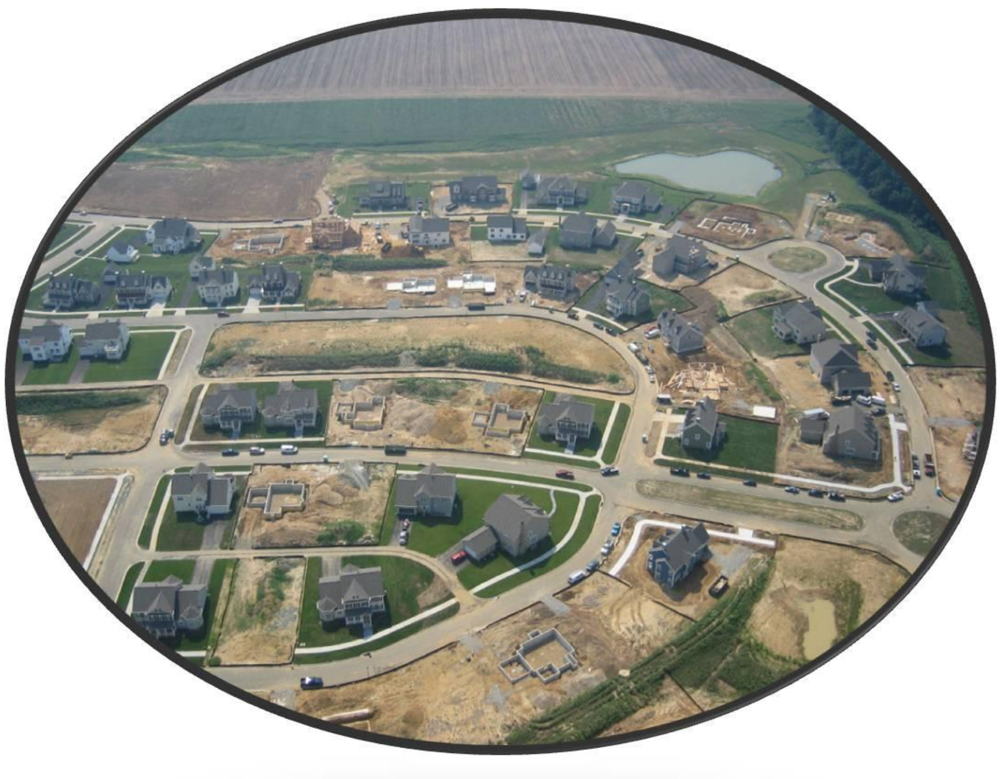
Recommendations of the Expert Panel to Define Removal Rates for Erosion and Sediment Control Practices

FINAL REPORT

Shirley Clark, Megan Grose, Randy Greer, Albert Jarrett, Summer Kunkel, Don Lake, Neely Law, John McCutcheon, Rich McLaughlin, Kip Mumaw and Bruce Young

1/4/2014



Prepared by:
Jeremy Hanson, Chesapeake Research Consortium
Tom Schueler and Cecilia Lane, Chesapeake Stormwater Network

Submitted to Urban Stormwater Workgroup 1/21/2014

Photo credit: Randy Greer, DE DNREC

Table of Contents

The following is a list of common acronyms used throughout the text:

ATS	Active Treatment Systems
BMP(s)	Best Management Practice(s)
CBP or CBPO	Chesapeake Bay Program Office
CBWM	Chesapeake Bay Watershed Model
CGP	Construction General Permit
CTS	Chemical Treatment Systems
DIN	Dissolved inorganic Nitrogen
EoF	Edge of Field
EoS	Edge of Stream
ESC	Erosion and Sediment Control
EMC	Event Mean Concentration
HSG	Hydrologic Soil Group
LOD	Limits of Disturbance
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NTUs	Nephelometric Turbidity Units
PAM	Polyacrylamide
Rv	Runoff Coefficient
RUSLE	Revised Universal Soil Loss Equation
ST	Stormwater Treatment (adjustor curve)
TMDL	Total Maximum Daily Load
TN or N	Total Nitrogen
TP or P	Total Phosphorus
TSS	Total Suspended Solids
USWG	Urban Stormwater Work Group
WIP	Watershed Implementation Plan
WQGIT	Water Quality Goal Implementation Team

EXECUTIVE SUMMARY

Construction sites are estimated to comprise about 84,500 acres of the watershed, but deliver about 16% of the total annual sediment load from the urban sector to the Bay, based on current model estimates. An expert panel was convened to review past estimates of the sediment and nutrient removal rates associated with erosion and sediment control (ESC) practices.

In recent years, all of the Bay states have strengthened their ESC requirements for construction sites, through more sophisticated practice specifications, new technology, and more stringent inspection and enforcement procedures. In 2011, West Virginia requested a new BMP review panel for enhanced ESC practices, and proposed an interim efficiency for these enhanced practices (See Appendix E). West Virginia noted that the more stringent design and inspection requirements contained in their most recent construction general permit should produce higher sediment and nutrient removal efficiencies than the existing rates of 25% (TN) and 40% (TSS and TP).

Based upon a review of current literature and monitoring data, the Panel devised a four tier system to classify the overall sediment removal performance of ESC practices based on past, current and future ESC implementation.

The Panel conducted an extensive review of the available science to define construction site hydrology, analyzed TSS outflow concentrations, and used the Simple Method to compute annual sediment loads for 3 of the 4 levels of ESC practice under normal conditions. The Panel also estimated sediment loss during periods where ESC practices are considered to be functionally deficient in their capacity to trap sediments. Based on this analysis, the Panel recommends the following sediment removal rates be applied to construction sites in the current version of the watershed model.

ESC Scenario	Discharged Load	Effective Removal Rate
ESC Sites Operating at Level 1	3.1 t/ac/yr	**74%**
ESC Sites Operating at Level 2	1.75 t/ac/yr	**85%**
ESC Sites Operating at Level 3	1.25 t/ac/yr	**90%**
ESC Sites Operating at Level 4	No estimate	No estimate

All of the Bay states are currently operating at an enhanced Level 2 performance rate, although several may be progressing to Level 3, which relies on greater use of polyacrylamide (PAM) to reduce construction site turbidity levels. The Panel encouraged states and localities to improve their ESC programs to achieve a higher and more reliable level of turbidity control.

The fine-grained particles that create turbidity are likely to have a higher delivery ratio to the Chesapeake Bay, given that it takes days or even weeks for them to settle out of the water column. Jurisdictions that improve their ESC program to shift to Level 3 ESC practice would have the further benefit of reducing the impact of turbidity on aquatic health and diversity in the streams, lakes and estuaries that discharge to the Bay.

The Panel also evaluated existing nutrient data for construction sites, and determined that there was no clear evidence that ESC practices can actually reduce nutrients, and some evidence that they may actually become a nutrient source. Consequently, the Panel assigned a zero nutrient removal efficiency for all four levels of ESC practice and supports the existing Chesapeake Bay Watershed Model (CBWM) target loads of 26.4 lbs/ac/yr for Total Nitrogen (TN) and 8.8 lbs/ac/yr for Total Phosphorus (TP).

Fertilizer wash-off appears to be a major risk for nutrient export, based on the prevailing fertilizer application rates used for vegetative stabilization at construction sites in the Bay watershed, as well as observations of high spikes in nutrient concentrations in several monitoring studies. The Panel urgently recommends additional monitoring studies to define the potential risk of fertilizer wash-off.

The Panel concluded that the existing ESC inspection and enforcement system was sufficient to verify this annual practice, and provided states with two options to estimate annual construction acreage.

Future Model Refinements:

The Panel recommends the modeling team consider the following refinements in the next phase of CBWM development.

1. Eliminate the simulation of the no-ESC baseline condition for construction sites, and instead simulate construction land use as its own BMP. Under this scenario, there would be four categories of construction land that correspond to the four ESC performance levels (factoring in the additional load from functionally deficient ESC sites).

2. The no-ESC condition has been a historic artifact for several decades now, and virtually every construction site in the Bay watershed employs ESC practices of one kind or another. The Panel was particularly concerned about the quality of the limited historical data used to derive calibration target loads for the no-ESC condition. If a no-ESC condition is required for modeling purposes, the Panel recommends that the target load be lowered to no more than 12 tons/acre/year.

3. Refine the parameters in the construction site simulation in PERLAND to explicitly simulate as many of the nutrient loss pathways as possible. At a minimum, construction sites should be subject to a weighted unit acre fertilization rate (which the model currently lacks).

4. Explicitly simulate sediment loss for construction sites located on the coastal plain physiographic region, which should be lower than other parts of the Bay watershed due to their gentle slopes, longer slope/length distances, and less erodible soil types.

Section 1
Charge and Membership of the Panel

The roster of the expert panel for erosion and sediment control practices can be found in the Table below.

EXPERT BMP REVIEW PANEL	
Panelist	***Affiliation***
Megan Grose	West Virginia Dept of Environmental Protection
Randy Greer	Engineer VI, Sediment and Stormwater Program, DE Dept. of Natural Resources and Environmental Control
Summer Kunkel, Dean Auchenbach	Pennsylvania Department of Environmental Protection
Dr. Shirley Clark	Pennsylvania State University, Harrisburg
Don Lake	State University of New York-College of Environmental Science and Forestry
Dr. Richard A. McLaughlin	Dept. of Soil Science. North Carolina State University
Dr. Albert Jarrett	Professor Emeritus, Pennsylvania State University
Bruce Young	St. Mary's Soil Conservation District (Maryland)
Kip Mumaw	Ecosystem Services
John McCutcheon	Virginia Department of Environmental Quality
Dr. Neely Law	Center for Watershed Protection, Chesapeake Bay Sediment Coordinator
Tom Schueler	Chesapeake Stormwater Network, Panel Co-facilitator
Jeremy Hanson	Chesapeake Research Consortium, Panel Co-facilitator
Non-panelists: Norm Goulet – Chair, USWG; Cecilia Lane, CSN; Chris Mellors – Tetratech. Special thanks to the CBPO Modeling Team: Guido Yactayo – UMCES, CBPO; Gary Shenk – EPA; Matt Johnston – UMD, CBPO; Jeff Sweeney – EPA	

Background on Panel:

Erosion and Sediment Control (ESC) Practices are required to be employed at construction sites in all of the Bay states. After considerable controversy, the Urban Stormwater Workgroup (USWG) approved sediment and nutrient reduction rates for ESC practices in 2007 (see Table 1). At that time, the Panel was limited to research studies conducted before 1995, and lacked any data on nutrient loadings from construction sites, or any nutrient removal rates by ESC practices.

The Panel noted in its report that they had low confidence in their findings due to the limited available research, and that the relatively low rates reflected a discount due to real world issues related to poor installation and maintenance of practices.

Table 1 – Removal Rates for ESC Practices for Construction Sites			
	TSS	TP	TN
Existing CBP-Approved Rate [1]	40	40	25
Interim Rate Requested by WV [2]	80	80	80
[1] approved by USWG, August 15, 2007 [2] interim rate requested by WV 9/15/2011 for enhanced ESC controls (see Appendix E)			

Since that time, all of the Bay states have strengthened their ESC regulations and construction general permits, improved their ESC technology, and developed more effective compliance and enforcement methods at construction sites. In 2011, the West Virginia Department of Environmental Protection (WVDEP) requested that higher sediment and nutrient removal rates be offered to reflect these "enhanced ESC practices". The Chesapeake Bay Program (CBP) granted an interim placeholder value for loading rates from bare construction to pervious land (“bar to pul”), subject to subsequent review by an expert panel (see Appendix E).

The initial charge of this Expert Panel was to review all of the available science on the nutrient and sediment removal performance associated with erosion and sediment control practices that are applied to construction sites.

The Panel was specifically requested to:

- Evaluate how construction sites are simulated in the context of CBWM version 5.3.2 (e.g., bare land use).
- Review available literature on the nutrient and sediment loading rates associated with construction sites, and the effect of conventional and enhanced ESC practices in reducing them.
- Provide specific definitions of "enhanced" and "conventional" ESC practices, and describe the qualifying conditions under which a locality can receive a nutrient and/or sediment reduction credit for each.
- Evaluate whether the existing CBP approved nutrient removal rates for conventional ESC practices developed in 2007 are still reliable.
- Define the proper units to report ESC practices for inclusion into the Watershed Model.
- Recommend procedures to report, track, and verify that conventional and enhanced ESC practices are actually being implemented and maintained until the site is fully stabilized.
- Critically analyze any unintended consequences associated with the sediment and nutrient removal rates and any potential for double or over-counting of the credit.

While conducting its review, the Panel followed the procedures and process outlined in the *Protocol for Development, Review and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls* (WQGIT, 2013). The meeting minutes for the expert panel can be found in Appendix F. Appendix G documents the Panel's conformity with the BMP review protocol requirements.

Section 2
Definitions and ESC Performance Levels

Construction sites are highly dynamic throughout the construction process, from initial clearing and grading, earthmoving, installation of streets and storm drains, building construction and finally, the final stabilization of the site. Consequently, the hydrology of a construction site constantly changes, based on soil exposure, new slopes, the growing season, grass cover, addition of hard surfaces, efficiency of stormwater conveyance, and the condition and performance of ESC practices. As a result, construction site erosion potential changes constantly over time, although significant soil loss is always expected during heavy or intense rainfall events.

The term erosion and sediment control refers to a combination of many different erosion prevention and sediment control practices that are progressively applied and maintained at site during the different stages of construction (Figure 1). *Erosion controls* are intended to prevent exposed soils from eroding, while *sediment controls* capture sediment that has eroded and traps it before it can leave the construction site.

A developer must submit an ESC plan for their construction project that specifies a unique combination of erosion and sediment controls for the unique conditions of the site. The plan is reviewed as part of the state and/or local land development approval process, and the ESC practices must be installed prior to construction activity. Construction sites are inspected periodically to ensure the practices are intact and working properly to prevent off-site sediment discharge.

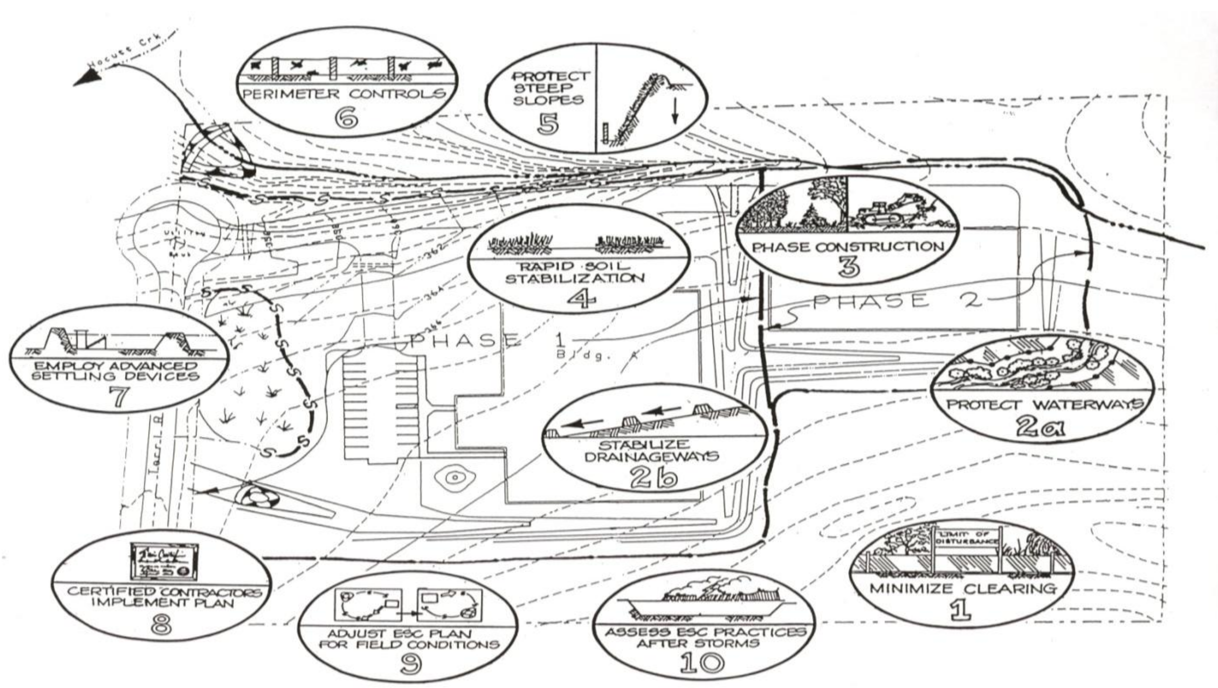


Figure 1: Elements of Erosion and Sediment Controls at Construction Sites (Source: Schueler and Holland, 2000)

The Panel defined the following terms to be consistent throughout the report:

Construction site: The total area of a site disturbed by construction activity (in acres). If the disturbed area is one acre or greater, a construction general permit or other NPDES permit is required from the state that includes implementation of an ESC plan. Many Bay states have lower disturbance area thresholds that trigger requirements for ESC practices, some of which can be as low as 2500 square feet.

Disturbed acres: The portion of a construction site subject to any grubbing, grading, or earth disturbance activity that removes pre-construction vegetation, or where dirt has been stockpiled or wasted.

Edge of field (EoF): The sediment load discharged at the boundary of the construction site, some of which may not be delivered to the stream

Edge of stream (EoS): The sediment load that is actually conveyed to a stream and available for transport downstream.

***Event Mean Concentration* (*EMC*)**: The flow-weighted concentration of a pollutant as measured by an automated sampler over the full duration of a storm event. A median EMC is computed when many storms are monitored at an individual site, and this concentration value is used as an important parameter to calculate annual pollutant loads using the Simple Method (Schueler, 1987).

Limits of Disturbance (***LOD***): The boundary around the disturbed acres within a construction site, as defined in the construction plan or permit. Perimeter controls, such as silt fence, berms, or diversion ditches are used to mark the LOD and protect streams, wetlands and forest conservation areas located outside of the LOD from any runoff or construction disturbance.

Regulatory Inspection: An on-site visit conducted by an authorized local, county, conservation district or state employee (or certified third party inspector) to ensure that the construction site is in compliance with its applicable ESC plan or permit requirements and take enforcement action if it is not.

Runoff Coefficient (Rv): The volumetric fraction of the rainfall on the site that is converted into storm runoff. Operationally, Rv is defined as r/p, where r and p are measured volume of storm runoff and rainfall in acre-inches, respectively. The Rv for a site is influenced by soils, topography and surface cover. In this report, the runoff coefficient is used as an important input parameter in the Simple Method, which is used to calculate annual sediment loads.

Sediment Load: The total mass of all soil particles that is discharged from the construction site, reported in tons/acre/year. In the context of this report, this load is also referred to as the "edge of field" sediment load.

Sediment Delivery Ratio: In the context of this report, it is the fraction of the edge of field sediment load that is (a) actually delivered to a stream and (b) is transported through the stream and river network of the watershed to reach the Chesapeake Bay. Sediments can be trapped, deposited or otherwise stored in hill-slopes, channels and floodplains, so the ratio is always less than one.

Sediment load with ESC: The total edge of field sediment load discharged from a construction site (tons/acre/year) for one of four ESC performance levels, based on recent monitoring studies.

Sediment load without ESC: The total edge of field sediment load discharged from a construction site (tons/acre/year) assuming that no erosion or sediment control practices were in place, as determined by historic monitoring studies.

Self-Inspection: A periodic check of the condition of ESC practices by a qualified individual that works for the contractor or construction company to maintain the integrity of ESC practices and keep the site in compliance. An on-site log of self-inspection reports must be maintained which is subject to review during regulatory inspections. Individuals that conduct self-inspections may be subject to training and/or certification requirements in the jurisdiction in which they are working.

Temporary Stabilization: An ESC practice where exposed soils are seeded and covered with straw or mulch to rapidly establish vegetation that helps to minimize future soil erosion. Most Bay states require that soils exposed after clearing be temporarily stabilized within 7 to 14 days of the earth-moving activity. In the context of this report, temporary stabilization frequently involves high N and P fertilizer applications which may be vulnerable to wash off.

Turbidity: A measure of water clarity that is sampled by sensors and reported in nephelometric turbidity units (NTUs). Turbidity is created by the presence of clay, silt, colloidal particles, organic and inorganic compounds, algae and microbial organisms. Turbidity levels measured in excess of 150 to 200 NTUs in receiving waters are harmful to aquatic life and may be considered a water quality standard violation in several Bay states.

2.1 Defining Levels of ESC Performance

The Panel was mindful that both the performance and implementation of ESC practices have continuously evolved and improved over the last three decades. Consequently, the Panel agreed that ESC practices can be classified into four broad levels of practice, based on key differences in ESC sizing, stabilization, treatment and inspection requirements. The Panel further hypothesized that sediment and nutrient removal rates for ESC practices may differ depending on which performance level they fall into. The basic classification scheme is portrayed in Table 2.

The ESC performance level is based on whether a state or local program meets the *majority* of the technical design criteria, timing requirements, inspection and enforcement provisions outlined in Table 2. The Panel acknowledges that each local and state ESC program is unique, and that not all of the criteria for each level of classification may apply within their jurisdiction.

Table 2: 4 Levels of ESC Practice, as Defined by the Panel

Practices	**Level 1 ESC**	**Level 2 ESC**	**Level 3 ESC**
Protect Natural Resources	Locate natural areas and mark LOD (up to edge of natural area)	Do #1 and add buffers to LOD to prevent discharge to natural area	Do # 2, and provide enhanced perimeter controls at LOD boundary for sensitive areas
Minimize Disturbance	No numeric construction phasing requirement	Construction phasing required for largest projects (e.g., 25 + acres)	Construction phasing required for smaller projects
Stabilize Soils	Stabilize w/in 14 to 21 days	Stabilize w/in 7 -14 days	Stabilize w/in a week
Internal Drainage	Temporary swales	Swales/diversions with check-dams and erosion control blankets	Do #2, but enhance with passive use of polymer (e.g., floc logs or wattles)
Perimeter Controls	Standard Controls (e.g., hay bales, entrance stabilization)	Reinforced silt fence and berms/diversions	Enhanced perimeter controls (i.e., super silt fence, compost logs, and filtering practices).
Sediment Traps and Basins	Sediment traps, filters, and basins that meet the 0.5" (1,800 cu.ft/acre) standard	Sediment basins that meet the 1.0" (3,600 cu.ft/ac) standard, with permanent pools and/or dewatering control devices (e.g., skimmers)	Do # 2, but enhance performance with passive use of chemical additives to improve settling, filtration and surface outlets
Inspections	Monthly	Every 1 to 3 weeks	Inspections once every seven days and after each precipitation event > 1.0"
Level 4 ESC	Do Level 3 and employ active chemical treatment system (ATS) with fully automated pumps, controls, settling tanks, and sand filters that are specifically designed to achieve low numeric turbidity effluent concentrations for construction site discharge		

Level 1 ESC: Includes ESC practices implemented under historical performance standards from approximately 2000 or before. The sediment trapping requirements were typically 1800 cubic feet/acre, stabilization requirement were less rapid, and inspections occurred less frequently, among other factors. At one point, all of the Bay states operated at this performance level; none of them are doing so now. Level 1 ESC practices are assumed during the calibration phase of the CBWM (1985-2005).

Level 2 ESC: This level of performance reflects the more stringent ESC requirements that have been adopted by local and state governments in the Bay watershed over the last several years, and generally conform to the standard requirements in EPA's 2012 Construction General Permit.

These include a greater sediment treatment capacity (typically 3600 cf/ac), surface outlets, more rapid vegetative cover for temporary and permanent stabilization, and improved design specifications for individual ESC practices to enhance sediment trapping or removal. In addition, many states now have construction phasing requirements for larger sites and all require more frequent self-inspections and regulatory inspections. As of this writing, all Bay states are operating at this level of performance.

***Level 3 ESC*:** This level of performance reflects the gradual shift in several Bay states to improve performance by expanded use of passive chemical treatment within Level 2 ESC practices. Chemical treatment involves the passive use of polyacrylamide (PAM) and other flocculants. The treatment relies solely on gravity to dose the sediments in construction site runoff (e.g., adding PAM granules to a check dam, erosion control fabric, or running basin flows across a block or sock containing flocculants).

This approach also integrates other design features to enhance the performance of individual practices, such as skimmers, baffles, surface outlets, compost, and stronger geo-textiles. Level 3 also involves more frequent inspection and maintenance, and more stringent requirements for phasing and resource protection. While several Bay states are experimenting with some of these techniques, none of them are currently requiring them on a widespread basis. Therefore, no Bay state yet qualifies for Level 3 practice at this time. The Panel outlined quantitative benchmarks for states and localities to achieve a Level 3 of ESC practice (Section 7.4) as they continue to improve their programs in future years.

Level 4 ESC: The highest level of performance is associated with active treatment systems (ATS) that are employed for turbidity and suspended solids control. The ATS captures and pumps muddy water to a location where PAM or other flocculants can be injected or introduced. ATS are specifically designed to achieve low numeric turbidity effluent concentrations for construction site discharge. A typical ATS is fully automated and includes pumps, controls, settling tanks, and sand filters.

Consequently, ATS is very expensive and requires extensive manpower for operation. While some ATS have been tested and refined in California and the Pacific Northwest, they have been rarely applied and never required at construction sites in the Chesapeake Bay watershed. Indeed, several Bay states have been concerned about the possible environmental impacts associated with flocculants on downstream ecosystems, and have been cautious about expanding their use.

Functionally Deficient ESC Sites: The four levels of ESC practice assume proper installation and maintenance of practices, as well as normal rainfall conditions that are within the design capacity of the practices. These assumptions are violated at some proportion of construction sites, and all sites during extreme storm events.

Three levels of functional deficiency were defined based on hydrologic considerations (Section 5.4). *Minor* deficiency refers to the routine problems that are encountered and fixed during regular inspections of construction sites. *Moderate deficiency* occurs for rainfall events that exceed the designed sediment trapping capacity of ESC practices, whereas *Extreme functional deficiency* occurs for major storm events that exceed certain rainfall intensity or volume thresholds, and overwhelms ESC treatment capacity.

Section 3
Background on Construction in the Bay States

According to CBP, the actual disturbed area by construction sites in the Bay watershed is estimated to be around 84,500 acres or about 132 square miles each year. This amounts to about 0.02% of the total area of the Chesapeake Bay watershed. In any given year, the total construction acres may fluctuate up or down, depending on the level of development activity.

According to the Watershed Implementation Plans (WIP) developed for the Chesapeake Bay Total Maximum Daily Load (TMDL), construction runoff produces an estimated 16% of the delivered sediment load from the urban sector, and 3% of the load from all sectors combined (Sweeney, 2013). Watershed sources of sediment comprise about 60% of the total input to the Bay estuary, with the remainder coming from the ocean, shoreline erosion and internal re-suspension (Langland and Cronin, 2003).

