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Water Research Institute

WV AMD Task Force
31 March 2015

Coal Industry application of discharge management to control Conductivity, TDS and Sulfate in the Monongahela River

TDS Problems on the Monongahela in Pennsylvania

- First noted in late summer 2008
- Report by Tetra Tech blamed the high TDS on:
  - West Virginia
  - Drought
- In July 2009 WVWRI starts studying the river and the major tribs
- January 2010 Coal Industry TDS Working Group starts managing discharge to control TDS/sulfate
- In December 2010 PADEP declares Mon impaired for potable water use by sulfate
- Prospect of sulfate TMDL
- NPDES Sulfate limits…

Outline

- Load model Ohio, Mon, Allegheny
- Discharge mgt
- SO_4, TDS trends
- Causal factors
- Compliance
- Delisting
- Application to other river basins

EARLY FINDINGS:

Major ions: Na, SO_4, Cl, Mg, Ca, HCO_3

- Sources?

- Gas development
  - Marcellus returned frac water
  - Produced water
  - Coal bed methane
- Coal mining
  - Abandoned mines
  - Active mines-treated effluent

3RQ Monitoring Program

Began in July 2009

In response to high TDS events on Monongahela River in 2008

Expanded to include Upper Ohio and Allegheny Rivers in 2012

Funding

USGS/Water Research Institute

Colcom Foundation

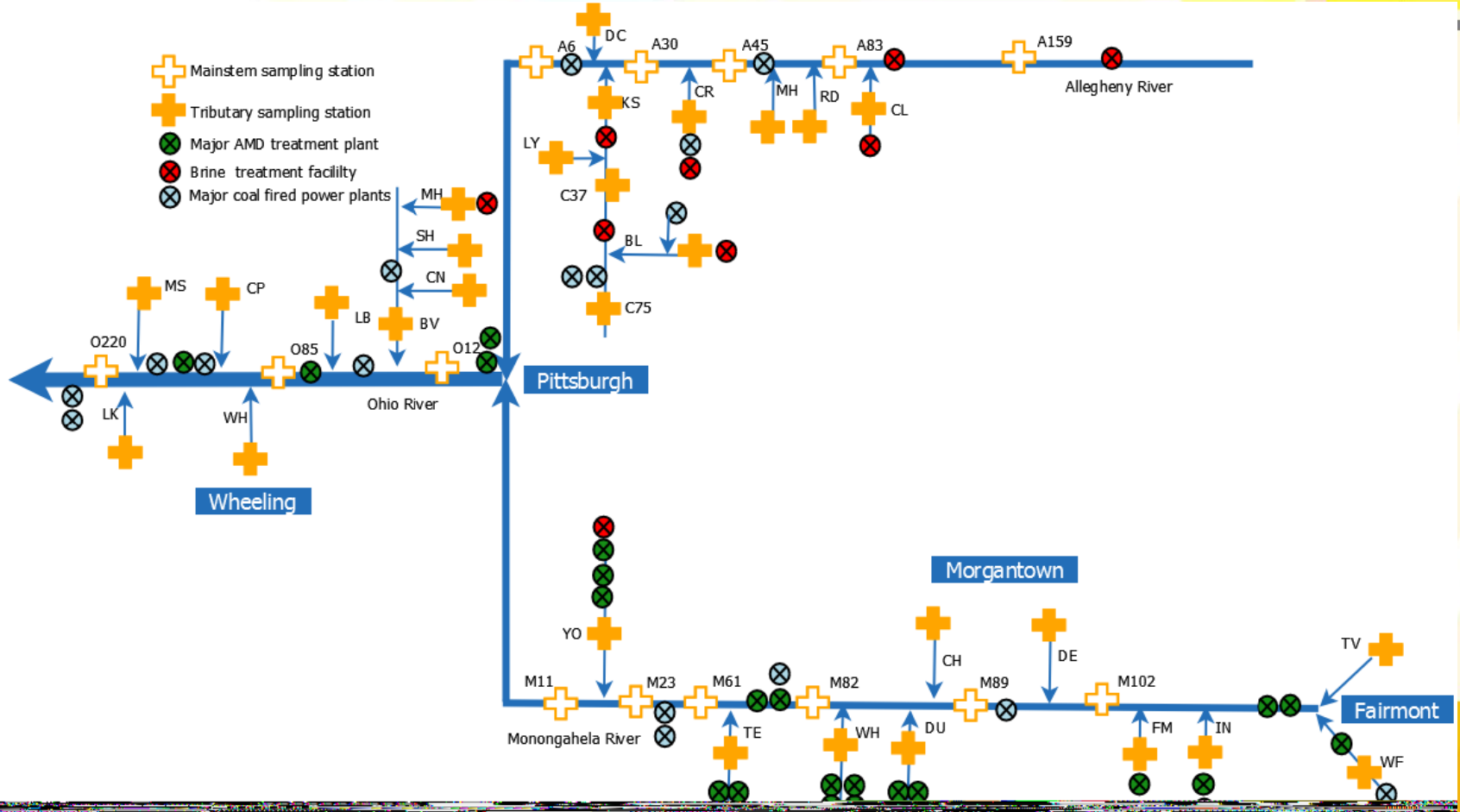
PARTNERS:

