Evaluating Systems to Reduce Road Improvement Impacts on Mountain Streams

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The Problem:

- Narrow drainage ditches along DOT roadways in the mountains have had limited sediment control BMP options (usually rock checks and small basins), often giving unsatisfactory results.

The Problem:

- Designated trout streams (common in up mountains) have a turbidity limit of 10 NTU for stormwater runoff. This is very strict (50 NTU is normal limit) and hard to meet under the best of circumstances.

Loss of Wildlife Habitat

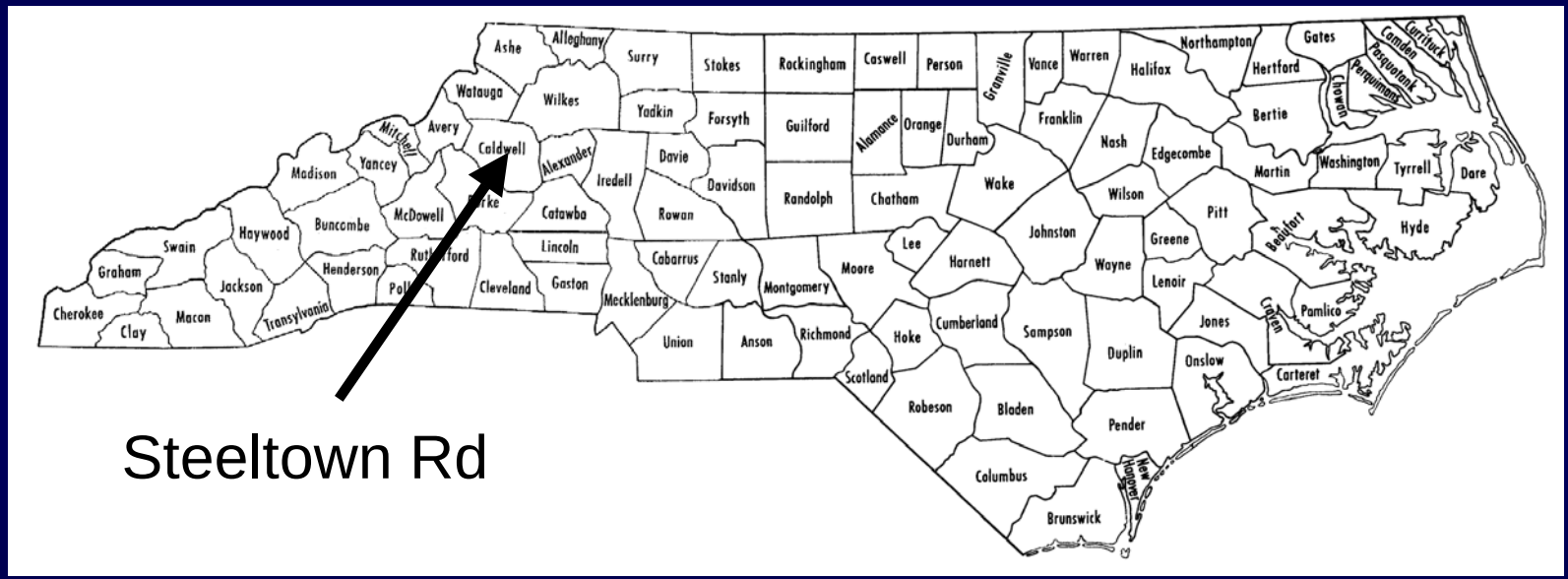
Loss of Aquatic Organisms

The Problem:

- So, alternate BMPs were tested to determine if they could improve runoff water quality as compared to the standard DOT BMPs.

Project Site: Steeltown Rd

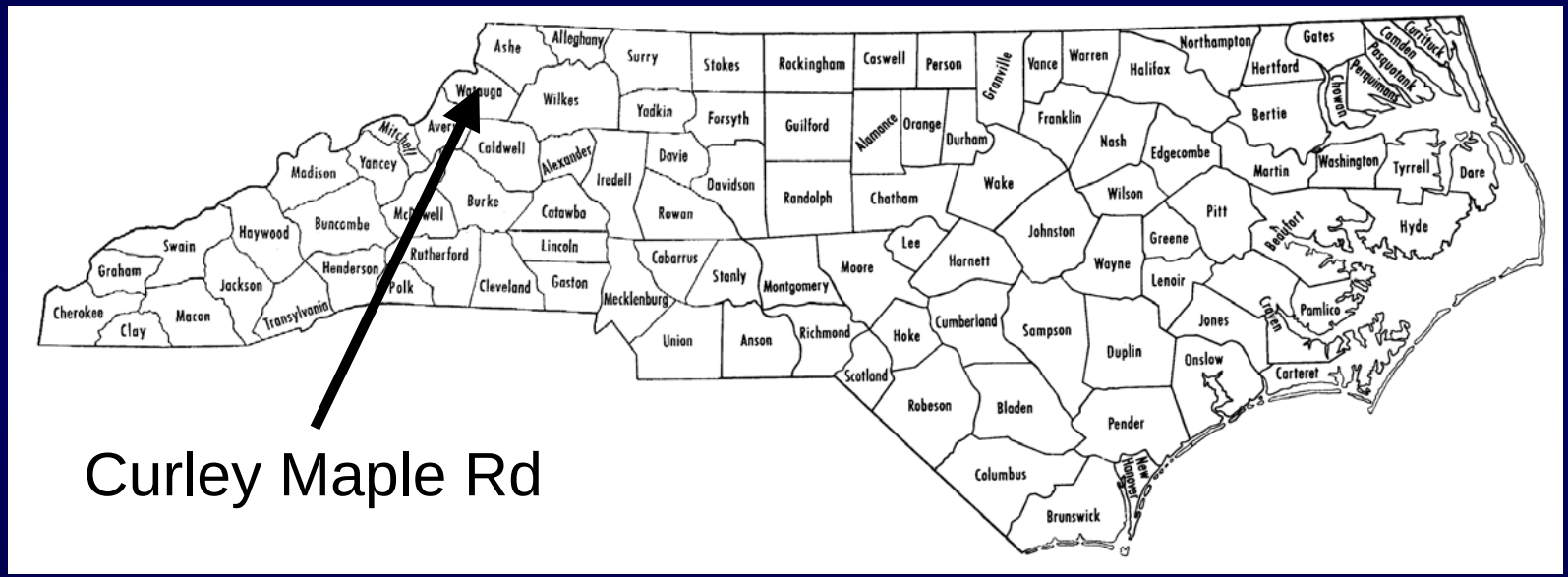
Caldwell County, just East of Patterson (DOT Division 11)




Project Site: Steeltown Rd

Project Site: Curley Maple Rd

Watauga County, North of Boone (DOT Division 11)



Project Site: Curley Maple Rd

Standard BMPs – Steeltown Rd

- Rock check dams and Type B silt basins

Standard BMPs – Curley Maple Rd

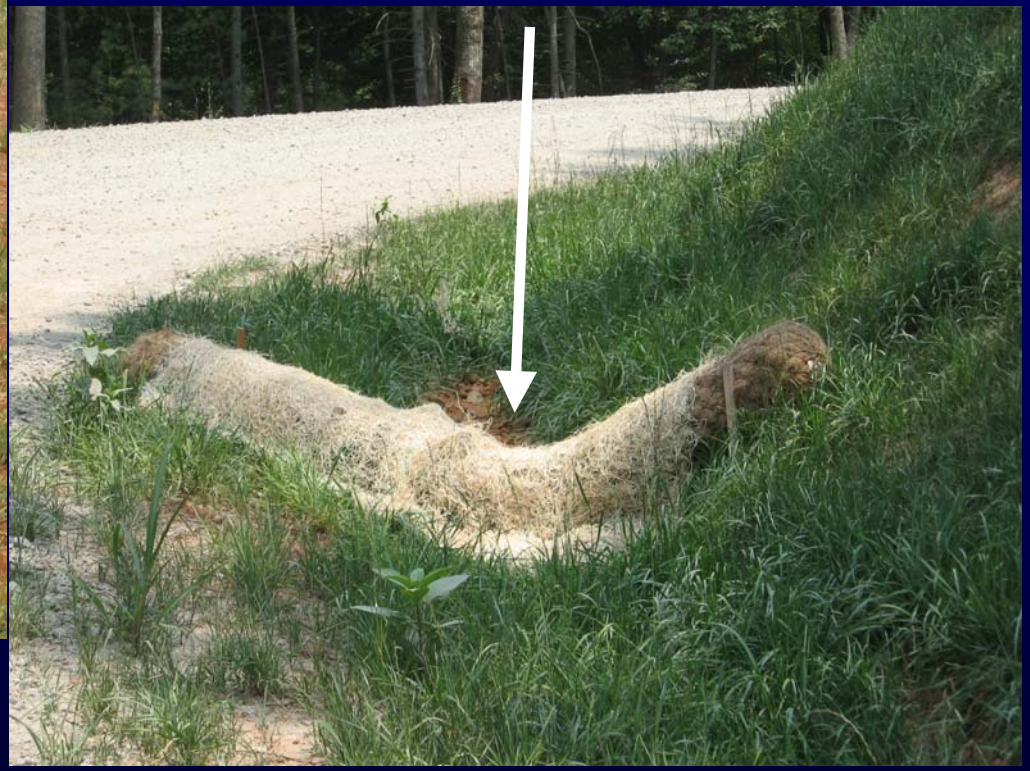
- Rock check dams with silt basins

Experimental BMPs

- Coir Logs (10’ long, 12” diameter) at $55 each

Photos from Steeltown Rd Site

Note: Erosion control matting placed on top of, or underneath, the center section of each BMP



