CHANNELING COMMUNITY CAPACITY FOR STORMWATER SOLUTIONS

SLOW THE FLOW

Taubman College of Architecture and Urban Planning
University of Michigan

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EXECUTIVE SUMMARY

Pittsfield Township, in collaboration with the Washtenaw County Water Resources Commissioner, invited the Taubman College Master of Urban and Regional Planning program at the University of Michigan to assist with crafting a community engagement process for gauging community preferences for stormwater management. Although the township has the technical expertise to implement stormwater solutions within the township, a formal mechanism for allowing resident preferences to inform the decision making process regarding stormwater infrastructure does not currently exist. Therefore, our group of six team members was entrusted with creating this formal mechanism, while in the meantime, implementing a process to determine residents' preferences for stormwater management levels of service. We were also tasked with crafting guiding principles for future replication of a similar community engagement strategy in other communities within Washtenaw County.

We decided to create a three part survey, which included an initial questionnaire to ascertain current knowledge, a public education video, and a final questionnaire to examine preferences for future stormwater management in the township and the effectiveness of the public education video. The survey was distributed to the public over a two week period in collaboration with Pittsfield Township, and multiple modes of communication were used to notify the public about the survey, including email, social media (Facebook, Twitter), and a press release, which was reported on by MLive.

Following the two week period, the survey was closed to the public. After analyzing the data, we observed that:

Respondents are interested in collaborative stormwater management amongst property owners and at least one government entity. Respondents believed that the township or the county should take primary responsibility for stormwater management. The public education video was a successful method for increasing public understanding of stormwater management and almost one-third of respondents were inspired to learn more about stormwater management after watching the video. Respondents are willing to pursue stormwater management solutions that require a greater investment of both time and finances.

Respondents are interested in supporting stormwater management efforts, although they currently feel unsupported and ill-equipped to address stormwater issues within their immediate neighborhoods. Respondents lack a clear understanding of governance structures that support and manage the stormwater landscape in the township.

In general, respondents who resided in planning areas with greater development intensity preferred increased government ownership over stormwater management moving forward, were willing to invest a greater amount of funding in future stormwater projects, were open to being more involved in maintaining stormwater infrastructure, and are interested in a more comprehensive, cohesive, and township-wide approach to stormwater management

As a result, our recommendations to Pittsfield Township include:

1. Assign a "Stormwater Liaison" to serve as a resource, educator, and open communication channel between township residents and the County.
2. Highlight current public education opportunities surrounding stormwater management while interest has piqued with the survey and provide clarity on the governance structures surrounding stormwater management in the township.
3. Encourage the Road Commission and the WCWRC to collaborate to discuss opportunities and lead stormwater management in the future in conjunction with the public.
4. Build accountability mechanisms into the stormwater management process to ensure that developers, landscapers, property owners, and government entities are committed to broader stormwater management goals.

This report includes our research methodology, a description of stormwater infrastructure practices, analysis of survey data, and recommendations to the township.

INTRODUCTION

01

PART I: PROJECT OVERVIEW

The Washtenaw County Water Resources Commissioner and Pittsfield Charter Township reached out to the Urban and Regional Planning Program at the University of Michigan to determine community preferences for future stormwater management in Pittsfield and to develop a mechanism for community engagement within the stormwater management decision-making process. Currently, technical experts within the Washtenaw County Water Resources Commissioner's office take primary responsibility for devising solutions to stormwater management issues while Township residents supplement this work by petitioning the Washtenaw County Water Resources Commissioner to address specific stormwater management problems in their community. Therefore, the team's expertise was sought to translate some technical aspects of stormwater management for residents and subsequently assess citizen priorities for future stormwater management.

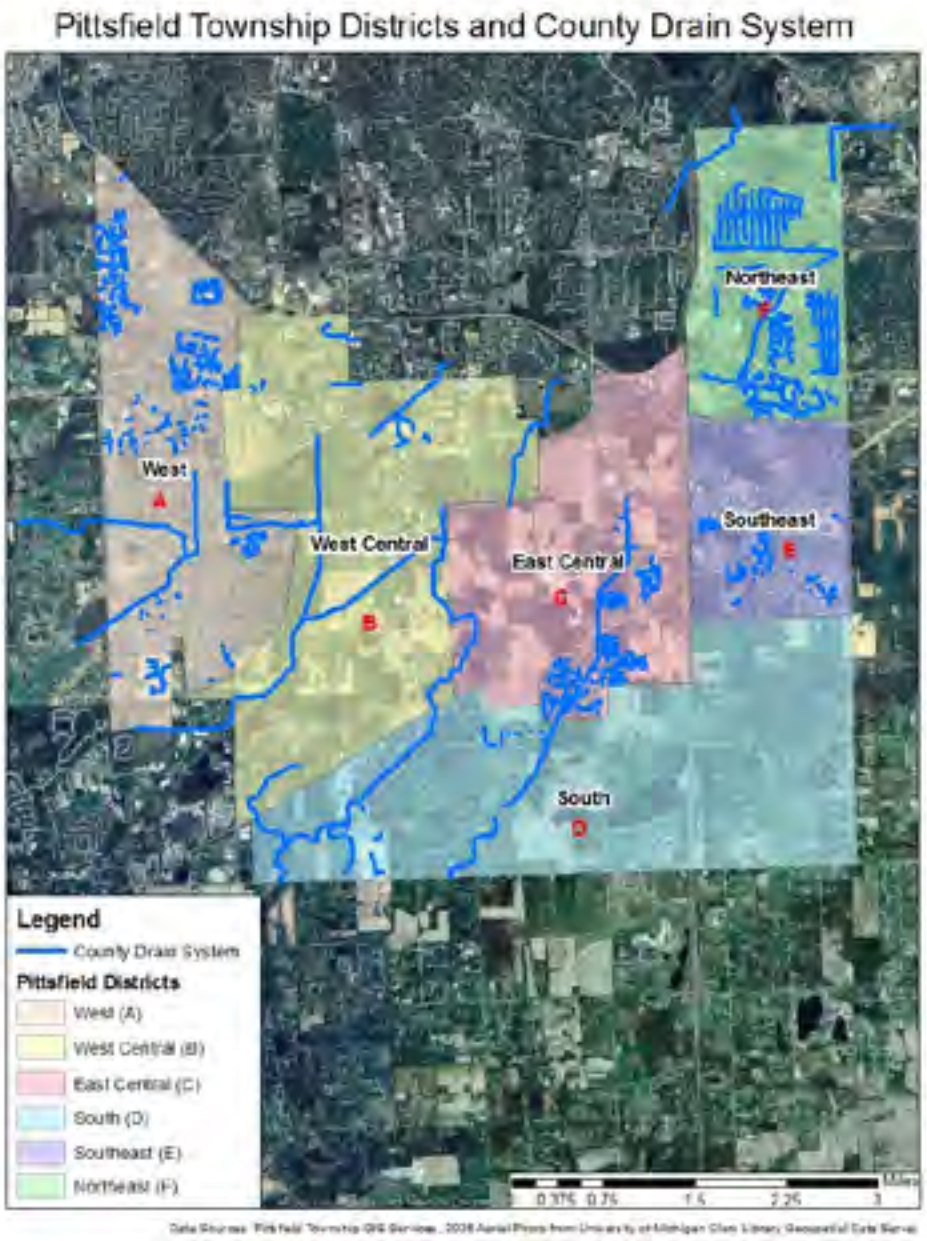

Figure 1.1 Washtenaw County Drains in Pittsfield Township and Planning Areas of Pittsfield Township.

THE CLIENTS

The Washtenaw County Water Resources Commissioner [1]

The Washtenaw County Water Resources Commissioner (called a "Drain Commissioner" in other Michigan counties) is directly elected by the residents of Washtenaw County to manage stormwater throughout the county. Shortly after Michigan became a state in 1837, legislators passed "Drain Code" legislation mandating that each county in the state elect a Drain Commissioner to guide construction on drainage infrastructure that would be used to convert the wetlands and forests that covered much of Michigan at the time into more agriculturally productive land.1 Although the responsibilities of drain commissioners have since expanded to include flood control in urbanized areas, drain commissioners (or the "Water Resources Commissioner in Washtenaw County) have retained jurisdiction over the drainage infrastructure in a county, which is comprised of a network of "county drains" (See Figure 1). The Washtenaw County Water Resources Commissioner has the authority and responsibility to maintain the system which controls the rate, volume and quality of the runoff that flows into the drains, both constructed and natural, within Washtenaw County. As of 2017, Pittsfield Township contains 14 open drains, which make up roughly 26 miles of the Washtenaw County drainage network, a network that is exclusively maintained by the Washtenaw County Water Resources Commissioner.

Pittsfield Charter Township [2]

Pittsfield Charter Township has grown dramatically in the last few decades. Table 1 shows the increase in population and housing units in Pittsfield since 1990. Currently, the population of Pittsfield Charter Township is estimated to be 37,225 and the township is estimated to contain 14,665 housing units.

The rapid increase in population and residential development, in addition to commercial and industrial development, has created a growing need to manage both the volume and quality of stormwater runoff, which is defined as water that is not absorbed naturally. Although Pittsfield's Township Ordinances require that all new residential subdivisions manage the first inch of rainfall on site, the increase in impermeable surfaces

(roads, sidewalks, rooftops, and driveways that prevent water from being absorbed by the soil) in Pittsfield has put added stress on the county drain network to manage stormwater in the township. In addition to increasing the volume of stormwater runoff that the township's system must manage, the increase in impervious surfaces has also increased the potential for runoff to become more polluted, as impervious surfaces introduce pollution into runoff as well as prevent soil and plants from removing pollutants from runoff.

The rapid increase in population and residential development, in addition to commercial and industrial development, has created a growing need to manage both the volume and quality of stormwater runoff, which is defined as water that is not absorbed naturally. Although Pittsfield's Township Ordinances require that all new residential subdivisions manage the first inch of rainfall on site, the increase in impermeable surfaces (roads, sidewalks, rooftops, and driveways that prevent water from being absorbed by the soil) in Pittsfield has

Year	Population	Number of Housing Units
1990	17,668	7,794
2000	30,167	12,337
2010	34,663	14,808

Figure 1.2 Population and Housing Units in Pittsfield Township in 1990, 2000, and 2010. Data gathered from the US Census Bureau.

put added stress on the county drain network to manage stormwater in the township. In addition to increasing the volume of stormwater runoff that the township's system must manage, the increase in impervious surfaces has also increased the potential for runoff to become more polluted, as impervious surfaces introduce pollution into runoff as well as prevent soil and plants from removing pollutants from runoff.

In updates to the Township's comprehensive master plan in 2017, the Township made a commitment to stormwater stewardship. The goals outlined in the recently adopted 2020 Sustainable Vision Plan serve as evidence that the township has maintained its commitment to improving stormwater management in the township. More specifically, the 2020 Sustainable Vision Plan states that the township will:

"...reduce general stormwater runoff pollution; promote the use of low impact development (LID) techniques to reduce stormwater runoff and increase infiltration; promote environmentally responsible maintenance activities (such as reducing the use of pesticides, herbicides and fertilizers); eliminate illegal dumping and improper disposal of common waste products that could adversely affect water quality; control erosion and sedimentation associated with construction and post-construction stormwater management; educate the public about the adverse effects of pollution and the negative impacts associated with impaired water quality; and initiatives that reduce pollution while promoting 'good housekeeping.'"

Pittsfield residents share a similar dedication to improving stormwater management, as 86% of respondents to a community survey that informed the development of the Sustainable Vision Plan agreed that the township should "continue to manage stormwater in a way that respects nature, not overburden Pittsfield's natural systems and the built environment, and promote green stormwater management concepts."

Although the community engagement process that provided valuable contributions to the 2020 Sustainable Vision Plan clearly indicated that Pittsfield residents hope to improve the manner in which stormwater is managed in the township, township officials and the WCRC were still unsure what Pittsfield residents would be willing to do to reform stormwater management practices. The following report will describe stormwater management more generally, outline previous community engagement strategies surrounding stormwater management, and present the results of the survey.

APPROACH

To determine community preferences for stormwater management in Pittsfield, we created a public education video to better inform Pittsfield residents about the importance of stormwater management and to describe potential options for future stormwater management in the Township. The community survey that accompanied the public education video provided residents with an opportunity to voice their preferences for stormwater management. The results of the survey were used to determine what future stormwater management strategies Pittsfield residents are most comfortable with pursuing.

METHODOLOGY

To inform Pittsfield residents about potential future stormwater management options, the team had to become subject matter experts in stormwater management, which we achieved by conducting background research on stormwater management practices, the governance structure of stormwater management activities in Michigan townships, and community engagement strategies. In addition to consulting academic research, the team relied on public reports from governmental entities and University of Michigan faculty who conduct research on stormwater management to augment our understanding of the issues surrounding stormwater management.

In addition, we reviewed long range comprehensive plans published by Pittsfield Township as well as Stormwater Asset Management Plans distributed by Washtenaw County. We also conducted site visits to observe conditions in the field during normal and high precipitation days and to document how the stormwater management systems currently used by the county respond to precipitation events.

To communicate potential options for future stormwater management, we created a public education video so that Pittsfield residents could make informed decisions. Finally, we distributed an online survey to gauge community interest in pursuing different alternatives for stormwater management in the Township.

REPORT CONTENTS

The following report will describe stormwater management more generally, examine current systems of stormwater management in Washtenaw County and Pittsfield Township, specifically, and offer case study examples of community engagement strategies surrounding stormwater management.

The report will also present the results of the public survey, offer some analysis of our findings, and will conclude with recommendations on how the Township and County may improve communication of stormwater management issues between government and the public, enhance community engagement practices around stormwater, and improve within-government collaboration on projects that impact stormwater management.

ENDNOTES

1. Spicer Group. (2017, October). *Stormwater Management Plan*. Retrieved January 26, 2018, from http://www.ewashtenaw.org/

2. United States Bureau of the Census. (2017). *American Community Survey Demographic and Housing Estimates*. Retrieved March 25, 2018, from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP05&prodType=table.

3. Pittsfield Charter Township. (2017). *2020 Sustainable Vision*. Retrieved January 6, 2018 from https://en.calameo.com/read/0026597862fe714f5c9f1.

STORMWATER MANAGEMENT BASICS

02

PART II: STORMWATER MANAGEMENT

WHAT IS STORMWATER MANAGEMENT [1]

The practice of dealing with rainfall and other types of precipitation is generally referred to as stormwater management. Stormwater management is a centuries-old practice that dates back to as early as 3500 BC, when drainage systems were constructed in Mesopotamia. Stormwater management is important for both rural and urban areas because stormwater management systems help prevent flooding that could be catastrophic for crops, homes, and businesses. Stormwater management systems are generally comprised of a network of pipes, culverts, and ditches that direct water towards natural water bodies. The water that falls in precipitation events, commonly referred to as runoff, collects a wide variety of pollutants and sediments as it travels over fields, roads, lawns, and roofs, among others. Common pollutants that are carried by runoff include nitrogen and phosphorous (key components of agricultural fertilizer), zinc and motor oil (from cars), and sediments.

THE IMPORTANCE OF STORMWATER MANAGEMENT [2]

In the United States, rapid urbanization during the 20th and early 21st centuries has led to a conversion of natural or agricultural land into residential, commercial, and industrial land, which has decreased the area covered by plants and trees and simultaneously increased the area of impervious surfaces. Impervious surfaces such as roads or roofs do not allow runoff to drain into the soil; they contribute to increased runoff volumes, reduced groundwater recharge, and deterioration of runoff water quality. Areas that undergo large increases in the amount of impervious surfaces are therefore subject to increased flood risk. Like many regions in the United States, Southeast Michigan has experienced a rapid increase in the amount of impervious area in recent years, which has implications for how communities in the region manage runoff volume and water quality today. The Southeast Michigan Council of Governments estimates that the transportation network in the region generates more than 100 billion gallons of stormwater runoff each year, containing more than 100 tons of phosphorous and 34,000 tons of sediment. Although imperviousness has a significant impact on water quality, forest clearing to enable low-density rural development has also been shown to degrade aquatic resources.

WATER QUALITY ISSUES [3]

To manage flood risk and assuage community concerns, the types of drainage systems used in communities like Pittsfield were designed to efficiently direct water away from developed areas and into receiving streams, rivers, lakes, ponds, and oceans. The design of these systems resulted in runoff being conveyed directly into receiving waters, with little or no treatment of runoff. Runoff that flows directly into receiving waters creates significant problems for downstream ecosystems, which must then deal with runoff that is carrying increased concentrations of pollutants. One of the most noticeable negative effects of runoff on downstream ecosystems is the presence of algae blooms. Algae, the photosynthesizing organism that lives in water and serves as a food source for fish and other small aquatic creatures, is similar to other photosynthesizing organisms in that it relies on nitrogen and phosphorous to grow. When water bodies like ponds and lakes have concentrations of nitrogen and phosphorous that are higher than normal, algae responds by growing at incredibly rapid rates. Algae blooms are the abnormally large accumulations of algae that grow in response to high concentrations of nitrogen and phosphorous (Figure 2.1).