WEST VIRGINIA UNIV.

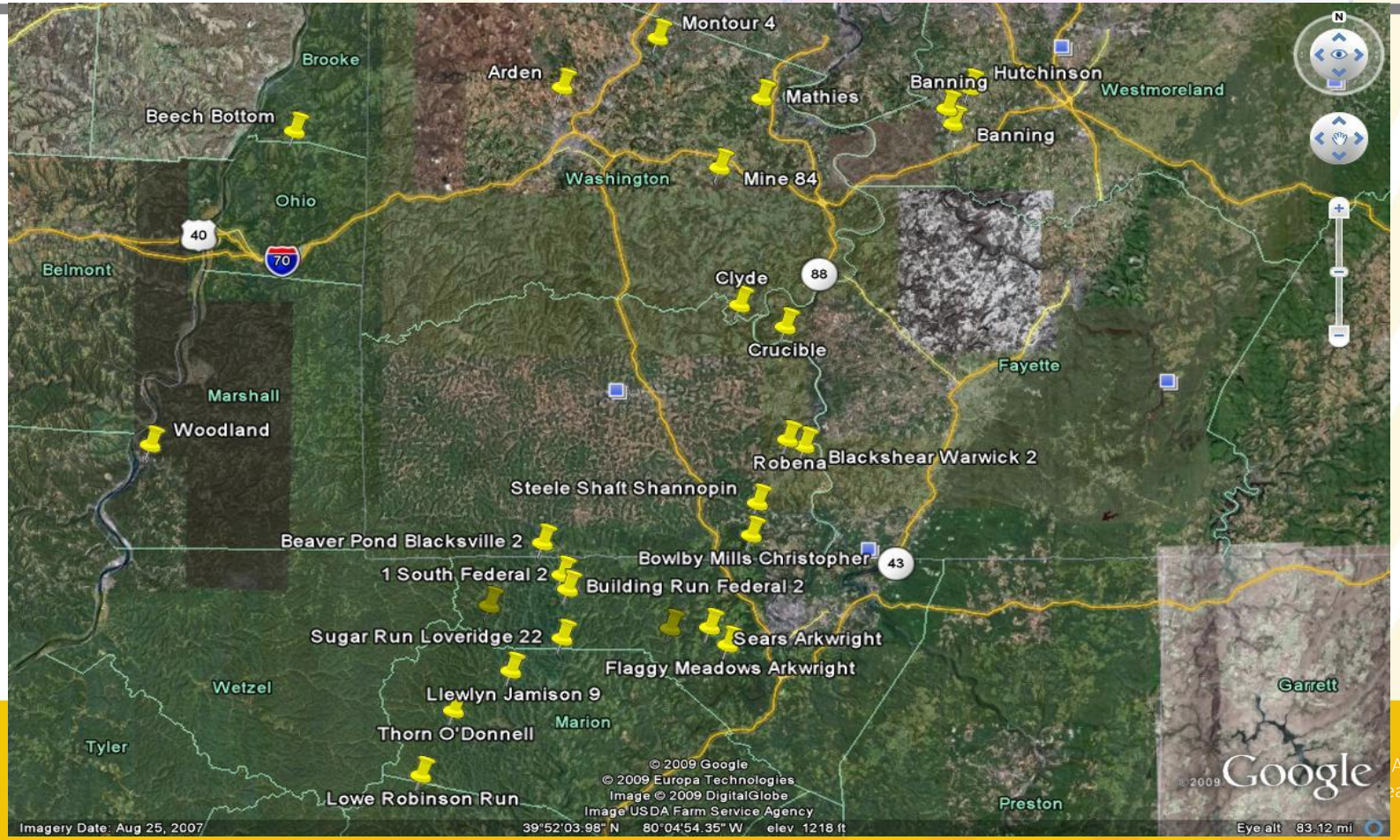
DUQUESNE UNIV.

WHEELING JESUIT UNIV.

