OKI GROUNDWATER COMMITTEE
March 7, 2012 - 10:00 AM
OKI Board Room
720 East Pete Rose Way (at the corner of Eggleston Avenue)*

AGENDA

1. Welcome/Introductions

2. Announcements

3. Update on Local Groundwater Management Efforts
   Dave Combs, Mike Ekberg, Tim McLelland, Donna Runkle

4. OKI Staff Update

5. Fracking: A National, State and Regional Perspective
   --Christopher Impellitterri, Chief, Water Quality Management Branch,
   National Risk Management Research Laboratory, U.S. EPA

   --Tom Tomastik, Geologist, Underground Injection Control
   Division of Oil & Gas Resources Management, Ohio Department of Natural Resources

   --Jason Heath, Manager, Monitoring, Assessment & Standards Programs
   Ohio River Valley Water Sanitation Commission (ORSANCO)

6. Other Business

   ADJOURNMENT

   ** SEE the MAP and DIRECTIONS on the REVERSE HARD COPY
   (or in separate attachment to email)
DEVELOPMENT OF THE SHALE PLAYS, HYDRAULIC FRACTURING, AND DISPOSAL OF OILFIELD WASTES IN OHIO

Tom Tomastik, Geologist, Ohio DNR, Division of Oil and Gas Resources Management
HISTORY OF OHIO’S OIL AND GAS INDUSTRY

- Drilling for oil and gas in Ohio began in the 1860s.
- By the 1880s, Ohio was the world’s leading oil producer.
- Natural gas, initially was considered a byproduct, but usage began in the 1880s.
Historically, oil and gas operations in Ohio were regulated by the Division of Mines. Predominantly in coal-bearing townships, regulations were pretty sparse – no spacing requirements.
In the early 1960s, oil discovery in Morrow County started a drilling boom.

- Town lot spacing
- No spacing or conservation measures in place
- Caused a national stir – wasting of a resources
- Under pressure, Ohio’s governor and state legislature passed laws and rules in 1965 and created the Division of Oil and Gas
INITIAL DISPOSAL REGULATIONS

- In 1965, few injection wells for disposal
- Most disposal in “evaporation pits”
- Lead to groundwater contamination
CLASS II INJECTION WELLS

- Division receives primacy of UIC Program from U.S. EPA in 1983
- Laws and rules established for Class II injection wells
- Proper way to handle and dispose of oil and gas fluid wastes
- Started increase in the number of injection well installations
Eliminated “evaporation pits” as of July 1, 1986
Established lawful disposal options – deep well injection or surface spreading
Established registration and reporting requirements for brine haulers
In July of 2000, Division of Oil and Gas merged with Mining and Reclamation. Formed Division of Mineral Resources Management (DMRM)

- Regulates oil and gas, coal, and industrial minerals mining
- Oil and gas separated out from DMRM – effective October 1, 2011 – now call Division of Oil and Gas Resources Management
Passed and went into effect on June 30, 2010

Laws strengthened for drilling operations, well construction, and stimulation reporting

Fee increases to offset general revenue funding elimination

New brine disposal fee – 5 cents per barrel in-district and 20 cents per barrel out-of-district – Paid quarterly to DOGRM

In-district is within one of the three DOGRM districts in Ohio

Out-of-district is outside one of these three districts

Maximum disposal fee payment per Class II saltwater injection well is $100,000 (500,000 barrels x $0.20 per barrel)
CLASS II SALTWATER INJECTION WELLS IN OHIO

- Requires three layers of steel casing to protect aquifers
- Surface casing set at least 50 feet below the deepest USDW
- Protect up to 10,000 mg/L total dissolved solids
CLASS II PERMIT APPLICATION

- Preliminary area of review – ¼ mile or ½ mile
- Pre-site review
- Public notice requirement
- Special conditions attached to the permit
- Ohio does not distinguish commercial vs. non-commercial wells
DOGRM Mineral Resources Inspector will conduct a pre-site field review after an application is received.

- Looking for proximity of water wells, dwellings, and surface bodies of water.
- If these are close to the proposed injection surface facilities, may require additional permit conditions.
CONDUCTING MECHANICAL INTEGRITY TEST

- After setting the packer, pressure test to maximum allowable injection pressure
- Monitor pressure for 15 minutes with no more than a 5% decline
SALTWATER INJECTION WELL FACILITY

- Requires a dike area either lined with 30 mil liner or concrete dike for tanks
- Able to hold all fluids within dike area is there is a release
- Concrete unloading pad with drain, vault and sump for trucks
TYPICAL INJECTION WELLHEAD
CLASS II INJECTION WELL INSPECTIONS

- Division inspectors conduct unannounced inspections every 11 to 12 weeks.
- Check injection and annulus pressures for integrity.
- Check facility and pipelines for leaks.
Approximately 98% of oilfield fluids in Ohio are injected. Remaining 2% is spread legally for dust and ice control. In 2010, over 8,500,000 barrels (42 gallons per barrel) were injected. Currently, 194 permitted Class II saltwater injection wells.
TYPES OF OILFIELD FLUIDS THAT CAN BE INJECTED INTO CLASS II WELLS

