Webinar Training Series

SeSwA Southeast Stormwater Association

Green Stormwater Infrastructure
What's Green Got to Do With It?

January 20, 2022 | 10:30 a.m. – 11:30 a.m. (Eastern)

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Today's Presenter

Chris Bogdan
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Urban Green Infrastructure
Ferguson Waterworks
chris.bogdan@ferguson.com

SeSwA Southeast Stormwater Association

Urban Green Infrastructure:

What's Green Got to Do With It?

Chris Bogdan – Urban Green Infrastructure Business Development Manager

FERGUSON® WATERWORKS

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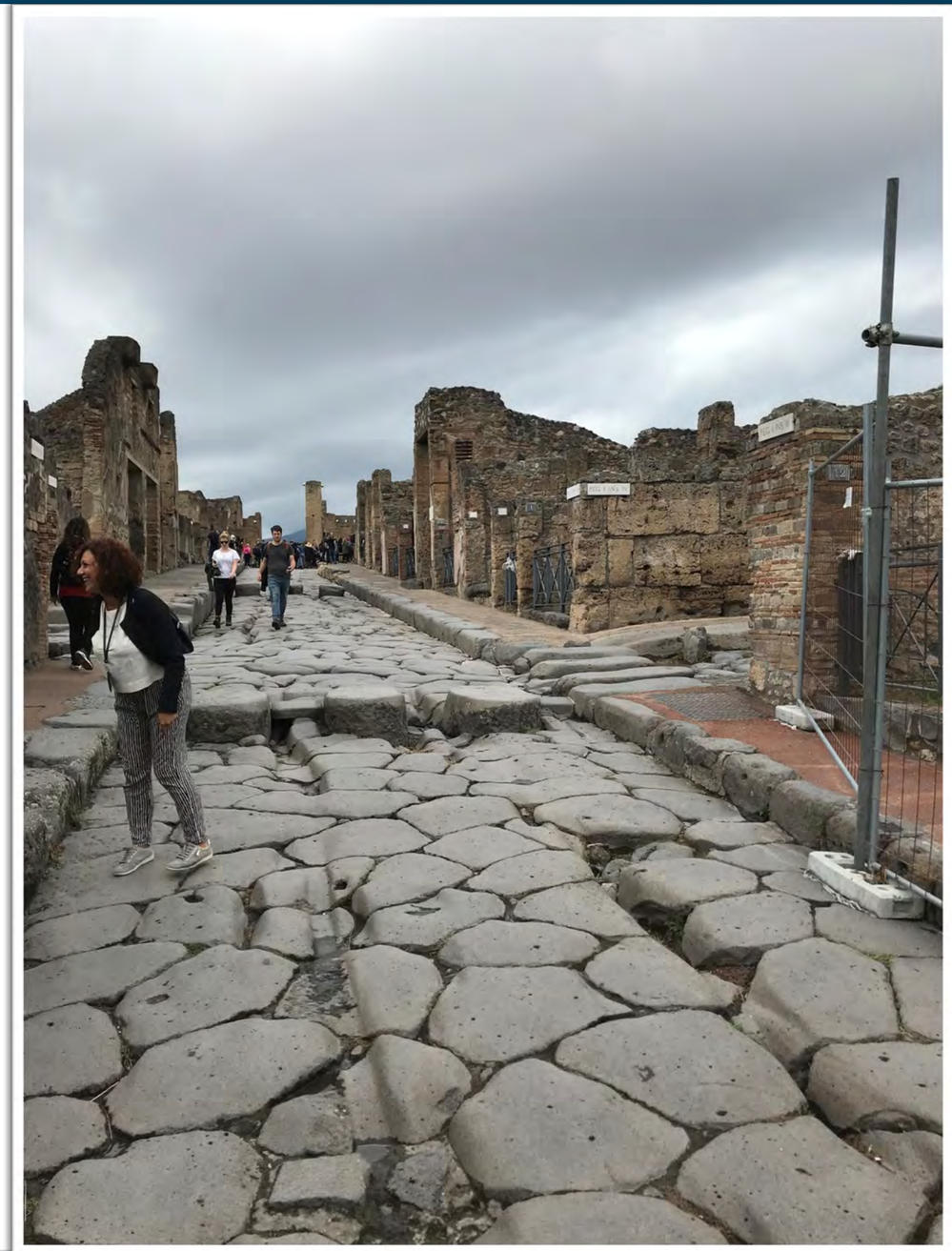


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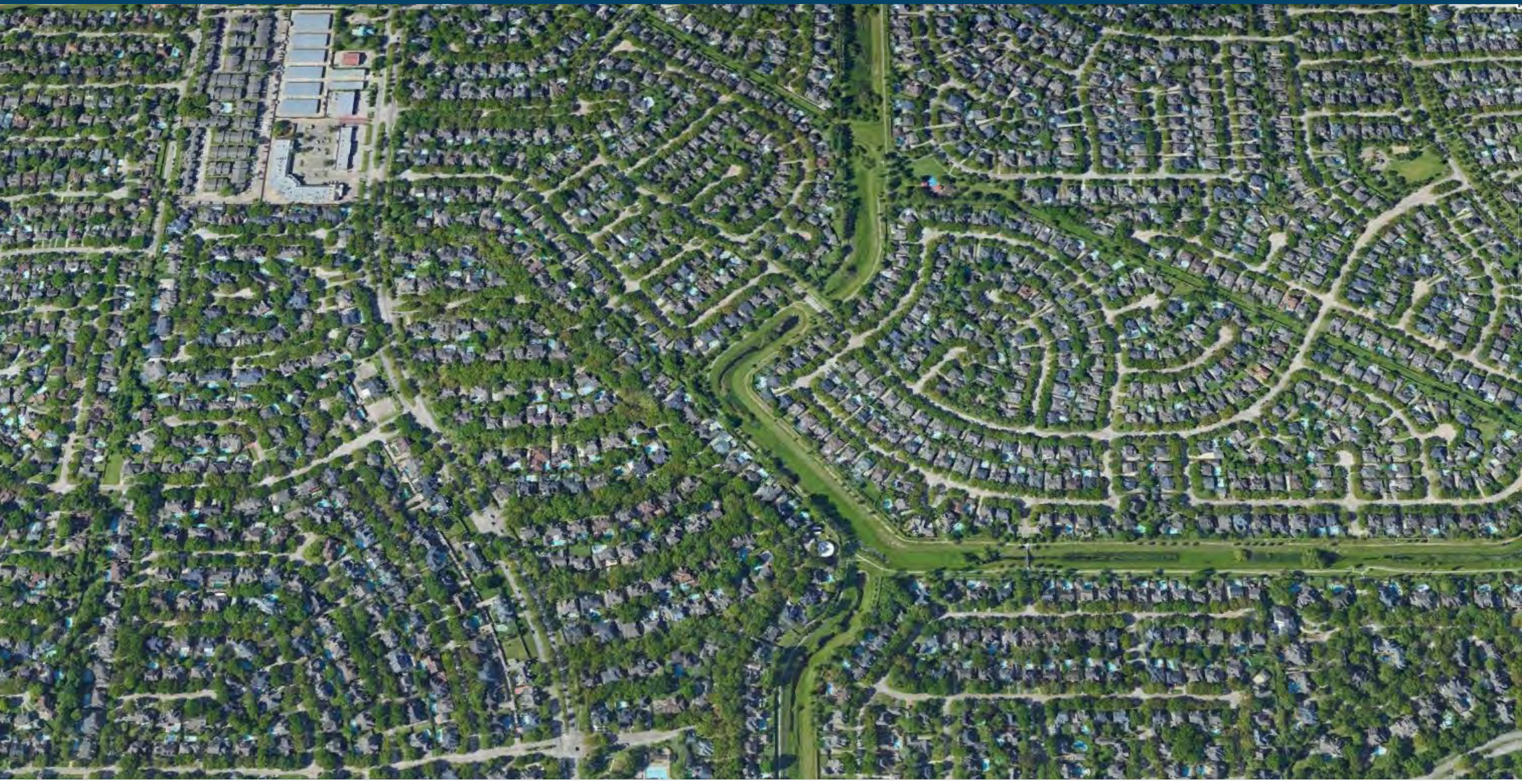

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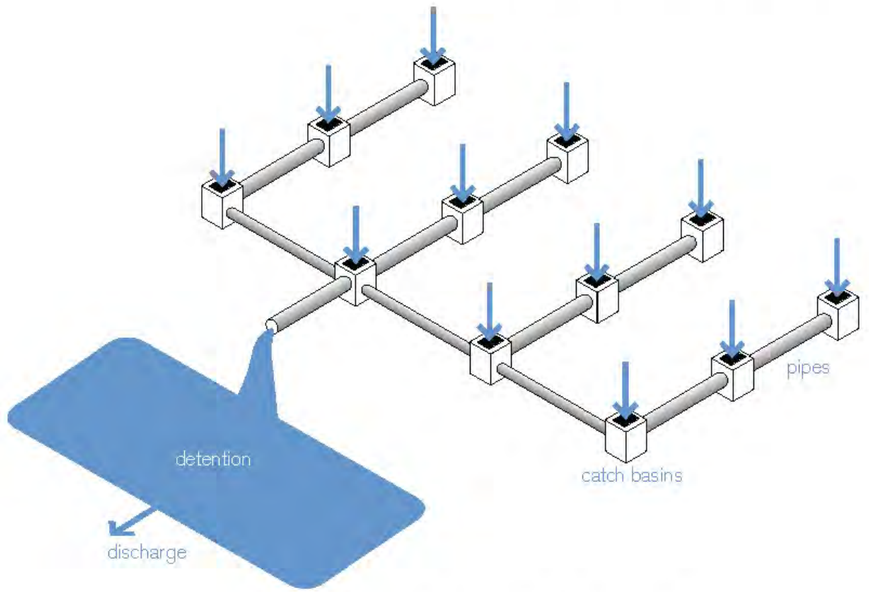
GSI: WHAT'S GREEN GOT TO DO WITH IT

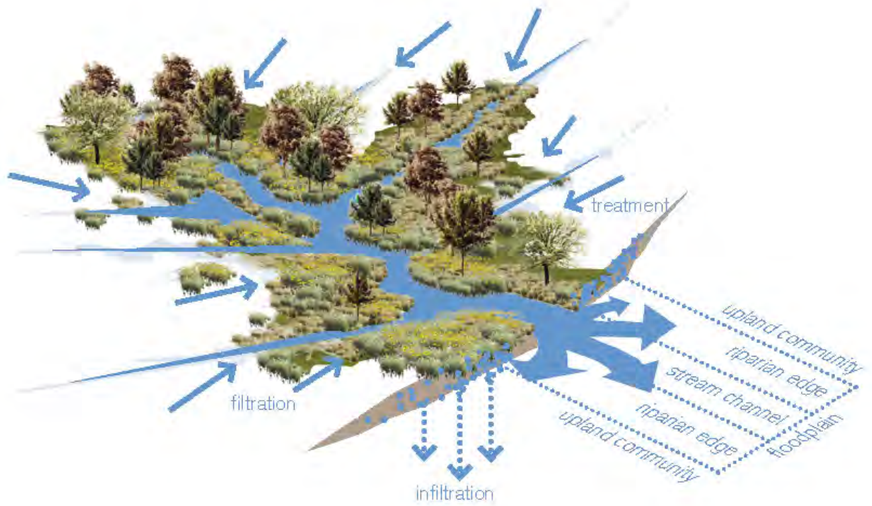
GSI Defined

hard engineering
...just transfers pollution
to another site



conventional management: "pipe-and-pond" infrastructure
drain, direct, dispatch

soft engineering
...metabolizes pollutants
on site—parks, not pipes!



low impact management: watershed approach
slow, spread, soak

GSI: WHAT'S GREEN GOT TO DO WITH IT

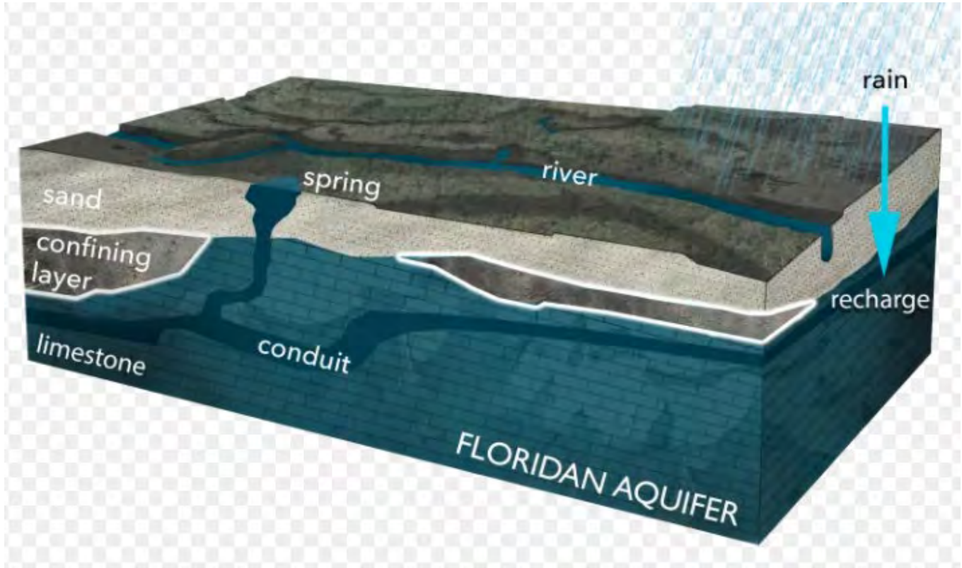
GSI Practices

- Rain Gardens
- Bioswales
- Permeable Pavements
- Tree Box Filters
- Green Roofs
- Urban Tree Canopy
- Constructed Wetlands
- Vegetated Filter Strip
- Rainwater Harvesting

