Science of Shale Gas Monitoring

Workshop funded by Colcom Foundation and Consortium for Scientific Assistance to Watersheds (C-SAW)
ALLARM Background

Empower communities with scientific tools to monitor, protect, and restore PA streams.

Who we are

- Project of the environmental studies department (1986)
- 3 full time staff
- 1 science advisor/Dickinson faculty member
- 10 – 15 students
### ALLARM History

#### Monitoring Program Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Acid Rain Monitoring</th>
<th>Watershed Technical Assistance</th>
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#### Monitoring Program Details

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<td>Marcellus &amp; Utica</td>
<td>Groups &amp; Individuals</td>
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</table>
Depth of Marcellus Shale

Depth of Marcellus Shale Base
- 2000 - 3000 ft
- 3000 - 4000 ft
- 4000 - 5000 ft
- 5000 - 6000 ft
- 6000 - 7000 ft
- 7000 - 8000 ft
- 8000 - 9000 ft
- < 9000 ft

--- Wet/Dry Gas Boundary

Marcellus Shale Extent
( includes non-economic areas)

Marcellus location modified from USGS Marcellus Shale Assessment Unit. Onondaga depth modified from Wrightstone, 2009.
Depth to Utica Shale

Map showing the depth to Utica Shale in various regions with color coded layers indicating depth ranges.
Shale Gas Wells in Region

Year Drilled
- 2004-2005 (111 wells)
- 2006-2007 (875 wells)
- 2008-2009 (1,825 wells)
- 2010-2011 (4,190 wells)
- 2012-2013 (3,710 wells)
- 2014-March 31, 2015 (2,253 wells)

Marcellus, Utica, and Upper Devonian Shale Outline

http://marcellus.psu.edu
## Differences in Drilling

<table>
<thead>
<tr>
<th>Traditional Hydrofracking</th>
<th>High Volume Hydrofracking (HVHF)</th>
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<tbody>
<tr>
<td>• In traditional hydrofracking, typically 20,000 to 80,000 gallons of fluid were used each time a well was hydrofractured.</td>
<td>• HVHF uses between 2 and 10 million gallons of fluid (on average 5.6 million), the exact amount depends upon the length of the well bore and the number of fractures created along the lateral extent.</td>
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<tr>
<td>• Traditional hydrofracking used 700 to 2,800 lbs. of chemical additives</td>
<td>• HVHF uses between 205,000 and 935,000 lbs. of chemical additives, per well many of which are toxic to humans and wildlife.</td>
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<td>• 1940s</td>
<td>• Late 1990s</td>
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www.TCgasmap.org Marcellus Accountability Project-Tompkins
3 Types of Pipelines

1. Gathering: Usually 6-24 inches in diameter. Carry gas at about 715 psi. These pipelines can travel long distances and there is no requirements to mark them or continually make sure they are cleared of vegetation etc. May clear rights-of-way of 30 to 150 feet wide.

2. Transmission: Large steel pipes (usually 24-48” in diameter), carry gas 200-1200psi. These federally regulated pipelines fall under eminent domain so don’t need land owner permission. The land is periodically cleared of large vegetation. Permanent structures and trees may never be placed there. Right-of-way widths of up to 200 feet.

3. Distribution: Small pipes (2-24” in diameter) that can be made of steel, cast iron, plastic or copper. Pressure of gas is reduced to less than 200psi. Mercaptan is added to the gas to give it a rotten egg odor at the city gate prior to being sent through distribution lines.

Source: Pipeline and Hazardous Materials Safety Administration
Hydraulic Fracturing (Fracking)

This protocol documents flowback pollution and visual observations in small streams.
# Protocol Overview

<table>
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<td>• Barium and strontium</td>
<td>• Certified lab analysis</td>
<td>• Twice a year and to confirm contamination event</td>
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<td>• Gas Related Earth Disturbance</td>
<td>• Visual survey</td>
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<td>• Spills and Discharges</td>
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<tr>
<td></td>
<td>• Gas Migration or Leakage</td>
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<tr>
<td></td>
<td>• Pipelines</td>
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</table>
Drilling Wastewater

• Frack water
  – Fluid that goes down the well
  – 160+ known hazardous materials

• Flowback water
  – Fluid that comes back out of the well
  – Steel and power companies can’t use it because TDS levels are too high
  – Recycled
  – Inject water into ground or caverns/mines
  – Treat at authorized treatment facilities
Flowback water: water that returns to surface it consists of frack water plus chemicals released from underground rock formations.