On a unit area basis, construction sites are simulated to have the highest annual EoF sediment loads of any land use category in the Bay watershed, even when ESC practices are applied, assuming the original rate approved by CBP (see Table 3). There are some other notable sediment hotspots in the watershed, such as degraded riparian pasture, and uncontrolled extractive mining.

Table 3: Comparison of Edge of Field Sediment Loads By Land Use in the Bay Watershed (CBWM 5.3.2)

Bay Model Land Use Category	Annual EoF Sediment Load (tons/acre/year)
Construction Sites, No ESC Practices	24.4
Construction Sites, with ESC Practices [1]	14.6
Degraded Riparian Pasture	14.0
Extractive, Uncontrolled	10.0
Crops, Conventional Till	5.8
Urban Impervious Cover	5.0
Crops, Conservation Till	3.9
Pasture	1.6
Hay	1.5
Urban Pervious Cover	1.2
Forest (un-harvested)	0.3

Sources: Table 9-1 and 9-12 in Chesapeake Bay Phase 5.3 Community Watershed Model (EPA CBP, 2011)
Note: Application of BMPs can reduce sediment loads as shown above
[1] ESC practices are assumed to have a 40% removal rate, per the existing CBP-approved removal rate

Also, it should be noted that the actual sediment load *delivered* from a construction site to the Bay (or for that matter, any land use) will be lower than the EoF load. Also, the unit loads in each land river segment will vary depending on terrain factors, watershed location, proximity to the Bay and trapping by any downstream reservoirs, floodplains or river channels.

Section 3.1 How ESC is Currently Regulated in the Bay States

All Bay States have significantly strengthened their ESC sizing, design specifications and inspection requirements over the last decade, which suggests that a re-evaluation of rates is warranted. A generalized comparison of the key ESC requirements in each Bay state is provided in Table 4. More detail on how each state runs its individual ESC programs can be found in Appendix D.

Table 4
Summary characteristics of Bay States' Erosion & Sediment Control Programs

	Delaware	**Maryland**	**New York**	**Pennsylvania**	**Virginia**	**West Virginia**
First ESC regulations/ permits took effect	1991	1970	1993	1972	1973	1992
Most recent ESC Design Manual or Regulations	2013	2011 Manual effective 1/9/13	2005	Manual - 2012 Regulations – 2010	Manual--1992; Regulations--2013	2006 Manual
Area threshold for regulations	5,000 sf	5,000 sf	1 acre 5,000 sf#	5,000 sf	10,000 sf or 2,500 sf in CBPA	1 acre
Sizing requirement for on-site retention	3,600 cf/acre or one inch	3,600 cf/acre or one inch	3,600 cf/acre or one inch	6,000 cf/acre (basin); 2,000 cf/acre (trap)	3,600 cf/acre or one inch	3,600 cf/ acre; half wet, half dry
Stabilization requirement *	14 days	7 days or less	7-14 days	within 4 days	7-14 days	7- 14 days
Regulatory inspection requirements	Weekly	Every other week	Weekly. more frequent at larger sites	Every 30 days	Every 2 weeks and within 48 hrs. of a runoff event	At least one visit for all sites ≥ 3 ac.
Self-inspection requirements	Weekly	Weekly and next day after a storm event	Daily	Weekly and after each storm event.	Daily to Bi-weekly, and after each storm event	Every 7 days and within 24 hrs after storm
Construction phasing	Phasing required to keep LoD < 20 acres	Required for projects with 20 + acres	Required on all projects.	Not required	Not required	Not required

* requirements may differ for temporary vs. final stabilization
# 5,000 square feet threshold applies to the East of Hudson New York City watershed

Each state takes a unique approach to their ESC standards and specifications, and links to their core ESC programs and ESC design manuals can be found in Table 5.

Table 5
Weblinks to Each Bay State ESC Program Page and ESC Manual

State	Type	Link
DE	Program	http://www.dnrec.delaware.gov/swc/pages/sedimentstormwater.aspx
	Manual	http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/Delaware%20ESC%20Handbook_06-05.pdf
MD	Program	http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SoilErosionandSedimentControl/Pages/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/index.aspx
	Manuals	http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SoilErosionandSedimentControl/Documents/2011%20MD%20Standard%20and%20Specifications%20for%20Soil%20Erosion%20and%20Sediment%20Control.pdf
NY	Program	http://www.dec.ny.gov/chemical/8694.html
	Manual	http://www.dec.ny.gov/chemical/29066.html
PA	Program	http://www.portal.state.pa.us/portal/server.pt/community/chapter_102_soil_erosion_and_sedimentation_control/10600
	Manual	http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8300
VA	Program	http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/ErosionandSedimentControl.aspx
	Manual	http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx
WV	Page	http://www.dep.wv.gov/WWE/Programs/stormwater/csw/Pages/home.aspx
	Manual	http://www.dep.wv.gov/WWE/PROGRAMS/STORMWATER/CSW/Pages/ESC_BMP.aspx

Section 3.2 How CBWM simulates loads from construction sites

In the current Chesapeake Bay Watershed Model (CBWM), *bare-construction* is treated as a transitional land use as forest or agricultural land uses are developed. Maryland, Pennsylvania, and West Virginia provided data on the number of permitted construction acres for Bay counties for use in the Phase 5.3.2 CBWM. Maryland and Pennsylvania provided several years of permitted acres and West Virginia provided data for 2010.

The permitted construction acres were set to be proportional to the change in impervious area in the given watershed model segment to determine the ratio of permitted acres to impervious change. The state median ratio or the Bay median ratio (for states that had not submitted construction data) were used to calculate construction acreage from 1982 to 2025. The ratios are subject to change as the states provide additional data through their annual progress submissions. The ratios based on the 2012 Progress Run are summarized in Table 6.

Table 6: Estimation of state construction area, based on IC change

Area	**Ratio (Permitted acres: Impervious change)**
Chesapeake Bay Watershed	7.6
Maryland	11.8
Pennsylvania	7.1
Virginia	6.16
West Virginia	42.8

During the calibration of the CBWM, very little monitoring data was available to set target sediment loads for construction sites, with a reliance on the historic studies and literature reviews shown in Table 7.

Table 7
Summary of literature cited in CBWM documentation to determine sediment erosion from construction sites

Source (year)	**Result**	**Unit**	**Comment**
Guy and Ferguson (1962)	39 to 78	ton/ac-yr	
USEPA (2005)	7.2 to 500	ton/ac-yr	
Schueler (1987)	35 to 45	ton/ac-yr	Literature review
CBWM 5.3	***40***	***ton/ac-yr***	*discounted to **24.4 ton/ac-yr** to account for estimated exposure and duration of construction phases*

The CBWM was then calibrated to calculate sediment loads using expected annual average EoF sediment erosion target load for construction land of 24.4 tons per acre per year.

The target load accounts for the estimated exposure of bare soils, assuming an erosion rate of 40 tons/acre/year for bare disturbed areas; this value is derived from the middle range of values in Table 7 above. The target loading rate was further adjusted to account for differential soil cover that occurs during a typical year in the construction process, as shown in Table 8.

The resulting target erosion rate of 24.4 ton/ac-yr *does not include erosion and sediment control practices*, but is discounted based on estimated exposure time and duration of construction phases, summarized in Table 8. The final target load used in the CBWM calibration is considered edge of field (EoF, see Figure 3).

Associated losses of sediment in overland flow and in low-order streams diminish the sediment load to an edge of stream (EoS) input. The sediment loss between the EoF and EoS is incorporated into the CBWM as a sediment delivery ratio. Figure 2 illustrates this process.

Table 8
Estimated construction phase duration and sediment load in the CBWM

Construction phase	(A) Portion of area exposed	(B) Portion of Year for Phase	(C) Lit. Value (tons/ac-yr)	(D) = A*B*C Yield for phase (tons/ac-yr)
Clearing & grubbing for E&S controls	10%	5%	40	0.2
Clearing & grubbing for remainder of site	75%	5%	40	1.5
Grade site to rough grade, install sewer, water, roads, etc	75%	25%	40	7.5
Partial stabilization	66%	50%	40	13.2
Project completion, final grade and stabilization	34%	15%	40	2.0
Total Annual Sediment Load				**24.4**

Figure 2 – Edge of Stream Sediment Delivery Factors in the CBWM

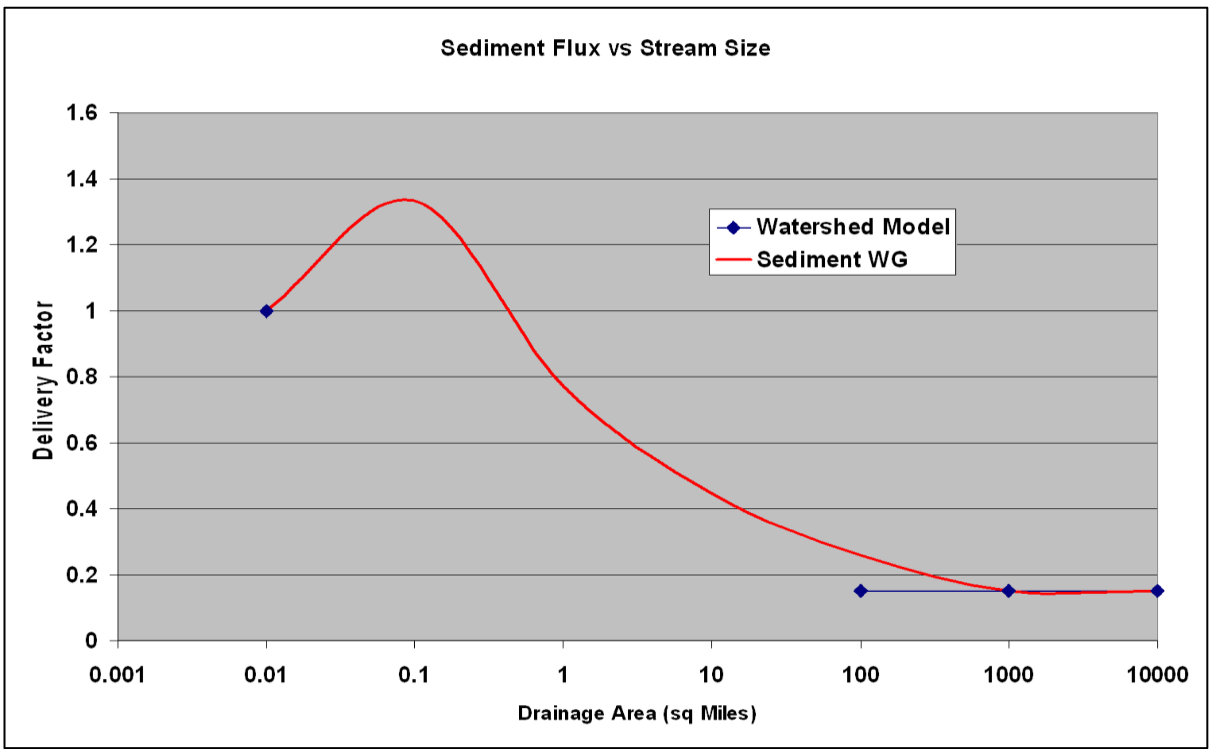
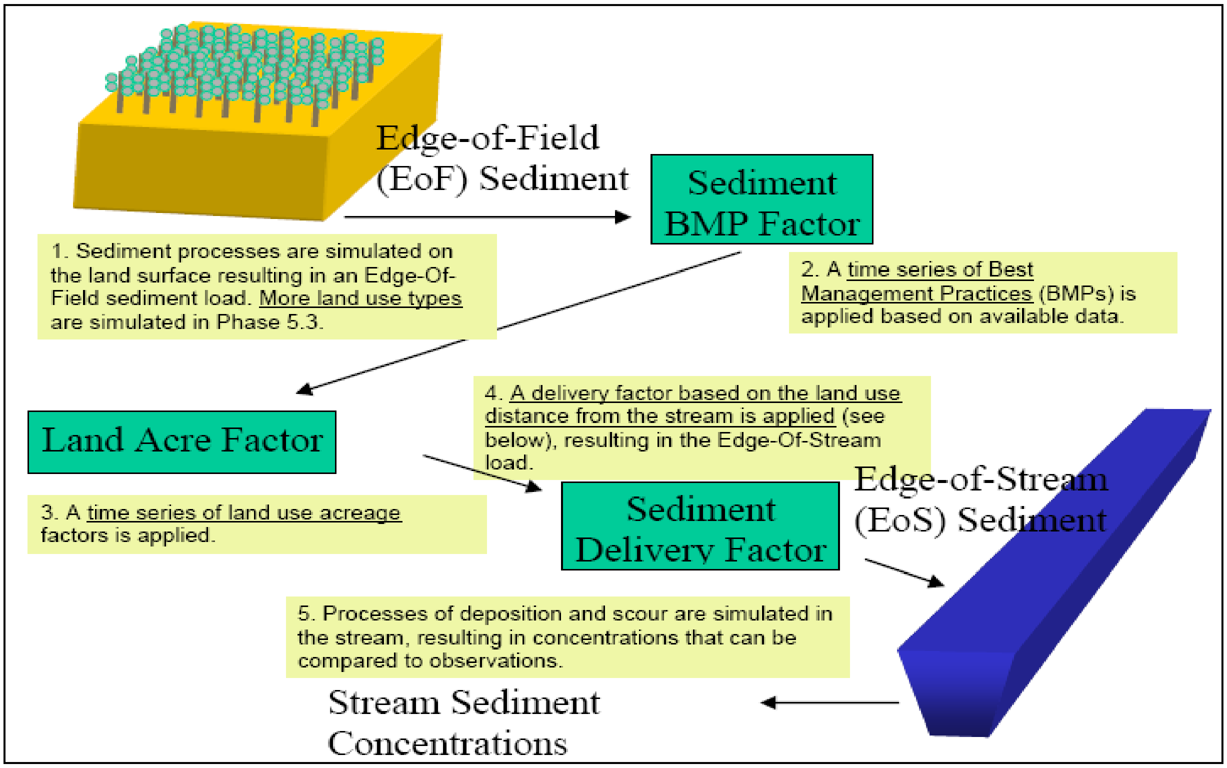


Figure 3 –Edge-of-Field (EoF), Edge-of-Stream (EoS), and Delivered Loads in the CBWM



The CBWM assumes that nutrient inputs to the bare-construction land use are from atmospheric deposition only, and simulate nutrient export based on the wash-off of the atmospheric load and the nutrients attached to soils that are eroded downstream. Target construction nutrient loading rates used to calibrate the Phase 5.3 CBWM were based on very limited literature which is summarized in Table 9.

Based on these two studies, median target values of 26.4 lb/ac-yr and 8.81 lb/ac-yr for TN and TP, respectively, were chosen. Once again, these target values are the estimated nutrient export from the bare-construction land use, assuming no erosion and sediment control practices (i.e., a "pre-BMP" condition).

Table 9

Sources of construction site nutrient loading rates in the CBWM

Source	TN load (lb/ac-yr)	TP load (lb/ac-yr)	Comment
Line and White (2001)	7.2	2.6	Residential, ESC 1
Daniel et al (1979)	12.2 to 49.5	6.7 to 17.9	Residential, ESC 1
Median target selected for CBWM	26.4	8.81	

Section 3.3 Derivation of Current and Interim Removal for ESC practices

Following a previous review of erosion and sediment control practices, the reduction efficiency for ESC practices was set at 25% for TN, and 40% for TSS and TP (Baldwin et al, 2007). The technical basis for the old removal rate was very limited and supported by two EPA literature reviews composed of studies conducted in the early 1990's or before (EPA 2000 and EPA 2005). Baldwin et al (2007) noted they had very little confidence in their effectiveness estimates, and heavily discounted them to reflect perceived real world ESC implementation problems.

In 2011, West Virginia, citing the low reduction efficiencies, requested a new BMP review for conventional ESC practices and proposed an interim efficiency for enhanced ESC practices (See Appendix E). West Virginia pointed out that various requirements in their general permit (e.g., basin storage volume, dewatering time, etc.) implied much greater nutrient and sediment removal efficiencies. The proposed interim rate for "enhanced" ESC practices were established as 80% removal for TN, TP and TSS, pending the work of this expert panel.

Section 4
Review of the Available Science: Construction Site Hydrology

4.1 Review of Construction Site Runoff Coefficients

The Panel began by reviewing construction site hydrology research as it concluded that a good understanding of the runoff volume generated from construction sites would be crucial factor in developing more accurate and reliable estimates of sediment loading.

The monitoring and modeling literature for construction site hydrology was rather sparse, but the Panel did analyze four independent lines of evidence that converged on a common estimate for the annual runoff coefficient for construction sites. The runoff coefficient (Rv) expresses what fraction of annual rainfall volume is converted to construction site runoff volume (Schueler, 1987), as measured by on-site rainfall gauges and automated flow measurements.

The first line of evidence was the only known study that actually comprehensively monitored the hydrologic response of a construction site to rainfall over the long term. Line and White (2007) measured the runoff coefficient during construction, final stabilization and post- construction conditions at residential development site in the NC Piedmont with soils in the HSG D category.

The storm-weighted Rv for the construction phase was 0.50 and rose to 0.60 during the landscape establishment phase (Table 10). These Rv's indicate that 50 to 60% of the rainfall over the construction site was converted into storm runoff. The key point is that construction sites are not just bare soil, but have compacted soils, impervious cover and storm drains installed during the construction process.

Table 10 Summary of Monitoring Results (N= 106 storms)
Line and White (2007) NC Piedmont [5]

STAGE	Runoff Coefficient	TSS (tons/acre)
Construction [1]	0.50	13
Establishment [2]	0.60	2.8
Post Construction [3]	0.55	0.9
Undeveloped [4]	0.21	0.16

[1] from initial clearing , grading, installation of infrastructure and seeding (0.7 years)
[2] Most homes constructed, and lawns and landscaping are becoming established (1.4 years)
[3] After home build out (3.6 years)
[4] Undeveloped reference watershed
[5] 6 years of sampling during and after construction at a 10 acre residential subdivision, compared to an undeveloped reference forest catchment less than a mile away (also sampled for same 5.6 years)

The second line of evidence was a national modeling assessment by EPA (2009). The EPA analysis of construction site loading included the derivation of runoff coefficients and discharged sediment loads for construction sites. The RUSLE model was used for the analysis, which was done for several hundred subwatersheds nationwide, using many recent data sources to define model parameters.

Of particular interest to the Panel were their estimates of the runoff coefficient , as documented in Sections 9 and 10 of their report (EPA, 2009). Table 11 shows the "annual" volumetric runoff coefficients for a typical construction site throughout the year, based on HSG, as well as higher Rv associated with a single high intensity event (the 2 year design storm event).

Table 11
Reported Volumetric Runoff Coefficient (Rv) for Construction Sites by Hydrologic Soil Groups

	HSG A	HSG B	HSG C	HSG D
Annual Rv [1]	0.15	0.27	0.39	0.49
Rv for 2 year Design Storm	0.37	0.57	0.70	0.79

[1] for the technical assumptions, see Section 9 and 10 of EPA (2009)

EPA (2009) also reported the fraction of acres within the four hydrological soil groups (HSG) for the Bay states, which is shown in Table 12. Based on the EPA analysis, the Panel computed a HSG-weighted average Rv for the typical "annual" construction site in the Bay watershed, by multiplying the values of in Table 11 and 12 together, which are shown in Table 13.

Table 12 Percent of each of the 4 HSG's in each Bay State [1]

Bay State	HSG A	HSG B	HSG C	HSG D
Delaware	21	31	13	35
Maryland	10	39	26	25
Pennsylvania	6	28	54	12
New York	10	19	51	21
Virginia	2	54	32	12
West Virginia	7	22	54	17
Mean of States [2]	**9%**	**32%**	**38%**	**21%**
Bay-Weighted MEAN [3]	**6%**	**38%**	**40%**	**16%**

[1] State-wide from STATSGO
[2] Value shown is simply the mean of the six Bay states, including non-Bay watershed area
[3] Mean adjusted to account for fraction of total state area that is located in Bay watershed

While the EPA (2009) data did not permit a precise calculation of an Rv for the portion of each state contained with the Bay watershed, Table 13 does show that the computed Bay-wide and individual state -wide construction Rvs were fairly consistent at about 0.35

.

Table 13 Computed Annual Construction Rv Using the EPA (2009) method	
State	Annual Rv
Delaware	0.34
Maryland	0.34
Pennsylvania	0.35
New York	0.37
Virginia	0.33
West Virginia	0.36
Mean of States [2]	**0.35**
Bay-Weighted MEAN [3]	**0.35**

The third line of evidence was a long-term analysis of the hydrologic response of Birmingham, Alabama construction sites to rainfall conducted by Pitt (2004). The study computed a weighted volumetric runoff coefficient for construction sites of 0.36, based on three decades of rain fall analysis. Pitt did not provide any information as to the hydrologic soil group that was assumed for the construction site analysis. Pitt noted that runoff coefficients were as low as 0.27 for rainfall events less than a half inch, and climbed to 0.48 for storms above 3 inches.

The last line of evidence on construction site hydrology used the NRCS TR-55 model, which is widely used in the design of ESC practices. An event based Rv can be derived through curve number calculations. Don Lake, who served on the panel, provided calculations for three construction scenarios, assuming they were located on HSG C soils during a **two inch** rain event. The back-calculated Rv's were:

Scenario A: Residential Construction Site: 0.50
Scenario B: Commercial Construction Site: 0.63
Scenario C: Highway Construction Site: 0.68

4.2 Panel Findings and Recommendations

The Panel reviewed the four lines of evidence and they converged in several respects. First, construction site runoff coefficients were much higher than would be simply indicated by a "bare soil" condition since impervious cover is progressively added during construction operations. The Rv increases with greater rainfall depth and intensity and also as soils move from HSG A to HSG D categories. Given that there is good distribution data on HSG for each Bay state, it was possible to compute weighted state average that were useful to characterize aggregate soil conditions for construction sites (which ranges around 0.35 on an annual basis).

The Panel considered that its estimates of construction site Rv to be conservative, primarily because the reliance on HSG for determining runoff assumes that soils are not compacted. The very nature of construction operations violates this assumption, given grading and scraping by earth moving equipment, engineered compaction for structural and stability purposes, and tracking and compression by construction vehicles.

Consequently, construction site soils are likely to have a greater runoff response than would be predicted from their undisturbed hydrologic soil group alone. At the present time, however, there is no research available to enable a more precise definition of the increased Rv associated with soil disturbance at construction sites.

In addition, the Panel noted that the runoff volumes produced by intense storms can overwhelm the trapping capacity of ESC practices, thereby diminishing their sediment removal performance. Consequently, the Panel developed operational definitions of this functional deficiency based on rainfall depth and intensity.

Section 5
Review of the Available Science: Sediment Loads and Turbidity Discharged from Construction Sites

5.1 Historic Studies of Construction Site Sediment Loads, without ESC Practices

The Panel evaluated historical research to determine the sediment load from construction sites in the absence of any erosion and sediment controls, and expand on the literature reviewed by the original expert panel report.

Several important points need to be kept in mind when looking at historical construction monitoring data:

> The first point to consider is the difference in how land was developed during the era in which data was collected (i.e., 1960' and 1970's), and in particular, the lack of environmental regulations. During this era, there were no clearing or grading restrictions, and one could build in streams, non-tidal wetlands, floodplains and steep slopes. There were also no stream or shoreline buffer, resource protection or forest conservation requirements in place to limit land disturbance.
>
> Consequently, extensive mass grading occurred over most, if not the entire site, during this era. Road construction techniques during this era also tended to promote massive erosion. Given the many different environmental regulations that now govern land development, it is probable that current construction site sediment loads would be lower, even in the absence of any ESC practices.
>
> The second point is that ESC requirements have been in place for decades at construction sites throughout the Bay watershed, so that it is virtually impossible to obtain monitoring data for construction sites that mimics the historical bare soil condition (i.e., nearly all construction sites have some kind of erosion control and sediment control practices in place that reduce sediment loads).
>
> The third point is that the monitoring and data analysis methods used in the historic construction research were probably less accurate, as researchers of the time did not have modern automated samplers, rain gauges, computers, and electronic laboratory analyzers. Grab samples were used to measure sediment concentrations, and the various devices used to measure flow were less accurate.
>
> The last point is that many of the historic studies were not able to segregate out stream channel and hill-slope erosion from their sediment load estimates. Consequently, the extremely high construction site sediment loads may be biased a bit high (which is not to diminish their critical influence in getting the first erosion and sediment control laws enacted).

The Panel reviewed five of the historic studies, which are shown in the shaded cells in Table 14. The historical sediment loads from construction sites without ESC practices ranged from about 50 to 300 tons/acre/year, which is well above the 24.4 tons/acre/year assumed in CBWM.

Six studies were discovered that measured sediment loads for construction sites that employed ESC practices, and these ranged from about 2 to 20 tons/acre/year. When the loads from historic construction studies are compared with recent studies for sites served by ESC practices, it is clear that ESC practices sharply reduce sediment loads from construction sites, even if the sample size is small, and given the provisos cited earlier about the quality of historic monitoring data.

Table 14
Measured Sediment Loading Rates for Construction Sites, w or w/o ESC.

Study	Region	Tons/acre/year	ESC Used?	Notes
CBWM	Bay	24.4	No	Model Assumption
Yorke and Herb, 1978	MD	33	No	
Nelson, 1984	SE US	100 to 300	No	
Cleaves et al, 1970	SE US	218.9	No	
Likens and Borman, 1974	NE US	48.4	No	
Cywin and Hendricks, 1969	SE US	134	No	
Line and White,2007	NC	13.0	Yes	Residential
Daniel et al, 1979	WI	7.8	Yes	Residential
Line, 2007	NC	18.5	Yes	Highway
Line and White, 2001	NC	4.4	Yes	Residential
Owens et al, 2000	WI	1.7-6.7	Yes	Resid./Comm.
Lee and Ziegler, 2010	KS	0.5 to 2.5	Yes	Residential

The Panel developed estimates of sediment loads from construction sites in the absence of erosion and sediment controls using the Simple Method (Schueler, 1987) to estimate annual loads. Model parameters (Rv, EMC) were developed for a worst case, average case or best case scenario, and a composite average of all three scenarios was used to derive an annual sediment load estimate. The technical assumptions for the computations are provided in Appendix A.

Based on these methods, construction sites are estimated to have an annual sediment load of 12 tons/acre/year in the absence of ESC practices. This represents about 50% of the current target sediment load used in the CBWM.

Section 5.2 TSS Concentrations Discharged from Construction Sites, as Modified by ESC Practices

The Panel concluded that it was important to characterize sediment concentrations discharged from construction sites with ESC practices. The primary data sources were about a dozen monitoring studies that measured inflow and outflow TSS concentrations from construction sites, usually from a sediment basin discharge located at its drainage outflow.

