

Baseline Monitoring in Selected Areas of the Marcellus Play



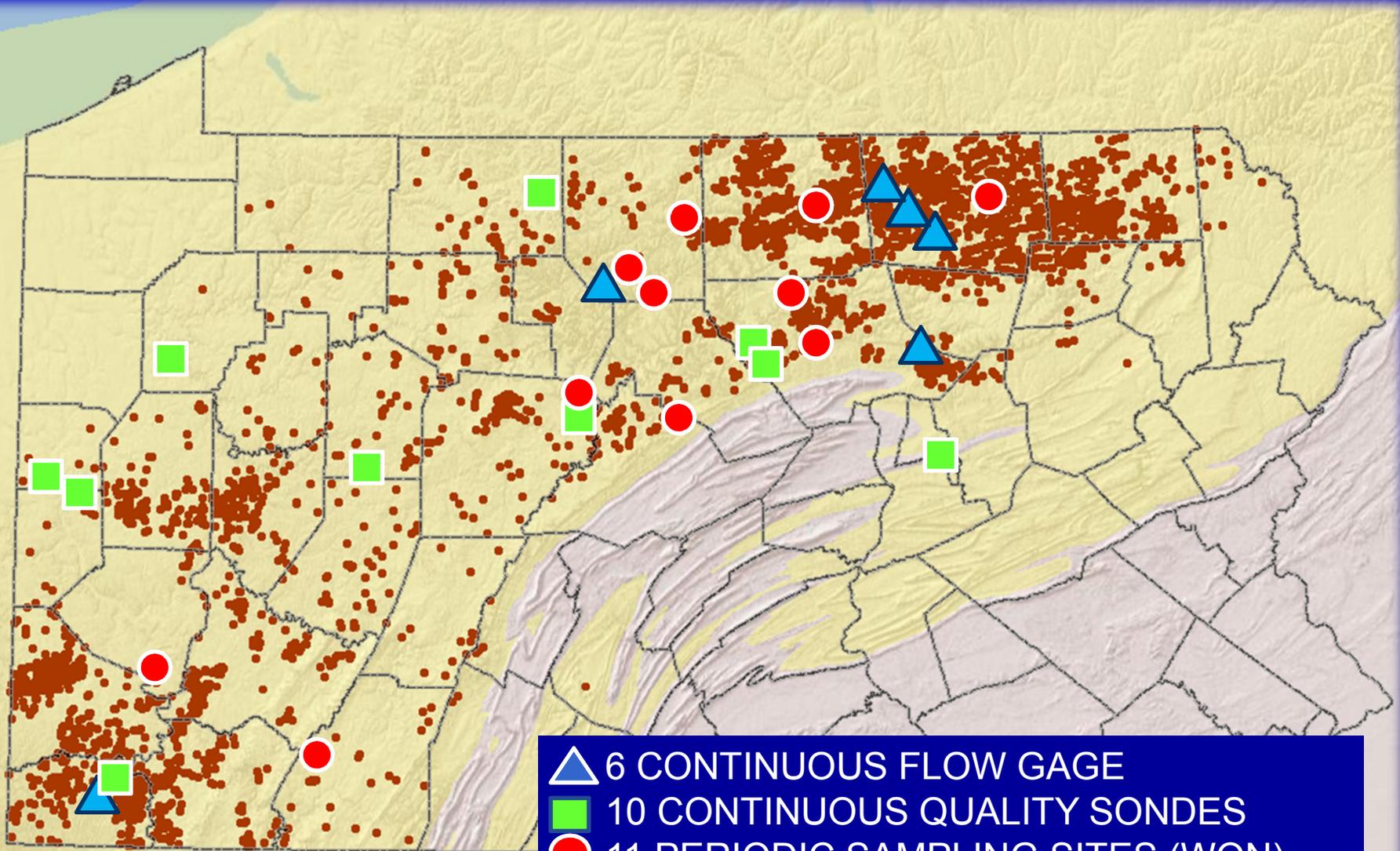
Daughterty Run near Powys, PA

USGS Water Resources Activities in PA

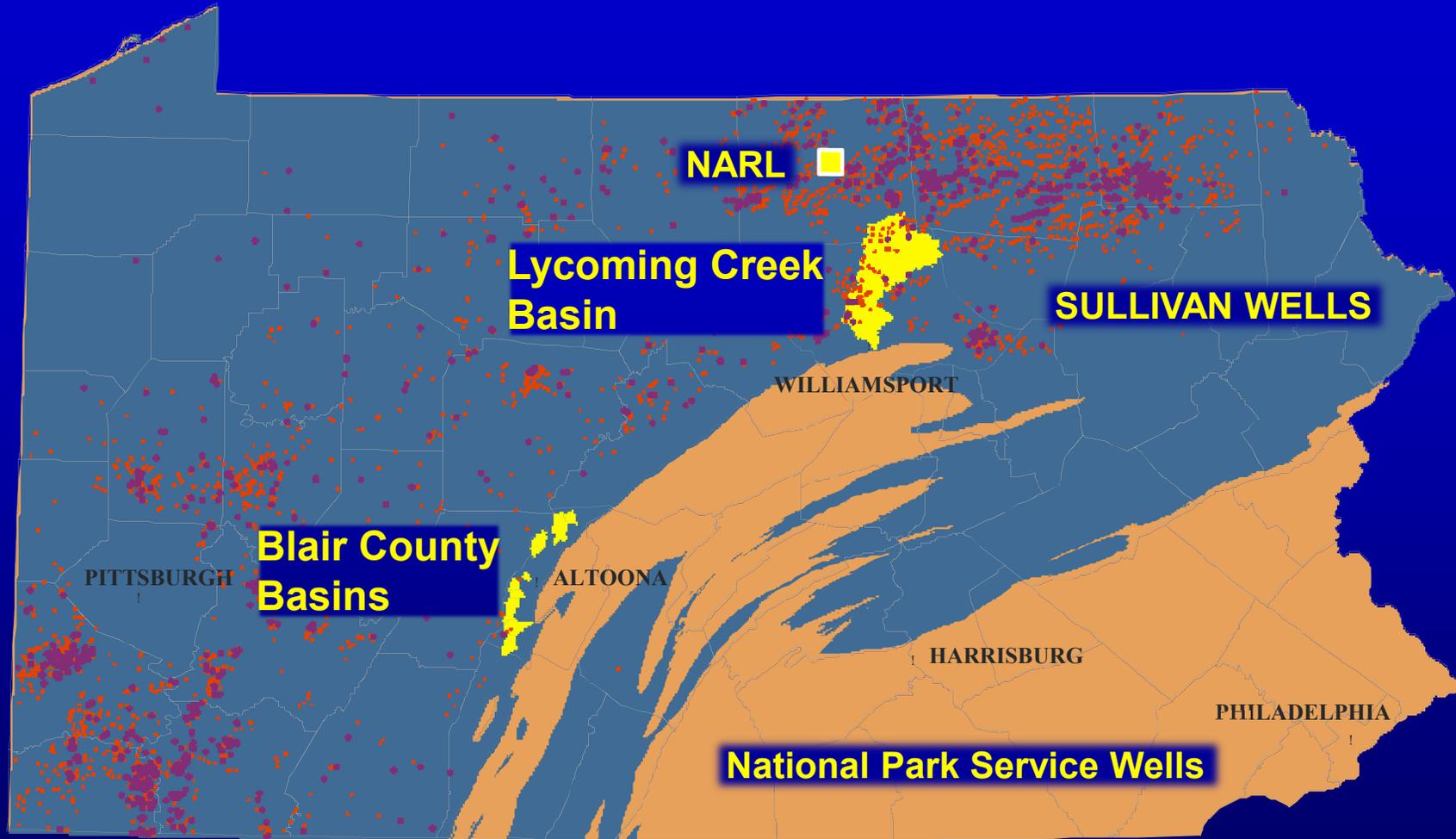
- Long-Term Monitoring
