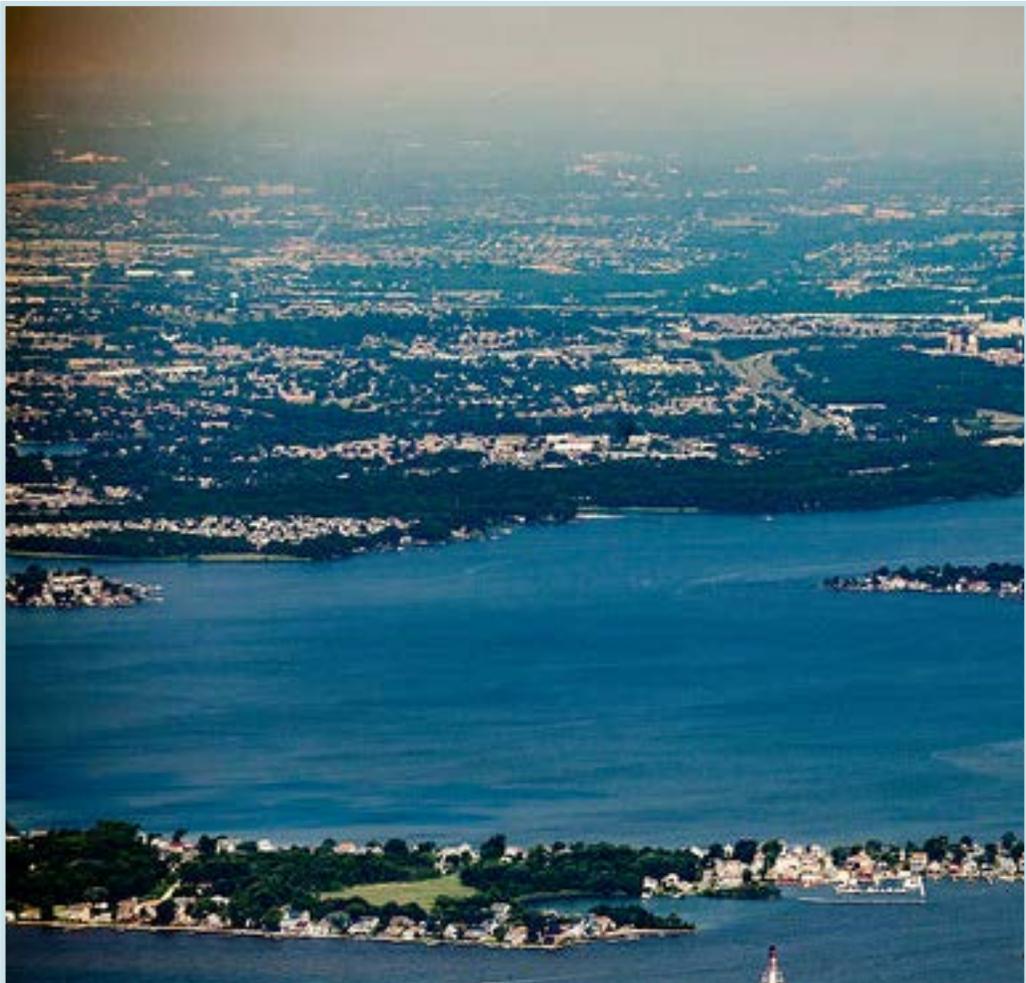# Climate Change and the Chesapeake Bay Total Maximum Daily Load:
Policy Priorities and Options

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About the Virginia Coastal Policy Center

The Virginia Coastal Policy Center (VCPC) at the College of William & Mary Law School provides science-based legal and policy analysis of ecological issues affecting the state's coastal resources, providing education and advice to a host of Virginia's decision-makers, from government officials and legal scholars to non-profit and business leaders.

With two nationally prominent science partners – the Virginia Institute of Marine Science, one of the largest marine research and education centers in the United States, and Virginia Sea Grant, a nationally recognized broker of scientific information – VCPC works with scientists, local and state political figures, community leaders, the military, and others to integrate the latest science with legal and policy analysis to solve coastal resource management issues. VCPC activities are inherently interdisciplinary, drawing on scientific, economic, public policy, sociological, and other expertise from within the College and across the country. With access to internationally recognized scientists at VIMS, to Sea Grant's national network of legal and science scholars, and to elected and appointed officials across the nation, VCPC engages in a host of information exchanges and collaborative partnerships.

VCPC grounds its pedagogical goals in the law school's philosophy of the citizen lawyer. VCPC students' highly diverse interactions beyond the borders of the legal community provide the framework for their efforts in solving the complex coastal resource management issues that currently face Virginia and the nation. Whether it is working to understand the underlying realities of local zoning policies or attempting to identify and reconcile the concerns of multiple stakeholders, VCPC students experience the breadth of environmental lawyering while gaining skills that will serve them well regardless of the legal career they pursue upon graduation.

