



Aquatic Resource Mitigation at Bensalem Township High School

AUGUST 2023

PRESENTED TO: National Stream Restoration Conference

PRESENTED BY: Andrew W. Donaldson, Senior Environmental Scientist



AGENDA:

PROJECT PURPOSE

AQUATIC RESOURCE IMPACTS

MITIGATION SITE SEARCH AND AGENCY COORDINATION

DESIGN APPROACH AND PROJECT SUCCESS

PROJECT PURPOSE

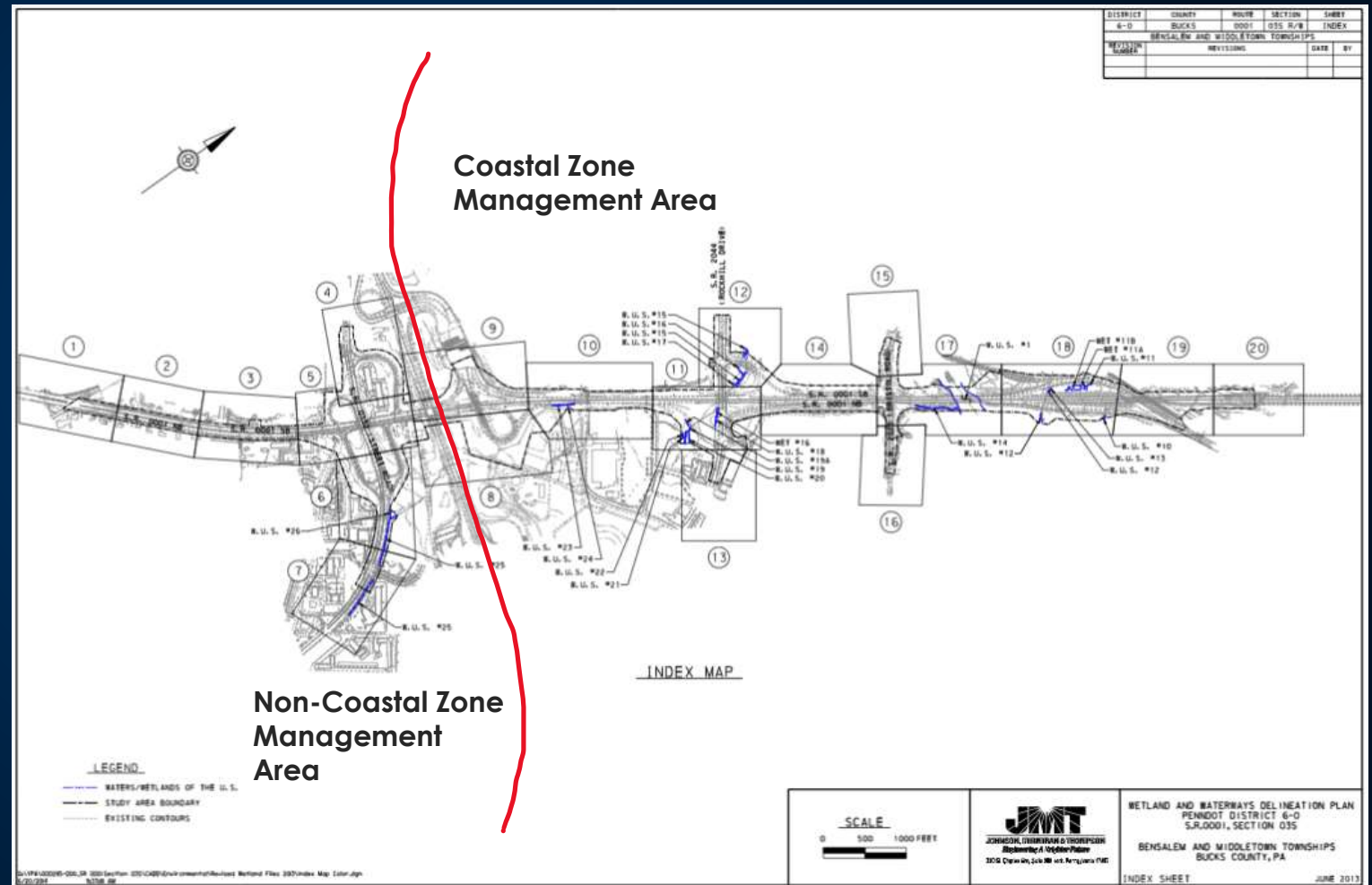
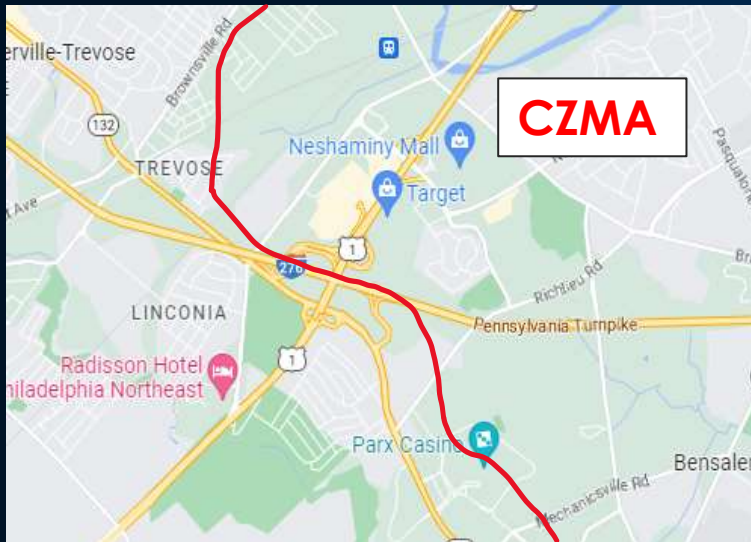
PennDOT District 6-0, S.R. 0001, Group 03S, Sections RC1 & RC2

