San Joaquin Renewables Class VI Permit Application Testing and Monitoring Plan

Prepared for

San Joaquin Renewables LLC
McFarland, California

Submitted to

U.S. Environmental Protection Agency Region 9
San Francisco, California

Prepared by

DBS&A
Daniel B. Stephens & Associates, Inc.

a Geo-Logic Company

43 Randolph Road, #129
Silver Spring, Maryland 20904
www.dbstephens.com
Project # DB19.1252.SS

June 29, 2023

TESTING AND MONITORING PLAN
40 CFR 146.90

SAN JOAQUIN RENEWABLES

1. Facility Information

Facility name:	San Joaquin Renewables Injection Well: SJR-I1
Facility contact:	T.J. Paskach, Ph.D. 1521 West F Ave, Nevada, IA 50201 515-292-1200 x121/tpaskach@frontlinebioenergy.com
Well location:	McFarland, Kern County, California 35.688330, -119.276642

This Testing and Monitoring Plan describes how San Joaquin Renewables (SJR) will monitor the site pursuant to 40 CFR 146.90. In addition to demonstrating that the well is operating as planned, the carbon dioxide plume and pressure front are moving as predicted, and that there is no endangerment to USDWs, the monitoring data will be used to validate and adjust the geological models used to predict the distribution of the CO_2 within the storage zone to support Area of Review (AoR) reevaluations and a non-endangerment demonstration.

Results of the testing and monitoring activities described below may trigger action according to the Emergency and Remedial Response Plan.

2. Overall Strategy and Approach for Testing and Monitoring

This Testing and Monitoring Plan is a component of the SJR application to the U.S. Environmental Protection Agency Region 9 (U.S. EPA) for an Underground Injection Control (UIC) Class VI permit for a planned facility located in McFarland, California. This plan is one of several separate documents submitted to the U.S. EPA Geologic Sequestration Data Tool (GSDT), and includes required information regarding planned testing and monitoring activities. Numerical modeling used to define the areas of anticipated carbon dioxide migration and the AoR are described in the Area of Review and Corrective Action Plan. Geologic analyses that underpin the conceptual model used in the AoR numerical modeling is primarily described in the narrative permit application report. Updating of the computational model is not a plume tracking method, but is a verification process.

The permit application and associated documents were prepared by a team including Daniel B. Stephens & Associates, Inc. (DBS&A), Driltek, Finsterle Geoconsulting, Keystone Diversified Energy, Inc. (KDEI), and Best Core Services.

2.1. Quality assurance procedures

A Quality Assurance and Surveillance Plan (QASP) for monitoring activities described in this report is included as Appendix 10.

2.2. Reporting procedures

SJR will report the results of all testing and monitoring activities to EPA in compliance with the requirements under 40 CFR 146.91. Data will be submitted in electronic format. In addition, SJR will notify the EPA Director at least 30 days prior to conducting any testing.

3. <u>Carbon Dioxide Stream Analysis</u>

SJR will analyze the CO_2 stream during the operation period to yield data representative of its chemical and physical characteristics and to meet the requirements of 40 CFR 146.90(a).

Anticipated injectate composition is presented in the narrative permit application report. The injectate is predicted to be 98.7-percent carbon dioxide by mass, with less than one percent of methane, benzene, ethane, and nitrogen making up the composition to 99.9-percent by mass.

The facility will have an in-house laboratory that will monitor injectate quality at least on a monthly basis, and often on a weekly or daily basis. In addition, on a quarterly basis the facility will collect a sample of the injectate for third-party laboratory analysis. Third-party samples will be extracted from a sample point just upstream of the wellhead via a valve and permitted to decompress into a gaseous phase within a sample holder for analysis by one of the methods described below. Standard methods will be used to calculate chemical and physical properties at in situ pressure and temperature from the results of analysis of the decompressed samples (U.S. EPA, 2013). Annulus pressure will be set at 50 psi for monitoring. The annulus/tubing differential will equal the injection pressure on the tubing less the annulus pressure (50 psig).

Third-party samples will be analyzed for the following using the analytical methods indicated (or equivalent with prior U.S. EPA approval):

- Carbon dioxide purity (ASTM E1747)
- Total sulfur (International Society of Beverage Technologists [ISBT] 14.0 or ASTM D3246)
- Hydrogen sulfide (ISBT 14.0 or ASTM D1945/D6228)
- Nitrogen (ISBT 4.0 or ASTM D1945)
- Total Hydrocarbons (ISBT 10.0 or ASTM D1945)
- Methane (ISBT 10.1 or ASTM D1945)
- Water Vapor (ISBT 3.0 CH)

- Ammonia (ISBT 6.0 DT)
- Oxygen (ISBT 4.0 GC/DID)
- Carbon Monoxide (ISBT 5.0 or ISBT 4.0)
- Oxides of Nitrogen (ISBT 7.0 Colorimetric)

All sample containers will be labeled with a unique sample identification number indicating the date of sample collection, and will be submitted under chain-of-custody protocols to an off-site third party laboratory for analysis.

