

SJR

5

# FISCAL NOTE

**STATE OF ALASKA**  
**2005 LEGISLATIVE SESSION**

Fiscal Note Number: \_\_\_\_\_  
 Bill Version: SJR005-DNR-O&G-02-04  
 ( ) Publish Date: \_\_\_\_\_

Revision Date/Time (Note if correction): \_\_\_\_\_ Dept. Affected: Natural Resources  
 Title: Reauthorize Methane Hydrate Research Act RDU: Resource Development  
 Component: Oil and Gas Development  
 Sponsor: Sen. Therriault  
 Requester: Senate Resources Component No. 439

**Expenditures/Revenues** (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

| OPERATING EXPENDITURES | FY 2006    | FY 2007    | FY 2008    | FY 2009    | FY 2010    | FY 2011    |
|------------------------|------------|------------|------------|------------|------------|------------|
| Personal Services      |            |            |            |            |            |            |
| Travel                 |            |            |            |            |            |            |
| Contractual            |            |            |            |            |            |            |
| Supplies               |            |            |            |            |            |            |
| Equipment              |            |            |            |            |            |            |
| Land & Structures      |            |            |            |            |            |            |
| Grants & Claims        |            |            |            |            |            |            |
| Miscellaneous          |            |            |            |            |            |            |
| <b>TOTAL OPERATING</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> |

|                             |  |  |  |  |  |  |
|-----------------------------|--|--|--|--|--|--|
| <b>CAPITAL EXPENDITURES</b> |  |  |  |  |  |  |
|-----------------------------|--|--|--|--|--|--|

|                               |  |  |  |  |  |  |
|-------------------------------|--|--|--|--|--|--|
| <b>CHANGE IN REVENUES ( )</b> |  |  |  |  |  |  |
|-------------------------------|--|--|--|--|--|--|

**FUND SOURCE** (Thousands of Dollars)

|   |            |            |            |            |            |            |
|---|------------|------------|------------|------------|------------|------------|
| 1002 Federal Receipts                   |            |            |            |            |            |            |
| 1003 GF Match                           |            |            |            |            |            |            |
| 1004 GF                                 |            |            |            |            |            |            |
| 1005 GF/Program Receipts                |            |            |            |            |            |            |
| 1037 GF/Mental Health                   |            |            |            |            |            |            |
| Other (Specify Type--Do not abbreviate) |            |            |            |            |            |            |
| <b>TOTAL</b>                            | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> | <b>0.0</b> |

Estimate of any current year (FY2005) cost: 00

Mark this box (X) if funding for this bill is included in the Governor's FY 2006 budget proposal:

**POSITIONS**

|           |  |  |  |  |  |  |
|-----------|--|--|--|--|--|--|
| Full-time |  |  |  |  |  |  |
| Part-time |  |  |  |  |  |  |
| Temporary |  |  |  |  |  |  |

**ANALYSIS:** (Attach a separate page if necessary)

No fiscal impact anticipated with passage of this resolution.

Prepared by: Mark D. Myers, Director Phone 269-8800  
 Division: Oil and Gas Date/Time 2/4/2005  
 Approved by: Tom Irwin, Commissioner Date 2/4/2005  
 Agency: Natural Resources

- **Call to Order – time – members present**  
Note that Senator Guess is NOT present – also Sen. Wagoner.
  
- **SJR 5 – Reauthorize Methane Hydrate Research**
  1. Invite sponsor to present to committee
  
  2. Go to Public Hearing
    - a. Offnet
    - b. Online other LIO's
    - c. Juneau
  
  3. Close Public Hearing
  
  4. Ask for motion to move from committee with individual recommendations & accompanying fiscal notes.
  
- **Meeting is adjourned at \_\_\_\_pm.**

# ALASKA STATE LEGISLATURE

SENATOR

**Gene Therriault**

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While in Juneau

State Capitol  
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Senate

Senate District F

Senate Joint Resolution 5

"Urging the United States Congress  
Congress to reauthorize the Methane Hydrate  
Research and Development Act."

SPONSOR: Senator Gene Therriault

## SPONSOR STATEMENT:

For many years—even decades—Alaskans have been waiting for a natural gas pipeline project to deliver our tremendous resource on the North Slope to market. The benefits of such a project will include access for in-state uses, jobs for Alaskans, and cash to the state treasury. However, if we want to maximize the benefits to Alaskans, we need to make sure that our focus doesn't narrow too tightly to exclude the very real possibilities that await us.

Current discussions and negotiations for an Alaska Natural Gas Pipeline envision a 4.5 billion cubic feet per day (bcfd) project based on proven commercial reserves of 35 trillion cubic feet (tcf). These reserves will provide a supply to the pipeline for 16-20 years. However, according to Department of Natural Resources projections, project life increases from about two decades to more than 3 ½ decades when the available reserves increase from the 30-35 tcf of known conventional gas associated with current oil fields to 60 tcf due to the discovery of new conventional reserves or commercialization of hydrates in place beneath existing infrastructure.

Gas hydrates are naturally occurring ice-like substances composed of water and gas, in which a solid water-lattice accommodates gas molecules in a cage-like structure. Gas hydrates are widespread in permafrost regions and beneath the sea in sediment of outer continental margins. While methane, propane, and other gases can be included in the hydrate structure, methane hydrates appear to be the most common in nature.

The amount of methane sequestered in gas hydrates is enormous, but estimates of the amounts are highly speculative. In 1995, the USGS conducted the first systematic assessment of the in-place natural gas hydrate resources of the United States. That assessment estimated that the permafrost-associated gas hydrates on the Alaska North Slope may contain as much as 590 trillion cubic feet of in-place gas. Of this total, 40-100 tcf are in-place in reservoirs beneath the current infrastructure of the central North Slope.

The most recent (2001) estimate by the Minerals Management Service (MMS) puts the off-shore estimate at more than 32,000 trillion cubic feet in the Beaufort and Chukchi Seas.

A growing body of evidence suggests that production of natural gas, stored as gas hydrates, may be technically feasible. However, numerous technical challenges must be resolved before this potential resource can be considered an economically producible reserve. To that end, Congress passed H.R. 1573 the Methane Hydrate Research and Development Act of 2000 to determine whether or not gas hydrates could become a significant source of natural gas in the future. That Act expires—along with federal funding—later this year.

