

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION
333 West 7th Avenue, Suite 100
Anchorage Alaska 99501

Re: THE APPLICATION OF Union Oil) Disposal Injection Order No. 30
Company of California for disposal)
of Class II oil field wastes by) Deep Creek Unit
underground injection in the Sterling) NNA No. 2 Well
and Beluga Formations in the Deep)
Creek Unit NNA No. 2 Well, Section)
11, T2S, R13W, S.M.) June 1, 2005

IT APPEARING THAT:

1. By correspondence to the Alaska Oil and Gas Conservation Commission received on March 23, 2005, Union Oil Company of California (“Unocal”) requested authorization to allow the underground injection of non-hazardous Class II oil field waste fluids into the Sterling and Beluga Formations within the Deep Creek Unit NNA No. 2 (“NNA #2”) well bore.
2. The Commission published notice of opportunity for public hearing in the Anchorage Daily News on March 30, 2005 in accordance with 20 AAC 25.540.
3. The Commission did not receive any protests to the application, comments, or requests for a public hearing.
4. A hearing was held on May 3, 2005 at which Unocal provided sworn testimony addressing engineering and geologic considerations in support of the NNA #2 disposal injection order application. The record was held open to allow Unocal to provide supplemental information about the projected zone of influence from injected waste as requested by the Commission.
5. Unocal provided supplemental information addressing the zone of influence, rate of injection, and duration for NNA #2 disposal injection in a letter dated May 19, 2005.

FINDINGS:

1. Location of adjacent wells (20 AAC 25.252 (c)(1))

NNA #2 is planned as a near vertical well located approximately 342 feet from the south line and 420 feet from the west line of Section 11, Township 2 South, Range 13 West, Seward Meridian. The well is proposed to be drilled from an existing drilling pad located on the Kenai Peninsula approximately 6 miles east of the city of Ninilchik. NNA #1, a disposal injection well supporting Deep Creek Unit development is the only well located within ¼ mile of the planned NNA #2 well. As proposed, there would be 370 to 440 feet of wellbore separation between NNA #1 and the NNA #2 at the proposed injection interval.

2. Notification of Operators/Surface Owners (20 AAC 25.252 (c)(2) and 20 AAC 25.252 (c)(3))

Unocal is the only operator within ¼ mile radius of the proposed disposal operation. The sole surface owner within a ¼ mile radius of the NNA #2 well is Ninilchik Native Association, Inc. Unocal provided evidence that a copy of its application for disposal injection in the NNA #2 well was sent by certified mail to Ninilchik Native Association, Inc., on March 17, 2005.

3. Geologic information on disposal and confining zones (20 AAC 25.252 (c)(4))

Unocal proposes to conduct disposal into the Sterling and Beluga Formations between 2,180 feet and 2,800 feet.¹ Disposal operations in the NNA #2 will not impact adjacent production from the Happy Valley Field as seismic and well control, including extensive testing demonstrate that the NNA #1 and NNA #2 wells are located off structure and outside of the known productive limits of the Happy Valley Field reservoirs; and the nearest development wells are approximately 2 miles away.

In the adjacent near vertical NNA #1 well the Sterling Formation is present in the interval from 220 feet to 2,529 feet. Similar depths are expected in the NNA #2. The Sterling Formation in the Happy Valley Field vicinity consists of thick and massive sandstones and conglomerates frequently exceeding 100 net feet in thickness interbedded with siltstones, shales, and minor amounts of thin coals. These sediments were deposited in terrestrial (fluvial, lacustrine, alluvial) environments. The sandstones typically have high permeability and porosity with common permeability's exceeding several 100 millidarcies and porosities between 25 and 30 percent.

¹ All depths noted in this Order are measured depth ("MD") referenced to NNA #2 and are substantially equivalent to true vertical depth ("TVD") below ground level in this near vertical well.

The Beluga Formation will be present in the NNA #2 from approximately 2,529 feet to total well depth at approximately 2,800 feet. The formation is comprised of thinly bedded and clay rich sediments otherwise lithologically similar to the Sterling Formation. The Beluga Formation was deposited in terrestrial environments similar to the Sterling Formation except Beluga Formation sandstones and conglomerates were deposited in predominately braided stream environments instead of fluvial systems. The NNA #2 will encounter sandstones in the Beluga Formation that are generally less than 20 feet thick, have good porosities (20%+ range), but with permeability's generally below 100 millidarcies due to large amounts of depositional clay.

Confining strata for the requested Sterling and Beluga Formation disposal zones consist of shales, claystones, siltstones and coal beds that range in thickness from 6 inches to more than 30 feet. Coals at the depths of the requested disposal zone in the Sterling and Beluga Formations do not behave elastically and their properties are difficult to determine from borehole logs, but UNOCAL's experiences in conducting hydraulic fracture treatments in this area suggest that coals typically act importantly as near plastic confining beds. Information provided by Unocal in their March 23, 2005 application identifies approximately 200 ft of confining lithologies between the aquifer exemption depth (1,800 feet per AEO No. 11) and the depth of uppermost planned injection perforations (2,180 feet). From offset well NNA #1, at least 350 feet of confining lithologies have been identified between the depths of 1,930 feet and 2,610 feet.

