TECHNOLOGY Locations: United States, onshore

# DOE-BLM Partnership

SUMMARY

**The Bureau of Land Management (BLM) and the Department of Energy (DOE) have joined forces to enhance protection of environmental and cultural resources on sensitive public lands. In these joint projects, advanced technologies and practices are shared across BLM, DOE, and the oil and gas industry to improve resource management and access to Federal lands. Currently, teams are studying issues such as the reversal of subsurface damage to freshwater aquifers at abandoned well sites in Oklahoma, the protection of archaeological remains in Nevada, and the improvement of air quality monitoring in remote Wyoming locations. In concert with Federal agencies striving to balance competing demands for the use of public lands, the DOE/BLM partnership seeks to ensure maximum resource recovery consistent with high levels of environmental protection and cultural sensitivity.**

BLUEPRINT ON TECHNOLOGY

## Strategic alliances leverage DOE and BLM resources and expertise to protect cultural resources and sensitive environments

### The role of BLM

BLM OVERSEES 264 million acres of Federal land and 300 million acres of subsurface mineral resources, primarily in the western United States and Alaska, about an eighth of the land in the United States. Federal lands under BLM oversight include extensive grasslands, forests, high mountains, arctic tundra, and deserts, as well as many fish and wildlife habitats and archaeological and historical sites. These lands contain subsurface resources amounting to eight percent of the natural gas and five percent of the crude oil produced annually, in addition to resources like coal, forest products, grazing forage, and rights-of-way for pipelines and transmission lines. Of the total $1.4 billion in annual revenues these lands bring, nearly $835 million, or 60 percent, is generated by royalties, rents, bonuses, sales, and fees from oil and gas operations. The total direct and indirect economic output of oil and gas production is estimated at nearly $12 billion annually.

### The role of DOE

DOE and BLM have entered into a memorandum of understanding (MOU) to help improve access to Federal land for oil and gas development, consistent with effective environmental protection. This includes technology transfer, data sharing, technical support, and sharing of expertise. Cooperative efforts under this agreement have included DOE participation on BLM streamlining and environmental incentives teams and BLM contributions to DOE's oil and gas databases. In addition, as part of the MOU activities, DOE and BLM have formed a Federal Lands Technology Partnership to address access issues and provide technical support to Federal land managers. Fiscal year 1998 was the first year of DOE funding under this partnership. The two agencies solicited projects from BLM field offices and worked together to prioritize the proposals. Three resulting projects initiated this year are discussed here.

ECONOMIC BENEFITS

Enhanced Federal revenues from increased oil and gas production on public lands

Accelerated planning and permitting schedules, reducing development costs and time

ENVIRONMENTAL BENEFITS

Greater protection of environmentally and culturally sensitive areas

Increased, more efficient recovery of oil and gas on Federal lands

CASE STUDIES

# Success in the Field

### Well decontamination in Oklahoma

BLM recently discovered brine and salt water contamination of both soil and freshwater sources on land held in trust to the Pawnee Indians in Payne County, Oklahoma. Today, BLM and DOE are working together with the Oklahoma Energy Resources Board, an industry-funded, publicly chartered site restoration agency, to reverse subsurface damage to a freshwater aquifer and to restore the area's damaged grasses, shrubs, and trees. Knowledge gained in this project will apply to a wide range of water-injection and water-disposal well problems, and technology developed for salvaging the contaminated aquifer will benefit other damaged sites on public lands.

### Archaeological and resource development in Nevada

BLM, DOE, and state agencies in Nevada are developing a predictive geographical information system (GIS) model that will help protect the rich archaeological remains of the northern Railroad Valley in Nye County, Nevada. This will enhance access to the area's rich oil and gas resources, often restricted by concerns about archaeological remains. A potentially powerful management tool, the model provides critical information on both subsurface resources and cultural sites, making it easier to determine lease boundaries, isolate sensitive areas, and accelerate resource development. For example, by identifying the likelihood of precious cultural resources in a specific area within the Nye Valley, the model will improve the routing of access roads and pad orientation, and help manage resource, range, wildlife, and recreation programs.

### Air quality monitoring in Wyoming

Since ongoing air quality data is often unavailable in many remote areas, it is becoming increasingly difficult for land management

agencies to complete air quality impact assessments required as part of Environmental Impact Statements (EIS). Because new oil and gas development projects are permitted only on condition that air quality will not significantly deteriorate, future access to some resources may be denied where air monitoring data are insufficient, even in areas where actual air quality impacts would be minimal.