Carbon dioxide injectate analyses will be submitted in semi-annual reports, including a list of all chemical analyses, original third-party laboratory reports, chain-of-custody forms, tabular results including in-house laboratory and third-party laboratory results, description of sampling activities, data interpretation, and identification of data gaps.

4. <u>Continuous Recording of Operational Parameters</u>

Continuous recording devices will be installed to monitor injection pressure, rate, and volume in the injection well. Injection and monitoring well schematics are provided in Appendix 11. Continuous monitoring will include (also see Table 1):

- Gas flow control valves, backpressure and check valves to be installed on the wellhead and flow lines to ensure injection to individual completion zones.
- Temperature and pressure gauges at the surface (calibrated over the full operational range annually).
- Coriolis mass flowmeter located at the wellhead or transfer pipeline at the facility prior to the wellhead. The flowmeter will be calibrated using standard methods to within 0.1 percent over the entire expected range of flow rates.
- Surface telemetry of pressure, temperature and injection rates.
- Downhole fiber optics for monitoring of completion zone pressure and temperature by interval.
- Pressure gauge to monitor pressure on the annulus between the tubing and long-string casing to verify internal mechanical integrity.
- Downhole density calculation based on measured pressure and temperature (e.g., Ouyang, 2011).
- Volume-based flow rate will be calculated based on the mass-based flow rate and the downhole density.

Injection rate data will be submitted to the U.S. EPA in semi-annual reports. Semi-annual reports will include electronic data submission of all raw data, tabular data of all flow rate measurements, monthly average flow rate, monthly maximum and minimum values, total monthly injected volume, cumulative volume over the lifetime of the project, flagging of any flow rate exceedances, and identification of data gaps.

Table 1. Sampling devices, locations, and frequencies for continuous monitoring.

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
Injection pressure	Pressure Gauge	Surface and downhole	30 seconds	2 minutes
Injection rate	Flowmeter	Surface	30 seconds	2 minutes
Injection volume	Calculated	Surface	30 seconds	2 minutes
Annular pressure	Pressure Gauge	Surface	30 seconds	2 minutes
Annulus fluid volume		Surface	4 hours	24 hours
Temperature	Temperature Gauge	Surface and downhole	30 seconds	2 minutes

Notes:

- Sampling frequency refers to how often the monitoring device obtains data from the well for a particular parameter. For example, a recording device might sample a pressure transducer monitoring injection pressure once every two seconds and save this value in memory.
- Recording frequency refers to how often the sampled information gets recorded to digital format (such as a computer hard drive). For example, the data from the injection pressure transducer might be recorded to a hard drive once every minute.

5. Corrosion Monitoring

To meet the requirements of 40 CFR 146.90(c), SJR will monitor well materials during the operation period for loss of mass, thickness, cracking, pitting, and other signs of corrosion to ensure that the well components meet the minimum standards for material strength and performance.

Well corrosion monitoring will be conducted to ensure wellbore mechanical integrity over the life of the project. Corrosion will be assessed quarterly using the corrosion coupon method. Coupons representative of the long string casing, injection tubing and wellhead materials, based on the materials used for the injection well, will be installed in a flow-through pipe arrangement directly upstream of the wellhead (Table 2). Coupon corrosion will be evaluated based on ASTM G1-03 or National Association of Engineers (NACE) TM01-69 including photographs, dimensional measurement and weighing.

An integrity concern would be identified from a measured corrosion rate of more than one mils per year (mpy; equal to a thousandth of an inch) per the EPA Testing and Monitoring Guidance (U.S. EPA, 2013).

Table 2. List of equipment coupon with material of construction.

Equipment Coupon	Material of Construction
Long string casing	L-80 CR13/29#/long
Injection tubing	Cr-13 L80/4.7#/Gas tight premium connection, JFE Bear or equivalent.
Wellhead materials	Chrome alloy consistent with final well construction

Corrosion monitoring will also include casing inspection logs using one or more of the following methods if requested by the UIC Program Director and/or as triggered by an integrity concern based on corrosion coupon monitoring:

- Ultrasonic imaging log to gauge casing inside and outside roughness and thickness, casing to cement bond.
- Multi-finger caliper to evaluate inner metal loss.
- Electromagnetic flux log to evaluate total metal loss.
- Downhole video if necessary to identify casing problems where other logs may be ambiguous.

Casing inspection logging procedures will be consistent with U.S. EPA (2013) and references therein.

Semi-annual reports will include the results of corrosion monitoring, including a narrative description of all corrosion monitoring activities, corrosion coupon measurement results in tabular form including all historical results, photographs of corrosion coupons, all casing inspection logs and interpretations, and identification of any data gaps.