GSI: WHAT'S GREEN GOT TO DO WITH IT

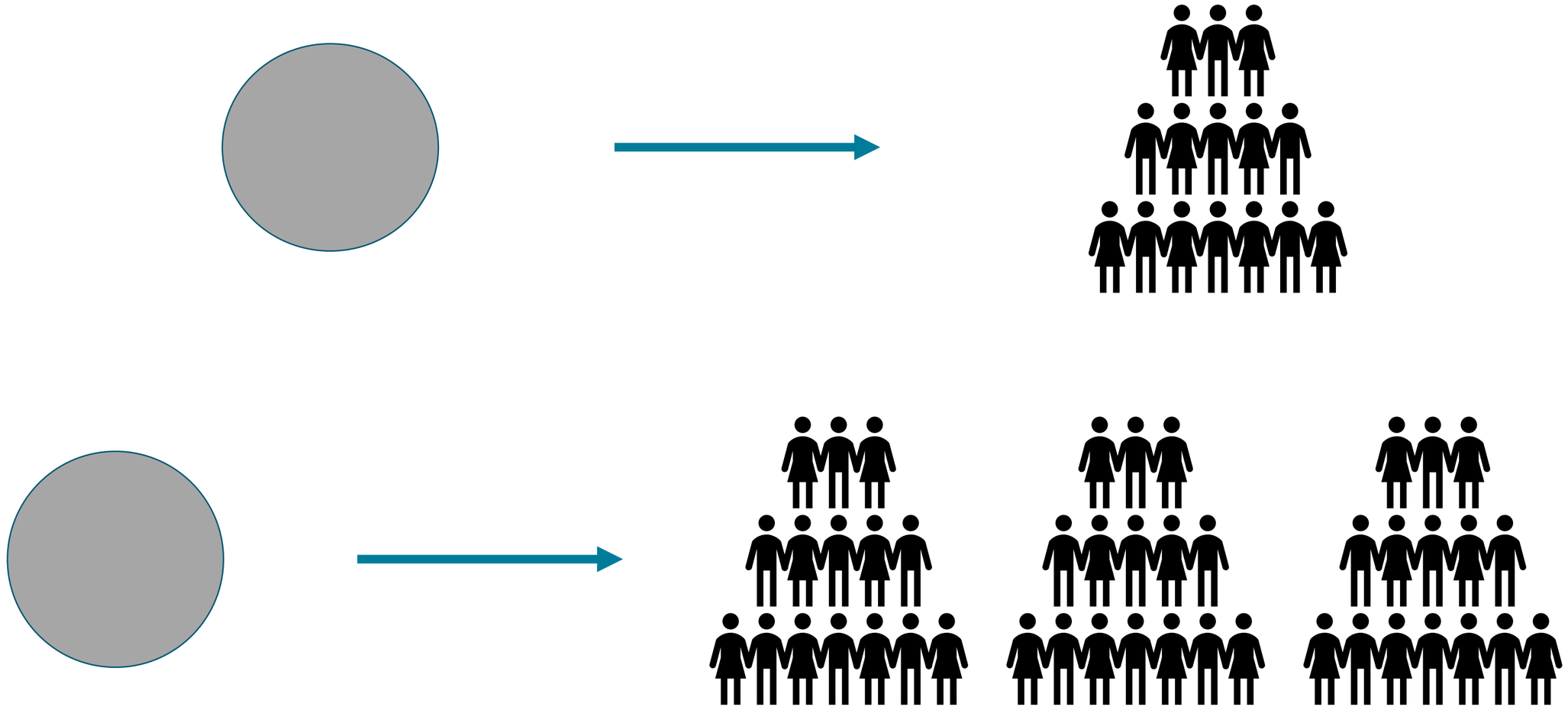
GSI- THE WHY FOR MUNICIPALITIES

- Recharge Aquifers to Combat Sea Level Rise
- Reduce Pressure on Municipalities to Clean Other People's Runoff
- Solves Tough Engineering Problems
- Adds Tax Revenue for Municipalities
- Mitigates Flash Flooding



GSI: WHAT'S GREEN GOT TO DO WITH IT

How's The Water Going To Get There?



GSI: WHAT'S GREEN GOT TO DO WITH IT

Where's the Water Going to Go- The Bucket is Full

Melbourne, FL

BUT

DO DEVELOPERS

CARE???

GSI: WHAT'S GREEN GOT TO DO WITH IT

GSI- THE WHY FOR DEVELOPERS

- Increased Lot Yield
- Lower Cost of Development
- Increase Project Revenue
- Maximize ROI
- Make More Money……The GREEN

GSI: WHAT'S GREEN GOT TO DO WITH IT

URBAN ADDED COMPLEXITIES- STREETSCAPE PROJECTS

- Tight spaces
- Working around existing infrastructure
- Poor Soils
- Steep Grades / Topography
- Need for function and feature / aesthetics
- Often research, design and maintenance are mutually exclusive. i.e. are we taking what we learn in the field back to the next design

GSI: WHAT'S GREEN GOT TO DO WITH IT

URBAN ADDED COMPLEXITIES

Design Challenges

- Developers Rush the Process
- Civil Engineers Product Knowledge
- Not Addressing Geotechnical Issues
- Civil Engineers and Landscape Architect Operate Independently
- Long-term Cost of Maintenance

Construction

- Poor Communication
- Unrealistic Expectations
- Inexperienced Contractors
- EOR is Often not Engaged During Construction
- Properly protect GSI assets during construction

GSI: WHAT'S GREEN GOT TO DO WITH IT

GSI Misconceptions

- Too Expensive to Build
- Too Expensive to Maintain
- Too Expensive to Repair
- Differences in Stormwater Code and Development Code

GSI: WHAT'S GREEN GOT TO DO WITH IT

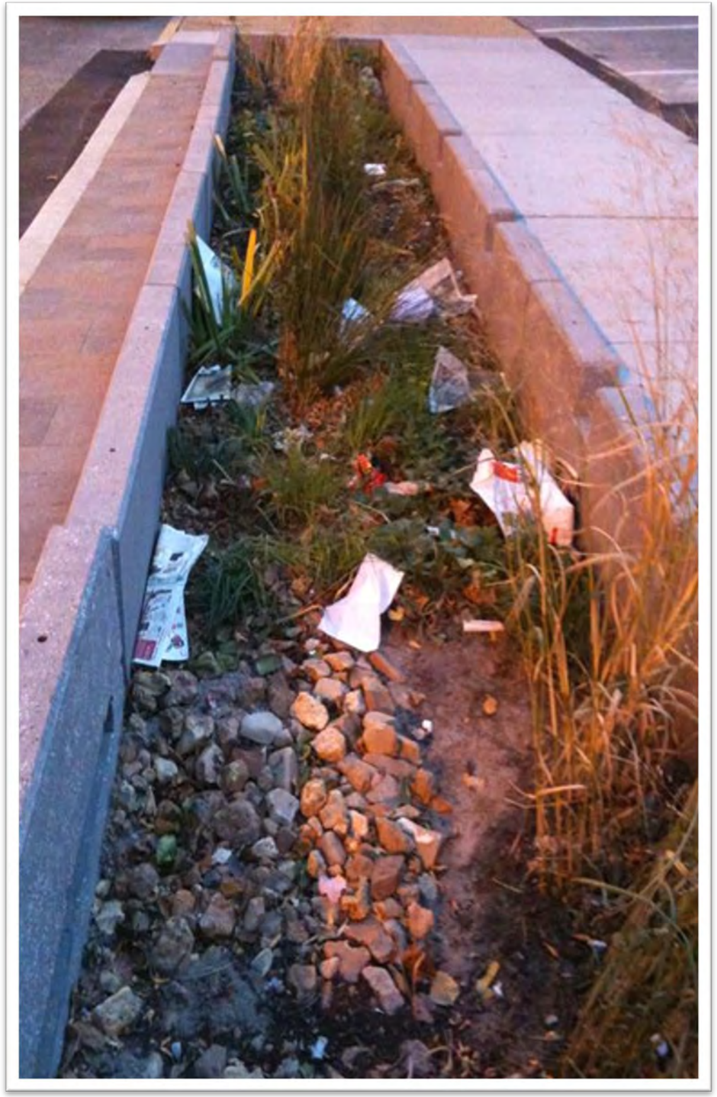
GOALS FOR RAIN GARDENS AND BIOSWALES

- Look amazing (aesthetics)
- Filter Pollutants (water quality)
- Be Maintenance Free (good luck ☺)
- Be able to handle a layer of trash and sediment

That's pretty much impossible – but using pretreatment devices gets us much closer!

* Energy Dissipation

* Collection of sediment/debris

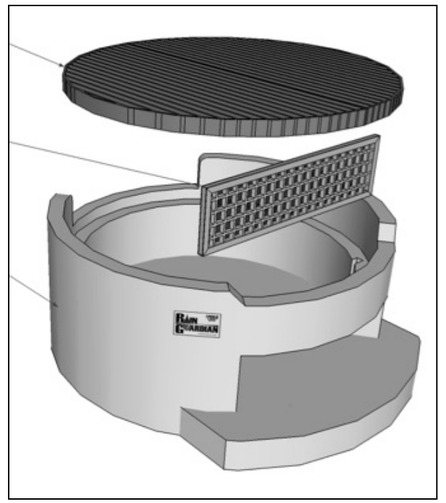


MAINTENANCE

GSI: WHAT'S GREEN GOT TO DO WITH IT

CURBLINE PRETREATMENT

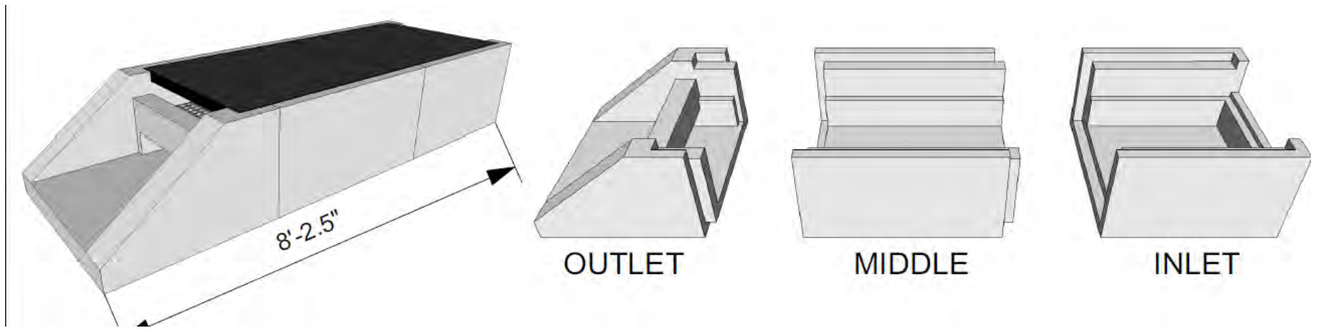
- Extend Effective Bioretention Cell Life
- Maximize Capacity
- Easy Installation
- Simplify Maintenance

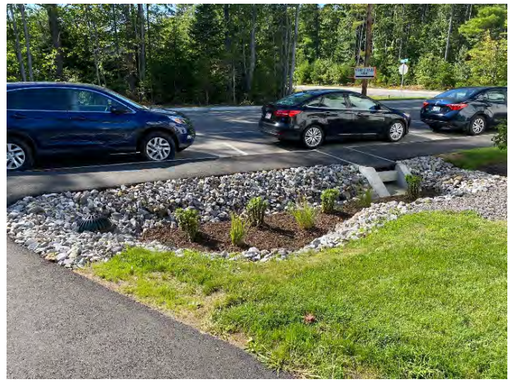


GSI: WHAT'S GREEN GOT TO DO WITH IT

CURBLINE PRETREATMENT

- When BMP is behind sidewalk
- Modular based on sidewalk width
- Solid cover on top

