

# Capturing Stormwater with a “Kitchen Sink” of Solutions In Anne Arundel County, MD

Chesapeake Water Environment Association Conference  
December 11, 2019

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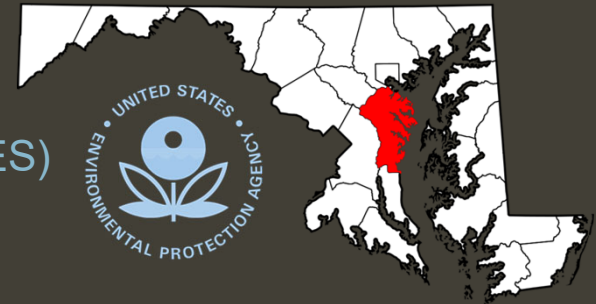
**Joe Ports**  
Project Manager, AACO DPW



# Anne Arundel County (AACo)

## WHY

- National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4)
- Chesapeake Bay Total Maximum Daily Load (TMDL)



## HOW

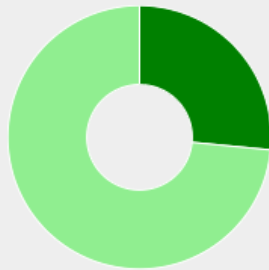
- AACo Watershed Protection & Restoration Program (WPRP)
  - Watershed Assessment & Planning
  - Restoration Implementation
  - Ecological Assessment & Evaluation
  - Education & Outreach



# AACo WPRP

## WPRP Restoration Project Goals

(Number of projects completed/anticipated)



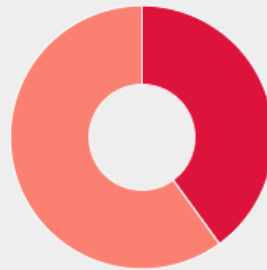
Stream & Wetland  
Restoration

13 out of 49 Completed



Stormwater Pond  
Retrofits

85 out of 144  
Completed

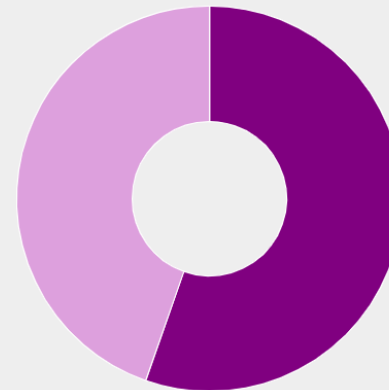


Stormwater Outfall  
Repairs

16 out of 40 Completed

## WPRP MS4 Attainment Goals

(acres to date/projected acres)



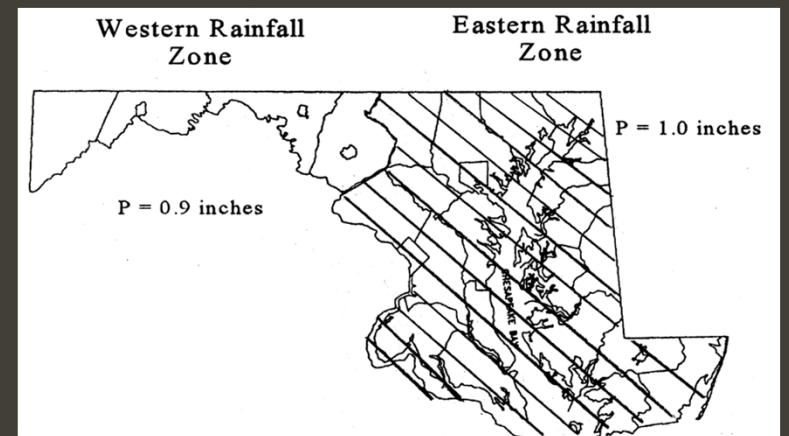
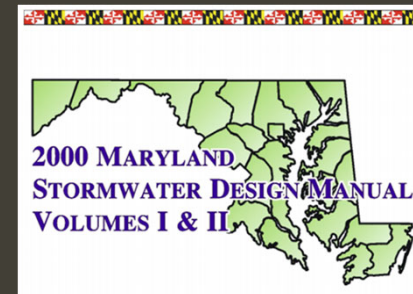
MS4 Permit Progress Tracking

2766 out of 4996 Completed

# AACo WPRP & AKRF

## GOALS

- Water Quality
  - Impervious Area Treatment
  - Chesapeake Bay TMDL (Nitrogen, Phosphorous, TSS)
- Quantity Control & Flood Mitigation
- Stability & Function of Outfalls & Waterways





# Estimate Load Reduction – Stormwater BMPs

## Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated

Guidance for  
National Pollutant Discharge Elimination  
System Stormwater Permits

August 2014

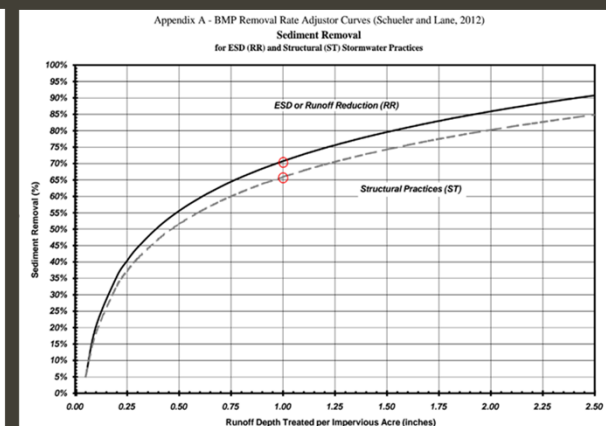
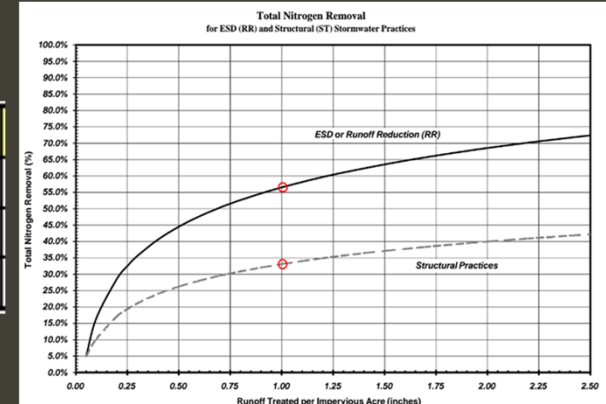
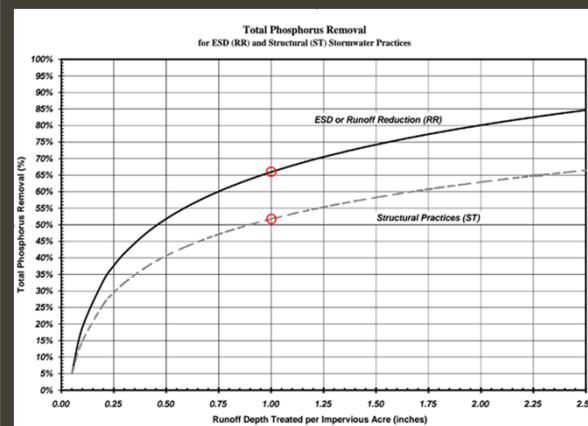


Department of the Environment

1800 Washington Boulevard, Baltimore, MD 21230-1718 | [www.mde.maryland.gov](http://www.mde.maryland.gov)  
410-537-3000 | 800-633-6101 | TTY Users 800-735-2258

Larry Hogan, Governor | Boyd Rutherford, Lt. Governor | Ben Grumbles, Secretary

Parameter	Urban Impervious
TN (lbs)	15.3
TP (lbs)	1.69
TSS (tons)	0.44



# Estimate Load Reduction – Stream Restoration



Protocol	Name	Units	Pollutants
1	Prevented Sediment (S)	Pounds per year	Sediment TN, TP
2	Instream Denitrification (B)	Pounds per year	TN
3	Floodplain Reconnection (S/B)	Pounds per year	Sediment TN, TP
4	Dry Channel RSC as a Retrofit (S/B)	Removal rate	Sediment TN, TP

## Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Joe Berg, Josh Burch, Deb Cappuccitti, Solange Filoso, Lisa Fraley-McNeal, Dave Goerman, Natalie Hardman, Sujay Kaushal, Dan Medina, Matt Meyers, Bob Kerr, Steve Stewart, Bettina Sullivan, Robert Walter and Julie Winters

Accepted by Urban Stormwater Work Group (USWG): **February 19, 2013**  
 Approved by Watershed Technical Work Group (WTWG): **April 5, 2013**  
 Final Approval by Water Quality Goal Implementation Team (WQGIT): **May 13, 2013**  
 Test-Drive Revisions Approved by the USWG: **January 17, 2014**  
 Test-Drive Revisions Approved by the WTWG: **August 28, 2014**  
 Test-Drive Revisions Approved by the WQGIT: **September 8, 2014**



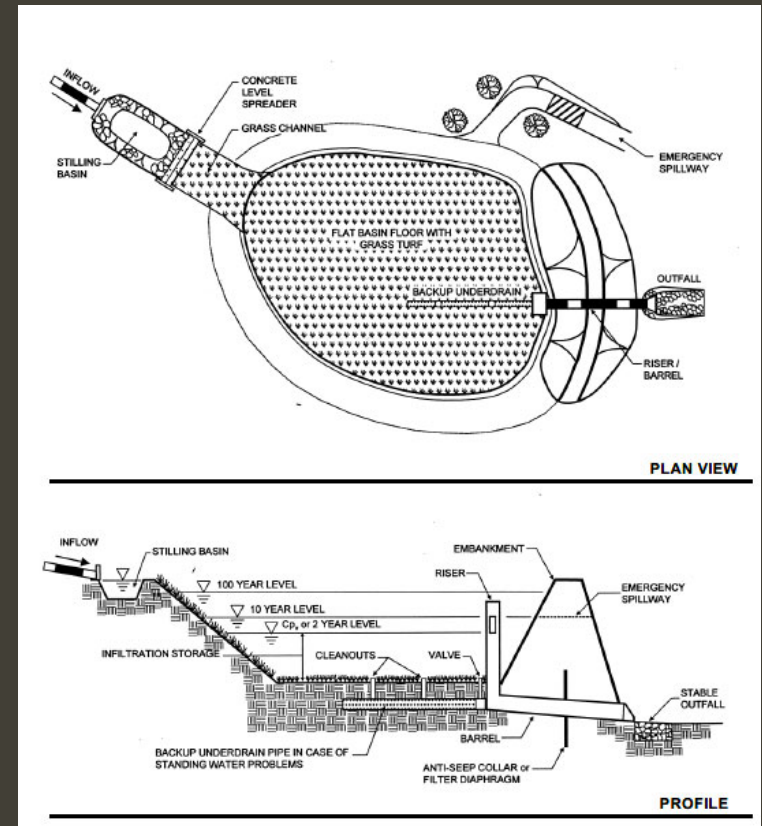
Prepared by:  
 Tom Schueler, Chesapeake Stormwater Network  
 and  
 Bill Stack, Center for Watershed Protection



# The Suite of Solutions

## INFILTRATION BASIN

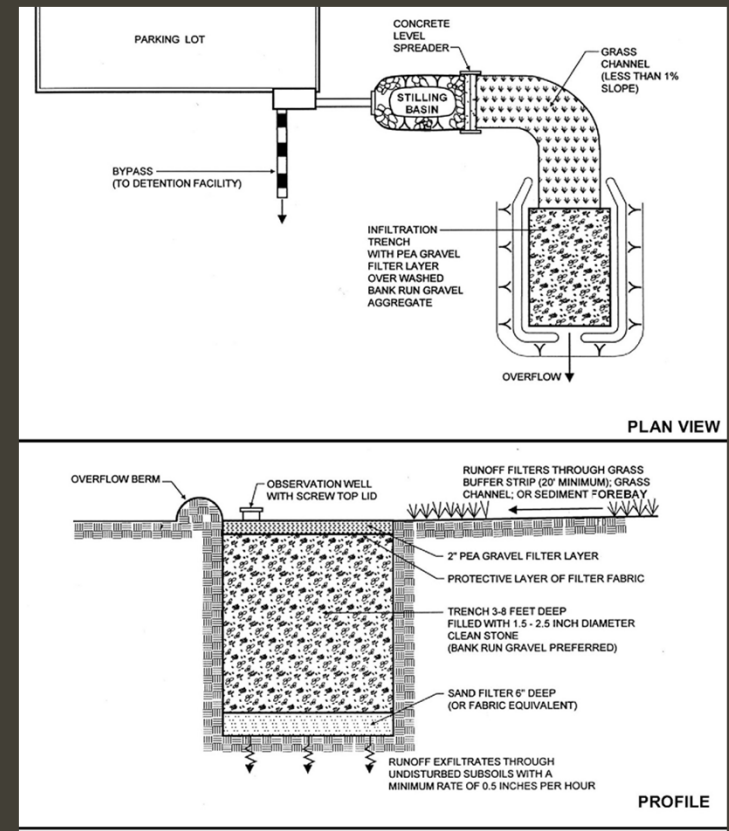
- Depressed area for temporary storage of Water Quality Volume (WQv)
- Facilitate infiltration / recharge
- Channel protection
- Flood protection



# The Suite of Solutions

## INFILTRATION TRENCH

- Capture and temporarily store WQv within the void space of material
  - Typically stone
- Facilitate infiltration / recharge
- Channel protection
- Flood protection

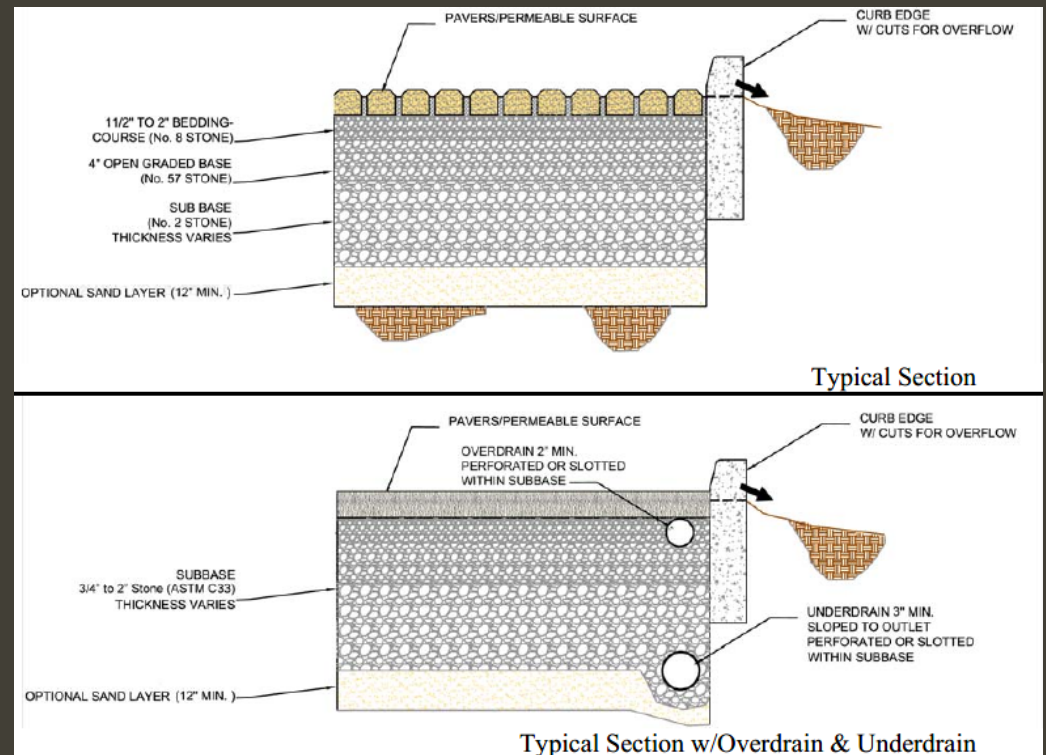




# The Suite of Solutions

## PERMEABLE PAVEMENT

- Alternative surfacing material
  - Porous asphalt
  - Pervious concrete
  - Interlocking pavers
- Open graded stone base/subbase
- Promote groundwater recharge
- Mitigate temperature increases



# The Suite of Solutions

## REGENERATIVE STREAM CONVEYANCE (RSC)

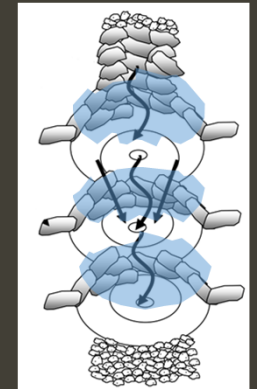
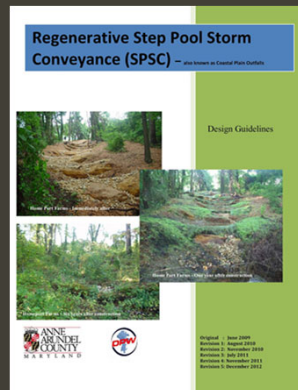
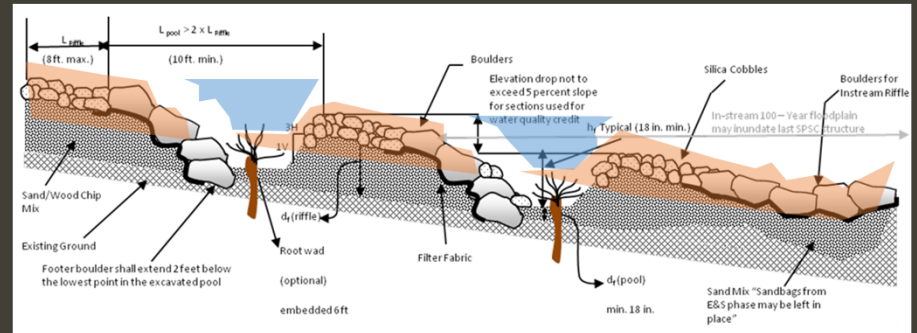
- Perennial channels
- Restore ecosystem functions of streams, floodplains, & wetlands
- Network of systems
  - seepage berms
  - pools
  - cobble weirs
  - floodplain & wetland connections



