Optimizing Resources for Restoring Streams Impaired by Acid Mine Drainage

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Program Scope:

Stream segments impaired by historic acid mine drainage

Program Objective:

To restore fisheries in the maximum number of stream miles

Treatment Options

- At source lime dosing with sludge collection and disposal
- In stream dosing:
  - Limestone sand dump stations
  - Pebble lime dosers
- At source passive treatment

WVDEP On Site Doser: Construction

Charging the Lime Bin

Sludge Cleanout

In Stream Dosing: Middle Fork Limestone Sand Station

In Stream Dosers: Maryland

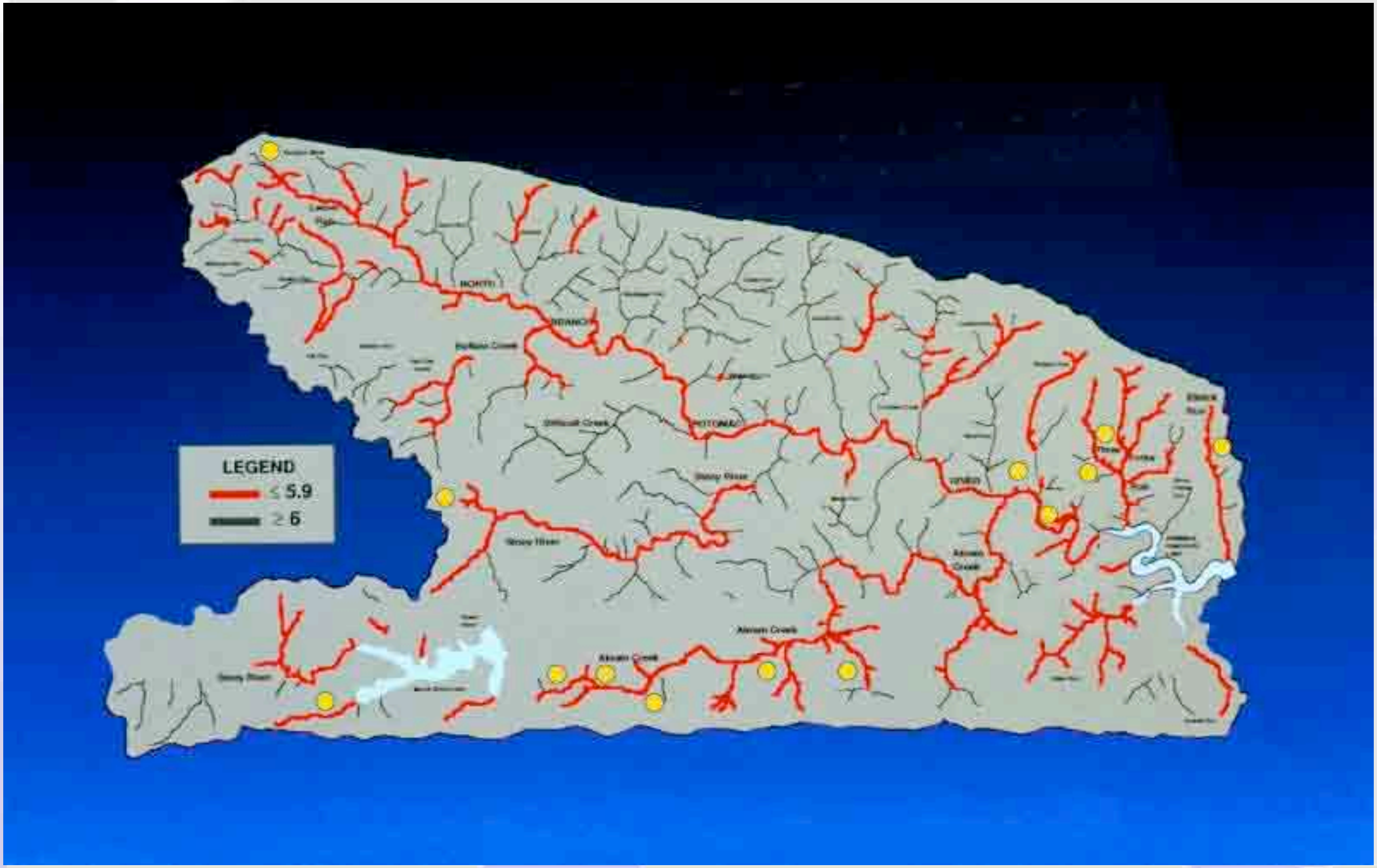
Boxholm

Pumpkonsult

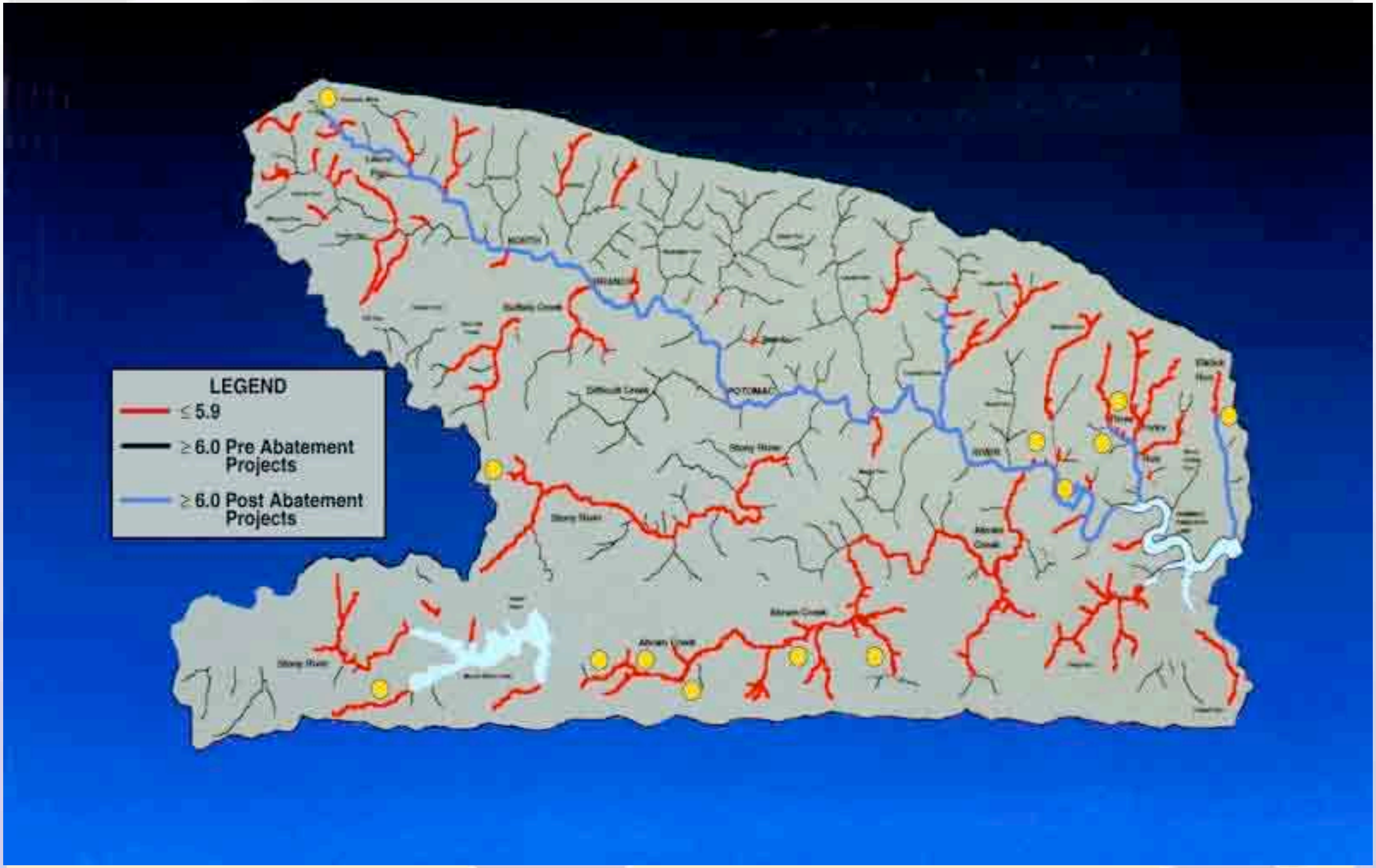
Aquafix

In Stream Lime Dosing: Davis WV

North Branch: pH Before Doser Project



North Branch: pH <u>After</u> Doser Installation



On Site Passive Treatment:
Open Limestone Channel

Ohio DNR: Slag Leach Bed

Ohio DNR: LCD-Lime-Cored Dam

Watershed-based versus At-source-based AMD Treatment: Costs and Benefits

Methods

A comparison of AMD treatment costs was made related to the following scenarios:

- Single AMD sources
- Multiple AMD sources
- Manganese sources.

Parameters

AMD Cost = *S+C+A+O+D*

•Site access	S
•Construction	C
•Alkalinity addition	A
•Oxidation	O
•Sludge disposal	D

Environmental efficiency = *AMD Cost/ Recovered stream miles*

Treatment efficiency= *AMD Cost/Tons of acid load removed*

Cost Centers

Capital Costs:

- doser installation, pond construction,
  - roads (3,000 ft ea.) land access, ditching, engineering

Annual Costs:

- water sampling, labor, operations and maintenance, chemical, sludge removal

In Stream Dosing:

- Delete pond construction and sludge removal

Multiple AMD Sources

S-91-85	ROCKVILLE MINING			
WVDEP sample #		acid load (tpy)	Capital cost	Annual cost
2	Discharge pond #3	5	$ 65,698	$ 18,026
3	Discharge pond #5	5	$ 65,698	$ 19,790
4	Discharge pond #4	33	$ 125,698	$ 30,206
5	Discharge pond #5 into sediment ditch	12	$ 125,698	$ 32,468
