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Analysis of Land Use and Development Related to Drainage Infrastructure in Georgetown

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Abstract

Georgetown County, SC envelops lush natural landscapes and complex water systems that host a diverse network of plant and animal species. This region is continuously threatened by natural disasters like flooding and stormwater issues, which inhibit the local economy and jeopardize the well-being of its inhabitants. Within the last decade, Georgetown County has been experiencing a consistent growth in population and development, specifically in vulnerable coastal areas. This growth must be addressed in order to provide a safe and resilient place for the community and nature to live in harmony. Through a case study of my experience in a local engineering firm working with future developments, this research examines the correlation between land management practices and sustainable development goals to assess the current conditions and the future state of the county, with implications for national and international best practices and challenges.

Role & SDG Observations

At G3 Engineering and Surveying my role is defined as Engineering Intern/Cad Technician. This position requires me to understand basic land development practices and techniques to help design and upgrade existing properties in accordance with local and state regulations. These practices include, but are not limited to, drainage systems above and below ground, connecting and creating roads, maintaining existing ecosystems, and disaster prevention. Understanding these aspects of land development are crucial when working in Civil Cad 3D, a software used by engineers and surveyors to design, draft, and manage civil engineering projects. The sector of work we provide relates directly to the sustainable

development goals (SDG's). More specifically, goals 6, 9, 11, and 15 can distinctly connect land development and sustainability.

'Clean Water and Sanitation' (SDG 6) involves sustainable management of water and sanitation. As engineers in this field, we develop water and sewage systems that properly handle and dispose of waste. This includes more than just typical household waste. Pools, for example, hold contaminated water that needs to be properly disposed of. It is our responsibility to find solutions to dealing with these types of contaminants, like creating an infiltration trench to filter the water. Improvement of water quality by reducing pollution and minimizing release of hazardous chemicals is target 6.3. It is part of our job to find solutions to problems like polluted pool water in order to protect water sources. Similarly, we utilize retention ponds to provide, retain, and treat contaminated stormwater runoff. Both solutions aim to reduce pollution to nearby bodies of water, reducing human impacts on nature.

SDG 9, 'Industry, Innovation, and Infrastructure', works towards creating more resilient infrastructure and promoting sustainable industrialization. Readying a plot of land for structures requires a few key factors to help create a more resilient and sustainable area. In low lying areas, we may require the land to be filled with an earthy material that helps increase the elevation for the intended structures. This helps protect against issues like flooding. In addition to land 'fill', we also are required to grade the property. Grading is essential in that it directs stormwater away from buildings and other important areas, preventing flooding and pooling of water in unwanted areas and providing a direction for water flow.

SDG 11 is perhaps the most implemented goal in land development practices. This goal, 'Sustainable Cities and Communities,' involves creating cities that are safe, resilient, and

sustainable. Creating residential developments requires using the land wisely and efficiently to create individual plots of land for future home buyers (Target 11.3). These plots are carefully designed to use the land effectively as to not waste any space while still providing enough room for each piece of property. This is very important, especially when considering the population increases we are seeing in this area and worldwide. Population is outgrowing available land so proper land planning can help deal with this increasing problem.

Target 11.5, 'Reduce Adverse Effects of Natural Disasters,' is another prominent target for civil engineers, especially in Georgetown County. We are responsible for developing land that can handle 100-year storm events. For low-lying regions, like Georgetown, a primary focus is mitigating flooding. Many of the concepts used have been previously mentioned (i.e grading and land fill) which help control the flow of water and reduce effects of natural disasters. Catch basins are also crucial in helping with these events. Proper placement of these drains can alleviate flooding and help filter runoff. Also, proper surveying of the area is important to identify possible flood zones. To avoid the costs of natural disasters, land should be developed in a way that places structures away from flood zones.

Lastly, SDG 15, 'Life on Land' is implemented by civil engineers when site planning. Georgetown County is known for its diverse species and natural habitats. Land development in this area must take precautions against disrupting these natural ecosystems. Part of what we do includes building around wetlands instead of on them. Wetlands provide wildlife habitat, maintain ecosystem productivity, and house diverse plant species. They also have many other unrelated beneficial functions like flood control and carbon capture. Georgetown County also has tree regulations in place that do not allow the removal of specific tree species, requiring us

to design around these trees. Trees hold an immense amount of value for many reasons including the support of wildlife, improvement of air quality, and erosion prevention.

