

A photograph of a forest stream flowing over mossy rocks. The water is clear and shallow, reflecting the surrounding greenery. The rocks are large and flat, covered in a thick layer of green moss. The forest is dense with tall trees and a thick canopy of leaves, creating a dappled light effect on the ground. The overall scene is peaceful and natural.

Remote Water Quality Monitoring Network (RWQMN)

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Susquehanna River Basin Commission
National Monitoring Conference May 2, 2012

Susquehanna River Basin

The Basin

- 27,510-square-mile watershed
- Comprises 43% of the Chesapeake Bay Watershed
- 4.2 million population
- 60% forested
- 32,000+ miles of waterways

The Susquehanna River

- 444 miles, largest tributary to the Chesapeake Bay
- Supplies 18 million gallons a minute to the bay



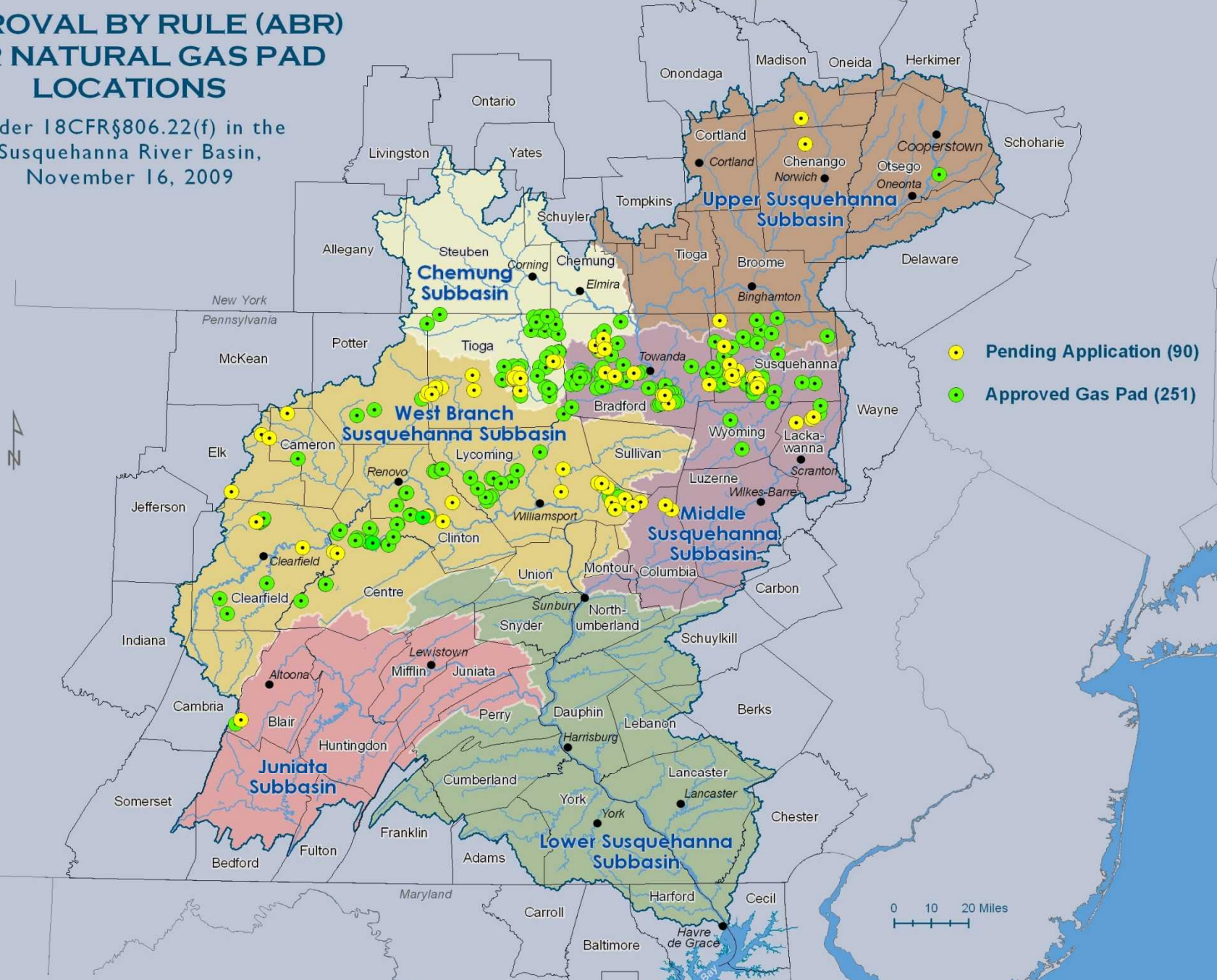
Remote Water Quality Monitoring Network Objectives

Establishing a real-time water quality monitoring network within areas of concern in the Susquehanna River Basin

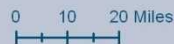
- Establish baseline water quality conditions;
- Determine if the natural gas well industry and/or other activities are causing adverse impacts on local water quality;
- Form collaborative partnerships to improve monitoring technology and provide educational opportunities;
- Enhance protection for water supplies; and
- Be responsive to public concerns.

