Bering Sea - Western Interior
Resource Management Plan

BLM

Alaska

Mineral Occurrence and Development Potential Report

Leasable Minerals

BLM Alaska State Office
Division of Energy and Solid Minerals
Branch of Energy

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BLM Cover Photo: Aerial photograph of Kuskokwim River near Holitna Basin
Photo by Robert Brumbaugh

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List of Acronyms

ADNR - Alaska Department of Natural Resources
ANILCA – Alaska National Interest Lands Conservation Act
BLM - Bureau of Land Management
BSWI - Bering Sea Western Interior
Btu – British thermal units
CFR - Code of Federal Regulations
DOE - Department of Energy
RMP - Resource Management Plan

I. Introduction

A. Purpose of Report

This Mineral Occurrence and Development Potential Report was prepared to assure the availability and consideration of leasable mineral resources data during the Bering Sea-Western Interior Resource Management Plan (BSWI RMP) development process. This report provides an intermediate level of detail for mineral assessments as prescribed in the 1985 BLM Manual Sections 3031 (Energy and Mineral Resource Assessment) and 3060 (Mineral Reports – Preparation and Review). Information provided in this report will be incorporated into the RMP and the environmental impact statement (EIS).

This report provides a geologic description of the area comprising the RMP including subsections on physiography, stratigraphy, structural geology, historical geology, and geophysical and geochemical data. In addition, the report describes the leasable mineral resources present in the planning area and includes a discussion of the occurrence and development potential. This report is not a decision document, and does not present specific recommendations as to which lands should be open for mineral leases, or which (if any) lease stipulations should be modified. Specific recommendations concerning land use planning issues will be included in the RMP EIS.

Two primary laws, the Mineral Leasing Act of 1920 and the Materials Act of 1947, excluded certain mineral types that could only be acquired through a federal leasing program or disposed of by sale. “Leasable” minerals include oil and gas, coal bed natural gas, geothermal fluids, peat, and certain solid minerals, such as potassium, sodium, phosphate, and oil shale.

Identified fluid leasable minerals (including oil, gas, geothermal, and coalbed natural gas) resources are classified according to BLM Handbook H-1624-1, Planning for Fluid Mineral Resources. The regulations governing management of coal can be found in 43 CFR 3400 and those governing the remainder of the leasable minerals can be found in 43 CFR 3500. BLM Manual 3031 specifies that minerals be classified according to mineral potential (used to rank the potential for presence or occurrence, as opposed to the potential for development or extraction). This classification system rates potential for the occurrence of mineral resources in categories of high (H), moderate (M), low (L), very low (V), and no potential (O). The classification is followed by a rating of the level of certainty of the data ranging from A to D, indicating degrees of confidence in the evidence regarding the presence of a particular mineral occurrence. A “D” rating indicates the least amount of data available, while an “A” rating indicates a high degree of data available (Table 1).

Table 1. Rating system for leasable minerals occurrence potential in the BSWI Planning Area

Leasable Mineral	Potential for Occurrence / Degree of Data
Oil	L/C
Natural Gas	L/C
Coal bed Natural Gas	L/C
Coal	L/C
Oil Shale	O/D
Phosphate	O/D
Sodium	O/D
Geothermal	V/B
Peat	L/C

Fluid mineral occurrence and development potential in the Bering Sea-Western Interior Planning Area is primarily associated with coal and coal bed natural gas, oil and gas, peat, and geothermal resources. Oil shale, phosphates, and sodium were not analyzed as there is no existing data for these resources in the planning area.

As described in BLM Manual H-1624-1, federal oil and gas leases (including coal bed natural gas) fall into one of four categories that become increasingly restrictive (BLM 1986):

1. **Open Subject to Standard Lease Terms and Conditions:** These are areas where it has been determined through the planning process that the terms and conditions attached to the leasing document are sufficient in allowing exploration and development.
2. **Open Subject to Seasonal or Other Minor Constraints:** These are areas where it has been determined that moderately restrictive lease stipulations may be required to mitigate impacts to other land uses or resource values. Category 2 leases frequently involve timing limitations such as restricting construction activities in designated big game winter ranges, or controlled surface use stipulations such as creating a buffer zone around a critical resource.
3. **Open Subject to No Surface Occupancy or Other Major Constraint:** These are areas where it has been determined through the planning process that highly restrictive lease stipulations are necessary to protect resources. Category 3 leases may prohibit the construction of well production and support facilities. These areas can be subject to directional drilling.
4. **Closed to Leasing:** These are areas where it has been determined that other land uses or resource values cannot be adequately protected, and appropriate protection can only be ensured by closing the land to leasing through either statutory or administrative requirements. These areas are outlined in 43 CFR 3100.

B. Lands Involved

The BLM manages the subsurface estate under BLM-managed lands, including the subsurface beneath private surface estate if the subsurface estate was reserved to the BLM in the conveyance of the private surface estate. The lands within the Yukon Delta National Wildlife Refuge established under the Alaska National Interest Lands Conservation Act (ANILCA) are open to oil and gas leasing (except those portions in wilderness areas). BLM administers any oil and gas leasing with the concurrence of the U.S. Fish and Wildlife Service.

The BSWI Planning Area encompasses approximately 62 million acres of land in western Alaska, including 10.6 million acres of BLM-administered land (surface lands and federal minerals). The planning area includes all lands south of the Central Yukon Watershed to the southern boundary of the Kuskokwim River Watershed, and all lands west of Denali National Park and Preserve to the Bering Sea, including Saint Lawrence, Saint Matthew and Nunivak Islands (Figure 1). There are several areas of interest within the planning area in terms of leasable minerals (Figure 2).

