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# Public Safety is Job 1 for Politicians and Engineers

Government officials and engineers have a duty of care to protect the public from the effects of disastrous storms. Drainage pipelines and culverts have critical elements that must work in harmony to ensure a durable, resilient and sustainable system.

National meteorological data and reports suggest that the frequency of significant rainstorm events have increased, in fact a number exceeding the truly remarkable threshold of the 1000-year rainstorm event.

Recent events point to the impact and burden that catastrophic rainstorms can leave on communities and local government agencies. Recognizing the high cost of disasters, the Federal Government passed legislation requiring strategic disaster evacuation routes be identified and designed to ensure that such routes withstand the worst of fires, floods, winds, storm surges, and other forces of nature.

Concrete pipe remained in place following road washout in Bay County, MI 2017

A 1000-year rainstorm has a 0.1% chance of occurring each year, yet in 2018 at least 5 such events occurred east of the Rocky Mountains.*

- Gogebic County, Michigan July 2016 rainfall over 12 inches in just 4 hours devastated the western portion of the Upper Peninsula.
- Northern Michigan/Northern Wisconsin Rainfall where flash flooding struck Houghton, Michigan on Father's Day morning (2018) with more than 6 inches in less than 9 hours
- Madison, Wisconsin flooding occurred in August 2018 where 10-15 inches of rain fell across Dane County and caused at least one death
- Colorado Flooding August 2018 6-8 inches of rain fell northeast of Trinidad, Colorado
- Chesapeake Flooding September 2018 where heavy rain fell along the Chesapeake bringing more than 10 inches to both Kilmarnock and Jamesville, Virginia.
- Upper Peninsula and Mid-Michigan flooding during April/May 2013, President declares a Disaster for 16 Michigan Counties due to flooding

The costs to communities and the local economy associated with catastrophic rainstorms do not stop at debris cleanup, physical damages to dwellings and businesses, detours, and other inconveniences. Loss of life and injuries are often unwelcome outcomes. Besides the economic loss to commerce and the inconvenience to the motoring public from prolonged road closures the impact to emergency responders is concerning.

For ambulances, law enforcement, and fire vehicles, the extended road closure and the added response time as a result may be the difference between life and death. This is especially true in rural areas where available detours may be limited or worse not possible at all.

*Weather Channel, "America's 1-in-1000-Year Rainfall Events in 2018, Jonathan Belles, September 2018

Environmentally the difference between a temporarily eroded culvert that is not rendered obsolete and one that is displaced or collapsed is significant. For a displaced culvert the added amount of siltation into the waterways during the event and throughout the construction phase is considerable. In general, the less impact from a washout in magnitude and time is a benefit to the environment that should not be considered lightly.

Urban areas hit hard by storms and flooding know all too well that roadways need to be rebuilt; these costs include engineering costs for the construction of new culverts. When a new culvert is required for a critical crossing, and possibly several others in the same area, replacement can be a most serious situation. Public officials are faced with availability of the correct size of culvert material, immediate availability of product, and availability of construction crews, especially if all hands are focused on cleanup.

Plastic pipe washed out, Houghton County MI, 2018

**Resiliency**

Resilience is about bouncing back. Applying the term to define infrastructure designed to preserve safe, healthy communities and local economies is most appropriate.

Communities need materials and products that can withstand the natural forces placed on infrastructure elements with little to no damage. Resiliency of pipe is a critical consideration that must be evaluated because the capacity and limits of drainage areas are changing, thereby increasing the odds of disastrous impacts on critical infrastructure.

Washouts, road closures and unnecessary construction costs are not an option. Public works officials know that the combination of increased development and increased major rainstorm events have impacted negatively Michigan roads and drains. The Father's Day storm in the Upper Peninsula was catastrophic to the Houghton area. The damage to roadway crossings left local officials, contractors and material suppliers scrambling to replace missing flexible pipe used for culverts that floated away, leaving roadways severely damaged.


Box Culvert remained in place, partial roadway washout. Backfilled and reopened to traffic within 36-hours. Houghton County, MI 2018

Recently, Mid-Michigan and the Bay area have been impacted in ways like the rainstorm damage in the Upper Peninsula. Public officials and drainage engineers must consider and evaluate much more design data and design options to specify products and materials to construct resilient infrastructure and reduce long-term maintenance and replacement costs.

The resiliency and durability of concrete accommodates easy repair of drainage crossings since concrete pipe and precast concrete boxes stay in place while the roadway may wash out.

With precast concrete culverts in place, road reconstruction may call for backfill over the existing culvert and pavement only. Road reconstruction time may take less than a half-day, once floodwater recedes.

Failed pavement caused by washout in Houghton County, 2018 Photo: John Moore WSMH

Washed out corrugated metal pipe, Houghton County, 2018 Photo: John Moore WSMH

**Responsibility and Durability**

Following powerful rainstorms, agencies and municipalities that specify flexible pipe such as corrugated metal and plastic are often left wondering, “Where is my culvert?”

Washed out corrugated metal culvert. Houghton County MI, 2018

The time to restore infrastructure to normal conditions, cost of repairs/replacement, and anxiety of local agencies and residents, along with impediments to emergency vehicles, and safety of everyone is an unquantifiable consideration that should be evaluated carefully. Such considerations can be unaccounted in the cost of construction.

To say that catastrophic storms “will not happen in my backyard” is irresponsible. As the EPA has stated in their 2016 circular about our backyard, Michigan, titled “What climate change means for Michigan” (EPA 430-F-16-024) “Changing the climate is likely to increase the frequency of floods in Michigan…During the next century, spring rainfall and annual precipitation are likely to increase, and severe rainstorms are likely to intensify. Each of these factors will tend to further increase the risk of flooding”. With disaster plans in place, many cities and towns have accepted that storms will happen, and the only unknown remaining is, “when?”

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Concrete pipeline left in place after roadway washed out, 2018

Water is a force unlike any other that can cause an incredible level of destruction. The force can be described as no less than catastrophic in disasters that occurred in Michigan during 2013, 2016, 2017 and 2018. Notions such as buoyancy, durability and resiliency must be a consideration for responsible evaluation of drainage options. Although contracts are often let on low bid, not all construction options and methods can be deemed as equal. The term “or equal” in a bid document is often misconstrued. The service life of a culvert or storm sewer and durability of the materials used in the system, should be directly involved in the "or equal" evaluation.

**What can protection of the public look like?**

The cost of material is typically a very small percentage of the overall cost of constructing a culvert compared to engineering design costs, labor, roadway construction, and replacement costs should any portion of the structure fail. Even for large drain pipeline projects, any cost of material differences is minor compared to the risk, liability and life cycle costs associated with the overall cost of the project.

During the project design stage, durability of products, sustainability of materials and products, and resiliency should be key considerations for life cycle analysis and long-term performance. An approved “or equal” clause should meet these same requirements, or the project should be designed to handle the same site conditions and specific design requirements for each material specified.

Reinforced concrete pipe is resilient, durable, sustainable and will likely not become displaced during these major rain events, leaving a much shorter and less expensive repair and re-open timeline.

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