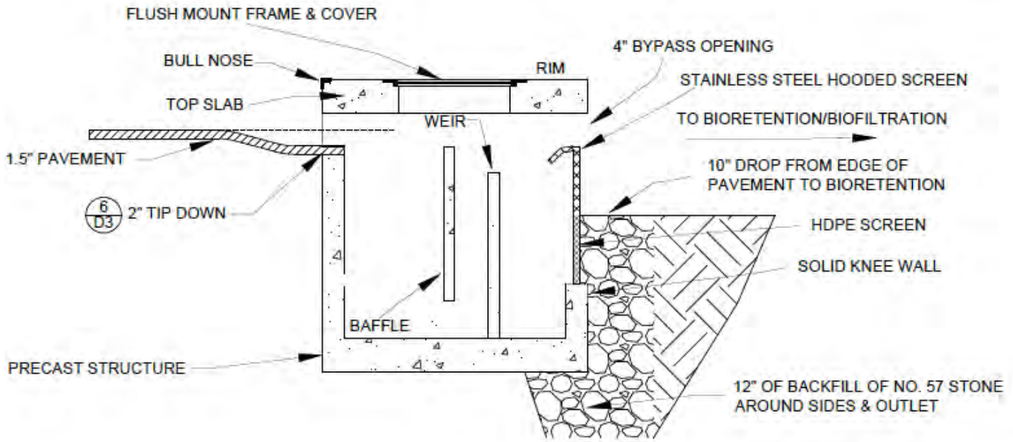




GSI: WHAT'S GREEN GOT TO DO WITH IT

CURBLINE PRETREATMENT

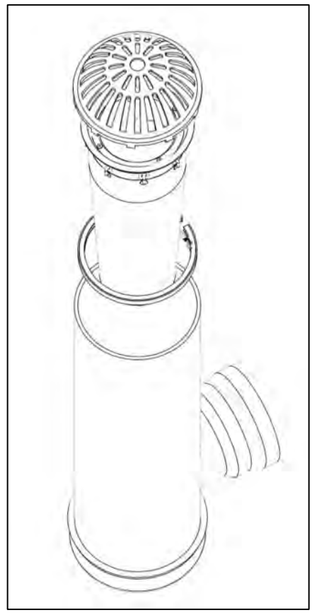
- Larger watersheds
- Higher volumes of sediment
- Formal sump and storage
- Baffles, weirs and screens

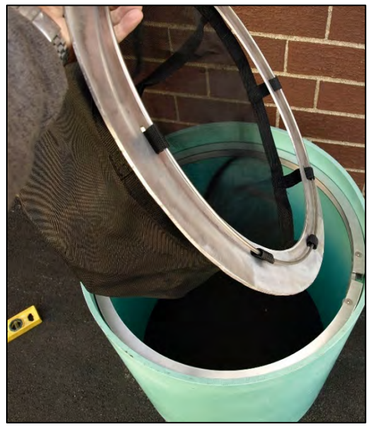


GSI: WHAT'S GREEN GOT TO DO WITH IT

DOMED OVERFLOW WITH FILTER INSERT

- Conveyance of larger storms
- Collection of floatables, mulch, debris
- Expanding ring mount
- No screws or fasteners
- Low cost
- Easy to clean





GSI: WHAT'S GREEN GOT TO DO WITH IT

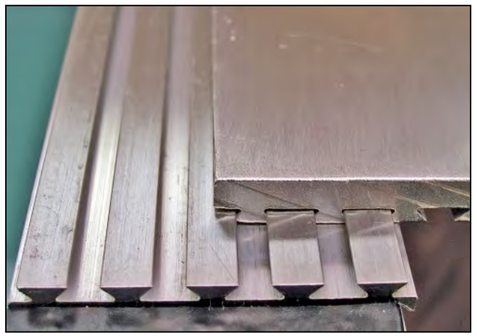
PRETREATMENT DEVICE FOR TRASH, SEDIMENT AND DEBRIS

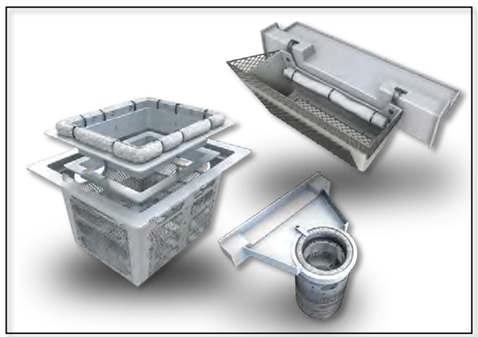
- Simple to Retrofit to Existing Catch basins.
- Installs Without Heavy Equipment.
- Adjusts to Irregular Catch basin Bottoms and/or Walls.
- Available in several different sizes.

GSI: WHAT'S GREEN GOT TO DO WITH IT

PRETREATMENT FILTER FOR TRASH AND SEDIMENT

- Post construction inlet protection
- Adjustable frame options
- Geotextile Options
- Rigid Basket Options
- Built in bypass
- Scour protection deflector
- Integral oil boom

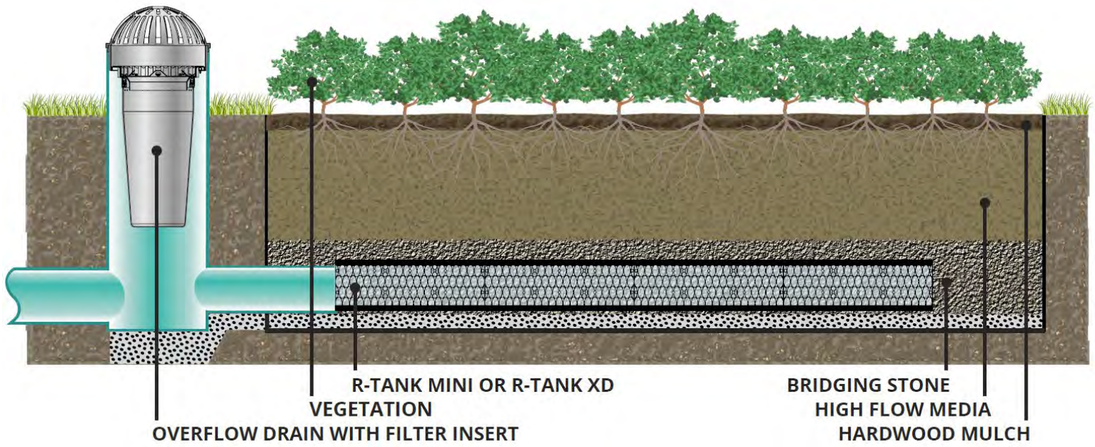



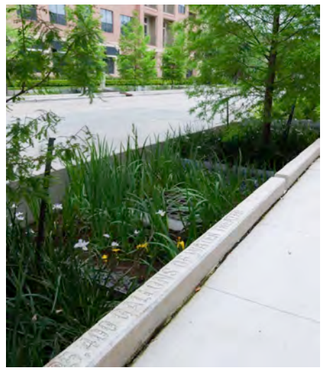




GSI: WHAT'S GREEN GOT TO DO WITH IT

MODULAR BIOFILTRATON SYSTEM

- Space efficient
- 100 in/hr innovative media
- Provides treatment for a variety of pollutants
- Engineered system





- Smaller footprint = less disturbance
- Smaller footprint = smaller maintenance footprint
- Smaller footprint = feasibility in tight spaces previously overlooked

GSI: WHAT'S GREEN GOT TO DO WITH IT

MODULAR BIOFILTRATION SYSTEM

Vegetated System:
Plants process pollutants removed from run-off and root system maintains drainage and aeration of media.

3" Layer of Shredded Hardwood Mulch:

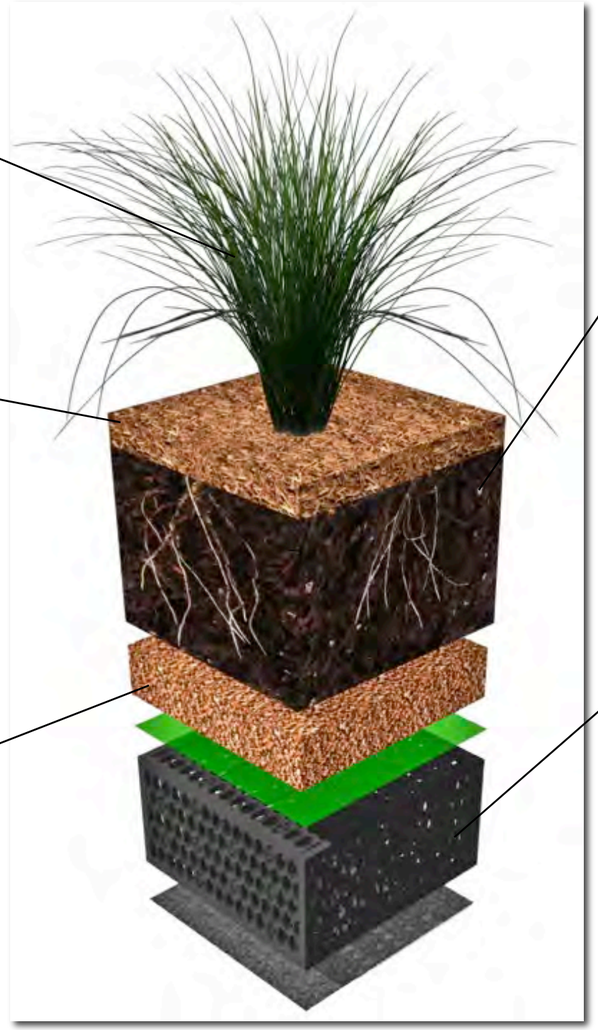
Pre-treatment mechanism.

Removal and Replacement of Mulch Represents the Bulk of System Maintenance!

6" Bridging Stone & Separation Layer:

Clog-Proof Clean Stone & Micro-Grid Replace Traditional Geotextile Layer

No geotextile = no clogging



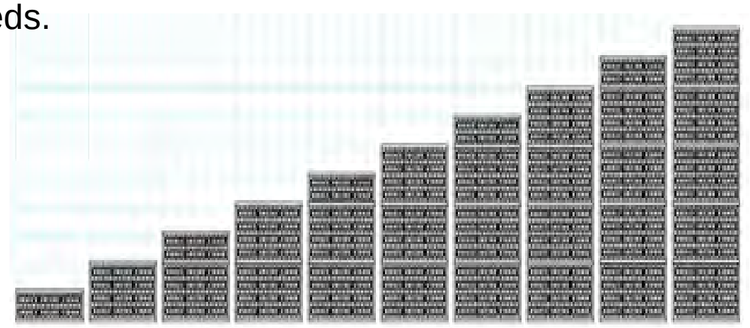
18" High Performance Media:

Flows at 100" Per Hour / 200 ft per day
Resistant to Clogging

High Performance Underdrain:
9.45" Modular Tank, or "Flat Pipe" w/95% Open Surface Collects Water Efficiently.

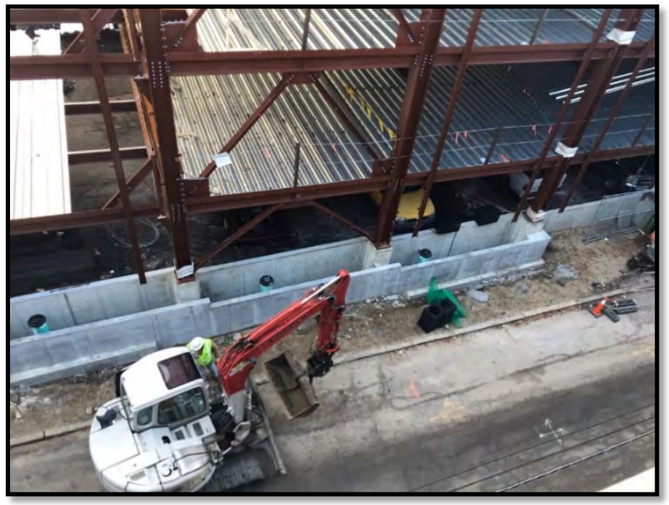
Optional 2" Low-Profile Panel Addresses Shallow Applications.

Expand into Modular Tanks for Larger Storage Needs.



