Demonstration of Non-Endangerment at the SECARB Anthropogenic Test Site

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Abstract

The Southeast Carbon Sequestration Partnership (SECARB) Anthropogenic Test became the first fully integrated carbon capture, transport, and storage project to successfully demonstrate non-endangerment and CO2 containment towards the closure of an underground injection control (UIC) permit utilizing monitoring and modelling approaches. Despite being a state-issued UIC Class V experimental well permit, this permit contained many UIC Class VI CO2 sequestration well elements. This paper will outline the permit structure and the steps taken to demonstrate non-endangerment for the first fully integrated Carbon Capture and Storage (CCS) project on a coal-fired power plant.

The SECARB Anthropogenic Test is a U.S. Department of Energy (DOE), Southern Company and Electric Power Research Institute (EPRI) funded, Southern States Energy Board (SSEB) managed, project designed to demonstrate deep underground injection and containment of anthropogenic CO2 sourced from a coal-fired electric generating unit at Plant Barry. From August 2012 to September 2014, a total of 114,104 metric tonnes of CO2 were captured and transported via a 12-mile pipeline from Alabama Power Company’s Plant Barry and successfully injected and stored in the upper Paluxy...
formation, a Lower Cretaceous sandstone unit, at the Denbury Onshore operated Citronelle Oil Field in Citronelle, Alabama.

One CO₂ injection well and two monitoring wells were drilled for this project. The initial Class V experimental technology UIC permit application was modified to include some Class VI permit requirements as suggested by the U.S. EPA to demonstrate protection of underground sources of drinking water (USDWs). These requirements included but were not limited to bottom to top cement coverage, a model-based Area of Review (AoR) determination with periodic updates, and a suite of Monitoring, Verification and Accounting (MVA) methods to track and monitor the plume migration and eventual leakage.

The UIC permit required extensive monitoring of the injected CO₂ with objectives to create and sustain well integrity, assure safe CO₂ injection operations, verify the location and migration of the CO₂ plume, and monitor for any CO₂ leakage. As such, a suite of technologies was applied and developed to demonstrate non-endangerment of underground sources of drinking water (USDW’s) and to ensure that CO₂ does not migrate out of the intended storage zone. This effort involved several levels of monitoring: surface monitoring, shallow groundwater monitoring, and deep reservoir monitoring via commercially available and experimental MVA methods.

Sufficient evidence was provided by the suite of monitoring efforts to indicate successful non-endangerment of USDWs at the Citronelle site. No shallow CO₂ release or buildup was detected using groundwater analysis, tracer detection, and soil CO₂ flux monitoring. Additionally, no evidence of gas saturation was observed within or above the confining zone, based on the results of cased hole time-lapse pulsed neutron capture logging. Cross-well seismic results show no negative velocity anomalies in or above the confining unit, which implies that there is no detectable leakage out of the injection zone. The associated models simulating the distribution of CO₂ through the injected geological layers agreed with observed monitoring data, demonstrating confinement within the injected zone and confirming that the Citronelle Dome structure forms an ideal CO₂ storage complex for the confinement of CO₂ in the subsurface.