Monitoring Re-Alignment Action Team
Final Report to the CBP Management Board

Dr. Denice Heller Wardrop
Chesapeake Bay Program Science and Technical Advisory Committee

Carlton Haywood
Interstate Commission on the Potomac River Basin

On behalf of the Monitoring Re-Alignment Synthesis Team:

Dr. Denice Heller Wardrop , Co-Chair
Carlton Haywood, Co-Chair
Richard Batiuk, US EPA
Dr. William Dennison, UMCES
Katie Foreman, CBPO/UMCES
Jacob Goodwin, formerly CBPO, now UMCES
Dr. Kirk Havens, STAC
Jacqueline Johnson, CBPO / ICPRB
Dr. Jeni Keisman, CBPO/UMCES
Scott Phillips, USGS
Dr. Peter Tango, USGS

Chesapeake Bay Program

October 27, 2009

TABLE OF CONTENTS

ATTACHMENTS

1) The Charge to the Monitoring Re-Alignment Action Team (MRAT)

\On March 13, 2009, the Management Board (MB) accepted the principal findings of a STAC review of Chesapeake Bay Program (CBP) Senior Managers' monitoring program priorities and objectives (Attachment A) that identified the following as short-term priorities for the monitoring program:

i. Delisting the tidal segments of the Bay and determining the effectiveness of management actions in the watershed should be the priorities of the CBP funded monitoring programs; and
ii. The current allocation of monitoring resources does not reflect these priorities and there should be some rebalancing.

Before making a recommendation on possible reallocation of funds for monitoring, however, the Management Board requested additional information (Attachment B). On April 14, 2009, Dr. Wardrop and Mr. Haywood proposed, and the Management Board accepted, the establishment of a Monitoring Re-alignment Action Team (MRAT) to engage the monitoring community in an evaluation of monitoring re-alignment options to better address the priorities identified above, to be presented to the Management Board in October (Attachment B).

2) The MRAT Process

The Synthesis team of MRAT formed in April and held, with STAC sponsorship, a widely advertised and open workshop on May 20-21 to discuss the process and invite participation from the monitoring community on issue-specific teams. After some evolution, the issue teams became the following: Watersheds, Partnerships, Communications, and Optimization. Teams met primarily by conference call through the summer, for some teams on a near weekly frequency. Each team was tasked with producing its own report, with authorship and final review by its members. The Synthesis Team guided discussions, provided staff support for the issue teams, and is responsible for the Synthesis Report and the accompanying tables of monitoring investment and disinvestment options. A Summit Workshop was held on October 7 to report out to the entire MRAT community the collective findings of the issue teams and to solicit comments on two draft monitoring re-alignment options. In addition, the workshop provided a facilitated discussion on how to institutionalize adaptive management into the allocation of monitoring funds. Attachment C describes the MRAT process in more detail. Subsequent to the last workshop, the Synthesis Team continued to evaluate options, ultimately arriving at its recommendation, which is a level of re-alignment that lies between the two extremes presented to the MRAT community on October 7.

After the MRAT was underway, two unanticipated events occurred to change the scope of this monitoring review. First, the President's Executive Order on the Chesapeake Bay offered the potential for significant increases in funding at some point in the future. The MRAT responded by developing a full funding option, which describes programs and costs to fully address CBP priority monitoring needs for water quality. This full funding option can serve as the basis for obtaining additional support from Congress and from Federal agencies. The full funding option also provides a benchmark against which the allocation of existing monitoring funds can be compared. The second event was the severe budget crisis in Maryland and Virginia which caused those states to begin cutting monitoring programs in advance of any recommendation by MRAT or the Management Board. The Synthesis team had to consider whether we could, or

should, include monitoring funds that are "gone" in our re-alignment options. The team decided to keep the programs recently cut or reduced by the States on the options list of potential disinvestments, with a notation that the disinvestment had already taken place, and to include the dollar value of those reduced programs on the options list of reinvestments, for these reasons:

- These budget cuts affected state match only and not EPA funds;
- The budget problem for states participating in CBP monitoring exists irrespective of any possible re-alignment of monitoring;
- In the next grant cycle the states and other partners will have the opportunity to provide new match funds or programs consistent with new priorities; and
- Even if there is a reduction in total dollars available in FY10, the identification of priorities for CBP investment in monitoring accomplished through the STAC review, the Monitoring Re-alignment Action Team process, and as approved by the Management Board, provides a road map for new monitoring resources in the future.

Responding to these two events and to feedback received from the monitoring community in their team deliberations, the Synthesis Team view of how to present a monitoring re-alignment recommendation to the Management Board evolved from the original $1 million re-alignment target. First, $0.56 million, $1.2 million, and "full funding" options were developed which provided useful context for the original target. However, the definitive packaging of options was not helpful in that the first two options each represented a set of unacceptable "extreme" circumstances. In response, a more flexible approach with a better ability to resolve a balanced option of investment and disinvestment was created. To achieve this, a set of highest priority watershed monitoring enhancements were selected from the Watershed Team report (Table 1), potential tidal disinvestments required to balance watershed enhancements under the assumption of no additional funds were selected from the Optimization Team report (Table 2), and a list of tidal and watershed enhancements for a full funding scenario were assembled with recommendations from the Watersheds, Partnerships, and Optimization teams (Table 3). With this approach, the Synthesis Team intends to provide the Management Board with an understanding of:

- The scale of resources required to fully address the key objectives of supporting delisting decisions and determining effectiveness of management actions and the gap between current and full funding levels;
- The overall scale of monitoring re-alignment necessary to achieve even modest improvements in support for determining effectiveness of management actions; and
- Program-specific implications of re-alignment toward more support for determining effectiveness of management actions if disinvestments in tidal monitoring are utilized as the only source of funds.

