State of the Monongahela River Research Symposium

Monongahela River Watershed Historical Water Quality Trends

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US Army Corps of Engineers
Pittsburgh District

September 16, 2010

District Water Management Mission

- 23 Locks & Dams
- 16 multipurpose headwater reservoirs
- 40 Local Flood Protection Projects
- Congressional authorization
  - Flood Control
  - Low flow augmentation
  - Water quality
  - Navigation
  - Fish & wildlife protection
  - Water supply
  - Recreation

Water Quality Mission

Operate reservoir projects for optimum water quality benefits to restore, maintain, and improve ambient chemical, physical, and biological integrity of the surface waters of the upper Ohio River drainage basin

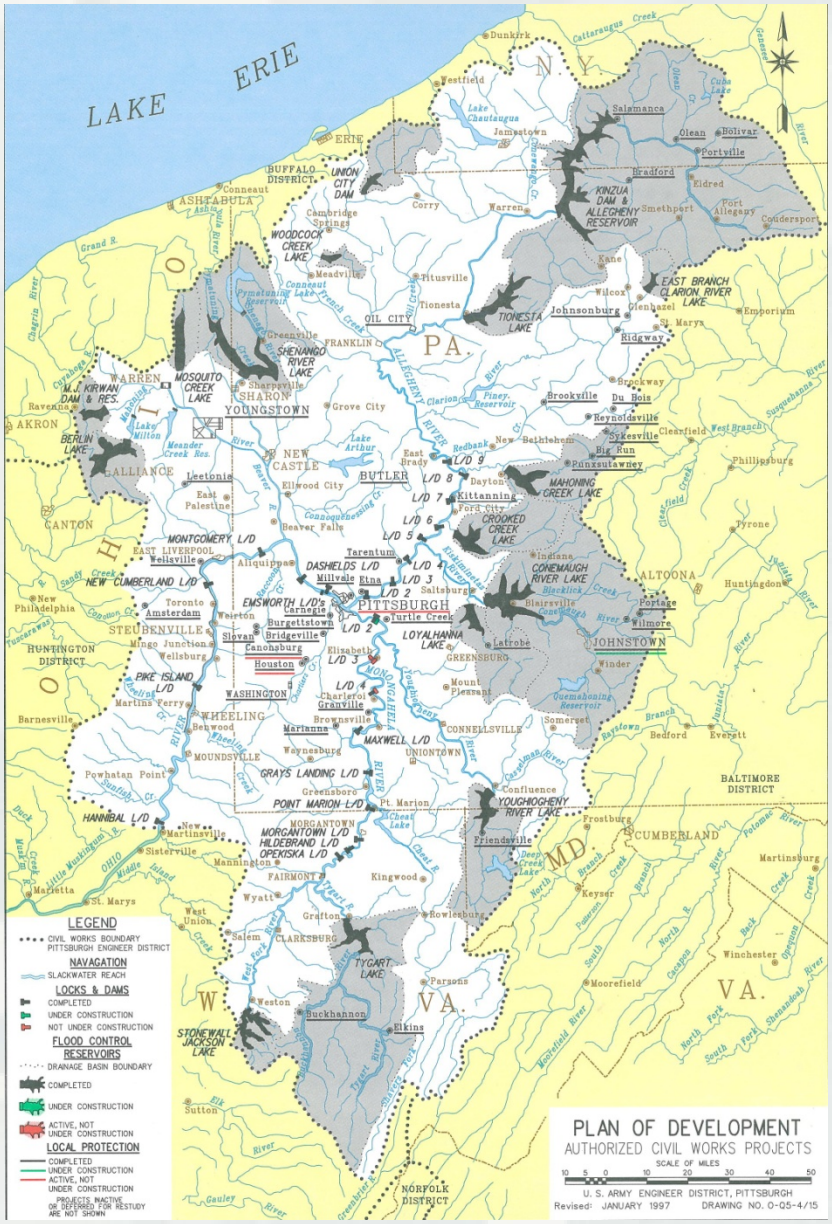
Water Quality

- >88% of reservoir storage exclusively dedicated to water quality
- 8,000 lineal miles of stream controlled by our reservoirs (7,942 square miles)
- 1,032.5 miles of 21 different major streams are directly influenced by our reservoir releases

Pittsburgh District

Business Lines:

- Navigation
- Environmental Stewardship
- Aquatic Ecosystem Restoration
- Flood and Coastal Storm Damage Reduction
- Recreation
- Emergency Management
- Water Supply
- Regulatory



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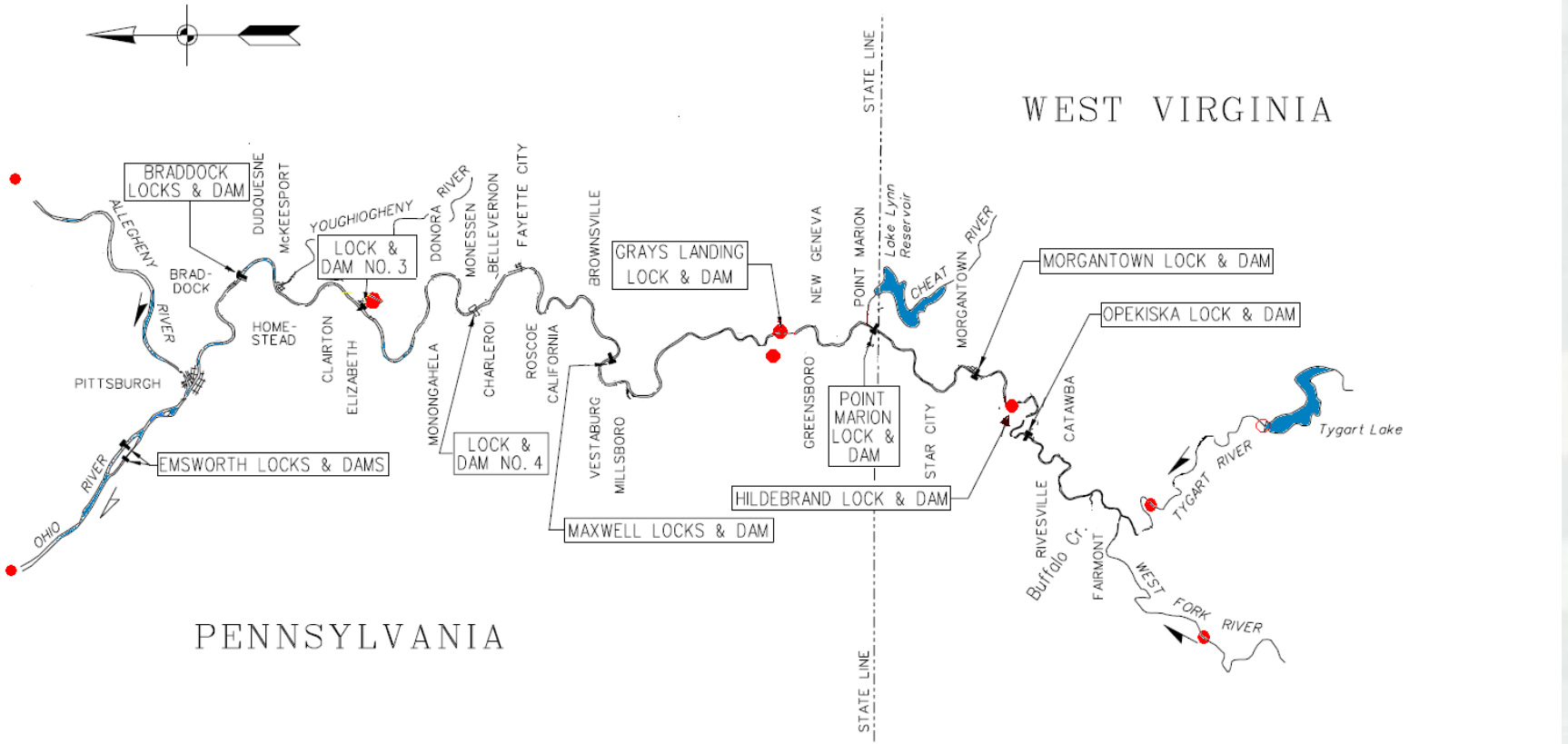
Monongahela River Continuous, Real-time, Water Quality Monitoring Stations

Real-time continuously recording monitors (DO, Conductivity, pH, & water temperature)

- **Mon River Mainstem**
  - Hildebrand L/D, Mile 108
  - Point Marion L/D, Mile 92.8
  - Elizabeth PA, Mile 23.8
- **Tygart River (Mon River Mile 128.7)**
  - Tygart Dam Outflow, Mile 23.3
  - Tygart River @ Colfax, WV, Mile 6.3
- **West Fork River (Mon River Mile 128.7)**
  - West Fork River at Stonewall Jackson Dam, Mile 74.5
  - West Fork River @ Enterprise, WV, Mile 12.0
- **Dunkard Creek @ Shannopin, PA (Mon River Mile 87.2)**
- **Youghiogheny River (Mon River Mile 15.5)**
  - Youghiogheny Dam outflow, mile 74.3
  - Casselman River @ Markelton, PA, mile 15.2, Yough Mile 73.3
  - Youghiogheny River at Confluence, PA, mile 72.8
  - Youghiogheny River @ Connellsville, PA, mile 44.7
  - Youghiogheny River @ Suttersville, PA, mile 15.3