SCHEMATIC DIAGRAM UPPER OHIO BASIN



PITTSBURGH BASIN-MAJOR AMD PLANTS

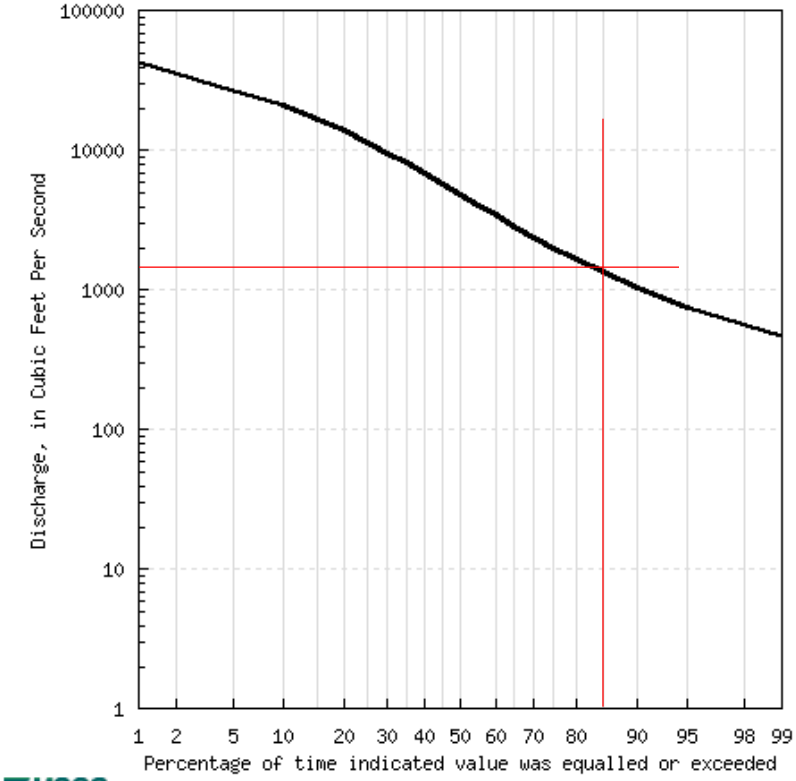


Early findings:

- High EC occurred only during low flow
  - July to November
  - Most TDS was Na, Ca, SO_4
  - Source-discharge from major AMD treatment plants
- Infinite assimilative capacity during high flow
- Monongahela River high flow > 1,500 cfs
- Occurs 85% of the year

FLOW IN THE MONONGAHELA R. AT MASONTOWN PA IS GREATER THAN 1,500 CFS 85% OF THE TIME

USGS 03072655 Monongahela River near Masontown, PA
Drainage Area: 4440 Square Miles, Length of Record: 69 Years



beg_dt:	19390101
end_dt:	20080930
N:	25476
mean:	8451.1
std:	9667.8
min:	177.0
p05:	753.0
p10:	1060.0
p25:	2020.0
p50:	4900.0
p75:	11500.0
p90:	21000.0
p95:	27000.0
max:	154000.0

Probability based on 69 year USGS record

USGS

THE MODEL ALLOWS THE AMD PLANT OPERATORS TO ADJUST THEIR FLOW AS A FUNCTION OF RECEIVING STREAM FLOW AND TARGET TDS

Drought

Target stream [TDS]	500	mg/L
Stream Q (cfs)	500	cfs
Factor of safety	2.0	

	MODEL OUTPUT	
AMD	Pumping Rate	
plant	Q (cfs)	Q (gpm)
A	0.7	323
B	0.1	54
C	0.9	387
etc.		

