CLASS VI INJECTION WELL:
QUALITY ASSURANCE AND SURVEILLANCE PLAN

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Prepared by:

BKVerde, LLC

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TITLE AND APPROVAL SHEET

This Quality Assurance and Surveillance Plan (QASP) is approved for use and implementation at Donaldsonville Sequestration. The signatures below denote the approval of this document and intent to abide by the procedures outlined within it.

Name Title	Date
Name Title	Date
Name Title	Date

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DISTRIBUTION LIST

The following project participants will receive the completed Quality Assurance and Surveillance Plan (QASP) and all future updates for the duration of the project.

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1. PROJECT MANAGEMENT

1.1 Project/Task Organization

1.1.1 Key Individuals and Responsibilities

The project, led by BKVerde, LLC. (BKVerde), includes participation from several subcontractors. The testing and monitoring activities responsibilities will be shared between BKVerde and their designated subcontractors and the program will be broken in six subcategories:

1. Groundwater Fluid Sampling
2. Well Logging
3. Mechanical Integrity Testing (MIT)
4. Pressure/Temperature Monitoring
5. Carbon Dioxide (CO_2) Stream Analysis
6. Geophysical Monitoring

1.1.2 Independence from Project QA Manager and Data Gathering

Most of the physical samples collected, and data gathered as part of the monitoring, reporting, and verification (MRV) program will be analyzed and processed. An independent third party may be used to witness the collection of data and physical samples a required by regulatory statutes.

1.1.3 QA Project Plan Responsibility

BKVerde will be responsible for maintaining and distributing the official, approved Quality Assurance and Surveillance Plan (QASP). BKVerde will periodically review this QASP and consult with U.S. Environmental Protection Agency (EPA) if/when changes to the plan are warranted.

1.2 Problem Definition/Background

1.2.1 Reasoning

The BKVerde Donaldsonville Site Sequestration MRV program has operational monitoring, verification, and environmental monitoring components. Operational monitoring is used to ensure safety with the procedures associated with fluid injection, the response of the injection interval, and the movement of the CO_2 plume. Key monitoring parameters include the pressure of injection well tubing and annulus and injection interval geochemistry. Other monitoring

parameters include injection rate, total mass and volume injected, injection well temperature profile, and pressure front tracking. The verification component will provide information to evaluate if leakage of CO_2 through the confining zone is occurring. This includes pulsed neutron, pressure, and temperature monitoring. The environmental monitoring components will determine if the injectate may be potentially released into the shallow subsurface. This monitoring includes pulsed neutron logging and groundwater monitoring.

The primary goal of the Donaldsonville Sequestration MVA program is to demonstrate that project activities are protective of human health and the environment. To help achieve this goal, this QASP was developed to establish the quality standards of the testing and monitoring program to meet the requirements of the EPA's Underground Injection Control (UIC) Program for Class VI wells.

1.2.2 Reasons for Initiating the Project

The goal of the Ciel- Donaldsonville Site Sequestration is to inject and retain CO_2 for permanent geologic sequestration. To demonstrate that this can be done safely, a rigorous MVA plan is proposed to demonstrate that the injected CO_2 is retained within the intended storage interval.

1.2.3 Regulatory Information, Applicable Criteria, Action Limits

The Class VI Rule requires owners or operators of Class VI wells to perform several types of activities during the lifetime of the project to demonstrate the injection wells maintain their mechanical integrity, fluid migration, the extent of pressure elevation are within the limits described in the permit application, and that underground sources of drinking water (USDW) are not endangered. These monitoring activities include mechanical integrity tests (MITs), injection well testing during operation, monitoring of groundwater quality, and tracking of the CO_2 plume and associated pressure front. This document details both the measurements that will be taken as well as the steps to demonstrate the quality can be used with confidence in making decisions during the life of the project.

1.3 Project/Task Description

1.3.1 Summary of Work to be Performed.

Table 1 describes the testing and monitoring activities, reasoning, responsible parties, locations, methods, techniques, and purpose. Table 2 and Table 3 summarize the instrumentation and geophysical surveys, respectively.

The Testing and Monitoring Plan (**Attachment D**) contains the schedule for the activities listed in the tables mentioned above.

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Table 1: Summary of Testing and Monitoring

Activity	Location(s)	Method	Analytical Technique	Lab/Custody	Purpose
CO_2 stream analysis	After compression and processing and before injection wellheads	Direct sampling	Chemical analysis	EPA certified laboratory	Monitor injectate
Injection rate and volume	Before wellhead	Flow meter	Direct measurement	Not applicable	Monitor injectate rate and volume
Injection temperature/ pressure	Before wellhead	Temperature/pressure gauge	Direct measurement	Not applicable	Monitor injectate temperature, pressure, and well integrity
Annular pressure	Wellhead	Pressure gauge	Direct measurement	Not applicable	Monitor annular pressure and well integrity
Downhole pressure/ temperature	Injection and Monitoring wells: injection formation	Downhole gauge	Direct measurement	Not applicable	Monitor injection interval pressure/injection temperature/well integrity
Corrosion monitoring	After compression	Coupon	Physical analysis	Not applicable	Monitor well integrity
Mechanical integrity	Injection and Monitoring wells	Temperature, acoustic, oxygen activation	Indirect Physical analysis	Not applicable	Monitor well integrity
Groundwater quality	Monitoring wells: Mississippi River Alluvial Aquifer and Miocene Sandstone	Direct sampling	Chemical analysis	EPA certified laboratory	Monitor for CO_2 leakage
CO_2 saturation	Injection and monitoring wells: injection zone, primary confining layer, and first permeable layer above primary confining layer	Pulsed neutron log and Vertical Seismic Profile (VSP)	Indirect measurement	Not applicable	Monitor CO_2 plume migration

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Table 2: Instrumentation Summary

Monitoring Location	Instrument Type	Monitoring Target (Formation or Other)	Data Collection Location(s)	Purpose
CO_2 facility	Pressure/temperature gauge	CO_2 stream	Facility, after compression	Monitor the operation, equipment and permit parameters
	Flowmeter	CO_2 stream	Facility, after compression	Monitor the operation, equipment and permit parameters
Monitoring wells	Pressure gauge	Miocene sand formations	Wellbore	1st permeable zone pressure monitoring
	Pulsed neutron log		Logged interval total depth (TD) to surface casing	Well integrity and CO_2 plume migration
	Distributed acoustic sensing (DAS)		Distributed acoustic	CO_2 plume migration
Injection wells	Pressure/temperature gauge	Injection	Wellhead	Monitor the operation, equipment and permit parameters
	Pressure/temperature gauge	Injection well annular pressure	Wellhead	Monitor the operation, equipment and permit parameters, integrity of casing, tubing and packer
	Fluid level acoustic sensor	Injection well annular fluid level	Wellhead	Monitor equipment, integrity of casing, tubing and packer
	Pressure/temperature gauge	64 Zone	One point location, near injection packer	Monitor the operation, equipment, and permit parameters
	DAS	All intervals	Distributed acoustic	Monitor the operation, equipment, and permit parameters; well integrity

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Table 3: Geophysical Surveys Summary

Monitoring Activity	Tool or Survey Description	Monitoring Location	Monitoring Target (Formation or Other)	Purpose
Well logs	Triple combo	New injection and monitoring wells	Surface to TD (total depth)	Injection interval and fluid properties, correlations
	Pulsed neutron log	Injection and monitoring wells	Injection interval, primary confining layer, and first permeable layer above primary confining layer	CO_2 plume saturation
	Cement bond log/ultrasonic casing cement inspection log	Injection and monitoring wells	All casing strings	Well integrity

1.3.2 Geographic Locations

The planned location of injection and monitoring wells are provided in Table 4 and are shown in **Figure 1.**

Table 4: Location of Injector and Monitoring Wells (NAD27: LA South Zone)

Injector Wells	**X**	**Y**
Ciel No. 1	**2,114,245.33'**	**511,857.41'**
Monitoring Wells		
Soleil No. 1	2,115,602.75'	511,781.60'
C. Schexnaydar et al. No. 1	2,114,132.79'	513,912.09'
Lune No. 1	2,114,195.78'	511,864.05'
USDW1	2,114,146.22'	511,870.68'
USDW2	2,114,139.76'	513,961.60'
GM1	2,115,765.31'	511,917.89'
GM2	2,114,216.08'	513,797.04'
GM3	2,114,413.90'	511,986.19'

1.3.3 Resource and Time Constraints

No resource or time constraints have been identified during the pre-construction phase.

