Managing TDS in the Upper Monongahela River Basin
Project WRI 119

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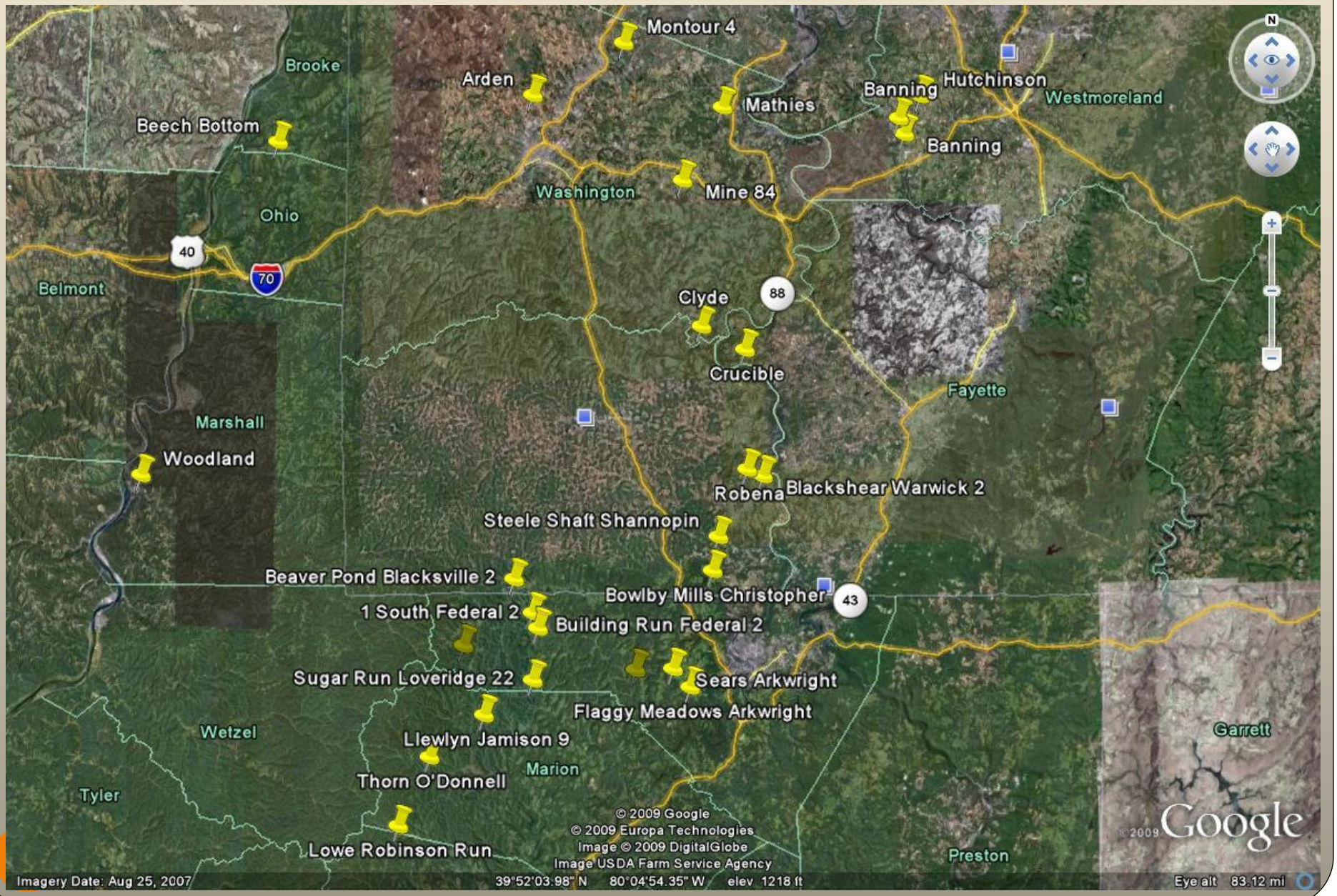
Major sources of TDS

Coal: AMD treatment plants: Regulated under CWA-NPDES
Abandoned mines

Gas: CBM
Marcellus
abandoned wells

Need to quantify each source's contribution to TDS

Pittsburgh Basin-Major AMD plants



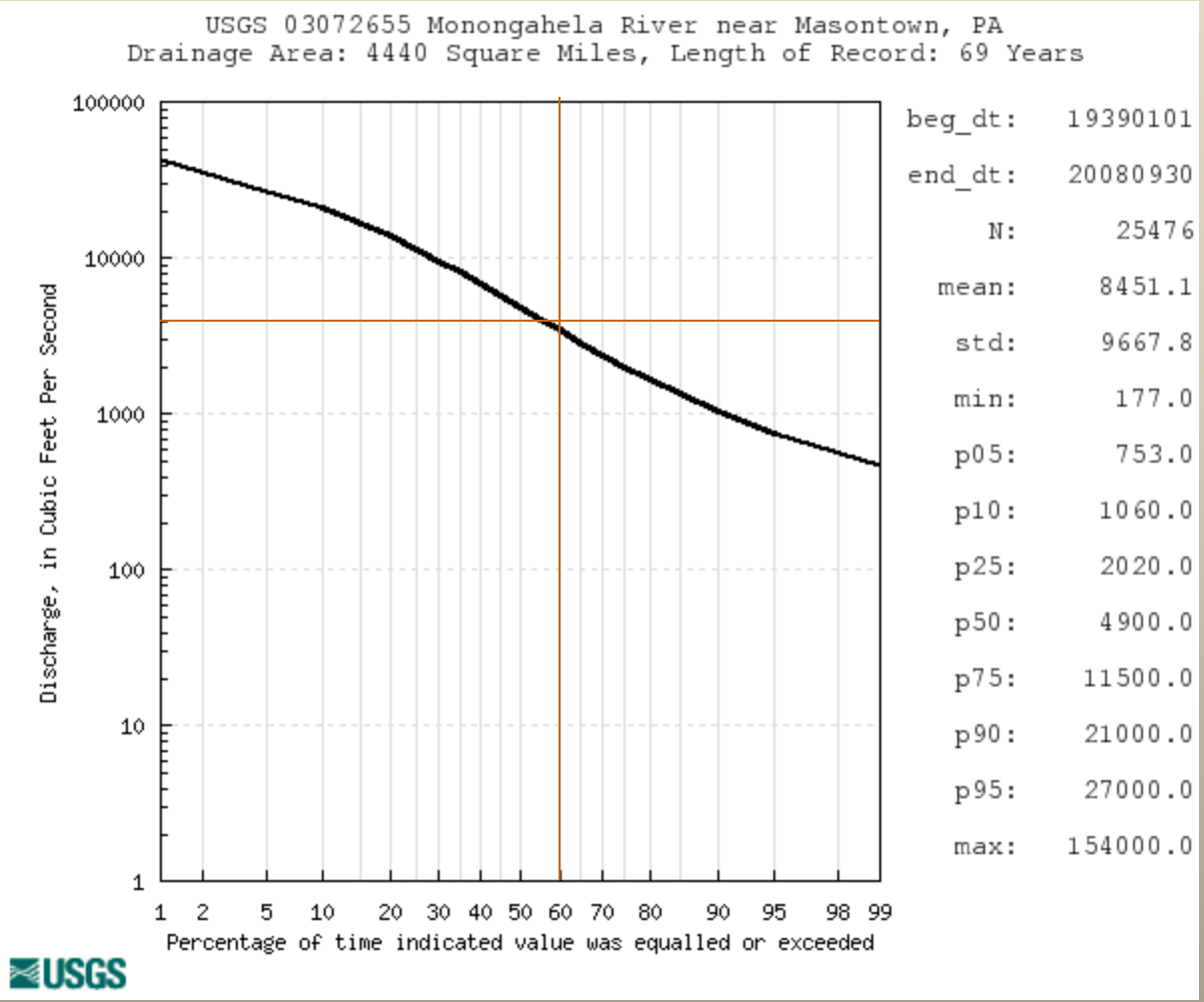
Estimated TDS loads (tpy) from Upper Mon AMD treatment plants

	average observed	maximum observed	full pump capacity
Dunkard Ck	153,340	190,784	257,950
Robinson Run (Mon Co.)	11,000	22,000	17,600
Flaggy Meadows Run	12,205	34,166	47,300
Indian Ck	12,975	30,008	115,500
Paw Paw Ck	2,200	4,400	11,550
Buffalo Ck	10,043	36,938	36,300
Robinson Run (Marion Co.)	3,900	9,779	27,500
Total	205,662	328,075	513,700

WVWRI project 119: Managing TDS

- How much TDS is coming from AMD treatment plants?
- How much comes from other sources?
- What is the assimilative capacity of Mon and tribs?
- How does that vary through the year?
- Can a coordinated pumping plan be developed?
- How to measure compliance?

