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National Petroleum Reserve in Alaska

HISTORY OF THE SECOND EXPLORATION 1975 to 1982

Husky

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NATIONAL PETROLEUM RESERVE IN ALASKA

THE SECOND EXPLORATION, 1975 - 1982

NATIONAL PETROLEUM RESERVE IN ALASKA
(Formerly Naval Petroleum Reserve No. 4)

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: John F. Schindler

For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
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FORWARD

When the Department of Navy conducted the exploration for oil in Naval Petroleum Reserve No. 4 during the years 1944 to 1953, the stated aim was "to ascertain whether or not petroleum existed in commercial amounts in the Alaskan Arctic". Those original efforts resulted in a partial appraisal and the discovery at two widely spaced locations of one medium and one small oil field (the Umiat and Simpson discoveries), a gas field thought to be large (the Gubic field) and other gas deposits of lesser size or more unknown potential. During the intervening years, geologic, seismic and logistic methods and techniques evolved considerably and became much more sophisticated. The "second" exploration, 1975 to 1982 had the advantage of the previously gained knowledge and the improved techniques of investigation and operation. When Public Law 94-258 transferred the Reserve and the responsibility for the exploration from the Secretary of the Navy to the Secretary of the Interior, there was a subtle change in exploration philosophy. The Congressional mandate directed the Secretary of the Interior to learn as much as possible about the Reserve and its renewable and non-renewable resources to better plan its wise management and utilization. The principal aim for the major portion of this second period of exploration became the acquisition of knowledge with the discovery of oil or gas a hoped for and fortuitous, but yet secondary, objective.

The success or failure of any program is highly dependent on the contribution of the people involved and the credit for the successful exploration of the NPRA belongs to all personnel. Numerous local, state, and federal government agencies contributed to the program as well as private organizations and industry contractors and subcontractors of many professions. The contributions of George Gryc, Chief of the Office of NPRA, USGS, and Max Brewer, Chief of Operations NPRA, USGS, deserve special mention, however, because their extensive knowledge of Arctic and NPRA matters and the diligence and dedication with which they applied that knowledge, contributed greatly to the excellent coordination between the diverse agencies, people, and organizations, and facilitated many projects that would otherwise have been impossible.

The purpose of this report is to provide the reader with a historical overview of the recent (1975-1982) exploration, and is to serve as the unifying prologue for a series of reports concerning geology, drilling, engineering, construction, transportation, communications, and environment. These reports are listed in the bibliography.

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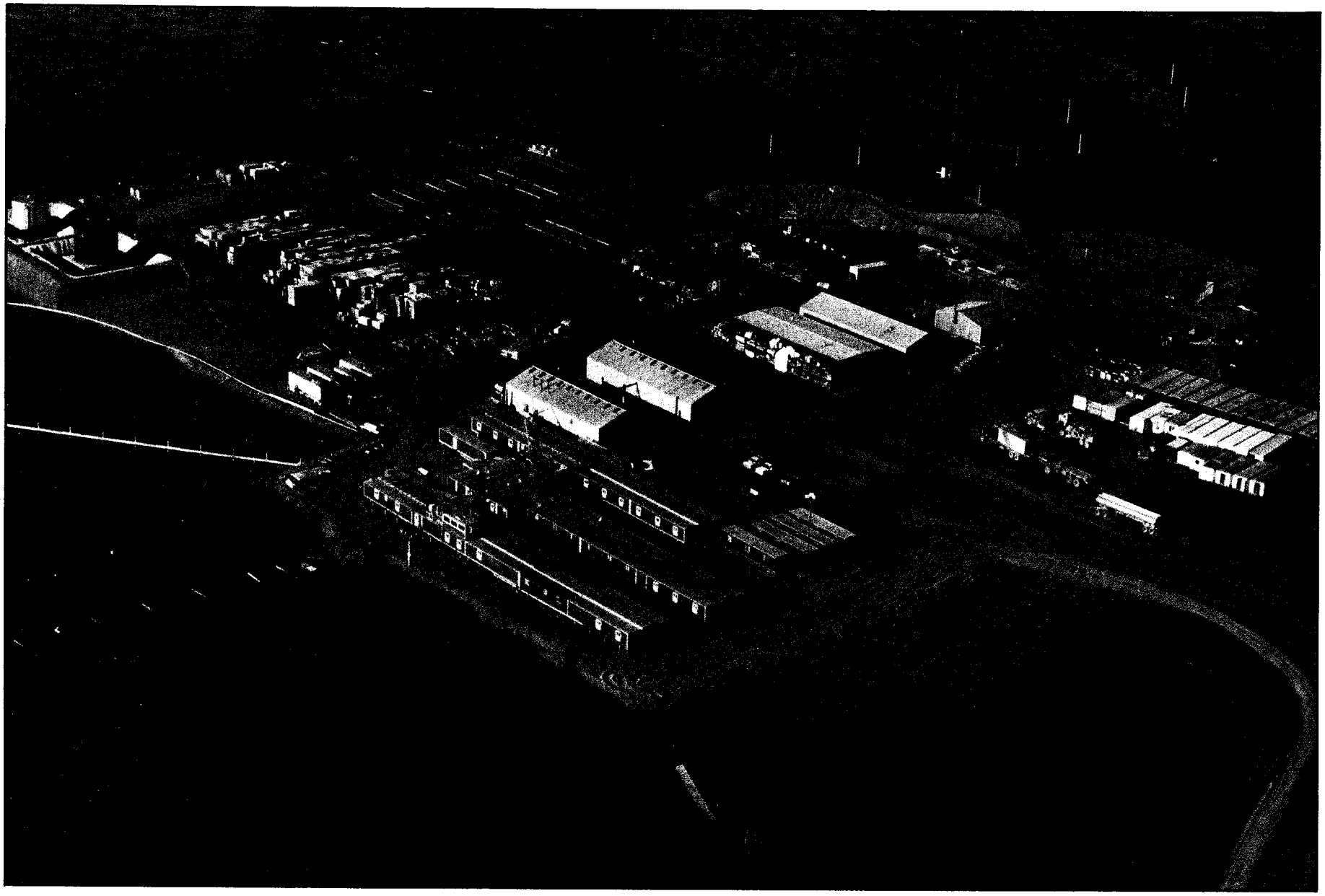


CAMP LONELY, the exploration base camp, near Pitt Point on the shore of the Beaufort Sea, July 1979.
(Photo by J. Haugh)

INTRODUCTION

The program of government exploration and investigation of the possible oil resources of the Alaskan North Slope spans over 38 years of time (1944 to 1982), and the historical gamut of many types of equipment, methods of investigation, and logistical support. All of this is a reflection of the progress of technology and the methods of getting the job accomplished, in response to, in spite of, and with protective deference for, the environment. The severe climate of the Arctic Slope is the overriding influence affecting plans, budgets, and operations. Few other geographic areas of the world require such consistent attention to the climatic restraints and the environmental parameters.

This exploration program was built on the experience of the earlier efforts of the U. S. Navy and also on the Prudhoe Bay lessons, and evolved into a sophisticated operation with excellent communication and control. It is a product of, and a tribute to, all of the personnel involved which included many agencies of federal, state, and local governments as well as private industry and individuals. This report is a brief history of those efforts.

Alaskan Arctic

The Arctic Slope of Alaska extends northward from the Brooks Range to the Arctic Ocean and from Cape Lisburne on the west to the Canadian boundary on the east. Its maximum dimensions are more than 600 miles east-west and 200 miles north-south. The area is equal to 1/7 the area of the entire State. A major portion of the Arctic Slope is within the National Petroleum Reserve in Alaska (NPRA). The Reserve boundary extends due south from Icy Cape (approximate longitude 162°W) to the drainage divide of the Brooks Range. It then follows the divide eastward to longitude 156°10'W where it turns due north to the Colville River. It follows the Colville to the mouth of the river at approximately latitude 70°25'N, longitude 151°20'W. The enclosed area encompasses approximately 37,000 square miles of Arctic terrain.

The Arctic Slope is divided into three physiographic provinces and each of these provinces is represented within the Petroleum Reserve. These are the Coastal Plain, the Foothills, and the northern slope of the Brooks Range. Each of these provinces has unique topography, geology, soil, vegetation, and to some extent climate (refer to Figure No. 1).

The Coastal Plain

The Coastal Plain ranges from sea level to between 500 and 1,000 feet in elevation. It is extremely flat, poorly drained, and underlain almost everywhere by permafrost. Frost polygons in the form of either high or low centers are prevalent especially where there is vegetative cover. About one-fifth of the Coastal Plain is covered with lakes which are frozen for nine months of the year. Streams thaw in June and meander towards the coast in broad shallow silty channels, often extremely braided. Much of the Coastal Plain soil is a coarse, unconsolidated deposit, and generally contains dark reddish-brown organic materials near the surface. In the broad shallow wet depressions, deposits of peat are common. Flood

beaches along the rivers and lakes consists of clean mineral soils sorted by the wind and the water. The climate of the Coastal Plain is modified by the adjacent cool ocean. Average temperature of the three summer months at the farthest north point (Barrow) is only 38 degrees Fahrenheit and there are only about 60 degree-days above freezing during the entire summer. During the summer months winds average more than 12 MPH and most of the time cloudiness or fog prevails.

The Foothills

The Foothills consist of rolling hills and valleys with moderately drained slopes and poorly drained lowlands. This treeless belt of rolling hills extends along the entire north side of the Brooks Range and varies in width from about 20 miles near the Canadian border to about 80 miles in the vicinity of the Colville River. The altitude of the Foothills starts at about 700 feet along the northern boundary and rises to as much as 4,000 feet along the southern boundary. The Foothills province consists of two subsections. The Northern Foothills are characterized by long parallel east-west ridges and valleys. The ridges commonly are formed of relatively resistant sandstone and conglomerate. The Southern Foothills have a more complex topography and form isolated hills perhaps of sandstone or limestone separated by lowlands commonly underlain by softer rocks such as shale. This topography contributes to three widespread soil types: (1) the residual silty soils of the uplands, (2) the peat deposits of the wetter lowlands and depressions, and (3) the coarse sand and gravel along the flood plains. The Foothills' climate is somewhat warmer than that of the Coastal Plains or the Mountain Provinces and the vegetation is a reflection of this increased temperature.

The Mountains

The Brooks Range is a northwest continuation of the Rocky Mountain system. Elevations vary from approximately 3,000 to 9,000 feet. The lower north-south passes through the mountains are at about 2,000 feet. The valleys along the mountain front are characterized by glacial lakes. Exposed bedrocks in these mountains include great thicknesses of limestone, sandstone, conglomerate, and shale. Because of glaciation, frost action, and rapid erosion of slopes by running water, little soil has accumulated and vegetation is sparse. Moraines and outwash deposits are locally common along the mountain valleys.

Drainage

Drainage varies greatly over these three physiographic divisions. In the Coastal Plain the streams are shallow and sluggish. They flow in contorted complex channels winding through literally thousands of shallow lakes. Lakes are so numerous that, in many places, areas contain more water than land. Lake shores are low bluffs commonly only a few feet high and sometimes lakes edges are indeterminate; the water gradually giving way to the swampy tundra. Over a large area the lakes are elongate and markedly oriented with their long axes approximately north, northwest or approximately perpendicular to a northeast/southwest direction. The area of oriented lakes covers over half of the Coastal Plain.

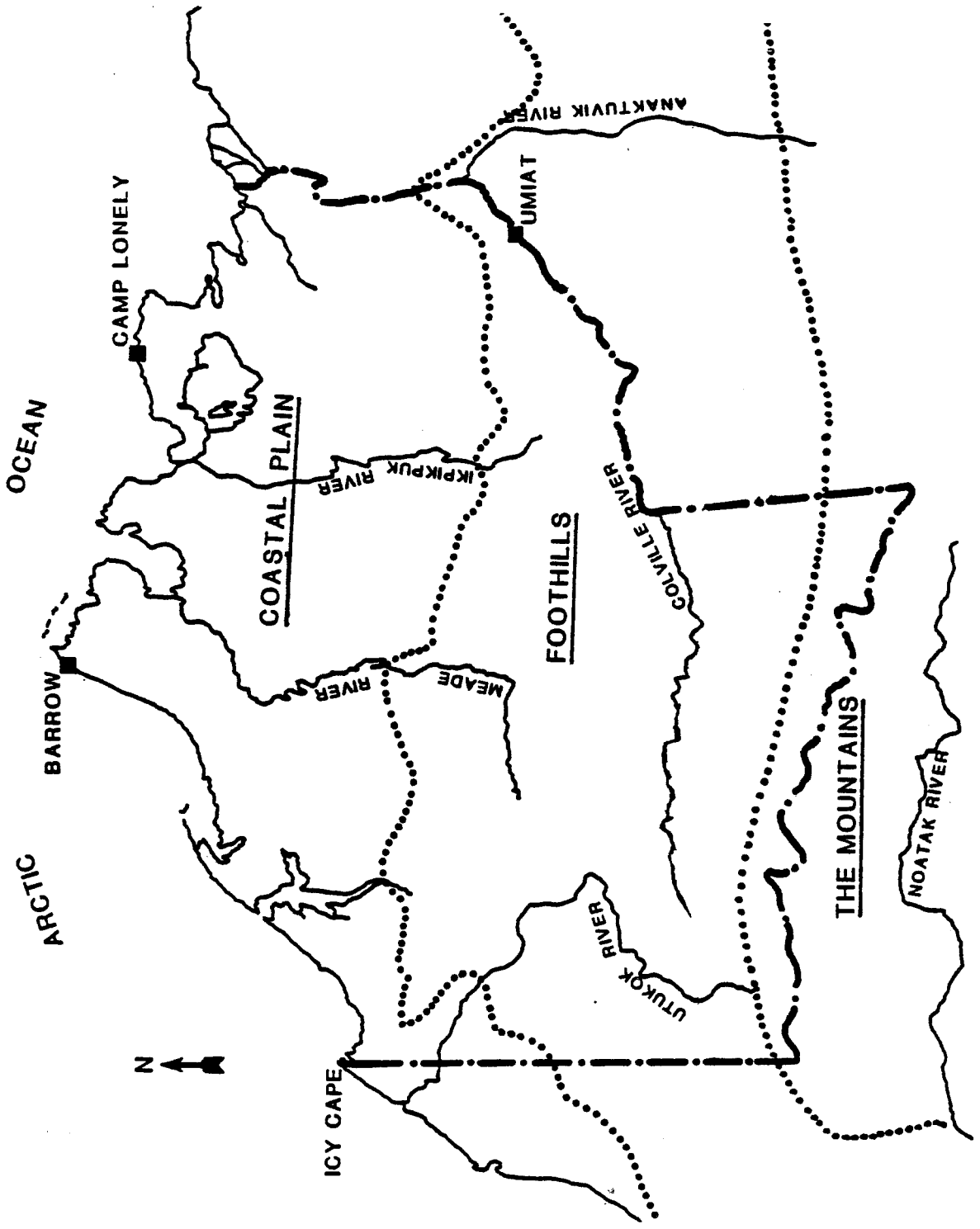


FIGURE NO. 1. PHYSIOGRAPHIC PROVINCES OF NPRA

The Coastal Plain. Polygons outlined by ice wedges are the most common feature. August 1980. (Photo by S. Krogstad).

The Foothills Province near Archimedes Ridge, August 1978. (Photo by D. Braden)

Within the Foothills, streams are incised into the gently rolling country. Major streams can be incised as much as 100 to 200 feet. These streams cross main structural trends and in many places expose the bedrocks. Minor streams and tributaries in the area are largely controlled by structure. The most important river of the Foothills is the Colville which forms a boundary for the eastern and southern portion of much of the Reserve. The Colville is of interest to geographers in that it is the only major river in the world with its entire drainage basin north of the Arctic Circle. As such it is subject to widely fluctuating water levels ranging from extreme highs during spring breakup, to lows in late July. August rains can also swell the volume of the river dramatically.

Drainage within the mountain areas is northward, often across dominant structural features. Valleys are deeply incised with steep slopes and the divides are generally sharp and craggy. Except for the Utukok River all significant rivers and streams arising within the mountainous area of the Reserve are tributary to the Colville River.

Climate

Temperatures vary widely within the Reserve and seem to be highly local in many instances, but weather generally can be characterized as cold and windy.

The climate along the coast is moderated by the ocean and does not reach the extremes of cold and warm that characterize many parts of the interior. Official temperatures as cold as minus 76 degrees Fahrenheit have been reported at Umiat, but the minimum temperature of record at Barrow is minus 56 degrees Fahrenheit. Likewise in the summer months temperatures in the coastal areas seldom reach 60 degrees while the interior has recorded temperatures as warm as 88 degrees. So the climate of the North Slope is thus characterized as severe with long winters and short cool summers, with frequent fog and persistent winds year-round. The warmest month everywhere on the Slope is July followed by August and then June.

Permafrost

Just as all operations above the surface of the ground are influenced by the severe weather of the Arctic Slope, all of the surface and subsurface activities are affected by the permafrost. Permafrost is generally defined as any naturally occurring material that has a temperature below the freezing point of fresh water for two or more years. By definition, it is a condition of temperature irrelevant of the presence of moisture. Near the coast, the depth of permafrost is from the seasonal thaw depth (± 2 feet) to about 400 feet at the ocean edge, and it increases in depth with inland progress. It is approximately 600 feet in depth 1,000 to 1,500 feet from shore and 1,200 feet in depth four to five miles inland. It can range to over 2,000 feet at its deepest in Arctic Alaska. There are three ground phenomena in the Petroleum Reserve that are prominent and prevalent and all owe their existence to permafrost. These are polygonally patterned ground, pingos, and oriented lakes.

The polygonal ground patterns, which are so evident to even the casual observer, constitute surface evidence of the ice wedges underneath. Such wedge-shaped vertical ice sheets vary in width from a few inches to ten feet wide at the top and from four to twenty-five or more feet deep when seen in vertical sections. It is now believed that the wedges are caused by the cold contraction of the tundra which forms cracks in the winter. In the spring the waters from the melting snow run down the cracks and freeze and then remain frozen all through the summer. In the following winter this ice filled crack is a zone of weakness and renewed contraction reopens the crack and continues the process. This cycle acting over centuries of time is thought to produce the vertical wedge shaped ice forms. The outlines of the network of these wedges form the boundaries of the surface polygons. The form of these polygons depends upon the surface drainage. In low or wet areas, low centered polygons are formed. In higher areas where drainage can occur and accelerate the melting along the ice rich wedge, high center polygons are formed. Even in areas where no polygonal structure is evident at the surface, the subsurface is almost always ice rich.

Pingos are another evidence of ice formation. It is thought that pingos are formed when a relatively deep lake drains over a short period of time. A deep lake is defined as one that does not freeze to bottom each winter but maintains a thawed zone in its lower extremities and subsurface deposits. When the lake drains, the moisture in this thaw bulb then begins to freeze, both from the surface downward and from the underlying permafrost upwards towards the surface. The theory is that the water is trapped under hydrostatic pressure, it freezes, and the resulting volume expands. This bulge, slowly formed, raises the surface tundra. Pingos can be quite high, some up to 50 feet or more, and the enclosed ice is generally a clear, sometimes massive, lens shaped body.

The phenomenon of oriented lakes, so strikingly evident in the northern third of the Coastal Plain, is found in an area of poor surface drainage. The waters are confined to the surface by the underlying cement-like permafrost. The lakes have their long axes in a slightly west of north to slightly east of south direction. Every theory imaginable from prehistoric winds to Paul Bunyan folklore has been proposed to explain these orientations. It is now generally thought to be a result of the present day prevailing northeast southwest winds. These winds are at right angles to the long axes of the lakes. When the lake ice begins to thaw in the spring a narrow moat of water is formed in the shallow area around the perimeter of the lake. The spring winds blow this central mass of ice back and forth across the lake and cause the water of the moat to move rapidly around the ends of the lake. This shifting of water has a somewhat venturi effect, and rapidly erodes those areas. The ice, of course, protects the longer edges of the lake from most of the water action. This sequence of events, repeated six, eight, or ten times each season, and season after season, gradually elongate the lakes perpendicular to the prevailing wind direction. Some studies with dye and water current tracers have been done in the lakes during thaw and this work supports the explanation.

Permafrost is far more than a fascinating scientific phenomenon. It is a dominant factor in engineering, building, and operating in the Arctic. In the summer the wet soggy tundra is difficult to traverse even on foot. Ground vehicles with normal tires find the terrain impassable. Tractors can operate with difficulty but leave surface disturbance scars that will be present for anywhere from 50 to 100 years. Surface water is abundant in the summer but there is no subsurface ground water and in the long winter the surface is frozen to the depth of permafrost. The only water available is beneath the ice in the deeper lakes. Sewage disposal is restricted to above ground operation or extremely well insulated utilidors. Foundations for major structures are usually supported on piles that are set and frozen in holes which were augered into the permafrost. The building or the drill rig must then be insulated sufficiently to prevent the heat from melting the supporting frozen ground. Warm drilling muds can cause special problems. Pad and road locations must be carefully selected so as not to disturb surface drainages sufficiently to cause erosion. Erosion only exposes the permafrost to further degradation. The implications of permafrost in relation to the engineering activities mentioned are obvious. Permafrost problems can be solved but the design solution is often difficult and expensive. The solutions as employed in this exploration program are discussed in the individual reports.

