

**STATE OF ALASKA  
ALASKA OIL AND GAS CONSERVATION COMMISSION  
333 West 7<sup>th</sup> Avenue, Suite 100  
Anchorage, Alaska 99501**

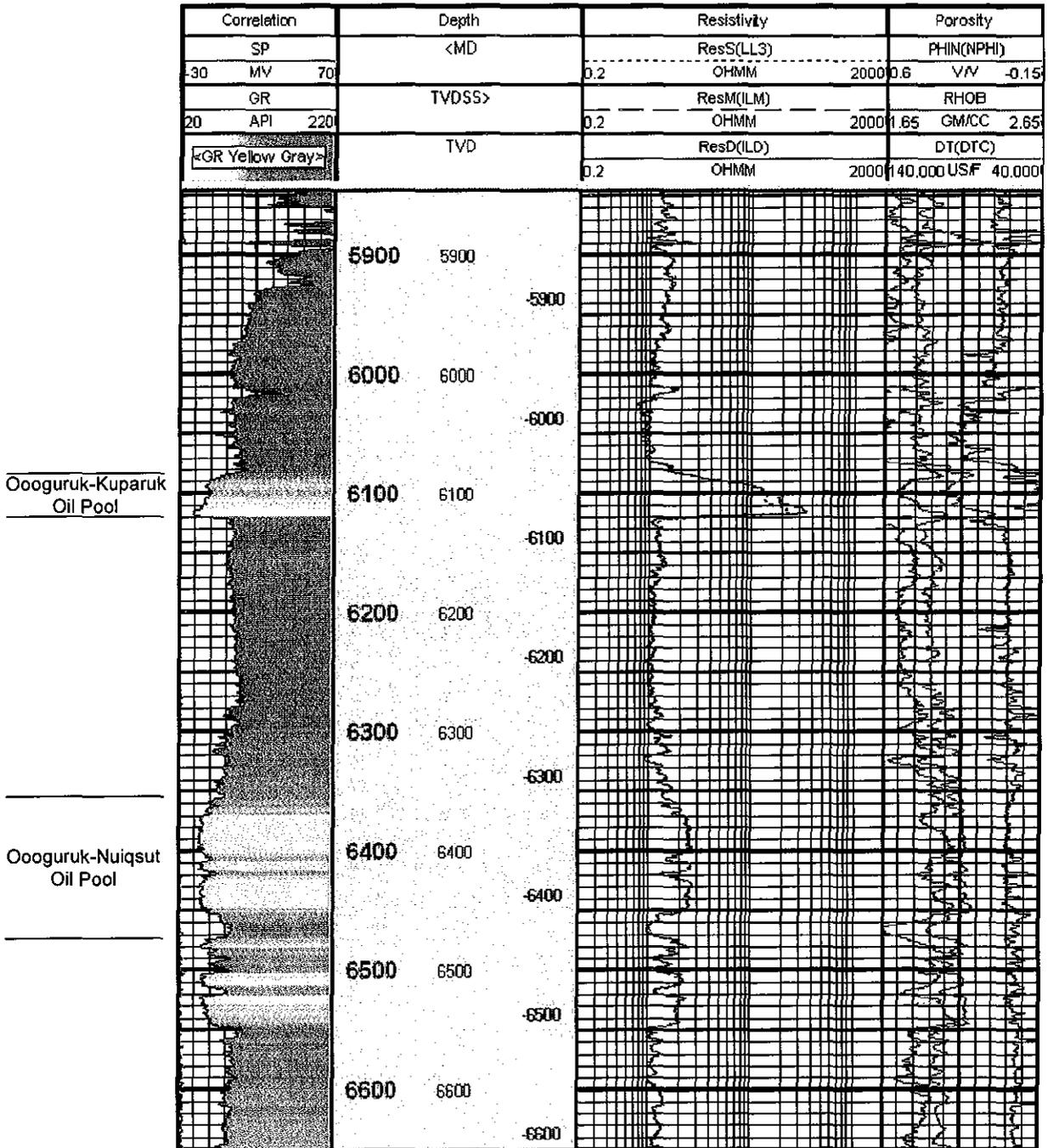
**Re: THE APPLICATION OF** ) **Area Injection Order No. 33**  
**PIONEER NATURAL** )  
**RESOURCES ALASKA, INC. for** ) **Oooguruk Field**  
**an order authorizing underground** ) **Oooguruk Unit**  
**injection of fluids for enhanced oil** ) **Oooguruk-Kuparuk Oil Pool**  
**recovery in the Oooguruk-Kuparuk** )  
**Oil Pool, Oooguruk Unit, Beaufort** ) **April 11, 2008**  
**Sea, Alaska** )

