Center for the Inland Bays

Scientific & Technical Advisory Committee

How Stream Corridor Watershed Restoration Can Help

July 16, 2010

Center for Watershed Protection

Center for the Inland Bays
PROTECTING AND PRESERVING DELAWARE'S INLAND BAYS

JMT
JOHNSON, MIRMIRAN & THOMPSON
Engineering A Brighter Future®

Watershed

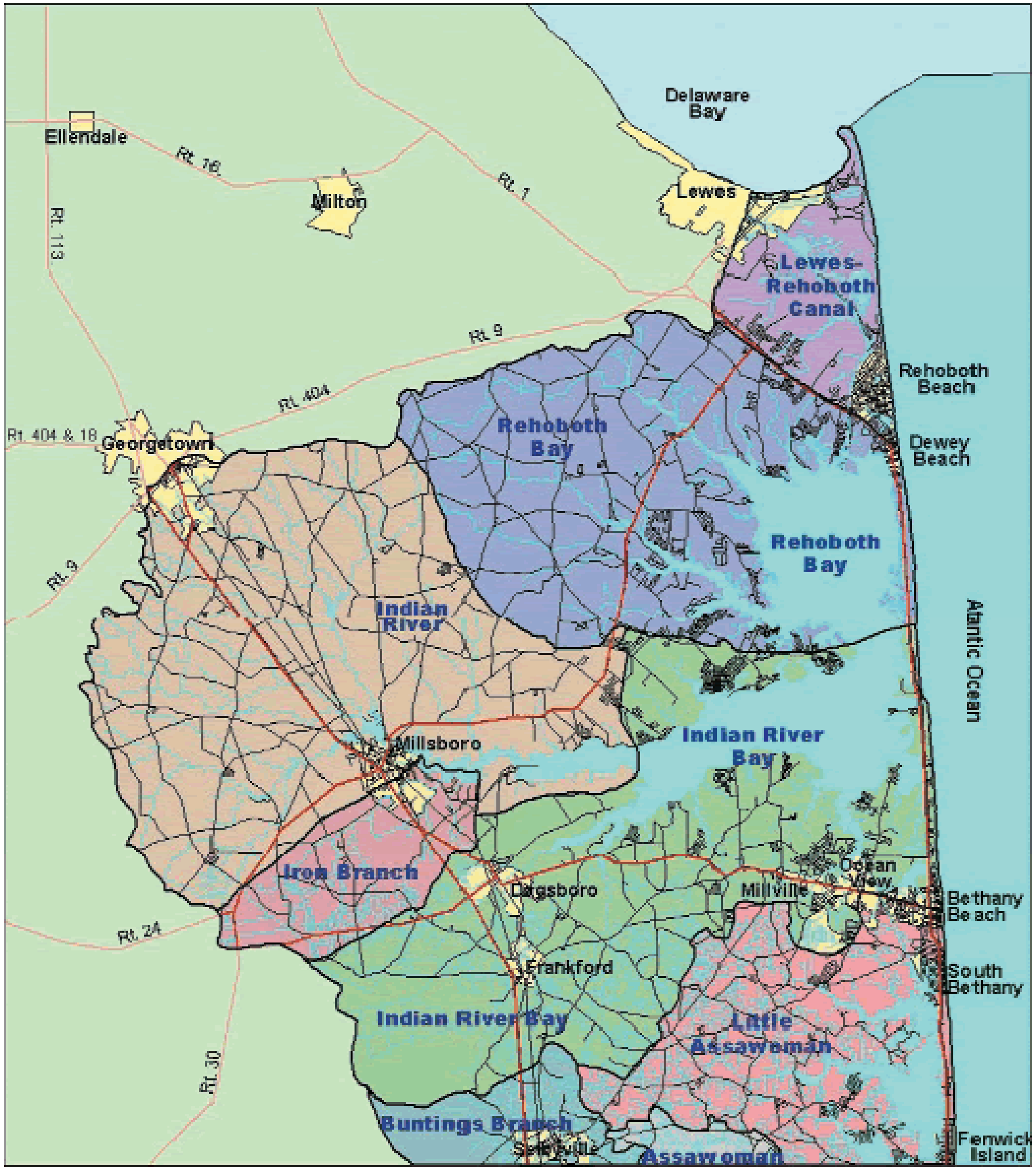


Figure credit: Center for Inland Bays website.

