TEXAS STORMWATER SCORECARD

Evaluating Municipal Policies for
Green Stormwater Infrastructure & Low Impact Development

Environment Texas Research & Policy Center

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Cover: HEB Children's Rain Garden, Zach Scott Theater, Austin
This page: Rain garden, Bagby Street, Houston

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Executive Summary

Rain is one of Texas's greatest resources, but it also causes some of our most serious problems. Too much produces flooding and erosion, too little produces droughts and aquifer depletion, and dirty runoff produces water pollution. These problems are becoming worse as more of the state's land is covered with buildings and roads that prevent rain from soaking into the ground where it falls. That's why more Texans are using building and landscaping features that can catch and cleanse rain where it falls. These features include rain gardens, green roofs, permeable pavement, and rain cisterns, and are known as Green Stormwater Infrastructure (GSI) and Low Impact Development (LID).

Stormwater has traditionally been viewed as an issue for flood management. The conventional approach has been to move runoff away from buildings and roads and into natural water bodies, and to do this as quickly as possible with concrete curbs, pipes, drains, and tunnels. Newer variations of this approach include detention features that can hold stormwater temporarily and release it slowly.

But water quality is becoming an additional priority for stormwater management because of urban runoff pollution. Gray infrastructure is being supplemented by green infrastructure, which uses plants, soil, and natural drainage processes to manage runoff on-site. These features can be very effective in reducing runoff pollution and flooding severity, as well as producing many other benefits. GSI/LID has started to appear in more places around Texas over the past decade, and the state's largest cities have begun creating policies to support its use. However, GSI/LID is still relatively rare in Texas, which means that our cities can do more.

For the Texas Stormwater Scorecard, Environment Texas evaluated GSI/LID policies in the state's five largest cities by a modified version of a policy checklist from the U.S. Environmental Protection Agency. Our checklist includes ten policies, divided into three categories:

Private Development Regulations
- *Flood detention requirement*
- *Water quality requirement*
- *GSI/LID regulatory credit*
- *Stormwater retention requirement*

Private Development Incentives
- *Regulatory incentives*
- *Financial incentives*
- *Stormwater fee discount*

Public Initiatives
- *Capital project construction*
- *Street construction*
- *Education*

The city scores in this report are based on information available from or provided by municipal officials, state agencies, community leaders, nonprofit organizations, environmental groups, and academic institutions from around Texas. We also gathered information from many professionals who have worked on GSI/LID projects, including engineers, landscape architects, and providers of GSI/LID equipment and services. While none of Texas's top cities achieved the highest possible score, the intent of this survey isn't to criticize them for what they haven't done, but to recommend what they could do next. Scores represent what percentage of the steps on our checklist have been implemented in each city.

Austin: 90%
The state's capital has long been known for its environmental policies, so its high score isn't surprising. But actual use of GSI/LID features in Austin is lower than the city's official support would lead one to expect. Many private-sector professionals also report that it can be difficult to get the city's approval for regulatory credit for GSI/LID installations. Austin should look for ways to improve its regulatory and financial incentives for GSI/LID, and to streamline its approval process.

San Antonio: 65%
While flooding is a less-pressing issue in our survey's driest city, water quality is a top concern. The San Antonio River Authority has provided financial and educational support for GSI/LID, and the city recently changed its development code to make it easier for developers to use GSI/LID. San Antonio could benefit by expanding its water quality and GSI/LID policies to cover the whole city.

Fort Worth: 60%
The city historically nicknamed Cowtown has been gradually embracing progressive urban policies. Fort Worth has higher flood mitigation and water quality requirements for developments in areas covered by form-based zoning codes. The Tarrant Regional Water District also has higher water quality requirements for developments along the Trinity River. As with San Antonio, Fort Worth could benefit by expanding these water quality and GSI/LID policies to cover the whole city.

Houston: 50%
Even before Hurricane Harvey devastated the city this year with unprecedented amounts of rain, Houston had been struggling to compensate for decades of development built with inadequate drainage. The Bayou City's longstanding preference for gray stormwater infrastructure has meant that it's been slow to support green infrastructure. Harris County, by contrast, has some of the most progressive GSI/LID policies in the state. Houston should consider following the county's lead.

Dallas: 40%
While Big D has some of the most prominent GSI/LID installations in the state, the city has few official policies to support green infrastructure. That may be remedied if Dallas adopts planned revisions to its drainage and paving manuals (last updated in 1993 and 1998, respectively). The city could also benefit by officially adopting the Integrated Stormwater Manual (iSWM) created by the North Central Texas Council of Governments.

We've tried to identify where each city can implement new policies, because we believe that increasing the use of GSI/LID is essential for Texas's future. Our cities are projected to grow even more in the coming decades, which will mean more buildings and more roads. By using green infrastructure, we can ensure that this new construction is built sustainably and for the long haul. GSI/LID isn't just good for the environment—it's good for Texas, too.

Runoff Problems, Runoff Solutions

A GROWING STATE

Over the past four decades, Texas's population has doubled to almost 28 million, and it's projected to double again during the next four decades. To accommodate all of these new Texans, more of the state's land has been covered with houses, buildings, roads, and parking lots. All of these structures are known as impervious cover, because they block rainwater from soaking into the ground. This in turn produces more runoff—and more of the problems caused by runoff.

While runoff rates on natural land can vary considerably depending on soil type and other conditions, some studies have found that 10 percent or less of the rain that falls on an undeveloped property will flow off-site as runoff. But when a property is developed for human uses, the amount of runoff will steadily increase as the amount of impervious cover increases. If a property has 50 percent impervious cover, for example, around 40 percent of its rainfall may turn into runoff. By way of reference, the most common zoning categories for single-family houses in Austin, Dallas, and Fort Worth allow up to 45 percent impervious cover. Even more runoff will be produced by larger multifamily, commercial, and institutional developments with higher percentages of impervious cover.

