Stream Health SHWP

Management Strategy

2015–2025, v.2

I. Introduction

Restoring health to local rivers and streams not only benefits the fish, wildlife and people using them, but is a necessary step toward meeting water quality standards in the Chesapeake Bay. Over 100,000 stream miles drain the vast Chesapeake landscape and connect it to its receiving water body—the Chesapeake Bay. Many of these streams are impaired, and management actions are needed to improve the physical, chemical and biological functions of such streams while the health of intact streams is maintained, thereby increasing the net functional stream network across the watershed. Because stream health is affected by numerous factors, both on the land and in the water and resulting directly or indirectly from human activities, the success of this strategy recognizes an inherent connection to actions under other outcomes, such as wetlands, forest buffers, brook trout, healthy watersheds, toxic contaminants and implementation of water quality best management practices.

II. Goal, Outcome and Baseline

This management strategy identifies approaches for achieving the following goal and outcome:

Vital Habitats Goal

Restore, enhance and protect a network of land and water habitats to support fish and wildlife, and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed.

Stream Health Outcome

Continually improve stream health and function throughout the watershed. Improve health and function of 10 percent of stream miles above the 2008 baseline for the Chesapeake Bay watershed.

This outcome would be tracked via improvements in the Chesapeake Bay-wide Indicator of Biotic Integrity (Chessie BIBI). The Chessie BIBI is derived using individual state benthic macroinvertebrate data collected based on a common methodology agreed to by the Bay Program's Nontidal Monitoring Workgroup.

For purposes of this strategy, the definition of stream health and function is to improve 10 percent of stream miles above the 2008 baseline for the Chesapeake Bay watershed. The definition of stream health and function for this restoration-based outcome thus differs from the Healthy Watersheds Outcome definition that focuses on maintaining "healthy waters and watersheds" using individual states criteria, rather than adopting a Baywide definition. As the Stream Health Outcome includes a Baywide metric to measure the improvement in stream health and function, the Management Strategy proposes a function-based definition of stream health addressing watershed level stressors and reach-level stream functions. The function-based definition provides the ability to report and track incremental improvements in stream health achieved from addressing stressors and improving stream function. In addition to the primary benefit of providing riverine habitat for fish, shellfish and wildlife, stream restoration also is a recognized best management practice for water quality and will provide a secondary benefit of reducing nutrient and sediment loads to achieve the target load reductions as part of the Chesapeake Bay total maximum daily load (TMDL) (Table 1).

Table 1: Chesapeake Bay watershed WIP progress and 2025 targets for stream restoration (units in feet). Source CBP

	2009 Progress	2011 Progress	2013 Progress	2015 Progress	2017 Progress	2025 WIP Commitment
Urban Stream Restoration	165,375	210,031	384,990	464,372	583,465 (25%)	2,332,664
Non-Urban Stream Restoration	191,638	1,088,732	963,315	1,129,549	1,055,278 (94%)	1,128,757
Total	357,013	1,298,763	1,348,305	1,593,921	1,638,743 (47%)	3,461,421

Baseline and Current Condition

Between 2000 and 2010, more than 14,000 stream sites were sampled and rated for biological integrity. Based on the Chessie BIBI, 43 percent of the streams were in fair, good, or excellent condition. Fifty-seven percent of the streams were in very poor or poor condition. In 2018, the baseline was defined as the years between 20016 and 2011 by ICPRB and an ad-hoc team formed from various CBP workgroups. This work is included and tracked as part of this strategy's biennial workplan.

CBP uses the Chessie BIBI as a "stream health indicator"[1]. Index results were included in CBP *Bay Barometer* reports between 2008 and 2012 and after 2016. The index is mentioned specifically as a measure of stream restoration progress in the 2009 Executive Order 13508, Draft Strategy for Protecting and Restoring the Chesapeake Bay. It is a biological endpoint that will reflect the improvements in stream health and function called for in the 2014 *Chesapeake Watershed Agreement*. The index is currently being updated with the most recent macroinvertebrate data from states and local jurisdictions. It is now possible to develop and test genus-level metrics to incorporate into the index, and further test the index's sensitivity to various stressors such as altered or degraded water quality, energy source, physical habitat, flow regime, and biotic interactions.

While the Chessie BIBI provides a rating of stream health, the data and methods used for its derivation limit annual trend analysis to document changes with time. Further, the Chessie- IBI provides information about the biological condition of streams, but does not elucidate stressors impairing stream health, nor which stream functions are performing at suboptimal levels. Robust statistical analysis of the data has shown significant relationships between watershed stressors and Chessie BIBI. Watershed and stream metrics derived from routinely collected, non-biological monitoring data (e.g., land use land cover, water quality) could be used to detect changes in stream health and function, in addition to biological function, that occur between the baseline period (2006-2011) and 2017. These metrics can contribute to a broader understanding of goal attainment for the Stream Health Outcome and be used to expand the geographic extent of stressor identification and prioritization analysis.

III. Participating Partners

Team Lead: Vital Habitats Goal Team

Workgroup Lead: Stream Health Workgroup

Opportunities for Cross-Goal Team Collaboration: Fisheries Goal Team, Water Quality Goal Team, and Healthy Watersheds Goal Team

Active Current Participation and Role (**Signatory agencies in bold**)

Level of Participation: High

- Interstate Commission on the Potomac River Basin (ICPRB)
  - *Re-evaluation of Chessie BIBI to update baseline*

[1] http://www.chesapeakebay.net/indicators/indicator/health_of_freshwater_streams_in_the_chesapeake_bay_watershed

