention is often not sufficient given the complex hydrologic, vegetation and soil processes and factors affecting the water quality performance of a wetland. The long-term success of wetland creation and rehabilitation may include monitoring, maintenance, remedial actions, and an adaptative management plan. In particular, successful vegetative management may potentially take multiple years.

The following list of qualifying conditions is not intended to be exhaustive, but rather to provide the following basic guidance:

- It is the intention of the panel that wetland BMP projects only earn nutrient and sediment reductions if they are implemented at appropriate sites which improve the ecological function of a wetland or a non-wetland site where a created wetland BMP is implemented.

- Negatively impacting the functions and/or values of existing wetland systems and high-quality or rare non-wetland ecosystems should not be pursued.

- Changing the functions of existing high-quality wetlands should not be pursued.

- Wetland BMPs should adhere to all federal, state, and local permit requirements and regulations pertaining to jurisdictional wetlands.

- All BMPs should avoid adverse impacts to watercourses or wetlands.

- BMP locations should be chosen to ensure hydrology is sufficient for long-term sustainability of the wetland.

- An assessment of pre- and post BMP conditions should document the identification of the appropriate wetland BMP and find that post-construction, the hydrologic, vegetation, and soil conditions exist for a functioning wetland. General guidance to evaluate the pre- and post BMP conditions is provided below.

- Wetland BMPs in agricultural areas should be designed to promote nutrient and sediment retention to the extent practical.

Guidance to Assess Pre- and Post- Wetland BMP Conditions

An existing conditions assessment of the proposed BMP wetland site will help to determine the BMP most applicable for water quality credit. Figure 3 provides a basic decision framework to identify the eligibility for the different wetland BMPs. This decision framework is based on the existing site conditions as determined in part by the Chesapeake Bay Program wetland definitions and the panel's expert judgment and field experience. For example, a key distinction between wetland restoration or creation wetland BMPs and wetland rehabilitation or enhancement is the presence or absence of an existing wetland. It is expected that the outcome of all management actions will result in hydrologic, vegetation and soil conditions that support a functioning wetland to provide water quality benefit.

The pre-BMP condition is central to determine the eligibility of the type of wetland BMP credit. The project goals and techniques implemented will vary depending on the existing conditions and type of wetland BMP, as shown in Table 13. The list of techniques is provided for example purposes and not intended to be an exhaustive list of all techniques that may be applied in a wetland BMP project. However, all post-BMP wetlands need to have hydric soils, sustainable wetland hydrology, and a dominance of hydrophytic vegetation, in line with the definition of a wetland (U.S. Army Corps of Engineers, 1987, p 9).

> *"Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."*

According to the 1987 USACE Wetland Delineation Manual, evidence of a minimum of one positive wetland indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination.

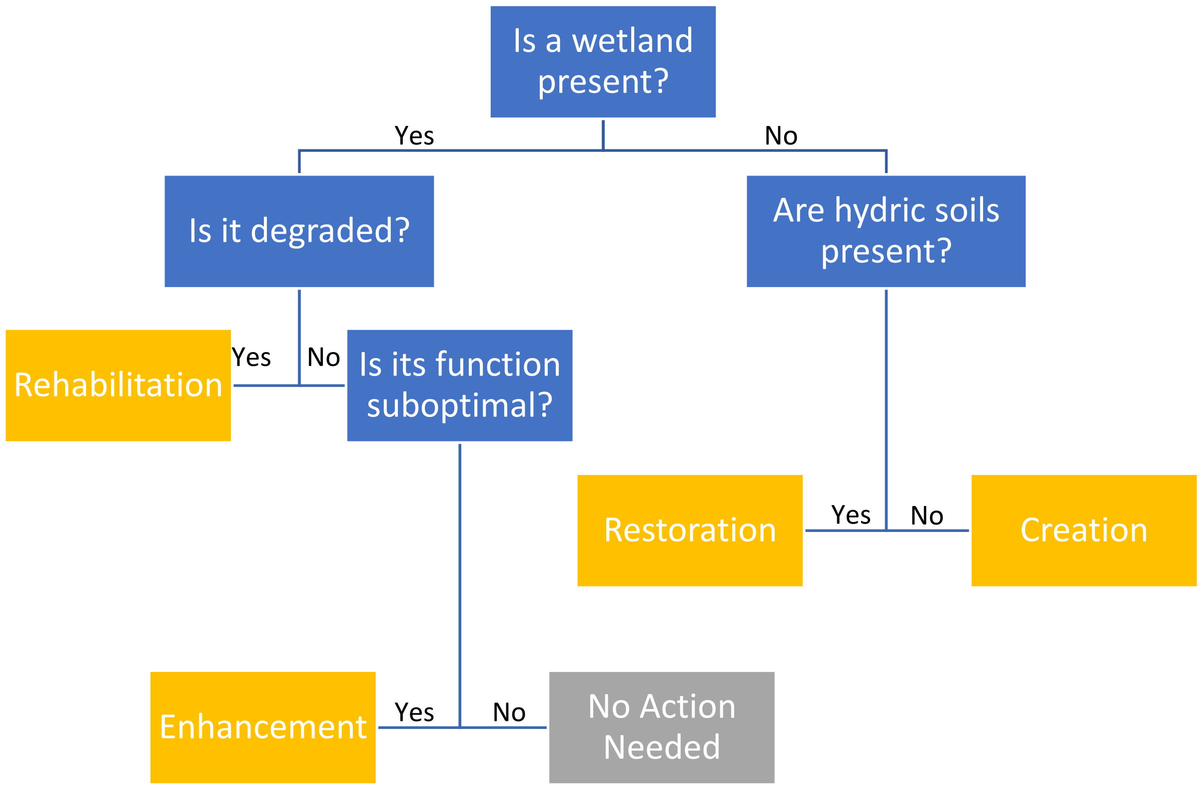

Figure 3. Wetland BMP determination based on existing conditions

Table 13. Wetland BMPs and example techniques to address the hydrologic, vegetation and soil conditions of a wetland post construction.

Wetland Techniques Matrix[1,2]							
BMP type	Number of Components Typically Addressed	Wetland Components					
		Hydrology		Vegetation		Soils	
		Goal	Typical Techniques	Goal	Typical Techniques	Goal	Typical Techniques
Restoration	2-3	Reestablish wetland hydrology	• Legacy Sediment Removal • Ditch Fills / Ditch Plugs • Tile Drain Plugs or Breaking Tile Drains • Berm Creation or Modification • Addition of Microtopography	Reestablish a functioning native plant community	• Planting • Seeding • Invasive Species Management • Manage Excessive Wildlife Browse • Livestock Fencing	Reestablish functioning hydric soils	• Fill Removal • Legacy Sediment Removal • Excavation • Decompaction • Organic Matter Addition
Creation	All 3	Establish and maintain wetland hydrology	• Berm Creation or Modification • Excavation • Water Control Structures*4 • Creation of Microtopography	Establish and maintain a wetland plant community	• Planting • Seeding • Invasive Species Management • Manage Excessive Wildlife Browse • Livestock Fencing	Establish wetland soils conditions	• Decompaction • Addition of soil • Organic Matter Addition • Soil Amendment
Rehabilitation	1-2	Modify current hydrology to repair degraded hydrologic conditions.	• Ditch Fills and Ditch Plugs • Regrading Ditch or Watercourse Banks • Levee Breach • Berm Creation or Modification • Addition or Enhancement of Microtopography	Supplement and improve existing plant community to reflect a reference community	• Planting • Seeding • Invasive Species Management • Manage Excessive Wildlife Browse • Livestock Fencing • Forest Management	Amend soils to support a functioning wetland	• Decompaction • Organic Matter Addition • Soil Amendment
Enhancement[3]	1	Improve Hydrologic Function	• Berm Modification • Microtopography/ Addition of Pools and/or Hummocks	Supplement and improve existing plant community to	• Planting • Seeding • Invasive Species Management	Enhance existing wetland soils	• Organic Matter Addition • Soil Amendment

				reflect a reference community	• Manage Excessive Wildlife Browse • Livestock Fencing			

1: Derived from Expert Elicitation, the 4/25/18 Strawman Common Wetland and specific inputs from panel members. The techniques provided in the table are included as examples and not intended to be an exhaustive nor complete list.
2: Represents typical techniques; other options may be used to achieve the same goals.
3: Although Hydrology and Soils goals and practices are identified, Enhancement typically focuses on a singular component, and modifying a functioning wetland could have potential negative ecological impacts.
4: Use of water control structures may create concerns as they typically require ongoing maintenance and may have impacts to other resources.

6. Accountability Mechanisms

The accountability mechanisms for wetland creation and rehabilitation practices are similar to wetland restoration practices. These practices must be accounted for and verified for credit toward Chesapeake Bay water quality goals. The Panel recommends the following reporting and verification protocols for wetland BMP projects, consistent with existing CBP wetland BMP verification guidance:

1. Initial verification – The installing agency must confirm that the proposed practice was installed to design specifications, is hydrologically stable and vegetatively stable, and all erosion and sediment control measures have been removed. It is recommended that the installing agencies use an assessment method to identify the applicable wetland BMP eligible for credit (see Qualifying Conditions for recommendations to include a pre- and post-conditions assessment).

   All jurisdictions have or will have verification protocols for reporting wetlands BMPs. Protocols must be based on Chesapeake Bay Program (CBP) guidance. Outreach to practitioners will be necessary to ensure that additional qualifying practices are reported. In addition, CBP will have to ensure that reporting databases contain appropriate fields to receive data on the new BMPs, distinct from other wetland BMPs.

2. Recordkeeping – The installing agency must keep records of all wetland BMP projects.

3. Reporting and duration of credit – Once a year, the NEIEN coordinator for each state will compile this information and submit it to Chesapeake Bay Program.

4. Tracking
    a. The following 8 fields are requested from the state contacts every year:
        i. Field 1: County
        ii. Field 2: HUC-10
        iii. Field 3: Is the project on Federal Land?
        iv. Field 4: Prior landuse
        v. Field 5: Wetland drainage area (acres)
        vi. Field 6: Project Partners
        vii. Field 7: Completion date
        viii. Field 8: Gains in acres (by wetland type: nontidal emergent, nontidal shrub, nontidal forested, nontidal other, tidal)
            1. Gains – Reestablishment (i.e. Wetland Restoration)
            2. Gains – Establishment (i.e. Wetland)
            3. Functional gains – Rehabilitation (i.e. Wetland Rehabilitation)
            4. Protection – Long-term (i.e. applied toward Watershed Agreement protection outcome)
            5. Protection – Short-term (i.e. applied toward Watershed Agreement protection outcome)

b. NEIEN has been updated for Phase 6 to reflect the four categories of wetland BMPs that are now available as defined by this panel and future panel(s). It will accept and distinguish Wetland Restoration and Wetland Creation as acreage gains and; Wetland Enhancement and Wetland Rehabilitation as functional gains. State databases must also be updated to accommodate the enhancement and rehabilitation entries.

5. Ongoing verification – Verification is required to ensure that the wetland BMP projects are performing as designed. The installing agency should confirm that the project was built according to plans (as-built survey was completed). Monitoring of vegetation, hydrology, and soil should be completed for the first three - five years of the project. Native vegetation species cover, invasive species, and wetland indicator status should be recorded. Invasive species should be managed early to prevent further invasion. Hydrology or indicators of hydrology should be recorded, as well as indicators of hydric soils (per the Army Corps of Engineers Wetland Delineation Manual and Regional Supplements). After 5 years, annual observations are recommended to document the continued success of the project. However, if on-site observations are not possible, other methods can be used as a proxy. The Chesapeake Bay Program BMP Verification guidance states the following:

> Onsite monitoring within the three years following construction is recommended. For any long-term monitoring, use of aerial or satellite imagery for remote observations is highly recommended for verification of wetland BMPs; remote observations can indicate encroachment of agricultural activities, clearing, and tree removal. Any issues or concerns with projects implemented on private lands are typically reported by the landowner to the installing agency and addressed as needed.

Wetland restoration, creation, rehabilitation and construction projects are reported to CBP either as stormwater BMPs or Ag BMPs/Voluntary restoration. The flow chart shown in Figure 4 (as shown in WEP, 2016) was developed to help practitioners and agency personnel determine how to correctly report wetland acres. Wetland restoration practices that would receive the recommended Phase 6 BMP efficiency values described in this report would fall under the Tidal and Nontidal portions of Figure 4; though as noted in the diagram there are other practices (e.g., shoreline management) that are covered through other BMPs as defined by the CBP.

Existing BMP verification guidance for wetlands is available online as part of the CBP's adopted BMP Verification Framework at: http://www.chesapeakebay.net/about/programs/bmp/verification_guidance

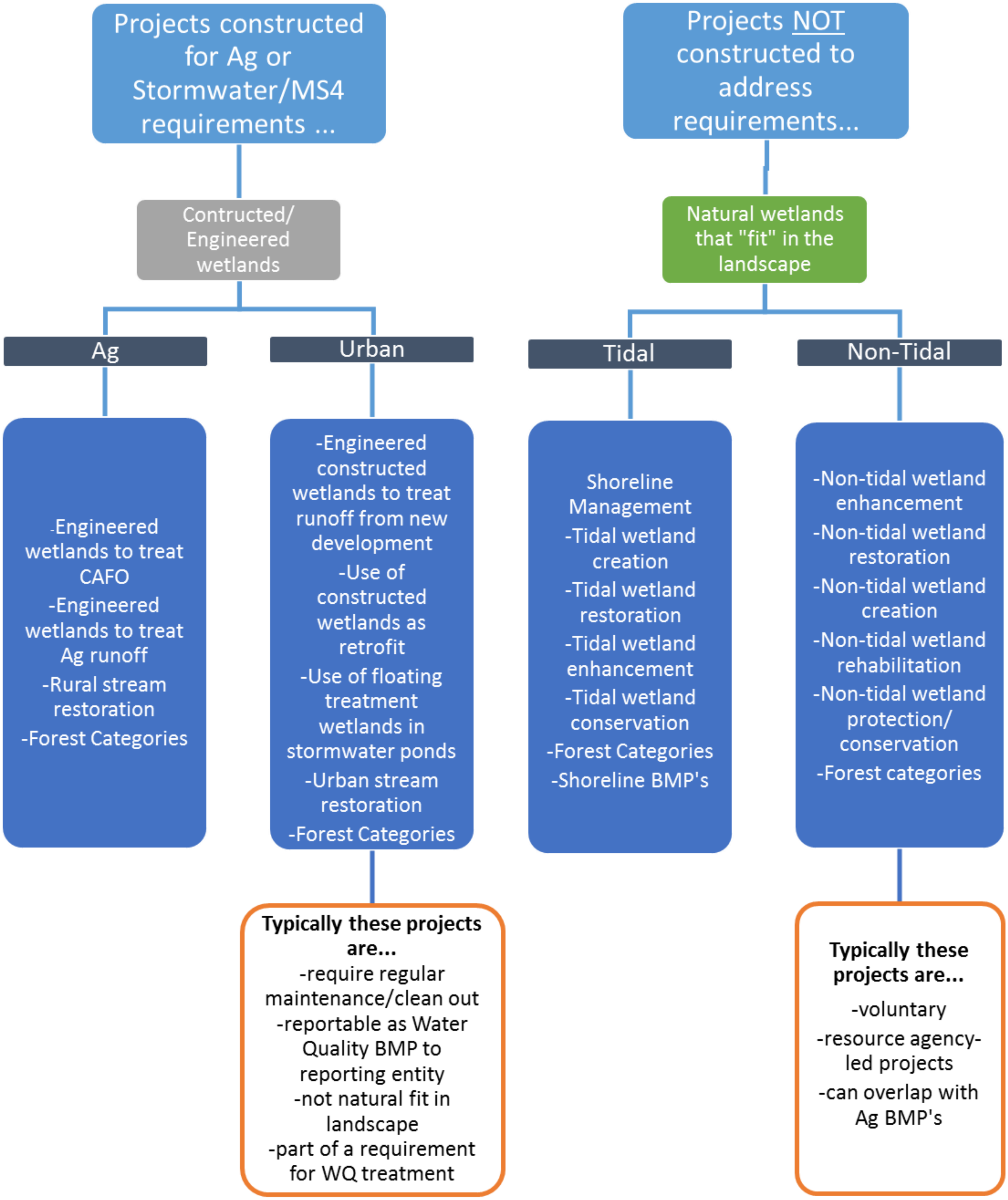

Figure 4. Wetland BMP Reporting Matrix

7. Unintended Consequences

Wetlands provide a vital function to the health and sustainability of the Chesapeake Bay and its watershed. The Chesapeake Bay Agreement acknowledges the significant habitat and water quality benefits provided by wetlands. Wetlands also provide key recreational opportunities and economic value for fishing, hunting and crabbing industry. The conservation of both nontidal and tidal wetlands could also have a critical role to mitigate the effects of sea level rise in coastal areas. The benefits provided by wetlands need to be safeguarded to ensure their long-term sustainability within the Chesapeake Bay watershed – through the protection and conservation of existing, functioning wetlands along with management actions that increase the acreage and function of wetlands through the implementation of wetland BMPS (e.g. wetland restoration, creation and rehabilitation). The Panel provides a set of issues to ensure these benefits are maintained and achieved with future management actions.

- The restoration, creation and rehabilitation of wetlands can not only achieve water quality outcomes and wetland acreage gains sought by the Bay Agreement but could also provide a significant benefit to local water resources and increase and improve habitat within the Bay watershed for a variety of species. However, there are also potential unintended adverse impacts.
- Similar to WEP (2016), the panel asserts the need to identify appropriate sites for wetland BMPs that avoid impact to or alteration of high-quality wetlands. Changing the structure and function of existing high-quality or rare wetland systems should be avoided due to potential unintended adverse impacts and tradeoffs.
- As indicated in Section 5, by removing enhancement as a potential BMP, the potential for unintended consequences of impacting fully functioning and high quality wetlands should be somewhat reduced.
- The potential to improve nutrient and sediment function of wetland should not overlook or take priority over other functions provided by the wetland; tradeoffs of functions should generally be avoided. Mindful consideration and evaluation by wetland professionals/practitioners is needed
- The location of management actions to implement wetland BMPs should be targeted where the need for water quality may be most beneficial; areas of high pollutant loadings/export.
- Avoid double counting of wetlands created in the floodplain for water quality credit from the implementation of stream restoration projects that reconnect streams to the floodplain (see Protocol 3 in Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects). It is recommended that the acreage of wetland created from such stream restoration effort be tracked and reported to the relevant State agency, and subsequently the Chesapeake Bay Program as part of the Agreement Outcomes.

8. Future Research and Management Needs

The recommendations provided by the Panel build on the work from the WEP (2106). The collective effort of these panels provided recommendations that reflect a comprehensive review and discussion of the relevant science and conceptual models to provide the best estimates for nutrient and sediment retention benefits of wetland BMPs for the Chesapeake Bay Watershed. The implementation of the WEP (2016) recommendations and the findings of this panel highlights a continued need to evaluate and quantify the water quality benefits of both natural wetlands and wetland BMPs and likely tradeoffs that result from management actions. The following recommendations are as follows:

- Continued need for research to understand the performance of the different wetland BMPs and how the techniques specifically affect water quality function of wetlands. This will likely require long-term research efforts given that climatic and seasonal patterns significantly affect wetland performance.
- Currently, very limited information is provided to States (reporting is primarily wetland acreage.) Information to track and report wetlands BMPs is needed, including the type of wetland BMP along with drainage area. This is integral to report progress on Agreement Outcomes.
- An accounting framework is recommended to distinguish between high functioning natural wetlands and existing wetlands that are degraded and eligible as a BMP. The implementation of the Phase 6 Watershed Model accounted for existing wetlands with the acreage provided by existing databases (i.e., NWI). There is no condition assessment associated with the mapped wetlands and therefore all acres of natural wetland acreage in the model receive the same land use loading rate.
- It is expected that high-functioning natural wetlands provide multiple benefits to the Chesapeake Bay watershed. Whereas, the water quality function of these wetlands may not be optimal, given the trade-offs with other functions, it is important to incentivize, account or recognize in some way the value of these wetlands to the overall health of the Chesapeake Bay and its ecosystem.
- Review and evaluation of how future versions of the Model may provide an improved representation of natural wetlands as a land use along with wetlands for water quality improvement. Reiterating a recommendation from the WEP (2016), it is recommended that future research using SPARROW or other tools be used to inform the partnership in the future about loading rates or retention factors more representative of wetlands' water quality function.

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Charge and Scope of Work

Nontidal Wetland Creation, Enhancement and Rehabilitation Phase 6.0 BMP Expert Panel

Prepared by the Chesapeake Bay Program Partnership's Wetland Workgroup

September 22, 2017

Background

The Chesapeake Bay Program (CBP) partnership's Wetland Workgroup convened an expert panel in 2014 to recommend improved definitions for effectiveness estimates for wetland Best Management Practices (BMPs) and new wetland land uses for the Phase 6 Chesapeake Bay Watershed Model (CBWM). The expert panel concluded at the end of 2016, establishing four categories of wetland BMPs that states can report for credit in the Phase 6 CBWM, however, three of the categories – creation, enhancement and rehabilitation – required further investigation by a new expert panel to evaluate the effectiveness of the practices to reduce nitrogen, phosphorus and sediment loads. This document describes the charge and scope of work given to the new expert panel by the Wetland Workgroup.

While conducting its review, the panel shall follow the procedures and process outlined in the Water Quality Goal Implementation Team's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, hereafter referred to as the BMP Protocol. [1]

Recommendations for Expert Panel Member Expertise

The BMP Protocol, requires that each expert panel is to include at least six members, one of whom serves as the Panel Chair. The panel members are supported by a Panel Coordinator and one non-voting representative each from the Watershed Technical Workgroup (WTWG) and Chesapeake Bay Program modeling team. An additional representative from the EPA Region III office is recommended in cases where implementation of the BMPs evaluated by the panel are associated with federal permitting processes. Panels are expected to include three recognized topic (wetland) experts and three individuals with expertise in environmental and water quality-related issues. A representative of USDA who is familiar with relevant USDA-Natural Resources Conservation Service (NRCS) conservation practice standards should be included as one of the six individuals who have topic- or other expertise. Panelists' areas of expertise may overlap.

In accordance with the BMP protocol, panel members should not represent entities with potential conflicts of interest, such as entities that could receive a financial benefit from Panel recommendations or where there is a conflict between the private interests and the official responsibilities of those entities. All Panelists are required to identify any potential financial or

[1] http://www.chesapeakebay.net/publications/title/bmp_review_protocol

other conflicts of interest prior to serving on the Panel. These conditions will minimize the risk that Expert Panels are biased toward particular interests or regions.

It is recommended that the Phase 6.0 Wetland Creation, Enhancement and Rehabilitation (CER) BMP Expert Panel should include members with the following areas of expertise:

- Familiarity with nontidal wetland hydrology and knowledge of wetlands in agricultural settings.
- Knowledge of soil science and pathways associated with nutrients and sediment in wetland systems.
- Understanding of regulatory programs or state permitting programs.
- Knowledge of how BMPs are tracked and reported, and the Chesapeake Bay Program partnership's modeling tools.
- Knowledge of relevant NRCS practice codes or standards or knowledge of similar programs that fund implementation of wetland practices.

The panel composition will ideally have two individuals for each of the above areas of technical expertise; an individual panel member may be considered an expert in multiple areas based on their CV. It is recommended that one member is selected who also served on the previous Wetland Expert Panel that concluded in 2016. A total of ten (10) panel members is the recommended maximum, which does not include the Panel Coordinator or supporting representatives of the Modeling Team and Watershed Technical Workgroup. Proposed panel membership will be distributed to the Wetland Workgroup, Agriculture Workgroup, WQGIT and other relevant CBP partnership groups for feedback as described in the BMP Protocol. Panel membership will be approved by the Wetland Workgroup.

Expert Panel Scope of Work

The panel will build off the Phase 6 BMP definitions developed by the previous expert panel for nontidal wetland creation (establishment), wetland enhancement and wetland rehabilitation, which are summarized in Table 1 below. The new panel will recommend effectiveness estimates for the creation, enhancement and rehabilitation BMP categories in nontidal areas. Recommended effectiveness estimates for nitrogen, phosphorus and sediment will be used to simulate reduced loads for those pollutants in the Phase 6 Chesapeake Bay Watershed Model.

Table 1 - CBP Wetland BMP Category Definitions for the Phase 6 Watershed Model

BMP Category	CBP Definition	CBP will count the BMP acres as...	Practice and Project Examples
Restoration	Re-establish The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland.	Acreage gain *(toward Watershed Agreement outcome of 85,000 acre wetland gain and in Phase 6 annual progress runs)*	Restore hydrology to prior-converted agricultural land (cropland or pasture); elevate subsided marsh and re-vegetate; ditch plugging on cropland; Legacy Sediment Removal NRCS Practice 657

BMP Category	**CBP Definition**	**CBP will count the BMP acres as...**	**Practice and Project Examples**
Creation	Establish (or Create) The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site.	Acreage gain *(toward Watershed Agreement outcome of 85,000 acre wetland gain* <u>*and*</u> *in Phase 6 progress runs)*	Modifications to shallow waters or uplands to create new wetlands. Placement of fill material or excavation of upland to establish proper elevations for wetlands; Hydrologic measures such as impoundment, water diversion and/or excavation of upland to establish nontidal wetlands NRCS Practice 658
Enhancement	Enhance The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).	Function gain *(toward 150,000 acre outcome* <u>*and*</u> *Phase 6 annual progress runs)*	Flood seasonal wetland for waterfowl benefit; regulate flow velocity for increased nutrient uptake; NRCS Practice 659
Rehabilitation	Rehabilitate The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland.	Function gain *(toward 150,000 acre outcome* <u>*and*</u> *Phase 6 annual progress runs)*	Restore flow to degraded wetland; ditch plugging in a forested wetland area; moist soil management*; invasive species removal; floodplain reconnection; re-establishing needed vegetation on cropland with wetland hydrology; native wetland meadow planting; May include some NRCS Code 657 practices. *<u>Moist soil management should only be counted if there are predominantly native wetland plants; and site can sustain itself as wetland without active management, meaning whether water control structure is operated or not</u>.

The Panel shall identify specific types of practices which should receive credit and new assigned efficiencies for wetland creation, rehabilitation, or enhancement. When developing its recommendations, the panel should work to provide reasonable criteria and examples to clarify when specific practices in the right-hand column fit best into which specific categories, or when a practice may not qualify as a wetland BMP as defined in Table 1. The Panel will provide recommendations for other existing BMPs which may receive credit under another BMP category, and how the practice should be reported if there are additional wetland credits which may be assigned. For example, livestock exclusion fencing may or may not qualify as wetland enhancement or rehabilitation, Invasive species removal is another practice which may qualify as rehabilitation or enhancement, but currently does not have a BMP efficiency.

The panel will work within established partnership constraints associated with crediting practices, including the guidelines listed below. The Panel Coordinator and CBP Modeling Team representative will notify the panel of any additional guidelines as may be needed for panel recommendations to conform with partnership decisions.

<u>Guidelines</u>

- The panel may first consider if the water quality benefits of wetland creation are different than wetland restoration as defined by the previous expert panel and, if so, to what degree. Both practices are understood as land use change BMPs that also provide treatment of upgradient land uses.
    - This evaluation should consider the long-term capabilities of created and restored wetlands to remove nitrogen, phosphorus and sediment on average, through time and spatial areas.
    - If there is a quantifiable difference in water quality benefits, the panel will deliberate how best to apply the gathered scientific evidence consistent with the BMP Protocol, and agree to defensible numbers that reflect the degree to which water quality benefits of creation differ from restoration, if at all.
- For wetland enhancement and wetland rehabilitation, the degree to which these activities yield nutrient and sediment reductions should be relative to the benefits of restoration and creation. Enhancement and rehabilitation are not simulated as a change in land use, but can provide water quality benefits by treating wetland or upgradient land uses.
    - Non-tidal wetlands are simulated as specific landuses in the Phase 6 modeling tools (as “Floodplain” and “Other”) with loading rates equal to pristine forest, which has the lowest nutrient and sediment loading rates among all Phase 6 landuses.
    - The benefits of enhancement and rehabilitation need to apply to landuse types that exist in the current models. No new land uses can be created for the Phase 6 modeling tools. There is no landuse for degraded wetlands.
- Current placeholder values exist to simulate the water quality benefits for the wetland creation, enhancement and rehabilitation BMPs in Phase 6. However, there is no substantive documentation supporting these placeholder values so the panel should not base its recommendations off those placeholder numbers.
- Within the extent of the BMP Protocol and their assigned Charge and Scope of Work, the panel will consider potential ancillary benefits and unintended consequences associated with the wetland creation, enhancement and rehabilitation BMPs. The panel will work to describe qualifying conditions that can reduce the risk of unintended impacts on other wetland or ecosystem functions – e.g., habitat or toxic contaminants – when implementing these BMPs for nitrogen, phosphorus and sediment water quality benefits.

The panel will consult peer-reviewed literature and any regionally-appropriate published data sources on created, enhanced or rehabilitated wetlands. Additionally, the panel should consider studies of natural wetlands to assist in describing an efficiency to be assigned to rehabilitated sites. Some studies – e.g., studies of forested riparian floodplain areas – may also be useful resources even if not associated with "wetlands" as a keyword. In developing its recommendations the panel will follow the data characterization approach described in Table 1 of the BMP Protocol (see Attachment 1). The panel is encouraged to utilize and build upon the framework and literature reviews of the previous wetland panel:

- Wetland Expert Panel. (*2016*). *Wetlands and Wetland Restoration: Recommendations of the Wetland Expert Panel for the incorporation of nontidal wetland best management practices and land uses in the Phase 6 Chesapeake Bay Watershed Model*. Hanson, J., and A. Molloy, Editors. Approved by CBP WQGIT, December 2016. http://www.chesapeakebay.net/publications/title/24978

The panel will develop a report that includes information as described in the Water Quality Goal Implementation Team's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, known as the BMP Protocol.[2] The elements of the report required under the BMP Protocol are listed here, but more details are available in the full Protocol.

- Identity and expertise of panel members
- Name or title of the practice(s)
- Detailed definition of the practice(s)
- Recommended N, P and TSS loading or effectiveness estimates
- Justification of selected effectiveness estimates
    - List of data sources considered and description of how each data source was considered
    - Identify data sources that were considered, but not used in determining practice effectiveness estimate
    - Documentation of uncertainties in the published literature
    - Documentation of how the Panel addressed negative results or no pollution reduction as a result of implementation of a specific practice
- Description of how best professional judgment was used, if applicable, to determine effectiveness estimates
- Land uses to which BMP is applied
- Load sources that the BMP will address and potential interactions with other practices
- Description of pre-practice and post-practice circumstances, including the baseline conditions for individual practices
- Conditions under which the practice performs as intended/designed
- Temporal performance of BMP including lag times between establishment and full functioning
- Unit of measure
- Locations in CB watershed where the practice applies
- Useful life; practice performance over time
- Cumulative or annual practice
- Recommended description of how practice could be tracked, reported, and verified

[2] http://www.chesapeakebay.net/documents/CBP_BMP_Expert_Panel_Protocol_WQGIT_approved_7.13.15.pdf

- Guidance on BMP verification
- Description of how the practice may be used to relocate pollutants to a different location
- Suggestion for review timeline; when will additional information be available that may warrant a re-evaluation of the practice effectiveness estimates
- Identification of any unintended consequences or ancillary benefits associated with a practice
- Outstanding issues that need to be resolved in the future and a list of ongoing studies, if any
- Documentation of dissenting opinion(s) if consensus cannot be reached
- Operation and Maintenance requirements and how neglect alters the practice effectiveness estimates
- A brief summary of BMP implementation and maintenance costs estimates, when this data is available through existing literature

While the panel is active the Panel Chair and Panel Coordinator will provide updates on the panel's progress to the Wetland and Agriculture Workgroups as described in the BMP Protocol.

As the panel drafts its report for release the Panel Chair and Panel Coordinator will work with the CBP modeling team and Watershed Technical Workgroup to develop a technical appendix for incorporating the recommended BMPs into Scenario Builder and the Watershed Model. Coordination with the panel's WTWG and Modeling Team representatives throughout the process will help to ensure the panel's recommendations fit within the overall model framework.

As described in the BMP Protocol, the Panel Chair and Panel Coordinator will facilitate the partnership review, comment and approval process on behalf of the panel, updating and seeking input from panel members as needed. The Chair and Coordinator will respond to partnership comments and make edits or revisions to the report, seeking panel input on substantive revisions. The panel is dismissed following partnership approval of the final report (as amended).

Timeline/Deliverables
The panel should deliver its draft report within 12 months after the panel's first meeting or conference call. An additional 3-6 months is typically needed for partnership review, comment and approval.

Phase 6.0 BMP Verification Recommendations

The panel will utilize the Partnership approved *Wetland Workgroup's BMP Verification Guidance*[3] as the basis for developing BMP verification guidance recommendations that are specific to the BMPs being evaluated. The panel's verification guidance will provide relevant supplemental details and specific examples to provide the Partnership with recommended potential options for how jurisdictions and partners can verify recommended creation, enhancement and rehabilitation BMPs in accordance with the Partnership's approved guidance.

[3] http://www.chesapeakebay.net/documents/Appendix%20B%20Wetlands%20BMP%20verification%20guidance.pdf

Attachment 1: Table 1 – Data Source Characterization (source: BMP Protocol)

	High Quality	**Medium Quality**	**Low Quality**
Extent of Replication	Clearly documented and well-controlled past work that has since been replicated or strongly supported by the preponderance of other work; recent (< 5-year old) work that was clearly documented and conducted under well-controlled conditions and thus conducive to possible future replication	Clearly documented older (>5-yr old) work that has not yet been replicated or strongly supported by other studies, but which has also not been contraindicated or disputed	Work that was not clearly documented and cannot be reproduced, or older (>5-yr old) work for which results have been contraindicated or disputed by more recent results in peer-reviewed publication or by other studies that are at least equally well documented and reproducible
Applicability	Purpose/scope of research/publication matches information/data need	Limited application	Does not apply
Study location	Within Chesapeake Bay	Characteristic of CB, but outside of watershed	Outside of CB watershed and characteristics of study location not representative
Data collection & analysis methods	Approved state or federal methods used; statistically relevant	Other approved protocol and methods; analysis done but lacks significance testing	Methods not documented; insufficient data collected
Conclusions	Scientific method evident; conclusions supported by statistical analysis	Conclusions reasonable but not supported by data; inferences based on data	Inconclusive; insufficient evidence
References	Majority peer-review	Some peer-review	Minimal to none peer-review

Appendix A: Panel Charge and Statement of Work

Nontidal Wetland Rehabilitation, Enhancement and Creation BMP Expert Panel

The Center for Watershed Protection, Inc. (the Center) in partnership with The Nature Conservancy (TNC). submits the following scope of work to Virginia Tech to assemble an Expert Panel to evaluate the nutrient and sediment removal and runoff reduction benefits associated with nontidal wetland rehabilitation, enhancement and creation. This panel will build on work completed by the Wetland Panel (the 2016 Panel Report; CBP, 2016). The proposed scope and charge of the panel includes developing performance credits for the Creation, Rehabilitation and Enhancement of Wetlands in relation to the Chesapeake Bay Program (CBP)'s established total maximum daily loads (TMDLs) for nitrogen, phosphorus, and sediment.

The Center has extensive experience with the CBP Expert Panel Process, and have been directly involved in the previous (2015-2016) Wetland Expert Panel (WEP). The Center has also conducted comprehensive reviews of the literature on development impacts to wetlands, benefits and functions of wetlands and wetland buffers, as well as a review of federal and state policies on wetland protection through three cooperative agreements with EPA to integrate wetlands in watershed planning. A partnership with TNC will strengthen the Center's capacity to establish science-based performance metrics for the Bay Program. Through their leadership to the Wetlands Workgroup, TNC has extensive knowledge of and experience in working through CBP expert panel process. In addition, TNC brings strong experience in watershed modeling, wetland restoration, and research and monitoring of wetland function. Currently, TNC is working with partners including USDA NRCS and USFWS, to restore more than 3,000 acres of strategically targeted wetlands across the Delmarva Peninsula, and is collaborating with USGS to measure water storage and nutrient retention among enhanced floodplains along a major tributary to the Chesapeake Bay.

The proposed Expert Panel Chair, Membership, Scope of Work, and Timeline are provided below.

Expert Panel Chair:
Neely L. Law, PhD, Director of Education and Training at the Center for Watershed Protection, will chair the Expert Panel. Neely led the Chesapeake Bay Program (CBP) Expert Panels on Filter Strips/Stream Buffer Upgrades and Urban Tree Canopy, and participated on the Urban Nutrient Management, Enhanced Erosion and Sediment Control, Street Sweeping, Catch Basin and Storm Drain Cleaning Expert Panels, as well as the 2015-16 Wetland Panel. Neely was also a Sediment Reduction and Stream Restoration Coordinator for the CBP from 2012-2015. Her CV is provided as an attachment to this statement of work (SOW).

Expert Panel Membership:
Table 1 presents the individuals who have been invited to participate on the Expert Panel. These are recognized topic experts and have expertise in environmental and water quality related issues. Panelists who have indicated their commitment to serve on the Panel have provided letters of support, which are attachments to this scope of work. CVs for all invited Panelists are also provided as an attachment.

Table 1. Membership for Nontidal Wetland Rehabilitation, Enhancement and Creation BMP Expert Panel

Panelist	Affiliation	Area of Expertise	Status
Neely L. Law, PhD, Panel Chair	The Center for Watershed Protection	Water quality, BMPs, previous expert panel chair(s) and member	Confirmed
Kathleen Boomer, PhD	The Nature Conservancy	Wetland eco-hydrology, modeling and landscape ecology, previous wetland panel member	Confirmed
Jeanne Christie	Association of State Wetland Managers	Regulatory and state permitting programs, including wetland mitigation	Confirmed
Greg Noe, PhD	U.S. Geological Survey	Wetland hydrology, groundwater, landscape modeling, familiarity with CBP process	Confirmed
Erin MacLaughlin	Maryland DNR	Wetlands and water quality, previous wetland panel member	Confirmed

Solange Filoso, PhD	Chesapeake Biological Lab	Best management practice performance, ecosystem ecology, biogeochemistry	Confirmed
Denise Wardrop, PhD, PE	Penn State	Nutrients and wetlands, wetland assessment	Confirmed
Scott Jackson	University of Massachusetts	Wetland creation, wetland ecology, wetland assessment	Confirmed
Steve Strano	NRCS	Agriculture BMPs and Farm Bill programs, previous wetland panel member	Confirmed
Rob Roseen, PhD, PE, D.WRE	Waterstone Engineering	Nutrients and water quality, watershed management	Confirmed
Ralph Spagnolo	EPA Region 3	Permitting programs, wetland ecology and biology, previous wetland panel member	Confirmed

In addition to the topic experts, the Panel membership will include a representative from the CBP Watershed Technical Work Group (WTWG) and a representative from the CBP modeling team, to be assigned by the CBP. An additional regulatory support person will be provided by EPA Region III. All Panel members will be asked to disclose any potential conflicts of interest prior to serving on the Panel.

Scope of Work:
The specific tasks to accomplish the project objectives are described below.

Task 1. Assemble Expert Panel
The Center will work with the Panel Coordinator to finalize the charge, scope, and membership of the Panel. Recommendations will be available to the source sector Workgroups, the Water Quality Goal Implementation Team (GIT) Chair and Vice Chair, and the other GITs with direct interest in the WEP's findings, as well as the Scientific and Technical Advisory Committee (STAC), for their review and approval.

The Center will revise the Panel scope and charge and membership based on input from these various stakeholders and will contact approved panelists about moving forward. A brief description of the key Panel roles is provided below:

- Panel Coordinator: The Panel coordinator will provide logistical support (scheduling calls/meetings, operating webinar and conference lines, etc.) and strategic guidance on the expert panel process. He/she will also serve as liaison between the Expert Panel and the wider CBP partnership.
- Panel Chair: The Chair will be the chief strategist and panel lead. The Chair will work with the Coordinator and Panel members to assign specific tasks and ensure the Panel is on schedule. The Chair will use his/her expertise to facilitate productive technical discussions among the panelists. The Panel Chair and Panel members are responsible for developing the Expert Panel report that conforms in form and content with the *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model* (CBP BMP Protocol).
- Panel Members: The Expert Panel is responsible for following the specific charge of the Panel, as well as adhering to the BMP Protocol. Panelists will participate and offer their own unbiased expertise and best professional judgment throughout the process, and will perform assigned or voluntary tasks that assist the development of the final Panel report.
- Modeling Team Representative: The modeling team representative will serve as liaison between the CBP modeling team and the Expert Panel, relaying and responding to questions that the Panel has for the modeling team regarding the simulation or incorporation of the BMP(s) into Phase 6 of the CBP Watershed Model. He/she will also assist with the development of the Technical Appendix, which accompanies each Panel report.
- WTWG Representative: The WTWG representative serves as a Panel participant to offer his/her expertise with BMP tracking and reporting, which is crucial for the Panel's final report and the development of the Technical Appendix.
- EPA Region III Representative: This representative will serve as a resource for regulatory questions that may arise during the Panel's work.

In addition to these key Panel roles, the following staff will support this project:

- Kathleen Boomer, PhD, Watershed Scientist for The Nature Conservancy, will provide technical capacity for developing the literature review and synthesizing report materials. As both a voting panelist and a staff team member, Boomer can ensure that feedback from the full panel membership is captured and technical challenges throughout the project period are addressed. Boomer served on the previous Wetlands Expert Panel and co-authored the report, "Wetlands and Wetland Restoration: Recommendations of the Wetland Expert Panel for the incorporation of non-tidal wetland best management practices (BMPs) and land uses in the Phase 6 Chesapeake Bay Watershed Model." She will contribute her knowledge and apply her expertise in watershed modeling and wetland biogeochemistry to synthesize information contributed by the Panel and to help develop a conceptual framework that can be fully integrated with the CBP's watershed model.
- Bill Stack, Deputy Director of the Center will act as a technical reviewer for the Center. Bill is a professional engineer with more than 35 years of experience in water resources management. As the Sediment Reduction and Stream Restoration Coordinator for the CBP from 2012-2015, Bill co-led the Expert Panel on Stream Restoration, led the development of revised recommendations on Stream Restoration for the "test drive period," chaired the Urban Shoreline Erosion Control Expert Panel, and participated on the Urban Stormwater Retrofits and Nutrient Discharges from Grey Infrastructure Expert Panels. He also chaired the Impervious Disconnection Expert Panel.
- Lisa Fraley-McNeal and Deb Caraco of the Center will provide technical assistance with literature review and synthesis, and statistical and GIS analysis.

Task 2. Literature Review and Synthesis

The proposed Expert Panel will build upon the findings and recommendations provided by the most recently published WEP report (2016). The report highlighted the importance of wetland type and watershed condition as primary controls of wetland water quality functions and presented a framework to evaluate wetland water quality benefits based on hydrogeologic and hydrogeomorphic settings. The recommendations have been adopted by the CBP mainly to account for water quality benefits associated with restoring prior converted wetlands (i.e., wetlands that were converted from a non-agricultural use to production of a commodity crop prior to December 23, 1985). Due to time constraints imposed by the CBP 2017 Mid-Point Assessment, the 2016 WEP requested that a future panel expand the science-based framework to relativize estimated water quality benefits across a broader range of wetland condition and wetland BMPs. Accordingly, the proposed WEP will build upon the current literature review 1) to evaluate and compare water quality benefits associated with rehabilitated, enhanced, and created wetlands, as well as natural, intact wetlands to provide comparability amongst different wetland conditions; and 2) to inform a crediting framework and resultant methods that best align with the scientific reporting and professional understanding of wetland functions.

The Expert Panel chair will coordinate a review and synthesis of the literature, including the 2016 WEP report, peer-reviewed publications and technical reports, and "gray" literature to address the following research questions:

1) *How do rehabilitated, enhanced, and created wetland water quality functions differ from those of restored wetlands?*
2) *How do rehabilitated, enhanced, created, and restored wetland water quality functions compare with those of intact, natural wetlands? Importantly, the findings will be evaluated using the current CBP adopted framework, specifically with consideration to hydrogeologic and geomorphic setting (i.e., physiographic province, watershed position, watershed condition, and climate).*
3) *To what extent have the water quality benefits of wetland rehabilitation or enhancement been directly documented?*
4) *What are critical research opportunities (i.e., knowledge gaps) essential to predicting wetland function at a local and regional scale, based on condition, location, and climate trends?*

These questions are in addition to the elements listed in the BMP Protocol and the Charge provided to the Panel by the Wetland Workgroup. The above questions provide additional guidance for the literature review for the Panel members to assess the nutrient and sediment functions of the BMPs.

Importantly, the proposed WEP will build upon work by the previous expert panel to provide improved clarity for wetland BMP function and their associated nutrient and sediment reduction benefits with associated qualifications to receive credit. To do so, similar to the past WEP, a conceptual framework to quantify the benefits of wetland BMPs will be created leveraging knowledge from past work of Jordan et al (2007) used in the Phase 5.3.2 model, but modified for wetland restoration, along with frameworks that provided a way to categorize wetland performance (e.g. by hydrogeomorphic classification). Further, the WEP will consider findings and recommendations provided by previous expert panels related to the current panel charge. For example, the proposed WEP will consider a report developed by a CBP Stream Restoration Expert Panel (2013) and a STAC workshop report that provided a comprehensive review of nutrient reduction rates associated with wetland restoration projects in rural areas (CBP, 2008). Most of the research reviewed in these previous reports focused on restored wetlands that received stormflow and in some cases groundwater, as opposed to engineered or created wetlands.

Task 3. Panel Meetings

The Panel Chair will facilitate productive technical discussions among the panelists by convening up to twelve WEP meetings, including a stakeholder forum. At least two and as many as three meetings will be organized as in-person meetings and held in the Annapolis-Baltimore area, including an early introductory stakeholder meeting (meeting #2), and a mid-point assessment meeting (meeting #6). If needed, a third in-person meeting may be organized to finalize a summary of findings and recommendations (meeting #11 or 12). The remaining (nine or ten) meetings will be held by telephone conference. At least one WEP meeting will be dedicated to review/discussion of the literature review results and one meeting will be centered around preliminary (strawman) recommendations for developing effectiveness estimates. All meetings will be shared through Webex or a similar platform to ensure full participation by distant panel members. Panel members may also participate in up to two meetings in-person as the travel expenses allow. The Panel Chair will prepare materials for presentation at each Panel meeting to highlight key discussion questions, identify critical decisions, summarize outcomes, and confirm task assignments.

The second Panel meeting will be dedicated to an open stakeholder forum where interested parties, other than the Expert Panel members, can share and present scientific data with the Panel members. The intent is to provide an open exchange of information that may help inform the Panel as it moves forward with its deliberations. Working with the Panel Coordinator, the Center will co-lead the Forum, which will be a half day meeting to be held at the CBP in Annapolis. At this meeting, the Panel Chair will present the charge of the Panel and will solicit feedback from attendees on specific issues to address with the Panel and relevant resources and research. The first part of the meeting will be open to stakeholders and the second part will constitute just the Panel members.

Efficiently approaching the panel meetings will be paramount for this panel, since the panel is tasked with quantifying the benefits of three practices (Wetland Rehabilitation, Wetland Enhancement, and Wetland Creation), which will likely have different benefits depending on the region in which they are implemented and their location (i.e., floodplain versus upland). Consequently, the first Panel meeting will focus on practice definitions and other overarching issues that the Panel will address throughout the project period. Specific items in the first meeting will include the following:

1) *Are current definitions of wetland BMPs adequate for assessing local and cumulative water quality benefits within the CBP watershed modeling framework (e.g., what is the distinction between Wetland Rehabilitation and Wetland Enhancement)?* Notes from the 2015-16 Panel discussed differences between these two practices, and there was some discussion of possibly combining them. The Expert Panel will explore the range of definitions and decide how best to describe different wetland types and conditions in the context of the Bay model and the TMDL accounting framework. The panel will be asked to address this question early in the process, because this decision will help guide both the Literature Review and the Panel process.
2) *How should we account for functional differences between Created versus Restored and Natural Wetlands?* This question will be a major focus on the literature review, and the Expert Panel will provide early guidance to inform this research.

3) *Should the same geophysical regions defined in the 2016 Panel Report be used by this Expert Panel?* The 2016 Panel Report defined nine Physiographic Subregions to refine the estimated nutrient reduction of wetlands. The Panel members will review these subregions and determine their applicability as part the BMP recommendations, recognizing modifications to the classifications would be limited to aggregation.
4) *Should the Expert Panel Report address the Wetland Restoration Credit Recommendations?* Currently, water quality benefits of existing wetlands are reflected through low pollutant loading rates also assigned to forested land use; no additional retention benefits are considered. In contrast, wetland restoration BMPs are assigned the same low loading rate, plus an additional coefficient is applied to reflect the unique capacity of restored wetlands to provide water quality benefits. The 2016 WEP raised concerns that this results in an unequal accounting framework that may lead to a disincentive for wetland preservation and conservation; however, the available time did not allow for development of a more equitable framework. While the Expert Panel scope will not explicitly revisit the restoration wetland credit, recommendations resulting from the three other wetland BMPs may require Panel recommendations for future updates to the CBWM to ensure there is consistency, or alignment, or relative comparability with the nutrient and sediment reduction benefits.
5) *What recent research could better inform the work of the Expert Panel?* This discussion will be used to identify speakers for the second panel meeting.

Task 4. Develop Report

Based on their findings, in part supported by expanding the WEP 2016 literature review, the proposed WEP will provide recommendations for improving upon the CBP modeling and accounting framework. The final report will include all the required elements described in the *Protocol for the Development, Review and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*.

Task 5. Approval Process

The Panel Chair will work with the Panel Coordinator to go through the CBP review and approval process. This will involve presenting the draft recommendations to the Wetlands Work Group (WWG), WTWG and the WQGIT and addressing and responding to any comments received during the comment period. The budget and schedule assume only one meeting with each workgroup plus two additional meetings with the Modeling Team if needed. Any additional meetings would be subject to additional expenses and an extension of the timeline. The Chair will seek the Panel's input in the event that significant comments are made, or major revisions are requested, as the report is reviewed by the CBP partnership. Although the Panel Chair and Coordinator are responsible for managing the comment process, Panel members may be expected to address and respond to comments received during the comment period, as appropriate.

