Chevron

human energy

Gorgon Project Carbon Dioxide Injection Project

Barrow Island Act 2003

Section 13 Approval Annual Operational Report (1 January 2020 - 31 December 2020)

contents

tables

Document Approvals

	Name	Digital Signature	
Prepared:	[redacted]		Out of Scope
Checked:	[redacted]		Out of Scope
Reviewed:	[redacted]		Out of Scope
Approved:	[redacted]		Out of Scope

1 Executive Summary

This report has been prepared to meet the requirements of Condition 11(a)(iii) of the *Barrow Island Act 2003* Section 13 Approval to Dispose of Carbon Dioxide by Injection into Subsurface Formation, dated 14th September 2009 ('the Section 13 Approval'). This report covers the period 1 January 2020 to 31 December 2020.

The Gorgon Carbon Dioxide Injection Project is the largest of its kind in the world and represents the largest greenhouse gas abatement project undertaken by industry. The reservoir carbon dioxide injection performance to date has been within the range of pre-injection estimates. By the end of 2020 in excess of 4 million tonnes of reservoir carbon dioxide had been injected into the Dupuy Formation beneath Barrow Island. Like any pioneering endeavour, the system has presented some challenges and we continue to monitor and optimise system performance, with a focus on long-term, safe and reliable operation. Delays have been experienced with the commissioning of the pressure management system however significant diagnostic and remedial work has been undertaken and it is anticipated the system will be operational by mid-2021.

During the 2020 reporting period, key activities have focused on:

- Maintaining reservoir carbon dioxide injection operations performance.
- Acquisition of reservoir monitoring data and updating reservoir models.
- Ongoing significant work on the pressure management system to endeavour to have it operational as soon as possible and to meet the requirements of the *Petroleum Pipelines Act 1969* PL93 'Consent to Operate' conditions. This work included:
    - The execution of well remediation scopes to improve water injectivity including flow back activities on water producers and the re-perforation of a water injector.
    - The selection of an option to mitigate the injectivity issue in the short-term by installing solids removal facilities and progressing engineering and procurement activities to enable the pressure management system to be operational by mid-2021.

For the next reporting period (2021), key activities will primarily focus on:

- Maintaining reservoir carbon dioxide injection operations performance.
- Installation and commissioning of the solids removal facilities at the pressure management drill centres.
- Ramping up pressure management operations and monitoring the performance of the system.
- Undertaking reservoir monitoring activities.

Reservoir carbon dioxide throughout this report will be referred to as 'CO_2'.

2 Overview of 2020 Reservoir CO_2 Injection Performance

In 2020, approximately 3.29 million tonnes of reservoir CO_2 was injected across the three reservoir CO_2 injection drill centers which brings the cumulative injection at the end of 2020 to 4.05 million tonnes of CO_2.

During the reporting period the average daily field injection rate was 102 kg/sec (170 MMScf/d). In late February 2020, the last of the three CO_2 compressor modules was brought online and a maximum daily field injection rate of 147 kg/sec (245MMscf/d) of CO_2 was achieved while all three LNG trains were in service (between February to May 2020). Field injection rates were curtailed from the 18th December 2020 to meet the CO_2 injection rate restriction of 42 kg/sec (70MMScf/d) imposed under the *Petroleum Pipelines Act 1969* PL93 'Consent to Operate' whilst the pressure management system was offline and being remediated (refer to Section 3).

Attachment A provides a summary of CO_2 injection well performance; below is an overview of injection performance at each drill centre:

- Drill Centre A (DC-A) accounted for 28% of CO_2 injection in 2020, split relatively evenly between injection wells, A-I1 and A-I2.
- Drill Centre B (DC-B) accounted for 41% of CO_2 injection in 2020, with the majority (88%) injected into B-I3, B-I4 and B-I5.
- Drill Centre C (DC-C) accounted for 31% of CO_2 injection in 2020, with injection well C-I8 accounting for almost 50% of the DC-C injected volume.

Repeat multi-rate tests were performed on all nine CO_2 injection wells between May and June 2020 for well performance calibration while ensuring formation integrity over the range of expected injection rates and pressures. The results showed no significant deviation from the baseline multi-rate tests performed after startup in August 2019.

The bottomhole pressure in all wells remained below the acceptable limit throughout the reporting period.

3 Status of Pressure Management System

While CO_2 injection is operating reliably, delays have been experienced with the commissioning of the pressure management system which remained offline for most of 2020 while significant diagnostic and remedial work was undertaken. As previously reported, in late 2019 a well clean up and remediation scope of works was developed and was scheduled to be executed in the first half of 2020; these works involved:

- Cleaning up water producers on DC-D and DC-E.
- Removal of grease and debris in the DC-D water injector which, at that time, was believed to be the root cause of lower than anticipated water injectivity.

In March/April 2020 all water production wells were flowed back to a temporary cleanup package (to avoid causing damage to the injection wells). The cleanup package included a tank farm, separator, filtering package, chemical inhibition, and a triplex

injection pump. The cleanup operation was performed in several stages due to limited tank volume (2000 bbls), with the holding tank purged after each flowback period. The process allowed for systematic ramp up of the water producers, proving their deliverability over a range of flowing conditions. During the well cleanup operation, samples were taken to measure the quality of the produced water. Measured total suspended solids (TSS) from all four wells was initially very high, but generally declined over the flowback period. In addition to high TSS measurements, a significant amount of sand accumulated in the tanks during the cleanup process.

Chevron methodically assessed a large number of options that could be implemented in the short term to enable the pressure management system to be operational within timeframes acceptable to the Department of Mines, Industry Regulation and Safety. The solution of installing solids removal equipment (hydrocyclones and filtration units) on both pressure management drill centres was selected and Chevron has been methodically accelerating this solution.

At the time of writing this report, the solids removal equipment has been installed on DC-D and commissioning works have commenced. Solids removal equipment on DC-E is anticipated to be installed in Q2 2021 and wells on both drill centres are anticipated to be operational by 30 June 2021 which is the timeframe imposed under the PL93 'Consent to Operate'. The performance of these wells, as well as the reservoir pressure response to the operation of the pressure management system, will be monitored in 2021 to determine the effectiveness of this solution. If effective at improving injectivity, work will be progressed in 2021 on the design and engineering of similar equipment to be installed long term at the drill centres.