3) Findings of the MRAT Teams

The Watersheds Team developed detailed recommendations (Attachment D) to improve monitoring support for priority management questions related to evaluating the effectiveness of management actions. These include 1) maintaining the existing watershed water quality monitoring network with improved data management, 2) enhancing analysis of CBP and partner data to document, explain, and communicate status and changes in water quality in the

watershed, 3) enhancing data collection on watershed landscape characteristics necessary to explain water quality change, and 4) adding new monitoring stations in small basins where significant pollution reduction efforts are being made and in particular predominantly agriculture or urban watersheds. Full funding to address these priority needs would cost about $4.6 million/year.

The Partnerships Team identified nearly three hundred monitoring programs in the basin, addressing CBP living resources, water quality, and habitat quality goals (Attachment E). Of the programs relevant to water quality, nearly three quarters are watershed focused which means that there are few opportunities for partners to backfill CBP disinvestments in tidal water quality monitoring. In its review of these other programs, the Team concluded that partner programs can provide useful information but, in general, cannot answer the specific management questions identified by Watersheds team. In addition, partnerships do not represent zero cost options; investment through either direct match or additional costs for quality assurance, data management, etc would be incurred. There may also be impacts of rebalancing felt in the existing partnerships. For example, in the case of shallow water monitoring fixed buoys, partners are already working with the CBP, and cutbacks in this program would impact the associated partner monitoring effort.

The Communications Team documented the multiple ways that monitoring data are used by the CBP for communication (Attachment F) and it identified these communication priorities: a) linking restoration activities to pollution reduction; b) identifying success stories; c) identifying struggling situations; d) communicating at smaller spatial scales, i.e. “my” watershed; and e) highlighting long term trends. The Communications Team did not, however, identify specific monitoring programs that must be protected or specific gaps that need to be filled.

The Optimization Team focused on identifying reductions in tidal monitoring that would have the least impact on CBP priorities (Attachment G). The team first documented the significant contributions CBP-funded tidal monitoring has made toward understanding the Bay ecosystem and past management decision-making. Responding to the Presidential Executive Order, the team prepared a set of increases in tidal monitoring which may be considered the tidal full funding option. They then evaluated potential reductions in tidal monitoring from the point of view that all elements of current tidal monitoring have value, but some elements may be more critical to current CBP management priorities. Where potential cuts are identified, the implications of those cuts for CBP management were articulated. Potential reductions were organized around two options, one totaling $0.56 million and a second option totaling $1.059 million in cuts. While the principal objective of this exercise was to find a way to reallocate CBP funding from tidal and toward watershed monitoring in response to current management priorities, MRAT recognized that even with the current level of funding there are unmet tidal water quality information needs as with, for example, short duration Dissolved Oxygen (DO) criteria and a list of tidal program enhancements, i.e. “full funding” was developed. The team report also includes a proposal for creation of a Chesapeake Bay Synthesis and Analysis Center to facilitate periodic intensive analysis by scientists to answer specific questions.

4) Comparison Of Current Funding And Re-Alignment Options To Full Funding

The full funding option described in Table 3 provides a rough benchmark, even as an initial estimate based on best professional judgement, against which current funding for monitoring can be assessed. In the table are tidal, watershed, and partner program enhancements totaling $6.3 million/year. When added to the current funding of $4.3 million/year, then the total cost for a monitoring program fully funded[1] to meet delisting and management effectiveness decision support is $10.6 million/year. The tidal portion of that amount is $5.65 million/year and the watershed portion is $4.95 million/year (partner opportunities enhancements allocated equally between tidal and watershed). Compared to these full funding levels, the current CBP allocation of $0.9 million for watershed monitoring is at 18% of full funding and the current allocation of $3.4 million for tidal monitoring is at 60% of full funding. If all the re-alignment options shown in Tables 1 and 2, valued at $1.059 million, are adopted by the CBP, then watershed monitoring would be at 39%, and tidal monitoring at 41%, of full funding[2].

This comparison of funding levels to a full funding benchmark shows how far from meeting CBP needs is the current level of investment in all monitoring and especially watershed monitoring, and it buttresses the qualitative assessment of the Synthesis team that even a substantial re-alignment of the current $4.3 million/year provides only modest, though valuable, gains for determining the effectiveness of management actions. In addition to a re-alignment of currently available funds, the MRAT Synthesis Team recommends that the Management Board vigorously pursue additional funding for monitoring as a long term solution.

5) Assessing Options for Monitoring Re-Alignment

The Synthesis Team, bearing in mind the charge from the Management Board, distilled and integrated the team reports into these findings:

a) The Watersheds team identified, and provided costs for, enhancements to non-tidal monitoring to improve the CBP's ability to determine the effectiveness of management actions. "Full funding" of all enhancements would cost $3.69 million/year above current funding levels.
b) The Partnerships team found that potential partners exist and should be pursued as a long term strategy, but they are not a substitute for CBP designed and funded networks.
c) The Communications team identified communications priorities but did not identify any current monitoring that should be immune from changes.

[1] Includes CBP spending (EPA plus partner match) for listing/delisting for water quality impairments and determining effectiveness of management actions. Does not include monitoring for other CBP goals such as living resources, habitat, and toxics reduction, nor does it include spending by other agencies on monitoring not directly connected to the EPA funds.

[2] That a re-alignment of $1.059 million results in tidal and watershed programs being funded at approximately equal percentages of the full funding benchmark is just a coincidence. The Synthesis Team is not suggesting that there is any intrinsic value in allocating funds to achieve similar percentages of full funding.

d) Absent a new source of funding, the only opportunity for the CBP to improve its ability to determine the effectiveness of management actions is to reallocate funds from tidal monitoring to watershed monitoring.
e) The Optimization team, while holding to the mandate to maintain an ability to make delisting decisions, identified candidate tidal programs for reductions up to $1.059 million. They also identified enhancements to the current program that would be required to address unmet tidal monitoring needs focused on delisting and determining effectiveness of management actions. This "full funding" option would cost $5.58 million/year above current funding levels.

