EPA Greenhouse Gas Reporting Program: Subpart RR 2023 Monitoring Report
40 CFR 98.446(f)(12)
March 2024

Facility Name: Red Trail Richardton Ethanol Broom Creek Storage Facility #1 (RTE-10 Well)
UIC Class VI Storage Facility Permit: NDAC Order No. 31453–31455
GHGRP ID: 530977
MRV Plan Approval Number: 1001157-1
MRV Plan Approval Date: April 12, 2022

Summary of Monitoring Efforts

40 CFR 98.446(f)(12)(i) A narrative history of the monitoring efforts conducted over the previous calendar year, including a listing of all monitoring equipment that was operated, its period of operation, and any relevant tests or surveys that were conducted.

Red Trail Energy, LLC (RTE) continued to inject a highly concentrated CO_2 stream into the Broom Creek formation via well RTE-10 throughout 2023. RTE monitored and recorded operations data in accordance with the approved Monitoring, Reporting and Verification (MRV) Plan. Monitoring activities included periodic CO_2 stream sampling and analysis; continuous monitoring of injection rate, pressure, and volume; corrosion coupon testing; mechanical integrity testing and continuous recording of pressure and temperature (P/T) in the RTE-10 (injection) and RTE-10.2 (reservoir-monitoring) wells; soil gas and groundwater sampling and analysis; seismicity monitoring; and reviewing injection operations data to verify the CO_2 plume and associated pressure front in the storage reservoir are conforming to expectations.

Analysis of monitoring data collected within the Active Monitoring Area (AMA) in 2023 revealed no evidence of surface or subsurface leakage of the CO_2 stream. Alarms and shut-off devices were active and operating normally during this time, and no emergency shut-off triggering event occurred. Initial analysis of the monitoring data used to track the CO_2 plume and pressure front remains consistent with preliminary reservoir modeling expectations.

The following table summarizes the 2023 monitoring activities relative to proposed monitoring strategies listed in Table 4-1 of the approved MRV Plan.

Method (target area/structure)	Activity During Reporting Period	MRV Commitment - During Injection	Comments
CO2 Stream Analysis (capture)	Quarterly	Real-time	Quarterly sampling is consistent with Class VI injection permit requirements
Surface Pressure Gauges and Temperature Sensors (RTE-10, RTE-10.2, and flowline)	Monitored in real-time	Monitor in real-time	Completed consistent with MRV
Mass/Volume Flowmeters (RTE-10 and flowline)	Monitored in real-time	Monitor in real-time	Completed consistent with MRV
Downhole Pressure Gauges and Temperature Sensors (RTE-10 and RTE-10.2)	Monitored in real-time	Monitor in real-time	Completed consistent with MRV
DTS/DAS Fiber (RTE-10 and RTE 10.2, dedicated Fox Hills monitoring wells, and flowline)	Monitored in real-time	Monitor in real-time	Completed consistent with MRV
Visual Inspections (flowline)	Quarterly	Quarterly	Completed consistent with MRV
Corrosion Coupons (flowline)	Quarterly sampling and analysis for mass loss/pitting	Quarterly	Completed consistent with MRV
SCADA Automated Remote System (surface facilities)	Monitored in real-time	Monitor in real-time	Completed consistent with MRV
Soil Gas Analysis (AOR)	Quarterly	Three to four seasonal samples per year	Completed consistent with MRV
Water Analysis: Shallow Aquifers (AOR)	Samples from three groundwater wells were collected and analyzed in 2023	Once per year during years 1 through 3 and 5, then every 5 years thereafter	Completed consistent with MRV
Water Analysis: Lowest USDW (AOR)	Four rounds of soil gas samples were collected and analyzed in 2023	Once per year during years 1 through 3 and 5, then every 5 years thereafter	Completed consistent with MRV
Cement Bond Logs (RTE-10 and RTE-10.2)	NA	As needed	Not required in this reporting period
Annular Pressure Test (RTE-10 and RTE-10.2)	NA	Perform during workovers but not more than once every 5 years	Not required in this reporting period
Pulsed-Neutron Logs (PNL) (RTE-10 and RTE-10.2)	PNL was conducted in RTE-10 and RTE-10.2 wells in 2023	Every 5 years in RTE-10.2 and as needed in RTE-10	Completed consistent with MRV
Ultrasonic Imager Logs (RTE-10 and RTE-10.2)	NA	Perform during workovers but not more than once every 5 years	Not required in this reporting period
Pressure Falloff Test (RTE-10)	NA	Every 5 years	Not required in this reporting period
Time-Lapsed Seismic Surveys (AOR)	NA - due every 5 years	Every 5 years	Not required in this reporting period
Surface Seismometers (AOR)	Real-time	Real-time	Completed consistent with MRV
InSAR (AOR)	NA	Real-time, if feasible	Deemed infeasible
Gravity Surveys (AOR)	NA	TBD – repeat survey at least once, if feasible	Deemed infeasible

Updates to the Monitoring Program

40 CFR 98.446(f)(12)(ii) A description of any changes to the monitoring program that you concluded were not material changes warranting submission of a revised MRV plan under § 98.448(d).

Section 6.0 of the approved MRV Plan states that mass of CO_2 injected (CO_{2I}) will be measured using a volumetric flow meter and reported using Equation RR-5. RTE installed and currently operates a mass flow meter (not a volumetric flow meter) near the RTE-10 wellhead to measure the flow of CO_2 injected into the storage reservoir. Therefore, RTE will continue to follow the requirements of 40 CFR 98.443(c)(1) to calculate the annual mass of CO_2 injected using Equation RR-4.