The Panel classified each study/monitoring site according to the three levels of ESC performance as previously defined in Section 2. None of the studies could be classified as Level 3 or 4; 17 sites that were classified as either Level 1 or Level 2. Table 15 shows the inflow and outflow TSS concentrations that were measured, and the differences noted between Level 1 and 2 ESC practice.

The first key finding is that TSS inflow concentrations are exceptionally variable across construction sites, and ranged from about 300 mg/l to 17,000 mg/l. The high variability is not surprising given the influence of soil, slope, cover, ESC practice level, storm size and intensity and other factors on sediment erosion. It should also be noted that the TSS inflow concentrations were presumably influenced by up-slope erosion control practices used to increase soil cover.

Table 15 TSS Concentrations in relationship to ESC Practice Level, Summary

ESC Level	Study	TSS IN (Mg/l)	TSS OUT (Mg/l)	Efficiency	Region	Notes
1	Schueler and Lugbill (1990)	359 4623 625 415 2670	224 127 322 91 876	18 99 55 80 67	Piedmont MD	5 Residential Basins and Traps
1	Horner et al 1990	1087	63	--	Seattle WA	Highway Sediment Basin
1	Line and White (2007)	--	--	59-69	NC	Residential with Sed trap
1	Islam et al 1998	2932	3507	35%	Ohio	Basins
1	Kalainsan, 2008	314	77	15 %	PA	Basins
1	Cleveland and Fashokun (2006)	1227	2018	Nsd	TX	Basin
LEVEL 1 MEANS		**1583**	**812**	**49%/50%**	First is based on level 1 means, second is mean percent removal	
2	Fennessy and Jarrett, 1997	1260	300	~ 90%	PA	Basins
2	Jarrett, 1996	9700	800	94.2	PA	Basin
2	Gharabaghi et al 2007	Nd	177	99%	ONT	Basins
2	Babcock and McLaughlin 2008	4601	1509	68%	NC	Cut slopes
2	Horner et al 1990	17,438 3502	154 626	99% 75%	WA	Experimental basins
2	McLaughlin, 2007	220-300	50 to 100	Significantly different	NC	PAM/mulch
2	Soupir et al 2004	6537	369-4800	46-93%	NC	Test plots, low PAM excluded
Level 2 MEAN		**6188**	**557**	**90%/83%**	First is based on level 1 means, second is mean percent removal	
Grand Mean, All Levels		**3598**				

The second finding is that the data indicate a difference in the performance of practices designed to Level 1 and Level 2. The mean outflow TSS concentrations from construction sites served by Level 1 practices was 812 mg/l, or about a 50% reduction of the inflow concentration.

By contrast, the mean outflow TSS concentration from Level 2 practices was 557 mg/l, which represented an 80 to 90% decrease from their TSS inflow concentration(which was higher for Level 2 practices than Level 1 practices).

Several researchers have noted that as much as 50% of the construction site TSS concentrations appear to be internally generated within individual ESC practices (i.e., erosion within temporary dikes, ditched and channel, as well as erosion of bed and banks of sediment basins and traps -- Madaras and Jarrett, 2000, Fennessey, 1994 and Kang et al 2013).

Given the variability in TSS concentrations, the Panel developed a method to define the performance of Level 1, 2 and 3 ESC practices. The method computed an annual sediment load using the Simple Method, based on technical assumptions as to what range of event mean concentrations (EMC) and runoff coefficients (Rv) would best characterize Level 1, 2 and 3 ESC practices. The analysis entailed three different construction site scenarios -- worst case, mid-range and best case. The average of the three scenarios was then used to compute a "best estimate" for annual sediment load for each ESC level under normal conditions, as shown in Table 16. For a full description of the technical assumptions involved in each scenario, consult Appendix A.

Table 16 Comparative Summary of ESC Scenarios (tons/ac/yr)

ESC Scenario	Worst Case	Mid-point Case	Best Case	**Best Estimate**
Construction w/o ESC	22.3	8.6	5.1	**12.0**
Sites Operating at Level 1	2.5	1.8	1.1	**1.8**
Sites Operating at Level 2	1.6	1.0	0.7	**1.1**
Sites Operating at Level 3	1.05	0.57	0.31	**0.65**
Sites Operating at Level 4	ND	ND	ND	**ND**

Important Note: Actual sediment loads for all 4 ESC levels will be higher when moderate and extreme storms exceed or overwhelm ESC capacity, and thus create functional deficiency, and much lower removal rates. ND= No data

The Panel compared these estimates to other monitoring and modeling studies of Level 1 ESC sites. For example, a national RUSLE modeling study calculated annual sediment loss for construction sites that had a defined baseline of ESC practice that generally corresponds to Level 1 (EPA, 2009). Nationally, EPA estimated that construction site sediment loss averaged 3.03 tons/acre/yr, and state-wide averages for individual Bay states ranged from 1.56 to 3.42 tons/acre/year.

A Wisconsin monitoring study of small construction sites operating at Level 1 by Owens et al (2000) reported annual sediment loads of 1.65 tons/ac/yr at a residential site and 6.7 tons/ac/yr for a commercial site. A more recent study of Kansas constructions sites operating at Level 1 reported annual sediment loads ranging from 0.5 to 2.5 tons/ac/yr (Lee and Ziegler, 2010).

Based on these comparisons, the Panel felt the computed loads for construction sites in the Bay watershed as shown in Table 16 are technically justified for normal site conditions, but need to be adjusted upward to account for higher loadings during periods of moderate to extreme functional deficiency.

While the Panel primarily focused on the cumulative impact of the entire set of ESC practices installed at a construction site, it did review many research studies that evaluated the sediment removal performance of individual ESC practices, with an eye toward the specific design features that promote greater sediment removal, some of which are profiled in Appendix C.

Section 5.3 Turbidity Levels Discharged From Construction Sites

Table 17 shows a representative summary of turbidity levels discharged from construction sites. Once again, the Panel classified each study according to its presumed ESC performance level.

Table 17 Turbidity in relationship to ESC Practice Level, Summary of Literature (NTUs)

Level	Study	Turbidity IN	Turbidity OUT	reduction	State	Notes
1	Schueler and Lugbill , 1990	600	200	++	MD	Basins and Traps
1	Kayhansana, 2000	--	702		CA	
1	McLaughlin et al 2009	6700	7014	-	NC	
1	Bhardwaj 2008	227	155	+	NC	Test basin
1	Cleveland & Fakoshun, 2006	141	159	-	OH	Basins
2	McLaughlin and King, 2008	2139	3449	--	NC	JACK
2	McLaughlin and King, 2008	5100	4790	+	NC	BUNC
2	McLaughlin and King, 2008	1381	382	++	NC	WAKE
2	Kang et al, 2013	--	420		NC	
LEVEL 1 and 2 MEANS		**2327**	**1919**			
3	Bhardwaj 2008			++	NC	PAM
3	Hayes et al, 2005	461	103	++	NC	PAM
3	McLaughlin, 2007	250-400	50 to 100	++	NC	PAM
3	McLaughlin et al 2009	1990	276	++	NC	PAM
3	McLaughlin et al 2009	3117	278	++	NC	PAM
3	Kang et al 2013	--	94	++	NC	PAM
LEVEL 3 MEANS		**1473**	**165**	**++**		

One of the key findings is the enormous variability in inflow turbidity levels, which can range from about 150 NTUs to more than 7000 NTUs. To put that into perspective, several Bay states have adopted turbidity standards for the protection of aquatic life that define a threshold level of 150 to 200 NTU for a water quality standard violation.

The second key finding is that it is much harder to control turbidity than TSS at construction sites. As can be seen, most construction sites served by Level 1 and 2 ESC practices have limited ability to achieve turbidity reductions, and some sites actually experienced negative turbidity efficiencies.

The six experimental studies on Level 3 ESC practices that used PAM show much more capability to reduce turbidity levels to around 50 to 300 NTU, but more research is needed to make a definitive conclusion. It should be noted that no Bay state currently requires Level 3 or Level 4 ESC practices on a state-wide basis.

5.4 Defining the Sediment Removal Performance of Functionally Deficient Sites

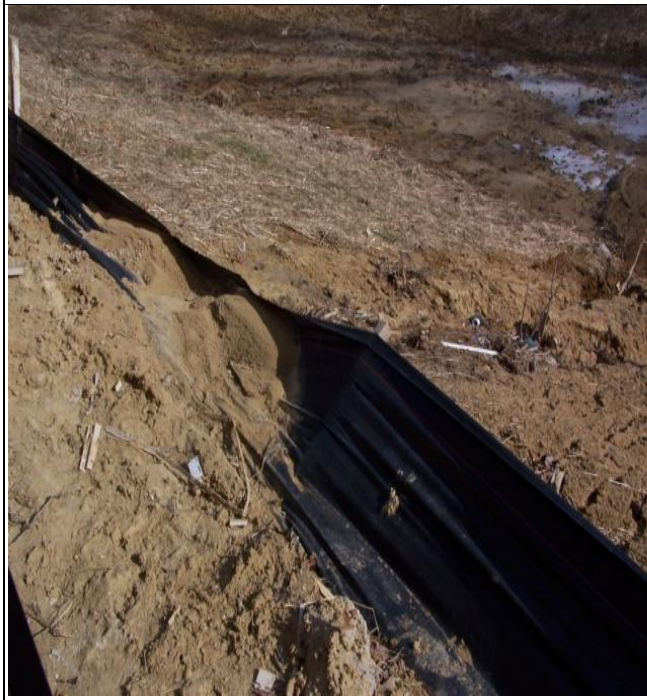
The Panel agreed that some fraction of construction sites in the watershed are functionally deficient, and will discharge sediment at levels well above those computed for the four ESC levels shown in Table 16. The photos shown in Table 18, all of which were taken in the last few years, clearly show major failures of ESC practices that significantly compromise their sediment removal function.

ESC sites can become functionally deficient even when local and state governments operate effective ESC programs for several reasons. First, weather factors such as intense thunderstorms, tropical depressions, extended droughts, exceptionally wet seasons, hard winters and early frosts cannot be eliminated, and each of these factors can quickly diminish the overall performance of any ESC practice. Failure caused by these weather conditions can eventually be fixed with diligent maintenance and repairs, but there will frequently be short periods where the system is not functioning as designed.

The second reason is the failure of the many different contractors involved in the construction process to understand and properly implement and maintain the prescribed practices in the ESC plan or permit. In other cases, the operator at the construction site may not to want incur additional costs associated to install, maintain, and especially repair ESC practices unless they are forced to by a regulatory authority.

Consequently, the Panel decided to define the fraction of construction sites that are functionally deficient over some part of the year, and thereby be subject to a lower sediment removal rate. The Panel distinguished three levels of functional deficiency -- minor, moderate and extreme.

Table 18:
Photos of Construction Sites with Functionally Deficient Practices

	
Silt fence that was overpowered in a heavy rain. Soil has collapsed the fence and erosion has formed a small gully. *Photo credit: Bruce Young*	Residential construction area where controls have been overwhelmed and large amounts of soil have eroded into the street. *Photo credit: Randy Greer*
	
Erosion and sedimentation due to poor design, lack of maintenance and insufficient stabilization. *Photo credit: Bruce Young*	The construction entrance and silt fence failed to keep soil from eroding onto the street. *Photo credit: Randy Greer*

Minor deficiencies include the normal problems that are routinely noted during a regulatory inspection (i.e., fixing a fallen section of silt fence, cleaning out a sediment basin, repairing an eroded dike). These individual problems certainly need to be quickly fixed, but they usually will not compromise the entire function of the system of ESC practices as a whole. Indeed, most of the monitoring studies for which sediment loads were computed were likely to have minor deficiencies at some point in the construction process.

Moderate deficiency occurs when the depth of rainfall exceeds the hydrologic design capacity of the ESC controls at the site, thereby diminishing their performance. For example, Level 1 ESC practices are designed to trap a half inch of rainfall, whereas Level 2 and 3 ESC practices are designed to treat one inch of rainfall. Storms in excess of these rainfall depths cause runoff bypass or overflow, as well as significant degradation of individual ESC practices.

Two previous Urban Expert Panels derived long-term rainfall frequency analyses (1977-2007) and developed adjustor curves to define sediment removal rates based on the design capacity of stormwater treatment (ST) practices up to 2.5 inches/day (SPSEP, 2012, SREP, 2012). Based on these curves, this Panel concluded that Level 1 ESC practices are exposed to moderate deficiency conditions during approximately 25% of the annual rainfall volume, whereas Level 2/3 ESC practices are exposed to moderate deficiency about 15% of the time (see Appendix A).

During periods of moderate functional deficiency, the sediment removal function ESC practices is sharply diminished, but does not go to zero. The Panel estimated an average of sediment loading for ESC practices under moderate functional deficiency of 4.3 tons/acre/year, which was then pro-rated by the fraction of the year in which this condition occurs (see Table A-5 in Appendix A). This loading rate is adjusted to apply for the proportion of the year for which a site is expected to experience moderately deficient conditions, and is added to the base loading rate for the appropriate level of ESC practice.

Extreme functional deficiency occurs during the rare storms that completely overwhelm the treatment capacity of ESC practices such that their collective sediment removal function is severely compromised. These conditions are expected to occur when hourly or daily rainfall intensities meet or exceed the following thresholds in any CBWM time step:

- 2.5 inches per day
- 1.5 inches per hour

During these extreme conditions, the ESC practices at construction sites are expected to fail completely, and discharge sediment at the no-ESC level of 12 tons/acre/year. For the technical assumptions the Panel used to define the no-ESC level, see Appendix A.

5.5 Panel Findings and Recommended Sediment Removal Rates

Based on the preceding review, the Panel recommends the sediment removal rates for the four levels of ESC practices for construction sites, as shown in Table 19. The sediment removal rates are expressed relative to the no-ESC condition of 12 tons/acre/year, as defined by the Panel in Appendix A. These rates should be applied to the construction site sediment loads generated under the existing CBWM. At the present time, all construction acres in each state are assumed to be operating at ESC Level 2.

Table 19 Computation of Sediment Removal Rates for Four Levels of ESC

ESC Scenario	Discharged Load [1]	Removal Rate	MFD [2] Adjustment	Effective Removal Rate [3]
Sites Operating at ESC Level 1	1.8	85%	3.1	**74%**
Sites Operating at ESC Level 2	**1.1**	**92%**	**1.8**	**85%**
Sites Operating at ESC Level 3	0.6	95%	1.3	**90%**
Sites Operating at ESC Level 4	ND	ND	ND	**ND**

[1] Best estimate for normal ESC site conditions from Table 16
[2] Additional sediment load discharged during conditions of moderate functional deficiency added to the discharged load
[3] Actual loads for all ESC Levels will be slightly higher to reflect extreme functional deficiency during the rare storms that exceed the rainfall volume/intensity thresholds.
ND: No monitoring data was available to compute an estimates for Level 4 ESC

The Panel also concluded that the current CBWM non-ESC target sediment load of 24.4 tons/ac/year too generous and recommends that it be reduced to 12 tons/acre/year in the next version of the CBWM.

Lastly, the Panel concluded that states and localities should strive to improve their ESC programs to achieve a higher and more reliable level of turbidity control. The fine-grained particles that create turbidity are likely to have a higher delivery ratio to the Chesapeake Bay, given that it takes days or even weeks for them to settle out of the water column. ESC program improvements to shift a Level 3 ESC practice would have the further benefit of reducing the impact of turbidity on aquatic health and diversity in the streams, lakes and estuaries that discharge to the Bay.

Section 6
Review of the Available Science:
Nutrient Dynamics on Construction Sites

6.1 Current Construction Site Nutrient Loading Assumptions in CBWM

The Panel began by examining the current target TN and TP unit area loading rates for construction sites used in the CBWM, and see how they compared to the EMC concentrations for post-construction runoff (Table 20 and 21). In the case of TN, construction sites had an average storm event mean concentration (EMC) of around 5 to 6 mg/l, which is 2.5 to 3 times the EMC for post construction storm runoff, as measured or modeled. The same basic trend was also observed for TP, in which the construction site EMC was three to five times higher than the post-construction EMC, as defined by monitoring data or model simulations.

Table 20
Summary of Modeled and Measured TN Yield from Construction Sites (lbs/acre/year)

Method	Load	Implied EMC mg/l	Notes
CBWM No ESC Practices	26.4	6.22	
CBWM w/ ESC Practices	21.2	4.98	25% Removal Rate
Median Urban Runoff		2.0	N=3100 (Pitt et al, 2004)
CBWM: Impervious Cover	16.6	2.14	Atmospheric deposition
CBWM: Urban Pervious Cover	12.4	1.6	

Table 21
Comparison of Modeled and Measured TP Yield from Construction Sites (lbs/acre/year)

Method	Load	Implied EMC mg/l	Notes
CBWM No ESC Practices	8.8	2.08	
CBWM w/ ESC Practices	5.3	1.25	40% Removal Rate
Median Urban Runoff		0.30	N=3100 (Pitt et al, 2004)
CBWM: Impervious Cover	1.9	0.25	
CBWM: Urban Pervious Cover	0.8	0.41	

6.2 Potential Nutrient Loss Pathways at Construction Sites

At least five potential pathways could produce nutrient export from construction sites:

1. Nutrients attached to eroded soils
2. Wash off of fertilizer due to hydro-seeding and permanent stabilization
3. Wash-off of nutrients deposited from the atmosphere
4. Decay of organic material used to cover soil (i.e., compost, mulches, erosion control blankets, etc)
5. Leaching into groundwater (primarily nitrate).

Pathway 1: Nutrients Attached to Eroded Soil

The first pathway involves the loss of nutrients that are attached to eroded sediments that leave the site. Although sediment loads are high at construction sites, the soils are not highly enriched with nutrients. The main reason is the sharp decline in soil nutrient content as one goes down the soil profile (i.e., from topsoil (horizon O), lower soil layers (Horizon A/B) and finally the sub soils. Topsoil is highly enriched with nutrients (Table 22), but nutrient content drops sharply through the A and B horizon, and is even lower in sub-soils.

The significance of this fact is that most of the nutrient-rich topsoil at construction sites are removed and stock-piled at the onset of construction operations. Topsoil is a valuable commodity at most construction sites and is either sold or used as a top-dressing during final stabilization. Consequently, the majority of excavated soils exposed to erosion have a very low nutrient content.

Table 22 Example of Nutrient Content by Soil Horizon in USDA Soil Survey

	Silt Loam	Loamy Sand
Organic Content	O Horizon: 5.5% AB Horizon: 1.8%	O Horizon: 9.5% AB Horizon: 1.4%
Cation Exchange Capacity [CEC] (meq/100 g)	O Horizon: 19 AB Horizon: 12	O Horizon: 15 AB Horizon: 11
Total Nitrogen (mg/kg)	O Horizon: 2,900 AB Horizon: 1,000	O Horizon: 4,700 AB Horizon: 700
Total Phosphorus (mg/kg)	O Horizon: 35 AB Horizon: 5	O Horizon: 16 AB Horizon: 2

Pathway 2: Fertilizer Wash-off

The second source of possible nutrient loss are the fertilizers applied during temporary and permanent stabilization. Most Bay state ESC specifications call for high fertilizer applications to establish a dense grass cover in the shortest time possible to prevent soil erosion. Most ESC professionals, as well as the expert panel, agree that rapid and dense vegetative stabilization is a critical element of erosion control, and is a major factor in preventing soil loss.

Table 23 summarizes the current Bay state requirements or recommendations for N and P fertilization rates during temporary and permanent stabilization. The mean application rate in the Bay states for TP is 74 lbs per acre, and TN is 114 lbs per acre, most of which is water-soluble and in readily available forms. Several fertilizer applications can be made during the course of most construction operations.

The initial application typically involves hydro-seeding for temporary stabilization in which a mix of seed, fertilizer, straw mulch, cellulose, tackifiers and water is blown over exposed soils. Hydro-seeding may need to be repeated if the grass does not take. A second application of starter fertilizer is typically made at the end of construction to establish stronger turf and landscaping.

Table 23
Comparison of fertilization recommendations for temporary and permanent stabilization in the Bay states

State	Fertilizer Formulation	Application Rate	N Rate	P Rate	Comment
DE	10-10-10	600 lbs/ac	60 lbs/ac	26.2 lbs/ac	Temp seeding
MD	10-20-20	436 lbs/ac	43.6 lbs/ac	38.1lbs/ac	Temp seeding
	10-20-20	436 lbs/ac	43.6 lbs/ac	38.1 lbs/ac	Perm seeding
NY	5-10-10	600 lbs/ac	30 lbs/ac	26.2 lbs/ac	Perm seeding*
PA	10-10-20	1000 lbs/ac	100 lbs/ac	43.7 lbs/ac	Perm seeding
	10-10-10	500 lbs/ac	50 lbs/ac	21.9 lbs/ac	Temp seeding
VA	10-20-10	500 lbs/ac	50 lbs/ac	43.7 lbs/ac	Perm seeding
	10-10-10	450 lbs/ac	45 lbs/ac	19.7 lbs/ac	Temp seeding
WV	10-20-10	1000 lbs/ac	100 lbs/ac	87.4 lbs/ac	Perm seeding*
Average			**49.7 lbs/ac**	**26.5 lbs/ac**	**Temp seeding**
			64.7 lbs/ac	**47.8 lbs/ac**	**Perm seeding**

*Fertilizer not recommended for temporary seeding
Note: These are the suggested application rates in the absence of soil tests or applicable nutrient management plans.
Source: respective state erosion and sediment control manual (see Table 5 for links)

These high fertilizer inputs are especially vulnerable to wash-off during the three to four weeks it takes for the grass to germinate and become well-established. Any intense storm that occurs during this germination window produces a very high risk of nutrient wash-off, particularly since a third to a half of rainfall that falls on a construction site is converted into runoff.

The risk for wash-off continues to be high even after grass is established. The Urban Nutrient Management Expert Panel identified 12 risk factors that increase the potential for high nutrient loss in its final recommendations (UNMEP, 2013). Most construction sites will typically have seven or more of these high export risk factors. Consequently, construction sites more than qualify as being in the high risk category (5% loss of applied nutrients), according to the UNM panel. Loss rates could easily be higher if intense storms occur during the bare-soil window.

Pathway 3: Wash-off of Atmospherically Deposited Nutrients

The third potential pathway involves the wash-off of nutrients that are deposited from the atmosphere. The potential for wash-off is high due to the fact that a third to a half of all rainfall over the construction sites will be converted into runoff, as compared to a mature lawn, which may experience little or no surface runoff.

Pathway 4: Decay and Wash-off of Organic Material

The fourth potential source of nutrient loss involves the decay of various organic materials that are used to temporarily cover soils and prevent erosion. These materials can include straw, mulch, wood chips, compost, erosion control blankets and organic tackifiers. In addition, certain ESC practices may utilize the same organic materials to improve sediment trapping performance.

As the material decays, there is a risk that nutrients could be exported downstream in either organic or inorganic forms. Relatively little research has been done to define this loss pathway, although Faucette et al (2005 and 2007) has reported significant nutrient export in a controlled study of the effectiveness of mulch and compost blanket practices.

Pathway 5: Leaching to Groundwater

The last pathway involves the infiltration of nutrients into the soils of construction sites and their eventual migration to streams. This could be a significant pathway for nitrate, but is probably not important for phosphorus. No lysimeter or groundwater monitoring data were available to evaluate the risk of leaching.

6.3 Mass Balance Check on CBWM Construction Site Nutrient Loading Rates

The Panel conducted a mass balance analysis to estimate nutrient loss under each of the four pathways that could be estimated, using a series of technical assumptions for best case, average case and worst case conditions. The methods and assumptions that the Panel used are fully described in Appendix B.

The purpose of the mass-balance analysis was to determine if the existing CBWM target nutrient loads for construction sites could be generally validated given how little monitoring data was available to measure them. Table 24 summarizes the mass balance estimates for all four loss pathways for each nutrient, and compares them to modeled loads used in CBWM. As can be seen, the CBWM load estimates fit squarely in the middle of the Panel's mass balance estimates for both nitrogen and phosphorus.

The Panel acknowledges all of the limitations and uncertainties inherent in its mass balance analysis, but was confident that the existing CBWM nutrient loads were consistent with what might be expected at a construction site.

Table 24
Comparison of Nutrient Loadings by all Five Pathways (low, medium or high) (lbs/ac/yr)

	Total Nitrogen			Total Phosphorus		
	Low	Med	High	Low	Med	High
Pathway 1	2.8	11.2	16.8	0.08	0.30	0.46
Pathway 2	1.1	5.7	11.4	0.7	3.7	7.4
Pathway 3	1.3	3.9	6.5	0.07	0.2	0.4
Pathway 4	0.7	2.8	4.2	0.2	0.8	1.2
Total	**5.9**	**23.6**	**38.9**	**1.1**	**5.0**	**9.5**
CBWM	**26.4**			**8.8**		

Note: N migration to groundwater was not included in the analysis, so N load mass balance may be conservative.

6.4 Review of Nutrient Monitoring Data from Construction Sites

The Panel was able to find ten recent research studies that measured nutrient EMCs at construction sites which are compared in Table 25.

Table 25: Comparison of nutrient concentrations in construction site runoff (mg/l)

Study	TN	DIN	TP	Notes
Kayhanina et al 2001	3.5	1.06	0.95	California, N=72 Highway
Line, 2007	1.7		0.47	NC, N=16
Cleveland and Fashokun, 2006		1.26	0.47 *	Above basin
Cleveland and Fashokun, 2006		1.57	0.21 *	Below basin
Kalanaisan et al 2008			0.72 *	Below basin
Soupir et al 2004	57.5	15.96	5.6	Fertilized test Plot
Faucette et al 2008	Nd	Nd	31.8	Fertilized test plot
McLaughlin and King, 2008	5.18	Nd	3.1	JACK
McLaughlin and King, 2008	19.8		34.6	BUNC
McLaughlin and King, 2008	3.78		0.3	WAKE
Horner et al, 1990	--	--	In: 12.3/2.25/0.55 Out: 0.44/0.6/0.14	3 basins in Seattle
Post Construction Stormwater Runoff	2.0	0.6	0.3	NSQD (Pitt et al, 2004)
Only measured as phosphate, not total P				

It should be noted that most studies had a rather small sample size. For comparison purposes, the construction site nutrient EMCs are also compared to EMCs for post construction stormwater runoff.

In general, Table 25 shows a bimodal distribution in nutrient EMCS, with about half of the studies within +/- 50% of the national EMC for urban stormwater runoff, and the other half at least an order of magnitude higher than the national EMC. Some of the highest TN concentrations were in the 20 to 60 mg/l range, and TP levels in the 30 mg/l range were recorded.

