Offshore Information for Area Contingency Planning

Arctic and Western Alaska

Oil and Gas Infrastructure Report

Technical Document #1

September 2023

Record of Changes

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1 Introduction

In 2019, the Bureau of Safety and Environmental Enforcement (BSEE) sponsored a project in cooperation with the United States Coast Guard (USCG) to improve the content of the coastal zone area contingency plans (ACPs) with respect to the information necessary to effectively plan for and respond to large oil spills from offshore oil and gas facilities. This collaboration between BSEE, the Bureau of Ocean Energy Management (BOEM), USCG Sector Anchorage, Alaska Department of Environmental Conservation (ADEC), resource trustees, state agencies, oil spill removal organizations (OSROs), and the Arctic and Western Alaska Area Committee resulted in a series of technical documents that provide offshore information on:

- **Oil and Gas Infrastructure (Arctic and Western Alaska Technical Document #1)**
- Worst Case Discharge Scenarios (Arctic and Western Alaska Technical Document #2 and Appendices 2A-C)
- Offshore Response Concept of Operations (Arctic and Western Alaska Technical Document #3)
- Offshore Response Strategies and BMPs (Arctic and Western Alaska Technical Document #4)
- Sensitive Species Profiles (Arctic and Western Alaska Technical Document #5)
- Offshore Environmental Sensitivity Index (ESI) Atlas (Arctic and Western Alaska Technical Document #6)

These documents were developed specifically for incorporation by reference into the ACP and are hosted on the BSEE Oil Spill Preparedness Division's (OSPD) website. In addition to the above technical documents, an inventory of offshore spill response equipment and a set of offshore Environmental Sensitivity Indices (ESI) maps were created and embedded in NOAA's Environmental Response Management Application (ERMA). Collectively, these materials provide a foundation of risk assessment, resources at risk, and conceptual response information to inform coastal zone ACP planning and responses to a significant offshore facility oil spill incident.

1.1 Content

This document provides information on:

- The geology of the offshore areas in the Arctic and Western Alaska;
- The oil and gas infrastructure, including leases, platforms, wells, and offshore pipelines, present; and
- The oil products stored and handled at the offshore oil and gas facilities and transported through pipelines that may potentially spill.

Information in this document is presented based on the three main regions of the Arctic and Western Alaska Area Contingency Plan (ACP) Planning Area. These areas, shown in Figure 1, are:

- Cook Inlet
- Chukchi Sea
- Beaufort Sea

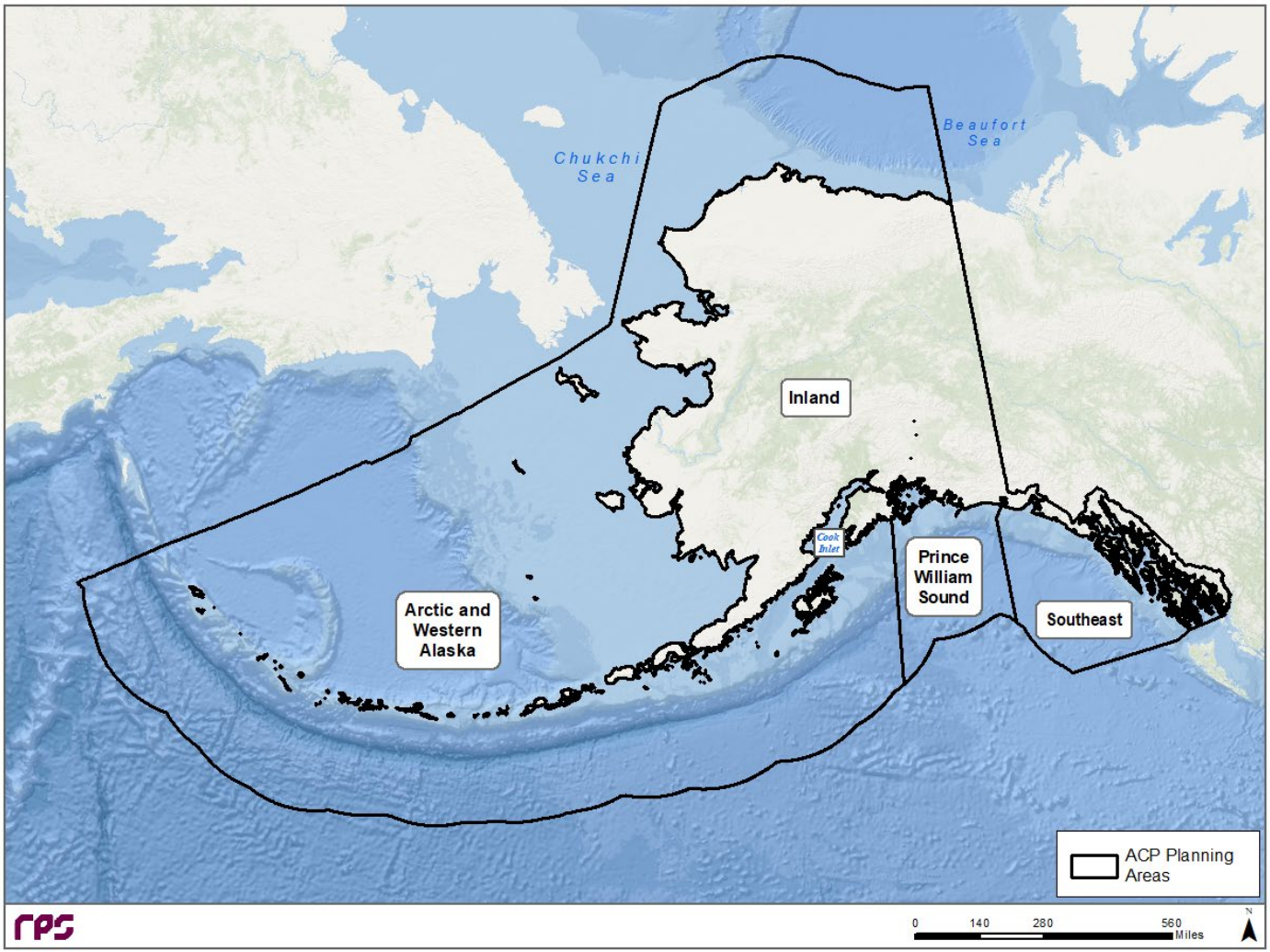

Figure 1. ACP Planning Areas in Alaska and Regions of the Arctic and Western Alaska ACP Planning Area.

2 Key Definitions

- **Artificial lift:** the application of pumps or gas injection to assist the lifting of heavier reservoir liquids.
- **Bathymetry**: originally referred to the ocean's depth relative to sea level or the depths and shapes of underwater terrain. In the same way that topographic maps represent the three-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in sea-floor relief may be depicted by color and contour lines called depth contours or isobaths.
- **bbl**: standard unit for measuring volume of crude oil, equal to 42 US gallons.
- **Drilling rig:** A drilling rig is an apparatus used to drill oil and gas wells. It may also be used for other downhole operations, such as well interventions. It may be mobile or attached to a fixed or floating platform.
- **Lease:** A grant by the Bureau of Ocean Energy Management (BOEM) to one or more parties of exclusive rights to a specific area located on the Outer Continental Shelf (see below) for the purpose of exploring for, developing, and producing oil and gas.
- **mcf:** standard unit for measuring volume of natural gas, equal to one thousand cubic feet. (1 billion mcf = 1 trillion cubic feet of gas)
- **Offshore supply vessel:** An offshore supply or service vessel brings supplies and personnel to offshore platforms.
- **Outer Continental Shelf (OCS):** The Outer Continental Shelf Lands Act (OCSLA), created on August 7, 1953, defines the OCS as all submerged lands lying seaward of state coastal waters which are under U.S. jurisdiction (i.e., those within 200 miles of the coastline).
- **Pipeline:** A pipeline is a steel pipe with pumps, valves, and control devices used to transport oil, gas, water, etc. A pipeline that is used to connect a single wellhead to a manifold or platform within a field is often called a flowline.
- **Platform:** A platform is an offshore structure used to support oil and gas drilling, development, and production activities. A fixed platform is a permanent structure that consists of a jacket (a tall vertical section made of tubular steel members supported by piles driven into the seabed) with a deck placed on top, providing working space that may include such things as crew quarters, one or more drilling rigs, and production and processing facilities. A floating platform is a structure that is not fixed to the ocean floor but floats and is usually attached to the ocean floor with anchors and chains. It could also be held in place through dynamic positioning with thrusters that automatically adjust to counter the effects of ocean currents. Figure 5 shows examples of different types of platforms.
- **Right-of-Way (ROW):** Right-of-Way (ROW) means an authorization issued by BSEE under the authority of section 5(e) of the OCSLA (43 U.S.C. 1334(e)) for the use of submerged lands of the Outer Continental Shelf for pipeline purposes. Pipelines contained within one or more leases with the same owner/operator are known as lease-term pipelines. Pipelines laid outside those boundaries (on other leased or unleased areas) require a Right-of-Way.

- **Shelf:** The continental shelf is the shallower area adjacent to the coastline. The water depth is generally 500 feet or less.
- **Sidetracks:** An additional well drilled from an existing borehole to a new geologic target, or a new location within the original target, by cutting through the side of the existing casing and drilling a new borehole. A bypass is a well drilled using the same method as a sidetrack to get around a mechanical problem in the original borehole to reach the original target.
- **Well:** A well is a hole drilled into the Earth for the purpose of extracting oil and/or gas from a petroleum reservoir. It may also be called a borehole. A well drilled to determine if a petroleum reservoir can be economically produced is known as an exploration well. A well that has been fully cased with steel pipe and is used to extract oil and/or gas is a production well. Most production wells are located beneath or immediately adjacent to a platform. A production well not located beneath or adjacent to a platform is known as a subsea well.

3 Description of Alaska

3.1 Description of the Alaskan Offshore Waters

The BSEE Alaska Region oversees more than one billion acres on the Outer Continental Shelf (OCS) and more than 6,000 miles of coastline – more coastline than in the rest of the United States combined. The region encompasses the Arctic Ocean, the Bering Sea and the northern Pacific Ocean. Since 1980, there have been 109 wells drilled in the federal waters offshore Alaska, including as recently as 2015. The primary interests for drilling activities are currently in the Arctic Ocean's Beaufort Sea and Cook Inlet, off Southcentral Alaska. Figure 2 captures the OCS planning area boundaries.[1]

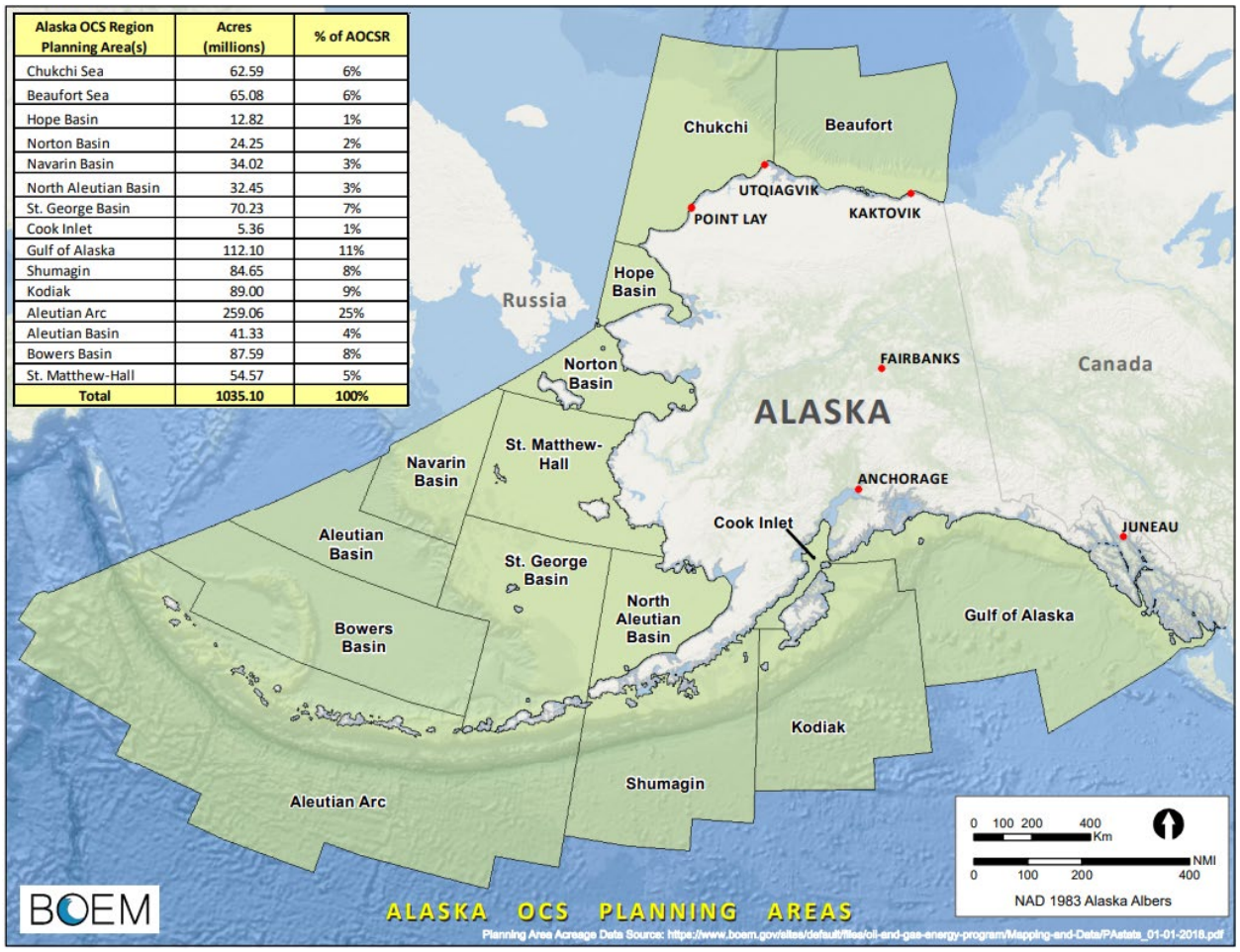

Figure 2. Offshore Waters of Alaska (Source: BSEE).

[1] https://www.bsee.gov/sites/bsee.gov/files/fact-sheet//alaska-ocs-region-fact-sheet.pdf

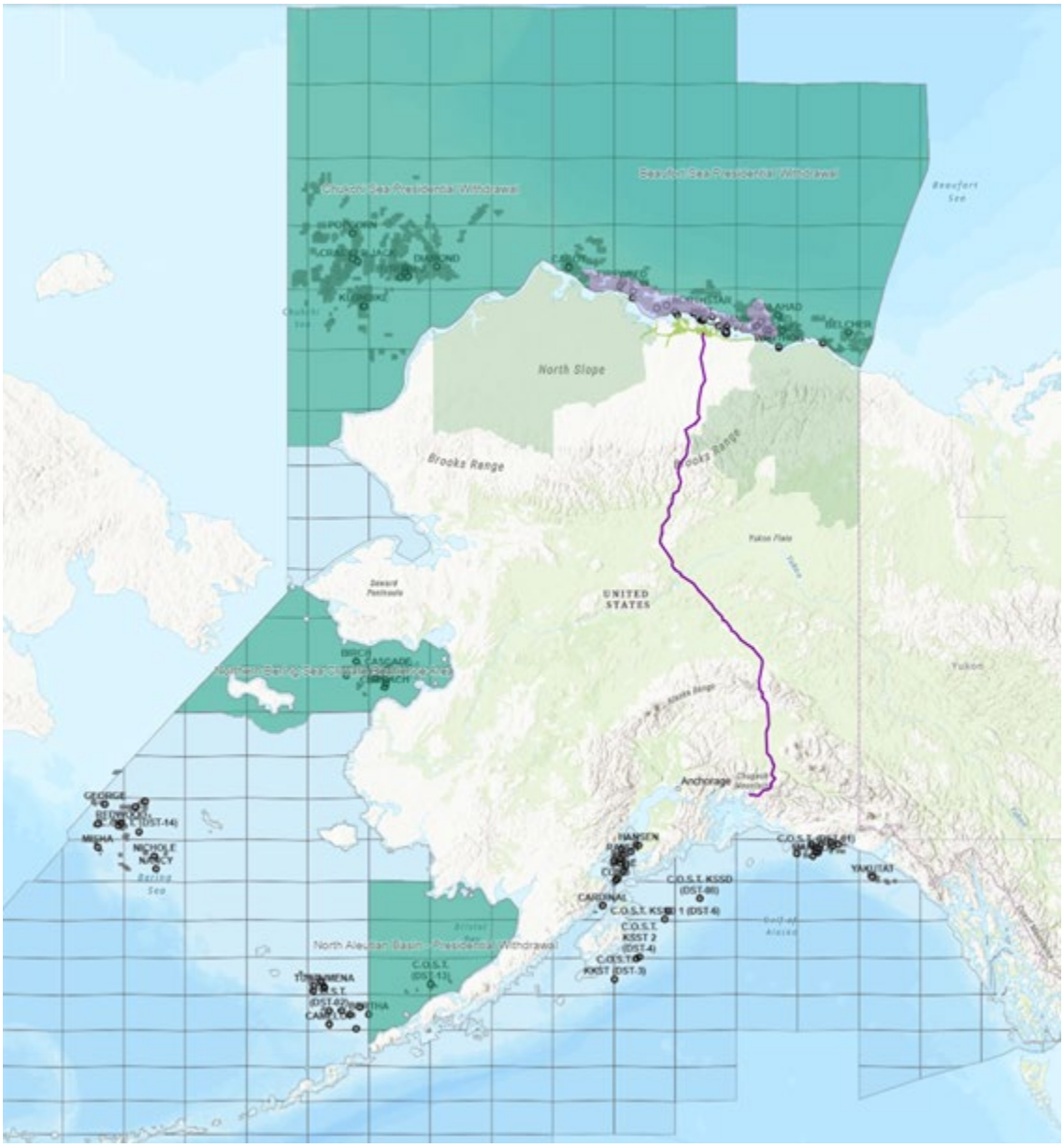

Figure 3. Offshore waters withdrawn in December 2016 by President Obama, under Section 12(a) of the Outer Continental Shelf Lands Act, 43 USC 1341(a).[2]

