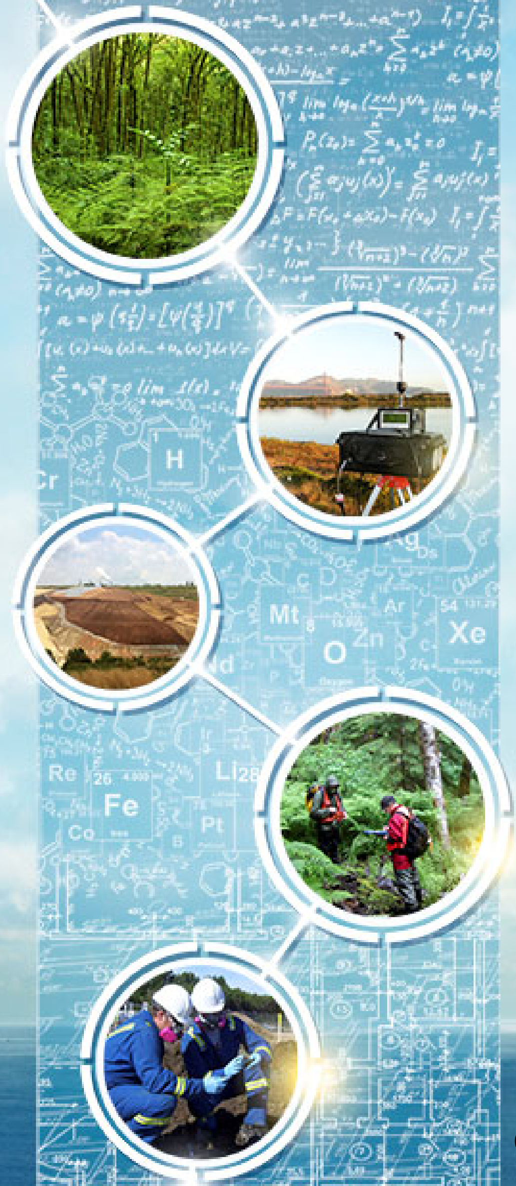

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Habitat Restoration and Enhancement – Maximizing Benefits from Sediment Remediation Projects

February 13, 2019

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International Conference on Remediation and Management of Contaminated Sediments
February 11 – 14, 2019
New Orleans, Louisiana

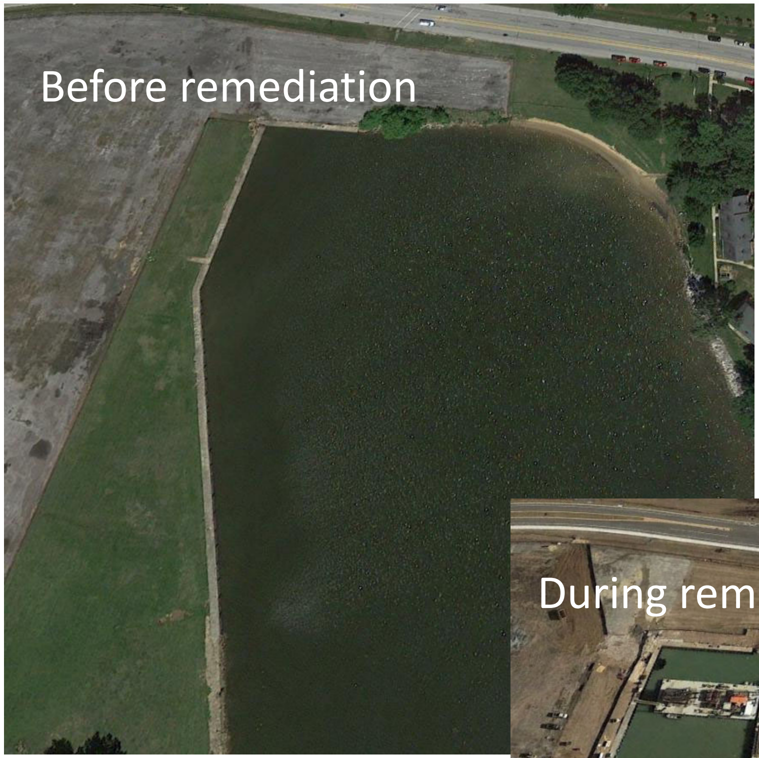
Introduction

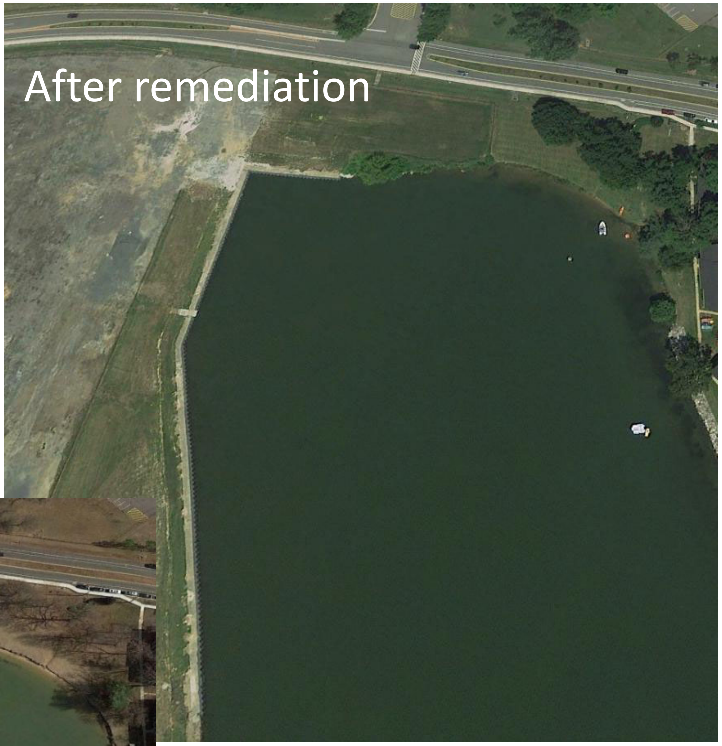
- Success of remediation projects can be maximized by add on value of **habitat restoration and enhancement.**
- Restoration will provide environmental and economic benefits, gain support from public and improve the reputation of the responsible party.