Chevron believes that CO_2 injection can be safely operated and maintained while the current technical issues on the pressure management system are being resolved. Chevron is taking the necessary time to safely address the pressure management system performance, with a focus on long-term reliable operation.

4 Injection Rate / Volume / Composition:

The Section 13 Approval condition 11 requires the annual operations report to include information relating to injection rates, volumes injected, injection stream compositional variation and the gross and net abatement of greenhouse gas emissions arising from the injected reservoir CO_2. The table below contains the required information in relation to injection rates and volume for the reporting period. Injection rates were below the restriction limits set under condition 4 of the Section 13 Approval.

Condition Reference	Information Required	Information
11 (d)(i)	Average annual rate of injection	9,027 tonnes/day; 170MMScf/d
11 (d)(ii)	Reservoir CO_2 Injection rate range	Minimum: zero Maximum: 12,921 tonnes/day; 245MMScf/d

Condition Reference	Information Required	Information
11(d)(iii)	Total volume of reservoir CO_2 injected*[1]	3,295,071 tonnes; 62,352MMScf
11(d)(v)	Gross and net abatement of greenhouse gas emissions arising from the injected carbon dioxide*[2]	Gross abatement: 3,957,190 tonnes CO_{2e} Net abatement: 3,505,095 tonnes CO_{2e}

Table 4-1 Injection Rate, Volume Injected Information

Appendix B contains information on the injection stream compositional variation for the period January to December 2020 in relation to approval limits. The injection stream composition was within restriction limits set under condition 3 of the Section 13 Approval. There were no exceedances of 3% (mol) hydrocarbon during the reporting period.

[1] Reservoir CO_2 refers to gases in the injection stream consisting predominantly of CO_2 together with incidental associated substances (e.g. hydrocarbon). This total volume injected represents the mass of reservoir CO_2 injected, not the greenhouse gas equivalent (CO_{2e}) in tonnes of those gases.

[2] As agreed with the Department of Jobs Tourism Science and Innovation, to meet this reporting requirement:

- gross abatement is equivalent to the volume of reservoir carbon dioxide removed from the incoming natural gas stream and available for injection;
- net abatement is equivalent to the volume of reservoir carbon dioxide injected.

Note these numbers will differ those reported under the [redacted] annual Environmental Performance Report submitted to meet the requirements of Ministerial Statement 800.

Out of Scope

5 Work Performed During the Reporting Period

Below is a summary of key work performed during 2020.

5.1 CO_2 Pipeline:

In December 2020 the CO_2 pipeline was inspected with in-line inspection services. The inspection did not highlight any concerns in relation to the integrity of the pipeline.

5.2 Well Work Activity

During the reporting period the following key well work was undertaken:

- In March / April 2020 clean-up scope on DC-D and DC-E water producers.
- In May 2020 a workover to re-perforate the damaged water injection well D-WI1 was completed using tubing conveyed perforating guns. An injectivity test and repeat clay stabilization treatment were completed. Acceptable injectivity was recovered.
- In August 2020 saturation logging surveys were performed in reservoir surveillance wells, A-RS1 and C-RS2 using the Halliburton TMD-3D tool.
- Annual preventative maintenance was performed on the wellhead/xmas trees for DC-D and DC-E wells in March 2020 and DC-A, DC-B and DC-C wells in August/September 2020.
- In December 2020 a workover was completed to replace the electrical submersible pump (ESP) in water production well D-WP2.

5.3 Subsurface Activity

Some key subsurface work during the reporting period included:

5.3.1 Uncertainty Management Plan (UMP)

A preliminary UMP review based on early injection data was undertaken in the reporting period. A more comprehensive UMP review is planned for the first half of 2021.

5.3.2 Gen 11 modelling

During the reporting period, the Gen 11 static reservoir model suite has been completed. These models incorporate the latest Dupuy Formation subsurface characterization (interpretation, seismic, well tops, well data, core) and have been history matched with early injection/production data to selected representative P10, P50 and P90 models. These models will be used for operational decisions, plume forecasting, risk assessment, long term monitoring and identification of low side mitigation strategies.

Following the completion of the static models, the Gen 11 dynamic model was built in Petrel using Intersect as the reservoir simulator. This model has been used for several purposes including:

- Comparing predictions of bottomhole pressure and well head pressure for actual rates with recorded pressures, and allowing modification of rock/fluid properties to achieve a history match and improve the predictability of the model.

- Developing a short-term CO_2 injection forecast based on expected supply and predicting pressure behavior at the well and reservoir level.
- Providing greater understanding of the pressure management system effectiveness.
- As an input to modelling CO_2 migration and seismic detectability to determine the optimal timing of surveillance activities including saturation logging and Vertical Seismic Profile acquisition.
- Providing forecasted pressures as an input for mechanical earth modeling.

The predicted areal extent of the injected CO_2 plume over time is shown in Attachment E. The plume predictions are based on a P50 subsurface outcome, based on analysis using the Gen11 dynamic models (2020 dynamic modelling vintage). The predicted areal extent does not exceed the baseline surface seismic survey area.

5.3.3 3D Mechanical Earth Model

The Gen 11 3D Mechanical Earth Model (MEM) has been generated using the new Gen 11 static model. The model incorporates 1D MEM data from 21 wells which have been calibrated with mechanical property data from 4 core wells and stress data from 8 wells, mostly from the Dupuy Formation. The 1D MEMs are further validated with formation micro image data from 15 wells. The bulk response of the 3D MEM is calibrated with InSAR data. The 3D MEM calibration exercise with InSAR data and updated Intersect history matching will be ongoing in 2021.

5.4 Monitoring Programme Activity

Below is a summary of the monitoring activities undertaken during 2020.

5.4.1 3D Seismic Data

No significant new processing of the baseline data set was performed during the reporting period.

5.4.2 Cased Hole Logging

Cased hole saturation logging surveys were performed in both Reservoir Surveillance wells (A-RS1 and C-RS2) in 2020. Analysis of the results confirmed that the injected CO_2 had not swept this area of the Dupuy Formation at the time of the survey.

5.4.3 Passive Microseismic Monitoring

Out of Scope

5.4.3.1 CO_2 Data Well

During the reporting period Chevron contracted [redacted] to operate, and monitor passive seismic data recorded from the CO_2 Data Well.