Senate Joint Resolution 5 calls on Congress to re-authorize the Methane Hydrate Research and Development Act along with appropriations totaling \$70 million over 5 years. The relevance of the potential additional reserves present in the form of gas hydrates is important to the pipeline project currently under discussion and negotiation. The sizing of the pipeline, access points into the pipeline, financing costs, and ultimately tariff rates could all be positively impacted by a determination of the commercial viability of gas hydrates.

**To:** The Honorable Pete V. Domenici, Chairman  
Senate Committee on Energy & Natural Resources

**From:** Dr. Mark D. Myers, Director, Alaska Division of Oil and Gas  
Senator Gene Therriault, Chair,  
Alaska Legislature, Legislative Budget and Audit Committee  
Representative Ralph Samuels, Vice Chair,  
Alaska Legislature, Legislative Budget and Audit Committee

**Subject:** State of Alaska Briefing Document on Proposal to Reauthorize  
Methane Hydrate Research and Development Act of 2000,  
Public Law 103-193, 114 Stat. 234

**Date:** January 24, 2005

### **Executive Summary**

Currently, 59 bcf/d of natural gas is consumed daily in the United States. The Energy Information Administration estimates that domestic demand for natural gas will increase to 77 bcf/d by 2015, and to 84 bcf/d by 2025. If the Alaska natural gas pipeline currently envisioned is built, the 35 tcf of known Alaska reserves could satisfy 4.5 bcf/d of the total domestic demand for a period of two decades. Alaska's vast gas resources are estimated to also include 250 tcf of undiscovered conventional resources, 590 tcf of onshore (100 tcf within or near existing North Slope infrastructure), and more than 32,000 tcf of offshore gas hydrates, which could supply a much greater percentage of domestic demand for generations to come, particularly if two conditions are met: 1) gas hydrates can be commercialized; and 2) the rules for access to and expansion of an Alaska natural gas pipeline encourage competition in the exploration for and development of Alaska natural gas. The latter condition is currently the subject of rule-making by the Federal Energy Regulatory Commission. However, the former—commercialization of gas hydrates—is at risk absent Congressional action in 2005. Congressional action is needed to reauthorize Pub. L. 106-193, 114 Stat. 234 (2000), the Methane Hydrate Research and Development Act, and to fund research and field testing under that Act. It is proposed that the Act be reauthorized for a period of five years, with appropriations of no less than \$10 million/year in years 1-3 and \$20 million/year in years 4-5.

The large quantity of hydrates that underlie the existing Kuparuk River, Milne Point, and Prudhoe Bay Fields could in itself remove all potential reserve risk from year 20-35 and beyond for an Alaska natural gas pipeline producing at 4.5 bcf/d. Reducing reserve risk will have a positive effect on project financing and potentially result in a lower tariff, which in turn could lead to increased exploration and early expansion of the pipeline.

### **Introduction**

Sharply rising U.S. consumption of natural gas coupled with increasing worldwide gas demand intensify the need to find additional sources of natural gas. An increasingly global LNG market is developing based on these growing international energy demands, and upon the enormous natural gas reserves in the Middle East and other areas of the world. Reliance on these supplies worsens the U.S. trade deficit, places the U.S. natural gas market increasingly in direct

competition with other regional natural gas markets (many of which are mushrooming), exacerbates public environmental and security concerns with proposed tanker traffic and plant sitings, and increases U.S. reliance on foreign sources for energy supplies.

Undeveloped Alaska natural gas resources, both conventional and unconventional, are capable of delivering a vitally important share of U.S. gas needs. The recent rise in energy costs to what many consider to be a new long-term level has led to negotiations for building an Alaska North Slope (ANS) natural gas pipeline to ship these domestic supplies to distribution hubs serving the lower 48 states. The currently envisioned pipeline would deliver 35 tcf of proven Alaskan gas reserves from existing oil fields at a rate of 4.5 bcf/d for more than two decades, supplying about 6% of the 77 bcf/d of U.S. demand forecast by the EIA for 2015.

Furthermore, numerous assessments recognize that the total North Slope gas resource far exceeds just these proven reserves. Mean estimates by USGS, MMS, and the State of Alaska place at least 242 tcf of undiscovered, technically recoverable conventional gas under federal onshore and offshore areas (Table 1, AK Division of Oil and Gas, 2005) plus 590 tcf in-place of gas hydrates onshore in permafrost areas, and more than 32,000 tcf in-place of gas hydrates offshore in the Beaufort Sea (Sherwood and Craig, 2001 after Collett, 1995). Alaska's total gas hydrate endowment, including the surrounding federal waters, is estimated at over 169,000 tcf of in-place gas hydrate (Sherwood and Craig, 2001 after Collett, 1995). USGS assessments estimate 40 to 100 tcf of gas in-place in shallow permafrost-associated gas hydrate reservoirs in the infrastructure-served central ANS onshore area alone (Figure 1). The Alaska North Slope is one of the most promising places in North America to determine the resource potential of gas hydrates because of existing infrastructure, which will prove vital in supporting the emerging technologies required (Johnson, 2003).

Given that all reasonable estimates of the total ANS gas resource are much larger than the 35 tcf basis for the currently envisioned Alaska to Lower 48 gas pipeline, including the vast potential in the form of methane hydrates, it is essential that the federal government take steps to ensure that two conditions be fulfilled: 1) current progress in gas hydrate research and development must continue at full momentum to determine as quickly as possible whether these resources are commercially viable, and 2) the rules for access to and expansion of an Alaska North Slope gas pipeline must encourage industry competition to develop much needed additional gas, both from potential gas hydrate reservoirs and from revitalized exploration for conventional gas reserves. The Federal Energy Regulatory Commission is aware of the second condition, and is actively working to establish rules that will safeguard its ability to require capacity expansion as new reserves become available.

The economic return and risk associated with building the ANS gas pipeline depends largely on its useful lifespan, a function of both available reserves and pipeline capacity. Table 2 summarizes the relationship between project lifespan and reserves for two capacity scenarios, the 4.5 bcf/d base case and a 5.6 bcf/d expansion case, respectively. In the base case, project life increases from about 2 decades to more than 3 1/2 decades when the available reserves increase from the 30-35 tcf of known conventional gas associated with current oil fields to 60 tcf due to the discovery of new conventional reserves or commercialization of hydrates in place beneath existing infrastructure.

