Naturalized Stabilization Measures and Their Effectiveness

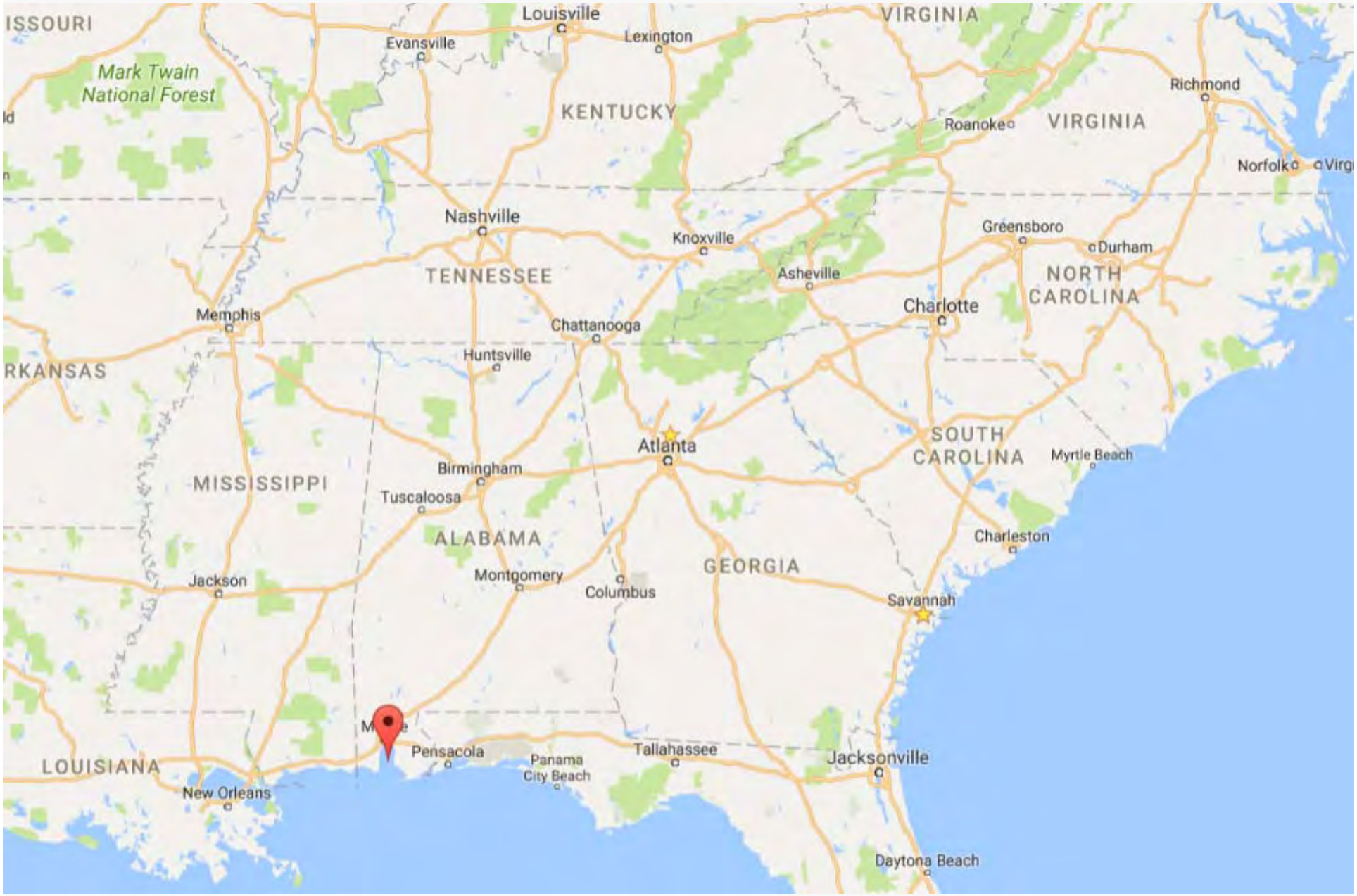
Southeast Stormwater Association's 12th Annual Regional Stormwater Conference

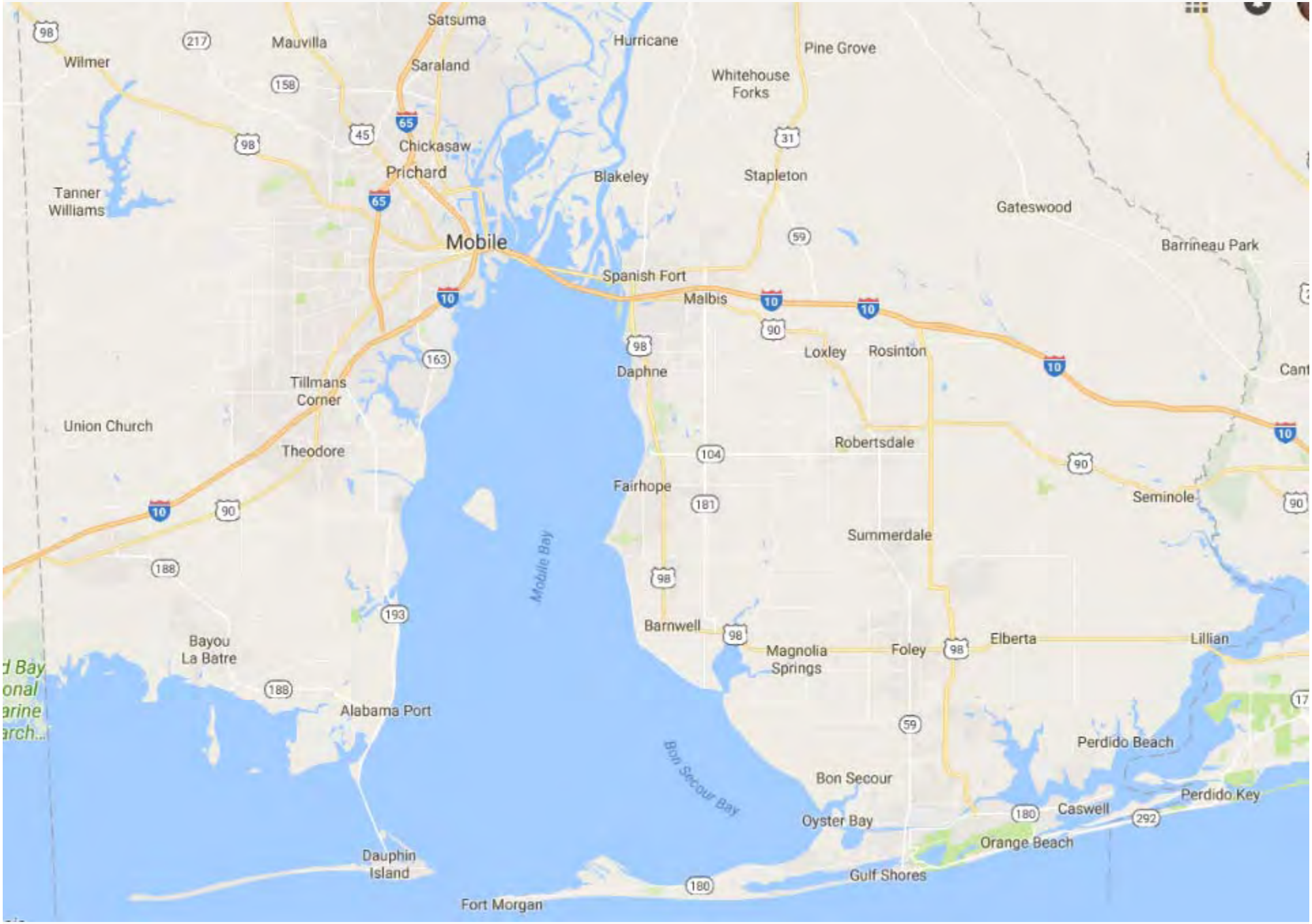
Louisville, KY

October 13, 2017

INTEGRATED Science & Engineering

These projects were supported wholly or in part by Mobile Bay National Estuary Program as part of a grant from the National Fish and Wildlife Foundation.