Above Zone Pressure:

Pressure has been observed to continue to increase in a gauge directly above the Basal Barrow Group Shale during the reporting period. The pressure has increased by 43 psi since commencement of CO_2 injection. The pressure changes correlate closely with the pressure measured in a DC-B injection well (B-I6) located very close to the CO_2 Data Well gauge. This pressure change observed is inclusive of the regional trend of increasing pressure that was occurring prior to the commencement of CO_2 injection;

the source of this regional trend is not understood. Based on rising pressure in the CO_2 Data Well gauge, B-I6 was shut in pending further assessment.

5.4.3.2 Near-surface Array

Out of Scope

Chevron contracted [redacted] to operate and monitor near surface passive seismic equipment on Barrow Island during the monitor period. In addition, planning for an expanded near surface microseismic monitoring array occurred. This installation was intended to occur during 2020 but was delayed due to COVID-19 restrictions. The installation was completed in February 2021.

5.4.3.3 Observed Microseismicity

Out of Scope

[redacted] was contracted to integrate the recorded surface and CO_2 Data Well passive microseismic data into a single analysis. This integrated analysis provides the most accurate positioning and magnitudes for microseismic events.

Human activities that typically induce seismicity include injecting fluid into the subsurface (liquid waste disposal, geothermal energy, Carbon Capture and Storage, fracture stimulation), construction of dams, mining practices, oil and gas production, as well as others. The induced seismicity observed on Barrow Island occurs in the reservoir where pore pressure changes create fault slip by changing the stress acting on faults, and in the overburden where the strain created by physically inflating the reservoir is transferred to the rock above poro-elastically (by grain-on-grain contact).

Microseismic events that have been observed are extremely low, approximately 100 times lower than events that could be felt at surface. They do not present safety, environmental, or CO_2 containment concerns. The pressure management system. once operational, is expected to lower the occurrence of induced seismicity.

During the monitoring period 1,229 microseismic events with clear P- and S- wave arrivals and exhibiting waveform characteristics typical of microseismic events were located. These located events had very low magnitudes between 1.1 M_w and -2.4 M_w. The magnitude and frequency of events observed are within the range of observations recorded on other similar successful commercial scale Carbon Capture and Storage projects. The Gorgon CO_2 project microseismicity is at the upper end of the analogues but this is consistent with the Gorgon Project's larger scale. An additional 2,760 microseismic single phase events were detected but the events were small and lacked both significant P- and S-wave arrivals and so the events were unable to be located.

The microseismic events are located within and outside the CO_2 injection interval in the Dupuy Formation and occur across a depth range from 1160m to 2760 m. The nucleation rate within the Dupuy Formation has been shown to respond relatively quickly to changes in the CO_2 injection rate while changes above the Dupuy Formation are less responsive.

A key observation made to date is that the amount of energy released by microseismic events is largest immediately after shutting in the carbon dioxide injection wells. This is common for fluid injection projects. Thus, a controlled ramp-down sequence is proposed whenever the carbon dioxide injection wells are taken off-line.

The microseismic data acquired to date has been used to develop a Gutenberg-Richter magnitude vs frequency trend. A very good correlation has been derived with a high

confidence B-value of close to 1. This B-value observed is as expected for the area and a matrix injection project like the Gorgon CO_2 Injection Project.

5.4.4 InSAR

InSAR monitoring is being used to measure small-scale (millimetre) changes in surface elevation. This can be correlated to pressure distribution in the subsurface and used in conjunction with microseismic data to better understand the stress changes in the reservoir.

Out of Scope

Chevron contracted [redacted] to acquire InSAR survey data during 2020. Radar data is acquired every 8 days by the Cosmo-SkyMed (CSK) satellite and every 11 days by the TerraSAR-X satellite. Processing of this ongoing monitoring data is completed every 6-months. This phase of monitoring provides 2-D (vertical and east-west) measurements by using imagery acquired from two satellite orbits.

Data from this baseline period was processed during September 2020 to create a view of the post injection ground deformation associated with CO_2 injection. Observed surface uplift (millimetres) was 10% less than the expected (modelled) uplift. Models have been recalibrated to better predict surface elevation changes. The onset of surface deformation coincides with the start of overburden microseismicity referred to in section 5.4.3.3. This is consistent with an interpretation that the shallow microseismicity is the result of poro-elastic stress transfer. There has been no evidence of subsurface fracturing on the InSAR.

5.5 Other

The annual review of the CO_2 Disposal Management Plan commenced in November 2020. Significant operations monitoring data and reservoir model updates are available for this review which will provide valuable insights into the performance of the reservoir and injection operations and inform what revisions may be required.

5.5.1 Groundwater & Soil Gas Monitoring

During the reporting period, four monitoring events were conducted during each quarter:

Monitoring Date	Sampling Event
February 2020	Reduced Scope (all 12 sites)
June 2020	Reduced Scope (4 sites only due to COVID restrictions)
July/August 2020	Full Scope* (all 12 sites)
December 2020	Full Scope* (all 12 sites)

Figure 5-1 Groundwater & Soil Gas Monitoring Events

**The full parameter suite for groundwater and soil gas is contained in Appendix C*

All monitoring events involved: in situ measurement of compositional gases (using GA5000); measurement of groundwater field parameters (using YSI ProDSS); and downloading data from continuous CO_2 data loggers (installed at DCA; DC-B and DC-C). The results of the December 2020 monitoring event are pending.

In situ compositional gas concentrations during the Q1, Q2 and Q3 monitoring events were generally consistent with baseline concentrations. Where exceedances of baseline concentrations were observed, they were also observed at background locations so changes in concentrations compared to baseline conditions are unlikely to be associated with CO_2 injection.

Analysis of soil gas geochemistry from the Full Scope July/August 2020 monitoring event indicates all three major processes identified during the baseline period continue to be observed. These processes include:

- Respiration of soil organic material by soil microbes
- CO_2 dissolution into pore water or groundwater, and
- Methane oxidation by soil microbes.

Groundwater field parameters during the Q1, Q2 and Q3 monitoring were generally consistent with baseline concentrations. Where exceedances of baseline concentrations were observed, they were also observed at background locations so changes in concentrations compared to baseline conditions are unlikely to be associated with CO_2 injection.