- Baseline Assessments



Long Term Monitoring



Baseline Water-Quality Monitoring

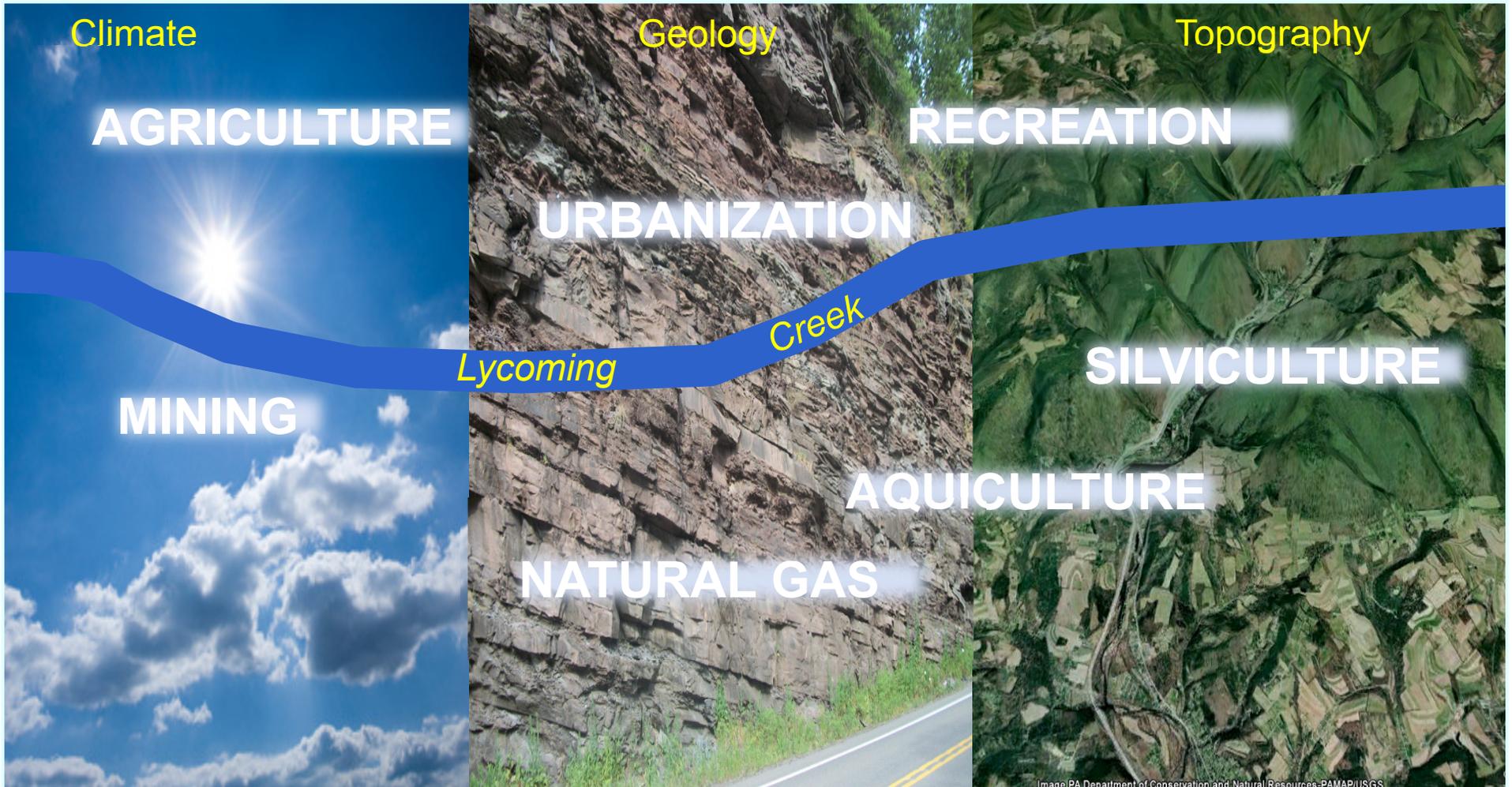


- Extent of Marcellus Shale in Pennsylvania
- Well Permits as of March 9, 2012
- Completed Wells as of March 9, 2012

