

Increasing Climate Resilience throughout MS4 Watershed Improvement Plans



RUTGERS UNIVERSITY
Water Resources Program
New Jersey Agricultural Experiment Station



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What is an MS4 Permit?

- Municipal Separate Storm Sewer System = MS4
- Five-year General permit (1/1/23 thru 12/31/27)
- The MS4 permitting program was created in 2004 and is required by both federal and state regulations to address water quality and flooding issues in municipal stormwater systems.
- The MS4 Tier A Permit was recently updated with the new permit becoming effective on January 1, 2023.

A primary objective of the MS4 stormwater program

... shall be to implement best management practices and other measures that are designed to reduce the discharge of pollutants from the permittee's MS4, municipal maintenance yards and other ancillary operations to the maximum extent practicable pursuant to N.J.A.C. 7:14A-25.6(a)1 and 40 CFR 122.34(a), to protect water quality, and to satisfy the applicable water quality requirements of the Clean Water Act.

Two Fundamental National Goals of the CWA:

1. To eliminate the discharge of pollutants into the nation's waters (zero discharge of pollutants by 1985)
2. To achieve water quality levels that are fishable and swimmable by mid-1983

Components of NJ MS4 Permit

Stormwater pollution prevention plan

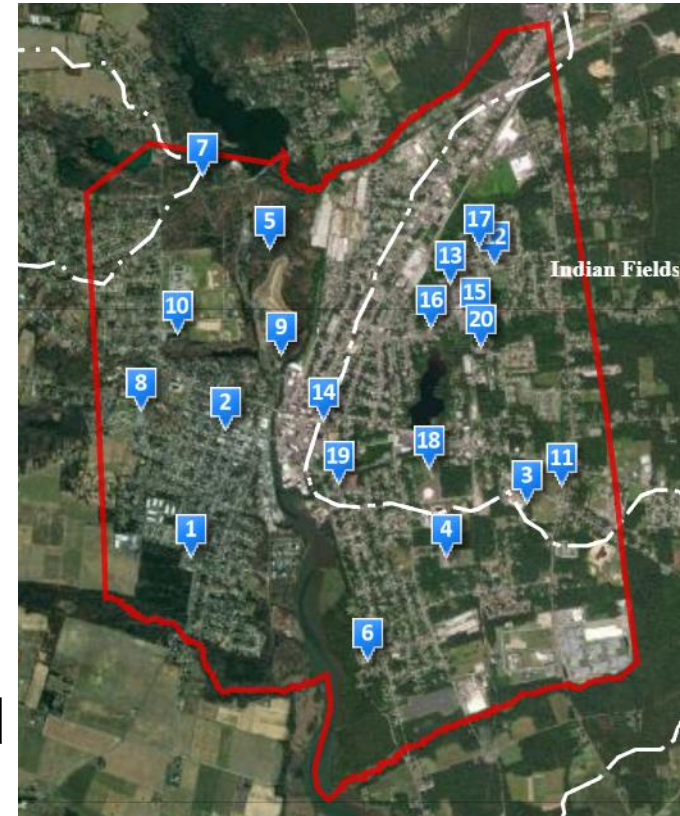
Minimum Standards:

1. Public involvement and participation
2. Local public education and outreach
3. Construction site stormwater runoff standards
4. Construction stormwater management in new development and redevelopment
5. Pollution prevention/good housekeeping for municipal operators
6. MS4 mapping, stream scouring, and illicit discharge detection and elimination program

Watershed improvement plan

Watershed Improvement Plan

- Designed to improve water quality problems
- Focused on reducing the MS4 contribution of pollutants to waterbodies with listed impairments and TMDLs
- Reducing or eliminating flooding with priority given based on human health and safety, environmental impacts, and frequency of occurrence
- Plan shall be developed with input from residents, businesses, neighboring towns, other dischargers



Total Maximum Daily Loads (TMDLs)

- A TMDL is a plan for restoring water bodies that have a water quality impairment
- A TMDL identifies the maximum amount of a pollutant allowed to enter a water body so that it will meet and continue to meet the water quality standard
- A TMDL identifies both point sources and nonpoint sources of pollution.
- Point sources include wastewater treatment plant discharges and stormwater outfalls from residential and other urban land uses
- Non-point sources include runoff from agricultural, forested, and barren land uses.
- NJDEP has developed a TMDL Look-up Tool which allows municipalities to view the TMDLs and associated pollutants that are applicable to the watersheds in their community.

Other Water Quality Impairments

- In addition to TMDLs, water body impairments also need to be addressed through the Watershed Improvements Plan
- The list of impaired waterways in New Jersey (303D List) are identified in the NJDEP's Integrated Assessment Report



Three phases of watershed improvement plans

Phase 1 – Prepare and submit the Watershed Inventory Report; conduct outreach (*January 1, 2026*)

- Summarize/map required information, some is available from the Department's GIS database

Phase 2 – Prepare and submit the Watershed Assessment Report; conduct outreach (*January 1, 2027*)

- Assess potential projects with estimates of the reduction in pollutant loading & funding need

Phase 3 – Prepare and submit the Watershed Improvement Plan Report; conduct outreach (*December 1, 2027*)

- Summarize proposed projects with improvement expected, comments received, costs, coordination with other regulatory programs, and implementation schedule

Watershed Inventory Report

(Due 1/1/2026)

- i. All stormwater outfalls owned/operated by the permittee
- ii. The drainage area for each outfall(s)
- iii. The receiving waterbodies of those outfalls
- iv. The water quality classification of all receiving waterbody segments
- v. All stormwater interconnections from the municipality into another entities' storm or sanitary sewer system
- vi. The drainage area for each interconnection into another entities' storm or sanitary sewer system

Watershed Inventory Report (cont'd)

- vii. All stormwater connection points into the municipality from another entities' storm sewer system
- viii. All storm drain inlets owned/operated by the permittee
- ix. Area associated with each TMDL for waters that lie within or bordering the municipality
- x. Area associated with each water quality impairment for waters that lie within or bordering the municipality
- xi. Overburdened communities
- xii. Impervious areas
- xiii. The location and ownership of all stormwater outfalls and basins/ infrastructure not owned/operated by the permittee.



Watershed Assessment Report (Due 1/1/2027)

- i. An assessment of potential water quality improvement projects by sub-watershed and parameter
- ii. An estimate of the percent reduction in loading of the TMDL/impaired parameters due to project(s)
- iii. A summary of feedback from public information sessions
- iv. An estimate of funding needs for each project, and identification of potential funding sources, including the New Jersey Water Bank (NJWB); the formation of an SWU, using 319 grants, FEMA BRIC grants
- v. An estimate of an implementation schedule.

Final Watershed Improvement Plan (Due 12/1/2027)

- i. A summary of proposed locations and load reductions of water quality improvement projects, both public and private, to be implemented
- ii. A summary of the public comments received, and the changes made to the Final Plan
- iii. A summary of how the projects will be coordinated with other regulatory requirements, such as:
 - flood protection
 - endangered habitat/species
 - surface & ground drinking water protection
 - climate change/resiliency
 - green infrastructure/stormwater management requirements
 - wildlife corridors
 - green acres

Final Watershed Improvement Plan (cont'd)

- environmental justice
 - Combined Sewer Overflow Long Term Control Plans
 - Wetlands
 - riparian buffers
 - forest corridors
 - related ongoing projects
 - Pinelands Commission
 - Highlands Council
 - Delaware River Basin Commission
- iv. The proposed implementation schedule for the water quality improvement projects
- v. A schedule of the public information sessions to be held

Final Watershed Improvement Plan (Due 12/1/2027)

- vi. A schedule of the public information sessions to be held
- vii. Problems identified that are outside the jurisdiction of the permittee, if any. These can be related to pollutant loading due to agricultural properties, or other lands not under the jurisdiction of the municipality, and opportunities to address them
- viii. Costs, broken down by project and year, the funding opportunities that will be sought
- ix. This plan shall describe how stormwater related problems in overburdened communities have been prioritized.

Green Stormwater Infrastructure As Stormwater Improvement Projects



Green Infrastructure

...an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly.

Green Infrastructure projects:

- capture,
- filter,
- absorb, and
- reuse

stormwater to maintain or mimic natural systems and treat runoff as a resource.



Green Infrastructure Practices

Bioretention Systems

- Rain Gardens
- Bioswales
- Stormwater Planters
- Curb Extensions
- Tree Filter Boxes



Permeable Pavements

Rainwater Harvesting

- Rain Barrels
- Cisterns

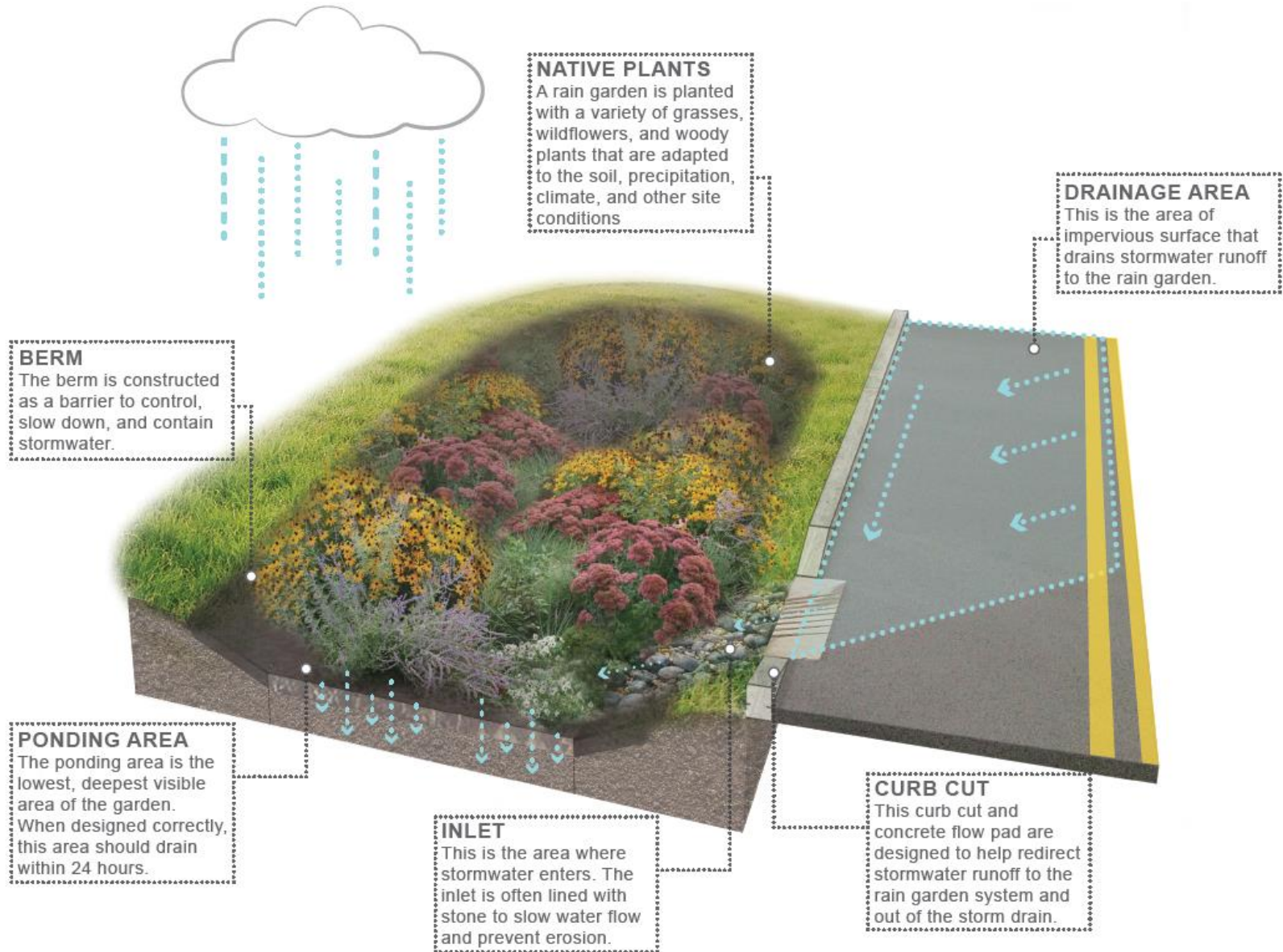
Dry Wells

Rooftop Systems

- Green Roofs
- Blue Roofs



Rain Gardens



Bioswale

NATIVE PLANTS

A bioswale is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions. The vegetation helps filter stormwater runoff as it moves through the system.

CONVEYANCE

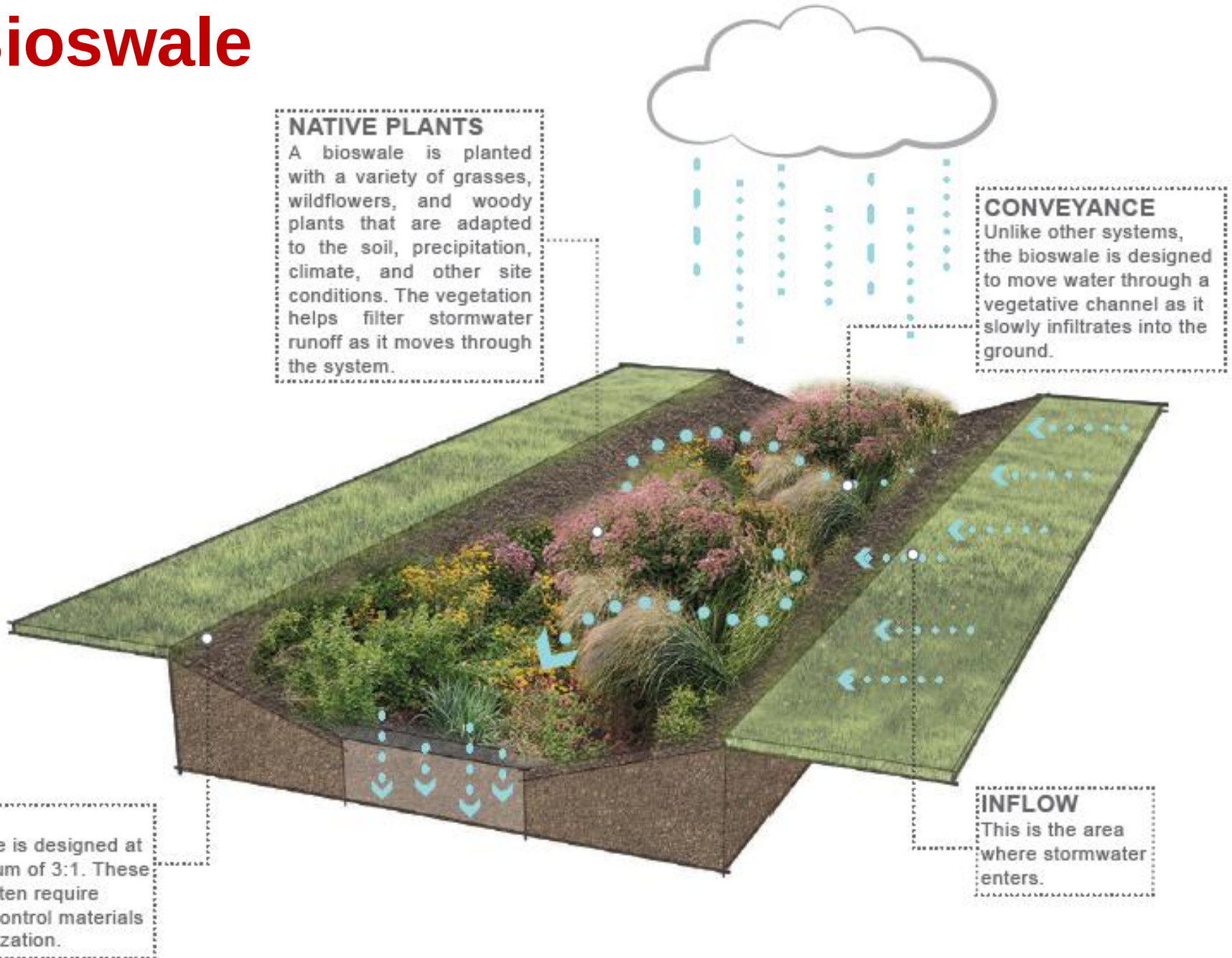
Unlike other systems, the bioswale is designed to move water through a vegetative channel as it slowly infiltrates into the ground.

SLOPE

The slope is designed at a maximum of 3:1. These slopes often require erosion control materials for stabilization.

INFLOW

This is the area where stormwater enters.



Stormwater Planters

NATIVE PLANTS

A stormwater planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

CURB CUT

This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.

CONCRETE WALL

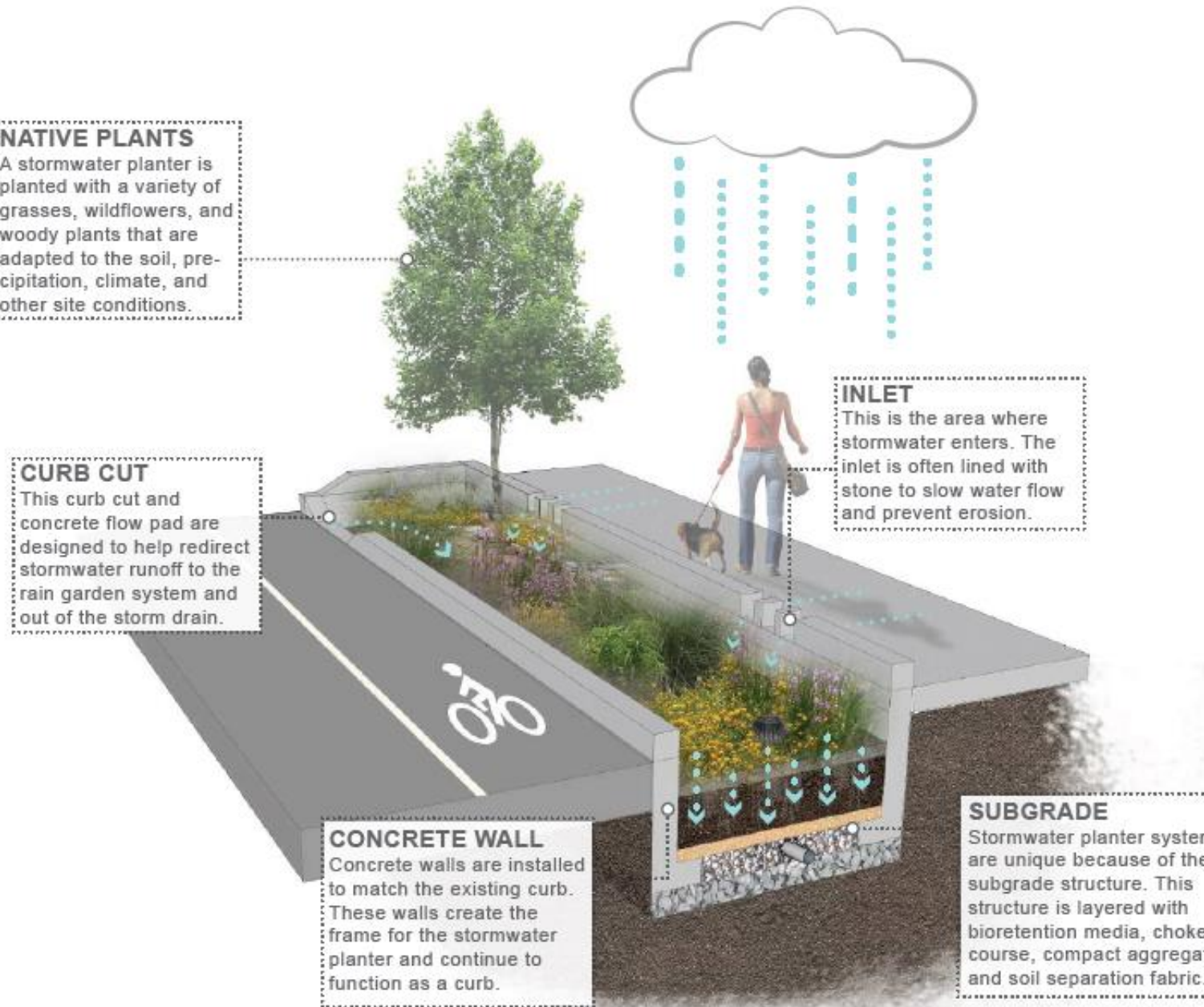
Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.