Experimental BMPs

- Coir Logs (10’ long, 12” diameter) at $55 each

Photos from Curley Maple Rd Site

Experimental BMPs

- Straw wattles (10’ long, 9” diameter) at $20 each

Photos from Steeltown Rd Site

Note: Erosion control matting placed on top of, or underneath, the center section of each BMP

Experimental BMPs

- Straw wattles (10’ long, 9” diameter) at $20 each

Photos from Curley Maple Rd Site

Note: Erosion control matting placed on top of, or underneath, the center section of each BMP

Experimental BMPs

- Granulated Polyacrylamide - PAM 705 added to BMPs (anionic PAM approved for use by DWQ)
  Apx. 100 grams added after every significant storm event

Steeltown site layout:

461’ long at 6% slope

450’ long at 5% slope

Pipes crossing under road

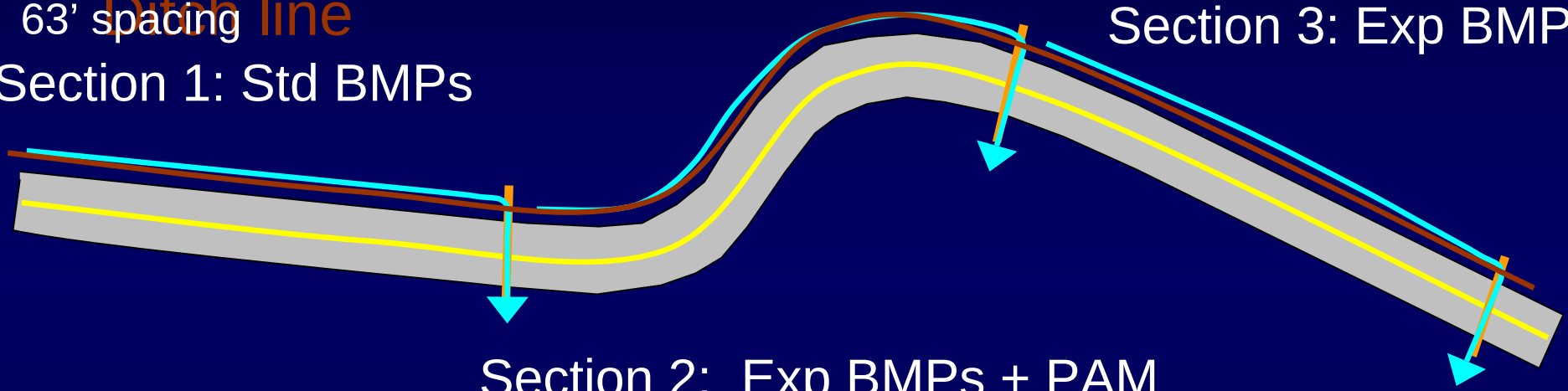
25’ spacing

63’ spacing

Ditch line

Section 3: Exp BMPs

Section 1: Std BMPs



Section 2: Exp BMPs + PAM

668’ long at 7% slope

32’ spacing

Project Site: Steeltown Rd

Weir installed for each section at culvert crossing

Standard BMPs over time – 5 months after paving

Standard BMPs over time – 5 months after paving

Standard BMPs over time – 5 months after paving

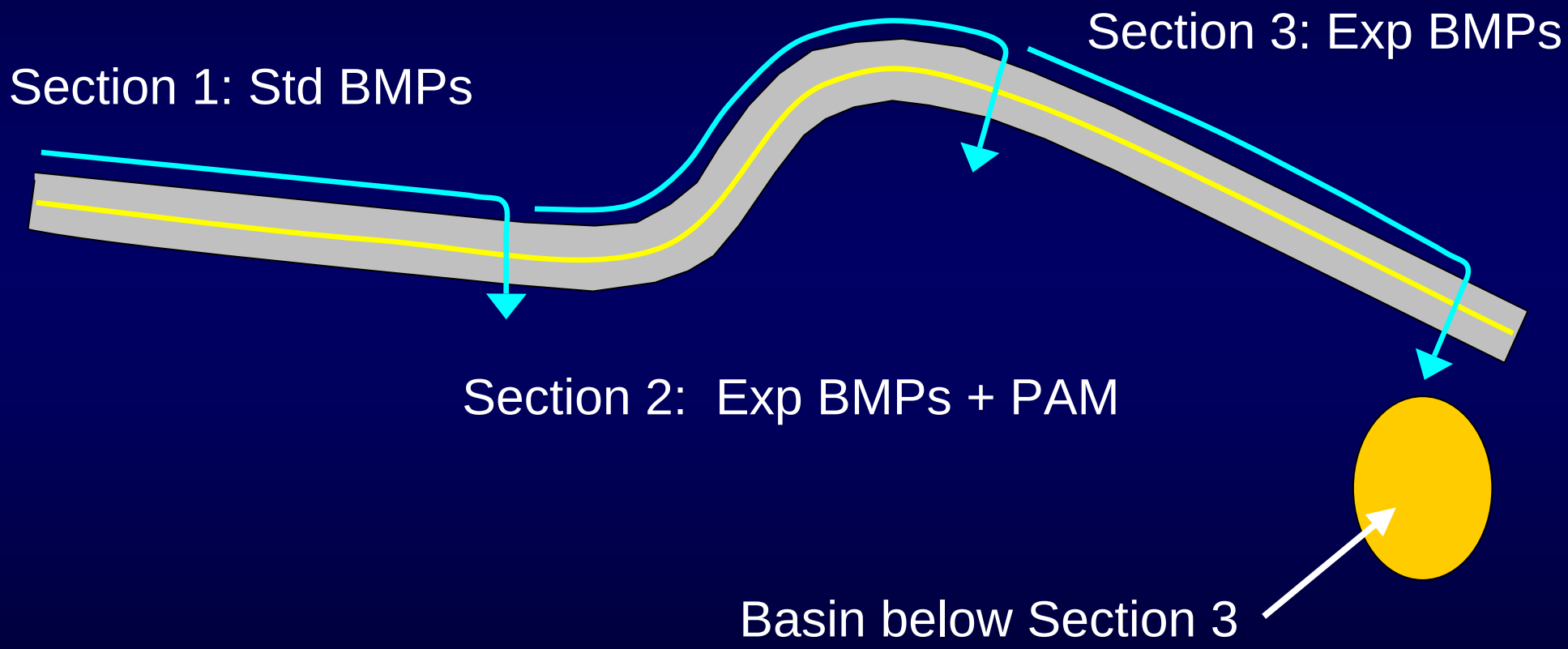
Standard BMPs over time – 5 months after paving