Lycoming Creek Objectives

- Develop a water-quality baseline for major ions, nutrients, trace metals and radiochemicals, in surface and groundwater.
- Provide guidance for further study as natural gas exploration accelerates

What Determines Water Quality



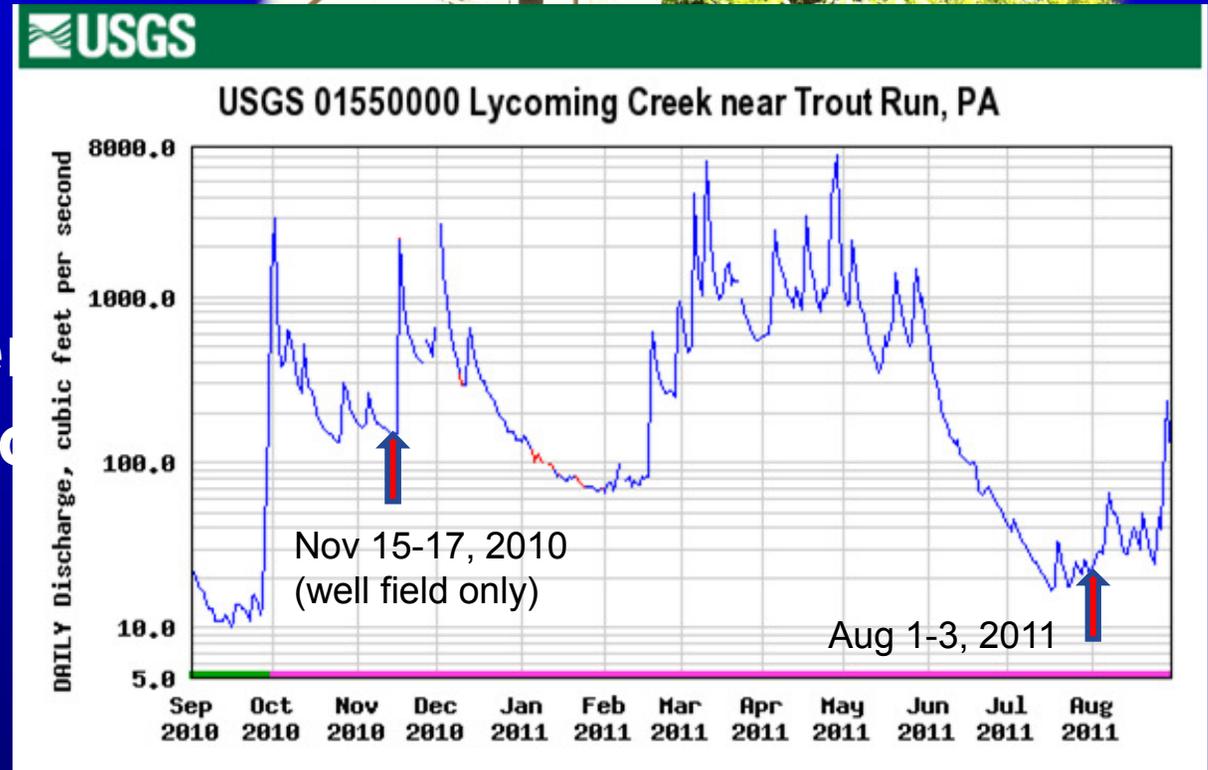
Lycoming Creek Study Design

Sampled at low
flow conditions

Sampled a broad
range of constituents
in water that are not
typically reported

Sampled at low
detection limits

Assessed water types



Lycoming Creek Study Design

Constituents Analyzed

Field Parameters – Temp, pH, DO, conductance, ORP, turbidity