- Pits water – fluids from drilling & cementing operations
- Mixture of drilling mud, freshwater, and formation brines
- Flowback or frac water – mixture of chemicals, brine, and brackish water associated with frac job
OILFIELD FLUIDS

- Production fluids – natural formation brine
- Byproduct of oil and gas production
- Mainly sodium, chloride, calcium, barium, iron, strontium, magnesium, and potassium
- Chloride is the predominant constituent with concentrations as high as 200,000 ppm (mg/L)
INITIAL WELL STIMULATION TECHNIQUES IN OHIO

- Initially, oil and gas well stimulation methods used in Ohio involved explosives – mainly nitroglycerin.
- Typical oil and gas wells were “shot” with one quart of nitro for every foot of reservoir rock.
- This was the primary completion technique employed in Ohio until the advent of hydraulic fracturing.
HYDRAULIC FRACTURING IN OHIO

- Hydraulic fracturing was first used in Ohio in 1951 and met with considerable success – particularly in the tight, Clinton sandstone.
- Hydraulic fracturing dramatically reduced the number of dry holes drilled in Ohio.
- Tens of thousands of oil and gas wells have been successfully hydraulic fractured in Ohio since 1951.
There is a lot of misinformation out there regarding hydraulic fracturing!

Ohio DMRM has conducted over 1000 groundwater investigations since 1983 and has no cases where hydraulic fracturing causing groundwater contamination.
REAL HYDRAULIC FRACTURING DATA – MARCELLUS SHALE FRAC HEIGHT DATA (FROM AMERICAN OIL AND GAS REPORTER & HALLIBURTON)
MARCELLUS SHALE MAP (from Ohio Division of Geological Survey)
MARCELLUS WELL
MAP SHOWING LOCATION OF UTICA SHALE PLAY (from Geology.com)
FLUID DISPOSAL IN OHIO

- Better Class II wells in Ohio inject between 1000 to 2000 barrel per day
- Best injection zone in Mt. Simon Sandstone in western Ohio
- Class II permit activity in 2010 increased dramatically
- Ohio has always received oilfield fluids from other states, it’s just increasing dramatically due to the shale plays
- In 4th quarter 2010, 39% of injected fluid in Ohio from out-of-district
- In the 2nd quarter of 2011, that increased to 54% or over 1.5 million barrels
- In the 3rd quarter of 2011, we have injected 3,371,898 barrels or an increase of 400,000 barrels from the 2nd quarter
GROUNDWATER INVESTIGATIONS

- Division has conducted over 1000 groundwater investigations since 1983
- No contamination cases caused by hydraulic fracturing
- Mostly surface issues
NATURAL GAS IN WATER WELL
CONTAMINATION CASES IN OHIO

![Pie chart showing the distribution of total incidents by phase.]

- Abandoned Sites: 40 incidents (22.1%)
- Site Preparation: 0 incidents
- Drilling & Completion: 72 incidents (39.8%)
- Well Stimulation: 0 incidents
- Production/Workover: 39 incidents
- Waste Storage Treatment: 39 incidents
- Off-Site Waste Management/Disposal: 26 incidents
- Plugging & Abandonment: 4 incidents
Incidents Caused by Regulated Activities by Year and Key Regulatory Reforms

Legend
- Plugging & Abandonment
- Off-Site Waste Management/Disposal
- Production/Workover Waste Storage Treatment
- Well Stimulation
- Drilling & Completion
- Site Preparation
- Class II UIC Pimacy
- Authority to order water supply replacement
- Produced water tracking
- Established deep injection of produced water as preferred disposal method
- Closure of all produced water earthen pits
- Reserve pit construction standards
- Annular disposal mechanical integrity test
- Annular disposal rules
- Orphan well emergency program
- Urban drilling rules
Due to the allegations that seismic activity near the Youngstown may be caused by the Class II saltwater injection well, additional conditions are being added to any new injection permits issued by the Division.

- If the well is to be an open-hole completion into the Mt. Simon Sandstone, then a radioactive tracer survey must be performed and witnessed by the Division prior to initiation of injection operations to determine that the injection fluids are entering the permitted zones.
- A Murphy switch or cut-off switch must be installed on the injection pump and set to the permitted maximum allowable injection pressure.
- The operator of the injection well must continuously monitor the annulus and injection pressures using a two-pen recorder or other continuous recording device.
CURRENT DEVELOPMENTS

- Leasing is booming in Ohio
- Marcellus Shale leasing limited to eastern Ohio
- Utica Shale extends into western Ohio – could become a major play in Ohio
- Division has issued the most Class II injection well permits this year since 1988 – 29 permits issued so far this year
- Class II injection still the best management practice for disposal
QUESTIONS?
Research on Potential Impacts from Hydraulic Fracturing on Drinking Water Resources