1.4 Quality Objectives and Criteria

1.4.1 Performance/Measurement Criteria

The overall objective of quality assurance for monitoring is to develop and implement procedures to provide results that meet the site characterization and non-endangerment requirements set for the Class VI permit.

Table 5 summarizes parameters for analytical and field monitoring of groundwater quality. Groundwater monitoring will be conducted during the pre-injection, injection, and post-injection phases of the project. Monitoring wells will be used to gather water-quality samples and pressure data. Table 6 and

Table 7 summarize the analytical parameters for CO_2 stream monitoring and corrosion coupon assessment. The list of analytes may be reassessed periodically and adjusted to include or exclude compounds based on their effectiveness to the overall monitoring program goals. **Table 8** summarizes the specifications for field gauges.

Table 9 summarizes the typical outcome of testing and monitoring results, including activity levels of each parameter, project action limits, detection limits, and anticipated readings. This will serve as a reference for data review, validation, and taking corrective actions.

Key testing and monitoring areas include

- Groundwater fluid sampling
    - aqueous chemical concentrations
- Well logging
    - pulsed neutron (PNL)
- Mechanical integrity testing (MIT)
    - pressure, temperature, and fiber-optic DAS
    - pulsed neutron
    - cement and casing evaluation logs
- Pressure/temperature monitoring
    - pressure/temperature from in-situ gauges
    - pressure/temperature from surface gauges
- CO_2 stream analysis
    - carbon dioxide (CO_2, % v/v)
    - moisture (H_2O, ppm v/v)
    - oxygen (O_2, ppm v/v)
    - nitrogen (N_2, ppm v/v)
    - argon (Ar, ppm v/v)
    - hydrogen (H_2, ppm v/v)
    - carbon monoxide (CO, ppm v/v)
    - nitrogen oxides (NOx, ppm v/v)
    - ammonia (NH_3, ppm v/v)
    - total hydrocarbons (THC, ppm v/v as CH_4)
    - methane (CH_4, ppm v/v)
    - aromatic hydrocarbons (ppm v/v)
    - total sulfur (TS, ppm v/v)
    - sulfur dioxide (SO_2, ppm v/v)

  - hydrogen sulfide (H_2S, ppm v/v)
  - isotope δ13C (per mil, ‰)

- Geophysical Monitoring
    - *Passive seismic monitoring*

- A passive seismic monitoring network using monitoring stations installed on the surface will be used to detect seismic events over magnitude 1.0 in the AoR. The action limit for seismic events is listed in Table 9.

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Table 5: Summary of Analytical and Field Parameters for Fluid Samples in Mississippi River Alluvial Aquifer and Miocene Sand Formations

Parameters	Analytical Methods[1]	Detection Limit/Range[2]	Typical Precisions (Laboratory Control Limit) [2]	Typical Quality Control (QC) Requirements
Cations/metals (aluminum, barium, manganese, arsenic, cadmium, chromium, copper, lead, selenium, titanium, zinc)	EPA Method 200.7/200.8 or similar by inductively coupled plasma optical emission spectroscopy (ICP-OES) or mass spectroscopy (ICP-MS) or EPA Method 6010B or EPA Method 6020	0.01 to 2 mg/L (analyte, dilution, and matrix dependent; scanning or selective ion monitoring mode dependent)	85–115%	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Cations/metals (calcium, sodium, potassium, iron, magnesium, silica)				Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Anions (chloride, sulfate, sulfide, bromide, fluoride, nitrate)	EPA Method 300.0/300.1 or similar by ion chromatography; SM 4500 for sulfide by colorimetry	0.1 to 1 mg/L for 300.0/300.1; 0.05 mg/L for SM 4500 (sulfide) (analyte, dilution, and matrix dependent)	90–110%; 70–130% for sulfide	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Dissolved CO_2	Coulometric titration ASTM D513-11 or RSK-175M by gas chromatography/flame ionization detector (GC/FID)	5 µg/L	80–120%	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Dissolved CH_4	RSK-175M by GC/FID	1 µg/L	80–120%	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Dissolved O_2	SM 4500 OG by membrane electrode method or RSK-175M by GC/FID	0.01 mg/L	80–120%	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Dissolved H_2S (field)	Field test kit	Dependent on selected field test kit	Dependent on selected field test kit	Dependent on selected field test kit
Total dissolved solids	Gravimetry; APHA 2540 C or EPA Method 160.1/SM 2540 C by gravimetry	1 mg/L	84–108%	Balance calibration, duplicate analysis, QC check standards

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Parameters	Analytical Methods[1]	Detection Limit/Range[2]	Typical Precisions (Laboratory Control Limit) [2]	Typical Quality Control (QC) Requirements
Alkalinity	APHA 2320B or SM 2320 B/EPA Method 310.1 by titration	5 mg/L	80–120%	Daily calibration of pH, blanks, duplicates, QC check standards
pH (field)	EPA Method 150.1/SM4500-H+B electrometrically	Dependent on field meter selected	Dependent on field meter selected	User calibration per manufacturer recommendation, QC check standards
Specific conductance (field)	APHA 2510 or EPA Method 120.1 by conductivity meter	Dependent on field meter selected	Dependent on field meter selected	User calibration per manufacturer recommendation, QC check standards
Temperature (field)	Thermocouple	Dependent on field meter selected	Dependent on field meter selected	Factory calibration
Hardness	SM 2340C by titration	7.05 mg/L	Dependent on selected laboratory	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Turbidity	SM 2130B by nephelometry	0.05 NTU	90–110%	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Specific gravity	SM 2710F by calculation	0.05	Dependent on selected laboratory	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Water density	SM 2710F by calculation	0.05g/cm^3	Dependent on selected laboratory	Daily calibration; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Dissolved inorganic carbon isotopes ($\delta^{13}C$)	Isotope ratio mass spectrometry	Dependent on selected laboratory	Dependent on selected laboratory	Dependent on selected laboratory

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.
Note 2: Detection limits and precision (laboratory control limits) are typical for these analytical methods and were provided by Eurofins Environment Testing.
Note 3: ISBT (International Society of Beverage Technologists)
Note 4: NACE (National Association of Corrosion Engineers)
Note 5: ASTM (American Society for Testing Materials)

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Table 6: Summary of Analytical Parameters for CO_2 Stream

Parameters	Analytical Methods[1]	Detection Limit/Range	Typical Precisions	QC Requirements[2]
Carbon dioxide (CO_2)	ASTM D1945-14 (2019). Gas Chromatography (GC) with thermal conductivity detector (TCD). ISBT 2.0 Caustic absorption Zahm-Nagel ALI method SAM 4.1 subtraction method (GC/DID) GC/TCD	0.01–20 mol%	0.01–0.10% repeatability and 0.02–0.15% duplicability between 0 and 20 mol%	Routine calibrations per ASTM standards; blanks, duplicates, QC check standards by the contracted laboratory
Moisture (H_2O)	ISBT 3.0 (FTIR). electrometric moisture analyzer.	0–100 ppm v/v	5–10% at 10 ppm v/v	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Oxygen (O_2)	ASTM D1945-14 (2019). ISBT 4.0 (GC/DID. GC/TCD.	0.01–20 mol%	0.01–0.10% repeatability and 0.02–0.15% reproducibility between 0 and 20 mol%	Routine calibrations per ASTM standards; blanks, duplicates, QC check standards by the contracted laboratory
Nitrogen (N_2)	ASTM D1945-14 (2019). ISBT 4.0 (GC/DID). GC/TCD.	0.01–100 mol%	0.01–0.10% repeatability and 0.02–0.15% reproducibility between 0 and 100 mol%	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Argon (Ar)	ISBT 4.0. GC with discharge ionization detector (DID).	0–100 ppm v/v	5–10% at 30 ppm v/v	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Hydrogen (H_2)	ASTM D1945-14 (2019). GC/TCD.	0.01—10 mol%.	0.01–0.08% repeatability and 0.02–0.12% reproducibility between 0 and 10 mol%	Routine calibrations per ASTM standards; blanks, duplicates, QC check standards by the contracted laboratory
Carbon monoxide (CO)	ISBT 5.0. GC Colorimetric with pulsed discharge ionization detector (PDID). ISBT 4.0 (GC/DID)	0–50 ppm v/v	5–10% at 10 ppm v/v	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Nitrogen oxides (NO_x)	ISBT 7.0. colorimetric tubes to detect NO and NO_2.	0.2–10 ppm v/v	5–30% of full scale	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Ammonia (NH_3)	ISBT 6.0. ammonia-specific colorimetric detector tube.	0.5–5 ppm v/v	5–30% of full scale	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory

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Parameters	Analytical Methods[1]	Detection Limit/Range	Typical Precisions	QC Requirements[2]
Total hydrocarbons (THCs)	ISBT 10.0. THA GC with flame ionization detector (FID). ISBT 10.1 (GC/AFAID).	0–100 ppm v/v	1–2% at 20 ppm v/v	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Methane (CH_4)	ASTM D1945-14 (2019). GC/TCD.	0–100 mol%	0.01–0.10% repeatability and 0.02–0.15% reproducibility between 0 and 100 mol%	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Aromatic hydrocarbons	ISBT 12.0. GC with photoionization detector (PID). 0–5 ppm	0–0.20 ppm	Not applicable	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards, and matrix spikes at 10% or greater frequency
Total sulfur	ISBT 13.0. GC with sulfur chemiluminescent detector (SCD).	0–5 ppm v/v	5–10% at 0.10 ppm	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Sulfur dioxide (SO_2)	ISBT 14.0. GC/SCD.	0–5 ppm v/v	5–10% at 0.10 ppm v/v	Routine calibrations per ISBT standards; blanks, duplicates, QC check standards by the contracted laboratory
Hydrogen sulfide (H_2S)	ASTM D1945-14 (2019), GC/TCD. ISBT 14.0 (GC/SCD)	0.3–30 mol%	0.04–0.10% repeatability and 0.07–0.15% reproducibility between 0.3 and 30 mol%	Routine calibrations per ASTM standards; blanks, duplicates, QC check standards by the contracted laboratory
Ethanol EtOH	ISBT 11.0 (GC/FID). EPA Method 8260B. GC with mass spectroscopy (MS).	25–500 ppbv/v	10–13% between 25 and 500 ppb v/v	Routine calibrations per EPA recommendations; blanks, duplicates, QC check standards by the contracted laboratory
^{13}C isotope	USGS techniques and methods 5-D4. GC with dual-inlet isotope ratio mass spectrometry (GC-IRMS)	–50 to 3‰	±0.1‰	Quality assurance information to be provided by the contracted laboratory

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.
Note 2: Key elements for quality assurance (QA) include: employing knowledgeable and responsible personnel to perform sample analysis, documentation, and reporting, establishing a QA team with experienced and dedicated reviewers to review results, and appropriate maintenance and calibration of equipment involved.

Table 7: Summary of Analytical Parameters for Corrosion Coupons

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Parameters	Analytical Methods[1]	Detection Limit/Range	Typical Precisions	QC Requirements
Mass	NACE RP0775-2005	0.005 mg	± 2%	Annual calibration of scale
Thickness	NACE RP0775-2005	0.001 mm	± 0.005 mm	Factory calibration

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.

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Table 8: Summary of Measurement Parameters for Field Gauges

Parameters	Methods	Detection Limit/Range	Typical Precisions	QC Requirements
Booster pump discharge pressure	ANSI Z540-1-1994	± 0.001 psi / 0–3000 psi	± 0.01 psi	Annual calibration of scale
Injection tubing temperature	ANSI Z540-1-1994	± 0.001°F / 0–500°F	± 0.01°F	Annual calibration of scale
Annulus pressure	ANSI Z540-1-1994	± 0.001 psi / 0–3000 psi	± 0.01 psi	Annual calibration of scale
Injection tubing pressure	ANSI Z540-1-1994	± 0.001 psi / 0–3000 psi	± 0.01 psi	Annual calibration of scale
Wellhead pressure	ANSI Z540-1-1994	± 0.001 psi / 0–3000 psi	± 0.01 psi	Annual calibration of scale
Downhole temperature	ANSI Z540-1-1994	± 0.001°F / 0–500°F	± 0.01°F	Annual calibration of scale
Injection mass flow rate	ANSI/ASHRAE Standard 41.10-2020	0.1% of flow rate	± 0.01 lb/hr	Annual calibration of scale

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Table 9: Actionable Testing and Monitoring Outputs

Activity or Parameter	Project Action Limit	Anticipated Reading
Seismic activity	Action taken when there is a detected seismic event greater than M3.5 within 2 miles of an injection well	No seismic event greater than M3.5 within 2 miles of the injection well
Mechanical integrity (pulsed neutron log)	Action taken when pulsed neutron measurements indicate CO_2 outside of expected range / zone	No measurement changes from baseline caused by CO_2 in annular space, above injection zone, or in formation above confining zone
Surface pressure / temperature	Action will be taken when pressures and temperatures are well outside of modeled / expected range	Pressures/temperatures within proposed operational ranges
Downhole pressure / temperature	Action will be taken when pressures and temperatures are well outside of modeled / expected range	Pressures/temperatures within proposed operational ranges
Groundwater quality	Action will be taken when changes in fluid constituent concentrations indicate movement of CO_2 or brines into or above the confining zone	Observed and baseline hydrochemical / physical parameter patterns within statistically
Above-confining-zone pressure	Action will be taken when pressures are well outside of modeled / expected range	Pressures within proposed operational range
Injection well annular volume	Action will be taken when annular volume is well outside of modeled / expected range	No expected annular volume change not related to temperature or tubing pressure

1.4.2 Precision

Assessment of analytical precision can be made using field-generated duplicate samples as well as laboratory-generated duplicate samples.

1.4.3 Accuracy and Bias

Data accuracy and bias will be assessed by analyzing standards of known concentrations and measuring its actual recovery in analysis versus the expected recovery. Laboratory assessment of analytical accuracy and bias will be the responsibility of the individual laboratories per their standard operating procedures (SOPs) and analytical methodologies and will be evaluated using laboratory control samples, matrix spikes, and surrogates (where applicable). Assessment of bias in the field can be ascertained through collection of field blanks. Field blanks will be collected no less than one per sampling event to screen for sample bottle contamination. For direct pressure or logging measurements, there is no potential for bias with the instruments used to collect data.

1.4.4 Representativeness

Data representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The sampling network has been designed to provide data representative of site conditions. For analytical results of individual groundwater samples, representativeness will be estimated by ion and mass balances. Ion balances with ±10% error or less will be considered valid. Mass balance assessment will be used in cases where the ion balance is greater than ±10% to help determine the source of error. For a sample and its duplicate, if the relative percent difference is greater than 10%, the sample may be considered non-representative.

1.4.5 Completeness

Data completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. It is anticipated that data completeness of 90% for liquid sampling will be acceptable to meet monitoring goals. For direct pressure and temperature measurements, it is expected that data will be recorded no less than 90% of the time.

1.4.6 Comparability

Data comparability expresses the confidence with which one data set can be compared to another. The data sets to be generated by this project will be comparable to future data sets because of the use of standard sample collection and analytical methods and the level of QA/QC effort. If historical groundwater quality data becomes available from other sources, their applicability to the project and level of quality will be assessed prior to use with data gathered on this project. Direct pressure, temperature, and logging measurements will be directly comparable to previously obtained data.