55	seep to diversion ditch to Pond #5	3	$ 65,698	$ 20,018
	totals: At source treatment	58	$ 448,490	$ 120,508
	In Stream Doser in Martin Ck to Glade	330	$ 94,325	$ 91,601

At-source vs. In-stream costs

Treatment Scenario	acid load (tpy)	20-yr Trt. ($)	Stream Rec. (mi.)	Stream Recovery Cost ($/mi/yr)	Acid Load Removal Efficiency ($/ton)
A. single AMD, in stream	253	885,171	2.0	22,129	175
A. single AMD, at source	12	532,569	0.3	106,514	2,211
B. multiple AMD, in stream	330	1,926,345	2.5	38,527	291
B. multiple AMD, at source	58	2,858,650	0.5	285,865	2,468

Conclusions: In-stream AMD Treatment vs. At-source treatment

- Always treated more acid load
- Recovers more stream miles
- More expensive than at-source, single AMD
- Less expensive than multiple at-source treatment

Conclusions: Stream miles recovered

- In-stream treatment resulted in much higher stream recoveries (1.5 to 2.5 miles)
- At-source treatment stream recoveries were always less (0.1 to 0.8 miles)
- The Mn treatment project resulted in negligible stream recovery

Conclusions: Acid removal efficiency ($/ton of acid load removed)

- All three of the most efficient sites were in stream dosing units.
- In-stream: $175 to $1,478
- At source: $2,200 to $272,000
- **Or between 12 and 180 times more efficient**
- In-stream efficiencies similar to on site passive

In-stream doser efficiencies similar to on site passive

- In Stream Dosing
  - Positives:
    - High stream recovery
      - Alkalinity export
    - Minor pre-design monitoring
      - Adjustable feed rate
      - Reliable performance
    - Few treatment units
    - Low cost
      - Low capital cost
      - High/predictable O&M cost
    - Works under most site conditions
- At Source Passive
  - Positives:
    - No in stream impacts
    - Minimal maintenance
    - Low cost
      - High capital cost
      - Low/variable O&M

In-stream doser efficiencies similar to on site passive

- In Stream Dosing
  - Negatives:
    - Stream impacts-sludge
      - Extent of mixing and precipitation zone
    - Regular maintenance