INLET

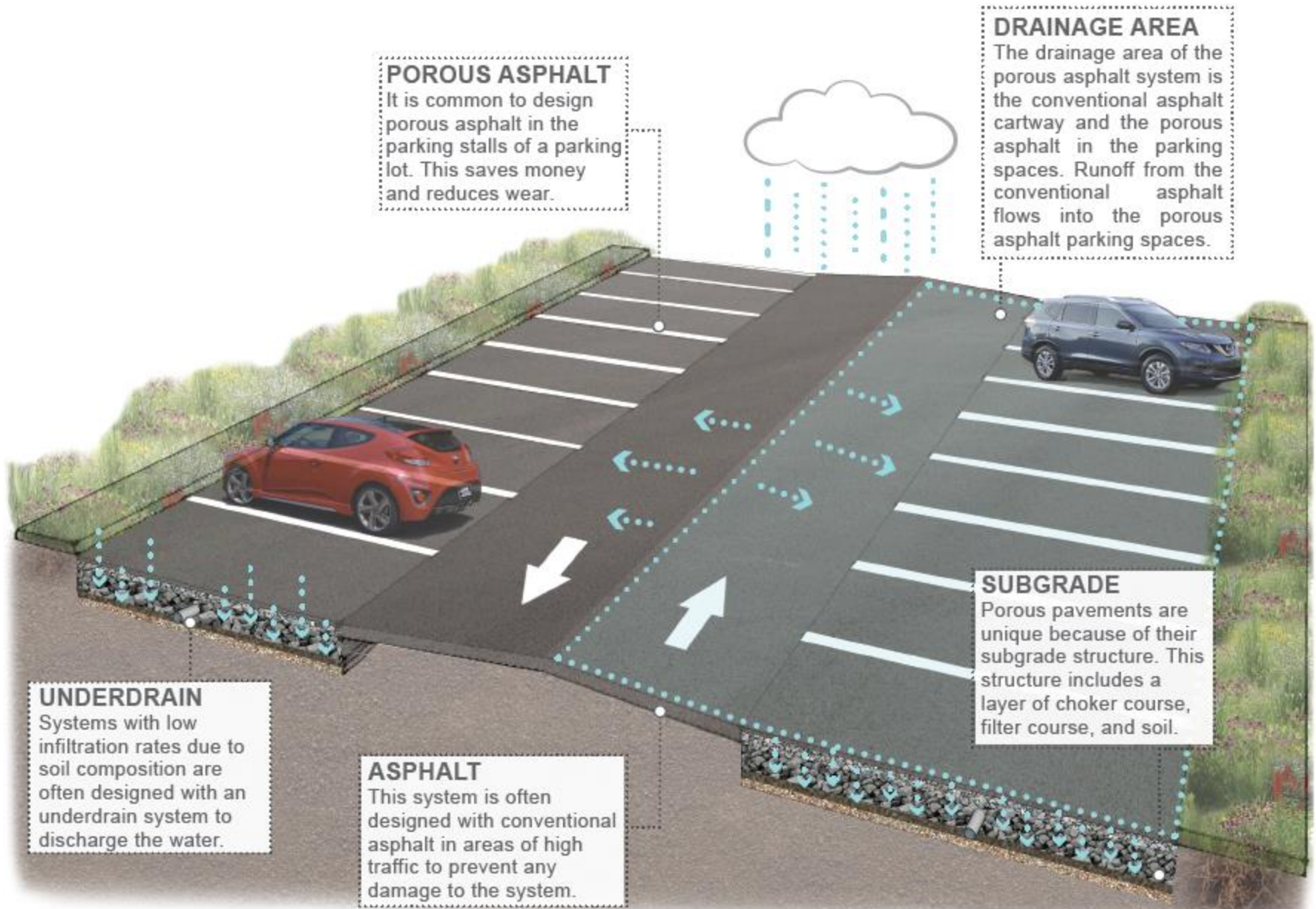
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

SUBGRADE

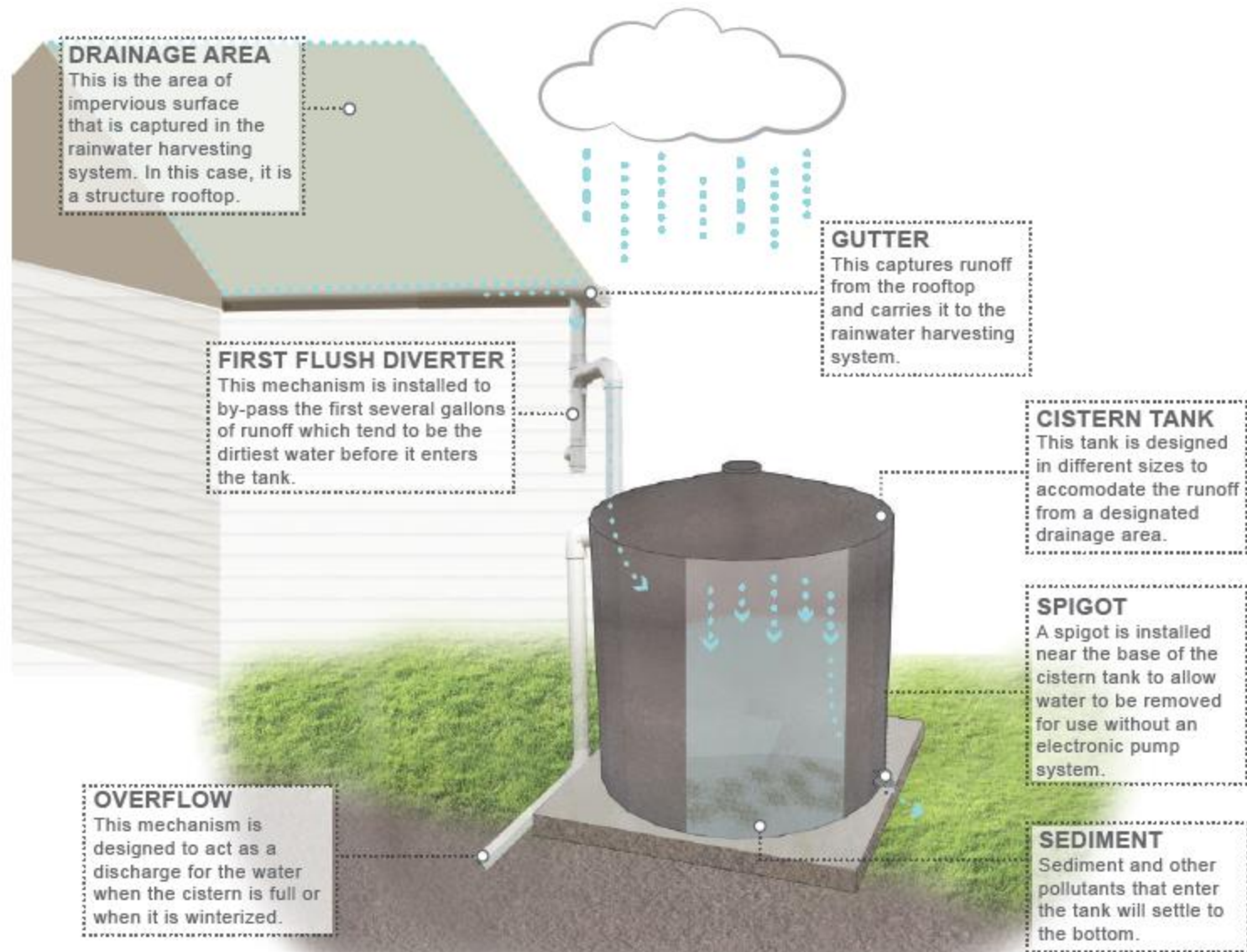
Stormwater planter systems are unique because of their subgrade structure. This structure is layered with bioretention media, choker course, compact aggregate, and soil separation fabric.



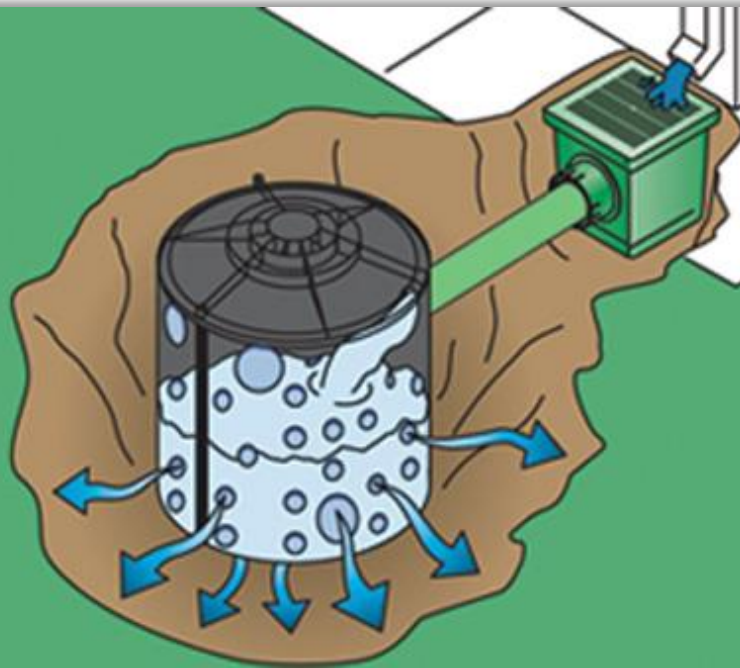
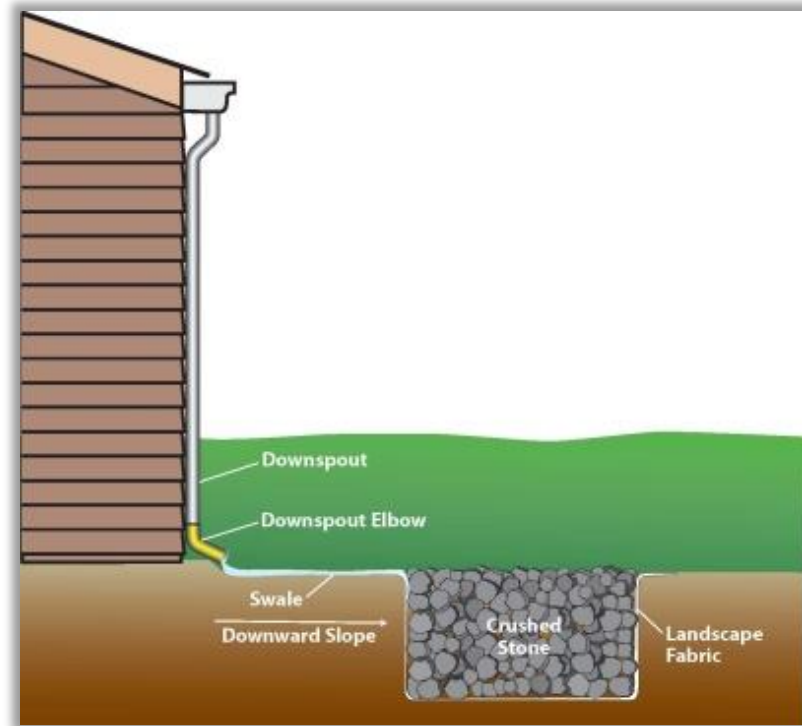
Permeable Pavement



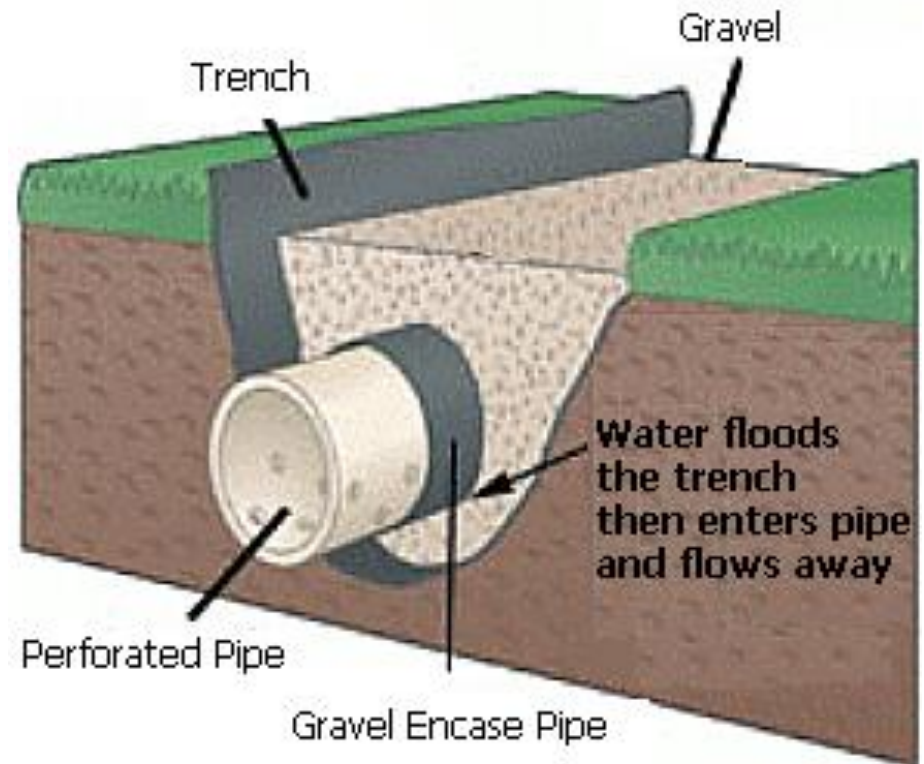
Rainwater Harvesting Systems



Dry Wells



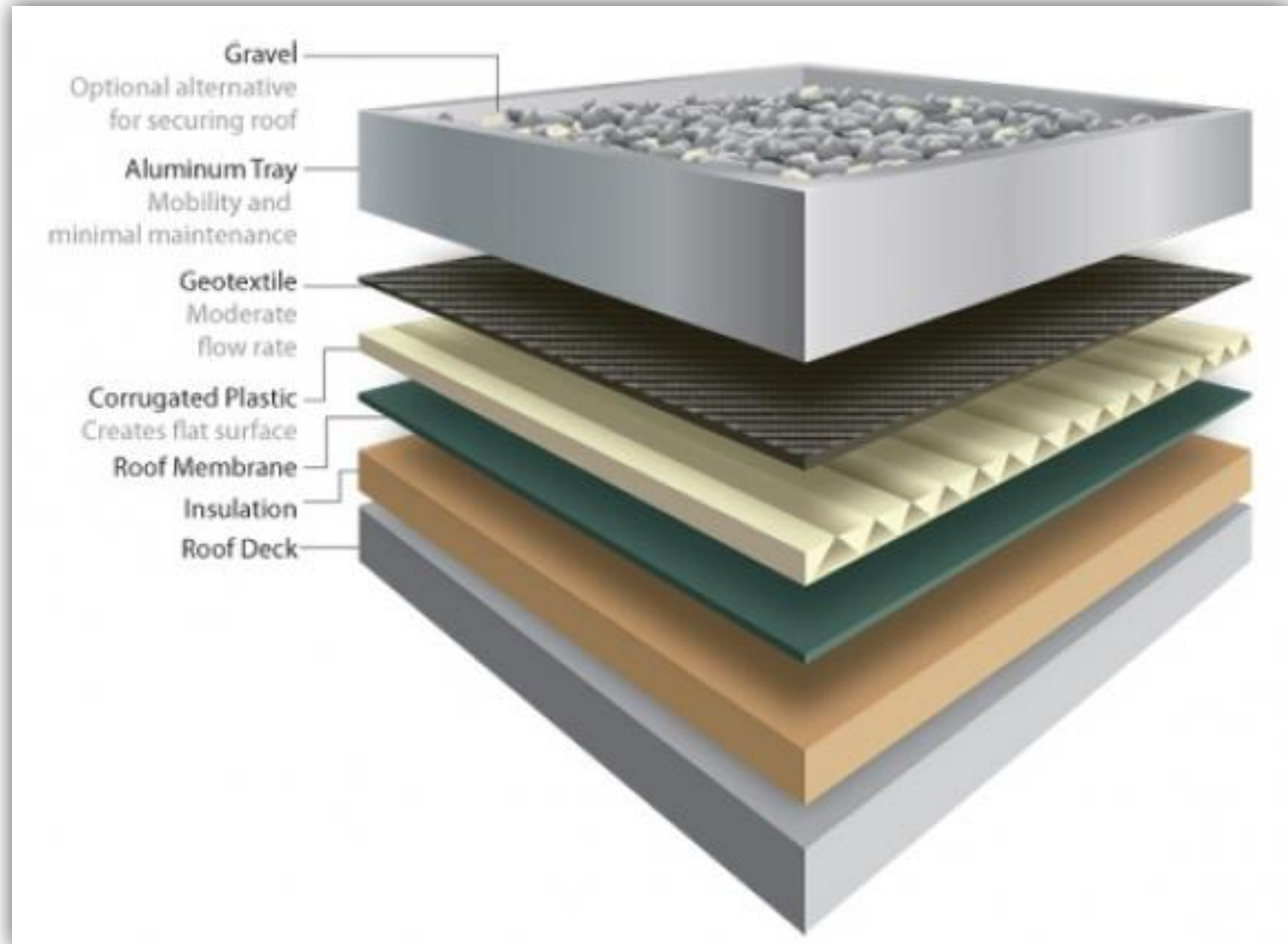
Infiltration Trench



Rooftop Practices – Green Roof



Rooftop Practices – Blue Roof



Identifying Watershed Improvement Projects





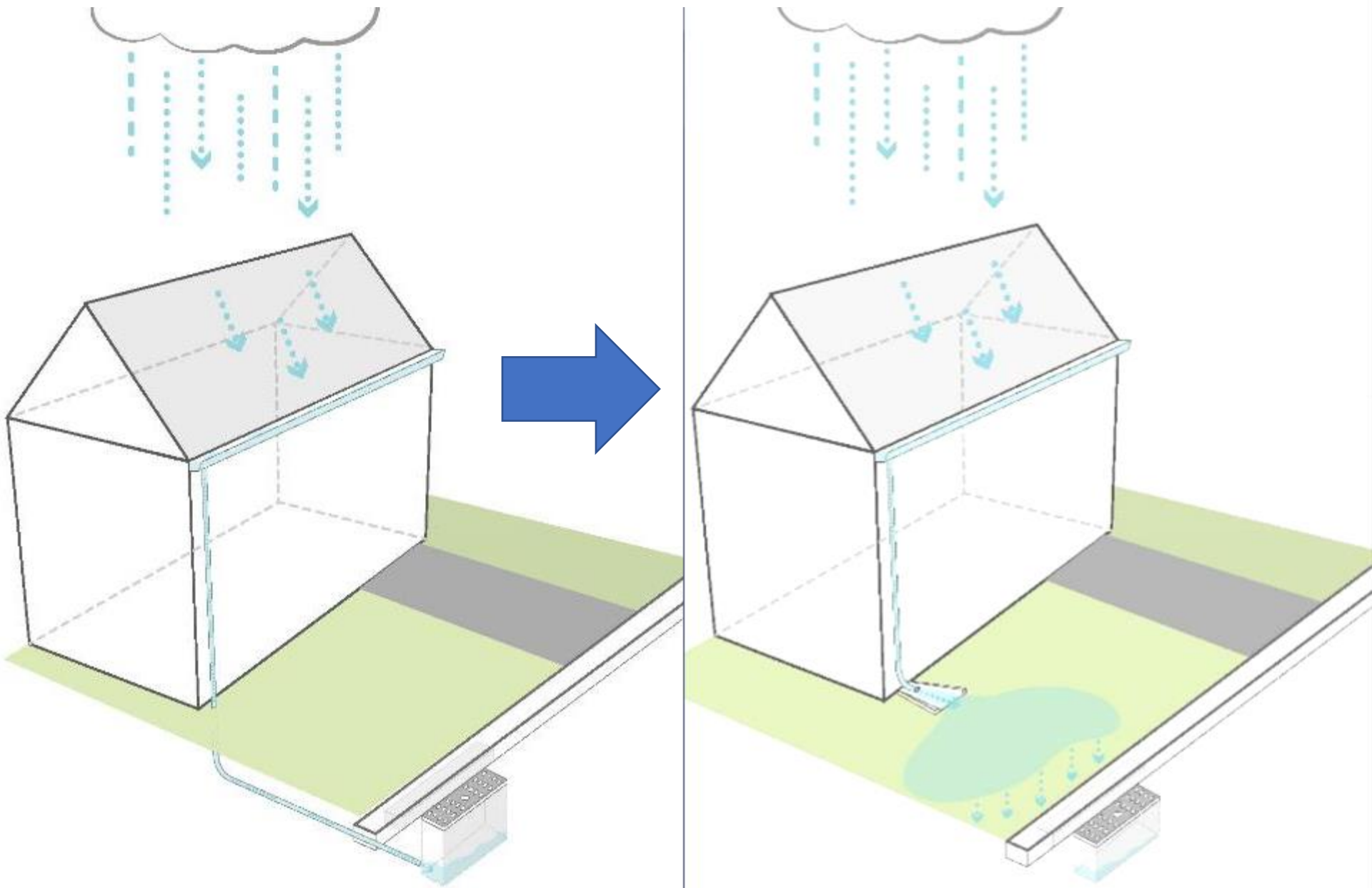
It is all about
controlling runoff
from impervious
surfaces