Project Timeline:

The project will be completed over an 18-month timeframe as shown in Table 2. Month 1 represents September 2017 if the Wetland Workgroup approves the panel membership following partnership review and feedback.

Table 2. Project Timeline

Task	**Key Deliverables**	**Completion Date (Months from Award)**
Task 1. Assemble Panel	Final panel charge and membership	Month 1
Task 2. Literature Review and Synthesis	Draft tabularized summary of research studies studying retention benefits of rehabilitated, enhanced, created, and natural wetlands.	Month 4
Task 3. Panel Meetings	1st WEP meeting - prioritize panel questions 2nd WEP meeting - stakeholder forum 3rd WEP meeting - define panel strategies, tasks 4th WEP meeting - review lit review updates 5th WEP meeting - review panel contributions	Month 2 Month 3 Month 4 Month 5 Month 6

Table 2. Project Timeline		
Task	**Key Deliverables**	**Completion Date (Months from Award)**
	6th WEP meeting - midpoint assessment 7th WEP meeting - adjust strategies, as needed 8th WEP meeting - review panel contributions 9th WEP meeting - discuss preliminary findings 10th WEP meeting - outline final report 11th WEP meeting - review remaining report tasks 12th WEP meeting - approve draft WEP report Minutes from the Panel meetings	Month 7 Month 8 Month 9 Month 10 Month 11 Month 12 Month 14 Months 2-14
Task 4. Develop Report	Complete technical review and editing of draft WEP report, including finalized tabular summary of published wetland studies.	Month 13
Task 5. Approval Process	Review and approval by WWG Review and approval by WTWG Review and approval by WQ GIT Final approved report with recommendations	Month 15 Month 16 Month 17 Month 18

References:

Chesapeake Bay Program (CBP). 2008. STAC Responsive Workshop: Quantifying the role of wetlands in achieving nutrient and sediment reductions in Chesapeake Bay. Annapolis, MD. STAC Publication 08-006.

Chesapeake Bay Program (CBP). 2016. Wetlands and Wetland Restoration; Recommendations of the wetland expert panel for the incorporation of non-tidal wetland best management practices (BMPs) and land uses in the Phase 6 Chesapeake Bay Watershed Model. Annapolis, MD. CBP/TRS-314-16.

Jordan, T. 2007. Wetland restoration and creation best management practice (agricultural). Definition of nutrient and sediment reduction efficiencies for use in calibration of the phase 5.0 Chesapeake Bay Program Watershed Model. Smithsonian Environmental Research Center. Edgewater, MD.

Appendix B: Technical Requirements to Enter Nontidal Wetland Creation and Wetland Rehabilitation BMPs in the Phase 6 Watershed Model

Version: 08/09/19 (DRAFT for CBP and WTWG review)

Presented to the WTWG for Review and Approval:

Background: In accordance with the *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model* (WQGIT, 2015) each BMP expert panel develops a technical appendix to describe how the panel's recommendations will be integrated into the Chesapeake Bay Program's modeling and reporting tools including NEIEN, CAST and the Watershed Model.

This appendix and the current panel's report do not alter or affect existing BMP definitions or effectiveness values for similar practices that were outside the scope of the panel, e.g., Wet Ponds and Wetlands (Urban), Stream Restoration (Urban/Non-Urban) and Shoreline Management (Urban/Non-Urban).

Q1. How are these Wetland BMPs defined in the Phase 6.0 Chesapeake Bay Watershed Model?

A1. The panel's report includes definitions for four categories of nontidal wetland practices: restoration, creation, rehabilitation, and enhancement. The latest panel's recommendations do not change the existing definition or effectiveness estimates for wetland restoration in the Phase 6 Chesapeake Bay Watershed Model (CBWM), which were established by a previous BMP expert panel (Wetland Expert Panel, 2016). The basic definitions for the other practices (creation, rehabilitation and enhancement) are also unchanged (Table B-1) under the new panel's recommendations, but with new recommended effectiveness values and operational definitions of the practices as described in Table 2 of the report.

Table B-1. Categories of nontidal wetland BMPs in the Chesapeake Bay Program's Phase 6 Chesapeake Bay Watershed Model.

BMP Category	**CBP Definitions for Phase 6 CBWM**
Restoration	Re-establish The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland.
Creation	Establish (or Create) The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site.

Enhancement	Enhance The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).
Rehabilitation	Rehabilitate The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland.

DRAFT

Q2. How will Wetland BMPs be simulated in the Phase 6.0 Watershed Model?

A2. Consistent with WEP (2016), the expert panel recommended that simulation of wetland BMPs vary by the type of practice. Functional gain practices treat upland acres only since they enhance or rehabilitate existing wetlands. Acreage gain practices treat upland acres and are also a land use conversion BMP in Phase 6 since they either re-establish or establish a wetland that was not there at time of implementation. The nutrient and sediment reduction credit for a land use conversion BMP equals the relative, or percent change in nitrogen, phosphorus and sediment load achieved by converting the existing land use to the appropriate wetlands land use.

Table B-2. Summary of proposed Wetland BMP simulation in the Phase 6 CBWM.

BMP Category	Land Use Conversion	Treatment of Upland Acres
Restoration*	YES	YES – based on physiographic region (WEP 2016)
Creation**	YES	YES – Report drainage area; if not, 1 upland acre per acre of created wetland (other), or 1.5 upland acre per acre (floodplain)
Rehabilitation**	NO	YES – Report drainage area; if not, 1 upland acre per acre of rehabilitated wetland (other), or 1.5 upland acre per acre (floodplain)
Enhancement***	Not recommended as a water quality BMP for TN, TP or TSS reductions	

*The efficiency values and the upland acres for Phase 6 Wetland Restoration are based on the WEP (2016) recommendations for the Restoration practice. The practice is included within this appendix for reference only.
**In accordance with its charge, the panel is recommending new efficiency values for these practices in the Phase 6 Watershed Model.
***As described in the report, the panel recommends that enhancement – as defined for CBP purposes – should no longer receive nutrient or sediment reductions in the Watershed Model.

Q3. What are the upland treatment efficiencies for Wetland BMPs in the Phase 6.0 Watershed Model?

A3. Upland treatment efficiencies for each Wetland BMP are summarized in Tables B-3 and B-4.

Table B-3. Summary of upland acres treated by each acre of wetland, by wetland BMP type and physiographic subregion.

		Upland Acres Treated per acre of BMP	
Wetland BMP Category	**Watershed Model HGMR**	**Other Wetlands**	**Floodplain Wetlands**
Restoration *[No change from WEP 2016, for reference only]*	*Appalachian Plateau Siliciclastic*	*1*	*2*
	Valley and Ridge Siliciclastic	*1*	*2*
	Blue Ridge	*2*	*3*
	Piedmont Crystalline *Mesozoic Lowlands*	*2*	*3*
	Western Shore: Coastal Plain Uplands *Coastal Plain Dissected Uplands*	*4*	*6*
	Eastern Shore: *Coastal Plain Uplands*	*1*	*2*
	Eastern Shore: *Coastal Plain Dissected Uplands*	*2*	*3*
	Coastal Plain Lowlands	*2*	*3*
	Piedmont Carbonate *Valley and Ridge Carbonate* *Appalachian Plateau Carbonate*	*2*	*3*
Creation	**N/A**	**Reported drainage area; otherwise, 1***	**Reported drainage area; otherwise, 1.5***
Rehabilitation	**N/A**	**Reported drainage area; otherwise, 1***	**Reported drainage area; otherwise, 1.5***
Enhancement	**N/A**	**N/A**	**N/A**

* Panel suggests that drainage area should be limited to 6 upland acres per acre created/rehabilitated for Floodplain; 4 upland acres per acre created/rehabilitated for Other/Headwater.

Table B-4. Summary of proposed upland treatment efficiencies for wetland BMPs in the Phase 6 Watershed Model

Wetland BMP Category	**Efficiency applied to upland acres**					
	TN% (existing)	**TN% (proposed)**	**TP% (existing)**	**TP% (proposed)**	**TSS% (existing)**	**TSS% (proposed)**
Restoration*	42	42	40	40	31	31
Creation**	16.75	30	32.18	33	9.82	27
Rehabilitation**	16.75	16	32.18	22	9.82	19
Enhancement***	16.75	N/A	32.18	N/A	9.82	N/A

Note: The efficiency values of 16.75% TN, 32.28% TP and 9.82% TSS are the average of the Phase 5 Wetland Restoration efficiencies for the Coastal Plain, Piedmont and Appalachian Plateau HGMs. These values were

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adopted as a placeholder within the Phase 6 Watershed Model until a panel could convene and recommend effectiveness values.
*From WEP (2016), included for reference only. No changes recommended to the wetland restoration BMP or its effectiveness values.
**The efficiency value for these practices will treat the reported upland drainage area (acres); if the drainage area is unknown or not reported then one acre is treated per acre of wetland created or rehabilitated (1.5 acres per acre of BMP in the floodplain, when drainage area not reported).
***As described in the report, the panel recommends that enhancement – as defined for CBP purposes – should no longer receive nutrient or sediment reductions in the Watershed Model.

Q4. What should jurisdictions submit to NEIEN to receive credit for Wetland BMPs in the Phase 6 Model?

A4. For wetland restoration there is no change from WEP 2016 and jurisdictions should report the following information to NEIEN:

- *BMP Name:* Wetland Restoration – Floodplain or Wetland Restoration – Headwater
- *Measurement Name:* Acres of Wetlands Restored (Acres)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the wetland was restored
- *Load Source:* All agricultural load source groups

For wetland creation, once the new recommendations are incorporated into the Model (see Q9 below), jurisdictions should report the following information to NEIEN:

- *BMP Name:* Wetland Creation – Floodplain or Wetland Creation – Headwater
- *Measurement Name:* Area of Wetlands Created (Acres); *(Optional)* Direct upland drainage area to the created wetland (Acres), if unknown the default is 1:1 upland acres per acre of created wetland for Headwater and 1.5:1 for Floodplain.
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the wetland was created
- *Load Source:* All agricultural load source groups; if none reported

For wetland rehabilitation, once the new recommendations are incorporated into the Model (see Q9 below), jurisdictions should report the following information to NEIEN:

- *BMP Name:* Wetland Rehabilitation
- *Measurement Name:* Area of Wetlands Rehabilitated (Acres); *(Optional)* Direct upland drainage area to the rehabilitated wetland (Acres), if unknown the default is 1:1 upland acres per acre of created wetland for Headwater and 1.5:1 for Floodplain.
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the wetland was rehabilitated
- *Load Source:* Wetland rehabilitation is applied to nontidal wetland land uses (Floodplain or Headwater). Indicate which of these land uses receives the BMP, if known.

Otherwise, the default is Headwater. The efficiency is applied to upland AG load sources by default.

For wetland enhancement, once the new recommendations are incorporated into the Model (see Q9 below), jurisdictions can report the following information to NEIEN but the data will not carry over into progress submissions and cannot be simulated in CAST:

- *BMP Name:* Wetland Enhancement
- *Measurement Name:* Acres of Wetlands enhanced (Acres)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the wetland was enhanced

Q5. Are the Wetland Creation and Wetland Rehabilitation BMPs annual or cumulative?

A5. The Wetland Creation and Wetland Rehabilitation BMPs are both cumulative, which means that the acres reported in a previous year carry over into the next year until the credit duration expires.

Q6. What is the credit duration for the Wetland Creation and Wetland Rehabilitation BMPs in the Model?

A6. The existing credit duration for both BMPs is 15 years.

Q.7 How will practices in the NEIEN appendix map to the proposed Phase 6 BMPs once they are in?

A7. A crosswalk between the BMPs in the Phase 5 NEIEN appendix and the Phase 6 BMPs are summarized in Table B-5.

Table C5. Summary of how BMPs currently mapped to wetlands BMPs will translate to amended Phase 6 wetland BMPs, as proposed, once incorporated into NEIEN and CAST

BMP in current Phase 6 NEIEN appendix	**Associated FSA or NRCS practice code, if applicable**	**Current wetland BMP associated with the NEIEN BMP within CAST**	**Proposed wetland BMP mapping to CAST when panel recommendations incorporated into model**
CREP Wetland Restoration	CP23, 327, 657	Wetland Restoration Floodplain or Wetland Restoration Headwater	Wetland Restoration Floodplain or Wetland Restoration Headwater
Wetland and Buffer Restoration, Wetland Restoration		N/A	N/A
Wetland Buffer		N/A	N/A
Wetland Creation	658	Wetland Creation (Floodplain or Headwater)	Wetland Creation (Floodplain or Headwater)
Wetland Functional Gains - Enhanced	659*	Wetland Enhancement	N/A

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Wetland [Acreage] Gains - Established	658	Wetland Creation (Floodplain or Headwater)	Wetland Creation (Floodplain or Headwater)
Wetland [Acreage] Gains - Reestablished	657	Wetland Restoration	Wetland Restoration
Wetland Restoration	657	Wetland Restoration	Wetland Restoration
Wetland Rehabilitation	657**	Wetland Rehabilitation	Wetland Rehabilitation

*Acres of NRCS 659 do not automatically map to Wetland Enhancement.
**NRCS Practice 657 includes re-establishment (restoration) and rehabilitation, as defined for CBP modeling purposes.

Q8. Are these practices eligible in tidal areas? How should jurisdictions report Wetland BMPs on tidal wetlands?

A8. Implementation of wetland practices in tidal areas cannot be credited using the nontidal wetland BMP definitions and efficiency values. As explained in WEP (2016), implementation of Wetland Restoration or other eligible wetland BMPs in tidal areas can be reported under the existing protocols (protocols 2-4, NOT protocol 1) for the Shoreline Management BMP. The Shoreline Management BMP is simulated as a load reduction per acre, as summarized in Table B-6 below.

Table B-6. Summary of load reductions from Shoreline Management Expert Panel Protocols 2, 3 and 4

Shoreline Management Protocol		TN	TP	Sediment
Protocol 2 – Denitrification	Acres of re-vegetation	85	NA	NA
Protocol 3 - Sedimentation	Acres of re-vegetation	NA	5.289	6,959
Protocol 4 – Marsh Redfield Ratio	Acres of re-vegetation	6.83	0.3	NA
Tidal wetland restoration		91.83 lbs/ac	5.589 lbs/ac	6,959 lbs/ac

Q9. When will the panel’s recommended changes to Creation, Rehabilitation and Enhancement be incorporated into the Watershed Model, CAST and NEIEN?

A9. The partnership has agreed to incorporate new/revised data inputs or BMPs following a certain schedule that aligns with jurisdictions’ development of 2-year milestones. The most recent deadline for new BMPs or data inputs passed in April 2019; the next opportunity to incorporate the panel’s recommended changes to wetland creation, rehabilitation and enhancement will be in 2021, when the model is updated for 2022-2023 milestones.

Appendix C: Conformity of report with BMP Protocol

Summarized list of BMP Protocol elements expected for BMP reports and recommendations

1. **Identity and expertise of panel members**: *See Section 1 and Appendix A*
2. **Practice name or title:** *See Table ES-1; Table 2; Appendix B*
3. **Detailed definition of the practice:** *There are a variety of specific actions or techniques that can be eligible under the BMP definitions; context and detail provided throughout the report*
4. **Recommended N, P and TSS loading or effectiveness estimates:** *See Table ES-1 and Appendix B, Tables B-3 and B-4*
5. **Justification of selected effectiveness estimates**: *See Sections 4 and 5 for the below items a-e*
    a. **List of data sources considered and description of how each data source was considered**
    b. **Identify data sources that were considered, but not used in determining practice effectiveness estimates**
    c. **Documentation of uncertainties in the published literature**
    d. **Documentation of how the Panel addressed negative results or no pollution reduction as a result of implementation of a specific practice**
6. **Description of how best professional judgment was used, if applicable, to determine effectiveness estimates:** *Sections 4 and 5*
7. **Load sources to which BMP is applied:** *See Appendix B*
8. **Load sources that the BMP will address and potential interactions with other practices:** *Appendix B with discussion throughout the report*
9. **Description of pre-practice and post-practice circumstances, including the baseline conditions for individual practices:** *Discussed at length by the panel as summarized in sections 4 and 5, particularly with respect to the panel's conceptual models and expert elicitation survey*
10. **Conditions under which the practice performs as intended/designed** (include conditions/circumstances where practice will not perform or will be less effective; any variations due to climate, HGMR, soils, or other factors)**:** *The panel did not constrain the application of this BMP or adjust the effectiveness estimates based on HGMRs or other factors. Wetland creation, however, should not be implemented if a site cannot support hydric soils and wetland vegetation. Wetland rehabilitation as recommended in the report is only applicable to existing nontidal wetlands that are considered to be degraded and in need of rehabilitation to improve functions. For both BMPs the*

intention is to promote the long-term sustainability of the created/rehabilitated wetland. See Section 5 for more information, particularly about the pre- and post- conditions assessment.

11. **Temporal performance of BMP including lag times between establishment and full functioning:** *The panel considered this when discussing conceptual models and the literature. Wetlands are complex systems. While created/rehabilitated wetlands' hydrologic improvements can occur immediately, the vegetation and soil functions will continue to improve over time.*

12. **Unit of measure:** *See Technical appendix*

13. **Locations in CB watershed where the practice applies:** *Watershed-wide, but not applicable in tidal areas*

14. **Useful life; practice performance over time**: *The report states that the desired outcome for wetland creation/rehabilitation projects is self-sustaining functional wetland. Therefore, the desired lifespan is a permanent, functional wetland. Areas with greater stressors may negatively affect the wetland's performance over time, so there is a need for ongoing verification and maintenance. For modeling purposes, the recommended credit duration is 15 years.*

15. **Cumulative or annual practice:** *See Appendix B. The recommended credit duration for both practices is 15 years.*

16. **Recommended description of how practice could be tracked, reported, and verified:**

17. **Guidance on BMP verification***: See Section 6.*

18. **Description of how the practice may be used to relocate pollutants to a different location; identification of any unintended consequences or ancillary benefits associated with the practice:** *See Section 7.*

19. **Suggestion for review timeline; when will additional information be available that may warrant a re-evaluation of the practice effectiveness estimates:**

20. **Outstanding issues that need to be resolved in the future and a list of ongoing studies, if any:** *See Section 8.*

21. **Documentation of dissenting opinion(s) if consensus cannot be reached:** *N/A*

22. **Operation and Maintenance requirements and how neglect alters the practice effectiveness estimates:** *See Section 6.*

23. **A brief summary of BMP implementation and maintenance costs estimates, when this data is available through existing literature:** *No new cost data was analyzed by the panel.*

24. **Technical appendix:** *Provided as Appendix B.*

Appendix D: Clarifying the definition of "Efficiency" to estimate TN, TP and TSS reductions as applied to wetland BMPs in the Phase 6 CBWM

Editor's note: this was originally a handout provided to the panel prior to its April 2019 conference call. Only minor edits (e.g., table/figure numbers) were made when updating it for the panel's report as Appendix D.

The panel will have an opportunity to review and provide input on efficiency values for the TN, TP and TSS reduction values (as percent values) for the three wetland BMPs within our scope/panel charge (creation, rehabilitation and enhancement[1]) at our April 12th meeting. These percent values reduce the estimated nutrient and sediment loads from upland areas such as cropland. One conceptual difficulty is how to quantify and differentiate the BMP-condition from a baseline condition to determine these efficiency values. Additional load reductions are gained for land use change BMPs, such a wetland creation. More details are provided later in this document.

To date the panel has considered and applied different definitions of the term "efficiency." For example, the term has been used to define the post -construction pollutant removal or effectiveness of a practice (i.e., difference between input and output loads in that post-construction condition) but, has also referred to a net efficiency that considers the baseline, or pre-treatment condition of the project site and post-construction conditions. The purpose of this memo is to resolve the differences in interpretations of the term "efficiency" and to agree on the best interpretation to apply to the panel recommendations for the three BMPs. For example, a post-construction efficiency would be calculated based on the difference in input and output loads shown in Figure . A net efficiency is defined by the difference in the output loads pre- and post-treatment, respectively, as depicted in Figures D-1 and D-2.

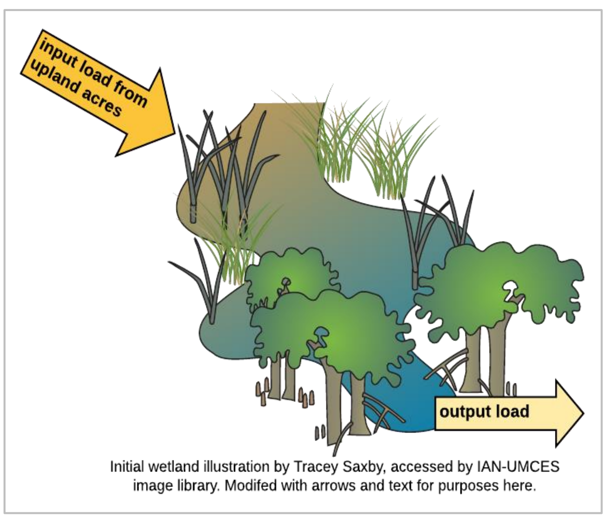


Figure D-1. Baseline or pre-treatment condition, with wetland present but conditions are degraded.

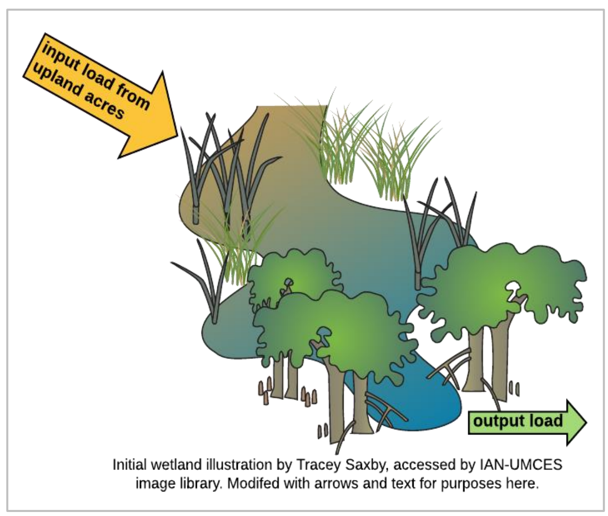


Figure D-2. Post-treatment, or desired outcome for a degraded wetland to repair functions to natural or historic functions (e.g. rehabilitated).

[1] Recommendations are forthcoming to determine if wetland enhancement BMPs are eligible for credit.

Consolidating our terminology: wetland BMPs and illustrations

For the purposes of crediting in the Chesapeake Bay Watershed Model, the overall **effectiveness** of a BMP is the difference between a **baseline** condition (no BMP or a natural, degraded wetland) and the post-implementation condition or **BMP condition**. This is consistent with other BMP credit methods. For example, an urban BMP retrofit practice is provided a 'bump-up' credit based on the difference between the pre-treatment (existing BMP, like a dry pond) and the post-treatment (retrofit) conditions.

To merge the terms and discussions so far, recall the four BMP categories as described in WEP 2016 (see Table D-1). A key distinction to remember is the resulting gains from the practices: **restoration and creation yield acreage and functional gains from wetlands**, **while rehabilitation and enhancement only represent functional gains**.

Table D-1 - CBP Wetland BMP definitions

Wetland BMP Definitions		
Wetland type	CBP Definition	Operational Definitions
Restoration	The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland	• No wetland currently exists, • Gain in wetland acreage • Hydric soils present • "Prior converted"
Creation	The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site.	• No wetland currently exists • Gain in wetland acreage • Hydric soils not present
Rehabilitation	The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland.	• Wetland present • Gain in wetland function • Wetland conditions/functions degraded
Enhancement	The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).	• Wetland present • Gain in wetland function • Some functions may be suboptimal

The distinction between acreage gain BMPs and functional gain BMPs is vital for determining the BMPs' effectiveness, as it informs an understanding of the possible baseline and BMP conditions. The panel has discussed the starting conditions in detail, but for simplicity we will assume two general possibilities: 1) no wetland is present, with or without hydric soils) or, 2) a wetland is present and degraded.

The post-implementation performance of the site (BMP condition) will vary, but the general concept is to improve upon existing site conditions that either restores or repairs to a natural or historic wetland condition; creates a wetland where one did not historically exist; or improves one or more functions of an existing wetland. The actual performance and function of the wetland will vary based on the type of BMP and the specific actions/techniques applied on the site. However, we are lumping them into one diagram for this basic illustration (Figure). The question remains: how should the panel quantify and define its recommended efficiency values?

Baseline Conditions

This section will revisit the concept of the baseline condition for wetland BMPs, focusing on restoration (for reference to the previous WEP), creation and rehabilitation. The Panel may apply this to wetland enhancement BMPs pending the discussion of recommendations.

Recall the conceptual baseline condition for Restoration or Creation in Figure D-3. In that case, the baseline consists of agriculture land – let's assume marginal cropland.

The previous WEP established its efficiency values for Restoration based on the literature, which generally reflects the reduction from inputs to outputs of a wetland. If we assume that the baseline condition (ag land) provides near zero retention or removal of loads from upland loads, then we can understand why the WEP went with the literature values (i.e., typically representative of post-construction loads).

For creation, therefore, we could make a similar assumption for the baseline condition - that it provides no retention or removal benefits for upland loads, but the established wetland will – thereby an efficiency value based on the post-construction condition will suffice.

Figure D-4 illustrates how wetland creation will be simulated in the Model as a land use change BMP with additional upland treatment. The wetland restoration BMP works the same way, but potentially with a different upland efficiency value or upland acre ratio, depending on the recommendations from this current panel.

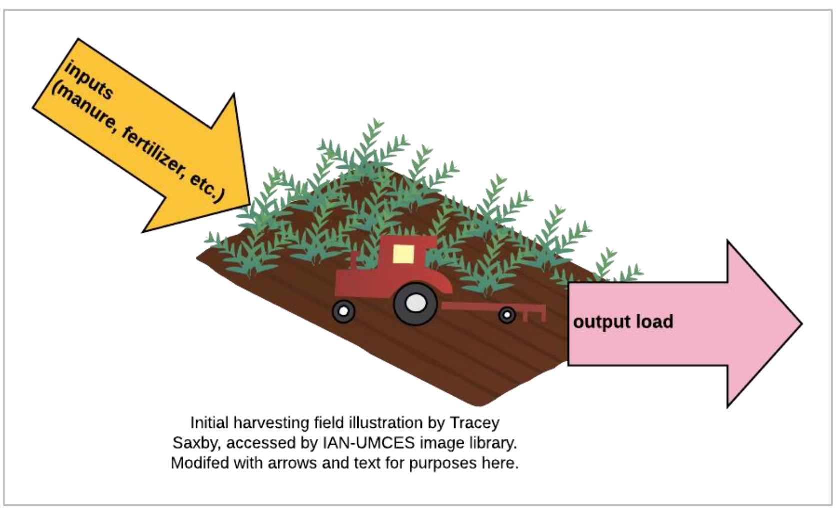
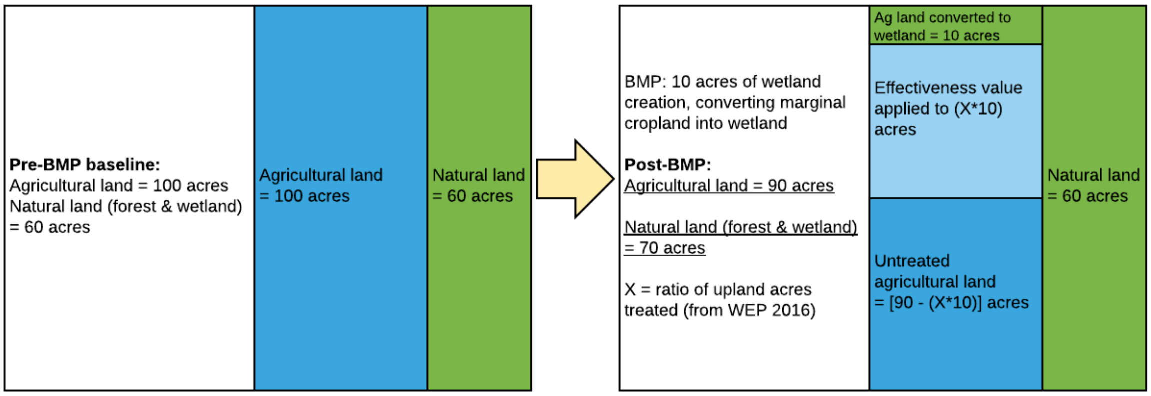
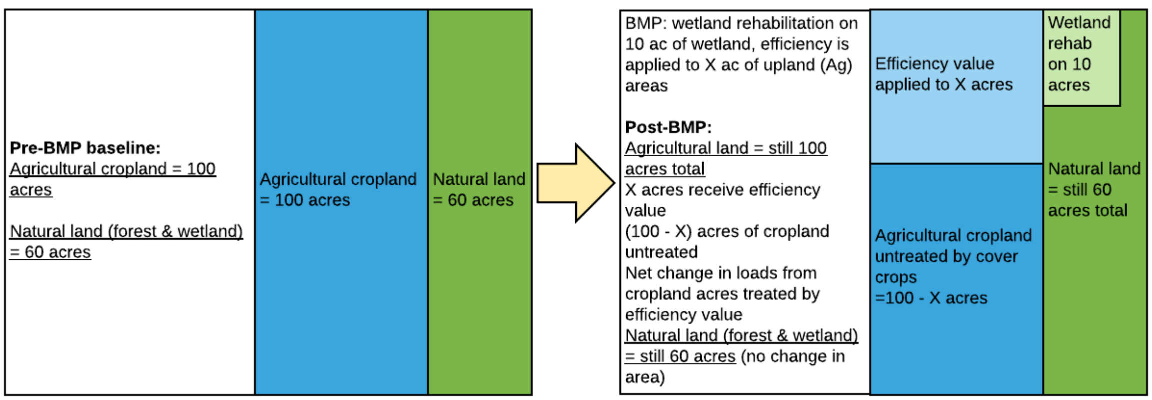


Figure D-3. Possible starting condition, with no wetland present. The site may be (A) prior-converted site with hydric soils present (restoration), or (B) hydric soils may not be present (creation). Hydric soils not illustrated.



In this example, the EFFECTIVENESS of the Wetland Creation BMP equals the net change in loads that result from (1) the change in land use from cropland to wetland, PLUS (2) the X upland acres treated by the EFFICIENCY value for TN, TP and TSS

Figure D-4. Theoretic example of wetland creation in the Watershed Model.



In this example, the EFFECTIVENESS of the Wetland Rehabilitation BMP equals the net change in loads that result from the X upland acres treated by the EFFICIENCY value for TN, TP and TSS. There is no change in area (acres) for either land use category.

Figure D-5. Theoretical example of wetland rehabilitation in the Watershed Model.

Now let's consider rehabilitation, which is a functional gain practice (Figure D-5). This practice can only be applied on acres of wetlands in the model, but it can treat loads from upland load sources (presumably Ag, but the panel can broaden that to developed or natural sources with justification). In this case, consider the shift from Figure D-1 to Figure D-2; there is currently a wetland – whose effects are implicitly captured in the model – and the management action (rehabilitation) improves its ability to retain or transform nutrients and sediment, shifting us toward the condition in Figure D-2. In this case, our desired efficiency value is the net change between the baseline (existing wetland) and the BMP-condition. A rehabilitated wetland could theoretically perform as well as a restored or created wetland, but the recommended efficiency value applied to upland load sources would necessarily be lower to reflect the difference between baseline- and BMP-conditions.

Table D-2 builds on the simple concepts of baseline and the BMP-condition for the three wetland BMPs from the above discussion and figures, clarifying if literature removal rate values are logical as-is or if a net change value is needed.

Table D-2 - Summary of wetland BMPs and how to set respective efficiency values given baseline and BMP-conditions

Wetland BMP type	**Types of gains**	**Existing Representation in the P6 Model (pre-treatment)**	**Representation in the P6 Model Post treatment**	**How to set the efficiency value for treatment of upland loads** *(not including load reductions from land use changes)*
Wetland restoration	Gain in acres and function	The existing land use (ag, forest)	Change in land use to wetland and efficiency applied to upland treated acres	In this case the difference in baseline (no wetland, hydric soils) and the BMP-condition (restored wetland) is reasonably equal to the post-construction assumed to be represented by literature removal rates.
Wetland creation	Gain in acres and function	The existing land use (ag, forest)	Change in land use to wetland and efficiency applied to upland treated acres	In this case the difference in baseline (no wetland, no hydric soils) and the BMP-condition (created wetland) is reasonably equal to the post-construction assumed to be represented by the literature removal rates, perhaps adjusted in relation to restoration, using other lines of evidence like the Riparia database.
Wetland rehabilitation	Gain in function	Existing natural wetland (implicit assumption that all existing wetlands are represented in the model, their condition is not evaluated)	Efficiency applied to upland treated acres	In this case the difference in baseline (wetland, degraded function or conditions) and the BMP-condition (rehabilitated wetland) is the difference between the expected removal rates under the baseline and BMP-condition.
Wetland enhancement	Gain in function	Existing natural wetland (implicit assumption that all existing wetlands are represented in the model, their condition is not evaluated)	Efficiency applied to upland treated acres	TBD
Natural wetland (existing)	n/a	Wetland land use loading rate (equivalent to forested land use)	n/a	Land to water factors adjusts the loads….

Appendix E. Summary of Literature Added to the Wetland Literature Review Database

The initial and primary focus of the literature review was to identify supporting research and/or data to differentiate amongst the wetland BMP types. The WEP2016 provided a comprehensive review of the literature describing wetland functions on nutrient and sediment retention.

Prepared by the Center for Watershed Protection, Inc.

Doherty, J. M., Miller, J. F., Prellwitz, S. G., Thompson, A. M., Loheide II, S. P., & J. B. Zedler. (2014). Hydrologic Regimes Revealed Bundles and Tradeoffs Among Six Wetland Services. *Ecosystems, 17*: 1026–1039. DOI: 10.1007/s10021-014-9775-3.

> This study evaluates the relationships between a variety of ecosystem services within three swales treating stormwater from an urban watershed in Wisconsin. Comprehensive sampling was conducted to measure the following six variables: peak flow reduction, outflow volume reduction, plant biomass, species richness, surface soil stability, and nutrient and sediment removal efficiency. The study concludes that hydrologic regime is a key determinant of the overall ecosystem services provided by wetlands, while net primary productivity is a potentially misleading indicator of overall ecosystem services.

Filoso, S., Smith, S. M. C., Williams, M. R., & M. A. Palmer. (2015). The Efficacy of Constructed Stream-Wetland Complexes at Reducing the Flux of Suspended Solids to Chesapeake Bay. *Environmental Science & Technology, 49*(15): 8986–8994. DOI: 10.1021/acs.est.5b00063.

> This study monitored the TSS retention effectiveness of two restored, nontidal, lowland valley stream reaches (forming stream-wetland complexes) in Maryland's Coastal Plain using a mass-balance approach. There was no statistically significant difference in the TSS load entering the reach and the TSS load leaving the reach, which indicates that these stream-wetland systems do not significantly lessen TSS loadings to tidal waters. The high variability of TSS retention documented in this study suggests that the TSS retention efficiency of these systems is dependent on: 1) the amount of TSS originating upstream, 2) system design characteristics, and 3) the frequency and magnitude of storm events.

Gumiero, B., Mant, J., Hein, T., Elso, J., & B. Boz. (2013). Linking the Restoration of Rivers and Riparian Zones/Wetlands in Europe: Sharing Knowledge through Case Studies. *Ecological Engineering, 56*: 36–50. DOI: 10.1016/j.ecoleng.2012.12.103.

> This meta-analysis assesses the loss of wetlands in Europe and evaluates how various policies have resulted in wetland re-establishment. The meta-analysis includes data from nine case studies. Only the results from one of those studies (Tockner et al., 2001) was included in the database as its own entry (meaning it is double-counted). Each case study highlights how different localities balance conservation, agriculture, socioeconomic needs, and policy drivers. The discussion concludes that hydrology is the most important determinant of wetland health, meaning that water management is the key to effective wetland restoration.

Kreiling, R. M., Schubauer-Berigan, J. P., Richardson, W. B., Bartsch, L. A., Hughes, P. E., Cavanaugh, J. C., & E. A. Strauss. (2013). Wetland Management Reduces Sediment and Nutrient Loading to the Upper Mississippi River. *Journal of Environmental Quality*. DOI: 10.2134/jeq2012.0248.

> This study measured the nutrient retention efficiencies of a marsh complex in Mississippi using a mass-balance approach. The marsh complex was an effective sediment trap, retaining approximately 75% of the sediment load entering the complex. While both nitrogen (N) and phosphorus (P) were retained in the marsh complex (although more P was retained than N), there was a net export of ammonium and soluble reactive phosphorus. Because the inlet of the most upstream section of the marsh complex was too high to intercept baseflow (it only intercepted strong storms and spring thaw), the nutrients and sediment in baseflow went directly into the adjacent river. Diverting more of the inflow into the marsh complex prior to it entering the adjacent river by lowering the inlet would further increase nutrient and sediment retention.

Kreiling, R. M., Thoms, M. C., & W. B. Richardson. (2018). Beyond the Edge: Linking Agricultural Landscapes, Stream Networks, and Best Management Practices. *Journal of Environmental Quality, 47*: 42–53. DOI: 10.2134/jeq2017.08.0319.

> Using a case study of the Fox Basin (which drains to Lake Michigan) in Wisconsin, this paper presents a framework for the interdisciplinary management of agricultural and riverine landscapes. The proposed framework is composed of three primary components: 1) ecosystems approach, 2) resilience thinking, and 3) strategic adaptive management. The ecosystems approach and resilience thinking are both conceptual components, while strategic adaptive management provides operational and logistical direction to the framework.

Land, M., Granéli, W., Grimvall, A., Hoffmann, C. C., Mitsch, W. J., Tonerski, K. S., & J. T. A. Verhoeven. (2016). How Effective are Created or Restored Freshwater Wetlands for Nitrogen and Phosphorus Removal? A Systematic Review. *Environmental Evidence, 5*(9). DOI: 10.1186/s13750-016-0060-0.

> This meta-analysis systematically reviewed nutrient removal rates by wetlands from a total of 2013 wetlands from 93 studies. Only the results from two of those studies (Jordan et al., 2003 and Ardón et al., 2010) were included in the database as their own entries (meaning they are double-counted). The TN removal efficiency of the evaluated wetlands was significantly correlated with both hydrologic loading rate and air temperature, while the TP removal efficiency of those wetlands was significantly correlated with TP concentration at the inlet, hydrologic loading rate, air temperature, and wetland area. The results indicate that both created and restored wetlands significantly reduce the transport of TN and TP in wastewater, urban runoff, and agricultural runoff. However, restored wetlands on previously-agricultural land were significantly less effective at TP removal than other types of wetlands. Additionally, wetlands with hydrologic loading rates that are driven by precipitation are significantly less effective at TP removal than their controlled-hydrologic-loading-rate counterparts.

Mitsch, W. J., Zhang, L., Stefanik, K. C., Nahlik, A. M., Anderson, C. J., Bernal, B., Hernandez, M., & K. Song. (2012). Creating Wetlands: Primary Succession, Water Quality Changes, and Self-Design over 15 Years. *Bioscience, 62*(3): 237–250. DOI: 10.1525/bio.2012.62.3.5.

This study monitored a pair of one-hectare, created riverine wetlands (one planted and one unplanted) for their first 15 years and compared them to a natural wetland (all located within the Oletangy River Wetland Research Park in Columbus, Ohio). Monitoring was conducted to evaluate vegetative succession, soil development, water quality conditions, and nutrient dynamics (specifically for carbon and nitrogen). While the planted wetland had higher vegetative diversity, the unplanted wetland was more productive. Both wetlands' soils became hydric within a few years of creation, and soil organic carbon nearly tripled in the 15-year study period. Both wetlands had similar nutrient removal and carbon retention rates. This study was ultimately removed from the database as an update to the study was published and included instead (Mitsch et al., 2014).

Mitsch, W. J., Zhang, L., Waletzko, E., & B. Bernal. (2014). Validation of the Ecosystem Services of Created Wetlands: Two Decades of Plant Succession, Nutrient Retention, and Carbon Sequestration in Experimental Riverine Marshes. *Ecological Engineering, 72*: 11–24. DOI: 10.1016/j.ecoleng.2014.09.108.

This study monitored a pair of one-hectare, created riverine wetlands (one planted and one unplanted) for their first 20 years and compared them to a natural wetland (all located within the Oletangy River Wetland Research Park in Columbus, Ohio). The primary inflow to the wetlands was water pumped from the adjacent Oletangy River. Monitoring was conducted to evaluate nitrogen and phosphorus budgets, vegetative structure and function, and carbon dynamics. The planted wetland retained significantly more TP than the unplanted wetland, while the unplanted wetland retained significantly more TN than the planted wetland. Overall, nutrient retention decreased over time. Both created wetlands sequestered more carbon than the reference natural wetland.

Annotated Bibliography of Additional Literature to Support the Wetland Rehabilitation, Enhancement and Creation Expert Panel.

Golden, H. E., Creed, I. F., Ali, G., Basu, N. B., Neff, B. P., Rains, M. C., McLaughlin, D. L., Alexander, L. C., Ameli, A. A., Christensen, J. R., Evenson, G. R., Jones, C. N., Lane, C. Rl., & M. Lang. (2017). Integrating Geographically Isolated Wetlands into Land Management Decisions. *Frontiers in Ecology and the Environment, 15*(6): 319–327. DOI: 10.1002/fee.1504.

This review paper details the environmental importance of geographically isolated wetlands (GIWs) and explains wetland connectivity in both scientific and management contexts. It also presents a variety of models available to quantify the connectivity of GIWs while recommending next steps to integrate and further improve such tools. While GIWs are often excluded from policy and management decision-making because of their apparent limited connection to downstream waters, their impacts on watersheds can be more accurately estimated as models improve.

Hansen, A. T., Dolph, C. L., Foufoula-Georgiou, E., & J. C. Finlay. (2018). Contributions of Wetland to Nitrate Removal at the Watershed Scale. *Nature Geoscience, 11*: 127–132. DOI: 10.1038/s41561-017-0056-6.

This study evaluated the effects of both wetland and cropland cover on nitrate levels by comparing high-resolution land cover data and extensive water quality sampling data within the

Minnesota River Basin (a region of the Mississippi River Basin). The results indicate that wetland cover is significantly related to nitrate concentrations under high-streamflow conditions, which is when most nitrate export takes place.

Hunt, P. G., Miller, J. O., Ducey, T. F., Lang, M. W., Szogi, A. A., & G. McCarty. (2014). Denitrification of Soils of Hydrologically Restored Wetlands Relative to Natural and Converted Wetlands in the Mid-Atlantic Coastal Plain of the USA. *Ecological Engineering, 71*: 438–447. DOI: 10.1016/j.ecoleng.2014.07.040.

This study monitored a total of 48 natural, converted, and restored wetland sites in Maryland, Virginia, and Delaware for three years to assess the soil denitrification capacity of wetlands in the Mid-Atlantic coastal plain of the United States. Soil enzyme analyses indicated that restored wetlands (NRCS Practice Standard 657 and 646) differed from both natural and converted wetlands. The results find that elevation (topographic gradient) and management approach will have an effect on denitrification.

Ducey, T. F., Miller, J. O., Lang, M. W., Szogi, A. A., Hunt, P. G., Fenstermacher, D. E., Rabenhorst, M. C., & G. W. McCarty. (2015). Soil Physiochemical Conditions, Denitrification Rates, and nosZ Abundance in North Carolina Coastal Plain Restoration Wetlands. *Journal of Environmental Quality, 44*: 1011–1022. DOI: 10.2134/jeq2014.09.0403.

This study monitored nine wetland sites in North Carolina's coastal plain in order to assess the impact of hydrological restoration on the denitrification capacity of wetland soils. The study compared natural, restored, and historic wetlands under agricultural production (i.e., prior converted—PC—croplands). Restored wetland soils had a significantly lower concentration of the nitrate-reducing enzyme *nosZ* than natural wetland soils. Additionally, the nosZ activity rate of wetland soils varied with soil wetness (typically increasing as moisture increases).

Moreno-Mateos, D., Meli, P., Vara-Rodríguez, M. I., & J. Aronson. (2015). Ecosystem Response to Interventions: Lessons from Restored and Created Wetland Ecosystems.

This study compared the biogeochemical functionality of 628 restored and created wetlands to 499 reference wetlands from across the globe. Recovery trajectories of wetlands under various restoration/creation approaches were studies under different environmental settings. The differences amongst wetland BMP functions based on a regression analyses were small (6-7%). Surface modification and hydrological re-establishment had similar effects on wetland recovery trajectory regardless of revegetation.

Appendix F: Conceptual Models Developed by the WEP

A series of conceptual models were developed by the Panel throughout the Panel process, to explore, communicate and develop hypotheses that might explain the wide range of water quality benefits reported in the wetlands' literature. This approach was intended to capture expert insights as to the controlling factors that primarily influence wetland function, to provide a relative understanding of the different wetland BMP water quality performance, and to provide guidance on how best to expand and interpret the literature database.

The first set of conceptual models, Figures F-1 to F-4, are based on work by Lake et al (2007) and presented in Kreiling et al (2018). Kreling et al (2018) presented a conceptual model illustrating the potential condition of a stream and associated wetlands in a natural and restored stated based on the amount of disturbance in the watershed. The conceptual model suggests that a restored stream does not regain functions of an undisturbed natural system.

<u>Figure F-1</u>: This model was expanded to highlight loss of nutrient and sediment retention capacity in degraded wetlands, and expected recovery of water quality benefits associated with re-established, rehabilitated, created, or enhanced wetlands (depending on how well natural conditions have been restored or disturbance has been counteracted). The different colors and sizes of the circles highlight variable response based on BMP type (and/or time since installation). It is expected that a wetland BMP moves along a trajectory of improved or increasing function, but does not fully attain the capacity of natural wetlands. "Sub" hypotheses to describe the relative success of different wetland BMP types are also inferred.

<u>Figure F-2</u>: Similar to Figure F-1 but expanded to highlight the expectation that restored and rehabilitated wetland water quality benefits are similar to natural wetlands. The bullseye symbols used to plot natural wetland function highlight the panel's intent to describe observed variation in wetland retention capacity.

<u>Figure F-3</u>: This conceptual model continues to illustrate the relative water quality benefits of wetland BMPs but differentiated by the potential effects of physiographic setting and/or watershed position (consistent with WEP2016 panel recommendations). The condition of the wetland, while a function of watershed disturbance, is also influenced by the physical location of the wetland. The WEP2016 evaluated the effect of landscape position using physiographic province as a proxy to differentiate the potential for contaminated source waters (surface and, or groundwater) to intersect organic-rich, anoxic wetland soils.

<u>Figure F-4</u>: The two-dimensional model was expanded to illustrate how water quality benefits of natural and wetland BMPs depend upon existing site conditions *and* watershed conditions. That is, the potential improvement or 'lift' expected from a management action would depend in part on the conditions prior to treatment. The expected decrease in nutrient and sediment loadings would be greater the more degraded a site relative to a site that is slightly degraded, yet functioning.

Figure F-5: An alternative to the Kreiling-based model was provided to capture more detailed characterization of the watershed/landscape setting and wetland conditions. This is referenced as the “Capacity-Opportunity” conceptual model. A common thread throughout these discussions focused on the combined effects of a wetland’s *capacity* and *opportunity* that drive the functional potential of a wetlands’ water quality benefit. *Capacity* refers to the condition of the wetland (characteristics and size), whereas *opportunity* acknowledges the importance of location including existing/surrounding site conditions (e.g. presence/absence of a wetland, existing land use/loadings). Both of these overarching components influence a wetland’s hydrology, soil, and vegetation characteristics indicative of biogeochemical functioning.

The conceptual models presented in Figures F-6 and F-7 focus on the effect of wetland specific factors and processes on nutrient and sediment retention capacity. These two models acknowledge the influence and interaction of wetland hydrology, vegetation and soils and their influence on water quality benefits provided by wetlands.

Figure F-6: The purpose of this conceptual model focused on the wetland itself and the identification of the key physical attributes, conditions and processes that influence the nutrient and sediment retention functions of a wetland. These components were identified based on available research and the ability to measure or observe them in the field.

Figure F-7: A similar approach was taken in this conceptual model that recognized the importance of wetland hydrology, vegetation and soils and their effect on wetland nutrient and sediment retention. The model illustrates how the linkages or interactions between the key drivers (factors and processes) may affect loadings to and within a wetland. The model attempts to illustrate how much load is getting to the wetland and what happens once the load gets into the wetland.

The final set of conceptual models are presented in Figures F-8 to F-11. These series of models combine the importance of landscape position and condition of the wetland, while reinforcing the integrated effects of wetland hydrology, vegetation and soil.

Figure F-8: Illustrates a conceptual diagram of regional watershed characteristics that effect wetland hydrology, water chemistry and vegetation. Combined, these influence nutrient availability and subsequently vegetation.

Figure F-9: Graphical representation of the conceptual diagram in Figure F-7 is used to illustrate the complexity of how landscape setting and local conditions affect the nutrient and sediment retention benefits of a wetland. The top left figure is from the Canadian Wetland Classification System as described by Zoltai and Vitt (1995). The classification of wetland is based on hydrology, surface morphology, and vegetation. This is presented as an over-arching model to illustrate that the condition/state of a wetland is the result of multiple components and their interactions. Secondarily, the figure in the upper right and blue arrows illustrate the influence of hydrological connectivity and wetland water chemistry. The water chemistry will affect the release and production of various anions and cations.

Figures F-10 and F-11: A set of key factors/process emerging from this conceptual model are presented.

