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Oil and Gas Case No. 15-2018

JUN 13 2018

**UIC Class II Permit Application**

DEPT OF ENVIRONMENT & NATURAL  
RESOURCES - RAPID CITY

Continental Resources is requesting to modify the injection fluid from air to water to support the secondary oil recovery project within the West Buffalo Red River Unit.

Well Name: WBRRU 12-31

Well Location: 2,080' FNL & 760' FWL Section 31-21N-4E, Harding County, Buffalo, SD.

The application for a permit to inject shall contain the following complete information:

**(1)** A one-half mile fixed radius area of review plat which shows the location of the injection well or wells, existing or proposed; the location of all oil and gas wells; the location of all water wells active and abandoned; the location of all other wells, including plugged and abandoned wells; abandoned locations; dry holes; current drilling locations; the names of operators; the surface and mineral owners; and each offset operator;

See attached map.

**Operator:** Continental Resources is the only operator of the West Buffalo Red River Unit.

**Working Owners:**

Continental Resources Inc.  
Robert G Fowler  
Michael Porter  
Linn Operating INC.

**Mineral Owners**

See Attached.

**Surface Owner**

Name: David Niemi

Address: 12201 South Cave Hills Rd, Buffalo, SD, 57720

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(2) The formation or formations from which oil, gas, and water wells are producing or have produced;

**Oil:** Red River "B" Formation

**Gas:** Red River "B" Formation

**Water:** Red River "B" Formation, Fox Hills, Hell Creek, Inyan Kara, Madison, & Minnelusa.

(3) The name, description (stratigraphic and structural), and depth of the receiving formation or formations and the overlying confining zone or formation;

Receiving formation(s): Red River "B" at 8,442' MD & 8,458' TVD

The Red River "B" zone porosity in the vicinity of the WBRRU #12-31 well is 15'-17' thick. It is composed of brown to tan dolomite, often with a chert layer between the upper and lower porosity zones. The upper "B" porosity is about 3' thick in this area and is usually laminated recrystallized algal mat, having better permeability and better oil saturation than the lower "B" porosity. The lower "B" porosity is more of a bioturbated mudstone, that is as porous or more porous than the upper "B" but with lower permeability and lower oil saturation.

Confining zone/formation(s): The WBRRU 12-31 well enters the Red River "B" zone porosity at 8,442' MD and ends in the "B" zone porosity at 8,458 MD.

The State #32-16 well in section 16-T21N-R4E shows 73' of shale above the Red River top from 8,435' to 8,508', which contains the water injection from going higher than the Red River formation. It also shows 39' of tight limestone below the base of the Red River "B" porosity from 8,563' to 8,602' which contains the water injection from going lower than the Red River "B" zone porosity zone. See attached type log for the State #32-16 well.

The State #32-16 is the closest well as most Red River "B" wells were intentionally not drilled into the Red River "C" zone due to the high volume of water within the zone.

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**(4)** The well type, construction, spud date, total depth, formation tops, record of completion or recompletion, and plugging for all oil, gas, and injection wells within the area of review, **and any additional pertinent information which the secretary determines is necessary to make an informed judgment on the issuance of a permit**, including drill stem tests and well logs for all oil and gas wells identified in the area of review;

- 1) WBRRU 32-36A – Well is producing
- 2) WBRRU 14-31 – Well is producing
- 3) WBRRU 33-36 – SWD
- 4) WBRRU 43-31H – Well is producing
- 5) WBRRU 32-36 - Plugged

See attached documents.

**(5)** Information on abandoned and active water wells, as follows:

See attached document.

**(a)** Abandoned water wells: None

- (i) The legal location;
- (ii) Well name; and
- (iii) Method of abandonment, if available;

**(b)** Active water wells: None

**(6)** A description of the injection well's casing and the proposed casing program, and the proposed method for testing the casing for mechanical integrity before use as an injection well.

See attached.

- 1) Wellbore diagram

The casing on the WBRRU #12-31 will be MIT tested as required by the State of South Dakota, which is a 15 minute test at 1000 psi with an allowable 10% fall off.