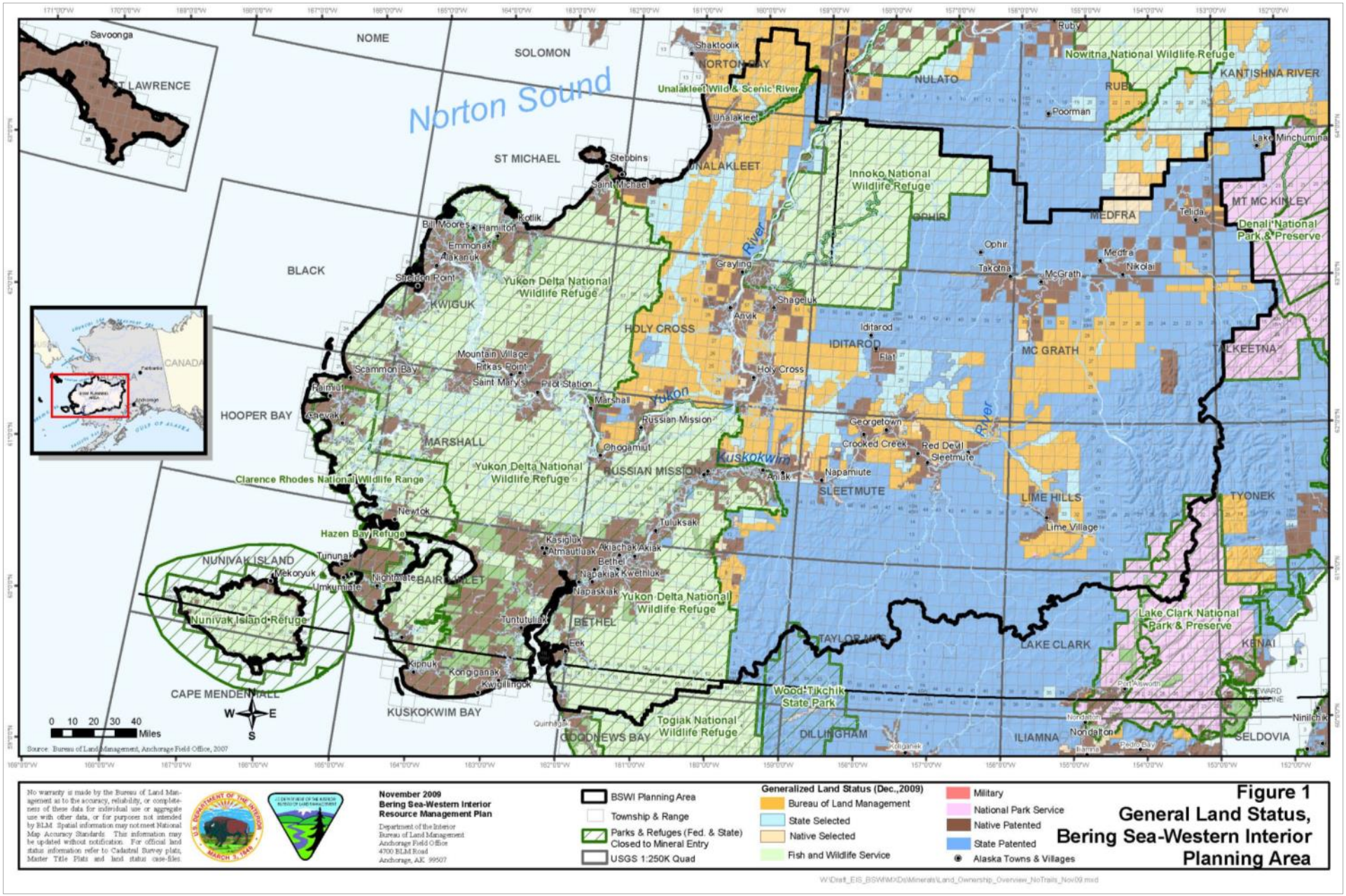

Figure 1. General land status, Bering Sea-Western Interior Planning Area

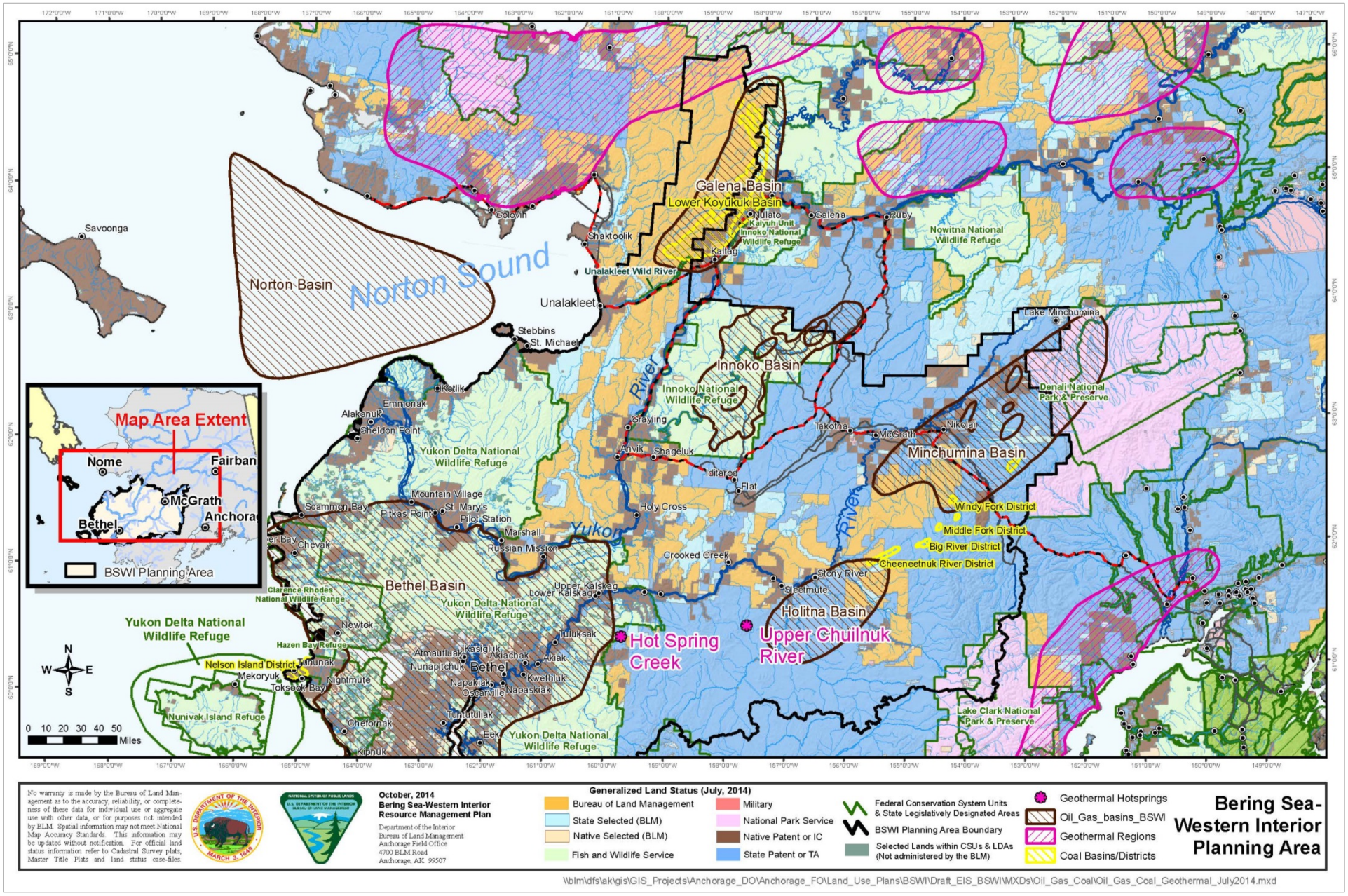

Figure 2. Areas of leasable mineral interest, Bering Sea-Western Interior Planning Area

Table 2. Land ownership in the planning area (in acres and percent) †

Land Ownership	Acres	Percent
BLM - Unencumbered	7,871,917	12.7
State	18,163,488	35.5
State Selected	2,586,808	4.2
ANCSA Native Corporation	11,685,961	22.9
ANCSA Native Corporation Selected	187,601	0.3
Private	3,159	0.0
National Wildlife Refuges	18,559,837	36.3
National Parks and Preserves	551,386	1.1
Military	34,365	0.01
Water	1,304,763	2.6
Total:	61,785,347	100.00

† Wildlife refuges are predominant on the western boundary of the planning area and flank BLM-managed lands in the northern tip of the planning area. The two major rivers, the Yukon and the Kuskokwim, that dominate the terrain throughout the planning area, drain into the Yukon Delta Wildlife refuge on the western boundary of the planning area.
Note: All acreage figures are rounded to the nearest 1,000 acre

II. Description of Geology

A. Physiography

See Mineral Occurrence and Development Potential Report, *Locatable and Salable Minerals Occurrence Report, Bering Sea-Western Interior Resource Management Plan*, BLM-Alaska Technical Report 60, November 2010 (pp.6-16).

B. Rock Units (Lithology and Stratigraphy)

See Mineral Occurrence and Development Potential Report, *Locatable and Salable Minerals Occurrence Report, Bering Sea-Western Interior Resource Management Plan*, BLM-Alaska Technical Report 60, November 2010 (pp.16-21).

C. Structural Geology and Tectonics

See Mineral Occurrence and Development Potential Report, *Locatable and Salable Minerals Occurrence Report, Bering Sea-Western Interior Resource Management Plan*, BLM-Alaska Technical Report 60, November 2010 (p. 21).

D. Geophysics and Geochemistry

See Mineral Occurrence and Development Potential Report, *Locatable and Salable Minerals Occurrence Report, Bering Sea-Western Interior Resource Management Plan*, BLM- Alaska Technical Report 60, November 2010 (p. 22).

III. Description of Leasable Mineral Resources

A. Coal

The quality of coal is ranked by the amount of metamorphism it has undergone since burial. Coal qualities are divided into four classes or ranks: in decreasing order of carbon content and heat value, these are anthracite, bituminous coal, subbituminous coal, and lignite. Within the bituminous class, coals are further subdivided based on the amount of volatile matter (low, medium, and high volatiles present) and heat value (A, B, and C).

The areas that contain coal within the planning area have been divided into 1 field and 5 districts: Farewell (Little Tonzona) Coal Field, and the Windy Fork, Middle Fork, Cheeneetnuk, Big River, and Nelson Island Districts (Figure 3).

The majority of the coal in the planning area is tertiary-aged and subbituminous. It underlies approximately 200 square miles of the Farewell Field, Windy-Middle Forks, Big River, and Cheeneetnuk River areas (Merritt 1986; Figure 3). Bundtzen and Kline (1986) estimated 4.4 billion short tons of coal present in the Cheeneetnuk River, Windy Fork, and Middle Fork area, but this volume is unproven. The Alaska Department of Natural Resources (ADNR) conducted field work in the Cheeneetnuk-Windy Fork-Middle Fork area in 2000 and 2001 and noted that most of the coal-bearing succession in this area was actually carbonaceous mudstone with thin stringers of coal, and few coal seams greater than half a foot thick were present (LePain et al. 2003). In Public-data File 85-21, Alaska Coal Summary (1984), Merritt classifies the development potential in the areas of Flat, Cheeneetnuk River, Windy and Middle Forks, Nelson Island as low.

Seven coal occurrences were studied in the vicinity of the Farewell Fault Zone on the Cheeneetnuk, Middle Fork, and Windy Fork Rivers by the Alaska Division of Geological and Geophysical Surveys in 1982 (Figure 4). The Farewell Fault Zone is a right lateral strike slip fault zone and trends northeast. It is part of the Denali Fault system and contains slivers of Tertiary nonmarine sedimentary rocks that include coal-bearing sections from 5 to 90 meters thick (Solie and Dickey 1982). The coal in these occurrences ranged from high volatile C bituminous to subbituminous A in zones of inter-bedded shale, mudstone, and coal up to 190 meters thick (Solie and Dickey 1982).

There are also known coal mineral resources, which are limited to a few thin coal beds, on Nelson and Nunivak Islands (Figure 3). However, these beds are considered noncommercial (Dobey and Hartman 1973) as they are estimated to be only about 2 feet thick (Rudis 2009).

Modest amounts of coal from Windy Fork have been used by trappers, prospectors, and big game hunters for local home heating applications. Coal was also mined at Flat, AK and used for home heating until the 1930s (John Muscovich, personal comm. 1985). Small local occurrences have also been observed in the Yukon Delta region of the planning area. The expense of developing the limited coal resources within the planning area will likely preclude small and large-scale development in the foreseeable future. There are no roads or railroads connecting the planning area to the rest of the state; therefore, coal would have to be shipped by boat.