[2] https://obamawhitehouse.archives.gov/the-press-office/2016/12/20/presidential-memorandum-withdrawal-certain-portions-united-states-arctic

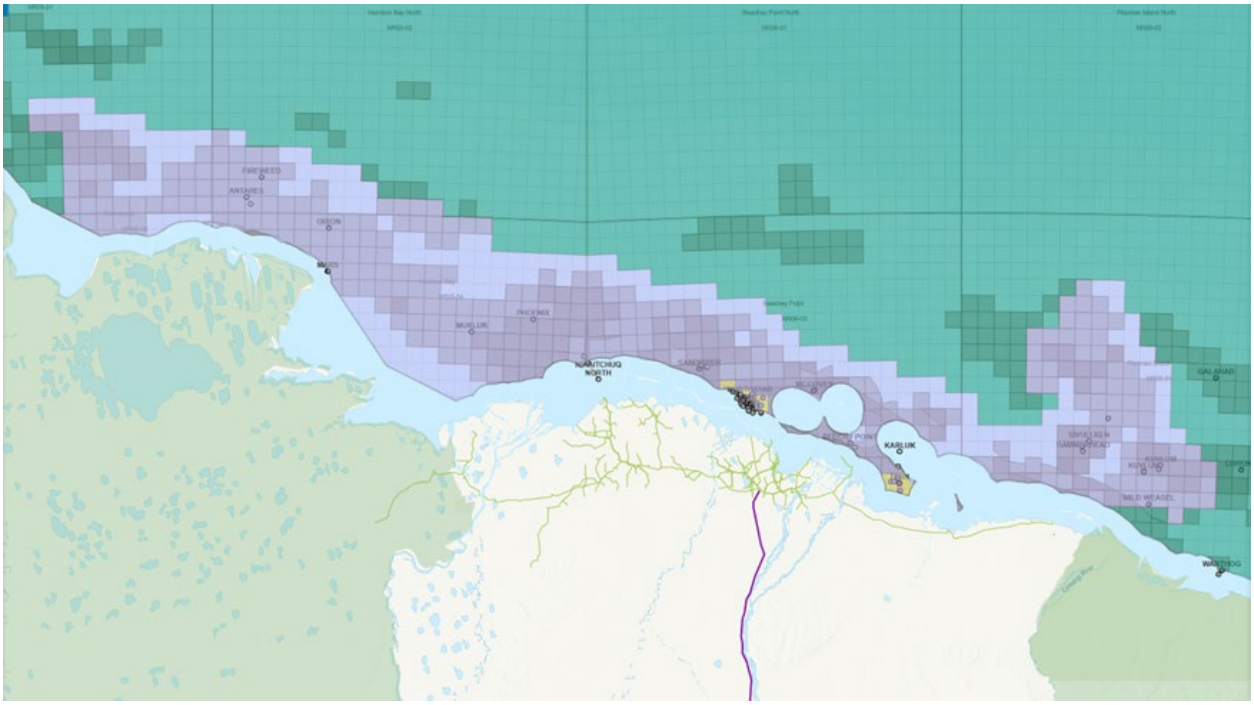

Figure 4. Offshore waters withdrawn from leasing in April 2023.

Figure 3 shows the offshore waters withdrawn from leasing by President Obama in December 2016 under Section 12(a) of the Outer Continental Shelf Lands Act, 43 USC 1341(a). In April 2023, under this same authority, President Biden withdrew "from disposition by oil or gas leasing for a time period without specific expiration the areas designated by the Bureau of Ocean Energy Management as the Beaufort Planning Area of the Outer Continental Shelf that have not previously been withdrawn."[3] The boundaries of the withdrawn areas are shown in Figure 4. This withdrawal prevents consideration of withdrawn areas for any future oil or gas leasing for purposed of exploration, development, or production.

3.2 Geologic Features of Alaska

Although commercial oil and gas production has taken place in Alaska since the 1960s, the sedimentary basins of the Beaufort Sea and Cook Inlet serve as potential available petroleum resources. Recent U.S. Geological Service surveys estimate mean volumes of over 24 billion barrels of oil and over 85 trillion cubic feet of natural gas on the North Slope and mean volumes of over 1.6 billion barrels of oil and over 20 trillion cubic feet of natural gas in Cook Inlet.[4]

[3] https://www.whitehouse.gov/briefing-room/presidential-actions/2023/03/13/memorandum-on-withdrawal-of-certain-areas-off-the-united-states-arctic-coast-of-the-outer-continental-shelf-from-oil-or-gas-leasing

[4] Popular Geology - Oil & Gas | Alaska Division of Geological & Geophysical Surveys

The North Slope is an ancient seabed with a source of oil. Within the North Slope, there is a geological feature called the Barrow Arch, a belt of rock that traps oil. This Arch runs from the city of Utqiaġvik to just west of the Arctic National Wildlife Refuge. The source rock for the Prudhoe Bay Oil Field and neighboring reserves possibly contains "up to 2 billion barrels of technically recoverable oil and up to 80 trillion cubic feet of natural gas, according to a 2012 U.S. Geological Survey report." Figure 3 shows these geologic features of the North Slope.

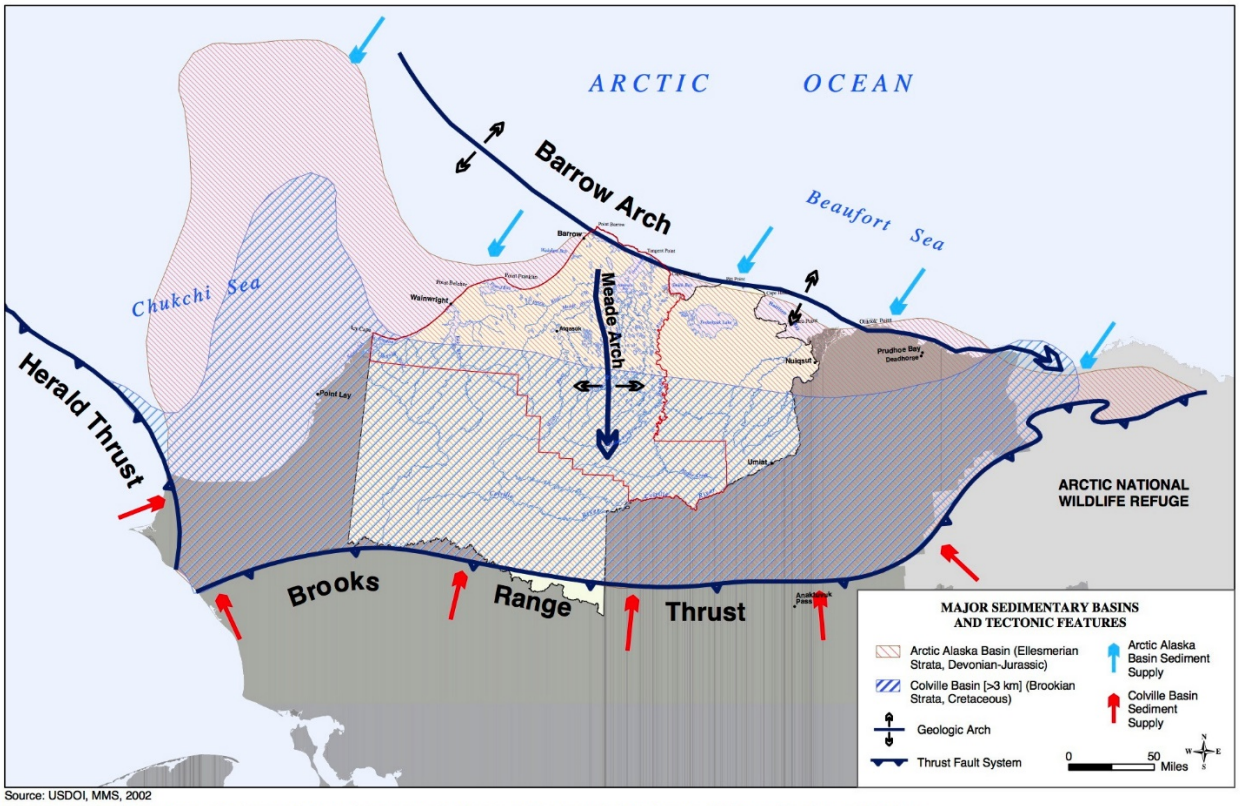

Figure 3. Geologic features of the Beaufort and Chukchi Seas.[5]

[5] https://www.blm.gov/pgdata/etc/medialib/blm/ak/aktest/planning/nw_npra/northwest_npr-a_final0.Par.32958.File.dat/027-major-sedimentary-basins.pdf

"Lower Cook Inlet is a tidal embayment of the North Pacific Ocean that projects north-northeast for over 150 mi (240 km) into the Southcentral Alaska coast. Lower Cook Inlet and Shelikof Strait are structural troughs formed by plate subduction tectonics. These structural lows and the mountains surrounding them have been sculpted into their present morphology primarily by the direct or indirect action of glaciers. Lower Cook Inlet generally is configured as a two-tier plateau, with the shallower (-10 to -90 m) northern part separated from the deeper (-90 to -200 m) southern part by an arcuate, open-to-the-south "ramp" feature."[6]

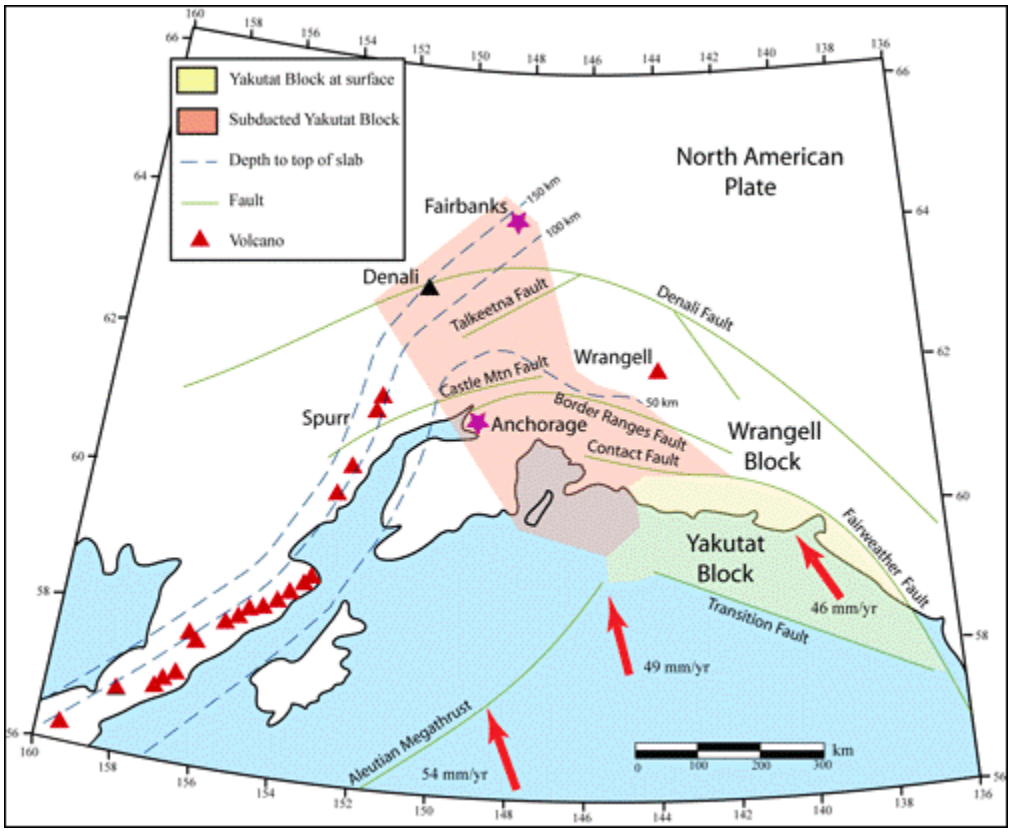

Figure 4. Geologic Features of Cook Inlet[7]

3.3 Bathymetry of Alaska

The western and northern coast of Alaska and Cook Inlet areas include shallower shelf areas. The Gulf of Alaska and Aleutian Island contain much deeper waters, not far from shore. The bathymetry of Alaska is shown in Figure 5.

[6] 94icam194-202.pdf (boem.gov)

[7] Eberhart-Phillips et al., 2006 - http://www.geology.um.maine.edu/geodynamics/AnalogWebsite/602-2008/Hooks%20GSM%20web%20page/Geology.htm

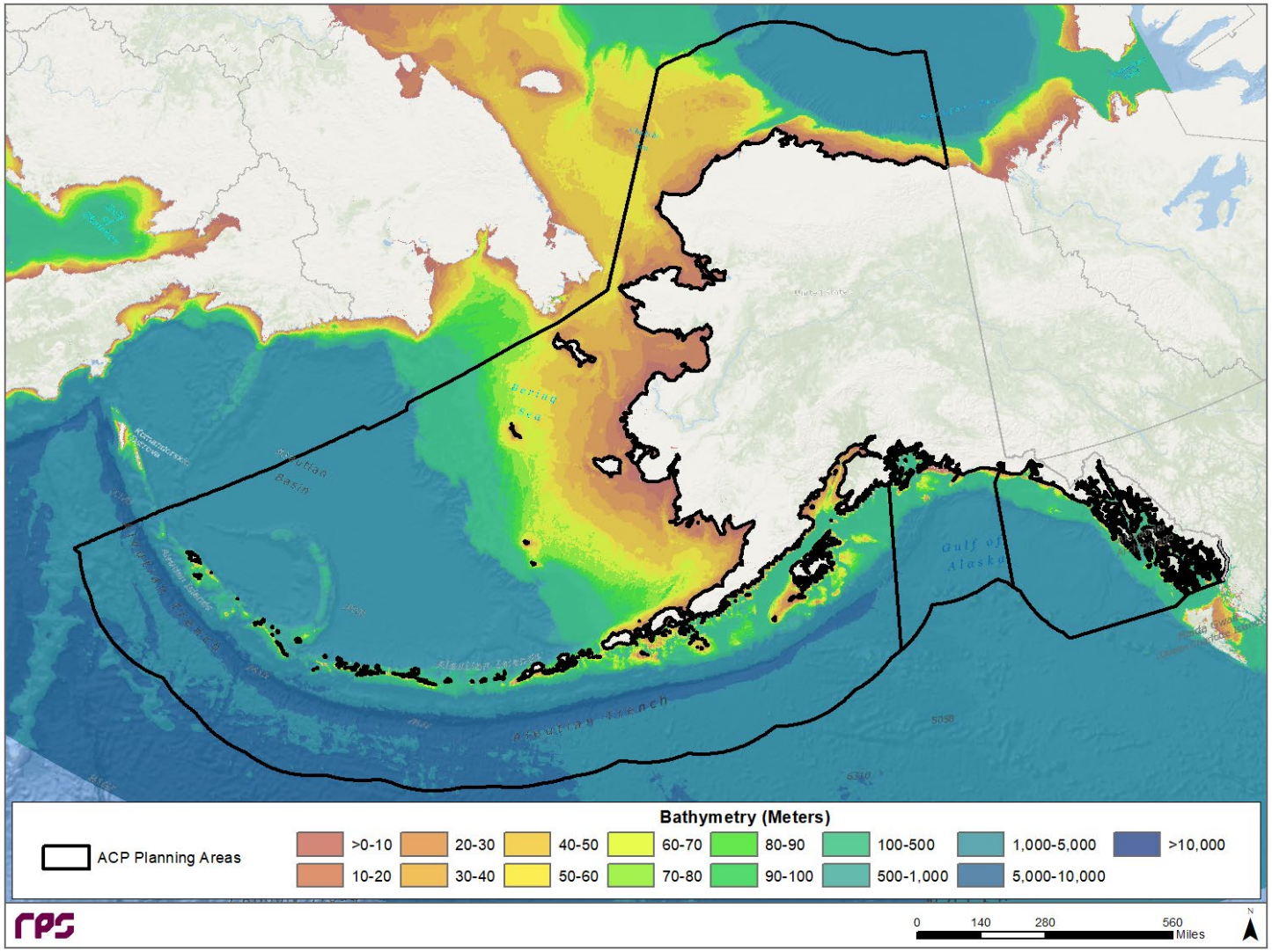

Figure 5. Bathymetry of Alaska.

4 Alaska Oil and Gas Infrastructure

4.1 Active OCS Lease Areas

Oil and gas exploration and production activities in OCS waters are conducted by leasing through the Bureau of Ocean Energy Management (BOEM) leasing policy and program. The active OCS oil and gas leases and BOEM protraction areas from the Official Protraction Diagram (OPD) in Alaska are shown in Figure 6 and Figure 7.

