Mitigation Localized Flooding - Development of a Green Infrastructure Master Plan in the Lower Rio Grande Valley

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Stormwater Runoff

- Urban stormwater runoff is a primary source of water quality impairment in receiving streams and water bodies.
- It is discharged into surface water untreated carrying numerous pollutants causing decline in aquatic biota and degradation of water quality.
- Typical pollutants in stormwater runoff are generally categorized as:

Pollutant	Source
TSS (Total Suspended solids)	Erosion of soil surfaces and dust deposition
Nutrients	Plant fertilizers, detergent and animal waste
Pesticides	control weeds and insects
Organic Compounds	use of petroleum products
Heavy metal (Pb, Cu, Zn, Cd and Ni)	associated with transportation
Pathogenic microorganisms	feces of domestic animals and wildlife or human

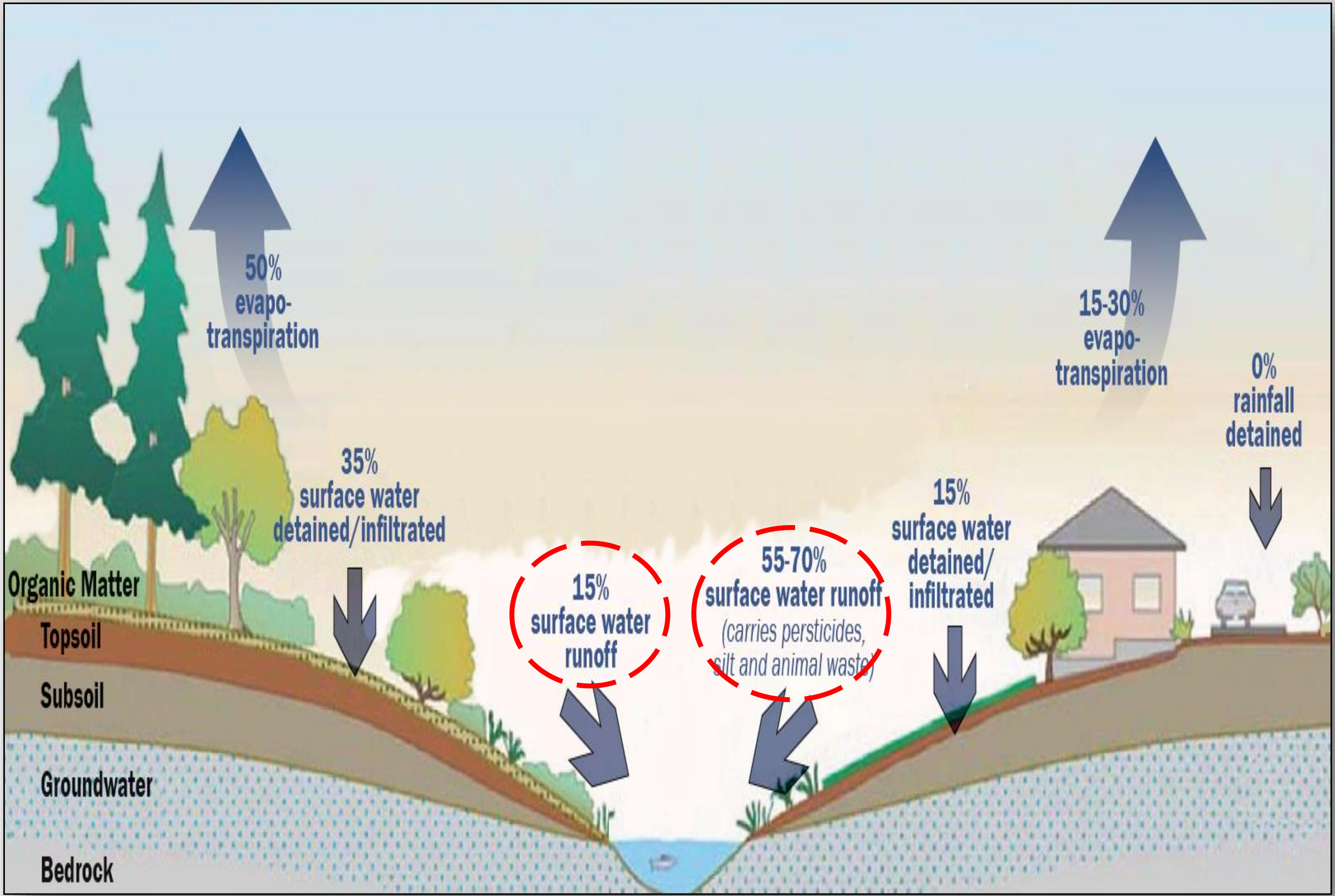
Gray Infrastructure

- **Gray stormwater infrastructure**—conventional piped drainage and water treatment systems—is designed to move urban stormwater away from the built environment,

http://niepe.com.au/wp-content/uploads/2017/06/Headwall-Photo-2-resized-1000x663.jpg

Green Infrastructure (GI)

- Is an ecologically-based storm-water management approach favoring soft engineering to manage rain fall on the site through vegetated treatment network.
- The goal is to reduce or eliminate the contaminants collected by stormwater as it moves into streams and rivers.
- **Green Infrastructure (GI)** attempts to includes as much green space as possible in urban planning and aims to maximize the benefit from these green spaces.
- GI are an integral component of sustainable communities, help communities protect the environment through minimize pollutant production and water recycling .



Showing the difference in the surface water runoff between pervious (15%) and impervious surface (55-70% carrying pollutants) that drain in the surface water bodies

- http://www.kirklandwa.gov/Assets/!Global+PDFs/LID+Residential+Stormwater.pdf

Wetland (Weslaco, LRGV TX)

Bio-swale, (Brownsville, LRGV TX)

Rain Harvesting system (Weslaco, TX)

Green Infrastructure (GI) in LRGV

Bioretention (McAllen, LRGV TX)

Green Roof (San Juan, LRGV TX)

Permeable Pavement (La Feria, LRGV TX)

Permeable Pavements

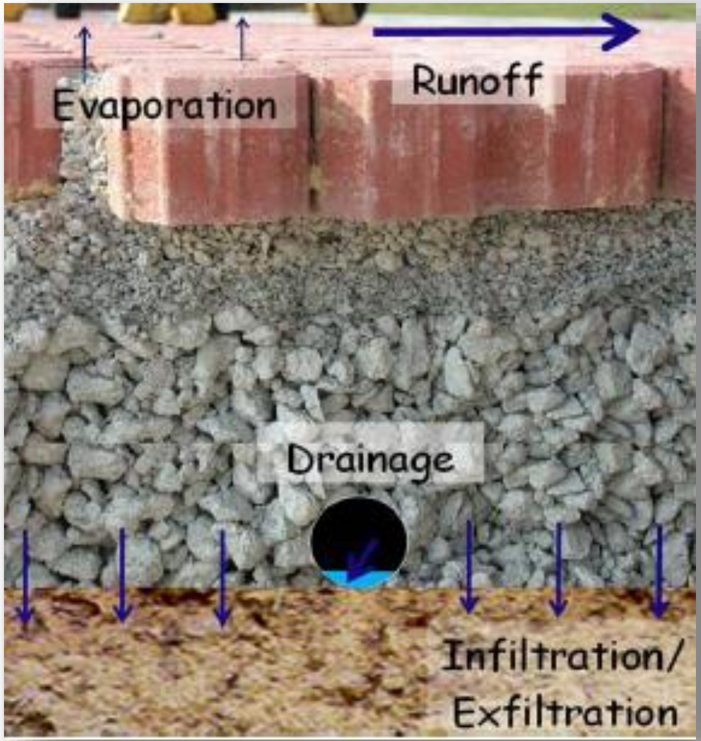
- Permeable pavement systems were developed for infiltration of surface runoff by passing through porous surface, allowing capturing and recycling of storm water on site.
- Effective reducing runoff besides removing various nutrients and pollutants loads associated to the streams in compared to impervious surfaces as asphalt to including :