ISSOURI
Louisville
VIRGINIA
Evansville
Lexington
Mark Twain
National Forest
KENTUCKY
Richmond
Roanoke
VIRGINIA
Norfolk
Nashville
Knoxville
Greensboro
Durham
TENNESSEE
Asheville
NORTH
CAROLINA
Charlotte
Memphis
Chattanooga
Huntsville
RKANSAS
Atlanta
SOUTH
CAROLINA
Myrtle Beach
Birmingham
MISSISSIPPI
Tuscaloosa
ALABAMA
Charleston
GEORGIA
Jackson
Montgomery
Columbus
Savannah
Pensacola
Tallahassee
Jacksonville
Panama
City Beach
LOUISIANA
New Orleans
Daytona Beach


Satsuma
Mauvilla
Hurricane
Pine Grove
Wilmer
Saraland
Whitehouse Forks
Chickasaw
Prichard
Blakeley
Stapleton
Tanner Williams
Gateswood
Mobile
Barrineau Park
Spanish Fort
Malbis
Loxley
Rosinton
Daphne
Tillmans Corner
Union Church
Theodore
Robertsdale
Fairhope
Seminole
Summerdale
Mobile Bay
Barnwell
Bayou La Batre
Magnolia Springs
Foley
Elberta
Lillian
Alabama Port
Perdido Beach
Bon Secour
Bon Secour Bay
Perdido Key
Oyster Bay
Caswell
Orange Beach
Dauphin Island
Gulf Shores
Fort Morgan

POTENTIAL FOR LARGE QUANTITIES OF SOIL LOSS

Highly Erosive Rainfall on Erodible Soils

- R-Factor 650
- Fine sandy soils
- Steep slopes
- Soil detachment from both overland runoff and stream channel erosion
- Gully and Headcuts

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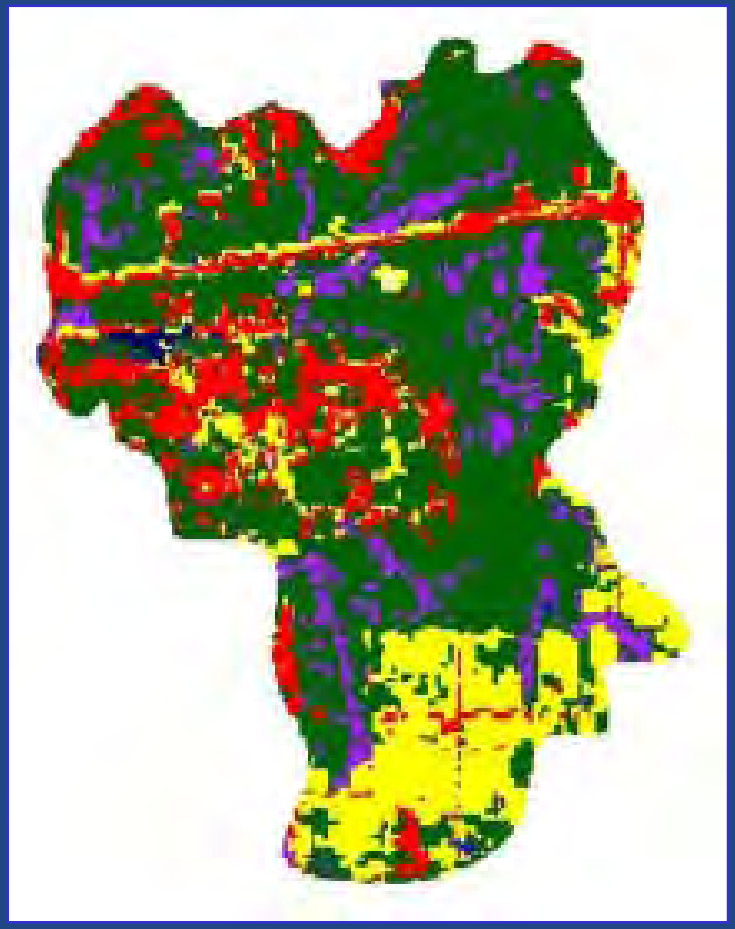
“PRE” CROSS SECTION

LAND USE AND LAND COVER CHANGES

1974



2008

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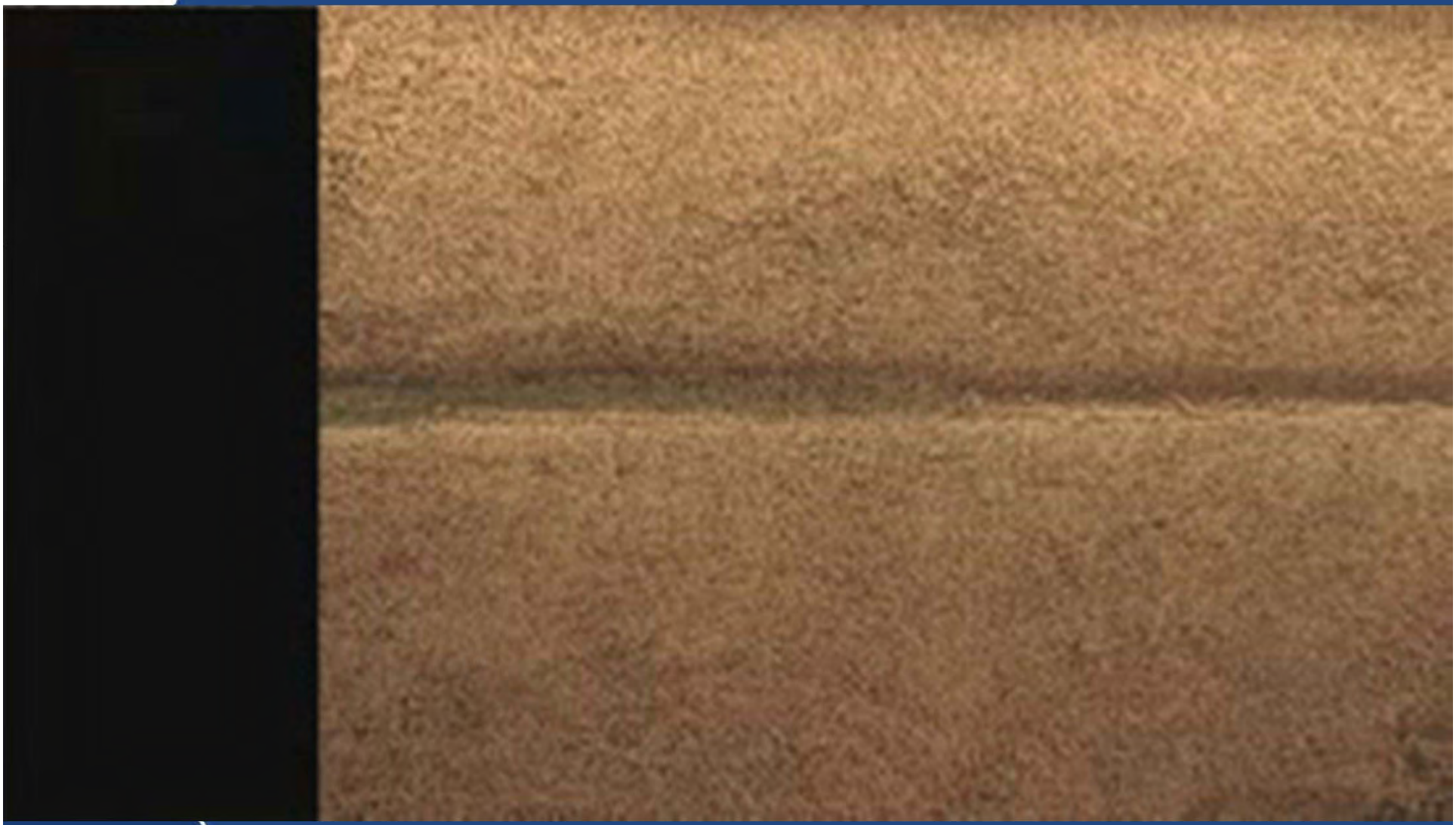
CLEAN STRAIGHT STREAM



