PRE-OPERATIONAL TESTING PROGRAM
40 CFR 146.82(a)(8), 146.87

FRONT RANGE STORAGE COMPLEX

Facility Information

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Well surface location:	31375 Great Western Drive, Windsor, CO 80550 Lat: 40.454962 Long: -104.859761 NAD 83 (2011)

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List of Acronyms and Abbreviations

Al = Aluminum	MDT = modular dynamic testing
Ba = Barium	Mg = Magnesium
C = Carbon	MIT = mechanical integrity test
Ca = Calcium	Mn = Manganese
Cl = Chlorine	Na = Sodium
CMR = combinable magnetic resonance	Ni = Nickel
CSS = Carbon Storage Solutions, LLC	O = Oxygen
Cu = Copper	PEF = photoelectric factor
Fe = Iron	PISC = Post Injection Site Care
FNXS = fast neutron cross section	S = Sulfur
ft = feet	Si = Silicon
ft KB = feet from Kelly Bushing	SP = Spontaneous potential
ft MD = feet measured depth	SWC = side wall core
ft TVD = feet total vertical depth	Ti = Titanium
Gd = Gadolinium	US EPA = United States Environmental Protection Agency
H = Hydrogen	
ISIP = Instantaneous Shut-in Pressure	USDW = Underground Source of Drinking Water
K = Potassium	

D.1. Summary

Carbon Storage Solutions, LLC (CSS) has and will carry out a Pre-Operational Testing Program in conformance to 40 CFR 146.82(a)(8) and 146.87. The plan includes: (a) Comprehensive logging and testing to ensure Front Range 1-1 (and Front Range 2-1) conforms to Class VI well construction standards, and establish a baseline of formation properties (depth, thickness, porosity, permeability, lithology, salinity) from field data collected during drilling, (b) Coring and formation fluid sampling in all relevant geologic formations from the upper secondary confining zones down through the lower pressure dissipation zone, (c) Measurement of injection zone fluid temperature, pH, conductivity, reservoir pressure, and static fluid level, (d) Method for determining fracture pressure and other physical and chemical characteristics of the injection and confining zones, and (e) Pressure fall-off test and a pump/injectivity test of Front Range 1-1 to determine near-wellbore formation properties.

The testing activities described in this document are restricted to Front Range 1-1 and Front Range 2-1 during the Pre-Injection period. Testing and monitoring activities during the Injection and Post-Injection Site Care (PISC) periods are described in the Testing and Monitoring Plan, along with other non-related Pre-Injection period activities such as near surface monitoring.