Literature Review

Preventative action is necessary to tackle flood and stormwater issues in growing areas. Understanding new alternatives to traditional infrastructure could be the key to overcoming these challenges. Most of these problems occur, for example, in coastal regions of Georgetown County, where areas are developing more rapidly. Historically, communities have relied on 'gray infrastructure' to move stormwater away from homes and towards treatment facilities or local bodies of water.[1] Gray infrastructure includes gutters, drains, pipes, and retention basins that are made up of materials like concrete or steel. According to the Environmental Protection Agency (EPA) "the gray infrastructure in many areas in aging, and its existing capacity to manage large volumes of stormwater is decreasing in areas across the country".[2] These outdated methods were not designed to be everlasting or to handle the harsh reality of global warming. Newer, 'green infrastructure' practices, however, aim to replace traditional water management systems and provide more sustainable, long-term solutions.

Green infrastructure is a viable option for the future of land development in Georgetown County. It's goal is to provide a cost-effective solution for flood and stormwater mitigation, two major factors in land development. The Water Infrastructure Improvement Act cites green infrastructure as "the range of measures that use plant or soil systems, permeable

[1] "What Is Green Infrastructure?" EPA. Environmental Protection Agency. Accessed March 17, 2022. https://www.epa.gov/green-infrastructure/what-green-infrastructure.

[2] Ibid.

pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.[3] In short, green infrastructure utilizes methods of absorbing stormwater where it lands, allowing it to easily seep into the soil, promoting filtration. Bioretention cells, or rain gardens, are great examples of this process. Consisting of vegetation in an engineered soil, these gardens act as drainage systems that slow and filtrate runoff. Expert placement of these bioswales is important in capturing the runoff at the source. Including bioswales in site plans is critical in mitigating stormwater runoff and decrease flooding.

At G3 Engineering, when designing commercial or residential properties, we adhere to the zoning ordinances of Georgetown County, which stats that a minimum, 10% of the parking area shall be landscaped with living natural material. Any parking areas containing over 10 parking spaces shall be required to provide a landscaped peninsula or island on each end.[4] This is a great practice for commercial properties as it reduces parking lot flooding and runoff. Permeable pavement, a stormwater drainage system, is another green infrastructure practice that is beneficial for risk aversion. The pavement is designed to allow stormwater and runoff to easily seep through the material to a small storage layer that eventually is absorbed into the ground. There are multiple types of permeable pavement available, like pervious concrete and

[3] Bill, 164 Water Infrastructure Improvement Act §. PUBLIC LAW 115–436 (115AD). https://www.govinfo.gov/content/pkg/PLAW-115publ436/pdf/PLAW-115publ436.pdf

[4] ARTICLE XII, Georgetown County § (n.d.).

porous asphalt, making it a perfect alternative to traditional pavements used in sidewalks, roads, and parking lots.[5]

According to Angela Christian, Georgetown's County Commissioner, there are more unpaved roads than paved roads in the county.[6] This could make permeable pavement a viable option for the future development of Georgetown County. Infiltration trenches also considered green infrastructure. These trenches are built using rocks and other materials that creates an underwater reservoir for storing excess water. Similar to the permeable pavements, the water volume is gradually drained through subsoils where it can safely enter the watershed. During my experience as an engineering intern at G3 I was tasked with designing a small infiltration trench for a residential amenity center. The purpose of the trench was to properly drain and filter pool water that is filled with chemicals and other contaminants. The zoning laws required this trench to be separate from the existing stormwater drains in the area because of the contaminants.

It is important to note that these methods not only find solutions for water reduction on land but also include solutions for filtering the contaminated water. Stormwater runoff, especially in urban areas, delivers pollutants to local streams, rivers, and beaches negatively impacting natural habitats and aquatic life. Filtration is necessary to reducing these impacts and replenishing the groundwater supply. Furthermore, green infrastructure reduces the load on

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Rowe, Amy, and Michele Bakacs. "An Introduction to Green Infrastructure Practices." Rutgers NJAES, December 2012. https://njaes.rutgers.edu/fs1197/.