- District 6-0 Transportation Improvement Project along the US State Route 1 corridor in Bensalem and Middletown Township, Bucks County PA.
- Design of roadway improvement project began in January 2001.
- Project design included widening of S.R.0001, upgrading four interchanges, and seven bridge reconstructions.
 - Project would impact wetlands and waterways
 - PennDOT to implement Permittee-Responsible Mitigation (PRM)



Aquatic Resource Impacts OVERVIEW

Water Obstruction and Encroachment Impact Plan (Index Map)



Permanent Aquatic Resource Impacts included 12 riverine resources and 3 palustrine resources



Aquatic Resource Impacts OVERVIEW

Table 1: Stream Impacts & Compensatory Stream Mitigation for the S.R. 0001, Group 03S, Sections RC1 & RC2 Improvement Project

Stream Impact Location	Stream Type	Permanent Stream Impacts (L.F.)	Mitigation Ratio*	Required Stream Mitigation (L.F.)	Provided Stream Mitigation (L.F.)
Section RC1	Perennial	515	1:1	515	860
Section RC2	Perennial & Intermittent	1,389	1:1	1,389	1,488
Total		1,904		1,904	2,348

Table 2: Wetland Impacts & Compensatory Wetland Mitigation for the S.R. 0001, Group 03S, Sections RC1 & RC2 Improvement Project

Wetland Impact Location	Wetland Type	Permanent Wetland Impacts (Ac.)	Mitigation Ratio	Required Wetland Mitigation (Ac.)	Provided PEM Wetland Mitigation (Ac.)
Section RC1	N/A	0	N/A	0	N/A
Section RC2	PFO	0.176	2:1	0.352	See Off-Site Info Below
	PEM	0.037	1:1	0.037	See Off-Site Info Below
Off-Site Mitigation	PFO	0.307	2:1	0.614	1.37
Total		0.520		1.003	1.37

Aquatic Resource Impacts **OVERVIEW**



WET-11B (CZMA)



WUS-26 UNT Poquessing Creek
(Non-CZMA)



WUS-14 UNT Neshaminy Creek
(CZMA)



