# 7. Pre-Injection/Operational Testing Plan

The testing activities at CCS#5, CCS#6 and CCS#7 described in this Section are restricted to the pre-injection phase. Testing and monitoring activities during the injection and post-injection phases are described in the Testing and Monitoring Plan, along with other non-well related pre-injection baseline activities such as geochemical monitoring.

The pre-injection operational testing plan presented herein addresses the requirements of 40 CFR Section 146.87 (a-f):

- Deviation checks during drilling (a)(1)
- Logging required before installation of surface casing and long string casing (a)(2)(3)
- Tests to demonstrate internal and external mechanical integrity (a)(4)(5)
- Proposed coring program (b)
- Proposed fluid sampling program, including those to assess the chemical characteristics of the injection and confining zones (c)(d)
- Tests to verify hydrogeologic conditions in the injection and confining zone and determine fracture pressure(d)(e)

## 7.1 Tests during well drilling/construction

ADM will perform logging, surveys and tests to determine or verify the depth, thickness, porosity, permeability, lithology, and formation fluid salinity in all relevant geologic formations. These tests shall include:

- Deviation checks that meet the requirements of 40 CFR 146.87(a)(1);
- Logs and tests before and upon installation of the surface casing that meet the requirements of 40 CFR 146.87(a)(2);
- Logs and tests before and upon installation of the long-string casing that meet the requirements of 40 CFR 146.87(a)(3);
- Tests to demonstrate internal and external mechanical integrity that meet the requirements of 40 CFR 146.87(a)(4); and
- Any alternative methods that are required by and/or approved by the Director pursuant to 40 CFR 146.87(a)(5).

### 7.1.1 Deviation Checks and casing design

The subsurface and surface design (casing, cement, and wellhead designs) meets the requirements to appropriately manage $CO_2$, the preserve mechanical integrity during injection operations and to sustain the integrity of the caprock to ensure $CO_2$ remains in the Mt. Simon. For reasons such as equipment or supply availability, or changes to the supplemental monitoring program, the final well design may vary but will meet or exceed requirements in terms of strength and $CO_2$ compatibility. See Appendix G for well cement information.

The injection well is planned to be drilled vertically with an inclination of 5° degrees or less. During drilling, the wellbore trajectory will be tracked and surveyed every 1,000 feet to reduce the risk of interception with adjacent wellbores. In the event that a deviation exceeds 5° degrees due to a well kick off or directional drilling to facilitate the construction and operation of the well. The permittee will notify the agency within 7 calendar days.

### 7.1.2 Mechanical Integrity Testing and Logging During and after Casing Installation

Wireline logging is an important tool that will be used to identify many characteristics of the formations encountered during drilling and for demonstrating mechanical integrity of the well. The logs discussed in this section were conducted on CCS#1-2 and VW#1-2 and are summarized in Table 7.1.2-1. The logging program for CCS#5, CCS#6 and CCS#7 will be comparable but may differ from the previous well logging programs. Logs for the proposed injection wells are presented in Section 7.1.2.2 and 7.1.2.3, and are summarized in Table 7.1.2-2.

Mechanical integrity testing and logging are described in Section 7.1.2.3 and proposed testing is summarized in Table 7.1.2-3. ADM will provide a schedule for all testing and logging to the permitting agency at least 30 days in advance of conducting the first such tests and/or logs.

#### 7.1.2.1 Historic Logs

Table 7.1.2-1 presents a summary of the previous geophysical logs collected in the existing CCS and VW wells. The logging programs for the two active CCS wells were similar. CCS#1 had triple combo logs (gamma ray, spontaneous potential, caliper, resistivity, bulk density, and neutron porosity) performed on all sections of each well. All casing strings had either a cement bond log (CBL) or ultrasonic CBL to confirm the condition of cement between the casing and reservoir. The intermediate and long string sections of the wells had open hole logging programs that included triple combo, dipole sonic, formation micro-imaging (fracture finder), spectral gamma ray, and nuclear magnetic resonance logs as part of the suite of open hole logs. The long string logs on CCS#1 included a modular dynamics tester and a versatile seismic imager. The long string on CCS#2 also included a Litho-Scanner (Lithology Scanner). Triple combo, modular dynamics tester, Pressure Express Tool (XPT) and pulse neutron logs were performed in VW#1-2. The logging suite performed on the CCS wells presents a comprehensive geophysical analysis of the injection zone, confining zone, and overlying formations. A summary of the geologic characterization is provided in Section 3. Site Geologic Characterization of this application document.