6 Email Angela Christian

traditional gray infrastructure allowing for an improvement in flood mitigation. Reducing flooding has many economic benefits.

Aside from health and safety, green infrastructure addresses major economic costs of flood damage. According to the South Carolina State Climate Office, from 1993-2020, $2.832 million dollars were spent in flood damages alone in Georgetown County.[7] Prioritizing action by implementing just a few of these practices could make a significant impact in the safety, health, and prosperity of the environment and the people that coexist within it.

Empirical Data

Over the past 20 years, Georgetown County has experienced consistent population growth. A 2020 Housing Needs Assessment shows a 20% increase in population from 2000 to 2020.[8] These projections, however, do not represent the recent unexpected migrations that came as a result of COVID-19. With the influx of people moving to the area, land development is necessary to accommodate this growth, whether commercial or residential. Holly Richardson, the county's chief planner, stated that Georgetown County had issued 561 new construction permits through most of 2021, which is up from the 333 issued in 2019.[9] This correlates with G3 Engineering project data. In 2019 the G3 Engineering and Survey Departments received only 27

[7] "Georgetown County Climate Data." South Carolina State Climatology Office. SCDNR. Accessed March 17, 2022. https://www.dnr.sc.gov/climate/sco/ClimateData/countyData/county_georgetown.php.

[8] Housing Needs Assessment-Georgetown County, SC. Bowen National Research, March 2021. https://coastalobserver.com/wp-content/uploads/2021/04/HousingNeedsAssessment.pdf.

[9] Strong, Hannah. "New Construction Permits Increased in Georgetown County Despite Pandemic." Georgetown Times, January 14, 2021. https://www.postandcourier.com/georgetown/new-construction-permits-increased-in-georgetown-county-despite-pandemic/article_d914c23c-4a09-11eb-9187-a70a14481808.html#:~:text=GEORGETOWN%20COUNTY%20%E2%80%94%20New%20construction%20permits,of%20the%20year%20through%20Dec.

projects in Georgetown County, whereas in 2021 they had completed a total of 103 projects.[10](CITE G3) The underlying problem with this growth and expansion is that a large majority of the development occurs in the coastal Waccamaw Neck region on or near flood zones creating major concerns for the community it supports. These low-lying regions are already prone to flooding from natural disasters and other climatic events but are also faced with stormwater flooding. Continued growth in coastal Georgetown County requires utilizing new methods to tackle land development challenges, especially as it relates to infrastructure. Understanding how to sustainably handle this growth while also finding solutions to current issues is crucial to creating a more resilient community.

	Total Population									
	2000 Census	2010 Census	Change 2000-2010		2020 Estimated	Change 2010-2020		2025 Projected	Change 2020-2025	
			Number	Percent		Number	Percent		Number	Percent
North	7,193	6,549	-644	-9.0%	7,113	564	8.6%	7,437	324	4.6%
East	16,615	22,223	5,608	33.8%	26,140	3,917	17.6%	28,143	2,003	7.7%
Central	15,587	15,235	-352	-2.3%	16,206	971	6.4%	16,817	611	3.8%
South	3,918	3,913	-5	-0.1%	4,210	297	7.6%	4,401	191	4.5%
West	12,453	12,238	-215	-1.7%	13,076	838	6.8%	13,625	549	4.2%
Georgetown County	55,766	60,158	4,392	7.9%	66,745	6,587	10.9%	70,423	3,678	5.5%
South Carolina	4,011,867	4,625,217	613,350	15.3%	5,282,077	656,860	14.2%	5,629,270	347,193	6.6%

Figure 1: Population increase in Georgetown County from 2000-2025.