Outline:

- Remediation and restoration of an urban creek
- Community involvement
- Technical challenges
- Lessons learned

A sediment remediation project

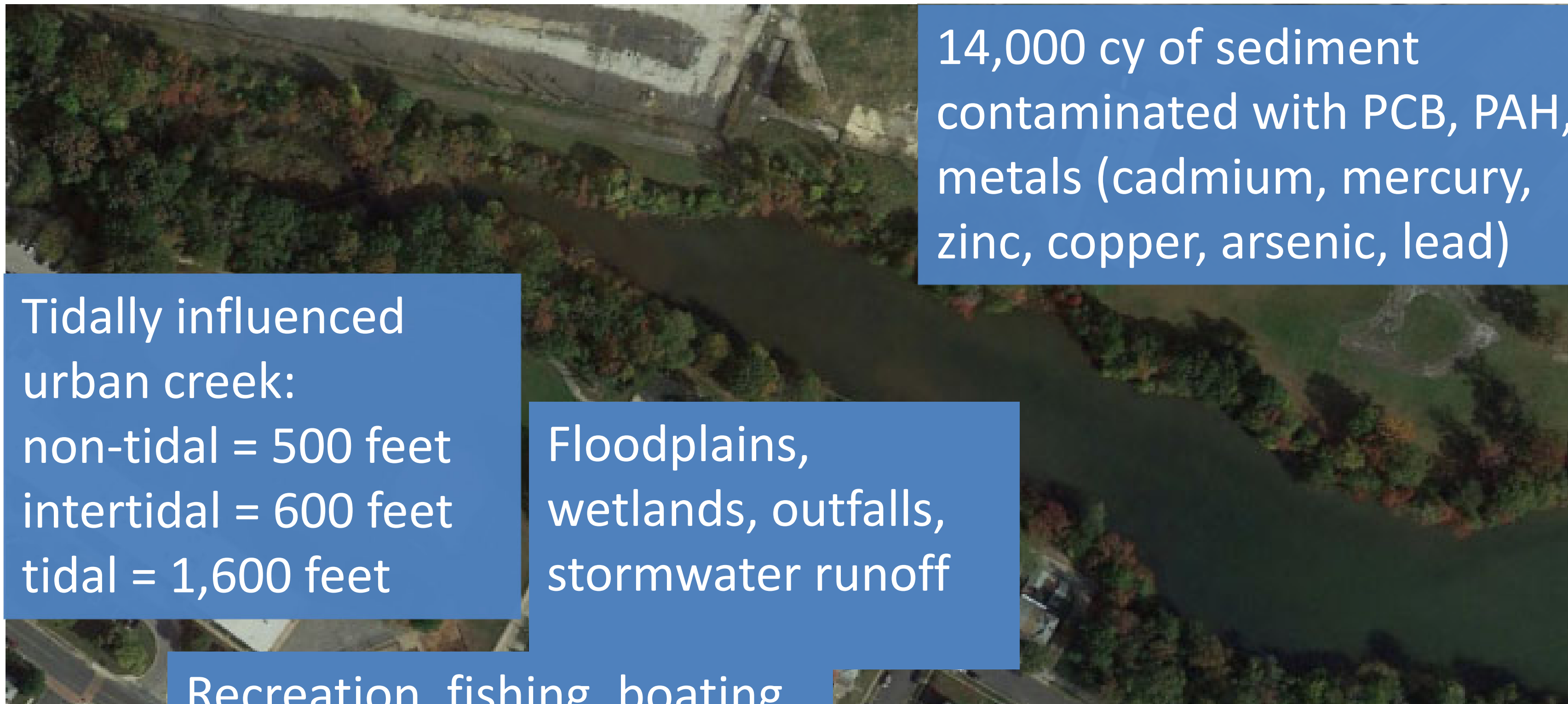




- 36,000 cy of sediment dredging
- RML placement
- 14-acre in situ treatment with PAC
- ~ $13M

- Regulatory obligations were fulfilled
- Benefits to the environment
- How about any visible benefits?

Remediation of an urban creek



14,000 cy of sediment contaminated with PCB, PAH, metals (cadmium, mercury, zinc, copper, arsenic, lead)

Tidally influenced urban creek:
non-tidal = 500 feet
intertidal = 600 feet
tidal = 1,600 feet

Floodplains, wetlands, outfalls, stormwater runoff

Recreation, fishing, boating

Before remediation and restoration

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Before remediation and restoration

Sediment remediation project

Typical process of sediment remediation projects:

- Remedial Investigations
- Feasibility Study
- Proposed Remedy
- Pre-design Investigations
- Remedial Design
- Project Permitting
- Construction

Any opportunities to maximize benefits of the project to the environment, community and to the responsible party?

Stakeholders and Public Involvement

- Local community includes neighborhood, elementary school, and fishermen.
- Project permit requirements include replacement of "functions and values"

- Public value boating, birding, fishing, water quality.
- Consider elements to restore/improve fish habitat.
- Overhanging trees add shade and cover for fish.
- Consider a buffer for stormwater management.

- Re-construct stream
- Restore wetlands
- Plant shoreline vegetation
- Plant tidal marsh fringe
- Addition of log / brush piles along shoreline
- Reestablish submerged aquatic vegetation naturally

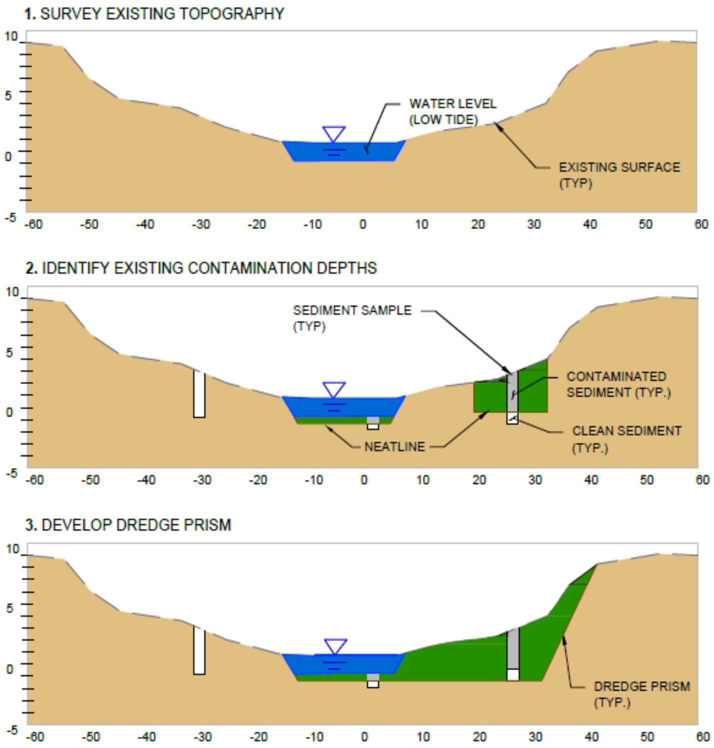
Involved agencies, coordination, permits