Vegetation

The most striking feature of the North Slope of Alaska is the wide open, flat, treeless space stretching from horizon to horizon. However, there are trees (willow, birch and alder) but they have such small stature and thickness as to be impractical even for firewood except in some of the deeper river valleys where they can grow to heights of fifteen feet. There are flowering plants in abundance but the season of blossoms is very short. They bloom quickly in the continual summer daylight and are present briefly in colorful profusion. Common flowers include purple and white anemones, poppies, mustard, saxifrage, roses and asters. Most of the area excluding the major valley bottoms is typically tundra. The tundra is commonly a thick spongy mat-like growth, made up predominantly of grasses, sedges, mosses, lichens and prostrate shrubs or bushes. Some areas, especially the ridge tops, are almost completely bare of vegetation.

Animals

The most numerous member of the animal population of the North Slope is a small rodent, the brown lemming. The lemming population locally fluctuates greatly in numbers varying from almost none to literally hundreds per acre of land surface every three to four or more years. Other small animals include mice, shrews, voles, weasels, squirrels, mink and martin. Of the larger animals it is the natural home of the Arctic wolf, the wolverine, caribou, moose, barren land grizzly and Arctic fox. The Arctic fox is also present in the blue color phase and the red fox is present along with its color phases - cross and silver. Dall sheep are also present in the mountains. Although the wolf and wolverine are very efficient hunters, they, like most wild animals, will avoid contact with man and are not considered dangerous unless cornered. The barren land

grizzly has little fear of anything and is dangerous because of his innate curiosity. Generally however, a loud noise is sufficient to scare him off. This is not true of a sow with cubs and they should be given a wide berth. Surprisingly the Arctic fox is the animal most dangerous to man on the North Slope. Rabies is endemic in the Arctic fox population and every fox can be considered to be a carrier of the disease. One must be especially fearful of animals which show unnatural boldness or lack of fear of man. These usually are infected animals and it is their disease that makes them so fearless.

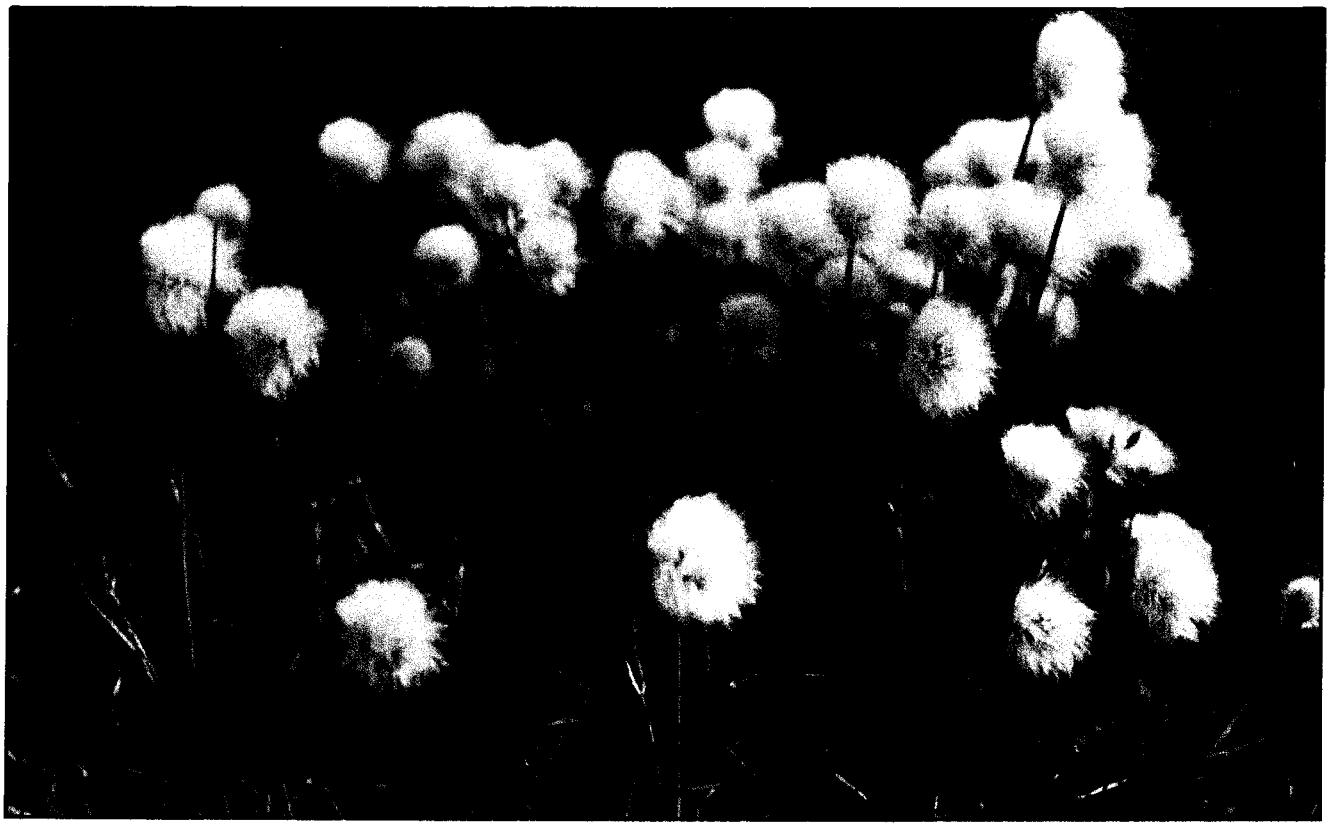
Birds are present on the Reserve in large numbers and great variety especially during the brief summer season. Gulls, Arctic terns and jaegers are abundant, as are ptarmigan, plovers and longspurs. Shore birds are conspicious on sandy stretches of beaches. Ducks, geese, loons and swans are widespread over the Reserve. There are also large numbers of hawks including the rough leg hawk and peregrine falcon. The great snowy owl is often abundant especially when the lemmings are numerous. For a few weeks in the summer from about mid-June until about early August mosquitoes are present in such unbelievable swarms as to be a great nuisance to field workers. They are harmless so far as disease is concerned but all activities are plagued by them. Repellents and other sorts of protection are a must in order to be able to carry on effective field operations.

Inhabitants

Anthropologists claim that Eskimos have resided in the Arctic for a period in excess of 8,000 years. Two distinct groups of Eskimos are to be found in the area of the North Slope. The Nunamiut, a land people whose mode of living evolved around the caribou and the Tareumiut, a coastal people whose life style was oriented toward sea mammal hunting. Historically the Eskimo population was comprised of nomadic bands whose location was determined by the availability of fish and wildlife. Today the Eskimos of the Petroleum Reserve reside principally in four cities. Ukpeagvik (Barrow) has a population of approximately 3,000 people. Olgoonik (Wainwright) has a population of approximately 400 people. The resettled village of Atkasook (Meade River) has a population of approximately 150 people and the new village of Nuiqsut on the Colville River has a population of approximately 300 people. The North Slope Borough reports a population overall of an estimated 6,200 persons of which 1,750 are concerned with oil and gas (i.e. temporary residents of Prudhoe Bay).

The first representatives from the Western world to discover Wainwright and Barrow were Captain F. W. Beechey and his crew of the HMS Blossom. When Beechey had passed Wainwright and was stopped by ice, he sent First Mate Thomas Elson and Seaman William Smyth in an open boat to explore northward. Beechey named the point in September 1826, for Sir John Barrow the First Lord of the Admiralty of the British Naval Administration and a strong advocate of exploratory navigation. The City of Barrow 10 miles southwest of the point was called Barrow by the white residents as they found it easier to pronounce than the Eskimo name (Ukpeagvik). The village of Wainwright was named by Beechey for Lt. John Wainwright, the Astronomical Observer and Navigational Officer of

Arctic Poppy. *Papaver lapponicum* subsp. *occidentale.*



Arctic Cotton Grass. *Eriophorum vaginatum* subsp. *spissum.*

his ship. Over the years the Natives have survived the sporadic contact with the white man that changed their way of life by being resilient and able always to return to the subsistence mode of living. Originally the Natives were susceptible to common diseases of the white man such as measles and tuberculosis, but over the years, with increased health care and increased contact, this resistance has significantly improved. The Eskimo people have contributed greatly to the early exploration program as well as to this one with their knowledge and experience of coping with this harsh environment.

Traveling

Historically the Eskimo covered great distances by dog team to hunt the caribou. Today they still hunt caribou but do so by snow machine, again covering great distances pulling sleds behind them, often on the trail for two to three weeks.

Winter travel is still the most feasible, especially for large equipment. For the original petroleum exploration (1944-1953), large tractors were by far the most important pieces of equipment. Tractors are still important for cross-country travel but in many cases they have been supplemented by rolligons and other large rubber-tired vehicles. Aircraft were used during the early Navy exploration and became the veritable work horse of the government's latest efforts. Modern day helicopters became the mode of support for almost all summer operations. Travel will be discussed again under "Equipment" and talked about throughout each year's history of the exploration.

EARLY EXPLORATION

So far as the record shows the first white man to see any part of the Petroleum Reserve was Captain James Cook, who, in 1778, penetrated the Bering Strait and sailed northeasterly along the coast of Alaska as far north as Icy Cape, the point approximately where the western boundary of the Reserve now reaches the Arctic Ocean. It was 48 years later in 1826 that Captain F. W. Beechey pushed northeastward until blocked by ice north of Franklin Point and Elson and Smyth proceeded north as far as Point Barrow. At the same time Sir John Franklin was working westward from the McKenzie River and reached a point near the eastern edge of the Colville Delta where he too was stopped by ice. Eleven years later, in 1837, Dease and Simpson, after traveling down the McKenzie, pushed westward past the Colville and reached a point a little beyond Cape Simpson where they landed and proceeded on foot. A short time later they reached Point Barrow finally closing the exploration "gap" after the long trek from the east.

Knowledge of the north was gained from the various expeditions between 1848 and 1853 sent out for the relief of the missing party of Sir John Franklin who was lost in 1845. On one of these (in 1849), Lt. Pollen proceeded in a small boat from Kotzebue Sound all of the way around the Arctic coast to the McKenzie River and then up the river to the Hudson Bay Company post. In 1848 and almost annually thereafter, vessels of the American whaling industry penetrated the Bering Strait into Arctic waters.

In 1881, Lt. P. H. Ray led the International Polar expedition to the vicinity of Barrow. At that time Northern Alaska had been American territory for 14 years. The first overland penetration of the Reserve was made by Ensign Howard when he left the Valley of the Noatak in the spring of 1886 and proceeded northeast to the Valley of the Colville. He continued overland to the Chipp River and followed the river to the coast in a skin boat and arrived in Pt. Barrow on July 15. Starting in the early 1900s, the U. S. Geological Survey sponsored many parties for exploration and geologic investigation including W. J. Peters and F. C. Schraeder in 1901 and Leffingwell and Anderson in 1906-1914. Further valuable contributions were made by Stefansson between 1908 and 1918. With the establishment of the Naval Petroleum Reserve by President Harding in 1923 another series of exploration and geologic investigations by the U. S. Geological Survey was begun at the request of the Navy Department. These, together with the information from the field survey efforts, supplied a reasonably adequate but still generalized picture of the major geologic features of the Reserve. By the 1940's the major features of the geology were reasonably well understood over the whole Reserve and much of the surrounding areas. Geographic positions and evaluations were known with reconnaissance accuracy and large areas had been mapped topographically.

THE U. S. NAVY SEARCH FOR OIL 1944 to 1953

The Director of the Naval Petroleum Reserves sent a proposal to the Secretary of Navy in February of 1944 to accomplish exploration and test well drilling of Naval Petroleum Reserve No. 4. By the following month the feasibility of this proposal had been determined and the Executive and Legislative branches of the Government were informed. A reconnaissance was made in March and April of that year and in June the President approved the project. By the end of 1944 a camp had been built near Pt. Barrow by a Navy construction battalion and air service was in operation. The project was ready to proceed. In the spring of 1945 the first tractor drawn sled train hauled large tonnages over long distances. The first ship expedition that summer was successful and air support had been established. Information from the geological and geophysical investigations as well as drilling was accumulated and interpreted.

In 1946 the operations switched from a military CB (Construction Battalion) detachment to a civilian contractor operation. Air photography and mapping were done as well as airborne magnetometer surveys. The first test hole, Umiat Test Well No. 1, was drilled to 6,005 feet. In 1947 more than 15,000 feet of drilling was done and over 700,000 ton miles of winter freighting were accomplished. Through 1947-48 the results of the drilling were supplying an ever increasing and ever improving background of data. During 1948 Simpson Test Well No. 1 was drilled to the basement rocks in the Cape Simpson area and a stratigraphic test had been drilled near Barrow. In 1949 winter freighting reached an aggregate of 1.3 million ton miles. South Barrow Test Well No. 2 was completed as a gas well and supplied gas to the Barrow Camp. In 1950 drilling totaled 36,000 feet at sixteen separate sites. Both Umiat and Simpson had indications of gas and oil. In 1951 the program was slow to start because of doubt as to whether or not it was to continue. In spite of the late start, winter freighting

totaled 1,860,000 ton miles and drilling at over 20 separate sites totaled over 47,710 feet. The small field at Cape Simpson was proven and the Umiat field better defined. In 1952 only 15,142 feet of hole were drilled at four sites. However, winter freighting totaled 2,412,000 ton miles. It was decided to recess the exploration in 1953 and equipment and supplies were moved to central points for inventory, storage, and in some cases return shipment. No drilling was accomplished but geology and geophysical work was continued to logical stopping points. Over the ten year period of exploration a total of 80 holes (36 cores tests and 44 actual wells) were drilled for a total of 169,250 linear feet. Most of these were very shallow with Topagoruk and Oumalik being deeper. Three possible oil fields were discovered, Umiat, Simpson and Fish Creek and six possible natural gas fields were found. These were Barrow, Gubic, Wolf Creek, Oumalik, Meade and Square Lake. It is interesting to note that when the exploration was recessed in 1953 by Presidential order, the Navy had a drill rig and supplies ready to move out from the Umiat area to drill on the Shaviovik River just to the east of Prudhoe Bay.

THE INTERIM: 1953 - 1974

Between the early government exploration efforts from 1944 to 1953 and the program under discussion here, a number of events occurred which had considerable impact on the latter.

In 1947, at the height of the Navy's exploration activity, another branch of the Navy, the Office of Naval Research, established a basic research laboratory in a vacant quonset in the Barrow Camp. The Laboratory slowly grew in number of people and stature and at the time of "close down" for the oil exploration activity, the Arctic Research Laboratory (ARL) fell heir to the Barrow Camp and a good deal of the facilities, equipment and supplies that were surplussed by the exploration program. The Laboratory was the sole "occupant" of the Camp until 1955 when the Air Force, under an agreement with the Navy, assumed the custodial responsibilities to use the facility as a base for the construction of the western third of the North American DEW (Distant Early Warning) Line. In 1957, when the DEW Line was commissioned, the Air Force retained the Barrow Camp as a support base for activities along the line. The laboratory was renamed the Naval Arctic Research Laboratory (NARL) in 1968.

In 1958, the law making Alaska a full fledged state of the union was passed and signed in January 1959. This law included provisions for the state selection from Federal lands of up to 104 million acres for support of the fledgling state government. Some leases and exploratory permits were issued on these selected lands and petroleum exploration activity began on the North Slope east of the Pet 4 (NPRA) in 1960.

In February of 1968, the Atlantic Richfield Company, drilling on land leased jointly with Humble Oil and Refining Company brought in its first well, Prudhoe Bay No. 1, and four months later made the confirmation strike. Reserves were estimated at up to 10 billion barrels. The sheer size of the strike encouraged a greater interest in North Slope Exploration and was the basis for the $900 million State of Alaska lease sale in

October of 1969. Also in 1969, the National Environmental Policy Act was passed and one of the sections of this new law required the federal government to write an environmental impact statement assessing any consequences of federal actions before they were undertaken. The EIS became a tool often utilized more in the courts than the public arena during these turbulent times. In 1971, the Alaska Native Claims Settlement Act was passed establishing private corporations owned by Native stockholders as real estate and financial forces in the State of Alaska. In 1973, the Congress passed the Endangered Species Act prohibiting any federal activity that would endanger the habitat or the life cycle of any listed species. Even though these events arose for different reasons in response to distinct political causes, they became highly interwoven in the exploration for Arctic petroleum.

The oil discovered at Prudhoe Bay under State lands selected under the Statehood Act could not get to market, because a pipeline plan could not be approved across federal lands. Approval was blocked in the courts under the NEPA law by the environmental movement in concert with the Native Claims proponents. The research done at the NARL became the basis both pro and con for arguments about the construction plan, and although the research results were utilized by both sides in the long confrontation, a better engineering and construction plan ultimately resulted. The time delay, however, became excessive and costly and the pressures increased for the Federal Congress to act.

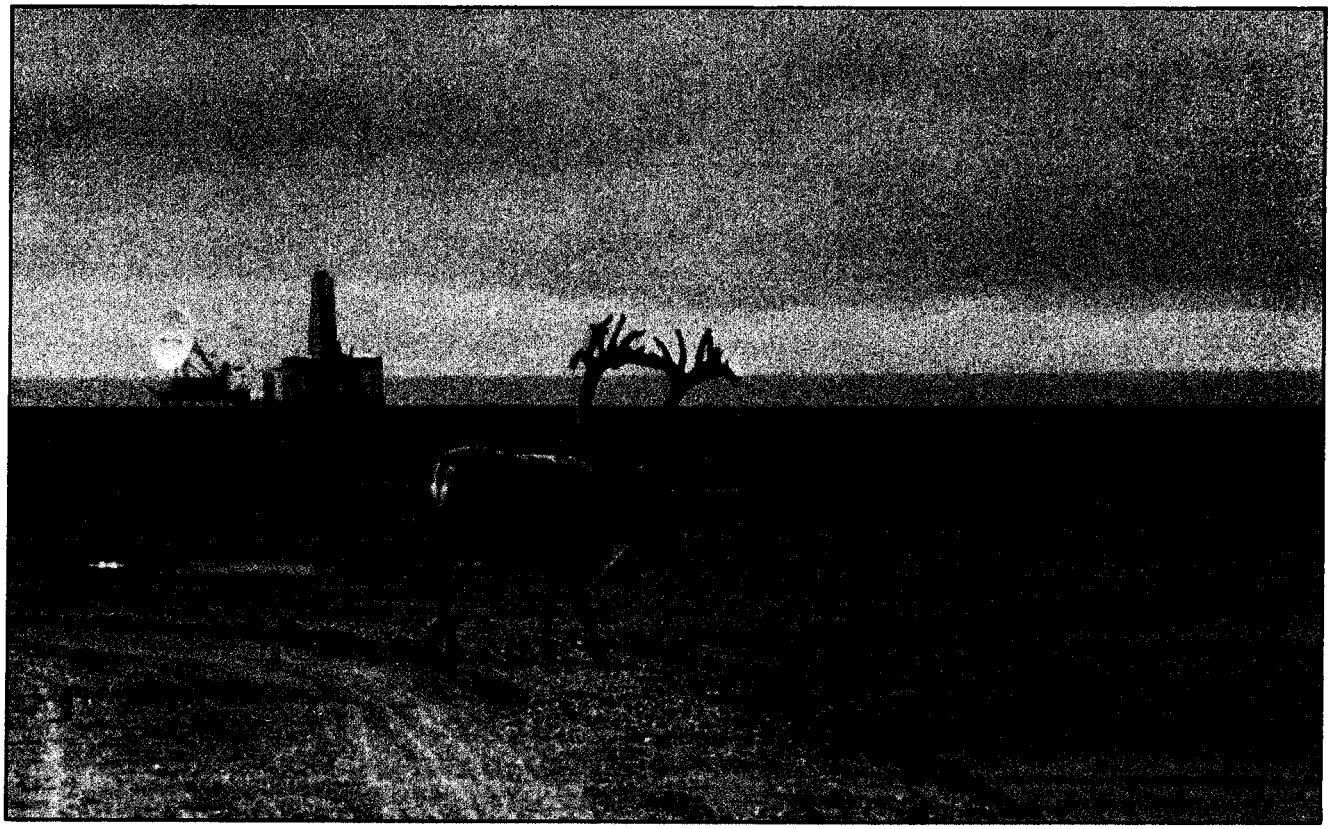
In 1971, partially as a result of NEPA, the Navy requested and received from Congress, funds to begin the cleanup of the debris left from earlier federal government activities on the Reserve. These cleanup efforts were directed at Umiat, Cape Simpson, Point McIntyre and the Barrow area. When the first exploratory program was funded by the Congress in response to the shortage of oil in the early 1970's, a cleanup effort was included as a line item in the exploration budget. Cleanup efforts were concurrently funded and accomplished during the entire program.

All of these activities focused increased interest on the Arctic petroleum reserve and the possibility of an oil discovery that would contribute to a solution for the National energy problem. The Navy formulated a plan for a new Pet 4 exploration program that would test formations deeper than the shallow Cretaceous rocks that were targeted in the 1944 to 1953 efforts. The Prudhoe Bay discovery was made in the deeper and older formations below the Cretaceous and the same formations were widespread throughout the Reserve.