Standard BMPs over time – 5 months after paving

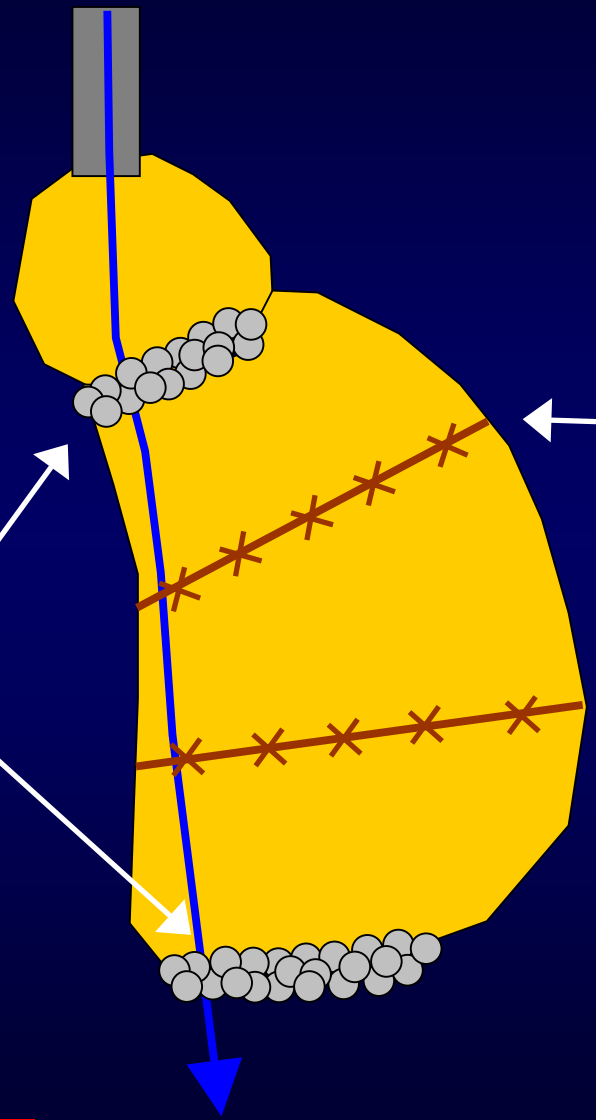
Exp BMPs over time – 5 months after paving

Exp BMPs over time – 5 months after paving

Steeltown site layout:



Steeltown basin design:

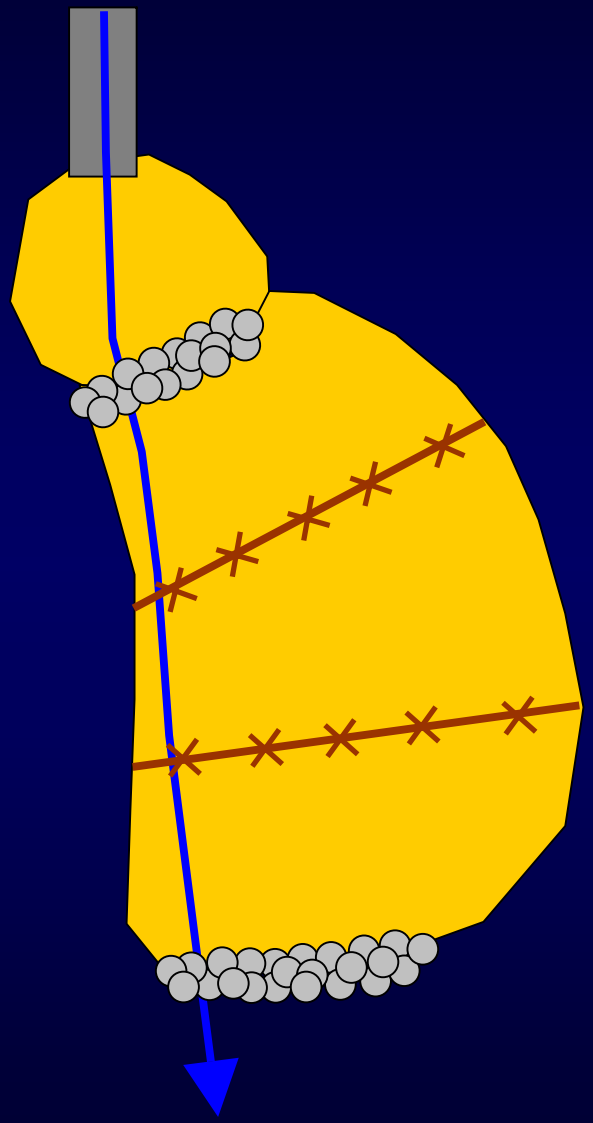


Coir Baffles

Flow was concentrated and bypassed baffles

Rock Outlets

Steeltown basin design:



Flow sampled at basin outlet was more turbid than Section 3 discharge flowing into the basin.

In fact, an average turbidity increase of 416 NTU was observed!

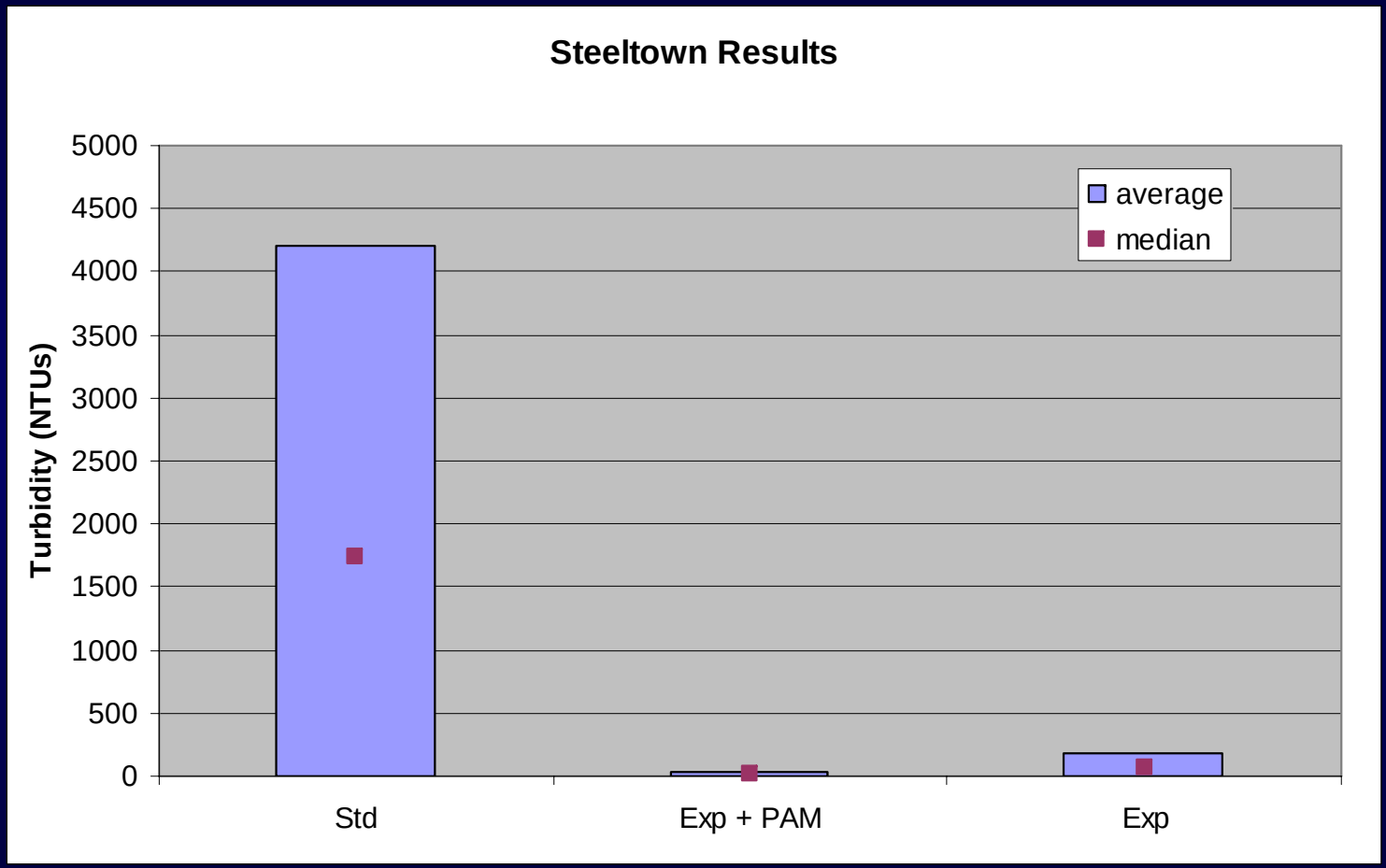
Results: Steeltown Rd

(Samples collected June 2006 to March 2007)