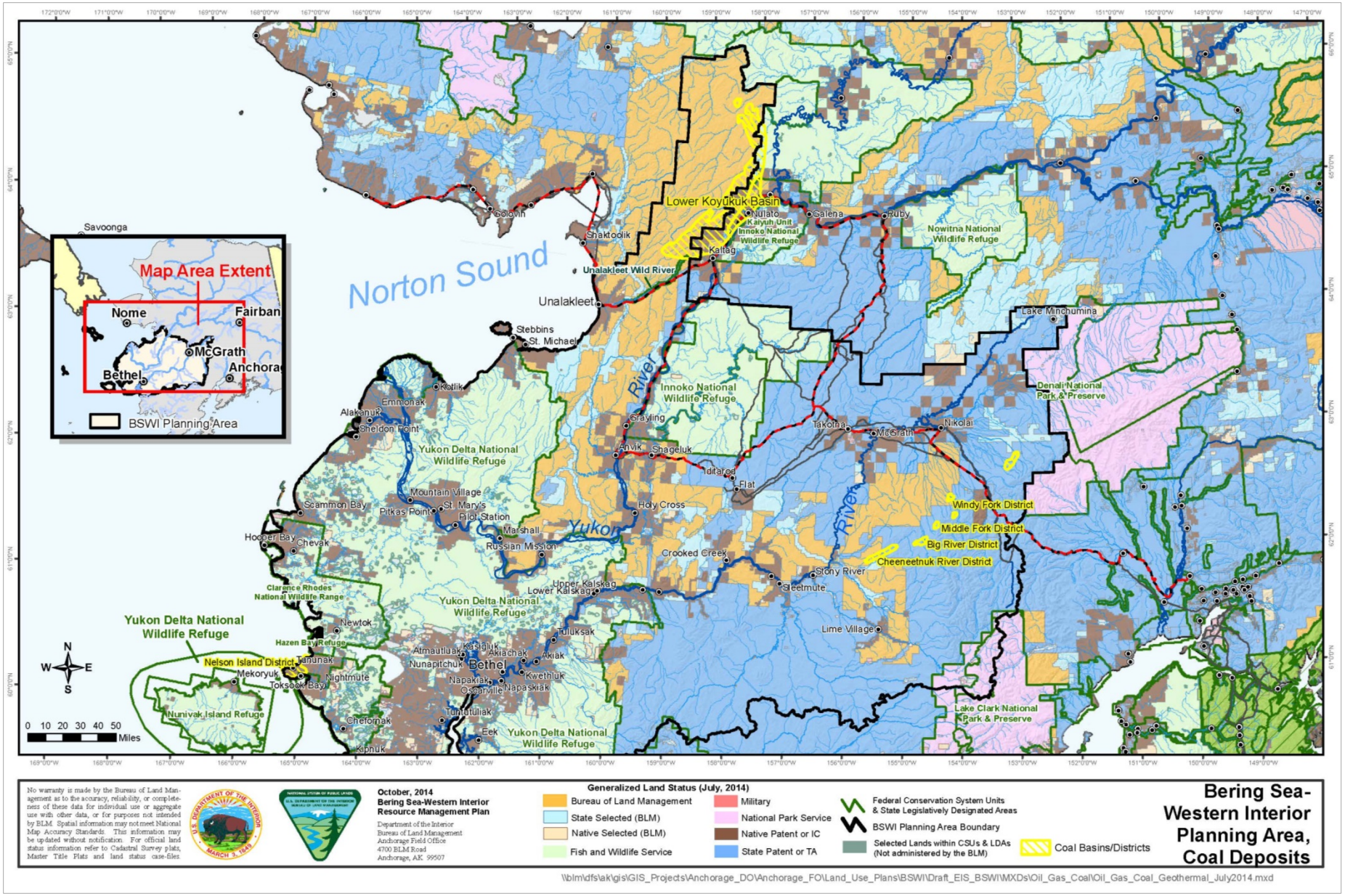

Figure 3. Coal deposits within the Bering Sea-Western Interior Planning Area

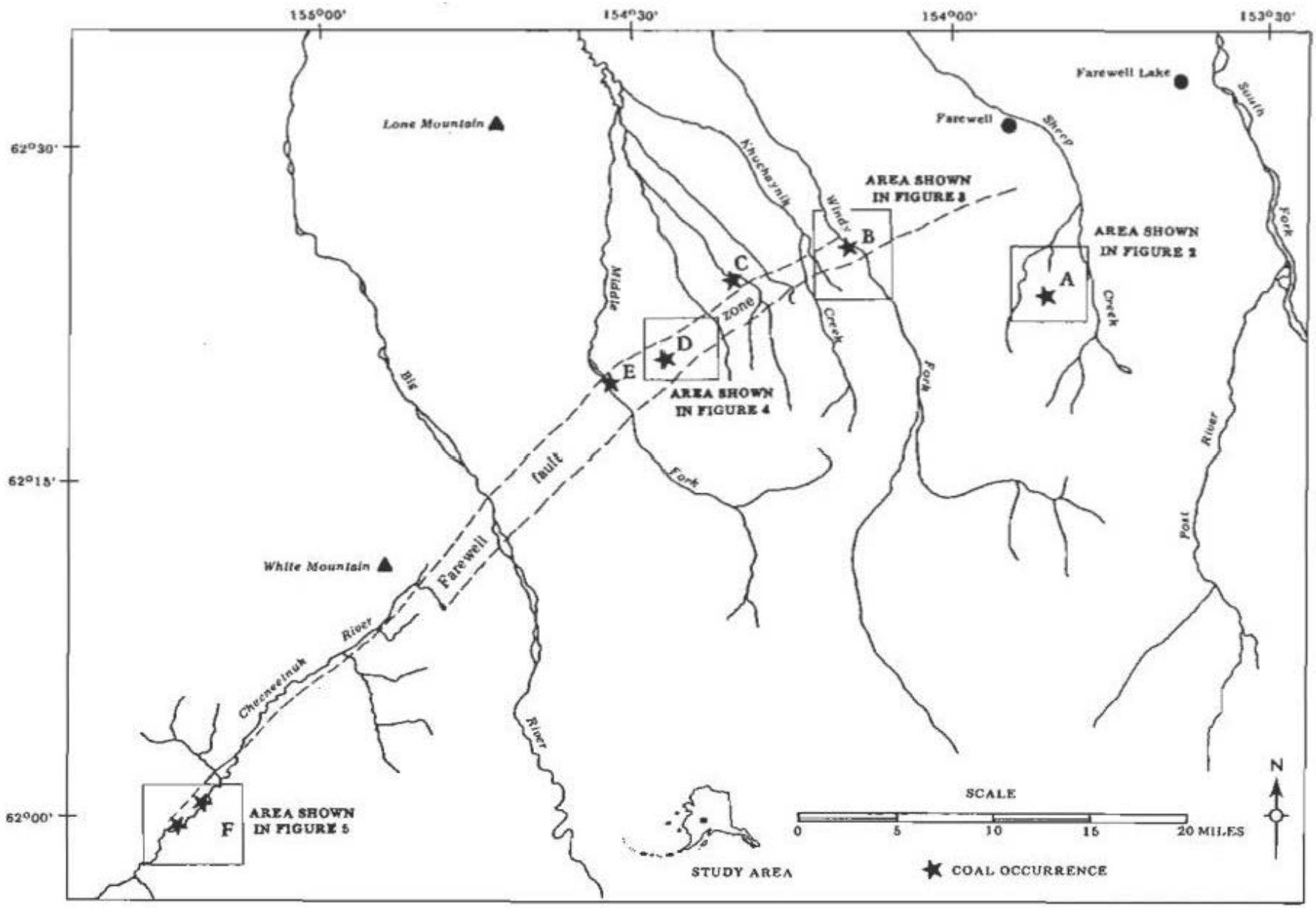

Figure 4**. Locations of coal samples analyzed by Solie and Dickey (1982)**

Farewell (Little Tonzona) Coal Field

The Farewell Coal Field occurs near the southeastern margin of the Minchumina Basin in Southwestern Alaska and contains outcrops scattered over an area of about 200 square miles from Little Tonzona River to the Middle Fork of the Kuskokwim River (Merrit 1986). The structure of the field is low-angle fault blocks and minor folds (Meyer 1987).

Swensen et al. (2012) noted exposed coal seams along the west bank of the Little Tonzona River that extend west of the river some distance. Coal samples were taken from shallow trenches and analyzed by the Department of Energy, Coal Laboratory in Pittsburgh, Pennsylvania. Heating values for the coal ranged from 8,466 to 9,517 Btu per pound on a moisture-ash free basis and from 7,848 to 8,295 Btu per pound on an as-received basis (Sloan and others 1979). Sulfur content varies considerably from bed to bed ranging from 0.7 to 1.7 percent. The sulfur content is considered moderate-to-high by ASTM[1] classifications.

Canadian Superior Exploration, Ltd. and McIntyre Mines were contracted to drill the Little Tonzona River coal deposits in 1980 for Doyon, Ltd. (the Fairbanks-based regional Native corporation; Merritt 1985). This exploration suggested that a minimum of 100 million metric tons of sub-bituminous coal, similar to seams at Healy (Thorpe 1981), exist beneath the area. Thorpe (1981) gave numerous detailed data on the drilling programs conducted in the Little Tonzona field. This field has had no significant past production.

B. Coalbed Natural Gas

Coalbed natural gas is low cost, clean burning, natural gas recovered and produced from coal beds. Unlike conventional gas, it is a nontraditional reservoir in the sense that the coal beds are both the source and reservoir for the methane gas (Tyler et al. 2000). The conversion of plant material to coal (coalification) produces large amounts of gas, comprised of mostly methane, that is then stored on the internal surfaces of the coal. Because coal has such a large internal surface area, due to fractures or cleats, it can store 6 to 7 times the amount of gas than a conventional gas reservoir of equivalent rock volume. Gas within the coal is held in place by hydrostatic pressure (Nuccio 1997).

Exploration costs for coalbed natural gas are low, and wells used to extract coal bed natural gas are cost effective to drill. Because methane is less dense than oxygen, it rises to the surface as water pressure is reduced within the coal seam by pumping. Coalbed natural gas is extracted, compressed, and then put into pipelines and burned like any other natural gas accumulation. No specialized technology is needed for its immediate utilization. Gas content generally increases with coal rank, with depth of burial of the coal bed, and with reservoir pressure (Nuccio 1997).

In the early stages of coalbed natural gas production, large amounts of water may be produced. Water disposal from the production of coalbed natural gas has been handled in many different ways depending on the water quality, quantity, and location where production is occurring. In some locations water has been disposed of at the surface when it has been relatively fresh. However, most water is injected into a rock at a depth often below that of the coal beds being produced where the water quality of the host rock is less than that of the injected water.

[1] American Society for Testing and Materials

The ideal scenario for maximum coal bed methane production would be:

- Thick, laterally continuous coals of high thermal maturity;
- Adequate permeability;
- Basinward flow of groundwater through coals of high rank and gas content orthogonally; toward no-flow boundaries (such as fault systems, structural hingelines, or facies changes);
- Generation of secondary biogenic gases; and
- Conventional trapping along those boundaries to provide additional gas beyond that generated during coalification.

Some sub-bituminous coal in the planning area may be at suitable depth to allow for in-situ gasification projects, but this is unverified. These projects could provide gas to local villages; however, there is no infrastructure to support such an undertaking and the cost of developing such infrastructure may not compare favorably to the existing cost of supporting the current diesel fuel-based system. LePain and others (2003) evaluated the shallow gas potential (coalbed natural gas) of the Holitna Basin and concluded it was low due to the likely structural complexity of the basin fill. Due to geologic similarities, it can be inferred that the shallow gas potential for the Minchumina Basin is similar to that of Holitna Basin. Based on the results of the Napatuk Creek No. 1 well drilled in Bethel Basin, coal bed natural gas potential is low for the Bethel Basin as well.

C. Oil and Gas

The BSWI Planning Area has received limited, intermittent interest and activity in oil and gas exploration since the early 1960s due to lack of evidence of a thick Tertiary section and poor source and reservoir potential in the Cretaceous sedimentary rocks (Kirchner 1994). The presence of large commercially valuable accumulations of gas is also presently unknown. Little additional subsurface well or seismic information has been collected in the planning area to date and much of the data collected remains proprietary.

Interpretations of the subsurface geology are based on geophysical profiling, extrapolation of map data from adjoining mountain areas northeast and south of the area, and from Napatuk Creek No. 1 well. Several geophysical surveys (e.g., airborne magnetic surveys, gravity surveys, and reflection seismic surveys) have been conducted in the region by governmental agencies and by the oil industry (Mull et al. 1995; Figure 5).

A major obstacle to economic development in this region of Alaska is the lack of energy infrastructure. Development of local energy sources, such as natural gas, is believed by local leaders to be critical in stimulating economic development and increasing the overall standard of living in the region (Petrotechnical Resources of Alaska, LLC 1999). Discoveries of economic quantities of natural gas, whether conventional or nonconventional, hold the potential to supplant or reduce imported fuels, thereby lowering energy costs. The State of Alaska (2010) has adopted an exploration incentive program (Figure 6) to entice industry interest in the area.

Exploration licensing supplements the State's conventional oil and gas leasing program by targeting areas outside known oil and gas provinces such as the North Slope, Beaufort Sea, and Cook Inlet (ADNR 2009). The intent of licensing is to encourage exploration in areas far from existing infrastructure, with relatively low or unknown hydrocarbon potential, where there is a higher investment risk to the operator. Lease sales held in some of these higher risk areas have

attracted little participation, a deterrent being the bonus money a bidder must pay to win the lease (ADNR 2009). Exploration licensing gives an interested party the exclusive right to conduct oil and gas exploration without this initial expense.