5.5.2 Remote Sensing

During the reporting period, pre- and post-injection high resolution satellite imagery was purchased. In October 2020 aerial imagery (10cm resolution) was captured over the whole island. A review of this data is planned for 2021.

6 Risk Review

As specified in the Section 13 Approval condition 11d (vi), the annual report is to include "*any recognized circumstances that might indicate that the risks associated with injected carbon dioxide have changed.*" The risks associated with the project are described in Section 6 of the CO_2 Disposal Management Plan.

Out of Scope

The [redacted]s continuing to improve its understanding of subsurface risks with continued operations. Induced microseismicity was an expected outcome of the CO_2 Injection Project. The observed events however are extremely low and the [redacted] believe they do not present safety, environmental, or CO_2 containment concerns. The pressure management system is expected to lower the occurrence of induced seismicity, once it is operational.

Out of Scope

7 Proposed Work Plan for Next Reporting Period (2021)

Outlined below is a summary of the current planned work scopes for 2021.

7.1 Planned Facilities Works / Operations

The following key activities are planned for the next reporting period:

- Re-perforation of the DC-E water injector (completed January 2021)

- Completion of a planned expansion of the permanent micro-seismic monitoring network on Barrow Island (6 borehole stations and 2 surface stations) (completed February 2021).
- Installation and commissioning of the solids removal facilities (hydrocyclones and filtration skids) at DC-D and DC-E.
- Ramping up of water production and injection operations at DC-D and DC-E.
- Planned maintenance for CO_2 compression, pipeline, wells and associated facilities will be in accordance with the (CMMS) Computerised Maintenance Management System.

7.2 Planned subsurface activities

The following key activities are planned for the next reporting period:

- Subsurface modelling: continued calibration of the Gen 11 reservoir model to dynamic data/observations, including interference pressure signals, injectivity and bottom-hole pressure changes.
- Calibrate the new 3D – Mechanical Earth Model. Use the InSAR measurements and updated Intersect history matching to predict changes in distribution of subsurface pressure.
- A review of the subsurface uncertainty management plan and risk management plan using available subsurface data.
- Annual review of the CO_2 Disposal Management Plan (as required by the Section 13 Approval).
- Interpretation of all dynamic reservoir data collected during the year. Detailed analysis of all dynamic performance data versus short term forecasts.
- Supervision of pressure management start-up activities.

7.3 Planned Monitoring Activities

The following monitoring related activities are planned for the next reporting period (refer to Appendix D):

- Soil gas and groundwater monitoring data.
- InSAR data collection.
- Purchase of 2021 high resolution satellite imagery. Completion of pre and post injection remote sensing data analysis.
- Acquisition of passive microseismic data from the CO_2 Data Well, the pilot near surface array and the expanded surface array. Installation of additional receivers near DC-D and DC-E.

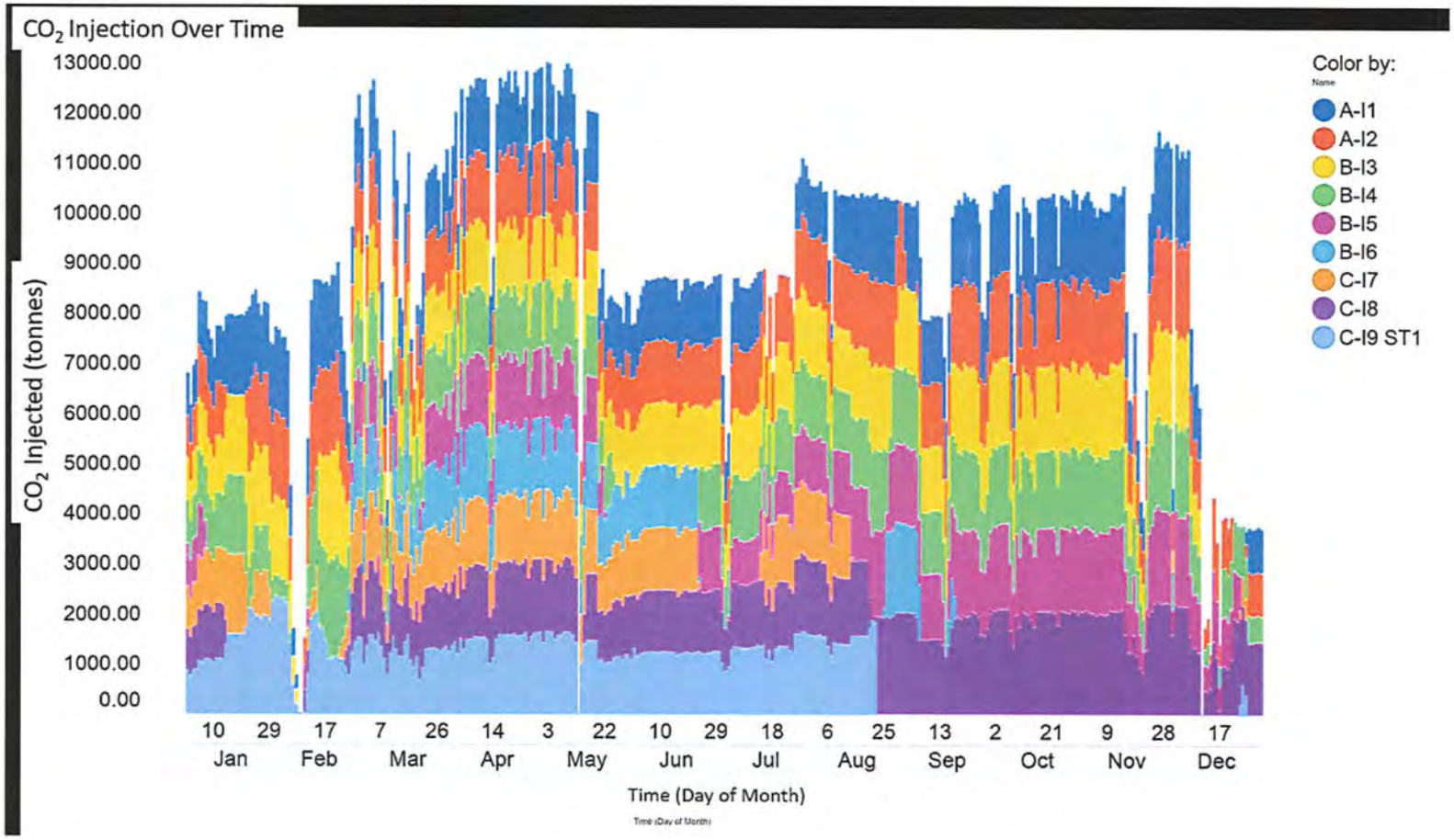
- Monitoring pressure and temperature from the surface and down-hole gauges in CO_2 injection wells and pressure management water production wells.
- Ongoing above zone pressure monitoring in the CO_2 Data Well.
- Planning for cased hole saturation logging in the reservoir surveillance wells (A-RS1; C-RS2) and production logging in the CO_2 injection wells.
- Planning and execution of the first repeat surface seismic survey.

