Stormwater Management Testimony Michele C. Adams, PE, LEED AP October 25, 2023

Back in 1900, when the Wright Brothers started to build their flying machines, their planes crashed just like everyone else's. The Wright Brothers were using a table of engineering coefficients for lift and drag that had been developed some 30 years earlier with very limited data. The Wright brothers realized this and that's when they built their wheeled contraption that sat on the bicycle handle bars. They came up with their own engineering coefficients and equations based on data, and now the bicycle contraption sits in the Smithsonian and planes stay in the air.

We are in a somewhat similar place with stormwater and flooding. Back in the 1950s when a group of engineers and technicians were tasked with building dams for flood control, they came up with engineering calculations and equations that had very little data behind them, and what data they did have has been lost to history. In 2009, the American Society of Civil Engineers recognized this and came out with the publication "Curve Number Hydrology: State of Practice".

In the 1970s, stormwater management and flood control began to take on increased importance, and engineers looked to the example of flood control dams and the idea of "slowing down the flow of water in very large storms" (or flow rate control) as way to manage stormwater and flooding. If the calculated flow of water after development was not larger than the calculated flow of water before development, then stormwater would be managed. This is still the main component for stormwater management in Pennsylvania.

Obviously, we still have stormwater and flooding problems, and now the climate is changing. We are seeing larger storms and much higher rainfall intensity. As hard as it is to predict the weather, it's even harder to accurately predict stormwater runoff flow rates. We just are not that good at it.

So there are two main reasons we have stormwater problems:

1. We are working with bad data and equations that need to be updated and informed by science.
2. Early stormwater engineers failed to account for the fact that changing the land surface with development creates impervious surfaces such as buildings and roads, and compacted soils from modern construction techniques. When precipitation cannot soak into the soil (and recharge our groundwater), there is a lot more volume of stormwater runoff than before. Much, much more water is sent downstream. Slowing it down is not enough. The 2006 Pennsylvania Stormwater Manual recognized this and introduced the idea of "volume control" and holding that water on-site, ideally infiltrating water to recharge aquifers. The updated Draft Manual builds on this idea.

Unfortunately, too much focus, especially at the municipal level, is placed on engineering calculations for flow rate. We need an updated, volume-based, green infrastructure approach to stormwater management and the training and resources for this approach to be implemented throughout the Commonwealth.

Recommendations:

1. **Use data and science to update the engineering tools used by engineers, including runoff coefficients of the USDA Cover Complex Methodology**. This is the most widely used and often mandated stormwater engineering calculation method. Update engineering land cover values with science-based coefficients that better reflect the larger amounts of stormwater runoff generated by the compacted soils that are created as a result of disturbance and development. Similarly, update the runoff coefficients, or curve number values, of natural undisturbed soils to better reflect the ecosystem services that areas such as riparian buffers, healthy woodlands, and native meadows provide. In other words, stop underestimating the amount of stormwater runoff from development.

2. **Update Pennsylvania's stormwater policy on managing the amount of runoff (or volume) to better reflect EPA's volume based approach for federal facilities** (Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act EPA 841-B-09-001 December 2009). EPA's stated goal in this policy is to "mimic natural hydrology" by reducing how much runoff leaves a site and using techniques such as green infrastructure. This is done by capturing and holding small frequent storms, usually 1.5 inches or less. Holding this volume reduces stormwater impacts and flooding in both small and large storms. Other states such as Maryland have implemented this approach with Maryland's Environmental Site Design requirements. The City of Philadelphia requires volume management of runoff from all new impervious surfaces. While the 2006 Pennsylvania Stormwater Manual introduced the concept of volume management, and this has been incorporated by PaDEP into NPDES permits for sites over 1 acre, at a municipal level, which is critical for a project to obtain approval for development, the focus is still primarily on runoff rate control (how fast water is moving). This is a legacy of how stormwater management has been implemented, but volume management should be the first and most important condition for approval at the state and municipal level. In Maryland, if runoff volume is managed, there is no requirement to reduce peak flow rates. Pennsylvania would benefit from a similar approach and municipalities need state standards. Make it clear and simple, with an emphasis on volume and green infrastructure. Minimize the opportunity for calculation errors by setting a simple rainfall depth to be retained on site, following EPA's federal policy, and reflecting the different rainfall patterns across Pennsylvania. Incorporate design recommendation to reflect changing rainfall intensity patterns and increased localized flooding.
3. **Provide Clearer Design Standards for the Stormwater Practices such as Infiltration systems, bioretention, etc.** For example, the Maryland Environmental Site Design Manual has specific

design criteria for different stormwater practices, including how large they can be, how big of an area they can receive runoff from, etc. The City of Philadelphia has specific standards for certain practices. While there should be room for engineering judgement, there is a very real need for clear design standards and criteria. Systems that incorporate green infrastructure may require the expertise of non-engineers such as landscape architects and arborists.

4. **Set Standards for and require an Environmental Site Assessment as part of all development and encourage municipalities to require this.** Too often, land development projects do not clearly map important natural features such as wetlands, floodplains, forested areas, steep slopes, erosive soils, etc., and then represent these natural features on the stormwater plans in a manner that clearly communicates the impact of the development on these features, and the potential loss of ecosystem services. Require the expertise of non-engineers such as arborists, soils scientists, and ecologists. Tax dollars are spent on restoring natural features, such as forested riparian buffers, that could be better protected. While PaDEP has riparian buffer requirements for EV and HQ streams, municipalities could better protect buffers and other natural features that provide stormwater benefit if clearer guidance and criteria were provided. This guidance needs to come from the state.
5. **Provide defined standards for site investigation and soil testing for stormwater infiltration practices, including oversight.** For example, Pennsylvania, in Title 25, Chapter 73 of the Pennsylvania Code, has clear criteria for Site Investigation, which requires oversite by a trained and licensed Sewage Enforcement Officer. While the Stormwater Manual has recommendations, there is no requirement for oversite and many inadequate testing results are accepted, resulting in stormwater systems that fail. Again, clear criteria from the state are needed.
6. **Provide Specifications for Stormwater Systems and the Materials and Construction of Stormwater Practices**. Engineers refer to specifications in PennDOT's Publication 408 for the

specific requirements for pavements and associated materials. There are similar standards for the components of water lines, for wastewater treatment plants, etc. Stormwater in Pennsylvania is a bit of the wild west in this regard. We need specifications and testing requirements for materials such as bioretention soils, aggregates used in stormwater systems, appropriate geotextiles, and landscape based standards for green infrastructure components such as planting trees and appropriate seed mixes.

7. **Require Inspection and Testing of Stormwater Practices**. Engineers routinely inspect and test other infrastructure. We pressure test water and sewer lines. We inspect pavement and new roads, we certainly inspect critical structures such as bridges. Stormwater management is infrastructure and should be inspected and tested the same as any other infrastructure.
8. **Require and Provide Training and Education at the County and Municipal Level** Many engineers learn stormwater management “on the job”, and there is tremendous variation in experience and expertise. There is a strong need for education and minimum experience requirements for both technical review staff, especially at the municipal level, and training requirements for design engineers. If the engineers doing the stormwater design or reviewing the stormwater design do not have the necessary expertise, we will continue to have stormwater problems.