Christopher A. Impellitteri
U.S. Environmental Protection Agency
Office of Research and Development

OKI Groundwater Committee Meeting
March 7, 2012
Purpose of the EPA Study *

In its FY 2010 Appropriations Committee Conference Report, Congress directed EPA to study the relationship between hydraulic fracturing and drinking water, using:

- Best available science
- Independent sources of information
- Transparent, peer-reviewed process
- Consultation with others

*http://www.epa.gov/hfstudy/
Purpose of EPA’s Study

• To assess the potential impacts of hydraulic fracturing on drinking water resources

• To identify the driving factors that affect the severity and frequency of any impacts

This study is not intended to determine or evaluate best management practices.
Research Approaches

- Gather and analyze existing data
- Case studies
- Scenario evaluations
- Laboratory studies
- Toxicological assessments
Water Use in Hydraulic Fracturing Operations

- Water Acquisition
- Chemical Mixing
- Well Injection
- Flowback and Produced Water
- Water Treatment and Waste Disposal

Fundamental Research Questions

- How might large volume water withdrawals from ground and surface water impact drinking water resources?
- What are the possible impacts of releases of hydraulic fracturing fluids on drinking water resources?
- What are the possible impacts of the injection and fracturing process on drinking water resources?
- What are the possible impacts of releases of flowback and produced water on drinking water resources?
- What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?
Hydraulic fracturing often involves the injection of more than a million gallons of water, chemicals, and sand at high pressure down the well. The depth and length of the well varies depending on the characteristics of the hydrocarbon-bearing formation. The pressurized fluid mixture causes the formation to crack, allowing natural gas or oil to flow up the well.

**Water Use in Hydraulic Fracturing Operations**

- **Water Acquisition** - Large volumes of water are transported for the fracturing process.
- **Chemical Mixing** - Equipment mixes water, chemicals, and sand at the well site.
- **Well Injection** - The hydraulic fracturing fluid is pumped into the well at high injection rates.
- **Flowback and Produced Water** - Recovered water (called flowback and produced water) is stored on-site in open pits or storage tanks.
- **Wastewater Treatment and Waste Disposal** - The wastewater is then transported for treatment and/or disposal.
HF in Ohio

- Marcellus Shale Horizontal Well Permits
  - 13 horizontal well permits issued-7 drilled from 2006-present
- Utica Shale Horizontal Well Permits
  - 137 horizontal well permits issued-35 drilled from 2009-present
Research on WW and DW

- Research Questions
  - How effective are conventional and commercial treatment systems in removing organic and inorganic contaminants of concern in HFWW?
  - What are the potential impacts from surface water disposal of treated hydraulic fracturing WW on DW treatment facilities?
What is HFWW?

• “Flowback”
  • Injected fracturing fluid returning to the surface after a fracturing event

• “Produced”
  • Water extracted from the formation during gas production

• Storm water runoff?
Volumes of WW

• 56 M bbl/day from on-shore oil and gas production*
  • = 2.353 Bgal. Los Angeles Hyperion Treatment plant treats 340 MGD. Seven days to treat a days’ worth of wastewater (Detroit could treat the volume in 1.5 days)

• Shale Gas well
  • Rough average 500 bbl/day = 21,000 Gal/day
  • Varies greatly depending on location, stimulation methods, geology etc.
    • e.g. Barnett 3-4X “wetter” than Marcellus

Duration of WW production

• Flowback
  • 2-8 MG/well for drilling/fracturing
  • 30-70% flowback*
  • 13.5% Susquehanna River Basin (131 Wells)**
  • Hours to weeks (14-30 days cutoff?)

• Produced
  • Greatly depends on formation
  • Generally less than 1000 gal/MMCF gas over lifetime***

***ERG Draft Pollutant Research Literature Review
Potential Contaminants

• TDS
• Anions
• Cations/elemental
• Organics
• Radionuclides (NORM)
  • Radium
  • Uranium
  • Thorium
WW Storage

• Lagoons, ponds, tanks
• Storage issues
  • Wildlife
  • Odor
  • Overflow/failure
• Regulations
  • States
    • Liners
    • Construction requirements
WW Treatment

- Direct discharge to surface
- Indirect discharge to surface water
  - Publically owned WW treatment plant (POTW)
    - Conventional WW treatment: Primary settling, aeration basin/activated sludge, secondary settling
  - Commercial Treatment
    - Evaporative/Distillation
- Underground injection
- Reuse
DW Issues

- **Direct contamination**
  - Subsurface migration
  - Faulty well construction

- **Discharge to surface water**
  - POTWs
  - Commercial facilities
  - Spills
DW-Bromide