Table 1, Watershed Monitoring Network Enhancements, and Table 2, Tidal Monitoring Network Disinvestments, are organized to focus attention on obtaining the maximum benefit at least impact from re-alignment of monitoring funds and explicitly identify the tradeoffs when considering what level of re-alignment to make. Table 1 lists eight potential watershed program enhancements in descending order of benefit for determining the effectiveness of management actions, i.e. highest benefit on top. Total cost of these enhancements, which were the highest priority items in the Watershed Team's list of all needed enhancements (pp 30-35 in the Watershed Team report), is $1.059 million/year. Some observations about these potential enhancements:

a) Most of the cost, $799,000, is for data management and analysis. Of that amount, the two highest priorities are $100,000 for data management and $200,000 for data analysis needed for the existing long term water quality monitoring network. The remaining $499,000, in four tasks, is for acquisition, analysis, and documentation of data from other sources, i.e. to take full advantage of existing information to characterize the watershed and better understand the factors affecting water quality.
b) The amount of $360,000 is for eight new monitoring stations in small watersheds where a response to management actions is predicted.
c) The $1.059 million for all enhancements in Table 1 is a small fraction of the watershed monitoring enhancements identified as necessary for evaluating the effectiveness of management actions in the Watershed Team report.

Paying for these enhancements, absent additional funding, will require disinvesting from some current tidal monitoring programs. The Optimization Team report provided ten potential tidal program disinvestments totaling $1.059 million/year[3]. These are listed in Table 2, in ascending order of impact on delisting decisions, i.e. least impact on top. Some subjective judgment is involved in the ordering, but a justification is provided in the "Effect of Change" and "Rationale" columns. Some observations about these potential disinvestments:

a) In general, each of the tidal program losses reduces the CBP's ability to track and explain annual changes in the Bay ecosystem, but the decision rules stated by the Senior Managers (Attachment A) specifies that information other than that which is "critical for

[3] The Optimization Team developed two options for disinvesting, Option 1 with $556,000 in reductions and Option 2 with $1,059,000 in reductions. The Synthesis Team decided it made more sense to present to the Management Board one list of all potential disinvestments, sorted by increasing impacts, rather than two options which imply that the choice is between Option 1 or Option 2. Table 2 includes all of the potential disinvestments that make up the Optimization Team's Option 2.

the long-term scientific understanding of the ecosystem" be considered as available for re-alignment.

b) None of the disinvestment options in Table 2 take away the ability to make delisting decisions although reductions in Shallow Water Monitoring may increase the number of years required to make decisions for every part of the Bay.

c) The first $432,000 in potential disinvestments in Table 2 represents reductions that Maryland and Virginia have made unilaterally in response to their fiscal crisis. Whether this amount is available for reinvesting in new watershed priorities is not clear. These two states may not have the funds in FY10, or may have a reduced amount available, but other partners might be able and willing to participate in the new watershed studies.

d) The $432,000 in tidal monitoring programs already disinvested by Maryland and Virginia has been used as match to an approximately equivalent amount of EPA dollars. Thus, the state disinvestment makes the EPA dollars available for reinvestment.

6) Fulfillment of Management Board Requested Information

The Management Board stated at the 13 March 2009 meeting (Attachment B) that a number of informational elements were necessary in order that an option could be selected for monitoring program rebalancing. Those requested elements, with the MRAT response in italics, are as follows:

- The ability of partners to backfill portions of the monitoring program that were designated as "flexible". *The Partnerships Team Report (Attachment E) is dedicated to this task, and presents partnering opportunities for all aspects of monitoring, not only those portions designated as flexible.*
- Impacts on linkages between the core monitoring program being considered and other monitoring/investigative efforts. *Where possible, these linkages are generally expressed in the "Effect of Change" column in Tables 1 and 2. The Optimization Team report (Attachment G) describes linkages between many tidal programs. In addition, some linkages to individual programs are identified in the package of comments by the MRAT community and submitted to the Management Board. Identifying all linkages to other efforts, however, was beyond the scope of possibility for this MRAT effort.*
- Impacts of the options on the ability to make management decisions. *Specific impacts on the ability to make delisting decisions and assess the effectiveness of management actions are expressed in the "Effect of Change" or "Rationale" columns of Tables 1 and 2. Impacts on other management decisions may be included in these columns as appropriate. The general impact of the options is discussed in Section 5 above and forms the basis of the recommendations.*
- The available flexibility in the EPA Grant Programs. *The EPA determined that it could amend grants in mid year, and it subsequently issued some grants with partial funding through December 2009, and a process is in place to amend those grants as appropriate effective January 1, 2010. An RFP was issued in August in anticipation of a re-alignment decision by the Management Board and the EPA will act on the proposals received as appropriate given the Management Board's decision.*

- The ability of individual states to meet the match requirements implied in the various options. *The states were polled in the Summer on their ability to meet match requirements but, given current budget uncertainties in all the jurisdictions, it is unlikely that anyone knows what match might be possible next year. The problem of how to meet match requirements, however, applies to all CBP monitoring whether or not there is any re-alignment. The Synthesis Team assessment is that, while some match opportunities may be lost in a re-alignment,existing state partners may find new ways to match new monitoring programs and new partners may appear as well.*
- Implications of the options on long term and/or critical scientific understanding of the Bay ecosystem (the remaining portions of "what is sacred"). *Implications identified by the MRAT Teams are expressed in the "Effect of Change" or "Rationale" columns of Tables 1 and 2, and more fully in the individual team reports (Attachments D through G). Additional implications identified outside of the MRAT Team Reports (e.g., submitted by individuals or representatives of some institutions) are present in the package of comments by the MRAT community and submitted to the Management Board*.