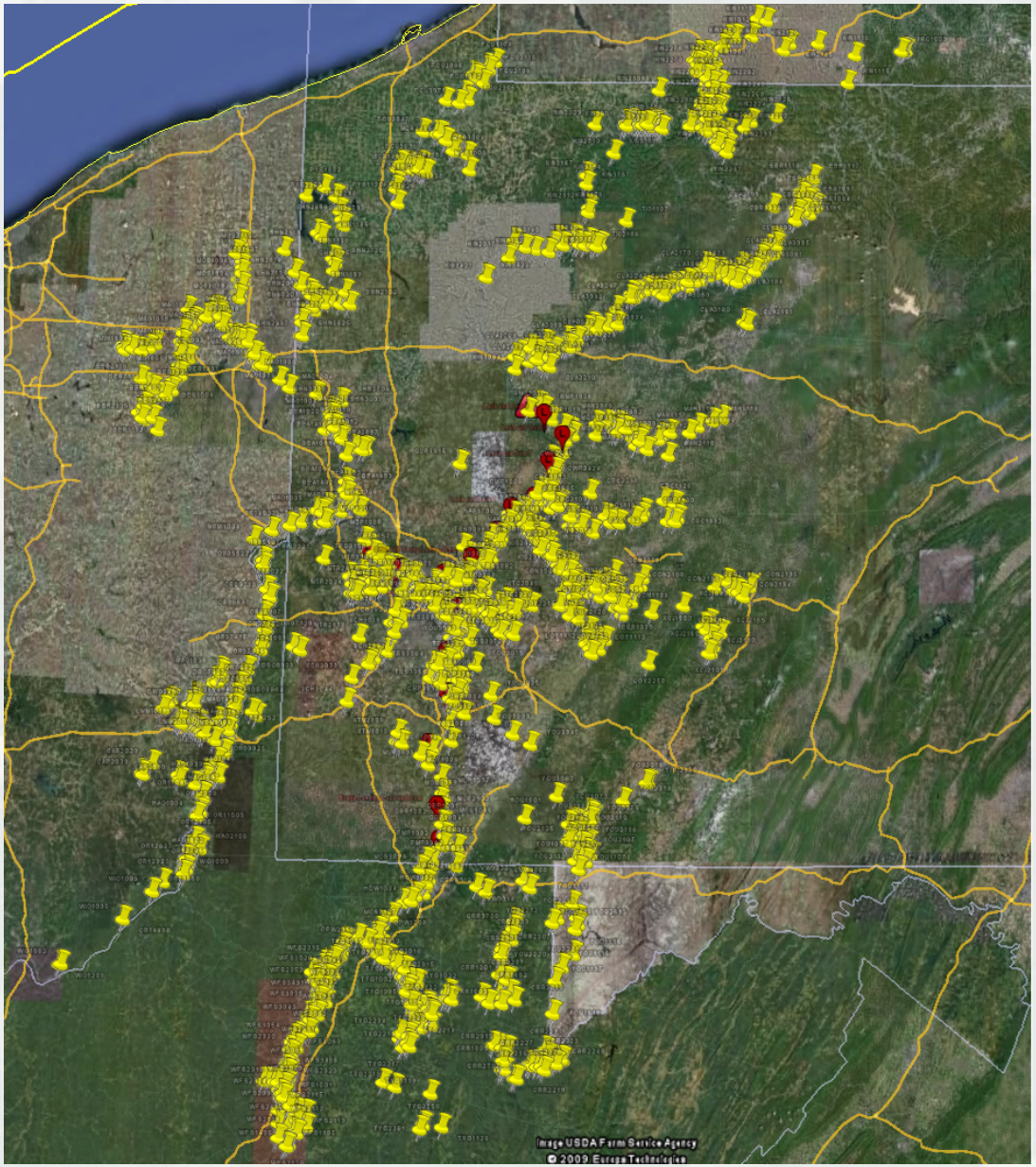


Mon River Basin Real-time WQ Monitoring Stations

Monongahela River Water Quality Monitoring

- **Grab Samples (**155 parameters, including metals, nutrients, alkalinity, acidity, pH, sulfate, chloride, hardness, conductivity, solids, organic compounds, DO, etc.)
  - **Historical "worse case",** summer season Water Quality Surveys 1975 – 2007
  - **TDS event**, Miles 91, 102, 108. October 2008
  - **Foam,** Mile 102, May 2009
  - **Mon River, Miles** 0 to 128.7 and major tributaries, August 2009 and 2010 (42 sampling stations)

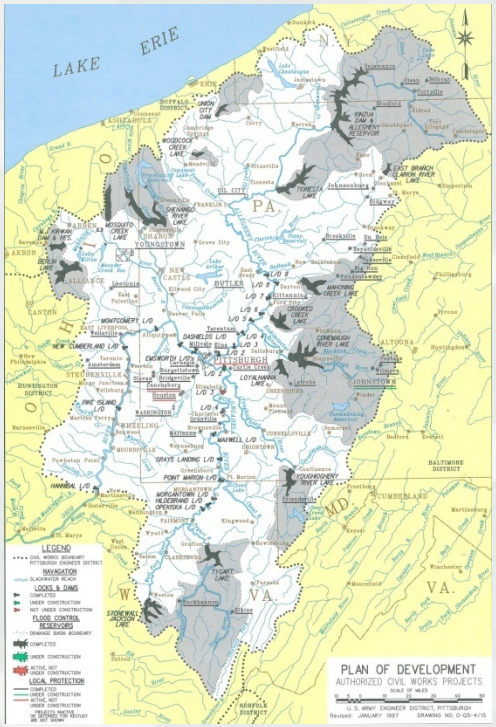
Pittsburgh District grab Water Quality Monitoring Stations



Monongahela River Water Quality Issues

- Resource extraction (legacy & new mine drainage, traditional gas drilling, valley fills, logging, etc)
- Industrial & municipal pollution (CSOs, leaking sanitary sewers, power generation, etc)
- Agriculture
- Land use & disturbance
- Dramatic increase in Marcellus Shale gas development
  - Surface disturbance, impacts on forest connectivity, erosion and turbidity
  - Fracwater disposal & increasing TDS
  - Increasing water withdrawals

Marcellus Shale Distribution & Pittsburgh District



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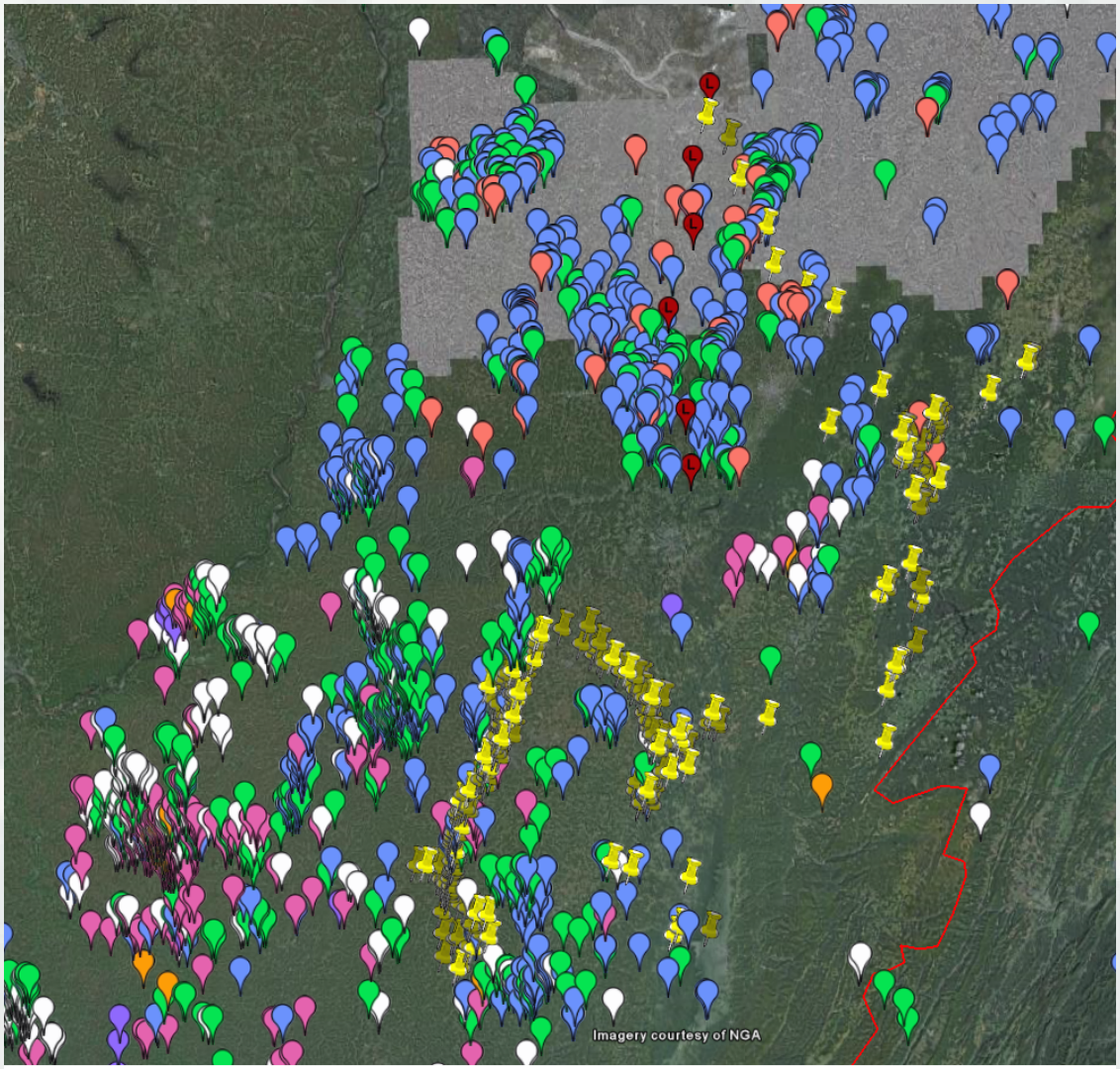
Fracwater Constituents

Brine (sodium, chloride, sulfates, calcium), metals (iron, aluminum, barium, boron, strontium), organic compounds (hydrocarbons, xylene, toluene), natural radioactivity

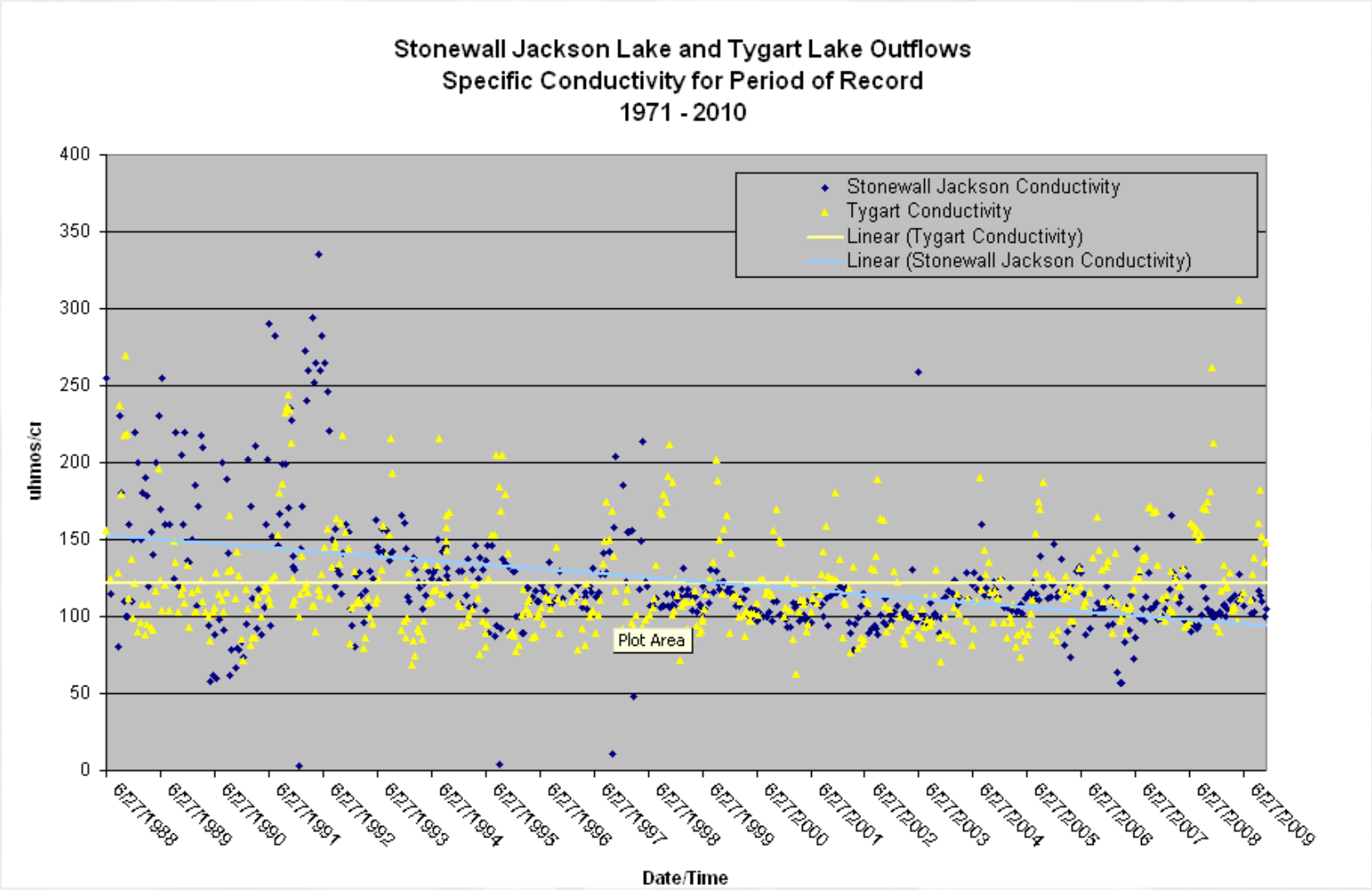
- Specific Conductivity (uhmos/cm)
  - Fracwater 500,000
  - Fresh water 50 - 800
  - Sea water 56,000
  - Potable water Maximum 1055
- Total dissolved solids (mg/l or ppm)
  - Fracwater 350,000
  - Fresh water <10 - 100
  - Sea water 35,000
  - PA TDS PWS criteria 500
- Chloride (mg/l or ppm)
  - Fracwater > 100,000
  - Fresh water < 1000
  - Sea water > 20,000