APPROVAL BY RULE (ABR) FOR NATURAL GAS PAD LOCATIONS

under 18CFR§806.22(f) in the
Susquehanna River Basin,
November 16, 2009

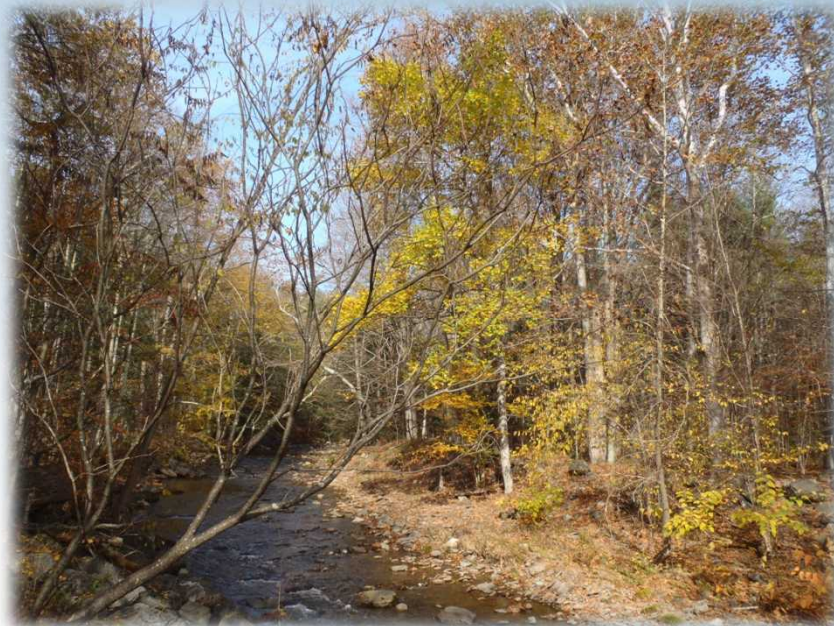
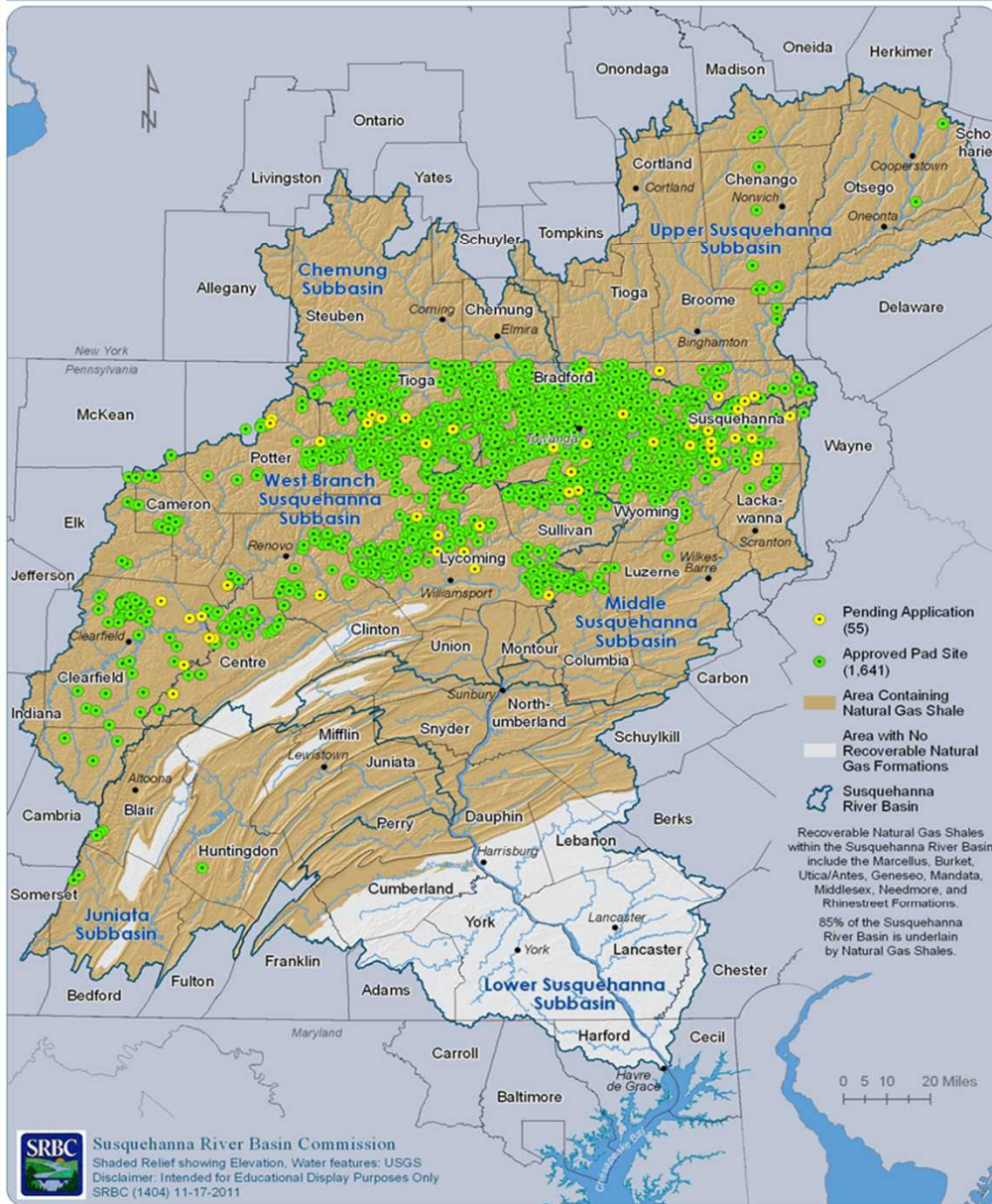