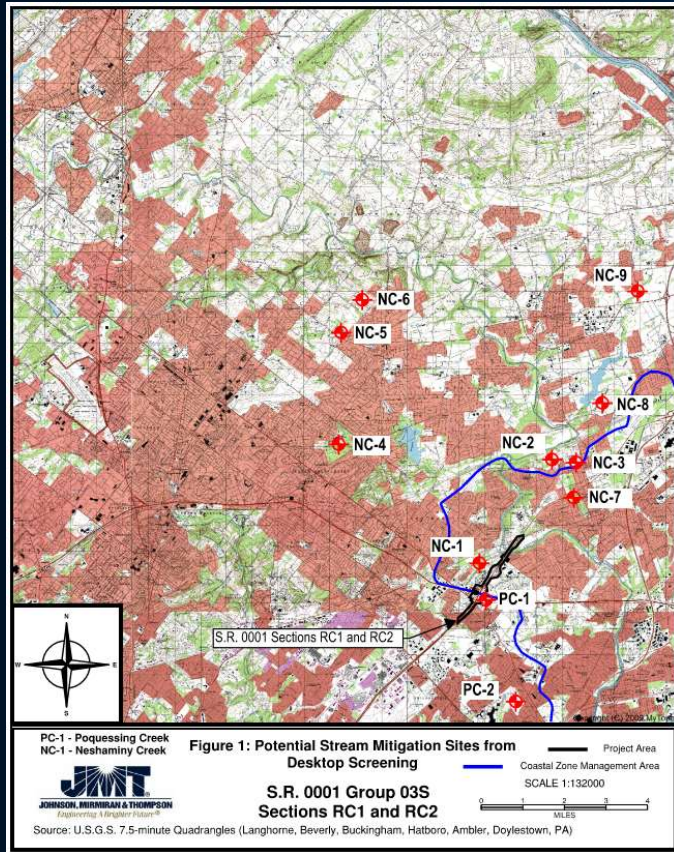
MITIGATION SITE SEARCH AND AGENCY COORDINATION

Mitigation Site Selection Criteria

- Proximity to Impacts and within the Neshaminy and/or Poquessing Creek Watersheds
- Perennial first and second order streams
- USEPA 303(d) listed
- Site access and possible utility constraints
- Potential for Stream and Wetland Restoration (Coupled resource benefits)
- **Coastal Zone Management Area (Learning Lesson #1)**

Desktop and Field Evaluated Sites

Desktop Screening



Field Evaluation Screening



Field Evaluation Form

S.R. 0001 Group 03S Sections RC1 and RC2 Stream Mitigation Site Selection Field Screening Form		
Site Name: NC-1	Township/Borough: Bensalem Township	
Field Access Date: 7/25/2013	Reviewer: AWD, JR	
1. Access from a public road: <input type="checkbox"/> <500 ft. <input checked="" type="checkbox"/> 500 - 2000 ft. <input type="checkbox"/> >2000 ft.		
Are there any access limitations? <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Steep slopes <input type="checkbox"/> Fencing <input type="checkbox"/> Other (law, pasture, park, etc.)		
2. Is Project site wooded? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No. Length of Site: 1,500 ft.		
If Yes, what density? <input type="checkbox"/> Dense <input type="checkbox"/> Sparse <input type="checkbox"/> 85-Approx. % of Site <input type="checkbox"/> 300 Avg. width of forest buffer (ft.)		
If No, why? <input type="checkbox"/> Pasture <input type="checkbox"/> Cropland <input type="checkbox"/> Mowed/maintained <input type="checkbox"/> Wetland		
3. Estimated Percentage of Stream Bank Erosion (combined length of both banks)? <input type="checkbox"/> 100-75% <input checked="" type="checkbox"/> 74-50% <input type="checkbox"/> 49-25% <input type="checkbox"/> 24-0%		
4. Describe general soil texture of stream banks: <input checked="" type="checkbox"/> Silt / loam		
5. Degree of Channel Incision: <input type="checkbox"/> 8.5-5.5 Avg. bank height: <input type="checkbox"/> 5.5-4.0 Avg. stream width:		
<input type="checkbox"/> Severe <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Minimal		
6. Stream Channel Debris/Blockages: <input type="checkbox"/> Infrequent <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Numerous		
Are any a barrier to fish passage? <input type="checkbox"/> Y/N <input type="checkbox"/> No		
If yes, Approx. type, size & location:		
7. Describe frequency of depositional features & approx. size fraction of sediments: Depositional features along inside meander banks consisting of gravels and small cobble as a result of bed degradation		
8. Do vertical controls exist within the active channel? <input checked="" type="checkbox"/> Yes		
If yes, what type? <input type="checkbox"/> bridge/culvert <input type="checkbox"/> structure <input type="checkbox"/> valley/bedrock <input type="checkbox"/> utility crossing <input type="checkbox"/> other		
Approx. location & condition: There is a railroad crossing within the project site.		
9. Lateral Encroachments? <input type="checkbox"/> embankment <input type="checkbox"/> structure/buildings <input type="checkbox"/> roadway <input type="checkbox"/> other		
If yes, what type? Deep kilidage exiting the railroad culvert and sewer line along left plain area.		
10. Sediment Storage / Nutrient Treatment Potential? <input type="checkbox"/> upstream sources <input type="checkbox"/> floodplain storage potential <input checked="" type="checkbox"/> retention time adjustment		
11. Identifiable Sediment (S) or Nutrient (N) Sources? <input checked="" type="checkbox"/> Yes		
If Yes, what type? <input type="checkbox"/> Duffels <input type="checkbox"/> Agricultural <input type="checkbox"/> Livestock <input type="checkbox"/> Streambanks		