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(7) The geologic name and the depth to and interval of all freshwater resources which may be affected by injection;

Name: Fox Hills Depth: Approx. 800'

The WBRRU #12-31 cement bond log shows water bearing sands at the following depths:

Name: Dakota Sand Interval: 4,362' – 4,630'

Name: Minnekahta Interval: 5,916' – 5,960'

Name: Minnelusa Sand Interval: 6,048 – 6,526'

(8) The names and addresses of the operators of the project;

Name: Continental Resources

Address: PO Box 268870, Oklahoma City, OK, 73126

(9) Schematic drawings of the surface and subsurface construction details of the well with detailed drawings of the gauge connections;

See Attached

(10) The source and nature of the substance or substances to be injected, its viscosity, its compatibility with the receiving formation, including stability indices, and the estimated average and maximum daily amounts to be injected. If the nature of the injected fluid is produced water, a water quality analysis must be submitted and must include information on total dissolved solids content, chlorides, sodium, sulfates, nitrates, and hydrocarbons;

See Attached water tests. Injection water will come from the WBRRU, a future WSW within the unit, and from the Table Mountain Field wells.

(11) The average and maximum estimated injection pressure;

Average: 1,650 psi

Maximum: 1,700 psi

Maximum Injection Rate: 3000 Bbls / Day

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**(12)** A narrative description of any proposed production stimulation program, including a feasibility study, process description, and an explanation of how the data were determined, such as working calculations;  
Production stimulation Program

Feasibility Study:

The feasibility of oil recovery using water injection has been demonstrated by the increase in production from the Central Buffalo Red River Unit.

Process description:

Water will be injection into the Red River "B" formation to help mobilize the oil place sweeping it towards a producing well.

How data was Determined:

Using production data from the Central Buffalo Red River Unit and multiple waterfloods in the US.

**(13)** An analysis of any corrective action on all wells identified on the plat required by subdivision (1) of this section and the basis for the conclusion;

Corrective Action:

Continental Resources is not aware of any corrective actions needed on any of the wells in the AOR.

Basis for the Conclusion:

All wells within the area of review are properly constructed so no corrective action is need.

**(14)** The injection zone characteristics, including porosity, compressibility, and intrinsic permeability. This information has been collected over the numerous years of drilling and completion of wells within the unit using well logs and core samples.

Porosity: 17%

Compressibility:  $0.7 \times 10^{-6}$  psi<sup>-1</sup>

Intrinsic Permeability: 10 md

**(15)** The expected project life

Years: 20 – 25

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(16) The surface owner's name, address, and telephone number.

Name: David Niemi

Address: 12201 South Cave Hills Rd, Buffalo, SD, 57720

Telephone number: (605) 375 - 3355

**As indicated in Section 4, the Secretary reserves the right to request additional pertinent information needed to make a recommendation on the approvability of the application. The secretary shall deny any permit application which is incomplete.**

In addition, the applicant will need to submit a notarized Certification of Applicant (Form 13), that can be obtained at <http://denr.sd.gov/documents/form13.pdf>. or by contacting the South Dakota Department of Environment and Natural Resources

All permits to inject are issued pursuant to the provisions of chapter 74:10:11.01.

Name of person legally responsible for Class II operation (owner/operator),

Continental Resources INC

Address: PO Box 268870, Oklahoma City, OK, 73126

Telephone: (405) 234-9000

Local representative or contact person if different from above:

Name: Corey Irons

Address: 11583 S. Cave Hills Road, Buffalo, SD, 57720

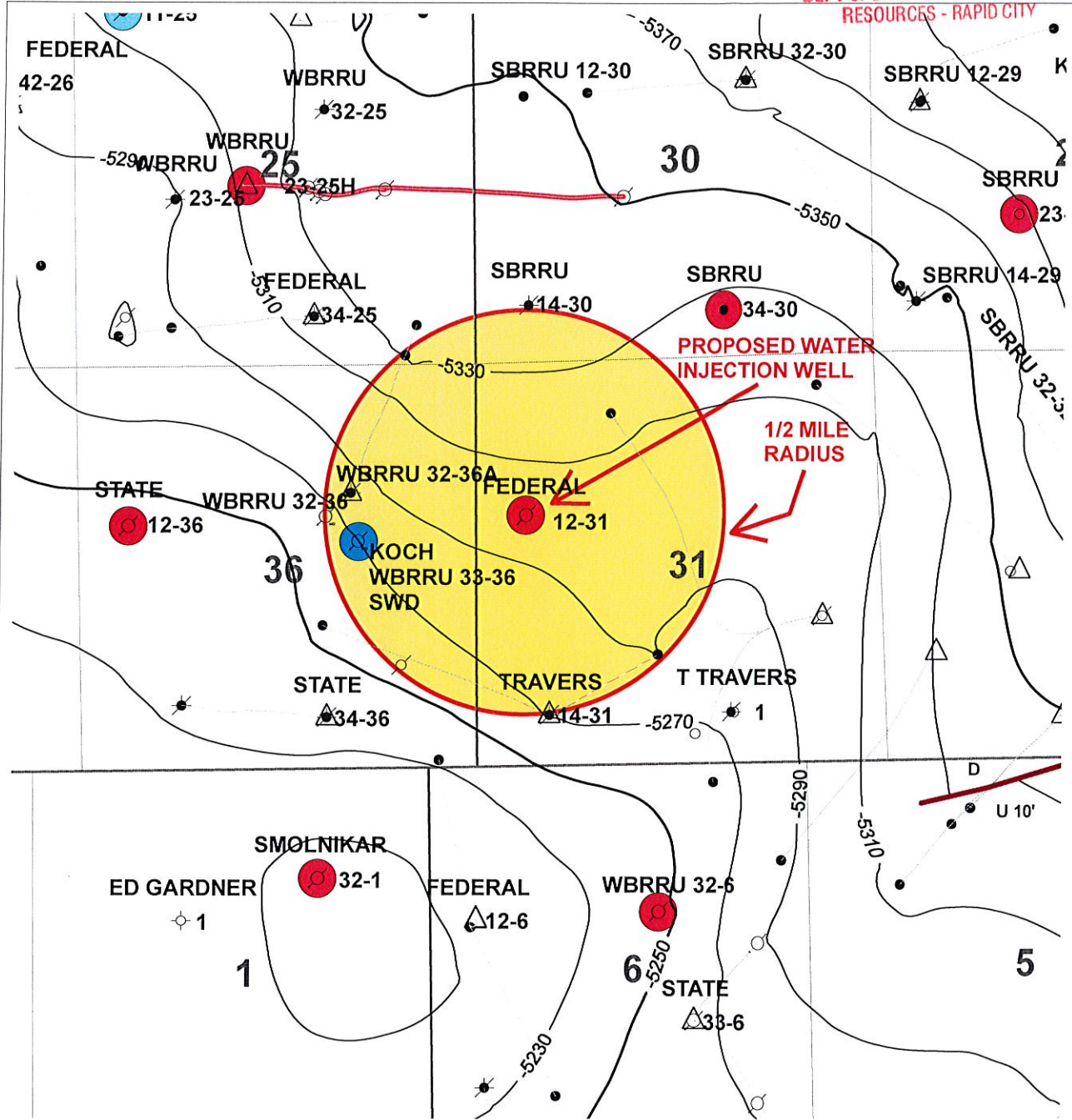
Telephone: (605) 375-3731



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- HORIZONTAL SURFACE LOCATION
- HORIZONTAL OIL SURFACE ONLY
- HORIZONTAL OIL BH LOCATION
- OIL PLUGGED & ABANDONED
- SALT WATER DISPOSAL WELL
- AIR INJECTION WELL
- DRY & ABANDONED

- Salt Water Disposal Well
- Water Injection Well
- Air Injection Well
- Air Injection to Water Injection

|   |   |
|---|---|
|   |   |
| <b>WBRRU 12-31</b><br>Red River B Structure<br>Sec.31-T21N-R4E, Harding Co., South Dakota |   |
| GA WBRRU 12-31 WF.gmp   |   |
| Date: 22 February, 2018   | Geologist: Gerry Allen<br>Scale: 1:24000<br>CI: 20' |