**Table 7.1.2-1.** Log Summary: Existing Site Wells

| Well Name | Log Vendor | Log Title | Date Run | Depth Interval (MD ft. KB ) |
|---|---|---|---|---|
| CCS#1 | Schlumberger | GR, CAL, SP, Resistivity, RHOB, NPHI | 3/9/2009 | Sensitive, Confidential, or Privileged Information [redacted] |
| CCS#1 | | Variable Density CBL | | [redacted] |
| CCS#1 | Schlumberger | GR, CAL, SP, Resistivity, RHOB, NPHI | 4/5/2009 | [redacted] |
| CCS#1 | Schlumberger | Sonic Scanner and FMI | 4/5/2009 | [redacted] |
| CCS#1 | Schlumberger | CMR, ECS, HNGS | 4/5/2009 | [redacted] |
| CCS#1 | Schlumberger | MSCT | 4/5/2009 | [redacted] |
| CCS#1 | | Ultrasonic Cement Imaging | | [redacted] |
| CCS#1 | Schlumberger | GR, CAL, SP, Resistivity, RHOB, NPHI | 4/26/2009 | [redacted] |
| CCS#1 | Schlumberger | Sonic Scanner and FMI | 4/26/2009 | [redacted] |
| CCS#1 | Schlumberger | CMR, ECS, HNGS | 4/26/2009 | [redacted] |
| CCS#1 | Schlumberger | MSCT | 4/26/2009 | [redacted] |
| CCS#1 | Schlumberger | MDT | 4/26/2009 | [redacted] |
| CCS#1 | Schlumberger | VSIT | 4/26/2009 | [redacted] |
| CCS#1 | | Ultrasonic Cement Imaging | | [redacted] |
| CCS#1 | | Variable Density CBL | | [redacted] |
| CCS#1 | | Pressure/Temperature Log | | [redacted] |
| CCS#1 | | Thermal Neutron Decay (Formation Sigma) Log | | [redacted] |
| CCS#1 | | Multi-Finger Caliper Log | | [redacted] |
| CCS#1 | | CCL and Perforation Record | | [redacted] |
| CCS#1 | | Injection Fullbore Spinner Logs | | [redacted] |
| [redacted] | | | | [redacted] |
| CCS#2 | Schlumberger | GR, Resistivity, NPHI, SlimPulse | 1/12/2015 | [redacted] |
| CCS#2 | Schlumberger | CAL, DSLT, GPIT | 1/12/2015 | [redacted] |
| CCS#2 | Wayne County Well Surveys | CBL | 1/16/2015 | [redacted] |
| CCS#2 | Schlumberger | GR, CAL, SP, Resistivity, RHOB, NPHI | 5/3/2015 | [redacted] |
| CCS#2 | Schlumberger | Sonic Scanner, FMI, CAL, GPIT | 5/3/2015 | [redacted] |
| CCS#2 | Schlumberger | ECS, HNGS | 5/3/2015 | [redacted] |
| CCS#2 | Schlumberger | Variable Density CBL | 5/31/2015 | [redacted] |
| CCS#2 | Schlumberger | Isolation Scanner Cement Evaluation | 5/31/2015 | [redacted] |
| CCS#2 | Schlumberger | Isolation Scanner Casing Integrity | 5/31/2015 | [redacted] |
| CCS#2 | Schlumberger | GR, CAL, SP, Resistivity, RHOB, NPHI | 5/29/2015 | [redacted] |
| CCS#2 | Schlumberger | Sonic Scanner, FMI, CAL, GPIT | 5/29/2015 | [redacted] |
| CCS#2 | Schlumberger | CMR, Litho Scanner, HNGS | 5/29/2015 | [redacted] |
| CCS#2 | Schlumberger | MSCT | 5/29/2015 | [redacted] |
| CCS#2 | Schlumberger | Multi-finger Imaging Tool | 6/10/2015 | [redacted] |
| CCS#2 | Schlumberger | Variable Density CBL | 6/10/2015 | [redacted] |
| CCS#2 | Schlumberger | Isolation Scanner Cement Evaluation | 6/10/2015 | [redacted] |