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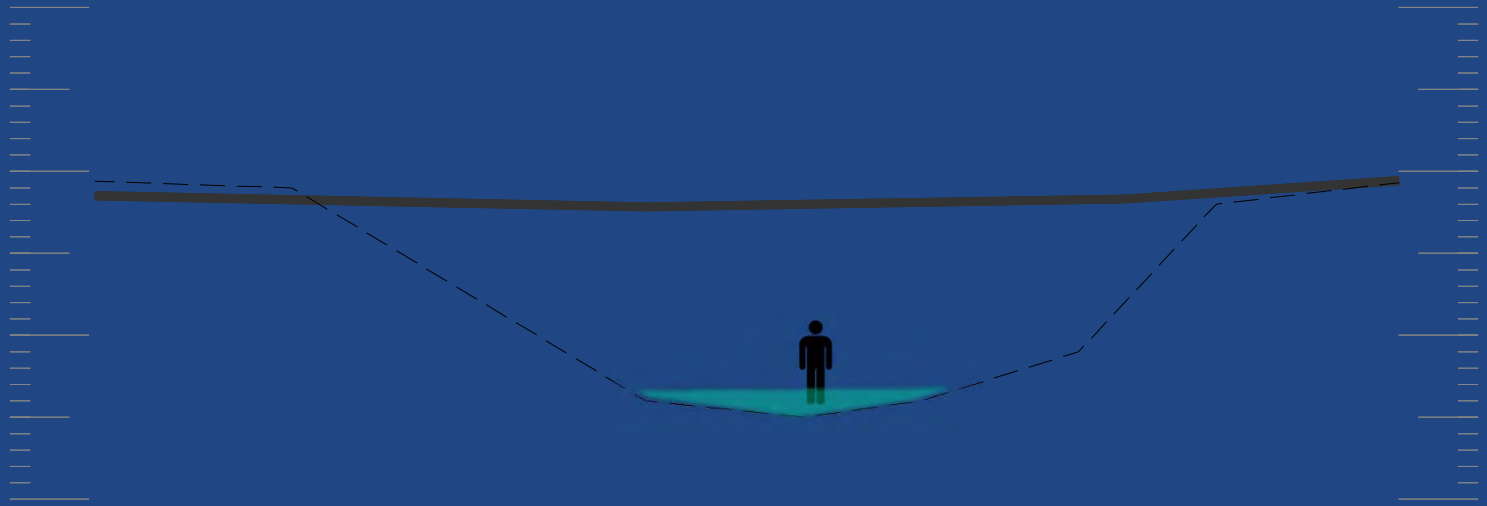
PRE-CONSTRUCTION CROSS SECTION



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CAUTION CAUTION
CAUTION CAUTION

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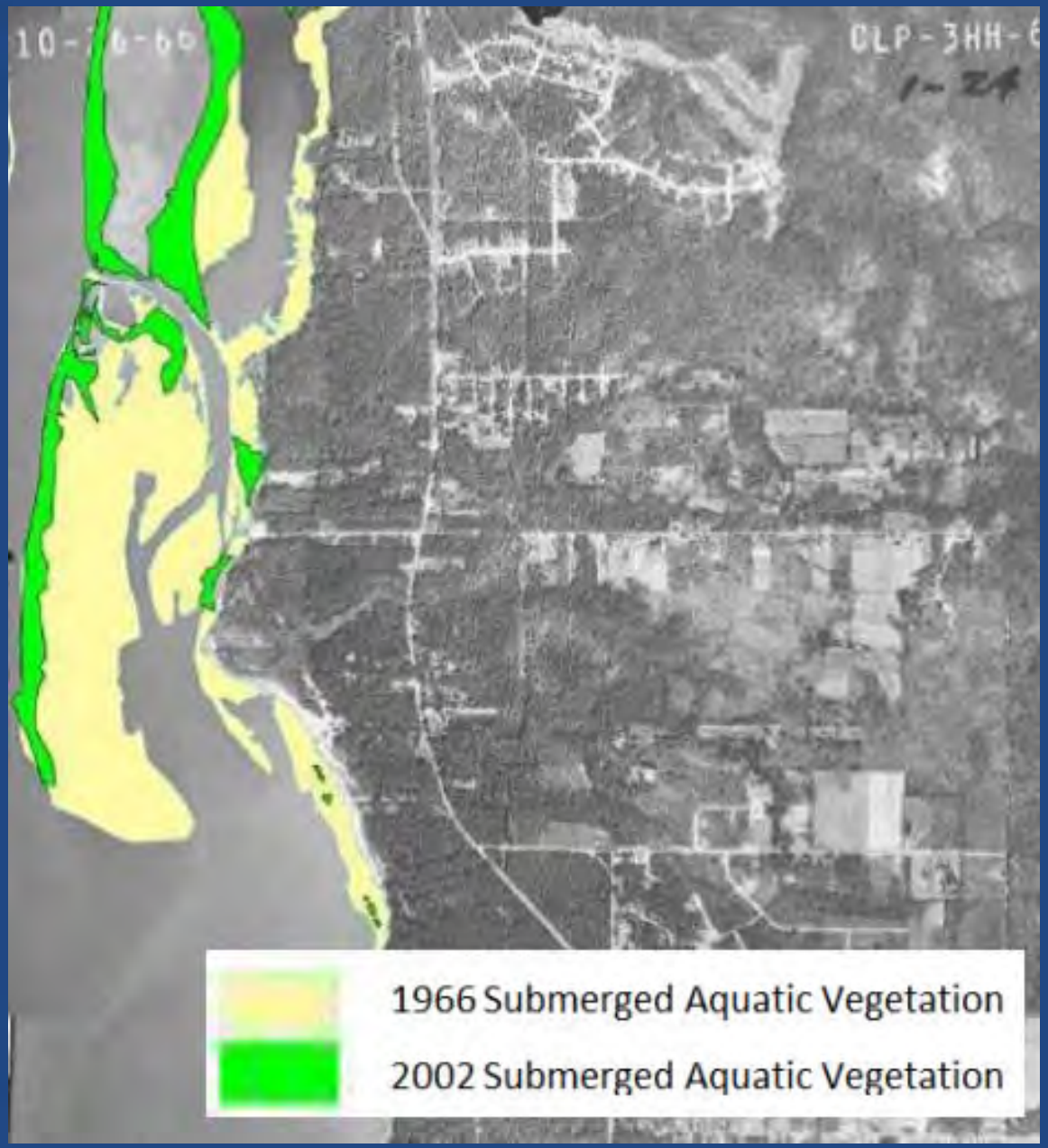
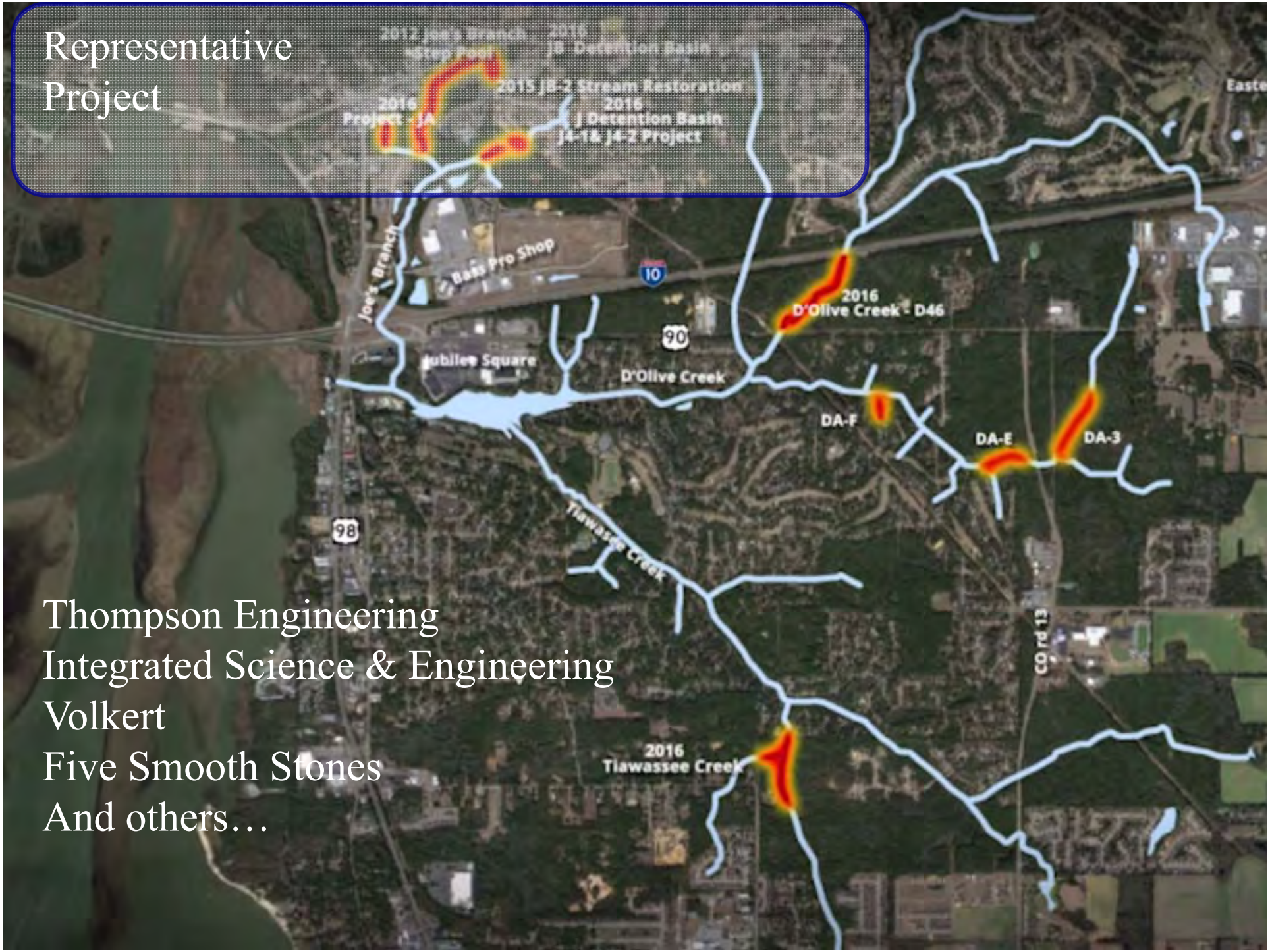