1.4.7 Method Sensitivity

Table 10 through 15 provide additional details on gauge specifications and sensitivities. Values may change depending on vendor, service provider, and specific item chosen at time of operation.

Table 10: Pressure and Temperature—Downhole Gauge Specifications.

Parameter	Value
Calibrated working pressure range	Atmospheric to 10,000 psi
Initial pressure accuracy	<± 2 psi over full scale
Pressure resolution	0.005 psi at 1-s sample rate
Pressure drift stability	<± 1 psi per year over full scale

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Calibrated working temperature range	77–266°F
Initial temperature accuracy	<± 0.9°F per ±0.27 °F
Temperature resolution	0.009 °F at 1-s sample rate
Temperature drift stability	<±0.1 °F per year at 302°F
Maximum temperature	302°F

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Table 11: Representative Logging Tool Specifications

Parameter	Pulsed Neutron Log	Cement Bond Log	Ultrasonic Casing / Cement Inspection
Logging speed	Up to 3,600 ft/hr	Up to 3,600 ft/hr	400 to 4,500 ft/hr
Vertical resolution	15 in	3 ft	0.6 to 6.0 in
Investigation	Formation fluid saturation, annular space, mechanical integrity	Cement bond (cement-casing, cement-formation)	Casing and cement (cement-casing, cement-formation and annular coverage)
Temperature rating	350°F	350°F	350°F
Pressure rating	15,000 psi	20,000 psi	20,000 psi

Table 12: Pressure Field Gauge—Injection Tubing Pressure

Parameter	Value
Calibrated working pressure range	0 to 3,000 psi
Initial pressure accuracy	< 0.04375%
Pressure resolution	0.001 psi
Pressure drift stability	To be determined after first year

Table 13: Pressure Field Gauge—Annulus Pressure

Parameter	Value
Calibrated working pressure range	0 to 3000 psi
Initial pressure accuracy	< 0.04375%
Pressure resolution	0.001 psi
Pressure drift stability	To be determined after first year

Table 14: Temperature Field Gauge—Injection Tubing Temperature

Parameter	Value
Calibrated working temperature range	0 to 500 °F
Initial temperature accuracy	< 0.0055%
Temperature resolution	0.001 °F
Temperature drift stability	To be determined after first year

Table 15: Mass Flow Rate Field Gauge—CO2 Mass Flow Rate

Parameter	Value
Calibrated working flow rate range	50,522 to 303,133 lb/hr
Initial mass flow rate accuracy	< 0.5%
Mass flow rate resolution	0.0001 lb/hr
Mass flow rate drift stability	To be determined after first year

1.5 Special Training/Certifications

1.5.1 Specialized Training and Certifications

The geophysical survey equipment and wireline logging tools will be operated by trained, qualified, and certified personnel, according to the service company that provides the equipment. The subsequent data will be processed and analyzed according to industry standards. No specialized certifications are required for personnel conducting groundwater sampling, but field sampling will be conducted by personnel trained to understand and follow the project specific sampling procedures. Upon request, BKVerde will provide the agency with the laboratory SOPs developed for the specific parameter using the appropriate standard method. Each laboratory technician conducting the analysis on the samples will be trained on the SOP developed for each standard method. BKVerde will include the technician's training certification with the annual report.

1.5.2 Training Provider and Responsibility

Training for personnel will be provided by the operator or by the subcontractor responsible for the data collection activity.

1.6 Documentation and Records

1.6.1 Report Format and Package Information

BKVerde will submit an annual report containing the required project data, including testing and monitoring information as specified by the Class VI permit. Data will be provided in electronic or other formats as required by the UIC Program Director.

1.6.2 Other Project Documents, Records, and Electronic Files

Other documents, records, and electronic files such as well logs, test results, or other data will be provided as required by the UIC Program Director.

1.6.3 Data Storage and Duration

BKVerde or a designated contractor will maintain the required project data as specified in the Class VI permit.

1.6.4 QASP Distribution Responsibility

The BKVerde Project Manager will be responsible for ensuring that those included on the distribution list will receive the most current copy of the approved QASP.

2. DATA GENERATION AND ACQUISITION

2.1 Sampling Process Design

Discussion in this section is focused on groundwater and fluid sampling and does not address monitoring methods that do not gather physical samples (e.g., logging, seismic monitoring, and pressure/temperature monitoring). During the pre-injection and injection phases, groundwater sampling is planned to include an extensive set of chemical parameters to establish aqueous geochemical baseline data. Parameters will include selected constituents that (1) have primary and secondary EPA drinking water maximum contaminant levels, (2) are the most responsive to interaction with CO_2 or brine, (3) are needed for quality control, and (4) may be needed for geochemical modeling. The full set of parameters is presented in Table 5. After a sufficient baseline is established, monitoring scope may shift to a subset of indicator parameters that are (1) the most responsive to interaction with CO_2 or brine and (2) are needed for quality control.

Implementation of a reduced set of parameters would be done in consultation with EPA. Isotopic analyses will be performed on baseline samples to the degree that the information helps verify a condition or establish an understanding of non-project related variations. For non-baseline samples, isotopic analyses may be reduced in the monitoring wells if a review of the historical project results or other data indicate that further sampling for isotopes is not needed. During a period when a reduced set of analytes is used, if statistically significant trends are observed that are the result of unintended CO_2 or brine migration, then the analytical list would be expanded to the full set of monitoring parameters. The groundwater samples will be analyzed using a laboratory meeting the requirements under the EPA National Environmental Laboratory Accreditation Program (NELAP). The other samples will be analyzed by the operator or a third-party laboratory. Dissolved CO_2 will be analyzed by methods consistent with Test Method B of ASTM D 513-11 or equivalent. Isotopic analysis will be conducted using established methods.

2.1.1 Design Strategy

2.1.1.1 CO_2 Stream Monitoring Strategy

The primary purpose of analyzing the CO_2 stream is to evaluate the potential interactions of CO_2 and/or other constituents of the injectate with formation solids and fluids. This analysis can also identify (or rule out) potential interactions with well materials. Establishing the chemical composition of the injectate also supports the determination of whether the injectate meets the qualifications of hazardous waste under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6901 et seq. (1976), and/or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601 et seq. (1980). Additionally, monitoring the chemical and physical characteristics of the CO_2 (e.g., isotopic signature, other constituents) may help distinguish the injectate from the native fluids and gases if unintended leakage from the storage interval occurred. Injectate monitoring is required at a sufficient frequency to detect changes to any physical and chemical properties that may result in a deviation from the permitted specifications.

Calibration of transmitters used to monitor pressures, temperatures, and flow rates of CO_2 into the injection well shall be conducted annually. Reports will contain test equipment used to calibrate the transmitters, including test equipment manufacturers, model and serial numbers, calibration dates, and expiration dates.

2.1.1.2 Corrosion Monitoring Strategy

Corrosion coupon analyses will be conducted quarterly to aid in demonstrating the mechanical integrity of the equipment in contact with the CO_2. Coupons shall be sent quarterly to a qualified company for analysis and an analysis conducted in accordance with NACE Standard RP-0775 (or similar) to determine and document corrosion wear rates based on mass loss.

2.1.1.3 Groundwater (Above Confining Zone) Monitoring Strategy

BKVerde will monitor groundwater quality for potential geochemical changes above the confining zone during the operation period to meet the requirements of 40 CFR 146.90(d).

Monitoring will be conducted in the following zone:

- Miocene Sand (4,020 feet true vertical depth [ft TVD])—first permeable zone above the primary confining layer (4,020 ft)

The monitoring wells Luna No.1 and C. Schexnayder etal No. 1 (API 1700520265) will be used for fluid sampling of the groundwater in the Miocene Sand at prescribed frequencies in **Attachment D (Testing and Monitoring)** and in consultation with EPA. Fluid sampling will occur using a portable swabbing rig or other available sampling technologies. Samples will be analyzed for constituents listed in Table 5 to document baseline fluid chemistry and to detect changes in fluid chemistry that could result from the movement of brine or CO_2 from the storage interval through the seal formation.