Agency Coordination

Off-site mitigation evaluation

- A total of 11 sites were evaluated as candidates for off-site mitigation

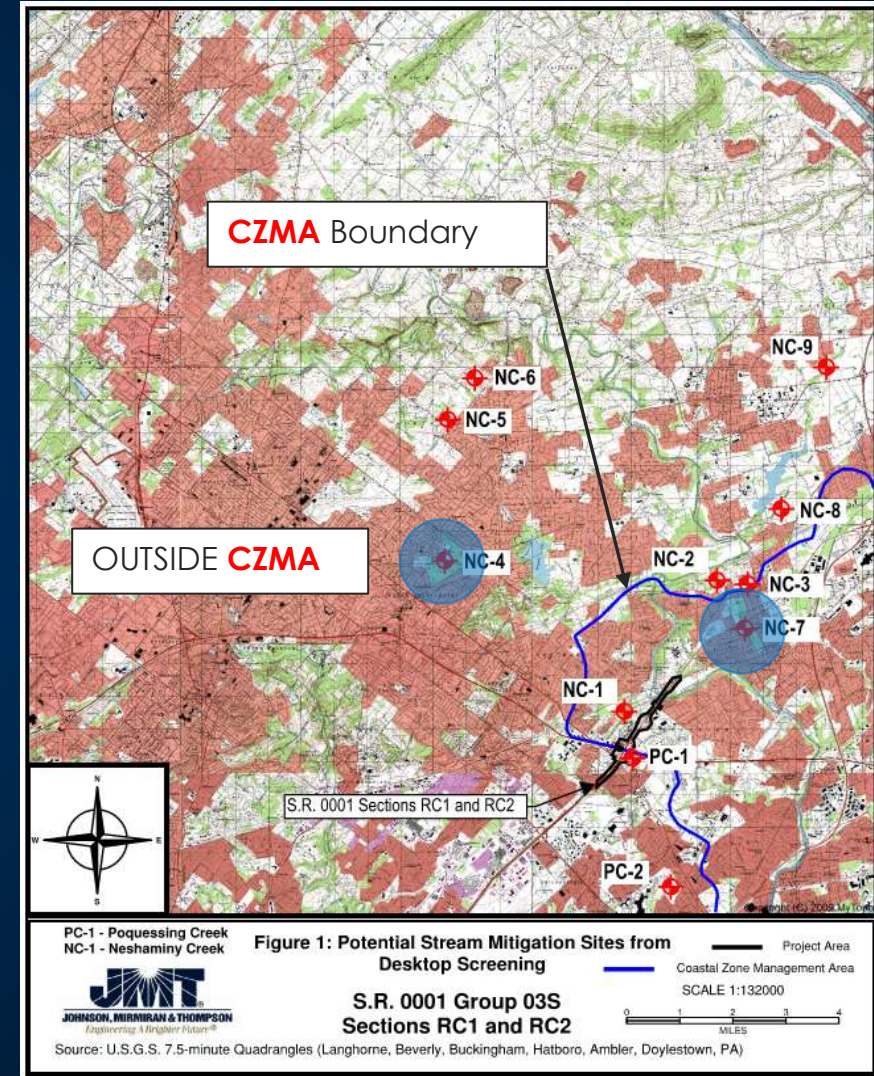


Example of off-site mitigation evaluated

Field View with Agencies to Garner Support for Mitigation Requirements

- Both palustrine and riverine impacts needed to be within the **CZMA**.
- Ideal site for addressing stream and wetland mitigation activities was Site NC-4 but outside the **CZMA**.
- Site NC-7 was inside the **CZMA**, however, not suitable for addressing stream and wetland mitigation impacts.

NEEDED SITE INSIDE CZMA – ASAP!



Watershed Partners

- Neshaminy Creek State Park
- Bucks County Conservation District
Watershed Specialist
- Bucks County Parks and Recreation
 - Silver Lake Nature Center
opportunities
 - Site search with staff to find
impacted stream at Bensalem
Township High





DESIGN APPROACH
BENSALEM TOWNSHIP HIGH SCHOOL

Stream and floodplain restoration to maximize ecological benefits

- Agricultural Pond Impacts
- Post-settlement land clearing
- Ditching and Channelization
- Post-settlement alluvium in floodplains