• Bromide + NOM + chlorination = Br disinfection by-products (DBPs)
  • Total Trihalomethanes (THMs)- 80 µg/L
    • Chloroform (aka trichloromethane) - CHCl₃
    • Bromodichloromethane - CHClBr₂
    • Dibromochloromethane - CHCl₂Br
    • Bromoform (aka tribromomethane) – CHBr₃
  • High source water bromide concentrations
    • Tend to shift THMs toward Br forms
    • Br is heavier thus 80 µg/L reg is exceeded
• Marcellus

  • Bromide ranges from non detect to 1600 mg/L in HFWW (PADEP 26R Forms-Annual Report by Generator)

  • Min: 0.14 mg/L Max: 1990 mg/L Avg.: 410 mg/L Median: 180.5 mg/L
DW-Bromide in SW

• Possible Sources
  • Coal fired power plants
  • Surface/Mountain Top Mining Valley Fill
  • Hydraulic Fracturing
    • Runoff/overflow/spills
    • Treated discharge
      • Commercial Trtmt. Facilities
      • POTWs
Research-Bromide

• Phase I: THM formation potential from Br containing compounds
  • Typically used as biocides in HF fluids
    • Bronopol: 2-bromo-2-nitro-1,3, propanediol
    • DBNBA: 2,2-dibromo-3-nitrilopropionamide
  • Do these Br compound contribute to Br-DBP formation?
  • Can they potentially form Br-DBPs in storage if shock chlorination is used (odor control in open lagoons)?
  • Can they be “ruled out” relative to naturally occurring bromide?
• Longevity
Research-Bromide

• Phase II: THM formation potential from Br in HFWW

  • Proposed methodology
    • Dilute actual HFWW (1%)
    • Account for, by estimation, receiving water dilution factor
      • Use actual PA numbers as a basis
    • Add NOM (e.g. Suwanee River Humic/Fulvic Acid)
      • 0, 1, 5, and 10 mg/L
    • Chlorinate (1-2 mg/L)
    • Chloraminate (1-2 mg/L)
    • Analyze for THMs, Haloacetic acids, and nitrosamines as a function of time
Research-Wastewater

• Phase I: Fate and transport of priority contaminants in WW treatment
  
  • Proposed methodology
    • Utilize target contaminant list (Brian’s list-under development)
      • Elements: Ba, Sr, Fe, Mg, Na, Ca
      • Organics: Ethylene glycol, acrylamide, glutaraldehyde, formaldehyde, alkylphenols, benzene/toluene/ethylbenzene/xylenes (BTEX), ethylene glycol monobutyl ether (aka 2-butoxyethanol)
      • Anions: Br, Cl, NO$_3$, PO$_4$, SO$_4$, F
    • Fate/transport studies (benchtop)
      • 10 L temperature controlled stainless steel reactors
Benchtop Reactor
Research-Wastewater

Pilot plant
Research-Wastewater

- Phase I: Fate and transport of priority contaminants in WW treatment
  - Proposed methodology
    - Fate/transport studies (benchtop, pilot-scale)
      - Blend HFWW with synthetic WW
        - 0, 1, 5, 10% HFWW
      - Hydraulic Residence Time
        - 6-8 hours
        - 1-2 hours primary settling
  - Concurrent Studies on effects on activated sludge process
    - Monitor biological oxygen demand, chemical oxygen demand, nitrogen (in/out) and phosphorous (in/out)
Research-Wastewater

- Phase II: Partitioning of contaminants in residuals
  - Proposed methodology
    - Analyze residuals from bench-top studies and actual HFWW residuals
      - Elemental
        - Bulk digestions, ICP-OES, ICP-MS
        - Elemental chemical speciation
        - Bonding/sorption characteristics (X-ray absorption spectroscopy)
      - Organics
        - Accelerated solvent extraction
        - LC-triple quadrupole mass spectrometry
Current Status

• QAPPs and HASPs in place
• Work has commenced on Br compounds/DBP formation
• Contract support for DBP work in place
• Contract support for WW work is in progress
• ORISE Post-doc expected on-board in March
Immediate Future

• Help to finalize(?) chemical contaminant priority list (end of March)
• Develop/optimize IC/MS procedure for Br analysis in high TDS matrix (end of March)
• Procure HFWW samples for benchtop DBP studies (by end of April)
• Begin setting up benchtop WW systems (May)
Questions?
ORSANCO’s Potential Role In Shale Gas Development
Feb 2012 Roundtable
Figure 1. Marcellus and Utica Shale distribution
# Marcellus Well Activity

<table>
<thead>
<tr>
<th>State</th>
<th>Marcellus Shale</th>
<th>Utica Shale*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
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<tr>
<td>Horizontal Permits issued</td>
<td>11</td>
<td>102</td>
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<tr>
<td>Horizontal Wells Drilled</td>
<td>7</td>
<td>27</td>
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*permits issued since December 2009

Updated 11/17/2012

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<thead>
<tr>
<th>Pennsylvania</th>
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<tr>
<td>Marcellus Well Applications 2005-Present</td>
<td>9,618</td>
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<tr>
<td>Marcellus Wells Drilled 2005-Present</td>
<td>4,436</td>
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<td>Marcellus Applications Issued in 2012</td>
<td>68</td>
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<tr>
<td>Non-Marcellus Wells Drilled 2005-Present</td>
<td>19,772</td>
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Updated 11/17/2012