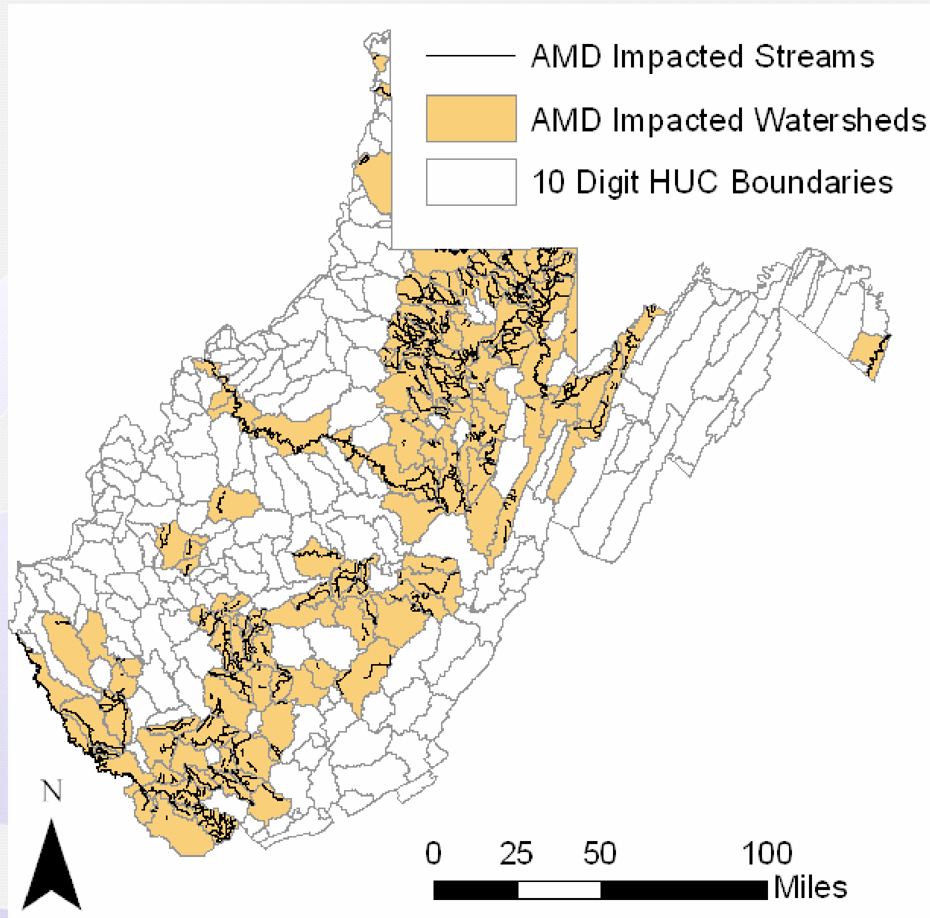
- At Source Passive
  - Negatives:
    - Low stream recovery
      - Little if any alkalinity export
    - Numerous treatment sites
      - Access agreements
      - Roads/maintenance
    - Site-limited treatment options
      - Water quality
      - Space
      - Flows

With In-Stream Treatment We Need to Know:

- How many miles of stream are actually restored to biological health with in stream treatment?
- How quickly metal floc comes out of the water column
- Effects of metal loading, stream hydraulics: oxidation and floc settlement

Reauthorized AML Set Aside Program

- Restore sustainable fisheries in the majority of WV stream miles lost to historic, pre -law coal mining.
- ~2,775 AMD impaired stream miles
- 114 10 digit HUCs (~500 streams)



Planning and Analysis

- Apply a landscape scale, interdisciplinary watershed approach integrating proven state of the art technologies to produce the most cost effective and ecologically beneficial outcome(s).
- Technically sound, transparent and defensible process
- Provide for adaptive management and partnerships

Planning and Analysis (con't)

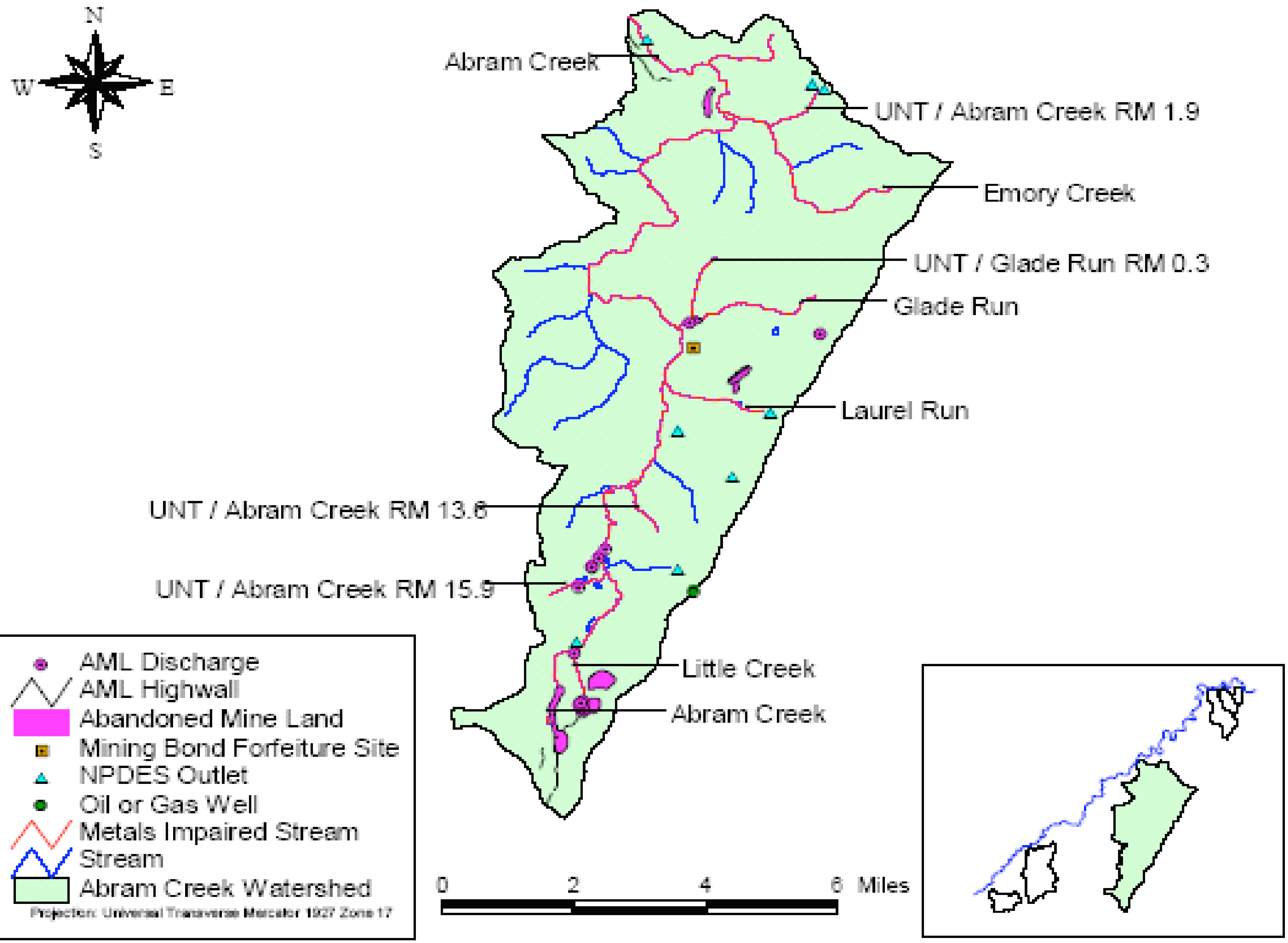
- Stream Restoration Steering Committee - Key stakeholders (DEP, DNR, watershed/conservation orgs.,etc)
- Immediately implement several low risk, high profile restoration projects (Abram, Paint, Three Fork, Cheat …)