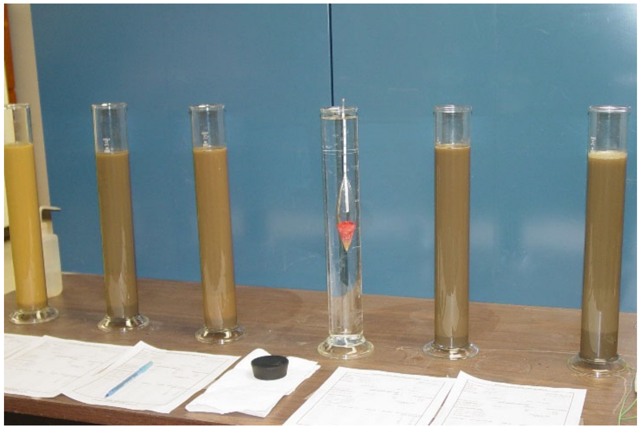
- U.S. Environmental Protection Agency
- U.S. Army Corp of Engineers
- National Oceanic and Atmospheric Administration
- U.S. Fish and Wildlife Service
- State Department of the Environment
- State Department of Natural Resources
- Board of Public Works
- Aviation Administration
- National Guard
- Heritage Trust
- County- Stormwater and Soil Conservation District
- Board of Public Works

Urban Creek Remediation and Restoration

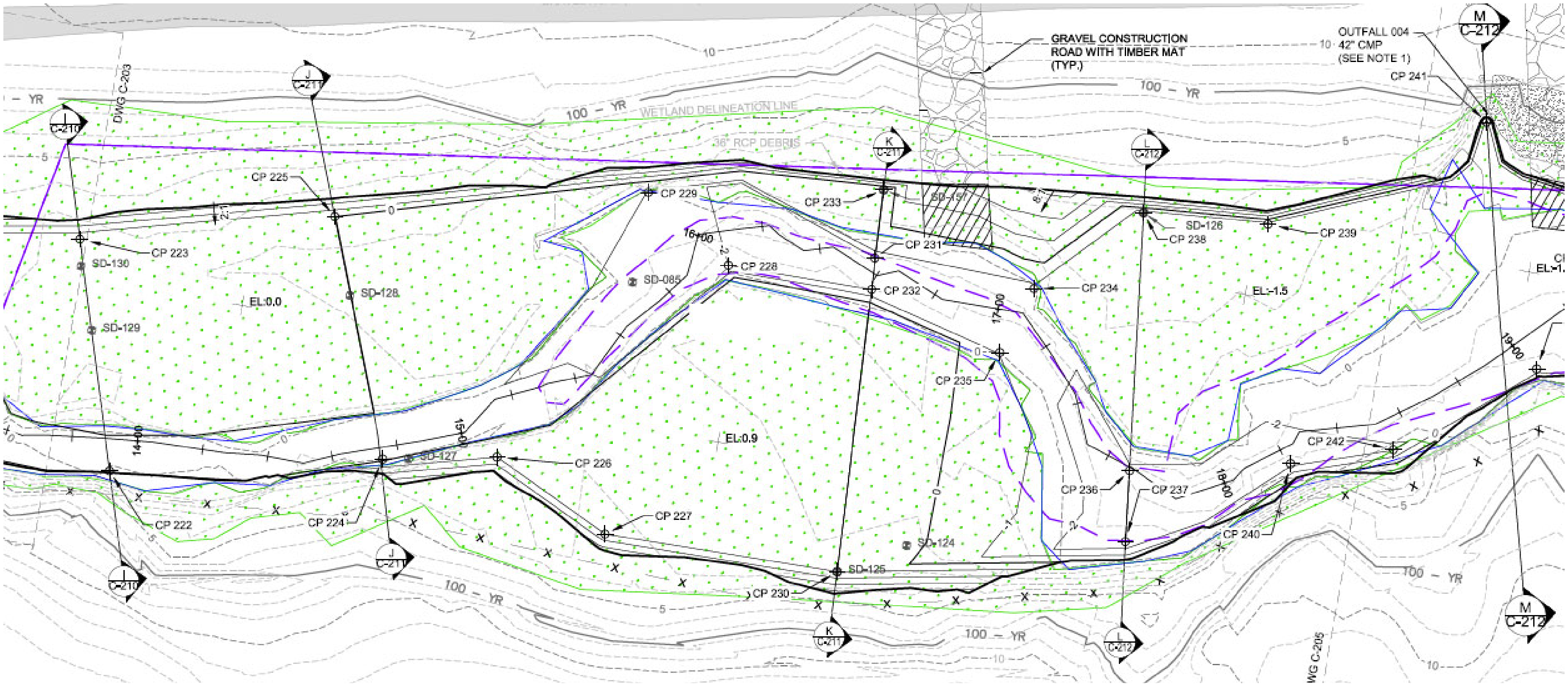
Project Elements:

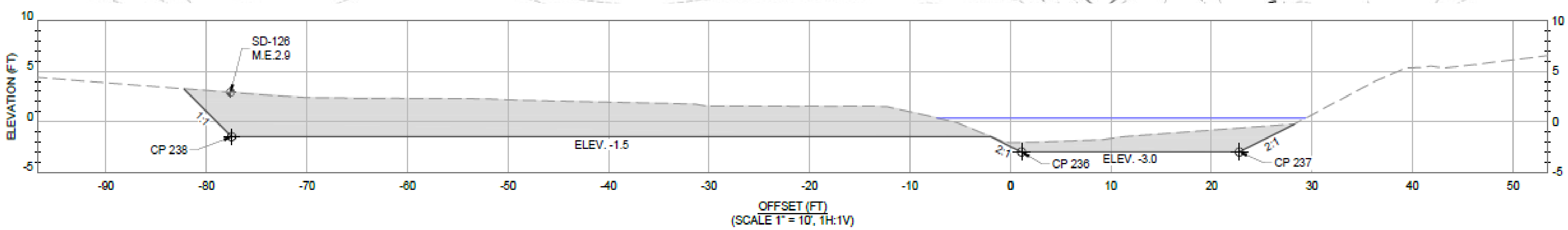
- PDIs
- Remediation Design
- Restoration Design





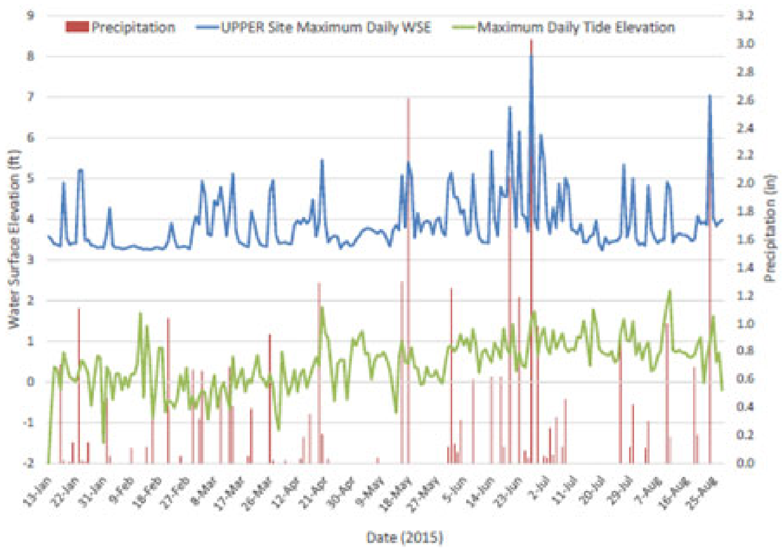
Develop Dredge Design

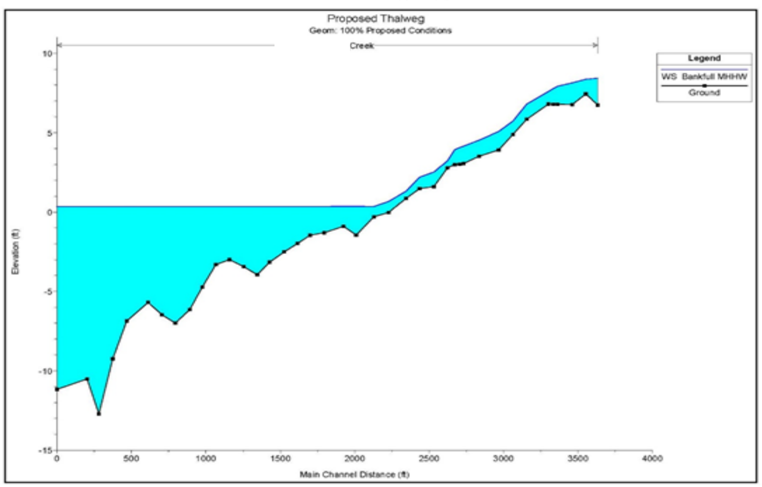


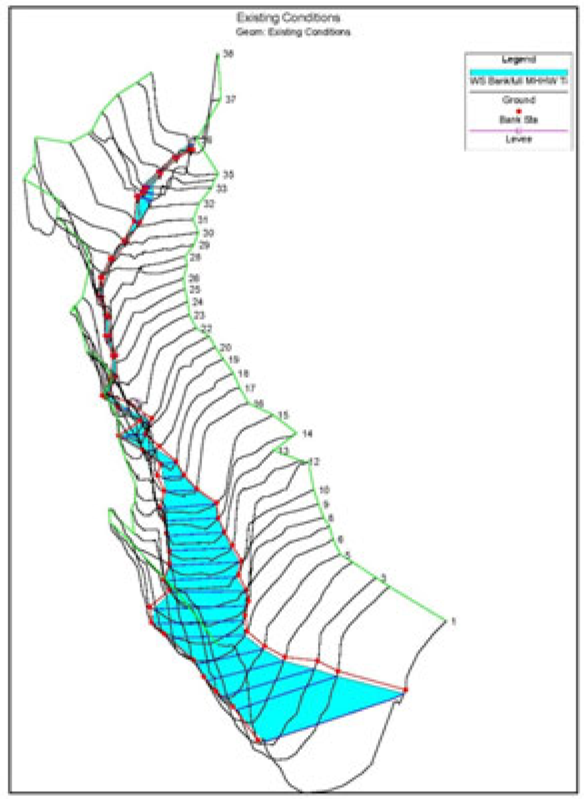


L C-204 CROSS SECTION AT STATION 17+67

Hydrologic Analysis and Hydraulic Modeling







Hydrologic Analysis and Hydraulic Modeling

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Summary of Cofferdam Heights

Station Range[a]	Existing Conditions Water Surface Elevation (ft)		Excavation Conditions Thalweg Elevation (ft)	Cofferdam Min. Height (ft)[b]
	2-year storm and tide event	10-year storm and tide event		
8+00 to 9+81	5.0 to 4.6	5.5 to 5.2	2.5 to 2.5	3.5
9+81 to 11+13	4.6 to 3.8	5.2 to 4.9	2.5 to 0.5	5.1
11+13 to 14+75	3.8	4.9	0.5 to -0.5	6.4
14+75 to 22+12	3.8	4.9	-0.5 to -3.0	8.9
22+12 to 26+39	3.8	4.9	-3.0 to -4.0	9.9

Utilize H&H:

- Design of BMPs
- Construction means and method
- Select dewatering techniques
- Restoration design elements