Major Ions – Ca, Mg, Na, K, HCO₃, SO₄, Cl

- Plot ion ratios – trilinear plots

Trace Metals– As, B, Ba, Br, Li, Sr

- These can be high in flowback
- Br needed to evaluate origin of salinity

Dissolved Gases (Groundwater only)– Methane and Ethane

- To monitor for stray gas

Radiochemicals – Gross Alpha, Gross Beta

- Flowback can be elevated in radium

Lycoming Creek Study Design

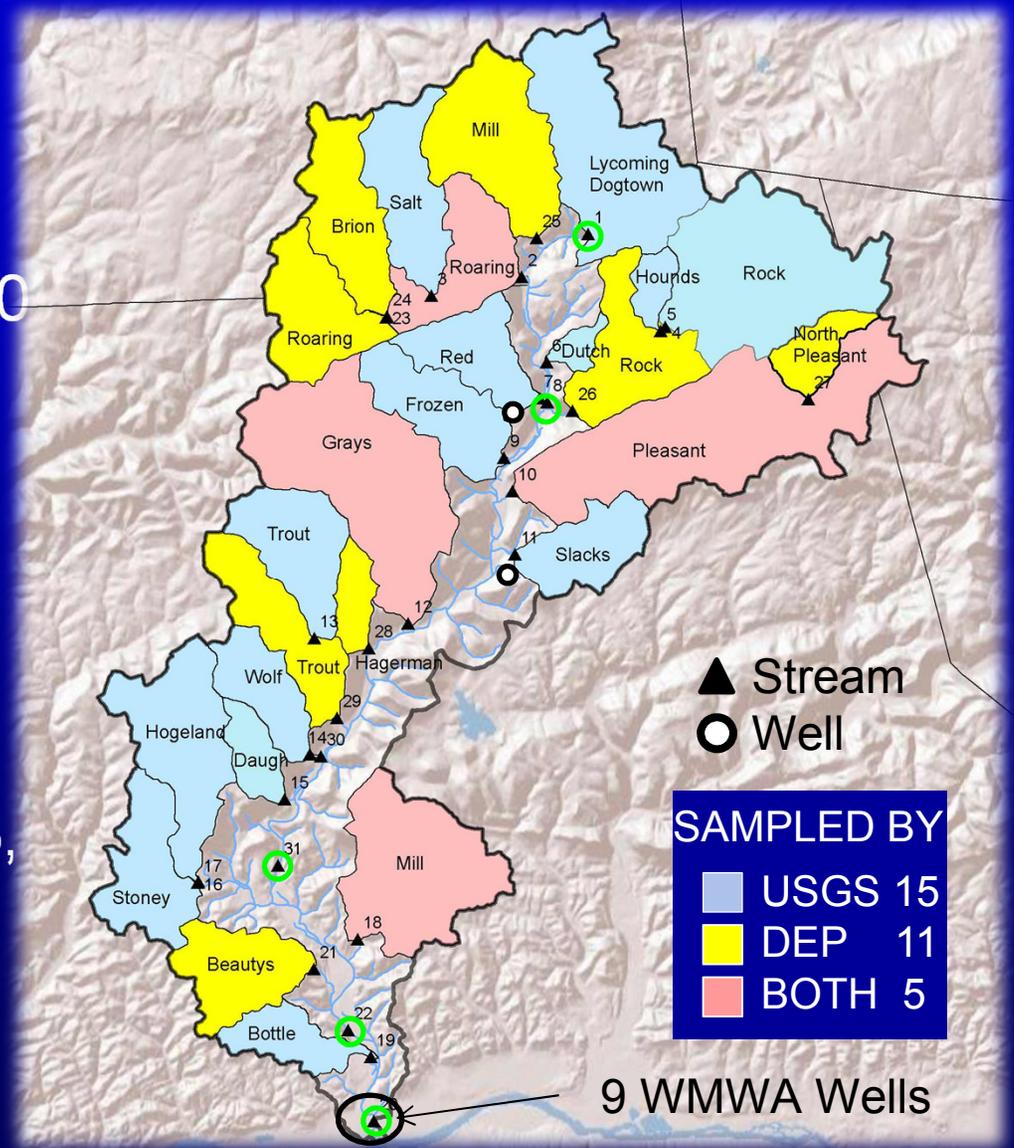
Sites Sampled

Groundwater Samples

- 9 Wells --Nov 15-17, 2010
- 5 wells -- Aug 1-2, 2011
- 4 QA samples

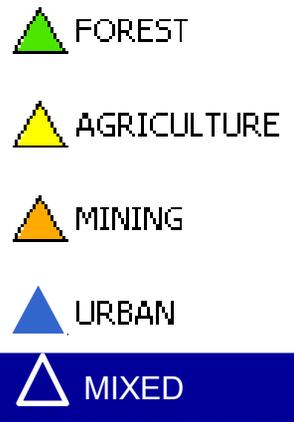
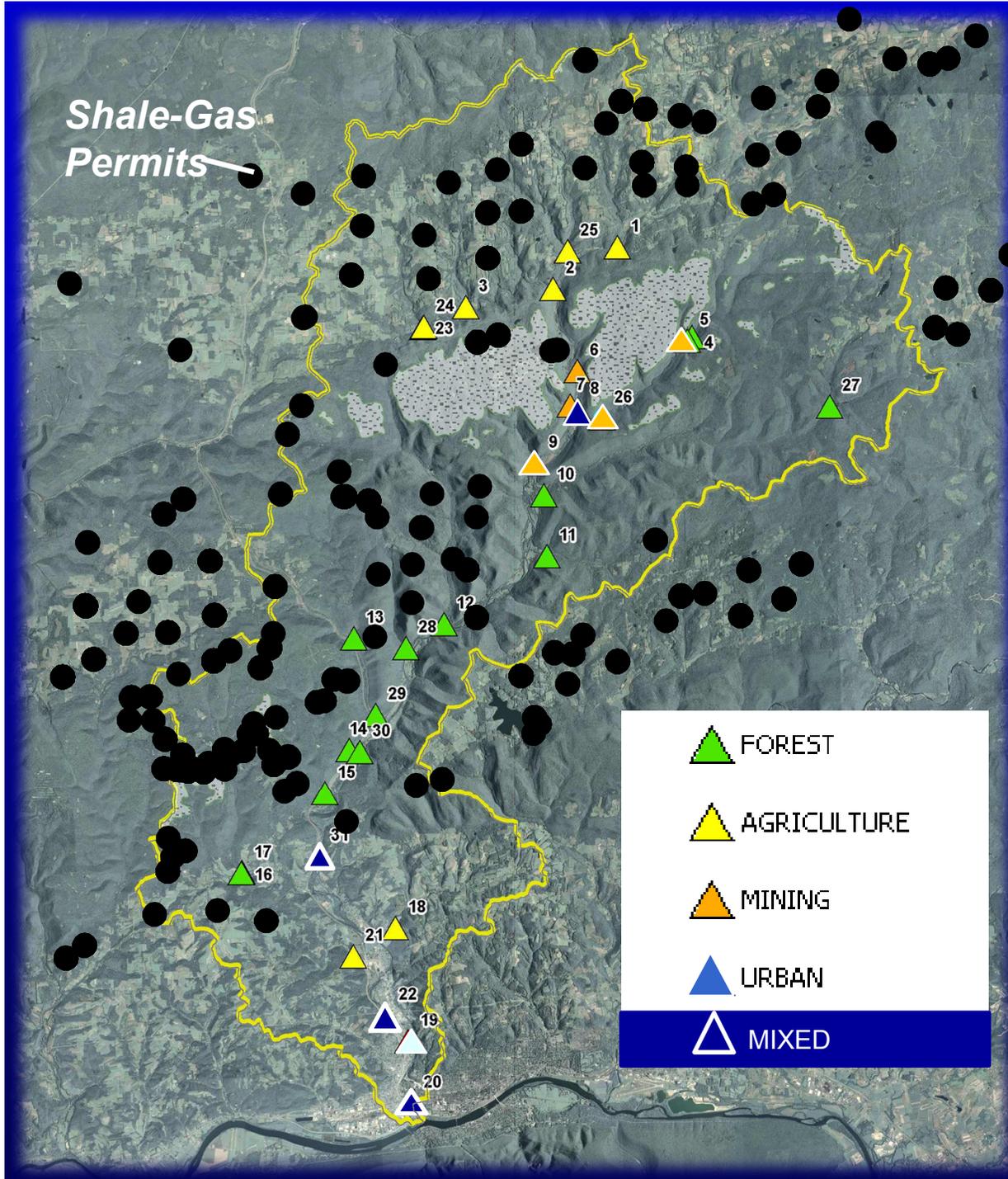
Stream Samples