4. Evaluation of Confining Zones (20 AAC 25.252 (c)(9))

The potential to fracture through the confining lithologies at the NNA #2 well was modeled by a Unocal consultant. The goal of this evaluation was to predict the expected upward fracture growth for cuttings disposal at NNA #2 using worst-case assumptions. The simulation assumed continuous 2-day injection of 8,000 barrels of slurry. Four perforated intervals spread over the proposed injection interval were individually evaluated, the shallowest being 2,210 feet to 2,240 feet. Slurry make-up was assumed to have a 12 percent solids concentration with 30/50-mesh sand distribution and density of 10 pounds per gallon. Injection rate for the modeling work was 3 barrels per minute.

In this worst-case model, the critical factor is vertical fracture propagation, with a critical limit being the freshwater aquifers. The fracture analysis indicates that coal and shale intervals overlying the injection intervals tend to impede the fracture height growth. For the shallowest interval evaluated, the fracture height growth under worst-case modeling does not grow above a depth of 2,180 feet. Unocal further notes that the injection assumptions included in the modeling work significantly exceed maximum estimated fluid injection per day.

Unocal's study of regional stresses in the area indicate that any fractures induced in the NNA #2 disposal interval will propagate away from the NNA #1 well.

5. Standard Laboratory Water Analysis of the Disposal Zone (20 AAC 25.252 (c)(10))

A laboratory analysis of water produced from the Beluga formation B-40 sand in the Happy Valley #8 well (taken in January 2005) indicates total dissolved solids greater than 8,000 ppm.

6. Well Logs (20 AAC 25.252 (c)(5))

Unocal plans to drill the NNA #2 beginning mid-July 2005. Commission regulation requires the submittal of well logs within 30 days of well completion. Well logs from the NNA #1 are on file with the Commission. In addition, there are offset data from the Happy Valley development.

7. Demonstration of Mechanical Integrity and Disposal Zone Isolation (20 AAC 25.252 (c)(6))

Well construction for the NNA #2 includes conductor pipe driven to refusal (estimated 100 feet) and production casing installed to a depth of 2,812 feet. Production casing will be cemented from total depth to surface. Unocal plans to evaluate the annulus cement with a cement mapping tool to confirm the adequacy of the cement sheath in providing isolation of the injected fluids from freshwater above 1,800 feet. The NNA #2 will be equipped with tubing and packer to isolate pressure to the disposal interval.

A mechanical integrity test will be conducted prior to injection; Unocal provides a proposed procedure that includes notification to the Commission, proposed test pressure, and documentation.

8. Disposal Fluid Type, Source, Volume and Compatibility with Disposal Zone (20 AAC 25.252 (c)(7))

NNA #1 injection is limited by performance to produced water and clear fluids (no solids). The NNA #2 will serve as the primary drilling waste disposal well for drilling at the Happy Valley Field, and a waste disposal well for disposal of approved Class II fluids from other Unocal operated fields. Specific wastes include drilling, completion, production, and workover fluids; stimulation fluids and solids; tracer materials; rig wash fluids; glycol dehydration wastes; drilling mud slurries; naturally occurring radioactive material scale slurries; tank bottoms; and other fluids brought to surface and generated in connection with oil and gas development activities.

Unocal estimates a maximum of 3,000 barrels per day of fluid will be injected in the NNA #2.

9. Estimated Injection Pressure (20 AAC 25.252 (c)(8))

Unocal estimates average surface injection pressure will be 650 psig and the maximum surface injection pressure will be 1,300 psig.

10. Aquifer Exemption (20 AAC 25.252 (c)(11))

Pursuant to a separate proceeding, an aquifer exemption has been granted, in Aquifer Exemption Order No. 11, for depths greater than 1,800 feet covering 3 specific areas within the Deep Creek Unit:

- A ¼ mile radius around the NNA #1;
- All of Section 22, which includes the Happy Valley pad and associated wells;
- The southeast one-quarter of Section 15; and
- All of Section 21, which will cover a new drillsite and associated wells planned by Unocal for the Deep Creek Unit.

The NNA #2 well falls within the ¼ mile radius around the NNA #1 well.

11. Mechanical Condition of Wells Penetrating the Disposal Zone within ¼ Mile of NNA #2 (20 AAC 25.252 (c)(12))

NNA #1 is the only well penetrating the disposal zone within a ¼ mile radius of the NNA #2. The top of cement in the 7-inch casing annulus of NNA #1 is approximately 5,860 feet, leaving the casing annulus open across the proposed disposal injection interval. Surface casing in the NNA #1 is set and cemented at a depth below the base of the aquifer exemption interval. Approved annular disposal operations in the NNA #1 below the surface casing shoe have placed nearly 175,000 barrels of drilling waste (as provided in 20 AAC 25.080) without incident. The receiving zone for annular disposal is coincident (and a subset) to the proposed disposal injection interval.