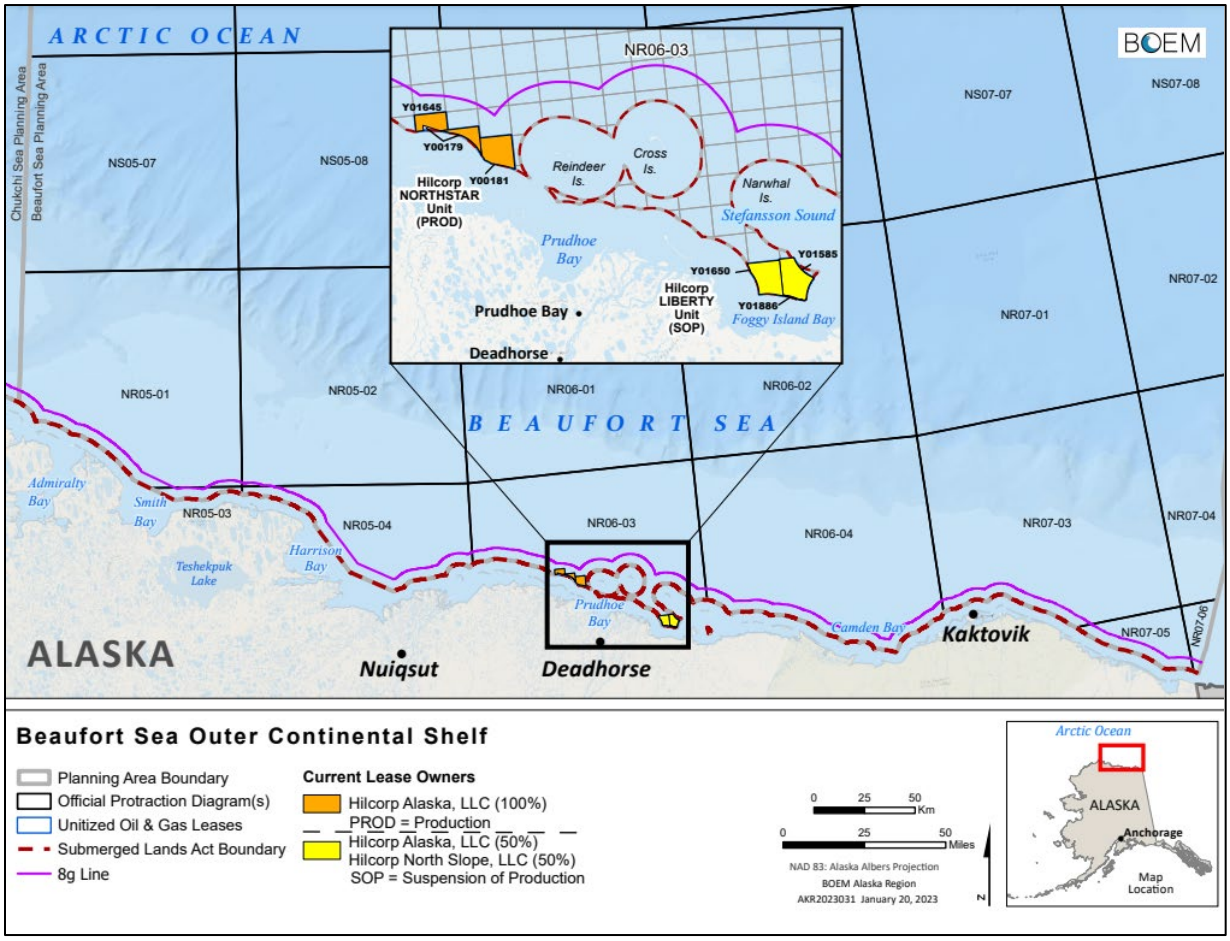

Figure 6. Active OCS Lease Areas in the Beaufort Sea.

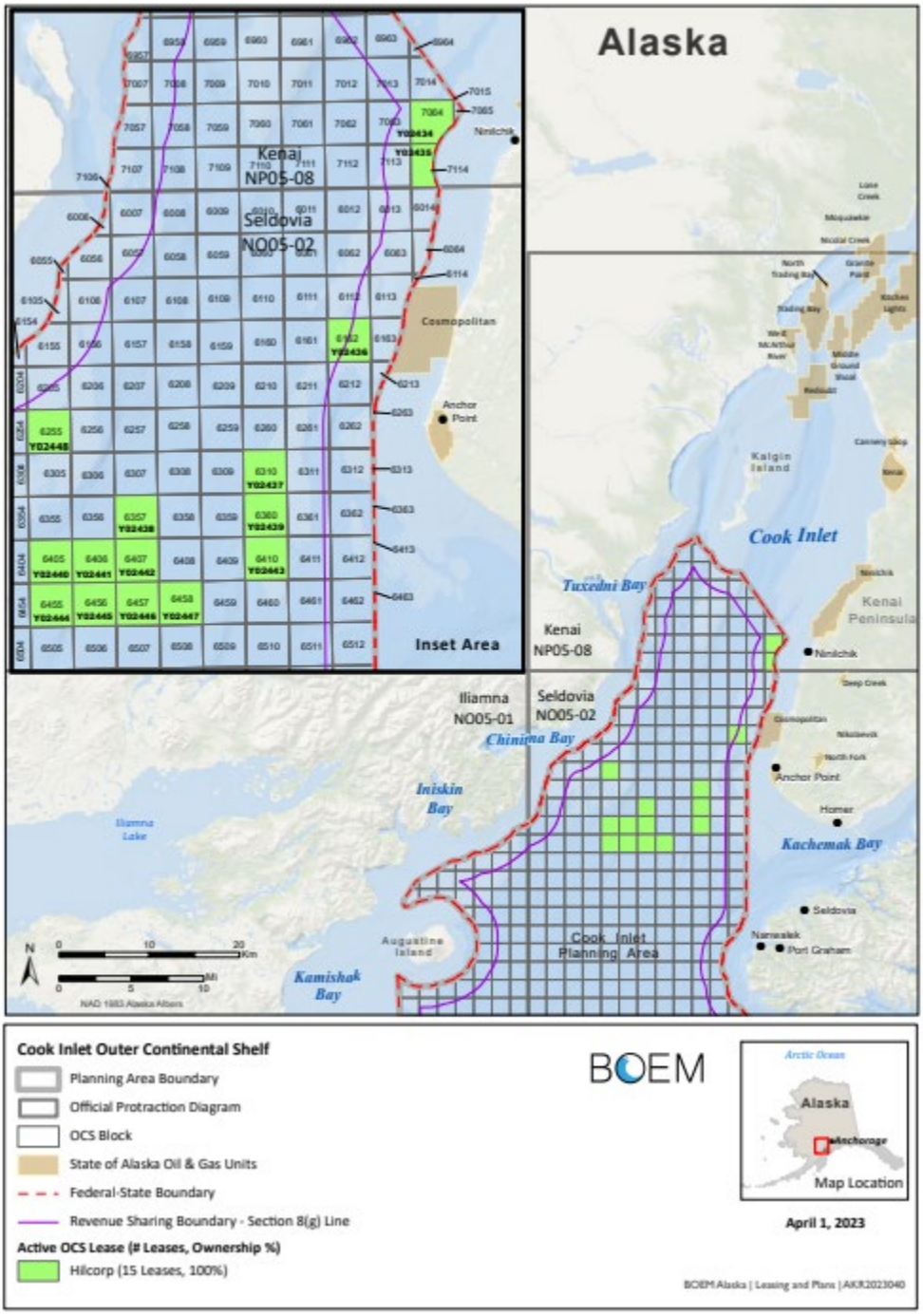

Figure 7. Active OCS Lease Areas in Cook Inlet.

4.2 Offshore Platforms and Wells

4.2.1 Wells in Alaska

As of 2022, there are 409 wells in the Alaskan offshore and areas of Alaskan state waters that are under BSEE jurisdiction for which data are available. Of these, over 27.6% are plugged and abandoned. The numbers of wells by status and region are shown in Table 1 and Figure 8.

Table 1. Numbers of Offshore Wells in Alaska by Well Status and Region.

Regions of the Arctic and Western Alaska ACP Planning Area	Well Status								Total
	Disposal Injection	Gas Injection Completion	Oil Well Completion	Permit Cancelled or Expired	Suspended Well	Water Injection Completion	Water Alt Gas Injection	Plugged and Abandoned	
Cook Inlet	0	0	0	0	0	0	0	13	**13**
Chukchi Sea	0	0	0	0	0	0	0	6	**6**
Beaufort Sea Offshore (OCS)	0	0	0	0	0	0	0	31	**31**
Beaufort Sea State Waters	3	7	187	19	5	46	29	63	**359**
Total	3	7	187	19	5	46	29	**113**	**409**

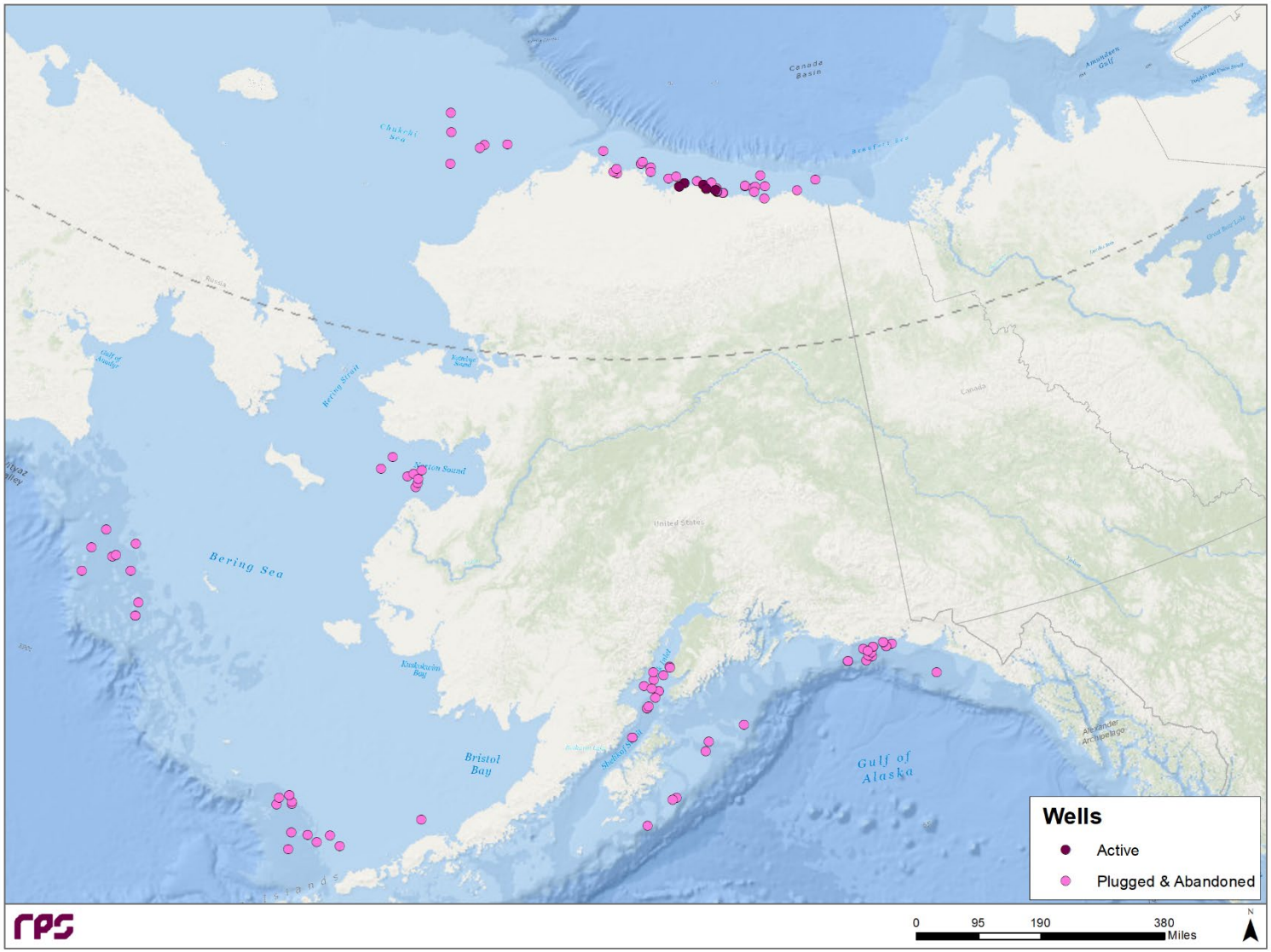

Figure 8. OCS Wells in Alaska.

4.2.2 Offshore Platforms in Alaska

There are seventeen platforms in Upper Cook Inlet. However, these facilities are in inland waters and are outside BSEE jurisdiction as depicted in Figure 9. These facilities are outside of the scope of this project. There are no BSEE-regulated facilities in Lower Cook Inlet.

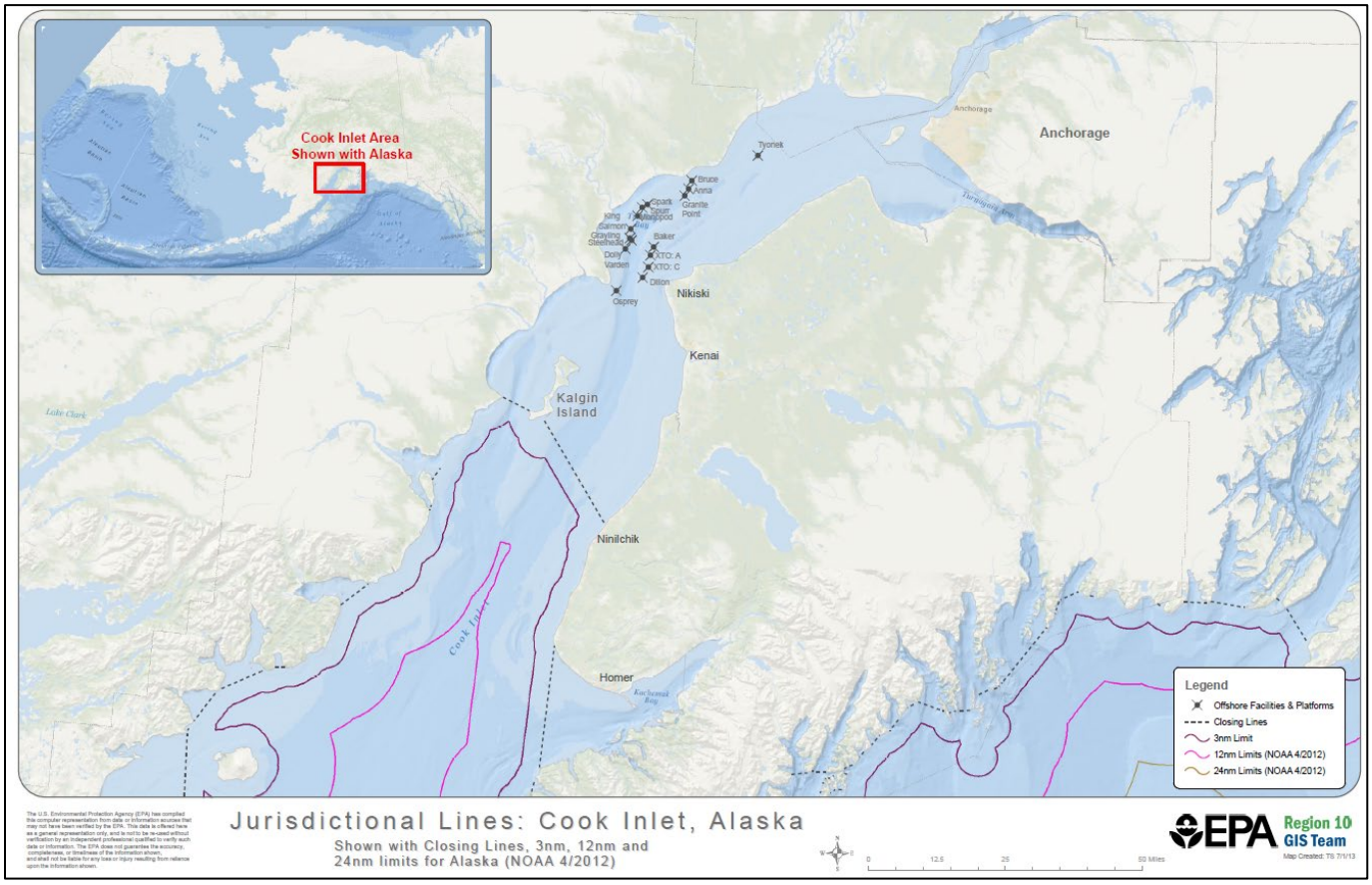

Figure 9. Jurisdictional Lines in Cook Inlet (Source: EPA Region 10).

There are five existing gravel islands on the North Slope. These facilities are Oooguruk, Nikiatchuq, Northstar, Endicott, and Pt. McIntrye. Figure 10 depicts the locations of these facilities. Details and locations for these facilities are also shown in Figure 11 which is taken from the Status of Arctic Pipeline Standards and Technology Final Report issued for use in January 2018.