- **Quantity:** 10-15% of frack water flows back
- **Quality:**
  - Brine (salty water) including high concentrations of chlorides, sulfates: very high TDS
  - Metals, e.g. barium iron, manganese, arsenic, strontium, lead, cadmium, chromium, aluminum
  - Naturally occurring radioactive materials such as uranium, radium, and radon
  - Bacteria
  - Methane
- **Pathway to environment:** spills, incomplete treatment, well casing leaks, migration through bedrock, illegal dumping
Why Volunteer Monitoring?
Volunteer Monitoring

- Citizens involved in data collection
- US: 1890 – 2016
- 48 states
- PA Streams: 1980s

Georgia Adopt-A-Stream

Citizen Stewards Water Quality Monitoring Program

NJ Watershed Watch Network

TEXAS STREAM TEAM
Volunteer Monitoring

• Feasibility
• Affordability
• Scientifically robust

ALLARMwater.org
Red Flag Protocol: What Will You Monitor?

1. Flowback Monitoring:  
   Chemical Parameters  
   Indicator chemicals  
   Conductivity & TDS  
   Signature Chemicals  
   Barium  
   Strontium  

   Stage Monitoring  
   Relationship to conductivity

2. Physical Impacts  
   Visual Observations:  
   - Land disturbances  
   - Spills and discharges  
   - Gas migration/leakages  
   - Pipelines
Conductivity and Total Dissolved Solids

• Conductivity measures the ability of water to pass an electrical current.
• Total Dissolved Solids (TDS) measures the amount of ions dissolved in the water (PA standard – 500 mg/L).

Voltage is applied between two probes to measure conductivity in microSiemens/centimeter (µS/cm).

TDS conversion ratio factor

TDS value (mg/L)
Why Conductivity and TDS?

• Frack water mixes with natural brine, found in the shale
• Flowback water contains higher concentrations of salts and metals

Picture by Amy Bergdale, US EPA
Dickinson students, faculty, and staff helped test conductivity/TDS meters to determine which meter is most accurate, precise, and easy to use.
Barium and Strontium

- Naturally-occurring metals found deep underground
- Indicate contamination from shale gas activities (signature chemicals)

https://www.msu.edu/~zeluffjo/periodic_table.gif
Stage Monitoring
Visual Observations

- Earth Disturbances
- Spills and Discharges
- Gas Migration/Leakages
- Pipelines

Marcellus Shale Well Sites in Dimock, PA; 2010
Determine Monitoring Locations

**Step 1:**
Find where drilling permits have been issued, or identify priority streams or existing pollution issues:
- PADEP map/reports
- PADEP eNotice
- FracTracker

**Step 2:**
Find coordinates and choose monitoring site based on important features:
- Well locations
- Stream access
- Availability
Data Use: Decision Trees

Chemical Monitoring

Visual Observations

Pipelines

Report monitoring information when values exceed criteria in decision trees.
Online Database and Toolkit

ALLARMwater.org
Building a Monitoring Constituency

- Movement - 2000 people trained since the start of 2010
- ALLARM, DRN, PACTU, PASA, MWA, Sierra Club, Waterdogs
Questions?

Alliance for Aquatic Resource Monitoring (ALLARM)
Dickinson College
P.O. Box 1773
Carlisle, PA 17013
717.245.1565
allarm@dickinson.edu
dickinson.edu/allarm
ALLARMwater.org
Identifying your monitoring location
Overview

We will be discussing:

• Tools for finding and tracking wells
• Considerations for monitoring sites
• Volunteer roles for the group
Determine Monitoring Locations

Step 1:
Find where drilling permits have been issued, or identify priority streams or existing pollution issues.
- PADEP map/reports
- PADEP eNotice
- FracTracker

Step 2:
Use reports and coordinates to choose monitoring site based on important features
- Well locations
- Stream access
- Availability
PA Oil and Gas Mapping

http://www.depgis.state.pa.us/PaOilAndGasMapping

Pros:
• Most current information
• Many options for searching (can search by well status, operator, permit number)