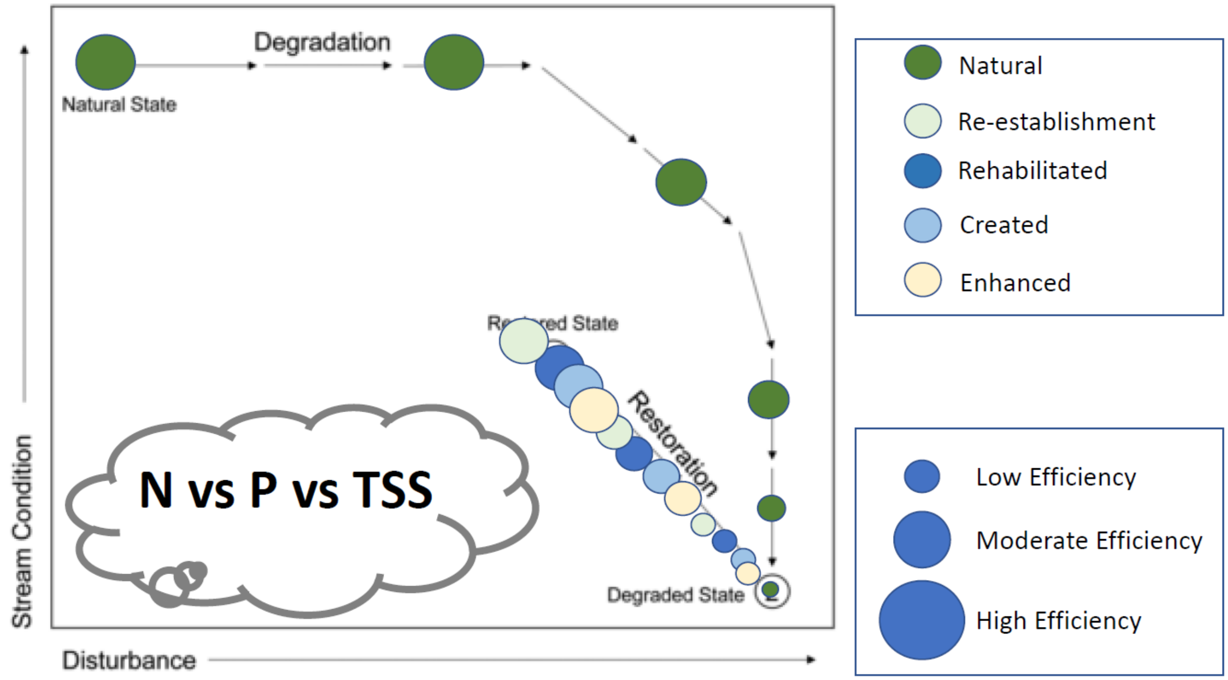


Figure F-1.

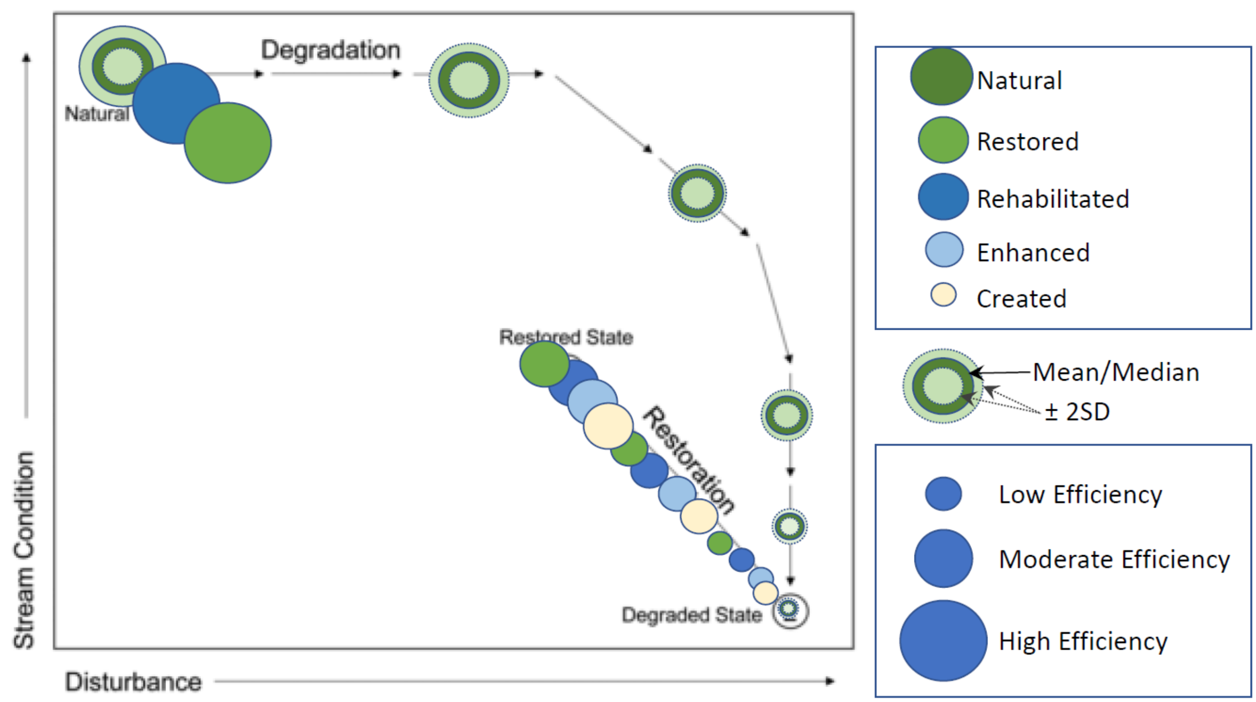


Figure F-2

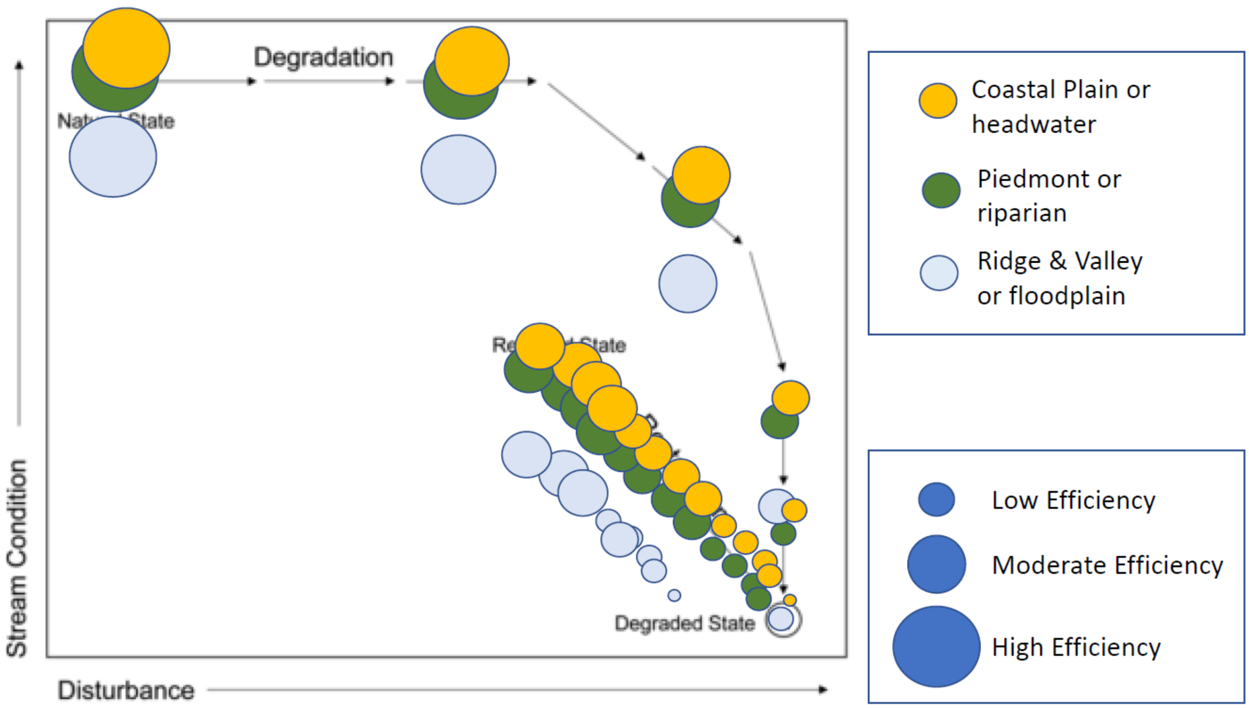


Figure F-3.

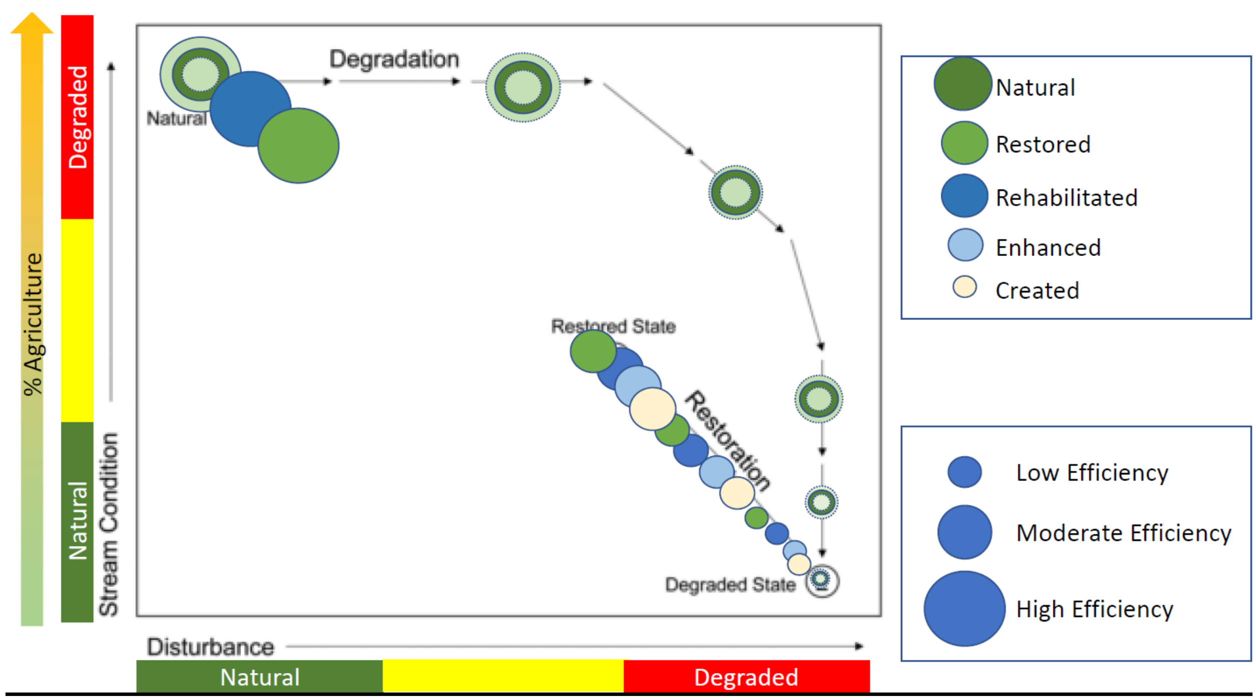


Figure F-4.

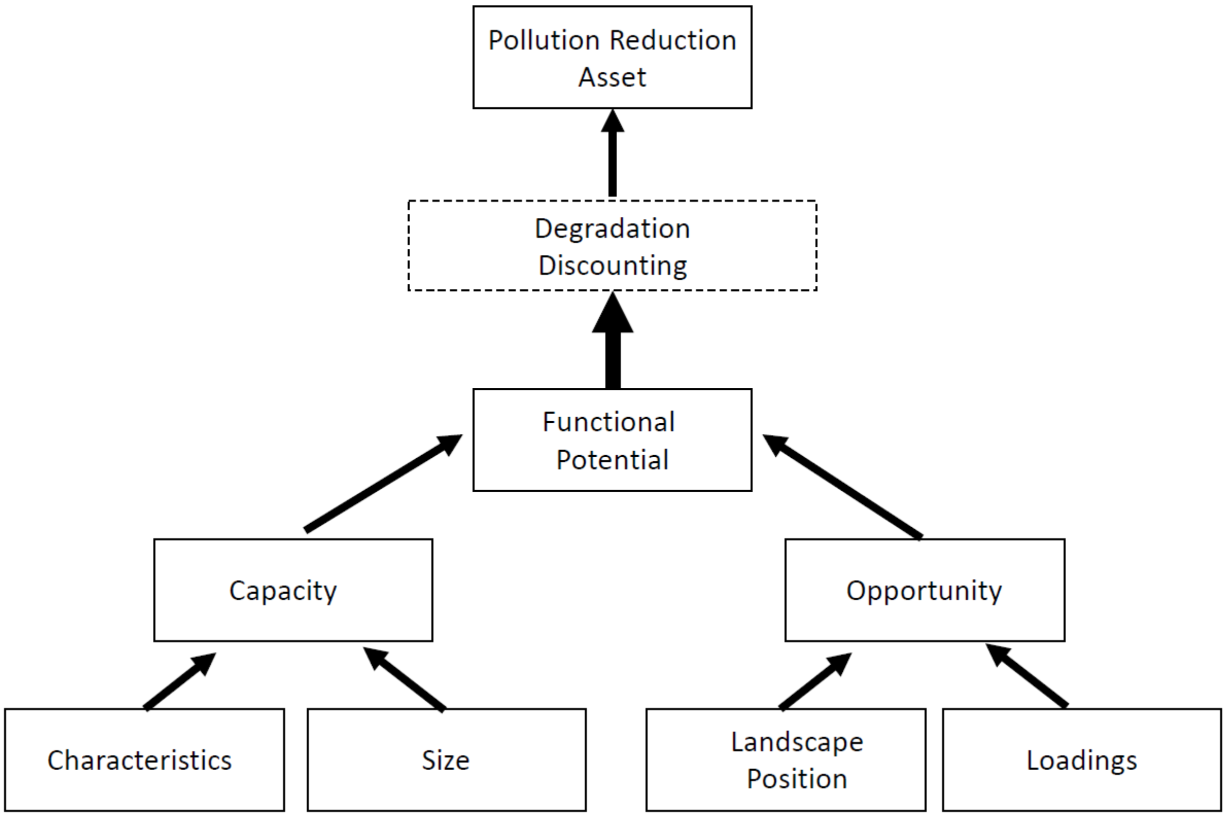


Figure F-5

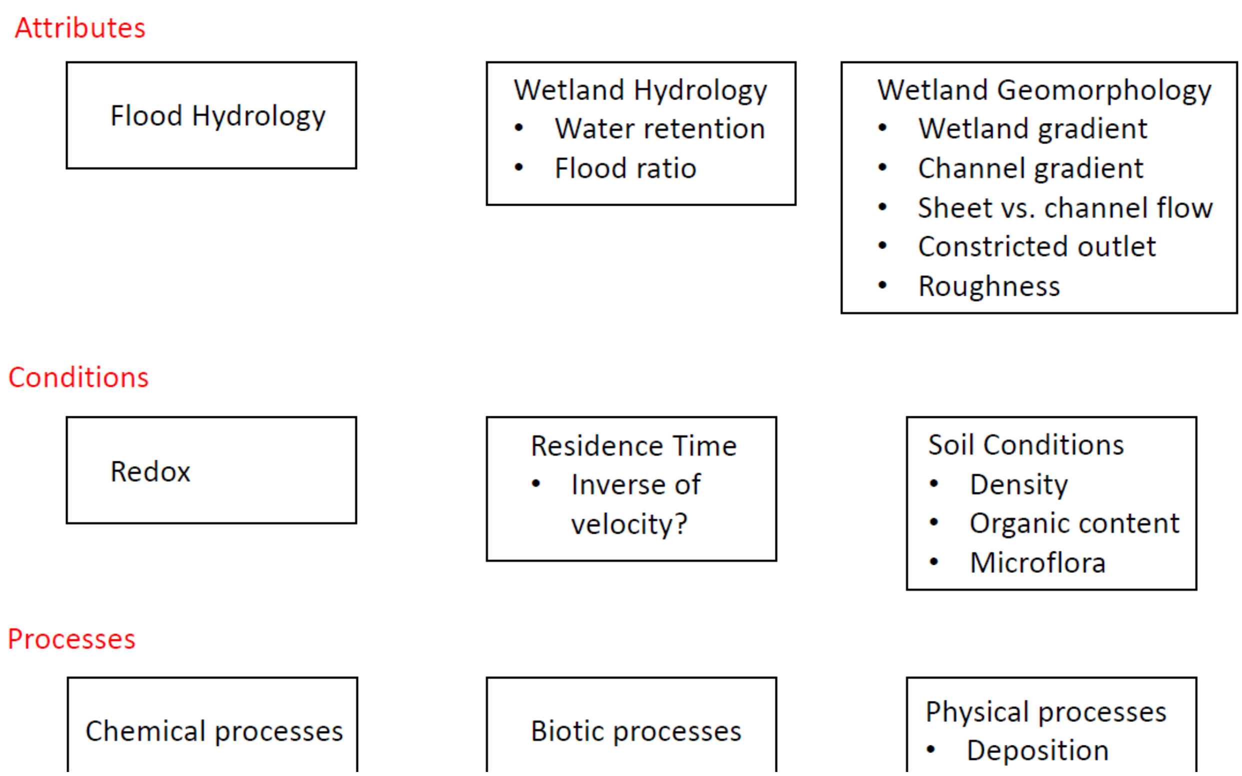


Figure F-6.

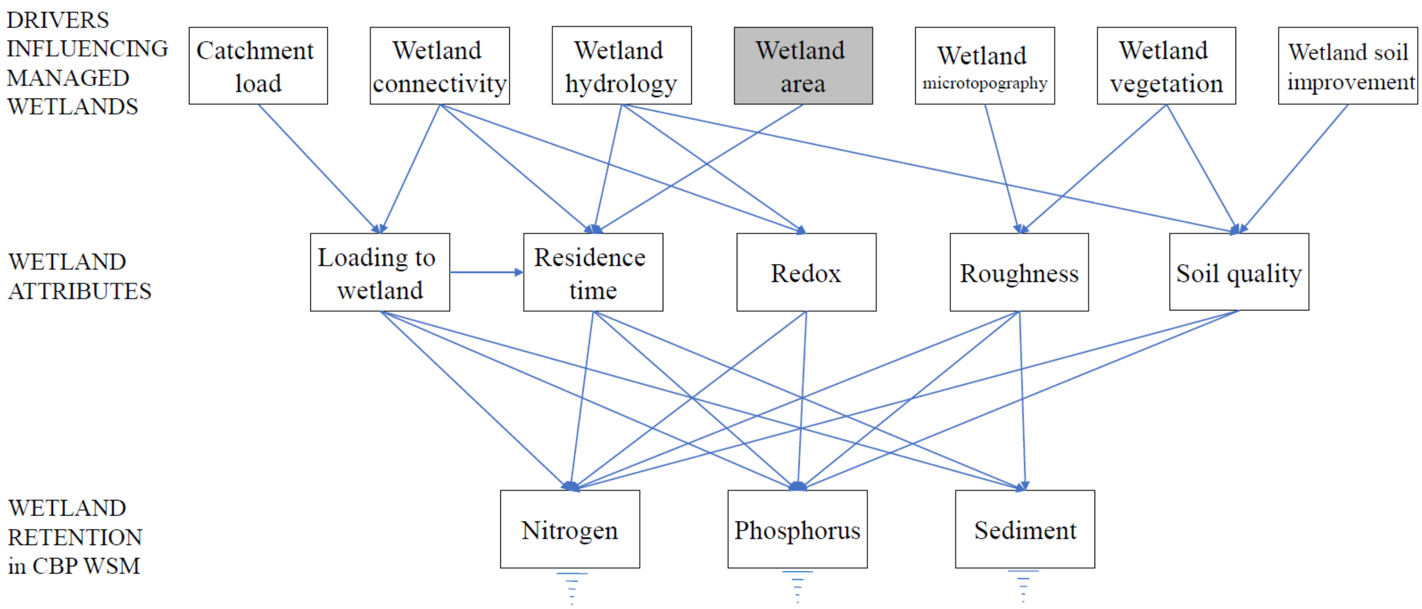


Figure F-7.

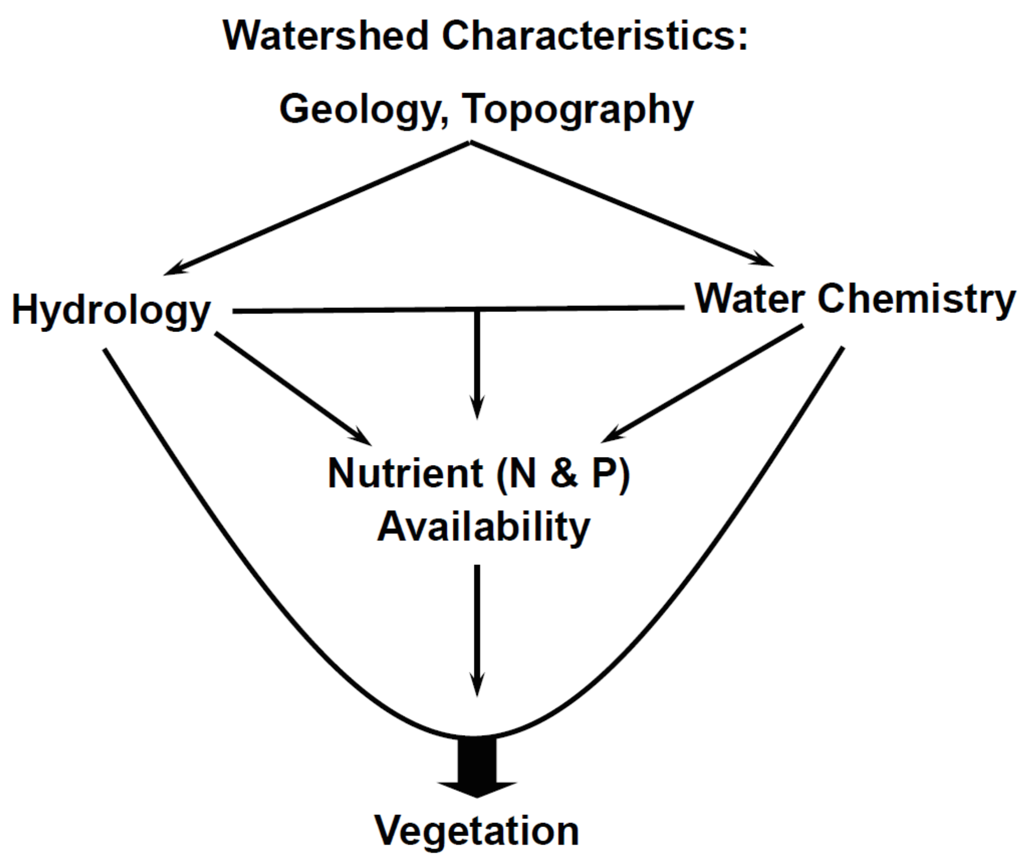


Figure F-8.

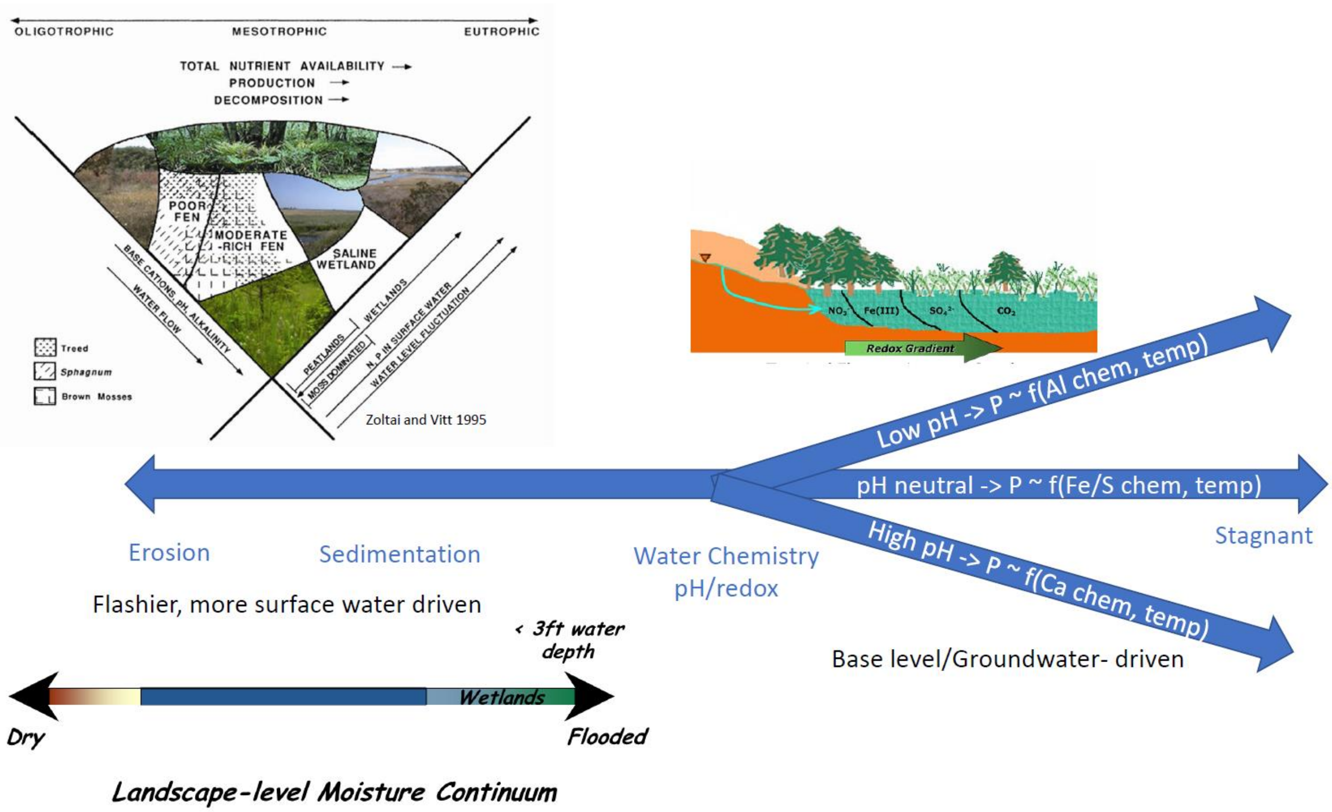

OLIGOTROPHIC
MESOTROPHIC
EUTROPHIC
TOTAL NUTRIENT AVAILABILITY →
PRODUCTION →
DECOMPOSITION →
POOR FEN
MODERATE -RICH FEN
SALINE WETLAND
BASE CATIONS, pH, ALKALINITY
WATER FLOW
PEATLANDS
MOSS DOMINATED
WETLANDS
N, P IN SURFACE WATER
WATER LEVEL FLUCTUATION
Treed
Sphagnum
Brown Mosses
Zoltai and Vitt 1995
Redox Gradient
Low pH -> P ~ f(Al chem, temp)
pH neutral -> P ~ f(Fe/S chem, temp)
High pH -> P ~ f(Ca chem, temp)
Erosion
Sedimentation
Water Chemistry
pH/redox
Stagnant
Flashier, more surface water driven
Base level/Groundwater- driven
< 3ft water depth
Wetlands
Dry
Flooded
Landscape-level Moisture Continuum

Figure F-9.

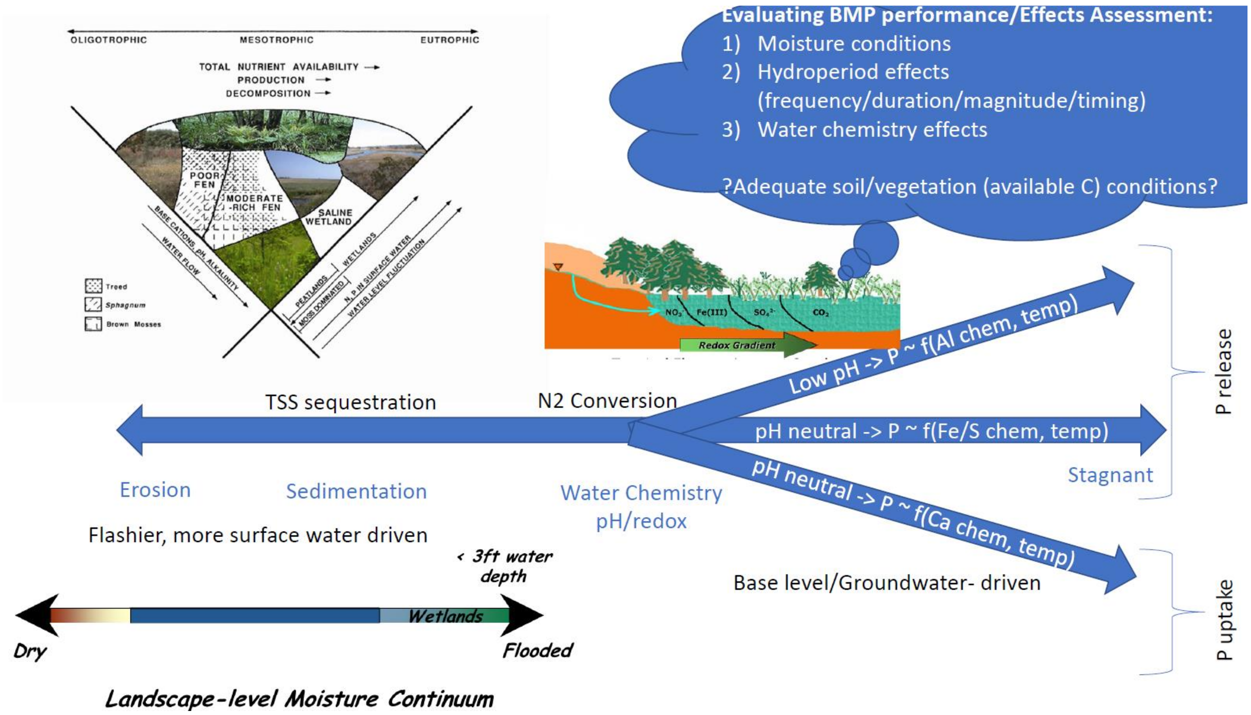


Figure F-10.

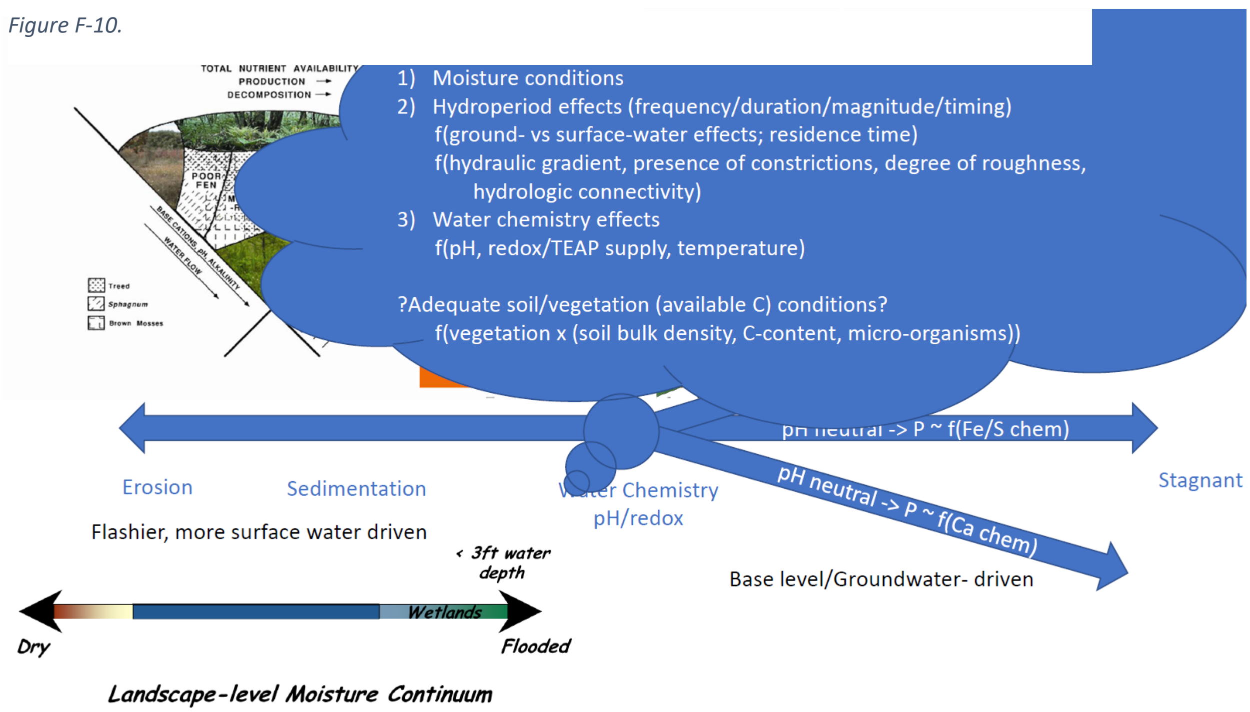
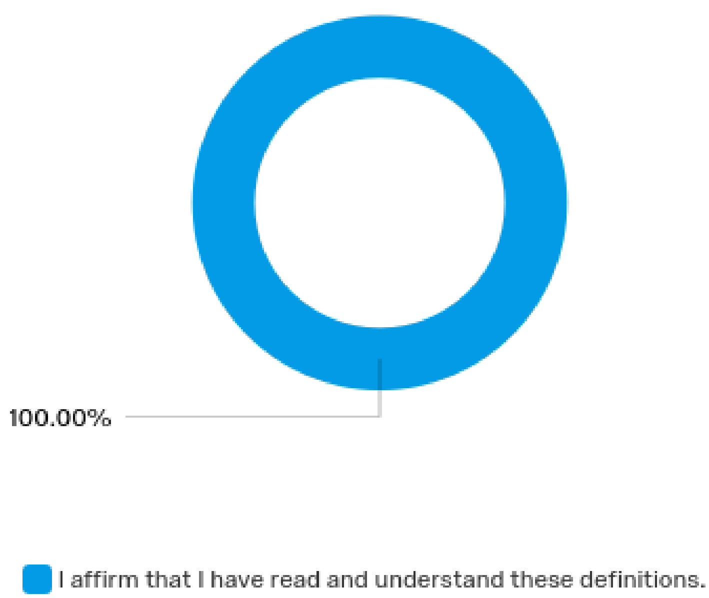


Figure F-11.

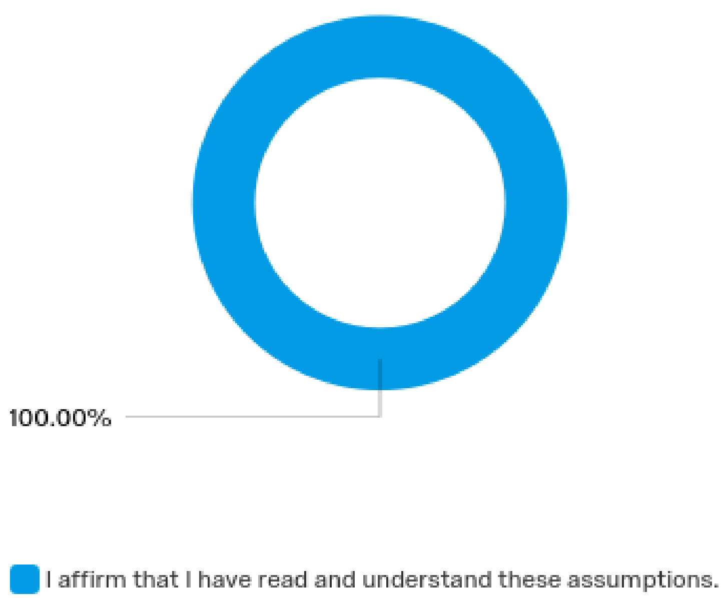
Appendix G.

Expert Elicitation Survey (Round Two) Questions and Results

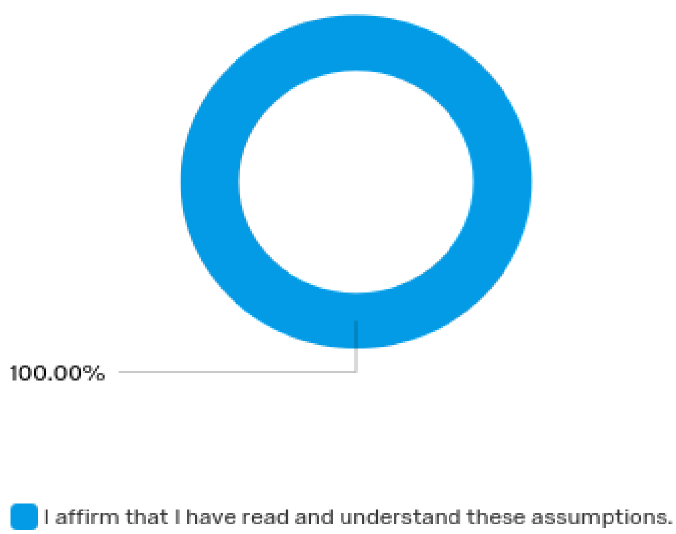
Q1 - For the purposes of this survey, the basic definition of the four wetland BMPs are as follows: Wetland Restoration BMP: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Hydric soils are present but a wetland does not exist on the site. Wetland Creation BMP: The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site. Hydric soils are not present. Wetland Rehabilitation BMP: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland. A wetland is physically present but there are multiple conditions within the wetland that are degraded. Wetland Enhancement BMP: The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s). A wetland is present and functioning but not in an optimal state. Typically one component of the wetland is addressed.



Q2 - For the purposes of this survey, there are four key assumptions for the panel to understand as you deliberate and provide a response: Wetland BMPs are implemented at sites where a natural wetland is degraded to some degree, existed previously at the site, or in the case of a created wetland, a wetland did not previously exist at the site. The efficiency - i.e., the average effectiveness - is the difference between the 'before' and 'after' condition of the wetland from pre- and post-project implementation. This is expressed as a percent (%) value of the pollutant load in absolute terms. The responses you provide for natural wetlands and the other BMPs may provide context to establish a ranking of wetland BMP pollutant load reduction benefits. For example, if you provide a response for a 60%TSS load reduction of a natural wetland (best guess), and you think an enhancement BMP may not perform as well as a natural wetland, and your response is a 25% TSS load reduction (as a best guess). The 25% is not 25% of the natural wetland, rather based on the performance of the wetland enhancement BMP. Read Attachment E for a more detailed explanation and example.   The existing condition of the degraded wetland may affect the performance of a wetland BMP (e.g. the 'before' or baseline condition). You will have an opportunity to characterize and/or explain how your responses considered the baseline condition of the existing, degraded wetland or site without a wetland. The hydrologic, vegetation and soil conditions effect the retention of nitrogen, phosphorus and sediment of a wetland. The degree to which any of these influence a wetland BMP will be determined by the current condition of the wetland (present/absent; what is degraded and to what extent) and techniques implemented. As such, we ask individuals to look at these three components of a wetland and how they may affect water quality as they are implemented individually as a basic approach to improve water quality, or collectively as a more comprehensive approach to improve water quality.



Q3 - Things to consider while formulating your responses Your response values should represent an average, annual performance of the wetlands to retain/reduce the constituent of interest (i.e., TN, TP or TSS). The value is for the (natural, restored/created/rehabilitated/enhanced BMP) wetland alone (i.e., 'edge of field') and not the cumulative effect of the wetland at the watershed scale (i.e., 'edge of stream'). For an undisturbed high-functioning natural wetland, this average annual performance represents the wetland's average annual ability to reduce nutrient or sediment loads as it exists at the site (difference in pollutant load import and export from the wetland). For the four wetland BMPs you are considering the absolute effectiveness of post-treatment conditions to reduce loads. For example, if you think the average pre-treatment wetland would reduce 25% of TN, and after treatment implementation it would reduce TN by 40% then your response would be 40% and not 15% (the difference between the pre- and post-treatment) or 10% (25% of 40%). This may be calculated based on the survey responses if needed, but it is not part of your survey response. See Attachment E for further clarification. From a timescale perspective, it is acknowledged that other time periods may impact the water quality function of wetlands or wetland BMPs such as individual storm events and their characteristics (intensity, frequency, amount of rainfall) or seasonality. However, the value relevant to the Chesapeake Bay watershed modeling tools for TMDL credit is based on the annual timescale. Your entered values may range from negative values up to 100, but remember your upper/lower bounds represent your reasonable bounds on the average, not the upper and lower bounds of the variable population. Please note that we are asking you to provide responses that may allow for a relative ranking of effectiveness for each of the four wetland BMP types (restoration, creation, rehabilitation and enhancement). While there is an existing efficiency assigned to restoration wetland BMPs (TN, TP and TSS load reduction for wetland restoration BMPs of 42%, 40% and 31%, respectively), we are not constraining your responses to relate to these values as the data used to inform these efficiencies were not specific to wetland restoration BMPs. You may choose to use this information to inform your response, or not.



Q5 - Based on the sources of available information and your effort so far, realistically, what is your best guess for the average, annual performance of the pre-treatment site conditions to reduce total nitrogen loads for each BMP? Please adjust the sliders below to provide your responses.

Editor's Note: Question 4 was omitted because it asked the respondent's name [results kept anonymous for the panel, only used for reference by the Chair (Neely), Coordinator (Jeremy) and Deb.

Editor's Note: Q5 and other questions refer to "sliders," which allowed respondents to more efficiently provide their answers for each field concurrently.

Editor's Note: The responses are given as % values (possible responses for efficiency values ranged from -100% to 100%).

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
2	Wetland Creation	-50.00	15.00	-4.30	17.58	10
4	Wetland Enhancement	-10.00	50.00	26.60	15.40	10
3	Wetland Rehabilitation	-12.00	27.00	18.00	10.99	10
1	Wetland Restoration	-5.00	30.00	10.50	10.30	10

Q6 - Based on the sources of available information and your effort so far, realistically, what do you think the lowest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total nitrogen loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	-8.00	55.00	29.70	18.08	10
2	Wetland Restoration	-8.00	28.00	15.70	9.76	10
3	Wetland Creation	-8.00	22.00	9.90	8.25	10
4	Wetland Rehabilitation	-8.00	31.00	17.80	11.96	10
5	Wetland Enhancement	-8.00	46.00	23.00	14.95	10

Q7 - Based on the sources of available information and your effort so far, realistically, what do you think the highest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total nitrogen loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	43.00	100.00	76.90	17.81	10
2	Wetland Restoration	27.00	80.00	58.80	17.05	10
3	Wetland Creation	20.00	85.00	51.40	17.37	10
4	Wetland Rehabilitation	35.00	80.00	60.40	15.52	10
5	Wetland Enhancement	30.00	85.00	62.40	18.53	10

Q8 - Based on the sources of available information and your effort so far, realistically, what is your best guess of the average, annual performance of natural wetlands or the four wetland BMP types to reduce total nitrogen loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	42.00	75.00	56.90	10.46	10
2	Wetland Restoration	30.00	54.00	39.80	6.29	10
3	Wetland Creation	15.00	42.00	29.80	6.66	10
4	Wetland Rehabilitation	33.00	54.00	41.00	6.40	10
5	Wetland Enhancement	25.00	60.00	45.10	10.17	10

Q9 - Please provide any statement or information in support of any of the answers provided above (e.g., were there specific studies or resources you relied on; which specific conceptual model(s) from Attachment A - if any - did you rely on?). Comments should be concise and based on the evidence used to provide your responses. Comments may be shared anonymously with other expert assessors.

Editor's Note: Attachment A is provided with this report as Appendix F. Other Attachments referenced in the survey (Attachments B through E) are provided at the end of this Appendix, without edits/updates aside from page numbers.

TBA
Data from Gebo and Brooks
Estimates based on WEP16 conclusions and evidence from WEP2 discussions/lit review
while we have been asked to base answers on the average and generalized condition, it should be noted that the variability with respect to surface water versus groundwater treatment is very important. In particular groundwater treatment could be expected to be nearly complete in anaerobic conditions and modest treatment for surface flow akin to a retention pond. therefore the cumulative effect would be a combination of the two and based on the degree of surface versus groundwater flow. Furthermore I am a little troubled (but I understand the need) to assess these 4 categories while not addressing the other perhaps equally important factors of soils, hydrology, etc
I used the "Wetland Type Summary" database of N, P, and sediment retention from the literature. I then calculated for "N and TN", "P and TP", and all sediment %retentions the following percentiles: 10, 20, 40, 50, 60, 70, and 80th. For pre-restoration, average %retention is assumed to be: creation=10th, restoration=20th, rehabilatation=40th, enhancement=60th, natural=80th. For post-restoration: created=40th, restoration=50th, rehabilatation=60th, enhancement=70th, natural=80th.
I consulted Table 9 from the 2016 WEP report and Attachment C to derive these values.
Wetland restoration is likely to perform nearly as well as a natural wetland because of the landscape positions in which they typically occur. Rehabilitation is likely to perform well, but the landscape position is much more variable - some will be receive high loads while others will not. Wetland enhancement varies based on what is being done, with some treatments not changing efficiency much and others potentially decreasing efficiency. Creation has the greatest potential for failure and may not be in a good landscape position.
I based my estimate of removal efficiency for natural wetlands on the bar graph provided in appendix C. I used values a little higher than what is represented on the bar graph assuming that not all wetlands used to create the graph were high-quality, natural wetlands. I had no basis to conclude that enhanced wetlands would perform better than natural wetlands, because enhancements may be targeted at achieving objectives other than N removal. I assumed that restored and rehabilitated wetlands would perform comparably, with both falling somewhat below the efficiencies for natural wetlands. Values for created wetlands were lowest and substantially lower than for natural wetlands because of doubts about the overall success rate for wetlands creation.
best prof. judgement
I reviewed all of attachment A and looked carefully through Attachment C before filling out the survey. In addition to the information provided, there is a lot of variability from site to site based on wetland type, wetland condition, landscape position, etc. so I do not have a high degree of confidence in my responses to the survey questions.

Q10 - For each of the above natural or BMP-treated conditions, how confident are you that your interval, from lowest to highest, captures the true average, annual efficiency of the natural or post-treatment wetland sites to reduce TN loads? See Attachment D for guidance on selecting a confidence value.

Editor's Note: Following guidance from Hemming et al (2018), panelists were instructed that their confidence should be >50%. If their confidence was below that level it would imply that they feel the truth is more likely to fall outside their provided interval, which is rarely what the expert actually believes. Therefore, responses for Q10, Q16 and Q22 are provided as % values between 50 and 100.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	70.00	80.00	76.10	3.73	10
2	Wetland Restoration	60.00	80.00	71.00	6.63	10
3	Wetland Creation	55.00	80.00	68.60	9.62	10
4	Wetland Rehabilitation	55.00	81.00	70.10	8.78	10
5	Wetland Enhancement	55.00	80.00	64.50	8.79	10

Q11 - Based on the sources of available information and your effort so far, realistically, what is your best guess for the average, annual performance of the pre-treatment site conditions to reduce total phosphorus loads for each BMP? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Wetland Restoration	-5.00	40.00	10.60	12.58	10
2	Wetland Creation	-50.00	15.00	-3.90	17.24	10
3	Wetland Rehabilitation	-15.00	30.00	11.50	12.36	10
4	Wetland Enhancement	-10.00	46.00	17.70	16.78	10

Q12 - Based on the sources of available information and your effort so far, realistically, what do you think the lowest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total phosphorus loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	-47.00	65.00	21.80	30.56	10
2	Wetland Restoration	-47.00	34.00	4.30	20.46	10
3	Wetland Creation	-47.00	25.00	0.30	18.60	10
4	Wetland Rehabilitation	-47.00	41.00	5.90	22.87	10
5	Wetland Enhancement	-47.00	55.00	12.00	25.96	10

Q13 - Based on the sources of available information and your effort so far, realistically, what do you think the highest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total phosphorus loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	22.00	100.00	73.60	22.26	10
2	Wetland Restoration	18.00	78.00	53.20	15.15	10
3	Wetland Creation	23.00	60.00	43.80	12.33	10
4	Wetland Rehabilitation	10.00	78.00	54.10	17.95	10
5	Wetland Enhancement	12.00	85.00	58.70	20.54	10

Q14 - Based on the sources of available information and your effort so far, realistically, what is your best guess of the average, annual performance of natural wetlands or the four wetland BMP types to reduce total phosphorus loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	15.00	80.00	52.70	18.88	10
2	Wetland Restoration	10.00	48.00	33.50	11.30	10
3	Wetland Creation	12.00	38.00	27.00	7.73	10
4	Wetland Rehabilitation	10.00	55.00	35.30	13.34	10
5	Wetland Enhancement	11.00	65.00	41.10	16.39	10

Q15 - Please provide any statement or information in support of any of the answers provided above (e.g., were there specific studies or resources you relied on; which specific conceptual model(s) from Attachment A - if any - did you rely on?). Comments should be concise and based on the evidence used to provide your responses. Comments may be shared anonymously with other expert assessors.

tba
Gebo and Brooks
WEP2016 report, combined with WEP2 lit review and discussions
Timescale could be important for development of hydric soils
I used the "Wetland Type Summary" database of N, P, and sediment retention from the literature. I then calculated for "N and TN", "P and TP", and all sediment %retentions the following percentiles: 10, 20, 40, 50, 60, 70, and 80th. For pre-restoration, average %retention is assumed to be: creation=10th, restoration=20th, rehabilatation=40th, enhancement=60th, natural=80th. For post-restoration: created=40th, restoration=50th, rehabilatation=60th, enhancement=70th, natural=80th. With a 10% range around mean
2016 WEP and Attachment C. Enhancement really depends on what function they are enhancing - vegetation enhancement by spraying phragmites can reduce water quality benefits; increased residence time can improve water quality benefits.
As with TN, some types of projects occur more often in good landscape positions to treat TP, while others are more variable, and creation has a greater chance of not being successful.
I based my estimate of removal efficiency for natural wetlands on the bar graph provided in appendix C. I used values a little higher than what is represented on the bar graph assuming that not all wetlands used to create the graph were high-quality, natural wetlands. I had no basis to conclude that enhanced wetlands would perform better than natural wetlands, because enhancements may be targeted at achieving objectives other than P removal. I assumed that restored and rehabilitated wetlands would perform comparably, with both falling

somewhat below the efficiencies for natural wetlands. Values for created wetlands were lowest and substantially lower than for natural wetlands because of doubts about the overall success rate for wetlands creation.

BPJ

I reviewed all of attachment A and looked carefully through Attachment C before filling out the survey. Phosphorus is challenging because it can be a sink and then become a source when there is substantial accumulation. In addition, there is a lot of variability from site to site based on wetland type, wetland condition, landscape position, etc. so I do not have a high degree of confidence in my responses to the survey questions.