GSI: WHAT'S GREEN GOT TO DO WITH IT

TIGHT URBAN SITES



GSI: WHAT'S GREEN GOT TO DO WITH IT

GREEN ROADWAY PROJECTS

GSI: WHAT'S GREEN GOT TO DO WITH IT

Rain Gardens on Private Projects

GSI: WHAT'S GREEN GOT TO DO WITH IT

Infill Housing









GSI: WHAT'S GREEN GOT TO DO WITH IT

ALTERNATIVE SURFACES

- Formal Surfaces
  - Permeable Pavers
  - Porous Concrete and Asphalt
- Informal Surfaces
  - Grass Surface
  - Gravel Surface

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL PERMEABLE PAVERS

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL PERMEABLE PAVERS

PROBLEM:

- Traditional Permeable Pavers Require a Filler Between Blocks
- Provides Stability Under Loads
- Filters Sediments at the Surface
- Accurately Called "Choker Stone"

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL PERMEABLE PAVERS

PROBLEM:

- Traditional Permeable Pavers Require a Filler Between Blocks
- Provides Stability Under Loads
- Accurately Called "Choker Stone" in Most Regulations
- Choker Stone Filters Sediments at the Surface
- Requires Frequent Maintenance

GSI: WHAT'S GREEN GOT TO DO WITH IT

Open-Joint Pavers Help Maximize Conveyance Rates and Reduce Maintenance

GSI: WHAT'S GREEN GOT TO DO WITH IT

INFILL vs OPEN JOINT PAVER

100" / Hour

50% Clogged – 50"/hr
75% Clogged – 25"/hr
90% Clogged – 10"/hr

vs

1,000" / Hour

50% Clogged – 500"/hr
75% Clogged – 250"/hr
90% Clogged – 100"/hr

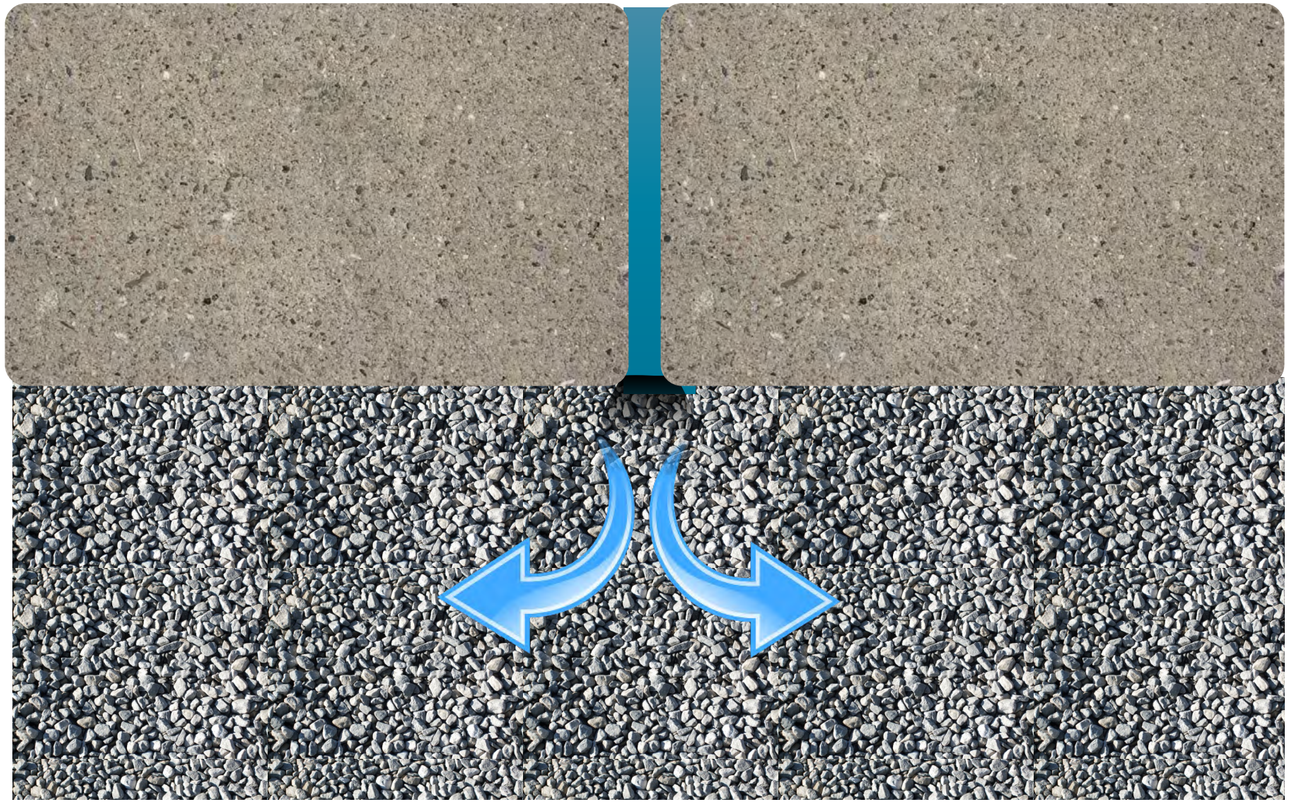
Higher Conveyance Rates (> 1000 inches/hour) Can Minimize Owner Pain By Extending Maintenance Cycles

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL PERMEABLE PAVERS

Typical Paver

Open-Joint Paver



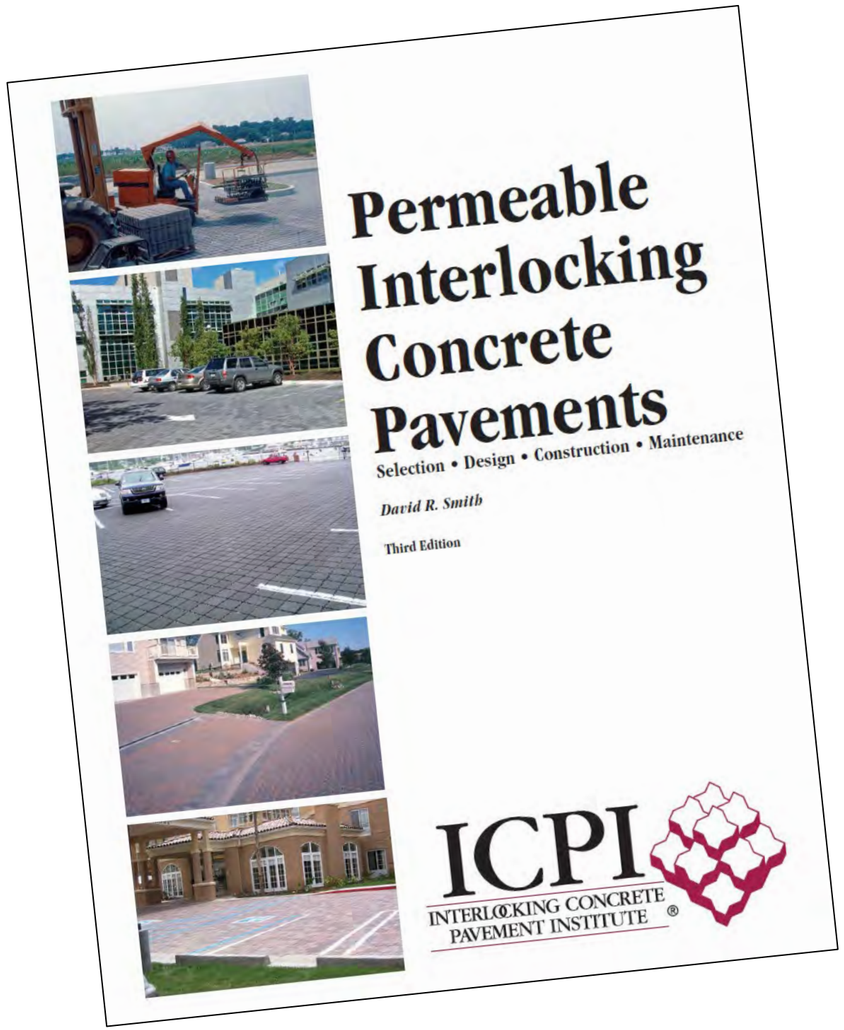
Where Does Clogging Occur?

Initiating clogging at the BOTTOM of the joint creates several inches of head pressure to drive water into the base.

…of course, that's only good if you can still remove the sediment!

GSI: WHAT'S GREEN GOT TO DO WITH IT

MAINTENANCE



In-service Inspection Checklist

- ❑ Vacuum surface openings in dry weather to remove dry, encrusted sediment. These appear as small, curled "potato chips." Vacuum settings may require adjustment to prevent uptake of aggregate in the pavement openings and joints.
- ❑ Inspect after at least one major storm per year.
- ❑ Maintained vegetation around pavement to filter runoff and minimize sediment deposition on the pavement.
- ❑ No standing water on the surface after storms.
- ❑ Repair ruts or deformations in pavement exceeding ½ in. or 13 mm.
- ❑ Repair pavers more than ¼ in. or 6 mm above/below adjacent units.
- ❑ Replace broken units that impair the structural integrity of the surface.
- ❑ Replenish aggregate joint materials as needed.
- ❑ Check drain outfalls for free flow of water.
- ❑ Check outflow from observation well annually.

"Vacuuming should be done <u>at least</u> once or twice annually"

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GSI: WHAT'S GREEN GOT TO DO WITH IT

MAINTENANCE

- Cost to Vacuum
- Cost of Replacement Rock
- Labor to Install
- Loss of Lot During Maintenance
- When Can Lot be Closed and How Long Must it Be Closed?
- What is the Maintenance Schedule?

GSI: WHAT'S GREEN GOT TO DO WITH IT

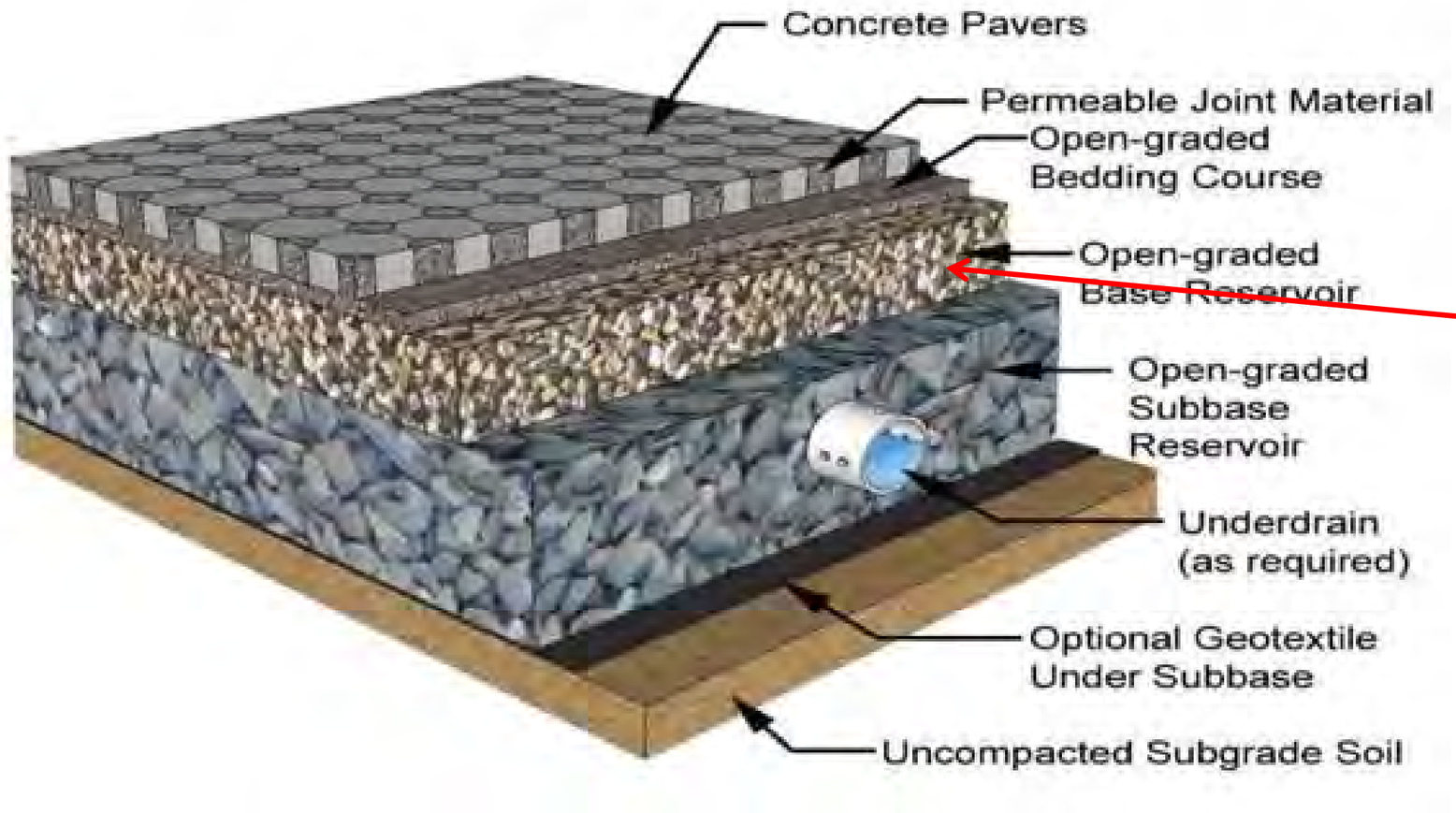
OPEN JOINT PERMEABLE PAVER SYSTEM

- Concrete Open-Joint Permeable Paver with 3 Functions

- Pavement – Handles Traffic Loads with 6000 psi Concrete
- Drains – Open Joints Move Water Without Inlets
- Stores & Infiltrates – Stores 1" of Water

GSI: WHAT'S GREEN GOT TO DO WITH IT

OPEN JOINT PERMEABLE PAVER SYSTEM



Increase rock base or add void space for additional water storage

GSI: WHAT'S GREEN GOT TO DO WITH IT

PAVERS, GRASS, AND GRAVEL- MODULAR OPTIONS

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL POUR IN PLACE CHALLENGES

- **Durability**
- **Labor Intensive**
- **Quality Control Issues**
- **Difficult to Produce**
- **Weather Dependent (can't install when too cold or hot)**
- **Difficult to Maintain and Repair**

HIGH RISK!!!