[10] Cite G3

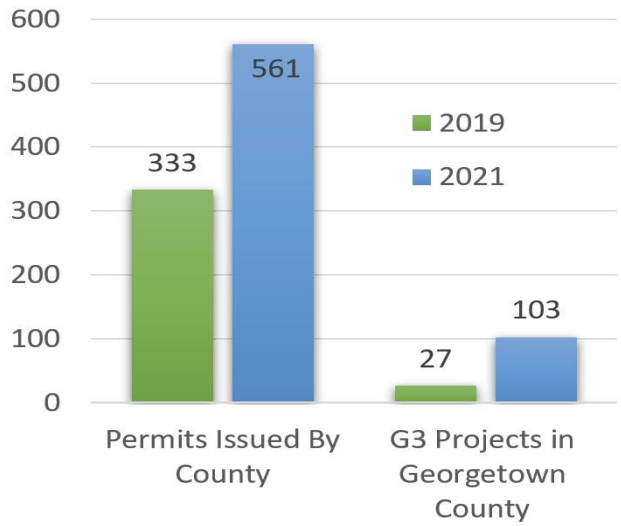

Figure 2: Construction permits issued by Georgetown County in 2019 and 2021 compared to G3 projects in the same years.

Around the country different cities are adopting new policies and implementing more sustainable practices to land management to stifle public concerns. A Clean Watersheds Needs Survey developed by the Environmental Protection Agency describes the total wastewater and stormwater needs for the country to be $298.1 billion with $105 billion being directly related to stormwater management and sewer correction.[11] In an effort to cut these expenses, Philadelphia, PA developed an award-winning "Green City Clean Waters" plan aimed at reducing the volume of stormwater in combined sewers and expanding the existing stormwater treatment capacity using green infrastructures. Backed by the EPA, the plan charts a 25-year course to reduce stormwater issues by 80-90% and has produced better than projected results since it was established in in 2011. Using green infrastructures, the plan projects a savings of

[11] "Clean Watersheds Needs Survey (CWNS) – 2008 Report and Data." EPA. Environmental Protection Agency. Accessed March 17, 2022. https://www.epa.gov/cwns/clean-watersheds-needs-survey-cwns-2008-report-and-data.

$6.5 billion in construction costs compared to replacing and expanding existing structures.[12] Additional billions of dollars were also calculated to be saved in other ways, like promoting health and safety from issues like air quality and sickness related to contaminated water. These savings are just one example of the economic benefits of the green infrastructure program. Oher economic gains include an estimated 430 new green industry jobs and increased tourisms dollars due to cleaner rivers.[13] Five years into the plan, Philadelphia successfully installed over 1,600 green stormwater structures across this city, reducing water pollution by 1.5 billion gallons each year.[14] The majority of the improvements came in the form of permeable pavement, bioswales, and green roof practices, all excellent mitigators of stormwater risks. Other green structures used include stormwater planters and tree trenches expertly placed along streets and near buildings to effectively infiltrate stormwater runoff while also providing a desirable appearance and thus raising property values. Overall, the city has seen a 21% improvement in yearly combined sewer overflow from stormwater impacts since it began in 2011.[15]

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[12]"Green City, Clean Waters: Philadelphia's 21st Century Green Stormwater Infrastructure Program." American Planning Association. Accessed April 11, 2022. https://www.planning.org/awards/2015/greencity.htm.

[13] "Case Study: Green City Clean Waters, Green Street Program, Philadelphia." National Association of City Transportation Officials. NACTO, October 5, 2017. https://nacto.org/case-study/green-city-clean-waters-green-street-program-philadelphia/#:~:text=Five%20years%20in%2C%20GCCW%20has,1.5%20billion%20gallons%20each%20year.

[14] Ibid.

[15] Rademaekers, Brian, and Grace Maiorano. "Green City, Clean Waters: Finding New Ways to Grow." Storm Water Solutions. SWS, August 3, 2021. https://www.estormwater.com/green-infrastructure/green-city-clean-waters-finding-new-ways-grow.