1966 Submerged Aquatic Vegetation
2002 Submerged Aquatic Vegetation

MOBILE BAY FROM NASA SKYLAB 1974


Representative Project
2012 Joe's Branch Step Pool
2016 JB Detention Basin
2015 JB-2 Stream Restoration
2016 Project JA
2016 J Detention Basin J4-1& J4-2 Project
Joe's Branch
Bass Pro Shop
10
Jubilee Square
90
D'Olive Creek
2016 D'Olive Creek - D46
DA-F
DA-E
DA-3
Tiawassee Creek
98
2016 Tiawassee Creek
Thompson Engineering
Integrated Science & Engineering
Volkert
Five Smooth Stones
And others…


Wren Ct
Robin Ct
Quail Ct
Linch Ct
Dove Ct
Chandler Ln
31
Dale Jarrett Hwy

- Hard construction techniques aren't always so hard.
- Connection to flood plain is more sustainable.
- Dissipates energy as opposed to moving/building it.



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CONSIDERATION OF ALTERNATIVE APPROACH

- Step Pool Storm Conveyance System
- Coastal Outfall Structure
- Regenerative Step Pool System
- Regenerative Stormwater Conveyance

DESIGNED TO PROVIDE:

- Attenuation
- Energy Dissipation
- Treatment
- Safe Conveyance
- Aesthetics

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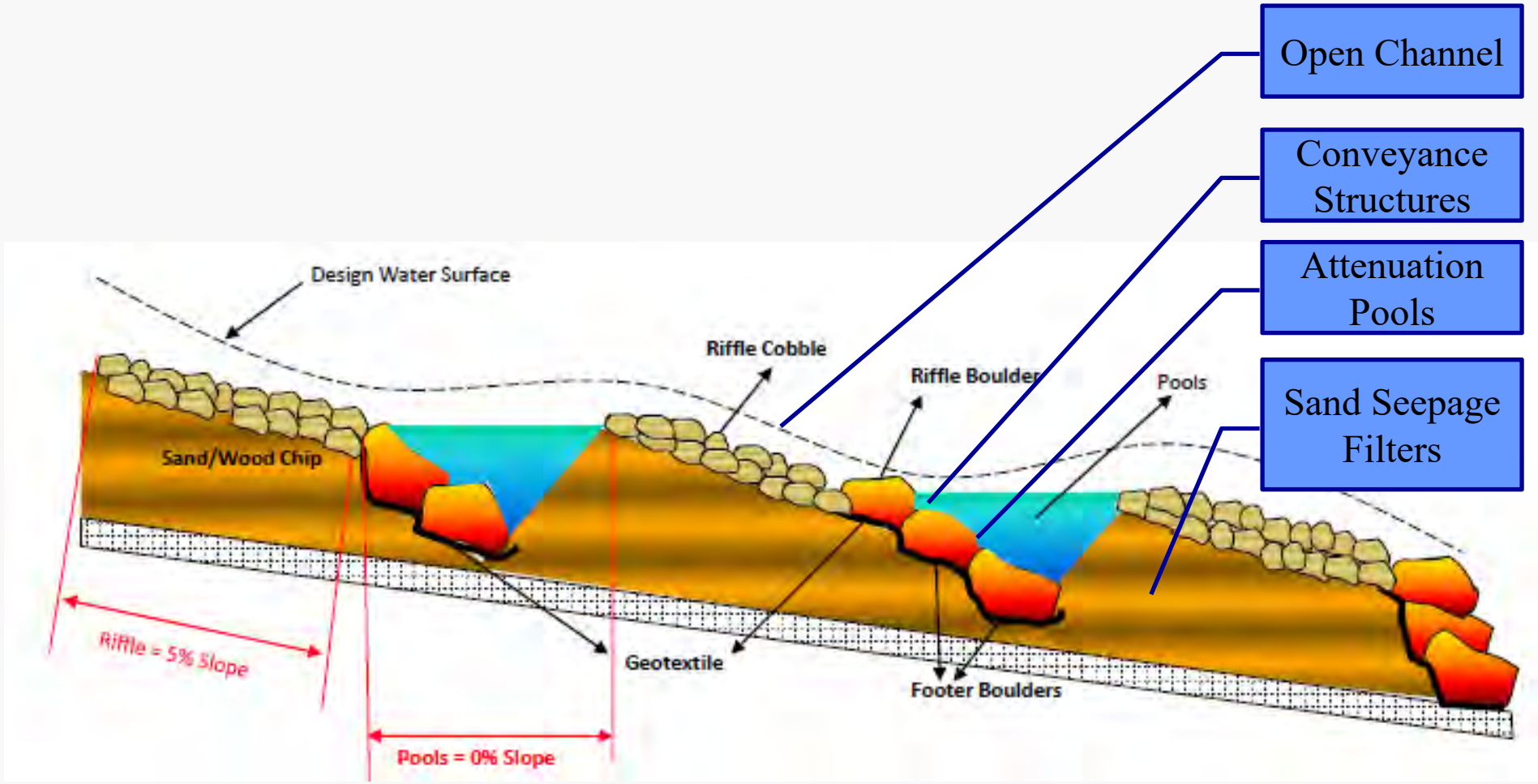
HOW DOES IT FUNCTION?



