

Findings and Decision of the Director  
of the Division of Oil and Gas

APPROVING THE  
G-Ø GAS PARTICIPATING AREA  
WITHIN THE REDOUBT UNIT

Under a Delegation of Authority  
from the Commissioner of the State Of Alaska  
Department of Natural Resources

August 20, 2004

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## **I. DECISION SUMMARY**

Forest Oil Corporation (Forest), as Redoubt Unit Operator applied to create the G-Ø Gas Participating Area (GPA) within the current boundary of the Redoubt Unit (RU). Forest's application (Application), if approved, would result in the formation of the GPA. Forest submitted geologic and well data that justifies the formation of the GPA. The data indicate that the proposed 360-acre participating area is capable of producing or contributing to the production of hydrocarbons in paying quantities.

The State of Alaska Department of Natural Resources, Division of Oil and Gas (Division) approves Forest's application to create the GPA. The GPA includes the area proposed by Forest because that area has been shown to be "reasonably known to be underlain by hydrocarbons and known or reasonably estimated ... to be capable of producing or contributing to production of hydrocarbons in paying quantities." 11 AAC 83.351(a). The Division also approves the tract allocation schedule, Exhibit C to the RU Agreement, for the GPA. The tract allocation schedule equitably allocates production and costs among the leases in the GPA.

## **II. APPLICATION FOR THE FORMATION OF THE G-Ø GAS PARTICIPATING AREA**

Forest submitted the application, dated December 30, 2003, under 11 AAC 83.351 and Article 9 of the RU Agreement. Forest applied to include portions of two state oil and gas leases, ADLs 374002 and 381203, totaling approximately 360.3 acres. Forest is the only working interest owner, but there are approximately 93 overriding royalty owners.

The proposed GPA encompasses the G-Ø Gas Reservoir within the Tyonek Formation, which is capable of producing or contributing to production of hydrocarbons in paying quantities. The legal description and initial tract participation schedule for the leases in the GPA (Exhibit C to the Unit Agreement) and a map depicting the GPA (Exhibit D to the Unit Agreement) are Attachments 1 and 2 to the application.

There is geologic and engineering evidence to support the formation of the GPA to develop the Tyonek Reservoir within the RU under a unified plan of development. Between June of 1967 and June of 1976, PanAm, Tenneco, and Unocal drilled five exploratory wells on the Redoubt Shoal in an attempt to delineate the original prospect. Since 2000, Forest has drilled an additional 5 wells on the structure and brought the first oil well on production on December 9, 2002. Production from the first gas well began May 28, 2003.

## **III. PARTICIPATING AREA DECISION CRITERIA**

AS 38.05.180(p) gives DNR the authority to form an oil and gas unit. The Commissioner of the DNR (Commissioner) reviews unit and participating area applications under AS

38.05.180(p) and 11 AAC 83.301 – 11 AAC 83.395. By memorandum dated September 30, 1999, the Commissioner approved a revision of Department Order 003, and delegated this authority to the Division Director (Director).

The Director will approve the Application upon finding that it will: 1) promote the conservation of all natural resources; 2) promote the prevention of economic and physical waste; and 3) provide for the protection of all parties of interest, including the State in accordance with 11 AAC 83.303(a). Subsection .303(b) sets out six factors that the Director will consider in evaluating the Application. A discussion of the subsection .303(b) criteria, as they apply to the Application, is set out directly below, followed by the Director's findings relevant to the subsection .303(a) finding and the Director's conditional approval of the Application.

A PA may include only land reasonably known to be underlain by hydrocarbons and known or reasonably estimated through use of geological, geophysical, or engineering data to be capable of producing or contributing to the production of hydrocarbons in paying quantities. 11 AAC 83.351(a). "Paying Quantities" means:

Quantities sufficient to yield a return in excess of operating costs, even if drilling and equipment costs may never be repaid and the undertaking as a whole may ultimately result in a loss; quantities are sufficient to yield a return in excess of operating costs unless those quantities, not considering the costs of transportation and marketing, will produce sufficient revenue to induce a prudent operator to produce those quantities. 11 AAC 83.395(4)

### **1) The Environmental Costs and Benefits**

Approval of the GPA itself has no environmental impact. Formation of the GPA is an administrative action and does not authorize any on-the-ground activity. Potential effects on the environment are analyzed when permits to conduct exploration or development in the unit area are reviewed. In fact, unitized development has less impact on the environment than development on a lease-by-lease basis. Approval of the GPA formation does not convey any authority to conduct any operations on the surface within the unit area. The DNR's approval of the Unit Plan of Development is only one step in the process of obtaining permission to drill a well or wells or develop the known reservoirs within the unit area. The Unit Operator must still obtain approval of a Plan of Operations from the state, and other permits from various agencies before drilling a well or wells or initiating development activities.