6. Groundwater Quality Monitoring

SJR will monitor groundwater quality and geochemical changes above the confining zone during the operation period to meet the requirements of 40 CFR 146.90(d). Groundwater quality monitoring will be conducted above the primary confining zone (Freeman Jewett formation) and within USDWs in the vicinity. Should any of the USDW wells be plugged by their owners, SJR will notify U.S. EPA and identify whether additional monitoring wells are needed and revise the plan if necessary. In addition, the results of formation water quality analyses conducted during drilling of the injection and monitoring wells will be used to confirm the appropriateness of the analytes selected for subsequent water quality analyses. Water quality sampling/analysis will be performed in accordance with the QASP (Appendix 10).

6.1. Above Confining Zone Monitoring

One dedicated monitoring well (ACZ well) will be installed at the SJR property in the vicinity of the injection well that will be screened in the first formation overlying the confining zone that has a sufficient permeability to support collection and analysis of ground water samples (Olcese Formation Sandstone). Pressure increase within the Vedder formation is greatest at the injection well; therefore this location represents the maximum risk of vertical fluid leakage. In addition, separate-phase carbon dioxide is predicted to extend only to the direct vicinity of the project site. Figure 1a displays the planned location of the ACZ monitoring well relative to simulated carbon dioxide saturation at various times during and after injection, and Figure 1b displays the monitoring well locations overlaid with the maximum pressure increase (see the AoR and Corrective Action Plan).

The ACZ well will be screened within the Olcese Formation, which occurs from approximately 6,625 to 7,095 feet below ground surface (ft bgs) at the SJR site. Per U.S. EPA guidance the perforated interval will be in the lower parts of the Olcese, closer to the Freeman Jewett formation (perforated approximately 7,045 to 7,095 ft bgs pending verification of stratigraphy upon drilling of the injection well). The ACZ monitoring well will be drilled and constructed according to U.S. EPA (2013) specifications.

The ACZ will be fitted with a continuous pressure gauge in order to monitor increases in pressure that may indicate fluid leakage. In addition, fluid samples will be collected quarterly during the injection phase for the following per U.S. EPA (2013) protocols (slickline downhole sampling device to maintain in-situ conditions):

- Carbon dioxide (ASTM D513-16)
- Dissolved metals (EPA 200.7, Rev. 4.4; 200.8, Rev. 5.4; 200.9, Rev. 2.2.)
- Total dissolved solids (ASTM D5907-18)
- Major anions (EPA 300.0))(Br^-, Cl^-, F^-, NO^-, NO_3^-, SO_2^4)
- Major cations (EPA 6020 [Feb 2007 version])(Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Sr, Ag, Na, Sn, Ti, Tl, V and Zn)
- Mercury (EPA 7470)
- pH, temperature, specific conductivity (calibrated field meter/flow-through cell)(documentation to be retained indicating reference standards are not out of date).
- Dissolved oxygen (calibrated field meter/flow-through cell)
- Hydrogen sulfide (Hach® 2537800 Hydrogen Sulfide field Test Kit, Model HS-C)(24-hour holding time)
- Alkalinity (SM 2320B)
- Dissolved methane (RSK-175 gas chromatography)

At least three sets of baseline water-quality samples will be collected upon installation of the ACZ monitoring well and prior to injection, spanning a period of at least six weeks. Baseline pressure will also be monitored continuously for a period of at least six weeks prior to injection.

Samples will be collected after the well has been purged sufficiently that field parameters (e.g., pH, temperature, specific conductivity) have stabilized. Samples will be collected in bottles provided by a third-party laboratory, and will be submitted under chain-of-custody protocols to the laboratory. Quality assurance/quality control (QA/QC) samples will include one field duplicate, one equipment rinsate/blank, one matrix spike (where needed based on the analytical method) and one trip blank.

6.2. USDW Monitoring

Several groundwater production wells located within the vicinity of the project are routinely monitored for groundwater level and water quality as a component of compliance with the California Sustainable Groundwater Management Act (SGMA). The project vicinity coincides with the Southern San Joaquin Municipal Utility District (SSJMUD) Management Area, which is located within the larger Kern County groundwater subbasin (GEI, 2019). West of the Pond Poso fault the area coincides with the North Kern Water Storage District (NKWSD). SSJMUD and NKWSD have identified wells that will be subject to routine monitoring under SGMA.

Figure 2 presents an overlay of the AoR and groundwater wells identified for monitoring under SGMA that will also be monitored for the SJR project. Information regarding each of these wells is reproduced from GEI (2019) in Appendix 12. Wells are owned by the City of Delano, the City of McFarland, NKWSD, and private parties. All supply wells in the vicinity, including these designated wells for monitoring, are screened within USDWs overlying the SJR project site. SSJMUD/NKWSD monitors each of these wells for water-quality data (GEI, 2019). Additional well construction for USDW monitoring wells will be requested from SSJMUD/NKWSD and/or obtained from well investigations (e.g., tagging the bottomhole depth), and provided to U.S. EPA when available.