D.2. Pre-Injection Period Testing Plan for Front Range 1-1

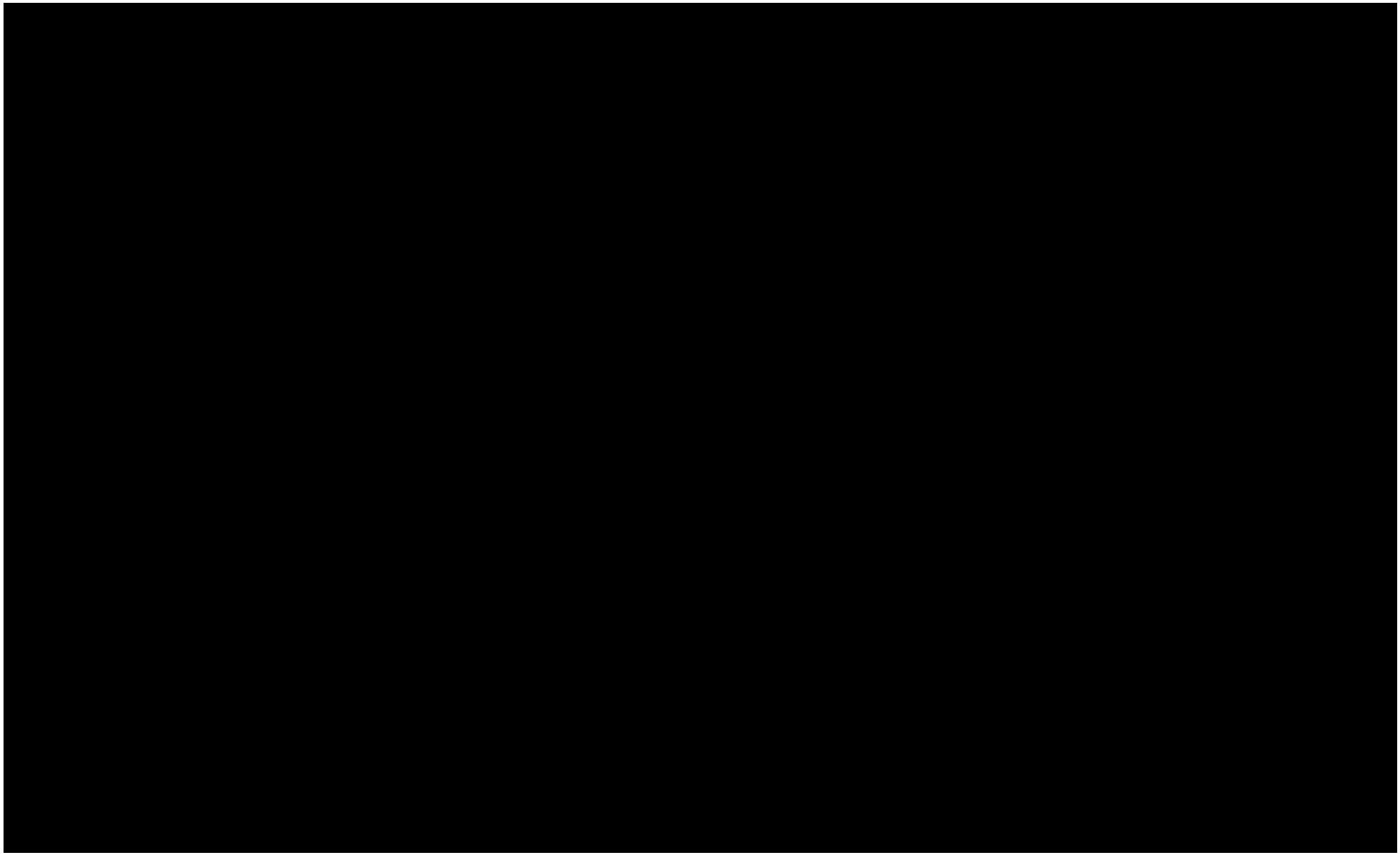
This section describes the tests and logs that have been (or will be) conducted on Front Range 1-1 during drilling, casing installation, and after casing installation in accordance with the requirements of 40 CFR 146.87(a), (b), (c), and (d). Figure D.2-1 illustrates the relationship of the pre-operational testing program with the geologic- and hydrogeologic-stratigraphic column at Front Range 1-1, with the wellbore diagram for Front Range 1-1 shown for stratigraphic well service.