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Introduction

President Obama rightly called the Chesapeake Bay a "national treasure," recognizing it as "one of the largest and most biologically productive estuaries in the world."[1] Aside from its remarkable beauty and biological diversity, the economic value of the Chesapeake Bay has been estimated at $1 trillion.[2] In recent decades, the Bay has been put under severe stress because of the pollution generated by the millions of residents of the Bay watershed.[3] In response to the Bay being listed as an impaired water under the Clean Water Act, in 2010 EPA, in coordination with the six states in the Bay watershed and the District of Columbia, promulgated a total maximum daily load ("TMDL") establishing limits for the phosphorus, nitrogen, and sediment entering the Bay.[4] EPA requires that all measures necessary to achieve these limits must be in place by 2025.

2017 marks the midpoint assessment of implementation of nutrient load reductions, which the Bay TMDL allocates among 92 Bay segments. 2017 will also see the completion of the latest suite of models that measures those nutrient loads. Of particular concern is the impact that climate change will have on nutrient loads. The updated models will incorporate climate change more fully. Potentially, these environmental shifts could make complying with maximum nutrient load allocations by the year 2025 substantially more difficult.

What follows is an analysis of how climate change could affect the Bay, what authority EPA has for responding to increased loads, and a host of equitable and practical considerations for how to respond most effectively in the event that the burden of meeting the TMDL goals is made heavier by climate change. The analysis has been informed in part by study of the TMDL document and related scientific materials. The primary sources were the many conversations we had with a range of experts, including scientists, Chesapeake Bay Program officials, Chesapeake Bay Commission members, planning district commission officials, local government attorneys, and a variety of other individuals with intimate knowledge of the TMDL. The conclusions that follow have particular value in that they synthesize the views of this wide range of stakeholders.

Part I. Impacts of Climate Change on Chesapeake Bay Resources

The Chesapeake Bay is a vast and unique body of water. It is the largest estuary in the United States, but it is also surprisingly shallow.[5] This combined with the Chesapeake Bay's 11,684 miles of shoreline—more shoreline than the entire west coast of the United States—gives the Bay the largest land-to-water ratio of Earth's large coastal areas.[6] Its mix of salt and fresh water, its shallowness, and its ability to retain sediments and nutrients make the Bay especially susceptible to a complex array of pollutants.[7] Scientists and policymakers consulted for this paper have identified two major problem areas for the Bay that must be addressed as climate change impacts increase: the impact of sea level rise on wetland resources, and the effects of shifting rainfall patterns.

A. Climate Change Impacts to Wetlands

Wetlands play an important role in the health of the Chesapeake Bay, with over 500,000 acres of wetlands that line the Bay proper and its tributaries.[8] These areas, where land meets the water, are buffers that slow the flow of pollutants running

into the Bay.[9] In this way, wetlands are a purification system for the Bay, because the trees and grasses in these areas filter and absorb different nutrients, sediments, and chemical contaminants before they can reach the Bay. Similarly, wetlands play an important role in erosion control by soaking up and holding large amounts of flood and stormwater, which they slowly release.[11] Wetlands located around the edges of bodies of water also slow down and absorb wave energy.[12] Lastly, wetlands provide valuable habitat and help preserve biodiversity within the Chesapeake Bay watershed.[13] Wetlands provide shelter and food sources for thousands of species within the watershed including, but not limited to, various fish, birds, mammals, reptiles, invertebrates, and insects.[14] Specifically, according to the Chesapeake Bay Program, two-thirds of the nation's commercial fish and shellfish depend on wetlands as nursery or spawning areas, and large flocks of waterfowl visit wetlands during their winter migrations to feed and rest.[15]

Wetlands have the ability to adapt to changing environmental conditions. They can retreat vertically and inland by trapping sediment to maintain the proper growing elevation.[16] Coastal wetlands have largely been able to keep up with the constant level of sea level rise,[17] but that is becoming more difficult as the pace of sea level rise picks up.[18] According to scientists interviewed for this paper, when sea level rise begins to outpace wetland movement, these areas can be inundated with saltwater and start to disappear. Trees and vegetation begin to die, and more sediment washes into the water, which increases the turbidity of the water and prevents sunlight from reaching underwater plants.[19] These sea level rise impacts lead to a loss of habitat and food sources for a number of species.[20]

While this process can have a severe impact on the Bay ecosystem, it is not clear that wetlands loss due to sea level rise is the most pressing environmental issue today. One expert interviewed for this project predicted that wetlands loss due to sea level rise would likely not become problematic until around 2050, and noted that it still is not clear to what extent wetlands will be impacted. This lack of scientific certainty, as well as the fact that it is not exactly clear that the organisms that like to use wetlands will not thrive in their absence, create questions about the impacts of wetlands loss on the Bay ecosystem. A recent study conducted by the United States Geological Survey adds some credence to this theory, suggesting that up to 70 percent of the coast from Virginia to Canada is more likely to shift than to drown because of the resilient and agile nature of wetlands.[21]