GSI: WHAT'S GREEN GOT TO DO WITH IT

TRADITIONAL POUR IN PLACE CHALLENGES

Project Conditions

A. Weather Restrictions

1. The Contractor shall not place pervious concrete pavement when the ambient temperature is predicted by the National Weather Service Point Forecast for the jobsite to be 40°F (4.4°C) or lower during the seven days following placement, unless otherwise permitted in writing by the Architect/Engineer.

2. The Contractor shall not place pervious concrete pavement later in the year than November 1 or earlier in the year than April 1 unless otherwise permitted in writing by the Architect/Engineer.

3. The Contractor shall not place pervious concrete pavement when the ambient temperature is predicted by the National Weather Service Point Forecast for the jobsite to rise above 90°F (32.2°C) during the seven days following placement, unless otherwise permitted in writing by the Architect/Engineer.

4. The curing cover shall remain securely in place, uninterrupted, until the concrete has reached a maturity equivalent to 14 days of curing at 70°F (21°C) at 95% relative humidity. Maturity shall be determined by an independent testing laboratory. No vehicular traffic shall be permitted on the pavement until curing is complete without written permission from the Architect/Engineer.

GSI: WHAT'S GREEN GOT TO DO WITH IT

PRECAST POROUS PANELS

- **Porous concrete is manufactured, cured and stored in controlled environment**
- **Ease of Installation**
- **Porous Section is Removable and Replaceable**
- **Can be Installed Year-Round in any Weather Condition**
- **Lower Life Cycle Costs**

Low RISK!!!

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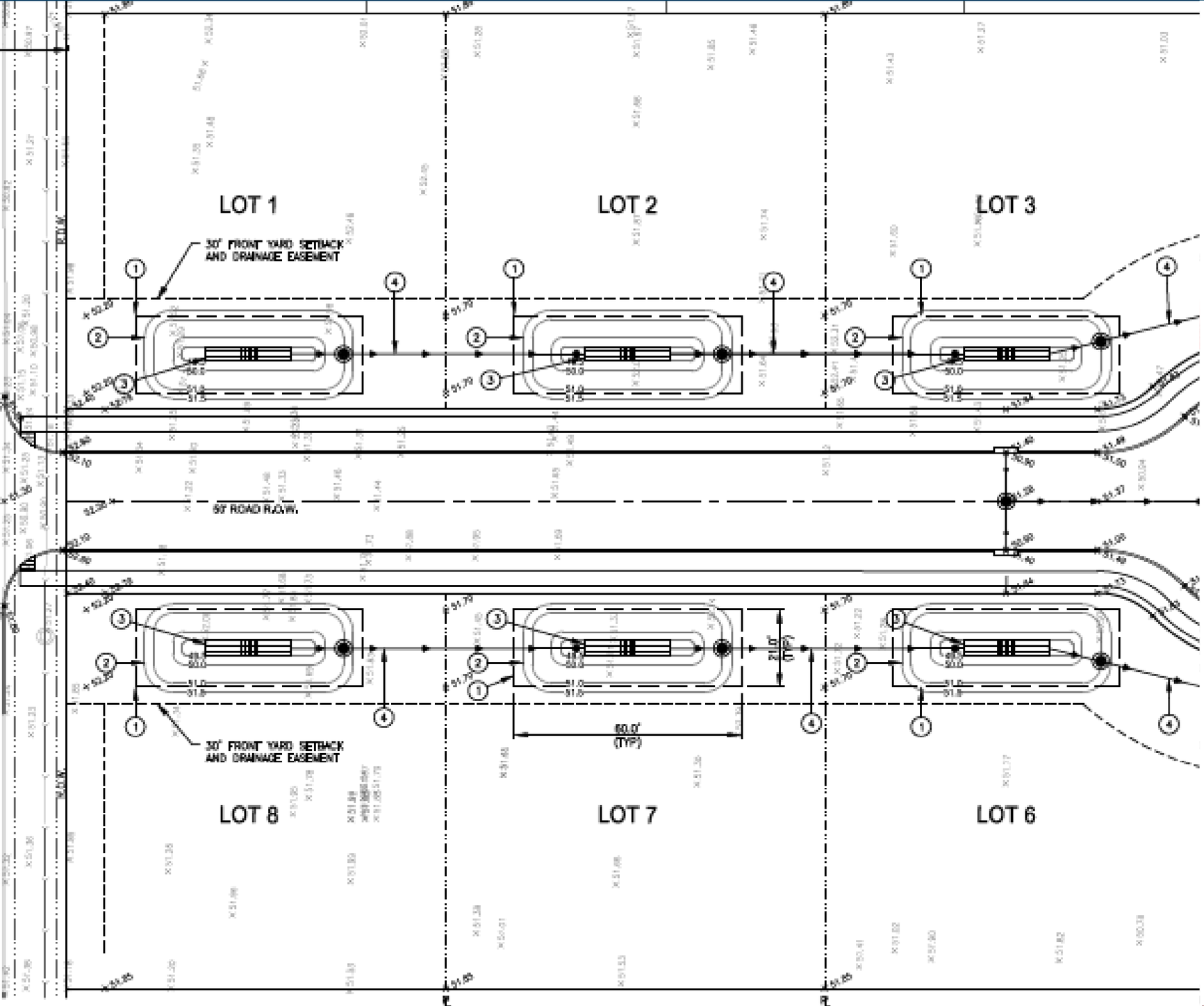
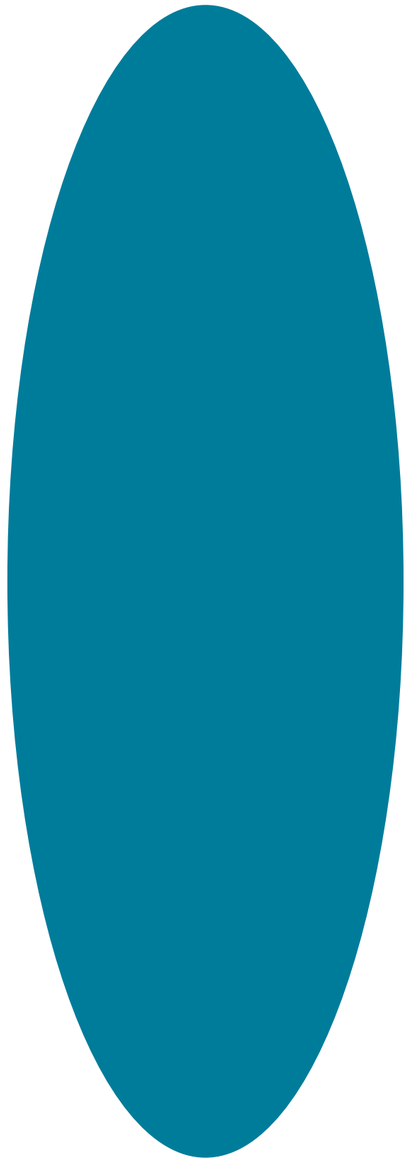
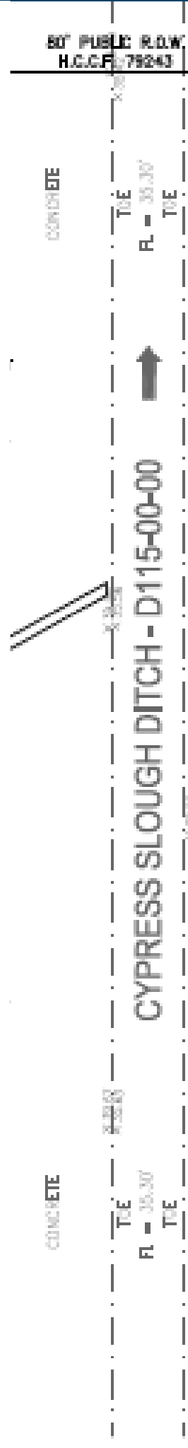
STOP


LOT 1
LOT 2
LOT 3
30' FRONT YARD SETBACK AND DRAINAGE EASEMENT
50' ROAD R.O.W.
21.0' (TYP.)
80.0' (TYP.)
30' FRONT YARD SETBACK AND DRAINAGE EASEMENT
LOT 8
LOT 7
LOT 6

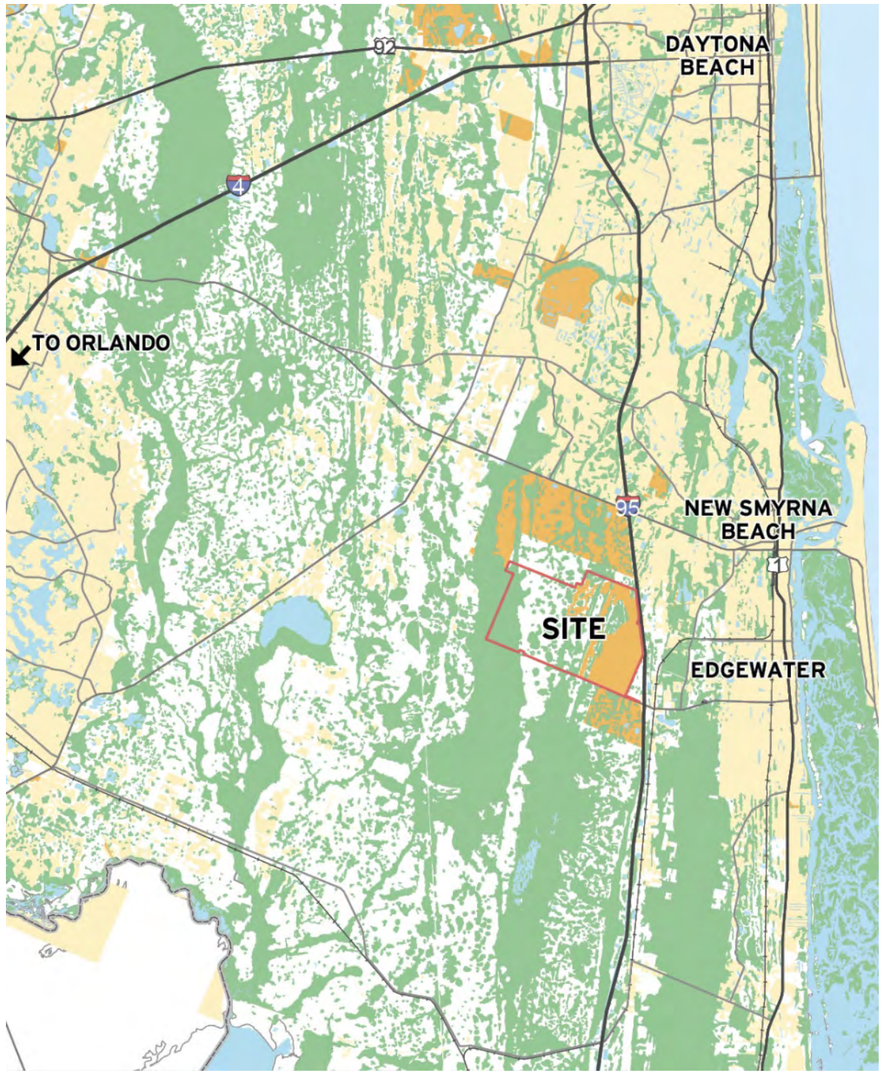



80' PUBLIC R.O.W.
H.C.C.F. 79243
CONCRETE
T.E
R. = 35.30'
T.E
CYPRESS SLOUGH DITCH - D115-00-00
CONCRETE
T.E
R. = 35.30'
T.E

GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration Case Study

- This 5,187-acre master plan evolved significantly over its 4-year permitting process.
- Designs were for 8,500 dwelling units.
- It was fully entitled earlier this summer based on the 2009 design.
- Restoration is entitled to create a mixed-use, transit oriented community with 3.5 million ft^2 of commercial space.