2.1.2 Type and Number of Samples/Test Runs

Groundwater sampling plans are detailed in **Attachment D (Testing and Monitoring)**. CO_2 stream analysis plans are also detailed in **Attachment D**.

2.1.3 Site/Sampling Locations

Table 16 shows the planned monitoring methods and locations for groundwater quality and geochemical monitoring above the confining zone. The anticipated locations of the monitoring wells in the first permeable zone above the injection interval are shown in **Figure 1**. Wells will be located to allow for early warning of any leakage from the injection interval into the Miocene Sands above the upper confining zone.

CO_2 gas stream sampling will occur after the last stage of compression.

Table 16: Monitoring of Groundwater Quality and Geochemical Changes Above the Confining Zone

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage
Miocene Sand (4,020 feet TVD)	Fluid sampling	Lune No. 1 Schexnayder No. 1	Lune No. 1 (injector location) Schexnayder No. 1 (North of the injector)
	Temperature and pressure monitoring	Lune No. 1 and Schexnayder No. 1	Vertical distribution within well casings (based upon geophysical data indicating most transmissive interval within the well screen)
	Pulsed neutron	Lune No. 1 and Schexnayder No. 1	Pulsed neutron log generated during well installation/injection operations/PISC
Mississippi River Alluvial Aquifer	Fluid Sampling	GM1, GM2, GM3, USDW1, and USDW2	North, South, East, and West of the injector location
Mississippi River Alluvial Aquifer	Wellhead tubing	GM1, GM2, GM3, USDW1 and USDW2	North, South, East, and West of the injector location

2.1.4 Sampling Site Contingency

The proposed monitoring wells are located on property owned by BKVerde and access permissions have already been granted. No problems with site accessibility are anticipated. If inclement weather makes site access difficult, sampling schedules will be reviewed, and alternative dates may be selected that would still meet permit-related conditions.

No problems of site inaccessibility are anticipated for CO_2 gas stream sampling. If inclement weather makes site access difficult, sampling schedules will be reviewed, and alternative dates may be selected that would still meet permit-related conditions.

2.1.5 Activity Schedule

The groundwater sampling activities are summarized in Table 5. The CO_2 gas stream sampling activities are summarized in Table 6.

2.1.6 Critical/Informational Data

During both groundwater sampling and analytical efforts, detailed field and laboratory documentation will be completed. Documentation will be recorded in field and laboratory forms and notebooks. Critical information will include time and date of activity, person/s performing activity, location of activity (well or field sampling location), method (instrument or laboratory analysis), field or laboratory instrument calibration data, and field parameter values. For laboratory analyses, the laboratory will provide a report containing critical data generated during

the analysis and provide to end users in digital and printed formats. Noncritical field data may include appearance and odor of the sample, problems with well or sampling equipment, and weather conditions.

2.1.7 Sources of Variability

Potential sources of variability related to monitoring activities include (1) natural variation in fluid quality, formation pressure and temperature and seismic activity; (2) variation in fluid quality, formation pressure and temperature, and seismic activity due to project operations; (3) changes in recharge due to rainfall, drought, and snowfall; (4) changes in instrument calibration during sampling or analytical activity; (5) different staff collecting or analyzing samples; (6) differences in environmental conditions during field sampling activities; (7) changes in analytical data quality during life of project; and (8) data entry errors related to maintaining project database.

Activities to eliminate, reduce, or reconcile variability related to monitoring activities include (1) collecting long-term baseline data to observe and document natural variation in monitoring parameters; (2) evaluating data in timely manner after collection to observe anomalies in data that can be addressed by resampling or reanalysis; (3) conducting statistical analysis of monitoring data to determine whether variability in a data set is the result of project activities or natural variation; (4) maintaining weather-related data using onsite weather monitoring data or data collected near the project site (such as from local airports); (5) checking instrument calibration before, during, and after sampling or sample analysis; (6) thoroughly training staff; (7) conducting laboratory quality assurance checks using third-party reference materials and/or blind and/or replicate sample checks; and (8) developing a systematic review process of data that can include sample-specific data quality checks (i.e., cation/anion balance for aqueous samples).

2.2 Sampling Methods

2.2.1 Sampling SOPs

2.2.1.1 Analytical Parameters

Table 5 identifies the parameters to be monitored and the analytical methods BKVerde will use for groundwater sampling. If new information or updates to the geochemical modeling based on pre-operational testing raises additional concerns about subsurface geochemical processes (e.g., potential changes in subsurface properties or potential contaminant mobilization), the list of groundwater quality analytical parameters may need to be updated to ensure that the applicable parameters are included.

Groundwater sampling data will be compared to baseline data to identify changing conditions in the subsurface, including fluid leakage. Abnormalities suggestive of leakage could include increased total dissolved solids (TDS), change in cation and/or anion signature(s), increase in

CO_2 concentrations, pH changes, or changes in dissolved metal concentrations that indicate leaching of the geological formation.

2.2.1.2 Sampling Methods

Groundwater samples will be collected primarily using a low-flow sampling method consistent with ASTM D6452-99 (2005a) or Puls and Barcelona (1996). If a flow-through cell is not used, field parameters will be measured in grab samples. Groundwater wells will be purged to allow collection of samples representative of formation water quality. Static water levels in each well will be determined using an electronic or sonic water level indicator before any purging or sampling activities begin.

Groundwater pH, temperature, specific conductance, dissolved oxygen, and oxidation reduction potential will be monitored in the field using portable probes and a flow-through cell consistent with standard methods (e.g., American Public Health Association (APHA), 2005) given sufficient flow rates and volumes. Field chemistry probes will be calibrated at the beginning of each sampling day according to equipment manufacturer procedures using standard reference solutions. When a flow-through cell is used, field parameters will be continuously monitored and will be considered stable when three successive measurements made 3 minutes apart meet the criteria listed in .

Table **17.**

Table 17: Stabilization Criteria of Water Quality Parameters During Shallow Well Purging

Field Parameter	Stabilization Criteria
pH	± 0.2 units
Temperature	± 1°C
Specific conductance	± 3% of reading in µS/cm
Dissolved oxygen	± 10% of reading or 0.3 mg/L whichever is greater
Turbidity	± 1 NTU
Oxidation reduction potential	± 10 mV

After field parameters have stabilized, samples will be collected. Samples requiring filtration will be filtered through 0.45-µm flow-through filter cartridges as appropriate and consistent with ASTM D6564-00 (2005b). Prior to sample collection, filters will be purged with a minimum of 100 mL of well water (or more if required by the filter manufacturer). For alkalinity and total CO_2 samples, efforts will be made to minimize exposure to the atmosphere during filtration, collection in sample containers, and analysis.

2.2.2 In-situ Monitoring

In-situ monitoring of groundwater chemistry parameters is not currently planned.

2.2.3 Continuous Monitoring

Pressure data will be collected from groundwater wells on a periodic basis (e.g., hourly to daily) using dedicated pressure transducers with data loggers to characterize pressure trends.

2.2.4 Sample Homogenization, Composition, Filtration

Described above in **Section 2.2.1**.

2.2.5 Sample Containers and Volumes

For CO_2 stream monitoring, samples will be collected in a clean sample container manufactured of corrosion resistant material rated for the appropriate collection pressure (i.e., mini cylinders or polybags). Details are summarized in Table 18.

The assay for CO_2 quarterly gas analysis will include

- carbon dioxide (CO_2, % v/v)
- moisture (H_2O, ppm v/v)
- oxygen (O_2, ppm v/v)
- nitrogen (N_2, ppm v/v)
- argon (Ar, ppm v/v)
- hydrogen (H_2, ppm v/v)
- carbon monoxide (CO, ppm v/v)
- nitrogen oxides (NOx, ppm v/v)
- ammonia (NH_3, ppm v/v)
- total hydrocarbons (THC, ppm v/v as CH_4)
- methane (CH_4, ppm v/v)
- aromatic hydrocarbons (ppm v/v)
- total sulfur (TS, ppm v/v)
- sulfur dioxide (SO_2, ppm v/v)
- hydrogen sulfide (H_2S, ppm v/v)

isotope δ13C (per mil, ‰)

For groundwater samples, new sample bottles will be used. Sample bottles and bags for analytes will be used as received (ready for use) from the vendor or contract analytical laboratory for the analyte of interest. A summary of sample containers is presented in Table 19.