Cons:
• Somewhat clunky interface (but does have help page with definitions and guides)
• May have limited browser support
Pros:
- Wider browser support
- Easier to use

Cons:
- Not always the most up-to-date information

https://www.fractracker.org/map/us/pennsylvania/pa-shale-viewer/
DEP Reports

http://www.depweb.state.pa.us
DEP Reports
REPORTS

In an effort to maximize transparency and improve efficiency, DEP provides easy access to dozens of online reports and key data about the many programs the agency administers.
DEP Reports

INTERACTIVE REPORTS

- Oil and Gas Mapping
- Interactive Reports Data Dictionary
- Permits Issued Detail Report
- Monthly – Permits Issued by County and Well Type Report
- Year to Date – Permits Issued by County and Well Type Report
- Oil and Gas Operator Well Inventory
- Oil and Gas Compliance Report
- SPUD Data Report
- Wells Drilled By County
- Wells Drilled By Operator
- Oil and Gas Production Reports
- Oil and Gas Well Production Status
- Oil and Gas Electronic Notifications
- DEP Orphan and Abandoned Wells
## DEP Reports

### DEP Office of Oil and Gas Permits Issued

**County:** Fayette; **Municipality:** All; **Region:** All; **Operator:** All; **Unconventional Only:** Yes; **Well Type:** GAS

125 issued permits from 1/1/2013 to 6/8/2016

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<th>REGION</th>
<th>COUNTY</th>
<th>MUNICIPALITY</th>
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<th>OPERATOR</th>
<th>APPLICATION TYPE</th>
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Contains information about oil & gas wells:
– Permits issued (by operator and county, updated weekly)
– Active well inventory (by county)
– Spud reports/date drilling begins (updated weekly)

DEP’s Active Well Inventory: All of the active oil & gas wells in Washington County

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eNOTICE

- DEP’s Electronic Notification system
- Receive information and track changes to oil & gas permits
- [http://www.ahs2.dep.state.pa.us/eNOTICEWeb/](http://www.ahs2.dep.state.pa.us/eNOTICEWeb/)
Group Roles – Checking Permits

- It may be effective to designate one person to check for new permits in the area
  - Can be someone who is already checking permits, or someone interested in permitting information, and report information to the group
Safety Considerations for Shale-Gas Volunteer Monitoring
General advice

Develop language as a group that describes what you are doing...

“Monitoring stream health” vs. “Tracking down fracking polluters”

http://www.alicia-logic.com/email/Close%20Encounter%20with%20a%20Pitbull.jpg
Property Access

• Public land, such as State Game Lands or state forests, are open to the public
  – Access rights are not a concern
  – However, you are not allowed on active drilling sites due to safety concerns (industrial site)

• For private properties, always ask the landowner’s permission
Personal Safety

• Do *not* make contact with water or soil that could be contaminated unless you have protective clothing
  – Wading boots
  – Latex gloves

• Do not put yourself into a situation that may be dangerous.
Personal Safety

• When out in the field, bring a cell phone and leave it on.

• Steer clear of confrontation. Leave the area if someone confronts or threatens you.
Visual Observation Checklist

Protocol developed alongside:

• Bradford County Conservation District
• Mountain Watershed Association
• PA Trout Unlimited
• Pine Creek Waterdogs
• EarthJustice
Visual Observations

• Document physical status of the stream
• Identify potential impacts/pollution events
• Report violations and/or suspicious activity
### Recording Observations: Data Sheet

#### Earth Disturbances:

- **Stream:**
  - **Sediment enters stream, pond, or other water body:**
  - **Access Road:**
    - Banks are not stabilized (no mulch, seeding, vegetation, etc.)
    - Crosses stream and drainage from road enters stream
    - Not stabilized with clean substrate material (i.e. gravel)
    - Drainage/mud/sediment from access road enters road ditch
    - Drainage/mud/sediment from access road travels to main road

- **Drill Pad, Storage Pond & Staging Area:**
  - **Yes**
  - **No**
  - **Pipeline**
  - **Photo**

- **Earth disturbed at edge of water, no controls to stop filter runoff:**
- **Clean water enters the site from uphill with no diversion ditch:**
- **Sediment BMP outlets empty into water body without filtering runoff:**
- **Sediment BMP outlets are not stabilized (no mulch, seeding, vegetation, etc.):**