Technical Approach

- Collect, compile and evaluate data
- Develop GIS -based decision support system
- Develop economic benefits framework
- Evaluate and establish restoration priorities
- Develop watershed restoration plans Include restoration alternatives evaluation (active and passive at source, in -stream, in -situ) and predicted benefits and associated costs
- Monitor and document reach and watershed scale environmental benefits
- Adapt restoration process as necessary

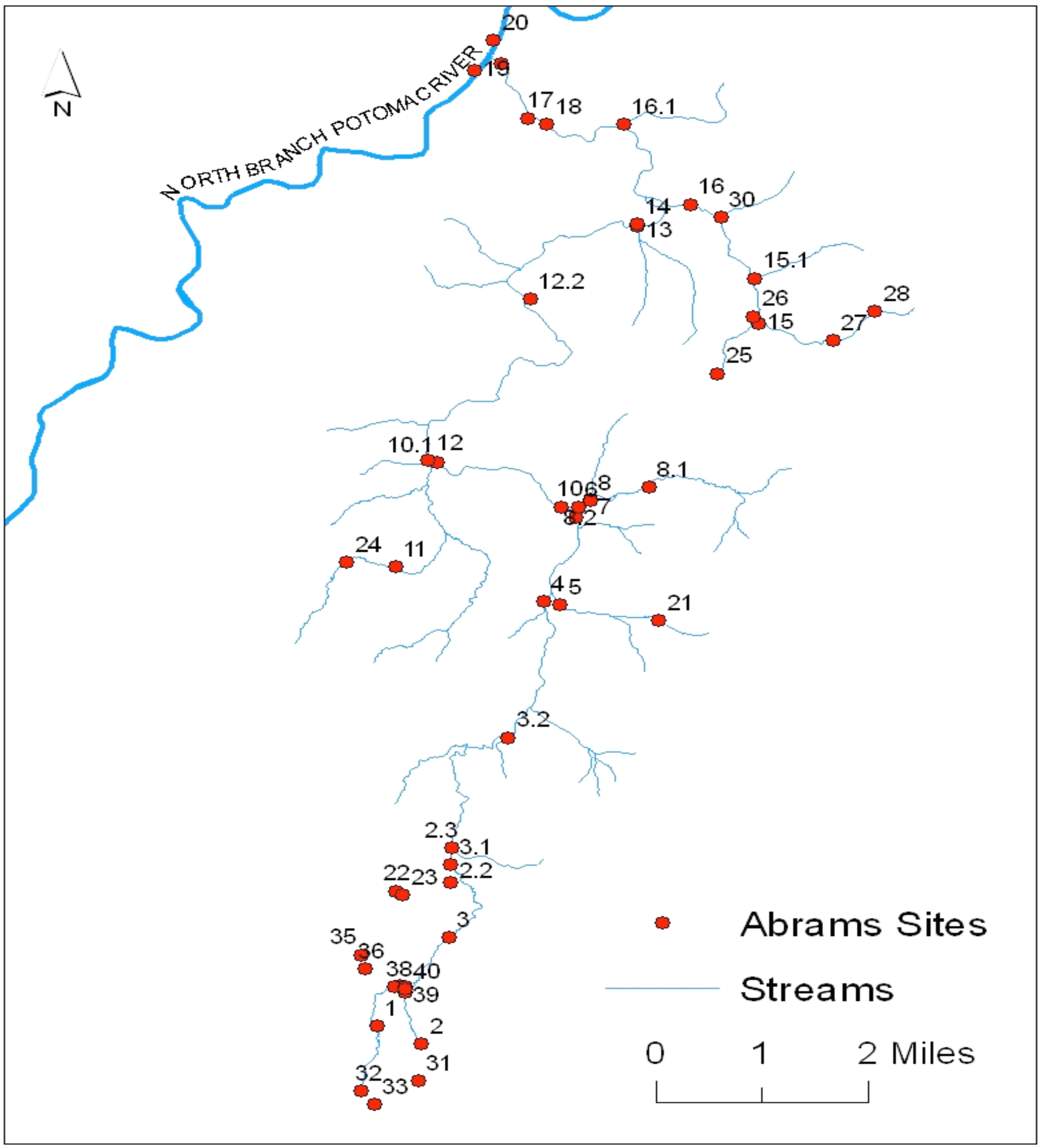
Case Study: Abram Creek

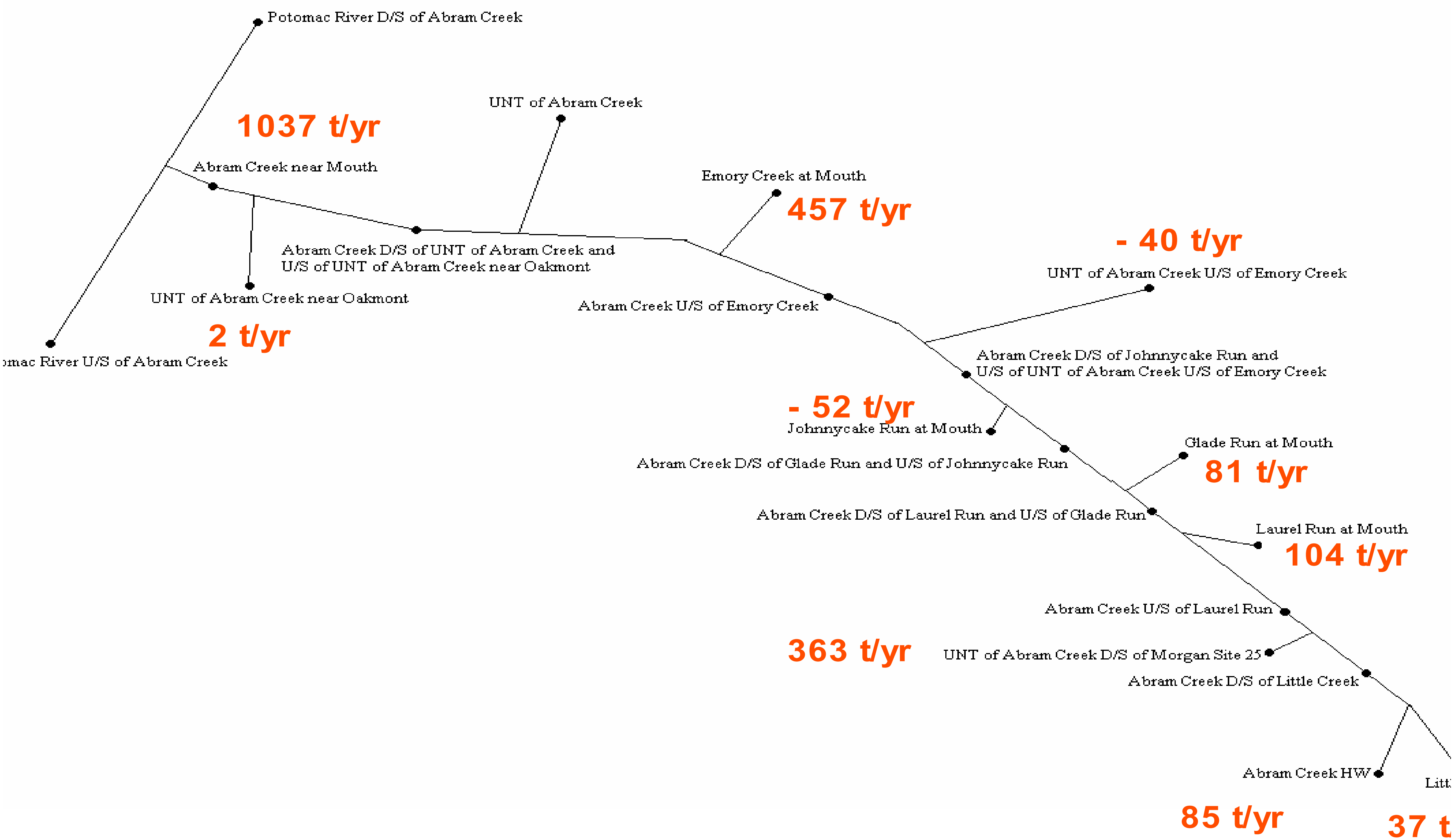
- 44.2 sq mi., ~20 miles long
- Elevation: 3,494 —1,693 ft. MSL
- 23 subwatersheds -10 impaired
- Largest subwatersheds -Laurel, Glade, Emory and Johnnycake
- TMDL- 27 AMLs, 1 BF



