STORMWATER

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Over the last several years economic turmoil brought residential and commercial development to a halt. This is significant because most stormwater management infrastructure is installed in new developments. At the same time, more frequent large storms, flooding, and episodes of drought are putting pressure on existing stormwater management infrastructure. Stormwater infrastructure should be designed to minimize the effects of drought and protect against flooding. Several new pieces of stormwater legislation were enacted in the last three years; however, no funding has been available for implementing those rules. Furthermore, the defunding of the 1978 watershed legislation (Act 167), which required the state to match funds with municipalities for the cost of writing comprehensive countywide stormwater plans, has offset the gains expected from the new legislation. Legislation promoting the formation of Stormwater Authorities to address the unfunded mandate of the National Pollution Discharge Elimination System (NPDES) seems like too little too late. The current and anticipated needs for stormwater infrastructure are too large for individual municipalities to fund, and the lack of funding and staff at PADEP makes the SWM regulatory environment unpredictable because too few staff are available to ensure that regulations are applied uniformly statewide. The lack of staff is likely to inhibit growth in construction in the near future because predictable review outcomes are central to attracting investment in the state. Whether Pennsylvania municipalities and the state will come together to address the problems caused by stormwater remains to be seen.

BACKGROUND

Stormwater management (SWM) is one of the three critical elements that protects our health, property, and the health of our streams, rivers, wetlands and lakes— those three critical elements are potable water/wastewater infrastructure, flood protection infrastructure, and SWM infrastructure. Stormwater infrastructure comprises a multifaceted system of ecological and engineering solutions that work together to mitigate the combined effects of development and climate change. Most SWM efforts are focused in urban areas, which represent only about 20 percent of Pennsylvania. Many factors in addition to residential and commercial development affect the quantity and quality of stormwater, including acid mine runoff, natural gas development (i.e., Marcellus Shale), and agriculture. Stormwater management is integrated with road, rail, and aviation infrastructure, and SWM affects other infrastructure such as dams, levees and inland waterways. Neighborhood drains that say, “This drain connects directly to the river” are stormwater infrastructure. Importantly, the huge quantity of stormwater runoff requires engineered structural and has recently included non-structural solutions.

The definition of stormwater management has evolved over time. Conventional SWM infrastructure includes facilities such as the stormwater ponds that regulatory agencies typically require to control stormwater runoff, which ultimately are owned and operated by a homeowners' association or a business. SWM generally is required for new communities and must include a component to mitigate the effects of adjacent older

communities that lack adequate stormwater infrastructure. Stormwater management also has become the common term for the good housekeeping and pollution control activities required of more than 940 urban communities under the Municipal Small Separate Storm Sewer (MS4) regulations prescribed by the NPDES, and the Combined Sewer Outfall (CSO) Long Term Control Plans of more than 150 communities in Pennsylvania. Other parts of the NPDES regulate stormwater flows from construction, agriculture, and industry, generally through County Conservation Districts.

Stormwater management infrastructure also includes the facilities that direct and detain flood flows before they reach our levees and dams. Levees are often operated by a municipal authority. The state, counties, conservation districts, municipalities, municipal authorities, and the U.S. Environmental Protection Agency (EPA) all are involved in SWM. Furthermore, the regulatory environment has changed considerably since the 1980s, requiring different kinds of structural stormwater infrastructure. Evaluating the efficacy and adequacy of SWM infrastructure, therefore, is complicated by the multitude of players and the diverse meanings of SWM to each of them.

CONDITION AND CAPACITY

Until recently, cities were not required to retrofit older communities with modern SWM infrastructure. Instead, state regulations and township ordinances required new development to include SWM infrastructure designed to mitigate the effects of adjacent older development. This approach has resulted in a gradual improvement in the capacity of SWM infrastructure; however, the lack of development in the past several years has slowed progress toward fixing the remaining deficiency in capacity. Now, MS4 regulations require retrofitting the SWM infrastructure in federally designated urban areas. Also, “green infrastructure” which uses strategically planted areas and open green space to manage stormwater is often employed to retrofit urban areas. These techniques are designed primarily to improve water quality but have the added ability to increase green space in a community while the amount of runoff is reduced. In general, green stormwater systems are designed to reduce overflows of combined sanitary systems and do not directly address flooding.