  Total Kjeldhal Nitrogen (TKN),

  Total suspended solids,

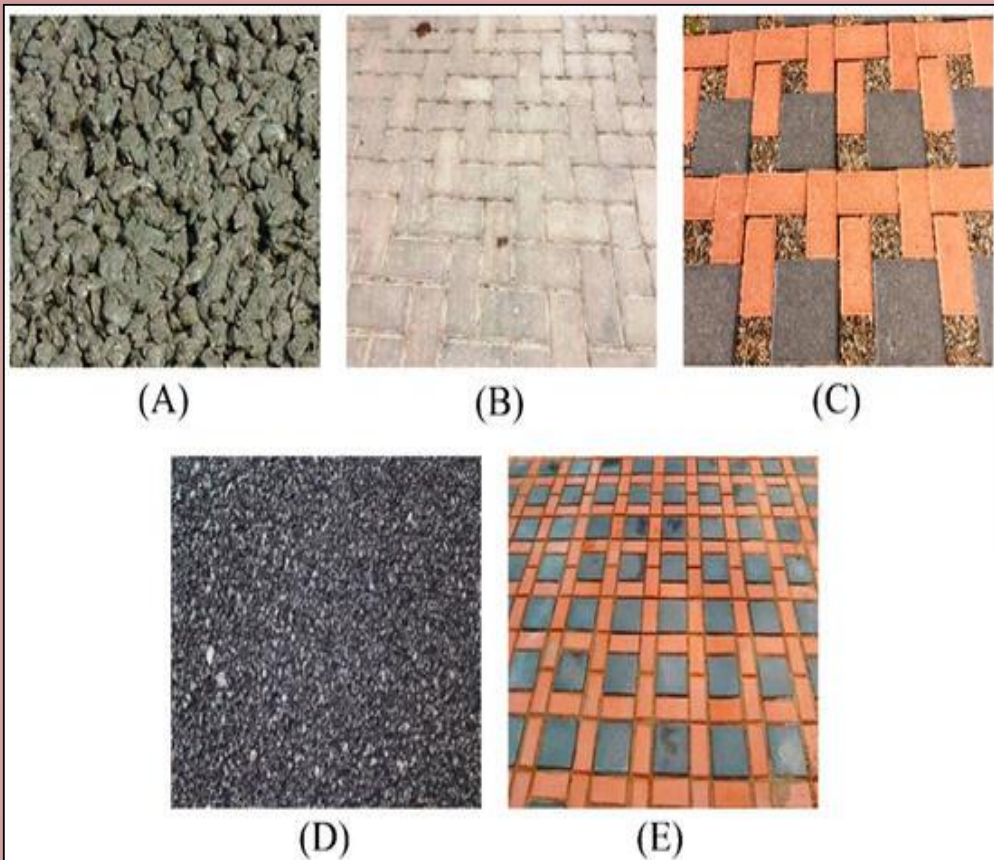
  Total phosphorus,

  Heavy metals.

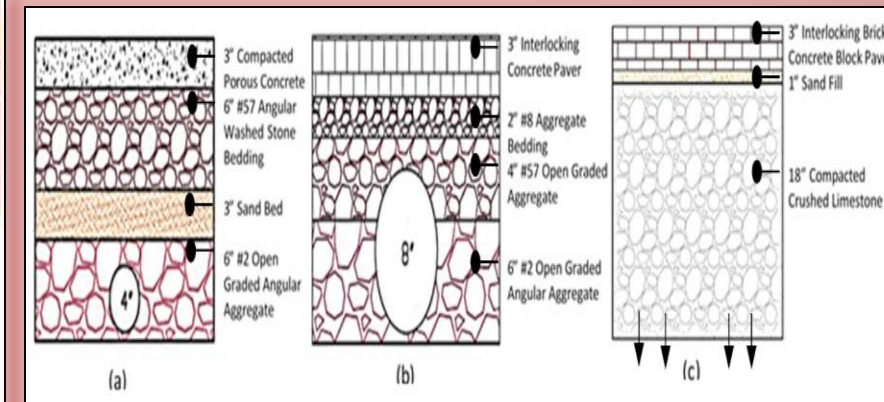


http://www.bae.ncsu.edu/stormwater/PublicationFiles/PermPave2008.pdf

Permeable Pavements



Surface of monitored pavements in different LRGV parking lots- (a) Monte Bella Park- PCP (b) Cameron County Drainage District #1 - PICP, and (c) La Feria Recreational Center – IBPG, (d) Monte Bella Park - TAP , and (e) La Feria Recreational Center – TBP



Cross section (as built) of three types of monitored permeable pavement installations in LRGV parking lots- (a) COB - PCP (b) CCDD#1- PICP, and (c) COLF-IBPG

water

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Open Access Article

A Comparison of Three Types of Permeable Pavements for Urban Runoff Mitigation in the Semi-Arid South Texas, U.S.A

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Abstract

This study examines the hydrologic and environmental performance of three types of permeable pavement designs: Porous Concrete Pavement (PCP), Permeable Interlocking Concrete (PICP), and Interlocking Block Pavement with Gravel (IBPG) in the semi-arid South Texas. Outflow rate, storage, Normalized Volume Reduction (NVR), Normalized Load Reductions (NLR) of Total Suspended Solids (TSS), and Biochemical Oxygen Demand (BOD_5) were compared to results obtained from adjacent traditional pavements at different regional parking lots. A notable percentage of peak flow attenuation of approximately 31–100% was observed when permeable pavements were constructed and implemented. IBPG was capable to hold runoff from rainfall depths up to 136 mm prior to flooding. PCP was the most satisfactory in reducing surface runoff (NVR: $2.81 \times 10^{-3} \pm 0.67 \times 10^{-3}$ $m^3/m^2/mm$), which was significantly ($p < 0.05$) higher (98%) than the traditional pavement. PCP was also very effective in TSS removal (NLR: $244 \times 10^{-5} \pm 143 \times 10^{-5}$ $kg/m^2/mm$), which was an increase of over 80% removal than traditional pavement. IBPG (NLR: $7.14 \times 10^{-5} \pm 7.19 \times 10^{-5}$ $kg/m^2/mm$) showed a significantly ($p < 0.05$) higher (46%) BOD_5 removal over traditional pavement. These results demonstrate that the type of permeable pavement and the underlying media can significantly influence the runoff reduction and infiltration in this climatic region. View Full-Text

Keywords: urban runoff; water quality; Low Impact Development (LID); permeable pavement; stormwater management

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Permeable Pavements

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New Orleans mandates permeable pavement to control stormwater runoff

David Wagman | September 12, 2019

Permeable paving allows stormwater to drain into the soil rather than flow into drainage systems. Source: Wikipedia

New surface parking areas in New Orleans will need to be built using water-permeable materials as a result of a new ordinance passed by council members in early September.

The ordinance is intended to reduce stormwater runoff into Lake Ponchartrain and mitigate soil subsidence in the city. During heavy rainstorms the city's drainage system can become overwhelmed and result in local flooding. Porous surfaces will allow rain water to soak into the ground where it falls.

Under the new ordinance, concrete bases and mortar are prohibited from new parking areas. Permitted materials include pervious concrete, porous asphalt, aggregate if stabilized with a grid system that prevents compaction and washout and permeable pavement such as open-jointed blocks, pavers or bricks.