| Well Name | Log Vendor | Log Title | Date Run | Depth Interval (MD ft. KB ) |
|---|---|---|---|---|
| CCS#2 | Schlumberger | Isolation Scanner Third Interface Echo | 6/10/2015 | Sensitive, Confidential, or Privileged Information [redacted] |
| [redacted] | | | | |
| VW#1 | | GR, SP, Resistivity, RHOB, NPHI, Sonic | | [redacted] |
| VW#1 | | CBL and/or Cement Imaging | | [redacted] |
| VW#1 | Schlumberger | GR, CAL, Resistivity, RHOB, NPHI | | [redacted] |
| VW#1 | Schlumberger | Sonic Scanner | | [redacted] |
| VW#1 | Schlumberger | GR, CAL, Resistivity, RHOB, NPHI | | [redacted] |
| VW#1 | Schlumberger | Sonic Scanner | | [redacted] |
| VW#1 | Schlumberger | MDT | 10/25/2010 | [redacted] |
| VW#1 | Schlumberger | XPT (Pressure Express Tool) | 11/17/2010 | [redacted] |
| [redacted] | | | | |
| VW#2 | Schlumberger | GR, CAL, Resistivity, RHOB, NPHI | 10/8/2012 | [redacted] |
| VW#2 | Schlumberger | Sonic Scanner | 10/8/2012 | [redacted] |
| VW#2 | Schlumberger | GR, CAL, Resistivity, RHOB, NPHI | 10/31/2012 | [redacted] |
| VW#2 | Schlumberger | Sonic Scanner | 10/31/2012 | [redacted] |
| VW#2 | Schlumberger | XPT (Pressure Express Tool) | 10/31/2012 | [redacted] |
| VW#2 | Schlumberger | RST | | [redacted] |

7.1.2.2 Proposed CCS#5, CCS#6 and CCS#7 Logs

Table 7.1.2-2 presents the proposed log suite for CCS#5, CCS#6 and CCS#7. Each open hole section (prior to setting each casing string) will be logged with multiple suites to fully characterize the geologic formations (reservoirs and seals). The logging program will include resistivity, spontaneous potential (SP), gamma ray (GR), cement bond, and caliper logs.

**Table 7.1.2-2.** Proposed Logging CCS#5, CCS#6 and CCS#7

| Log Type (Open Hole or Cased Hole) | Log Run Title | Hole Section |
|---|---|---|
| Open Hole | GR, SP, Resistivity, Caliper | Sensitive, Confidential, or Privileged Information [redacted] |
| Cased Hole | Radial Cement Bond Log | |
| Cased Hole | Temperature Log | |
| Open Hole | GR, SP, Resistivity, Caliper | |
| Open Hole | Bulk Density, Neutron Porosity | |
| Open Hole | Sonic | |
| Cased Hole | Radial Cement Bond Log or Ultrasonic Cement Bond Log | |
| Cased Hole | Temperature Log | |
| Open Hole | Spectral GR, SP, Resistivity, Caliper | |
| Open Hole | Bulk Density, Neutron Porosity | |
| Open Hole | Sonic | |
| Open Hole | Nuclear Magnetic Resonance | |
| Open Hole | Fracture Finder | |
| Cased Hole | Radial Cement Bond Log or Ultrasonic Cement Bond Log | |
| Cased Hole | Temperature Log | |

With the exception of the 20” conductor casing, a cement bond log (CBL) with radial capability and/or ultrasonic cement imaging logs will be run on all casing strings. In addition to cement evaluation data, ultrasonic imaging and/or multi-finger caliper (MFC) logs will provide baseline casing thickness and/or internal radius measurements. Follow-up MFC logs will be performed in the event the injection tubing is removed during a well recompletion or workover.

Regarding the conductor casing, due to the large casing size, a cement bond log with radial imaging is not practical and when performed typically yield ambiguous results. To achieve good cement mechanical integrity, the best practice indicators are returning excess clean cement to the surface during cement displacement, having minimal cement fallback after completing cement displacement, and successfully passing a casing shoe test.

Based on previous experience with CCS#1 and CCS#2, hydraulic stimulation of the injection zone is not expected but an acid matrix stimulation to reduce perforation skin damage may be necessary. To reduce the risk of formation damage during well perforation, the operator will employ a static or dynamic underbalanced techniques.

