Restoring Ecological Function to Headwater Streams

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Ohio Stormwater Conference
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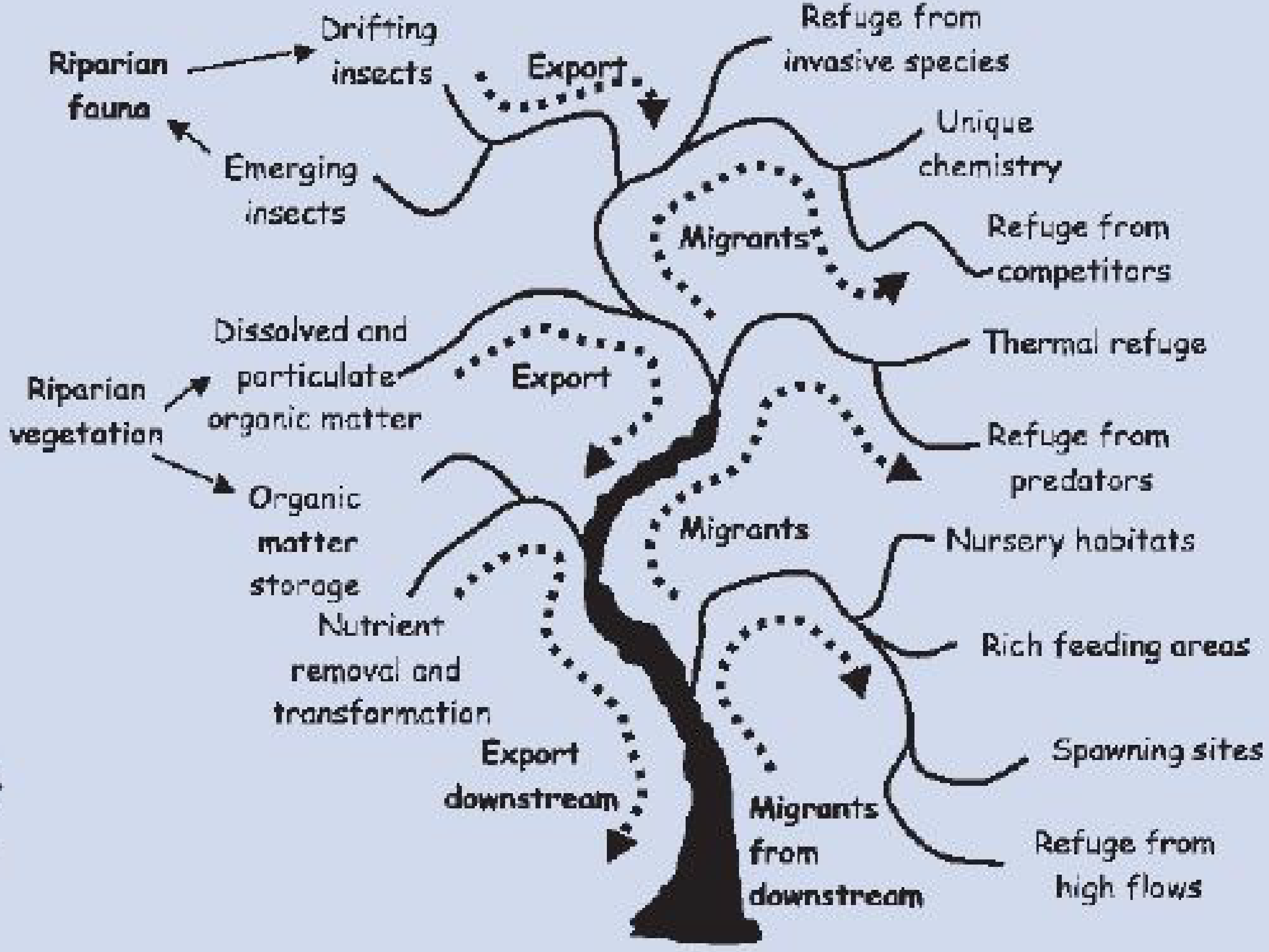
What is a headwater stream?