2.2.6 Sample Preservation

No preservation is required or used for CO_2 gas stream, and additional details of sampling requirements are shown in Table 18. For groundwater and other aqueous samples, the preservation methods in **Table 19** will be used.

Corrosion coupon sampling only requires that the coupons be physically separated (e.g., sleeves, baggies) during transportation to prevent physical abrasion.

2.2.7 Cleaning/Decontamination of Sampling Equipment

Pumps and related equipment and materials necessary for groundwater sampling will be selected based onsite needs and cleaned and decontaminated according to standard guidelines.

The field glassware (pipettes, beakers, filter holders, etc.) will be cleaned with tap water to remove any loose dirt, washed in a dilute nitric acid solution, and rinsed three times with deionized water before use.

CO_2 gas stream sampling containers will be either disposed of or decontaminated by the analytical laboratory.

2.2.8 Support Facilities

For sampling of groundwater, the following are required: air compressor, vacuum pump, generator, multi-electrode water quality sonde, analytical meters (pH, specific conductance, etc.). Field activities are usually completed in field vehicles and portable laboratory trailers located on site.

Sampling tubing, connectors and valves required to sample the CO_2 gas stream will be supplied by the analytical laboratory providing the sampling containers. Sampling will occur within the CO_2 compression unit or on the flowline downstream of the last stage of compression.

Field gauges will be removed from injection and monitoring wells utilizing existing standard industry tools and equipment. Deployment and retrieval of verification gauges will be done using procedures and equipment recommended by the vendor, subcontractor, or per standard industry practice.

2.2.9 Corrective Action, Personnel, and Documentation

Field staff will be responsible for properly testing equipment and performing corrective actions on broken or malfunctioning field equipment. If corrective action cannot be taken in the field, then equipment will be returned to the manufacturer for repair or replacement. Significant corrective actions affecting analytical results will be documented in field notes.

2.3 Sample Handling and Custody

Logging, geophysical monitoring, and pressure/temperature monitoring does not apply to this section and is omitted.

Sample holding times will be consistent with those described in EPA (1974), APHA (2005), Wood (1976), and ASTM Method D6517-00 (2005c). After collection, samples will be placed in ice chests in the field and maintained thereafter at $\leq 6°C$ but not frozen until analysis. The samples will be maintained at their preservation temperature and hand-delivered or shipped via overnight carrier to the designated laboratory within 24 hours. Analysis of the samples will be completed within the holding time listed in Table 18 and Table 19. As appropriate, alternative sample containers and preservation techniques approved by the UIC Program Director will be used to meet analytical requirements.

CO_2 stream sampling occurs under high pressure. Impurities in CO_2 may be improperly measured due to the partitioning coefficient of CO_2 when in the sampling system. It is a significant factor for consistently obtaining accurate analytical results. The point in the system where vaporization occurs must be well managed to prevent impurity partitioning and avoid over- or under-reporting of impurities. ISBT 2.0 standard recommends that the vaporization devices including the pressure regulators remain heated during sample collection and analysis. Precautions should be taken to prevent icing at the vaporization point. Samples should be analyzed as soon as practically possible after collection to minimize potential sample adulteration.

2.3.1 Maximum Hold Time/Time Before Retrieval

See **Tables 18** and **19** for maximum sample holding time for CO_2 stream and groundwater samples.

2.3.2 Sample Transportation

See description at the beginning of this section.

2.3.3 Sampling Documentation

Field notes will be collected for the groundwater samples collected. These forms will be retained and archived as reference. The sample documentation is the responsibility of groundwater sampling personnel.

An analysis authorization form will be provided with each CO_2 gas stream sample provided for analysis.

2.3.4 Sample Identification

The sample bottles will have waterproof labels with information denoting project, sampling date and time, sampling location, sample identification number, sample type (freshwater or brine), analyte, volume, filtration used (if any), and preservative used (if any).

Table 18: Summary of Sample Containers, Preservation Treatments, and Holding Times for CO2 Gas Stream Analysis

Sample	Volume/Container Material	Preservation Technique	Sample Holding time (max)
CO_2 gas stream	(2) 2-L MLB polybags (1) 75 cm^3 mini cylinder	Sample storage cabinets	5 days

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Table 19: Summary of Anticipated Sample Containers, Preservation Treatments, and Holding Times for Groundwater Samples

Target Parameters	Volume/Container Material	Preservation Technique	Sample Holding Time
Cations/metals (aluminum, barium, calcium, manganese, sodium, potassium, iron, arsenic, magnesium, silica, cadmium, chromium, copper, lead, selenium, titanium, zinc)	250 ml/HDPE	Filtered, nitric acid, 4°C	180 days
Anions (chloride, sulfate, sulfide, bromide, fluoride, nitrate)	125 ml/ HDPE	4°C	28 days (48 hours for nitrate)
Dissolved gases CO_2 CH_4 O_2	 2 X 40-mL VOA vials 2 X 40-mL VOA vials 500-mL amber glass	 4°C, no headspace HCl, 4°C, no headspace 4°C, no headspace	 7 days 14 days 15 minutes
TDS	1 liter/HDPE	4°C	7 days
Alkalinity	250 ml/HDPE	4°C	14 days
Hardness	250 ml/HDPE	Nitric acid	180 days
Turbidity	125 ml/ HDPE	4°C	48 hours
Specific gravity	250 ml/HDPE	4°C	28 days
Water density	250 ml/HDPE	4°C	28 days
Dissolved inorganic carbon isotopes ($\delta^{13}C$)	Dependent on selected analytical laboratory		
Note: HDPE – High-density polyethylene			

2.3.5 Sample Chain-of-Custody

For CO_2 stream analysis, an analysis authorization will accompany the sample to the laboratory at which point a chain-of-custody accompanies the sample through their processes.

For groundwater samples, chain-of-custody will be documented using a standardized form. Copies of the form will be provided to the person/laboratory receiving the samples as well as the person/laboratory transferring the samples. These forms will be retained and archived to allow simplified tracking of sample status. The chain-of-custody form and record keeping is the responsibility of groundwater sampling personnel.

2.4 Analytical Methods

Logging, geophysical monitoring, and pressure/temperature monitoring does not apply to this section and is omitted.

2.4.1 Analytical SOPs

Analytical SOPs are referenced in the laboratory methods provided in Table 5. Other laboratory-specific SOPs utilized by the laboratory will be determined after a contract laboratory has been selected. Upon request, BKVerde will provide the agency with the laboratory SOPs developed for the specific parameter using the appropriate standard method. Each laboratory technician conducting the analysis on the samples will be trained on the SOP developed for each standard method. BKVerde will include each technician's training certification with the annual report.

2.4.2 Equipment/Instrumentation Needed

Equipment and instrumentation are specified in Table 5for the individual analytical methods.

2.4.3 Method Performance Criteria

Tables 5 through **7** list the analytes specific to each method along with the associated performance criteria, including reporting limits, method detection limits, and accuracy and precision limits. Nonstandard method performance criteria are not anticipated for this project.

2.4.4 Analytical Failure

Each laboratory conducting the analyses in Table 5through **7** will be responsible for appropriately addressing analytical failure according to their individual SOPs.

2.4.5 Sample Disposal

Each laboratory conducting the analyses in Table 5through **7** will be responsible for appropriate sample disposal according to their individual SOPs.

2.4.6 Laboratory Turnaround

Laboratory turnaround will vary by laboratory, but generally turnaround of verified analytical results within one month will be suitable for project needs.

2.4.7 Method Validation for Nonstandard Methods

Nonstandard methods are not anticipated for this project. If nonstandard methods are needed or proposed in the future, EPA will be consulted on additional appropriate actions to be taken.