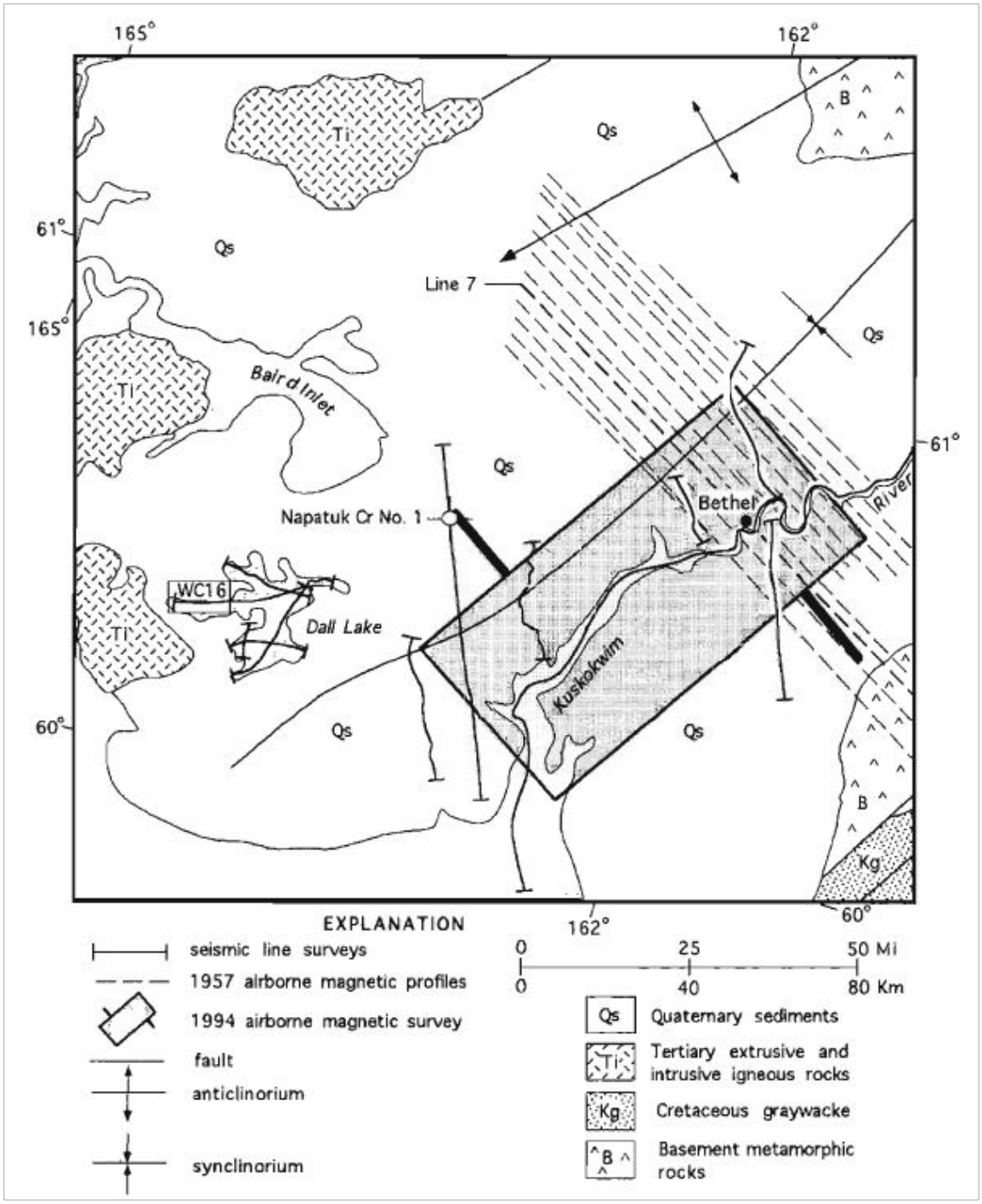

Figure 5. Map of industry seismic lines (Dempsey and Others 1957)

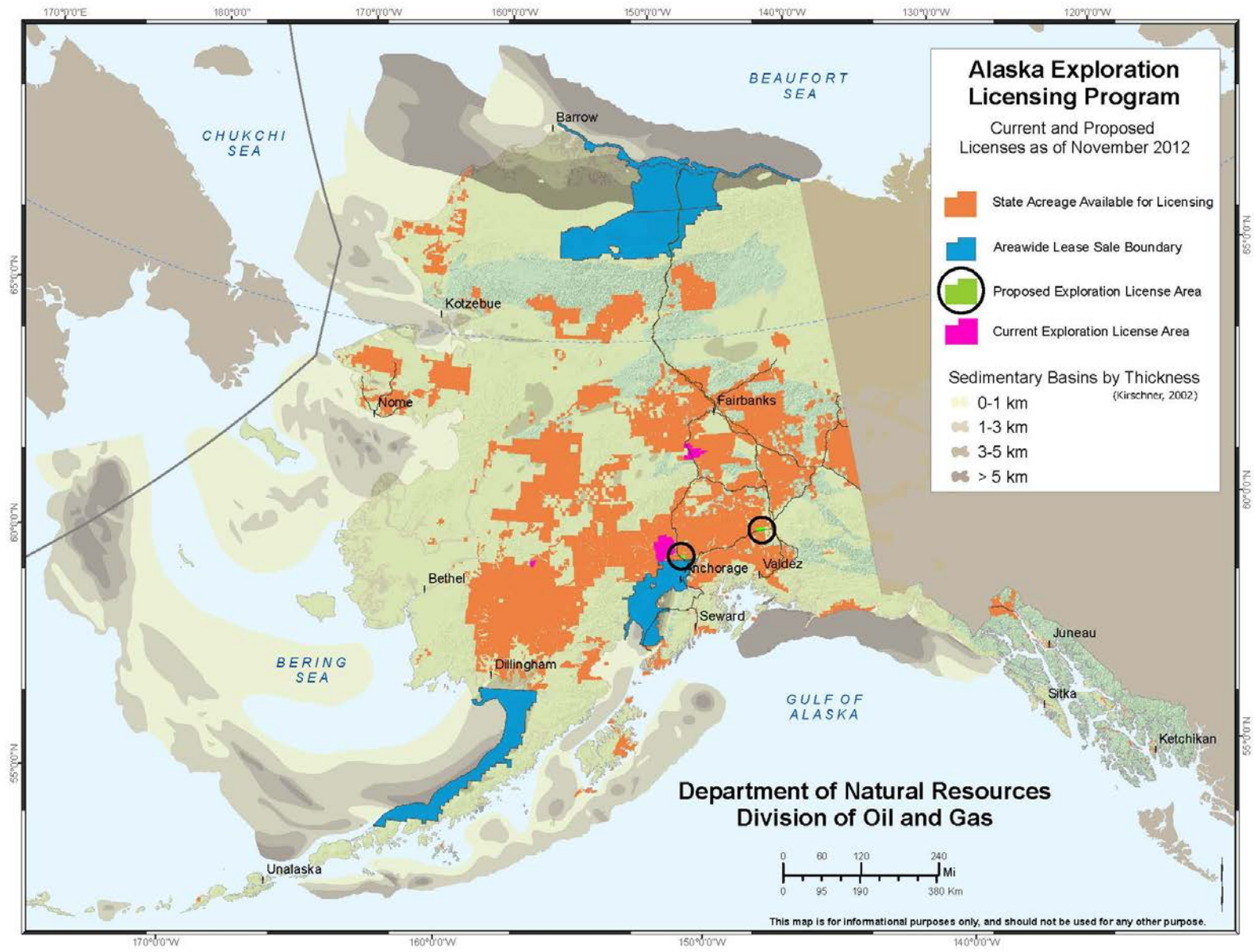

Figure 6. Exploration licensing map

National goals relating to oil and gas are to maximize the availability of the federal oil and gas estate for exploration and development. The BLM is responsible for making public lands available for orderly and efficient development of oil and gas resources under principles of multiple-use management. The BLM actively encourages development by private industry of public land mineral resources, and promotes practices and technology that least impact natural and human resources. Except for Congressional withdrawals, public lands shall remain open and available for oil and gas exploration and development unless withdrawals or other administrative actions are clearly justified in the national interest.

Currently, no wells are producing oil or gas in this region, and no recent geophysical or drilling exploration activity in the planning area. No recent federal oil and gas leasing has taken place. Prospective oil and gas basins in the region of the planning area include the Holitna, Bethel, and Minchumina Basins, along with the Yukon Delta. The Norton Basin lies offshore in Norton Sound but is outside of the planning area (Figure 7).

Pending Oil and Gas Leases

There are 59 oil and gas pending Pre-Reform Act lease offers within the BSWI Planning Area, all within the boundary of the Yukon Delta National Wildlife Refuge. Nearly all (58 of 59) pending applications were filed in 1968 and one in 1969. The Secretary of the Interior subsequently ordered the suspension of pending oil and gas lease offers until the availability of the lands for oil and gas leasing was, or is, finally determined after considering selections proposed by the State of Alaska and various Native entities. (Public Land Order 4582, 34 Federal Register 1025, January 16,1969). Public Land Order 4582 was extended and continued, in effect, until the passage of the Alaska Native Claims Settlement Act (ANCSA)(Dec 1970. Section 17(d)(1) of ANCSA expressly revoked Public Land Order 4582, but, at the same time, established a 90-day temporary withdrawal of "all unreserved public lands in Alaska from all forms of appropriation under the public land laws . . ." 43 U.S.C. § 1616(d)(1). Public Land Orders issued since then have continued the suspension, and the lands underlying the lease offers remain unavailable for oil and gas leasing. The 59 within the planning area are further suspended because they lie within a National Wildlife Refuge. Section 1008 of ANILCA also addressed potential oil and gas leasing within wildlife refuges and requires a determination as to impacts of potential oil and gas leasing. If the U.S. Fish and Wildlife Service were to make a determination that oil and gas leasing were not compatible with the refuge, the 59 lease offers would be closed.

The U.S. Fish and Wildlife Service's Yukon Delta National Wildlife Refuge final comprehensive Plan/EIS/Wilderness Review/Wild River Plan of 1988 must find any oil and gas lease issued compatible with the purposes of the Yukon Delta National Wildlife Refuge:

> A 1982 Memorandum of Understanding between the U.S. Department of the Interior, U.S. Department of Agriculture, and the State of Alaska states that the refuge comprehensive conservation plans will be the vehicle used to determine if oil and gas leasing and development activities may be compatible with the purposes of Alaska refuges.

The plan (1988) describes that if it is determined oil and gas leasing is compatible, leasing may be allowed on areas of the refuge that are under intensive and moderate management and the activities would be subject to site-specific stipulations. It also states that oil and gas leasing may be allowed in areas under minimal management only if it is determined by the Secretary of Interior to be in the national interest, and subject to site-specific stipulations. A compatibility determination was not completed as part of the 1988 plan because "… determinations cannot reasonably be done for activities such as oil and gas leasing . . . without knowing the level of

intensity of the activity, season of use, and specific area to be used." The plan clarifies that the U.S. Fish and Wildlife Service will make compatibility determinations on a case-by-case basis as applications are received and that no formal leasing program will be initiated until the oil and gas potential of the refuge has been assessed by the Bureau of Land Management, a determination is made that leasing would be in the national interest, and would be compatible with refuge purposes. These 59 lease offers will remain pending until final adjudication by BLM.