- A stream with a drainage area less than 20 square miles (Ohio EPA)
- A perennial stream that has 0.5 L/s or about a 5.5 hectacre (12 acres) watershed – Eastern Pennsylvania (Kaplan et. Al., 2008)
- Smallest channel where flow begins (EPA, 2015)
- First, Second or Third Order stream (Beilfuss, et al, 2007)

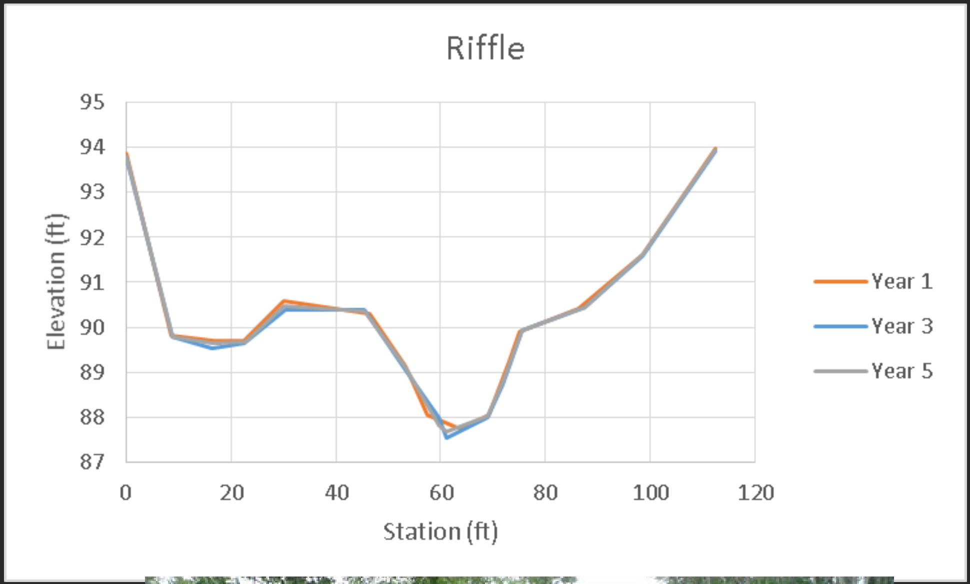
This figure illustrates the many benefits headwater streams provide to organisms living in downstream ecosystems and the connections between headwater streams and other ecosystems. Illustration courtesy of: Judy Meyer, University of Georgia.