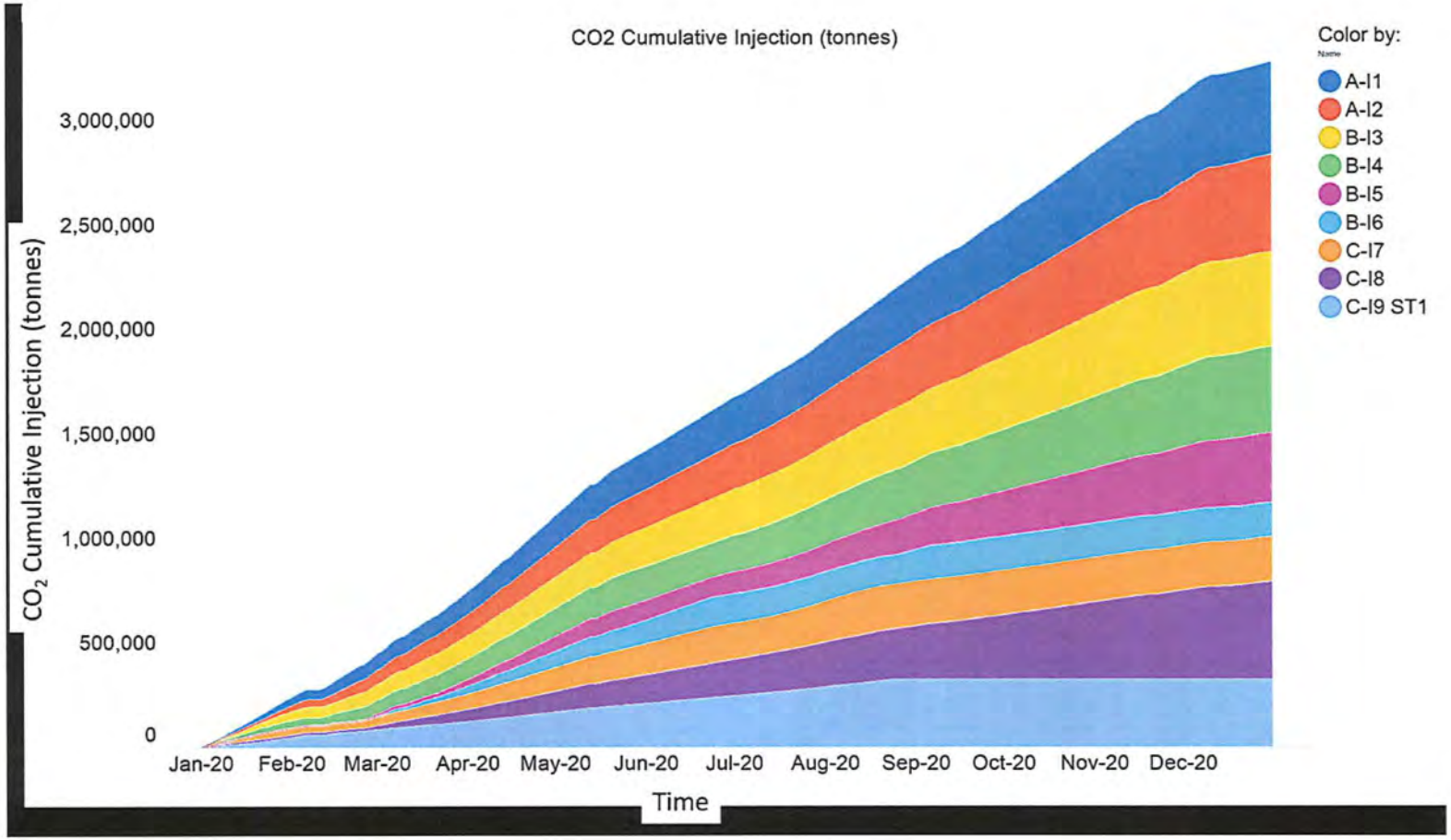
7.4 Forecast of Injection Rate / Volume for 2021