Flow in the Monongahela R. at Masontown PA is greater than 3,000 cfs 60% of the time



At near maximum mine pumping rates, the [TDS] in Dunkard Ck will respond to flow

Q > 192 cfs ~50% of the time

TDS load tpy	Q cfs	[TDS] mg/L
250,000	50	5051
250,000	150	1684
250,000	250	1010
250,000	350	722
250,000	450	561

TDS in The Monongahela River

Assimilative Capacity

9 Oct 09	Pt Marion	Elizabeth	
flow	1,305	2,210	cfs
TDS	357	500	mg/L
TDS	459,176	1,089,088	tpy
difference		629,912	tpy

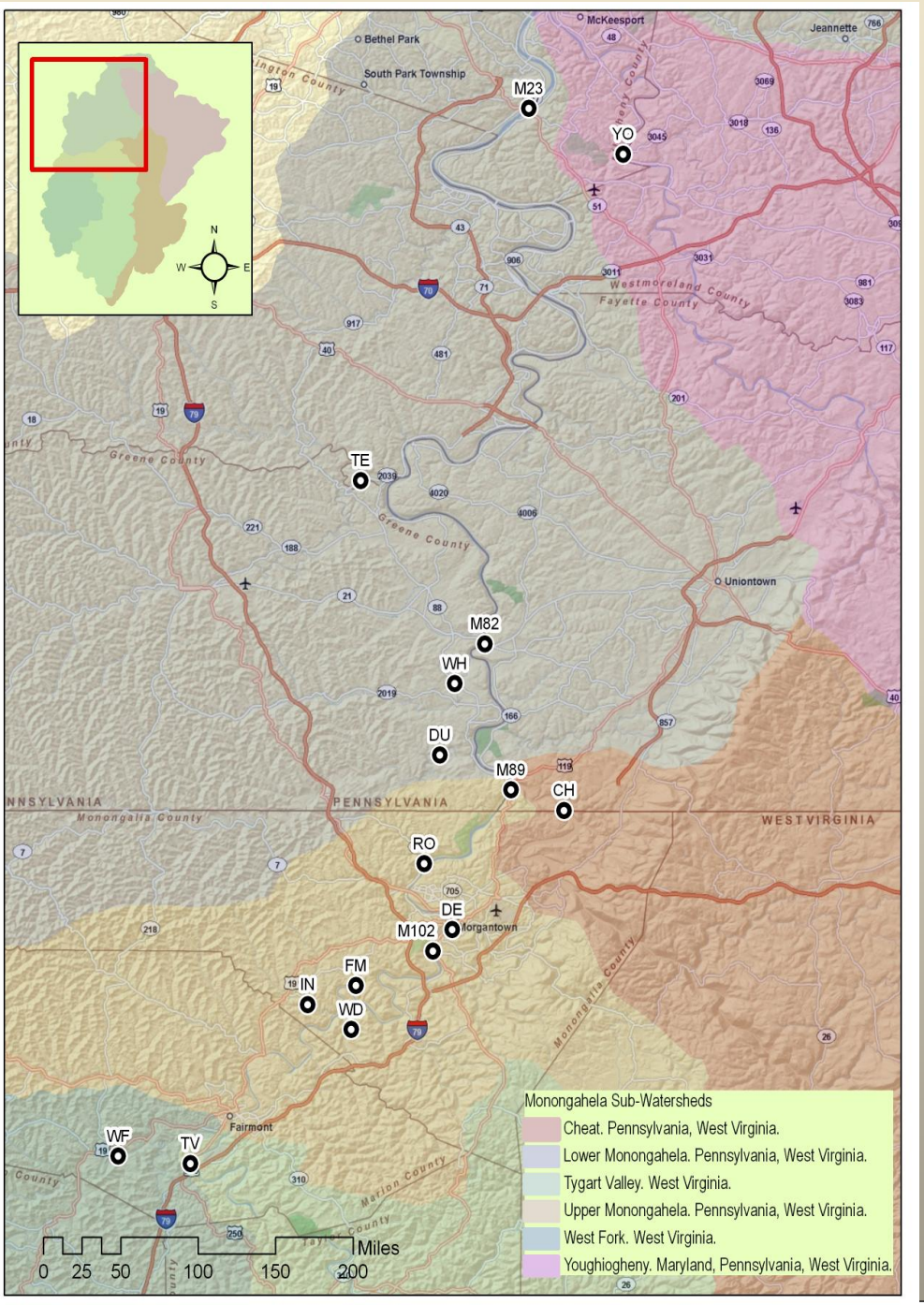
Drought	Pt Marion	Elizabeth	
flow	400	500	cfs
TDS	500	500	mg/L
TDS	197,120	246,400	tpy
difference		49,280	tpy

High Flow	Pt Marion	Elizabeth	
flow	12,000	18,000	cfs
TDS	500	500	mg/L
TDS	5,913,600	8,870,400	tpy
difference		2,956,800	tpy

Some recent findings

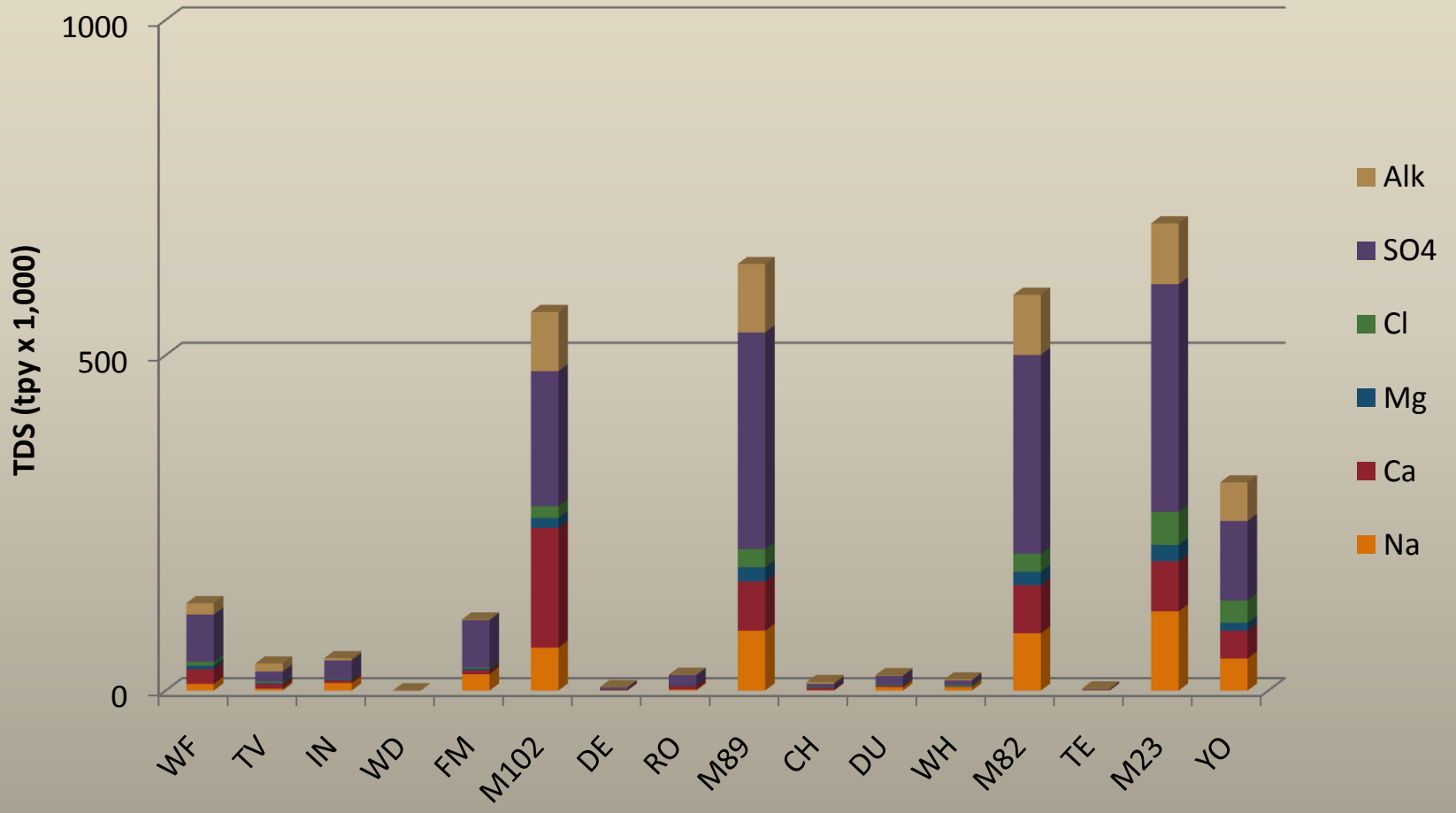
West Virginia Water Research Institute's monitoring network: 16 stations Na, Mg, Ca, Cl, Br, SO_4 …, Q, concentration and loads