7) Implementing Adaptive Management

The Senior Manager's Workshops coupled with the Monitoring Re-alignment Action Team deliberations are an application of adaptive management to the problem of determining the best allocation of scarce resources, in this case EPA and partner match monitoring funds. The process to align monitoring program design and resources with Bay program needs recognizes that the mission of monitoring is to inform management endpoints as well as the necessary scientific understanding of the ecosystem. This is best accomplished via a two-part process that should be repeated regularly to have real value. The first part of the process succeeded in establishing one absolutely critical part of the process that is the unambiguous articulation of information needs by CBP Senior Managers, as reported in Attachment A. This is the information that is essential in order to frame and bound the response of the science and technical community for design option development. The second process (MRAT) is one by which the science and technical community can effectively advise managers about the balancing of management-related and scientific information needs while recognizing the reality of constrained resources. This report has documented the results of the second part of this process in its first iteration for the Bay program. In subsequent iterations of this monitoring review, the following points (with a fuller explanation in Attachment H: "Lessons Learned") are suggested by the MRAT community:

- Identifying priority important management endpoints and decisions was critical for the technical review process.
- Ongoing communication between scientists and managers is essential in this process. The communication should be two way: scientists inform the managers on important ecosystem information and managers inform the scientists on management endpoints critical to decision-making
- Two-year assessments of progress are going to become the norm. Bay scientists need to help select appropriate metrics and measures of both outcomes and outputs that show progress over two-year intervals. In addition to providing information on early successes,

however, it must be reinforced continually that lags in the response of the estuary are expected and timelines for improvement must be realistic.

- Synthesis is critical. The Monitoring Realignment helped drive home the value of the interactions among tidal and non-tidal scientists. However, synthesis is not free – it requires time and money and it is a difficult process.
- A balance needs to be reached in the effort allocated to near term, high priority or crisis issues that can change every few years and the effort allocated to long term and emerging issues.

8) Synthesis Recommendations

Considering the information summarized above and documented in additional detail in the Appendices, including outcomes from the Senior Manager Workshops, the March 2009 Management Board meeting, the MRAT workshops and team deliberations, the President's Executive Order, and state unilateral disinvestments, the MRAT Synthesis Team makes these recommendations to the Management Board:

1) That the CBP adopt the list of monitoring enhancements in Table 1, in the order presented, as the highest priority for allocation of monitoring funds as they become available through a combination of re-alignment of current funds and new funds.
2) After the monitoring enhancements in Table 1 are met, that Table 3 be used as a guide for the allocation of new monitoring funds (above the current EPA + match level) as they become available to the EPA and other agencies supporting the CBP. Determining the effectiveness of management actions and ability to make delisting decisions remain the most important objectives, but the selection of which enhancements in Table 3 (watershed, tidal, or partner opportunities) may depend on the particular sources of new funds.
3) That an amount approximating $864,000 be disinvested from tidal programs in Table 2 and reinvested in watershed programs in Table 1, this amount being comprised of $432,000 of state match already lost plus $432,000 of EPA funds. The EPA funds amount should be immediately applied to watershed programs and the partner match re-investment amount will depend on what is offered by grantees in responses to the RFP. The remaining $195,000 needed to fund all watershed monitoring enhancements should not be taken from current tidal monitoring at this time.
4) That a workgroup consisting of EPA, Maryland, and Virginia grant managers, and the Technical and Support Services (TSS) Chairman, be formed to determine the most expeditious way to disinvest EPA funds from current tidal monitoring so that: a) EPA and state match are appropriately aligned for those tidal programs that continue in FY10, i.e. grant match requirements will be met and the scope of continuing programs is, where necessary, redefined; and b) there is an orderly transition that minimizes, to the extent possible, disruption to current monitoring efforts. Their work should be completed promptly so as not to delay the issuance of FY09 grant amendments or the FY10 grant guidance and RFP. One outcome of their work may be a recommendation to adjust the target of $864,000 up or down by a moderate amount to arrive at rational 'break points' in EPA and state match amounts and in the scope of continuing tidal programs. The TSS

Chairman will report to the Management Board on the findings and decisions of this workgroup.

5) That the Scientific and Technical Advisory Committee, in the next year, consider and make recommendations to the Management Board on how frequently to repeat a review of CBP monitoring that asks the question "Are our monitoring investments appropriately aligned with management objectives?"
6) That the TSS, in the next year, consider and make recommendations on how it might undertake a process similar to this monitoring review to establish priorities for monitoring for the living resources and habitat restoration goals of the Bay program. This new monitoring review will necessarily be directed at securing and directing new funding.

Table 1. CBP Watershed Monitoring Network Enhancements: table sorted in recommended order of consideration.

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment
Watershed long term water quality monitoring network	Increase data management support	+$100,000	The Watershed water quality network is an 85 station network that is the foundation for all analysis, interpretation, and communication of water quality trends in the watershed.	Increase data management and quality assurance support.	51 of the 85 stations have just reached the minimum record length to document trends. As yet there has been no increase in data management support commensurate with increase in # of stations.	$100,000
Watershed long term water quality monitoring network	Increase data analysis support	+$200,000	The Watershed water quality network is an 85 station network that is the foundation for all analysis, interpretation, and communication of water quality trends in the watershed.	Increase data analysis support to document and begin to explain patterns in water quality change (but not factors affecting change) through yearly reporting of the nutrient and sediment loads and trends in the full 85 site Watershed network.	51 of the 85 stations have just reached the minimum record length to document trends. As yet there has been no increase in data analysis support commensurate with increase in # of stations.	$300,000
Watershed long term water quality monitoring network	Add 3 new monitoring sites in small watersheds with enhanced implementation	+$135,000	The current Watershed water quality monitoring network does not monitor at scales and in landscapes appropriate to the evaluation of localized management actions. Adding small watersheds and targeted landuses sites in the network will help evaluate the effects of management actions.	Adding small watersheds and targeted landuses sites in the network will help evaluate the effects of management actions.	Quickest way to relate BMP implementation to water quality is to monitor in small watersheds with high levels of implementation of management actions.	$435,000
Watershed data analysis	Increase data analysis and synthesis support	+$100,000	There are over 60 studies in the watershed where small watersheds are or have been monitored and assessed, however none of the results have been synthesized.	Synthesize lessons learned from global literature review of small watershed studies to begin to assess the effectiveness of management actions.	Synthesis of data analysis and lessons learned from small watershed studies is critical to developing an adaptive management approach to monitoring and restoration in the watershed.	$535,000