### **2) The Geological and Engineering Characteristics of the Proposed PA area**

The Division received the following technical data in support of the Application: a history of oil and gas exploration in the area; Forest's geological justification for the formation of the Redoubt Unit GPA; and annotated well logs, representative strike and dip seismic cross sections across the Redoubt anticline structure, a structure-contour map on the top of the upper

Tyonek Formation, an isopach of GPA reservoir sands, and allocation methodology calculations. The Division cannot discuss the details of these data held confidential under AS 38.05.035(a)(9)(C) and 11 AAC 96.220.

The State's evaluation of the subsurface geology supports the formation of the GPA to include the lands described in Exhibit A and depicted in Exhibit B to the Agreement (Attachments 1 and 2 to this decision, respectively). The GPA is defined vertically as the upper Tyonek Formation interval (also referred to as the G-Ø interval) encountered between 14,490 and 15,050 feet measured depth (MD) in the Forest Oil Redoubt Unit No. 3 well (API 507332050400). The current interpretation of geological and engineering characteristics of the proposed GPA indicate the area is known, or is reasonably estimated, to be capable of producing or contributing to the production of hydrocarbons in paying quantities, as is required under 11 AAC 83.351(a).

The GPA reservoir limits are controlled by the Redoubt structure, a fault-bounded, plunging anticline of Tertiary age. The Redoubt structure anticlinal axis is on trend with the McArthur River field structure and roughly six miles south of that field. Forest has defined the limits of the reservoir by a three-way dip closure to the west, east and south and a northwest-southeast trending fault zone, currently interpreted as impermeable, on the north. No field-wide gas/water contact has been defined. In the Forest Redoubt Unit No. 3 well, GPA reservoir sands appear to be gas filled down to 11,361 feet (subsea true-vertical depth).

The operator will produce gas from upper Tyonek Formation sandstones in the GPA. Prior activity has defined an oil accumulation, the Redoubt Unit Hemlock Participating Area, that underlies the GPA gas reservoir. Upper Tyonek Formation sands are generally lower porosity and permeability than the lower Tyonek. The lower Tyonek Formation and the Hemlock Conglomerate are generally more porous and permeable and are the most common oil exploration targets in Cook Inlet. In the GPA the porosity is expected to average roughly 14%-15%; permeability is expected to average roughly 20 millidarcies.

### **3) Prior Exploration Activities in the Redoubt Unit-G-Ø Gas Participating Area**

The Redoubt Unit GPA is located in Cook Inlet, about two miles southeast of West Foreland and 16 miles northwest of the City of Kenai. Portions of the proposed GPA were included in three previous unit agreements prior to RU formation in 1997. These unit agreements include: 1) the Redoubt Shoal Unit Agreement, approved on February 7, 1968, and terminated November, 1970; 2) the Redoubt Bay Unit Agreement, approved November, 1975, and terminated on June 1, 1977; and 3) the South McArthur River Unit, approved December 31, 1982, and terminated March 23, 1986.

Oil at Redoubt field was discovered in 1968, but after testing, all wells in the field were plugged and abandoned (P&A). Six exploration wells were drilled in or near the GPA during the early exploration phase (Table 1) prior to creation of the unit in 1997 and none of those wells flow tested the upper Tyonek Formation sands.

The Pan Am Redoubt Shoal State 22064 No. 1 (API No. 507331002400) was P&A June 4, 1967 as a dry hole at a total depth of 14,367 feet MD and was a straight hole. This was the first well drilled on the Redoubt Shoal anticline structure. Pan American Petroleum used very high mudweights and a 6-8% diesel mud to prevent hole problems. No drillstem tests (DSTs or RFTs) were run, no cores were cut, and no mudlog gas chromatography is available to determine hydrocarbon shows. Thus, this well did not provide enough data to adequately evaluate the prospect.

