West Branch Susquehanna Recovery Benchmark

PA Abandoned Mine Reclamation Conference

August 5th, 2011

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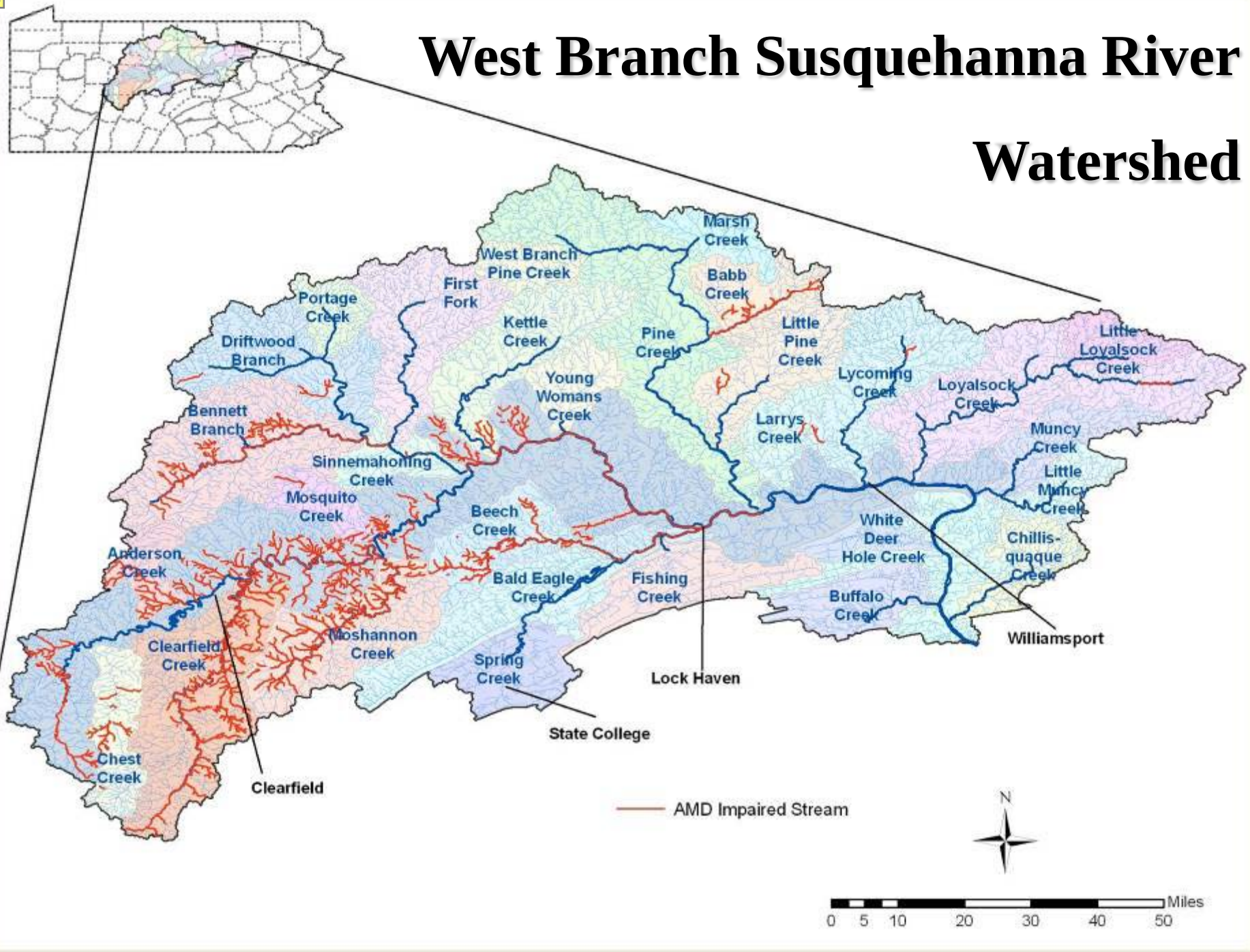
West Branch Susquehanna River Watershed

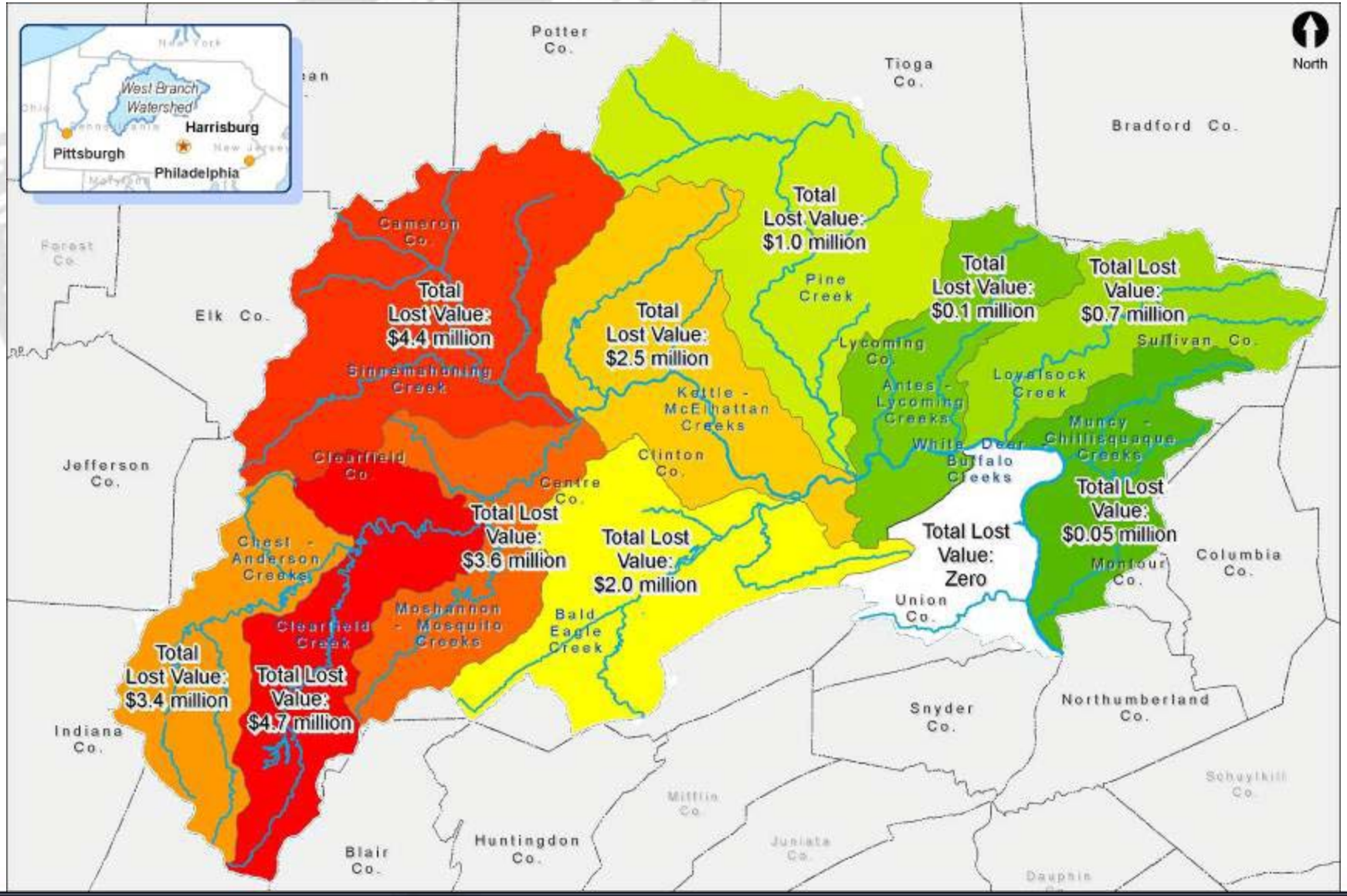


Jobs and Economic Activity

- Remediation Costs
  - Capital Costs = $110 Million to $453 million
    - Construction
    - Engineering
    - Materials
  - Operation & Maintenance = up to $16 million /yr
    - Alkaline materials
    - Electricity
    - Labor