**IT APPEARING THAT:**

1. By letter and application dated December 20, 2007, and received by the Alaska Oil and Gas Conservation Commission (Commission) on December 21, 2007, Pioneer Natural Resources Alaska, Inc. (Pioneer), in its capacity as unit operator and on behalf of the working interest owners of the Oooguruk Unit (OU), requests an order from the Commission authorizing the injection of fluids for enhanced oil recovery in the Oooguruk-Kuparuk and Oooguruk-Nuiqsut Oil Pools. Pioneer's request regarding the Oooguruk-Nuiqsut Oil Pool is addressed in Area Injection Order No. 34.
2. Notice of a public hearing was published in the ANCHORAGE DAILY NEWS on January 8, 2008.
3. On January 24, 2008, the Commission received a request for a hearing. No other requests or comments were submitted to the Commission during the 30-day public comment period.
4. The Commission held the public hearing on February 14, 2008. During the hearing, the Commission requested additional information from Pioneer, and left the hearing record open until February 22, 2008.
5. On February 19, 2005, the Commission requested further technical information from Pioneer.
6. Pioneer submitted written responses to the Commission's requests on February 21, 2008. The hearing record closed February 22, 2008.

**FINDINGS:**

1. Operator: Pioneer is the operator of the leases in the area proposed for development.
2. Project Area Pool and Formations Authorized for Enhanced Recovery: Enhanced recovery injection is proposed within the Oooguruk-Kuparuk Oil Pool, which is defined in Conservation