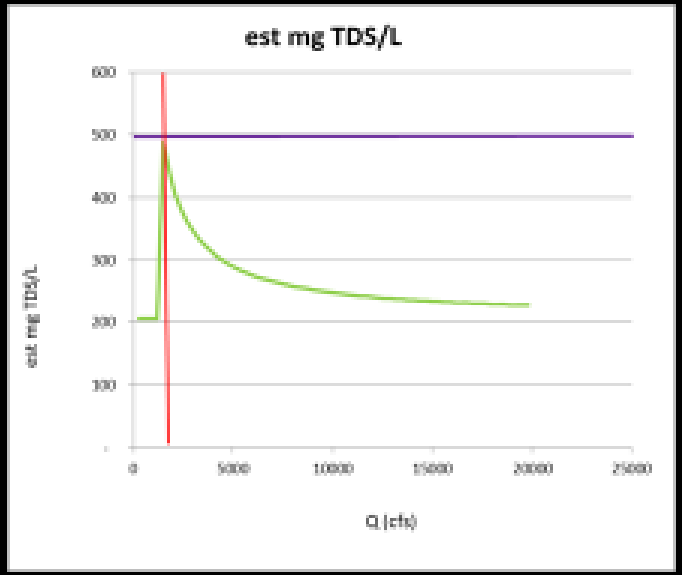
Mid-range river flow

Target stream [TDS]	500	mg/L
Stream Q (cfs)	3,600	cfs
Factor of safety	2.0	

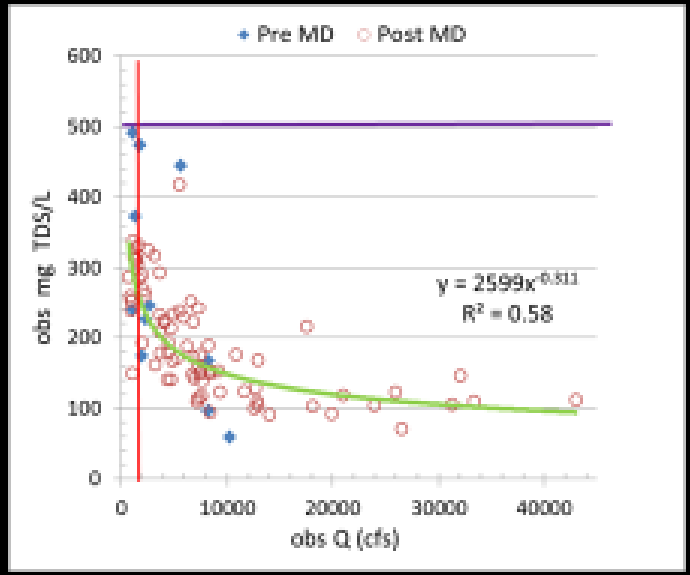
	MODEL OUTPUT	
AMD	Pumping Rate	
plant	Q (cfs)	Q (gpm)
A	5.2	2,322
B	0.9	387
C	6.2	2,787
etc.		

Response of TDS concentration to change in river flow at M82. The vertical red line is Q=1,500

