

**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 FOREST OIL CORPORATION for an order authorizing a pilot waterflood project designed to test the potential for enhanced oil recovery in the Hemlock Formation, Redoubt Unit, Cook Inlet, Alaska ) Enhanced Recovery Injection Order No. 2 ) Redoubt Unit ) Hemlock Formation ) Well RU-6 ) August 26, 2004**

**IT APPEARING THAT:**

1. By letter and application dated June 14<sup>th</sup>, 2004, Forest Oil Corporation, (“Forest”), Operator of the Redoubt Unit (“RU”) requested an order from the Alaska Oil and Gas Conservation Commission (“Commission”) to authorize pilot water injection into Well RU-6 for enhanced oil recovery under 20 AAC 25.402.
2. Pilot projects for enhanced recovery may also be administered under 20 AAC 25.450(b) where feasibility of a process has not been proved.
3. Notice of a public hearing was published in the Anchorage Daily News on June 25, 2004.
4. No comments, protests or request for public hearing were received during the protest period.
5. The Commission determined it had sufficient information as a basis for ruling, and a tentative public hearing was canceled.

**FINDINGS:**

1. Operator:

Forest Oil Corporation (“Forest”) operates the Redoubt Shoal Undefined Oil Pool in the Redoubt Unit, Cook Inlet, Alaska.

2. Project Location

The surface location of Redoubt Unit Well No. 6 (“RU-6”) is 1,909 feet from the south line and 318 feet from the east line of Section 14, T7N, R14W of the Seward Meridian. The bottomhole location is 1,137 feet from the north line and 1,518 feet from the east line of Section 19, T7N, and R13W of the Seward Meridian. The surface location of the well is located on Osprey Platform, which is approximately 1.5 miles southeast of West Foreland, offshore Cook Inlet.

3. Operators/Surface Owners Notification:

Forest provided operators and surface owners within one-quarter mile of the proposed area with a copy of the application for injection. The only affected operator is Forest.

The State of Alaska, Department of Natural Resources is the only affected surface owner.

4. Description of Operation:

Current development of the field consists of five production wells in the Hemlock Formation. The Redoubt Unit ("RU") waterflood pilot project plan includes a single injector, Well RU-6. RU-6 is an oil producer that has cumulative production of 177,497 barrels of oil through May 2004.

A pilot project of about 36 months duration is proposed with the following objectives:

- Determine the injectivity into the Hemlock Formation.
- Confirm that geological barriers will contain the injection fluid when injected at injection pressures above fracture gradient.
- Evaluate injection influence on offset producers.

Data gathered will include:

- Injectivity in well RU-6.
- Production and injection rates and pressure.
- Rate and pressure response to injection in various wells.
- Confinement of injected fluids.

5. Geologic Information:

- a. Injection will occur within RU-6 in the Hemlock Formation. The pool is being developed under statewide regulations and has not been defined in vertical or regional space.
- b. The Hemlock Formation resulted from fluvial deposition in meandering, coalescing stream channels. It consists of interbedded fine to medium-grained sand and gravels, pebble conglomerates, dense silts and occasional thin coal beds. Core from RU-2 indicated a distal low energy depositional environment. There are six identified lithofacies within the Hemlock based on conventional core analysis in Well RU-2. Porosity is intergranular with well-cemented and competent rock. Clay volume ranges from 9-20% of rock volume and appears to be dispersed. Reservoir facies consist of pebble conglomerate (porosity 7-13%), pebble-gravel sandstone (porosity 10-16%), medium to coarse grain sandstone (porosity 10-16%) and fine-grained sandstone (porosity 12-14%). Permeability ranges from 0.1 to several hundred millidarcies throughout the reservoir facies.
- c. Non-reservoir facies consist of very fine-grained siltstone (porosity 1-4%) and generally impermeable carbonaceous claystone and coals.
- d. The injection interval is will be from 15,130 to 15,890 feet measured depth in RU-6, the same intervals that produced oil.

6. Well Logs:

The initial formation logs obtained while drilling RU-6 are on file with the Commission.

7. Mechanical Integrity and Well Design of Injection Wells:

Well RU-6 was permitted, drilled and then completed in accordance with statewide regulations. A cement bond log was run on well RU-6 that demonstrates good cement integrity between the Hemlock Formation and overlying Tyonek Formation.

8. Injection Rates, Pressures, Fracture Propagation

The initial injection rate will be 2,500 to 3,000 barrels water per day ("BWPD") and may vary according to production from RU wells. The operator anticipates the injection will exceed the withdrawals from the area of influence offsetting the injector. Pressure support is anticipated at RU-1, -7 and possibly -2.

The injection pumps will be located at the onshore Kustatan Production Facility. To account for friction loss, the maximum injection pressure planned for the RU-6 pilot water flood is approximately 4800 psi. Forest plans to verify pressure loss when RU-6 is recompleted. The pilot water flood will be operated to prevent fracture of the confining zone or the Hemlock Formation. Regulation 20AAC 25.402 (b)(11) requires operation of the injection well at pressures less than that required to initiate or propagate fractures through confining zones.

9. Type of Fluid / Source Water Analysis:

Fluids requested for injection are filtered, produced Hemlock Formation water from RU wells 1, 2, 5A and 7. The produced water source is the Hemlock Formation; therefore compatibility is not an issue.

10. Freshwater Exemption:

Hemlock formation water analyses submitted with Forest's application averaged 11,060 mg/l TDS for 6 separate samples. The Hemlock Formation is hydrocarbon bearing in the area of RU and produced water contaminated with oil and total dissolved solids (TDS) has no potential as a source of drinking water. Both of these characteristics disqualify the Hemlock Formation at RU as a source of drinking water. No aquifer exemption is necessary.