The remainder of this proposal addresses meeting the former condition – federal funding in support of gas hydrate resource commercialization.

### **Call for Legislative Action**

The Methane Hydrate Research and Development Act of 2000 (Public Law 103-193, 114 Stat. 234) was created to determine whether or not gas hydrates could become a significant source of natural gas in the future. Because this Act expires at the end of the 2005 fiscal year, immediate congressional action is needed to replace it. Governor Murkowski's proposal urges new legislation to cover the five year period 2006-2010, with total appropriations of no less than \$70 million. Beginning with annual funding of \$10 million to continue and expand ongoing research in 2006-2008, appropriations would increase to \$20 million annually in 2009-2010 as the emphasis shifts from laboratory research and computer simulations to field testing and development pilot projects.

As stated in the proposal, the goals of the reauthorization and appropriations are threefold: 1) determine conclusively whether major gas hydrate accumulations can become a commercially producible resource, 2) grow the body of publicly available data, knowledge, and technology relevant to detailed resource assessment, exploration, and production of gas hydrates, and 3) fund a field testing program at a level adequate to remove commercial hurdles that would impede or prevent private industry from pursuing gas hydrate pilot projects. Specific steps will enable achieving each of these objectives and a careful review of the previous legislation may be required to ensure language in the reauthorization that is consistent with this legislative intent.

### **Conceptual Steps and Justification**

The suggestions that follow are not intended to replace careful planning by those managing gas hydrate research and development programs and should not be used in constructing legislative language without broad support of those program managers. At this point, we recommend using language in the reauthorization that will ensure clear legislative intent without specifying detailed procedures for reaching these goals. In the broadest sense, activities fall into two categories: 1) developing improved assessments of both the total resource potential associated with gas hydrates and the volume of hydrate-related gas likely to become commercial over time given that pipeline capacity exists to ship it to market, and 2) developing gas hydrate production technologies, including field tests to prove up and compare alternative techniques. Both goals should be pursued beginning in year 1 with expanded desktop research and maintaining current research programs leading to a greater emphasis on testing operations in years 4 and 5. Participation in "wells of opportunity" (i.e., industry wells targeting deeper horizons providing opportunity for data acquisition during penetration of shallow gas hydrate-bearing horizons) during years 1 through 4 merits federal funding to share or offset the costs of reservoir evaluation.

***Continue technical and commercial assessments of onshore North Slope sub-permafrost gas hydrates and their associated free gas resources***

Ongoing office, laboratory, and field research projects will feed directly into activities under a renewed gas hydrates act. The most successful research is likely to come from collaborative interdisciplinary teams of geologists, geophysicists, reservoir engineers, petroleum engineers, and commercial analysts representing a cross section of federal and state resource management agencies, industry, consultants, and universities. As stated in the proposal, the Alaska Department of Natural Resources, Division of Oil and Gas is also discussing with the Alaska State Legislature obtaining funding for an additional geologist dedicated to gas hydrate issues. This would facilitate the pairing of state and federal expertise and data sets, allowing for faster and more accurate collaborative resource assessments. In order for this structure to be effective, early administrative attention will be required from the participating organizations to establish the ground rules and data confidentiality requirements. Some of these ground rules and requirements which must be agreed upon early are likely to include issues such as the extent of data sharing, assessment methodologies, conditions for using proprietary data in making public resource interpretations, and specific data types and interpretive results that can be released to the public and/or shared with participating industry to support the conclusions.

Once these resource evaluation and development planning teams are in place, they should be authorized to integrate and expand upon current regional-level assessments of in-place permafrost-related gas hydrate and associated free gas resources. Some of these current assessments include the collaborative efforts underway involving the BLM, USGS, and State of Alaska. Future assessments funded by this legislation should expand upon this coordination, using consistent methodologies across federal and state lands of North Alaska. Assessment provinces should include the known hydrates in and near existing infrastructure on state lands of the central North Slope Colville-to-Canning corridor as well as more remote areas. The first remote provinces to be assessed should include state-lands foothills, the NPRA in the west, and the ANWR 1002 area in the east.

The proliferation of 3D seismic data across large areas of the North Slope over the last decade provides these research teams the opportunity to create much more reliable assessments than has ever been possible before. Access to these privately-acquired seismic surveys is restricted, but includes the state or federal agency that manages the lands in question. By assigning appropriate technical personnel in accordance with their agency's data access privileges, the research teams should be able to obtain, use, and integrate all available 3D seismic data coverage to develop a comprehensive portfolio of specific gas hydrate and associated free gas prospects. In some cases, it may be appropriate to license new or existing seismic surveys for assessment work, or even purchase the rights to release certain seismic data to the public. The portfolio should quantify the geologic risk profile and probabilistic distribution of in-place resource for each prospect using a standard petroleum systems approach. This work has been pioneered with tremendous success in the Milne Point Unit through the BPXA – DOE cooperative research study (e.g., Inks and others, 2004), where it is the basis for highly detailed gas hydrate resource estimates and production profile modeling.

Dedicated logging and/or coring of gas hydrate and sub-hydrate free gas intervals in several key wells per year should be considered beginning in year 1. The additional data obtained will

improve assessments of hydrate resource beneath existing infrastructure. Office and laboratory studies should continue into years 4 and 5, when they will begin to benefit from incorporation of the results of more field-based production testing. Subsequent iterations of reservoir performance models will thus be better calibrated and will more reliably forecast production rates and ultimate recovery of untested gas hydrate reservoirs. Better production forecasting will mean better ability to convert assessments of in-place resource to estimates of technically and economically recoverable gas reserves. Ultimately, the research will develop regional depletion plans and realistic potential development programs using reserves and rate profiles to assess regional development economics. The work will extrapolate reservoir models into regionally verified resource potential, construct production rate profiles within a range of expectations, and calculate potential regional gas reserves.

A final step in the office-based research process will be to develop commercial filters to apply to in-place or technically recoverable assessment figures to screen out resources located in accumulations too small to develop profitably. Estimates of the magnitude of reserves that may eventually be shipped would be far more useful than the technically recoverable reserves figures so often cited in resource assessments.