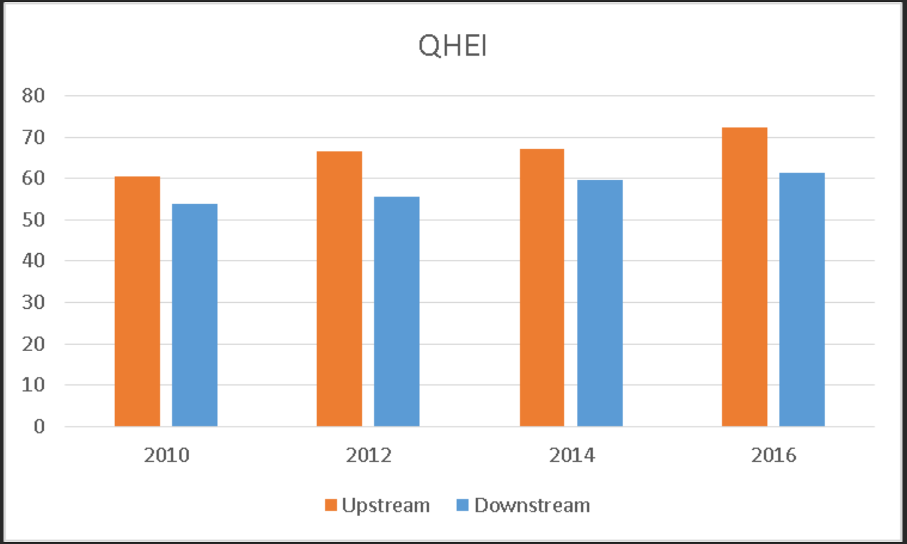


Bear Creek Stream Monitoring

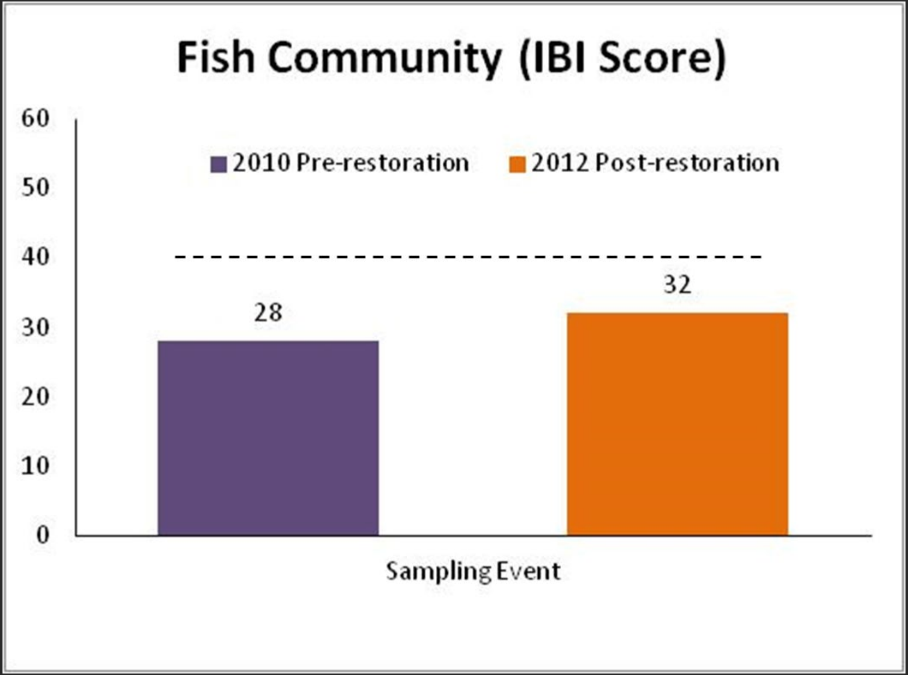
- 2012 Construction
- 2012 Planting

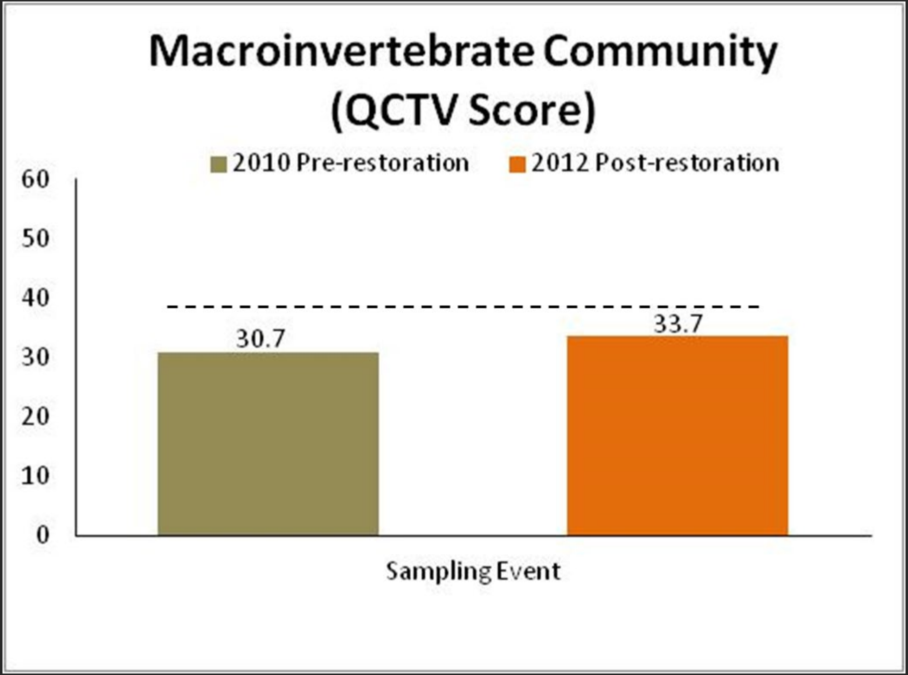
Bear Creek Stream Monitoring





Bear Creek Stream Monitoring





Bear Creek Stream Monitoring

Goal	Attained?	Note/Action
Dissipate Stream Energy	Yes	Series of riffles and pools, plus a wider and shallower cross section.
Reduce Sedimentation and Erosion	Yes	Bed and bank erosion stopped (eco-friendly hard armoring)
Stabilize/Protect Infrastructure	Yes	Roads, parking, lot and outfalls protected
Improve Habitat	Yes	Limited in riparian category.
Floodplain Connection	Yes	Limited potential
Water Quality	No	Fair/Poor fish and macroinvertebrate community scores
Stable Dimension and Pattern	Yes	Locked dimension and pattern
Vegetation (85% coverage by native plants)	No	Currently 30% invasive herbaceous cover (to be removed in 2014)

14% woody & herbs 2016

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Stream Function Pyramid

5 **BIOLOGY** » *Biodiversity and the life histories of aquatic and riparian life*