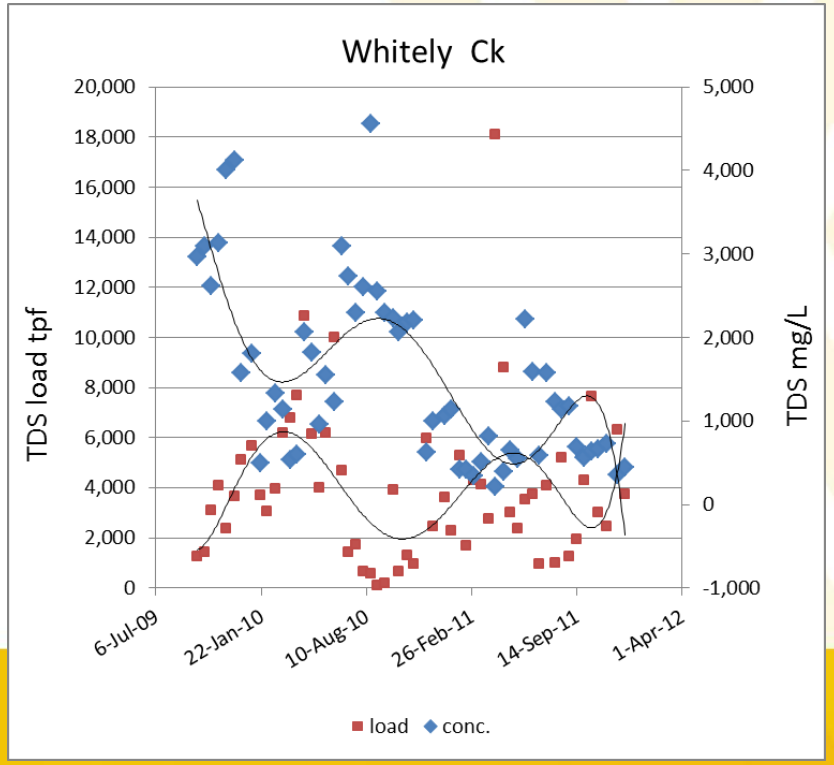
Theoretical: conservative assumptions

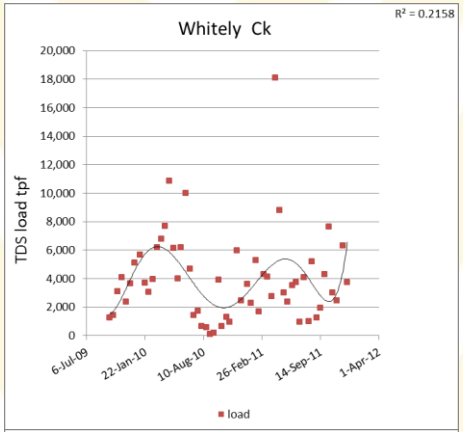


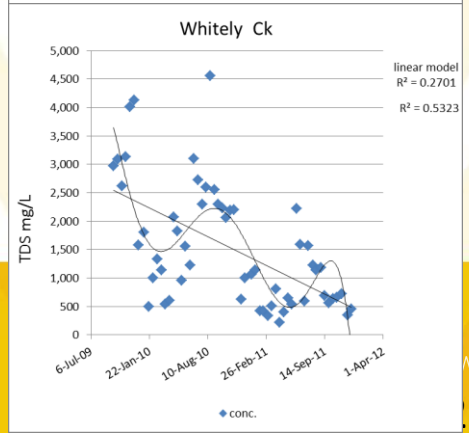
Observed: includes safety factor of 2x



Whiteley Ck. Loads and concentrations are 180° out of phase





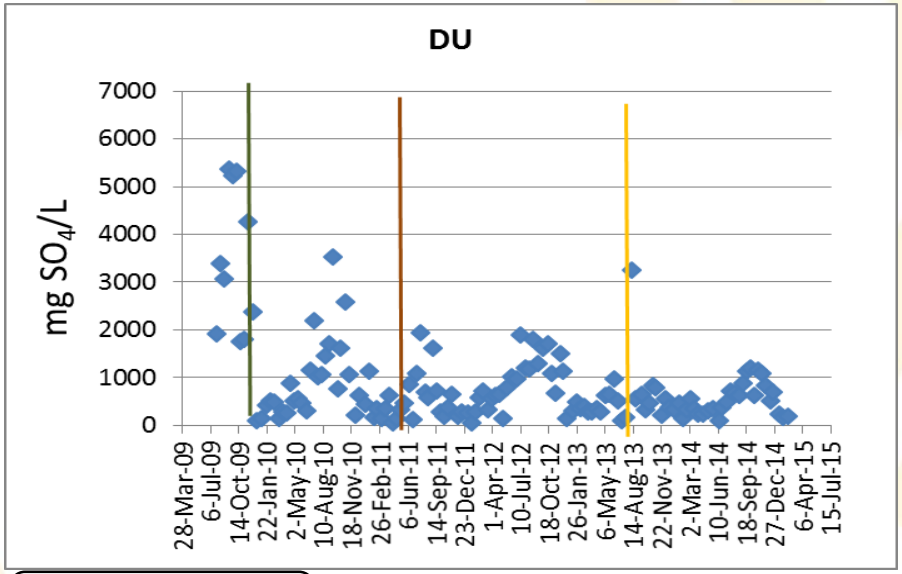


Significant events

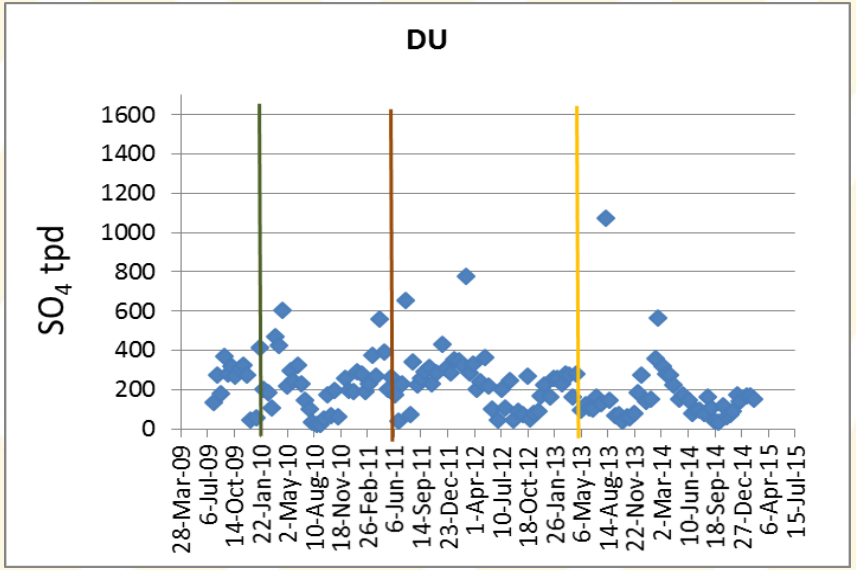
- January 2010-Industry initiates discharge management
- May 2011-PA restricts produced water processing in POTWs
- May 2013-Mannington RO plant goes online

