

March 20, 2017

8100-4900-59240-16

Richard Gareau, P. Eng
Exploitation Engineer
Canadian Natural Resources Ltd.
2500, 855 – 2nd St. S.W.
Calgary, AB T2P 4J8

Dear Mr. Gareau:

**RE: ACID GAS DISPOSAL APPROVAL
CNRL HZ W STODDART 08-29-87-21W6M; WA# 10347
STODDART WEST FIELD – DOIG “E” POOL**

Commission staff have reviewed the application, submitted by Canadian Natural Resources Limited (CNRL), dated January 10, 2017 requesting approval to operate the subject well for acid gas disposal into the Doig “E” pool. CNRL intends to use this location to dispose of acid gas from the Stoddart 2-34-87-21 gas sweetening facility replacing the existing acid gas disposal wells CNRL W Stoddart 7-34-87-21 (WA 11398) and CNRL W Stoddart 1-33-87-21 (WA 9887).

This horizontal well was completed in 1997 for the purpose of production from the Doig “E” oil pool. Casing was landed at 1724 m KB measured depth, with the remainder of the wellbore open hole to a TD of 2200 mKB. In April 2000, the casing was perforated from 1691 to 1695mKB MD, then hydraulically fractured. The Doig “E” pool consist of 40 similarly completed oil wells, all of which have ceased production. In order to ensure containment of the disposal fluid, 34 of the remaining wells in the pool will be Level A non-routine abandoned in 2017. The well CNRL Hz W Stoddart 07-21-087-21 (WA 10743) will be converted to a water disposal well. The well CNRL Hz W Stoddart 11-29-087-21 (WA9971) will be used for observation purposes. Three wells will be suspended, as required in the OGC Well Activity: Completions, Maintenance and Abandonment Guideline, allowing for potential future use as observation or disposal locations. This required program of work is noted in attached Appendix B.

A maximum reservoir pressure limit, equal to 80% of initial reservoir pressure, is included in the Order. This conservative limit, 14,500 kPaa, will ensure protection of this unique disposal opportunity, CNRL may apply to increase the maximum reservoir pressure limit with a history of disposal volumes and data that confirm containment.

Ground water monitoring will be implemented to monitor groundwater chemistry. The monitoring will involve the installation of monitoring well(s), to establish reference groundwater chemistry and to demonstrate consistency in groundwater chemistry over time at the monitoring well location(s). Specific groundwater monitoring program requirements are outlined in Appendix A.

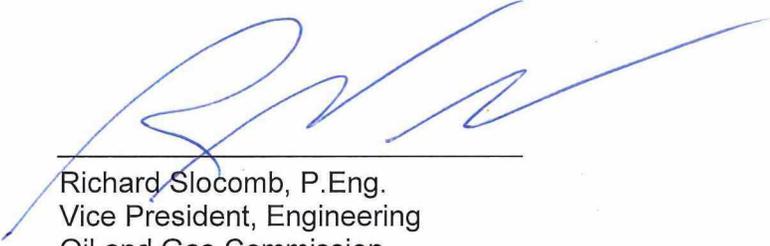
The Emergency Planning Zone (EPZ) will be calculated based on the maximum H2S and maximum allowed reservoir pressure. The changes to the Emergency Response Plans and planning zones will be conducted through the Commission’s Public Protection and Safety group. If the EPZ existing has not been determined using these values, please contact the Peter Dalton

(Peter.Dalton@bcogc.ca), Director, Public Protection and Safety, Compliance to make the required amendments.

For the inspection requirement of Order condition 2h), please arrange via email to OGCPipelines.Facilities@bcogc.ca.

Should you have any questions, please contact Michelle Gaucher at (250) 419-4482 or Ron Stefik at (250) 419-4430.

Sincerely,



Richard Slocomb, P.Eng.
Vice President, Engineering
Oil and Gas Commission

ORDER 17-16-002

- 1 Under Section 75(1)(d) of the *Oil and Gas Activities Act*, the Commission designates the Doig 'E' pool as a special project for the operation and use of a storage reservoir for the disposal of acid gas within the following area:

DLS TWP 87 RNG 21 Sec 29.

- 2 Under section 75(2) of the *Oil and Gas Activities Act*, the special project designation in this Order is subject to the following conditions. The Permit Holder shall:

Well Details

- a) Inject acid gas only into the well CNRL HZ W STODDART 08-29-87-21; WA 10347 – Doig 'E' pool (1691.0 – 2200 mKB MD).