***Design and conduct field production tests and pilot development of North Slope hydrates to assess viability of producing free gas and associated methane hydrate by depressurization of the free gas leg***

The dearth of factual production data is one of the most critical gaps in commercializing much needed gas hydrate resources. Many in private industry acknowledge the enormous scale of the in-place resource, but without proven production potential, are unwilling to risk large-scale investments in testing and developing these reservoirs. Given the gas supply shortage facing the nation and the likelihood that construction of a gas pipeline will begin in the near future, the national interest is best served by funding public projects to close the gap in collaboration with, but without relying exclusively upon industry.

Beginning in year 1, and working in parallel with the assessment teams, engineers and geologists will be tasked with designing testing operations to begin during year 2 and continuing with the increased funding in subsequent years. Research to date has identified gas hydrate accumulations within the footprint of existing North Slope infrastructure that include a gas hydrate cap in communication with an underlying free gas column (Figures 2 and 3) as viable candidates for initial production testing. Accumulations of this description have been termed Type 1 hydrates (Moridis and Collett, 2003). Conventional completion and production of the free gas column eventually lowers reservoir pressure below the stability limit of the overlying gas hydrate zone, causing it to dissociate and release additional free gas across a broad regional contact. Because hydrates store 164 to 180 times as much methane as the same volume of free gas, their dissociation contributes large volumes of producible gas. The Messoyakha gas field in the West Siberian Basin is often cited as a producing example of a permafrost-associated gas hydrate accumulation, due to the difference between expected and actual declines in both reservoir pressure and production rate.

Feasibility studies carried out under a cooperative project between BP Exploration (Alaska) and the DOE (Howe and others, 2004) have adapted commercially available reservoir simulation

software to model schematic and actual hydrate-bearing reservoirs, with more detailed versions in progress (Figure 3).

The following discussion provides an overview of the current understanding in some of the more significant modeling. Cases 1-3 of Figure 4 depict simulated production profiles of a Type 1 gas hydrate representing 15 years of production from the same 300 mD permeability reservoir, but with variations in the type and number of producing wells. The initial plateau flow rates of these three cases are operationally constrained at levels ranging from 25 to 50 million cubic feet per day (mmcf/d) per well. A 50 mmcf/d plateau rate can be maintained significantly longer using a single horizontal producer than with two vertical producers constrained to 25 mmcf/d each. After 15 years, the simulated total flow rates are nearly the same at about 18 mmcf/d, regardless of whether one, two, or three producers are involved. Additional models indicate that after the steep decline that initially follows the plateau, the very slow decline rate of later years is due to steady supply of free gas from hydrate dissociation (Figure 5). This modeling is highly encouraging, but requires validation by field testing.

Details of design activities would be determined by the actual team, but a logical workflow would presumably begin with selection of candidate prospects for field testing within areas supported by existing North Slope infrastructure. Potential locations are already available in the Milne Point Unit where collaborative studies have integrated well data and 3D seismic data to quantify both Type 1 and Type 2 (hydrate only) prospects.

Numerous questions will be addressed at the outset of the design phase, including whether to drill a dedicated research well or share one intended for deeper production. Decisions will be required regarding optimal borehole angle, the duration of test production, and facility limitations. Depending on the type of wellbore selected for the testing and pilot program, drilling or work-over and completion operations will be necessary to expose the production zone in the free gas leg. This stage, including formation evaluation, should be complete within the first month, followed by an initial well testing phase that may last several weeks or months.

At this point, it is recommended that the well be placed on long-term production test for meaningful comparison to modeled production profiles. Depending on free gas volumetrics, the difference between original reservoir pressure and the hydrate stability limit, and operational constraints on the test producer's plateau flow rate, a pilot production plan lasting more than two years may be required to monitor the effects of depressurization and consequent hydrate dissociation. Because long term production testing may yield substantial quantities of methane, it will be advantageous to plan for local use of the gas. Possibilities include fuel for testing operations or field utilities, or reinjection for pressure maintenance of other reservoirs.

***Design and conduct field production tests and pilot development of North Slope hydrates to assess viability of producing directly from hydrates without free gas depressurization***

A second test should be designed to assess the viability of producing directly from hydrates that have no free gas leg available for conventional completion and depressurization. A major share of potential ANS gas hydrate resources appear to be trapped within these hydrate-only areas. Potentially, such a test could be conducted in the hydrate cap of a Type 1 reservoir, in Type 2 hydrates, which are accompanied by an underlying zone of movable water in the reservoir, or in

Type 3 hydrates, which fill the entire formation (Moridis and Collett, 2003). The project team will face many of the same decisions as for the free gas/hydrate dissociation test, including site selection, type of wellbore, and duration.

The critical difference between this and a free gas production test is that steps must be taken to prevent further cooling of the reservoir around the producer that would lead to reformation of the hydrates and shut off the flow of gas. The three ways of dissociating the hydrate structure to release gas are by lowering pressure, increasing temperature, or altering reservoir chemistry. However, dissociation is an endothermic (heat consuming) reaction that lowers the temperature of the surrounding formation. So, while it may be possible initially to liberate some free gas simply by lowering reservoir pressure adjacent to the well bore, it can freeze solid again unless heat and/or chemical inhibitors are added to the formation. The optimum test for producing directly from hydrates would provide the capability of experimenting with and comparing various thermal and chemical stimulation technologies. Several processes have been proposed that warrant consideration in the design phase:

- thermal stimulation with steam huff and puff
- thermal stimulation by closed-system circulation of warm water from the surface (either artificially heated on-site or still-warm formation water separated out of production stream from deeper reservoir)
- thermal stimulation by closed-system circulation of hot waters brought directly to the reservoir from a deeper aquifer zone in the same well
- thermal stimulation by in-situ catalytic combustion, electromagnetic, or microwave sources
- inhibitor injection (e.g., methanol)
- Carbon dioxide replacement of methane in hydrate structure (McGrail and others, 2004). If this process becomes viable, it may provide synergistic carbon sequestration benefits, in addition to liberating methane.

It will be up to the test design team to identify and select the most promising of these methods for direct field comparison.