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<thead>
<tr>
<th>West Virginia</th>
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<tr>
<td>Marcellus Well Permits since 2008 - 1651.</td>
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<tr>
<td>Marcellus Well Completion Reports since 2008 - 1053</td>
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<tr>
<td>Non-Marcellus O&amp;G Permits since 2008 - 6455.</td>
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Updated 02/1012
Frac Flow Back Waste

- Average Water Use for each frac - 4.8 Million Gallons
- Average Frac Waste - 477,000 Gallons
- Average lifetime of Well – 30 years
- Wells may require Re-Fracing.
Frac Flow Back Waste

• WV – 81% of Frac Water is reused, 18% sent to Underground Injection Well, 1% other

• PA – 99% reused, Underground Injection Well, industrial Water Treatment Plant

• OH – Sent to Underground Injection Wells or Reused
Marcellus Shale State Requirements

• PA
  – Moratorium on sending well waste water to WWTP
  – Currently no approved shale waste discharges from WWTPs.

• WV
  – Stringent permitting requirements at domestic or industrial WWTPs if accepting frac waste water.

• OH
  – Moratorium for sending well waste water to WWTP

• NY
  – No Marcellus Drilling until Draft EIS is finalized.
Surface Water Quality Monitoring

- **West Virginia**
  - Cooperative agreement with USGS to test GW quality by testing nearby wells and streams from 2011-2012
  - West Virginia Water Research Institute (WVWRI) has an established monitoring network on the Monongahela River (19 Parameters including Br- & TDS)

- **Ohio**
  - No monitoring directly related to Drilling
Surface Water Quality Monitoring

• Pennsylvania
  – RAIN (River Alert Information Network) – a surface water protection network monitoring Cond, pH, & Temp at 13 Locations (adding a 14th in WV)
  – Freshwater Biology Team has a monitoring network for Fish Creek, WV; Cross Creek & Tenmile Creek, PA
  – Modifications to existing monitoring network to address Marcellus.

• Susquehanna
  – Network of 51 in-stream monitors
  – 50% of well applications get a baseline biological assessment at a fee of $5700
Parameters to be tested in cooperative agreement with USGS on wells and streams

<table>
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<tr>
<th>Constituent</th>
<th>Method</th>
<th>Constituent</th>
<th>Method</th>
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<tr>
<td><strong>Field Measurements and Unstable Constituents</strong></td>
<td></td>
<td><strong>Major Constituents (dissolved, 0.45 micron filtration)</strong></td>
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<tr>
<td>pH</td>
<td>Field meter</td>
<td>Dissolved Oxygen</td>
<td>Field meter</td>
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<td>Alkalinity, carbonate</td>
<td>Titration, increment</td>
<td>Temperature, water</td>
<td>Field meter</td>
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<td>Barometric Pressure</td>
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<td>Specific Conductance</td>
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<td>Chloride</td>
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<td>Sodium</td>
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<td>Sulfate</td>
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<td>Silica</td>
<td>ICP-AES</td>
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<td>ICP-AES</td>
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<td>Boron</td>
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<td><strong>Trace Elements (dissolved, 0.45 micron filtration)</strong></td>
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<td>Aluminum</td>
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<td>Cobalt</td>
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<td><strong>Dissolved Gases</strong></td>
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<td>Argon</td>
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<td>Carbon Dioxide</td>
<td>GC-TCD</td>
<td>Oxygen</td>
<td>GCT-CD</td>
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<td>Methane</td>
<td>GC-TCD</td>
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<td><strong>Radio-Chemicals</strong></td>
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<td>Gross-Alpha/Beta Count</td>
<td>Th-230 Curve, ESL/ Cs-137 Curve, ESL</td>
<td>Radium-228(^1)</td>
<td>Beta-counting, ESL</td>
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<td>Uranium-234/235/238(^2)</td>
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<td>Radium-224/226</td>
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<tr>
<td><strong>Isotope Ratios for Water and Major Ions</strong></td>
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<tr>
<td>(^13)C/(^12)C Dissolved Inorganic Carbon</td>
<td>MS, IST</td>
<td>(^2)H/(^1)H Water/(^18)O/(^16)O Water</td>
<td>MS, IST</td>
</tr>
<tr>
<td>(^34)S/(^32)S and (^18)O/(^16)O of Sulfate</td>
<td>MS, RSIL</td>
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TDS Data from RAIN on the Ohio River at Mile Point 4
Source: RAIN, Site O4, 1/1/11-12/31/11, translated from Cond. to TDS using 0.625 factor
Total Dissolved Solids/Bromide Study

• To Characterize ambient background levels of TDS & Bromide
• Develop site-specific translators to convert conductivity to TDS.
• Provide data to support possible development of an Ohio River bromide stream criterion.
• Weekly Samples from 17 Sites (4 tribs) for 1 year (Dec ‘11 – Dec ‘12)
QUESTIONS?
OKI GROUNDWATER COMMITTEE MEETING SUMMARY
Wednesday, March 7, 2012
OKI Board Room – 10:00 a.m.