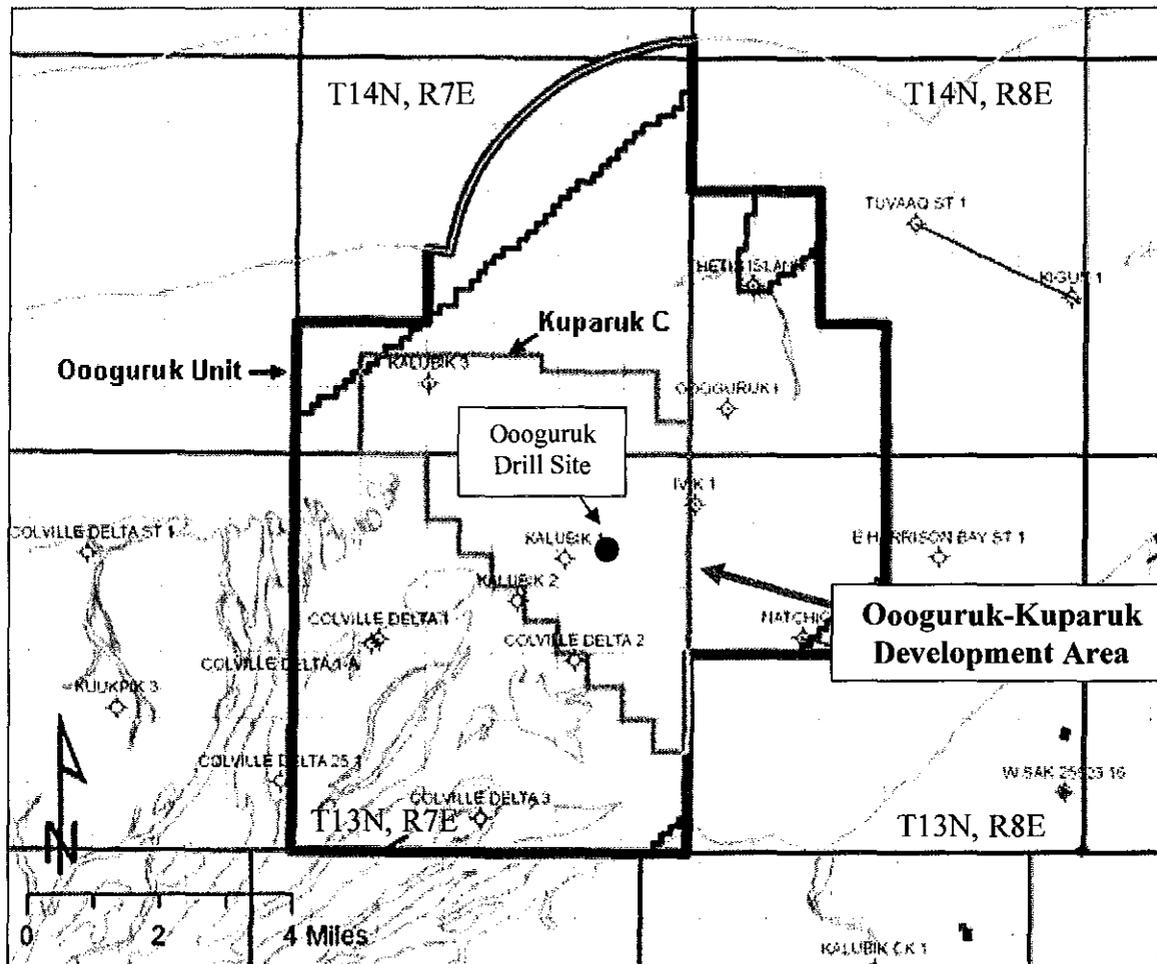


**Figure 1. Kalubik No. 1 – Type Well Log for Oooguruk-Kuparuk Oil Pool<sup>1</sup>**

<sup>1</sup> Figure 1 is presented for illustration purposes only. Refer to the Dual Laterolog/Micro Laterolog recorded in the Kalubik No. 1 exploratory well for the precise representation of the Oooguruk-Kuparuk Oil Pool.

Order No. 596. The target injection zone is the Oooguruk-Kuparuk Oil Pool, which is correlative to the interval between the measured depths of 6,083' and 6,121' on the Dual Laterolog-Micro Laterolog recorded in the Kalubik No. 1 exploration well (see Figure 1).

3. **Proposed Injection Area:** Pioneer requests authorization to inject fluids for the purpose of enhanced recovery operations on lands in the OU. The proposed injection area includes portions of Township (T) 13N, Range (R) 7E and T14N, R7E, Umiat Meridian (Figure 2).



**Figure 2. Proposed Injection Area for Oooguruk-Kuparuk Oil Pool<sup>2</sup>  
(highlighted in green)**

<sup>2</sup> This map was provided by Pioneer, and it is presented here for illustration purposes only. Refer to the legal description for the precise representation of the affected area.

4. Operators/Surface Owners Notification: All lands within the proposed development area are leased and lie within the OU. Two companies hold working interests in the proposed Oooguruk-Kuparuk Oil Pool: Pioneer and Eni Petroleum US LLC (Eni). The only affected landowner and surface owner is the State of Alaska, Department of Natural Resources. The affected operators are Pioneer, operator of the OU, and ConocoPhillips Alaska, Inc., operator of the Kuparuk River Unit (KRU), which lies immediately to the southeast of the OU. Pioneer provided a copy of the application for injection to all operators and surface owners within a one-quarter mile radius of the proposed injection wells.
5. Description of Operations: The Oooguruk-Kuparuk Oil Pool will be developed with five to eight horizontal wells, with a producer-to-injector ratio of about 1:1. The production and injection wells will range in length from 3,000' to 5,000' within the reservoir. Production and injection wells will be parallel to one another in an alternating arrangement to form a line-drive flood pattern. Individual wells will be spaced 2,000' to 4,000' apart.

The pool will be developed utilizing water injection as the enhanced recovery mechanism. Water injection is scheduled to begin shortly after production commences. Production from this pool will be commingled on the surface with produced fluids from other pools within the OU prior to shipment to the Kuparuk River Unit drill site DS-3H for processing.

Annualized peak production rate for the Oooguruk-Kuparuk is expected to be between 2,000 barrels of oil per day (BOPD) and 8,000 BOPD. Annualized waterflood injection rates are expected to peak between 3,000 barrels of water per day (BWPD) and 12,000 BWPD.