Summary of Modeled Proposed Hydraulic Characteristics

Modeled Event	Station	Maximum Depth	Average Velocity	Shear Stress
		ft	ft/sec	psf
Bankfull Event, MLLW	8+21	1.0	1.2	0.2
	9+24	1.1	0.9	0.1
	11+25	0.9	0.8	0.1
	12+21	0.7	1.5	0.1
	13+12	0.5	2.6	0.5
	14+30	0.7	0.9	0.0
2-Year Storm Event, MLLW	8+21	1.7	1.8	0.4
	9+24	1.7	1.5	0.3
	11+25	1.5	1.4	0.2
	12+21	1.2	2.5	0.3
	[illegible]	[illegible]	[illegible]	[illegible]
100-Year Storm Event, MLLW	8+21	2.4	2.3	0.5
	9+24	2.4	2.4	0.6
	11+25	2.3	2.2	0.4
	12+21	1.5	4.3	0.7
	13+12	1.2	3.6	0.6
	14+30	1.6	2.3	0.2

Summary of Sediment Sizing Analysis

Location	Station	Median Grain Size (D_{50})		Largest Grain Size (D_{95})	
		Hydraulic Model Conditions for Stability Sizing	D_{50} (mm | inches)	Hydraulic Model Conditions for Sediment Sizing	D_{95} (mm | inches)
Non-tidal	0+00 to 13+00	2-Year	52 | 2	100-Year	152 | 6
Inter-tidal	13+00 to 19+00[a]	100-year associated with a 1.6 foot spring tide	Fine Gravel 8 | 0.3	100-year associated with a 1.6 foot spring tide with conservative factor of safety	25 | 1

[a]Streambed substrate could transition to a graded sand (less than 1 mm) in the downstream portion of the inter-tidal area where shear stresses are lower.

Stream Restoration Design

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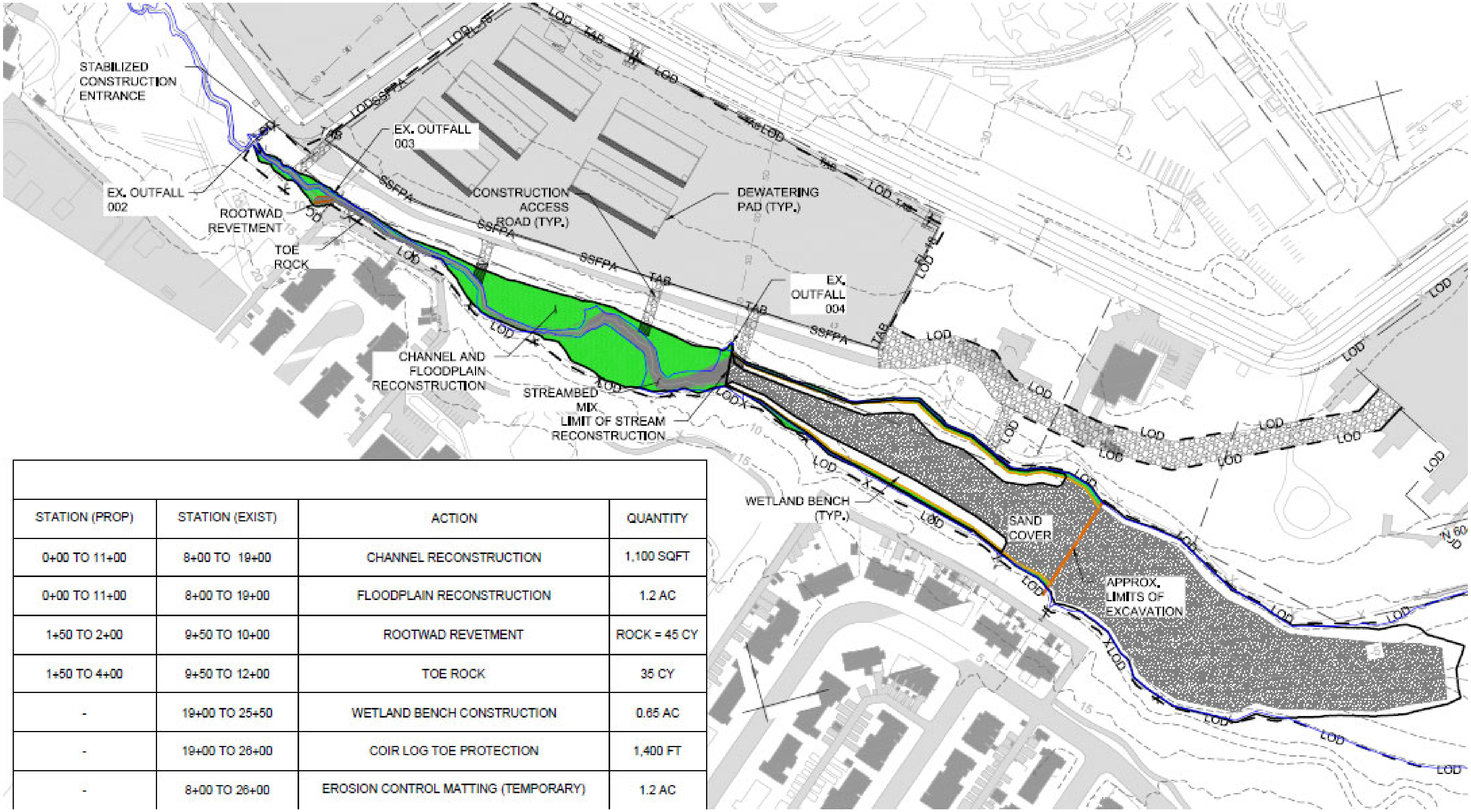

STATION (PROP)	STATION (EXIST)	ACTION	QUANTITY
0+00 TO 11+00	8+00 TO 19+00	CHANNEL RECONSTRUCTION	1,100 SQFT
0+00 TO 11+00	8+00 TO 19+00	FLOODPLAIN RECONSTRUCTION	1.2 AC
1+50 TO 2+00	9+50 TO 10+00	ROOTWAD REVETMENT	ROCK = 45 CY
1+50 TO 4+00	9+50 TO 12+00	TOE ROCK	35 CY
-	19+00 TO 25+50	WETLAND BENCH CONSTRUCTION	0.65 AC
-	19+00 TO 26+00	COIR LOG TOE PROTECTION	1,400 FT
-	8+00 TO 26+00	EROSION CONTROL MATTING (TEMPORARY)	1.2 AC