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment
Watershed data interpret-ation	Increase funding to gather information important to explaining water quality change	+$71,000	There is a lack of available data needed to explain water quality change including information on land use, point sources, population, and agricultural activities.	Initial investment in assembling and documenting historical information on landuse, point sources, population, and agricultural activities throughout the watershed. This would be a multi-agency, multi-scaled effort including using new technologies and adding technical support to key agencies responsible for housing different unused datasets.	Initial coordination on Assembling and documenting historical information on land use, point sources, population, and agricultural activities throughout the watershed is essential information that is necessary for linking management actions to water quality response.	$606,000
Watershed data interpret-ation	Increase funding to gather information important to explaining water quality change	+$201,000	There is a lack of available data needed to explain water quality change including information on land use, point sources, population, and agricultural activities.	Larger investment in documenting and assembling missing watershed information (see above) necessary for linking management actions to water quality response.	Technical Assembling and documenting historical information on land use, point sources, population, and agricultural activities throughout the watershed is essential information that is necessary for linking management actions to water quality response.	$807,000
Watershed long term water quality monitoring network	Add 5 new monitoring sites in small watersheds with enhanced implementati on	+$225,000	The current Watershed water quality monitoring network does not monitor at scales and in landscapes appropriate to the evaluation of localized management actions. Adding small watersheds and targeted landuses sites in the network will help evaluate the effects of management actions.	Adding small watersheds and targeted landuses sites in the network will help evaluate the effects of management actions. Supports unmet local scale needs for information; monitors previously unrepresented land use composition in the watershed network	Quickest way to relate BMP implementation to water quality is to monitor in small watersheds with a predominant landuse and high levels of implementation of management actions.	$1,032,000
Watershed data analysis and interpret-ation	Increase funding to provide monitoring and analytical support to small watershed studies and synthesis results	+$27,000	There are over 60 studies in the watershed where small watersheds are or have been monitored and assessed –however, many of these projects need additional monitoring and analytical support and none of the results have been synthesized across the entire watershed.	Analyze data from small watershed studies and provide monitoring support to these studies. Begin to link management actions to changes in water quality (i.e. nutrient and sediment loads and trends).	Analysis of data analysis and lessons learned from small watershed studies is critical to developing an adaptive management approach to monitoring and restoration in the watershed	$1,059,000

Table 2: CBP Tidal Monitoring Network Disinvestments: table sorted in recommended order of consideration.

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment	Reinvestment funds available
Shallow Water Monitoring Program	VA – reduced sample collection effort	-$50,000# (VA State Funds)	SAV/water clarity listing assessments DO criteria listing assessments VA VECOS website	Less information is available for analyses related to regulatory criteria	This action reduced continuous monitoring and dataflow sampling in VA, from only those sites paid for by State Match funds.	-$50,000	$0
Phyto-plankton Monitoring Program	MD & VA - only collect an analyze minimum required to support P-IBI, at cost = current VA program, for a total of $150,000	-$220,000* (MD & VA State Funds)	Trend analyses (note: non-303d listing chlorophyll a analyses) Some "Level 1" reports Academic research Harmful Algae assessments lending support to narrative chlorophyll criterion evaluations. Understanding/ explaining ecosystem functioning (e.g. mechanisms driving HABs) Used to calculate Phytoplankton Index of Biotic Integrity (P-IBI), CBP Bay Barometer indicator; component of the UMCES Ches Bay Report Card Fish habitat Suitability modeling	Horizontal and vertical fluorescence trend analyses for states, which give more comprehensive view of chlorophyll a trends than surface data alone May reduce our ability to detect early improvements in trends Reduced explainability of bay ecosystem phenomena	Much of this program involves collection and analysis of data that are not used in criteria listing and delisting analyses or communicati ons products. A single-source provider could maintain sufficient sampling and analysis to support existing communicati ons products (Bay Barometer, UMCES Report Card) at a cost savings.	-$270,000	$0
MD Benthic Monitoring Program	MD Eliminated spring sampling	-$20,000** (MD State Funds)	Long-term trends Measuring effects of anoxic events on benthic communities	Loss of long-term trends information for spring season Loss of ability to compare benthic community health before and after summer anoxic events	VA already eliminated their spring sampling Samples do not contribute to de-listing assessments	-$290,000	$0

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment	Reinvestment funds available
Tributary Water Quality Monitoring	VA Reduced number of nutrient monitoring stations in Elizabeth River from 10 to 5	-$30,000# (VA State Funds)	Water quality criteria assessment Status and trends Part of core fixed station long-term monitoring dataset for Chesapeake Bay mainstem	Reduced explainability	Elizabeth River has an excess of nutrient monitoring stations relative to other tributaries.	-$320,000	$0
Ecosystem Processes Analysis	MD – reduced funding of MD's ecosystem processes analysis program	-$112,000** MD State Funds	Analysis support for shallow water monitoring program Development of new technological and analytical capabilities	Loss of expertise in realms of data analysis and new methods development	These functions are not critical to current needs vis-à-vis listing assessments and communications products. Other resources and new initiatives may provide similar analytical support.	-$432,000	$0
Shallow Water Monitoring Program	MD - reduce collection/analysis of nutrient samples at Shallow Water Continuous Monitoring sites)	-$40,000† (MD State Funds)	Diagnostic analyses in SAV beds Targeting of SAV restoration activities MD Baystat Summer tracking and review Comparing near-shore and open-water habitats	Would reduce information available for targeting and managing SAV restoration Less information available for comparing near-shore and open-water habitats	This action would cut nutrient sampling and analysis from continuous monitoring and dataflow samples in MD, from only those sites paid for by EPA &/or State Match funds. These analyses go beyond those performed for shallow water monitoring in VA.	-$472,000	$40,000 ($0) This funding value in parentheses is the cumulative total of only the EPA funding disinvestments without State cuts.