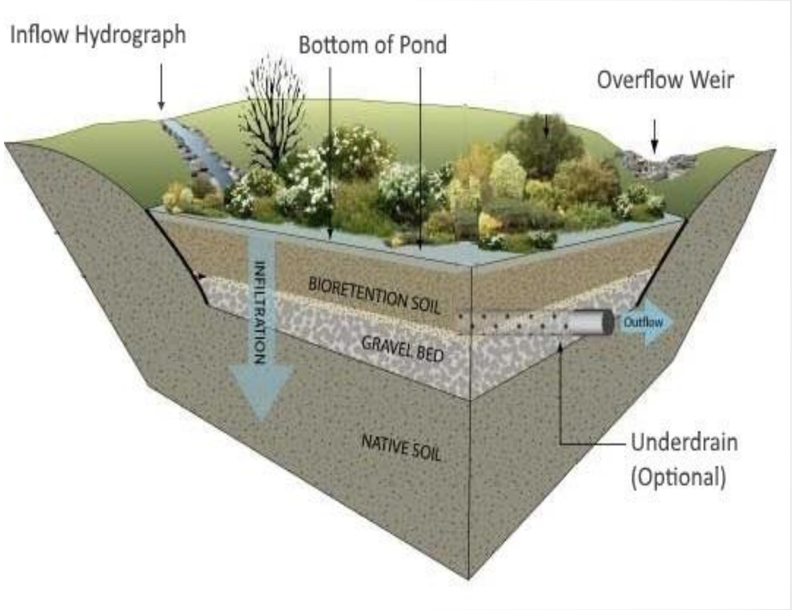
Once in place, the paving is subject to water infiltration testing based on ASTM International C1701 or C1781 standards. Pavement must maintain a minimum infiltration rate of 200 in per hour, the ordinance said.

The ordinance also requires new paving installations to have a minimum aggregate subbase of 24 in, measured from the base of the permeable pavement system.

More broadly, the City of New Orleans was awarded $141 million through the U.S. Department of Housing

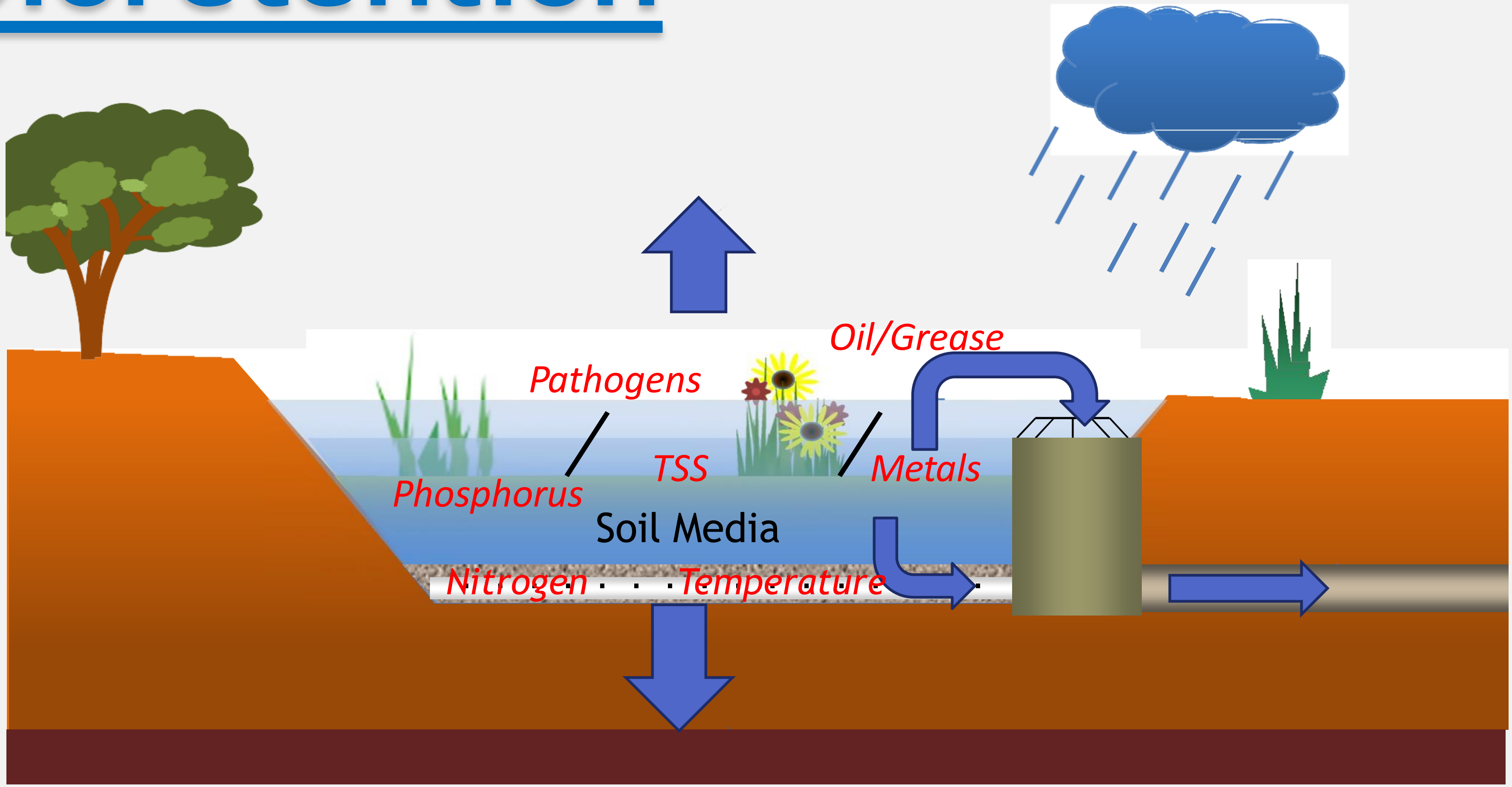
Bioretention

- Bioretention is an infiltration practice through porous media; that uses a biologically active filtration bed to remove contaminants.
- One of the most commonly used GI practices.
- Significant reduction of runoff volume provided by the bioretention cells with water quality improvement by substantially reducing the various pollutants.



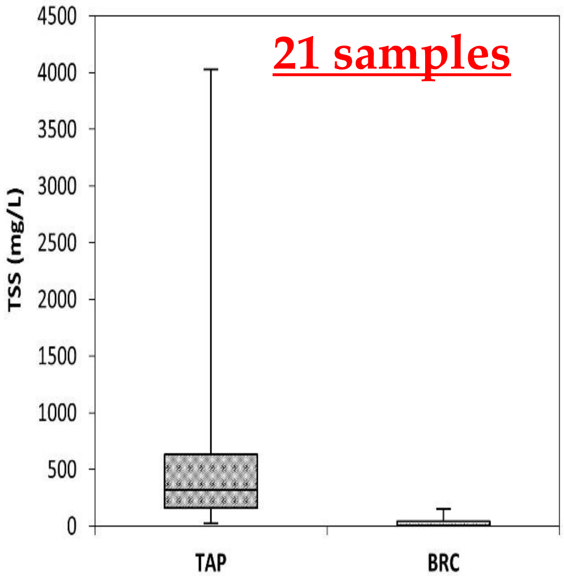
https://www.hydrologystudio.com/help/bioretention-ponds.htm