#### Spills and Discharges:

- **Stream:**
  - **Unusual odor:**
  - **Discolored water (i.e. oily film):**
  - **Persistent foam/bubbles (where there isn’t normal agitation):**
  - **Dead fish/organisms:**
  - **Evidence of illegal dumping:**

#### Gas Migration and Leakages:

- **Stream:**
  - **Gas bubbling to surface:**
  - **Unusual gas-like odor (methane):**

#### Record Information:

<table>
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<th>Sample Information</th>
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<tr>
<td>Monitor’s Name</td>
<td>Assessment Data</td>
</tr>
<tr>
<td>Site Location</td>
<td>Assessment Time</td>
</tr>
</tbody>
</table>

- **Record latitude and longitude or Site ID/location description**
- **Take photograph (date and time stamp) and record on the data sheet**
- **Record thorough description of the observation**
Recording Observations: Field Data Log

Record Site ID or latitude and longitude

Record multiple times or locations

Record visual observation description and outcomes
Recording Observations: ALLARMwater.org
Visual Observation Categories

- Earth Disturbances
- Spills and Discharges
- Gas Migration/Leakages
- Pipelines

Marcellus Shale Well Sites in Dimock, PA; 2010

http://www.swarthmore.edu/x29615.xml
Pipelines
• **Gathering Lines**: Small lines from wells.
• **Transmission Lines**: Larger lines that transport gas long distances, compressor stations every 40-60 mi to keep gas at a high enough pressure for travel.
• **Distribution Lines**: Small lines going into homes, businesses etc.

Source: Pipeline and Hazardous Materials Safety Administration
Major Pipelines
Environmental Concerns

• Erosion and sedimentation (largest concern, most common violation)
• Loss of riparian zones – vegetated buffer along the stream
• Stream geomorphology impacts (changes in stream shape)
• Habitat fragmentation
• Methane leakages
Stream Crossings

Through the stream

Under the stream


Through the Stream

- Open-cut
- Flumed or Partial Diversion
- Dam & Pump method

http://www.tpm-clynch.com/services.html
portadam.com
Under the Stream

Horizontal Directional Drilling

(Nacap, 2014)
Earth Disturbances

http://www.postcarbon.org/reports/shale-gas-well.jpg
Earth Disturbances

- Sediment entering streams as a result of any earth disturbance
- Sediment on/from access roads, well pads.
What do you notice?
Access Roads

What do you notice with these access roads?
What’s the issue here? Is this reportable?
Monitoring E&S BMPs: need to confirm that they are installed correctly and maintained properly.
Sediment from Earth Disturbances

Is there a problem with these best management practices?
E&S Best Management Practice

Is there anything wrong with this?
• E&S plans are on site & are available to the public.
Pipeline Erosion & Sedimentation
Spills and Discharges

http://www.theintelligencer.net/photos/news/md/587542_1.jpg
<table>
<thead>
<tr>
<th>Spills and Discharges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unusual odor, color, foam and/or bubbles</td>
</tr>
<tr>
<td>![Image 1](Cumberland CCD)</td>
</tr>
<tr>
<td>Dead fish and/or other organisms</td>
</tr>
<tr>
<td><img src="Ctiv.com" alt="Image 2" /></td>
</tr>
</tbody>
</table>
Spills and Discharges

Drilling fluid spill at Cabot site
Dimock, PA
September 2009
Pipeline Spills and Discharges
Bentonite Blowouts

Marcellus Outreach Butler
Illegal Dumping into Streams

- No pump running
- Bubbling at end of hose
- Unusual odors
- Discoloration of water near hose
Illegal Dumping

Which is illegal dumping?