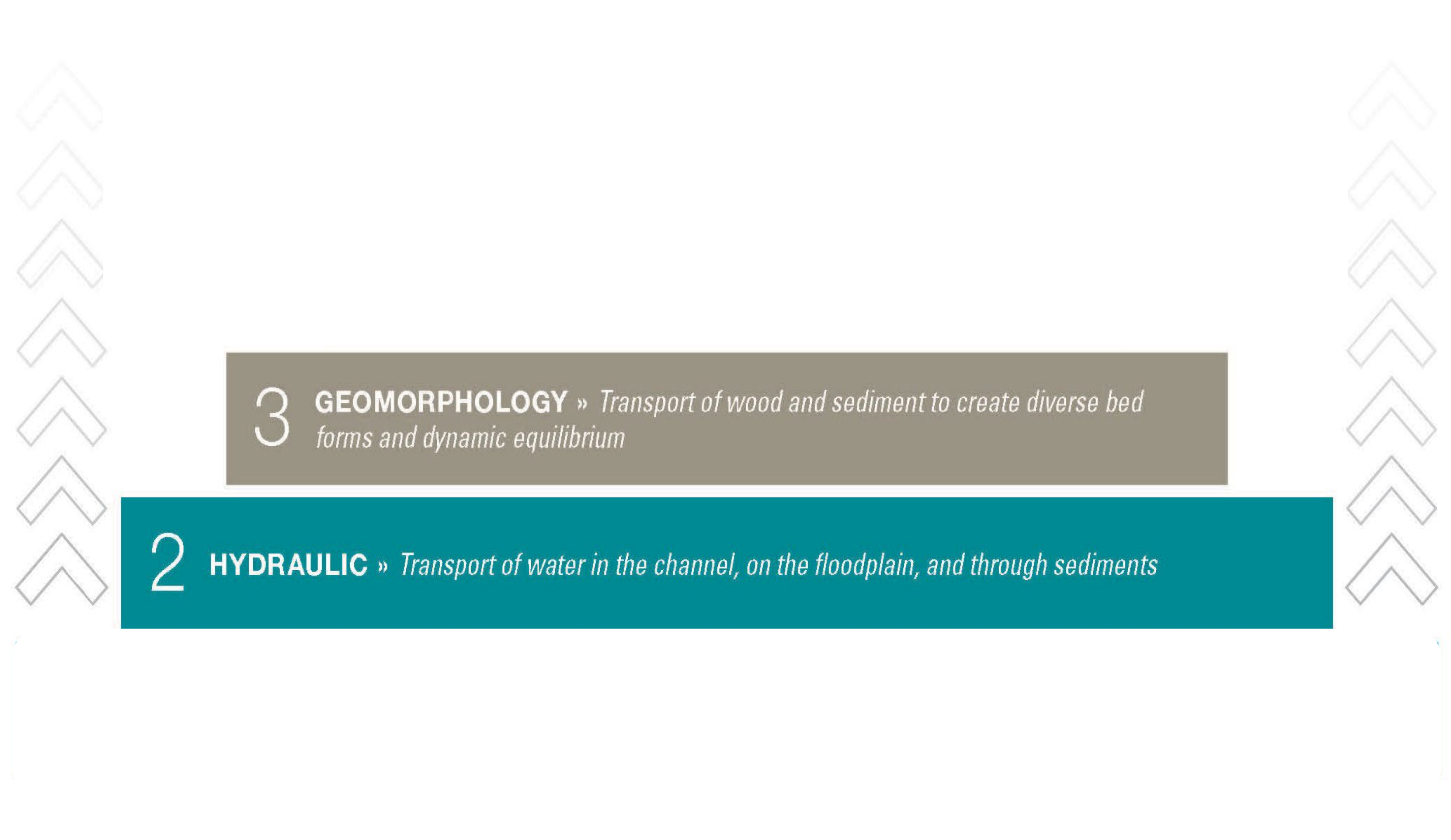
4 **PHYSIOCHEMICAL** » *Temperature and oxygen regulation; processing of organic matter and nutrients*

3 **GEOMORPHOLOGY** » *Transport of wood and sediment to create diverse bed forms and dynamic equilibrium*

2 **HYDRAULIC** » *Transport of water in the channel, on the floodplain, and through sediments*

1 **HYDROLOGY** » *Transport of water from the watershed to the channel*

Stream Function Pyramid



Bank Assessment for Non-point source Consequences of Sediment (BANCS)

- Model to predict streambank erosion rates

- Methods based on Rosgen (2006)

  Rosgen, D.L. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology, Pagoas Springs, CO.