- Pending Application (90)
- Approved Gas Pad (251)



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Purposes Only; SRBC (1404bb) 11-16-2009

APPROVAL BY RULE (ABR) FOR NATURAL GAS PAD LOCATIONS
 under 18CFR§806.22(f) in the Susquehanna River Basin, November 17, 2011



Remote Water Quality Monitoring Network – Timeframe

- Project Scope – late 2009
- First Stations Deployed – January 2010
- Expanded into New York State – May 2010
- Expanded to State Forest lands in PA – December 2010
- April 2012 – 51 real-time stations

REMOTE WATER QUALITY MONITORING NETWORK PRIORITY WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN

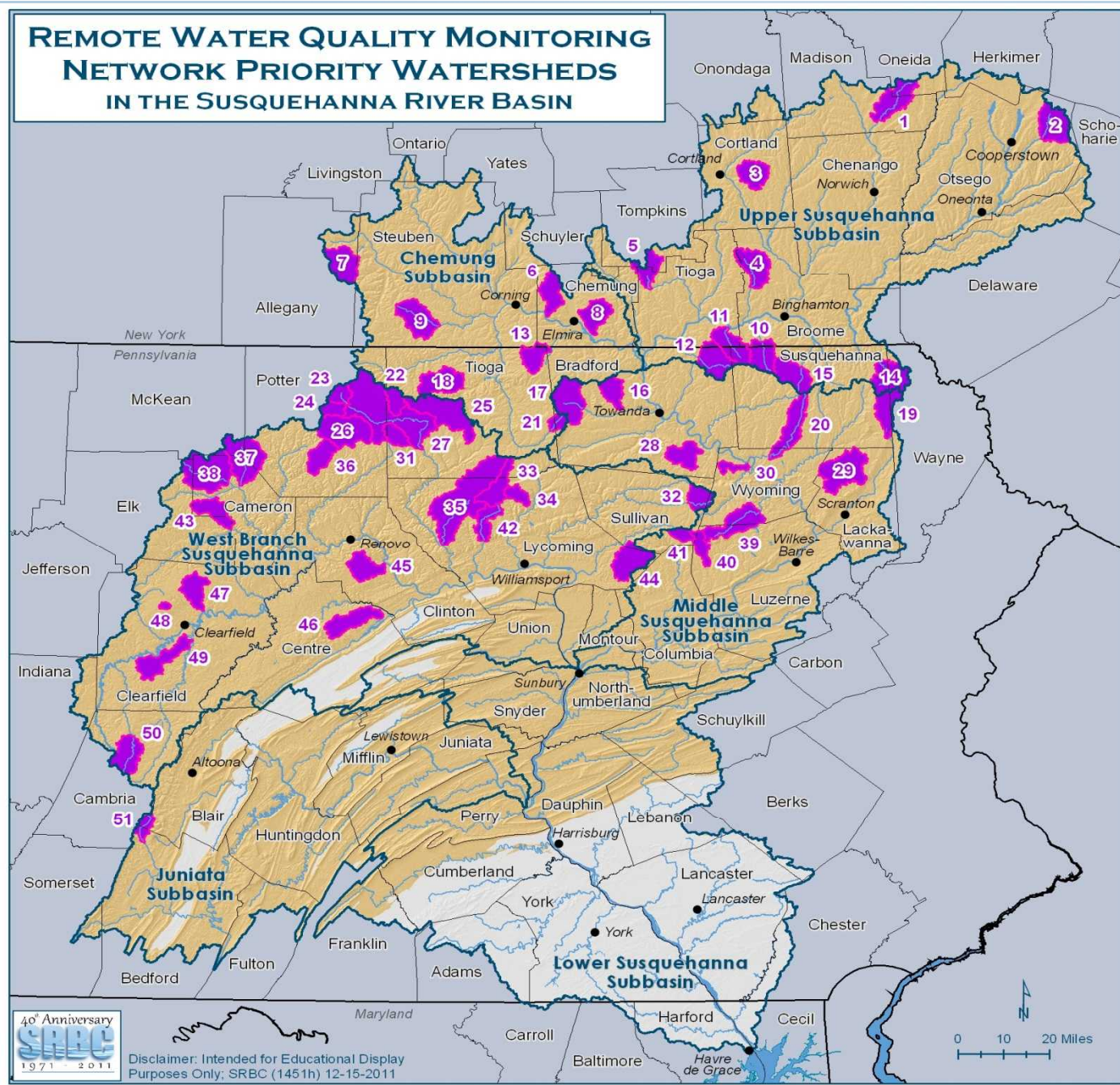
-  Area Containing Natural Gas Shales
-  Area with No Recoverable Natural Gas Formations

Recoverable Natural Gas Shales within the Susquehanna River Basin include the Marcellus, Burket, Utica/Antes, Genesee, Mandata, Middlesex, Needmore, and Rhinestreet Formations.