RESUMPTION OF EXPLORATION

The OPEC (Organization of Petroleum Exporting Countries) oil embargo of 1973 again drew attention to the Naval Petroleum Reserves. Financial support had been proposed earlier in Congress to explore Pet 4 (NPR-4) and Teapot Dome, Wyoming (NPR-3) and to develop Elk Hills, California (NPR-1). The threat of continued oil shortages prompted Congress to add $11.5 million to the Navy budget in the Supplemental Appropriations Act of 1974. Of the $11.5 million, $4.0 million was designated to develop Elk Hills and $7.5 million was to initiate a small exploratory program in Pet 4.

Arctic fox near weather shack at Tunalik, March 1979. (Photo by P.D.J. Smith).



Caribou behind Camp Lonely, August 1981. (Photo by C.K. Lee).

Earlier, for ease in processing the old seismic data, NPR-4 had been arbitrarily divided into five zones, A through E. The Navy felt that Zone A was the most likely area to encounter an extension of the Prudhoe Bay productive zones, and in the interests of time, efforts were limited to this area. Thus the Navy began the preparation of a Draft Environmental Impact Statement (DEIS) for Zone A, to carry out the Congressional mandate for exploration as quickly as possible.

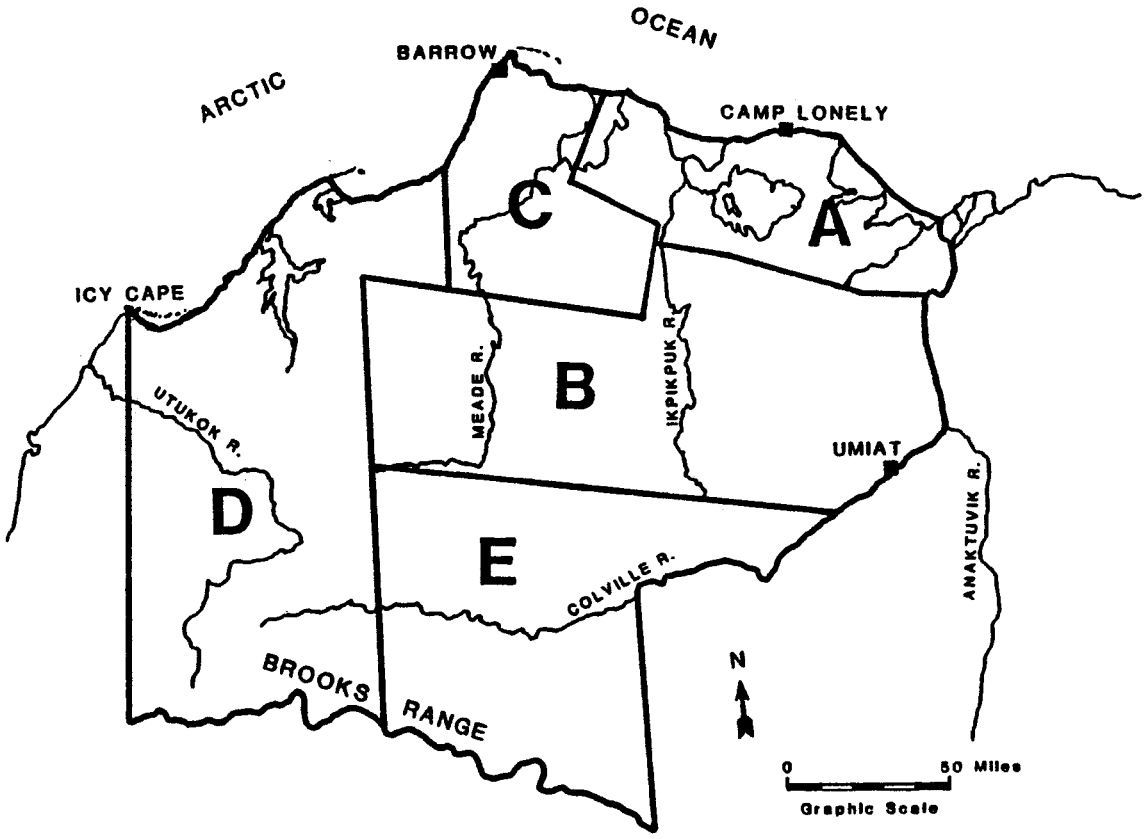


FIGURE NO. 2. SEISMIC ZONES A THROUGH E

While the Navy realized that restricting the DEIS to the area of Zone A was less than desirable, the funding provided by Congress did not indicate a large scope of work at that time.

The Navy planned to continue its earlier program of seismic surveying and exploratory drilling on Pet 4 in order to assess the petroleum potential of the entire reserve. The new plan called for over 10,000 line miles of seismic and geophysical surveys and the drilling of 26 exploratory wells.

Congress, based on hearings before a subcommittee of the Armed Services Committee, added $62.5 million to the Fiscal Year 1975 Defense Appropriations Act for the exploration and development of the Naval petroleum reserves. As part of the Administration's national energy program, the President also called for the exploration of NPR-4.

With this expanded funding and increased scope to encompass the entire area of NPR-4, the Navy thereupon announced a seven year program of exploration to obtain a preliminary inventory of the petroleum potential of NPR-4. The Navy proceeded with the preparation of a Draft Environmental Impact Statement for the program covering the entire reserve. Ancillary to conducting the earlier Pet 4 oil exploration program the Navy accomplished a great deal of pioneering in Arctic operations both on land and in seaborne transportation. The Navy had conducted research, particularly in the fields of permafrost, sea ice prediction, and Arctic engineering. Grant funding and logistical support through the Arctic Research Laboratory also were provided for many projects in basic research. This information, including the experience gained from some of the mistakes that had been made, was put to good use during the construction of the DEW Line during 1955-1957. The oil industry would also use this Arctic engineering and research data for the petroleum exploration in the Prudhoe Bay area and the construction of the development facilities and the pipeline to Valdez. In 1975-76 this information was used in the preparation of the draft and final environmental impact statements for this program.

Between 1953 and 1974, the Navy drilled eight additional shallow wells (South Barrow Wells Nos. 5 through 12) in the Barrow area to more fully develop the small natural gas field there for the use of the local government agencies and the people of Barrow. A ninth shallow exploratory well was drilled at Iko Bay in the spring of 1975. This was not considered part of the expanded exploration program.

EXPLORATION OPERATIONS 1974 - 1975

The early exploration program (1944-1953) acquired 3,300 line miles of seismic data. Although the results were crude when compared to those obtained with modern methods, these 3,300 miles of information provided a base for the beginning modern exploration program.

When Congress passed the Supplemental Appropriations Act of 1974, some of the $7.5 million designated for the exploration of Pet 4, was to be used for seismic investigations. In the winter-spring of 1974, GSI (Geophysical Services Inc.) working under the Navy's prime geophysical contractor (Tetra Tech, Inc.) completed 1,016 line miles, mostly in the area known as Zone A.

The Navy, recognizing its responsibility to conduct petroleum exploration over the entire reserve and also cognizant of the respect necessary for the land selections and other benefits that were made available to the Native peoples, entered into an agreement on May 14, 1974 with the Arctic Slope Regional Corporation and the cognate village corporations. This agreement withdrew any appeals made by the Navy concerning eligibility and withdrawals of lands by the Natives and in return the Navy was allowed to pursue exploration activities on Native lands that were, or might be, selected. The Navy promised to avoid interference with Native occupancy. This included the promise to minimize adverse effects to the environment and damage to the land and not to impair or otherwise interfere with the wildlife and its habitat or the use of the land to hunt and fish. Under the Settlement Act the subsurface estate of the entire reserve was retained

by the federal government. During the summer of 1974, a 200 x 300 foot gravel pad was built at POW 1, located at Pitt Point, by Environmental Services, Inc. (ESI) and the materials received on APUTCO Barge 570 were stored on that pad. These materials included tubular goods, drilling muds, cements, chemicals, piling, wood supplies and metal stocks. At that time the Navy operated and made purchases directly or through the services of James W. Dalton, an operations manager who was retained under a contract arrangement. In the fall of 1974, preparations were underway for a drilling effort that winter season (1974-1975). At that time, the camp at POW 1 consisted of three small orange colored ATCO sleepers - total of 18 beds, bunkhouse style - an office unit and a kitchen-mess hall unit, set on the gravel near the beach. The contractor (Frontier Sand and Gravel) was hauling material from a sand bar near the mouth of the Smith River to build a pad. A 40 x 100 foot prefabricated metal building was erected, on piling, to serve as a shop facility. Heat and lights were installed in this building by January 1975. That was the extent of the base camp facilities at the beginning of the year when the exploration drilling program got underway. The men of the DEW Line had for years referred to the POW 1 Station (Pitt Point) by the unofficial name "Lonely" and the new oil exploration camp quickly became known as Camp Lonely.

Cape Halkett No. 1

Early in January, work began at Deadhorse (Prudhoe Bay) to ready some of the Frontier Sand and Gravel Company equipment to be used in support of the drilling. The runway lights generator unit was overhauled and a water tank was readied for water haul. On January 17, the GSI (Geophysical Services Inc.) Caterpillar tractors arrived at Lonely and almost immediately departed for Halkett to start work on the ice runway to be built on nearby lake ice. Cape Halkett No. 1 was located at latitude 70°45'N, longitude 152°26'W approximately 22 miles east-southeast of Camp Lonely. Clearing snow to prepare the strip started on the 18th. By January 20, the strip was approved for use by C-130 Hercules aircraft and the first two Hercs arrived on the 22nd. By January 31, 28 Hercs had delivered the basic drilling camp and equipment. Thirty men were on site; the support contractor (Boatel, Inc.) was operating the camp.

Parts of the camp, generator and water plant were placed on piling as was the rig subbase. The rest of the units were placed directly on the tundra/ice surface. The area around the rig was low and swampy so the frozen surface was relatively flat. Gravel was used to build berms for the fuel pit and sewer pond and spread around the area of the rig itself. This gravel was hauled all the way from Camp Lonely from the Smith River borrow site. No reserve pit was dug. The drilling muds were deposited directly on the surface of the tundra as had been successfully practiced for years in the Barrow gas fields.

Operations slowed up a bit the first week in February due to high winds but rig components began to arrive by the 8th. The rig to be used was Parco Drilling Company No. 128, located in Edmonton, Canada. By February 14, 37 of the 46 Herc loads from Canada had arrived as well as 10 Herc loads of supplies and fuel. By the 24th the camp, rig piling and

caps, and shop were in place, the last nine Herc loads had arrived, and the rig was moved from the airstrip to the drill site, a distance of about three-quarters of a mile. Rig-up began on February 27, and the well was spudded on March 24.

Cape Halkett No. 1 bottomed in argillite, the assumed basement, at 9,900 feet in early May of 1975. Because of the late start, the well was not completed with sufficient time left before melt began so that the rig could be moved without damage to the tundra. Thus the rig was laid down and left for the summer. Plans were to move the rig to the next wellsite in the fall after freeze-up and the accumulation of a sufficiently thick blanket of snow to prevent tundra damage.

During the spring of 1975, as a continuation of the 1974 work, Geophysical Services, Inc. (GSI) gathered 2,519 line miles of seismic data, mostly in the area known as Zone A. This meant that in two years, the program had gathered as much seismic data as was available to the earlier exploration geologists at the end of the eight-year Pet 4 program.

TABLE NO. 1

Summary of Field Seismic Activity

EARLIER PROGRAM

1944 - 1953 3,300 line miles

MODERN PROGRAM

1974	1,016 line miles	GSI through Tetra Tech
1975	2,519 line miles	GSI through Tetra Tech
1976	3,100 line miles	GSI through Husky NPR
1977	2,638 line miles	GSI through Husky NPR
1978	1,934 line miles	GSI through Husky NPR
1979	1,872 line miles	GSI through Husky NPR
1980	1,110 line miles	GSI through Husky NPR
1981	581 line miles	GSI through Tetra Tech
Total	14,770 line miles	

Program Administration - 1975

A number of important administrative changes were made in 1975 that changed the character of the exploration program. In the early spring, the Navy recognized that they were now tasked with conducting a large scale exploration program, although not yet funded, and they issued a request for proposals for a company, preferably a petroleum company, to serve as operations manager. The successful proposer for this work was Husky Oil Incorporated of Delaware, with headquarters located in Cody, Wyoming. Husky formed an ad hoc Alaskan corporation, Husky Oil NPR Operations, Inc., as a wholly owned subsidiary for the operation of the contract. Because of the magnitude of the operation, the contract needed review and approval of the Justice Department as well as the Defense

Department. The authority for the exploration was included in the legislation of June 30, 1938 which tasked the Navy with the "conservation" and protection of the reserves" but because of the history of the "Teapot Dome" the actual contract required the signature of the President of the United States. Finally, all of the reviews and approvals were completed and President Ford signed the contract on November 23, effective December 1, 1975.

In preparation for the anticipated completion of these contract matters, the Navy, at the end of the summer of 1975, moved their Officer-In-Charge LCDR Terrence Woods from Barrow to Anchorage and took temporary office space with Mr. M. F. Westfall, the Executive Vice President and Manager of Operations of the fledgling company, Husky Oil NPR Operations, Inc. When the contract became effective in December a nucleus of workers was already in place to begin the program.

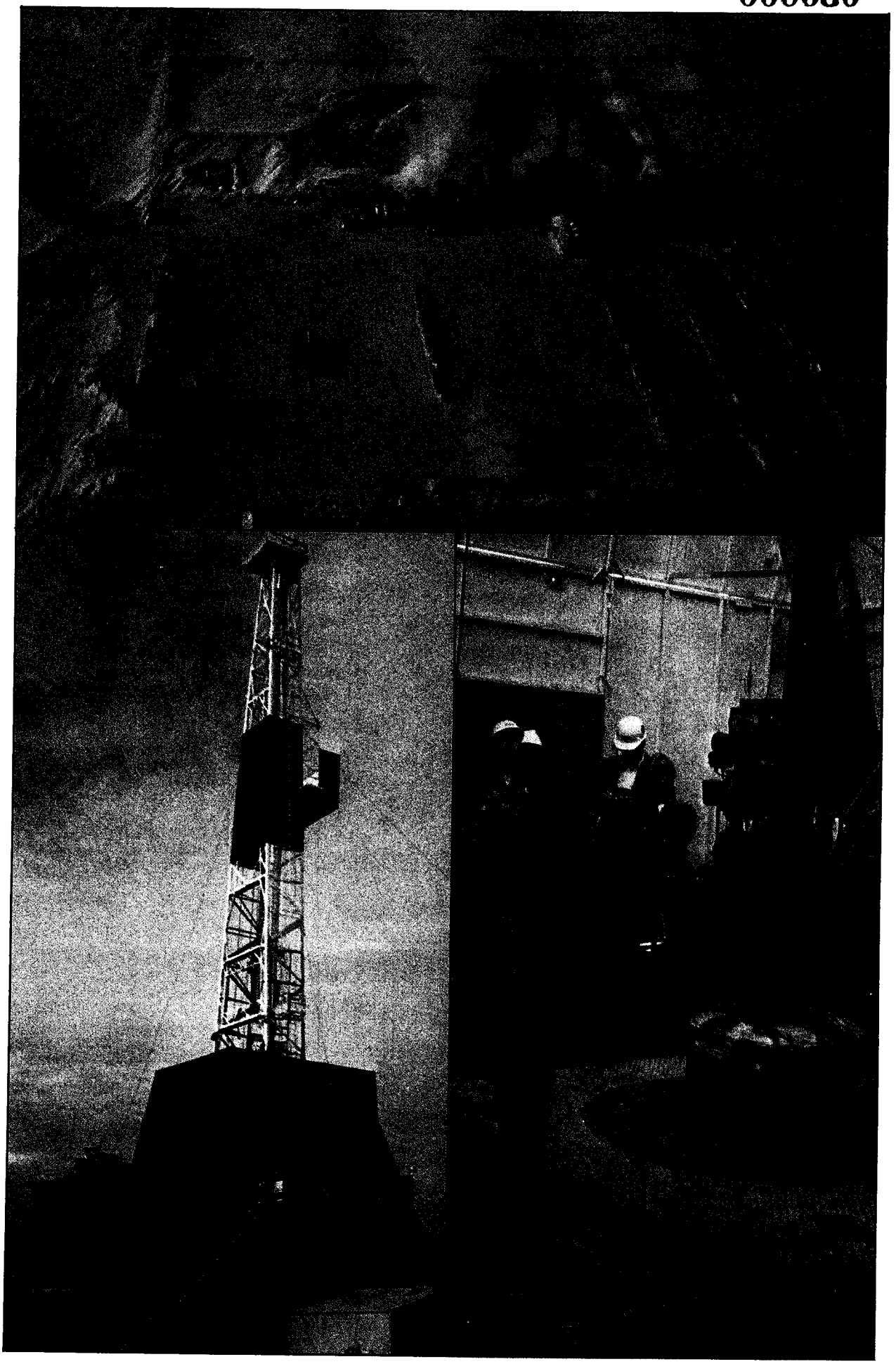
Equipment

In October of 1975, the Navy published the final environmental impact statement (FEIS) for the continuing exploration and evaluation of Zone A. Although the FEIS for Zone A had been necessary to expedite the start of the program, it was recognized that it would be inadequate for exploration of the total Reserve. Work was immediately begun to expand the FEIS to include all of the exploration work to be conducted within the Reserve.

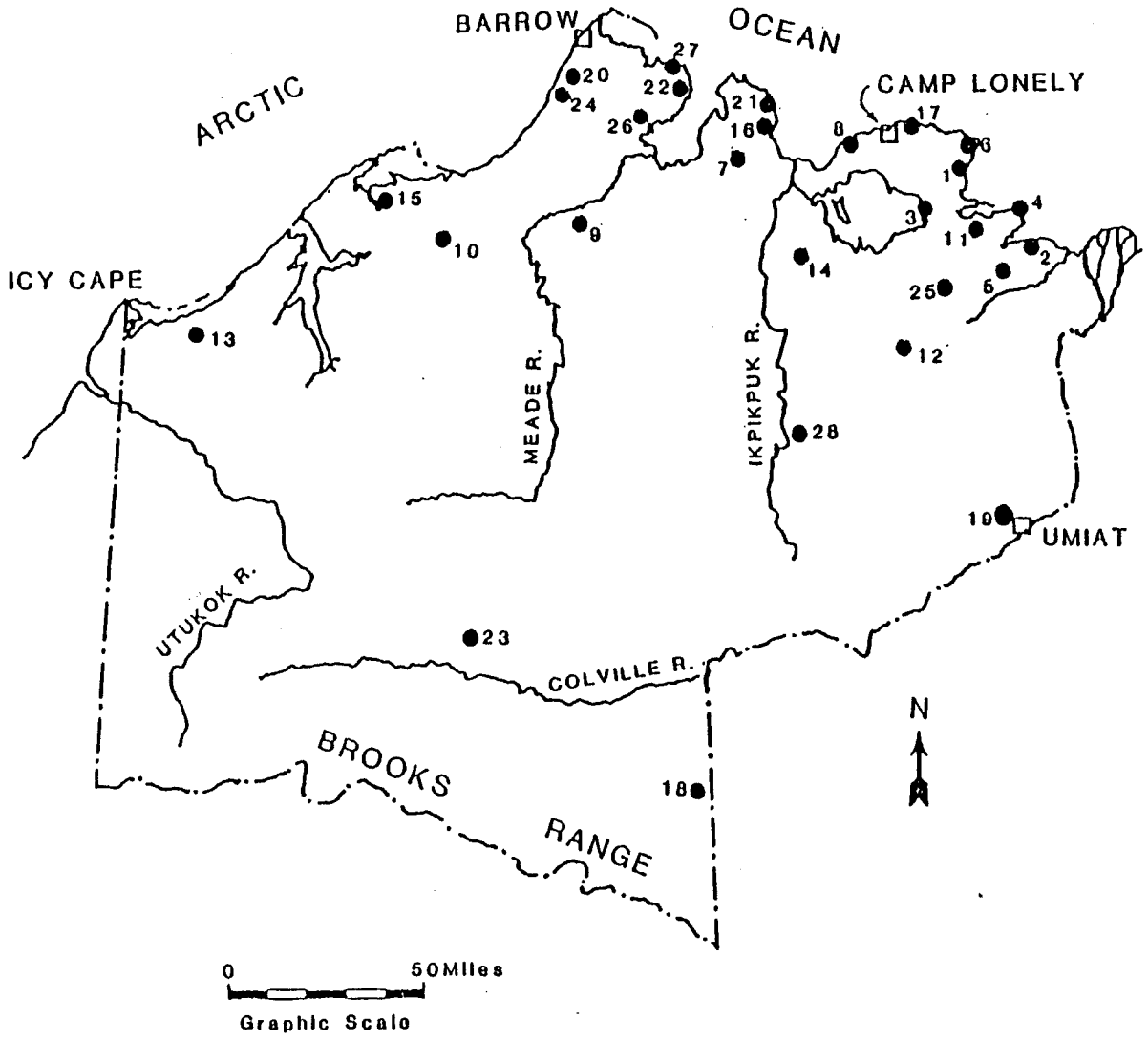
Modern methods of exploration, with prudent care and caution, can be employed so as to cause minimal tundra disturbance. Equipment and supplies that previously were hauled by D-8 Cat trains, sometimes during the summer with the blade down, now were scheduled to be flown or moved in winter by rolligon - a large vehicle with low pressure, balloon-like tires. Winter seismic trains were a combination of equipment carried on Nodwells or other light weight tracked vehicles and camps mounted on Michler Sleighs (a steerable, bob-sled like arrangement) pulled by D-7 tractors. The Navy produced a set of stipulations governing "Winter Seismic and Related Geophysical Operations." These stipulations defined the amount of snow cover and the depth of freeze-down required for operating conditions to avoid tundra damage. They also outlined where camps could be placed and how river crossings were to be accomplished. Modern equipment operating within these guidelines provided environmentally acceptable logistics. (Refer Appendices I and II.)