To address this concern, BLM and DOE, in collaboration with other agencies, are establishing a network of low-cost, portable, solar-powered monitoring stations in southwestern Wyoming, which has seen a marked increase in oil and gas development over the last five years. These stations will measure ambient air concentrations and calculate dry deposition of nitrogen oxides and sulfur oxides in remote areas where environmental concerns are high and development is likely to increase. This will greatly enhance permitting decisions and EIS preparation. Five aerometric stations currently used to measure climate and air quality parameters will be converted for operational air quality monitoring. Three will be mobile; the other two will remain fixed to provide long-term air quality data.

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TECHNOLOGY Locations: Worldwide

# Coastal and Nearshore Operations

SUMMARY

**From Alabama's Mobile Bay to the North Irish Sea, operators are employing advanced exploration, drilling, production, and site restoration techniques to protect sensitive coastal wetlands and nearshore environments. For example, through collaborative planning with several Federal and State agencies and state-of-the-art drilling and site restoration technologies, Bright & Co. drilled an environmentally unobtrusive exploratory well on the Padre Island National Seashore. In conformance with extensive regulatory requirements, every phase of Bright's operation was designed to minimize environmental impacts, leaving virtually no footprint on the area. Although no hydrocarbon resources were found, the undertaking demonstrated that exploratory drilling can be done without disturbing coastal environments. The use of advanced technology helps preserve delicate ecosystems.**

BLUEPRINT ON TECHNOLOGY

## Cooperative planning, advanced technology, and detailed habitat enhancement render operations virtually invisible

### Gulf coast breakthrough

A FEDERALLY MANAGED recreational area and wildlife and nature preserve, Padre Island National Seashore has 133,000 acres of beaches, grasslands, tidal flats, dunes, and ponds that are home to a huge variety of plant life as well as marine life, reptiles, sea turtles, coyotes, waterfowl, and more than 350 species of birds, including some threatened or endangered species. Hiking, camping, fishing, nature studies, and water sports attract some 800,000 visitors annually. This 80-mile long barrier island sits four feet above an underground freshwater aquifer, which is the primary source of drinking water for area wildlife and thus critical to the island's ecosystem. The island is also situated in a high-potential oil and gas resource zone, challenging private parties who own subsurface oil and gas rights to develop these resources under the strict environmental regulatory oversight of several Federal and State agencies, including the U.S. Army Corps of Engineers, the National Park Service, and the Texas Railroad Commission.

### Planning for all contingencies

Before Bright & Co. could begin drilling, the National Park Service required a comprehensive plan of operations, including a timetable and description of all proposed construction, drilling, completion, and production activities; spill control and site reclamation plans; environmental impact statements; and documentation of the archaeological and cultural resources potentially affected by the operations. Bright & Co.'s plan included site management equipment to minimize the operation's footprint and safely manage wastes as well as a directional drilling strategy that would minimize contact with sensitive wetlands and environmental impacts. Upon plan approval, Bright & Co. also posted a $200,000 performance bond, the estimated maximum cost of site reclamation and clean-up should an oil spill occur. Finally, a U.S. Army Corps of Engineers permit to build an access road across reclaimed wetlands was obtained, requiring Bright & Co. to compensate the 0.4 acres of nontidal wetlands lost to road construction with 0.8 acres of new wetlands.

ECONOMIC BENEFITS

- Sensitive project execution averted potential negative impacts on a popular tourist area
- Cost-effective, low-impact operations proven successful

ENVIRONMENTAL BENEFITS

- Virtually no footprint following operation
- Habitats, wildlife, and cultural resources intact and unmolested
- Fresh and marine water resources meticulously safeguarded
- Reduced air emissions and lower risk of fuel spills through use of electric equipment

**A "no footprint" drilling site**
Using 7,600 tons of imported, compacted caliche, Bright & Co. built a 1.6-mile, 14-foot wide access road to the drill site. They constructed a 300-foot square caliche pad, covered by a polyethylene liner, on which they mounted the drill rig, mud tanks, and pipe racks. The company then built a berm around the liner and sloped the pad to capture any discharges in a subsurface "cellar," draining it with a centrifugal pump. A three-foot high levee ringed the pad perimeter, ensuring no groundwater contamination.

