Brook Trout

Principles for Phase III Watershed Implementation Plans

Protecting Brook Trout for the Benefit of Watershed Residents

Brook trout are a valuable species to the Chesapeake Bay watershed, providing social, economic, and ecological benefits to residents. Designated as the state fish in New York, Pennsylvania, Virginia, and West Virginia, brook trout play an important part in the natural heritage of the watershed. Brook trout are highly prized by recreational anglers who spend millions of dollars annually on related goods and services, including travel, that directly benefit local and state economies.

The presence of brook trout indicate healthy waters as they rely on clean, cold headwater stream habitat for survival. They are particularly sensitive to changes in water temperatures (preferring waters under 68°F) and to human actions impacting land use. Increases in impervious surface, tree clearing, and water impoundments can warm stream temperatures above 68°F, leading to stress on and possible death of brook trout populations. Brook trout are also very sensitive to sediment deposits, which degrade habitat and smother eggs in spawning nests built in the gravel of streams.

As they are just one of the many species that inhabit headstream waters, the protection of brook trout also safeguards additional fish habitat. Adopting certain brook trout habitat protection practices, like streamside and agricultural buffer plantings, can also benefit other priorities like water quality and stream health.

If brook trout are present in your area, you have a unique location that is worthy of conservation and attention.

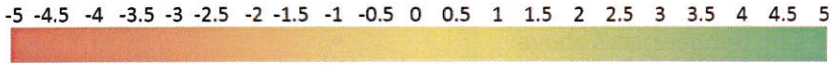
Best Management Practices with Brook Trout in Mind

Best management practices (BMPs) are designed to improve water quality and achieve the Chesapeake Bay TMDL, but many of these same measures may enhance brook trout habitat as well. Incorporating the protection of Brook Trout habitat into project design does not necessarily require large changes. With deliberate planning, you can maximize your water quality investment by implementing practices that result in the improvement of brook trout habitat and added ecosystem value. The chart below highlights current BMPs that experts have rated based on the value a BMP provides to several Chesapeake Bay Program (CBP) outcomes. **Comparing across multiple CBP outcomes demonstrates how a BMP can provide co-benefits to more than one outcome.** However, case-by-case evaluation of co-benefits is recommended.

Updated February 2018

Best Management Practice	Brook Trout	Additional Co-Benefits					
		Habitat and Biodiversity	Stream Health	Fish Habitat	Healthy Watersheds	Forest Buffer	Tree Canopy
Agricultural Forest Buffer	4.5	4	4	4.5	4	5	4.5
Streamside Forest Buffer	4.5	4	3	4.5	3	5	5
Forest Conservation	4	5	4	4	5	3.5	5
Agricultural Stream Restoration	3	3	5	3	1	1	0
Agricultural Stream Access Control with Fencing	3	2	1	1.5	1	1	1

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies survey by Tetra Tech and are based on the best professional judgment of subject matter experts. Appendix E. Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows select BMPs that scored a 3 or higher for the Brook Trout Outcome, however, not all of these BMPs would merit the score of +3 for all projects. Closer evaluation of project site designs, including those from BMPs shown in the above table, is warranted when interpreting these scores.** More information on brook trout and the outcome's guiding documents can be found at the Chesapeake Bay Program's Habitat Goal Implementation Team webpage.



Guiding Principles for Phase III Watershed Implementation Plan

WIP Development

- Know where your brook trout populations exist (use EBTJV Spatial Tool, State Identified Priority Brook Trout Sub-watershed, contacts listed below).
- Recognize and consider existing stressors: Extent of agriculture, mining, and impervious surface in the watershed, water impoundments, impassable dams/culverts and brown trout competition (use USFWS Fish Habitat Tool, NAACC and Chesapeake Dam Prioritization links below).
- Reduce impacts to brook trout: Design and implement BMPs to reduce impervious surface, avoid/minimize creating permanent pools, increase forest buffers, consider brown trout competition when planning in-stream work, protect groundwater sources (consider streamside wetland restoration) and reduce blockages to fish passage. Avoid BMPs that may increase stream temperature or high velocity flow events.

WIP Implementation

- Capitalize on co-benefits: Choose water quality BMPs that also protects other fish habitat, stream health and healthy watersheds. Streambank stabilization, access control fencing, floodplain reconnection and off-stream watering systems improve fish habitat and reduce sedimentation and phosphorus loading.
- Engage partners: Collaborate with federal and state agencies, elected officials and NGOs to share resources, help identify watersheds and streams important to brook trout, and incorporate conservation efforts into your WIPs (use contacts listed below).

Tools and Resources

- Eastern Brook Trout Joint Venture Spatial Tool: Includes information on the extent of Brook Trout habitat and habitat status.
- State Identified Priority Brook Trout Sub-watersheds: Includes description, HUC12 codes, and map.
- USFWS Fish Habitat Decision Support Tool – Chesapeake Bay Brook Trout Assessment: Includes information on Brook Trout habitat stressors and future habitat quality change.
- North Atlantic Aquatic Connectivity Collaborative (NAACC): Includes information, maps, and a regional database on road-stream crossings (bridges/culverts).
- Chesapeake Fish Passage Prioritization Tool: Includes map and information on dams.

Contacts for More Information about Brook Trout in Your Jurisdiction

Jurisdiction	Website	Lead	Email
CBP Contact	Habitat Goal Implementation Team	Jennifer Greiner	Jennifer_greiner@fws.gov
CBP Contact	Brook Trout Action Team	Stephen Faulkner	faulkners@usgs.gov
Maryland	MD Dept. of Natural Resources	Alan Heft	Alan.heft@maryland.gov
New York	NY Dept. of Environmental Conservation	Fred Henson	Fred.henson@dec.ny.gov
Pennsylvania	PA Fish and Boat Commission	Jason Detar	jdetar@pa.gov
Virginia	VA Dept. of Game and Inland Fisheries	Steve Reeser	Steve.reeser@dgif.virginia.gov
West Virginia	WV Dept. of Natural Resources	David Thorne	David.w.thorne@wv.gov

Climate Resiliency

Principles for Phase III Watershed Implementation Plans

Protecting People and Infrastructure

The Chesapeake Bay watershed has experienced changes in climate over the last century. On the whole, the watershed is experiencing stronger storms, an increase in heavy precipitation events, increasing air and water temperatures and a rise in sea level. These trends are altering the watershed, its ecosystems and the human communities of the Chesapeake Bay. Adapting to these impacts will require changes in programs and projects to successfully achieve restoration and protection goals.

Addressing these impacts in conjunction with ongoing restoration efforts will prepare communities for greater variability and can help achieve cost savings and reduce risks. Considering future impacts during the planning, siting, design and implementation of best management practices (BMPs) can help to reduce the vulnerability of a project to failure (structural or programmatically).

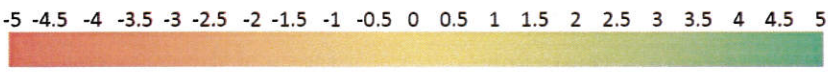
Assessing climate impacts at the initial stage of watershed implementation planning will increase effectiveness, decrease maintenance costs, and contribute to meeting the U.S. EPA's TMDL pollution reduction goals.

Best Management Practices with Resiliency in Mind

In addition to water quality benefits, several suites of BMPs can aid with natural hazard risk reduction (riverine and coastal flood, heat and drought). See the table* below for BMPs that have several co-benefits.

Best Management Practice	Climate Adaptation	Additional Co-Benefits	
		Energy Efficiency	Flood Risk Mitigation
Urban Shoreline Management	4	0.5	1
Urban Forest Buffers	3.5	4	3.5
Forest Conservation	3.5	3	3.5
Urban Stream Restoration	2.5	2.5	3.5
Agriculture Forest Buffer	2.5	0.5	3.5
Urban Tree Planting	2	4.5	2
Bioretention, Raingardens, Bioswales	2	3	3.5
Wetland Restoration	2	1	3.5
Agriculture Shoreline Management	0	0	4

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). This table shows BMPs that scored a 3.5 or higher for the Climate Adaptation Outcome.



Updated February 2018

Guiding Principles for Incorporating Climate Resiliency

WIP Development

- Capitalize on "co-benefits": Select BMPs to maximize climate resiliency, flood control, carbon sequestration or socio-economic benefits.
- Account for existing stressors: Consider existing stressors (e.g., land-use change) in combination with climate impacts when establishing reduction targets.
- Align with existing plans and strategies: Align WIPs with existing greenhouse gas and climate adaptation strategies, hazard mitigation plans or floodplain management programs.
- Manage for risk and plan for uncertainty: Employ iterative risk management to achieve and maintain water quality standards in changing conditions.
- Engage local agencies and leaders: Work cooperatively with agencies, elected officials and staff to account for localized impacts.