The pattern observed in this limited dataset suggests that construction sites appear to have a baseline nutrient concentrations that is slightly higher than post-development stormwater runoff concentration for a good portion of the construction year

Construction sites also appear to occasionally experience very high spikes in nutrient levels which may reflect fertilizer wash off, and possibly other loss mechanisms. Two research studies that monitored fertilized test plots were able to conclusively link these spikes to wash-off of fertilizer and organic matter, but the other studies did not focus on this issue. It should also be noted that most of the nutrients measured in these construction sites were found in organic form.

Line and White (2007) was the only research study that sampled enough storm events to calculate a reliable annual load associated with a construction site. Their results are portrayed in Table 26, and several findings were notable. First, while the TN load during the construction and permanent stabilization phase was general in the range of the annual CBWM load for nitrogen, but the measured phosphorus loads were lower.

It is also interesting to note that nutrient loads increased the most during the establishment phase when young lawns and landscaping were still at risk of fertilizer wash-off. This finding is consistent with the UNM expert panel who noted that initial lawn establishment was a very high risk factor for nutrient export (UNMEP, 2013).

Table 26 Summary of Monitoring Results (N= 106 storms)
Line and White (2007) NC Piedmont

STAGE	Runoff Coefficient	TSS (tons/acre)	TP (lbs/acre)	TN (lbs/ac) [5]
Construction [1]	0.50	13	2.5	9.3
Establishment [2]	0.60	2.8	1.16	28
Post Construction [3]	0.55	0.9	1.51	16
Undeveloped [4]	0.21	0.16	0.44	5.6

[1] from initial clearing , grading, installation of infrastructure and seeding (0.7 years)
[2] Homes constructed, and lawns and landscaping established (1.4 years)
[3] After home build out (3.6 years)
[4] Undeveloped reference watershed
[5] about 70 to 90% of TN was in the form of TKN
5.6 years of sampling during and after construction at a 10 acre residential subdivision, compared to an undeveloped reference forest catchment less than a mile away (also sampled for same 5.6 years)

The Panel could find only three studies that looked at the nutrient dynamics with sediment basins and other ESC practices (Horner et al 1990, Cleveland and Fashokun, 2006 and McLaughlin and King, 2008). The findings from this very limited group of studies were inconclusive, as some showed basins having some effect in reducing nutrients, whereas in others, nutrient concentrations appeared to spike.

Table 27 shows this pattern for the most extensive upstream/downstream study on the impact of ESC practices on nutrient concentrations by McLaughlin and King (2008). Only sampling sites that had more than five paired entrance and exit samples are included.

Table 27
Nutrient Concentrations From Construction Sites in NC
Source: McLaughlin and King (2008)

SITE	Total Nitrogen (mg/l)			Total Phosphorus (mg/l)		
	Entrance	Exit	Change	Entrance	Exit	Change
JACK (N=10)	5.27	5.18	-2%	3.21	3.1	-2%
BUNC (N=6)	7.24	19.8	+++	3.5	34.6	+++
WAKE (N=7)	4.67	3.78	-20%	0.7	0.3	53%

As can be seen, there was no consistent pattern in N or P reduction as they passed through the construction sites. In some cases, a minor reduction was seen, in others a small increase, and a few cases of major nutrient increases in the outflow (e.g., BUNC and JACK sites). The author of the study, who is also a member of the Panel, cautions that the sample size in the study was far too small to make any inferences about the nutrient reduction performance of ESC practices, except that it is predictably variable.

6.5 Panel Findings and Recommended Nutrient Loading Rate

Based on the preceding review, the Panel concluded that the mass balance approach supported the current CBWM unit N and P target loads and should be retained, albeit this finding was based on limited sampling data.

Fertilizer wash-off appears to be a major source of nutrient export from construction sites, based on the high spikes observed in nutrient concentrations in several of the monitoring studies. The limited performance research was equivocal, with no clear evidence that ESC practices can reduce nutrients, and some evidence that they may actually be nutrient sources.

Consequently, the Panel elected to assign a zero N and P removal rate for all four levels of ESC practice, and rely instead on the current CBWM target nutrient loads of 26.4 lbs N/acre/year and 8.8 lbs P/acre/year as our best understanding of the probable nutrient load generated for construction sites with ESC practices.

Section 7
Accountability Mechanisms

The Panel concurred with the conclusion of the National Research Council (NRC, 2011) that verification of BMP installation and subsequent performance is a critical element to ensure that pollutant reductions are actually achieved and sustained across the Bay watershed. The Panel also concurred with the broad principles for urban BMP reporting, tracking and verification contained in the technical memo approved by the Urban Stormwater Workgroup (USWG, 2013). Since ESC is an annual BMP (i.e., reported as ESC acres per year), it does not have the long BMP duration like many other urban practices.

7.1 Adequacy of Existing Construction Site Verification Protocols

The Panel noted that verification is a critical element in existing ESC programs, and that it has improved considerably compared to historic requirements. Each individual construction site is now subject to both self inspections by the contractor and regulatory inspections by the local or state ESC enforcement authority that occur multiple times during the construction year.

In addition, new training, certification and enforcement provisions are frequently in place to improve the outcome of each on-site inspection. Despite the fact that they are in place for a short time (one year in the CBWM), they are subject to more on-site verification than any other urban or agricultural BMP used in the watershed. Current construction inspection protocols are more than sufficient to meet the CBP verification principles for crediting BMPs in the TMDL. Consequently, the Panel does not recommend any additional field verification protocols beyond those that are already in place in the Bay states.

7.2 State Options for Reporting Construction Acres Each Year

States have two options for the determining the number of acres that are under construction each year.

> (1) The first option is to do nothing and simply accept the CBP estimate of state construction acres that is currently used which is described in Section 3.2 of this report
>
> (2) The second option is for the state to aggregate permitted construction acreage in their portion of the Bay watershed every year, based on the CGP data reported to them by individual construction permitees. Most Bay states now have some kind of tracking system or database to analyze the CGP permits that are issued, although some additional post-processing may be needed to ensure the acres are within the Bay watershed, and are assigned to the proper river-basin segment.

While the Panel encourages states to develop more reliable statistics on year to year state-wide construction site acreage, it also recognized that it is hard to tease the actual construction area from CGP permit data alone. Given the year to year variability in the activity of the construction industry, the lack of accurate mapping data, and the internal mechanics of the CBWM, the Panel concluded that the existing CBP method used to provide a long term average estimate of state construction acres is acceptable for the modeling purposes.

7.3 *Other Local and State ESC Reporting Requirements*

The Panel recommends no additional reporting requirements to qualify for the sediment removal credit, beyond the existing state reporting requirements under their MS4, CGP or state ESC regulations.

The reporting requirements for the Bay states are also minimal, and are limited to notifying the CBP if they are still performing at the Level 2 ESC practice level on a state-wide basis, or have shifted to a higher level of performance (e.g., Level 3 ESC).

7.4 Qualifying Criteria to Achieve Level 3 ESC Practice

Most Bay states are solidly within Level 2 ESC practice, and are gradually implementing several aspects of Level 3. The Panel anticipates that some states and/or localities may formally request a shift from Level 2 to Level 3 for qualifying construction sites at some point in the future. To this end, the Panel outlined a series of criteria to define when a jurisdiction crosses over the threshold to Level 3 ESC, as follows:

- Passive chemical treatment is utilized within the construction site by adding PAM or other flocculants to:
  - Hydro-seeding mixes used for temporary stabilization
  - Fiber logs, socks, wattles or check dams installed in internal diversions, ditches, or channels
  - Sediment basins or traps
- Enhanced sediment basin design to include baffles, surface outlets, and skimmers
- ESC maintenance inspections at least once a week
- Enhanced measures for perimeter controls and natural resource buffers
- More stringent stabilization and construction phasing requirements than currently required

Section 8
Future Research and Management Needs

8.1 The Panel's Confidence in its Recommendations

One of the key elements of the CBP BMP Review Protocol is that each expert panel should express its confidence in the BMP removal rates that they ultimately recommend (WQGIT, 2013). While the Panel concluded that its recommendations for sediment and nutrient removal rates for Level 1, 2 and 3 ESC practices are based on a much stronger scientific foundation than the previous panel estimate, it also clearly acknowledges that major gaps exist in our understanding the nutrient and sediment dynamics of construction sites in the Bay watershed. The Panel's greatest uncertainties include:

- The limited and variable monitoring data that was available to characterize the nutrient concentrations in construction site discharges, and in particular, the risk of fertilizer wash off, during and after temporary and permanent stabilization.

- The monitoring data was insufficient to derive sediment removal rates for Level 4 ESC practices. This is not a major concern at present since no Bay states currently operate at this level of ESC performance, but it could become an future issue if local or state ESC programs evolve to that level.

- The estimates of the proportion of functionally defective ESC sites was primarily based on a hydrologic definition of failure, and further monitoring and modeling of construction sites under large storm and extreme storm conditions would improve confidence in this estimate.

Given these significant gaps, the Panel agreed that the recommended rates should be reevaluated by a new panel when better research data on ESC performance becomes available.

8.2 High Priority Research and Management Recommendations

The Panel urges state and federal authorities to provide funding for a short-term and intensive monitoring study that focuses on the nutrient concentrations in construction site discharges during the period of high fertilizer wash off risk that occurs during and after site stabilization.

The scope of the study might involve a total of 100 to 200 flow-weighted composite samples to measure nutrient concentrations at 10 to 15 different construction sites in the Bay region. The objective of this urgent sampling effort is to define more accurate EMC estimates for N and P, which would provide a more technically sound basis to compute annual nutrient loads for construction sites.

Should the short-term monitoring study indicate that construction site nutrient loads are equal to or greater than the target CBWM nutrient loads, a longer term study should commence. The focus of the long term study should be to determine whether fertilization rate or formulation recommendations, vegetative stabilization methods and/or down-gradient ESC practices could be modified in order to reduce nutrient export, while still maintaining effective vegetative and soil cover during the entire construction process.

In particular, the potential benefits of incorporating low doses of PAM to hydro-seeding mixes on erosion-prone soils should be investigated. Lastly, the nutrient dynamics within individual ESC practices should be investigated to ascertain whether some practices or design variations promote greater nutrient reduction.

One potential mechanism to finance this critical research is for states to allow localities to pool a portion of their existing MS4 stormwater outfall monitoring budgets to fund a regional monitoring consortium that could undertake the research or hire a university to do so.

Shifting to a higher level of ESC practice in future years will require several key management initiatives. Jurisdictions will need to continue to strengthen their ESC requirements and specifications. This will probably require a major re-analysis of monitoring and field data to determine how to optimize the use of passive chemical treatment and enhanced ESC practices to maximize sediment and turbidity removal in a cost-effective fashion.

Once the next generation of Level 3 ESC technology has been developed, a comprehensive training program will be needed so that designers, plan reviewers, contractors and inspectors can all effectively implement it on the ground.

8.3 Proposed Refinements in Next Phase of Bay Watershed Model

The Panel recommends the modeling team consider the following refinements in the next phase of CBWM development.

1. Eliminate the simulation of the no-ESC baseline condition for construction sites, and instead simulate construction land use as its own BMP. Under this scenario, there would be four categories of construction land that correspond to the four ESC performance levels (factoring in the additional load from functionally deficient ESC sites).

2. The no-ESC condition has been a historic artifact for several decades now, and virtually every construction site in the Bay watershed employs ESC practices of one kind or another. The Panel was particularly concerned about the quality of the limited historical data used to derive calibration target loads for the no-ESC condition. If a no-ESC condition is required for modeling purposes, the Panel recommends that the target load be lowered to no more than 12 tons/acre/year.

3. Refine the parameters in the construction site simulation in PERLAND to explicitly simulate as many of the five nutrient loss pathways described in this

report as possible. At a minimum, construction sites should be subject to a weighted unit acre fertilization rate (which the model currently lacks).

4. Explicitly simulate sediment loss for construction sites located on the coastal plain physiographic region, which should be lower than in other portions of the Bay watershed due to their gentle slopes, longer slope/length distances, and less erodible soil types.

References

Babcock, D., and R. McLaughlin. In Press. Erosion control effectiveness of straw, hydromulch, and polyacrylamide in a rainfall simulator.

Babcock, D., and R. McLaughlin. 2011. Runoff water quality and vegetative establishment for ground covers on steep slopes. *J. Soil Water Cons. 66*(2):132-141.

Baldwin, A., Simpson, T., and S. Weammert. 2007. Urban erosion and sediment control best management practice; definition and nutrient and sediment reduction effectiveness estimates. Chesapeake Bay Program. University of Maryland Mid-Atlantic Water Program. College Park, MD.

Barrett, M., J. Kearney, T. McCoy, J. Malina, R. Charbeneau, and G. Ward. 1995. An evaluation of the use and effectiveness of temporary sediment controls. Technical Report CRWR 261, *Center for Research in Water Resources*; University of Texas, Austin, TX.

Benik, S., B. Wilson. D. Biesboer, B. Hansen, and D. Stenlund. 2004. Performance of erosion control products on a highway embankment. *Transactions of the ASABE. 46*(4): 1113-9.

Benik, S., B. Wilson, D. Biesboer, B. Hanse, and D. Stenlund. 1998. The efficacy of erosion control products at a MN/DOT construction site. Paper No. 982156. American Society of Agricultural Engineers. St. Joseph, MI.

Benik, S., B. Wilson, D.Biesboer, B. Hansen, and D. Stenlund. 2003. Evaluation of erosion control products using natural rainfall events. *Journal of Soil and Water Conservation. 58*(2): 98-106.

Bhardwaj, A. and R. McLaughlin. 2008. Energy dissipation and chemical treatment to improve stilling basin performance. *Transactions of the ASABE. 51*(5): 1645-1652.

Bidelspach, D. and A. Jarrett. 2004. Electro-mechanical outlet flow control device delays sediment basin dewatering. *Applied Engineering in Agriculture. 20*(6):759-763.

Bidelspach, D. 2002. Lag-time effects on the treatment efficiencies of sedimentation basins. M.S. Thesis in Agricultural and Biological Engineering, The Pennsylvania State University, University Park, PA. pp 196.

Bidelspach, D., A. Jarrett, and B. Vaughan. 2004. Influence of increasing the delay-time between the inflow and outflow hydrographs of a sediment basin. *Trans. ASAE.* 47(2):439-444.

Brown, E. 1997. Filtering efficiency and water transmissibility of geotextiles utilized in the design of sediment detention basin discharge riser pipes. M.S. in Civil and Environmental Engineering. The Pennsylvania State University, University Park, PA.

Bradford A., A. Fata , B. Gharabaghi , J. Li , G. MacMillan and R. Rudra. 2006. Evaluation of sediment control pond performance at construction sites in the Greater Toronto Area. *Canadian Journal of Civil Engineering*. *33*(11): 1335

Britton, S., K. Robinson, and B. Barfield. 2001. Modeling the effectiveness of silt fence. *Proceedings of the Seventh Federal Interagency Sedimentation Conference*, March 25 to 29, 2001, Reno, Nevada.

Carino, H., L. Faucette, J. Governo, R. Governo, C. F. Jordan and B. Lockaby. 2007. Evaluation of erosion control methods for storm water quality. *Journal of Soil and Water Conservation*. *62*(6).

Chesapeake Stormwater Network (CSN). 2011. Technical Bulletin No. 9: Nutrient accounting methods to document local stormwater load reductions in the Chesapeake Bay watershed. Version 2.0. Ellicott City, MD. (www.chesapeakestormwater.net)

Chesapeake Stormwater Network. (CSN). 2012 Summary of nutrient content of sediments, soils, solids and vegetation in the urban landscape. unpublished data. Ellicott City, MD.

Cleveland, T. and A. Fashokun. 2006. Construction-associated solids loads with a temporary sediment control BMP. *Journal of Construction Engineering and Management*. *132*(10).

Daniels, T., P. McGuire, D. Stoffel and B. Miller. 1979. Sediment and nutrient yield from residential and commercial construction sites. *Journal of Environmental Quality*. 8(3): 304-8.

Ehrhart, B. J. 1996. Effects of detention time on sedimentation basin performance. The Pennsylvania State University Scholar's Thesis in Environmental Resource Management, University Park, PA. pp 47.

Ehrhart, B. J. and A. R. Jarrett. 1997. Effects of detention time on sedimentation performance. In Proceedings, National Conference on Undergraduate Research. University of Texas, Austin, TX. pp. 6.

Engle, B.W. and A.R. Jarrett. 1991. Sediment retention efficiencies of sediment basin filtered outlets. *ASAE* Microfiche No. 91-2578. St. Joseph, MI.

Ehrhart, B., R. Shannon and A. Jarrett. 2002. Effects of construction site sedimentation basins on receiving stream ecosystems. *Trans. ASAE*. *45*(3): 675-680.

Engle, B. and A. Jarrett. 1995. Sediment retention efficiencies of sedimentation basin filtered outlets. *Trans. ASAE. 38*(2): 435-439.

Environmental Protection Agency (EPA). 2005. National management measures to control nonpoint source pollution for urban areas. Office of Water .EPA-841-B.05-004. Washington, DC.

Environmental Protection Agency (EPA). 2009. Development document for final effluent guidelines and standards for the construction and development category. US EPA Office of Water. Washington, DC.

EPA Chesapeake Bay Program (CBP). 2011. Chesapeake Bay Phase 5.3 community watershed model. Documentation Report. Chapter 9. Chesapeake Bay Program Office. Annapolis, MD.

Faucette, L., C. Jordan, L. Risse, M. Cabrera, D. Coleman, and L. West. 2005. Evaluation of storm water from compost and conventional erosion control practices in construction activities. *Journal of Soil and Water Conservation. 60*(6): 288.

Faucette, L., L. Risse, M. Nearing, J. Gaskin, and L. West. 2004. Runoff, erosion, and nutrient losses from compost and mulch blankets under simulated rainfall. *Journal of Soil and Water Conservation. 59*(4): 154-160.

Faucette, L., L. Risse, M. Nearing, J. Gaskin, and L. West. 2007. Erosion control and storm water quality from straw with PAM, mulch, and compost blankets of varying particle sizes. *Journal of Soil and Water Conservation. 62*(6): 404-413

Faucette, L., R. Rowland , A. Sadeghi and K. Sefton. 2008. Sediment and phosphorus removal from simulated storm runoff with compost filter socks and silt fence. *Journal of Soil and Water Conservation. 63*(4): 257-264.

Faucette, L., G. Gigley , J. Governo, C. Jordan , B. Lockaby and R. Tyle. 2009. Performance of compost filter socks and conventional sediment control barriers used for perimeter control on construction sites. *Journal of Soil and Water Conservation. 64*(1): 81-88.

Fennessey, L. A. J. 1994. Sediment retention efficiency of a full scale sedimentation basin. M.S. Thesis in Agricultural and Biological Engineering. The Pennsylvania State University. University Park, PA. pp. 97.

Fennessey, L. and A. Jarrett. 1997. Influence of principal spillway geometry and permanent pool depth on sediment retention in sedimentation basins. *Trans ASAE, 40*(1): 53-59.

Fifield, J. 2001. *Designing Effective Sediment and Erosion Control for Construction Sites*. Santa Barbara, CA: Forester Press.

Fisher, L.S. and A.R. Jarrett. 1984. Sediment retention efficiency of synthetic filter fabrics. *Trans. ASAE*. 27(2):429-436.

Gharabaghi, B., A Fata, R. Van Seters, R. Rudra, G. MacMillan, D. Smith, J. Li, A, Bradford and G. Tess. 2006. Evaluation of sediment control pond performance at construction sites in the greater Toronto area. *Canadian Journal of Civil Engineering*. 35: 1335-1344.

Guy, H. and G. Ferguson, 1962.Sediment in small reservoirs due to urbanization. *Proceedings ASCE, Journal of Hydraulics Division*. 88:27-37.

Hayes, S., R. McLaughlin and D. Osmond. 2005. Polyacrylamide use for erosion and turbidity control on construction sites. *Journal of Soil and Water Conservation*. 60(4): 193-199.

Horner, R., J. Guedry and M. Kortenhof. 1990. Improving cost-effectiveness of highway construction site erosion and pollution control. Washington State Transportation Center. Federal Highway Administration. Seattle, WA.

Islam, M., D. Taphorn, and H. Utrata-Halcomb. 1998. Current performance of sediment basins & sediment yield measurement of construction sites in unincorporated Hamilton County, Ohio. Hamilton County Soil and Water Conservation District.

Jarrett, A. 1996. Sediment basin evaluation and design improvements. Final completion report. Hillsborough, N.C.: Orange County Board of Commissioners.

Jarrett, A. R. 1997. Evaluation of sediment particle size distributions entering a sedimentation basin. Final Completion Report to Pennsylvania Department of Environmental Protection, Harrisburg, PA. pp. 105.

Jarrett, A. and B. Barfield. 2001. Designing sedimentation basins for better capture. Conference Presentation.

Kang, J., M. McCaleb and R. McLaughlin. 2013. Check dam and polyacrylamide performance under simulated stormwater runoff. *Journal of Environmental Management*. 129:593-598.

Kalainesan, S., R. Neufeld, R. Quimpo, and P. Yodnane. 2009. Sedimentation basin performance at highway construction sites. *Journal of Environmental Management. 90*: 838-849.

Kalainesan, S., R. Neufeld, R. Quimpo, and P. Yodnane. 2008. Integrated methodology of design for construction site sedimentation basins. *Journal of Environmental Engineering*. *134*(8), 619-627.

Kayhanina, M., K. Murphy and R. Haller. 2001. Characteristics of stormwater runoff from construction sites in California. Transportation Research Board. 1743: Paper 1-3081. National Academy Press.

Lake, D. 2013. Personal Communication. Computations of runoff coefficients for three construction site scenarios (panelist)

Langland, M. and S. Cronin, 2003. A summary report of sediment processes in the Chesapeake Bay and watershed. *USGS Water Resources Investigation Report. 03-4123*.

Lee, C. and A. Ziegler. 2010. Effects of urbanization, construction activity, management practices and impoundments on suspended sediment transport in Johnson County, northeast Kansas, February 2006 through November, 2008. *USGS Scientific Investigations Report. 2010-5128*. 54 p.

Line, D. 2007. Monitoring the effects of highway construction in the Sedgefield Lakes Watershed. North Carolina Dept. of Transportation. Report No. FHWA/NC/2006-07.

Line, D. and N. White. 2001. Efficiencies of temporary sediment traps on two North Carolina construction sites. *Transactions of the ASAE. 44*(5): 1207-1215.

Line, D., N. White, D. Osmond, G. Jennings and C. Mojonnien. 2002. Export from various land uses in the Upper Neuse River basin. Environmental Research. 74(1): 100-108.

Line, D. and N. White. 2007. Effects of development on runoff and pollutant export. *Water Environment Research. 79*(2), 185-190.

Madaras, J. S. 1997. The spatial and temporal distribution of suspended sediment. M.S. Thesis in Agricultural and Biological Engineering. The Pennsylvania State University, University Park, PA. pp. 155.

Madaras, J. and A. Jarrett. 2000. Spatial and temporal distribution of sediment concentration and particle size distribution in a field scale sedimentation basin. *Trans. ASAE. 43*(4): 897-902.

Markusic, M. 2008. Effects of design changes on sediment retention basin efficiency. Master's thesis, advised by R. McLaughlin. North Carolina State University. Raleigh, NC.

Masters, A., K. Flahive, S. Mostaghimi, D. Vaughan, A. Mendez, M. Peterie, and S. Radke. 2000. A comparative investigation of the effectiveness of polyacrylamide (PAM) for erosion control in urban areas. *2000 ASAE Annual International Meeting*, Milwaukee, WI, USA, 1-22.

McCaleb, M. M. and R. A. McLaughlin. 2008. Sediment trapping by five different sediment detention devices on construction sites. *Transactions of the ASABE. 51*(5): 1613-1621.

Mclaughlin R., S.E. King and G.D. Jennings. 2009. Improving construction site runoff quality with fiber check dams and polyacrylamide. *Journal of Soil and Water. 64*(2): 144-154.

McLaughlin, R. and N. Bartholomew. 2007. Soil factors influencing suspended sediment flocculation by polyacrylamide. *Soil Sci. Soc. Am. J. 71*: 537-544.

McLaughlin, R. and T. T. Brown. 2006. Evaluation of erosion control products with and without added polyacrylamide. *J. Am. Water Res. Assoc. 42*(3): 675-684.

McLaughlin, R. 2009. Water quality improvements using modified sediment control systems on construction sites. *Transactions of the ASABE. 52*(6), 1859-1867.

McLaughlin, R. 2006. Polyacrylamide blocks for turbidity control on construction sites. *ASABE* Paper No. 062254, St. Joseph, MI.

McLaughlin, R. 2005. Minimizing water quality impacts of mountain construction projects. North Carolina Dept. of Environment and Natural Resources. Contract No. EW03024.

McLaughlin, R. 2008. Stilling basin design and operation for water quality field testing. NCDOT Research Project HWY-2007-02.

McLaughlin, R. 2002. Measures to reduce erosion and turbidity in construction site runoff. U.S. Dept. of Transportation, Report No. FHWA/NC/2002-023.

McLaughlin, R. and A. Zimmerman. 2008. Best management practices for chemical treatment systems for construction stormwater and dewatering. Federal Highway Administration, Western Federal Lands Highway Division, Report No. FHWA-WFL/TD-09-001.

McLaughlin, R. and G. Jennings. 2007. Minimizing water quality impacts of road construction projects. North Carolina Dept. of Transportation, Project Authorization No. HWY- 2003-04 (Contract No. 98-1783).

McLaughlin, R. and S. King. 2008. Monitoring of nutrient and sediment loading from construction sites. NC DENR, Division of Water Quality. DWQ Contract Number: EW05015.

McLaughlin, R. and M. Markusic. 2007. Evaluating sediment capture rates for different sediment basin designs. North Carolina Dept. of Transportation, Project Authorization No. HWY- 2006-17 (Contract No. 98-1783).

McLaughlin, R., S. Hayes, D. Clinton, M. McCaleb, and G. Jennings. 2009. Water quality improvements using modified sediment control systems on construction sites. *Transactions of the ASABE. 52*(6):1859-1867.

Millen, J. A. 1996. Water and sediment discharge from sedimentation basins with combinations of barriers, a perforated riser, and a floating riser. M.S. thesis in Agricultural and Biological Engineering, The Pennsylvania State University, University Park, PA. pp. 103.

Millen, J. A., A. R. Jarrett and J. W. Faircloth. 1997. Experimental evaluation of sedimentation basin performance for alternative dewatering systems. *Trans. ASAE* 40(4):1087-1095.

Millen, J., A. Jarrett and J. Faircloth. 1997. Experimental evaluation of sedimentation basin performance for alternative dewatering systems. *Trans. ASAE, 40*(4): 1087-1095.