Similar cases can be observed in other cities too, like Santa Monica, California. Because of its beachside location, water quality is central to the community and economy of Santa Monica. Urban runoff was found to be the key contributor to pollutants entering Santa Monica Bay and other water bodies.[16] In 2006, the city adopted a Watershed Management plan to provide a "balance between urban land use and ecosystem function" by targeting five areas, decreasing runoff and flooding, and increasing water conservation, open space, and marine and wildlife ecosystems.[17] They were successfully able to meet these needs by implementing "a stormwater management ordinance, stormwater fee, and rebate program".[18] The stormwater management ordinance is a requirement of all new developments and renovations to "manage the first 0.75" of runoff from imperviable surfaces, which accounts for approximately 80% of storm events annually."[19] If achieving this is not possible, developers are still required to pay a mitigation fee that, in turn, funds green infrastructure projects to manage stormwater. Santa Monica has two stormwater fees for all parcel owners, the Stormwater Management User Fee and the Clean Beaches & Ocean Tax. Together these fees bring around $4 million a year, helping

[16] "Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure." EPA. Environmental Protection Agency, August 2010. https://nepis.epa.gov/Exe/ZyNET.exe/P100FTEM.txt?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX+DATA%5C06THRU10%5CTXT%5C00000033%5CP100FTEM.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8%2Fr75g8%2Fx150y150g16%2Fi425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results+page&MaximumPages=1&ZyEntry=63.

[17] Ibid.
[18] Ibid.
[19] Ibid.

to finance their watershed management program.[20]. The rebate program provides incentives for home installation of green infrastructure. Each of these rebates involves rainwater harvesting and runoff management. Some rebates include up to $2000 for permeable driveways or receiving $200-$2000 for home installation of rain barrels and cisterns.[21] The barrels not only manage large volumes of rainwater but also conserves water that is helping make the city more self-sufficient in terms of water supply. All these programs have proven beneficial in stormwater mitigation, environmental protection, and climate resiliency.

Analysis of SDGs

Understanding the implications of sustainable infrastructure in relation to current data from Georgetown County is an important context that can be used by city and county officials in an effort to support a clean, resilient future. Using the United Nations Sustainable Development Goals (UN SDG) as a guideline to analyze the information surrounding land management in the area, I will correlate my findings with specific targets on a local level. Furthermore, my project has a distinct link with goals 6, 9, and 15.

SDG 6

The sixth UN SDG is clean water and sanitation for all and is a big player in land management practices. Targets 6.3 and 6b illustrate the specific relation to my project.

[20] "Urban Runoff Stormwater Parcel Fees." City of Santa Monica. Office of Sustainability and the Environment, April 9, 2020. https://www.smgov.net/Departments/OSE/Categories/Urban_runoff/Stormwater_Parcel_Fees.aspx.

[21] "Rain Harvesting Projects: A Guide for Santa Monica's Rain Harvest Rebate." City of Santa Monica. Accessed March 21, 2022. https://www.smgov.net/uploadedFiles/Departments/OSE/Rebates/RH_Checklist_FY20-21_WEB-PRINT.pdf.

Target 6.3

Target 6.3 focuses on improvement of water quality through reduction of pollution and halving untreated wastewater. Georgetown County is currently in the process of creating a watershed master plan. The plan will take around 3-5 years to finalize but promises to examine each watershed and drainage basin in the county, beginning with the Waccamaw Neck, the most populous area. An engineering firm was hired in 2020 to assess the current situation as it relates to "each watershed's major stormwater conveyance systems and channels as well as the defined problem areas."[22] The data will be used to identify solutions for remediation.

Target 6.b

This target encompasses community involvement in helping to repair and improve water and sanitation management. Recently, in 2021, Georgetown County created an interactive flood map that allowed residents to identify and chart problem flooding areas. The city has hosted public meetings presenting and demonstrating how to use the mapping software. The result provides a generated model of flood areas that will be examined by civil engineers to determine improvements and solutions to current infrastructure. Stormwater manager, Tracy Jones stated that only "residents and business owners know what happens on

[22] Swenson, Charles. "County Hires Firm to Create Stormwater Plan for Waccamaw Neck." Coastal Observer, December 21, 2020. https://coastalobserver.com/county-hires-firm-to-create-stormwater-plan-for-waccamaw-neck/.

their streets and in their neighborhoods. We want to add their information to the database so we can use their information to complete the watershed masterplan."[23]

SDG 9

The United Nations 9th goal includes building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. Land management requires the implementation of new infrastructures and ideas to satisfy current and future concerns. Target 9.4 relates to evidence of practices already being put into place by Georgetown County.