# The Suite of Solutions

## STEP POOL STORM CONVEYANCE (SPSC)

- Similar in design to RSC
- Ephemeral or intermittent channels
- Surface step pools and subsurface sand seepage filter
- Convert surface flow to shallow groundwater flow
- Energy reduction
- Habitat benefits



# Project Examples

- Patapsco Non-Tidal Untitled Tributary Project
  - Performing Arts Center (PAC)
  - Brooklyn Park (BP)
  - Riverside Park (RP)
- Najoles Road Pond Retrofit & Stream Restoration Project



# Performing Arts Center



## PAC: Site Overview



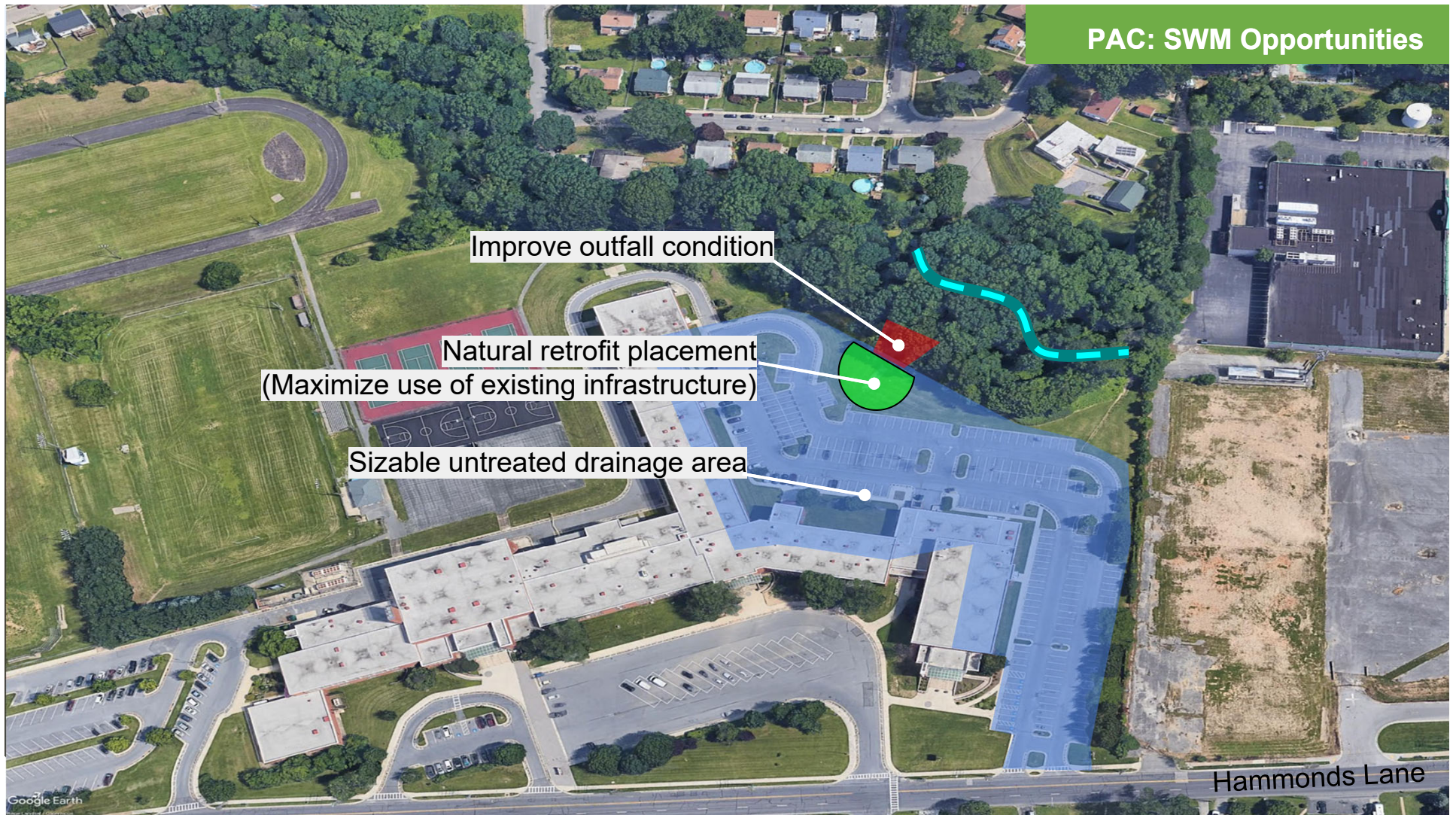


## PAC: Site Overview





## PAC: SWM Opportunities





# Performing Arts Center

## SITE CHALLENGES

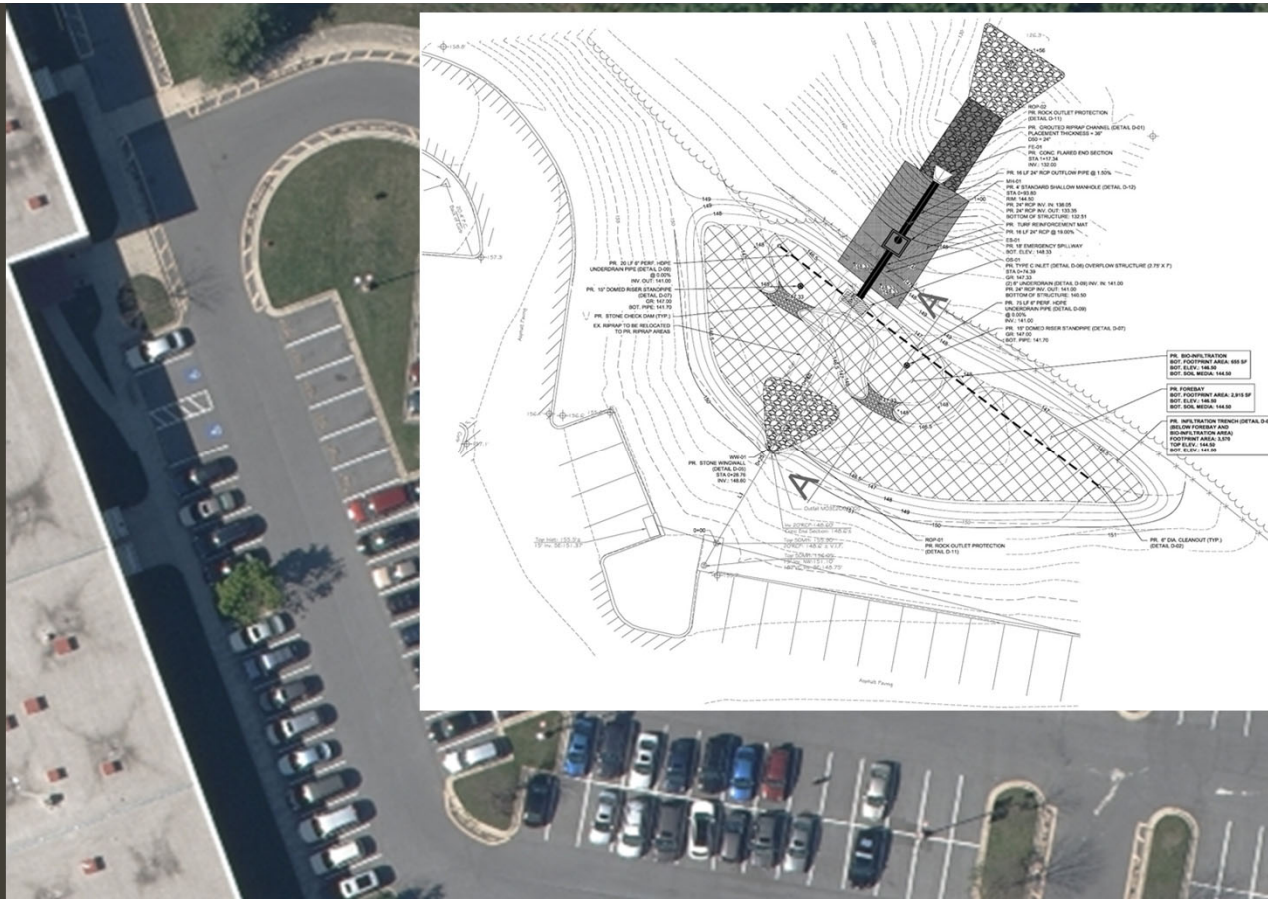
- Maintain stability and function of outfall
- Conserve forest resources



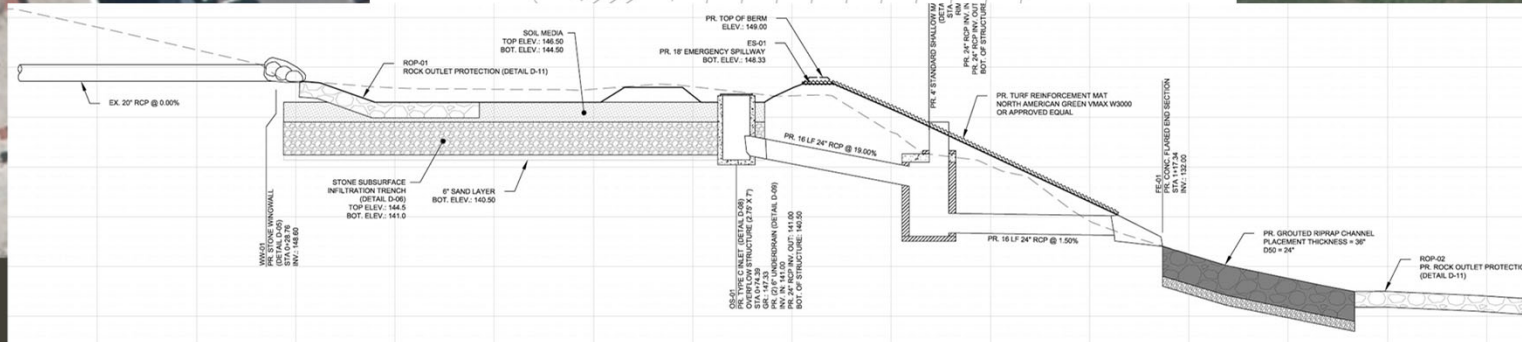
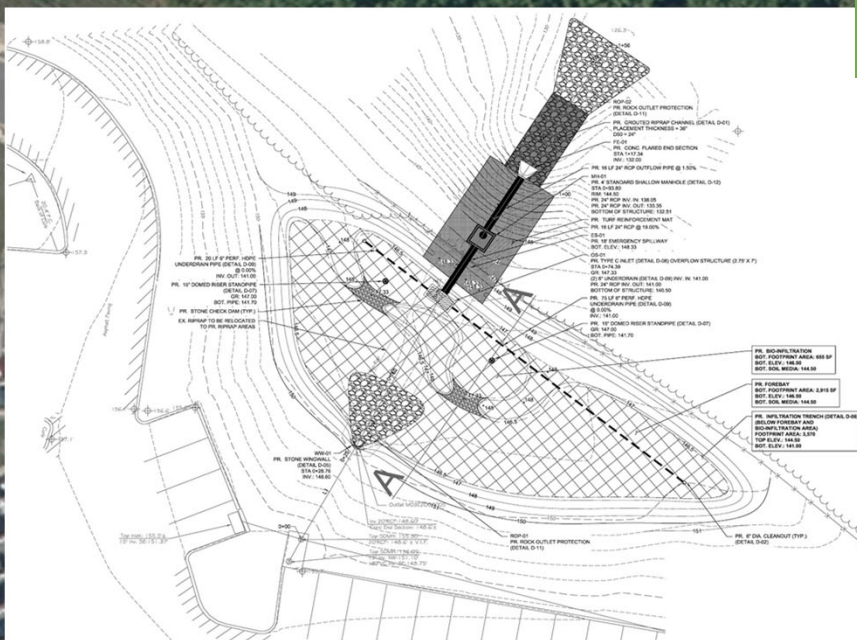
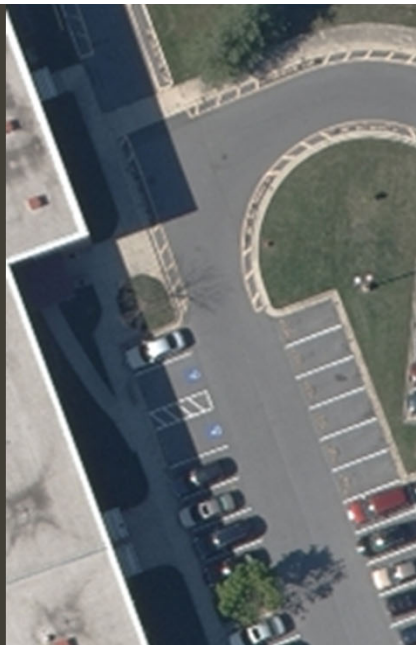
## PAC: Design Overview



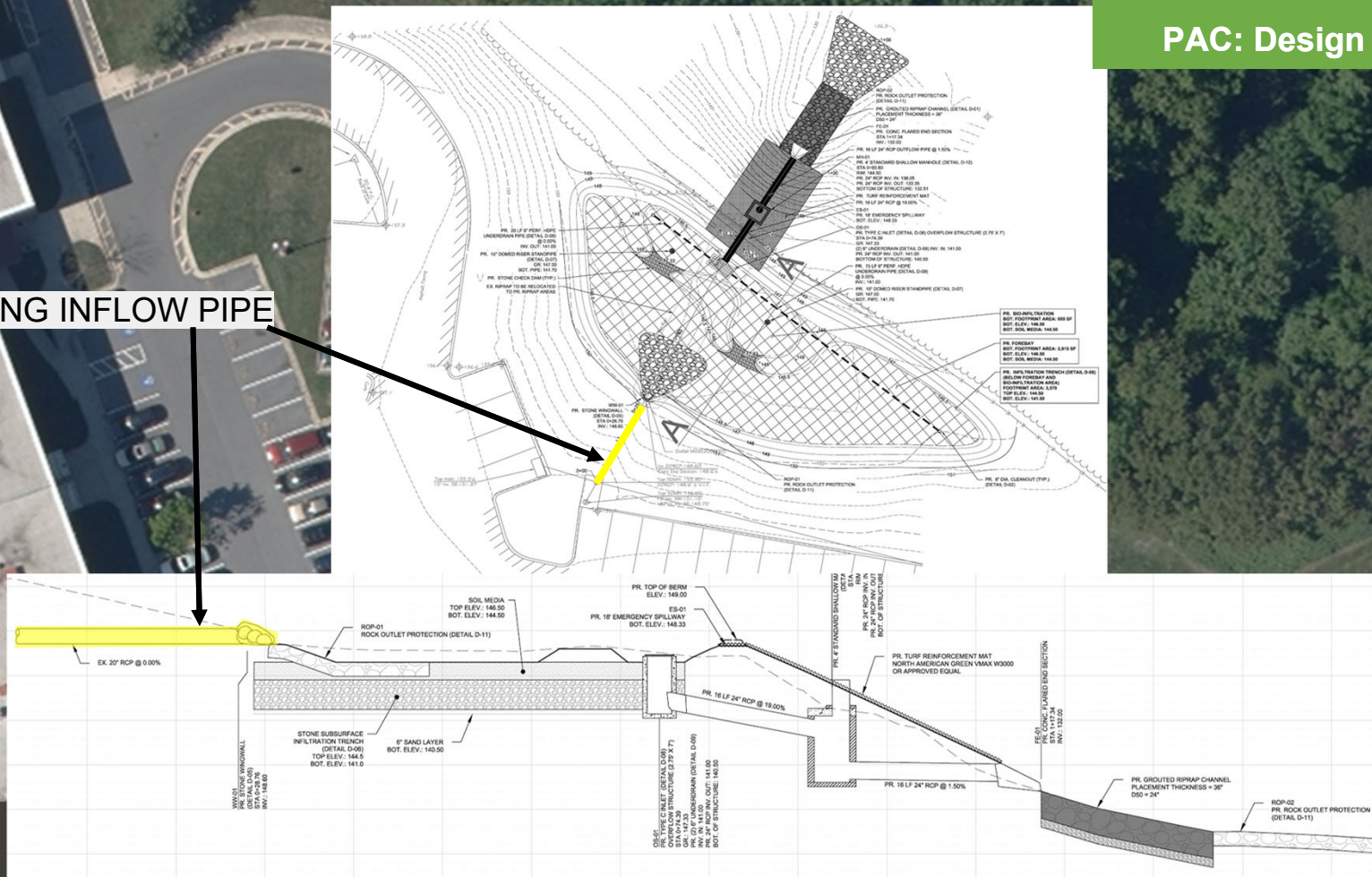
## An aerial photograph showing a paved parking lot with white diagonal lines in the foreground. A dense, green forest occupies the upper portion of the image. A small, light-colored area, possibly a clearing or a path, is visible between the parking lot and the forest. The image is oriented vertically on the page.