- US Geological Survey (USGS)
  - *Development of Chessie BIBI, monitoring data of streams and their assessment*
- US Fish &Wildlife Service (USFWS)
  - *Manages and implements stream restoration projects, provides training on stream restoration assessment methods and development of guidance*
- US Army Corps of Engineers (USACE)
  - *Review and approval of stream restoration projects*
  - *USACE cost-shares stream and floodplain habitat restoration projects under its ecosystem restoration mission. Under administration policy, USACE does not generally cost-share projects undertaken for principal purpose of water quality improvement*
- **EPA Region III**
  - *Review and approval of stream restoration projects*
- **EPA Chesapeake Bay Program Office (CBPO)**
  - *Partnership of federal, state and resource agencies to restore Chesapeake Bay*
- **Center for Watershed Protection (CWP)**
  - *Sediment Reduction and Stream Corridor Analysis Coordinator for the CBP*
- Virginia Tech (VT)
  - *Member of STAC, Stream Health Workgroup Drafting Team*
- **Chesapeake Bay state (VA, MD, WV, DE, PA, NY) and District of Columbia natural resource, stormwater and permit approval agencies**
  - *Monitoring stream conditions and health, implements/manages stream restoration projects and other BMPs, provides funding to support project implementation. Review and approval of stream restoration projects*
- Chesapeake Bay Trust (CBT)
  - *Co-Chair Habitat GIT, lead effort to organize pooled monitoring approach*
- National Fish and Wildlife Foundation (NFWF)
  - *Provides funding for stream restoration projects and BMPs to reduce nutrient and sediment loadings*
- Local government
  - *Responsible for implementation of BMPs to include stream restoration projects as part of the WIPs*
- Urban Stream Restoration BMP Expert Panel Members
  - *Development of protocols and nutrient and sediment pollutant load reductions to credit stream restoration projects for water quality improvements*

Level of Participation: Medium

- Natural Resources Conservation Service USDA
- University of Maryland, UMCES
- Stroud Research Center
- Johns Hopkins
- Franklin & Marshall
- Severn River Keeper: Manages/Implements Stream Restoration Projects
- American Rivers: Manages/Implements Stream Restoration/Dam Removal Projects

- Maryland Stream Restoration Association (MSRA)
- Maryland Department of Environment (MDE)

Likely Participating Jurisdictions: All listed above in addition to Maryland Water Quality Monitoring Council and Maryland State Water Quality Advisory Committee.

Local Engagement

Local government is responsible for implementation of BMPs to include stream restoration projects as part of the WIPs.

IV. Factors Influencing Success

To fully achieve this outcome, it is critical to address priority stressors to restore stream functions and improve local stream health, as well as the Bay. A stressor in the context of this strategy is any factor limiting to aquatic life, or stream processes, that occurs as a direct or indirect impact of current or past human actions. Stressors refer to both biological and physical properties. Many factors, with wide-ranging levels of importance and management potential, influence the attainment of the stream health outcome. However, the identification of principal stressors affecting stream health is needed followed by promoting measures to remediate them (USEPA 2014). A thorough understanding of ecological stressors and factors, policy/and administrative factors, and scientific knowledge and the application of research, necessary to improve stream health and function at both the local and Baywide scales is needed. Depending upon the type of stressor, the biological, chemical, and/or physical conditions of the stream ecosystem may be impacted.

1. **Ecological stressors & factors** are the physical, chemical and biological factors that impair or limit stream health recovery. They may also be watershed-based factors that limit stream function(s) or negatively affect downstream waters. Further, these factors affect stream health at two scales—local and downstream waters to the Bay. Management actions are needed to reduce stressors to improve stream health. Where appropriate and feasible, measures should be implemented outside of the stream itself to correct or limit the stress to the aquatic ecosystem. In cases where that is not practical, and or where the problem is physically in the stream channel or valley itself, stream channel and floodplain restoration work might be optimal management measures. Improvement in local streams overall is paramount to achieving this Outcome. Many of the factors listed are contributing pollutants to 303(d) listed impaired waters for which local TMDLs are established. Ecological stressors and factors influencing the Outcome include:
2. **Within the stream channel and floodplain factors:**
    - Excessive sediment and nutrients in-stream from unstable stream banks and legacy sediments in the floodplain
    - Limited nutrient and organic processing-instream
    - Alteration in channel form and function resulting in instability and disequilibrium affecting diversity and quality of habitat
    - Concentrated flows and reduction in baseflows
    - Piped and channelize streams

- Removal/Loss of forested riparian areas and the benefits provided by shading

3. **Watershed-based factors:**
   - Impervious cover and increases in stormwater runoff
   - Significant changes in watershed hydrology (time of concentration) related to overland flow impacted by road drainage, ag land drainage, driveways, stormwater collection systems, etc.
   - Flow alteration and flashy hydrology
   - Excessive nutrient loading to streams from excess untreated runoff (agricultural and urban) from the upland areas in the watershed and groundwater
   - Implementation of stormwater management controls (e.g. BMPs)
   - Leaky wastewater infrastructure
   - Toxicity of effluent from resource extraction activities (i.e., acid mine drainage, fracking)
   - Road de-icing practices (salt)
   - Thermal impacts
   - Invasive species
   - Endocrine disrupting chemicals

4. **Policy and Administrative** factors limit the implementation potential of an action. Stressors degrading streams that originate from watershed land use and or from leaky public and private wastewater infrastructure are often very challenging to address because of the scale of the problem, cost of remediation, difficulty of acquiring space for remediation projects, and other challenges. Many of these stressors are poorly dealt with via existing laws and policies. In regard to stream restoration, key among these factors are related to the permit approval process, that despite approval of many projects throughout the Chesapeake Bay, there are projects that encounter delays during the permit review process hindering, significantly in some cases, their implementation. Uncovering factors that are common to both the practitioner and regulator need to be overcome to address this barrier to implementation. The current assessment of jurisdictions to meet their 2017 and 2025 WIP targets heightens the need to address these factors to implement projects that meet the sediment and nutrient loads reductions necessary to improve stream health. Factors that influence the outcome include:
   - Review and approval of stream restoration projects for WIP implementation
   - Lack of common watershed, stressor and stream assessment and restoration guidelines
   - Integration of water quality and living resource goals during WIP stream restoration
   - MS4 permits focus on water quality
   - Adequate financial resources to support local implementation efforts
   - Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions
   - In very urban area, the availability of land to retrofit and implement upland BMPs

5. **Scientific Knowledge & Application of Research** are factors related to our current understanding of streams and their response to management interventions and the ability to effectively translate the most up-to-date scientific understanding to address Bay Agreement outcomes and regulatory guidance. Factors that influence the outcome include:
   - Stressor identification and prioritization procedures

- Functional metrics that correlate with priority stressors identified for measurement
- Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation
- Possible lag times that affect the ability to evaluate the effect of upland BMP on stream health
- Research needed to guide the selection of achievable reference conditions/design approaches based on watershed and stream functions to include an urban reference continuum
- Insufficient data to develop Baywide fish-based indicator to complement macroinvertebrate indicator (Chessie BIBI)
- Lengthy timeframe for adjusting BMP credit or recognizing new BMPs
- Limitations of the applicability of the Chessie BIBI (and other similar ecological data) to streams where restoration work is being conducted on an annual basis.
- Identify nutrient hotspot in stream valley where erodible geologic materials and soils contain excess nutrients
- Additional research to refine nutrient credits for stream restoration projects as supported by the Expert Panel recommendations on Individual Stream Restoration Projects to include for example bioavailability of nutrients.