SJR will seek to enter into a memorandum of understanding (MOU) with SSJMUD/NKWSD to (1) gain access to water-quality data obtained from each of the monitoring wells in their network within the vicinity as shown on Figure 2; and (2) if needed in order to obtain necessary water-quality parameters, obtain access to the wells for periodic direct sampling. SSJMUD/NKWSD wells within the project vicinity that will be sampled are shown on Figure 2.

SJR will seek to collect the following data on a semi-annual basis:

- Carbon dioxide (ASTM D513-16)
- Dissolved metals (EPA 200.7, Rev. 4.4; 200.8, Rev. 5.4; 200.9, Rev. 2.2.)
- Total dissolved solids (ASTM D5907-18)
- Major anions (EPA 300.0))(Br^-, Cl^-, F^-, NO^-, NO_3^-, SO_2^4)

- Major cations (EPA 6020 [Feb 2007 version])(Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Sr, Ag, Na, Sn, Ti, Tl, V and Zn)
- Mercury (EPA 7470)
- pH, temperature, specific conductivity (calibrated field meter/flow-through cell)(documentation to be retained indicating reference standards are not out of date).
- Dissolved oxygen (calibrated field meter/flow-through cell)
- Hydrogen sulfide (Hach® 2537800 Hydrogen Sulfide field Test Kit, Model HS-C)(24-hour holding time)
- Alkalinity (SM 2320B)
- Dissolved methane (RSK-175 gas chromatography)

All data, including original laboratory reports and field notes, will be obtained from SSJMUD/NKWSD if possible. If SJR needs to collect samples independently, samples will be collected after the well has been purged sufficiently that field parameters (e.g., pH, temperature, specific conductivity) have stabilized. Samples will be collected in bottles provided by a third-party laboratory, and will be submitted under chain-of-custody protocols to the laboratory. Quality assurance/quality control (QA/QC) samples will include one field duplicate, one equipment rinsate/blank, one matrix spike (where needed based on the analytical method) and one trip blank.

6.3. Data Interpretation and Reporting

SJR will maintain an electronic database of all monitoring results, that will record date of sample collection, resulting sample concentrations, analysis date, analytical detection limit, and any QA/QC flags.

All groundwater quality data will be subjected to standard quality review prior to data interpretation per Standard Methods (1999). Data quality evaluation will include calculation of the cation-anion balance (CAB) with the following acceptable criteria:

- Anion Sum (meq/L) 0 – 3.0, Acceptable Difference = 0.2 meq/L
- Anion Sum (meq/L) 3.0 – 10.0, Acceptable Difference = 2%
- Anion Sum (meq/L) 10 – 800, Acceptable Difference = 5%

Charge balance error will also be calculated for analyses where the anion sum is greater than 800 meq/L, with the limit of accepting an analysis by the charge balance error calculation being 5%. A final check will include comparison of measured and calculated TDS, and the ratio of measured to calculated TDS should be within 1.0 to 1.2 (Standard Methods, 1999).

SJR will evaluate all groundwater quality monitoring data against baseline samples collected prior to injection for any indication of fluid leakage, including:

- Increasing TDS
- Changing major cation/anion signature, as displayed on standard Piper and Stiff diagrams
- Increasing carbon dioxide concentration
- Decreasing pH
- Increasing concentration of dissolved metals, which (along with other indications listed above), may indicate leaching of certain inorganics from the formation due to lowered pH

Groundwater quality monitoring results will be reported to U.S. EPA in semi-annual reports and in an electronic format, including the most recent water-quality database including all recent and historical results, complete original laboratory reports, data interpretation including time series charts, Piper and Stiff diagrams, narrative explanation of all sampling activities, data quality evaluation, calibration records for field meters, and identification of data gaps.

7. External Mechanical Integrity Testing

SJR will conduct at least one of the tests presented in Table 3 at the injection well and IZ and ACZ monitoring wells periodically during the injection phase to verify external MI as required at 146.89(c) and 146.90.

7.1. Testing location and frequency

MITs will be performed annually, up to 45 days before the anniversary date of authorization of injection each year. In addition, a deviation of +/- 25psi in annular pressure from the 50psi set point will trigger a mechanical integrity investigation for cause. If pressure drops or increases, it will be returned to its operating pressure and monitored to verify integrity. If the deviation continues, mechanical integrity will be verified. A wider range of pressure variation will be observed after an interruption in injection or well intervention or until the well stabilizes.

Table 3. MITs.

Test Description	Location
Temperature Log	Wireline log along wellbore
Oxygen Activation Log	Wireline log along wellbore

7.2. Testing details

Temperature and/or OALs will be conducted according to U.S. EPA (2013) specifications. Temperature logging procedures per U.S. EPA Region IX are provided in Appendix 13.