Q16 - For each of the above natural or BMP-treated conditions, how confident are you that your interval, from lowest to highest, captures the true average, annual efficiency of the natural or post-treatment wetland sites to reduce TP loads? See Attachment D for guidance on selecting a confidence value.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	57.00	81.00	71.30	7.73	10
2	Wetland Restoration	60.00	80.00	69.50	6.50	10
3	Wetland Creation	55.00	81.00	65.60	9.85	10
4	Wetland Rehabilitation	55.00	80.00	65.70	8.57	10
5	Wetland Enhancement	55.00	80.00	63.20	8.84	10

Q17 - Based on the sources of available information and your effort so far, realistically, what is your best guess for the average, annual performance of the pre-treatment site conditions to reduce total sediment loads for each BMP? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Wetland Restoration	-5.00	44.00	14.30	16.14	10
2	Wetland Creation	-50.00	32.00	-1.30	20.88	10
3	Wetland Rehabilitation	-35.00	30.00	13.10	18.43	10
4	Wetland Enhancement	-15.00	52.00	22.30	19.37	10

Q18 - Based on the sources of available information and your effort so far, realistically, what do you think the lowest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total sediment loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	-30.00	78.00	31.30	30.49	10
2	Wetland Restoration	-30.00	50.00	13.00	22.01	10
3	Wetland Creation	-30.00	45.00	7.90	20.22	10
4	Wetland Rehabilitation	-30.00	55.00	14.90	23.39	10
5	Wetland Enhancement	-30.00	65.00	21.50	26.79	10

Q19 - Based on the sources of available information and your effort so far, realistically, what do you think the highest plausible, average, annual performance of natural wetlands or the four wetland BMP types to reduce total sediment loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	48.00	96.00	76.30	17.49	10
2	Wetland Restoration	26.00	91.00	53.50	19.42	10
3	Wetland Creation	14.00	87.00	45.80	19.71	10
4	Wetland Rehabilitation	20.00	93.00	55.40	19.12	10
5	Wetland Enhancement	21.00	95.00	61.60	20.93	10

Q20 - Based on the sources of available information and your effort so far, realistically, what is your best guess of the average, annual performance of natural wetlands or the four wetland BMP types to reduce total sediment loads entering the natural or post-treatment site? Please adjust the sliders below to provide your responses.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	31.00	85.00	59.40	19.62	10
2	Wetland Restoration	25.00	71.00	39.90	13.95	10
3	Wetland Creation	17.00	64.00	32.60	12.48	10
4	Wetland Rehabilitation	20.00	76.00	39.80	16.15	10
5	Wetland Enhancement	15.00	80.00	44.10	18.81	10

Q21 - Please provide any statement or information in support of any of the answers provided above (e.g., were there specific studies or resources you relied on; which specific conceptual model(s) from Attachment A - if any - did you rely on?). Comments should be concise and based on the evidence used to provide your responses. Comments may be shared anonymously with other expert assessors.

tba
Wardrop dissertation and unpublished data
WEP2016 report, combined with WEP2 lit review and discussions
I would expect that the range of high to low would be less for TSS as it is less complex of a process and does not involve chemical or biological processes
I used the "Wetland Type Summary" database of N, P, and sediment retention from the literature. I then calculated for "N and TN", "P and TP", and all sediment %retentions the following percentiles: 10, 20, 40, 50, 60, 70, and 80th. For pre-restoration, average %retention is assumed to be: creation=10th, restoration=20th, rehabilatation=40th, enhancement=60th, natural=80th. For post-restoration: created=40th, restoration=50th, rehabilatation=60th, enhancement=70th, natural=80th. With a 10% range around mean
same sources as before
As with TN and TP, related to landscape position and difference in locations of various BMPs.
I based my estimate of removal efficiency for natural wetlands on the bar graph provided in appendix C. I used values a little higher than what is represented on the bar graph assuming that not all wetlands used to create the graph were high-quality, natural wetlands. I had no basis to conclude that enhanced wetlands would perform better than natural wetlands, because enhancements may be targeted at achieving objectives other than TSS removal. I assumed that restored and rehabilitated wetlands would perform comparably, with both falling somewhat below the efficiencies for natural wetlands. Values for created wetlands were lowest and substantially lower than for natural wetlands because of doubts about the overall success rate for wetlands creation.

BPJ

I reviewed all of attachment A and looked carefully through Attachment C before filling out the survey. In addition to the information provided, there is a lot of variability from site to site based on wetland type, wetland condition, landscape position, etc. The location and morphology of a wetlands will be particularly important for retention of TSS. So, with all the variables from site to site, I do not have a high degree of confidence in my responses to the survey questions.

Q22 - For each of the above natural or BMP-treated conditions, how confident are you that your interval, from lowest to highest, captures the true average, annual efficiency of the natural or post-treatment wetland sites to reduce sediment loads? See Attachment D for guidance on selecting a confidence value.

#	Field	Minimum	Maximum	Mean	Std Deviation	Count
1	Natural wetland	65.00	85.00	73.00	6.40	10
2	Wetland Restoration	63.00	80.00	70.20	6.00	10
3	Wetland Creation	54.00	80.00	64.70	8.21	10
4	Wetland Rehabilitation	55.00	80.00	67.80	7.59	10
5	Wetland Enhancement	51.00	80.00	63.30	9.47	10

Q24 - Please provide responses to the best of your ability to identify the individual wetland techniques that are commonly associated with the four different wetland BMP types. A technique may apply to one or more of the BMPs, or none at all. Secondly, please identify to the best of your ability if you would classify the technique as 'simple', 'comprehensive', or 'both'. For the purposes of this survey, a simple technique is one that is typically used alone, to address a single wetland condition and/or function while a comprehensive technique is commonly used as part of a suite of techniques to address multiple wetland conditions. The implementation of the simple and/or comprehensive techniques should be evaluated with respect to their impact on a wetland BMP's water quality. Attachment B is provided for guidance. Please select all boxes below that apply, given your individual breadth of knowledge and experience.

Question	Restoration	#	Creation	#	Rehabilitation	#	Enhancement	#
Ditch plugs	32.00%	8	8.00%	2	20.00%	5	8.00%	2
Ditch fills	28.57%	8	10.71%	3	25.00%	7	7.14%	2
Low profile berms	24.14%	7	17.24%	5	17.24%	5	13.79%	4
Shallow excavation	15.38%	4	26.92%	7	11.54%	3	19.23%	5
Levee breach	23.08%	6	7.69%	2	26.92%	7	15.38%	4
Water control structures/weirs	14.81%	4	18.52%	5	25.93%	7	14.81%	4
Poly barrier/slurry wall	9.09%	1	27.27%	3	18.18%	2	0.00%	0
Grading ditch banks	20.00%	5	16.00%	4	24.00%	6	12.00%	3
Fill removal	25.93%	7	14.81%	4	22.22%	6	11.11%	3
Legacy sediment removal	26.09%	6	13.04%	3	21.74%	5	13.04%	3
Tile drainage plugs	29.17%	7	8.33%	2	20.83%	5	12.50%	3
Microtopography	14.29%	4	17.86%	5	21.43%	6	21.43%	6
Phragmites control	12.50%	3	12.50%	3	20.83%	5	25.00%	6
Woody vegetation control - pine removal	9.09%	2	13.64%	3	22.73%	5	22.73%	5
Woody veg. control - maple, gum, alders & invasive species	11.54%	3	11.54%	3	23.08%	6	26.92%	7
Tree and shrub planting	17.86%	5	17.86%	5	21.43%	6	17.86%	5
Grass and forb plantings	18.52%	5	18.52%	5	18.52%	5	18.52%	5
Soil decompaction	23.08%	6	15.38%	4	15.38%	4	15.38%	4

Question	Simple	#	Comprehensive	#	Both (Simple & Comprehensive)	#
Ditch plugs	8.00%	2	0.00%	0	24.00%	6
Ditch fills	3.57%	1	0.00%	0	25.00%	7
Low profile berms	0.00%	0	3.45%	1	24.14%	7
Shallow excavation	3.85%	1	3.85%	1	19.23%	5
Levee breach	7.69%	2	3.85%	1	15.38%	4
Water control structures/weirs	3.70%	1	3.70%	1	18.52%	5
Poly barrier/slurry wall	18.18%	2	9.09%	1	18.18%	2
Grading ditch banks	4.00%	1	8.00%	2	16.00%	4
Fill removal	0.00%	0	3.70%	1	22.22%	6
Legacy sediment removal	0.00%	0	4.35%	1	21.74%	5
Tile drainage plugs	4.17%	1	0.00%	0	25.00%	6
Microtopography	3.57%	1	10.71%	3	10.71%	3
Phragmites control	8.33%	2	8.33%	2	12.50%	3
Woody vegetation control - pine removal	4.55%	1	13.64%	3	13.64%	3
Woody veg. control - maple, gum, alders & invasive species	3.85%	1	3.85%	1	19.23%	5
Tree and shrub planting	3.57%	1	3.57%	1	17.86%	5
Grass and forb plantings	3.70%	1	3.70%	1	18.52%	5
Soil decompaction	7.69%	2	11.54%	3	11.54%	3

Editor’s Note: The final question (Q25) asked respondents for their confidence in each of their answers for Q24. The results from that question could not be reasonably summarized here. Q24 and Q25 were optional questions and had less than 10 responses. The responses helped to inform discussions that eventually built Table 13 in the report, but the quantified responses from Q24 and Q25 were not used directly in the way that the responses for TN, TP and TSS were.

Editor’s Note: Attachment A is provided in this report with minor updates as Appendix F. Attachments B-E are added on the subsequent pages for documentation/reference, with no updates aside from page numbers.

As part of the survey you will be asked to select which of the BMPs you feel are applicable to a given wetland management technique (you can select more than one if you feel the technique can be used as part of multiple BMPs, as defined for CBP purposes). You are then asked whether you think the technique is best described as “simple” or “comprehensive.”

Wetland Restoration BMP: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Hydric soils are present but a wetland does not exist on the site.

Wetland Creation BMP: The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site. Hydric soils are not present.

Wetland Rehabilitation BMP: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland. A wetland is physically present but there are multiple conditions within the wetland that are degraded.

Wetland Enhancement BMP: The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s). A wetland is present and functioning but not in an optimal state. Typically, one component of the wetland is addressed.

Simple: Basic or ‘quick fix’ to modify a single wetland component, typically implemented as a stand-alone technique.

Comprehensive: A comprehensive technique that has potential to affect more the one wetland component to return natural/historic wetland functions, and may be used in combination with other techniques.

Note: If a technique can be either Simple or Comprehensive depending on the site context, then select the 'Both (Simple and Comprehensive)' option for that technique in the survey.

Table B.1. List of Commonly Used Techniques to Implement Wetland BMPs (list provided by Expert Panel members Steve Strano, NRCS and Erin McLaughlin, MD DNR; expanded to reflect panel discussion and input)

	Restoration (Re-establish)	Rehab	Enhancement	Creation (establish)	Wetland Function or Process Designed to Improve
HYDROLOGY					
Ditch Plugs	X	X			Hydrology
Ditch Fills	X	X			Hydrology
Low profile berms	X			X	Hydrology
Shallow excavation	X			X	Hydrology - Used to impound water for emergent wetland, or to restore/establish wetland hydrology when blocking drainage is not feasible
Levee breach		X			Hydrology/Floodplain reconnection
Water control structures/weirs	X	X		X	In combination with embankments to control water level or provides safe outlet; or, within ditches to raise water level; or, within channelized streams to restore

					water surface profile, hydrology, floodplain reconnection
Poly barrier/slurry wall	X	X			Hydrology - Installed along tax ditches/large ditches to restore groundwater surface profile
Grading ditch banks	X	X			Hydrology, habitat - Convert steep banked ditch to shallow swale
Fill removal	X				Restore hydric soils and hydrology;
Legacy sediment removal	X				Excavate to historic wetland layer to restore hydric soils and hydrology
Tile drainage plugs	X				Restore hydrology
Microtopography			X		Provide diversity of hydroperiods and vegetation; create pit and mound topography
VEGETATION					
Phragmites control			X		Native vegetation
Woody veg control - pine removal			X		Restore native plant communities in pine plantations
Woody veg control - maple, gum, alders, and invasive species		X			Restore hydrology and vegetation
Tree and shrub plantings			X		Restore native plant communities
Grass and forb plantings	X				Restore native plants for early successional habitat
SOILS					
Soil decompaction					

ATTACHMENT C: TN, TP and TSS Reductions from Updated Database

The following document summarizes data contained in the WEP wetland database and is presented to act as a support tool to panelists as guidance for estimating wetlands performance. To date, five additional studies have been added to the database from the WEP literature review completed this past March, and one study and one data point has been excluded from analyses. The resulting TN, TP and TSS removal rates for all wetlands except constructed wetlands are presented here, along with a more detailed description of the changes to the database and the summaries presented. The database includes studies for both natural wetlands and wetland BMPs and wetlands within and outside of the Chesapeake Bay watershed. The majority of the data entries to estimate the percent efficiency is based on a loads, while there are a few studies that just report concentration for the parameters of interest (nitrogen, phosphorus and sediment). The WEP (2016) report provides a more detailed description of the database (see page 53, Table 9 of the report).

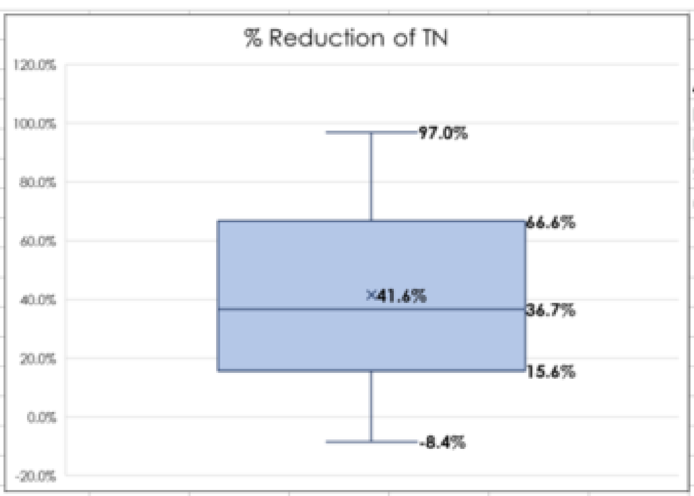
<u>Removal Rates and Basic Statistics</u>

The mean removal rates presented in Table 1 represent all studies in the database that were not identified as Constructed Wetlands, and that calculated some measure of Total Nitrogen, Total Phosphorus, or Total Sediment (or Total Suspended Solids). More detailed summary statistics and Box Plots are included in Figures 1-3 to include the range, median (50th percentile), 25th and 75th percentile efficiencies.

Table 1. Mean Efficiencies for Non-Constructed Wetlands in the Wetland Expert Panel Database

Parameter	Removal Percentage
Nitrogen	41.6%
Phosphorus	37.5%
Sediment	33.8%

Figure 1. Summary Statistics for TN Removal



% Reduction of Total Nitrogen (TN)	
Metric	Value
Average	41.6%
Minimum	-8.4%
Maximum	97.0%
Standard Deviation	0.316
Count	40

Figure 2. Summary Statistics for TP Removal

% Reduction of Total Phosphorus (TP)

Metric	Value
Average	37.5%
Minimum	-46.5%
Maximum	98.4%
Standard Deviation	0.336
Count	61.00

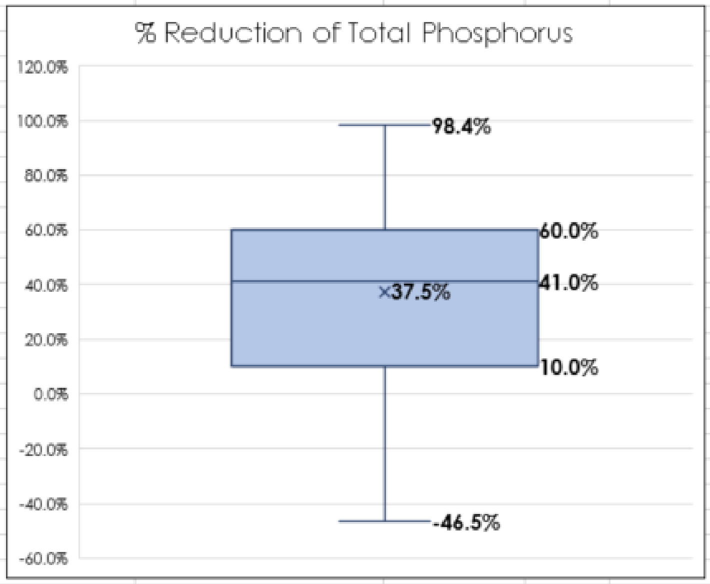
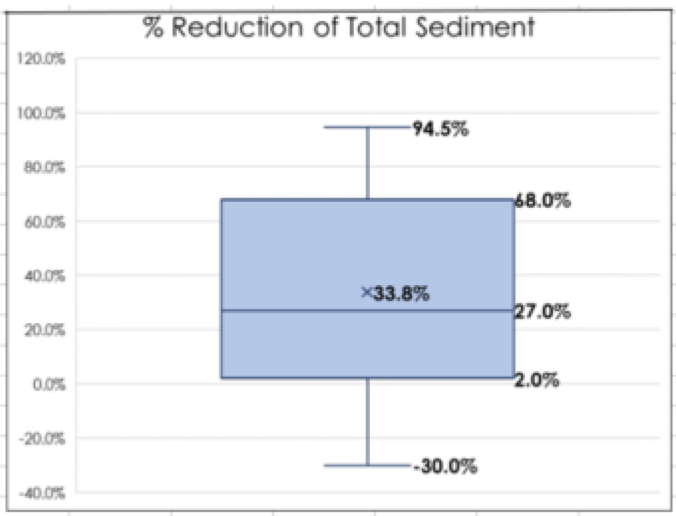


Figure 3. Summary Statistics for TSS Removal



% Reduction of Total Suspended Sediment (TSS)

Metric	Value
Metric	Value
Average	33.8%
Minimum	-30.0%
Maximum	0.945
Standard Deviation	0.367829567
Count	19

Chemical Constituents included in Summary Data

Data reported in the above plots were restricted to measures of Total Nitrogen, Total Phosphorus or Total Suspended Sediment as certain forms of these parameters have different removal rates. For example, Soluble Reactive Phosphorus (SRP) typically has much lower removal rates than Total Phosphorus. The parameters included in the data in figures 1—3 and Table 1 are summarized in Table 2.

Table 2. Parameters Included in Summary Data	
Parameter	**Measured or Reported Parameter**
Nitrogen	TN, N
Phosphorus	TP, Total PO_4-P, PO_4-P
Sediment	TSS, Suspended Solids, Total Solids, Total Suspended Sediment

Studies Added and Removed

The following studies have been added to the database to date:

Doherty, J. M., J. R. Miller, S. C. Prellwitz, A.M. Thompson, S. P Loheide II, J. B. Zadler. 2014. Hydrologic regimes revealed bundles and tradeoffs among six wetland services. Ecosystems, 17:1026-1039.

Gumiero, B., J. Mant, T. Hein, J. Elso and B. Boz. 2013. Linking the restoration of rivers and riparian zones/wetlands in Europe: sharing knowledge through case studies. Ecological Engineering, 56:36-50.

Kreiling, R. M and W. Richardson. 2014. Wetland management reduces sediment and nutrient loads on the Upper Mississippi.

Land, W., W. Graneli, A. Grimwall, C. Hoffman, W. Mitsch, K. Tondersi and J. Verhoeven. 2016. How effective are created or restored freshwater wetlands for nitrogen and phosphorus removal? A systematic review

Mitsch, W., J. Zhang, E. Waletzko and B. Bernal. 2014. Validation of the ecosystem services of created wetlands: Two decades of plant succession, nutrient retention, and carbon sequestration in experimental riverine marshes.

We removed data from the following reference, which was originally in the database as there was an update to the study provided in Mitsch et al 2014.

Mitsch, W. J., L. Zhang et al 2012. Creating wetlands: Primary succession, water quality changes and self-design over 15 years. BioScience, 62(3); 237-250. DOI: 10.1525/bio.2012.62.3.5

In addition, we removed one data point from the WEP 2016 database taken from the following summary article:

Ardón, M., Morse, J.L., Doyle, M.W., Bernhardt, E.S. 2010. The Water Quality Consquences of Restoring Wetland Hydrology to a Large Agricultural Watershed in the Southeastern Coastal Plain. Ecosystems (2010) 13: 1060. https://doi.org/10.1007/s10021-010-9374-x

The data point removed was for a single wetland in the Everglades, which reported greater than 100% removal for some parameters. On closer examination, it appeared that the methodology used to determine efficiencies in this particular study was highly suspect.

<u>Additional Data</u>

The complete database, divided into separate spreadsheets for Nitrogen, Phosphorus, and Sediment may be made available on October 17, upon request or by downloading it directly from the Sharepoint site. In addition to the summaries presented above, the database includes data for additional forms of N, P and S, as well as queries for different types of wetlands, vegetation, and regions.

Attachment D – Guidance for Assigning Percent Confidence Level

- **50-59%** confident that the interval is about as likely as not to contain the true annual average
- **60-69%** confident that the interval is fairly likely to contain the true annual average
- **70-79%** confident that the interval is likely to contain the true annual average
- **80-89%** confident that the interval is highly likely to contain the true annual average
- **90-95%** confident that the interval is very likely to contain the true annual average
- **96-100%** confident that the interval is virtually certain to contain the true annual average

Attachment E

The Round 2 survey questions will solicit responses about your best guess for the "pre-treatment performance" or baseline to help clarify individual responses on wetland BMP performance. The results in Round 1 did not necessarily reflect a common understanding of how efficiency was interpreted and the relationship between a natural wetland performance and a wetland BMP. For example, responses may have reflected a "net efficiency change" or the "post-treatment performance". Consequently, the results entered in Round 1 would differ as shown in the table below.

For Round 2, we ask you to provide a percent reduction for both "pre-treatment" and "post treatment" that represents the absolute pollutant load reduction given either scenario (yellow and green highlighted cells, respectively).

Example:
What we are asking for in Round 2:
Yellow and green highlighted responses provided by the example respondents are in absolute terms, i.e., the percent reduction based on input and export of pollutant load on an average, annual basis. If desired, we can use survey responses to calculate a net change (pink cells), but you do not provide that information directly as an answer.

What we are <u>not</u> asking for in Round 2:
When formulating your responses, please do not provide responses that are calculated based on a relative measure to another wetland BMP or natural wetland.

Table 1. Example responses for the performance of wetland restoration BMP, pre- and post-treatment (best guess), TN

Survey respondent	Pre-treatment performance	"Best Guess" Post-treatment performance	Net efficiency change
1	20	40	20
2	5	25	20
3	40	60	20

Table 2. Example responses for the performance of a natural wetland (best guess, TN).

Survey respondent	Existing high-functioning natural wetland condition
1	50
2	25
3	40

Appendix H. Application of the Riparia database analysis to estimate TN, TP and TSS efficiencies

Editor's note: this was originally a handout provided to the panel prior to its May 2019 conference call. Only minor edits (e.g., table/figure numbers) were made when updating it for the panel's report as Appendix H.

This document provides a description of the multiple data sources/lines of evidence available to the Panel to inform efficiency values for the three wetland BMPs (creation, rehabilitation and enhancement). The panel has considered the water quality benefits of natural wetland and restoration wetlands to provide context for assigned efficiency values for the three BMPs. There are four parts to the document as follows:

- Lines of Evidence for Efficiency Values
- Data to support preliminary values for efficiency
- Proposed Method
- Sensitivity to Assumptions

1. Lines of Evidence for Efficiency Values

Error! Reference source not found. attempts to summarize the panel's primary sources and lines of evidence, including a description of how to interpret the efficiency value(s) in the right-hand column. Conceptual models are not included here, as the present concern is only for lines of evidence that deal with numeric efficiencies or related values.

Table H-1 – Summary of and Relationship Between Sources' Efficiency values

Source	What efficiency value(s) emerged	Short summary of method (if completed) or issue (if currently part of panel discussions)	Translation or relation to other sources or line of evidence
WEP 2016	Recommended 42% TN, 40% TP and 31% TSS efficiency values for **wetland restoration**, applied to varying ratios of upland acres based on landscape position and HGMR	The efficiency value was derived from literature values of non-constructed wetlands (included sites whether they were natural, or "restored" in some way). The values likely reflected differences between the input loads and output loads of the sites from the sources cited in the literature.	In relation to the Expert Elicitation survey, the literature-derived efficiency values are similar to the "post-treatment" efficiency values, reflecting the difference between input and output loads for the final site conditions. A net change efficiency was not used in this case.
Expert elicitation survey results	Round Two responses included best guess values for pre- and post-treatment conditions for the BMP categories, which allowed calculation of a "net efficiency" or net change value from pre- to post-treatment conditions	The panel was not comfortable using the survey results as a primary source given the individual panel member's interpretation of the questions (post construction vs net efficiency). There was a lot of uncertainty about the pre-treatment values, and less variability on post-construction efficiency values. The Panel found it agreeable to use the results in combination with other lines of evidence.	The survey essentially asked for the estimated efficiency values of a site under both baseline (pre-treatment) and a BMP-condition (post treatment), allowing calculation of the net change in efficiency – for each BMP category. The net efficiency change reflects the improvement in those efficiencies due to the management action.
Updated/ current lit review	The 2016 literature database was updated with studies reviewed by Panel members. The database allows to separate natural and BMP-wetland sites. Provides a range/quantiles of efficiency values. The updated literature review result in a change in the median, average values compared to the 2016 literature review.	The panel can now distinguish studies for natural and BMP wetland sites. Efficiency values reported in literature, as above, reflect difference between input and output loads post-construction	It remains difficult to distinguish specific interventions or techniques studied in the literature and relate those to the four wetland BMP categories
Riparia data analysis	Data provided for reference, reference standard and created wetlands in the Commonwealth of PA using an HGM field protocol. Values represent "Functional Assessment Model"scores of 0-1 for HGM classified wetlands, not efficiency values.	Use and application of this analysis is currently under panel discussion.	This line of evidence does not provide efficiency values, but it provides information to distinguish amongst wetland types that may relate to efficiency values following development of analytical methods.

Phase 6 Chesapeake Bay Watershed Model	16.75% TN, 32.18% TP and 9.82% TSS efficiency values are in place for the wetland creation, rehabilitation and enhancement BMPs until/unless this panel recommends otherwise. Wetland creation is also a land use change.	The old Phase 5.3.2 "wetland restoration" efficiency values and 1:1 upland acre ratio were approved for the Phase 6 CBWM until another panel recommends otherwise.	The panel expressed unanimous support against this status quo for the wetland creation, rehabilitation and enhancement BMPs. Panel may consider this as supporting evidence but not as a primary source or method.

Based on feedback from a survey and discussion at the March 4th meeting, the Panel reached a general agreement to use the Literature Review as a starting point to quantify the retention efficiencies for the three wetland BMPs and include the restoration wetland BMP for additional context. Additional data sources described in **Error! Reference source not found.** may be used to refine these initial values. For example, panel member, Denice Wardrop provided an analysis of the Riparia and the Pennsylvania Created Wetlands data to estimate and differentiate the relative water quality functions of natural and created wetlands in the Commonwealth of Pennsylvania. A method is proposed using these two data sources to provide preliminary pollutant retention efficiencies for the three wetland BMPs. A description of the two key data sources is provided below.

2. Data to Support Preliminary Efficiency Values

Literature Review (Updated database)

The results of the literature from 2016 Wetlands Expert Panel (WEP16) was used to assign TN, TP and TSS retention efficiencies to the wetland restoration BMP. Table 9 in the WEP16 report summarizes the results. The current WEP completed a literature review to update the previous panel's work and resulted in the addition of eight additional studies to the database. These eight studies were reviewed by the Center to ensure they were relevant and did not duplicate any previous entries. These studies were used to update Table 9 in the WEP16 report and is presented in **Error! Reference source not found.** below.

Table H-2. Summary of literature review to update WEP16 Table 9. (n= number of studies)

Wetland Type	Vegetation Type	TN % Reduction	TP % Reduction	TSS % Reduction
Headwater/Depressional	All	31.0% (10)	18.8% (16)	28.3% (6)
Floodplain	All	43.8% (22)	26.2% (15)	37.1% (11)
All except constructed	Forest, mixed, and unknown	45.1% (21)	44.4% (45)	37.3% (11)
All except constructed	Emergent	38.8% (22)	18.6% (16)	29.7% (8)
All	All	37.7% (57)	37.6% (88)	43.6% (24)
Chesapeake Bay only	All	26.0% (12)	23.9% (14)	24.4% (8)

All except constructed	All	40.7% (40)	37.6% (61)	34.1% (19)

The data from the literature were further analyzed to separate retention efficiencies for natural and wetland BMPs; constructed wetlands were not included. Appendix A provides the results with a summary in Table H-3.

Table H-3. Average Retention Efficiencies (%) for Natural and Wetland BMPs from the Literature Review, (n= number of studies)

Wetland Type	TN (%)	TP (%)	TSS (%)
Natural wetlands	45 (15)	42 (17)	n/a
Wetland BMPs	39 (21)	42 (46)	43 (12) | 36 (10)[1]

[1] The average TSS percent reduction from all studies in the literature review database is 36%. The analysis was repeated using this value to adjust the TSS retention efficiency values.

Riparia and Created Wetlands Data

The Riparia Reference Wetland Database (herein referred to as PA Reference or Riparia) (Brooks et al., 2016) consists of 222 natural wetland sites that were originally established during the period of 1993-2003; many have been re-sampled on a 10-year interval since then. The uses of the dataset, background on its formation, and definitions of terms can be found in Brooks et al. (2016). The Pennsylvania Created Wetlands Dataset (herein referred to as Created) is the result of a research project by Naomi Gebo, and the majority of the sites (72) in the database are detailed in Gebo and Brooks (2012); this study compared created wetland sites to the natural wetlands contained in the aforementioned database (additional sites were subsequently added to the database).These datasets contain values across three sampling protocols, termed Level 1, 2, and 3. Level 1 is a Landscape Assessment, which characterizes land cover parameters surrounding the site and can give a rough approximation of expected condition of the site based on these parameters. Level 2 is termed a Rapid Assessment, and supplements the Level 1 assessment with a short field visit that obtains data on the presence of various stressors of the site (e.g., evidence of eutrophication, sedimentation, invasive plants) and buffer characteristics. Level 3 involves a detailed field assessment that obtains information required to estimate various condition indicators (e.g., Floristic Quality Assessment Index, Plant-based Index of Biotic Integrity) and a suite of Hydrogeomorphic (HGM) Functional Assessments. The datasets are presented in Table H-4; the data was obtained under various US EPA grant programs, and is considered to be publicly-available.

Table H-4. Datasets Used in the Analysis.

Database	Classification System	Level 1 Landscape Assessment	Level 2 Stressor Checklist and Buffer Characterization	Level 3 Intensive Condition and HGM Functional Assessment	Comments
PA Reference Sites (n=222)	HGM	Available	Available	Available	Includes Reference Standard sites in each category of ecoregion/HGM class
PA Created Wetlands (n=120)	HGM	Available	Available	Available	Sampled in 2007/2008; sites ranged in age from 3 to 17 years since construction

Classification System

Both the PA Reference and Created Sites utilize the Hydrogeomorphic System classification. Brinson's (1993) HGM classification system looked to properties of geomorphic setting, water source, and hydrodynamics to derive a set of classes of wetlands associated with their ecological functions. Not all wetlands provide the same functions or to the same level (e.g., wetlands in a floodplain setting provide storage of flood waters, while slope wetlands, which by Brinson's definition do not have contours that create a basin, do not). As stated above, HGM classification describes an approach to classifying wetlands that aids in distinguishing the functions that each type can perform and in the identification of the potential effects of anthropogenic disturbance. For purposes of this exercise, we concentrate on three major HGM classes: Riverine (wetlands located along 4th order or greater streams/rivers), Headwater (wetlands occurring in the riparian areas on up to 3rd order streams), and Isolated Depressions. Fringing wetlands (those wetlands located on lakes and ponds) are excluded from the analysis.

Reference, Reference Standard, and Created

The PA Reference Sites are composed of natural wetlands that cover the full range of condition and level of anthropogenic disturbance. A subset of sites is designated as Reference Standard; Reference Standard refers to conditions at the least, or minimally, impacted sites, thereby providing the potential to develop a quantitative description of the best available chemical, physical, and biological conditions in the wetland resource given the current state of the landscape. This conceptual framework and family of definitions is adaptable to any wetland type in any geographic setting; for example, a Reference Standard can be developed for Riverine wetlands in the Piedmont ecoregion. The PA Reference Sites were decomposed into two groups for analysis: Reference Standard (i.e., least impacted) and Reference (all remaining sites).

Water Quality Functions

For this analysis, we are concentrating on the HGM water quality functions F5, F6, F7. The results of the complete analysis are provided in Appendix B. As an expanded example, the model for F5, Removal of Inorganic Nitrogen, is shown below:

Removal of Inorganic Nitrogen
$(V_{REDOX} + V_{BIOMASS} + V_{ORGMAT})/3$

Where:
V_{REDOX}: Redoximorphic status of upper soil profile based on mottle and matrix chromas
$V_{BIOMASS}$: Cover of trees, shrubs, and herbs
V_{ORGMAT}: % organic content in the top 5 cm of soil determined by combustion
All variables are data collected in the field.

The remaining models are as follows.

Solute Adsorption Capacity (F6)
$[(V_{FLOODPL} * 0.67) + (V_{ALTFLOODPL} * 0.33)] *$
$[(V_{REDOX}+V_{ROUGH}+V_{MACROTOPO})/3 + V_{ORGMAT}+$
$V_{SOILTEX})/2]/2$

Retention of Inorganic Particulates (F7)
$[(V_{FLOODPL} * 0.67) + (V_{ALTFLOODPL} * 0.33)] * [(V_{ROUGH} +$
$V_{MACROTOPO} + V_{GRAD})]/3$

The following figures provide a summary of how the HGM scores compare in different wetland settings (i.e., floodplain, headwaters and isolated depression).

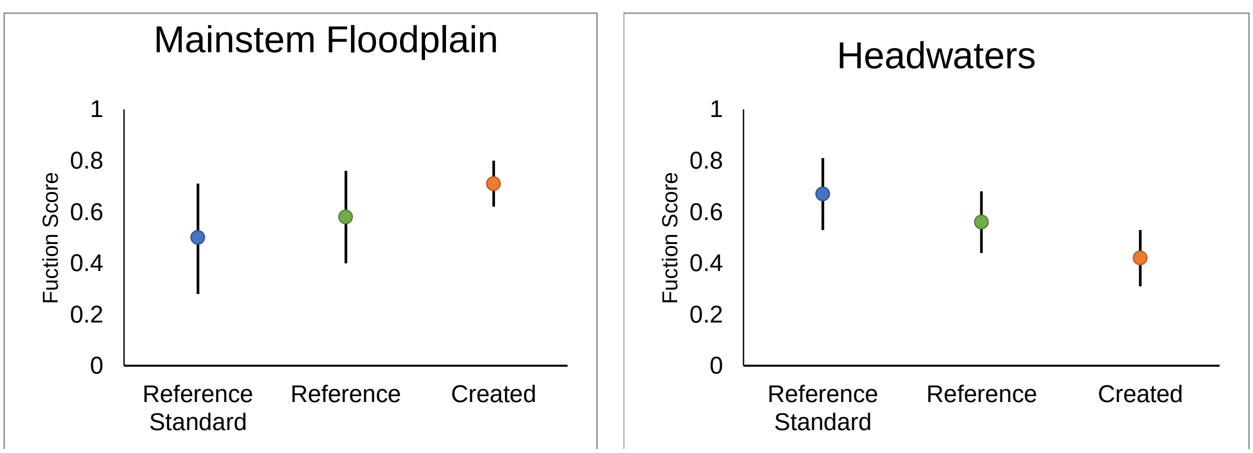


Figure H-1. HGM Scores (Mean with SD Ranges) for Score F5: Inorganic Nitrogen

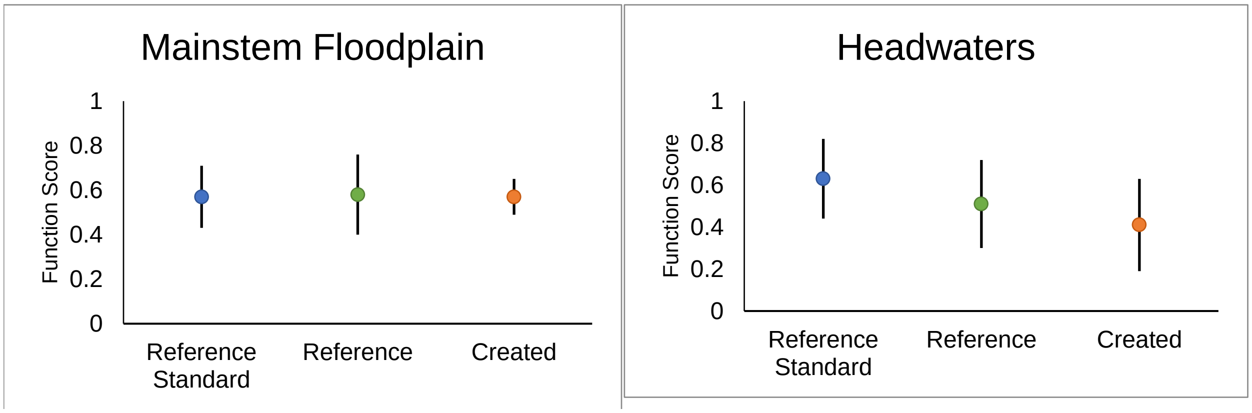


Figure H-2. HGM Scores (Mean with SD Ranges) for Score F6: Solute Absorption

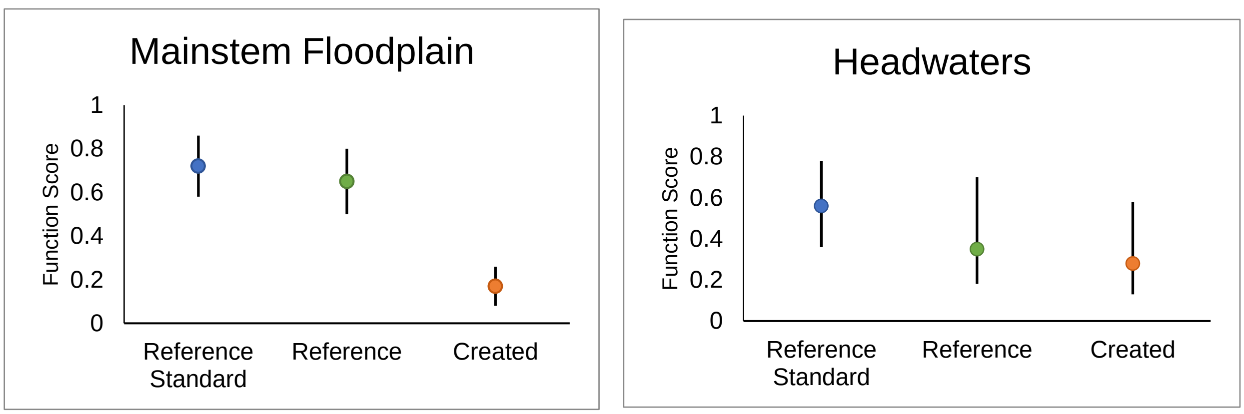


Figure H-3. HGM Scores (Mean with SD Ranges) for Score F7: Retention of Inorganic Particulates

3. Proposed Method

The following outlines a method for using the HGM Scores (using the Headwaters setting as the example) combined with the wetlands literature review database to estimate removal efficiencies. The method uses the scores to represent a percentile among the Wetland Database efficiencies.

To facilitate this analysis, a set of assumptions and a definition of net efficiency was applied.

1. The scores for the Reference wetlands in the Riparia database are representative of post-construction BMP wetland conditions for restoration and rehabilitation. Both wetland BMPs have similar outcomes according to the Chesapeake Bay definitions, where a restoration and rehabilitated wetland should result in the return or repair of wetland functions similar to a historic or natural wetland, respectively. As such, **Error! Reference source not found.** presents the following wetland conditions assigned for the purposes of method development.

Table H-5. Wetland condition assigned to wetlands in the Riparia database.

Wetland type	**Description**	**Condition**
Reference Standard	Existing wetlands in forested settings	Natural, undisturbed wetland
Reference	Existing wetlands in agricultural or urban settings	Approximate water quality functions of a restored or rehabilitated wetland
Created	Created wetlands	Created wetlands

2. The mean scores (0-1) represented by each wetland type are used to scale efficiency values between wetland types.
3. The results using the Headwater Wetlands category are used in the analysis, as these wetlands are predominant in Pennsylvania, where the Riparia data originate from.
4. A net efficiency definition is used, where it is assumed that a restoration and created wetland have a pre-treatment of "0" as there is no wetland present. For the Pre-BMP Condition for Rehabilitation, we assume that the score is equivalent to the 10^{th} percentile for Reference Wetlands. This was based on best professional judgement given the distribution of the Riparia data and a first estimation.

Error! Reference source not found. provides a summary of the data used for the Headwater Wetlands from analysis provided by Denice Wardrop.

Table H-6. Mean Scores from the HGM Functional Assessment Models for Headwater Wetlands for Each Wetland Type

Wetland Type	**Wetland BMP State Represented**	**Scores (Headwater Wetlands)**		
		F5. Inorganic Nitrogen	**F6. Solute Adsorption**	**F7. Inorganic Particulates**
Reference	Post-BMP for Rehabilitation and Restoration	0.56	0.51	0.50
Created	Created	0.42	0.41	0.38
10^{th} percentile for Reference Wetlands[1]	Pre-BMP Condition for Rehabilitation	0.41	0.24	0.24
1: This value is estimated assuming a normal distribution, and the mean and standard deviation provided for each score.				

Scaling Factor Method

In this approach, the scores from the HGM Functional Assessment Models (the HGM scores) are used to represent the ratio of performance for each wetland condition. Using this approach, the efficiency for any condition is calculated using the following equation:

$$E = E_{base} \times F$$

Where:

E = Efficiency for a particular wetland state and pollutant

E_{base} = "Base" efficiency represented as the mean value for wetland BMPs (from Table 2)

F = Factor used to scale the efficiency (derived from HGM Scores)

As a first step, we derive individual F values for each HGM score, assuming that:

1) The Scaling Factor for Reference Values is 1.0, since the efficiency for this condition is equivalent to the mean efficiency from the wetlands database. That is, the efficiency value from the literature review database from Table H-2 is multiplied by 1.
2) Other scaling factors are calculated by determining the ratios of the score for a particular condition relative to the reference value.

As an example calculation, the Efficiency Ratio for F5 for Created wetlands is calculated as:

$F_{F5\text{-}Created}$ = (F5 HGM Score for Created) /(F5 HGM Score for Reference)

= 0.42 /0.56

= 0.75

The resulting scaling Factors (Table H-7) begin to indicate the relative condition for each wetland state. Although the factors for each score are relatively similar across each wetland type, there are some distinctions. For example, the F5 scaling factor for the Pre-BMP Condition for Rehabilitation (0.72) is much higher than the ratio for other factors (0.47-0.48).

Table H-7. Scaling Factors (F) for HGM Scores

Wetland Type	**Wetland BMP State Represented**	**Scores**		
		F5. Inorganic Nitrogen	**F6. Solute Adsorption**	**F7. Inorganic Particulates**
Reference	*Post-BMP for Rehabilitation and Restoration*	*1.00*	*1.00*	*1.00*
Created	*Created*	*0.75*	*0.80*	*0.76*
10th percentile for Reference Wetlands	*Pre-BMP Condition for Rehabilitation*	*0.72*	*0.47*	*0.48*

The scaling factors (F) in Table H-7 can then be used to estimate a composite or average factor for each chemical parameter. Since each score represents a different wetland function, we represent the performance for each chemical parameter using a different set of scores, as follows:

- TN is the average of F5 (Inorganic Nitrogen Retention) and F7 (Inorganic Particulate Retention)
- TP is the average of F6 (Solute Adsorption) and F7 (Inorganic Particulate Retention)
- TSS is F7 (Inorganic Particulate Retention)

The resulting average ratios are presented in Table H-8. As indicated in the table, we generally see similar scaling factors across different parameters, except for an elevated scaling factor (0.60) for TN for the Pre-BMP condition for Rehabilitation, compared with 0.48 for TP and TSS for the same condition.

Table H-8. Efficiency Scaling Factors for Each Chemical Parameter

Wetland BMP State Represented	**Parameter**		
	TN	**TP**	**TSS**
Post-BMP for Rehabilitation and Restoration	*1.00*	*1.00*	*1.00*
Created	*0.78*	*0.78*	*0.76*
Pre-BMP Condition for Rehabilitation	*0.60*	*0.48*	*0.48*

Next, these ratios can be translated into efficiencies, using the mean values from the wetland literature database to represent the mean efficiencies for the Post-Restoration/Rehabilitation condition. Each other efficiency can then be determined using the multipliers in Table H-8.

For example:

- The Mean TN for non-natural wetlands from the wetland literature review database is 39%.
- The ratio to convert to a Created wetland efficiency is 0.78

Calculate the TN removal for created wetlands as: 0.78*39% = 30.42% (use 30%)

For Rehabilitation, we assume that the rehabilitation efficiency is the difference between the Post-BMP and Pre-BMP condition. For example, the TN efficiency would be calculated by the following:

- The Mean TN for non-natural wetlands from the wetland literature review database is 39%.
- The ratio for a Pre-BMP Condition is 0.60

Calculate the TN removal for rehabilitation as: 39%*(1-0.60) = 15.6% (use 16%)

The Resulting efficiencies are presented in Table H-9.

Table H-9. Estimated Wetlands Efficiencies Using Scaling Factors

	Wetland BMP Efficiency	**Parameter**		
		TN	**TP**	**TSS**
Restoration[1] **Mean from our literature review database**	*Pre-Restoration*	0%	0%	0%
	Post-Restoration	39%	42%	43%
	Lift	39%	42%	43%
Creation	*Pre-Creation*	0%	0%	0%
	Post-Creation Riparia Scaling of restored efficiency (ratio of Created to Reference)	30%	33%	35%
	Lift:	30%	33%	35%
Rehabilitation	*Pre-Rehabilitation* *Riparia Scaling (ratio of 10th percentile Reference to Mean of Reference)*	23%	20%	20%
	Post-Rehabilitation	39%	42%	43%
	Lift	16%	22%	23%

1: Note that these efficiencies are derived from the updated literature review database and are not the same as those used in the Watershed Model.

4. Sensitivity to Assumptions

Some of the assumptions made for this analysis may alter the estimated efficiency (i.e., the lift). Two that panel members expressed concern about include:

1) The representation of Rehabilitation (i.e., using the 10th percentile of reference for pre-BMP and the Mean of reference for post-BMP).
2) Using Headwaters wetlands to represent the overall wetland condition.

Assumption 1: Representing Rehabilitation

To address panel member concerns regarding how to estimate the Pre-BMP and Post-BMP efficiencies for Rehabilitation, we evaluated the potential impacts of alternative assumptions. We evaluated the effect of using different percentiles of the reference wetlands for the pre- and post-treatment condition. We used the 25th percentile and 75th percentile values for the pre- and post- condition, respectively, with resulting HGM scores presented in Table H-10. Using the same process as described in Section 3, the resulting removal percentages for each condition would vary based on the underlying assumptions (Table H-11).

Table H-10. Riparia Scores Using Alternative Assumptions for Rehabilitation

Wetland Type[1]	**Wetland BMP State Potentially Represented**	**Scores (Headwater Wetlands)**		
		F5. Inorganic Nitrogen	**F6. Solute Adsorption**	**F7. Inorganic Particulates**
Reference	Post-BMP for Rehabilitation	0.56	0.51	0.50
75th Percentile		0.64	0.65	0.63
10th percentile	Pre-BMP Condition for Rehabilitation	0.41	0.24	0.24
25th Percentile		0.48	0.37	0.37
1: Percentiles estimated assuming a normal distribution, and the mean and standard deviation provided for each score.				

Table H-11. Resulting Percent Pollutant Removal for Rehabilitation Using Alternative Assumptions for the Pre- and Post-Wetland Condition (this does not express the "net improvement" or "lift")

Wetland Type[1]	Wetland BMP State Potentially Represented	Removal Efficiency		
		TN	TP	TSS
Reference	Post-BMP for Rehabilitation and Restoration	39%	42%	43%
75th Percentile		47%	53%	55%
10th percentile	Pre-BMP Condition for Rehabilitation	23%	20%	20%
25th Percentile		31%	33%	35%
1: Percentiles estimated assuming a normal distribution, and the mean and standard deviation provided for each score.				

The resulting lift will vary depending on how these assumptions are combined. As illustrated in Figure H-4, the lift is quite different when the extreme assumptions (in either condition) are made. For example, by assuming that Rehabilitation increases performance from a very degraded (10th percentile) wetland to a highly functioning (75th percentile), it would result in a 24% lift for TN, compared with the 16% estimated using our "baseline" assumption of an increase from the 10th percentile to the Reference Mean. However, when we compare the two more moderate assumptions (i.e., increasing from the 10th percentile to the mean, or increasing from the 25th percentile to the 75th percentile), there is almost no difference, in that the calculated lift is within 1% regardless of the method used.

