



Texas Stormwater

Scorecard 2020

Ranking Texas cities
on nature-based stormwater management



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Cover photo: Anna Farrell-Sherman. A rain garden outside a row of town houses built by Terramark LLC in San Antonio.

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Executive Summary

Water is a part of life, and our waterways are a part of what makes Texas special. But runoff pollution threatens our favorite swimming holes, our drinking water, our pets and wildlife. When stormwater runs off roofs, roads, parking lots, and sidewalks, it gathers toxic chemicals, excess nutrients, trash, and other forms of pollution. Traditional concrete channel infrastructure compounds the problem: it concentrates pollutants and directs the dirty water directly into local streams. To address the issue Texas municipalities are turning to nature-based infrastructure. Rain gardens, green roofs, the conservation of natural spaces, and other techniques can reduce runoff pollution by up to 90%¹

The Texas Stormwater Scorecard evaluates the stormwater management policies of local governments across Texas to see how well they support the use of nature-based infrastructure. This year's scorecard grades 9 Texas cities and 1 county, ranking them based on how well they make use of Nature-based Infrastructure, sometimes called Low Impact Development (LID) or Green Stormwater Infrastructure (GSI), to prevent water pollution, mitigate flooding, alleviate drought, and reduce urban heat. Policies were divided into nine fundamental categories of three types:

Private Development Regulations

- Stormwater Detention Requirements
- Water Quality Requirements
- Maintenance Requirements

Private Development Incentives

- Regulatory Incentives
- Financial Incentives

Public Initiatives

- Construction of Public Projects
- Education
- Monitoring and Evaluation
- Regional Collaboration

The results show nature-based infrastructure is growing across the state. Austin, which received the highest score on the 2017 publication of the scorecard², is now tied with San Antonio in first place, with Harris County close behind. All three local governments have impressive public initiatives, from San Antonio's citywide watershed modeling and LID planning to Austin's exemplary education program complete with workshops and manuals. San Antonio is also the only local government with any kind of nature-based infrastructure mandate. Cities including Dallas and El Paso are considering significant nature-based infrastructure mandates, which could cost Austin and San Antonio the top honor unless Austin passes its own proposed nature-based requirements in their Land Development Code rewrite³. Governments across the state incorporated incentives for private developers, and many more began public education campaigns, installed nature-based technologies on public projects, or set up projects to evaluate how to best use nature-based solutions in their communities. The full ranking is shown below:

Rank	City / County	Score
1	San Antonio	69%
1	Austin	69%
3	Harris County	66%
4	San Marcos	58%
5	Dallas	56%
6	Fort Worth	56%
6	Denton	53%
8	Houston	50%
9	El Paso	42%
10	Farmers Branch	36%

1 William J. Taylor, Taylor Aquatic Science and Policy, White Paper for Stormwater Management Program Effectiveness Literature Review: Low Impact Development Techniques, April 2013. Archived at web.archive.org/web/20170110230133/http://www.ecy.wa.gov/programs/wq/psmonitoring/ps_monitoring_docs/SWworkgroupDOCS/LIDWhitePaperFinalApril2013.pdf

2 Environment Texas, Texas Stormwater Scorecard, September 2017. <https://environmenttexas.org/reports/txe/texas-stormwater-scorecard>

3 Environment Texas, CodeNext: Less Flooding, Cleaner Creeks, May 29 2018. <https://environmenttexas.org/blogs/blog/txe/codenext-less-flooding-cleaner-creeks>

Across Texas, every local government surveyed is making strides to prevent flooding and improve water quality, and many of their policies directly promote nature-based techniques. Some of the most exciting policies from each government include:

- **Austin** - The City took bold action creating city wide plans like Water Forward⁴, Functional Green⁵, and the Community Climate Plan⁶ that emphasize water reuse, urban green space, and nature-based infrastructure. While these plans are not currently legally binding, they provide exemplary guidelines, and some pieces within the plans could become law with the passage of the proposed Land Development Code in the spring of 2020.⁷
- **San Antonio** - San Antonio has an exceptionally strong set of public initiatives, including thorough water quality models to ensure protections for sensitive waterways. They are also the only city in the state to have any kind of nature-based infrastructure mandate.
- **Harris County** - The only county surveyed, Harris County has an exceptional monitoring program, which provides detailed data on how features are working, and includes a novel drone-based data collection method to determine how to improve the efficiency of nature-based features.
- **San Marcos** - The City incorporates education into its maintenance program. If any feature fails its annual inspection, City staff work with the owner to develop a plan to address the problem with best-management practices and the facility is reinspected.
- **Dallas** - Dallas was central to the development of the North Central Texas Council of Government (NCT-GOG)'s integrated Stormwater Management (iSWM) Program, which encourages the use of nature-based features. They have now incorporated many of those

recommendations into their own drainage manual and help encourage other cities to do the same.

- **Denton** - The City of Denton, home to waterways like Lewisville Lake and Hickory Creek, proactively guards water quality in environmentally sensitive areas, particularly by encouraging developers to stay away from untouched natural areas.
- **Fort Worth** - This large Texas city should be commended for always considering nature-based techniques on public projects, which has resulted in numerous features around the city.
- **Houston** - Considering nature-based features on all public projects is standard in Houston. The Bagby Street redevelopment and Buffalo Bayou park are prime examples.^{8,9}
- **El Paso** - The desert climate of El Paso provides a different landscape for implementing nature-based features than other parts of the state. They have created outstanding pilot programs, including one starting in March 2020 that will create a bioswale with a shade tree on streets where rainwater collects.
- **Farmers Branch** - Farmers Branch recently updated their drainage manual to include stormwater detention and water quality requirements. This is an essential first step to promoting nature-based infrastructure.

Just as the successful policies across the state are unique to each place, so are the ways local governments can improve their scores and promote nature-based infrastructure.

- **Austin** - To remain a state leader in stormwater management, Austin needs to pass the proposed Land Development Code, which will mandate the use of nature-based infrastructure for water quality treatment on highly urban sites.
- **San Antonio** - The city should work to expand their water quality requirements to the whole city, a step they can take as part of their United Development

4 Austin Water, Water Forward. Archived at <https://web.archive.org/web/20190710142515/http://austintexas.gov/waterforward>.

5 City of Austin, Austin Land Development Code: Functional Green Overview, February 2018. Archived at https://web.archive.org/web/20190415142010/http://www.designingthesustainable.com/uploads/1/0/3/8/10386536/austinldc_functionalgreen_2018.02.08_final.pdf.

6 City of Austin, Austin Community Climate Plan, 2015. Archived at <https://web.archive.org/web/20200204024033/http://www.austintexas.gov/edims/document.cfm?id=269714>.

7 Environment Texas, CodeNext: Less Flooding, Cleaner Creeks, May 29 2018. <https://environmenttexas.org/blogs/bxe/codenext-less-flooding-cleaner-creeks>

8 Congress for the New Urbanism, Bagby Street, 2013. <https://www.cnu.org/what-we-do/build-great-places/bagby-street>

9 Urban Land Institute, Buffalo Bayou Park. <https://developingresilience.uli.org/case/buffalo-bayou-park/>



Standup paddle boarding on Lady Bird Lake in downtown Austin.

Code amendments in the summer of 2020.¹⁰

- **Harris County** - The county is doing a great job promoting nature-based infrastructure, despite the restrictions placed on them as a governing entity. They should examine the possibility of expanding their incentive program or adding regulations to ensure private development adoption of nature-based solutions.
- **San Marcos** - The City should work to update the way they monitor nature-based projects. Connecting water quality data taken from the San Marcos River to nature-based projects nearby, for example, could provide invaluable data on how well these features work.
- **Dallas** - The City is considering requiring nature-based features in their new drainage manual. Doing so would put them in first place on this scorecard, and be a huge step for nature-based solutions in Texas.
- **Denton** - Denton should look at increasing their water quality regulations to include areas outside the designated environmentally sensitive areas currently listed.
- **Fort Worth** - The City currently only requires water quality standards be met along the Trinity River. Fort Worth should expand those requirements across the city to protect the City's other waterways including the river's tributaries.
- **Houston** - The City of Houston recently proposed an aggressive set of nature-based infrastructure incentives. Implementing these incentives effectively could turn the City into a nature-based infrastructure hotspot in the state.
- **El Paso** - As the City of El Paso updates its drainage code this year, they should consider requiring nature-based infrastructure for meeting their water quality goals.
- **Farmers Branch** - The next step for cities like Farmers Branch, which recently adopted water quality and stormwater detention requirements, is to promote nature-based features through a formal education program and incentive program to help developers meet those requirements.

10 SA Speak Up, Ready SA Unified Development Code Assessment & Alignment, 2019. <https://www.saspeakup.com/Speak-Up/Survey-Details/ArtMID/27435/ArticleID/17480/Ready-SA-Unified-Development-Code-Assessment-Alignment>



Rain garden outside the San Antonio River Authority Building.

Across Texas, it is clear that local governments are recognizing the power of nature-based infrastructure for stormwater management, and that change is on the horizon. Since the last publication of this scorecard in 2017, governments across the state incorporated nature-based features into their public projects, added additional incentives for private developers, and expanded their public education programs to teach Texans about the benefits of treating our stormwater naturally by letting it soak into the ground, instead of forcing it to run over concrete roads, gathering water pollution and flooding communities downstream. Many cities, including Dallas, San Antonio and El Paso, are looking to update their drainage manuals and/or development code in the next year, and plan to include stronger support for nature-based features. Officials across Texas are forming regional partnerships and sharing best practices to incorporate the benefits of nature-based infrastructure into their communities.

To help them in this effort, the state government needs to step in as well. Texas state agencies such as the Texas Water Development Board (TWDB) and Texas Environmental Commission on Environmental Quality (TCEQ) need to lead the way with educational workshops, funding resources, and statewide studies demonstrating the efficacy of nature-based techniques. The TWDB has begun to recognize the importance of these features in their flood planning rules, but needs to fully commit to providing funding, and requiring they are incorporated into local flood mitigation plans.

Environment Texas Research and Policy Center hopes this scorecard can help in both the statewide effort, and those by local governments, by providing a summary of the good work taking place across the state, offering inspiration, and giving recommendations to expand and amplify the benefits of nature-based features.

Introduction

Water is a part of life here in Texas, but stormwater runoff and the pollution it carries often leaves the waterways we love too polluted to enjoy. Two thirds of freshwater sites and half of all beaches were too polluted to safely swim in on at least one testing day in 2017.¹ When stormwater runs off our roofs, roads, commercial centers, farms, and parking lots, it picks up toxic chemicals, excess nutrients, and other forms of pollution. This pollution not only threatens our health when we swim at local beaches, but also can contaminate our drinking water and endanger the habitat of our state's wildlife.

To address the problem of runoff pollution in our waterways, we need to examine how we deal with stormwater. Traditional stormwater management techniques aim to capture water and move it away from urban centers as quickly as possible. This has resulted in a network of concrete along which stormwater collects fertilizer, car oil, pet waste, litter, gasoline, and more before dumping the toxic load into our rivers and streams. Luckily, Texas has a solution.