WIP Implementation

- Reduce vulnerability: Site and design BMPs to reduce future impact of sea level rise, coastal storms, increased temperature, and extreme precipitation.
- Build in flexibility and adaptability: Allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage: Allow for changes in BMP selection or WIP implementation as new climate and ecosystem science, research or data becomes available and our understanding of the impact of climatic and weather conditions on the performance of watershed restoration practices improves.

Tools and Resources

- Resilient BMPs: Planning Tools and Resources – Fact sheet with links to available tools and resources.
- Chesapeake Bay Program, Climate Smart Framework and Decision Support Tool – This report details "Climate Smart" decision-making processes for implementation of goals, strategies and actions.
- Best Management Practices: Preserving Clean Water in a Changing Climate – This fact sheet provides information on climate risks and solutions for implementation of water quality related BMPs.
- Climate Data for the Mid Atlantic – Portal with gridded climate datasets for the Chesapeake Bay watershed.
- Managing Water Quality in the Face of Uncertainty - A report describing how to manage future uncertainties such as climate change and evolving land use patterns.
- National Climate Assessment – A report on the impact of climate change on the U.S., with regional information.
- Climate Resilience Toolkit - A compilation of tools, resources, data and projections, and case studies.
- BASINS Climate Assessment Tool - Combines GIS, national watershed data, and watershed modeling tools to model potential climate change scenarios.
- Tools for Water Related Climate Change Adaptation - A database of climate adaptation tools for communities.

Contacts for More Information on Climate Resiliency in your Jurisdiction

Jurisdiction	Website	Lead	Email
Delaware	Delaware Division of Energy and Climate	Jennifer DeMooy	jennifer.demooy@state.de.us
D.C.	Sustainable DC	Katherine Johnson	katherine.johnson@dc.gov
Maryland	MD Commission on Climate Change	Matthew Rowe	matthew.rowe@maryland.gov
New York	NY Dept. of Environmental Conservation		climatechange@dec.ny.gov
Pennsylvania	PA DCNR and PA DEP	Greg Czarnecki	gczarnecki@pa.gov
Virginia	Adapt Virginia	Elizabeth Andrews	eaandrews@wm.edu
West Virginia	WV Dept. of Environmental Protection	Teresa Koon	teresa.m.koon@wv.gov
CBP	Climate Resiliency Workgroup	Zoe Johnson	zoe.johnson@noaa.gov

Updated February 2018

Fish Habitat

Principles for Phase III Watershed Implementation Plans

Improving Habitat Benefits People and Fish

Fish provide tremendous benefits to both our society and environment. They support multi-billion dollar industries including tourism, food service, commercial and recreational fishing, all while nourishing and sustaining the ecosystems in which they live. However, when watersheds are developed and nearshore areas hardened, fish habitat is threatened as well as the many benefits these fish provide to people.

Tree Planting at Stream Restoration Site in Annapolis, MD

Reedville VA Living Shoreline. Photo: Northern Neck Master Gardeners

Local land use decisions impact the production and sustainability of fish resources. While fishery managers can adjust the harvest of fish resources to ensure sustainable and healthy fish populations, these protective measures are limited by the availability and condition of fish habitat. For that reason, fish habitat depends on more than good water quality. Fish Habitat comprises the water or substrate necessary for fish or aquatic organisms to live and thrive, including areas for spawning, feeding, growing, or migrating. Fish need shade from trees to cool rivers to a livable temperature, roots and underwater grasses to inhabit as juveniles, unimpeded waters to spawn, and shallow areas to hide from aquatic predators.

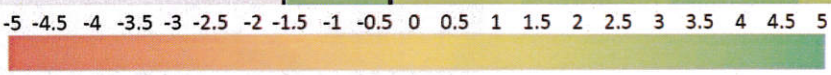
Fortunately, many of these habitat requirements can be generated through infrastructure projects. If designed effectively, infrastructure projects can improve fish habitat, create resiliency to projected climate change impacts, and decrease erosion. Reducing contaminants into the water can also improve fish health and provide a healthier food product when fish are consumed. Recent research suggests that BMPs designed to trap sediment can effectively suspend non-soluble toxins.

Our future and the future of fish in the Chesapeake Bay are tied to the protection, restoration, and enhancement of our shared habitat. Fishable and swimmable waters can be achieved with careful planning, conservation, and Total Maximum Daily Load (TMDL) reductions.

Water Quality Improvement Practices Benefit Fish Habitat

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies project by Tetra Tech Appendix E. Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows select BMPs that scored a 3.5 and higher for the Fish Habitat Outcome, however, not all of these BMPs would merit this score for all projects. Closer evaluation of project site designs, including those BMPs shown in the above table is warranted when interpreting these scores.**

Best Management Practice	Fish Habitat	Additional Co-Benefits						
		Protected Lands	Habitat Biodiversity	Brook Trout	Blue Crab	Recreation	Forage Fish	Wetlands
Agricultural Forest Buffer	4.5	3.5	4	4.5	4.5	4	4	3.5
Narrow Forest Buffer	3.5	2	2.5	3.5	3	1.5	2	2
Streamside Forest Buffer	4.5	3	4	4.5	4	3	3	3
Urban Forest Buffer	4	3.5	5	5	2.5	3	3	3.5
Forest Conservation	4	5	5	4	3	3.5	3	2.5
Urban Shoreline Management	4.5	4.5	4	1.5	5	4.5	4.5	4.5
Wetland Restoration	3.5	3.5	3	1.5	2.5	2	1.5	5
Urban Stream Restoration	4	3	3.5	4	3	3	4.5	3.5



Guiding Principles for Incorporating Fish Habitat

WIP Implementation Principles

- Consider Existing Conditions and Stressors: Evaluate how site-specific conditions can influence overall BMP impact.

  Conserve Habitat:
  - Natural shorelines provide suitable habitat health for fish and other important watershed resources.
  - Continuous habitat is more favorable for supporting fish and shellfish populations than fragmented habitat.
  - Conserving high quality habitat will maintain ecosystem services at a lower cost than restoration.
  - Fish are more responsive to restoration efforts in less developed areas.

  Prevent Fish Habitat Degradation:
  - Tree canopy cover lowers stream temperature by providing shade. However, some BMPs impound water, resulting in increased water temperature on sunny days. This adversely impacts sensitive aquatic species, such as brook trout.

  Improve Water Quality:
  - Nutrient reductions help reduce algae which improves oxygen resources for fish and shellfish. These reductions improve light conditions, which support healthy aquatic vegetation structure and function for fish diversity.
  - BMPs that slow runoff flow benefits native fish communities while reducing impacts of nutrient and sediment loading.
  - Reducing toxic contaminants supports improved survival, growth and reproduction of fish and shellfish, reduced water treatment costs, improved water quality, and reduced human health risks associated with fish and shellfish contaminant exposures through consumption.
- Capitalize on Co-benefits: Prioritize BMPs that enhance fish habitat or offer other ecosystem benefits. Projects with ecosystem benefits such as maintaining stream health, enhancing wetland function, or conserving submerged aquatic vegetation often result in a positive impact.
- Engage Partners: Use the fish habitat contacts provided below to help you plan a project that supports water quality improvements and protects or restores fish habitat. These contacts can help you determine if you have temperature sensitive species in your area.

Tools and Resources

A wide variety of fish habitat tools and datasets can help you capitalize on multiple ecosystem benefits when selecting and designing water quality improvement projects. Find a full listing of fish habitat mapping tools and spatial datasets here.

- Link to detailed BMP table
- Link to maps and datasets with multiple ecosystem benefits
- Living Shorelines Resources : Virginia, Maryland, Delaware
- More information on Fish Habitat Outcome can be found at the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team webpage.

Contacts for More Information on Fish Habitat in Your Jurisdiction

Jurisdiction	Lead	Phone	Email
Delaware	Edna Stetzar	(302) 735-8654	Edna.Stetzar@state.de.us
D.C.	Bryan King	(202) 997-9607	Bryan.King@dc.gov
Maryland	Jim Uphoff Margaret McGinty	(443) 258-6087 (410) 260-8297	Jim.Uphoff@maryland.gov Margaret.McGinty@maryland.gov
New York	Josh Thiel	(518) 402-8978	Josh.Thiel@dec.ny.gov
Pennsylvania	Geoffrey Smith	(717) 265-7837	GeofSmith@pa.gov
Virginia	Rachael Peabody (tidal) David Whitehurst (nontidal)	(757) 247-8027 (804) 367-4335	Rachael.Peabody@mrc.virginia.gov David.Whitehurst@dgif.virginia.gov
West Virginia	David Thorne Brandon Keplinger	(304) 637-0245 (304) 822-3551	David.W.Thorne@wv.gov Brandon.J.Keplinger@wv.gov
CBP Contact	Gina Hunt	(410) 948-9836	Gina.hunt@maryland.gov

Forest Buffers

Principles for Phase III Watershed Implementation Plans

Planting Buffers for Human Health, Economic Development and Infrastructure

Restoring riparian forest buffers are vital to healthy watersheds due to their effectiveness at cleaning water. Buffers reduce bacteria, microorganisms, microplastic fibers, harmful algal blooms and many emerging contaminants that are found in surface waters. They also keep stream temperatures down, which can reduce the occurrence of algal blooms and bacteria, making the water in our streams more swimmable and drinkable. Herd health also directly improves once cows are fenced out of a stream and a forest buffer is established.