- 31 Stream Sites--Aug 1-3, 2011
- 9 QA samples



Land Use

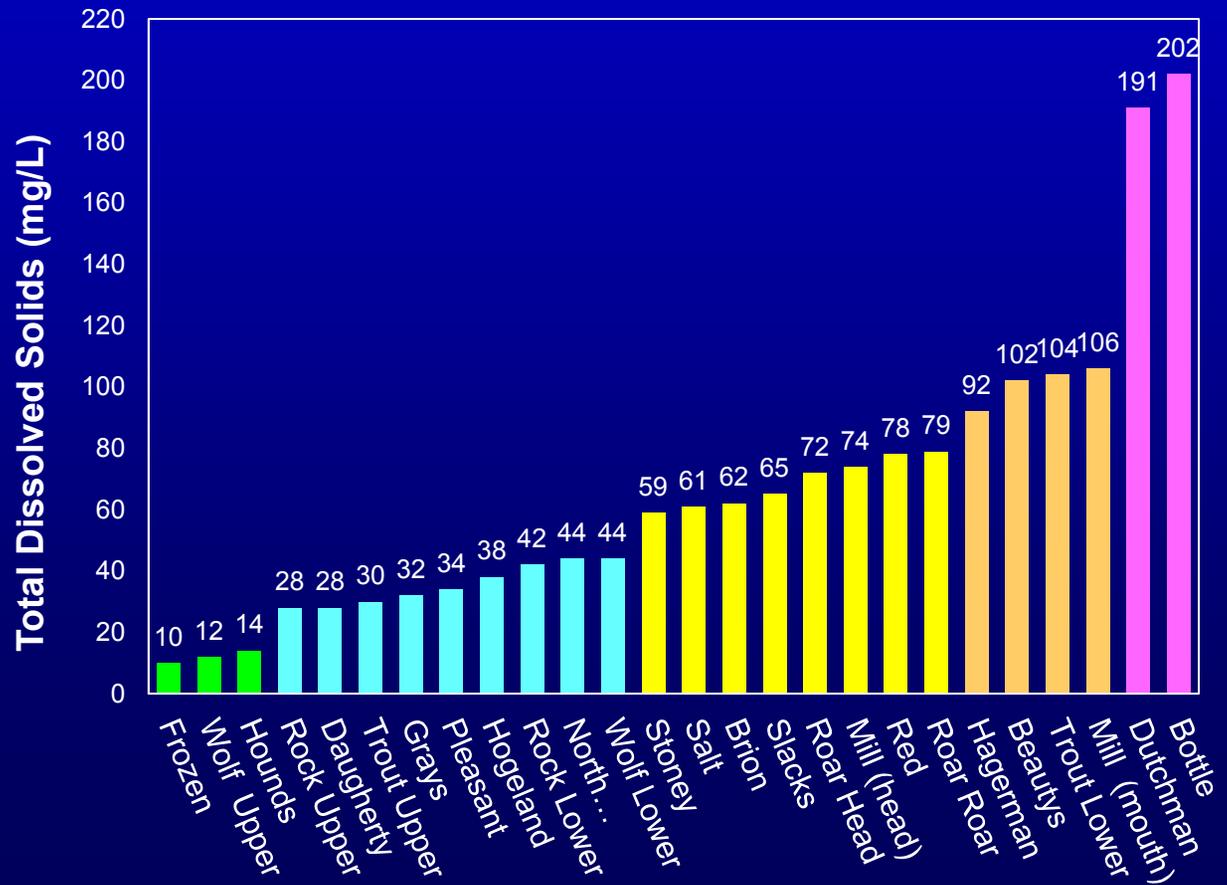
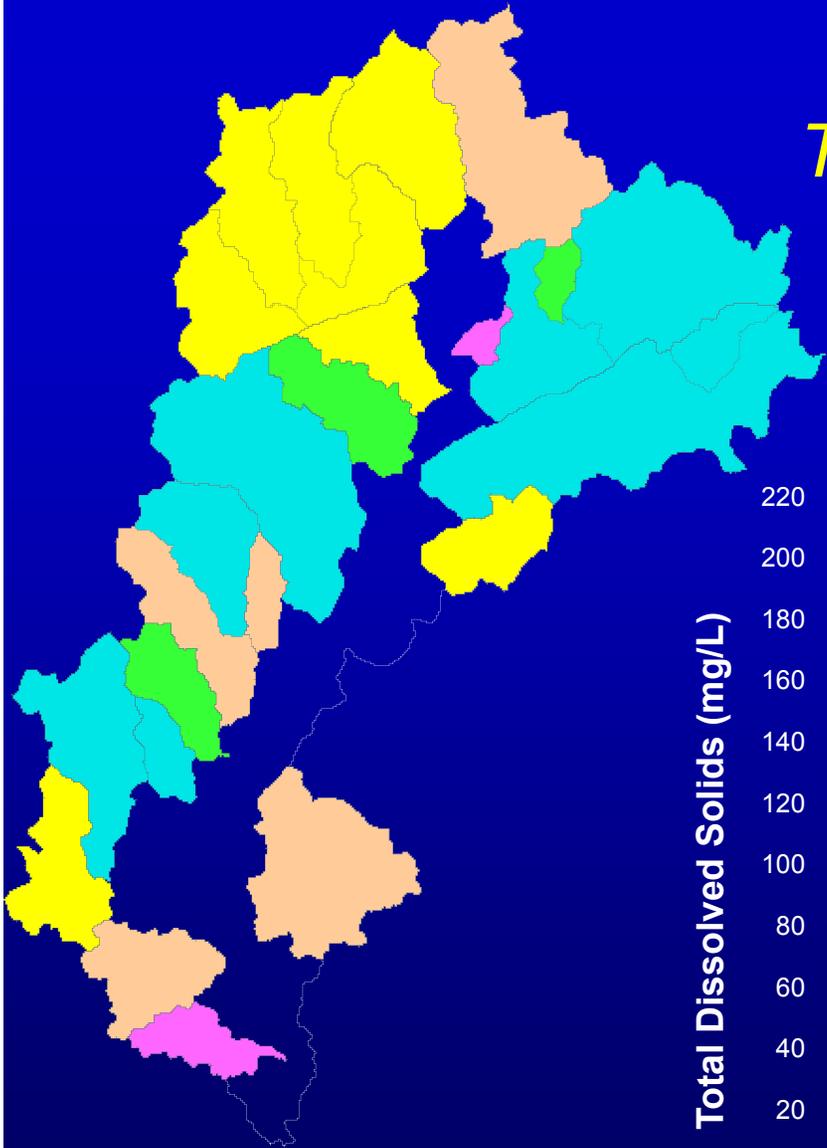
Shale-Gas Permits



