

# Water Data to Answer Urgent Water Policy Questions: Shale Gas Development in the Susquehanna River Basin

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## ABSTRACT

Hydraulic fracturing and shale gas development in the Marcellus shale of Pennsylvania has taken off in the past decade. The number of unconventional wells grew from less than 200 in 2007 to more than 9,300 as of August, 2015. Along with this new growth comes concern about potential water quality impacts of the relatively new technique of high-volume hydraulic fracturing (HVHF) and the cumulative shale gas development activities that have moved into minimally developed areas, especially in the headwaters of the Susquehanna River Basin.

### Do shale gas development activities contaminate surface water or groundwater?

This policy question was the subject of a study by the Northeast-Midwest Institute evaluating available water data to answer urgent water policy questions. The study found that, even after 8 years of intense shale gas development in the Susquehanna River Basin, current water quality monitoring is inadequate for detecting potential surface water or groundwater quality impacts of shale gas development activities in the basin. Historical monitoring sites are not located near hydraulic fracturing well pads, and more recent monitoring programs lack the frequency needed to detect water quality change to support timely decision making. There is no systematic, large-scale, long-term groundwater monitoring network to confirm or reject these water quality concerns. The foundation of a strong surface water monitoring program is in place in the basin, but increased sampling frequency, analysis of water quality parameters, and streamflow data are needed before water quality trends can begin to be detected and explained.

## WATER DATA NEEDED

It is not possible to identify water data needs for answering the case-study policy question without an initial discussion of an appropriate study design (Figure 1). The right water data must be available in the right locations with the right supporting information to detect water-quality change and identify the cause of that change.

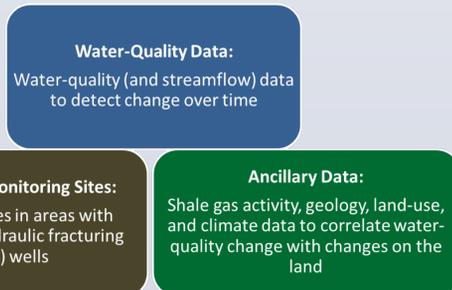


Figure 1: Study design needed to answer "Do shale gas development activities contaminate surface water or groundwater?"

## PRIORITY SURFACE-WATER AND GROUNDWATER PARAMETERS

**Parameters recommended for both surface water and groundwater:** alkalinity, dissolved barium, bromide, calcium, chloride, dissolved oxygen, gross alpha, gross beta, lithium, magnesium, nitrate, pH, potassium, radium-226 and -228 (but only if there are changes in gross alpha and gross beta), sodium, specific conductance, strontium, sulfate, total dissolved solids, uranium, and water temperature.

**Additional parameters recommended for surface water only:** total barium, suspended sediment concentration, total organic carbon, total phosphorus, turbidity, and streamflow.

**Additional parameters recommended for groundwater only:** benzene, toluene, ethylbenzene, xylene, and methane.

## SURFACE-WATER DATA NEEDED AND AVAILABLE

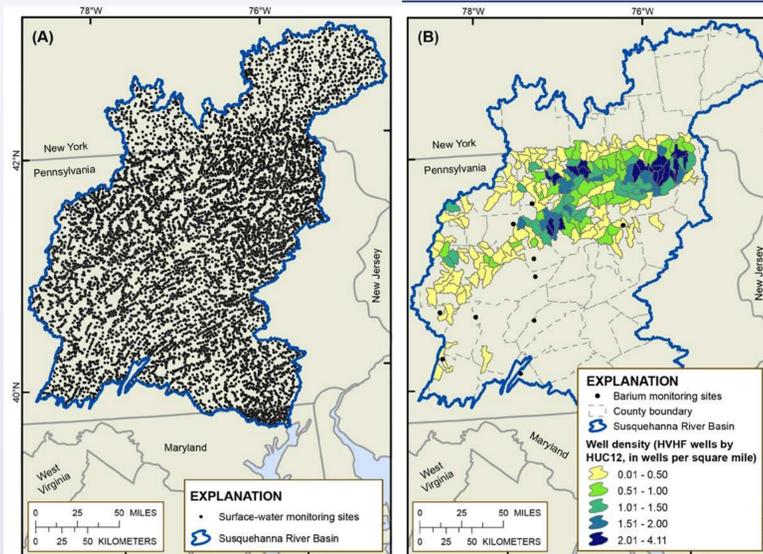


Figure 2: (A) Surface-water monitoring sites in the Susquehanna River Basin with water-quality records for at least one of the Comprehensive List of surface-water parameters selected by the Technical Advisory Committee (n=14,730), and (B) Surface-water monitoring sites where the minimum data for detecting changes in barium concentration (total or dissolved) have been collected (n=10). None of the 10 monitoring sites are located in a watershed with a high density of HVHF wells.