MonWQ.net

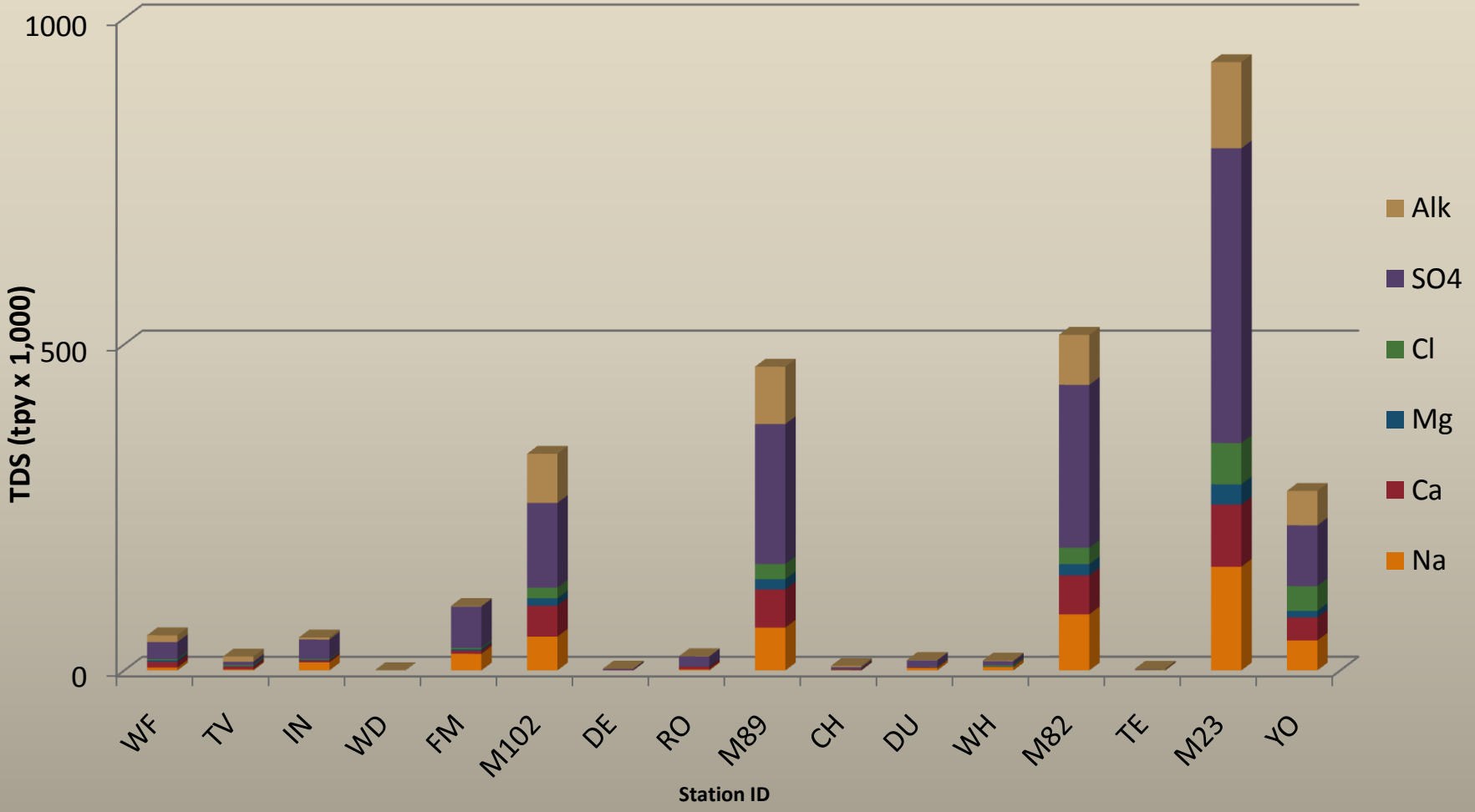


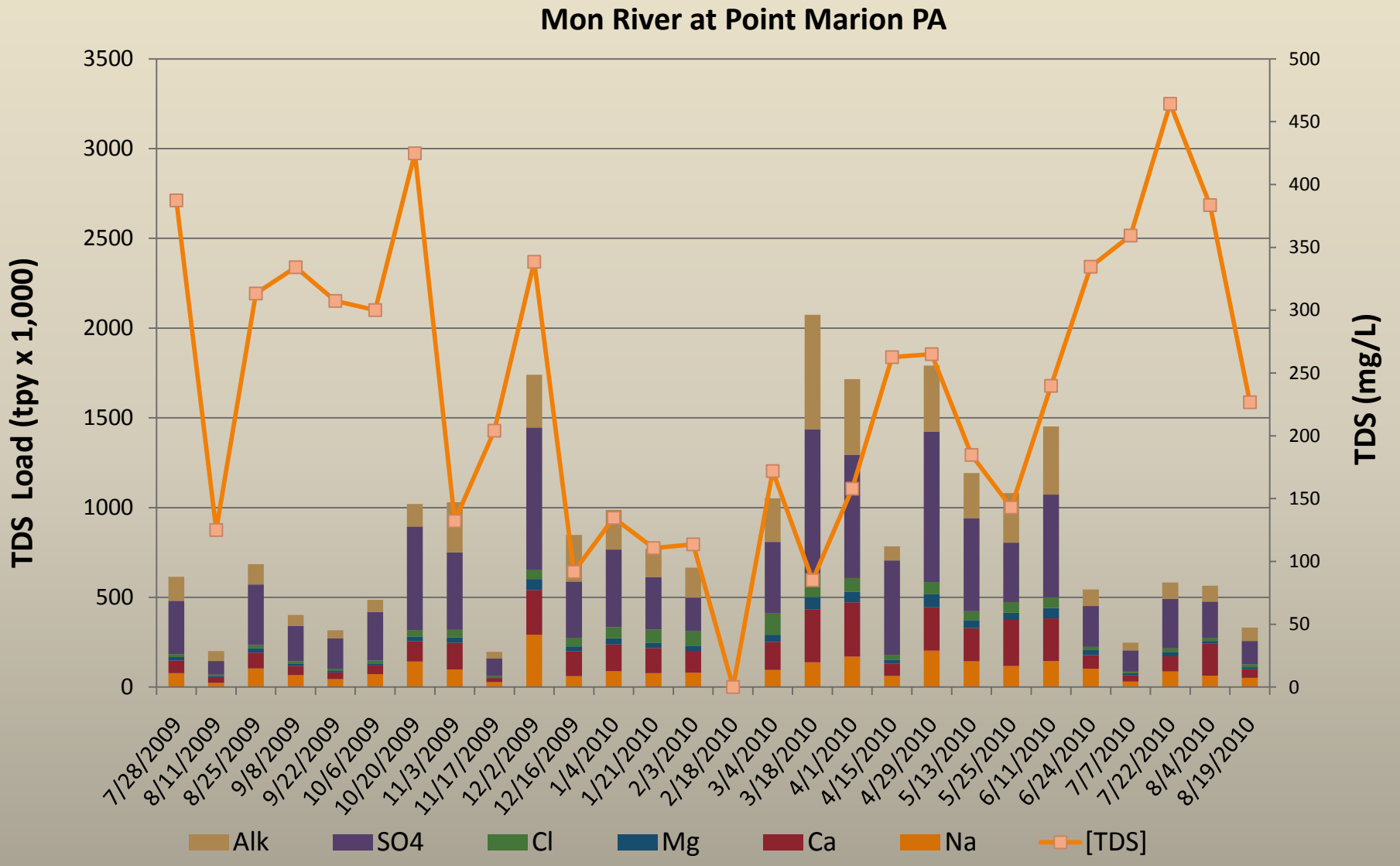
Samples every two weeks since July 2009

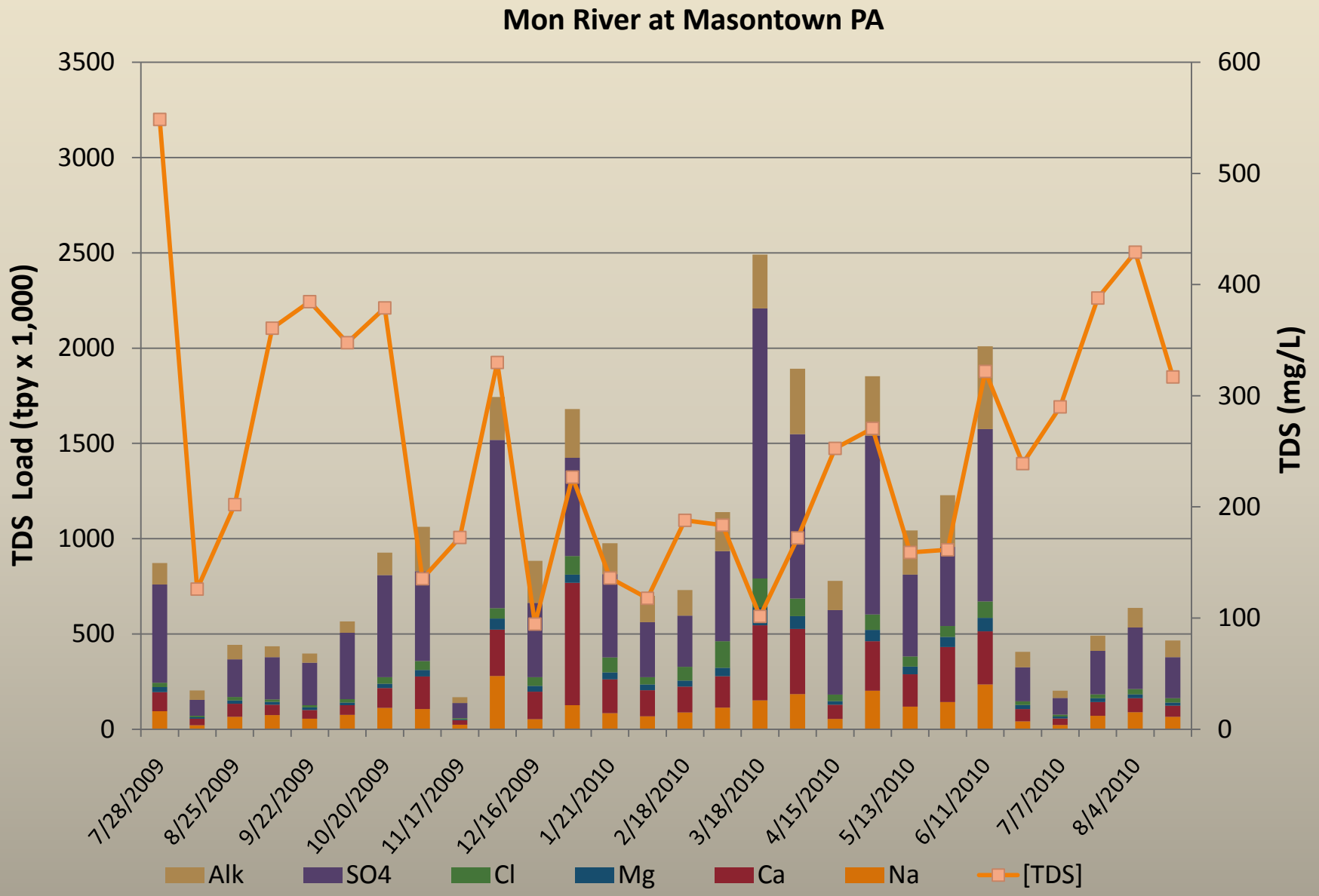