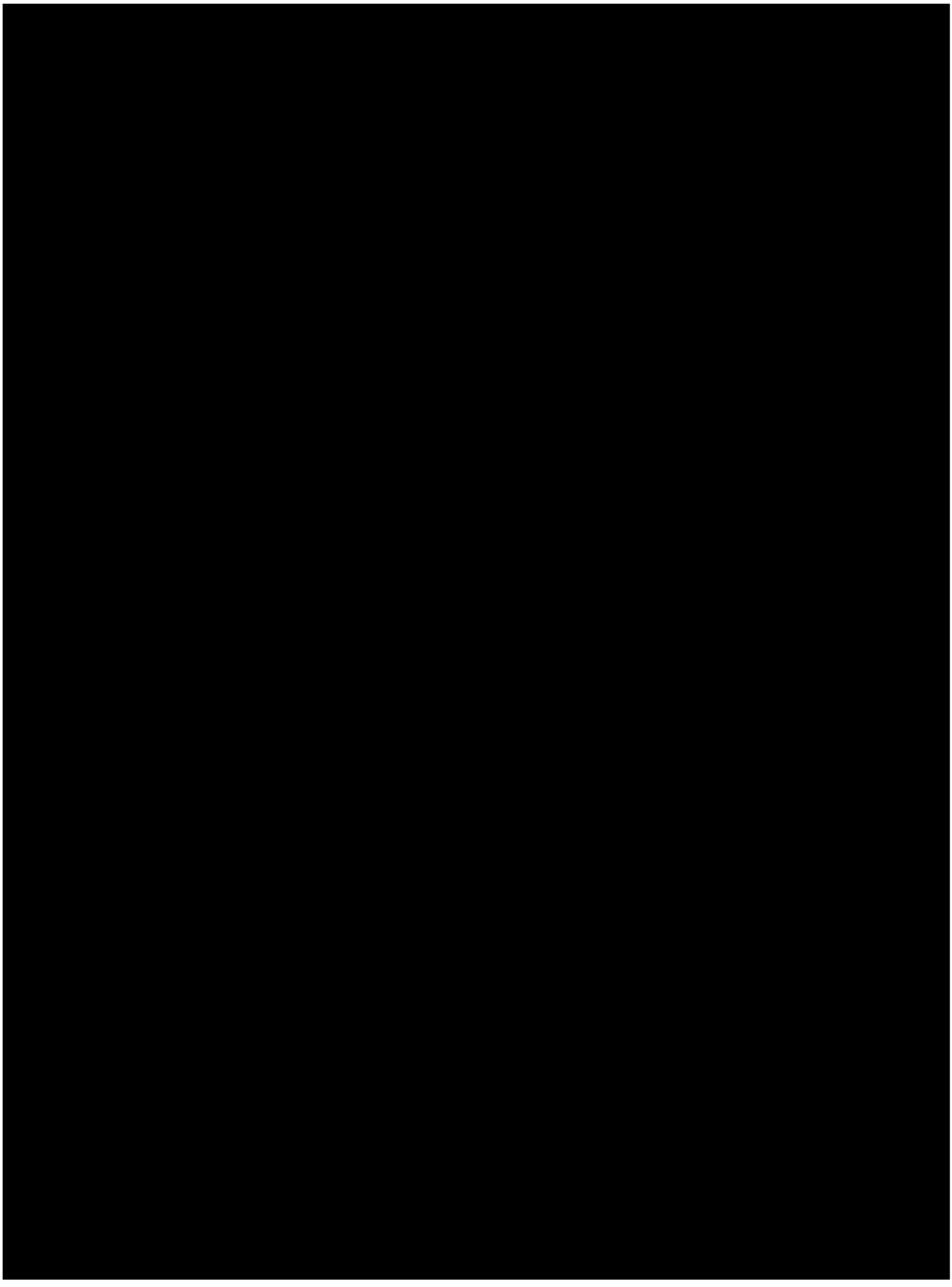
D.2.1. Deviation Checks [40 CFR 146.87(a)(1)]