B. Climate Change Impacts on Precipitation

According to the scientists interviewed for this report, changing precipitation levels pose a more immediate threat within the confines of the Chesapeake Bay TMDL than predicted wetlands losses. The major concern is that substantive change in the nature of rainfall events is the most likely thing to affect nutrient loading to the Bay, because transmissions of sediment result from runoff events.[22] This is a problem moving forward because stormwater runoff is the fastest growing source of pollution to the Chesapeake Bay.[23]

According to a report published by the Chesapeake Bay Program Science and Technology Advisory Committee (STAC), climate change will likely bring an increase in mean rainfall.[24] While the rainfall that falls directly on the Bay does not necessarily have a major influence on the water level, precipitation impacts streamflow, which

plays an important role in regulating the Bay's overall health.[25] Sources predict an increased shift in seasonal rainfall, which will result in wetter springs and drier late summers.[26] This means that in the spring, when vegetative cover is at the lowest level, there could be an enhanced erosion of the land surface. We can also expect an increase in the intensity of precipitation, which impacts the amount of sediment, phosphorous, and to a lesser extent nitrogen in the watershed estuaries.[27]

Climate change will also lead to more intense extreme weather events.[28] Although the number of storms is predicted to decrease, even a few storms could have a long-lasting impact on the Chesapeake Bay.[29] For example, the STAC report notes that 50% of all sediment deposited in the northern Chesapeake Bay between 1900 and the mid-1970s was due to Tropical Storm Agnes (June 1972) and a cyclone associated with the Great Flood of (March) 1936.[30]

Precipitation in the watershed has an effect on the amount of fresh water that flows into the Chesapeake Bay.[31] Under normal conditions, the fresh water from the Bay's tributaries constitutes about half of the Bay's water volume.[32] The intensity and seasonal shifts in precipitation can, therefore, have major impacts on the Bay's ecosystem. When there is a more intense precipitation event, stream or river flow increases and more fresh water enters the Bay, lowering the salinity of the water in the process.[33] The change in salinity can negatively affect reproduction and behavior of several Chesapeake Bay species.[34] Along with a change in salinity, stormwater runoff transports sediment, nutrients, and other pollutants into the Bay and its tributaries, which can increase the turbidity of the water and block the sunlight from reaching underwater vegetation.[35] Excess nutrients from runoff can also feed algal blooms that create low-oxygen dead zones in the Bay, causing the suffocation of marine life.[36]

Seasonal fluctuations in rainfall can create additional problems for the Bay. During these times, river and stream flow decreases along with the amount of fresh water into the Bay.[37] This results in less sediment, nutrients, and other pollutants flowing into the Bay, but also means that these things are not flowing out of the smaller tributaries.[38] In those areas, algal growth and turbidity may increase.[39] Having less fresh water flowing into the Bay can also lead to increased salinity higher up in the Bay.[40] This can have an impact on the behavior and movement of species. For, example some underwater vegetation cannot survive if the salinity is too high, which leads to loss of habitat and food for other species.[41]

Precipitation is an area of Bay research where scientific predictions are the most difficult, and where there is still a relatively large gap in research.[42] For example, at the time of the STAC report on the impact of climate change on the Bay, there were no studies focusing specifically on cyclone changes in the Chesapeake Bay.[43] While it is likely that changes in precipitation patterns will have a large impact on the Chesapeake Bay watershed, the outcome resulting from those changes is still uncertain.

Part II. Climate Change and the TMDL: EPA's Broad Authority to Deal With Anticipated Modifications

At the time the Chesapeake Bay TMDL was being developed, it was already understood that climate change would likely impact nutrient loading into the Bay. A full year before the TMDL was promulgated in 2010, Executive Order 13508, geared toward the protection and restoration of the Bay, ordered an assessment of the impacts of climate change on the Bay's water quality and called for the development of strategies to adapt to such changes.[44] The document cited the impact of climate change on nutrient and sediment loading into the Bay as a specific concern.[45]

The TMDL document itself also anticipated that climate change would affect efforts to reduce pollutant loads to a level that would allow the Bay to meet water quality standards. EPA attempted to incorporate climate change impacts in setting load allocations, but the TMDL document acknowledged "well-known limitations in the [then] current suite of Bay models."[46] EPA is currently developing Phase 6 models[47] that more accurately reflect the impacts of climate change and fulfill the commitment EPA made in the TMDL to "conduct[] a more complete analysis of climate change effects on TMDL nitrogen, phosphorus, and sediment loads, which is to be made during the midcourse assessment...."[48]

While EPA and others have foreseen that climate change could alter the value of nutrient loads into the Bay, the magnitude of such changes remains unclear, as discussed above. But whatever the effects turn out to be, potentially increased loads will affect the framework of the TMDL in one of three ways:

1. Nutrient loads into the Bay will increase (perhaps modestly), making it harder for Bay jurisdictions to stay within their maximum load allocations, but leaving intact the current TMDL allocations;
2. Because of heavily increased and/or unevenly distributed nutrient loads, it may be necessary to redistribute load allocations among the 92 Bay segments in order to reach TMDL goals; or
3. In addition to increased loading, climate change's alteration to the Bay's hydrology may require a lowering of the TMDL value itself and a corresponding increase in the required amount of reductions, generating distributive questions with respect to the heavier overall burden of load reductions.