Historical/Modern Impacts

Natural Streams and the Legacy of Water-Powered Mills

Robert C. Walter and Dorothy J. Merritts

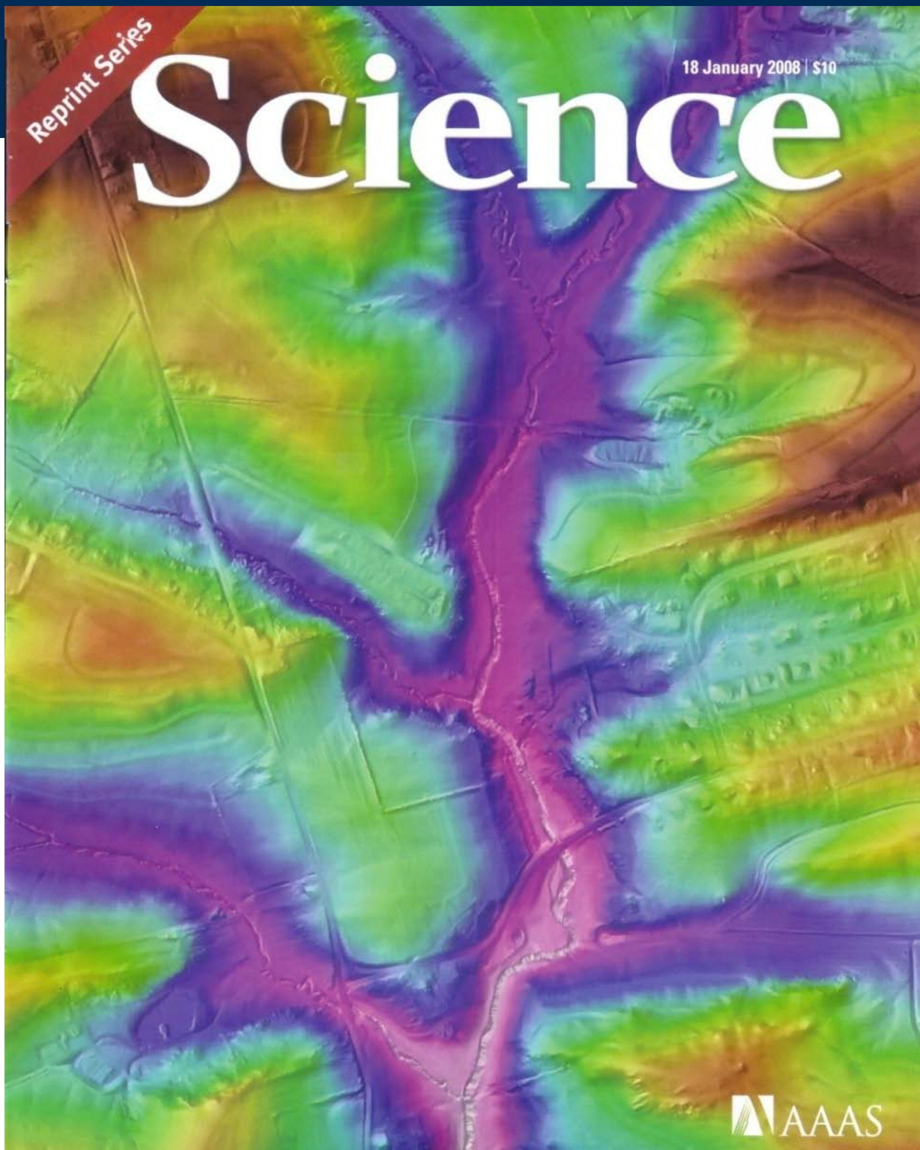
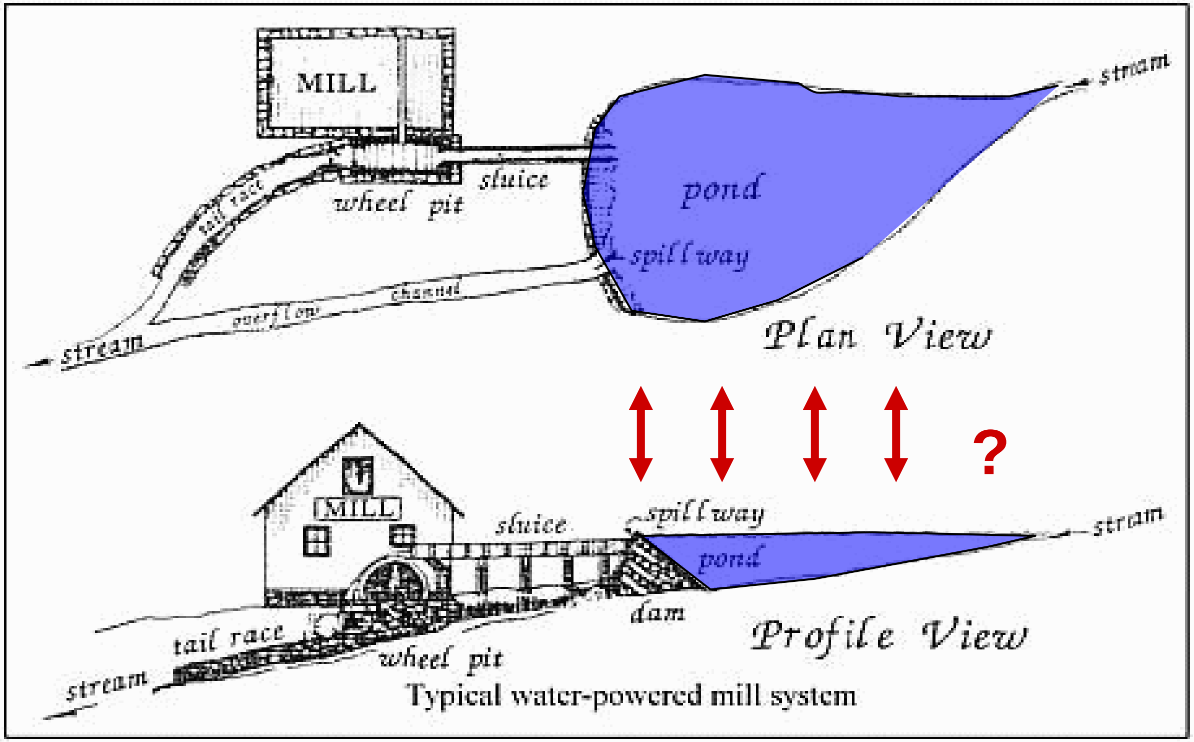