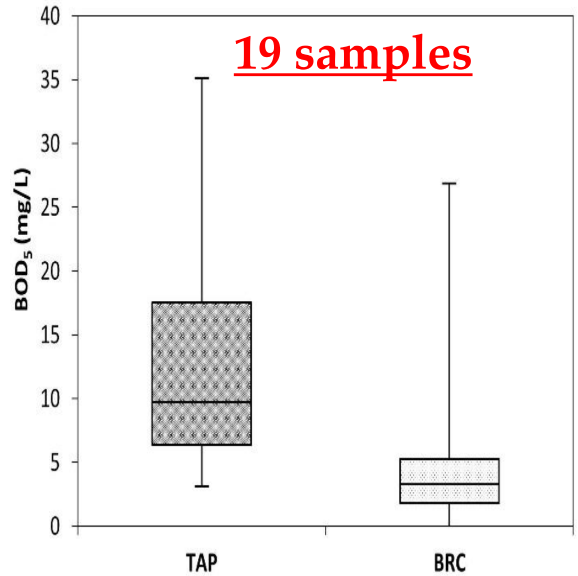
Bioretention

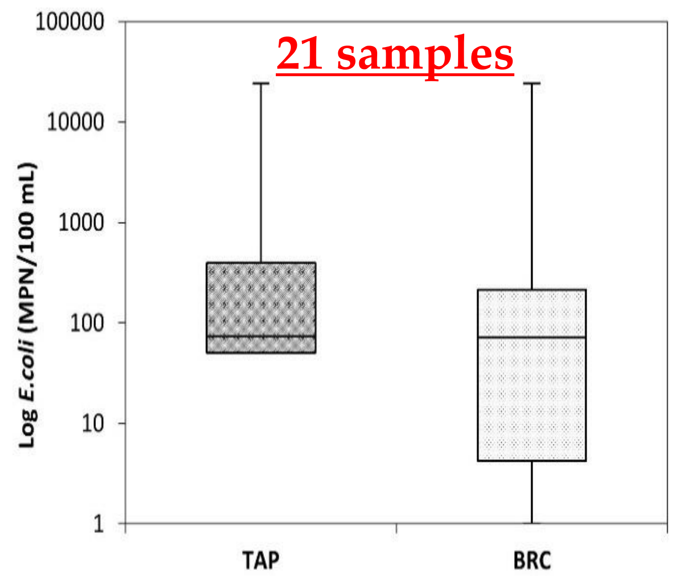


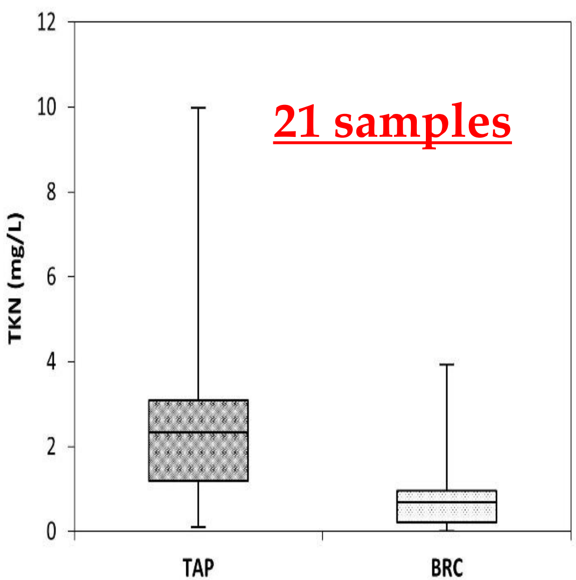
Runoff water is captured in a shallow depression and infiltrates through selected bioretention media, where physical, chemical and biological processes and mechanisms are employed for pollutant removal and runoff reduction .

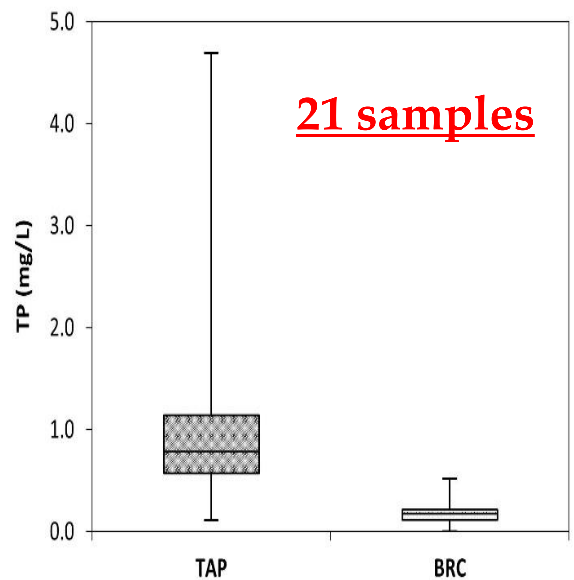
STC Bioretention (McAllen)

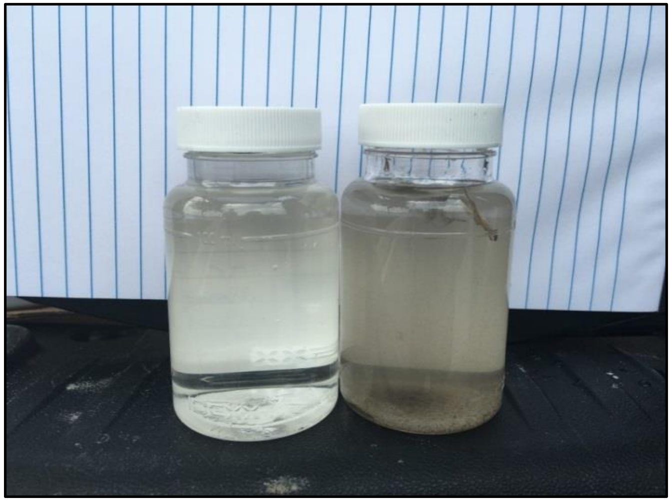












- https://www.sciencedirect.com/science/article/pii/S2590290319300070

Green Infrastructure Master Plan

The main objectives of the GI Master Plan that the City wants to implement are to:

1) Minimize the environmental impact of the rainwater,
2) Avoid localized flooding,
3) Stop the contamination of the water and
4) Integrate it to the construction projects through the development of natural drainages.

Green Infrastructure Master Plan

Task 1 - Inventory of City-Owned property (right-of-ways, corner clips, parks, bus stops, other)

Task 2- Identify areas of localized flooding that occur with small storm events (< 2" of rain)

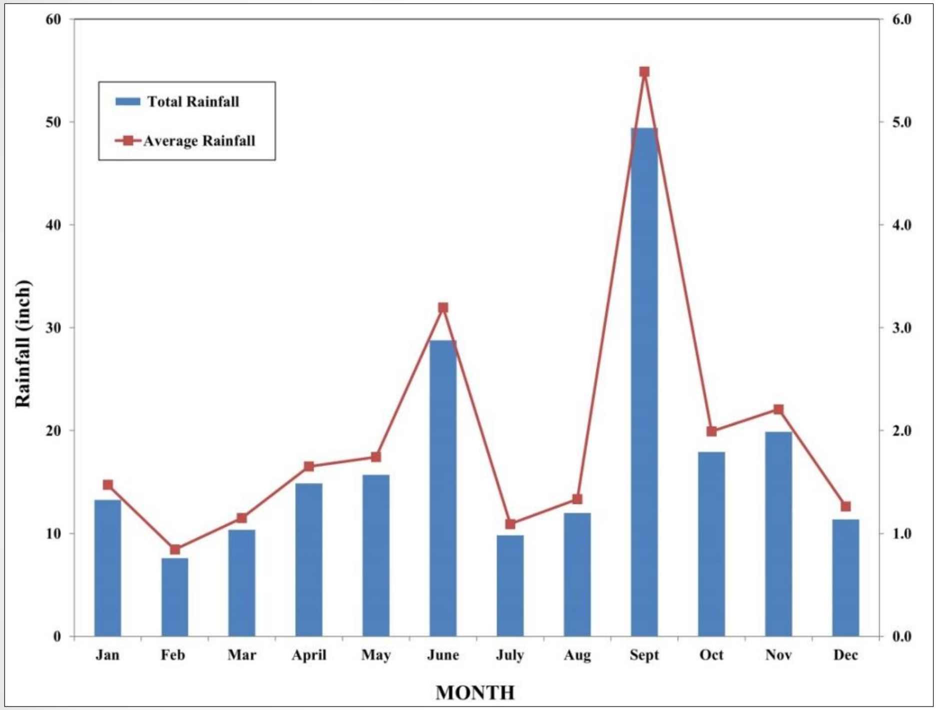
Task 3- Conceptually design green infrastructure facilities, primarily bioretention systems