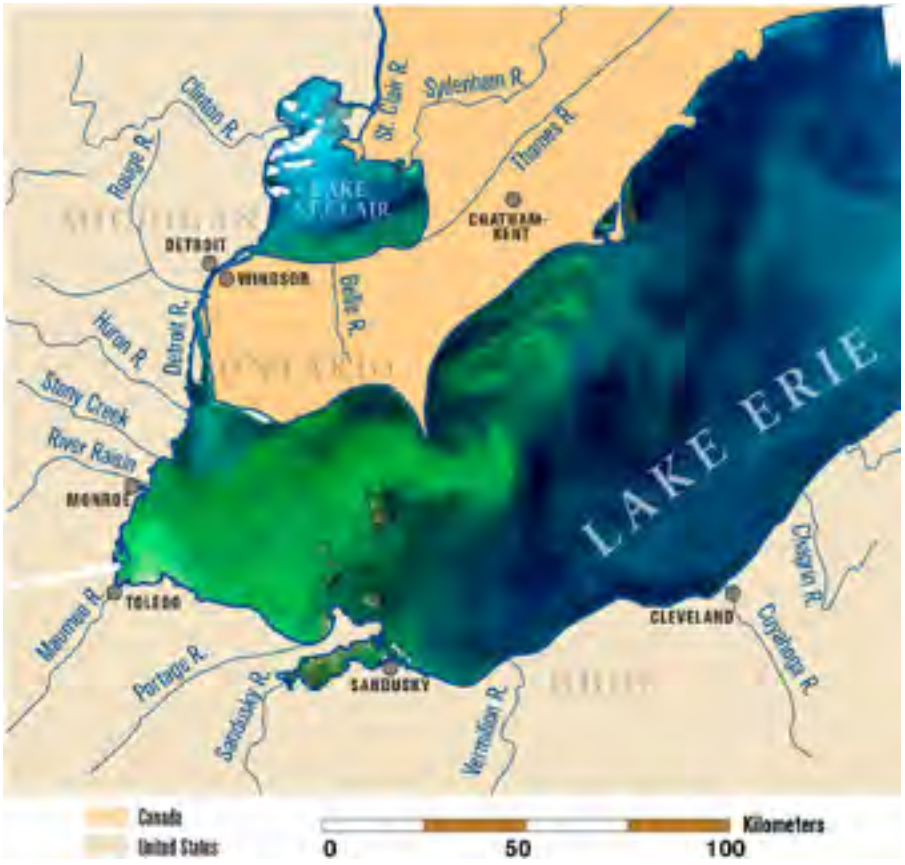

Figure 2.1. MODIS Satellite Image of Record-Setting Algae Bloom in Lake Erie, 2011. Algae bloom is visible in the green areas of Lake Erie and Lake St. Clair.
Source: https://stanford.edu/~jeffho/images/michalak_pnas_fig1.jpg

Algae blooms are problematic for lakes and ponds because in the process of photosynthesis, algae also consume the oxygen in water. If the algae blooms in water grow sufficiently large, they can deplete the water of its oxygen, killing fish and other aquatic organisms that must get their oxygen from the water. Lake Erie is currently dealing with large algae blooms that have grown as increased amounts of nitrogen and phosphorous made their way through the agricultural and urban areas of Michigan, Ohio, and Indiana to Lake Erie. Stormwater management therefore plays an integral role in impacting ecosystems downstream.

WATER QUANTITY ISSUES

Stormwater management, while having important implications for downstream communities, is also important for local communities. In metropolitan areas in particular, stormwater management systems are important for reducing the impacts of flooding. As metropolitan areas have expanded their geographic reach into formerly agricultural areas, the amount of impervious surface has also increased, which increases flood risk.

Stormwater management therefore is important for improving the quality of runoff and for controlling the quantity of runoff. Although there have been advancements in the mechanisms that we use to address runoff quality and quantity, the improvements in such systems have not been enough to prevent flooding or environmental issues like algae blooms. Ensuring that effective stormwater management practices are in place is therefore essential to creating healthy environments.

GRAY INFRASTRUCTURE

There are two primary means by which to manage stormwater in urban water systems: gray infrastructure and green infrastructure. Gray infrastructure is generally defined as a constructed network of pipes, pumps, culverts, ditches, and drains that rapidly collect runoff and transport it directly into receiving waters. The variant of gray infrastructure used in Pittsfield is called a separate system, which collects runoff in stormwater-specific pipes and releases it directly into water bodies without any treatment. One issue with gray infrastructure systems like the one used in Pittsfield is that runoff containing toxic components that could harm aquatic life downstream is not treated prior to being released into nearby water bodies.

SYSTEMS OF URBAN STORMWATER

Gray Infrastructure [4]

There are two primary means by which to manage stormwater in urban water systems: gray infrastructure and green infrastructure. Gray infrastructure is generally defined as a constructed network of pipes, pumps, culverts, ditches, and drains that rapidly collect runoff and transport it directly into receiving waters. The variant of gray infrastructure used in Pittsfield is called a separate system, which collects runoff in stormwater-specific pipes and releases it directly into water bodies without any treatment. One issue with gray infrastructure systems like the one used in Pittsfield is that runoff containing toxic components that could harm aquatic life downstream is not treated prior to being released into nearby water bodies.

Green Infrastructure [5]

Green infrastructure is an approach to stormwater management that uses vegetation, soil, and natural processes to manage stormwater where it falls. The term green infrastructure first emerged in the US in the 1990s, which coincided with the recognition that stormwater runoff carrying large amounts of pollutants (particularly nitrogen and phosphorous) could critically threaten regionally important coastal areas such as the Chesapeake Bay. A number of major cities in the US have since embraced green infrastructure in their stormwater management plans, including Portland, Oregon; Philadelphia, Pennsylvania; and Chicago, Illinois. Green infrastructure systems retain stormwater runoff and allow it to be used by plants or to filter into the soil, which decreases the volume of runoff and filters out contamination naturally. Green infrastructure has a variety of definitions but generally refers to a "network of decentralized stormwater management practices, such as green roofs, trees, rain gardens, and permeable pavement, that can capture and infiltrate rain where it falls." Green infrastructure also has the potential to sequester atmospheric carbon, remove atmospheric pollutants, and reduce the urban heat island effect to save energy and money in cooling costs. Furthermore, green infrastructure can restore natural patterns of drainage, recharge groundwater, and decrease the rate at which stormwater flows to streams, which restores stream health. Green infrastructure is best suited to manage small, frequent precipitation events and is generally impractical for controlling large-scale floods. This suggests that despite the issues created by gray infrastructure systems, achieving a balance between

green and gray infrastructure would aid in flood control and lessen the negative environmental impacts of gray infrastructure.

One advantage of green infrastructure systems is that they are typically less expensive to install than gray infrastructure systems. According to a report published by the American Society of Landscape Architects, green infrastructure can be less costly to implement than gray infrastructure and can offer the best stormwater management per dollar spent on construction and maintenance. One study in St. Paul, Minnesota revealed that various green infrastructure systems saved 20% in installation costs over the projected gray infrastructure strategy and were projected to cost roughly $0.04 per cubic foot of stormwater removed over a 35 year life cycle.

There are a wide variety of types of green infrastructure, each suited to a particular hydrological goal. Larger scale installations that have big drainage areas are generally referred to as "Best Management Practices," or BMPs. Examples of BMPs are retention ponds, detention basins, and wetland basins and they are typically placed at the outlet points of drainage areas. In contrast, smaller installations that have more localized benefits and draw from smaller drainage areas are referred to as "Low Impact Development" or LID. LID was first piloted in Prince George's County, Maryland in 1999 as a way to counteract the negative impacts of urbanization. LID installations such as green roofs, rain barrels, and rain gardens are typically more decentralized in comparison to BMPs and aim to treat stormwater runoff as close to the source as possible. LID concepts have been praised in recent years for their ability to decrease the negative impacts of urban development on stormwater runoff quality and quantity by providing on-site reductions in pollutant loads and runoff volumes through retaining runoff and allowing it to filter into the soil. LID practices are also more well-suited than BMPs to preserving pre-development patterns of stormwater drainage.

Figure 2.2. Retention Basin.
Source: https://c1.staticflickr.com/8/7090/7184528667_f0c5a86fe1_b.jpg

BEST MANAGEMENT PRACTICES (BMPs)

Retention Basins [6]

Retention basins are large, vegetated basins that are are continuously filled with some volume of water, which fluctuates based on rain events (Figure 2.2). They are designed to hold water and reduce peak runoff rates during heavy precipitation events and are very effective at reducing runoff volumes and reducing concentrations of natural organics such as fecal matter or leaf detritus.

Figure 2.3. Constructed Wetland.
Source: http://vaswcd.org/wp-content/uploads/2016/09/2703608861_e4be8d381c_b.jpg

Constructed Wetlands [7]

Constructed wetlands are defined as manufactured replicas of wetland systems that are heavily vegetated (Figure 2.3). They can remove runoff pollutants through vegetative uptake and by allowing runoff to slowly filter into the soil. Constructed wetlands are commonly placed at the end of watershed catchments, which has been shown to be effective in reducing pollutant loads. Constructed wetlands, however, have occasionally reduced the normal amount of water contained in tributaries downstream, exacerbating problems already caused by drainage management systems. The placement of constructed wetlands at the ends of catchments has also been criticized for failing to protect upstream waters.

Figure 2.4. Detention Basin.
Source: http://mnerosion.org/wp-content/uploads/2012/01/Two-Harbors_Cemetery-Detention-Basin.jpg

Detention Basins [8]

Detention basins are large, vegetated basins that are usually dry and hold water only during storm events (Figure 2.4). They are very effective at reducing runoff quantity, particularly during heavy precipitation events, and at reducing the concentrations of natural organics (fecal matter, etc.) and sediments. A study of detention ponds in North Carolina showed that they were also effective at reducing concentrations of nitrogen, phosphorous, and heavy metals in runoff.

LOW IMPACT DEVELOPMENT (LID) INSTALLATIONS

Rain Gardens / Bioretention [10]

Rain gardens, also known as bioretention systems, are shallow, vegetated basins that contain a mix of soil and plant media and allow runoff to infiltrate into the ground while also filtering out pollutants (Figure 2.5). Academic studies have shown that rain gardens/bioretention systems do well at filtering out natural organic compounds (from food waste, leaves, branches, fecal matter, and animal corpses) and nutrients such as nitrogen and phosphorous while providing moderate runoff quality reduction. Furthermore, rain gardens that allow for focused groundwater recharging have been shown to be effective in reducing both the rate at which runoff flows out of rain gardens following heavy storms and the total volume of stormwater runoff, although these benefits are largely contingent on the scale of the installation.

Figure 2.5. Rain Garden.
Source:http://www.soildistrict.org/wp-content/uploads/2012/07/rain-garden-maplewood-minnesota.jpg

Figure 2.6. Bioswale.
Source: https://www.livingconceptslandscape.com/wp-content/uploads/2015/09/IMG_6653-1024x683.jpg

Bioswales [11]

Bioswales are long, vegetated channels along roads or parking lots that slow, store, infiltrate, and treat stormwater flows (Figure 2.6). They are less vegetated than rain gardens and typically require less maintenance. Academic studies have shown that bioswales significantly reduce total suspended solids concentrations and sediments in runoff.

Figure 2.7. Green Roof.
Source: http://www.zinco-greenroof.com/sites/default/files/styles/flexslider_full/public/2017-02/Kolumbien_Mario_Laserna1.jpg?itok=Qwe-aC5b

Green Roofs [12]

Green roofs are roofs with growing media, vegetation, and/or stormwater collection basins that allow rainfall to be used by plants or filter into soil (Figure 2.7). They reduce runoff volumes, reduce impervious surface area, provide natural insulation, and have aesthetic benefits. Green roofs are best suited for commercial or industrial properties that have flat roofs and that can support the added weight of soil and plants.

Figure 2.8. Permeable Pavement.
Source: https://nacto.org/wp-content/themes/sink_nacto/views/design-guides/retrofit/urban-street-design-guide/images/pervious-pavement/carousel//pervious-pavement-9.jpg

Figure 2.9. Rain Barrels.
Source: https://i1.wp.com/www.owensboroliving.com/wp-content/uploads/2014/09/rain-barrels1.jpg?fit=1600%2C1067&ssl=1

Permeable Pavements [13]

Permeable, or porous, pavements are paved surfaces with pores that infiltrate and store rainwater on-site (Figure 2.8). They are usually made of penetrable surfaces like porous concrete, porous asphalt, or a matrix of interlocking pavers filled with gravel or soil and plant media. They are often installed in parking lots or sidewalks where traffic volumes are light to moderate and where the load-bearing requirements for paved areas are lower. Permeable pavements have been shown to provide effective runoff quantity reduction and effective pollutant reduction, particularly for synthetic organic materials such as car effluents.

Rainwater Harvesting: Rain Barrels and Cisterns [14]

Rainwater harvesting practices collect and store rainwater in rain barrels or cisterns (a large tank that stores rainwater) for later use (See Figure 2.9). These are generally the simplest and least expensive form of Low Impact Development and are very effective at reducing the volume of runoff but are only mildly effective at reducing pollutant loads in runoff. In addition, rainwater harvesting systems provide a non-potable alternative for irrigating lawns, washing cars, and other household uses. Scholars also suggest that overflow from rainwater harvesting receptacles can be connected to other forms of green infrastructure to provide additional volume and water quality benefits.

COST OF CONSTRUCTING GREEN INFRASTRUCTURE INSTALLATIONS [15]

The cost of green infrastructure installations can vary widely in different contexts. The primary components of cost for green infrastructure installations are the cost of excavation, the cost of adding soil, and the cost of planting native species. Because green infrastructure installations often include elements that collect stormwater in ponds or pools, excavation is an important cost component. In addition, because green infrastructure systems are commonly used to improve the quality of stormwater runoff, the cost of any additional soil that may be able to better manage runoff is a critical aspect of the cost of any installation. The cost of native plants is another consideration because green infrastructure systems typically aim to restore the natural water cycle. This involves planting species that are well-accustomed to the temperature and precipitation characteristics of the area.

Based on these components, the cost of building green infrastructure installations generally varies according to the amount of excavation, soil amendment, and native planting that is required. Installations like constructed wetlands are therefore typically the most expensive, because they frequently require massive excavation, soil amendments, and native plantings. An installation like a retention basin would likely be less expensive because it would not require as much soil amendment and native planting. A rain barrel would typically be the least expensive type of green infrastructure, because it requires no excavation, soil amendment, or native planting.

The scale of each type of green infrastructure can also impact the cost. Installations that cover a wide area will therefore be more expensive than those that cover a small area. With the scale component of costs in mind, installations like rain gardens will typically be less expensive than bioswales, as rain gardens are not usually very large. Bioswales, in contrast, are frequently deployed along roads or in parking lots, which increases their total area and also their cost. Scale, however, can also improve the cost efficiency of an installation because larger installations typically provide more stormwater benefits.

ACADEMIC STUDIES ON THE EFFECTIVENESS OF GREEN INFRASTRUCTURE[9]

The benefits derived from particular green infrastructure installations are highly context dependent and vary according to topology, soil characteristics, and position within a watershed. Although there are limited academic studies that investigate the efficacy of different green infrastructure types in a suburban/rural watershed in southeast Michigan, modeling studies of two urban watersheds in Indiana provide some inclination for how different green infrastructure installations might perform if installed in Pittsfield Township. The studies revealed that retention ponds generated the largest reductions in runoff volume and pollutant loads but that bioretention systems, bioswales, permeable pavements, and rain barrels/cisterns were also effective, even at low levels of implementation. Green roofs generated only minimal reductions in pollutant loads and runoff volumes. A major focus of the studies was the cost effectiveness of bioretention and permeable pavements, which varied in cost effectiveness according to the drainage characteristics of the soils in the area.

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STORMWATER MANAGEMENT IN PITTSFIELD TOWNSHIP

03

PART II: STORMWATER MANAGEMENT

GOVERNANCE OF STORMWATER MANAGEMENT IN MICHIGAN TOWNSHIPS [1]

Different levels of government in Michigan have different responsibilities for stormwater management. The state has regulatory control over any wetlands adjacent to the Great Lakes, as well as any contiguous wetlands greater than five acres in size. County and municipal governments, however, are also tasked with developing additional regulations for water resources. According to Michigan law, each county must publicly elect a "Drain Commissioner" to supervise any activities that involve public stormwater management. These include the construction, maintenance, and planning of pipes, culverts, and other structures that manage stormwater. Each county's Drain Commissioner therefore has jurisdiction over anything that is considered a "county drain." County drains, which are publicly owned structures that collect or direct stormwater, can be open ditches on the side of a road or enclosed pipes that travel under the ground. Although incorporated municipalities in Michigan or other sectors of government (such as a Road Commission) may also have responsibilities for managing stormwater, the County Drain Commissioner has jurisdiction over the majority of the drains in a given county.`To determine community preferences for stormwater management in Pittsfield, we created a public education video to better inform Pittsfield residents about the importance of stormwater management and to describe potential options for future stormwater management in the Township. The community survey that accompanied the public education video provided residents with an opportunity to voice their preferences for stormwater management. The results of the survey were used to determine what future stormwater management strategies Pittsfield residents are most comfortable with pursuing.