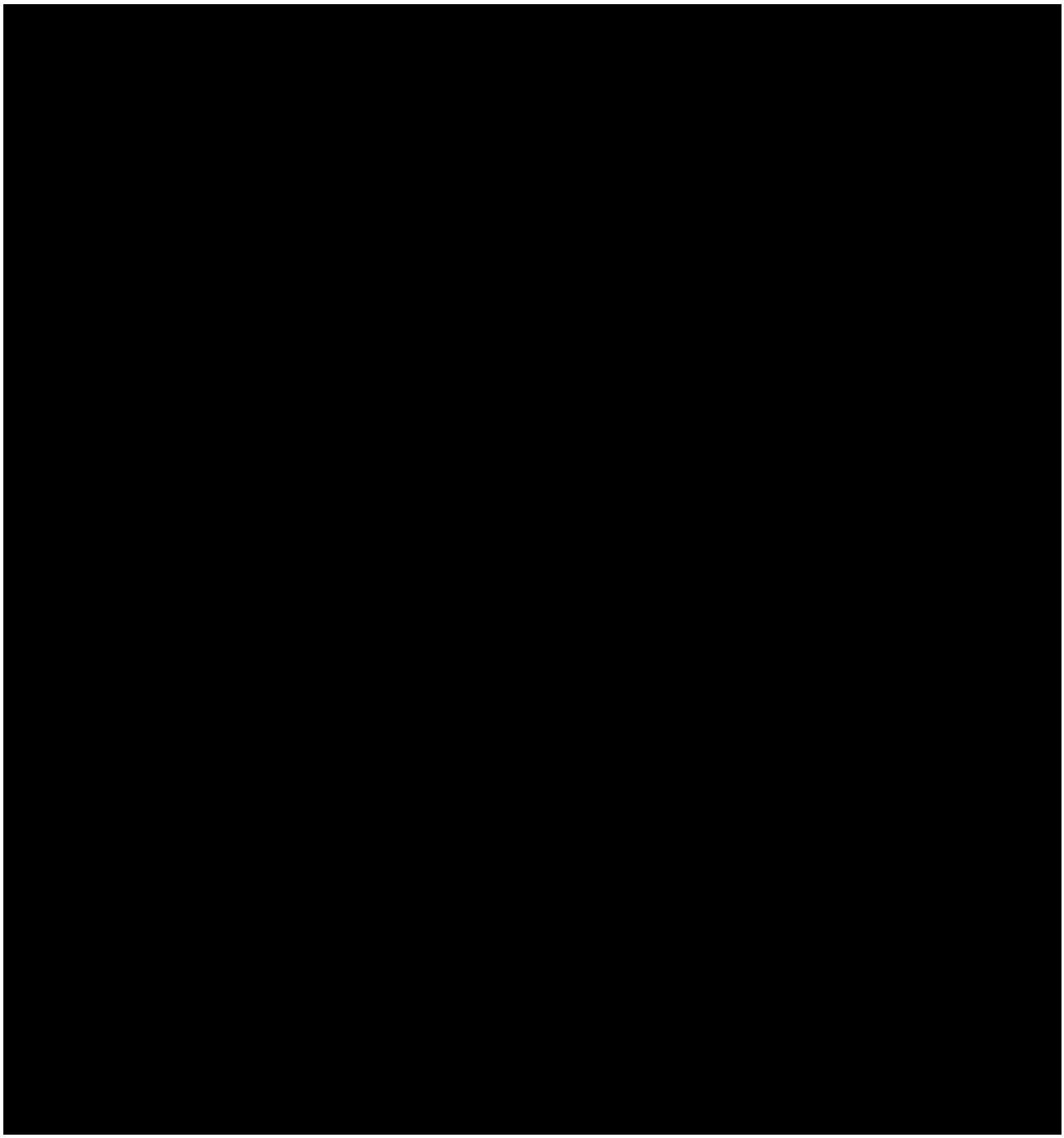
Deviation measurements were conducted during drilling of Front Range 1-1. The well was drilled directionally and surveys were taken approximately every 90 feet, measuring inclination and azimuth in degrees during construction of the well. Further while logging the well, surveys were taken every 30 feet from 2,144 feet from Kelly Bushing (ft KB) measuring inclination and azimuth in degrees.

