

# FLOODING

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**N6.** ADOPT AND ENFORCE ZONING CODES TO REDUCE LOCALIZED FLOODING AND BASEMENT/SEWAGE BACKUPS

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One major aspect of Columbus' changing climate is increased precipitation. As temperatures rise, the water cycle is intensified, leading to more evaporation and more moisture in the atmosphere.<sup>1</sup> For places like the Midwest, including Ohio, dramatic increases in precipitation have been observed over the last several decades.<sup>2</sup> The [Climate Change in Columbus, Ohio](#) report shows that total precipitation increased by 19.8% from 1951 through 2012, with fall precipitation experiencing the most significant rise at 43.5%.<sup>3</sup> The number of very heavy precipitation events, which represent the heaviest 1% of all daily events, increased by 32% between 1951 and 2012. Finally, the number of days per year that experienced more than 1.25" of rainfall – the amount at which nuisance flooding and other impacts become more frequent – increased by 78% over this same time period. All of these changes have led to a greater risk of flooding in our area, which can result in major infrastructure damage and public health issues.

The *Climate Change in Columbus, Ohio* also noted three major vulnerabilities that arise due to the greater flood risk. The first, and most obvious, is the increased risk of damage to infrastructure throughout our communities. Heavy precipitation events are already challenging stormwater treatment and management systems, but flooding events pose additional risks to our roadways, the electrical grid, dams, and many other key pieces of infrastructure around the city. These issues lead to another potential vulnerability: difficulties in transportation and the ability to respond to emergencies after a flooding event. Damaged roadways and disrupted power supplies present obstacles for emergency

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<sup>1</sup> S. J. Levang, and R. W. Schmitt. "Centennial changes of the global water cycle in CMIP5 models." *J. Climate* 28, (2015): 6489-6502. <https://doi.org/10.1175/JCLI-D-15-0143.1>. Accessed Jan. 2018.

<sup>2</sup> J. Andresen, S. Hilberg, K. Kunkel. "Historical Climate and Climate Trends in the Midwestern USA." *In: U.S. National Climate Assessment Midwest Technical Input Report*. J. Winkler, J. Andresen, J. Hatfield, D. Bidwell, and D. Brown, coordinators. Mar. 2012. [http://glisa.msu.edu/media/files/NCA/MTIT\\_Historical.pdf](http://glisa.msu.edu/media/files/NCA/MTIT_Historical.pdf). Accessed Jan. 2018.

<sup>3</sup> Great Lakes Integrated Sciences and Assessment (GLISA) and the University of Michigan Climate Center. "Climate Change in Columbus Ohio: An assessment of Columbus' Key Climate Changes, Impacts, and Vulnerabilities of Concern." Mar. 2016. [http://research.bpcrc.osu.edu/education/greenteam/FINAL\\_ColumbusFinalReport\\_3.0.pdf](http://research.bpcrc.osu.edu/education/greenteam/FINAL_ColumbusFinalReport_3.0.pdf). Accessed Dec. 2017.

responders, police, and hospitals that provide necessary services during, and immediately after a flood. The final vulnerability identified involves health risks that are associated with flooding. Stronger storm events can lead to sewer overflows and increased runoff, potentially resulting in the contamination of water and food sources, exposure to chemicals or waterborne pathogens, or the growth of dangerous mold in affected buildings.

In order to address these concerns, four necessary actions and two aspirational actions are proposed. These actions will tackle the first vulnerability through updated infrastructure. If adopted, they would ensure that any new or redevelopment project would account for the expected increase in storm and flooding events. The proposed necessary actions would also address the need for an updated transportation plan that would enable emergency responders to determine the best routes to use during and after a flood. This plan would also identify how to transport critical resources throughout the city during a flood event. Finally, the aspirational actions include reducing runoff and backflow in order to prevent the contamination of water supplies. Together, these actions will better ensure that our communities will be prepared to deal with more frequent and more severe flooding events that are expected to occur in the future.

## **N6. ADOPT AND ENFORCE ZONING CODES TO REDUCE LOCALIZED FLOODING AND BASEMENT/SEWAGE BACKUPS**

With an intensifying hydrologic cycle (precipitation and evaporation), communities are experiencing a greater frequency of 100- and 500-year floods. While most consider it ill-advised to construct buildings and critical infrastructure in floodplains that could be inundated during floods, flooding does occur outside of these areas as well. For instance, localized “nuisance” floods, which begin to occur when daily rainfall exceeds 1.25”, are a problem in particular parts of the city. Consequences of nuisance flooding include basement backups and standing water in streets.