6. Hydrocarbon Recovery: Estimates of original oil in place and recovery (in units of one million stock tank barrels or MMSTB) within the Oooguruk-Kuparuk development area are:

Hydrocarbon Volume	Low Estimate (MMSTB)	High Estimate (MMSTB)
Original Oil in Place (OOIP)	15	25
Primary Recovery (6% to 10% of OOIP)	1	2.5
Primary + Waterflood (26 to 34% of OOIP)	4	8.5

7. Geology:

- a. Stratigraphy: The Oooguruk-Kuparuk Oil Pool encompasses early Cretaceous-aged (Neocomian), transgressive sediments deposited within a marine shelf and shoreface environment directly atop the Lower Cretaceous Unconformity. This interval of bioturbated sandstones, siltstones and mudstones correlates directly to the basal portion of the Kuparuk C interval within the adjacent Kuparuk River Unit, and to the Kuparuk C interval in the Colville River and Milne Point Units. Within the OU, the Kuparuk C is generally concentrated and preserved in structural depressions and grabens on the downthrown side of syn-depositional faults, which range up to 200' in vertical displacement.

Within the OU, the Kuparuk C interval ranges from 0' to about 55' thick. Along with mudstone and siltstone, it consists of very fine- to coarse-grained, fining-upward sandstone that has 5% to 25% glauconite, 10% to 35% siderite cement, and up to 50% clay matrix. Here, the Kuparuk C appears to have been deposited as part of a transgressive marine shoreface and shelf system. The sediments thicken locally on the

downthrown side of northwest-trending normal faults that occur within the development area. On the upthrown side of these same faults, and away from them, the Kuparuk C decreases in reservoir quality and becomes thin to absent. Kuparuk porosity ranges from 13% to 32%, and averages approximately 17%. Permeability ranges from 0.5 millidarcies (md) to 500 md, and averages approximately 50 md to 100 md. Average water saturation is about 30%.

- b. Structure: Within the Oooguruk-Kuparuk development area, the structure at Kuparuk level is a northwest-plunging anticlinal nose centered in the southeastern-most corner of the OU, to the east of the Colville Delta No. 3 well and to the southeast of the Colville No. 2 well. The flanks of this structure are cut by northwest-trending normal faults that are more commonly downthrown toward the northeast. These faults were active during early Cretaceous time, and created accommodation space for accumulation of the Kuparuk C sediments.
- c. Trap Configuration: Well log and seismic information indicate that the Kuparuk C reservoir at the OU is best developed on the downthrown side of northwest-trending normal faults within the development area. The trapping mechanisms for oil within the Kuparuk reservoir are juxtaposition against non-reservoir rock across the northwest-trending normal faults and stratigraphic pinch-outs into very fine-grained, non-reservoir rock. The Oooguruk-Kuparuk Oil Pool is not in hydraulic communication with the underlying Oooguruk-Nuiqsut Oil Pool.
- d. Confining Intervals: The Oooguruk-Kuparuk Oil Pool is overlain, in ascending order, by approximately 200' of marine shale assigned to the Kalubik Formation, about 100' of Highly Radioactive Zone (HRZ) shale, and then roughly 1,000' of shale assigned to the Hue Formation. The pool is underlain by about 150' to 350' of shale assigned to the Miluveach Formation, which separates and isolates the Oooguruk-Kuparuk Oil Pool from the underlying Oooguruk-Nuiqsut Oil Pool. The overlying and underlying confining intervals are laterally continuous throughout the proposed development area.

- 8. Well Logs: Logs of injection wells will be filed with the Commission according to the requirements of 20 AAC 25.
- 9. Mechanical Integrity and Well Design of Injection Wells: The casing programs for all injection wells will comply with 20 AAC 25.030.

Pioneer requests a waiver from the requirements of 20 AAC 25.412(b) so that packers may be located more than 200' measured depth (MD) above the top of the injection zone to facilitate the completion and long-term operation of the well. However, packers will not be set above the confining zone. Tubing or other equipment will be designed and installed in accordance with 20 AAC 25.412.

Cement-bond logs will be run to demonstrate isolation of injected fluids to the Oooguruk-Kuparuk reservoir as required by 20 AAC 25.412(d). Mechanical integrity tests will be performed in accordance with 20 AAC 25.412(c).