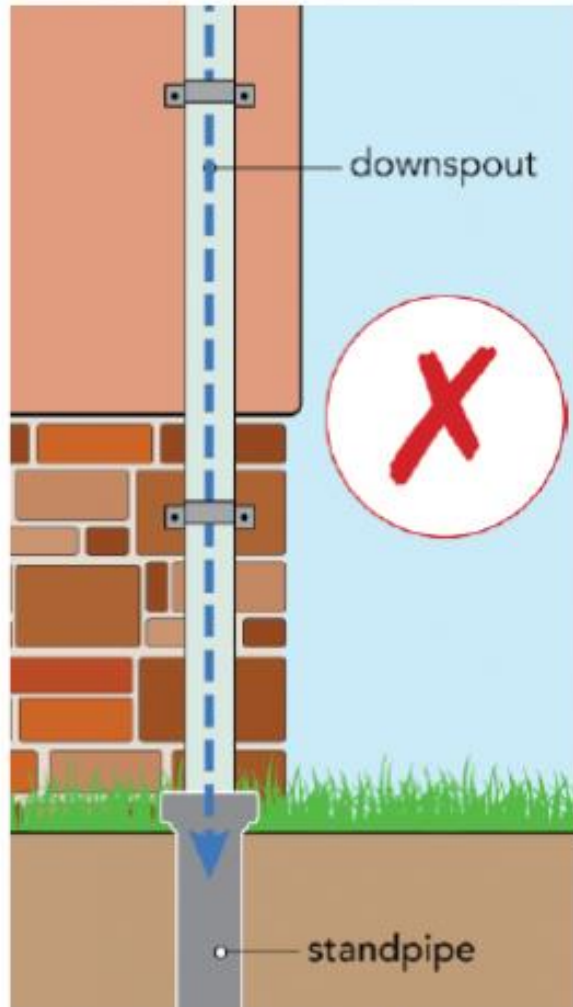
Connected or Disconnected?



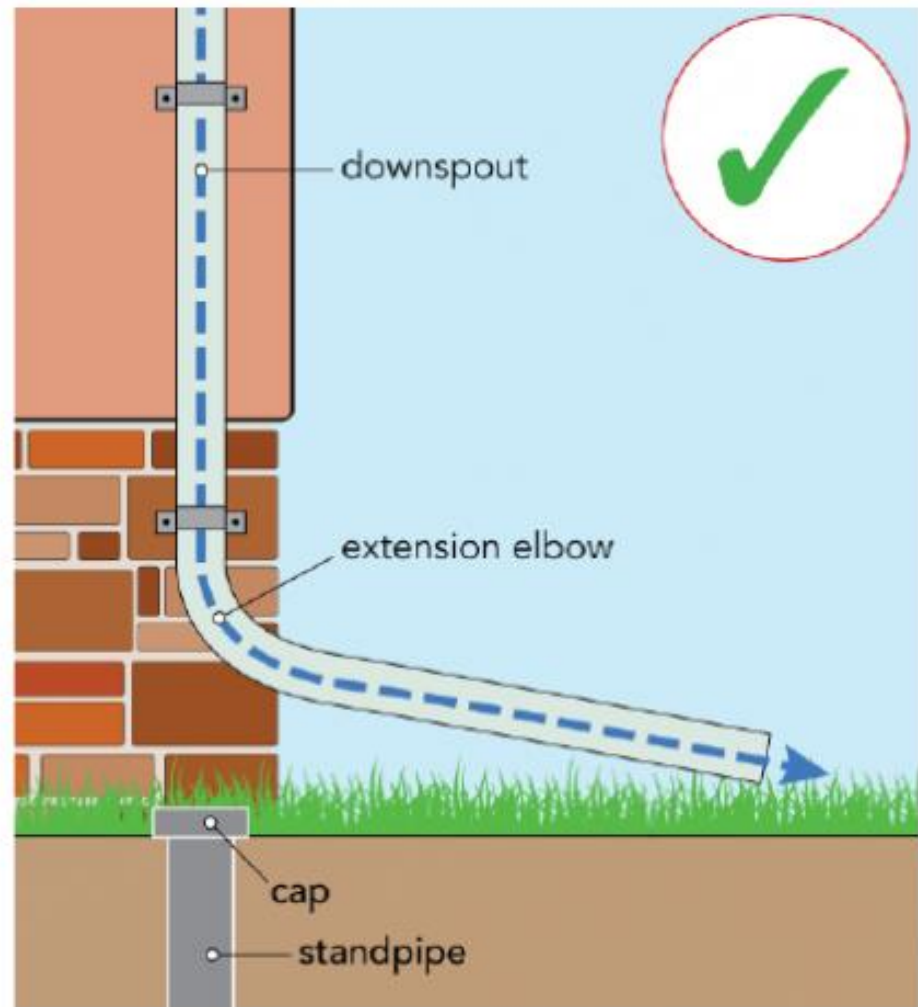
Simple Disconnection



Downspout Disconnection



**DOWNSPOUT CONNECTED
TO SEWER SYSTEM**



**DOWNSPOUT DISCONNECTED
FROM SEWER SYSTEM**

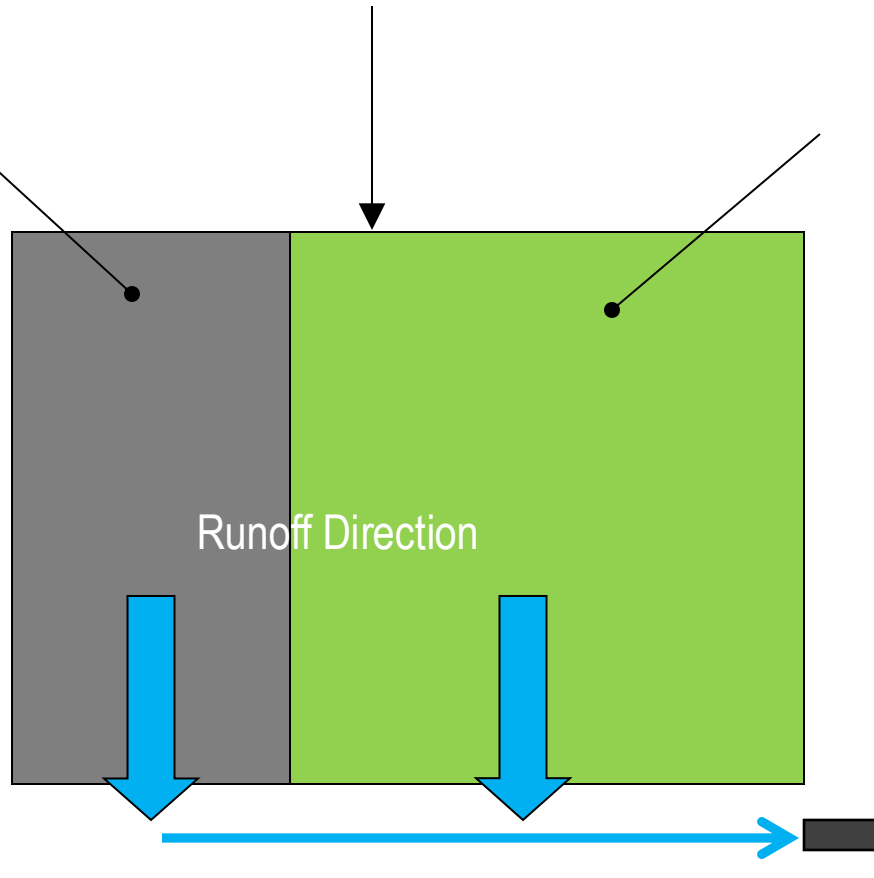
Another Example of Simple Disconnection

For 1.25 inch storm, 3,811 cubic feet of runoff = **28,500 gallons**

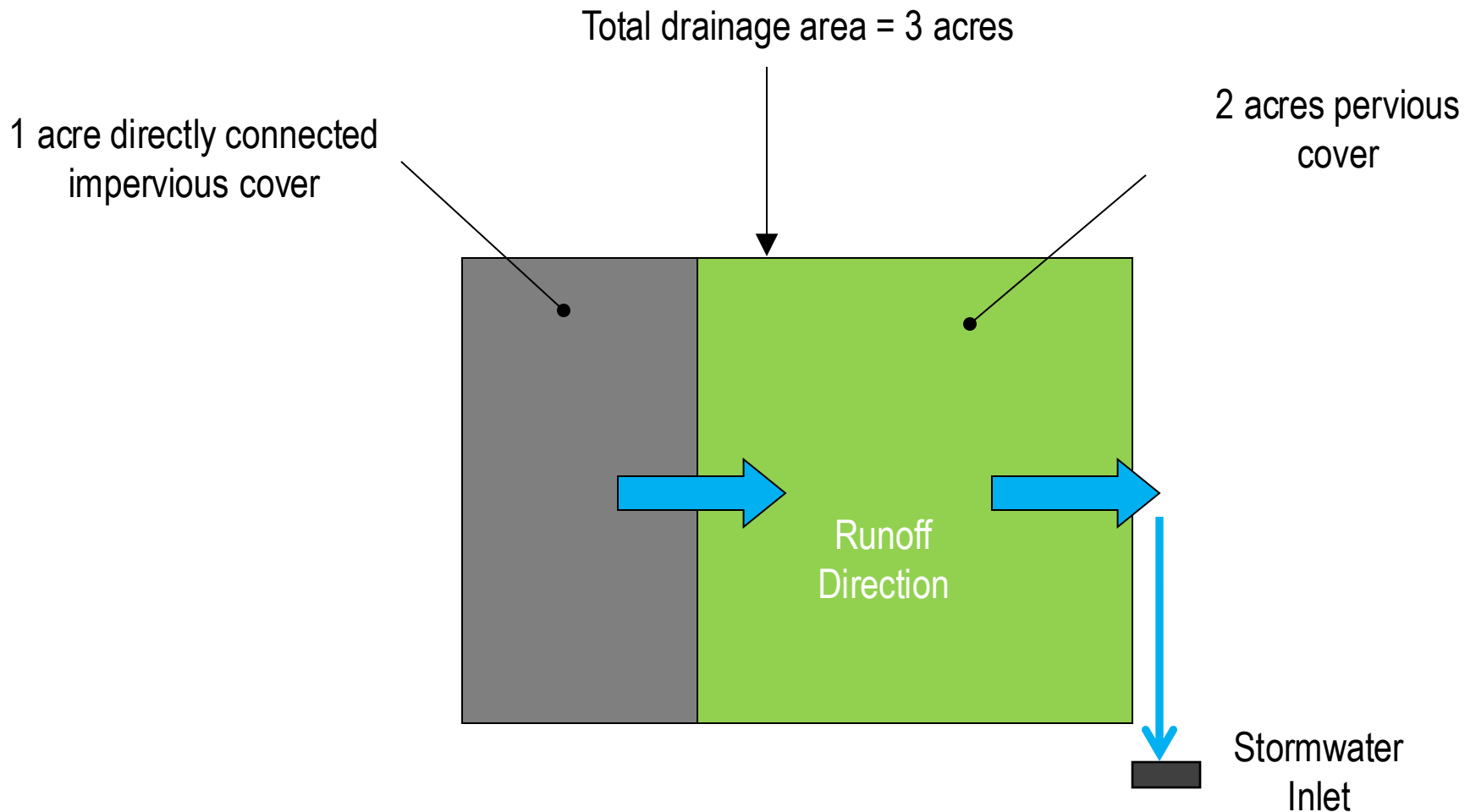
Total drainage area = 3 acres

1 acre directly connected
impervious cover

2 acres pervious
cover

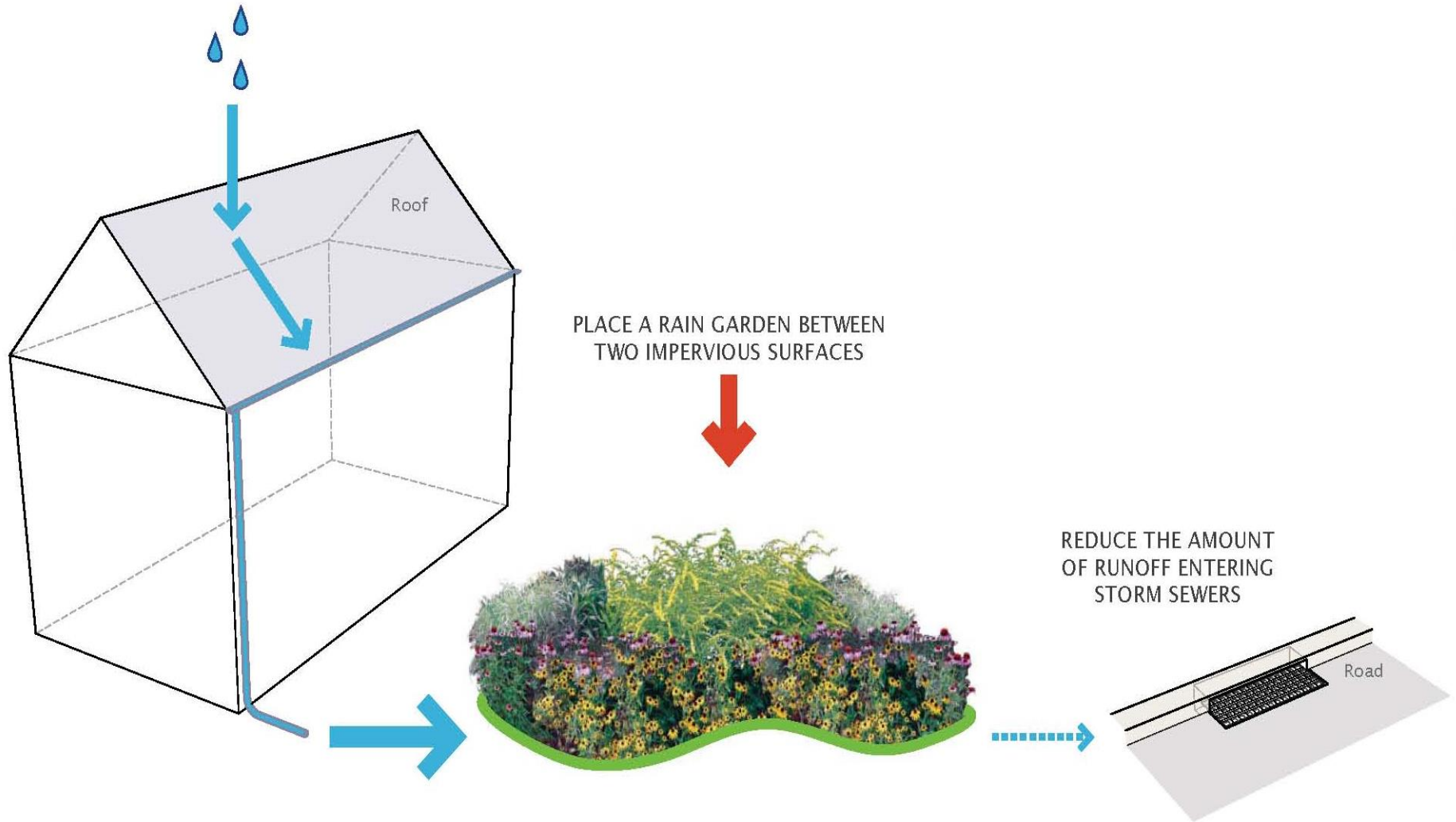


For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**



	Volume of Runoff		
Design Storm	Connected (gallons)	Disconnected (gallons)	Percent Difference
1.25 inches (water quality storm)	28,500	4,360	85%

Disconnect with a rain garden



SITE SELECTION

What are good sites?