2.5 Quality Control

Geophysical monitoring and pressure/temperature monitoring does not apply to this section and is omitted. For log quality control, please refer to specific vendors at time of logging, following industry standard practices.

2.5.1 Field Quality Control Samples

2.5.1.1 Blanks

For groundwater sampling, a field blank will be collected and analyzed for the inorganic analytes in Table 5at a frequency of 10% or greater. Field blank samples consist of laboratory supplied, reagent-free water that are collected in the field. Field blanks will be exposed to the same field and transport conditions as the groundwater samples. Field blanks will be used to detect contamination resulting from the collection process. Trip blanks will be included with each set of samples being transported to analytical laboratories to detect contamination resulting from the transportation process.

2.5.1.2 Duplicates

For each groundwater sampling event, a duplicate groundwater sample will be collected from a well from a rotating schedule at 10% or greater frequency. Duplicate samples will be collected from the same source immediately after the original sample in different sample containers and processed as the other samples. Duplicate samples will be used to assess sample heterogeneity and analytical precision.

2.5.2 Exceeding Control Limits

If the sample analytical results exceed control limits (i.e., ion balances > ±10%), further examination of the analytical results will be done by evaluating the ratio of the measured TDS to the calculated TDS (i.e., mass balance) per the American Public Health Association (APHA) method. The method indicates which ion analyses should be considered suspect based on the mass balance ratio. Suspect ion analyses will then be reviewed in the context of historical data and interlaboratory results, if available. Suspect ion analyses will then be brought to the attention of the analytical laboratory for confirmation and/or reanalysis. The ion balance will be recalculated, and if the error is still not resolved, suspect data will be identified during data validation and may be given less importance in data interpretations.

2.5.3 Calculating Applicable QC Statistics

2.5.3.1 Charge Balance

The analytical results will be evaluated to determine correctness of analyses based on anion-cation charge balance calculation. Because the potable waters are electrically neutral, the

chemical analyses should yield equally negative and positive ionic activity. The anion-cation charge balance will be calculated using the formula

$$\% \, difference = 100 \text{ x } \frac{\sum \text{cations} - \sum \text{anions}}{\sum \text{cations} + \sum \text{anions}},$$

where the sums of the ions are represented in milliequivalents (meq) per liter and the criteria for acceptable charge balance is ±10%.

2.5.3.2 Mass Balance

The ratio of the measured TDS to the calculated TDS will be calculated in instances where the charge balance acceptance criteria are exceeded using the formula

$$1.0 < \frac{\text{measured } TDS}{\text{calculated } TDS} < 1.2,$$

where the anticipated values are between 1.0 and 1.2.

2.5.3.3 Outliers

Identification of statistical outliers is essential prior to the statistical evaluation of groundwater. This project will use the EPA's Unified Guidance (March 2009) as a basis for selection of recommended statistical methods to identify outliers in groundwater chemistry data sets as appropriate. These techniques include probability plots, box plots, Dixon's test, and Rosner's test. The EPA-1989 outlier test may also be used as another screening tool to identify potential outliers.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Logging tool equipment will be maintained as per wireline industry best practices and standards.

For groundwater sampling, field equipment will be maintained, factory serviced, and factory calibrated per manufacturer's recommendations. Spare parts that may be needed during sampling will be included in supplies on-hand during field sampling.

For the laboratory equipment, testing, inspection, and maintenance will be the responsibility of the analytical laboratory per standard practice, method-specific protocol, or NELAP requirement.

2.7 Instrument/Equipment Calibration and Frequency

2.7.1 Calibration and Frequency of Calibration

Pressure/temperature gauge calibration information is located in Table 10 through Table 15. Logging tool calibration will be performed at the discretion of the service company providing the equipment, following standard industry practices. Calibration frequency will be determined by standard industry practices.

For groundwater sampling, portable field meters or multiprobe sondes used to determine field parameters (e.g., pH, temperature, specific conductance, dissolved oxygen) will be calibrated according to manufacturer recommendations and equipment manuals (Hach, 2006) each day before sample collection begins. Recalibration will be performed if any components yield atypical values or fail to stabilize during sampling.

2.7.2 Calibration Methodology

Logging tool calibration methodology will follow standard industry practices.

For groundwater sampling, standards used for calibration are typically 7 and 10 for pH, a potassium chloride solution yielding a value of 1413 micro-siemens per centimeter (µS/cm) at 25°C for specific conductance, and a 100% dissolved O_2 solution for dissolved oxygen. Calibration will be performed for the pH meters per manufacturer's specifications using a two-point calibration bounding the range of the sample. For coulometry, sodium carbonate standards (typically yielding a concentration of 4,000 mg CO_2/L) will be routinely analyzed to evaluate instrument calibration.

2.7.3 Calibration Resolution and Documentation

Logging tool calibration resolution and documentation will follow standard industry practices.

For groundwater sampling, calibration values will be recorded in daily sampling records and any errors in calibration will be noted. For parameters where calibration is not acceptable, redundant equipment may be used so loss of data is minimized.

2.8 Inspection/Acceptance for Supplies and Consumables

2.8.1 Supplies, Consumables, and Responsibilities

Supplies and consumables for field and laboratory operations will be procured, inspected, and accepted as required from vendors approved by BKVerde or the respective subcontractor responsible for the data collection activity. Acquisition of supplies and consumables related to groundwater analyses will be the responsibility of the laboratory per established standard methodology or operating procedures.

2.9 Non-direct Measurements

Seismic Monitoring Methods

2.9.1 Data Sources

For time lapse seismic surveys, repeatability is paramount for accurate differential comparison. Therefore, to ensure survey quality, the locations for the shots and acquisition methodology of sequential surveys will be consistent. Once these surveys are conducted, they will be compared to a baseline survey to track and monitor plume development.

For in-zone pressure monitoring, the in-zone pressure gauges in Ciel #1 and Soleil #2 will be used to gather pressure data.

2.9.2 Relevance to Project

Time lapse seismic surveys will be used to track changes in the CO_2 plume in the subsurface. Processing and comparing subsequent surveys to a baseline will allow project managers to monitor plume growth, as well as to ensure that the plume does not move outside of the intended storage reservoir. Numerical modeling will be used to predict the CO_2 plume growth and migration over time by combining the processed seismic data with the existing geologic model.

In-zone pressure monitoring data will be used in numerical modeling to predict plume and pressure front behavior and confirm the plume stage within the AOR.

2.9.3 Acceptance Criteria

Following standard industry practices will ensure that the gathered seismic data will be used for accurate modeling and monitoring. Similar ground conditions shot points located within tolerable limits, functional geophones, and similar seismic input signal will be used from survey to survey to ensure repeatability.

When processing seismic data, several QA checks will be done in accordance with industry standards including reformatting to Omega structured files, geometry application, amplitude compensation, predictive deconvolution, elevation statics correction, RMS amplitude gain, velocity analysis every 2 km, NMO application using picked velocities, CMP stacking, random noise attenuation, and instantaneous gain.

2.9.4 Resources/Facilities Needed

BKVerde will subcontract all necessary resources and facilities for the seismic monitoring, in-zone pressure monitoring, and groundwater sampling.

2.9.5 Validity Limits and Operating Conditions

For seismic surveys and numerical modeling, intraorganizational checks between trained and experienced personnel will ensure that all surveys and numerical modeling are conducted conforming to standard industry practices.

2.10 Data Management

2.10.1 Data Management Scheme

BKVerde or a designated contractor will maintain the required project data as provided elsewhere in the permit. Data will be backed up on tape or held on secure servers.

2.10.2 Recordkeeping and Tracking Practices

The records of gathered data will be securely held and properly labeled for auditing purposes.

2.10.3 Data Handling Equipment/Procedures

The equipment used to store data will be properly maintained and operated according to proper industry techniques. BKVerde's supervisory control and data acquisition (SCADA) and vendor data acquisition systems will interface with one another, and all subsequent data will be held on a secure server.

2.10.4 Responsibility

The primary project managers will be responsible for ensuring proper data management is maintained.