Monongahela river TDS loading
4 August 2010

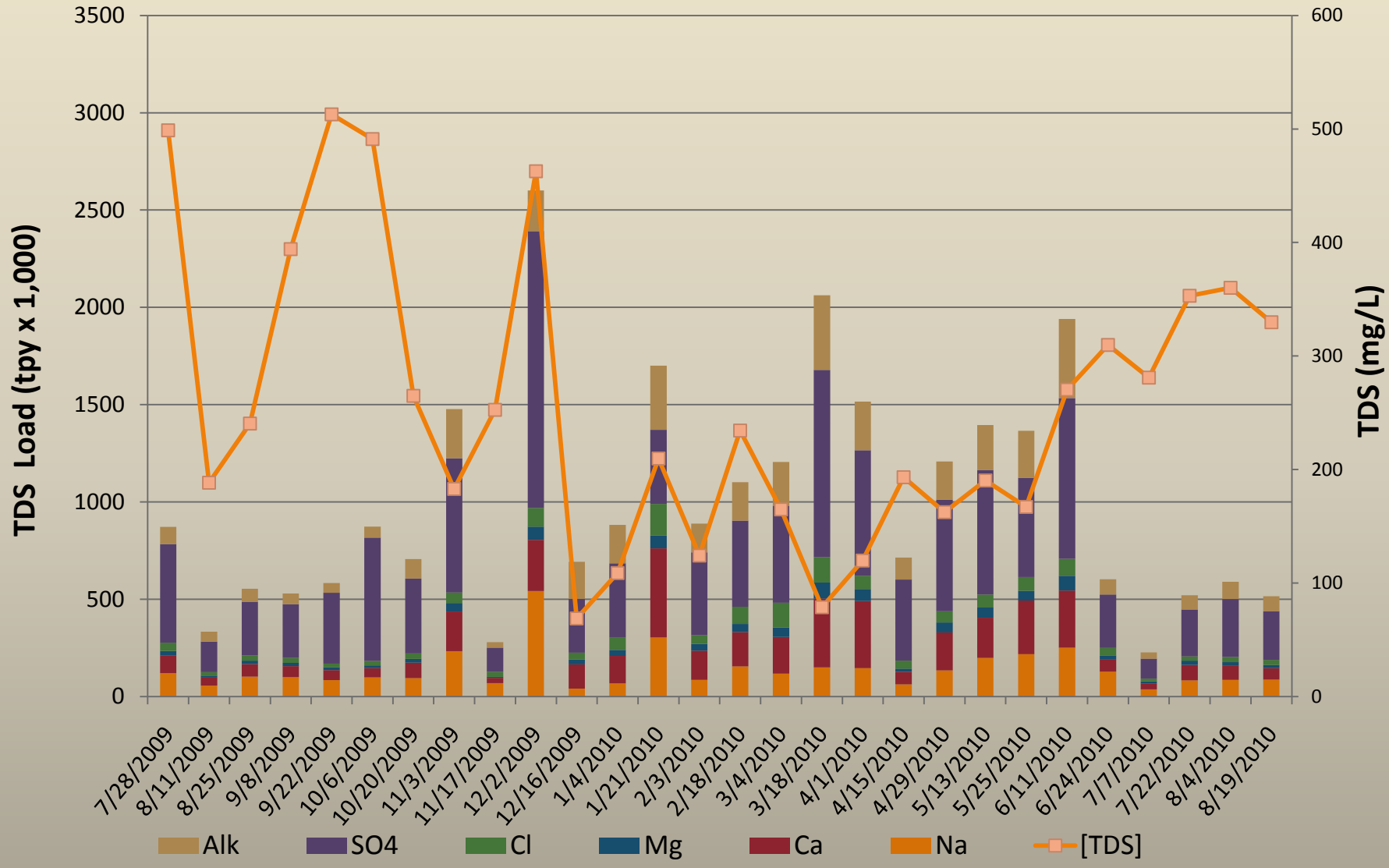


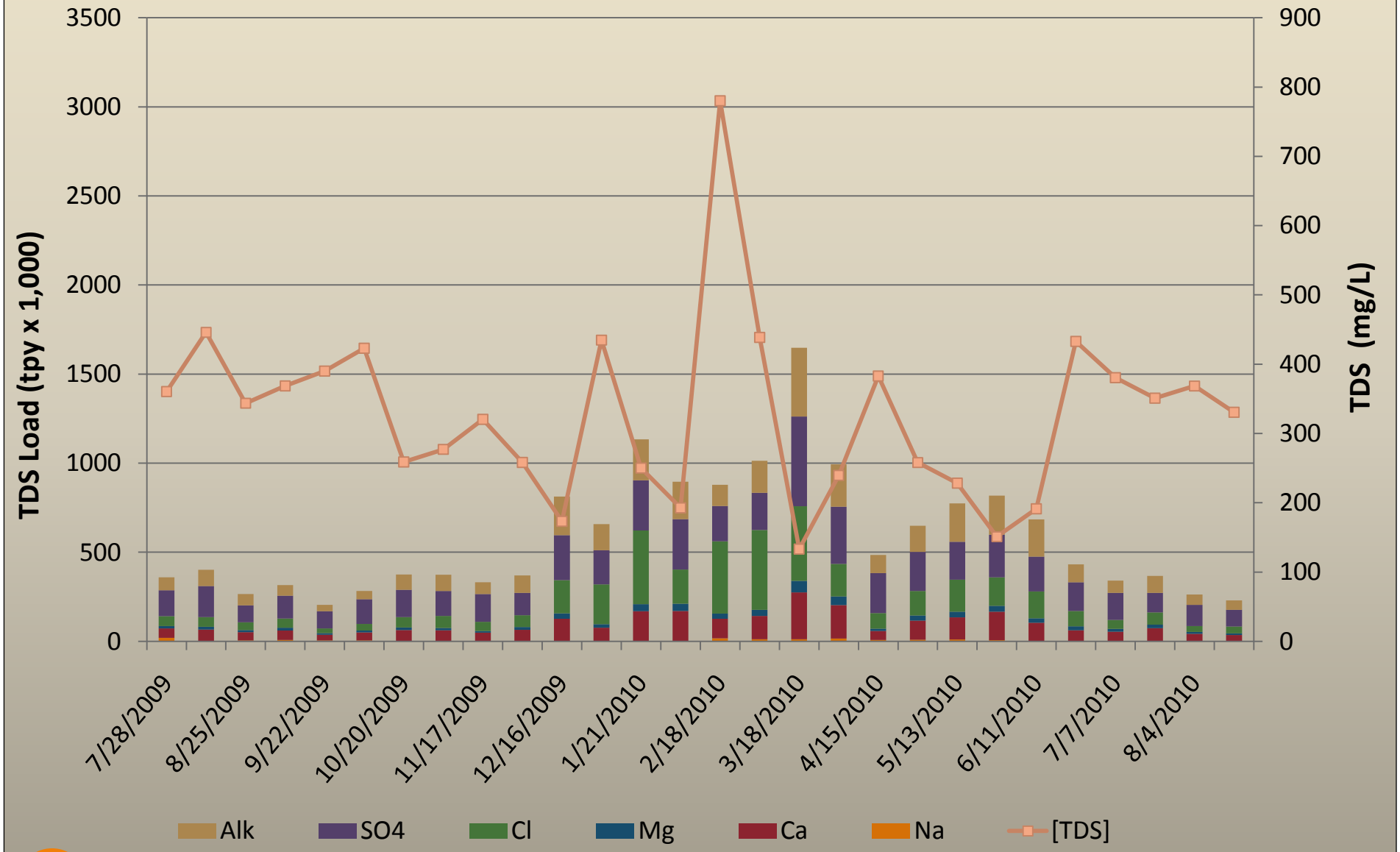
Monongahela river TDS loading
19 August 2010