### The surface-water data needed for answering the case-study policy question are not currently available in the Susquehanna River Basin.

While there are some applicable surface-water data available, each of the existing monitoring sites does not meet at least one of the criteria for location, parameters analyzed, frequency of monitoring, or duration of monitoring to detect statistically significant change associated with cumulative effects of shale gas development.

New monitoring programs at the Susquehanna River Basin Commission (SRBC) and the Pennsylvania Department of Environmental Protection (PADEP) collect data more closely associated with shale gas development than previous monitoring efforts. Many of the monitoring sites for these programs are in the right locations, but additional sampling frequency, parameters, and streamflow data are needed.

Table 1: Summary of surface-water data needed to detect water-quality change resulting from cumulative shale gas development activities in the Susquehanna River Basin. Analysis supporting these findings is presented in Chapter 6 of the report. [Abbreviations: HVHF, High-volume hydraulic fracturing].

Criteria	Surface-water data needed
Monitoring parameters	• Suite of priority surface-water parameters (listed in left column) and streamflow at each monitoring site
Sampling frequency	• Monthly
Locations of monitoring sites	• Monitoring sites in each of the ecoregions with active or predicted HVHF activity, including: <ul style="list-style-type: none"> <li>○ Northern Allegheny Plateau,</li> <li>○ North Central Appalachians,</li> <li>○ Central Appalachians, and</li> <li>○ Ridge and Valley.</li> </ul>
Watershed characteristics	• Watersheds smaller than 70 square miles. • Medium and high density and reference watersheds: <ul style="list-style-type: none"> <li>○ Watersheds with greater than 0.5 HVHF wells per square mile, and</li> <li>○ Watersheds with 0 HVHF wells per square mile and no significant shale gas development expected.</li> </ul>
Number of monitoring sites	• Watersheds larger than 70 square miles that offer opportunities for nested monitoring (i.e. one or more small watersheds that are being monitored for change are nested within the larger watershed) • Minimum of 1 monitoring site in a high density watershed per ecoregion. • Minimum 1 reference monitoring site per ecoregion.
Duration and timing of monitoring	• At least 36 samples collected at monthly or longer intervals over 3-4 years including data collected after shale gas development (post-2007) • Minimum duration of monitoring to detect water-quality change varies by ecoregion • Ideal monitoring sites will have: <ul style="list-style-type: none"> <li>○ Data collected before shale gas development (pre-2007),</li> <li>○ An uninterrupted data record,</li> <li>○ Current/ongoing data collection (2009 or later), and</li> <li>○ Plans for long-term monitoring.</li> </ul>

## GROUNDWATER DATA NEEDED AND AVAILABLE

Table 2: Summary of groundwater data needed to detect water-quality change resulting from cumulative shale gas development activities in the Susquehanna River Basin. Analysis supporting these findings is presented in Chapter 9 of the report.

Criteria	Groundwater data needed
Monitoring parameters	• Suite of priority groundwater parameters (listed in left column) at each monitoring site.
Spatial networks	• Minimum of 5 networks in each of the major drinking water aquifers with shale gas development, distinguished by topography: <ul style="list-style-type: none"> <li>○ Upper Devonian Lock Haven aquifer with upland topography,</li> <li>○ Upper Devonian Lock Haven aquifer with valley topography,</li> <li>○ Upper Devonian Catskill aquifer with upland topography,</li> <li>○ Upper Devonian Catskill aquifer with valley topography, and</li> <li>○ Pleistocene deposits aquifer.</li> </ul>
Number and location of sampling sites	• For each network: <ul style="list-style-type: none"> <li>○ 25-30 sampling sites</li> <li>○ Each site within 1 mile of a HVHF well</li> </ul>
Duration, frequency, and timing of monitoring	• Two samples at each site, separated by approximately 10 years and taken: <ul style="list-style-type: none"> <li>○ before shale gas development, and</li> <li>○ after shale gas development</li> </ul>
	• Additional long-term monitoring, in subsequent 10 year increments, • A subset of 5 sites per network sampled every 2 years.

