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Marcellus-Utica Shale Gas Concept Proposals

USGS, New York Water Science Center

I - AREAL GROUND-WATER QUALITY ASSESSMENT

Background - The USGS in cooperation with the NYSDEC Division of Water conducts ground-water quality surveys of the major river basins in New York State on a 5-year rotating basis. This program, commonly called the 305B project, samples and analyzes ground water from public and private wells completed in unconsolidated and bedrock aquifers for an extensive suite of inorganic and organic chemical constituents.

Proposal - Following the lead of this program, the USGS proposes to enhance the ground-water quality network within the Marcellus-Utica shale play area by supplementing the network with additional well-sampling sites and increased sampling frequency, as well as refining the suite of water-quality parameters that are monitored to include potential shale-gas development contaminants.

Benefit – The enhanced program will provide a database of ambient water quality from which to assess the regional water-quality characteristics of the freshwater aquifers in the Marcellus/Utica shale play area, and it will provide data useful to compare with that from any water-supply wells that potentially are adversely affected by shale-gas development activities.

II – CHARACTERIZATION OF THE FRESHWATER AQUIFER SYSTEM WITH DEPTH

Background – Grouted steel casings are used to isolate freshwater bedrock aquifers from potential hydraulic and water-quality impacts associated with shale-gas development activities. However, the depth to the base of the freshwater in the bedrock aquifer system is not well documented. Scanty information indicates the depth to the freshwater aquifer base varies topographically and from east to west across the Marcellus-Utica play area. Due to the natural degradation of water quality with depth, public and private water-supply wells typically tap the shallower parts of the bedrock aquifers, and provide very limited information on aquifer characteristics with depth. The deeper parts of the freshwater system and its interface with the saline-water system need to be better characterized.

Proposal – The USGS proposes to characterize water-quality changes with depth in the freshwater bedrock aquifers and delineate the freshwater/saline water interface in representative hydrogeologic settings across the Marcellus-Utica shale play area. Existing information from NYSDEC Divisions of Water and Mineral Resources, NYSDOH, and USGS records will be assessed to formulate and guide this characterization. Geophysical logging and depth-dependent water-quality sampling will be completed in available deep wells. Bedrock wells will be drilled to the freshwater/saline-water interface and completed for multiple-zone hydraulic and water-quality monitoring

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Benefit – This project would provide an increased understanding of the freshwater resource in bedrock aquifers in the Marcellus-Utica play area, and would compliment the areal ground-water quality assessment. The project would also provide a sound scientific basis for decisions related to the casing and grouting of shale-gas wells.

III – IMPACT OF FRACK-WATER WITHDRAWAL

Background – Three to five million gallons of fresh water will be used for the hydraulic fracturing of each horizontal gas-well lateral. The SRBC and DRBC have protocols that cover the regulation and permitting of surface-water withdrawals to be used for frack water in their respective river drainage basins. Similar regulations and protocols are not in place in the Marcellus-Utica play area outside of the Susquehanna and Delaware River basins.

Proposal – The USGS proposes to develop statistical and GIS tools and data bases to help the NYSDEC Divisions of Water and Mineral Resources evaluate single and cumulative impacts of surface-water withdrawals for frack-water use in the Marcellus-Utica play area outside of the Susquehanna and Delaware River basins.

Benefit - This project will provide important tools and information for the NYSDEC to make scientifically based decisions concerning surface-water withdrawals associated with hydraulic fracturing of shale-gas wells.

IV – GEOCHEMICAL AND RADIOCHEMICAL CHARACTERIZATION OF FLUIDS AND SOLIDS

Background – Large volumes of fluids and solids with a range of toxicity will be generated during shale-gas development activities. These fluids and solids include formation brines, drill cuttings, and frack and flowback waters. The geochemical and radiochemical characteristics of these fluids and solids are not well documented

Proposal – The USGS proposes to first compile existing geochemical and radiochemical data, and then based on those results, sample and analyze formation, frack, and flowback fluids and drill cuttings at representative shale-gas well sites.

Benefit – This project would provide information needed to properly handle and regulate the fluids and solids associated with shale-gas development. In addition, it will provide the fluid and solids characterization necessary to focus water-quality monitoring activities.

V – WATER-RESOURCE IMPACT ASSESSMENT OF DRILLING PADS

Background – The proposed development of large (5 acre) drilling pads that would support multiple horizontal gas-well laterals in the Marcellus-Utica shale play area will concentrate shale-gas development activities. While this will reduce the number of

surface locations and associated land disturbances, it also concentrates the potential for water-resource impacts.