Riparian forest buffers are also a cost-effective water quality practice. Every dollar spent on forest buffers reduces the need for costlier urban practices and less effective agricultural practices. Funding is available to restore riparian forest buffers. Through the federal and state Conservation Reserve Program almost all costs for this practice can be met.

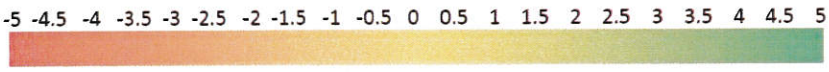
Stream and buffer restoration offers great opportunities for economic revitalization. Buffers help municipalities by treating stormwater, dissipating flood energy and reducing erosion potential of streams, rivers and tides. Floodplain buffers are particularly important for treating flood water. Buffers also improve recreational services such as fishing, boating, swimming, hiking, biking and wildlife viewing. In addition, quality of life is perceived higher around trees.

Best Management Practices (BMPs) with Forest Buffers in Mind

Many believe that forest buffers are the best BMP especially when considering their multiple co-benefits and cost-effectiveness. All growing forests contribute to clean water, but forest buffers provide critical barriers between polluting landscapes and receiving waterways, reducing the adverse effect of excessive pollutants (including nitrogen, phosphorus, and suspended sediment) while occupying relatively little land. In addition to their well-recognized role in improving water quality, riparian forests fulfill important habitat needs for a host of aquatic and terrestrial species. See the table below for forest buffer BMPs with other co-benefits.*

Best Management Practice	Forest Buffers	Additional Co-Benefits					
		Habitat Biodiversity	Brook Trout	Stream Health	Fish Habitat	Healthy Watersheds	Tree Canopy
Agricultural Forest Buffer	5	4	4.5	4	4.5	4	4.5
Forest Conservation	3.5	5	4	4	4	5	5
Forest Harvesting Practices	3.5	2	2	4	3	3	2
Narrow Forest Buffer	5	2.5	3.5	2	3.5	2	5
Streamside Forest Buffers	5	4	4.5	3	4.5	3	5
Urban Forest Buffers	5	5	5	4	4	3.5	4.5

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows BMPs that scored a 3.5 or higher and -3.5 or lower for the Forest Buffer Outcome.**



Updated February 2018

Guiding Principles for Incorporating Outcome

WIP Development

- Calculate benefit of establishing buffers by using the Chesapeake Assessment Scenario Tool (CAST).
- Identify areas where more buffers are needed.
- Increase resources for establishing buffers on agricultural and developed land.
- Insist on buffering all streams on conserved agricultural land.
- Improve internal and external education around the importance of buffers.

WIP Implementation

- Use every opportunity to engage with landowner about buffer restoration efforts, including when contacting for a different restoration practices or conservation easements.
- Educate landowners and increase incentives to establish a buffer.

Tools and Resources

- A Guide for Forestry Practices for Phase III WIPs: Packet of information on all forestry practices
- Healthy Watersheds Forestry TMDL Forest Retention Study: This report includes a toolbox of recommendations and incentives for stimulating forestland retention.
- Chesapeake Riparian Forest Buffer Network: Website with information, resources and success stories related to riparian forest buffers
- Additional information can be found on the Forestry Workgroup page.

Contacts for More Information on Forest Buffers

Jurisdiction	Website	Lead	Email
Delaware	Delaware Forest Service	Marcia Fox	marcia.fox@state.de.us
D.C.	DOEE – Trees in the District	Luke Cole	luke.cole@dc.gov
Maryland	MD Forest Service Buffer Initiative	Anne Hairston-Strang	Anne.Hairston-Strang@maryland.gov
New York	NYDEC Riparian Buffers	Lauren Townley	lauren.townley@dec.ny.gov
Pennsylvania	PA DCNR Riparian Buffers	Matt Keefer	makeefer@pa.gov
Virginia	VA DOF Riparian Forest Buffers	Todd Groh	todd.groh@dof.virginia.gov
West Virginia	WV Chesapeake Bay Forestry	Herb Peddicord	herb.f.peddicord@wv.gov
CBP Contact	CBP Forestry Workgroup	Sally Claggett	sclaggett@fs.fed.us

Healthy Watersheds

Principles for Phase III Watershed Implementation Plans

Protecting Healthy Waters for Human Health, Economic Development and Infrastructure

Maintaining healthy watersheds is of the utmost importance due to the critical ecosystem and economic services they provide which are essential to our social, environmental and economic well-being. These include, but are not limited to: nutrient cycling, carbon storage, sediment control, increased biodiversity, soil formation, wildlife movement corridors, source water protection, flood control, food, timber, recreation and reduced vulnerability to natural disasters.

The wide array of critical ecosystem services provided by healthy watersheds is frequently undervalued when making land use decisions. Due to the complexity of natural systems and economic precedents, it is difficult to assign a dollar amount to a particular ecosystem service. However, there is a large body of research and evidence showing that intact healthy ecosystems prevent costly restoration and ecosystem service replacement and provide long-term societal benefits including economic opportunities and jobs. Property values are also generally higher near open space; therefore, integrating healthy watersheds into communities and the landscape provides an opportunity for an increased tax base.

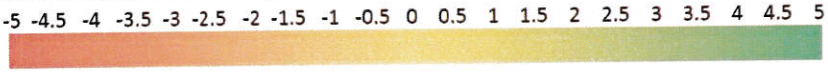
Protecting healthy watersheds can also defer stormwater treatment costs and flood related property damage when conservation principles are included in development policies and land use or zoning decisions. Healthy watersheds can contribute to the reduction of climate related impacts as these healthy ecosystems provide flexibility in a changing climatic environment and increase overall resiliency. In addition, access to these pristine areas can provide recreational and tourism opportunities like fishing, boating, swimming, hunting, hiking and wildlife viewing.

Best Management Practices with Healthy Watersheds in Mind

Incorporating the protection of healthy watersheds into project design does not necessarily require a wholesale change in implementation. There are many best management practices (BMPs) that address the Bay TMDL, healthy watersheds vulnerability and other Chesapeake Bay Program outcomes. Evaluating projects for watershed health vulnerabilities and developing a range of strategies to offset those vulnerabilities will increase effectiveness, decrease maintenance costs, and still help to ensure you are meeting the Chesapeake Bay TMDL requirements into the future. See the table below for healthy watershed BMPs that have several co-benefits*

Best Management Practice	Healthy Watersheds	Additional Co-Benefits							
		Protected Lands	Biodiversity Habitat	Brook Trout	Stream Health	Fish Habitat	Forage Fish	Flood Mitigation	Recreation
Ag Forest Buffer	4	3.5	4	4.5	4	4.5	4	3.5	4
Forest Conservation	5	5	5	4	4	4	3	3.5	3.5
Urban Forest Buffers	3.5	3.5	5	5	4	4	3	3.5	3
Urban Growth Reduction	4	5	4.5	4	3	3	3	3	3
Urban Stream Restoration	4	3	3.5	4	3.5	4	4.5	3.5	3

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows BMPs that scored a 3.5 or higher and -3.5 or lower for the Healthy Watersheds outcome.**



Updated February 2018

Guiding Principles for Incorporating Healthy Watersheds

WIP Development

- Know where your healthy watersheds are (see interactive map link below)
- Capitalize on co-benefits: Select BMPs that also protect healthy watersheds and increase land conservation.
- Account for and consider existing stressors: Offset future urban growth through forestland retention to help meet TMDL requirements.
- Align with existing climate resiliency plans (i.e. hazard mitigation, floodplain management and drinking water source protection plans)
- Engage partners: work with government agencies, elected officials and NGOs to incorporate updated data and conservation efforts into existing WIPs.

WIP Implementation

- Reduce vulnerability: Design BMPs to reduce land use change, increase land protection and reduce water demand and withdrawals.
- Build in flexibility and adaptability: Allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage: Allow for changes over time as new data regarding healthy watershed vulnerability becomes available and as more watersheds are restored.