Flooding is the most obvious problem caused by stormwater, and more runoff makes flooding worse. That's because impervious cover doesn't just increase the *volume* of runoff—it also increases the *frequency* and shortens the *duration* of runoff. In general, only the biggest storms will produce runoff on an undeveloped piece of land, and even then, this runoff will be discharged slowly over a day or more. But on a developed site with impervious cover, smaller storms may produce runoff too, and runoff will flow off-site in a matter of hours. Faster discharge means faster stream-flow velocity, which leads to increased erosion of stream banks. In addition, the water level in streams and aquifers may drop since less rainwater is able to soak into the ground.

However, the more serious problem caused by increased runoff is water pollution. Though rain is clean when it falls, it becomes dirty when it flows over impervious surfaces such as roofs, roads, and parking lots. Runoff can pick up a range of pollutants from these surfaces, including roofing chemicals, automotive oil and fluids, litter, and debris. Even when runoff flows over pervious surfaces such as lawns and parks, it can pick up fertilizer and herbicide residue, as well as bacteria-laden animal waste from both pets and wildlife. Runoff then carries these pollutants into creeks, bayous, rivers, lakes, and bays.

Data collected by the Texas Commission on Environmental Quality (TCEQ) shows the harm that runoff pollution is causing to the state's waters. According to the agency, 1,500 miles of Texas streams are threatened or impaired because of urban runoff, as well as 4,000 acres of Texas lakes.

THE REGULATORY FRAMEWORK

In order to understand how runoff pollution came to be seen as a problem, it helps to understand how stormwater became a regulatory issue. Scientific research was already beginning to show the effects of runoff when Congress passed the Clean Water Act (CWA) in 1972. However, stormwater wasn't covered in the law, which focused on the regulation of *point source pollution*, primarily from municipal sewage systems and industrial facilities.

Congress amended the CWA in 1987 by passing the Water Quality Act (WQA), which addressed stormwater in two ways. First, the WQA expanded the scope of point source pollution regulation to include stormwater discharged from industrial facilities and from municipal separate storm sewer systems, known as MS4s. Second, the WQA addressed *nonpoint source pollution*, which comes from multiple sources and can't be attributed to a single one. Rather than regulating nonpoint source pollution, Congress decided to encourage voluntary remediation efforts by creating a program to fund demonstration projects, education, technical assistance, and other activities. (These funds are often referred to as Section 319 grants.)

The U.S. Environmental Protection Agency has issued several regulations over the years to implement these laws. In 1990, the EPA created National Pollutant Discharge Elimination System (NPDES) Phase I permits, which are issued to municipal separate storm sewer systems (MS4s) in cities of 100,000 or more people. And because construction work is one of the top causes of runoff pollution, the agency also required Phase I permits for construction sites that disturb 5 acres or more. In 1999. the EPA created NPDES Phase II permits to cover MS4s in cities of 50,000 or more, construction

sites of 1 acre or more, and state transportation departments.

Stormwater NPDES permits generally don't set numerical limits on pollutants. Instead, the permit holder is required to prepare a Stormwater Management Plan in order to reduce pollutants to the maximum extent possible. The EPA suggests that this be done by choosing from a menu of Best Management Practices (BMPs). The agency's BMP list includes a wide range of steps, from public education to site design and more.

However, many NPDES permits issued to MS4s end up including pollutant limits anyway, because the holder is required to meet Total Maximum Daily Load (TMDL) allocations for specific pollutants. Under Section 303(d) of the CWA, states must set water quality standards for all water bodies depending on their use—for example, drinking water or recreation. Water bodies that do not meet these standards are categorized as *impaired*. (Waters that barely meet standards are labeled as *threatened*.)

Once a water body is listed as impaired, the state sets a TMDL limit (called a waste load allocation) for each pollutant causing or contributing to the impairment. MS4 permit holders are required to develop implementation plans to comply with their local TMDLs. The pollutants most commonly targeted are bacteria, nitrogen, phosphorus, and suspended solids.

In Texas, the EPA's regulations are carried out by the TCEQ. The commission issues MS4 permits through the Texas Pollutant Discharge Elimination System (TPDES). The agency also updates the list of 303(d) impaired streams every two years, sets TMDL limits for specific pollutants, and requires local MS4 permit holders to create an implementation plan to meet these limits. Through the Texas Clean Rivers Program, the TCEQ contracts with regional water authorities to collect water quality data in the state's major river and coastal basins. Finally, the commission gives out Section 319 grants to fund voluntary remediation efforts to reduce nonpoint source pollution.

Rain cistern, New Hope Sakowitz Residence, Houston

Rain gardens, Elm Street, Dallas

THE EVOLUTION OF GSI/LID

Around the same time that the EPA began to regulate stormwater, some cities began to experiment with a new way of managing stormwater. In 1990, a developer in Prince George's County, Maryland, won approval to build rain gardens in a new subdivision instead of detention ponds. Larry Coffman, the county stormwater official who approved the change, went on to popularize the concept of what was initially called Low Impact Development (LID). As the use of LID spread across the U.S. and around the world, it took on other names. Green Stormwater Infrastructure (GSI) has become an increasingly common label, and is now the EPA's term of choice. (Because Texas cities use both names, GSI/LID is used in this report.)