1. Bethel Basin

Bethel Basin (Figure 7) is a large, lowland area bordered on the south and west by the Bering Sea and to the north by uplifted metamorphic rocks of the Yukon-Koyukuk Basin (Kirchner 1994). Patchy permafrost and numerous small lakes underlie this marshy area. Bethel Basin has experienced low level petroleum industry interest due to industry interpretations that only a thin petroleum-prone Tertiary section (2,000 feet) exists and that there is poor source rock potential in the Cretaceous and older rocks (Kirschner 1994).

No wells have ever produced oil or gas in this region, and no recent geophysical or drilling exploration activity in Bethel Basin has taken place. Napatuk Creek No. 1, the only exploratory well drilled in Bethel Basin, reached a total depth of 14,890 feet in 1961 (Petrotechnical Resources of Alaska, LLC. 1999). The well penetrated a thick section of Cretaceous rocks with poor source rock and reservoir rock potential, overlain by thin uppermost Cretaceous and Tertiary rocks with good source rock and reservoir potential (Kirchner 1994). No visible hydrocarbon shows were visible in the drill logs (Petrotechnical Resources of Alaska, LLC. 1999) and Napatuk Creek No.1 was abandoned as a dry hole. No additional exploratory wells have been drilled in the area and no recent federal oil and gas leasing has taken place.

2. Galena Basin

Galena Basin (Figure 7) is a Cenozoic-aged sedimentary basin located within the Nulato Hills region of the planning area. It occupies an area of approximately 5,000 square miles and is included in the Nulato, Kateel River, and Melozitna quadrangles (Miller et al. 1959). Outcrops within the Galena Basin indicate that the Cretaceous strata could be several thousand feet thick (Stephenson et al. 2002). Tertiary strata have not been described within the basin, and the Cretaceous section is thought to be overlain by Quaternary sediments of the Yukon River (Miller et al. 1959; Stephenson et al. 2002).

Subsurface data is almost completely nonexistent. There is only one well within the basin, which is a water-well only penetrating 360 feet of soft sediments near the city of Galena. There is also one shallow seismic survey that was only sufficient to image the bedrock interface (Stephenson and others 2002). Evidence of regionally extensive low-permeability units within the basin is absent and the quality of porous reservoir units is largely unknown (Craddock et al. 2014). Although gravity data suggests that there are deeper parts of the basin, these are not capable of generating appreciable volumes of petroleum and the rest of Galena Basin is likely too shallow to generate petroleum through thermal alteration of organic material (Swensen et al. 2012).

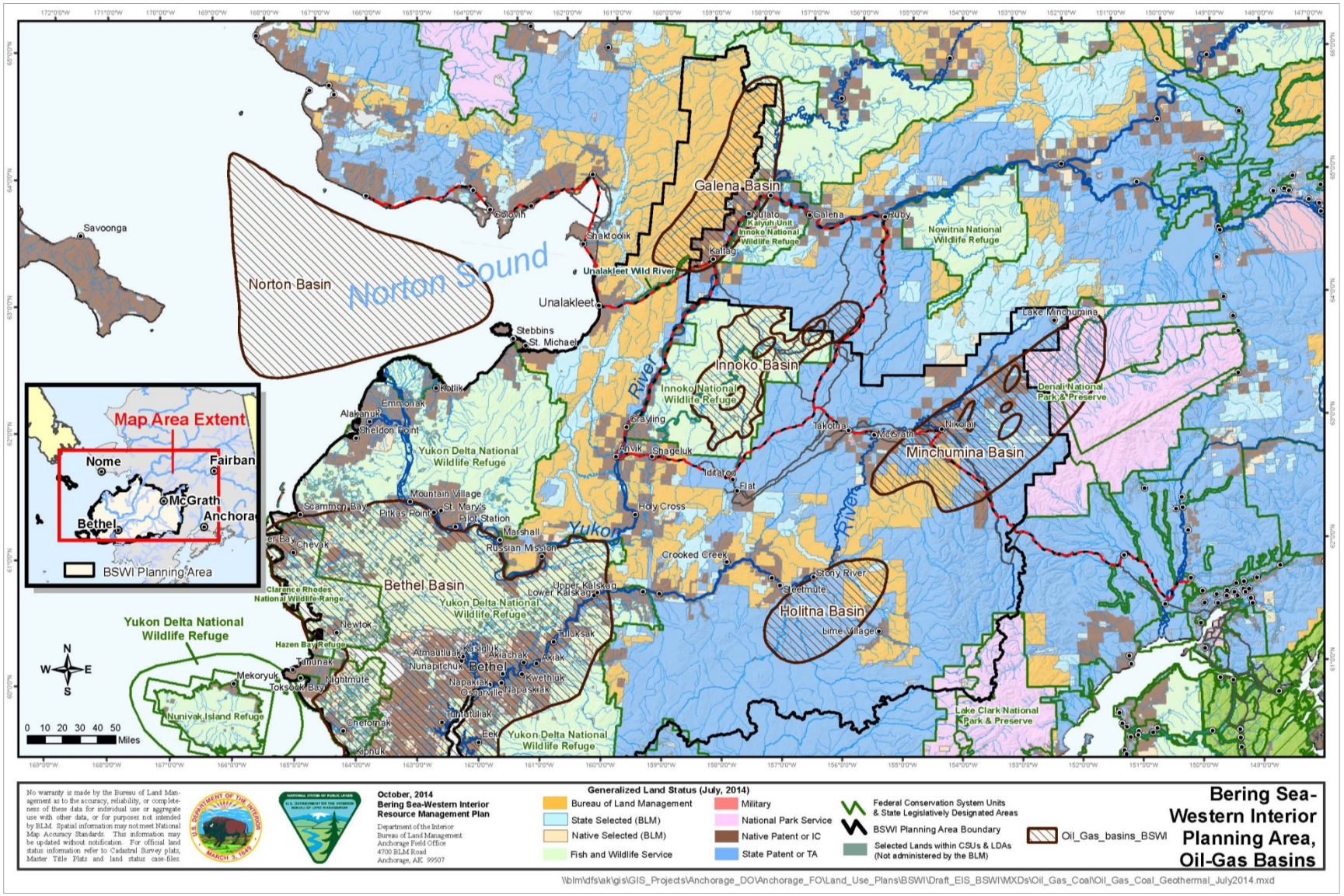

Figure 7. Oil and gas basins in the Bering Sea-Western Interior Planning Area

3. Holitna Basin

Holitna Basin (Figure 7) is a small, Cenozoic basin on the Denali-Farewell fault zone next to the Kuskokwim River and west of the Alaska Range. The area is roughly outlined by a 3,200-square-mile airborne magnetic survey completed in 1998 by the Alaska Division of Geological and Geophysical Surveys (Sial Geosciences Inc. 1998). The basin itself is defined by gravimetric data that indicate it is as deep as 15,000 feet (Kirschner 1994, Smith et al. 1985). In the absence of well and seismic data, the basin stratigraphy is poorly understood and largely extrapolated from surrounding surface outcrops and from other basins of similar age in Central Alaska. Deep marine sedimentary rocks of the Kuskokwim Group, a possible source for hydrocarbons, may underlie parts of the Holitna Basin (Kirschner 1994). However, these rocks have been strongly deformed and extensively intruded (Kirschner 1994). This deformation and intrusion results in poor oil source rocks for the overlying reservoir rocks, which covers less than 1 percent of the total basin area (Kirschner 1994).

Two studies by the Division of Geological and Geophysical Surveys, evaluated petroleum potential in the Holitna Basin. The first study reviewed previous investigations by oil companies in the mid-1980s and a reconnaissance-level study by the Division and the Alaska Department of Oil and Gas in 1998. Results from this study indicated a poor potential for commercial quantities of oil in the Holitna Basin and poor to fair potential for commercial quantities of gas (LePain et al. 2000).

The second study included a stratigraphic analysis of potential reservoir rocks in the southern McGrath Quadrangle that are considered analogous to the Holitna Basin sediments. In the analog, the absence of visible porosity in outcrop samples implies low reservoir potential. However, suitable porosity and permeability may have been preserved in potential reservoir rocks at depth, allowing entrapment of any hydrocarbons generated within the basin. The potential for generation of conventional gas and oil is considered low, as possible source rocks appear to be absent in surface exposures throughout the region. The estimated gas potential in the Holitna Basin is 100 to 200 billion cubic feet (LePain et al. 2003) which, although not commercial, could be used for local consumption.

Holitna Energy Co., LLC, believed the Holitna Basin may contain enough natural gas resources to provide an alternative fuel source for Donlin Creek gold mine, located about 50 miles to the northwest of the basin. The state rejected an exploration license in October 2006 at the confluence of the Holitna River and Basket Creek (10 miles south of Sleetmute) as the Alaska Department of Natural Resources (ADNR) concluded the project was not in the State's best interest. Holitna Energy Co., LLC then proposed to convert two shallow gas applications to an exploration license. Following an administrative appeal in Alaska Superior Court by Holitna Energy, ADNR agreed to reconsider its finding and in 2009 reversed its earlier decision by issuing the license. The Final Finding of the Director on Remand, 2009, found that the Holitna exploration license was not in the State's best interests because the small size of the license area would make it difficult to condition the license in a manner that allowed exploration activities to occur in a way that did not negatively impact other uses in the area, including sensitive fish and wildlife resources. There was also a lack of local support for the project (ADNR 2009).

4. Innoko Basin

Innoko Basin (Figure 7) is a lowland area of about 6,000 square kilometers (Kirchner 1994) in the Kuskokwim Mountains, 150 km west of the Minchumina Basin. It is believed to have formed in the Late Cretaceous to early Tertiary (Bundtzen et al. 1987) and contains about 8000 feet of

Cretaceous strata that were intruded and overlain by Late Cretaceous to early Tertiary plutons and mafic extrusive rocks (Bundtzen and Laird 1980; Bundtzen et al. 1987). This Cretaceous section is thought to consist of a sequence of turbidites, followed by deltaic deposits, and finally near-shore shallow-marine deposits (Bundtzen and Laird 1980). There have been no Tertiary sedimentary units identified within the basin. Like the Galena basin, it is probably too shallow to generate petroleum through thermal alteration of organic material. While gravity data suggest deeper parts of the basin exist, they underlie very small areas and are probably not capable of generating appreciable volumes of petroleum (Swensen et al. 2012).

5. Minchumina Basin

The Minchumina Basin (Figure 7) is a large Cenozoic basin located southwest of Lake Minchumina in the upper portion of the Kuskokwim River drainage area. The basin is bounded on the southeast by the Denali fault system, including the Farewell fault, and on the northwest by the Nixon Fork fault system (Meyer and Krouskop 1986) and covers an area of about 21,000 square kilometers (Kirschner 1994). The same intruded and deformed deep marine sedimentary rocks that could underlie the Holitna Basin also may underlie the Minchumina Basin (Kirschner 1994).