### **Hypothetical R&D Activity and Expenditure Timeline**

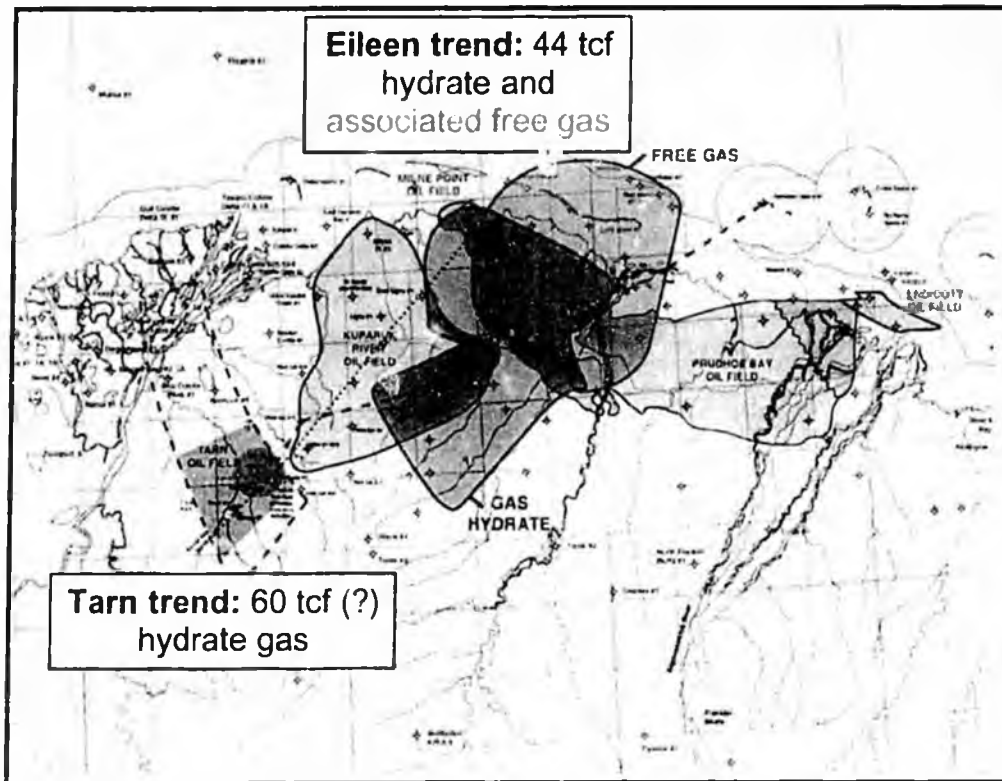
Table 3 represents a broad framework for executing the suggestions outlined above. This legislative proposal is submitted in recognition of the need for funding rapid and material advances toward unlocking the potential of our gas hydrate resources. Details of research and development tasks and the proposed expenditure timeline are subject to revision by project teams.

### **Recommendation**

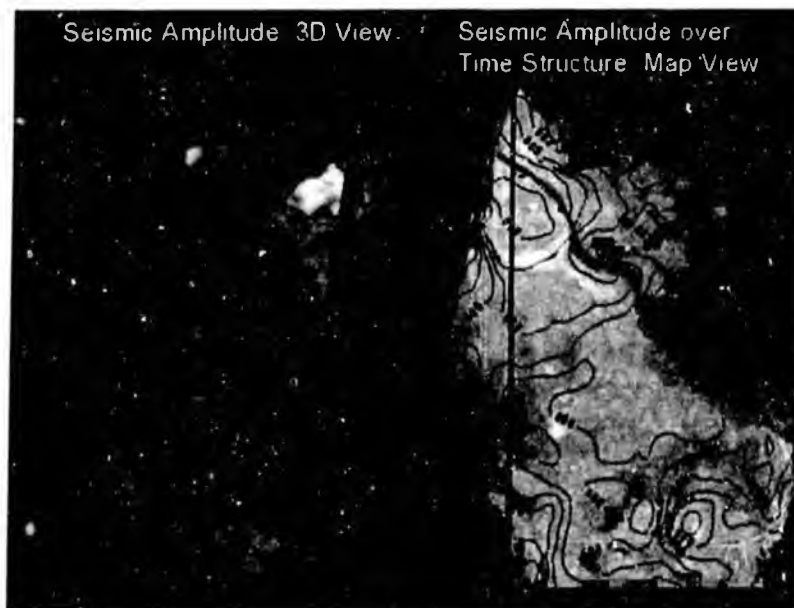
An urgent need exists for the reauthorization of federal legislation appropriating funds to support gas hydrate research and development. In the face of escalating demand and uncertain supply from overseas imports, it is critical that the United States increase domestic supply and diversify its sources of natural gas to include the development of unconventional resources. Known gas

hydrates overlying the already-developed oil fields of Alaska's North Slope afford a unique opportunity to meet both objectives provided they can be produced and brought to market economically. The need to better understand hydrate commerciality is all the more pressing given the inter-relationship to planning for the construction, operation, and regulation of an Alaska gas pipeline. The steps suggested here are offered as a conceptual basis for more detailed planning that will be needed to realize the intended goals of the proposed legislation.

*(Figures 1-5, Tables 1-3, and References following on separate pages)*



**Figure 1.** Known gas hydrate accumulations (blue) and hydrate-associated free gas accumulations (orange) in the vicinity of the major North Slope oil fields (green). The USGS estimates up to 100 tcf in place of hydrate in the Eileen and Tarn trends combined. From T.S. Collett, 10/01 and Hunter and Collett, (2004).



**Figure 2.** Seismic amplitude of a gas hydrate prospect within the Milne Point Unit in 3-dimensional view (left) and in map view with time structure (right). Warmer shades in shallowest corner of the fault-bounded reservoir compartment are interpreted to be gas hydrates, consistent with the estimated depth of the hydrate stability zone. From Hunter (2004).