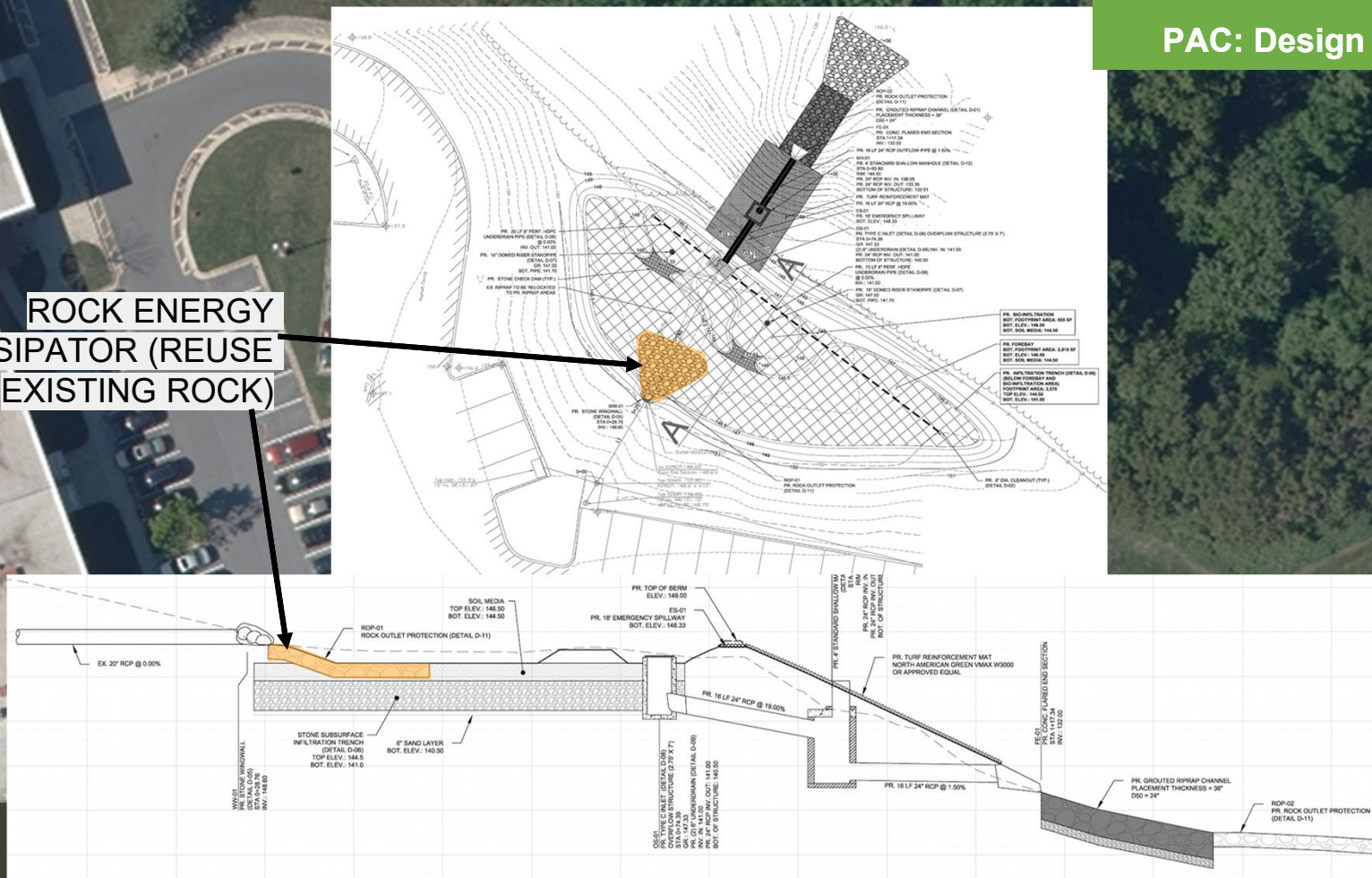




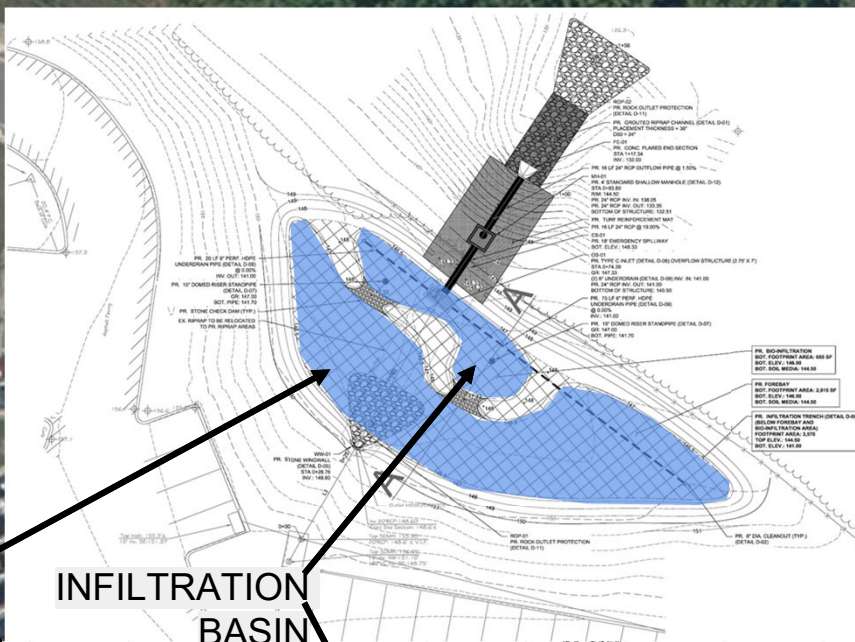
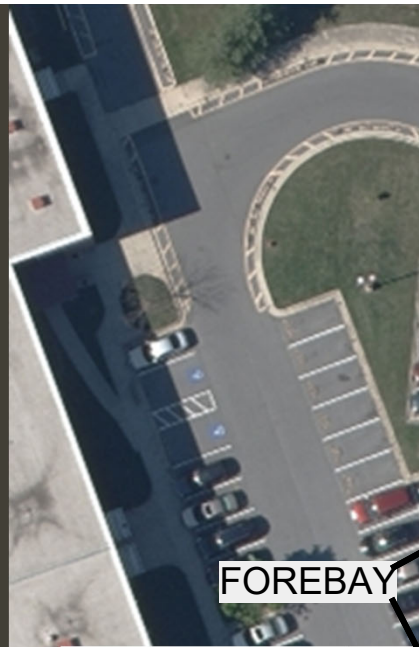


An aerial photograph of a baseball field. A curved concrete structure, identified as a rock dissipator, runs along the edge of the infield. The field is green grass, and the surrounding area includes a parking lot with several cars and a building. A black line points from the text box to the dissipator structure.

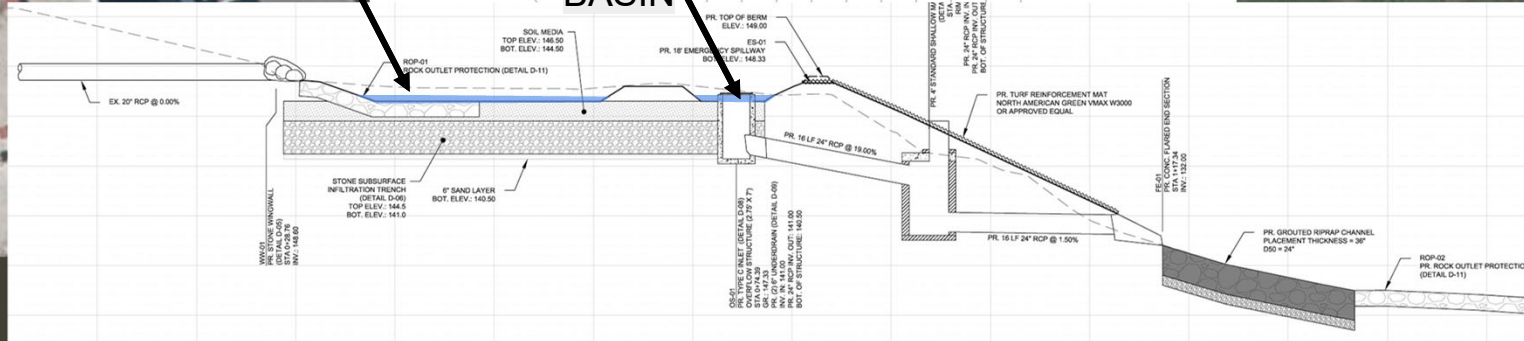
ROCK ENERGY DISSIPATOR (REUSE EXISTING ROCK)

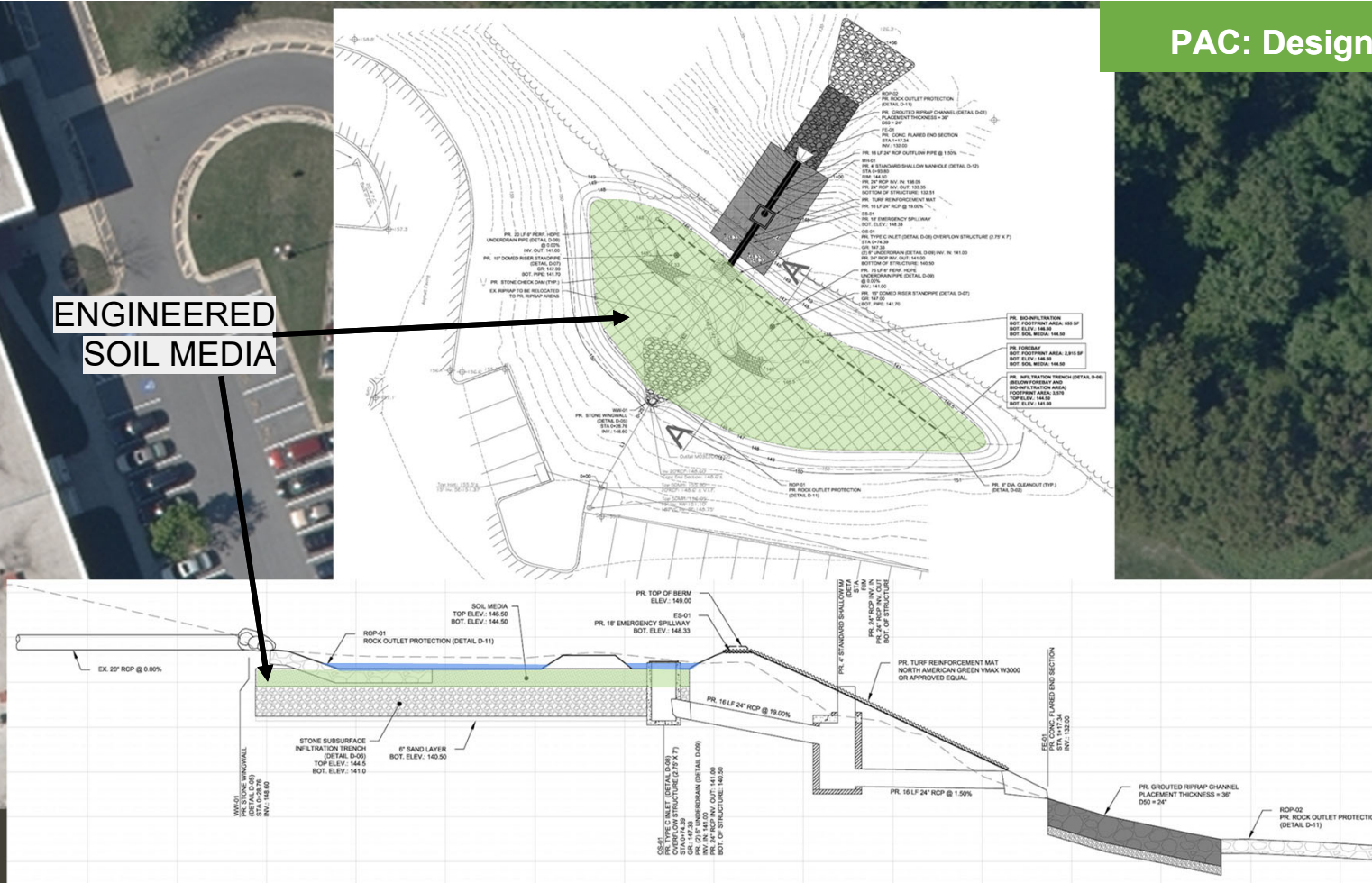






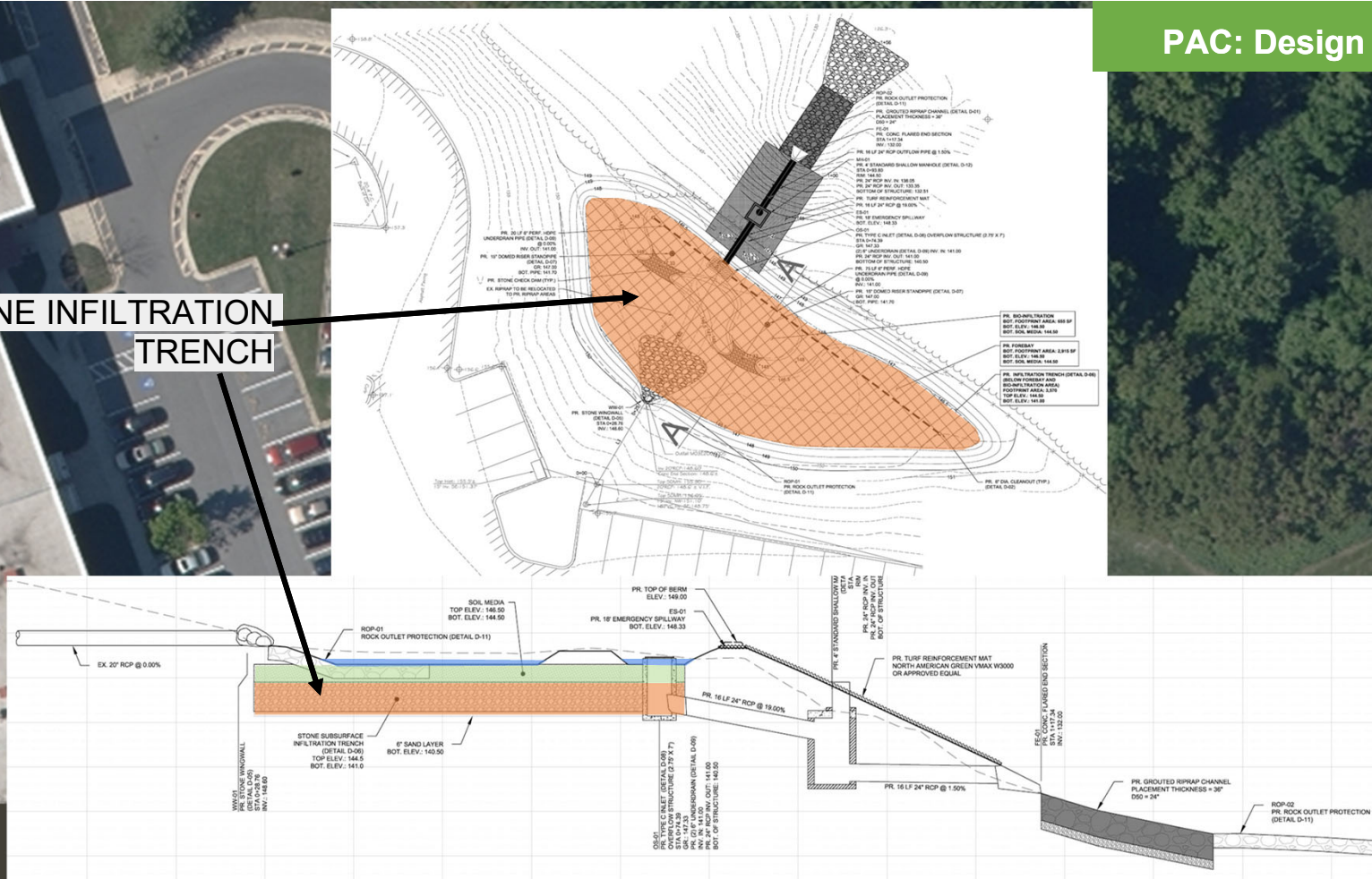
# INFILTRATION BASIN



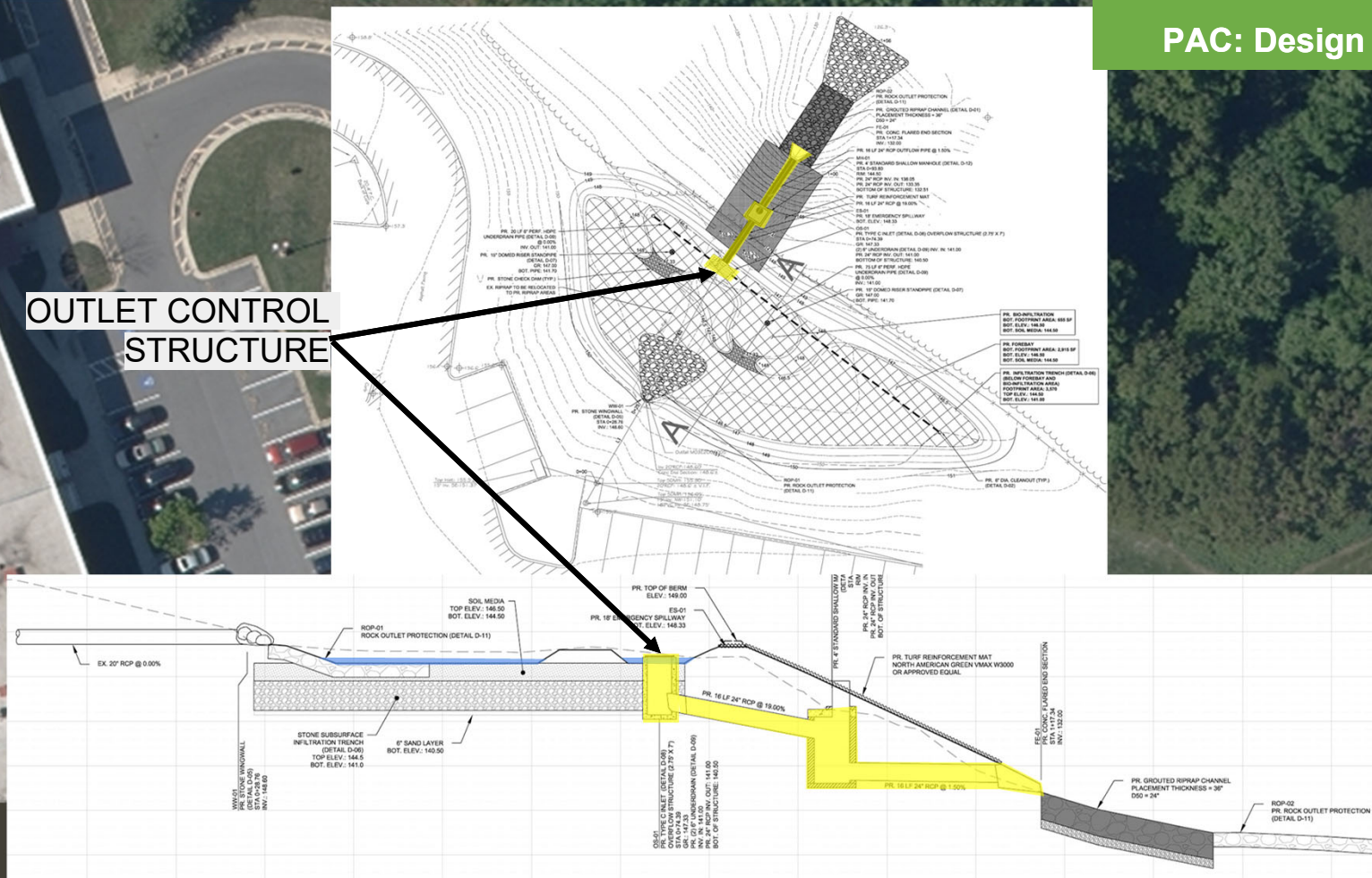
An aerial photograph showing a parking lot with several cars, a building, and a grassy area. The text "ENGINEERED SOIL MEDIA" is overlaid in a white box with a black border. A black line points from the text to a specific area in the parking lot.