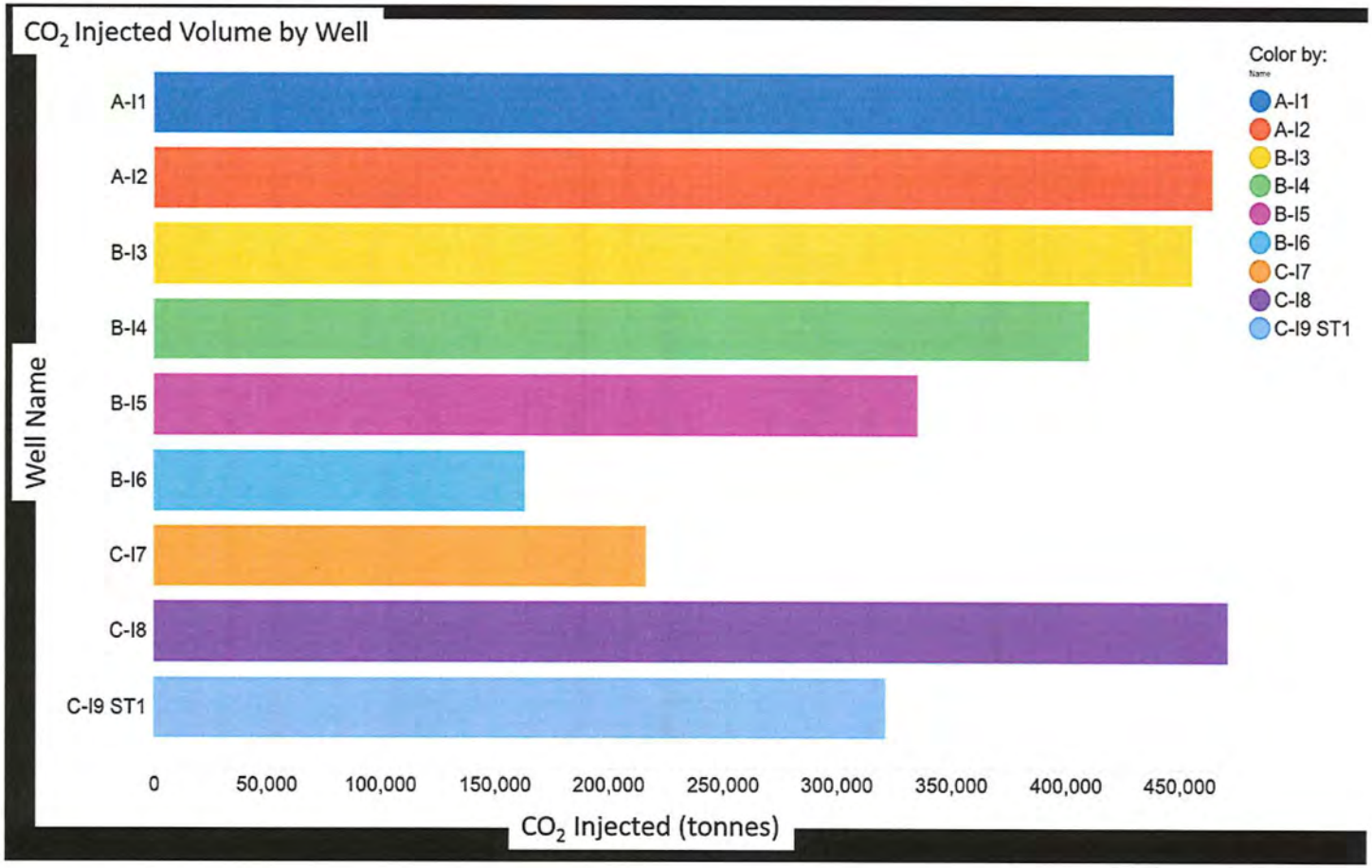
In the previous report approximately 3.2 million tonnes of CO_2 was forecasted to be injected during 2020. A total of 3.2 million tonnes of CO_2 was actually injected bringing the cumulative injection since August 2019 to over 4 million tonnes of CO_2.

Based on current estimates, which takes into account regulatory restrictions imposed on the project, during 2021 approximately 2.5 million tonnes of CO_2 is anticipated to be injected.

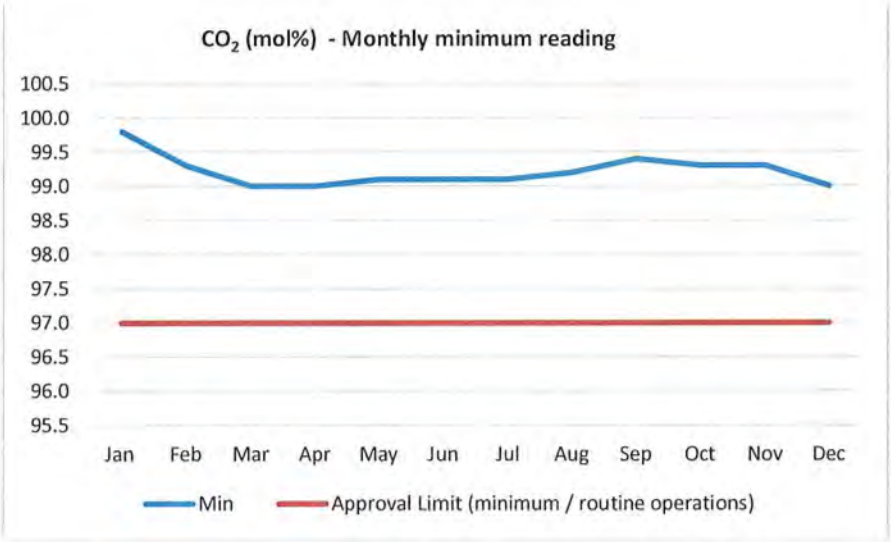
APPENDIX A: 2020 CO_2 Injection Performance