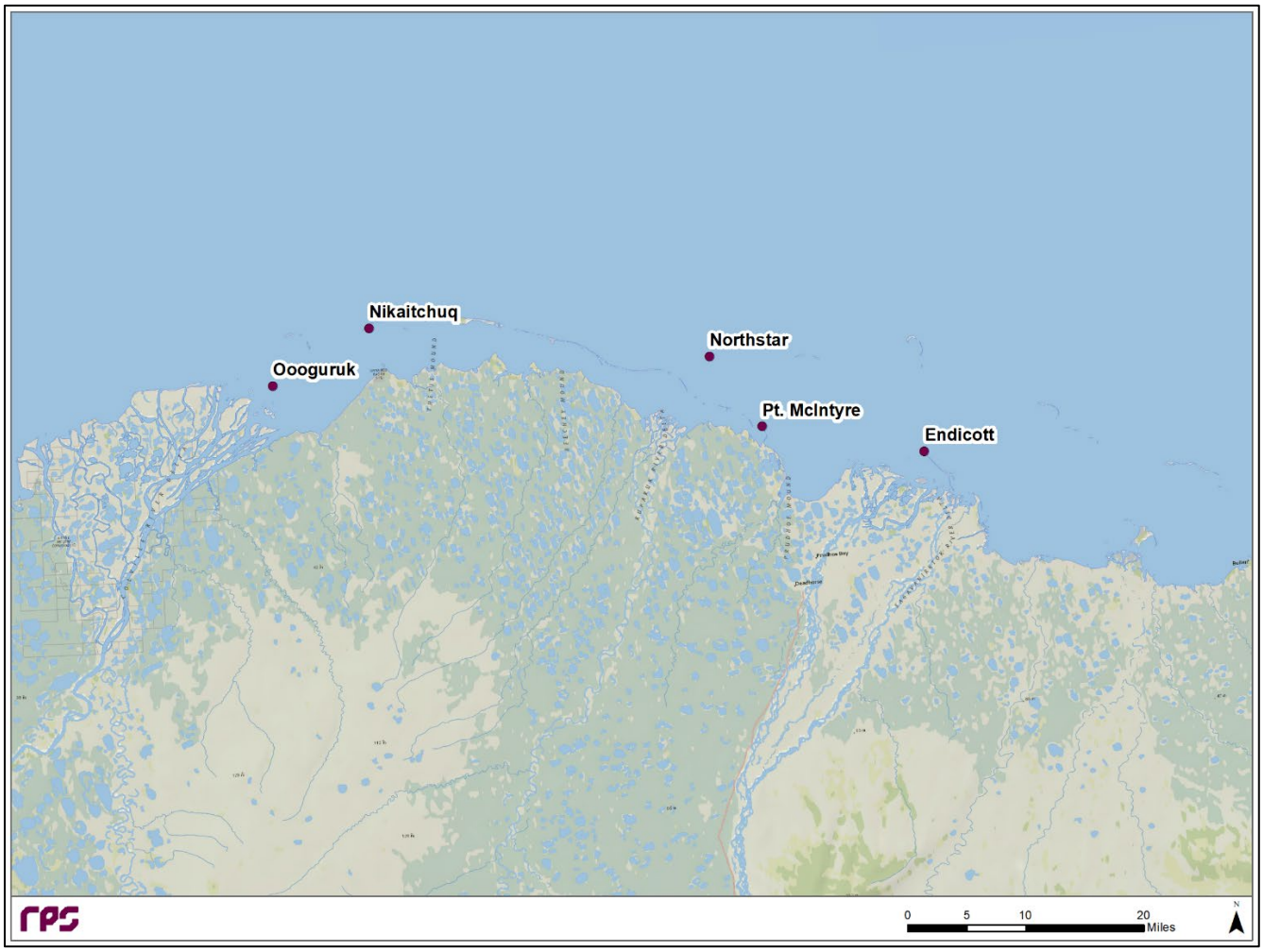

Figure 10. North Slope oil production facilities.

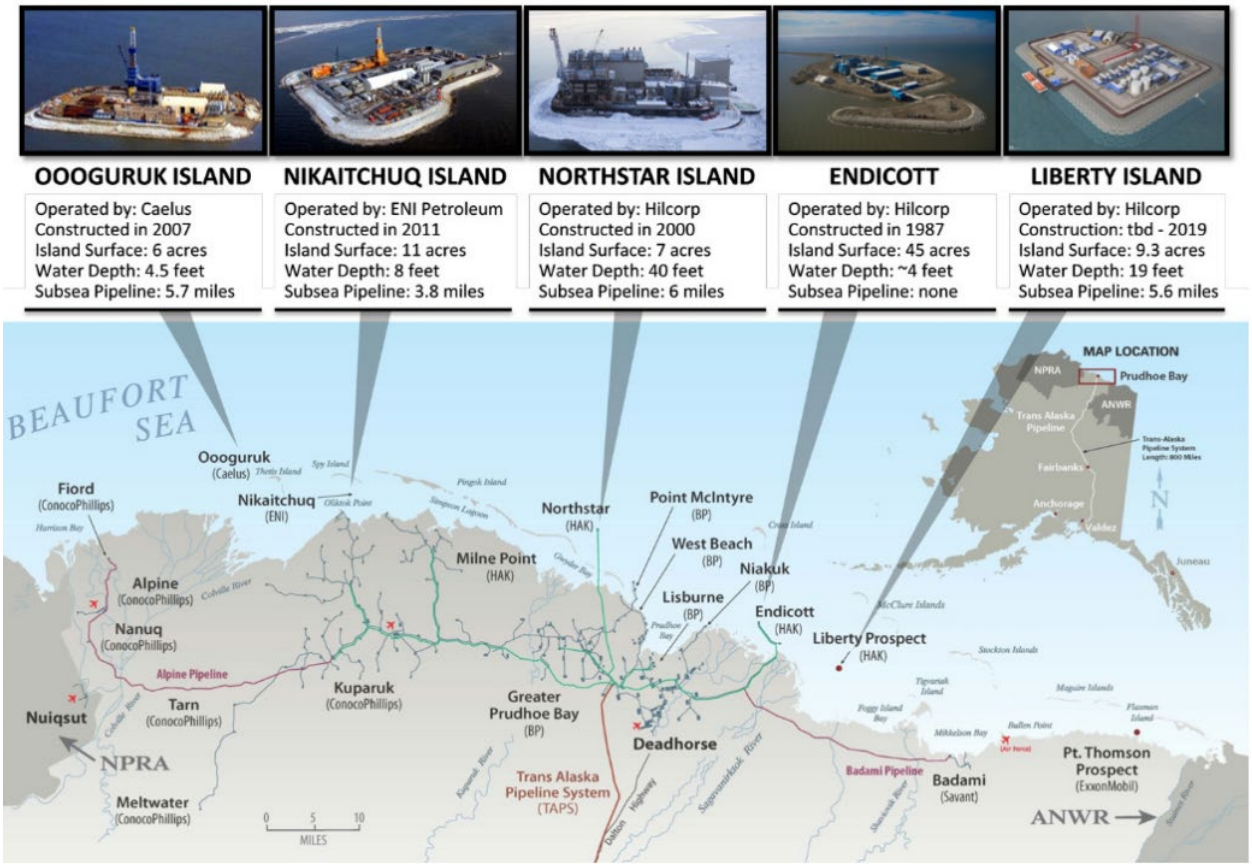

Figure 11. Details on several North Slope oil production facilities and the Liberty Island prospect facility.[8]

4.2.3 Well Age

The oil and gas wells with respect to well status are shown in Table 2.

[8] Status of Arctic Pipeline Standards and Technology Final Report (January 2018) https://www.bsee.gov/sites/bsee.gov/files/research-reports/791aa.pdf

Table 2. Age Categories of Wells in Beaufort Sea by Well Status.

LOCATION	WELL STATUS	TOTAL WELLS (BY AGE IF KNOWN)			TOTAL
		< 20 YEARS	20–50 YEARS	> 50 YEARS	
BEAUFORT OFFSHORE (OCS)	**PLUGGED AND ABANDONED**	0	31	0	**31**
BEAUFORT STATE WATERS	**DISPOSAL INJECTION**	2	1	0	**3**
	GAS INJECTION COMPLETION	1	6	0	**7**
	OIL WELL COMPLETION	92	95	0	**187**
	PERMIT CANCELLED OR EXPIRED	N/A	N/A	N/A	**19**
	SUSPENDED WELL	2	3	0	**5**
	WATER INJECTION COMPLETION	20	26	0	**46**
	WATER ALT GAS INJECTION	13	16	0	**29**
	PLUGGED AND ABANDONED	6	57	0	**63**
TOTAL WELLS		**136**	**233**	**0**	**390**

4.3 Offshore Pipelines

The Alaska OCS contains over 32 miles of active oil and gas pipelines that have small portions in the offshore waters of the Beaufort Sea.[1] The 10-inch-diameter Northstar gas pipeline is 4.88 miles long. The 10-inch-diameter Northstar oil pipeline is of the same length. There are two 16-inch-diameter Endicott oil pipelines each of which is 6.99 miles long. Fluids are transported to SID via a 2.7 mile long subsea bundle, that includes a pipe-in-pipe-in-pipe 10-inch flowline system to carry three-phase fluids, a pipe-in-pie 2-inch-diameter diesel pipeline, and a pipe-in-pipe flowline to transport produced water to SID. Fluids are transported to Oooguruk island via a 5.7 mile long sub-sea bundle, that includes a pipe-in-pipe 12-inch flowline system to carry three-phase fluids, water injection pipeline, a gas injection pipeline, and a 2-inch-diameter diesel pipeline .

4.3.1 Pipeline Locations Across Alaska

The locations of offshore pipelines in Alaska are shown in Figure 12.

[1] This total mileage does not include the part of the Endicott pipeline from Duck Island.

4.3.2 Pipeline Age

The oldest of the pipelines, Endicott, was constructed in 1987. Pt McIntyre was discovered in 1989. The Northstar oil and gas pipelines in the Beaufort Sea were built in 2000, and Oooguruk was constructed in 2007. Spy Island at Nikaitchuq was built in 2011.

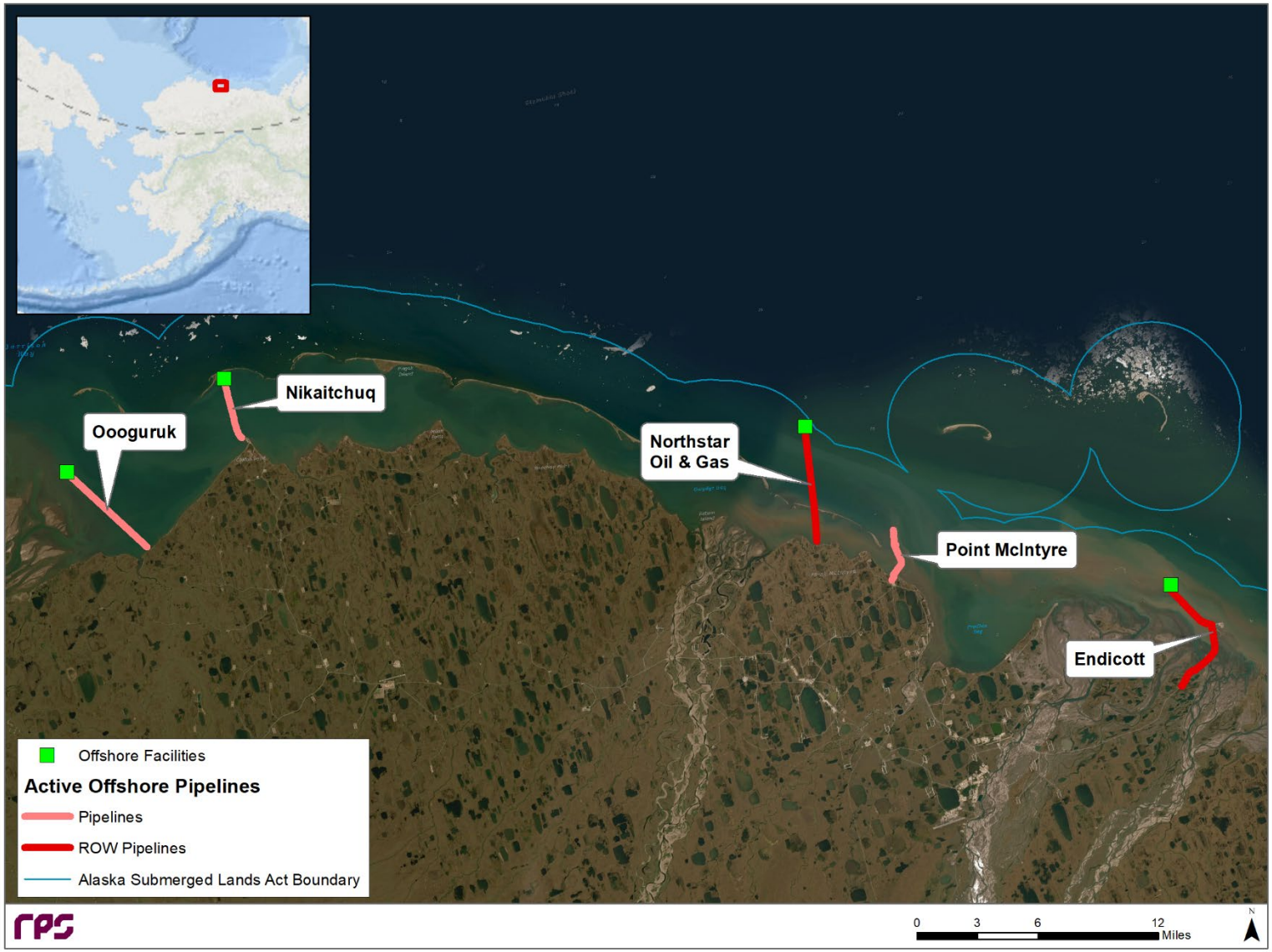

Figure 12. Active Offshore Pipelines in Alaska (Beaufort Sea).

4.4 Offshore Oil and Gas Production

Each year, nearly 125 million bbl of oil and over 3.4 billion mcf of gas are produced in offshore Alaska.

There is considerable variation in the amount of oil and gas production by individual wells in the Alaska. The highest-producing oil well produces over 3.2 million bbl of oil per year. The lowest-producing wells produce less than 10 bbl per year. The highest-producing gas wells produce over 3.2 billion cubic feet of gas annually.

For leases, each may contain numerous wells and platforms. The active leases are shown in Figure 13. There are five active OCS leases in the Beaufort Sea.

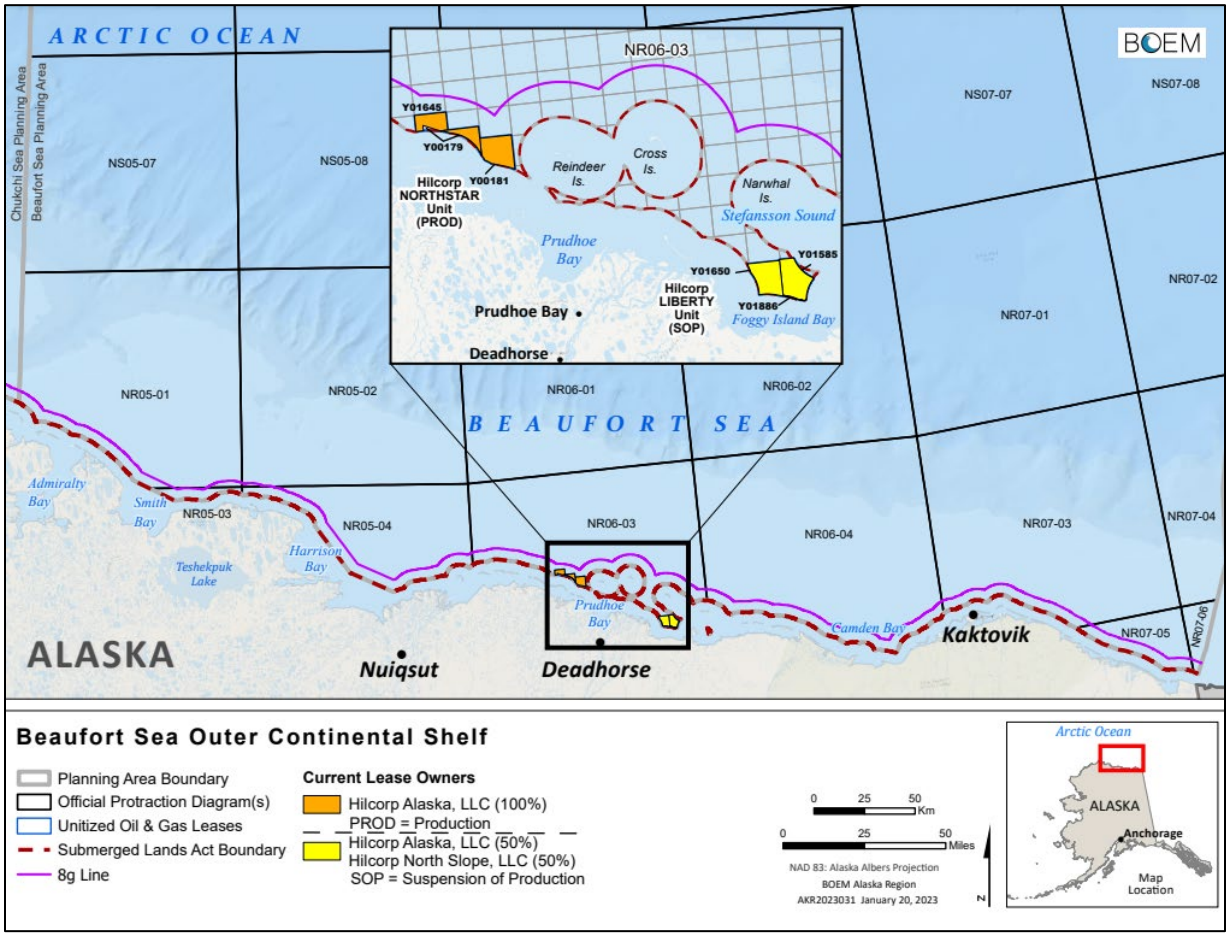

Figure 13. Active OCS Lease Areas in the Beaufort Sea.