Temperature logs will be conducted with dedicated fiber optics for monitoring of completion zone pressure and temperature by interval by the following procedure:

- Upon well installation collect a baseline temperature profile representative of the natural geothermal gradient
- During operation record temperature profile for at least six hours prior to shutting in the well
- Stop injection and record temperature profile for approximately 36 hours.
- During the shut-in period, the temperature within the well bore will typically change toward static geothermal conditions. If there has been a leak of fluid out of the well, the temperature within the well bore at this location will change to a lesser degree and be measured as an anomaly because the temperature of the surrounding formation will have been modified by the leaking fluid (U.S. EPA, 2013).

OALs will be conducted only if necessary to resolve temperature logging results and further assess mechanical integrity if temperature logging results indicate potential failure. OAL procedures are provided in Appendix 13.

All external MIT results will be submitted to U.S. EPA in an electronic format within 30 days of the completion of each test. MIT reports will include charts and/or tabular results of each log including a comparison of the temperature profile during injection, during the shut-in over various time periods, and the background geothermal gradient, and a description of each test including date and time of test and well shut in.

8. <u>Pressure Fall-Off Testing</u>

SJR will perform pressure fall-off tests (PFOTs) during the injection phase as described below to meet the requirements of 40 CFR 146.90(f). U.S. EPA PFOT guidelines that will be followed are provided in Appendix 14. Upon initial completion of the injection well, a pressure fall-off test and injectivity test will be conducted to verify the fracture gradient and pressure for maximum allowable injection pressure, and a test will be repeated every five years to confirm reservoir and well conditions.

Pressure fall-off testing will include ceasing injection (shutting in the well at the wellhead) and monitoring pressure decay within the well. Continuous pressure measurements will be conducted with dedicated downhole fiber optics for monitoring of completion zone pressure and temperature by interval. A secondary pressure gauge will also be deployed during the test for verification. The shut-in period will be at least four days, or longer if needed to reach a straight-line of pressure decay on a semi-log plot.

Pressure readings and temperature within the well during the test will be plotted as a function of time prior to and during the test, including log-log and semi-log diagnostic plots. Observations of anomalous pressure decay at greater rates than previous tests may indicate a number of scenarios such as changes in relative permeability, the effects of well stimulation procedures, or leakage of fluid (U.S. EPA, 2002). The Site TOUGH numerical model will also be used to interpret the test results by adjusting model parameters to fit the observed decay curve and assess the resulting permeability.

Pressure fall-off test results will be submitted electronically to U.S. EPA within 30 days of the completion of each test in a tabular format, including a description of the test (date, duration), bottomhole pressure and temperature at specified depth(s), records of all gauges, raw data in a tabular format, injection rates and pressure prior to the test, diagnostic plots, plots of TOUGH modeling compared to pressure fall-off tests and changes to any TOUGH model parameters if necessary, calculated parameter values (permeability, transmissivity, skin factor), and identification of data gaps.

9. Carbon Dioxide Plume and Pressure Front Tracking

SJR will employ direct and indirect methods to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure during the operation period to meet the requirements of 40 CFR 146.90(g).

As required by the Class VI rule, plume and pressure-front tracking within the Vedder formation will include the following:

- Direct pressure and geochemical monitoring within the injection well and a monitoring well that will be installed within the Vedder formation

- Indirect geophysical monitoring (surface seismic) on a repeated basis within the area of projected carbon dioxide migration

- Computational modeling that is updated to incorporate monitoring results (computational modeling methodology is discussed in the AoR and Corrective Action Plan).

Pressure will be monitored directly within the injection well as discussed in Section 4, above. In addition, a monitoring well will be installed updip of the project in order to track pressure increases in the vicinity and ensure that pressure increase is similar to model projections. Figure 1a displays the planned location of the Injection-Zone (IZ) monitoring well (35.692503, -119.242309). The IZ monitoring well will be perforated exclusively within the Vedder formation, which is approximately 6,672 ft bgs at this location. Final perforated interval will be determined based on updated stratigraphy obtained during monitoring well drilling. The IZ monitoring well will be fitted with a downhole transducer for continuous pressure measurement. Geochemical groundwater monitoring will be conducted from the IZ-monitoring well on a semi-annual basis during the injection phase of the project via a slickline downhole sampling device to maintain in-situ sample conditions (U.S. EPA, 2013). Samples will be analyzed for the following:

- Carbon dioxide (ASTM D513-16)

- Total dissolved solids (ASTM D5907-18)

- Major anions (EPA 300.0))(Br^-, Cl^-, F^-, NO^-, NO_3^-, SO_2^4)
- Major cations (EPA 6020 [Feb 2007 version])(Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Sr, Ag, Na, Sn, Ti, Tl, V and Zn)
- pH (calibrated meter).