Although this basin has State of Alaska acreage available for licensing under the State's exploration incentive program, no proposals are under review for licensing. Kirschner (1994) concluded that petroleum potential in the Minchumina Basin is limited to small gas prospects. No oil or gas wells have been drilled within the basin to date. Gravity data indicate basement rocks are at depths of a kilometer or less across much of the basin while there are deeper fault-bounded depressions that appear to be present in localized areas (Meyer and Krouskop 1986). These deeper depressions are presumably filled with nonmarine Tertiary strata (Meyer and Krouskop 1986), which could contain mostly gas-prone source rocks (ADNR 2012). Despite its size, the Minchumina Basin probably too shallow to generate conventional petroleum from the organic material that might be present in the basin fill (Kirschner 1994)

6. Yukon Delta

The lower Yukon River area (Figure 7) is a large, modern, deltaic complex adjacent to the Norton Basin. Amoco seismically identified an anticline on the coast of the Lower Yukon Delta in 1981, but no drilling of this structure has occurred (Petrotechnical Resources of Alaska, LLC 1999). A lower Tertiary sedimentary section may have organic rich shale but this is unverified (Petrotechnical Resources of Alaska, LLC 1999). Interest in the area fell after the unfavorable results of the Napatuk Creek No. 1 well in the nearby Bethel Basin (Gibson et al. 1988).

D. Geothermal

There are two confirmed geothermal springs within the planning area; Ophir Hot Springs and Chuilnuk Hot Springs (Figure 8). The water at Ophir Hot Springs is 61 degrees Celsius and flows at a rate of 270 liters per minute, while the Chuilnuk Hot springs water is at 51 degrees Celsius and flows at a rate of 550 liters per minute (Miller et al. 1973). These springs are classified as hot springs since the water emerging from them is above 50 degrees Celsius (U.S. NOAA Geophysical Data Center). The only spring that is currently being used as a source of energy is the hot spring occurrence near Ophir Creek. An occurrence on Tuluksak River was reported by Waring (1917). He observed "green slime" and a distinct sulphurous odor but did not take note of the actual water temperature or flow rate. This occurrence has not yet been confirmed in any literature as an actual geothermal occurrence.

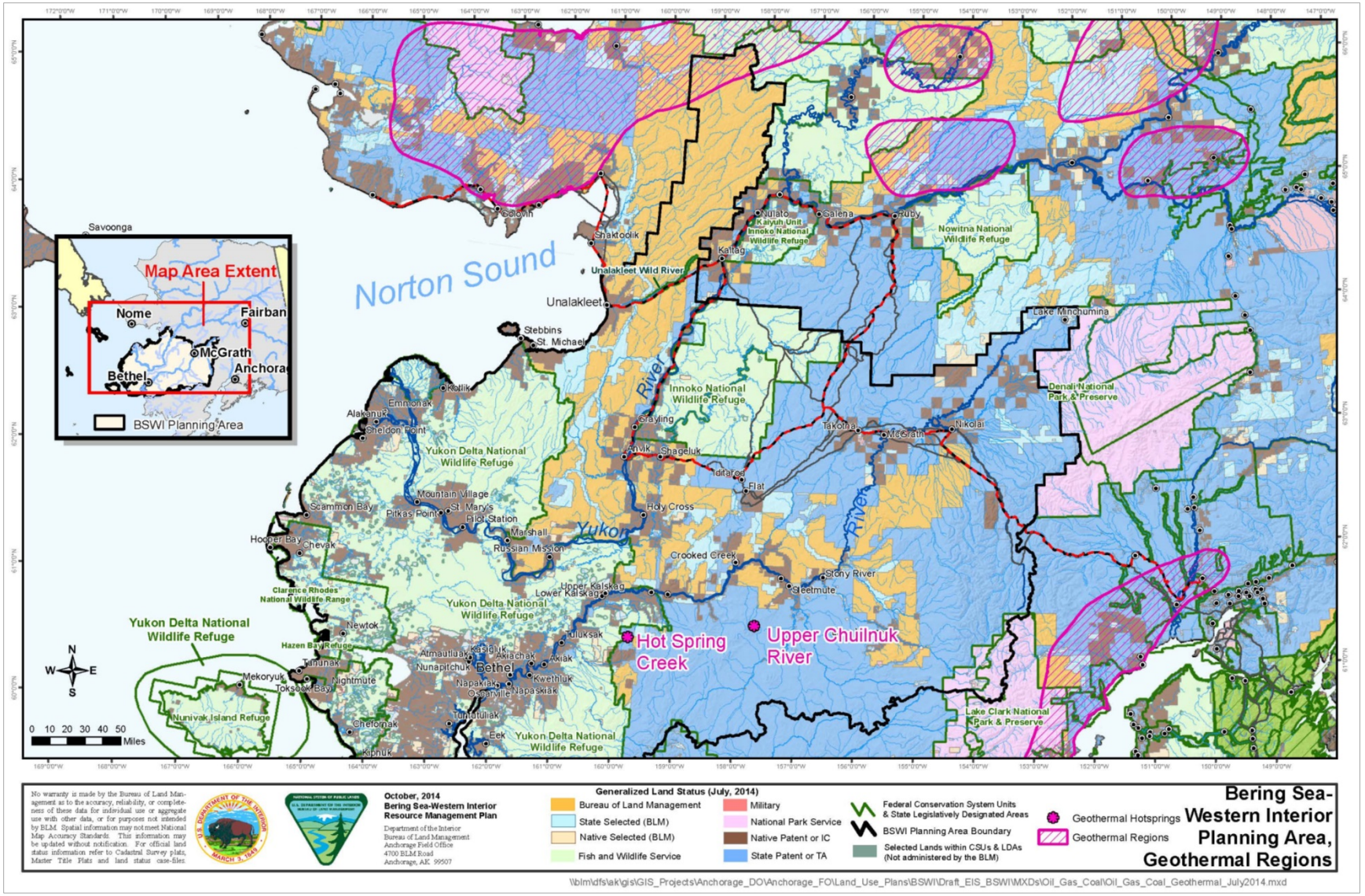

Figure 8. Geothermal occurrences in the Bering Sea-Western Interior Planning Area

A private individual owns two parcels of private patented land in T. 13. R. 59 W., SM, at river mile 15 of Ophir Creek and it tributary Hot Springs Creek (Figure 9). Two parcels of land on Hot Spring Creek in 1966 were surveyed as Lots 1 and 2, U.S. Survey No. 5238 and approved on April 22, 1975. Ophir Creek flows through Lot 1, U.S. Survey No. 5238. It was patented as a 79.98-acre trade and manufacturing site, and encompasses the confluence of Hot Springs Creek and Ophir Creek. The parcel is a homestead, awarded Patent No. 50-81-0096 on April 13, 1981. There is a 30-year lease (AA-12502) for a pipeline that brings water from the geothermal hot spring on Hot Spring Creek to the patented land. This lease expires in 2040.

Figure 9. Photo looking northeast over Hot Spring Creek. Harry Faulkner's residence is at center right and the pipeline to the hot springs is in the foreground.
(Photo taken by BIA in 1988 from file AA-10267)

Table 3. Locations of known geothermal occurrences in the BSWI Planning Area

Location	Latitude	Longitude
Hot spring near Ophir Creek	N 61.19927	W -159.86532
Hot spring on Upper Chuilnuk River	N 61.3623	W -157.73534

E. Peat

Peat is an accumulation of partially decayed organic material. It forms when plant material, typically in wet areas, is prevented from fully decaying due to acidic or anaerobic conditions.

Peat is soft, easily compressed, and once the water has been removed, can be used as a source of fuel. The planning area contains large amounts of peat; however, according to the American Society for Testing and Material Standards for fuel grade peat, it must have a minimum thickness of 5 feet, have an energy value of 8300 Btu per pound, and have an ash content of less than 25 percent (Lukens 1981). Other criteria include presence of permafrost, texture and density, the

water table, and relative moisture content. Location and access is also an important factor since it is doubtful that peat can be economically hauled any notable distance. Therefore, peat is best viewed as a significant resource only if those resources are immediately adjacent to the existing infrastructure in need of energy resources (Bundtzen and Kline 1986) and if it meets the aforementioned criteria.

Barrick Gold United States Inc. conducted the Donlin Creek Peat Resource Evaluation to assess the feasibility of using peat-fired power plants to operate the proposed Donlin Creek Mine. This study included testing and sampling peat deposits on two currently unencumbered BLM federal public lands and State-selected land near the proposed mine (Griffin 2007). Refer to Figure 10 for the locations of the two study areas. It was determined that the use of peat to fuel peat-fired power plants was not feasible because all of the peat drilled and sampled existed in permafrost.

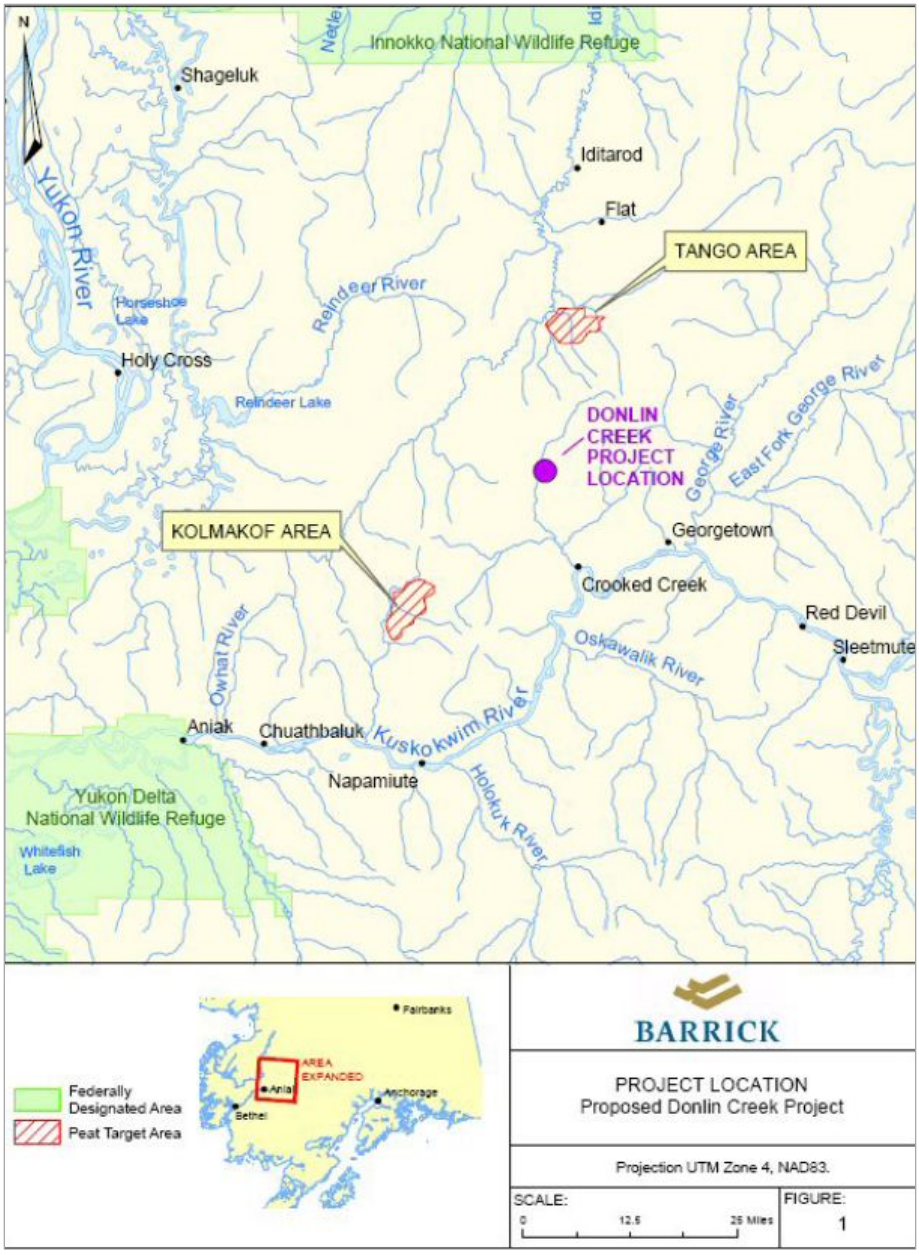

Figure 10. Map showing areas in which Peat was evaluated (Griffin 2007)

F. Phosphate, Sodium, Oil Shale

No literature currently exists for oil shale, phosphate, sulphur, or sodium resources within the planning area. If any studies have been conducted, the data remains proprietary.