igure A-1-3. Metals sources in the Abram Creek watershed.

Abram Creek Water Quality Stations





Potomac River D/S of Abram Creek
1037 t/yr
UNT of Abram Creek
Abram Creek near Mouth
Emory Creek at Mouth
457 t/yr
- 40 t/yr
Abram Creek D/S of UNT of Abram Creek and U/S of UNT of Abram Creek near Oakmont
UNT of Abram Creek U/S of Emory Creek
UNT of Abram Creek near Oakmont
Abram Creek U/S of Emory Creek
2 t/yr
mac River U/S of Abram Creek
Abram Creek D/S of Johnnycake Run and U/S of UNT of Abram Creek U/S of Emory Creek
- 52 t/yr
Johnnycake Run at Mouth
Glade Run at Mouth
Abram Creek D/S of Glade Run and U/S of Johnnycake Run
81 t/yr
Abram Creek D/S of Laurel Run and U/S of Glade Run
Laurel Run at Mouth
104 t/yr
Abram Creek U/S of Laurel Run
363 t/yr
UNT of Abram Creek D/S of Morgan Site 25
Abram Creek D/S of Little Creek
Abram Creek HW
85 t/yr

Abram Creek Treatment Alternatives

Tributary	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Abrams HW, Little Ck	I.S. Dosers	I.S. Dosers	I.S. Dosers	I.S. Dosers	Passive	I.S Dosers	A.S. Dosers
of AC D/S of Morgan Site 25	I.S. Dosers	I.S. Dosers	I.S. Dosers	Passive	Passive	I.S Dosers	A.S. Dosers
Laurel	Passive	LS Sand	A.S. Doser	Passive	Passive	I.S Dosers	A.S. Dosers
Emory	LS Sand	LS Sand	I.S Doser	Passive	Passive	I.S Dosers	A.S. Dosers
Glade	Passive	Passive	Passive	Passive	Passive	Passive	Passive

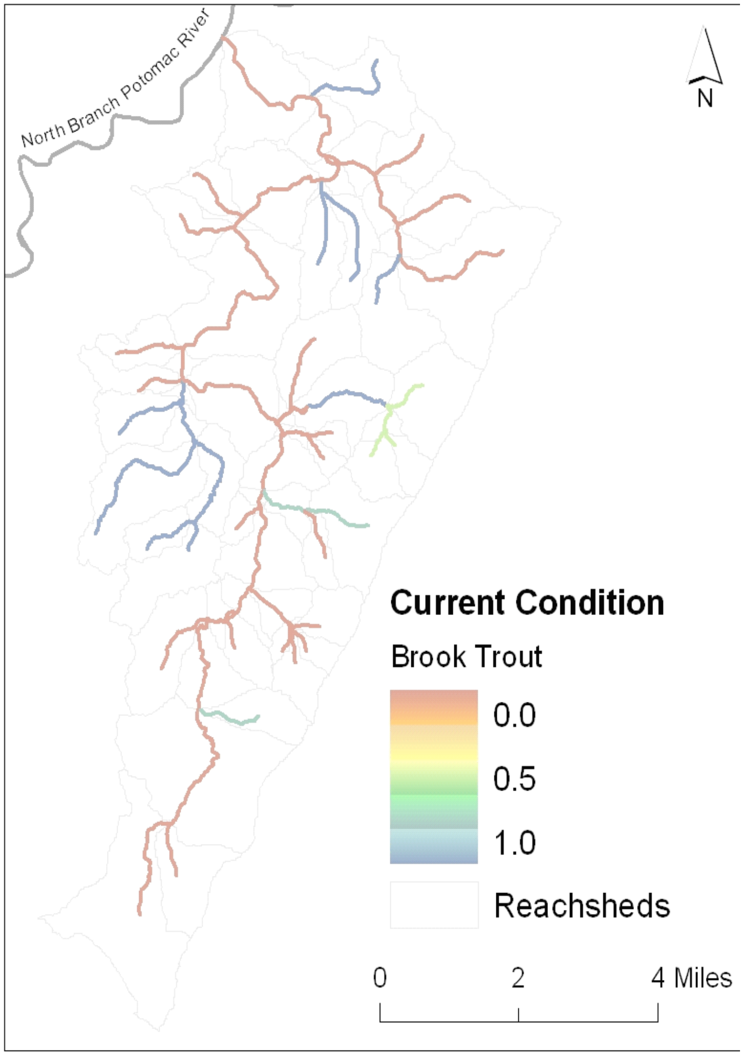
Abram Creek mainstem stations.