Nature-based infrastructure, including rain gardens, green roofs, and the restoration of natural spaces can combat these problems. Nature-based solutions allow stormwater to slow down and soak into the ground, giving the soil the chance to filter our pollutants before they reach our fragile streams and aquifers. These techniques can reduce runoff pollution by up to 90%, preventing pollution from endangering our waterways.² At the same time, nature-based features also help mitigate localized flooding, reduce the wear and tear of stormwater on traditional infrastructure, maintain flows in streams, reduce the urban heat island effect, and make our communities more beautiful.³

Recognizing the benefits of nature-based infrastructure, municipalities across Texas have begun to encourage its use. The policies they use to do so vary widely, in both scope and effectiveness. To examine how well Texas's cities and counties are addressing the issue, Environment Texas Research and Policy Center created a stormwater scorecard with nine policy categories that highlight the differences among Texas municipalities, the ways in which they are succeeding, and the ways in which they could improve.

The results presented in this report show widespread improvement from the Stormwater Scorecard published in 2017. San Antonio and Austin, both of which reported robust public initiative programs, are tied with the highest score while Harris County follows close behind. Even in places where nature-based infrastructure was non-existent three years ago, local governments have incorporated incentives for private developers, begun public education campaigns, installed nature-based technologies on public projects, or set up projects to evaluate how to best use nature-based solutions in their communities. And more change is on the horizon; the City of Dallas has a chance to edge Austin out of the top spot if the Northern Texas City beats the capital to mandating nature-based infrastructure in private and public construction. This report examines all these policies, putting them in perspective, and giving recommendations to help governments across Texas protect our communities with nature-based infrastructure.

1 Environment Texas, *Swim at your own risk*, August 2018. Archived at <https://web.archive.org/web/20190914141456/https://environmenttexas.org/reports/txe/swim-your-own-risk>.

2 William J. Taylor, Taylor Aquatic Science and Policy, *White Paper for Stormwater Management Program Effectiveness Literature Review: Low Impact Development Techniques*, April 2013. Archived at web.archive.org/web/20170110230133/http://www.ecy.wa.gov/programs/wq/psmonitoring/ps_monitoring_docs/SWworkgroupDOCS/LIDWhitePaperFinalApril2013.pdf

3 Environmental Protection Agency, *Benefits of Green Infrastructure*, 2008. <https://www.epa.gov/green-infrastructure/benefits-green-infrastructure>

Stormwater Concerns in Texas

The saying goes, “when it rains, it pours;” Texas is a good example. The boom and bust cycles of rainfall we have come to expect in our state exacerbate many environmental issues. Months without rainfall dry out our soils, let oil and pollution build up on our roads, and heat up our cities to dangerously high temperatures in the summer. When the rain finally comes, the downpour washes oil and toxic chemicals into our waterways, creating a contaminated torrent that erodes riverbanks, pollutes our environment, and floods our communities.

Water Pollution

According to the Texas Commission on Environmental Quality (TCEQ), more than 780 miles of rivers and streams across the state are impaired due to stormwater runoff.¹ This is a clear indicator that we have a problem with water pollution entering our waterways. On its city government website, Austin warns local residents to “refrain from swimming after flooding or heavy rains”² because stormwater has been known to transport manure and hazardous waste to local streams.³ In Galveston Bay as well, stormwater is often cited as a source of human and animal waste pollution causing beach closures and environmental degradation.⁴ Our research shows it is an issue across the state; 63% of Texas beach locations and 49% of freshwater sites were unsafe for swimming on at least one water quality testing day during 2017 because fecal bacteria levels were too high.⁵ These facts outline a concerning reality: Texas needs to change the way we manage stormwater to keep our waterways safe.

1 Texas Commission on Environmental Quality, Texas Nonpoint Source Management Program, July 2017. Archived at https://web.archive.org/web/20190906130536/https://www.tceq.texas.gov/assets/public/waterquality/nps/mgmt-plan/2017_NPSManagementProgram.pdf.

2 Austin-Travis County Emergency Medical Services, Water Safety. Archived at <https://web.archive.org/web/20200204024342/http://www.austintexas.gov/page/water-safety>.

3 Science Direct, Waste-derived Compost and Biochar Amendments for Stormwater, February 2020. Archived at <https://web.archive.org/web/20200204024528/https://www.sciencedirect.com/science/article/abs/pii/S0304389419311975>.

4 Environmental Protection Agency, LEARN: What Affects Beach Health, June 2019. Archived at <https://web.archive.org/web/20191015123552/https://www.epa.gov/beaches/learn-what-affects-beach-health>.

5 Environment Texas, Swim at your own risk, August 2018. Archived at <https://web.archive.org/web/20190914141456/https://environmenttexas.org/reports/txe/swim-your-own-risk>.

Flooding

In addition to dealing with our water quality, Texas stormwater infrastructure must protect us Texans from flooding. The Texas Water Development Board has estimated that one in every ten Texans faces moderate or high risk from riverine floods,⁶ meaning

6 Texas Water Development Board, State Flood Assessment: Report to the 86th Texas Legislature, January 2019. Archived at web.archive.org/web/20190828160358/http://www.texasfloodassessment.com/doc/State-Flood-Assessment-report-86th-Legislation.pdf

Houston’s Buffalo Bayou during Hurricane Imelda in September of 2019



Photo: Jennifer Schmerling.



Polluted stormwater as it flows through Waller Creek in Austin after a rainstorm.

that flooding affects the “lives and livelihoods of all Texans.”⁷ In 2018, 12 people and thousands of animals across the state were killed by floods,⁸ and damages from flooding totaled more than \$3 billion in Texas in 2015, the most expensive year on record. These numbers are predicted to continue to get worse as climate change makes storms even stronger. In 2017, Hurricane Harvey alone dumped 27 trillion gallons of rainwater across Texas.⁹ This type of threat to our infrastructure systems needs to be addressed.

Failing Infrastructure

Our state has a vast infrastructure system to deal with the issues associated with stormwater, however, that

infrastructure is not up to the task. The American Society of Civil Engineers assigned Texas a D grade for flood infrastructure, a D+ for drinking water, and a D for wastewater, a grade which they define as “poor” and “at risk,” exhibiting “significant deterioration.”¹⁰ These failures put Texan in danger. Swimming in water contaminated with fecal bacteria can lead to gastrointestinal illness, respiratory disease, ear and eye infections, and skin rashes. The Texas Water Development Board estimates that one in every ten Texans faces moderate or high risk from riverine floods.¹¹ To protect our communities from these dangers, we need to look closely at how we manage stormwater, and consider techniques like nature-based infrastructure as an essential part of the solution.

7 Texas Water Development Board, *Informed Flood Planning for Texas*, August 2019. Archived at web.archive.org/web/20190828160118/http://www.twdb.texas.gov/newsmedia/featured/stories/2019/08/index.asp

8 NOAA, *2018 Flood Fatalities*, 2019. <https://web.archive.org/web/20190807114945/https://www.nws.noaa.gov/om/hazstats/flood18.pdf>

9 World Vision: *2017 Hurricane Harvey: Facts, FAQs, and How to help*, August 2017. Archived at <https://web.archive.org/web/20200204233203/https://www.worldvision.org/disaster-relief-news-stories/2017-hurricane-harvey-facts>

10 Texas Ace: *Report Card for Texas's Infrastructure*, 2017. Archived at https://www.texasace.org/wp-content/uploads/2018/11/FullReport-TX_2017.pdf

11 Texas Water Development Board, *State Flood Assessment: Report to the 86th Texas Legislature*, January 2019. Archived at web.archive.org/web/20190828160358/http://www.texasfloodassessment.com/doc/State-Flood-Assessment-report-86th-Legislation.pdf

Nature Based Infrastructure for Stormwater Management

One of the best ways to address the issues of our current stormwater infrastructure is through nature-based techniques. We've historically dealt with stormwater using "gray" infrastructure, including pipes, tanks, pumps, and other materials that force water away from cities as quickly as possible. This type of system is expensive to build, expensive to maintain, and threatens our environment with pollution, flooding, and development. In response to these dangers, Texas is increasingly adopting nature-based techniques, such as rain gardens and green roofs, which reduce runoff pollution, slow down and absorb floodwaters, and add green spaces to our communities.

Types of Nature-based Infrastructure

Nature-based Infrastructure imitates nature by allowing rainwater to slow down, and soak in to local soil. This prevents water pollution while mitigating floods, combating drought, and reducing urban heat.

Common examples include:

- **Rain gardens** - planted depressions that collect rainwater and become small ponds when it rains
- **Bioswales** - shallow, vegetation-lined drainage channels
- **Conservation and restoration** of streams, rivers, and wetlands
- **Green roofs** - vegetated roofs or walls that capture rainfall on the building itself
- **Permeable surfaces** - concrete, asphalt, or paving stones that allow water to seep through
- **Rainwater harvesting** - storage containers that collect rainwater from roofs

Benefits of Nature-Based Infrastructure

The benefits of nature-based infrastructure are wide ranging. Techniques ranging from neighborhood rain

gardens to city-scale bioswale construction and rural wetland restoration can reduce runoff pollution by up to ninety percent.¹ Allowing stormwater to soak into the ground also mitigates flooding and stores water to help alleviate later drought. Planted features reduce urban heat in the summer, and remove greenhouse gasses from the atmosphere while adding beautiful greenspace to our communities.

¹ William J. Taylor, Taylor Aquatic Science and Policy, White Paper for Stormwater Management Program Effectiveness Literature Review: Low Impact Development Techniques, April 2013. Archived at web.archive.org/web/20170110230133/http://www.ecy.wa.gov/programs/wq/psmonitoring/ps_monitoring_docs/SWworkgroupDOCS/LIDWhitePaperFinalApril2013.pdf

A permeable sidewalk near City Hall in Dallas, Texas

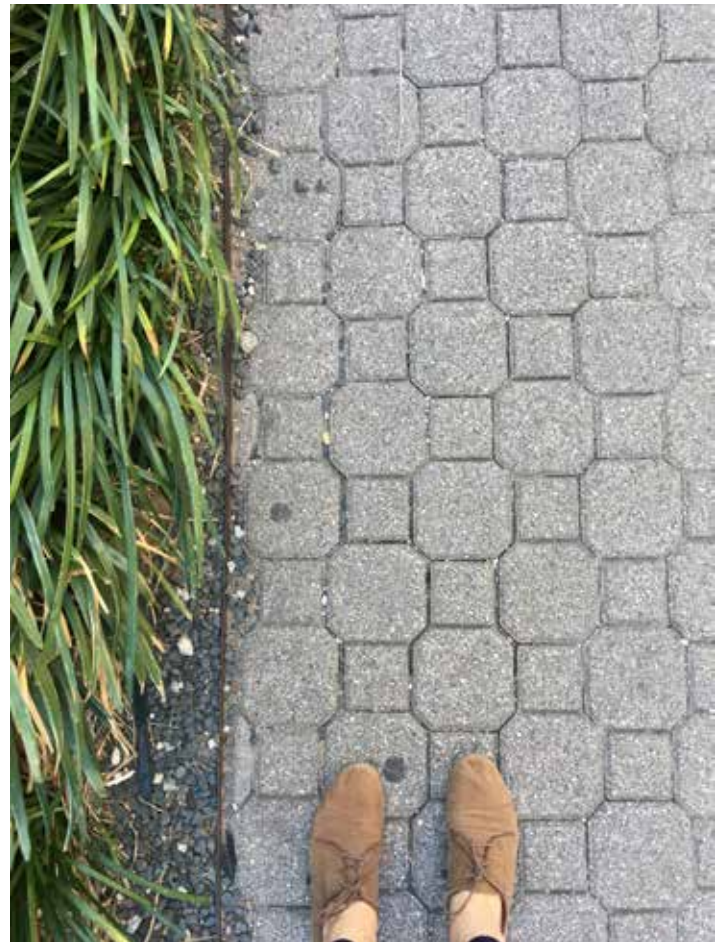


Photo: Anna Farrell-Sherman



SA bioswale in Singapore's MacRitchie Reservoir Park helps remove stormwater pollutants while adding beautiful green space to a highly urban city.