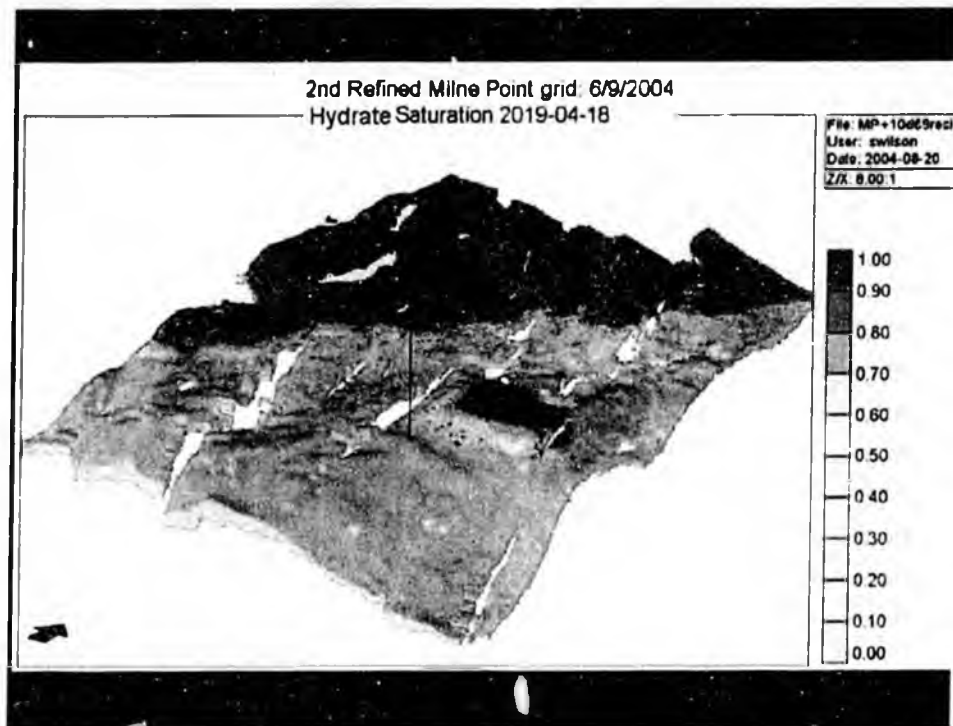


Figure 3. Milne Point Unit reservoir model showing gas hydrate cap (orange) overlying free gas (green) and a single vertical producing well. From Howe and others (2004).

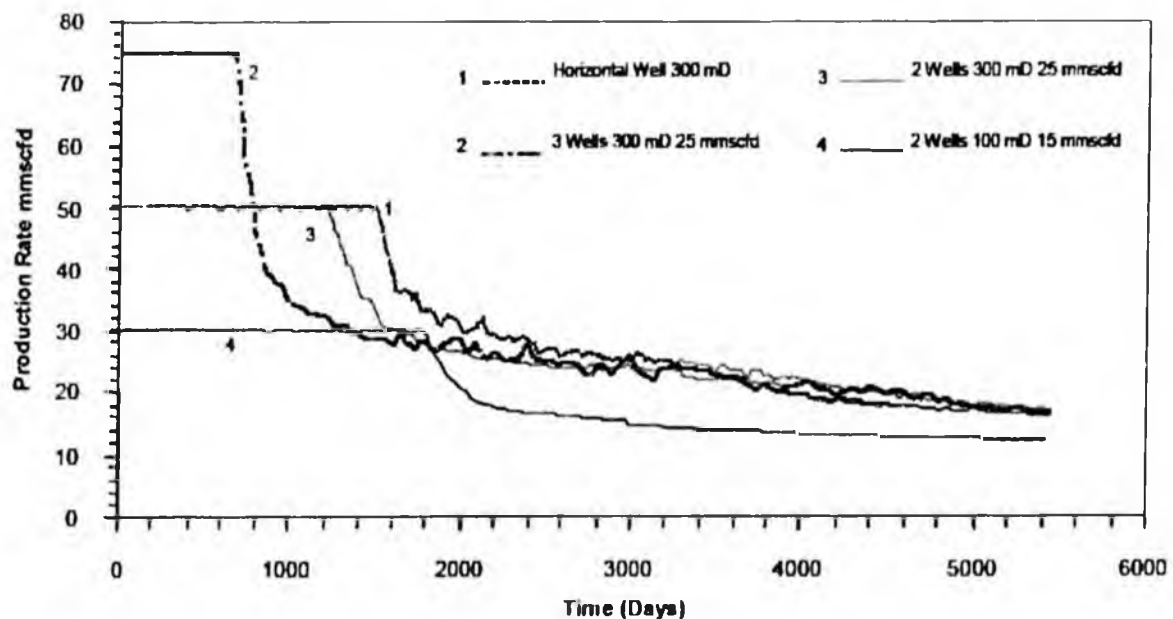
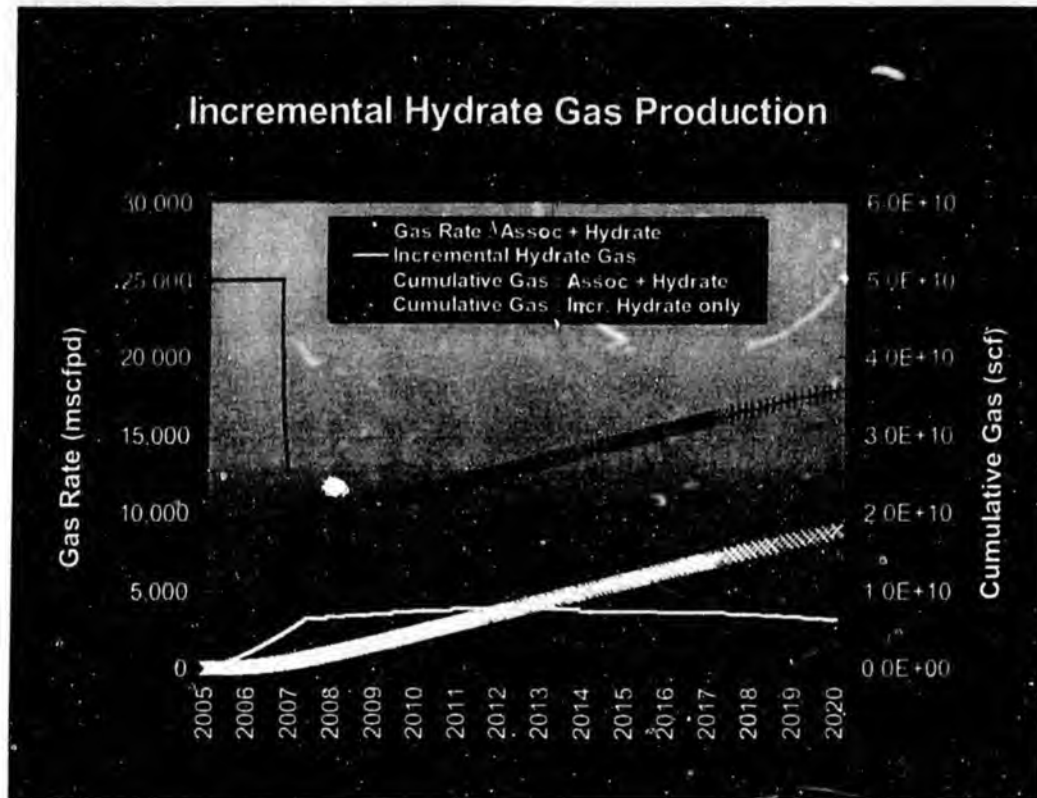