Figure from 1868 Hundreds Map

Historical Impacts

Stream/floodplains were altered dramatically during the European settlement era



Mill Dams

U.S. Census in Eastern US - ~60,000 mills in 1840

1840 US CENSUS OF WATER-POWERED MILLS FOR EASTERN USA

Mills Per County

0 - 5

6 - 20

21 - 50

51 - 90

91 - 150

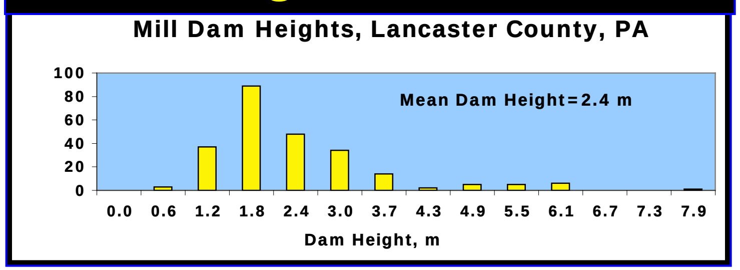
151 - 225

225 - 999

Total = >60,000

Delaware

Average dam ht 2.4 m

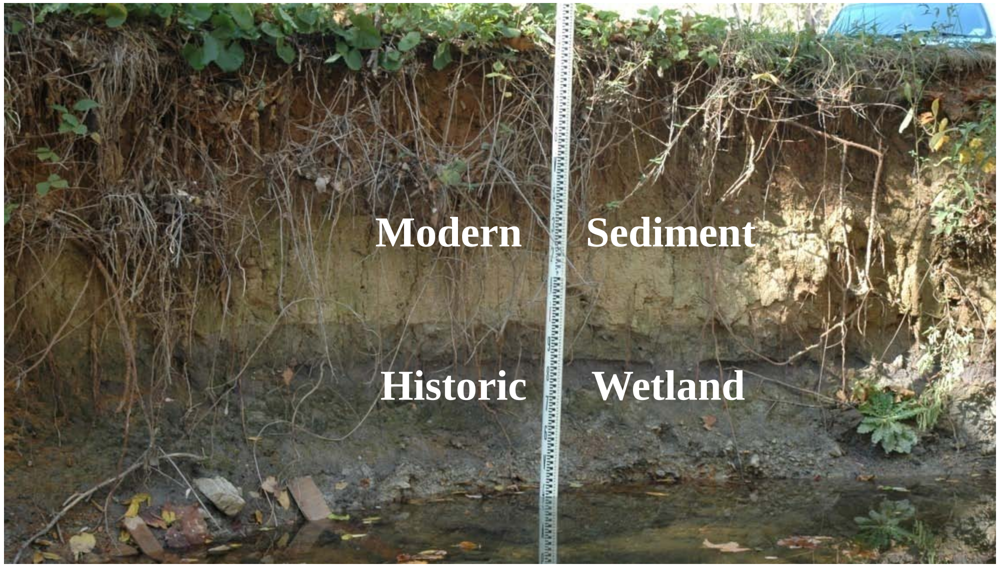


D. Merritts, R. Walter, A. Ross, and S. Siddiqui
Franklin & Marshall College

Figure credit: Franklin & Marshall College, Lancaster, PA.

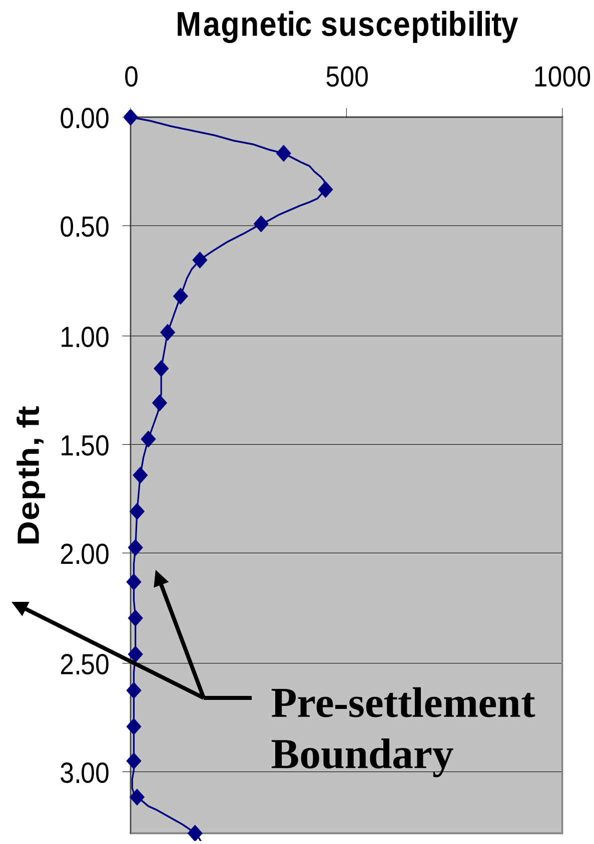
Floodplain Sediment Analysis

Floodplain Sediment Analysis



F&M College collaboration:

- Radiocarbon dating of sediments
- Magnetic susceptibility
- Buried historic (wetland) floodplain
- Buried seed bank & carbon source



Historical Impacts

Indian Creek – Western Coastal Plain valley wide impacts

Modern Impacts

Land development & urbanization

Grade Control Effects

Piedmont Region

Powder Mill Run - 56% Impervious Cover

Roland Run - 40% Impervious Cover

Grade Control Effects

Coastal Plain Region

Indian Creek - 24% Impervious Cover

Massey Branch - 2% Impervious Cover

Assessment of Pollution Load

Stream Erosion: Measured vs. Predicted

Creek (County or State)	Length of Stream Studied (feet)	Measured Erosion Rates (tons per year) for study area	Predicted "Problem" Area Erosion Rates* (tons per year) for study area
Codorus – East Branch	5,410	2,070	90 – 1,794
Codorus – South Branch Granary Rd.	2,200	2900	56 – 1,122
Codorus – South Branch Phase I	1,770	1,083	15 - 304
Codorus – South Branch Phase II	2,050	500	15 - 298
Codorus – South Branch Phase III	4,170	2,180	33 - 654
Conewago	800	8,000	20 - 400
Cowanshannock – Reach 1	80	31	1 - 20
Cowanshannock – Reach 2	50	52	1 - 20
Crabby	400	1,444	4 - 80
Long Draught Branch	1,607	427	19 - 380
Octoraro – West Branch	1,650	1,200	4 - 84
Stewart Run	60,429	4,415 – 5,459	187 – 3,744
Santo Domingo	193	80	2 - 32
Spencer Run	16,250	3,200 – 3,900	133 – 2,666
Stony Run	1,392	912	12 - 238
Trout Run	50	20.5	1 - 20