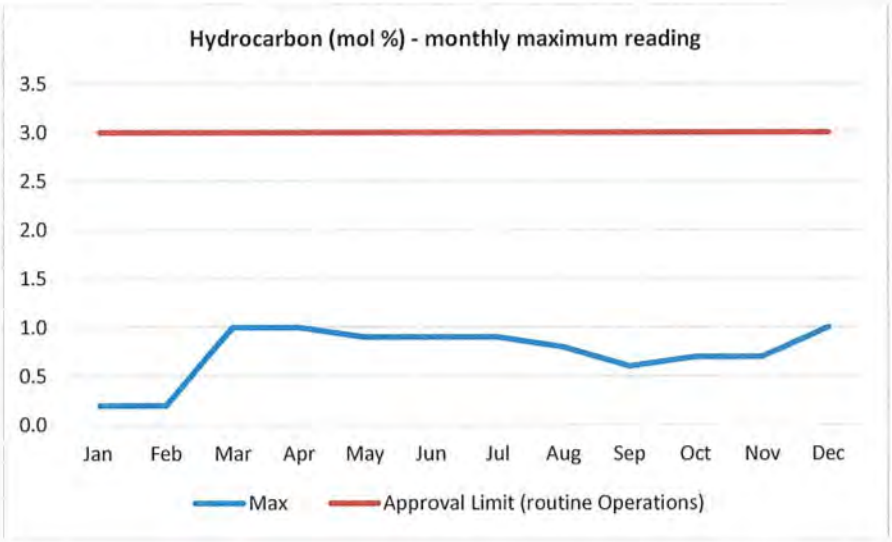


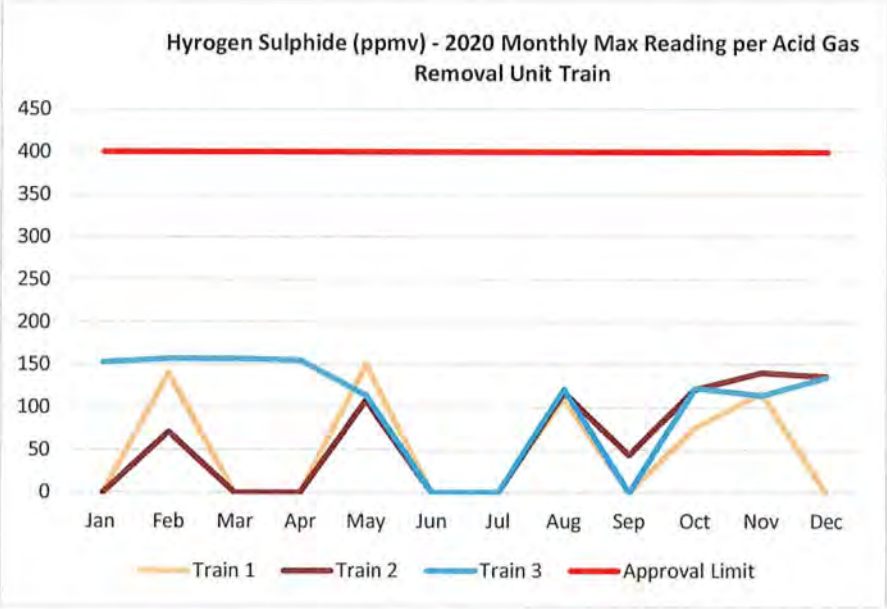

CO2 Cumulative Injection (tonnes)
Color by:
Name
A-I1
A-I2
B-I3
B-I4
B-I5
B-I6
C-I7
C-I8
C-I9 ST1
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
CO_2 Cumulative Injection (tonnes)
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Time


CO_2 Injected Volume by Well
Color by:
Name
A-I1
A-I2
B-I3
B-I4
B-I5
B-I6
C-I7
C-I8
C-I9 ST1
Well Name
A-I1
A-I2
B-I3
B-I4
B-I5
B-I6
C-I7
C-I8
C-I9 ST1
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
450,000
CO_2 Injected (tonnes)

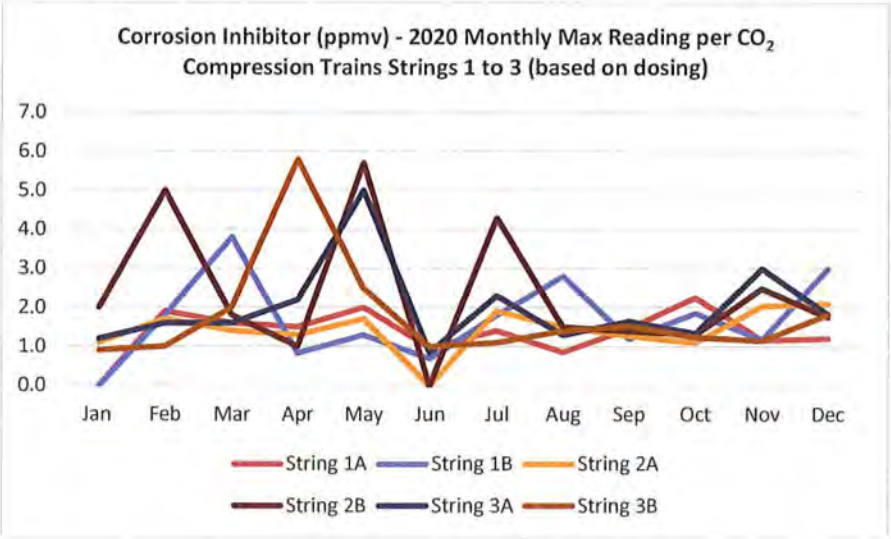
APPENDIX B Injection Stream Compositional Data in relation to Section 13 Approval Limits







Low Volume Chemical Substances Allowed under CO_2 Disposal Management Plan (Section 5.1)



Monoethylene Glycol ("MEG"): no MEG was added to the CO_2 compression trains during the reporting period.

APPENDIX C Groundwater / soil gas analysis suite

Full parameter suite - Groundwater

Groundwater Monitoring Wells	Monitoring Suite	Instrument
CS2 – (CONTROL AREA) DC-A P18J DC-E U22J CS1 – (T24) CO_2 DATA WELL DC-B DC-C X62J X53J DC-D (Y58J)	**Field Parameters** pH Pressure Electrical conductivity Dissolved oxygen Redox potential	YSI EXO01
	Dissolved Gases Carbon Dioxide (CO_2) Oxygen (O_2) Hydrogen Sulfide (H_2S) Hydrogen (H_2) Helium (He) Nitrogen (N_2) C_1-C_{12}+ Isotopes ($\delta^{13}C_1 - C_3$ of DIC, $\delta^{13}CO_2$)	Summa Canisters
	Groundwater Monitoring Suite pH EC TDS Total Inorganic Carbon (TIC) Alkalinity Carbon Dioxide Total Recoverable Hydrocarbons (TRH) Monocyclic Aromatic Hydrocarbons (MAH) Cations (Na^+, Ca^{2+}, Mg^{2+}, K) Anions (CO_3^{2-}, Cl^-, SO_4^{2-} and Br^-) Trace metals (Ba, Fe, Mn and Zn) Sulfide and unionised sulfide Nutrients (ammonium, nitrate-N, nitrite-N, total kjeldahl N, total N and total P)	Laboratory analysis