4	Rock Run at McIntyre Twp
10	Pleasant Stream at Marsh Hill
11	Slacks Run at Bodines
12	Grays Run nr Fields Station
13	Trout Run at Route 15
14	Wolf Run nr Trout Run
15	Daugherty Run nr Powys
16	Hogeland Run nr Quiggville
17	Stoney Gap Run nr Quiggville
27	North Pleasant Stream
28	Hagerman Run at mouth
29	Trout Run at Trout Run
30	Wolf Run
1	Lycoming Creek at Dogtown
2	Roaring Branch nr Roaring Branch
3	Salt Spring Run nr South Union
18	Mill Creek nr Hepburnville
21	Beautys Run
23	Roaring Branch Run Headwaters
24	Brion Creek at Roaring Branch Run
25	Mill Creek (upper LC watershed)
5	Hounds Run at McIntyre Twp
6	Dutchman Run nr Ralston
7	Red Run at Ralston
9	Frozen Run nr. Ralston
26	Rock Run nr. Mouth
19	Bottle Run nr Williamsport
8	Lycoming Creek @ Ralston
20	Lycoming Creek @ 3rd Street
22	Lycoming Creek @ Hesehbon
31	Lycoming Creek @ Haleeka

Preliminary Results

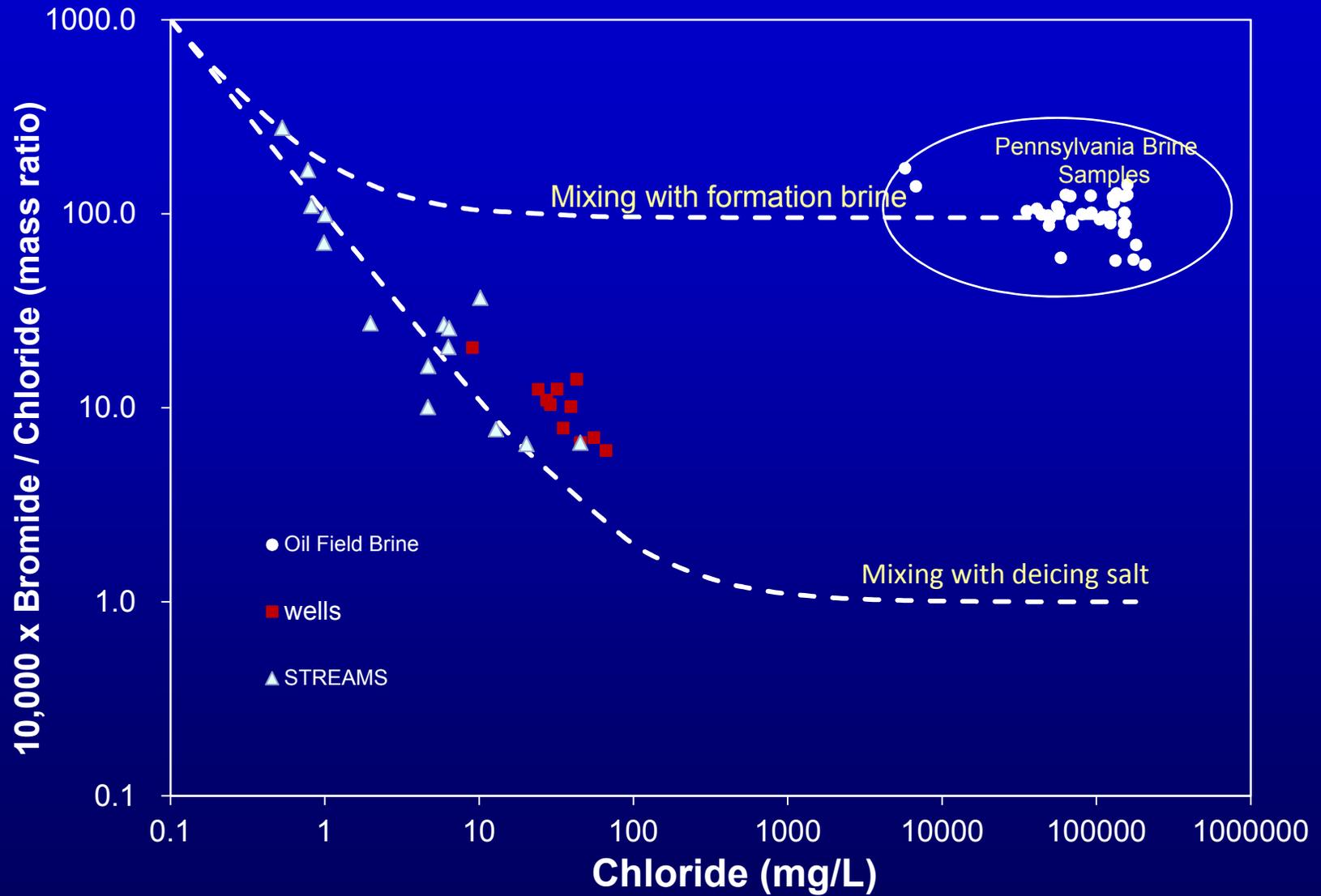
Total Dissolved Solids in Steams



Preliminary Results - TDS in Groundwater

Local identifier	Date of collection	TDS mg/L
Hatchery	08/02/2011	89
WMWA-9	11/17/2010	107
WMWA-4	11/16/2010	113
WMWA-5	11/15/2010	121
WMWA-6	11/17/2010	148
WMWA-3	11/16/2010	152
WMWA-11	11/15/2010	164
WMWA-7	11/16/2010	165
WMWA-5	08/01/2011	180
WMWA-8	11/16/2010	234
WMWA-7	08/01/2011	250
Ralston 2	08/02/2011	254
WMWA-10	11/15/2010	283
WMWA-10	08/01/2011	302