The location and reach of "drainage districts" within a given county is also an important component of the stormwater management governance structure. Drainage districts are a smaller level of geography than a county and they typically follow the boundaries of smaller catchments within a given watershed (Figure 3.1). Drainage districts generally serve to identify which property owners are deriving benefits from which county drains. In addition, they determine the way in which maintenance and construction costs are distributed among property owners as drainage districts are also used to establish who will pay for the construction and maintenance of county drains. For drain maintenance

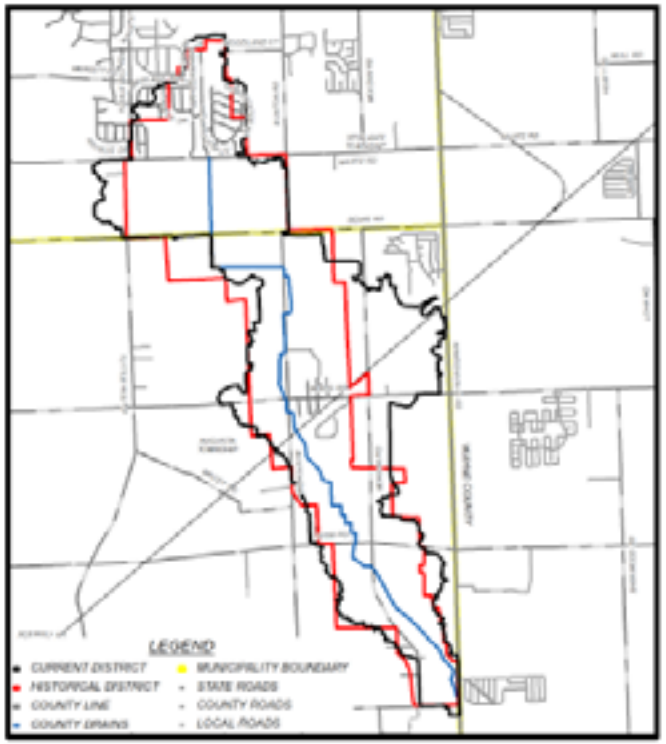

Figure 3.1. Historical and Current Swan Creek and Pilney Harris Drain Drainage District. From Washtenaw County SAW Stormwater Management Plan, p. 8.

and construction projects that exceed $5,000 per mile of drain constructed/maintained, the property owners belonging to the drainage district that would benefit from the construction or maintenance of that drain are billed for the costs of construction through a Special Assessment. For routine maintenance projects for which the costs do not exceed $5,000 per mile of drain, the Drain Commissioner is permitted to conduct maintenance without seeking additional approval from members of the drainage district that would benefit and the County includes the cost of these projects in the property tax bills issued to property owners within the benefitting drainage district.

Although it is subject to the same laws as any other county in the state, Washtenaw County does not have a "Drain Commissioner." Instead, Washtenaw County has a Water Resources Commissioner that has the same responsibilities as the Drain Commissioner in other counties.

Land Use Change in Pittsfield Township, 2001 - 2011				
land Use	2001 Area (Acres)	2006 Area (Acres)	2011 Area (Acres)	% Change, 2001-2011
Agriculture/Pasture/ShrubScrub	5441.2	4902.3	4670.3	-14.2
Barren	76.8	189.5	105.6	37.5
Developed	8899.8	9456.3	9846.1	10.6
Forest	1625.6	1517.1	1465.3	-9.9
Water	38.3	37.2	35.65	-7
Wetland	1330.6	1309.6	1288.8	-3.14

Figure 3.2 Land Use Change in Pittsfield Township from 2001 to 2011.

STORMWATER MANAGEMENT IN PITTSFIELD [2]

Pittsfield Township's zoning ordinance states that new developments that require a site plan must include a stormwater management plan for the site that meets Washtenaw County Water Resources Commissioner (WCWRC) standards. These standards require the treatment and detention of the first inch of runoff as well as the 100-year storm event (4.9-inches of rain over 24 hours). To guarantee long-term maintenance, developers must enter into a "Stormwater Maintenance Agreement" that requires the developer to inspect, repair, and maintain the storm drainage system within the development.

Land Use Change in Pittsfield Township, 2001 - 2011

Figure 3.3 Land Use Change in Pittsfield Township from 2001 to 2011. Land use data was gathered from the USGS National Land Cover Database (NLCD). NLCD data was reclassified to aid in the ease of analysis. The reclassification system used in this analysis can be found in Appendix A.

CHANGES IN LAND USE IN PITTSFIELD AND IMPACTS ON STORMWATER MANAGEMENT [3]

Pittsfield has experienced significant land use change in recent decades, largely in response to the rapid rise in the Township's population. Once primarily agricultural land, Pittsfield has seen the area of residential, commercial, and industrial development increase markedly over time. Consequently, the area of agricultural land, pasture, and forest has decreased. Since 2001, the area of "developed" land (i.e. residential, commercial, industrial) has increased over 10% while the area of agricultural/pasture/shrub-scrub land and the area of forested land has decreased by roughly 14% and 10%, respectively (Figure 3.2). Conversions of agricultural land to residential land have been concentrated in the northwest and northeast portions of the township. Changes in land use have implications for stormwater management because increases in the area of developed land increases the amount of impervious surfaces and is associated with a corresponding decrease in the amount of vegetated land that could manage stormwater through plants and soil. Increases in impervious surface area limit the ability of natural systems to manage the quantity and quality of stormwater runoff, which leads to increases in the volume of runoff and in pollutant concentrations in runoff.

CONDITIONS OF CURRENT STORMWATER SYSTEM [3]

According to the WCWRC's Stormwater Asset Management Plan, the majority of the constructed assets that manage stormwater runoff in Pittsfield are in good condition. Despite the generally good condition of these assets, when examining the potential for already constructed assets to manage runoff under future development conditions, the WCWRC indicated that changes in development patterns will require careful management of runoff as Pittsfield continues to grow. To determine the ability of stormwater assets to manage stormwater in the future, the WCWRC ran a series of models that estimated the impacts of development on runoff quality and runoff quantity under a variety of future development scenarios. In these models, the WCWRC determined that if Pittsfield was developed exactly according to the 2010 Master Plan, runoff volume in the Northeast Saline River Watershed (which encompasses the majority of Pittsfield Township) would be much greater than current conditions, and runoff quality (measured in terms of total suspended solids concentrations and total phosphorus concentrations) would be much worse than current conditions.

To evaluate the effectiveness of alternative future development scenarios in mitigating the impacts to runoff quantity and quality, the WCWRC modeled a "high and medium potential development" scenario (in which sites that have a high and medium potential of development were assumed to be fully developed), a "tree canopy" scenario (in which portions of high intensity developed areas, medium intensity developed areas, and cultivated crops were converted to deciduous forest), and a "disconnected impervious surfaces" scenario (in which portions of medium and high intensity development were downgraded to low and medium intensity development, respectively). The high and medium development scenario resulted in increased runoff volume and deteriorated runoff quality compared to current conditions. Both the disconnected impervious surface scenario and the tree canopy scenario resulted in decreased runoff volume and increased runoff quality compared to current conditions and all other future development scenarios (Figures 3.3, 3.4, and 3.5). This indicates that if the Township were to reduce the amount of impervious surfaces that directly connect to the stormwater management system and also were to increase the tree canopy in the township, the volume

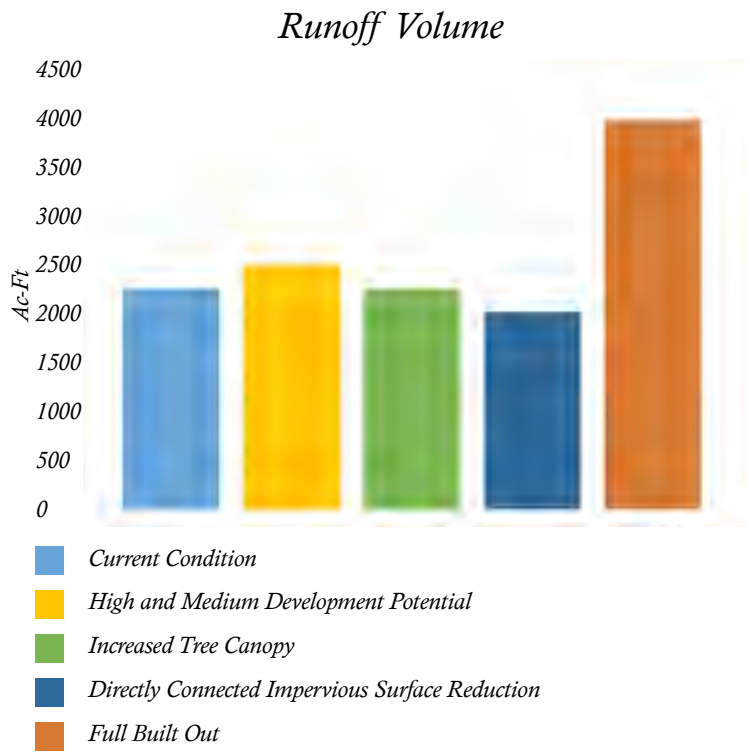

Figure 3.4 Results of WCWRC modeling of runoff volume under future development scenarios. From Washtenaw County Water Resources Commissioner SAW Stormwater Asset Management Plan, p. 119.

Figure 3.5 Results of WCWRC modeling of Total Suspended Solids under future development scenarios. From Washtenaw County Water Resources Commissioner SAW Stormwater Asset Management Plan, p. 120.

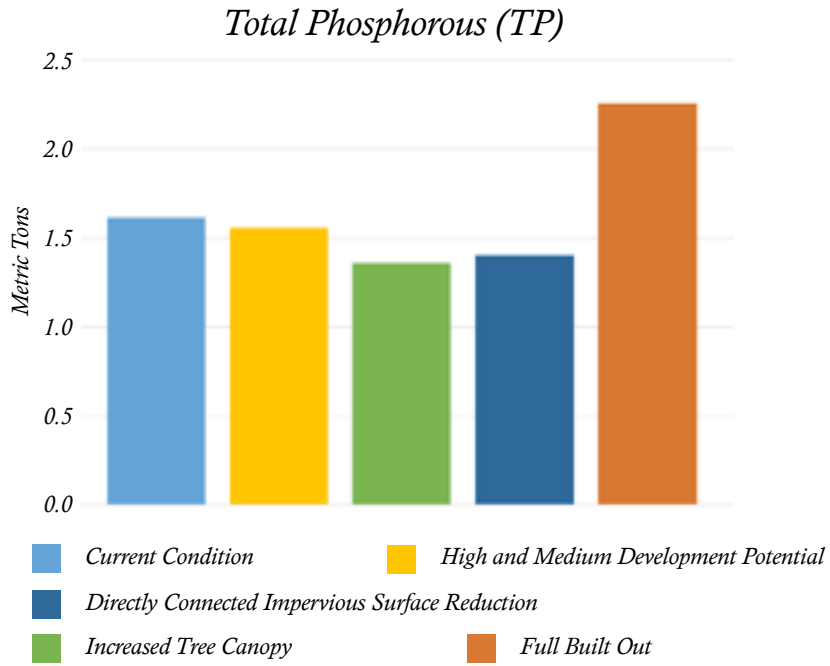

Figure 3.6 Results of WCWRC modeling of Total Phosphorus under future development scenarios. From Washtenaw County Water Resources Commissioner SAW Stormwater Asset Management Plan, p. 121.

of runoff would be reduced while the water quality of runoff would be improved. Based on this modeling, two potential opportunities for future stormwater management include disconnecting impervious surfaces and increasing the tree canopy. A more in-depth discussion of potential future stormwater management options is presented in the next chapter.

ENDNOTES

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2. Pittsfield Charter Township Zoning Ordinance Section 9.08, B. 11 Pittsfield Charter Township. 2020 Sustainable Vision. (Pittsfield Charter Township, MI, 2017), https://en.calameo.com/read/0026597862fe714f5c9f1.

3. Spicer Group, 2017.

SELECT FUTURE OPPORTUNITIES FOR PITTSFIELD TOWNSHIP

04

PART II: STORMWATER MANAGEMENT

Pittsfield Township has a variety of available options for future stormwater management, each with their own unique combination of runoff quality benefits, runoff quantity benefits, relative cost, and parties responsible for implementation. Figure 4.1 summarizes the options available to Pittsfield residents, with an indication of the relative stormwater benefit, the relative cost, and the level of public commitment of each option.

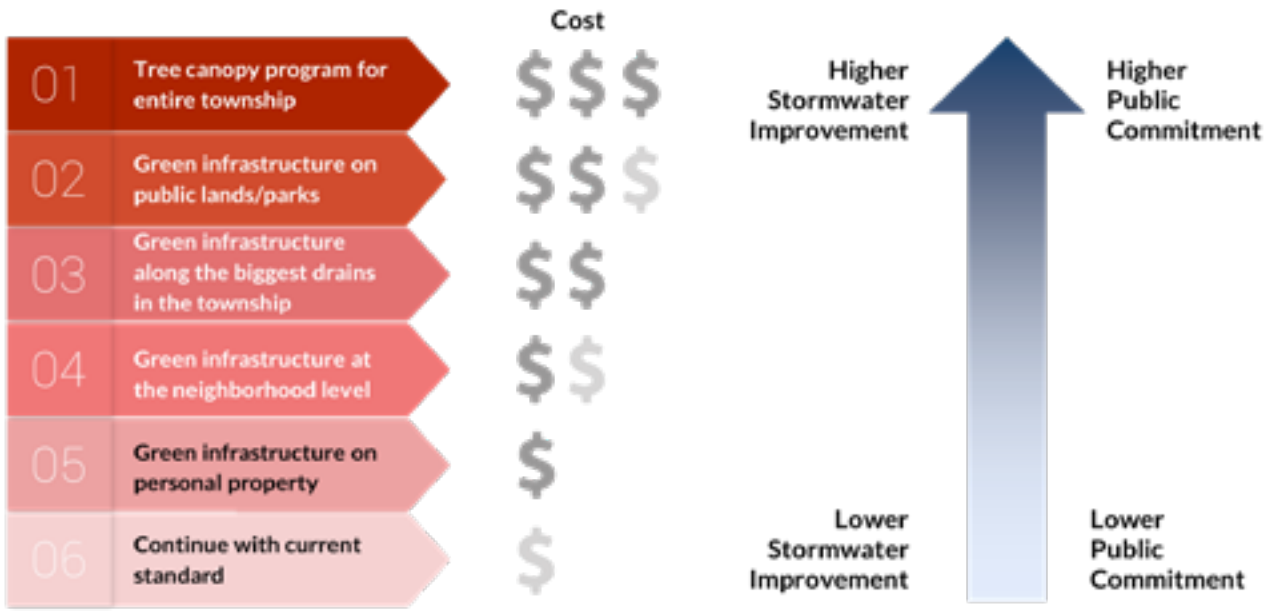

Figure 4.1. Future stormwater management options available to Pittsfield residents.

OPTION 1: TOWNSHIP-WIDE TREE CANOPY PROGRAM [1]

This option, which entails instituting a public program to plant trees throughout the township, has the potential to achieve the greatest runoff quality and runoff quantity benefits of any option discussed in this report, although this is predicated on widespread participation. Increasing the tree canopy in developed areas has been shown to reduce runoff volumes and improve runoff quality. Tree canopy programs have also garnered support because urban and suburban watersheds, even with the construction of Best Management Practices (BMP) or Low Impact Development (LID) installations, are generally unable to hydrologically mimic forested areas, which offer superlative runoff quantity reduction and runoff quality improvement capabilities. In addition to the stormwater management benefits, planting a single tree is estimated to remove 10 pounds of air pollutants each year. A tree canopy program would therefore likely generate greater water quality and runoff quantity benefits than Option 2, although absent widespread participation, it is possible that Option 2 would generate better water quality and runoff quantity benefits.

Figure 4.2 A Tree Planting Program in Another City
Source: http://www.iberkshires.com/story/51809/A-Tree-Grows-in-Pittsfield-2-399-More-to-Go.html

Figure 4.3 TreeVitalize Grants Program in Pennsylvania
Source: https://treepennsylvania.org/treevitalize-grants-program/

A successful tree canopy program would also likely take pre-development land cover into consideration. Although Pittsfield is currently comprised of agricultural, residential, and commercial/industrial land uses, the mix of land uses prior to development included more forested and wetland areas. If the Township were to pursue this option, it would be ideal to encourage the planting of native trees, as such trees would likely perform better than tree species not suited to the area's climate conditions. The cost of this option would likely be slightly higher than that of Option 2 and would lend itself to taking advantage of economies of scale.

Figure 4.4 Pittsfield Public Park
Source: http://annarbordetroit.kidsoutandabout.com/content/pittsfield-township-parks-and-recreation

OPTION 2: CONSTRUCT GREEN INFRASTRUCTURE ON PUBLIC PARKS/ LANDS

This option would require the Township to build green infrastructure installations on public parks and/or lands within the township. Considering the potential to achieve larger economies of scale, this option would likely allow for the construction of large installations. Given the relative lack of space constraints compared to other options, this option offers the opportunity to chain LID

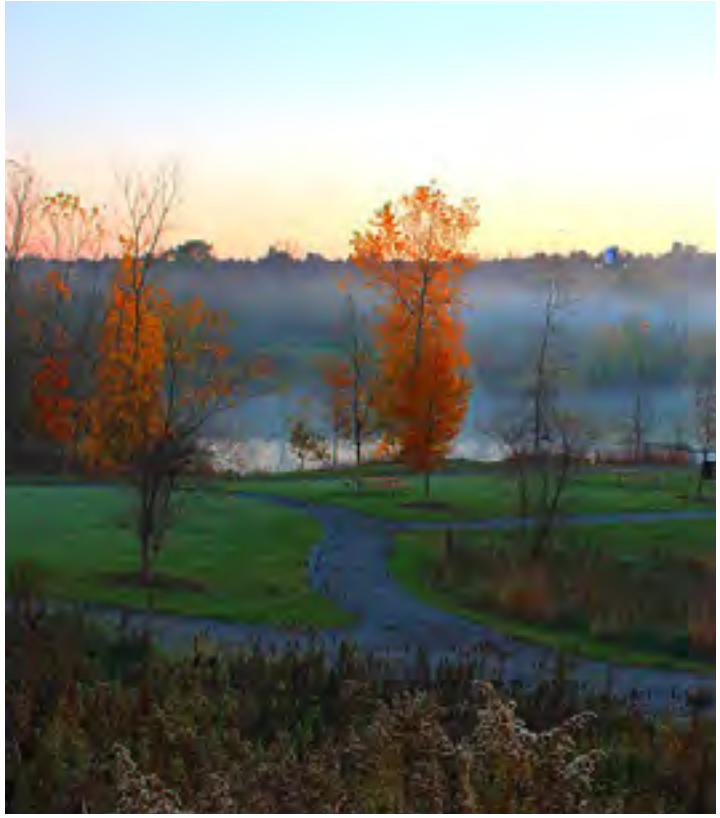

Figure 4.5 Pittsfield Lillie Park
Source: https://commons.wikimedia.org/wiki/File:Dawn_on_Haven_Lake,_Lillie_Park,_Pittsfield_Township,_Michigan_-_panoramio.jpg

and BMP installations together to achieve greater water quality and runoff quantity benefits. Given the increased potential for larger installations to further modify pre-development hydrology, however, emphasis for this option should be placed on restoring natural hydrology patterns. This option would likely achieve greater runoff quality and runoff quantity benefits compared to most other options summarized in Figure 4.1, but it would likely be less effective than Option 1. The total expenditures involved in pursuing this option would likely be greater than Option 3, but as the cost would be distributed across Pittsfield residents, it could be less financially burdensome on each individual resident. Care should be taken, however, to ensure that the expected contributions from Pittsfield residents do not overly strain lower income residents, as a purely uniform funding model would cause lower income residents to spend a larger portion of their income on stormwater improvements compared to higher income residents. This option would likely involve a similar level of public involvement as Option 3, with the Township and County assuming the role of project designers and implementers while residents contribute financially.