Visual Assessment

- Upstream, Downstream, and Project Reach



- Breached Primary Dam



- Severely entrenched



- Debris jams from fallen trees



- Breached Secondary Dam



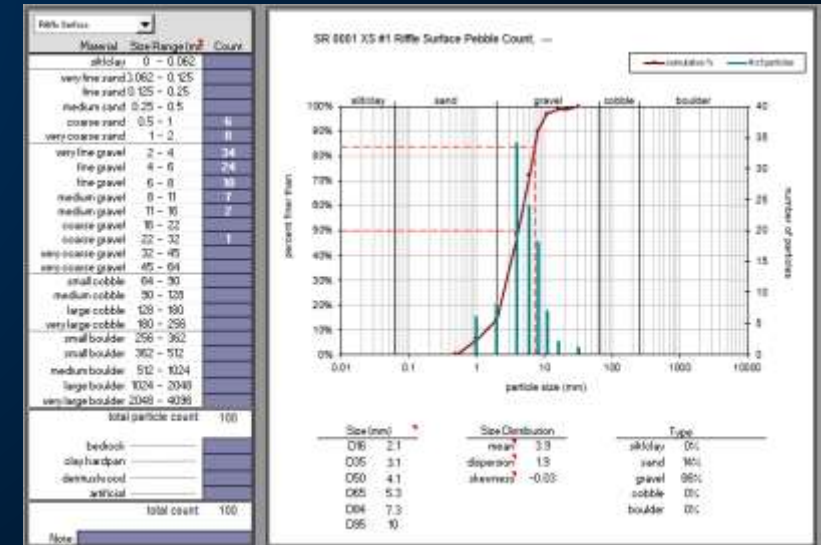
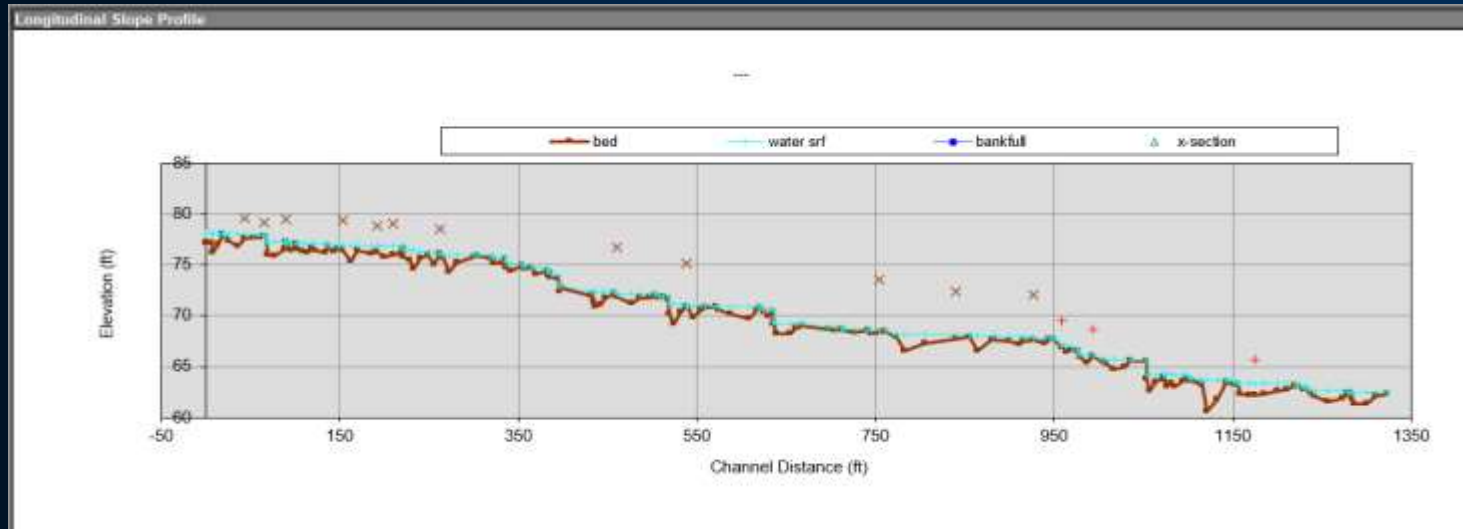
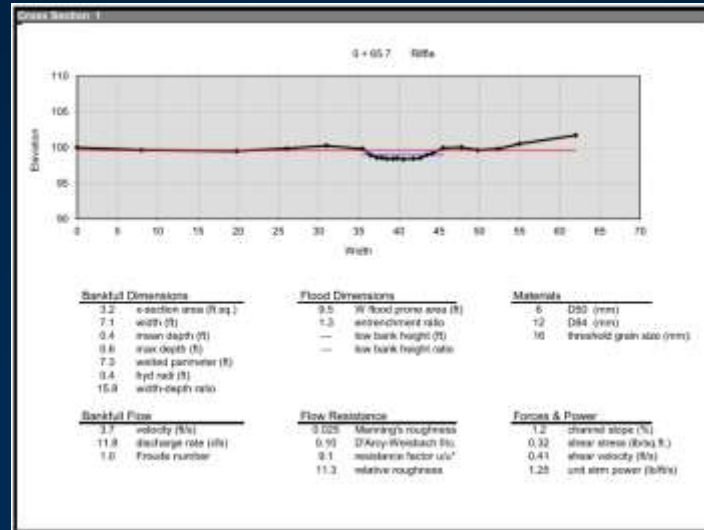
- Draining perched wetlands

Justification of Impairment and Need for Restoration

Geomorphic Assessment

- Characterize Existing Stream Conditions

- Stream Type
- Entrenchment Ratio
- Cross-Sectional Area
- Channel width
- Mean depth
- Substrate Analysis
- Longitudinal Profile