Each GSI/LID feature functions differently, but what they all have in common is that they can catch rain where it falls, either for short-term detention or long-term retention. The following features are most commonly included under the GSI/LID label:

• ***Rain gardens*** are shallow depressions that allow runoff to temporarily pool and collect so that it can later soak into the ground, evaporate into the air, or be absorbed by plants. The same design can be used for shallow channel called ***bioswales***, which are usually used along the sides of roads and parking lots and in medians.

• ***Green roofs*** use plants (usually grasses) in a thin soil layer over a waterproof barrier, and manage smaller amounts of rainfall.

• ***Permeable pavement*** use either porous concrete, permeable asphalt, or paving bricks, and can soak up a significant amount of water when placed over a gravel bed. It is best used in low-traffic parking lots, alleys, and driveways.

• ***Rain harvesting systems*** use barrels, cisterns, or underground tanks to store water for later on-site needs such as landscape irrigation.

Other features can function as GSI/LID elements, though they generally provide less retention and less filtration:

• ***Vegetated filter strips*** are usually sloped bands of grasses placed next to parking lots or roads.

• ***Planter boxes*** can be designed as smaller and elevated versions of a rain garden.

• ***Biofiltration areas*** are generally larger and simpler versions of a rain garden.

• ***Detention basins*** can function as low-level GSI/LID features when covered with vegetation.

• ***Constructed wetlands*** must have a minimum level of water at all times to support aquatic vegetation.

Many GSI/LID features rely on soil and plants because the combination of the two can can both get rid of rainwater (by infiltration, absorption, and evaporation), and filter out pollutants from runoff. An engineered soil mix (usually containing sand and compost in at least a 2:1 ratio) is used to increase the rate at which water infiltrates into the soil. Plants are used because they absorb water and then release it by evaporation, and because their roots break up the soil and wick water downward, which can help facilitate infiltration. When local conditions make infiltration difficult or impossible, GSI/LID features can be designed with an underdrain connected to the storm sewer system so that runoff is still filtered, but not retained on-site.

GSI/LID represents a sharp change in stormwater management. The traditional approach has been to move runoff away from buildings and roads as quickly as possible, and to do this with concrete curbs, pipes, drains, and channels—sometimes referred to as gray stormwater infrastructure. (More recent variations of this approach also use detention features to hold water temporarily and release it slowly in order to reduce flooding severity.)

While both gray and green forms of infrastructure rely on nature for the ultimate disposal of stormwater, they differ in how many points of interaction they have with nature. Gray infrastructure collects runoff from many sites and then releases it into natural water bodies at a few locations. Because green infrastructure retains rain on-site, it releases water at more locations. The contrast between gray and green infrastructure can be thought of as the difference between collecting runoff from 1,000 homes and then discharging it into a stream at one location, versus collecting and managing runoff at each of those 1,000 home sites.

This difference means that gray and green infrastructures have very different impacts on the environment. Because gray infrastructure releases a much larger volume of water at each point of interaction with nature, it also releases a much larger volume of pollutants. Green infrastructure releases smaller amounts of runoff at more locations, which is why it's been referred to as decentralized stormwater management.

As GSI/LID features have become more popular, engineers, planners, and developers have worked to improve their functionality. This has meant experimenting with the soil mix used in rain gardens, bioswales, and bioretention ponds in order to boost infiltration rates. (Most mixes consist of at least two-thirds sand, with compost as the remainder, and sometimes a small percentage of clay.) It's meant realizing that native plants work best, because they're already adapted to local precipitation conditions and only require little or no long-term irrigation. It's meant developing forms of

Permeable pavement and bioswales, Mission Branch Library, San Antonio

Green roof, University Health System, San Antonio

permeable pavement that are both more durable and more pervious. And it's meant upgrading rain harvesting systems with larger-capacity cisterns and tanks, and adding plumbing that enables the stored water to be used for landscaping irrigation and on-site building needs (and, with the right filters, for drinking water).

Depending on local soil and climate conditions, GSI/LID features can be very effective in retaining rainwater on-site, especially when they're used in combination with each other. For example, a green roof may be designed with an underdrain that allows excess water to flow into a cistern, which in turn can discharge its overflow into a rain garden. Or a parking lot can be built with permeable pavement as well as curb cuts (or no curbs at all) that allow runoff to flow into adjacent bioswales.

GSI/LID features are the Swiss army knives of stormwater management, producing many benefits:
• ***Pollution reduction***: These features can be especially successful in improving water quality, since even the lowest-capacity features can generally capture and cleanse around one inch of rain, which is also generally the amount of the "first flush" of stormwater that picks up most of the pollutants that have accumulated on surfaces between rains.
• ***Flood mitigation***: These features generally can't trap enough runoff to prevent the worst flooding, such as 100-year floods. But they can usually retain enough water to reduce more frequent and smaller floods—the 2-, 5-, and 10-year floods.
• ***Erosion mitigation***: These features can reduce the speed of runoff as well as the volume, which reduces the scouring effect of stormwater on stream banks.
• ***Aquifer replenishment***: Because these features allow more rain to soak into the ground, they can help maintain water levels in aquifers.
• ***Beautification***: Since most features use plants, they double as landscape amenities. For example, green roofs and parking lot bioswales can introduce greenery where there otherwise would be none.
• ***Economic benefit***: Developers can often save money with GSI/LID, since using these features may allow them to reduce the size (and cost) of other stormwater infrastructure such as drainage pipes and detention ponds. This in turn may sometimes allow more of the property to be developed.

The biggest push for GSI/LID in recent years has come from the EPA, which stepped up its enforcement actions for Combined Sewer Overflows (CSOs) in 1994. These actions are aimed at sewage overflows in the approximately 880 U.S. cities that use a combined system to handle both wastewater and stormwater. Because increased runoff can produce increased overflows, cities have sought to reduce the amount of runoff that enters into their systems. Over the past decade, more cities have embraced GSI/LID as a way to accomplish this goal.