Tools and Resources

- Healthy Watershed Maps (Contact: Renee Thompson, USGS)
    - Map of State Identified Healthy Waters and Watersheds on Chesapeake Progress
    - Map of State Identified Healthy Waters and Watersheds and Protected Lands on LandScope Chesapeake
    - Maryland's Tier II Waters Story Map
- Conservation Land-Use Policy Toolkit and Webinar
  This toolkit provides local governments with information about land use policy tools to slow land conversion
- Healthy Watersheds Forestry TMDL Forest Retention Study
  This report includes a toolbox of recommendations and incentives for stimulating forestland retention
- EPA Preliminary Healthy Watersheds Assessment
  Comprehensive, national information about watershed health and vulnerability
- These tools and resources and more can be found at the Maintain Healthy Watersheds Team page
  https://www.chesapeakebay.net/who/group/maintaining_healthy_watersheds_goal_implementation_team

Contacts for More Information on Healthy Watersheds in your Jurisdiction

Jurisdiction	Website	Lead	Email
Delaware	DNREC Division of Watershed Stewardship	Stephen Williams	stephen.williams@state.de.us
D.C.	DOEE Watershed Protection Division	Matt Robinson	matthew.robinson@dc.gov
Maryland	MDE Tier II High Quality Waters	Angel Valdez	Angel.Valdez@maryland.gov
New York	NYDEC Keeping Waters Clean	Lauren Townley	lauren.townley@dec.ny.gov
Pennsylvania	DEP Bureau of Clean Water	Gary Walters	gawalters@pa.gov
Virginia	DCR Healthy Waters Program	Todd Janeski	todd.janeski@dcr.virginia.gov
West Virginia	DEP Nonpoint Source Program	Tim Craddock	Timothy.D.Craddock@wv.gov
CBP Contact	Maintain Healthy Watersheds Team	Renee Thompson	rthompso@chesapeakebay.net

Updated February 2018

Protected Lands

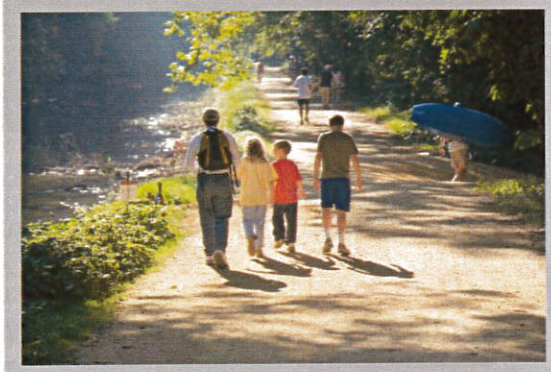
Principles for Phase III Watershed Implementation Plans

Protecting Lands for Local Economies, Human Health and Reduced Reliance on Built Infrastructure

Protected lands are viewed as increasingly essential to maintaining and growing various local economies; restoring human health and the social fabric of communities; ensuring the survival of wildlife and other species critical to the future of all living things; providing buffers and pathways for flooding and storm inundation; providing a "platform" to achieve Total Maximum Daily Load (TMDL) nutrient and sediment reduction goals in certain areas of the watershed; and providing opportunities for offsets to future growth and development (and their attendant built infrastructure costs) in certain areas of the watershed.

There are many economic assessments of how property values of residential developments are enhanced by adjoining nearby parks, trails and other open spaces. Economic benefits are also generated by the outdoor recreation industry to states across the country, as well as preserving working farmlands and forestlands to regional, state and local economies. Local economies are buoyed by tourism to preserved historic, cultural and heritage sites and landscapes. The availability of private markets in allocating capital for environmental restoration, often in tandem with acquiring interests in lands or using already preserved lands for restoration, also provide attendant economic benefits to local economies. Finally, a growing body of science demonstrates the many links between maintaining and restoring human health and well-being regularity of spending time in nature.

Almost nine million acres are permanently protected in the Chesapeake watershed, including significant forest lands and farm lands along the Susquehanna. Photo: Nicholas Tonelli



Conservation efforts date back to the mid-19th century resulting in tremendous public resources like the 186 mile long Chesapeake and Ohio Canal National Historical Park on the Potomac River. Photo: Chris Spielmann

There is one recent development, which if successfully implemented, will provide additional resources and means to further the conservation of certain lands in the watershed. Given the Chesapeake Bay Program's recent approval of projected growth and development scenarios around the watershed, the program is now perfecting for the first time a set of new "Conservation Plus best management practices (BMPs)" with estimated pollution load reductions for the retention of high quality forest and agricultural lands, as well as another set for growth management. These new BMPs will be available for localities projected to experience future growth and development to consider in preparing their Phase III WIPs.

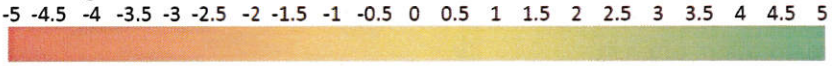
Best Management Practices with Protected Lands in Mind

The Chesapeake Conservation Partnership has developed maps depicting the most valued forests, agricultural lands, habitats, and heritage areas within the Bay Watershed. Please see the link to these maps in the section below on Tools and Resources. Using these maps for land conservation actions going forward, will serve as one resource for states and counties seeking to target conservation actions with multiple co-benefits. See the table below for Protected Lands BMPs that have several co-benefits*

Updated February 2018

Best Management Practice	Protected Lands	Additional Co-Benefits							
		Biodiversity and Habitat	Wetlands	Healthy Watersheds	Land Use Methods and Metrics	Fish Habitat	Climate Adaptation	Forest Buffers	Recreation
Ag Forest Buffer	3.5	4	3.5	4	4	4.5	2.5	5	4
Forest Conservation	5	5	2.5	5	3.5	4	3.5	3.5	3.5
Urban Forest Buffers	3.5	5	3.5	3.5	4	4	3.5	5	3
Urban Growth Reduction	5	4.5	1	4	5	3	2	2	3
Urban Shoreline Management	4.5	4	4.5	2	2.5	4.5	4	2.5	4.5
Wet Ponds	3.5	3.5	4.5	1.5	2	1	2	1	2.5
Wetland Restoration	3.5	3	5	1	4	3.5	1	1	2
Wetlands	4	3	5	1.5	2	2	2	1	3

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows BMPs that scored a 3.5 or higher and -3.5 or lower for the Protected Lands Outcome.**



Guiding Principles for Phase III Watershed Implementation Plan

WIP Development

- Review the Bay Program's projected growth and development scenarios to determine where impacts are projected to occur.
- Review the new "Conservation Plus BMPs" to determine if any of the growth management policies can be scheduled for inclusion in local WIPs.
- If conservation Plus BMPs are included in a local WIP, the WIP should select BMPs in each of the three categories to reflect a balanced approach.
- Consult partners (elected officials, state and federal agency representatives, land trusts, and others) in the development of WIP strategies. If land conservation is one of the BMPs pursued, determine capacity to reach out to land owners in areas targeted for conservation.

WIP Implementation

- If land conservation is one of the BMPs selected for inclusion in a local WIP, conduct an outreach effort to confirm an initial level of landowner interest in each target area if not already known.
- Focus on areas for land conservation which reflect the co-benefits shown in the CCP maps under "Tools and Resources."
- Take advantage of the growing number of resources and entities available for implementing land acquisition (and in some cases, restoration) of lands identified in local WIPs.

Tools and Resources

- Chesapeake Conservation Partnership Website: https://chesapeakeconservation.org.
- Chesapeake Conservation Partnership Maps: https://landscope.org/chesapeake/Priorities
- Conservation Land-Use Policy Tool Kit/Webinar and Healthy Watersheds Forestry TMDL Forest Retention Study: https://www.chesapeakebay.net/who/group/maintaining_healthy_watersheds_goal_implementation_team
- "Chesapeake: A Network of Conservationists Across 64,000 Square Miles" Jonathan L. Doherty and Suzanne E. Copping, *The George Wright Forum* Vol. 33, No. 2 (2016), pp. 185-198 http://www.georgewright.org/332doherty.pdf
- Outdoor recreation economy generates $887B in consumer spending annually and supports 7.6M in jobs. See state by state data: http://oia.outdoorindustry.org/e/51282/7-outdoor-rec-economy-resource/8hcywd/493072607
- Report by Forest Trends summarizing the $8.2 billion in private investment raised and committed in the last decade for a variety of renewable, sustainable, environmental restoration and conservation projects and another $3.2 billion raised and planned to be committed over the next 2 to 3 years: http://www.forest-trends.org
- Private Capital for Working Lands (Farms and Forests) Conservation: A Market Development Framework. The Conservation Finance Network: www.conservationfinancenetwork.org
- Economic Benefits of Parks-- State and National Surveys of Parks and Other Natural Assets: www.conservationtools.org/guides/98-economic-benefits-of-parks
- BBC Earth. How nature is good for our health and happiness: http://www.bbc.com/earth/story/20160420-how-nature-is-good-for-our-health-and-happiness
- Call to the Wild: This is Your Brain on Nature. National Geographic. https://www.nationalgeographic.com/magazine/2016/01/call-to-wild/