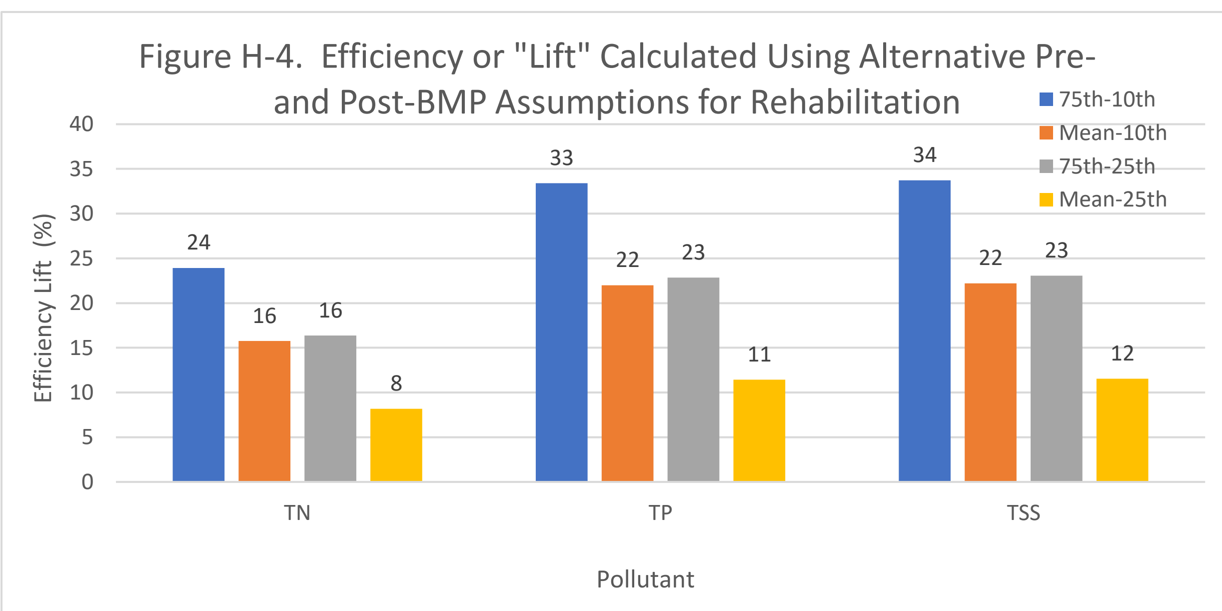
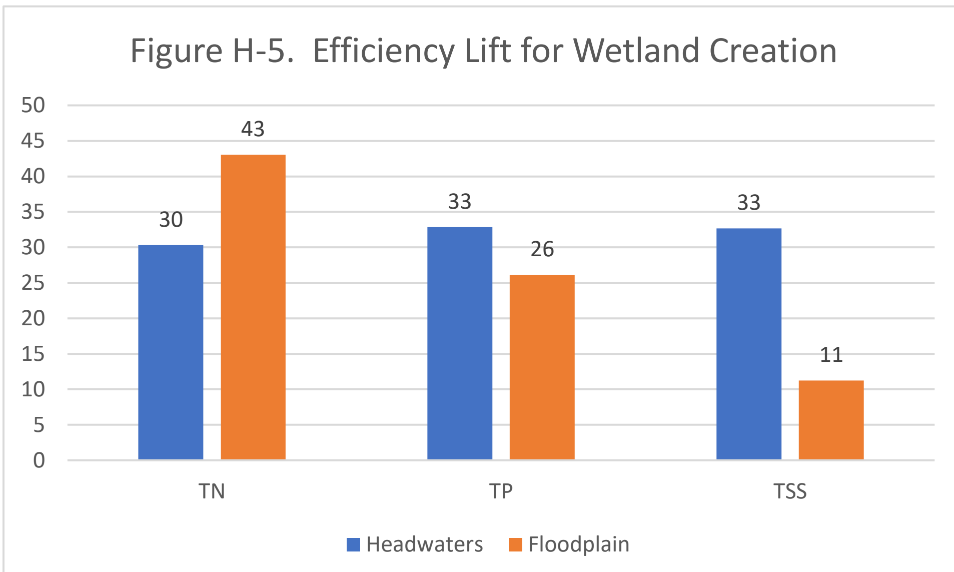
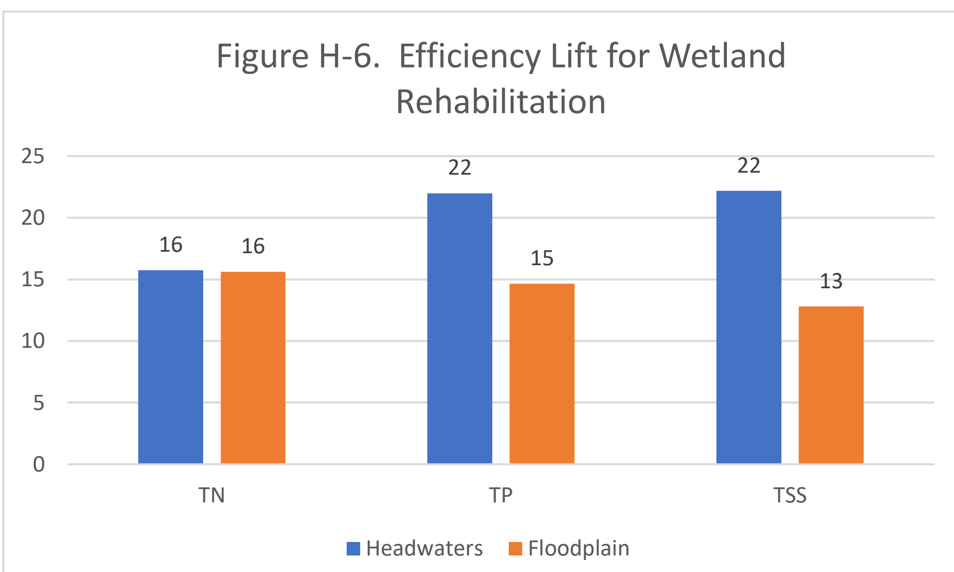


Figure H-4. Efficiency or "Lift" Calculated Using Alternative Pre- and Post-BMP Assumptions for Rehabilitation

Assumption 2: Use of Headwaters Data

The Riparia dataset includes both Headwaters and Floodplain wetlands. In developing our efficiency methods, we chose to use Headwaters wetlands to reflect the conditions of wetlands at various states. Since this dataset is from Pennsylvania, where the great majority of wetlands were in the headwaters, it was determined that these values may be a more representative depiction of performance. However, this assumption did result in different efficiency values than we would have calculated using headwater calculations. For wetland creation, the estimated efficiency ranges from 30% and 33% depending on the pollutant using headwater wetlands, but the efficiency ranges from about 11% for TSS up to 43% for TN using floodplain data (Figure H-5). The results between the two datasets are more similar for wetland rehabilitation. Using the headwaters data, the efficiency is 16% for TN, and 22% for TP and TSS. When using the floodplain data, the TN efficiency is still 16%, but the TP and TSS efficiencies are 15% and 13%, respectively (Figure H-6).





Appendix I – Compilation of partnership feedback and responses on the draft report

The draft report was posted on July 10, 2019 and subsequently distributed to the Water Quality GIT, Habitat GIT, Wetland Workgroup, Agriculture Workgroup, Urban Stormwater Workgroup, Watershed Technical Workgroup and CBP Advisory Committees (STAC, CAC and LGAC) for review and feedback. A "recommendations roll-out" webcast was hosted on July 31 detailing the panel's recommendations. The webcast recording and other materials are available on the corresponding CBP calendar entry: https://www.chesapeakebay.net/what/event/wetland_bmp_expert_panel_recommendations_roll_out_webcast

Feedback on the draft report was requested by COB August 15. Under the BMP Protocol, the Panel Chair (Neely Law) and Panel Coordinator (Jeremy Hanson) worked to compile the feedback and respond on the panel's behalf. The panel would be consulted in the event that partnership feedback would involve substantive changes to the panel's conclusions or recommendations. To date (September 3, 2019), there were no revisions that required the full panel's input.

Name of commenter (affiliation)	**Section or page reference, if provided**	**Comment or suggested change**	**Response from Panel Chair and Panel Coordinator**
Karen Coffman		(during webcast) Would this BMP be available to the urban sector for load reductions?	The panel's efforts were focused on *voluntary* wetland practices that are historically applied within agricultural settings, as those areas offer the greatest acreage of prior-converted or degraded wetlands. There are other existing practices for constructed wetlands in developed areas that are engineered for stormwater treatment, and this panel's recommendations do not alter those existing BMPs for the developed sector. While the panel's focus was for voluntary practices within agricultural settings, it is possible that these voluntary wetland practices are occasionally applied in suburban or exurban areas that could fall within developed load sources. It is also true that floodplain reconnection or legacy sediment removal projects that restore/create/rehabilitate wetlands do occur within developed areas, and therefore we will ask the USWG to consider if these wetland practices should be expanded to include developed load sources.
Ellen Gilinsky, Ph.D. (STAC)		Jeremy, I read the report as a STAC member and wetland practitioner. Very good report and conclusions make sense.	Thank you very much for reading the report and providing your feedback. We appreciate it!

Tom Schueler (CSN)		Congrats on getting the wetland report done. I think it was well done, and technically sound, and I certainly support its adoption. I did want to check in with you about some issues on how the new wetland report intersects with our protocol 3 stream restoration effort, and the issue of how to credit LSR or valley restoration efforts. It would be helpful to have some agreement on these issues before the report goes to the USWG in September. Although our fledging group 4 may want to weigh in, it would be helpful to get a sense whether floodplain reconnection falls under wetland restoration, creation or rehabilitation, in the context of your new report, especially as it potentially relates to modifying Protocol 3.	The application of the recommended credits as a part of a stream restoration effort will depend on the context, and arguments can be made for any of the three wetland BMPs. If hydric soils exist and the reconnected floodplain was previously a wetland, then it would match the previous panel's definitions of wetland restoration. Alternatively, if a wetland still remains in the floodplain, but in a degraded condition, then it would more closely represent wetland rehabilitation for that floodplain reconnection. Wetland creation seems less likely to apply, but if there are no longer hydric soils then wetland creation may be the more applicable wetland BMP. We acknowledge that Greg Noe (USGS) served on this panel and is also a member of Group 4 for the USWG, along with Bill Stack (CWP). We are confident that Group 4 can make a determination of how to best apply the wetland BMPs in the context of urban (and non-urban) stream corridors, especially in relation to Protocol 3. A main point of consideration is to ensure practice implementation does not result in double-counting of load reductions; one or the other credit protocol should be used. Further, it is encouraged for implementation projects that increase wetland acreage, even though it is a part of a stream restoration project, would ideally be reported and tracked as a separate Bay Agreement Outcome.
Dianne McNally (EPA R3)		I've reviewed the report and consulted with one of our wetlands contacts here at EPA on the expert panel recommendations. I do not have any significant concerns or comments.	Thanks for working with your wetland colleagues to consider the report, and for reaching out to confirm you don't have any significant concerns.
Tess Thompson (Virginia Tech)		Jeremy, I realize I'm a day late, but I wanted to include some comments on the nontidal wetland expert panel report. I think the recommendations contained in the report are reasonable and well justified, given the complexity of the task of assigning nutrient and sediment removal rates for wetlands. I recommend that the report authors complete editorial revisions of page 16. There are numerous typos and grammatical errors that obscure the meaning of the text. If the authors would like a detailed list, I can provide that, but I think a careful reading would clear up the errors.	We edited this section for greater clarity.
Tess Thompson (Virginia Tech)		My only technical concern is the last sentence of the second bullet on page 16. Specifically, the report states that "Created wetlands are least likely to provide improved water quality	Thank you for the suggestion and insight. See edits on page 16-17.

		benefits, assuming the location is not positioned to allow the development of natural wetland processes (else wetlands would have occurred at that location historically)." I find this argument specious. There would be no need to create a wetland in areas that would have had them historically, so, by default, one must choose a non-wetland area to create a wetland. If the conditions in a location are changed to promote wetland hydrology (which the report acknowledges is the master variable), then it is reasonable to assume that created wetlands can eventually develop similar water quality benefits as natural wetlands. In the past the Pierce method (aka the "bathtub" method of compacting soils to minimize infiltration and constructing a berm to regain surface water) was used to create perched wetlands with few functions. However, in more recent years, wetland creation has focused on creating better groundwater/surface water interactions to better replicate natural wetland hydroperiods. Thus, the stated assumption that natural wetland processes cannot be created where they do not currently exist should be substantiated or removed. I recommend the second bullet on page 16 be rewritten. There are many reasons why created wetlands may not function as well as natural wetlands (e.g. due to lower organic matter levels in the soils), but the reason provided in the report is not well supported. If you have any further questions, don't hesitate to contact me.	
PA DEP (David Goerman, Jr.; Jamie Eberl; Jeff Hartranft), submitted by Kristen Wolf		[Editor's Note: PA DEP had a short call with the Panel Chair and Coordinator on 8/16/19 and were given a short extension to finish their feedback.]	[Editor's Note: DEP's memo with full feedback was provided by Kristen Wolf on 8/19/19. The full memo is copied in the rows below, but without corresponding figures or references. In some cases the paragraphs in the original memo have been split to separate issues for the panel's response. The full memo is included at the end of this appendix for the reader and the graphics and bibliography from DEP can be found there.]
PA DEP	General, MS4 Program Comment	Pennsylvania's MS4 program refers MS4 permittees to the Chesapeake Bay Program's Expert Panel Report for guidance when developing BMPs and calculating the sediment and	We appreciate the effort by PA and other jurisdictions when translating recommendations from CBP expert panels into their respective state programs. The wetland practices (creation and rehabilitation) recommended in this panel

		nutrient load reductions that correspond with those BMPs. Therefore, it is important to Pennsylvania that the wording of the Expert Panel Report be concise and avoid using language that can be open for interpretation. While the state has flexibility in approving BMP credit for MS4 permittees to comply with state permitting requirements, we exercise caution when approving credit for any BMP project that cannot be defended by the language in the Expert Panel Report. We use it as a standard for consistency between MS4 permittees. The state must also ensure that any BMP approved to meet the pollutant load reduction obligations of MS4 permittees, is also eligible for the state to use in meeting their pollutant load reduction obligations from the Chesapeake Bay TMDL.	report are associated with voluntary environmental programs, predominantly focused in agricultural areas. The panel's recommendations may be expanded to include developed load sources, per other CBP feedback, but the panel did not consider setting extensive standards or criteria for these practices because they are not directly associated with regulatory programs like MS4 programs. Rather, it is the stormwater practices like the "wet pond or wetland" or the "stormwater performance standard" or "retrofit" practices that would apply in a regulatory context that has standards and specs described in a jurisdiction's respective Stormwater BMP Manual. The panel determined that the best approach was to set basic guidance in the report and qualifying conditions that are not exhaustive or prescriptive, thereby giving flexibility to the jurisdictions. Additional guidance for the CBP practices can be developed following approval of the report, e.g., and entry for in CBP's BMP Guide and a more detailed fact sheet.
	General, MS4 Program Comment	Inclusion of clarification language in the following areas of the Expert Panel Report would be of assistance to Pennsylvania's MS4 program: qualifying site conditions for use of the Wetland Creation Expert Panel Report (versus other related expert panel reports), applicability of compensatory mitigation projects for use as Bay Program BMPs, and description of whether or not land use change is included as part of the wetland removal efficiencies.	[see previous comment regarding qualifying conditions] Compensatory Mitigation projects are not eligible for nutrient and sediment reductions toward the TMDL, as stated in WEP (2016). This fact was implied but not explicitly stated in the current draft report. Language has been added to the report (p. 5, under Panel Charge and Membership) to clarify that compensatory mitigation projects, while important, remain ineligible for reporting and credit toward TMDL goals. See Table B-2 in Appendix B. A land use change is part of the overall reduction for the Wetland Creation BMP, as simulated in the CBWM. Wetland Rehabilitation does not have a land use change associated with it. Both BMPs apply an efficiency to upland acres to thereby reduce those loads.
PA DEP	Introduction (pg. 3)	A statement in the second paragraph is not supported by our knowledge and understanding of temporal losses in PA and outside of the coastal plain. Most of the historic wetland losses by infill (i.e. legacy sediment) were prior to the 20th century (Walter and Merrtitts, 2008, Merritts, et al., 2011,). These losses from infill in PA impacted natural wetlands, similar to modern reference standard wetlands, and exceed the functional losses from typical 20th century activities. Wetland infills from legacy sediment impacted the highest functioning wetlands in the watershed.	We appreciate the additional context. Clarifying edits have been made accordingly to the given paragraph to describe the regional history of wetlands more accurately, and in coordination with feedback from Chris Spaur, USACE, on the same section.
PA DEP	Introduction (pg. 3)	One key principle for successful aquatic ecosystem restoration projects is identifying the cause of degradation and addressing it (USEPA, 2000). A statement that current site	Wetland projects are complex and each one is unique, and the current language did not intend to exclude important factors like the cause of degradation from

		conditions identify which techniques are appropriate is problematic for identifying impairments that occurred centuries prior (e.g. Legacy sediment). Modern conditions, particularly those derived from current and adjacent land uses, often will not result in appropriate selection of a restoration technique.	consideration. We will insert "and the cause of degradation" into the first/second sentence to clarify.
PA DEP	Introduction (pg. 3)	While the generalizations regarding wetland loss may apply to some areas of the six Bay states, it has become clearer and clearer, that Pennsylvania lost the majority of its wetlands in the 18th and 19th centuries rather than the latter half of the 20th century. This is evidenced by the widespread occurrence of buried organic horizons across the Commonwealth in a variety of physiographic provinces and landscape positions. This infill occupies the former wetlands, in many cases it has for over 200 years, during which time if not manipulated, the fill surface has naturalized and now gives the appearance of an unaltered landscape in many instances. This “modern” land surface may have subsequently developed wetlands that were then altered or drained at a later time for land development or agricultural production. However, the wetlands that are present on this modern land surface are not as interconnected hydrodynamically as the original wetlands. The landscapes we see today are an integration of past natural processes and events and anthropogenic alterations that have varying time and spatial scales of effect or impact that can establish boundary conditions that control modern conditions and restoration of environments (Beven, 2015). Suffice it to say that little effort has been expended by most parties to better understand these altered landscapes and how they affect water quality and biological communities at varying scales. Without such knowledge it is difficult to understand how recovery can occur when we do not understand or even identify the persistent modified boundary conditions that affect resource recovery.	We appreciate the additional information and insight. We think edits made thus far provide sufficient clarity about past causes of wetland loss. While informative, the comments primarily refer to broader policy or management concerns beyond the purview of the panel.
PA DEP	Wetland Mapping and Acceptance as Landcover	The Department would like to have the process (including associated time frames) outlined for the jurisdictions for updating the wetland land cover data layer or the location of that process referenced. The wetland program is working to develop a living mapping system that provides a variety of updates to the baseline wetland probability of occurrence	It is great that PA DEP continues to build on its previous efforts to map wetlands and improve its geospatial data layers. The specific process and methods for how land cover data and wetlands are translated into land uses for the CBWM is outside the scope of this expert panel and report and thus we will not add/edit language in the report to address this issue. We can work with relevant DEP and CBPO staff to clarify the process and applicable timelines/deadlines offline.

		mapping recently completed for the entire state. This process may already be outlined, but since there are clear cross connections from one expert group to another the process for updating and/or revision should be clearly cross-referenced. ***How does the Department update its wetland mapping for the Chesapeake Bay in the near future when the upgraded mapping is completed?***	
PA DEP	Page 7: Discussion of Land to Water (L2W) Factors	The Department is in the process of developing a research study that may better inform the L2W factors related to wetlands and degraded headwater environments. The Department will be seeking additional information to understand how these factors are utilized within the modeling to better inform its multi-year study. As it currently appears, there is a lot to learn about headwater hydrodynamics and nutrient cycling. The Department is interested in providing quality data that will better inform modeling of these processes.	[see two rows down]
PA DEP	Page 7: Discussion of Land to Water (L2W) Factors	However, there are studies that provide lines of evidence to better support the role that headwater hydrodynamics play in nutrient transformation. Specifically, how in-stream hydraulics play a role in residence-time distributions in water transient storage zones which influence whole-reach nutrient-uptake rates for NH4+ but do not for soluble reactive phosphorus. (Drummond, et. al., 2016). This review did not include enough time to review Chapter 7 of the Chesapeake Bay Watershed Model (CBWM) documentation. Although, the current factors as outlined in Table 1 may be too inadequate or simplified to truly address the complexities of L2W dynamics. However, there has been a significant amount of research looking into these factors that may be worth revisiting in the very near future. The DEP is reserving further ability to evaluate these factors as they affect headwater wetland/riverine systems.	[see next row down]
PA DEP	Page 7: Discussion of Land to Water (L2W) Factors	This may not be the location for this comment, but it underlies everything about the CBWM. Much of the hydrology underlying our wetlands and stream, especially in the headwater systems in many cases flows through agricultural soils or soils that were once farmed. There are other legacy alterations that affect watershed hydrologic and biogeochemical processes that may present additional	The information about L2W factors was included in the report for background and context only. This aspect of the CBWM is outside the purview of this Wetland BMP expert panel. We shared your input with Gary Shenk (USGS, CBPO) who provided the following response:

		boundary conditions (Larson, 2015, Sloan, 2016 and Van Meter 2015, 2016). For example, recent work done by Van Meter 2016 estimates that there is a reactive nitrogen pool and that approximately 18% of the annual load in the Susquehanna River Basin is greater than 10 years old. The soil organic nitrogen legacy pool does not form from overland flow but is generated from groundwater systems, many of which are short circuited through tile drainage and ditching of uplands and wetlands.	Thank you for the comments on land-to-water factors in the CBWM. There are no current plans to update the land-to-water factors in the immediate future, however the Modeling Workgroup is always interested in new techniques to improve future modeling efforts that may be requested by the partnership. The Modeling Workgroup would welcome presentations on the plans for and findings of the study of factors controlling headwater nutrient dynamics referenced in your comment.
PA DEP	Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).	The categories of “Other Wetlands” and “Floodplain Wetlands” for establishing upland acres treated and wetland retention efficiencies is problematic because it may discount the functions and services of headwater wetlands and there are many misgivings about these designations. This classification’s purpose stems from how the model characterizes the pollution sources. There is no accounting of groundwater as a main nitrogen source (significant portion). While it is understandable from a modeling stance to simplify the process of how nitrogen enters surface waters, however, it is not acceptable that this pathway is completely ignored altogether. This is especially true for understanding the role wetlands play in the groundwater to surface water hydrodynamics and biogeochemistry. The “wetland” classification system results in reducing or discounting headwater systems where groundwater is expressed most often in the form of headwater complex wetlands/riverine systems across all jurisdictions. These areas represent the majority of the land surface of the watershed, generation of shallow (lateral) and deep groundwater interfaces, and therefore provide the majority of the base flow and biogeochemistry of any given riverine system.	The information about the two wetland land use categories was included in the report for background and context only. This aspect of the CBWM is based on previous recommendations from WEP (2016), the Wetland Workgroup and Land Use Workgroup, as part of the overall Midpoint Assessment effort to develop the Phase 6 Watershed Model. Concerns or issues over the existing land use categories and land use mapping/classification is outside the purview of this Wetland BMP expert panel. We shared your comments with Peter Claggett (USGS, CBPO) who provided the following response: The Land Use Workgroup oversees the development of the CBP high-resolution land cover data for 2017/18 and 2021/22. Currently, we are working on updating the 2013/14 land use data with 2017 and 2018 imagery and LiDAR. While the Water Quality Goal Implementation Team and Modeling Workgroup require that future land use maps can be completely cross-walked to the original 2013 land use classification, we can subdivide classes now and in the future for other purposes. Headwater wetlands fall under our “Wetland Other” category. I expect that most if not all of these wetlands are “headwater wetlands”. With additional information such as topographic derivatives, we could subdivide this class into headwater and non-headwater categories. A finer classification of wetlands might be useful for local implementation of restoration activities and inform future variable BMP efficiencies if the CBP Partners decide to develop them. However, for running the watershed model (aka CAST) through 2025, we will continue to need to aggregate wetland classes into the more general “floodplain” and “other” categories. I [Peter C.] suggest this issue be raised at a future Land Use Workgroup and/or Wetlands Workgroup meeting.

PA DEP	Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).	In the three major physiographic provinces that occur in PA's portion of the Chesapeake Bay watershed these streams represent between 69% and 82% of all the stream reaches (2008 Walsh). Regionally, headwaters are the cumulative source of approximately 60% of the ***total mean annual flow*** to all northeastern U.S. streams and rivers (EPA, 2015).	[see previous response]
PA DEP	Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).	This is especially the case for those wetlands connected to and integrated in the upper portions of watersheds (reference to streams of first through third order) and that are classified as "Other Wetlands". ***The jurisdictions should have control over how these classifications are made and provide them to the CBP for their use. Conversely, the CBP should not delineate these resources absent our direct involvement and utilization of accepted classification criteria.***	[see previous]
PA DEP	Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).	Numerous studies have been conducted related to the role that Iron, Manganese and Sulphur, but especially Iron (Fe) plays in nutrient transformation processes and pathways. A metadata study utilizing EPA's stream water quality monitoring data developed recommended levels of Fe for stream types and found that wetland presence was the most dominant contributable variable to whether a stream achieved those minimum levels. It should be noted that most streams are Fe deficient by that study's standards, despite the pervasive presence of iron in most shale formations prevalent across Pennsylvania. Local research into Fe cycling hypothesis' that isotopically heavy Fe-rich colloids form in soils and are then transported out of soils to streams. This transported Fe could be important sources of isotopically heavy Fe to rivers (Yesavage, et al, 2012). The comparison of precipitation and observed total dissolved Fe levels in a small stream in York County, PA depicted in the chart below supports this hypothesis (PA DEP Water Quality Data). The general trend of increased annual precipitation and	[see previous]

		corresponding increases in observed dissolved Fe levels can be seen in the chart below.	
PA DEP	Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).	The Department is developing a more robust geomorphic landform-based classifications to better inform its wetland mapping recently completed. This mapping will also inform stream classification (PA ACC) systems as well. The current wetland classification does not adequately represent headwater systems and the critical role that wetlands play in establishing the base flows and geochemistry of riverine systems. ***How will the Chesapeake Bay Program allow for the utilization of such efforts in the near future when completed?***	[see previous]
PA DEP	Page 11-12: Discussion of conceptual modelling to explain the wide range of water quality benefits reported in wetlands.	The Department believes that there is an argument to be made that wetland rehabilitation, should have two different efficiencies. Especially when reestablishment of a wetlands former hydrodynamics is involved. PA DEP believes this type of project is significantly more valuable than wetland creation as it relates to functioning and pollutant removal potential. These natural systems in our experience have significantly more organic matter present, have significantly higher levels of micro and macro-topographic relief, soil heterogeneity and microbial activity. These features are critical in nutrient transformation and sediment deposition and long-term storage. In some cases, these hydrodynamically altered wetlands could be leaky sources of forms of nitrogen and reactive phosphorus instead of the sinks they are generally believed to be when the hydrodynamics are intact.	Recommended efficiencies reflect the average expected "lift" versus the post-construction effect of the (rehabilitated) wetland. All effectiveness estimates for BMPs approved by the CBP must account for the baseline (pre-BMP or pre-construction) condition of the site. The panel's understanding of the post-construction performance of a rehabilitated wetland matches the commenter's description of beneficial characteristics (organic matter, etc.). Sites that are candidates for rehabilitation are already reflected in the model through calibration, as they are existing wetlands.
PA DEP	Page 11-12: Discussion of conceptual modelling to explain the wide range of water quality benefits reported in wetlands.	These factors are echoed by the panel's report on Page 14 under the Key Findings Section, but yet the efficiency's and preferential treatment of Creation remains. The WEP argues that there was sufficient information to separate naturally wetland efficiencies from wetland BMP efficiencies. Which just based upon the basic definition and comparison of accompanying attributes, wetland creation is a wetland BMP and not a natural wetland. The argument that created wetlands perform at a higher efficiency because they are converting upland to wetland and that a wetland rehabilitation is not because it was already a wetland, regardless of how altered, is a tenuous argument. On Page 26, the WEP	[see previous response]

		argument for relative ranking of wetland BMPs and their efficiencies is solely based upon best professional judgement. In our professional experience restoring wetland systems, this includes rehabilitating as well, we respectfully disagree.	
PA DEP	Page 11-12: Discussion of conceptual modelling to explain the wide range of water quality benefits reported in wetlands.	It would be best left to the jurisdictions to decide when a wetland rehabilitation project rises to a higher level of efficiency by providing some qualitative factors related to hydrologic modification and/or departure from typical HGM hydrographs. ***To better reflect real world projects, we would propose a tiered approach at this time. This would allow jurisdictions to address real world circumstances when awarding efficiencies, which further provides jurisdictions a means to push priorities as well.*** No factors listed – current proposed efficiency Qualitative Factors occurring - same as creation efficiency Hydrograph departure demonstration - same as restoration efficiency	Conference calls to review comments and responses with representatives from PA DEP occurred on August 16 & 28. PA DEP described efforts of continuously improving their wetland mapping and the site-specific conditions that may warrant, and result in, more comprehensive wetland function to an existing degraded wetland. The panel acknowledged, and supported through the literature, the wide range in water quality benefits provided by a wetland BMP that depends on many factors. As noted in the Panel's report the ability to capture all of these factors – from design parameters to site location –into a crediting protocol was challenging and therefore a multiple lines of evidence approach was used to adopt the recommended credit protocols. As such, the credit for rehabilitation converged upon multiple sources of information that provided an acceptable and reasonable value given the wide range of possible water quality outcomes. No change is recommended. In our discussion with DEP staff, it was clear that there were concerns about how to translate wetland restoration/creation/rehabilitation activities, as understood and defined by DEP, into the CBP-defined wetland BMPs. The panel's recommendations are intended to provide flexibility for the states to determine how BMPs implemented with their jurisdiction should be counted for CBP purposes, which will reflect their unique programs. For example, DEP described instances of perched wetlands in floodplains that resulted from legacy sedimentation. While these areas would not necessarily count as prior-converted or historic natural wetlands, if they are mapped as wetlands then restorative actions to these wetlands would best be considered as wetland rehabilitation for CBP purposes.
PA DEP	Page 27: Discussion of Upland Treated Acres for reported wetland BMPs.	The original proposal in the WEP(2016) was perplexing as much as it was disturbing in recommendations. Many of the recommendations were counter to the building resource knowledge of wetland hydrodynamics. At least the WEP acknowledged they had as much p[problem rectifying this approach as the jurisdictions did. This proposed section in the WEP(2016) report was not received well then and nor is the continuation of the use of this proxy for assigning the upland treatment acres. This proxy measure is trying to turn what are mainly groundwater dominated systems into some surface	Jurisdictions will have the option to report the contributing area for the created/rehabilitated wetland. It is outside the scope of the current panel to revisit the previous panel's upland acre ratios as applied to the restoration BMP.

		drainage proxy to address the CBWM 's lack of integrating groundwater nutrient source loading. ***This whole approach should be revisited altogether, there is no real apparent basis for this ratio.***	
PA DEP	Table 13. Wetland Techniques Matrix (pg. 31-32)	The Legacy Sediment Removal BMP should be included in the Typical Techniques, especially for Hydrology and Soils Wetland Components. This is particularly true because Legacy Sediment Removal is included in WEP(2016). The WEP(2016) recommendations include Legacy Sediment Removal as a Practice and Project Example in Table 2. Practice and Project Examples from WEP(2016) are equivalent to the Typical Techniques categories for each wetland component in the Wetland Techniques Matrix presented in Table 13.	We will add Legacy Sediment Removal to Table 13.
PA DEP	Bibliography	[see full PA DEP memo at end of this appendix]	

Mr. Spaur's feedback is provided in a separate table to include his full input that included an additional column.

Name (affiliation)	Section or page ref.	Comment or suggested change	Rationale	Response from Panel Chair and Panel Coordinator
Christopher Spaur (USACE)		[Email text provided in this row; comments from attached comments copied verbatim here in separate rows] Attached please find comments from me (Wetland Workgroup Member). Because of competing priorities (my own and others), I wasn't able to circulate these comments internally with adequate time for other USACE people to review what I'm sending in. However, I attempted to think from both USACE planning and regulatory perspective, and although I err on being too wordy (and perhaps slightly rude), I think comments I've submitted are fair.		
Christopher Spaur (USACE)	Cover Page, Title	Change title to something like "Nontidal Wetland Best Management Practices (BMPs)"	Current title (Nontidal Wetland Creation, Rehabilitation and Enhancement) confusing in that it leaves out term "restoration," but	We've included "enhancement" in the title and other places in the report alongside creation and rehabilitation since all three were considered throughout the panel's

			includes term "enhancement" but then this BMP type is rejected within the document	deliberations. Wetland restoration was included in the deliberations as a point of reference, but the panel was not charged to recommend any changes to that practice. The suggested change would therefore be too general so we will instead keep the existing title for posterity.
Christopher Spaur (USACE)	Executive Summary	Include summary of "Future Research and Management Needs." Also, consider adding ideas from comments below on bioavailability to that subsection.	Future research topic omitted (?) from executive summary, even though considered in report.	The executive summary does not summarize all aspects of the report in order to limit its length to a single page.
Christopher Spaur (USACE)	Executive Summary and Throughou t	Note that it's arguably inconsistent with other TMDL credited efforts that we're rejecting "wetland enhancement." In reality the vast majority of sanctioned "stream restoration" projects would be called "stream enhancement" projects if the Stream Health Workgroup utilized the Wetlands Workgroup definition for the term "enhancement."	Following Wetlands Workgroup terminology, the only "stream restoration" projects that aren't "enhancement" are those that restore actual LOST streams (i.e., daylighting piped streams, taking concrete substrate out from concreted streams, rewatering dewatered streams). Most stream restoration work in urban areas is effectively instream stormwater management.	Enhancement, as defined in the report, is considered to occur on otherwise functioning wetland sites, whereas rehabilitation occurs on degraded wetlands. The CBP's qualifying conditions for the stream restoration BMP include an expectation of functional uplift on a stream that is actively enlarging or degrading. Therefore the "stream restoration" BMP is more analogous to the proposed wetland rehabilitation BMP, while stream restoration of lost streams is indeed analogous to wetland restoration. Thus, we respectfully offer that the wetland panel's logic is fully consistent with other credited BMPs like stream restoration.
Christopher Spaur (USACE)	Introductio n, p.3, first paragraph	Revise first two sentences of first paragraph to one sentence focused on habitats rather than species, something like "The modern history of human activities across a 64,000 square mile watershed has dramatically shifted the ecosystem structure of the Chesapeake Bay, thus leading to the decline of many iconic habitats, including submerged aquatic vegetation, wetlands, and oyster beds. In 2014, the Chesapeake Bay Program (CBP) partnership committed to the fundamental goal of restoring the Bay ecosystem health in the Chesapeake Bay Restoration Agreement."	Paragraph somewhat misrepresentative of Bay charismatic resources, stressors, and trends. Easy correction would be to simplify it. Identifying "species" regarding SAV somewhat misleading in that SAV beds include many, and are more accurately considered a habitat type. SAV has declined because of impaired water clarity (principally from anthropogenic nutrient loading [water quality]). Blue crab populations are dynamic and have had periods of recovery; fishing pressure can be less important than natural factors involving Bay-ocean circulation (anthropogenic water quality impacts of low importance). Oysters have	We accept this clarifying edit with slight modification. We will also correct the [Chesapeake Bay] "Restoration Agreement" to "Watershed Agreement" for consistency with CBP parlance.

			declined because of parasites/disease, habitat loss (from overfishing reducing shell production), and overfishing reducing population. If oysters hadn't been overharvested, population arguably could've evolved and recovered by developing resistance to MSX/Dermo. Water quality impairment probably at greater depths (i.e., below pycnocline), but that's not usually what's quantified.	
Christopher Spaur (USACE)	Introduction, p.3, first paragraph	After sentence "Since colonialization, more than 70 percent of historic wetlands were lost by drainage or infill." add new sentence stating something like "Substantial additional historic floodplain wetlands were lost by burial under anthropogenic sediment ("legacy sediment") following European Settlement."	Historic wetlands losses much greater than what captured by Dahl (1980) or Pavelis (1987). The loss of pre-European Settlement wetlands in floodplains from burial under sediment generated by anthropogenic erosion ("legacy sediment") has not been determined to my knowledge regionally. However, this loss is IN ADDITION to losses from agricultural drainage and infill, etc.	Similar comment offered by PA DEP. Incorporated suggested edit with slight modification.
Christopher Spaur (USACE)	Intro, p. 3, para 2, sentence 3	Change sentence to "The most extensive losses from active ditching and filling occurred in the Coastal Plain, where proximity to water and highly tillable lands naturally led to a concentration of human activities.	To clarify that this sentence refers only to quantified losses, not those unquantified losses from burial under anthropogenic sediment.	We accept this clarifying edit as suggested.
Christopher Spaur (USACE)	Intro, p. 3, para 3	Delete sentence "At this scale, costs and benefits of individual practices likely will not be as significant as evaluating progress toward regional goals (e.g. load reduction targets)."	Sentence confusing and unnecessary. I think (?) it's attempting to state that cumulative impacts (benefits) are what matter, but these aren't well-considered when making local-scale decisions.	We accept this clarifying edit as suggested.
Christopher Spaur (USACE)	2 Natural Wetlands, p. 7	Prior to Table 1, add sentence stating that these factors do not consider actual bioavailability of N and P forms.	This can set the stage for stating in research needs that better consideration of bioavailability likely important to fairly weigh costs/benefits of various nutrient load reduction strategies.	The opening sentence states "account for spatial differences in loads due to physical watershed characteristic" so it infers that other biological and chemical factors are not considered.
Christopher Spaur (USACE)	12, para 1	Clarify that restored wetlands would likely be in landscape setting that historically supported wetlands and may still have wetlands soils, and these factors could optimize potential for nutrient load reduction.	Discussion appears to have likely been limited to like replacing historic like, rather than considering substantial "redesign" to optimize for nutrient load reduction. Wetlands	These are excellent points that did arise in the panel's discussions. The bullet point on page 16 reflects the fact that these points arose later in the panel's evolving deliberations, so we

		However, it should be speculated that created wetlands designed for nutrient load reduction could likely over the long-term outperform natural wetlands as mother nature doesn't design wetlands for this explicit purpose (but people can)! (This is partly discussed in bullet "Optimally Designed Wetland BMPs …" on p. 16.	"designed" to reduce nutrient loads could incorporate numerous features that may not be present in natural features (optimal residence time, tortuous flow, positioned to capture nutrients from known anthropogenic sources, etc.) These designed wetlands though could differ substantially from natural wetlands. Also, two entire HGM classes of natural wetlands – mineral soil flats and organic soil flats – would largely only intercept airborne pollutants. While these can have high biological value, it is quite possible that their pollutant load reduction capability could be enhanced to greater than natural levels (although perhaps with unacceptable risk of biological harm).	prefer to not incorporate the edits as suggested on page 12, which describes the first iteration of conceptual modeling efforts that occurred earlier in the panel's process. The edits would not accurately reflect the panel's own process in that particular sub-section. Instead, we will insert new text on page 11 above Table 2 explaining that the information presented in the section represents the development of panel deliberations as new information arose and panel discussions advanced or revised ideas.
Christopher Spaur (USACE)	13, Key Findings	Add "risk of biotic harm" for enhancement, as mentioned elsewhere in document.	Biologic support functions of existing wetlands can be of substantial enough value that we shouldn't risk compromising those.	We will add a new statement earlier in this section to acknowledge the panel's recognition of these additional functions and possible tradeoffs. The addition fits more appropriately there instead of under key findings for this section. See edits on page 12.
Christopher Spaur (USACE)	15 Conceptua l Modeling, Part II	Disagree with combining landscape location/position (essentially HGM class) with pollutant loadings delivered to wetland (function of up-gradient pollutant sources, largely function of land use). I think document should be restructured accordingly.	While I don't know intricacies of Bay Model, this is potentially serious error in that it fails to allow for discriminating between these two factors. However, if that doesn't matter in quantifying benefits because of state of Bay Model, then state that as reason to combine.	The language in the specified section reflects some of the many guiding concepts considered by the panel at the given stage in their deliberations. These were an extension from the WEP (2016) framework and were only "combined" in a conceptual manner as the panel continued their deliberations.
Christopher Spaur (USACE)	15-16 Conceptua l Modeling, Part II	Reduce length of paragraph on bottom of p15/top of p 16 to just the first 3 sentences, delete from "The multiple hypotheses …" onward.	Paragraph long and confusing, the first 3 sentences I think sum it up.	We accept deletion of the first sentence mentioned, but feel the need to keep the following sentences, with slight modification, as they support future research recommendations and acknowledge the panel's individual and collective contributions to explain variability and nutrient and sediment processing of wetlands.
Christopher Spaur (USACE)	16, Wetland	Add text clarifying that this section is NOT referring to HGM classification (and thus landscape position), but instead ANY wetland ANYWHERE	I was confused reading this trying to figure out how capacity to provide water quality benefits,	[See added text on page 16

	Condition Heading		and hydrologic degradation related to HGM class.	
Christopher Spaur (USACE)	16, Natural Wetlands … Bullet	Last sentence problematic, re-word to allow for situation that if seeking TMDL credits, and credits were given based upon BMP design and likely function, why would someone NOT put a created wetland in an appropriate position?	Contradictory, unless allowing for crediting based upon additional criteria not practicable. Then, problem is benefits quantification procedures, not engineering design possibilities.	See edits in response to comments from Tess Thompson
Christopher Spaur (USACE)	16, Hydrologic Alteration …" Bullet	After "The extent of hydrologic alteration primarily influences wetland" add "interception and" prior to "retention capacity"	Drainage, which can direct water away from wetlands, would also reduce wetland nutrient load reduction functions.	We accept the suggested clarifying edit.
Christopher Spaur (USACE)	17, "Complexity of Biophysical …" Bullet	After "soil compaction and oxidation" add "soil organic content"	Loss of organic content occurs by drainage/oxidation. While implied, better to just state it	We accept the suggested clarifying edit.
Christopher Spaur (USACE)	17, "Hydrologic connectivity …"	Change word "capacity" after "… sediment loads have greater" to instead the word "opportunity"	Mistaken use of word capacity	Good catch; change made.
Christopher Spaur (USACE)	17 "Expert Elicitation," 2nd paragraph	Explain why "restoration" omitted from list of wetland BMPs in this section when that term is used in table ES-1	Confusing	Restoration was omitted from that statement because it was not a primary focus of the panel's evaluation. As instructed by the Wetland Workgroup the panel was asked to evaluate the other 3 BMPs, with consideration of restoration as a point of reference.
Christopher Spaur (USACE)	18, Key Findings, 2nd Bullet	Could add that wetlands to be enhanced/rehabilitated likely have some level of hydric soil character already which can be quickly restored	To support assumption	We added language to this effect, modifying the sentence for clarity.
Christopher Spaur (USACE)	21, Table 7	Add note that functions 5 and 6 refer to forms of nutrients which are a subset of TN or TP.	Set stage for later "research need" that we need to consider bioavailability, not just TN and TP	This addition fits better in the context of Table 9, so we will accept the clarifying edit there instead.
Christopher Spaur (USACE)	23, Table 9	Follow up comment to above. F5 and F6 are likely highly bioavailable. F7 may not be.	TP if on inorganic particulate only highly "bioavailable" once it reaches Bay in anoxic salty water, NOT oxidized fresher water.	We will accept a clarifying footnote to Table 9 to this effect for F5 and F6. F7 is implied to not be bioavailable.

Christopher Spaur (USACE)	23, last para	Uncomfortable with NOT allowing for wetland enhancement BMP, although I think restrictions should be applied analogous to stream restoration arena in which indicators of severe degradation must be present	Note that "stream restoration" is essentially "stream enhancement." By the reasoning we're applying, we should probably disallow most of that because of concern over more harm than good (or minimal good).	See earlier response.
Christopher Spaur (USACE)	24, Wetland Enhancement	Uncomfortable with not allowing enhancement of Phragmites (and perhaps other highly degraded wetlands) wetlands to be given TMDL credit. Enhancement could be done in such a way as to increase water tortuousity, residence time, etc., that would improve water quality functions. However, would require criteria stipulating what degradation adequate to think risk of harm less than likelihood of doing good.	See above – compare to stream restoration logic which effectively allows for stormwater management in the stream channel.	See responses above regarding analogy of wetland enhancement and stream restoration. The CBP's definitions of enhancement states that the characteristics of a wetland are manipulated to "heighten, intensify, or improve a specific function(s)." As such, minimal interventions could be associated with enhancement. The panel recognized a paucity of data associated with any specific enhancement technique and the subsequent uncertainty associated with the potential water quality lift. For example, a recently published review of phragmites in wetlands by Bansal et al 2019 (https://link.springer.com/article/10.1007/s13157-019-01174-7) finds a range of "negative ecological impacts to wetland and agricultural system, but also is linked with a variety of ecosystem services such as bioremediation ..." There is section in the paper that discusses the tradeoffs between invasive phragmites and their nutrient retention function and other wetland functions. We added language (p. 26) to capture tradeoffs discussed in Bansal et al. (2019) regarding phragmites.
Christopher Spaur (USACE)	34, 5 Ongoing verification	To long-term monitoring, could also add satellite imagery	Clarify that some of this now high resolution and likely adequate in some cases	We can add this in the report, but a jurisdiction would have discretion to add this into their verification plans. Added "satellite" on page 36.
Christopher Spaur (USACE)	36, 7 Unintended	Change "will" to "could" in "The conservation of both nontidal and tidal wetlands will also have a critical role	As rate of sea-level rise accelerates, "conserving" tidal wetlands over most of the low-sediment input settings of Bay will likely be	We accept the suggested clarifying edit.

	Consequences	to mitigate the effects of sea level rise in coastal areas.”	impossible because of scale of loss. They will instead drown in place, then erode on Bay side.	
Christopher Spaur (USACE)	37, 8 Future Research	Add bullet stating that quantification of wetlands storing/transforming bioavailable (versus poorly bioavailable) nutrient forms should perhaps be given consideration in TMDL crediting. Wetlands likely excel at removing bioavailable forms of N. Conversely, wetlands have finite P storage capability	The topic of “bioavailability” is increasingly recognized to be of importance. For example, see recent Chesapeake Bay Program STAC workshops covering this topic	Will follow-up for clarification about specific STAC workshop(s) for review and referred to here. Willing to add a new bullet point.
Christopher Spaur (USACE)	Appendices	None	Didn’t actually review these as didn’t see. Not provided for review or available separately (?).	The appendices were posted at a later date than the webcast. Except for the technical appendix (Appendix B) they are for the reader's reference and comments are not expected for the appendices.
Christopher Spaur (USACE)		Dahl, T.E. 1980. https://www.fws.gov/wetlands/documents/Wetlands-Losses-in-the-United-States-1780s-to-1980s.pdf Pavelis, G.E. 1987. https://eric.ed.gov/?id=ED295043		

MEMO

TO Kristen Wolf,
Chesapeake Bay Coordinator
Chesapeake Bay Office

FROM David Goerman, Jr.
Water Program Specialist
Wetland, Encroachment and Training Division
Bureau of Waterways Engineering and Wetlands

DATE September 3, 2019

RE Review and Comments on Draft Nontidal Wetland Creation, Rehabilitation and Enhancement BMP Expert Panel report-July 10, 2019

Please note that comments from Jamie Eberl and Jeff Hartranft at the Department were incorporated into these comments.

General MS4 Program Comment

Pennsylvania's MS4 program refers MS4 permittees to the Chesapeake Bay Program's Expert Panel Report for guidance when developing BMPs and calculating the sediment and nutrient load reductions that correspond with those BMPs. Therefore, it is important to Pennsylvania that the wording of the Expert Panel Report be concise and avoid using language that can be open for interpretation. While the state has flexibility in approving BMP credit for MS4 permittees to comply with state permitting requirements, we exercise caution when approving credit for any BMP project that cannot be defended by the language in the Expert Panel Report. We use it as a standard for consistency between MS4 permittees. The state must also ensure that any BMP approved to meet the pollutant load reduction obligations of MS4 permittees, is also eligible for the state to use in meeting their pollutant load reduction obligations from the Chesapeake Bay TMDL. Inclusion of clarification language in the following areas of the Expert Panel Report would be of assistance to Pennsylvania's MS4 program: qualifying site conditions for use of the Wetland Creation Expert Panel Report (versus other related expert panel reports), applicability of compensatory mitigation projects for use as Bay Program BMPs, and description of whether or not land use change is included as part of the wetland removal efficiencies.

Introduction (pg. 3)

A statement in the second paragraph is not supported by our knowledge and understanding of temporal losses in PA and outside of the coastal plain. Most of the historic wetland losses by infill (i.e. legacy sediment) were prior to the 20th century (Walter and Merrtitts, 2008, Merritts, et al., 2011,). These losses from infill in PA impacted natural wetlands, similar to modern reference standard wetlands, and exceed the functional losses from typical 20th century activities. Wetland infills from legacy sediment impacted the highest functioning wetlands in the watershed.

One key principle for successful aquatic ecosystem restoration projects is identifying the cause of degradation and addressing it (USEPA, 2000). A statement that current site conditions identify which techniques are appropriate is problematic for identifying impairments that occurred centuries prior (e.g. Legacy sediment). Modern conditions, particularly those derived from current and adjacent land uses, often will not result in appropriate selection of a restoration technique.

While the generalizations regarding wetland loss may apply to some areas of the six Bay states, it has become clearer and clearer, that Pennsylvania lost the majority of its wetlands in the 18th and 19th centuries rather than the latter half of the 20th century. This is evidenced by the widespread occurrence of buried organic horizons across the Commonwealth in a variety of physiographic provinces and landscape positions. This infill occupies the former wetlands, in many cases it has for over 200 years, during which time if not manipulated, the fill surface has naturalized and now gives the appearance of an unaltered landscape in many instances. This "modern" land surface may have subsequently developed wetlands that were then altered or drained at a later time for land development or agricultural production. However, the wetlands that are present on this modern land surface are not as interconnected hydrodynamically as the original wetlands. The landscapes we see today are an integration of past natural processes and events and anthropogenic alterations that have varying time and spatial scales of effect or impact that can establish boundary conditions that control modern conditions and restoration of environments (Beven, 2015). Suffice it to say that little effort has been expended by most parties to better understand these altered landscapes and how they affect water quality and biological communities at varying scales. Without such knowledge it is difficult to understand how recovery can occur when we do not understand or even identify the persistent modified boundary conditions that affect resource recovery.

Wetland Mapping and Acceptance as Landcover

The Department would like to have the process (including associated time frames) outlined for the jurisdictions for updating the wetland land cover data layer or the location of that process referenced. The wetland program is working to develop a living mapping system that provides a variety of updates to the baseline wetland probability of occurrence mapping recently completed for the entire state. This process may already be outlined, but since there are clear cross connections from one expert group to another the process for updating and/or revision should be clearly cross-referenced. ***How does the Department update its wetland mapping for the Chesapeake Bay in the near future when the upgraded mapping is completed?***

Page 7: Discussion of Land to Water (L2W) Factors

The Department is in the process of developing a research study that may better inform the L2W factors related to wetlands and degraded headwater environments. The Department will be seeking additional information to understand how these factors are utilized within the modeling to better inform its multi-year study. As it currently appears, there is a lot to learn about headwater hydrodynamics and nutrient cycling. The Department is interested in providing quality data that will better inform modeling of these processes.