G. Nulato Hills and Lower Kobuk-Koyukuk Basin

Nulato Hills and Lower Kubuk-Koyukuk Basin leasable minerals potential is covered in the Mineral Occurrence and Development Potential Report, Leasable Minerals, Kobuk-Seward Peninsula Resource Management Plan (2005).

IV. Recommendations

The purpose of this report is to identify areas of high development potential for leasable minerals that could become an area of interest to industry during the life of the RMP. Rankings given in this report are based solely on documented literature and the BLM's interpretations of their conclusions.

Table 4. Resource development potential

Resource	Potential
Coal	Low
Coal Bed Natural Gas	Low
Oil and Gas	Low
Geothermal	Low
Peat	Low
Oil Shale	Low
Phosphate	Low
Sodium	Low
Coalbed Natural Gas	Low

A Reasonable Foreseeable Development Scenario is not recommended for oil and gas due to low development potential of the frontier basins and lack of infrastructure within the planning area. However, leasing and exploration assumptions will be made within the RMP for the alternatives that recommend lifting the ANCSA 17(d)1 Withdrawals.

V. Specific Mandates and Authorities

A series of statutes establish and define the authority of the Secretary of the Interior to make decisions regarding fluid minerals leasing and development.

A. Laws

1. Mineral Leasing Act of 1920

This Mineral Leasing Act, as amended, is the primary authority under which the federal government leases the majority of federal onshore minerals (currently applies to coal, phosphate, sodium, potassium, oil, oil shale, gilsonite, and gas). It requires all public lands be open to mineral leasing unless a specific land order has been issued to close the area. The Act gives the

BLM responsibility for oil and gas leasing on about 570 million acres of BLM, national forest, and other federal lands, as well as private lands where mineral rights have been retained by the federal government. The BLM works to assure that development of mineral resources is in the best interests of the nation.

2. Mineral Leasing Act for Acquired Lands of 1947

The Mineral Leasing Act (Ch. 513, 61 Stat. 913; 30 USC 351, 352, 354, 359) provides that all deposits of coal, phosphate, oil, oil shale, gas, sodium, potassium, and sulfur that are owned or may be acquired by the United States and that are within the lands acquired by the United States may be leased by the Secretary of the Interior under the same conditions as contained in the leasing provisions of the mineral leasing laws. No mineral deposit covered by this section shall be leased except with the consent of the head of the Executive Department, independent establishment, or instrumentality having jurisdiction over the lands containing such deposit, or holding a mortgage or deed of trust secured by such lands that is unsatisfied of record, and subject to such conditions as that official may prescribe to ensure the adequate use of the lands for the primary purposes for which they have been acquired or are being administered.

3. Geothermal Steam Act of 1970

The Geothermal Steam Act (30 U.S.C. 1001 et seq.), as amended, authorizes the Secretary of the Interior to issue leases for development and utilization of geothermal steam and associated geothermal resources in lands administered by the Secretary, including public, withdrawn and acquired lands; national forests or other lands administered by the U.S. Forest Service, including public, withdrawn and acquired lands; and lands conveyed by the U.S. subject to a reservation to the U.S. of geothermal steam and associated geothermal resources. The Secretary also is prohibited from issuing leases on lands not subject to leasing under § 226-3 of the Mineral Leasing Act of 1920 (wilderness study areas). Title 30 USCS § 1002, 1014, and 1027 address which lands may and may not be subjected to geothermal leasing. This authority has been delegated to the BLM, given the assurance that the land may continue to be used adequately for the purposes for which it was withdrawn or acquired.

4. Alaska Native Claims Settlement Act (ANCSA)

The Secretary may convey to a Native, upon application within 2 years from the date of enactment of this Act, the surface estate not to exceed 160 acres of land occupied by the Native as a place of primary residence on August 31, 1971.

5. Federal Land Policy and Management Act of 1976

The Federal Land Policy and Management Act (FLPMA) of 1976, as amended and supplemented, requires that the BLM prepare land use plans and that BLM-administered lands be managed in a manner that recognizes the nation's need for domestic sources of minerals, food, timber, and fiber from the public lands (FLPMA, Sec. 102 (a) (12)).

6. Federal Coal Leasing Amendments Act of 1976

The Federal Coal Leasing Amendments Act (FCLAA) of 1976, which amended Section 2 of the Mineral Leasing Act of 1920, requires that all public lands available for coal leasing be leased competitively. There are two notable exceptions to this requirement: (1) preference right lease applications where a lease may be issued on a noncompetitive basis to owners of pre-FCLAA prospecting permits; and (2) modifications of existing leases where contiguous lands of less than 160 acres are added non-competitively to an existing lease.

7. Surface Mining Control and Reclamation Act of 1977

The Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.) requires application of unsuitability criteria prior to coal leasing and to proposed mining operations for minerals or mineral materials other than coal.

8. Alaska National Interest Lands Conservation Act (ANILCA), Section 905

Subject to valid existing rights, all Alaska Native allotment applications made pursuant to the Act of May 17, 1906, as amended, which were pending before the Department of the Interior on or before December 18, 1971, were approved. The land described in the allotment application may be valuable for oil and gas, coal, and sand and gravel but must be held in reserve to the U.S. government. Section 1008 establishes an oil and gas leasing program for non-North Slope federal lands. Additionally, ANILCA Section 1110(b) establishes a right of access to inholdings, including subsurface rights, "for economic and other purposes" within or effectively surrounded by conservation system units and other areas designated by ANILCA. ANILCA Section 1323(b) also establishes a right of access to inholdings surrounded by general BLM-managed lands for "reasonable use and enjoyment thereof."

9. Federal Oil and Gas Royalty Management Act of 1982 (30 U.S.C. 1701)

The Federal Oil and Gas Royalty Management Act authorizes the Secretary of the Interior to implement and maintain a royalty management system for oil and gas leases on federal lands, Indian lands, and the Outer Continental Shelf. This includes the development of enforcement practices that ensure the prompt and proper collection and disbursement of oil and gas revenues owed to the U.S. and Indian lessors and those inuring to the benefit of States.

10. Federal Onshore Oil and Gas Leasing Reform Act of 1987

The 1987 Leasing Reform Act (30 USC 181, et seq.; PL 100-203) requires the BLM to offer all lands available for leasing competitively prior to leasing noncompetitively and adds environmental provisions to the leasing process. The Act was a response to concerns that leasing often was occurring at below market rates and to concerns about environmental protection. The Act also provides for inspections and enforcement of operations once commenced. In addition, the BLM is required to have the consent of the Forest Service before leasing oil and gas on National Forest System lands. The maximum competitive lease size is 5,760 acres in Alaska. The maximum noncompetitive lease size is 10,240 acres.

11. Energy Policy Act of 1992

Since passage of the Energy Policy Act of 1992 (Section 2509), both competitive and noncompetitive leases are issued for a 10-year period. Both types of leases continue for as long thereafter as oil or gas is produced in paying quantities.

12. Alaska Land Status Technical Corrections Act of 1992

This act amends Section 905 of ANILCA: it reserves to the U.S. all interests in oil, gas, and coal in the conveyed lands, and the right of the U.S., of lessee or assignee of the U.S., to enter on lands conveyed to the applicant or to the heirs of the applicant, to drill, explore, mine, produce, and remove the oil, gas, or coal.

13. Energy Policy Act of 2005

The passage of the Energy Policy Act is projected to expand domestic oil and gas production by making reforms to the permitting process to encourage new exploration in environmentally

friendly ways. The Denali Commission was tasked to implement an energy program that addresses energy development, energy transmission, replacement and clean-up of fuel tanks, construction of fuel transportation networks, and power cost equalization programs and projects using coal as a fuel. Specific commodities are also addressed in the act. Export and import of natural gas would be handled by the Federal Energy Regulatory Commission. Gas hydrates production is encouraged by providing royal incentives or by allowing the Secretary to grant royalty relief for natural gas from gas hydrate resources. The act encourages the recapturing of produced or natural carbon dioxide for sequestration in oil and gas fields (to enhance production) and provides royalty incentives for enhanced recovery techniques. It also provides a demonstration grant program to encourage the injection of carbon dioxide.

14. Alaska Statute 38.05.555(f)

This statute states:

> Notwithstanding (a) - (e) of this section, for the purpose of creating incentives for the development of peat as a source of heat or power, the director may negotiate the sale of peat to individuals, organized or unorganized communities, tribal governments, or private profit or nonprofit organizations. Under this subsection, the director may provide (1) for personal use by an individual, not more than 200 cubic yards of peat a year at no cost; (2) for commercial use, not more than 30,000 cubic yards of peat during a single 10-year period at no cost; or (3) for commercial use requiring more than 30,000 cubic yards of peat, the amount required by the user during a 10-year period beginning when the user uses more than 30,000 yards of peat at the price of (A) 20 percent of the representative regional sales price determined by the director under AS 38.05.550 (d)(1); or (B) 20 percent of the fair market value determined by an appraisal completed under AS 38.05.550 (d)(2), if the applicant provides the appraisal at the applicant's expense and the appraisal is approved by the commissioner.

Disclaimer: This code may not be the most recent version. Alaska may have more current or accurate information.

B. Executive Orders

There are no executive orders specific to leasable minerals.

C. Regulations

The BLM is committed to ensuring that oil and gas operations on federal lands are conducted in accordance with all applicable regulations, Onshore Orders, Notices to Lessees and permit conditions of approval. The Nationwide Oil and Gas Inspection and Enforcement Strategy provides consistent methods and procedures for conducting and documenting inspections, prioritizing inspections, determining workload and staffing needs, and projecting inspection accomplishments.