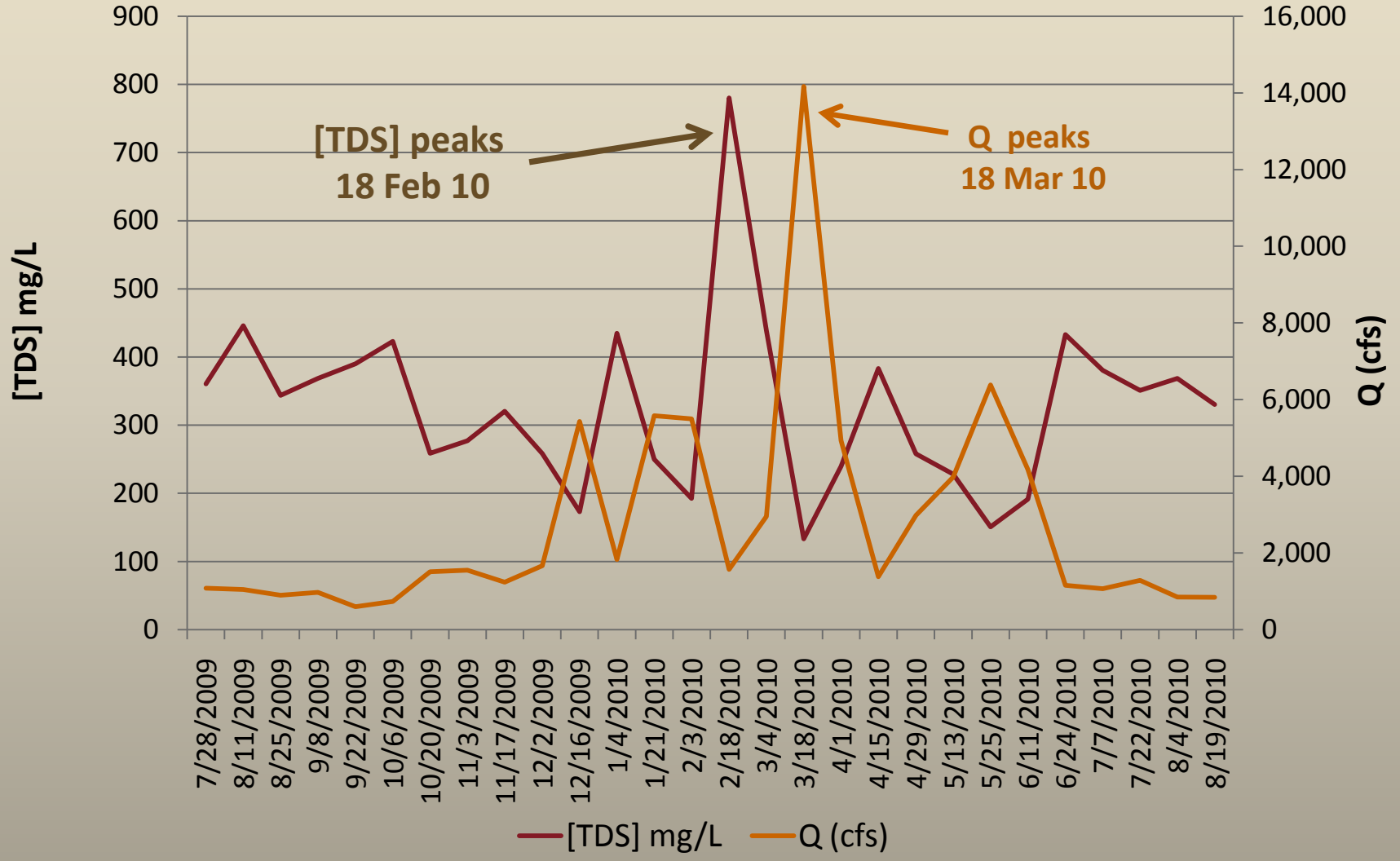

Mon River at Point Marion PA
TDS Load (tpy x 1,000)
TDS (mg/L)
3500
3000
2500
2000
1500
1000
500
0
500
450
400
350
300
250
200
150
100
50
0
7/28/2009
8/11/2009
8/25/2009
9/8/2009
9/22/2009
10/6/2009
10/20/2009
11/3/2009
11/17/2009
12/2/2009
12/16/2009
1/4/2010
1/21/2010
2/3/2010
2/18/2010
3/4/2010
3/18/2010
4/1/2010
4/15/2010
4/29/2010
5/13/2010
5/25/2010
6/11/2010
6/24/2010
7/7/2010
7/22/2010
8/4/2010
8/19/2010
Alk
SO4
Cl
Mg
Ca
Na
[TDS]

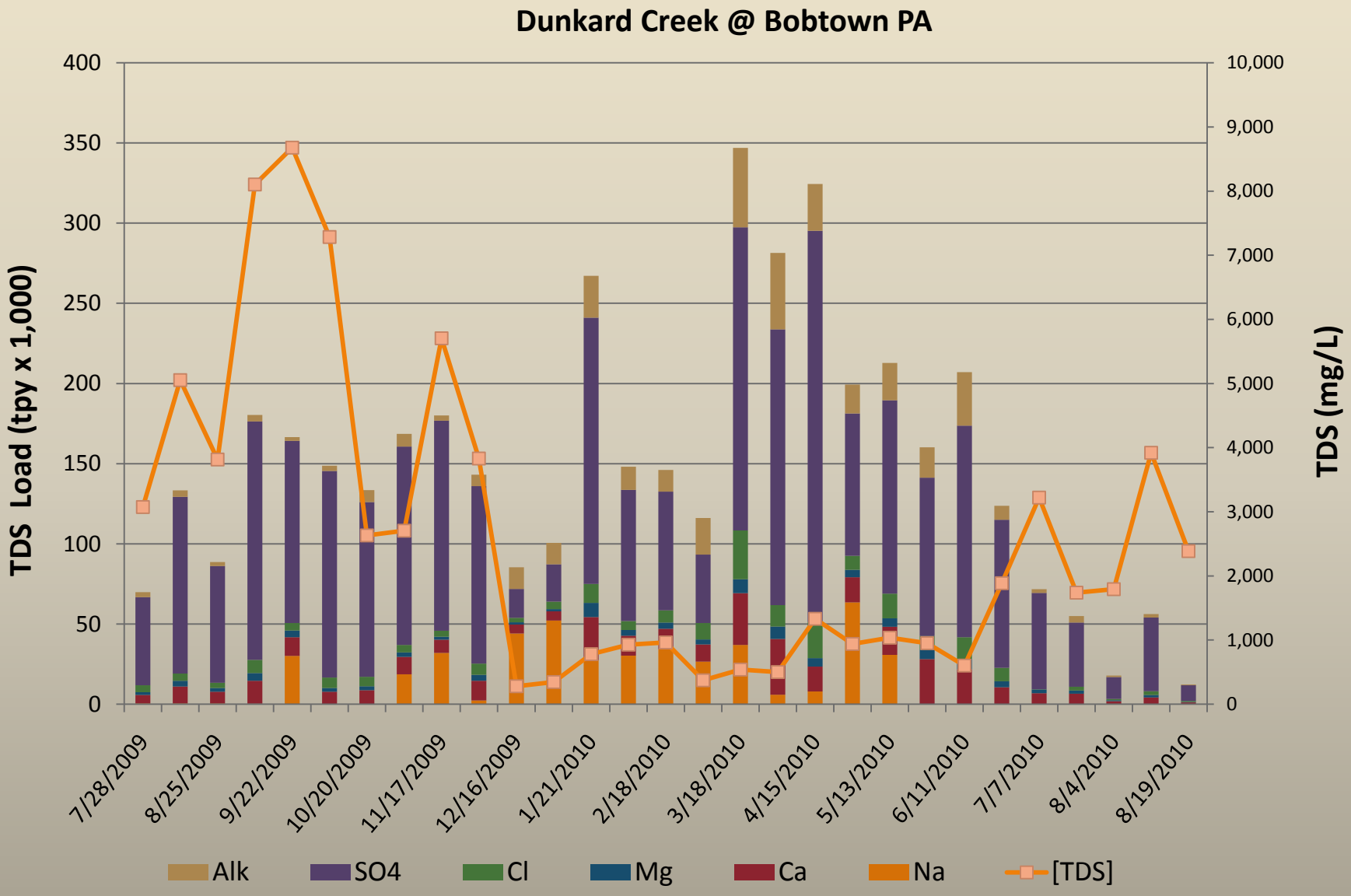

Mon River at Masontown PA
TDS Load (tpy x 1,000)
TDS (mg/L)
3500
3000
2500
2000
1500
1000
500
0
600
500
400
300
200
100
0
7/28/2009
8/25/2009
9/22/2009
10/20/2009
11/17/2009
12/16/2009
1/21/2010
2/18/2010
3/18/2010
4/15/2010
5/13/2010
6/11/2010
7/7/2010
8/4/2010
Alk
SO4
Cl
Mg
Ca
Na
[TDS]


