

April 13, 2017

8100-4900-32640-60

Richard Gareau, P.Eng.
Exploitation Engineer
Canadian Natural Resources Ltd.
Suite 2500, 885 – 2nd Street SW
Calgary, Alberta T2P 4J8

Dear Mr. Gareau:

**RE: OBSERVATION WELL STATUS APPROVAL
CNRL HZ W STODDART 11-29-87-21, WA 9971
STODDART WEST – DOIG ‘E’ POOL**

BC Oil and Gas Commission (Commission) staff have reviewed the April 4, 2017 application from Canadian Natural Resources Ltd. seeking approval of observation well status for CNRL HZ Stoddart 11-29-87-21 (WA 9971) in the Stoddart West, Doig ‘E’ pool.

The Drilling and Production Regulation Part 1 defines an observation well as “a well or a portion of a well designated as an observation well under section 2 (7)”.

- 2 (7) An official may designate a well as an observation well if
- (a) the well is being used to monitor reservoir pressures or to obtain other formation information, and
 - (b) the well is not used to produce from, or inject or dispose of fluids into, a formation being monitored.

The horizontal subject well was drilled in 1996 and the Doig formation was completed as open hole for the purpose of oil production. The well actively produced from November 1996 to August 2016.

Canadian Natural Resources Ltd. is requesting use of this well to monitor the reservoir pressure and fluid mitigation for acid gas disposal into CNRL HZ West Stoddart 8-29-87-21 (WA 10347), approved on March 20, 2017. All wells in this pool, including the observation well, must be rigorously monitored and tested due to the integrity concerns associated with disposal.

Approval of observation status is granted for CNRL HZ W Stoddart 11-29-87-21 (WA 9971), for the Doig ‘E’ pool, with the following requirements;

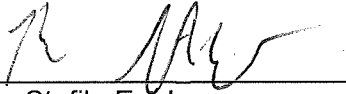
- submit a BC-11 form to the Ministry of Finance to update the well status,
- collect, analyze and submit two gas samples per year,
- conduct a reservoir pressure test annually, and
- conduct a surface casing vent flow test annually.

Results of the reservoir pressure test, gas analyses and surface casing vent flow test must be reported to Commission, as outlined in Sections 34(5), 41(3), 41(4), and 73(3) of the Drilling and Production Regulation. A summary of these results must also be provided in the Acid Gas Progress Report.

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 ground water 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 approval. Specific groundwater monitoring program requirements are outlined in Appendix A.

Should you have any questions, please contact Kathryn Archibald at (250) 419-4457 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, EngL
Supervisor, Reservoir Engineering
Oil and Gas Commission

Appendix A – Groundwater Monitoring Requirements

CNRL HZ W Stoddart 11-29-87-21 Observation Well

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 (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
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.