NAVY/HUSKY OPERATIONS - SPRING 1976

The "Old Navy Camp" at Lonely was obviously not adequate to fill the needs of the expanded operation so a prefabricated camp of Alberta Trailer Co. (ATCO) units that could be airlifted by C-130 Hercules aircraft was purchased in Canada and flown to Lonely. By the first of March, the camp was partially assembled and placed on piling and additional gravel had been added to the camp pad for more space. Early camp operations were hampered by a series of weather problems and "making do" with what was available. The water haul and fuel runs were subcontracted to Mukluk Freight and this eased the pressure on the camp staff. The catering contractor was ITT Arctic Services and they housed a population



Drilling at Inigok Test Well No. 1, 1978-1979.



Exploration Wells
1975-1981

1. Halkett
2. S. Harrison
3. E. Teshekpuk
4. Atigaru
5. W. Fish Creek
6. W. T. Foran
7. S. Simpson
8. Drew Point
9. S. Meade
10. Kugrua
11. N. Kalikpik
12. Inigok
13. Tunalik
14. Ikpikpuk
15. Peard
16. E. Simpson No. 1
17. J. W. Dalton
18. Lisburne
19. Seabee
20. Walakpa No. 1
21. E. Simpson No. 2
22. W. Dease
23. Awuna
24. Walakpa No. 2
25. N. Inigok
26. Kuyanak
27. Tulageak
28. Koluktak

FIGURE NO. 3. EXPLORATION WELLS, 1975 to 1981

of up to 43 people a day during the month camp construction was underway. During this brief period the sewage plant was installed, along with the incinerator, water plant, generators, communications, plumbing and utilidor in the camp and foldaway building. Water sheds, airport sheds and a shop loft were also built. It was hectic at times, but a good pioneer operation that was only possible through the excellent cooperation of all personnel.

Seismic - Spring 1976

During this same period, the spring seismic program was highly successful with GSI parties identified by numbers 1182 and 1186 covering 3,100 miles. Record quality was good to excellent. Most of the effort was made in the relatively flat coastal plain from the Kuk River to the eastern edge of the Reserve with special attention to the Simpson Peninsula.

East Teshekpuk No. 1

In January 1976, the construction contractor, Arctic Slope Alaska General (AS/AG) left Service City, their base camp in the Prudhoe Bay area, to travel overland, or more accurately over ice, arriving at the East Teshekpuk No. 1 location on January 26 and immediately began the construction of the reserve pit and pad. It was planned to excavate a reserve pit at this well rather than release the drilling fluids to the tundra surface as at Halkett for a number of reasons. East Teshekpuk was planned for greater depth so there would be a greater volume of mud and cuttings and the site was located on a narrow peninsula of land near the water's edge. The location was at the east end of Lake Teshekpuk approximately 25 miles south of Camp Lonely. The coordinates were latitude 70°34.2'N, longitude 152°56.6'W. The construction material for the pad was a deltaic sand located at the mouth of Kealok Creek about 5.3 air miles to the southwest where the creek emptied into Teshekpuk Lake. A road was cleared over the ice between the drill site and the borrow site for the hauling operation. At the same time a C-130 runway was cleared on the lake ice immediately south of the drilling location. The strip was oriented generally northeast southwest along the direction of the prevailing winds. Field operations were plagued by frequent storms, blowing snow, and whiteouts but the site was ready by February 12.

The rig scheduled to drill East Teshekpuk was Parco Rig No. 128 which was stacked at the Cape Halkett location approximately 17 miles to the northeast. However, the rig move was made over ice roads that were laid out in a meandering pattern to take advantage of the frozen flat surfaces of lakes, streams and even sea ice where possible. These meanders made the ice road 36 miles in length. The rig move was frequently delayed by high winds and blowing snow and the road between Teshekpuk and Halkett had to be cleared and recleared. The rig move was accomplished by Mukluk Freight, AS/AG and Parco personnel all working together. It took from February 4 to the 17th to get the first piece of rig moved. "Digging out" and "Opening road" are the two most frequent entries in the daily reports. Rig-up at East Teshekpuk was actually started on February 22 while the moving of the rig, camp and supplies continued. Once the drilling camp was in place (February 28) the AS/AG construction

camp moved overland to the South Harrison Bay location (latitude 70°25.6'N, longitude 151°43.8'W). Rig-up was completed on March 12 and the well spudded that same day.

During late April, the drilling fluids in the reserve pit reached sufficient volume that their depth exceeded the excavated portion of the pit and they melted out an ice rich area of the retaining berm. The failed section of berm was composed principally of material that had been excavated from the reserve pit. As a result, some muds escaped the reserve pit and flowed to the nearby edge of Teshekpuk Lake. Although the amount was minor and minimal ephemeral environmental damage was caused, the event inspired a redesign of reserve pit parameters. All future reserve pits were designed to contain the total estimated volume of drill cuttings and muds below the level of the original tundra surface and the containment volume provided by the dikes was to serve as a safety factor in case an emergency discharge of mud should occur. Material from excavating the pit was spread as a "primary lift" in the camp area of the drill pad. Dike material surrounding the reserve pit was to be clean, well drained material and free of segregated ice masses.

The well was drilled to a total depth of 10,664 feet (reached on May 7, 1976) to penetrate and evaluate the Sadlerochit Formation with secondary interests in the "Pebble Shale" and Sag River Sandstone, and Lisburne carbonates. At the conclusion of the drilling and evaluating operations the well was abandoned with cement plugs at selected intervals. Diesel was left in the wellbore across the permafrost interval to allow subsequent temperature logging operations planned by the USGS as part of an ongoing North Slope geothermal measurement program. The abandonment wellhead was designed to also accommodate this activity.

At the conclusion of the abandonment operations, the drilling equipment was rigged down and stacked on the pad in preparation for moving. The pad was graded and cleaned up. Seven 3,750 gallon steel fuel tanks were placed in the fuel containment berm and approximately 21,000 gallons of JP-5 Jet fuel were put in the tanks for summer helicopter use and rig move in early fall. Operations at the site were terminated on May 16, 1976.

South Harrison Bay No. 1

When the AS/AG construction train left East Teshekpuk at the end of February for the South Harrison Bay No. 1 drilling site they almost immediately encountered poor weather. However, the entire move was completed in two and a half days and construction of the South Harrison Bay reserve pit commenced the evening of March 3. Borrow material came from the sand dune area along the edge of Harrison Bay at the mouth of the Kalikpik River about seven miles west of the drill site. A road was cleared on the ice of the bay for the hauling operation. It was planned to deliver the rig piling and pile caps that summer by barge. To insure that an early construction startup would be possible in the fall, a thin, 2,000-foot long, sand runway was constructed immediately to the west of the drill site. A few days were also spent unsuccessfully searching within a 10 mile radius of the site for a suitable water supply. The South Harrison Bay drill site and runway were completed by March 26, and the

construction camp and part of the equipment were demobilized to Service City. The remaining equipment was demobilized to Camp Lonely for use that summer.

NAVY/HUSKY - SECOND SEASON: JUNE 1976 - MAY 1977

Summer Operations

The plans for the 1976 summer cleanup program were made after a reconnaissance of sites was accomplished in mid-May. Arrangements were made with AS/AG to provide the labor and with Crowley All Terrain Vehicle Company (CATCO) to provide the rolligons. The helicopters and the Twin Otter aircraft that were under contract and based at Lonely were to be used for cleanup and the summer survey effort.

Two cleanup crews were used; one based at Lonely and one based at Barrow. Between June 15 and September 8, cleanup was accomplished at Iko Bay and the Barrow area, the Simpson area, POW A, Alaktak, West Topogaruk, the Lonely area, Pitt Point, POW B and the East Teshekpuk drill site. A total of 23,500 barrels were retrieved and of these 10,650 were crushed and stockpiled. In addition, approximately 750,000 pounds of debris were collected; 350,000 pounds of which were burned; and the remainder was left in stockpiles for later disposition.

Summer survey that year included staking the five proposed wellsites as well as the winter trails to each. Water sources were located, borrow sites defined and soil samples acquired. Local topography at each wellsite was taken from the USGS maps (1:63,360 series) where available. In addition, the all season road from the NARL to the South Barrow gas field pressure reducing station was staked.

At Camp Lonely, physical improvements were continued with the installation of piling for two warehouses, the camp extension, and the communications tower. Designs were finished for the airport terminal, the weather shacks for the wellsites and the heat recovery system for Lonely. In addition, the installation of the motor gasoline (Mogas) tanks was completed and this made it much more efficient to operate the local transportation.

The 1976 barge delivery included 2,424,400 gallons of fuel and 10,233 tons of supplies. This amount of fuel was nowhere near the anticipated annual need for the program but was the maximum possible until the storage capability could be increased.

The rest of the summer season was spent cleaning up the pad at Camp Lonely, increasing its size, stabilizing the gravel areas, and sorting out the materials received on the barge so they were easily accessible after the snow and dark period began.

Winter Cleanup

A trial run was made during the fall of 1976, to test the economic feasibility of winter cleanup. Winter was defined for these purposes as November 1 to January 31. To accomplish the winter work it was necessary

to provide a self-sustaining camp for the 18 person crew. Skull Cliff, an abandoned LORAN navigational site about 24 miles south/southwest of Barrow was selected for this effort. The site consisted of abandoned buildings and supplies, debris, and a collapsed 625-foot tower scattered over an area of approximately six square miles. Work was conducted from October 26 to December 15, and during this period 2,280 barrels and 2,000 pounds of debris were picked up. The sub-zero temperatures were not as much of a problem as the lack of daylight. Hard packed snow and reduced light made much of the debris impossible to locate and difficult to retrieve. The frozen contents of the barrels made them impossible to empty and very heavy and contributed to excessive work. This coupled with the lengthy mobilization period helped to increase the costs per unit of work accomplished to the point it was decided to abandon the winter effort.

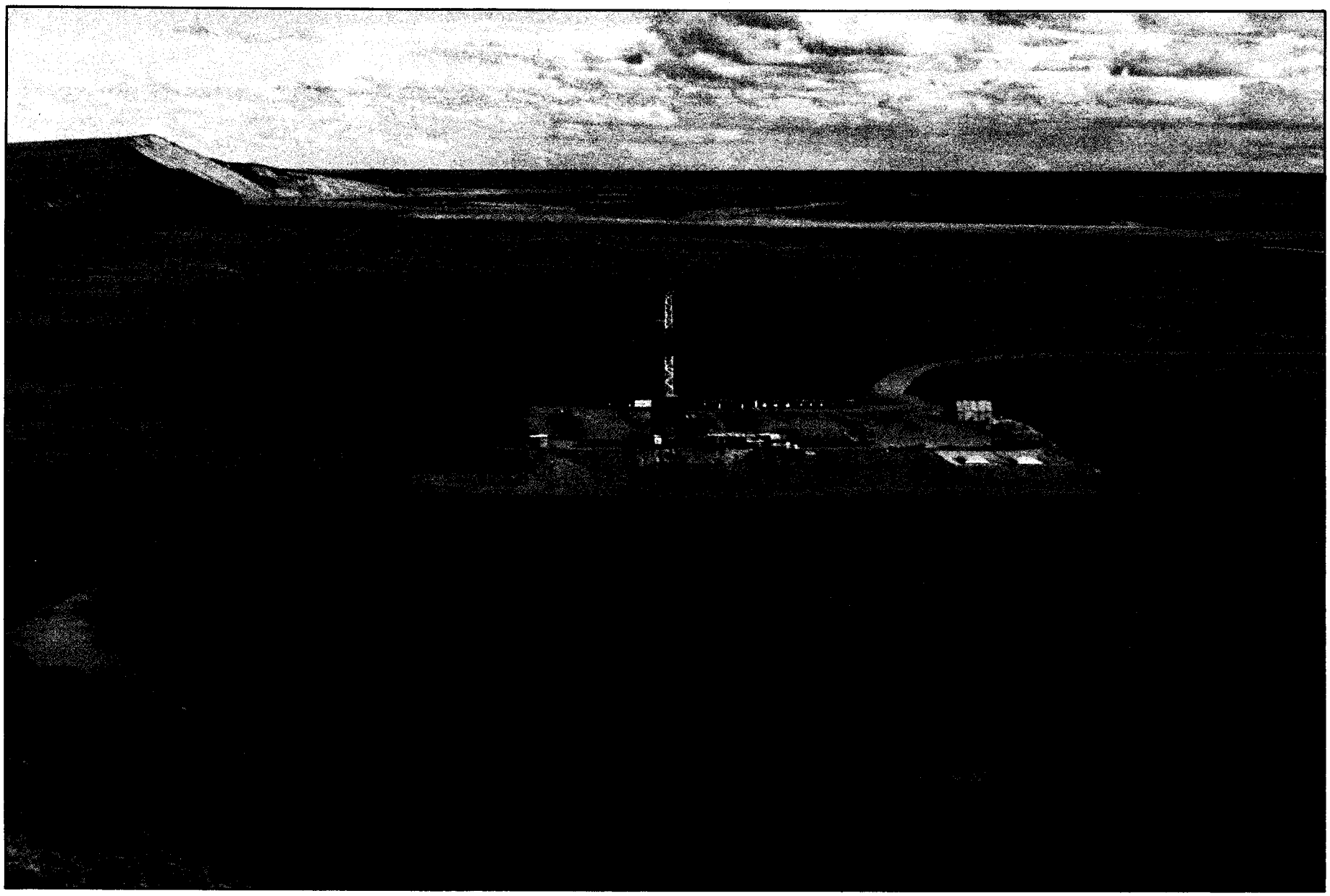
South Harrison Bay No. 1

During the summer, the barges found it impossible to reach the South Harrison Bay site because of shallow water and had to return to Lonely to off-load. As soon as tundra conditions would allow that fall, a small construction group departed Lonely to install the piling and pile caps at the South Harrison Bay site. On-tundra operation for rolligons began on October 18 of that year. While the earth auger was working, the Otter strip was cleared and readied by October 19. Work began immediately on clearing a C-130 strip on the ice of Harrison Bay just north of the drill site. The sand strip was used by the Twin Otter while waiting for the ice to thicken sufficiently to support the Hercules C-130 aircraft.

Rig mobilization operations began on October 28. The rig (Parco No. 128) was stacked at the East Teshekpuk location and was moved using CATCO rolligons on the winter trail connecting the two locations. Rig move (129 loads) took 19 days. Weather conditions were generally good during this period, however a brief period of warm temperatures (+10° to +15°) and high winds (30-35 knots) at the end of the first week in November disrupted operations and broke up the ice strip on Harrison Bay. Because it was feared that the ice would not thicken fast enough to have the C-130 strip ready by spud date, it was decided to build the strip on the shallow waters of the frozen mud flats near the mouth of the Kalikpik River about 6.5 miles to the west along the shore of the Bay. An ice road was cleared near the shore to connect the strip to the wellsite.

Rig-up operations began on November 10, and were completed in 11 days. The well was spudded at 3:00 p.m. on November 21 and was drilled to a total depth of 11,290 feet. The primary objective of the well was the Sadlerochit Group with secondary interests in the Kuparuk River sandstone, and the basal sand of the Torok Formation. At the conclusion of the drilling and evaluation operations the well was abandoned with cement plugs at selected intervals.

Rig-down began on February 8, and the rig was demobilized to Deadhorse to fulfill other commitments. The pad was cleaned and graded in preparation to serve for summer stack-out of the Parco No. 95 rig after it finished drilling operations at Atigaru Point.



Drilling Seabee Test Well No. 1 near Umiat on the Colville River, July 1979. (Photo by J. Haugh)

South Barrow Well No. 13

South Barrow Well No. 13 is located in the South Barrow Gas Field approximately five miles southeast of the city of Barrow. The pad for the well had been constructed earlier by the Navy and the Cardwell Model H rig, owned by the Navy, was stacked-out on the pad.

Field operations began on November 16, 1976 with the movement of camp units from the Naval Arctic Research Laboratory facility to the well location. Once on location, considerable time was spent overhauling and repairing rig components. Actual rig-up began on December 1, and the well was spudded at 10:00 a.m. on December 17, 1976.

The well was drilled to a depth of 2,534 feet into the Jurassic gas sands above the argillite basement. After evaluation, the well was suspended as a marginal producer. At rig release on January 16, the rig was taken down and moved to the South Barrow Well No. 14 location. The drilling pad was cleaned and leveled and a shelter placed over the wellhead.

South Barrow Well No. 14

South Barrow Well No. 14 was located 12 miles east-southeast of the city of Barrow and represented a "step-out" of approximately seven miles from the South Barrow Gas Field. Mobilization of the construction crews for the building of the pad occurred on November 20, 1976. Rig-up operations began on January 18, 1977 and the well was spudded at 1:30 a.m. on January 28. The rig used was the Navy owned Cardwell Model H.

The well was drilled to a total depth of 2,257 feet. The primary objectives of the well were the Jurassic gas sands and the Sag River Sandstone. After evaluation the well was completed as a gas well. The well was cleaned up and lubricated with alcohol through the tubing and annulus to prevent freezing and the "tree" was nippled up and tested. The rig was released on March 3, 1977 and moved to storage. The pad was cleaned and leveled and the wellhead shelter installed.

W. T. Foran No. 1

On November 23, 1976 an AS/AG construction train left Camp Lonely for the W. T. Foran No. 1 drill site located at latitude 70°49.5'N, longitude 152°18'W. The borrow sites for this pad were located six, seven and nine miles from the site, westward along the coast. The first two sources were quite small, so to minimize disturbance, all of the material was taken from the most distant site (near Cameron Point). Care was taken to avoid the Esook trading post nearby and material was extracted only to within one foot of sea ice level. The construction of the drill pad and the airstrip cleared on the nearby lake to the west was completed in a month and the construction train moved back to Lonely for equipment repair. On January 1, 1977 this crew moved to the South Simpson wellsite.

Rig move-in operations to W. T. Foran No. 1 began on January 31, 1977. The rig, Nabors Drilling Company (Nabors) No. 23, had been stacked at Deadhorse and the rig move was via air.

In twenty days a total of 110 Hercules C-130 loads brought in the rig, cement, and other miscellaneous equipment. Rig-up began on February 12 and was completed in 21 days. Weather conditions during rig-move and rig-up were generally good but intermittent winds of 25-35 knots with blowing snow hampered flying conditions on three days. The well was spudded at 12:00 midnight on March 6, 1977.

Lt. W. T. Foran, a Naval Reserve officer and a geologist in civil life, was a strong proponent of the petroleum possibilities of Pet 4. It was his memo to the Bureau of Budget written in March of 1943, outlining the reasons to explore the Pet 4 that was largely responsible for the earlier exploration program. Appropriately, he was named to head the first reconnaissance party to the Reserve and was very active in the geologic exploration efforts throughout the program.

The W. T. Foran well was drilled to a total depth of 8,864 feet. The primary objectives of the well were the Sadlerochit Formation and the Lisburne Group with secondary interests in the Kuparuk River Sandstone. The well was abandoned with cement and mechanical plugs set at selected intervals. The well was terminated on April 24 and the rig was stacked out for the summer at the W. T. Foran site. All personnel left the site on April 30, 1977.

Atigaru Point No. 1

A second construction train left Lonely on December 3, 1976 for the overland move to Atigaru Point. The Atigaru Point wellsite was located at approximately latitude 70°33.3'N, longitude 151°43.0'W. The material to build the pad came from a number of small deposits along the beach to the west of the wellsite. All were within six miles of the site and all were of relatively poor quality; the material contained a high amount of organics and clays. This caused no immediate trouble, in the frozen state, but caused numerous problems during rehabilitation and revegetation. The pad was designed to leave undisturbed a LORAN tower that was already on site. An ice runway oriented northeast-southwest was cleared in the shallow mud flat areas of Harrison Bay, behind the protection of Atigaru Point and the numerous exposed mud/sand bars. Construction was completed on January 1 and the next day the train moved on to the West Fish Creek site.

The first drilling personnel arrived at Atigaru Point on December 15, 1976 and rig move in operations began on December 17. The rig, (Parco 95), had previously been used by Mobil Oil Company in the Prudhoe Bay vicinity and the move was accomplished by Hercules C-130. The rig move was completed in 11 days with a total of 99 loads. Other drilling supplies arrived from Lonely via rolligon. Rig-up began on December 31 and was completed in 13 days. The well was spudded on January 12, 1977 at 4:00 p.m.

The Atigaru Point well was drilled to a depth of 11,535 feet. The primary objectives of the well were the Kuparuk River Sandstone, the Sadlerochit Formation, and the Lisburne Group with secondary interests in the Sag River Sandstone and the basal Torok sand. The well was abandoned with mechanical and cement plugs at selected intervals. Operations were

terminated on March 29, 1977 and the rig was moved over the ice of Harrison Bay to be stacked out for summer storage on the South Harrison Bay drilling pad.