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment	Reinvestment funds available
Shallow Water Monitoring (SWM) Program (1)	MD - reduce number of SWM stations to 15	-$100,000 (EPA Funds)	SAV/water clarity listing assessments Event-based monitoring and explanatory analyses (i.e. HAB monitoring, Fish Kill analyses, catastrophic event analyses) Tributary basin summaries Fisheries management Education curricula Fieldwork planning for other programs (e.g. SAV overflights) Restoration & permitting of wetlands Storm surge model calibration Websites: MD Eyes on the Bay ; VA VECOS Comparisons of near-shore & open water habitats	Reduces number of CBP-funded continuous monitoring sites in MD from 27 to 15. Would reduce number of Dataflow cruises in MD from 12/month to 9/month Would probably push back completion date of complete coverage of bay from 2014 to 2016-17 in MD Reduce efficiency and/or effectiveness of other monitoring programs that use data from continuous monitors to guide their data collection	This action would reduce the number of CBP-funded SWM sites to the same number currently funded in VA. MD has been able to backfill their SWM program with funding from other partners. While data available for SAV/water clarity listing assessment would be reduced from current levels, listing assessments could still be conducted with remaining data.	-$572,000	$140,000 ($100,000)
Tidal Mainstem Water Quality Monitoring Program	MD - reduce number of mainstem cruises from 16 to 14	-$34,000 (EPA Funds)	Water quality criteria assessment Status and trends Part of core fixed station long-term monitoring dataset for Chesapeake Bay mainstem	Reduce number of cruises in June and September of each year from 2 to 1	VA's mainstem cruise schedule has comprised only 14 cruises for the majority of years since 1996. This action would reduce the number of mainstem cruises in MD to the level conducted in VA	-$606,000	$174,000 ($134,000)

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment	Reinvestment funds available
Shallow Water Monitoring (2)	Further reduce federal funding to bring entire program's cost to $115,000 per state	-$190,000 (EPA Funds) (reduction equally divided between MD & VA)	SAV/water clarity listing assessments Event-based monitoring and analyses Tributary basin summaries Fisheries management Education curricula Fieldwork planning for other programs Restoration & permitting of wetlands Storm surge model calibration Websites MD Eyes on the Bay; VA VECOS Comparisons of near-shore & open water habitats	Reductions in addition to the those listed for Shallow Water Monitoring (1), affecting both MD & VA Reduce amount of data available for SAV/water clarity listing assessments Would lengthen time to completion of one-time Shallow Water listing assessment from 2014 to approximately 2023.	This option maintains some degree of all programs that contribute data to listing assessments and communications products.	-$796,000	$364,000 ($324,000)
Ecosystem Processes Analysis	Eliminate funding for MD's Ecosystem Processes Analysis Program	-$100,000† (MD State Funds)	Analysis support for shallow water monitoring program Development of new technological and analytical capabilities	Loss of expertise in realms of data analysis and new methods development This action eliminates a full program.	These functions, while important, are not critical to current needs vis-à-vis listing assessments and maintaining current communications products. There may be other resources and new initiatives that could provide similar analytical support in new ways.	-$896,000	$464,000 ($324,000)

Program	Change	Change Value ($)	Current Uses	Effect of Change	Rationale	Cumulative Investment	Reinvestment funds available
Status & Trends	Eliminate funding for status and trends (VA & MD)	-$112,000 (EPA Funds)	Tributary strategies Track progress of nutrient reduction strategies Data QA/QC MD Eyes on the Bay website	As presently provided, these analytical results would not be available for current uses	Not used for listing/delisting. Potential exists to backfill these analytical activities through other RFPs and analytical vehicles currently being developed or discussed.	-$1,008,000	$576,000 ($436,000)
Tidal Mainstem Water Quality Monitoring	Reduce mainstem nutrient sampling by 50%	-$51,000 EPA Funds ($41,000 from MD; $10,000 from VA)	Exploration of mechanisms controlling status and functioning of the system Summer tracking/ review Targeting and assessment of management actions Long-term trends P-IBI	P-IBI needs would dictate where (32 stations)/when nutrient samples are taken, in order to maintain Report Card Loss of explainability regarding mechanisms of ecosystem conditions	This option does not affect data collected on delisting parameters during cruises. Tidal Bay nutrients are not used in listing/delisting decisions.	-$1,059,000	$627,000 ($487,000)

† State funds are allocated at the discretion of individual states and may not be available for reallocation to watershed monitoring network without State partners consent.

* MD has already eliminated its phytoplankton program ($219,000) in recent budget cuts, and VA has trimmed $25,000 from its phytoplankton monitoring budget. These funds are not be available for reallocation.

VA has already eliminated these funds in recent budget cuts, thus funds are not be available for reallocation.

** MD has already eliminated these funds in recent budget cuts, thus funds are not be available for reallocation.

Table 3: Increased Investment in Monitoring Programs to fully meet management effectiveness and delisting objectives focused on water quality.