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GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration Case Study

Benchmarking Performance:
Roads

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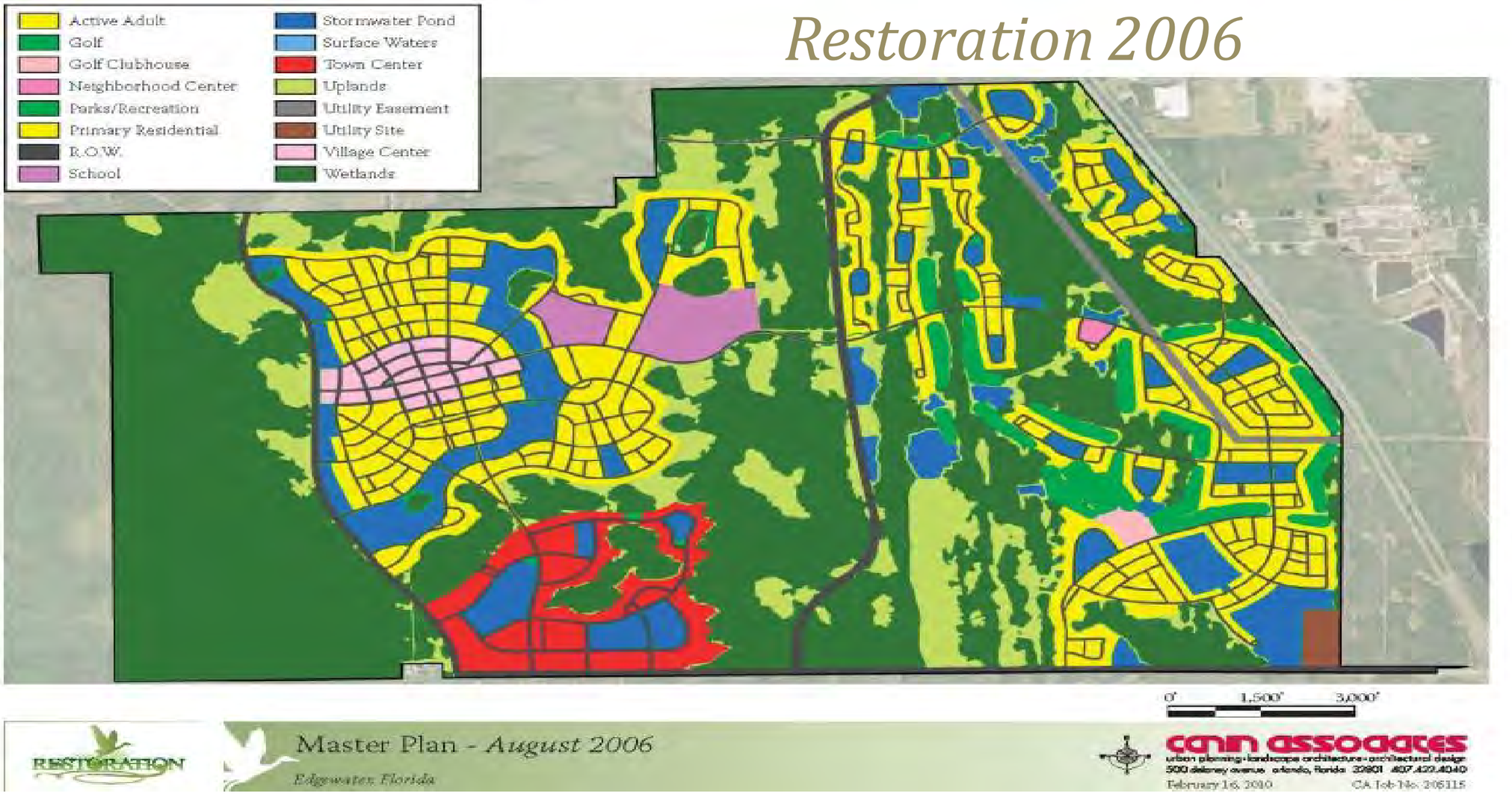
GSI: WHAT'S GREEN GOT TO DO WITH IT

Conventional Approach



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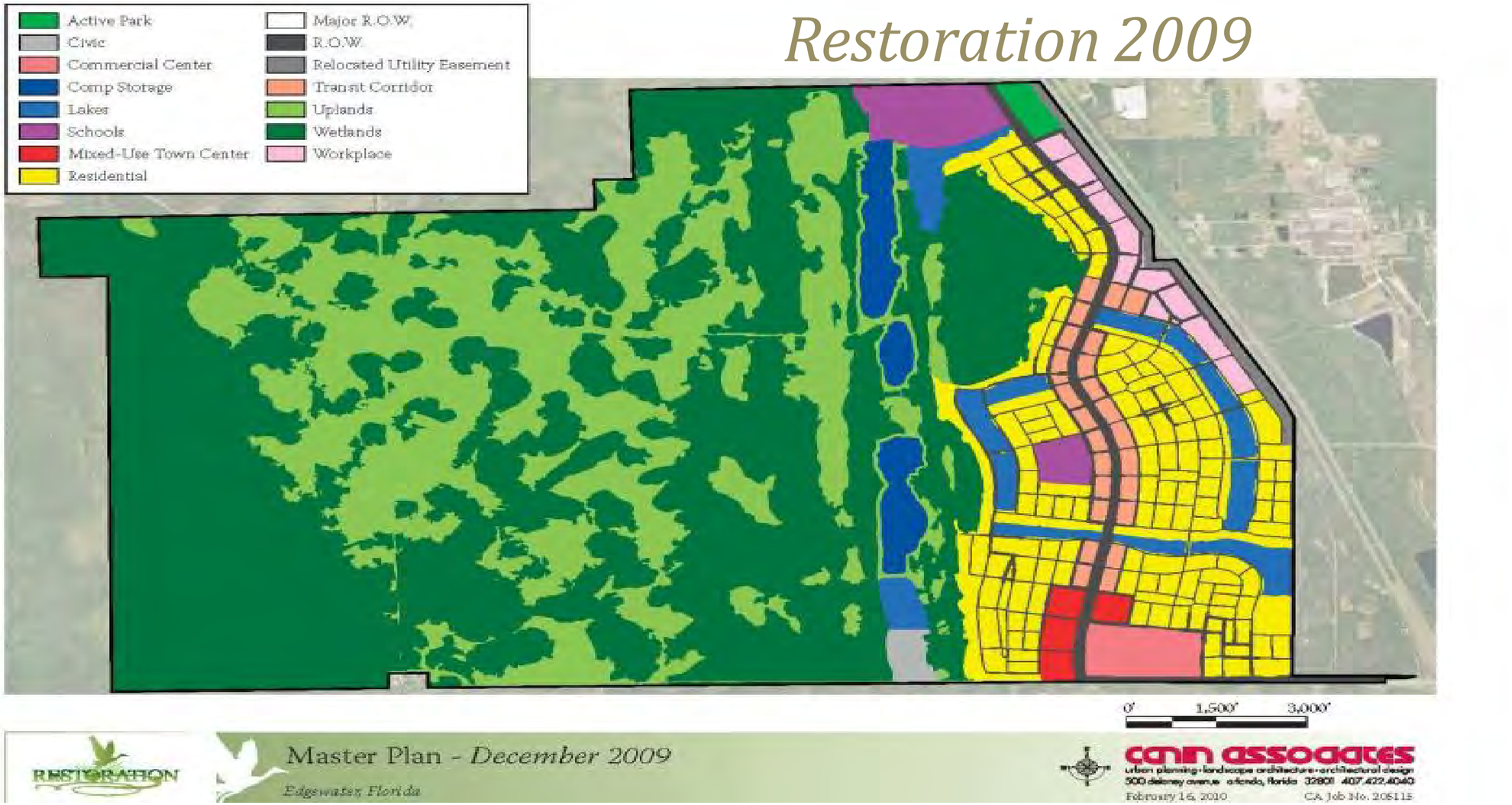
GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration's 2006 Road Infrastructure Life Cycle Analysis (50-year Life)

Location and Type	Description	ROW (Ft)	Miles	Lane Miles	$/Linear Ft	Cost	Annual $MtCO_2e$
Onsite: A	6-lane divided	150	5.45	32.7	$2,000	$57,552,000	2,289
Onsite: B	4-lane divided	124	2.17	8.68	$1,500	$17,186,400	608
Onsite: D	2-way street with bike lanes and on-street parking	70	9.36	18.72	$1,000	$49,420,800	1,310
Onsite: E	2-way street with parking on 1 side	52	50.27	100.54	$800	$212,340,480	7,038
Offsite: A	6-lane divided	150	2.58	15.48	$2,000	$27,244,800	1,084
Offsite: B	4-lane divided	124	2.51	10.04	$1,500	$19,879,200	703

GSI: WHAT'S GREEN GOT TO DO WITH IT

GSI Approach



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GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration's 2009 Road Infrastructure Life Cycle Analysis (50-year Life)

Location and Type	Description	ROW (Ft)	Miles	Lane Miles	$ / Linear Ft	Cost	Annual $MtCO_2e$
Onsite: A	6-lane divided	150	0.67	4.02	$2,000	$7,075,200	281
Onsite: C	6-lane boulevard with streetcar frontage lanes and parking	190	2.68	16.08	$4,000	$56,601,600	1,126
Onsite: D	2-way street with bike lanes and on-street parking	70	6.03	12.06	$1,000	$31,838,400	844
Onsite: E	2-way street with parking on 1 side	52	26.75	53.5	$800	$112,992,000	3,745
Offsite: A	6-lane divided	150	2.81	16.86	$2,000	$29,673,600	1,180

Dr. Pierce Jones, University of Florida

GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration's 2006 to 2009 Road Infrastructure Comparison

Inputs	2006 Plan	2009 Plan
• Miles:	72	39
• Lane miles:	186	103
• Impervious area, ft^2	17,000,000	10,000,000
• Landscaped area, ft^2	6,000,000	3,000,000
• Cost	$383,623,680	$238,180,800
GHG Emissions		
• Mtons CO2e/yr:	13,031	7,176

GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration's 2006 to 2009 Road Infrastructure Comparison

Inputs	2006 Plan	2009 Plan
•		
•		
•		
•		
• Cost	$[illegible]	$[illegible]
GHG Emissions		
• Mtons CO2e/yr:	13,031	7,176

Road Construction Costs Avoided:

$145,000,000

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GSI: WHAT'S GREEN GOT TO DO WITH IT

Restoration Case Study

Benchmarking Performance:
Transportation

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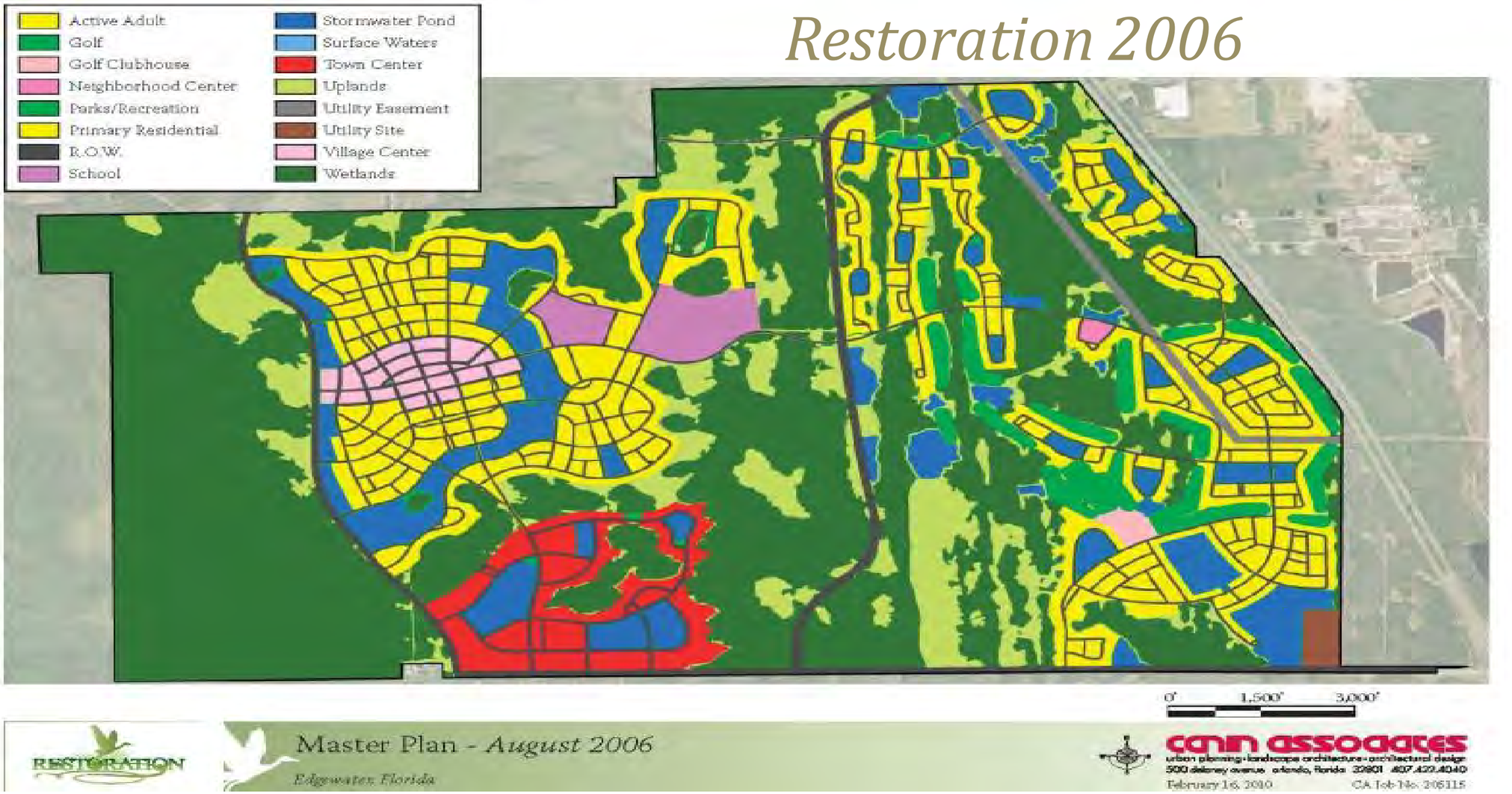
GSI: WHAT'S GREEN GOT TO DO WITH IT