Trench Investigation

- Characterize Soil Profile

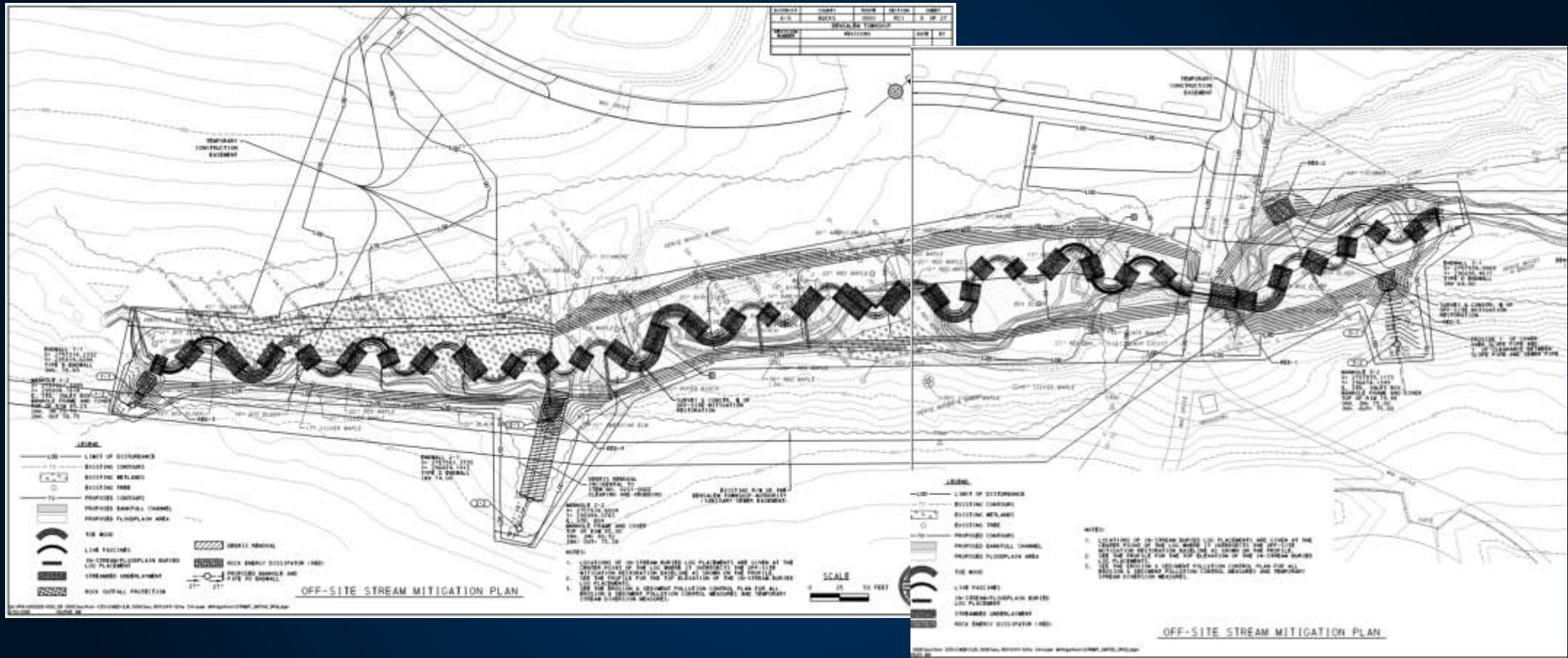
- Soil Types
 - Clay, loam, sand, silt
- Hydric Soils
- Red/Ox Conditions
- Soil Horizons
 - Depths
 - Thickness
- Soil color



DESIGN APPROACH

- Maximize stream and wetland restoration to maximize mitigation credits for Permittee-Responsible Mitigation (PRM)
- Sustainable for the full range of flows (up to 100-year event)
- Floodplain reconnection to promote wetland establishment as well as provide long-term stability (Aquatic Resource Coupling)
- Sediment transport analysis of the sediments from the watershed

STREAM AND WETLAND DESIGN PLANS



- Approximately 1,488 LF of stream mitigation (restoration)
- Approximately 1.2 acres emergent wetland (reestablishment)

DESIGN ELEMENTS

- In-Stream Structures
 - Engineered Riffle
 - Log Sills (both channel and floodplain)
 - Toe Wood Structures
- Robust Wetland Seed Mix
- Existing and New Outfall Stabilization
- River continuum through existing utility bridge crossing