Stream Restoration Design

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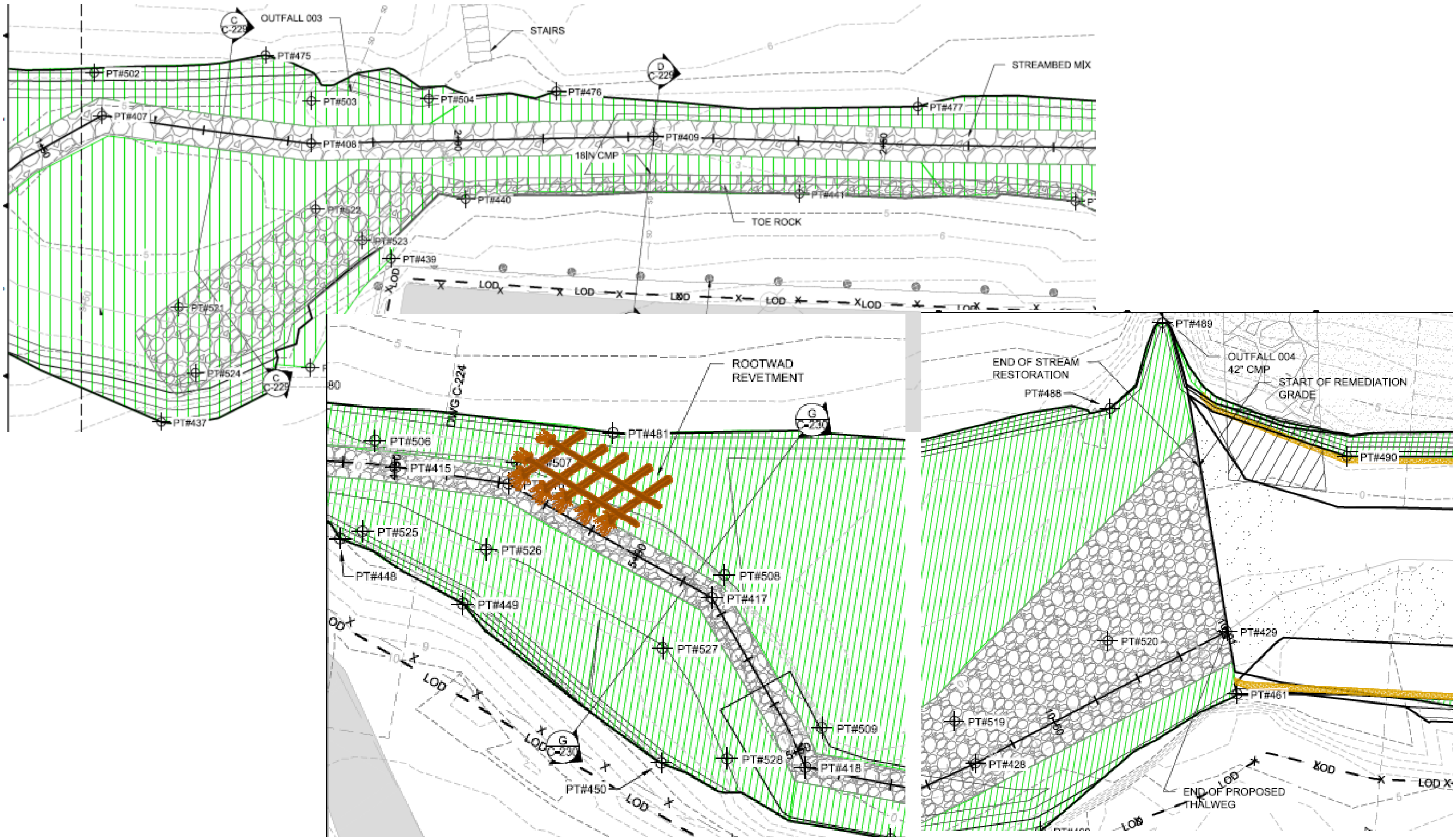
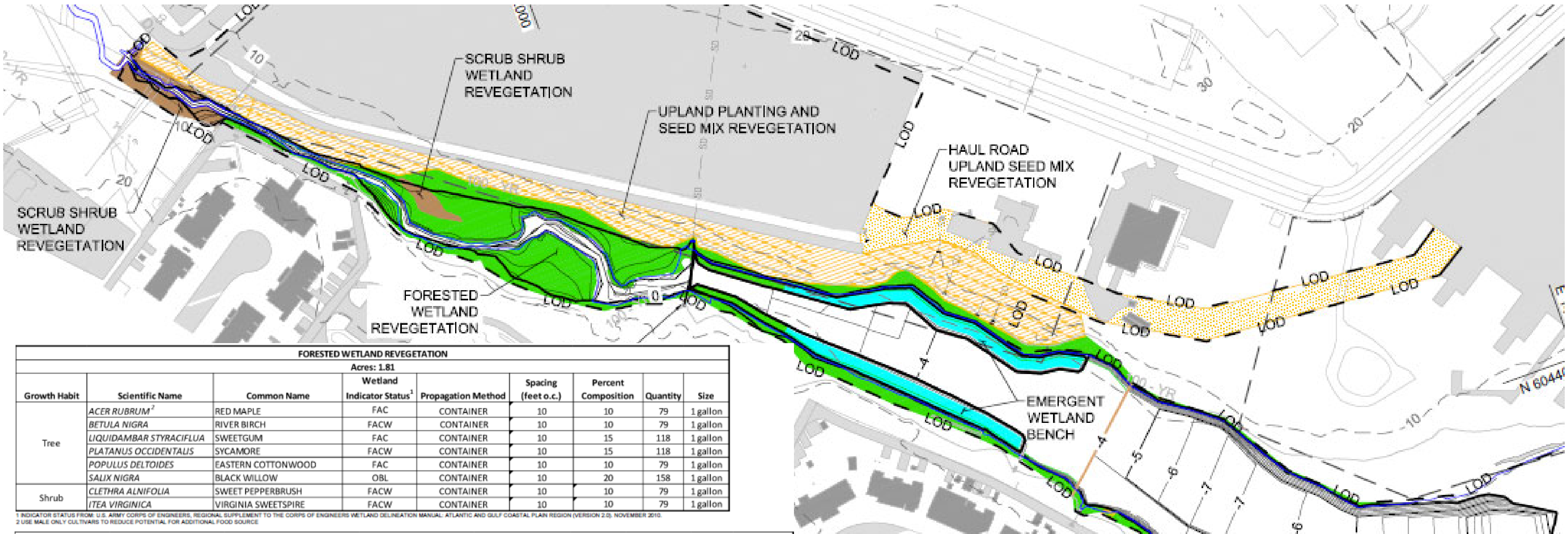