Contacts for More Information on Protected Lands in Your Jurisdiction

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CBP/CCP	www.chesapeakeconservation.org	John Griffin	jgriffin@chesapeakeconservation.org
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D.C.	Department of the Environment	Diane Davis	Diane.davis2@dc.gov
Maryland	Department of Natural Resources	Emily Wilson	emilyhwilson@maryland.gov
New York	Parks, Recreation and Historic Preservation	Mark Hohengasser	Mark.hohengasser@oprhp.state.ny.us
Pennsylvania	Department of Conservation and Natural Resources	Tom Ford	thoford@pa.gov
Virginia	Department of Conservation and Recreation	Sarah Richardson	Sarah.Richardson@dcr.virginia.gov
West Virginia	Outdoor Heritage Conservation Fund	Joe Hankins	jhankins@conservationfund.org
National Park Service	www.nps.gov/chba	Jonathan Doherty Amy Handen	Jonathan_doherty@nps.gov Amy_handen@nps.gov

Submerged Aquatic Vegetation

Principles for Phase III Watershed Implementation Plans

Protecting Submerged Aquatic Vegetation for the Benefit of Watershed Residents

SAV, also known as underwater grass, is a biologically and economically valuable resource and an important component of the Chesapeake Bay due to the ecosystem services it provides. Found throughout the shallow waters of the Bay, the presence of SAV has long been used as an indicator of bay health due to its need for clean, clear water. SAV is integral to the life cycle of many bay creatures; it provides food and shelter for blue crabs and juvenile rockfish, supporting the health of valuable commercial and recreational fisheries. When it thrives, SAV traps and filters sediment and nutrients, and through photosynthesis, supplies the surrounding water with oxygen necessary to support other aquatic life. Studies show that SAV also protects infrastructure by reducing the impacts of shoreline erosion, saving adjacent property owners money on potential storm damage.

SAV is sensitive to changes in water quality, particularly clarity. Large sediment and nutrient loads lead to impaired conditions under which SAV cannot thrive. SAV relies on sunlight to grow – sediment clouds the water column and nutrients cause algae growth that shades SAV. Sediment and nutrient loads can be particularly heavy in areas with high amounts of impervious surface cover and during times of substantial precipitation. Changes in salinity, temperature, and sea level may affect the future distribution of SAV in the Bay.

We can work to mitigate the impact from these stressors by reducing activities that are known to negatively impact SAV, such as shoreline hardening. Natural shorelines (i.e., free from rip rap and bulkheads) also allow for inland migration of SAV over time and the maintenance of the ecosystem services that SAV provides. Taking measures to reduce human and climate stressors can improve water quality for SAV, bay fish and waterfowl, and humans alike.

Best Management Practices with SAV in Mind

Incorporating the protection of SAV into project design does not necessarily require additional or substantial investments. The chart below highlights current BMPs that experts have rated based on the value a BMP provides to several Chesapeake Bay Program (CBP) outcomes. However, case-by-case evaluation of co-benefits is recommended. Nutrient management plans, wetland and streamside wetland restoration, agricultural stream restoration and advanced gray infrastructure nutrient discovery programs are all regarded as BMPs that would positively benefit SAV habitat and recovery by improving water quality and clarity.

Best Management Practice	SAV	Additional Co-Benefits						
		Wetlands	Blue Crab Abundance	Oyster	Stream Health	Fish Habitat	Forage Fish	Drinking Water Protection/Security
Nutrient Management Plan	3	2	3	3	2	2	3	2.5
Wetland and Streamside Wetland Restoration	3	5	2.5	2.5	1	3.5	1.5	1
Ag Stream Restoration	3	3	2.5	1.5	5	3	3	1
Advanced Grey Infrastructure Nutrient Discovery Program	3	1	2.5	2.5	1.5	2	2	3.5

-5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

Updated February 2018

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech and are based on the best professional judgment of subject matter experts. Appendix E. Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows select BMPs that scored a 3 and higher for the SAV Outcome, however, not all of these BMPs would merit the score of +3 for all projects. Closer evaluation of project site designs, including those from BMPs shown in the above table, is warranted when interpreting these scores.**

Guiding Principles for Phase III Watershed Implementation Plan

WIP Development

- Know if and where SAV exists in your area.
- Recognize and consider existing stressors: Poor water quality, hardened shorelines, areas of increased development and impervious surface, sea level rise.
- Capitalize on co-benefits: Choose BMPs that protect SAV, wetlands, stream health and fish habitat.
- Engage partners: Collaborate with state agencies and elected officials to share resources and incorporate conservation efforts into your WIPs.

WIP Implementation

- Reduce vulnerability: Design BMPs to reduce impervious surface/runoff and allow for inland migration of SAV. Consider converting bulkheads and rip rapped shorelines into natural shorelines. Avoid BMPs that may increase nutrient or sediment loading and/or negatively affect SAV.
- Build in flexibility and adaptability: Allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage: Allow for changes over-time as new data regarding SAV habitat vulnerability becomes available and as more SAV becomes restored.

Tools and Resources

- Virginia Institute of Marine Science – SAV Portal
- Maryland Department of Natural Resources – SAV Page

Contacts for More Information

Jurisdiction	Website	Lead	Email
CBP Contact	Habitat Goal Implementation Team	Jennifer Greiner	Jennifer_greiner@fws.gov
CBP Contact	SAV Workgroup	Brooke Landry Rebecca Golden	brooke.landry@maryland.gov Rebecca.golden@maryland.gov
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Pennsylvania	PA Fish and Boat Commission	Jason Detar	jdetar@pa.gov
Virginia	VA Dept. of Game and Inland Fisheries	Steve Reeser	Steve.reeser@dgif.virginia.gov
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Stream Health

Principles for Phase III Watershed Implementation Plans

Protecting streams for Human Health, Economic Development, and Infrastructure

The Chesapeake Bay watershed has over 100,000 miles of rivers and streams. They provide recreational opportunities such as canoeing and fishing, help crops to grow, replenish reservoirs, serve as critical habitat for valuable and endangered species, and provide essential natural services to the environment.

Our on the land directly influence the health of these valuable parts of the Bay watershed's landscape. Stream health can be improved by utilizing best management practices (BMPs) which stabilize banks, improve water quality through reduced sediment loading, improve fish and upland habitat, improve biodiversity and restore aesthetic value.

The types of BMPs implemented are dependent on principal stressors impacting a given stream. Stream bank erosion resulting from increased stormwater runoff related increased impervious surfaces (e.g., roads, rooftops, parking lots) result in significant sources of sediment and nutrients impacting the Bay. Locally, stream erosion and degradation results in the loss of land, habitats and decreases in species abundance and diversity. Degraded stream channels also pose safety hazards and impacts to infrastructure like utilities, roads, and buildings.

Human-impacted streams have altered water movement patterns and do not connect with other groundwater sources, leaving stagnant pools or preventing pollutants from filtering through the soil. Current stream restoration techniques can help remove steep banks which can lead to accidents (e.g., falling and drowning hazards). BMPs also help purify water by allowing groundwater reconnection, as well as incorporating floodplain areas that create diverse habitats and foster healthy ecosystem food chains.

Stream restoration projects and naturally healthy streams can become an economic cornerstone for a community. These projects provide an excellent opportunity for development of passive recreational facilities including walking paths, playgrounds and nature centers. Protecting stream valleys and utilizing these areas as parks is a valuable way to use open space. These parks can enhance surrounding property values, create a sense of community, or offer recreational thoroughfares and destinations, and may provide other types of recreational opportunities for hunting or fishing. These activities foster economic growth and development, as well as provide opportunities for individuals to invest in their communities.

Streams that are deeply incised and are disconnected from their floodplain are unable to have normal out-of-bank flow events which disperse the increased volumes and speeds of water. This can be a public safety hazard and result in increased downstream flooding. Current stream restoration techniques highlight the importance of reconnecting a stream to its floodplain. This is accomplished by creating areas where the stream can safely spill over the banks in high water situations. This design helps to provide flood protection for surrounding infrastructure and keeps water away from homes and businesses.

The benefits of functioning streams and adjacent wetlands, while significant on their own, are even more powerful when acting together in wetland/stream complexes on the landscape. Thus, these should be considered inextricably linked for planning and implementation purposes.

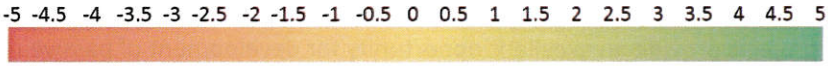
Best Management Practices with Stream Health in Mind

Stream health reflects the biological, chemical and physical conditions of the stream and riparian corridor and watershed. Incorporating the protection or restoration of streams through effective land use policies and stormwater management does not necessarily require a wholesale change in implementation. There are many BMPs that address

the Bay TMDL, stream vulnerability, and other Chesapeake Bay Program outcomes. Evaluating projects for stream health vulnerabilities and developing a range of strategies to offset those vulnerabilities will increase effectiveness of BMPs, decrease maintenance costs, and still help to ensure you are meeting the Chesapeake Bay TMDL requirements into the future. See the table below for BMPs that have several co-benefits* (the goal is to integrate various BMPs that will address the stressors affecting stream health).