- Sites with impervious surfaces that are directly connected
- Sites with a lawn area that can be converted to accept stormwater runoff
- Sites with highly visibility – good educational opportunities
- Sites in impaired watersheds
- Sites on municipal owned land/public land
- Sites that provide partnership opportunities

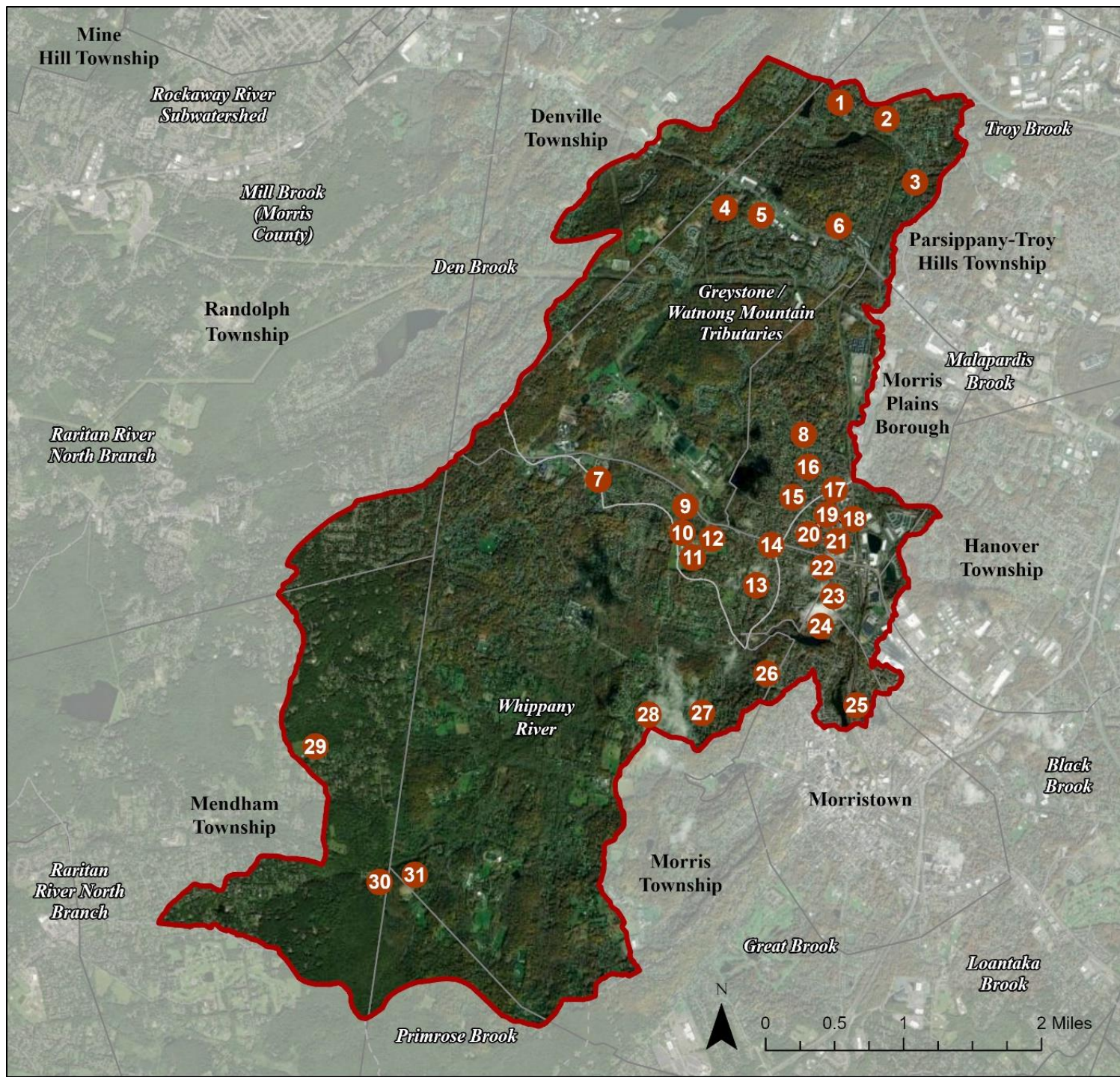
We Look Here First:

- ✓ Schools
 - ✓ Places of Worship
 - ✓ Libraries
 - ✓ Municipal Building
 - ✓ Public Works
 - ✓ Firehouses
 - ✓ Post Offices
 - ✓ Elks or Moose Lodge
 - ✓ Parks/ Recreational Fields
- 20 to 40 sites are entered into a PowerPoint
 - Site visits are conducted

Or you can identify tax exempt parcels:

Tax Exempt Property Class Codes for NJ:

- 15A Public School Property
- 15B Other School Property
- 15C Public Property
- 15D Church & Charitable Property
- 15E Cemeteries & Graveyards
- 15F Other Exempt

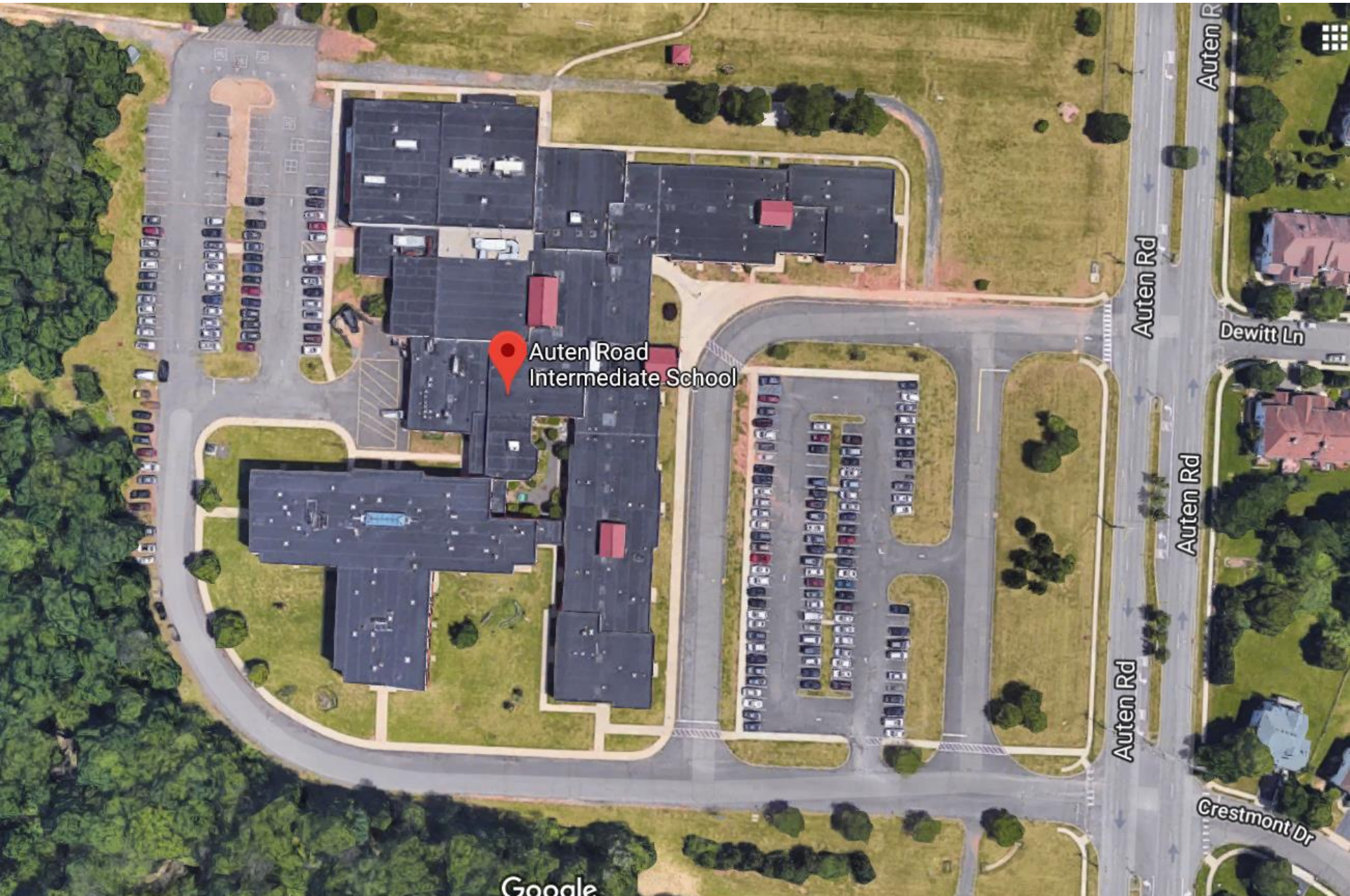


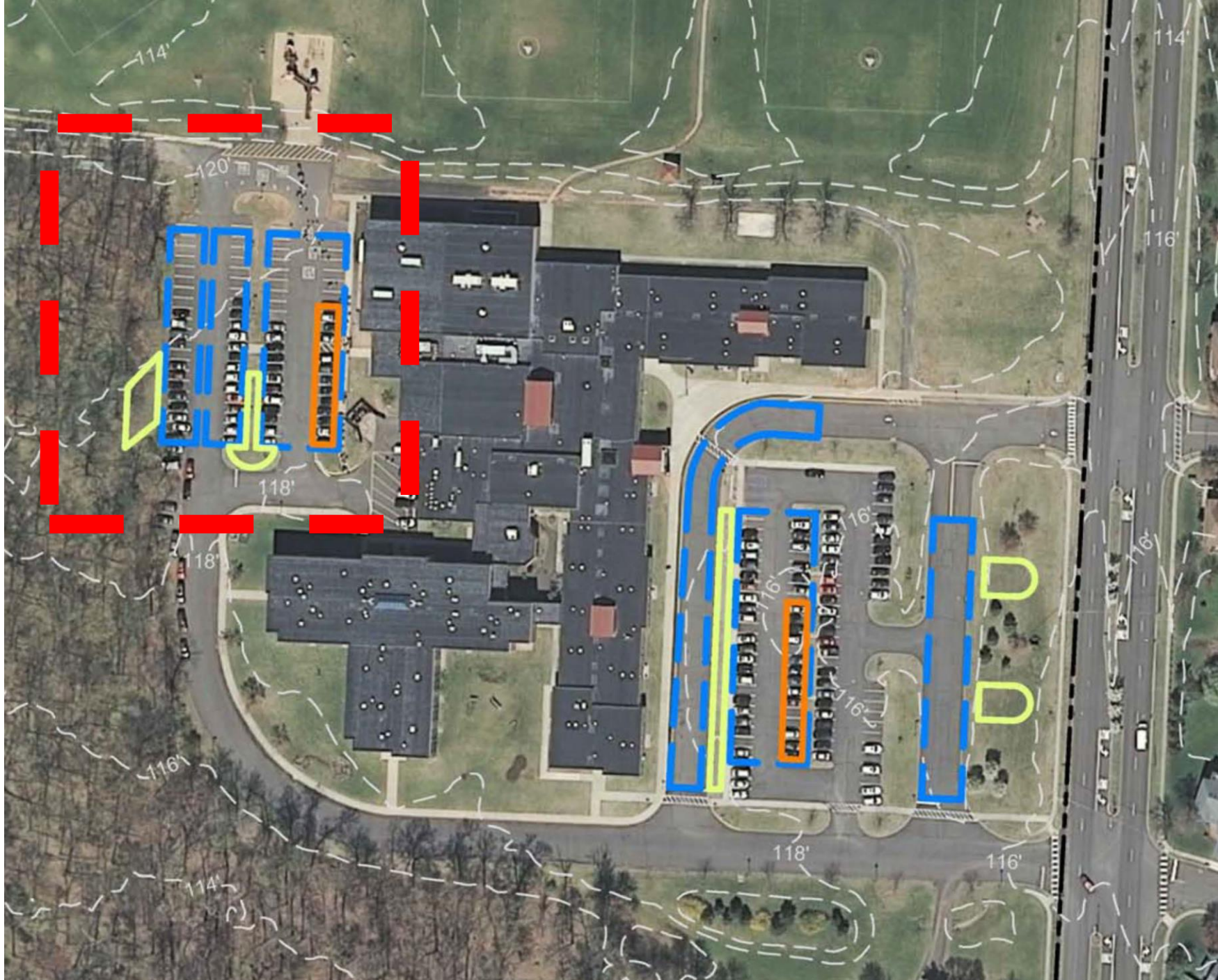
ID	Name	Address	Property Use	Block	Lot	Property Owner	Acres
1	Christian Meeting Room	1386 Tabor Road, Tabor, NJ 07878	Church	29	4	Morris Christian, Associates, Inc	0.8
2	Mount Tabor School	900 Park Road, Tabor, NJ 07878	School	93	7	Board of Education	8.0
3	Mount Tabor Volunteer Fire Department	909 Tabor Road, Morris Plains, NJ 07950	Fire Station	168	170.0 1	Mt Tabor Vol Fire Dept-Dist 1	1.1
4	Temple Beth Am	841 Mountain Way, Morris Plains, NJ 07950	Synagogue	15	56	Temple Adath Shalom	8.1
5	Mount Tabor Volunteer Fire Department	72 S Powder Mill Road, Morris Plains, NJ 07950	Fire Station	15.1	1.1	Board of Fire Comm-Dist 1	0.8

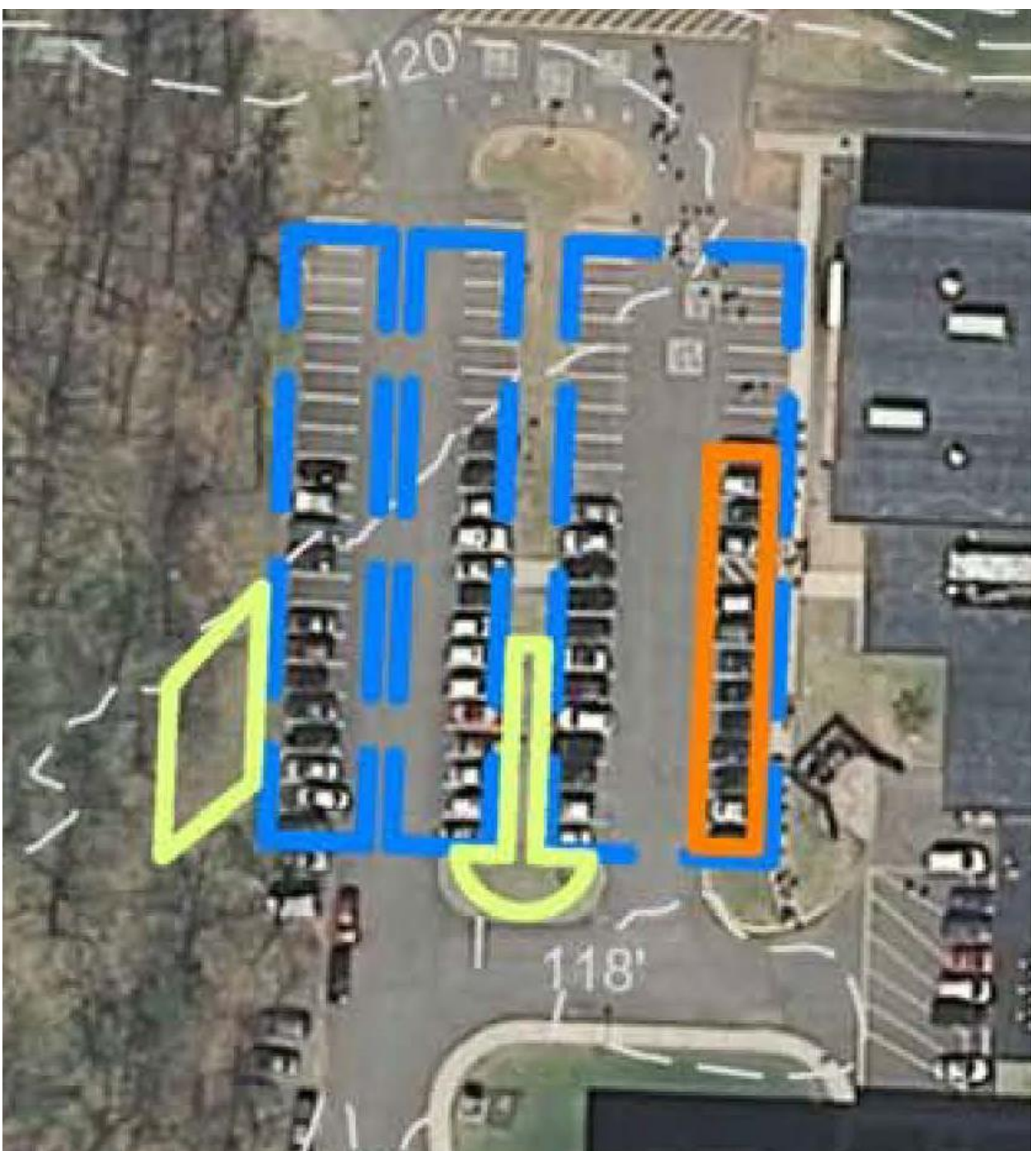
Google Maps

- Go to Google
- Type in address
- Aerial or birds eye view
- “Snip It” (MS Windows Accessory)
- Insert into PowerPoint
- “Crop It”

Auten Road School in Hillsborough, NJ
281 Auten Rd, Hillsborough Township, NJ 08844

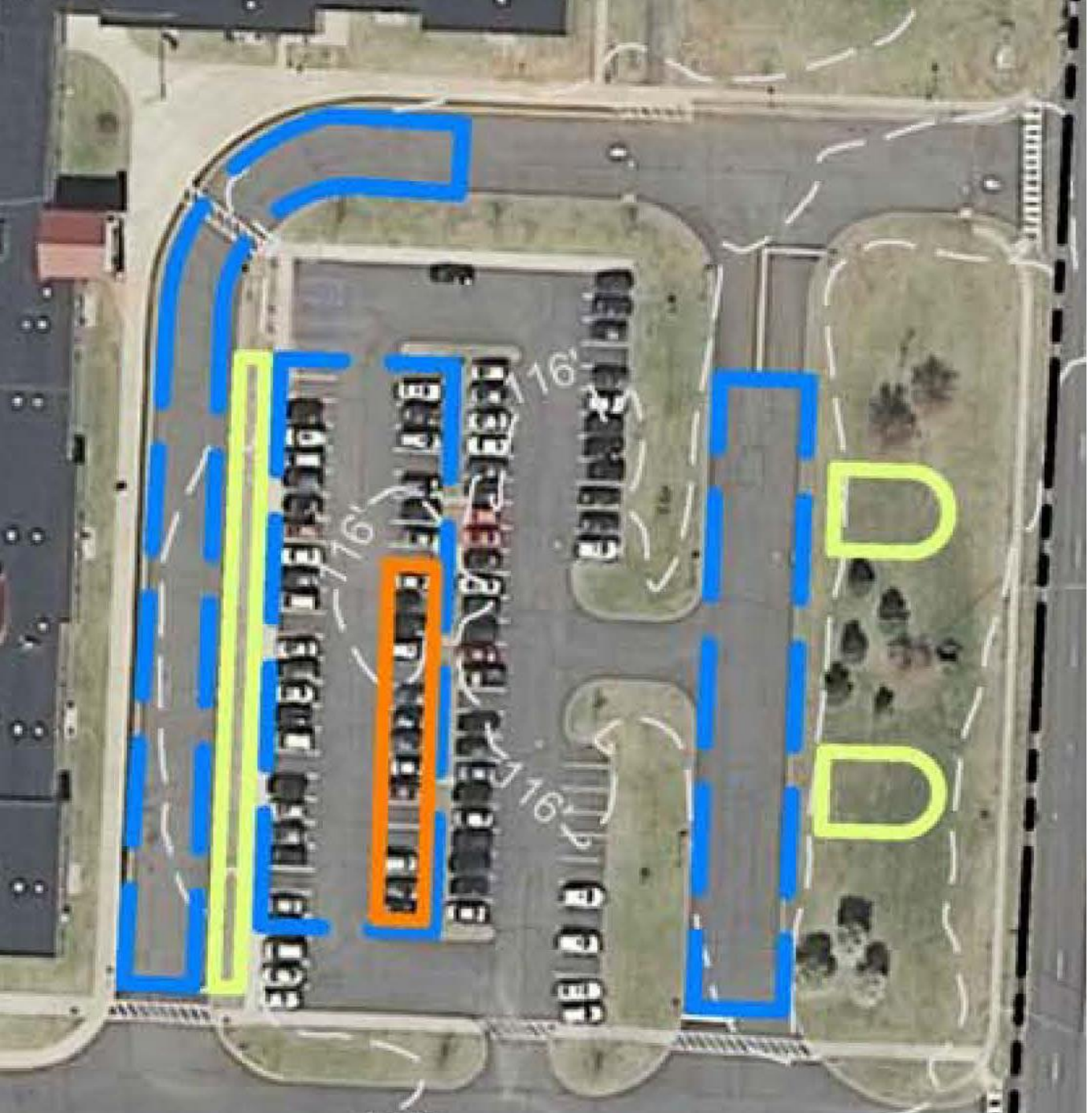


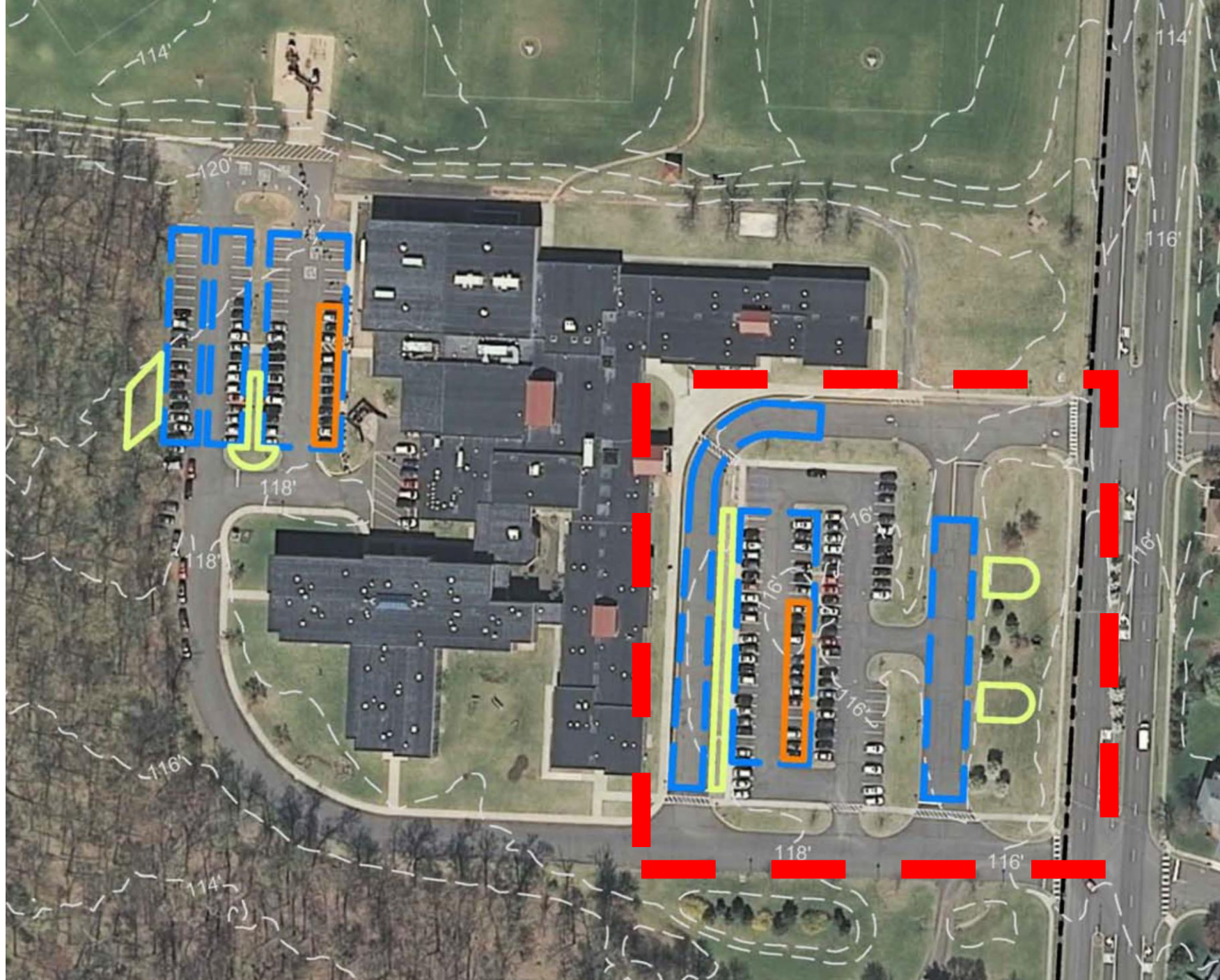












Pittsgrove Baptist Church

Subwatershed: Salem River

Site Area: 696,419 sq. ft.