South Simpson No. 1

The construction train left Lonely on January 1, 1977 and moved overland to the South Simpson No. 1 location. The trail followed the edge of the ice of Smith Bay and then the course of the Piasuk River. Deep snow along the banks of the river and frequent high winds and blowing snow slowed the operation considerably. The site was located at approximately latitude 70°48.3'N, longitude 154°58.9'W.

The material for construction of the pad was taken from a high sand bank of the Piasuk River about five miles to the east of the site. However, because the ice road for the haul followed the lakes and streams wherever possible, the haul distance was over 6.5 miles. The material was a well drained sand and excavation was relatively easy. An ice strip was cleared on an unnamed lake about 0.6 of a mile directly west of the well site. The road connecting the site to the airstrip followed a frozen stream bed of a tributary to the lake. Construction was finished on February 13 and the construction train retraced the trail back to Camp Lonely where it remained for the summer season.

Rig move-in operations commenced on February 12, 1977. Portions of the rig (Nabors No. 1) had been moved to Lonely by barge during the summer of 1976. The other portions remained at Deadhorse. Those parts of the rig at Lonely were transported to South Simpson by rolligon, while the components at Deadhorse were flown in using Hercules C-130 aircraft. Fifty-seven Herc loads and 15 rolligon loads were required to move the rig to the location. Rig-up began on February 20, and required 17 days. The well was spudded at 8:00 a.m. on March 9, 1977.

The well was drilled to a total depth of 8,795 feet. The primary objectives were the Kingak sands and the Sadlerochit Formation with secondary interest in possible sands in the Okpikruak Formation. The well was abandoned with cement and mechanical plugs. The abandonment marker was set and the rig released on April 30, 1977 at 3:00 p.m. The rig was taken down and stacked-out on location for the summer season.

West Fish Creek No. 1

On the second day of the new year (1977), the construction train left the Atigaru Point drill site to travel over the ice of Harrison Bay to the mouth of the Kalikpik River, then up the Kalikpik to the West Fish Creek drill site. The drill site was located at latitude 70°19.6'N, longitude 152°03.6'W approximately 4.5 miles west, northwest of the Fish Creek Test Well drilled in 1949.

The weather was good for the overland move but while traveling along the western shore of Harrison Bay, approximately 2.5 miles from the mouth of the Kalikpik, a D-8 Cat fell through the ice. Fortunately the water was

not deep, and the Cat went down, tipped to the right side, in about five feet of water and mud. The operator was not hurt. The ice in the area was evidently thin due to excessive current being channeled at that point. The surrounding ice was also quite thin so the Cat was left for retrieval at a later and safer time. The construction train finally arrived at the site on the afternoon of January 4. The Cat was extricated the first week of May with an auger and four flat bed trucks with gin poles rigged over their rear wheels.

Upon arrival, work began immediately on the excavation of the reserve pit. Borrow material for the pad was taken from a 20-foot high sand bank of an unnamed lake 2.2 miles west, northwest of the site. The material was well drained dune sand so that excavation was relatively easy. An ice runway was cleared on the unnamed lake one mile east of the drill site. Construction was essentially completed by January 29, but another week was spent readying some of the equipment for summer stack out on the site where it would be available for the North Kalikpik work. The construction personnel departed the site on February 6 with that portion of the equipment that was demobilized overland to Camp Lonely.

Rig move-in operations were begun on January 20, 1977. The rig (Parco No. 96) had been used by Mobil Oil at the West Staines location and was located at Deadhorse. It was mobilized from Deadhorse using Hercules C-130 aircraft in 105 loads in 14 days. Weather conditions during rig move and rig-up were good with only three days lost to blowing snow. The well was spudded on February 14, Valentine's Day, at 9:00 a.m.

The objectives of the well were the Kuparuk River Sandstone, the Sadlerochit Formation and the basal Torok Sand. The well was drilled to a total depth of 11,427 feet. The well was plugged and abandoned and the rig released on April 27, 1977. The rig was taken down and prepared for moving but was stacked on the location for the summer. Operations ceased May 4, 1977.

Seismic Program - Spring 1977

The goal for the spring seismic program was to acquire 2,830 line miles of seismic data. To do this, five seismic trains were mobilized in January 1977; two trains (No. 1182 and No. 1186) started out from Icy Cape and three trains (No. 1173, No. 1184, and No. 1195) started out from Umiat. Work was scheduled in the western sector, the Colville, Utukok, and Ikpikpuk basins, and included over 1,500 line miles of reconnaissance in the Foothills Province. From the onset, poor weather with white-out conditions, blowing snow and cold temperatures hampered operations. At the end of March everyone concerned was guessing they'd be lucky to get 2,500 miles accomplished. However, extremely carefully planning and some deeper and longer lasting snow cover allowed later operations in some areas. Party No. 1182 finished up in Barrow on May 11. Party No. 1186 finished some experimental work and "stacked" at Brady on May 25. Parties Nos. 1173, 1184 and 1195 all arrived at Umiat by May 20 where they "stacked" for the summer. A total of 2,638 line miles were accomplished.

Cleanup - Spring 1977

During this phase of the cleanup program, efforts were concentrated at three sites: POW A, a former DEW Line site, Simpson Test Well, drilled during the 1947 program, and the Topogaruk Test Wells from the 1951 program. It was decided to pick up the debris from the Simpson and Topogaruk sites and retrograde everything to POW A. The final plans for the disposition of the debris had still not been decided, but locating the debris at POW A allowed the additional option of backhaul to the South 48 via barge. A portable barrel crusher was used to consolidate the bulk as much as possible.

Operations were begun February 10, and were halted at the end of the first week of May and the camp and rolligons returned to Camp Lonely. A total of 175 tons of debris were retrieved, 9,718 barrels were collected and 12,233 barrels were crushed. Although barrels were often filled with snow, covered and frozen as in the fall work, the spring phase of cleanup was more productive because of the increased daylight and the greater dependability and speed of the CATCO rolligons. In addition many of the barrels at these sites were above the frozen tundra and more accessible for retrieval.

Camp Lonely

Early in 1977, the Navy, recognizing the program needs for great amounts of fuel and the economics of bringing it north by barge, let a contract to build storage tanks at Lonely. The design included two tanks, each with 30,000 barrel capacity, and four tanks, each with 10,000 barrel capacity for a total capacity of 100,000 barrels or 4,200,000 gallons. A fixed price contract was issued out of Naval Facilities Engineering Command, San Bruno, California to Arctic Slope/Alaska General, the successful bidder. Gravel placement began in late March. Construction of the tanks was started in early May and final inspection and acceptance of the tanks was on July 20, 1977 just in time for fuel delivery on the 1977 barge lift.

NATIONAL PETROLEUM RESERVES PRODUCTION ACT OF 1976 (PL-94-258)

The National Petroleum Reserves Production Act was passed by Congress in response to the shortage of gasoline and heating oil in 1975. The act called for the production of petroleum by the Navy, from the Naval Petroleum Reserves Numbers 1 (Elk Hills, California), 2 (Buena Vista, California) and 3 (Teapot Dome, Wyoming). It called for the transfer of all of Petroleum Reserve No. 4, except for the Naval Arctic Research Laboratory, from the Navy to the Department of the Interior effective June 1, 1977. It charged the Secretary of the Interior with the continuation of the exploration program in Pet 4 and the continuation of the supply of natural gas to the community of Barrow. The act also changed the name of Pet 4 to the National Petroleum Reserve in Alaska (NPRA).

In addition, PL 94-258 charged the Secretary of the Interior with two studies which became known by their paragraph designations in the law. The 105B study was to investigate and recommend the best overall procedures to be used in the development, production, transportation, and

distribution of petroleum from NPRA. In addition, this study was to investigate the economic and environmental consequences of this development. The 105C study was to determine the value of and the best uses for the lands of NPRA and make appropriate recommendations thereof. The law also gave recognition to the special environmental areas of Teshekpuk for nesting wildfowl and the Utukok Uplands for caribou calving. It further authorized the Secretary to designate other areas for special environmental consideration.

Previously, the Navy had restricted its activities to Zone A while they were writing the overall EIS, and Zone A was the only area considered by the environmental impact statement produced in October 1975. The Navy, although now being relieved of responsibility for the program felt because of their many years of involvement and the head start they had made, that they were better geared and morally obligated to finish the overall FEIS. This effort was given high priority in the spring of 1977.

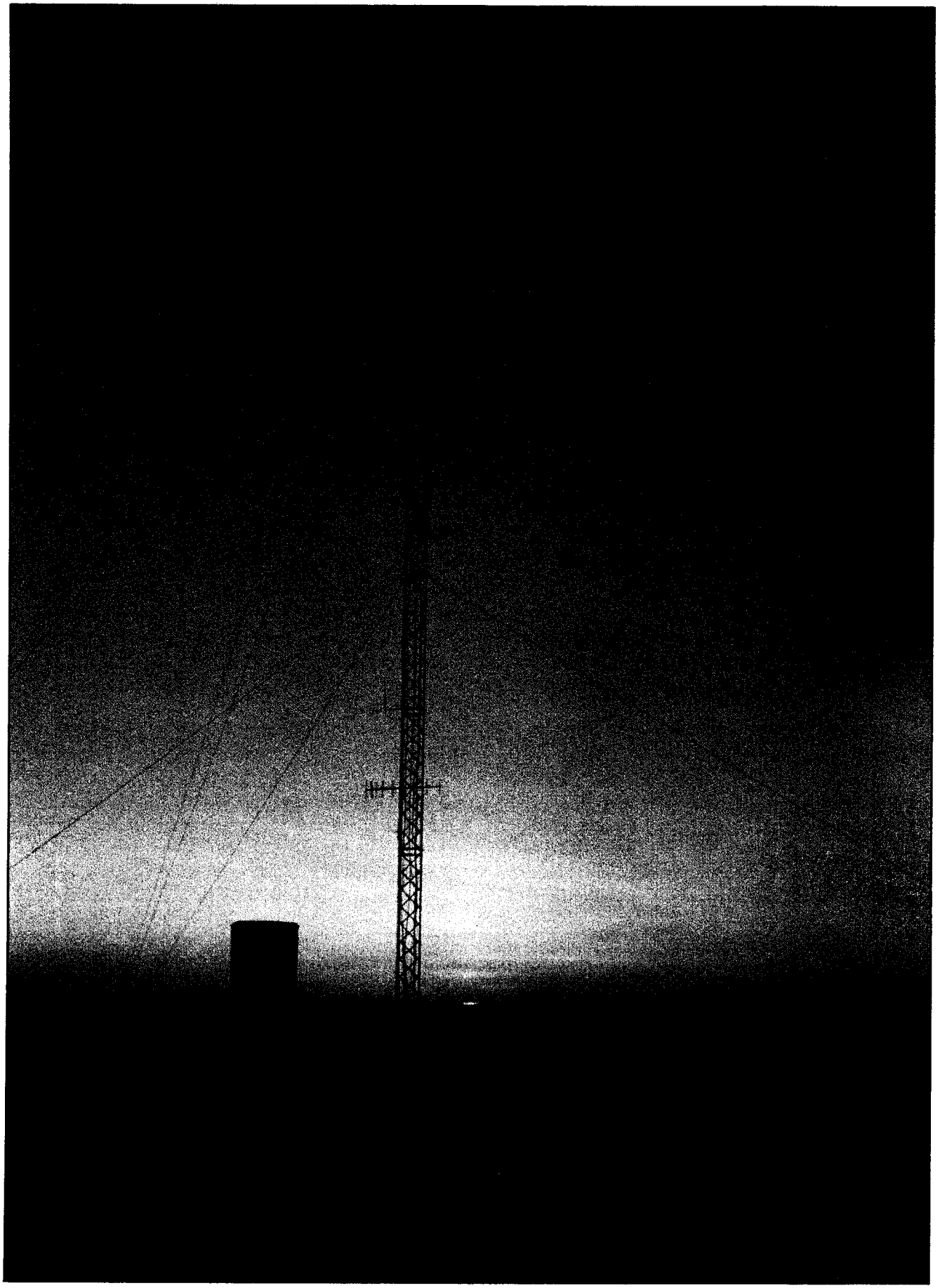
The draft EIS was submitted to the Council on Environmental Quality in February and notice of its availability was published in the Federal Register in March. Distribution of copies was made to state, federal and local government offices throughout Alaska and approximately 230 additional copies were distributed to private industry, organizations and individuals. Public hearings were held in Barrow, Fairbanks and Anchorage. The record was kept open to receive written comments until April 18, and then a concerted effort was made to respond to and accommodate if possible, all questions, pertinent points and objections. The final Environmental Impact Statement was presented to the President's Council on Environmental Quality on May 27, 1977.

About this same time, the Navy in cooperation with the USGS drew up a set of stipulations concerning winter road and trail construction and use within the NPRA. These stipulations were included in the FEIS and were a more detailed and specific set of guidelines similar to the winter seismic stipulations published in the EIS for Zone A.

To carry out the responsibilities of PL 94-258, the Secretary of the Interior delegated to the Bureau of Land Management (BLM) the surface management of the Reserve and the protection of surface values from environmental degradation. To the U. S. Geological Survey (USGS), he delegated the management of the continuing exploration program, the enforcement of stipulations related to the petroleum exploration and the operation of the Barrow gas fields as specified in the act. A Memorandum of Understanding (MOU) was drawn up to identify the procedures to be taken to facilitate the interfacing between the two agencies.

The MOU called for an Annual Plan of Operations to be jointly written each year, describing the proposed exploration program. This plan was circulated to all cognizant federal, state and local governments, private organizations and individuals. Such distribution helped to surface any concerns or reservations a government agency or individual might hold about exploration in a specific area.

After the annual plan was written, the next step was to accomplish the summer field work at each drilling site so that a site specific Environmental



Communication tower at Camp Lonely, February 1978.

Assessment (EA) could be written. This EA would address such items as location of the drill site in relation to special areas, local topography and drainage, water resources, fisheries resources, cultural and socio-economic resources, clean air degradation, noise pollution and human presence, degradation of scenic and wilderness values, and the presence of rare or endangered species and/or archaeological resources. These assessments were done for each wellsite and associated winter trails as well as any additions to the planned seismographic program for that coming spring.

USGS/HUSKY - THIRD SEASON: JUNE 1977 TO MAY 1978

Summer Operations

Summer survey in 1977 was extensive as not all of the subsurface data could be analyzed in time to make final well location decisions before the summer began. Therefore, four survey crews were mobilized to survey ten sites. These were:

Inigok	latitude 70°00'N, longitude 153°06'W
Key River	latitude 69°53'N, longitude 153°40'W
Ikpikpuk	latitude 70°27'N, longitude 154°20'W
East Simpson	latitude 70°55'N, longitude 154°37'W
Tunalik	latitude 70°12'N, longitude 161°04'W
Kugrua	latitude 70°35'N, longitude 158°40'W
Maguriak	latitude 70°24'N, longitude 159°15'W
South Meade	latitude 70°37'N, longitude 156°53'W
Drew Point	latitude 70°53'N, longitude 153°54'W
North Kalikpik	latitude 70°31'N, longitude 152°22'W

Of these sites, Key River, East Simpson and Maguriak were ultimately dropped from that season's program.

Improvements continued to be made at Camp Lonely to better cope with the increased number of personnel and other attendant logistic needs of the large program. A heat recovery system was installed on the power generation plant. An extended aeration waste water treatment plant of much larger capacity was installed. A four unit extension, on piling, was added to the camp, and shelves and bins were added to the warehouse. Plans were also made for increased shop and warehouse space.

The barges for that year's sealift left Seattle on June 29, with the season's resupply of 23,872,928 pounds of pipe, chemicals, cement, muds, lumber and piling and 5,435,780 gallons of fuel. Ice conditions were good that year and unloading operations went smoothly. Lateral moves that summer included 790,000 pounds of equipment to Peard Bay (LIZ C) to prepare for mobilization that fall.

Cleanup

The cleanup program for the 1977 summer included the "policing" of the exploratory wells that had been drilled during the 1976-77 season. Each site was visited to remove the piling caps and cut off the piling below

ground level. All the debris that was buried under the snow during the winter operation was picked up and all combustibles were burned. Those sites included: (1) East Teshekpuk (from the 1975-76 season); (2) South Harrison Bay; (3) W. T. Foran; (4) Atigaru Point; (5) South Simpson; and (6) West Fish Creek. In addition, Cape Halkett was seeded with a northern mix of grasses and fertilized in late August, and debris and piling cleanup was accomplished at South Barrow Gas Wells Nos. 13 and 14 and also in the Camp Lonely area.

Cleanup of "old" Navy sites was limited to the crushing of barrels at POW A and POW B that had been stockpiled there that spring and during the previous summer's program. In addition, LIZ C was cleaned up to prepare the site for use as a logistics base for the coming season.

A total of 14,875 barrels were retrieved; 16,743 were crushed, some of these having been retrieved previously, and 485 tons of debris collected and burned or stockpiled.

Western Sector Staging - Summer 1977

Mobilization of the construction crews for the well locations in the western sector required a temporary staging area located on the gravel base of the old DEW Line Station at Peard Bay (LIZ C). The facility served during that summer as a receiving depot for barge deliveries from Seattle, Anchorage, and Lonely. Lateral barge moves delivered 395 tons which included a minimum complement of operating equipment, as well as two complete construction Cat trains. In addition, two 17,000 gallon double walled steel tanks and two 10,000 gallon bladders were used for fuel storage. Personnel and supplies to assemble the trains and support the initial move arrived from Lonely and Barrow by Twin Otter aircraft utilizing the existing gravel strip. The gravel on the unvegetated spit along the ocean was to be leveled to allow a C-130 to land after freezeup to deliver supplies and fuel for the camp and for the overland trip to the Kugrua and South Meade wellsites in December. Overland delivery to the wellsites was employed until the ice strips at these sites became operational.

In addition to the Peard Bay (LIZ C) site, quantities of drill pipe and crated drill muds were offloaded and stored on an unnamed point of gravel within the confines of Kasegaluk Lagoon just south of Nokotlek Point at latitude 76°18.5'N, longitude 161°04.5'W. For ease of identification this was called Husky Point. Supplies and materials from this site were moved inland to the proposed Tunalik Borrow Site No. 2 (3/4 mile distant) and then over the prepared snow route to the drill site.

Late in the month of September 1977 work was begun at Peard Bay to drag an airstrip on the unvegetated gravel beach immediately to the west of the DEW Line site in preparation for the mobilization to Kugrua and South Meade. Also in September, improvements continued to Camp Lonely with the installation of two 250 KW generators for more dependable and increased power. Runway lights and weather shacks had been purchased early in the summer in anticipation of the coming season and these began to arrive.

Early in November, the Drilling Department negotiated contracts for the use of Brinkerhoff Signal Rig No. 31 in the Barrow gas fields.

The 1977-78 construction and drilling program was ambitious and schedules were quite tight. Once the snow depth became deep enough to protect the surface of the tundra and the depth of freeze was sufficient to support heavy equipment, the season got underway. Construction trains were mobilized from Lonely to Drew Point (December 1, 1977) and from Lonely to North Kalikpik (December 4, 1977). The North Kalikpik train was supplemented on December 6, by the parts of a train that were stacked out for the summer at West Fish Creek. In addition, two trains left Peard Bay (LIZ C); one for Kugrua (December 2, 1977) and one for South Meade (December 5, 1977). All moves were overland and followed trails that had been staked and approved during the previous summer.

Drew Point Test Well No. 1

Field operations for Drew Point commenced when the construction train left Camp Lonely on December 1, 1977. The site was located at latitude 70°53'N, longitude 153°55'W on the eastern shore of Smith Bay about 18 miles west of Camp Lonely. The sea ice near shore was traveled as much as possible as travel there was much smoother and there was less chance of environmental degradation. Material for the drill pad was taken from a partially drained lake basin about six miles south of the wellsite. However, access to the borrow site was mainly over the ice along the edge of Smith Bay and less than one mile of overland ice road was required. An ice strip was cleared on a lake 3.5 miles to the east of the site. The water-source lake was located three miles to the southeast. Construction was completed on January 5, 1978 and the train moved on to the Ikpikpuk site.

The rig-move (Nabors No. 25) was from the W. T. Foran drill site and was originally scheduled to be accomplished by air. An airstrip was cleared at the W. T. Foran site as the ice on that shallow lake froze to bottom early in the season. However, the ice strip at Drew Point was much slower to freeze to sufficient thickness. This, combined with some bad weather and aircraft scheduling problems, made it expedient to accomplish the entire rig move by rolligon. Rig move-in operations began on December 20, 1977 and were completed on January 1, 1978. Rig-up began on January 2, and was completed in eleven days. The well was spudded on January 13 at 4:00 p.m.

The Drew Point well was drilled to a total depth of 7,946 feet. The primary objectives of the well were the Sadlerochit and Lisburne rocks with a secondary interest in the possible presence of the Kuparuk River Sandstone. Although minor oil shows were encountered, the potential reservoir zones were thin and/or had low porosity and permeability. At the conclusion of the drilling and evaluation process, the well was left abandoned with cement and mechanical plugs at selected intervals. The rig was released at 2:00 p.m., March 13, 1978.