Attendees:
Bruce Whitteberry, Chair, Greater Cincinnati Water Works
Jack Thornsberry, Vice Chair, Butler County Water and Sewer Dept.
Brian Bohl, Hamilton County Soil & Water Conservation District
Chris Brausch, Warren County Water and Sewer Department
Ken Broberg, S.M. Stoller
Jim Collins, City of Hamilton
Dave Combs, City of Trenton
James Combs, City of Fairfield
Bob Curley, Citizen
Nancy Dawley, LWVCA
Frank Divo, Southwestern Ohio Water Company
Andreas Eddy, City of Fairfield
Mike Ekberg, Miami Conservancy District
Carl Gatton, Warren County Water and Sewer
Mike Halfrisch, Ohio Dept. of Natural Resources
Jason Heath, ORSANCO
Jamey Hinkle, Western Water Company
Doug Hunter, Leggette Brashears & Graham, Inc.
John Hunter, LWVCA
Chris Impellitteri, U.S. EPA
Tammy Jett, Duke Energy Environmental Department
M. Scott Kirk, Western Water Co.
Tim McLelland, Hamilton to New Baltimore Groundwater Consortium
Dave Morrison, SW Regional Water District
Michael Miller, Rivers Unlimited
Tim Neyer, Clermont County Water Resources
Jeanne Nightingale, WCC
James O’Reilly, City of Wyoming
Norma Pennock, SW Regional Water District
Greg Petredis, City of Hamilton
Allison Reed, Ohio EPA
Richard Renneker, Committee Member
Mary Clare Rietz, Ohio Alliance for People and Environment
Donna Runkle, USGS
Adam Sackenheim, Butler County Recycling
Ken Shearwood, Village of New Richmond
Tom Tomastik, Ohio Department of Natural Resources, Div. of Oil & Gas Resources
Leon Simpson, Citizen
Tom Yeager, Clermont County Water Resources
**OKI Staff:**
Brian Cunningham, Gayle Foster, Bruce Koehler, Robert Lakeberg, Emi Randall, Jane Wittke

**Welcome/Introductions/Announcements:**
Bruce Whitteberry called the meeting to order at 10:10 a.m. and those attending introduced themselves. He announced that the next Groundwater Committee meeting is scheduled for Wednesday, May 30, 2012.

**Local Groundwater Management Updates**
**Dave Combs from the City of Trenton** explained that the City’s water system serves a population of about 11,000 and pumps an average of 1.1 to 1.2 million gallons per day (MGD). The City has four wells and two wellfields, and their treatment process involves ion exchange. Work is progressing with major maintenance on a 1 million gallon storage tank. Dave also reported that the City is experiencing a 30% water loss in its distribution system, and that reducing the loss is a priority for their operations.

**Mike Ekberg from Miami Conservancy District (MCD)** reported that MCD recently partnered with the U.S. Geological Survey (USGS) and the ODNR Division of Soil and Water to add two real-time observation wells in the Great Miami River Basin. One well is an ODNR observation well identified as MT6 and located in downtown Dayton. The other well is an MCD observation well near the Miller Coors Plant in Trenton identified as BU32. The addition of these two wells brings the total of real-time observation wells in the basin to 12. Data from the wells can be accessed online at [http://groundwaterwatch.usgs.gov/StateMapsNet.asp?ncd=rtn&sc=39](http://groundwaterwatch.usgs.gov/StateMapsNet.asp?ncd=rtn&sc=39)

MCD recently completed a study of 22 pharmaceuticals and personal care products (PPCPs) in the Great Miami River Basin, based on sampling at wastewater outfalls, in the river itself, and at headwaters and groundwater sites. As might be expected, the highest concentrations were found in wastewater outfalls and downstream of them in the river. The report can be accessed on the MCD website at [www.miamiconservancy.org/water/groundwater_evalu.asp](http://www.miamiconservancy.org/water/groundwater_evalu.asp)

MCD also completed a study of fecal indicator bacteria in the Great Miami River and its large tributaries, comparing them with Class A primary contact recreation standards. Results indicate that the samples generally met standards during low flow periods, but exceeded them during rain and run-off events. That study is also available at [www.miamiconservancy.org/water/groundwater_evalu.asp](http://www.miamiconservancy.org/water/groundwater_evalu.asp)

**Tim McLelland of the Hamilton to New Baltimore Groundwater Consortium** reported that Fairfield has adopted updates to its source water protection ordinance. He said that he had recently met with Butler County Emergency Management to talk about debris disposal. He also gave kudos to the City of Hamilton for providing over one
Donna Runkle from the United States Geological Survey (USGS) reported that there are several new publications on groundwater online at http://pubs.er.usgs.gov/#home:Mar-2012:30. USGS has started a project in Licking County to educate homeowners about arsenic in drinking water, which will include three events to collect samples from private wells. Donna noted that a USGS work group is researching Marcellus and Utica Shale formations and includes Mary Ann Thomas and Ralph Haefner.