The benefits of nature based systems include:

- **Improving water quality** - Stormwater systems can trap between 45 and 99 percent of solid pollutants.²
- **Mitigating flooding** - Nature-based systems can absorb between 50 and 90 percent of rainfall and have the potential to fully prevent flooding from less severe storms.³
- **Preventing drought** - Allowing rainfall to soak into local soils replenishes aquifers easing droughts later on.
- **Reducing urban heat** - Green areas of cities absorb more heat reducing summer temperatures by 10-15 degrees.⁴
- **Removing greenhouse gases from the atmosphere.** Trees and green roofs can capture hundreds of pounds of carbon dioxide over their lifetimes.
- **Preventing toxic algae blooms** - Filtering out pollutants decreases the amount of nutrient laden runoff that enters local waterways reducing the risk of toxic algae blooms.⁵
- **Beautifying the landscape** - Projects add greenspace to our communities, improving the quality of life.

One Water Philosophy: Using Nature-based Infrastructure for water reuse.

The One Water philosophy treats all types of water, from drinking water to stormwater, wastewater to river water, as one resource. It highlights water reuse, water conservation, and holistic water management to ensure sustainable clean water for our communities and our environment. Nature-based infrastructure is an essential part of the One Water movement because of its ability to retain and clean stormwater, allowing it to be used again. Rainwater harvesting, for example, can provide landscape irrigation instead of contributing to the burden already placed on local storm drain systems.

² William J. Taylor, Taylor Aquatic Science and Policy, White Paper for Stormwater Management Program Effectiveness Literature Review: Low Impact Development Techniques, April 2013. Archived at web.archive.org/web/20170110230133/http://www.ecy.wa.gov/programs/wq/psmonitoring/ps_monitoring_docs/SWworkgroupDOCS/LIDWhitePaperFinalApril2013.pdf

³ William J. Taylor, Taylor Aquatic Science and Policy, White Paper for Stormwater Management Program Effectiveness Literature Review: Low Impact Development Techniques, April 2013. Archived at web.archive.org/web/20170110230133/http://www.ecy.wa.gov/programs/wq/psmonitoring/ps_monitoring_docs/SWworkgroupDOCS/LIDWhitePaperFinalApril2013.pdf

⁴ KR Gunawardena, Science Direct: Utilising green and bluespace to mitigate urban heat island, April 2017. Archived <https://www.sciencedirect.com/science/article/pii/S0048969717301754>

⁵ Environmental Protection Agency: Harmful Algal Blooms, December 2019. Archived at <https://www.epa.gov/nutrientpollution/harmful-algal-blooms>

Local Government Policies for Nature-based Stormwater Management

Local governments across Texas, and across the globe have begun to adopt policies to help incorporate more nature-based techniques into their stormwater management systems. There are three types of regulations that are commonly used.

Type 1: Private Development Regulations

Private development regulations include requirements for stormwater detention and water quality controls on new developments, as well as requirements to maintain any nature-based features used to meet those requirements. Stormwater detention is usually used to prevent new developments from flooding their neighbors, while water quality controls are used to make sure those developments do not have negative effects on local waterways and drinking water sources. These policies require developers to manage the water that runs off their site and prevent negative impacts to surrounding areas. While some developers might choose to use nature-based techniques to meet these requirements, the specific way these regulations are written make a significant impact on how easy it is to do. Most cities we surveyed allow nature-based technologies, while a few go further to actively promote or even require their use whenever possible. This is an important step because it helps break the current paradigm of grey concrete infrastructure that permeates most stormwater infrastructure.

Photo: Anna Farrell-Sherman



All properties that front the San Antonio River Walk are required to use nature-based techniques to preserve water quality.



A boat on Lake Travis, Austin's largest water supply



The view from the rooftop deck of Austin Public Library's Central Branch features Lady Bird Lake and the library's array of solar panels.

Type 2: Private Development Incentives

Municipalities that do not yet require nature-based technology to meet stormwater and water quality requirements often encourage their use through incentives. The scorecard breaks these up into regulatory incentives, which give developers more favorable regulations in exchange for GSI techniques, and financial incentives, which give users of GSI discounts or rebates. These policies help developers learn about GSI, giving them the ability to get something in return for trying out a new a different technique.

Type 3: Public Initiatives

To show how successful nature-based projects can be, and to create more widespread systematic change in the way stormwater is managed, many municipalities decide to demonstrate their effectiveness with public initiatives. The most significant of these policies are capital construction projects, where cities incorporate nature-based infrastructure into their traditional systems. Other public initiatives include education programs to increase public awareness, monitoring programs to keep track of GSI project efficacy, and collaboration programs either on the local or national level.

Methodology

Environment Texas Research and Policy Center created a nine category scorecard based on the three major types of stormwater policy that can incentivise nature-based infrastructure. The scorecard evaluates local governments on how well their stormwater policy allows for and encourages the use of nature-based techniques. The categories seek to cover the broad range of policies used to address these issues while setting the bar high and looking towards a future in which nature-based techniques are used in concert with traditional techniques.

POLICY	Level 1	Level 2	Level 3	Level 4
PRIVATE DEVELOPMENT REGULATIONS				
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	At least some sites are required to detain stormwater so as to not increase runoff	All sites are required to detain stormwater so as to not increase runoff	All sites are required to detain stormwater, GSI is recommended	All sites are required to detain stormwater, GSI is required (other methods only as needed)
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	Water quality is regulated on some developments but not all	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	All developments must meet water quality standards, GSI is recommended	All developments must meet water quality standards, GSI is required (other methods only as needed)
Maintenance Requirements Requirements to maintain installed GSI	Maintenance recommended but not required	Maintenance is required, but enforcement is lacking	Maintenance is required and those requirements are enforced	In addition to enforcing maintenance requirements, the city has a maintenance education program
PRIVATE DEVELOPMENT INCENTIVES				
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	The permitting process favors GSI projects in multiple ways (increase size, faster process, advice from city)	GSI is required on some types of projects, and favored in others (through increase size, faster process, advice from city)	GSI is required on all projects and permitting for projects without GSI requires an exception
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	Small incentives exist but are not significant	There is at least one significant financial incentive (rebate, tax credit, etc.)	There are multiple pathways for financial reimbursement	GSI is clearly defined as the cheaper alternative through regulations and incentives
PUBLIC INITIATIVES				
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	Some attempt at GSI in public spaces	Multiple public GSI projects across community	GSI is considered for all public projects	GSI is required in public projects

Education Public awareness is developed through GSI signage, written materials, and other efforts	Small scale* in one or two categories: public signage, webpage, manual, programs	Small scale in 3 or large scale* in 1: public signage, webpage, manual, programs	small scale in all or large scale in 2: public signage, webpage, manual, programs	All are large scale: public signage, webpage, manual, programs
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	The city does one of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	The city does ALL of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	Pilot projects, monitoring existing GSI, and a GSI database is used to shape policy and educational materials
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	City has reached out to regional partners about protecting regional water quality	City has reached out to regional partners about GSI	City works closely with regional partners	In addition to regional collaboration, the city has reached out to other cities with GSI advice

TOTAL POINTS

*NOTE: Small scale refers to focusing on only a few GSI types or a few locations in the municipality. Large scale is something that works across most features and locations

To evaluate the cities and counties in this scorecard, Environment Texas Research and Policy Center interviewed municipal representatives from the local agency in charge of stormwater. Initial interviews were written up with the scorecard and sent back to those representatives for review. Feedback was also used to modify the scorecard to best represent the wide range of stormwater policies in place across the state.



Results

Austin and San Antonio tied with the highest scores in Texas. Both cities boast impressive public initiatives, from San Antonio's citywide watershed modeling and LID planning to Austin's exemplary education program complete with workshops and manuals. San Antonio is also the only local government with any kind of nature-based infrastructure mandate. Harris County, a close third place, has created a stellar education and monitoring program of its own. Cities across the state have stepped up their game with additional incentives, new public programs, and exciting pilot projects.

Interesting Trends

- Cities tend to require stormwater detention more often than they regulate water quality. To fully make use of the wide ranging benefits of nature-based solutions, cities need to recognize that water quality benefits can come hand in hand with detention, working together to make safer communities.
- The creation of capital improvement projects using nature-based infrastructure is essential to helping spur adoption in other sectors. Even cities with fairly good incentive programs did not have widespread adoption of nature-based techniques unless they also had public features and pilot projects.
- Across the state, cities need to be doing more to monitor and evaluate their nature-based infrastructure. GSI databases should be made public and data from monitoring them should be shared to help experts around the state learn from the features that already exist.

City Rankings

Rank	City / County	Score
1	San Antonio	69%
1	Austin	69%
3	Harris County	66%
4	San Marcos	58%
5	Dallas	56%
6	Fort Worth	56%
6	Denton	53%
8	Houston	50%
9	El Paso	42%
10	Farmers Branch	36%

The progress we have reported here is just the beginning. Across all the local governments surveyed, stormwater agencies are looking to further improve their policies. Many cities, including San Antonio, Dallas, and El Paso will update their drainage manuals in the next year, and plan to include stronger support for nature-based features when they do so. Both Dallas and Austin have proposed city wide nature-based infrastructure requirements; the first to do so will become the first municipality in the State to institute such a requirement, becoming the highest scoring government on this scorecard. As policies continue to improve statewide, the growing collaborations we have reported here will continue to foster a state with more robust, sustainable, and flexible infrastructure system, incorporating both traditional and nature-based infrastructure to keep our communities safe.

San Antonio

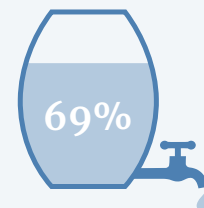
Summary

San Antonio, a city that prides itself on its beautiful waterways, is notable among all the municipalities surveyed for its consistency across the scorecard: there is no one category in which they fall dramatically short, and, in particular, their public initiatives are strong across the board. The city can boast of being one of only two cities in the scorecard to have a GSI requirement, which mandates nature-based features along the San Antonio and San Pedro Creeks, and an incentive program for features outside of those areas. They also construct a significant number of public projects, have a robust educational program, and work hard to make sure all GSI features are well-monitored and well-maintained. To improve their score, San Antonio should look to update their United Development Code to expand their GSI regulations to more areas throughout the city.

Private Development

San Antonio focuses on promoting nature-based infrastructure near the City's environmentally sensitive waterways, thanks in part to the San Antonio River Authority (SARA)'s leadership. All sites must either detain stormwater onsite or pay into a fee in-lieu-of program to support regional projects. Water quality is not regulated city wide, but through various mechanisms in different areas. Some are regulated by the City's MS4 permit, others by the Edwards Aquifer Protection Program, and the rest through SARA. The City's United Development Code mandates that sites along the San Antonio River and San Pedro Creek must use GSI to meet these water quality requirements, which is the only mandate for nature-based features in Texas. Sites not in specific water quality zones can get density bonuses for LID features, and are able to count those features twice to meet other requirements, like those for parking lot shading and tree canopy, as well as receive financial incentives through a stormwater fee discount and rebates from SARA.