- Two Measurements
  - Bank Erosion Hazard Index (BEHI)
  - Near Bank Stress (NBS)

- Erosion rates estimated using bank erodibility curves
  - None for NE OHIO – most similar is NC curves

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

Pollutant Loading

1.2 lb Phosphorus/ton sediment/year

2.6 lb Nitrogen/ton sediment/year

Apply 50% Reduction Rate

http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2013/05/stream-restoration-merged.pdf

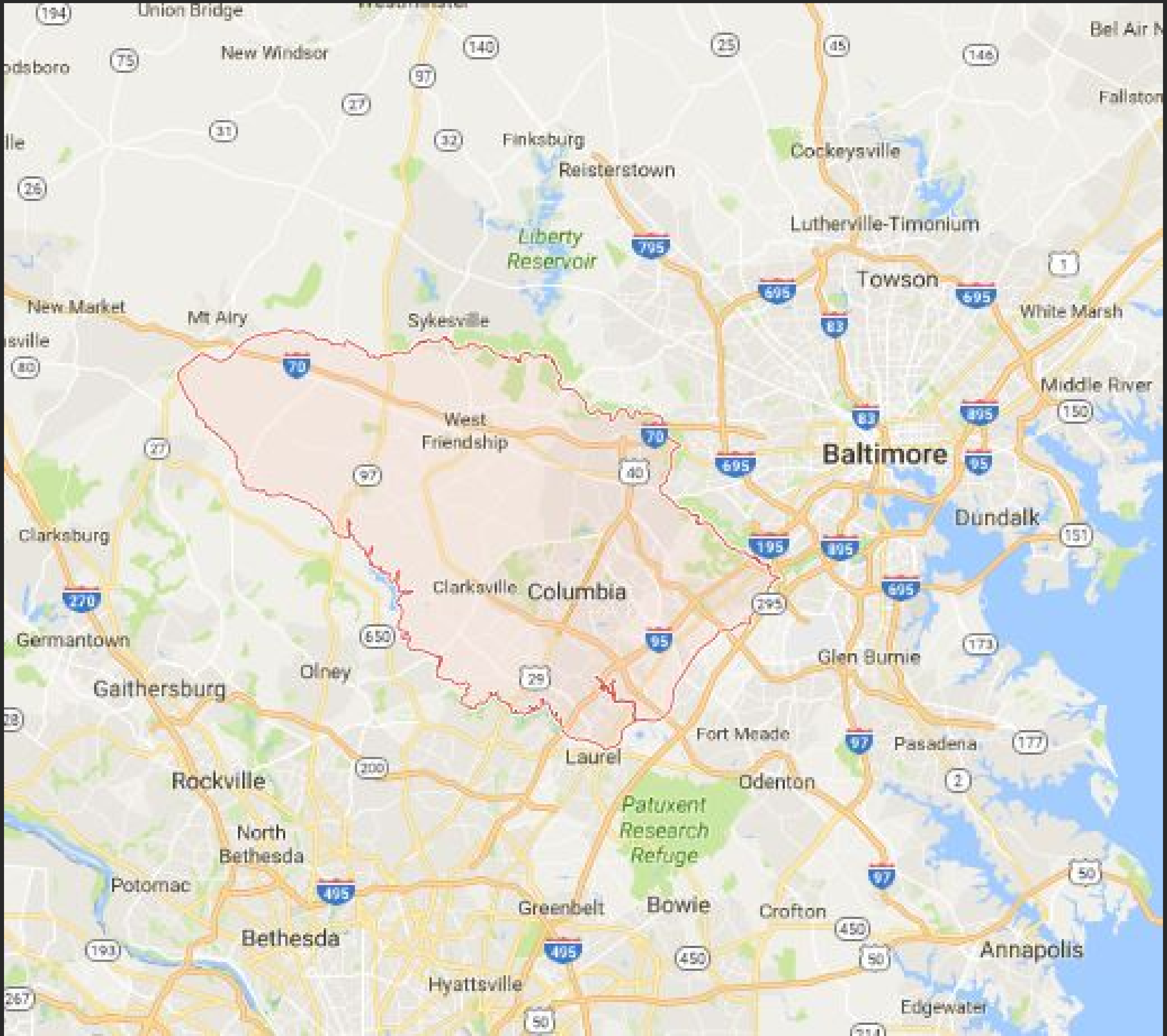
NE Ohio Sediment Loads

Site	P loading (lbs P/ton sediment/yr)	N loading (lbs P/ton sediment/yr)	TSS loading (lbs/yr)	Stream Length (LF)
A	2.0	4.4	3,390.3	912
B	44.0	95.4	73,352.8	1491
C	17.5	37.9	29,117.4	1507
D	1.0	2.1	1,619.1	48
E	36.8	79.6	61,259	917
Total	101.3	219.4	168,798.6	4875
Total per LF	**0.02**	**0.045**	**34.6**	