Regulations that govern the BLM's oil and gas leasing program may be found in Title 43, Groups 3000 and 3100, of the Code of Federal Regulations (CFR):

- Subpart 3000 - Minerals Management
- Subpart 3100 - Oil and Gas Leasing
- Subpart 3150 - Onshore Oil and Gas Geophysical Exploration

- Subpart 3160 - Onshore Oil and Gas Operations
  The regulations in this part govern operations associated with the exploration, development and production of oil and gas deposits from leases issued or approved by the U.S., restricted Indian land leases and those under the jurisdiction of the Secretary of the Interior by law or administrative arrangement, including the National Petroleum Reserve in Alaska.
- Subpart 3180 - Onshore Oil and Gas Unit Agreements: Unproven Areas
  The regulations in this part prescribe the procedures to be followed and the requirements to be met by the owners of any right, title, or interest in Federal oil and gas leases and their representatives who wish to unite with each other, or jointly or separately with others, in collectively adopting and operating under a unit plan for the development of any oil or gas pool, filed, or like area.

Regulations that govern the BLM's coal program may be found in Title 43, Groups 3000 and 3400, of the CFR.

Public lands are available for coal leasing only after they have been evaluated through the BLM's multiple-use planning process. In areas where development of coal resources may conflict with the protection and management of other resources or public land uses, the BLM may identify mitigating measures to leases such as either stipulations to uses or restrictions on operations.

1. Onshore Oil and Gas Orders No. 1 and No. 2

Onshore Oil and Gas Orders No. 1 and No. 2 are authorized under 43 CFR Parts 3160 and 3180, and provide uniform national standards for performance and operations when conducting oil and gas exploration and development on public land. Onshore Order No. 1 requires conformance with federal and State laws and regulations and ensures environmental safeguards, public health and safety, and proper reclamation of disturbed lands. This order was revised March 2007 to use performance-based standards in certain instances in lieu of the current prescriptive requirements. The change also takes into account other regulations to eliminate overlap and redundancies, clarify procedures, regulatory requirements, and streamline processes. Order No. 2 establishes specific requirements and standards for operation and equipment. (Refer to Proposed Rule 43 CFR Part 3100 and others above.)

2. Onshore Oil and Gas Leasing and Operations: Proposed Rule (43 CFR Part 3100)

Subpart 3104 of the proposed rule states that the BLM can include stipulations restricting surface use on leased land, or restrict the use of the lease after issuance through conditions of approval in order to protect environmental quality and resources, threatened or endangered species, cultural or historic resources, or private or other rights when the surface area is not managed by the BLM. Conditions of approval may include measures to modify the location or design of proposed operations, restrict timing of surface disturbance, or interim and final mitigation.

Subpart 3120 discusses public land available to leasing. Recreation and Public Purpose land is subject to oil and gas leasing under stipulations, if appropriate. It should be noted that the proposed rule was published in the Federal Register for review and comment by the public, and is subject to revision prior to becoming final.

3. Geothermal Resources Leasing and Operations: Final Rule (43 CFR Part 3200)

A final rule issued in September 1998 amends the regulations that implement the Geothermal Steam Act of 1970 (Federal Register, September 30, 1998). The final rule revises 43 CFR parts 3200, 3210, 3220, 3240, 3250, and 3260, which implement the classification, leasing,

exploration, drilling, and utilization requirements of the act. These regulations affirmed that the BLM may issue geothermal leases on land administered by the Department of the Interior including public, withdrawn, and acquired lands; lands administered by the Department of Agriculture with their concurrence; lands conveyed by the U.S. government wherein geothermal resources were reserved to the U.S.; and lands subject to Section 24 of the Federal Power Act as amended (16 USC 818) with concurrence from the Secretary of Energy. The BLM cannot issue leases for land on which the Secretary of the Interior has determined the issuance of the lease could cause unnecessary and undue degradation of public land and resources; lands administered by the National Park Service or a National Recreation Area; lands where it is determined that a lease is likely to result in a significant adverse effect on a significant thermal feature within the National Park System (if activities resulting from a lease might result in such an effect, the BLM will include stipulations to protect the feature in the lease or permit); wildlife management areas or hatcheries administered by the Department of the Interior; or Indian trust or restricted lands.

Geothermal leases are issued through competitive bidding for federal lands within a known geothermal resource area, or noncompetitively for federal lands outside of a known geothermal resource area. BLM issues both types of leases from the Alaska State Office.

D. Policy

- Maintain opportunities for mineral exploration and development while maintaining other resource values.
- Withhold oil and gas leasing in the planning area until a resource management plan is in place.
- Instruction Memorandum No. 97-145
- Fiscal Year (FY) 1998 Oil and Gas Inspection and Enforcement (I&E) Strategy

The BLM is committed to ensuring that oil and gas operations on federal and Indian lands are conducted in accordance with all applicable regulations, Onshore Orders, Notices to Lessees and permit conditions of approval. The nationwide Oil and Gas I&E Strategy provides consistent methods and procedures for conducting and documenting inspections, prioritizing inspections, determining workload and staffing needs, and projecting inspection accomplishments.

Instruction Memorandum No. 2000-191

1. Conduct drilling inspections on all high priority drilling wells. The priority will be determined at the time of Application for Permit to Drill approval and inspections conducted in accordance with that priority.

2. Conduct plugging and abandonment inspection on all wells determined to be high priority at the time of approval of the Notice of Intent to Abandon.

   Note: High priority drilling and abandonment inspections shall take precedence over production inspections if scheduling conflicts arise. Drilling and plugging inspections are externally driven, while production inspections are controlled internally and can be more easily rescheduled. Ensuring that drilling and plugging operations are in compliance from the outset will minimize potential problems in the long term, particularly with regard to contamination of subsurface water resources, and reduce future liability problems and workloads. These operations often occur outside normal work hours. Field offices must ensure that resources are available to conduct these inspections.

3. Inspect all federal and Indian leases rated high to the Federal Oil and Gas Royalty Management Act criteria annually.

4. Inspect all tribal and allotted Indian low priority producing leases in accordance with any negotiated frequency agreed to with tribal governments and individual Indian allottees.

5. Conduct all work over operations rated high. Review and identify any critical operations to be conducted upon approval of the work plan. Inspect those operations deemed to be high priority at the time of approval.

6. Inspect all low priority federal and Indian producing leases every 3 years.

E. Current Management with Existing Land Use Plans

There are currently no public land orders that are open to either fluid or solid leasable minerals. All BLM land within the planning area in the vicinity of any leasable resource is subject to a public land order segregating it from entry for both fluid and solid leasable minerals (Figure 11). Minerals decisions from the existing land use plans are summarized below.

1981 Southwest Management Framework Plan Summary for Oil and Gas, Coal, and Geothermal

The Southwest MFP made an effort to encourage opportunities for the development of leasable minerals on public lands administered by the BLM.

Section 1008 of ANILCA calls for upland oil and gas leasing on public lands. The State of Alaska has lease sales scheduled for several petroleum basins in the Southwest Planning Area.

Coal resources are available in the planning area and may be developed to meet international, national, or local demands.

Geothermal resources are available and may be developed for local use as an alternative energy source.

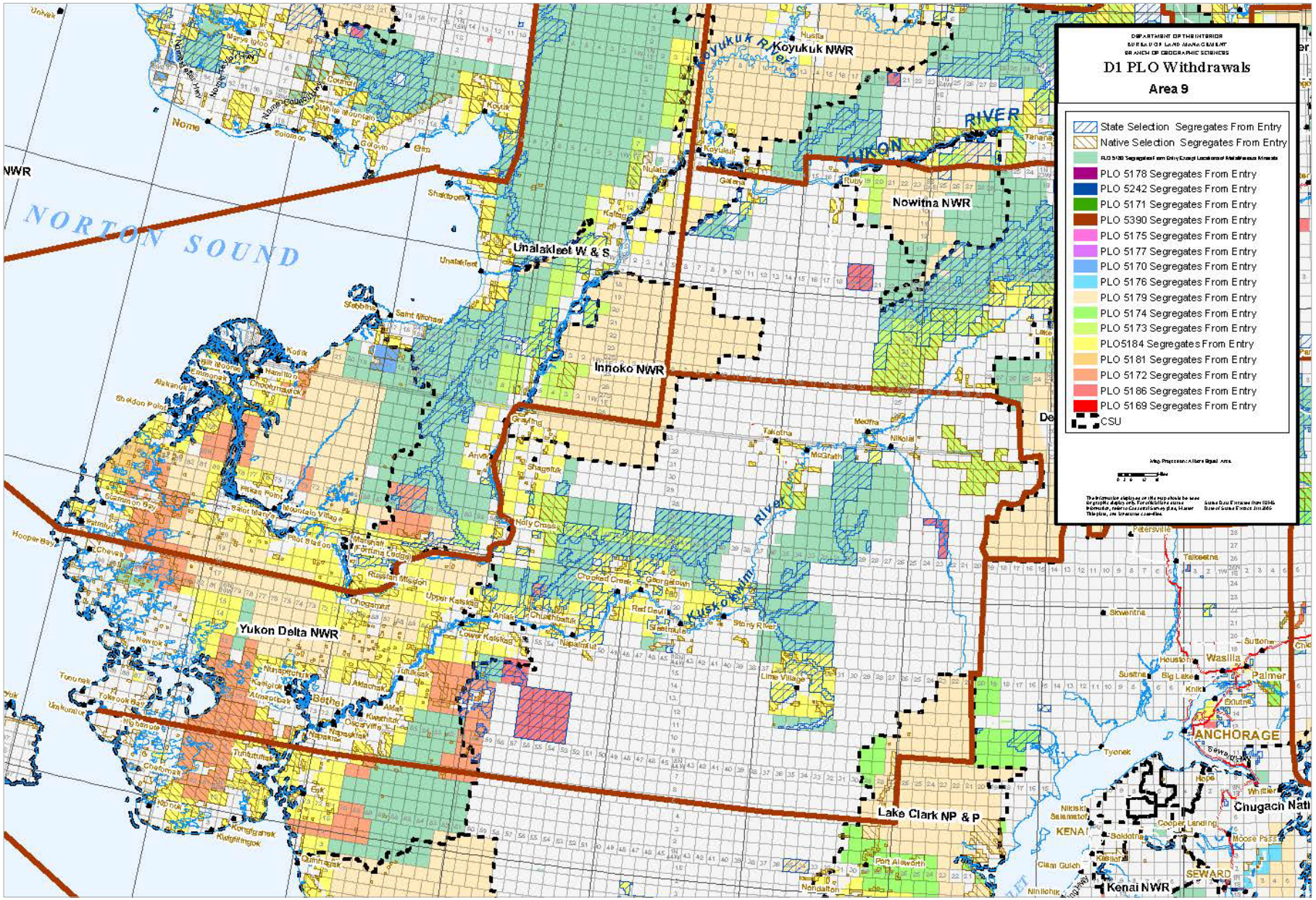

Figure 11. Public land order (PLO) withdrawals in the Bering Sea-Western Interior Planning Area

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