Figure 3 presents the simulated pressure changes at the IZ monitoring well location during the lifetime of the project based on the project TOUGH numerical model. Pressure measurements at the IZ well and injection well will be compared to corresponding model-simulated pressure profiles to confirm that pressure increases within the Vedder formation are not greater than simulated. Pressure monitoring data will be submitted to U.S. EPA in semi-annual reports, including raw pressure data, transducer calibration logs, time-series graphs of measured pressure versus model-simulated predictions, and identification of data gaps.

Indirect plume monitoring will include time-lapse three-dimensional surface seismic surveys covering the entire extent of the area anticipated to be subject to carbon dioxide migration. Figure 1a displays the anticipated seismic area overlaid with model simulated extent of carbon dioxide during the lifetime of the project. The anticipated area for seismic surveys is approximately six square miles. The 3D seismic survey will be conducted prior to injection (baseline), and at years 2, 5 and 10 during the injection phase. Seismic methods will be consistent with U.S. EPA (2013) including ensuring that the exact same methodology is used in repeat surveys. The second seismic survey will be completed prior to the initial AoR reevaluation. SJR will also include monitoring for seismic events via existing state- or USGS-operated seismic monitoring networks to afford an opportunity to respond to any events that could affect the injection/monitoring wells.

Surface-seismic results will provide an indication of whether supercritical-phase carbon dioxide is present in any given location, but does not generally provide an estimate of carbon dioxide saturation. Plan-view maps of survey results will be compared to model-predicted carbon dioxide extent as shown in Figure 1a. Geophysical survey results will be submitted to U.S. EPA in semi-annual reports following the survey event, including a detailed independent report by the geophysical contractor of all survey methods, map(s) showing all survey equipment positions, date/time of all survey data collection, near surface conditions during the test, raw seismic data and interpreted diagrams, maps showing the location of the carbon dioxide plume, and maps comparing the carbon dioxide plume progression over time to model simulated projections. All geophysical surveys and reporting will be overseen by a California Registered Professional Geophysicist.

References

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United States Environmental Protection Agency (U.S. EPA), 2002. EPA Region 6 UIC Pressure Falloff Testing Guideline, Third Revision (August 8, 2002).

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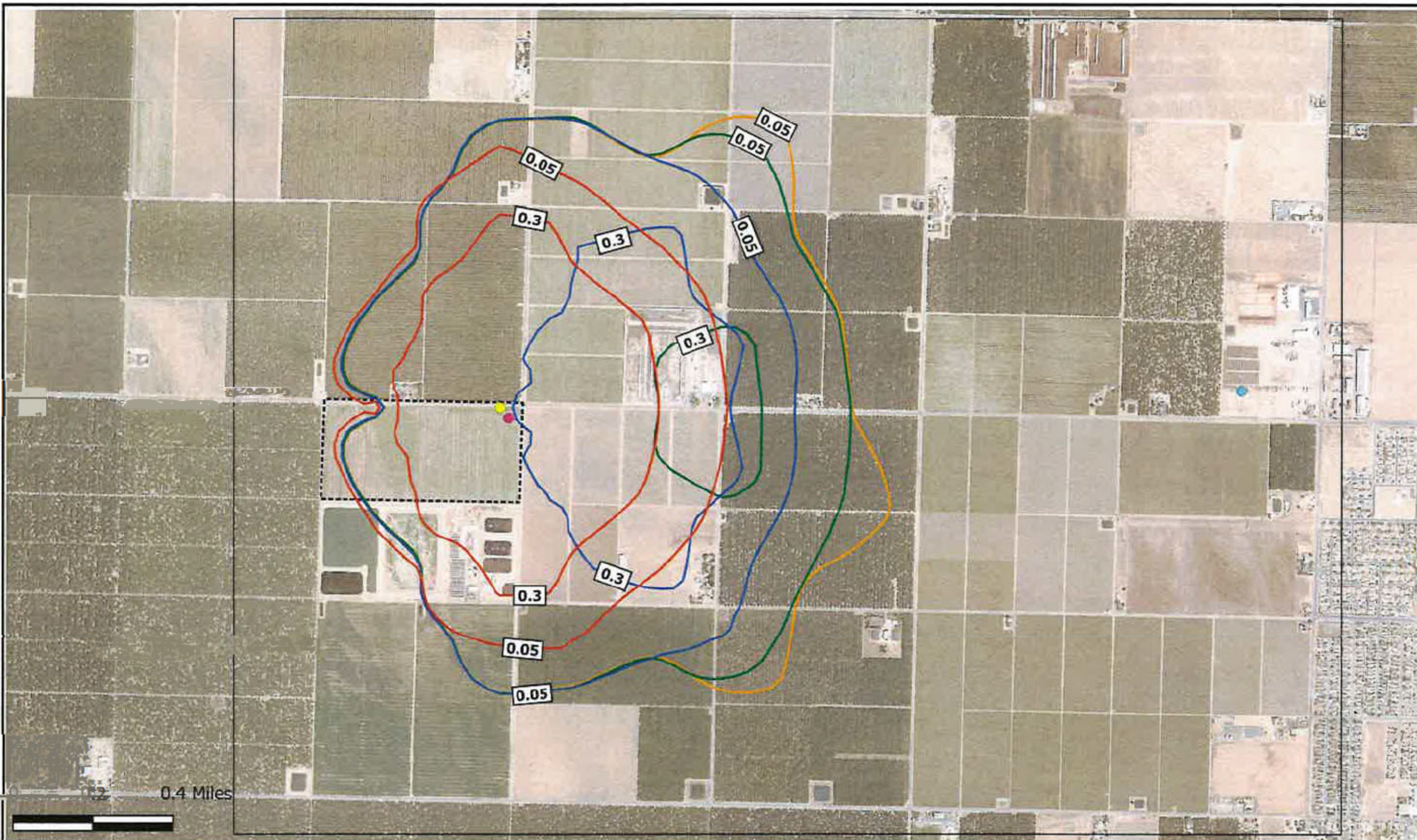
Figures