Mon River at Elizabeth PA
TDS Load (tpy x 1,000)
TDS (mg/L)
3500
3000
2500
2000
1500
1000
500
0
600
500
400
300
200
100
0
7/28/2009
8/11/2009
8/25/2009
9/8/2009
9/22/2009
10/6/2009
10/20/2009
11/3/2009
11/17/2009
12/2/2009
12/16/2009
1/4/2010
1/21/2010
2/3/2010
2/18/2010
3/4/2010
3/18/2010
4/1/2010
4/15/2010
4/29/2010
5/13/2010
5/25/2010
6/11/2010
6/24/2010
7/7/2010
7/22/2010
8/4/2010
8/19/2010
Alk
SO4
Cl
Mg
Ca
Na
[TDS]

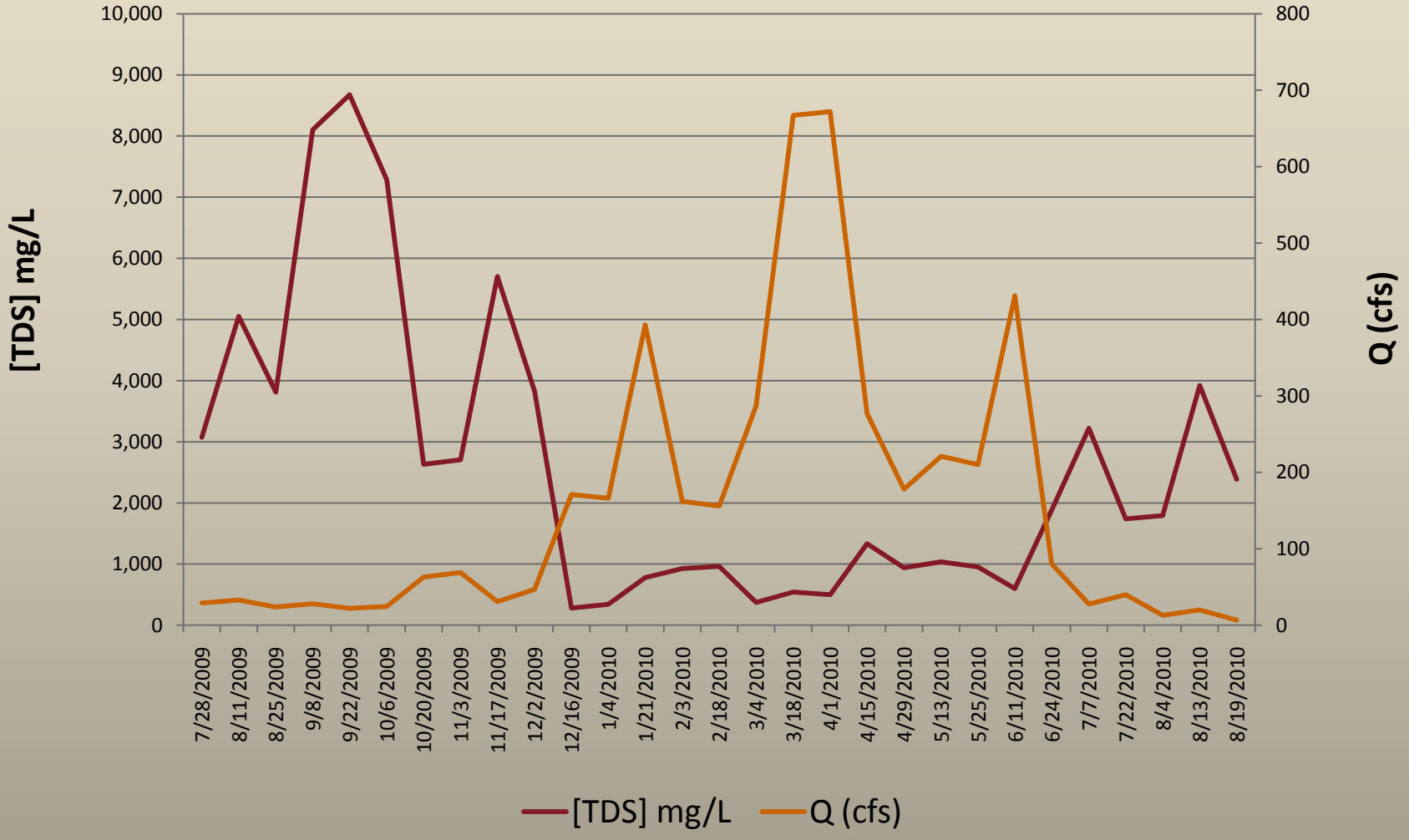

Youghiogheny River at Sutersville
TDS Load (tpy x 1,000)
TDS (mg/L)
3500
3000
2500
2000
1500
1000
500
0
900
800
700
600
500
400
300
200
100
0
7/28/2009
8/25/2009
9/22/2009
10/20/2009
11/17/2009
12/16/2009
1/21/2010
2/18/2010
3/18/2010
4/15/2010
5/13/2010
6/11/2010
7/7/2010
8/4/2010
Alk
SO4
Cl
Mg
Ca
Na
[TDS]

Youghiogheny R. @ Sutersville PA
Unmanaged discharge

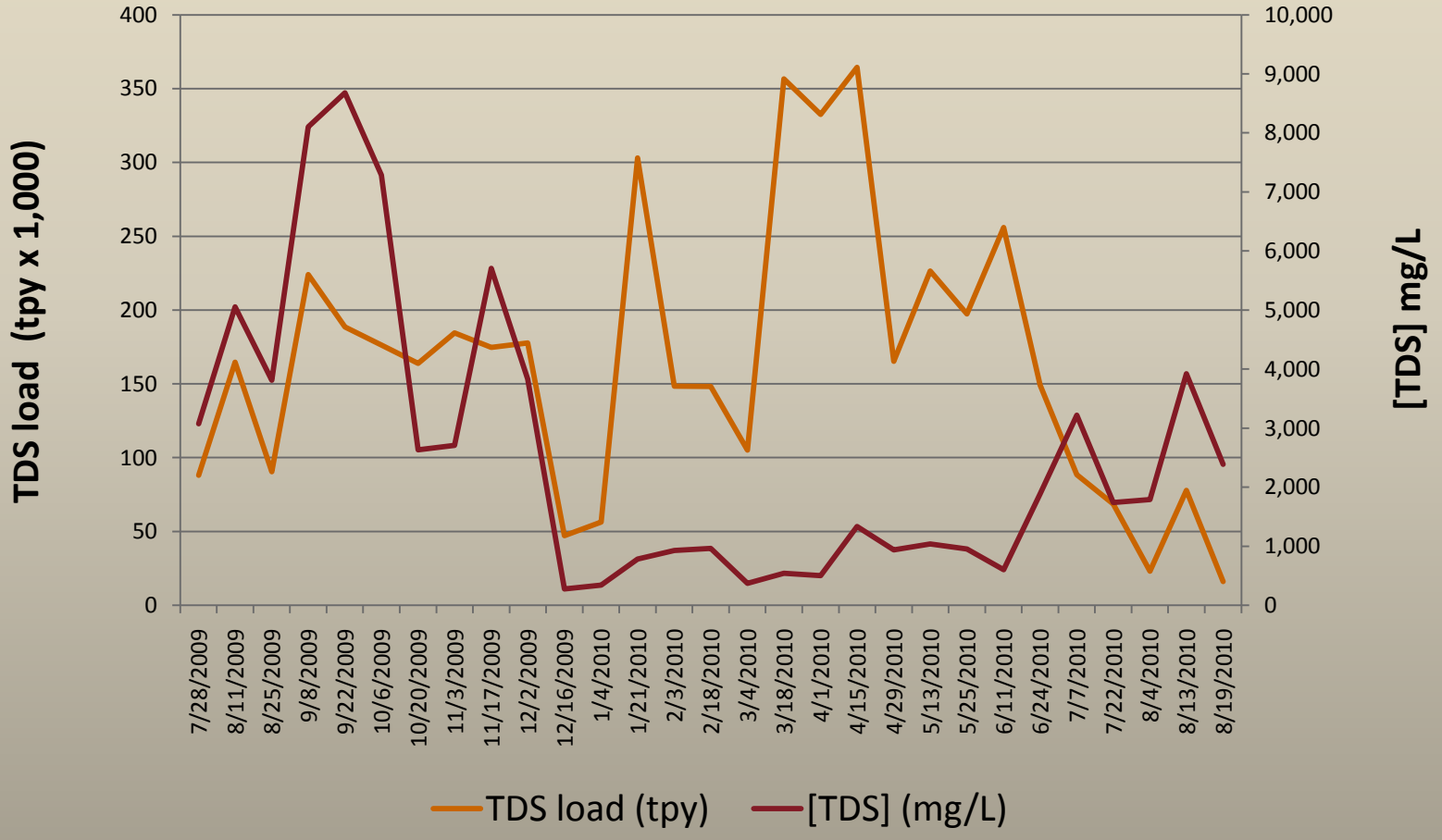



Dunkard Creek @ Bobtown PA
TDS Load (tpy x 1,000)
TDS (mg/L)
400
350
300
250
200
150
100
50
0
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
7/28/2009
8/25/2009
9/22/2009
10/20/2009
11/17/2009
12/16/2009
1/21/2010
2/18/2010
3/18/2010
4/15/2010
5/13/2010
6/11/2010
7/7/2010
8/4/2010
8/19/2010
Alk
SO4
Cl
Mg
Ca
Na
[TDS]