Minton, G., and A. Benedict. 1999. Use of polymers to treat construction site stormwater. *Proc. International Erosion Control Assoc. Conference, 30*: 177-188. Steamboat Springs, CO.

National Research Council (NRC). 2001. Achieving nutrient and sediment reduction goals in the Chesapeake Bay: an evaluation of program strategies and implementation. National Academy of Science Press. Washington, DC.

Owens, D.,P. Jopke, D. Hall, J. Balousek and A. Roa. 2000. Soil erosion from two small construction sites, Dane County, Wisconsin. *USGS Fact Sheet FS*-109-00.

Novotny, V. and G. Chesters. 1981. Handbook of nonpoint source pollution: sources and management. Van Nost and Reinhold Company, New York, NY.

Pitt, R. 2004. Modules 3. Regional rainfall conditions and site hydrology for construction site evaluation. University of Alabama

Pitt, R.,T. Brown and R. Morchque. 2004. National stormwater quality database, Version 2.0. University of Alabama and Center for Watershed Protection. Final Report to US EPA.

Pouyat, R., I. Yesilonis, J. Russell-Anelli, and N. Neerchal. 2007. Soil chemical and physical properties that differentiate urban land-use and cover types. *Soil Science Society of America Journal.* 71(3):1010-1019.

Rauhofer, J. 1998. Effectiveness of under-sized sedimentation basins. M.S. Thesis in Agricultural and Biological Engineering. The Pennsylvania State University, University Park, PA. pp. 115

Rauhofer, J, A. Jarrett and R. Shannon. 2001. Effectiveness of sedimentation basins that do not totally impound a runoff Event. *Trans. ASAE. 44*(4):813-818.

Risse, L., S. Thompson, J. Governo and K. Harris. 2008. Testing of new silt fence materials: A case study of belted strand retention fence. *Journal of Soil and Water Conservation. 63*(5): 265-273.

Roa-Espinosa, A., G.D. Bubenzer, and E.S. Miyashita. 2000. Sediment and runoff control on construction sites using four application methods of polyacrylamide mix. American Society of Agricultural Engineers, Paper No. 99-2013; St. Joseph, MI.

Rounce, D. 2012. Reducing turbidity of construction site runoff via coagulation with polyacrylamide and chitosan. Thesis, University of Texas: Austin.

Schueler, T. 1987. Controlling urban runoff: a practical manual for designing urban best management practices. Metropolitan Washington Council of Governments. Washington, DC.

Schueler, T. and J. Lugbill. 1990. Performance of sediment controls at Maryland construction sites. Final Report to MD DNR. Metropolitan Washington Council of Governments. Washington, DC.

Schueler, T. and H. Holland. 2000. Article 52. The Practice of Watershed Protection. techniques for protecting our nation's streams, lakes, rivers and estuaries. Center for Washed Protection. Ellicott City, MD.

Soupir, M., S. Mostaghimi, A. Masters, K. Flahive, D. Vaughan, A. Mendez, and P. McClellan. 2004. Effectiveness of polyacrylamide (PAM) in improving runoff water quality from construction sites. *Journal of the American Water Resources Association. 40*(1): 53–66.

Stormwater Performance Standards Expert Panel (SPSEP). 2012. Recommendations of the expert panel to define removal rates for new state stormwater performance standards. Approved by Chesapeake Bay Water Quality Goal Implementation Team. Annapolis, MD. www.chesapeakebay.net/.../Final_CBP_Approved**_Expert_Panel_Report_**on_ Stormwater_Performance_Standards_SHORT.pdf

Stormwater Retrofit Expert Panel (SREP). 2012. Recommendations of the expert panel to define removal rates for urban stormwater retrofit projects. Approved by Chesapeake Bay Water Quality Goal Implementation Team. Annapolis, MD. http://www.chesapeakebay.net/publications/title/stormwater_retrofits_expert_ panel_report_with_appendices

Sweeney, J. 2013. personal communication. Chesapeake Bay Program.

Taleban, V., K. Finney, B. Gharabaghi, E. McBean, R.Rudra, T. Van Seters. 2009. Effectiveness of compost biofilters in removal of sediments from construction site runoff. *Water Quality Research Journal of Canada*. *44*(1): 71.

Thaxton, C., and R. McLaughlin. 2005. Sediment capture effectiveness of various baffle types in a sediment retention pond. *Transactions of the ASAE*. *48*(5), 1795-1802.

Urban Nutrient Management Expert Panel (UNMEP). 2013. Recommendations of the expert panel to define removal rates for urban nutrient management. CBP-approved final report. EPA Chesapeake Bay Program. Annapolis, MD. www.chesapeakebay.net/.../Final_CBP_Approved_**Expert_Panel_Report**_on_Urban_Nutrient_Management--short.pdf

Urban Stormwater Work Group (USWG). 2013. Principles and protocols for urban BMP verification in the Chesapeake Bay watershed. Chesapeake Bay Program Partnership. Annapolis, MD.

Vaughan, B. T. 2002. Experimental evaluation and modeling of sedimentation basin performance using skimmer-type dewatering control devices. Ph.D. Thesis in Agricultural and Biological Engineering, The Pennsylvania State University, University Park, PA. pp. 319

Water Quality Goal Implementation Team (WQGIT). 2010. Protocol for the development, review and approval of loading and effectiveness estimates for nutrient and sediment controls in the Chesapeake Bay Watershed Model. US EPA Chesapeake Bay Program. Annapolis, MD.

Wishowski, J., M. Mamo, and G. Bubenzer. 1998. Trap efficiencies of filter fabric fence. *ASAE Annual Meeting, Paper No*. 982158, St. Joseph, MI

Wolman, G. and A. Schick. 1967. Effects of construction on fluvial sediment, urban and suburban areas of Maryland. *Water Resources Research*. 3(2); 451-464.

Yoho, S. 1980. Forest management and sediment production in the South- a review. *Southern Journal of Applied Forestry*. 4(1): 27-36.

Yorke, T. and W. Herb. 1978. Effects of urbanization and stream flow and sediment transportation in the Rock Creek and Anacostia river basins, Montgomery County, MD, 1962-1974. *USGS Professional Paper #1003*.

Appendix A
Technical Rationale for Estimating Sediment Loads at Construction Sites for Different Levels of ESC Practice

The Panel decided to take an empirical approach to estimate the average annual sediment load generated by construction sites with various levels of ESC controls. The Simple Method is an empirical equation developed by Schueler (1987) to estimate annual pollutant loads in stormwater runoff using easily derived parameters. It computes loads for storm events only, and is best applied to individual drainage areas or catchments. The basic equation is:

$$L = [\ P * Pj * Rv / 12\ ]\ [\ EMC * A * 2.72]$$

Where:

L = Annual load (lbs)
P = Annual rainfall (in)
Pj = Fraction of storms producing runoff (0.9)
Rv = Construction Site runoff coefficient
EMC = TSS event mean concentration (mg/l)
A = Site Area (acres)
2.72 = Unit conversion factor

L is divided by 2000 to get tons of sediment per acre per year.

In the analysis, the following parameters were held constant:

P = 40 inches/yr
Pj = 0.9
A = 1 acre

Parameter values for Rv and EMC were based on the review of construction site monitoring data for five sediment loading scenarios:

Scenario 1: NO ESC: Historical construction sites without ESC controls
Scenario 2: ESC 1: Construction sites with Level 1 ESC controls
Scenario 3: ESC 2: Construction sites with Level 2 ESC controls
Scenario 4: ESC 3: Construction sites with Level 3 ESC controls
Scenario 5: MFD: Construction sites with moderate functional deficiency.

The Panel evaluated three different technical assumptions for each scenario -- parameter values that defined a worst case, average case, and best case for potential sediment loading in each scenario. For each case, the annual sediment load was computed using the Simple Method, and the final load was determined by averaging all three values. The results for the five scenarios are shown in Tables A-1 to A-5

Table A-1
Scenario 1: Historical Construction Site without ESC

Parameter	Worst Case	Average	Best Case
Rv	0.65 [1]	0.50 [3]	0.35 [5]
EMC TSS OUT	8,400 [2]	4,200 mg/l [4]	3600 mg/l [6]
COMPUTED LOAD	**22.3 tons/ac/yr**	**8.6 tons/ac/yr**	**5.1 tons/ac/yr**

Notes on Technical Assumptions:
[1] Assumes historic construction sites w/o ESC had an Rv 30% higher than the one measured at a construction site with ESC control
[2] TSS EMC is double the 4,200 mg/l reported by Yorke and Herb (1978)
[3] Measured value, see Table 10
[4] Average concentration derived from Yorke and Herb (1978)
[5] Bay-wide average Rv for construction sites (Table 13)
[6] Grand mean of all ESC studies for TSS EMC IN (Table 15)

Table A-2
Scenario 2: Construction Sites Operating at Level 1 ESC Practice

Parameter	Worst Case	Average	Best Case
Rv	0.50 [1]	0.43 [3]	0.35 [5]
EMC TSS OUT	1,200 mg/l [2]	1,000 mg/l [4]	800 mg/l [6]
COMPUTED LOAD	**2.5 tons/ac/yr**	**1.8 tons/ac/yr**	**1.1 tons/ac/yr**

Notes on Technical Assumptions:
[1] Measured value, see Table 10
[2] Most conservative, assumes bigger storm events produce greater annual EMC
[3] Intermediate value between measured value and the Bay-wide average
[4] Conservative rounding up, given TSS variability
[5] Bay-wide average Rv for construction sites (Table 13)
[6] Mean TSS OUT for Level 1 ESC sites, as shown in Table 15

Table A-3
Scenario 3: Construction Sites Operating at Level 2 ESC Practice

Parameter	Worst Case	Average	Best Case
Rv	0.50 [1]	0.43 [3]	0.35 [5]
EMC TSS OUT	800 mg/l [2]	557 mg/l [4]	500 [6]
COMPUTED LOAD	**1.6 tons/ac/yr**	**1.0 tons/ac/yr**	**0.7 tons/ac/yr**

Notes on Technical Assumptions:
[1] Measured value, see Table 10
[2] Most conservative, assumes bigger storm events produce greater annual EMC
[3] Intermediate value between measured value and the Bay-wide average
[4] Mean TSS OUT for Level 1 ESC sites, as shown in Table 15
[5] Bay-wide average Rv for construction sites (Table 13)
[6] Rounding down, given the effect of the outliers in Table 15

Table A-4 Scenario 4: Construction Sites Operating at Level 3 ESC Practice			
Parameter	Worst Case	Average Case	Best Case
Rv	0.43 [1]	0.35 [3]	0.27 [5]
EMC TSS OUT	600 [2]	400 [4]	280 [6]
COMPUTED LOAD	**1.05 t/ac/yr**	**0.57 t/ac/yr**	**0.31 t/ac/yr**

Notes on Technical Assumptions:
[1] Intermediate value between measured value and the Bay-wide average (i.e., Level 3 ESC practices act to reduce site Rv).
[2] Mean TSS OUT for level 2 ESC in Table 15, rounded up
[3] Bay-wide average Rv for construction sites (Table 13)
[4] Best professional judgment that Level 3 can reduce Level 2 TSS outflow concentrations by approximately 30%
[5] Best professional judgment that Level 3 practice can reduce site Rv by approximately 25%
[6] Best professional judgment that Level 3 can reduce TSS outflow concentrations by 50% below current level 2 practice

Table A-5 Scenario 5: Construction Sites w/ Moderate Functional Deficiency			
Parameter	Maximum	Average	Minimum
Rv	0.50 [1]	0.43 [3]	0.35 [5]
EMC TSS OUT	3,600 [2]	2100 [4]	1400 [6]
COMPUTED LOAD	**7.3 tons/ac/yr**	**3.7 tons/ac/yr**	**2.0 tons/ac/yr**

Notes on Technical Assumptions:
[1] Measured value, see Table 10
[2] Rounded grand mean TSS IN in Table 15, presumes some effect of upland erosion practices, but complete failure of sediment controls
[3] Intermediate value between measured value and the Bay-wide average
[4] Assumes that sediment controls work at 40% removal, compared to the grand mean
[5] Bay-wide average Rv for construction sites (Table 13)
[6] Assumes that sediment controls work at 60% removal, compared to the grand mean

Notes on How Moderate Functional Deficiency was Derived:

Two previous expert panels conducted long-term rainfall frequency analyses (1977-2007) and developed adjustor curves to define sediment removal rates based on the design capacity of stormwater practices up to 2.5 inches/day (SPSEP, 2012, SREP, 2012). The stormwater treatment (ST) curve for sediment removal is shown in Figure A-1, which portrays how sediment removal rates increase as a direct function of the runoff depth captured per impervious acre by a stormwater BMP.

The Panel reasoned that the ST curve could not be used to define ESC sediment removal rates (primarily because ESC practices are subject to incoming TSS levels that are an order of magnitude higher than for urban stormwater runoff, and contain sediment particles that are much easier to settle out).

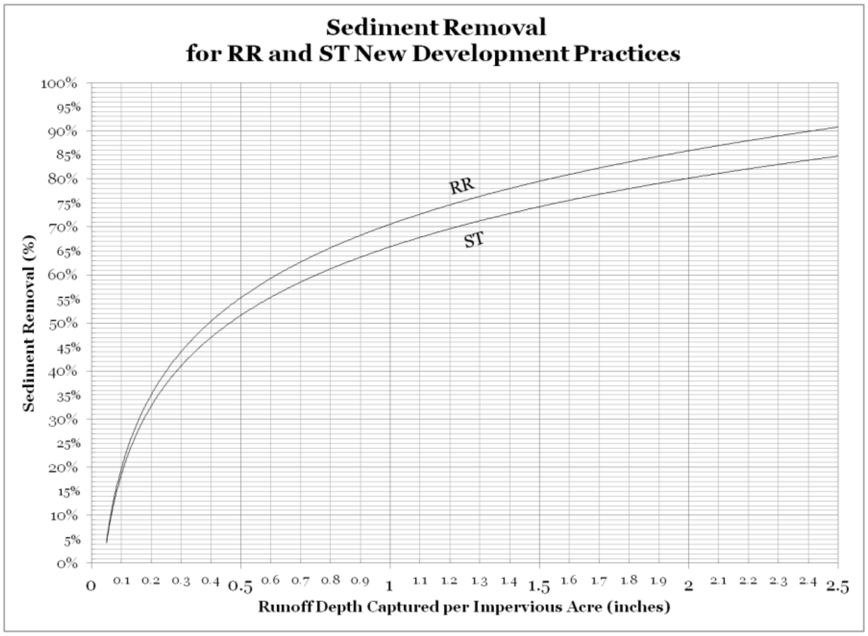


Figure A-1 Stormwater Adjustor Curve from SPSEP, 2012

The Panel did conclude that the ST curve could be used to define the annual fraction of runoff volume that would exceed the design capacity of ESC practices. Level 1 ESC practices are designed on a half-inch of runoff capture per acre, whereas Level 2 practices are designed based on one-inch of rainfall capture. Periods of moderate functional deficiency are operationally defined as runoff depths that exceed the design capacity of the ESC facility from its normal capacity up to the 2.5 inch runoff depth. The rainfall frequency analysis that was used to construct the curves for this range of storm events was then used to determine the fraction of annual runoff volume generated under moderate deficiency conditions.

The analysis indicated that Level 1 ESC practices are exposed to moderate deficiency conditions during approximately 25% of the average annual runoff volume, whereas Level 2/3 ESC practices are exposed to moderate deficiency about 15% of the time. During these periods, the sediment removal function of ESC practices is sharply diminished, but does not go zero.

A best estimate of the annual sediment loading rate under moderate deficient conditions is presented in Table A-5. The annual loading rate is then pro-rated over the fraction of the annual runoff volume for which a site is expected to experience moderately deficient conditions, and is this additional fractional load is added to the base loading rate for the appropriate level of ESC practice.

For ESC Level 2, this was computed as (0.15) (4.3 tons/acre/year), or an additional 0.65 tons/acre/year to be added to the base load.

Defining Extreme Functional Deficiency:

Extreme functional deficiency occurs during the rare storms that completely overwhelm the treatment capacity of ESC practices such that they fully compromise their collective sediment removal function. In the best professional judgment of the Panel, these conditions are expected to occur when hourly or daily rainfall intensities meet or exceed the following thresholds in any CBWM time step:

- 2.5 inches per day (the top end of the ST curve)
- 1.5 inches per hour (an intense thunderstorm

During these extreme conditions, the ESC practices at construction sites are expected to fail completely, and discharge sediment at a bare soil estimate of sediment loading of 12 tons/acre/year (Table A-1).

For the current version of the CBWM, this would imply a 50% reduction, since the target load for version 5.3.2 is 24 tons/acre/year.

Overall Summary

Table A-6 summarizes how the five scenarios compare.

Table A-6
Comparative Summary of the Five Scenarios (tons/ac/yr)

ESC Scenario	Worst Case	Mid-point Case	Best Case	**Best Estimate**
1. Construction w/o ESC	22.3	8.6	5.1	**12.0**
2. Sites Operating at Level 1	2.5	1.8	1.1	**1.8**
3. Sites Operating at Level 2	1.6	1.0	0.7	**1.1**
4. Sites Operating at Level 3	1.05	0.57	0.31	**0.65**
5. Moderate Functional Deficiency	7.3	3.7	2.0	**4.3**

Important Note: Actual sediment loads for all 3 ESC levels will be higher when moderate and extreme storms exceed or overwhelm ESC capacity, and thus create functional deficiency, and much lower removal rates.

Appendix B
Mass Balance Analysis of Nutrient Loss Pathways at Construction Sites

Given that construction sites exported about three times more nutrients than developed land, the Panel created a simple mass balance model to analyze the nutrient loss pathways at construction sites. The objective of the analysis was to check whether the higher unit nutrient loads used in CBWM could be supported by various nutrient inputs, sources and pathways that occur in construction sites.

Pathway 1: Nutrients Attached to Eroded Soil. The first pathway involves the loss of nutrients that are attached to eroded sediments that leave the site. The Panel tested this proposition through a simple mass balance approach as shown in Table B-1. Three levels of construction site sediment loss were assumed, based on the data analysis in Section 5, and multiplied by an estimate of nutrient content for urban soils. The median nitrogen and phosphorus levels in the top 5 inches of urban soils were based on Pouyat et al (2007) survey of nutrient content of a wide range of soil types in Baltimore metro area. These values were discounted by 50% to reflect the fact that most exposed soils at construction sites would have a lower nutrient content.

As can be seen in Table B-1, the mass balance suggests that loss of nutrients attached to eroded sediment can explain a significant fraction of potential nutrient export, especially when sediment loss conditions are high.

Table B-1 Nutrient Loss Pathway 1:
Potential N and P Loss Attached to Eroded Sediments (lbs/acre/year)

Nutrient	12 tons/ac/yr erosion rate	8 tons/ac/yr erosion rate	2 tons/ac/yr erosion rate
Total P	0.46	0.30	0.08
Total N	16.8	11.2	2.8

Based on Pouyat et al (2007) measurements of median soil nutrient content in Baltimore metro area soils, N = ~ 110. These values were reduced by a factor of two to reflect the fact that Pouyat's measurements were taken in 0 and A soil horizons.

Pathway 2: Fertilizer Wash-off. The second source of possible nutrient loss is the fertilizers applied during temporary and permanent stabilization. Once again, the Panel analyzed the potential contribution of fertilizer wash-off through a simple mass balance approach as shown in Table B-2. Three levels of fertilizer loss were used (1%, 5% and 10%), assuming a single fertilizer application at the Bay state average as shown in Table 23.

Table B-2 Nutrient Loss Pathway 2 Potential N and P Loss Using Fertilizer Wash off (lbs/acre/year)			
Nutrient	1% Loss	5% Loss	10% Loss
Total P	0.7	3.7	7.4
Total N	1.1	5.7	11.4
Assume 114 lbs/acre/year application for TN and 74.3 lbs/acre/year for TP, which is average of required fertilization rate specified in Bay state temporary and final stabilization specs (see Table 23). It was conservatively assumed that only one application would occur over the course of a construction year.			

Based on the mass balance, fertilizer wash-off can account for most, if not all, of the modeled phosphorus load at the 5 and 10% loss rates. The effect is less pronounced for nitrogen. Fertilizer wash-off could potentially account for a third to a half of the modeled nitrogen load. It should be noted that the CBWM does not account for any fertilizer inputs to construction sites at the current time.

Pathway 3: Wash-off of Atmospherically Deposited Nutrients

The third potential pathway involves the wash-off of nutrients that are deposited from the atmosphere. For purposes of mass balance, the Panel used regional data on annual nutrient deposition rates, and three different assumptions regarding the risk for wash-off (10%, 30% and 50%). The results, shown in Table B-3, indicate that wash-off of the deposited nutrients is a significant loss pathway, that can account for about 15 to 30% of the modeled nitrogen loads under moderate and high wash-off conditions. By contrast, the loss pathway does not appear to be very significant for phosphorus.

Table B-3 Nutrient Loss Pathway 3 Potential N and P Wash-off of Atmospherically Deposited Nutrients (lbs/acre/year)			
Nutrient	10% Wash-off	30% Wash-off	50% Wash-off
Total P	0.07	0.21	0.35
Total N	1.3	3.9	6.5
Assume 13 lbs/acre/year for TN and 0.7 lbs/acre/year for TP, based on regional wet and dry atmospheric deposition rates, reported in CSN (2011). Wash-off rates based on assumption that wash-off cannot exceed the runoff coefficient			

Pathway 4: Decay and Wash-off of Organic Material

The fourth potential source of nutrient loss involves the decay of various organic materials that are used to temporarily cover soils and prevent erosion. These materials can include straw, mulch, wood chips, compost, erosion control blankets and organic tackifiers. In addition, certain ESC practices may utilize the same organic materials to improve sediment trapping performance.

The assumptions in the mass balance to analyze the potential loss pathway were fairly simplistic, and assumed three levels of organic material loss that were a tenth of the three sediment loss rates used in Pathway 1 mass balance. Several recent studies that have analyzed the nutrient content of vegetative detritus in catch basins and storm drain outfalls were used to define the potential nutrient content of these organic materials. As shown in Table B-4, the wash-off of organic matter does not appear to be a major loss pathway for either nitrogen or phosphorus.

Table B-4 Nutrient Loss Pathway 4
Potential N and P Loss Via Organic Matter Degradation (lbs/acre/year)

Nutrient	0.6 tons/ac/yr	0.4 tons/ac/yr	0.1 tons/ac/yr
Total P	1.2	0.8	0.2
Total N	4.2	2.8	0.7

Assume 2 lbs/ton for TP and 7 lbs/ton for TN, based on nutrient content of vegetation measured in catch basins outfalls (CSN, 2012)
Assume 5% of sediment yield is actually organic matter rather than eroded soil

Summary of Nutrient Losses From all Pathways. The purpose of the mass-balance analysis was to determine if the existing CBWM target nutrient loads for construction sites could be generally validated given how little monitoring data was available to measure them. Table B-5 summarizes the mass balance estimates for all four loss pathways for each nutrient, and compares them to modeled loads used in CBWM. As can be seen, the CBWM load estimates fit squarely in the middle of the Panel's mass balance estimates for both nitrogen and phosphorus. The Panel acknowledges all of the limitations and uncertainties inherent in its mass balance analysis, but also gained more confidence that the existing CBWM nutrient loads were in the ball park of what might be expected at a construction site.

Table B-5 Mass Balance Comparison of Nutrient Loadings by Loss Pathways

	Total Nitrogen (lbs/ac/yr)			Total Phosphorus (lbs/ac/yr)		
	Lo	Med	High	Lo	Med	High
Pathway 1	2.8	11.2	16.8	0.08	0.30	0.46
Pathway 2	1.1	5.7	11.4	0.7	3.7	7.4
Pathway 3	1.3	3.9	6.5	0.07	0.2	0.4
Pathway 4	0.7	2.8	4.2	0.2	0.8	1.2
Total	**5.9**	**23.6**	**38.9**	**1.1**	**5.0**	**9.5**
CBWM	**26.4**			**8.8**		

Note: N migration to groundwater was not included in the analysis, so N load mass balance may be conservative.

Appendix C
Performance of Individual ESC Practices

Some of the most extensive literature has focused on design features that improve the performance of the sediment basins. Some of the landmark research in this area was performed by Dr. Jarrett, Emeritus Professor of Biological Engineering at Penn State University and his graduate students between 1991 and 2002.

The research team sampled sediments within a 5,000-ft^3 and a 1,800-ft^3 experimental sediment basin. Each experimental treatment, replicated three times, consisted of injecting a simulated 3,500-ft^3 inflow hydrograph containing 1,000 lbs of locally available, screened Hagerstown silty clay loam A-horizon soil particles into the basin. The soil injected into the basin was screened and contained a wide range of soil/sediment sizes ranging from clays to10-mm diameter particles.

Thirty-four percent (or 340 lbs) of the injected soil was smaller than 45µm, the average diameter discovered to be the largest particles that are typically hydraulically transported into sediment basins located on construction sites (Jarrett, 1997). A wide range of basin modifications and dewatering control devices were evaluated to determine what design parameters improved the basin's ability to capture the suspended sediment.

In all experiments the dewatering control device was designed to dewater the 3,500-ft^3 inflow hydrograph in 24 hrs and the basin had no permanent pool unless indicated in the descriptions below. The large basin was used for all experiments except No. 12 below. The results of these experiments are summarized below:

(1) The basin captured 80% of the 340 lbs of injected soil (93.2% of the total soil injected) when the basin was dewatered using a perforated riser or a single orifice principal spillway (Fennessey, 1994; Fennessey and Jarrett, 1997).

(2) The basin captured 90% of the 340 lbs of injected soil (96.6% of the total soil injected) when the basin was dewatered using a skimmer principal spillway(Millen, 1996; Millen et al., 1997).

(3) The basin captured 92% of the 340 lbs of injected soil (97.2% of the total soil injected) when the basin was dewatered using a perforated riser and a 1.5-ft deep permanent pool was maintained in the basin (Fennessey, 1994; Fennessey and Jarrett, 1997).

(4) Lining the basin with close-growing grass/vegetation produced the same improvement in sediment capture as maintaining 1.5-ft deep permanent pool (Fennessey, 1994; Madaras and Jarrett, 2000).

(5) Half of the sediment released from the basin originated from within the basin after being eroded from the basin floor and sides (Fennessey, 1994; Madaras and Jarrett, 2000).

(6) The basin captured 68% of the 340 lbs of injected soil (89.1% of the total soil injected) and 86% of the 340 lbs of injected soil (95.2% of the total soil injected) when the basin was dewatered in 6 hrs using a perforated riser and skimmer, respectively (Ehrhart, 1996; Ehrhart and Jarrett, 1997).