Kugrua Test Well No. 1

The airstrip at Peard Bay (LIZ C) was ready by November 10, 1977 and strip checked and approved by a C-130 Captain. Mobilization of the construction equipment began in mid-November and approximately two weeks were spent putting the train together, checking generators and equipment and other preparations for the overland move. The first train departed LIZ C November 30, and arrived at the Kugrua site late in the evening of December 1. The Kugrua Test Well No. 1 was located at latitude 70°35'N, longitude 158°40'W. Construction was begun the next morning on the reserve pit, the pad, the ice airstrip and ice roads. The airstrip was located on a lake about one mile to the southwest of the well. This lake also served as a water source. The material for the pad was obtained from a slightly elevated sand dune area about 1-1/4 miles southeast of the wellsite. Construction was completed on January 7, but a ruptured fuel bladder delayed the overland move to Tunalik. A long period of blowing snow hampered the crews cleaning the fuel pit and salvaging fuel. The train finally moved out on January 29.

The rig move (Parco No. 95) from the South Harrison Bay wellsite was accomplished by air and by rolligon. The ice runway was cleared again on the shallow mud flats at the west end of Harrison Bay. Rig move-in operations began on January 17 and were completed in 25 days. The well was spudded at 3:00 p.m. on February 12, 1978.

The Kugrua well was drilled to a total depth of 12,588 feet. The objective of the well was to test a stratigraphic closure within the basal Lisburne or Devonian Section. The primary zones of interest included the Sadlerochit and Lisburne and possibly the Kuparuk River Sandstone. Drilling was uneventful except for repeated problems with severely sloughing shale.

The well was drilled to test a seismic anomaly in Paleozoic strata in an onlap sequence along the Arctic Coast. Although the anomaly was penetrated, explanation of the relationship was not obvious. The seismic interpretations may be related to an unanticipated sequence of Pennsylvanian-Mississippian age limestone exceeding 1,400 feet in thickness encountered by the well. The projected depth of the Kugrua well was argillite basement at 12,220 feet, but the caving shale and the unanticipated sequence of limestone at the bottom of the hole slowed drilling considerably and the well was terminated in Lisburne Group at a depth of 12,588 feet, still short of the argillite.

At the conclusion of the drilling and evaluating process, cement and mechanical plugs were set at selected intervals and diesel left in the top 1,800 feet of the well bore. The abandonment marker was set and the rig released on May 29, at 9:00 p.m. Fortunately snow cover on the tundra was still "good" and the rig was quickly broken down and moved by rolligon to Peard Bay where it was stacked to await the barges that summer.

North Kalikpik Test Well No. 1

The North Kalikpik drill site was located at latitude 70°31'N, longitude 152°22'W. The construction train was mobilized in part from Camp Lonely

on December 2, 1977 and in part from West Fish Creek on December 5. Both moves were overland. Construction actually started on December 4. The material for the pad was obtained from a high sand bank along a small unnamed tributary of the Kalikpik River approximately four miles southeast of the location. The Herc strip was cleared on the ice of a lake about a mile and a half to the northwest of the site and the principal water source was a small lake a quarter mile directly south of the site. Construction work was completed on January 25, but the crew remained on site until the drilling crews could get established. The construction train left for the Inigok location on January 31, 1978.

Rig move-in operations began on January 29. The rig (Parco No. 96) was moved from West Fish Creek to North Kalikpik by rolligon. A total of 110 loads were hauled in eight days. The ice of the airstrip lake was not thick enough to support heavy aircraft operations at the time of the rig move. Rig-up began on February 6 and was completed in 22 days. The well was spudded at 10:00 a.m. on February 28, 1978.

The well was drilled to a total depth of 7,395 feet. The objective of the well was to test a stratigraphic erosional remnant of the Kuparuk River Sandstone. No attractive reservoirs were encountered, although the equivalent rocks of the target interval were highly organic and contained traces of bitumen and gas.

After drilling and evaluation the well was abandoned with cement and mechanical plugs separating formations. The abandonment marker was set and the drilling rig released at 2:00 p.m., April 14, 1978. The rig was broken down in preparation for moving to the Ikpikpuk location.

South Meade Test Well No. 1

On December 5, 1977, the second construction train left Peard Bay (LIZ C) enroute to the South Meade site located at latitude 70°37'N, longitude 156°53'W. Construction began immediately upon arrival. Clearance for some of the borrow sites was not possible because archaeological materials were encountered. Where it was possible the borrow area was excavated by professional archaeologists. Where time did not allow excavation, the site was rejected. The well location itself was moved a few hundred feet so as to be located on one of the acceptable borrow sites. This significantly reduced the amount of effort and the degree of tundra disturbance necessary to build the site. A number of borrow sites were approved and designated but none were used. The relocation of the wellsite meant the reserve pit excavation was pure sand and so additional borrow was unnecessary. The airstrip was cleared on the ice of a lake located one mile west of the location. The primary water-source lake was located one mile south of the drill site. Ready access to the airstrip lake was afforded by a convenient water channel which when frozen provided an ideal road. Construction was completed on January 6, 1978 and the train departed on the morning of January 8 for the Tunalik location.

The rig move (Nabors No. 1) from South Simpson No. 1 was done completely by rolligon and was efficient and uneventful. The operation began on January 6 and was completed January 19. Rig-up operations

began on January 18 and were completed in 21 days. The well was spudded on February 7, 1978.

The target depth for the well was estimated at 9,825 feet. Later in the season it was evident that tight hole problems, parting drilling jars and fishing problems, and severely sloughing shales had delayed progress sufficiently to preclude reaching the target depth in one season. After setting casing and plugging the well at an appropriate depth, the mud was reversed out of the annulus and the annulus was Arctic packed to the surface. The tree was nippled up and the well secured for the summer. The rig was released on May 17, the derrick lowered, and the camp and rig prepared for summer suspension and the well scheduled for reentry in the fall. Operations were suspended on May 20, 1978.

Ikpikpuk Test Well No. 1

The construction train left Drew Point on January 5, 1978 and proceeded to the Ikpikpuk well site located at latitude 70°27'N, longitude 154°20'W. It was planned to build the drilling pad in the spring, move the rig to the site and get partially rigged up so as to get as early a start as possible in the fall. It was hoped that with an early start, the drilling operations could reach the target depth of 15,175 feet in one season.

Construction began immediately upon arrival. An ice runway was cleared on an interconnected complex of lakes immediately to the northwest of the site. One of these lakes also served as a water source. Access to the closest lake required only a couple of hundred feet of ice road construction. Borrow material for the drilling pad was taken from two, higher, dune-like areas; the first was a mile to the south and the second was a mile to the west of the wellsite. Construction was completed on February 7, 1978.

Rig move-in operations began April 14. Ninety-one Herc loads and 51 rolligon loads were required to move the rig (Parco Rig No. 96) from North Kalikpik to Ikpikpuk. The move was completed on May 2, 1978. Operations were suspended for the summer on May 6 with the rig-up eighty-five percent complete.

Inigok Test Well No. 1

The first contingent of the construction crew to build the Inigok site arrived from North Kalikpik on January 25, 1978. The remainder of the equipment and men arrived from Ikpikpuk on February 13, 1978.

The Inigok Test Well, located at latitude 70°01'N, longitude 153°06'W, was the first deep test on the Reserve; it was scheduled to reach 19,750 feet in depth. It was not planned to suspend the drilling operations during the summer as the three and possibly four reentries could prove very costly. A year-round runway, although expensive, was more economical when measured against rig costs. The plan was to build an ice airstrip on a nearby lake to serve during the spring construction season while the all-season runway was being built. The pad, runway and connecting road were all partially built of local materials, mostly gained from leveling out

Gravel haul over the ice road at South Simpson, February 1977.

the ridgetop runway site. This cut and fill operation produced the sand subgrade. Over this were placed three inches of Styrofoam insulation which was in turn covered by eighteen inches of gravel to serve as a protective and load bearing surface. Such a design reduced the gravel requirements from about 300,000 cubic yards to about 88,000 cubic yards and made the Styrofoam insulation an economical design choice. Gravel sources were investigated for miles in every direction. Although numerous small sources were found, their utilization would have meant the expense of numerous shorter ice roads and extensive tundra disturbance. A sufficient quantity of gravel was found at the mouth of the Kikiakrorak River where it joined the Colville River, about 37.5 miles to the east of the site. Ice road construction began on February 1, taking advantage of the frozen surface of every lake, pond and river that was encountered en route. Construction of the ice road was round-the-clock from February 1 until March 8 when the gravel haul began. Gravel haul was accomplished each day in two ten-hour shifts and the remaining four hours were spent repairing cracks in the ice road and servicing the equipment. In the 38 days of the gravel haul, approximately 132,000 tons of gravel (88,000 cubic yards) were hauled over 35,000,000 gallons of water frozen to form the ice road. Construction was completed on the drilling pad on May 2, 1978. Some of the construction equipment was demobilized via air lift to South Meade on May 14, to assist in the building of the ice airstrip at that site in the fall. A full construction train departed Inigok on May 15, for the summer "stack-out" location at Wolf Creek. This site was chosen as central to as many possible 1979 locations as feasible. The remaining construction equipment finished "working" the surface of the all-season airstrip until it was ready to receive "strip check" and certification on the first of June.

Nabors Rig No. 25 was moved earlier via air from Drew Point using the Inigok temporary ice runway and was stacked at the site to await the completion of the gravel runway. Rig-up began on April 25, and was essentially complete by May 22 when the ice airstrip was closed. Final rig-up up was delayed until the completion of the all-season gravel airstrip. The well was spudded on June 7, 1978.

Barrow Gas Field(s)

The construction and drilling operations for the Barrow area during 1977-78 were planned to center around two locations. A lake for an ice strip and two small borrow sites were selected for South Barrow No. 16 and ice strip locations and a larger borrow site selected for South Barrow Nos. 17 and 19. However, at the last minute the local residents of Barrow objected to the two borrow sites located east of Tekegakrok Point and only consented to the larger borrow site, north of South Barrow No. 19, on the condition that the gravel be replaced. The condition was extremely limiting but not impossible and was adhered to stringently. Some of the gravel from the South Barrow No. 16 pad was retrieved and used for South Barrow No. 17. Part of the gravel from South Barrow No. 17 was retrieved again and used at South Barrow No. 19. This reduced the amount of gravel taken from the borrow site. The ice strip for South Barrow No. 16 was constructed on an unnamed estuary known locally as Wohlschlag Slough. The ice strip for South Barrow Nos. 17 and 19 was constructed on the edge of Elson Lagoon immediately north of the drill

sites. Because of the increased effort planned for the Barrow area and the need for better housing in the field, an ATCO "Drilling Camp" was purchased in October 1977 and flown from Fairbanks to Barrow in C-130 aircraft.

South Barrow No. 16

South Barrow No. 16 was located six miles east of Barrow, approximately one mile east-northeast of the nearest producing wells in the South Barrow Gas Field. Pad construction started on December 15, 1977; rig-up began on January 8, 1978; the well was spudded on January 28. South Barrow No. 16 was an exploratory investigation of a structure similar to that into which Barrow No. 14 was drilled in an attempt to locate a new gas field to supplement the diminishing reserves of the South Barrow field. The rig used was a National T-20, Brinkerhoff Signal No. 31. The well, drilled on a seismically identifiable structure, penetrated a Cretaceous section of sediments to the argillite basement. Small shows of gas were noted but the primary objective, the Jurassic Barrow gas sand appeared to have been removed by Early Cretaceous erosion. A secondary objective, the Sag River Sandstone, a potential oil reservoir, was missing probably for the same reason. The well reached a total depth of 2,400 feet and after evaluation of the logs, South Barrow No. 16 was considered a "dryhole" and was plugged and abandoned. The rig was released on February 17 and partially rigged down for the move to the South Barrow No. 17 location.

South Barrow No. 17

South Barrow No. 17 was located approximately 13 miles east-southeast of Barrow. The rig employed was Brinkerhoff Signal No. 31. Installation of the piling for the rig began on January 8, 1978; rig move and rig-up began on February 19; and the well was spudded at 6:00 a.m. on March 3, 1978. South Barrow No. 17 was an attempt to learn more about the East Barrow field. The Barrow gas sand was the primary objective with secondary interests in the Sag River Sandstone and several thin but persistent sands in the "Pebble Shale" Formation. The well was drilled to a total depth of 2,382 feet penetrating sediments of Recent to Triassic age and terminated in the argillite of Pre-Carboniferous age. After evaluation the well was suspended in the production mode as an "edge" well that produced considerable water with its gas. The rig was released on April 13, 1978 and partially rigged down for the move to the South Barrow No. 19 location.

South Barrow No. 19

South Barrow No. 19 was another attempt to learn more about the East Barrow gas field; the well was located about 11 miles east-southeast of Barrow about two miles west and north of South Barrow No. 17. Installation of the piling for the rig began on January 27, 1978; rig-up began on April 14; and the well was spudded at 5:00 a.m. on April 18, 1978.

The well was drilled to a total depth of 2,300 feet with the Barrow gas sand as the primary objective and the Sag River Sandstone as a secondary

objective. At the conclusion of testing the well was completed as a gas well in the upper Barrow gas sand and left suspended in a production mode. Production tests in the Barrow gas sand resulted in a calculated absolute open-flow potential of 7.2 million cubic feet of gas per day with no water. Tests for oil in the Sag River Sandstone were negative. The drill rig was released at midnight on May 16, 1978 and rig-down commenced immediately. The rig components were moved to South Barrow No. 6 well pad and camp and support units were moved to storage at NARL facility.

Tunalik Test Well No. 1

The construction train from South Meade arrived at the Kuk River crossing, approximately 25 miles south of Wainwright on January 15, 1978. Thin ice coupled with blowing snow delayed the train until a timber reenforced ice crossing could be constructed (refer to Figure No. 4).

The first units of the train crossed the Kuk River on the 29th and the last units crossed on the 31st. The train arrived at Tunalik on February 2. The second construction train left Kugrua on January 29, arrived at the Kuk River on February 1, and crossed the same day. This train arrived at Tunalik on February 4, 1978. Although there were many difficulties encountered during the overland trip, once at the site, operations proceeded efficiently. Weather cooperated with a long period of relatively mild temperatures (i.e. minus 10° F) and little wind. Tunalik is located at latitude 70°12'N, longitude 161°04'W.

Tunalik was the second deep well (target depth 19,980 feet) scheduled for year-round drilling and therefore required an all-season runway. The selected borrow site was located approximately 4 1/2 miles directly west of the wellsite. However, the ice road interconnected the wellsite, the all season runway construction site, the Twin Otter strip, the material site and the ice Herc strip and thus totaled about eight miles in length.

The borrow site was located on a western facing knoll and contained an archaeological site in a section of the borrow area referred to as Aliquot A. Permission was obtained from the State Archaeologist to excavate the archaeological materials so the site could be utilized as a material source. This excavation was accomplished the previous summer under the supervision of a BLM archaeologist at the same time the site topographic survey was accomplished.

Material was removed from Aliquots A & B to build the runway, the gravel access road from the airstrip to the drill site, and the drill pad itself. Insulation was employed in the design of all three to reduce the amount of material needed. Construction was completed by May 1.

On April 9, a loader, generator, grader and survival shack were flown from Tunalik to Betty Lake for the proposed Etivluk area well. The original landings were made on an ice airstrip cleared by GSI. This airstrip was improved and the remainder of an entire construction train was flown in to Betty Lake for summer stackout. The camp was to be utilized during the summer as a base camp for the survey work. Betty Lake is located at latitude 68°29'N, longitude 156°30'W.

The second construction train was moved from Tunalik overland to Husky Point on May 5. It was positioned near the beach so the barges could move it up to LIZ C in preparation for the Peard Bay wellsite construction in the fall and on their return move the Parco No. 95 rig from LIZ C to Husky Point.

In addition, a few pieces of equipment were flown from Tunalik to Barrow on May 7, 1978 to assist in construction there. A small camp and two pieces of equipment were left at the Tunalik site to "work" the runway and gravel road to remove excess moisture during the spring thaw period.

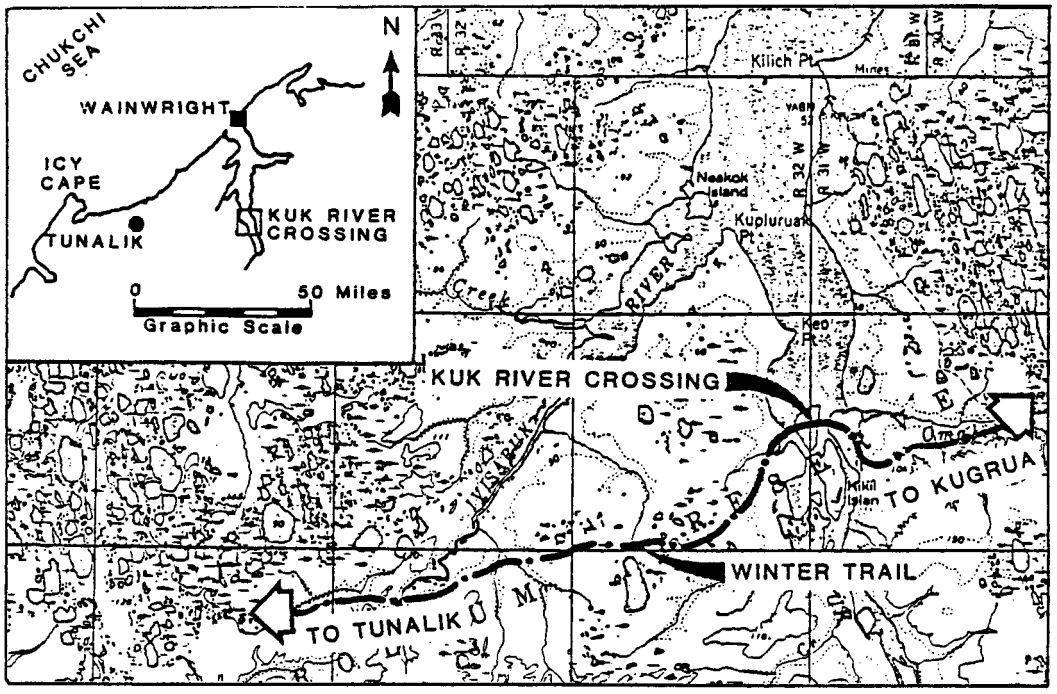


FIGURE NO. 4. KUK RIVER CROSSING

Camp Lonely - February 1978

On February 23, 1978 a fatal accident occurred at Camp Lonely. Steve Rusnak, a truck driver, was driving the water haul vehicle, a large rubber-tired ARDCO all terrain vehicle from Okalik Lake to the Camp. He pulled up behind the water treatment unit behind the camp kitchen and jumped down presumably to connect the hoses. Somehow, the vehicle was slightly moving and he slipped or otherwise fell and became caught under one of the front tires. The vehicle was then up against the building and could not creep any further. Although not crushed by the tire, he could not remove himself or call out and the weight of the vehicle restricted his breathing. When found by co-workers, he was carried to the camp medical station. Oxygen and cardiopulmonary resuscitation were administered by the medic and a doctor was dispatched from Prudhoe. However, all efforts were in vain.

Seismic - Spring 1978

The spring geophysical program included an ambitious amount of data acquisition in the Southern Foothills area and the Brooks Range in addition to some over ice work on Smith Bay. Four crews were mobilized; three in the south portion and one in the north. They were blessed with exceptionally good weather and a minimum of blowing snow and 1,934 line miles of survey were accomplished in spite of the difficult drilling conditions in the Brooks Range and Southern Foothills region. Three of the seismic trains were stacked for the summer at Umiat and the fourth was stacked at the Kiligwa airstrip near Brady. It was a favorable season and all "assigned miles" were accomplished.

The annual plan of operations for 1978-79 proposed to extend the NPRA regional geophysical surveys out of the Reserve and across the Brooks Range via Howard Pass. No part of the Brooks Range had previously been crossed by seismic surveys and the results of the proposed seismic and gravity investigations were of intense interest to both government and industry. It was hoped to obtain information which would assist in the understanding of the orogeny of the Brooks Range and thence in a better understanding of the subsurface geology of the Foothills Province on the North Slope, including NPRA. If, as many geologists have suggested, the Brooks Range is comparable to the foothills belt of the Canadian Rockies, an extensive exploration program for major natural gas reserves in the foothills area of the Brooks Range would appear to be mandatory. If, on the other hand, the structural style of the Brooks Range is fundamentally different from that found in the foothills belt of the Canadian Rockies, it would suggest a major difference, most likely a reduction, in the assessment of the natural gas potential for the area and thus, a major change in the mode of exploration.

Two generally parallel geophysical traverses, referred to as a doublet, were planned for this study. However, because the survey in the southern portion of Howard Pass was to cross a small section of D(2) lands, permission was not received even though the environmental assessment demonstrated that any effects of the study would be very minor and transitory in nature. D(2) lands were those lands proposed for parks, wildlife reserves, or similar uses under the Alaska Native Claims Settlement Act but not yet selected.