CONCLUSIONS:

1. The application requirements of 20 AAC 25.252(c) have been met.
2. The proposed well design (casing, cement, tubing and packer) for the NNA #2 will provide the necessary protection for freshwater by isolating injected fluids and pressure to the wellbore and intended injection zone. Verification of well design through cement evaluation and mechanical integrity testing will be necessary prior to injection.
3. As planned, there are approximately 200 ft of confining lithologies between the aquifer exemption depth (1,800 feet per AEO No. 11) and the depth of the uppermost planned injection perforations (2,180 feet). Annular disposal of nearly 175,000

barrels of drilling waste coincident to this interval in the NNA #1 has proven the effective isolation of injected material from the freshwater aquifer.

4. Worst-case fracture modeling confirms that waste fluids will be contained within the receiving intervals by the confining lithologies within the Sterling Formation, cement isolation of the well bore and operating conditions. Experience from hydraulic fracture treatments and simulation has shown that shales, claystones, siltstones and coal beds are the main components of the confining interval and will impede fracture height growth.
5. Disposal injection operations in the NNA #2 well will be conducted at rates and pressures below those estimated to fracture through the confining zones. Therefore, oil field wastes will not enter freshwater strata.
6. Supplemental mechanical integrity demonstrations and surveillance of injection operations are appropriate to ensure waste fluids are contained within the disposal interval. Included are mechanical integrity testing, temperature surveys, monitoring of injection performance (pressures, rates), and analysis of the data for indications of anomalous events.
7. Additional information was provided that documents a zone of influence (calculated volumetric pore space available within the disposal interval) because of the NNA #2's proximity to the aquifer exemption boundary (1/4 mile around NNA #1). Using conservative estimates of effective porosity and net thickness for the receiving zone, and a realistic daily injection rate based on historical disposal injection in analogous fields on the Kenai Peninsula, NNA #2 can operate 10-plus years before wastes reach the aquifer exemption boundary. The operator should periodically review with the Commission the actual performance of disposal injection in NNA #2.

NOW, THEREFORE, IT IS ORDERED THAT:

RULE 1: Authorized Injection Strata for Disposal

Subject to the other provisions of this order, injection of authorized fluids for purposes of underground disposal of oil field wastes is permitted into the Sterling and Beluga Formations between 2,180 feet and 2,800 feet in the NNA #2 well. The Commission may immediately suspend, revoke, or modify this authorization if injected fluids fail to be confined within the designated injection strata.

RULE 2: Authorized Fluids

This authorization is limited only to Class II waste fluids as follows: produced water, drilling, completion, production and work over fluids (including stimulation fluids and solids, and tracer materials), rig wash, drilling mud slurries, NORM scale, tank bottoms, and glycol dehydration wastes. The Commission may authorize the disposal of additional

fluids not identified above on a case-by-case basis if the Commission determines they are suitable for disposal in a Class II well.

RULE 3: Demonstration of 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 two years thereafter. 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 1,500 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. A written record of the results of all mechanical integrity tests must be readily available for Commission inspection.

RULE 4: 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 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 5: Surveillance

The operator shall obtain a baseline temperature log and a baseline step rate test prior to initial injection. A subsequent temperature log must be performed 1 month after injection begins, to demonstrate the receiving zone of the injected fluids. Surface pressures and rates must be monitored continuously during injection for any indications of fracture height growth. Results of daily wellhead pressure observations in both the NNA #1 and NNA #2 must be documented and available to the Commission upon request. Subsequent temperature surveys or other surveillance logging (oxygen activation, acoustic) will be based on the results of the initial and follow-up temperature surveys, and injection performance monitoring data.

An annual report evaluating the performance of the disposal operation must be submitted to the Commission by July 1 of each year. The report shall include pressures, fluid volumes (disposal and clean fluid sweeps), injection rates, an assessment of fracture height growth, a description of any anomalous injection results, and a calculated zone of influence by the injection fluids.

RULE 6: Notification of Improper Class II Injection

The operator must immediately notify the Commission if it learns of any improper Class II injection including any movement of injection fluids outside the area covered by Aquifer Exemption Order #11. Additionally, notification requirements of any other State or Federal agency remain the operator's responsibility.

RULE 7: Administrative Action

Unless notice and public hearing are 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.

RULE 8: Conditions

It is a condition of this authorization that operations be conducted in accordance with the rules set out in this order, with AS 31.05, and (unless specifically superseded by Commission order) with 20 AAC 25. Failure to comply with an applicable provision of AS 31.05, 20 AAC 25, or these rules may result in the suspension or revocation of this authorization.

DONE at Anchorage, Alaska and dated June 1, 2005.

John K. Norman, Chairman

Daniel T. Seamount, Jr., Commissioner

Cathy P. Foerster, Commissioner

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 may file with the Commission an application for rehearing. A request for rehearing must be received by 4:30 PM on the 23rd 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 nonaction 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., 10th day after the application for rehearing was filed).