2.10.5 Data Archival and Retrieval

The data will be held by BKVerde. These data will be maintained and stored for auditing purposes as described in **Section 2.10.1**.

2.10.6 Hardware and Software Configurations

BKVerde and vendor hardware and software configurations will be appropriately interfaced.

2.10.7 Checklists and Forms

Checklists and forms will be procured and generated as necessary.

3. ASSESSMENT AND OVERSIGHT

3.1 Assessments and Response Actions

3.1.1 Activities to be Conducted.

Groundwater quality data will be collected at the frequency outlined in Table 1. After completion of sample analysis, results will be reviewed for QC criteria as noted in **Section 2.5**. If the data quality fails to meet criteria set in **Section 2.5.**, samples will be reanalyzed, if still within holding time criteria. If outside of holding time criteria, additional samples may be collected, or sample results may be excluded from data evaluations and interpretations. Evaluation for data consistency will be performed according to procedures described in the EPA 2009 Unified Guidance (EPA, 2009).

3.1.2 Responsibility for Conducting Assessments

Organizations gathering data will be responsible for conducting internal assessments. Stop-work orders will be handled internally within individual organizations.

3.1.3 Assessment Reporting

The assessment information will be reported to the individual organizations' project manager outlined in **Section 1.1**.

3.1.4 Corrective Action

The corrective action affecting only an individual organization's data collection responsibility will be addressed, verified, and documented by the individual project managers and communicated to the other project managers as necessary. Corrective actions affecting multiple organizations will be addressed by the members of the project leadership and communicated to other members on the distribution list for the QASP. Assessments may require integration of information from multiple monitoring sources across organizations (operational, in-zone monitoring, above-zone monitoring) to determine whether correction actions are required and/or the most cost-efficient and effective action to implement. BKVerde will coordinate multiorganization assessments and corrective actions as warranted.

3.2 Reports to Management

3.2.1 QA Status Reports

QA status reports are not expected to be required. If any testing or monitoring techniques are changed, the QASP will be reviewed and updated as appropriate in consultation with the EPA.

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Revised QASPs will be distributed by BKVerde to the full distribution list at the beginning of this document.

4. DATA VALIDATION AND USABILITY

4.1 Data Review, Verification, and Validation

4.1.1 Criteria for Accepting, Rejecting, or Qualifying Data

Groundwater quality data validation will include the review of the concentration units, sample holding times, and the review of duplicate, blank, and other appropriate QA/QC results. The groundwater quality results will be entered into a database or spreadsheet with periodic data review and analysis. Verde will retain copies of the laboratory analytical test results and/or reports. Analytical results will be reported on a frequency based on the approved Class VI permit conditions. In the periodic reports, data will be presented in graphical and tabular formats as appropriate to characterize general groundwater quality and identify intrawell variability with time. After sufficient data have been collected, additional methods, such as those described in the EPA 2009 Unified Guidance (EPA, 2009), will be used to evaluate intrawell variations for groundwater constituents, to evaluate if significant changes have occurred that could be the result of CO_2 or brine seepage beyond the storage interval.

4.2 Verification and Validation Methods

4.2.1 Data Verification and Validation Processes

See **Sections 2.5** and **4.1.1**. Appropriate statistical software will be used to determine data consistency.

4.2.2 Data Verification and Validation Responsibility

Verde or its designated subcontractor will verify and validate groundwater sampling data.

4.2.3 Issue Resolution Process and Responsibility

Verde or its designated representative will oversee the groundwater data handling, management, and assessment process. Staff involved in these processes will consult with Verde or its designated representative to determine actions required to resolve issues.

4.2.4 Checklist, Forms, and Calculations

Checklists and forms will be developed specifically to meet Class VI permit requirements.

4.3 Reconciliation with User Requirements

4.3.1 Evaluation of Data Uncertainty

Statistical software will be used to determine groundwater data consistency using methods consistent with EPA 2009 Unified Guidance (EPA, 2009).

4.3.2 Data Limitations Reporting

The organization-level project managers will be responsible for ensuring that data developed by their respective organizations are presented with the appropriate data-use limitations.

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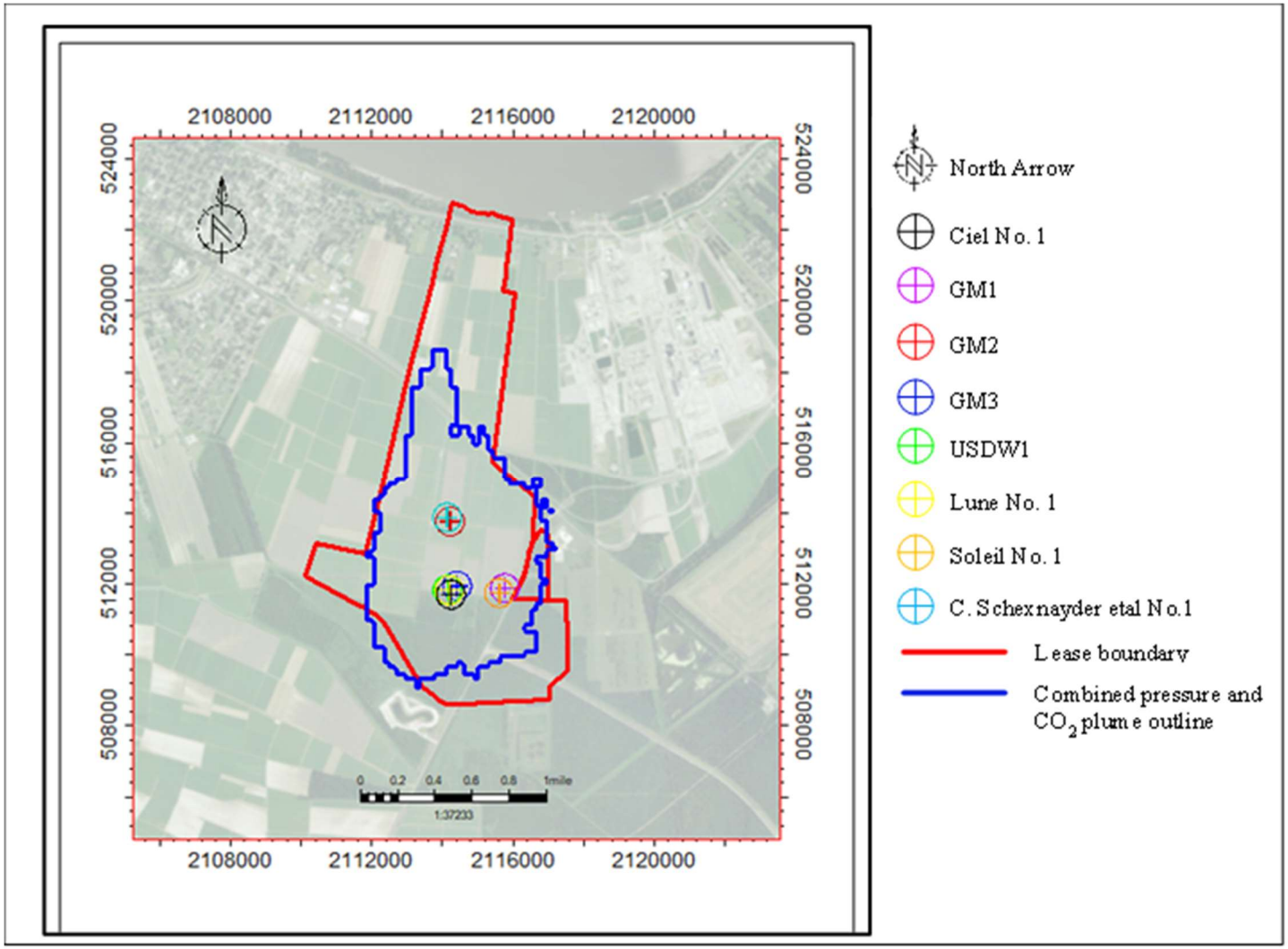

Figure 1: Map of the Donaldsonville Site, showing the location of the proposed injector and the monitoring wells.