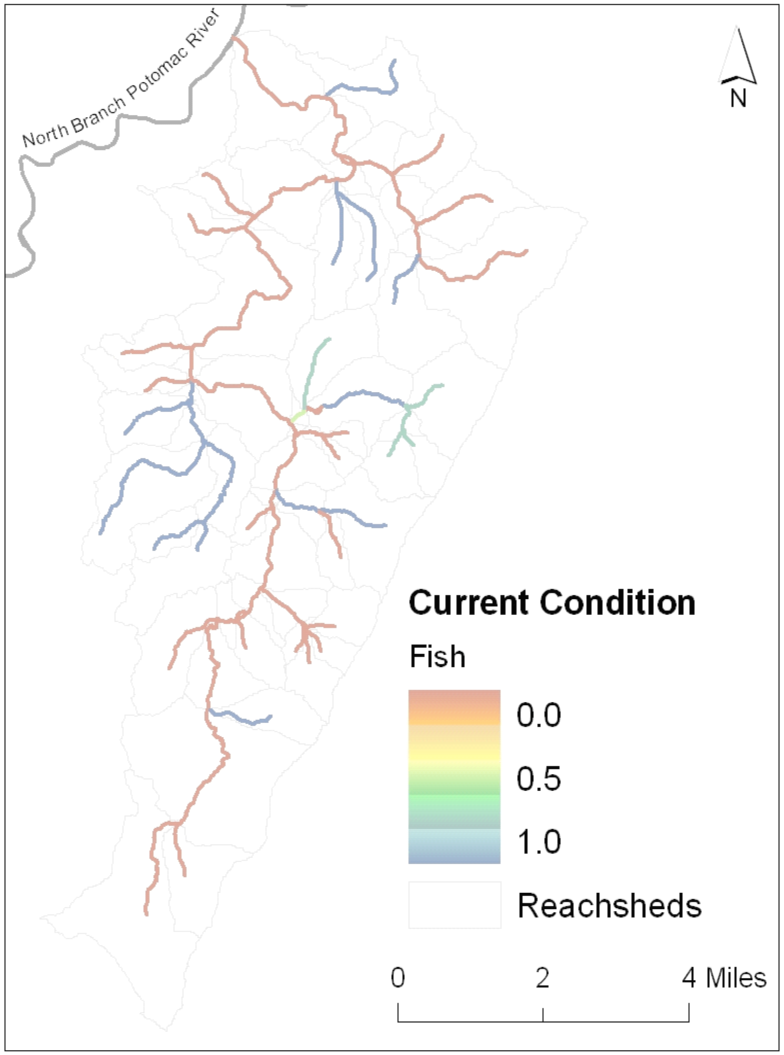
Abram Creek Mainstem Station	Model Net Acidity, mg/L $CaCO_3$						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
D/S of Little Creek	-186.27	-155.16	-103.95	-457.40	5.88	-103.95	-103.95
D/S of UNT of A.C. D/S of Morgan Site 2 and U/S of Laurel Run	-214.50	-187.76	-111.64	-327.08	17.30	-111.64	-111.64
D/S of Laurel Run and U/S of Glade Run	-145.24	-135.71	-132.34	-203.91	13.28	-132.34	-132.34
D/S of Glade Run and U/S of Johnnycake Run	-77.86	-72.68	-70.85	-109.72	8.23	-70.85	-70.85
D/S of Johnnycake Run and U/S of UNT of A.C. U/S of Emory	-59.06	-55.67	-54.47	-79.96	-2.61	-54.47	-54.47
U/S of Emory Creek	-54.84	-51.77	-50.68	-73.72	-3.81	-50.68	-50.68
D/S of UNT of A.C. and U/S of UNT of A.C. near Oakmont	-50.53	-50.40	-50.19	-50.22	-0.35	-50.19	-50.19
near Mouth	-50.37	-50.24	-50.04	-50.06	-0.30	-50.04	-50.04
of the Potomac River D/S of A.C.	-18.57	-18.56	-18.54	-18.54	-12.93	-18.54	-18.54

Treatment Alternative Costs

Total Cost over Project Lifetime* (2007 dollars, discounted at 3%)				
Alternative	**Total 1 Year**	**Total 5 Year**	**Total 10 Year**	**Total 20 Year**
1	$815,959	$1,172,501	$1,562,797	$2,189,888
2	**$534,207**	**$810,043**	**$1,111,993**	**$1,597,137**
3	$873,387	$1,294856	$1,756,227	$2,497,513
4	$2,868,074	$3,789,240	$4,979,617	$6,417,780
5	**$2,879,005**	**$3,826,044**	**$4,862,743**	**$6,528,410**
6	$865,532	$1,257,805	$1,687,217	$2,377,153
7	$2,325,786	$3,289,276	$4,005,918	$5,416,656

Ecological Benefits



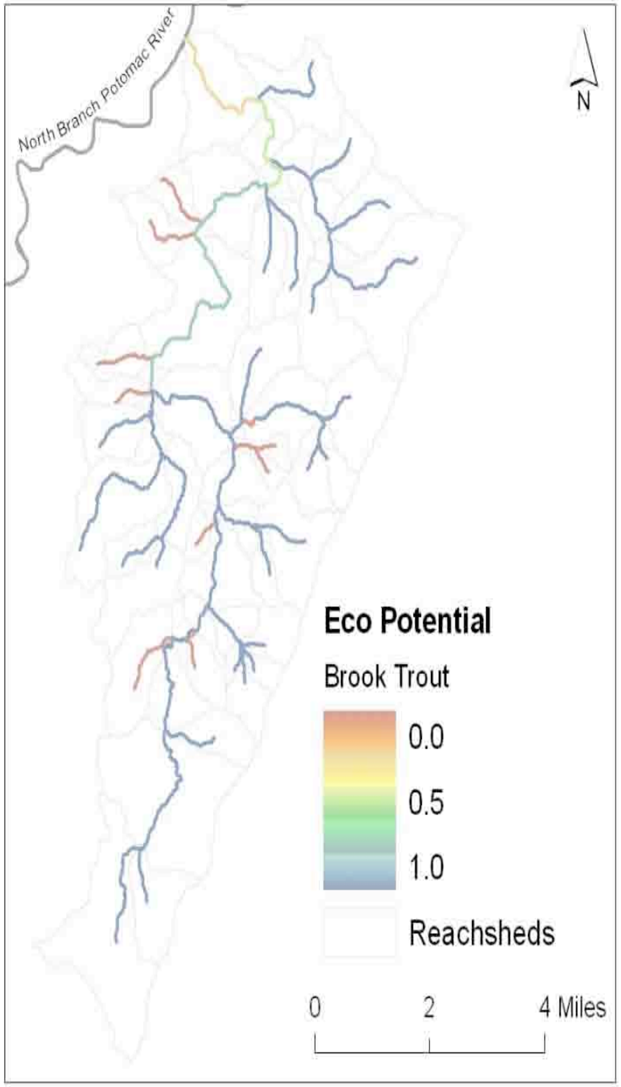


Recoverable EcoUnits (Miles)				
Alternative	Diversity	Brook Trout	Stocked Trout	Overall Fishery
1	11.11	10.51	11.87	14.19
2	10.97	10.34	11.85	14.03
3	11.11	10.51	11.87	14.19
4	12.68	12.25	11.98	15.93
5	4.76	3.46	5.11	5.11
6	10.97	10.34	11.85	14.03
7	15.62	16.23	12.88	19.91