Best Management Practice	Stream Health	Additional Co-Benefits				
		Brook Trout	Healthy Watersheds	Forest Buffers	Flood Control/ Mitigation	Protected Lands
Agricultural Stream Restoration	5	3	1	1	0	1
Alternative Water System	5	2	3	1	0	1
Forest Harvesting Practices	4	2	3	3.5	2.5	0.5
Forest Conservation	4	4	5	3.5	3.5	5
Agricultural Forest Buffer	4	4.5	4	5	3.5	3.5
Urban Forest Buffers	4	5	3.5	5	3.5	3.5
Urban Stream Restoration	3.5	4	4	3	3.5	3

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech and are based on the best professional judgement of subject matter experts. Appendix E. Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows select BMPs that scored a 3 or higher for the Stream Health Outcome; however, not all of these BMPs would merit the score of +3 for all projects. Closer evaluation of project site designs, including those from BMPs shown in the above table, is warranted when interpreting these scores.** *It is unlikely to find brook trout in urban streams, despite high BMP scoring (indicated by underlining and italics).*



Guiding Principles for Incorporating Stream Health

WIP Development

- Know where your healthy streams are and work towards identifying those that are restoration priorities.
- Capitalize on co-benefits: Select BMPs that protect healthy streams, maximize upland treatment and increase land conservation.
- Account for and consider existing stressors: Select BMPs that will contribute to reducing principal stressors.
- Consider how future population growth and land-use changes will affect BMPs.
- Align with existing climate resiliency plans (i.e., hazard mitigation plans, floodplain management programs).
- Engage partners: Work with government agencies, elected officials and NGOs to incorporate updated data and conservation efforts into existing WIPs.

WIP Implementation

- Reduce vulnerability: Design BMPs to function with existing and future pollutant loads, land use and disturbances such as floods and wildfires.
- Maintain in-stream flows by reducing water demand and withdrawals.
- Build in flexibility and adaptability: Allow for adjustments in BMP implementation to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage: Allow for changes in design, construction and maintenance over time as new data regarding stream health and restoration processes becomes available.

Tools and Resources

- Chesapeake Progress: Stream Health Mapper
- Chesapeake Bay Program, Scientific and Technical Advisory Committee: Stream Restoration Design Workshop – 2014 Workshop Report
- Maryland Biological Stream Survey (MBSS): Probability-based Random Design Stream Surveying
- EPA Stressor Identification and Prioritization Tool
- Maryland Tier II High Quality Waters Map
- Literature
    - Harman, W., R. Starr. 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington, D.C. EPA 843-B-12-005
    - Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. A Function-Based Framework for Stream Assessment and Restoration Projects. US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.
    - Palmer, M.A., Hondula, K.L. and Koch, B.J., 2014. Ecological restoration of streams and rivers: shifting strategies and shifting goals. *Annual Review of Ecology, Evolution, and Systematics*, *45*, pp.247-269.

Contacts for More Information on Stream Health in Your Jurisdiction

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Maryland	Floodplain and Waterways	Scott Stranko	Scott.stranko@maryland.gov
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Pennsylvania	Stream Improvement Program	Derrick McDonald	emcdonald@state.pa.us
Virginia	Stream Protection	Louise Finger	Louise.Finger@dgif.virginia.gov
West Virginia	Division of Water and Waste Management	Alana Hartman	Alana.c.hartman@wv.gov
CBP Contact	Stream Health Workgroup	Jennifer Greiner	Jennifer_greiner@fws.gov

Submerged Aquatic Vegetation

Principles for Phase III Watershed Implementation Plans

Protecting Submerged Aquatic Vegetation for the Benefit of Watershed Residents

SAV, also known as underwater grass, is a biologically and economically valuable resource and an important component of the Chesapeake Bay due to the ecosystem services it provides. Found throughout the shallow waters of the Bay, the presence of SAV has long been used as an indicator of bay health due to its need for clean, clear water. SAV is integral to the life cycle of many bay creatures; it provides food and shelter for blue crabs and juvenile rockfish, supporting the health of valuable commercial and recreational fisheries. When it thrives, SAV traps and filters sediment and nutrients, and through photosynthesis, supplies the surrounding water with oxygen necessary to support other aquatic life. Studies show that SAV also protects infrastructure by reducing the impacts of shoreline erosion, saving adjacent property owners money on potential storm damage.

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Best Management Practices with SAV in Mind

Incorporating the protection of SAV into project design does not necessarily require additional or substantial investments. The chart below highlights current BMPs that experts have rated based on the value a BMP provides to several Chesapeake Bay Program (CBP) outcomes. However, case-by-case evaluation of co-benefits is recommended. Nutrient management plans, wetland and streamside wetland restoration, agricultural stream restoration and advanced gray infrastructure nutrient discovery programs are all regarded as BMPs that would positively benefit SAV habitat and recovery by improving water quality and clarity.

Best Management Practice	SAV	Additional Co-Benefits						
		Wetlands	Blue Crab Abundance	Oyster	Stream Health	Fish Habitat	Forage Fish	Drinking Water Protection/Security
Nutrient Management Plan	3	2	3	3	2	2	3	2.5
Wetland and Streamside Wetland Restoration	3	5	2.5	2.5	1	3.5	1.5	1
Ag Stream Restoration	3	3	2.5	1.5	5	3	3	1
Advanced Grey Infrastructure Nutrient Discovery Program	3	1	2.5	2.5	1.5	2	2	3.5

-5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

Updated February 2018

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Guiding Principles for Phase III Watershed Implementation Plan

WIP Development

- Know if and where SAV exists in your area.
- Recognize and consider existing stressors: Poor water quality, hardened shorelines, areas of increased development and impervious surface, sea level rise.
- Capitalize on co-benefits: Choose BMPs that protect SAV, wetlands, stream health and fish habitat.
- Engage partners: Collaborate with state agencies and elected officials to share resources and incorporate conservation efforts into your WIPs.

WIP Implementation

- Reduce vulnerability: Design BMPs to reduce impervious surface/runoff and allow for inland migration of SAV. Consider converting bulkheads and rip rapped shorelines into natural shorelines. Avoid BMPs that may increase nutrient or sediment loading and/or negatively affect SAV.
- Build in flexibility and adaptability: Allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage: Allow for changes over-time as new data regarding SAV habitat vulnerability becomes available and as more SAV becomes restored.

Tools and Resources

- Virginia Institute of Marine Science – SAV Portal
- Maryland Department of Natural Resources – SAV Page

Contacts for More Information

Jurisdiction	Website	Lead	Email
CBP Contact	Habitat Goal Implementation Team	Jennifer Greiner	Jennifer_greiner@fws.gov
CBP Contact	SAV Workgroup	Brooke Landry Rebecca Golden	brooke.landry@maryland.gov Rebecca.golden@maryland.gov
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Virginia	VA Dept. of Game and Inland Fisheries	Steve Reeser	Steve.reeser@dgif.virginia.gov
West Virginia	WV Dept. of Natural Resources	David Thorne	David.w.thorne@wv.gov

Toxic Contaminants

Principles for Phase III Watershed Implementation Plans

Managing Toxic Contaminants to Protect Fish, Wildlife and People

Toxic Contaminants are a Public Health Risk to People and Harm Fish and Wildlife. Toxic contaminants, primarily high levels of polychlorinated biphenyls (PCBs) and mercury, lead to advisories on the amount of fish people should consume from the Chesapeake Bay and its tributaries. Some contaminants can increase cancer risk (PCBs, polycyclic aromatic hydrocarbons (PAHs)). Other contaminants (e.g., mercury) can cause developmental and neurological damage in humans, especially children. Toxic contaminants have shown to cause health and reproductive problems in fish and wildlife. Because of these concerns the Chesapeake Bay Program Partnership developed a goal to reduce the impacts of toxic contaminants.

An oily sheen colors asphalt at a commercial complex in northwest Baltimore on Jan 24, 2017. When it rains, chemical contaminants and trash that have collected on pavement and other impervious surfaces can get washed into local streams.

Vicki Blazer of the U.S. Geological Survey leads a field survey of smallmouth bass from the Shenandoah River. Blazer's team has observed the effects of pesticides, pharmaceuticals or other chemicals that disrupt the hormonal systems of smallmouth bass.