The Tenneco State 36465 No. 1 (API No. 507332003300), was P&A November 15, 1967 at a total depth of 13,963 feet MD (straight hole) despite minor amounts of oil recovered during several tests of the Hemlock Formation and one test of the West Foreland Formation. No cores were cut. DST #1 recovered 91 barrels of 23.5° API gravity oil over 22 hours from 12,778-12,894 feet MD in the Hemlock Formation. DST #2 flowed 65 barrels oil and swabbed 93 barrels oil, for a total of 158 barrels, over a 28.5 hour test period from 12,778-12,894 feet MD. DST #3 recovered 69 barrels oil over 17 hours from 12,778-12,894 feet MD, after acidizing the formation. DST #4 recovered 2 barrels of 28.4° API gravity oil from 13,287-13,545 feet MD in the West Foreland Formation.

Table 1. Wells Drilled on the Redoubt Anticlinal Trend

Operator	Well Name & No.	Year Drilled	Status <sup>1</sup>	Location	API Number
Pan Am	Redoubt Shoal St. 22064 #1	1967	P&A	26-7N-13W SM	507331002400
Tenneco	Tenneco State 36465 #1	1967	P&A	31-7N-14W SM	507332003300
Pan Am	Redoubt Shoal #1	1967	P&A	19-7N-13W SM	507332004000
Pan Am	Redoubt Shoal #2	1968	P&A	19-7N-13W SM	507332004001
Unocal	Redoubt Bay Unit #1	1976	P&A	18-7N-13W SM	507332027000
Mobil	South McArthur River #1A	1982	P&A	6-7N-13W SM	507332036100
Forest	Redoubt Unit #1	2001	Oil	18-7N-13W SM	507332049700
Forest	Redoubt Unit #2	2001	Oil	19-7N-13W SM	507332050100
Forest	Redoubt Unit #3	2001	Gas	30-7N-13W SM	507332050400
Forest	Redoubt Unit #4	2002	P&A	20-7N-13W SM	507332050600
Forest	Redoubt Unit #5	2002	P&A	24-7N-13W SM	507332051300
Forest	Redoubt Unit #5A	2002	Oil	NA	507332051301
Forest	Redoubt Unit #4A	2003	OPSHD	NA	507332050601
Forest	Redoubt Unit #6	2003	Oil	19-7N-13W SM	507332051900
Forest	Redoubt Unit #7	2004	Oil	19-7N-13W SM	507332052600

1. P&A-plugged and abandoned, Oil-completed as oil producer, Gas-completed as gas producer, OPSHD-operational shut-down, well is not completed, suspended, nor abandoned.

The Pan Am Redoubt Shoal No. 1 (API No. 507332004000), was P&A December 13, 1967, at a total depth of 13,950 feet MD (12,770 feet true vertical depth (TVD)), despite minor amounts of oil recovered during several tests of the Hemlock Formation. In this well, one conventional core was cut from the Hemlock Formation and five open hole DSTs were run.

DST #1 recovered 10 barrels of water-cut mud with oil stain and 122 barrels of water from 13,540-13,716 feet MD. DST #2 recovered 110 barrels of 27.1° API gravity oil and 85 barrels oil-cut mud from 13,245-13,540 feet MD. DST #3 reversed 105 barrels 26.7° API gravity oil from 12,965-13,540 feet MD. DST #4 flowed 15 barrels of oil and died, then reversed 60 barrels diesel, 65 barrels gas-cut oil, and 70 barrels gas-cut mud from 13,965-13,540 feet MD. DST #5 recovered 125 barrels of 26.8° API gravity oil and 10 barrels gassy mud from 12,980-13,083 feet MD.

The Pan Am Redoubt Shoal No. 2 (API No. 507332004001) was P&A September 27, 1968, at a total depth of 14,060 feet MD (12,410 feet TVD). This well is considered the discovery well of the Redoubt field, with successful tests in the Hemlock Formation. DST #1 recovered 72 barrels of 24.4° API gravity oil and 20 barrels muddy water from 13,485-13,845 feet MD. DST #2 flowed 28.6° API gravity oil to surface at a maximum rate of 480 barrels oil per day (BOPD) from 13,260-13,845 feet MD. DST #3 flowed 28.2° API gravity oil to surface at a rate of 1,291 BOPD over a 3.5 hour test from 13,260-13,845 feet MD.

The Unocal Redoubt Bay Unit No. 1 (API No. 507332027000) was P&A October 31, 1976, at a total depth of 13,950 feet MD (12,770 feet TVD), despite oil shows in several tests. Two conventional cores were cut from 13,033-13,080 and 13,502-13,525 feet MD. Three DSTs were run, one in the West Foreland Formation and two in the Hemlock Formation. Only minor amounts of hydrocarbons were recovered in the two Hemlock Formation tests.