OPTION 3: CONSTRUCT GREEN INFRASTRUCTURE ALONG THE LARGEST COUNTY DRAINS [2]

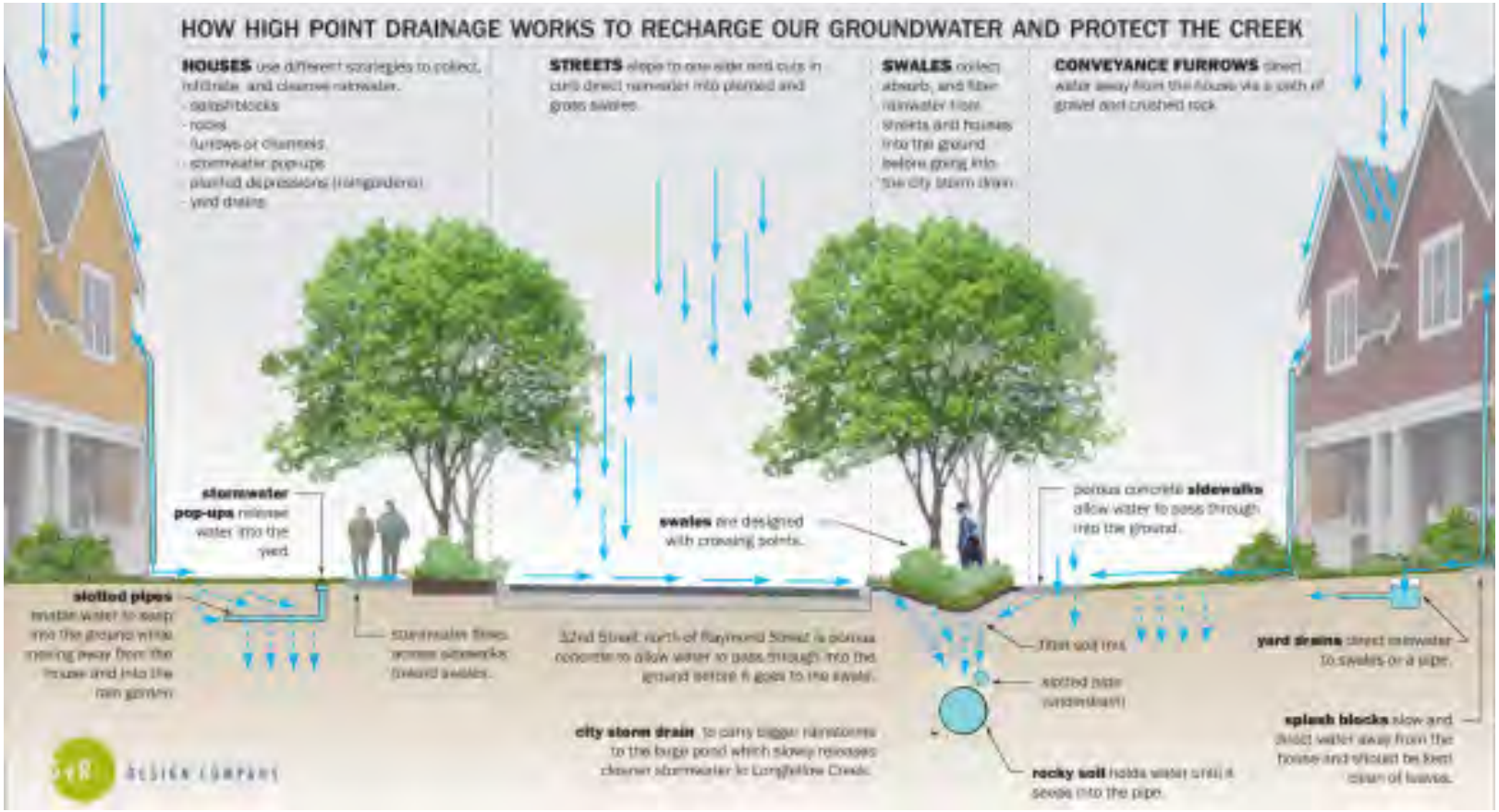

Figure 4.6 Stormwater Management Example along Drains
Source: https://aqueductfutures.wordpress.com/2013/03/04/ways-to-manage-stormwater-2/

This option would involve residents contributing financially to build large green infrastructure installations along the largest county drains in the township. Because this option would afford the Township the opportunity to construct larger scale green infrastructure installations, it has the potential to generate greater water quantity and water quality benefits than Option 4. The Washtenaw County Water Resources Commissioner (WCWRC)'s modeling of future stormwater flow regimes indicates that disconnecting impervious surfaces from the drainage infrastructure would mitigate some of the negative impacts of future development in Pittsfield. This option has the potential to achieve similar results if the installed green infrastructure disconnected previously connected impervious surfaces from county drains, instead allowing runoff to pass through green infrastructure installations before it reaches the drains. Modeling studies in Melbourne, Australia lend support for the efficacy of this method, as the ecological condition of streams that were not directly connected to impervious surfaces was preserved when runoff was informally directed towards pervious land.

This option would likely also generate greater runoff quality benefits than Option 4 because of the ability of larger scale installations to reduce pollutant loads. Previous research has indicated, however, that establishing new flow patterns that run parallel to pre-development flow patterns could undermine these installations' ability to restore pre-development hydrology, potentially negatively impacting downstream ecosystems. That being said, considering that the hydrology of the township has already been significantly altered, this option would likely generate net benefits for the community with regards to runoff quality and runoff quantity. This option's total relative cost would likely be higher than the total expenditures of Option 4, but with the potential to distribute this cost among a larger number of residents, the financial burden on individual residents would likely be lessened. This option would require significant involvement on the part of the Township and the County, as Pittsfield and the WCWRC would have to collaborate on project development and ask residents for input.

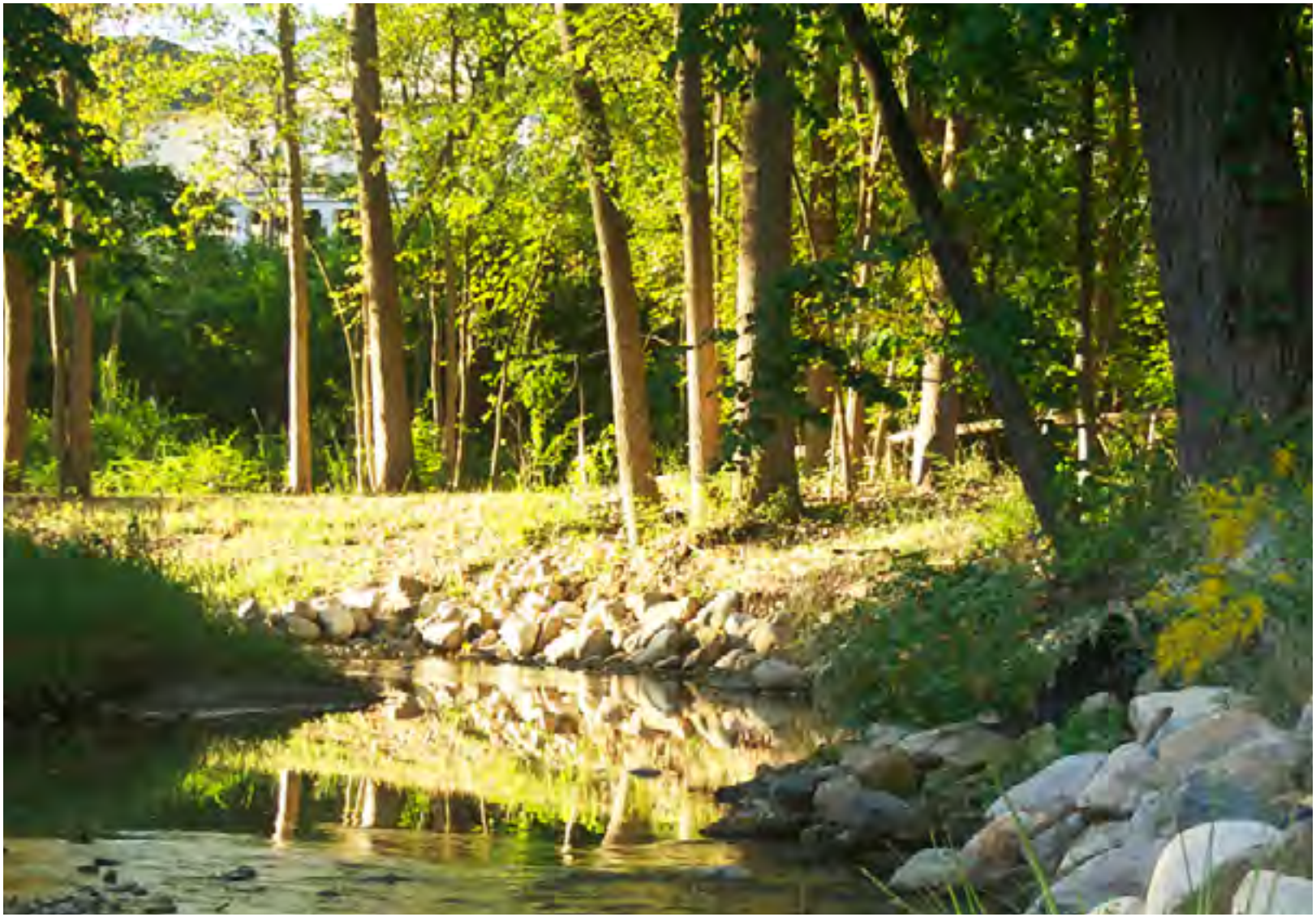

Figure 4.7 Mallett's Creek, Ann Arbor, MI
Source: http://www.ohm-advisors.com/what-we-do/services/engineering/stormwater-management/

OPTION 4: GREEN INFRASTRUCTURE IN NEIGHBORHOODS [3]

Figure 4.8 Retention Pond at the Hamptons of Cloverland Apartments
Source: https://www.apartments.com/hamptons-of-cloverlane-apartments-ypsilanti-mi/rtgqc22/

This option would involve neighborhoods in the township organizing themselves to design, construct, and maintain green infrastructure installations. Given the potential for the construction of larger-scale BMPs or networks of LID installations, this option offers superior water quality and runoff quantity benefits compared to Option 5. Some researchers argue that sub-catchment approaches (which align with the

neighborhood scale of this option) to stormwater management may be more effective than campaigns for dispersed green infrastructure because there is no guarantee that enough property owners will build green infrastructure such that it would generate significant stormwater management benefits. Because the Township already requires that newer developments manage some portion of stormwater on-site, the greatest gains from this option would likely come from older neighborhoods building green infrastructure. There is, however, potential for newer neighborhoods to improve their stormwater management practices by incorporating LID installations into already established BMPs like retention ponds. Overall, this option has the capacity to generate significant runoff quantity and runoff quality benefits but such benefits are dependent on sufficient participation. The relative cost of this option would likely be higher than Option 5, and lower than Option 3, although the financial burden placed on individual residents living in neighborhoods that opt to participate might be higher than Option 3 due to the inability to achieve the same economies of scale. This option would not require large amounts of public involvement and would be contingent on individual neighborhoods taking the initiative to build green infrastructure.

OPTION 5: GREEN INFRASTRUCTURE INSTALLED ON A VOLUNTARY BASIS ON PERSONAL PROPERTY

Encouraging Pittsfield residents to install green infrastructure on their personal property on a voluntary basis is another option available to residents. This option holds promise to achieve significant runoff quality and quantity benefits through the restoration of pre-development flow regimes, although this outcome is predicated on widespread participation among residents. Assuming that this option garners sufficient participation, this option's potential to generate numerous, dispersed stormwater management installations that would allow for infiltration and treatment of stormwater where it falls is appealing. Previous studies have indicated, however, that there is no certainty that each individual landowner would elect to build green infrastructure on their properties, which is a significant limiting factor in this option's potential ability to address runoff quantity and quality concerns. With regards to cost, the costs to implement this option would likely remain low relative to the other options, as the green infrastructure installations that property owners would likely pursue are at smaller scales and require less excavation and soil amendment. Given the cost of installing green infrastructure on one's property, the most plausible installations would be rain barrels, cisterns, or rain gardens. The required level of public involvement to implement this option is low relative to the previous options discussed as residents

would be responsible for installing green infrastructure on their own properties. Public involvement could nonetheless aid in increasing the efficacy of this option as the Township and/or County could facilitate increased participation by holding workshops to inform residents about how to construct or acquire rain barrels, cisterns, rain gardens, and other smaller variants of green infrastructure.

Figure 4.9 Rain Garnden Installation Program in Pinckney Township, Washtenaw County, MI
Source: http://blog.reedecologicaldesign.com/2015/04/project-report-pinckney-town-hall-rain.html

OPTION 6: CONTINUE WITH THE CURRENT SYSTEM

From a public involvement perspective, the least demanding option for Pittsfield residents is to continue with the current system. As mentioned previously, Pittsfield residents petition the WCWRC for any maintenance or construction of county drains that amounts to greater than $5,000 per mile of drain being constructed/maintained. Smaller projects whose expenditures do not exceed $5,000 per mile of drain are billed to residents living in the drainage district that benefits from the project, which they then pay alongside property taxes to the county. Although this option requires no additional effort on the part of residents, if Pittsfield continues to develop according to its 2020 Sustainability Plan, runoff will need to be managed carefully.

Figure 4.10 Pittsfield Township Hall
Source: http://desarch.com/com/pittsfield-hall

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Southeast Michigan Council of Governments. Green Infrastructure Vision for Southeast Michigan. (Detroit, MI, 2014), https://semcog.org/Reports/GIVision/index.html.

2. Burns, M.J., T.D. Fletcher, C.J. Walsh, A.R. Ladson, and B.E. Hatt. "Hydrologic shortcomings of conventional urban stormwater management and opportunities for reform." Landscape and Urban Planning 105 (2012): 230-240.

Booth et al., 2002.

3. Burns et al., 2012.

COMMUNITY ENGAGEMENT & SURVEY METHODOLOGY

PART III: COMMUNITY ENGAGEMENT

05

Figure 5.1 Community Engagement Day at UNT Dallas
Source: https://www.untdallas.edu/sites/default/files/legacy/feature/news/16258-community_engagement-7763.jpg

GOALS OF COMMUNITY ENGAGEMENT [1]

Community engagement is an integral facet of the planning process. It affords planners the opportunity to bridge the gap between government entities and the public while gathering input from residents about planning initiatives. Community engagement in planning typically aims to reach the following three goals:

1. To involve residents in the decision-making process and encourage future participation in community engagement efforts.

2. To provide residents with a platform so that their voices can heard and use resident input to improve plans, decisions, service delivery, and communities.

3. To promote a sense of community.

By engaging the public, local governments can draw on critical sources of information about local conditions, wants, needs, and attitudes: residents themselves. Achieving inclusivity in the engagement process is imperative to ensure that goals and objectives are set and attained collectively. Therefore, it is important to provide mechanisms for those that tend to be underrepresented in the community as a result of their income, culture, language skills, race, age, or religion so that all residents have the opportunity to influence the decision-making process. Inclusivity can also lead to reciprocal learning and foster a sense of mutual respect among community members and the government.

COMMUNITY ENGAGEMENT METHODS [2]

Community engagement can be approached through a variety of strategies, although surveys, public meetings, and public education initiatives are the most common community engagement strategies that planning departments employ. The following section will describe each of these community engagement methods.

Surveys

Surveys are sets of questions that aim to elicit a direct response. They are widely used and are well-known as an effective means by which to gather information from community members. Most surveys are designed either as a questionnaire or an interview and can be distributed through the mail, in-person, online, or through a combination of these three mediums. One advantage of surveys is that they lend themselves to quantitative analysis that can be used to discover relationships between, and see patterns in, responses. Surveys are often used to determine community opinions, knowledge, or characteristics of behavior. Two basic forms of questions are used: closed-ended questions, in which the respondent is asked to choose a specific option from a set of given responses, and open-ended questions, in which the respondent is asked to provide feedback without picking from a predetermined set of responses.

