Delineation of the Spatial Extent of Valley-Fill Aquifers in Five Counties in South-Central New York State (NY-12P)

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Problem: Unconventional shale gas drilling is currently being extensively developed in northeastern and southwestern Pennsylvania and northern West Virginia through a combination of horizontal drilling and high-volume hydraulic fracturing. It is anticipated that development of shale gas will soon begin in south-central New York, specifically in Steuben, Chemung, Tioga, Broome, and Chenango Counties (fig.1). Concern has been expressed over the potential effect of shale gas development on groundwater resources in this five-county area. Proper management of water resources in this region requires a detailed knowledge of the spatial extent and hydrogeologic characteristics of the valley-fill aquifers within it, as these aquifers are widely used for water supply.

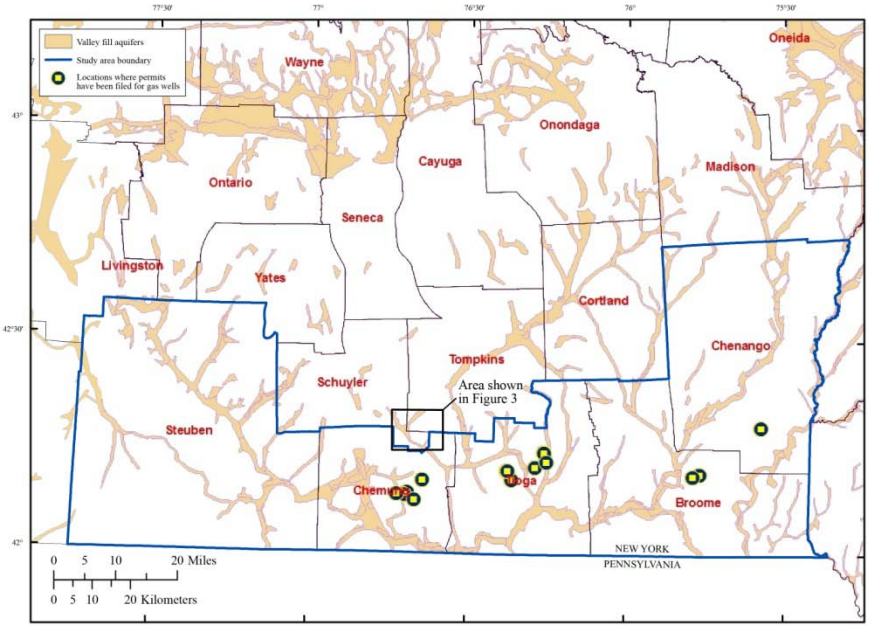

Figure 1.—Map of the five-county study area in south-central New York showing locations of valley-fill aquifers (tan), where permits have been filed to conduct gas drilling using unconventional methods (green; as of June, 2012), and the location of Figure 3.

Detailed aquifer maps are available in digital form at a scale of 1:24,000 for many valley-fill aquifers in this region (areas shown as green, fig. 2). These detailed aquifer maps have been generated over several decades by the USGS in cooperation with NYSDEC and local governments using consistent techniques, and so form the basis of a consistent, reliable source of information of the spatial extent and hydrogeologic setting for valley-fill aquifers throughout much of this area. However, there are approximately 375 linear miles of valley-fill aquifers in the study area that are not mapped at a scale of 1:24,000 (shown in red in Figure 2). Thus, a substantial portion of the five-county area lacks basic hydrogeologic information, including accurate spatial extent of valley-fill aquifers. In addition, there is

no digital GIS data set available that shows the extent of valley-fill aquifers in the five-county area at 1:24,000 scale. A digital map is available that shows generalized aquifer boundaries for the five-county area at 1:250,000 scale (based on a series of 1:250,000 scale maps published by the USGS), however the aquifer boundaries delineated at this scale are inadequate for effective water -resource planning. For most water-resource planning purposes, scales larger than 1:250,000 (such as 1:24,000) are needed.