STONE INFILTRATION TRENCH



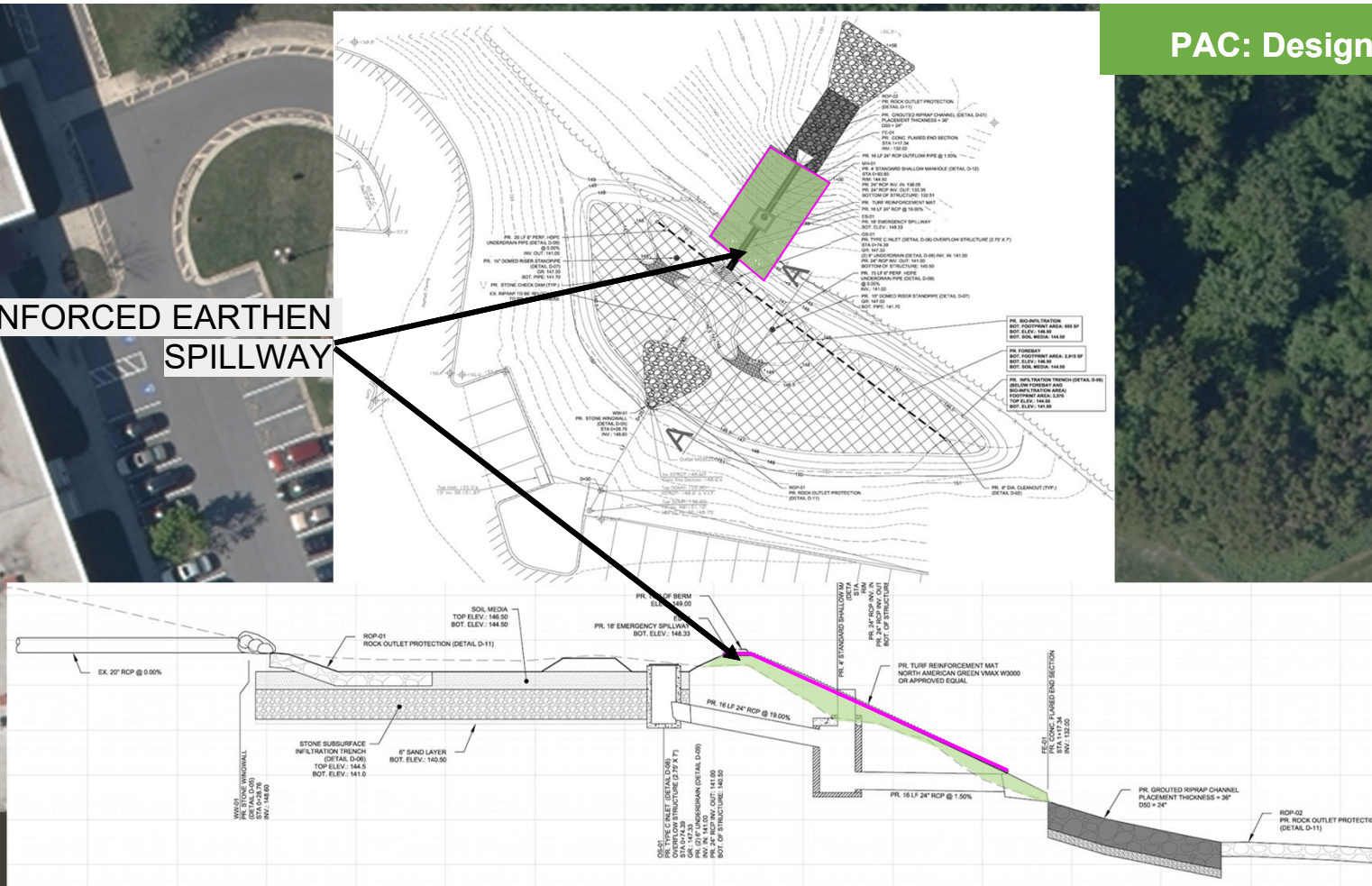
An aerial photograph of a baseball field. The field is green with a brown dirt infield. A white line marks the edge of the infield. A white fence surrounds the field. A parking lot with several cars is visible in the foreground. The text "OUTLET CONTROL STRUCTURE" is overlaid in white capital letters on a black background.





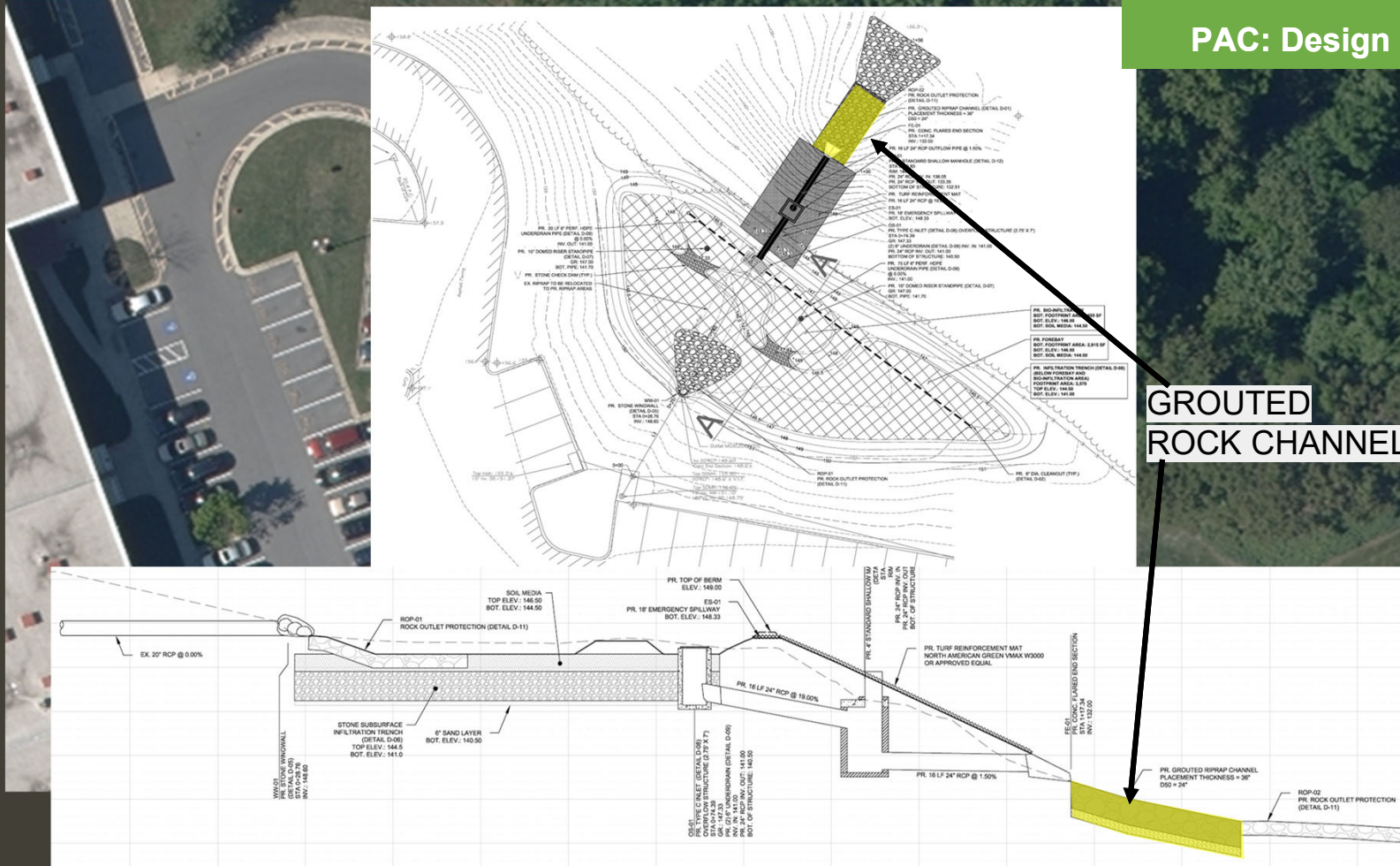


REINFORCED EARTHEN  
SPILLWAY



## PAC: Design Overview

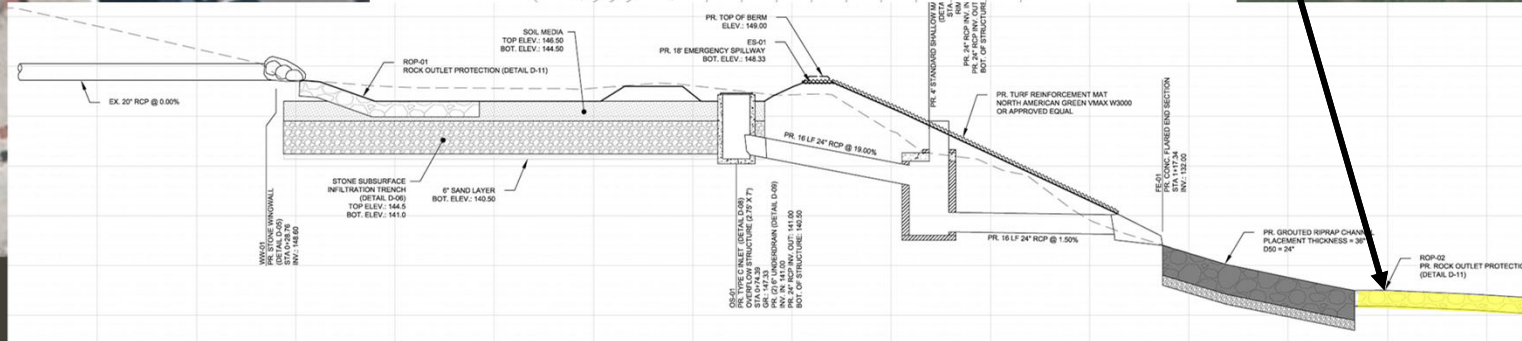
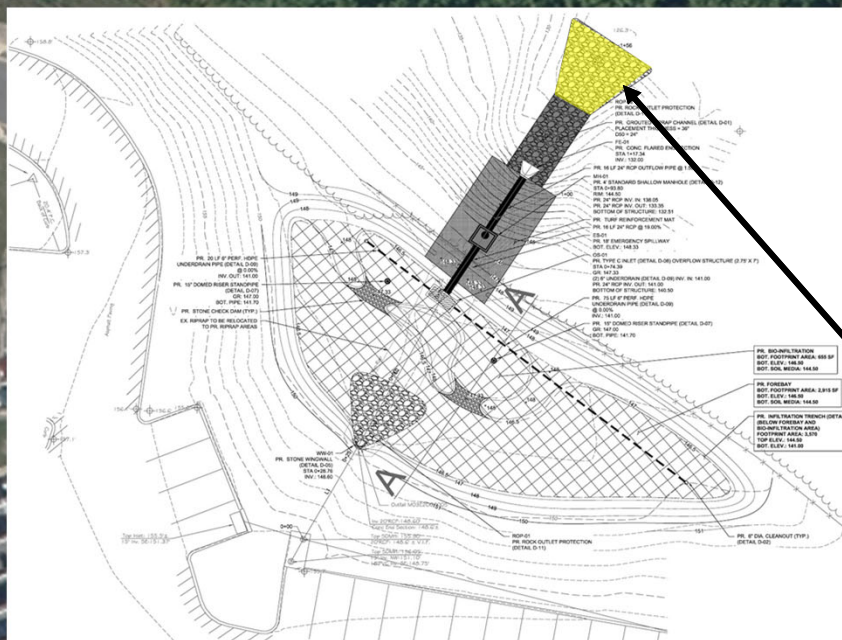
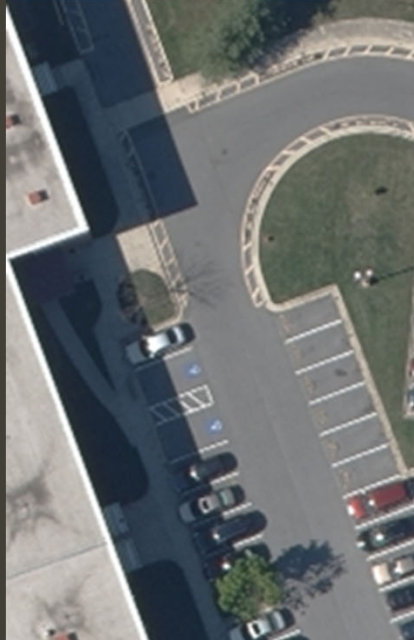
GRouted  
ROCK CHANNEL