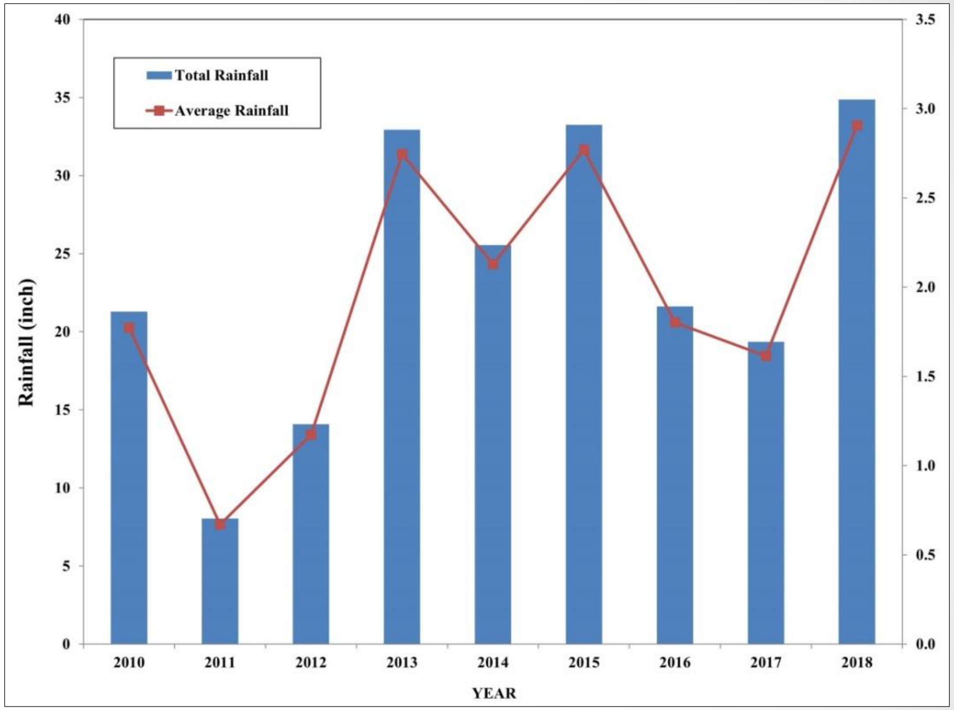
Task 4- Provide outreach to promote strategy

Task 5- Incorporate GI in local stormwater

Rainfall Data

The closest rainfall monitoring station for NOAA was located in Harlingen International Airport with station ID (USW00012904).

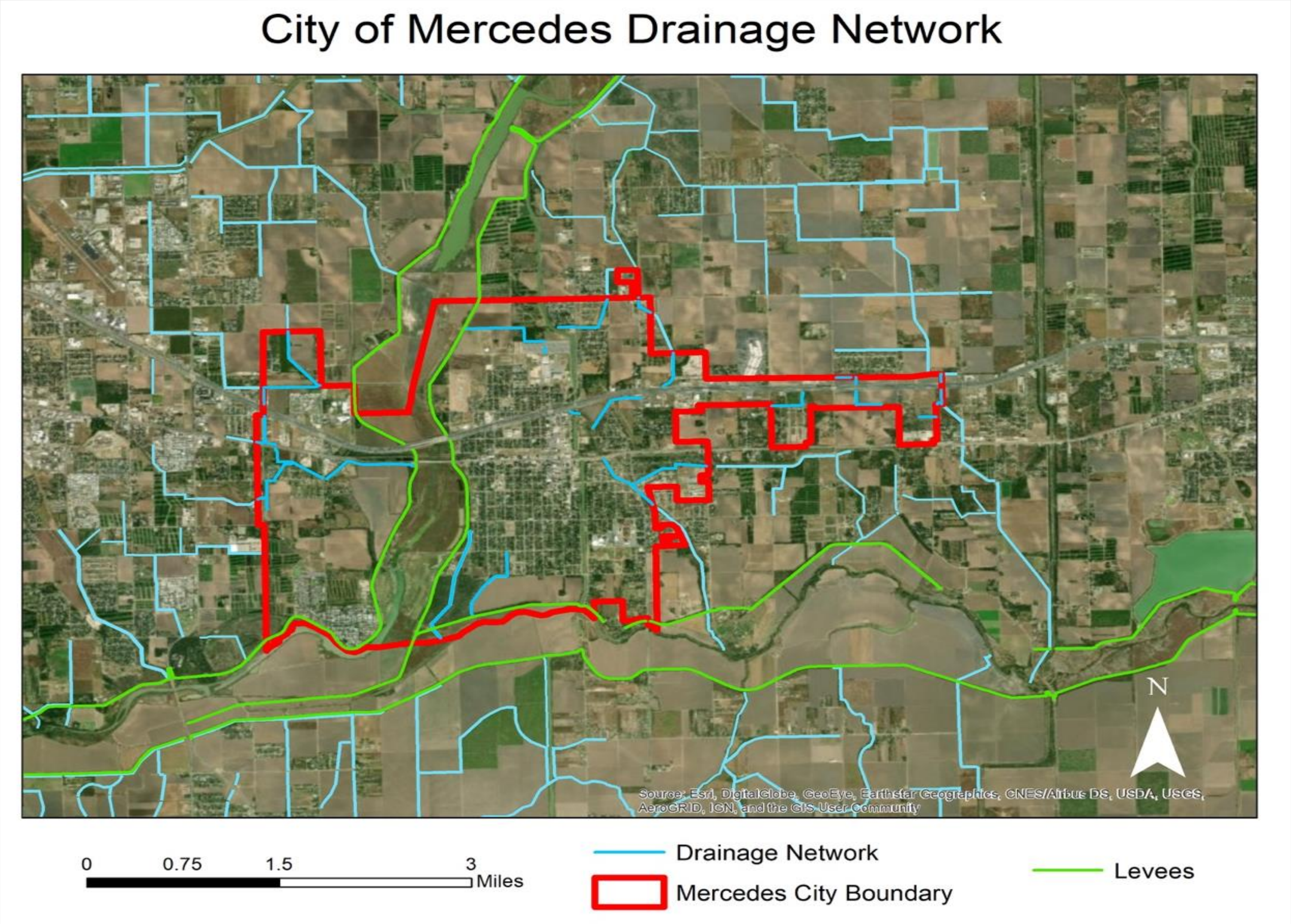




June and September with an average value of 3.2 ± 3.6 and 5.49 ± 4.68 inches

The total rainfall value 2013 and 2018 was 32.9 and 34.8 inches; respectively

- Most precipitation occurs from April through June and from August through October
- June 1st through November 30th is hurricane season



City of Mercedes has some ditches and drainage lines with inlets to properly divert rain & flood waters.