Updated codes could include enhanced specifications for wetlands, catchments, and stormwater pipes to take into account greater loads due to more intense rainfall events. New construction and retrofits could be required to include infrastructure that has the ability to store stormwater or promote its infiltration into the subsurface. Results of infrastructure installed through [Blueprint Columbus](#) should inform how to best update codes.<sup>4</sup> In some cases, technology, such as backflow preventers on sewage and stormwater systems, can be installed to reduce damage to property during localized flooding. In the case of backflow preventers, their cost is negligible if installed during construction or retrofit when pipes are exposed, but their impact can be tremendous if they prevent even one basement backup. Consideration should be given to redundancy in systems. For instance, sump pumps are commonly used in new construction but, without a battery backup, they will not function during an intense rainfall event with a power outage. Finally, green infrastructure is another option that assists with stormwater while also having co-benefits, including ecosystem restoration, providing local jobs, and aesthetic beauty. More details regarding green infrastructure are included in **N7**.

Sufficient enforcement is required to ensure that property owners and developers abide by approved plans in compliance with regulations. As was discovered during an investigation over an

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<sup>4</sup> “Blueprint Columbus.” *The City of Columbus, Public Utilities*.  
<https://www.columbus.gov/utilities/projects/blueprint/>. Accessed Jan. 2018.

eight-county region around Houston in 2015, a random sampling of permits issued by the Army Corps of Engineers to developers showed an oversight failure in enforcing wetlands mitigation. The failure resulted in 236 acres actually being installed when 1,306 acres should have been installed.<sup>5</sup> In this case, the permitting was not the issue but rather ground-truthing that mitigation wetlands were installed. Enforcement staff needs to be trained to review plans and to inspect construction that would be in compliance with new requirements. Likewise, staffing needs to be sufficient to accommodate the demands of oversight, including follow up with projects that are approved. Arguably, the Army Corps of Engineers is understaffed for the demands placed on the agency. Finally, the city should have sufficient power to enforce or incentivize compliance. In a city without oversight, proper installation of risk-reducing measures may not be taken voluntarily, and the failure of individual property owners to comply can result in damage to properties other than their own.

To inform policies over the long-term, a monitoring program should be created that collects data annually from a certain portion of completed projects. Such a program would gauge the efficacy of various installed solutions and ensure that they result in the desired storage or infiltration goals. As with all code and zoning requirements, state law limits actions which can be taken by the city. When necessary, the city should reiterate to state agencies and elected officials concerns about limits on its ability to deliver service safely and affordably. Minimal regulation of flood prone areas may exacerbate property damage, enhance risks to human health, and increase long-term costs.

## **N7. REDUCE IMPACTS OF STORMWATER RUNOFF AND PROMOTE GREEN INFRASTRUCTURE IN NEW DEVELOPMENT AND REDEVELOPMENTS**

Planning and development should be informed by Earth science processes and geohazards in addition to the basket of economic factors traditionally taken into account. With climate change, both means and extremes are shifting; therefore, both need to be considered in new- and redevelopment projects.<sup>6</sup> The frequency, duration, and intensity of rainfall events and site geography should be factored into cost-benefit analyses that underpin planning. Planning that proactively mitigates a problem is often preferable, and less costly, than reactively responding to it. While flooding from Hurricane Harvey was a millennial event, the 2017 Houston floods, in addition to two previous 500-year floods over the past three years, serve as case studies in how known facets of the region's physical geography were not sufficiently accounted for in development patterns and how planned mitigation often failed to be installed.<sup>7,8,9</sup>

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<sup>5</sup> Matthew Tresaugue. "Review: Developers failing to follow wetlands mandate." *Houston Chronicle*. Aug. 2, 2015. <http://www.houstonchronicle.com/news/houston-texas/houston/article/Review-Developers-failing-to-follow-wetlands-6417918.php>. Accessed Jan. 2018.

<sup>6</sup> S. C. Lewis, and A. D. King. "Evolution of mean, variance and extremes in 21st century temperatures." *Weather and Climate Extremes* 15, (2017): 1-10. <https://doi.org/10.1016/j.wace.2016.11.002>.