## PAC: Design Overview

ROCK OUTLET PROTECTION



# Brooklyn Park



## BP: Site Overview





## BP: Site Overview



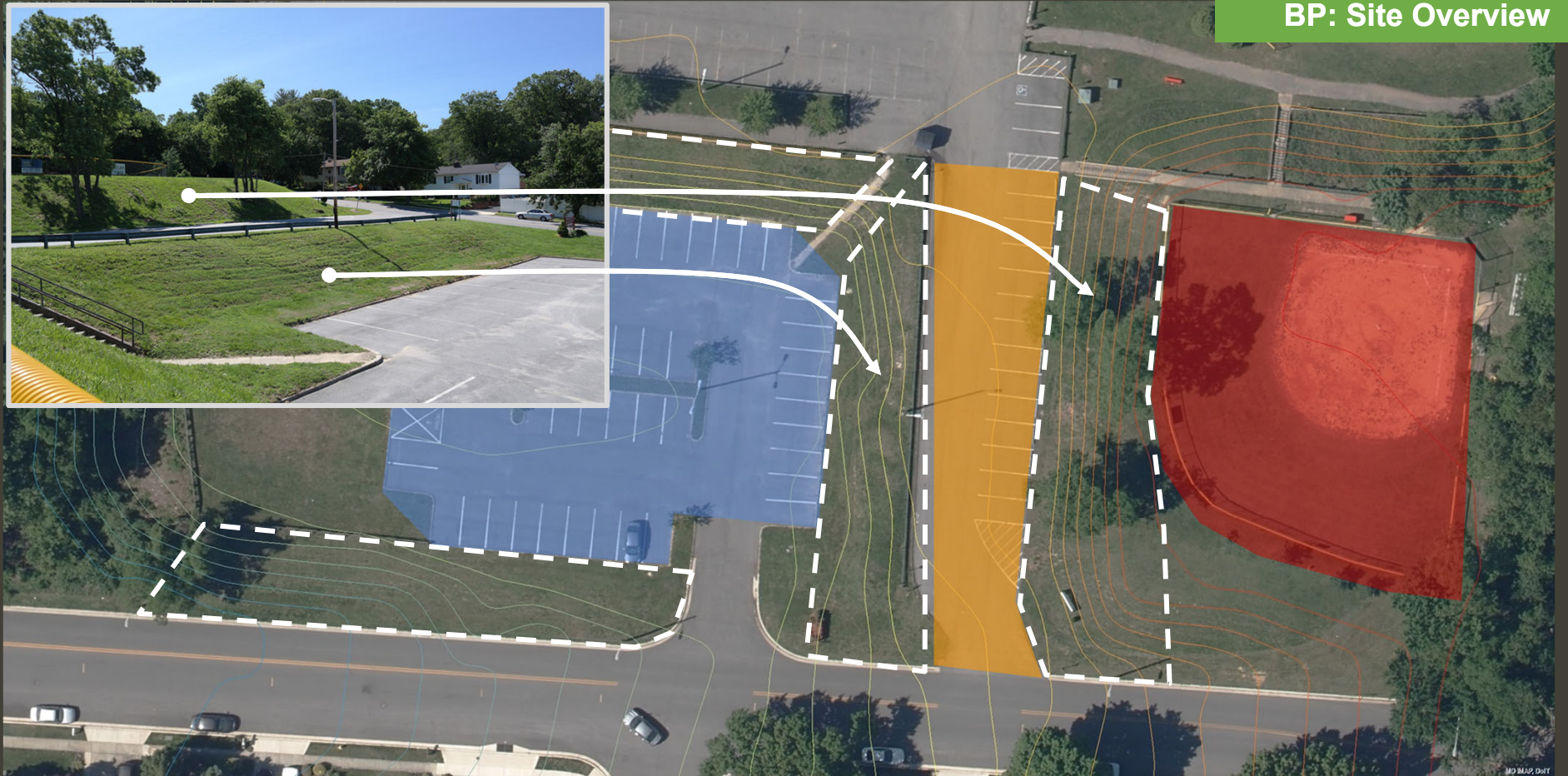


## BP: Site Overview



MD MAP, DOT

## BP: Site Overview





# Brooklyn Park

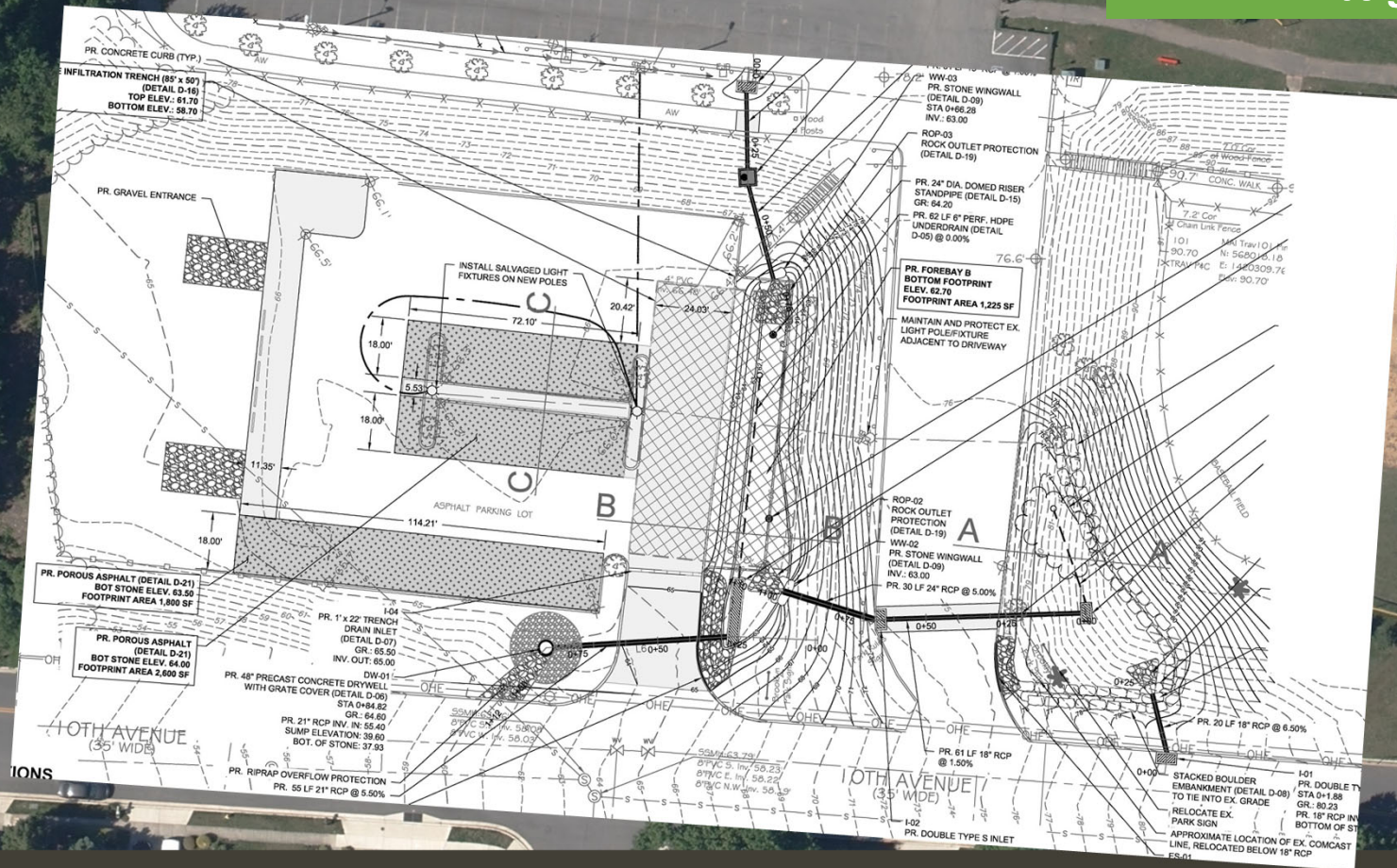
## SWM OPPORTUNITIES

- Manage untreated drainage area
- Mitigate roadway flooding
- Public exposure to County SWM initiatives
- Drywell pilot

## SITE CHALLENGES

- Site constraints for SMP location
  - Steep grades
- Safe conveyance of overflow (no public storm sewer)
- Construction timing

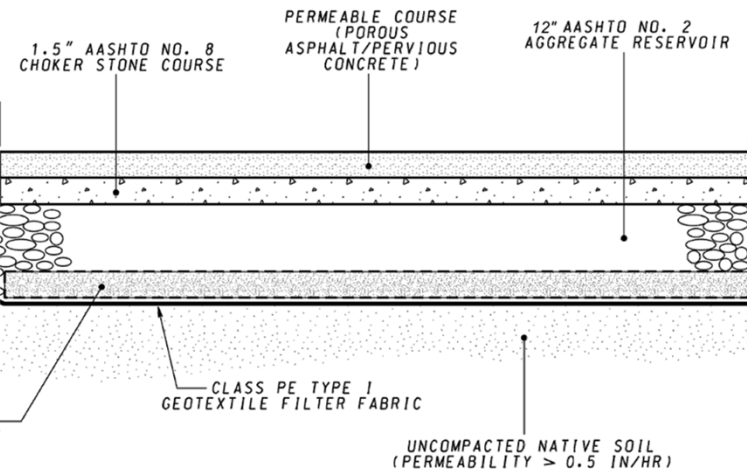
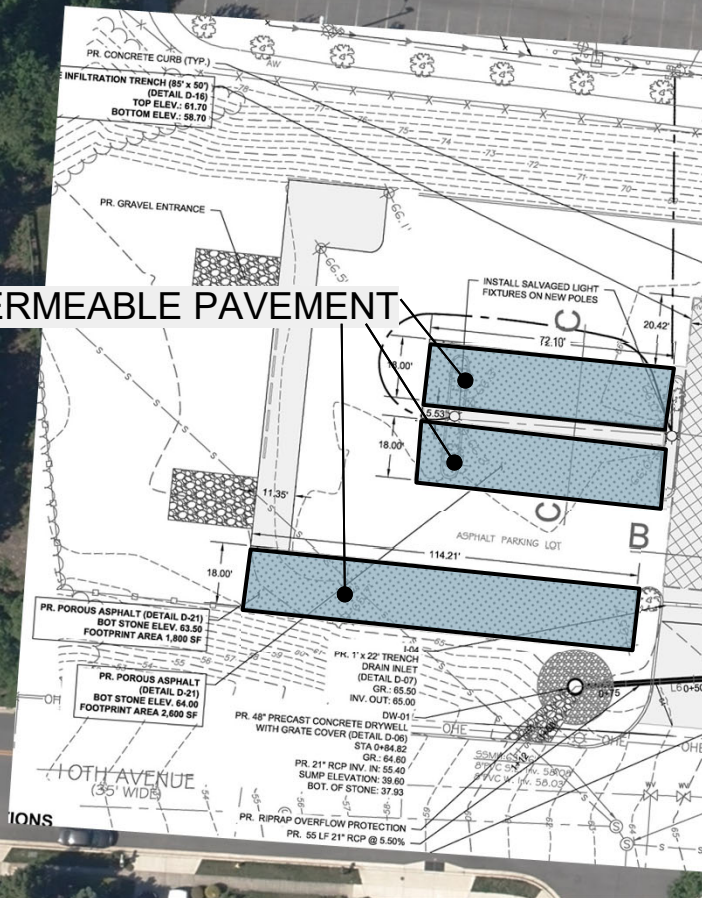
## BP: Design Overview