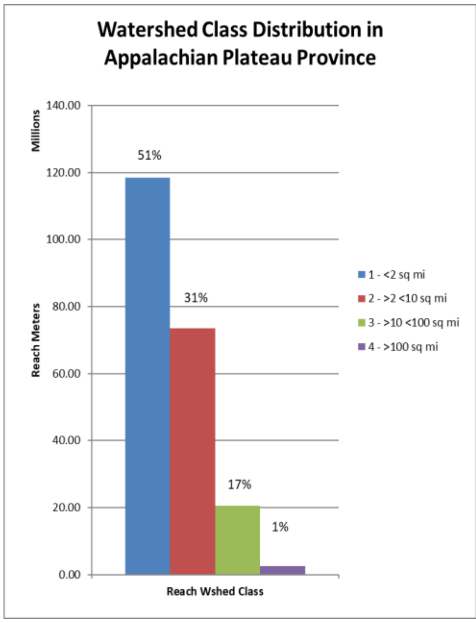
However, there are studies that provide lines of evidence to better support the role that headwater hydrodynamics play in nutrient transformation. Specifically, how in-stream hydraulics play a role in residence-time distributions in water transient storage zones which influence whole-reach nutrient-uptake rates for $NH4^+$ but do not for soluble reactive phosphorus. (Drummond, et. al., 2016). This review did not include enough time to review Chapter 7 of the Chesapeake Bay Watershed Model (CBWM) documentation. Although, the current factors as outlined in Table 1 may be too inadequate or simplified to truly address the complexities of L2W dynamics. However, there has been a significant amount of research looking into these factors that may be worth revisiting in the very near future. The DEP is reserving further ability to evaluate these factors as they affect headwater wetland/riverine systems.

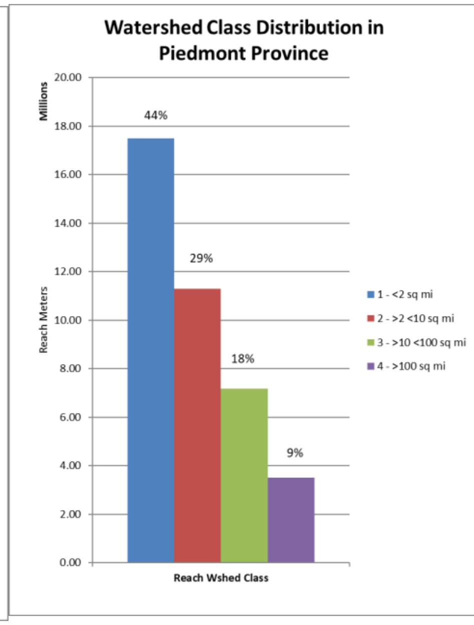
This may not be the location for this comment, but it underlies everything about the CBWM. Much of the hydrology underlying our wetlands and stream, especially in the headwater systems in many cases flows through agricultural soils or soils that were once farmed. There are other legacy alterations that affect watershed hydrologic and biogeochemical processes that may present additional boundary conditions (Larson, 2015, Sloan, 2016 and Van Meter 2015, 2016). For example, recent work done by Van Meter 2016 estimates that there is a reactive nitrogen pool and that approximately 18% of the annual load in the Susquehanna River Basin is greater than 10 years old. The soil organic nitrogen legacy pool does not form from overland flow but is generated from groundwater systems, many of which are short circuited through tile drainage and ditching of uplands and wetlands.

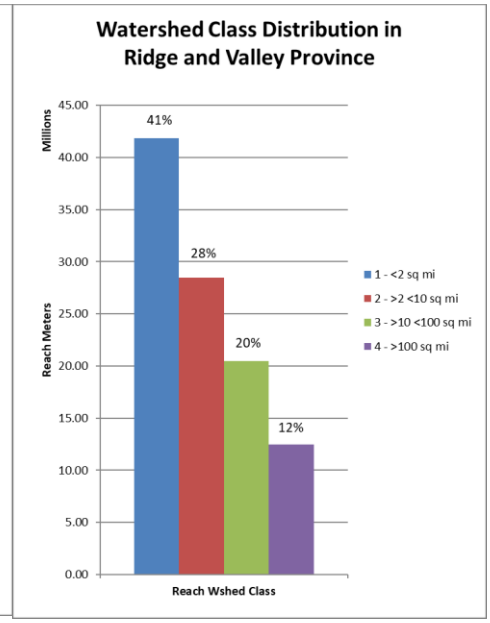
Page 7-8: Phase 6 Wetland Landuses: Discussion of wetland classification carried forward from the WEP(2016).

The categories of "Other Wetlands" and "Floodplain Wetlands" for establishing upland acres treated and wetland retention efficiencies is problematic because it may discount the functions and services of headwater wetlands and there are many misgivings about these designations. This classification's purpose stems from how the model characterizes the pollution sources. There is no accounting of groundwater as a main nitrogen source (significant portion). While it is understandable from a modeling stance to simplify the process of how nitrogen enters surface waters, however, it is not acceptable that this pathway is completely ignored altogether. This is especially true for understanding the role wetlands play in the groundwater to surface water hydrodynamics and biogeochemistry. The "wetland" classification system results in reducing or discounting headwater systems where groundwater is expressed most often in the form of headwater complex wetlands/riverine systems across all jurisdictions. These areas represent the majority of the land surface of the watershed, generation of shallow (lateral) and deep groundwater interfaces, and therefore provide the majority of the base flow and biogeochemistry of any given riverine system.

In the three major physiographic provinces that occur in PA's portion of the Chesapeake Bay watershed these streams represent between 69% and 82% of all the stream reaches (2008 Walsh). Regionally, headwaters are the cumulative source of approximately 60% of the ***total mean annual flow*** to all northeastern U.S. streams and rivers (EPA, 2015).



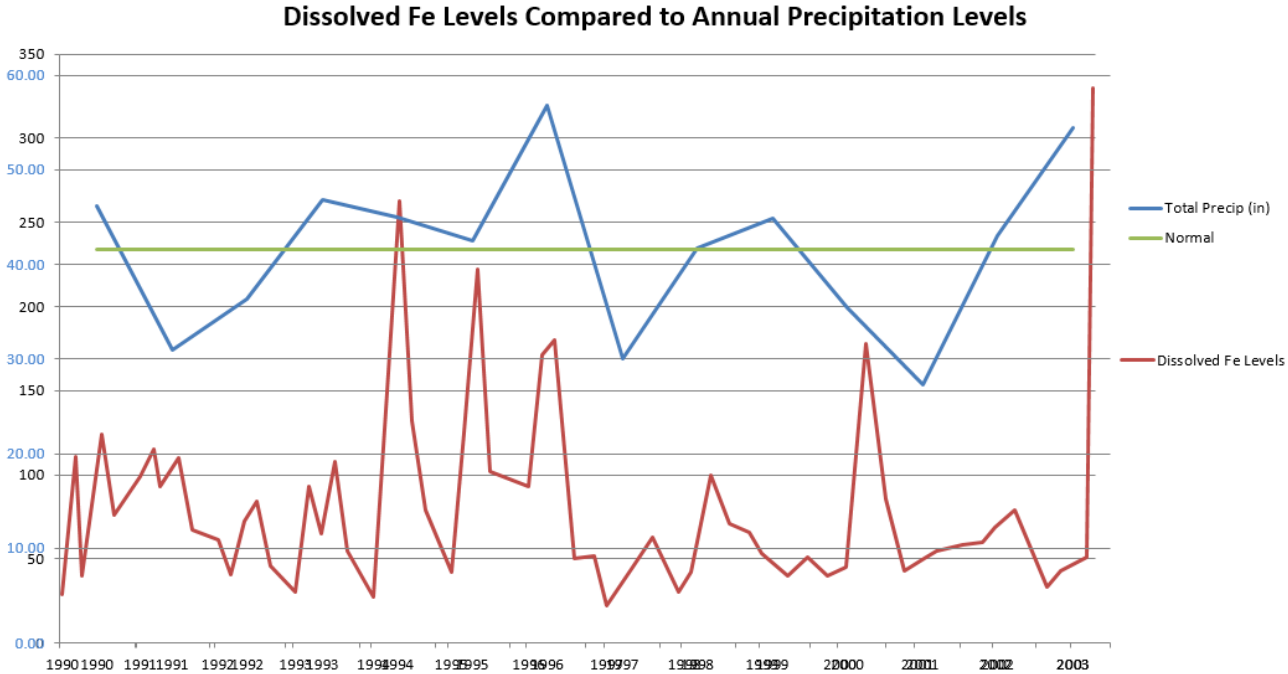




Source: 2008 Walsh; PA ACC Data

This is especially the case for those wetlands connected to and integrated in the upper portions of watersheds (reference to streams of first through third order) and that are classified as "Other Wetlands***". The jurisdictions should have control over how these classifications are made and provide them to the CBP for their use. Conversely, the CBP should not delineate these resources absent our direct involvement and utilization of accepted classification criteria.***

Numerous studies have been conducted related to the role that Iron, Manganese and Sulphur, but especially Iron (Fe) plays in nutrient transformation processes and pathways. A metadata study utilizing EPA's stream water quality monitoring data developed recommended levels of Fe for stream types and found that wetland presence was the most dominant contributable variable to whether a stream achieved those minimum levels. It should be noted that most streams are Fe deficient by that study's standards, despite the pervasive presence of iron in most shale formations prevalent across Pennsylvania. Local research into Fe cycling hypothesis' that isotopically heavy Fe-rich colloids form in soils and are then transported out of soils to streams. This transported Fe could be important sources of isotopically heavy Fe to rivers (Yesavage, et al, 2012). The comparison of precipitation and observed total dissolved Fe levels in a small stream in York County, PA depicted in the chart below supports this hypothesis (PA DEP Water Quality Data). The general trend of increased annual precipitation and corresponding increases in observed dissolved Fe levels can be seen in the chart below.



The Department is developing a more robust geomorphic landform-based classifications to better inform its wetland mapping recently completed. This mapping will also inform stream classification (PA ACC) systems as well. The current wetland classification does not adequately represent headwater systems and the critical role that wetlands play in establishing the base flows and geochemistry of riverine systems. ***How will the Chesapeake Bay Program allow for the utilization of such efforts in the near future when completed?***

Page 11-12: Discussion of conceptual modelling to explain the wide range of water quality benefits reported in wetlands.

The Department believes that there is an argument to be made that wetland rehabilitation, should have two different efficiencies. Especially when reestablishment of a wetlands former hydrodynamics is involved. PA DEP believes this type of project is significantly more valuable than wetland creation as it relates to functioning and pollutant removal potential. These natural systems in our experience have significantly more organic matter present, have significantly higher levels of micro and macro-topographic relief, soil heterogeneity and microbial activity. These features are critical in nutrient transformation and sediment deposition and long-term storage. In some cases, these hydrodynamically altered wetlands could be leaky sources of forms of nitrogen and reactive phosphorus instead of the sinks they are generally believed to be when the hydrodynamics are intact.

These factors are echoed by the panel's report on Page 14 under the Key Findings Section, but yet the efficiency's and preferential treatment of Creation remains. The WEP argues that there was sufficient information to separate naturally wetland efficiencies from wetland BMP efficiencies. Which just based upon the basic definition and comparison of accompanying attributes, wetland creation is a wetland BMP and not a natural wetland. The argument that created wetlands perform at a higher efficiency because they are converting upland to wetland and that a wetland rehabilitation is not because it was already a wetland, regardless of how altered, is a tenuous argument. On Page 26, the WEP argument for relative ranking of wetland BMPs and their efficiencies is solely based upon best professional judgement. In our professional experience restoring wetland systems, this includes rehabilitating as well, we respectfully disagree.

It would be best left to the jurisdictions to decide when a wetland rehabilitation project rises to a higher level of efficiency by providing some qualitative factors related to hydrologic modification and/or departure from typical HGM hydrographs. ***To better reflect real world projects, we would propose a tiered approach at this time. This would allow jurisdictions to address real world circumstances when awarding efficiencies, which further provides jurisdictions a means to push priorities as well.***

No factors listed – current proposed efficiency

Qualitative Factors occurring - same as creation efficiency

Hydrograph departure demonstration - same as restoration efficiency

Page 27: Discussion of Upland Treated Acres for reported wetland BMPs.

The original proposal in the WEP(2016) was perplexing as much as it was disturbing in recommendations. Many of the recommendations were counter to the building resource knowledge of wetland hydrodynamics. At least the WEP acknowledged they had as much p[problem rectifying this approach as the jurisdictions did. This proposed section in the WEP(2016) report was not received well then and nor is the continuation of the use of this proxy for assigning the upland treatment acres. This proxy measure is trying to turn what are mainly groundwater dominated systems into some surface drainage proxy to address the CBWM 's lack of integrating groundwater nutrient source loading. ***This whole approach should be revisited altogether, there is no real apparent basis for this ratio.***

Table 13. Wetland Techniques Matrix (pg. 31-32)

The Legacy Sediment Removal BMP should be included in the Typical Techniques, especially for Hydrology and Soils Wetland Components. This is particularly true because Legacy Sediment Removal is included in WEP(2016). The WEP(2016) recommendations include Legacy Sediment Removal as a Practice and Project Example in Table 2. Practice and Project Examples from WEP(2016) are equivalent to the Typical Techniques categories for each wetland component in the Wetland Techniques Matrix presented in Table 13.

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Appendix J: Compilation of meeting minutes

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Friday, November 3, 2017, 1:00PM-3:00PM
Conference Call

Name	Affiliation	Present? Y/N
Neely Law (Chair)	Center for Watershed Protection	Y
Kathy Boomer	The Nature Conservancy	Y
Jeanne Christie	Association of State Wetland Managers	Y
Greg Noe	US Geological Survey	Y
Erin McLaughlin	MD Dept. of Natural Resources	Y
Solange Filoso	Chesapeake Biological Lab	Y
Denice Wardrop	Penn State	N
Scott Jackson	U. of Massachusetts	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	Y
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	N
Lisa Fraley-McNeal	Center for Watershed Protection	Y

Welcome and introductions

- Jeremy welcomed participants and verified attendance.
- Neely thanked everyone for their time and agreement to participate in the panel. She reviewed the objectives and agenda for the call.
- Everyone introduced themselves and gave a brief description of their applicable experience for the panel.

Overview and discussion of panel's charge, panel roles and expectations; panel Q&A

- Jeremy described the Chesapeake Bay watershed, the Chesapeake Bay Program (CBP) partnership structure, and introduced the Chesapeake Bay TMDL to participants. He noted that the panel will discuss the CBP modeling tools in more depth in December, in the context of how wetlands BMPs fit into the model structure. He emphasized that the model's primary purpose is as a management tool to track progress and load reductions toward jurisdictions' TMDL goals. He also explained the panel should focus on their assigned BMPs and the science, as the panel has supporting participants to help make connections to the model.
- Neely reviewed the roles of panel participants. Panel members are "voting" members who ultimately determine the panel's recommendations based on the best available science.
    - Supporting participants to the panel do not "vote" on the panel's recommendations, but they participate in the panel by providing their perspective, answering questions, etc. These supporting include reps from the CBPO Modeling Team (Jeff), Watershed Technical Workgroup (Jeff), EPA Region 3 (Carrie), and a Panel Coordinator (Jeremy)

that assists with managing the process. The CWP also has staff that will support the panel's work and report development (Lisa, Bill and Deb).

- Neely explained the panel will seek decisions through consensus. In rare cases where consensus cannot be reached, panelists have opportunity to draft a dissenting opinion that will be included in the panel's report to the partnership.
- Panel meetings and calls are closed during the process, with the exception of one session that is a public stakeholder forum where others are invited to give presentations and interact with the panel.
- Neely noted that a great deal of literature has already been reviewed through the previous Wetland Expert Panel's work.
- Neely explained this panel will be focused on nontidal wetland rehabilitation, enhancement and creation BMPs that were defined by the previous Wetland Expert Panel.
- Jeremy emphasized that panels' recommendations and BMP definitions are for CBP purposes only; state or federal programs may have slightly different definitions but for CBP purposes the panels do their best to provide a framework so the jurisdictions can determine how CBP definitions crosswalk with other programs.
- Rob: How was the choice made to combine constructed versus non-constructed wetlands?
    - Steve noted that often for rehabilitation we see wetlands with severely degraded drainage or hydrology, and so we reconnect or correct the hydrology so it can once again function as it should.
    - Kathy noted that Rob's point may help with early decisions as to how we organize and structure the lit review and how to consider constructed wetlands.
    - Rob mentioned that in his area natural wetlands cannot be considered for functionality as BMPs, so it will be interesting to see this panel's recommendations for how to consider rehab or enhancement of impaired or existing wetlands.
- Neely encouraged panelists to write down and communicate any thoughts or concerns going forward. Open and frequent communication helps the overall process.

OneDrive Demo

- Jeremy asked if anyone tried to access the OneDrive folder and was unable to do so; no issues were raised. Jeremy explained the OneDrive folder can be organized and adapted to the panel's needs going forward, but it will be especially useful for concurrent review and editing of the draft report. No questions were raised by participants, but Jeremy encouraged anyone to contact him if they encounter problems. He noted the most important thing is that they save the link to the folder for easy future access.
- **ACTION**: Contact Jeremy with any issues related to the panel's OneDrive. Please save/bookmark the link to the folder that was included in invitation to share the folder.

Timeline and schedule

- Neely presented a general schedule of proposed meeting topics for the next 10-12 months. The next couple of calls will focus on background and framework of the previous panel's report and the CBP modeling tools. There will also be discussion of how to organize and frame the lit review and synthesis. Looking at February for potential face-to-face meeting in the Annapolis-Baltimore area to include public open stakeholder session.
- Jeremy asked participants for thoughts on what days in February could work best for a 1.5 day face-to-face meeting in the Annapolis-Baltimore area. Panelists preferred avoiding Mondays and Fridays, so the poll will include Tuesday-Wednesday and Wednesday-Thursday as options for each week in February.
- Solange noted she will be out of country from mid-December through mid-January and asked about options to participate without calling in. Jeremy is able to connect the conference line to the

Adobe Connect platform, though he will only do so if he knows one or more participants will be unable to call into the conference line, e.g., traveling internationally.

- Participants were supportive of having a standing day/time for a call each month starting in March.
- **ACTION**: Jeremy will distribute polls to schedule a call in January, the meeting in February and a recurring monthly call for March and beyond.

Wrap-up, review actions and next steps

- Kathy suggested panelists should come prepared with questions and thoughts for discussion of the previous panel's recommendations in December.
- **ACTION**: Panel members should bring their questions and thoughts about previous panel's report and framework for discussion on December 12th call.
- Rob suggested including background on the wet pond and wetland BMP, what's included and what is not included in that practice definition.
- **ACTION**: Jeremy will work with Jeff to include information about other BMPs related to wetland practices in the materials for December's call, e.g., wet ponds and wetlands, shoreline management (living shorelines) and riparian buffers.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Tuesday, December 12, 2017, 10:00AM-12:00PM
Conference Call

Name	**Affiliation**	**Present? Y/N**
Neely Law (Chair)	Center for Watershed Protection	Y
Kathy Boomer	The Nature Conservancy	Y
Jeanne Christie	Association of State Wetland Managers	Y
Greg Noe	US Geological Survey	N
Erin McLaughlin	MD Dept. of Natural Resources	N
Solange Filoso	Chesapeake Biological Lab	N
Denice Wardrop	Penn State	Y
Scott Jackson	U. of Massachusetts	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	Y
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	N
Carrie Travers	EPA Region 3	Y
Lisa Fraley-McNeal	Center for Watershed Protection	Y
Bill Stack	Center for Watershed Protection	Y

Welcome and introductions

- Jeremy verified participants on the line.

- Neely noted there were three active polls for panelists to provide their availability for upcoming calls and face-to-face meeting. **ACTION**: Panelists should complete all three polls by COB Friday December 15th to schedule future panel calls and February face-to-face.

Overview and discussion of 2016 wetland panel recommendations

- Kathy recapped the charge of the previous wetland expert panel (WEP) that concluded in 2016. That panel was asked to review the existing Phase 5.3.2 Watershed Model's definitions for the wetland restoration BMP and consider wetlands as a land use in the Phase 6 Watershed Model.
- She described the 2016 panel's framework and recommendations, explaining the panel's approach for restored wetland water quality benefits, recognizing the importance of physiographic setting, including watershed condition, and position in the watershed landscape. Denice asked if the previous panel was able to input and check their recommendations using the CBP Watershed Model and observation data. Jeremy noted that the previous panel could not do that while the Phase 6 panel was still in development and that the Watershed Model itself is more of a management model than for specific research questions, however the CBP partnership has ongoing efforts to pull in various observational, monitoring and other available data at local watershed scales. So it may be possible and easier to investigate that sort of question in a year or two.

Overview of Phase 6 Watershed Model

- Jeremy described the Phase 6 Chesapeake Bay Watershed Model and expanded on the modeling background memo provided to the panel in advance of the call. The memo and his slides are available on the panel's OneDrive for future reference. Jeremy noted that he added some illustrated examples at the end of the slides to better explain how BMPs are simulated.
- Kathy explained the placeholder BMPs established for creation, enhancement and rehabilitation in the Phase 6 Model. Jeremy pointed out the placeholder values were simply an average of the Phase 5 values from Jordan et al (2008). He emphasized the panel should not rely on those values in their efforts, as the placeholder was created to ensure the three wetland BMPs had space in the Phase 6 modeling tools and there was little to no substance behind them, just basic logic to distinguish functional and acreage gains.

Discussion: Gaps, concerns and opportunities for the current panel

- Neely recalled Kathy's overview of the WEP (2016) framework, which considered factors that affect retention and input concentrations, e.g., soil carbon, inflows from surface and groundwater, etc.
- Neely posed three discussion questions for panelists that can be considered offline following the call as well:
    - Is there a general sense about the performance (water quality reduction benefits) of the different types of wetlands BMPs should be ranked amongst themselves? With natural wetlands?
    - What are your thoughts on methods used to quantify the water quality benefits for wetlands BMPs and how this may affect approaches used to quantify the water quality benefits of other wetland BMPs (creation, rehabilitation, enhancement)? Is the WEP 2016 logic framework applicable? If not, what is missing? How may these gaps be addressed?
    - What are the gaps, issues from wetland restoration BMP and where and what may it be appropriate to modify (i.e. get more/better information, empirical data, modeling approach) to quantify benefits for other non-tidal wetland BMPs?
    - **ACTION**: Panelists should send their thoughts an input on the above discussion questions to Neely, Kathy and Jeremy by COB Friday January 5th.

- Denice noted that with natural wetlands there are large datasets to look at gradient of natural wetlands' condition. Conditional assessment data for natural and restored wetlands could be useful to the panel.
    - Kathy: CBP's adoption of the previous panel's framework assumes restored wetlands provide greater water quality benefits than natural wetlands; the framework did not address wetland condition. Could the different BMP categories address wetland condition or does condition need to be a considered as an independent, key driver of wetland bmp performance? Is there adequate information, capacity to evaluate or characterize this driver?
    - Denice: There may be a way to use condition assessment data to help calibrate the other categories. There is a collection of 235 reference wetlands across PA, by HGMR; could look at range of scores for HGM assessment for natural wetlands compared to restored wetlands for example.
    - Scott: Would be skeptical of HGM functions in that way, may not crosswalk well to functional assessment for nutrients, for example. Steve felt that HGM could at least give a sense of potential for nutrient effectiveness.
    - Kathy noted the previous panel did not look at literature in terms of wetland condition, may be worth looking into it as Denice suggests. Neely agreed the data could help the panel get a sense of the variability.
    - Ralph noted that cases of wetland creation may take time to observe wetland characteristics in the soils, etc. May want to consider the categories separately given those functions.
- Jeanne: Glad to see that the wetlands were added as a land use in the Phase 6 Model and that there is a recommendation to relativize wetland bmp performance to natural wetland capacity. Natural wetlands often are excluded from TMDL frameworks, thus providing no incentive for protecting and conserving reference conditions.
- Neely: Grappling with variability is always a challenge for panels; the panel can choose to lump, split and make choices based on available data and the uncertainties and confidence that are involved.
- Rob noted there is a lot of variation but a tremendous amount of information about wetlands, wetland buffers and these practices' performance. It is important to balance need for simplified model representation and true variability of wetland conditions that occur throughout the Bay region.

Recap and next steps

- Neely noted the time and committed to following up with the panelists for continued input via email. Will want to build and refine lit review strategy with intent of focusing on lit review at February face-to-face meeting.
- Kathy noted that the panel could be especially helpful for identifying priority studies and reviews. Would also appreciate thoughts on how to organize framework. **ACTION**: Panelists should identify and share any key studies or literature reviews from peer-reviewed or gray sources that are relevant to the panel's tasks. Contact Neely, Kathy and Jeremy with questions. Sources can be uploaded to the panel's OneDrive under the "Literature" folder (additional instructions or organizational suggestions to be shared later, if needed).
- Rob suggested providing list of specific questions to panelists ahead of the next call, referencing back to previous panel work to better direct feedback. **ACTION**: Neely, Kathy and Jeremy will provide panelists with discussion questions for panel feedback via email in advance of the next panel call. Will include requests for input on structure of lit review/synthesis and review of the wetland BMPs. Panelists are welcome to provide thoughts and input to Neely and Kathy on lit review before discussion questions are distributed.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Tuesday, January 23, 2018, 1:00PM-3:00PM
Conference Call

Name	Affiliation	Present? Y/N
Neely Law (Chair)	Center for Watershed Protection	Y
Kathy Boomer	The Nature Conservancy	Y
Jeanne Christie	Association of State Wetland Managers	Y
Greg Noe	US Geological Survey	Y
Erin McLaughlin	MD Dept. of Natural Resources	Y
Solange Filoso	Chesapeake Biological Lab	Y
Denice Wardrop	Penn State	Y
Scott Jackson	U. of Massachusetts	N
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Lisa Fraley-McNeal	Center for Watershed Protection	Y
Bill Stack	Center for Watershed Protection	Y
Margot Cumming	Chesapeake Research Consortium	Y

Welcome and introductions

- Neely verified participants on the line and convened the call.
- Kathy explained a couple clarifications to the December 12 minutes to be added offline.
- Solange mentioned a 2012 study that did meta-analysis of over 600 wetland sites. (Moreno-Mateos, D., M.E. Power, F.A. Comín, and R. Yockteng, 2012. Structural and Functional Loss in Restored Wetland Ecosystems. PLoS Biology 10:1–8.)

Review and discussion of feedback from 12/12 panel call

- Neely recalled the three discussion questions posed to the panel in December and over email and discussed the feedback received with the panel.
  - Q1. Is there a general sense about the performance (water quality reduction benefits) of the different types of wetlands BMPs should be ranked amongst themselves? With natural wetlands?
    - In general, there was a mixed response but enhancement was thought to be lowest boost to benefits.
    - Jeanne suggested there is strong evidence that natural wetlands tend to be better performers than restored, created or enhanced wetlands generally. There should be an incentive to keep them on a landscape in the model.
    - Solange agreed with Jeanne and noted that created wetlands can perform better for some pollutant than others compared to natural wetlands; it can take a long

time for created or restored wetlands to become fully established and functional, so there are some tradeoffs.

    - Denice: It seems that natural are clearly the top performers, while less clear how to rank the practices beyond that.
    - Rob generally agreed. He noted there are perhaps other reasons for prioritizing certain practices; constructed wetlands may be able to approximate water quality benefits but the wider ecological benefits may never be the same as they are for a natural wetland. Can see multiple ways to rank or prioritizing these practices based on various viewpoints.
    - Greg: Seems there are two main things to consider when it comes to water quality. First, what is the load to that wetland? Second, what happens in that wetland? Landscape position determines how much load the wetland can intercept and the characteristics within the wetland determine how effectively it can remove the pollutants.
    - Rob asked for clarification about the landscape position aspect. Is that considering attenuation and drainage area characteristics in the context of the BMP performance? Those seem to be different issues; you have to consider those things when selecting a BMP. Jeremy explained that the Watershed Model already accounts for attenuation or landscape factors outside of the BMP itself, so the panel does not need to focus on those processes.
    - Steve mentioned that as with the previous expert panel, the panel is charged with focusing on the water quality benefits, specifically nutrients and sediment. Also the restoration practice was quantified by the previous panel so we can focus on the other three categories. Should also clarify that "constructed" wetlands are a separate BMP; NRCS has a separate practice standard for that type of heavily engineered system designed specifically for capture or treatment of a source, such as agricultural waste.
    - Neely agreed and explained that we have been including natural wetlands as a frame of reference in our discussions; it is useful for the panel to be aware of. We don't want to ignore other benefits or impacts of these practices, but in the panel's documentation we can acknowledge and be transparent about possible tradeoffs that may exist between water quality and other benefits.
    - There was discussion of preservation or conservation, which is not currently a BMP. It was pointed out that currently wetlands in the watershed model have the lowest loading rate, equal to pristine forest. There was a concern by the previous panel since they were unable to quantify a lower loading rate for wetlands compared to forest. However, if acres of wetlands are replaced by any other land use in the model the simulated load would increase.
    - Neely reminded panelists that they can contact her and Jeremy if they need further clarification of how the land uses or BMPs are simulated in the modeling tools.
    - Neely recalled that the HGM approach has been discussed and so Scott suggested in his comments that the panel should make a clear distinction between condition, function and process and how we translate those factors into our evaluation. She added that we want non-wetland-scientists to grasp the factors within the framework we apply; should keep that in mind moving forward.
- The group discussed Q2 and Q3. Q2: What are your thoughts on methods used to quantify the water quality benefits for wetlands BMPs and how this may affect approaches used to quantify the water quality benefits of other wetland BMPs (creation, rehabilitation, enhancement)? Is the WEP 2016 logic framework applicable? If not, what is missing? How may these gaps be addressed? Q3. What are the gaps, issues from

wetland restoration BMP and where and what may it be appropriate to modify (i.e. get more/better information, empirical data, modeling approach) to quantify benefits for other non-tidal wetland BMPs?

  - Greg reiterated the point that landscape position is important. Floodplains may not be connected at all times during the year, but they
  - Solange noted a concern with the temporal scale of retention in floodplain areas compared to headwater riparian wetlands. Floodplain wetlands may retain a lot but if the upstream areas are not in good condition then large events can potentially wash out the retained sediment or cancel out those benefits.
    - Denice agreed and noted there needs to be further discussion on the question and statements so far as to how floodplain wetlands compare with headwater riparian areas; no clear answer yet.
    - Solanage: If you consider the benefits provided given the smaller drainage area, perhaps looking at retention rates per unit area, the upland sites can perform better.
  - Kathy noted that this panel may be able to expand on what the 2016 panel did regarding natural vs created wetlands and relative benefits of the floodplain or riparian wetlands compared to other types.

Panel literature review

- Kathy recalled the key overarching questions for the panel's literature review
  - How do retention efficiencies of restored, enhanced, rehabilitated and created wetlands compare in relation to natural wetlands? Effects of landscape setting?
  - Is there enough information to differentiate among practices when modeling water quality benefits? Can we simplify or group into a single BMP?
  - Kathy reiterated that "constructed" wetlands are not considered; focused on wetlands that attempt or intend to provide natural wetland functions, at least in theory.
- Kathy reviewed the framework from a recent study (Kreiling, Thomas and Richardson, 2018, Journal of Environmental Quality) that looks at the condition of both a wetland and its watershed. Kathy suggested a version of the Kreiling framework adapted for the panel's purposes. Can perhaps use the framework to test various hypotheses about the performance of wetlands or BMPs in various conditions or settings.
- Denice pointed out that the initial presentation suggests the degradation or loss of function is non-linear especially past a certain threshold, while the gain in value or recovery of function is linear. Neely agreed that actual data will not be as neat or linear, and added that the theoretical framework can at least help to organize our thought process and evaluation.
  - Solange: Natural wetlands can perform very well but they can also change over time if the system is overwhelmed by pollutant loads in the long term.
    - Denice agreed and described experiences where there can be lag times in how long a wetland takes to recover function, and also cases where older wetland systems flatline.
  - Solange: "natural" does not mean "pristine."
- Kathy noted an issue that the presented framework implies that you are not only restoring or fixing the wetland itself, but the surrounding area as well, from degraded or disturbed to a more pristine condition. There may be a way to weight factors as a solution that issue. Denice suggested that we may be able to set guiding principles to help guide the analysis. The conceptual framework seems helpful; perhaps we can band the X-axis or Y-axis to clarify the approach.
  - Kathy suggested that panelists should make a note of the monitoring duration in studies they review. That could help the understanding of performance or changes over time.

- Greg: the wetland and watershed condition are conceptually related and we will need to carefully distinguish them in our panel's work.
- Neely: generally the Y-axis is the watershed loading or characteristics while the X-axis represents the conditions within the wetland itself. Unsure where the hydrologic pathways could fit in. Kathy pointed out that the Y-axis is not dependent on the X-axis in that case.
- There was discussion that the wetland and watershed condition may be related too much to have them as an X- and Y-axis.
    - Denice suggested the Y-axis made sense as wetland or overall function while the X-axis was disturbance or watershed condition. Curious to know if recovery of function can return function along the same non-linear degradation curve or not. There are outliers on the curve in instances where the condition has special case, e.g., highly urbanized area but there is a large buffer around the wetland.
- Denice and Greg suggested the two axes may be helpful to sort and bin the different types of practices or benefits.
- Kathy proposed working with conceptual model a little more offline and add some of the related questions and information to the literature review.
- Kathy reviewed the field categories used in the previous panel's lit review by Tetra Tech. She encouraged panelists to suggest any other information fields that could be beneficial during the review (e.g., duration of study monitoring).
- **ACTION**: Panelists should send additional input on the conceptual framework to Neely and Kathy by Wednesday, January 31st.
- **ACTION**: Neely and Kathy will send guidance to panelists for the literature review the week of February 5th.

Recap and next steps

- Neely described some logistics for panelists travel to the meeting, now scheduled for February 28th and March 1st at the USGS office in Catonsville, MD near BWI. **ACTION**: Neely will provide instructions to panelists via email regarding travel reimbursement procedures.
- Neely and Jeremy noted that panelists can begin uploading references to the shared OneDrive folder.
- **ACTION**: Panelists should contact Jeremy if they have any issues accessing the group's shared OneDrive folder.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Wednesday, February 28 to Thursday, March 1, 2018
Meeting

Name	Affiliation	Present? Day One	Present? Day Two
Neely Law (Chair)	CWP	Y	Y
Kathy Boomer	TNC	Y	Y
Jeanne Christie	ASWM	N	Y
Greg Noe	USGS	N	N
Erin McLaughlin	MD DNR	Y	Y
Solange Filoso	UMCES CBL	Y	Y
Denice Wardrop	PSU	Y (phone)	Y (phone)

Scott Jackson	UMass	Y (phone)	Y
Steve Strano	NRCS-Maryland	Y	Y
Rob Roseen	Waterstone Engineering	N	N
Ralph Spagnolo	EPA Region 3	Y	Y (phone)
Panel Support			
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y	Y
Jeff Sweeney	EPA, CBPO	N	N
Carrie Travers	EPA Region 3	Y	Y (phone)

DAY ONE
Debrief from public session, getting started

- Neely summarized objectives for the afternoon and recalled discussion from the morning's open session, asking panelists to share key points or lessons from that session.
- Erin commented that federal definitions for the practices still causing confusion and will need to careful of that moving forward.
  - Solange agreed that classification of wetlands/practices may be different between literature and federal or panel terms.
  - Denice: seems that it is very practice-specific based on the study site; practices could be considered different things in different contexts, e.g. rehabilitation versus enhancement.
  - Ralph suggested when looking at the literature panelists could perhaps identify the specific functions the authors are looking at; if the study looks at only one function it is probably an enhancement project, if it is six functions it is rehabilitation.
- There was further discussion of definitions and the group briefly revisited the WEP2016 definitions that were based predominantly on the federal (EPA, USACE) definitions for compensatory mitigation, but with some minor differences. Steve noted that NRCS standards are different, particularly for rehabilitation which is considered "restoration" by NRCS. It was mentioned that in soils manual, if hydric soils are present it is considered re-establishment (restoration for CBP), if not, establishment (creation for CBP).

Lit review report outs

- *Slides from each panelist are posted on group's OneDrive; bullets or text from slides not repeated here, only key questions and discussion are captured.*
- Neely reviewed Moreno-Mateos et al 2015; Hefting et al 2013.
  - Jeremy: Hefting et al found concerning N2O loss at lower pH and other conditions (wetlands bordering lower-order streams fed primarily by shallow groundwater)…are any of those conditions possible or observed in the CBW? Neely pointed out the Dommelbeemden site was 3rd order stream ag, flow bypassed wetland area that included peat on top of sand. Discussion among the group suggested that this is probably not a transferrable concern for conditions in the CBW; acidic conditions created by organic leachate.
- Erin: Brinson 1993; Mitsch et al 2014.
  - Some discussion of the Mitsch et al study site, a research park complex at Ohio State. Carefully designed and controlled site that allowed for careful measurements.
- Solange: Land et al 2016; Filoso et al 2015
  - Solange noted that Land et al lumped restored and created wetlands together.
  - Solange noted an error on one of her slides about Filoso et al 2015; ignore the low density urban and high density urban practices.

    - Solange felt that going forward, the large systematic reviews are very useful, help us understand what factors may control the variability.
- Kathy, reviewed five papers. Palmer-Felgate et al 2013 and Thorslund et al 2017 less applicable; she focused presentation on two: (Newcomer) Johnson et al 2016 and Moreno-Mateos et al 2015 (latter overlaps with Neely). She also gave an overview of Newman et al 2015.
    - Kathy thought it might be beneficial if we can reach out to Johnson et al 2016 authors to utilize and build on their database. She noted that Moreno-Mateos et al 2015 includes some basic cost data.
    - Kathy noted that the Newman et al 2015 authors articulated their search and screening approach; initial search over 111 thousand hits; total number of articles included in the database and assessment, only 19. Most of the data was for constructed wetlands and not relevant.
    - Denice noted that Table 1 from Newcomer Johnson study was consistently in the 60-75% range for "positive results." Solange pointed out that most of the studies and data was based only on concentrations and may be misleading. Want to be careful that studies of effectiveness are in fact based on proper indicators and measures of their performance and effectiveness (e.g., loads that account for flow and concentration).
- Discussion of first four report-outs by Neely, Erin, Solange and Kathy.
    - Denice: we start trying to understand expectation of positive results and from there we can try to understand the variability.
    - Neely: in natural systems, we see many complex relationships and "spaghetti diagrams" where everything is supporting or influencing everything else; when we design or consider restoration it is much more linear.
- Next three report-outs by Denice, Ralph and Scott.
- Denice: Ballentine and Schneider 2009, a long term look at a restored wetland in comparison to reference natural wetland. Also reviewed Wardrop et al 2007.
    - Ralph asked for clarification about soil function and the first study (Ballentine). Denice noted the authors looked at cation exchange capacity (CEC) as a proxy, and even after 50+ years, still only saw half the CEC at the restored site compared to the reference natural site. Neely noted that the Moreno study also showed that the soil function was slow to return. There was discussion that indeed organic matter is slow to rebuild in the soil, but that the Ballentine study is probably not representative of wetlands and practices in most of the CBW, more applicable in glaciated areas and Great Lakes. Denice noted the Ballentine study did compare their results to wetlands in other states, including PA, VA and MD though.
- Ralph: Kreiling et al 2013. Ralph noted there were some issues with the restored site, e.g., not as wet as they intended; found natural wetlands in the complex performed much better overall. Doherty et al 2014, also in Wisconsin (3 parallel swales at UW-Madison Arboretum), Ralph also considered this a constructed wetland. Ralph felt the study suggests that wetter is not always better. There was group discussion about the results and general agreement that wetter may not always be better, want to be careful about message and potential impacts from recommendations.
- Kathy suggested the panel could build on WEP2016 work, specifically by describing typical characteristics for the hydrologic regime of "other" wetlands in each physiographic province, based on the type and location of those "other" wetlands as described in the WEP2016 (e.g., headwater Delmarva Bays and flats which occur in the Outer Coastal Plain)
- Scott reviewed Hunt et al 2014 and Dusey et al 2015. He noted that most of the co-authors were the same for each study, but the lead author was different. Same three objectives in each study, but different sites, Hunt et al sites were in Mid-Atlantic Coastal Plain (Delmarva Peninsula) and Ducey et al sites were in North Carolina, near Virginia border.

- Ralph: were the restored wetlands the same type as the natural? Scott indicated no, they were not the same type, but they did try to mimic hydrology of the reference sites.
- Steve asked for clarification about the DEA and nosZ results in Hunt et al 2014. Scott noted the authors' conclusion that the restored sites may never achieve function of natural sites, the practices are beneficial but due to the legacy conditions of their sites they may never achieve same functionality. Solange noted that the restored sites may have greater nosZ due to elevated existing nitrate in the soils.
- Jeremy asked about the timeframe/age of restored sites in the studies and if they are similar ages in each study. Scott noted that for Delmarva, sites were 2-8 years old prior to study; in NC all were restored between 2004 and 2006, so about 6-8 years old based on when study was published.

- Neely asked for thoughts and input from the group about what stood out, so group can start to get a sense of where we are going next. She summarized the points below on a flip chart.
  - Scott felt meta-analyses noted high variability; was very interesting to see Mitsch paper and their performance and the emphasis/importance about the landscape position. Concern with lumping different wetland types in some studies given many processes at work.
  - Denice: We know organic matter is important for denitrification, but not for sediment removal. Driving factors/processes for N, P and S (different functions).
  - Solange: Complexity of interacting functions (trap sediment/P, dilute OM accumulation→denitrification)
    - The positive effect of wetland function to trap sediment therefore, may have a negative, less positive effect to reduce N via denitrification; understanding of 'intermediate' steps that affect N, P and S within wetland
  - While there is a lot of variability reported in the literature, is the variability of natural wetlands similar to the variability observed with wetland BMPs?
  - Constructed wetlands, there is a wide range of input concentrations and loads so the variability is understandable in that sense; for natural wetlands the drivers may be the same but the range of input concentrations (or loads) may be narrower.
  - Techniques/designs/practices for wetland BMPs affect hydraulics (flow), but not the incoming concentration (watershed); therefore important to evaluate loads
  - Water chemistry of the source water is another driver, e.g. diverted river water if it was historically a groundwater fed site.
  - Did not see as wide variation among the wetland BMP practices over time.
  - Some practices can achieve natural performance level, at least at individual practice level (e.g., Mitsch study).
  - A lot of organic matter was lost over time, oxidized. Much harder to recover to the natural condition from the prior-conversion. Losing a foot or more of OM in some areas.
- There was group discussion about overall approach, pre-meeting questions and conceptual models. Kathy commented that the group was asking the right questions, but less optimistic that it is possible to extract the necessary information from the research to fully address and answer them.
  - Studies to capture natural variability; observational
  - See Land et al 2016
  - Review natural wetland studies. The BMPs intend to mimic the functions of the natural wetlands; can use to inform our work as a source of reference for the BMPs.
  - Can learn from the meta-analyses and what they found, which studies they focused on and why.
  - Is the variability in the BMPs associated with natural wetlands too? Useful analogy for our work.

DAY TWO
Facilitated open discussion

- Neely recapped the first day. She recalled two of the meta-analyses that identified very large numbers of studies and narrowed it down to only a small number of them for their objectives; it seems that literature can inform a conceptual model but likely insufficient to give us specific values or numbers.
- Denice mentioned the STAC Workshop report for BMP performance uncertainty. There was discussion about how the panel may be able to build on the workshop's recommendations to the extent we can. Newman et al and Land et al were identified as two studies that did a good job of explaining their process for narrowing down the articles.
    - Kathy added that the initial WEP2 panel discussion and process of documenting different models of how wetland water quality benefits vary in relation to wetland condition (i.e., natural vs restored, rehabilitated, enhanced, or created) is based on principles of expert elicitation, as promoted by the STAC uncertainty workshop. Ideally, a full set of conceptual models that includes or captures all panel members' beliefs and expectations will provide a basis for guiding the literature review and data analysis.
- Steve mentioned that some of the articles reviewed so far may challenge the conceptual model that natural wetlands always perform better than restored sites.
- Scott noted that there is a range and variability for all the natural and restored or rehabilitated or created wetlands. If we had a plot of all the wetlands' performance we would see dots or points all over the graph.
- Kathy pointed out that the panel has multiple conceptual models to work with so far; we want to see what modifications we want to make or if there are alternatives.
- Denice agreed the conceptual models have been very helpful for organizing the panel's work, but the models so far have been similar in their view or interpretation of how the world works, and we may want to consider alternatives that take a different view. She noted that the CBP is also a living resource program and it is important to not be overly focused on water quality. Erin echoed the concern and mentioned that many programs do their planning based on living resources or other non-water-quality criteria, but for the model those actions still need to be interpreted in a water quality context so they can get some credit for those living resource projects.
- Neely commented about experiences on the stream health side of the CBP. Current discussions at CBP about co-benefits of BMPs. Past Expert Panels provide narrative; Tetra Tech report attempt to rank/quantify based on ordinal scale the co-benefits of BMPs, but analysis had very limited data to support; reliance on professional judgement; Panel has opportunity to define and describe these benefits on its own terms.; Discussion supported narrative approach and not note quantification of co-benefits where provided but EP needs to focus on water quality benefits
- Scott recalled a wetland function deficit analysis effort in Massachusetts, where they tried to assess the balance of all wetland functions, watershed by watershed, to understand which functions were in deficit; the effort proved to be too resource intensive. He commented that often in areas where you are working to reduce pollution it is an area that is not ideal for biological functions or habitat, e.g., it is highly developed or impacted.
- Jeremy mentioned the CBP partnership has efforts underway to better understand "co-benefits" of all BMPs; many partners and managers recognize the need to consider effects beyond water quality. As a single panel we are able to make recommendations and provide basic or narrative information but the wider partnership needs to determine the overall path forward before panels can provide the kind of information the managers want.
- Jeanne asked perhaps there is a way to include or recognize stacking benefits?
- Denice noted she had to leave the call early; she felt the group may be able to have a simple approach or framework, indicating potential positive or negative impacts to non-WQ functions.

- Solange suggested encouraging a local scale approach for planning or incentivizing projects designed for the local functional needs and conditions.
- Steve: most of the time for voluntary wetland projects we are simply returning hydrology or vegetation. Most of the planners doing wetland work are biologists or ecologists by training.
- Jeremy commented that each axis and component of the conceptual models so far seem to have their own underlying variability, distribution. He suggested the group may need to break down each aspect of the conceptual framework in a piecemeal way to determine the path and eventual answers.
- Solange: probably will not get our answers only from the ranges and variability, but from understanding the drivers of the variability.
- It was agreed that the Land et al 2016 paper is worth a look by others. **ACTION**: Panelists should read or skim Land et al (2016) systematic review.

Continued Discussion

- Neely asked for panelists' input on two questions, (1) how to handle co-benefits in panel's framework/approach, and (2) thoughts on conceptual models, including (a) specific likes/dislikes or (b) improvements.
    - Scott shared a slide and potential approach for understanding the pollution reduction benefits, considering the factors that determine capacity and opportunity, which together inform the functional potential, followed by discount for degradation and a pollution reduction score. *Scott's slide is posted to meeting folder in OneDrive as "framework.pptx"*
        - Steve noted the practices are improving a degraded site, and may not make sense to use natural sites as point of reference.
- Co-benefits? How to handle or address them? Possible options, with narrative, identifying plus or minus,
    - Steve noted NRCS has conservation practice physical effects that is an example of trying to give simple -3 to +3 scores of a practice's effect on other resources. There is so much uncertainty though; the panel could spend a lot of time on even a simple matrix, so narrative warnings and information may be the best approach.
    - Kathy suggested building on WEP 2016 framework, using the tables that panel developed to summarize the types of wetlands that exist in various landscapes of the region. I.e., a narrative combined with simple scoring similar to the "high, medium and low" used by WEP 2016.
    - Jeanne: not sure what kind of approach to recommend in this context, but suggest we push the envelope to encourage planners or decision makers to consider the broader picture of co-benefits. May not be able to be conclusive in our role, but can identify the next steps and things they should consider.
    - Erin: if we can go down that road and start looking at the stream restoration there is an opportunity to address and improve protocol 3 (floodplain reconnection) in coordination with what our panel has to say. Do not think we should take an approach like a recent CBP co-benefits report (scoring on a -5 to +5, ten point scale), but a simple framework to present the information could be useful.
    - Solange: we should focus on outcomes and priorities, having summarized scores looking at those outcomes or priorities and the contribution wetlands or wetland BMPs can make.
    - Scott noted some of the practice categories offer improvements and net benefits (creation, re-establishment and rehabilitation) while enhancement may involve some losses or impacts to other functions to get the gains in another specific function like water quality. May want a cautious approach to enhancement given the potential impacts to other

functions. Could factor these plus or negative gains/impacts, may be able to fit within the crediting approach.
    - Neely suggested that some information from the practitioners like Steve or Erin about typical examples of the different practices, which could be helpful for organizing and informing the panel's work. **ACTION**: Jeremy and Neely will work with Steve and Erin to identify/describe common 'restoration' techniques (design strategies such as ditch plugs and berm excavations) to help panel associate a practice(s) with possible wetland function(s)/characteristic(s).
    - Steve noted that these wetland projects never or rarely look at water quality explicitly, it is about habitat first. Neely commented that it is similar to street sweeping, in a way, because street sweeping is done for aesthetic or other reasons, but there have been many past studies and recent studies to understand the WQ benefits. The idea is that since resources are spent on the practice it is important to have some estimate or sense of the water quality benefits, since the practice is being done anyway.
    - Carrie noted that the practice could become more about water quality, similar to what has happened with stream restoration since those projects became eligible for credit toward the TMDL. She agreed with others that quantifying co-benefits could be very difficult.
    - Erin mentioned that the vast majority of effort currently goes into wetland rehabilitation rather than enhancement or creation.
    - Neely reiterated Kathy's suggestion to build on the narrative and information from the previous panel. Pushing the envelope would be an important contribution.
- *Discussion of conceptual models: likes/dislikes? Improvements?*
    - Scott listed factors he felt were key for such conceptual models
        - Capacity for ponding or flooding
        - Flood ratio
        - Retention
        - Presence of constrictive outlet
        - Sloped versus flat; residence time
        - Sheet flow versus channelized flow
        - Duration of inundation
        - Vegetation
        - Soil
    - Steve: Site conditions starting from determine characteristics and components for the N, P and S functions/processes. Three major factors:
        - Type of vegetation, how much is vegetated
        - Inflow source area, agricultural or not?
        - Watershed to wetland ratio
    - Moving in direction of describing factors that determine performance for N, P and S.
    - Kathy suggested next steps to advance understanding of putting information into base "boxes" of Scott's model; by explicitly describing the characteristics of "other" wetlands in each physiographic province, defining the typical hydroperiod and other characteristics of the hydrologic regime that may affect water quality benefit capacity, and assessing connectivity to up-gradient sources of excess nutrients and other pollutants. Need also to refine definitiions of wetland bmp definitions to bridge the science and management definitions.
    - Capacity is what the site can do; opportunity is what goes into the site or is contributed to the site. Build on WEP1, be more explicit about types of wetlands' characteristics in the regions. Describe "other" wetlands more explicitly, hydro regime, how they function relative to water quality;
    - Will likely need to revisit and extract info about type of practices, functions, or other info

Logistics and Next Steps

- Jeremy noted that multiple panelists (Jeanne, Steve, Rob, Greg) and Bill Stack still needed to give a lit review report for their selected studies. However we do not want to fall behind by spending next month on that item, so he committed to scheduling two calls for the panel. The first call (tentatively) in late March or early April to finish literature report outs; second call to discuss the next iteration of what was discussed today, i.e. expanded info from WEP1, any updates to conceptual models, etc. following the meeting. Jeremy will distribute a poll for panelists to indicate their availability.
- **ACTION**: Kathy and Neely will take panel input and present updated framework to help focus literature review. Begin with expanding on Table 10 from WEP2016's framework, to further characterize 'natural' wetland types that will help to evaluate effect of wetland BMP on water quality.
- Neely, Kathy and Jeremy thanked everyone for their participation and contributions.