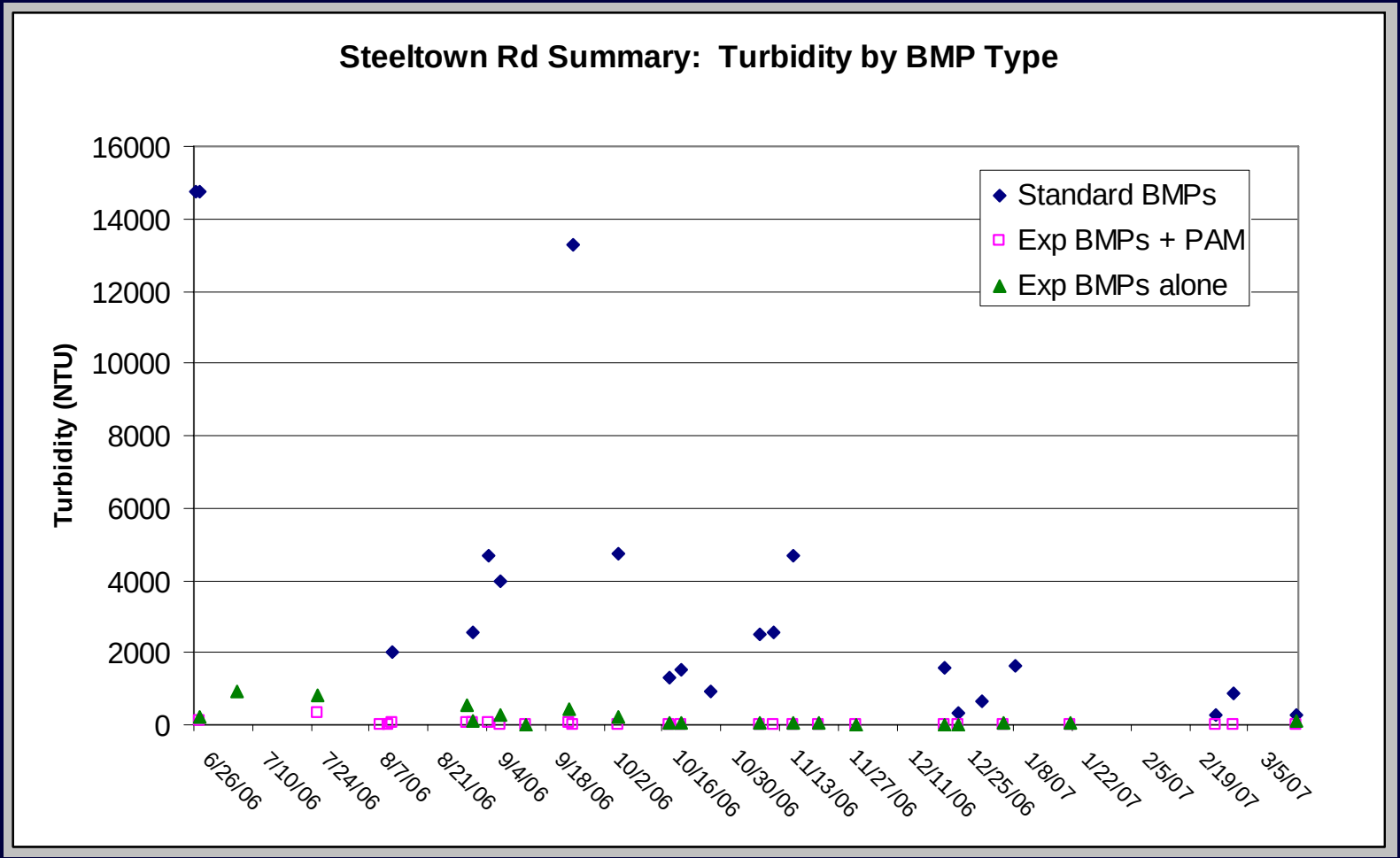
Turbidity (NTUs)	Standard	Exp+PAM	Exp
Average	4,198	30	187
Std Dev	6,552	120	426
Median	1,737	12	65

Note: Exp+PAM was the longest and steepest section!

Results: Steeltown Rd



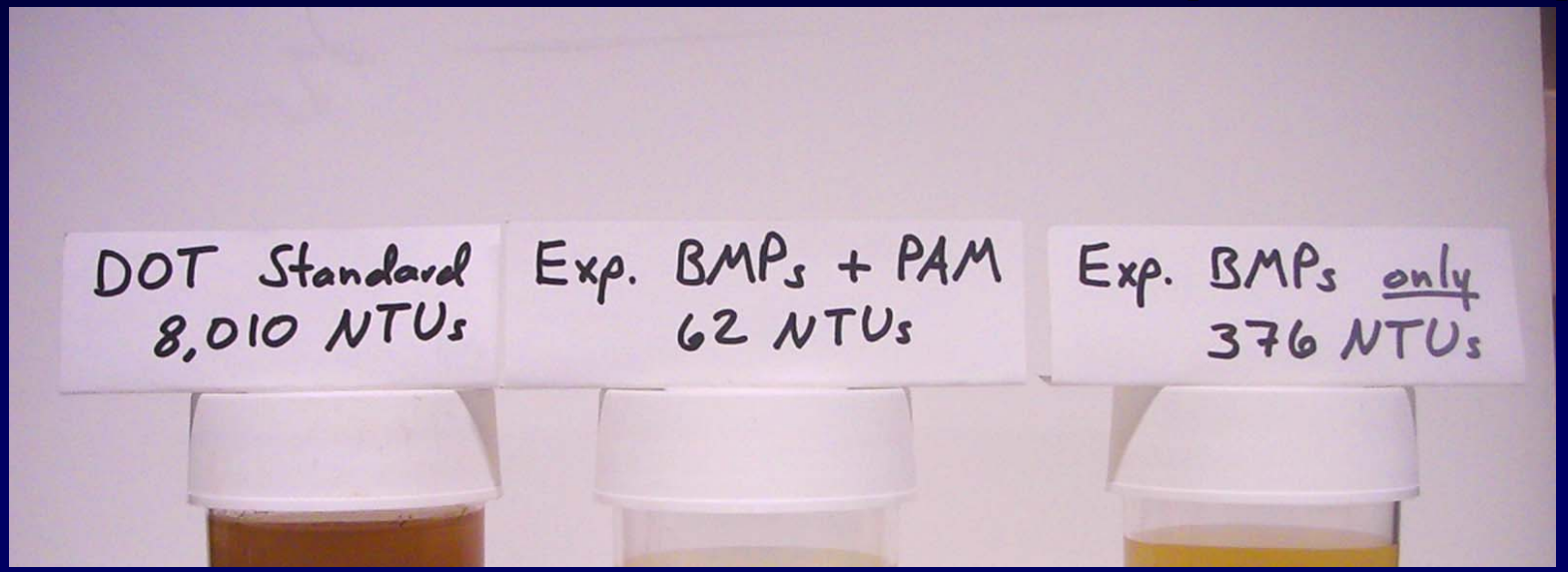
Results: Steeltown Rd



Results: Steeltown Rd

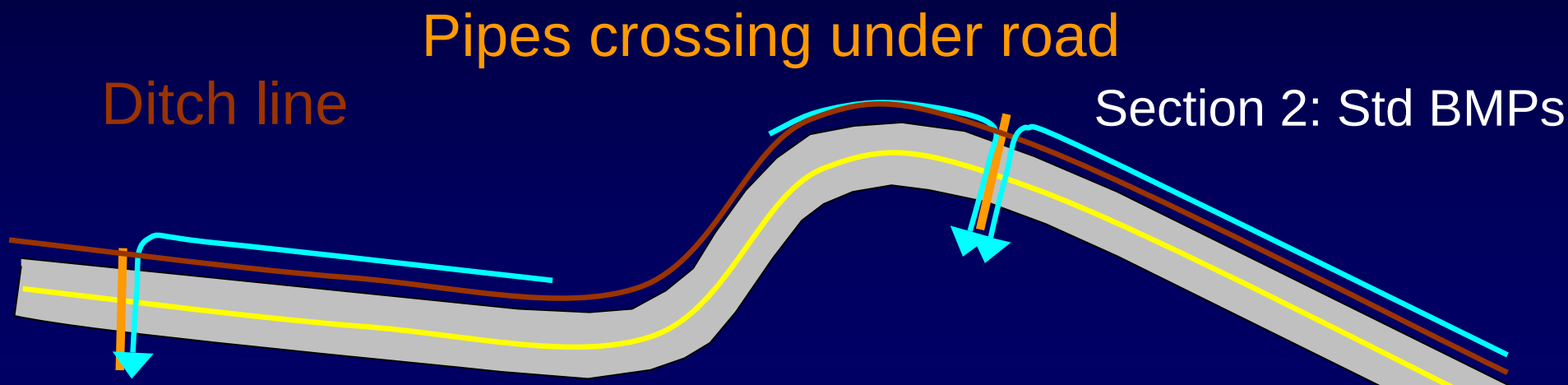
Sediment Loading (kg)	Standard	Exp+PAM	Exp
Total Sum	9,415	24	59
Average per storm event	448	1	3

Results: Steeltown Rd (Dec 06)



Some initial storms had 14,000+ NTU for Standard BMPs but just 190 and 250 NTU for Exp BMPs!