Revegetation Plan



FORESTED WETLAND REVEGETATION

Acres: 1.81

Growth Habit	Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Spacing (feet o.c.)	Percent Composition	Quantity	Size
Tree	*ACER RUBRUM*[2]	RED MAPLE	FAC	CONTAINER	10	10	79	1 gallon
	BETULA NIGRA	RIVER BIRCH	FACW	CONTAINER	10	10	79	1 gallon
	LIQUIDAMBAR STYRACIFLUA	SWEETGUM	FAC	CONTAINER	10	15	118	1 gallon
	PLATANUS OCCIDENTALIS	SYCAMORE	FACW	CONTAINER	10	15	118	1 gallon
	POPULUS DELTOIDES	EASTERN COTTONWOOD	FAC	CONTAINER	10	10	79	1 gallon
	SALIX NIGRA	BLACK WILLOW	OBL	CONTAINER	10	20	158	1 gallon
Shrub	*CLETHRA ALNIFOLIA*	SWEET PEPPERBRUSH	FACW	CONTAINER	10	10	79	1 gallon
	ITEA VIRGINICA	VIRGINIA SWEETSPIRE	FACW	CONTAINER	10	10	79	1 gallon

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.
2 USE MALE ONLY CULTIVARS TO REDUCE POTENTIAL FOR ADDITIONAL FOOD SOURCE

Scrub-shrub Wetland Revegetation

Acres: 0.22

Growth Habit	Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Spacing (feet o.c.)	Percent Composition[2]	Quantity	Size
Shrub	*CLETHRA ALNIFOLIA*	SWEET PEPPERBRUSH	FACW	CONTAINER	8	25	37	1 gallon
	EUONYMUS AMERICANUS	STRAWBERRY BUSH	FAC	CONTAINER	8	25	37	1 gallon
	ITEA VIRGINICA	VIRGINIA SWEETSPIRE	FACW	CONTAINER	8	25	37	1 gallon
	MAGNOLIA VIRGINIANA	SWEETBAY MAGNOLIA	FACW	CONTAINER	8	25	37	1 gallon
Herbaceous Species	*HIBISCUS MOSCHEUTOS*	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	60	639	10 cubic inc
	SOLIDAGO RUGOSA	GOLDENROD	FAC	PLUGS	3	40	426	10 cubic inc

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.
2 PERCENT COMPOSITION BASED ON GROWTH HABIT; COMPOSITION OF SHRUB SPECIES SUMS TO 100 AND COMPOSITION OF HERBACEOUS SPECIES SUMS TO 100.

EMERGENT WETLAND REVEGETATION

Acres: 0.39

Growth Habit	Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Spacing (feet o.c.)	Percent Composition	Quantity
Herbaceous Species	*CAREX STRICTA*	TUSSOCK SEDGE	OBL	PLUGS	3	15	283
	HIBISCUS MOSCHEUTOS	CRIMSON-EYED ROSE MALLOW	OBL	PLUGS	3	20	378
	IRIS VERSICOLOR	BLUE FLAG IRIS	OBL	PLUGS	3	10	189
	JUNCUS EFFUSUS	COMMON RUSH	OBL	PLUGS	3	15	283
	PELTRANDRA VIRGINICA	GREEN ARROW-ARUM	OBL	PLUGS	3	10	756

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.

UPLAND REVEGETATION

Acres: 1.76

Growth Habit	Scientific Name	Common Name	Wetland Indicator Status[1]	Propagation Method	Suggested Plant Spacing (feet o.c.)[1]	Percent Composition	Approximate Quantity	Size
Tree	*ACER RUBRUM*[2]	RED MAPLE	FAC	CONTAINER	10	30	230	1 gallon
	LIQUIDAMBAR STYRACIFLU	SWEETGUM	FAC	CONTAINER	10	30	230	1 gallon
	POPULUS DELTOIDES	EASTERN COTTONWOOD	FAC	CONTAINER	10	30	230	1 gallon
Shub	*EUONYMUS AMERICANUS*	STRAWBERRY BUSH	FAC	CONTAINER	10	10	77	1 gallon

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0). NOVEMBER 2010.

WETLAND SEED MIX : TO BE APPLIED IN ALL WETLAND REVEGETATION AREAS

Acres to be seeded:	**2.42** acre - total wetland area					
Pounds Required (per acre):	**131** lbs - per MAA specs. Seed mix.#3					
Scientific Name	**Common Name**	**Wetland Indicator Status[1]**	**Propagation Method**	**Percent Composition**	**Quantity (lbs) per Acre**	**Total Quantity (lbs)**
AGROSTIS STOLONIFERA	CREEPING BENTGRASS	FACW	SEED	60	83	201
POA PALUSTRIS	FOWL BLUEGRASS	FACW	SEED	30	34	82
PANICUM VIRGATUM	SWITCHGRASS	FAC	SEED	10	14	34

1 INDICATOR STATUS FROM: U.S. ARMY CORPS OF ENGINEERS, REGIONAL SUPPLEMENT TO THE CORPS OF ENGINEERS WETLAND DELINEATION MANUAL: ATLANTIC AND GULF COASTAL PLAIN REGION (VERSION 2.0).