The most ambitious GSI/LID programs are in cities with combined sewer systems, including New York, Philadelphia, Chicago, Seattle, and other cities in the northern half of the U.S. However, a few southern cities have been spurred to adopt GSI/LID, including Atlanta, Nashville, and New Orleans. No Texas city has a combined wastewater-stormwater sewer system, which means that none face EPA pressure to use GSI/LID.

GSI/LID IN TEXAS

Partly because of the lack of regulatory pressure, Texas has lagged in the use of GSI/LID compared to the rest of the country. The state has also been slow to adopt GSI/LID because of resistance from developers who think that it will increase their project costs, and from engineers who believe that its effectiveness in Texas has yet to be proven.

Still, GSI/LID features have started to pop up in prominent spots across the state over the past two decades. The George W. Bush Library in Dallas uses captured rainwater for 50 percent of its landscape irrigation needs. Rain gardens have been included in the reconstruction of Bagby Street in Houston, Elm Street in Dallas, and Rosedale Street in Fort Worth. The UT/Dell Medical School in Austin, the Johnson Space Center outside Houston, and the Hipolito F. Garcia Federal Building in San Antonio have green roofs. Rain harvesting systems have been included at the New Hope Sakowitz residence in Houston and Mission Branch Library in San Antonio. And permeable pavement is becoming increasingly common in parking lots around the state.

Most of the early advocacy for GSI/LID in Texas came from organizations and institutions, with the most influential champion being the Lady Bird Johnson Wildflower Center. Not only does its Austin campus incorporate a range of GSI/LID features, the center also helped create SITES, the Sustainable Sites Initiative, in 2006. SITES is a certification program for sustainable design in landscaping that was modeled after the LEED certification program for energy conservation in buildings. The Wildflower Center developed SITES in conjunction with the U.S. Botanic Garden in Washington, D.C., and the American Society of Landscape Architects (ASLA). Both the SITES and LEED programs are now run by Green Building Certification Inc.

Quasi-governmental organizations have been some of the most important GSI/LID proponents in Texas have been. The Houston-Galveston Area Council (H-GAC) and the San Antonio River Authority (SARA) have both developed comprehensive LID manuals, while the North Central Texas Council of Governments (NCTCOG) has included LID in the water quality section of its Integrated Stormwater Manual (iSWM).

Crucial support has also come from several non-governmental groups. The Greater Edwards Aquifer Alliance (GEAA), a coalition of groups spanning from Austin to Del Rio, created its own LID manual. The Central Texas chapter of ASLA has supported GSI efforts in Austin. The Houston Land/Water Sustainability Forum, a group of engineers and other construction industry professionals, has played an important role because of the LID design competitions that it has helped organize around the state. (The forum's first contest in Houston led to the drafting of LID guidelines that were subsequently adopted by Harris County.) And faculty members at several colleges, including the University of Texas, Texas A&M University, Rice University, and Texas State University, have conducted important research on GSI/LID.

COMMON POLICIES

Despite this broad support for GSI/LID, Texas's cities have been slow to promote its use. For this report, we looked at the level of implementation of common GSI/LID–related policies in the state's five biggest cities: Austin, Dallas, Fort Worth, Houston, and San Antonio. We used a modified version of a policy checklist that the EPA published in *Green Infrastructure Case Studies*, a 2010 report. We broke down some of the EPA's steps into separate steps, and we also grouped them into three broad categories: policies that allow or require private developments to use GSI/LID; policies that incentivize private developments to use GSI/LID; and policies that support the use of GSI/LID by the city and the public.

Private Development Regulations

• Flood detention requirement
Many Texas cities have floodplain management rules that require the use of detention features to slow the flow rate of stormwater from a site. Several cities also have detailed drainage design requirements.

• Water quality requirement
The vast majority of Texas cities have yet to make water quality a priority for regulation, meaning that they do not require new developments to treat stormwater for pollutant removal. This is a necessary first step in promoting GSI/LID, since runoff pollution has to be recognized as a problem before a solution can be put in place. Regulations for

Permeable pavement and rain gardens, Bagby Street, Houston

both flood detention and water quality require that any stormwater detained on a property must be discharged within a short amount of time (for example, 24 hours for flood detention, or 72 hours for water quality). This is mandated both to ensure that the stormwater feature is available to handle rainfall from a later storm, and to prevent the accumulation of standing water.

• ***GSI/LID regulatory credit***
Some cities are allowing property owners to meet part of their water quality or flood detention requirements by using GSI/LID features.

• ***Stormwater retention requirement***
This requirement can be the biggest spur to use GSI/LID. Retention requirements can use a variety of performance measures. Some cities require that a minimum amount of stormwater be retained onsite: for example, 1 inch of rainfall from all storms, or 90 percent of all runoff. Another common standard is to require that the post-development peak runoff rate not be greater than the pre-development peak rate.

Private Development Incentives

• ***Regulatory incentives***
Inducements to private property owners to use GSI/LID are especially important in cities that don't require its use (which includes all Texas cities). Regulatory incentives can include zoning upgrades—such as density bonuses that allow a property owner to increase the size of a development in exchange for including GSI/LID features—or an expedited permitting process for developments that use GSI/LID.

• ***Financial incentives***
These inducements can take several forms, including rebates that cover part or all of the cost of installing GSI/LID features, or tax credits for their installation (for example, a property tax discount).