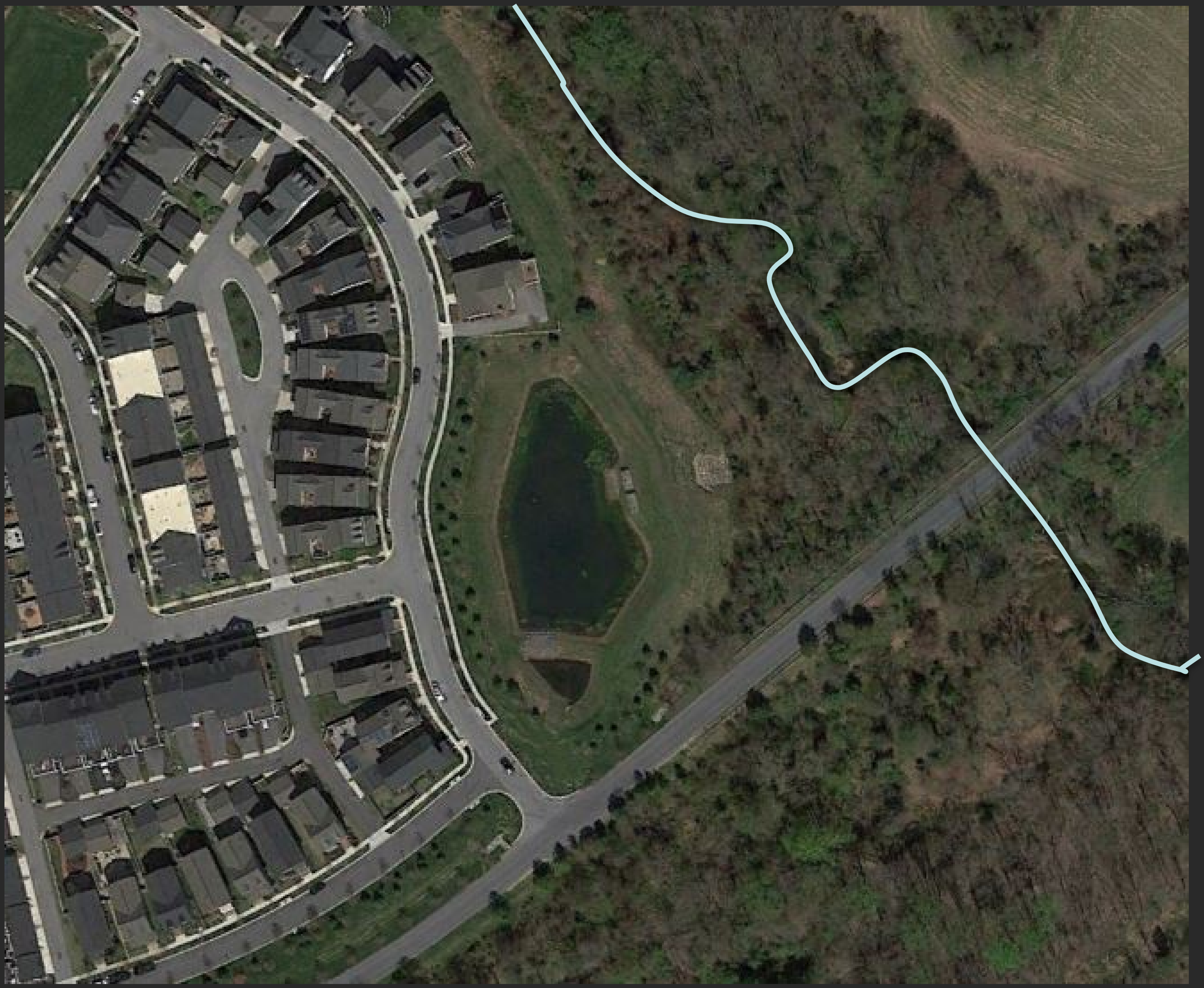
That's a football field covered with 4.5 feet deep of sediment from one mile of stream length every year!