Passive Treatment

Sport fishing revenue lost annually due to AMD



Property Values

50 YEARS
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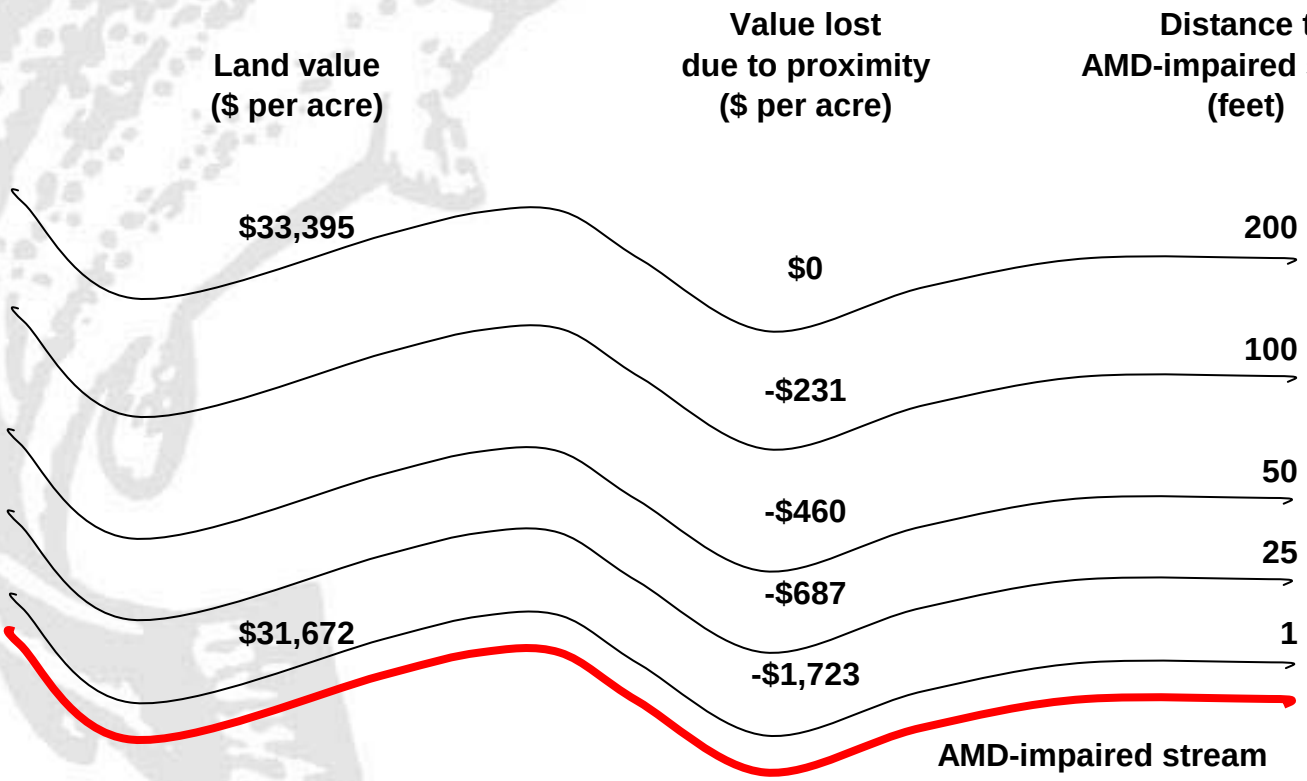
Lost land value near an AMD–impacted stream



50 YEARS
TROUT UNLIMITED

Aggregate impact across Clearfield County

- >2,700 parcels within zone of influence
- $1,500 per parcel
- $2,600 per acre
- $4 million total

The Environmental Impact of Historical Resource Extraction REMEDIATION in Pennsylvania

Jobs and Economic Activity

- Remediation Costs
  - Capital Costs = $110 Million to $453 million
    - Construction
    - Engineering
    - Materials
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Passive Treatment

Benefits of capital expenditures
($110 - $ 453 Million)

- To watershed
  - Multiplier: 1.36
  - Benefits: $151-616 million
  - Jobs: 1,038-4,120 ← Green jobs!

Benefits of O&M expenditures
(Up to $16 Million/yr)

- To watershed
  - Multiplier: 1.44
  - Benefits: $23 million
  - Jobs: 152-157 ← Green jobs!

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Economic Benefits: Conclusions

- Remediation generates jobs and stimulates the local economy
- Recreational spending will increase with cleaner waters
- Property values will increase with AMD remediation
- Residents are willing to pay for remediation
- Policymakers and the public should consider not just the costs, but also the benefits

But, there is GOOD news!

- Millions of dollars spent to clean up the West Branch
  - $73 million in GG grants for 620 projects
  - 210 remining permits = 5,100 acres AML reclaimed
  - 63 bond forfeiture projects, $14 million = 1,313 acres of AML reclaimed
  - Undetermined amount of federal and local dollars
- Realizing Successes!

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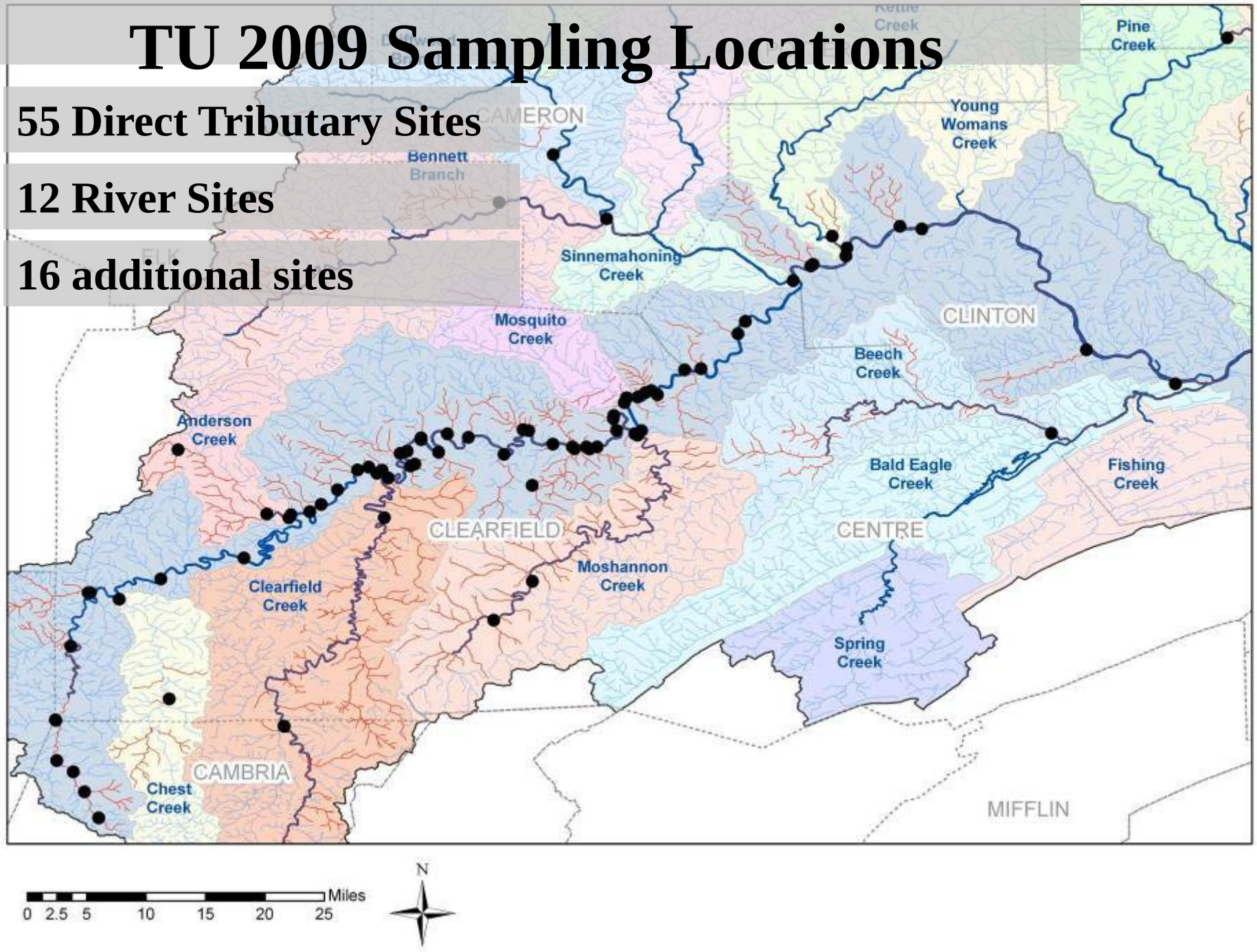
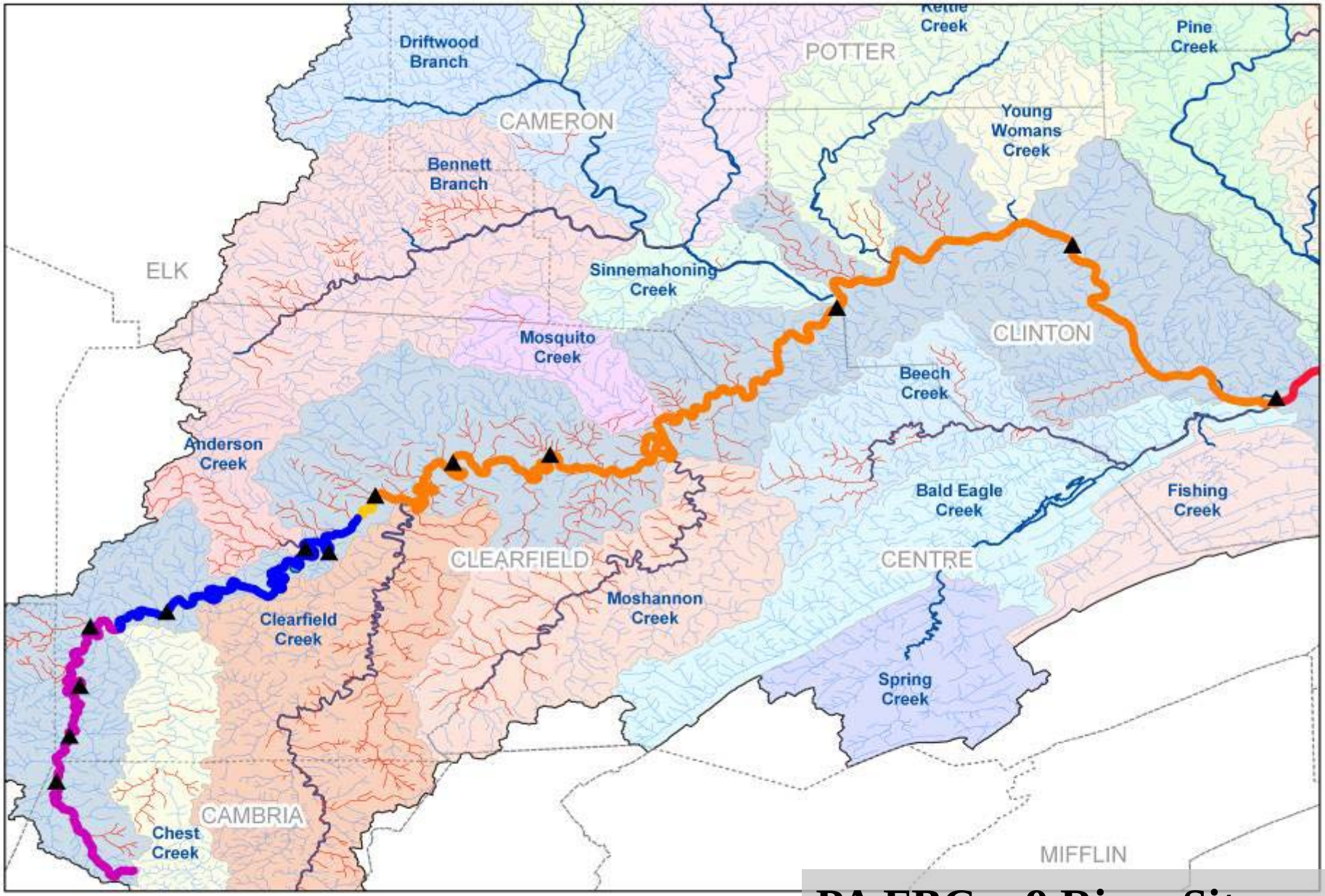
TU 2009 Sampling Locations