PRIORITY WATERSHEDS

Station Installed

- | | |
|------------------------|--|
| 1. Sangerfield River | 29. South Branch |
| 2. Cherry Valley Creek | 30. Little Mehoopany Creek |
| 3. Trout Brook | 31. Elk Run |
| 4. Nanticoke Creek | 32. Loyalsock Creek |
| 5. Catatunk Creek | 33. Blockhouse Creek |
| 6. Sing Sing Creek | 34. Grays Run |
| 7. Canacadea Creek | 35. Little Pine Creek |
| 8. Baldwin Creek | 36. East Fork First Fork Sinnemahoning Creek |
| 9. Tuscarora Creek | 37. Portage Branch |
| 10. Choconut Creek | 38. Driftwood Branch |
| 11. Apalachin Creek | 39. Bowman Creek |
| 12. Wappasening Creek | 40. Kitchen Creek |
| 13. Hammond Creek | 41. East Branch Fishing Creek |
| 14. Starrucca Creek | 42. Larrys Creek |
| 15. Snake Creek | 43. Hicks Run |
| 16. Tomjack Creek | 44. Little Muncy Creek |
| 17. Sugar Creek | 45. Baker Run |
| 18. Crooked Creek | 46. Marsh Creek |
| 19. Lackawanna River | 47. Trout Run |
| 20. Meshoppen Creek | 48. Moose Creek |
| 21. Tioga River | 49. Little Clearfield Creek |
| 22. Long Run | 50. Chest Creek |
| 23. Upper Pine Creek | 51. Bobs Creek |



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Equipment

- Data sonde
 - YSI 6600 V2-4 data sonde
- Data platform
 - NexSens 3100 or 6100 iSIC unit
- Power source
 - Solar panel – most common
 - Direct power connection



Network Design - Watershed Selection

- Watershed size - 30-60 square miles
- Activities associated with natural gas development
(Drilling activity, wastewater/chemical storage and transport, water withdrawals, etc.)
- Areas of potential natural gas development
(Leasing activity, existing pipeline infrastructure, transportation corridors, etc.)
- Sensitive and high quality headwater areas
(Aquatic life, recreation, public water supply)
- Site conditions
(channel morphology, seasonal conditions, etc.)
- Land use
- Property access/agreements – private and public





Operation & Maintenance

- Data Sonde
 - Site visit every 6-8 weeks
 - Sonde is calibrated before deployment and post calibrated after deployment
 - Annual tune-up
- Data Platform - software updates
- Data
 - Corrected for fouling and probe drift
 - Aquarius 3.0 software
 - Corrected data are posted on SRBC's web site
 - Data reports

Continuous Parameters

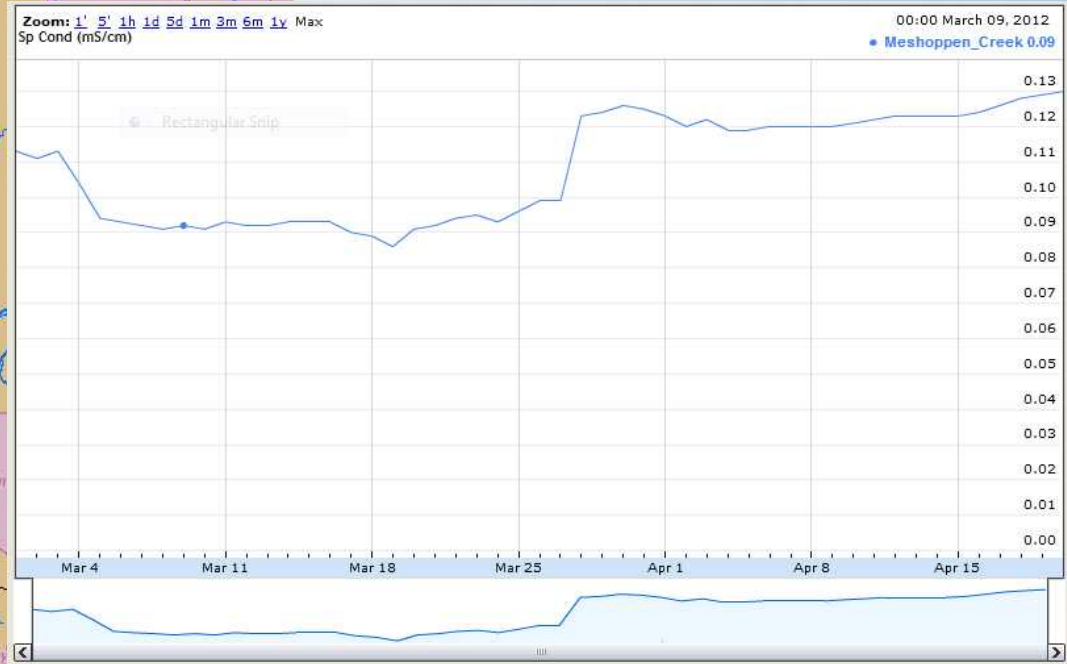
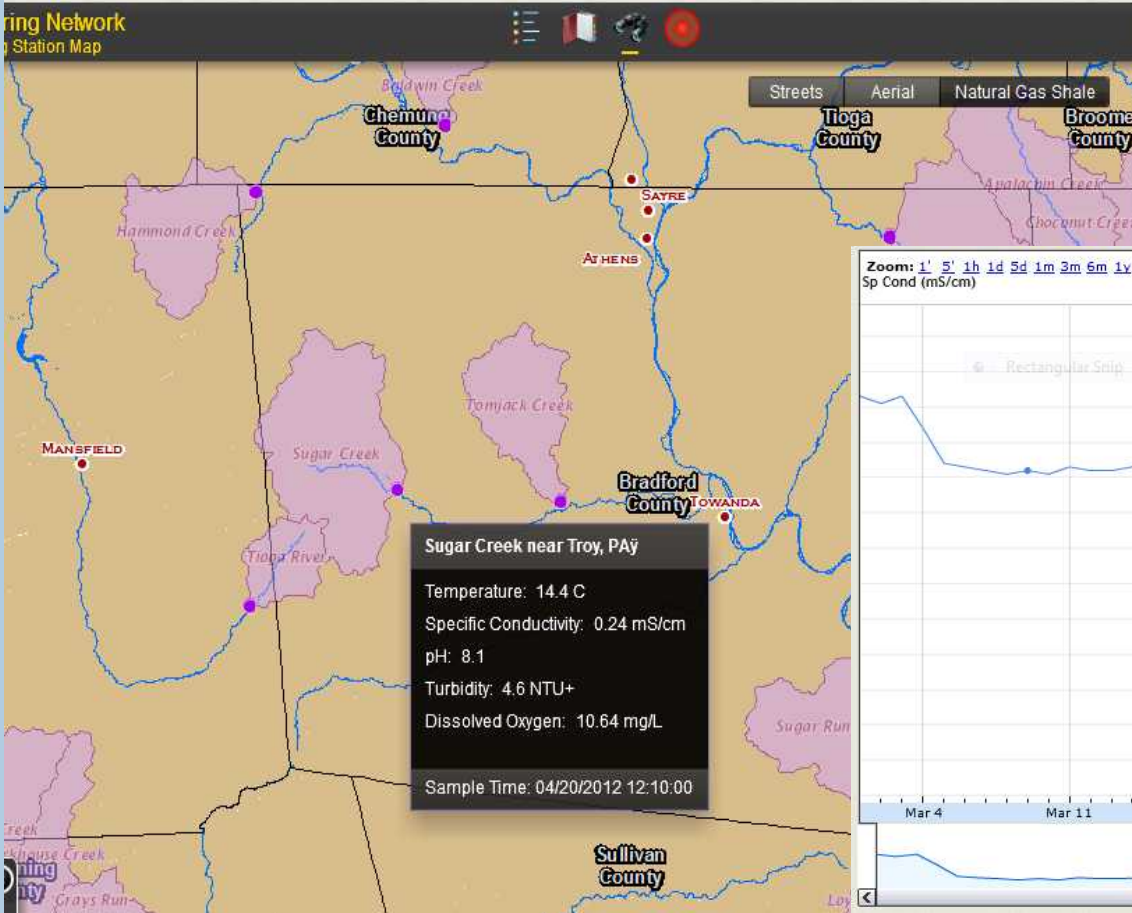
- Dissolved Oxygen
 - Temperature