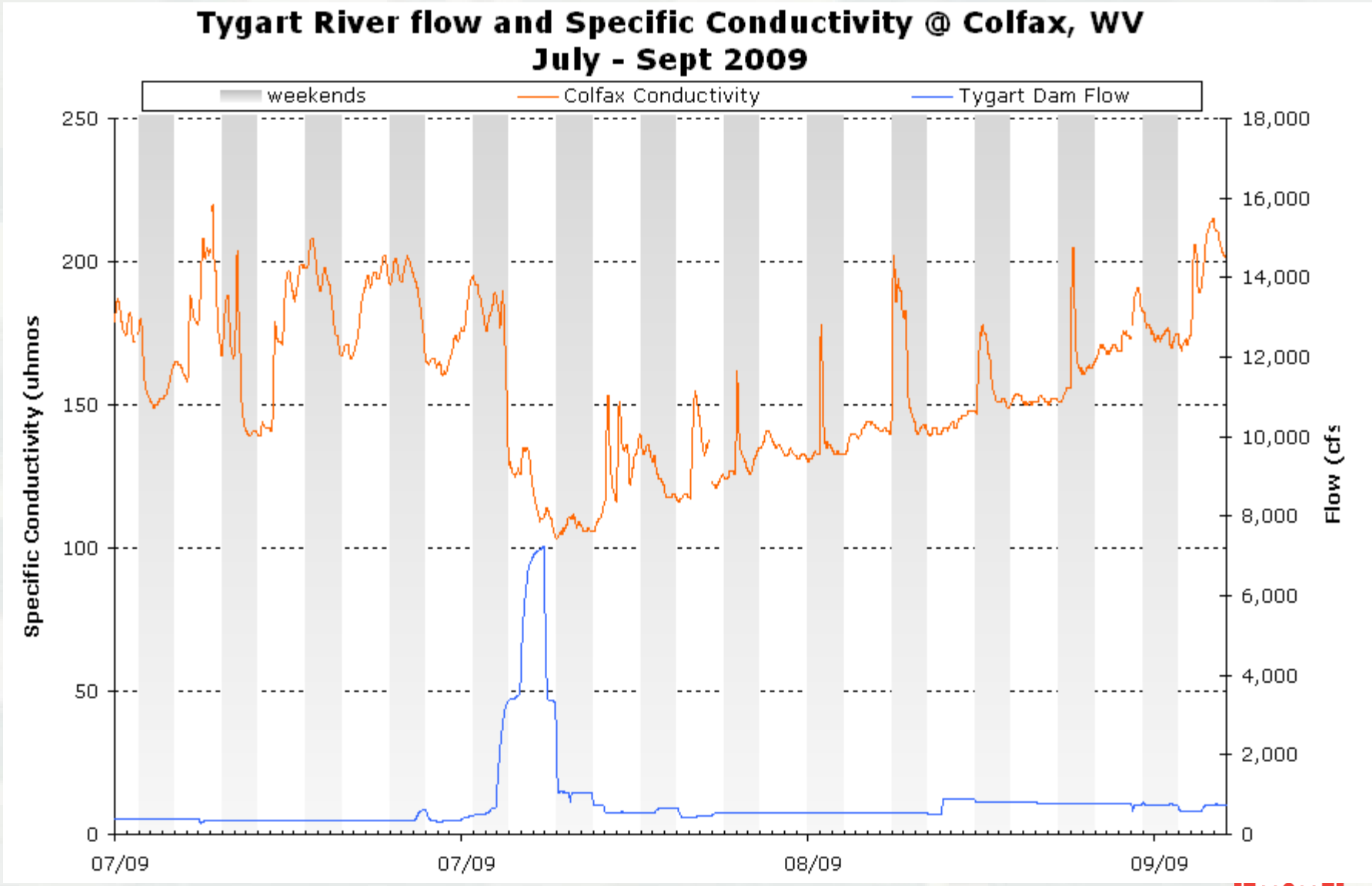
Monongahela River Basin Grab Sample Monitoring Locations and Permitted Marcellus Gas Wells