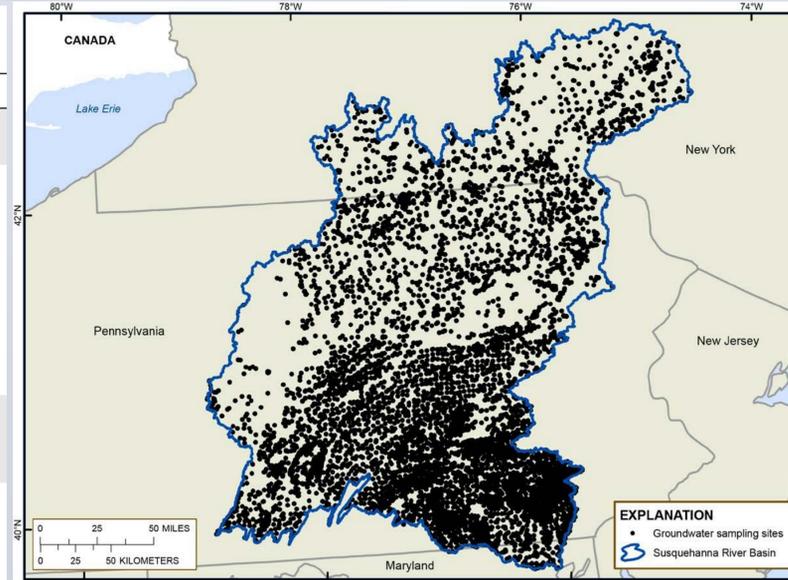


Figure 3: Groundwater sampling sites in the Susquehanna River Basin with water-quality records for at least one of the comprehensive list of groundwater parameters selected by the Technical Advisory Committee (n=9,761).

## GROUNDWATER DATA NEEDED AND AVAILABLE (cont'd)

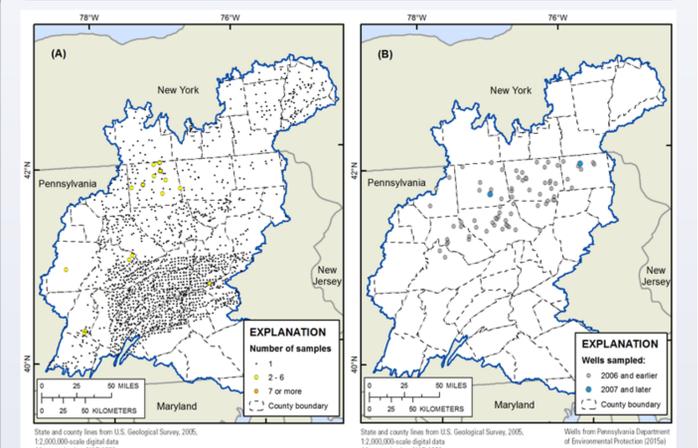


Figure 4: (A) Groundwater sampling sites with bromide data in the Marcellus and Utica Shale area of the Susquehanna River Basin (n=1,686), and (B) Groundwater sampling sites located within 1 mile of an HVHF well (n=74). None of the 74 sampling sites have data available both before and after shale gas development, and few of the suite of priority groundwater parameters were measured before shale gas development.

### The groundwater data needed for answering the case-study policy question are not being collected.

There is no systematic, large-scale, long-term monitoring effort underway to assess the effects of shale gas development on groundwater quality in the Susquehanna River Basin, and from the data sources that do exist, Figure 4 shows that limited groundwater data are publicly available to answer the policy question. The groundwater sampling sites with existing data are rarely located within 1 mile of an HVHF well, but even when they are in the right locations the sites lack data for most of the priority groundwater parameters. The available groundwater data lack the sampling frequency needed for a water-quality trend analysis and lack the number and location of sampling sites needed for a spatial water-quality network analysis.

## SUMMARY OF INFORMATION NEEDS TO ANSWER "DO SHALE GAS DEVELOPMENT ACTIVITIES CONTAMINATE SURFACE WATER OR GROUNDWATER IN THE SUSQUEHANNA RIVER BASIN?"

- Increase monitoring at a subset of targeted surface water monitoring sites.
- Maintain data collection and analysis at enhanced surface water monitoring sites for a minimum of 10 years and as long as shale gas development activities continue in the Susquehanna River Basin.
- Design and implement a systematic, long-term groundwater monitoring program, building on data collected by shale gas industry, if appropriate.
- Establish a coordinating entity to develop and implement surface water and groundwater monitoring plans in the Susquehanna River Basin, with representation from water monitoring organizations, the shale gas industry, domestic well owners, and public citizens.

### FOR MORE INFORMATION:

Download the full report at [www.nemw.org](http://www.nemw.org).  
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