Score: 25/36



Population: 1,532,233¹

Average Annual Precipitation: 33 inches²

Average Rainy Days per Year: 82 days³

Major Water Features: Edwards Aquifer, Trinity Aquifer, San Antonio River, Salado Creek, San Pedro Creek, and Leon Creek.

Municipal Agency for Stormwater: City of San Antonio Department of Transportation and Capital Improvements, Storm Water Division.

Highlight

San Antonio has an exceptionally strong set of public initiatives, including conducting thorough water quality modeling to ensure protections for sensitive waterways. They are also the only city in the state to have any kind of nature-based infrastructure mandate.

Recommendation

The city should work to expand their water quality requirements to the whole city, a step they can take as part of their United Development Code amendments in the summer of 2020.

1 World Population Review: San Antonio, Texas Population 2020.2019. Archived at <https://web.archive.org/web/20190730161425/http://worldpopulationreview.com/us-cities/san-antonio-population/>

2 Sperling Best Places: San Antonio, Texas Climate. 2019. Archived at <https://web.archive.org/web/20190730161425/http://worldpopulationreview.com/us-cities/san-antonio-population/>

3 Sperling Best Places: San Antonio, Texas Climate. 2019. Archived at <https://web.archive.org/web/20190730161425/http://worldpopulationreview.com/us-cities/san-antonio-population/>



Confluence Park in San Antonio.

Public Projects

The city boasts a wide variety of public projects funded through the City, Bexar County Flood Control, and SARA. SARA was the first to push for LID features in the city, both along the San Antonio River and in their own buildings, but increasingly the City considers LID on every capital improvement project in the city and makes an effort to use LID infrastructure where feasible to restore riverways. The City is also working with SARA to do significant modeling of the watersheds in the metropolitan area to determine where LID features could have the biggest impact and monitor installed features to see how well they are working.

One strong example of San Antonio's public features is Confluence Park, a multi-use greenspace on the San Antonio River that provides recreation for local residents, a classroom for events and field trips, and a native Texas grassland habitat irrigated entirely through rainwater collection. This park's ability to offer space for recreation, while educating residents on nature-based solutions through its classroom space and beautiful nature-based stormwater treatment feature serves as an example for the rest of the state.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites must detain stormwater so as to not increase runoff	All development projects must examine their downstream impact and either detain the runoff to mitigate adverse impacts, or pay into a fee in lieu program. GSI is an available tool, but not the recommended tool to meet requirements.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	The City collaborates with SARA to evaluate LID/GSI strategies within regional centers identified in the SA Tomorrow Plan. This includes water quality models to confirm protection of major creeks and rivers. The City's UDC mandates GSI along the river and creek.
Maintenance Requirements Requirements to maintain installed GSI	2	Maintenance is required, but enforcement is lacking	Maintenance is required and monitored during the establishment process, but additional enforcement is only applicable if issues arise.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	3	GSI is required on some types of projects, and favored in others (through increase size, faster process, advice from city)	GSI is required on site along the city's waterways. Other sites can get density bonuses for LID features, and are able to count features towards other requirements like those for parking lot shading and tree canopy.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	3	There are multiple pathways for financial reimbursement	The City offers a reduction in development fees as well as Storm Water Utility Fee discount. The San Antonio River Authority runs a rebate program called Watershed Wise.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	GSI is always the favored approach to public projects, and implemented when feasible.
Education Public awareness is developed through GSI signage, written materials, and other efforts	3	Small scale in all or large scale in 2: public signage, webpage, manual, programs	The City has a group that works on stormwater education as part of their MS4 permit. Most of the City's educational material is produced by the San Antonio River Authority, and includes a GSI manual, some signage, and a workshop series.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	4	Pilot projects, monitoring existing GSI, and a GSI database is used to shape policy and educational materials	The City is ahead of the curve with GSI planning that includes a block by block analysis of drainage and stormwater runoff throughout the city. All features are evaluated to inform future projects. There is no public facing database, but GSI features are recorded internally and well monitored.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	3	City works closely with regional partners	The City works closely with Bexar County and Bexar Regional Watershed Management to coordinate flood control and water quality initiatives.
TOTAL POINTS SAN ANTONIO		25	

Austin

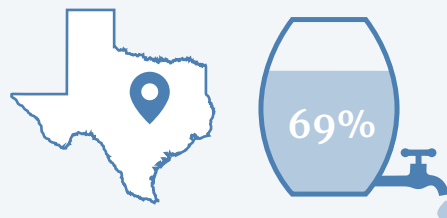
Summary

The City of Austin, which first adopted city water quality standards in the Comprehensive Watershed Ordinance of 1986, received the highest score on our 2017 scorecard but now shares that honor with San Antonio. The City boasts extensive education, monitoring, and evaluation programs, however, it could still improve its patchwork of small incentives into a comprehensive program to motivate adoption by private developers. The city could dramatically improve its score by approving the proposed Land Development Code Rewrite in the spring of 2020. The proposed draft code mandates the use of GSI for water quality treatment on sites with over 90% impervious cover, and adds nature-based water management to capital improvement projects throughout the city. These policies would make Austin a leader in nature-based stormwater management statewide.

Private Development

Private developments in Austin must meet both stormwater detention and water quality requirements. As of early 2020, nature-based features are considered one of many tools to meet these requirements, but are not recommended or required. The City incentivizes their use through a number of small discounts and upgrades. The current incentives are useful, but would better encourage adoption if combined into a single incentive program. The largest incentive is a drainage utility fee discount, along with rules allowing GSI features to be placed in areas of properties usually undevelopable for environmental reasons. In addition to the drainage utility discount, the City allows zoning upgrades if an environmental benefit review includes GSI, gives density bonuses for downtown developments with green roofs, and awards Austin Energy Green Building program points for GSI. Every three years, any features created using these incentives are inspected as part of the City's maintenance program, which also provides certification to people who take a course on proper maintenance.

Score: 25/36



Population: 964,254¹

Average Annual Precipitation: 34.32 inches²

Average Rainy Days per Year: 79 days³

Major Water Features: Lady Bird Lake, Barton Creek, Barton Springs, Boggy Creek, Bull Creek, Onion Creek, Shoal Creek, Waller Creek, Walnut Creek

Municipal Agency for Stormwater: Watershed Protection Department

Highlight

The City took bold action creating city wide plans like Water Forward, Functional Green, and the Community Climate Plan that emphasize water reuse, urban green space, and nature-based infrastructure. While these plans are not currently legally binding, they provide exemplary guidelines and could become law with the passage of the proposed Land Development Code in the spring of 2020.

Recommendation

To remain a state leader in stormwater management, Austin needs to pass the proposed Land Development Code, which will mandate the use of nature-based infrastructure for water quality treatment on highly urban sites.

1 World Population Review: Dallas Texas Population 2020, 2019, archived at <http://worldpopulationreview.com/us-cities/dallas-population/>

2 Climate Data: Dallas Climate: average temperature, weather my month, day, and year, 2019, archived at <https://en.climate-data.org/north-america/united-states-of-america/texas/dallas-292/>

3 Climate Data: Dallas Climate: average temperature, weather my month, day, and year, 2019, archived at <https://en.climate-data.org/north-america/united-states-of-america/texas/dallas-292/>



A rain garden at Austin's Reilly Elementary School filled after a winter rainfall.

Public Projects

The City of Austin's own capital projects always consider the use of GSI, and they have built various features across the city. They also have a commendable education program, with a detailed website, signage on all publicly accessible features, manuals both for expert engineers and less-technical homeowners, and occasional workshops. The City built its program in part through their monitoring and evaluation of existing programs, which not only monitor the effectiveness of GSI features themselves, but also how well those programs work to educate the public.

Austin has room to improve in their regional collaborations. Currently, they coordinate with Travis County, the Texas Department of Transportation (TxDOT) and Central Texas Regional Mobility Authority (CTRMA) on GSI programs, and participate in regional and national programs that address stormwater, but there is no formal regional structure for stormwater-specific collaborations. Connecting with peers in San Antonio and throughout the region could increase protections for waterways, like the Edwards Aquifer and Colorado River, which provide drinking water to millions of Texans.

POLICY	Points	Level	Rationale
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PRIVATE DEVELOPMENT REGULATIONS

Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites must detain stormwater so as to not increase runoff	All sites must meet detention requirements, which vary based on site size, and location in the watershed. GSI features can be counted towards this requirement, but the city emphasizes GSI for water quality and does not use it for stormwater detention.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard	All sites greater than 8,000 square feet must meet water quality standards. GSI is one available tool to meet those requirements.
Maintenance Requirements Requirements to maintain installed GSI	4	In addition to enforcing maintenance requirements, the city has a maintenance education program	Maintenance is required on registered sites. Commercial installations are maintained by the owner with inspections every three years, while most residential sites are maintained by the City and must renew their certification every two years to maintain their drainage fee discount. The City helps to educate GSI professionals on proper maintenance through the new National Green Infrastructure Certification Program.

PRIVATE DEVELOPMENT INCENTIVES

Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	2	The permitting process favors GSI projects in multiple ways (increase size, faster process, advice from city)	Austin provides a diverse set of smaller GSI incentives. GSI features can extend into otherwise undevelopable environmentally sensitive areas, can be used to reduce landscaping requirements, and their use allows for zoning upgrades as part of a larger environmental benefit review through the Planned Unit Development District Designation program. Downtown sites can receive a density bonus for a green roof, and the city awards points for GSI in the Austin Energy Green Building program.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	2	There is at least one significant financial incentive (rebate, tax credit, etc.)	The City provides a drainage utility fee discount to sites that add additional GSI above and beyond features used to meet WQ and drainage requirements. Sites can also get one time rebates for GSI features that promote water conservation through the City Water Utility.

PUBLIC INITIATIVES

Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	GSI is considered on all public projects. Examples include various Right of Way programs, mobility bond projects and the Waterloo Greenway for Waller Creek.
Education Public awareness is developed through GSI signage, written materials, and other efforts	4	All are large scale: public signage, webpage, manual, programs	The city provides exceptional educational material. All GSI projects include educational signage. The City's website provides resources, brochures, and toolkits. Manuals exist for both engineers and homeowners. Educational workshops cover multiple topics.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	4	Pilot projects, monitoring existing GSI, and a GSI database is used to shape policy and educational materials	Extensive pilot projects like the Raincatcher program, thorough monitoring of existing GSI, and a database of GSI projects in Austin are all used to help guide policy, future public projects, and the City's educational programming.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	2	City has reached out to regional partners about GSI	The City coordinates subdivision and development policies with Travis County and GSI retrofits with TxDOT and CTRMA. They have organized national stormwater workshops, and is part of groups like the Texas Clean Rivers Association. There is no formal CAPCOG stormwater partnership, but Austin has participated in regional programs like the 2005 Barton Springs Zone Regional Water Quality Protection Plan

Harris County

Summary

Harris County has long been a leader in innovative GSI programs. They were one of the first local governments in the state to incorporate LID into their drainage manual and hosted the Nation's first LID design competition. Unlike a city, which can enact ordinances, Harris County is limited in the types of incentives and regulations they can enforce, but have nevertheless led by example on many public projects, and recommend GSI for private development.