Wetzel County Action Group
Gas Migration or Leakages
What do you see?
Data Management: Record Results

ALLARMwater.org
Reporting Observations

It is important to communicate with your local agencies – "hey, we’re here and we’re monitoring."
Pipeline Monitoring Decision Tree

1. **Do you have disturbances from pipelines?**
   - **Yes**: Is the situation an imminent threat to the health of residents? Does it cross state lines?
     - **Yes**: Notify
       - Local Emergency (911, Fire Department, Hospital)
       - FERC
       - County Conservation
       - District
       - PA DEP Regional Office
       - PA Fish and Boat Commission
       - EPA Region 3 Tipline
     - **No**: Notify
       - County Conservation District
       - PA DEP Regional Office
       - PA Fish and Boat Commission
       - EPA Region 3 Tipline
   - **No**: Notify
     - County Conservation District
     - PA DEP Regional Office
     - PA Fish and Boat Commission
     - EPA Region 3 Tipline
Parameter Overview

Alliance for Aquatic Resource Monitoring
Objectives

• Learn about water quality parameters.
• Build basic skills for monitoring.
• Learn about quality assurance/quality control.
Indicators

Water Quality:
- Conductivity
- Total Dissolved Solids (TDS)

Water Quantity:
- Stage (water depth)
Dickinson students, faculty, and staff helped test conductivity/TDS meters to determine which meter is most accurate, precise, and easy to use.
Calibration

• Calibrate every day you monitor
• Dispose of calibration fluid after use
Conductivity ($\mu S$/cm)

- Conductivity measures the ability of water to carry an electrical current/presence of ions:
  - Inorganic compounds = good conductors
    - Example: dissolved salts and heavy metals
  - Organic compounds = poor conductors
    - Example: pesticides
- Conductivity is measured with a meter. Voltage is applied between two electrodes in a probe immersed in water.

Ranges

- Distilled Water: 0.5 – 3 $\mu S$/cm
- US Streams: 15 – 500 $\mu S$/cm
- US Rivers: 50 – 1500 $\mu S$/cm
- Industrial Waters: up to 10,000 $\mu S$/cm
Total Dissolved Solids (mg/L)

- TDS measures the amount of ions in the water.
  - Example: dissolved salts, nutrients, heavy metals
- Meters first measure conductivity and calculate TDS using an equation.
- TDS can be measured directly using the gravimetric method (actual weight).

Ranges

<table>
<thead>
<tr>
<th>Type</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Water</td>
<td>&lt; 1,500 mg/L</td>
</tr>
<tr>
<td>Brackish Water</td>
<td>1,500 – 5,000 mg/L</td>
</tr>
<tr>
<td>Saline Water</td>
<td>&gt; 5,000 mg/L</td>
</tr>
</tbody>
</table>
Why Conductivity and TDS?

- Frack water mixes with natural brine, found in the shale
- Flowback water contains high concentrations of salts and metals

Picture by Amy Bergdale, US EPA
Stage Monitoring (ft)
Flowback Water Concentrations

TDS: 70,000 mg/L
TDS: 211,000 mg/L
TDS: 132,000 mg/L
TDS: 217,000 mg/L

Source: Amy Bergdale, USEPA
A conductivity level 3x or higher than a measurement at a comparable stage.

<table>
<thead>
<tr>
<th>Date</th>
<th>Stage</th>
<th>Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/6/2016</td>
<td>1.7</td>
<td>119.3</td>
</tr>
<tr>
<td>2/15/2016</td>
<td>1.7</td>
<td>132.3</td>
</tr>
<tr>
<td>3/7/2016</td>
<td>0.8</td>
<td>361</td>
</tr>
<tr>
<td>3/13/2016</td>
<td>1.7</td>
<td>670</td>
</tr>
</tbody>
</table>

What do you do if you have a reportable event?
Reportable Event Steps:

1. Re-calibrate meter and re-test your water.
2. Collect a sample for barium & strontium analysis (to send to a local, certified lab).
3. Contact your local group leaders.
4. Contact enforcement agencies.
5. Contact ALLARM.
Barium & Strontium: Signature Chemicals

- If Conductivity/TDS levels increase, that could mean pollution from shale gas flowback water.
- Data are confirmed by analyzing samples for Ba & Sr.