Adjourned

SUMMARY OF DISCUSSION
Nontidal Wetland Rehabilitation, Enhancement and Creation BMP Panel – Open Session
Wednesday, February 28, 2018 10:00AM – 12:00PM
USGS Water Science Center (Catonsville, MD)

CBP calendar entry and materials:
https://www.chesapeakebay.net/what/event/open_session_nontidal_wetland_rehabilitation_enhancement_and_creation_bmp_e

Archived webinar recording: http://epawebconferencing.acms.com/p1m4y8qiaah/

Welcome and Introductions

- Jeremy Hanson (Virginia Tech, Chesapeake Bay Program Office) welcomed participants. His presentation slides provided background and context about the BMP expert panel process and the charge for the current panel.
- BMP Panel Background:
  - Best Management Practices = practices that reduce pollution loads when implemented
  - Panels use best information to evaluate current practices
    - Produce write up a report of recommendations
    - Goal of adding specific BMP to the modeling tools for next 2-year milestones
- Wetlands in the Phase 6 Watershed Model
  - Previous wetland expert panel convened late 2014 – late 2016 with goal of land use classifications for wetlands and specific BMPs
    - Two land uses were accepted for nontidal wetlands in the Phase 6 Watershed Model (floodplain, other)
    - 4 BMP categories accepted: restoration, creation, enhancement, rehabilitation
      - The previous panel defined reductions for restoration – other 3 categories to be defined by the current panel
  - See previous report posted on the 2/28/18 CBP calendar entry or under BMP expert panel publications: https://www.chesapeakebay.net/documents/Wetland_Expert_Panel_Report_WQGIT_approved_December_2016.pdf
- Current Panel aiming to evaluate three remaining BMPs for rehabilitated, created or enhanced wetlands

- **Not** "constructed wetlands" as described by the previous expert panel, which are designed and engineered for specific treatment of wastewater or other similar sources; urban stormwater wetlands; floating treatment wetlands; stream restoration; shoreline management; or forest buffers
- Goal to deliver draft report within 12 months after panel's first conference call (November 2017), followed by 3+ months for partnership review and comment process

Panelist Introductions

Stakeholder Presentation and Discussion

- Steve Strano slideshow, "Wetland BMPs within Agricultural Landscape on the Maryland Coastal Plain" provided pictures and overviews of several example wetland projects in Maryland.
    - With artificial drainage features that drain agricultural lands, water may still run through wetlands but limited storage or treatment in some cases.
        - Reestablish wetland with berm – previous ag land converted back into wetlands
            - Small wetland features at outlets of drainage ditches can provide some treatment
        - Rehabilitation – often uses techniques to encourage water to slow down through wetlands near agricultural areas (weirs, ditch plugs)
    - Floodplain disconnection from dredging and channelization
        - Levee breach projects allows for water to access floodplain and associated wetlands
- Questions:
    - Solange Filoso: does spoilage levee removal impact infiltration?
        - Response: the impacted spoil piles are not the wetland areas – wetlands behind spoil piles. And the soils are very sandy which fosters infiltration
    - Denice Wardrop: define differences between reestablishment, rehabilitation, reconnection?
        - Strano explained typical projects and the NRCS definitions for each category:
            - if have ag field, with no wetland functions / OR restoration of prior converted wetlands = **reestablishmen**t.
            - Wooded wetlands that have drainage through (i.e. have hydrology and natural plant community) = **rehabilitation** to help alter drainage flows.
            - Taking a wetland and doing something to change function OR changing plant communities (removing invasives) = **enhancement**.
            - Creating a wetland in non-hydric soils = **creation**.
    - Kathy Boomer: in literature, are the researchers' definitions consistent with each other and/or federal definitions?
        - Strano responded that the scientific community doesn't always connect with implementers, so language are often different.
        - Ralph Spagnolo – the previous panel decided to go with EPA and Army Corps definitions, and the literature often doesn't reflect the 4th category of enhancement
        - Solange Filoso – in situations when stream restoration is combined with wetlands, line is especially unclear
        - Steve Strano – NRCS has some specific practices that include wetland work but is reported with stream restoration

- Neely Law: when doing work, are there multiple types of practices happening at one project site?
  - Strano: yes – often
- Neely Law: in ag fields where there was a preexisting wetland, is lowering of groundwater table an issue and is this investigated in these practices?
  - Strano: groundwater is hard to monitor, and we focus on structural and vegetation success. Often, can infer the groundwater behavior based on topography and soils. Also, important to rely on adaptive management – continually adjust.
  - Kathy Boomer: groundwater studies often are short term and seasonal, so it is hard to translate that into long term
- Jeremy Hanson: how was the two-stage ditch funded or designed under NRCS standards? As an NRCS 658 practice for wetland creation?
  - Strano responded it was lumped into wetland restoration because some areas had hydric soils. Could also potentially be considered as "constructed" – treating agricultural runoff.
  - Kathy Boomer: with this kind of ditch restoration we are seeing additional water quality benefits due to shallow groundwater interactions with plant communities in the ditch benches.
  - Jeremy Hanson: There is an ongoing panel for agricultural ditch BMPs – will follow up with them regarding two stage ditches and potential overlap.
  - Steve Strano – get into increasing wetland functions due to water manipulation structures – ex: partial flooding of farm fields
- Solange Filoso: cost of different BMPs and difference in effectiveness?
  - Strano noted that ditch pugs are cheapest, but if able to do field restoration should take advantage of that.
  - Solonge Filoso: at some point, a cost benefit analysis might be useful?
  - Strano: not enough people for that to be useful, try to be opportunistic and act when possible

Closing Thoughts and Discussion

- Contact Jeremy Hanson with any further questions:
  - JCHanson@vt.edu
  - (410)267-5753

Adjourned

Participants

Name	***Affiliation***
In-person	
Jeremy Hanson	Virginia Tech, CBPO
Ralph Spagnolo	EPA Region 3
Neely Law	Center for Watershed Protection
Steve Strano	USDA NRCS, Maryland
Erin McLaughlin	MD Dept. of Natural Resources (DNR)
Margot Cumming	Chesapeake Research Consortium, Habitat GIT
Kathy Boomer	The Nature Conservancy (TNC)
Solange Filoso	UMCES Chesapeake Biological Labratory
Carrie Traver	EPA Region 3
Bruce Michael	MD DNR
Rebecca Cope	EPA Region 3
Remotely	
Denice Wardrop	Penn State
Amy Jacobs	TNC
Jeff Sweeney	EPA, CBPO
Melissa Yearick	Upper Susquehanna Coalition
Alana Hartman	WV Dept. of Environmental Protection
Jim Bays	JACOBS
Loretta Collins	Univ. of MD
Stephen Reiling	DC Dept. of Environment and Energy (DOEE)
Jennifer Dietzen	DC DOEE
Karen Coffman	Maryland Dept. of Transportation State Highway Admin. (MDOT SHA)
Ryan Cole	MDOT SHA
Kristen Saacke-Blunk	HeadWaters LLC

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Tuesday, April 3, 2018, 2:00PM-4:00PM
Conference Call

Name	**Affiliation**	**Present? Y/N**
Neely Law (Chair)	Center for Watershed Protection	Y
Kathy Boomer	The Nature Conservancy	Y
Jeanne Christie	Association of State Wetland Managers	Y
Greg Noe	US Geological Survey	Y
Erin McLaughlin	MD Dept. of Natural Resources	Y
Solange Filoso	Chesapeake Biological Lab	Y
Denice Wardrop	Penn State	Y
Scott Jackson	U. of Massachusetts	N
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	N

Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Lisa Fraley-McNeal	Center for Watershed Protection	Y
Bill Stack	Center for Watershed Protection	Y

DECISION: The minutes from February 28 and March 1 were approved.
ACTION: Solange will share the two articles with the group. **Post-meeting note:** The articles have been uploaded to the group OneDrive.
ACTION: Carrie offered to check if there were any relevant ones missing from the panel's list and share them related to Greg's summary on isolated wetlands.

Welcome and introductions

- Jeremy checked attendance and thanked everyone for participating on relatively short notice. Panelists' schedules did not provide many options with a critical mass of panelists, so he was thankful they could get together with less than a week notice.
- Jeremy noted he made one small edit provided by Scott to the minutes for the face-to-face meeting. He asked if there were any other edits or corrections; hearing none, the minutes would be considered approved.
- **DECISION**: The minutes from February 28 and March 1 were approved.
- Jeremy mentioned that all the panel minutes would eventually be compiled as an appendix to the report so he encouraged panelists to review minutes and ensure they are accurate.

Lit review report-outs

- *Written summaries/slides available on the group OneDrive. Points or statements written on the slides are not repeated. Highlights from discussion are summarized here.*
- Rob reviewed Gold et al 2001, Groffman et al 2006, and Dupas et al 2015.
    - Solange noted there was a 2013 article in Water Resources Res, with additional conclusions addressing residence time and flow through denitrification hot spots. Also it is important to consider the concentration of nitrate for the wetlands to intercept for denitrification. She described another paper by Kaushal and Groffman (2010?) that used marked nitrogen to track the residence time and flow through denitrification hot-spots. **ACTION**: Solange will share the two articles with the group. **Post-meeting note:** The articles have been uploaded to the group OneDrive.
    - Kathy commented the articles reinforce work from previous panel, and the importance of flowpath and residence time for pollutant removal.
- Steve reviewed Ligi et al 2014; Tanner and Kadlec 2012.
    - He noted the Ligi et al study was on the same Ohio State research complex as Mitsch study. The authors had noted that 1/3 of denitrifying bacteria lack the nosZ gene, so the process ends in N2O instead of N2. Study looked at relative abundance of the genes in the microbes of each wetland.
    - Denice asked about sampling regime for the microbial community for each wetland on the site. Steve noted the authors couldn't determine what factors affected the abundance of the nosZ genes.
    - Tanner and Kadlec 2012 study used a model, using flow data from two agricultural catchments with contrasting hydrological regimes; catchments located in New Zealand, 7 years of climate and flow data for established wetlands treating tile-drainage flows.
- Jeanne reviewed Christen and Daalgard 2012; Mitsch et al 2012.

- Christen and Daalgard study looked at buffers, not wetlands specifically, but had some interesting insights for stackable benefits and management of riparian areas in general.
    - Erin had reviewed the other Mitsch study and agreed with Jeanne's assessment of the data and conclusions that seemed counter-intuitive in the 2012 study. However, the study site and practices are not reflective of practices in the Chesapeake Bay Watershed.
    - Erin noted that removing existing vegetation is not something that would be done for restoration in the region.
- Greg reviewed Houlton and Morford 2015; Golden et al 2017.
    - Solange commented that Golden et al is important since "isolated" wetlands in parts of the watershed are still connected to waterways and cumulatively contribute quite significantly. Greg agreed, and it reinforces the point that landscape position matters.
    - Carrie noted there have been a number of very recent papers she had seen. **ACTION**: Carrie offered to check if there were any relevant ones missing from the panel's list and share them related to Greg's summary on isolated wetlands.
- Bill reviewed Gemiermo et al 2013; Hansen et al 2018; Zhou et al 2014.
    - Kathy asked if Hansen et al study had consistent understanding of the wetland types or BMP types. Bill explained the article did not distinguish between natural and restored or enhanced wetlands, but looked at overall contribution of wetlands at watershed scale.
    - Kathy noted that landscape position continually comes up as an important factor in the reviewed studies. Solange agreed and also commented that the overall presence of wetlands seems more important than whether the wetlands present were established or re-established.
    - Rob: seems we are getting some consistent and predictable information on wetlands and BMPs, and where we don't have consistent information it seems to be for things that are mostly absent from literature. Rob noted that incentivizing conservation is something they are looking at in the northeast to help meet goals.
    - Kathy: there is a real need to bridge managers' and researchers' definitions of wetlands and wetland BMPs. If the panel can clarify and help bridge that gap as part of its recommendations it would be a significant contribution.

Next steps

- Jeremy noted the next call will be Tuesday, May 1st. He and Neely thanked everyone for their contributions and completing the lit reviews. Kathy agreed and commented it will be a good time to revisit the original questions and hypotheses to see what needs to be updated going forward. They thanked everyone for their participation and discussion.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Tuesday, May 1, 2018, 1:00PM-3:00PM
Conference Call

Name	Affiliation	Present? Y/N
Neely Law (Chair)	Center for Watershed Protection	Y
Kathy Boomer	The Nature Conservancy	Y
Jeanne Christie	Association of State Wetland Managers	Y
Greg Noe	US Geological Survey	Y
Erin McLaughlin	MD Dept. of Natural Resources	N
Solange Filoso	Chesapeake Biological Lab	Y

Denice Wardrop	Penn State	Y
Scott Jackson	U. of Massachusetts	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	N
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Lisa Fraley-McNeal	Center for Watershed Protection	Y
Bill Stack	Center for Watershed Protection	Y

DECISION: The minutes from April 3 were approved.
ACTION: Panelists will receive instructions via email and will be asked to provide the requested information/fields for their two studies.
ACTION: Panelists should look over the strawman table and provide feedback to Jeremy, Neely and Kathy by COB Wednesday May 16.
ACTION: Neely and Jeremy will look into Nature's Network and nutrient enrichment dataset offline with Scott.
ACTION: Prior to the next call (TBD), panelists should review Chapters 4-5 of the WEP 2016 report consider if the framework and approach discussed today adequately capture the importance of landscape position and source loadings as a way to describe wetlands' potential to improve water quality.
ACTION: Neely, Jeremy and Kathy to follow-up offline with Denice about potential use for PA wetlands HGM database.
REMINDER: If panelists have not already done so, they should submit their expense reports to the CWP as previously instructed. Contact Neely if you need further information and instructions.

Welcome and introductions

- Jeremy checked attendance and thanked everyone for participating on relatively short notice.
- **DECISION**: The minutes from April 3 were approved.

Findings from lit review and next steps

- Neely noted the panel is now 6 months into its 1-year schedule, and still on track overall. Around now the goal is to begin drafting and describing the crediting framework, so she, Kathy, Jeremy and CWP staff have been discussing the panel's work so far and potential stepping stones the current panel can use from the previous panel (WEP 2016). She recapped the panel's task to determine the BMPs' benefits and reviewed how the BMPs are credited in the model.
- Neely explained that the conceptual framework discussed in previous calls did not seem to resonate with the panel and ways to best represent literature findings and understanding of wetland functions on water quality. The discussions so far have yielded insights and also reinforced much of the conclusions by WEP2016. She described how she and Kathy are suggesting the panel may expand on the WEP2016 work to describe and classify wetland functions of natural wetlands, techniques/methods used to modify functions in degraded wetlands, associate those techniques with different wetland BMPs (restoration, enhancement, creation), and finally define and quantify the benefits of the BMPs.
- Neely recapped what the panel discussed and saw in its lit review over the past couple months.

- Neely asked panelists to add attributes to the database/spreadsheet, including BMP type and definition, techniques used and associated wetland function altered/addressed. Panelists will receive instructions via email. **ACTION**: Panelists will receive instructions via email and will be asked to provide the requested information/fields for their two studies.

Next step: Capturing the importance of landscape position

- Neely revisited Scott's framework and explained how it can inform/guide the panel's work moving forward, in particular for its lower three levels:
  - functional potential = potential for a wetland to reduce N, P and sediment loadings
  - capacity = condition of the wetland; management actions may effect characteristics or size of the wetland
  - opportunity = is wetland present and the existing land use; management actions may not affect the landscape position or loadings.
    - Greg noted that some management actions may impact the connectivity in a way that those boxes on the right side may be affected. Jeremy noted there may be possible feedback or link between capacity and opportunity in those cases.
    - Scott commented that "opportunity" part of the framework is looking in a general way at o the surrounding land use and loadings to the wetland.
- Neely linked the landscape position box in Scott's framework to Table 10 in the WEP2016 report. The loadings box is related to Table 12 in WEP2016 and summarizes how that panel approximated upland "disturbed" area.
- Kathy explained how she expanded on the WEP2016 report and information with respect to landscape position.
  - Denice requested clarification, when discussing "landscape position" are we talking about hydrogeomorphic properties? Kathy confirmedthat it is more about the water, not about the surrounding land cover for that "landscape position" piece of the framework.
- Kathy described how she extracted key information and built on three levels of the WEP2016 report. First, narrative descriptions of the important hydrogeologic factors affecting wetland distribution in different physiographic provinces of the Chesapeake Bay watershed. Then, the types of nontidal wetlands, descriptions of the systems, hydroperiods and retention (table 1 of meeting materials word doc) and the hydrologic characteristics of the most common wetland types in each of the physiographic provinces (table 2). She asked if/how the table(s) can help the panel describe and account for landscape position.
  - Denice asked for clarification on how the table might bridge understanding natural wetlands and the BMPs. Neely noted the tables summarize natural wetland functions. The application is to identify the management approaches/techniques needed to restore these functions of degraded wetlands.
  - Denice pointed out that it will be difficult to have enough information for the finer scale of the wetland types and ecoregions. The difference between a sloping wetland and riverine floodplain wetland in a region may be greater than the difference between riverine floodplain wetlands in two difference regions.
  - Neely: we may not be able to fill in every cell for a table like this, but we want to see if this framework from WEP2016 adequately reflects and can address the importance of landscape position. Panel will need to use BPJ to fill in gaps
  - Scott: we are trying to understand what is potentially entering or contributing to a wetland; the physiographic regions may not be the best way to generalize based on these characteristics. Do not know what a better alternative would be, however.
  - Bill thought this approach was a good starting point.
- Neely recapped the WEP2016's approach to consider loadings based on landscape setting and contributing source area, ultimately deriving Table 12 in their report. She focused on the

opportunity (loadings) portion of the WEP2016 recommendations, how they described high, moderate or low water quality benefit potential in terms of source areas and hydrologic connectivity; and how those were translated to the general upland treated acre ratios.

- Greg noted there may be potential double counting of land use loadings with the ratios given how the credit is currently quantified.
- Kathy clarified this is not necessarily the case as the ratios take into consideration multiple factors to provide a relative basis for the potential for a wetland to treat pollutant loadings (surface and groundwater), to include predominant land use in the physiographic regions, along with landscape position and hydrogeologic conditions affecting the wetland's connectivity to the watershed.
- Solange: loading and efficiencies are not always directly related; increased loads or concentrations do not always result in an increased or decreased efficiency.
- Denice expressed concern that the ratios varied so much between the regions and the potential signals that can send to managers or decision-makers.
  - Kathy explained some of the WEP2016's reasoning for their recommendations. She noted that WEP2016 determined it was unable to differentiate the efficiencies between the regions as there was not sufficient information to make that judgment, but they were more comfortable differentiating the upland treated acres.
- Scott mentioned Nature's Network project, and that part of that project looks at nutrient enrichment in the landscape using 30-meter grid cells. May be a potential resource for the panel to look into, may help address topographic and land use data.

- **ACTION**: Neely and Jeremy will look into Nature's Network and nutrient enrichment dataset offline with Scott.
- **ACTION**: Neely, Jeremy and Kathy to follow-up offline with Denice about potential use for PA wetlands HGM database.

Next step: Bridging BMP terminology and restorative techniques

- Jeremy reiterated his thanks to Steve and Erin for putting the draft strawman table together, listing various techniques and how they relate to wetland functions and the CBP wetland BMP categories.
- **ACTION**: Panelists should look over the strawman table and provide feedback to Jeremy, Neely and Kathy by COB Wednesday May 16.
- Describe functions of natural wetlands that affect WQ function/benefits, and link those with restorative techniques used to address degraded functions/conditions.
- Denice: would available reference wetland datasets be useful for this exercise? Kathy and Denice to talk offline about how to possibly use available reference datasets. MAWWG
- Wanted to step back and take a more qualitative look at these wetlands, functions, etc.
- Denice described an effort completed for CEAP and can maybe take a similar approach to link specific attributes to techniques that can address
- Carrie pointed out the current draft strawman table may not be representative of the entire watershed. Right now seems more reflective of Maryland, so we may need to expand or clarify it for other parts of the watershed.

Recap and next steps

- Jeremy noted he distribute a scheduling poll to panelists, with options after Memorial Day for the next conference call (date/time TBD).
- Neely encouraged panelists to revisit the WEP2016 report, specifically Chapters 4-5. They should consider if the framework and approach discussed today adequately capture the importance of

landscape position and source loadings as a way to describe wetlands' potential to improve water quality.

- **ACTION**: Prior to the next call (TBD), panelists should review Chapters 4-5 of the WEP 2016 report consider if the framework and approach discussed today adequately capture the importance of landscape position and source loadings as a way to describe wetlands' potential to improve water quality.
- **REMINDER**: If panelists have not already done so, they should submit their expense reports to the CWP as previously instructed.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Thursday, July 19, 2018
Meeting
CBPO, Annapolis, MD

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y, phone
Greg Noe	USGS	Y, phone
Erin McLaughlin	MD DNR	Y
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y, phone
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y, for afternoon
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	Y
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y, phone
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y

Welcome and overview for the meeting

- Neely welcomed everyone and described the goals for the day. Following May meeting, she, Kathy and Jeremy met with individual panelists over the past several weeks for their input. Neely summarized elements of those conversations. Based on those conversations, it is apparent we will need to use an organizing framework and best professional judgment to define the nutrient and sediment effectiveness values for these wetland BMPs. The research/literature alone does not provide explicit answers that we need.
- Neely reviewed some "rules of engagement" for the group; she reminded everyone of the panel's charge to make recommendations for the wetland BMP categories described by the previous panel. She noted that the panel may want to categorize or describe our recommended BMPs differently, but we will still need to align those with the existing categories.

- Neely acknowledged that there was agreement in all the 1-on-1 conversations with panelists about the importance of landscape position, as suggested by the previous WEP.
    - Agreement on other points as well, including:
        - Wetlands provide more than WQ functions and benefits
        - Unsure how physiographic province may be addressed beyond WEP1 recommendations for wetland restoration BMP
        - Focus on understanding local condition/processes affecting nutrient and sediment retention
    - Denice asked for clarification that when talking about landscape position, are we talking about wetland type or something else?
        - Kathy: we've been thinking of it geomorphic setting and position within the watershed, as described by WEP1. Now we may want to think of a wetland's benefits in terms
        - Neely: Need to consider that "landscape position" is interpretable, can be understood differently
    - Solange: at the local scale, the hydrology and concentrations of nutrients are drivers of efficiency; maybe one way to account for landscape position is through hydrology.
    - Greg: hydrology, the loading, the characteristics of the wetland are all determined by the landscape position, but ultimately it is the local site factors that determine the WQ function.
    - Rob noted that "wetland" may also include a buffer zone or wetland buffer in some cases.

Facilitated discussion

- Neely explained that the morning portion of the meeting would be spent discussing conceptual models/diagrams. The goal is for the group to determine that most relevant factors or processes are the major drivers for nutrients/sediment. The details of the group's full diagram can wait (arrows, links, etc.) but identifying the boxes we want to focus on is our goal, for at least one of the pollutants.
- Neely summarized an example from Noe and Hupp (2007) and asked panelists to consider factors for our own conceptual model. She noted that in the afternoon the functions/processes would be combined with common practices/techniques in a matrix to help guide our evaluation of the BMPs by identifying which techniques can improve which functions.
- Ralph asked when or how the group will consider which techniques/practices are matched to the enhancement, rehabilitation or enhancement categories. Neely indicated that will be step 4 in what was explained for our current overview, and that will be an item for future discussion. There was discussion how various federal or state definitions may add layers of difficulty or confusion between the panel's ultimate BMP recommendations for the CBP.
- Greg described a simplified conceptual diagram he put together for the panel. Neely asked for feedback to Greg's example
- Scott: the opportunity of a wetland to reduce pollution, is a function of landscape position and loading; looking at local effects, we should set aside the catchment load and loading to wetland for now. Scott also noted that the microbial community and processing may be worth adding. Hydrology or floodplain hydrology would be important to the degree it is retained and infiltrates or flows through, e.g., if a wetland is near capacity most of the time then it does not retain as much. Residence time is very important and may be worth defining in further detail.
- Denice: Usually see microtopography and vegetation in response to other factors, not sure they should be "drivers" themselves. Should the "drivers" be independent?
    - Greg noted there is a feedback between microtopography and vegetation with hydrology. For our purposes it seems helpful to identify them as drivers or factors.

    - Denice: may help to add more geochemical or soil-based factors like soil organic matter to the conceptual framework.
- Rob: would also like to add seasonality, even though it is a factor we cannot control. Climate or seasonal factors can be majorly important even though we have no control over them.
- Jeanne: Like the direction so far and Greg's basic layout. Want us to consider how much we can really build into our conceptual model for practical purposes; we may not be able to address all details.
    - Neely: agreed; the factors/boxes in the conceptual model may not be things that would be used for field assessments, but they are useful for the panel to approach its recommendations.
- Solange: we should consider how to account for vulnerability and export/flow-through from large events or storms
- Kathy walked through her approach to a conceptual model. She explained she started with generating ideas from microtopography, vegetation, from the right-hand side of Greg's diagram. So, increasing wetness and groundwater level. Focus on hydrology, capture physical processes to capture N or P.
    - Moisture conditions
    - Hydroperiod effects (frequency, duration, magnitude, timing); function(ground- surface-water effects, residence time); function(hydraulic gradient, presence of constrictions, degree of roughness, hydrologic connectivity)
    - Water chemistry function(redox, TEAP supply, temperature, pH)
    - Adequate soil/vegetation (available carbon) conditions? Function(vegetation x (soil bulk density, C-content, micro-organisms))
- Kathy, on hydroperiod: frequency and duration of flooding, it's an annual average condition that describes flooding regime of the wetland.
- Scott: Flood hydrology is different than wetland hydrology, because flooding may be a common event in some wetlands and only happen every few years in other cases; overbank flow and other flood characteristics are kind of imposed on top of wetland hydrology which is a descriptive annual average condition.
- Greg noted that he considered all these hydrologic concerns within "hydrologic connectivity."
- Kathy agreed that soil moisture is captured within the hydroperiod idea; it relates to the frequency of saturated conditions.
- Rob suggested adding seasonality or seasonal flooding under wetland hydrology.

Lunch break

Recap and synthesis of morning discussion

- Neely re-convened the group after lunch. She recapped the objectives from the morning and noted that Erin wanted to share examples of the data tracking for wetland practices in Maryland.
- Erin described and shared example of how Maryland tracks wetland BMPs and the data elements they collect. There was discussion about the level of detail in the data and the difficulty to collect anything more detailed than what Maryland already does, which is more detailed than average thanks to effort by the MDE wetlands staff. Jeremy explained that for NRCS wetland practices, the jurisdictions may only know the location, practice code number and the size of the project in acres, perhaps a little more. Panels sometimes recommend tiers or levels of BMPs that give larger nutrient and sediment reductions for jurisdictions with better data that provides greater confidence in the performance of their BMPs, e.g., manure treatment technologies.
- Steve and Erin reminded the group that the example from Erin is only for voluntary restoration in agricultural areas; stormwater wetlands are tracked separately.

- At one point there was group discussion of anoxic conditions and potential for increased phosphorus export.
    - Solange: reduced forms of iron can be a substitute for DOC as electron donor in denitrification. Unsure how common that may be in regional wetlands, but we do know it can occur.
- Neely: we seem to be approaching a single conceptual model and then the arrows or significance of those connections would depend on whether its N, P or sediment. Scott noted that sediment may have fewer boxes than N or P, but we can present them all in a similar way.
    - Solange: for sediment, water depth may matter. Scott noted that wetland hydropattern could account for that. Perhaps the bullet points will vary based on constituent.
    - Scott: I see an "attribute" as a visual characteristic that you can measure or evaluate.
    - Denice: indicators can be developed for characteristics, processes or attributes. Agree with way that the conditions are laid out above the chemical and biotic processes, but maybe attributes are something you can manipulate rather than something you can measure or have an indicator for.
- Neely asked for thoughts on anything that might be missing from the two diagrams (Greg's and Scott's). Kathy suggested adding temperature and pH somewhere in the conceptual diagram. There was discussion of how the factors might fit in under redox, soil conditions or other places.
- Neely noted that the group seemed comfortable with the overall characterization of the factors/drivers/attributes etc. The specifics can be ironed out later, along with the terminology and explanatory narrative. She noted the time and directed the group to the next item.

Practice/technique evaluation

- Neely described the intended purpose of the matrix to help guide and summarize how the various techniques connect to or influence the characteristics/drivers/attributes/ conditions.
- Carrie noted that weirs/cribs seemed more tidal; Steve and Erin confirmed, so it was removed as the panel is only focused on nontidal practices.
- There was discussion about the difference between fill removal and legacy sediment removal. Erin and Steve noted they are essentially the same practice, but different context (how the material was deposited). Neely tabled fill and legacy sediment removal following extended discussion of the practices and how they are the same or different.
- Soil decompaction added to the list, suggested by Carrie (panel may have better term for it later).
- Rob and Carrie suggest the techniques could be distinguished by categories based on what they do, e.g., hydromodification. Steve noted that almost all of the treatments are hydrology, except the vegetative ones that target vegetation.
- Denice: set the standard for when a project gets a credit, flip the burden of proof; do not think we can possibly parse everything on our end. I.e., we don't specify the specific practices.
- Neely clarified that we do not intend to be specific, we are trying to describe the relevant practices, what they can or cannot do, to inform our next steps and recommendations.
- Denice: If the conceptual model boxes are across the top, then for example a major restoration project would improve function in all those boxes. Like the idea of linking the treatments to those attributes. Think it is more about the attributes. Enhancement might mean you only elevate one attribute of the site. Like the idea of linking the techniques to the attributes like soils, geomorphology, etc.
    - Greg agreed, noting that the development of the tables also provides some transparency to our thought process and how we view the techniques' links to wetland attributes and function.
- Rob noted there are differences between performance specs (i.e., "thou shall get 80% removal") and design specs (i.e., "build it this way") for practices. Performance specs encourage more innovation.

- Neely noted that the techniques modify something particular within that site. We will not be able to say that a specific technique is a specific reduction percentage, but we can try to understand the relative effect of these interventions or treatments on the attributes.
    - Rob: Out of context for a site it is difficult to know the effectiveness of these techniques, even in relation to each other.
    - Jeremy noted that every panel has the same limitation and they have to consider average or expected conditions based on what they do know about the practice or areas of the watershed that it is most likely to occur.
    - Carrie: Then we get back to the idea of grouping these, such as by what gets modified, the hydrology, the vegetation, etc. Technique by technique is difficult.
- Denice wondered if the relative effectiveness is best left to the practitioner. She suggested that what is important is that as long as you restore the flood hydrology, or geomorphology, for example, then it does not matter which specific technique you choose. The ideal treatment choice might differ from site to site, so the practitioner should make that decision site by site.
    - Scott noted that we have no real way to assess or know if a given project really did all the various interventions for a site. Not sure how much farther we can go considering what Erin illustrated for the group earlier.
    - Neely: we are definitely data-limited, but the matrix and our approach will help to document the panel's logic for its final recommended values.
- Kathy: A lot of the techniques are specific to landscape setting or position, for example some practices are only applicable in floodplain areas, and others are more applicable in headwater areas. May also be able to categorize according to connections to groundwater and surface waters.
- Denice: Attributes from the conceptual model would be the headings across the top of the matrix, so we could see which treatments or interventions could have a direct or indirect impact to those attributes or conditions. My personal thinking is all about the conceptual model and would like to see how the list of interventions map to those attributes, not necessarily in a relative ranking or scoring, but simpler.
- The group worked on the draft matrix based on the continued group discussion. It was noted that some terminology (e.g., "attributes" vs "conditions") would need clarification for future discussions.
- Denice noted that the intervention can either have a direct or indirect impact on the attribute or condition, e.g., a technique could restore flood hydrology directly and indirectly affect the vegetation as well.
- Erin explained that on a site a practitioner will look at the problems on a site and identify what needs to be addressed or fixed to meet the desired conditions or functions.
- Steve suggested doing a matrix for re-establishment, which might help as a baseline for the matrices for the other 3 BMPs.

Next steps

- Neely recapped some of the discussion points. The group had great discussion even if they were not able to get as far with the matrix as hoped.
- Neely noted the time and committed to follow up with the group with further instructions and next steps after she, Kathy, Jeremy and others at CWP have a chance to debrief and discuss the path forward.
- Neely, Kathy and Jeremy thanked everyone for their participation and contributions.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Thursday, October 25, 2018, 2:00-4:00PM

Conference call

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	N
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	N
Ralph Spagnolo	EPA Region 3	Y
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	Y

Welcome and call to order

- Jeremy verified participants and welcomed everyone.
- Neely summarized the objectives for the call.

Recap of panel progress, status

- Neely explained the purpose of the afternoon's discussion is to clarify any ambiguities in the questions and ensure the group has a good mutual understanding of the terms and questions heading into the Round 2 survey. She thanked everyone for completing the Round 1 survey and recapped the reasons for the expert elicitation approach.

Round 1 Survey, review and discussion of results, clarifications

- Neely: We are not here to agree on any specific values or conclusions today, just discuss and clarify some issues about how the survey was presented, interpreted, or can be used going forward.
- Neely described how the round 1 data was summarized in graphs shared with the panel.
- Solange: I was unclear if we were really focusing on removal, or net gain, or what specific kind of change.
- Kathy noted she followed the assumption in the survey that the responses are in relation to a natural wetland. Neely noted there did seem to be some differences in interpretation on how efficiency was defined from the responses provided. Jeanne agreed it would be good to clarify if the reduction is compared to natural wetlands or based on pre- and post-BMP condition.
- Neely described the intended definition for "efficiency" as included in the survey. Greg explained he was considering the overall load going into and leaving the wetland site.

- Kathy explained her thought process. All else being equal, what was the difference at a site between the various conditions with the various practices implemented.
- Neely reviewed the definitions and how they relate to the starting/existing site condition and the intended outcome, i.e. a high(er) functioning natural wetland. Ralph pointed out that a wetland could be very degraded and be enhanced, and still be degraded after the single function is enhanced.
- Ralph stated the definitions with the added descriptors of hydric soils present/absent and if a wetland present/absent was a good start, simple that provides key distinguishing characteristics
- Solange noted that created wetlands can often perform well because they are strategically implemented according to the site and location in the landscape. Steve noted that voluntary creation projects are typically in agricultural areas.
- There was continued discussion about how the panelists should frame their responses, either relative to natural wetlands or as an absolute value.
    - Greg described a possible example. If we assume that natural wetlands are a 100, and then a rehabilitated wetland goes from 25% to 50% then the reduction would be 50% relative to a natural wetland, though it is a +25% increase from before. The end condition for any of these BMPs will be less than a natural wetland, so a more appropriate change would be like from 25% to 40%.
    - Neely asked if that approach makes sense to everyone, and asked for what they would need to clarify the questions and responses for round two.
    - Denice noted that that the approach is very sensitive to each person's idea or understanding of how effective a natural wetland is. Would help to remove the relative comparison to a natural wetland. If that starting point is different for each person, then we would need some way to account for that.
    - Steve commented that having it all in relation to the wetland restoration rates from WEP (2016) would ultimately make the most sense.
    - Neely commented this approach was not adopted in the survey as the WEP2016 database, while used to define an efficiency of wetland restoration BMPs, was not specific to restoration and included a range of BMPs.
    - Scott also found the efficiency concepts confusing, as it was requested both in relation to a natural wetland and in absolute terms annually. He explained he used Attachment C that was provided to panelists, which seems to place efficiencies in absolute terms and not as relative to a natural condition.
    - Neely asked if panelists had strong preferences for the absolute efficiency approach versus a relative approach, e.g. responding 40% in the survey (absolute) versus 80% response (relative approach). In this example, we assume a natural wetland is 50% effective and a restored wetland is 40% effective for pollutant like TN, then the intended response from a panelist would be 80% if we ask for relative value, but 40% if we take the absolute approach.
        - Steve, Kathy and Denice wanted to go with the absolute approach, as that is more comparable to Attachment C and how things are ultimately depicted in the model. Greg and Solange agreed; so did Ralph. Scott was fine with the absolute approach, so long as the directions were clear.
    - Kathy suggested an option that the round 2 survey could include a question(s) about natural wetlands for comparison. Jeremy mentioned this was discussed when developing the survey, but went the other route to keep the survey shorter. We can add a fifth series of the questions, one for natural wetlands and then the four BMPs.
    - Solange noted she had to leave and she posed two questions she felt the group would need to address. First, the effectiveness of these wetlands to reduce pollutants. Second, the uncertainty of these practices doing what they are expected to do. Want to capture

how they perform and how likely they are to perform and provide the desired/expected benefit, like an investment. Is important to capture that through the questions if possible. Neely noted she may need to follow-up with Solange offline.
    - Neely asked if anyone objected to adding a question(s) for natural wetlands. No objections were raised.
    - Kathy asked if it is possible to organize survey by TN, TP and TSS instead of by the BMP as it was organized in round 1. It might be easier to think through responses in that manner. Neely noted this option and will follow-up about panelists' preferences for the round 2 survey.
    - Neely pointed out that respondents' understanding of initial conditions seemed to affect some responses, looking at initial survey results.
    - **ACTION**: Neely and Jeremy will share text of (revised) questions before Round 2, with examples, to ensure there is common understanding before the survey is distributed.
    - Greg suggested that panelists could be asked what the baseline condition is for each BMP, so it is clearer how each person and the group formulated their responses. Neely will follow-up with Greg offline.
- Neely noted the time and quickly described how the optional survey question about techniques worked, and could possibly be used by the panel.
    - Kathy: may be helpful to provide explanations or expectations about how many functions or techniques are used for restoration or other practices.
    - Carrie noted she did not do the survey but was somewhat uncomfortable with how to capture or account for the techniques. Everything is very site-specific and we do not want to encourage stacking techniques that are not needed.
- There was brief discussion of possible timing for the next two calls. Kathy noted conferences in 1st and 2nd weeks of Dec that may be a conflict for some panelists. **ACTION**: Jeremy will send a poll(s) to the group alongside other follow-up materials.
- **ACTION**: Neely to provide a write-up describing the "Suitability" and "Applicability" indices used to summarize panel members' responses to this part of the survey.

Discussion of Round 2 Survey instructions and next steps

- Neely noted the call was running late and she thanked everyone for staying on. She and Jeremy will follow up with a poll to schedule the next two conference calls, one to discuss the round 2 responses and then the second one to discuss tentative recommendations.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Friday, November 30, 2018, 1:00-3:00PM
Conference call

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	N
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	Y
Solange Filoso	UMCES CBL	N
Denice Wardrop	PSU	Y

Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	Y
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	N
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	Y

Welcome and call to order

- Jeremy verified participants and welcomed everyone.
- Neely summarized the objectives for the call: to review round 2 results and consider how to use them to inform efficiencies and recommendations.

Case study review, Round 2 Survey, review and discussion of results, directions

- Neely recapped how the round 2 survey approached net efficiency as the change from the pre-treatment site and the post-treatment site condition. After first round we added questions about the pre-BMP baseline condition for each type of BMP treatment. For natural wetlands there is no pre- and post- difference.
- Neely asked panelists to consider if the raw group efficiency values seem reasonable, and if they should be modified in some way based on confidence or variability. Further, also weigh in if they agree with the general relative ranking of the practices.
- Denice expressed confusion and uncertainty regarding the pre-treatment condition for enhancement in particular. Kathy agreed with Denice's concern.
- Erin noted that enhancement is even more complicated because the practitioner chooses the specific function that is enhanced.
- There was discussion of panelists' assumptions about the starting conditions for each BMP category.
- Neely noted there was no clear ranking among the BMP categories, at least not a significant one, but there is a general loose ranking in terms of the net change (restoration/creation>rehabilitation/enhancement). Similar TP efficiencies for all wetland BMPs, looking at the difference between the pre- and post-treatment values.
- There was discussion and general confusion about the summary tables shared with the group.
    - Jeremy and Neely explained that the median and mean values in the tables were the difference between panelists' survey responses for pre- and post-treatment conditions and not the survey responses. Jeremy suggested the updated tables can add columns to include the direct panelist responses for pre- and post-treatment conditions, which may alleviate some of the concerns about the numbers and relationship between the BMP categories.
    - Neely emphasized that the survey is one more piece of information to guide our recommendations, we did not do it to replace or substitute any other existing lines of evidence like the literature review results.
- Denice and Kathy asked about confidence values for the pre-treatment conditions. Jeremy noted that the survey questions for confidence were about confidence in the respondent's range from

lowest to highest and whether it contains the true average value; not a question for confidence in the pre-treatment condition.

- There was continued discussion about the relative ranking of the BMPs. Jeremy noted there seemed to be consensus that restoration has the greatest overall effect, greater than creation. Some felt that enhancement would be the lowest effect, but it depends on the function(s) enhanced. Erin and Steve noted that most enhancement is done for habitat functions or phragmites control. Denice noted that she assumed that enhancement was done to improve water quality and she was concerned her responses may need to be updated accordingly.
- Scott suggested it would be beneficial to have consistent scenarios or situations for the practice categories.

Wetland techniques

- Neely described how Deb used responses to the wetland BMP techniques question to estimate the suitability.
- Rob suggested perhaps the group could connect the main survey results to the literature results and begin narrowing in from there. Would be more comfortable for some conclusions on something like creation than for enhancement.
- Kathy wondered if the difficulty of connecting the literature and specific techniques to the four BMP categories as defined by the CBP and previous WEP. There are not consistent and common linkages in the literature between techniques and the four BMP categories, so that may be why there's variability in the panel's own responses. Everyone has own conceptualization of these techniques and which BMP they are associated with.
- There was continued discussion of how the panel may classify techniques as one of the four BMPs.
    - Kathy noted that there are many complexities, such as the use of multiple techniques. There is also disconnection between how the literature defines the practices and techniques from how the CBP and panel understand or define the techniques. There's no common conception of what these techniques are.
- Neely described the "applicability" metric and how the "simple," "comprehensive" and "both" responses were weighted as 0, 1.0 or 0.5, respectively. Carrie recalled Kathy's comments that techniques can often be combined, so even simpler techniques may be bundled and then become comprehensive.

Next steps

- Jeremy noted the time and that the group needed to wrap up discussion.
- **ACTION**: Jeremy and Neely will send out updated survey summary materials, including tables and graphs with all ten responses, plus the suitability and applicability results.
- Neely recalled the group's concerns about the rankings and some possible implications of partial survey results.
- Kathy asked the group to consider if or how the process may be affecting the end product as a contribution to the science.
- **ACTION**: Jeremy will send out a scheduling poll to schedule potentially two calls in January.
- **ACTION**: Jeremy will send each panelist their individual round 2 survey results
- Neely and Jeremy thanked everyone for their effort in completing the survey and the afternoon's discussion.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Tuesday, January 29, 2019, 10:00AM-12:30PM

Conference call

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	Y
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	N
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	N

Welcome and call to order

- Neely verified participants and welcomed everyone.
- Neely summarized the objectives for the call: to discuss the panel timeline post-government-shutdown to finish the report and release it for CBP review and approval; discuss the report outline, and; spend the bulk of the time discussing options to define the BMP reductions.

Panel timeline and schedule

- Neely explained the tentative panel timeline, noting the plan to draft and finalize a report within three additional calls/meetings. The report itself would then be ready for release to the CBP partnership in the spring, and takes at least 3 months to go through the various CBP workgroups and committees. The panel used the first WEP's recommendations as our starting point, and then we evolved through four core approaches, conceptual models part 1, literature review, conceptual models part 2, and then the expert elicitation.

Discussion and review of report outline

- Neely explained the working logic for the first draft and outline. The report will try to document the evolution of the panel's full discussions and evolution of its direction, including conceptual models and the elicitation survey.
- Neely and Jeremy encouraged panelists to write down any thoughts or input on the draft report outline going forward. Any thoughts, even simple paragraph or two can be added to the report, and any writing now will be easier to add in and save time later.

Discussion of options/methods to define the pollutant reduction estimates

- Neely described the options and the need for the panel to move forward with specific methods to quantify and recommend removal rates.
- Jeremy noted the three options are there for the panel to react to and they can certainly decide to invent a new option or combine/modify the proposed options.
- *Neely reviewed the options in the document with the panel and led discussion.*
- Option 1, status quo
    - Erin noted that rehabilitation has been done more widely and is lower-hanging fruit. Restoration is harder to get done. Enhancement has been reported in Maryland, but very little of it.
    - Solange felt option 1 is not a viable alternative. There is quite a bit of information about creation and does not seem equal to the other types and should be distinguished.
    - Denice agreed with Solange and that there should be distinction between them. Think rehabilitation is also a closer look.
    - Jeanne also did not support option 1 on its own, but there may be some TBD aspect of the option worth retaining when we make a final decision.
    - Scott also did not support option 1, and BPJ from the panel would likely be a better option.
    - Steve did not support the option, but noted the upland acres from the restoration BMP may be reasonably applicable to creation and rehabilitation.
- Option 2, literature review database
    - Neely recapped the method and how it could potentially work with the existing database.
    - Solange liked the idea, but felt it was hard to know if the data variability is due to the study design or actual variability in the practice/site performance. Could perhaps look at a subset of studies that are most similar in design and most applicable. Select or at least recognize the potential reasons for variability.
    - Denice asked for clarification where the data from the graphs came from, noting slight differences from the WEP2016 recommendations. Neely indicated our panel added about 8 studies to the database, which slightly changed the distribution.
    - Greg noted he took a similar approach to his elicitation survey responses, by ranking and ordering the BMP categories based on our understanding and using the distribution to get results and distinguish the BMPs, e.g., natural wetlands at a higher percentile, and each of the BMPs subsequently at quintiles below that.
    - Denice commented that this could be a great approach as one line of evidence, but not necessarily comfortable with relying strictly on one approach. Can use the options together and see what they tell us cumulatively.
    - Scott noted he took a similar approach to Greg and supported it.
    - Steve agreed that option 2 is the way to go.
    - Erin liked the idea of using option 2 as a line of evidence, it is not perfect, but the best we currently have.
    - Jeanne was on the fence, needed time to consider.
- Option 3
    - When describing Option 3, Neely noted that the survey results for TP were not consistent with responses with TN and TSS and can impact the net improvement efficiency and ranking of the BMPs. There was high variability in responses associated with pre-treatment, whereas there was more agreement in responses for the post-treatment effectiveness.
    - Scott noted a discrepancy between the slides and the tables. Neely noted that one used mean and the other expressed the values as a median.
    - Greg noted the way the option is currently written makes a number of assumptions that we may want to examine more closely.

    - Kathy asked for clarification if Greg was alluding to the post-treatment estimates might be more appropriate than the net improvement.
    - Greg felt that if the updated literature has slightly different values then it would make sense to recommend updated values for the restoration BMP.
  - Jeff asked for clarification about the pre-treatment condition. Neely explained that, for example, a restoration site has hydric soils present and the pre-treatment condition is higher than for creation where hydric soils do not exist.
    - Scott noted that for restoration and creation he was considering a corn field as the starting point. Do we mean hydric soil indicators or functionally present hydric soils. There was some discussion about the specific meaning of hydric soils. Neely noted that is something we will need to clarify in the report's section for definitions and/or qualifying conditions.
  - Greg: an adjustment factor makes sense if we cannot recommend tweaks to the restoration BMP credit, but the factor may be unnecessary if we can change the restoration numbers.
  - The box plots and values from the literature were more consistent with post-construction values. Jeremy noted that if that's the case then option 3 may warrant adjustment.
  - Denice asked Greg if he noticed anything between the elicitation results and the lit survey results. Greg had not had a chance to look at that due to the shutdown. Deb commented that the mean of the lit review database is a post-treatment value whereas the survey we asked about the baseline that would allow quantification of a net improvement (difference between the baseline and post-treatment condition)
    - Neely: the net improvement does give a sense of the uplift and how the practices should rank. If you look only at the post-treatment values from the elicitation survey then the ranking flips.
    - Kathy suggested the panel should look at the numbers more closely before taking a next step about how to proceed.
  - Erin noted that with enhancement or creation you are aiming for something new, whereas with restoration or rehabilitation you are mostly returning it to a historic condition or function.
  - Neely described the possible reasons for the TP discrepancy for rehabilitation and enhancement. The average pre-treatment TP values for rehab and enhancement were lower than the others.
  - Jeanne: there tends to be good uptake early on for TP but that can decline over time as TP accumulates. There is definitely a lot of variability in pre-treatment conditions so that was personally challenging to account for in the survey responses.
  - Jeremy recalled previous discussions about pre-treatment, noting the survey did not ask questions about the upper- or lower-bounds for the pre-treatment conditions.
  - Solange asked if the data from Option 2 could be used to understand pre-treatment, post-treatment or net improvement in more detail.