After the well is cased, pre-injection testing will be performed to provide well specific data for the reservoir model. During these tests, P/T gauges will be deployed near the perforated interval while the pressure fall-off and step rate tests are performed. The final perforating scheme will be based on interpretation of the test results.

After installation of the 5-1/2” injection tubing, a baseline temperature and pulse neutron (PN) log will be performed. These logs will be compared to subsequent timelapse logs to inform the operator about the accumulation and movement of $CO_2$ behind the wellbore and the state of the well’s mechanical integrity. The PN logs will provided information about the location and vertical movement of $CO_2$ near the wellbore. This allows the operator to monitor the movement of $CO_2$ within the injection zone and above the seal formation. Both logging techniques will be used to demonstrate the mechanical integrity of the well.

7.1.2.3 Proposed Mechanical Integrity Testing

After setting and cementing the casing, a radially capable cement imaging log and casing inspection log will be run to evaluate the cement bond between the casing and the reservoir and to provide a baseline casing inspection log. Next, the casing string will undergo a one-hour pressure test at 750 psig and will pass if the pressure loss is less than 3%. After passing these tests, the well will be perforated and completed with 5.5-inch tubing and packer assembly. After well completion, the tubing/casing annulus will undergo a one-hour pressure test. As mentioned above, a baseline pulse neutron log will be run. Repeat PN logs can be run if anomalous temperature data indicates a need for further analysis. Monitoring the distributed temperature system (DTS) data across the top of the Mt. Simon Sandstone formation, as well as the porous zones above the seal, will be used to validate the integrity of the completion. Table 7.1.2-3 below is a summary of the pre-injection testing program.

**Table 7.1.2-3** Summary of MITs and Pressure Fall-Off Test to be Performed Prior to Injection

| Class VI Rule Citation | Rule Description | Test Description | Program Period |
|---|---|---|---|
| [40 CFR 146.89(a)(1)] | MIT – Internal | Annulus Pressure Test | Prior to Operation |
| [40 CFR 146.87(a)(4)] | MIT – External | OA or Temperature Log | Prior to Operation |
| [40 CFR 146.87(e)(1)] | Testing prior to operating | Pressure Fall-off Test | Prior to Operation |

## 7.2 Injection zone characterization and core sampling

ADM will provide the agency 30 days notification for the planned CCS#5, CCS#6, CCW#7, VW#4 and VW#5 coring events and/or reservoir fluid sampling. Because the permittee has a significant data set from previously obtained whole core samples, the permittee may only obtain sidewall cores from the new wells.

### 7.2.1 Historic injection zone fluid characterization and core sampling

The following information provides a review of the historic coring and fluid sampling programs. This dataset supports the basis of the proposed coring and reservoir fluid sampling programs for CCS#5, CCS#6 and CCS#7.

7.2.1.1 Historic Fluid Sampling

This section discusses the historic fluid sampling that has been conducted in CCS#1 and CCS#2 to characterize the Eau Claire (confining zone) and Mt. Simon (injection zone). The previous sampling and analysis of the fluid of the injection zone included fluid temperature, pH, conductivity, reservoir pressure, and static fluid level. In addition, total dissolved solids (TDS), fluid chemistry, density, and viscosity of the fluid in the injection zone were performed. The fluid samples were collected using Schlumberger’s Modular Formation Dynamics Tester (MDT). Sampling of CCS#1 and CCS#2 were completed using the MDT tool at several depths within the Mt. Simon. Average fluid parameters of the injection zone are included in Table 7.2.1-1. These were collected using the MDT at multiple points in the injection zone. Using the fluid parameters from Table 7.2.1-1 , an estimated static fluid level for the injection reservoir was calculated to be 249.5 feet above mean sea level (AMSL). Explanation of the historical analyses and results are discussed in more detail in previous permit applications and completion reports.

**Table 7.2.1-1.** Average Injection Zone Fluid Parameters

| Constituent | Value |
|---|---|
| Conductivity (mS/cm) | Sensitive, Confidential, or Privileged Information [redacted] |
| TDS (mg/L) | |
| $Cl^-$ (mg/L) | |
| $Br^-$ (mg/L) | |
| Alkalinity (mg/L) | |
| $Na^+$ (mg/L) | |
| $Ca^{2+}$ (mg/L) | |
| $K^+$ (mg/L) | |
| $Mg^{2+}$ (mg/L) | |
| pH (units) | |
| Pressure (psi) | |
| Temperature (deg. F) | |
| Density (g/L) | |
| Viscosity (Pa sec) | |

Historic information pertaining to physical characteristics of the injection and confining zone can be derived from log and core data and are discussed below.