Curley Maple site layout:



Section 1: Exp BMPs + PAM

489’ long at 3% slope

27’ spacing

507’ long at 3% slope

85’ spacing

Project Site: Curley Maple Rd

- Samplers placed at culvert outfall

Standard BMPs over time – 5 months later

Standard BMPs over time – 5 months after paving

Exp BMPs over time – 5 months later

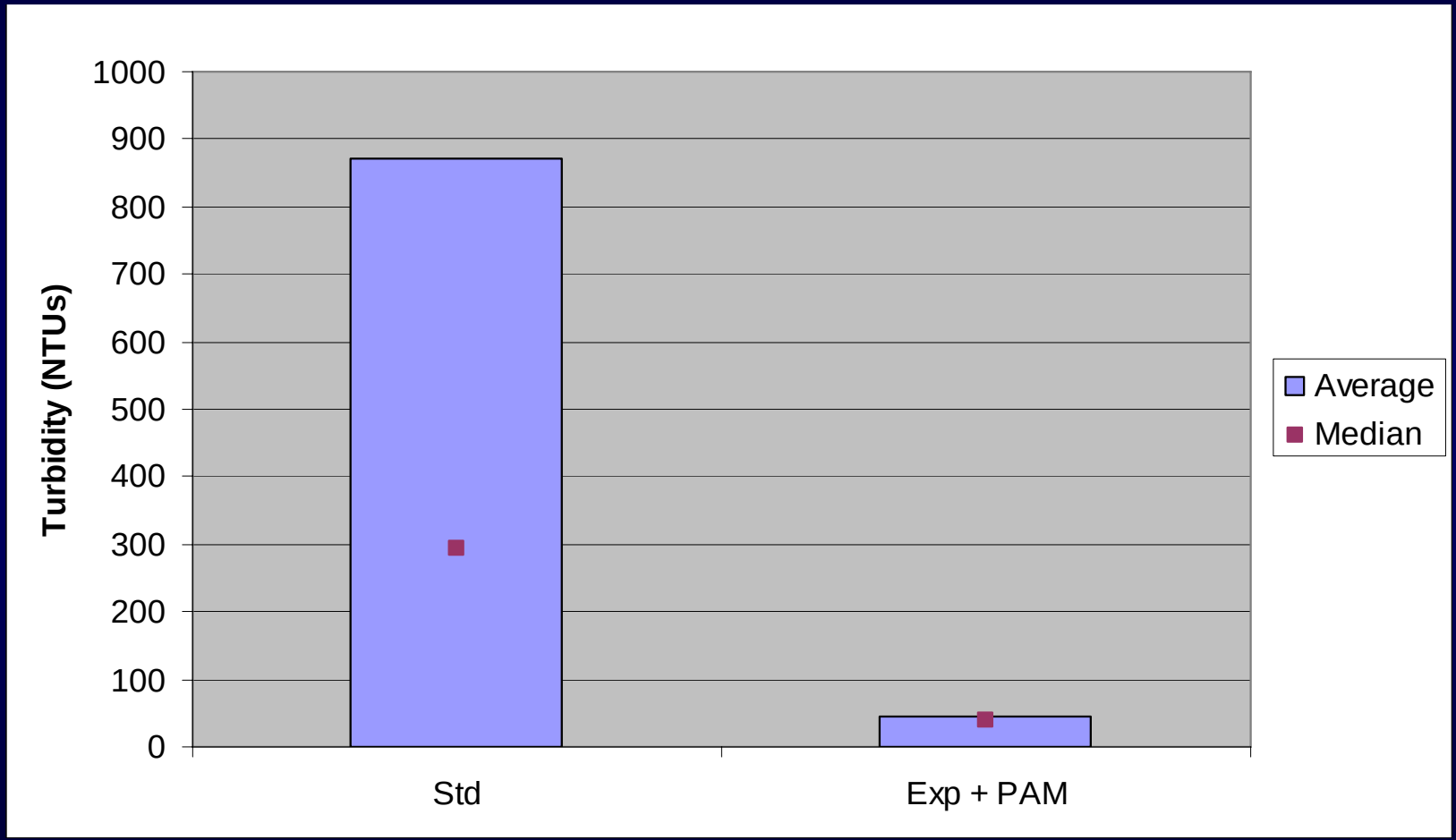
Exp BMPs over time – 5 months later

Results: Curley Maple Rd

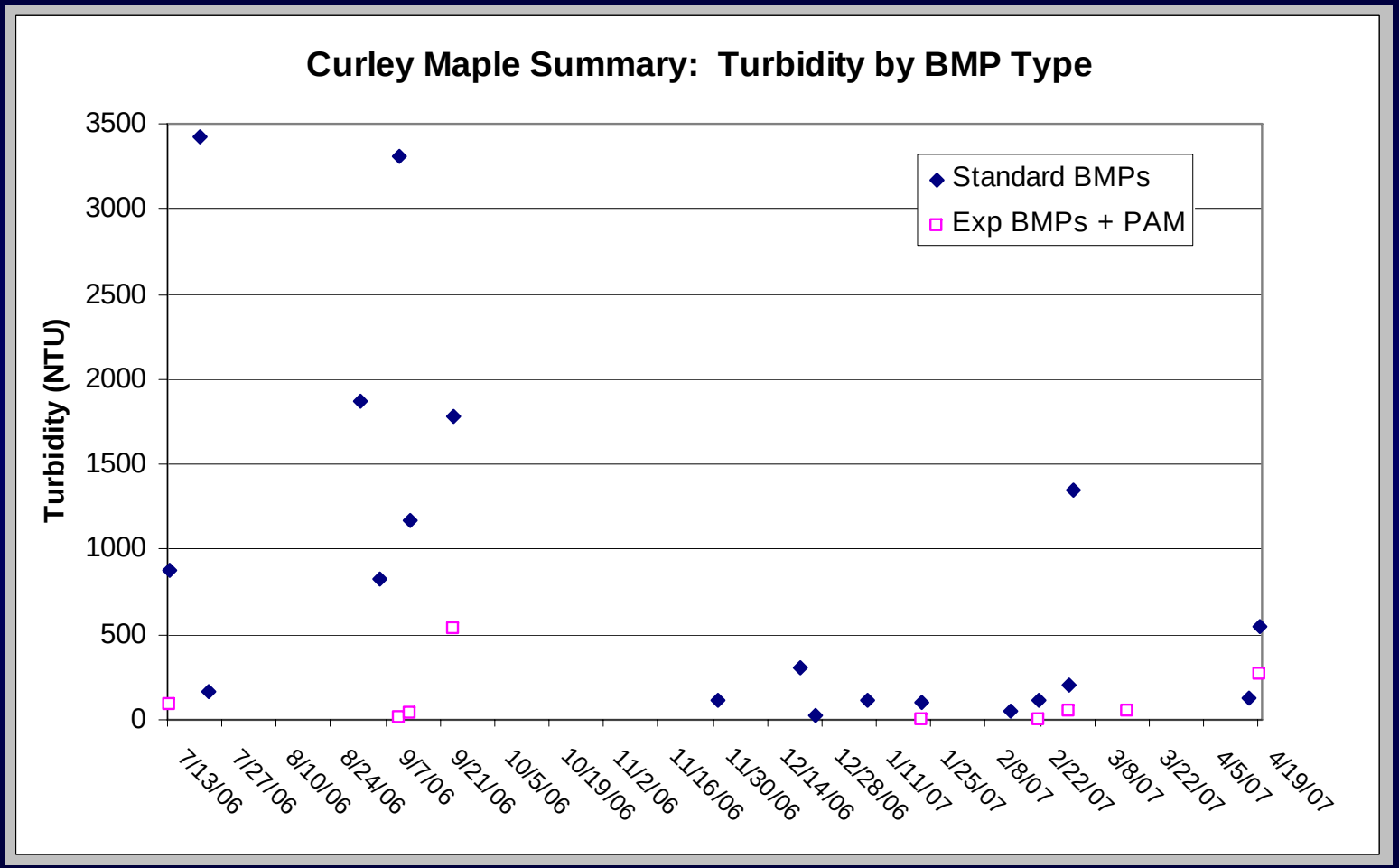
(Samples collected July 2006 to March 2007)