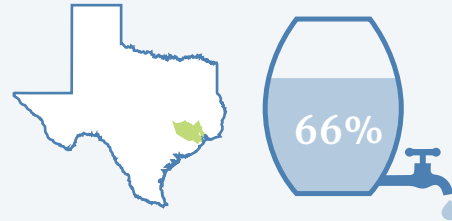
Private Development

All sites must detain stormwater, and water quality is regulated by the county's MS4 permit, as the County is not allowed to enforce more stringent guidelines. While this does limit their power to push for nature-based solutions to improve water quality, the County uses their drainage manual to recommend LID features for meeting stormwater detention and water quality requirements. All features must obtain an annual permit, which ensures they are maintained. To incentivise adoption, the County lowers the detention requirement for sites using GSI and allows them to count the volume of roadside drainage ditches in their detention calculations if those ditches have GSI features.

Public Projects

By the winter of 2019, the County completed approximately 25 major capital improvement projects that incorporated nature-based infrastructure, including roadways, parks, and county buildings. A few chosen projects are carefully monitored as pilot projects in order to improve projects in the future. The data gathered is also used to inform the educational program, which relies heavily on the regional stormwater management website, but also includes a construction manual and signage on wetlands and riparian areas.

Score: 24/36



Population: 4,664,159¹

Average Annual Precipitation: 53 inches²

Average Rainy Days per Year: 81 days³

Major Water Features: Greens Bayou, White Oak Bayou, Buffalo Bayou, Cedar Bayou, Clear Creek, San Jacinto River, Lake Houston, Spring Creek

Municipal Agency for Stormwater: Harris County Engineering Department (HCED), Harris County Flood Control District (HCFCD)

Highlight

The only county surveyed, Harris County has an exceptional monitoring program, which provides detailed data on how features are working, and includes a novel drone-based data collection method to determine how to improve the efficiency of nature-based features.

Recommendation

The county is doing a great job promoting nature-based infrastructure, despite the restrictions placed on them as a governing entity. They should examine the possibility of expanding their incentive program or adding regulations to ensure private development adoption of nature-based solutions.

¹ World Population Review: Harris County, Texas Population 2020, 2019, archived at <https://web.archive.org/web/20190722090149/http://worldpopulationreview.com/us-counties/tx/harris-county-population/>

² Sperling Best Places: Harris County, Texas Climate, 2017, archived at <https://web.archive.org/web/20171128133753/https://www.bestplaces.net/climate/county/texas/harris>

³ Sperling Best Places: Harris County, Texas Climate, 2017, archived at <https://web.archive.org/web/20171128133753/https://www.bestplaces.net/climate/county/texas/harris>

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	3	All sites are required to detain stormwater, GSI is recommended	All developments must detain stormwater to mimic pre-development flows and ensure no impact to the watershed. The County recommends meeting the requirement with GSI where feasible.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	Harris County does not have the authority to enact city style ordinances and therefore cannot regulate water quality past state requirements. However, the County's MS4 permit regulates water quality on new developments greater than 1 acre and significant redevelopments. The County recommends GSI where feasible.
Maintenance Requirements Requirements to maintain installed GSI	3	Maintenance is required and those requirements are enforced	The county issues stormwater quality permits which must be maintained and renewed annually.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	Developments using GSI can model post-development flows with a reduced detention storage rate, reducing the burden of detention requirements on the development. They can also count roadside drainage ditch volume in the detention plan if the ditch contains GSI.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	0		None. The County cannot enact fees or give fee discounts which limits the types of financial incentives possible.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	The HCED's policy is to implement GSI whenever feasible and cost effective, which has resulted in ~25 major capital improvement projects around the county.
Education Public awareness is developed through GSI signage, written materials, and other efforts	4	All are large scale: public signage, webpage, manual, programs	The County's has material on their website about LID, as well as a regional stormwater quality website primarily for education which includes material for schools, residents, and professionals; the Stormwater Management Handbook for Construction Activities provides technical advice; educational signage is installed to delineate and identify stormwater quality wetlands, prairies and riparian areas, as well as GSI features; and the County partners with the flood control district to hold discussions, training, and presentations on nature-based practices.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	4	Pilot projects, monitoring existing GSI, and a GSI database is used to shape policy and educational materials	The County monitors some of their numerous GSI features to determine their effectiveness, including developing a novel drone-based data collection method to improve the efficiency of the project. These pilot projects are used to guide future projects and the County's educational programs. All GSI projects are recorded in a permit database.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	4	In addition to regional collaboration, the city has reached out to other cities with GSI advice	The County is part of many regional collaborative organizations including the Houston Land Water Sustainability Forum (HLWSF), Houston Galveston Area Council (HGAC), and the Institute for Sustainable Infrastructure (ISI). The County helps manage a joint MS4 permit with HCED, HCFDC, and the City of Houston.

TOTAL POINTS **HARRIS COUNTY** 24

San Marcos

Summary

The City of San Marcos is becoming a bigger player in the world of nature-based stormwater management. The city has an exceptional maintenance program, and a significant number of public GSI installations. They encourage nature-based solutions to water quality management in environmentally sensitive areas of the city, aiming to protect the San Marcos River and the five endangered species which reside there. As they continue to expand their education program, monitoring program, and regulatory framework, they will continue to improve their score and expand benefits they can bring to the City through nature-based infrastructure.

Private Development

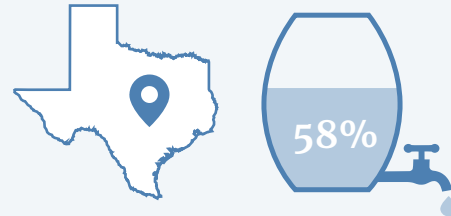
The City has a robust maintenance system, that not only makes sure all GSI features in the city are functioning properly, but also helps educate owners on proper maintenance by providing assistance from city staff fixing issues that arise. This is particularly useful for nature-based infrastructure features, which developers sometimes have less experience with, but can then learn how to maintain properly.

Nature-based features are recommended to meet stormwater detention requirements and water quality standards in environmentally sensitive zones of the City, helping San Marcos protect the San Marcos River and the five endangered species that call it home. They incentivize GSI on private developments by stacking benefits that allow nature-based features to be counted towards parkland, landscaping, and encroachment requirements. Property owners can also get a rebate by installing rainwater harvesting, planting shade trees, and removing turf grass.

Public Projects

San Marcos has installed an impressive number of public nature-based projects, including 1,300 feet of permeable sidewalks, multiple biofiltration ponds, drainage projects, and restoration projects, showing

Score: 21/36



Population: 63,509¹

Average Annual Precipitation: 35 inches²

Average Rainy Days per Year: 83 days³

Major Water Features: Blanco River, San Marcos River, Cottonwood Creek, Purgatory Creek, Sink Creek, and Willow Springs Creek.

Municipal Agency for Stormwater: City of San Marcos Stormwater Systems and Engineering Department.

Highlight

The City should work to update the way they monitor nature-based projects. Connecting water quality data taken from the San Marcos River to nature-based projects nearby, for example, could provide invaluable data on how well these features work.

Recommendation

The City should work to update the way they monitor nature-based projects. Connecting water quality data taken from the San Marcos River to nature-based projects nearby, for example, could provide invaluable data on how well these features work.

1 World Population Review: San Marcos, Texas Population 2020, 2019, archived at <https://web.archive.org/web/20190802090808/http://worldpopulationreview.com/us-cities/san-marcos-tx-population/>

2 Sperling Best Places: San Marcos, Texas Climate, 2017, archived at https://web.archive.org/web/20170724004403/https://www.bestplaces.net/climate/city/texas/san_marcos

3 Sperling Best Places: San Marcos, Texas Climate, 2019. Archived at https://www.bestplaces.net/climate/city/texas/san_marcos



A duck testing the waters in a biofiltration pond in San Marcos.

the City's commitment to nature-based solutions to stormwater management. The city could do more by formalizing a process to consider GSI on every public project, which they currently only do in environmentally sensitive zones, expanding their educational materials, and monitoring the effectiveness

of their GSI features. These steps will help the city become a leader in the region, providing data and example projects to collaboratives such as the Central Texas Stormwater Coalition, Edwards Aquifer Habitat Conservation Plan, and the Upper San Marcos River Watershed Protection Plan.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	3	All sites are required to detain stormwater, GSI is recommended	All developments are required to detain all stormwater flow from storms as big as the 100 year storm. The Stormwater Technical Manual promotes GSI to meet these requirements, and staff verbally recommends GSI during the permitting process.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	Water quality treatment is required in environmentally sensitive areas of the city including the Edwards Aquifer Recharge Zone, Transition Zone, and Contributing Zone, as well as the San Marcos River Protection Zone, and San Marcos River Corridor. GSI is recommended for water quality treatment.
Maintenance Requirements Requirements to maintain installed GSI	4	In addition to enforcing maintenance requirements, the city has a maintenance education program	A 2018 ordinance mandates annual inspection and maintenance of all stormwater management facilities including GSI. If a feature fails inspection, City staff work with the owner to develop a plan to address the problem and the facility is reinspected, helping to educate developers on best-practice maintenance techniques.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	GSI features count towards landscaping requirements, give credit towards the parkland development fee, and may encroach into required setbacks.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	2	There is at least one significant financial incentive (rebate, tax credit, etc.)	The city provides rebates for the cost of installing rainwater harvesting features, planting shade trees, and removing turf grass.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	2	Multiple public GSI projects across community	The City consistently adds GSI into roadway, building, and facility projects. Including 1,300 feet of permeable sidewalks, multiple biofiltration ponds, drainage projects, and restoration projects. GSI is always considered on projects in water quality treatment areas.
Education Public awareness is developed through GSI signage, written materials, and other efforts	2	Small scale in 3 or large scale* in 1: public signage, webpage, manual, programs	The City plans to place signage on multiple public projects, has held holds tours and presentations, and provides guidance for GSI site design in the City's Stormwater Technical Manual. They also have an educational program called "What Goes Here Flows Here" in collaboration with Texas State University.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	All GSI projects are evaluated to understand how to improve future work, and water quality is monitored in the San Marcos River but that data is not connected to nearby GSI projects.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	3	City works closely with regional partners	San Marcos works closely in regional collaborations including the Central Texas Stormwater Coalition, Edwards Aquifer Habitat Conservation Plan, and the Upper San Marcos River Watershed Protection Plan. They also work with Texas State University to promote stormwater education.

TOTAL POINTS **SAN MARCOS** 21

Dallas

Summary

Dallas's led the way creating NCTCOG's iSWM program recommendations for sustainable stormwater management and nature-based features. Having now incorporated those recommendations into the City's Drainage Manual, Dallas is well positioned to become a statewide leader. The City has work to do making sure their education and monitoring programs are able to support the increased implementation of nature-based features, but is considering mandating the use of nature-based infrastructure city wide, which if implemented, would make it the uncontested leader in stormwater management in Texas.