Net Present Value of Alternatives (2007 dollars, discounted at 3%)				
Alternative	1 Year	5 Year	10 Year	20 Year
1	(804,389)	(28,466)	1,244,503	3,296,170
2	(555,719)	167,937	1,379,802	3,333,234
3	(876,926)	(222,094)	918,319	2,757,009
4	(2,642,806)	(1,500,992)	225,456	3,006,527
5	(2,645,138)*	(2,329,712)	(1,831,562)	(1,028,878)
6	(907,524)	(230,247)	987,686	2,951,723
7	(2,325,786)	(1,739,902)	(558,897)	1,346,761

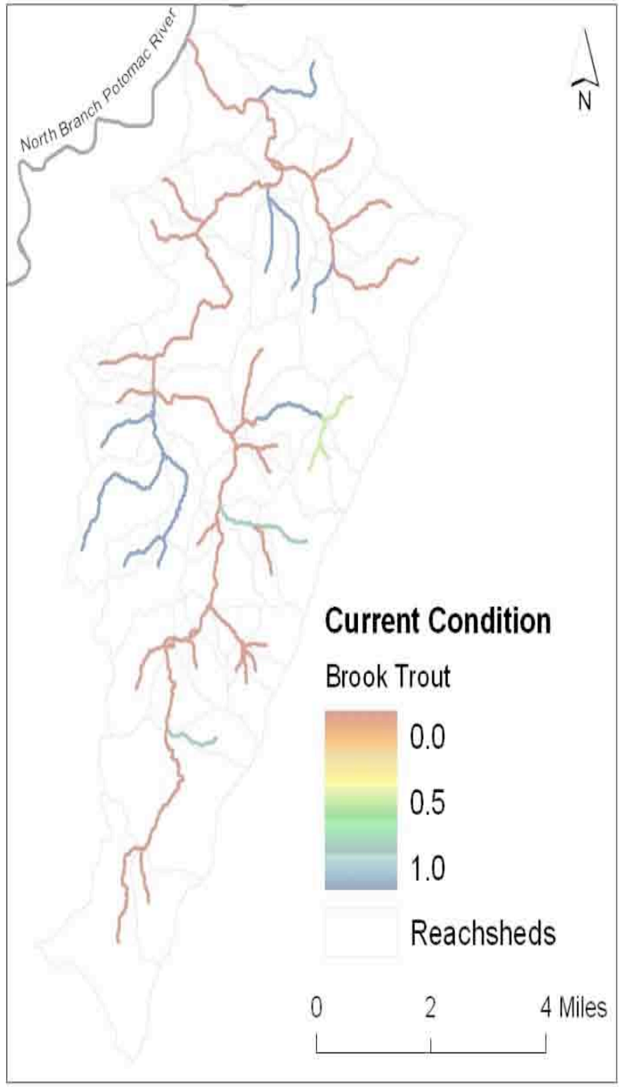
Brook Trout Habitat Futures in Abram Creek: Alternative 2

Historic EUs



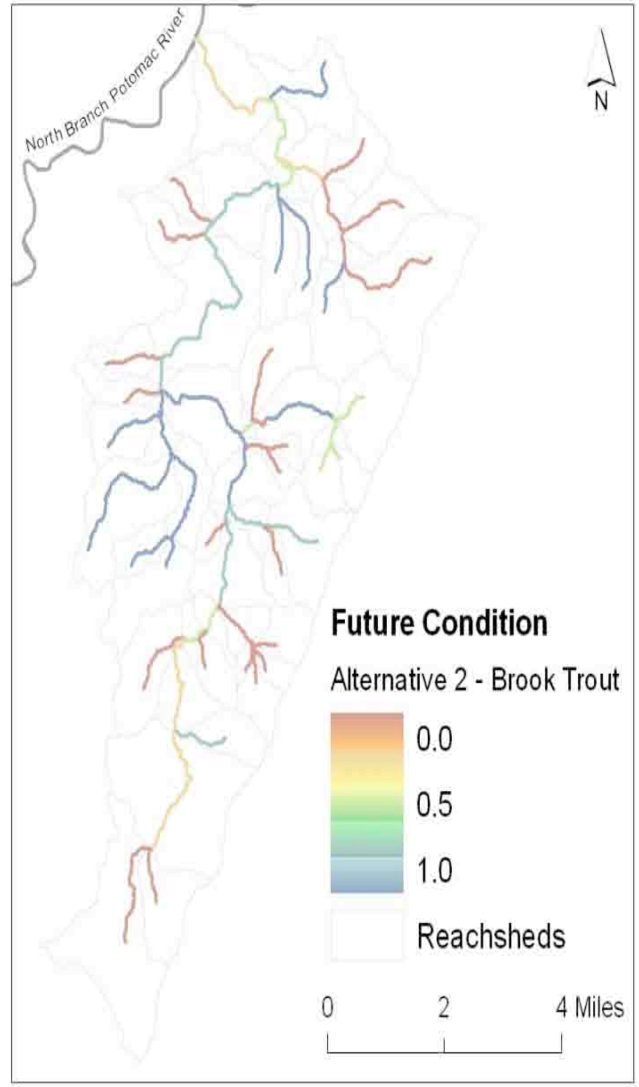
45.7 miles

Current EUs



16.7 miles (36%)

Expected EUs



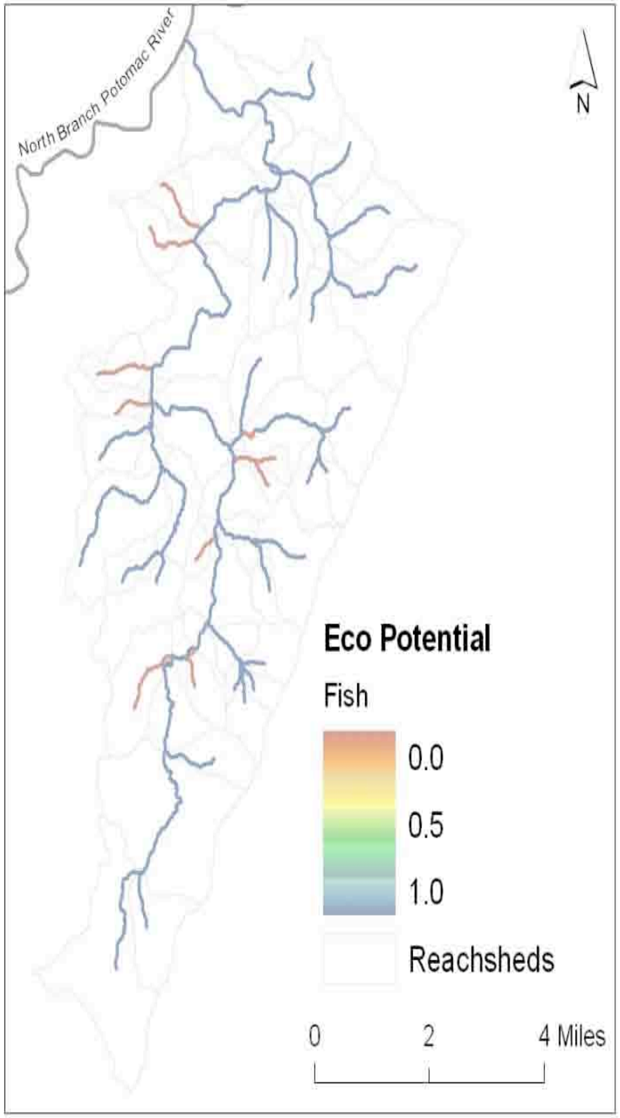
27.0 miles (59%)