**Advanced technology at work**
Mesa Drilling Inc. drilled the well with a diesel-electric, silicon controlled rectifier unit, significantly reducing noise impact on visitors and wildlife. Most of the rig's components were wheel-mounted, thus minimizing equipment mobilization across the beach. Electric mud pumps and draw works reduced air emissions and potential oil leaks. An advanced closed-loop mud system collected drill cuttings in 85-barrel boxes mounted on tracks for immediate transport and disposal off site.

Bright & Co. employed directional drilling to hit the targeted pay zone—the Frio Marg A sand at approximately 7,500-foot true vertical depth—located beneath a large wetlands area. Directional drilling allowed Bright & Co. to avoid reclaiming additional wetlands for the drilling pad. An 8 $^{3}/_{4}$-inch polycrystalline diamond compact drill bit was selected to maintain direction and angle, prevent formation damage, and minimize drilling time and air emissions. At an average rate of 58 feet per hour over 14 days, the well was first drilled vertically to 1,830 feet, then angled 2 degrees per 100 feet, reaching an ultimate angle of 29 degrees and a measured depth of 8,900 feet. When no productive zones were found, Bright & Co. plugged the well, removed the pad and access road, restored the ground surface to its original contours, and reseeded with native grasses.

CASE STUDIES

## Beyond South Padre Island

Advanced technology is enhancing access to oil and gas resources while protecting sensitive coastal and wetlands ecosystems throughout the United States:

In Mobile Bay, Alabama—a complex marine environment with important commercial fisheries and recreational facilities—ARCO's Dauphin Island production facility has successfully minimized visual and environmental impacts while developing the area's rich natural gas resources. Less than three miles from Dauphin Island residents, the ARCO platform's unique structural design minimizes aesthetic drawbacks. The facility also used advanced horizontal drilling techniques to reduce the production footprint.

Covering 125,000 acres in southwest Louisiana, the Sabine National Wildlife Refuge sustains more than 250 species of birds, alligators, and marsh mammals, and is a major wintering ground for migratory waterfowl. In 1993, Vastar Resources selected the refuge's Black Bayou as an exploratory prospect. In close cooperation with the U.S. Fish & Wildlife Service and other Federal and State agencies, Vastar used innovative drilling, waste minimization, and site restoration techniques to drill two exploratory wells in this fragile coastal wetlands area, with minimal impacts.

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TECHNOLOGY Locations: Alaska's North Slope

# Insulated Ice Pads



SUMMARY

**New, prefabricated insulation panels can be used to preserve ice drilling pads from arctic summer thaw, thereby extending the exploratory drilling season as much as 50 percent. Insulated pads permit ice pad construction prior to the winter drilling season, enabling drilling operations to begin some two months earlier than if the pad had been built in December for a mid-January drilling start—the typical exploratory drilling schedule. The extended season allows single-season well completions, which reduce seasonal equipment mobilization and environmental impacts, as well as associated costs.**

BLUEPRINT ON TECHNOLOGY

## Extending the drilling season with insulated ice pads can minimize environmental disruption and exploratory drilling footprints, while reducing costs

### Drilling in the Arctic

CLIMATIC CONDITIONS on Alaska's North Slope have restricted the exploratory drilling season in remote Arctic environments to 135 to 170 days. The tundra has to be frozen solid enough to allow equipment transport to the drilling site as well as sustainable ice road and ice pad construction and maintenance. At its longest, the tundra travel season extends from November through May, although specific conditions dictate load weight on any given date. At the drilling site, ice pad construction, often as large as an acre, is usually begun in early December, although November is possible under optimal conditions. By mid-May, equipment must be removed to a non-tundra area. While conventional ice pads are far less environmentally intrusive and less costly than gravel drilling pads, their impermanence means an additional round of equipment demobilization and storage at an offsite gravel pad. If, as is common, the exploratory well is not completed, remobilization the following season is necessary. Such operations entail environmental disturbance and additional costs.

Innovative insulated ice pads, however, can extend the available drilling season to a total of 205 days and effective well operations up to 160 days, potentially enabling completion of one or perhaps two exploratory wells in a single season. Single-season completions substantially reduce mobilization costs and related environmental effects, and also cut time between initial investment and returns.