Remediation Construction

Remediation Construction

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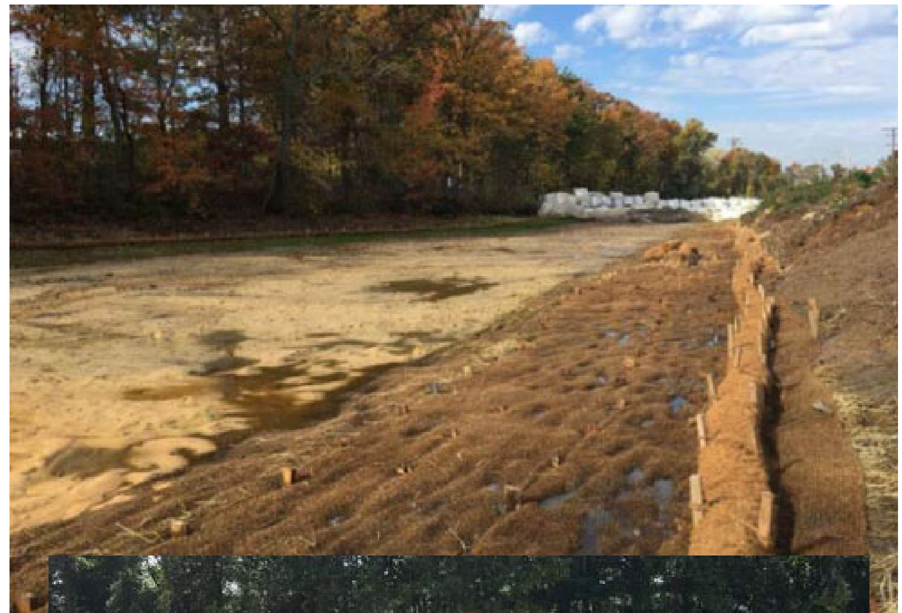
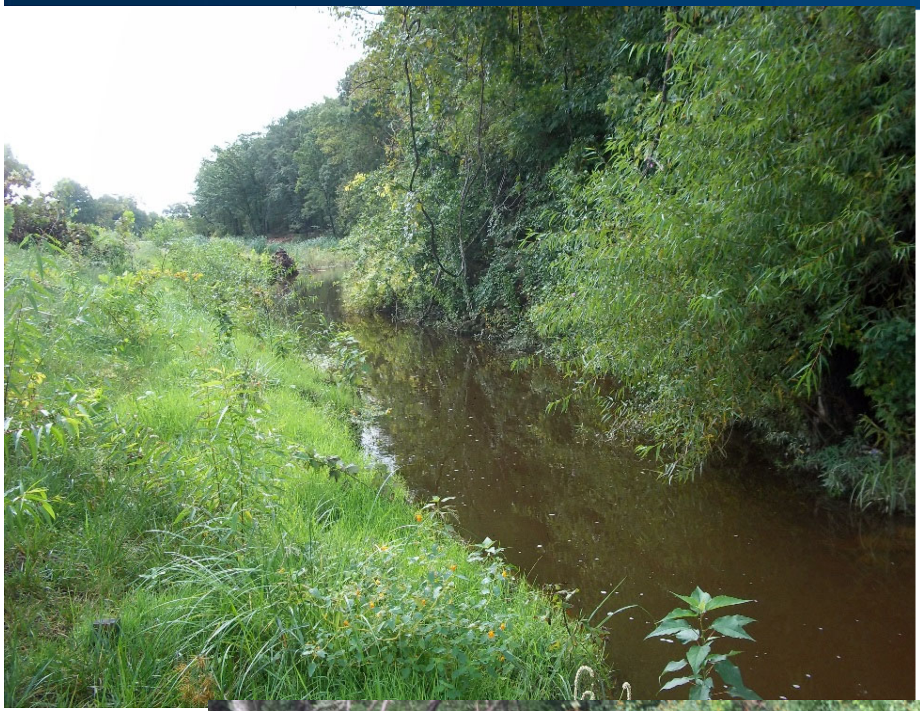
Reconstruction of creek



Streambed gravel, TRM, rootwads, planting

Revegetation

Restoration – Year 1



Restoration – Year 1

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Month	30-Year Avg . Rainfall (in)	Observed Monthly Rainfall (in)
Jul 2017	4.07	7.11
May 2018	3.99	8.17
Jun 2018	3.46	4.77
Jul 2018	4.07	16.73

Daily	24-hr Rainfall (in)
July 21, 2018	4.79
July 24, 2018	4.07

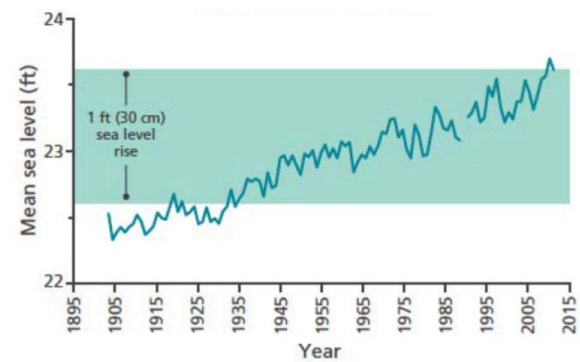
Storm Event	24-hour Precipitation	Discharge[a]
	inches	cfs
Baseflow[b]	0	0.6
Bankfull	--[c]	6.0
2-year	3.3	19.2
10-year	5.1	29.4
100-year	8.8	50.3

Challenges:
Erosion, streambed mix wash, bare areas, emergent wetland establishment.

Typical design guidance:
2-year storm event (24-hour rainfall total of 3.3 inches, 19 cfs)

Bank stabilization, streambed mix design was based on 100-year storm (approx. 50 cfs)

Consider the impact of climate change, add contingency.



Plan impacts of frequent high-water events in survivability of wetland species, especially the ones very sensitive to inundation (e.g., emergent wetlands).

Lessons learned

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- **Planning.** Investigate habitat restoration opportunities during the feasibility and planning stage of the project
- **Permitting, public involvement and outreach.** Coordinate with permitting agencies and public early and often during planning of remediation project.
- **Open discussions.** Plan a balanced design of remediation and restoration through open discussions with agencies and public.
- **Design.** Consider sea level rise, frequent high-water events during design.
- **Risk management.** Consider risks and plan corrective actions.

Conclusions

- As consultants, engineers, scientists: plan, incorporate **habitat restoration and enhancement** to remediation projects to maximize benefits
  - Environmental benefits
  - Economic benefits
  - Public support
  - Company's reputation

- A well-planned restoration added to the project will likely return as success of the remediation project and maximized benefits to the responsible party.