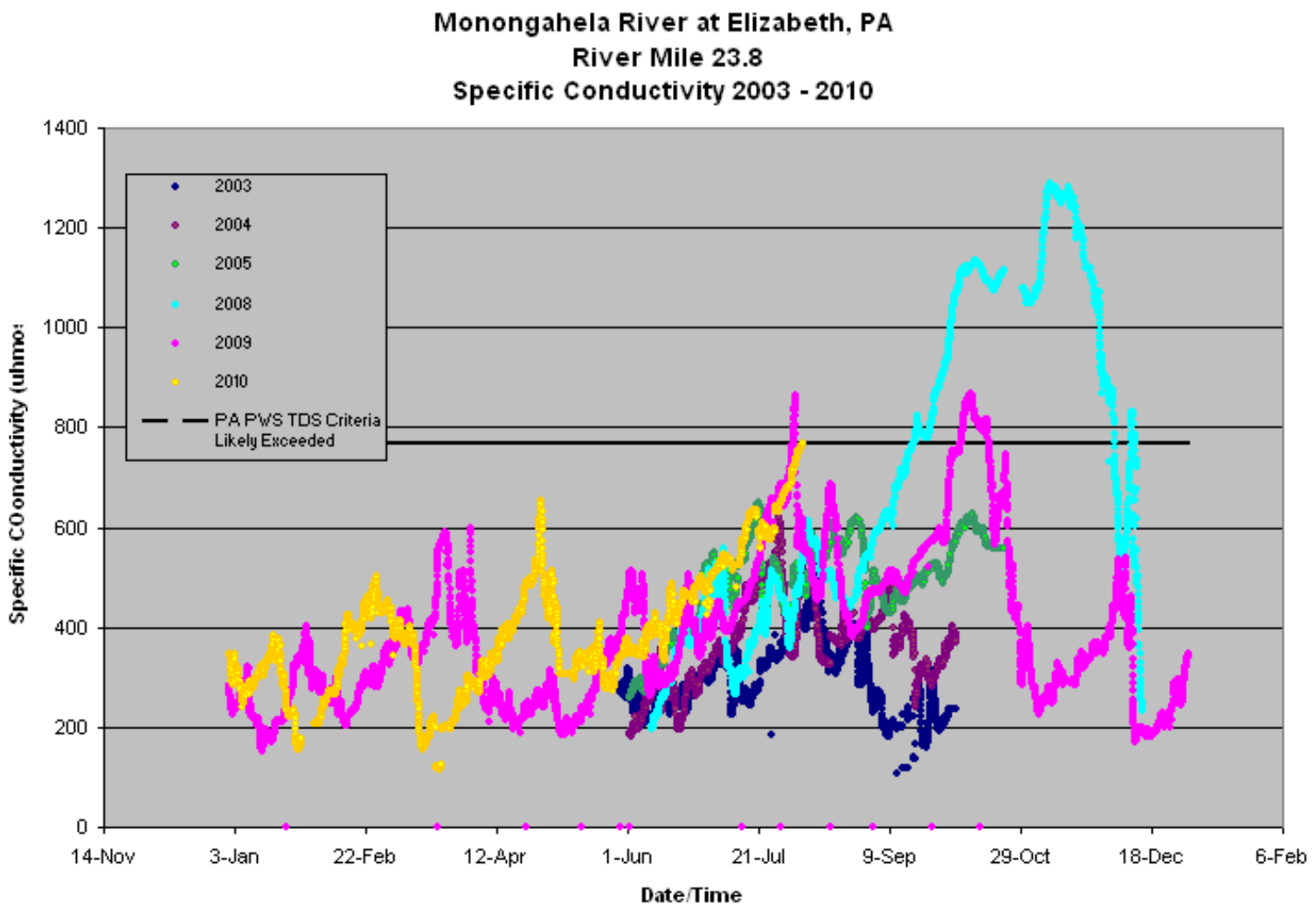


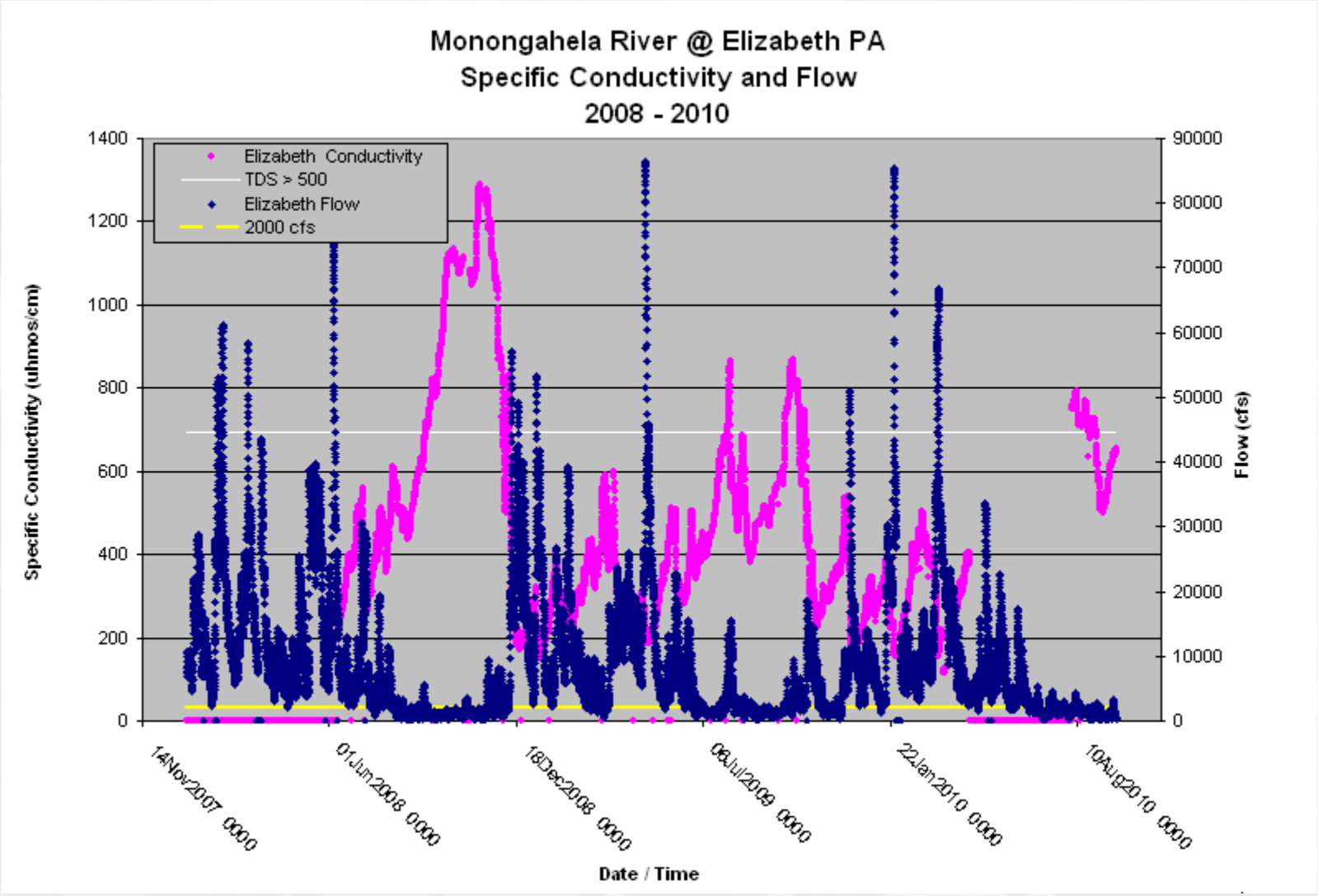
What the Data Show

- Low Specific Conductivity in headwater reservoirs. Stonewall Jackson Lake outflow shows trends towards improvement, but Tygart Lake outflow shows higher levels since 2008
- Tygart River at Colfax, WV: Conductivity levels spike on weekends, independent of flow
- Since 2008, Mon River @ Elizabeth, specific conductivity levels have exceed historical maximums
- inverse relationship between flow and conductivity @ Elizabeth PA, & historical maximum levels are exceeded when flow < 2000 cfs
- Dunkard Creek (mile 87) conductivity was extremely elevated before and during the Sept 2009 fish kill, and impacts were observable at Elizabeth (mile 24)
- Mon River Conductivity levels were average during our August 2009 survey, except in upper river in WV, where TDS, conductivity, and Na were 2X as high as the historical maximum, respectively.
- Mon River foam contains exceptionally high metal concentrations (Fe, Mn, Al, Ba, Sr)
- The West Fork River @ Enterprise and the Youghiogheny River @ Suttersville conductivity values were close to historical maximums during 2009 and 2010, a wet and dry water year.


Stonewall Jackson Lake and Tygart Lake Outflows
Specific Conductivity for Period of Record
1971 - 2010
Stonewall Jackson Conductivity
Tygart Conductivity
Linear (Tygart Conductivity)
Linear (Stonewall Jackson Conductivity)
Plot Area
umos/cm
Date/Time
400
350
300
250
200
150
100
50
0
6/27/1988
6/27/1989
6/27/1990
6/27/1991
6/27/1992
6/27/1993
6/27/1994
6/27/1995
6/27/1996
6/27/1997
6/27/1998
6/27/1999
6/27/2000
6/27/2001
6/27/2002
6/27/2003
6/27/2004
6/27/2005
6/27/2006
6/27/2007
6/27/2008
6/27/2009


Tygart River flow and Specific Conductivity @ Colfax, WV
July - Sept 2009
weekends
Colfax Conductivity
Tygart Dam Flow
Specific Conductivity (uhmos
Flow (cfs
250
200
150
100
50
0
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
07/09
07/09
08/09
09/09


Monongahela River at Elizabeth, PA
River Mile 23.8
Specific Conductivity 2003 - 2010
Specific COonductivity (uhmo:
1400
1200
1000
800
600
400
200
0
2003
2004
2005
2008
2009
2010
PA PWS TDS Criteria Likely Exceeded
14-Nov
3-Jan
22-Feb
12-Apr
1-Jun
21-Jul
9-Sep
29-Oct
18-Dec
6-Feb
Date/Time