Vehicle Miles Traveled Analysis- 2006 Design



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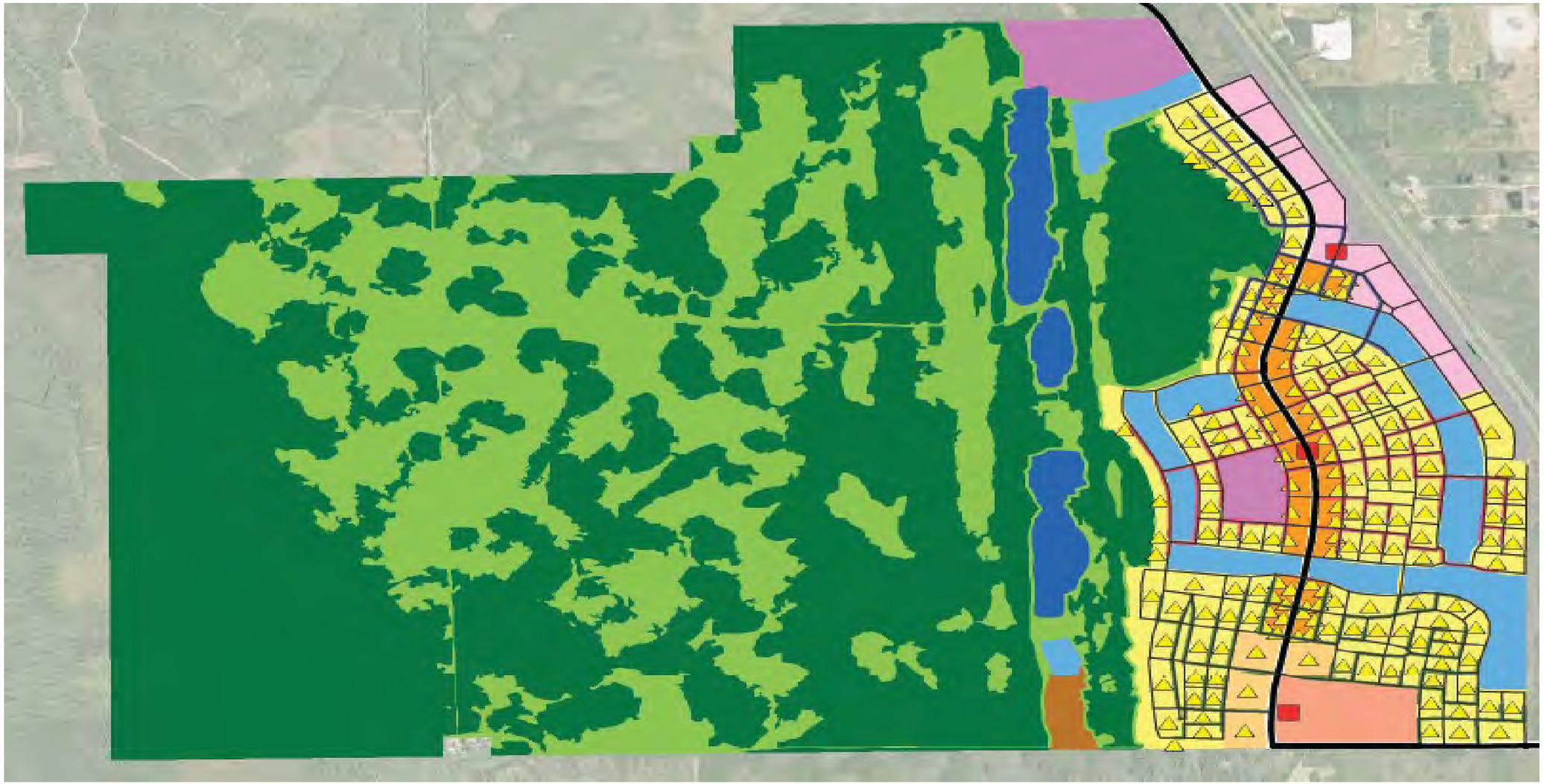
GSI: WHAT'S GREEN GOT TO DO WITH IT

Vehicle Miles Traveled Analysis- 2009 Design



GSI: WHAT'S GREEN GOT TO DO WITH IT

Vehicle Miles Traveled Analysis- Comparison

Inputs:	2006 Plan	2009 Plan
• Trips, #	68,000	68,000
• Internal trip length, miles	1.75	0.38
• Onsite trip capture, %	20%	50%
• Total daily travel, miles	594,000	349,000
• Gasoline, gallons/day	29,254	17,216
GHG Emissions		
• Mtons CO2e/yr	98,900	58,200

GSI: WHAT'S GREEN GOT TO DO WITH IT

Vehicle Miles Traveled Analysis- Comparison

Inputs:	2006 Plan	2009 Plan
• Trips, #	68,000	68,000
• Gallons Per Year Not Consumed:		**4,400,000**
• Fuel Costs Per Year Avoided:		**$13,000,000**
GHG Emissions		
• Mtons CO2e/yr	98,900	58,200

GSI: WHAT'S GREEN GOT TO DO WITH IT

Case Study- Habitat Trails, Benton, Arkansas

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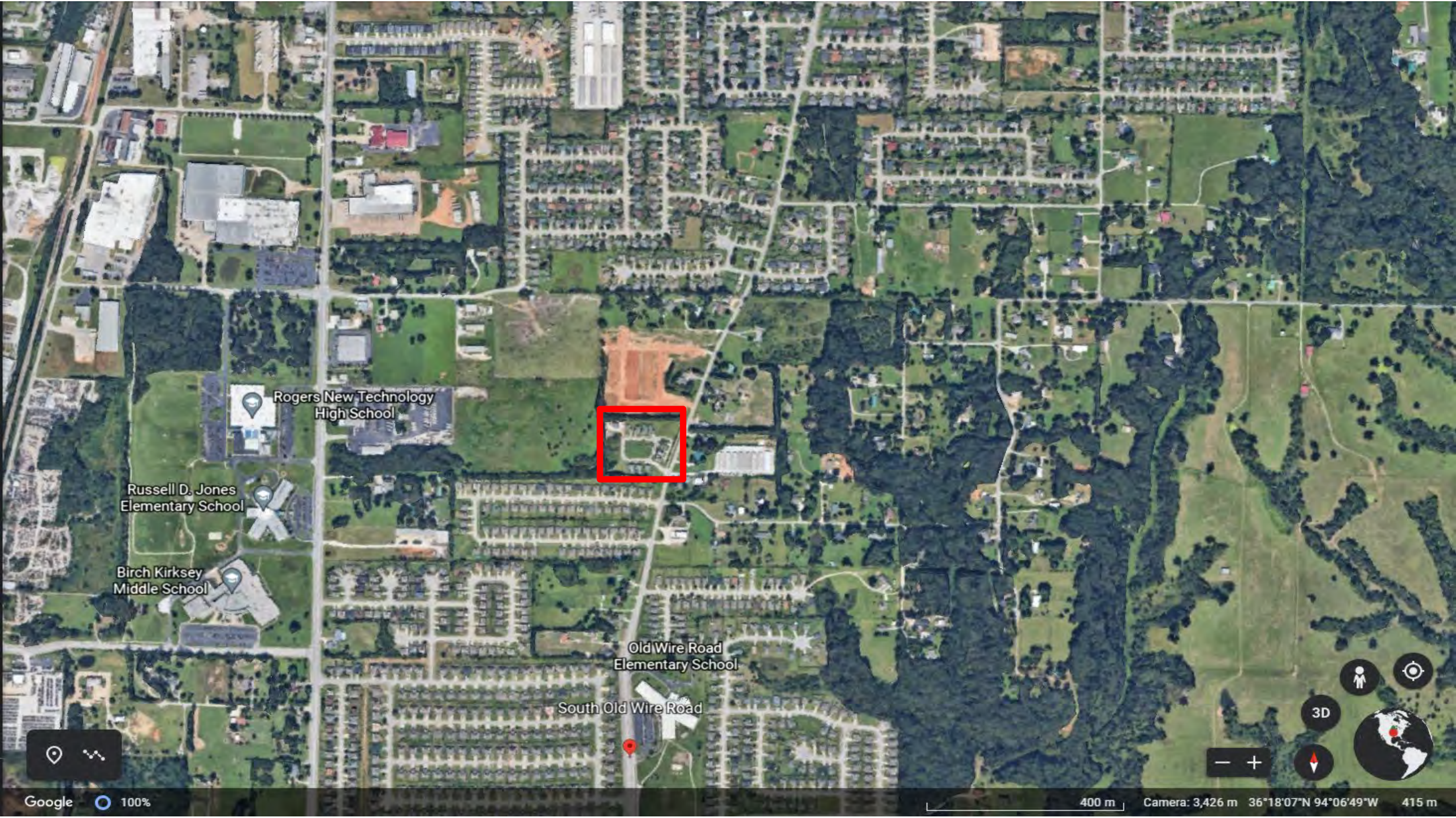
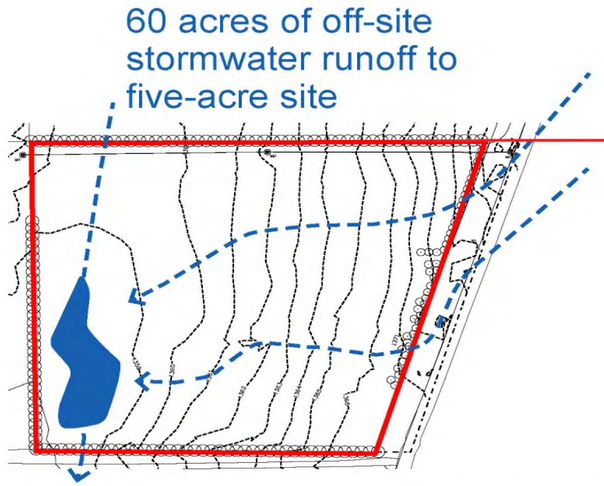
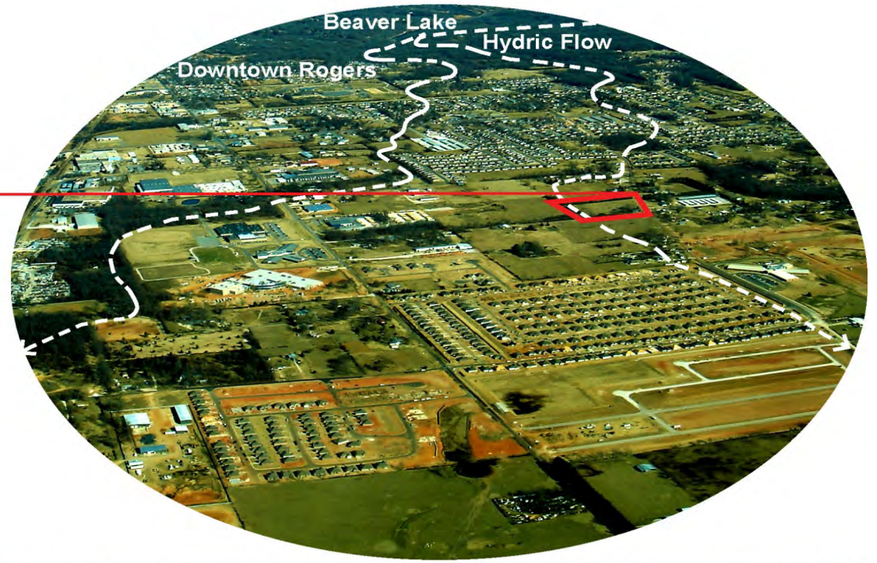
Jeffrey Huber, University of Arkansas


Rogers New Technology High School
Russell D. Jones Elementary School
Birch Kirksey Middle School
Old Wire Road Elementary School
South Old Wire Road
3D
Google
100%
400 m
Camera: 3,426 m 36°18'07"N 94°06'49"W 415 m