Public Meetings

Public meetings include, but are not limited to, informal gatherings, charrettes, focus groups, community visioning exercises, and town hall meetings. Informal gatherings are impromptu assemblies in which officials ask the public questions. These often happen in public spaces and at public events. Charrettes are work groups in which community members are invited to learn more about an issue and are asked to brainstorm ideas about how to address a given problem. Charrettes are often more intensive than other public meetings (taking place for multiple hours each day for a period of a few days) and they are often constructed to elicit solutions to a particular design problem. Community visioning exercises are similar to charrettes but are more concerned with devising abstract standards that will be used to shape specific planning efforts in the future. Town hall meetings are traditionally associated with the political

process and serve as an arena for constituents to speak directly to elected representatives and voice opinions or ask questions. Focus groups are closed meetings of a curated group of diverse stakeholders that aim to ascertain community members' beliefs, opinions, attitudes, or perceptions of proposed or ongoing planning efforts. Public meetings provide an opportunity for governments to collect qualitative data that can be used to inform planning initiatives and they are a staple of current planning processes.

Figure 5.2. Previous public meeting held in Pittsfield
Source: http://pittsfield-mi.gov/images/pages/N105/IMG_1188_thumb.j

PUBLIC EDUCATION

Public education is generally defined as the process by which officials communicate information about a specific topic to the general public. Public education is often achieved through a variety of mediums including mass mailings, websites, advertisements in public media sources, or organized educational sessions at public institutions such as schools, community centers, and senior centers. Public education serves a valuable role in community engagement as it provides an opportunity for residents to gain the necessary knowledge base with which to make informed decisions.

CASE STUDIES

Similar to planning more generally, successful stormwater management requires community input. The Washtenaw County Water Resources Commissioner (WCWRC) currently offers a variety of community engagement programs that pertain to stormwater management, which are summarized in Figure 5.3. In order to have a better understanding of how different government entities engage their communities around stormwater management, we examined two cases: Washington State and Western Australia, Australia's largest state.

WCWRC COMMUNITY ENGAGEMENT PROGRAMS

The details about each of the programs summarized below were gathered from the Washtenaw County SAW Stormwater Asset Management Plan.

(1) The Community Partner for Clean Streams Program -- this program currently seeks to provide local businesses, institutional landowners, and multi-family residential developments with information regarding opportunities to implement practices that encourage pollution prevention. The program currently has a recognition component for those who choose to participate in the program.

(2) The RiverSafe Homes Program -- this program supports resident education on practices that help promote water quality around their homes. The program extends a survey to residents in order to gauge resident participation in practices around their home that contribute to protecting water quality. Those who participate in the program receive a market for their home, allowing residents to be involved in an educational opportunity surrounding stormwater management while also displaying their commitment to protecting water quality within their local community.

(3) The Rain Garden Program -- this program includes the Master Rain Gardener Class, rain garden design assistance, and rain garden volunteer program.

(a) Master Rain Gardener Class -- this allows for residents to become certified Master Rain Gardners over the course of 5 classes, allowing residents to become aware of how to design rain gardens and serve as a neighborhood expert for others who may be interested in planting their own rain garden.

(b) Rain Garden Design Assistance -- the WCWRC and staff collaborate with landowners to design and install rain gardens. An onsite visit is coordinated and a design is provided to the landowner.

(c) Rain Garden Volunteer Program -- residents have the opportunity to adopt public rain gardens and support other local rain garden projects. This allows for the community to become aware of rain gardens, supports existing rain gardens, and through community interest and collaboration, spur the creation of new rain gardens.

Figure 5.3 Community Engagement Programs Currently Offered by the WCWRC. [3]

Washington State [4]

In order to seek assistance in educating community members about stormwater management and in informing municipalities and businesses about the process of applying for stormwater permits, the State of Washington established the Stormwater Center in 2010 in partnership with universities, nonprofit organizations, and other public and private entities that provide tools for stormwater management. The Stormwater Center's primary goal is to assist the community in better understanding the results of stormwater research and applicable tools for stormwater management. To achieve this goal, the Stormwater Center, located on the Puyallup (a suburb of Tacoma) campus of Washington State University, researches stormwater management technologies and strategies, conducts pilot projects, and performs public outreach activities while relying on the collaboration of other agencies and programs.

The Stormwater Center offers a slate of educational resources on different aspects of stormwater management including municipal permitting, business permitting, and Low Impact Development (LID). Educational information is presented through videos, written documents, presentations, guidance manuals, and reports.

In addition, the Center offers workshops and webinars where attendees can learn more about stormwater management permits and LID. The workshops offered by the Center are designed to supply introductory-level information to attendees with limited background knowledge of stormwater management. The Center also publishes the presentation slides and materials used and distributed in workshops so that those interested in stormwater management can learn at their own pace.

Figure 5.4 LID education video by Washington Stormwater Center
Source: http://www.wastormwatercenter.org/lid-permeable-pavements/

In order to address aspects of stormwater management that are most relevant to municipalities, businesses, and community partners that must submit stormwater permits to the Washington State Department of Ecology, the Center created the "Lunchtime Municipal Webinar Series." These 30-60 minute webinars are offered periodically throughout the year and cover topics such as watershed management plans, the economic benefits of ecosystem services, and stormwater decant facilities (large concrete pads where stormwater waste can be disposed of properly), among others. Each webinar video is available on the Stormwater Center's website in the form of YouTube links and PDFs.

One particularly intriguing program offered by the Stormwater Center is the Hybrid LID Certificate Program, which gives designers, contractors, and builders the opportunity to learn more about the design, construction, and maintenance of LID. The Certificate Program offers a variety of course modules that explore specific types of LID (such as permeable pavements, bioretention, and rainwater collection), the site assessment and planning process, and hydrologic modeling, among others. The program boasts a combination of online and in-person learning although the most recent in-person training sessions, slated to begin in March 2018, were cancelled due to low enrollment. A contributing factor could be that the state government ceased granting subsidies to cover the cost of the program, which increased the price of obtaining a certificate. In addition to the Hybrid LID Certificate Program, the Stormwater Center has partnered with the Northwest Environmental Training Center to provide Certified Erosion and Sediment Control Lead (CESCL) training and grant the CESCL certification that is required for personnel responsible for managing stormwater on construction sites larger than one acre.

Beyond the Stormwater Center, Washington State is home to other examples of public engagement programs that focus more directly on encouraging public participation in stormwater management efforts among residents. One such program, 12,000 Rain Gardens in Puget Sound, has built rain garden resource hubs in all 12 Puget Sound counties to facilitate residential construction of rain gardens. This program, a collaborative effort between the nonprofit organization Stewardship Partners and Washington State University Extension,

Figure 5.4 12000 Rain Gardens Program
Source: http://www.12000raingardens.org/build-a-rain-garden/champions/

hopes to help build 12,000 rain gardens, a goal which if met, would remove an estimated 160 million gallons of polluted runoff from Puget Sound waterways. Currently, according to a rain garden counter on the program's website, there are 3,981 rain gardens registered with the program. In addition to programs designed specifically to address stormwater management, other nonprofit organizations in the area focus on stormwater management's connections to other facets of life. Supported by the United Way of King County, the Tilith Alliance offers hands-on workshops for residents to learn how to build and maintain their gardens, which includes some instruction on the importance and mechanics of stormwater management. It also provides farmers with resources related to the use of LID in farming.

Figure 5.5 Sydney Park
Source: http://www.gufc.org/wp-content/uploads/2010/02/Stormwater-photo-for-workshop.jpg

Western Australia [5]

Encompassing roughly one third of the country's area, the state of Western Australia is an intriguing example of a high level of government devising strategies to impact stormwater management on a local level. Of particular interest is the Stormwater Management Manual for Western Australia, a manual published by the Western Australia Department of Environment. The manual provides information for an intended audience of developers, communities, industries, and local governments on best management practices for stormwater management and highlights strategies to promote public environmental awareness.

Throughout the manual, a common theme is that the Department aims to promote stormwater as a resource that provides value, as opposed to a waste product with a

cost. Recasting stormwater as a valuable natural resource could provide social, environmental, and economic opportunities for stormwater management and augment public interest in enhancing stormwater management efforts.

Chapter 8 of the manual, titled "Education and Awareness for Stormwater Management," was particularly intriguing as it offered strategies for how an education and awareness program could be developed such that it speaks to the variety of stakeholders in a community. One of the primary roles of education and awareness according to the manual is to provide a catalyst for a change in behavior. In order to create change, the manual suggests that public engagement about stormwater management should include educating the public about the nature of the problem, providing information to people about what they can do to solve the problem, and involving the local community in hands-on activities to achieve pollution reduction or restoration targets.

In the manual, the Department of Environment presented a nine step process for planning an effective public education and awareness program (Figure 5.6).

Figure 5.6 Steps to create a community education and awareness program; based on planning techniques described in Stormwater Management for Western Australia.

A key part of the public education design process is defining and analyzing the problem or issue. A salient recommendation from the manual is that community engagement programs should be developed with a specific issue in mind, as the methods and actions that can best address a given issue might not be relevant for all facets of environmental problems, including stormwater management. For example, the manual notes that a public education and awareness program that provides information on the impacts of car washing or automotive repair on stormwater may not be particularly relevant for a community that does not have many automotive repair shops. This highlights that prior to embarking on a community engagement program that deals with stormwater, it is important to have a comprehensive understanding of the type of stormwater management issues facing the community and the factors within the community that may be contributing to stormwater management problems.

The manual also provides intriguing examples for how various levels of government or stakeholders might approach public education for stormwater management. Figure 5.7 presents a selection of example projects that would be best implemented by different stakeholders.

Sector	Example projects
Local government	Providing subsidised composting bins Talks, presentations and seminars Exhibitions and displays Targeted mail outs
State government	River cleanup programs Joint government/industry programs Courses through schools, universities, TAFE and other educational bodies
Environmental community groups	Planting days Project development Drain Stencilling Permanent displays and signs erected adjacent to waterways School visits Professional Development for Teachers
Industry associations	Teachers notes (like NIA) Workdays Member accreditation

Figure 5.7 Delivery methods for stormwater-related environmental education projects. From Stormwater Management for Western Australia, chapter 8, p. 5. TAFE stands for "Technical and Further Education."

Figure 5.2 highlights how different organizations are best suited for different aspects of public education. Ideally, a successful community engagement strategy would draw on a variety of organizations to provide the breadth and depth of information necessary for the public to make informed decisions about how to deal with stormwater.

For Step 6, "Design Your Methods," the manual offers a set of possible educational tools and techniques that may be incorporated in the community engagement and public education process (Figure 5.8).

1. printed material – in the form of newsletters or brochures
2. other distribution material – fridge magnets, pens and car stickers
3. media – newspapers, television, magazines and radio
4. interactive computer packages
5. launches and public releases by influential community citizens
6. signs – at bus stops or on billboards
7. displays – at local shopping centres or at special functions, festivals and trade displays
8. courses through schools, universities and community colleges
9. awards or accreditation programs as part of an integrated program
10. demonstrations such as water quality monitoring
11. talks, presentations and seminars

Figure 5.8 Education tools and techniques. From the Stormwater Management Manual for Western Australia, chapter 8, p. 14.

The diversity of methods presented in the manual highlights that effective community engagement will ideally use a variety of mediums to disseminate information. The manual also notes that when designing educational methods, it is important to incorporate principles of effective communication. In order to ensure that communication is beneficial, the manual recommends using messaging that is clear and concise, uses plain English, presents an accessible amount of information, includes up-to-date information, and provides an opportunity for two-way interaction.

Each of these case studies influenced how we designed our community engagement strategy, which will be described in the next section.

COMMUNITY ENGAGEMENT FOR PITTSFIELD

In order to gauge community preferences for future stormwater management, we created a three-part community survey that included a public education video about stormwater management. Although our background research indicated that effective community engagement strategies employ a diversity of mediums for disseminating information and collecting data on residents' preferences, we did not have sufficient resources to design and implement a fully inclusive community engagement process. Given the limited time-frame within which we needed to collect information, we elected to use an online-based survey because it could be easily distributed, because it could incorporate a public education video, because it afforded us the ability to use quantitative data in analyzing responses, and because it worked well with our time constraints.

2018 SURVEY DESIGN

Survey Goals
The survey was designed to achieve the following primary goals:

- Determine residents' existing knowledge and perceptions about stormwater management systems and governance structures.
- Assess the community's preferences regarding the importance of contributing public resources.
- Help residents learn more about stormwater management and green infrastructure generally and in Pittsfield Township.
- Evaluate the effectiveness of the public education video.
- Understand residents' preferences for future stormwater management in Pittsfield Township and their views on who should take primary responsibility.

Survey Content
The public engagement survey that we designed is divided into 3 sections:

1. "Pre-test" Survey

2. Public Education Video

3. "Post-test"/Decision-making Survey

Part 1: Pre-test Survey

The pre-test survey aimed to determine respondents' existing knowledge about stormwater management and the present stormwater situation in Pittsfield. By asking respondents what they already know about stormwater management, this portion of the survey aided in evaluating the effectiveness of the public education video by establishing a baseline to which post-test responses were compared.

More specifically, this portion of the survey included questions that determined respondents' current knowledge about stormwater, what entities they believed were currently responsible for stormwater management, and their general inclinations about the importance of, and willingness to, taking steps to manage stormwater. The full version of the pre-test survey is included in Appendix B.

Part 2: Public Education Video

In order to ensure that residents were empowered to make informed decisions about future stormwater management in the township, we created a 7-minute video (published on YouTube) that covered topics such as the definitions of various stormwater-related terms, reasons why stormwater management is needed, and what systems and government entities currently support stormwater management in Pittsfield. In addition, the video discussed the set of six options we devised for future stormwater management in Pittsfield.

The URL for the public education video, screenshots of the slides used in the video, and the narration script used in the video are included in Appendix B.

Part 3: "Post-test"/Decision-making Survey
Following the public education video, the third part of the survey asked three questions related to the effectiveness of the public education video, opinions on who should be responsible for stormwater management in Pittsfield, and preferences for future stormwater management according to the set of six options given to survey respondents. This section served to establish connections between pre-education and post-education knowledge levels, views on responsibility, and preferred options for stormwater management.

The survey in its entirety is included in Appendix B.

SURVEY DISTRIBUTION METHODS

Relying on the expertise of Pittsfield's Community Development Manager Jessica West, the survey was distributed through: email listservs of homeowners associations within the township, social media posts from the Township's Facebook and Twitter accounts, the Township's website, and a press release distributed by the Township. Emails containing the link to the survey were sent to the leaders of homeowners associations within the township, who then distributed it to residents of those homeowners associations. The Township made social media posts containing the link to the survey at various points throughout the two-week period during which the survey as active. In addition, the survey received news coverage from MLive, a news service focused on local news in Michigan communities.

LIMITATIONS OF COMMUNITY ENGAGEMENT STRATEGY

As mentioned previously, the timeframe for completing the project introduced some limitations that likely impacted the ability of the survey to accurately capture a representative sample of Pittsfield residents. Because our distribution methods relied heavily on internet-based mediums, we collected only a convenience sample of residents who have regular access to social media and the internet or who lived in homeowners associations and had access to email. This prevented our survey from collecting information from individuals, households, businesses, or neighborhoods who may not have access to the internet or were unaware of the survey for other reasons. Our inability to achieve a random, representative sample therefore resulted in an overrepresentation of residents who have access to the internet and are already interested in stormwater management.

In addition, although the public education video helped residents to understand the basic concepts of stormwater management and explained the choices we devised for future stormwater management in the township, the complexity of stormwater management systems and the governance structure of stormwater management in Pittsfield Township made it difficult to distill the most important aspects of stormwater management. A community engagement strategy that also provided an opportunity for residents to have face-to-face interaction and ask questions about stormwater management in person would likely have allowed for greater understanding of stormwater management and could have generated different results.

ENDNOTES

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5. Western Australia Department of Environment. Stormwater Management Manual for Western Australia. (Perth, Western Australia, 2004), http://www.water.wa.gov.au/urban-water/urban-development/stormwater/stormwater-management-manual

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ANALYSIS

06

PART IV: RESULTS

The survey was active for a period of two weeks. We received a total of 132 responses to the survey during the two-week period, 128 of which were from those who live in Pittsfield Township.

Our analysis of the data led us to conclude the following:

(1) Respondents are interested in collaborative stormwater management amongst property owners and at least one government entity. Respondents believed that the township or the county should take primary responsibility for stormwater management.

(2) The public education video was a successful method for increasing public understanding of stormwater management and almost one-third of respondents were inspired to learn more about stormwater management after watching the video.

(3) Respondents are willing to pursue stormwater management solutions that require a greater investment of both time and finances.

(4) Respondents are interested in supporting stormwater management efforts, although they currently feel unsupported and ill-equipped to address stormwater issues within their immediate neighborhoods.

(5) Respondents lack a clear understanding of governance structures that support and manage the stormwater landscape in the township.

RELATIONSHIP WITH STORMWATER

Over half of survey respondents think of stormwater as "causing flooding in their yard or basement immediately after a heavy rain or snow melt," indicating that residents are aware of the flooding issues that stormwater causes on their own property. Approaching stormwater management in the township by highlighting flooding impacts may therefore be an effective way to engage residents who are interested in finding solutions to problems that are visible.