* *These values were calculated using lateral erosion rates of 1.0 x 10-2 to 2.0 x 10-1 meters/year as suggested by Evans et al, 2003.*

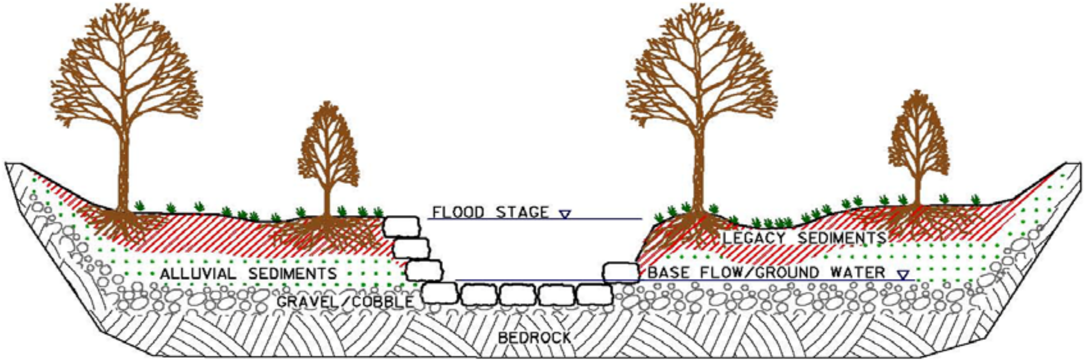
Typical Stream Bank Nutrients

Measured nutrient content in eroding stream banks

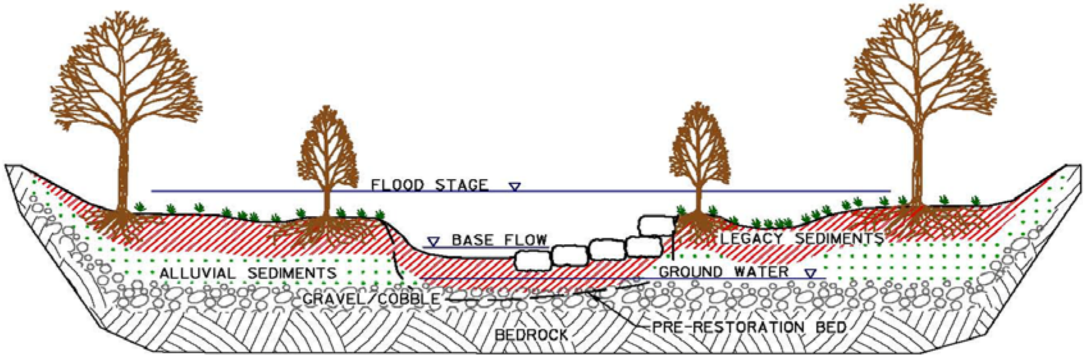
Nutrient Measurement Site No.	TP lb/ton (ppm)	Available P lb/ton (ppm)	TN lb/ton (ppm)	Nitrate-N lb/ton (ppm)	Ammonium-N lb/ton (ppm)
Long Draught Branch Gaithersburg, MD	0.62 to 0.79 (311 to 394)	0.012 to 0.028 (6 to 14)	1.20 to 2.21 (600 to 1100)	0.006 to 0.016 (3.2 to 8.1)	0.002 to 0.007 (1.23 to 3.47)
Santo Domingo Creek Lititz, PA	0.93 to 1.88 (463.9 to 936.9)	0.020 to 0.168 (10 to 84)	2.81 to 6.62 (1400 to 3300)	0.005 to 0.067 (2.7 to 33.5)	0.006 to 0.57 (2.8 to 28.2)
Big Spring Run Willow Street, PA	0.87 (434.4)	0.028 to 0.044 (14 to 22)	1.40 to 2.00 (700 to 1000)	0.007 to 0.012 (3.5 to 6.1)	0.006 to 0.048 (2.9 to 23.8)
Stony Run Baltimore, MD	0.30 to 0.54 (150 to 270)	Not Measured	0.13 to 0.18 (65 to 92)	Not Measured	Not Measured
Lititz Run Lititz, PA	0.99 to 2.45 (491.9 to 1222.2)	Not Measured	3.01 to 6.82 (1500 to 3400)	0.007 to 0.046 (3.7 to 23.1)	0.023 to 0.053 (11.7 to 26.2)
Conoy Creek Elizabethtown, PA	0.39 to 0.96 (196.3 to 479.1)	0.050 to 0.068 (25 to 34)	0.80 to 3.21 (400 to 1600)	0.002 to 0.005 (0.9 to 2.3)	0.002 to 0.013 (1.08 to 6.54)