<sup>7</sup> Satija Neena, Kiah Collier, and Al Shaw. "Everyone Knew Houston's Reservoirs Would Flood — Except for the People Who Bought Homes Inside Them." *ProPublica co-published with The Texas Tribune*. Oct. 12, 2017. <https://projects.propublica.org/graphics/harvey-reservoirs>. Accessed Jan. 2018.

<sup>8</sup> Ian Bogost. "Houston's Flood Is a Design Problem." *The Atlantic*. Aug. 28, 2017. <https://www.theatlantic.com/technology/archive/2017/08/why-cities-flood/538251/>. Accessed Jan. 2018.

<sup>9</sup> Matthew Tresaugue. "Review: Developers failing to follow wetlands mandate." *The Atlantic*. Jul. 31, 2015. <http://www.houstonchronicle.com/news/houston-texas/houston/article/Review-Developers-failing-to-follow-wetlands-6417918.php>. Accessed Jan. 2018. REPEATED

Green infrastructure, as has been deployed with [Blueprint Columbus](#), reduces impacts of stormwater runoff by temporarily storing water, promoting infiltration and uptake of water by vegetation, and capturing sediment and pollutants contained within runoff.<sup>10</sup> Green infrastructure also has the potential to provide co-benefits, including ecosystem restoration, local jobs, and aesthetic beauty. Policies or best-practices should be adopted by the development and zoning that require or incentivize any new- or redevelopment projects to use green infrastructure to reduce runoff. For homeowners, the Franklin County Soil and Water District provides an example of how an agency can deploy a number of innovative strategies to reduce runoff using incentives.<sup>11</sup> Market mechanisms, including assessing a cost per volume of anticipated or actual runoff, could also be considered. Regardless, the costs associated with runoff, which have often been an externality, need to be explicitly accounted for in both development and redevelopment.

In addition to nuisance flooding and the potential for infrastructure damage, the precipitation that falls on Columbus captures pollutants and sediment in our urban landscape and transports them downstream to communities along the Scioto and Ohio Rivers. By avoiding runoff with pollution and nutrient loading, Columbus can serve as a role model for other communities in how we care for our watersheds and their ecosystems.

## **N8. DEVELOP EMERGENCY TRANSPORTATION PLAN THAT CAN BE IMPLEMENTED DURING A FLOOD**

### **N9. ASSESS AND ENSURE ADEQUATE TRANSPORTATION AND LOGISTICS FOR CRITICAL RESOURCES**

Extreme precipitation can inundate low-lying roadways, fill reservoirs beyond capacity, and render damaged bridges unusable. In such circumstances, it can become increasingly difficult to move people out of harm's way or to transport assets to neighborhoods in need. As was witnessed in South Carolina in 2015, California in 2016-17, and Houston in summer 2017, a geographically widespread and temporally sustained event can isolate resources far from those individuals who need them.<sup>12,13,14</sup> While the Great Flood of 1913 was the last time that Ohio experienced such conditions, the enhanced hydrologic cycle brought about by climate change will make such events more likely.

FCEM&HS has developed the Emergency Support Function 1 (ESF1): Transportation that may be implemented during floods.<sup>15</sup> ESF1 is responsible for management of transportation systems and management of transportation infrastructure during threats or in response to actual incidents. Activities under this ESF1 are directed by FCEO and COTA with support from many other transportation industry entities. Transportation encompasses all transit surface modes, including land-based wheeled vehicles,

<sup>10</sup> "Blueprint Columbus." *The City of Columbus, Public Utilities*.

<https://www.columbus.gov/utilities/projects/blueprint/>. Accessed Jan. 2018. (REPEATED)

<sup>11</sup> "Conservation, Protection and Improvement of Soil and Water Resources in Franklin County." *Franklin Soil and Water Conservation District*. <http://www.franklinswcd.org/>. Accessed Jan. 2018.

<sup>12</sup> U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Weather Service - Silver Spring Maryland. "The Historic South Carolina Floods of October 1-5, 2015." Jul. 2016. <https://tinyurl.com/y9aefmgh>. Accessed Jan. 2018.

<sup>13</sup> Lauren Sommer. "With Climate Change, California is Likely to See More Extreme Flooding." *NPR Morning Edition*. Feb. 28, 2017. <https://tinyurl.com/yd689f9b>. Accessed Jan. 2018.