Preliminary Results Br/Cl Ratios



Preliminary Results – Methane

Detected in 86% samples at very low concentrations. Highest concentration was 0.6 mg/L.

Far below the action level of 10 mg/L.



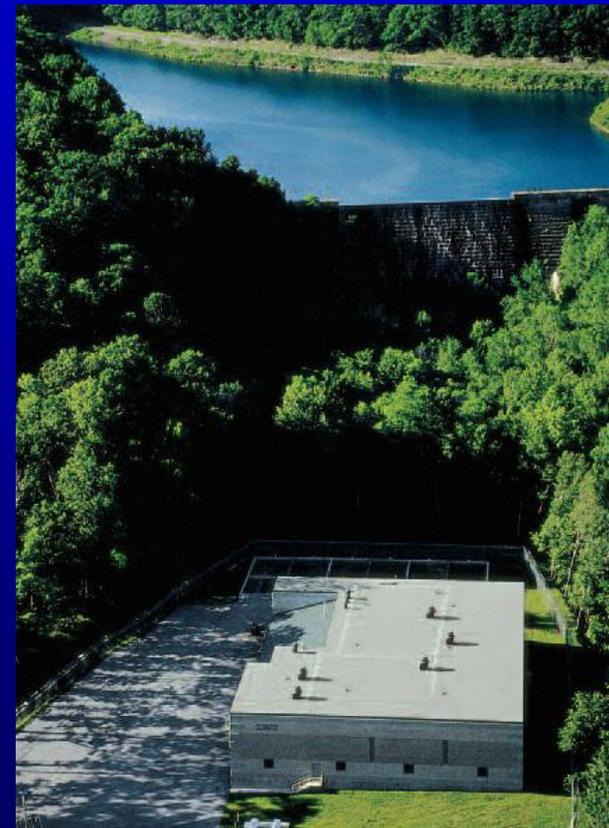
Lycoming Creek: Summary of Preliminary Results

- **TDS** varies widely across watershed.
- **Chemical composition** varies widely across watershed.
- **Methane detected** in most wells
- **Br/Cl ratios** can help determine sources of elevated chloride
- **Uranium and radium** levels were low. Highest values were from bedrock wells.

Blair County Baseline Monitoring

*In Partnership with:
Altoona Water Authority (AWA), and
Blair County Conservation District (BCCD)*

- AWA serves 23,000 customers throughout twelve municipalities in Blair County
- Constructed over 40 major capital improvement projects over the last 25 at a cost approaching \$200 million.
- Water is supplied by seven reservoirs system and one well field that is only used for emergencies.
- Reservoir systems is fed by eleven surface water sources



Tipton Run Reservoir and
Treatment Plant

Blair County Baseline Monitoring

Objectives

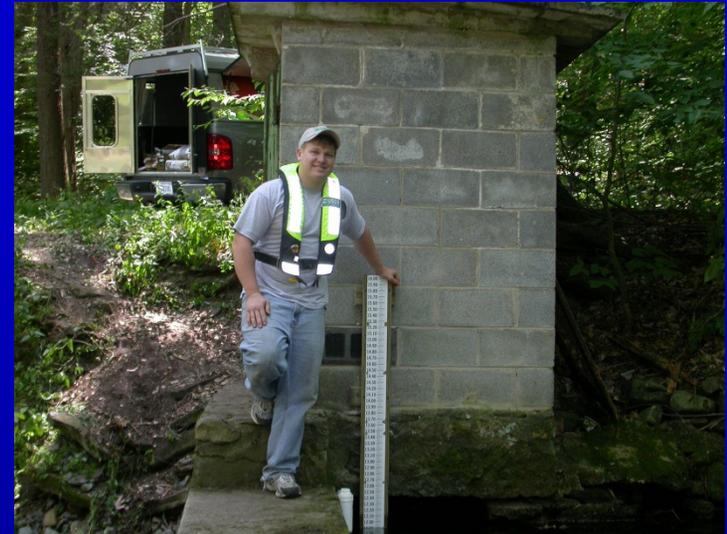
- Document existing channel characteristics
- Characterize stream-water chemistry
- Characterize composition and relative abundance of benthic macroinvertebrates and fish.