Stormwater Benefits to Restoration

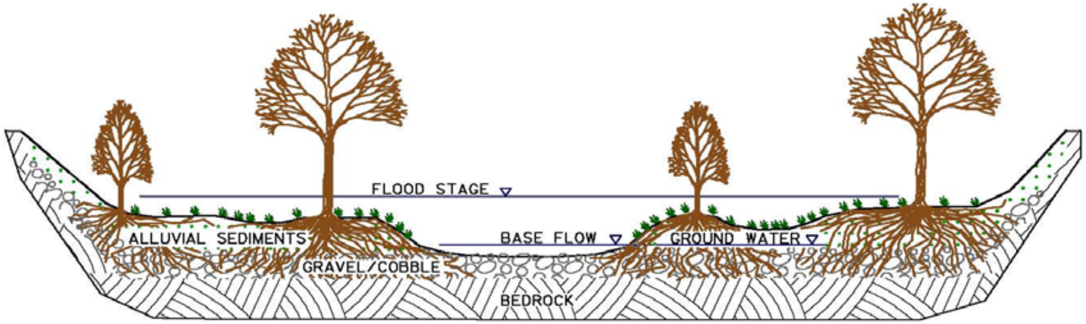
Potential Restoration Solutions



Channel armoring to store modern sediment



Re-build/patch dams to store modern sediment



Remove modern sediment to re-create riparian wetland floodplain

Quantifiable Stormwater Benefits

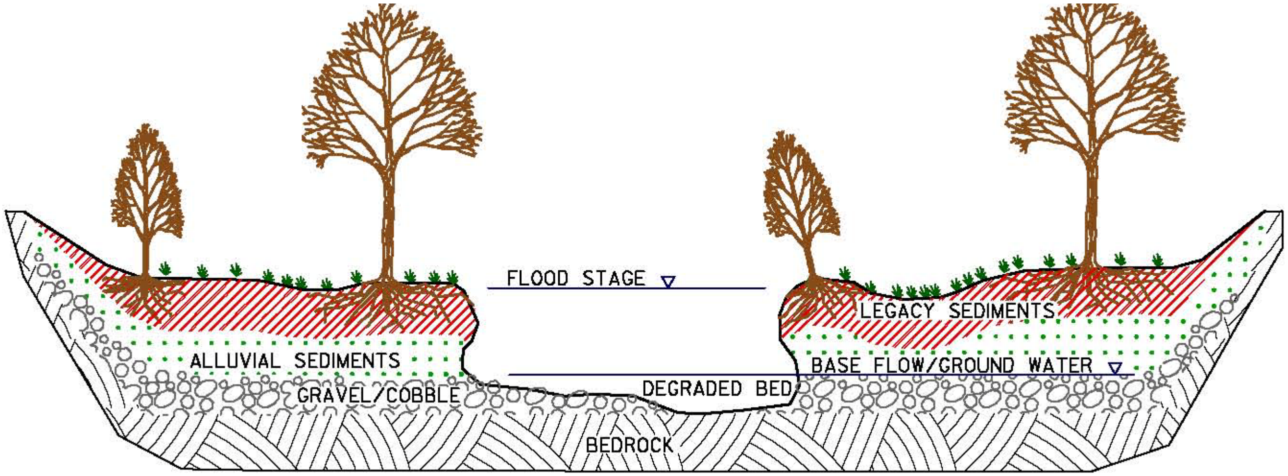
Benefits from Floodplain Restoration

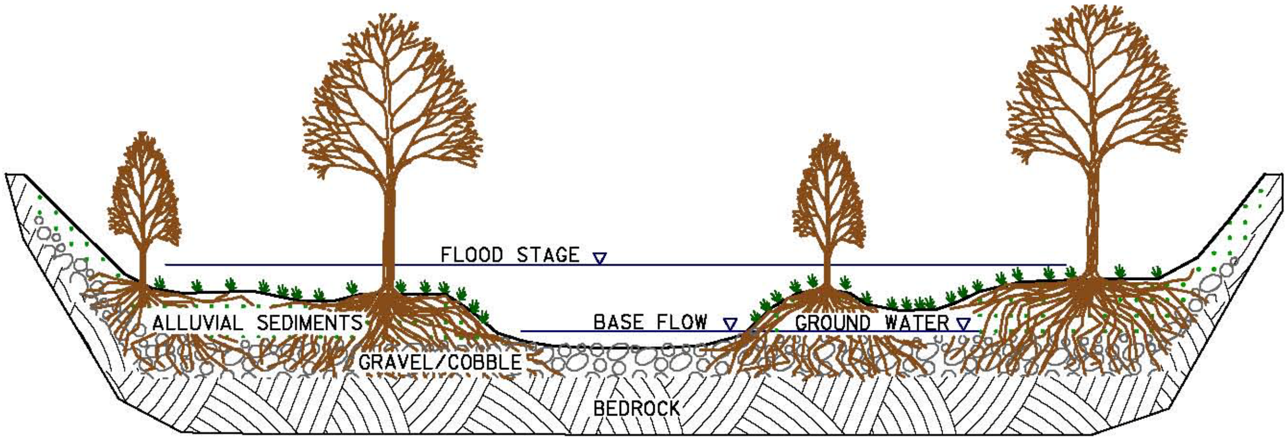
- Peak Discharge Reduction
- Runoff Volume Reduction
- Water Quality Improvement

Peak Discharge Reduction

- Modern sediment removal yields increased flood storage
- Peak discharge reduction
  - ✓ Project specific variation
  - ✓ Extent of flood storage increase
  - ✓ Existing/proposed controls (culverts, bridges, pinch points)
  - ✓ Valley slope
- Quantification of flood flow attenuation
  - ✓ Discharge vs. area rating curves developed from HEC-RAS
  - ✓ Reach routing analysis using TR-20

Peak Discharge Reduction





Runoff Volume Reduction

- Remove low permeability modern sediment infill
- Expose organic-rich historic soil, if possible
- Increased wetted surface area for frequent flood flows
- Create densely vegetated floodplain
- Yields increased soil permeability
- Yields increased evapotranspiration
- Quantification methods
  - ✓ Measure improved infiltration rate
  - ✓ Area x Improved infiltration Rate x Storm Duration (similar to Filter Strip BMP)