• ***Stormwater fee discount***
Reducing the stormwater fee for a property that incorporates GSI/LID features can be an especially effective inducement. All of the cities in our Scorecard have implemented a stormwater fee, possibly because it's been an attractive funding alternative in a tax-averse state. Funding from this source (sometimes referred to as a drainage utility) is generally used for improvements to a municipal drainage system. However, the fee itself can be a useful tool for stormwater management when it's calculated on either the amount or percentage of impervious cover on a property (which is the case with all of the cities in this report). This means that properties with more impervious cover are charged

Rain garden, Vic Mathias Auditorium Shores, Austin

more, since they're pouring more runoff into the city's stormwater infrastructure.

Public Initiatives

- ***Capital project construction***
- ***Street construction***

All of the cities on our Scorecard have begun to include GSI/LID features in the construction of municipal buildings and facilities, and in the reconstruction of individual streets.

- ***Education***

It's hard to overstate the importance of explanatory signage in a city's GSI/LID efforts. Rain gardens, bioswales, green roofs, permeable pavement, and rain harvesting systems are new or unknown features for much of the public. People may not even recognize one of these features when they see one, let alone know what it's supposed to do, which is why signage on GSI/LID installations is especially useful. These signs help passers-by realize that what they're seeing aren't just attractive design features, but functional ones too. More traditional forms of education, such as manuals, websites, and presentations, can help reinforce the public's understanding of the GSI/LID features they see in their city.

SCORING THE CITIES

City evaluations in this study are based on information available from or provided by more than 50 municipal agencies, other government entities, community leaders, academic institutions, and private-sector professionals. Scores represent the percentage of steps on the Scorecard checklist that have been implemented in each city.

Austin: 90%

The state's capital has long been known for its environmental policies, so its high score isn't surprising. But actual use of GSI/LID features in Austin is lower than the city's official support would lead one to expect. According to the city's statistics, all of the existing rain gardens, green roofs, permeable pavement, and rain cisterns in Austin handle the drainage for 188 acres. (Drainage for additional 3,410 acres is managed by various biolfiltration features and vegetated filter strips.) Some private-sector professionals also report that it can be difficult to get the city's approval for regulatory credit for GSI/LID installations. *Recommendations:* Austin should look for ways to promote its existing GSI/LID policies and programs, improve its regulatory and financial incentives, and streamline its approval process.

San Antonio: 65%
While flooding is a less-pressing issue in our survey's driest city, water quality is a top concern. The San Antonio River Authority has provided financial and educational support for GSI/LID, and the city recently changed its development code to make it easier for developers to use GSI/LID.
Recommendations: San Antonio could benefit by expanding its water quality and GSI/LID policies to cover more developments.

Fort Worth: 60%
The city historically nicknamed Cowtown has been gradually embracing progressive urban policies. Fort Worth has higher flood mitigation and water quality requirements for developments in form-based zoning areas. The Tarrant Regional Water District also has higher water quality requirements for developments along the Trinity River.
Recommendations: Fort Worth should likewise look at expanding its water quality and GSI/LID policies to cover more developments.

Houston: 50%
Even before Hurricane Harvey devastated the city this year with unprecedented amounts of rain, Houston had been struggling to compensate for decades of development built with inadequate drainage. The Bayou City's longstanding preference for gray stormwater infrastructure has meant that it's been slow to support green infrastructure. (Harris County, by contrast, has some of the most progressive GSI/LID policies in the state.)
Recommendations: Houston should consider creating regulatory and financial incentives, such as giving detention credit or stormwater fee discounts for GSI/LID use.

Dallas: 40%
While Big D has several GSI/LID installations in high-visibility locations, the city has few official policies to support green infrastructure. That may be remedied if Dallas adopts planned revisions to its drainage and paving manuals (last updated in 1993 and 1998, respectively). The city could also benefit by officially adopting the Integrated Stormwater Manual (iSWM) created by the North Central Texas Council of Governments.
Recommendations: Dallas should develop more attractive regulatory and financial incentives for GSI/LID use.

With this report, we've tried to identify where each city can implement new policies, because we believe that increasing the use of GSI/LID is essential for Texas's future. Our cities are projected to grow even more in the coming decades, which will mean more buildings and roads. By using green infrastructure, we can ensure that this new construction is built sustainably and for the long haul. GSI/LID isn't just good for the environment—it's good for Texas too.

Scoring Methodology

City evaluations in this study are based on information available from or provided by more than 50 municipal agencies, other government entities, community leaders, academic institutions, and private-sector professionals. Scores represent the percentage of steps on the Scorecard checklist that have been implemented in each city. Because few reports of this kind have been produced for GSI/LID, a number of judgment calls had to be made about which policies would receive credit in individual city evaluations, and which wouldn't. The key parameters for this report:

• Full credit (indicated by a score of 1.0 on the main chart, and by "yes" in the city charts) is given to policies or programs that are either mandatory, or applied in all possible instances. Partial credit (indicated by a score of 1.0 on the main chart, and by "partial" in the city charts) is given to policies or programs that are either optional, or applied in limited instances. For example, full credit would be given to a water quality standard that is required of all developments in a city, but partial credit would be given for one that is either voluntary or only applies to certain kinds of development or to developments in certain areas.

• City evaluations are for the most part limited to official city policies or programs. However, in some instances, partial credit is given if a non-municipal entity has GSI/LID policies that are in effect within a city. For example, the Tarrant Regional Water District has water quality regulations for development in the Trinity River floodplain that apply within the Fort Worth. Similarly, the San Antonio River Authority offers GSI/LID installation rebates that are available within that city. On the other hand, while Harris County has progressive GSI/LID policies, they do not apply within the city of Houston, and thus are not covered in Houston's evaluation.