Figure 4. Gas production profile from a schematic reservoir. Cases 1, 2, and 3 compare offtake profile from the same reservoir using one horizontal, three vertical, and two vertical wells, respectively. Note extended plateau for one horizontal compared to two vertical wells, and that total flow in all scenarios is virtually the same after 15 years. Case 4 represents a lower permeability reservoir. Originally from Howe and others (2004) cited by Hunter (2004)



**Figure 5.** Graph showing modeled contribution of hydrates to total production for the reservoir model in Figure 3 (not the schematic reservoir represented in Figure 4). Production of original free gas constitutes all of the initial production; reservoir depressurization results in dissociation of overlying hydrates into free gas. In this particular simulation, dissociated hydrate gas accounts for nearly all production beyond the fifth year, and continues at a nearly constant rate for the next decade.

**Table 1. Mean value, total natural gas reserve and resource base for Alaska assessment areas.**

**All Values Trillions of Cubic Feet (TCF)  
Alaska Division of Oil and Gas (01/12/05)**

| BASIN                                      | KNOWN RESERVES            | RISKED UNDISCOVERED CONVENTIONALLY RECOVERABLE RESOURCE | RISKED UNDISCOVERED CONVENTIONALLY RECOVERABLE DEEP GAS RESOURCE <sup>2</sup> | GAS HYDRATES IN PLACE RESOURCE <sup>6</sup> | COALBED METHANE IN PLACE RESOURCE | BASIN TOTAL       |
|--|---------------------------|---|---|---|-----------------------------------|-------------------|
| NORTH ALASKA (onshore)                     | 35.000 <sup>1</sup>       | 141.700 <sup>8</sup>                                    | 17.700 <sup>2</sup>   | 590.000 <sup>6</sup>                        | 800.000 <sup>7</sup>              | 1,566.700         |
| NORTH ALASKA (Beaufort shelf) <sup>2</sup> | 0.000                     | 32.070  | N/A   | 32,325.000 <sup>3</sup>                     | N/A                               | 32,357.070        |
| NORTH ALASKA (Chukchi shelf) <sup>2</sup>  | 0.000                     | 60.110  | N/A   | 50.000 <sup>3</sup>                         | N/A                               | 110.110           |
| CENTRAL ALASKA <sup>4</sup>                | 0.000                     | 2.760   | N/A   | N/A   | N/A                               | 2.760             |
| YUKON FLATS <sup>9</sup>                   | 0.000                     | 5.460   | N/A   | N/A   | N/A                               | 5.460             |
| KANDIK <sup>5</sup>                        | 0.000                     | 0.116   | N/A   | N/A   | N/A                               | 0.116             |
| NENANA/TANANA                              | 0.000                     | N/A   | N/A   | N/A   | N/A                               | N/A               |
| COPPER RIVER                               | 0.000                     | N/A   | N/A   | N/A   | N/A                               | N/A               |
| <b>TOTAL BY GAS TYPE</b>                   | <b>35.000<sup>1</sup></b> | <b>242.216</b>  | <b>17.700<sup>2</sup></b>   | <b>32,965.000</b>                           | <b>800.000<sup>7</sup></b>        | <b>34,042.216</b> |

After Craig, J., and Sherwood, K., Prospects for development of Alaska natural gas: a review as of January 2001, Minerals Management Service, Alaska Region. tbl. 9, p. 76.

Modified to include only North and Central Alaska basins and updated to include new information as footnoted

N/A = Not Assessed

<sup>1</sup> Current estimate of known "stranded" recoverable North Slope conventional gas reserves in Prudhoe Bay, Point Thomson and smaller fields.

<sup>2</sup> Subcategory of and included in "Undiscovered Technically Recoverable Conventional Reserves". Represents Basin Deep or Basin Centered component > 15,000' depth.

<sup>3</sup> Craig and Sherwood arbitrarily split offshore hydrate resource estimates between Beaufort and Chukchi Sea shelves. Total North Alaska offshore gas hydrate potential remains 32,375 tcf.

<sup>4</sup> 1995 National Assessment of United States Oil and Gas Resources, U.S. Geological Survey, Open File Report, Digital Data Series-30, pub. 1995. For all central Alaska basins except the Kandik Basin. Other basins not evaluated individually.

<sup>5</sup> Geological Survey of Canada estimated mean undiscovered gas in place ~ 0.489 - 0.800 TCF. Alaska component estimated as 0.116 Tcf.

<sup>6</sup> Collett, personal communication, 11/26/04.

<sup>7</sup> Barker, C.E., Clough, J.G., Roberts, S.B., and Fisk, R., Coalbed methane in Northern Alaska: potential resources for rural use and added supply for the proposed trans-Alaska gas pipeline, AAPG-SPERM Joint Technical Conference, Anchorage, AK, May 2002.

<sup>8</sup> Includes nonassociated and associated gas. State and Native lands are estimated to be approximately 60 TCF and are included in this total

<sup>9</sup> Oil and Gas Assessment of Yukon Flats, East-Central Alaska, 2004, USGS Fact Sheet 2004-3121, December 2004.