The first scenario, playing out within the present framework, might require increased enforcement by EPA. The second and third scenarios would involve altering the framework itself. The TMDL document explicitly foresees this possibility: "Based on possible updates to the model and on jurisdictions' WIPs [watershed implementation plans], EPA will consider revising the Chesapeake Bay TMDL, if appropriate, in 2012 and 2017."[49]

Courts have found that EPA has the authority to issue the Chesapeake Bay TMDL and take certain enforcement measures to ensure the completion of TMDL goals, so EPA appears to have the necessary authority to pursue measures to achieve water quality standards in the Bay. In this regard, EPA cleared a significant legal hurdle when the Supreme Court of the United States denied certiorari on the American Farm Bureau Federation's appeal of a ruling by the Third Circuit Court of Appeals.[50] The Third Circuit's opinion, which now stands as the final word on the matter, emphatically confirmed EPA's power to allocate loads among Bay segments, to set target dates for implementation of

nutrient loading goals, and to require states to give reasonable assurance that their plans will result in meeting those goals.[51]

The opinion approvingly references EPA's "backstop authority," a series of enforcement mechanisms that can be employed in the case of a Bay jurisdiction's failure to meet its goals. Embedded in the TMDL document, these enforcement tools include:

1. Expanding National Pollutant Discharge Elimination System (NPDES) permit coverage requirements to currently unregulated sources;
2. Increasing federal oversight of state-issued NPDES permits;
3. Requiring additional loading reductions from federally regulated sources;
4. Ratcheting up federal enforcement and compliance efforts;
5. Prohibiting new or expanded pollution discharges, or requiring net improvement offsets for these discharges;
6. Conditioning or redirecting EPA grants;
7. Revising water quality standards to better protect local and downstream waters; and
8. Discounting nutrient and sediment reduction progress if the jurisdiction cannot verify proper installation and management of pollution controls.[52]

States, of course, will almost certainly be called upon to exercise their power to enact legislation and enforce regulations that will ensure that they meet their respective load allocations. The aptly named "backstop" authority is a mechanism whereby EPA can exert pressure on states to take such actions where necessary. An additional area where EPA can operate is in the 5.3 percent of the Chesapeake Bay watershed that consists of federally owned land.[53]

Thus, EPA has the requisite authority and enforcement tools to modify the TMDL if the impact of climate change makes it necessary to do so. The more salient question, however, is political and strategic in nature: *How* should EPA exercise its power if the Phase 6 suite of models reflects significant changes in nutrient loading and/or the hydrology of the Bay on account of climate change?

Part III. Pursuing TMDL Policy Goals With an Eye Towards the Future

According to NASA, in coming decades, the myriad impacts of climate change on the global environment will continue to grow.[54] These alterations to the environmental status quo, for many reasons, are likely to increase the amount of nutrients being loaded into the Chesapeake Bay.[55] Modest increases in nutrient loads would not necessarily require EPA and the seven Bay jurisdictions to drastically alter their strategies for ensuring that TMDL goals are met. However, should increased nutrient loads become significant or distributed unevenly, or both, difficult questions of how to respond to, and perhaps reallocate, that additional burden will inevitably arise.

Although the impact of climate change on nutrient loads remains uncertain, the distinct possibility that they will be significantly higher is ample reason for TMDL jurisdictions to anticipate how they will respond to what could be a substantial policy challenge. In weighing various equitable and practical considerations, those who make

and enforce policy should pursue TMDL commitments as vigorously as possible without losing sight of longer-term goals. For whether it is yet-to-be-understood impacts of climate change or continued population growth and development in the Bay watershed, those working for the healthiest possible Chesapeake Bay will continue to face evolving challenges beyond the year 2025. This fundamental truth should inform how EPA pursues TMDL goals in the near term.

A. Uncertainty and Trust

The periodically updated suite of models used to calculate nutrient loading into the Chesapeake Bay is an invaluable tool in developing and implementing the TMDL. The Phase 6 models will be completed in 2017. Inputting the latest data available, the Phase 6 models will present the clearest possible picture of the impacts of climate change. However, it will not be the last word on the matter. In addition to uncertainty about just how much the Earth's temperature will rise in coming decades, climate change's diverse impacts on the Bay are likely to be better understood over time. It is almost certain that substantial alterations to the models will occur at some point in coming years.

While the models should become the best assessment tools available, policymakers should recognize the implications of their imperfections. For example, one challenge for localities is adjusting to "moving goalposts" when model numbers are changed. Changing course midstream might prove difficult because meeting load reduction goals often entails the marshalling of substantial resources, and thus involves political challenges. A change in best management practice ("BMP") standards (perhaps required to respond to increasing heavy rainfall events), for instance, would present a huge challenge for many localities; making repeated alterations to BMP standards could be difficult politically and perhaps untenable to put into practice.