Turbidity (NTUs)	Standard	Exp+PAM
Average	852	64
Std Dev	1,265	108
Median	305	40

Results: Curley Maple Rd



Results: Curley Maple Rd



Results: Curley Maple Rd

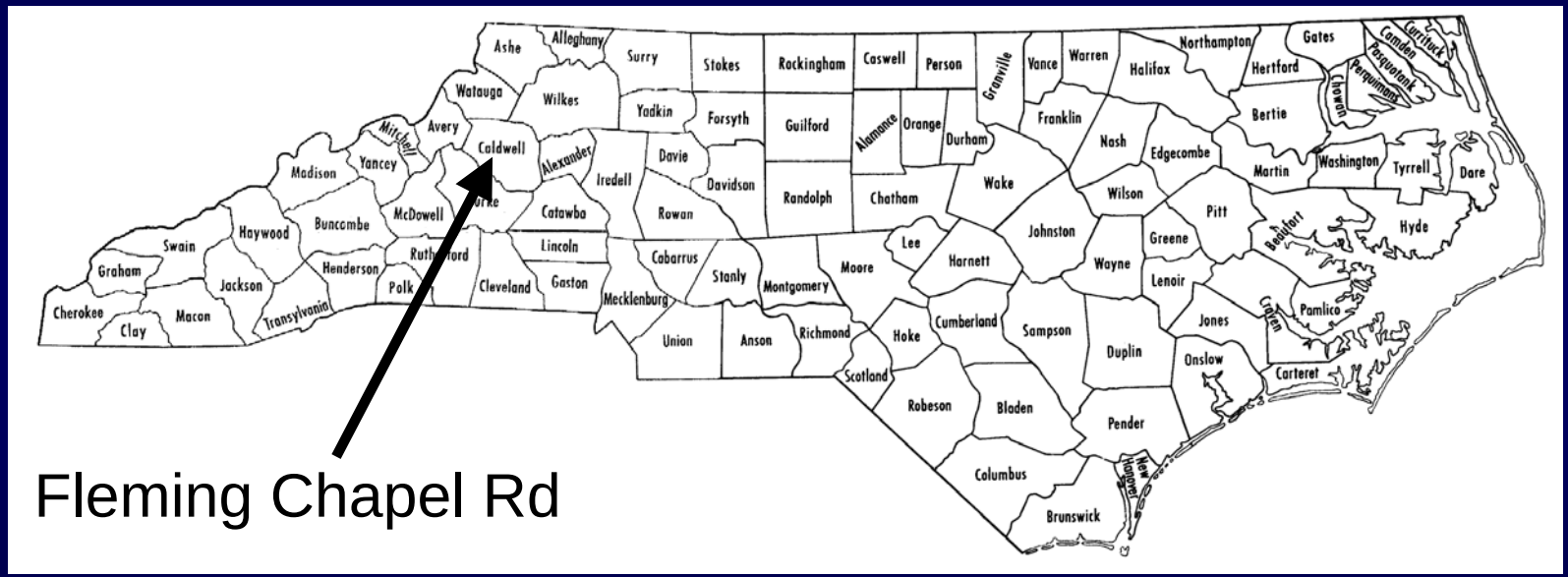
Sediment Loading (kg)	Standard	Exp+PAM
Total Sum	65	7
Average per storm event	4	1

Results: Curley Maple Rd (Dec 06)

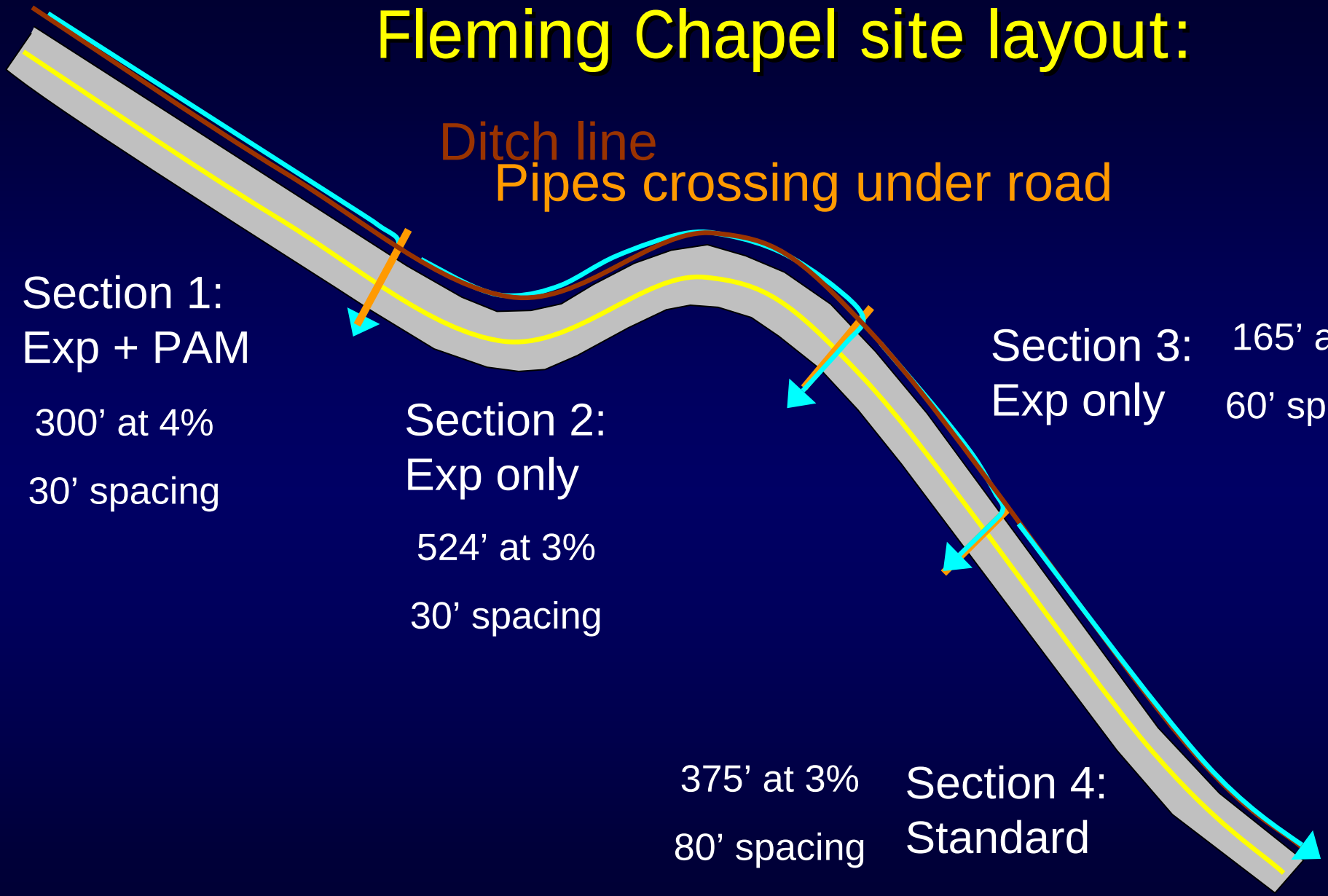
Some initial storms had 1,000-2,000 NTU for Standard BMPs but just 90 to 180 NTU for Exp BMPs!

Project Site: Fleming Chapel Rd

Caldwell County, West of Lenoir (DOT Division 11)



Fleming Chapel site layout:



Section 1:
Exp + PAM

300’ at 4%

30’ spacing

Section 2:
Exp only

524’ at 3%

30’ spacing

Section 3:
Exp only

165’ at 3%

60’ spacing

375’ at 3%

80’ spacing

Section 4:
Standard

Experimental BMPs

- Coir wattles (6’ long, 6” and 9” diameter) at $25 each

Note: Erosion control matting placed over center section of each BMP

Photos from Fleming Chapel Rd Site

Project Site: Fleming Chapel Rd

Weirs placed over culvert outfall

Project Site: Fleming Chapel Rd

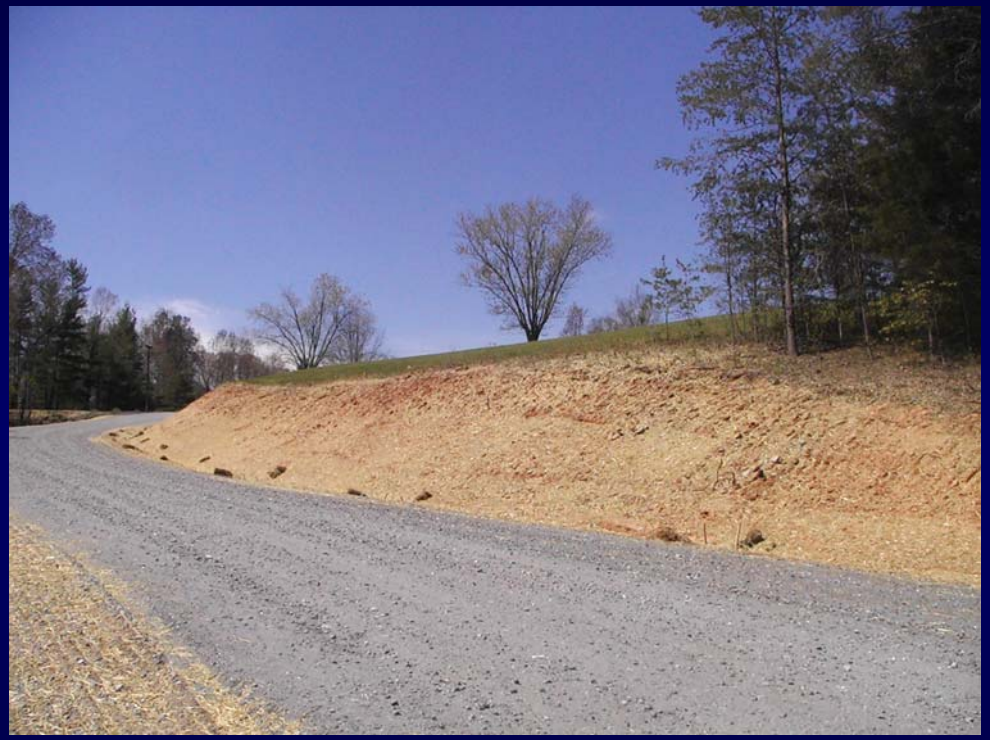
DOT Standard Section

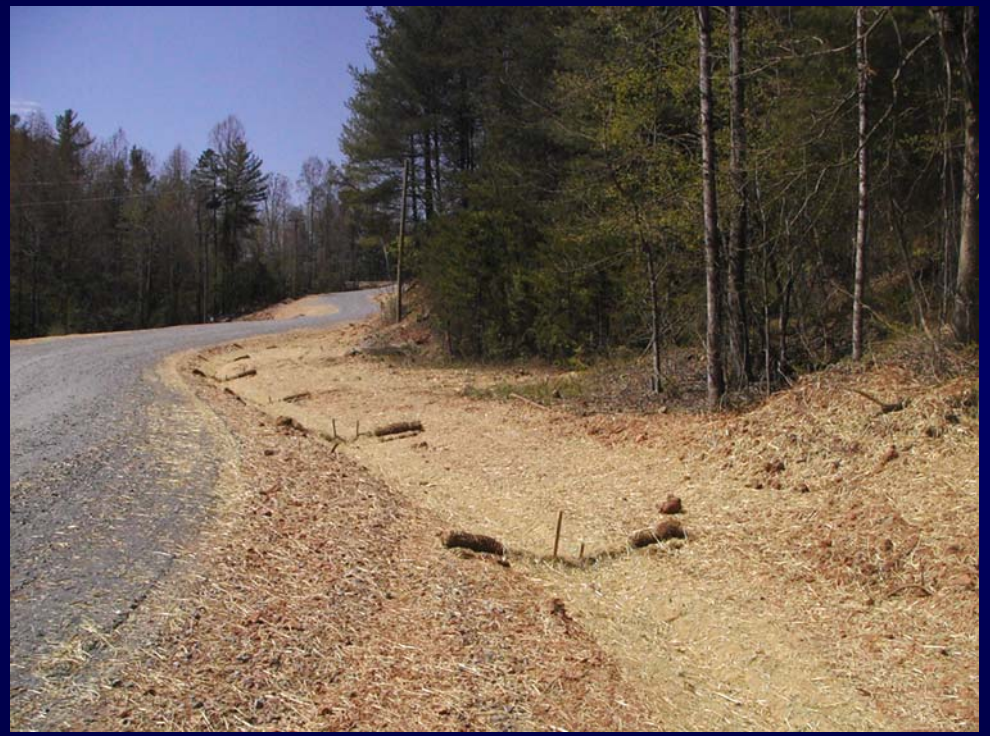
April 2007

June 2007

Project Site: Fleming Chapel Rd

Experimental Sections





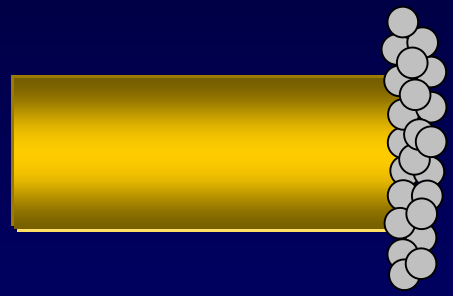
Results: Fleming Chapel

	Average Turbidity (NTU)	Sediment Load (kg)
Standard		
4/15/200	5744	323
6/12/2007	7310	12
6/14/2007	7915	30
Experimental plus PAM		
6/12/2007	304	16
Experimental alone (30' spacing)		
4/15/2007	5335	100
Experimental alone (60' spacing)		
4/15/2007	7474	51
6/12/2007	4796	17
6/14/2007	4992	11

Experimental plus PAM the cleanest by far!

Cost Estimate Comparison

Standard DOT BMP costs:



Silt Basin
$15

Rock check
$80

Total: $95

Plus maintenance cost $15

Cost Estimate Comparison

Experimental BMP costs:

Coir Log $62

Straw Wattle $27

Costs include staples, stakes, and labor.

PAM costs about $2 per 100g application

Cost Estimate Comparison

Steeltown:

450’ Standard section	**$1.26/foot to maintain**
668’ Experimental BMPs + PAM	**$1.40/foot to maintain**
461’ Experimental BMPs only	**$1.21/foot to maintain (spacing closer)**

Curley Maple:

450’ Standard section	**$1.26/foot to maintain**
668’ Experimental BMPs + PAM	**$1.40/foot to maintain**

The logs and wattles do not have to be removed either, they can decompose in place.

Conclusions

- The alternate BMPs tested showed dramatic improvements in turbidity and sediment loading at two mountain DOT sites, with a third site still be evaluated.

- These alternate BMPs are fairly easy to install, require no special maintenance, and appear economically reasonable as compared to the standard practices.

Any Questions?

Please contact:
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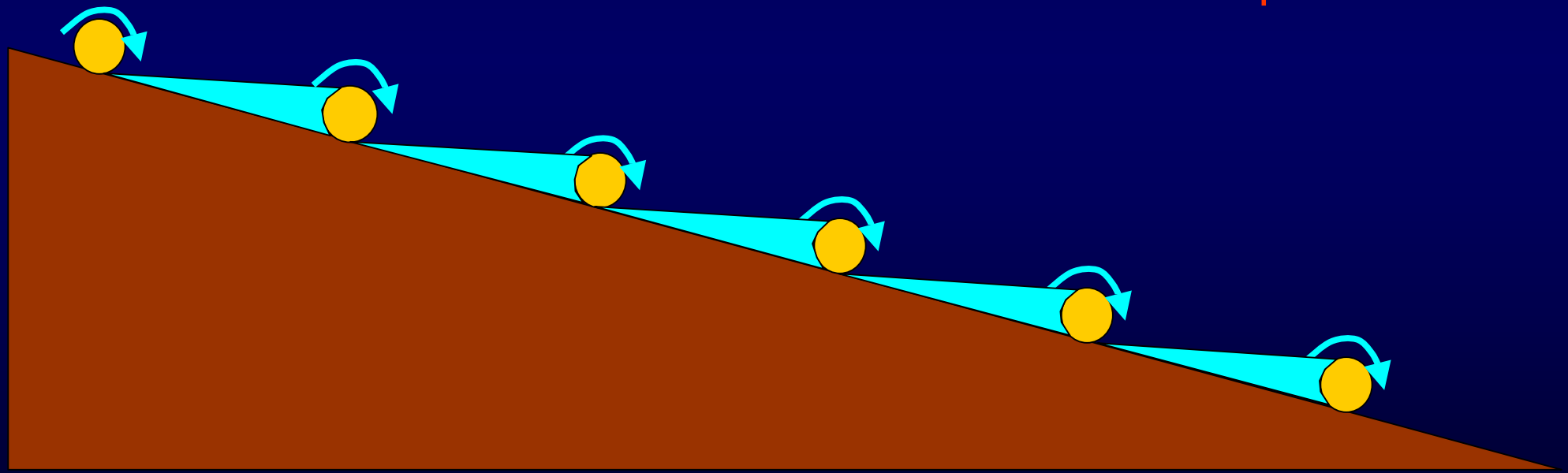
919-513-0968

Experimental BMP Spacing

- BMPs theoretically spaced such that flow goes from pool to pool…

This slows water velocity down and gives more time for water to infiltrate into the ground and causes sediment to fall out of suspension!