WHAT DOES IT LOOK LIKE?

BASIS OF DESIGN

- Risk are hard to communicate
- Basis of Design
  - Design storm, shear stress, channel forming discharge, geomorphological reference?
- Joe's Branch Project 1 - Reinforced Channel – 100 year design storm
- Joe's Branch Project 2 – Shear Stress (based on reference storm)
- Joe's Branch 2015 Design J4-2 – Channel forming discharge reinforced
- Joe's Branch 2015 Design J4-1 – Reference reach (sort of)

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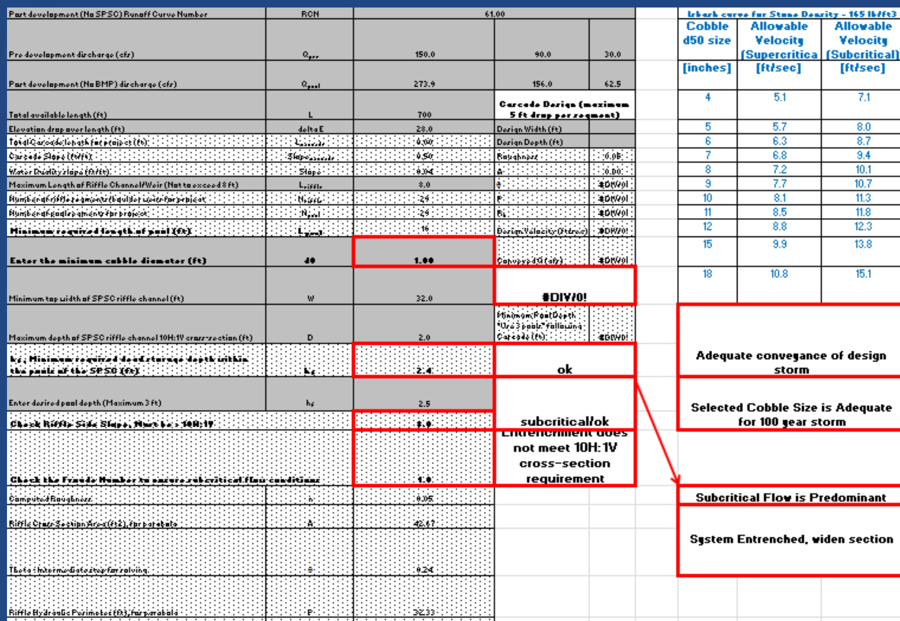
DESIGN WORKFLOW



Post development (No SPSC) Runoff Curve Number	RCN	61.00		
Pre development discharge (cfs)	Q_{pre}	150.0	90.0	30.0
Post development (No BMP) discharge (cfs)	Q_{post}	273.9	156.0	62.5
Total available length (ft)	L	700	Cascade Design (maximum 5 ft drop per segment)	
Elevation drop over length (ft)	delta E	28.0	Design Width (ft)	
Total Cascade length for project (ft)	$L_{cascade}$	0.00	Design Depth (ft)	
Cascade Slope (ft/ft)	$Slope_{cascade}$	0.50	Roughness	0.05
Water Quality slope (ft/ft)	Slope	0.04	A	0.00
Maximum Length of Riffle Channel/Weir (Not to exceed 8 ft)	L_{riffle}	8.0	θ	#DIV/0!
Number of riffle segments (boulder weirs) for project	N_{SPSC}	29	P	#DIV/0!
Number of pool segments for project	N_{pool}	29	R_h	#DIV/0!
Minimum required length of pool (ft)	L_{pool}	16	Design Velocity (ft/sec)	#DIV/0!
Enter the minimum cobble diameter (ft)	d50	**1.00**	Conveyed Q (cfs)	#DIV/0!
Minimum top width of SPSC riffle channel (ft)	W	32.0	**#DIV/0!**	
Maximum depth of SPSC riffle channel 10H:1V cross-section (ft)	D	2.0	Minimum Pool Depth "Use 3 pools" following Cascade (ft)	#DIV/0!
h_s; Minimum required dead storage depth within the pools of the SPSC (ft)	h_s	2.4	**ok**	
Enter desired pool depth (Maximum 3 ft)	h_p	2.5	**subcritical/ok**	
Check Riffle Side Slope, Must be > 10H:1V		8.0	**Entrenchment does not meet 10H:1V cross-section requirement**	
Check the Froude Number to ensure subcritical flow conditions		1.0		
Computed Roughness	n	0.05		
Riffle Cross Section Area (ft2), for parabola	A	42.67		
Theta: Intermediate step for solving	θ	0.24		
Riffle Hydraulic Perimeter (ft), for parabola	P	32.33		

Isbash curve for Stone Density - 165 lb/ft3

Cobble d50 size [inches]	Allowable Velocity (Supercritica [ft/sec]	Allowable Velocity (Subcritical) [ft/sec]
4	5.1	7.1
5	5.7	8.0
6	6.3	8.7
7	6.8	9.4
8	7.2	10.1
9	7.7	10.7
10	8.1	11.3
11	8.5	11.8
12	8.8	12.3
15	9.9	13.8
18	10.8	15.1

Adequate conveyance of design storm

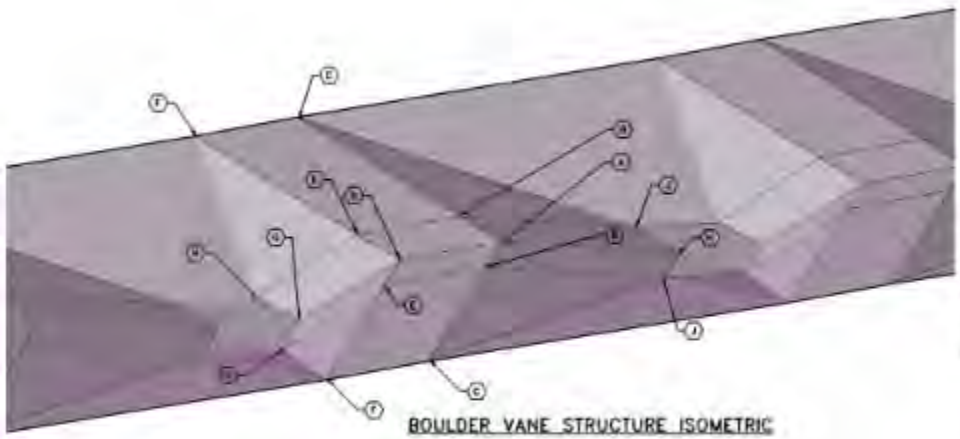
Selected Cobble Size is Adequate for 100 year storm