7.2.1.2 Historic Well Coring Programs

Thorough coring programs, utilizing both conventional whole core and rotary sidewall core and including wide-ranging analytical suites, were performed at CCS#1, CCS#2, VW#1, VW#2, and GM#2. While the focus on coring and analysis was the confining and injection zones in VW#2 and CCS#2, core-related information on overlying formations was also gathered in VW#1, CCS#1, and GM#2. A total of approximately 1,268 feet of whole core was recovered between the five wells, the bulk of which was captured in VW#1 (700 feet) and VW#2 (392 feet). Recovered sidewall core samples from the two injection wells and two verification wells totaled 400 samples. Of these 400 samples, 174 sidewalls were from VW#1, 62 sidewalls were from CCS#1, 69 sidewalls were from VW#2, and 95 sidewalls were from CCS#2. A summary of the core collected in these wells is presented in Appendix D and is discussed in more detail below.

Sensitive, Confidential, or Privileged Information

[redacted]

Sensitive, Confidential, or Privileged Information

[redacted]

### 7.2.2 Proposed Coring and Fluid Sampling Program

This section addresses the pre-operational sampling proposed by ADM to ensure that sufficient characterization of the subsurface at CCS#5, CCS #6 and CCS #7 is performed in addition to satisfying Class VI regulations. These requirements include injection and confining zone physical and chemical characteristics including coring and formation fluid sampling. Subpart (f) of §146.87 requires 30-day notice of any logging or testing of the Class VI well to the Director so that the Director has the opportunity to witness well activities.

7.2.2.1 Proposed Coring Program

The coring program and analysis that ADM performed at CCS#1, CCS#2, VW#1, and VW#2 provides extensive characterization of various formations, particularly the confining zone and injection zone, as described in Section 7.2.1. Appendix D provides more detail on the core data collected in these wells. The data provided from the site wells included both whole core and sidewall core focusing on the confining zone and injection zone. The testing in the existing core included routine core analysis (porosity, permeability, grain density, fluid saturations, and lithology descriptions), mercury injection capillary pressure, geomechanics, x-ray diffraction, quantitative evaluation of minerals by scanning electron microscopy, focused ion beam electron microscopy, tight rock analysis, total organic carbon content, nuclear magnetic resonance, pulse decay permeability, laser grain size analysis, CT scanning, and thin sections.

The coring program for CCS#5, CCS#6 and CCS#7 may include whole core within the confining zone (Eau Claire) and injection zone (Mt. Simon), as well as potential sidewall coring within select formations, as necessary based on open hole logging results. Routine core and geomechanical analysis will be performed on recovered core, as applicable. Data will be correlated with openhole geophysical well logs from the wells, and compared to core sample results obtained from previous wells.

7.2.2.2 Proposed Fluid Sampling Program

Although sufficient data has been acquired from the reservoir from the two injectors already installed and tested at the site, prior to any well testing in a newly drilled well a sample of the formation fluid from the injection zone will be collected to measure the pH, conductivity, physical, chemical, static fluid level and other characteristics to satisfy §146.87 (c) and (d)(3), and to determine whether the $CO_2$ plume has reached any newly drilled injector (CCS#5, CCS#6 and CCS#7) during the time of completion. These data are also important in the analysis of the initial pressure falloff test. Collection of these data, and previous reservoir sampling in combination with temperature and pressure logs noted in Section 7.4 Injection and confining zone formation testing , will satisfy §146.87 (c).

Well sampling will be conducted to satisfy regulations stated in Section 7.2. While a similar method of sample collection via wireline used to sample CCS#1 and CCS#2 is expected, the detailed procedure will depend on borehole conditions encountered during operations, as well as equipment and personnel availability experienced near the time of completion of the well. Detailed procedures outlining the expected sampling and subsequent analysis will be submitted in accordance with federal regulations and guidance prior to implementing a specific sampling procedure in the field.