6. **Partner coordination** is an important factor influencing success across state and jurisdiction boarders. With streams such an integrated part of the ecosystem, there are many additional CBP outcomes that rely on stream health. Efforts in the current workplan highlight the importance of coordinating, not only within the workgroup members but also across workgroups to achieve functional lift across the stream habitat. Additionally, the linear nature of streams causes them to cross boarders into different states or jurisdictions. It is important to ensure that efforts coordinated up and downstream.

7. **Funding** sources in the watershed are diverse. The current workplan aims to take advantage of a number different sources to achieve research to support functional uplift and other stream health cornerstones.

Because the definition of stream health and function for this restoration-based outcome uses a Baywide metric to measure the improvement in stream health and function, this Strategy proposes a function-based definition of stream health that provides a common framework for reporting and tracking incremental improvements in stream health based on functional lift. For example, the IBI aggregates multi-function improvements, while a disaggregation would help to determine a finer resolution of stream health indicators.

Healthy streams support and maintain basic functions associated with either structure or processes (Fischenich 2006). Stream functions are the physical, chemical and biological processes that support and sustain a stream's ecology and it is the stressors that affect these functions that are integral to improving stream health. While there are a number of ways in which stream functions may be defined (see Table , they are synergistic, or hierarchical in their function such that the quality and condition of each stream process impact others. Therefore, the processes and functions that are most critical to improve stream health will vary depending on what the stressors are for a stream and which of those stressors must be reduced or removed (Table 2).

Table 2. A summary and comparison of watershed stressors and stream functional categories.

Harman et al 2012[1]	Fischenich 2006[2]	FISRWG 1998 (updated 2001)[3]	Stressor Categories (from MDE 2015[4] and MD DNR 2005[5])
Hydrology: Transport of water from the watershed to the channel	**Hydrologic Balance:** • Surface water storage processes; • Maintain surface/subsurface water exchange • General hydrological balance	**Conduit:** the ability of the system to transport materials, energy and organisms	• Land use land cover (urban, impervious cover, mine land use)
Hydraulics: Transport of water in the channel, on the floodplain, and through sediments			• Flow regime
Geomorphology: Transport and deposition of wood and sediment to create diverse bed forms and dynamic equilibrium	**System Dynamics:** • Maintain stream evolution processes • Energy management processes • Provide for riparian succession **Sediment processes and character:** • sediment continuity, • Maintain substrate and structural processes • Quality and quantity of sediments		• Instream and riparian habitat • Habitat structure • Sediment/stream flow
Physicochemical: Temperature and oxygen regulation; processing of organic matter and nutrients	**Chemical processes and pathways:** • Maintain water & soil quality, • Maintain chemical processes and nutrient cycles • Maintain landscape pathways	**Filter:** the selective penetration or materials, energy and organisms **Barrier:** the stoppage of materials, energy, and organisms	• Water chemistry (dissolved oxygen, various pollutant parameters) • Energy source
Biology: Biodiversity and the life histories of aquatic and riparian life	**Biological support:** • Support biological communities and processes, • Provide necessary habitats for all life cycles • Maintain trophic structure and processes	**Habitat:** the spatial structure of the environment which allows species to live, reproduce, feed and move	• Biotic interactions
		Source: a setting where the output of materials, energy and organisms exceeds input **Sink:** a setting where the input of water, energy, organisms and materials exceeds output	

[1] 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.

[2] Fischenich, J.C., 2006. Functional Objectives for Stream Restoration, EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-52), US Army Engineer Research and Development Center, Vicksburg, Mississippi. http://el.erdc.usace.army.mil/elpubs/pdf/sr52.pdf

[3] FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN3/PT.653.

[4] Maryland Department of the Environment. 2015. Biological stressor identification studies. Accessed June 2015: http://www.mde.state.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/bsid_studies.aspx

[5] Maryland Department of Natural Resources. 2005. Maryland Biological Stream Survey 2000-2004, Volume XIV: Stressors Affecting Maryland Streams. Accessed June 2015: www.dnr.state.md.us/irc/docs/00007266.pdf

V. Current Efforts and Gaps

The Habitat GIT, together with the Health Watersheds GIT recognize that streams are on a spectrum of health from those that are deemed impaired to those that the states have identified as being outstanding and healthy. The Stream Health and Healthy Watersheds outcomes are complementary in that one focuses on improving the health of degraded streams (Stream Health Outcome) while the other works to maintain one hundred percent of state-identified current healthy waters and watersheds (Healthy Watershed). Streams that are in the "middle"—or marginally healthy—are at potential risk of becoming the impaired or degraded stream reaches of tomorrow that could offset any progress in neighboring or downstream reaches. Further, these marginal streams may also benefit from minimal restoration or conservation work in the watershed or in-stream that removes stressors preventing further degradation. However, restoration activity in marginal streams should proceed carefully such that appropriate restoration designs are taken to maintain and enhance natural stream processes. As streams have degraded over time, further research is needed to understand and predict how the streams will react to anthropogenic and natural pressures. It is also likely that restoration activity to improve stream health in highly degraded streams may only result is marginal improvements (e.g. Chessie BIBI poor to fair). However, as these streams may be located in ultra-urban environments, marginal improvements may contribute towards broader societal benefits (e.g. environmental justice). There is a data gap that needs to be addressed in order to develop a method to track the improvement/degradation of the marginal streams.

<u>Gaps</u>:

Information & Data

- Benthic macroinvertebrate data from enough streams with enough frequency to track progress over time. Chessie BIBI provides limited capacity for annual tracking, trend analysis less than five to seven years.
- Baywide and stream metrics other than biological indices, such as the Chessie BIBI, to assess physical and chemical health and functions of streams
- Update or review of methods to define reference conditions or endpoints for streams
- Sufficiency of data to demonstrate effectiveness of stream restoration practices
- Sufficiency of data to demonstrate restoration of stream processes following installation of upland watershed BMPs. Sufficiency
- Cumulative effects and interactions between stressors
- Completion of stressor analysis for additional watersheds

Regulatory & Programmatic

- Project design process for stream restoration that can measure change in stream functions and/project success based on a project goals and objectives. Specific to the Bay TMDL, a design process for restoration projects to reduce nutrient and sediments loads delivered downstream while at the same time ensuring optimal habitat conditions are restored.
- Information needs to support innovative, effective design approaches to identify restoration potential and success for different land uses, stream types, and current and future site

constraints, causes of impairment/stressors (e.g. legacy sediment, contaminants in water and sediment, runoff volume and velocity).