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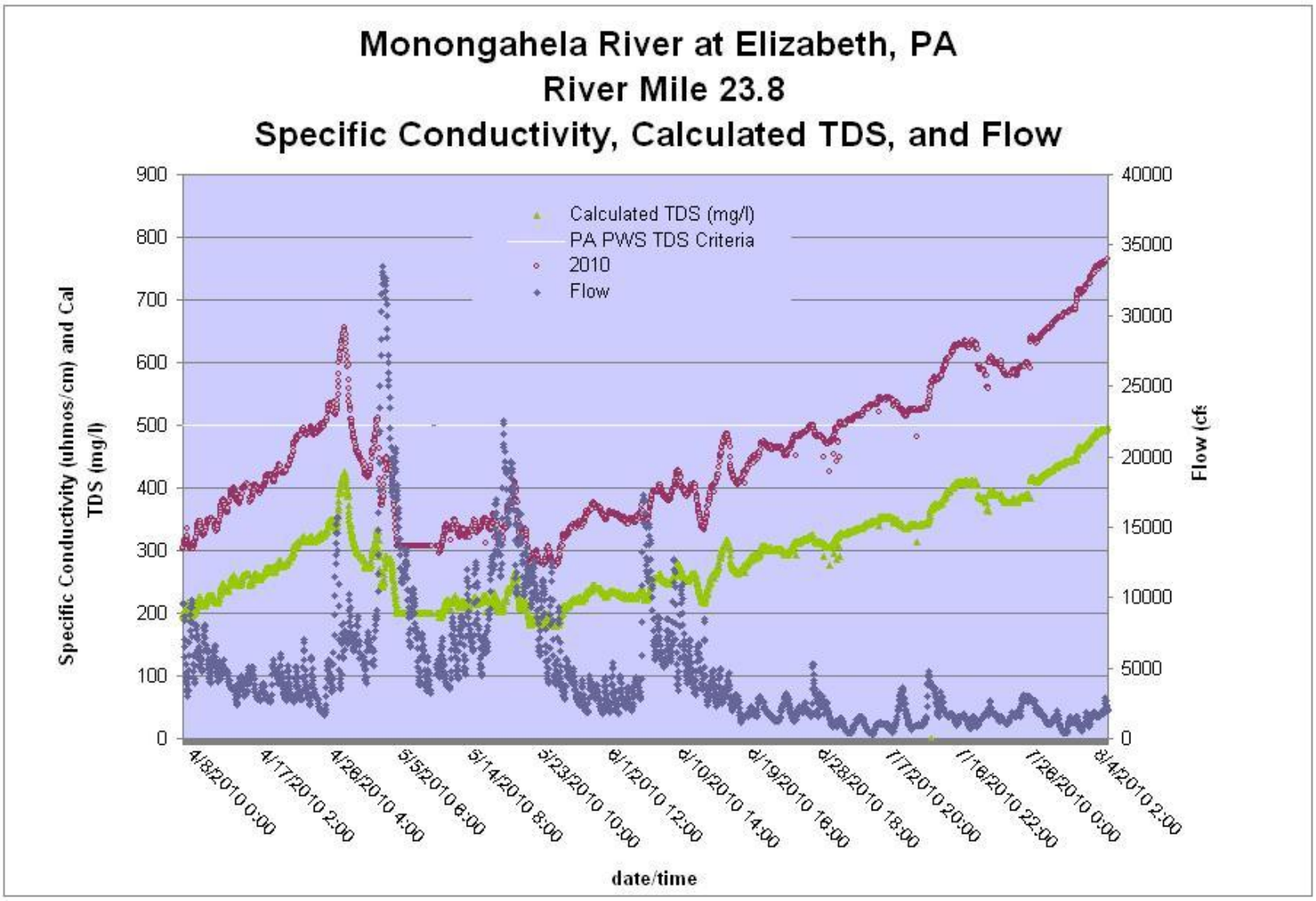
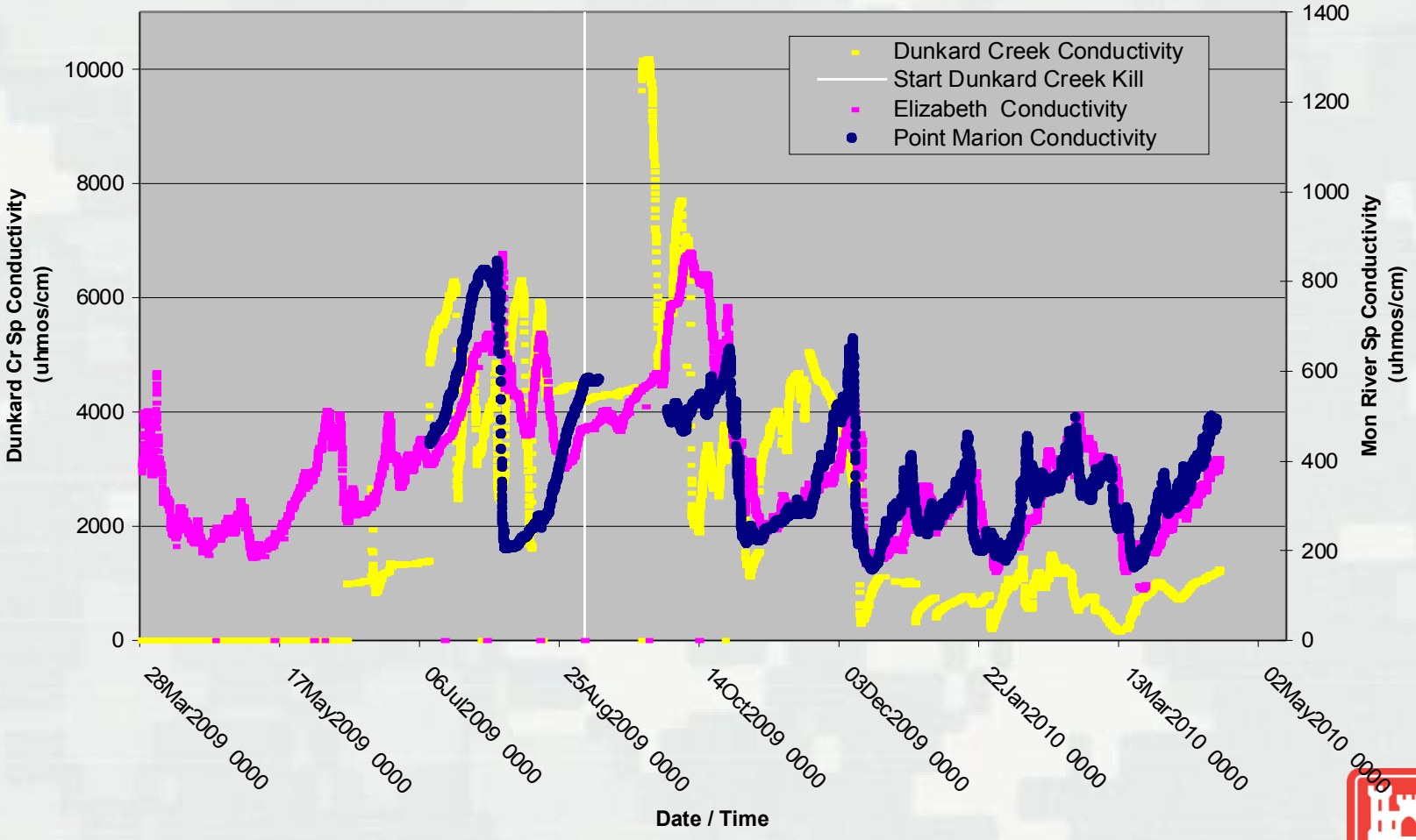
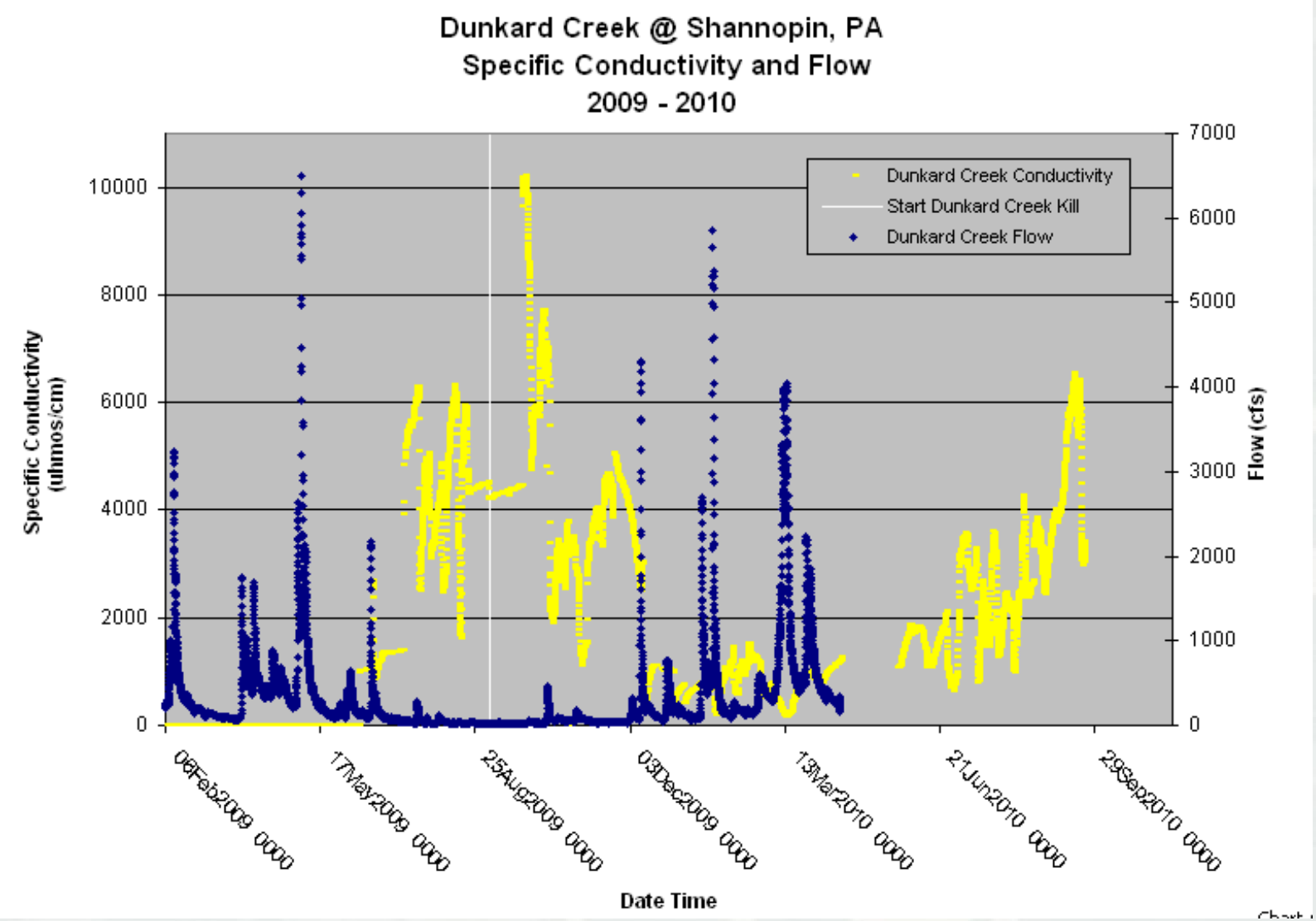
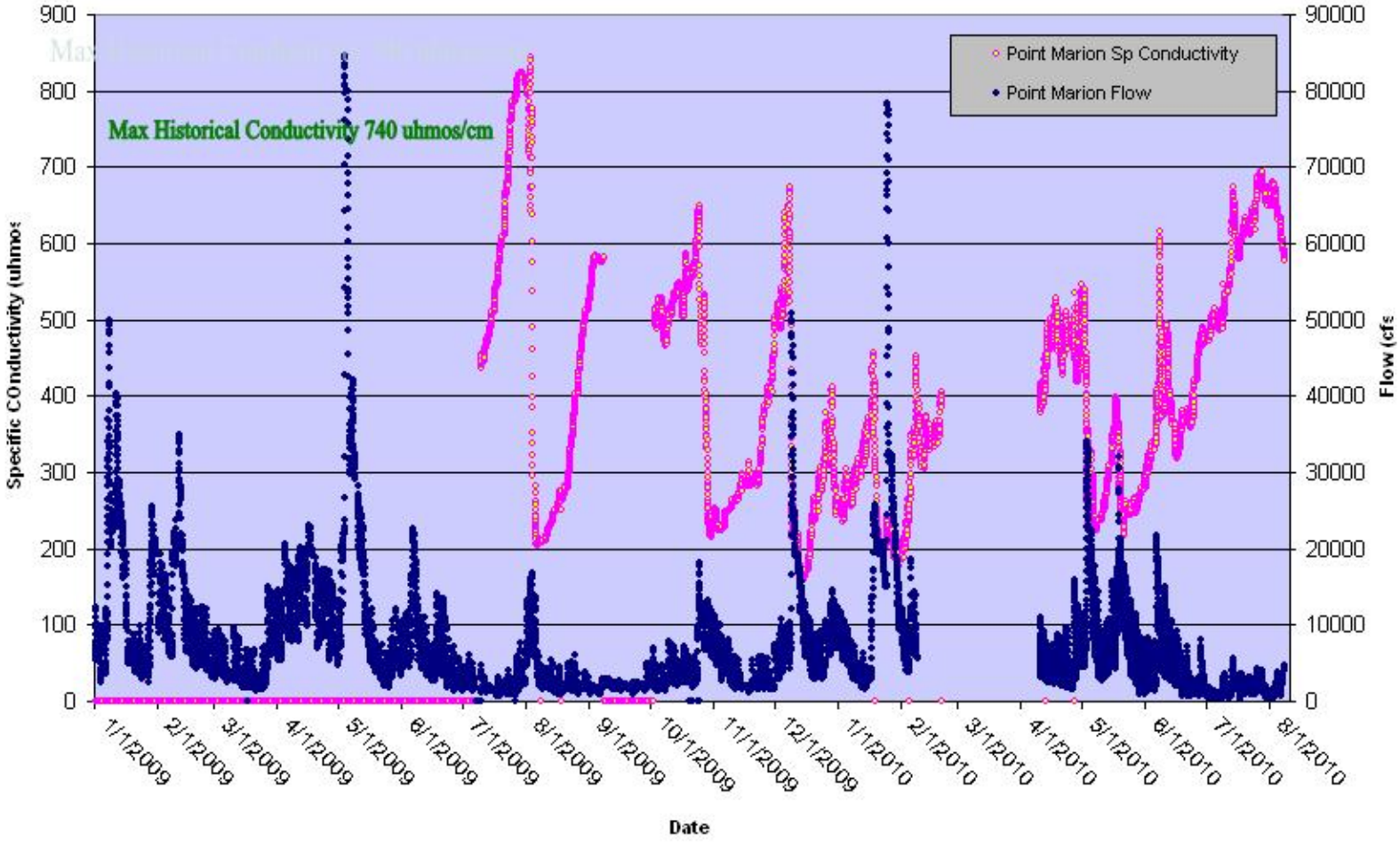

Monongahela River at Elizabeth, PA
River Mile 23.8
Specific Conductivity, Calculated TDS, and Flow
Specific Conductivity (uhmos/cm) and Cal TDS (mg/l)
Flow (cfs
Calculated TDS (mg/l)
PA PWS TDS Criteria
2010
Flow
900
800
700
600
500
400
300
200
100
0
40000
35000
30000
25000
20000
15000
10000
5000
0
4/3/2010 0:00
4/17/2010 2:00
4/26/2010 4:00
5/5/2010 6:00
5/14/2010 8:00
5/23/2010 10:00
6/1/2010 12:00
6/10/2010 14:00
6/19/2010 16:00
6/28/2010 18:00
7/7/2010 20:00
7/16/2010 22:00
7/26/2010 0:00
8/4/2010 2:00
date/time