Beginning in the mid-1990s the national focus of SWM approaches shifted from slowing the rate of stormwater leaving a property during large storms and conveying it away from developed areas efficiently, to managing the quality of stormwater and reducing the volume of runoff associated with smaller, more frequent storms. In Pennsylvania, that shift began in the early 2000s with the advent of the Pennsylvania Stormwater Best Management Practices Manual. The anchor best management practice (BMP) for reducing the volume of stormwater runoff in that manual is infiltration (water soaking into the soil). The life cycle of infiltration facilities is short, however, and reliance on these facilities may present a risk to system capacity. It has taken nearly 20 years to recognize that the focus on rate control was near-sighted and change management practices accordingly; it may take another 20 years to determine whether the shift to volume control is the correct move or not.

Pennsylvania has made some strides in improving SWM infrastructure capacity. In response to the increasing frequency with which storm drain systems throughout the

state are flooding, the Pennsylvania Department of Transportation (PennDOT) recently updated the deffinition of the storm required to be accounted for in the design for storm drains. However, the change in requirements will take decades to affect areas with older systems. The recent passage of agricultural stormwater rules known as Concentrated Animal Feed Operation (CAFO) regulations will increase the capacity of SWM infrastructure on agricultural land.

Considering the age of various components is an important step in evaluating the condition of SWM infrastructure in Pennsylvania. Various designs of SWM infrastructure can be traced to different eras:

1.	Combined Sewer Systems	1850s to 1980s
2.	Roadway Storm Drain Systems	1920s to Present
3.	Detention and Retention Ponds	1980s to Present
4.	Low Impact Development	1990s to Present
5.	Infiltration Basins	2000 to Present (older systems exist)
6.	Green SWM Infrastructure	2010 to Present

Combined sewers are antiquated systems that collect wastewater from commercial and residential buildings and stormwater runoff from roadways and other impervious surfaces in the same drain pipes. They are prevalent in approximately 152 large urban areas in Pennsylvania and contribute significantly to overloading urban sanitary sewer systems. Some combined sewer systems are more than 150 years old, and they allow direct connection to groundwater through infiltration and leaking resulting from deterioration. These systems provide no treatment of stormwater during large storms, and they can release untreated sewage when stormwater exceeds their capacity. Most communities in Pennsylvania with combined sewer systems are in the process of preparing or implementing long-term control plans to address the effects of this aging infrastructure, but the improvement of the infrastructure is still years in the future and will cost billions of dollars.

Municipalities, counties, and PennDOT own between 130,000 and 200,000 miles of storm drain in the state. Many miles of storm drain are nearing the end of their design life. Roadway repairs generally do not include replacing storm drain pipes unless the road is to be realigned or reconstructed extensively. PennDOT replaces about 4.5 miles of storm drain pipe annually, or between 2.5 percent and 5 percent of the miles of pipe that need to be replaced annually. No reliable information is available about the frequency of replacement of storm drains owned by counties and municipalities. Older storm drain systems are not sized for storms of the intensity we have experienced over the past few years, and the intensity of storms are likely to only increase in the future due to climate change. These storm drain pipes are designed to accommodate the runoff from storms of the size that meteorologists predict to occur infrequently, but the capacity of the inlet grates generally is designed for much smaller storms. PennDOT's standard inlet grates generally have smaller capacity than other designs and are difficult to install properly to prevent by-pass of flow along a street. Even new systems suffer from inadequate inlet capacity.

Detention/retention basins were the backbone of SWM infrastructure for more than three decades. Many of these facilities are nearing the end of their design life, and no funding is budgeted for replacing them. These ponds often have small dams associated with them that are not inspected regularly, and the homeowners' associations that own these systems frequently have minimal understanding of how to maintain them. Recent changes in regulations include provisions for deed-restricting the maintenance of new facilities and inspecting 10 percent to 20 percent of the older ones every year, but clarity is still needed concerning maintenance requirements.

Current SWM regulations require a large amount of stormwater to be removed from the flow leaving a property over land. Generally, this is accomplished by constructing facilities that enable a portion of stormwater to be infiltrated into the soil. Reliance on infiltration to satisfy stormwater requirements has increased in recent years; however, infiltration facilities have a shorter life expectancy than detention/retention facilities, and many of Pennsylvania's infiltration facilities have passed their design life expectancy. Like other SWM facilities, new infiltration facilities will be protected by a deed restriction that is recorded and runs with the property, but no funds are dedicated for replacing or refurbishing the existing facilities.

Low-impact development is an aggregate of techniques such as reducing roadway width, clustering houses, and concentrating development in defined areas, all intended to preserve open space. Several other methods of preserving open land include deed-restricted ownership by a homeowners' association or business, dedication to a municipality, and donation to a non-profit. Fully evaluating the condition of preserved open space in Pennsylvania is outside the scope of this investigation, but the relatively recent advent of this approach to SWM suggests that the condition is likely to be adequate. To ensure continued adequate condition of preserved open space, the Pennsylvania Department of Environmental Protection (PADEP) and municipalities statewide need to consider the question of how to guarantee that a roadway width prescribed in the SWM design and other low-impact design techniques are perpetually maintained.