Address: 368 Daretown Road
Elmer, NJ 08318

Block and Lot: Block 59, Lot 14, 17



Rain gardens can be installed in the turfgrass area at the front of the church and behind the church. The gardens would capture, treat, and infiltrate runoff from the roof of the building and the parking area. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
5	34,224	1.6	17.3	157.1	0.027	0.94

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention systems	0.107	18	7,840	0.29	1,050	\$5,250

GREEN INFRASTRUCTURE RECOMMENDATIONS



Pittsgrove Baptist Church

-  bioretention system
-  drainage area
-  property line
-  2015 Aerial: NJOIT, OGIS



CURRENT CONDITION



CONCEPT DESIGN



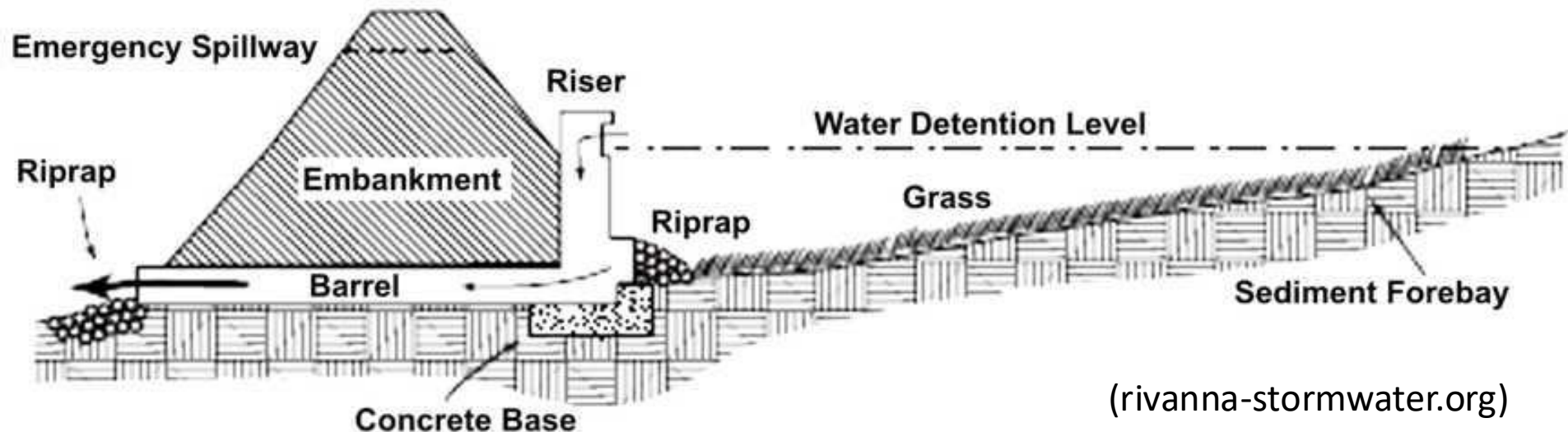
The main goal of the watershed improvement projects are to improve water quality and reduce localized flooding but are there opportunities to address flooding from extreme weather events?

Increases in Rainfall Totals due to Climate Change

Condition (100-yr Design Storm)	24-hour rainfall total (in)
Prior to Jan 1, 2005	7.50
2005 Rainfall Total	8.21
2020 Rainfall Total	8.95
2100 Rainfall Total	12.15

How can we reduce 100-YR storm flooding?

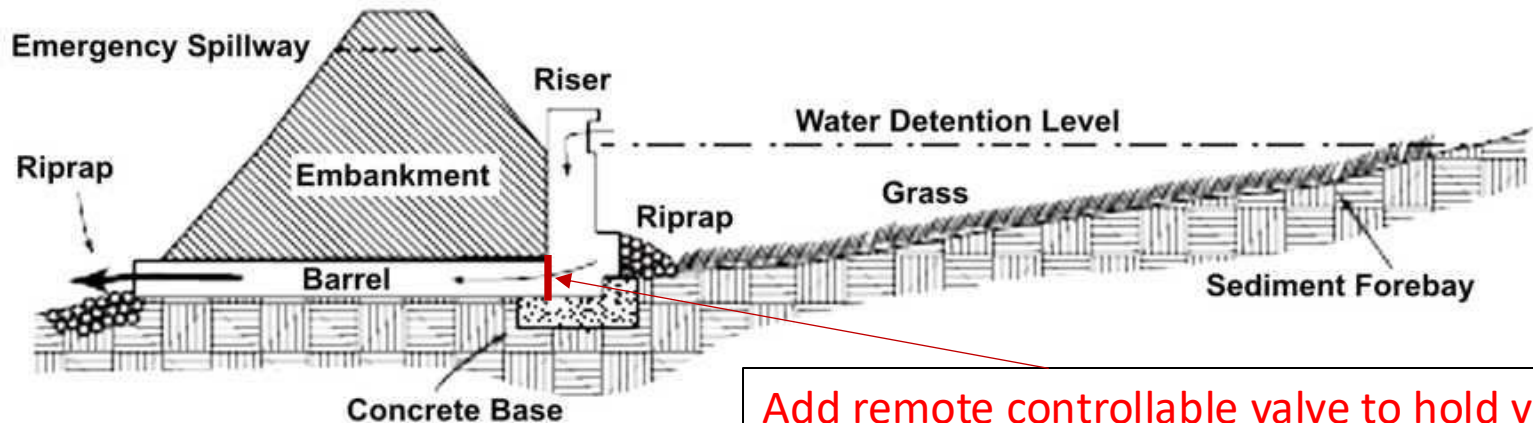
- Capture stormwater and detain it to reduce the peak flow of the flooding
 - Typical detention basin approach
 - Effective if no backup downstream
 - Can combine with distributed systems to hold more volume



(rivanna-stormwater.org)

How can we reduce 100-YR storm flooding?

- Hold a retain stormwater as long as possible
 - More effective when floodwater backed up downstream
 - Digital control system to hold volume and release water once flood recedes
 - Would not work well as passive system due to smaller storm event management not draining quick enough
 - Difficult to combine with distributed storage systems



Add remote controllable valve to hold volume

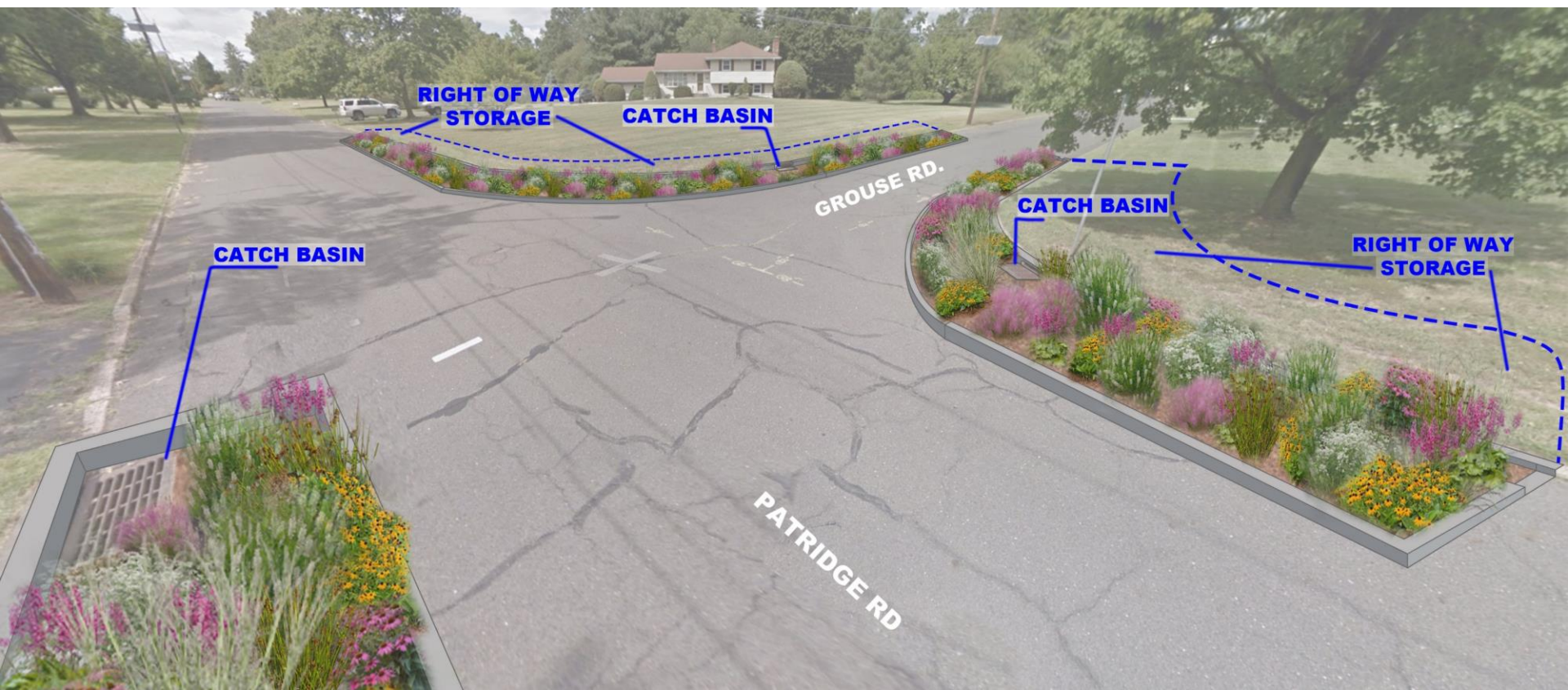
Where do we target our efforts?

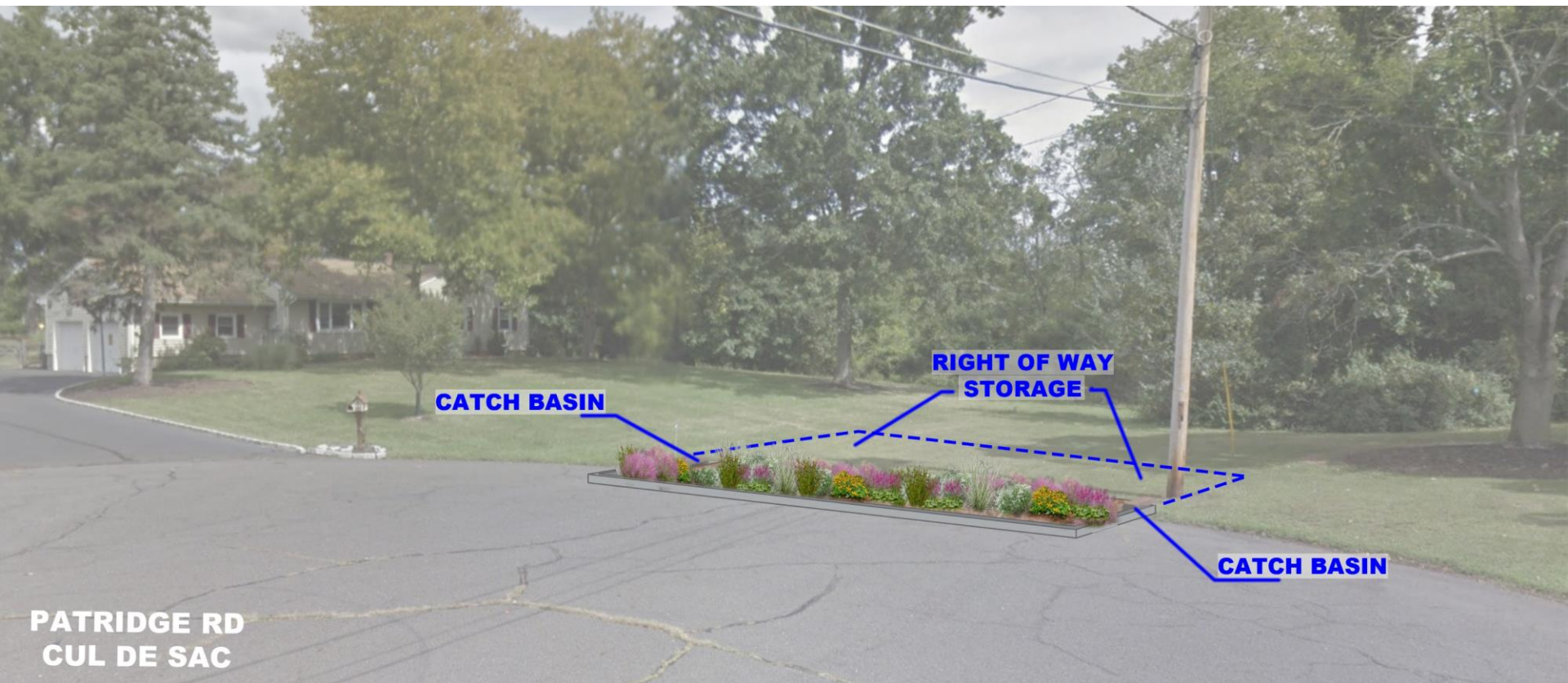
- Target developments with:
 - little to no existing stormwater management
 - available land to capture and hold large volumes of stormwater
 - willing participants for buyouts to create land for stormwater management
- Identify key flooding hotspots and identify areas contributing upstream of those areas
- Use right-of-way areas to capture stormwater
- In-line stream storage (complicated design and difficult to obtain NJDEP permits)

How can we hold the volume?

- Smaller distributed systems
 - Individual household rain gardens
 - Pervious pavement
 - Right-of-way stormwater planters