Subcritical Flow is Predominant

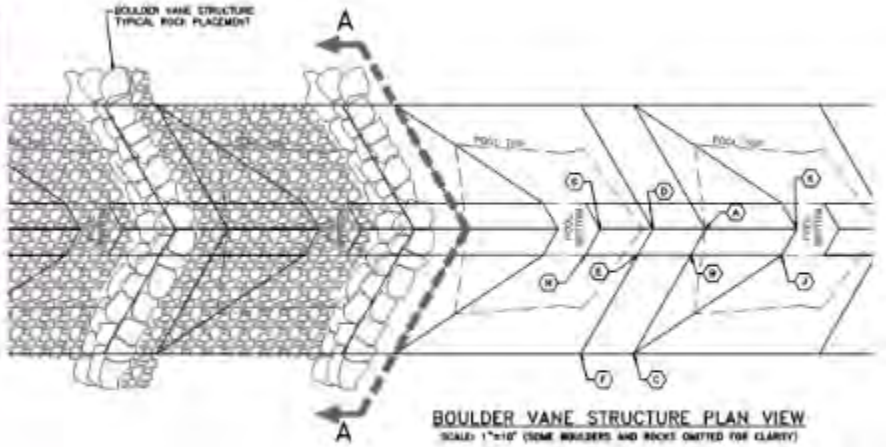
System Entrenched, widen section

- Determine stable riffle size.
- Size for subcritical flow.
- Cascade sizing function of riffle.
- Determine energy dissipation requirements.
- Determine attenuation requirements.

FIT TO SITE

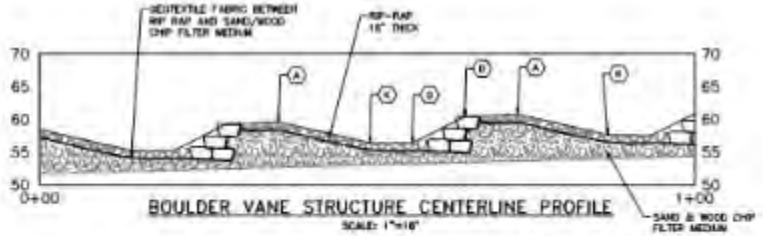


BOULDER VANE STRUCTURE ISOMETRIC



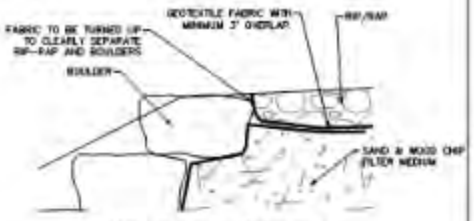
BOULDER VANE STRUCTURE PLAN VIEW

SCALE: 1"=10' (SOME BOULDERS AND ROCKS OMITTED FOR CLARITY)



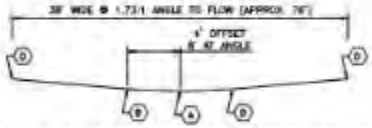
BOULDER VANE STRUCTURE CENTERLINE PROFILE

SCALE: 1"=10'



GEOTEXTILE FABRIC DETAIL

SCALE: 1"=10'



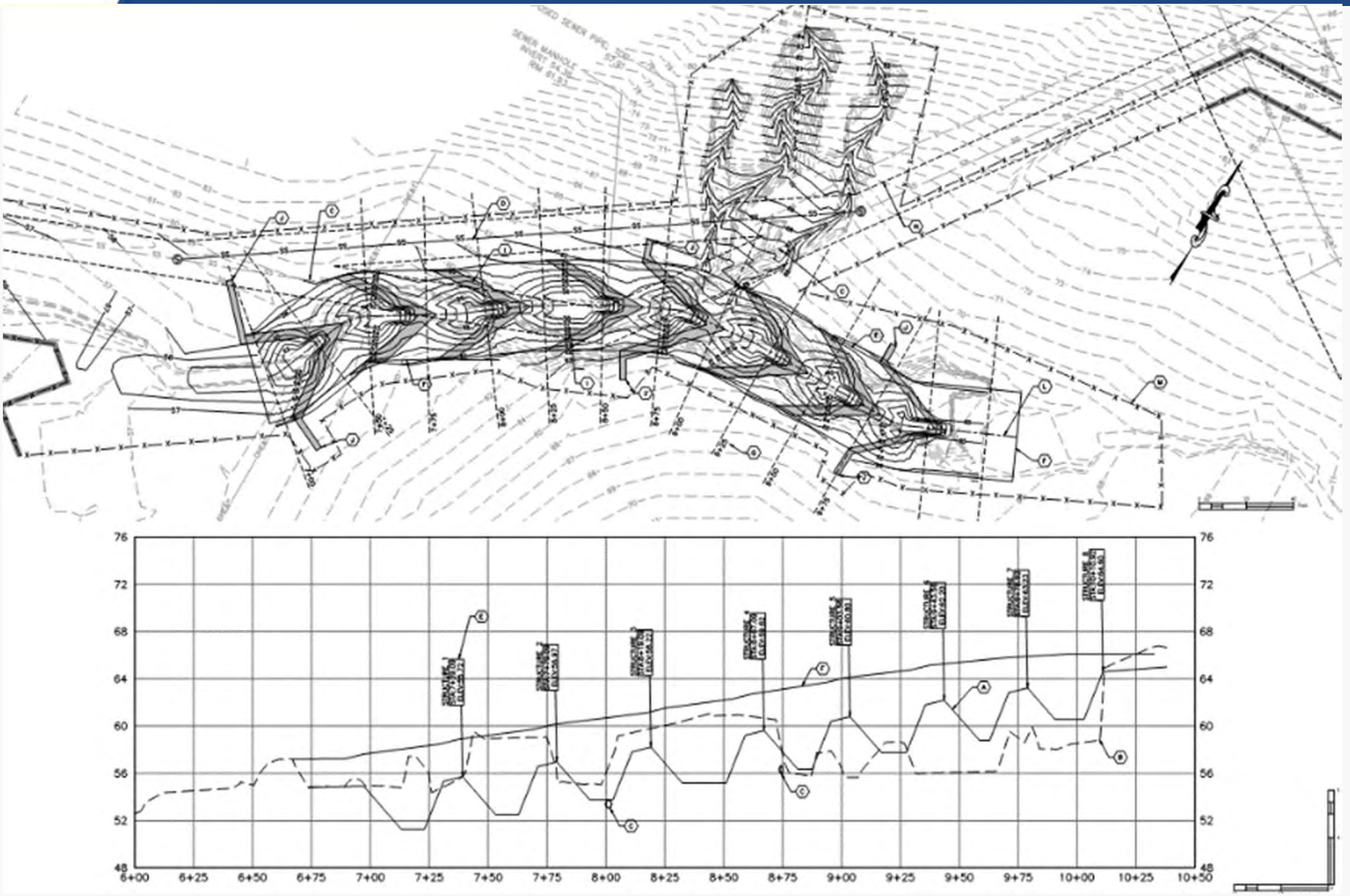
SECTION A–A BOULDER VANE STRUCTURE

SCALE: 1"=10'