10. Type of Fluid / Source: Fluids requested for injection are:
- source water from the Kuparuk sea water treatment plant;
  - injection water provided by the Kuparuk River Field;
  - produced water from the Oooguruk-Kuparuk and Oooguruk-Nuiqsut Oil Pools; and
  - small amounts of the following fluids: fluids from reverse osmosis water treatment units, sumps, and hydrotests; rinsate from washing mud hauling trucks; excess well-work fluids; and treated camp waste water. These fluids will usually be injected into the ODS Class I disposal well, but may be blended with the fluids described in a, b, and c above, if necessary. The volume of these fluids is expected to be less than 0.1%, and is not expected to affect the efficiency of recovery from the oil pool.
11. Water Compatibility with Formation: Pioneer conducted special core analyses on a limited number of core samples from the Kalubik No. 1 exploratory well. Pioneer reports that Kuparuk core samples are insensitive to formation and injection brine salinities and flow rates, and that fines did not migrate to impair permeability.
12. Injection Rates and Pressures: Injection rates will be adjusted to manage voidage for the reservoir. The maximum expected injection well rate is 10,000 BWPD, and the average injection well rate is expected to be 2,500 BWPD. Injection pressures are expected to range from approximately 1,800 psi to 2,000 psi at the wellhead. Injection will be managed to try to match voidage on an instantaneous basis.
- Original pressure of the Oooguruk-Kuparuk reservoir was measured at about 3,150 psi at 6,050' true vertical depth subsea, and the bubble point is about 2,600 psi. The proposed project will be operated to attempt to maintain the average pressure in the Oooguruk-Kuparuk Oil Pool within about 500 psi of original pressure. Average reservoir pressure will be maintained above the bubble point pressure.
13. Fracture Information: Although normal water injection pressure will be close to the Oooguruk-Kuparuk reservoir rock parting pressure, computer modeling indicates that, provided injection pressure is maintained below 2,900 psi, fractures will propagate to, but not into, the shale beds that bound the pool above and below. Therefore, injection fluids will remain within the Oooguruk-Kuparuk reservoir.
14. Absence of Underground Sources of Drinking Water: According to the August 18, 2006, findings and conclusions of the U.S. Environmental Protection Agency (EPA), portions of the aquifers beneath the ODS that lie within a one-half mile radius of two potential Class I waste disposal candidate wells to be drilled from the ODS, do not qualify as underground sources of drinking water.<sup>3</sup> Formation water salinity calculations by the Commission using log data from four exploratory wells and methods compatible with the  $R_{wa}$  method endorsed by the EPA confirm that there are no aquifers within the Affected Area that could serve as

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<sup>3</sup> Letter dated August 18, 2006 from Michael A. Bussell, Director of the Office of Compliance and Enforcement, U.S. Environmental Protection Agency, Region 10, to Mr. John Hellen of Pioneer Natural Resources Alaska, Inc., submitted by Pioneer to AOGCC as Attachment 1 to the Application for Proposed Oooguruk-Kuparuk and Oooguruk-Nuiqsut Oil Pools, Oooguruk Unit, North Slope, AK, on January 8, 2008.

underground sources of drinking water.<sup>4</sup>

15. Mechanical Condition of Adjacent Wells: The Kalubik No. 1, Colville Delta No. 2, Ivik No. 1, and Ooguruk No. 1 exploration wells all penetrate the proposed Ooguruk-Kuparuk injection interval within, or in the near vicinity of, the Affected Area. All of these wells have been plugged and abandoned. All four of these wells have sufficient mechanical isolation to confine injected fluids to the target reservoir and prevent cross flow into other intervals.