Urban Toxic Contaminants (UTCs), Ecological and Human Health: UTCs such as PCBs, PAHs, and mercury can negatively impact living resources and affect human health through consumption of contaminated fish and seafood and exposure to airborne contaminants. These UTCs are often related to industrial, commercial and transportation-related sources. The contaminants impact aquatic ecosystems through association with urban runoff, atmospheric deposition and previously contaminated sediment.

Stormwater Management and Sediment Control: Many toxic contaminants, especially UTCs (PCBs, PAHs, mercury) tend to associate with sediment and originate in urban and industrial areas where they are transported into the ecosystem through contaminated sediment in stormwater. Thus, any best management practice (BMP) that controls or traps sediment and prevents stormwater runoff can aid in preventing release of UTCs into waterways and aquatic ecosystems.

Agriculture-associated Contaminants and Ecological Health: Chemical contaminants associated with agricultural crop lands and animal production, include biogenic hormones (from animal manure), veterinary pharmaceuticals and antibiotics, herbicides and other pesticides. Mixtures of these chemicals have been shown to harm stream conditions, fish health and local biodiversity.

Agriculture Practices: BMPs on agricultural land that control nutrients and sediment also trap herbicides, pesticides, biogenic hormones, and pharmaceuticals from crop land and animal operations and prevent them from entering the Bay and its tributaries.

Updated February 2018

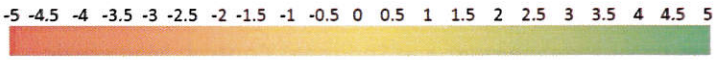
Best Management Practices for Toxic Contaminants Management*

Best Management Practice	Urban Pollutants	Additional Co-Benefits			
		Agricultural Pollutants	Stream Health**	Forage Fish**	Citizen Stewardship**
Ag Forest Buffer		4	2	2	0
Streamside Forest Buffers		3	2	2	0
Narrow Forest Buffer	3	3	2	2	0
Runoff Reduction	2.5		3	2.5	0.5
Wet Ponds	2.5		1.5	2.5	1
Urban Forest Buffers	2.5		4	3	2
Filtering Practices	2		2	3	1.5
Infiltration Practices	2		2.5	3	2
Dry Ponds	2		1	1	1.5
Bioretention	1.5		3	2.5	4.5

*Values were taken from a Tetra Tech study evaluating BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). Values were averaged estimates from various Chesapeake Bay Program Partnership workgroups and reports, based on best professional judgement. Scores are not based on empirical research on BMP performance related to co-benefits.

* Recent research indicates that upgrades to municipal wastewater treatment plants (WWTPs) can significantly reduce PCB loads in wastewater effluent. In addition to the nonpoint source BMPs above, enhanced nutrient removal upgrades to WWTPs may have significant co-benefits for toxic contaminants management.

**Stream Health, Forage Fish were selected for inclusion in the co-benefits table due to recognized effects of contaminants on fish health and fish habitat. Citizen Stewardship was selected for inclusion because raising stakeholder awareness is important to gain public support for managing toxic contaminants.



Guiding Principles for Incorporating Contaminants Management into Phase III WIPs

WIP Development

- Target areas with known legacy contaminants, often historically urban and industrial sites. One primary focus is PCBs, which were banned from production in the 1970s. However, PCBs are very environmentally stable and persist in sediments associated with contaminated land.
- Emphasize BMPs that trap sediments and associated contaminants, particularly in areas that flood or erode.
- Consider practices to reduce agriculture-associated contaminants: Contaminants, associated with pesticides and manure can enter waterways through agricultural runoff and contaminate drinking water.
- Consider toxic contaminants management in a local area planning goal: To reduce the impacts of toxic contaminants, consider inclusion of activities to mitigate that risk in your jurisdiction's phase III WIP.

WIP Implementation

- Environmental justice is an important consideration for toxic contaminants management. It has been established that many UTCs are concentrated in historically diverse and underserved communities. Members of these communities should be engaged in the planning and implementation of practices to manage toxic contamination.
- When implementing cover crop BMPs and other agricultural practices that use herbicides, use practices that minimize the risk of runoff and groundwater contamination, such as buffers and proper application rates and procedures.
- Combine BMP implementation efforts with traditional contaminant regulatory measures where there are local TMDLs and permits for toxic contaminant reduction.
- Partner with Local Governments, NGOs and local stakeholders on approaches that provide co-benefits for reduction of contaminants, nutrients and sediment.
- Plan for effects of climate change: Consider impacts of climate change-related phenomena such as flooding and increased storm frequency and severity when siting, designing, and maintaining BMPs.

Tools and Resources

- Toxic Contaminants Workgroup Chesapeake Bay Program page
- Report: Quantification of BMP Impact on Chesapeake Bay Program Management Strategies and Link to Co-benefits scoring
- Chesapeake Stormwater Network Report: Part One (Urban Contaminants) and Part Two (Agriculture and Wastewater Contaminants)
- Interactive Maps:
  - Tidal Chesapeake Bay Chemical Contaminants Indicator Map (2016 update)
  - PCB TMDL Map (2015 update)
- Link to Chesapeake Assessment Scenario Tool (CAST)
  - Resources for PCB TMDLs: Maryland | Virginia | Washington, DC

Contacts for More Information about Toxic Contaminants in Your Jurisdiction

Jurisdiction	Website	Lead	Email
Delaware	Division of Water	John Hayes, DNREC	John.hayes@state.de.us
D.C.	Chesapeake TMDL and Toxic Substances page	Aaron Waters, DOEE	Waters.aaron@dc.gov
Maryland	MDE Chesapeake Bay TMDL Center and WIP Development Resources	Len Schugam, MDE	leonard.schugam@maryland.gov
New York	Water Pollution Management	Jackie Lendrum, NYS DEC	Jacqueline.lendrum@dec.ny.gov
Pennsylvania	Bay TMDL and WIP Resources	Amy Williams Tom Barron	amywilli@pa.gov
Virginia	Bay TMDL page	Mark Richards, VA DEQ	Mark.Richards@deq.virginia.gov
West Virginia	Bay TMDL Resources	John Wirts	John.C.Wirts@wv.gov
Delaware River Basin Commission	Water Quality and Toxic Pollutants	Greg Cavallo, DRBC	Greg.Cavallo@drbc.nj.gov
CBP	Toxic Contaminants Workgroup	Greg Allen, EPA	Allen.greg@epa.gov

Tree Canopy

Principles for Phase III Watershed Implementation Plans

Growing Tree Canopy for Human Health, Economic Development and Infrastructure

Tree canopy is the leafy crown of the trees that grace our cities and towns. Tree canopy provides numerous benefits to human and watershed health. We all know that trees give us oxygen, but recent research shows that trees remove over 650,000 tons of air pollution in the US each year. Trees are an important frontline defense to reduce air pollution-related deaths and respiratory disease. In the face of changing climatic conditions, tree canopy offers critical shading and cooling effects to reduce the urban heat island effect in cities, lowering heat-related public health risks.

At the same time, the tremendous shading power of tree canopy produces energy savings to homeowners, businesses, local governments and utilities. Across the country, utilities are investing in "Energy Saving Trees" programs to maximize cost reduction benefits. Other economic benefits of community trees include increased home property values, enhanced business activity, and overall community revitalization that occurs when incorporating trees and green space into community development. Efforts to protect and grow tree canopy create green jobs in growing, planting, and managing trees and, ultimately, jobs in repurposing the urban wood that results when trees die or need to be removed.

Trees are truly the first and fundamental "green infrastructure" of communities. Green stormwater infrastructure BMPs are designed to mimic the function of a natural forest, and community trees are a critical piece of the system. With each rainfall, trees intercept and slow the delivery of stormwater runoff pollution to waterways while filtering and taking up pollutants. While the effect of each individual tree may be modest, the collective effect of the entire tree canopy makes a significant and cost-effective contribution to addressing communities' stormwater and flooding challenges.

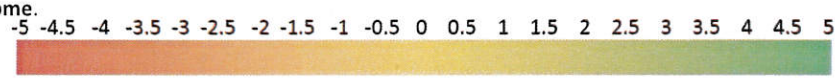
Best Management Practices with Tree Canopy in Mind

All of the forest-based best management practices listed in the table below support tree canopy in the watershed, but urban tree planting and urban forest buffers are particularly applicable to expanding tree canopy in the community context. The ratings below for fish habitat, healthy watersheds and forest buffers assume those goals are focused in more rural areas, so urban forest buffers and urban tree planting received a relatively lower score. Regardless of the ratings listed, tree canopy efforts broadly support healthy watersheds and habitat across communities of all sizes, urban to rural.