(7) The basin captured 94% of the 340 lbs of injected soil (98.0% of the total soil injected) and 97% of the 340 lbs of injected soil (99.0% of the total soil injected) when the basin was dewatered in 7 days using a perforated riser and skimmer, respectively (Ehrhart, 1996; Ehrhart and Jarrett, 1997).

(8) Delaying the release of water from a sediment basin until the inflow has stopped greatly improved the basin's sediment capture efficiency (Vaughan, 2002; Bidelspach, 2002; Bidelspach et al., 2004).

(9) Where the natural soil's infiltration rate exceeds 0.5 in/hr sediment basins can be dewatered by infiltrating the captured water through the basin floor, thus capturing 100% of the suspended sediment (Bidelspach, 2002; Bidelspach et al., 2004).

(10) Attempting to filter suspended sediment from the basin's outflow water by passing the water through geotextiles does not effectively remove the suspended sediment and greatly increases the dewatering time (Fisher and Jarrett, 1984; Brown, 1997). The piling of gravel up around a perforated riser was also found to not improve sediment capture (Engle and Jarrett, 1991; Brown, 1997).

(11) Geotextile barriers, designed and installed to subdivide the basin into three chambers in series, did not improve sediment capture (Millen, 1996; Millen et al., 1997)

(12) Flow through an emergency spillway is similar, in concept, to dewatering a sediment basin using a skimmer. When the basin was undersized to impound only 1,800 ft^3 of inflow about half of the inflow volume left the basin via the emergency spillway. Under these conditions, the basin captured 86% of the 340 lbs of injected soil (95.2% of the total soil injected) when the basin was dewatered using a perforated riser, and 95% of the 340 lbs of injected soil (98.3% of the total soil injected) when the basin was dewatered using a skimmer principal spillway, respectively (Rauhofer, 1998; Rauhofer et al., 2001).

Appendix D
Summary of Individual States ESC Programs and Regulations in the Bay States

Delaware

First state-wide ESC regulations/permits took effect in:
1991

Date of most recent Design Manual/Regulations:
2013

ESC is regulated in this state through:
- MS4 Phase 1 and 2 Permits
- Construction General Permit
- State Law

Area threshold for ESC regulations
5000 sq. ft.

Sizing requirement for on-site retention
3,600 cf/acre or one inch

Temporary stabilization required within
14 days

Regulatory Construction site inspections are required:
Weekly inspections performed by private Certified Construction Reviewers with min. monthly oversight by regulatory agency.

Construction site self-inspections are required:
Weekly

Construction site phasing is
Required for projects that meet some other threshold (please specify) Phasing is required in order to keep Limit of Disturbance under 20 acres to any given discharge point.

Notes on Green Card Certification and Inspector Training
At least one person in responsible charge at a construction site must have completed the 1-day Contractor's Certification Training (Blue Card). Delegated agencies may require services of a Certified Construction Reviewer (Gold Card) for larger projects and/or for installation of post-construction SWM BMPs.

Summary of enforcement requirements

Step 1: Corrective Action Notice by delegated agency Step 2: Referral to DNREC by delegated agency Step 3: Violation Notice by DNREC Step 4: Civil penalty through JP court Step 5: Criminal action through Superior Court (NOTE: DNREC Secretary may issue administrative penalty as an alternative to a criminal action.)

Unique elements to state program:
Third party inspectors must complete a 3-1/2 day training program to become Certified Construction Reviewers. Certification is valid for 5 years, at which point a 1-day recertification must be completed to remain current.

Maryland

First state-wide ESC regulations/permits took effect in
1970

Most recent Design Manual/Regulations
2011 Standards & Specifications became effective 1/9/13

New changes or additions in last round of design guidance

- Compost logs or polymer enhanced checkdams
- Improvements in sediment basin design (skimmers/baffles, etc)
- More restrictive buffer distances
- 20 acre grading unit
- 3 and 7 day stabilization requirement

ESC is regulated in the state through

- MS4 Phase 1 and 2 Permits
- Local Ordinance
- Construction General Permit
- State Law

Area threshold for ESC regulations
5000 square feet or disturbance and/or 100 cubic yards of cut or fill.

Sizing requirement for on-site retention
3,600 cf/acre or one inch

Temporary stabilization required within
7 days or less

Regulatory Construction site inspections are required
Every other week

Construction site self-inspections are required
Weekly and the next day following a rain event.

Construction site phasing is

Required for projects that meet some other threshold (please specify) 20 acre grading unit.

Notes on Green Card Certification and Inspector Training
Responsible person "Green Card Holder" is identified at the pre-construction meeting. Classes taught on a regular basis state-wide. "Green Card" certified person is required to be on-site at all construction projects.

Summary of enforcement requirements
Most of the more urban county's have delegated enforcement authority. In the more rural areas of Western Maryland and the Eastern Shore, Maryland Department of Environment is the regulatory authority. In a couple of County's, the SCD's have an MOU with MDE to do inspections, but MDE is still the regulatory agency. In approximately 5 County's, the local SCD's perform the pre-construction meetings.

Any other unique elements to your state program (e.g., third party inspection)
Green Card certification.

New York

First state-wide ESC regulations/permits took effect in
August 1993

Most Recent Design Manual/Regulations
August 2005 (Note: NYSDEC is beginning the update of the manual shortly)

ESC is Regulated in the State through

- Construction General Permit
- MS4 Phase 1 and 2 Permits
- State Law: NYS Environmental Conservation Law, 1971 is used as program basis.
- Local Ordinance: all MS4s must have an ordinance and many others have adopted ones.

Area Threshold for Regulations
One acre. There is a 5,000 square foot disturbance threshold for phosphorous restricted watersheds (none currently in the Chesapeake Bay watershed).

Sizing Requirement for On-site Retention
3600 cf/acre or 1 inch

Temporary stabilization required within
7-14 days

Regulatory Construction Site Inspections are required

Weekly. If the construction phase exceeds 5 acres, two inspections per week are required separated by at least two days.

Construction site self-inspections are required
Daily.

Construction Phasing is required for projects
Construction phasing and sequencing are required on all projects, although small projects may have only one phase.

Notes on Green Card Certification and Inspector Training
In NY a contractor must have an individual onsite that carries a wallet card verifying that he/she has attended the NYSDEC Contractor 4 hour Training Course. These individuals must be onsite during soil disturbing activities. There are approximately 35 DEC approved instructors that teach the course during the winter months. Approximately 30,000 attendees have gone thru the course.

Summary of Enforcement Requirements
NYSDEC (and hence local MS4's) enforce site compliance with routine inspections, notice of violation, follow up inspection, compliance conference, site shut-down orders if a water quality violation is occurring, and order of compliance which states actions to be carried out to put the site into compliance and the monetary fines to be paid.

Other unique elements to the state program
NYSDEC has contracted with Soil and Water Conservation District Staff, where qualified, to perform compliance inspections. Some MS4's do as well.

Pennsylvania

First state-wide ESC regulations/permits took effect in
1972 (E&S); NPDES 1992

Most Recent Design Manual/Regulations
Manual: 2012, Regulations: 2010

ESC is Regulated in the State through:
- MS4 Phase 1 and 2 Permits
- Local Ordinance
- Construction General Permit
- State Law
- Other
    - Both General and Individual construction permits;
    - Act 167 Comprehensive Stormwater Management Planning;
    - All earth disturbance activities are regulated

Area Threshold for Regulations
5,000 s.f. (for E&S Plan), however:

- All earth disturbance activities require the implementation of BMPs to minimize the potential for pollution;
- At 5,000sqft of DEP Chapter 102 described earth disturbance activities, a written E&S Plan is required;
- At 1 acre or more of DEP Chapter 102 described earth disturbance activities, a permit is required.

Sizing Requirement for On-site Retention
6,000 cf/acre (basin); 2,000 cf/acre (trap)

Temporary stabilization required within
Within 4 days

Regulatory Construction Site Inspections are required
Every 30 days. Inspections are prioritized based on pollution potential, sensitive environmental resource, continuing violations and a history of non-compliance.

Construction site self-inspections are required
Weekly and after each stormwater runoff event

Construction Phasing is NOT required

Notes on Green Card Certification and Inspector Training:
No Green Card Certifications. DEP relies on licensed professionals to certify as-builts and to be on-site during critical stages of implementation of PCSM Plans. DEP also supports CPESC and NICET certifications. DEP provides continuing ed credits for professionals.

Summary of Enforcement Requirements:
Enforcement is based on immediate or potential threats to public health, safety or the environment or if a program integrity issue exists. Compliance and enforcement tools include:
Compliance Notices
Notices of Violation
Compliance Orders
Criminal and Civil penalties
Criminal referrals
Withholding of permits
Consent Assessments of Civil Penalty
Consent Order and Agreements
Complaints for Assessment of Civil Penalties

Other unique elements to the state program
-Delegation agreements with County Conservation Districts
-Requirements for antidegradation and addressing potential thermal pollution
-Regulating Oil and Gas activities
-Requirements for agricultural plowing and tilling and animal heavy-use areas

-Regulating all earth disturbance activities
-Requirements for minimizing duration of earth disturbance, maximizing the protection of existing drainage features and vegetation, minimizing soil compaction and preventing/minimizing increased stormwater runoff

Virginia

First state-wide ESC regulations/permits took effect in
1973

Date of most recent Design Manual/Regulations
Manual 1992/ Regulations 2013

ESC is regulated in the state through

- State Law
- Construction General Permit
- Local Ordinance

Area threshold for ESC regulations
10,000 s.f or 2,500 s.f. in Chesapeake Bay Protection Areas in eastern localities

Sizing requirement for on-site retention
3,600 cf/acre or one inch

Temporary stabilization required within
7-14 days

Construction site inspections are required
Every 2 weeks and within 48 hrs. of a runoff producing storm

Construction Phasing is NOT required

Notes on Green Card Certification and Inspector Training
Certification required to work for a program operated by a local government.

Summary of Enforcement Requirements
Corrective actions first noted on inspection report, then, written notice to comply, then stop work order. Civil and criminal penalties available but seldom used.

Other unique elements to the state program
Self-enforcement allowed for some entities (federal, state, linear) through annual specifications or allowing adoption of a program.

West Virginia

First state-wide ESC regulations/permits took effect in
1992

Most Recent Design Manual/Regulations
2006 WVDEP Erosion and Sediment Control BMP Manual
http://www.dep.wv.gov/WWE/Programs/stormwater/csw/Pages/ESC_BMP.aspx
(guidance document only)

ESC is Regulated in the state through

- Construction General Permit
- MS4 Phase 2 Permits
- One county in Bay drainage has its own ESC and stormwater ordinances voluntarily

Area Threshold for Regulations
One acre

What is the Sizing Requirement for On-site Retention
3600 cf/acre or 1 inch per ac drained (not disturbed) half wet/half dry volume

Temporary stabilization required within
7-14 days. Tighter stabilization time frames can be required on specific sites to protect Tier 3 waters or to meet TMDLs waters impaired for iron or sediment

Regulatory Site Inspections
DEP's stormwater inspectors try to conduct at least one site visit during construction for all sites ≥ 3 ac and all sites must be inspected before Notice of Termination is approved. Other inspections are usually complaint driven.

Construction Site Self Inspections are required
Every 7 calendar days and within 24 hours after any rainfall event of 0.5 inches or more in 24 hours. Inspections done by permittee/contractor.

Construction Phasing is NOT required

Notes on Green Card Certification and Inspector Training
WV has no such program and no plans currently to develop one

Unique elements to state program
All SWPPPs for sites ≥ 3 ac are reviewed and approved through WVDEP's Construction Stormwater program. Smaller sites (1<3) get reviewed when the site discharges to or upstream of a Tier 3 water.

Appendix E
WV 2011 Request for Enhanced ESC Controls

WVDEP is proposing universal application of the "BAR to PUL" BMP to bare construction land as a placeholder for Phase 2 model improvements and our plans to seek approval of improved E&S efficiencies for areas subject to regulation under our Construction Stormwater General Permit.

In the development of the Phase 1 WIP, WVDEP performed a detailed analysis to capture existing, concurrently registered area under the permit and proposed land use modifications to provide the appropriate area. The existing area differed greatly from that provided in the TMDL's 2010 land use (14,000 acres vs. 450 acres).

Bare construction is a very high loading land use and application of the E&S BMP provides only modest nitrogen and phosphorus reduction efficiencies of 25% and 40%, respectively. In contrast, the general permit requires installation of sediment traps and sediment basins for the vast majority of registered area, and the sediment removal efficiencies of those BMPs (under required design standards) far exceed those associated with the E&S BMP.

The permit requires sediment traps for projects between 3 and 5 acres and sediment basins for all projects greater than 5 acres. In Berkeley County, 98% of the registered area is associated with projects greater than or equal to 3 acres and 96% of the area is associated with projects greater than 5 acres. In Jefferson County 98% of the registered area is associated with projects greater than or equal to 5 acres. As such, the overwhelming majority of registered area has sediment basins installed.

Per EPA guidance, expected sediment removal efficiencies for basins range from 55% to 100% and average 70%. 80% removal efficiencies are assumed in BMP guidance published by California, South Carolina and Massachusetts. In addition to other requirements, the following design specifications applicable to WV sediment basins support an assumption of sediment removal efficiency at the high end of the published ranges:

- Storage volume = 3600 cubic feet/acre of total drainage area
- Perforated risers or skimmers
- 48-72 hour dewatering
- Maintenance of 50% volume in wet storage
- Stabilization(erosion protection) of basin inlets and outlets

The phosphorus removal efficiency of sedimentation structures should be equal to sediment removal efficiency. The required volume and velocity controls and the sealing of ponds to maintain wet storage should provide similar nitrogen removal efficiencies.

Also, planned model revisions include lowering the baseline sediment yield from bare construction land by approximately 40% (see email from Guido Yactayo to VA, WV, PA, MD 8/19/10). Considering the model revision and anticipating approval of increased removal efficiencies, the BAR to PUL mechanism should provide a close approximation of the loading characteristics of CSGP registered area in Phase 2.

Appendix F:
Consolidated Expert Panel Meeting Minutes

Enhanced Erosion & Sediment Control Expert Panel
First Teleconference Meeting Minutes
Tuesday, July 31, 2012

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DNREC	Yes
Dean Auchenbach	PA DEP	Yes
Shirley Clark	Penn State	Yes
Don Lake	NY	Yes
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	No
Tom Schueler, Cecilia Lane	CSN (facilitator)	Yes
Non-panelists: Chris Mellors – Tetra Tech, Norm Goulet – Chair, USWG; Jeremy Hanson – CRC; Jeff Sweeney – EPA, CBPO; Guido Yactayo – UMCES		

1. **Call to Order and Panelist Introductions** Tom Schueler, CSN
Tom Schueler called the meeting to order and thanked panelists for their time and service on the Panel. He gave a brief background of erosion and sediment control (ESC) practices under the Chesapeake Bay Program (CBP). **Tom** asked the participants to introduce themselves and briefly describe their background in erosion and sediment control. **Tom** mentioned that ESC practices were previously approved by the CBP back in 2007 based on a very thin, and old (pre-1990), body of literature. West Virginia requested this new review to evaluate the existing rates for conventional ESC practices and determine appropriate rates for enhanced practices.

2. **Review of the Charge for the Panel, the BMP Panel Review Process and Panelist Responsibilities** (Attachments A and B) Jeremy Hanson, CRC
Jeremy Hanson explained the Bay Program's BMP review process and reviewed the proposed Charge. **Tom Schueler** verified the panelists had received and read the Charge. He asked the panelists for amendments to the Charge. **Randy Greer** asked for clarification that the Panel will also evaluate conventional ESC practices. **Shirley Clark** agreed with **Randy**. **Tom Schueler** acknowledged that all, or most, of the Bay states have revised their erosion and sediment control manuals in recent years. He clarified that "conventional" or "basic" ESC practices are methods or technologies established in the mid-1990s or earlier, and were included in the previous ESC review. Tom explained that "enhanced" practices are more recent and were not part of the available research in 2007. **Jeff Sweeney** emphasized the importance of definitions that clearly distinguish between basic and enhanced

practices. He pointed out that state and local officials must be able to track and report these practices to the CBP in a way that distinguishes enhanced practices from basic. **Jeff** encouraged the panelists to keep this in mind going forward. **Kip Mumaw** observed that enhanced ESC and conventional ESC may sometimes be distinguished at a program level. The panel approved the proposed charge with the noted amendment.

ACTION: CSN and Jeremy to update the charge and send around to the panel (including the correction of removal rates noted below).

3. **Background: How ESC Practices are estimated/simulated in the Watershed Model** Guido Yactayo, UMCES & Jeff Sweeney, EPA CBPO
Guido Yactayo explained how the Watershed Model incorporates various sources of data and described how ESC practices are currently integrated in the model. **Randy Greer** asked how the edge of field load is calculated. **Jeff Sweeney** indicated the model uses a loading factor, building in algorithms further downstream. **Tom** requested a write-up on how erosion algorithms work in the model, if available. **Guido** noted the current loading rate for construction sites as 24 tons per acre per year, prior to any BMPs or attenuation. **Tom** reminded the panel that they can recommend a different loading rate if one is needed. **Jeff** asked the Panel to lookout for information about BMP implementation in the literature. **Kip Mumaw** noted that the removal efficiencies were incorrect on the proposed charge. **Correct rates: 40% for TP and TSS, 25% for TN. Randy** asked what the assumed nutrient concentrations for soil are in the model. **Tom** requested that **Guido** share the nutrient targets with the panel. **Don Lake** expressed concern about the raw loading rate for construction sites in the model. **Rich** mentioned a North Carolina study that found more effective inspection and monitoring at the local level than state level.

ACTION: CBP staff will provide available write-ups of the erosion algorithms used in the Bay Model.
ACTION: Guido will provide the Panel with the soil-nutrient targets (29 lbs-per-acre for nitrogen)

4. **Review of Recent Literature on ESC Practices** Christina Mellors, Tetra Tech
Christina Mellors instructed panelists how to access the SharePoint site, where reviewed literature and administrative documents are shared. She asked the panel to review the surveyed literature and recommend any additional sources or notify her of any errors via email. **Tom requested that panelists review the posted literature and suggest additional literature by August 15th.**

ACTION: Panelists will review the posted literature and suggest additional literature, sending any missing documents to Chris Mellors (Christina.Mellors@tetratech.com) no later than 8/15/2012.

5. **Scoping of Technical Issues to Address** Tom Schueler, CSN

Tom asked the panelists to describe key issues that need to be resolved to determine the panel's recommendations.

- **Tom** mentioned the issue of discount rates for communities without good inspection, compliance and enforcement programs.
- **Rich** suggested compiling a list of standard practices and enhanced practices among the states.
- **Randy** suggested considering regional rates (e.g., E&S controls in piedmont vs. coastal plains).

ACTION: Jeremy will compile a list of standard and enhanced E&S practices from the states' manuals.

6. **Set Next Meeting Date and Adjourn** Jeremy Hanson, CRC

Tom suggested a research workshop the week of August 27th. **Norm Goulet** thanked the panelists for their time and participation.

ACTION: Jeremy will send around a Doodle poll to the panelists for the week of August 27-31.
Adjourned

Enhanced Erosion & Sediment Control Expert Panel
Teleconference Meeting Minutes
Wednesday, August 29, 2012

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DNREC	Yes
Dean Auchenbach	PA DEP	Yes
Shirley Clark	Penn State	Yes
Don Lake	NY	No
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	No
Bruce Young	St. Mary's SCD	Yes
Tom Schueler, Cecilia Lane	CSN (facilitator)	Yes
Non-panelists: Chris Mellors – Tetra Tech, Norm Goulet – Chair, USWG; Jeremy Hanson – CRC;		

Welcome and introduction Tom Schueler, CSN

Tom Schueler called the meeting to order and thanked the panelists for participating.

1. **Refined definition of "traditional" and "enhanced" ESC practices**

Jeremy Hanson, CRC & Tom Schueler, CSN

Jeremy Hanson and **Tom** explained the draft table that serves as the strawman comparison of traditional and enhanced practices requested during the 7/31 call. They noted that **Randy Greer** and **Don Lake** provided some feedback before it was distributed to the panel. **Tom** opened the floor for comments and thoughts on how to improve the table.

- **Randy** asked what happens when a state has a mix of practices that fall under different columns of traditional or enhanced. **Tom** replied that the classifications are a general guide. So if a state mostly meets enhanced criteria, but has an outlier – e.g. 14-day stabilization– then it makes sense to still classify the overall set of practices as "enhanced."
- **Bruce Young** commented that stabilization offers the greatest, and most cost-effective, erosion control; he suggested giving a greater weight to stabilization. **Bruce** also recommended adding phasing to the list of practices. **Tom** agreed with Bruce's suggestion about weighting certain practices, but pointed out that phasing is difficult to express numerically.
- **Tom** directed attention to the "enhanced" column and asked if there were any missing or redundant entries. **Tom** and **Jeremy** agreed with **Rich McLaughlin**, who noted that polymer and chemical practices should better distinguish between passive application and active treatment. **Rich** also asked for clarification or criteria on "high performance." For example, North Carolina requires settling >70% of <40 micron particles. Delaware, Maryland, Virginia, and West Virginia do not have particle-size or similar turbidity standards. **Shirley Clark** pointed out it's possible to achieve a similar standard through dewatering time and other engineering specs.
- The panelists agreed that the 1.0" traditional practices are prerequisites for enhanced practices, i.e. the basic controls are needed in order for enhanced practices to go "above and beyond."
- **Dean Auchenbach** observed that inspections and maintenance are necessary; without in-field implementation and verification an ESC plan is fairly hollow. Other panelists echoed Dean's concern. **Megan Grose** pointed out that West Virginia requires daily inspections under certain conditions. **Kip Mumaw** noted that the panel should be careful not to contradict EPA's or other regulations for inspection or compliance. **Tom** agreed that Kip's concern is important to consider, and that it will resurface when the panel discusses the reporting, tracking, and verification part of the charge.
- **Dean** commented that PA used the language for inspections following a "stormwater runoff event" as opposed to a "rain event" or "storm event;" the former accounts for snowmelt, which also affects E & S controls. **Megan** also noted that "weekly inspections" could be less frequent than intended, which is why WV defines its inspection frequency at "every seven days" instead.

ACTION: Tom and Jeremy will revise the table based on the panelists' comments and share the updated version by 9/7.

2. Status of Literature Review Christina Mellors, Tetra Tech

Chris Mellors noted that a couple articles were added after the last call, but nothing new was received in last two weeks. **Rich McLaughlin** suggested that more of **Al Jarrett**'s work needs to be added to the list.

Randy asked for clarification about the representation of bare construction loading rates in the model. Since there were no modelers on the call, **Jeremy** promised to share available documentation with the panelists and ask for at least one modeler to join the next call. **Megan** pointed out that the new Land Use workgroup might also be interested in the construction land use issue; she will be participating on the group, so she will bring the issue to the workgroup's attention. **Tom** encouraged panelists to provide new or missing studies within two weeks so that the body of literature is as comprehensive as possible going forward. **Tom** encouraged panelists to set a goal of reading 5 or 10 papers before the next call. **Jeremy** agreed to create a sign-up sheet for the literature to help the panelists choose their articles without duplication of effort. **Tom** requested the panelists to provide 2-3 PowerPoint slides, or a 1-page bulleted list, that summarizes the relevant findings from the panelists' selected literature; each panelist would share his/her slides or summary during the next conference call.
ACTION: Chris and Al Jarrett will make sure that Dr. Jarrett's relevant work is more fully represented on the Lit Survey spreadsheet; full articles preferred, but at least missing citations will be added.

ACTION: Jeremy will consolidate the current model documentation for bare construction sites and share the information with the panel.
ACTION: Panelists are encouraged to send additional or missing literature by 9/12 to Chris (Christina.Mellors@tetratech.com) or Jeremy (jhanson@chesapeakebay.net); studies can still be accepted after this date.

ACTION: Jeremy will send a literature sign-up sheet to the panel; each panelist will sign-up for 5-10 studies. After signing up for their 5-10 articles, each panelist will compile 2 or 3 slides (.ppt), <u>or</u> a 1-page bulleted list (.doc), that summarizes the key points/findings from the studies that relate to the Panel's charge. The slides/list should be ready for the next call.

3. Research Presentations

Post-meeting note: All presentations are available on the ESC Panel's Share Point. In the "Admin and Meeting Notes" Folder, select "2012-08-29 Meeting;" this folder contains the "Presentations" sub-folder along with other materials. This call summary provides a brief snapshot of the presentations, and focusing on key points of discussion rather than information presented on the slides. Consult the presentations for details.

Albert Jarrett, Rich McLaughlin, and **Shirley Clark** each gave presentations on research on the effectiveness of various erosion and sediment controls.

- **Al** focused on his own 15+ years of research on design parameters of sediment basins; he included data on the performance of dewatering devices (e.g., skimmers and perforated risers), linings, geotextiles, etc. [slides 30 and 31 summarize most key items from the presentation]
    - Experiments with lined sediment basins found that roughly ½ of sediment is from the basin itself (24% resuspended sediment from previous storms; 24% from basin walls).

  - **Al** noted that he didn't have any research data on grassy/vegetated basins, but he believes that these are much better than standard basins.
  - He also described studies with delayed dewatering times, but pointed out that the technology for this technique is still experimental, though it displays promising results (e.g., 7-day lag captures almost all sediment).
  - **Al** pointed out that it's possible to achieve 100% sediment removal if you dewater entirely though infiltration, but this depends on local soils.
  - **Rich** commented that in basins with permanent pools, the clean water is pushed out first, which improves removal rates.
- **Rich** described various approaches to inexpensively improve E & S controls
  - He provided examples of how/why/when traditional practices often fail, and how they can be improved or installed/maintained properly.
  - **Rich** also discussed simple, cost-effective ways to use chemical flocculants or coagulants to supplement or enhance traditional practices; he provided data from the literature on performance.
  - He emphasized that passive controls don't work if the runoff does not pass through the treatment zone, or if the practice is not maintained.
- **Shirley** focused on the treatability of sediment and nutrient erosion from construction sites [slide 26 outlines the key points]
  - She summarized some of the (limited) literature on nutrient and sediment loading rates.
    - Soil disturbance breaks bonds between nutrients and the soil, thus increasing nutrient release to nearby waters.
    - Phosphorous capture is more feasible when soils have higher Al or Fe content.
  - She pointed out that many of the E & S controls display impressive removal rates when installed by researchers for experimental purposes; the same practices on actual construction sites display poorer results.
- **Tom** thanked Al, Rich, and Shirley and opened the floor to the panelists for Q&A on the research presentations.
  - **Bruce Young** asked **Shirley** about nutrient losses associated with depth of construction disturbance soil horizons and top soil removal.
    - **Shirley** wasn't sure of the numbers off the top of her head, but commented that there fewer nutrients the deeper you go.
    - **Bruce** noted that many construction sites go well below the top soil and that there this is very little nutrient content at 20-50 ft depth.
  - **Randy** asked for clarification about potential toxicity concerns with cationic, anionic, and non-ionic polymers.
    - Panelists agreed that anionics appeared to be less toxic than cationic; **Rich** noted research showing that non-ionic polymers are less toxic than anionic.
  - **Tom** asked the three speakers (a) if they've collected any data on the escape of nutrients in/out of sediment basins or construction sites, and (b) if they felt that other BMP performance literature (e.g., post-construction wetlands) might serve as an effective analog to determine nutrient removal rates.
    - **Shirley** responded no to (a), yes to (b)

  - **Rich** has done monitoring related to (a), but felt reluctant about (b) since the soil chemistry and biology might be much different for post-construction BMPs. He noted nutrient data is intensive to collect, and it is often seen as a non-issue given low-nutrient content in soil. He described a student's ongoing research showing lower nutrient losses than expected. He will try to locate more data.
  - **Tom** noted plans to ask the Urban Fertilizer Management panel to look at this issue as well.