NE Ohio Sediment Loads

Howard County



Howard County



Howard County

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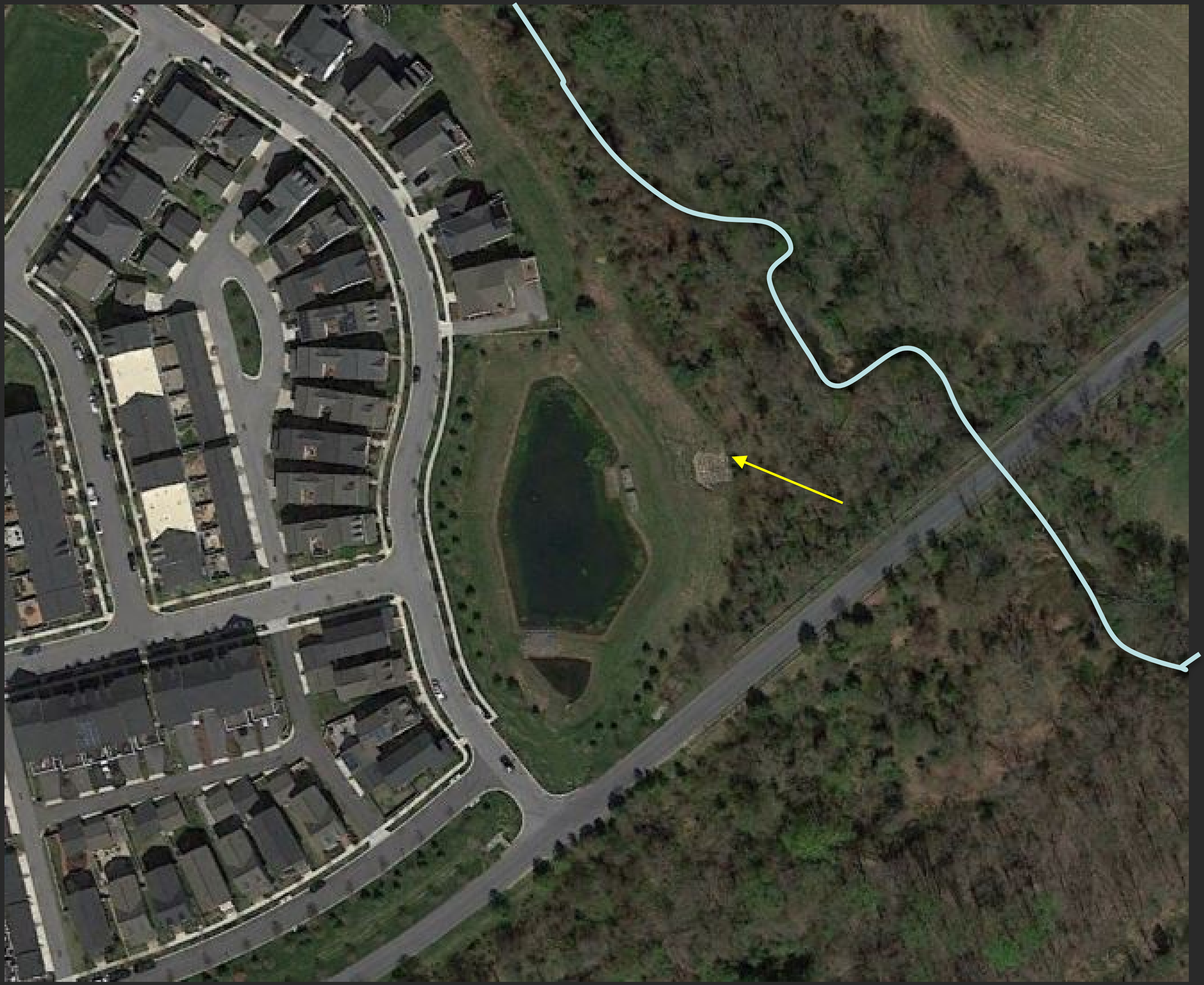