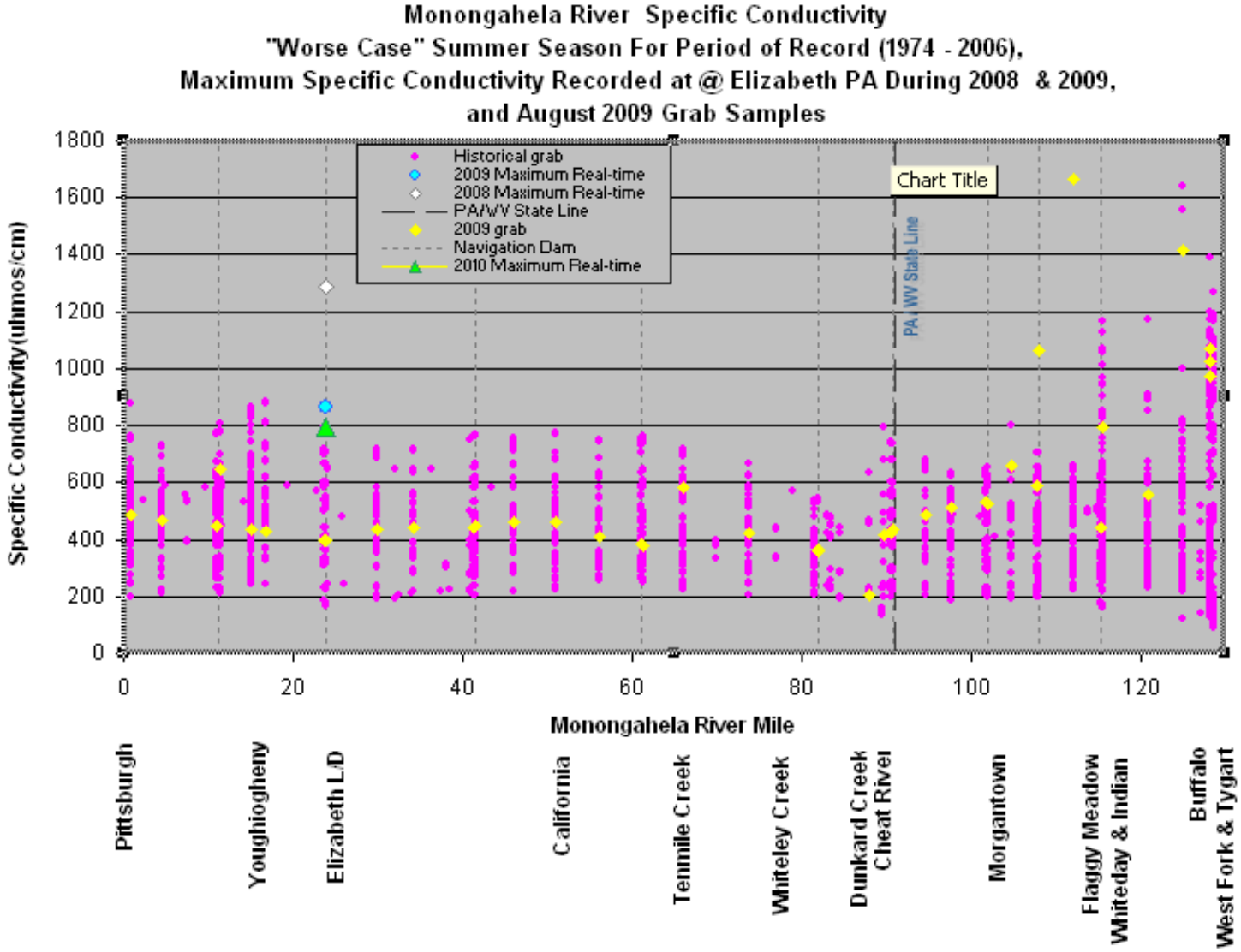
Dunkard Creek @ Shannopin, PA ,
Monongahela River @ Point Marion, WV (mile 91), and Elizabeth PA (mi 24)
Specific Conductivity
2009 - 2010




Dunkard Creek @ Shannopin, PA
Specific Conductivity and Flow
2009 - 2010
Dunkard Creek Conductivity
Start Dunkard Creek Kill
Dunkard Creek Flow
Specific Conductivity (uhmos/cm)
Flow (cfs)
10000
8000
6000
4000
2000
0
7000
6000
5000
4000
3000
2000
1000
0
06Feb2009 0000
17May2009 0000
25Aug2009 0000
03Dec2009 0000
13Mar2010 0000
21Jun2010 0000
29Sep2010 0000
Date Time

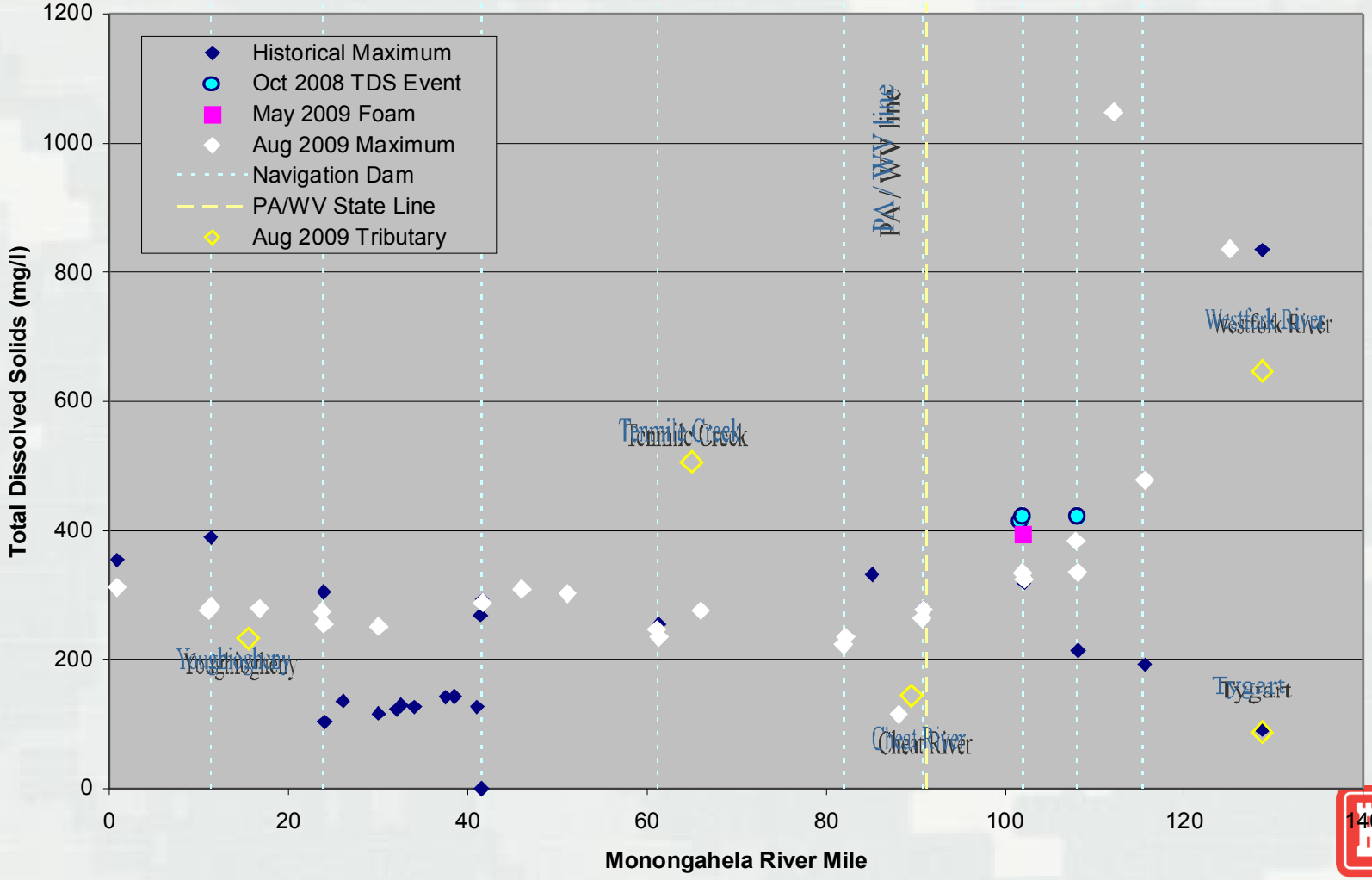

Monongahela River At Point Marion, PA
Specific Cnductivity and Flow
2009 - 2010
Max Historical Conductivity 740 uhmos/cm
Point Marion Sp Conductivity
Point Marion Flow
Specific COnductivity (uhmos
Flow (cfs
Date
900
800
700
600
500
400
300
200
100
0
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
7/1/2009
8/1/2009
9/1/2009
10/1/2009
11/1/2009
12/1/2009
1/1/2010
2/1/2010
3/1/2010
4/1/2010
5/1/2010
6/1/2010
7/1/2010
8/1/2010

Specific Conductivity



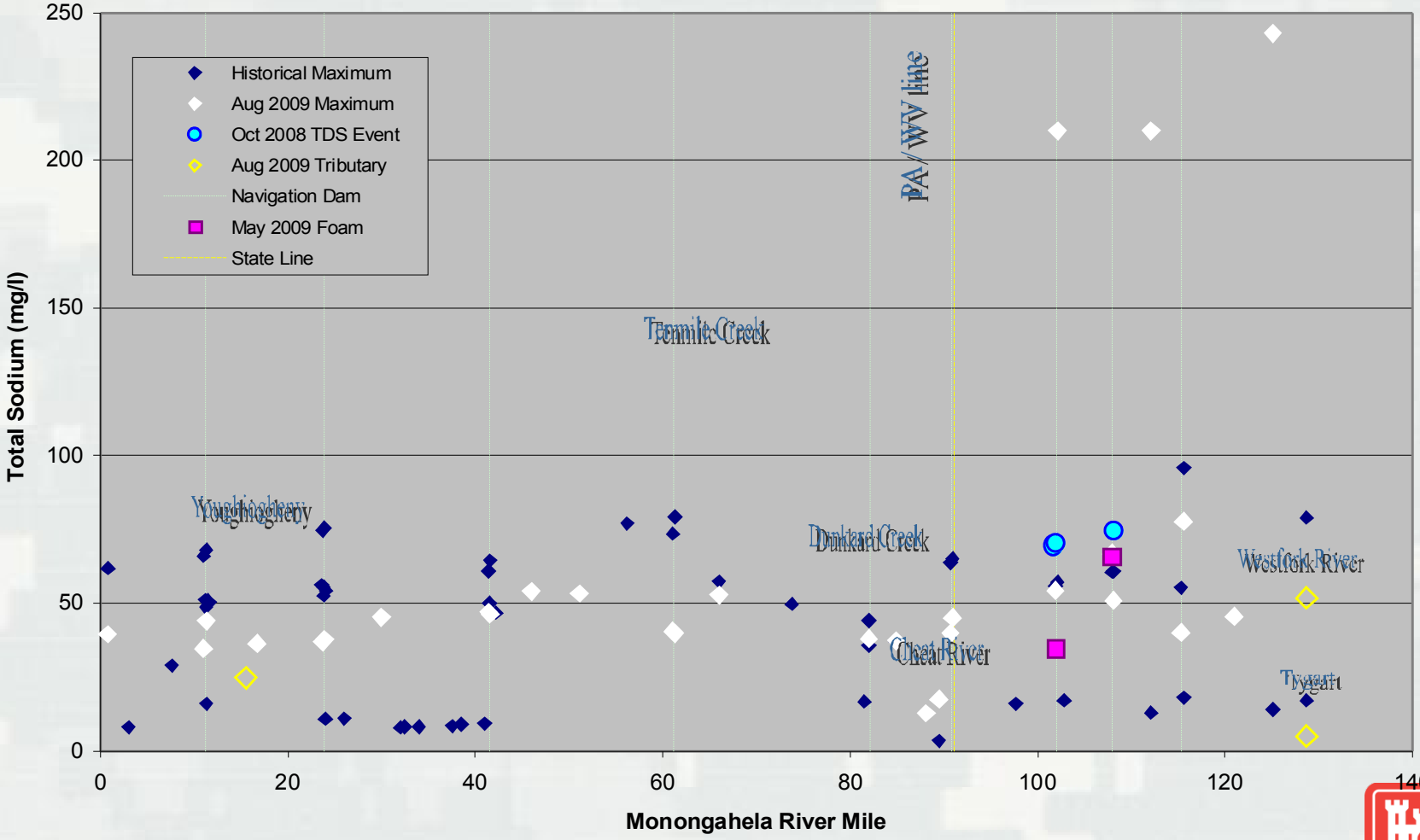
Total Dissolved Solids

Monongahela River and Major Tributaries Total Dissolved Solids
Maximum Summer Season 1975 - 2004, Oct 2008 Grab,
May 2009 Foam, and Maximum August 2009 Grab