It is imperative that EPA communicate broadly and effectively to all stakeholders the possibility that climate change will have significant implications for achieving TMDL goals. A number of scientists interviewed for this project have expressed the opinion that the impact of climate change will be rather modest in the near term, with more significant impacts taking place after 2025. If this is true, it gives scientists an opportunity to prepare jurisdictions and localities for future changes. If its message is properly calibrated, the scientific community can maintain the trust of these stakeholders.

The uncertainty involved also suggests that EPA should exercise caution in implementing new BMP standards, increasing enforcement where present allocations are more difficult to achieve because of increased loads, or reallocating load burdens because of the impacts of climate change. The worst-case scenario is that localities, possibly without much warning, feel the screws being tightened as a result of the Phase 6 models, only to have them tightened further in the wake of more complete data in the future.

B. Changes in Hydrology Will Alter the Equitable Distribution of Additional Burdens

The dominant principle for setting load allocations among the 92 Bay segments has been that those segments contributing the most pollutants must make the most significant pollutant reductions.[56] Together, geography and the hydrology of the Bay

(especially the Bay's counterclockwise current) heavily inform this calculation, the result being that the same load of a given nutrient deposited into the watershed in one locale may have as much as ten times the impact as the same pound deposited in another locale. [57] EPA terms this "relative effectiveness" between major river basins.[58] This is used to determine what percentage of all possible load reduction measures must be implemented.[59] Dischargers in segments with the lowest relative impact on nutrient loads are required to take about two-thirds of all possible load reduction measures, while the heavier contributors need to implement 90% of all such measures—the latter considered to be the maximum "controllable load."[60]

In a perhaps unfortunate twist of fate, numerous segments that are farthest away ultimately pollute more than many segments that border the Bay itself.[61] The resulting irony is that New York and Pennsylvania, jurisdictions that enjoy the benefits of the Bay the least, are required to bear particularly heavy burdens.[61] These states are far behind Virginia and Maryland in their progress towards attaining their maximum load levels.[62]

These present realities make finding an equitable method of distributing additional burdens a confounding problem. While a strong equity-based argument can be made that Bay-bordering jurisdictions should take on any additional burdens, the disparate impacts of pound-for-pound nutrient loading will almost certainly make it impracticable for Virginia, for example, to carry Pennsylvania's additional burden.

The principle of demanding more reductions from the biggest polluters has been a sensible way to spread the burden, but there are obvious limits to that approach. If the impacts of climate change are spread roughly evenly across the watershed, the factors that determine the "relative effectiveness" of load reduction measures in the river basins will cause the gap between segments' pollution contributions to widen even further. And many localities that have made the least progress towards reaching their current TMDL goals will find themselves even farther behind. The upshot is that even modestly increased loads could make it very difficult for some segments to attain their loading reductions by 2025.

C. Prudent Enforcement: Current Commitments and Additional Burdens

EPA's backstop authority is a critically important enforcement tool built into the TMDL. Where Bay jurisdictions manifestly fail to adopt practices that will result in their meeting their load reduction commitments, EPA should employ well-considered backstop measures that will both reduce nutrient loads in their own right and also give states an incentive to take necessary measures to attain their TMDL goals.

Not all backstop measures are equal, however. Some actions seem more appropriate for ensuring that localities meet their present commitments, such as increasing oversight of state-issued NPDES permits, increasing federal enforcement and compliance efforts, and conditioning or redirecting EPA grants. Other backstop measures may be better suited towards redistributing present or increased burdens. These include expanding coverage of permit requirements, requiring additional reductions from federally regulated sources, or prohibiting new, or expanded, pollution discharges.

The latter class of backstop mechanisms would achieve reduced loads at the cost of significantly hampering the growth of effected communities. And if such measures are adopted while states take insufficient steps to regulate pollutants from the agricultural sector, it heightens the risk that localities will feel unjustly punished after bearing an already heavy burden. EPA should use redistributive backstop measures judiciously, taking particular care to reward—or at least avoid punishing—localities that have made substantial progress already.

D. The Agriculture Conundrum

Beyond geographic differences in pollution contributions, a disparity in EPA's substantial regulatory authority amongst sectors may further confound efforts to equitably distribute additional burdens. EPA has substantial regulatory authority over pollutant sources that tend to be centered in urban areas, like wastewater treatment plants and Municipal Separate Storm Sewer System ("MS4") discharges. However, EPA's authority is generally scant in the agriculture sector, with its ability to regulate Concentrated Animal Feeding Operations ("CAFOs") being an exception.

It is the agriculture sector, however, that is the most obvious candidate for load reductions. Agricultural practices are the single biggest source of nutrients, contributing almost half of all the nitrogen and phosphorus entering the Bay and almost two-thirds of sediment deposits.[64] Interviewees outlined a host of practices—from fencing cattle out of streams to planting cover crops—that could result in significant load reductions if implemented comprehensively. The numerous state programs that offer cash payments for the voluntary adoption of such practices are a good start, but these are temporary, incomplete, and inefficient solutions. While EPA cannot mandate these practices, states do have the authority to enact legislation and adopt regulations that do just that.