Target 9.4

The target seeks to upgrade existing infrastructure and retrofit industries with an increased use of clean and environmentally sound processes. The watershed master plan is an indicator of this target. The plan will use current data and projections to determine where infrastructure improvements need to be made. With enough information the County intends to apply for grants and other forms of funding to address flooding and drainage issues. In addition to the watershed masterplan, some areas, like the City of Georgetown have begun trying to understand stormwater issues and their associated costs. In 2019, the city underwent a stormwater study that estimated around $21 million in upgrades. (cite/email Dr. Eudacy: in class notes)

SDG 15

[23] Rowles, Courtney. "Stormwater Division Plans to Address Flooding Issues in Georgetown County." WPDE, July 23, 2021. https://wpde.com/news/local/stormwater-division-plans-to-address-flooding-issues-in-georgetown-county.

The 15th sustainable development goal is 'Life on Land.' The intention of this goal is to 'protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat deforestation, and halt and reverse land degradation. This SDG is especially important for land management. Without taking these sustainable priorities into account there would be serious problems surrounding environmental health. Targets 15.1 and 15.5 correspond with preventative measures taken in Georgetown County.

Target 15.1

The aim is to "ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services." Georgetown County's current ordinances follow best management practices for regulating land design. Land parcels that include wetlands are required to remain undisturbed to maintain natural ecosystems, store flood water, and protect vegetation. At G3 Engineering we have had to alter site plans and file permits to make adjustments to proposed land designs that met county guidelines.

Target 15.5

Target 15.5 involves taking "action to reduce the degradation of natural habitats and halt the loss of biodiversity." Specifically, within the world of land development, Georgetown County requires engineers to preserve certain species of trees. For example, rural Georgetown County (excludes Waccamaw Neck) requires preservation of distinct tree species over 10" like Live Oaks, Red Maples, Bald Cypress, and the Yellow Popular. Also, when clearing land, a minimum of 10 trees or 100" of tree diameter is required per acre.

Conclusion

Based on my work as an engineering intern and my research of Georgetown County, the influx of population to the area has caused an uptick in land development that requires further analysis. The current structures and practices in place must be reviewed in order to provide a safe, habitable, and resilient community for everyone. More specifically, desirable coastal areas that house most of the population, namely the Waccamaw Neck region, need to find solutions to their current issues surrounding flooding. Within the past few years, the county has taken appropriate measures to understanding these issues by conducting studies, creating community involvement, and designing a stormwater master plan. Upgrades to existing infrastructure, especially related to drainage, should be a main priority for the county to reduce damage to properties, improve water quality, and restore natural habitats. Incorporating more green infrastructure technologies into land planning would have a significant positive impact on the future environment of the county, allowing them to better manage water flows and pollution levels. Taking action is crucial in preparing for the devastating effects of climate change.

Recommendations

Based on the evidence collected, finding solutions to the current flooding and stormwater challenges is necessary for combating these issues. The following suggestions were compiled to be considered by the county, including local and state officials, department chairs, community members, and other stakeholders.

Higher utilization of green infrastructure in land development could make a substantial difference in the future of the county. Green infrastructure has been proven to make a positive impact in alleviating water concentrations in developed areas. Requiring developers to use these systems could significantly reduce water damage and take the stress off the current drainage infrastructures. A few examples to consider include rain barrels, permeable pavements, increased planter boxes, and greater

use of bioswales. The current development codes may require amending in order to make the necessary adjustments for greener infrastructure practices.

Community involvement is also important for tackling current stormwater issues. Creating a stormwater week or month could generate interest among residents. This period would allow the county to educate the community about the effects of stormwater and teach them how to take steps to reduce their individual impacts. Stormwater awareness helps make everyone accountable and work together to tackle drainage and pollution problems.

Lastly, to increase funding for major infrastructure projects, Georgetown County may consider increasing the stormwater tax for property holders. Other cities around the country have successfully used tax acts to create new or improve existing infrastructure capable of handling large stormwater concentrations. The tax percentage does not need to be excessive and may adjust individual costs based on land size. Georgetown County could also consider offering tax breaks to residents who implement green infrastructure practices on their land.

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