Cleanup - Spring 1978

The spring efforts at cleanup of the old abandoned sites focused on the Skull Cliff Air Force Tower site and the Navy's Topagoruk and East Topagoruk test well sites. Working out of Cat trains from April 1 through May 15, the cleanup crews stockpiled 2,120,000 pounds of debris on the beach at Skull Cliff. This included the 236,000 pounds of tower, 200,000 pounds of crushed barrels, 1,380,000 pounds of cement and mud canisters, and about 300,000 pounds of miscellaneous debris. Favorable weather contributed significantly to a productive season.

Drilling Site Rehabilitation - Spring 1978

The plan called for using Caterpillar tractors to lower the profile of the drill pads and to "erase" their straight edges that indicated their man-made origins. In anticipation of accomplishing this civil work at the recently abandoned drill sites, D-8 tractors with blades and two drums of fuel were positioned before spring break up at Atigaru, West Fish Creek, South Harrison, East Teshekpuk, W. T. Foran and South Simpson wellsites. These Cats were to be used at various times during the summer to "rework" the pads and fill in the reserve pits as much as possible. The Cat that was scheduled to be left at W. T. Foran, finished the rehabilitation of Halkett before proceeding to W. T. Foran.

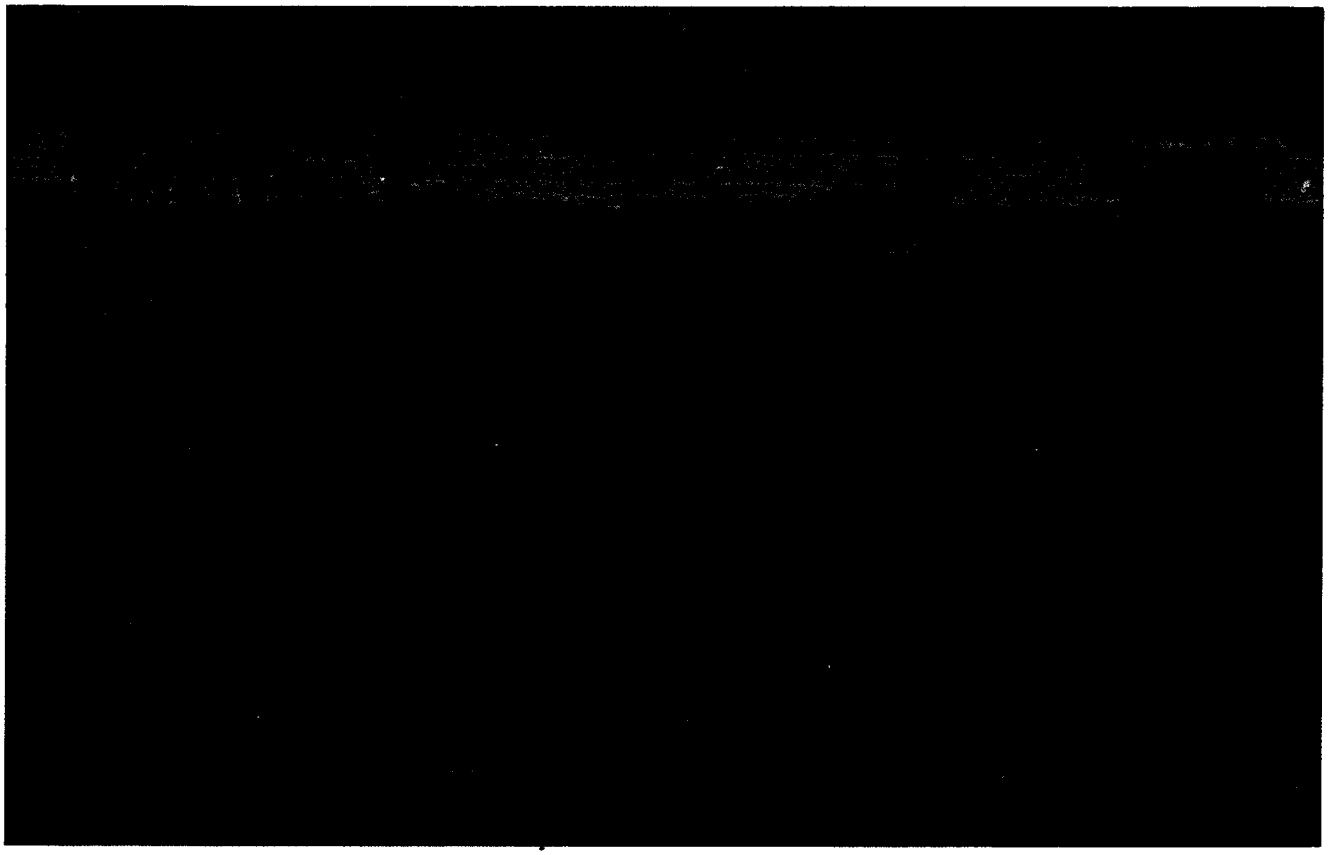
USGS/HUSKY - FOURTH SEASON: JUNE 1978 TO MAY 1979

Summer Operations

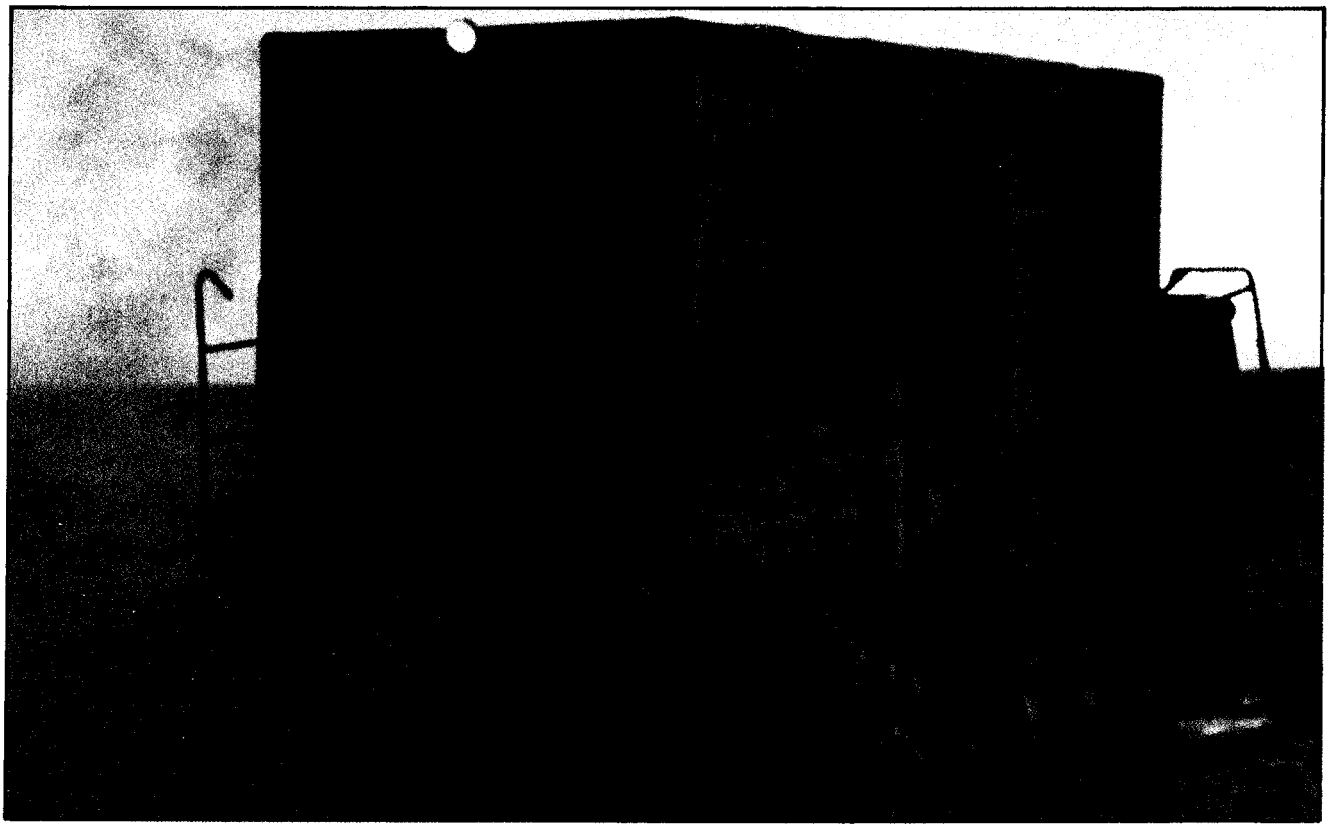
The 1978 summer survey was a very active and busy period as many drill sites were still being considered and final decisions had been reached on only three sites out of the five proposed wells. The program was scheduled to complete the two deep exploratory wells, Inigok and Tunalik, that were started the previous season, reenter and complete South Meade and Ikpikpuk, and drill three newly selected medium depth wells and prepare pads for two deeper drilling sites. One wellsite in the Barrow area was moved from Nuwuk Point to Tapkaluk Island to Tulageak Point to south of Tangent Point and finally back to Nuwuk before being dropped from consideration. The Tangent site was actually surveyed as that was the popular choice during the field season. Because of archaeological resource discoveries, peregrine nesting locations and other reasons, the Lisburne wellsite included separate topographic surveys and soil samples for three runway locations and two well locations before finalization was accomplished.

Survey crews were based out of Lonely and Barrow as well as the Betty Lake and Wolf Creek construction trains. The following sites were actually surveyed during the 1978 summer season. Borrow sources were located and sampled where necessary; archeological clearance and rare and endangered species clearance were obtained; and water sources, runway and pad locations, and designs proposed.

Site	Location
Lisburne	latitude 68°29'N, longitude 155°41'W
Seabee	latitude 69°22'N, longitude 152°10'W
Peard	latitude 70°43'N, longitude 159°00'W
East Simpson	latitude 70°55'N, longitude 154°37'W
Tangent	latitude 71°07'N, longitude 155°04'W
J. W. Dalton	latitude 70°55'N, longitude 153°08'W
Carbon	latitude 69°29'N, longitude 160°20'W
Carbon Alternate	latitude 69°29'N, longitude 160°36'W
Kungok	latitude 70°24'N, longitude 159°12'W
Kigalik	latitude 69°28'N, longitude 157°22'W
Etivluk	latitude 68°24'N, longitude 156°52'W



Installing insulation in the Inigok runway, April 1978.



Building ice road at South Simpson, January 1977.

Three additional wells were planned in the East Barrow field, South Barrow Nos. 15, 18, and 20 and these locations were also surveyed.

Barrow No. 15 - latitude 71°14'N, longitude 156°21'W
Barrow No. 18 - latitude 71°14'N, longitude 156°17'W
Barrow No. 20 - latitude 71°14'N, longitude 156°20'W

Of the surveyed wells, Tangent, Carbon, the Carbon Alternate, Kungok, Kigalik, Etivluk and the Barrow wells were deferred for either fiscal, logistical or geophysical reasons.

An unusual amount of rain and cloud cover during that summer plagued operations all over the North Slope and many operations were completed in spite of the wet, adverse conditions. The Lonely airstrip gravel parking apron was enlarged by the addition of 220,000 square feet of space. Work continued on the Inigok and Tunalik airstrips to compact and consolidate the gravel and work the moisture to the surface.

However, the warmer, rainy weather promoted an area of ice free water in the Arctic Ocean early in the season and the Cool Barge deliveries were completed unusually early at Lonely. By July 19, 23,872,950 pounds of dry cargo had been delivered to the camp plus 5,594,300 gallons of POL products (petroleum, oil and lubricants). Later in early August 13,000,000 pounds of "lateral" transfer were accomplished. The Nabors No. 17 drill rig arrived at Lonely and the construction train was moved from Husky Point to LIZ C and the Parco No. 95 rig was moved from LIZ C to Husky Point. Retrograde that year totaled 864,000 pounds.

Summer cleanup of the recently utilized drill sites commenced on June 8, 1978 and the trash and debris that was hidden by the winter snows was picked up by the end of July at Ikpikpuk, Drew Point, Kugrua, South Meade and the Inigok Ice Road Camp. The cleanup at the old Navy sites continued concurrently with one crew working out of Skull Cliff and a second crew stationed at Wolf Creek. The sites cleaned that season included:

Skull Cliff Tower Site
Topagoruk and East Topagoruk
Wolf Creek Test Wells 1, 2 and 3
Weasel Creek Test Well
Square Lake Test Well
Knife Blade Test Wells 1, 2 and 2A
Mona Lisa Seismic Camp
East Oumalik Test Well, and
the explosives cache discovered in the Ikpikpuk area.

The summer's accomplishment are summarized as follows:

Barrels retrieved (uncrushed)	187,100 pounds
Barrels crushed	712,725 pounds
Combustible debris stockpiled	377,350 pounds
Combustible debris burned	294,310 pounds
Other debris	270,430 pounds
	1,841,915 pounds

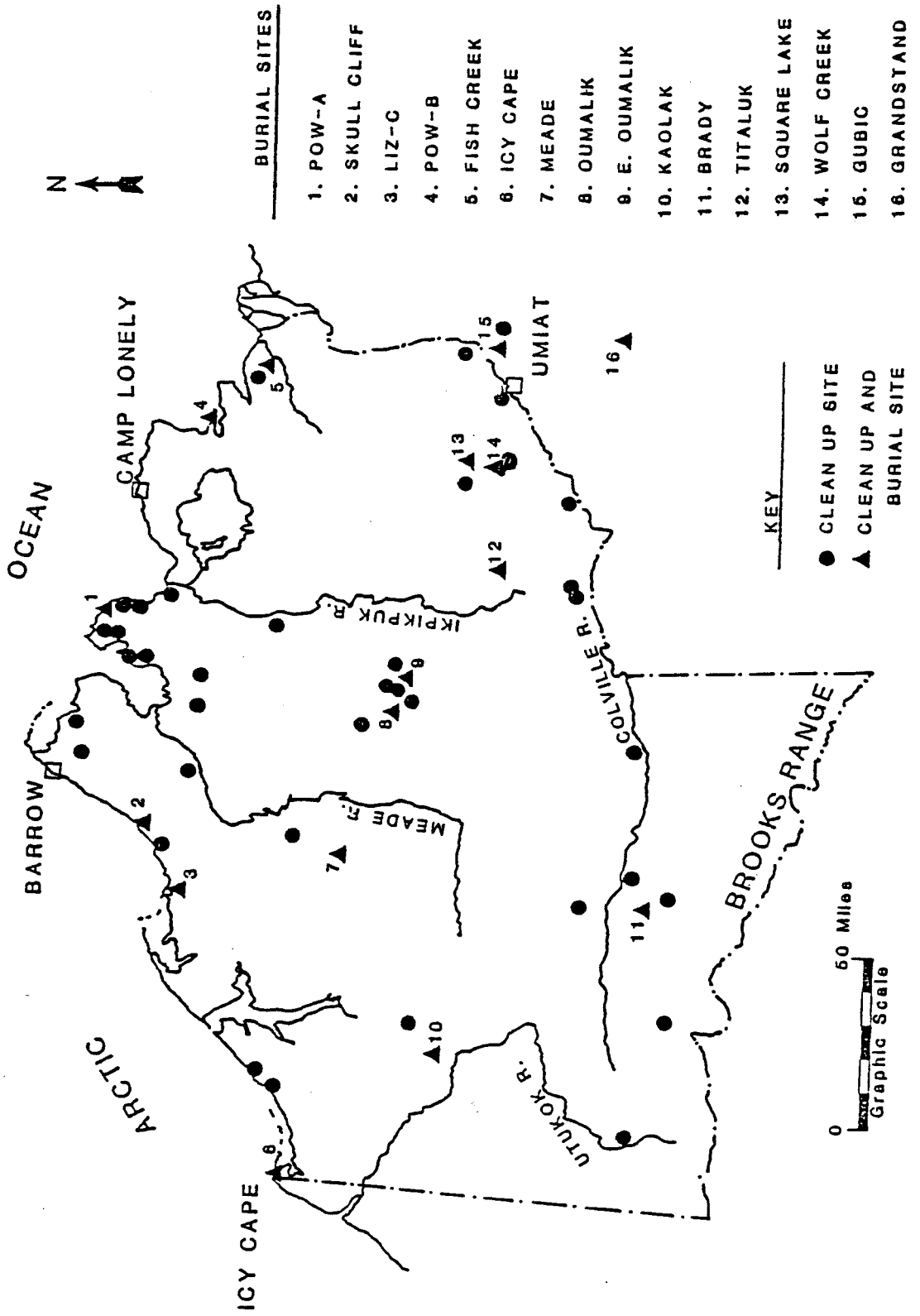


FIGURE NO. 5
CLEANUP AND/OR BURIAL SITES OF THE REHABILITATION PROGRAM

In excess of 920 tons of material and debris were burned or stockpiled (refer to Figure No. 5).

Rehabilitation and Revegetation Operations

The revegetation program for 1978 was to encompass the six sites previously drilled by Husky Oil NPR and one site drilled earlier by the Navy. They were: Cape Halkett No. 1 (Navy), East Teshekpuk No. 1, South Harrison Bay No. 1, W. T. Foran No. 1, Atigaru No. 1, West Fish Creek No. 1 and South Simpson No. 1. After the cleanup of miscellaneous debris it was planned to use the D-8 Cats that were positioned on the sites the previous spring to push as much of the pad as possible into the reserve pit. The object was to reduce the elevation of the pad as low as possible and place the surface closer to the moisture table to facilitate revegetation and also reduce the man-made intrusion to the landscape. Attempts were made to pump out the reserve pits to facilitate fill in with pad material. This was only partially successful. In some cases, the water would percolate back into the pit almost as fast as it was pumped out.

Because of the very wet summer, a good deal of difficulty was encountered with the civil work. The pads were very wet and the tractors continually bogged down. It was decided to delay the civil work as long as possible and then to dormant seed the grasses in the fall. This delay allowed the pads to "dry" as much as possible and even to "crust over" with the first frosts to provide better trafficability. The aim of the civil work was to erase the straight man-made edges of the pads and to leave the remaining material as natural looking as possible. Some work was accomplished in July and the first week of August before the decision was made to await better conditions. At that point, South Harrison Bay, Atigaru Point and East Teshekpuk were ready to seed. The remainder of the program was then accomplished between September 1-22. A gravity feed, helicopter transportable, hopper/spreader was fabricated for the distribution of the seed and fertilizer. After spreading, the seed was "walked into" the surface by the onsite tractor if conditions permitted.

Reseeding and fertilizing was accomplished at the following sites:

September 14, 1978 - Tunalik Borrow Site, Aliquot A & B and the Delta-3 track that paralleled the road (fertilizer only on the track).

September 16, 1978 - W. T. Foran No. 1 and Atigaru Point No. 1.

September 21, 1978 - West Fish Creek No. 1 and South Harrison Bay No. 1.

September 22, 1978 - Cape Halkett No. 1, East Teshekpuk No. 1, and South Simpson No. 1.

In addition, the borrow area at Inigok (the area of "cut" along the runway from where the primary fill was obtained) was dormant seeded in the fall of 1978. Two types of seed were used: Tundra Bluegrass (Poa glauca) was spread on the area northeast of the taxiway and Alyeska Northern mixture was spread on the area southwest of the taxiway.

Camp Lonely

During the fall of 1978 a subcontractor erected the fabricated steel aircraft hangar at Lonely on the newly enlarged apron. This 130 x 130 foot structure greatly alleviated the aircraft maintenance problems and provided warm storage for the aircraft. Although it was unknown at that time how long the exploration program would continue, the time saved due to good maintenance and the greatly reduced ferry costs to mobilize and demobilize exchange aircraft for periodic maintenance combined with the greatly increased safety factor made the project very attractive. It proved cost effective as the exploration program continued at full pace for three more winter seasons.

Changes in Operational Design

Two design changes in operational methods were made during the summer of 1978 that significantly impacted the ensuing seasons in both effort and cost. The construction department designed a double-walled fuel storage tank that was completely self contained, held 23,000 gallons, had a safety catchment basin to contain any valve leaks and was transportable by Hercules aircraft. Prior to this, single wall fuel tanks or fabric storage bladders were used for fuel storage within gravel or timber diked areas lined with impermeable membranes. These liners were expensive, and because of cold weather handling and the need to retrieve them, often before breakup, they were seldom used more than one season. The double-walled steel tanks would eliminate the need for these membranes and containment berms required under the state regulations. The concept was discussed with the State Department of Environmental Conservation and after concurrence was received, a number of tanks were ordered. The tanks proved to be very economical as they were safe, conveniently transportable and highly adaptable to the needs of the program.

The second change of operational methods that had considerable effect on the program was the decision to employ the "thin-pad concept" in the design of all one season wells. It was reasoned that if the drilling pad surface was to be utilized only for one winter season and would always be frozen during use, then the stabilization of the surface was a product of the weather and the ice/moisture content of the pad material was irrelevant. This allowed the material obtained from excavating the reserve pit to be used to build the drilling pad no matter what its ice content or thaw characteristics. The reserve pit was so designed to contain all of the anticipated volume of fluids below the original tundra level. The drill rig was still placed on piling to prevent any settlement during the drilling operation.

Upon abandonment of the wellsite, rehabilitation of the drill pad consisted of the removal below surface level of the piling and sills. In most cases, the ice content of the pad material was quite high and the disintegration and slumping of the surface during the thaw process accomplished the change in profile that was previously necessary to do with Caterpillar tractors on the thick pads. The thin pads had two other environmental advantages. Since no "imported" select material from a borrow pit was

Rolligon transporting "outsize" rig component over tundra. January 1977.
(CATCO Photo).

