

April 3, 2017

8100-4900-32640-02

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

Dear Mr. Gareau:

**RE: PRODUCED WATER DISPOSAL SPECIAL PROJECT APPROVAL
CNRL HZ W STODDART 7-21-87-21 W6M; WA# 10743
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 produced water disposal into the Doig “E” pool. CNRL intends to use this location to dispose of produced water from their West Stoddart 2-34-87-21 W6M plant.

This horizontal well was open hole completed in the Stoddart West Doig ‘E’ oil pool in December 1997. It produced from January 1998 to January 2016. In December 2016, the well underwent a workover to convert to disposal configuration. Cement and wellbore integrity testing indicate that the well is suitable for disposal purpose. Reservoir pressure testing indicates that the pool is significantly depleted. The Doig ‘E’ pool is also the subject of an acid gas disposal scheme into well CNRL Hz West Stoddart 8-29-87-21, approved on March 20, 2017. Due to the heightened integrity concerns of acid gas disposal, all wells in the pool, including the water disposal well, must be rigorously monitored and tested.

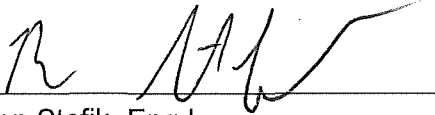
Attached please find **Order 17-02-002**, designating an area in the Stoddart West field – Doig ‘E’ pool as a Special Project under section 75 of the *Oil and Gas Activities Act*, for the operation and use of a storage reservoir for the disposal of produced water. This Order contains a number of detailed operational conditions, including continuous wellhead measurements and a maximum wellhead injection pressure. The ultimate reservoir pressure limit is set to 80% of initial reservoir pressure, to be in line with the acid gas approval limit. CNRL may apply to increase this limit in the future with a history of disposal volumes and data that confirm fluid containment.

Ground water monitoring will be implemented to monitor groundwater chemistry. The monitoring will involve the installation of one monitoring well within 50 m of the subject well, to establish reference groundwater chemistry and to demonstrate consistency in groundwater chemistry over time at the monitoring well location. This is in conjunction with the groundwater monitoring well program outlined in Order 17-16-002 for acid gas disposal. Specific groundwater monitoring program requirements are outlined in Appendix A.

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 Harding at (250) 419-4493 or the undersigned at (250) 419-4430.

Sincerely,

A handwritten signature in black ink, appearing to read 'R. Stefik', written over a horizontal line.


Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

Attachment



ORDER 17-02-002

- 1 Under Section 75(1)(d) of the *Oil and Gas Activities Act*, the Commission designates the operation and use of a storage reservoir for the disposal of produced water, including flowback from fracturing operations, into the Doig 'E' pool – Stoddart West field as a special project in the following area:
DLS Twp 87 Rge 21 W6M Section 21 - Lsds 1, 2, 7 and 8
- 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:
 - a) Inject produced water only into the well CNRL Hz W Stoddart 7-21-87-21; WA# 10743 – Doig 'E' pool (open hole 1782.0 to 2757.0 mKB MD).
 - b) Not exceed an injection pressure, measured at the wellhead on the subject well, of 12,170 kPag or the pressure required to fracture the formation, whichever is lesser.
 - c) Inject only through tubing with a packer set as near as is practical above the injection interval.
 - d) Continually measure and record the wellhead casing and tubing pressures electronically.
 - e) Cease injection and notify the Commission immediately if hydraulic isolation is lost in the wellbore or formation.
 - f) Submit the annual packer isolation test report to the Commission within 30 days of the completion of the test.
 - g) Conduct and submit an annual Surface Casing Vent Flow test to the Commission within 30 days of the completion of the test.
 - h) Include the disposal operating hours and the maximum injection pressure value on the monthly BC-S18 disposal statement.
 - i) Conduct an annual reservoir pressure test on the formation in the subject well, with a shut-in period of sufficient length to provide data for calculation of the reservoir pressure, and submit a report of the test within 60 days of the end of the test.
 - j) Cease injection upon reaching a maximum formation pressure of 14,600 kPaa, measured at 1162 mKB TVD.
 - k)
 - i) Perform a 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 every 10 years, commencing from the date of initial disposal.
 - ii) 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 every 5 years, commencing from the date of initial disposal.
 - l) Not conduct a hydraulic fracture stimulation on any formation in the subject well without prior Commission approval.
 - m) Complete an inspection, satisfactory to the Commission, within 4 weeks of initial disposal operations.
 - n) Implement a groundwater monitoring program as detailed in Appendix A.



Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

DATED AT the City of Victoria, in the Province of British Columbia, this 3rd day of April, 2017.

Advisory Guidance for Order 17-02-002

- I. A production packer must be set above the injection interval and the space between the tubing and casing filled with corrosion and frost inhibiting fluids, as per section 16(2) of the Drilling and Production Regulation.
- II. Annual packer isolation tests are required to be submitted, as per section 16(3) of the Drilling and Production Regulation.
- III. Injected fluids must be metered and the injection pressure measured at the wellhead, 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. Seismic events must be reported and disposal operations suspended as per section 21.1 of the Drilling and Production Regulation.

Appendix A – Groundwater Monitoring Requirements

CNRL Hz W Stoddart 7-21-87-21 (WA 10743) Produced Water Disposal

1. One groundwater monitoring well shall be installed by June 30, 2017 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. During drilling of the monitoring well, geological conditions shall be logged.
3. A minimum of one representative “reference” groundwater sample shall be collected from the monitoring well following installation and appropriate development/purging.
4. 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 (EPHw10-19)
 - Extractable Petroleum Hydrocarbons C19-C32 (EPHw19-32)
5. The static water level shall be measured following development/purging and prior to sampling.
6. 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:
 - a. graphical monitoring well logs showing construction details and geological conditions;
 - b. 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;
 - c. documentation of the UTM coordinates of the monitoring wells (NAD1983) and monitoring well top elevations;
 - d. descriptions of the procedures used in drilling and installing the monitoring wells and procedures for sampling;
 - e. data for the measured static water levels in the monitoring wells;

- f. tabulated analytical results; and
- g. the laboratory analytical reports.

One combined reference groundwater monitoring report may be submitted to satisfy requirements for both WA 10743 and acid gas disposal well WA 10347 (CNRL Hz Stoddart 8-29-87-21)

7. 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 (HCO₃, CO₃, SO₄, NO₂, NO₃, Cl, Ca, Mg, K, Na, Fe, Mn)
 - Total Dissolved Solids (TDS)
 - Alkalinity
 - pH
 - Electrical Conductivity
 - Dissolved Metals
 - Dissolved Gases (C1-C3)
 - Dissolved sulphides
8. 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.
9. 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
10. 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.
11. If groundwater is not intersected at depths shallower than 30 m below ground during drilling for a groundwater monitoring well (under requirements 1 and 2 of this Appendix), the borehole shall be backfilled with appropriate sealant or grout to a depth of approximately 3 m below ground and a subsurface gas monitoring well shall be installed, with a screen length of approximately 1 to 2 m. The subsurface gas monitoring well shall be designed to permit the measurement of subsurface gas concentrations using field equipment and/or the collection of gas samples for laboratory analysis. The subsurface gas monitoring well design may be adjusted as deemed necessary based on field observations and recommendations by a qualified professional at the time of drilling. The subsurface gas monitoring well shall be tested using a field gas detection meter(s) for the presence of hydrocarbon gases and H₂S to establish baseline conditions by completion of at least 3 preliminary monitoring events conducted on different dates. Subsequent monitoring and sampling requirements will be determined following the Commission's review of the baseline testing results.