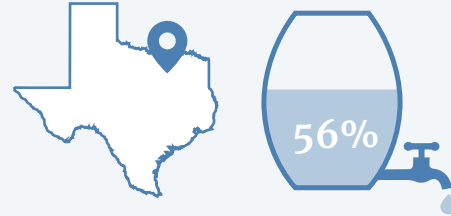
Private Development

The City of Dallas has strong recommendations for the use of nature-based solutions on private development, but these recommendations are not followed up with strong requirements. All sites must detain stormwater, but the City does not have water quality standards. The City is considering mandating nature-based infrastructure, which would be a historic step launching them into a leadership position in Texas. To prepare for this role, the City needs to create a robust maintenance and education system to make sure the city has capable professionals to implement new requirements in private development. Currently, there is no formal maintenance requirement, putting the responsibility for maintenance on the property owner; an official will only be sent to investigate an issue if it negatively affects a public space. If a new GSI requirement significantly increases the number of features in the city, this could become a problem. Financial incentives are currently limited to a stormwater fee discount for GSI features, and the only regulatory incentive is a reduced detention requirement for sites that use nature-based features.

Public Projects

Seeing the benefits of GSI on city scale projects, the City updated their policies to include it in projects of all types, regardless of their size. This policy continues to help incorporate GSI features and complete streets

Score: 20/36



Population: 1,345,047¹

Average Annual Precipitation: 36.2 in²

Average Rainy Days per Year: 78 days

Major Water Features: Trinity River, Lake Ray Hubbard

Municipal Agency for Stormwater: Dallas Water Utilities

Highlight

Dallas was central to the development of the North Central Texas Council of Government (NCTGOG)'s integrated Stormwater Management (iSWM) Program, which encourages the use of nature-based features. They have now incorporated many of those recommendations into their own drainage manual and help encourage other cities to do the same.

Recommendation

The City is considering requiring nature-based features in their new drainage manual. Doing so would put them in first place on this scorecard, and be a huge step for nature-based solutions in Texas.

¹ World Population Review: Dallas Texas Population 2020, 2019. Archived at <http://worldpopulationreview.com/us-cities/dallas-population/>

² Climate Data: Dallas Climate: average temperature, weather my month, day, and year, 2019, archived at <https://en.climate-data.org/north-america/united-states-of-america/texas/dallas-292>

³ Sperling Best Place: Climate in Dallas Texas, 2019, archived at <https://web.archive.org/web/20180411050218/https://www.bestplaces.net/climate/city/texas/dallas>.



The green roof on Dallas' Perot Museum of Nature and Science.

across the city, an important step to mitigate the increasing intensity of urban heat in the summer, and created a number of large-scale constructed wetlands and water gardens. The City's Comprehensive Environmental Climate Action Plan has also helped spur public use of nature-based features including using GSI to help alleviate the stress of aging neighborhood drainage systems, and the creation of an Urban Forest Master Plan in collaboration with the Texas Tree Foundation.

The City has also had a leadership role in regional GSI planning. Dallas helped develop the 1993 integrated Stormwater Management (iSWM) Program for Construction and Development, which provides detailed criteria manuals for nature-based infrastructure and best practice recommendations. While Dallas never officially adopted the iSWM criteria, and could do more to interact with the current iSWM collaboration, they have incorporated the iSWM criteria into their own drainage manual

to make the process simpler for developers. They are now encouraging other cities to do the same. They participate in other North Central Texas Council of Governments (NCTCOG) partnerships such as the Sustainable Public Rights of Way, which helps cities achieve "complete streets."

Unfortunately, the City has not yet created a comprehensive educational program to support their impressive set of requirements, although they are working to organize and standardize their current programs. Property owners can access maintenance information in the Drainage Design Manual and the iSWM manual, but professionals would benefit further from workshops to help developers understand how to implement nature-based infrastructure. Signage on projects could also help the public understand and appreciate the benefits. Additionally, the City could better monitor the features they install to see how they impact local water quality, while conducting more in-depth pilot projects.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	3	All sites are required to detain stormwater, GSI is recommended	All sites that require a building permit must detain stormwater as necessary depending on capacity. GSI is recommended as a way to do so.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	The city does not require sites to maintain a water quality standard, however, it does actively encourage the use of GSI to protect water quality through iSWM recommendations which have been incorporated into the drainage manual.
Maintenance Requirements Requirements to maintain installed GSI	1	Maintenance recommended but not required	Maintenance is the responsibility of the property owner, who have access to manuals detailing maintenance protocols. Officials will check only if it begins to negatively affect public space.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	Sites that use GSI receive a lower required volume for detention.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	2	There is at least one significant financial incentive (rebate, tax credit, etc.)	Residential stormwater fees are tiered based on 1,000 ft ² impervious cover. Sites with GSI have reduced impervious cover and so get discounts.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	GSI is considered on all public projects, including redevelopments, regardless of size (the exception being areas with underlying environmental concerns that make nature-based features difficult).
Education Public awareness is developed through GSI signage, written materials, and other efforts	2	Small scale in 3 or large scale* in 1: public signage, webpage, manual, programs	GSI educational material is available on the website and in the drainage manual. The City has hosted some workshops, and is considering adding signage to public projects but does not do so yet.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	The City frequently updates policy to improve GSI use, and has a few pilot projects. They monitor for water quality as well, but do not yet have analysis that connects the monitoring to GSI projects.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	4	In addition to regional collaboration, the city has reached out to other cities with GSI advice	The City is part of multiple NCTCOG water focused partnerships including Sustainable Rights of Way. They also were part of developing iSWM, and since incorporating iSWM into their own drainage manual, encourage other regional cities to do the same.

TOTAL POINTS **DALLAS** 20

Fort Worth

Summary

The City of Fort Worth is beginning to support the use of nature-based infrastructure, but has yet to fully commit to incentives and regulations that would spur widespread adoption. The City requires stormwater detention, but does not yet regulate water quality, which many Texas cities feel is the best way to spur the adoption of nature-based features. The City should be commended for their commitment to consider GSI on all public projects, and their enforcement of project maintenance, but can improve their signage on those public projects and education on proper maintenance of those projects. They should also significantly expand their incentive program, and formalize how they encourage the use of GSI to developers making their way through the permitting process.

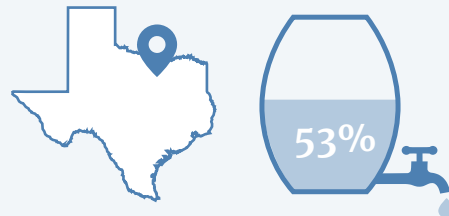
Private Development

Fort Worth put the iSWM materials to good use, encouraging developments to consider nature-based infrastructure, but could still do more to incentivise it. While sites are required to detain stormwater runoff whenever there are adverse impacts, they are not required, only encouraged, to protect water quality through iSWM's best management practices. The iSWM manual provides examples of GSI best practice for developers to use, but they are not required to use said best practices. A few private developers have installed GSI features, making use of a stormwater fee discount and, in particular areas of the city, zoning upgrades for using nature-based infrastructure practices. The city requires maintenance of these features through a permitting program with annual inspections.

Public Projects

Fort Worth has begun to emphasize nature-based infrastructure in their public programming, but still has room to grow. While GSI is always considered in public projects, and implemented when feasible, projects rarely have educational signage explaining the benefits of nature-based features. The City keeps a database of GSI features, including all public projects,

Score: 20/36



Population: 895,008¹

Average Annual Precipitation: 36.7 inches²

Average Rainy Days per Year: 79 days³

Major Water Features: Trinity River, Lake Worth, Lake Como, Greenbriar Lake.

Municipal Agency for Stormwater: Transportation & Public Works Department.

Highlight

This large Texas city should be commended for always considering nature-based techniques on public projects, which has resulted in numerous features around the city.

Recommendation

The City currently only requires water quality standards be met along the Trinity River. Fort Worth should expand those requirements across the city to protect the City's other waterways including the river's tributaries.

1 World Population Review: Fort Worth Texas Population, 2020, 2019. archived at <https://web.archive.org/web/20190730165008/http://worldpopulationreview.com/us-cities/fort-worth-population/>

2 Sperling Best Places: Fort Worth, Texas Climate, 2019, archived at https://web.archive.org/web/20180513135049/http://www.bestplaces.net/climate/city/texas/fort_worth

3 Sperling Best Places: Fort Worth, Texas Climate, 2019, archived at https://web.archive.org/web/20180513135049/http://www.bestplaces.net/climate/city/texas/fort_worth



Green spaces around the Trinity River in Fort Worth, Texas help to filter out pollutants before stormwater reaches waterway.

all projects issued a permit, and all projects in the stormwater fee discount program. However, none of these projects are monitored to quantify their water quality benefits. The City's educational program is limited to the iSWM Criteria manual, iSWM technical

manual, and NCTCOG sponsored workshops, which are also the City's main regional collaborations. They also work with the Tarrant Regional Water District, but could do more to lead all these partners in expanding the use of nature-based infrastructure in North Central Texas.

POLICY	Points	Level	Rationale
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PRIVATE DEVELOPMENT REGULATIONS

Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites are required to detain stormwater so as to not increase runoff	Detention requirement states that developments cannot have adverse impacts on hydrology by increasing runoff. While there are no official GSI recommendations, GSI is allowed and city staff inform developers about the stormwater fee discount in early review stages.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard OR GSI is recommended on sites where water quality is regulated	Water quality volume treatment is required within a certain distance of the Trinity River, a practice the City has proven to be effective through water quality modeling. All properties are encouraged through a credit system to follow iSWM best management practices, and extra credit is given for GSI features.
Maintenance Requirements Requirements to maintain installed GSI	3	Maintenance is required and those requirements are enforced	If a site uses GSI to meet water quality or stormwater detention requirements they must sign a formal maintenance agreement with the city which gives the city rights to inspect that feature annually.

PRIVATE DEVELOPMENT INCENTIVES

Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	In specific “form-based code” areas within the city, developments get zoning upgrade incentives if they use GSI.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	2	There is at least one significant financial incentive (rebate, tax credit, etc.)	Developments get a stormwater fee discount for using GSI

PUBLIC INITIATIVES

Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	GSI is always considered as one of the options for public projects, and implemented when feasible.
Education Public awareness is developed through GSI signage, written materials, and other efforts	2	Small scale in 3 or large scale* in 1: public signage, webpage, manual, programs	The City provides access to iSWIM Criteria manual and iSWIM technical manual and partners with NCTCOG who hosts workshops. Not all public projects have signs, but some (including a few private projects) do have signage.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	Pilot projects are used as examples for demonstration. The City keeps a database including all GSI projects that are (1) public, (2) in the credit program, (3) have a storage commitment, and/or (4) were permitted for development. The City does not yet monitor any of these sites for water quality benefits.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	3	City works closely with regional partners	Works with the Tarrant Regional Water District, NCTCOG, and others.

TOTAL POINTS **FORT WORTH** 20

Denton

Summary

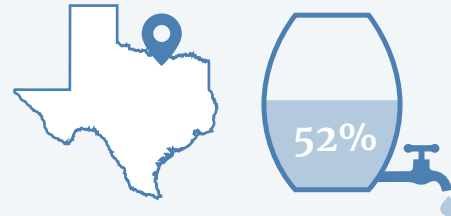
The City of Denton has become a leader in public GSI projects, and has put a lot of energy into the conservation of the City's natural greenspaces, however, it has not followed up with regulations or incentives for the private sector. The City requires all new developments to conduct a downstream impact assessment and design the development to ensure no negative impacts on the receiving waterway. This City is also particularly strict with developments in specially designated environmentally sensitive areas (ESAs). This distinction shows that the city takes maintaining water quality seriously and sees how stormwater management can be a valuable tool to achieve that goal. The city should expand these regulations to more areas in the city.