It is important to obtain baseline data for conductivity/TDS and barium/strontium. It is also important to understand how they relate under different flow conditions.
Reporting Events

**Chemical Monitoring Decision Tree**

1. **Baseline Data Available**
   - Is conductivity ≥3x baseline conductivity at comparable stage?
     - Yes: Proceed to next step
     - No: Contact PA DEP Regional Office, PA Fish and Boat Commission, ALLARM, EPA Region 3 Tipline, County Conservation District, Local Community/Environmental Group, Facility Owner/Operator

2. **No Baseline Data Available**
   - Is conductivity greater than 3x the previous week conductivity or 2x upstream conductivity?
     - Yes: Collect a sample at the stream for certified lab analysis of barium and strontium.
     - No: Contact PA DEP Regional Office, PA Fish and Boat Commission, ALLARM, EPA Region 3 Tipline, County Conservation District, Local Community/Environmental Group, Facility Owner/Operator

**Contact:**
- PA DEP Regional Office
- PA Fish and Boat Commission
- ALLARM
- EPA Region 3 Tipline
- County Conservation District
- Local Community/Environmental Group
- Facility Owner/Operator
Baseline Monitoring Steps

1. Visual Observation Checklist
2. Conductivity & Total Dissolved Solids In-stream testing
3. Stage Monitoring
Stream Testing

• Test stream water with meter
  – Walk into middle of the creek
  – Or sample from a bridge using a bucket
Creekside vs. Home testing

Mandatory Creekside Testing
• Stage
• Visual observations

Can do at home in bad weather
• Calibration
• Conductivity/TDS

Meter does not stabilize quickly in freezing temperatures, turn the meter on when you arrive at the site or let the water warm to room temperature test at home or in the car.
Recording Results

1. Record site information in the boxes below:
   - Stream Name: Monitor's Name
   - Site Location: Collection Date
   - Latitude Coordinate: Collection Time
   - Longitude Coordinate: County Monitored

2. Record weather information:
   - Sunny: Light rain
   - Partly Cloudy: Heavy rain
   - Cloudy: Snow

3. Record conductivity, TDS, and stage results:
   - Conductivity: \( \muS/cm \)
   - Total Dissolved Solids: mg/L
   - Stage: feet

4. Did you calibrate your meter the day you monitored? Yes No

5. How much time did you spend monitoring? [ ] hours
Data Management

ALLARMwater.org

• ‘My Data’ profile page
• Submit data through site
• Can view data and create graphs
• Resources, research and forms all housed on site
Data Management: ALLARMwater.org

- Submit data through site
- Checks values and tests for reportable events
Data Management: ALLARMwater.org

- Can create data and create graphs
- Resources, research and forms all housed on site
Quality Control Program

- Ensures the credibility of the data collected.
- ALLARM will test the water using the same equipment as well as other methods.
- Compare monitor’s results to ALLARM’s results.

<table>
<thead>
<tr>
<th></th>
<th>Conductivity (LaMotte)</th>
<th>Conductivity (Accumet)</th>
<th>TDS (LaMotte)</th>
<th>TDS (Accumet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ALLARM</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
QA/QC Sampling

• Fill out QA/QC form
• Collect sample
• Send form and sample to ALLARM lab
• Do twice a year – high stage & low stage
Quality Control

Send water sample to ALLARM within **first month of monitoring** for QA/QC and barium/strontium analysis.

---

### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Replicate #1</th>
<th>Replicate #2</th>
<th>Average Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>μS/cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage</td>
<td>feet</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Monitor Information

<table>
<thead>
<tr>
<th>Monitor Information</th>
<th>Sample Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor's Name</td>
<td>Site ID or Stream Name</td>
</tr>
<tr>
<td>Mailing Address</td>
<td>Latitude Coordinate</td>
</tr>
<tr>
<td>Email Address</td>
<td>Longitude Coordinate</td>
</tr>
<tr>
<td>County Monitored</td>
<td>Collection Date</td>
</tr>
<tr>
<td>Affiliation (if applicable)</td>
<td>Equipment Used (i.e. LaMotte meter)</td>
</tr>
<tr>
<td></td>
<td>Bottle # (on label)</td>
</tr>
</tbody>
</table>

---

5. Pack a small box with your QA/QC bottle and this QA/QC form. Secure the bottle so it cannot move around during shipment. Mail the box to ALLARM for QA/QC processing at:

ALLARM
Dickinson College
5 N Orange Street
Carlisle, PA 17013
In your kit

1. LaMotte Tracer PockeTester and calibration solution vial
2. 84 µS/cm & 1413 µS/cm standard calibration solution
3. Distilled water wash bottle
4. Stream testing bottle
5. 3 sample bottles
   – Two sample bottles for QA/QC
   – One bottle for pollution event Ba and Sr analysis
6. Gage Stick