In another irony, EPA may find that in many instances, although it does not have the authority to regulate the agriculture industry itself, using its backstop authority is necessary as a mechanism for pressuring states that are under-regulating their agriculture sectors. The potential injustice here is that urban localities that have devoted significant resources towards implementing BMPs may find themselves bearing additional burdens where states have felt that regulating the agricultural industry is too politically fraught. EPA might then be seen as further wringing a near dry sponge for water instead of putting a pail under a nearby gusher.

Part IV. Smart Solutions for Natural Resources Impacts

Any discussion of responsibility for increased nutrient loads under the TMDL must also include a discussion of smart solutions to deal with climate change on-the-ground in affected communities moving forward. These solutions are practices and strategies that should not only be implemented during the timeline of the Chesapeake Bay TMDL, but in the future to ensure the continued improvement of the health of the Bay. Two solutions mentioned repeatedly by scientists and policymakers interviewed for this paper are community outreach and redesigning BMPs to be more effective in the face of changing climate conditions.

A. The Importance of Community Outreach in Achieving the TMDL Goals

Community outreach and education are important factors in achieving the Chesapeake Bay TMDL goals for a number of reasons. First, communicating with localities reduces a perceived disconnect between scientists and decision makers and those impacted by the science and policy in practice. This disconnect leads to uncertainty regarding incorporating climate change impacts into the TMDL. Climate change is a complicated and evolving field, and education helps communities better understand why climate change impacts them. For example, farmers' lands are their livelihoods, so if the state tells them that they need to change how they manage that land or that they cannot use part of it, they are going to need a reason why the change is required. Otherwise, serious tensions may arise. Community outreach is particularly attractive because it opens up dialogues about local projects and provides the opportunity for community members to ask questions. It also brings the experts to the communities, so it is easier for people to learn from one another.

Education also can be helpful for communities that are not necessarily dealing with climate change issues first hand. It is often difficult for people who do not live around the water to understand the implications of climate change and sea level rise. For example, sea level rise in Norfolk, Virginia affects people in Richmond, Virginia. This is not necessarily obvious to a layperson when first considering the issue, but Norfolk is a major port to which goods are shipped and then distributed throughout the state and country. If flooding restricts the distribution of goods from Norfolk, Richmond and other cities will lose access to that stream of commerce. Education is one method of bringing such issues to light and helping communities that are not directly affected better understand what other localities are dealing with.

Lastly, education can help foster the next generation of individuals engaged in Bay protection. As mentioned above, some of the impacts of climate change will not be felt during the timeframe of the Bay TMDL. The next generation of scientists and policymakers will take up the mantle of protecting the Chesapeake Bay. This starts with teaching children and young adults about the Bay by incorporating it into academic curricula.[65] Doing this will get people interested in the Chesapeake Bay from an early age, and foster an appreciation for and desire to help the Bay in the future.

B. The Importance of Smart Engineering Practices in Achieving the TMDL Goals

One of the most discussed topics throughout the course of this project was the importance of BMPs, or best management practices, in dealing with the consequences of climate change. EPA defines BMPs as "[m]ethods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources."[66] BMPs vary depending on their environment and what issues they are addressing. Two examples are agricultural BMPs and urban stormwater BMPs. The top five most cost-effective agricultural BMPs, as listed by the Chesapeake Bay Foundation, are streamside buffers, streamside fencing, nutrient management plans (NMPs), continuous no-till, and cover crops.[67] Some examples of urban stormwater BMPs include retention ponds, silt fences, and rain gardens.[68]

BMPs present problems in that they can only handle a certain amount of water. Theoretically, BMPs capture water, treat it, and then allow the water to flow out. Currently, according to experts interviewed for this paper, the design of most stormwater BMPs in Virginia is based on trying to contain a ten-year rainfall event, or the first inch of rainfall. However, these strategies to mitigate nutrient loads will not be enough when one-inch rainfall becomes a monthly event instead of a yearly event.[69] Climate change may degrade many BMPs currently in place. The effectiveness of BMPs depends on location and factors that include "weather, soil type, slope, wildlife, stream size and other unique site-specific characteristics."[71] Effectiveness also varies over time depending on factors such as land use changes and the amount of maintenance done on the BMPs.[72] These factors help demonstrate why redesigning BMPs came up frequently among the various officials interviewed.

States have certain standards and specifications that BMPs have to meet for implementation,[73] and any changes to BMPs are scrutinized based on those standards. The Chesapeake Bay Program also has a BMP verification process that applies throughout the life cycle of BMPs and includes initial inspection, follow-up checks and evaluation of BMP performance.[74] According to the Chesapeake Bay Program, its BMP verification process is "the process through which agency partners ensure practices, treatments and technologies resulting in reductions of nitrogen, phosphorus and/or sediment pollutant loads are implemented and operating correctly."[75] After a jurisdiction submits BMP verification quality assurance plans to the Chesapeake Bay Program, there is a series of steps that Bay Program partners can take as ongoing evaluation and oversight tools to verify the effectiveness of BMPs.[76] The first step is to ask if there is a BMP in place, and involves an initial inspection and validation that data was collected and submitted properly, and that there are no issues with old BMP data that need to be addressed.[77] The second step deals with follow-up checks to make sure the BMP is still operating correctly.[78] This is done over a period of time to make sure the BMP is functioning correctly throughout its lifespan.[79] The third and final step deals with collecting data to analyze BMP performance, and determining whether the BMP should be re-verified, upgraded, or removed because it is no longer functioning.[80]