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
Data management and yearly updates from maturing 85 mature watershed network sites	Watershed	0.5	USGS and states, 1.25	2	USGS/States	100,000-200,000	Meet the previously unmet support needed to attain full data management, quality assurance, and reporting of nutrient loads and trends in the matured 85-site watershed network. This network is the backbone to understanding loads and trends in the watershed
Stewardship of watershed information (landuse/landcover change, BMP information, etc.); data assimilation and quality assurance to explain the effects of management actions	Watershed	1	States, Academics and Watershed groups, 5 FTE	4	CBP Science Team/States/ Watershed groups/Counties/NRCS/USDA / NFWF/Academics/NOAA	400,000	Assembling and documenting historical information on landuse, point sources, population, and agricultural activities throughout the watershed is essential information that is necessary for linking management actions to water quality response.
Explain water-quality change and assess the effectiveness of management actions using long-term NTN sites (≥10 years)	Watershed	0	USGS and States, 1.25	1-2	USGS, Academics (SERC, VA-tech, etc.), States, Mid Atlantic WQ Network	100,000-200,000	Documenting patterns in water quality change and linking them to the factors affecting change is essential in the longterm watershed water monitoring network to help assess the sum of impacts of management actions in large watersheds.
Implement sites in targeted small watersheds with enhanced implementation - ag and urban landuse (add 6-18 sites)* Assumes large amount of monitoring already being done by partners in each small watershed	Watershed	0	0	NA	NTWG members/MWCOG	270,000-810,000	The current watershed water quality monitoring network does not monitor at scales and in landscapes appropriate to the evaluation of management actions. Adding small watersheds and targeted landuses sites in the network will help evaluate the effects of management actions.
Synthesis of lessons learned, data analysis and assessment in small watersheds to evaluate the effectiveness of management actions	Watershed	0	States, Watershed groups, Academics, 5 FTE	1 FTE	States/ Watershed groups/Counties (ex. Fairfax)/NRCS/ USDA/ NFWF/Academics (ex. St. Mary's College)/ARS	100,000	Synthesis of data analysis and lessons learned from small watershed studies is critical to developing an adaptive management approach to monitoring and restoration in the watershed

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
					CEAP/NFWF/ Baltimore LTES/USGS		
Develop additional trend analysis techniques for documenting water quality change	Watershed	0	USGS, 1	1	USGS/Academics	100,000	Current trend techniques lack the ability to look at short-term trends and flow-regime related trends that are crucial to understanding water quality trends and the effectiveness of management actions.
Improve and update stream health indicator	Watershed	0.5	ICPRB and States,1	1	ICPRB/UMCES	100,000	This indicator is an important tool for targeting restoration and monitoring resources in the watershed.
Small watershed studies: Synoptic surveys and other monitoring support. *Assumes large amount of monitoring already being done by partners in each small watershed	Watershed	0	0	varies	USGS/States/Academics	100,000-200,000	Monitoring support for small watershed studies is critical in order to provide specific data (e.g. groundwater quality data, etc.) that help evaluate the effectiveness of management actions.
Continue to use and improve CBP modeling tools for targeting	Watershed	2	USGS, 0.5	0.25-0.5	USGS/CBP-modelers	25,000-50,000	Improving and using the CBP watershed modeling is essential for decision support tool development.
Determine how data from state integrated assessments can be used to target - Database management and synthesis	Watershed	0	States, 0.25	0.25-0.5	States/ICPRB/ CBP	25,000-50,000	There is a lot of information that is available from state integrated assessment reports that could be used as addition information to help make management decisions. This data should be evaluated for its usability before it is considered. (i.e. method comparability across the watershed)
Develop analytical techniques that use ambient state data for load and trend analysis	Watershed	0	States and Academics, 4 FTE	1-3	USGS/States/Academics	100,000-300,000	States have many additional sites in their ambient programs that are sampled and not included in the watershed network. Determining how this data can be used in conjunction with the watershed network data would be valuable to fill spatial and temporal

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
							gaps in the watershed network.
Address source sectors in regional network - at a variety of scales (add 6-12 sites)	Watershed	0	0	NA	NTWG members	270,000-540,000	The watershed network lacks sites in specific source sectors (predominately urban and agricultural landuse areas). Filling in these gaps would aid in the ability of the network to answer specific management questions (i.e. the effectiveness of management actions)
Add sites in coastal plain to improve load estimates and integrate with tidal monitoring (add 6-12 sites)	Watershed	0	0	NA	NTWG members	270,000-540,000	The watershed network lacks sites in the coastal plain. Filling in this gap would aid in the ability of the network to answer specific management questions (i.e. the effectiveness of management actions) and improve watershed models.
Producing additional communication products utilizing a science communicator to develop status and trends indicators and other communication products	Watershed	0.25	States and Ecocheck, 1 FTE	1	Ecocheck/ UMCES/USGS /Academics	100,000	Additional communication products are important to relay watershed information to decision makers and the public. Currently only 2 indicators are represented for the watershed in the Bay Barometer.
Total Cost – Watershed: 2,060,000-3,690,000							

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support needed (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
Develop analytical methods to better separate "signal" of management actions from "noise" of natural and sampling variability at multiple spatial and shortest possible temporal scales	Tidal, watershed, integrated	0	TBD	2	TMAW members, TBD	300,000	Monitoring programs currently lack dedicated resources focused on developing analytical methods that will allow us to provide answers that are critical to effective adaptive management decision-making. New analytical methods need to be developed to meet this need.
Synthesize information from monitoring data and modeling exercises to better support targeting of management actions	Tidal	1	1-2	1-3	TMAW members, TBD	100,000 – 500,000	Modeling staff are constantly refining their modeling and analytical tools in ways that can advance monitoring and adaptive management needs, yet the monitoring and modeling programs lack sufficient resources (primarily staff time) to integrate lessons from the monitoring and modeling arenas.
Quantify relationships between pollutant loads, BMPs, and water quality/living resource indicators at multiple spatial scales	Tidal, watershed, integrated	TBD	2-4	1-3	TMAW and NTWG members, TBD	300,000	The effectiveness of management actions needs to be assessed across spatial and temporal scales ranging from short-term response in small, watershed streams to responses seen over longer timescales in large tributaries and segments of the Bay. Analyses integrating these scales are an important tool for ensuring that the management actions continue to be effective as temporal and spatial timescales increase.
Deduce causes of degraded water clarity observed in Chesapeake Bay	Tidal	0.5	1-2	2 (Research)	TMAW members, UMCES, SERC	150,000	Significant degradation of water clarity has occurred in large portions of the Chesapeake Bay and its tidal tributaries even as nutrient and sediment loads have generally decreased or remained stable over the past 20 years. In order to identify actions that will help to reverse this disconcerting trend, we must understand its causes.
Quantify expected lag times between load reductions and improved	Tidal, watershed, integrated	0	1-2	Research	TMAW and NTWG members, TBD	150,000	Monitoring programs currently lack dedicated resources focused on developing analytical