The Mobil South McArthur River No. 1A (API No. 507332036100), was P&A December 12, 1982, at a total depth of 12,857 ft MD (12,247 feet TVD). Several tests were run, but recovered no significant hydrocarbons. This well is located north of what is interpreted as the Hemlock reservoir-bounding fault at the north end of the Redoubt structure.

Since formation of the Redoubt Unit, several additional exploration wells have been drilled (see Table 1). Only one DST has been conducted on the upper Tyonek Formation (G-Ø) reservoir sands within the Redoubt Unit area, in the Forest Redoubt Unit No. 3 well. The Forest Redoubt Unit No. 3, API No. 507332050400, was completed as a gas well on October 22, 2001 at a total depth of 16,940 ft. MD (13,016 ft. TVD). The DST in the upper Tyonek Formation realized a maximum flow rate of 8.67 million cubic feet per day at a flowing bottom hole pressure of 4,744 psia.

#### **4) The Applicant's Plan for Development of the Participating Area**

Included in the application is the Initial Plan of Development for the GPA (GPA POD). The GPA POD is approved for the period beginning on the effective date of this decision through August 14, 2005. On May 19, 2004, Forest submitted the 4<sup>th</sup> Plan of Development for the Redoubt Unit (4<sup>th</sup> POD). The 4<sup>th</sup> POD includes the Hemlock PA, the GPA formation sands and all RU lands not included in a PA. The 4<sup>th</sup> POD was approved on July 8, 2004.

No additional GPA wells are planned at this time. The production data will be integrated into

a reservoir model and used to plan future development drilling.

### **5) The Economic Costs and Benefits to the State**

Approval of the proposed GPA and associated field development will provide economic benefits to the state. The long-term goal is to maximize the physical and economic recovery of hydrocarbons from the GPA. Maximum hydrocarbon recovery will enhance the state's long-term royalty and tax revenue stream.

Any additional administrative burdens associated with the proposed GPA are far outweighed by the additional royalty and tax benefits derived from production.

### **6) Other Relevant Factors**

Under 11 AAC 83.351 and 11 AAC 83.371, Forest submitted with the application an allocation of cost for the leases in the proposed GPA (Attachment 3 to the Findings and Decision and Exhibit E to the RU Agreement). The proposed tract allocation schedule distributes working interest equity and over-riding royalties among the leases according to recoverable reserves. The Division finds Forest's tract allocation schedule acceptable for allocating production and costs among the leases in the GPA.

## **IV. FINDINGS**

### **1) Conservation of Natural Resources**

The formation of oil and gas units, as well as the formation of PAs within units, generally conserves hydrocarbons. Coordinated development of leases held by diverse parties maximizes total hydrocarbon recovery and minimizes waste. Formation of the GPA will provide for efficient, integrated development of the Tyonek reservoir within the RU. A comprehensive operating agreement and plan of development governing the area will help avoid duplicative development efforts on and beneath the surface.

Producing hydrocarbon gas from the area through the Kustatan facility reduces the incremental environmental impact of the production. Creating the GPA will help maximize oil and gas recovery, while minimizing negative impacts on all other natural resources.

### **2) Prevention of Economic and Physical Waste**

Generally, the formation of a PA facilitates the equitable division of costs and allocation of the hydrocarbon shares, and provides for a diligent development plan, which helps to maximize hydrocarbon recovery from a reservoir. Further, the formation of a PA, which enables both facility sharing opportunities and adoption of a unified reservoir management strategy, may allow economically marginal hydrocarbon accumulations to be developed.



Formation of a PA promotes complete development of a reservoir with variable productivity across adjoining leases.

### **3) Protection of All Parties**

Because hydrocarbon recovery will more likely be maximized, the state's economic interest is promoted. Diligent exploration and development under a single approved unit plan without the complications of competing leasehold interests promotes the state's interest. The formation of the GPA advances the efficient evaluation and development of the state's resources, while minimizing impacts to the area's cultural, biological, and environmental resources. Operating under the RU Agreement provides for accurate reporting and record keeping, royalty settlement, in-kind taking, and emergency storage of oil. These all protect the state's interest.

The proposed GPA protects the economic interests of all working interest owners and the royalty owner. Combining interests and operating under the terms of a unit agreement and unit operation agreement assures each individual working interest owner an equitable allocation of costs and revenues commensurate with the resources on and value of its lease(s).