4.4.1 Descriptions of Active Leases in Beaufort Sea

Endicott

The Endicott facilities are approximately 2.5 miles seaward of the Sagavanirktok River Delta, shoreward of the barrier islands, in water up to 14 feet deep. With production starting in 1987, Endicott includes three manmade gravel islands in the Beaufort Sea: the Main Production Island (MPI), the Satellite Drilling Island (SDI), and Endeavor Island. The gravel islands provide stable services for drilling and production systems, the base operations center, and support facilities.

A 1.9-mile long causeway extends from the Sagavanirktok River Delta to Endicott's inter-island causeway. The causeway provides year-round vehicle access from the mainland. Three permanent breaches are installed in the causeway. A 200-foot breach, Little Skookum, is located offshore near the junction of the two causeways. Approximately 500 feet south of the Little Skookum is a 650-foot breach, Resolution. The third breach, Big Skookum, is a 500-foot breach, approximately 1,500 feet from shore. A 1.5-mile gravel approach extends from the southern end of the causeway across the Sagavanirktok River Delta to the Sagavanirktok River Delta uplands, connecting the causeway with the 8-mile gravel access road to Prudhoe Bay.

Northstar

Northstar is a self-contained offshore production facility on a gravel island outside the barrier islands with pipelines to shore. Water depth at the island is approximately 39 feet. The Northstar development is built on Seal Island which was constructed in 1999 with production starting in 2001.

Major facilities are elevated on spread footings. Northstar does not have permanent gravel roads connecting it to existing North Slope facilities.

GPB

The GPB facilities comprise over 1,000 oil production wells on more than 40 gravel pads. Prudhoe Bay has approximately 1,100 miles of aboveground pipelines, seven oil processing centers, large plants for natural gas treatment and compression, seawater treatment and injection plants, a crude oil topping refinery unit, a gas-fired electrical power plant, and three major camps. More than 100 large oil storage tanks, both stationary and portable, are in sercice.

Nikaitchuq

Offshore facilities of the Nikaitchuq Production Facility include Spy Island Drill Site (SID) in the Beaufort Sea. SID is a manmade gravel island with both injector and production wells and a subsea pipeline bundle transporting three-phase fluids (oil, produced water, and natural gas) between SID and the mainland production pad as well as diesel fuel and drilling fluids from the mainland pad to SID.

Nikaitchuq production wells will not flow to the surface unassisted. Given the low flow rates and low gas-to-oil ratios, it is unlikely a blowout would flow out of the well containment modules. Under most situations, flow from a blowout would simply flow to the sumps in the modules where it would be pumped into onsite tanks. Although it is possible that limited oil could escape the module if a hatch was open directly above a blowing well and spray in the immediate vicinity, it is unlikely that fluids from a well blowout would spray off the production pad.

Oooguruk

Oooguruk was constructed by winter placement of gravel fill on approximately 8 acres. The well bay space was constructed for 48 well on 7-foot centers. About half the wells are producer wells, the other half are injector wells, and up to two will be Class I Underground Injection Control (UIC) disposal wells. The three-phase flowline (oil, water, gas) transports the produced fluids to the existing KRU facilities for separation and transmission through the Trans Alaska Pipeline System.

Oooguruk connects to gravel roads on the mainland by an ice road constructed each winter during developmental drilling. The ice road allows vehicle access from late December through May. During the rest of the year, access is limited to helicopter during Break Up or Freeze Up or by vessel in Open Water season (July to September). A winter ice road to Oooguruk is built only as needed to support operations and maintenance activities. However, winter access is available each year after grounded ice has formed offshore when a road could be bladed across the generally smooth ice. As soon as stable ice of adequate thickness forms, rolligons and tracked vehicles could access Oooguruk if necessary.

At Oooguruk, the Nuiqsut and Torok Formation wells are not capable of unassisted flow without stimulation and/or artifical lift mechanisms. The reservoir characteristics of the Kuparuk structure overlying the Nuiqsut Formation that the dedicated Nuiqsut wells will penetrate is also not capable of unassisted flow. Wells completed in these formations will be drilled year-round.

The highest-producing oil and gas leases are shown in Table 3 and Table 4. Figure 14 shows the highest producing leases in Alaska.

Table 3. Highest-Producing Oil Wells in Alaska State Waters Beaufort Sea (BSEE Jurisdiction Only)

API Well Number	Well Name	Annual Production	
		Oil (bbl)	Gas in the Same Lease (mcf)
50629234800000	Nikaitchuq (Spy Island SP33-W03)	475,329	43,948
50629235130000	Nikaitchuq (Spy Island SP12-SE3)	427,473	43,263
50629234530000	Nikaitchuq (Spy Island SP18-N05)	316,667	61,624
50629234670000	Nikaitchuq (Spy Island SP16-FN03)	313,313	33,121
50629234730000	Nikaitchuq (Spy Island SP10-FN05)	305,201	50,360
50629234760000	Nikaitchuq (Spy Island SP30-W01)	301,161	34,036
50029227610000	Pt McIntyre (Prudhoe Bay UN PTM P2-01)	277,384	3,874,279
50629234780000	Nikaitchuq (Spy Island SP22-FN01)	269,937	21,237
50029222890000	Pt McIntyre (Prudhoe Bay UN PTM P2-30)	249,894	1,417,536
50629235370000	Nikaitchuq (Spy Island SP04-SE5)	248,633	40,555

Table 4. Highest-Producing Gas Wells in Alaska (BSEE Jurisdiction Only).

API Well Number	Well Name	Annual Production	
		Gas (mcf)	Oil in Same Lease (bbl)
50029224640100	Endicott Satellite Drilling Island (SDI 4-10A)	62,941	13,070,594
50029225690000	Endicott Main Processing Island (MPI 1-19)	49,313	10,777,317
50029220140000	Endicott Main Processing Island (MPI 2-36)	47,475	8,514,446
50029225620000	Endicott Main Processing Island (MPI 1-31)	34,922	8,186,194
50029218580000	Endicott Main Processing Island (MPI 2-68)	98,129	7,602,435
50029220320000	Endicott Main Processing Island (MPI 2-18)	80,443	7,024,276
50029228380000	Endicott Satellite Drilling Island (SDI 3-31)	106,281	6,207,014
50029218470200	Endicott Main Processing Island (MPI 2-28B)	61,139	6,053,628
50029223060000	Endicott Satellite Drilling Island (SDI 3-03)	37,790	5,986,520
50029224640100	Endicott Satellite Drilling Island (SDI 4-10A)	196,893	5,330,773

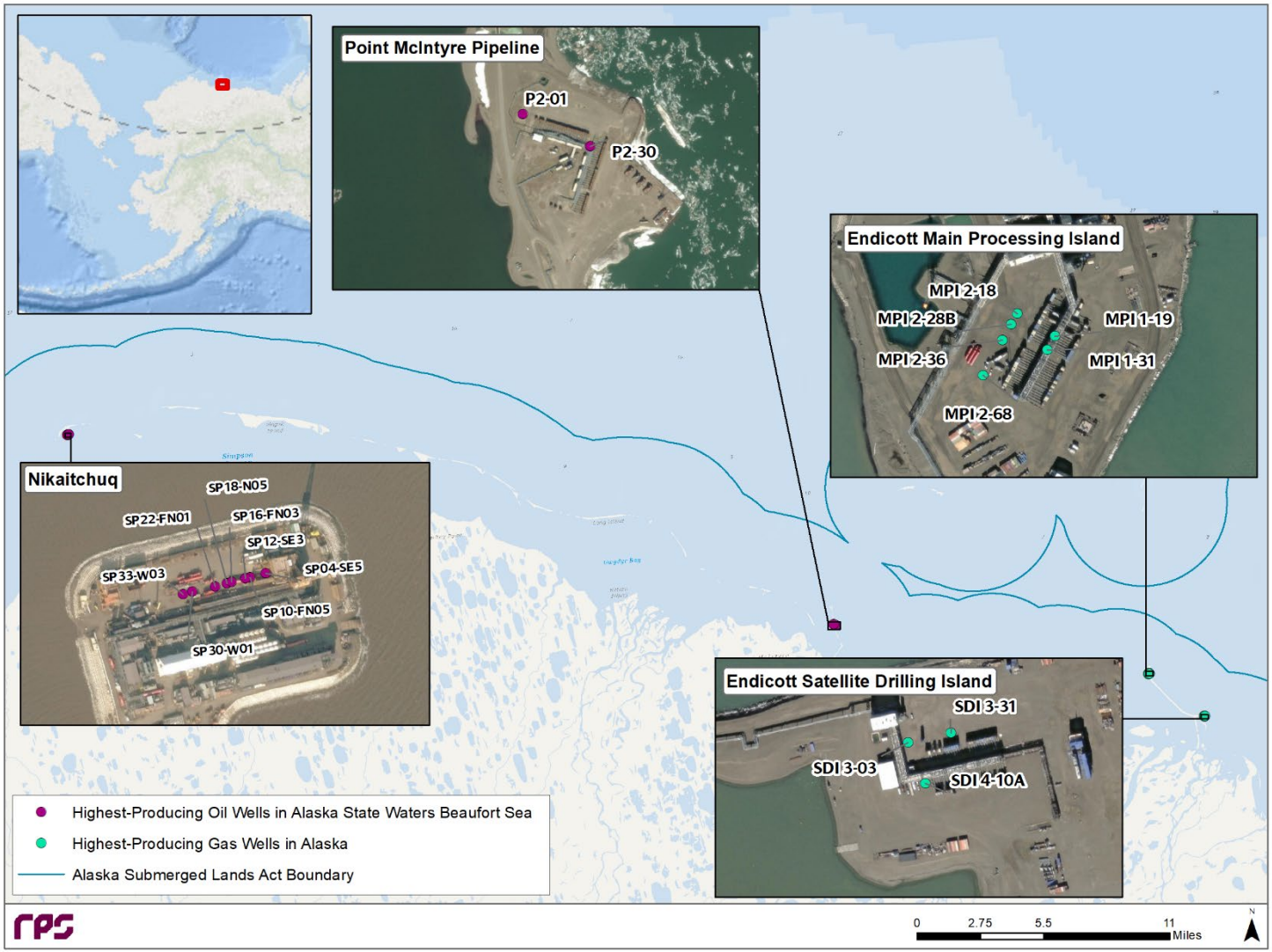

Figure 14. Highest-Producing Leases in Alaska.

NOAA's Environmental Response Management Application (ERMA) also contains data on offshore infrastructure that can be viewed under "Public Safety and Infrastructure/Oil and Gas" layers. ERMA can be accessed at https://erma.noaa.gov/arctic#layers=3+12864+676+8480&x=-161.91096&y=64.76126&z=4&panel=layer.

4.4.2 Alaska State Waters

Additional information can be found on offshore infrastructure in state waters at the following state websites:

- Alaska Department of Natural Resources, Division of Oil and Gas: https://dog.dnr.alaska.gov/
- Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys: https://dggs.alaska.gov/pubs/id/15750
- Alaska Oil and Gas Conservation Commission: http://aogweb.state.ak.us/DataMiner4/Forms/Home.aspx and https://www.commerce.alaska.gov/web/aogcc/Data.aspx

4.5 Oil Product Chemistry/Characteristics

A variety of oil types may potentially discharge from offshore oil and gas operations – including crude oils and crude condensates from wells and pipelines, as well as fuels, lubricating oils, and hydraulic oils used on offshore supply vessels.

Oils differ considerably in their properties based on their composition and the degree of weathering after discharging. Crude oils are composed of a mixture of many different types of hydrocarbons – from light, volatile compounds, such as benzene, toluene, ethylbenzene, and xylene (BTEX), to heavier compounds, such as asphaltenes. Refined petroleum products made from crude oils, such as gasoline, diesel fuel, and heavy fuel oil, exhibit different properties as well.

4.5.1 Alaska Facility-Specific Oils

The Oooguruk drill site produces oil from three oil pools: Torok, Kuparuk, and Nuiqsut. All three reservoirs are developed using horizontal wells. The Torok and Nuiqsut incorporate hydraulic fracturing completions. Secondary recovery techniques are employed in all three pools to maximize recovery.

The Torok oil pool at approximately -5,000 feet true vertical depth subsea (TVDss) is a low permeability, high water saturation, turbidite reservoir consistently yielding 24 API crude. The Kuparuk oil pool at approximately -6,050 feet TVDss is a moderate permeability, low water saturation shoreface reservoir yielding 23-26 API crude. The Nuiqsut oil pool at approximately -6,350 feet TVDss is a low permeability, low water saturation marine shelf reservoir yielding 19-26 API crude.

The Northstar oil exhibits properties amenable to burning. Its density ranges from 0.80 g/cm^3 for fresh oil at 15ºC to 0.88 g/cm^3 for 55% weathered oil at 1ºC. The oil's viscosity ranges from 1.7

mPa s when fresh and at 15ºC to 5,363 mPa s when weathered 55% and at 1ºC. The ASTM Standard D97 pour point is below the method limit for fresh oil. The pour point is 18ºC for 55% weathered oil. Fresh oil is unlikely to emulsify regardless of whether it is near freezing or at higher ambient temperatures. Weathered oil that has lost almost half its mass to evaporation has some emulsification likelihood at near-freezing temperature and may have a water content from 17% to 49%. Maximum weathering (i.e. 55% loss) makes the oil more likely to form an emulsion with water content of approximately 35 to 39% (SL Ross Environmental Research Ltd., 2006).

Endicott's oil density ranges from 0.8695 g/cm^3 when fresh and at 15ºC to 0.932 g/m^3 when evaporated to 15% loss and at a temperature of 1ºC. At 1ºC, its viscosity ranges from 6 mPa s when fresh and at 15ºC to 1,405 mPA s when evaporated 15% and at 1ºC. The pour point ranges from -3ºC for fresh oil to 12ºC for oil evaporated 15%. The flash point ranges from -2.5ºC for fresh oil to 38ºC for oil evaporated 15%. At freezing water temperatures, Endicott crude is likely to form meso-stable water-in-oil emulsions in the presence of wave action with water contents in the 50-60% by volume range. At warner temperatures (15ºC), emulsification is unlikely with fresh Endicott oil, but the evaporated crude would likely form an entrained water emulsion with water contents in the 20% range (SL Ross Environmental Research Ltd., 2006).

Prudhoe Bay oil is also amenable to burning. Densities range from 0.856 g/cm^3 when fresh and at 15ºC to 0.938 g/m^3 for 40% weathered oil at 1ºC. The oil's viscosities range from 8 mPa s when fresh and at 15ºC to 4,538 mPA s when weathered 40% and at 1ºC. The highest viscosity of fresh oil at 1ºC is 53 mPa s.

4.5.2 API Gravity (Oil Density)

Oil density is an important property for classifying oils. Oil density can be expressed in two ways: specific gravity or °API gravity.

Specific gravity is the ratio of the density of oil relative to water. The density of freshwater is 1.0 while the density of salt water (seawater) is 1.02 to 1.03, depending on the temperature. At colder temperatures, sea water is slightly denser. Oil is generally lighter than water (with a density of less than 1.0) which means that it floats on water. The lighter the oil, the lower the density or specific gravity value.

°API gravity is a measure developed by the American Petroleum Institute (API) to represent how light or heavy an oil is compared to water. °API gravity is an inverse measure, meaning the higher the number, the lighter the oil. Heavier oils have lower °API gravities.

The density of oil increases with weathering (evaporation of volatile hydrocarbon components) and decreasing temperature. The density of oil affects its buoyancy. An increase in the oil density increases the possibility of the oil sinking. Oil will sink if its density is higher than that of the water. It will also sink when it comes in contact with sediment, other particles, or debris that make the mixture heavier than water. Sunken oil presents challenges for spill response.

Oil density also affects the rate of natural dispersion with lighter oils dispersing more readily. Lighter oils also spread faster on the water surface in the early stages of a spill.

4.5.3 Lowest °API Gravity and Heaviest Oil Group in Alaska

The lowest °API gravity oil (i.e., the heaviest oil) modeled in the Arctic and Western Alaska ACP Planning Area has an °API gravity of 23.

4.6 Other Oil Products Handled in Offshore Oil and Gas Operations

Offshore oil and gas operations include the use of various types of oils, such as fuels and lubricants for platform and drilling rig or mobile offshore drilling unit operations, as well as fuels and lubricants for the offshore supply or service vessels that bring supplies to the offshore facilities. The most commonly encountered oils include hydraulic fluids, diesel fuel, and drilling muds.