## 7.3 Fracture pressure and downhole hydrogeologic testing of conditions

Specific regulatory requirements exist as permitting standards for testing and data collection associated with new wells. As presented at 40 CFR §146.82 (c), (d) and (e), the following are among the data that must be acquired for any new Class VI Injection well:

(c) The owner or operator must record the fluid temperature, pH, conductivity, reservoir pressure, and static fluid level of the injection zone(s).

(d) At a minimum, the owner or operator must determine or calculate the following information concerning the injection and confining zone(s):

  (1) Fracture pressure

(e) Upon completion, but prior to operation, the owner or operator must conduct the following tests to verify hydrogeologic characteristics of the injection zone(s):

(1) A pressure fall-off test; and

(2) A pump test; or

(3) Injectivity tests.

CCS#5, CCS#6 and CCS#7 are new wells that may be installed at the site in the future and hence must comply with requirements at 40 CFR §146.87 (c), (d) and (e) (see Section 7.2 for the proposed fluid sampling and coring program). Data obtained as part of previous injection and monitoring requirements at the site are relevant to data acquisition to be collected from any new site wells. Historic activities are summarized in Section 7.3.1, which supports the proposed data collection activities presented in Section 7.3.2.

### 7.3.1 Historic testing

This section discusses the historic testing that has been conducted in CCS#1 and CCS#2 to characterize the Eau Claire (confining zone) and Mt. Simon (injection zone).

The well testing performed in both injection wells at the ADM site consisted of a pressure build-up falloff test (FOT) and a step rate test (SRT). The well testing performed in CCS#1 and CCS#2 are presented in Table 7.3-1. As presented in previous and forthcoming sections, historical sampling and testing activities conducted to characterize the subsurface at the site were comprehensive. No pressure transient testing was conducted in the VM wells.

<u>7.3.1.2 Historic Reservoir Testing</u>

Well testing in the two injection wells CCS#1 and CCS#2 included an initial FOT and an SRT. A description of tests performed at each injection well is discussed in greater detail below and summarized in Table 7.3-1.

**Table 7.3-1.** Testing Summary: Existing Site Wells

| Activity | Well | Formation | Depth (feet KB) | Comment |
|---|---|---|---|---|
| Pressure of Reservoir | CCS#1 | Sensitive, Confidential, or Privileged Information [redacted] | | From Pressure Falloff |
| | CCS#2 | | | From Pressure Falloff |
| Pressure Step Rate | CCS#1 | | | Permit Perforations |
| | CCS#2 | | | Permit Perforations (Gross Interval) |
| Pressure Falloff | CCS#1 | | | Permit Perforations |
| | CCS#2 | | | Permit Perforations (Gross Interval) |

<u>CCS 1 Test History</u>

Three FOTs of varying duration were conducted in September and October 2009 as part of the initial completion of CCS#1. FOT involve two parts. During the first portion of the falloff tests, the reservoir was stressed by injecting fluid at a (traditionally) relatively stabilized rate, causing an increase in reservoir pressure. During the second portion of the test, injection was stopped and the well shut-in while the reservoir pressure monitored as it decayed and approached near-static condition.

Sensitive, Confidential, or Privileged Information [redacted] To conduct initial reservoir testing, water, treated with a clay-stabilizing potassium chloride (KCl) substitute, was injected at rates of between 1.5 to 2.0 barrels per minute (bpm) (63 to 84 gallons per minute [gpm]) for approximately two hours. A 19.5-hour pressure falloff period followed this injection period.

After this test, the perforations were acidized and an SRT was conducted by pumping at increasing rate steps to observe a change of the well injectivity.  Following the SRT, treated water was injected at a rate of 3.1 bpm (130 gpm) for five hours. After this period of relatively stable injection, the well was shut in and pressure was monitored for approximately 45 hours as a second FOT.

A third FOT was conducted after additional perforations were made in the well and subsequently stimulated with acid. Sensitive, Confidential, or Privileged Information [redacted] For the third FOT, treated water was injected at an increasing rate of 3.1 to 4.2 bpm (130 to 176 gpm) over 6.5 hours and then at 4.2 bpm (176 gpm) for an additional 6.5 hours. After this 13-hour period of injection, the well was shut in and pressure was monitored for 105 hours.