Water Quality Improvement

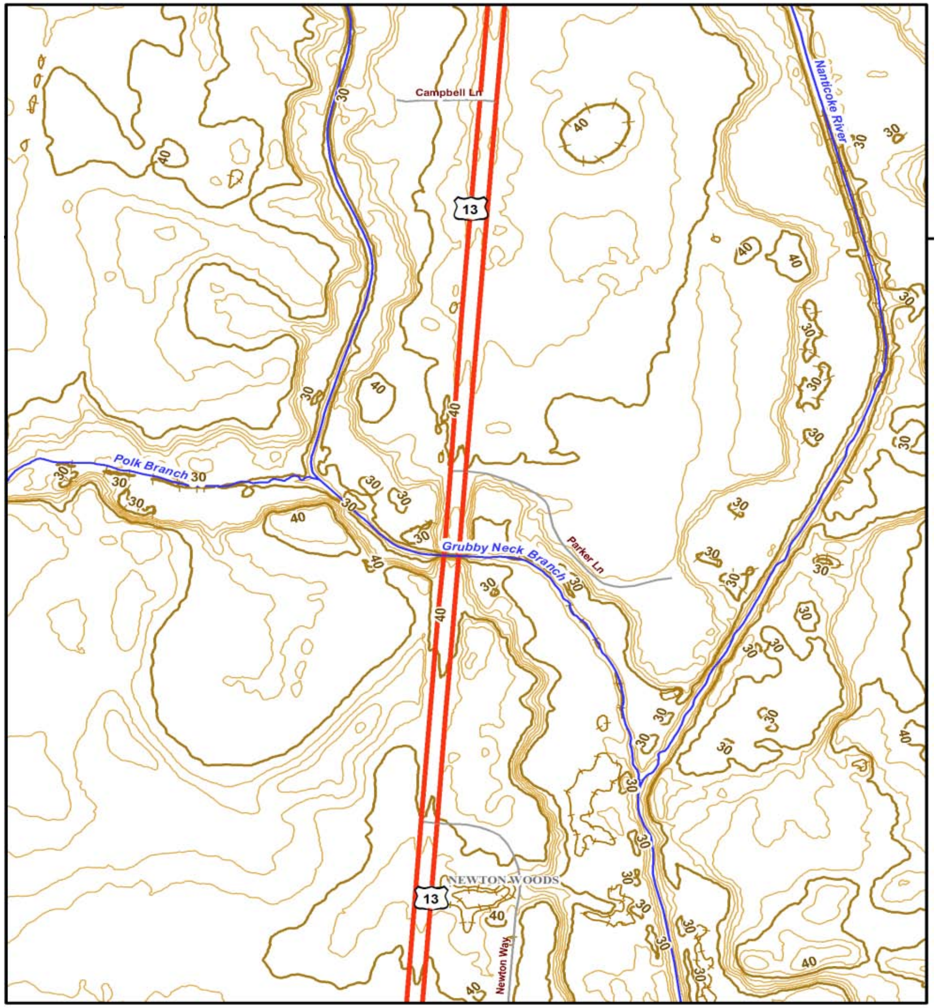
- Plant filtration of TSS and nutrient uptake
- Adjacent land runoff filters though riparian wetland floodplain
- Stormwater outfalls flow to floodplain, not directly to stream
- Increased frequency of stream flow access to floodplain yields greater filtration of all watershed flood flows
- Eliminates unstable channels - source of sediment & nutrients

Other Restoration Benefits

- Riparian wetland creation or enhancement
- Reconnection to buried wetland seed and carbon source
- Improve aquatic habitat functions and diversity
- Remove/reduce invasive species