 - pH
 - Conductance
 - Turbidity
- ❖ Turbidity, conductance and pH are the parameters of focus.

Continuous Data

- Collected at 5-minute intervals
- Transmitted to a public web site at 2-4 hour intervals
- Posted as provisional data
- “Alarms” sent via email to alert staff of potential problems or sonde malfunctions

<u>Monitoring Station</u>	<u>Temperature (C)</u>	<u>Specific Conductivity (mS/cm)</u>	<u>pH</u>	<u>Turbidity (NTU+)</u>	<u>ODO (mg/L)</u>
Apalachin Creek <i>(4/20/2012 11:55:00 AM)</i>	13.11	0.159	7.31	0.2	9.83
Baker Run <i>(4/20/2012 8:00:00 AM)</i>	8.5	0.028	6.32	1.3	11.43
Baldwin Creek <i>(4/20/2012 12:00:00 PM)</i>	16.8	0.167	8.42	5	11.25
Blockhouse Creek <i>(4/20/2012 12:10:00 PM)</i>	13.77	0.105	7.85		10.82
Bobs Creek <i>(4/19/2012 12:00:00 PM)</i>	13.07	0.06	7.52	0.1	10.83
Bowman Creek <i>(4/20/2012 12:10:00 PM)</i>	13.13	0.051	7.71	1.1	12.11
Canacadea Creek <i>(4/20/2012 12:15:00 PM)</i>	18.22	0.593	8.26	229.8	13.64
Cherry Valley <i>(4/20/2012 8:00:00 AM)</i>	11.38	0.216	7.55	4.81	7.24



Driftwood Branch					
Parameter	Samples	Average	Maximum	Minimum	Standard Deviation
Sp Cond (mS/cm)	14545	0.057	0.074	0.035	0.012
pH	14545	6.911	7.27	6.64	0.121
Turbidity (NTU+)	14545	2.143	494.9	0	6.278

<http://mdw.srbc.net/remotewaterquality/>

Supplemental Sampling

- Discharge measurements
- Macroinvertebrates
- Habitat
- Fish
- Lab water chemistry



Supplemental Sampling Parameters

Bi-monthly Sampling	Quarterly Sampling
Acidity	Calcium
Alkalinity	Magnesium
Chloride	Sodium
Barium	Potassium
Aluminum	Nitrate
Total Dissolved Solids	Phosphorus
Sulfate	Carbonate Alkalinity
Total Organic Carbon	Bicarbonate Alkalinity
pH	Carbon Dioxide
Specific Conductance	Bromide
	Strontium
	Lithium
	Gross Alpha
	Gross Beta