4.6.1 Synthetic-Based Drilling Muds (SBMs)

Synthetic-based drilling muds (SBMs) are often used during drilling of deep water and directional wells. The EPA prohibits the routine discharge of synthetic-based drilling muds and oil-based drilling muds and cuttings. SBMs almost completely replaced oil-based muds. Both SBMs and cuttings mixed with the muds can be accidentally discharged.

SBMs are generally comprised of 30–90% by volume (20–50% by weight) of synthetic organic compounds (which act as lubricants), that are dispersed in a salt brine to form an emulsion, along with other ingredients including emulsifiers, wetting agents, a weighting material (usually barite, $BaSO_4$, or ilmenite, $FeTiO_3$), clays, lignite, and lime. They are much denser than seawater. SBMs are synthesized specifically to not include PAHs, thus resulting in less environmental impact and lower toxicity for workers. There is no information about any SBMs contained at the Beaufort Sea facilities.

4.6.2 Diesel Fuel

Diesel fuel, a Group II oil, is commonly used on offshore platforms, gravel islands, and in vessels. This product is the only type of non-crude petroleum that would be found in significant quantities in a single container (> 1,000 bbl). When spilled, diesel fuel will evaporate, dissolve, and naturally disperse to some extent. Diesel fuel includes moderate concentrations of toxic, soluble compounds. These components tend to evaporate (often more than 50%), but they can also leave residues that persist in the environment for days to weeks. At Endicott, there is a tank of 1,269 bbl of diesel and a tank containing 562 bbl of a gasoline/diesel mixture. At Nikiatchuq, there are tanks containing 750 bbl of diesel. At Northstar, there is a tank containing 2,800 bbl of diesel.

4.6.3 Hydraulic Fluids

Hydraulic fluids or oils are used on both vessels and on offshore platforms. Based on density, hydraulic oils range from Group II to Group IV, depending on their specific formulation and application. They are usually found in relatively small quantities. There is no information on hydraulic fluids contained at the Beaufort Sea facilities.

4.6.4 Lubricants

Lubricating oils (lubricants) are also used on both vessels and offshore platforms. Based on density, lubricants range from Group II to Group IV, depending on their specific formulation and application. They are also usually found in relatively small quantities. At Endicott, there is a tank

containing 357 bbl of lube oil. At Nikiatchuq, there are two tanks containing 750 bbl each of base oil, which is a type of lubricant.

5 Cook Inlet

5.1 Cook Inlet Oil and Gas Fields

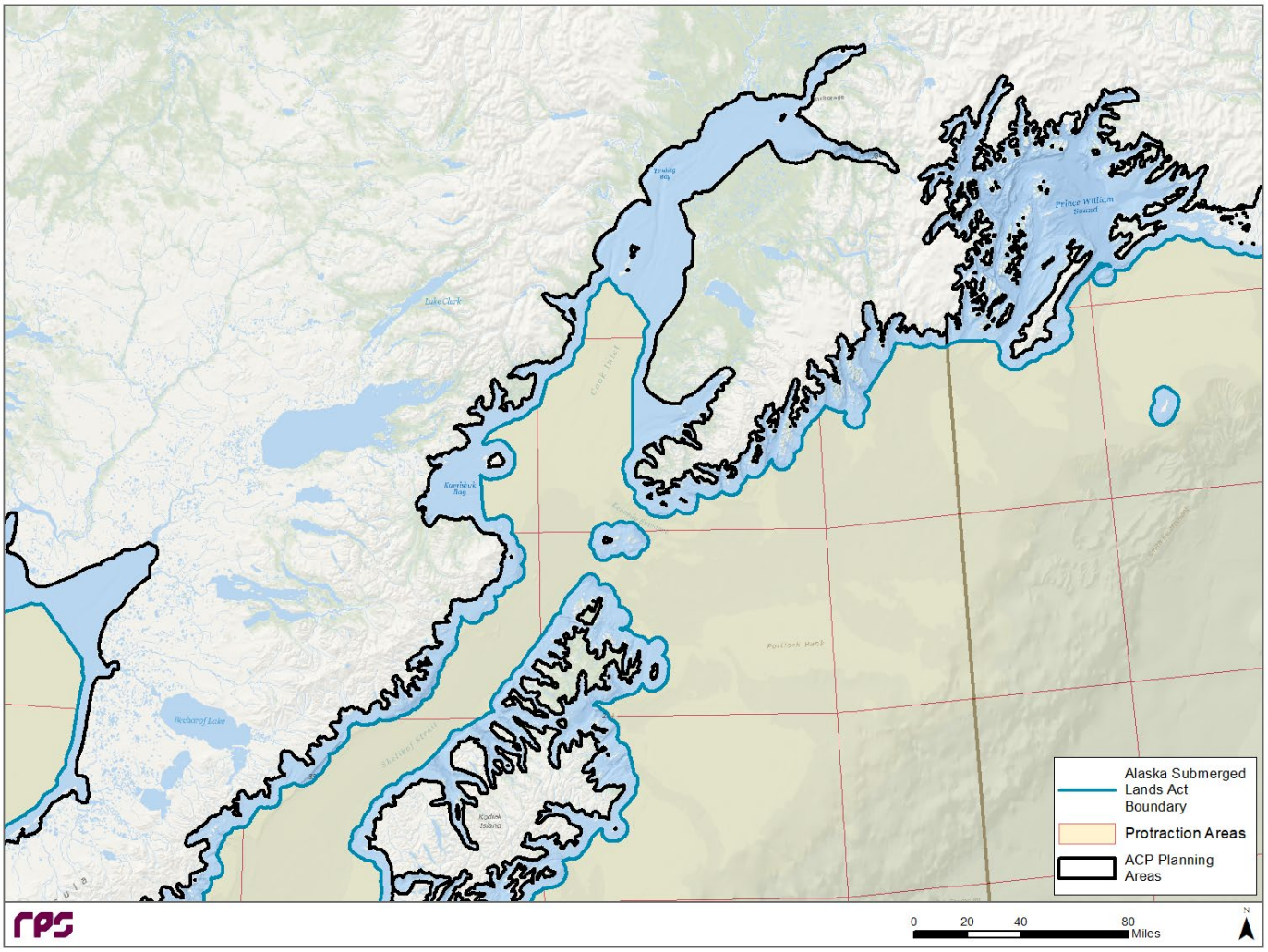

Figure 15. Protraction Areas in Cook Inlet.

5.2 Cook Inlet Bathymetry

Tidal fluctuations in the main body of Cook Inlet regularly reach 25 feet (7.6m) or more and exhibit currents in excess of 5 knots (9.3 km/h) at full tidal flow.

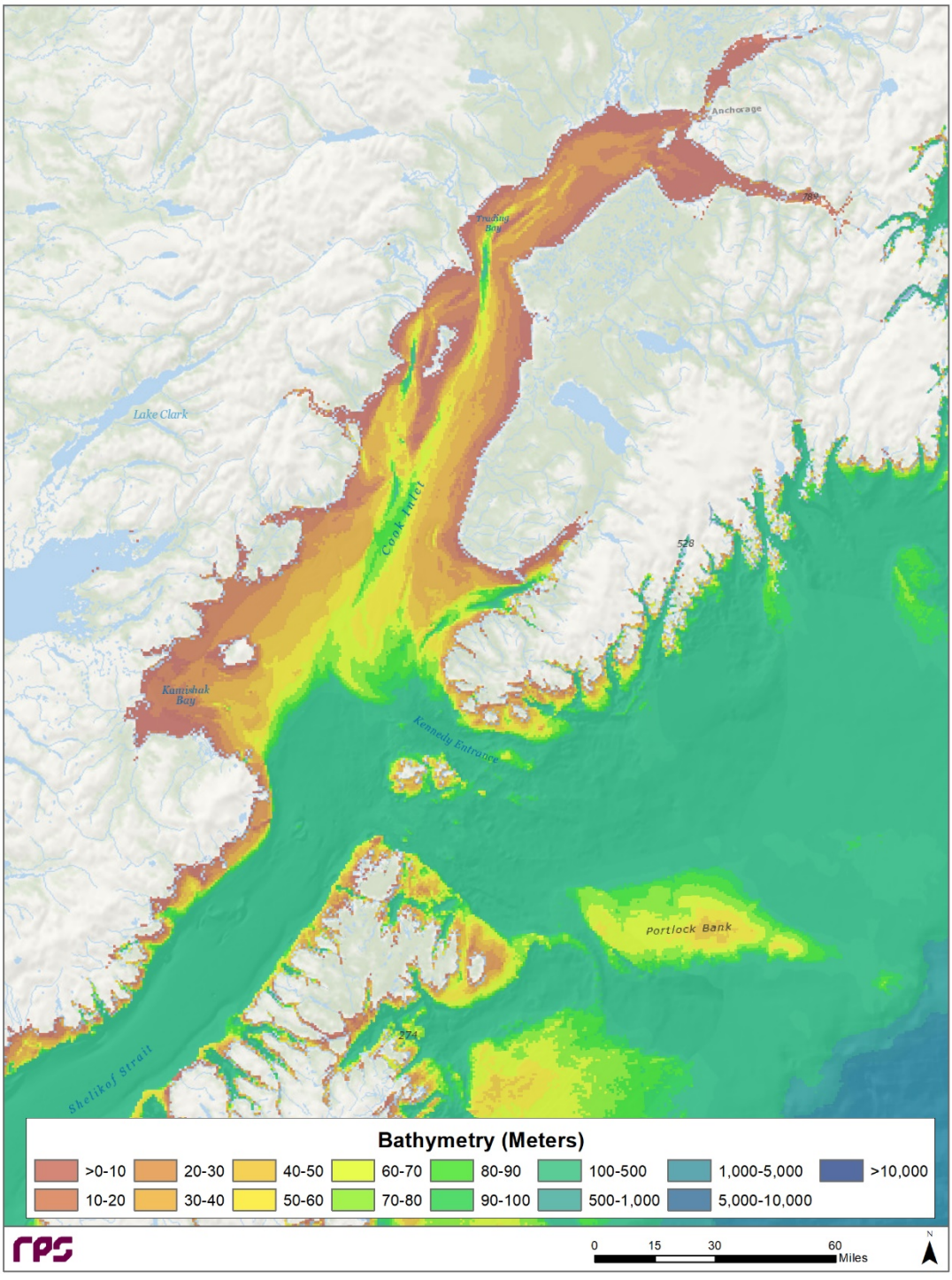

Figure 16. Bathymetry of Cook Inlet.

5.3 Cook Inlet OCS Wells

The plugged and abandoned exploratory wells in Lower Cook Inlet are shown in Figure 17.

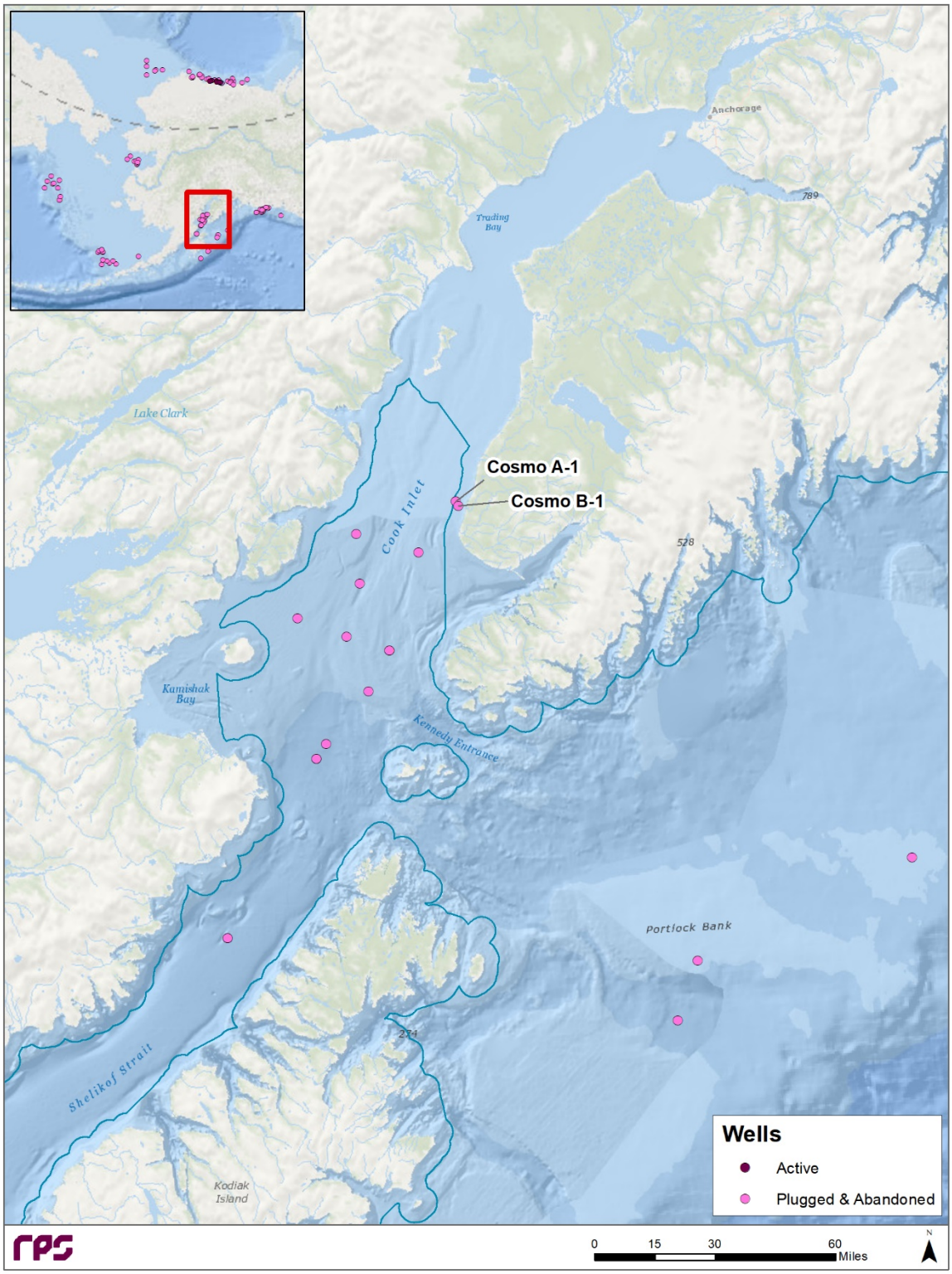

Figure 17. Offshore plugged and abandoned Exploratory Wells in Cook Inlet.

5.4 Pipelines

There are no offshore pipelines in Cook Inlet under BSEE jurisdiction.

5.5 Cook Inlet Offshore Production

There is currently no oil production in Lower Cook Inlet. There are two offshore oil and gas exploration drilling proposals in Lower Cook Inlet.

Blue Crest Cosmopolitan proposed to drill a well at the Cosmo Project. This project consists of the Cosmo No. 1 and No. 2 well. The proposed wells will be located offshore on the east side of Lower Cook Inlet near Cape Starichkof and north of Anchor Point. The drilling rig is located offshore and is accessible by vessel or by helicopter. In 2001, ConocoPhillips drilled a well in the Cosmopolitan Field. This well was not capable of sustaining natural flow to the surface due to low permeability and low API gravity of the oil. Artificial lift such as nitrogen and jet pump would likely be required at Cosmo.

The second drilling proposal in Cook Inlet is for Hilcorp Alaska. The potential drilling locations for Hilcorp can be seen in Figure 18. Hilcorp proposed drilling, completion, and testing for up to five wells at ten possible locations grouped into the three prospect areas of Blackbill, Steller, and Tetra. Hilcorp intends to drill three exploration wells, one on each of the prospects, and two delineation wells at the most encouraging sites during the first year of the exploration program.