While over 60% of survey respondents recognized that fertilizers and other chemicals are carried into storm sewers after a rain or snow event, only 30% of survey respondents responded "yes" to the question "In your

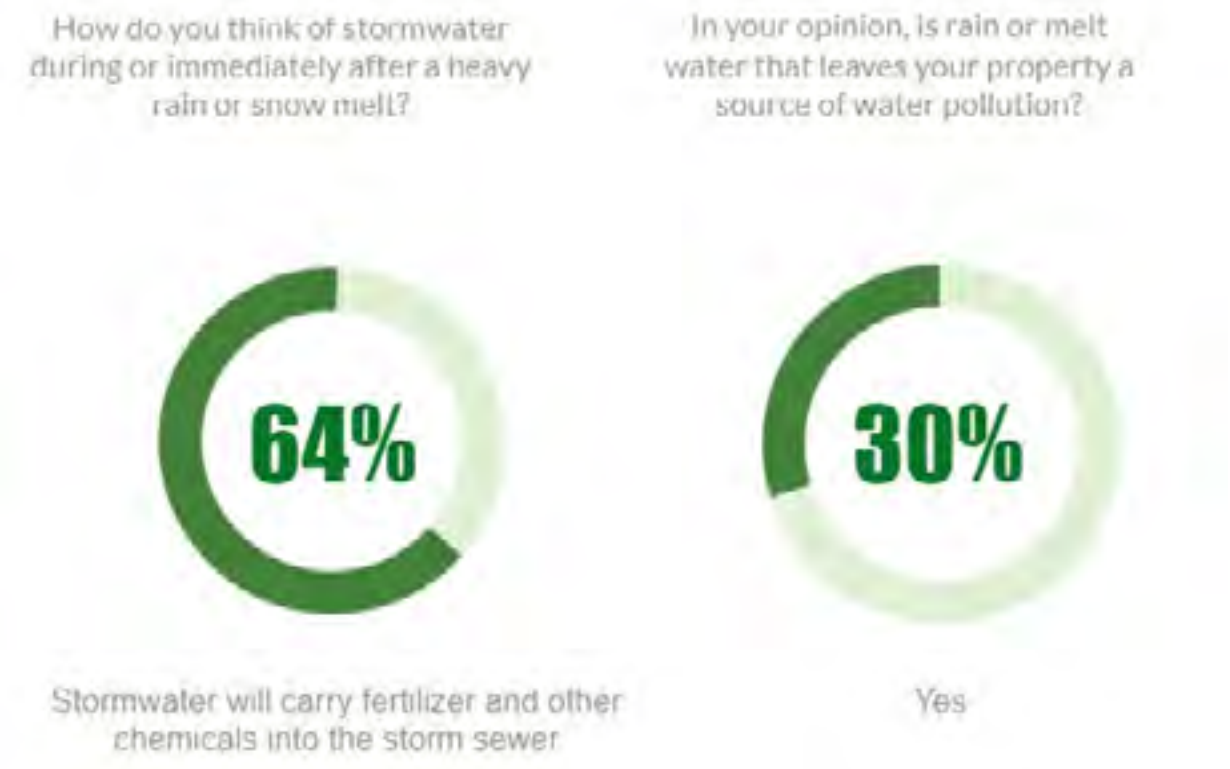


Figure 6.1 Responses to questions about stormwater's impacts on pollution.

opinion, is rain or melt water that leaves your property a source of water pollution?" (Figure 6.1). This suggests that respondents did not recognize their own contributions to water pollution despite being aware of the broader pollution impacts of stormwater. Public education about each residents' contribution to pollution might be able to address this gap in understanding and help residents begin to see themselves as part of the various contributors to stormwater pollution.

STORMWATER STAKEHOLDERS & COLLABORATIVE MANAGEMENT

Prior to watching the educational video, 58% of survey respondents said that they would like township and/or county government to take primary responsibility for stormwater management while only 24% of respondents said that property owners should take primary responsibility (Figure 6.2).

In a question asked after the educational video, the overwhelming majority of respondents believed that future stormwater management should be a shared responsibility amongst property owners or neighborhood associations and at least one government entity (Figure 6.3). A very small portion of respondents believed that property owners should take sole responsibility for stormwater management in the future.

This suggests that respondents are significantly in favor of increased government involvement in stormwater management, while also maintaining the expectation that responsibility for stormwater management practices be shared between residents,

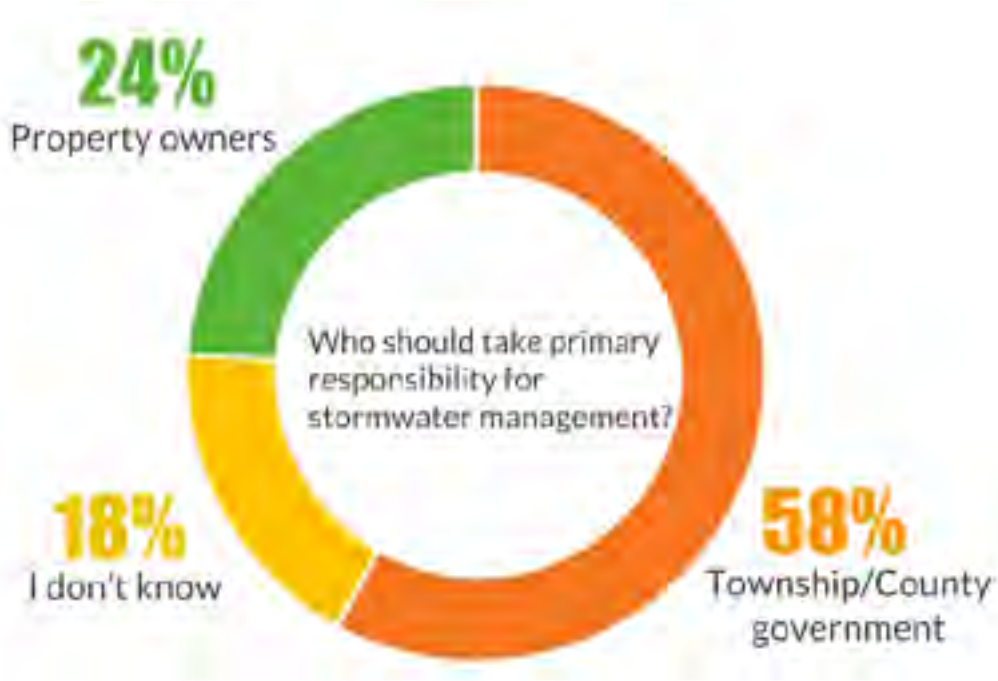


Figure 6.2 Responses to a survey question about responsible parties for stormwater management.

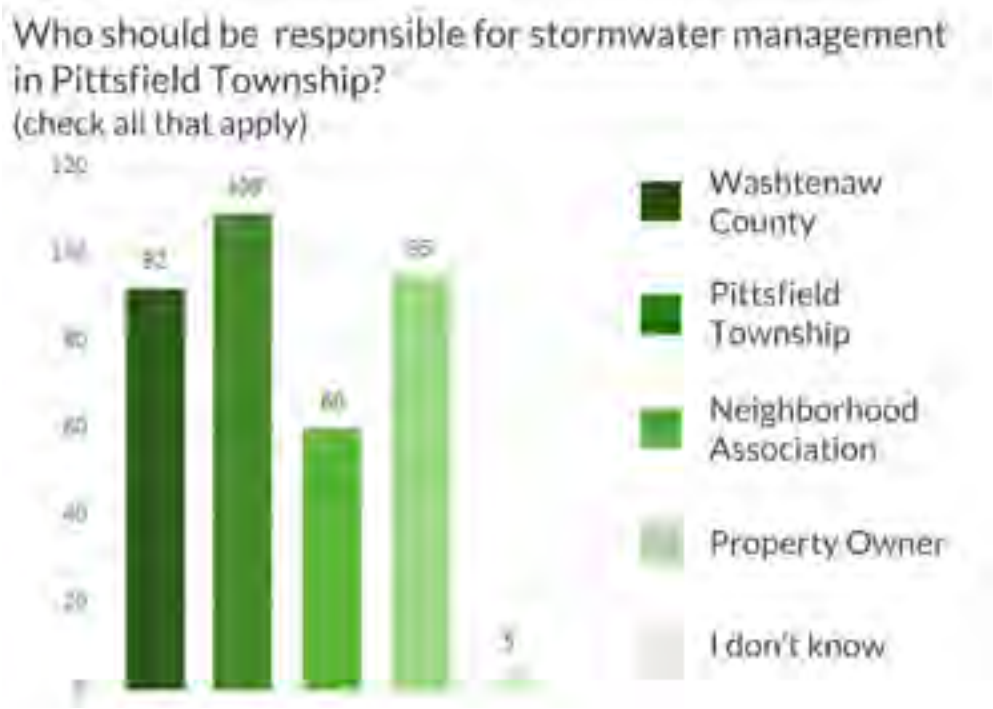


Figure 6.3 Responses to a survey question about responsible parties for stormwater management.

"The largest burden placed on lot owner associations is storm water system maintenance. There is no experience with the engineering, heavy equipment and management yet the boards (individual volunteers) are saddled with the burden ..... My neighborhood had an inadequate storm water system installed by the developer and we had to pay over $1M to repair it. Now we have to maintain it and just do not have the resources, both financially and knowledge on how to do it. To hire landscape companies to allegedly do the work is exceedingly expensive. Most of the time the 'landscape' companies don't really know what they are doing."

neighborhood associations, and government. In addition, in the open comments portion of the survey, a respondent suggested that a lack of developer oversight, of commitment to stormwater infrastructure maintenance, and of support for homeowner associations that are burdened with spearheading stormwater management are contributing to stormwater management issues. This response highlighted that neighborhood associations, some of whom are expected to manage stormwater projects, may lack the proper resources and understanding of the role that the County or Township plays in managing stormwater projects.

In addition to apprehension about resources and expertise, respondents raised concerns in the open comment section of the survey regarding poor stormwater system installation and development practices that undermine long term maintenance of landscaped areas. We recommend that future stormwater efforts include commitments from all stormwater stakeholders to invest both time and resources to maintaining stormwater infrastructure.

Respondents also commented on the road commissioner's role in stormwater management and drainage issues. In particular, respondents shared their frustrations regarding the work that was recently done on Textile Road and the impact that it had on the surrounding environment. The actions that were taken to create a greenway, including uprooting trees and paving the road, seemed counterintuitive to residents who are concerned with long-term stormwater goals in the township . Respondents seemed not only frustrated with current development efforts, but also appeared to direct such frustration at "the government" more generally, inclusive of County and Township governments. Lacking a clear actor to blame when attempting to assign responsibility for projects that they disagreed with, residents appeared to become disappointed with all government entities and were unable to ascribe culpability to the appropriate sector of government. When residents associate poor development processes with "the government," disdain for government officials and actions grows, discouraging residents from depending on government entities to follow through on supporting and maintaining stormwater infrastructure projects in the future. This, in turn, generates a level of distrust, breeding a divisive environment for moving forward with stormwater management, especially because it was not clear from the survey that respondents had a clear understanding of the responsibilities of townships and counties with regards to stormwater management. Given the Township's recent efforts to improve the brand recognition of "Pittsfield Charter Township", this is a dangerous path for residents to continue on, and it is therefore imperative to provide clarity for residents about the complex governance structures that support the stormwater landscape in the township.

"We were satisfied with that distinction and knew that the trees in this area sucked up a lot of rainwater, thus preventing flooding in a responsible manner. A cityscape was never desired here. A Natural Beauty Road would have been the more responsible decision for this section of Textile Road. Paving everything in site and making Pittsfield Township into a pit is not a wise path."

Although the Washtenaw County Road Commission's role in stormwater management was not a primary focus of our project, the Road Commission's work and priorities impact drains, therefore we believe that they should be involved in the discussion surrounding the future of stormwater management in the township. The Township could also collaborate with the Road Commission on stormwater management projects moving forward while ensuring that public engagement remains at the forefront of development processes to mitigate future public resistance.

To address the concerns of neighborhoods and property owners who feel isolated from the decision-making process and to facilitate communication between the public and government entities, the township could appoint a "Stormwater Liaison" who would organize and distribute training programs and resources about stormwater management to neighborhoods throughout the township. The individual in this role would serve as a point of communication for stormwater concerns for neighborhoods and connect with the appropriate individuals within the WCWRC's office to provide the appropriate expertise, materials, and funding to reconcile stormwater related concerns. This role could also assist with creating a stormwater vision plan in partnership with neighborhoods and help them take measurable steps towards their stormwater management goals. Since residents would bring their concerns to someone in this role, it would allow for concerns to be directed to the most appropriate individual within township or county government, increasing the number of resident concerns

being addressed. If community concerns were directed to the most appropriate individual by the Stormwater Liaison, there would likely be additional layers of accountability for government entities to follow through on addressing resident concerns and fewer complaints gone unaddressed, leading to greater public satisfaction and trust of government entities.

As part of their broader educational responsibilities, the Stormwater Liaison would also be responsible for creating an accessible infographic or web page that would inform residents about the complex governance structures that support stormwater management in the township. The Stormwater Liaison would also be responsible for maintaining ongoing education surrounding stormwater issues, infrastructure, projects, and regional efforts in collaboration with the Huron River Watershed Council and homeowner associations within the township. The Stormwater Liaison would thus serve as a public facing government entity that is consistently involved with the community. The Stormwater Liaison could also participate in neighborhood meetings on a semi-regular basis in order to make themselves available for questions regarding stormwater, allowing them to offer support where appropriate and provide suggestions to solving issues.

In addition, the Stormwater Liaison would be responsible for advertising the stormwater education and outreach programs already supported by the WCWRC's office, including the rain barrel program, more widely. Within the public comment section of the survey, a respondent requested that a rain barrel program be instituted, although because organizations that deal with stormwater in the region (such as the Huron River Watershed Council) already offer similar programs, creating new programs may not be the most appropriate way to expand educational options for residents. Rather, simply making residents aware of the stormwater education and outreach programs already available and offering residents an opportunity to voice their preferences for additional programming would allow for the efficient and collaborative expansion of stormwater management-related public engagement in the township.

WILLINGNESS TO INVEST RESOURCES & OPENNESS TO CHANGE

70% of survey respondents preferred options that, while having the greatest impact, also required the most investment of time and money and involved some amount of participation from government entities. The majority of respondents were not averse to pursuing additional investment for stormwater management and respondents were generally willing to invest in the development of green infrastructure.

As Figure 6.4 shows, the overwhelming majority of respondents were in favor of future stormwater management options that entailed at least some installation of green infrastructure. Respondents generally preferred future stormwater options that required increased financial investment and public involvement, as the most popular options were a tree canopy program for the entire township and installing green infrastructure along the largest drains in the township. Installing green infrastructure on public lands and parks was also a popular option, garnering 1 vote for every 5 responses.

Figure 6.4 Respondents' preferences for future stormwater management options.

Respondents were overwhelmingly in favor of committing public resources to stormwater management. A total of 97% of survey respondents agreed that allocating public resources to stormwater management was either "very important" or "somewhat important" (Figure 6.5). In addition, for those who stated that allocating public resources was "very important," the tree canopy program was the most popular option for future stormwater management. Those who stated that apportioning public resources for stormwater management was "somewhat important" preferred installing green infrastructure along the biggest drains in the township (Figure 6.6). Respondents who believed that allocating public resources for stormwater management was not important preferred to maintain the current standard. Therefore, the overwhelming majority of respondents are both open to green infrastructure solutions and are interested in enhancing current systems for managing stormwater, although preferred options for stormwater management is in part dependent on respondents' views about allocating public resources to stormwater management more generally.

In general, Pittsfield Township is a wealthy community, although there is a broad range of socioeconomic levels across the township. Therefore, survey respondents within Pittsfield Township may be more willing to invest public resources in stormwater management infrastructure rather than divert funding to other public services.

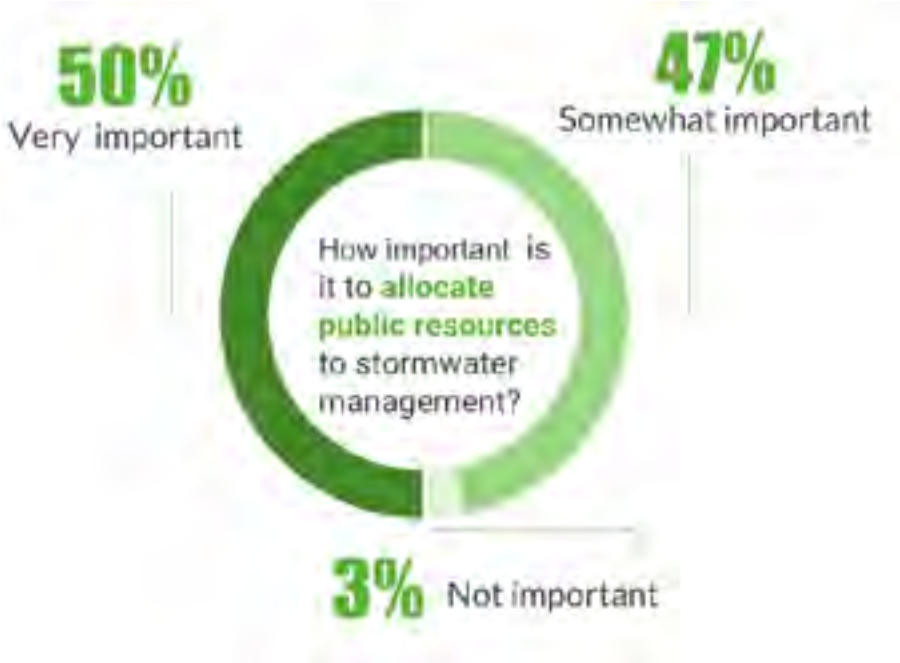


Figure 6.5 Responses to a question asking about allocating public resources to stormwater management.