HCDD#1, USIBWC and Irrigation District No. 9

Storm Drainage Policy

Mercedes adopted its first Storm Water Management Plan in February 2008, obtained an individual NPDES permits for its stormwater discharges

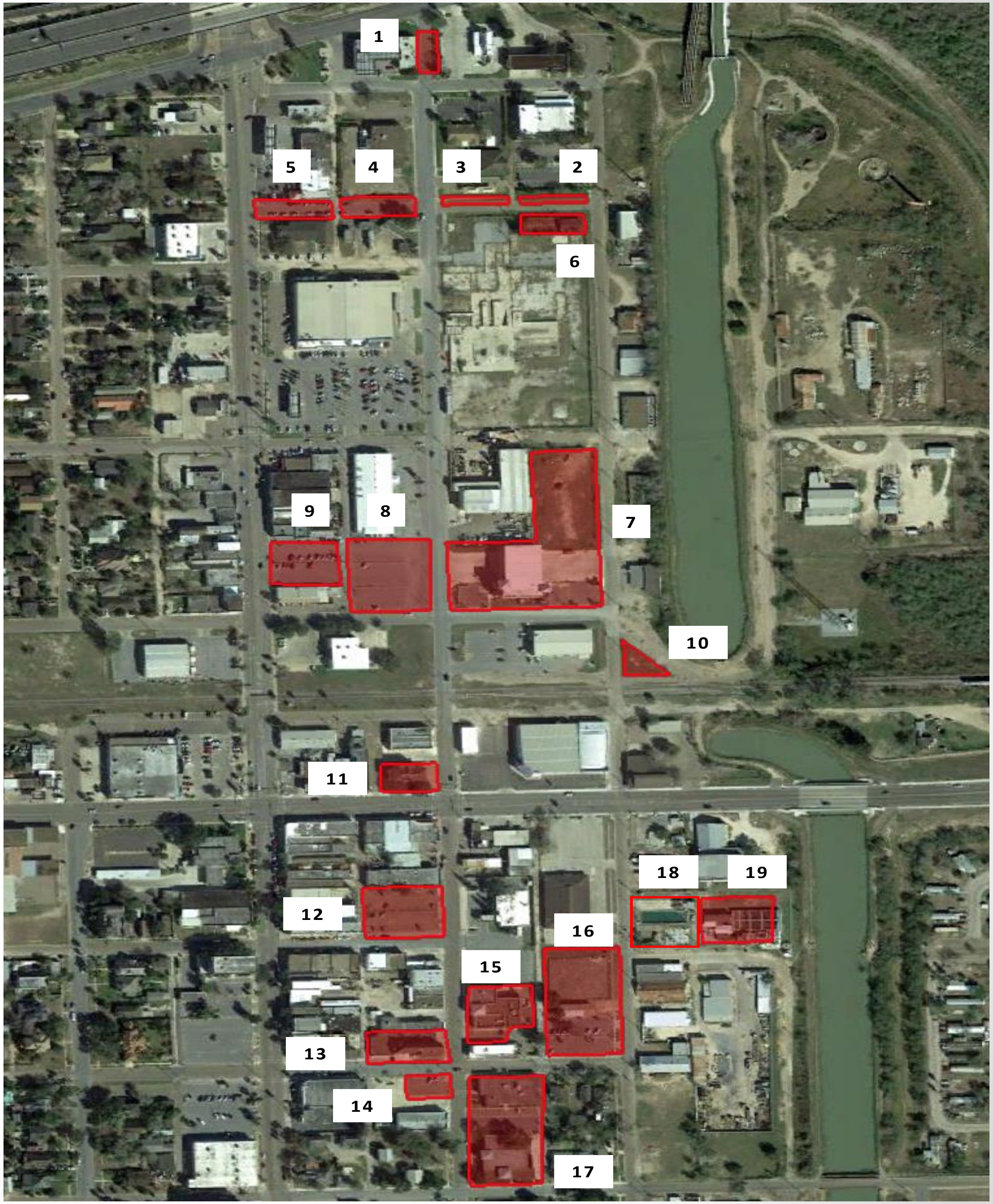
According to **the city subdivision ordinance** (link), in Section 30 which includes the storm drainage policy, it is stated that:
"Storm drainage shall be installed at the expense of the developer. It shall be designed by the Rational Method or other methods as approved by the Planning Commission and a copy of the design computations shall be submitted along with plans. Run-off Computations - To determine the runoff rates for the various areas, the standard rational method may be used utilizing the formula
Q =CIA,
where Q - rate of runoff in cubic feet per second,
C = runoff coefficient, I = rainfall intensity for the particular duration in inches per hour and A = the drainage area in acres.

The runoff factor C I used in the design of storm drainage shall be a minimum of 1.3 cubic feet per acre for a minimum time concentration of ten (10) minutes."

PROJECT

- Priority Areas (19 locations)

Majority in Texas, Ohio, Illinoi Avenues and Capisallo St



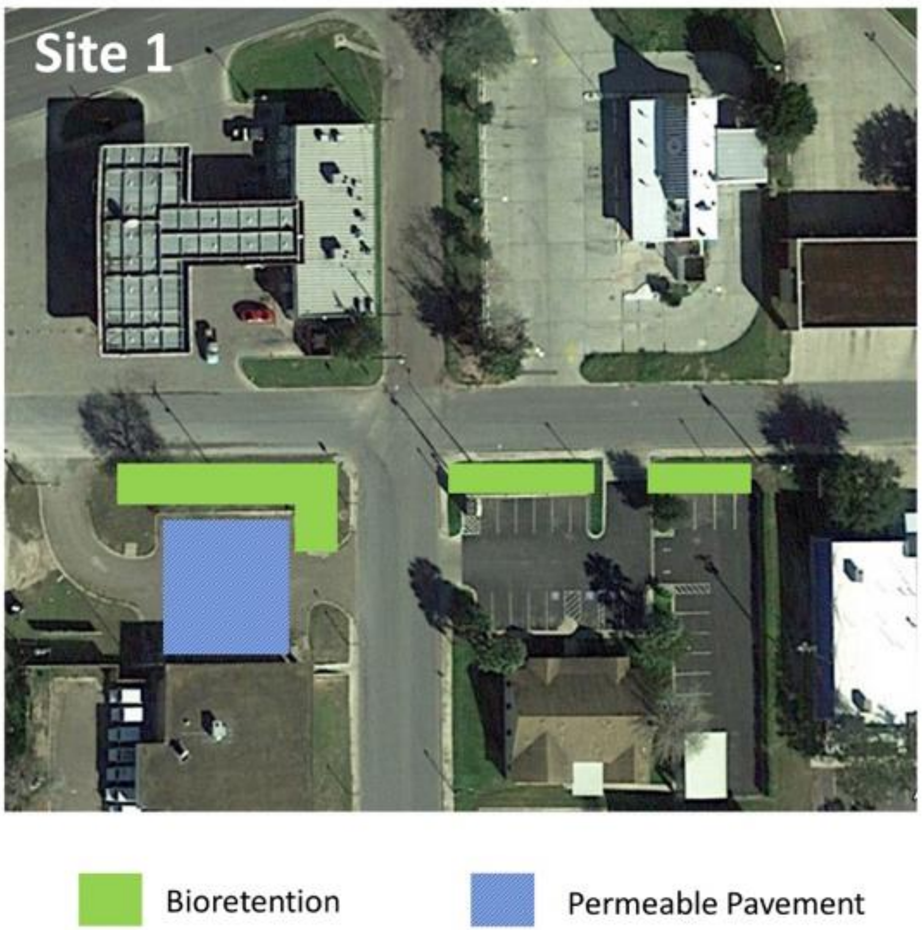
Priority Sites List

Area	Address	Description
1	300 E Expressway 83, Mercedes, Tx 78570	area east of Exxon
2	208 Starr St, Mercedes, TX 78570	area south of Childrens Clinic, intersection of Start St and Cameron St
3	300 N Ohio Ave, Mercedes, TX 78570	area south of Family Dentistry, along Cameron St
4	307 Starr St, Mercedes, TX 78570	area south of post office, along Cameron St
5	331 N Texas Ave, Mercedes, TX 78570	area south of Juanitos Restaurant, along Acmeron St
6	215 N Illinois Ave, Mercedes, TX 78570	area south of Area 2, intersection of Cameron St and Illinois Ave
7	105 N Ohio Ave, Mercedes, TX 78570	Mercedes Fire Station
8	150 N Ohio Ave, Mercedes, TX 78570	parking area south of Knights of Columbus
9	129 N Texas Ave, Mercedes, TX 78570	parking area north of Atlas Credit Co
10	100 N Ohio Ave, Mercedes, TX 78570	area east of Dollar General, intersection of S. Illinois Ave and Capisallo St.
11	111 S Ohio Ave, Mercedes, TX 78570	My Secret Closet clothing store
12	325 W 3rd St, Mercedes, TX 78570	parking lot south of Eye Care Center
13	333 S Ohio Ave, Mercedes, TX 78570	property along intersection of S Ohio Ave and W 4th St
14	417 S Ohio Ave, Mercedes, TX 78570	parking area north of Mercedes Development Corporation
15	316 S Ohio Ave, Mercedes, TX 78570	Mercedes Police Department
16	321 S Illinois Ave, Mercedes, TX 78570	area east of Police Department
17	400 S Ohio Ave, Mercedes, TX 78570	Mercedes City Hall and Public Library
18	202 US-83 BUS, Mercedes, TX 78570	area east of Health & Human Services Dept
19	203 US-83 BUS, Mercedes, TX 78570	area east of Area 18

Developed a list a visited each site to assess and evaluate causes of flooding and possible installation of GI systems.