- Identification of local and watershed priority stressors that affect local steam health and management actions to results in associated function lift
- Collaboration with the Healthy Watersheds GIT to identify marginal streams and various definitions for stream health (i.e., Chessie BIBI to individual state metrics).

Prioritization

- Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement. WIPs provide a level of analysis on the type and mix of projects to meet load reductions and associated costs. The process to identify the projects varies by jurisdiction along with cost estimates.
- Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health.

Current Efforts:

Development of 2008 Baseline for the Chessie BIBI

The Interstate Commission on the Potomac River Basin received funding to reevaluate the Chessie BIBI and to provide an update to the 2008 baseline. Additional efforts are currently underway to hone the strength of the Stream Health index to reflect regional differences.

Pooled Monitoring Approach to Stream Restoration Projects

During the summer and fall of 2014, an ad-hoc committee represented by regulatory agencies (USACE, EPA, MDE, FWS), other state agencies (MDE, MD DNR, MD SHA), stream organizations (MSRA), local government (Anne Arundel County) was coordinated and lead by the Chesapeake Bay Trust to explore and begin development of a pooled monitoring approach. In most cases, the data currently generated from permitted stream restoration projects are insufficient to assess the functional improvement, or uplift, as a result of management actions. While other factors affect the ability to assess the impact of stream restoration projects, the identification of specific monitoring parameters that align with project goals and objectives is needed. A Request for Proposals was released by this committee through the CBT to answer research questions that will ultimately lead to an increased confidence in stream restoration project outcomes, clarification of the optimal site conditions in which to apply particular stream restoration techniques, information useful to regulatory agencies in project permitting and information that will help guide monitoring programs.

With this program up and running, the Stream Health workgroup is currently expanding the efforts to jurisdictions besides Maryland, an already active participant. The workgroup is providing input to the existing pooled monitoring research program, including topics for research and dissemination support of the effort/results. Furthermore, the workgroup is assisting with key expansion/development efforts (e.g., proposed effort to support the MD MS4 permit monitoring requirements through the Pooled Monitoring Program, and a long-term funding plan). Finally, the workgroup is supporting efforts to disseminate results via an annual forum and a data clearinghouse.

Ongoing Monitoring Efforts

There are several state and resource agency monitoring programs to support the assessment of stream health and function at the state level. These can be used along with the Chessie BIBI to track stream health toward meeting the goal of the Management Strategy. Each of the data sets have unique advantages for use in tracking. Examples of some of these efforts include:

- EPA National Rivers and Stream Assessment: The EPA NRSA sampled between 90 and 100 randomly selected sites in the Chesapeake Bay watershed. These sites have benthic invertebrate, fish, periphyton, water quality and habitat data. The EPA NRSA surveys are conducted every five years, including 2008/2009, 2013/2014, with the next one scheduled for 2018/2019.
- State 305b (Integrated Report) Reports (e.g. see http://www.mde.state.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/bsid_studies.aspx. Accessed Jan 15, 2015.)
- Tidal Network monitoring sites
- Non-Tidal Network monitoring sites
- National Park Service has five inventory and monitoring networks operating within the Chesapeake Bay (provided by Marian Norris);
- Maryland Biological Stream Survey (MBSS): Sampled 252 randomly selected sites during 2007-2009 to characterize Maryland's ecological condition. Round Four is scheduled for 2014-2018.
- County monitoring programs

MS4 permits that have incorporated Bay TMDL goals

Integration of efforts to implement BMPs to coordinate management actions to address both MS4 permit requirements along with nutrient and sediment load reductions for the Bay TMDL.

WIP implementation of BMPS

The Chesapeake Bay TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of implementation by 2017. WIPs detail how and when the Bay jurisdictions will meet their pollution load allocations. The progress for WIP implementation is reported annually to the Chesapeake Bay Program. BMPs that most notably influence stream health include runoff-reduction urban BMPs and agricultural BMPs such as stream fencing, forest buffers, grass buffers and wetland restoration.

Approximately 700 miles of stream restoration projects are expected to be implemented to achieve the nutrient and sediment load reductions required by the Chesapeake Bay TMDL. As a result, the projected implementation rate of stream restoration projects to meet the 2025 timelines with the Bay watershed is unprecedented. Based on the planned 2025 Phase II WIPs, the Chesapeake Bay Program reports that approximately 47 percent of planned stream restoration projects were implemented based on the 2017 progress reported by the Chesapeake Bay jurisdictions (NY, PA, MD, WV, VA, DE, DC), with 94 percent of the projects located in areas with non-urban land use.

Table 3: Stream restoration projects identified in the Phase II Watershed Implementation Plans (in feet) for 2025

Jurisdiction	NY	PA	MD	VA	WV	DE	DC	CBW
Non-urban	337,999	529,435	73,975	104,528	19,618	63,202	0	1,128,757
Urban	26,500	55,000	2,527,626	116,399	0	200	42,240	2,332,664
Total	364,499	584,435	2,601,601	220,927	19,618	63,402	42,240	3,461,421 (655 mi)

Development of Chesapeake Bay BMP Verification

In August 2014, the Management Board approved a framework[2] by which the Bay Program partners will develop verification programs to ensure that implemented BMPs continue to work properly and are eligible to receive nutrient and sediment load reduction credits towards the TMDLs. The framework includes BMP verification guidance from the Bay Program's six technical sector and habitat workgroups (e.g., agriculture, forestry, urban, wastewater, wetlands, and streams). While the recommended verification guidance is specific to the source sector BMPs, there are over-arching principles to which the guidance is based: practice reporting, scientific rigor, public confidence, adaptive management and sector equity. The verification process is set to go into effect in late 2018.