Green infrastructure is the most recent emerging trend in SWM technology. It uses vegetation and soil to manage rainwater where it falls. What is required for maintenance is still being evaluated. Current indications are that the cost of maintenance will be high, in part because this form of SWM infrastructure is often installed in highly urbanized areas. Green infrastructure is designed to manage smaller, more frequent storms. Its effectiveness for managing runoff during larger storms needs further investigation.

FUNDING AND FUTURE NEEDS

The number of new stormwater requirements introduced since the last American Society of Civil Engineers (ASCE) *2010 Report Card on Pennsylvania's Infrastructure* is impressive; however, not one of those requirements has come with adequate funding to address the mandate. The EPA began a renewed push to clean up the Chesapeake Bay by adopting new guidelines for total maximum daily loads (TMDLs) that required Pennsylvania to develop a Watershed Improvement Plan and spurred the development of several of the new regulations. Moreover, the EPA's 2010 "Needs Survey" indicates

that Pennsylvania's infrastructure needs include more than $900 million for separate sewer and wet-weather issues, $8.7 billion for combined sewer overflow correction, and $6 billion for other stormwater management. Several of Pennsylvania's new stormwater requirements rely on local municipalities to enforce them, and the cost is anticipated to be high. A few municipalities whose charter or code includes a provision for establishing a fee for funding SWM have enacted such a fee, but most of the state's nearly 2,600 municipalities lack the option to enact a fee without forming a stormwater authority. To pay for SWM these municipalities will likely need to find solutions for raising revenue, but the political viability of such efforts remains unclear.

New legislation allowing the municipalities to form stormwater authorities has been passed (SB-351), but it may not go far enough to enable a stormwater authority to charge a fee. This legislation shows that the state government recognizes the need to increase funding but also highlights that little assistance is available from the state's coffers. The defunding of Act 167 further illustrates the state government's lack of commitment to supporting SWM. Cuts in the PADEP's SWM staff compound the problems developing in this arena. As of publication of this Report Card, the position of lead stormwater engineer with PADEP is open in Harrisburg but is frozen by budget constraints.

Development has always been a major source of SWM funding for municipalities, however, the condition of the national economy over the past few years has reduced the investment in and revenue from development to its lowest level in decades. New regulations that constrain development may continue to limit the availability of funding for SWM. New regulations such as new riparian buffer rules that require developers to maintain vegetation along waterways and prohibit development within a buffer zone are making development more costly. These regulations will protect the waters of the Commonwealth better than almost any other BMP, but they could result in decreased development because of the high cost of compliance. The regulations by themselves may not inhibit development; however, an unpredictable regulatory environment can drive development away. The lack of funding and staff at PADEP makes the SWM regulatory environment unpredictable because too few managers are available to ensure that regulations are applied uniformly statewide. The lack of staff at DEP has necessitated a reduction in coordination with municipalities and reduced training for design engineers needed to facilitate better compliance with stormwater regulations. The lack of staff at DEP and lack of training for municipalities and design engineers has lead to an environment of uncertainty for builders that may inhibit growth in construction that is needed to restore the traditional funding of stormwater infrastructure, new development.

Pennsylvania municipalities have budgeted an estimated $230 million for stormwater improvements to be implemented during the next 5 years. Based on national levels of funding, this is about one-quarter of the amount needed during that time period, and the need will continue well into the future. No reliable estimate of the percentage of the average municipal public works budget ($500,000) that is spent on SWM is available, but it is estimated to be between 10 percent and 20 percent and will rise significantly in the near future. Improving combined sewer outfalls (CSO) could cost $20.8 billion based on applying reported costs from Pittsburgh, Philadelphia, and the City of Lancaster to

the remaining 151 cities with CSO. This cost is higher than the EPA estimated cost cited above. The source of those funds has yet to be determined.

Restoring waters that have been degraded by acid mine runoff will require about $1 billion according to PADEP. The Commonwealth has made slow but steady progress in treating acid mine runoff, but 5,500 miles of stream are still polluted. Federal money is available, but grants are the primary state funding participation offered. Currently, the state is offering acid-mine-polluted water to natural gas developers (for fracking water); stormwater runoff from gas developments is regulated differently than the rest of the state's stormwater.

