

October 4, 2017

8110-4060-32640-02

Stephen Penner
Exploitation Engineering Technologist
Canadian Natural Resources Limited
2100, 855 – 2nd Street SW
Calgary AB, T2P 4J8

Dear Mr Penner,

**RE: PRODUCED WATER DISPOSAL SPECIAL PROJECT APPROVAL TERMINATION
SUKUNKA SUKUNKA b-65-B/93-P-5; WA# 3793
SUKUNKA FIELD – PARDONET-BALDONNEL 'A' POOL**

Approval for disposal of produced water was issued for the subject well, Pardonet-Baldonnel 'A' pool, on November 29, 1994 under Order 94-02-009. A thorough review has been conducted of the disposal scheme.

The subject well was drilled into the Sukunka Pardonet-Baldonnel 'A' pool, and produced sour gas from June 1977 to September 1994. Originally, 3 wells were mapped in the pool: WA 3793, WA 1517 (a-43-B/93-P-5), and WA 3658 (b-19-A/93-P-5). However as production progressed, the wells did not appear to show pressure connection, and thus were segregated into the Sukunka Pardonet-Baldonnel 'A', 'J', and 'C' pools, respectively. WA 3793 was classified as the single-well 'A' pool.

When WA 3793 became depleted, a workover was done to convert the well to disposal. During the November 1994 workover, tubing was pulled and casing was inspected; both were in poor condition. The 177.8 mm production casing was found to be in communication with the 245 mm intermediate casing. Together the two casing strings provide isolation, as proven by a successful packer isolation test in March 2016. A temperature log dated October 26, 2016 shows that disposal fluids continue to be isolated to the zone of interest.

WA 1517, to the south of the subject well, produced from the Pardonet-Baldonnel zone between December 1980 and June 2002. In March 2004, acid gas disposal started into WA 1517, and continued until September 2012. In 2009, increased H₂S and CO₂ was noted at WA 3658. Reservoir pressures at WA 3658 had also increased between 2004 and 2009, indicating a clear communication with the acid gas disposal reservoir, since no disposal was occurring into the Pardonet-Baldonnel 'C' pool. WA 3658 had to be shut-in due to high H₂S content.

Although the 3 wells appeared to be separate when pressure depletion was occurring, the increase in pressure from disposal caused a pressure connection. For this reason, the Commission considers all 3 wells to be within the same pool for the purposes of long-term fluid containment. This must then be considered an acid gas pool.

A well 800 m from WA 3793 has a known gas migration issue, potentially sourced from the Pardonet-Baldonnel zone. Although the source of the leak has been plugged with a cement squeeze, this well provides another example of the effects of the poor casing and cement quality of the vintage wells in the area. Continued elevation of reservoir pressure due to disposal into the subject well represents a risk to area well integrity.

The October 2016 reservoir pressure measured at WA 3793 of 31,422 kPa is 99.6% of the initial value of 31,563 kPa, measured in July 1977. This pool was initially over-pressured for depth, with a 12.7 kPa/m gradient (130% of normal hydrostatic gradient). Allowing the pool pressure to increase significantly past this value will create an area of severe over-pressure. Considering this an acid gas pool increases the risk. Due to the age of wells in the area and the sour gas that has historically been produced, casing quality has proven to be poor. With multiple wellbores penetrating the pool, there are multiple potential leak pathways.

Based on the above factors, a maximum pressure limit of 100% of P_i is appropriate. The well is approaching and may have already surpassed the acceptable fill-up pressure.

Due to the reasons discussed above, the subject well has reached the end of its operational life. In order to accommodate operations, disposal may continue until November 30, 2017, at which time Order 94-02-009 will be terminated, and disposal activity must cease into the well SUKUNKA SUKUNKA b-65-B/93-P-5; WA# 3793.

CNRL was provided with a draft copy of this letter on September 19th, 2017. On October 4th, CNRL responded with a letter indicating their agreement to cease water disposal into the disposal well by the above mentioned date.

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