VI. Management Approaches

This management strategy is based on a holistic approach to improve stream health and function. The following major points are fundamental to the Stream Health Outcome Management Strategy for which actions are defined. This outcome recognizes:

- The health and function of streams affects the local stream environment as well as the downstream waters to the Bay.
- Streams are a part a system that includes the stream corridor, floodplain, wetlands and watershed, and as such, stream health is affected by both in-stream and watershed functions, processes and characteristics.
- Measures that would improve stream functions may occur in the stream itself, in the floodplain or in the watershed. Some measures could serve to meet more than one outcome of the Bay Agreement.
- Stream functions related to nutrient and sediment delivery to the Bay are of fundamental importance because of their explicit inclusion in the Bay Agreement.

Figure 1 is a conceptual illustration of this management approach showing that improvement to stream health relies upon the ability to identify the key factors that affect critical stream functions. The key factors influencing the outcome are described in Section III and include: ecological stressors and factors, policy and administration, scientific knowledge and the application of research, partner coordination and funding. Table 2 provides a list of known stressors for which thresholds that impact stream health are established, with less well-developed metrics to identify, measure and track critical stream

[2] *"Strengthening Verification of Best Management Practices Implemented in the Chesapeake Bay Watershed: A Basinwide Framework. Prepared by the Water Quality Goal Implementation Team's BMP Verification Committee.*

functions. For example, recommendations in the STAC report on “Designing Sustainable Stream Restoration Projects in the Chesapeake Bay” include a need to develop a baseline list of critical stream functions and assessment parameters to monitor the effectiveness of stream restoration to support the programmatic goal of the Chesapeake Bay TMDL, which is the driver for many stream restoration projects in the watershed. Management actions identified to address these factors are directed to remove or reduce the impact of the ecological stressor that is affecting stream function(s). Metrics are needed that quantify the effect of removing that stressor (e.g. excessive sediment) on stream response (e.g. water quality improvement). The ability to improve steam health and function is not only limited by the ability to identify the ecological stressor(s), it is also affected by policy and administration factors that may limit implementation potential of an action. For example, sufficient monitoring data to demonstrate the effectiveness of stream corridor restoration projects or new design approaches may limit permit approval, or the ability to effectively translate the most up-to-date scientific understanding into effective policy and regulatory guidance. The ability to assess progress toward the outcome will rely on the collective effect of individual actions as measured by indices of stream ecological condition (e.g., Chessie BIBI) from streams throughout the watershed, while incremental improvements may be assessed by information generated at the site-specific project scale to provide a forecast of future assessment at more regional scales.

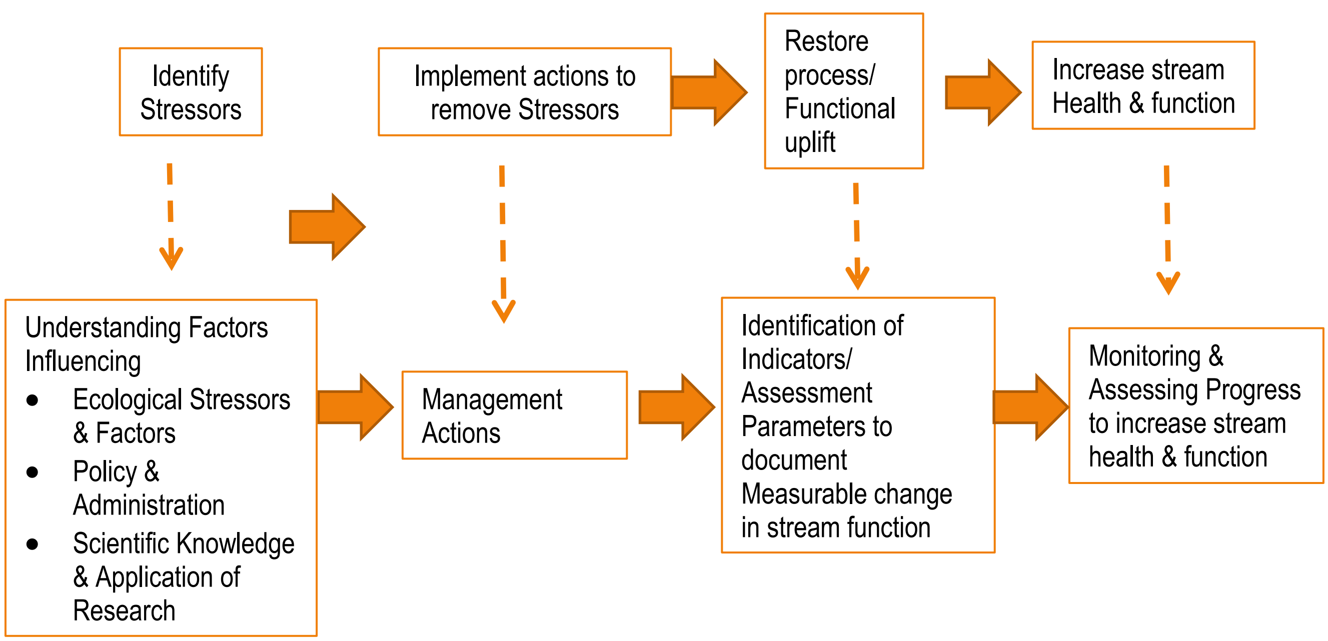

Figure 1. Schematic for Stream Health Outcome Management Strategy

Strategies to attain the Water Quality Goal outcomes (2017 WIP, 2025 WIP, Water Quality Standards and Attainment and Monitoring) complement this outcome as actions to reduce or remove stressors or factors affecting stream health may also be related to watershed activities. As such, implementation of BMPs to reduce nutrient and sediment pollution load reduction necessary to achieve water quality standards would contribute toward improving stream health. Perhaps more important, however, is the implementation of upland BMPs that reduce the volume and rate of stormwater runoff entering streams, assisting in efforts to restore ecologically sustainable flow regimes. Similarly, the practices and controls put into place that reduce and prevent the effects of toxic contaminants below levels that harm aquatic systems and humans would have a similar affect (Toxic Contaminants Outcome). Further, other outcomes that increase the wetland acreage and forested buffers in the watershed would also support improvement in stream health and function as they address the removal or reduction in priority ecological stressors and factors. Overall, the Strategy recognizes the need to identify principal stressors affecting stream health if maximum in-stream uplift is going to be achieved, then identify and promote measures to remediate principal stressors through implementation actions (USEPA, 2014).