• The water quality requirements that are part of a city's MS4 permit are generally not included in that city's evaluation, because these are external requirements imposed by the EPA and TCEQ as opposed to internal requirements adopted by the city itself. The latter receive higher priority in this report since the report focuses on what cities have chosen to do, rather than on what's been chosen for them. However, one exception was made for Houston, which jointly holds the local MS4 permit with Harris County and the Harris County Flood Control District. This permit requires construction sites to not only submit a stormwater pollution prevention plan for the construction phase (which is the norm for most MS4 permits), but for the post-construction phase too (which isn't the norm). However, because this requirement was adopted in conjunction with other entities, it only receives partial credit in Houston's evaluation.

TEXAS STORMWATER SCORECARD

Scoring key:
1.0 points—Policy or program is either mandatory or applied in all possible instances
0.5 points—Policy or program is either optional or applied in limited instances

POLICY	AUSTIN	DALLAS	FORT WORTH	HOUSTON	SAN ANTONIO
PRIVATE DEVELOPMENT REGULATIONS					
Flood detention requirement An amount of stormwater must be detained on-site for flood control	1.0	1.0	1.0	1.0	1.0
Water quality requirement An amount of stormwater must be treated on-site for pollutant removal	1.0		0.5	0.5	0.5
GSI/LID regulatory credit GSI/LID features can be used to meet water quality and/or flood detention requirements	1.0		0.5	0.5	0.5
Stormwater retention requirement An amount of stormwater must be retained on-site	0.5				
PRIVATE DEVELOPMENT INCENTIVES					
Regulatory incentives Zoning upgrades, expedited permitting, or other incentives are provided for using GSI/LID	0.5		0.5	0.5	0.5
Financial incentives Rebates, tax credits, or other forms of funding are provided for using GSI/LID	1.0				0.5
Stormwater fee discount Fee is reduced for for developments using GSI/LID features	1.0	0.5	0.5		0.5
PUBLIC INITIATIVES					
Capital project construction GSI/LID features are included in the construction of public buildings and facilities	1.0	1.0	1.0	1.0	1.0
Street construction GSI/LID features are included in the construction of streets and transportation elements	1.0	1.0	1.0	1.0	1.0
Education Public awareness is developed through GSI/LID signage, written materials, and other efforts	1.0	0.5	1.0	0.5	1.0
TOTAL POINTS	9	4	6	5	6.5
PERCENTAGE SCORE	**90%**	**40%**	**60%**	**50%**	**65%**

Austin

Population: 947,890
Average annual precipitation: 34.3 inches
Major water features: Lady Bird Lake, Barton Creek
Main municipal stormwater agency: Watershed Protection Department
Main non-municipal GSI/LID advocate: Lady Bird Johnson Wildflower Center

Community groups have been largely responsible for creating the political will to protect Austin's water quality. Local activists first called for limits on development in the recharge zone for Barton Springs, a popular swimming spot, and later for the entire city. After a series of regulations for specific watersheds, Austin enacted the Comprehensive Watershed Ordinance in 1986. Voters approved the sweeping Save Our Springs Ordinance in 1992 by a two-to-one margin. The city adopted a revised Watershed Protection Ordinance in 2011.

The Watershed Protection Department (WPD), originally called the Drainage Utility, was created in 1991 and charged with monitoring natural water quality throughout the city, as well as managing the city's stormwater sewer system. WPD has regulated the construction of thousands of stormwater control features of varying sizes throughout the city. Because Austin started to tackle stormwater management before the popularization of GSI/LID, it was on a different evolutionary track that led the city to develop a relatively unique preference for sedimentation-filtration systems. Also known as sand filters, these are essentially detention ponds with added pollutant filtration capability.

PRIVATE DEVELOPMENT REGULATIONS

Flood detention requirement: YES
Peak flow rates for 2-, 5-, 10-, and 100-year-frequency storms cannot create increased inundation of any building or roadway surface, or create any additional adverse flooding impacts.
Water quality requirement: YES
Water quality controls must be used to capture and treat the first 0.5 inch of runoff, plus an additional 0.1 inch for each 10% increase in impervious cover over 20%. The water quality control must provide at least the same treatment level as a sedimentation-filtration system (a sand filter). Captured runoff must be infiltrated or discharged within 48 to 72 hours in most cases.
GSI/LID regulatory credit: YES
Several types of GSI/LID features may be used as water quality controls. In addition, projects may propose additional innovative runoff management practices that meet the treatment standard required by the city's development code. GSI/LID features can achieve partial credit for flood detention volumes by stacking flood flows on top of the water quality volume, and demonstrating available capacity due to drawdown during a storm event. In Transit-Oriented Development (TOD) Districts, a minimum of 75% of the required water quality volume must be treated with green water quality controls.
Stormwater retention requirement: PARTIAL
Commercial developments must direct stormwater runoff to 50% of required landscaping.

PRIVATE DEVELOPMENT INCENTIVES

Regulatory incentives: PARTIAL
One Austin Energy Green Building point is available for managing 25-50% of water quality volume using infiltration, depending on the site's impervious cover. Sites can gain 10 positive points by providing green water quality controls for alternative compliance with landscaping requirements. Through a density bonus program, property owners in the Downtown area may be able to increase the size of a development by using green roofs.
Financial incentives: YES
Rebates through the WaterWise program can cover up to 50% of the equipment cost for rain harvesting systems, and up to $500 of the cost for other GSI/LID features.
Stormwater fee discount: YES

Fee is reduced for property owners who install GSI/LID features above and beyond what is required. Discount is based on the amount of volume retained.