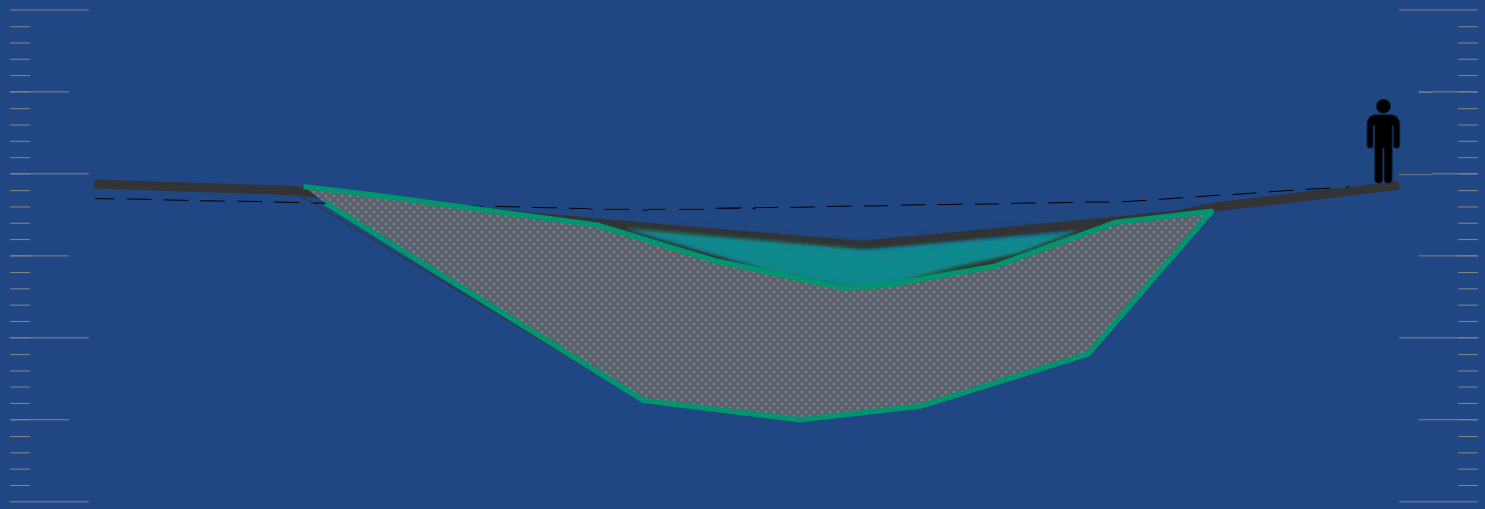
STEP POOL LAYOUT DIMESIONS

USE PLAN, SECTION, AND PROFILE VIEWS FOR POINT LOCATIONS

FIT TO SITE


76
72
68
64
60
56
52
48
6+00
6+25
6+50
6+75
7+00
7+25
7+50
7+75
8+00
8+25
8+50
8+75
9+00
9+25
9+50
9+75
10+00
10+25
10+50

POST-CONSTRUCTION CROSS SECTION



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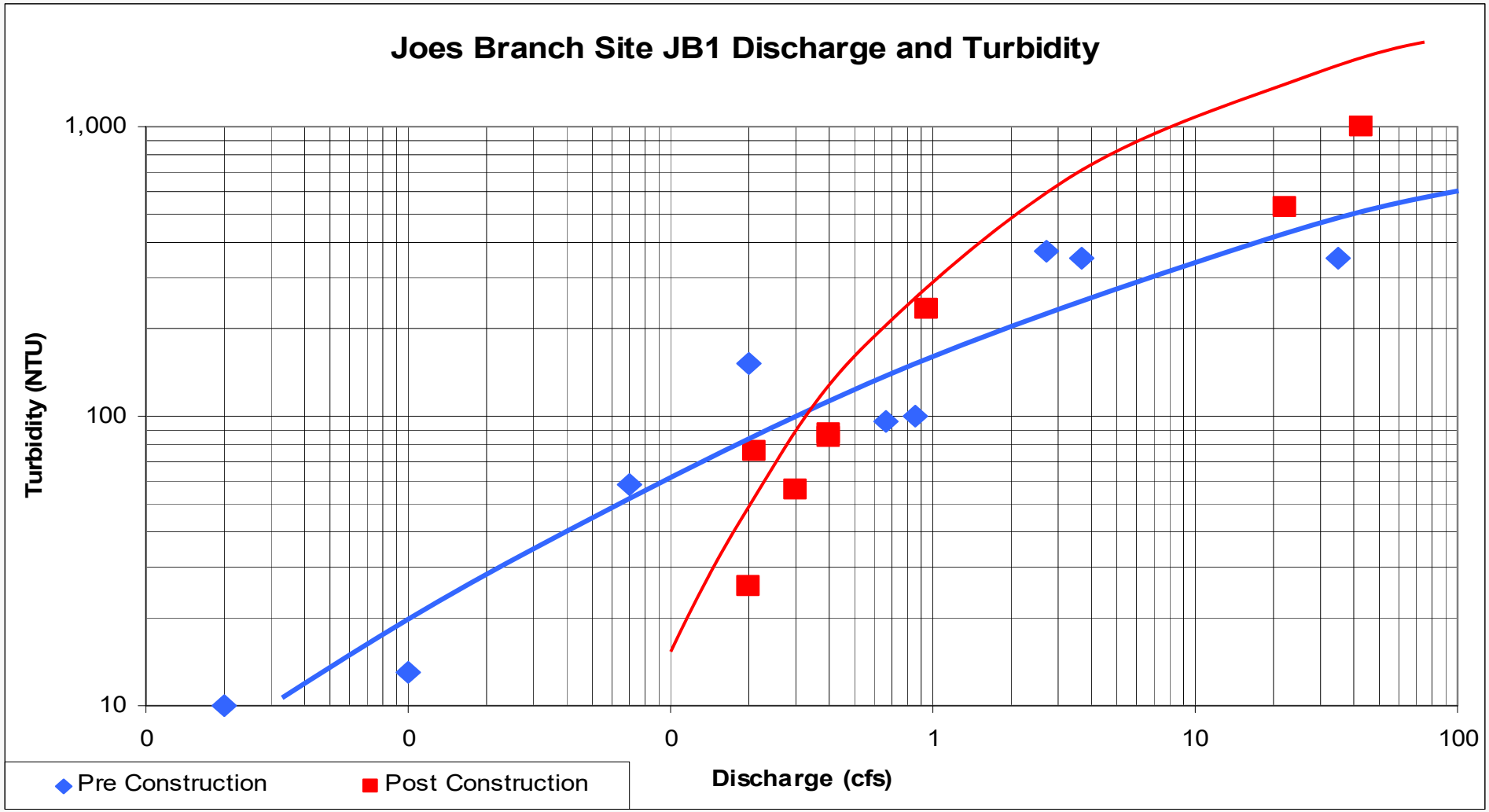
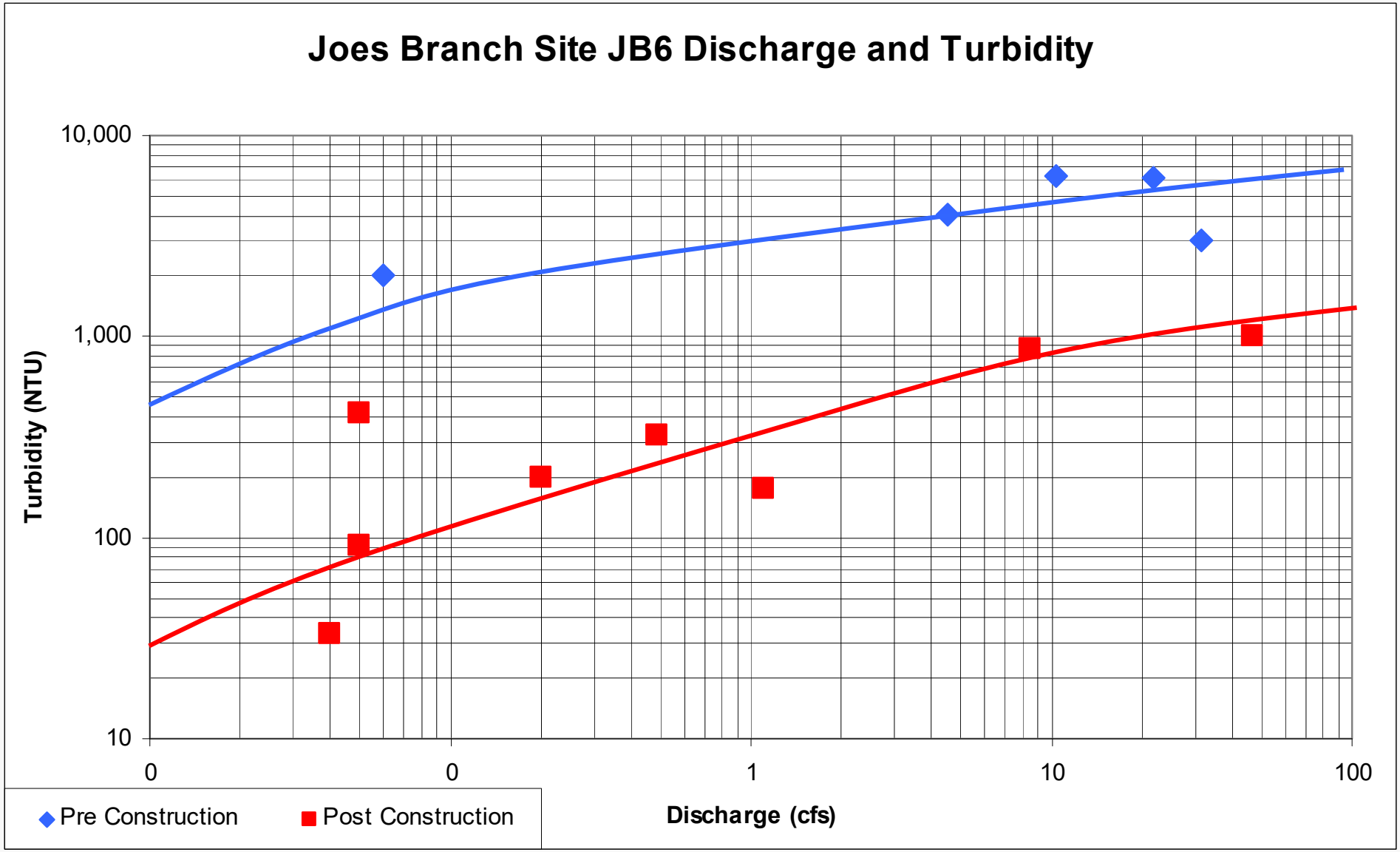