55 Direct Tributary Sites

12 River Sites

16 additional sites

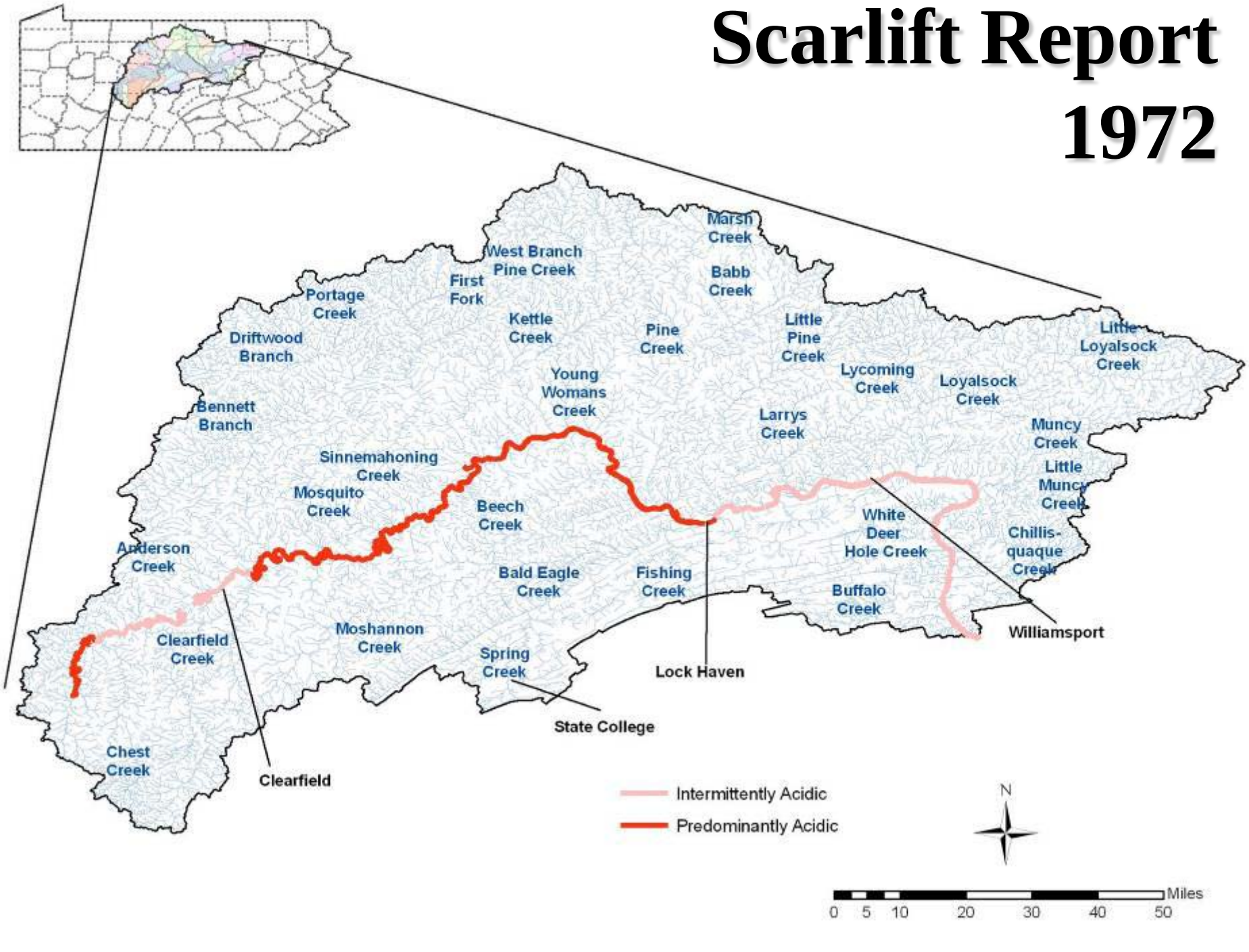




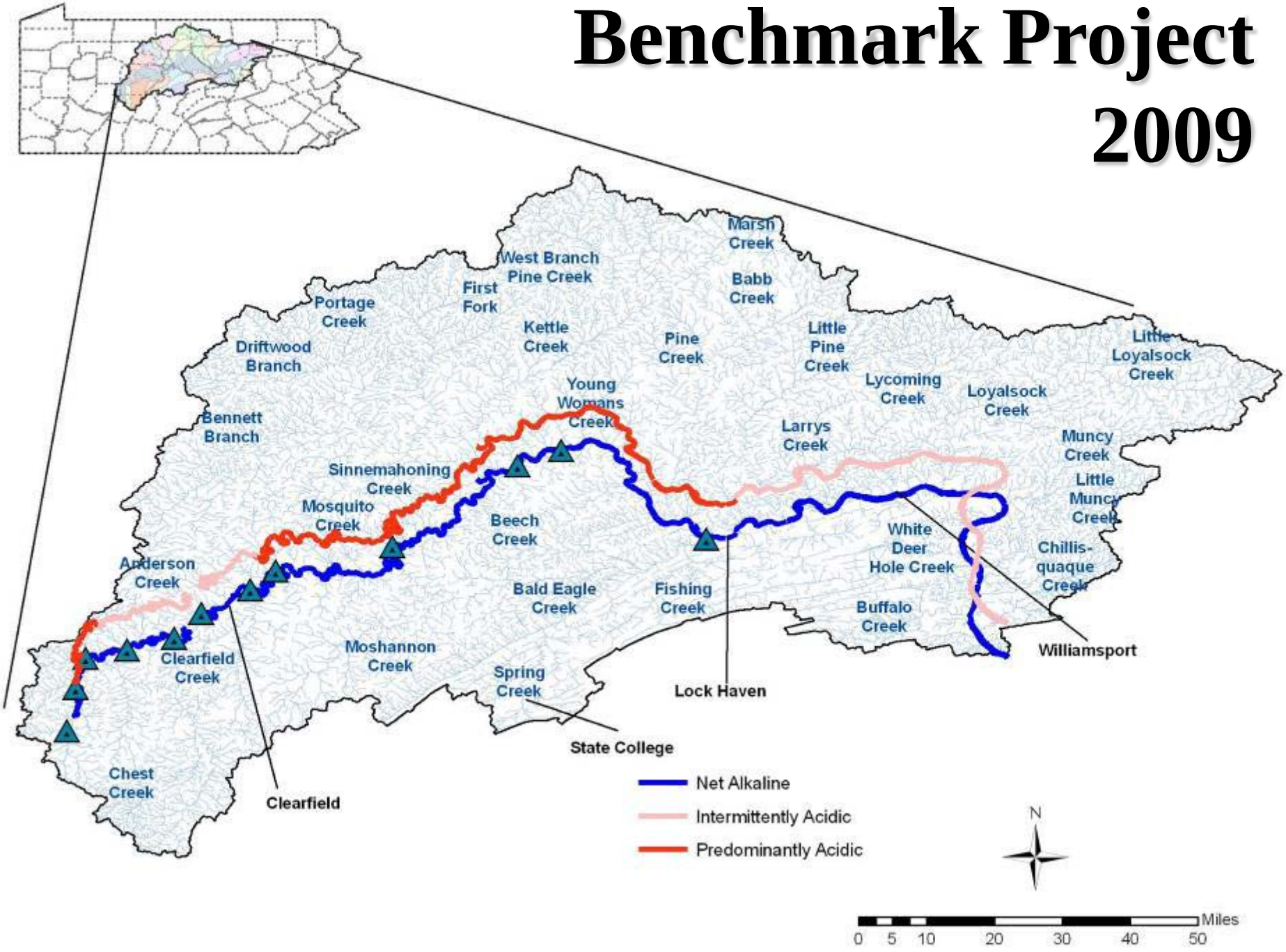
PA FBC = 9 River Sites

SRBC = 8 River Sites

Scarlift Report 1972



Benchmark Project 2009



West Branch @ Karthaus

	pH	Iron (mg/L)	Aluminum (mg/L)	Sulfate (mg/L)
Spring - 1984	3.9	1.9	1.7	140
Summer - 1984	4.1	0.73	3	300
Spring - 2009				
Summer - 2009				
% Reduction - Spring				
% Reduction - Summer				

Red indicates value is outside of DEP water quality criteria levels

West Branch @ Karthaus

	pH	Iron (mg/L)	Aluminum (mg/L)	Sulfate (mg/L)
Spring - 1984	3.9	1.9	1.7	140
Summer - 1984	4.1	0.73	3	300
Spring - 2009	**6.4**	**0.53**	**0.65**	**123**
Summer - 2009	**6.2**	**0.24**	**0.38**	**214**
% Reduction - Spring		**72%**	**62%**	**12%**
% Reduction - Summer		**67%**	**87%**	**29%**