PUBLIC INITIATIVES

Capital project construction: YES

GSI/LID features have been included in projects including Twin Oaks Library. A Council resolution directs the city to look for opportunities to include GSI/LID features in the construction of new buildings and facilities.

Street construction: YES

GSI/LID features have been included in the reconstruction of some streets, including Todd Lane. The Complete Streets Policy directs the city to "seek opportunities to integrate" Green Streets principles, including GSI/LID.

Education: YES

Explanatory signage is included on some but not all city GSI/LID installations. The city has produced numerous guides and other educational materials.

Dallas

Population: 1,317,929
Average annual precipitation: 37.6 inches
Major water features: Trinity River, Lake Ray Hubbard
Main municipal stormwater agency: Trinity Stormwater Management
Main non-municipal GSI/LID advocate: North Central Texas Council of Governments

The state of stormwater management in Dallas is perhaps best symbolized by the fact that it last revised its Drainage Manual in 1993. The city is currently updating the Drainage Manual as well as the Paving Manual (last revised in 1998), and though both will include GSI/LID provisions, the revisions have yet to be adopted. The city also hasn't adopted the Integrated Stormwater Management (iSWM) Manual produced by the North Central Texas Council of Governments (NCTCOG). NCTCOG first developed the iSWM Manual in 2006 to help its member cities and counties meet their MS4 permit requirements with policies for flood mitigation, streambank protection, and water quality. Dallas does allow developers to voluntarily use the draft iSWM Manual. One bright spot in Dallas: the city has rebuilt or plans to rebuild several thoroughfares as "green streets" that incorporate GSI/LID features, including lower Greenville Avenue and Elm Street in the popular Deep Ellum neighborhood.

PRIVATE DEVELOPMENT REGULATIONS

Flood detention requirement: YES

Stormwater detention is required when developments are in escarpment areas, when downstream facilities do not have sufficient capacity, when increased zoning results in a significant increase in runoff, or when downstream cities have their own detention requirements.

Water quality requirement: NO

The city encourages but does not require the implementation of "stormwater friendly" design measures to improve water quality as a part of a site's drainage design.

GSI/LID regulatory credit: NO

The city is reviewing but has yet to adopt a revision of its drainage design criteria that would include GSI/LID features as a part of its water storage (flood detention) requirements.

Stormwater retention requirement: NO

PRIVATE DEVELOPMENT INCENTIVES

Regulatory incentives: NO

Financial incentives: NO

Stormwater fee discount: PARTIAL

The fee is reduced to the next lower tier for residential customers who address at least 1,000 gallons of stormwater with at least 1,000 square feet of pervious paving.

PUBLIC INITIATIVES

Capital project construction: YES

GSI/LID features have been included in Moneygram Soccer Park, the first city facility designed to meet draft NCTCOG's iSWM water quality criteria, as well as in several fire stations and libraries.

Street construction: YES

GSI/LID features have been included in the reconstruction of Elm Street, South Lamar Street, and Riverside Drive. As part of the city's Complete Streets program, GSI/LID features are included in 22 street projects currently in the planning and design stages.

Education: PARTIAL

The city has produced some stormwater educational materials.

Fort Worth

Population: 854,113

Average annual precipitation: 36.5 inches

Major water features: Trinity River, Lake Worth

Main municipal stormwater agency: Stormwater Management Division

Main non-municipal GSI/LID advocates: North Central Texas Council of Governments, Tarrant Regional Water District

In contrast to its neighbor to the east, Fort Worth has adopted NCTCOG's iSWM Manual. Design for streambank protection, flood mitigation, and stormwater conveyance is mandatory; design for water quality protection is encouraged, but not required. The city has updated its iSWM Manual several times based on feedback from stakeholders and developers. A new ten-year master plan is currently being prepared for the city's Stormwater Management Division. GSI/LID features have been included in several developments, including Tarrant Community College–South Campus and the award-winning stream restoration project at Bluestem Park.

PRIVATE DEVELOPMENT REGULATIONS

Flood detention requirement: YES

Drainage requirement adheres to criteria of no adverse impact and adequate outfall.

Water quality requirement: PARTIAL

The city encourages, but does not require, developers to use iSWM's water quality practices. The treatment criteria is 85 percent of a 24-hour rainfall, which is equivalent to 1.5 inches (first-flush treatment). Tarrant Regional Water District, which has jurisdiction of the Trinity River floodplain, requires water quality treatment for direct discharges into the river.

GSI/LID regulatory credit: PARTIAL

GSI/LID features can meet some or all of a development's detention requirements.

Stormwater retention requirement: NO

PRIVATE DEVELOPMENT INCENTIVES:

Regulatory incentives: PARTIAL

Form-based code is used to to incentivize flood detention and water quality mitigation with height incentives when compatible with zoning.

Financial incentives: NO

Stormwater fee discount: PARTIAL

Fee credits are given to non-residential properties that include water quality measures.

PUBLIC INITIATIVES:

Capital project construction: YES

GSI/LID features have been included in projects including the Bolen Police and Fire Training Center and the Northside Service Center, as well as in stream restoration at Sandy Lane Park.

Street construction: YES

GSI/LID features have been included in the reconstruction of some thoroughfares, including Rosedale Street. GSI/LID design guidance has been incorporated into the Major Thoroughfare Plan.

Education: YES

The city has a program to promote rainwater harvesting through discounted water barrel purchases, and stormwater educational inserts are included in water bills. The city makes the iSWM Manual available to developers and engineers. Fort Worth Independent School District has adopted a stormwater curriculum.