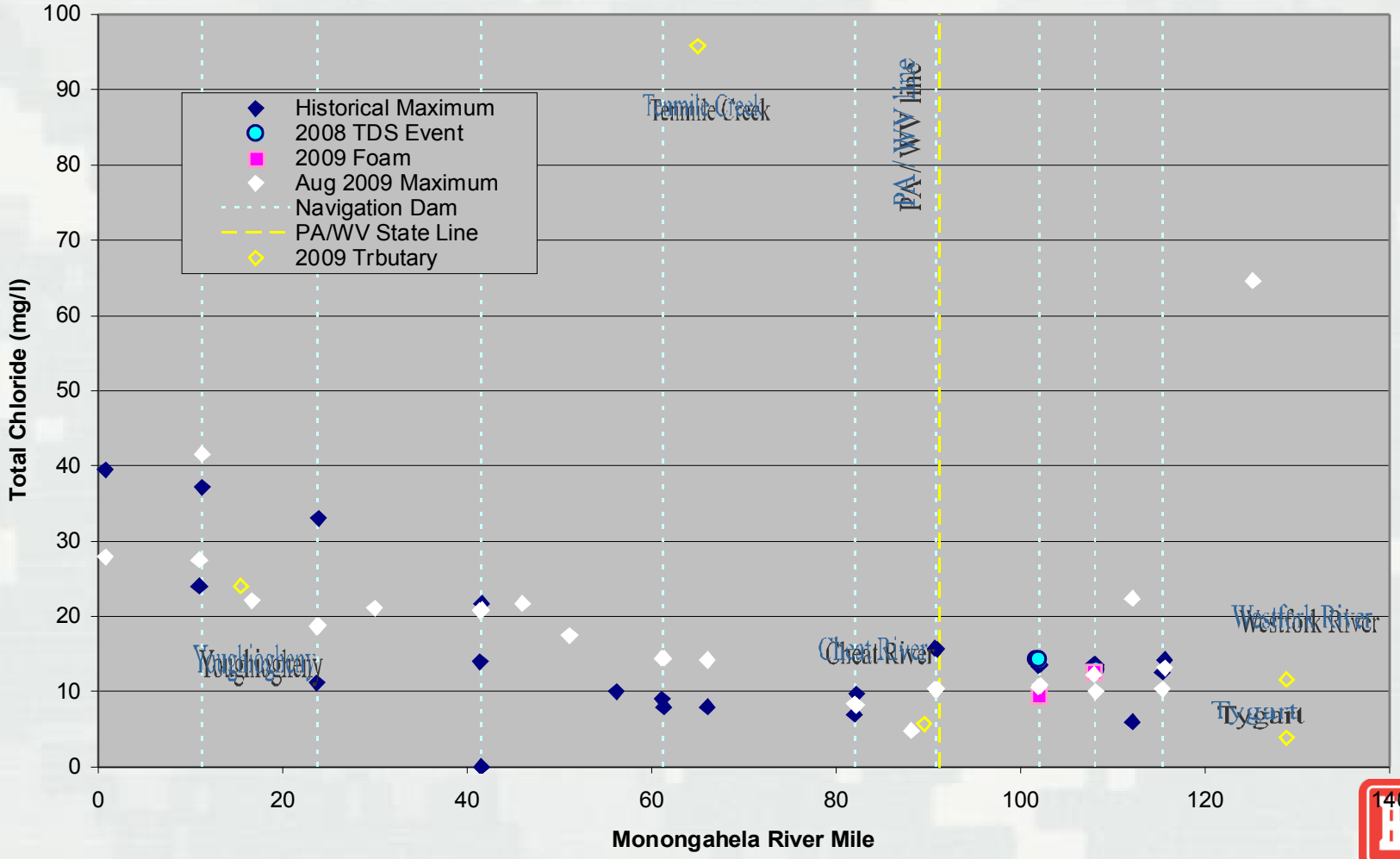
Total Sodium

Monongahela River and Major Tributaries Sodium
Maximum 1975-2007 "worse case" Summer Season, 2008 TDS event,
May 2009 Foam, and August 2009 Grab



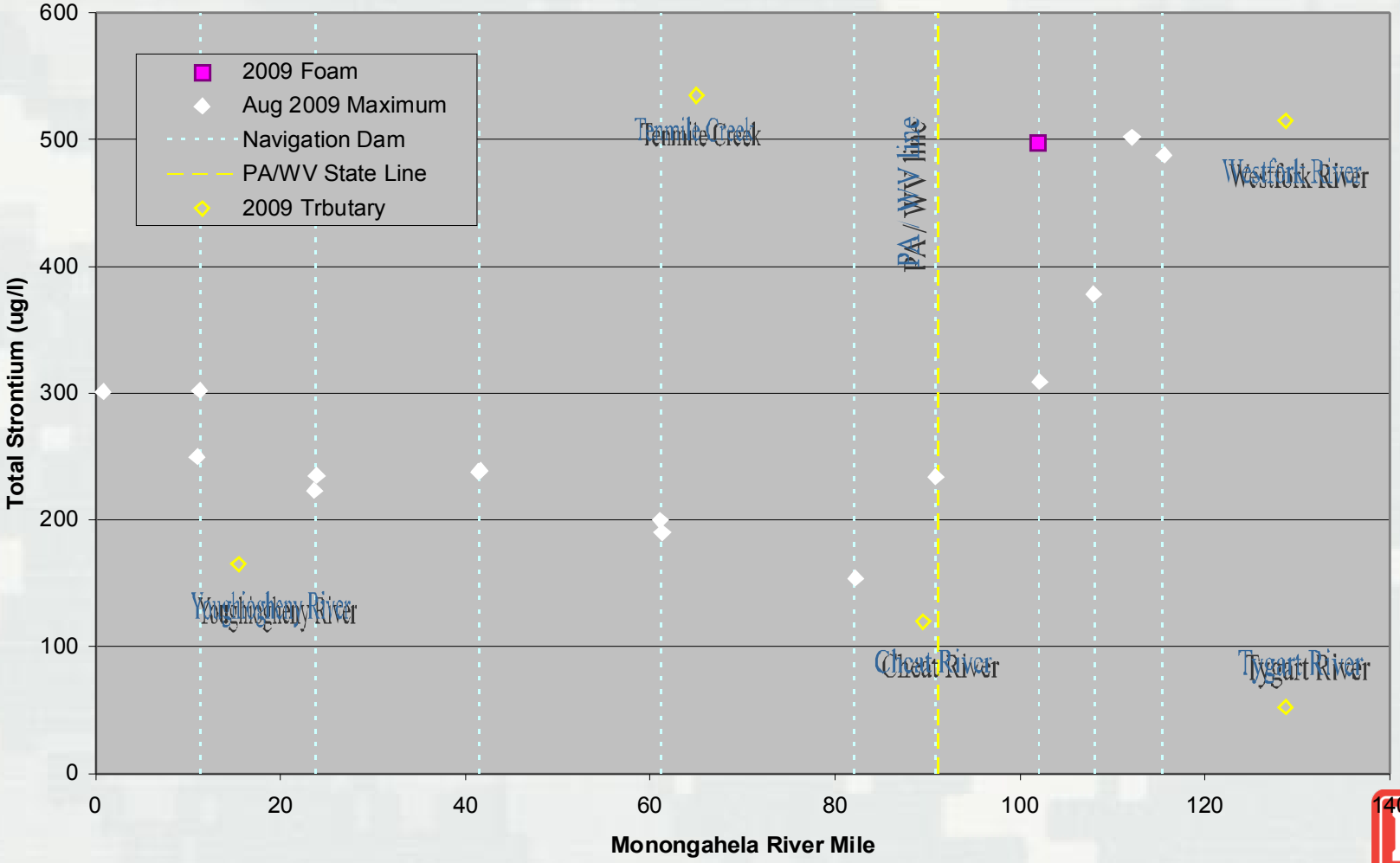
Total Chlorides

Monongahela River and Major Tributaries Total Chloride
Maximum 1975-2007 "worse case" Summer Season, 2008 TDS event,
May 2009 Foam, and August 2009 Grab



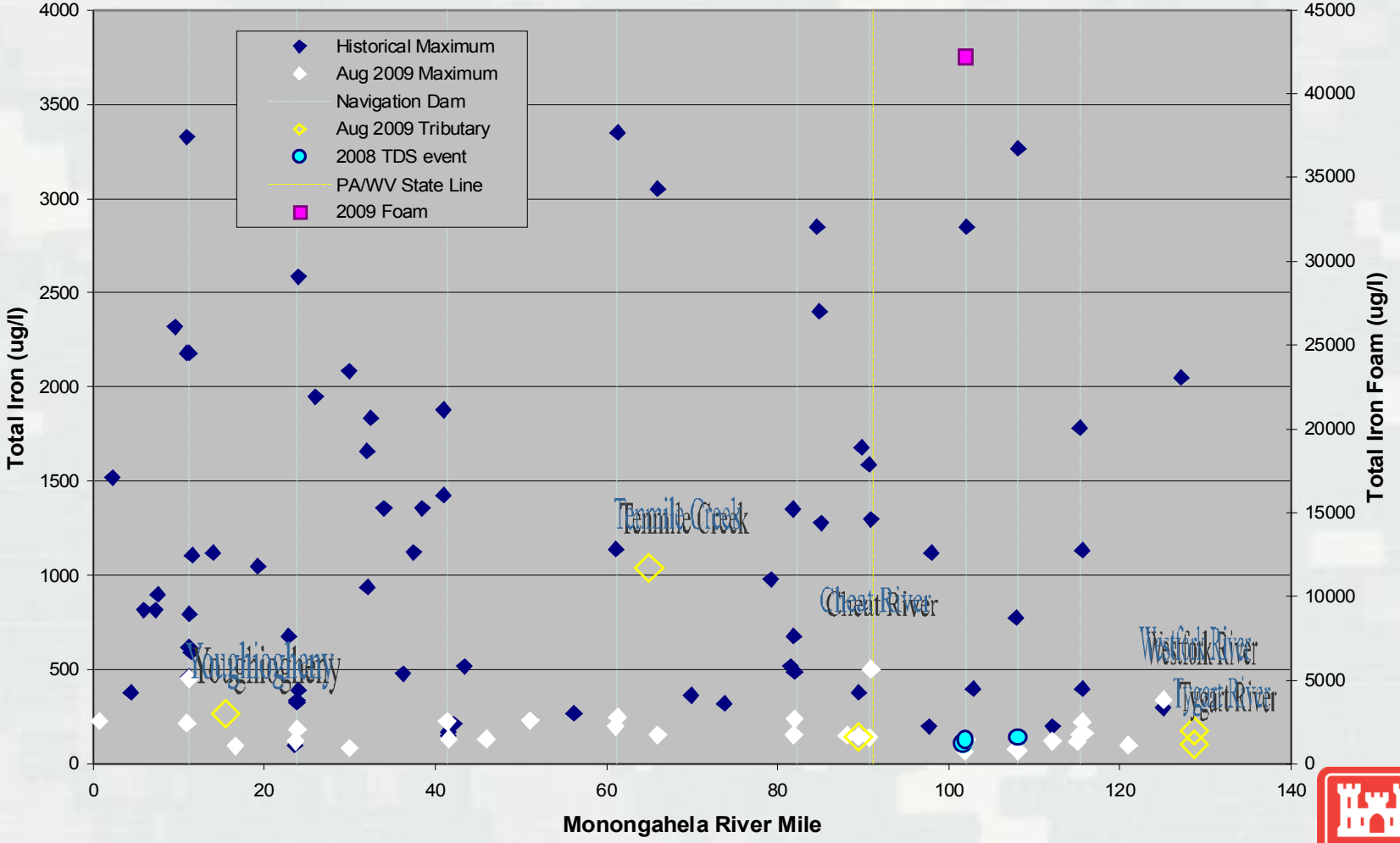
Total Strontium

Monongahela River and Major Tributaries Total Strontium
May 2009 Foam and August 2009 Grab