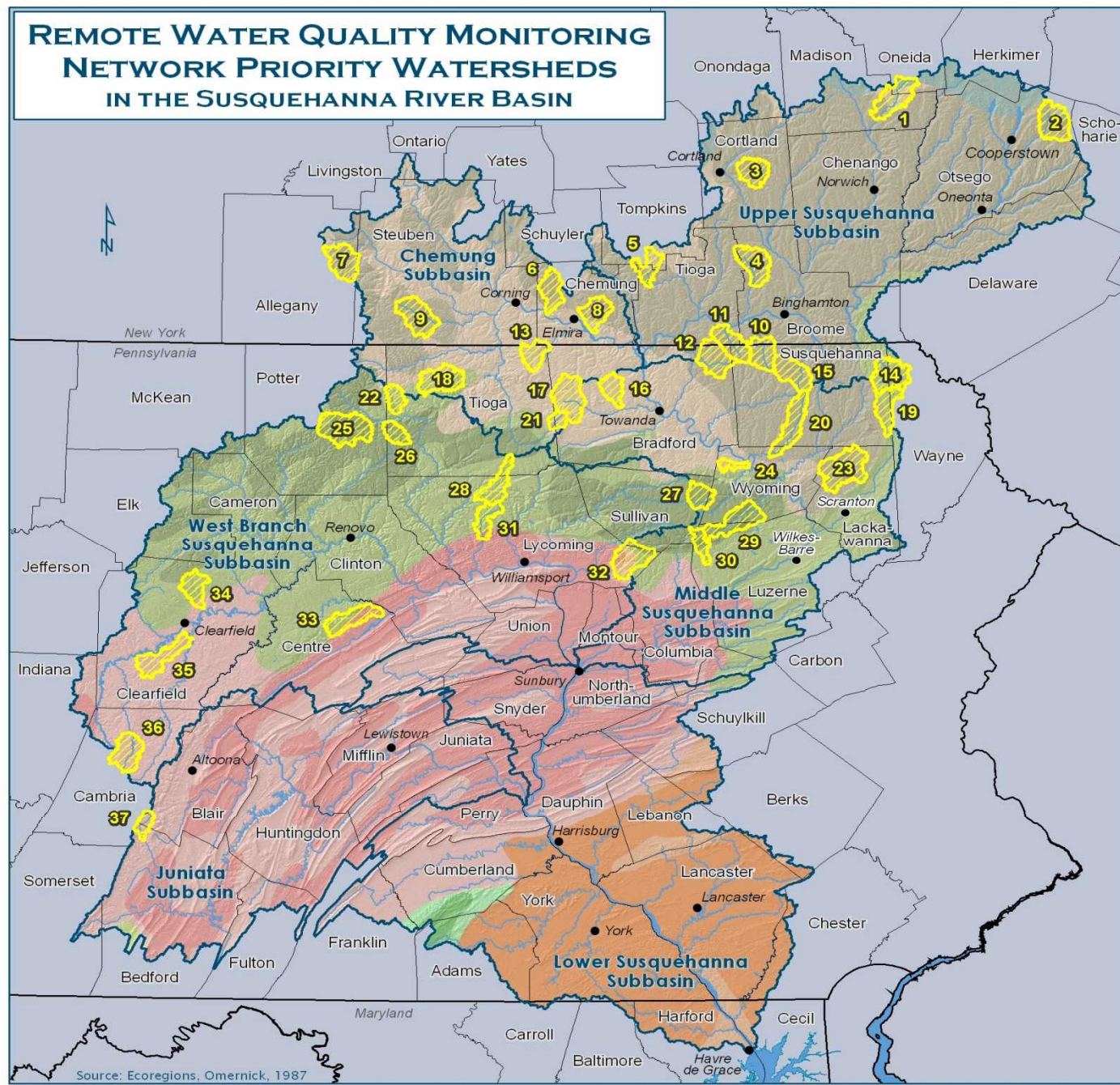
Data Report

- Released April 2, 2012
- Focus – determine existing conditions in the initial 37 stations installed (minimum of 6 months of data)
- Inform the public of the future direction of data collection and analysis
- Available on SRBC's web site and in hard copy

Level 3 Ecoregions

- Northern Appalachian Plateau and Uplands
 - 22 stations
- Northern Central Appalachian
 - 10 stations
- Central Appalachian Ridges and Valleys
 - 5 stations

REMOTE WATER QUALITY MONITORING NETWORK PRIORITY WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN



ECOREGIONS

-  Northern Appalachian Plateau and Uplands
-  Erie/Ontario Lake Plain
-  North Central Appalachians
-  Northern Piedmont
-  Blue Ridge Mountains
-  Central Appalachian Ridges and Valleys
-  Central Appalachians

PRIORITY WATERSHEDS

- | | |
|------------------------|------------------------------------|
| 1. Sangerfield River | 21. Tioga River |
| 2. Cherry Valley Creek | 22. Long Run |
| 3. Trout Brook | 23. South Branch Tunkhannock Creek |
| 4. Nanticoke Creek | 24. Little Mehoopany Creek |
| 5. Catatunk Creek | 25. West Branch Pine Creek |
| 6. Sing Sing Creek | 26. Elk Run |
| 7. Canacadea Creek | 27. Loyalsock Creek |
| 8. Baldwin Creek | 28. Blockhouse Creek |
| 9. Tuscarora Creek | 29. Bowman Creek |
| 10. Choconut Creek | 30. Kitchen Creek |
| 11. Apalachin Creek | 31. Larrys Creek |
| 12. Wappasening Creek | 32. Little Muncy Creek |
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| 15. Snake Creek | 35. Little Clearfield Creek |
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| 17. Sugar Creek | 37. Bobs Creek |
| 18. Crooked Creek | |
| 19. Lackawanna River | |
| 20. Meshoppen Creek | |