Why Brook Trout?

Because We Care

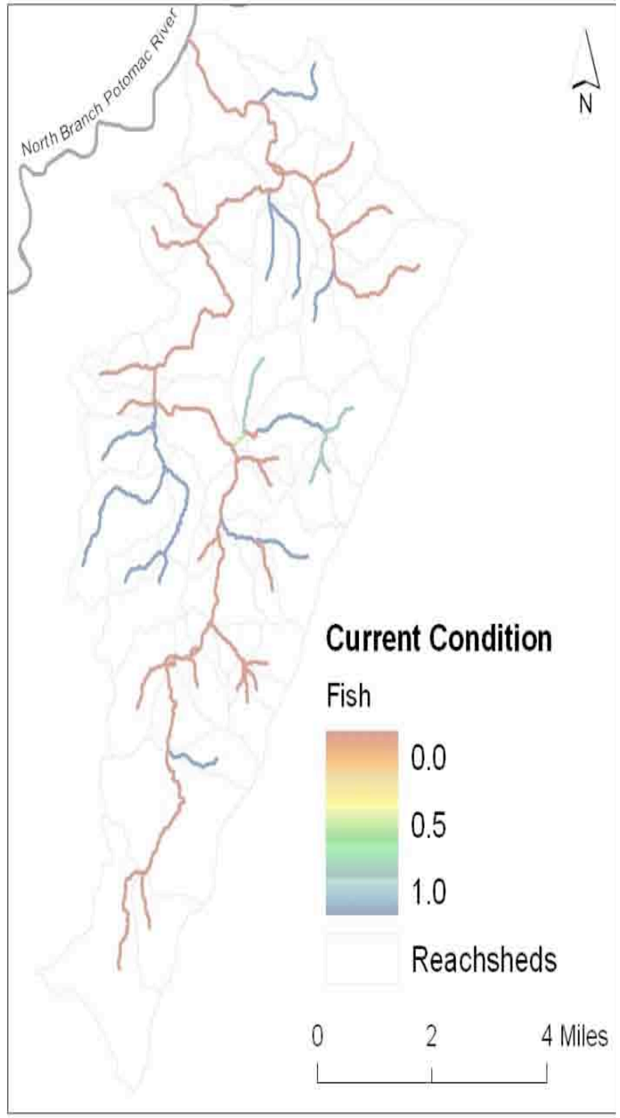
Fisheries Futures in Abram Creek: Alternative 2

Historic EUs



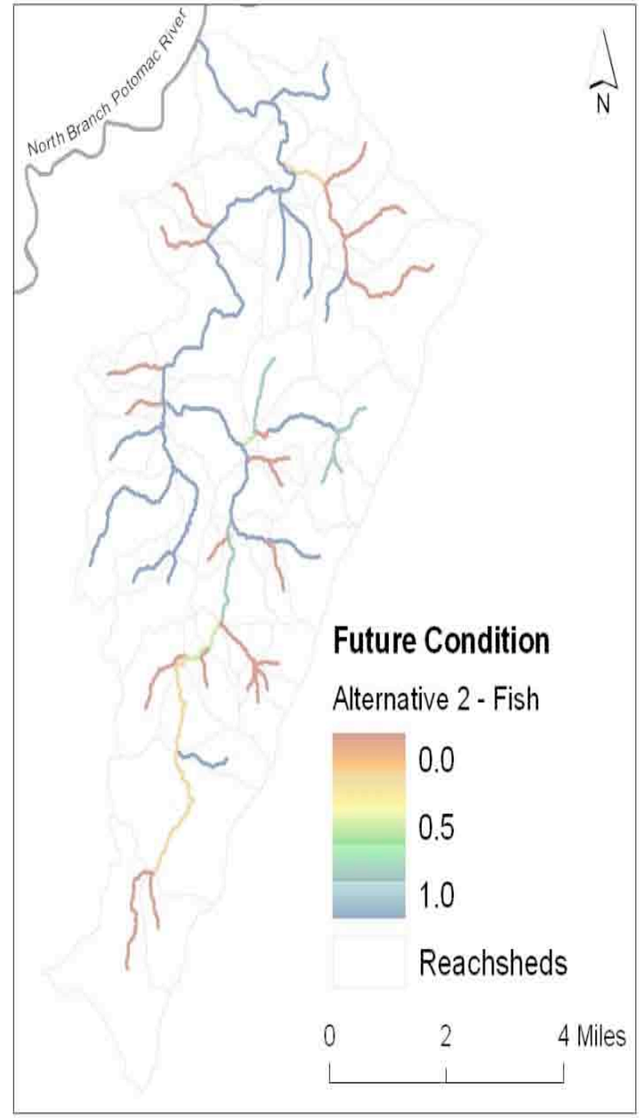
49.5 miles

Current EUs



18.4 miles (37%)

Expected EUs



32.3 miles (65%)

Summary

- We recommend implementation of Alternative 2
  - Three dosers-Little Ck, Head of Abrams, UNT @ Morgan 23
  - Limestone sand in Emory and Laurel Cks
  - Passive treatment at Glade Run
- Lowest cost/nearly highest ecological benefit
  - Capital cost: $534,207
  - Annual cost: $ 53,147
  - Highest efficiency: $/ton of acid load removed.
- Alternative 2 will restore main stem of Abram Ck

Summary (continued)

- Further improvements in headwaters possible through watershed organizations and other programs: WCAP, Sec. 319, etc
- This would enable full recovery of these small tributaries and link with high quality brook trout habitats in the Abram Creek main stem Johnnycake Run
- It is unlikely that the Abram Creek headwaters and Emory Creek will ever fully recover as brook trout habitat