Total Iron

Monongahela River and Major Tributaries Total Iron
Maximum 1975-2007 "worse case" Summer Season, 2008 TDS event,
May 2009 Foam, and August 2009 Grab



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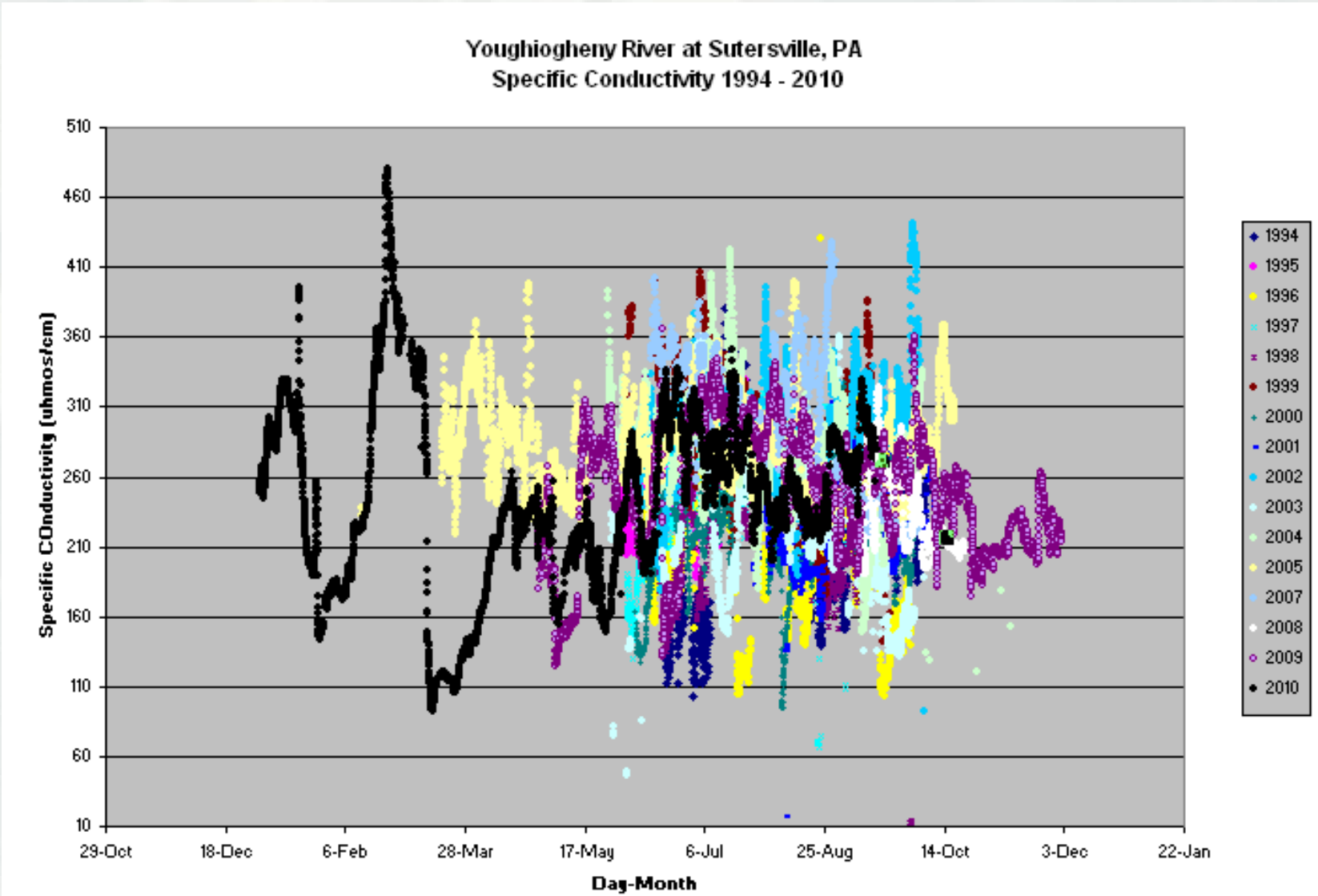
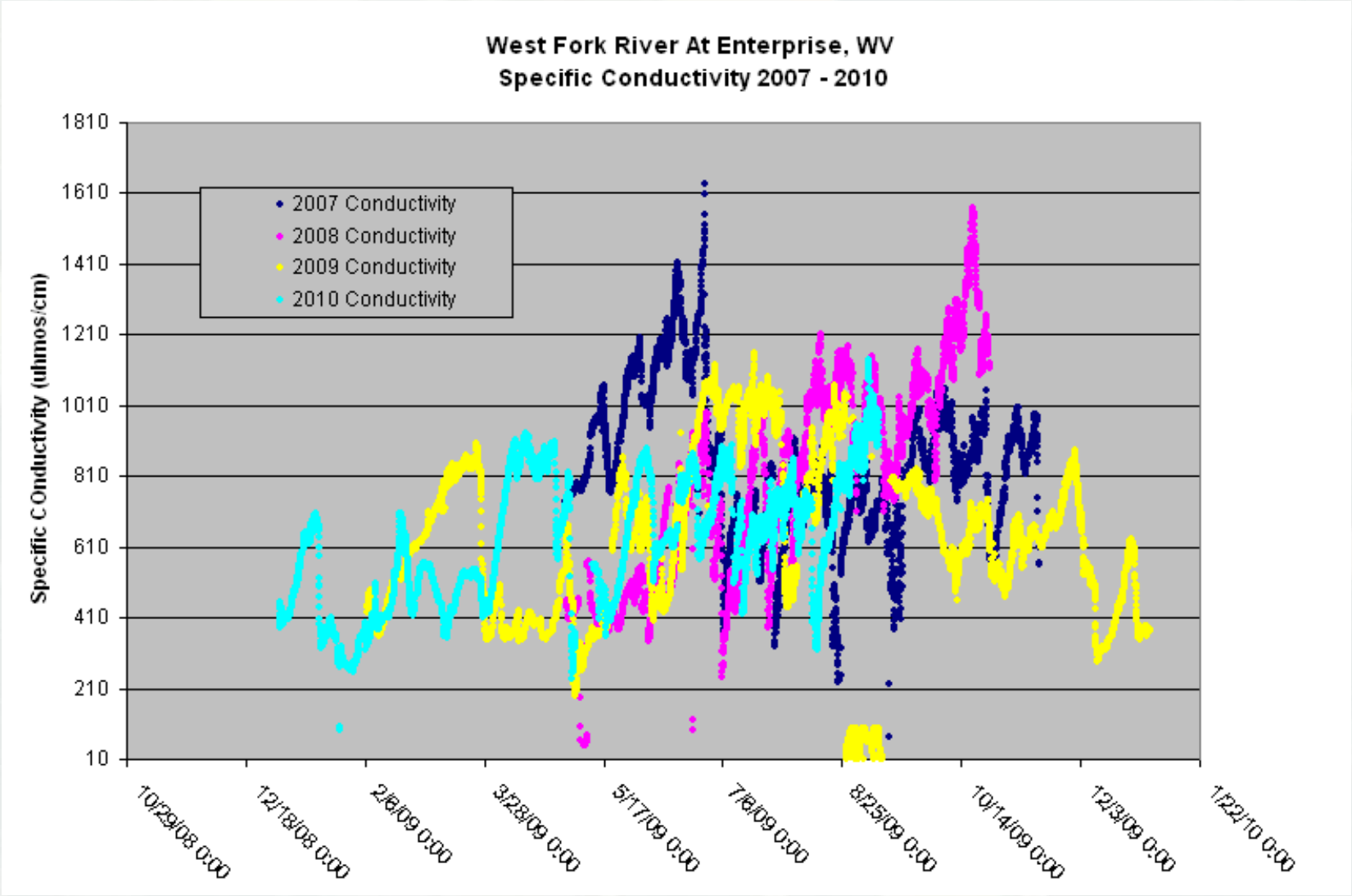

Youghiogheny River at Sutersville, PA
Specific Conductivity 1994 - 2010
Specific COnductivity (uhmos/cm)
510
460
410
360
310
260
210
160
110
60
10
29-Oct
18-Dec
6-Feb
28-Mar
17-May
6-Jul
25-Aug
14-Oct
3-Dec
22-Jan
Day-Month
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2007
2008
2009
2010


West Fork River At Enterprise, WV
Specific Conductivity 2007 - 2010
Specific COnductivity (uhmos/cm)
1810
1610
1410
1210
1010
810
610
410
210
10
2007 Conductivity
2008 Conductivity
2009 Conductivity
2010 Conductivity
10/29/08 0:00
12/18/08 0:00
2/6/09 0:00
3/28/09 0:00
5/17/09 0:00
7/6/09 0:00
8/25/09 0:00
10/14/09 0:00
12/3/09 0:00
1/22/10 0:00

Concerns

- Increasing TDS loads and water withdrawals interfere with / reduce benefits of authorized Corps reservoir project purposes (water quality, fish & wildlife, water supply, navigation, etc)
  - Withdrawal of low TDS water for Marcellus hydrofracing from reservoir inflows
    - loss of dilution
    - interference with reservoir operation schedules
    - loss of highest quality streams/biodiversity
  - Withdrawal of augmented flow Congressionally designated for water quality
  - Disposal of treated/untreated Marcellus fracwater (brine) or other sources of high TDS into surface waters or on land
- Resource extraction is degrading streams in areas not traditionally impacted (reservoir tributaries, headwaters)
- Mon River TDS assimilative capacity has been reached. Similar WQ problems developing in other watersheds (Allegheny, Youghiogheny, Kiskiminetas, Cheat etc.)
- Corps Mon River basin reservoirs have little or no capacity to release enough water to meet PA drinking water TDS criteria during low flow periods
- Marcellus drilling (TDS) projected to increase dramatically

Recommendations

- Adequate regulation of water withdrawals & point and non point source pollution, ensuring adoption and enforcement of appropriate standards addressing withdrawals and discharge, treatment, and/or storage of fracwater by watershed.
  - Sustainable water withdrawals to assure protection of water quality & aquatic life (biologically diverse headwater tributaries)
  - Seasonal TDS TMDLs for the Mon River basin
  - Ambient end of pipe treatment of fracwater & other high TDS pollution sources
- Protection of Congressionally authorized reservoir augmented flow (water quality storage) and the sources of reservoir storage (inflow tributaries)
- Continue agency coordination, engage stakeholders, share information
- Upper Ohio River Basin Commission for Water Resource Management (withdrawals, TDS TMDL's, WQ Criteria)