Federal funding under the Clean Water Act State Revolving Loan Fund (CWSRF) program has decreased over the past decade. The American Recovery and Reinvestment Act of 2009 (ARRA) provided a one-time inflow of funding during 2009 and 2010. In 2012, federal funding for Pennsylvania's CWSRF was $56.5 million, which decreased to $53.4 million in 2013. This amount of funding is not likely to cover the gap of several billon that appears to exist.

Pennsylvania created the Pennsylvania Infrastructure Investment Authority (PENNVEST) in 1988 to help communities finance infrastructure investments. The PENNVEST CWSRF program provides funding to projects throughout Pennsylvania for the construction and maintenance of wastewater treatment facilities, SWM projects, nonpoint-source pollution controls, and watershed management. This program offers low-interest loans with flexible terms to assist a variety of borrowers, including local governments, municipalities, and non-profit entities, and to establish partnerships to leverage other funding sources. In 2010-2011, the last year for which full reporting is available, PENNVEST had disbursed $204 million in ARRA funds to 110 projects. For the fiscal year as a whole, taking all funding sources into account, a total of 93 projects were provided with $437 million in financing. Of this total, $330 million was in the form of low-interest loans and $107 million was in the form of grants. In November 2008, Pennsylvania voters approved a $400 million bond issue on water and wastewater infrastructure. This grant program is being administered by the Commonwealth Financing Authority. Few of the funded projects are focused solely on stormwater.

Other programs designed to aid municipalities to fund improvements of water quality include the offset program (stormwater quality trading) and nutrient trading. The latter has had a few participants, but the trading value appears to be too low to provide reliable funding. The former is suffering from the lack of PADEP staff to move it from conceptual development to final implementation, leaving an important part of the solution to SWM funding incomplete.

Pennsylvania's recently enacted SWM regulations range from a new comprehensive regulation to guidance for designing riparian buffers, and a new BMP manual is promised. The state completed the new Erosion Control Manual last year. Implementing these regulations will improve many aspects of SWM, including control of erosion and sediment (E&S) during construction and operation and maintenance of BMPs in the future. However, the regulated community needs to be educated about these new requirements to promote their effectiveness, and funding for that education has yet to be made available.

The accomplishments of the regulatory community will direct the future of SWM only if adequate funding is provided to enact the rules. For example, the effectiveness of the 1978 Act 167 regulations- which required a comprehensive SWM plan in every county—is historically mixed. To date, there are many counties without comprehensive plans due to a lack of funding. Simply, the emerging regulatory framework that is now in place could greatly improve SWM in Pennsylvania, if it were adequately funded.

OPERATION AND MAINTENANCE

For many years Pennsylvania had no formal policy or regulations requiring any entity to maintain SMW BMPs built to comply with state requirements. Like most things in Pennsylvania, the ultimate responsibility falls on the townships and boroughs, but detention/retention ponds often are owned by a private entity, such as a homeowners' association or business, that inherits a pond built years ago. State regulations now require deed restrictions over all BMPs that allow the state to inspect them, but municipalities still are likely to have to enforce operation and maintenance issues under their MS4 permits. MS4 regulations, however, cover only about one quarter of the state. There is no clarity in State rules regarding which agency will ensure that BMPs located outside of MS4 communities are operating effectively. The EPA has issued draft requirements for verification of the operation of BMPs in the Chesapeake Bay watershed, which covers about half of Pennsylvania. This new EPA mandate is likely to drive a change in policy at PADEP.

Many private-sector owners of SWM BMPs are ill-equipped to maintain them. Pennsylvania rules that allow SWM infrastructure on private lots exacerbate this problem because municipalities or the state cannot maintain BMPs on private land easily. Other states have had to step in to assist homeowners with maintenance and to educate them about proper operation of BMPs to ensure the continued functionality of SWM infrastructure on private property.

Many problems with operation and maintenance of SWM BMPs begin with improper construction. The new MS4 permits and other new regulations now require an engineer to monitor construction of new SWM BMPs. New post-construction SWM requirements include providing notes about proper operation and maintenance of BMPs on plans to help owners understand requirements better, but few owners ever read these plans, and few engineers understand the new requirements.

PUBLIC SAFETY

On August 20, 2012 flash flooding in Pittsburgh killing 3 people, and flooding along the Delaware has become a regular event. Generally, townships cannot resolve their flooding issues locally because many of the sources of flood waters originate outside their boundaries. A watershed-based approach (large scale such as by stream valley or for an entire river) is required to solve most flooding issues. Eliminating the Act 167 funding for comprehensive watershed planning has created the challenge of trying to address flooding by building a series of BMPs in individual townships without any

mechanism for coordination among them. The PADEP's focus on stream capacity in reviewing development plans can bridge the need for comprehensive watershed planning, but it will not address all of the problems that an Act 167 plan could solve.