ECONOMIC BENEFITS

- Single-season exploratory well completions, greatly reducing mobilization costs
- Valuable subsurface data one year earlier than would otherwise be possible, enhancing operational planning

ENVIRONMENTAL BENEFITS

- Smaller footprints and less time on-site
- Elimination of seasonal equipment mobilization, minimizing environmental impacts on land and air

CASE STUDIES

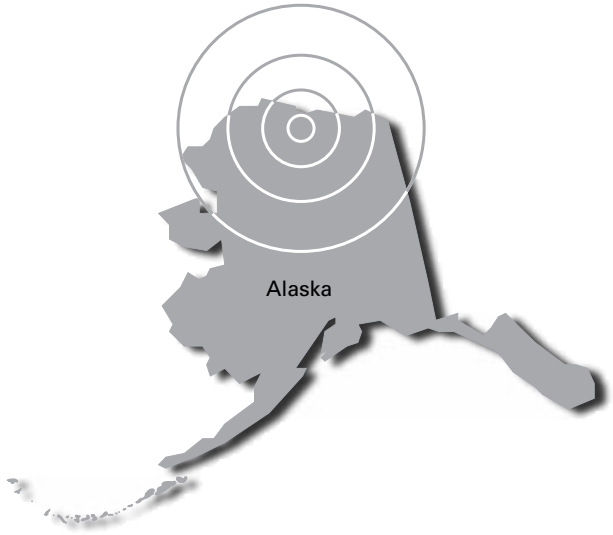
# Success in the Field

### Drilling two months earlier, saving more than $2.3 million

When a BP Exploration (Alaska) Inc. (BPXA) engineering feasibility study indicated that constructing an insulated ice pad in March 1993 at Yukon Gold #1 on the North Slope would significantly extend the winter drilling season, BPXA built a 390-by-280-foot ice pad covered with nearly 600 wind-resistant insulating panels. Summer visits confirmed that the ice beneath the panels remained sufficiently frozen. When the panels were disassembled in October 1993, they had not bonded to the resting surface, or scattered, and nearly 90 percent were in excellent condition and reusable.

BPXA began drilling in mid-November, two months ahead of conventional Arctic practice. With such an early start, Yukon Gold #1 was completed in time to begin drilling immediately at nearby Sourdough #2, where the insulated panels were placed under the rig to give BPXA the option of leaving the rig on location over the summer and avoiding remobilization should the well not be completed before season's end. This was not necessary, however, as the Sourdough well was also successfully completed during the same season.

Overall, BPXA netted a cost savings of more than $2.3 million from the two single-season completions. In addition, the tundra endured significantly less impact than would have been the case had seasonal equipment mobilization been required. Subsequent site monitoring showed no long-term environmental impacts.




METRICS

Results of a BPXA study, comparing drilling season length using conventional practices versus insulated ice pads

| Time Period | Conventional | Insulated Ice Pad |
|---|---|---|
| Construction start date | December 1–15 | Previous Winter |
| Start of rig mobility | December 15–31 | October 7–21 |
| Spud date for first well | January 15–31 | November 7–21 |
| Tundra-travel end of season | April 29–May 22 | April 29–May 22 |
| End of well operations | April 15–May 8 | April 15–May 8 |
| **Total Season Available** | **135–170 days** | **175–205 days** |
| **Effective Well Operations Season** | **75–110 days** | **145–160 days** |



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TECHNOLOGY Locations: Alaska's North Slope

# North Slope Operations

SUMMARY

**North Slope oil and gas operations showcase a number of technological triumphs over powerful natural forces, enabling successful operations in this extreme, sensitive environment. Since these resources represent nearly a quarter of U.S. oil reserves, the need to access them has accelerated development of environmentally responsible, cost-effective practices and technologies. For instance, the difficulties of winter exploration have been mitigated by innovations such as ice roads and ice pads that have no lasting effects on delicate tundra. Drilling advances—extended reach drilling, coiled tubing drilling, multilateral completions and "designer" wells—are increasing resource recovery and reducing drilling costs, footprints, and waste volumes. Today's exploration and production facilities are radically streamlined, occupying far less surface area than operations did 25 years ago.**