Operating Limits

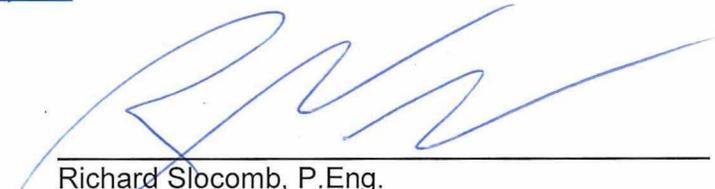
- b) Limit the maximum H₂S concentration to 70.0%
- c) Not exceed an injection pressure, measured at the wellhead on the subject well, of 11,800 kPag or the pressure required to fracture the formation, whichever is lesser.
- d) Inject only through tubing with a packer set as near as is practical above the injection interval.
- e) Continually measure and record the wellhead casing and tubing pressures electronically, including when the disposal well is inactive or suspended.
- f) Alarm the annulus pressure monitoring system to indicate when casing pressure varies outside a normal range of 1000 kPa
- g) Cease injection upon reaching a maximum pool pressure of 14,500 kPaa measured at MPP.

Monitoring

- h) An inspection satisfactory to the Commission is required within 4 weeks of initial disposal operations.
- i) Sample gas from the observation well each 6 months and submit the analysis.
- j) Sample the disposal fluid and submit composition analysis at least twice annually, indicating the disposal well as the sample source.
- k) Submit the annual packer isolation test report to the Commission within 30 days of the completion of the test.
- l) Conduct and submit an annual Surface Casing Vent Flow test to the Commission within 30 days of the completion of the test
- m) Include the disposal operating hours, the maximum injection pressure and the minimum temperature values on the monthly BC-S18 disposal statement.
- n) At each facility turn-around with a shut-in period of sufficient length to provide data for calculation of the reservoir pressure or at a period of no greater than 5 years, conduct a reservoir pressure test on the formation in the subject well, and submit a report of the test within 60 days of the end of the test.
- o) Implement a groundwater monitoring program as detailed in Appendix A.

Wellbore Integrity and Hydraulic Isolation

- p) Ensure a Wellhead Emergency Shut-Off Device and Subsurface Safety Valve are installed to operate "fail-safe" and are linked to H₂S detector heads at the wellhead.
- q) Implement appropriate corrosion and freeze protection measures in the casing-tubing annulus.
- r) Conduct function testing of SSSV at least annually, or as recommended by API 14B or the manufacturers - whichever is more rigorous.
- s) Conduct SSSV (or check valve) retrieval and inspection as per API 14B or the manufacturers recommended practice – whichever is more rigorous.
- t) Annually confirm the Subsurface Safety Valve is capable of activation remote from the wellhead.
- u) Install seismic ground motion monitoring on the wellsite with capability to measure events as indicated in this document <http://www.bcogc.ca/node/13256/download> by June 30
- v) Immediately suspended all injection operations if any injection equipment, monitoring equipment or safety devices considered necessary for safe operation should fail.
- w) Cease injection and notify the Commission immediately if hydraulic isolation is lost in the wellbore or formation.
- x) Complete suspension and abandonment of all wells in the Doig E pool as provided in Appendix B.
- y) Perform casing inspection log on the subject well and submit results to the Commission within 30 days of the completion of logging, at an interval of not more than 10 years, commencing from the date of initial disposal. Through tubing logging is acceptable.
- z) Perform a Distributed Temperature Survey (DTS) hydraulic isolation temperature log on the subject well and submit results to the Commission within 30 days of the completion of logging, at an interval of not more than 5 years, commencing from the date of initial disposal
- aa) Install a barricade around the wellhead that is capable of withstanding vehicle collision.
- bb) Not conduct a hydraulic fracture stimulation on any formation in the subject well without prior Commission approval.
- cc) Submit a Progress Report to the Commission for each six month period the project is in operation. The Progress Report must be filed within 60 days after the end of each period and must contain the information specified in the Acid Gas Progress Report Requirements document found on the OGC website here: <http://www.bcogc.ca/industry-zone/documentation/Subsurface-Disposal>.



Richard Slocomb, P.Eng.
Vice President, Engineering
Oil and Gas Commission

DATED AT the City of Victoria, in the Province of British Columbia, this ^{23rd} day of March, 2017.

Advisory Guidance for Order 17-16-001

- I. A production packer must be set above the injection interval and the space between the tubing and casing filled with corrosion inhibiting fluids, as per section 16(2) of the Drilling and Production Regulation.
- II. Annual packer isolation tests are required, as per section 16(3) of the Drilling and Production Regulation.
- III. Injected fluids must be metered, as per section 74 of the Drilling and Production Regulation.
- IV. A monthly disposal statement must be submitted to the Commission not later than the 25th day of the month following the reported month, as per section 75 of the Drilling and Production Regulation.
- V. All fluid analyses must be submitted with 30 days of tests as per section 34 (5) (a) of the Drilling and Production Regulation.