4. State ESC program presentations: recent changes to state/local programs

Tom explained the intent of the presentations as a way to capture the evolution of the jurisdictions' erosion and sediment control programs in recent years. **Randy** (DE)**, Dean** (PA)**, Bruce** (MD)**,** and **Megan** (WV) presented on their respective state programs. **Don Lake** and **John McCutcheon** were unable to attend, but provided written descriptions of New York's and Virginia's programs, respectively, which are available in the "presentations" folder described above. Some presentation highlights include:

- DE's ESC handbook was rewritten in 2003; the State is rewriting its sediment and stormwater regulations in 2012 and will update its 2003 ESC handbook accordingly; DE offers a "blue card" program to teach foremen E & S basics.
  - **Tom** asked **Randy** about E & S differences as a jurisdiction on the Coastal Plain; **Randy** noted that it's easier to control sediment loss than in the Piedmont region (the Plain has coarser sediment), but there are still problems related to fine particles.
- PA's recently revised stormwater rule (Chapter 102) strengthened numerous ESC requirements, e.g. 102.5 requires a preconstruction meeting.
- WV requires "advanced" BMPs – e.g., flocs/polymers, skimmers/baffles/forebays, phasing, etc. – in Tier 3 segment areas.
- MD revised its ESC manual in 2011 (first revision since the 1994 version); the new specs take effect on January 9, 2013; stabilization period reduced from 7-14 days to 3-7 days.

5. Discussion

Tom asked everyone to consider what they learned during the day; based on the lessons learned, he asked each panelist to describe the headlines and how to meet the charge.

- **Randy** was surprised to learn how efficient some of the practices (e.g. basins) could be, when installed and maintained properly.
- **Kip** echoed Randy. **Kip** also added that the panel should consider site characteristics; when certain practices are appropriate, and look hard at real-world considerations and discount accordingly.
- **Megan** noted that bare land use loading rates are a major issue going forward; the panel should start compiling info about nutrient and sediment rates from construction sites.
- **Rich** agreed with Megan. He felt that the current 24 tons/acre-year is probably too low if it excludes BMPs, too high if it includes E & S controls.

- **Norm Goulet** observed that maintenance and loading rates are two key components moving forward; he expressed concern about the perceived lack of information on nutrients.
- **Bruce** pointed out that the urban element of the WIPs assumes construction is a non-issue since it is regulated, which may be a very poor assumption given everything discussed by the panel. He asked how the panel might affect the 2017 model refinements. **Tom** agreed with Bruce's concern and noted that the issue certainly falls within the purview of the panel. **Tom** mentioned that the Urban Stormwater Workgroup plans to discuss stormwater requests and priorities for 2017 model refinements at its 9/18 meeting; he encouraged interested panelists to attend that conference call.
- **Dean** echoed the importance of proper installation and maintenance.
- **Tom** relearned that sediment basins can themselves be a source of sediment; he also noted that all the states are making progress in their ESC programs, though they are taking slightly different approaches.

6. Set Next Meeting Date and Adjourn Jeremy Hanson, CRC

Tom restated the general idea of the next call: to discuss the reviewed literature and to build on today's conversation and themes. **Norm Goulet** thanked the panelists for their time and participation

Adjourned

Enhanced Erosion & Sediment Control Expert Panel
Teleconference Meeting Minutes
Monday, October 15, 2012

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DNREC	Yes
Dean Auchenbach	PA DEP	No
Shirley Clark	Penn State	Yes
Don Lake	NY	Yes
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	No
John McCutcheon	VA DCR	Yes
Bruce Young	St. Mary's SCD	No
Tom Schueler, Cecilia Lane	CSN (facilitator)	Yes
Non-panelists: Chris Mellors – Tetra Tech, Norm Goulet – Chair, USWG; Jeremy Hanson – CRC; Jeff Sweeney – EPA, CBPO; Gary Shenk – EPA, CBPO; Guido Yactayo – EPA, CBPO; Neely Law – CWP		

1. Call to order

Schueler introduced Neely Law and explained the Center for Watershed Protection's (CWP) new role as the Chesapeake Bay Program's Sediment/Streams Coordinator. **Law** mentioned that Bill Stack, Sadie Drescher, and Lisa Fraley-McNeal (all CWP) are working together with Law as the Coordinator.

2. Discussion of traditional/enhanced practices table

(Attachment B)

Schueler described the purpose of the table to show and define three different levels of erosion and sediment control: the first level that resembles pre-2000 programs; a second level that resembles most jurisdictions' current requirements, and a third level that goes above and beyond current efforts to treat construction site runoff. **Jeremy Hanson** and **Schueler** described some of the changes in response to comments on the previous conference call (8/29). Highlights from the discussion are summarized below, followed by an overview of the suggested and accepted changes.

Schueler asked for suggestions how to separate "protect perimeter areas and retain sediment on-site" into three categories. **McLaughlin** and **Greer** suggested the third level should be "silt fence plus additional filter." **Lake** mentioned that a vegetative buffer plus a silt fence would also work.

Construction phasing:

- **Grose**: West Virginia doesn't require phasing
- **Lake**: New York requires phasing for all projects, but written authorization for projects of 5 acres or more of disturbance

- **Greer**: Delaware's new proposed regulations would limit the maximum area of disturbance at a given time
- **Schueler** summarized that perhaps the second column would be a level of review and the third tier would be a limit on disturbance
- **Sweeney** noted that throughout documentation, need clear definitions of these requirements and what acreage they apply to
- **Sweeney**: would jurisdictions be able to report by level?
- **Schueler**: probably. Each jurisdiction would be a mix of the categories and levels. For example, they could report *x* acres of a practice at level 2; the panel still has to work out and finalize the approach.
- **Sweeney** explained when information is unavailable when reported, typically take lowest level by default. He asked the panel to be aware of this so it can define the default levels and rates accordingly. **Schueler** thought they could have an appendix that specifies how the levels compare to each state's erosion & sediment control standards; this could set the defaults

Protect/avoid natural resources:

- **Grose**: should we include default/minimum definition of buffers?
- **Schueler**: want to be careful, use language that doesn't supersede or conflict with states' definitions of buffers
- **McCutcheon**: assume vegetated buffers? Undisturbed?
- **Greer**: language needs to be consistent with general permits

ACTION: Hanson will look at EPA's draft construction general permit and identify areas of the table that should be adjusted.

Sediment retention structures:

- **Grose**: need to be a skimmer or could a standard riser also meet the second level?
- **Greer**: may need to check general permit on this issue too, make sure the second level is consistent with the general permit
- **McCutcheon**: Where would basins with baffles fall? Between 2nd and 3rd columns?
- **McLaughlin**: North Carolina has two requirements: surface outlet and baffles
- **Lake**: was there a proposed percentage to replace "x%"?
  - **McLaughlin** noted that North Carolina set a standard of 70% of 40 micron particles, but documentation is unavailable for that calculation.
  - **Schueler** agreed to revisit this issue and propose some alternate language.

Grose noted that West Virginia reviews the permits at state level (excluding 1-3 acres), and this was one of the reasons for their request to review the BMP. **Schueler** understood and noted that permit review by a state or local official would be considered a qualifying condition for credit.
ACTION: Hanson will ensure "level 2" practices are consistent with minimum construction general permit standards

The following changes to the table were suggested and accepted:

- Replace 0.5" and 1.0" with 1800 ft^3/acre and 3600ft^3/acre, respectively
- Remove the 280 NTU's label from column 3;
- Other changes by row:
  - Protect/avoid natural resources: clarify the language
  - Protect/avoid steep slopes: remove
  - Stabilize soils: change 2nd column to read "stabilize w/in 7-14 days"
  - Sediment Retention Structures: add perforated risers along with permanent pools

3. Nutrient data from construction sites McLaughlin

McLaughlin described the data he sent to the panel. He noted the numbers are not annualized and the number of storm events varied by site. **Shenk** pointed out that it's important to consider baseflow movement of nitrogen too. **Schueler** mentioned that a lot of the erosion is from very low soil horizons with low nutrient content.
ACTION: Tom, Jeremy, and Rich to consolidate the nutrient runoff data and make the appropriate conversions.

4. Discussion of loading rates and the Watershed Model

Shenk explained the Phase 5.3 was first version of the Watershed Model to include construction land use; tried to get a better picture of the state by state total disturbed area in 5.3.2. For sediment, there were three literature surveys used to determine the median value of 40 tons/acre-year. Assuming 60% of construction area is disturbed, the sediment rate was set at 24.4 tons per acre per year.

- **Greer**: constant rate across the watershed or vary by jurisdiction?
- **Shenk**: constant, but can adjust based on panel's recommendations. He confirmed that the loading rate reflects what leaves the site, without BMPs.
- **Greer** asked if any of the three studies used actual monitoring data or used RUSLE analysis. **Shenk** was unsure; the person who originally reviewed them for the CBPO no longer works there.

ACTION: Schueler and Hanson will find the core references and upload to Sharepoint.

- **McLaughlin** observed the numbers seem higher than his field monitoring results; RUSLE always underestimated, by far, what he found. He theorized that the water conveyances produce much of the sediment (80-90%), which aren't included in RUSLE.

ACTION: Clark, Schueler, Hanson and McLaughlin will update the table (Attachment C)
Sweeney: make sure the jurisdictions' data is consistent with the loading rates (disturbed area or total project area, etc.). **Schueler** agreed that for the next call panelists can describe what jurisdictions currently report (disturbed area, etc.).

5. Reading reports

Lake and **Grose** described the highlights from the studies they reviewed; their summaries are available on the Sharepoint site in the "Panelists Reading Reports" folder for the October 15th call. Their summaries capture the findings from the studies; key points from the discussion are as follows:

McLaughlin commented that the Kalainesan et al (2008) study had a questionable sampling structure; it is otherwise a great paper with useful information, but surprised it was published. He also suggested if an article doesn't have information relevant to the charge, then it does not need to be reviewed by the Panel.

Lake asked how the panel will divide up the remaining articles on the list. **Schueler** suggested that panelists who have not yet signed-up will sign-up for their share articles; CSN (Tom & Cecilia) will take 10 of the ones left; Hanson will take the rest.

6. Discussion of Qualifying Conditions and Reporting, Tracking & Verification

Schueler explained part of the charge is consideration of reporting, tracking, and verification; there is a difference in most states between MS4 and non-MS4 areas. Some panels apply a discount, others require qualifying conditions. He asked for the panelists' preliminary thoughts on the issue:

- **Greer**: Delaware is unique as a small state that is able to centrally manage its permitting; delegate some review to local agencies; system is mainly complaint driven.
- **Clark**: From teaching and education standpoint, expect to find there's less data out there than we think there is; choose to defer to **Auchenbach** for the regulatory perspective.
- **Lake**: New York has a few layers of inspections: contractor inspections (daily, and after rainfall events), and someone onsite who's gone through DEC training, plus weekly compliance inspections (NYS DEC, local agency, MS4, etc.) weekly that have to be filed with DEC or local municipality, must keep reports on site. A lot of oversight in MS4 areas; DEC staff are charged with oversight of non-MS4 areas. New York has very detailed scrutiny.
- **McCutcheon**: pretty much every county/city has an ESC program at a local level. Sites have to be inspected at least once every two weeks, and within 48 hours after a rainfall event. Virginia's handbook is relatively out of date, but the state has focused heavily on the permit review process. He estimated about 85% of local programs are able to meet the state's expectations/requirements (has fallen somewhat from 90% as a result of recession); this was an improvement from about 20% when the efforts began. The biggest problems are the areas without much practice or experience with construction; there is more incentive to be more lenient with developers in these areas.
    - **Schueler**: does 85% of communities seem consistent with other jurisdictions?
        - **Greer** felt DE is at that level; there's no difference between the MS4 and non-MS4 areas in DE, since they all have to meet the state's requirements
        - **Grose**: pretty comfortable with level of inspection and review in MS4 areas, given level of state oversight; hard to say what the percentage would be

    - **Lake**: New York's system has evolved to be pretty solid
- **McLaughlin** offered no comments on the issue
- **Jarrett** observed the system is too big and too complex to reasonably think that the performance is as good as expected

Enhanced Erosion and Sediment Control Expert Panel
Teleconference Meeting Minutes
Monday, January 28th, 2013

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DE DNREC	No
Summer Kunkel	PA DEP	Yes
Shirley Clark	Penn State	Yes
Don Lake	SUNY-SESS	Yes
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	Yes
Bruce Young	St. Mary's SCD	Yes
Tom Schueler	CSN (facilitator)	Yes
Non-panelists: Norm Goulet – Chair, USWG; Jeremy Hanson – CRC, CBPO; Jeff Sweeney – EPA, CBPO; Matt Johnston, UMD, CBPO; Guido Yactayo – EPA, CBPO; Neely Law – CWP		

1. Call to order

Tom Schueler convened the meeting at 2:00PM, verified participants and reviewed the agenda. **Summer Kunkel** explained that she will be replacing Dean Auchenbach as PA DEP's representative on the Panel.

2. Review of meeting minutes & action items from October call

Jeremy Hanson summarized the status of the action items from the October 15th conference call, noting that he and Tom will continue to work on the lingering items.

3. Review of Possible Areas of Concurrence and Framework for Final Report

Schueler described Attachment B and asked the panelists for feedback. Below are some highlights from the Panel discussion.

- **Shirley Clark** explained that the data used in Table 4 was from a soil survey on native soils in central Pennsylvania.
- **Kip Mumaw** agreed with the general definition. He suggested that the loading and runoff rates would ideally be tied to local conditions. There was a journal article (Boomer and Weller) that argued RUSLE may not be accurate predictor of erosion in the Bay watershed. **Post-meeting note**: Boomer Weller Jordan (2008) has been added to the Panel Sharepoint site under "Documents."
- **Bruce Young** felt that the runoff does not necessarily run through a series of practices, but only into one individual practice. The O Horizon may have higher nutrient levels, but erodes less frequently. He noted the literature demonstrates that PAM is effective at reducing erosion, but he needed more information about

polyacrylamide's impact on receiving waters; this was why Maryland left PAM out of its last design manual.
- **Megan Grose** pointed out that some practices, such as temporary stabilization, timing, and maintenance, are not visual.
- **Clark** did not feel percent removal efficiencies were very useful. Schueler agreed, since extremely high influent rates can skew the efficiency.
- **ACTION**: If the panelists have additional studies, suggestions, or corrections for Attachment B, they should send them to Jeremy and Tom.

4. Reading reports/literature reviews

Schueler explained that the literature reviews may be combined into some form of annotated bibliography for the final report. The literature reviews are available for the panelists' review on the Panel's SharePoint site. Since he was absent from the call, Randy Greer provided some thoughts via email, which are included at the end of this section. Below are key points from the discussion.
- **Al Jarrett** agreed with **John McCutcheon** that introducing and using PAM can take a lot of effort and is often impractical.
    - **Clark** and **Young** also felt that the panel should be cautious about advocating the use of PAM.
- **Rich McLaughlin** clarified that the McLaughlin & Zimmerman (2008) article was a manual for active treatment systems, primarily on the west coast, and should not be confused in the discussion with passive application of PAMs. He also suggested differentiating between erosion studies, control basin studies, and studies on real construction sites.
- **Decision**: The panel agreed that there should be a fourth performance level for programs that require active treatment systems to meet very low turbidity standards.

Schueler asked if there seemed to be any articles missing from the literature review. He explained that completing the literature review is a tremendous step for the Panel; now the panel can move on to deliberating and defining its recommendations and conclusions. **McLaughlin** noted that he has four manuscripts, but there were no other comments.

ACTION: Panelists should send new studies to Jeremy if they discover any more that are relevant.

Thoughts on the literature from Randy Greer (via email, 1/28/2013):
1. Sediment and pollutant load data from construction sites is highly variable (no surprise!)
2. There doesn't seem to be any statistically significant correlation between sediment & nutrient loads from construction sites
3. The benefits of chemical additives such as PAM seem to be inconclusive, but I have personally seen that it can be very effective if used properly. We helped develop a mix of PAM and ag gypsum for use in Delaware (which ACF now markets under the "Pond Clear" name) which has worked well here
4. One of the studies (I can't remember which one it was and I don't have access to it from home.......Line et al maybes?) was more of a stormwater runoff study

than a ESC study, so probably is not relevant to this panel though it was an interesting paired watershed study with over 5 years of stormwater runoff data
5. One of Rich McLaughlin's studies assessed the performance of various traps and basins in the mountain, Piedmont and one from the coastal plain of North Carolina. Only one event created a discharge from the coastal plain basin since the soils were so permeable. This supports my belief that ESC practice efficiency is at least partly dependent on the geographic province.

Follow-up notes from Al Jarrett (via email, 1/28/13)**:**
In Attachment B, Table 2, the line from Kalainsan, 2008 the efficiency should be 75%, not 15%. In Table 3 at Bharduaj, 2008, the efficiency should be 33%.

I am always concerned about using percentages to reflect how well BMPs work. Percentages are based on the "base", which greatly affects the results without necessarily improving the results. Until we start thinking in terms of discharge standards (in my opinion these should be in NTUs because they are easier to measure in the field) we will always be guessing at the desired results. Someone needs to set a "discharge standard" such as 100 or 200 or some other number of NTUs in the site discharge and everyone else is in violation.

Lastly, I think we can do the job of regulating site discharge to receiving waters without requiring that a chemical treatment like PAM be used everywhere. Implementing and applying PAM to every construction site seems unnecessary to me and there are still too many unanswered questions about this technology. Rich McLaughlin is probably the best person to answer questions about this technology.

5. Proposal for Data and Program Analysis

- Derivation of Construction Site Runoff Coefficients
    - **ACTION**: Schueler asked Clark to review Pitt's runoff coefficients.
    - **Don Lake**: has anyone taken a good look at standard hydrologic methods to use construction ground runoff curve numbers for the hydrologic soil groups, i.e. more site-specific analysis instead of a generalized approach.
        - **ACTION**: Schueler and Lake will look at this in more detail before the next call.
- Nutrient Loads and Concentrations
    - **ACTION:** Schueler and Hanson will continue to build on the nutrient load and concentration data
- Matrix of ESC Construction Site Sediment Loads/Concentrations
    - **ACTION:** Hanson and Schueler will continue to compile and refine this information from the literature.
- Matrix of effect of ESC practices, sorted by ESC practice level
    - **ACTION:** Hanson will add a fourth level, as agreed by the panel.
- State program assessment template, including program evolution, current Level assessment

- **Hanson** described the draft state ESC program assessment template developed by himself and Schueler. The answers will help compile a table that compares the program requirements across the jurisdictions.
- **Young** noted that there are different inspection requirements for self-inspections and regulatory inspections. **Schueler** agreed to divide the question into two, one for regulatory and one for self-inspection requirements.
- **ACTION:** Schueler requested that panelists representing jurisdictions fill out the Assessment, either via Survey Monkey or using the Word document.

6. Discussion of next steps and remaining schedule Schueler/Hanson

- **Schueler** felt that the panel may only need a couple more meetings, depending on the ability to reach consensus. He commended the panelists for their time and progress thus far.
- **Goulet** thanked the panelists for their work and agreed that they have made a lot of progress.

Adjourned

Enhanced Erosion and Sediment Control Expert Panel
Teleconference Meeting Minutes
Friday, April 19th, 2013

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DE DNREC	Yes
Summer Kunkel	PA DEP	Yes
Shirley Clark	Penn State	Yes
Don Lake	SUNY-SESS	Yes
Rich McLaughlin	NC State	No
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	Yes
Bruce Young	St. Mary's SCD	Yes
Tom Schueler	CSN (Coordinator)	Yes
Jeremy Hanson	CRC, CBPO (Facilitator)	Yes
Non-panelists: Norm Goulet – Chair, USWG; Jeff Sweeney – EPA, CBPO; Matt Johnston, UMD, CBPO; Guido Yactayo – EPA, CBPO; Neely Law – CWP		

1. Call to order

Tom convened the meeting at 1:00PM, verified participants and reviewed the agenda.

2. Review of meeting minutes & action items from January call

Jeremy summarized the status of the action items from the January 28th conference call. Tom will follow-up with Lake and Clark on runoff coefficients as the one lingering action item.

3. Review of State ESC Program Matrix

- Bruce noted the states were not ranked level 1, 2, or 3 on a consistent basis. Tom and Jeremy agreed, noting the panel still has to discuss the state programs. The panel will determine the level for the states at the next meeting
- Tom: summary of the table will be in intro section of the report and the full version of the table will serve as an appendix.

4. Review of Write-up on how construction sites are simulated in the Watershed Model

- **Bruce**: Does it account for time of year when there is more erosion?
    - Tom: it is explicitly simulated with daily rainfall events.
    - Jeff: for precipitation the simulation is hourly. The more intense the land use, the more runoff.
    - Kip noted the localities don't track or report the time of year for the construction.
    - Johnston: WV's data does include dates for when the site is active.
        - Grose: Those are the dates the permit was issued and closed. Just because they received the permit, it does not mean they've started construction.
- Tom directed the panelists' attention to Figure 1. The same basic concept was used in the stream restoration report. It illustrates that 70-85% of sediment washing off construction site doesn't make it to the Bay, as it is deposited in floodplains, etc.
- Tom: Some of the other panels deal with site or project specific BMPs. For construction sites the states aggregate totals under their general permits.

5. Proposed options for ESC reporting, tracking, and verification

- Tom noted that going forward the CBP expects every BMP to be associated with a verification element to ensure the numbers are accurate and the BMPs are installed and functioning. Unlike other urban practices, ESC on construction sites are an annual practice. Furthermore, states are not reporting individual construction sites, but aggregate totals of disturbed or permitted acres.
- Tom asked if that was true of the Bay states. Do they have some kind of system to collect the number of acres under the construction permits?
    - DE, MD, WV, PA, and VA have reporting systems already in place through their CGP/NOI.
- Tom described the proposed breakdown for compliant and non-compliant sites.
- The states would assume that a certain percentage of a state's construction sites are "noncompliant" and would get no credit (15% based on previous discussions).
- **The panel will need a more explicit definition of non-compliant vs. significant violations.**
- Thoughts from the states:

  - Randy: A number of sites will be out of compliance at any given time. Not sure if more inspections necessarily changes the compliance rate or performance.
  - Megan: Agree with Randy. Struggling with the concept of the percent of sites. A single inspector can focus on a small number of larger sites or a large number of small sites. Perhaps inspections could be weighted by the acreage covered. Also, a site should not be considered non-compliant just because it is under the permitting threshold.
  - Bruce: Compliance inspections depend on whether the site is in a delegated or non-delegated county in Maryland. Continued minor non-compliance can add up to more significant problems.
  - Don distinguished between minor noncompliance (paperwork) vs. major noncompliance (WQ violation). Whether a discharge occurs is the significant aspect from perspective of the model.
  - Summer: this is something we're working on with our SCDs here in PA, so they recognize more significant violations and distinguish them from less significant violations.
- Tom noted that everyone agreed with the Water Quality Violation approach, which will be defined in the report.
  - Will include photos of violations in appendix.
  - **Panelists to share pictures of serious violations for use in the appendix.**
- Tom asked panelists for their thoughts on a threshold for larger storm events where model would not offer credit, or offer reduced credit. If so, what would it be: 2" or 3" etc?
  - Jeff: if the panel recommends it, we could reduce the effectiveness of the practices when there are extreme events. We do not reduce effectiveness down to zero.
  - Randy: it seems like an issue we should address to some degree.
- Tom noted that even if a CGP requires weekly inspections, there's a question whether they are happening or not, or whether connections (to water quality) are being made.
  - Megan: even if they are doing the inspections, it's a question if they are making the corrections.
  - Bruce: In Maryland, a log book has to be kept of self-inspections and inspectors are supposed to check the log.
- Tom: **we'll include a section in the report with case studies on some of the more effective inspection programs.**
- John: It would be useful to have a Baywide standard to distinguish minor violations and water quality violations. Not every site that is noncompliant or every violation is a water quality violation.
- Megan: looks like we could get the same information from attachment E.
  - Tom asked the other state panelists to do likewise.
  - **State panelists to talk with compliance departments and submit compliance data for ESC.**

- Bruce: believe significant violations are defined as where there are documented discharges to waters of the state.

6. Further discussion of areas of concurrence memo

- Tom: spent some time looking at the fertilization rates and specs for stabilization in the Bay states. The rates were surprisingly high.
- Tom reviewed comparison for sediment, nitrogen, and phosphorous loads using different methods or approaches. He noted the Simple method is likely an underestimate since it estimates storm flow loads only, not base flow loads.
    - He also described some potential pathway approaches.
- He asked for the panelists thoughts on nutrients.
    - Bruce: probably do not see a lot of nutrient reduction from ESC controls. Once the top soil is stripped and cleared it is a matter of sediment.
    - Randy: struggling with removal efficiencies, perhaps we could develop unit loads instead. Think it would be easier to incorporate into the model.
    - Jeff: we would take the recommended load and turn it into a reduction rate. We want to quantify the benefits of additional management actions. The panel can make recommendations for this version of the model and other recommendations for the next version.
    - Shirley: would be hesitant to say that the lower horizons are lower contributors.
    - Megan: Based on experience with hydroseeders, don't expect inspectors are checking those rates or application. They often just spray everything, including rocks.
    - Matt: if the panel finds that construction and hydroseeding actually account for large influxes of nutrients, it could be interesting to see how that affects urban loads in the next version of the model.
    - Megan: do any of the regional universities are interested in looking into these topics?
    - John: would vote for the zero removal idea. Virginia's controls were never developed for nutrients, only sediment.
    - Shirley: most of the nutrients, if they associate with sediment at all, will associate with the finer particles that are not contained by most ESC practices.
- Sediment. Tom noted the current Rv being used is 0.50, he will need to verify that Rv is closer to impervious cover Rv.
    - Randy: not sure they are the right numbers yet. Not sure which number is off, but something doesn't seem right.
- Q from panel: Rather than just having storm depth, is there a way to flag rainfall intensity?
    - **Jeff and Guido will look into rainfall intensity vs. storm depth and report back to the group**.
    - **Shirley will look into the data, believes there is a study that looks at intensity.**
- Don: have some calculations to share with the panel. About 50-60% of annual soil loss can occur in a 2-3 month period.