Table 4-1 of the approved MRV Plan states that CO_2 stream composition analysis will be conducted in real time and section 8.0 of the MRV states that "quarterly CO2 concentration will be reported from near-continuous measurement." RTE has sampled and analyzed the CO_2 stream quarterly since the beginning of injection. Quarterly analysis has shown consistently high purity of the CO_2 stream (99.9+% v/v) and RTE believes that there is little potential for CO_2 concentration variation due to (1) the captured source of CO_2 is already high purity and (2) the additional purification achieved through the CO_2 compression and dehydration process. 40 CFR 146.90(a) requires that testing and monitoring include analysis of the carbon dioxide stream with sufficient frequency to yield data representative of its chemical and physical characteristics. Similarly, North Dakota Department of Mineral Resources (ND DMR), under North Dakota Administrative Code 43-05-01-11.4(1)(a), requires analysis of the carbon dioxide stream in compliance with applicable analytical methods and standards generally accepted by industry and with sufficient frequency to yield data representative of its chemical and physical characteristics. RTE believes that quarterly sampling is sufficient to meet the EPA and ND DMR requirements for characterizing the CO_2 stream that is being sequestered.

Monitoring Anomalies and Resolution

40 CFR 98.446(f)(12)(iii) A narrative history of any monitoring anomalies that were detected in the previous calendar year and how they were investigated and resolved.

Scheduled plant shutdowns and routine preventative maintenance, as well as unexpected mechanical and electrical outages, caused periodic disruptions of CO_2 injection activity. During these periods, annular pressure increased as the injection pressure decreased. Once injection resumed, annular pressure quickly normalized. RTE completed installation of a seal pot system (SPS) with nitrogen cushion on November 16, 2023, to maintain a positive annulus pressure of approximately 100 psi on the RTE-10 well.

Three of the seismometer stations became nonoperational in 2023. Station ST03 became nonoperational in January 2023 when RTE discovered the cables to the solar panel and global positional system (GPS) were chewed through by animals. ST04 became flooded in the spring of 2023, which caused the battery and digitizer to fail. ST08 continued to fail

due to electrical malfunction. The stations are scheduled to be repaired as conditions allow in spring of 2024.

Leak Monitoring Results

40 CFR 98.446(f)(12)(iv) A description of any surface leakages of CO_2, including a discussion of all methodologies and technologies involved in detecting and quantifying the surface leakages and any assumptions and uncertainties involved in calculating the amount of CO_2 emitted.

Surface components of the injection system, including the aboveground portions of the CO_2 transport flowline and wellhead, were monitored throughout the year per the approved MRV Plan. Routine visual inspections were conducted along the flow line and DAS/DTS fiber data were continuously monitored for anomalies by system operators. No surface CO_2 leaks were observed or detected during the initial reporting period. Corrosion coupons were also sampled quarterly during this reporting period and no loss of mass or pitting were observed.

Quarterly CO_2 stream sample analysis indicates that RTE is consistently injecting a high purity CO_2 stream of over 99.9% v/v.

Three groundwater monitoring wells were sampled on August 8, 2023, and analysis results were within expected baseline ranges. Minor variations observed were not indicative of out-of-zone migration of CO_2.

A total of four rounds of soil gas samples were collected in 2023: February 16, April 26, August 8, and November 27. Samples were collected at all three depths associated with SS01. Two samples were collected at the 4-ft depth at SS02 in February and April. During both sampling events at SS02, the other two depths were inundated with water, precluding sample collection at 9 ft and 14.5 ft. Additional efforts to collect samples from SS02 were made in August and November, but all depths were inundated with water. A third soil gas profile station, SS03, was installed on September 20, 2023, to replace SS02. Sample analysis shows that overall soil gas measurements were consistent with expected seasonal values and no evidence of near-surface CO_2 leaks were observed.

Throughout 2023, RTE continuously monitored the temperature profile of the RTE-10 and RTE-10.2 wells with fiber-optic DTS cable installed outside the long-string casing. The recorded temperature profiles illustrated some seasonal variation between the surface and the storage reservoir. Clearly defined warming trends on the DTS data were correlated with operational changes (e.g., unplanned electrical outages or planned shutdowns) and no evidence of CO_2 leakage from the storage reservoir was observed.

RTE initially verified external mechanical integrity of the RTE-10 and RTE-10.2 wellbores with an ultrasonic imaging tool (USIT) and internal mechanical integrity in the RTE-10 with annulus pressure tests prior to injection. In June 2023, RTE acquired a Pulsed Neutron Log (PNL) in the RTE-10 and RTE-10.2, which confirmed no vertical movement

of CO_2 in or behind the well casing and/or beyond the storage reservoir in either well. In addition, RTE performed an annulus pressure test in the RTE-10.2 in June 2023.

Casing-conveyed tandem pressure/temperature (P/T) gauges in the RTE-10 and RTE-10.2 wells continued to monitor the injection response of the storage reservoir. The observed pressures continue to conform to modeled expectations. In addition, temperature measurements collected from both the P/T gauges and DTS fiber-optic cable in the RTE-10.2 well show no indications of CO_2 plume arrival, thereby supporting the interpretation that the CO_2 plume has not yet reached the RTE-10.2 monitoring well.

RTE continued to monitor for seismicity with a surface array of seismometer stations. Analysis of the data showed a single anomalous noise event on August 29, 2023, but this noise was determined to not have been caused by an earthquake. Inspection of the U.S. Geological Survey (USGS) Advanced National Seismic System (ANSS) confirmed no earthquake events were detected in the state of North Dakota during the time period the anomalous event occurred.