MONONGAHELA R. ELIZABETH PA JUL 2009 TO FEB 2015

SO_4 concentration



SO_4 load

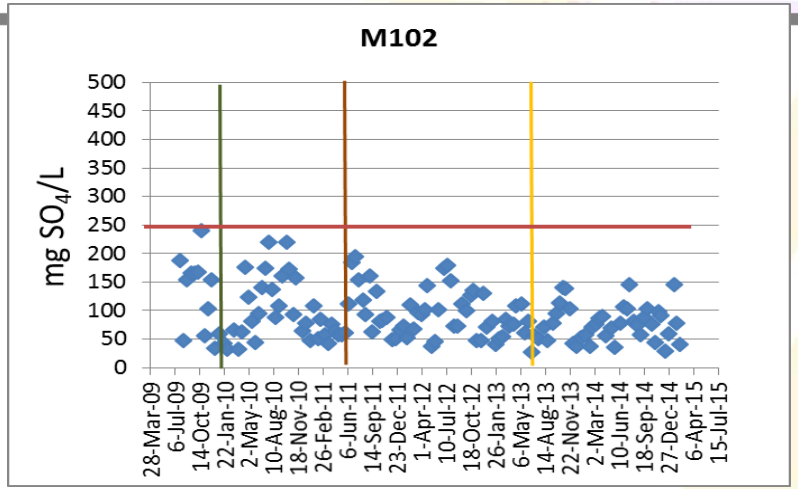


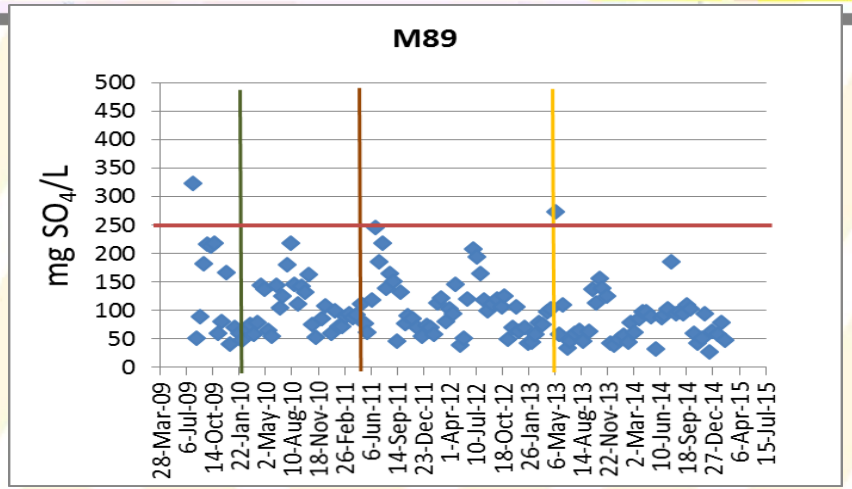
Begin managed discharge

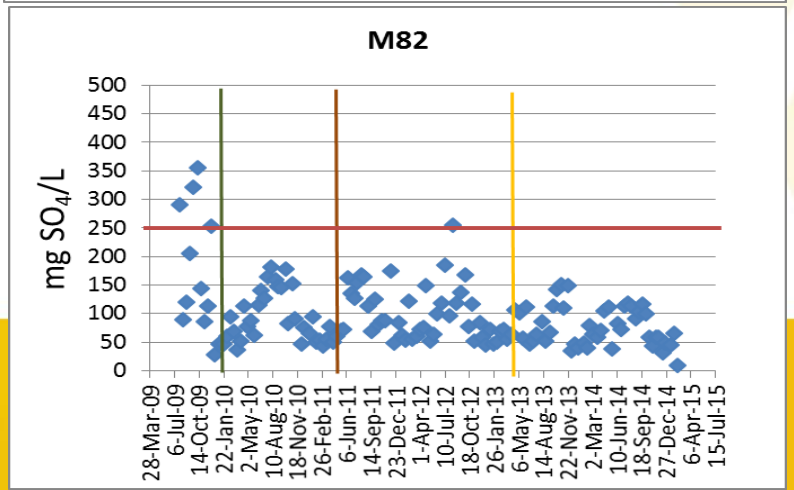
PA POTWs restrict brine trt

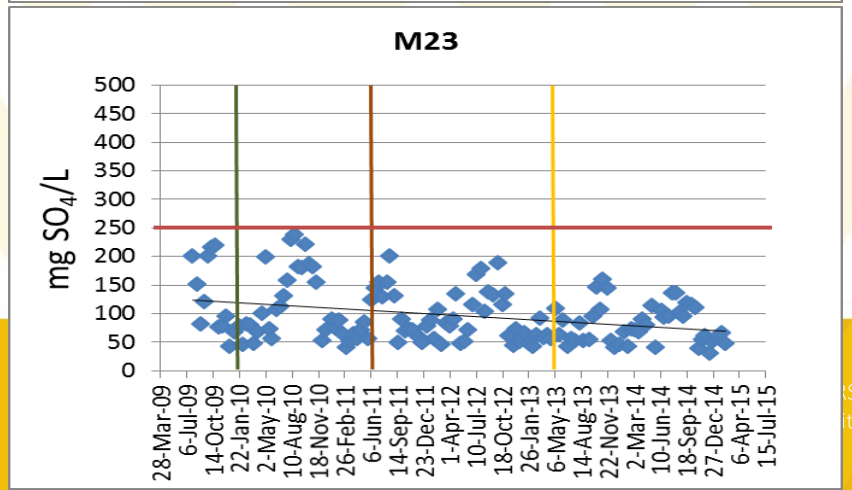
Mannington RO plant

Sulfate-Monongahela R. Jul 2009 to Feb 2015









TWO SULFATE EXCEEDANCES SINCE JAN 2010 (100 SAMPLES)