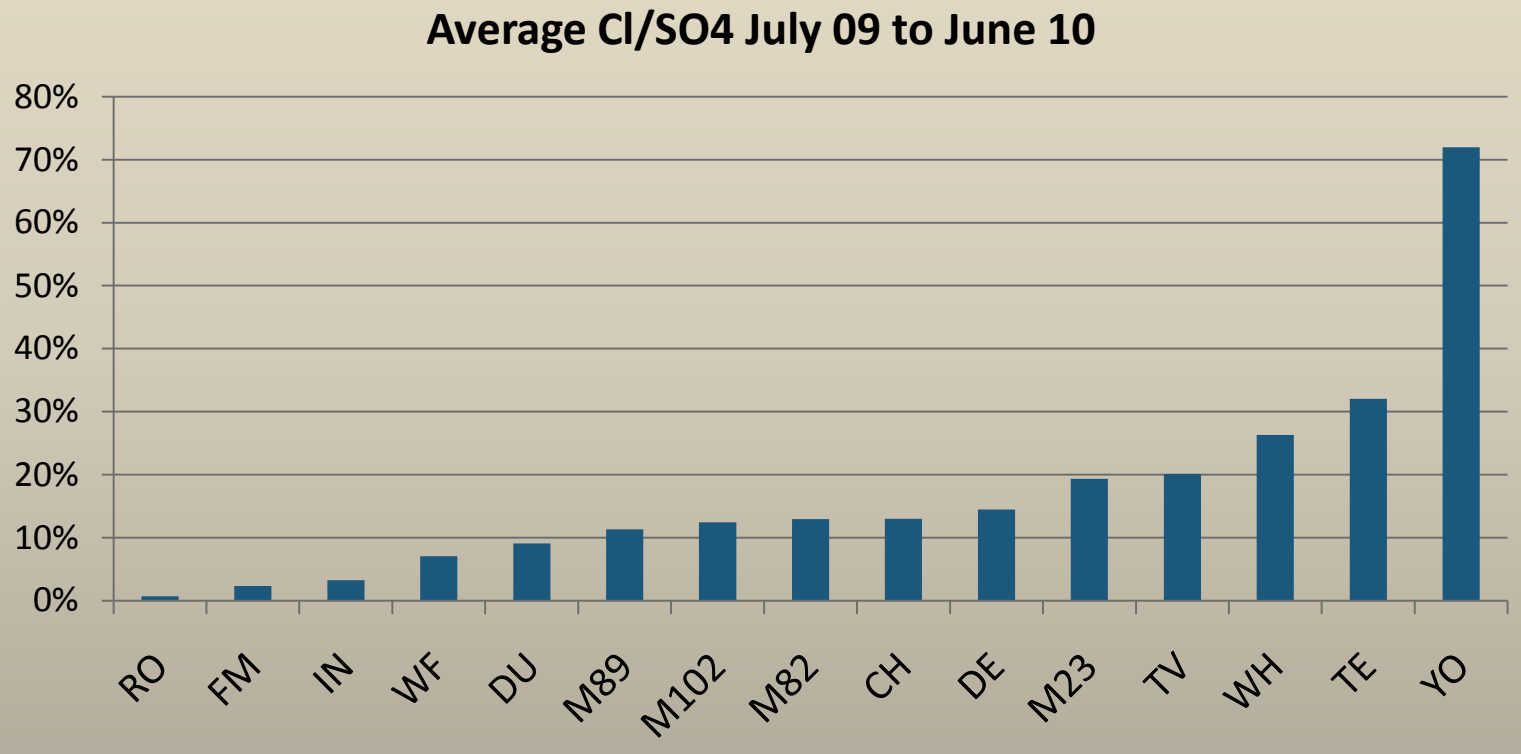
Dunkard Ck. [TDS]=(1/Q)



Dunkard Ck. Load decouples from [TDS]



The Chloride to Sulfate ratio may be a good indicator of mining vs. brine water



TDS loadings: RFW vs. treated AMD

	Relative Loadings		
	1 frac job 6 million gal*	1 UG mine	
discharge	2.3	3,000	gpm
TDS	150,000	5,000	mg/L
TDS	753	33,000	tpy
ratio Frac/mine	44	1	
# units	613	14	
TDS	462,000	462,000	tpy

* assumes 20% RFW

How much RFW is needed to cause the chemical shift in the Youghiogheny River?

		tons per day				
Date	Q cfs	Na	Ca	Cl	TDS	TDS mg/L
11/3/2009	1,550	145	162	184	1162	277
2/18/2010	1,570	953	301	1112	3315	780
difference	mg/L	808	138	928	2153	
	mol	35	3	26		
RFW (Presumptive)	mg/L	50,000	23,600	100,000	150,000	
Gallons of RFW		**1,976,631**	**1,073,140**	**1,942,853**	**2,119,975**	

Road salt does not explain the high [TDS]

WVDOH consumption: July 09 to June 10

(that covers an exceptionally snowy winter)

Marion	tons
Mannington	1,390
Fairmont	2,636
subtotal	**4,026**

Preston	
Albright	2,145
Aurora	1,485
Bruceton	2,572
Fellowsville	1,009
Terra Alta	1,209
subtotal	**8,420**

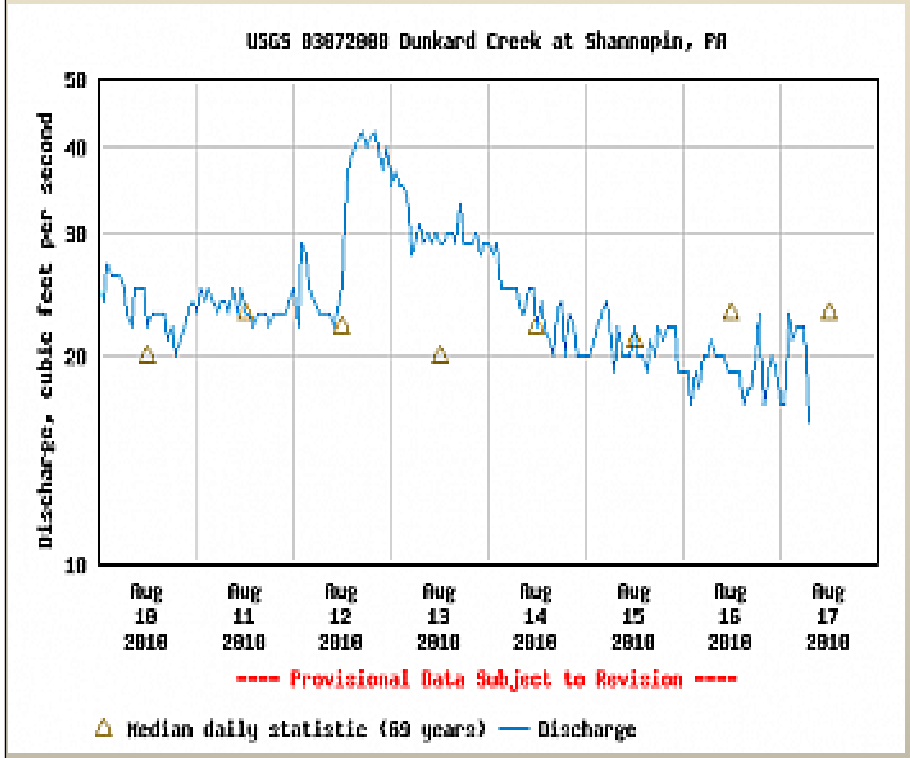
Monongalia	tons
Goshen	5,462
Pentress	962
subtotal	**6,424**