<sup>14</sup> L. Hamel, B. Wu, M. Brodie, S.-C. Sim, and E. Marks. "An Early Assessment of Hurricane Harvey's Impact on Vulnerable Texans in the Gulf Coast Region: Their Voices and Priorities to Inform Rebuilding Efforts." *The Henry J. Kaiser Foundation*. Dec. 5, 2017. <https://tinyurl.com/y8alu2p7>. Accessed Jan. 2018.

<sup>15</sup> Franklin County Emergency Management and Homeland Security. "Franklin County Emergency Operations Plan." Document not available to the general public.

trucks, and buses traveling on streets, roads, highways, and bridges; air travel, rail routes; transportation infrastructures (roads, routes, and bridges) and assets that move people and supplies in and out of Franklin County. During disaster events it may become necessary to protect citizens by moving or relocating them from areas of the county which are threatened to areas which are more secure. Conducting these types of movement is the primary responsibility of COTA supported by support agencies charged through ESF1. This emergency support function also includes the City of Columbus Downtown Evacuation Plan and the MORPC Evacuation Framework.<sup>16,17</sup> Regardless of whether ESF1 is deemed to be sufficient for emergency transportation in Columbus during floods or a supplement is needed for the city, all planning documents should be periodically updated as our scientific understanding of flood threats improves and lessons are learned from floods affecting other communities.

As is noted in the Emergency Preparedness chapter of this document, Columbus should develop GIS resources that tag critical assets and transportation infrastructure that could potentially be affected by a flood. By allowing this information to be shared with various stakeholders, new transportation routes could be developed based on a variety of circumstances. Particularly vulnerable populations, such as those in close proximity to a floodplain or unlikely to relocate due to inaccessibility of transportation, should also be identified on the GIS resource. ODOT recently identified transportation links that are most at risk due to climate change; these include one that is susceptible to flooding in Central Ohio and should be included in all planning documents.<sup>18</sup> GIS staff knowledgeable in the tools which have been developed need to share updated maps with the public. He or she should also be available during the entirety of an emergency to provide information to decision makers and emergency services. Such a staff position exists within FCEM&HS.

In addition to transporting people away from affected areas, plans need to be developed to provide transportation and logistics for critical resources, such as medical supplies and bottled water, in the case of a flood. GIS resources should be used to identify both critical assets (e.g., hospitals, fire stations, shelters, and distribution centers) and transportation routes between them (e.g., primary and secondary routes and alternates). These GIS tools should include identification of neighborhoods and routes that are likely to be inundated under various scenarios. In the case of a large-scale, regional events, plans should make considerations for procurement of supplies from outside the region via reliable transportation routes.

## **A7. LOBBY STATE AND FEDERAL GOVERNMENT TO IMPLEMENT POLICIES THAT REDUCE EROSION AND RUNOFF AND PROMOTE INFILTRATION**

As the well-known educational refrain states, “we all live downstream.” This is true of Columbus, which receives its drinking water from surface and groundwaters that originate in lands north of the city. These lands are largely used for agriculture, with the rest primarily being residential property. During

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<sup>16</sup> City of Columbus. “Downtown Evacuation.”

<https://www.columbus.gov/WorkArea/DownloadAsset.aspx?id=15442>. Accessed Jan. 2018.

<sup>17</sup> Mid-Ohio Regional Planning Commission. “*The Planning Framework for the Evacuation of the Transportation Needs Populations of Central Ohio.*” Sept. 30, 2010.

<sup>18</sup> Ohio Department of Transportation, Division of Planning, Office of Environmental Services. “*Ohio DOT Infrastructure Resiliency Plan.*” May 6, 2016. <https://tinyurl.com/yacpj8aj>. Accessed Jan. 2018.

storm events, runoff can deliver pollutants and sediment to the waterways that travel downstream. These pollutants include excess fertilizer, herbicides, and pesticides from non-point sources, while the sediment is largely composed of topsoil from non-vegetated surfaces. These materials damage aquatic ecosystems and make water treatment more difficult and therefore costly. As we have seen with inland lakes, such as Buckeye Lake and Grand Lake St. Marys, there are both economic and quality of life consequences that result from impaired waterways.