Red indicates value is outside of DEP water quality criteria levels

Karthaus

Then & Now

↑ 2 pH Units

Spring

↓ 246 Tons/Day Acidity

↓ 15.0 Tons/Day Iron

↓ 11 Tons/Day Aluminum

↓ 862 Tons/Day Sulfate

Summer

↓ 54 Tons/Day Acidity

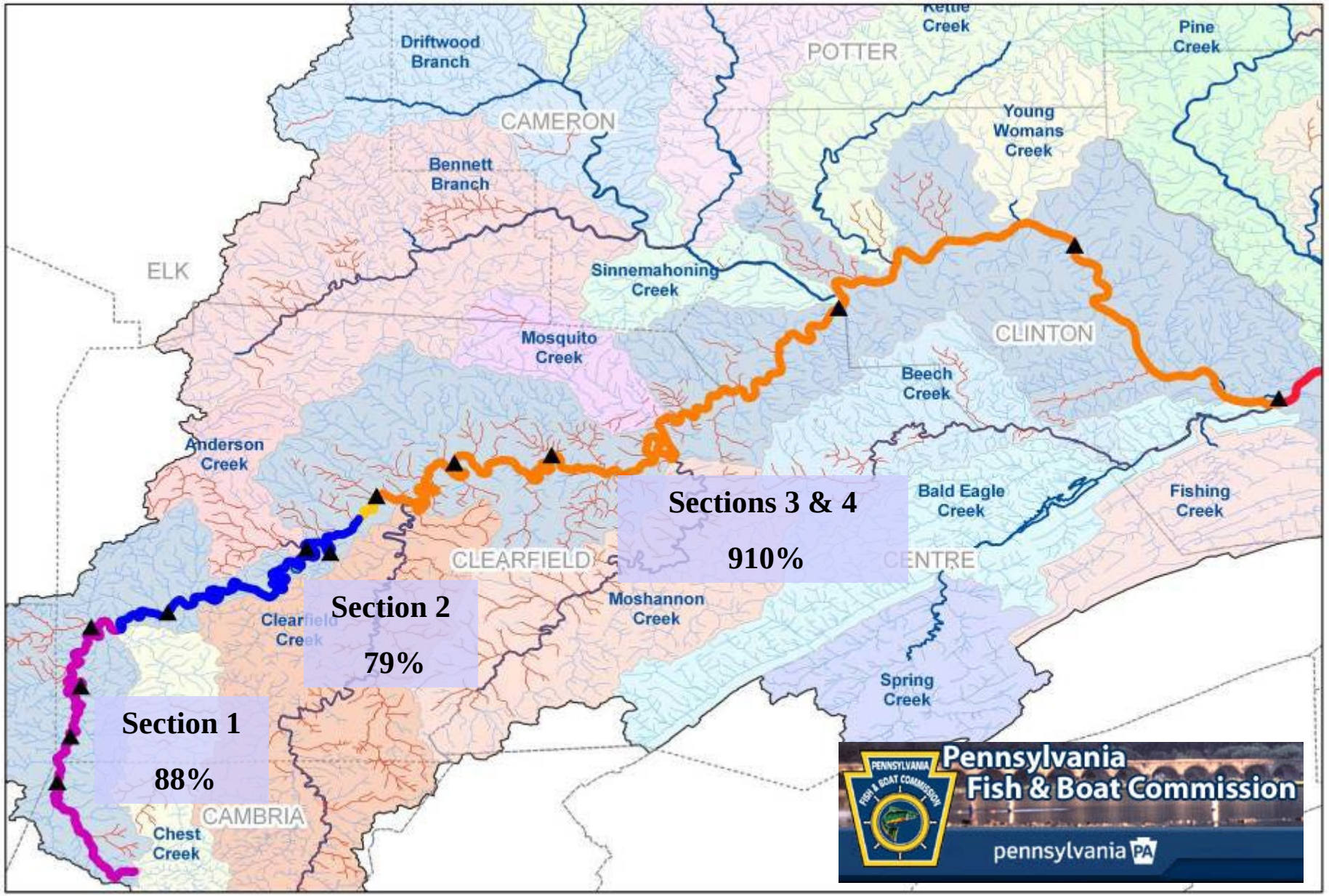
↓ 1.0 Tons/Day Iron

↓ 6.0 Tons/Day Aluminum

↓ 222 Tons/Day Sulfate

Fish Species in West Branch Watershed

60-65 species



Total Catch Increases
1998 / 1999 vs. 2009

Total Catch & Species

	Total Catch			Species	
Site	1998	2009	% Increase	1998	2009
Emeigh Run	57	150	163%	6	10
Shyrock Run	206	417	102%	17	19
Burnside					
McGees Mills	113	143	26%	14	14
Bower	141	167	18%	11	13
Curwensville					
Hogback	234	504	115%	19	20
Clearfield	40	113	182%	6	10
Egypt	8	115	134%	5	11
Deer Creek	12	135	1025%	6	14
Burns Run	9	45	400%	5	12
Hyner	13	420	3130%	3	16

Why are things so much better?

Investigated:

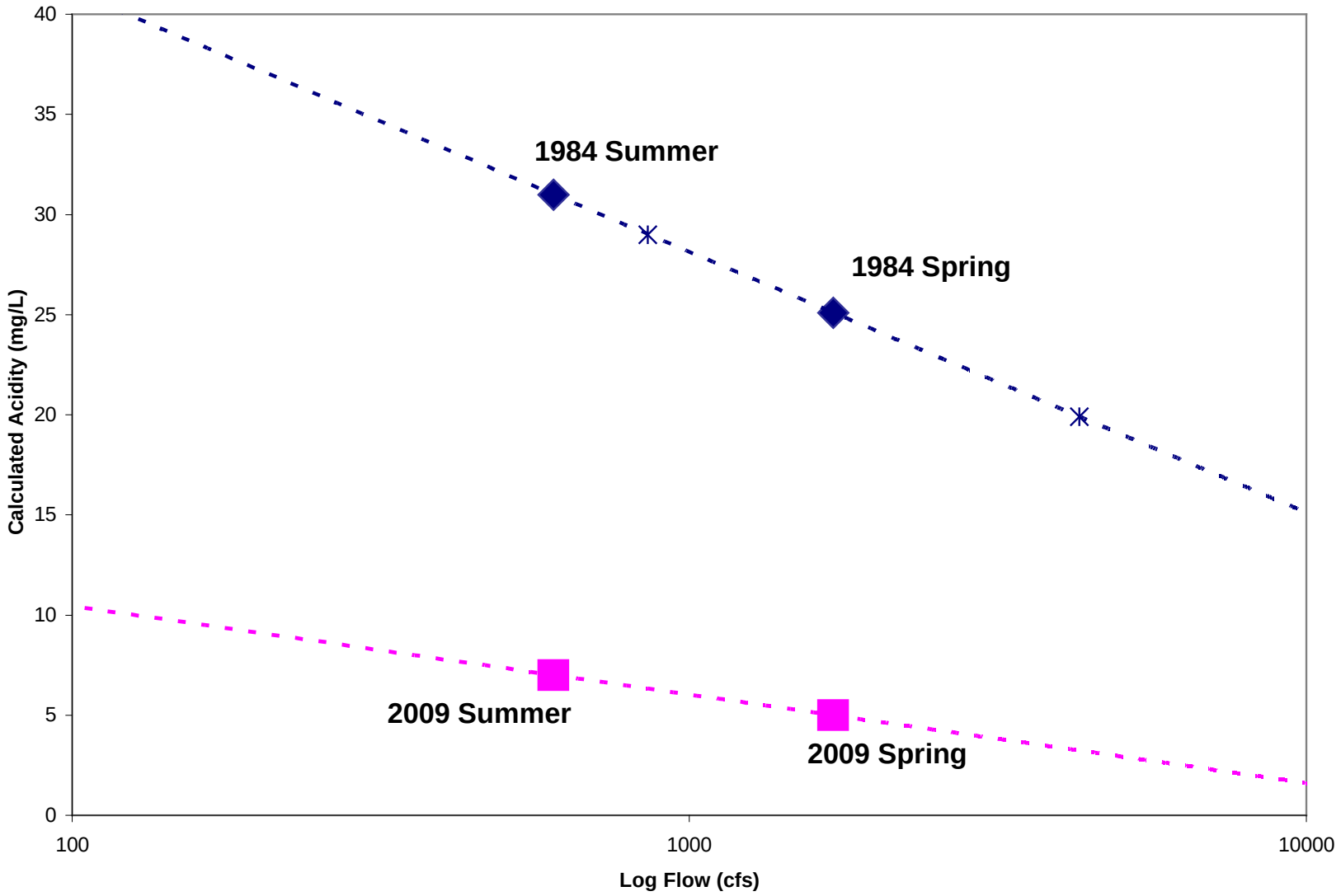
- **Treatment**
- **Remining**
- **Natural Attenuation / Natural Decay**