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support needed (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
water quality/benthic health for each Chesapeake Bay segment							methods that will allow us to provide answers that are critical to effective adaptive management decision-making. New analytical methods need to be developed to meet this need.
Quantify uncertainty in water quality analyses	Tidal	0	0	0.25-0.5	TMAW members, TBD	50,000	Quantifying uncertainty, particularly in criteria assessment analyses for dissolved oxygen, has been an outstanding and much-repeated need expressed by states and stakeholders.
Resolve statistical issues in existing trends analyses	Tidal, watershed, integrated	0	1	0.25 – 0.5	TMAW and NTWG members, USGS, TBD	20,000	A number of issues have been identified for existing methods in use for performing trends analyses of tidal data, which may be obscuring our ability to identify trends. A dedicated effort to resolve outstanding issues would improve our ability to accurately detect trends in key indicators of ecosystem recovery.
Thorough optimality analysis: identify optimal locations and timescales for monitoring with limited resources	Tidal	0	0	1	TBD	20,000	Critical to effective optimization of limited resources for monitoring in the Chesapeake Bay and tidal tributaries
Enhanced data management for assembling and managing data needed for integrated analyses	Tidal, watershed, integrated	2	TBD	TBD	CBP, States, TBD	200,000	Data management activities currently occur in parallel in tidal and watershed realms. In order to develop and perform integrated analyses that extend across spatial and temporal scales, resources must be dedicated to assembling the appropriated synthetic datasets in a meaningful manner.
Communications Product Development and Distribution	Tidal, watershed, integrated	2	2-4	2	IAN/Ecocheck	200,000	Communication products need to be developed or further refined in order to relay information that integrates response to management actions in watershed and tidal portions of the watershed to decision makers and the public.
Total Cost – Tidal and Integrated: 1,490,000 to 1,890,000							
Running Total-3,550,000 to5,580,000							

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support needed (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
Acquire updated land use coverage's for use in watershed modeling and monitoring activities	Integrated watershed and tidal	1	TBD	2 once every 5 years	USGS, NOAA, USDA	300,000 once every 5 years	Updated land use/ land cover is a critical component for linking changes in land use and management activities to water quality across scales in the watershed, tributaries, and Chesapeake Bay
Better integration of USFWS and NOAA supported Fisheries monitoring Programs with ongoing water quality monitoring	Integrated watershed and tidal	2	2	TBD	NOAA, USFWS, States	TBD	Fishery monitoring needs to be coordinated with water quality and habitat monitoring so they are spatially and temporally compatible to support Ecosystem Based Fisheries Management. There a need for the maintenance, enhancement and expansion key non-fisheries monitoring programs (water quality, SAV, phytoplankton, zooplankton, and benthos and forage fish) and facilitated regular data exchange between programs to enhance our ability to assess effectiveness of management actions.
Better integrate the products of the NOAA-Coastal Prediction Center in conjunction data from NASA's-Earth Observing System- AM & PM Missions, and SeaStar Mission	Tidal	0	4-NOAA NCBO	0.5	NOAA, NASA	100,000	A partnership with the National Oceanic and Atmospheric Administration-Coastal Prediction Center and National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center's ocean color group would provide a variety of satellite data, which have potential for filling spatial and temporal gaps in Bay water quality monitoring (chlorophyll, turbidity and sea surface temperature) and land use data (elevation).
National Oceanic and Atmospheric Administration-Physical Oceanographic Real-Time System and National Data Bouy Center-National Weather Service	Tidal	0	Numerous	TBD	NOAA	TBD	Buoy observing systems operated by NOAA have been a long under utilized data source. The data available as little cost to CBP could be used to fill gaps created by decreased funding for continuous water quality monitoring in tidal areas. CBP would also want to approach NOAA about adding additional instrumentation on selected buoys for selected parameters. (DO salinity, turbidity & pH).

Activity	Tidal/ Watershed/ Integrated	Existing activities: currently coordinated by CBP, (#FTE)	Existing activities: currently coordinated by partners, (#FTE)	Additional support needed (#FTE)/yr	Partnering opportunities	Total estimated cost ($) activities	Rationale for investment
Acquire updated wetlands coverage data. Through a partnership with United States Fish and Wildlife Service-National Wetland Inventory	Integrated watershed and tidal	0.25	TBD	TBD	UFFWS, USGS, Ducks Unlimited, USDA	100,000	Last comprehensive assessment of wetland in the water shed was completed in 1995 and need to be updated. Currently available C-CAP data is adequate to see wetland changes in select tidal areas of the Bay, but lacks resolution adequate to see changes in the resource over time on a bay wide scale.
Better integration with small independent water quality monitoring programs to better assess near field effects of management actions	Integrated watershed and tidal	0	TBD	1	St. Mary's College of Maryland , USGS, USFS, Fairfax County, VA, USDA, MDDNR, DC Government	350,000	Numerous small monitoring programs have been identified as high potential monitoring partners due their locations and the quality of there programs. These programs include St. Mary's River Monitoring, the Baltimore Ecosystem Study-, Fairfax County Monitoring Project, Choptank River monitoring Program and District of Columbia Water Quality Monitoring Program
Total Cost – Partnering Opportunities: 725,000							
Running Total-4,300,000 to 6,305,000							