Water concerns in the Midwest have historically been of lower consequence than those in more water-stressed regions of the country, because water supplies here are plentiful relative to population size. However, water quality issues have become more frequent and severe in Ohio, as has been the case with the increasing occurrence of harmful algal blooms throughout the state. While local municipalities and water districts are responsible for providing drinking water, with OEPA playing a role in certifying drinking water quality, the state and federal governments are responsible for the regulation of practices within watersheds. This creates tension as local municipalities have no direct control of what arrives in its waterways - even drinking water supplies - from landowners upstream. Despite this, it is the downstream residents that assume the cost of treating the water. In Columbus, this was manifested in a contingency contract for \$1 million for reagents and \$3 million for upgrades to a water treatment facility to address taste associated with algal blooms driven by actions in the watershed upstream of the city.<sup>19</sup> Downstream locations also lose out on recreation opportunities and the aesthetic enjoyment of nature as water quality deteriorates.

The City of Columbus needs to work collaboratively with state and federal agencies and elected officials to improve the management of our aquatic ecosystems and water resources on a larger scale. Sustainable Scioto, an effort to ensure sufficient drinking water for Columbus in light of our anticipated population growth, provides a blueprint through mid-century.<sup>20</sup> State actions, such as an addition to the state budget bill in 2017 that weakens protections to lands surrounding reservoirs, impair the ability of Columbus to provide safe water for its citizens.<sup>21,22</sup> Ongoing conversations to continue protection of our waters need to be informed by published research, best practices, and respect for the rights of all individuals within a watershed. Creative solutions, such as payment to landowners for ecosystem services, could emerge from such conversations. In fact, these types of innovative solutions emerged to provide clean drinking water to such large metropolitan areas as New York City more than 100 years ago with the added benefit of protecting ecosystems and providing for recreation.<sup>23,24</sup>

## **A8. RETROFIT FLOODGATES OR BACKFLOW PREVENTERS ON STORMWATER INFRASTRUCTURE**

<sup>19</sup> Lucas Sullivan. "Columbus earmarks \$1 million to fight smelly water." *The Columbus Dispatch*. Nov. 23, 2014. <http://www.dispatch.com/article/20141123/NEWS/311239753>. Accessed Jan. 2018.

<sup>20</sup> "Sustaining Scioto." *Mid-Ohio Regional Planning Commission*. <http://www.morpc.org/tool-resource/sustaining-scioto/>. Accessed Jan. 2018.

<sup>21</sup> Stephanie Warsmith. "Reservoir amendment illustrates concerns over budget process in Columbus." *Akron Beacon Journal*. Jul. 9, 2013. <https://tinyurl.com/yck5ha7x>. Accessed Jan. 2018.

<sup>22</sup> Jim Siegel. "Columbus lawmakers want to restore buffer zones around reservoirs." *The Columbus Dispatch*. Nov. 17, 2015. <http://www.dispatch.com/article/20151117/news/311179788>. Accessed Jan. 2018.

<sup>23</sup> "Forest Management." *NYC Environmental Protection*. [http://www.nyc.gov/html/dep/html/watershed\\_protection/forest\\_management.shtml](http://www.nyc.gov/html/dep/html/watershed_protection/forest_management.shtml). Accessed Jan. 2018.

<sup>24</sup> "New York City's Water Supply System Map." *NYC Environmental Protection*. [http://www.nyc.gov/html/dep/html/drinking\\_water/wsmaps\\_wide.shtml](http://www.nyc.gov/html/dep/html/drinking_water/wsmaps_wide.shtml). Last updated Jan. 17, 2007. Accessed Jan. 2018.

Infrastructure, such as floodwalls, has been installed in portions of the city along major drainages to mitigate property damage during flooding events. Following the massive floods of 1913 and 1959, measures were taken to mitigate damage from future events. However, these were still not enough, and 7 mile-long Franklinton Floodwall was built between 1993 and 2004. Maintenance schedules and flood control plans guide the upkeep and use of the physical infrastructure. However, stormwater systems in many areas have not been upgraded to include floodgates or backflow preventers. Normally, water flows through storm sewers under the force of gravity to lower elevations. The lowest elevations are drainages, including the city's major rivers. Unfortunately, during a flooding event, the river, swollen with water constrained by floodwalls, could reach a height greater than the elevations of nearby areas protected by those floodwalls. In such cases, water flow in storm sewers could reverse direction and flow from the river into protected areas. Floodgates and backflow preventers are designed to allow the water flow to be stopped or restricted to one direction, from the protected areas to the drainage. Stormwater infrastructure, without floodgates or backflow preventers installed, could therefore contribute to localized flooding by providing a route for floodwaters to exit drainages. Plans on where to add these would be determined by city departments.

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