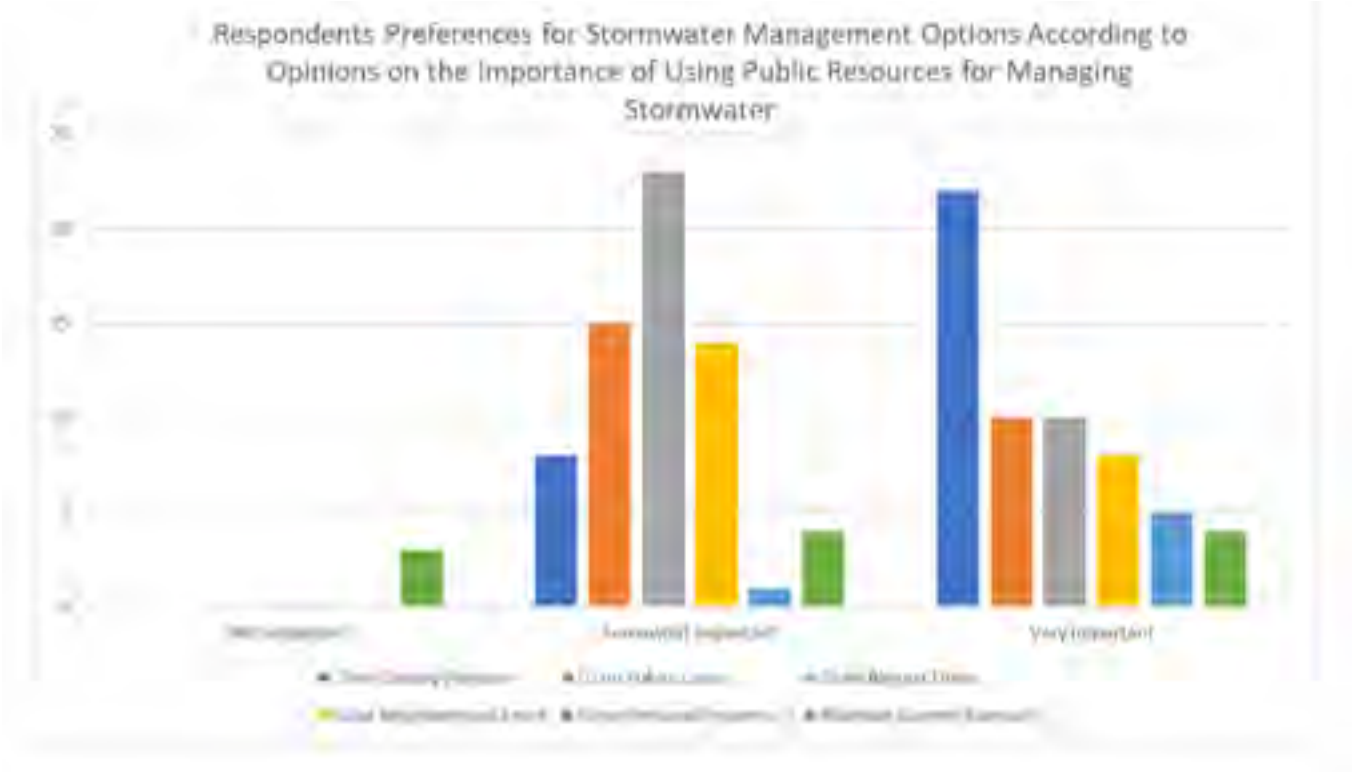


Figure 6.6 Respondents' preferences for future stormwater management according to their belief on the importance of allocating public resources to stormwater management. The x-axis represents respondents' beliefs about allocating public resources for managing stormwater and the y-axis represents the number of respondents who chose a given option for future stormwater management.

THE ROLE OF PUBLIC EDUCATION

The public education video not only increased understanding of stormwater management within the township, but also stirred interest amongst approximately one-third of the respondents to re-engage in another learning opportunity in connection to the video provided.

At the onset of the survey, 41% of respondents felt "reasonably knowledgeable" about stormwater management in the township. Following the public education portion of the survey, 57% of respondents felt "reasonably knowledgeable" about stormwater management in the township, while 30% of respondents felt that they "had learned some new things but wanted to learn more." Furthermore, those who had initially "heard about stormwater management but did not know a lot about it" felt either "reasonably knowledgeable" after the video, or had "learned something new and wanted to learn more" (Figure 6.7). This indicates that the public education video was successful in helping respondents gain new knowledge about stormwater management and that the video generated interest in learning more about stormwater management. Therefore, the township has an opportunity to build on the public education video content and meet the demand for additional

In the open comments portion of the survey, respondents highlighted a disconnect between the environmental landscape and the complex governance structures that impact how stormwater is managed. Residents see an increase in impervious surfaces in the township and generally exhibit a general understanding about contributions to increased runoff, but are not as clear about the decision-making and implementation processes behind paving and construction projects. In addition, the survey revealed that respondents were unclear about who governs stormwater management in the township. The Township could therefore use public education efforts to assist residents in gaining a more thorough understanding of what government entities take responsibility for stormwater management, which would help both residents and the Township to achieve their stormwater goals. As stated previously, a liaison that reports directly to the WCWRC could serve as a bridge to support the expansion of existing programs and encourage engagement. Rather than creating new programs, the Stormwater Liaison would have the responsibility of increasing public awareness of stormwater-related public engagement programs that already exist.

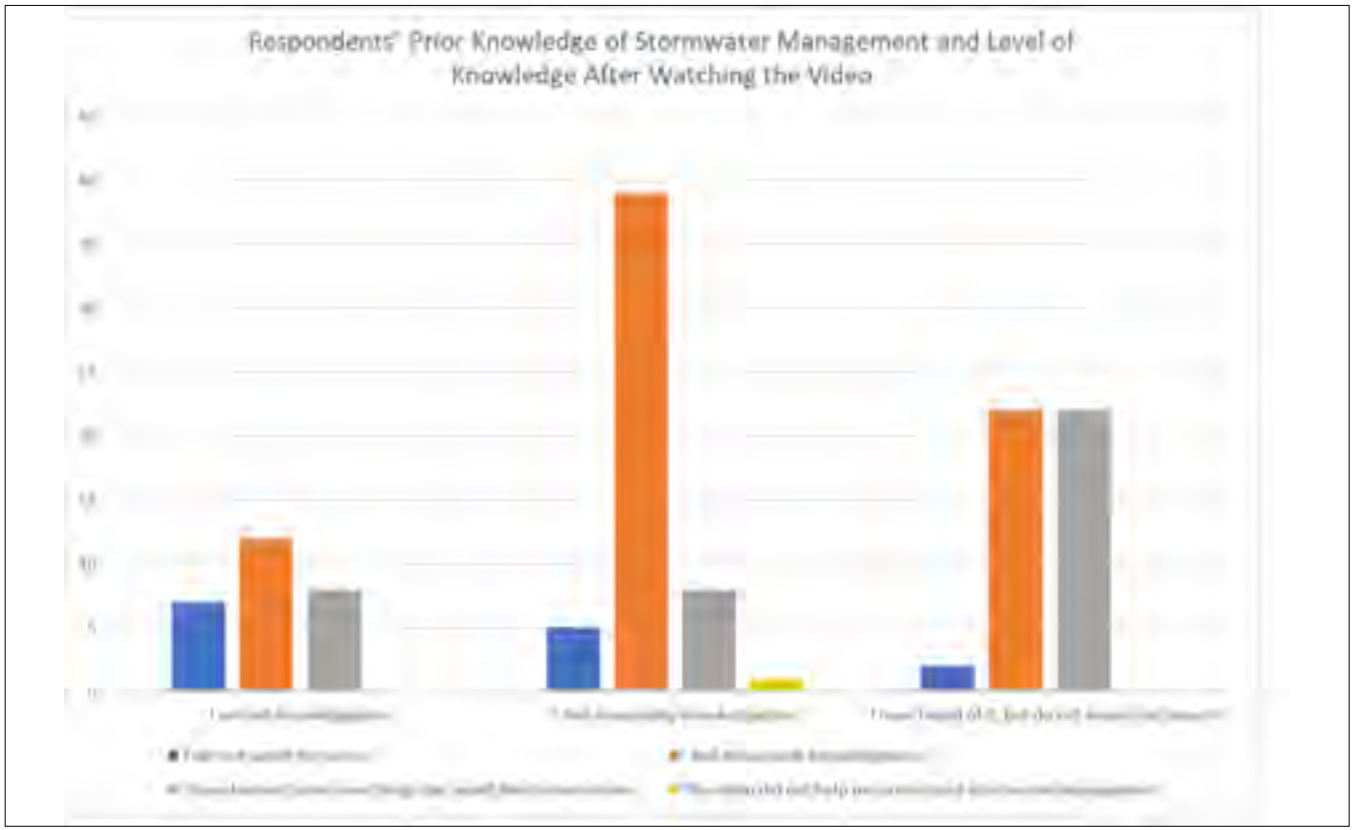


Figure 6.7 Responses to two questions about respondents' knowledge of stormwater management. The x-axis represents responses to the question asked prior to the educational video, "how knowledgeable do you feel about stormwater management?" The y-axis represents the number of responses to the question "after watching the video, how much more knowledgeable do you feel about stormwater management," based on those respondents' answers to the first question.

SPATIAL DIFFERENCES IN PREFERENCES

In Pittsfield Township's 2010 Master Plan, plan developers referenced six distinct "Planning Areas" within the township, each having their own distinct levels of housing density, mixes of land uses, and intensity of development (Figure 6.8). When considering how different regions of the township wanted to approach stormwater management in the future, we relied on these planning areas to guide our analysis.

For most of the planning areas within the township, the number of responses received from each planning area was approximately proportional to the percent of Pittsfield's population living in each planning area (Figure 6.9). The "Northeast (F)" planning area, however, was highly underrepresented in the survey responses, which limits the survey's ability to adequately represent the preferences of everybody living in Pittsfield. The West (A), East Central (C), and South (D) planning areas were overrepresented in the survey responses, with the largest discrepancy between the percent of survey responses and the percent of the population living in a given planning area occurring in the East Central (C) planning area.

In order to understand how stormwater management preferences may be shaped by levels of development

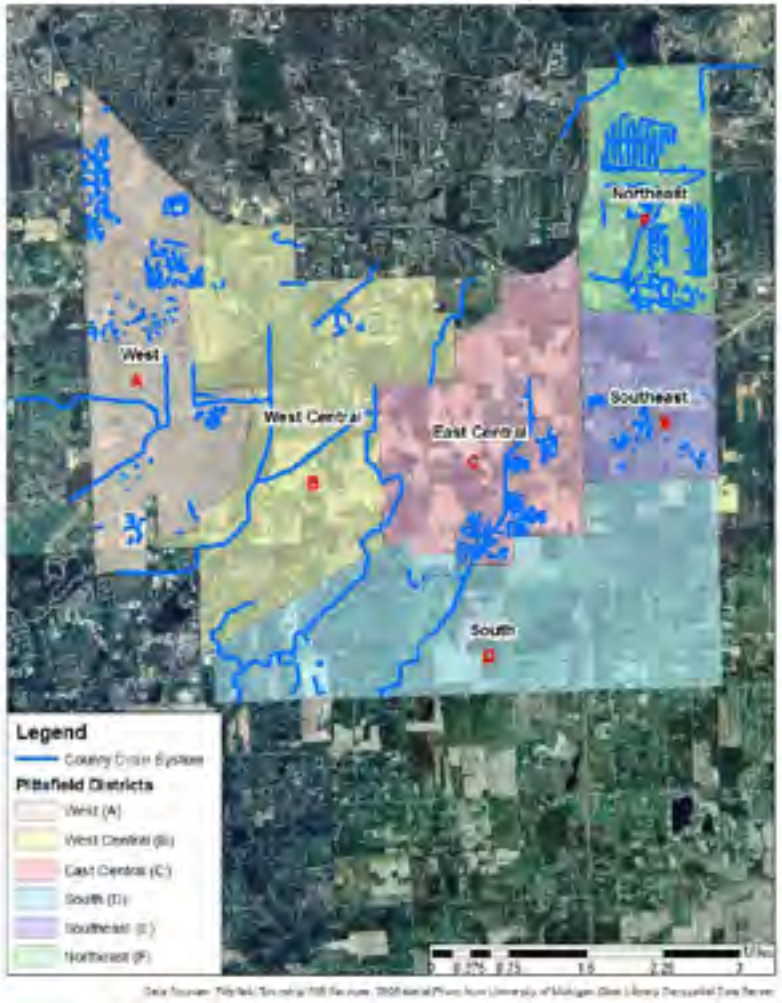


Figure 6.8 Map of planning areas in Pittsfield Township and County Drains. Planning area data was provided by Pittsfield Township GIS staff.

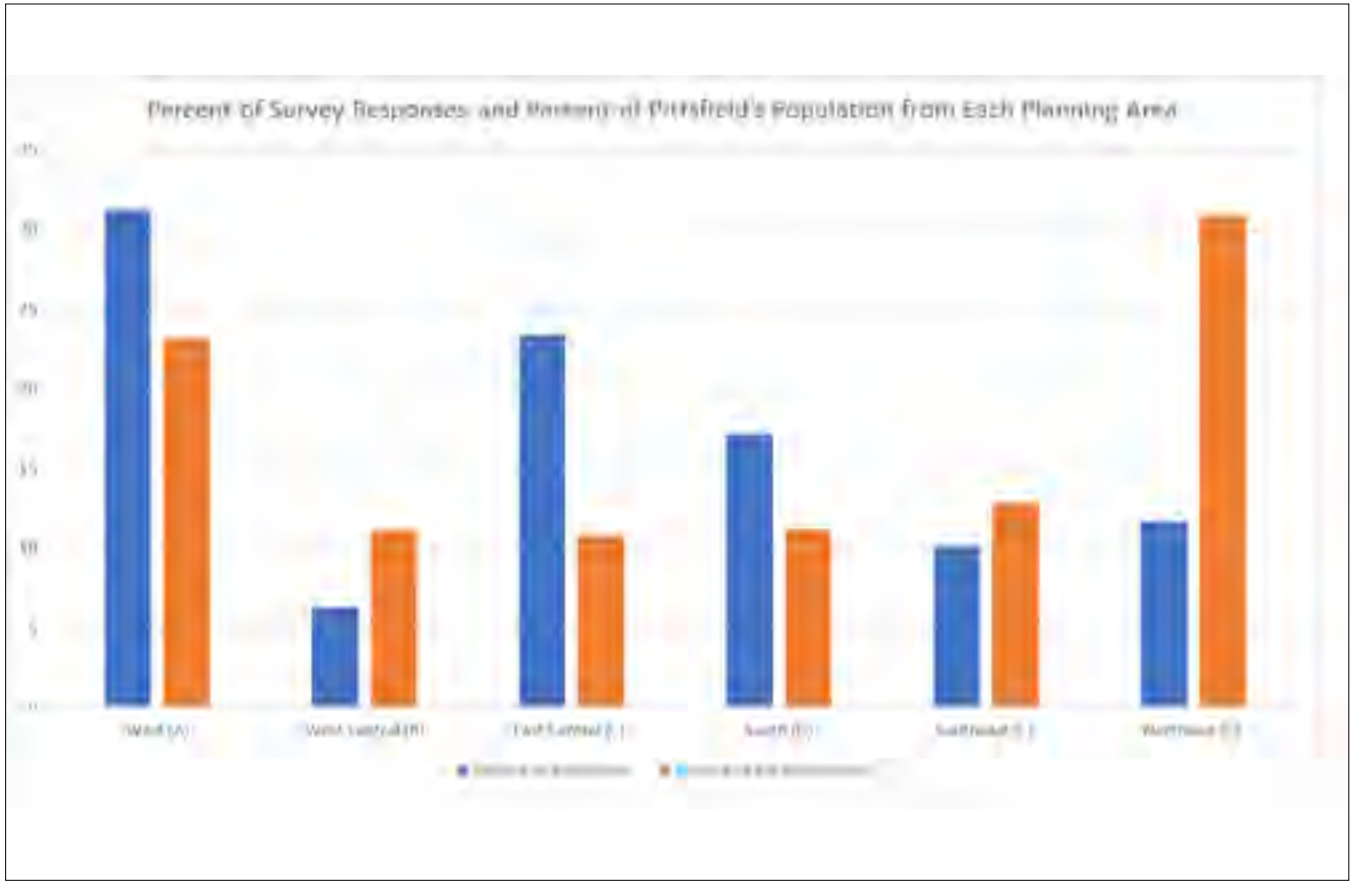


Figure 6.9 Percent of responses and percent of Pittsfield's total population living in each planning area. Population data was gathered from 2016 American Community Survey Estimates.

intensity in different regions of the township, we used the planning areas to generalize survey responses according to levels of development. The most developed planning area in the township is the Northeast (F) planning area, while the least developed planning area is the South (D) planning area. Therefore, as representative of the different development patterns in the township, we examined the preferences of those in both the Northeast (F) planning area and the South (D) planning area.

Whereas respondents in the Northeast (F) planning area are most interested in instituting a tree canopy program or building green infrastructure in public lands or parks, those in the South (D) planning area were more interested in localized approaches to green infrastructure, particularly at the neighborhood level. Our analysis led us to conclude that respondents living in areas with higher development intensity are more likely to:

01 Desire larger scale projects that require a greater investment of time and financial commitment from residents

02 Desire projects that require greater involvement of government actors and outside stormwater expertise

03 Desire projects that are more comprehensive and have a broader reach than individualized, localized approaches

Accessibility, Inclusion, and Implications for Future Community Engagement

The outreach strategy and survey distribution methods that we employed were in large part dependent on the support and engagement of homeowner associations within the township, as we took advantage of an established communication network that linked homeowners associations with Township government. Because homeowners associations are generally comprised of wealthier households, any outreach strategy that relies heavily on homeowner associations is going to overselect for wealthier residents and would therefore fail to generate an inclusive response sample. If a similar community engagement process were used in other communities within Washtenaw County, we recommend that the sampling process be improved to generate broader engagement from residents from a diverse range of socioeconomic backgrounds. In addition, the sampling strategy could be modified so that business owners and those who live within multifamily developments would be included. Offering public meetings, holding workshops in public libraries, or collaborating with schools could be beneficial in increasing the reach of the survey to areas that may not be as connected to the Township through electronic means. Because experiences and concerns with stormwater management may differ across various stakeholders, developing a comprehensive engagement process that captures the wide range of interests present within the township is imperative for developing good stormwater management strategies.