The following five strategies are specific to the Stream Health Outcome, focusing on a well-developed, broadened application of a function-based approach to stream restoration. A function-based approach is not only central to the permit and review process, but also is recognized by researchers as a sound approach to restoration when implemented using a well-defined project process (e.g. with clearly articulated project goals and objectives). A supplemental table is provided following the Management Strategy to illustrate the priority factors and gaps addressed by the five strategies.

Strategy 1:
Identify an appropriate suite of metrics to measure the multiple facets of stream health to complement the baywide Chessie BIBI.

a. Develop a definition of stream health, measured as the length (miles) of streams improved that shows the linkage between upland drainages and local stream health, and between local stream health and the health of downstream receiving waters. This effort would work to associate metrics developed for the Chessie BIBI with individual state metrics used to track and report the Healthy Watersheds Outcome that states, “100 percent of state-identified currently healthy waters and watersheds remain healthy”.
b. Develop metrics/composite indices from routinely collected, non-biological data to measure changes in stream function to assess regional improvement
c. Include common indicators of stream functions to include for example, lateral stability, bedform diversity, habitat diversity, riparian corridor, nutrient and organic matter processing, as part of monitoring guidance for stream restoration projects to demonstrate functional lift.
d. Align metrics of functional lift with stream restoration protocols crediting projects for the Chesapeake Bay TMDL for nutrient and sediment reduction
e. Collaborate with the Healthy Watersheds GIT to identify marginal streams where restoration activity in-stream and, or in the watershed may improve stream functions and health. Once identified, work with the partnership and funders to develop incentives to build on existing efforts to target beneficial restoration activity along with guidance for permits to implement the proposed activity

Strategy 2:
Provision of adequate funding and technical resources to support functional lift in stream restoration projects, in addition to nutrient and sediment reduction.

a. Subwatershed monitoring studies that could explore how much upland retrofit implementation is needed to optimize functional uplift when stream restoration and stormwater retrofits are installed as part of an integrated restoration plan.
b. Provide training to jurisdictions to implement expert panel report recommendations.
c. Work with funding agencies to provide multi-year funding to monitor effects of stream restoration.
d. Adopt a pooled monitoring approach for different stream restoration project designs that collectively generates data to demonstrate functional lift on a project-specific basis. Overall, monitoring data generated from stream restoration projects should have the potential to demonstrate restored steam functions.
e. Establishment of an on-going stream restoration monitoring consortium and data clearinghouse within the CBP partnership to share project data.
f. Recommend incentives for projects that provide both functional uplift and water quality benefits.
g. Literature synthesis to fully document response of stream ecological conditions from stream restoration management actions that may be used to support an expert panel similar to those available for expected nutrient and sediment reductions. Part of the expert panel would address the applicability of Chessie BIBI (and other similar ecological data) where restoration work is being conducted to improve stream functions. Recommendations could be applied to help track estimated stream improvements similarly to the way nutrient and sediment trends are already tracked by the Bay Program. This panel could also develop guidance on how the restoration/enhancement of stream functions translates to nitrogen, phosphorus, and sediment "credit‟ as recommended by the STAC report on "Designing Sustainable Stream Restoration Projects within the Chesapeake Bay Watershed".

Strategy 3:
Active and engaged participation by local communities with federal and state partners is central to Bay restoration. Improvements to stream health and function will rely upon significant investments by local communities, municipal, county governments and watershed groups for example, to implement restoration and conservation actions. While, Executive Order 13508 states the Federal Leadership Committee shall closely coordinate actions by state and local agencies and consult with stakeholders and members of the public in development annual action plans and reporting progress, actions to clearly define a process for local input to advance project implementation is needed. Therefore, state and federal agencies shall ensure the participation of local communication in support of activities that advance project implementation. Ongoing coordination with stream restoration stakeholders (e.g., state and federal stream and wetland permitting authorities, natural resource agencies, local governments, non-profit organizations, stream restoration designers, researchers) needs to be improved to identify and remove barriers providing a clearly defined path to expedite the submittal and review of permit

applications, whether the proposed activity is for marginal streams, impaired streams, or for credit in the Bay TMDL.

a. A need to conduct a comprehensive review of existing stream restoration permit documentation was identified by certain members of the Stream Health Workgroup. Both permit reviewers and permitees have identified factors related to incomplete permit application submittals, monitoring requirements, and inconsistent information requested (or provided) to evaluate projects. Other factors include the need for training and guidance on the information needed to support site selection, and design approaches. Resolution of these issues should facilitate an understanding of the policies and requirements associated with regulatory review of stream restoration projects and result in a more transparent and consistent approval process in accordance with appropriate regulations and policies.
b. Review and identify opportunities to improve stream health and function, while meeting other regulatory requirements, through the coordination of multiple regulatory programs that have identified principal stressors impairing streams. For instance, states might use a biological stressor identification analysis (BSID) to identify sources of stream impairment yet resulting TMDLs might only focus on one stressor (e.g., sediment). Restoration opportunities to address this stressor are often singularly focused missing opportunities to improve other stressors identified through the BSID analysis.

Strategy 4:
Develop and promote holistic stream restoration design guidelines that identifies the level of degradation and improvement of stream functions and key stressors/factors limiting potential uplift

a. Development of function-based stream assessment framework. Current work by MDE and USFWS may be used as a template to apply in other Bay jurisdictions
b. Develop case studies to document functional response in stream with various management interventions.
c. Add language to MS4 permits to recognize function uplift as part of nutrient and sediment credits towards meeting the Bay TMDL

Strategy 5:
Work with Chesapeake Bay partners to include the Enhancing Partnering, Leadership and Management GIT, to enhance the capacity of local governments, organizations and landowners of beneficial stream restoration and maintenance practices

a. Engage with local governments to inform landowners as well as the general public of beneficial stream restoration and maintenance practices, as well as individual homeowner practices (e.g. rain barrels, lawn care) and their impact on the community. Streams in the backyards of many large and small property owners, as well as public places. A programmatic approach similar to the Upper Susquehanna Coalition Emergency Stream Intervention initiative that provides outreach and technical training and assistance through a network of conservation specialists.
b. Provide research and, or documentation that identifies the nexus between improving stream functions and health and broader societal issues such as environmental justice in support of the Diversity Outcome

VII. Monitoring Progress

Monitoring programs are critical to understanding response of stream to restoration activities—in-stream or upland areas. Federal, state, local and natural resource agency monitoring programs generate data on the physical, chemical and biological conditions of streams. These data are used to generate the Chessie BIBI. The Chessie BIBI is key to monitoring progress toward improving 10 percent of stream health and function. The strategy does not advocate for new monitoring programs. Rather, to monitor annual progress, the strategy recommends other existing data sources supplement this Bay-wide indicator (e.g. jurisdiction-specific metrics). While minor differences in stream biological, physical habitat, and water quality monitoring methods exist, jurisdiction assessments may also be useful in tracking stream health and function over time at individual sites. Further, the development of common stream assessment and restoration guidelines would generate comparable datasets across stream restoration projects. This would provide data to characterize stream health across all stream functions so that incremental changes in stream functional lift can be reported, and support data needs for the Chessie BIBI.