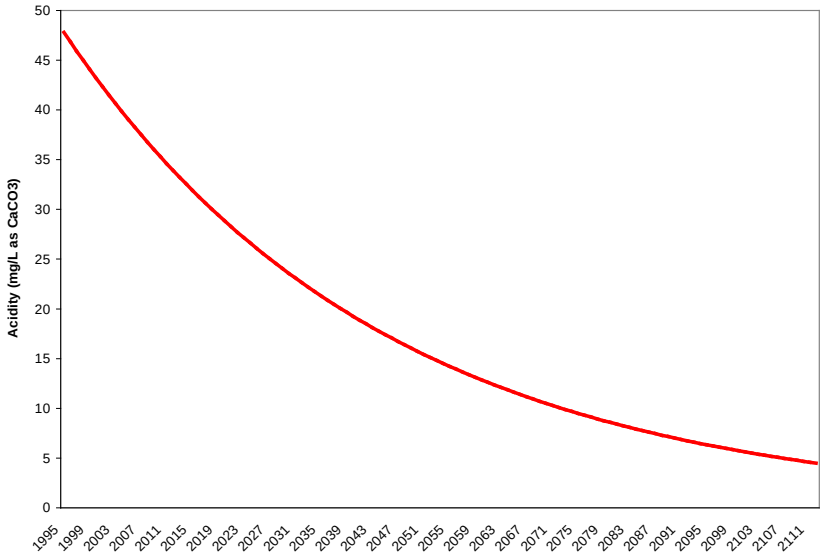


West Branch at Karthaus



Natural Attenuation

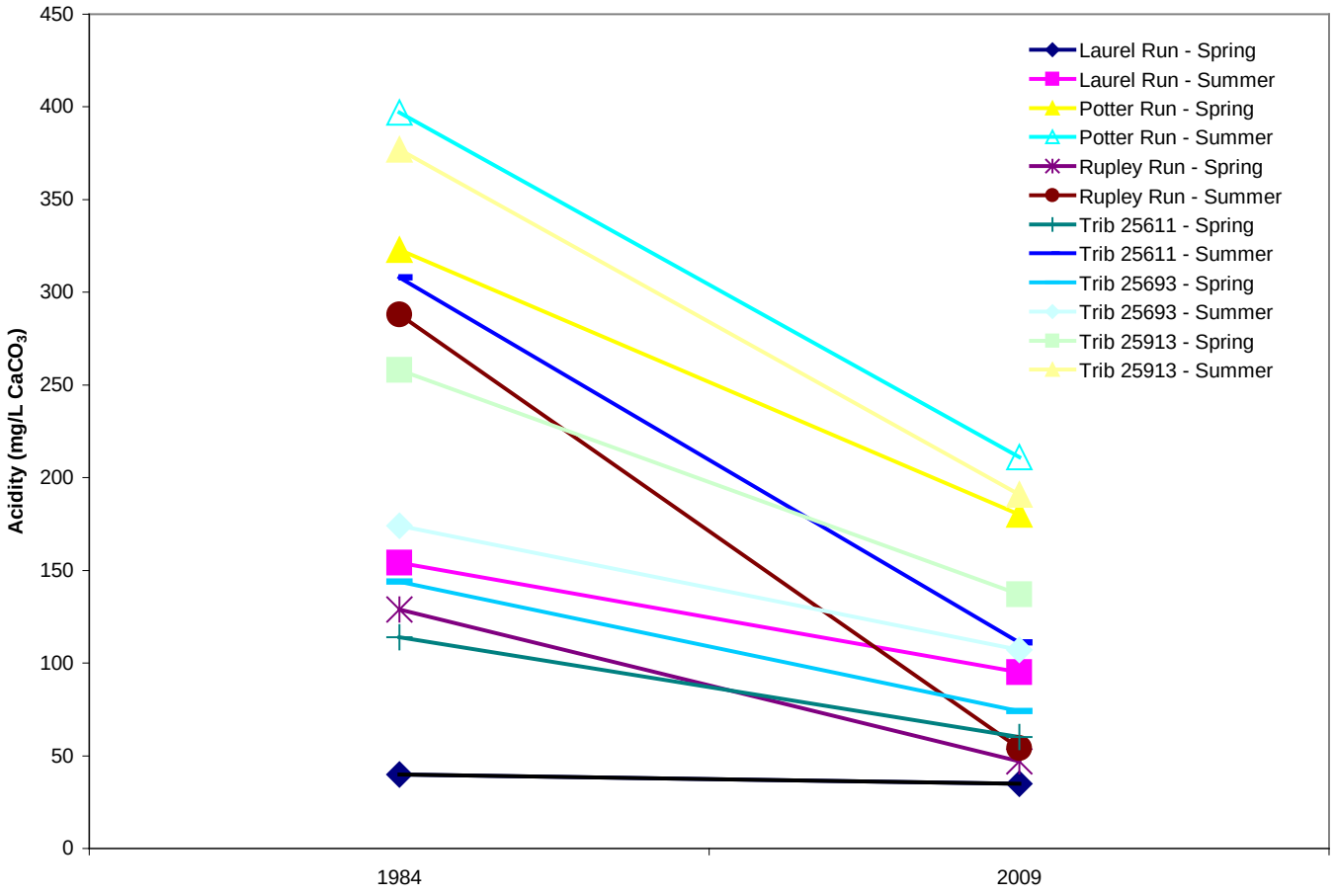
- Literature supports a 2.1% per year decay rate in acidity



Pyrite Oxidation Reaction

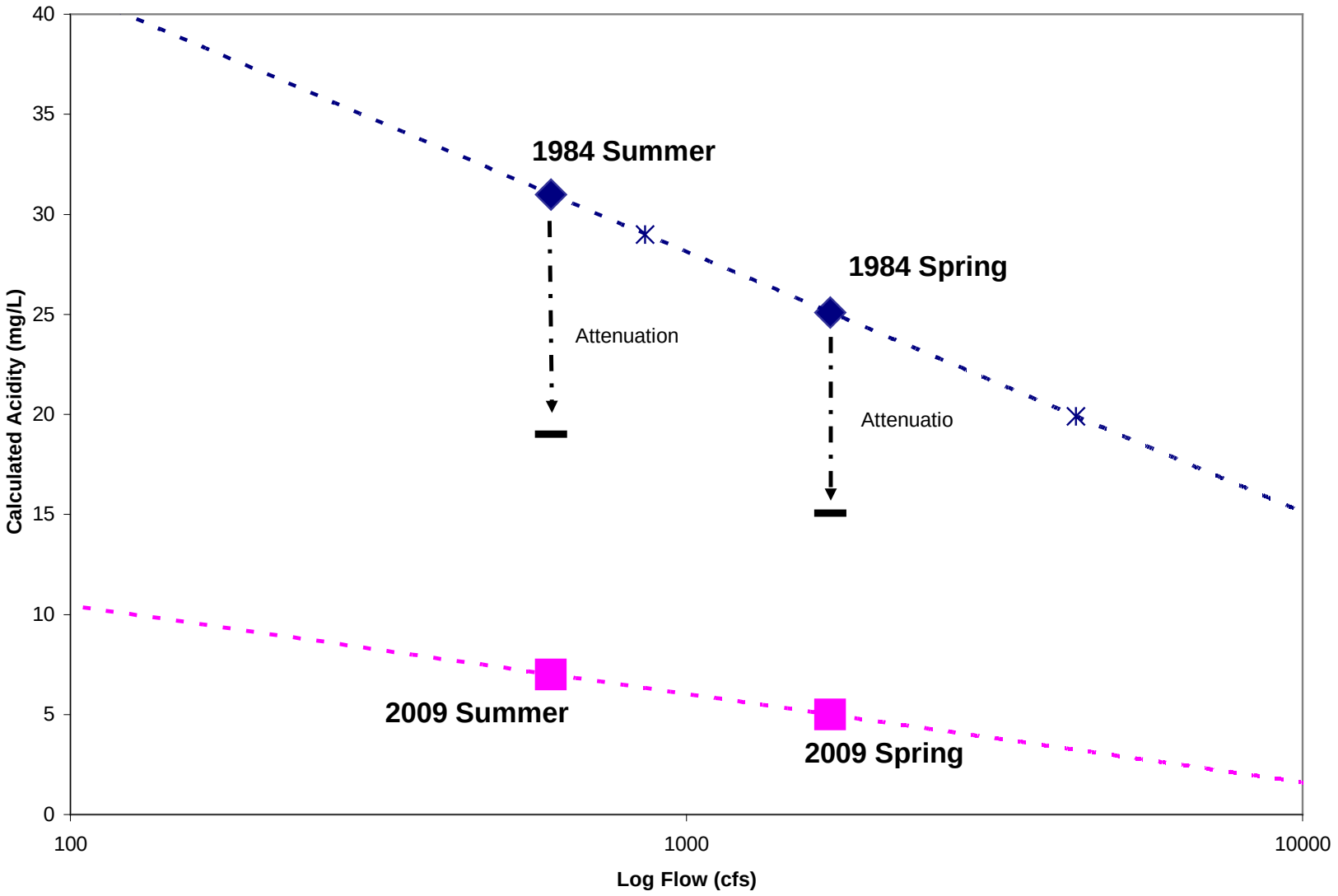
$$FeS_{2(s)} + O_{2(g)} + H_2O_{(l)} \rightarrow Fe^{2+}_{(aq)} + SO_4^{2+}{}_{(aq)} + H^+_{(aq)}$$

Pyrite + Oxygen + Water → Ferrous Iron + Sulfate + Hydrogen



	Laurel Run		Potter Run		Rupley Run		Trib 25611		Trib 25693		Trib 25913	
	Spring	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
1984 Acidity (mg/L $CaCO_3$)	40	154	323	397	129	288	114	308	144	174	258	377
2009 Acidity (mg/L $CaCO_3$)	35	95	180	211	47	54	60	111	74	107	137	191
Reduction (mg/L $CaCO_3$)	5	59	143	186	82	234	54	197	70	67	121	186
% Total Reduction	12.5%	38.3%	44.3%	46.9%	63.6%	81.3%	47.4%	64.0%	48.6%	38.5%	46.9%	49.3%
% Attenuated per Year	**0.5%**	**1.5%**	**1.8%**	**1.9%**	**2.5%**	**3.3%**	**1.9%**	**2.6%**	**1.9%**	**1.5%**	**1.9%**	**2.0%**