Site JB1 Upstream Pre- and Post-Construction Turbidity and Discharge



Site JB6 Downstream Pre- and Post-Construction Turbidity and Discharge

SEDIMENT LOAD REDUCTIONS

Post-Phase I Sediment Load Impacts

- Suspended sediment was reduced 97%
- Bed sediment was reduced 72%
- Total sediment was reduced 90%

Post-Phase II Sediment Load Impacts

- Suspended sediment was reduced 99%
- Bed sediment was reduced 96%
- Total sediment was reduced 99%

Marlon Cook
Cook Hydrogeology, LLC.

LESSONS LEARNED

Typical construction mindset doesn't work.

- Contractors
- Designers
- Standard Specifications & Documents
- Inspectors

LESSONS LEARNED

- Few contractors (and therefore bidders) have previous experience.

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LESSONS LEARNED

Larger pools have unique design considerations.

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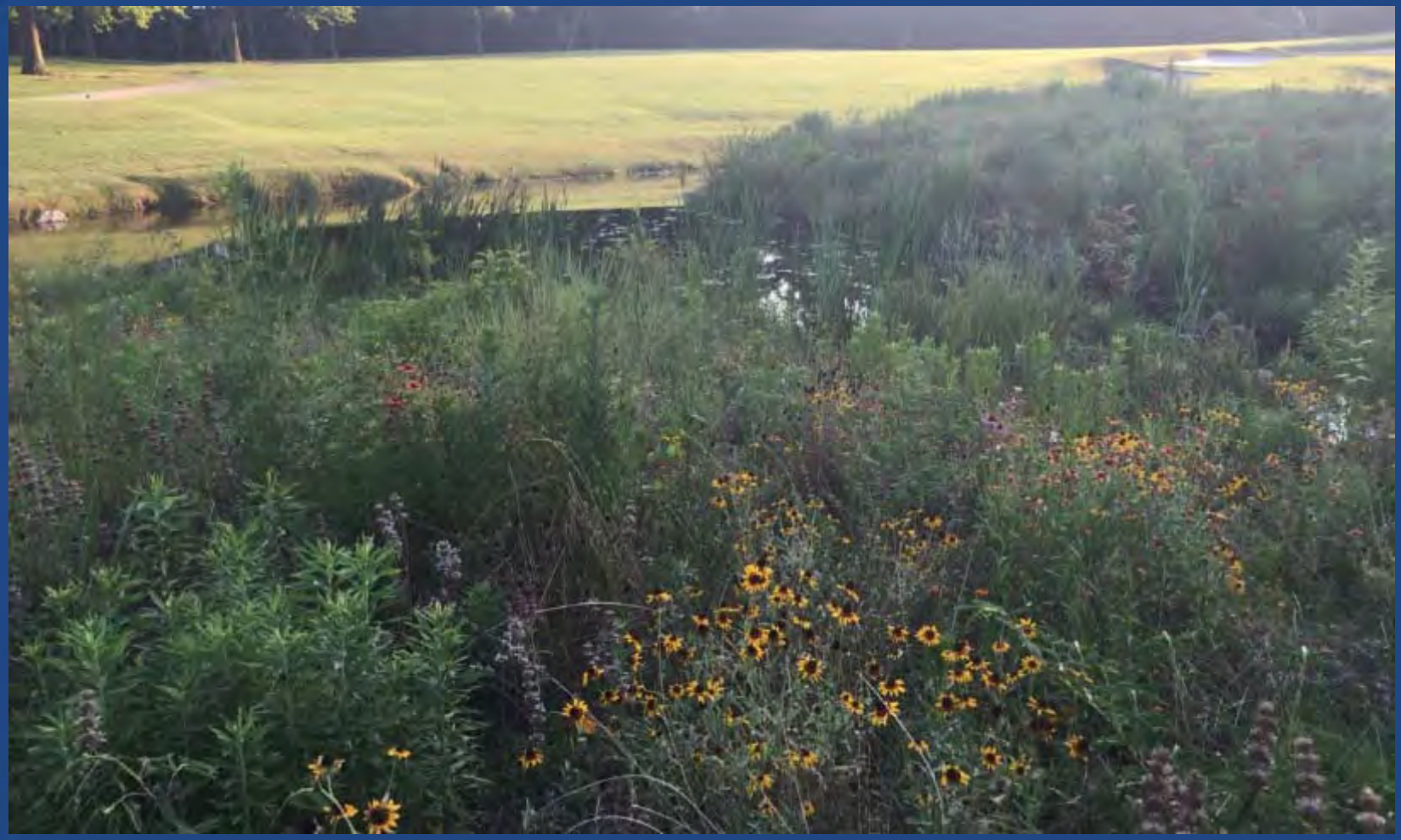

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THANKS!

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