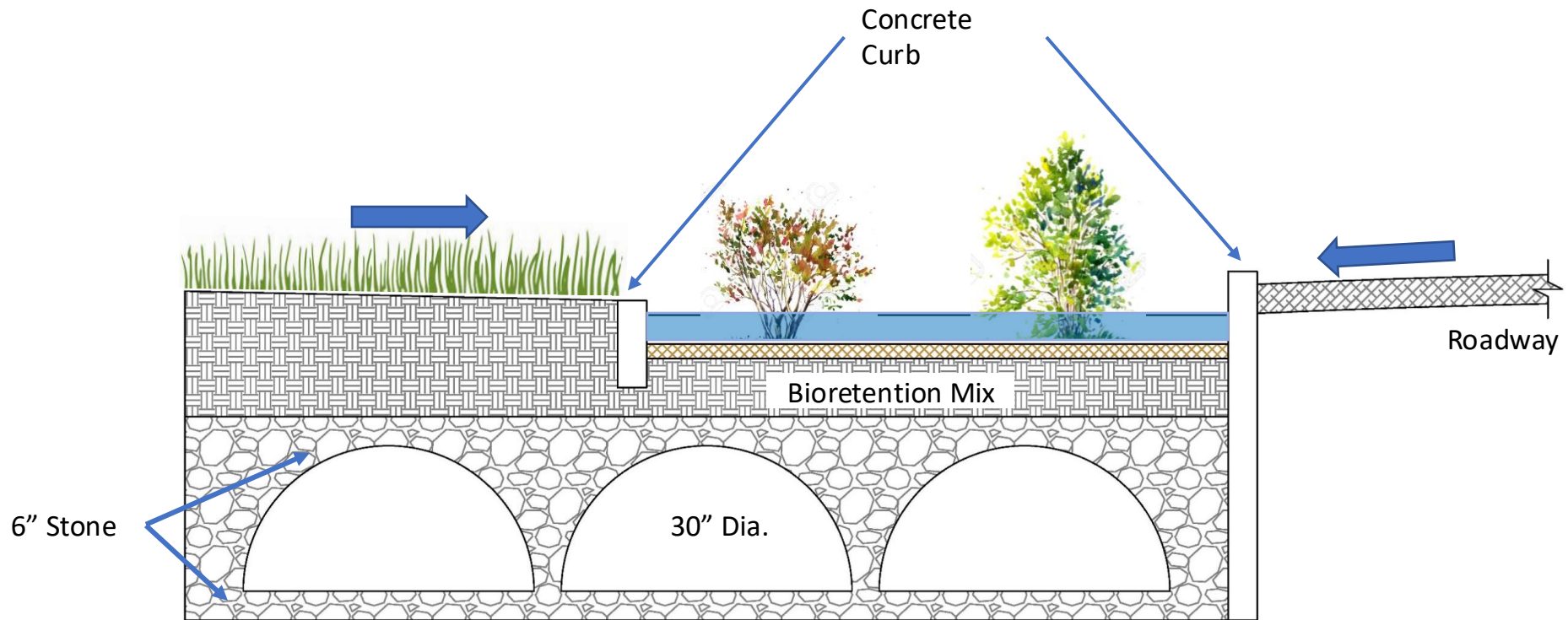


**PATRIDGE RD
CUL DE SAC**

CATCH BASIN

**RIGHT OF WAY
STORAGE**

CATCH BASIN



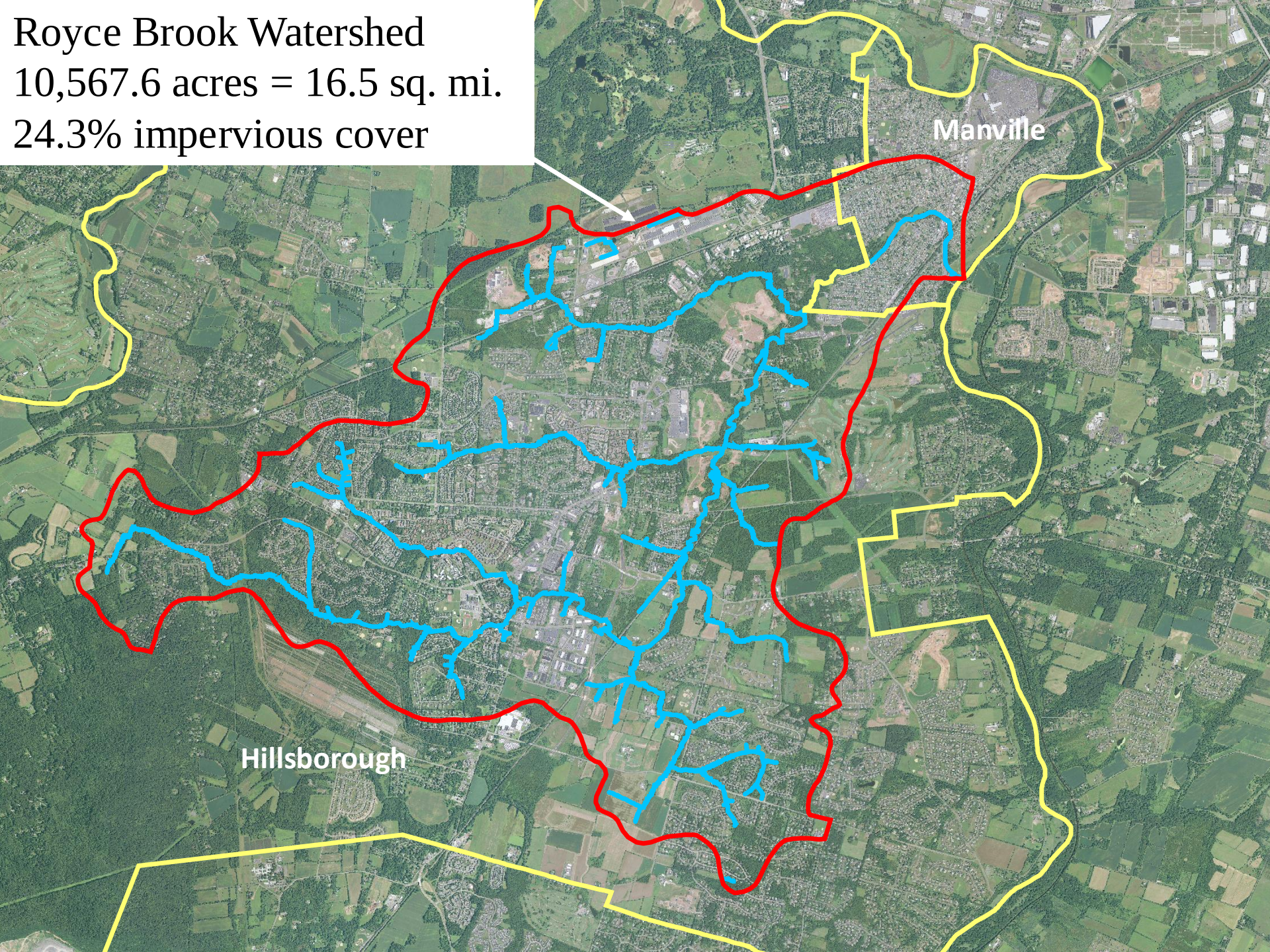
How can we hold the volume?

- Large detention/ bioretention basins
 - Can provide largest volume storage to land area
- Underground storage systems
 - Can create systems under lots by combining storage; allows mixed use of stormwater management area and recreational uses (i.e., parks)



YES, WE CAN!

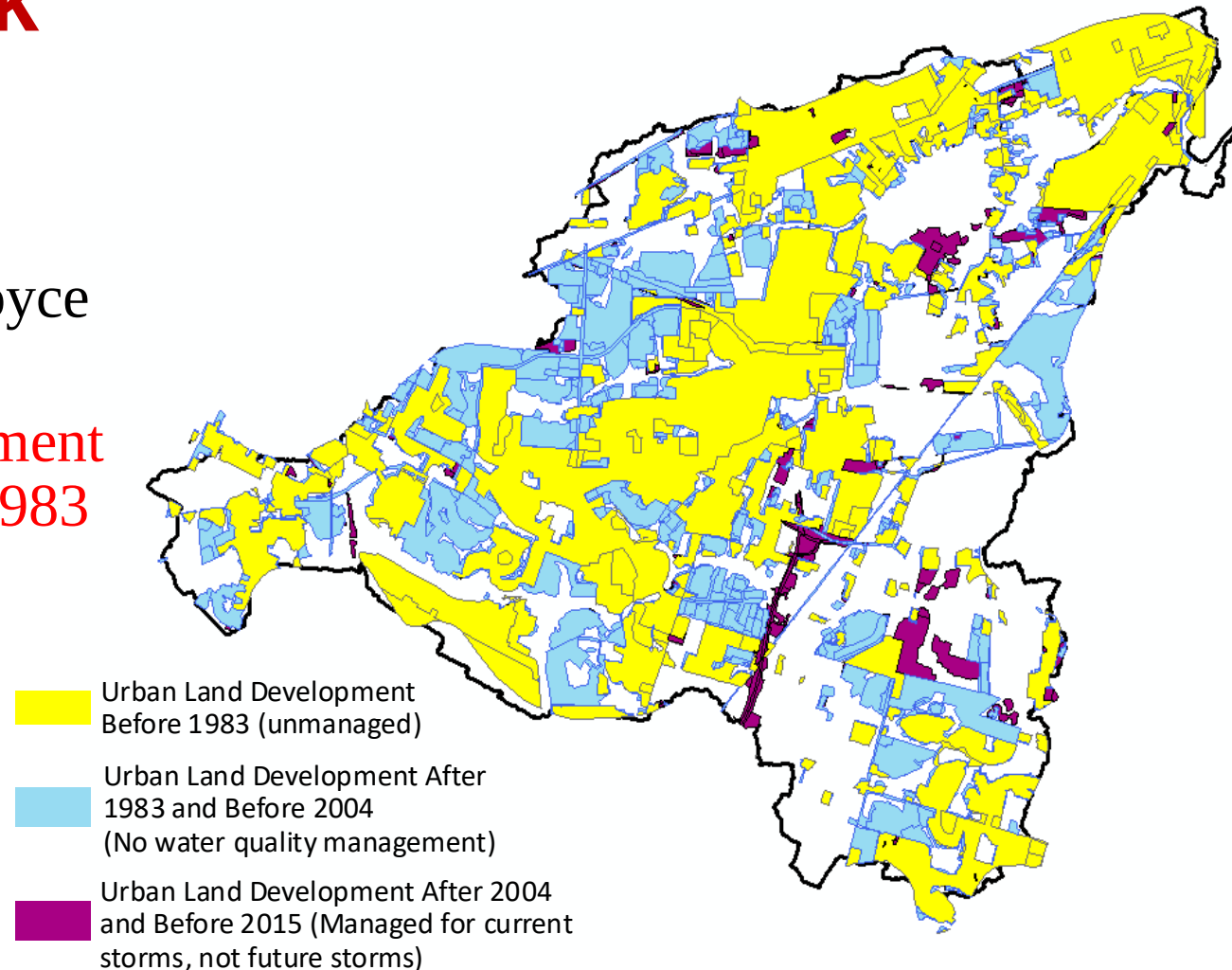
Royce Brook Watershed
10,567.6 acres = 16.5 sq. mi.
24.3% impervious cover



What land is being managed in the Royce Brook Watershed?

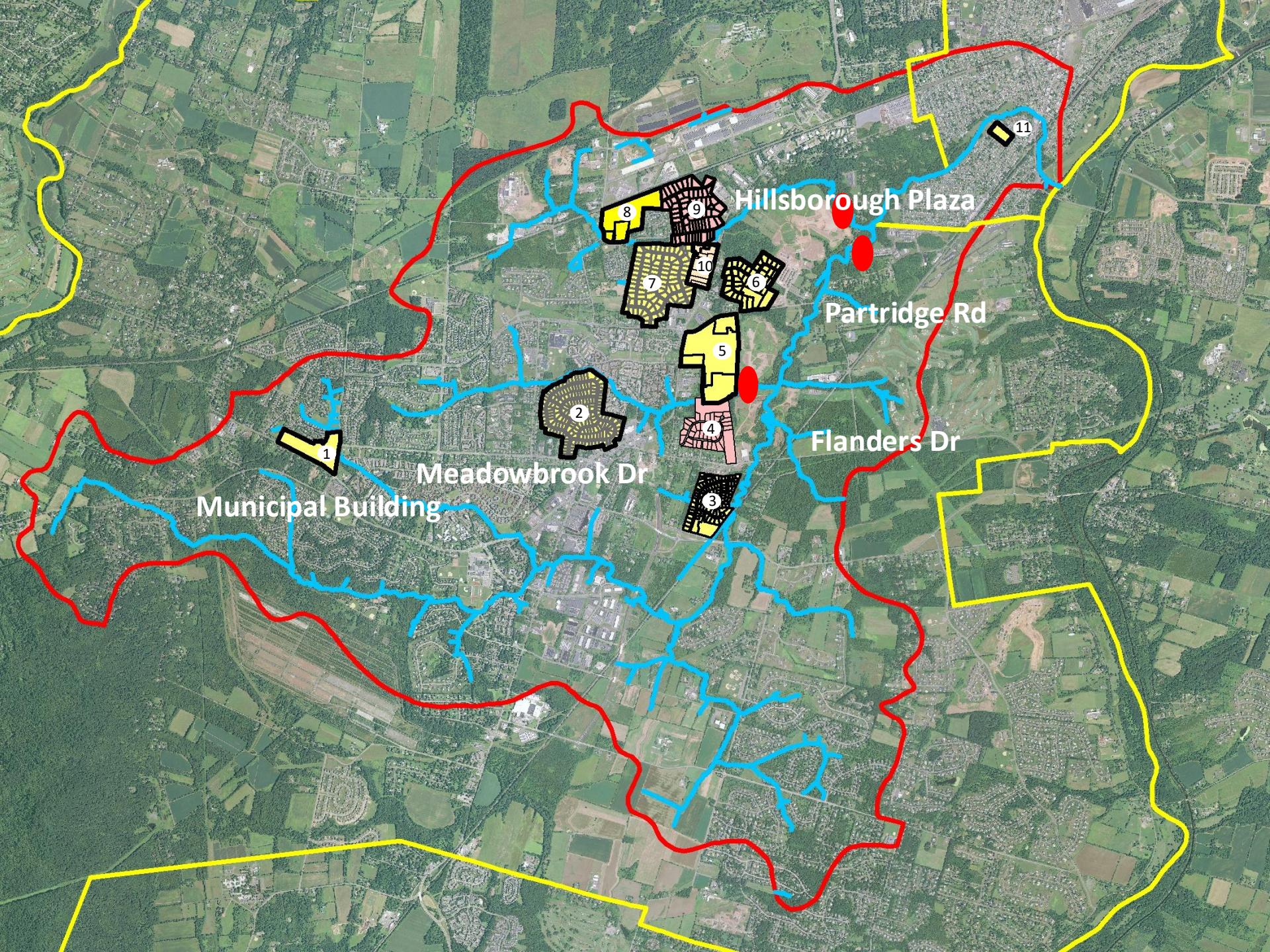
- Urban land in the Royce Brook Watershed
- Majority of development was created before 1983

Managed and Unmanaged Urban Land Use in the Royce Brook Watershed



11 potential development sites for retrofitting

- 673.4 acres = 1.05 sq. mi.
- Six residential developments
- Three commercial sites (one with some stormwater management)
- One municipal site
- One public school
- Possible solutions
 - Constructed wetlands
 - Bioretention
 - Permeable pavement
 - Roadside rain gardens
 - Homeowner rain gardens



Municipal Building

Meadowbrook Dr

Hillsborough Plaza

Partridge Rd

Flanders Dr



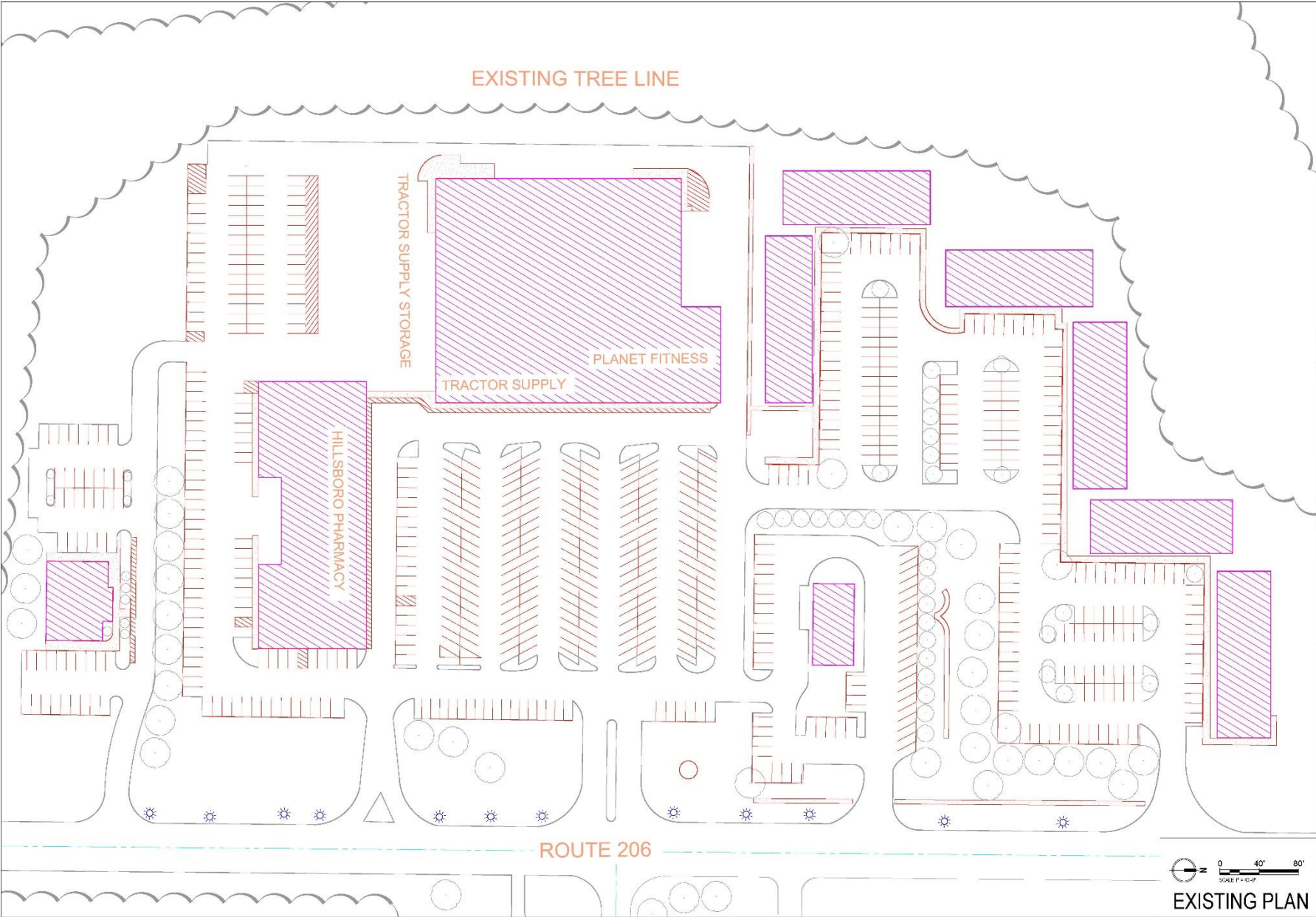
Example:
Hillsborough Plaza
256 Route 206
Hillsborough, New Jersey



Google







 RUTGERS New Jersey Agricultural Experiment Station	HILLSBOROCH PLAZA GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT 256 US-126 HILLSBOROUGH CITY SOMERSET COUNTY, NJ	EXISTING CONDITIONS AND DEMOLITION PLAN	DATE: _____	DESIGNED BY: _____	PROJECT NO: _____
			DATE: _____	DATE: _____	DATE: _____
EXISTING PLAN			DRAFT		
SHEET NAME: P-1			CHRISTOPHER C. OSBORT, P.D., P.E. INDEPENDENT CONSULTANT & ARCHITECT		

Water Quality Storm Analysis (1.25 inches)