11. Expected Increase in Hydrocarbon Recovery

Forest estimates primary recovery of oil would be about 6% of original oil in place or about 3 million barrels to the reservoir pressure bubble point of 1,490 psi, without any pressure maintenance process. The crude gravity is 26.5 degrees API and is undersaturated with a solution gas-oil ratio of 250 scf/STB oil. Preliminary studies indicate waterflood will increase recovery to greater than 20% assuming full field development. Data acquisition on injection response and recovery benefits is an objective of the pilot project.

12. Mechanical Condition of Adjacent Wells:

Well RU-7 and exploration well Redoubt State 29690 #1 are within ¼ mile of RU-6. Both wells were cemented satisfactorily to isolate hydrocarbons within the Hemlock and in the case of Redoubt State 29690 #1, isolation plugs were satisfactorily placed to permanently confine any hydrocarbons to the Hemlock and abandon the well.

## **CONCLUSIONS:**

1. The application requirements of 20 AAC 25.402 have been met.
2. 20 AAC 25.450 allows the Commission to approve pilot projects for enhanced recovery if the project will not result in an increased risk of fluid movement into freshwater sources.
3. Mechanical integrity of the well was demonstrated at completion and conformed to Commission regulations at that time.
4. Water injection is anticipated to significantly increase recovery.
5. Freshwater aquifer exemption for the Hemlock formation is not necessary.
6. Sufficient information has been provided to authorize pilot water injection into the Hemlock Formation to evaluate pressure maintenance and the enhanced oil recovery process, and to provide data to evaluate full field waterflood development.
7. Injection pressure will be less than fracture gradient of the confining zone. Forest intends to establish injection operation limits during the pilot project.
8. Reservoir and well surveillance coupled with regularly scheduled mechanical integrity tests will demonstrate appropriate performance of the enhanced oil recovery project and disclose anomalous performance.
9. An annual report will keep the Commission apprised of the pilot project's progress.

## **NOW, THEREFORE, IT IS ORDERED THAT:**

The underground injection of fluids for evaluation of enhanced oil recovery is authorized, subject to the following rules and the statewide requirements under 20 AAC Chapter 25 to the extent not superseded by these rules.

### **Rule 1 Expiration Date**

This Order shall expire September 30, 2007 unless the Operator applies to extend the test, expand the pilot area up to a full field project, or abandon the pilot.

### **Rule 2 Authorized Injection Strata**

Strata common to the Hemlock Formation between 15,130 to 15,890 feet measured depth are authorized for injection for pressure support and enhanced oil recovery injection.

### **Rule 3 Fluid Injection Well**

Well RU-6 is the only well authorized for fluid injection during this pilot project. Well RU-6 bottomhole location is in Section 19, T7N, and R13W of the Seward Meridian.

### **Rule 4 Authorized Fluids for Enhanced Recovery**

Produced water from the Hemlock Formation is the only authorized injection fluid.

### **Rule 5 Demonstration of Tubing/Casing Annulus Mechanical Integrity**

The mechanical integrity of an injection well must be demonstrated before injection begins, at least once every four years thereafter (except at least once every two years in the case of a slurry injection well), and before returning a well to service following a work-over affecting mechanical integrity. 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. The Commission must be notified at least 24 hours in advance to enable a representative to witness mechanical integrity tests.

### **Rule 6 Pilot Project Surveillance**

Prior to initiating injection, a baseline temperature survey within RU-6 is required from above the Hemlock Formation to total depth of the well. Within 60 days after injection begins, a step rate test is required. The need for subsequent temperature or step rate tests shall depend on injection performance or notable performance anomalies. Information gathered from the pilot, including daily wellhead injection pressures and rates, results of injection surveys, shall be monitored and provided monthly to the Commission until the maximum surface pressure is determined by a step-rate test.

In addition to reporting requirements of 20 AAC 25.432 (1) an annual progress report of pilot operations shall be submitted within 90 days of the project startup anniversary and annually thereafter. The progress report shall contain information regarding project parameters including but not limited to:

- a. Reservoir Voidage balance within the project area.
- b. Analysis of pressure response and production response.
- c. Analysis of injection performance.
- d. Analysis of fluid containment surveys, step-rate tests or MIT's that would demonstrate confinement of injected fluids.
- e. Review of any specialized tests performed to gauge performance and results of the pilot project.

### **Rule 7 Notification of Improper Class II Injection**

Injection of fluids other than produced water from the Hemlock formation is considered improper Class II injection. Upon discovery of such an event, the operator must immediately suspend injection, notify the Commission, and provide details of the operation. Additional notification requirements of any other State or Federal agency remain the operator's responsibility.

### **Rule 8 Well Integrity Failure 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 immediately notify the Commission 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.

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

**Rule 9 Administrative Actions**

Unless notice and public hearing is otherwise required, the Commission may administratively waive or amend any rule stated above 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 fluid movement outside of the authorized injection zone.

**DONE** at Anchorage, Alaska and dated August 26, 2004.

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

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

AS 31.05.080 provides that within 20 days after receipt of written notice of the entry of an order, a person affected by it must file with the Commission an application for rehearing. A request for rehearing must be received by 4:30 PM on the 23<sup>rd</sup> day following the date of the order, or next working day if a holiday or weekend, to be timely filed. The Commission shall grant or refuse the application in whole or in part within 10 days. The Commission can refuse an application by not acting on it within the 10-day period. An affected person has 30 days from the date the Commission refuses the application or mails (or otherwise distributes) an order upon rehearing, both being the final order of the Commission, to appeal the decision to Superior Court. Where a request for rehearing is denied by non-action of the Commission, the 30-day period for appeal to Superior Court runs from the date on which the request is deemed denied (i.e., 10<sup>th</sup> day after the application for rehearing was filed).