OKI Staff Update

Robert Lakeberg reported on an impervious surface analysis that OKI is undertaking for Butler, Clermont, Hamilton and Warren Counties with funding from the state of Ohio. Robert described impervious surfaces as hard surface area that prevents the entry of water into the soil mantle or hard surface area that causes water to run off the surface in greater quantities, such as roof tops, pavement, and asphalt.

Robert explained that final products of the project will include maps of the percent of impervious surface by 12-digit hydrologic unit codes and impervious cover ratings by watershed. The project will also compare the results of impervious surface analysis with slopes, erodible soils, riparian corridors and the buried valley aquifer, as all of these features affect or are affected by impervious surface. Such comparative analysis should be helpful in identifying areas where increased runoff, sedimentation and streambank erosion are expected and areas with reduced aquifer recharge.

Bruce Koehler gave an update on recent developments with the Mill Creek Watershed Council of Communities. The Council recently secured a grant under Section 319 of the Clean Water Act to add a watershed planning coordinator to the Council staff and is currently seeking to fill the position. The Council also organized a development committee to work on the Upper Mill Creek Watershed Action Plan.

Research on Potential Impacts from Hydraulic Fracturing on Drinking Water Resources: Chris Impellitteri of the U.S. EPA’s Office of Research and Development explained that Congress had recently directed the EPA to conduct a study on the potential impacts of hydraulic fracturing on drinking water resources, and to identify the driving factors that affect the severity and frequency of any impacts, with research to be completed by 2014. The national study is not intended to analyze best management practices for drilling operators. (He also noted that the Marcellus and Utica Shale formations subject to drilling exist in eastern Ohio, not in western Ohio.)

Chris commented that research on potential drinking water impacts is a challenge because the hydraulic fracturing industry moves fast in response to price fluctuations: when the price of natural gas goes down, wells may be capped until the price rises; if
the price goes up, the driller may go to another potentially more productive area. As an example, he noted that at the beginning of the winter, the price of natural gas was $11 per 1,000 cubic feet, but had plummeted to $3 per 1,000 cubic feet.

He gave an overview of the process of hydraulic fracturing, which involves the injection of more than a million gallons of water, chemicals and sand at high pressure to create a well. (Horizontal drilling can create many more wells in an area than drilling a vertical well.) The depth and length of each well varies depending on the characteristics of the hydrocarbon-bearing formation. The pressurized fluid mixture causes the formation to crack, allowing natural gas or oil to flow up the well. After the natural gas or oil has surfaced, flowback of a significant percentage (30-70%) of injected fracturing fluid also returns to the surface, and mining of the oil or gas also results in water being extracted, which is referred to as “produced” water: both flowback and produced water constitute hydraulic fracturing waste water (HFWW).

Chris also described the cycle of water use involved in hydraulic fracturing, each phase of which raises questions for potential research, e.g.:
--In the water acquisition phase, how might large volume water withdrawals from ground and surface water impact drinking water resources?
--In the chemical mixing phase, what are the possible impacts of releases of hydraulic fracturing fluids on drinking water resources?
--In the well injection phase, what are the possible impacts of the injection and fracturing process on drinking water resources?
--In the flowback and produced water phase, what the possible impacts of releases such as flowback and produced water on drinking water resources?
--In the water treatment and waste disposal phase, what are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?

He commented on the large volumes of wastewater associated with the HF process and how it is stored. EPA is studying how effective conventional and commercial treatment systems are in removing organic and inorganic contaminants of concern in HFWW. EPA is also looking at potential impacts from surface water disposal of treated hydraulic fracturing wastewater on drinking water treatment plants. Storage of this wastewater consists of lagoons, ponds, and tanks, which involve issues of wildlife, odor and overflow. Treating wastewater is of concern for drinking water: contamination could occur due to faulty well construction and subsurface migration. Contaminants of concern include total dissolved solids such as sodium, bromide and sulfides, which are very hard to remove. He noted that it is possible to re-use salty water for HF without much treatment, which makes economic sense because of the high water demand that comes along with the HF process, but advances are needed in re-use technology.

**Development of the Shale Plays, Hydraulic Fracturing, and Disposal of Oilfield Waste in Ohio:** Tom Tomastik, Ohio Department of Natural Resources, Division of Oil and Gas Resources Management, presented a historical perspective
on Ohio’s oil and gas industry and described how Ohio regulates the disposal of wastewater associated with hydraulic fracturing (HFWW) into Class II deep injection wells. He noted that by the 1880’s Ohio was the world’s leading oil producer, and that natural gas, once considered a byproduct of oil production, was being used as an energy source in its own right. For many years, few regulations were in place in Ohio for oil and gas mining. In the early 1960’s, the discovery of oil in Morrow County brought on a drilling boom that led to creating a division at ODNR in 1965 to enforce newly passed laws and regulations for the oil and gas industry.

