



March 23, 2017

9045-7400-32640-02

Ramona Stoica
Encana Corporation
P.O. Box 2850, 500 Centre St SE
Calgary, AB, T2P 2S5

Dear Ms Stoica:

**RE: PRODUCED WATER DISPOSAL SPECIAL PROJECT APPROVAL, AMENDMENT #1
ECA KIWIGANA b-95-L/94-O-02; WA# 27905
HORN RIVER FIELD – DEBOLT FORMATION**

Approval for disposal of produced water, Order 12-02-019, was issued for the subject well, Debolt formation, on August 13, 2012. The Commission is presently amending disposal well approvals to conform to current requirements. The subject well has disposed 373,816 m³ of produced water into the Debolt formation since December 2012. A June 2016 reservoir pressure test indicates that the current pressure is at 106% of initial pressure.

Attached please find **Order 12-02-019 Amendment #1**, designating an area in the Horn River field – Debolt formation 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 tubing and casing pressure monitoring. The MWHIP has been decreased from the 2012 approval value based on a conservative calculation for prudent operation. The Debolt formation was initially over-pressured at a relatively shallow depth for disposal. The maximum reservoir pressure has been set to a value based on the remaining disposal volumes forecasted to be required to support continued declining production in the area. Additional general information regarding disposal wells is available on the Commission's website at <http://www.bcogc.ca/industry-zone/documentation/Subsurface-Disposal>.

The top of the disposal zone within 100 m of the Base of Usable Groundwater as determined by the OGC. As such, a groundwater monitoring program is required to be implemented, involving the installation of a single monitoring well, to establish reference groundwater chemistry and to demonstrate consistency in groundwater chemistry over time at the monitoring well location. Specific groundwater monitoring program requirements are outlined in Appendix A.

In certain circumstances, disposal well operation may induce seismicity. The Commission advises that disposal well permit holders monitor seismic events in proximity to the well and be prepared to modify operations to mitigate induced seismicity. Permit holders may monitor seismic events through the Natural Resources Canada seismic monitoring network at <http://www.earthquakescanada.nrcan.gc.ca/recent/index-eng.php>

Should you have any questions, please contact Michelle Harding at (250) 419-4493 or the undersigned at (250) 419-4430.


Sincerely,

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

Attachment

ORDER 12-02-019 Amendment #1

- 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 Debolt formation – Horn River field as a special project in the following area:
NTS 94-O-02 Block L Unit 95
- 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 ECA Kiwigana b-95-L/94-O-02; WA# 27905 – Debolt formation (perforations from 378.0 – 582.0 mKB).
 - b) Not exceed an injection pressure, measured at the wellhead on the subject well, of 5,750 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) Include the disposal operating hours and the maximum injection pressure value on the monthly BC-S18 disposal statement.
 - h) Conduct an annual reservoir pressure test on the formation in the subject well using bottom-hole recorders, 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.
 - i) Cease injection upon reaching a maximum formation pressure of 6,120 kPaa, measured at 480 mKB
 - j)
 - 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 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.
 - k) Not conduct a hydraulic fracture stimulation on any formation in the subject well without prior Commission approval.
 - l) 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 23rd day of March, 2017.

Advisory Guidance for Order 12-02-019 Amendment #1

- 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

ECA Kiwigana b-95-L/94-O-02 (WA 27905) Produced Water Disposal

1. One groundwater monitoring well shall be installed by December 31, 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 sample 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 Gases (C1-C3)
 - 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})
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 log showing construction details and geological conditions, a site plan showing the location of the monitoring well relative to the disposal well and other site infrastructure, documentation of the UTM coordinates of the monitoring well (NAD1983) and monitoring well top elevation, descriptions of the procedures used in drilling and installing the monitoring well and for sampling, record of the measured static water level in the well, tabulated analytical results, and the laboratory analytical report.

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)
8. Annual sampling shall commence one year after the collection of the reference groundwater sample. 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.