Masontown PA

Monongahela River mile	10-Aug-12 mg SO4/L
M23	104
M61	136
M82	254
M89	119
M102	72

Anion/ catio= 1.37

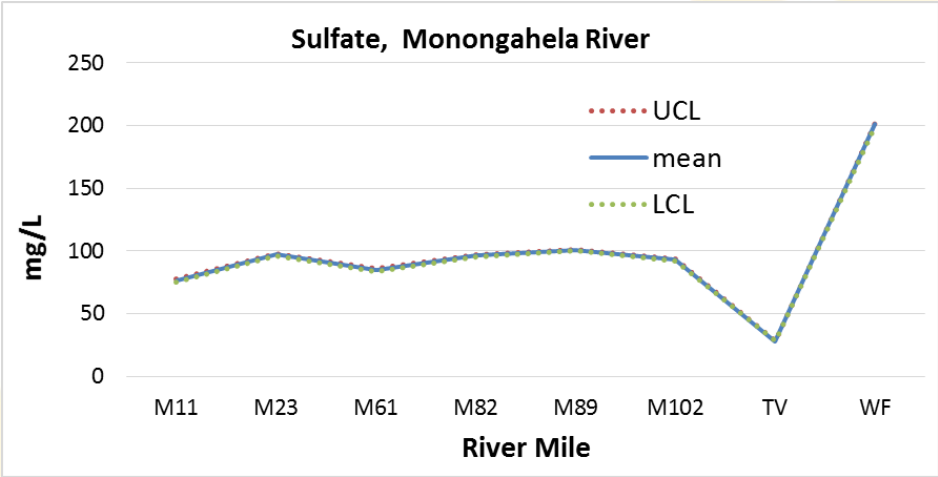
Pt. Marion PA

Monongahela River mile	7-May-13 mg SO4/L
M11	96
M23	110
M61	76
M82	102
M89	274
M102	111

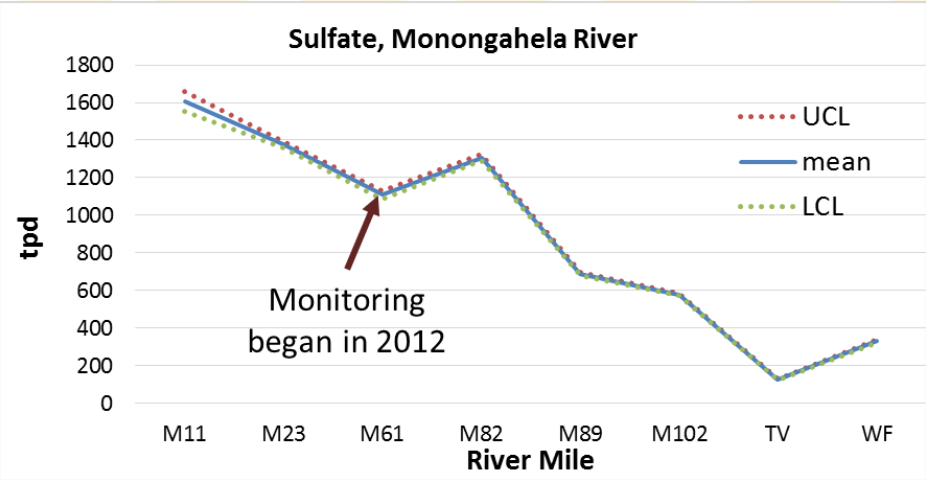
Anion/ cation= 0.93

Monongahela River Sulfate
Mean values with 95% confidence intervals
~143 samples/station