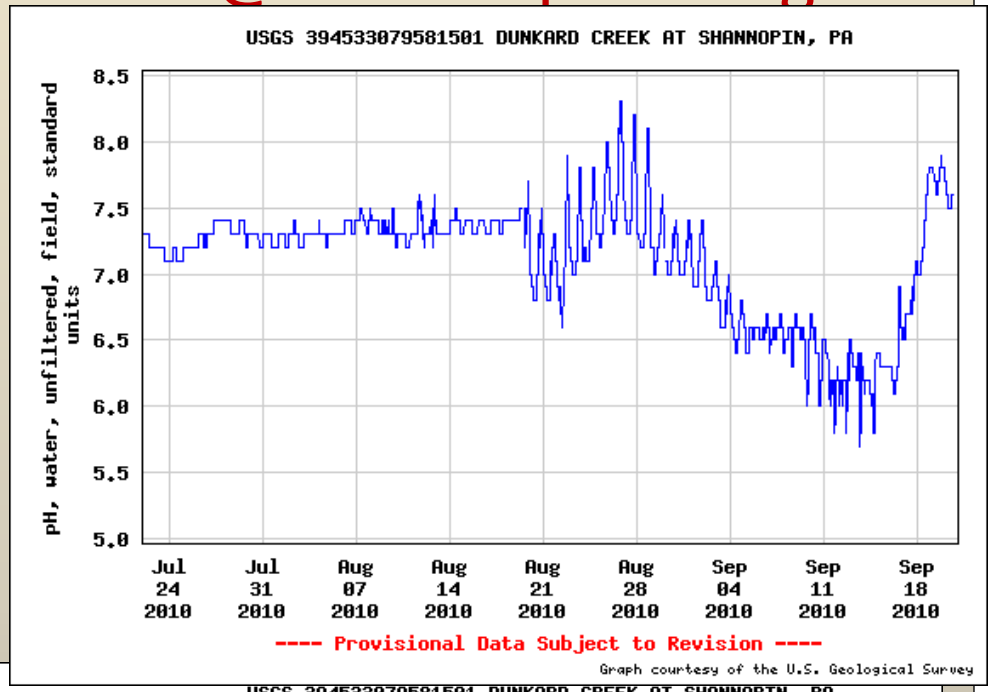
Taylor	**3,535**

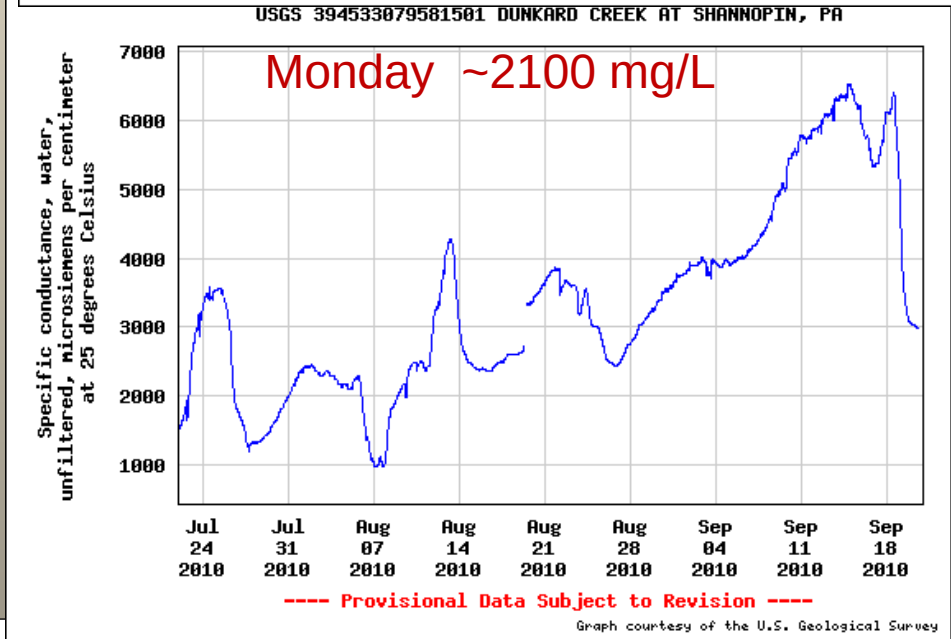
Interstates	
I 79-Goshen Rd (PA to exit 132)	4,379
I 68-Coopers Rock (MD to I-79)	4,544
subtotal	**8,923**

Total **31,328 tpy**

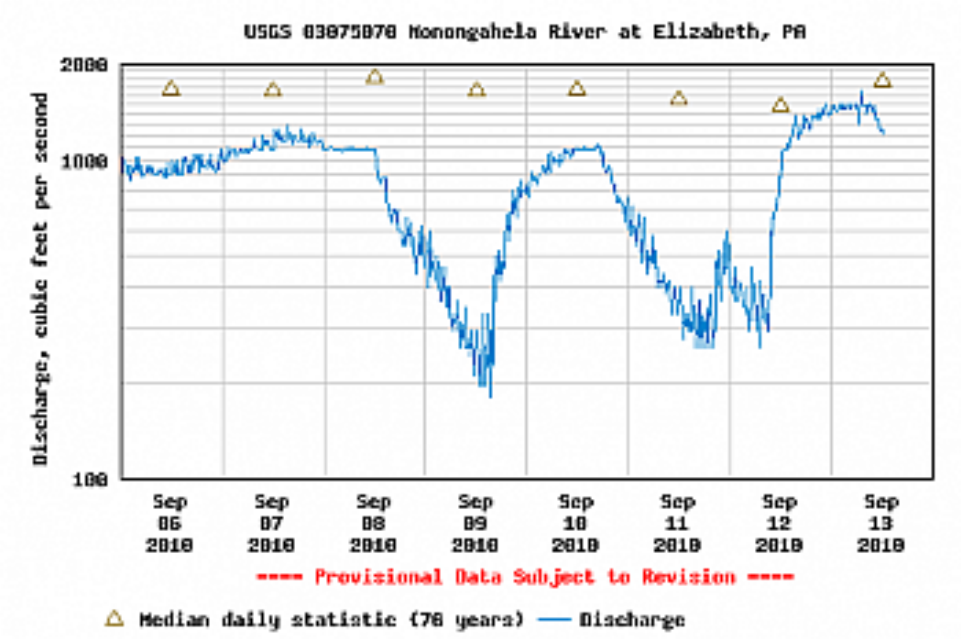
Recent readings on Dunkard Ck. @ Shannopin Gauge

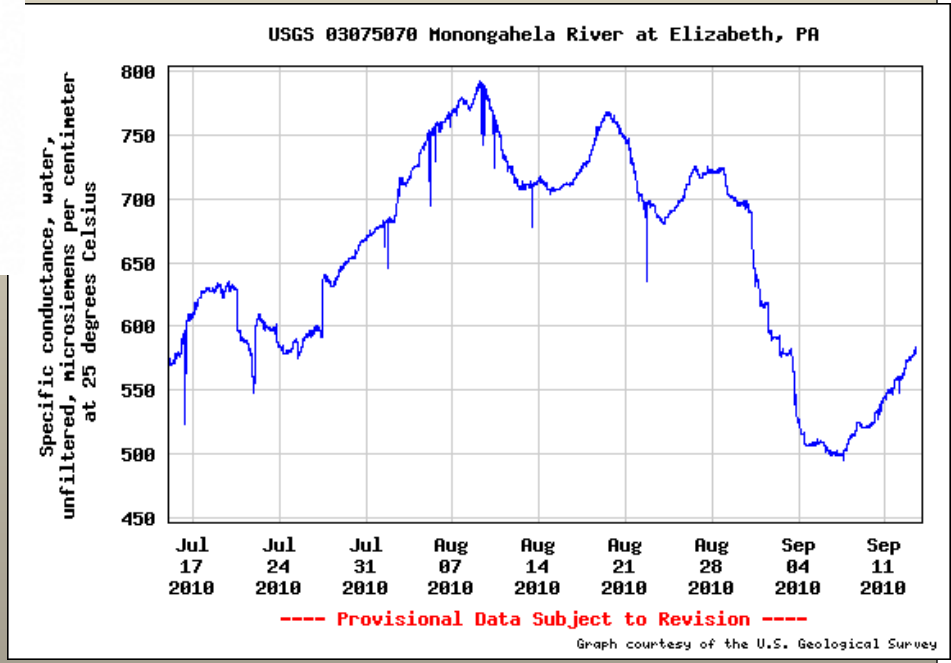






Monongahela R. @ Elizabeth PA





Estimated survival in Mon basin water

Modeled from Mount et al., 2009 Env. Toxicol. Chem.

		19-Aug-10				8-Sep-09	
		M23		Dunkard		Dunkard	
		mg/L	% survival	mg/L	% survival	mg/L	% survival
Na	Cerio 24-h	89	100	569	100	1592	3
K	Cerio 48-h		100		99		2
Ca	Magna 24-h	50	99	158	99	515	97
Mg	Magna 48-h	16	99	49	99	178	97
Cl	FHM 24-h	33	100	84	99	265	68
SO_4	FHM 96-h	238	99	1465	98	5380	55
HCO_3	FHM 96-h	70	98	60	96	144	29
TDS		496		2386		8073	

Conclusions:

- None of the TDS constituents are cumulative or toxic at reasonable concentrations
- Upper Mon AMD plants generate between 200,000 and 500,000 tpy of TDS
- That accounts for between 20 to 100% of TDS in the Mon
- For much of the year the Mon can easily assimilate that sort of loading while maintaining a [TDS] below 500 mg/L
- It should be possible to develop a managed, load-weighted discharge program to control [TDS] at the desired levels
- That will require organization, commitment , transparency and accountability
- Must quantify other TDS sources

Questions?

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http://www.MonWQ.net

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