West Branch at Karthaus



Remining

Before

During

After

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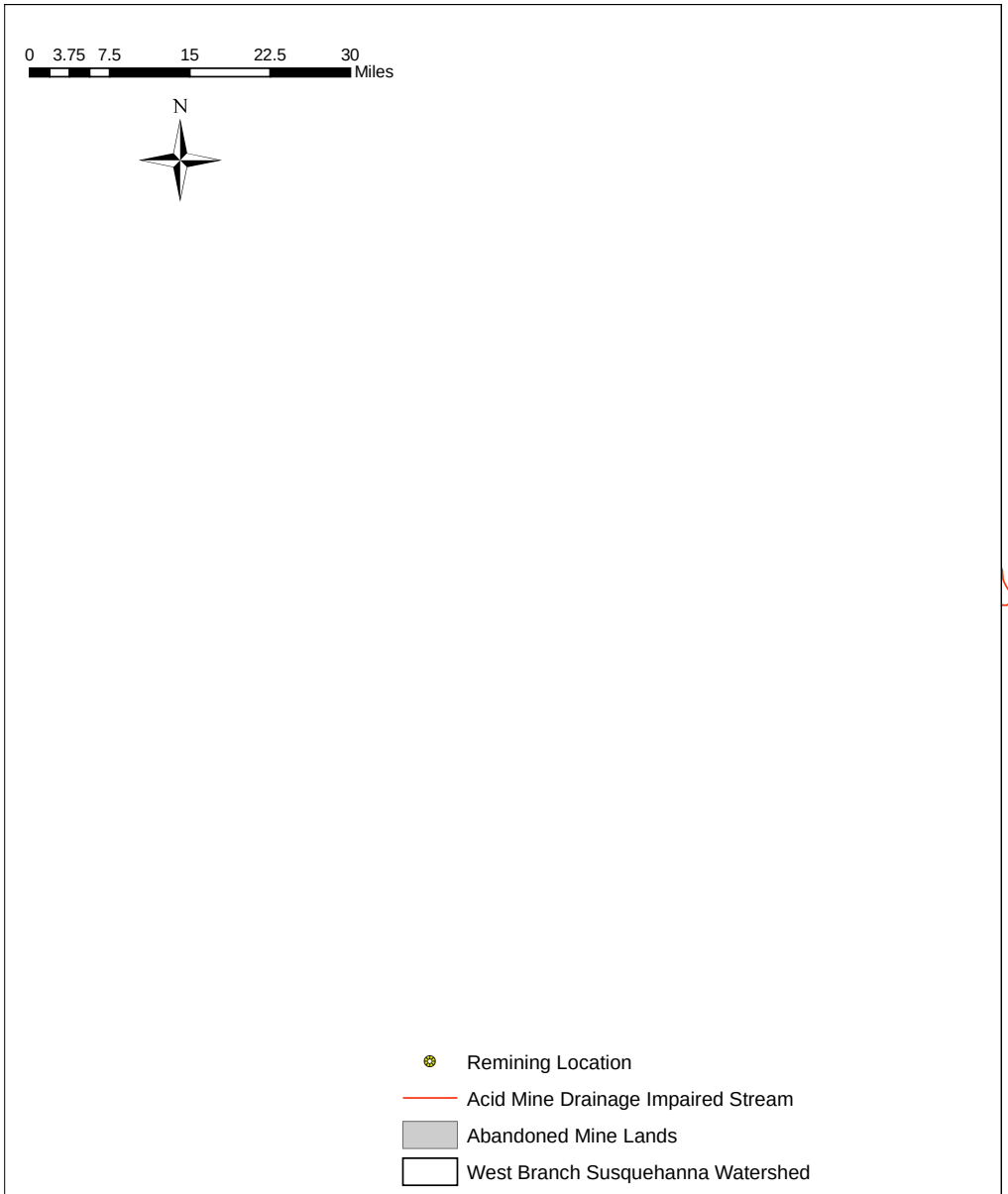
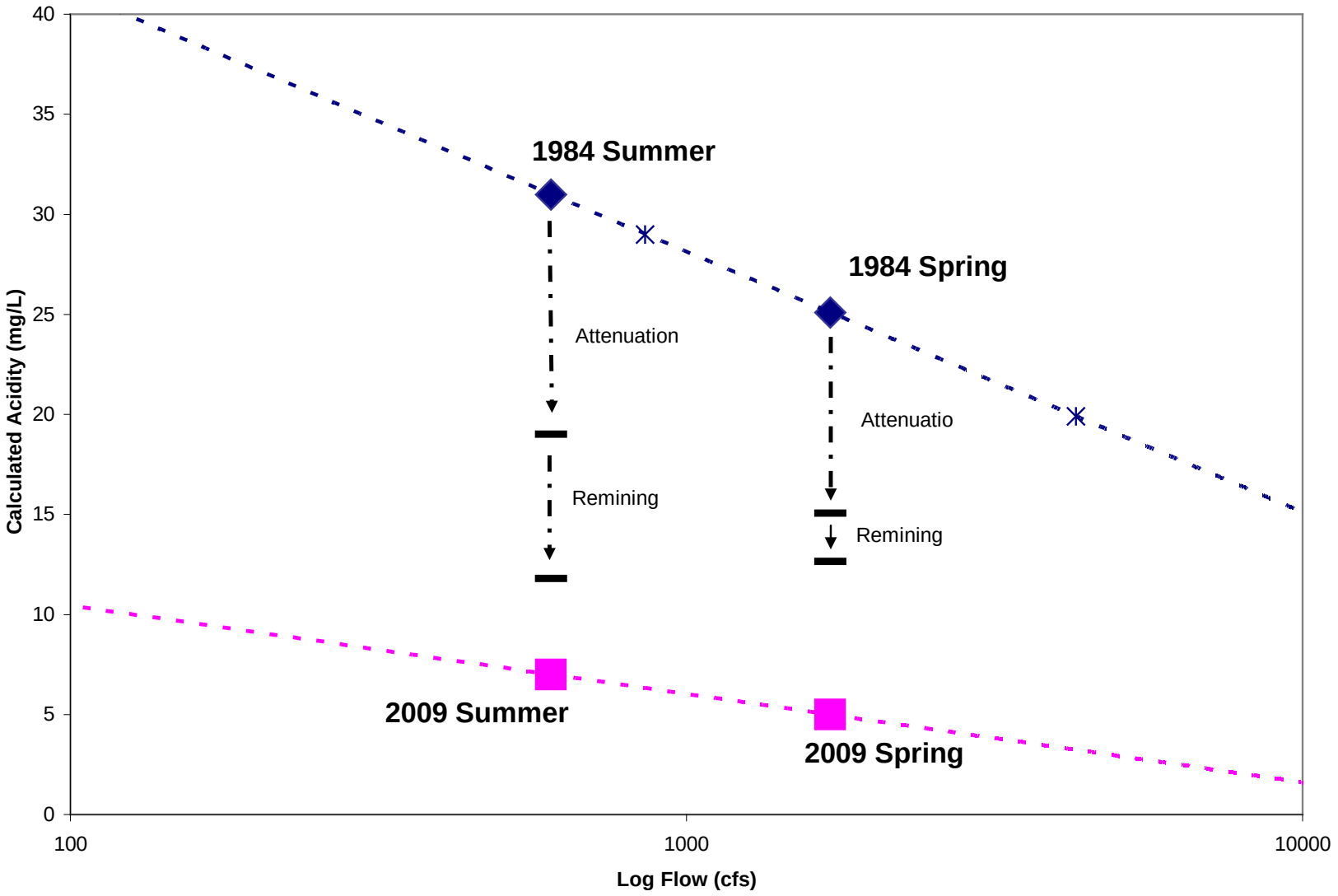


Effectiveness of Pennsylvania's remining program in abating abandoned mine drainage: water quality impacts