The monitoring data would be based on routinely, collected data to measure changes in stream functions for instream and floodplain conditions. The management strategies provide examples of the types of indicators that may be used to measure critical stream functions (e.g., lateral stability, bedform diversity, habitat diversity, floodplain connectivity, riparian corridor condition, water quality and benthic macroinvertebrates, and fish) from project specific locations throughout the watershed and streams in general. The task to identify the indicators selected to support the management strategy is recommended as part of the biennial workplan, and may include these indicators, or others as the work is undertaken. Data are routinely generated from stream restoration projects as part of permit requirements but the data requirements are not necessarily comparable across projects, nor do they necessarily inform functional improvement related

Lessons Learned

The Stream Health Workgroup updated the workplan to reflect lessons learns while trying to implement the key actions. The progress made on the work plan reflected the ability to identify a person to lead the implementation of an action.

The identification of a lead person was mostly due to an action that aligned with an organization's mission, work or directive, or funding was provided to allocate staff time to implement an action. For example, MD DNR's work and available date on stressor identification provided a good fit to lead Action 4.2. Funding made available to ICPRB provided the resources necessary to devote staff time to address Actions 1.1 and 1.2. The Chesapeake Trust is the lead organization for the Pooled Monitoring Approach (Action 2.1).

The ability to leverage existing resources or mutually beneficial actions with other groups also provided an opportunity to advance actions in the work plan. For example, a joint meeting with the Urban Stormwater Workgroup was held in June to address cross cutting issues related to stream restoration, while an opportunity to provide training in Pennsylvania lead by the Center for Watershed Protection was possible due to existing grant funding (external funding source).

The annual review of the workplan also provided an opportunity to better define (refine) actions and performance targets. For example, previously defined actions were either eliminated as they were too loosely defined, did not have an individual or organization to lead its implementation or was redundant with work underway.

Lastly, changes to the workplan occurred as it was more appropriate to define an action as a performance target of another action.

to nutrient and sediment delivery downstream, or stream health, in general. The ability to adopt a pooled-monitoring approach using commonly accepted stream assessment and restoration guidelines could then demonstrate the effect of design approaches and stream functional response from case studies analyses. Post-construction monitoring would also be supported by data generated and reported from the Chesapeake Bay Program verification guidance for stream restoration BMP implementation that recommends site visit and evaluations two years after construction and then every five years or after catastrophic event. Jurisdiction-specific verification guidance is under development.

VIII. Assessing Progress

The Chesapeake Bay Program annual progress reports on BMP implementation, specifically BMPs identified to impact critical steam functions (e.g., stream restoration, stream fencing and forest buffers) can be used to estimate the project nutrient and sediment load reductions expected from practice implementation. Assessing progress should also focus on remediation of principal stressors and stream reach functional lift based on stream restoration project goals and objectives. While projects undertaken for Bay TMDL purpose focus on nutrient and sediment reduction, information available from completed stressor identification analysis should be taken into consideration to improve stream health, as well as to instream and floodplain habitats. While we want to encourage the remediation of priority stressors to improve stream health, or maximize functional lift for all stream restoration projects, we cannot require it given site specific constraints and the ability to address watershed stressors affecting the health of the stream. It is important that a progress reporting process be developed that can be used to assess progress up through biology but allow for lower levels (i.e., stability) of report only.

IX. Adaptively Managing

For any given restoration project, there are uncertainties in the application of even the best restoration science, both stream corridor restoration and upland BMPs, which includes some level of risk that implementation may not achieve its objectives. At the scale of the Chesapeake Bay watershed this uncertainty is compounded by the extent of BMP implementation required to meet the Chesapeake Bay TMDL. The adaptive management approach to address the urban, agricultural and wastewater management measures that may improve stream health undertaken outside of the steam corridor and floodplain are addressed in the Water Quality Outcome management strategies.

As the field of watershed management, stream restoration and BMP science continue to evolve, the desired ecological endpoint for any given project may also evolve throughout the project life and through feedback from monitoring of the relevant function-based parameters. Further, understanding the response in stream health to a management action is affected by nature itself to include lag times but also the interactions amongst many stream functions. For example, the improvement in biological stream function will take a longer time period compared to improved flow regimes. In short, the understanding of stream process functions and the interrelationship with the watershed will continue to advance with implementation in the field. A process that communicates the current state of the science on the influence of efforts to improve stream health now, with periodic updates, would help ensure the most successful practices are implemented and the most benefits possible for stream health are achieved.

Supplemental Table. Stream Health Outcome Strategy, Priority Factors Influencing and Gaps Addressed by the Proposed Stream Health Outcome Management Strategy with Potential Indicators to Track Progress Towards Achievement

Management Strategy	Priority Factors Influencing	Gaps	Potential Indicators
Strategy 1: Identify an appropriate suite of metrics to measure the multiple facets of stream health.			
a. Develop a definition of stream health that shows the linkage between upland drainages and local stream health, and between local stream health and the health of downstream receiving waters	• Lack of common watershed, stressor and stream assessment restoration guidelines • Integration of water quality and living resource goals during WIP stream restoration project implementation • See list of ecological stressors and factors where the def'n would address factors affecting local stream health vs downstream waters	• Baywide and stream metrics other than biological indices, such as the Chessie BIBI, to assess physical and chemical health and functions of streams	Definition of stream health and function to support stream restoration efforts implemented to support of TMDL (Bay health) and local stream health improvements
b. Develop metrics/ composite indices from routinely collected, non-biological data to measure changes in stream function to assess regional improvement	• Limited nutrient and organic matter processing • Excessive sediment (erosive, legacy sediment) • Excessive nutrient loading to streams • Alteration in channel forms and function resulting in instability/dis-equilibrium • Flow dynamics	• Benthic macroinvertebrate data from enough streams with enough frequency to track progress over time. Chessie BIBI provides limited capacity for annual tracking, trend analysis less than 5-7 yrs. • Identification of priority stressors that affect local stream health and appropriate management actions that will result in functional lift	Linear feet restored stream length benefited Length of stream corridor which is weighted by overall uplift Reduction in biological impaired 303d streams Pounds of sediment and nutrients removed from implemented WIP stream restoration projects.
c. Develop common indicators of stream functions such as, lateral stability, bedform diversity, riparian corridor, nutrient and organic matter processing, as part of monitoring guidance for stream restoration projects to demonstrate functional lift.	• Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation • Limitations to the applicability of the Chessie BIBI (and other similar ecological data) to streams where restoration work is being conducted.	• Sufficiency of data to demonstrate effectiveness of stream restoration practices • Sufficiency of data to demonstrate restoration of stream processes following installation of upland watershed BMPs.	Coordination needed to track and report attainment of Forest Buffer Outcome