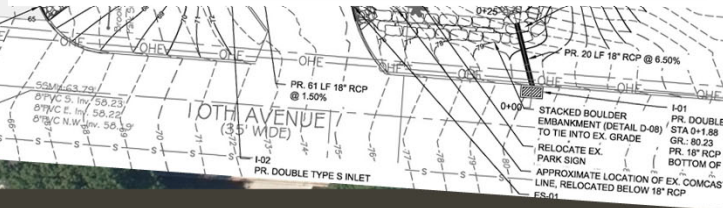


## BP: Design Overview

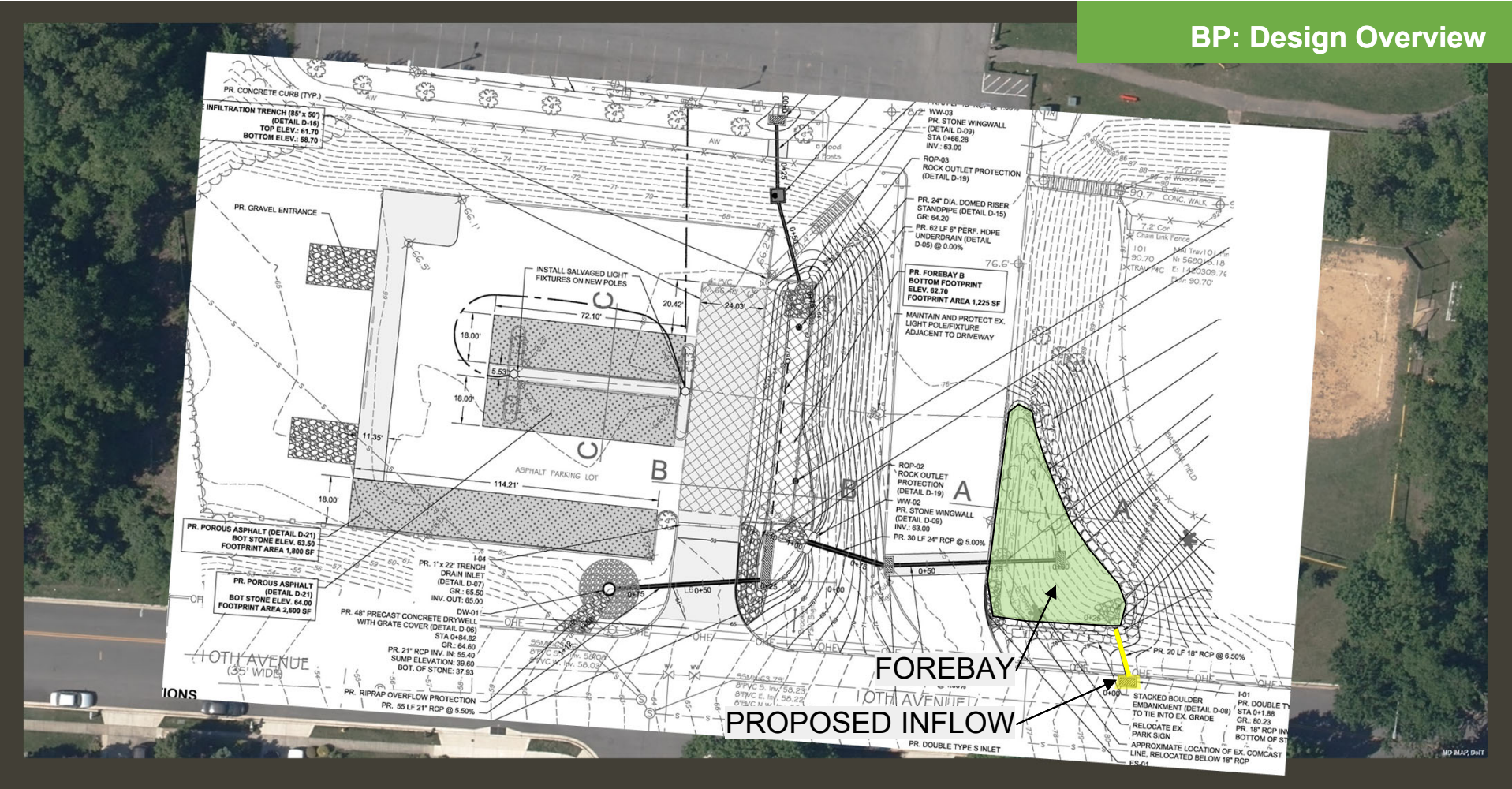
### PERMEABLE PAVEMENT



### PERMEABLE PAVEMENT SECTION

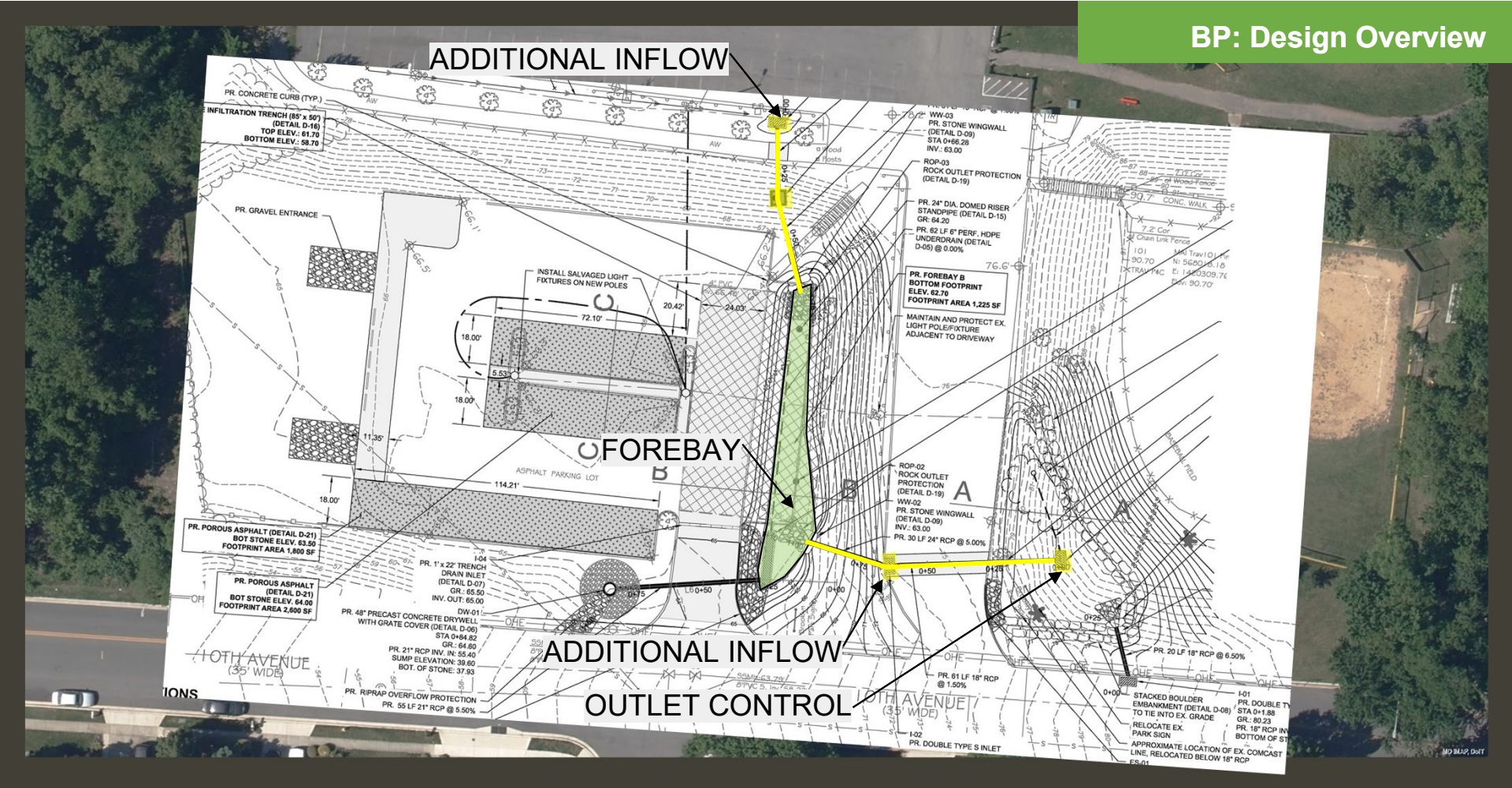


## BP: Design Overview



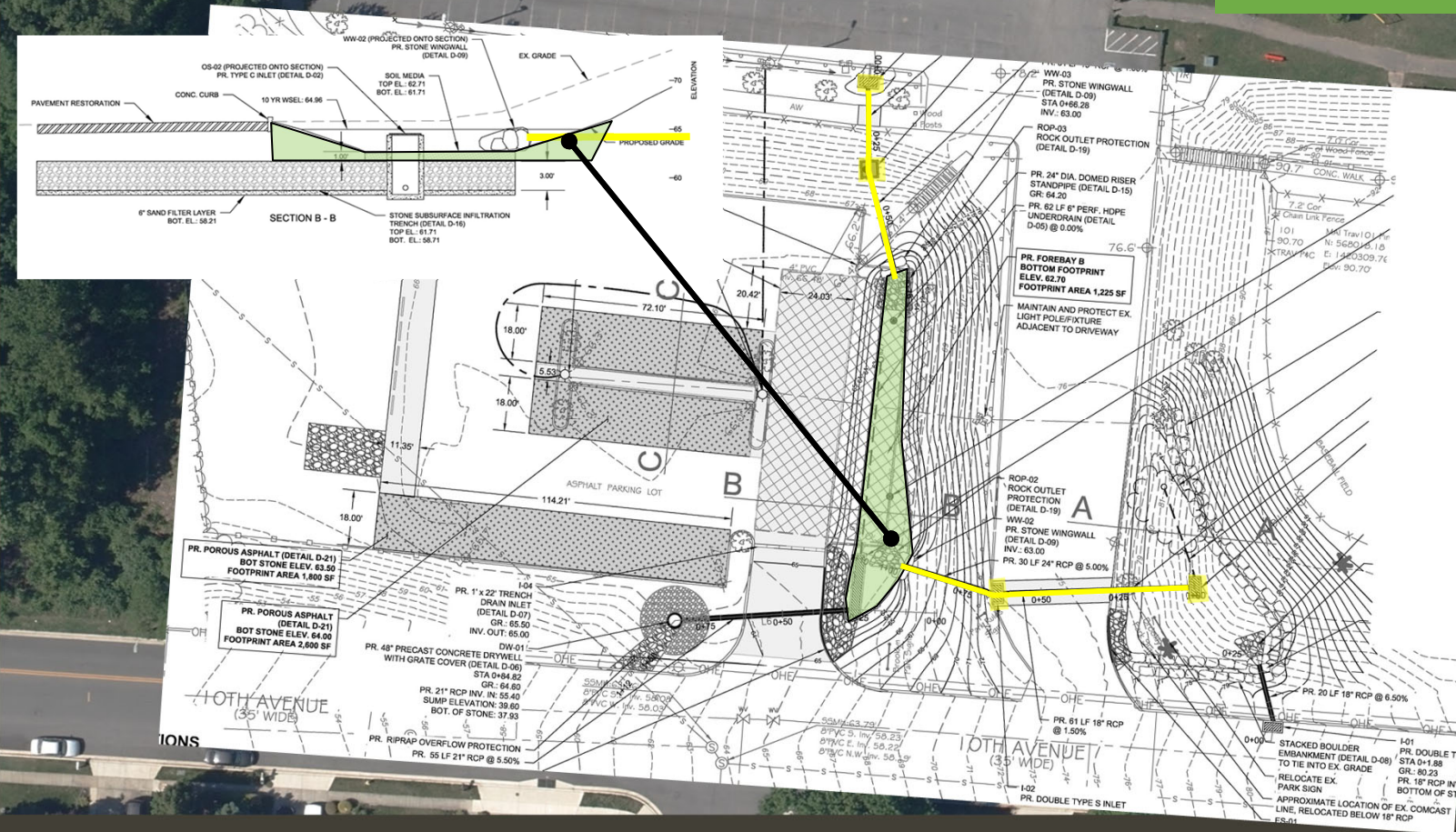


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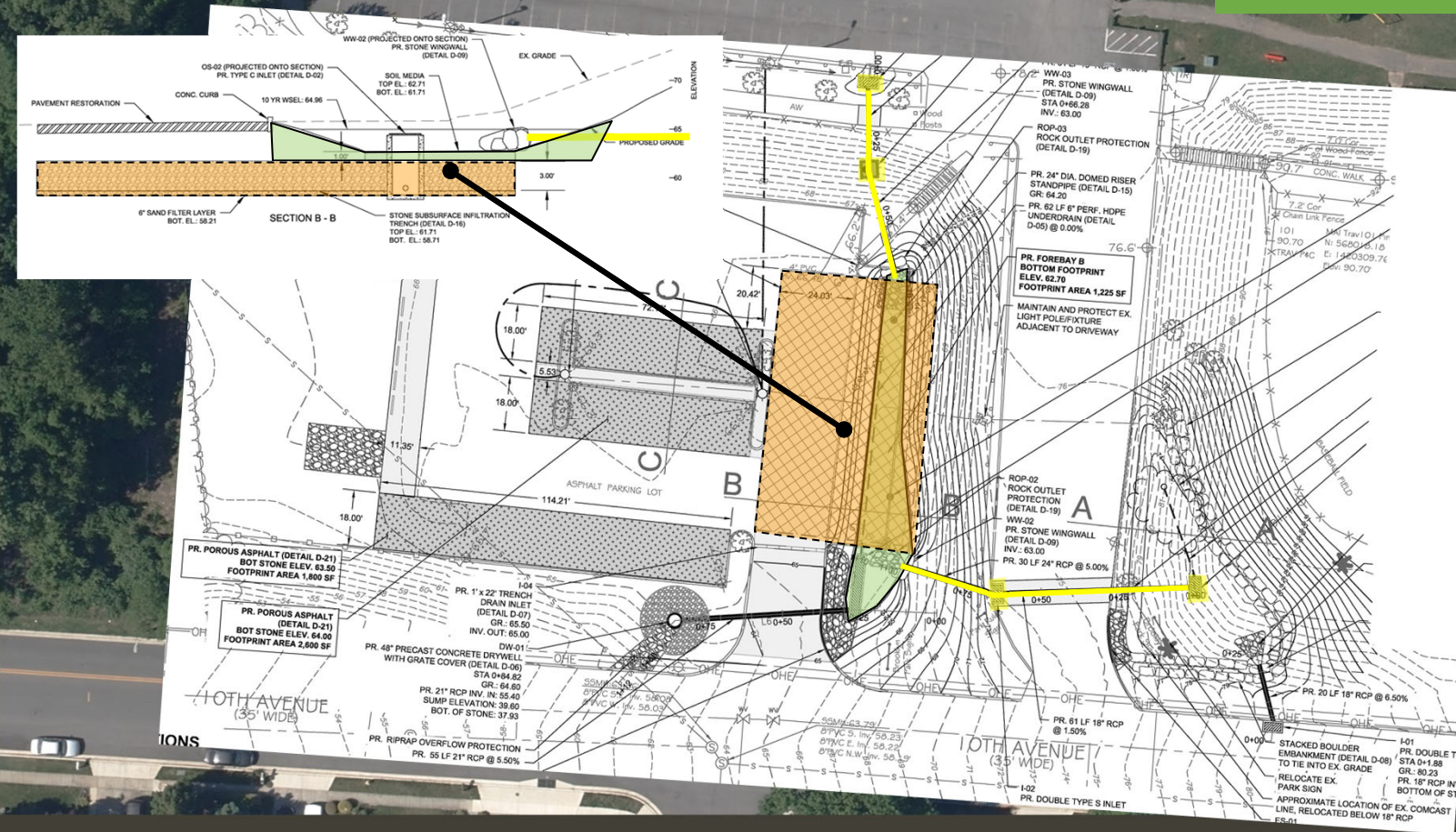


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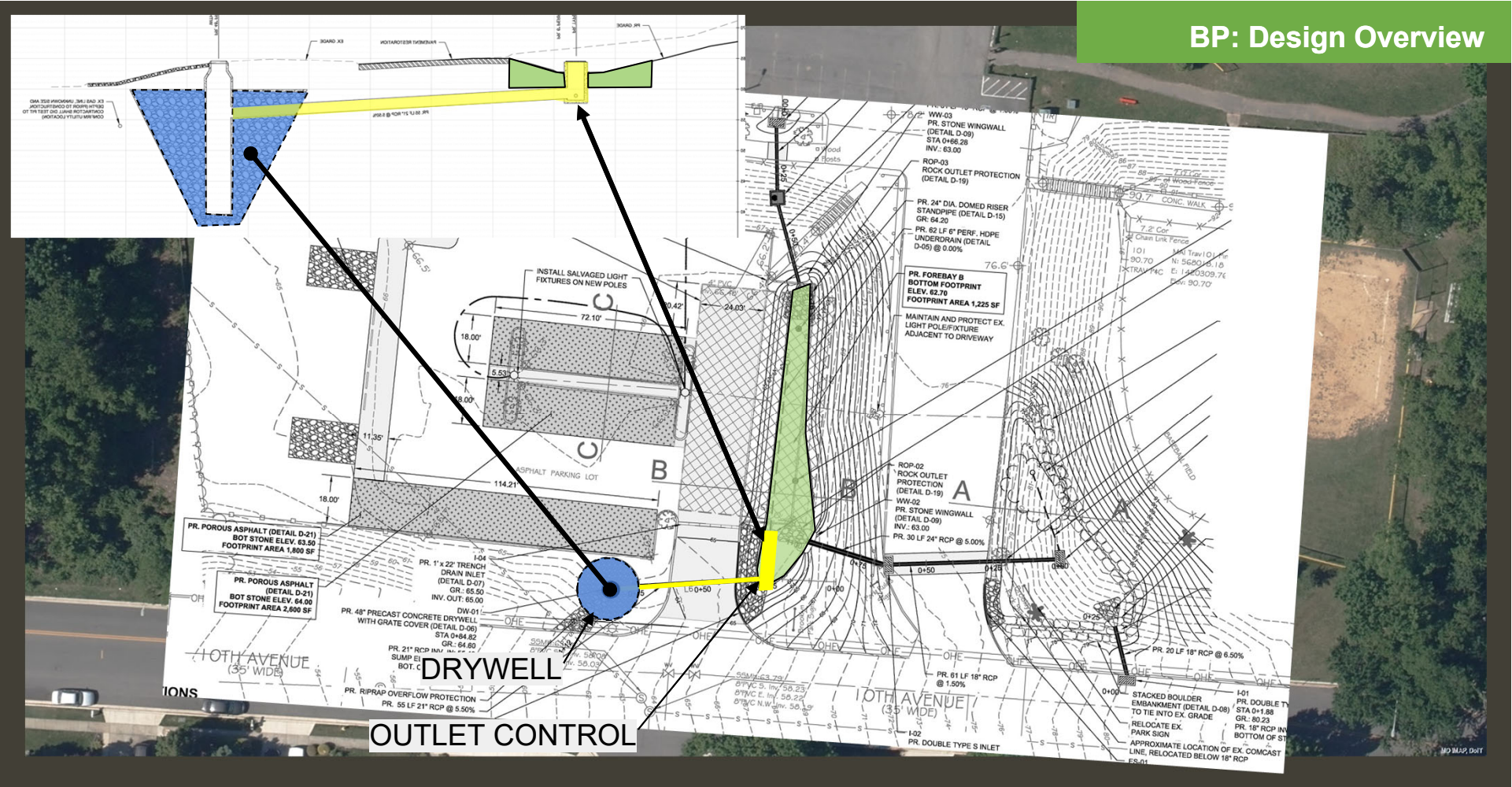


## BP: Design Overview





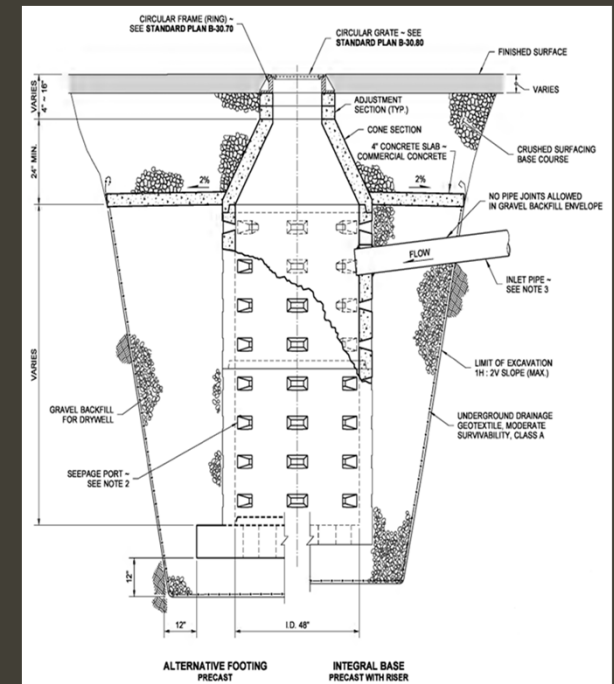
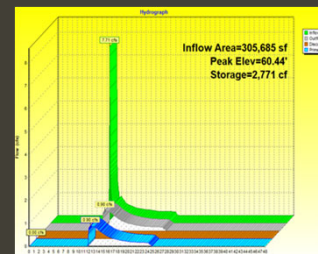
## BP: Design Overview



# DRYWELL PILOT

- Washington DOT Drywell Detail
- Manhole embedded in stone
- Typical depth: 10 FT - 30 FT
- AACo Drywell Pilot
  - Storage volume for 2-year storm
  - Overflow via surcharge

STORM	RAINFALL DEPTH	REQ. DRYWELL(S)
1YR - 24HR	2.70 IN	(1) 10-FT Drywell
2YR - 24HR	3.30 IN	(1) 20-FT Drywell
10YR - 24HR	5.20 IN	(6) 20-FT Drywells





# Riverside Park



## RP: Site Overview





## RP: Site Overview

OUTFALL PIPE FROM I-895



12 FT WIDE CONCRETE CHANNEL





## RP: Site Overview



# Riverside Park

## STORMWATER MANAGEMENT OPPORTUNITIES

- Ephemeral channel well suited for SPSC
- Convert impervious concrete swale into pervious, naturalized step-pool channel system
- Remove invasive plants and establish native landscaping