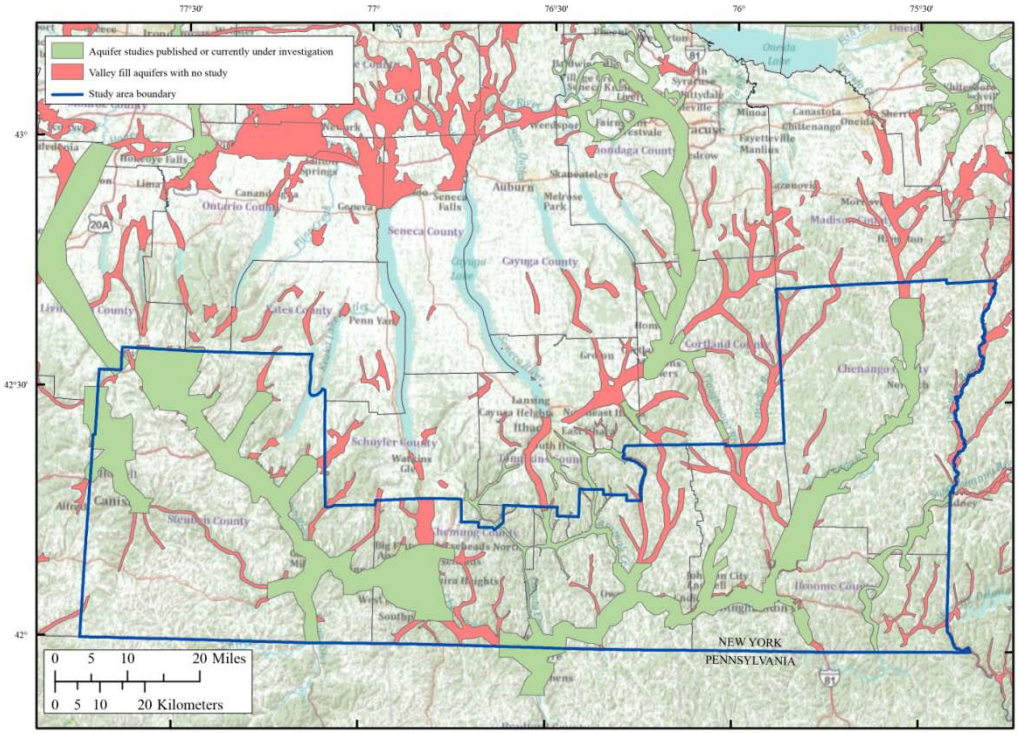

Figure 2. –Location of valley-fill aquifer mapping completed or in progress by the USGS (in green) and locations of unmapped valley-fill aquifers (in red) within the five-county study area of New York State.

The 1:250,000 scale aquifer map that covers this study area (Miller, 1988) is inadequate for most water resource planning because (1) the aquifer boundaries shown on regional maps like this are highly inaccurate when overlain onto more detailed maps, such as 1:24,000 scale topographic maps (fig. 3), and (2) the aquifer boundaries have not been updated using completed detailed aquifer studies conducted since the 1990's. A comparison of the valley-fill aquifer boundary digitized at 1:250,000 scale with the boundary digitized as part of a recent detailed aquifer mapping project completed at 1:24,000 scale (fig. 3) shows that the aquifer boundary of the 1:250,000 scale map is generally 30% larger in spatial extent than the aquifer boundary mapped at 1:24,000 and, in some areas, the boundary of the 1:250,000 scale aquifer is absent where there is an aquifer shown in the 1:24,000 scale aquifer map (fig. 3).

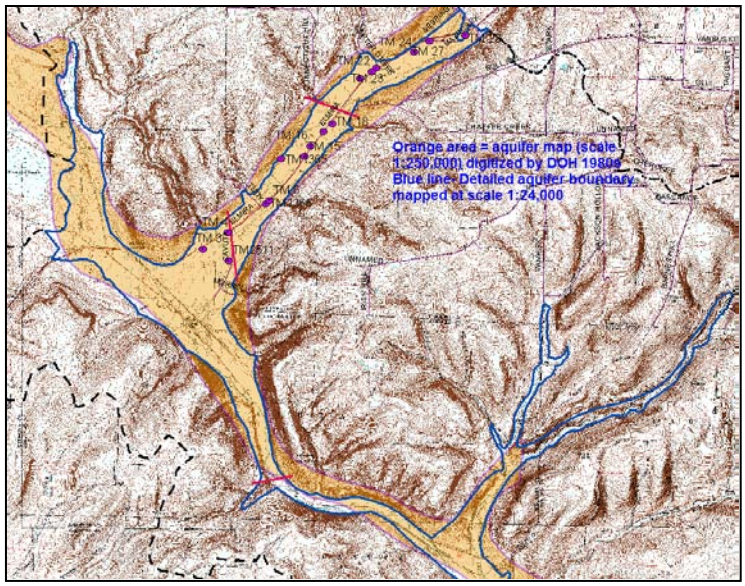

Figure 3. –Comparison of spatial extent of a valley-fill aquifer mapped at a 1:24,000 scale (blue line) to the spatial extent of the same aquifer digitized at 1:250,000 scale (shaded orange).

Objective: In order to adequately protect groundwater resources in the five-county area, there is an immediate need (by the end of March 2013) to (1) delineate at, 1:24,000 scale, the spatial extent of the valley-fill aquifers that are currently unmapped, and (2) compile these new maps with existing maps to produce a single digital map showing the spatial extent of the valley-fill aquifer in the five-county area.