Next steps

- Neely noted the time and that the group needed to wrap up discussion though there was not an emerging consensus at this point, we can get a clearer sense of individuals' thoughts and common points of agreement offline. She asked panelists to provide additional thoughts and comments on Options 1-3 via email after the call; she and Jeremy will follow-up with instructions.
- **ACTION**: Jeremy and Neely will provide instructions and guidance to the panel for feedback on the draft outline and Options 1-3.
- Neely quickly summarized that there are three Riparia databases available as a supplemental dataset for the panel, and are being discussed with Denice.

- Solange asked about the literature and its view of “created” wetlands. Jeremy pointed out that there is sometimes overlap with “constructed” wetlands as described by WEP2016 that are sometimes called “created” wetlands in the literature.
- Neely also welcomed other input or comment from panelist offline. She thanked everyone for their time and discussion.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Monday, March 4, 2019, 1:00PM-3:30PM
Conference call

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	N
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	N

Welcome and call to order

- Jeremy verified participants and welcomed everyone.
- Neely summarized the objectives for the call and moved on to the agenda items.

Recap and objectives

- Neely explained the goal to agree on a method for defining an efficiency, not specific values at this time, but at least the method to get there. She also described the goal to agree on other key basics, such as confirming definitions for the panel’s recommendations.
- Neely shared a table of wetland BMP definitions with “operational definitions” alongside the current CBP definitions for the wetland BMPs. There was discussion clarifying that “created” wetlands do have specific goals, but if they are designed for a specific purpose or input source, like wastewater, then that would be a “constructed” wetland. The panel is focused on more voluntary style practices, like ones described by Steve.

- Neely presented a new draft table by her and Deb that combines some of the common wetland techniques, broken down by wetland characteristic (hydrology, vegetation, soils) and associated with the four wetland BMPs. The goal is to convey some key information at a basic level, given all the various conceptual models and discussions the panel has previously had. She asked if the panel preferred to receive the table via email for feedback from the group, or if they prefer to respond and provide feedback in a small group.
  - Steve and Carrie raised questions about enhancement as a BMP. Jeanne also expressed concern that some enhancement projects convert a wetland to another type to enhance a specific function.
  - Kathy commented that some of the techniques are not holistic in and of themselves, and may only be cost-effective, e.g., a ditch plug. It would take supplemental techniques to be more effective, and that is something to keep in mind. If you restore the hydrology the other functions may not also return.
  - Neely noted that the panel also needs to articulate the qualifying conditions for the BMPs.
  - Rob: a lot of this discussion seems to stem from differences in our individual understanding of the starting condition for the BMP project sites.
  - Neely suggested we can at least work to include a narrative or text in the qualifying conditions section to describe a range of projects from simple to comprehensive to speak to Kathy's and others' concerns on that. We will continue to discuss this after today.
  - **ACTION**: Panelists should send feedback on Table 2 to CWP (Deb Caraco) by COB Wednesday March 13.
- Neely summarized feedback received following the panel's January call about those 3 proposed options for quantifying possible upland efficiency values. The status quo (option 1) was not supported by the panel, though it may offer some basic information alongside the other lines of evidence. Everyone supported option 2, using the lit review, at least as a starting point. Option 3 had mixed responses, with mix of concerns and support, given some different interpretations of pre- and post- conditions by panelists. But there was general support for using option 3 in combination with option 2. Neely asked if the panel agreed with using option 2 as a starting point, with our sources of information (e.g., elicitation survey and/or Riparia) to refine and develop recommendations/options at the next call.
  - Jeanne, Greg, Scott and Denice supported that approach, using multiple lines of evidence. Solange did too, but noted a need to discuss how to apply BPJ down the road. Rob noted he also supported it.

Riparia dataset

- Denice described the analysis and datasets she had for created wetlands (n = 120) and reference sites (n = 222) in Pennsylvania. Created wetlands from mitigation or in-lieu-fee programs. She explained that she split reference sites into the "best" wetlands (Reference Standard) and all the remaining reference sites (Reference), and then the created sites, for a total of three groups. She described the water quality functions and the assessment measures used to calculate those functional scores.
- Scott asked for clarification about PA's approach to HGM. He noted there can be confusion between ecological functions and wetland functional performance. For example, for flood/water retention, since the reference standard wetland sets the baseline for the function, then another wetland that retains more water may actually have a lower functional score because it departs from that standard condition; wonder if that is an issue here for PA's HGM approach and nitrogen retention.
  - Denice: Might be an issue, great question. May have to look into the data a little more to answer that. Approached this analysis with broad questions. Interested mostly in

comparison between created sites and the reference or reference standard sites. Felt this approach would be helpful as a check on our thought process and other lines of evidence. Overall, HGM functional assessment approach seems to do great for habitat functions, okay for hydrology functions, and most poorly for the hydrogeochemical functions, though the carbon export functional assessment works great. A lot of thought has gone into the HGM functional model framework and it should be helpful as a complement and proxy for some of the panel's other work.

- Rob found the information very helpful, need a little more time to absorb it fully. Do the scores refer to load or concentration? Denice indicated it is load based.
- Solange: Agree this is a helpful exercise. The method does not account as well for outside loadings or conditions, but this approach combined with other lines of thinking could be very helpful to account for internal and external factors.
    - Denice: It can be complicated. We can potentially split the reference standard further into "best attainable" category. For example, you could go in and plant the best possible native plant community but if surrounding area is heavily impacted then high vegetative scores may not be attainable in the sense the system you installed could be overwhelmed. Could potentially sub-divide this further into sites based on surrounding dominant land cover (ag, urban, forest, etc.).
- Scott: is it possible for the scores to be made absolute instead of relative? Sometimes with the HGM models the created sites could possibly go beyond the reference site, but they are capped to fall below the reference scores.
    - Denice: asked for clarification for Scott's question; asking about raw variable scores? Denice may need to look into those raw variable scores to see if Scott's concerns are applicable for these sites.
- Neely: as a starting point, the idea for today was to see how these datasets from Riparia and these sites could illustrate how the various categories and sites compared to one another for various functions. We'll continue to look into this with Denice's help. Very appreciative of Denice's efforts.
- Greg asked for clarification about how the HGM scores relate to possible efficiency values. For example, if a wetland site has 3x the nitrate load into it than a similar wetland, how would the HGM score for F5 differ?
    - Denice: They are set up to be a potential efficiency, but at some point there is a saturation point or a cap in the performance. If under that saturation point, it seems the data would work that way.
- Denice explained that the HGM models for each wetland type is different, so you cannot compare the scores between types. For example, if mainstem floodplain is 0.56 and headwaters is 0.57 that does not mean that the latter is better at that function. The reference standard sites are predominantly in forested landscapes. So the best you can achieve might be closer to "reference" where you have sites in a areas with a variety of land covers.
    - Steve asked if the sites would include any "restored" sites. Denice noted that based on her reading of the data they would mostly be created, but some restored. Carrie noted based on previous experience it could include more restored sites, but it is hard to know with some of the historic data.
    - Steve asked if the site age was incorporated into the analysis. Denice noted that Gebo had included that kind of analysis in her published work and thesis.
    - Denice noted that she can do some further basic analysis if there are questions from the group.
    - Neely noted that we do not want to overburden Denice, but the data can help us understand how the categories might relate to each other, so we will help filter and organize follow-up questions for Denice.

        - **ACTION**: Panelists should send their follow-up questions about Denice's Riparia analysis and/or the Riparia data to Jeremy and Neely by COB Friday March 8.

Follow-up discussion of methods for defining efficiency estimates and recommendations

- Neely noted three questions for the group, including their thoughts about whether Enhancement should get credit as a BMP, starting with yes or no.
    - Scott: no, since it would involve changing an existing wetland.
    - Rob agreed with those concerns.
    - Greg: agreed with what others said so far. In practice the common techniques for enhancement like phragmites removal may actually negatively impact water quality.
    - Jeanne: in reality there will be some "gaming" so people may just call something rehabilitation instead of enhancement, so it helps to be clear about what counts or does not count within those categories.
        - Neely: it may not always be black and white; best the panel can do is provide some guidance.
    - Steve: given the existing structure for how permits and these programs work, it wouldn't be much of a concern that wetlands would be at risk due to enhancement type projects. That said, enhancement is such a minimal amount of water quality benefit, if any, given the starting condition of the sites.
    - Carrie: crediting enhancement as a BMP really incentivizes things that we do not want to see done from an environmental quality perspective.
    - Scott: if there is only marginal benefit then it may not be worth crediting, but if we can state clear qualifying conditions or credit it proportionally then perhaps we can credit it as a BMP.
    - Neely noted there was not a clear consensus on whether enhancement should be a creditable BMP. It may help to write out some possible qualifying conditions that may avoid some of the considerations, or to credit it at a proportional level so that it the incentive does not lead to unintended consequences. She will work with CWP staff and Jeremy on next steps for this issue.
        - **ACTION**: Jeremy, Bill, Steve, Solange and Carrie met for a subsequent call to discuss the issue in more detail and return to the full panel with a recommended option for decision on the next call.
- **ACTION**: CWP and Jeremy will bring recommended explanations/definitions for "efficiency" for the group to consider during the next call.
- **ACTION**: CWP will take panels' input and present draft options for recommendations with supporting documentation at the next meeting for the Panel to approve, in part with revisions, or 'as-is'. Draft materials will be distributed to the panel prior to the meeting for review.

Next steps

- Neely noted the time and that the group needed to wrap up discussion. She thanked everyone for the wonderful discussion and their time; there will be follow-up via email from her and Jeremy regarding next steps.
- **ACTION**: Jeremy will distribute polls to schedule the panel's last two calls.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Friday, April 12, 2019, 1:00PM-3:30PM

Conference call

Name	Affiliation	Present?
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	N
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	N
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	N

Welcome and call to order

- Jeremy verified participants and welcomed everyone.
- Neely summarized the objectives for the call and moved on to the agenda items.

BMP definitions and wetland enhancement

- Bill stack explained the recommendation from the panel's subgroup (Steve, Solange and Carrie) that discussed wetland enhancement and whether it should be eligible as a water quality BMP for nutrients and/or sediment. That group had a number of reasons for its conclusion that wetland enhancement should not be a water quality BMP in the modeling tools; Bill summarized those points.
- Neely and Jeremy asked if there were any objections to accepting the subgroup's recommendation; none were raised. **DECISION**: **The panel agreed that wetland enhancement should not be eligible as a water quality BMP for nitrogen, phosphorus or sediment.**
- Deb reviewed the tables of wetland definitions and techniques table.
    - Neely asked if there were any objections
        - Kathy: should say "field-determined" conditions to specify that hydric soils aren't determined through SSURGO, but through actual site information.
    - No objections raised, but there was further discussion and points of clarification.
        - Carrie pointed to some phrasing and truncation for techniques under rehabilitation and enhancement (e.g., fencing)
        - Kathy agreed with Carrie. Jeanne agreed but noted there will
        - Jeremy noted the clarification were helpful and asked if there were any red flags or significant problems.

        - Carrie: There are caveats that we need to include, but fine with the approach and table.
        - Solange: we need language about the systems being self-sustaining in the report; intent and language in the report should be clear that wetland practices should strive for systems that are self-sustaining and functional.
        - Steve: suggest we need clarification about the "typical techniques" and if they apply to the component goal, the BMP, or how they fit together in a more comprehensive manner.
        - **DECISION: General agreement on the approach in the definition/technique tables, but further clarification and narrative needed to address feedback.**

Draft qualifying conditions

- Neely noted that the qualifying conditions information was not provided in advance, given the amount of other materials provided. She walked through the draft set of qualifying conditions that Lisa and other CWP staff put together. The goal was to walkthrough the draft conditions with the panel and get feedback and reactions during the call and following the call.
    - Neely described the general logic: the qualifying conditions depend on the pre-BMP or existing condition. They compiled some initial example metrics, not to be prescriptive. For each wetland BMP, breakdown the components (soils, hydrology and vegetation) necessary for a functional wetland, identify actions to achieve the intended post-BMP condition from the pre-BMP condition. There are interactions between the components, but continued with that breakdown for simplicity and to explain the key concepts.
    - Neely asked for immediate thoughts and feedback on the approach
        - Kathy: seems helpful and practical. Should perhaps start with a question about whether the wetland is mapped or not, getting back to issues of wetland inventories. As much for improving our own respective databases and land cover/use maps.
        - Denice: this may be another good place to reiterate the importance of self-sustaining wetlands.
        - Carrie: some potential issues with the simplified approach, need to process more offline. There may be a need to consider siting decisions and criteria as well, to avoid impacts on any high value habitats or other high value resources.
        - Denice mentioned a recent study that found NWI only captured 56% of wetlands in the Juniata watershed. May need to think through issues on that inventory issue. Steve noted the NWI is also notorious for missing wetlands in the coastal plain. For cost-shared practices there wouldn't be an option to specify locations for that protected information and include them in another database.
        - Steve: permitting systems may be able to help input an inventory system.
        - Solange asked if the qualifying conditions do, or should, account the surrounding drainage area
            - Jeanne: that would factor back into the ability of the wetland to sustain itself.
    - **ACTION: Panelists should send feedback on the draft qualifying conditions to Neely by COB Friday 4/19. (See slides sent out on 4/12 and the spreadsheet attached to this message). Neely will follow-up with individuals as needed.**

BMP definitions of efficiency

- Neely summarized attachment 3
    - Kathy suggested that perhaps there should be some accounting for or representation of degraded wetlands, distinct from wetlands that are less impacted.

- Jeff noted there is "harvested forest" and "pristine forest" within the model's land uses, which load differently.
- Denice: there is a desire to address that issue; not starting from zero, can probably amass some direction.
- There was additional discussion but the wetland land uses established for the Phase 6 model were outside the panel's assigned scope and the discussion focused on therefore adding it as a research need.
- **DECISION: General support from panelists for future research need in report re: wetland land uses and distinction for degraded wetlands; Denice can list some potential data sources.**

- Neely summarized the description and definition to efficiency and the wetland BMPs.
  - Neely asked for objections.
  - Denice: suggest using the term "lift" instead of "bump-up" or "improvement." Jeanne agreed that the term lift is easily recognizable by relevant practitioners.
  - **DECISION: The panel agreed on the conceptual approach and definition for "efficiency" as applied to the wetland BMPs.**

Riparia data analysis and credit estimation method

- Deb walked through the assumptions and methods from Attachment 5 that utilized the literature review results and Riparia datasets and HGM functional assessment models (F5, F6 and F7). Riparia data helped to scale the practices and obtain possible efficiency values for each practice category and pollutant. For TN, averaged F5 and F7; for TP, averaged F6 and F7; for TSS, used F7. She walked through the steps used to take the information and scale the potential efficiencies.
- Neely asked for clarifying questions from the group:
  - Jeanne asked why the 10th percentile was chosen for the comparison. Deb responded
  - Denice: in general, a lower 10th percentile will often be in an agricultural or developed area, lacking a buffer, with lots of stressors present. Felt that was a reasonable representation.
  - Carrie: why headwater chosen and not the other categories like depressional?
    - Deb: depressional wetlands didn't have values for all the scores, so we couldn't use that category. There were some contradictory results when looking at the mainstem floodplain scores.
    - Denice: our reference collection only covers 4 eco-regions, so we don't have coastal plain sites unfortunately. Others may have datasets that could potentially fill gaps for flats or depression wetlands.
- Neely asked the group to express their comfort with the method. Are they comfortable proceeding with the approach overall?
  - Jeanne: agree with the approach, still a need to understand what the data limitations might be.
  - Scott: read more about the PA method and feel this method is the best available option for us.
  - Denice: very comfortable with the difference and adjustments for created sites, but need to think further when it comes to rehabilitated and restored.
  - **DECISION: The panel supported the approach presented and discussed, using Riparia data to supplement the lit review results.**
- Neely moved on to some of the discussion questions.
  - Are headwater wetlands a good general representation of the relative performance?
    - Denice noted that the large majority of the sites were headwater.
    - Jeanne: would be great to have some coastal plain information if it was possible to incorporate that at this point. Fine with using the headwater right now.

    - Greg: would be good to see floodplain results for comparison. Kathy agreed, noting that the watershed model splits the wetland land uses between floodplain and other.
- Is "reference" a good representation of the post-construction/BMP condition for restoration and rehabilitation?
    - Greg: support the decision, given the available data from Riparia, but think we might be over-estimating the performance of those created/restored sites.
    - Jeanne: agree that the assumption makes sense.
    - Deb: any gut-feeling about how much the over-estimation might be?
        - Greg: Purely a gut feeling, 25-50% over-estimated, based on experience with restored and created sites. Would need to look at some studies and data to make a better judgment.
        - There was some group discussion on this, could perhaps use a percentile score instead of the mean to calculate the factors.
    - Neely summarized: seem to have agreement on the use of "Reference" but the group may want to consider if we adjust starting condition then it would increase the reduction from rehabilitation.
    - Neely asked how each panelist felt about the approach and the relative values in the draft table.
        - Scott: like it the way it is now, comfortable with it after reading and understanding the assumptions.
        - Greg: structurally good, want to compare some alternate results though.
        - Solange: curious about creation versus restoration and want to think more about which of these should be higher or lower than the other.
        - Kathy: accept it with reservations, curious about how this relates to the expert elicitation results and some of the uncertainties involved.
        - Jeanne: have some questions, but it's a good approach. Comfortable with creation being less than restoration, given experience with those sites.
        - Carrie agreed with Jeanne. Carrie added that we also want to be careful about over-crediting rehabilitation, from her standpoint having a lower incentive for rehabilitation makes sense.
        - Denice: need to parse out some of the concepts a little further, but don't think my reservations deal with the approach itself but with some other concepts like natural wetlands in the model.
        - Deb recapped some of the items for further analysis.
            - It was suggested to reach out to Amy Jacobs to see if it's possible to get Nanticoke data, since much of the Riparia data came from a sister study in the Juniata.
            - Kathy noted that Tom Jordan was also part of that study and may have the data.
- Is the 10^{th} percentile among Reference wetlands a good representation of pre-BMP rehabilitation wetlands?
    - Denice offered to provide histogram so the group can see the distribution of scores.
- Is it appropriate to combine the functional models to approximate TN and TP retention of wetlands?
    - Jeremy asked if weighing the scores differently instead of taking an average would make sense for the group.
        - Deb noted that nitrogen would be more sensitive to different weights than phosphorus, given the scores.

- **ACTION: Feedback and suggestions from panelists will be incorporated into the Riparia analysis; updated options will be provided for a final decision at the next call.**
    - Things that will be looked at include:
        - Coastal Plain data from Amy Jacobs, if possible
        - additional "pre-treatment" percentiles
        - restoration end point as something less than 50th percentile or mean

Next steps

- Neely and Jeremy recapped decisions and follow-up items from the call. They thanked everyone for their time and participation.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Thursday, May 16, 1:00PM-3:30PM
Conference call

Name	**Affiliation**	**Present?**
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	Y
Jeanne Christie	ASWM	Y
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	N
Solange Filoso	UMCES CBL	N
Denice Wardrop	PSU	N
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	N
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y
Lisa Fraley-McNeal	CWP	Y

Welcome and call to order

- Jeremy verified participants and welcomed everyone.
- Neely summarized the objectives for the call, noting this may be the panel's final call pending decisions or lingering items by the end of the meeting.

Qualifying Conditions

- Lisa reviewed the feedback and revisions made to qualifying conditions since the last panel call.

- Kathy suggested that maintenance seemed missing from some of the text, should include that concept. Carrie agreed that some of the text that she initially suggested could change to include maintenance; seems consistent just word-smithing.
- Lisa explained other language that was added to the report, and gave a summary of the USACE regional supplements that Steve and Carrie recommended for reference for qualifying conditions in the report.
    - Carrie and Kathy suggesting removing reference to constructing dams/structures.
- Neely asked the panel if there was agreement on the general statements preceding qualifying conditions, noting the minor revisions.
    - No objections raised.
- Neely asked if there is agreement on the qualifying conditions that provide basic guidance. Carrie noted she had sent some clarifying edits, but had no objections, just those minor comments.
    - No objections raised. **DECISION: The panel accepted the updated language in the report for qualifying conditions.**

Multiple lines of evidence & Riparia data analysis to derive BMP efficiency values for creation and rehabilitation

- Neely noted that the panel would be asked to make a decision about the efficiency values after Deb reviewed the updated analysis.
- Deb described some of the results when changing the percentiles and uplift assumptions.
    - Rob: would like to compare results with other BMPs as another check.
- Deb described the Center's recommendation for the panel to consider (slide 18). Results from the floodplain analysis provides mixed results that is not necessarily consistent with the expected water quality performance of wetlands and other supporting evidence that suggest floodplain wetlands may have a greater net benefit due to their landscape position. The upland acres treated is a preferred approach to capture the enhanced water quality benefits of floodplain wetlands.
    - Greg: not quite sure what the ideal phrasing might be, and we may not know exactly how to quantify or estimate the upland acres.
    - Kathy recapped WEP2016's logic, that floodplain wetlands are at least as effective as headwater wetlands on average, but that since they also capture those overbank flows and upstream loads to an extent, WEP2016 set ratios for floodplain wetland at 1.5x the headwater/depressional wetland ratio.
    - Rob: may be a way to stay with current 1.5x bump, until that stream protocol group or other research can illuminate otherwise.
- Neely recalled that the group had discussed reaching out to Amy Jacobs for Nanticoke data similar to what Riparia had for PA wetlands. It doesn't seem that the Nanticoke data will be available and vetted within the panel's timeframe.
    - Stream restoration protocol 3 uses estimates of upstream/overbank flow as proxy and uses the Jordan equations to calculate a reduction. Hope that the wetland panel may have an efficiency that may help in that calculation to inform another ad hoc group's efforts on those stream restoration protocols.
    - Jeremy noted that group can determine if or how to use this panel's recommendations.
    - Neely refocused discussion for efficiency and summarized the option on the table: distinguish efficiency for floodplain or only distinguish the upland treated acre ratios.
        - Rob: makes sense to distinguish the upland ratios, not efficiency in our case.
        - Neely asked if there were any objections to the approach to distinguish the upland acres treated as proposed. No objections were raised. DECISION: The panel agreed with the proposed approach to distinguish upland acres treated.

- Neely: recapped the proposed efficiency values from the last meeting and the updated analysis, using multiple lines of evidence. Restoration BMP (42%TN, 40%TP, 31%Sediment), last meeting the value for Creation was 30%TN/33%TP/35%TSS)
    - Rob found the Riparia analysis was extremely valuable to ground the other lines of evidence.
    - Jeremy pointed out that the sediment value was higher and asked for input from the group about that.
        - Deb noted that the updated literature value was significantly higher for sediment. Since that was the anchor for the Riparia analysis that is why the values changed that way.
        - Kathy: suggest we consider the precision in the approaches and whether the Riparia is reinforcing the elicitation results rather than vice-versa. Rob noted that in the elicitation the group was largely thinking about the BMPs in relation to each other, whereas the Riparia helped to provide some objectivity to the values.
        - There was additional discussion. Where the values are different, it raises more concern in terms of the uncertainty it suggests.
    - For wetland creation:
        - 30% TN
            - Previous concerns noted. No further objections, Tentative agreement, noting that the values are not final.
        - 33% for TP, consistent enough with the other values and the methods.
            - Previous concerns noted. No further objections, Tentative agreement, noting that the values are not final.
        - 35% for TSS
            - Greg: the 35% is too large and too inconsistent with the rest of our logic framework and thought process.
            - Jeremy: if we anchor to 31 instead of 43, we could see what value comes out?
            - Carrie: agree it's worth looking at, but am comfortable with the 35% even though it is larger than the TSS value for restoration.
            - Neely recalled Scott's earlier comment about sticking to our logic for how we considered these BMPs throughout our discussions.
            - Scott: If we scale the 31 instead of the 43, then the result would be about 25.
            - Amended recommendation 25% (do we slightly adjust the other values?)
                - Neely explained the updates to the literature review.
                - Rob: comfortable with that; prefer 35
                - Kathy: 35
                - Greg: 25
                - Scott: 25
                - Carrie: unsure at the moment, TBD
    - For wetland rehabilitation
        - 16% TN
            - Carrie and Rob were comfortable with the value. No objections raised.
            - Previous concerns noted. No further objections, Tentative agreement, noting that the values are not final.
        - 22% TP
            - Previous concerns noted. No further objections, Tentative agreement, noting that the values are not final.
        - 23% sediment

        - Would be 17% if we did same correction that we did to arrive at 25% for creation.
            - Rob felt 17 was too low for sediment.
        - Previous concerns noted. No further objections, Tentative agreement, noting that the values are not final.
        - Greg: would prefer a logic-based decision as opposed to splitting the difference, for sake of transparency.
        - If splitting the difference, 30% TSS for Creation and 20% TSS for Rehabilitation.
    - **Action: Panelists are asked to confirm their preferences via email by May 30, and input from those who missed the call will be sought.**

Upland acre ratios

- Jeremy recapped the options on the table and reviewed the WEP2016's approach.
    - Scott: may have misinterpreted the question or issue. Feel that the projects and sites will sort themselves out, did not feel that the upland treated ratios would need to change based on the geomorphic regions.
    - Kathy: because of the variation in the regions, the panel felt that distinguishing them was important, so they worked to distinguish the practices based on hydrogeomorphic regions.
    - Carrie: maybe we just haven't talked about it enough. Not opposed to the ratios for rehabilitation, but not convinced yet. Makes sense for restoration from the previous panel's work. More comfortable with the floodplain adjustment.
    - Neely: could perhaps ask to report the drainage area, and if not provided then it would revert to a 1:1 ratio.
    - Neely noted that there were actually two different adjustments to consider. Neely asked if there general agreement on adjusting the effectiveness upward for Floodplain across the board.
        - Scott: not sure. Is there data to support that greater reduction for floodplain over headwater/other?
        - Greg: that's a relevant point, and am not sure if 1.5 is the best scaling factor, but there is strong evidence that active floodplains are greater at reducing loads. If it's a terrace or inactive floodplain then it may not perform that well. We may not want to make that a qualifying condition due to regulatory or legal complications.
        - Kathy: Most of the sediment and phosphorus is coming through with major storm events, so that is something to consider in floodplain wetlands. The 1.5 factor acknowledges the boost that occurs during those large events, but not too high or generous.
    - Neely: first part of question, is preference to apply a boost/multiplier for floodplain.
        - Kathy: think there is a need for something; elevation relative to base level is more important than stream order.
        - Greg: think it deserves a boost. It is difficult with current science to set a value or predict the value. It is complicated so we should probably go with some simple scaling factor, so would grudgingly accept the 1.5 value for lack of a better option.
        - Carrie: agree with Greg that would begrudgingly accept the 1.5 value.
        - Rob: it makes sense, but I think the multiplier is overly simplistic. Using stream order might be simplifying, but better, option.
    - **Action: Interested panelists will discuss the options in more detail offline and report back to the full group. Volunteers requested by May 30.**

Draft report outline and next steps

- Neely noted the need for further input and consideration of the issues, including offline discussion of the upland acres issue. The panel will need to meet again in June.

Adjourned

SUMMARY OF ACTIONS AND DECISIONS
Wetland Rehabilitation, Enhancement and Creation Expert Panel
Friday, June 21, 2:00PM-4:00PM
Conference call

Name	Affiliation	Present?
Neely Law (Chair)	CWP	Y
Kathy Boomer	TNC	N
Jeanne Christie	ASWM	N
Greg Noe	USGS	Y
Erin McLaughlin	MD DNR	N
Solange Filoso	UMCES CBL	Y
Denice Wardrop	PSU	Y
Scott Jackson	UMass	Y
Steve Strano	NRCS-Maryland	Y
Rob Roseen	Waterstone Engineering	Y
Ralph Spagnolo	EPA Region 3	N
Panel Support		
Jeremy Hanson (Coord.)	Virginia Tech, CBPO	Y
Jeff Sweeney	EPA, CBPO	Y
Carrie Travers	EPA Region 3	Y
Bill Stack	CWP	Y
Deb Caraco	CWP	Y

Welcome and call to order

- Jeremy verified participants and welcomed everyone.

Timeline and process

- Jeremy and Neely reviewed the overall timeline for releasing the report and seeking CBP partnership input and approval from workgroups, Water Quality and Habitat Goal Implementation Teams, as described in the BMP Review Protocol

Upland acre treated ratios

- Neely noted the panel has had limited time to discuss options for upland treated acre ratios.
- Deb summarized some results from Denice's analysis into Nanticoke wetlands data and drainage areas. The data was courtesy of Amy Jacobs and Denice was kind enough to analyze the information to see how it might inform the panel's final recommendations. It was very difficult to make any conclusions considering the distribution of the wetland drainage areas. The median drainage area was only .27 ha, and the variability was extremely high. There was insufficient time

to do more in-depth statistical analysis. The analysis was only able to look at the direct drainage and not areas like overbank treatment.

- Neely explained that the language in the current report is that drainage area associated with the wetland BMP should be reported, and when not provided the default would be 1:1.
  - Greg: would need to clarify the language to ensure the drainage area reflects the direct drainage and not upstream or overbank areas.
  - Steve supported using
  - Scott: if you don't report drainage area then use a ratio, whichever is smaller
  - Denice agreed with having some sort of upper limit
  - Steve: everyone agrees that these wetlands are providing treatment for watersheds so we should work to account for that benefit.
  - Denice: Support incentivize drainage area for these practices. We can only get better data by asking them to report the drainage area and then building a database to better inform ourselves.
  - Bill: we've been building some case studies behind the scenes. Using pre-determined ratios creates confusion when compared to case studies and actual drainage areas.
  - Neely: ask for drainage area, with 1:1 default if no drainage area reported.
    - Solange: keeping 1:1 seems unfair across the board. Perhaps the compromise should be 2:1 for floodplain and 1:1 for other wetlands.
      - Deb: is there guidance to help define drainage area?
      - Carrie: we are talking only rehabilitation and creation, not sure if we should do 2:1 based only on floodplain or not.
      - Scott: unable to articulate a better approach and okay with the group's recommendations.
    - Related issue: should there be an upper limit and if so, what?
      - Scott and Solange: there should be an upper limit
      - What should the upper limit be?
        - There was discussion with some noting that the ratios from WEP2016 could be wrong, so we don't necessarily want to use them as the upper limit.
        - Steve: we should have them report the drainage area, but then use the WEP2016 ratios as an upper limit.
    - **DECISION: The panel agreed that drainage area should be reported for creation/rehab BMPs in addition to the wetland area.**
      - **If the drainage area is not reported, then the default upland acres treated ratio will be 1:1 for non-floodplain wetland creation/rehab and 1.5:1 for floodplain wetland creation/rehab.**
      - **Upper limit for upland acres treated will be 4:1 for non-floodplain wetland creation/rehab and 6:1 for floodplain (reported drainage area is still collected).**

TSS efficiency

- Neely described the TSS efficiency options for the panel's decision. There was no consensus among the responses, Neely opted for Option 4 in the draft report as the reasonable point for compromise (27% for creation and 19% for rehabilitation).
  - Denice: agree with the recommendation, but have concerns with the final sentence on the slide.
  - Solange: the kind of wetland creation done in the region is not to intercept high loads of sediment.

- Neely asked if there we any objections to proceeding with the suggested option for the panel's recommendations; no objections were raised.
- **DECISION: The panel agreed to recommend 27% and 19% TSS efficiency values for creation and rehabilitation, respectively.**

Overview of draft report

- Neely recalled the need for the group to release its report in early July. We need all final comments on the draft report by July 1st. She reviewed the NTPs (notes to panel), calling for panelists to pay particular attention to those particular parts of the draft report. **ACTION: Panelists should provide all final comments or suggested edits on the draft report by COB July 1.**
- Jeremy and Neely deeply thanked all the panelists and participants for their time and effort over the many months of the panel. Updates and communication after this point will be via email or phone, as there will be no more panel discussions unless partnership feedback necessitates a group discussion and decision. Otherwise Jeremy, Neely and the CWP will work with individual panelists as needed to respond to feedback and make clarifying edits to the report based on partnership feedback.

Adjourned

Appendix K: Record of Decisions

Partnership review and approval process, starting with most recent decision

Water Quality Goal Implementation Team

March 23, 2020:

https://www.chesapeakebay.net/what/event/water_quality_goal_implementation_team_conference_call_march_23_2020

Announcement confirming **approval of the Wetland panel report via email as of March 18**, as no additional comments or concerns were submitted. Body of email copied here for posterity.

March 4 email sent to WQGIT by Hilary Swartwood, WQGIT Staffer:

> Good afternoon WQGIT members and interested parties,
>
> During the December WQGIT meeting, PA DEP placed a "hold" on approval due to three primary concerns that were raised during the review and approval process. Since then, leadership of the WQ and Habitat GITs have worked with the Panel Coordinator and PA DEP to determine a path forward for the partnership to further investigate and resolve the issues. A memo from the Habitat and WQ GIT Chairs was drafted and finalized based on feedback following the January WQGIT call. The final memo is attached to this message and will be added to the Wetland BMP panel's report as an appendix.
>
> With the final memo documenting a path forward, PA DEP agrees to stand aside for the Wetland BMP panel's report. Since there were no other "holds" or objections to the wetland panel's report and recommendations raised in December or offline, we are sharing the memo and confirming consensus of the wetland panel's report via email. Any GIT members with concerns or objections to the panel report should raise them immediately to the GIT Chairs and Panel Coordinator (Jeremy Hanson, jchanson@vt.edu). If no objections are received by COB March 18th then the report will be considered approved by consensus on that date.

January 13, 2020

https://www.chesapeakebay.net/what/event/water_quality_goal_implementation_team_conference_call_january_13_2020

Action: WQGIT members should send feedback regarding the Wetland BMP memo to Jeremy Hanson (jchanson@vt.edu) by COB, January 27, 2020.

Action: The Nontidal Wetland Rehabilitation, Creation, and Enhancement BMP Expert Panel report and the Wetland BMP memo will be brought before the WQGIT in February or March for final approval, while compensatory mitigation will be added as an agenda item for the WQGIT meeting in March.

December 9, 2019

https://www.chesapeakebay.net/what/event/water_quality_goal_implementation_team_conference_call_december_9_2019

Decision: The Habitat and Water Quality GIT postponed approval of the Nontidal Wetland Rehabilitation, Creation, and Enhancement BMP Expert Panel report to the January 13th WQGIT conference call, based on concerns raised by PA regarding: 1) wetland land use mapping and classification, 2) compensatory mitigation wetlands (eligibility, tracking, and reporting toward TMDL targets), and 3) BMP panel report approval process.

Watershed Technical Workgroup
October 3, 2019:
https://www.chesapeakebay.net/what/event/watershed_technical_workgroup_conference_call_october_2019
Decision: The WTWG did not reach consensus on the Wetland Creation, Rehabilitation and Enhancement BMP Expert Panel report due to concerns raised by Pennsylvania regarding headwater floodplains and mapping. CBP and PA will work with each other to reach consensus before the report goes to the Water Quality and Habitat GITs for approval in November.

Urban Stormwater Workgroup
September 17, 2019
https://www.chesapeakebay.net/what/event/urban_stormwater_workgroup_conference_call_september_17_2019
No action or decision was sought or requested. Presentation for informational purposes.

Agriculture Workgroup
September 19, 2019:
https://www.chesapeakebay.net/what/event/agriculture_workgroup_conference_call_september_2019
No action or decision was sought or requested. Presentation for informational purposes.

Wetland Workgroup
September 10, 2019
https://www.chesapeakebay.net/what/event/wetland_workgroup_meeting5
Summary: Consensus not achieved. PA DEP stated its "hold" and concerns.
Action: PA DEP to provide formal write-up of issues with BMP expert panel report and provide to Pam and Carin.
Resolution: Jeremy will move forward with report to next group, PA will send email to Pam with issues, Carin will bring up issue to Management Team.

"Roll-out" webcast and presentation of recommendations
July 31, 2019
https://www.chesapeakebay.net/what/event/wetland_bmp_expert_panel_recommendations_roll_out_webcast

Panel deliberations

Panel deliberations are closed and not found on the CBP meetings calendar. See the compiled minutes in Appendix J.

Panel formation and open stakeholder meeting

Open stakeholder meeting
February 28, 2018
https://www.chesapeakebay.net/what/event/open_session_nontidal_wetland_rehabilitation_enhancement_and_creation_bmp_e

Wetland Workgroup
September 14, 2017:
https://www.chesapeakebay.net/what/event/wetland_workgroup_meeting_september_2017
Action Item: Members vote to Approve EP members: Outcome: **request responses by end of next week – 9/22** Send out email to prompt – disclaimer of no response = approval
Note: no objections or responses were received and the panel was approved and convened as proposed.

May 18, 2017: https://www.chesapeakebay.net/what/event/wetland_workgroup_meeting_may_2017
Action: Please vote on approval of the scope by May 24th, 2017 by an email to ajacobs@tnc.org, erin.mclaughlin@maryland.gov, and runion.kyle@epa.gov. Any concerns can also be brought to jchanson@vt.edu.
Decision: The charge and scope of work for the next wetland panel are approved.

March 23, 2017:
https://www.chesapeakebay.net/what/event/wetland_workgroup_meeting_march_2017
Action: Workgroup members should contact runion.kyle@epa.gov by April 6th if they are willing to volunteer to join the group to write the panel charge. This charge will be presented at the next Wetland Workgroup's meeting for approval.

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MEMORANDUM

To: Chesapeake Bay Program Water Quality Goal Implementation Team Members

From: Christine Conn and Bill Jenkins, *Habitat Goal Implementation Team Chairs*
and
Ed Dunne and James Martin, *Water Quality Goal Implementation Team Chairs*

Date: February 25, 2020

Re: Chesapeake Bay Program Water Quality GIT and Habitat GIT Responses to PA DEP Hold on Wetland BMP Expert Panel Report

Executive Summary
At the September 10, 2019 Wetland Workgroup meeting, the Pennsylvania Department of Environmental Protection (PA DEP) Wetland Workgroup members using the consensus continuum recommended a HOLD on finalizing the current Draft Wetland Best Management Practice (BMP) Expert Panel Report. PA DEP continued its HOLD on the report during the December 9, 2019 Water Quality Goal Implementation Team (WQGIT) meeting, during which the Expert Panel Coordinator sought approval of the report from WQGIT members.

The HOLD recommendation was made due to PA DEP's dissatisfaction with the "continued propagation of deficiencies" from past expert panels and the perceived lack of a process to resolve these issues. The three concerns registered by PA DEP relate to the following topics: wetland land use classification; compensatory mitigation wetlands; and general BMP panel report review and approval process. Below is a summary of each issue and the most recent response from the WQGIT chairs, Habitat GIT (HGIT) chairs, Expert Panel Coordinator, and other Chesapeake Bay Program leadership.

Issue: Wetland land use classification
PA DEP's largest concern with wetland classification lies in the use of the categories of "Floodplain Wetlands" and "Other Wetlands" for establishing upland acres treated and wetland retention efficiencies, as well as Total Maximum Daily Load (TMDL) reductions in the Watershed Model. Research within the jurisdiction shows that headwater systems are high value landscapes and play an important role in reducing pollutant loads. Because headwater systems are included in this category of "Other Wetlands", rather than as "Floodplain Wetlands" or its own classification, PA maintains that the important role of these complexes, and any restoration that is completed within them, is discounted and not sufficiently simulated in the Watershed Model.

The Department would like to re-visit the two classifications for wetland restoration and the subsequent effect in terms of BMP model reductions. They request an action plan and time frame outlined for the jurisdictions for resolving this issue. They suggest that since this classification issue arose during the 2016 BMP report and has not been resolved, the action plan and timeline should be

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included as an addendum to the 2016 BMP report as a formal Chesapeake Bay Program commitment to resolve this concern.

Response:
The WQGIT and HGIT chairs agree with the significant role that headwater systems play with respect to water quality. Two different accounting process are linked to wetland classification; one, the contribution of the land use as a load to the watershed model, and two, the BMP efficiencies dependent on the upland treatment area. With regard to the land use loading, the loading rates for all non-tidal wetlands are the same. The wetland restoration BMP does receive larger simulated reductions when the restoration occurs in the floodplain, as extensively justified in the 2016 panel report. There is agreement that more work is needed to clarify the appropriate place for headwater wetland complexes in the wetland classification scheme of "floodplain" and "other" to better reflect their importance. The HGIT and WQGIT chairs propose to provide a mappable redefinition of wetlands as part of new land use/land cover data. By working with PA DEP, the Wetland Workgroup, and the Land Use Workgroup, the mapping team can develop GIS layers that PA deems more relevant and applicable, given recent research and new data.

Broadening the definition of floodplain wetlands and reflecting this change with mapping visualizations must be substantiated by the partnership, starting with the Wetland Workgroup. Peter Claggett has offered to hold a "kick-off" presentation for this process at the next Wetland Workgroup meeting, scheduled for Monday March 2. This will build from the current proposed land use and land cover classification scheme as presented to the Land Use Workgroup (LUWG) on February 5. It was reiterated at that LUWG meeting that the land use classes in the Phase 6 Watershed Model cannot be changed until after 2025, and therefore the current classification used for annual progress submissions and CAST scenarios will stay the same. The proposed land use and land cover classes will be available as a resource for all partners, however. The mapping team estimates that they can create a better floodplain methodology over the course of a year with partnership input, particularly from PA DEP. This process will include a literature review, prototyping of visuals, simultaneous mapping of the updated 2017-2018 land use/ land cover classification, and a vetting process. A more detailed timeline cannot be provided here, as it will require input from the Wetland Workgroup and further coordinated discussions with the CBP GIS team and LUWG leadership.

Beyond improvements to partnership data layers, GIT leadership and CBPO staff discussed how the current Phase 6 wetland land use classification, which uses FEMA floodplain and SSURGO soil data to separate the two wetland classes, does not constrain PA's designation and reporting of wetland restoration BMPs as "floodplain" or "other". Whether a wetland restoration project is in a "floodplain" or not is determined by site conditions, such as hydrology and connectivity, and not based on FEMA floodplain layers. FEMA floodplain maps were and are not intended to provide a wetland classification or designation. Indeed, some projects will reconnect areas to the floodplain. Jeremy Hanson will summarize this clarified definition in a section of an updated fact sheet regarding the findings from both wetland BMP panel reports and provide a draft to the workgroup by May 2020. In the next cycle of progress reporting for 2020, PA can begin recording wetland restoration projects that occur in headwater systems as floodplain wetland restoration where appropriate. Clarifying the application of the definition for reporting purposes, combined with improved mapping of wetlands is consistent with the recommendations of both wetland expert panels (2016 and 2020). It will also provide greater

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clarification both within the Bay Program partnership and broader stakeholders. We encourage PA DEP to remain active and engaged champions throughout this process.

Issue: Compensatory mitigation wetlands
As with the previous Wetland Expert Panel that concluded in 2016, this current panel and report are focused on voluntary wetland activities that can be tracked and reported toward TMDL progress. Compensatory wetland mitigation is outside the purview of the panel and is not creditable for Chesapeake Bay TMDL purposes. PA DEP disagrees with the ineligibility of compensatory wetland mitigation projects for use as Bay Program BMPs. They argue that when land is converted to urban uses developers can implement several BMPs, such as erosion control measures, various storm water controls, infiltration, etc., that are accepted as mimicking the natural processes that were lost due to development. Yet wetland compensatory mitigation projects that are developed to account for loss of wetlands to development are not eligible as a BMP. PA sees this ineligibility as a historical carry-over and not reflective of the current WIP strategy that includes both regulatory and voluntary strategies. PA DEP advocates for the inclusion of these projects as a BMP across all jurisdictions.

Response:
The Bay Program has a long-standing distinction between wetlands as a voluntary BMP and regulatory wetland mitigation under Section 404 of the Clean Water Act. The wetlands regulatory programs are intended to ensure no net loss of function and value, which includes the mitigation requirement. The goal of wetlands as a voluntary BMP is net gain and functional uplift, which is captured by restoration, rehabilitation, and creation of wetlands outside of the regulatory context. Therefore, as it stands, wetlands created through compensatory mitigation are not eligible as a BMP. If compensatory mitigation projects exceed the demand or need for off-site mitigation, perhaps that surplus could be applied towards TMDL progress.

To move this issue forward, PA DEP is encouraged to request the Management Board's approval to form an ad hoc group to investigate the issue of wetland mitigation accounting for CBP partnership purposes. The group, if formed by the Management Board, would deliver a memorandum that will (1) document the existing accounting procedures across Bay jurisdictions, and (2) provide a range of options for the Management Board's consideration. Specifics of the group's formation, scope of work, composition and operations would be determined through discussion at the Management Board or partnership feedback. Dianne McNally, EPA Region 3's WQGIT member, specifically requested that wetland regulatory staff in Region 3 be part of future partnership discussions on this issue. Dianne and others have acknowledged that this is a policy issue. Indeed, it is a cross-GIT policy issue affecting the partnership and should therefore be brought to the Management Board. To facilitate a robust discussion and form an effective group, PA DEP should prepare a "proposed charge and scope of work" for the requested ad hoc group. The Management Board could consider the request at its April conference call. If the request is approved, the partners would then select members to serve on the group for subsequent confirmation by the Management Board, allowing the group to convene as early as May.

Issue: Overarching concerns regarding the general BMP panel report review/approval process

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In the past, PA DEP has registered its comments during the BMP report review process. Though their concerns were not resolved, they allowed the report to be finalized so as not to interfere with the other jurisdictions' implementation. However, they feel that past comments regarding these issues have been carried forward into the latest report and have still not been satisfactorily addressed, causing dissatisfaction with the overall BMP panel report review and approval process. They suggest that within the adaptive management framework of the Chesapeake Bay Program, it is essential that there is a process to correct past mistakes or misinformation in these reports, move forward with amendments, and allow for the integration of new research.

PA DEP would also like to address the challenges that several jurisdictions have with conflicting priorities across workgroups. Perceptions of unequal load reductions in the Watershed Model (i.e., between wetland restoration and riparian forest buffers) lead to greater prioritization and emphasis on projects that get the highest credit, despite their actual ecological effects on the environment. PA DEP would like the see the role of the CBP Cross-GIT Coordinator and other leadership fully utilized in resolving these conflicts across workgroups and encouraging greater communication and transparency.

Response:
Per the partnership's BMP Expert Panel Protocols, there is a process in place to revisit past panel reports to integrate new science or information and correct what may be perceived as errors:

> *C. Existing estimates or treatment processes*
> *The WQGIT will periodically re-evaluate existing loading and effectiveness estimates if new science or information becomes available, to determine if a review is warranted. Such reviews can be prompted by the availability of new information, such as a new treatment process or new information on efficiencies. Reviews can also be initiated if current estimates produce illogical model outputs or if there is reason to believe that they were developed using inaccurate information. Requests for reviews are typically submitted by a source sector Workgroup or GIT but are not restricted to these groups. (WQGIT BMP Review Protocol, 2015, p.3)*

Throughout the entire expert panel process, there are several opportunities to raise concerns and/or provide feedback. However, the WQGIT and HGIT chairs recognize that improvements can be made to provide more clarity on points in the process where partners can interact with the reports. CBPO staff are exploring the concept of a "dashboard" or improved webpage for BMP panels, similar to Chesapeake Decisions, that clearly outlines the current status of each panel and holds an archive of completed reports. However, the creation of a web platform will depend largely on usefulness to the jurisdictions and other partners, the number of panels expected in the future, and resources needed to create and maintain this website. Staff at CBPO will continue to engage with PA DEP as possible updates to the website are considered. Staff at CBPO will also make a more concerted effort to communicate each step of the BMP panel process with other GITs and workgroups. The appropriate staffer for each BMP report will provide updates related to panel charges, webinars, review and comment periods, etc. at the bi-weekly Coordinator/Staffer meetings, so coordinators and staffers of other workgroups can pass on announcements to their respective workgroup members.

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As for potential workgroup conflicts, again there are ample points of engagement throughout the panel process. Every CBP partnership workgroup, GIT, and Advisory Committee has an opportunity to review the panel charge, proposed membership, panel scope and the draft report; participate in the panel's kick-off webinar and review and comment period; and engage in the workgroup and GIT decisional meetings. The WQGIT and HGIT chairs feel that the Scientific, Technical, Assessment, and Reporting (STAR) group is an appropriate place to identify and begin addressing cross-GIT issues or scientific needs that arise in the panel or review process.

With regards to "unequal crediting," it is important to reiterate that these expert panels are charged with assigning nutrient and sediment reduction efficiencies for BMPs based on the available science. It is entirely up to each state and local jurisdiction to select which BMPs to prioritize, emphasize, and ultimately implement based on unique programs, priorities, political realities, funding opportunities and constraints, etc. Per the BMP Panel Protocol (p.7):

> *It is important to note that the purpose of the Panels is not to incentivize or promote the use of any BMP; it is to increase the understanding of the nutrient and sediment reductions associated with these practices. In addition, any appendix on ancillary benefits or unintended consequences does not change the definitions and loading or effectiveness estimates for nutrient and sediment reducing technologies and practices in the final Panel report. State and local governments may then consider both the definitions and effectiveness estimates from the main panel report, as well as ancillary benefits or unintended consequences from the appendix, when deciding upon which technologies and practices they intend to select, fund, and implement within their respective jurisdictions.*

The GITs are aware of the issues caused by perceptions and perverse incentives in BMP model reductions and the importance of co-benefits, and is actively trying to discuss this in workgroup, GIT, and higher-level conversations. The Wetland Workgroup recently tried to develop a Scientific and Technical Advisory Committee (STAC) Workshop proposal regarding this issue, but could not get sufficient support necessary for the proposal. A STAC Workshop would be an excellent forum to discuss this issue at a larger scale within the Bay Program. If PA DEP is willing to help champion such a proposal with the Wetland Workgroup, it may be possible to achieve critical mass during the next round of proposal solicitation.

Conclusion

Once consensus has been reached on these outstanding issues and PA releases its HOLD on the report, the Chesapeake Bay Program agrees to add a finalized version of this memo, with resolutions to each issue clearly stated, as an appendix to the approved 2020 Wetland Best Management Practice (BMP) Expert Panel Report.

Furthermore, through your participation on the GITs, PA may at any time request the GIT add issues of concern to meeting agendas for discussion, consideration and decision by the Partnership. We encourage PA to use the existing Partnership decision structure by raising issues at the appropriate level, be that workgroups, GITs or the Management Board. It is our hope that moving forward, any concerns can be promptly discussed and resolved before they intensify and become barriers to Partnership consensus building.