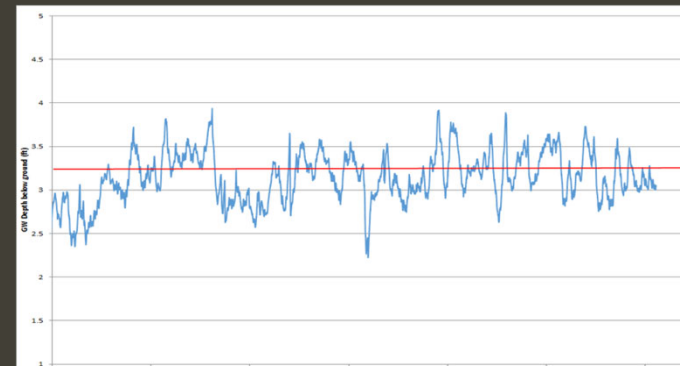




# Riverside Park

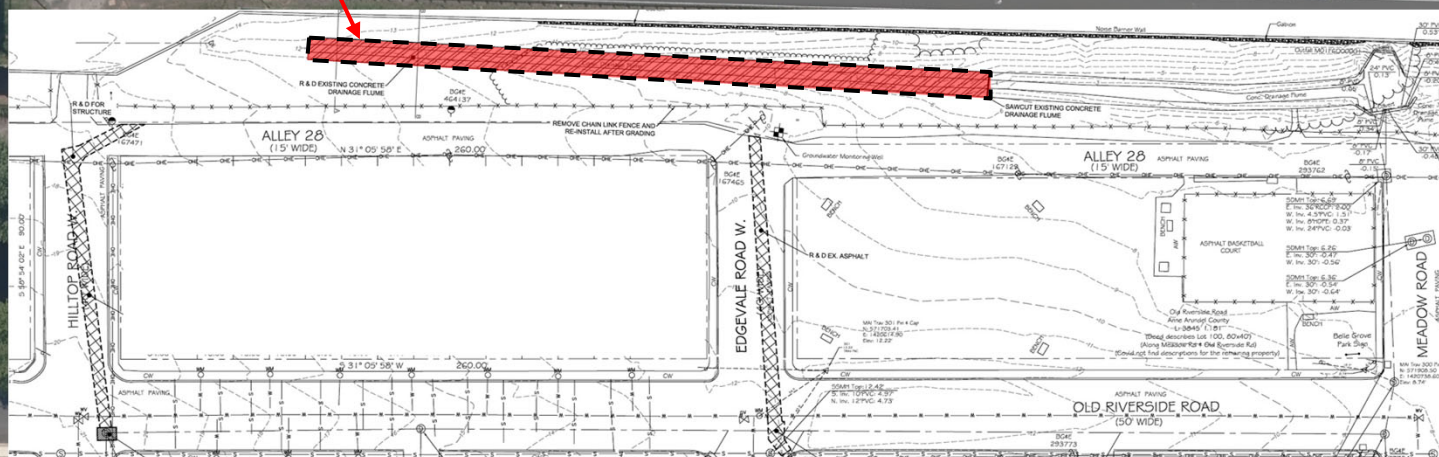
## SITE CHALLENGES

- Physical space
- I-895 noise wall foundation
- Shallow groundwater table





REMOVE SEGMENT OF  
CONCRETE CHANNEL



I-895 INFLOW

EXISTING STORM SEWER

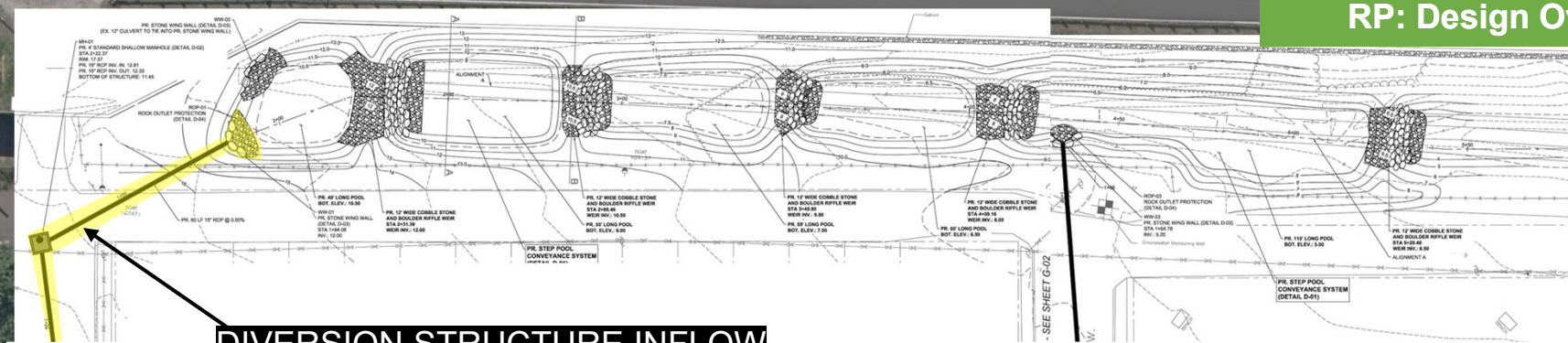
DIVERSION STRUCTURES



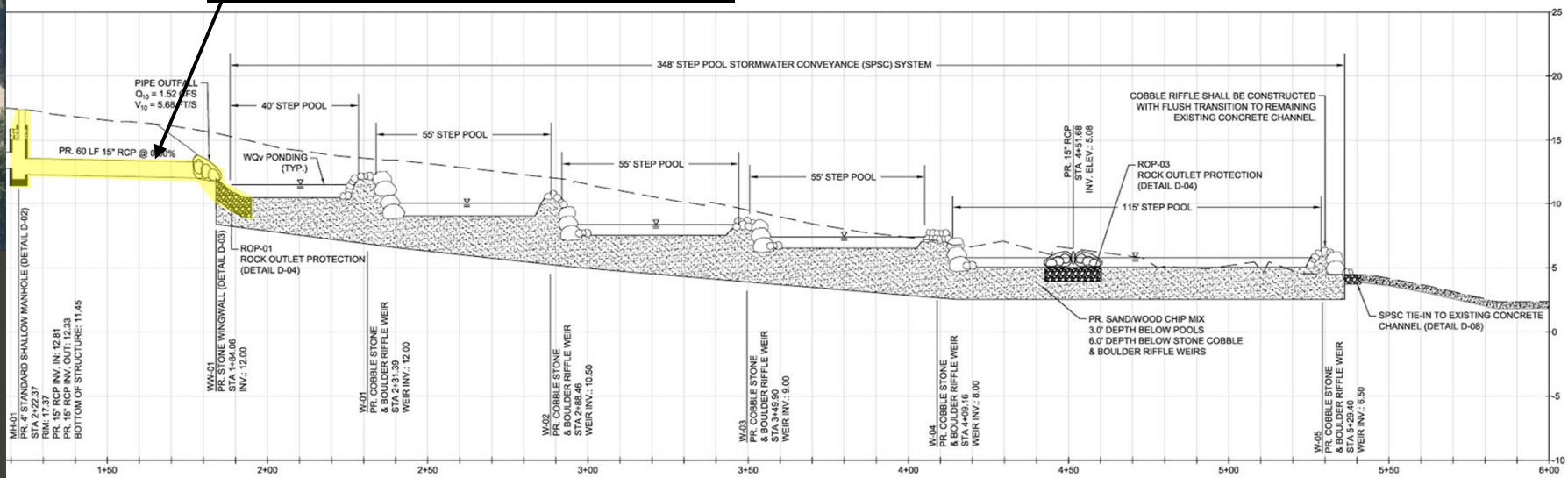
## RP: Design Overview



## RP: Design Overview

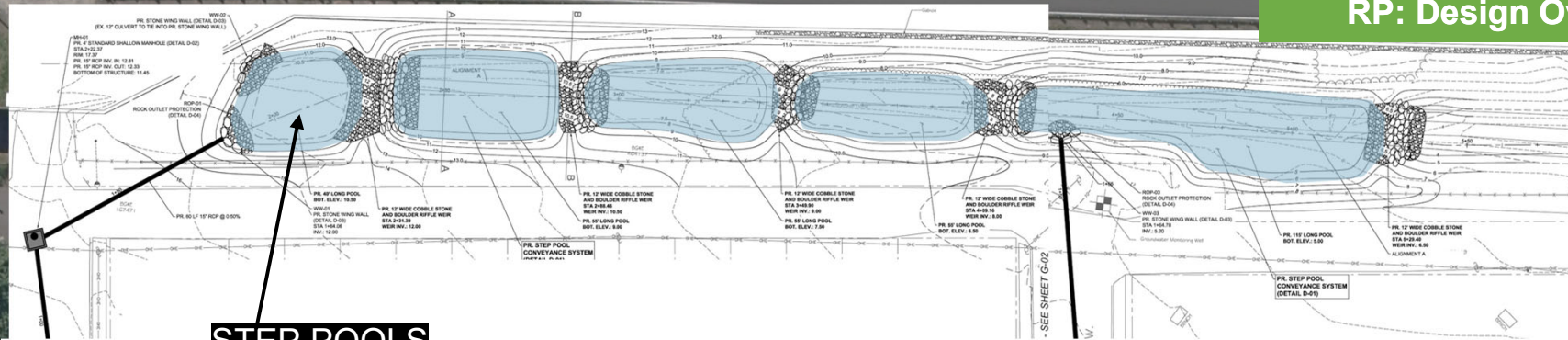


**DIVERSION STRUCTURE INFLOW**

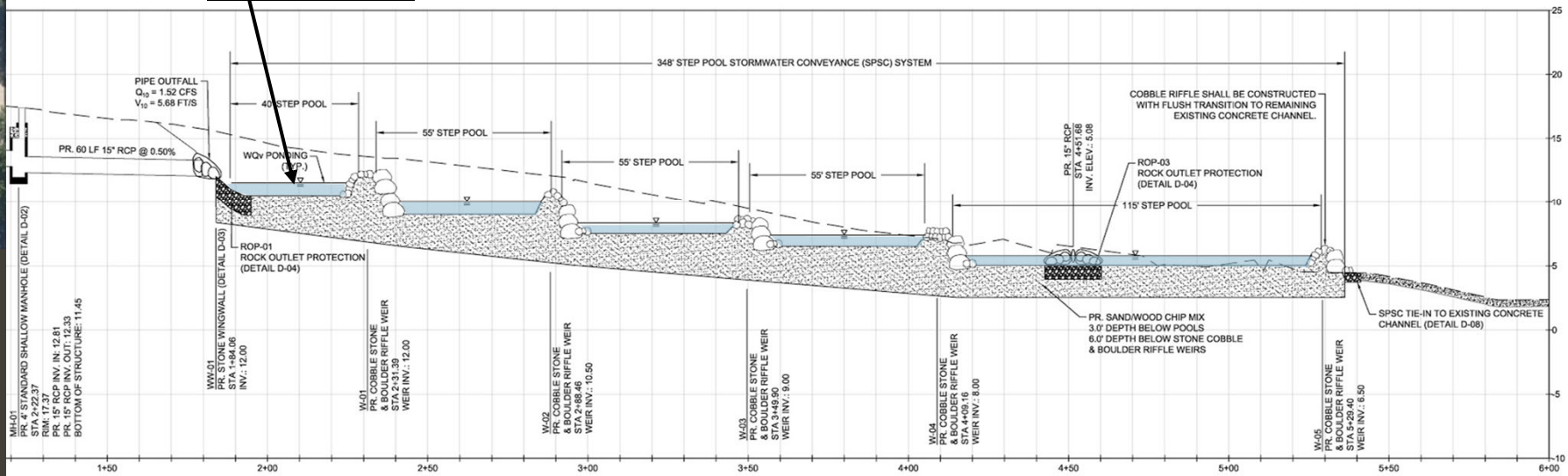




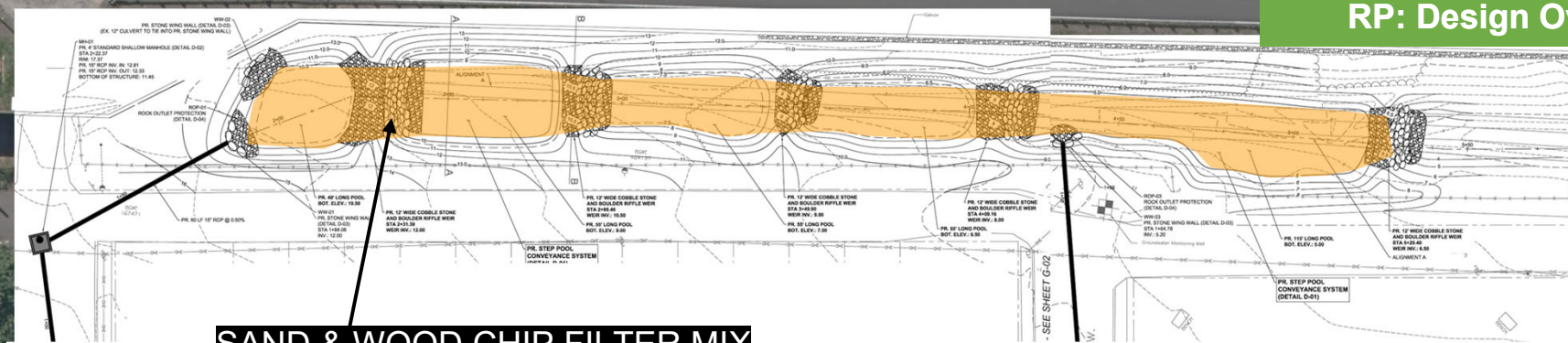
## RP: Design Overview



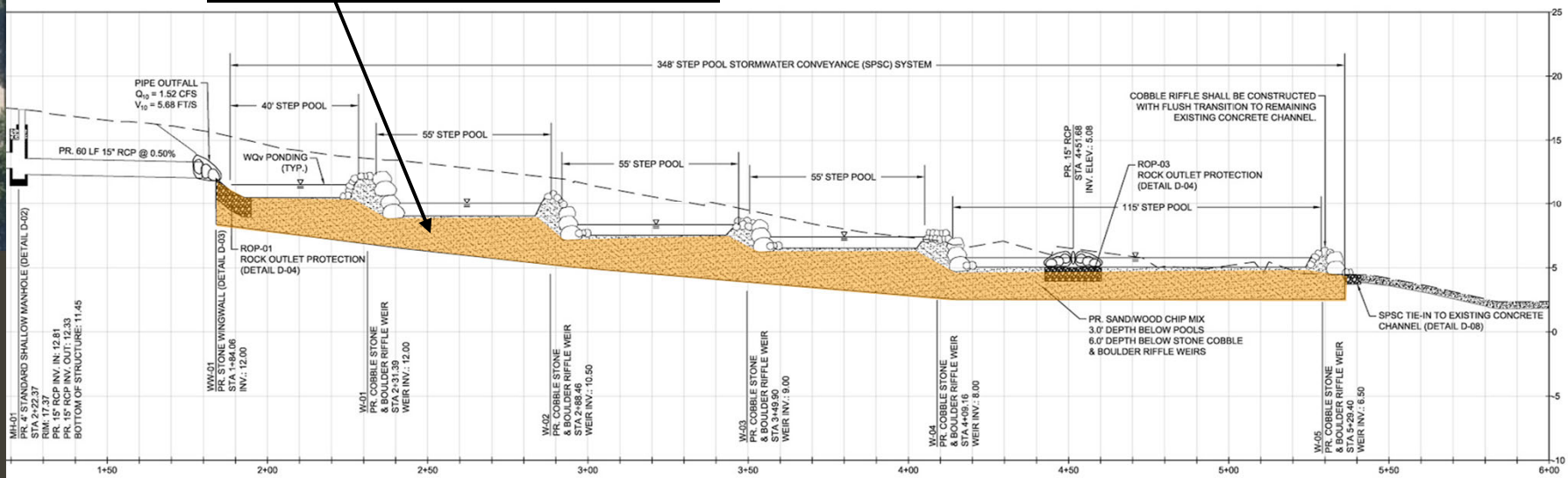
### STEP POOLS



## RP: Design Overview

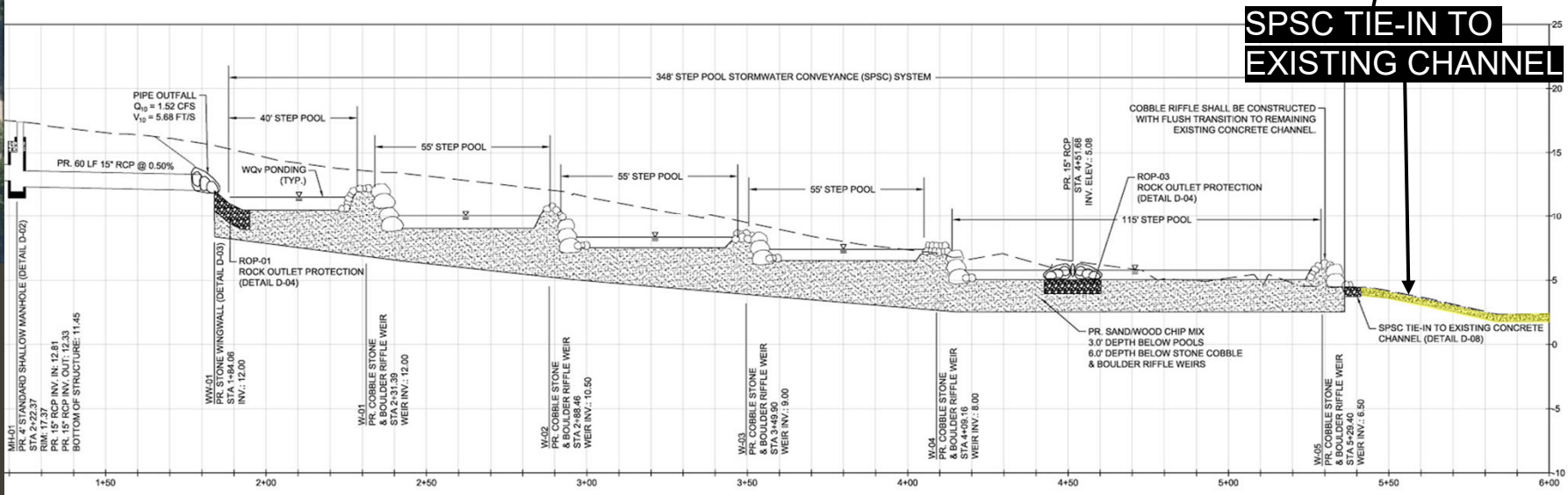
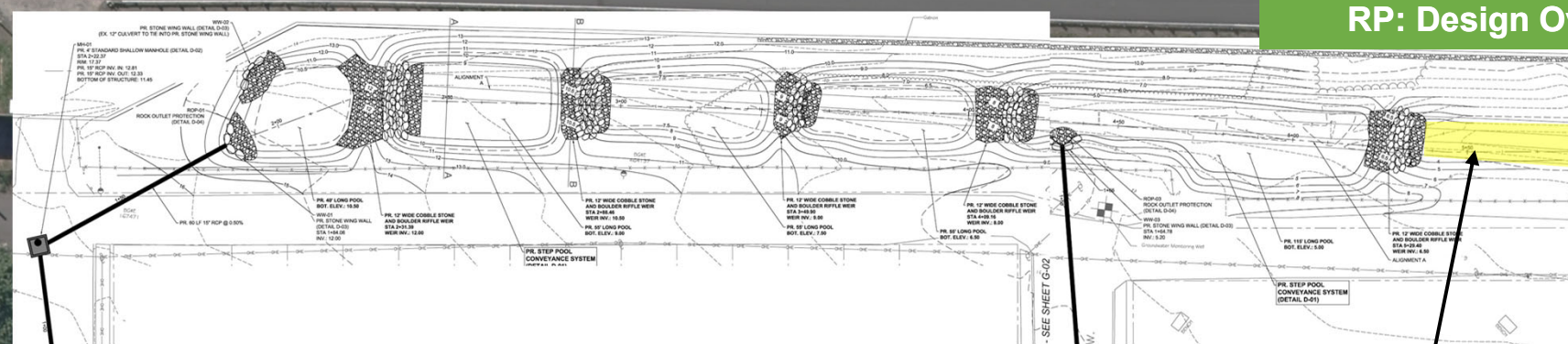


**SAND & WOOD CHIP FILTER MIX**





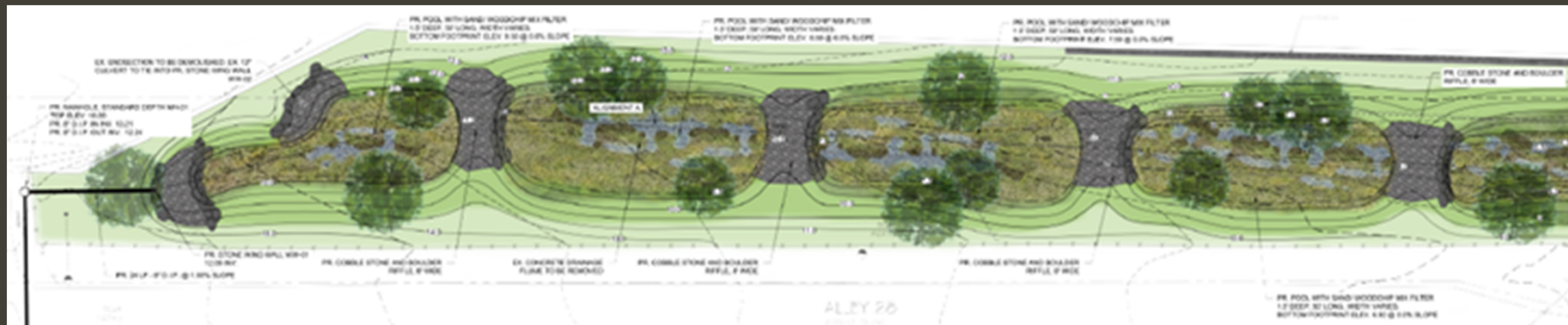
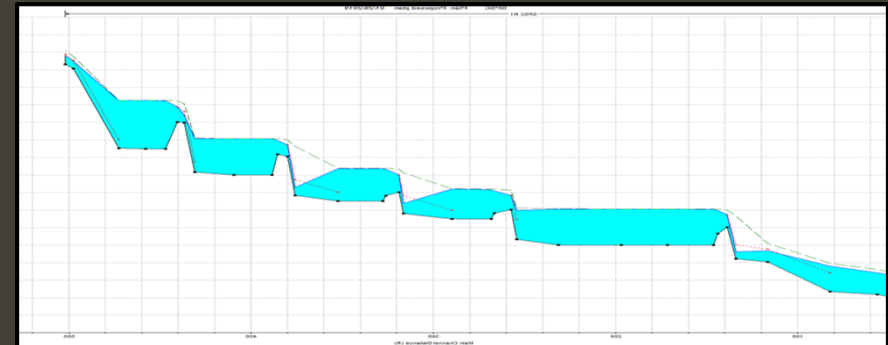
# RP: Design Overview



**SPSC TIE-IN TO EXISTING CHANNEL**

## ADDITIONAL ANALYSIS

- 1-D steady state HEC-RAS modeling of SPSC
- Propose to line 5 FT of pool with cobble material