Management Strategy	Priority Factors Influencing	Gaps	Potential Indicators
d. Align metrics of functional lift with stream restoration protocols crediting projects for the Chesapeake Bay TMDL for nutrient and sediment reduction	• Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation • Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions	• Sufficiency of data to demonstrate effectiveness of stream restoration practices	
Strategy 2: Provision of adequate funding and technical resources to support functional lift in stream restoration projects, in addition to nutrient and sediment reduction.			
a. Subwatershed studies that could explore how much upland retrofit implementation is needed to optimize functional uplift when stream restoration and stormwater retrofits are installed as part of an integrated restoration plan.	• Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation • In very urban area, the availability of land to retrofit and implement upland BMPs	• Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement. • Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health. • Sufficiency of data to demonstrate effectiveness of stream restoration practices • Sufficiency of data to demonstrate restoration of stream processes following installation of upland watershed BMPs • Identification of local and watershed priority stressors that affect local steam health and management actions to results in function lift • Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health	• Watershed indicator such as impervious cover controlled
b. Provide training to jurisdictions to implement expert panel report recommendations	• Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions	• Sufficiency of data to demonstrate effectiveness of stream restoration practices	

Management Strategy	Priority Factors Influencing	Gaps	Potential Indicators
c. Work with funding agencies to provide multi-year funding to monitor effects of stream restoration	• Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation • Possible lag times that affect the ability to evaluate the effect of upland BMP on stream health	• Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement. • Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health.	
d. Adopt a pooled monitoring approach	• Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation • Possible lag times that affect the ability to evaluate the effect of upland BMP on stream health • Limitations to the applicability of the Chessie BIBI (and other similar ecological data) to streams where restoration work is being conducted.	• Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health.	
e. Establishment of an on-going stream restoration monitoring consortium and data clearinghouse within the CBP partnership to share project data	• Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions • Robust stream restoration monitoring to evaluate the potential functional lift or improvement in stream functions from BMP implementation	• Investments in research to improve the body of knowledge surrounding restoration techniques and net benefit to stream and watershed health.	
f. Recommend incentives for projects that provide both functional uplift and water quality benefits.	• Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement	• Information needs to support innovative, effective design approaches to identify restoration potential and success for different land uses, stream types, current and future site constraints, causes of impairment/stressors (e.g. legacy sediment vs runoff volume & velocity).	

Management Strategy	Priority Factors Influencing	Gaps	Potential Indicators
Strategy 3: Ongoing coordination with state and federal stream and wetland permitting authorities to ensure that stream restoration projects used for credit in the Bay TMDL are consistently applied and meet or exceed permitting requirements established to protect waters of the US			
a. TBD			
Strategy 4: Develop and promote holistic stream restoration design guidelines that identifies the level of degradation and improvement of stream functions and key stressors/factors limiting potential uplift			
• Development of function-based stream assessment and restoration guidelines. Current work by MDE and USFWS may be used as a template to apply in other Bay jurisdictions. Review potential to integrate stream function frameworks into the watershed planning process.	• Ecological stressors and factors would be addressed on a project-specific basis (related to stream channel and floodplain factors) • Lack of common watershed, stressor and stream restoration and assessment guidelines	• Information needs to support innovative, effective design approaches to identify restoration potential and success for different land uses, stream types, current and future site constraints, causes of impairment/stressors • Identification of local and watershed priority stressors that affect local steam health and management actions to results in function lift • Sufficiency of data to demonstrate effectiveness of stream restoration practices • Uniform design process for stream restoration that can measure change in stream functions and/project success based on a project goals and objectives. Specific to the Bay TMDL, a design process for restoration projects to reduce nutrient and sediments loads delivered downstream while at the same time ensuring optimal habitat conditions restored.	
• Develop case studies to document functional response in stream with various management interventions.	• Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions • In very urban area, the availability of land to retrofit and implement upland BMPs • Lengthy timeframe for adjusting BMP credit or recognizing new BMPs	• Identification of local and watershed priority stressors that affect local steam health and management actions to results in function lift	

Management Strategy	Priority Factors Influencing	Gaps	Potential Indicators
• Add language to MS4 permits to recognize functional uplift as part of credit for stream restoration projects	• MS4 permits focus on water quality	• Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement	
• Convene an Expert panel similar to those available for expected nutrient and sediment reductions, to address the applicability of Chessie BIBI (and other similar ecological data) where restoration work is being conducted.	• Limitations to the applicability of the Chessie BIBI (and other similar ecological data) to streams where restoration work is being conducted.	• Baywide and stream metrics other than biological indices, such as the Chessie BIBI, to assess physical and chemical health and functions of streams	
Strategy 5: Local Engagement			
a. Engage with local governments, stormwater managers, stream restoration practitioners to inform landowners as well as the general public of beneficial stream restoration and maintenance practices and their impact on the community.	• Adequate financial resources to support local implementation efforts • Adequate extension infrastructure to communicate newest research and technical guidance to jurisdictions • List of ecological stressors this would address dependence on restoration practices and maintenance practices addressed. Removal/loss of forested riparian area by landowners and excessive sediment and nutrients in-stream would be two priority factors to address	• Targeting procedures for cost-effective restoration actions and design approaches that will achieve both water quality and biological functional improvement	

X. Biennial Workplan

Biennial workplans for each management strategy will be developed by February 2019. It will include the following information:

- Each key action
- Timeline for the action
- Expected outcome
- Partners responsible for each action
- Estimated resources