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**Date:** March 3, 2021

**Re:** Geological Review of UIC Disposal Application  
Bear Lake Properties, LLC  
Smith-Ras No. 1, API 123-34843  
Warren County, Columbus Township

## **Review Process**

Kendra II submitted a permit application to the Department of Environmental Protection (DEP) on October 15, 2020, on behalf of Bear Lake Properties, LLC. The purpose of the application is to change the use of the Smith-Ras 1 well from a conventional gas well to a disposal well. In accordance with the 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 Kendra II 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 Plateau Physiographic Province in an area with a gentle dip to the southeast. Mapping indicates the closest fault to be approximately 8 miles northwest of the well in New York, and not within the mile radius area of review. Precambrian basement rocks are found approximately 4,730 feet below the base of the deepest injection formation, the Whirlpool Sandstone. No wells in the area of review penetrate the Precambrian basement. Any faulting in the Precambrian basement is not expected to be of concern at this location.

## **Potential Migration Pathways**

The Smith-Ras 1 is located within the Northwestern Glaciated Plateau Section of the Appalachian Plateau Physiographic Province. Unconsolidated glacial sediments in this area contain underground sources of drinking water (USDW). Below the glacial deposits is the Venango Formation, which is composed of interbedded sandstones, conglomerates, siltstones, and shales. The well record for the Smith-Ras 1 indicates that fresh water is found at a depth of approximately 120 feet within the glacial deposits. In the EPA UIC application, Kendra II states that freshwater may also be found in the underlying Venango Formation, but may contain saline water. A conservative depth of 300 feet for the lowest USDW is reasonable, because according to Kendra II, wells in this area usually encounter salt water below 100 feet.

There is one water well within the ¼-mile area of review. An analysis of area well records reveals the Salina Salt Formation, the Lockport Dolomite, and several shale confining layers exist between the lowest USDW and the Medina Group. These impermeable confining layers will prevent the upward migration of fluids into the USDW. The Smith-Ras 1 well surface casing and production casing are cemented to a depth well below the USDW and provide several hundred feet of protection to the USDW and the water well that uses it.

The lowermost injection formation of the Medina Group, the Whirlpool Formation, is separated by the brittle crystalline basement rock by approximately 4730 feet. The Queenston, Lorraine and Utica Shales and the Cambrian-Ordovician Carbonates all act as confining layers between the Whirlpool Formation and the basement rock. These confining layers should prevent downward migration of fluids into the layers below the Medina Group.

There are no oil or gas wells with the ¼-mile area of review.

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

There are no known faults or lineament with 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 Medina Group. The following factors indicate that this location has a low risk of induced seismicity:

1. Because the Medina Group is a depleted reservoir, the reservoir pressure will be low.
2. The Medina Group is approximately 4730 feet above the Precambrian basement rock 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.

3. There are no known faults within the 1-mile buffer zone, or any other structural geologic features of concern.
4. The only reported earthquake in Warren County was a 2.4 magnitude earthquake in 1995. This earthquake was approximately 25 miles away from the Smith-Ras 1 well location and is not considered a seismically active area.
5. The applicant has demonstrated that the Medina Group is geologically suitable for injection and that injection pressures will be below the fracture gradient of the formation.
6. 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 30,000 bbls/month.

### **Conclusions and Recommendations**

Based on the data reviewed, the location of the Smith-Ras 1 well is suitable for conversion from a production well to an underground injection well for disposal of wastewater from oil and gas activities.

The casing and cementing design of the proposed injection well must satisfy 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.