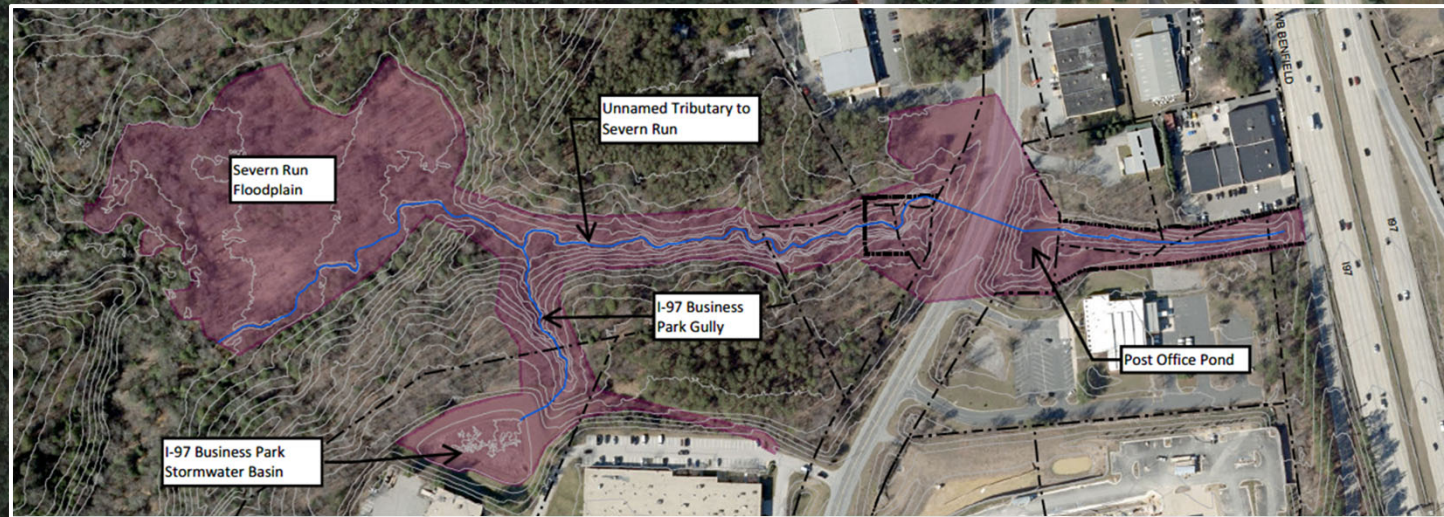




# Najoles Road Pond Retrofit and Stream Restoration



## Najoles Road: Site Overview



Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, MD MAP, DOT





## Najoles Road: Site Overview



- Pond constructed in 1990s for I-97
  - Potentially for sediment control
- Does not provide water quality treatment
- UNT to Severn Run
  - First order stream, Class IV tributary to SR, approx. 1800 LF to SR Floodplain
  - Tall banks severely eroded, sediment being mobilized to SR Natural Environment Area owned by MD DNR
- Gully from adjacent I-97 Business Park

# Najoles Road



## SITE CHALLENGES

- Topography; access
- Temporary dewatering of pond and UNT to SR
- Floodplain tie-in to Severn Run (work near delineated wetland)
- Climbing Fern (*Lygodium palmatum*)
  - G4-S2 State Threatened Plant



# Najoles Road



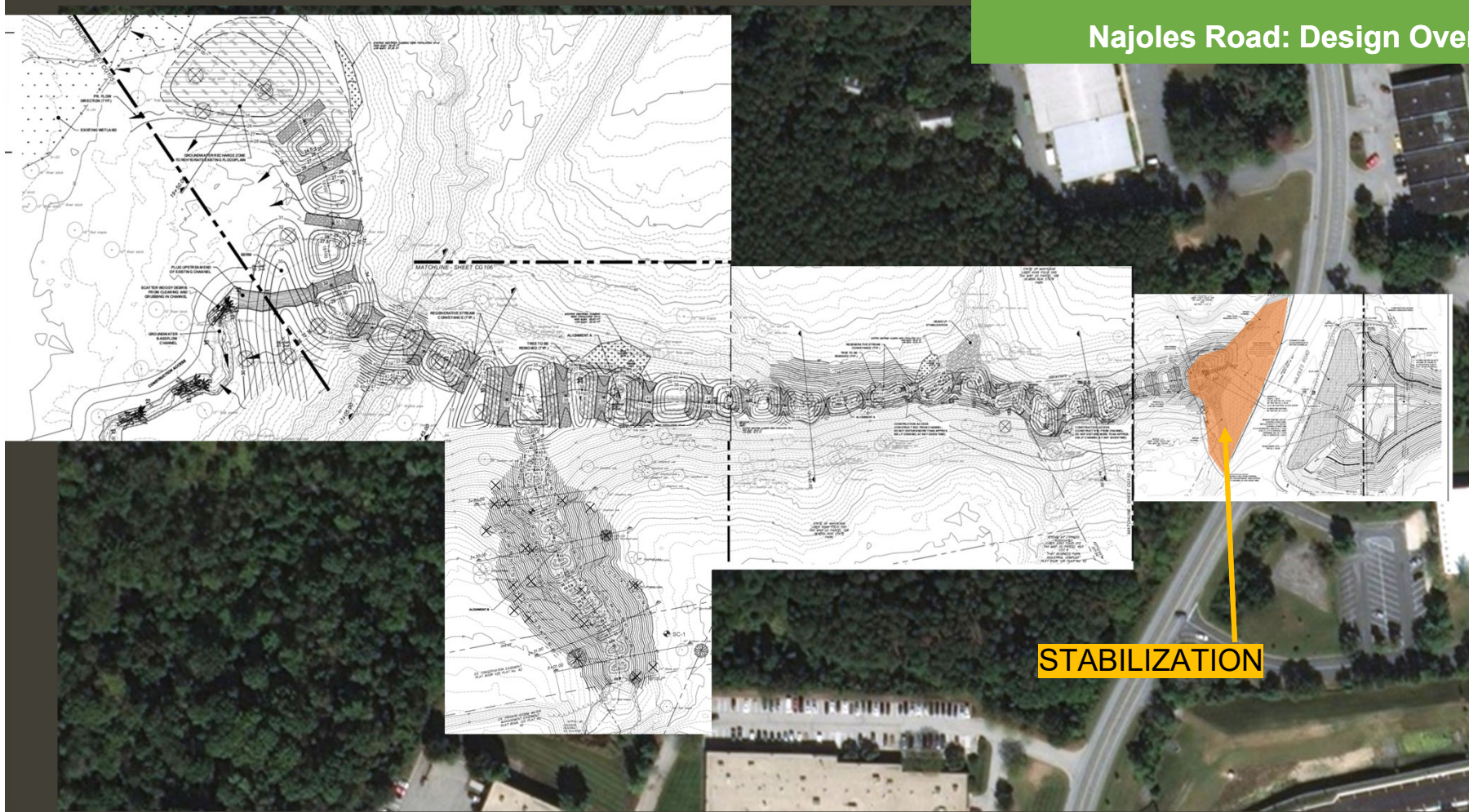
## SWM OPPORTUNITIES

- Retrofit wet pond to current standards for WQv treatment
- Stabilize eroding banks
- Groundwater reconnection within Severn Run Floodplain
- Remove transient sediment deposits from upstream bank erosion



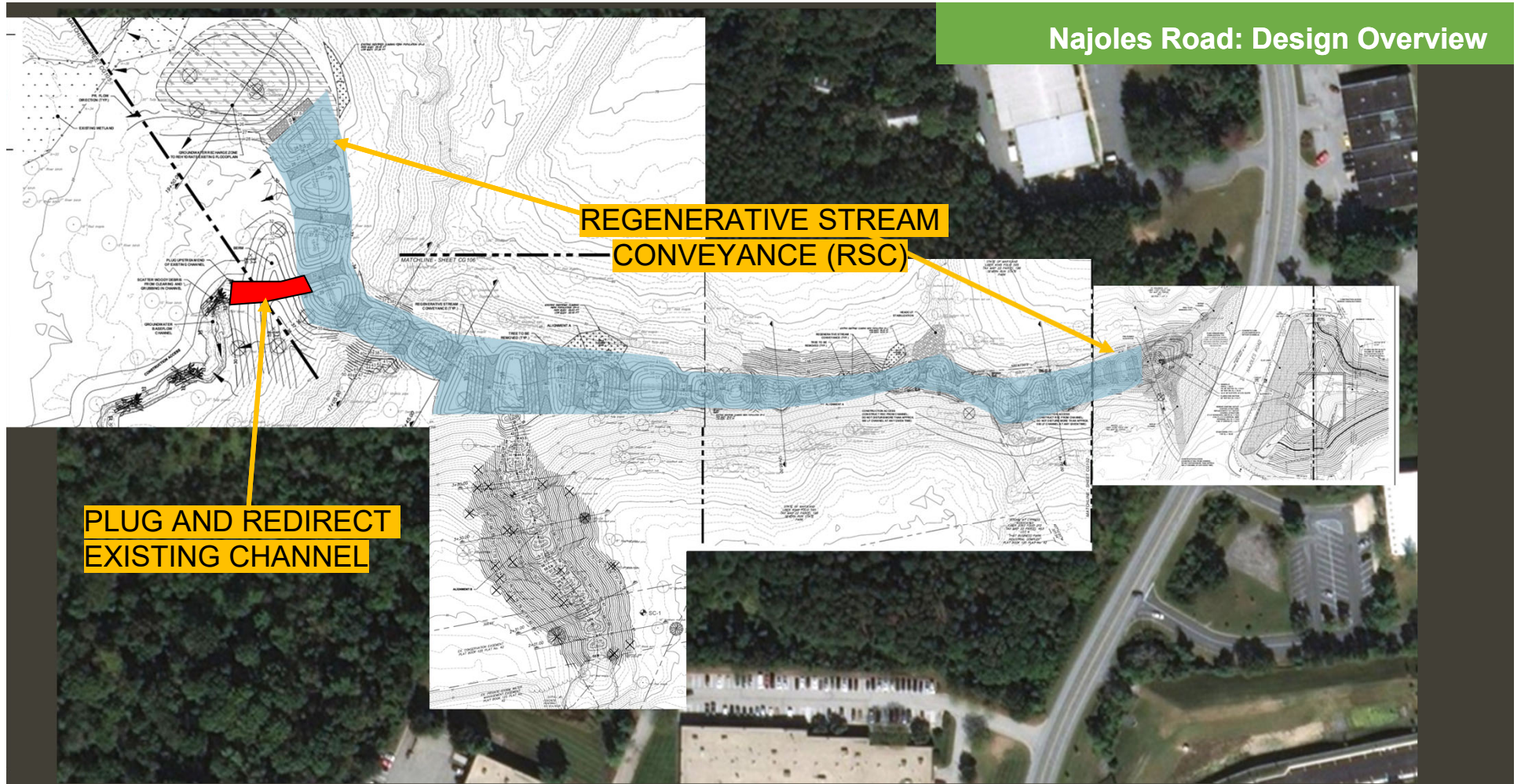


## Najoles Road: Design Overview



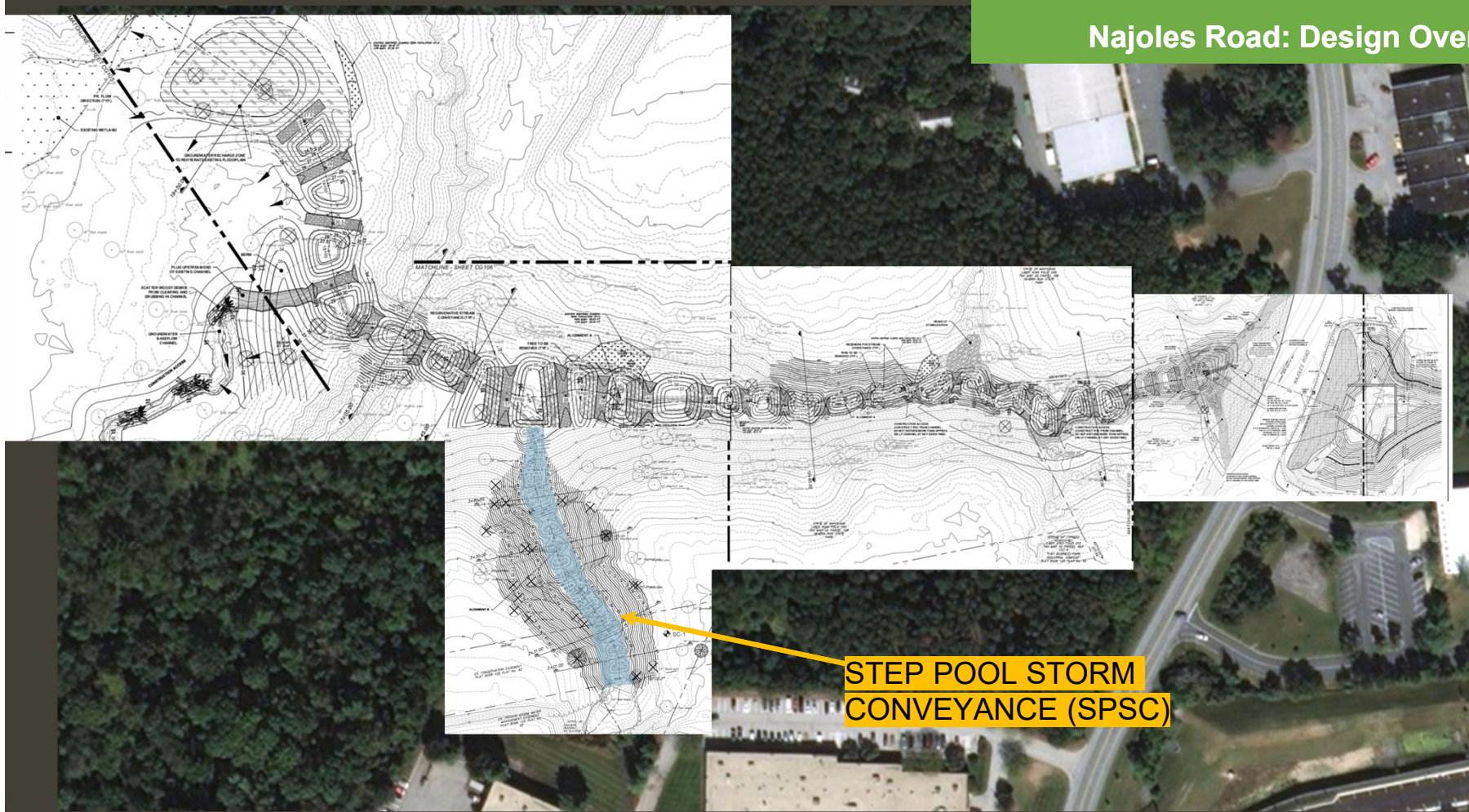


## Najoles Road: Design Overview



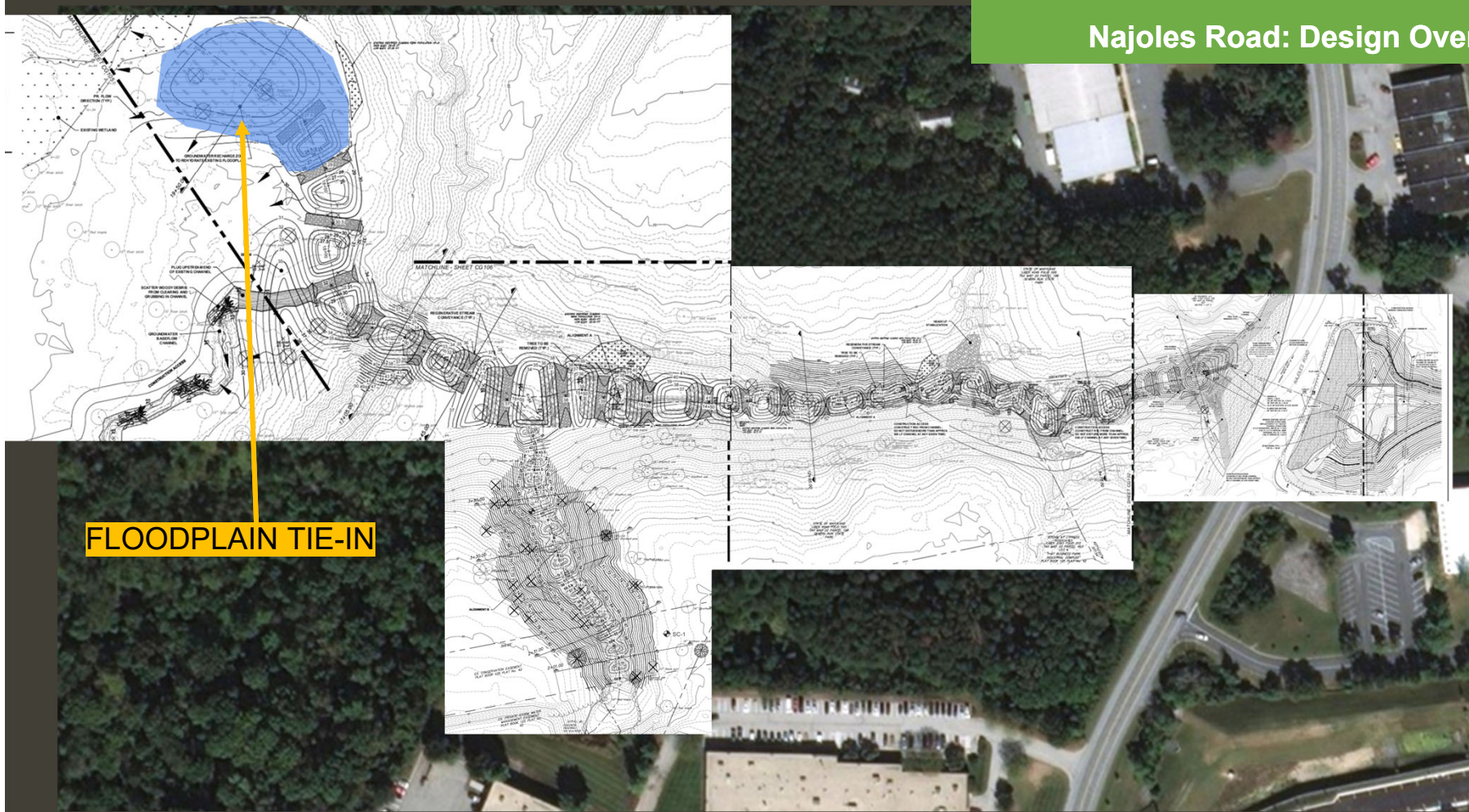


## Najoles Road: Design Overview





## Najoles Road: Design Overview





# Summary

## STORMWATER RETROFITS

- Variety of System Options & Combinations
  - Hybrid BMP configurations
    - Infiltration Basin
    - Infiltration Trench
  - Permeable Pavement
  - Step Pool Storm Conveyance
  - Regenerative Storm Conveyance
- Impervious Acres Treated: 66.65
- TSS removed: 2,288,746 lb/yr
- TN removed: 773 lb/yr
- TP removed: 187 lb/yr



source: Underwood & Associates

# Thank You

**Mark Southerland, Ph.D.**  
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