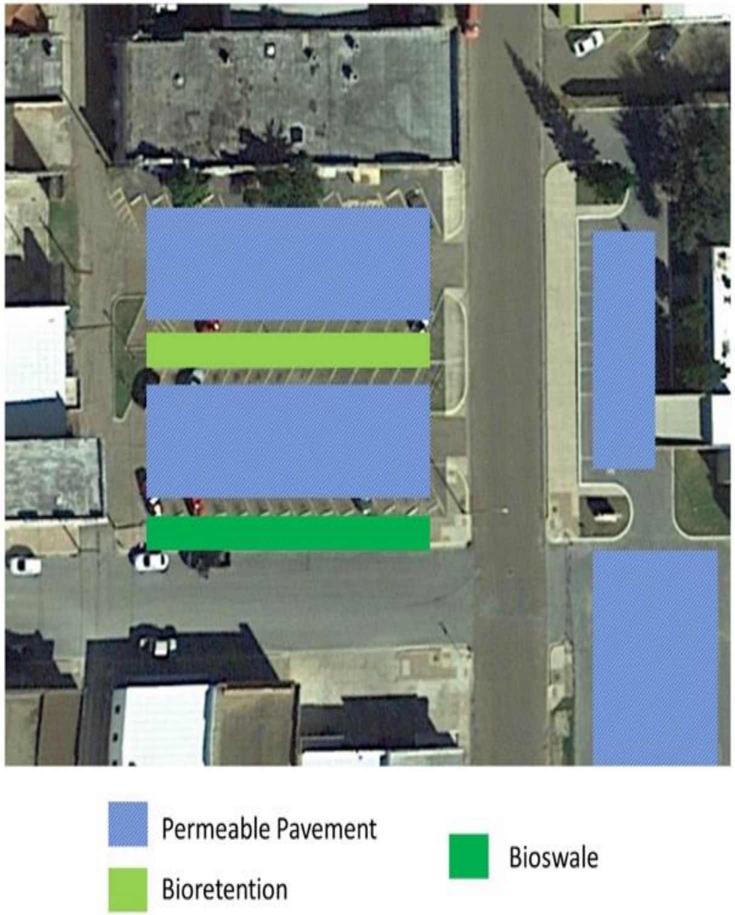
Priority Sites

Most of the flooding sites evaluated during the field visit, showed the presence of impervious parking areas which will increase overall volume and velocity of runoff into city drainage system.



Priority Sites

Switching the impervious parking areas to permeable pavements, can reduce the amount of stormwater runoff from a site, and improve water quality.



Site #5 Parking at Juanitos Restaurant

Priority Sites

Bioretention areas can be incorporated into the city commercial areas to capture roof runoff and parking lot runoff on private property

PROJECT

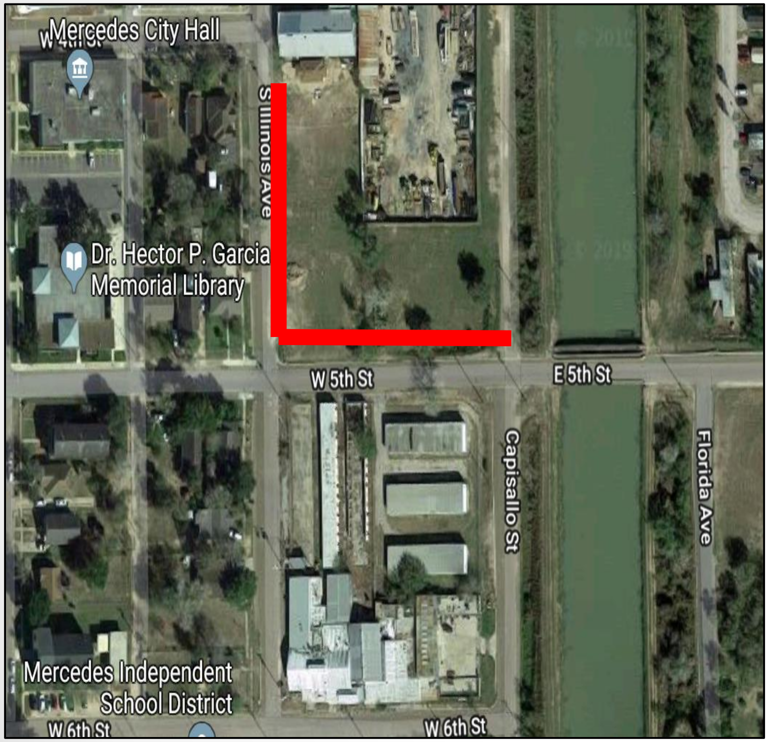
Site Number	Permeable pavement/sidewalk	Bioretention/Bioswale
Site #1	1	3
Site 2	2	3
Site 3	7	1
Site 4	1	4
Site 5	3	3
Site 6	-	1
Site 7	1	2
Site 8	4	2
Site 9	5	2
Site 10	3	3
Site 11	2	-
Total	**29**	**24**