  - **Don to provide a copy of Rv calculations to Jeremy for distribution to the panel.**

7. **Review of decision & action items and set next meeting date**
   - Tom asked panelists what they felt they need to help complete the report.
     - Megan: pleased with the direction so far. Need to come up with some final numbers and definitions.
     - Randy: nailing down the hydrology for the annual runoff from construction sites. Like the approach of backing up from load and deriving a reduction rate.
     - Summer: feel the compliance criteria should be consistent with state programs.
     - Shirley: Feel we're on the right track.
     - Don: Sediment that leaves the site can be a catalyst downstream for pollutants that attach to sediment.
     - Bruce: Still concerned about proximity to water bodies. The runoff coefficient should probably be higher for construction sites.
     - John: a failure of onsite controls can also lead to downstream channel erosion that can result in nutrient loads.
     - Kip: along those lines that nutrients will be difficult to justify a nutrient removal rate. Could be useful to know what percentage of construction sites are not included under the permit thresholds.
     - Al: think we're on track. First, need to get the hydrology right.
     - Matt: can expect feedback from the workgroups if there are changes to the efficiencies, particularly if the panel determines there isn't enough science to justify nutrient removal.

Adjourned

Enhanced Erosion and Sediment Control Expert Panel
Teleconference Meeting Minutes
Friday, June 14th, 2013

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DE DNREC	Yes
Summer Kunkel	PA DEP	Yes
Shirley Clark	Penn State	No
Don Lake	SUNY-CESF	Yes
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	No
Bruce Young	St. Mary's SCD	Yes
Tom Schueler	CSN (Coordinator)	Yes
Jeremy Hanson	CRC, CBPO (Facilitator)	Yes
Non-panelists: Norm Goulet – Chair, USWG; Jeff Sweeney – EPA, CBPO; Matt Johnston, UMD, CBPO; Guido Yactayo – EPA, CBPO; Neely Law – CWP; Joe Kelly – PA DEP		

1. Call to order

Tom convened the meeting at 10:00AM, verified participants and reviewed the agenda.

2. Review of meeting minutes & action items from April conference call

Jeremy summarized the status of the action items from the April 19th conference call. Jeremy noted a couple corrections to the minutes from Don Lake.

3. Review of Draft Panel Report

- Tom described some of the gaps in the current draft of the report.
- He asked each panelist for their initial or general reactions to the draft report
    - Randy: Good first effort. Table 11—a Baywide weighted mean may overestimate the runoff in coastal plain areas (Delmarva)
        - We can determine whether to do rates statewide, by soil groups, or hydrogeomorphic region
    - Grose: WV is 6% shy of 100 in Table 11. Have been in touch with enforcement staff. Unable to collect or report data similar to what was gathered from MDE.
        - Greer: Same for DE. We used to keep those records through early 2000s, but not anymore
        - Grose: we dropped (a) on page 29, second paragraph.
    - Lake: seem to be missing a Table 12 on page 16.
        - Tom noted it was an error in table numbering.

    - Law: could use a little more clarification about 40 tons/ac and 24 tons/ac rates for construction sites.
        - Guido Yactayo: 40 tons/ac would be a site that is completely disturbed throughout the year, without controls. 24.4 accounts for phasing and erosion and sediment control, following the assumptions in the documentation.
- The Panel reviewed some draft definitions. Highlights and requested changes are captured here.
    - Tom: we'll add a sentence that none of the Bay states currently operate at level 1.
    - Tom: We'll keep a level 1 to show comparison between old and new efficiencies.
        - Matt Johnston: historical BMPs could be kept at the old rate or the level 1 efficiency
        - Add sentence that Bay states are operating at level two under their most recent permits and regulations.
        - Add grading units, or phasing limits to disturbance (level 3)
    - Tom asked if any state feels up to level 3
        - Megan: WV has a lot of these elements, though there's no micron levels. Not sure what is meant by "regular basis" for inspections.
    - Megan: add definition for Chemical Treatment Systems and Active Treatment Systems
        - Randy: DE just added flocc into our manual, would that be under chemical treatment systems? Flocculants are usually reserved for problem sites. Not required.
        - Rich McLaughlin: active treatment is chemical treatment. Flocculation is also chemical, but there are passive (gravity driven) and active systems.
        - Kip: For level 2, would this be up to standards of 2012 CGP?
            - Tom: The newest permit would be closer to a level 2.5
            - Kip: suggest that one of the levels should correspond to the 2012 Construction General Permit.
            - **Collapse levels 2 and 3 into one category**
    - Suggested definition: Total permitted area where construction activity will occur throughout the life of the project.
    - Disturbed acres: mention exposed soil, include cut and fill
    - Remove first "construction" from LOD definition
    - Add "and take enforcement actions where needed" to regulatory inspection definition.
    - Tie hydrology and sediment concentrations into "sediment load" definition
    - Non-compliance should be tied to water quality violation for purposes of panel
    - Grose: believe definition of water quality violation is spelled out in the regulations. Could be in compliance with SWPP, but still have a water quality violation.
    - **Each state rep panelist to send definition or narrative of "water quality violation" to Jeremy**

- There is a section of performance of individual ESC practices. Volunteers to draft one or two paragraphs for performance of individual practices.
    - **Jarrett to help draft text on sediment basins.**
- Tom described some considerations and options for sediment discharge rates and efficiencies. He noted for this version of the Model, the sediment load from sites will remain 24.4 tons/ac-yr. Can suggest new rate for next version of the Model.
    - Tom: Most conservative approach for sediment would be to use Rv 0.50 and 2000 EMC for level 1, 1000 EMC for level 2. No final decision on the options today, but asking for guidance on direction and what matches real world.
    - Randy: Option 3 would probably serve same basis as a regional Rv value. Would support diminished efficiencies for storms over 2 inches.
        - Matt: could have different efficiencies based on soil regions.
    - Bruce: We might want 3 different numbers for Maryland: mountain, Piedmont, and coastal.
    - Tom: We could explore that.
    - Randy: The soils would be a surrogate.
    - Johnston: we have tables for hydrogeomorphic and soil groups in Scenario Builder, but would need to investigate options for cross referencing those two tables.
        - **Tom and CBPO staff to investigate this further.**
    - Someone raised the rainfall intensity issue.
    - Yactayo noted the Model simulation for rainfall is hourly.
        - Tom: **CBPO staff needs to investigate the practicality of reducing the efficiency based on intensity.**
    - Kip: Caution for using HSG to derive Rv. Perhaps change them based on site conditions since many sites have had disturbed soils in the past so they may be different soils than when the HSGs were derived decades ago.
        - Jarrett: good point, but not sure how to incorporate it.
            - Tom: We could maybe incorporate it in the runoff coefficient. Perhaps use an empirical value. We'll look into this.
        - Grose: might find that development occurs more often on some soils rather than others. Developers will usually check the soil survey for their NOI, thought there is often more than one soil group is on a site.
        - Should there be a development vs redevelopment category?
        - Tom: caution as we get into the weeds. We need to consider the complexity of the recommendations and the data the states and CBPO are able to collect and report.
- Nutrient data and options for N and P removal rates
    - Tom recalled there was limited nutrient data, and the results were bimodal: some had positive removal rates, others negative. The fertilization rates for growing turf for stabilization suggests there may be a contribution of nitrogen or phosphorous. He suggested the decision should be based on whether the CBWM rates are technically justifiable. He asked the panelists to weigh in on which option they felt comfortable with.

Last time we were leaning towards Option 2, i.e. having no removal efficiency for nutrients.

- Bruce: Still my thought.
- Randy: my thought as well. At least in DE, new development tends to be on Ag lands, so perhaps we should correlate loading rates.
  - Tom: Good point. Will ask modeling team to provide some comparative nutrient loading rates from other land uses, e.g. conventional till row crops.
  - Jarrett noted that some sites are abandoned or idle for a long time before they are disturbed or constructed, so we should be careful.
  - Tom: Can also compare the sediment rates with other land uses, since construction is likely the highest.
- Megan noted there will be much less interest in this BMP if there will be no nutrient reductions assigned to it.
  - Tom: Good point. The panel should also consider potential consequences for their recommendations.
- Bruce: Still think sediment is the primary focus here.

- Tom explained he will be on a 6 week vacation starting next week. Goal is for a more final draft in August, and submit the report to the appropriate workgroups starting in September or October.

4. ESC Reporting and Tracking

- Tom: The old way of estimating construction for any given year has been somewhat crude in the past. Guido has been considering ways to improve the methods with state data.
- Guido Yactayo: construction land use is not measured through satellite imagery. Without data, CBPO has to estimate the land use. Received some data from WV, PA, and MD. Saw the same patterns between disturbed acres reported to the CBP and the change in impervious cover. So we are able to use a ratio of permitted acres to impervious surface change to estimate the construction land use acres for areas where construction data was not provided.
  - Questions or reactions from the panel
    - Randy: so these are methods for looking back?
      - Yactayo: Yes. In absence of additional data we have to go through these methods and apply these ratios. Any available data would be helpful for calibrating the next version of the Model.
        - Randy: we started tracking NOIs in 2001 in DE.
    - Tom: alternative would be to keep it the way it is and not worry about year to year variation of land use. Something for the states to mull over. There are transaction costs for each element of additional data.
      - Randy: not difficult to compile data from NOIs, but there's an issue that not all projects are done annually. Some take multiple years.

        - Megan: we can track when we open and close permits. It's not exact, but we at least know when the permits were opened or closed.
    - Tom asked panelists to think through reporting options, e.g. do we recommend reporting aggregate data every year, or make assumptions and go by averages/trends, etc?
    - Yactayo: for progress runs, we use the actual data submitted by the states and calculated new ratios if there is no data for
    - **Jeremy will contact each state what they currently report, what they would be able to report, and willing to report**

5. Review decision & action items and next steps

- Randy: Comfortable with hydrology element of report. Would like to see relative loads from ag land uses. Report seems 50-70% done.
- In June and July: continue to share any thoughts or information with Jeremy. Will update the draft report in August and convene again in September.

Adjourned

Enhanced Erosion and Sediment Control Expert Panel
Teleconference Meeting Minutes
Thursday, September 26th, 2013

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DE DNREC	No
Summer Kunkel	PA DEP	Yes
Shirley Clark	Penn State	No
Don Lake	SUNY-CESF	Yes
Rich McLaughlin	NC State	No
Dr. Albert Jarrett	Penn State	Yes
Kip Mumaw	Ecosystems Services	Yes
John McCutcheon	VA DCR	No
Bruce Young	St. Mary's SCD	No
Tom Schueler	CSN (Coordinator)	Yes
Jeremy Hanson	CRC, CBPO (Facilitator)	Yes
Non-panelists: Norm Goulet – Chair, USWG; Jeff Sweeney – EPA, CBPO; Guido Yactayo – EPA, CBPO; Neely Law – CWP;		

1. Call to order

Tom convened the meeting at 10:00AM, verified participants and reviewed the agenda. He noted the goal is to reach a consensus on a decision draft in the next month if possible.

2. Review of meeting minutes & action items from June conference call

Tom called for questions or corrections to the June minutes. No comments were raised; the minutes were accepted as written.

3. Review of Appendix A Sediment Loading Calculations

- Tom reviewed the methods and results described in draft Appendix A.
- Don felt comfortable with the numbers used and he had checked the math. He suggested restoring the old level 3. There are enhanced level programs without use of polymers or active treatment systems. New York does not encourage use of polymers except in rare and controlled circumstances.
    - Tom noted he had received that comment from others. However, there is little to no data on how to characterize that level 3 if we restore it. It would have to be best professional judgment.
    - Kip: We could perhaps recommend or require downstream monitoring to earn credit for level 3. Not sure if that is feasible, but it could yield more data or force people to demonstrate their own effectiveness.
    - Neely asked about the runoff coefficients Tom used.
        - Tom explained that monitored and modeled values seem to converge on .35, Baywide. We can come up with a recommended value or a range of values if the Panel wants. The 0.5 Rv was from the Line and White study. The .43 Rv was the midpoint between 0.5 and 0.35.
- Tom summarized that the panelists seem comfortable with keeping this as an appendix.
- There was discussion about a differential rate for the coastal plain.
    - Megan: Would the model itself account for the differential rates, i.e. through regional factors, etc?
        - Guido Yactayo: The EOF would be the same everywhere, unless the panel recommended different EOF targets.
        - Jeff Sweeney: that's right. The regional factors are added to adjust the sediment to meet the monitored loads in the calibration.
        - Kip: would still be open to changing target loads for different regions or coastal plain. Perhaps using the HSGs or RUSLE would help generate estimates.
            - Don: think it is possible to generalize soil types or grouping of slopes.
            - **ACTION: Tom and Don to determine if lower rate for coastal plain would be supported.**
                - Tom: Is necessary data available to generate average K-value?
                    - Don: K-value, probably. Not sure about slope factor.
                    - Kip: NRCS web soil survey characterize a lot of their soils by slope.
- Tom noted that CBPO staff pointed out some modeling issues with the draft recommendations.
    - Sweeney: in the current model we cannot change the rates for the practice since we are measuring changes in management. We can incorporate the new rate for historical practices in the next model.

- Tom noted the level 2 ESC rate is post-calibration and would be ok for this version of the model.
- Megan: question about Pouyat et al (2007). Perhaps work with Tom to better understand where the numbers came from.
  - **ACTION: Tom to double-check the numbers/citations.**

DECISION: The old level 3 will be re-added as level 2.5.

4. Panelist Comments on Second Draft of Report

- Tom asked each panelist to describe what they like, don't like, and need to see addressed for a decision draft.
  - Don: Like the organization and flow of the report. Feel it would be a benefit to add another level between the current levels 2 and 3
    - To clarify, it would be an enhanced version of level 2, but would not be at level 3.
  - Megan: for placeholder BMP Bar-to-PUL, conversion from bare construction to Pervious Urban. The BMP and end result of panel is for no reduction in N and P, which is fine, but we should recognize that sediment is not important for decision makers in the states. Nutrients are the drivers. If the ESC BMP does not provide reductions, then there will be less reason to spend effort tracking or reporting.
    - Sweeney: Correct about the placeholder for milestones and WIPs, which is the patch until this panel makes its recommendations. The placeholder BMP used by WV is Bar-to-PUL.
  - Kip: may be good to include language that recommends monitoring downstream conditions with construction sites. That way a future panel could hopefully have better data to work with. Having recommendations that encourage better data would be smart.
  - Al Jarrett: not much to add. The report seems to capture most of the panel's discussion. Trying to connect all this disconnected research is difficult, but overall in good shape.
  - Summer: we felt it was well organized. Maybe revising the levels to include a 2.5 with passive polymers. …violations…would be good addition to that section.
  - **ACTION: Tom and Jeremy to follow-up with panelists who were unable to call in.**
  - Megan noted that Dave Montali noticed a potential issue with the EOF and EOS loads and plans to speak with CBPO staff on this.

5. Discussion of Remaining Technical Areas to Gain Panel Consensus

- Tom noted he's received enough guidance to develop a level 2.5. Megan and John have identified some areas where the definitions diverge from the states' definitions. Will add some language that these proposed CBP definitions do not supersede the states'.
- Megan**:** when did we discuss and derive the phosphorous rates?
  - Tom believed it was during the April and June calls.

        - Megan noted that from regulatory perspective, will not be able to require monitoring under construction general permit.
            - Tom: we recognize that. We may suggest that states allow local governments to shift focus from monitoring outfalls to also monitoring construction sites.
- **ACTION: Panelists to submit photos of violations**

6. Next Steps to Produce a Decision Draft

- Tom: We will try to get the next draft out in 3 weeks. Will coordinate with Matt Johnston and CBPO to draft a technical appendix for Scenario Builder. Will also work with modelers to run a scenario to assess effects of reduced effectiveness when storms exceed the intensity threshold.
- Jeremy will distribute a poll to schedule the next call in late October or early November.
- Tom thanked panelists for their time and insights.

Adjourned

Enhanced Erosion and Sediment Control Expert Panel
Teleconference Meeting Minutes
Thursday, November 21st, 2013

EXPERT BMP REVIEW PANEL Enhanced ESC Controls		
Panelist	***Affiliation***	***Present?***
Megan Grose	WV DEP	Yes
Randy Greer	DE DNREC	Yes
Summer Kunkel	PA DEP	Yes
Shirley Clark	Penn State	Yes
Don Lake	SUNY-CESF	Yes
Neely Law	CWP	No
Rich McLaughlin	NC State	Yes
Dr. Albert Jarrett	Penn State	No
Kip Mumaw	Ecosystem Services	Yes
John McCutcheon	VA DEQ	Yes
Bruce Young	St. Mary's SCD	Yes
Tom Schueler	CSN (Coordinator)	Yes
Jeremy Hanson	CRC, CBPO (Facilitator)	Yes
Non-panelists: Norm Goulet – Chair, USWG; Matt Johnston – UMD, CBPO; Cecilia Lane – CSN;		

1. Call to order

Tom convened the meeting at 1:00PM, verified participants and reviewed the agenda.

2. Review of meeting minutes & action items from September 26 conference call

Tom called for questions or corrections to the September minutes. No comments were raised; the minutes were accepted as written.

3. Review and Comment of Final Report

- Norm discussed his written comments that he provided Tom. Mainly wanted to make sure that the conclusions and recommendations were included in the executive summary. Also wanted to make sure the interim rate request from WV was directly addressed in the report.
- Tom noted there are a couple adjustments the CBPO modelers requested. Specifically, the effective removal rate (%) would be based on the 12 tons/ac loading rate rather than the current 24.4 tons/ac. The percentage would thus be lower than the numbers in the decision draft. The sediment loading rate would remain at 24.4 tons/ac/yr for this version of the model, but the relative rate would need to be based on the 12 tons/ac/yr.
- Tom reviewed the summary slides of the panel's recommendations, as written in the decision draft. He noted a major change was adding the "functional deficiency" term as suggested by Goulet. Neely had felt the loading estimates were poorly documented in Appendix A, so she suggested adding text to clarify.
- **ACTION: Tom to draft a couple more paragraphs for insertion into Appendix A, as suggested by Neely. Will share text with Panel.**
- Norm: we may need a qualifying condition for level 3, such as passive application of PAM treatments. Should make that an explicit qualifying condition.
- Some concerns and potential mistakes, Table 24, page 33. **ACTION: Tom and Jeremy to double check Table 24 with Bruce, Megan and other state reps.**
- Rich: we just completed a study that monitored nutrient wash off from various construction cover types with 2:1 slopes and were surprised by the low runoff rates, i.e. usually less than 5% nutrient runoff, regardless of cover type. Have the data, which is currently unpublished. The panel should still encourage these studies in the report.
    - Tom: That's encouraging because in our mass balance we used 10% as worst case, 5% as middle, and 1% as best-case.

Tom reviewed the next steps for the panel. He asked each panelist to describe their thoughts and feelings on the decision draft, including any input on what may be needed to reach consensus, or any outstanding concerns.

- Shirley: in general, very comfortable with the report. Numbers seemed reasonable, given limited data. Focused most on HSG issues; do not feel they have as big of an impact as the group may think. Need to address issue of compaction. Could use a little more discussion about how sites are set up. Once a storm drainage system is set up. Felt the report addressed functional deficiency well. There will be functional deficiencies that increase the load.
- Megan: Had a lot of comments in previous draft. Previously unimportant pathways now seem to be the most important. Not comfortable with nutrient loading numbers. **ACTION: Tom to revisit and double check Megan's comments from the previous draft.**
- Tom: we'll share the missing appendices once the panel reaches consensus.

- Randy: having the rates based on the 12 tons/ac makes more sense. Could use some clarification on the functional deficiency and the 15% deficiency rate. During a large storm event, not all the practices fail. Some will and some will not.
- Summer: Still reviewing it. Will provide written comments asap.
- Don: No significant comments to add. Think the report is well put together and flows well.
- John: As a non-scientist, the report is logical and easy to understand. It does a good job handling the uncertainty and variability. Some polishing to do. Specifically, agree with Randy that not using the 24 tons/ac rate would make the rates more reasonable. Definitely support the suggestion for more study in nutrient runoff from construction. We've seen spikes in phosphorous in streams downhill from highway construction sites. The management of construction sites can be so variable, not sure how to address that in a study like this.
- Rich: Variability will occur at all sites, so we've seen a lot of different problems on sites in our studies. In reviewing programs and violations, there are always issues on construction sites. On 2:1 slopes we've seen surprisingly low nutrient runoff; recommend continued research on this. Only two major comments, first is on tables 15 and 17 efficiencies. One study (McCaleb and McLaughlin 2008) showed 99% retention on an actual construction site using baffles in a basin. The study was in the lit review but is missing from the tables. Second, the 12 tons is close to some of our studies. A lot of the sediment was from the diversions, not overland flow.
    - Tom: We'll add it to the tables and to Appendix C (research on sediment basin performance).
- Kip noted a couple small changes. Want to make sure whatever we're recommending is not too difficult for states to follow. Perhaps we need to be clearer. Also, not sure if it's okay to assume the HSGs can be evenly distributed across the state. Glad we got more insight into the functional deficiency. Would like to read more about how the percentage of storm events was calculated to ensure the thresholds make sense. Precipitation for a two-year storm is over 3 or 3.5 inches in a single day in some places.
- Bruce: In general, very comfortable with the report. Concern about the events associated with moderate storms. I know we try to average everything, but we have more events that exceed our design specs for perimeter controls than we used to. Not sure if there is anywhere in the document that addresses the distance from streams.
    - Tom noted that distance to stream is discussed on page 17 of the report, which explains sediment delivery factors.
    - Bruce: Since we moved to "ESD to the MEP" in Maryland, we are not seeing as many sediment basins now. Typically have to exhaust all other ESC practices before needing a basin. We see more traps and super silt fences and breaking up the drainage areas into smaller sizes. We also encourage putting in storm drains first. We do a lot more of baffles and try to incorporate them in most of our traps. We also try to include sump pits. We try to divert as much clean water around the site as we can.

Certification classes and pre construction meetings are concentrating more on proper design and construction of these practices.

4. Panelist Comments on Third and Final Draft of Report

- Tom: Assuming the above concerns are addressed in the revised version, does the panel feel comfortable submitting the report to the WTWG and WQGIT?
    - There was consensus among the panelists that they would like to see a final document with the incorporated changes before signing off on it.
    - Kip: Did we cover the coastal plain issue?
        - Tom: Since we were unable to develop a defensible recommendation, we will recommend it as a research recommendation.
- Tom noted the panel's consensus that more time was needed. He asked panelists to provide all comments by end of first week of December (by December 6th). Will incorporate the comments and distribute a revised draft, asking for final yay/nay by Dec 31st.
- **ACTION: Panelists to submit all final comments on the decision draft by Friday, December 6th.**
- **ACTION: Once final comments have been incorporated, a revised draft of the report will be distributed for panelists' consideration. Panelists will provide their final yes/no vote for submitting the report to the USWG by December 31st.**

Tom thanked the panelists for their hard work and time over the past 15 months.

Adjourned

Appendix G:
Conformity with WQGIT BMP Review Protocol

The BMP review protocol established by the Water Quality Goal Implementation Team (WQGIT, 2010) outlines the expectations for the content of expert panel reports. This appendix references the specific sections within the report where the panel addressed the requested protocol criteria.

1. **Identity and expertise of panel members:** *See Table in Section 1*

2. **Practice name or title:** *Erosion and Sediment Control, which consists of four levels of ESC practice at construction sites.*

3. **Detailed definition of the practice:** *See section 2.1 for detailed definitions of ESC levels 1, 2, 3 and 4.*

4. **Recommended N, P and TSS loading or effectiveness estimates:** *See Table 19 (Section 5.5) and Appendix A for recommended TSS removal rates for use in the Phase 5.3.2 Watershed Model. The panel recommended a zero N and P removal rate for all four levels of ESC practice.*

5. **Justification of selected effectiveness estimates:** *See Sections 4 and 5 to understand how the panel derived the effectiveness estimates for sediment removal. See Section 6 for an explanation of the recommended zero nutrient removal credit.*

6. **List of references used:** *See page 41*

7. **Detailed discussion on how each reference was considered:** *See Sections 3, 4, and 5 for details on the review of available science.*

8. **Land uses to which BMP is applied:** *ESC practices are applied to the bare-construction land use in the Phase 5.3.2 WSM and the equivalent land use in the future Phase 6 WSM.*

9. **Load sources that the BMP will address and potential interactions with other practices:** *The ESC BMP will address runoff from construction sites in the Bay watershed. It is the only BMP that is eligible and applicable to the construction land use and therefore does not interact with other BMPs.*

10. **Description of pre-BMP and post-BMP circumstances and individual practice baseline:** *See Sections 3, 4, 5, and 6, As well as Appendix A and B for a discussion of pre- and post-BMP site hydrology and pollutant runoff.*

11. **Conditions under which the BMP works/not works:** *See Section 5.4 for a discussion of functionally deficient sites.*

12. **Temporal performance of BMP including lag times between establishment and full functioning:** *No lag time is assumed. In recent years each state has adopted more stringent ESC standards that, among other things, require rapid stabilization of bare soil on construction sites.*

13. **Unit of measure:** *Acres*

14. **Locations in CB watershed where the practice applies:** *All acres of construction sites in the Bay watershed*

15. **Useful life of the BMP:** *Varies by specific ESC practice and duration of specific construction project. For the purposes of this report, however, the useful life of the practice is annual.*

16. **Cumulative or annual practice:** *Annual*

17. **Description of how BMP will be tracked and reported:** *See Section 7.1 and 7.2 for discussion of how state governments can track and report to the Bay Program. More details are also available in the "Technical Requirements for Scenario Builder" document accompanying this report.*

18. **Ancillary benefits, unintended consequences, double counting:** *Increasing the Level of ESC practice can reduce turbidity levels which can harm aquatic life. No unintended consequences or issues with double counting*

19. **Timeline for a re-evaluation of the panel recommendations:** *Depends on continued research*

20. **Outstanding issues:** *See Section 8 for a discussion of outstanding issues and future research needs*

Appendix H: Technical Requirements for Entering ESC Practices into Scenario Builder