Blair County Baseline Monitoring

Study Design

- 10 Surface water sites
 - 6 AWA source water streams
 - 1 stream source for Tyrone Water Authority
 - 3 Other streams
- Stream-water samples analyzed monthly for Barium, Strontium, Chloride, Bromide, Sulfate and TDS.
- Continuous monitoring of specific conductance, water temperature, and stage at 4 of the 10 sites
- Macroinvertebrates and fish sampled at each one time.
- Surveys of channel morphology and particle-size distribution completed once at each site.



Blair County Study Area



- Well Permit
- Drilled Well
- Reservoir
- Marcellus Shale



Blair County

Blair County Study Area

- Streamwater samples
- Macroinvertebrates and fish
- Channel morphology
- Continuous monitoring



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- Marcellus Shale



Blair County

Preliminary Results - Blair County Baseline

Parameter	Range - No Historical Mining	Range - With Historical Mining	MCL or Secondary Standard
TDS, mg/L	25 - 220	78 - 309	500
Specific Conductance, uS/cm	10 - 115	125 - 378	NA
Chloride, mg/L	2.0 - 15.0	4.0 - 26.0	250
Bromide, mg/L	0.0 - <.20	0.0 - <.20	NA
Barium, ug/L	28 - 64	38 - 43	2,000
Strontium ug/L	14 - 55	41 - 114	NA

MCL: Maximum Contaminant Level allowed by EPA in drinking water.

Secondary Standard: Guidelines set by EPA for regulating contaminants that may cause cosmetic or aesthetic effects.

Blair County Baseline Monitoring

Plans

- Continue data collection through April 2013
- Add additional major ions and Trace metals in June 2012
- Final report planned in 2014

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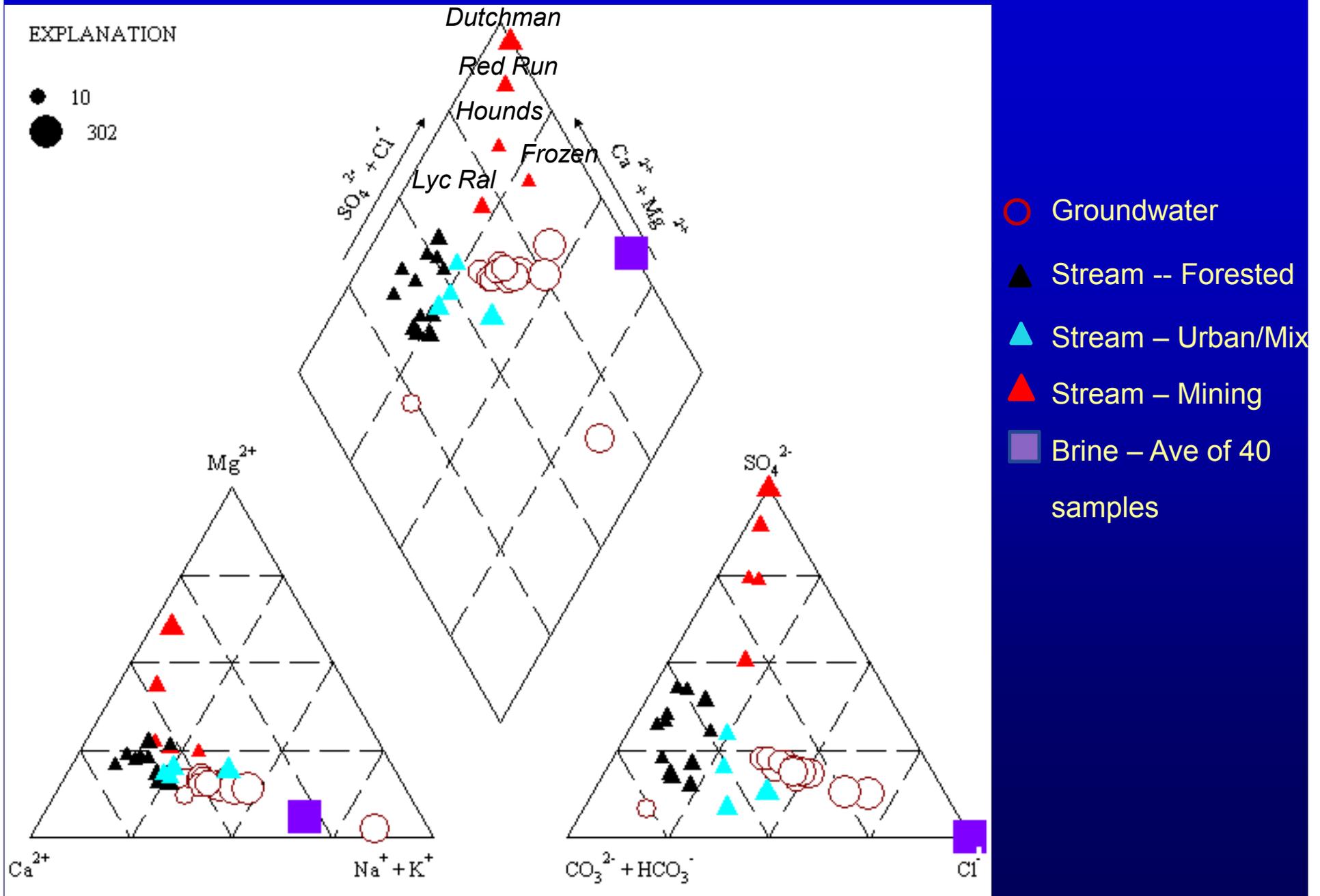




Preliminary Results - Ionic Composition

EXPLANATION

- 10
- 302



- Groundwater
- ▲ Stream -- Forested
- ▲ Stream -- Urban/Mix
- ▲ Stream -- Mining
- Brine -- Ave of 40 samples

Blair County Study Area



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Blair County