BLUEPRINT ON TECHNOLOGY

## Technology advances protect the environment and improve recovery under hostile arctic conditions

**Low-impact operations increase resource recovery, reduce costs, and protect sensitive habitats**

THE LARGEST OIL field in North America, the North Slope's Prudhoe Bay has estimated total recoverable reserves of 13 billion barrels of oil and 46 trillion cubic feet of natural gas. Alaska is also home to diverse, unique, and fragile ecosystems, inspiring extensive Federal, State, and local regulatory protection. Since the onset of the North Slope oil boom in the late 1960s, operators have been forced to develop more cost-effective, less environmentally intrusive ways to develop these resources. For example, the exploration sector has developed innovative ice-based transportation infrastructure serving remote locations, even during winters characterized by -70°F temperatures, 20-foot snowdrifts, and limited daylight. In the 1920s, road construction by bulldozing tundra proved disastrous. After only one season, the route was impassable when the permafrost thawed. Operators turned to gravel to insulate the permafrost and stabilize roadbeds, airstrips, and drilling pads, but gravel mining and construction are expensive and environmentally harmful. In the last decade, ice-based technology has become the new standard for exploration. Its low-cost, low-impact performance continues to be refined by techniques like ice pad insulation, which can extend drilling seasons and reduce equipment mobilization. Where ice roads are impractical, low-pressure balloon-tire vehicles haul loads, leaving practically no footprint.

Recent advances in drilling technology are increasing North Slope E&P productivity and protecting the environment. Through-tubing rotary drilling, for example, allows new wells to be drilled through the production tubing of older wells, saving time

ECONOMIC BENEFITS

- Enhanced resource recovery and more efficient operations
- Lower operating costs

ENVIRONMENTAL BENEFITS

- Reduced surface footprints and disturbance
- Protection of sensitive habitats, wildlife, and cultural resources
- Greater access to resources with fewer wells drilled, through advanced drilling technology
- Reduced waste volumes requiring disposal, through innovative waste management and recycling techniques

and, potentially, up to $1 million in operating costs per well. New directional drilling tools and an advanced form of horizontal drilling ("designer wells") permit drillers to curve around geological barriers to tap small, difficult-to-reach pay zones. Another advanced technology is coiled tubing, which allows extended-reach, directional drilling, and multilateral completions—all major contributors to increased resource recovery, reduced costs, smaller footprints, and less waste.

METRICS

## Advanced technologies have significantly reduced the footprint of North Slope operations

- If Prudhoe Bay were developed with today's technology, its footprint would be 64 percent smaller: the drilling impact area would be 74 percent smaller, roads would cover 58 percent less surface area, and oil and gas separating facilities would take 50 percent less space.
- A new 55-acre contractor base supports ARCO Alaska's Kuparuk field; similar facilities built over 20 years ago occupy more than 1,000 acres.
- Surface wellhead spacing has been reduced from 145 feet to 35 feet onshore and 10 feet offshore.
- Production pads are dramatically streamlined: the 1971 Prudhoe Bay "A" Pad was built with 35 wells on 44 acres; the 1989 "P" Pad was built with 21 wells on less than 11 acres.

*Source: Alaska Department of Natural Resources and BP Exploration (Alaska) Inc.*

CASE STUDIES

## Success in the Field

### Improving waste management

North Slope operators are using advanced technology to manage drilling wastes more effectively. A 1988 ARCO pilot project demonstrated that processed drill cuttings could be safely used as road construction materials, since the cuttings' composition was essentially identical to that of native gravel and surface soils. Based on these findings, in 1990 BPXA built a prototype grinding and injection facility that recycled recovered cuttings into construction gravel, and ground remaining waste for subsurface reinjection. By 1994, refined grind-and-inject technology enabled BPXA and other Prudhoe Bay operators to achieve "zero discharge" of drilling wastes, eliminating the need for reserve pits. These innovative strategies yield significant environmental benefits—decreased waste volumes, less mining of surface gravel, smaller pad sizes, and less surface disturbance.

### Restoring affected areas

The fragile North Slope ecosystem makes site restoration and habitat enhancement a vital post-production process. In recent years, BPXA and ARCO Alaska have created artificial lakes by flooding abandoned gravel mining sites. This practice, encouraged by the Alaska Department of Fish and Game, creates overwintering habitats for fish and predator-free nesting areas for waterfowl. BPXA and the U.S. Department of Fish and Wildlife collaborated to restore 10 miles of habitat along Endicott Road, demonstrating that transplanting Arctic pendant grass effectively revegetated disturbed aquatic sites. This technique was also applied at BPXA's BP Pad, where restoration began in 1988. Within three years, native vegetation was restored.

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