Houston

Population: 2,303,482
Average annual precipitation: 54.6 inches
Major water features: Buffalo Bayou, White Oak Bayou, Brays Bayou
Main municipal stormwater agency: Public Works and Engineering Department
Main non-municipal GSI/LID advocates: Harris County Engineering Department, Houston-Galveston Area Council

As a coastal city repeatedly hit by hurricanes, the top stormwater issue in Houston has always been flooding. Yet for decades, property owners weren't required to do anything to mitigate flooding, and were even allowed in many instances to build in floodplains. That changed in 1986, when the city began requiring new developments to provide on-site detention.

Water quality has been slower to develop as a concern in Houston, but that's slowly changing as the city rediscovers its bayous. The reconstruction of the downtown stretch of Buffalo Bayou, and the series of trails being built through the Bayou Greenways program, have been popular, and as a result, some Houstonians have started to work to improve the quality of the stormwater that drains into these bayous.

While several local entities have been strong proponents for GSI/LID, so far they've only been able to affect policy in Harris County, which in 2010 adopted a LID design criteria manual for private property developments. Most significantly, the manual provides for a reduction in required on-site detention features when a development uses GSI/LID. However, the county's manual doesn't apply within the city of Houston, which has no equivalent regulation.

PRIVATE DEVELOPMENT REGULATIONS:

Flood detention requirement: YES

Detention volume increases linearly with the change in a property's imperviousness. New development or redevelopment cannot alter existing overland flow patterns and cannot increase or redirect existing sheet flow to adjacent property. If the property is fully or partially within a floodplain, the detention requirement is not based on the increase of impervious cover, on the equal amount of displacement in the floodplain area.

Water quality requirement: PARTIAL

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 submit a post-construction stormwater pollution prevention plan in addition to a construction-phase plan.

GSI/LID regulatory credit: PARTIAL

Some GSI/LID features can be used to meet a property's flood detention and water quality requirements.

Stormwater retention requirement: NO

PRIVATE DEVELOPMENT INCENTIVES:

Regulatory incentives: PARTIAL

The city engineer's office provides GSI/LID advice to building permit applicants on a case-by-case basis.

Financial incentives: NO

Stormwater fee discount: NO

PUBLIC INITIATIVES:

Capital project construction: YES

GSI/LID features have been included in projects including the Houston Permitting Center and the Kendall Neighborhood Library.

Street construction: YES

GSI/LID features have been included in the reconstruction of Bagby Street and Almeda Streets (both funded by Tax Increment Reinvestment Zones, or TIRZs), and on Darling Street in the Cottage Grove neighborhood.

Education: PARTIAL

The city has some educational efforts, including GSI/LID signage, as well as some manuals and guides.

San Antonio

Population: 1,492,510

Average annual precipitation: 32.3 inches

Major water features: San Antonio River

Main municipal stormwater agency: Transportation & Capital Improvements Department

Main non-municipal GSI/LID advocate: San Antonio River Authority

San Antonio has long relied on wells drilled into the Edwards Aquifer for its drinking water, which is why concerns about the state of the aquifer have driven local water quality concerns. In 1975 the Alamo City implemented a zoning overlay for the aquifer's recharge zone, then followed up in 1987 with a plan for non-degradation of the aquifer, and in 1994 adopted a comprehensive regional plan to protect water quality in the Edwards in 1994. Responsibility for local water quality has been split among the the San Antonio Water System (SAWS) and the San Antonio River Authority (SARA). SAWS has diversified the city's drinking water supply by tapping into lakes and smaller aquifers, while SARA has prioritized measures to reduce stormwater pollution in the San Antonio River watershed.

PRIVATE DEVELOPMENT REGULATIONS

Flood detention requirement: YES

The peak runoff rate from a new development must be less than or equal to the site's predevelopment peak rates for 5-, 25-, and 100-year storm events. Developers are allowed to pay a fee-in-lieu to the Regional Storm Water Management Program (RSWMP), which is the city's preferred alternative to site-specific stormwater mitigation. However, detention ponds are mandatory in some areas, including the Upper San Antonio River, Leon Creek, and Mitchell Lake watersheds.

Water quality requirement: PARTIAL

Developers wanting to take advantage of the incentives available through the city's voluntary Low Impact Development and Natural Channel Design Protocol (LID/NCDP) must manage 60% of water quality volume, defined as the runoff resulting from the first 1.5 inches of rain falling in 24 hours. Compliance requires removal of 80% of total suspended solids and 60% of bacteria. Developments in the city's River Improvement Overlay (RIO) districts that are adjacent to the San Antonio River must either discharge runoff through drainage features below water level, or through an approved GSI/LID feature.

GSI/LID regulatory credit: PARTIAL

GSI/LID features may be considered as on-site detention features if they reduce the amount of runoff expected downstream.

Stormwater retention requirement: NO

PRIVATE DEVELOPMENT INCENTIVES:

Regulatory incentives: PARTIAL

Developments that meet the voluntary LID/NCDP water quality criteria can receive credit and offsets towards stream protection, parkland, and criteria, and tree preservation, as well as a density bonus allowing a 10% increase in density. IN addition, permeable pavement does not count as impervious cover if it is designed to store stormwater from a two-year, 24-hour event.

Financial incentives: PARTIAL

LID/NCDP developments can receive discounts on fees-in-lieu paid into the RSWMP. In addition, SARA offers GSI/LID installation rebates.

Stormwater fee discount: PARTIAL

LID/NCDP developments can receive discounts on stormwater fees.

PUBLIC INITIATIVES:

Capital project construction: YES

GSI/LID features have been included in projects including Mission Branch Library.

Street construction: YES

GSI/LID features have been included in projects including Ray Ellison Road.

Education: YES

SARA offers annual trainings and certification and registration courses.