PHOTOS OF DESIGN ELEMENTS

- In-Stream Structures
 - Engineered Riffle
 - Log Sills
 - Toe Wood Structures



PHOTOS OF DESIGN ELEMENTS

- One Existing and Three New Stormwater Outfalls



PHOTOS OF DESIGN ELEMENTS

- River continuum and Aquatic Organism Passage (AOP) through existing bridge



TROPICAL STORM ISAIAS - August 2020

Approximately 2 months after Construction



7/19/2021

NOAA Atlas 14, Volume 2, Version 3
 Location name: Bensalem, Pennsylvania, USA*
 Latitude: 40.1247°, Longitude: -74.8451°
 Elevation: 195.62 ft**
 *Source: USGS
 **Source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES
 S.M. Benson, G. Barker, B. Liu, T. Pieloušek, M. Serrin, and L. Eiler
 NOAA, National Weather Service, Silver Spring, Maryland
[PF_tutorial](#) | [PF_instructions](#) | [Menu](#) | [Feedback](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.316-0.381)	0.416 (0.376-0.455)	0.481 (0.445-0.519)	0.547 (0.495-0.601)	0.615 (0.554-0.675)	0.681 (0.606-0.757)	0.714 (0.627-0.801)	0.759 (0.673-0.845)	0.816 (0.716-0.920)	0.880 (0.744-1.022)
10-min	0.694 (0.606-0.792)	0.832 (0.706-0.971)	0.976 (0.811-1.161)	1.074 (0.904-1.261)	1.166 (1.001-1.341)	1.246 (1.071-1.431)	1.324 (1.149-1.514)	1.399 (1.224-1.584)	1.476 (1.291-1.661)	1.548 (1.363-1.733)
15-min	0.893 (0.766-1.021)	1.033 (0.886-1.191)	1.184 (1.011-1.361)	1.311 (1.131-1.501)	1.424 (1.244-1.614)	1.524 (1.344-1.714)	1.614 (1.434-1.804)	1.699 (1.519-1.889)	1.776 (1.591-1.961)	1.848 (1.663-2.033)
30-min	0.956 (0.801-1.111)	1.115 (0.951-1.291)	1.281 (1.091-1.491)	1.411 (1.221-1.611)	1.524 (1.344-1.714)	1.624 (1.444-1.814)	1.714 (1.534-1.904)	1.799 (1.619-1.989)	1.876 (1.691-2.061)	1.948 (1.763-2.133)
60-min	1.19 (1.03-1.35)	1.44 (1.21-1.68)	1.61 (1.41-1.83)	1.76 (1.56-1.98)	1.89 (1.71-2.09)	2.01 (1.83-2.21)	2.11 (1.93-2.31)	2.20 (2.02-2.38)	2.28 (2.10-2.46)	2.36 (2.18-2.54)
24hr	1.63 (1.45-1.81)	1.73 (1.51-1.95)	1.79 (1.59-1.99)	1.83 (1.63-2.03)	1.87 (1.67-2.07)	1.91 (1.71-2.11)	1.95 (1.75-2.15)	1.99 (1.79-2.19)	2.03 (1.83-2.23)	2.07 (1.87-2.27)
34hr	1.98 (1.71-2.25)	1.96 (1.72-2.19)	2.40 (2.15-2.65)	2.78 (2.53-3.03)	3.33 (3.08-3.58)	3.76 (3.51-4.01)	4.22 (3.97-4.47)	4.68 (4.43-4.93)	5.14 (4.89-5.39)	5.60 (5.35-5.85)
64hr	1.97 (1.74-2.19)	2.36 (2.11-2.61)	2.90 (2.65-3.15)	3.51 (3.26-3.76)	4.23 (3.98-4.48)	4.83 (4.58-5.08)	5.47 (5.22-5.72)	6.16 (5.91-6.41)	7.15 (6.90-7.40)	7.98 (7.73-8.23)

1-Year Post-Construction – Tested Again



- 6.0"-10.0" rain in 3-4 hours
- Greater than the 100-year storm event

July 22, 2021

One week after 100-Year storm event



July 2022 – Two Years Post Construction

Looking downstream



Looking upstream



Questions



PLEASE
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