Appendix A

Groundwater Monitoring Program Requirements

For Acid Gas Disposal Wells – WA 10743 and WA 10347

1. One groundwater monitoring well shall be installed by June 30 within 50 m of the disposal well. The monitoring well shall be installed to a depth within the saturated groundwater zone, below the water table, to enable the collection of representative samples of groundwater from the well, to a maximum depth of 30 m.
2. One groundwater monitoring well shall be installed by June 30 within 50 m of the Observation Well WA 9971. The monitoring well shall be installed to a depth within the saturated groundwater zone, below the water table, to enable the collection of representative samples of groundwater from the well, to a maximum depth of 30 m.
3. During drilling of the monitoring wells, geological conditions shall be logged.
4. A minimum of one representative “reference” groundwater sample shall be collected from each monitoring well following installation and appropriate development/purging.
5. The samples shall be submitted for laboratory analysis for analytical parameters including:
 - Major Cations and Anions (HCO₃, CO₃, SO₄, NO₂, NO₃, Cl, Ca, Mg, K, Na, Fe, Mn)
 - Total Dissolved Solids (TDS)
 - Alkalinity
 - pH
 - Electrical Conductivity
 - Hardness
 - Dissolved Metals
 - Dissolved Hydrocarbon Gases (C1-C3)
 - Dissolved sulphides
 - Benzene, Ethylbenzene, Toluene, Xylenes (BETX)
 - Volatile Hydrocarbons (VHw) (C6 to C10)
 - Volatile Petroleum Hydrocarbons (VPHw) (C6 to C10 - BETX)
 - Extractable Petroleum Hydrocarbons C10-C19 (EPH_{w10-19})
 - Extractable Petroleum Hydrocarbons C19-C32 (EPH_{w19-32})
6. The static water level shall be measured following development/purging and prior to sampling.
7. A reference groundwater monitoring report shall be submitted to the Commission within 60 days of the date of groundwater sampling. The report, pdf format, shall include:
 - graphical monitoring well logs showing construction details and geological conditions;

- a site plan showing the locations of the monitoring wells relative to the disposal well and the observation well (WA 9971), and other well pad infrastructure;
- documentation of the UTM coordinates of the monitoring wells (NAD1983) and monitoring well top elevations;
- descriptions of the procedures used in drilling and installing the monitoring wells and procedures for sampling;
- data for the measured static water levels in the monitoring wells;
- tabulated analytical results; and
- the laboratory analytical reports.

One combined reference groundwater monitoring report may be submitted to satisfy requirements for both WA 10743 and WA 10347 .

8. Long term monitoring shall involve the collection of one representative groundwater sample from the monitoring well on an annual basis, and analysis for the following parameters:
 - Major Cations and Anions (HCO_3 , CO_3 , SO_4 , NO_2 , NO_3 , Cl, Ca, Mg, K, Na, Fe, Mn)
 - Total Dissolved Solids (TDS)
 - Alkalinity
 - pH
 - Electrical Conductivity
 - Dissolved Metals
 - Dissolved Gases (C1-C3)
 - Dissolved sulphides
9. Annual sampling shall commence one year after the collection of the reference groundwater samples. The analytical results shall be submitted to the Commission annually within 60 days of sample collection by eSubmission, if available, or by Email to Hydrogeology@bcogc.ca. Long term groundwater monitoring shall be implemented over the period extending from the date of reference groundwater sampling until one year after ceasing disposal and until authorized by the Commission.
10. Monitoring well installation and groundwater sampling procedures for this program shall be consistent with standard practices for environmental investigations such as those outlined in the British Columbia Field Sampling Manual (2013)
http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/field_sample_man2013.pdf
11. At any time during this program, the Commission may require re-sampling to confirm a result or further investigation which may include additional sampling and/or additional analytical requirements.