Analysis of the pressure transient data using analytical simulations was performed by Schlumberger. [redacted]

Sensitive, Confidential, or Privileged Information [redacted] This analysis was performed graphically by plotting the pressure at the end of each step versus rate.  The intersection of lines before and after a pressure sensitive threshold was used to estimate the fracture pressure. This approach is an industry standard method for estimating conservative values.

Copies of the pressure transient data and analyses were presented to EPA in previous reports and are available upon request.

Sensitive, Confidential, or Privileged Information [redacted]

<u>CCS#2 Test History</u>
An SRT and two FOTs were performed in July 2015 as part of the initial completion of CCS#2.
Sensitive, Confidential, or Privileged Information [redacted]

This data was analyzed by Schlumberger and was reported in an Injection-Falloff Analysis dated August 24, 2015. Schlumberger's Report Summary stated:

> Sensitive, Confidential, or Privileged Information [redacted]

Sensitive, Confidential, or Privileged Information [redacted]

Sensitive, Confidential, or Privileged Information [redacted]

Copies of the pressure transient data and analyses were presented to EPA in previous reports and are available upon request.

### 7.3.2 Proposed CCS#5, CCS#6 and CCS#7 testing program

This section addresses the pre-operational testing proposed by ADM to ensure that sufficient characterization of the subsurface at CCS#5, CCS#6 and CCS#7 is performed and to satisfy Class VI regulations. These requirements include those addressed in Section 7.2 (e.g., injection and confining zone physical, chemical, and fluid characteristics) as well as fracture pressure determination and well testing located in §146.87(d)(1) and (e). ADM will provide 30-day notice of any logging or testing of the Class VI well to the Director so that the Director in order to provide the Agency the opportunity to witness such activities.

<u>7.3.2.1 Well Testing - Injection Zone</u>

After CCS#5, CCS #6 and CCS#7 are cased, perforated, and fluid sampling has been complete, an SRT will be performed to obtain a confirmatory estimate of the fracture pressure of the injection zone. Subsequent wells will not be subjected to an SRT upon completion unless irregular data is obtained from the third injection well. It is noted that the existing Class VI program offers the following discussion regarding the use of additional site SRT data, and similar practices are proposed for new injectors:

> "It was determined that these values (calculated based on CCS#1 results) accurately represent the system and will continue to be used for the fracture gradient and fracture pressure for CCS#2, until and unless more accurate project-specific data are available. A step-rate test run after the construction of CCS#2 yielded results that do not contradict initial fracture pressure gradient estimates, although some testing did produce inconclusive results. Injection pressure limits based upon this fracture pressure gradient should not create new fractures or extend any existing fractures. However, additional precautions for initial injection operations and monitoring have been added to Attachment A of this permit."

<u>7.3.2.2 Well Testing - Confining Zone</u>

As discussed in Section 7.3.2.2, a "mini-frac" using the MDT tool was used to estimate the fracture gradient of the confining zone in CCS#1 and CCS#2. In addition, dipole sonic data are available through the confining zone to estimate the geomechanics. If the results of CCS#5, CCS#6 and CCS#7 geophysical well logging conducted through the confining zone indicate that conditions are similar to the results found using previous logging conducted at CCS#1 and CCS#2, then no additional testing of the confining zone is proposed for CCS#5, CCS #6 and/or CCS #7. Dipole sonic logs will be correlated to existing well logs with similar results and can also be used to infer the representativeness of the CCS#1 and CCS#2 MDT "mini-frac" results.

## 7.4 Injection and confining zone formation testing

CCS#5, CCS #6 and CCS #7 are new wells that may be installed at the site in the future and hence must comply with requirements at 40 CFR §146.87 (a), (b) and (e). Data obtained as part of previous injection and monitoring requirements at the site are relevant to data acquisition to be collected from any new site wells and are summarized in Tables 7.1.2-1, 7.1.2-2, and 7.1.2-3. Historic activities are summarized in Section 7.3.1, which supports the proposed data collection activities presented in Section 7.3.2 because a significant quantity of data has already been obtained to characterize the site during previous testing that supports the proposed CCS#5, CCS#6 and CCS#7 program.

## 7.5 Quality Assurance Surveillance Plan (QASP)

The QASP is provided in APPENDIX C: Quality Assurance and Surveillance Plan which meets relevant requirements under 40 CFR 146.90