**CONCLUSIONS:**

1. The application requirements of 20 AAC 25.402 have been met.
2. Injection of water will significantly improve recovery.
3. There are no underground sources of drinking water beneath the proposed Affected Area.
4. Increasing the distance between the packer and top of the injection zone will not compromise well integrity, so long as the top of the production casing cement is at least 300' measured depth above the packer.
5. The proposed injection operations will be conducted in permeable strata, which can reasonably be expected to accept injected fluids at pressures less than the fracture pressure of the confining strata.
6. Injected fluids will be confined within the appropriate receiving intervals by impermeable lithology, cement isolation of the wellbore and appropriate operating conditions.
7. Seawater and injection water provided by the Kuparuk River Field and produced waters from the Ooguruk-Nuiqsut and Ooguruk-Kuparuk Oil Pools will be compatible with the Ooguruk-Kuparuk reservoir.
8. Compatibility has not been demonstrated for mixtures of waters or the following fluids: fluids from reverse osmosis water treatment units, sumps, and hydrotests; rinsate from washing mud hauling trucks; excess well-work fluids; and treated camp waste water.
9. Reservoir pressure will be maintained above bubble point.
10. Reservoir and well surveillance, coupled with regularly scheduled mechanical integrity tests, will demonstrate appropriate performance of the enhanced oil recovery project or disclose possible abnormalities.
11. Sufficient information has been provided to authorize injection of water into the Ooguruk-Kuparuk Oil Pool for the purposes of pressure maintenance and enhanced oil recovery.

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<sup>4</sup> Colville Delta 1, Colville Delta 2, Kalubik 1, and Thetis Island 1 log data were analyzed using techniques consistent with EPA guidance document "Survey of Methods to Determine Total Dissolved Solids Concentrations," KEDA Project No. 30-956, prepared by Ken E. Davis Associates in 1988 and revised in 1989.

**NOW, THEREFORE, IT IS ORDERED** that:

The underground injection of fluids for pressure maintenance and enhanced oil recovery is authorized in the following area, subject to the following rules and the statewide requirements under 20 AAC 25 to the extent not superseded by these rules:

**Affected Area:**

**Umiat Meridian**

<u>Township, Range</u>	<u>Sections</u>
T13N, R07E	1, 2, 3, 4, 10, 11, 12, 13 and 14: ALL 9: NE/4 15: NE/4 23: NE/4 24: ALL 25: NE/4
T14N, R07E	25: S/2 SW/4 26: S/2 S/2 27: S/2 SE/4, NW/4 SE/4, SW/4 28: S/2 29: S/2 32, 33, 34, 35: ALL 36: S/2, NW/4

**Rule 1 Authorized Injection Strata for Enhanced Recovery**

Authorized fluids may be injected for purposes of pressure maintenance and enhanced recovery within the Oooguruk-Kuparuk development area into strata that are common to, and correlate with, the interval between 6,083' and 6,121' measured depth on the Dual Laterolog/Micro Laterolog recorded in the Kalubik No. 1 exploration well.

**Rule 2 Well Construction**

To facilitate wireline access, packers in injection wells may be located more than 200' MD above the top of the Oooguruk-Kuparuk Oil Pool; however, packers shall not be located above the confining zone. Production casing cement volume must be sufficient to place cement a minimum of 300' MD above the planned packer depth.

**Rule 3 Authorized Fluids for Enhanced Recovery**

Fluids authorized for injection are:

- a. source water from the Kuparuk sea water treatment plant;
- b. injection water provided by the Kuparuk Field;
- c. produced water from the Oooguruk-Kuparuk and Oooguruk-Nuiqsut Oil Pools; and

- d. tracer survey liquid to monitor reservoir performance.

The injection of any other fluids, or mixtures of the above fluids, shall be approved by separate administrative action.

#### **Rule 4 Authorized Injection Pressure for Enhanced Recovery**

Injection pressures must be maintained such that the injected fluids do not fracture the confining zones or migrate out of the approved injection stratum.

#### **Rule 5 Monitoring Tubing-Casing Annulus Pressure**

The tubing and casing annuli pressures of each injection well must be monitored at least daily, except if prevented by extreme weather condition, emergency situations, or similar unavoidable circumstances. Monitoring results shall be documented and made available for Commission inspection.