EXISTING TREE LINE

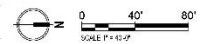
11.6 acres

46,834 m²

52,635 ft³ of
runoff for 1.25
inch storm

1,490 m³ of
runoff for 31.8
mm storm

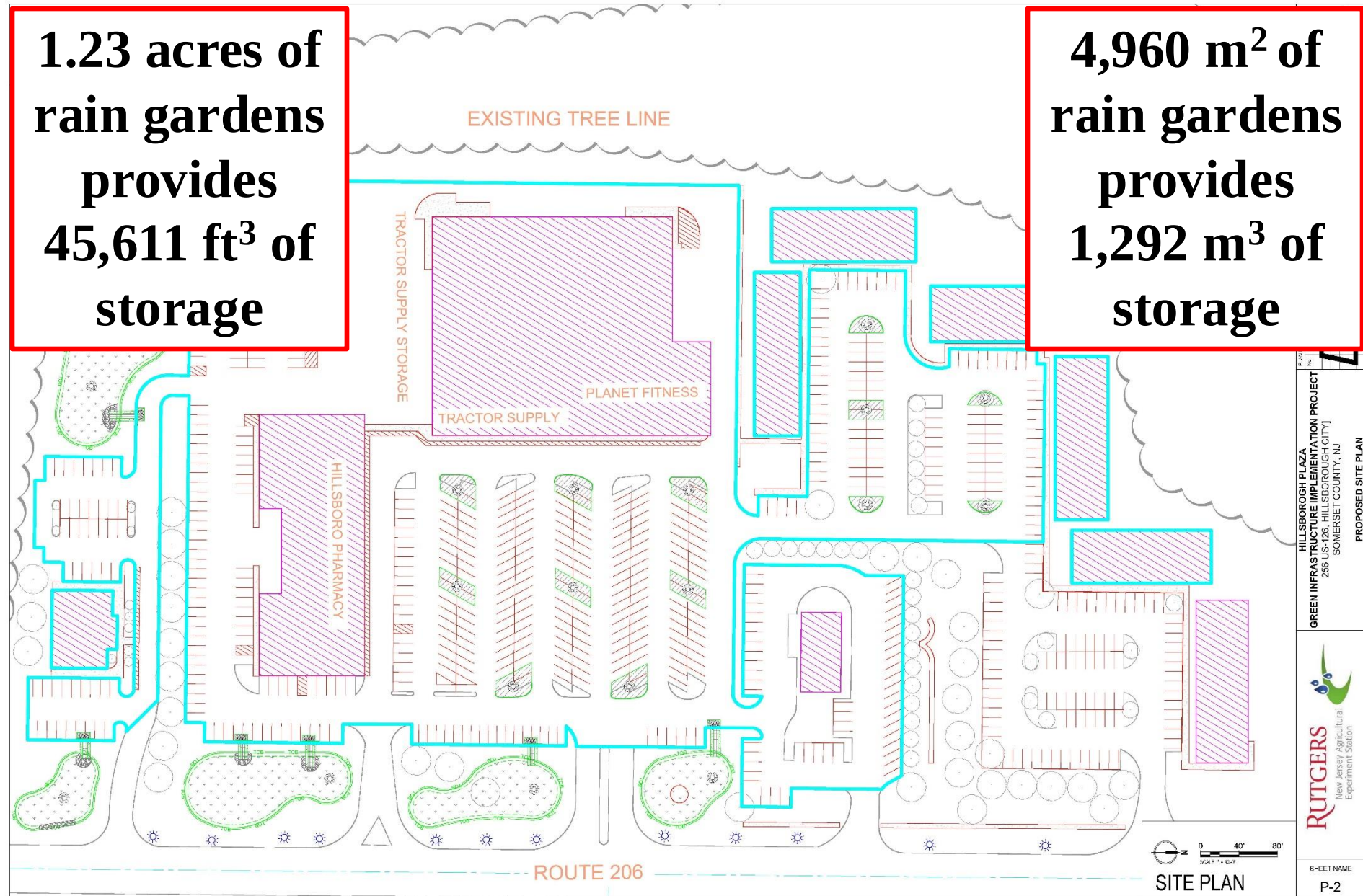
ROUTE 206



EXISTING PLAN

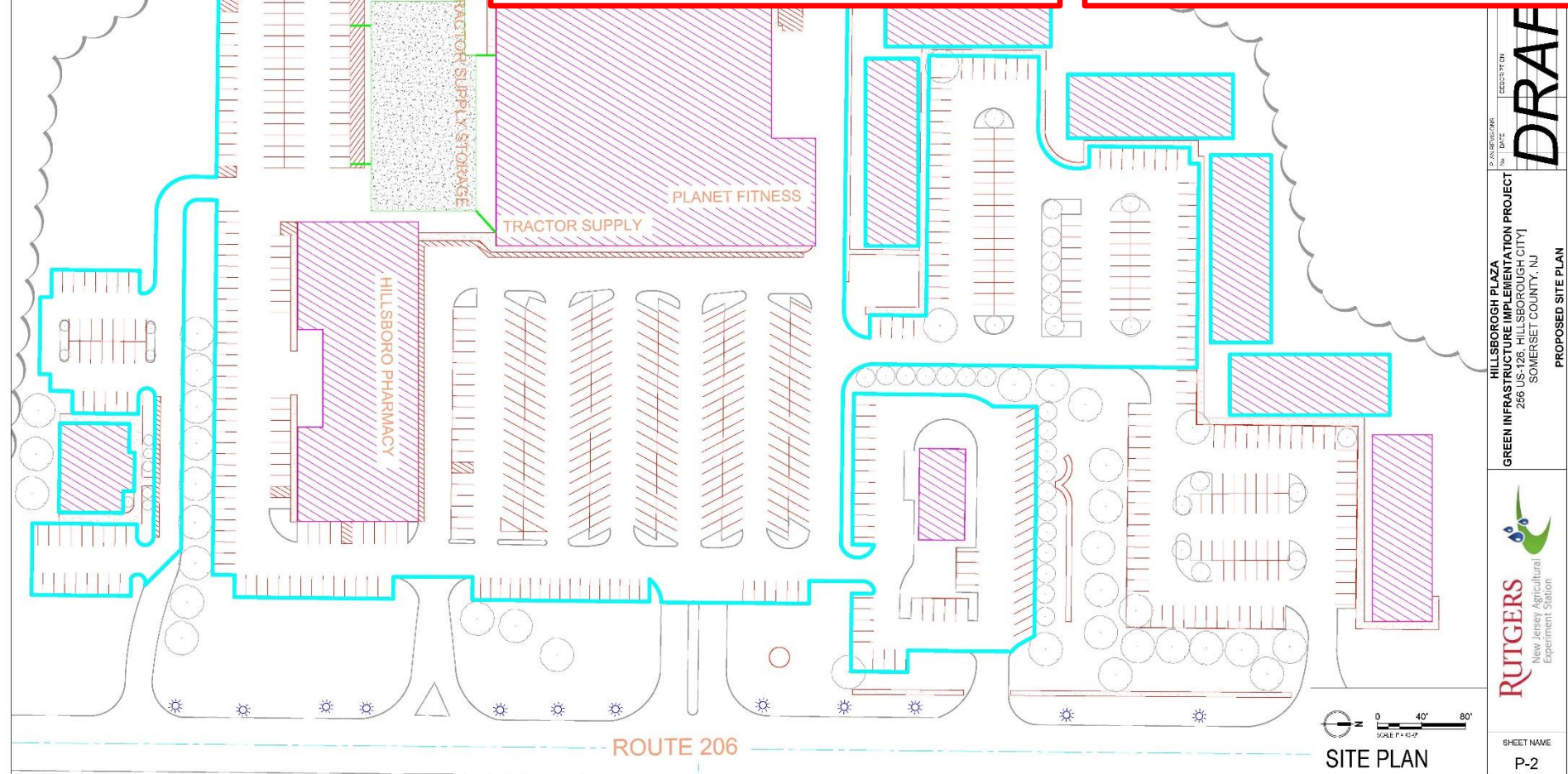
**1.23 acres of
rain gardens
provides
45,611 ft³ of
storage**

**4,960 m² of
rain gardens
provides
1,292 m³ of
storage**

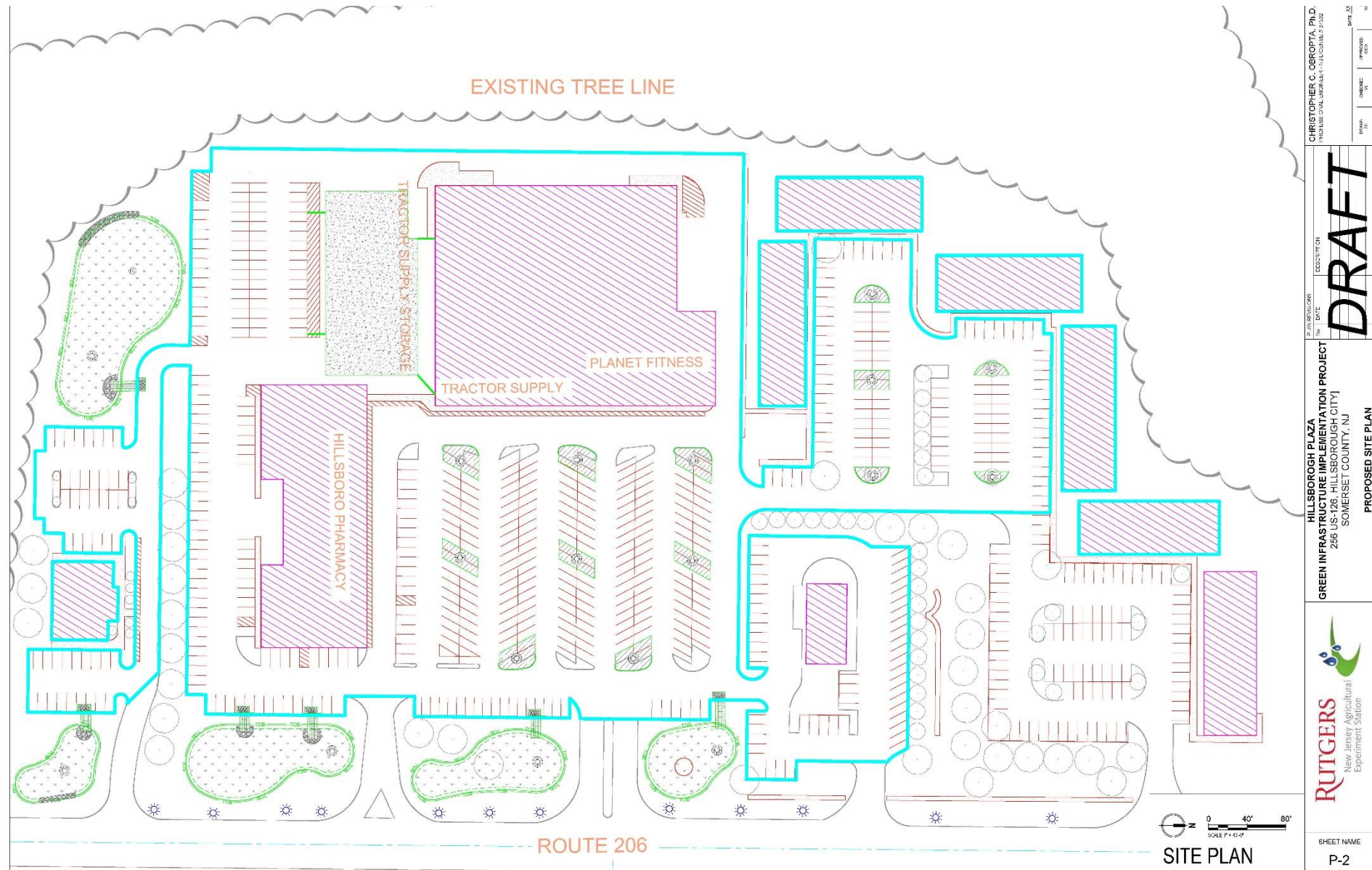


**17,560 ft² of
pervious concrete
provides
7,024 ft³ of storage**

**1,631 m² of
pervious concrete
provides 199 m³
of storage**



All of the Green Infrastructure Practices



100-Year Storm Analysis (8.25 inches)