The third step of the BMP verification process is where climate change could be factored in to decide whether the BMP is equipped to handle changing environmental conditions. However, the BMP verification process can take years, and one official interviewed for this project noted that political pressure constitutes a major factor in reengineering BMP designs. Specifically, engineering and retrofitting BMPs costs money, and communities that have already invested millions of dollars into their BMPs will not be happy being told they are no longer sufficient. This problem can be dealt with by planning in anticipation of climate change.

However, reengineering BMPs to handle climate change impacts is not necessarily just a political issue. There are many practical scientific implications to deal with, which makes reaching consensus a slow process. One solution suggested by interviewees is upgrading and redesigning BMPs constructed of PVC, steel, or concrete that might be found in urban environments to deal with additional stormwater capacity. According to those interviewed, engineering innovators around the country are experimenting with low impact BMP designs such as swales or rain gardens, but these BMPs may be more difficult to redesign to deal with more intense

storm events than BMPs constructed with the materials mentioned above, which can more easily be built bigger or stronger. One additional consideration is that correct BMP placement is important so that BMPs have the best chance to be effective for many years.[81] To encourage these practices, BMP funds could be prioritized for those projects that have been shown to be resilient to the future anticipated precipitation effects from climate change.

C. Innovative Smart Practices Will Facilitate Achievement of Additional TMDL Goals

There are additional smart practices aside from community outreach and redesigning BMPs that will be instrumental in implementing the TMDL goals in the face of climate change. One interesting example is the Hampton Roads Sanitation District's ("HRSD") proposed plan to inject its wastewater discharges into the groundwater aquifer in eastern Virginia.[82] This plan would eliminate most of the discharges from its treatment plants into surrounding rivers. It would help combat land subsidence due to groundwater depletion, which is a contributor to sea level rise.[83] It would also cut nutrient pollution, helping localities meet their required reductions.[84] Although this is just one proposed plan to combat the impacts facing Virginia's coast, innovative strategies like this could successfully supplement policymaking and engineering in the face of climate change.

Conclusion: The Primacy of Incremental Progress Over Achievement at Any Cost

A vitally important enforcement consideration is maintaining the coalition of partners that has contributed to substantial progress in the health of the Bay over the past couple of decades. Recognizing the value of a healthy Bay and the benefits of reduced nutrient loads to local waterways, each of the seven Bay jurisdictions have teamed up with EPA in a remarkable effort of cooperative federalism in developing the Chesapeake Bay TMDL. Notably, none of the six Bay states sided with the American Farm Bureau when it challenged EPA's legal authority to issue and enforce the Bay TMDL.

Discussions with a wide variety of stakeholders make clear, however, that for many of them the prospect of increased load reduction burdens on account of climate change produces considerable anxiety. Even among officials who enthusiastically support the goals of the TMDL, there is a sense that not all parties are taking on their fair share of the load as it currently stands. Added to this concern of distribution inequity is the fear that tremendous past efforts will be for naught because the allocation targets will change.

EPA cannot back away from the goal of attaining water quality standards for the Bay. But the reality is that its enforcement mechanisms are limited to such a degree that, by themselves, they cannot ensure that those standards are met. Only with the broad, continued buy-in of stakeholders—along with some cajoling of those less willing—can the Chesapeake Bay be brought back to its fullest possible health. Those who recognize the incalculable value and beauty of the Bay want to see TMDL goals met by 2025. If, however, the impacts of climate change make that impossible, substantial incremental progress made by a healthy, continuing partnership of federal, state, and local actors is a far superior outcome to aggressive pursuit of an unattainable goal that splinters that coalition.

Appendix: Questions Asked of Stakeholders

- What do you think is the biggest impact that climate change will have on the Bay watershed?

    - Should we be prioritizing anything in particular, or looking at the big picture?

    - Should there be more focus on the airshed? Does this impact responsibility?

- What threats do climate change pose to the TMDL?

- Do different warming rates in the lower and upper portions of the Bay watershed mean different levels of damage?

    - Does this impact the allocation of responsibility?

- Are legislators more likely to approve of resilient (don't need forecasts of future conditions) or adaptive (looking at clear trends and consistent projections) responses to climate change?

    - Would using one type of response over the other hinder progress in dealing with climate change issues?

- Is it possible to have an evolving plan to deal with events that are hard to predict like more intense rainfall events happening more frequently?

- How big of an impact does climate change have on resource loss?

    - Is this something that can even be addressed by the TMDL?

- Is there an area other than resource loss that we should focus our research on?