Private Development

The City of Denton has focused its work on protecting natural spaces, rather than on creating incentives and requirements for developers to use nature-based techniques. Water quality and stormwater detention are regulated at sites in ESAs, which require a special permitting process, making it more difficult to initiate development and requiring stricter stormwater management practices.

Outside of ESAs, all sites must ensure no negative impacts on waterways downstream, but there is no strong regulatory incentive program to promote nature-based solutions, and only a few financial incentives for decreasing impervious surfaces. Additionally, maintenance of nature-based features is not yet formalized into a structured system, which could decrease their effectiveness. Focusing on protecting ESAs is an important first step to protecting regional waterways, but the city should work to expand these policies to protect more areas and support more types of nature-based infrastructure.

Score: 19/36



Population: 133,808¹

Average Annual Precipitation: 39 inches²

Average Rainy Days per Year: 75 days³

Major Water Features: Lewisville Lake, Hickory Creek, Pecan Creek, Cooper Creek, Clear Creek.

Municipal Agency for Stormwater: Watershed Protection.

Highlight

This small city is home to a few major waterways, and the City has taken proactive steps to guard water quality in environmentally sensitive areas, particularly by encouraging developers to stay away from untouched natural areas.

Recommendation

Denton should look at increasing their water quality regulations to include areas outside the designated environmentally sensitive areas currently listed.

1 World Population Review: Denton, Texas Population 2020, 2019, archived at <https://web.archive.org/web/20190801082710/http://worldpopulationreview.com/us-cities/denton-tx-population/>

2 Spering Best Places: Denton, Texas, 2019, archived at <https://web.archive.org/web/20170710072012/https://www.bestplaces.net/climate/city/texas/denton>

3 Spering Best Places: Denton, Texas, 2019, archived at <https://web.archive.org/web/20170710072012/https://www.bestplaces.net/climate/city/texas/denton>



A whitetail doe wades with egrets in a wetland in Denton's Highway 380 Greenbelt Park, July 2005.

Public Projects

Denton has been a leader in the use of nature-based features for public projects. While GSI is not yet standard on public projects, it is considered in the review process, and the resulting projects range from bioswales and cisterns on public buildings to major retrofits along Hickory Street and Cedar Street as part of a continuing “main street” redevelopment. In addition, every feature with public access has educational signage, an essential step to educate the public on the benefits of nature-based techniques. The City could expand their educational

programming with GSI information on their website to supplement their current information on general stormwater management.

Denton is a leader in the regional community, as a founding member of the Upper Trinity Conservation Trust and an active participant in several regional programs for implementation of GSI. Their work includes hosting outreach and stakeholder meetings, coordinating planning, sharing information, providing regulatory updates, decision-making, and increasing future collaboration.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites must detain stormwater so as to not increase runoff	All sites must conduct a downstream assessment and design the development to cause no negative impacts to the receiving waterway. GSI is encouraged in the iSWM manual.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard	Water quality treatment requirements must be met on all new development sites that meet or exceed certain thresholds, such as proposing more parking spaces than allowed and proposing end uses that are considered “hot spots” for pollution.
Maintenance Requirements Requirements to maintain installed GSI	2	Maintenance is required, but enforcement is lacking	The City requires a maintenance plan be provided with any proposed water quality treatment feature. A program to inventory, inspect and enforce maintenance of private features is under development.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	The City provides flexibility to increase paving for parking through the installation of GSI that would intercept pollutants from the parking spaces.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	1	Small incentives exist but are not significant	There are two small incentives: (1) a property tax benefit for setting aside ESAs into conservation easements and (2) an exemption to the drainage fee for extending permeable surfaces.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	2	Multiple public GSI projects across community	GSI is recommended for city projects, and considered in the review process, but not required. It has been implemented in several places, including the “main street” redevelopment at the center of the city, and other projects funded through two TWDB grants.
Education Public awareness is developed through GSI signage, written materials, and other efforts	3	small scale in all or large scale in 2: public signage, webpage, manual, programs	Denton has placed signage on GSI projects with public access, collaborated on a field-course on rain gardens with A&M, and released some educational material and information and brochures online (although it is focused on watersheds in general, not GSI).
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	The city maintains a GSI inventory, and has completed multiple pilot projects that combined innovative BMPs with education on the issue.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	4	In addition to regional collaboration, the city has reached out to other cities with GSI advice	Founding member of Upper Trinity Conservation Trust. Participates in several regional programs for implementation of GSI, has conducted outreach and stakeholder meetings, coordinates planning, information sharing, regulatory updates and decision-making, as well as planning for more collaboration in the future.
TOTAL POINTS DENTON		19	

Houston

Summary

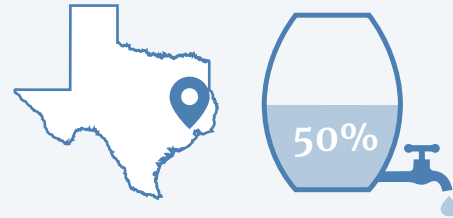
Houston, a city known for heavy rains and flooding, is beginning to embrace nature-based solutions to stormwater management. Recognizing the efficacy of nature-based techniques, the City considers GSI on all public projects, building some of the most frequently cited example projects in Texas. The Bagby Street retrofit added rain gardens and bioswales to the landscaping, creating an extensive greenstreet, while the 2015 Sims Bayou restoration project helped ensure Sims Bayou was the only Houston Bayou which did not flood during Hurricane Harvey.⁴

However, there are currently few formal incentives and regulations for private development in Houston. To truly push for GSI, the City needs to adopt more incentives, recognize the importance of monitoring and regulating water quality above and beyond the state's recommendations, and work more closely with regional partners. The Mayor's office recently completed a thorough study of green infrastructure, which resulted in a set of recommended incentives which "will be completed and formally adopted in the coming months in concert with stakeholders."⁵ If well implemented, these incentives could turn the city into a statewide leader.

Private Development

Houston's positive steps to allow developments to use nature-based infrastructure if they choose, but the City is just beginning to incentivise nature-based solutions over conventional ones. All new developments are required to detain stormwater onsite to prevent runoff, which mitigates flooding during the city's many storms. Water quality, however, is regulated under state law through the Municipal Separate Storm Sewer System (MS4) permits, which are part of an EPA program to help protect local waterways from stormwater pollution and provide good structure to local protection, but are often improved upon by individual municipalities. While nature-based features can be used to satisfy the detention requirement and water quality requirements, the only formal incentive

Score: 18/36



Population: 2,325,502¹

Average Annual Precipitation: 45.1 inches²

Average Rainy Days per Year: 106 days³

Major Water Features: Lake Houston, Galveston Bay, Buffalo Bayou, White Oak Bayou, Brays Bayou

Municipal Agency for Stormwater: Public Works and Engineering Department

Highlight

Considering nature-based features on all public projects is standard in Houston. The Bagby Street redevelopment and Buffalo Bayou park are prime examples.

Recommendation

The City of Houston recently proposed an aggressive set of nature-based infrastructure incentives. Implementing these incentives effectively could turn the City into a nature-based infrastructure hotspot in the state.

1 Houston Government: Demographic Data, 2019. Archived at <https://www.houstontx.gov/planning/Demographics/>

2 Climate Data: Climate Texas: Temperature, climate graph, & Climate Table, 2019 <https://en.climate-data.org/north-america/united-states-of-america/texas-929/>

3 US Climate Data: Houston- Texas and Weather, 2019. Archived at <https://www.usclimatedata.com/climate/houston/texas/united-states/ustx0617>

4 Christof Spieler, To fight flooding in Houston, we have to think big, November 2017. Archived at web.archive.org/save/https://www.houstonchronicle.com/local/gray-matters/article/To-fight-flooding-in-Houston-we-have-to-think-big-1236246

5 Mayor's Office Press Release. Mayor Announces Incentives for the Spread of "Green" Development, August 2019. Archived at <https://web.archive.org/web/20200128173359/http://www.houstontx.gov/igd/>



Houston's Buffalo Bayou is home to one of the City's many nature-based parks, which serve as green spaces and stormwater management.

to do so is a drainage fee discount. The Mayor's Office recently proposed a detailed incentive plan, which would improve Houston's score, but it has not yet been adopted.

Until the City releases more formal incentives, the City engineer's office should be commended for encouraging developers to adopt GSI throughout the permitting process. Their office also enforces a robust maintenance policy for all public and private projects that includes education on how to maintain nature-based features.

Public Projects

Houston has more public nature-based infrastructure projects than private ones. City projects, such as the Bagby Street greenstreet retrofit and the Sims Bayou Restoration Project, received statewide acclaim, and the City now considers nature-based solutions in every project. The City also has a robust educational program with multiple workshops, a detailed design manual, and signage on public projects. The city could do more to collaborate with regional partners outside of their MS4 permit, including coordinating large scale nature-based projects with Harris County.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites are required to detain stormwater so as to not increase runoff	All sites are required to detain stormwater to prevent increased runoff. GSI is allowed to meet detention requirements, which helps developers maximize their use of buildable land, but it is not officially encouraged over other methods.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	1	Water quality is regulated on some developments but not all	Under the MS4 permit jointly held by Houston, Harris County, and the Harris County Flood Control District, construction sites of 1 acre or larger must meet state water quality requirements, but the city has no additional requirements.
Maintenance Requirements Requirements to maintain installed GSI	4	In addition to enforcing maintenance requirements, the city has a maintenance education program	All GSI used to fulfill requirements must get an annual permit. The city holds maintenance education classes to assist developers.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	0	The permitting process favors GSI projects in multiple ways (increase size, faster process, advice from city)	None
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	2	There is at least one significant financial incentive (rebate, tax credit, etc.)	Sites with non-underlined GSI receive a drainage fee credit.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	3	GSI is considered for all public projects	GSI is used whenever possible in public projects.
Education Public awareness is developed through GSI signage, written materials, and other efforts	3	Small scale in all or large scale in 2: public signage, webpage, manual, programs	Multiple workshops, a robust design manual, and signage on public projects.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	Pilot projects are not used to inform current policy, but the city has recently completed a study that resulted in a forward-thinking incentive program still under review in early 2020.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	1	City has reached out to regional partners about protecting regional water quality	City is part of a joint MS4 permit, through which they collaborate on water quality, but does not collaborate on nature-based solutions, and could work more closely with Harris County.
TOTAL POINTS HOUSTON		18	

El Paso

Summary

Nature-based infrastructure is not yet formally a priority in El Paso's stormwater management toolkit; however, the City does have some pilot programs unique among the cities in this scorecard. Like other Texas cities, stormwater on commercial and industrial developments must be detained onsite, but unlike the rest of the state, El Paso's residential sites direct all runoff to neighborhood public ponding areas managed by the city. This allows El Paso Water to manage the water on public land, which is easier to maintain. Many of these ponding areas are built out as Park Ponds, where GSI is combined with public space to create neighborhood amenities.

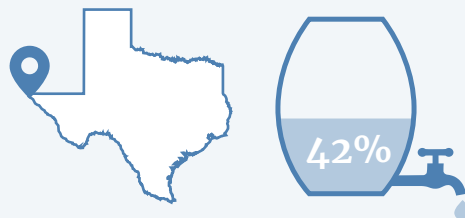
The city is currently working on updating their drainage manual, and could greatly increase their score by requiring GSI in landscaping features, or by regulating water quality.