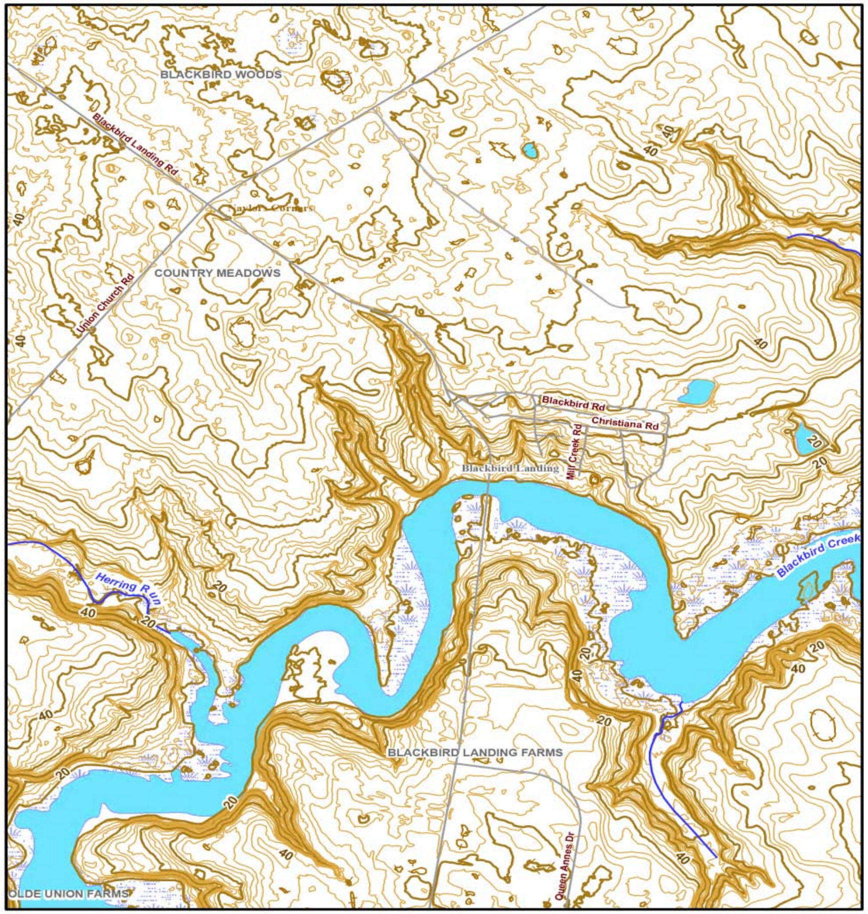
Case Studies

Bee Branch Stream Bank Restoration



Bee Branch Stream Bank Restoration

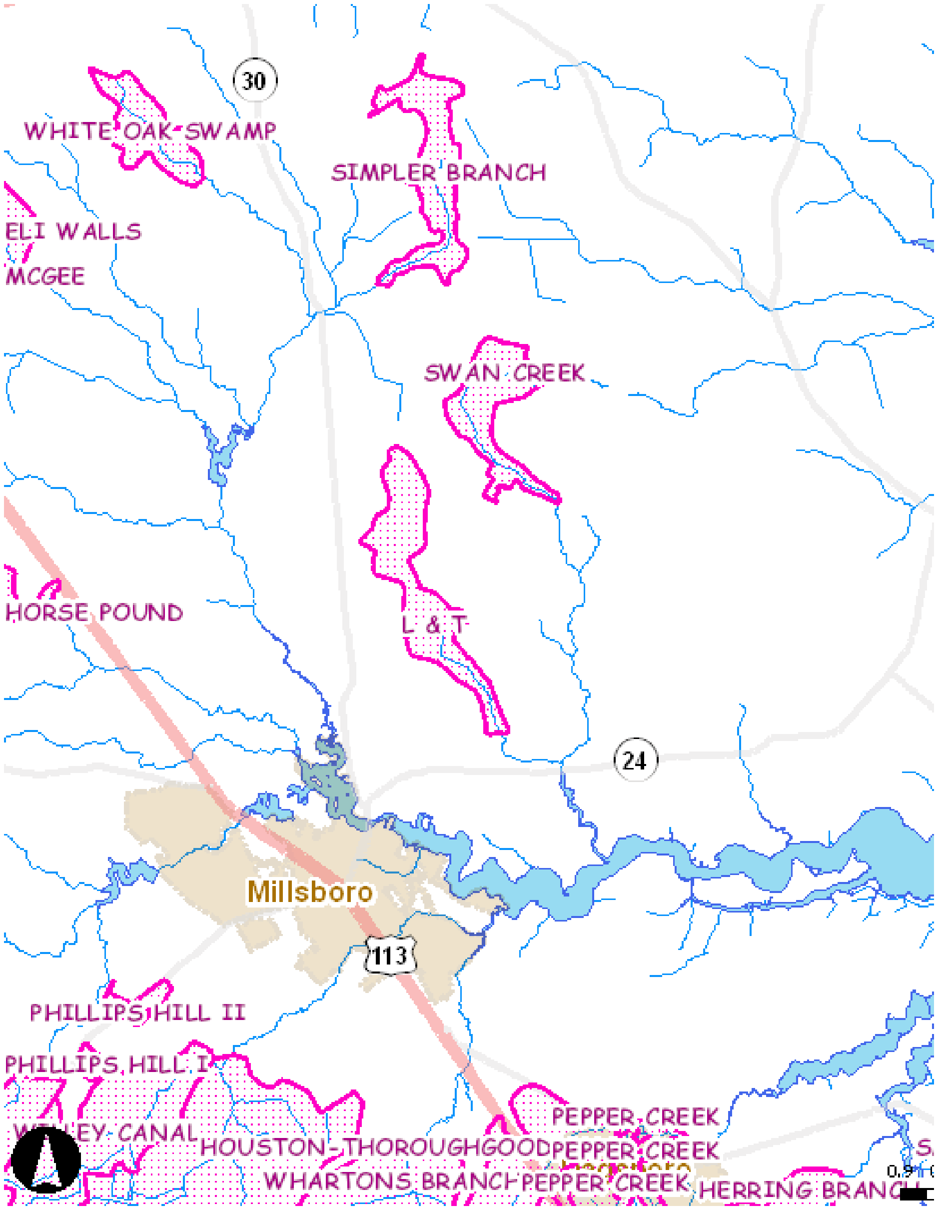
Blackbird Creek Stream Restoration

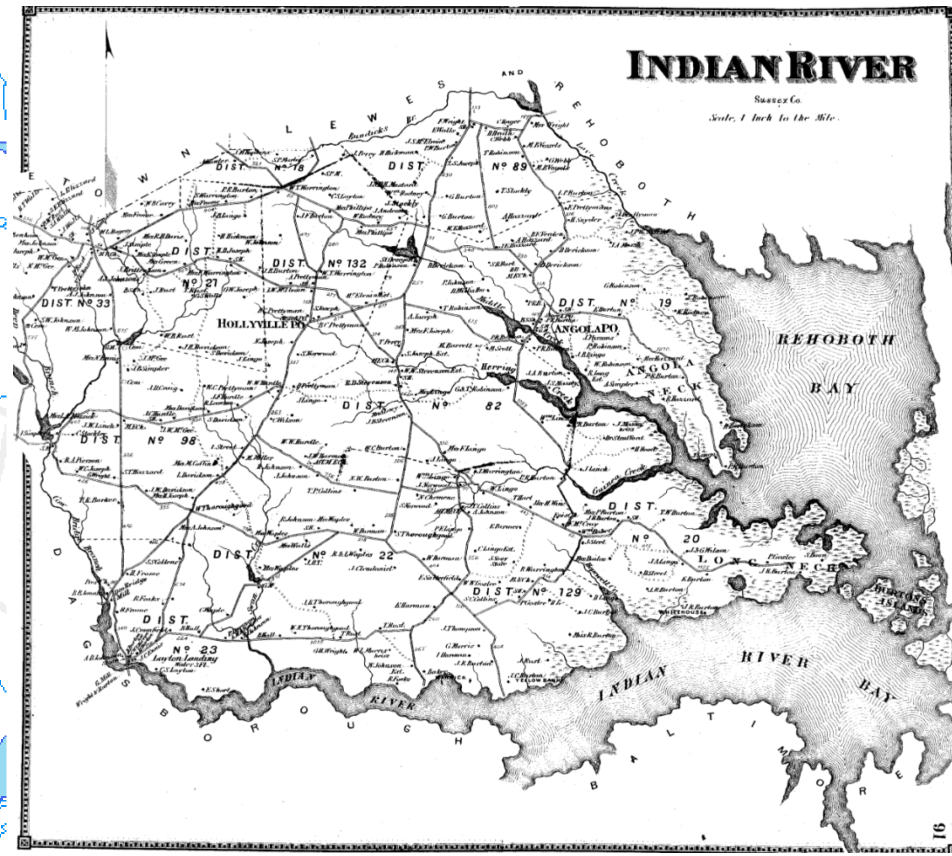


Blackbird Creek Stream Restoration

Methods to Target Restoration Sites

Tax Ditch & Hundreds Mapping





Watershed Assessments

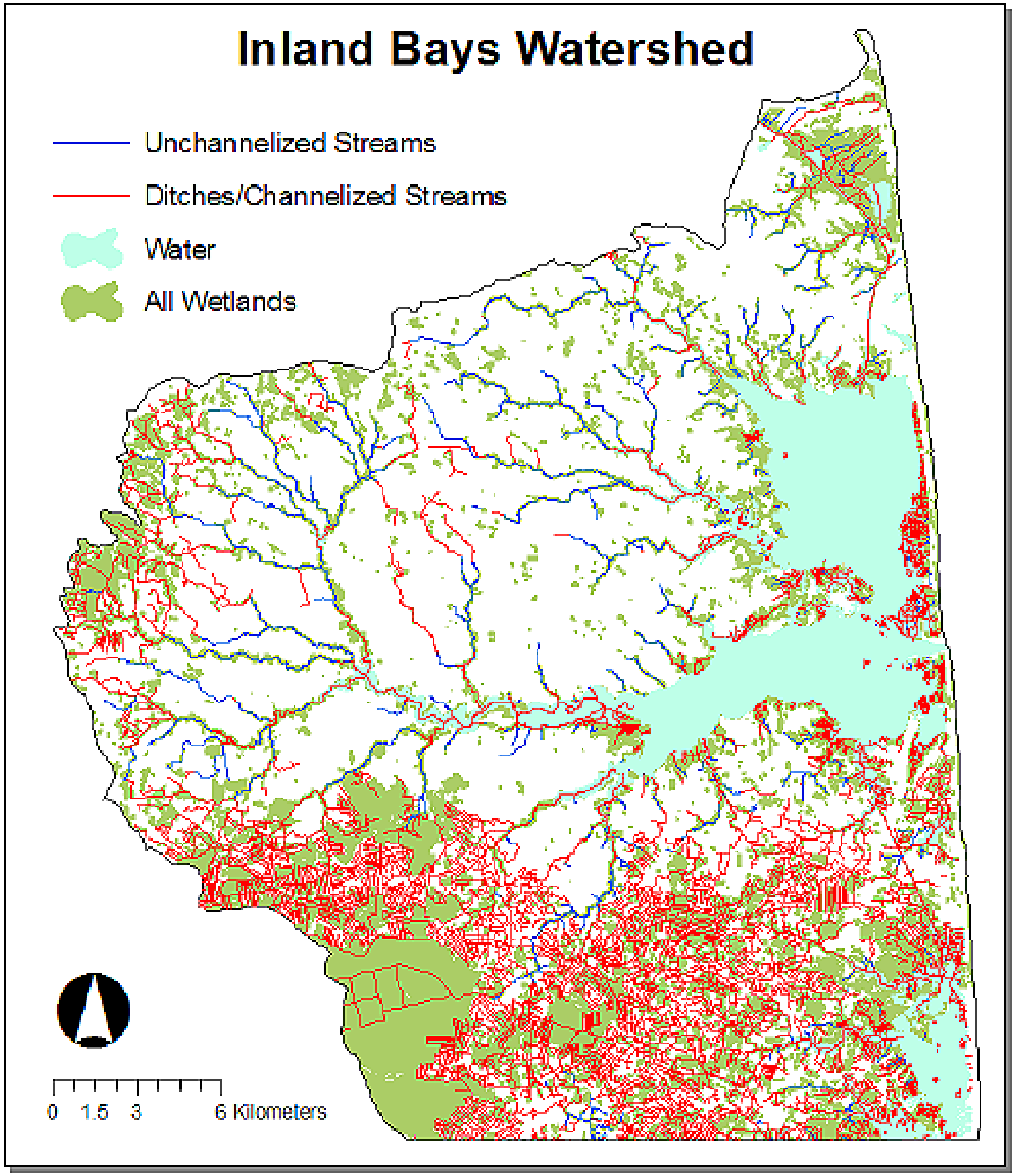


Figure credit: Wetland Condition of the Inland Bays Watershed Report – Volume 1.

Example Projects

Lititz Run Restoration

Stream relocation and riparian wetland creation

Constructed 2004

May 2008

Lititz Run

Pre-restoration Conditions

Saucon Creek Restoration

Stream relocation and riparian wetland creation

Constructed 2008

October 2009

Saucon Creek

Pre-restoration Conditions

Upper Stony Run Restoration

Urban stream relocation/stabilization and floodplain attachment

Constructed 2006

Upper Stony Run

Pre-restoration Conditions




Questions?