The spatial extent of the valley-fill aquifers in the five-county area will be delineated at a scale of 1:24,000 using existing data, including soils maps, topographic data, LIDAR data, published reports, and selected well records. The aquifer boundaries constructed for this study will be merged with aquifer boundaries from previously published maps to produce a single GIS dataset, thereby producing a uniform aquifer boundary dataset for the five-county study area. A USGS webpage will document the project and provide a link to the map, which will be produced as a GIS dataset available through the NYS GIS Clearinghouse.

Relevance and Benefits: The delineation of aquifer boundaries will provide basic information needed to protect groundwater resources in the five-county area in a short timeframe. These data can provide a basis for future detailed aquifer mapping that provides more detailed hydrogeologic information on selected valley-fill aquifers. The proposed project will provide a consistent dataset mapped at a suitable scale for managing valley-fill aquifers in the five- county area, which is expected to experience shale gas development. The availability of this data in an electronic format at 1:24,000 scale will insure that State, county, and local water resource managers have access to the locations and extent of valley-fill aquifers. This basic information will advance the knowledge of the regional hydrogeology by providing a regionally consistent dataset that identifies the locations of valley-fill aquifers, which will provide a basis for future detailed investigations of these important aquifers.

Approach:

The USGS will delineate the boundaries of the unmapped valley-fill aquifers in the five-county study area, including adjacent areas that may be underlain by permeable stratified drift in hydraulic contact with the aquifers. This approach will be consistent with similar USGS projects that have produced maps

of the extent of valley fill aquifers at 1:24,000 scale
(see http://ny.cf.er.usgs.gov/nyprojectsearch/projects/2457-CJY-1.html).

Delineation of aquifer boundaries would be conducted at a scale of 1:24,000 through the following sequential tasks:

Task 1 –Compile necessary data, including Natural Resources Conservation Service SSURGO soils data, LIDAR imagery, published reports, well records from the NYSDEC Water Well database and the USGS NWIS database.

Task 2 –Delineate the boundary of the valley-fill aquifer at 1:24,000 scale within each unmapped valley segment, including contiguous deposits of ice-contact sand and gravel, alluvial fans, and glaciofluvial terraces that, while thinly saturated, would act as recharge areas for the valley-fill aquifer.

Task 3 – Develop GIS datasets of the newly mapped valley-fill aquifer boundaries and merge with the aquifer boundaries from recent aquifer studies to produce a single map (GIS dataset) that depicts the aquifer boundary in the five-county study area.

Task 4 –Compile metadata for newly created GIS dataset and document methods used to produce the dataset.

Task 5 –Review GIS dataset including metadata file through internal USGS review and NYS DEC review.

Task 6 –Release GIS dataset to NYS GIS Clearinghouse and document products using a USGS project website.

Limitations: This project will be limited to providing a consistent 1:24,000 scale map of the spatial extent of valley-fill aquifers within the five-county study area. The delineation of aquifer boundaries in this manner is intended as a preliminary means to provide the spatial extent of valley-fill aquifers necessary for the protection of groundwater resources in the five-county area and allow the NYSDEC to determine whether future permits for unconventional gas well drilling are properly located. However, this effort only supplies the spatial extent of the valley-fill aquifer and does not provide subsurface information that is necessary for understanding the hydrogeologic framework and hydraulics of the aquifers, which is critical to assessing aquifer vulnerability to groundwater contamination. In order to fully protect groundwater resources in this area and provide the information necessary for aquifer vulnerability assessment, additional hydrogeologic information is needed for these aquifers. These data should include: (1) the three-dimensional hydrogeologic framework of these aquifers, (2) valley-fill stratigraphy, and (3) the location of any confined aquifers, and 4) the potentiometric surface and general directions of groundwater flow. These additional tasks can be addressed in follow-up studies. Data from such studies would be used to develop a three-dimensional assessment of valley-fill aquifers delineated in this proposed project.

Deliverables: A GIS map will be compiled that delineates the boundaries of valley-fill aquifers within the five-county study area at 1:24,000 scale. The product will be a single GIS dataset of the spatial extent of valley-fill aquifers, mapped at 1:24,000, including those produced in earlier projects and those produced as part of this project. After internal USGS review, this GIS data set will be released to the public though the NYS GIS Clearinghouse. In addition, a project web page will summarize the objectives, methods, and limitations of the data. This web site will provide a link to the GIS dataset and provide metadata for the digital product. The USGS would make this information available in draft form within six months of the start date of the project to insure that the necessary information required for the protection of groundwater resources in the five-county area will be available to NYSDEC in a timely manner.

Reference:

Miller, T.S., 1988, unconsolidated aquifers in upstate New York –Finger Lakes Sheet: U.S. Geological Survey Water Resources Investigation Report 87-4122, 1 sheet, 1:250,000 scale.