Appendix B

Suspension and Abandonment of Stoddart Doig "E" wells

WA	Well Name	Bottom Hole	Mode	Fluid	Oper	Conf Rels Date	Suspension/Downhole Abandon Date	Cut & Cap Date	Reasoning for Abnd/Susp and Timing
9971	CNRL HZ W STODDART 11-29-087-21	12-29-087-21	SUSP	OIL	PROD	19970121	Observation Q1 2017		Keep for observation
10347	CNRL HZ W STODDART 08-29-087-21	03-29-087-21	SUSP	OIL	PROD	19970908	Acid Gas Disposal Q1 2017		
10743	CNRL HZ W STODDART 07-21-087-21	14-21-087-21	SUSP	OIL	PROD	19980228	Water Disposal Q1 2017		
10290	CNRL HZ W STODDART 10-21-087-21	08-21-087-21	SUSP	OIL	PROD	19970905	High risk suspend 2017 Q3/Q4		Keep for future injection potential
10348	CNRL HZ W STODDART 03-31-087-21	07-31-087-21	SUSP	OIL	PROD	19970919	High risk suspend 2017 Q3/Q4		Keep for future injection potential
10371	CNRL HZ W STODDART 16-25-087-22	08-25-087-22	SUSP	OIL	PROD	19970917	Already suspended - Ensure high risk		Keep for future injection potential
9830	CNRL W STODDART 01-31-087-21	01-31-087-21	ABAN	OIL	PROD	19970314	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
9830	CNRL W STODDART 01-31-087-21	01-31-087-21	SUSP	OIL	PROD	20050613	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
9891	CNRL W STODDART 03-06-088-21	06-06-088-21	SUSP	OIL	PROD	19970228	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
9972	CNRL HZ W STODDART 14-31-087-21	05-31-087-21	SUSP	OIL	PROD	19970112	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10045	CNRL HZ W STODDART 05-30-087-21	04-31-087-21	SUSP	OIL	PROD	19970708	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
10241	CNRL HZ W STODDART 04-31-087-21	10-31-087-21	SUSP	OIL	PROD	19970419	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10241	CNRL HZ W STODDART 04-31-087-21	11-31-087-21	SUSP	UND	UND	19970419	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10261	CNRL HZ W STODDART 03-29-087-21	01-29-087-21	SUSP	OIL	PROD	19970807	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
10289	CNRL HZ W STODDART 16-20-087-21	11-20-087-21	SUSP	OIL	PROD	19970825	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10289	CNRL HZ W STODDART 16-20-087-21	10-20-087-21	SUSP	OIL	PROD	19980911	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10470	CNRL HZ W STODDART 06-29-087-21	02-30-087-21	SUSP	OIL	PROD	19970630	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
10485	CNRL HZ W STODDART 01-29-087-21	05-28-087-21	SUSP	OIL	PROD	19970618	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
10499	CNRL HZ W STODDART A05-30-087-21	14-30-087-21	SUSP	OIL	PROD	19970917	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10505	CNRL HZ W STODDART 14-20-087-21	10-29-087-21	SUSP	OIL	PROD	19970808	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
10509	CNRL HZ W STODDART 12-30-087-21	04-30-087-21	SUSP	OIL	PROD	19971004	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10514	CNRL HZ W STODDART 13-30-087-21	05-31-087-21	SUSP	OIL	PROD	19971019	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10570	CNRL HZ W STODDART A13-31-087-21	15-31-087-21	SUSP	OIL	PROD	19970905	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10583	CNRL HZ W STODDART 09-20-087-21	05-21-087-21	SUSP	OIL	PROD	19971217	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10583	CNRL HZ W STODDART 09-20-087-21	12-21-087-21	SUSP	OIL	PROD	19971217	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10654	CNRL W STODDART 15-06-088-21	15-06-088-21	SUSP	GCAP	PROD	20020104	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
10719	CNRL HZ W STODDART 01-01-088-22	03-06-088-21	SUSP	OIL	PROD	19980413	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
10726	CNRL HZ W STODDART 13-20-087-21	16-20-087-21	SUSP	OIL	PROD	19980420	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
10749	CNRL HZ W STODDART 13-21-087-21	11-21-087-21	SUSP	OIL	PROD	19981225	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11238	CNRL HZ W STODDART 04-30-087-21	02-30-087-21	SUSP	OIL	PROD	19980524	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11276	CNRL HZ W STODDART 04-28-087-21	03-28-087-21	SUSP	OIL	PROD	19980623	Downhole Abandon Q1 2017	2019	Close proximity to AG injector - abandon first round
11364	CNRL HZ W STODDART A16-25-087-22	09-25-087-22	SUSP	OIL	PROD	19981211	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11427	CNRL HZ W STODDART 07-36-087-22	12-36-087-22	SUSP	OIL	PROD	19980911	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11555	CNRL HZ W STODDART A09-20-087-21	10-20-087-21	SUSP	OIL	PROD	19990116	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11557	CNRL HZ W STODDART 02-36-087-22	07-36-087-22	SUSP	OIL	PROD	19981231	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11599	CNRL HZ W STODDART A01-31-087-21	02-31-087-21	SUSP	OIL	PROD	19990207	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11600	CNRL HZ W STODDART 16-21-087-21	15-21-087-21	SUSP	OIL	PROD	19990211	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
11628	CNRL HZ W STODDART A16-21-087-21	09-21-087-21	SUSP	OIL	PROD	19990109	Downhole Abandon 2017 Q3/Q4	2019	Abnd second round due to distance from AG injector
23714	CNRL W STODDART 14-29-087-21	14-29-087-21	SUSP	UND	UND	20080421	Downhole Abandon Q3 2017	2019	No use for well - Abnd first round
10578	CNRL HZ W STODDART 13-25-087-22	13-25-087-22	SUSP	OIL	PROD		Downhole Abandon Q3 2017	2019	No use for well - Abnd first round