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Source: Ecoregions, Omernick, 1987

Data Report

Northern Central Appalachian

- 10 stations
- Showed smallest variability of conductance, turbidity, and pH
- Lowest values of conductance, turbidity, and pH



Data Report

Northern Appalachian Plateau and Uplands

- 22 stations
- More variability seen in conductance, turbidity, and pH
 - Stations with glacial till geology showed higher conductance and turbidity values



Data Report

Central Appalachian Ridges and Valleys

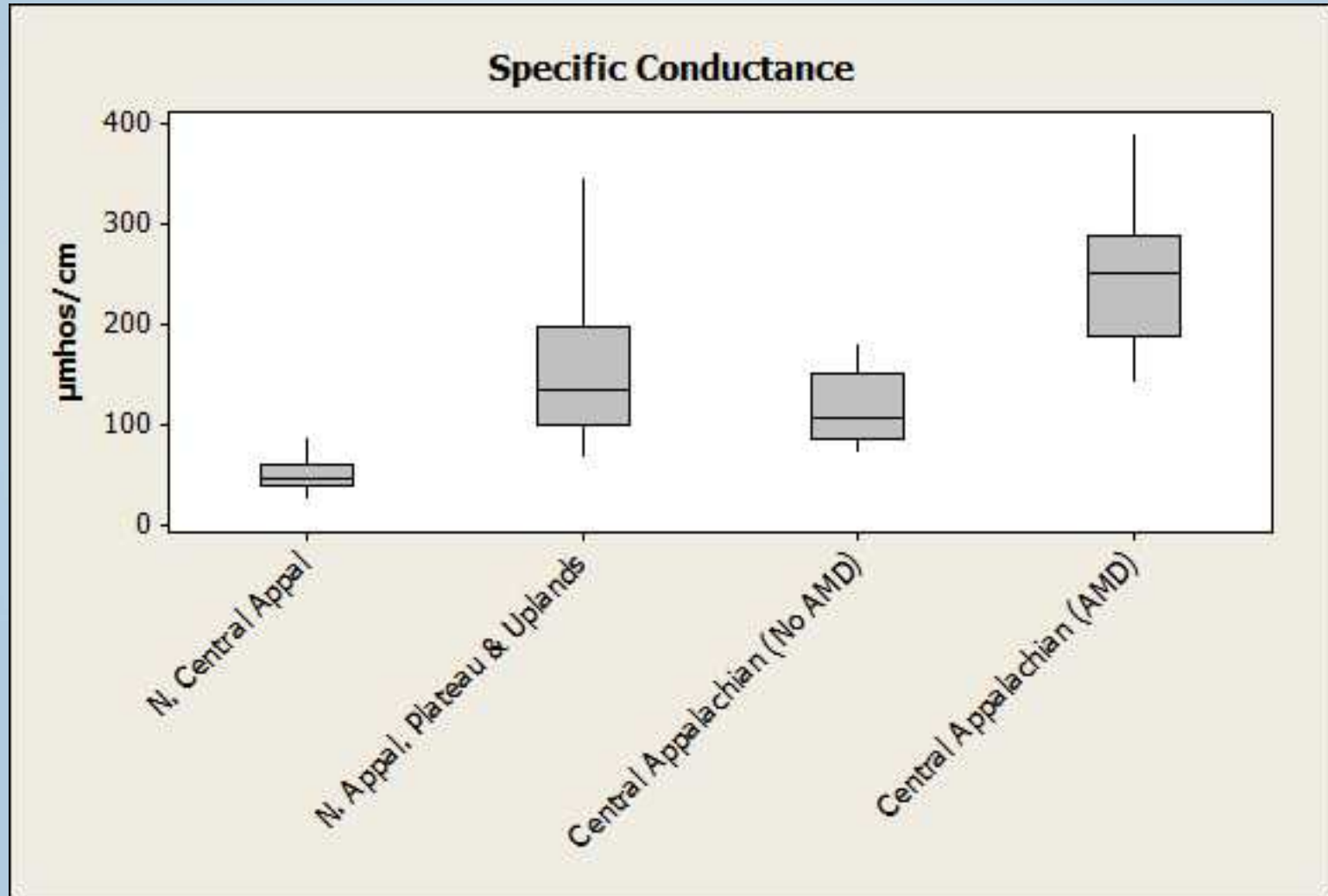
- 5 stations
- Largest variability in conductance, turbidity, and pH
 - Small sample size
 - Two stations impacted by mine drainage