#### **Rule 6 Demonstration of Tubing/Casing Annulus Mechanical Integrity**

The mechanical integrity of an injection well must be demonstrated before injection begins, and before returning a well to service following a workover affecting mechanical integrity. A Commission-witnessed mechanical integrity test must be performed after injection is commenced for the first time in a well, to be scheduled when injection conditions (temperature, pressure, rate, etc.) have stabilized. Subsequent tests must be performed at least once every four years thereafter (except at least once every two years in the case of a slurry injection well). The Commission must be notified at least 24 hours in advance to enable a representative to witness mechanical integrity tests. Unless an alternate means is approved by the Commission, mechanical integrity must be demonstrated by a tubing/casing annulus pressure test using a surface pressure of 1500 psi or 0.25 psi/ft multiplied by the vertical depth of the packer, whichever is greater, that shows stabilizing pressure and does not change more than 10 percent during a 30-minute period. Results of mechanical integrity tests must be readily available for Commission inspection.

#### **Rule 7 Well Integrity and Confinement**

Whenever any pressure communication, leakage or lack of injection zone isolation is indicated by injection rate, operating pressure observation, test, survey, log, or other evidence, the Operator shall notify the Commission by the next business day and submit a plan of corrective action on a Form 10-403 for Commission approval. The Operator shall immediately shut in the well if continued operation would be unsafe or would threaten contamination of freshwater, or if so directed by the Commission. A monthly report of daily tubing and casing annuli pressures and injection rates must be provided to the Commission for all injection wells indicating well integrity failure or lack of injection zone isolation.

#### **Rule 8 Notification of Improper Class II Injection**

Injection of fluids other than those listed in Rule 4 without prior authorization is considered improper Class II injection. Upon discovery of such an event, the operator must immediately notify the Commission, provide details of the operation, and propose actions to prevent recurrence. Additionally, notification requirements of any other State or Federal agency remain the operator's responsibility.

If fluids are found to be fracturing the confining zone or migrating out of the approved injection stratum, the Operator must immediately shut in the injection wells. Injection may not be restarted unless approved by the Commission.

**Rule 9 Other Conditions**

The Commission may suspend, revoke or modify this authorization if injected fluids fail to be confined within the designated injection strata.

**Rule 10 Administrative Action**

Upon proper application, or its own motion, and unless notice and public hearing is otherwise required, the Commission may administratively waive the requirements of any rule stated herein or administratively amend this order as long as the change does not promote waste or jeopardize correlative rights, is based on sound engineering and geoscience principles, and will not result in an increased risk of fluid movement into freshwater.

**ENTERED at Anchorage, Alaska, and dated April 11, 2008.**



Daniel T. Seamount, Jr., Chair  
Alaska Oil and Gas Conservation Commission

John K. Norman, Commissioner  
Alaska Oil and Gas Conservation Commission

Cathy P. Joerster, Commissioner  
Alaska Oil and Gas Conservation Commission

**RECONSIDERATION AND APPEAL NOTICE**

As provided in AS 31.05.080(a), within **20** days after written notice of the entry of this order or decision, or such further time as the Commission grants for good cause shown, a person affected by it may file with the Commission an application for reconsideration of the matter determined by it. If the notice was mailed, then the period of time shall be **23** days. An application for reconsideration must set out the respect in which the order or decision is believed to be erroneous.

The Commission shall grant or refuse the application for reconsideration in whole or in part within 10 days after it is filed. Failure to act on it within 10 days is a denial of reconsideration. If the Commission denies reconsideration, upon denial, this order or decision and the denial of reconsideration are **FINAL** and may be appealed to superior court. The appeal **MUST** be filed within **33** days after the date on which the Commission mails, **OR 30** days if the Commission otherwise distributes, the order or decision denying reconsideration, **UNLESS** the denial is by inaction, in which case the appeal **MUST** be filed within **40** days after the date on which the application for reconsideration was filed.

If the Commission grants an application for reconsideration, this order or decision does not become final. Rather, the order or decision on reconsideration will be the **FINAL** order or decision of the Commission, and it may be appealed to superior court. That appeal **MUST** be filed within **33** days after the date on which the Commission mails, **OR 30** days if the Commission otherwise distributes, the order or decision on reconsideration. As provided in AS 31.05.080(b), "[t]he questions reviewed on appeal are limited to the questions presented to the commission by the application for reconsideration."

In computing a period of time above, the date of the event or default after which the designated period begins to run is not included in the period; the last day of the period is included, unless it falls on a weekend or state holiday, in which event the period runs until 5:00 p.m. on the next day that does not fall on a weekend or state holiday.