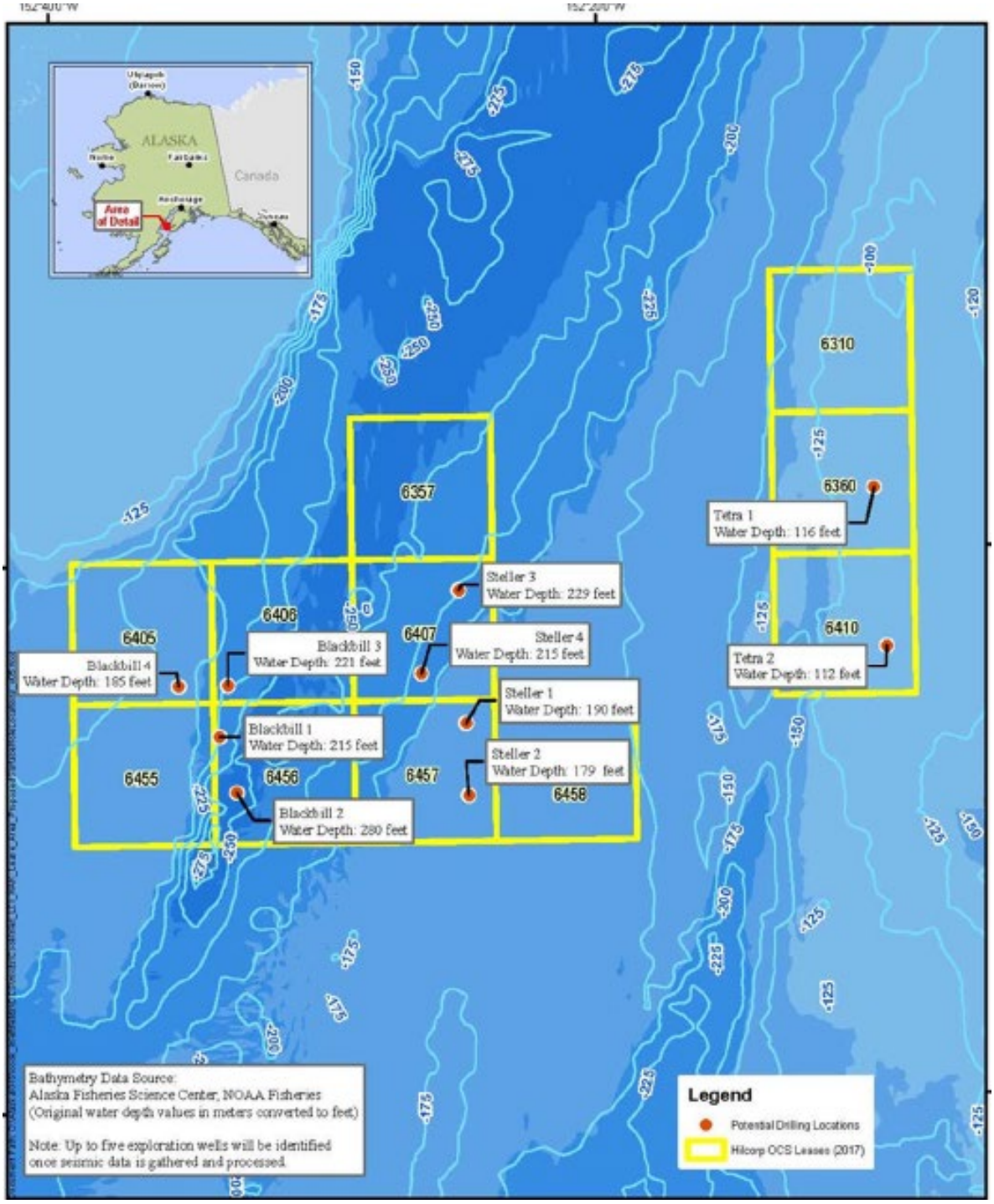

Figure 18. Hilcorp Proposed Leases (BOEM, 2017).

6 Chukchi Sea

6.1 Chukchi Sea Oil and Gas Fields

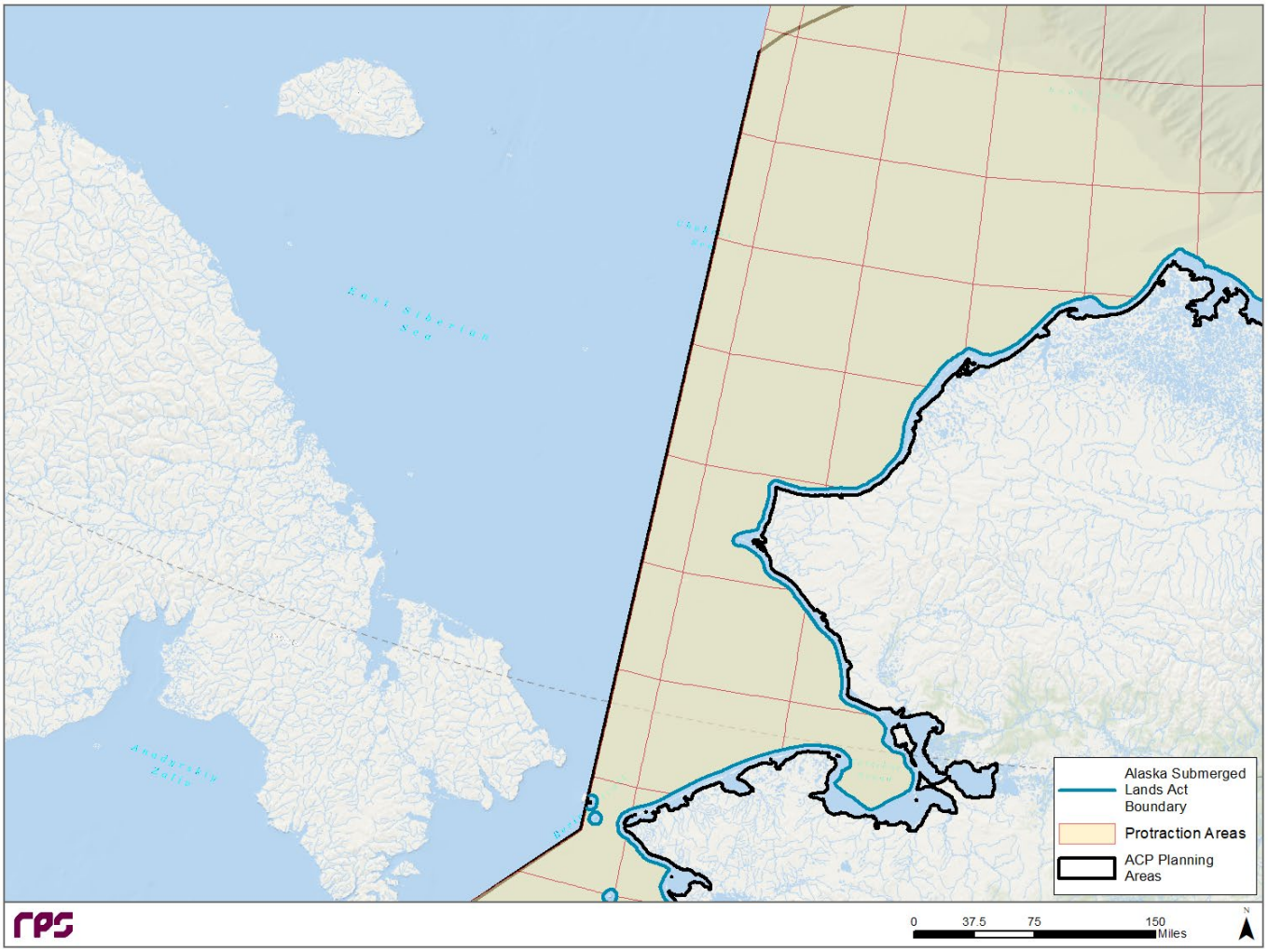

Figure 19. Protraction Areas in Chukchi Sea.

6.2 Chukchi Sea Bathymetry

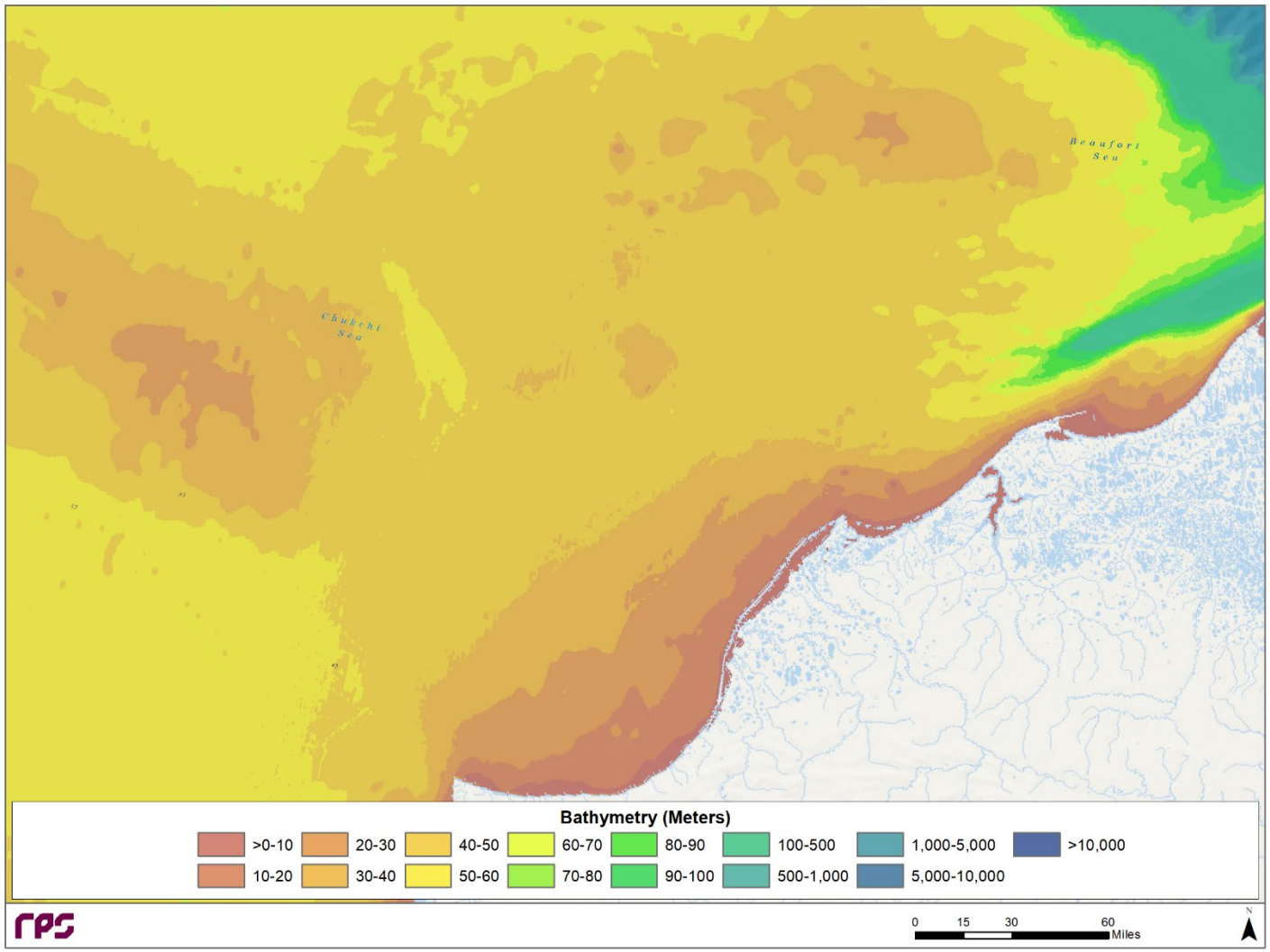

Figure 20. Bathymetry of Chukchi Sea.

6.3 Chukchi Sea OCS Wells

The locations of the five inactive wells in Chukchi Sea are shown in Figure 21.

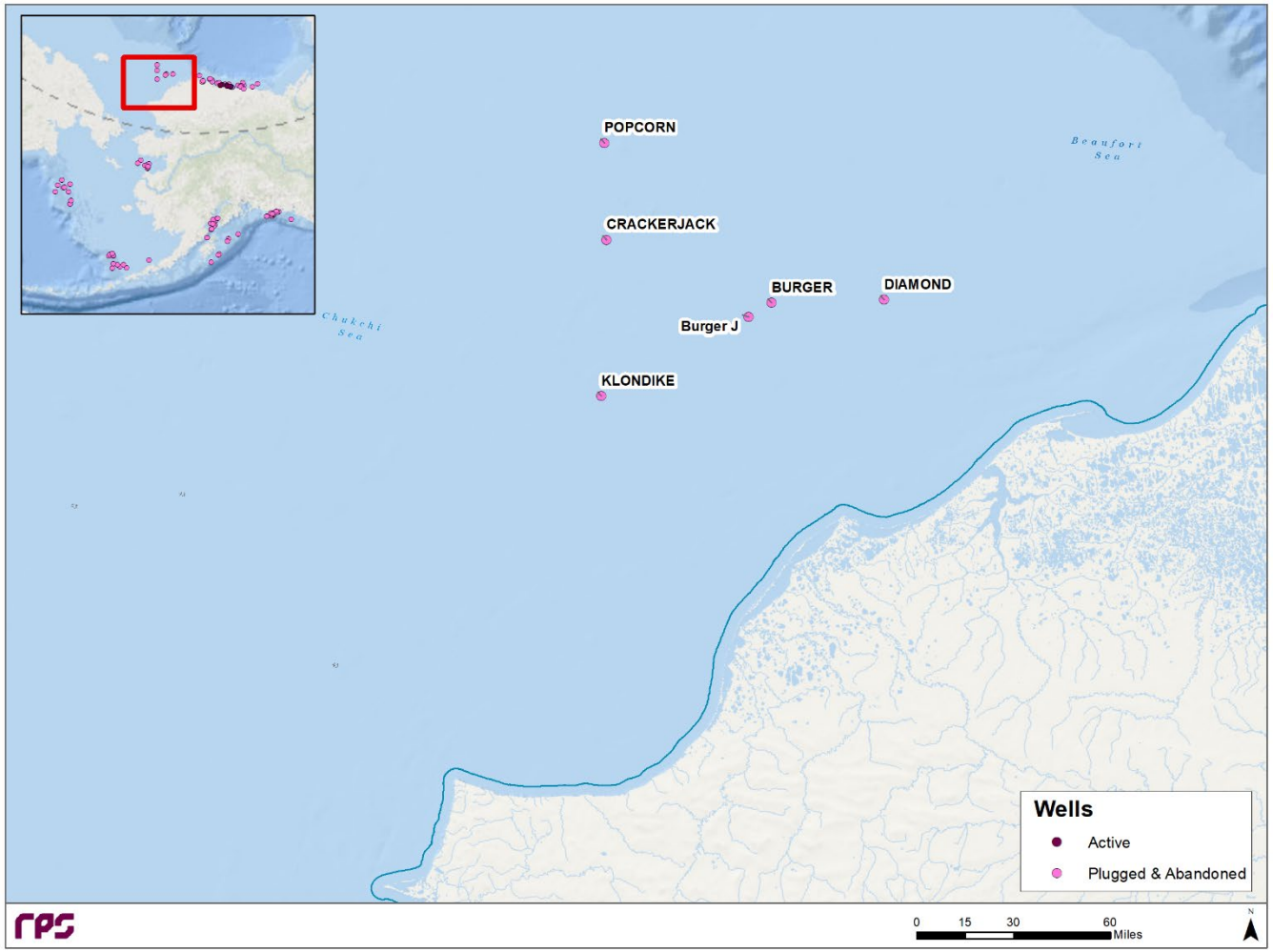

Figure 21. OCS Wells in Chukchi Sea.

6.3.1 Well Age

The age of oil and gas wells in the Chukchi Sea by name are shown in Table 5.

Table 5. Age of Wells in Chukchi Sea.

Name of Well	Year Well Completed
Burger	1990
Burger J	2015
Klondike	1989
Popcorn	1990
Diamond	1991
Crackerjack	1991

6.4 Chukchi Sea Pipelines

There are no pipelines in Chukchi Sea.

6.5 Chukchi Sea Offshore Production

There is no production in Chukchi Sea.

7 Beaufort Sea

7.1 Beaufort Sea Oil and Gas Fields

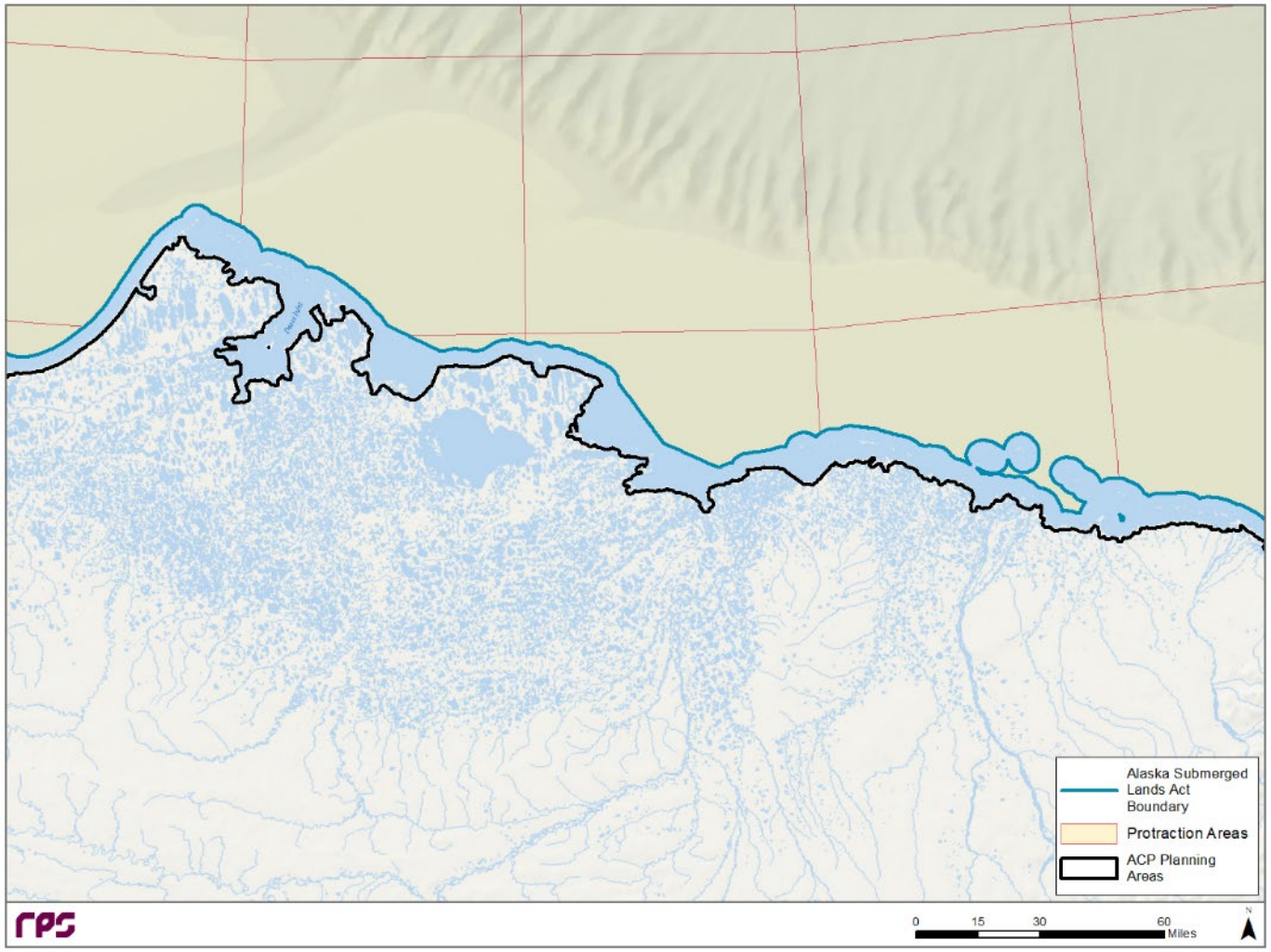

Figure 22. Protraction Areas in Beaufort Sea.