Proposal – The USGS proposes to develop a generic surface- and ground-water monitoring design for large drilling pads. The design would include 1) unconsolidated and bedrock well inventory and installation and ground-water-level and -quality monitoring; 2) surface-water inventory, flow measurement, and water-quality monitoring (springs and seeps, streams, ponds, and wetlands); and 3) stormwater and sediment runoff monitoring. The monitoring program will be implemented at representative shale-gas development sites. The monitoring network would be ongoing prior to any site development activities, and would continue through the drilling, hydraulic-fracturing, and production phases.

Benefit – The water-resource monitoring would provide information on impacts of the site development, horizontal well drilling, hydraulic fracturing, and production activities. The results would help guide and streamline future programs to focus on the critical elements needed to be monitored

VI - WASTEWATER/BIOSOLIDS AND RECEIVING-WATER MONITORING

Background - Wastewater treatment plants are being considered for treatment of frack-flowback water with subsequent disposal to surface water. It is unclear how the chemistry and volume of the frack-flowback water will impact the operation of the treatment plants, the quality of the plant discharge water, and, ultimately, the quality of the receiving stream or river. The Monongahela River in western Pennsylvania, which recently had started to receive treated frack-flowback water from multiple municipal plants, showed dissolved solid concentrations significantly above past documented levels during this year's low flow.

Proposal – The USGS proposes at representative wastewater treatment plants to: 1) assess the quality of the frack-fluid flowback prior to treatment; 2) evaluate the current capability of the wastewater plant to treat both normal wastewater and flowback fluids; 3) monitor discharges from the wastewater plant as the fluids pass through the system; and 4) monitor the bio-solid residuals from wastewater treatment to determine their quality, especially if they are land applied and monitor surface- and ground-water quality in such application areas.

In addition, the USGS proposes to monitor the quality of receiving streams and rivers at selected existing gaging stations through continuous collection of specific-conductance data. Flow data are already collected and reported in near-real time, and the addition of specific-conductance measurements, which are directly related to dissolved solids concentrations, would provide the basic data needed to evaluate baseline conditions and future changes in surface-water quality.

Benefit – Monitoring of the wastewater plants would allow for evaluation of treatment, and protect the receiving-water quality downstream of the facility. Such an

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understanding would protect the State's water resources. The quality of land-applied bio-solids would be assessed to assure that any potential chemical residuals do not get into the food chain or the State's water resources.

Monitoring the basic water-quality of a number of streams across the state (at a minimum, specific conductance) will establish a baseline from which to assess future high salinity water (flow-back/formation water) as it passes through wastewater treatment plants. These data will also provide a means to assess the possible impact of this high conductivity flow on the ecology of these receiving water bodies.

VII - CHARACTERIZATION OF HYDRAULIC PROPERTIES AND FORMATION WATERS OF DEEP SALINE AQUIFERS THROUGH GAS WELL DRILLING

Background - Deep saline aquifers have been proposed as potential horizons for 1) disposing of wastewaters produced by hydraulic fracturing and production of gas wells and 2) sequestering CO_2 captured from power-plant emissions. Little public information is available, however, concerning the hydraulic properties of these aquifers and the chemistry of the formation waters within them.

Proposal – The USGS proposes to collect information from past and current drilling operations to characterize the hydraulic properties of deep saline aquifers and the chemistry of formation waters within both saline aquifers and gas production zones. The study requires the participation of gas-production companies to obtain this information in a cost-effective manner, by allowing inspection of well completion records and access to boreholes to conduct drill-stem tests (DSTs). In the first phase of the study, gas-production companies will be contacted to determine the amount of existing information available and to identify two to four potential partners for conducting tests during drilling of planned boreholes. Well completion records and geophysical logs will be reviewed to determine the number of saline water-bearing zones intercepted by drilling, and the quantity of water produced by each zone. Formation waters from gas-producing zones will be sampled from above-ground storage tanks and analyzed for dissolved constituents, including major ions, trace elements, and stable isotopes.

In the second phase, potential disposal horizons will be tested by coordinating the services of well-testing companies with ongoing drilling operations. When a saline aquifer is encountered in a borehole, drilling operations will temporarily cease, and a DST will be conducted and a water-quality sample will be collected. The pressure-buildup data will be analyzed to determine the ambient hydraulic head and transmissivity of the test zone, and the water-quality sample will be analyzed for the same constituents as above.

Benefit – This project would provide the information required to assess the potential storage capability of saline aquifers, and to predict chemical reactions that could result from injection of wastewater or CO_2.