If a similar community engagement process were to be pursued in other municipalities within Washtenaw County, we also recommend that educational programs be expanded to explore more complex aspects of stormwater management. Considering that there was a lack of awareness among residents as to their personal contributions to pollution in stormwater runoff, future educational offerings could explore the connections between separate stormwater management systems and water bodies, as it was not immediately clear that residents understood that storm drains in Pittsfield run directly into nearby rivers. The public education video we created did not address the differences between combined stormwater systems and separate stormwater systems, so it is difficult to be certain that respondents did not understand where storm drains direct runoff, although the lack of recognition of residents' contribution to pollution provides some tangential evidence that this is the case. The results from the survey indicated that the public education video was successful in increasing awareness of stormwater management, therefore we are optimistic that future community engagement processes could further enhance residents' understanding of stormwater management and their personal impacts on stormwater pollution.

RECOMMENDATIONS

07

PART IV: RESULTS

In conclusion, our recommendations for public education and stormwater management in the township are:

01 Assign a "Stormwater Liaison" to serve as a resource, educator, and open communication channel between township residents and the County.

02 Highlight current public education opportunities surrounding stormwater management while interest has piqued with the survey and provide clarity on the governance structures surrounding stormwater management in the township.

03 Encourage the Road Commission and the WCWRC to collaborate to discuss opportunities and lead stormwater management in the future in conjunction with the public.

04 Build accountability mechanisms into the stormwater management process to ensure that developers, landscapers, property owners, and government entities are committed to broader stormwater management goals.

APPENDIX A

PART V: APPENDICES

APPENDIX A: LAND USE RECLASSIFICATION SYSTEM USED IN DETERMINING LAND USE CHANGE IN PITTSFIELD SINCE 2001.

To calculate the change in land use over time, we used reclassified National Land Cover Database (NLCD) layers from 2001, 2006, and 2011. The reclassification system used to derive the reclassified NLCD layers is as follows:

Class/Value	Class Name	Reclassified Category
11	Open Water	Water
12	Perennial Ice/Snow	Water
21	Developed, Open Space	Developed
22	Developed, Low Intensity	Developed
23	Developed, Medium Intensity	Developed
24	Developed, High Intensity	Developed
31	Barren Land (Rock/Sand/Clay)	Barren
41	Deciduous Forest	Forest
42	Evergreen Forest	Forest
43	Mixed Forest	Forest

(continued)

Class/Value	Class Name	Reclassified Category
51	Dwarf Scrub	Agriculture/Pasture/ShrubScrub
52	Shrub/Scrub	Agriculture/Pasture/ShrubScrub
71	Grassland/Herbaceous	Agriculture/Pasture/ShrubScrub
72	Sedge/Herbaceous	Agriculture/Pasture/ShrubScrub
73	Lichens	Agriculture/Pasture/ShrubScrub
74	Moss	Agriculture/Pasture/ShrubScrub
81	Pasture/Hay	Agriculture/Pasture/ShrubScrub
82	Cultivated Crops	Agriculture/Pasture/ShrubScrub
90	Woody Wetlands	Wetland
95	Emergent Herbaceous Wetlands	Wetland

APPENDIX B

PART V: APPENDICES

APPENDIX B: PUBLIC ENGAGEMENT SURVEY

Survey

Stormwater Management Practices in Pittsfield Township

This survey is part of a partnership between the University of Michigan Urban and Regional Planning Program and Pittsfield Township to better understand community preferences for stormwater management. Stormwater specifically refers to all forms of rain water and snow melt that run off the land into streams and lakes.

1. **How knowledgeable do you feel about stormwater management?**
   Mark only one oval.
   - ( ) I feel reasonably knowledgeable.
   - ( ) I have heard of it, but do not know a lot about it.
   - ( ) I am not knowledgeable.

2. **How knowledgeable do you feel about the impact of stormwater?**
   Mark only one oval.
   - ( ) I feel reasonably knowledgeable.
   - ( ) I have heard of it, but do not know a lot about it.
   - ( ) I am not knowledgeable.

3. **How knowledgeable do you feel about green infrastructure solutions, like rain gardens, green roofs and natural places for water to go?**
   Mark only one oval.
   - ( ) I feel reasonably knowledgeable.
   - ( ) I have heard of it, but do not know a lot about it.
   - ( ) I am not knowledgeable.

4. **How do you think of stormwater during or immediately after a heavy rain or snow melt? (Select all that apply.)**
Check all that apply.

- [ ] Stormwater will cause flooding in my yard or basement.
- [ ] Stormwater will cause flooding on streets within my neighborhood.
- [ ] Stormwater will carry fertilizer, and other chemicals, into the storm sewer.
- [ ] Stormwater will be collected, on my property, for watering plants.
- [ ] Stormwater will not affect my property and will be handled off-site.
- [ ] I do not think about stormwater most of the time.

5. **In your opinion, is rain or melt water that leaves your property a source of water pollution?**
Mark only one oval.

- ( ) Yes
- ( ) No
- ( ) I don't know

6. **Who is responsible for stormwater management on your property? (Select all that apply.)**
Check all that apply.

- [ ] Neighborhood association
- [ ] Pittsfield Township
- [ ] Washtenaw County
- [ ] Property owners
- [ ] I don't know
- [ ] Other: _____

We would like your thoughts on how to avoid potential stormwater related issues in the future

7. **On your property, what are you willing to do to help avoid future stormwater problems? (Select all that apply.)**
Check all that apply.

- [ ] Plant more trees in my yard.
- [ ] Landscape my property to retain more stormwater and let it drain naturally.
- [ ] Purchase rain barrels to collect and use the water on my property.
- [ ] I am not willing to change my property to help avoid stormwater problems.
- [ ] Other: _____

8. **In your opinion, who should take primary responsibility for stormwater management?**
Mark only one oval.

- ( ) Property owners
- ( ) Township/County government
- ( ) I don't know

9. **In your opinion, how important is it to allocate public resources to stormwater management?**
Mark only one oval.

- ( ) Very important
- ( ) Somewhat important
- ( ) Not important

10. **Where do you live? (Choose from areas identified on the map.)**

Mark only one oval.

- A
- B
- C
- D
- E
- F
- I don't live in Pittsfield Township

Please watch the following short video to learn more about stormwater in your community and provide your input to help set the future direction for stormwater management practices in the Township.

Skip to "Get to know stormwater management in Pittsfield in 7 minutes!."

Get to know stormwater management in Pittsfield in 7 minutes!

http://youtube.com/watch?v=0dH24O6AG5c

TIME FOR YOU TO HELP!

11. **After watching the video, how much more knowledgeable do you feel about stormwater management?**
Mark only one oval.

- ( ) I feel reasonably knowledgeable.
- ( ) I have learned some new things but would like to learn more.
- ( ) The video did not help me understand stormwater management.
- ( ) I did not watch the video.

12. **In your opinion, who should be responsible for stormwater management in Pittsfield Township? (Select all that apply.)**
Check all that apply.

- [ ] Property owners
- [ ] Neighborhood association
- [ ] Pittsfield Township
- [ ] Washtenaw County
- [ ] I don't know
- [ ] Other: _____

13. Please choose one of the following options to indicate your preference for how you would like stormwater to be managed in Pittsfield Township.

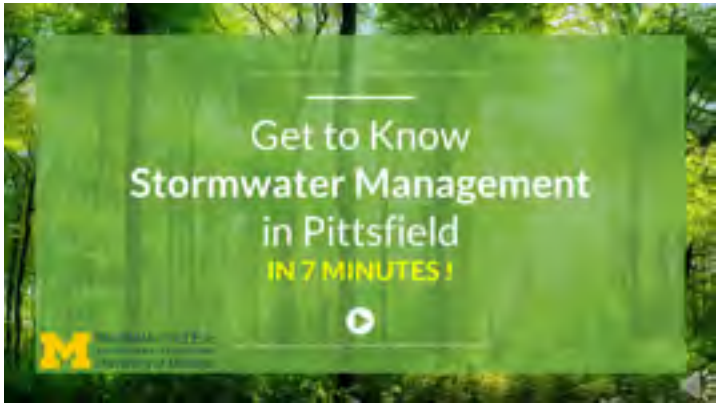
Mark only one oval.

- Option 1: Tree canopy program for the entire township
- Option 2: Green infrastructure on public lands/parks
- Option 3: Green infrastructure along the biggest drains in the township
- Option 4: Green infrastructure at the neighborhood level
- Option 5: Green infrastructure on personal property
- Option 6: Maintain current standard

14. If you have any other comments related to stormwater management practices in Pittsfield, feel free to include them below.

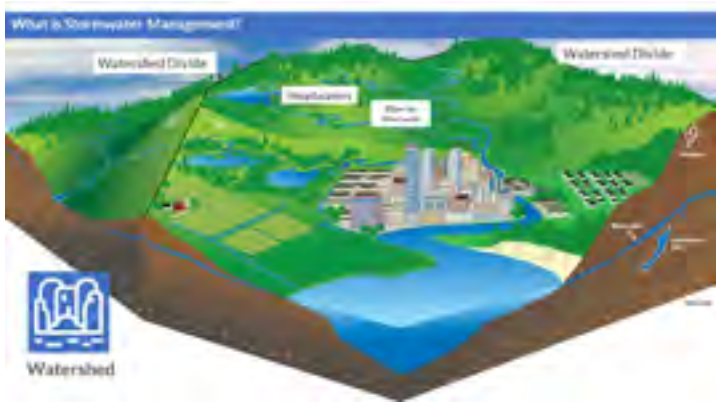
Thank you for completing the survey.

Education Video & Narration Script



In natural systems, rainfall and snowmelt get used by plants, travel through the soil to reach underground stores of water, and are directed towards streams, rivers, ponds, lakes, and oceans.

In developed areas, roads, parking lots, and roofs limit the amount of water that natural systems are able to absorb. Stormwater that is not absorbed naturally is called runoff.



A watershed is the area of land that collects and directs water towards a common outlet point.

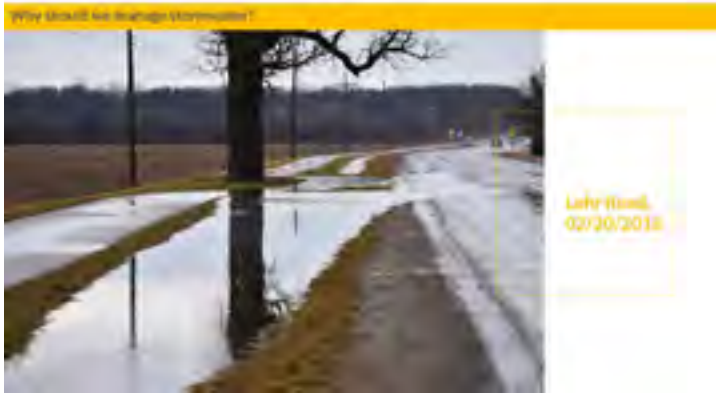
The US is comprised of hundreds of different watersheds, all draining to different parts of the country.

All of the watersheds in Pittsfield drain to Lake Erie. This means that all of the water that falls in Pittsfield Township eventually makes its way to Lake Erie.

The primary reasons we manage stormwater runoff are to limit the amount of flooding in developed areas and to reduce the amount of pollution that ends up in runoff.

Because the landscape we build limits the ability of natural systems to manage runoff, we build new systems to deal with the quantity of runoff.

Also, because pollutants from fertilizers and car by-products collect in runoff as it moves across the landscape, we use stormwater management to improve the water quality of runoff.

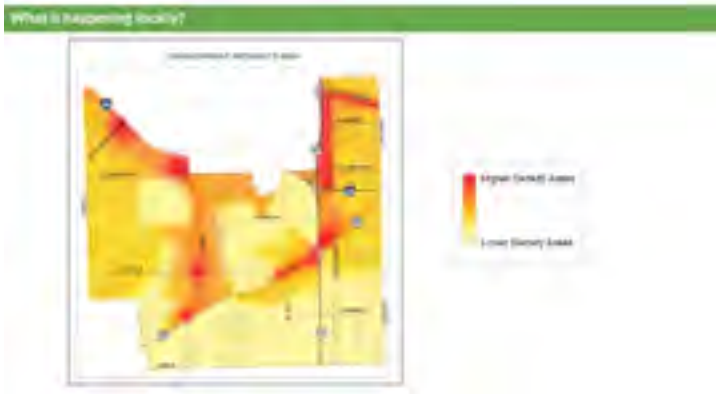


Stormwater management is important in your community in order to reduce the amount of flooding that could damage farms, businesses, and homes.

Also, because the water that falls in Pittsfield drains to Lake Erie, it is important to improve the water quality of the runoff in your community. Lake Erie is one of the most polluted Great Lakes and is home to large blooms of algae that thrive when there is too much fertilizer in the water.

Algae blooms can kill fish and other aquatic organisms and contaminate drinking water.

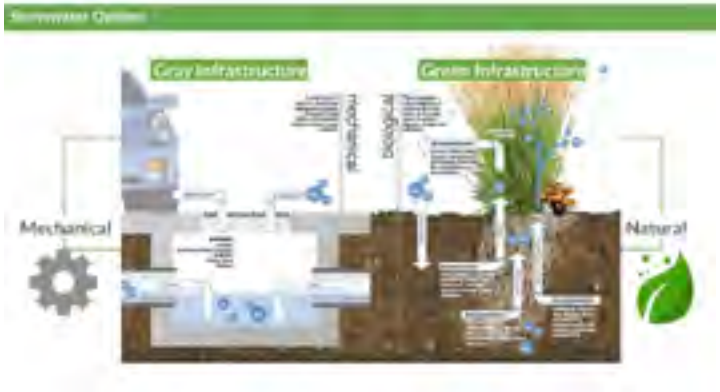
Once a primarily agricultural area, Pittsfield is now increasingly suburban and urban, which means that more rainfall and snowmelt becomes runoff and harms water quality.



Also, if Pittsfield continues to develop according to its 2010 Master Plan, runoff will need to be managed carefully.

To control stormwater in your community, Pittsfield Township requires that new developments manage the first inch of rainfall onsite. The Township also is home to a network of "County Drains" that fall under the jurisdiction of the Washtenaw County Water Resources Commissioner, which deals with stormwater for the entire county.

An example of so-called "grey infrastructure," Pittsfield has four major county drains that direct runoff towards the Saline River. These County Drains are either pipes, culverts, or natural streams that have been widened to manage stormwater. There are many more county drains in the township, but these four drains are the largest and carry the most amount of stormwater.



As opposed to pipes, green infrastructure uses the natural ability of plants and soil to absorb water, reduce the amount of runoff, and filter out pollutants. Green infrastructure seeks to mimic natural processes of stormwater management. In addition to providing water quality and water quantity benefits, green infrastructure can be visually pleasing. There are many different types of green infrastructure that vary in relative cost and in their ability to reduce runoff quantity and improve water quality.

Examples of small green infrastructure installations are rain barrels and cisterns (which collect small amounts of stormwater but do not filter out pollutants) and rain gardens and bioswales (which are both good at filtering out pollutants but do not hold large quantities of stormwater). Other examples of this type of green infrastructure are pavements that allow water to flow into the ground or roofs that absorb water using plants.

Examples of larger green infrastructure installations include detention and retention basins, which collect large amounts of runoff but are not very effective at filtering out pollutants. Another example is constructed wetlands, which are good at reducing both the quantity of runoff, at improving the quality of runoff, while also being visually pleasing. Large-scale tree canopy programs that increase the number of trees are also good at reducing runoff quantity and improving runoff quality, while also offering visual benefits. These types of green infrastructure could be installed in neighborhoods, in public parks and lands, or throughout the township.

There are a variety of potential options for future stormwater management in Pittsfield Township, with varying costs and abilities to reduce runoff quantity and improve runoff quality.

It is up to Pittsfield residents to help determine how best to manage stormwater in the future.

One option is for Pittsfield residents to collaborate at the township level to increase the tree canopy in the community. This would likely require residents to plant trees on their property or contribute financially to plant trees in other parts of the Township. Depending on the rate of participation, a tree canopy program could provide good quality and quantity benefits throughout the Township. It would also make areas of the Township more visually pleasing.

At the township level, Pittsfield residents could also band together to build large green infrastructures like constructed wetlands on publicly-owned lands and parks within the Township. With the potential for building larger-scale installations, this option would likely provide good quality and quantity benefits. It would likely require investment from the Township that would be used to improve the parks and public lands in the Township.

Pittsfield residents could also collaborate to install green infrastructure along the largest country drains in the township. With increased potential for large scale installations, this option would likely provide good quality and quantity benefits. It would likely require investment from the Township, while stormwater professionals organize the work.

Pittsfield residents could also organize on a neighborhood level to build green infrastructure in their neighborhoods. Because cooperation at this level would allow for larger and more expensive installations like retention ponds, this would likely provide better quantity and quality benefits than the voluntary green infrastructure option. It would also increase the visual beauty of neighborhoods in the township, but would depend on those neighborhoods organizing themselves to act.

Another option is for Pittsfield residents to install green infrastructure on their own property on a voluntary basis. This could include installing rain barrels or building small rain gardens. It would improve stormwater management on individual properties but would require widespread participation to make a noticeable difference in stormwater management at the township level.

One option is to continue with the current system. This would require Pittsfield residents to contact the County Water Resources office to request service on county drains in response to a problem, but would not require additional township-wide coordination. This course of action may not be effective in anticipating the future demands of stormwater in Pittsfield as the township continues to develop.

To sum up, here are the options we have discussed for your community's stormwater future. We look forward to hearing your preferences in the final stage of our survey.