- Would states be willing to be more strict with regulating an individual industry like agriculture? (Especially states with disproportionate interests)

    - Depending on the answer would it make more sense to have the EPA step in to reduce permits or withhold money from the states?

- Is there a way of talking to constituents to get them to understand that plans cannot remain static if TMDL goals for the watershed are to be met?

- What do you think is the best plan for the future dealing with wetland loss?

    - What impact does wetland loss actually have?

- What do you think is the best storm water solution?

- What do you think is the best solution to dealing with agriculture?

References

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[3] *Id.* at 288.

[4] EPA, Chesapeake Bay TMDL (2010), https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document

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[6] *Id.*

[7] William C. Dennison, *Why is the Chesapeake Bay so vulnerable (and productive?)*, Chesapeake Bay Action Plan (2016), http://www.bayactionplan.com/why-is-chesapeake-bay-so-vulnerable-and-productive/.

[8] *See Video: Bay 101: Wetlands*, Chesapeake Bay Program (February 8, 2016), http://www.chesapeakebay.net/discover/bay101.

[9] *Id.*

[10] *Id.*

[11] *See Understand - Conserving Coastal Wetlands for Sea Level Rise Adaptation*, National Oceanic and Atmospheric Administration, https://coast.noaa.gov/applyit/wetlands/understand.html, (last visited June 7, 2016).

[12] *Id.*

[13] *Id.*

[14] *See Marshes & Wetlands,* Chesapeake Bay Program, http://www.chesapeakebay.net/S=0/fieldguide/categories/category/marshes_wetlands (last visited May 3, 2016).

[15] *Id.*

[16] *See Virginia Wetlands Reporter, Vol. 2, Issue 1*, Virginia Institute of Marine Science (Spring 2007), http://ccrm.vims.edu/publications/publications_topics/vwr/vwr-spring07.pdf.

[17] *Id.*

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[20] *See supra* note 8.

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[22] *See NPDES Stormwater Program,* U.S. Environmental Protection Agency, https://www.epa.gov/npdes/npdes-stormwater-program (last visited May 5, 2016).

[23] *See Stormwater Runoff*, Chesapeake Bay Program, http://www.chesapeakebay.net/issues/issue/stormwater_runoff#inline (last visited May 3, 2016).

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[25] *Id.* at 17.

[26] *Id.* at 17-19.

[27] *Id.* at 17.

[28] *Id.* at 21.

[29] *Id.* at 21-22.

[30] *Id.* at 21.

[31] *See Weather*, Chesapeake Bay Program, http://www.chesapeakebay.net/issues/issue/

weather#inline (last visited May 3, 2016).

[32]   *Id.*

[33]   *Id.*

[34]   *Id.*

[35]   *Id.*

[36]   *Id.*

[37]   *Id.*

[38]   *Id.*

[39]   *Id.*

[40]   *Id.*

[41]   *Id.*

[42]   *See* supra note 24, at 17 (discussing simulations of climate models).

[43]   *Id.* at *22*.

[44]   *See* supra note 1, at § 202(d).

[45]   *Id.* at § 601(a).

[46]   *See* Chesapeake Bay TMDL, *supra* note 4, at § 10.5.

[47]   While technically a suite of models, experts often refer to Phase 6 as a single model.

[48]   *Id.* at § 5.11.

[49]   *Id.* at § 10.3.

[50]   *Am. Farm Bureau Fed'n v. EPA*, 136 S. Ct. 1246 (2016).

[51]   *Am. Farm Bureau Fed'n v. EPA*, 792 F.3d 281 (3rd Cir. 2015).

[52]   *See* Chesapeake Bay TMDL, supra note 4, Executive Summary at 13. *See* also Letter from Shawn M. Garvin to The Honorable L. Preston Bryant (Dec. 29, 2009), available at https://www.epa.gov/sites/production/files/2015-07/documents/bay_letter_1209.pdf (discussing EPA's Chesapeake Bay Accountability Framework).

[53]   *Id.* at § 10.4.

[54]   *See The Consequence of Climate Change*, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (April 27, 2016), http://climate.nasa.gov/effects/.

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[57]   *Id.* at § 6.3.1.

[58]   *Id.* at § 6.3.

[59]   *Id.* at § 6.3.3.

[60]   *Id.*

[61]   *Id. See* figures 6-5 and 6-6.

[62]   *Id.*

[63]   *See Chesapeake Bay Milestones, EPA*, https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-milestones (last visited April 28, 2016).

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[72]   *Id.*

[73]   *See e.g.,* Virginia Stormwater Management Program, 2013 BMP Standards & Specifi-cations, Virginia Department of Environmental Quality, available at http://www.deq. virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx (last visited May 5, 2016).

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[75]   *Id.*

[76]   *Id.*

[77]   *Id.*

[78]   *Id.*

[79]   *Id.*

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[81]   *See generally* Loperfido et al., E*ffects of Distributed and Centralized Stormwater* Best Management Practices *and Land Cover on Urban Stream Hydrology at the Catchment Scale*, 519 Journal of Hydrology 2584 (Nov. 2014).

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[83]   *Id.*

[84]   *Id.*

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