Explanation

- 15-Year
- 40-Year
- 75-Year
- 115-Year
- Injection Well
- Frontline Property Boundary
- 0.3 Simulated Carbon Dioxide Saturation

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Monitoring Wells

- Above Confining Zone
- Injection Zone
- Planned Seismic Area

Note: Carbon dioxide saturation after the 115-year simulation period is < 0.3

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TOUGH2 simulated maximum carbon dioxide saturation and planned monitoring network

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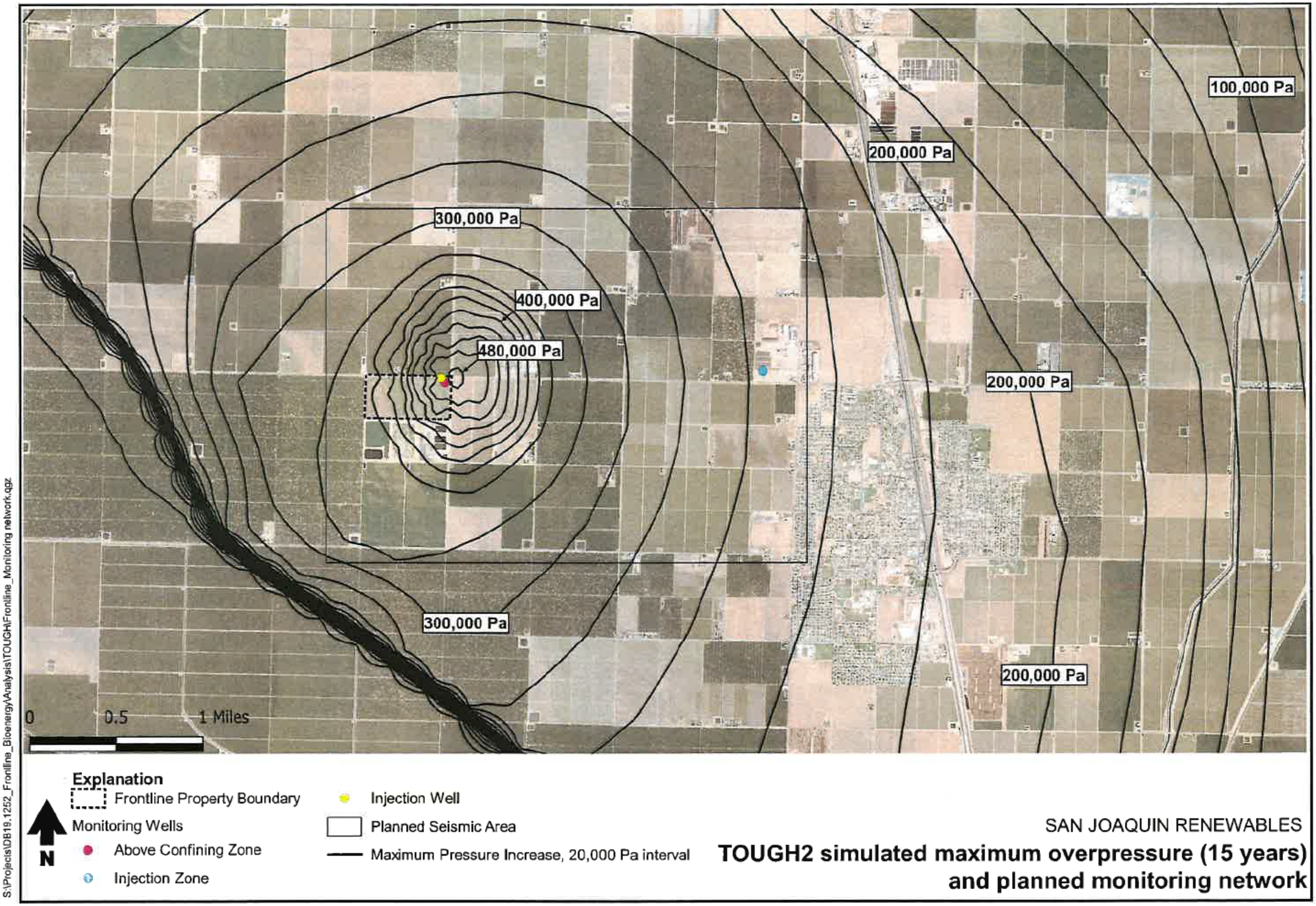
Figure 1a