EXISTING TREE LINE

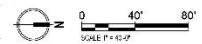
11.6 acres

46,834 m²

294,756 ft³ of
runoff for 7.0
inches rain

8,347 m³ of
runoff for 178
mm storm

ROUTE 206

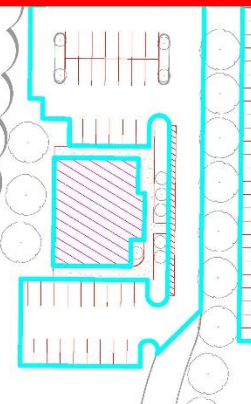


EXISTING PLAN

**2.4 acres of
underground
storage
system
provides
351,208 ft³ of
storage**

**9,712 m² of
underground
storage
provides
9,945 m³ of
storage**

**64,800 ft (19,750 m) of two-foot (0.6 m)
diameter pipe**

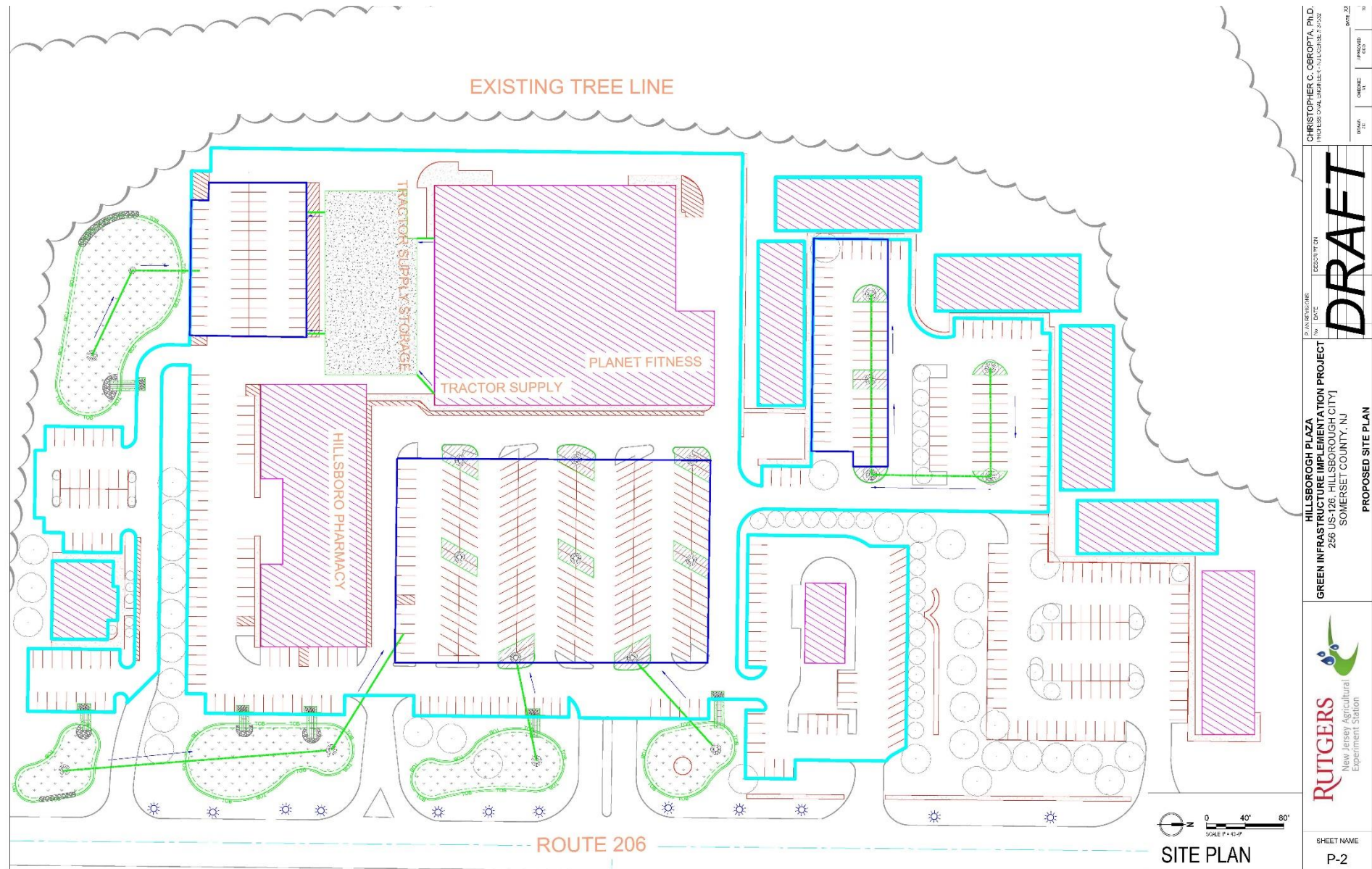


ROUTE 206

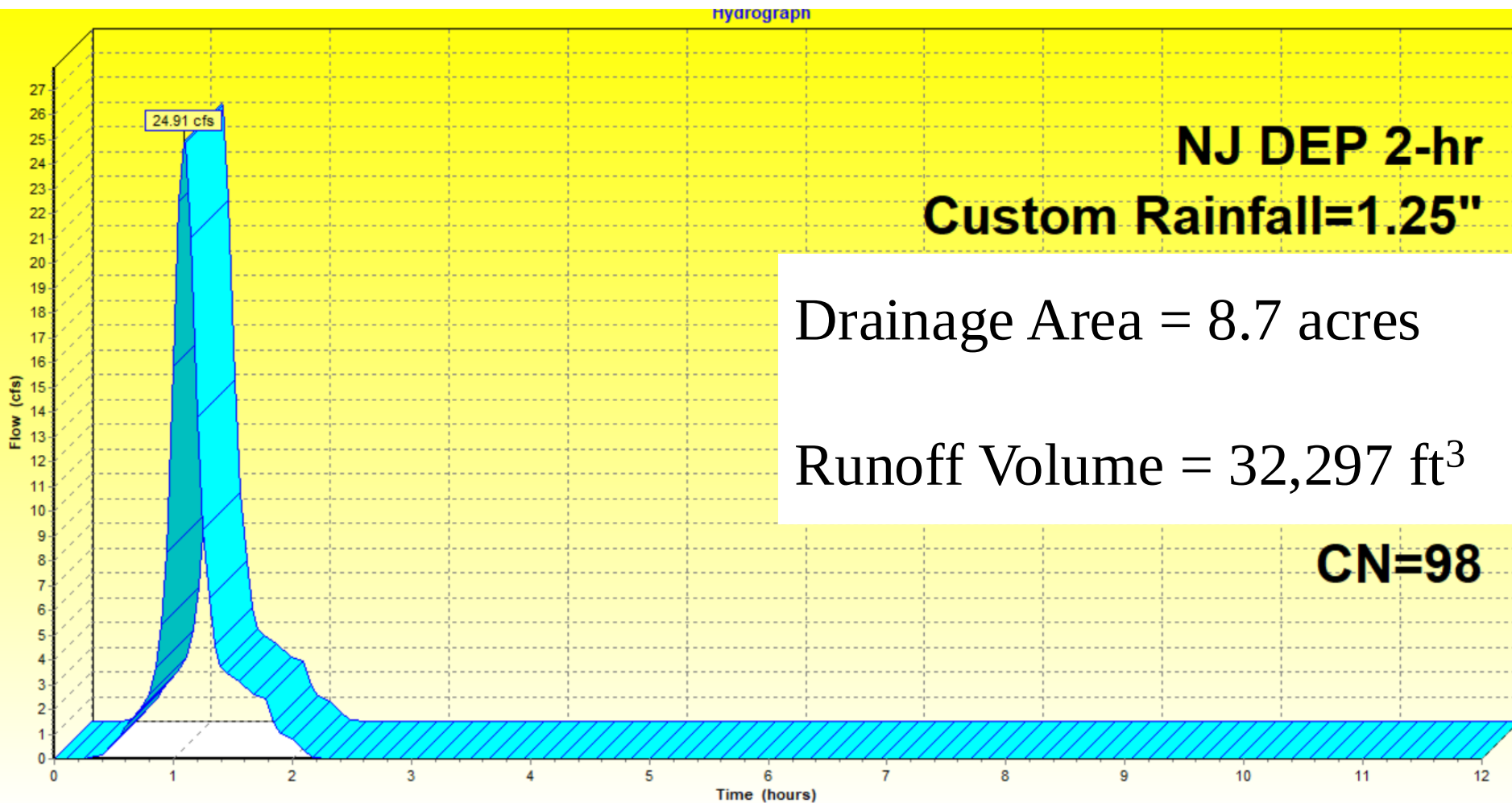


SITE PLAN

Green and Gray Infrastructure Practices

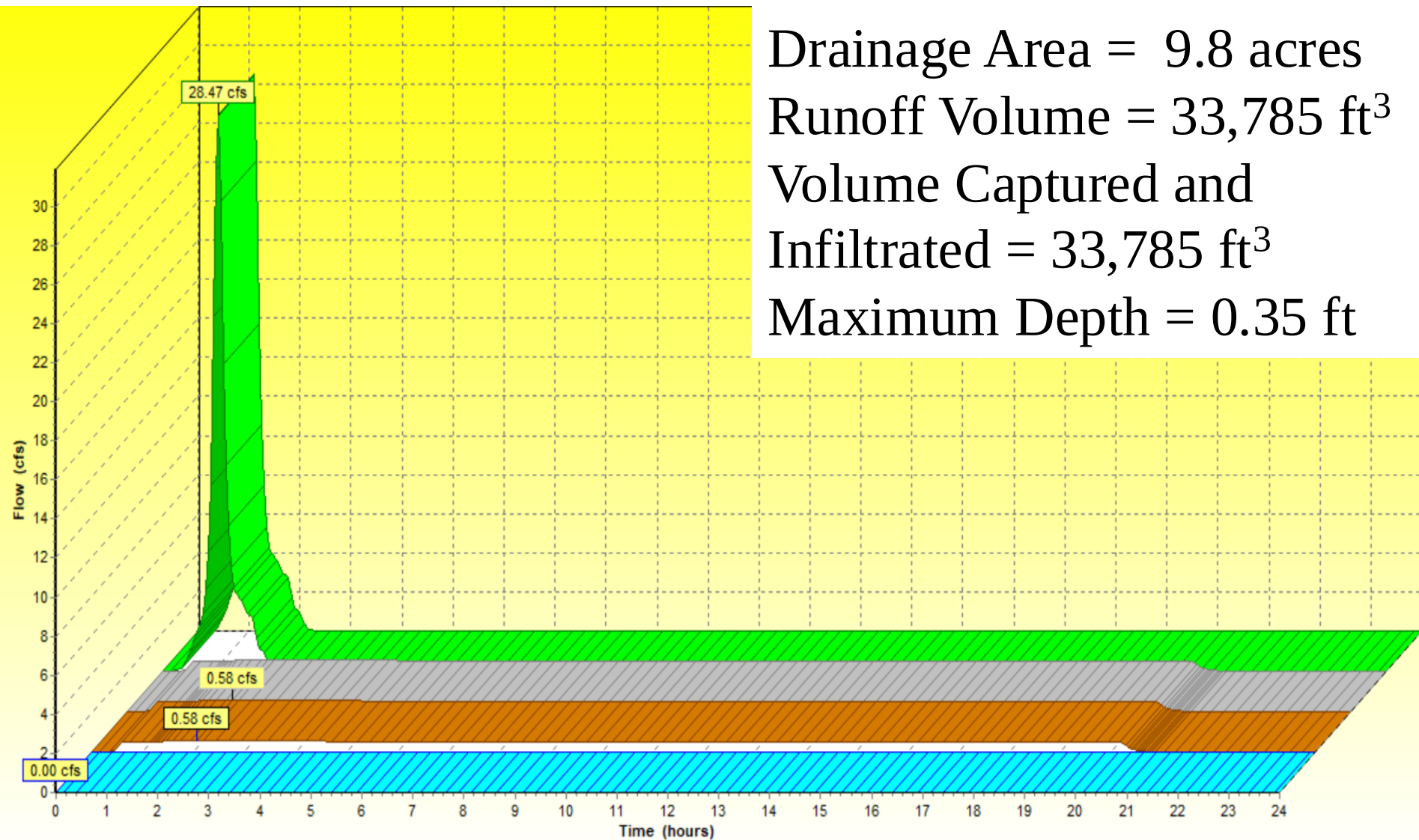


**EXISTING CONDITIONS (3/4th of the site)
(NEW JERSEY WATER QUALITY PEAK DISCHARGE 1.25")**

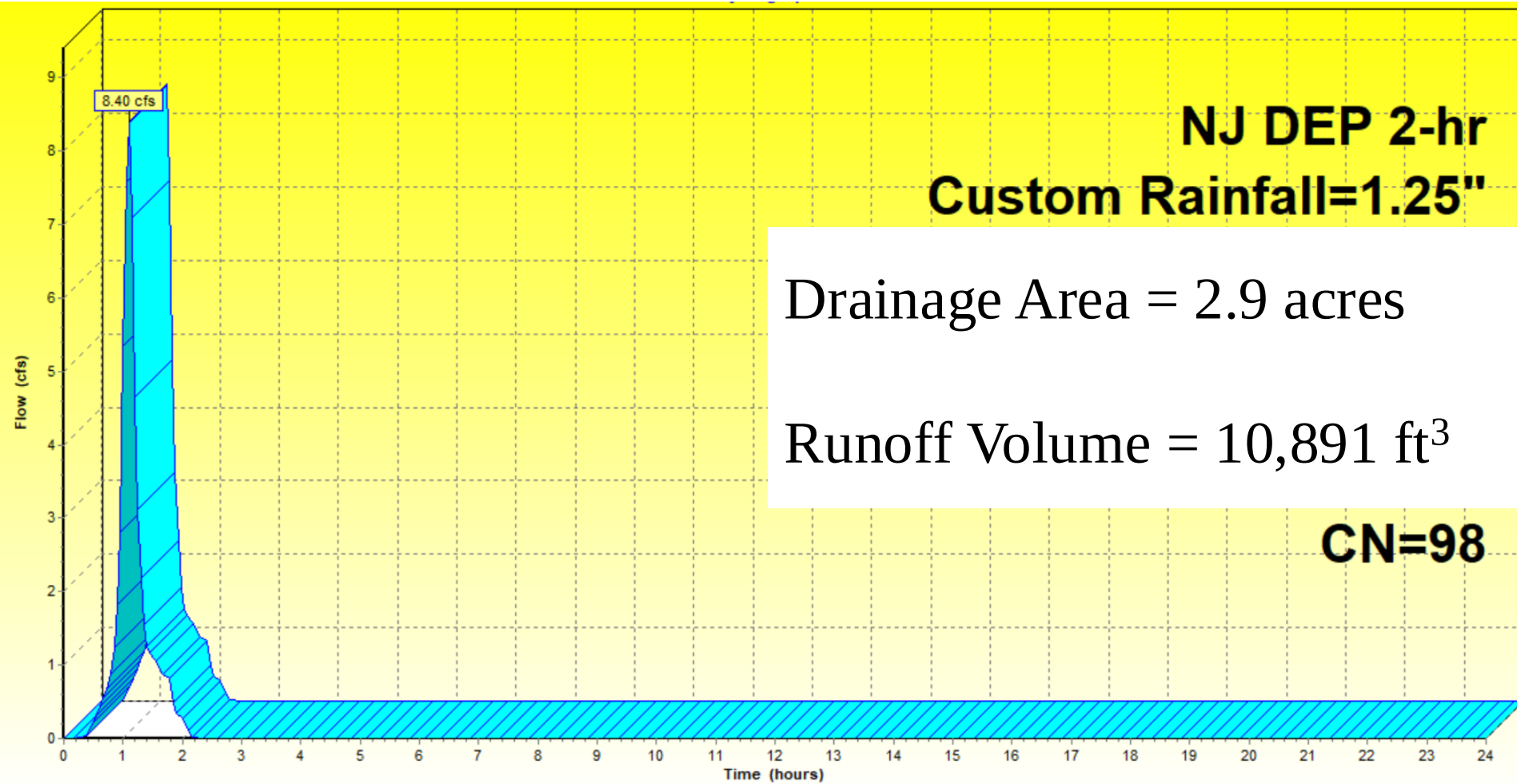


PROPOSED CONDITIONS (RAIN GARDENS) (NEW JERSEY WATER QUALITY PEAK DISCHARGE 1.25")

Drainage Area = 9.8 acres
Runoff Volume = 33,785 ft³
Volume Captured and
Infiltrated = 33,785 ft³
Maximum Depth = 0.35 ft

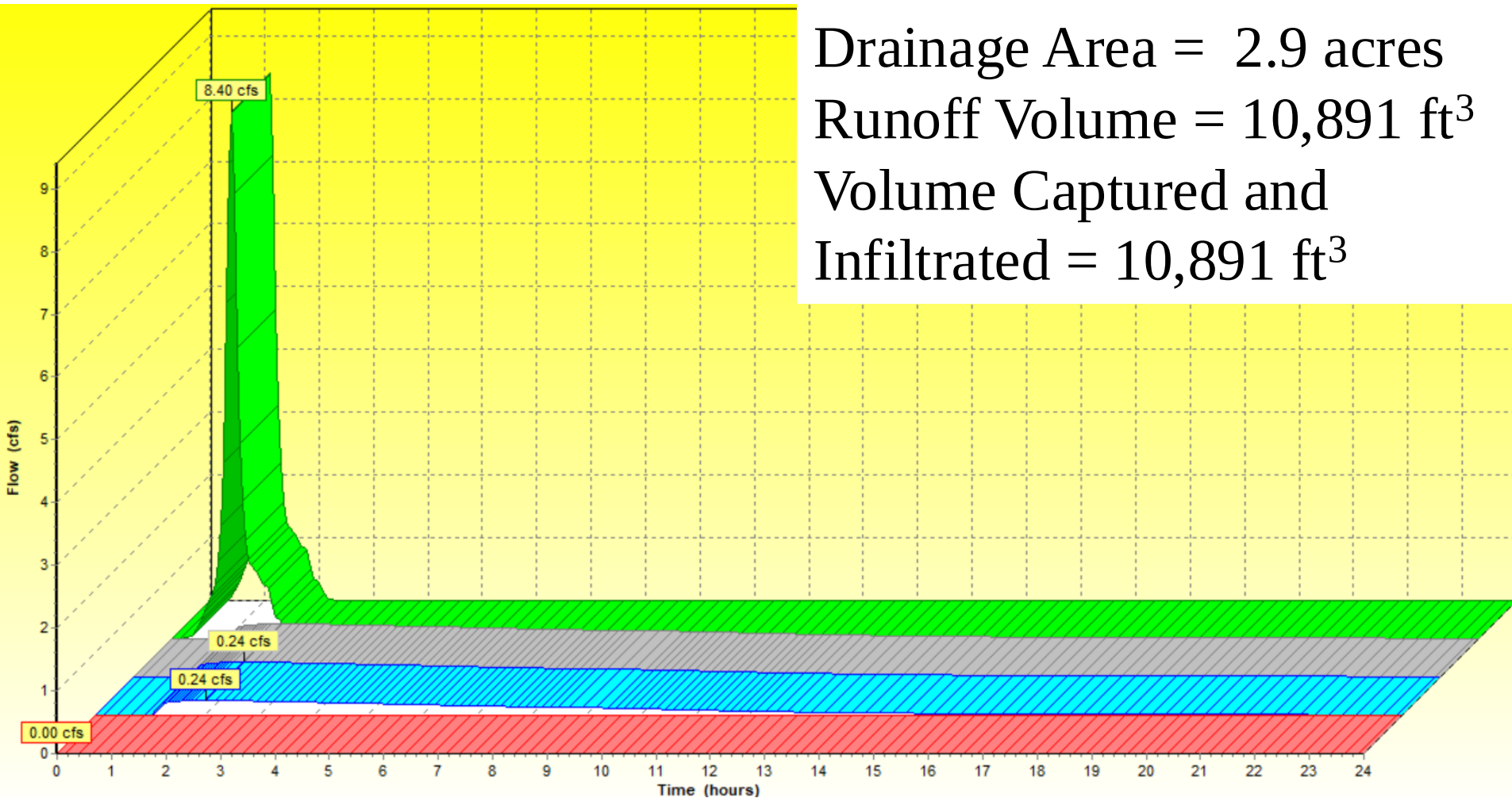


EXISTING CONDITIONS (1/4th of the site)
(NEW JERSEY WATER QUALITY PEAK DISCHARGE 1.25")

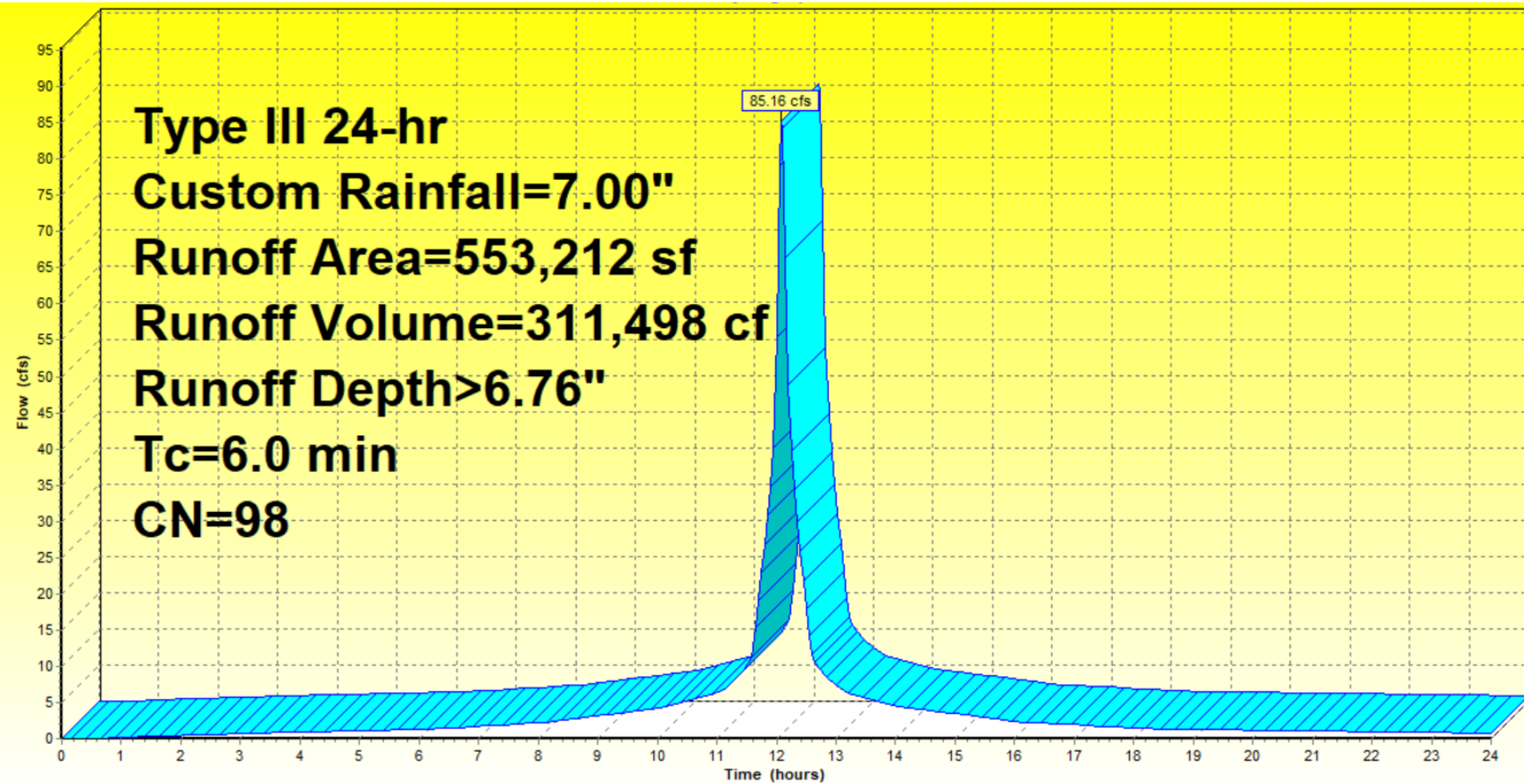


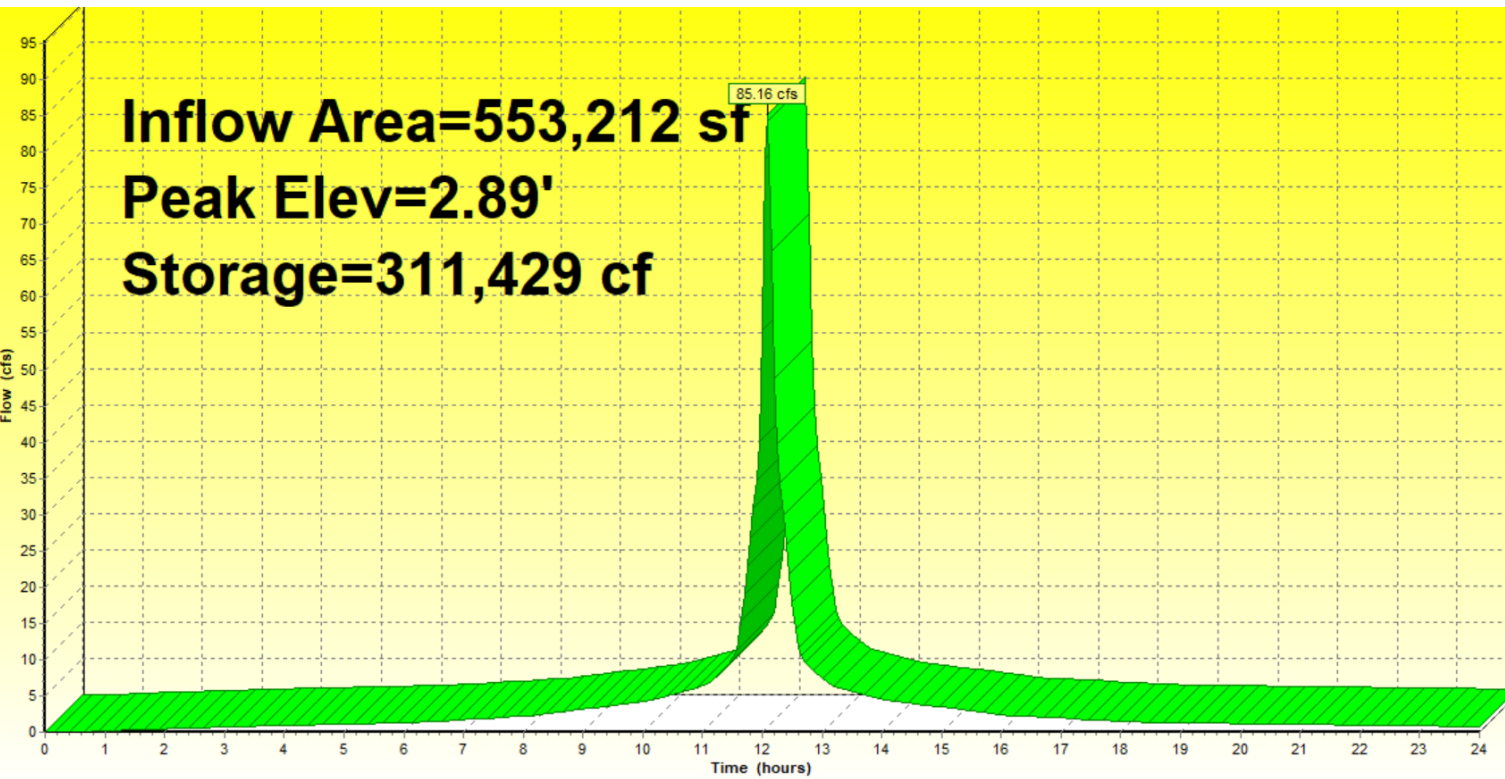
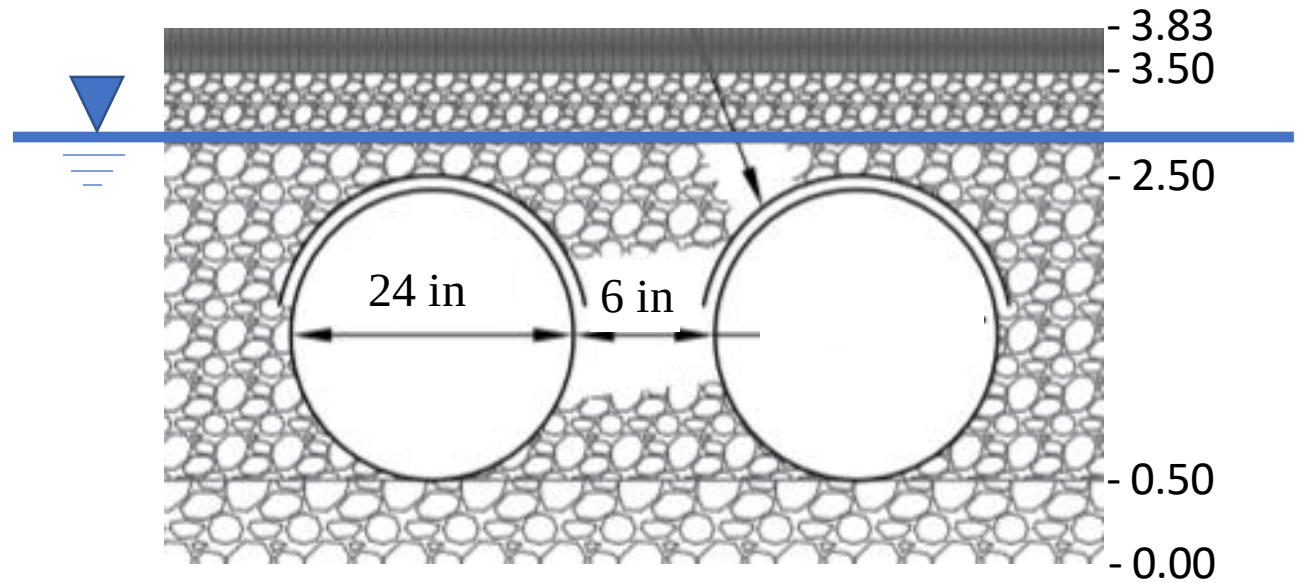
PROPOSED CONDITIONS (PERVIOUS CONCRETE) (NEW JERSEY WATER QUALITY PEAK DISCHARGE 1.25")

Drainage Area = 2.9 acres
Runoff Volume = 10,891 ft³
Volume Captured and
Infiltrated = 10,891 ft³



UNDERGROUND STORAGE SYSTEM FOR REMAINDER OF 100-YEAR STORM







Questions?

RUTGERS

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