Concentration (mg SO_4/L)



Load (t SO_4/day)



IMPROVEMENTS: CAUSAL FACTORS

- AMD treatment plants:
  - Managed discharge
  - Coal Industry TDS working group
  - Started in January 2010
  - Pumping rates based on flow in Monongahela River
  - Voluntary, effective, efficient
- Brine:
  - Improved water management
  - Decreasing rate of surface disposal
    - POTWs
    - Partial treatment plants
  - Increased recycling

SUMMARY

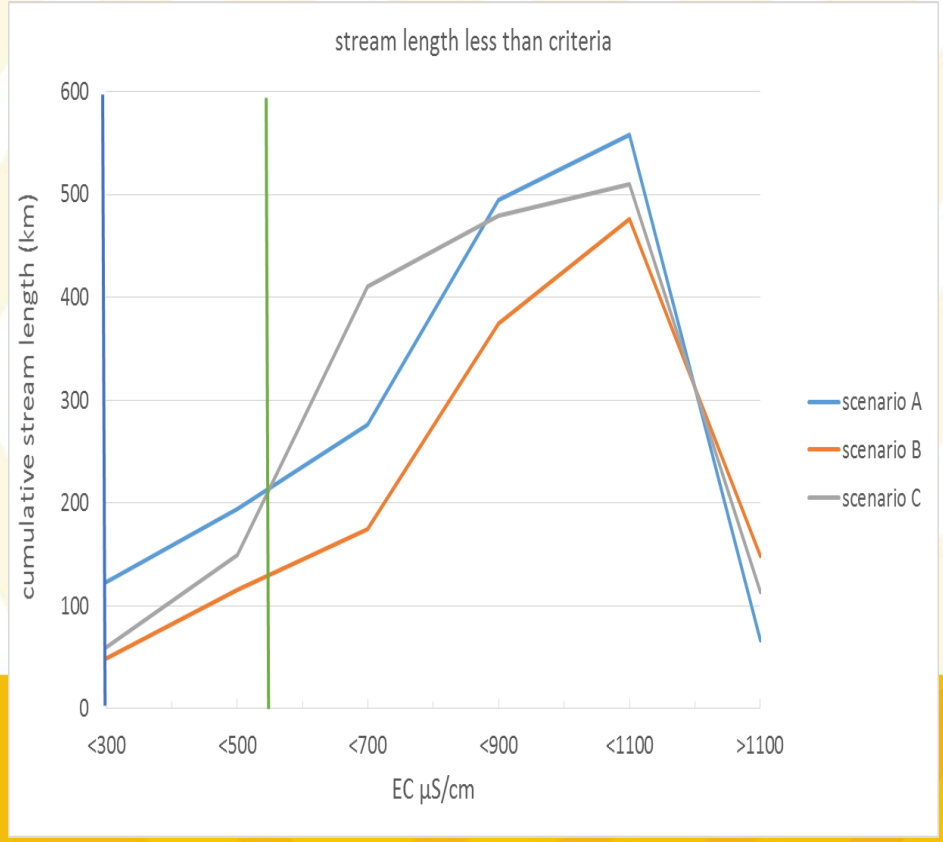
- Sulfate load in the Monongahela River averages 412,000 tpy
- Treated coal mine drainage accounts for between 202,000 tpy sulfate (48% of TDS)
- Water quality is improving
- Active chemistry/load monitoring is critical
- Managed discharge from active mines
- Three Forks Creek Stream Dosing
- Reduction of brine @ POTWs

How does this apply to MTM?

EC criteria	scenario A Current	scenario B MTM	scenario C MTM + UG mine discharge mgt.
<300	123	49	60
301-500	71	67	89
500-700	82	59	262
701-900	219	200	68
900-1100	63	101	31
>1100	66	148	113

EC criteria	Cumulative*		
<300	123	49	60
<500	194	116	149
<700	276	175	411
<900	495	375	479
<1100	558	476	510
>1100	66	148	113

* This table estimates stream length under various EC criteria if scenarios A, B, C were implemented.



FOR MORE INFORMATION PLEASE CONTACT:

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