Two Priority Sites

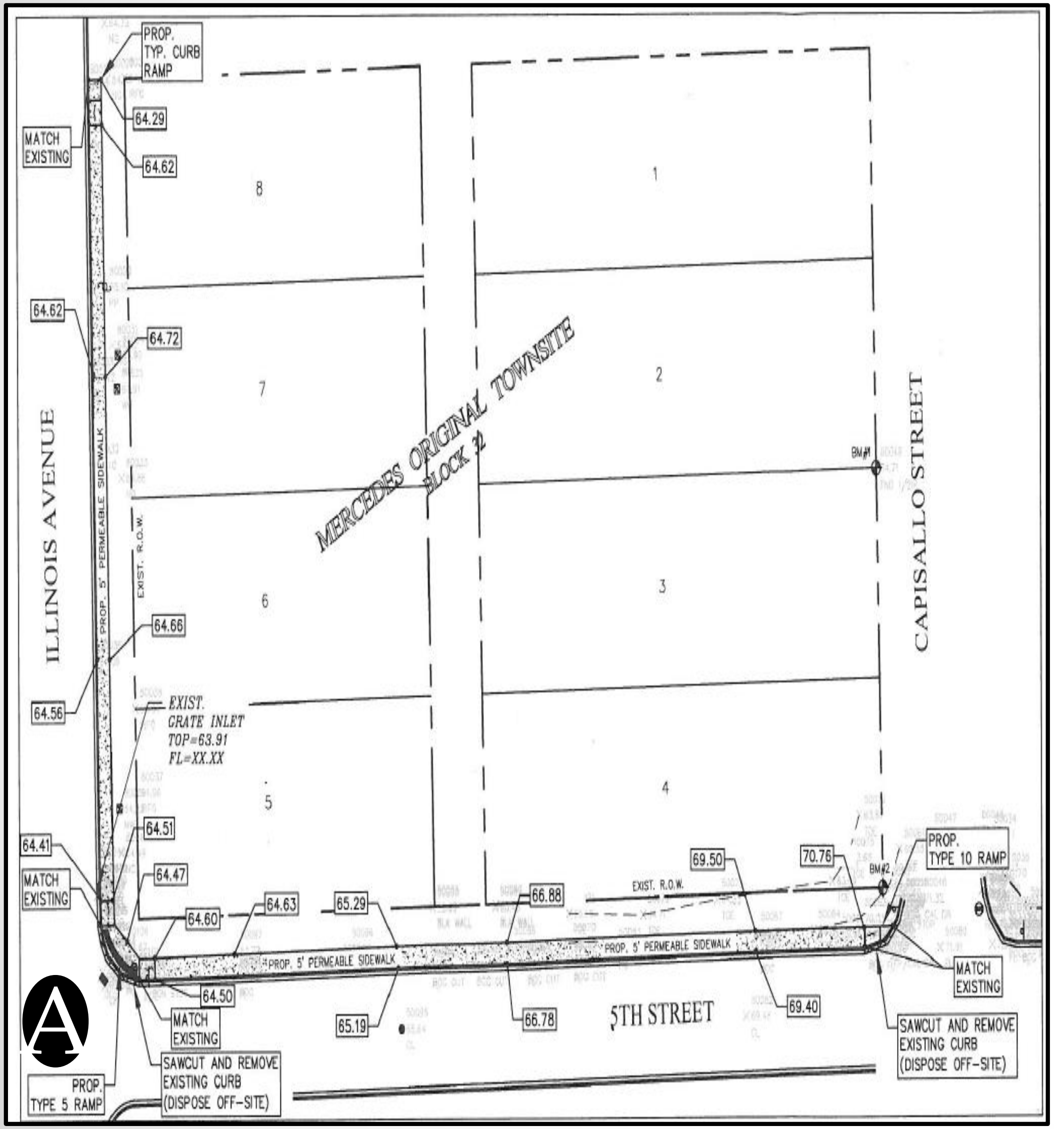
The first site located in Kennedy-Collier Park in Mathis Street.

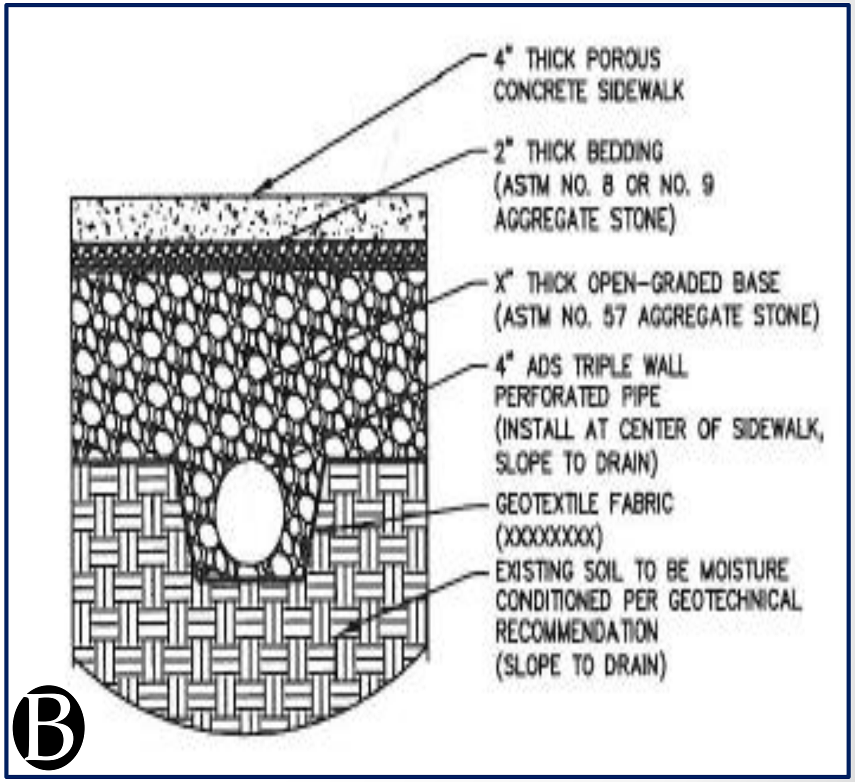
Two Priority Sites

The second location is the intersection between the fifth and Illinois streets.



Permeable Pavement Design





During Construction

After Construction

Permeable Pavement Design

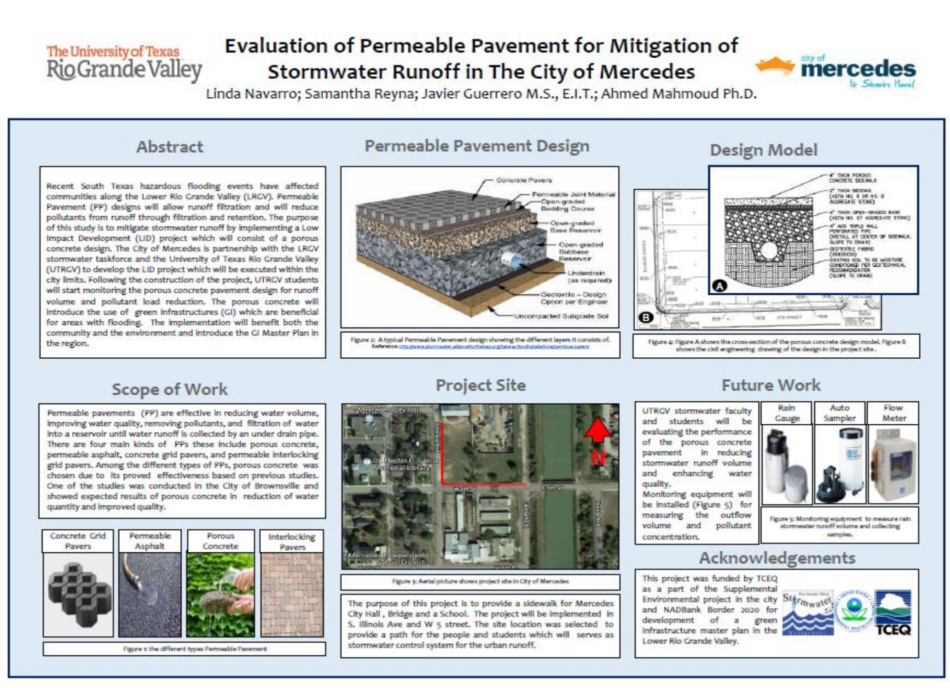
Outreach and Educational

- https://rgvstormwater.org/projects/mitigating-localized-flooding-development-of-a-green-infrastructure-master-plan-in-the-lower-rio-grande-valley/

Outreach and Educational

- The project team gave a technical presentation on the scope of the GI Master plan for the City of Mercedes in the 2019 EPA Region 6 Stormwater Conference, July 28 - August 1, 2019, Denton, Texas.

- Two UTRGV undergraduate students presented the project in the 21st Annual Lower Rio Grande Valley Water Management & Planning Conference, May 21-24, 2019, South Padre Island, Texas.



Recommendations

- Work with owners on construction and installation of the GI systems at the priority sites
- Change the drainage policy to convey more runoff from the sites
- Quantifying estimated pollutant load reductions for the GI Master Plan.
- Explore additional funding streams to facilitate widespread implementation

Recommendations

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UTRGV Co-PI: Ahmed Mahmoud, Ph.D.

Thanks

Bioretention basin at Water Street in Plymouth Center, Massachusetts.
https://capecodgreenguide.wordpress.com/bio-retention/

http://www.southwesturbanhydrology.com/solutions/bio-retention-basins/

Questions?