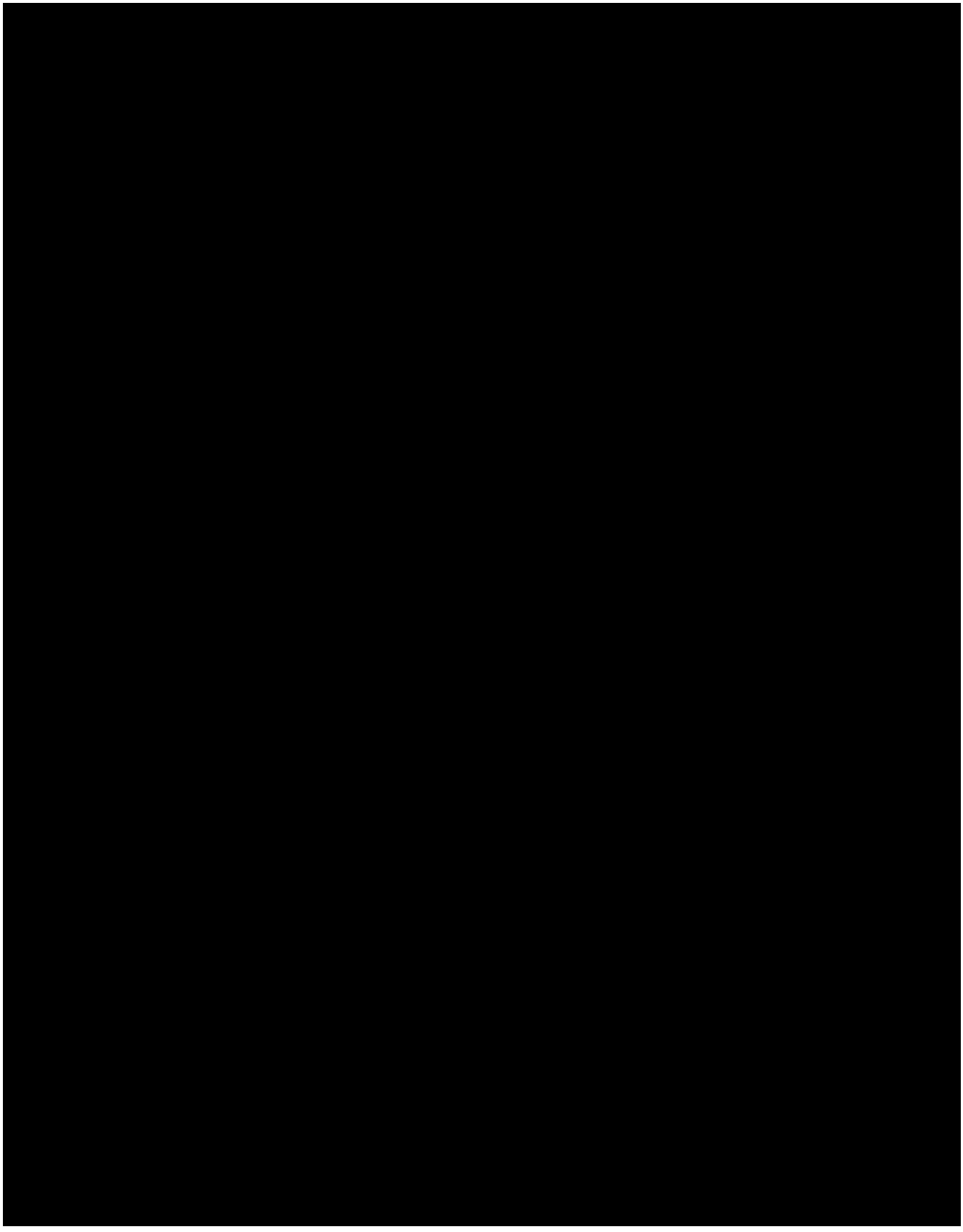
D.2.2. Tests and Logs Performed During Drilling Operations

Table D.2-1 outlines the Front Range 1-1 open hole logging program conducted during drilling operations to ensure conformance to injection well construction requirements and establish a baseline for formation properties per 40 CFR 146.87(a)(2)(i) and (3)(i).









2. Measure initial reservoir pressure. Pressure should be static. It can be measured at the reservoir level by means of a downhole gauge, or by measurement of pressure at the surface or near the surface and addition of the pressure exerted by the column of liquid in the well.
3. Begin pressure measurements at high rate.
4. Establish injection rate. A short pretest at a low rate may be used to determine an appropriate rate for testing. Continue injection until pressure measurements become near stable unless this is impossible due to slow increase, insufficient injection fluid, or high injection pressure.
5. Shut in the injection well.
6. Continue to collect pressure measurements for a period equal in length to the injection portion of the test. The resulting data will constitute a pressure fall-off test.
7. Remove test tools from the well.