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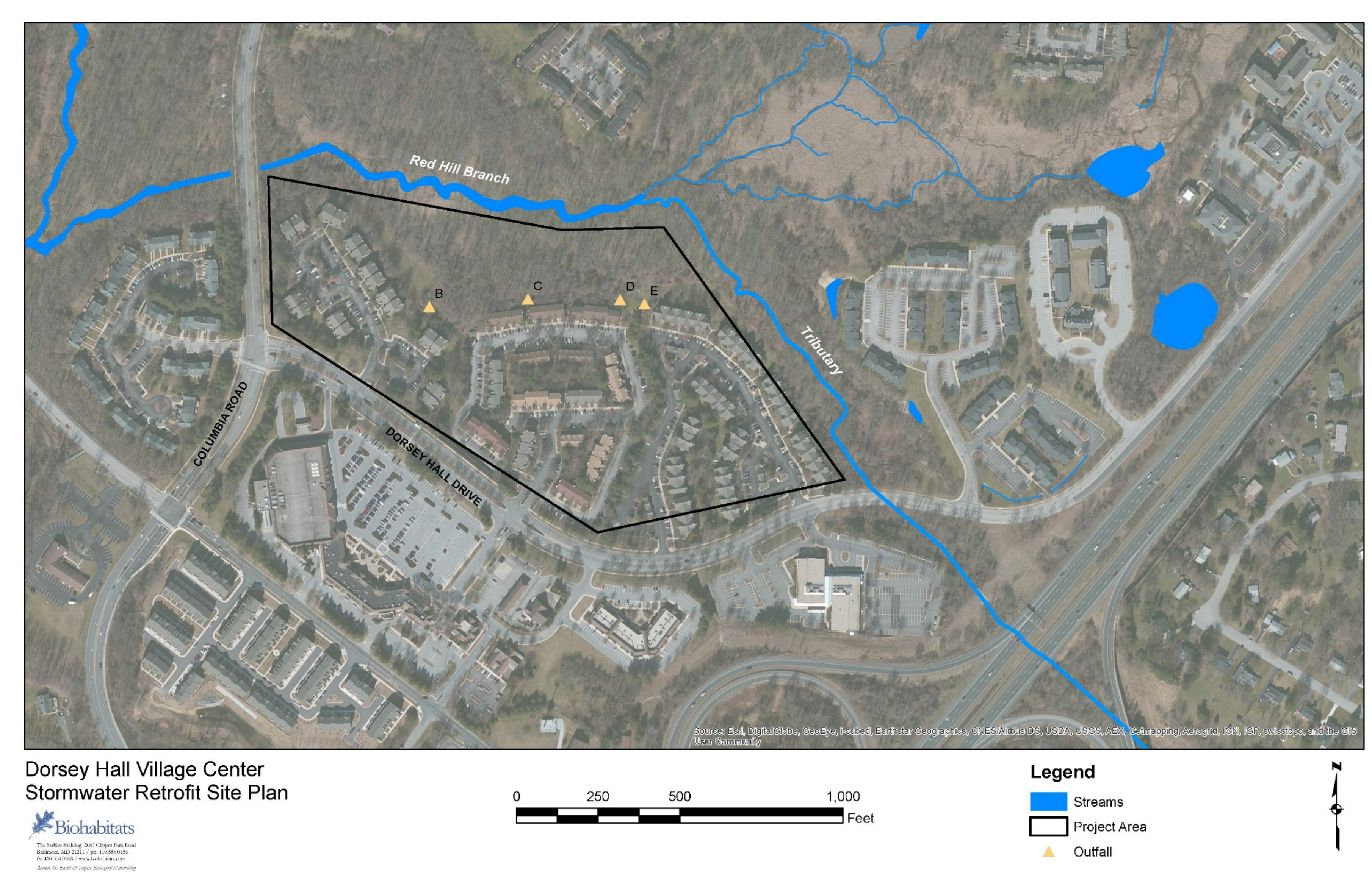
Outfalls- stable up to the 10 yr storm event

And the water flows to the stream. . . .

But there is a problem. . .

One solution.

Dorsey Village



Dorsey Village

Dorsey Village

Outfall ID	Retrofit Type	IA Treated (AC)	% DA Treated	Estimate of Probable Cost	Cost Per AC Treated
B	SW Wetland	7.3	100	$335,300	$45,932
C	SW Wetland	2	100	$183,300	$91,650
D	SW Wetland	2.8	100	$222,000	$79,286
E-J	Stream Restoration	14.2	59	$691,800	$48,718

* Costs include engineering and construction

Dorsey Village

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Outfalls B,C, and D (stormwater wetlands)

Load Reductions	Pre-BMP Loads	Planned Load	Cost per Unit reduced per year (assume lifespan of 30 yrs)	Cost per Unit reduced per year/ per acre treated (assume lifespan of 30 yrs)
Nitrogen (lbs/yr)	5.17	1.03	$ 6,768	$ 559
Phosphorus (lbs/yr)	0.54	0.24	$93,400	$7,655
Sediment (lbs/yr)	760	460	$93.40	$7.72

Dorsey Village

Outfalls E-J (Stream Restoration)

Load Reductions	Pre-BMP Loads	Planned Load	Cost per Unit reduced per year (assume lifespan of 30 yrs)	Cost per Unit reduced per year/ per acre treated (assume lifespan of 30 yrs)
Nitrogen (lbs/yr)	101.6	50.94	$ 455	$32.04
Phosphorus (lbs/yr)	199.35	100.03	$ 232	$16.34
Sediment (lbs/yr)	184,100	92,500	$0.25	$0.01

Dorsey Village

Load Reductions	Stormwater Wetland **Cost per Unit reduced per year/ per acre treated** (assume lifespan of 30 yrs)	Stream Restoration **Cost per Unit reduced per year/ per acre treated** (assume lifespan of 30 yrs)
Nitrogen (lbs/yr)	$ 559	$32.04
Phosphorus (lbs/yr)	$7,655	$16.34
Sediment (lbs/yr)	$7.72	$0.01

If we want to improve our ecological function in headwater streams -

We live on a blue planet that circles around a ball of fire next to a moon that moves the sea, and you don't believe in miracles?

Questions?