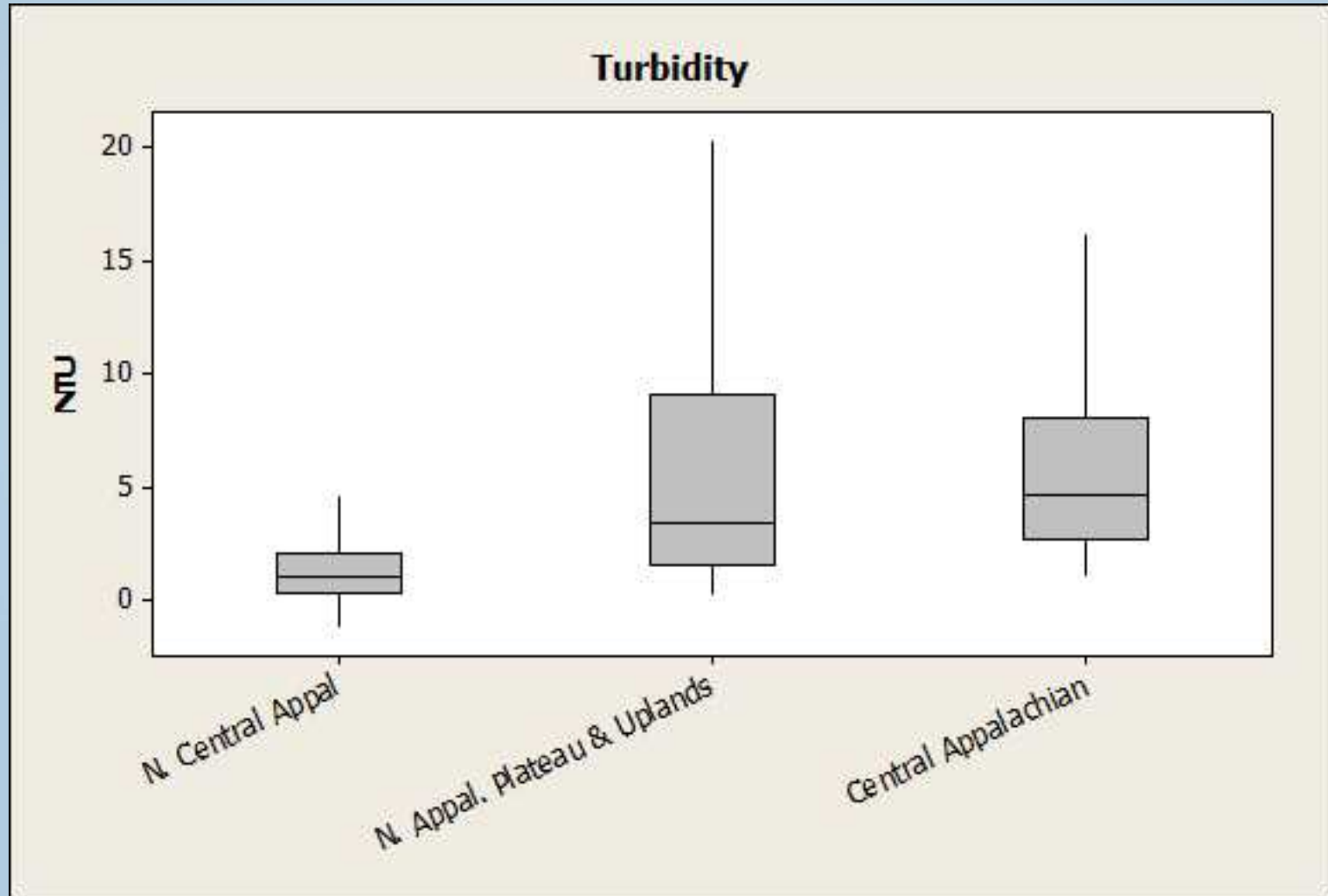
Conductance and Turbidity

- Main two parameters of concern
- Conductance - frack flowback/wastewater have very high conductance
- Turbidity - related activities
 - New roads
 - Pad construction
 - Pipelines

Conductance



Turbidity



Biological Data

- Collected at each station in 2011

	PINE CREEK WATERSHED								
	Upper Pine	Ninemile	Pine	Little Pine	Elk	Long	West Pine	Blockhouse	Baker
PERCENT FORESTED	75	85	80	83	82	81	86	75	99
DRAINAGE AREA SQM	19	16	385	180	21	21	70	38	35
TOTAL INDIVIDUALS	229	261	223	228	224	242	234	181	210
TOTAL TAXA	40	40	28	27	38	36	42	30	44
PA IBI METRICS									
Taxa Richness	40	40	28	27	38	36	42	30	44
EPT Taxa (PTV 0-4)	32	28	20	16	24	23	28	21	26
Beck's Index	42	38	23	14	33	37	40	31	43
Hilsenhoff Biotic Index	2.65	2.68	3.18	3.39	2.93	2.62	2.84	2.58	3.35
Shannon Diversity	3.27	2.60	2.82	1.80	3.11	2.90	3.21	2.68	3.19
Percent Sensitive (PTV 0-3)	64.19	67.43	56.95	71.49	62.05	65.29	62.39	67.40	46.67
IBI SCORE (small)	96.19	93.51			91.24	94.27		89.56	89.53
IBI SCORE (large)			95.39	84.83			98.92		

- Pine Creek Watershed – scenic, recreational river
- Baker Run – drilling is the only activity in the watershed

Future Direction of the Project

- Continuous real-time monitoring at the 51 stations
 - Plan to increase the network to 60 stations
- Continue supplemental water chemistry sampling
- Macro sampling
- Select sites
 - Fish sampling
 - Pressure transducers
 - Rain gauges



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