**Table 2. Useful life of an Alaskan gas pipeline given variations in reserves and capacity.**

|                               | Reserves, TCF | Project Life (Years)               |             |
|-------------------------------|---------------|------------------------------------|-------------|
|                               |               | Pipeline Capacity BCF/Day<br>(4.5) | (5.6)       |
| <b>Known Resources</b>        | <b>33</b>     | <b>20.1</b>                        | <b>16.1</b> |
|                               | <b>36</b>     | <b>21.9</b>                        | <b>17.6</b> |
| ↕                             | <b>40</b>     | <b>24.4</b>                        | <b>19.6</b> |
|                               | <b>60</b>     | <b>36.5</b>                        | <b>29.4</b> |
| <b>Undiscovered Resources</b> | <b>100</b>    | <b>61.5</b>                        | <b>48.9</b> |
|                               | <b>150</b>    | <b>91.3</b>                        | <b>73.4</b> |

**Table 3. Methane Hydrate Research, Development and Field Operations -- Authorization Budget**

|  | 2006         | 2007         | 2008         | 2009         | 2010         | Total Spending |
|--|--------------|--------------|--------------|--------------|--------------|----------------|
| <b>North Slope Studies</b>                                   |              |              |              |              |              |                |
| Seismic data processing and/or acquisition                   | 4.00         | 2.00         | -            | -            | -            | 6.00           |
| Regional resource assessments                                | 0.50         | 0.75         | 1.00         | 1.00         | 0.50         | 3.75           |
| Prospect definition studies                                  | 1.00         | 1.00         | 1.00         | 0.75         | 0.50         | 4.25           |
| Data Acquisition (wells of opportunity)                      |              |              |              |              |              |                |
| Logs (3 ea, 2006 - 2009)                                     | 0.36         | 0.36         | 0.36         | 0.36         | -            | 1.44           |
| Core (1, for thermal studies)                                |              | 0.50         | 0.50         | -            | -            | 1.00           |
| Thermal stimulation research                                 | 0.50         | 0.50         | 0.50         | 1.00         | 1.00         | 3.50           |
| Carbon dioxide replacement research                          | 0.50         | 0.50         | 0.50         | 0.50         | 0.50         | 2.50           |
| Test designs/site selection/planning/permitting/I.L items    | 0.50         | 0.75         | 0.75         | 0.25         | -            | 2.25           |
|  | <b>7.36</b>  | <b>6.36</b>  | <b>4.61</b>  | <b>3.86</b>  | <b>2.50</b>  | <b>24.69</b>   |
| <b>North Slope Field Operations</b>                          |              |              |              |              |              |                |
| Test production of NS Hydrates from underlying free gas zone | -            | 3.00         | 4.56         | 4.56         | 2.00         | 14.12          |
| Test direct production of NS Hydrates                        | -            | -            | -            | 6.38         | 5.48         | 11.86          |
|  | -            | 3.00         | 4.56         | 10.94        | 7.48         | 25.98          |
| <b>Total North Slope Spending</b>                            | <b>7.36</b>  | <b>9.36</b>  | <b>9.17</b>  | <b>14.80</b> | <b>9.98</b>  | <b>50.67</b>   |
| <b>Gulf Coast and Other L-48 Studies</b>                     | <b>2.64</b>  | <b>0.64</b>  | <b>0.83</b>  | <b>5.21</b>  | <b>10.02</b> | <b>19.34</b>   |
| <b>Total Spending</b>  | <b>10.00</b> | <b>10.00</b> | <b>10.00</b> | <b>20.00</b> | <b>20.00</b> | <b>70.00</b>   |

Average daily fully-loaded rig cost: \$35,000/day 45 days, RU, D&C, rig test = \$1.575 million  
 Production testing costs: \$12,500/day 15,000 /day for direct production test (includes thermal costs)  
 Incremental shallow logging costs: \$120,000/well

Test production of NS Hydrates from underlying free gas zone: - operations start mid-2007, w/ 45 days of rig work, prior to long-term production testing  
 Test direct production of NS Hydrates: - operations start early-2009, w/ 45 days of rig work, prior to long-term production testing

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# ALASKA LEGISLATURE - ONLINE TELECONFERENCE ORDER FORM

Note: All Fields Must Be Completed

Sponsor and/or Committee Name: Senate Resources

Date of Teleconference: Feb. 7

Start Time: 3:30 End Time: ?

Chairing Site: Juneau Juneau Room: 205

- Testimony:  Yes  No  Invitation Only  N/A
- Testimony Time Limit:  1 min  2 min  3 min  5 min  no time limit  other - see instructions

Contact Person Mary Jackson

Telephone Number 465-4907

- LIO sites:  Anchorage  Barrow  Bethel  Cordova  Delta Junction  Dillingham  Fairbanks  Glennallen  Homer  Juneau  Kenai  Ketchikan  Kodiak  Kotzebue  Matsu  Nome  Petersburg  Seward  Sitka  Tok  Valdez  Wrangell
- Other sites may add?  Yes  No
- Offnet Name (s)

No LIOs

**Subject of meeting and/or Bills on Agenda**

SJR 5: REAUTHORIZE METHANE HYDRATE RESEARCH ACT

**THE FOLLOWING DOCUMENT  
HAS NOT BEEN FILMED BUT IS  
AVAILABLE IN THE ORIGINAL FILE**

# North Slope Gas Hydrate Resources

State of Alaska Briefing on Proposal to Re-authorize  
Methane Hydrate Research and Development Act of 2000,  
Public Law 103-193, 114 Stat. 234  
(MAP)

January 2005



State of Alaska  
Department of Natural Resources  
Division of Oil and Gas

### Map Legend

- Natural Gas Pipeline Study Corridor (200 Miles Corridor)
- Proposed Natural Gas Pipeline Highway Route
- Trans-Alaska Pipeline
- Gas accumulation  
Sedimentary Basins (Kirochauer, 1968)
- Coal accumulation (DGGS, 1986)
- Hydrate Stability Limit (Colett, 1994)
- ☀ Oil well with Gas show
- ☀ Well with gas show
- ☀ Well with oil and gas show
- Highways
- Population Centers

### Natural Gas Resource Estimates

- 3.8 Tcf Mean Risked, Undiscovered, Technically Recoverable Conventional Gas (Tcf)
- 26 Tcf Estimated Recoverable Gas (Tcf)
- 50 Tcf Estimated In-Place Gas Hydrates (Tcf)

### Indications of Petroleum in Central Alaska

after Troutman, S.M. and Stanley, R.G. 2002, Map and digital database of sedimentary basins and indications of petroleum in the Central Alaska Province, U.S. Geological Survey, OFR 02-483, Scale 1:2,500,000.

- 44 Oil seep, reported but doubtful or disproved

Reports of three oil seeps near Allakaket on the Koyukuk River are regarded as doubtful because the reports were based on observations "made by a prospector many years ago, and seeps have not been seen by, or reported to, geologists who have recently been in Allakaket" (Miller and others, 1959, p. 72).

- 44 Well with gas show(s)



Milne Point Unit re vertical producing v