National weather charts were updated to address the more frequent and intense storms Pennsylvania is experiencing, and PennDOT has adjusted its design rain depths as well; however, statewide townships have antiquated rainfall depths in their ordinances. To protect the public, a better system of mandating design rainfall depths is needed. National weather charts and PennDOT publications allow for regional variations in weather. Townships should simply adopt both in their ordinances, and eliminate the practice of including a depth in their ordinances.

Sinkholes, which are prevalent in Pennsylvania, are a danger to the public and a detriment to commerce. A sinkhole in a heavily travelled state highway in Chester County caused a major road closure and detoured traffic for more than a year. Many sinkholes are caused by improper SWM or poorly designed storm drains. Control of sinkholes in the state will require proper maintenance of BMPs and storm drains.

RESILIENCE

The resilience of a structure or system is dependent on its design life. Designers of SWM infrastructure generally do not consider the design life of BMPs. Pond designs include safe passage of the 1 percent probability storm and this protects them from damage due to high flows. Other BMPs (infiltration, bio-retention, bio-swales) are often designed for probability of a smaller storm, leaving them vulnerable to damage during larger storms. The newest BMPs include plants and soils as vital components, but plant secession and soil life often are not considered adequately in their design. Riparian buffers will be quite resilient over a time, and new regulations could result in increased use of buffers, which is likely to improve system resilience.

INNOVATION AND TECHNOLOGY

The state developed an innovative public/private partnership to revise its SWM BMP manual. The intent is to make the manual a “living document” that can be updated as better technology is proven. Similarly, the state is working with soil scientists to bolster site-specific infiltration investigations. The state's promotion of evapotranspiration (the use of water by plants) as a SWM technique is a progressive step. The new riparian buffer legislation has more generous widths than similar laws in other states and is likely to have a large positive effect on SWM in the future.

POLICY OPTIONS

The Federal Clean Water Act and the Pennsylvania Clean Streams Law set goals for the health of waters of the Commonwealth and waters of the United States. The difficulty in evaluating Pennsylvania’s adherence to these laws is entwined in the complex and decentralized web of rules, ordinances, acts, and guidelines meant to

enforce them and the many regulatory entities involved (i.e., EPA, PADEP, all 67 PA counties, 67 Conservation Districts, 2,600 municipalities).

This complex web of entities and regulations could be simplified if the state takes a more central role in SWM, such as increasing PADEP's educational efforts. Leaving Pennsylvania's municipalities to “go it alone” puts the state at a significant economic disadvantage compared with other states in the region. The EPA regulations that drive all SWM regulation envisioned countywide enforcement, which would provide a cost savings by virtue of the economy of scale.

RECOMMENDATIONS

Ultimately all efforts in stormwater management are judged by how well the Commonwealth protects our streams. Despite the lack of a significant decrease in the number of stream miles listed as impaired on the state reports to the EPA over the last few years, the health of the waters of the Commonwealth has noticeably improved over the last several decades. It is well-known, however, that as things get better, further improvement will cost more.

The four Pennsylvania sections of ASCE recommend that the following measures be taken to improve and promote SWM within Pennsylvania:

- To continue the improvement, the Commonwealth needs to better fund SWM, build PADEP staff, and increase training opportunities for the regulated community and regulators on the new rules that have been enacted. Additional personnel are needed to develop consistency in enforcement of the regulations by PADEP regional offices and to promote acceptance of new BMPs among regulators and the regulated.
- The Commonwealth must assume a more central role in the unification of the SWM infrastructure design community because the economic health of the state requires organization of the thousands of regulatory approaches to SWM enforced by municipalities and the varied interpretations of rules by the state itself.
- State funding for Act 167 needs to be restored to foster a regional approach to stormwater issues. In addition, legislation may be needed to reinforce the stormwater authority legislation in place.
- The Commonwealth must engage in monitoring and maintaining SWM BMPs. Municipalities are unlikely to be able to undertake maintenance of BMPs, which is likely to be the main issue in SWM for the foreseeable future.
- Funding must be found to address the change in rainfall patterns, increased flooding, sinkholes, and maintenance of SWM BMPs and to promote predictable regulatory enforcement that will foster development.
- The new regulations enacted will serve the Commonwealth well if adequate staff and support is provided to bring their promises to fix BMP operation, maintenance, and other SWM issues to fruition.

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ASCE POLICY STATEMENTS

- ASCE Policy Statement 441: Storm Water Management