D.2.8. Pump Test Procedure

CSS will conduct either a pump test or injectivity test per the requirements of 40 CFR 146.87(e)(2) – (3). In the event that CSS does not elect to conduct a combined injectivity/pressure fall-of test as described in Section D.2.7, CSS will conduct a pump test (aka step rate test) per the procedure outlined below:

1. The well is shut-in long enough prior to testing such that the bottom hole pressures approximate shut-in formation pressures. If the shut-in well flows to the surface, the wellhead injection string will be equipped with a gauge and the static surface pressure read and recorded.
2. A series of successively higher injection rates are used, and the elapsed time and pressure values are read and recorded for each rate and time step, which is the same amount of time as the previous step.
3. Record injection rates using a chart recorder.
4. Pressures measured with both a down hole pressure and surface pressure gauge.
5. Measure and record injection pressures with a gauge or recorder (for immediate test results). Record each time step and corresponding pressure.
6. A plot of injection rates and the corresponding stabilized pressure values should be graphically represented as a constant slope straight line to a point at which the formation fracture, or “breakdown”, pressure is exceeded. The slope of this subsequent straight line should be less than that of the before-fracture straight line.
7. If the formation fracture pressure has definitively been exceeded, as evidenced by at least two injection rate-pressure combinations greater than the breakdown pressure, the injection pump can be stopped, the line valve closed and pressure allowed to bleed-off into the injection zone. There will occur a significant instantaneous pressure drop (Instantaneous Shut-in Pressure [ISIP]), after which the pressure values will level out. This ISIP value must

be read and recorded. The ISIP obtained in this manner may be considered to be the minimum pressure required to hold open a fracture in this formation at this well.

8. Once the ISIP is obtained, the step rate test is concluded.
9. In the event that the breakdown pressure was not obtained at the maximum test injection pressure utilized, the test results may indicate that the formation is accepting fluids without fracturing.

D.3. Pre-Injection Period Testing Plan for Front Range 2-1

CSS will complete the tests and logs described below on Front Range 2-1 during drilling, casing installation, and after casing installation. Class VI requirements for injection well construction do not strictly apply to a monitoring well, however CSS has elected to follow the spirit of 40 CFR 146.87 to ensure Front Range 2-1 is built to an appropriate standard. Additional information on tests and procedures is provided in the Well Construction Details and the Testing and Monitoring Plan. Detailed discussion of test results is (or will be) provided in the Site Characterization attachment to the Application Narrative.

D.3.1. Deviation Checks

Deviation measurements will be conducted during drilling of Front Range 2-1 at least every 90 feet, and inclination and azimuth will be measured in degrees during construction of the well.

D.3.2. Tests and Logs Performed During Drilling Operations

A basic log suite will be conducted which will include but is not limited to a Quad Combo and FMI (Formation MicroImager) (or equivalent).

D.3.3. Tests and Logs Performed During and After Casing Installation

The cased hole logging and testing program will include but is not limited to: a cement bonding log (CBL), and a mechanical integrity test.

Water samples will be collected from the Ingleside, Lyons, and Entrada prior to injection and during the monitoring phase. These samples will be analyzed using the groundwater test methods described in Section E.9 of the Testing and Monitoring Plan.

D.3.4. Demonstration of Mechanical Integrity

Mechanical integrity will be demonstrated using a temperature log.

CSS will notify the US EPA at least 30 days prior to conducting a test and provide a detailed description of the testing procedure. Notice and the opportunity to witness these tests/logs shall be provided to the US EPA at least 48 hours in advance of a given test/log.

The external MIT temperature log will establish a baseline for static geothermal conditions, needed for interpretation of future temperature logs obtained during Injection and PISC periods of the project.