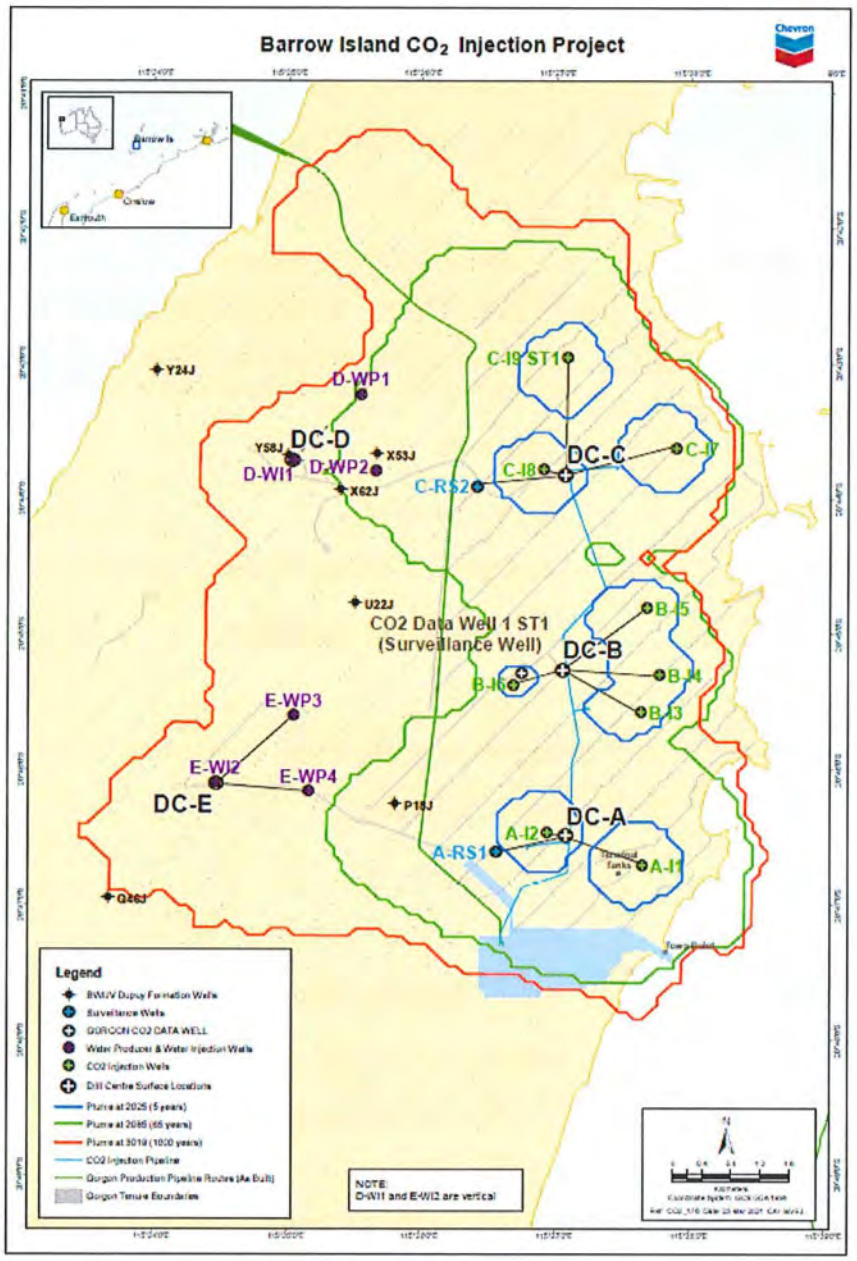
Full Parameter Suite – Soil Gas

Soil Gas Monitoring Wells	Soil Gas Parameters	Instrument
CS2 – (CONTROL AREA) DC-A P18J DC-E U22J CS1 – (T24) CO_2 DATA WELL DC-B DC-C X62J X53J DC-D (Y58J)	Carbon monoxide (CO) Carbon dioxide (CO_2) Hydrogen Sulphide (H_2S) Methane (CH_4) Oxygen (O_2) Barometric pressure	GA5000 Ground Gas Analyser
	Ionisable gases	MiniRae 3000 PID
	Carbon dioxide (CO_2) Oxygen (O_2) Carbon monoxide (CO) Nitrogen (N_2) Carbon ($C_1 – C_6+$) Isotopes ($\delta^{13}C$ of CO_2, $\delta^{13}C$ of C_1-C_5) Helium (He) Hydrogen (H_2)	Tedlar bag

APPENDIX D Monitoring Data collection

Technique	Monitoring Purpose				Collected During the Reporting Period	Planned for 2021 Reporting Period
	CO_2 Distribution in subsurface	CO_2 Seepage / Leakage	Reservoir Pressure	Induced Seismicity		
Time-lapse Seismic	√	√	X	X	No	Yes
Time-lapse VSP	√	√	X	X	No	No
Passive Microseismic	X	X	√ *1	√	Yes	Yes
InSAR	√*1	X	√ *1	√*1	Yes	Yes
Injection Well Monitoring	√	X	√	X	Yes	Yes
Reservoir Surveillance Well Monitoring	√	√	√	X	Yes	To be confirmed
Pressure Management Wells Monitoring	√*4	X	√	X	Yes	Yes
Groundwater	X	√*2	X	X	Yes	Yes
Soil Gas	X	√*3	X	X	Yes	Yes
Remote Sensing	X	√*1 *3	X	X	Yes	Yes
*1 Indicator only *2 Near surface seepage/leakage only *3 Surface seepage/leakage only *4 In later years if CO_2 plume migrates to wells						

APPENDIX E Predicted Injected CO_2 Areal Plume Map (GEN 11)



APPENDIX F Acronyms and abbreviations

The following acronyms and abbreviations may have been used in this document.

3D	Three dimensional
bbl/d	barrels per day
BI Act	*Barrow Island Act 2003*
BHP	Bottom hole pressure
BI Act Minister	means the Minister to whom the administration of the Barrow Island Act is for the time being committed
CO_2	Means gases consisting predominantly of reservoir CO_2 recovered during gas processing on Barrow Island
DC	Drill centre
DHGP	Downhole gauge
DMIRS	Department of Mines, Industry Regulation and Safety
ESP	Electrical submersible pump
Gen	Generation
[redacted]	Out of Scope
GRL	Gas to liquid ratio
kPag	kilopascal gauge
m	Metres
MMScf/d	Million standard cubic feet per day
PL93	*Petroleum Pipelines Act 1969* Carbon Dioxide Injection Pipeline and Wells Pipeline Licence PL93 dated 1 December 2011, as varied from time to time.
ppm	parts per million
Section 13 Approval	Section 13 Approval means the document dated 14 September 2009 setting out the conditions and restrictions of the Gorgon Gas Processing and Infrastructure Project Agreement Minister's approval granted to the Joint Venturers (as defined in that document) under section 13 of the Act to inject carbon dioxide into the Dupuy Formation beneath Barrow Island as varied, added to or substituted for in accordance with condition 19 of that document.

sm^3	Standard cubic metre
TCF	Trillion cubic feet
VSP	Vertical Seismic Profile
WHP	Well head pressure