




**MEMO**

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**Through:** Randall Kresge, P.G.   
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**Date:** February 18, 2020

**Re:** Geological Review of UIC Disposal Well Application  
Seneca Resources Co., LLC  
FEE Seneca Resource Warrant 3771 No. 38282, API 047-23885  
Elk County, Highland Township

### **Review Process**

Seneca Resources Company, LLC (Seneca) submitted a permit application to the Department of Environmental Protection (DEP) on June 4, 2019. The purpose of the application is to change the use of the FEE Seneca Resources Warrant 3771 38282 (38282) well from a conventional gas well to a disposal well. In accordance with 25 Pa. Code, Chapter 91.51, DEP Licensed Professional Geologists conducted a geologic review of the change of use application, the EPA permit and its accompanying materials, and additional geological information requested by the DEP from Seneca, including information on the potential for induced seismicity. Numerous GIS layers were reviewed as well, which include: Oil and Gas Wells, Gas Storage Fields, Public Water/PAGWIS, Mining, Geology Basement Contours, and Pennsylvania Faults and Earthquakes.

### **Geologic Setting and Structure**

The well lies within the Appalachian High Plateau, which is an area of low-amplitude open folds. The Department's review of the GIS Pennsylvania Faults layer indicates that the nearest known fault is approximately 12 miles southeast of the well, and not within the mile radius area of review. Precambrian basement rocks are found approximately 11,000 feet below the Devonian Elk 3 Sandstone. Any faulting in the Precambrian basement is not expected to be of concern at this location.

### **Potential Migration Pathways**

A review of area well records reveals several shale confining layers above the top of the Elk 3 Sandstone injection formation, which is at a depth of 2,327 feet. According to information submitted by Seneca with the EPA UIC permit application, the lowest underground sources of drinking water (USDW) within the local area are at a depth of approximately 400 feet. Between the lowest USDW depth and the top of the Elk 3 Sandstone, there are several shale confining layers, including a shale layer directly above the Elk 3 Sandstone.

The Elk 3 Sandstone is separated from the brittle crystalline basement rock by approximately 11,000 feet, with several confining layers in between. A review of area well records reveals that directly below the Elk 3 Sandstone there is a shale confining layer. The confining layers should prevent downward migration into the layers below the Elk 3 Sandstone.

There are no underground mines or underground gas storage fields within a mile of the well that could potentially transmit fluid.

There are two gas wells within the ¼ mile area of review. The George W. Archer 4406, API No. 047-00516 was drilled to a depth of 2,732 feet. The George W. Archer 4384, API No. 047-00515 well was drilled to a depth of 2,527 feet. These two wells penetrate the injection formation and will be used by Seneca Resources as monitoring wells during injection into the 38282 well.

There are no known faults or lineaments within the 1-mile buffer zone that could potentially transmit fluid.

### **Seismic Review**

A review of the well location was completed to determine the risk of induced seismicity from injection of fluid into the Elk 3 Sandstone. The following factors indicate that this location has a low risk of induced seismicity:

1. As indicated by the pressure decline curves submitted by Seneca Resources to the EPA, the Elk 3 Sandstone is a depleted reservoir, which will have a low initial pressure.
2. The Elk 3 Sandstone is approximately 4,000 feet above the Salina Group. The Salina's semi-plastic nature truncates the faulting that exists below the Salina Group. Therefore, formations above the Salina Group such as the Elk 3 Sand, should not be affected by the faulting below the Salina.
3. The Elk 3 Sand is separated from the brittle crystalline basement rock by approximately 11,000 feet, with several confining layers in between. Studies indicate that larger, potentially damaging induced seismic events are often associated with movement along faults in the basement rock.

4. There are no known faults within the 1-mile buffer zone, or any other structural geologic features of concern.
5. No seismic activity that has originated in either Elk or McKean County has been recorded by the Pennsylvania State Seismic Network (PASEIS).
6. The applicant has adequately addressed reservoir characteristics, which included analysis of pore pressures, transmissivity, bottom hole injection pressure, reservoir static pressure, sustainable injection rates and geologic boundaries. Seneca has demonstrated that formation breakdown is completely minimized by well specific calculated and tested injection rates for proposed injection well Fee Seneca Resources Warrant 3771, No. 38268, which is located approximately a half-mile south of well 38282.
7. Case studies in other states have indicated that large volumes of fluid over 100,000 bbls/month are more likely to cause induced seismicity. In this case, the injection volume will not exceed 45,000 bbls per month.

#### **Conclusion and Recommendations**

Based on the data reviewed, the location of well 38282 is suitable for conversion from a production well to an underground injection well for disposal of wastewater from oil and gas activities.

The Department needs to ensure the casing and cementing design of the proposed injection well satisfies the requirements of 25 Pa. Code Chapter 78, Subsection D. If the well meets these mechanical integrity requirements and well integrity is maintained, there is no expected risk with this disposal well.