Private Development

El Paso's stormwater detention requirements encourage the use of GSI on commercial and industrial sites and give the city the unique ability to treat all residential stormwater on public ponding locations. While not all sites have GSI, City staff recommend nature-based techniques to both private developers and for use in public stormwater ponds. Incentives for private developers are limited to (1) stacking GSI on green space requirements and (2) a stormwater fee discount for a 100% detention of a 100-year storm event which may or may not include nature-based features. GSI sites are maintained by the private or public entity that constructs it, and subject to fines if they do not comply, but there is no permit process.

El Paso does not regulate water quality except during construction. As a desert city prone to extreme floods after rare rainfalls, the city could do a lot to preserve water quality during these storms by requiring developments to meet a water quality standard.

Score: 15/36



Population: 682,669¹

Average Annual Precipitation: 8.71 inches²

Average Rainy Days per Year: 43 days³

Major Water Features: Rio Grande

Municipal Agency for Stormwater: El Paso Water, Planning and Inspections Department, Community and Human Development Department

Highlight

The desert climate of El Paso provides a different landscape formakes implementing nature-based features different than in other parts of the state. They have created some outstanding pilot programs, including one starting in March 2020 that will create a bioswale with a shade tree on streets where rainwater collects.

Recommendation

As the City of El Paso updates its drainage code this year, they should consider requiring nature-based infrastructure for meeting their water quality goals.

1 World Population Review, El Paso, Texas Population 2020, 2019. Archived at <http://web.archive.org/web/20190707074430/http://worldpopulationreview.com/us-cities/el-paso-population/>

2 Government Weather: El Paso Monthly Precipitation totals, 2019. Archived at https://www.weather.gov/epz/el_paso_monthly_precip

3 Sperling Best Places: El Paso, Texas Climate, 2019. Archived at https://www.bestplaces.net/climate/city/texas/el_paso



Rain garden outside El Paso Public Library's José Cisneros Cielo Vista Branch.

Public Projects

El Paso Water, the City's water and wastewater utility, always considers GSI for public projects, but other city departments currently do not. The city is working on re-writing its drainage manual, which is an opportunity to provide more incentives for GSI in landscaping features both city owned and private. The manual could formally endorse practices they are currently testing on a number of interesting pilot projects, including a major GSI-based restoration of a drainage channel into a public park, called the Playa Drain Trail, and GSI-based public drainage ponds, like the Thomas Manor

Park Pond. They are also considering a project starting in March 2020 to plant trees in biosales along roads known to pool rainwater in storms, which will provide shade, public green space, and water quality benefits.

With so many interesting and unique policies, El Paso should look to foster more regional collaborations to help spread their nature-based techniques to other Texas cities and gain valuable expertise, as well as more opportunities to highlight the water quality and stormwater management features of their pilot projects in their educational materials.

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	3	All sites are required to detain stormwater, GSI is recommended	Commercial and industrial sites are required to detain stormwater onsite. Residential sites direct stormwater to local ponding sites which are publicly maintained. GSI is recommended to meet requirements.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	0	All developments must meet a water quality standard	Water quality is regulated on sites during construction but not after.
Maintenance Requirements Requirements to maintain installed GSI	2	Maintenance is required, but enforcement is lacking	All private developments are required to maintain GSI features. There is no permitting process to insure compliance, but owners will face fines if features cause with City drainage.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	GSI features count towards both open space and detention requirements allowing developers to stack benefits.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	1	Small incentives exist but are not significant	Developments that retain 100% of the 100-year storm event get a 25% stormwater fee credit. GSI can be used towards that goal but is not required.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	2	Multiple public GSI projects across community	EP Water always considers adding GSI to public water projects, and many of the neighborhood ponding centers are build out as park ponds. Road and transportation projects try to include landscaping, but not always GSI.
Education Public awareness is developed through GSI signage, written materials, and other efforts	3	small scale in all or large scale in 2: public signage, webpage, manual, programs	GSI always includes signage. El Paso water promotes it on social media, through their Tech20 learning center, and through workshops hosted in collaboration with the parks and recreation department. They do not yet have GSI in their manual, and information is difficult to find online.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	El Paso plans to use software based monitoring on all GSI projects, and holds records for maintenance purposes. They have a database of Park Ponds but not other GSI features. Pilot projects include and innovative program to create bioswales in landscaping near roads on which water tends to collect.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	1	City has reached out to regional partners about protecting regional water quality	The City is part of a national network discussing GSI in cities (for which it is awarded one point), but is not part of any regional collaborations.
TOTAL POINTS EL PASO		15	

Farmers Branch

Summary

Farmers Branch, a small urban city in the Dallas-Fort Worth area, is beginning to incorporate nature-based infrastructure into the City's landscaping, but still can improve its stormwater policy. The City recently updated their drainage manual with new stormwater detention and water quality requirements, which provide a structure for nature-based solutions to be adopted, but the City should go further and create GSI incentives and/or requirements to help steer developers practices that have the most benefits for the community. They currently have a few in depth public pilot projects, but should look to expand that program and provide educational materials to accompany it.

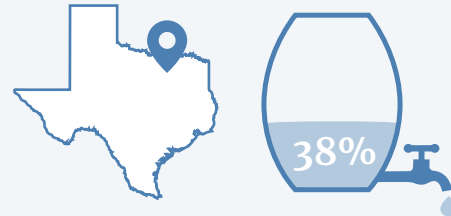
Private Development

When they updated the City Drainage Manual in September 2019, the City created a stormwater detention and water quality requirement, which allows for the use of green infrastructure. This is an important first step; however, the City has no private development requirement for GSI, and relies on the inherent benefits of nature-based infrastructure to provide incentives. Given the bias towards traditional infrastructure in the private sector, the City has a big opportunity to increase adoption of nature-based infrastructure by instituting further incentives.

Public Projects

The City has implemented a few public projects, such as the 2019 riparian "Grow Zone" along Rawhide Creek near the Farmers Branch Manske Library. These sites are well-monitored, allowing the City to gather the data necessary to build more projects in the next few years. While they have educational materials on water quality as required by their MS4 permit, none of those materials are focused on nature-based infrastructure or GSI.

Score: 14/36



Population: 40,209¹

Average Annual Precipitation: 38 inches²

Average Rainy Days per Year: 75 days³

Major Water Features: Trinity River, Lake Ray Roberts, Lake Grapevine

Municipal Agency for Stormwater: Sustainability & Public Health Department

Highlight

Farmers Branch recently updated their drainage manual to include stormwater detention and water quality requirements. This is an essential first step to promoting nature-based infrastructure.

Recommendation

The next step for cities like Farmers Branch, which recently adopted water quality and stormwater detention requirements, is to promote nature-based features through a formal education program and incentive program to help developers meet those requirements

¹ World Population Review: Farmers Branch, Texas Population 2020, 2019. Archived at <http://worldpopulationreview.com/us-cities/farmers-branch-tx-population/>

² Sperling's Best Places, ZIP 75234 (Farmers Branch) Climate, 2019. Archived at https://www.bestplaces.net/climate/zip-code/texas/farmers_branch/75234

³ Sperling's Best Places, ZIP 75234 (Farmers Branch) Climate, 2019. Archived at https://www.bestplaces.net/climate/zip-code/texas/farmers_branch/75234

POLICY	Points	Level	Rationale
PRIVATE DEVELOPMENT REGULATIONS			
Stormwater Detention Requirement Requirements to slow down stormwater leaving the developments	2	All sites must detain stormwater so as to not increase runoff	The City released a new drainage manual in September 2019, which requires stormwater detention and allows GSI as a technique to meet those requirements.
Water Quality Requirement Requirements to treat stormwater onsite for pollutant removal	2	All developments must meet a water quality standard	All developments must consider water quality, although requirements vary by location. If a meeting with the planning department is required, they may recommend GSI as a WQ measure.
Maintenance Requirements Requirements to maintain installed GSI	2	Maintenance is required, but enforcement is lacking	All sites must submit a maintenance plan. The City is considering requiring an annual renewal of permits but does not currently.
PRIVATE DEVELOPMENT INCENTIVES			
Regulatory Incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI	1	The permitting process has some incentive to employ GSI (increase size, faster process, advice from city)	The City allows GSI to overlap with landscaping features, but otherwise relies on the inherent benefits of nature-based techniques to provide inherent incentives.
Financial Incentives Rebates, tax credits, fee discounts or other forms of funding are provided for using GSI	1	Small incentives exist but are not significant	In determining impervious cover for calculating the commercial stormwater fee, GSI counts as pervious surface.
PUBLIC INITIATIVES			
Construction of Public Projects GSI features are included in public buildings, facilities, roads, and transportation services.	1	Some attempt at GSI in public spaces	The City has not official policy covering GSI in public projects, but does sometimes include it in the City's landscaping
Education Public awareness is developed through GSI signage, written materials, and other efforts	1	Small scale* in one or two categories: public signage, webpage, manual, programs	Conduct various public outreach and informational events as part of their Level 2 Phase II MS4 permit. The NCTCOG Stormwater Program provides education materials to the city as well. However, none of the material is focused on GSI.
Monitoring and Evaluation The City implements pilot projects, data collection initiatives, and monitors the success of GSI projects	2	The city does two of: conducting pilot projects, maintaining a GSI database, monitoring public GSI	The city has a few well monitored pilot projects. They do not currently maintain a GSI database, but are looking to in the near future.
Regional Collaboration Regional collaboration is key in ensuring the long lasting protection of watersheds	2	City has reached out to regional partners about GSI	Part of NCTCOG regional stormwater program, Trinity Common Vision Program, and TCEQ Sanitary Sewer Overflow Initiative. The City tries to share new landscaping techniques and educational materials, as well as learning from their partners: the newest drainage ordinance was based on one from Plano.
TOTAL POINTS FARMERS BRANCH	14		

Conclusion

Photo: Anna Farrell-Sherman



US-90 as it crosses the Pecos River Bridge outside of Del Rio, Texas.

Across Texas, it is clear that local governments are recognizing the power of nature-based infrastructure for stormwater management. Since the last publication of this scorecard in 2017, governments across the state have begun incorporating nature-based features into their public projects, adding additional incentives for private developers, and expanding their public education programs to teach Texans about the benefits of treating our stormwater naturally by letting it soak into the ground instead of forcing it to run over concrete roads gathering water pollution and flooding communities downstream.

Perhaps most exciting, staff from every department surveyed for this scorecard expressed their hope that their government can continue to expand support for nature-based features into the future. This shows how our work is paying off to make Texas's waterways cleaner and safer for everyone. It is our hope at

Environment Texas Research and Policy Center that this scorecard can help in that effort by providing a summary of the good work taking place across the state, providing inspiration and giving recommendations to help expand the benefits of nature-based features.

As Texas continues to grow, adding new Texans to our cities everyday, this type of policy will only become more important. Adding additional concrete to our cities will increase runoff, adding to the pollutant load in our rivers, increasing the likelihood of localized flooding, and removing greenspaces from our communities. By incorporating nature-based infrastructure, we can reverse that trend. Cities like Seattle and Singapore have shown the world that it is possible to bring green into even the densest urban areas. Let's show the world how Texas can do it even better.