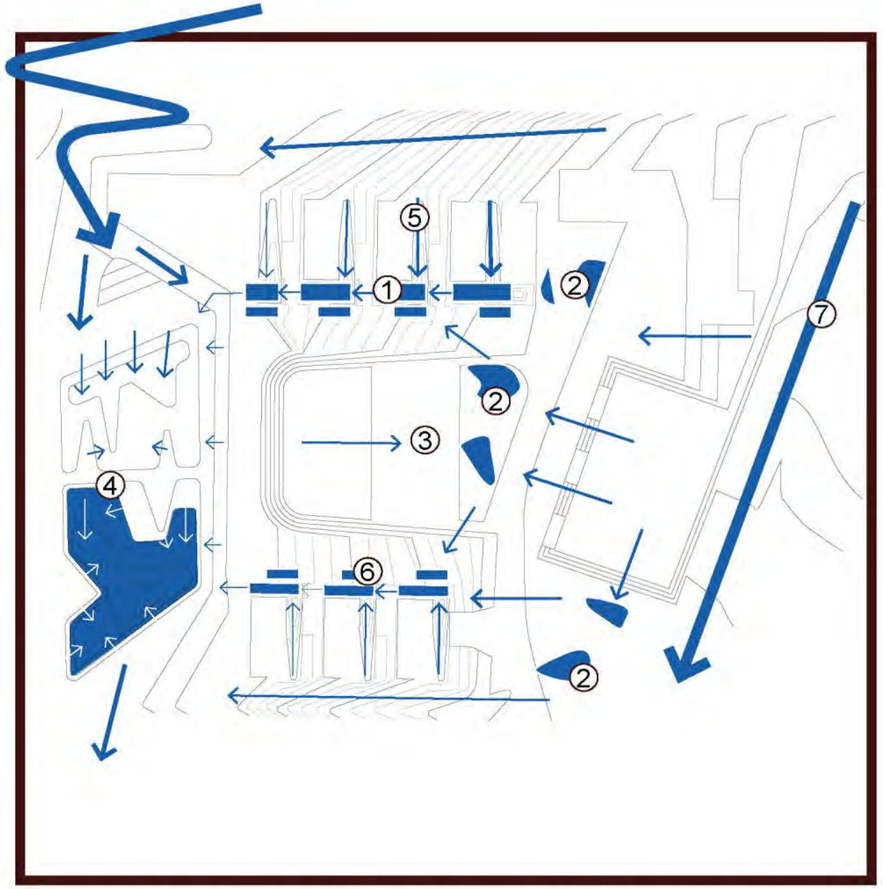
GSI: WHAT'S GREEN GOT TO DO WITH IT





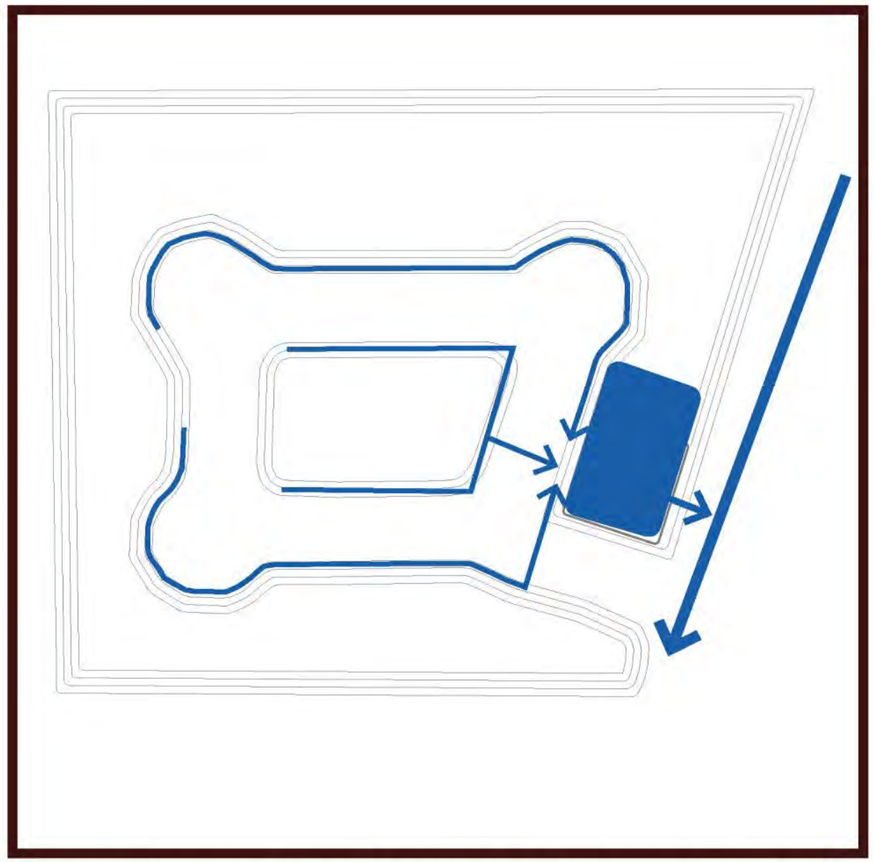
GSI: WHAT'S GREEN GOT TO DO WITH IT

GSI Design Versus Conventional Design



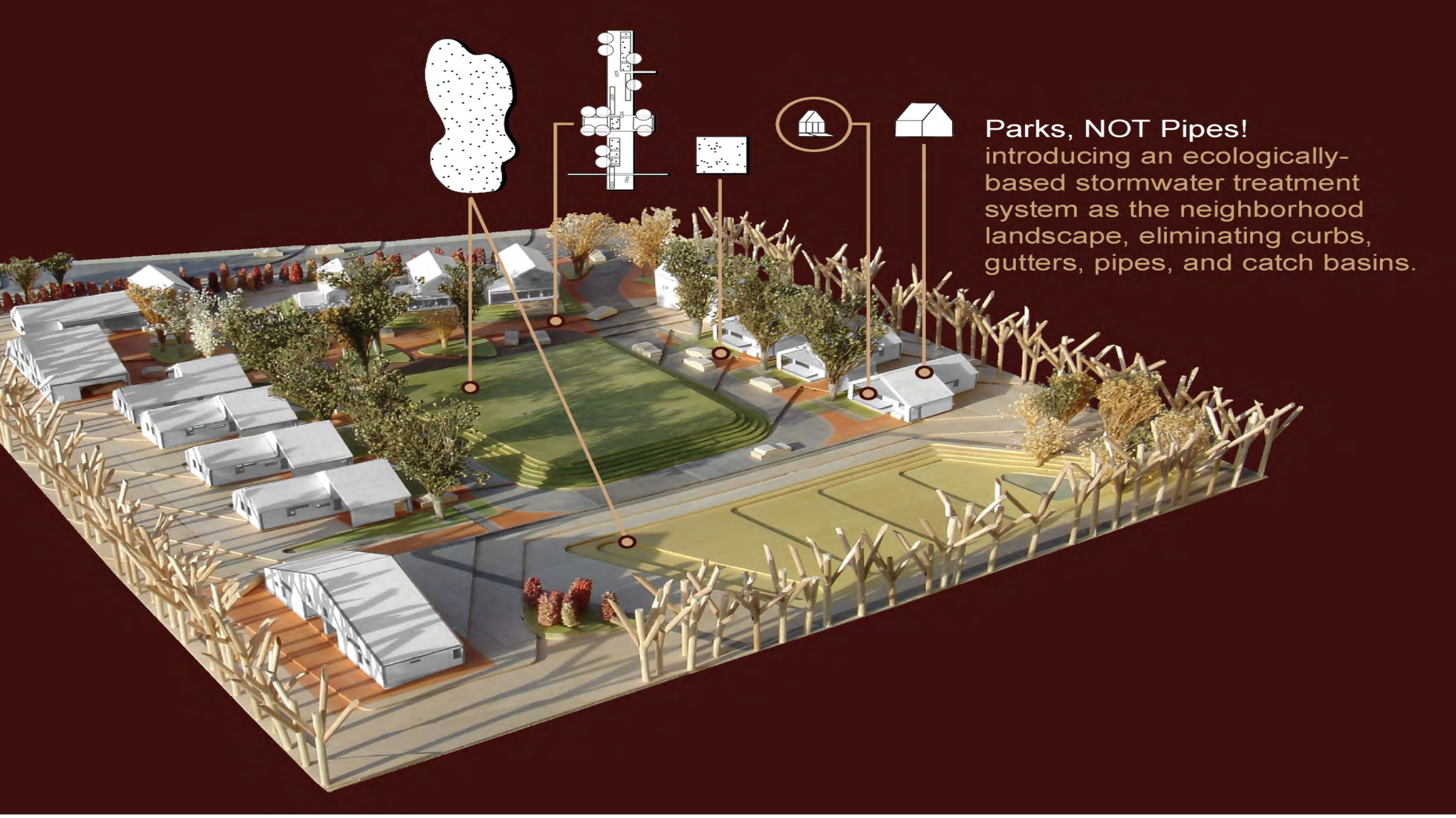
Ecologically Engineered Stormwater Treatment System

bioswale-conveyance/treatment 1
infiltration trenches-subgrade retention 2
sheetflow-recharge 3
wet meadow-treatment/recharge 4
5 side yard bioswales-treatment/conveyance
6 parking filter strips-sediment control
7 piped civil stormwater catchment

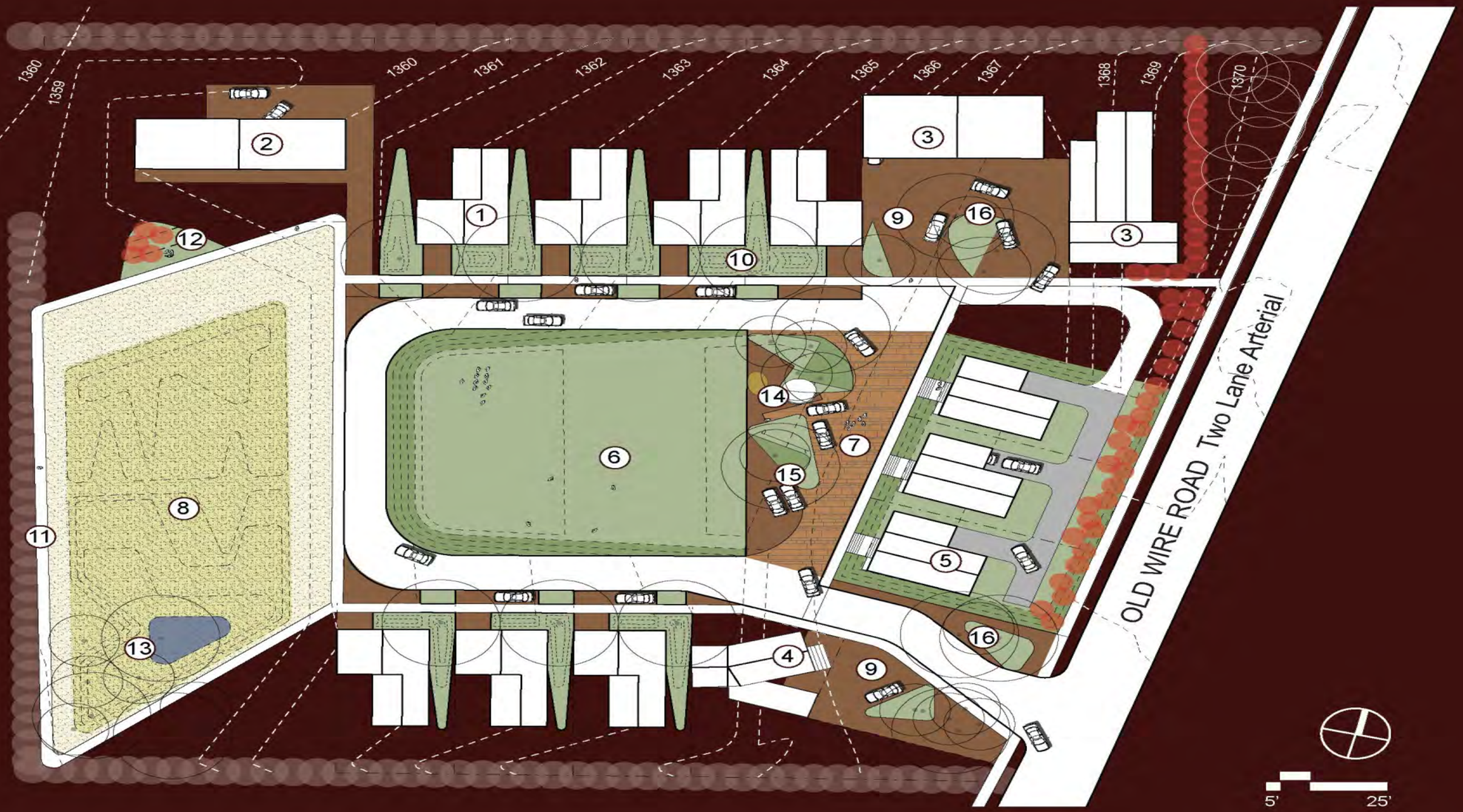


Conventionally Engineered Stormwater Detention System

"pipe and pond solution"



Parks, NOT Pipes!
introducing an ecologically-based stormwater treatment system as the neighborhood landscape, eliminating curbs, gutters, pipes, and catch basins.



green street bungalow 1
meadow duplex 2
autocourt duplex 3
entry court house 4
5 urban vernacular
6 lawn
7 neighborhood plaza
8 wet meadow
auto court 9
bioremediation swales 10
walking trail 11
recreation mound/water diverter 12
13 new tree stand
14 gazebo, mailboxes, playground equipment
15 infiltration trench
16 stormwater gardens


Estimated Curb and Gutter Design Cost of Construction: $425 per Linear Foot
Estimated GSI Cost of Construction: $250 per Linear Foot
3D

GSI: WHAT'S GREEN GOT TO DO WITH IT

Benefits of Green Infrastructure- Triple Bottom Line

Environmental

- Reduces water pollution and improves quality of ground and surface waters
- Reduces urban heat island effect
- Protects and enhances aquatic and wildlife habitats

Social

- Improves aesthetics of communities
- Improves water and air quality
- Increases appeal of recreational opportunities

Economic

- Reduces clearing and grading costs, and long-term costs of stormwater management
- Increases property values
- Lower heating and energy costs

Reference FDEP Website: GSI.floridadep.gov

Thank you!!

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