## **V. DECISION**

Based on the facts discussed in this document and the administrative record, I make the following findings and decision:

- 1) The proposed acreage is underlain by hydrocarbons and known and reasonably estimated to be capable of production or contributing to production in sufficient quantities to justify the formation of the GPA within the RU.
- 2) The geological and engineering data justify the inclusion of the proposed acreage within the GPA under the terms of the applicable regulations governing formation and operation of oil and gas units (11 AAC 83.301 – 11 AAC 83.395) and the terms and conditions under which these lands were leased from the state.
- 3) The GPA is limited to the stratigraphic interval in the upper Tyonek Formation encountered between 14,490 and 15,050 feet (measured depth) in the Forest Oil Redoubt Unit No. 3 (API 507332050400).
- 4) The formation of the GPA provides for the equitable division of costs and an equitable allocation of produced hydrocarbons under a development plan designed to maximize physical and economic recovery from the reservoirs within the approved participating area. The allocations of production and costs for the tracts within the GPA (Exhibits C and E), Attachments 1 and 3 to this Findings and Decision, are approved.

- 5) The production of GPA gas through the existing production and processing facilities reduces the environmental impact of the additional production. Using existing facilities will avoid unnecessary duplication of development efforts on and beneath the surface.
- 6) The RU Owners have agreed to an interim redetermination of the GPA after 30 months (February 1, 2007) and a final redetermination after six years (August 1, 2010).
- 7) The RU Owners plan sufficiently diligent exploration and delineation of the reservoirs outside of the GPA under the approved plan of development and operation.
- 8) Approval of the formation of the GPA and the attached Exhibits to the RU Agreement are effective August 1, 2004.

For these reasons I hereby approve the formation of the G-Ø Gas Participating Area within the Redoubt Unit.

A person adversely affected by this decision may appeal this decision, in accordance with 11 AAC 02, to Tom Irwin, Commissioner, Department of Natural Resources, 550 W. 7<sup>th</sup> Avenue, Suite 1400, Anchorage, Alaska 99501-3561. Any appeal must be received at the above address, or by fax to 1-907-269-8918, within 30 calendar days after the date of “delivery” of this decision, as defined in 11 AAC 02.040. A copy of 11 AAC 02 may be obtained from any regional information office of the Department of Natural Resources.

Signed on 8/20/2004  
Mark D Myers  
Division of Oil and Gas

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Date

Attachments:

1. Exhibit C to the RU Agreement (GPA Tract Production Allocation Schedule)
2. Exhibit D to the RU Agreement (Map of GPA Tracts)
3. Exhibit E to the RU Agreement (GPA Tract Expense Allocation Schedule)

**Attachment 1 - Exhibit C to the RU Agreement (GPA Tract Production Allocation Schedule)**

**Redoubt Unit Agreement**

**Exhibit C (G-Ø)**

**Table of Acreage in the Initial Redoubt Unit G-Ø Gas Participating Area and Tract Participation**

Redoubt Unit Agreement					
Exhibit C (G-Ø)					
Table of Acreage Included in Initial Redoubt Unit G-Ø Gas Participating Area and Tract Participation					
Tract & ADL Number	Initial Tract Participation	Township, Range & Section	Portions of Section Included in Participating Area	Tract Acreage Within RUGØPA	
1 (ADL 378114)	0%	-----	-----	0	
2 (ADL 374002)	83.9%	T.7N., R.13W., S.M. Sec. 19 Sec. 30	S/2; S/2 of NW/4 N/2 of NW/4; NW/4 of NE/4	281.5	
3 (ADL 381203)	16.1%	T.7N., R.14W., S.M. Sec. 24 Sec. 25	SE/4 of NE/4; E/2 of SE/4 NE/4 of NE/4	78.8	
4 (ADL 381003)	0%	-----	-----	0	
5 (ADL 381201)	0%	-----	-----	0	
				100%	360.3

December 29, 2003



**Attachment 3 - Exhibit E to the RU Agreement (GPA Tract Expense Allocation Schedule)**

Redoubt Unit Agreement

Exhibit E (G-Ø)

Allocation of Redoubt Unit G-Ø Gas Participating Area Expense

- RUGØPA expenses will be allocated to each tract using the Initial Tract Participation decimals contained in Exhibit C of the Redoubt Unit Agreement.
- Future RUGØPA expense allocations will reflect revisions to the Tract Participation decimals as depicted in the revised Exhibit C (G-Ø) of the Redoubt Unit Agreement, including any realignment of historical Tract production or expense.

December 29, 2003