Best Management Practice	Tree Canopy	Additional Co-Benefits					
		Habitat Biodiversity	Air Quality	Land Use Methods	Fish Habitat	Healthy Watersheds	Forest Buffers
Agricultural Forest Buffer	4.5	4	4	4	4.5	4	5
Narrow Forest Buffer	5	2.5	2	3	3.5	2	5
Streamside Forest Buffers	5	4	3	4	4.5	3	5
Forest Conservation	5	5	4.5	3.5	4	5	3.5
Mine Reclamation	5	5	2	3	3	3.5	3
Urban Forest Buffers	4.5	5	4.5	4	4	3.5	5
Urban Tree Planting	5	2.5	4	3	2	2	2

Updated February 2018

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows BMPs that scored a 3.5 or higher and -3.5 or lower for the Tree Canopy Outcome.**



Guiding Principles for Incorporating Healthy Watersheds

WIP Development

- Quantify current and potential tree canopy, using the latest high-resolution tree canopy data and tools like i-Tree Landscape (both free and online).
- Emphasize actions to conserve existing canopy, as well as expand it through specific planting targets.
- Integrate tree canopy and planting goals into local planning, ordinances, and stormwater management.
- Engage a diverse coalition of partners with an interest in trees – public health, community development, sustainability, planning, etc.

WIP Implementation

- Require and encourage best practices for tree planting and maintenance that will maximize canopy growth and survival in the long-term.
- Invest in the ongoing protection and maintenance of new and existing tree canopy as critical infrastructure.
- Work with community members and groups as equal partners – target efforts in areas of greatest need.
- Track the progress of plantings as well as canopy losses, and adapt strategies accordingly.

Tools and Resources

- Chesapeake Tree Canopy Network: One-stop partnership website for state and local contacts, funding, technical guidance, and local examples from around the watershed.
- A Guide for Forestry Practices for Phase III WIPs: Packet of information on all forestry BMPs
- i-Tree Landscape tool and Webinar: Online tool allows you to do assessments of tree canopy benefits, including census block group comparisons, using the latest high-resolution Chesapeake Bay tree canopy data.
- Additional information can be found on the Forestry Workgroup page.

Contacts for More Information on Tree Canopy in Your Jurisdiction

Jurisdiction	Website	Lead	Email
Delaware	Delaware Forest Service	Kesha Braunskill	kesha.braunskill@state.de.us
D.C.	DDOT Urban Forestry Division DOEE Water Quality Division	Earl Eutsler Luke Cole	Earl.eutsler@dc.gov luke.cole@dc.gov
Maryland	Maryland Forest Service	Marian Honeczy	marian.honeczy@maryland.gov
New York	NYDEC Lands and Forests	Mary Kramarchyk	mary.kramarchyk@dec.ny.gov
Pennsylvania	DCNR Bureau of Forestry	Mark Hockley	c-mhockley@pa.gov
Virginia	Virginia Department of Forestry	Barbara White	Barbara.White@dof.virginia.gov
West Virginia	WV Project CommuniTree	Frank Rodgers	frodgers@cacaponinstitute.org
CBP Contact	CBP Forestry Workgroup	Julie Mawhorter	jmawhorter@fs.fed.us

Wetlands

Principles for Phase III Watershed Implementation Plans

Protecting Wetlands for Human Health, Economic Development and Infrastructure

Wetlands are a vital part of the landscape and are often overlooked as a key component to habitats and waterways.

Functional wetlands can benefit community health by being an area of filtration for water moving through the watershed. These areas allow for streams and runoff flows to be slowed down, allowing water to filter through the ground, often reducing pollutants and toxins, while also assisting counties and states to meet TMDL requirements. Furthermore, wetlands provide habitat for a diversity of wildlife and a complex food web, helping to minimize mosquitos and other nuisance insects (through predator-prey interactions).

Wetlands provide recreational opportunities for bird watching and hunting. Leasing areas for hunting can generate income for landowners, while promoting economic investment by community members, and encourage visitors to the area. Wetlands also create buffer zones between water and upland areas, allowing for flood and sea level rise protection helping to prevent damages to the surrounding infrastructure.

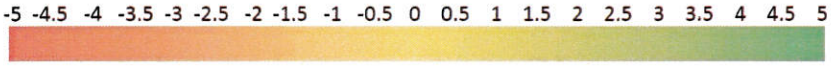
In addition to restoring and creating wetlands, identifying existing, degraded wetlands and working to improve their function, can offer powerful water quality and habitat benefits. Furthermore, the benefits of functioning wetlands and streams, while significant on their own, are even more powerful when acting together in wetland/stream complexes on the landscape. Thus, these should be considered inextricably linked for planning and implementation purposes.

Best Management Practices with Wetlands in Mind

Incorporating the protection of wetlands into project design does not necessarily require large changes in implementation. There are many best management practices (BMPs) that address the Bay TMDL, wetland vulnerability, and other Chesapeake Bay Program outcomes. Evaluating projects for wetland vulnerabilities and developing a range of strategies to offset those vulnerabilities will increase effectiveness, decrease maintenance costs, and help to ensure achievement of the Chesapeake Bay TMDL requirements into the future. See the table below for wetland-related BMPs that offer significant co-benefits for communities.*

Best Management Practice	Wetlands	Additional Co-Benefits				
		Black Ducks	Climate Adaptation	Flood Control/ Mitigation	Groundwater Recharge/Infiltration	Recreation
Wetland Restoration/ Streamside Wetland Restoration	5	4.5	1	1	1	2
Wetlands	5	3.5	2	3.5	0.5	3
Wet Ponds	4.5	2.5	2	3	0	2.5
Urban Shoreline Management	4.5	3.5	4	1	0.5	4.5
Urban Stream Restoration	3.5	3	2.5	3.5	1.5	3
Agricultural Forest Buffer	3.5	3.5	2.5	3.5	2	4
Contracted Wetland Elevated Mound	3.5	1.5	-0.5	-1	0.5	1.5
Constructed Wetland Septic	3.5	1.5	-0.5	-1	0.5	1.5
Constructed Wetland Shallow Pressure	3.5	1.5	-0.5	-1	0.5	1.5

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech and are based on the best professional judgement of subject matter experts. Appendix E. Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows select BMPs that scored a 3 or higher for the Wetland Outcome, however, not all of these BMPs would merit the score of +3 for all projects. Closer evaluation of project site designs, including those from BMPs shown in the above table, is warranted when interpreting these scores.**



Guiding Principles for Incorporating Wetlands

WIP Development

- Identify healthy wetlands and designate areas for protection.
- Capitalize on co-benefits by selecting BMPs that also protect wetlands and increase land conservation.
- Account for and consider existing stressors by integrating future population growth and land-use changes.
- Align with existing climate resiliency plans (i.e. hazard mitigation plans, floodplain management programs).
- Engage Partners – work with government agencies, elected officials, and NGOs to incorporate updated data and conservation efforts into existing WIPs.

WIP Implementation

- Reduce vulnerability - design BMPs to maximize upland treatment, reduce land use change, increase land protection, increase land value, reduce wildfires, and reduce water demand and withdrawals.
- Build in flexibility and adaptability - allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options.
- Adaptively manage - Allow for changes in design, construction and maintenance over-time as new data regarding wetland vulnerability becomes available. and as more watersheds are restored

Tools and Resources

- US Fish and Wildlife Service National Wetlands Inventory: https://www.fws.gov/wetlands/
- Wetlands Mapper: https://www.fws.gov/wetlands/data/Mapper.html
- Status and Trends Report: Status and Trends of Wetlands in the Conterminous United States 2004 to 2009
- Environmental Protection Agency: Section 404 of the Clean Water Act Resources
- National Resources Inventory: Wetland Status Report 2010
- Wetlands of Global Importance: https://www.ramsar.org/
- Chesapeake Bay Estuarine complex: https://rsis.ramsar.org/ris/375
- Chesapeake Bay Program Wetland Expert Panel: Recommendations for Incorporation of Best Management Practices in Phase 6 Chesapeake Bay Watershed Model
- Chesapeake Progress Wetlands Outcome

Contacts for More Information on Wetlands in your Jurisdiction

Jurisdiction	Website	Lead	Email
Delaware	Wetland Monitoring and Assessment	Mark Biddle	Mark.biddle@state.de.us
D.C.	Wetlands in the District	Steve Saari	Steve.saari@dc.gov
Maryland	Wetlands Program Wetlands and Waterways	Erin McLaughlin Denise Clearwater	Erin.mclaughlin@maryland.gov Denise.clearwater@maryland.gov
New York	Wetlands Program	Melissa Yearick	melissa@u-s-c.org
Pennsylvania	Waterways Engineering and Wetlands	Ken Murin	kmurin@pa.gov
Virginia	Wetland Protection	Michelle Henicheck	Michelle.henicheck@deq.virginia.gov
West Virginia	West Virginia Division of Natural Resources	Danielle Elliott	Danielle.a.elliot@wv.gov
CBP Contact	Wetland Workgroup	Jennifer Greiner	Jennifer_greiner@fws.gov