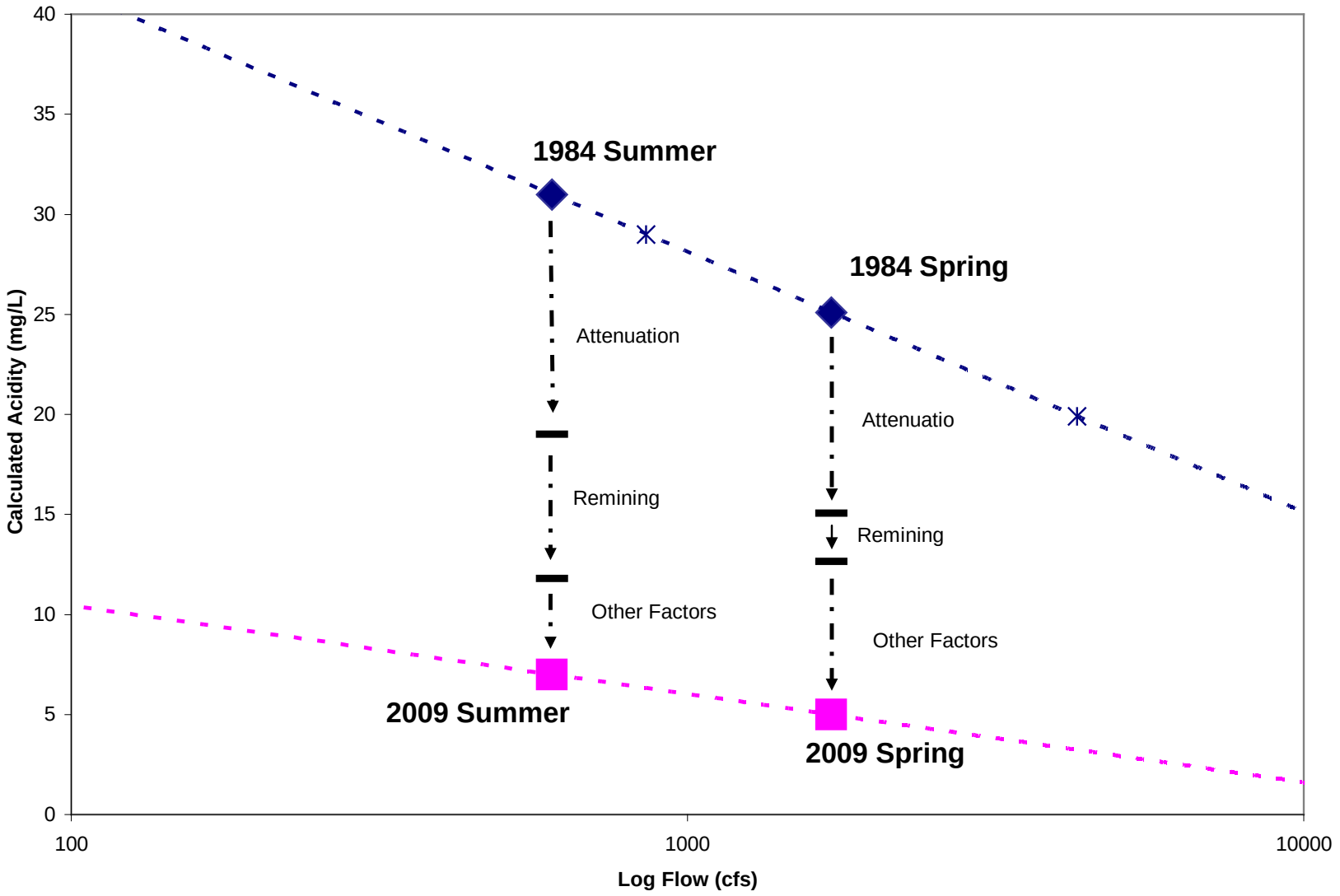
- **Median acidity load reduction = 61%**

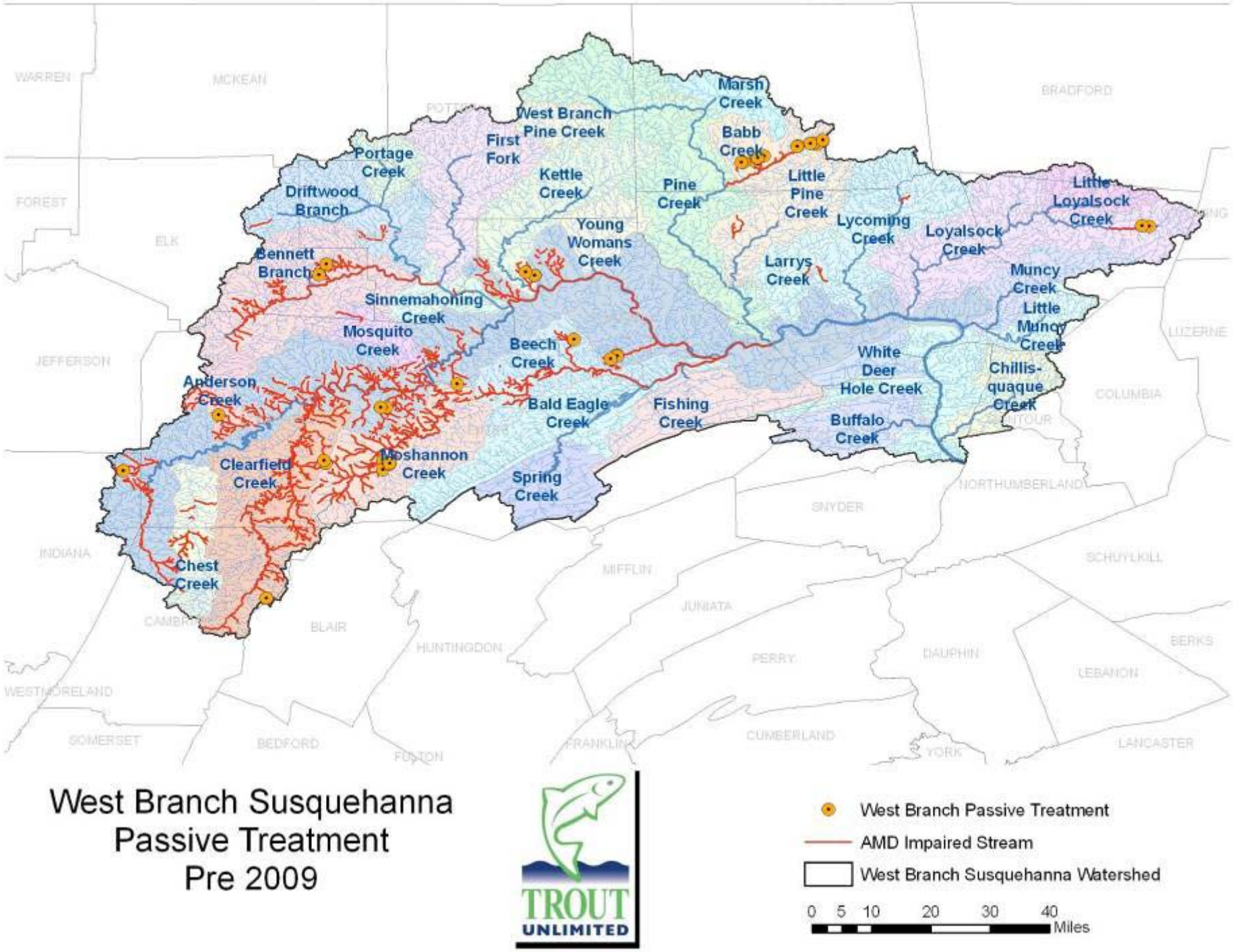
Estimated ~8,111 acres remined

West Branch at Karthaus



West Branch at Karthaus





West Branch Susquehanna Passive Treatment Pre 2009

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West Branch Passive Treatment

AMD Impaired Stream

West Branch Susquehanna Watershed

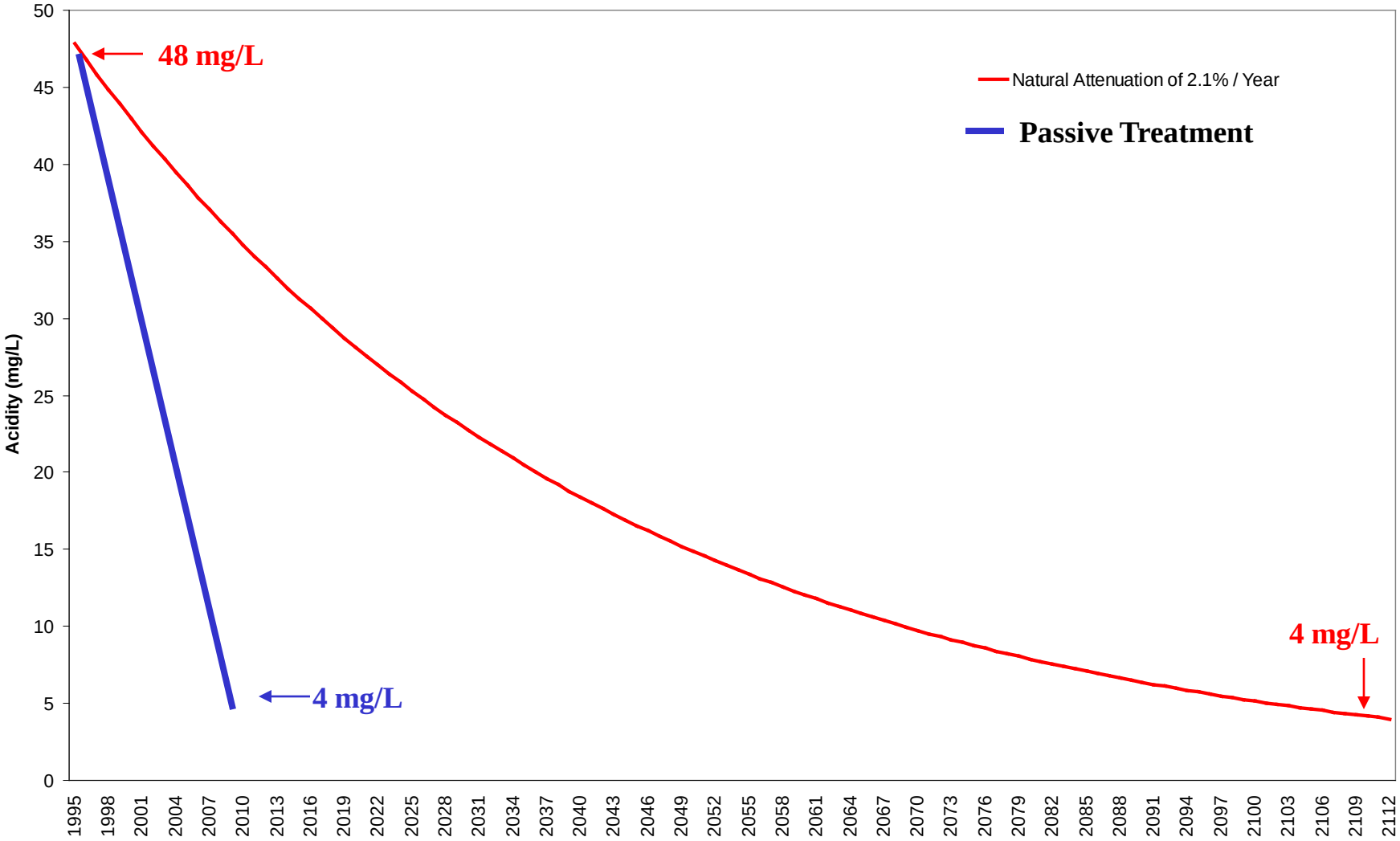
0 5 10 20 30 40 Miles

Middle Branch Passive Treatment System

Raw AMD
pH = 3.2
Acidity (mg/L) = 125
Fe (mg/L) = 1.0
Mn (mg/L) = 10.0
Al (mg/L) = 19.3