7.2 Beaufort Sea Bathymetry

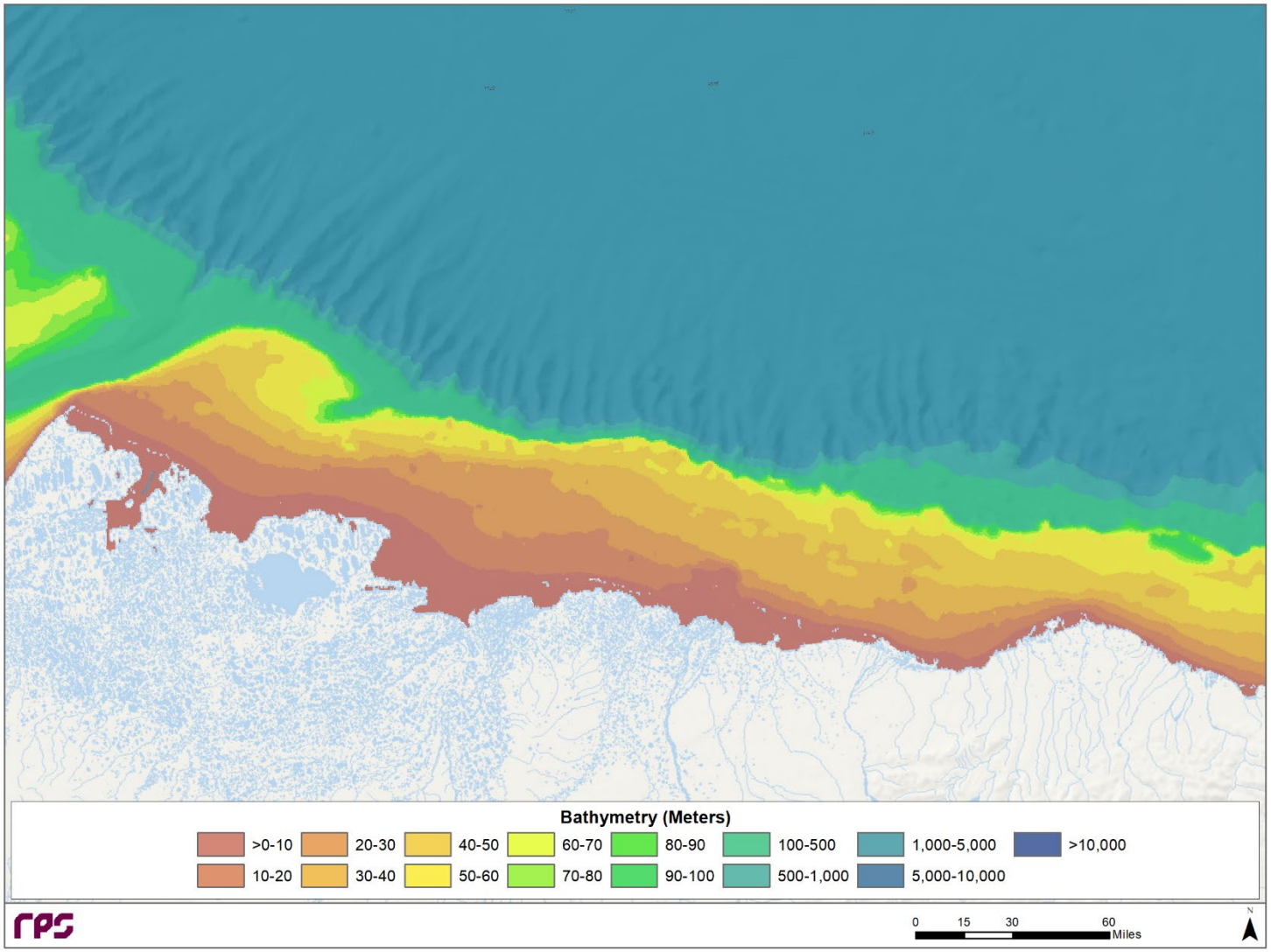

Figure 23. Bathymetry of Beaufort Sea.

7.3 Beaufort Sea Offshore Wells

The wells by status in the Beaufort Sea are summarized in Table 6. A map of the active well locations by production type is shown in Figure 24. The wells are classified by age in Table 7.

Table 6. Numbers of Offshore Wells in Beaufort Sea ACP Planning Area.

Regions of the Arctic and Western Alaska ACP Planning Area	Well Status								Total
	Disposal Injection	Gas Injection Completion	Oil Well Completion	Permit Cancelled or Expired	Suspended Well	Water Injection Completion	Water Alt Gas Injection	Plugged and Abandoned	
Beaufort Sea Offshore	0	0	0	0	0	0	0	31	**31**
Beaufort Sea State Waters	3	7	187	19	5	46	29	63	**359**
Total	3	7	187	19	5	46	29	**94**	**390**

Table 7. Age Categories of Shallow Wells in Beaufort Sea by Well Status.

LOCATION	WELL STATUS	TOTAL WELLS (BY AGE IF KNOWN)			TOTAL
		< 20 YEARS	20–50 YEARS	> 50 YEARS	
BEAUFORT OFFSHORE (OCS)	**PLUGGED AND ABANDONED**	0	31	0	**31**
BEAUFORT STATE WATERS	**DISPOSAL INJECTION**	2	1	0	**3**
	GAS INJECTION COMPLETION	1	6	0	**7**
	OIL WELL COMPLETION	92	95	0	**187**
	PERMIT CANCELLED OR EXPIRED	N/A	N/A	N/A	**19**
	SUSPENDED WELL	2	3	0	**5**
	WATER INJECTION COMPLETION	20	26	0	**46**
	WATER ALT GAS INJECTION	13	16	0	**29**
	PLUGGED AND ABANDONED	6	57	0	**63**
TOTAL WELLS		**136**	**233**	**0**	**390**

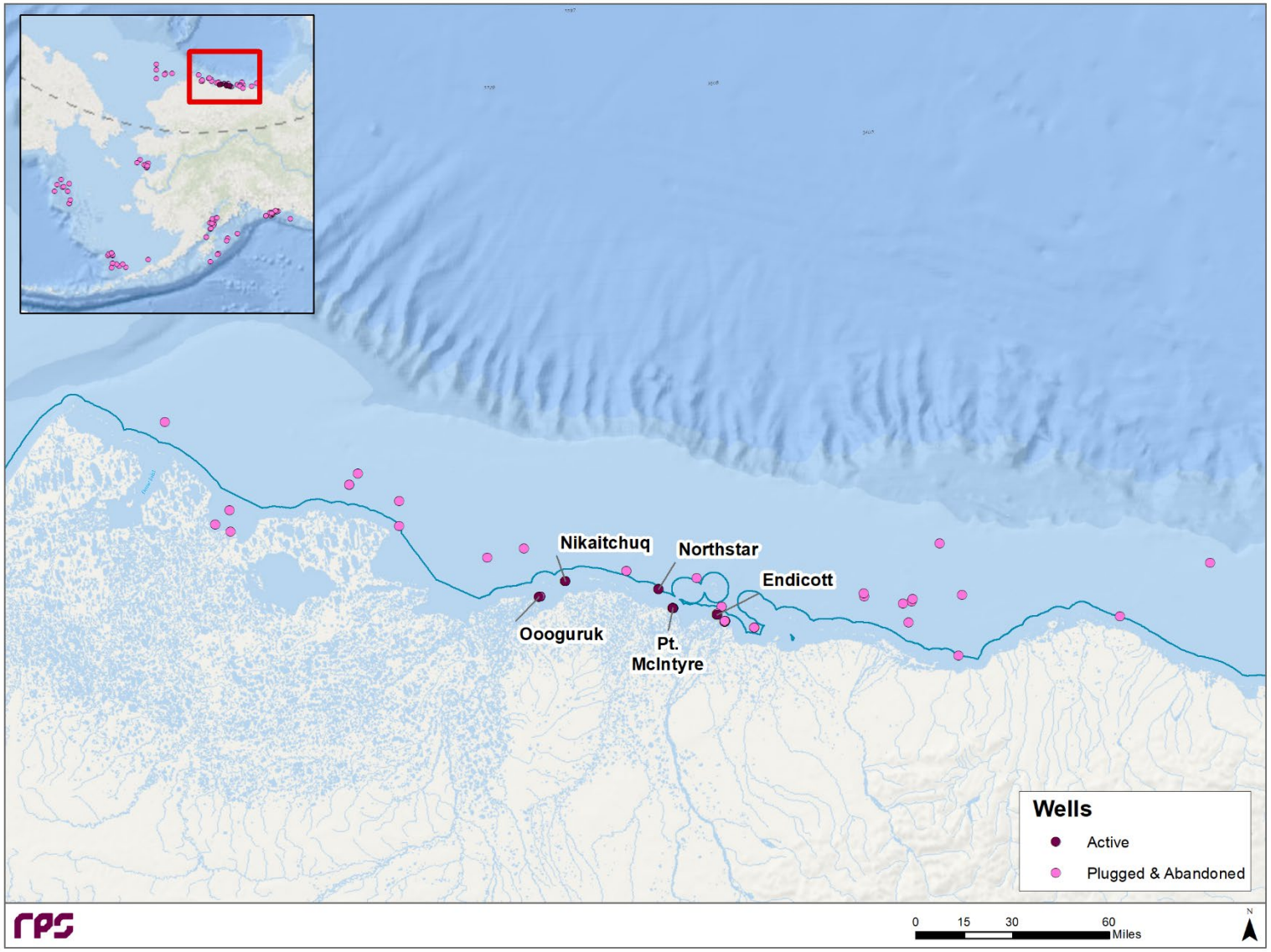

Figure 24. Active Offshore Platforms and Wells in Beaufort Sea.

7.4 Beaufort Sea Pipelines

The locations of pipelines in the Beaufort Sea are shown in Figure 24.

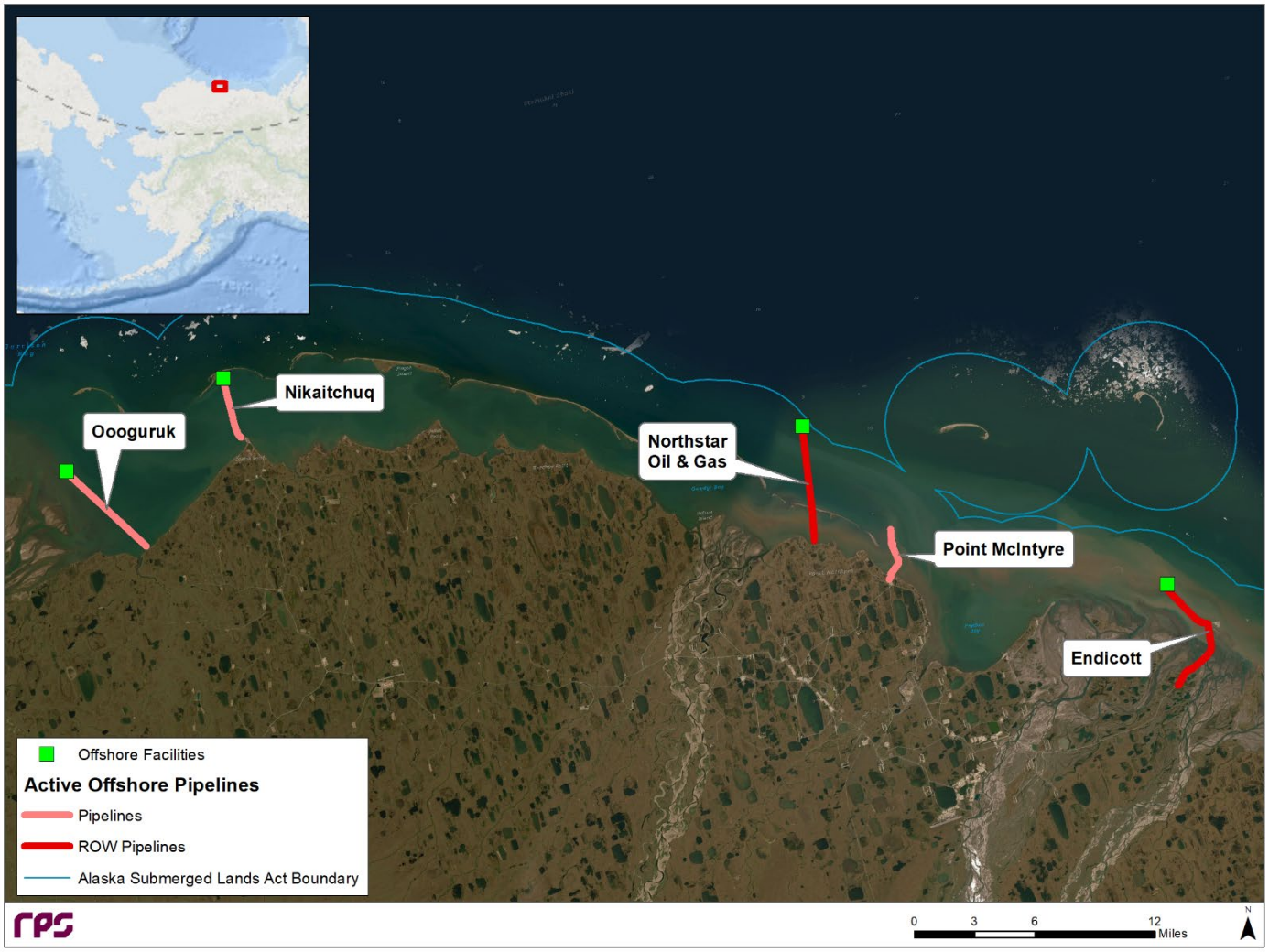

Figure 25. Pipelines in Beaufort Sea.

7.5 Beaufort Sea Offshore Production

Each year, over 121 million bbl of oil, and over 3.4 million mcf of gas are produced in the offshore wells in the Beaufort Sea.

7.5.1 Highest-Producing Leases

The highest-producing oil and gas leases in the Beaufort Sea, state and federal lease planning areas, are shown in Table 8 and Table 9, respectively.

Table 8. Highest-Producing Oil Wells in Alaska State Waters Beaufort Sea (BSEE Jurisdiction Only)

API Well Number	Well Name	Annual Production	
		Oil (bbl)	Gas in the Same Lease (mcf)
50629234800000	Nikaitchuq (Spy Island SP33-W03)	475,329	43,948
50629235130000	Nikaitchuq (Spy Island SP12-SE3)	427,473	43,263
50629234530000	Nikaitchuq (Spy Island SP18-N05)	316,667	61,624
50629234670000	Nikaitchuq (Spy Island SP16-FN03)	313,313	33,121
50629234730000	Nikaitchuq (Spy Island SP10-FN05)	305,201	50,360
50629234760000	Nikaitchuq (Spy Island SP30-W01)	301,161	34,036
50029227610000	Pt McIntyre (Prudhoe Bay UN PTM P2-01)	277,384	3,874,279
50629234780000	Nikaitchuq (Spy Island SP22-FN01)	269,937	21,237
50029222890000	Pt McIntyre (Prudhoe Bay UN PTM P2-30)	249,894	1,417,536
50629235370000	Nikaitchuq (Spy Island SP04-SE5)	248,633	40,555

Table 9. Highest-Producing Gas Wells in Alaska (BSEE Jurisdiction Only).

API Well Number	Well Name	Annual Production	
		Gas (mcf)	Oil in Same Lease (bbl)
50029224640100	Endicott Satellite Drilling Island (SDI 4-10A)	62,941	13,070,594
50029225690000	Endicott Main Processing Island (MPI 1-19)	49,313	10,777,317
50029220140000	Endicott Main Processing Island (MPI 2-36)	47,475	8,514,446
50029225620000	Endicott Main Processing Island (MPI 1-31)	34,922	8,186,194
50029218580000	Endicott Main Processing Island (MPI 2-68)	98,129	7,602,435
50029220320000	Endicott Main Processing Island (MPI 2-18)	80,443	7,024,276
50029228380000	Endicott Satellite Drilling Island (SDI 3-31)	106,281	6,207,014
50029218470200	Endicott Main Processing Island (MPI 2-28B)	61,139	6,053,628
50029223060000	Endicott Satellite Drilling Island (SDI 3-03)	37,790	5,986,520
50029224640100	Endicott Satellite Drilling Island (SDI 4-10A)	196,893	5,330,773