Tom said that hydraulic fracturing in Ohio began in 1951, and tens of thousands of oil and gas wells have since been hydraulic fractured in the state. He commented that since 1983, the Division of Oil and Gas Resources Management has conducted more than 1000 groundwater investigations of alleged oil and gas contamination cases, and found that none were caused by hydraulic fracturing. He stated that the majority of groundwater contamination cases caused by oil and gas operations are typically surface spills that have been pretty much eliminated by the passage of more stringent regulations since 1985.

He noted that for years there were few deep injection wells for HFWW disposal, and most HFWW disposal was in evaporation pits. These pits led to groundwater contamination. In 1983 Ohio DNR received primacy or authority over the underground injection control (UIC) program from U.S. EPA. Subsequently, the Ohio legislature passed Amended Substitute House Bill 501 in 1985 with several components: it eliminated evaporation pits as of July 1, 1986; established lawful disposal options for hydraulic fracturing waste of deep well injection or surface spreading; and established registration and reporting requirements for brine haulers. He stated that many of Ohio’s UIC regulations are more stringent than U.S. EPA’s regulations for injection wells. He said that Ohio has become the “go to” state for disposal of hydraulic fracturing wastes because other states have limited disposal options; Ohio can’t stop oilfield fluid wastes from coming into the state for disposal as they are considered Interstate Commerce.

The most recent and relevant Ohio legislation for hydraulic fracturing is Senate Bill 165 which went into effect on June 30, 2010. It strengthened the law for drilling operations and well construction, increased fees and added a new brine disposal fee of 5 cents per barrel in-district and 20 cents per barrel out of district. It also requires ODNR to spend 14% of fee revenue on plugging decommissioned oil and gas wells. Tom reviewed how Class II Permits for saltwater injection wells are processed in Ohio. Permits require three layers of steel casing to protect aquifers; a surface casing set at least 50 feet below the deepest underground sources of drinking water; and that wells must protect up to 10,000 mg/L total dissolved solids. The application process includes preliminary review of an area within ¼ or ½ mile of the site, pre-site review, a public notice requirement and the option of attaching special conditions to the permit.
He reported that Ohio has 196 permitted Class II injection wells, of which about 172 are in operation. He noted that Class II injection well permitting associated with hydraulic fracturing has slowed greatly because of seismic activity near a deep injection well in the Youngstown area. In addition, Marcellus shale drilling has dropped off because the supply of natural gas is so plentiful that prices have gone down. He said that the best injection well zone geologically in western Ohio would be areas of Mt. Simon sandstone that are 300-500’ thick. In southwest Ohio, there are only two deep injection wells, both of which are Class I wells regulated by Ohio EPA, located in the Middletown area and associated with AK Steel. In response to a question, he noted that he had received a few inquiries about possible HFWW disposal in southwest Ohio, but subsequently clarified that no permit applications have been received.

ORSANCO’s Potential Role in Shale Gas Development
Jason Heath, Ohio River Valley Water Sanitation Commission (ORSANCO)

Jason gave an overview of hydraulic fracturing and ORSANCO’s monitoring work, and displayed maps showing the locations of Marcellus and Utica shale deposits and well permits in New York, Ohio, Pennsylvania, and West Virginia. He explained that horizontal well drilling enables more fractures to be made in greater spaces to inject water and force natural gas out. Instead of going deeper, the well bore can go wider, thereby getting more natural gas with less drilling.

He stated that the average water use for each hydraulic fracturing involves 4.8 million gallons; the average flowback of wastewater is 477,000 gallons; and the average lifetime of a well is 30 years. Ohio’s fracturing flowback wastewater in either re-used or sent to an underground injection well. There is a moratorium on sending fracturing wastewater to treatment plants in Ohio, and Ohio does not monitor surface water specifically for drilling waste. Jason noted that West Virginia has entered into a cooperative agreement with USGS to monitor wells and streams for compounds that may come from hydraulic fracturing.

ORSANCO has monitoring responsibilities for the Ohio River, which receives run-off from watersheds where hydraulic fracturing operations are located, and the agency has a monitoring program for total dissolved solids (TDS). Jason displayed a list of the parameters to be tested and described sampling at several sites along the river to characterize ambient background levels of TDS and bromide. This data will be evaluated and possibly may be used to develop an Ohio River bromide stream criterion, as levels of bromide do not attenuate as bromide moves downstream. He noted that data from the Ohio River TDS monitoring location in Pittsburgh indicates that TDS levels have always been below ORSANCO’s criterion of 500 mg/L.

Adjournment: The meeting was adjourned at 12:15 p.m.; the next meeting is scheduled for 10 a.m. on May 30, 2012.