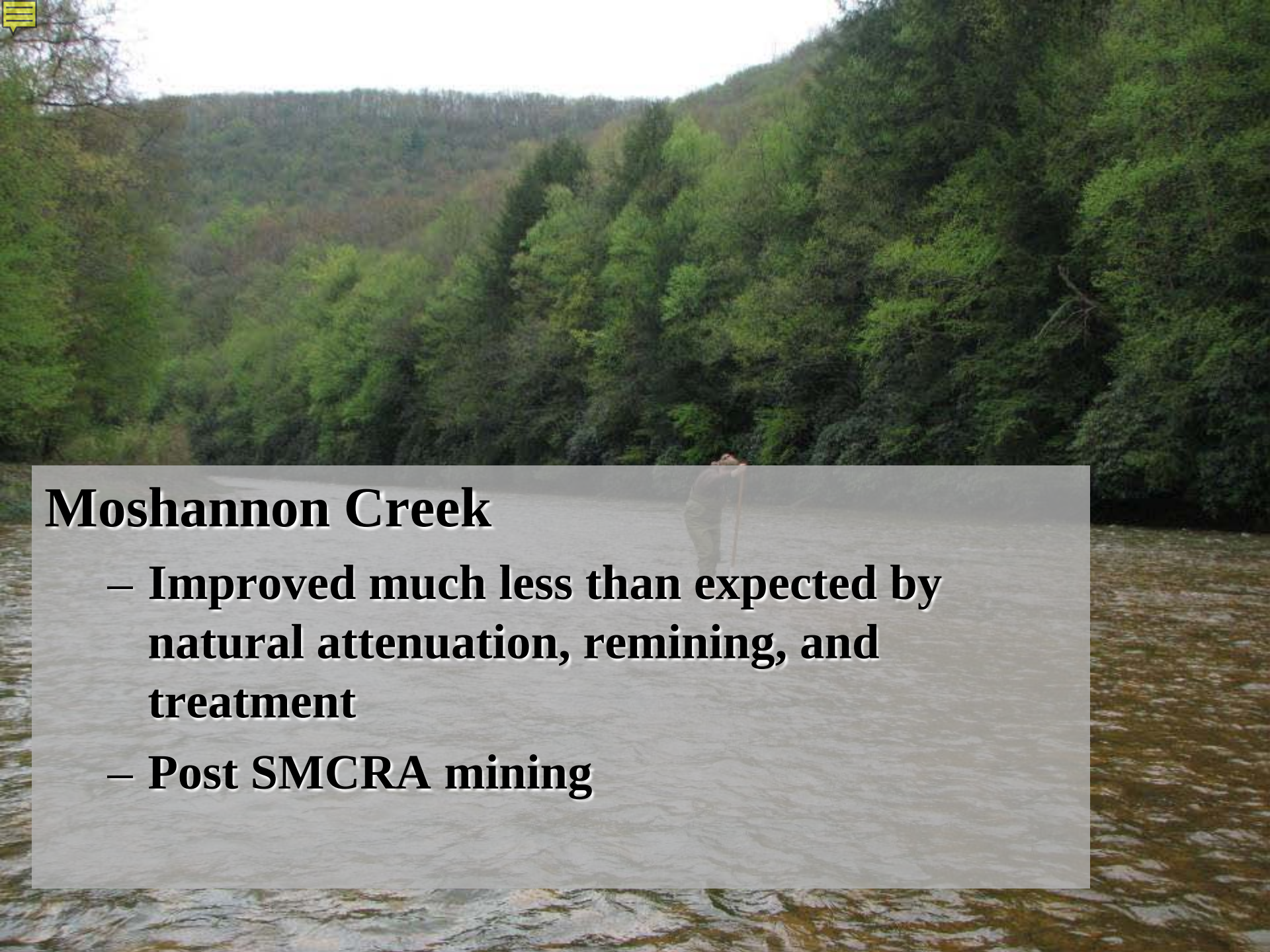
Effluent
pH = 7.1
Acidity (mg/L) = -80
Fe (mg/L) = 0.2
Mn (mg/L) = 4.0
Al (mg/L) = 0.6

Middle Branch of Twomile Run



Clearfield Creek

- Improved much more than expected by natural attenuation, remining, and treatment
- Mining in the middle Kittaning and Upper Freeport Coal seams: have increased alkalinity over background



Moshannon Creek

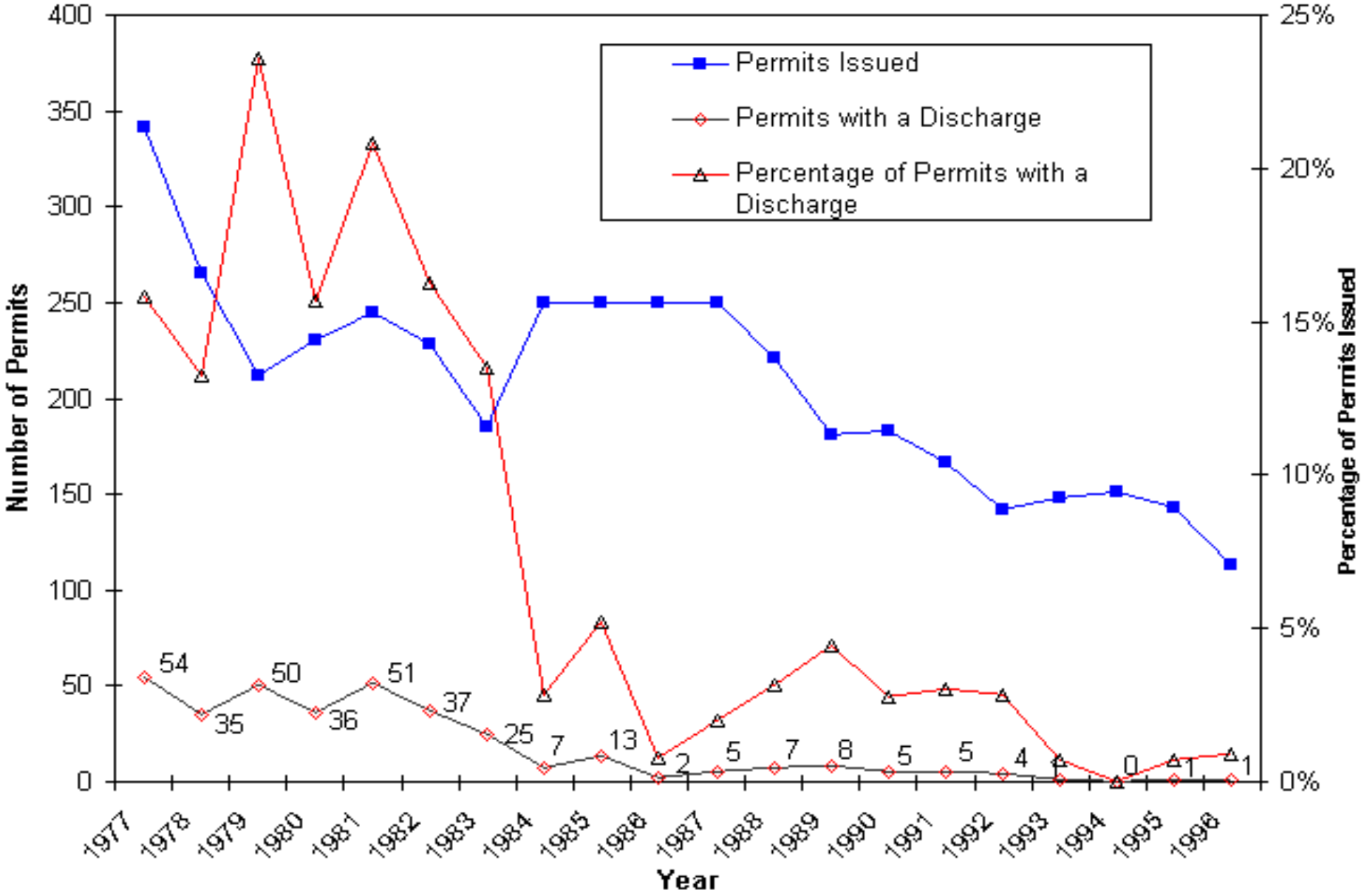
- Improved much less than expected by natural attenuation, remining, and treatment
- Post SMCRA mining

Alder Run

- Got worse
- “Bad Permitting”

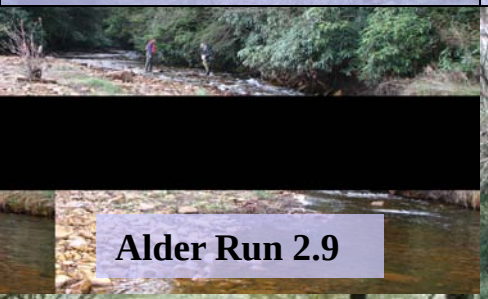
Permits with post-mining discharges:

1977 – 1996



The “Ugliest” of 2009

pH	acidity	Fe	Al



Alder Run 2.9

UNT 25913 2.9

Milligan 2.9

~1,200 miles of impaired stream in the West Branch

Alder Run 247 mg/L

Milligan Run 19.2 mg/L

Alder Run 46.6 mg/L

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