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TOUGH2 simulated maximum overpressure (15 years) and planned monitoring network

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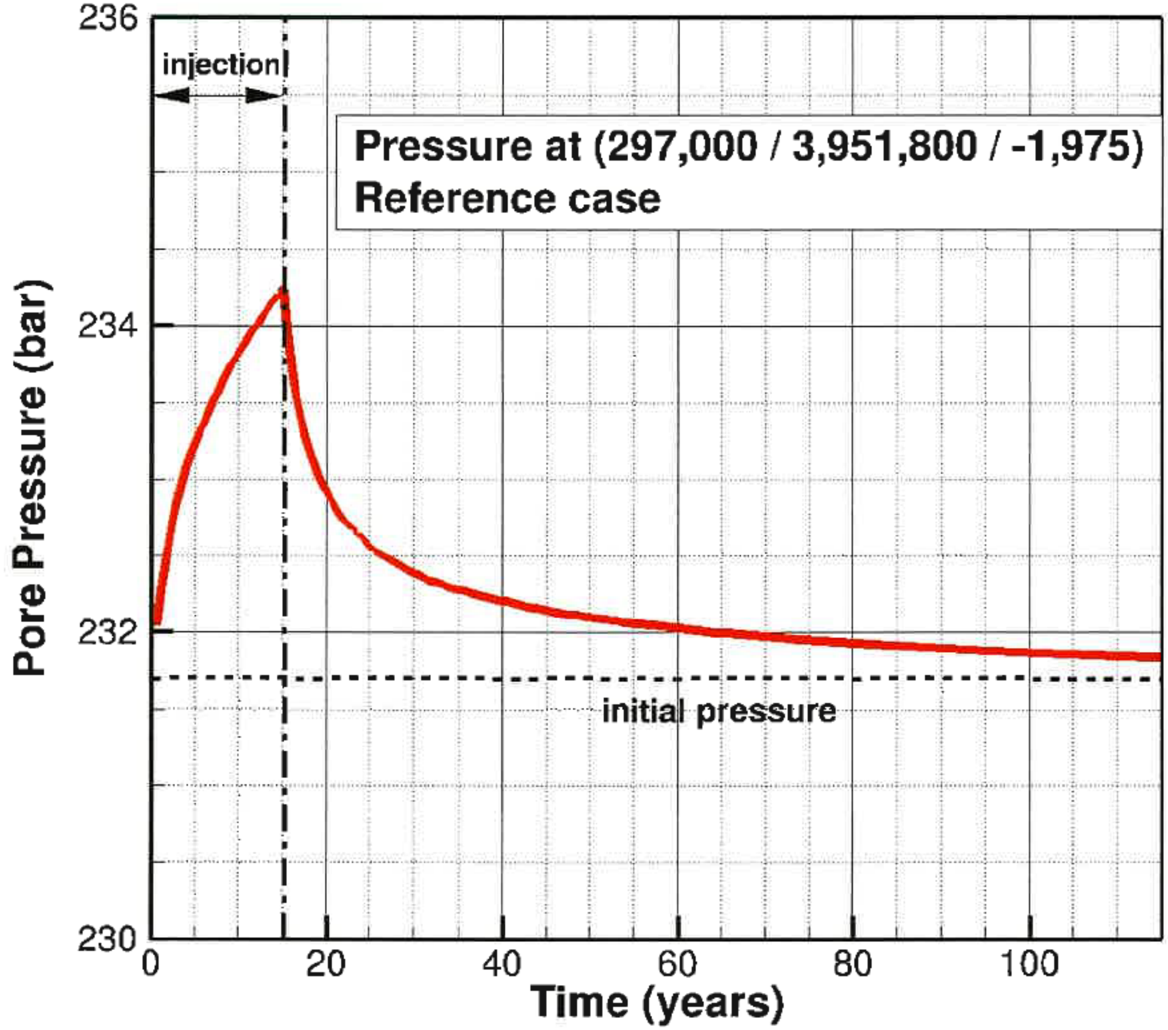
Figure 1b



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Simulated Pressure Profile at Pressure-Front Tracking Well Location, Vedder Formation