Standard BMP Spacing

- Standard BMPs spaced using the following DOT formula for the Mountains/Piedmont:

300 / % slope grade = spacing in ft

At Steeltown:

300 / 5% slope grade = 60’ spacing

At Curley Maple:

300 / 3.5% slope grade = 86’ spacing

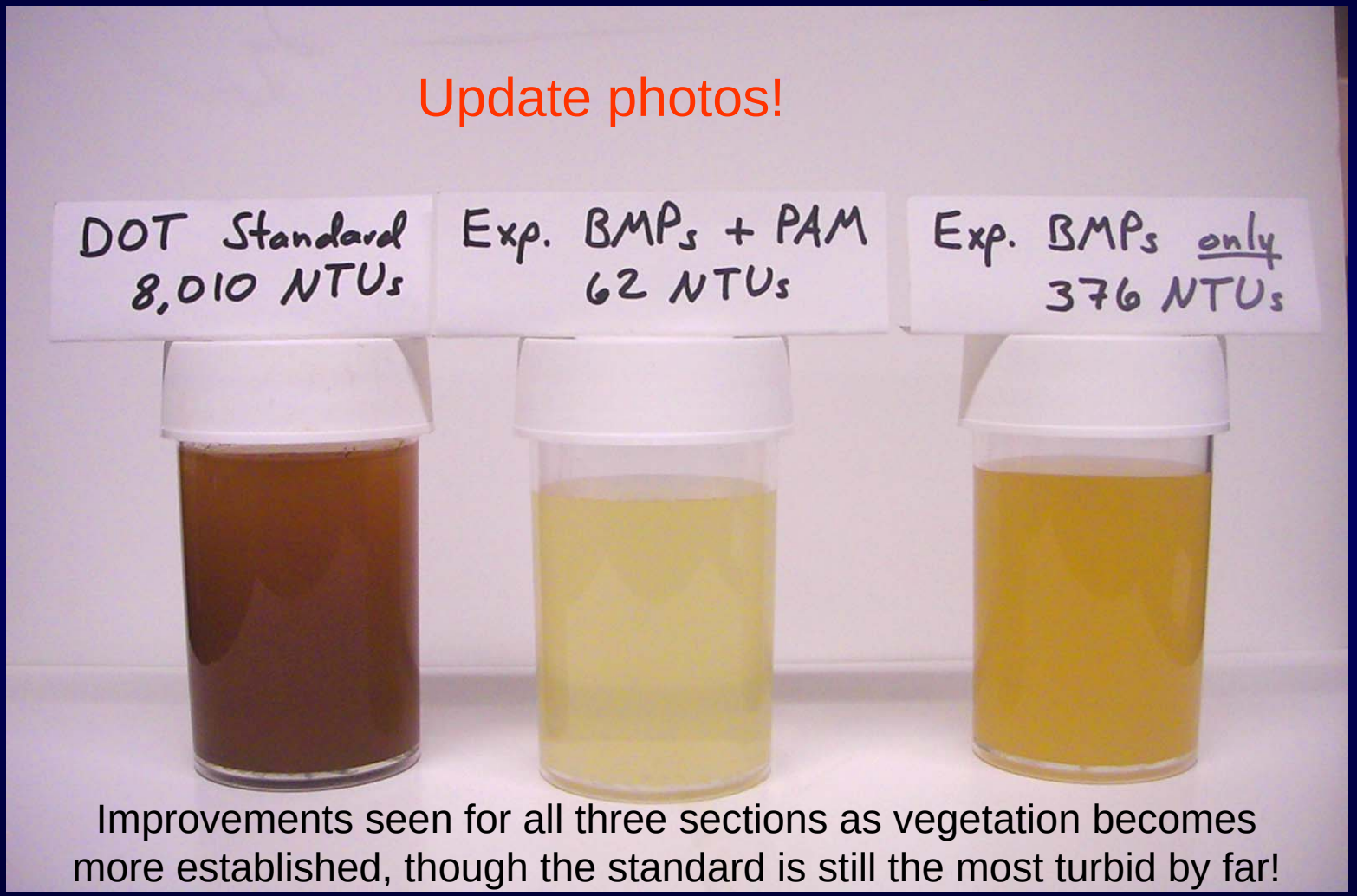
Project Site: Steeltown Rd

- Three designated sections:
  - Standard DOT BMPs (500’ at 5% slope)
    - Std BMPs spaced every 75’
  - Experimental BMPs plus PAM 705 (670’ at 7%)
  - Experimental BMPs alone (460’ at 6%)
    - Exp BMPs spaced every 30’

- Erosion control matting placed on top of, or underneath, the center section of each of the new BMPs

Results: Steeltown Rd (March 07)

Update photos!



Improvements seen for all three sections as vegetation becomes more established, though the standard is still the most turbid by far!

Project Site: Curley Maple Rd

- Two designated sections, apx. 500’ long each
  - Standard DOT BMPs (at 3% slope)

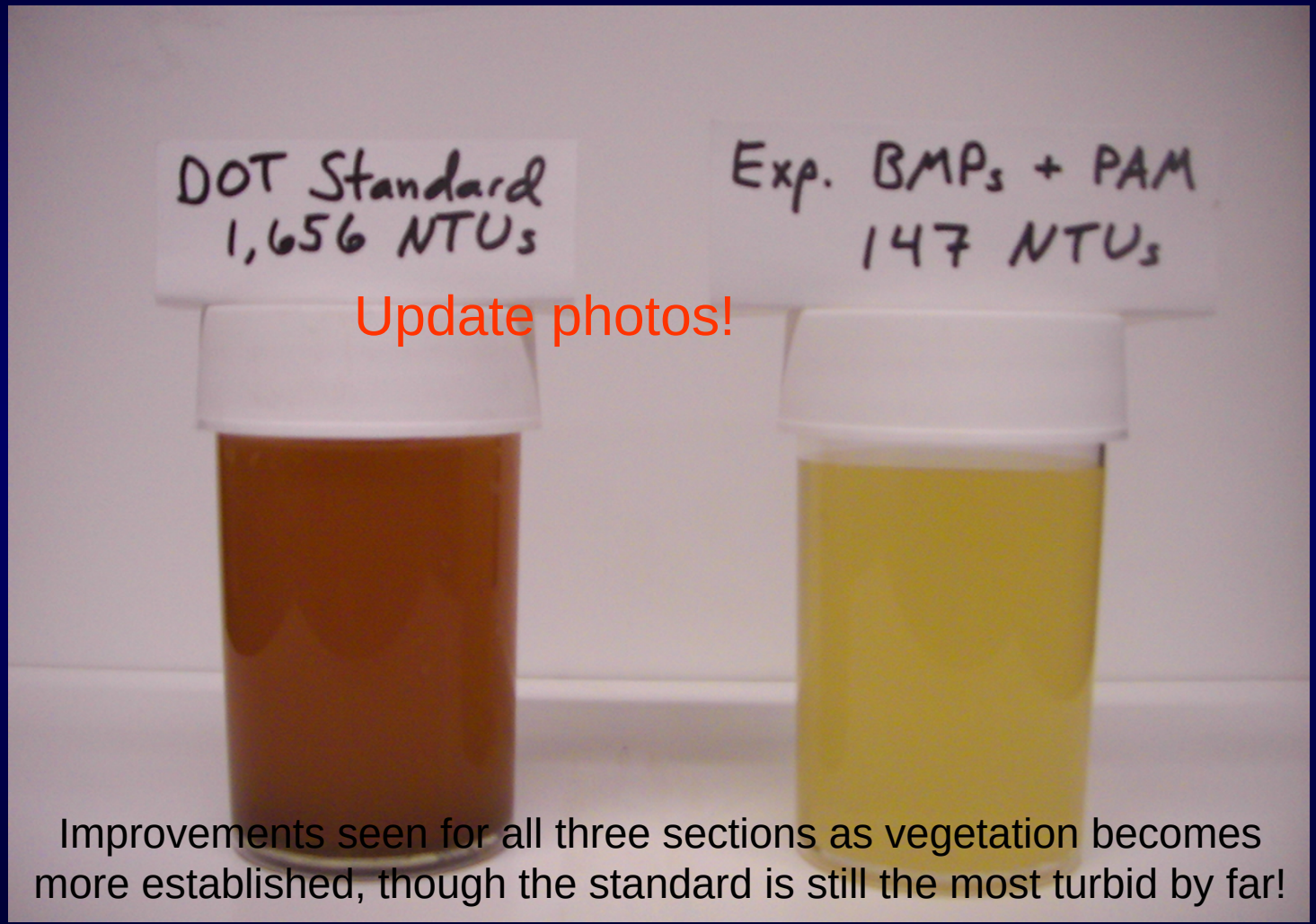
    Std BMPs spaced every 85’

  - Experimental BMPs plus PAM 705 (at 3%)

    Exp BMPs spaced about every 30’

- Erosion control matting placed on top of, or underneath, the center section of each of the new BMPs

Results: Curley Maple Rd (March 07)



Update photos!

Improvements seen for all three sections as vegetation becomes more established, though the standard is still the most turbid by far!

Steeltown Rd Site Section Descriptions			
Treatment Section	Length (ft)	Slope (%)	BMP spacing (ft)
DOT Standard BMPs	450	5	63
Experimental BMPs with PAM	668	7	32
Experimental BMPs alone (no PAM)	461	6	25