"Anchoring" the SeaLift barge with a caterpillar tractor at Camp Lonely.
September 1981. (Photo by S. Krogstad).

needed the overall area of operational environmental impact was reduced by the size of the borrow pit and the length of any associated roads. In addition, the resulting "scar" of the drill pad was of lower profile and closer to the natural water table of the tundra so that revegetation was more successful. The reserve pit would be cleaned of any petroleum residue and the edges would quickly thaw to assume an outline difficult to distinguish from the many thousands of natural ponds of the tundra. Thus the thin pad design was less expensive to build, less expensive to rehabilitate and had less environmental impact. If oil or gas was discovered at a thin pad exploratory well, the well would be suspended for the melt season and the pad would be rebuilt with a more permanent surface the following winter season.

Inigok Test Well No. 1

Drilling at Inigok continued throughout the summer and fall of 1978. Numerous cores were taken and the usual problems occurred with "iron-in-the-hole" and "fishing" that can be expected on such a deep well. In December, while circulating and conditioning the hole to run intermediate logs at 17,750 feet, the circulating mud brought up high concentrations of hydrogen sulfide gas and native sulfur. The sulfur and gas were controlled and drilling continued but the sulfide problem impede the drilling operation from then until total depth was reached.

On January 5, 1979, the Great Northern Airlines contract Electra N403GN was en route from Anchorage to Inigok. Weather was clear and cold with visibility over seven miles. On approaching the runway, the left main gear of the aircraft contacted the ground about eight feet short of the runway and eight inches below the runway surface. The left wing assembly with the attached gear, separated from the fuselage when the gear impacted the runway threshold. The wing and gear continued down the runway about 1,050 feet, stopping on the left side and immediately caught fire. The main fuselage continued straight down the runway for about 900 feet, then veered left, coming to rest, upside down, about 500 feet off the runway. There were nine passengers and six crew on board, all strapped in their seats and badly shaken but unhurt. With help from ground personnel, they quickly released themselves and each other from their inverted dangling positions and evacuated the aircraft. The wreckage caught fire almost immediately after it was cleared. Attempts were made to put out the fire, but no proper equipment was available on site to reach the wreckage with sufficient quantities of water. Minor explosions began to occur from emergency survival ammunition and other materials on board the aircraft which forced the firefighters to retreat from their task. The medic flew down from Camp Lonely in case first aid was necessary, and all passengers and crew were evacuated to Lonely for further examinations. Luckily, all injuries were of a minor nature.

The Inigok well was drilled to a depth of 20,102 feet reaching that depth on May 16, 1979. The true vertical depth was calculated at 20,004.76 feet. The well was drilled to test a deeply buried east-trending faulted anticlinal feature separating the Umiat and Ikpikpuk Basins. The primary zones of interest included the Sadlerochit and Lisburne Groups and the possible Kuparuk River Sandstone. Minor gas shows were encountered in

several zones but no good reservoirs were found. Although argillite was not penetrated the drilling was terminated because of excessive borehole drift. However, the 20,102 feet was a new depth record at that time for an Alaskan well. The well was plugged and abandoned with cement in place May 21, 1979 at 1:10 a.m. The rig was released on May 22 at 12 noon. On May 31, the ninth day of rig down, preparations were underway to airlift the rig to the Seabee location.

Tunalik Test Well No. 1

The move of Parco Rig No. 95 from Husky Point to Tunalik began on October 11, 1978 with the arrival of the crews at Tunalik. The move took 97 rolligon loads and was accomplished in 10 days, finishing up on the evening of the 20th. Rig-up began on October 18, along with several major rig modifications that were concurrently accomplished. The derrick was raised on November 4. Rig-up and winterization continued including the tie-in of the new equipment. The 42-inch conductor pipe was cemented in with 450 sacks of Permafrost II cement as rig-up was completed. The well was spudded on November 10, 1978 and drilling operations continued for the next 420 days.

Ikpikpuk Test Well No. 1

Skeleton crews of Parco and Kodiak Oilfield Haulers (KOH) personnel arrived on location November 2, 1978 to activate the Ikpikpuk rig camp for support of the ice runway construction crew. A Twin Otter strip was prepared and the camp placed in full operation. A Delta-Commander and two Delta-3 all terrain vehicles arrived at the drill site on November 6, after the overland trip from Camp Lonely. Construction of the ice-on-tundra runway began on November 7. Because of the target depth of the well it was decided to build an ice strip on tundra as it would be operational long before the lake ice would freeze to the 48 inches of ice thickness required by the Hercules aircraft. It was hoped that an early start would allow completion within one winter season. The ice strip was completed and checked on November 21, 1978.

During this time partial rig-up had begun and maintenance work was being conducted on the rig. Rig-up with full crew began on November 22. The derrick was raised on November 23. The 30-inch conductor was cemented in place with 305 sacks of Permafrost II cement on November 26. Rig-up was completed and the well was spudded on November 28 at 3:00 p.m.

Almost immediately downhole problems were encountered with sloughing shales and lost mud. Numerous cores were requested to better understand the stratigraphy, and each trip, even short trips, required considerable reaming to reach bottom. It became obvious, even though TD was less than 1,500 feet away it would not be reached that season so at the casing point (14,210 feet), casing was set and Arctic pack was placed in the annulus. The well was secured and the rig released on April 17, 1979. The derrick was laid down and the rig and camp shut down for the summer. All personnel were off location by April 21, 1979.

South Meade Test Well No. 1

The skeleton crews from Nabors and KOH arrived on location on November 11, 1978. They opened the rig camp for the support of the construction group scheduled to rebuild the ice airstrip on the very shallow lake used the first season. It was hoped to get an early start, finish early, and free the rig for use on another location. On November 13, the airstrip construction got underway. A Twin Otter strip was cleared on a nearby lake for "interim" support and it was ready on the 14th. The rig derrick was raised on November 21, and preparations got underway while awaiting completion of the airstrip. The airstrip was ready on the 27th, and checked for use on the 29th and reentry of the well began December 3.

South Meade was drilled to the argillite "basement" at 9,945 feet. The well was drilled to test for a possible oil and gas accumulation in some truncated onlap strata on the southern flank of the Barrow Arch. Minor gas shows were observed from many zones but none were judged to be commercially significant. The well was plugged and abandoned and the rig released on January 22, 1979. Rig-down began immediately and the move of Nabors No. 1 to the East Simpson No. 1 site got underway on January 26, 1979.

Barrow Gas Field(s)

The program for Barrow for FY79 included no additional wells to be drilled but planned considerable construction and rehabilitation work to consolidate and efficiently utilize the resources already discovered.

That season's schedule called for reentry and rehabilitation of South Barrow No. 6 to cure a "rattle" that had been discovered earlier during a "blowdown". This work involved "killing" the well with calcium chloride mud and pulling the tubing; then deepening the well about 30 feet and anchoring the tubing to the bottom. Work was also accomplished at South Barrow Nos. 14, 17 and 19 to prepare them for production. A cement plug was set at the bottom of No. 17 in an attempt to seal off the water producing formation.

Overall, planning for the Barrow area proposed the construction of three-inch gathering lines in the eastern part of the field and a six-inch transmission line to connect the eastern portion with the producing field to the west. A connecting road and power line were also planned. An all weather road is necessary for the round-the-clock attendance required to operate the field. The pipeline was to be three feet above ground on wooden piling placed 35 feet apart and set 10 feet into the ground. To allow traffic to reach the other side of the pipeline there would be gravel ramps across the line. Every 105 feet or every third pole that supported the pipeline was to be tall enough to carry the proposed power line.

The schedule of construction for the 1978-79 season included completing the 2.4 mile extension of road to serve the South Barrow operating field and the 6-inch transmission line from the east field. This section of road became known as the Cake Eater Road after an earlier Air Force project of that name that was located along the right-of-way. The following season,

1979-80, the government planned to continue the road to connect with the newer eastern portion of the gas field. Spur roads would eventually connect each well to the main road. Spur roads were designed to be 14-feet wide, main roads were to be 18-feet wide, and both were to be constructed of five feet of gravel fill. The source of the gravel for all gas field construction was the borrow pit located on Barrow townsite land in the beach bluff area southwest of the city.

A construction Cat train arrived from Peard Bay on January 8, and Hercules C-130 flights began bringing equipment from Tunalik at the same time. Work began immediately on the ice road from the borrow source southwest of the city to the work site in the South Barrow field. Gravel was also hauled to rebuild the pad at South Barrow No. 14. The first portion of the construction plans, i.e., the Cake Eater Road, was completed this season as well as the "work overs" of South Barrow Nos. 6, 14, 17 and 19.

Peard Test Well No.1

A construction crew mobilized at LIZ C in early November 1978. They departed there on November 22, and traveled overland following the previously staked trail to the Peard site at latitude 70°43'N, longitude 159°00'W. An additional small construction crew came overland from the South Meade site where they had built the ice runway arriving at the Peard site on December 3.

Construction of the drilling pad at Peard consisted of excavating the reserve pit and using the removed material to build the pad. Borrow sites were not used, but were identified if it became necessary to build a pad to stack out for the summer or drill another season. These sites would be the material sources to build a pad with a more permanent surface. The airstrip was cleared on a shallow lake southwest of the drill site. A small extension of the strip was made on the tundra as the lake was not long enough to accommodate the 5,000-foot required length. The rig piling were in place and the ice road finished to the water source by December 29. After a few days of repairs, preparations, and some bad weather, the construction train left for the overland trip to Barrow on January 7, 1979 after the drilling camp was in place.

On December 19, 1978 Nabors, Kodiak and Husky personnel started the air move of the Nabors Rig No. 17 components from Lonely. Support equipment was moved between the 19th to the 21st with the flying of the actual rig components starting on the 22nd. By January 1, 1979, 98 Herc loads of rig components and 13 loads of Kodiak equipment had been received. Rig-up and assembly of the camp began on January 2. The 20-inch conductor was cemented in place by the 20th, and rig-up continued until the well was spudded on January 27, 1979 at 4:30 p.m.

Peard Test Well No. 1 was drilled to test for possible oil and gas accumulations in Cretaceous, Jurassic and Carboniferous rocks along the northern flank of the Meade basin. Minor gas shows were noted in several zones but no attractive reservoirs were encountered. No trace was found

of the 1,400 feet of Lisburne limestone that was present in the Kugrua well only 12 miles to the southeast. The well was plugged and abandoned at a depth of 10,225 feet and the rig released on April 13, 1979. Rig-down began immediately and the components were stacked in Herc sized loads to await the completion of the Ivotuk airstrip at Lisburne. It became a race against time and the melt of the ice strip at Peard but all the rig was finally airlifted out by May 18,1979.

J. W. Dalton Test Well No. 1

A construction crew arrived at the J. W. Dalton site, 3.5 miles east of Lonely, on December 11, 1978. The site is located on the high ground just east of the Smith River at latitude 70°55'N, longitude 153°08'W. Since the best utilization of rig time dictated that this well be drilled after East Simpson No. 1, the pad for J. W. Dalton was the conventional thick pad design. The gravel material was taken from a source, just behind the beach about two miles to the east of the drill site. The thickness of the drill pad and its accessibility via the beach to the Lonely airstrip would allow drilling to continue into the summer months. The construction was finished on December 29 and the crews moved back to Lonely and then on to the East Simpson No. 1 site.

Rig move-in operations were over the sea ice from the East Simpson No. 1 location. The moving operation began on April 11 and it took 69 truck loads and eleven rolligon loads to move the Nabors No. 1 rig. Rig-up began on April 16 and took 21 days. A rather large modification and maintenance program was accomplished on the rig and the camp concurrent with rig-up. The well was spudded on May 7, 1979 at 12:00 noon.

On May 30, a group of dignitaries gathered at the site to formally dedicate the well to James W. Dalton who had passed away two years earlier, almost to the day. Dalton pioneered much of the early work accomplished north of the Arctic Circle and his reports on the petroleum potential of the North Slope greatly influenced the State of Alaska's decision to select land in the Prudhoe area. Included at the ceremonies were his wife, Kathleen (Mike) Dalton and his children, George and Elizabeth.

The J. W. Dalton well was drilled to test for oil and gas accumulations on the southern flank of the Barrow-Prudhoe high. Oil shows had been encountered in a nearby well (W. T. Foran) located further down the structure. At the J. W. Dalton location heavy residual oils and/or tars were encountered and tests of several zones recovered small amounts of gas and heavy asphaltic oil. The occurrence of heavy oil and salt water may indicate that the well penetrated a reservoir just below the oil-water contact. If gas or oil is present in the reservoir, it may lie offshore. The well drilled to argillite basement at 9,367 feet and was plugged and abandoned.

The rig was released at midnight August 1, and the rig taken down and moved to Camp Lonely. Since the Nabors No. 1 rig consisted of many loads that were outsized to the Hercs it was decided to move the rig by barge. The rig was loaded on the barges on August 8 and hauled to Cape Simpson (POW A) to be close to the East Simpson No. 2 proposed well site.

East Simpson Test Well No. 1

On January 2, 1979 the construction train that built the J. W. Dalton drill pad set out for the East Simpson No. 1 site located at latitude 70°55'N, longitude 154°37'W. It was an easy trip following the relatively smooth coastal ice almost the entire route. The well was located about a quarter mile inland from Smith Bay on the Simpson Peninsula, the site of the numerous oil seeps that sparked the Executive Order in 1923 creating Naval Petroleum Reserve No. 4.

East Simpson No. 1 was constructed utilizing the "thin-pad concept", the drill pad consisting only of material excavated from the reserve pit. Borrow sites were identified but not utilized. Water was drawn from a lake 4.5 miles to the west and a C-130 runway cleared on a lake two miles to the west. Access to both was over a common ice road. Construction went smoothly without weather delays and was finished on January 22. However, the construction camp was needed until the drill camp was in place and blowing snow and poor weather compounded scheduling delays until February 10.

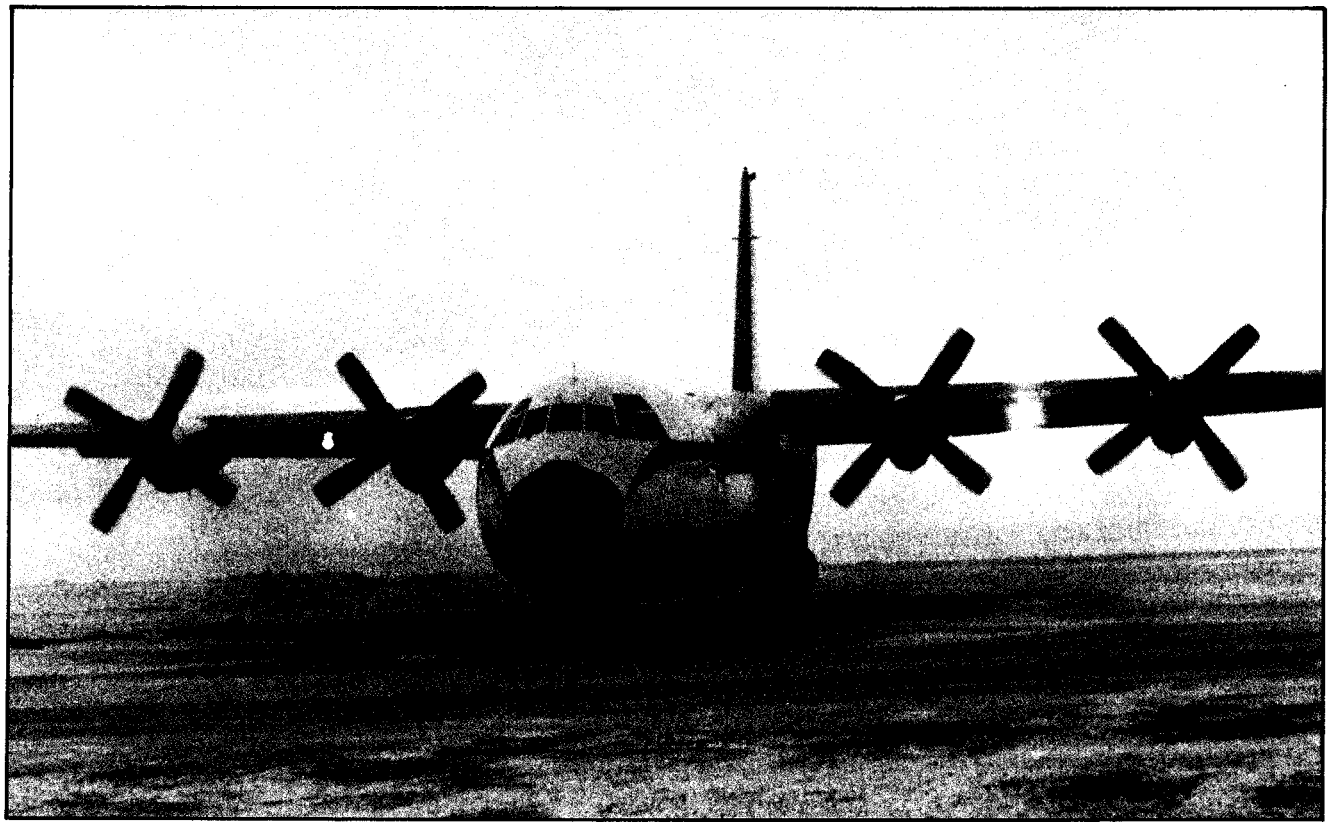
Nabors Rig No. 1 was airlifted from South Meade beginning January 28, 1979 and the move took 89 Herc loads. The outsized loads were delivered overland in two Magnum vehicle loads and 23 rolligon loads. Rig-up began on February 7, and was completed in 12 days. The well was spudded on February 19, 1979 at 8:00 a.m.

East Simpson No. 1 was a test of possible stratigraphic traps, especially in the Sadlerochit Group rocks of Permo-Triassic age. Shows of oil and gas and residual oil were noted in several zones, but no significant reservoirs were found. Potential reservoir zones had low to moderate porosity and permeability. Structural and stratigraphic relations at the well indicated that the location was structurally too low. The well reached a total depth of 7,739 feet on April 3, and was logged, plugged, and abandoned by April 10, 1979. The rig was released at midnight and the abandonment marker set. The rig was then moved overland to the J. W. Dalton site beginning on April 11.

Seabee Test Well No. 1

Part of the construction crew that built the Inigok all-season runway in the spring of 1978 was stacked out for that summer at the old Wolf Creek site established by the Navy in the early 1950's. That location was central to a number of wellsites that were being considered and served as a base camp for the 1978 summer survey work. Late in the year the train was prepared for overland travel and in January of 1979, the train left Wolf Creek for Umiat arriving on the 21st for the rehabilitation of the Umiat airstrip and the construction of the Seabee drilling pad. An agreement had been reached with the State of Alaska for the use of the runway and a major rehabilitation was scheduled to bring the gravel strip into satisfactory operating condition. Work began immediately. During the next month, as equipment was freed from other uses at various sites it was flown to Umiat, when runway conditions would allow, to assist in the construction. The runway surface was improved by filling in the low

Loading passengers at the Lonely airport for the flight to Anchorage.
March 1981. (Photo by E. Grant).



Lockheed Hercules C-130, the work horse of the air logistics program.
Camp Lonely, March 1981. (Photo by E. Grant)

areas and placing a six-inch lift of crushed rock on the level surface. This was followed by grading and compaction of the surface, plus the addition of a new lighting system for improved winter operations. An NDB (non-directional beacon) was added off the west end of the runway to meet the requirements of the increased amount of air traffic and the approach pattern for landing was altered to avoid undue disturbances of any nesting peregrine falcons.

The wellsite was located to the north and west of the Umiat runway at latitude 69°23'N, longitude 152°10'W. Access to the site was over an improved gravel road that was built as much as possible along the same course as the trail established by the Navy in 1951. Construction included a low water crossing of Seabee Creek and the summer placement of oversized culverts to provide a stable roadway surface during normal water flows of the creek. It was anticipated that if early spring or late fall flooding did occur this section could be washed out with only the roadway within the confines of the creek being effected, and this was easily replaced. Such an arrangement would have the least permanent environmental impact.

Construction was finished on April 2, 1979 and the equipment and trains were stacked near the runway apron for the summer. It was planned to demobilize these construction trains overland to Service City in the spring of 1980.

Lisburne Test Well No. 1

The design and construction of the Lisburne test well located at latitude 68°29'N, longitude 155°41'W near the eastern edge of the southern portion of the Reserve was a challenge to schedules as well as engineering know-how. It was anticipated that the target depth of 15,000 feet would take 200 days of drilling to reach. Since the formations are all steeply dipping in the area and the rocks are harder than those encountered elsewhere in the Reserve, it was deemed impossible to complete the well in one season.

The small construction train which had been stacked out at Betty Lake in Howard Pass to serve as a base camp for summer survey was mobilized in early February 1979. A Hercules airstrip was cleared on Betty Lake and 80 Herc loads of additional equipment and camp units were flown in from Camp Lonely, East Simpson, Inigok and other sites. Traveling overland along the staked trail, the enlarged train arrived on the site February 21, 1979.

Upon arrival, the camp was established on durable ground and work began. Water for the 140-man camp was hauled from a nearby lake about 2.5 miles to the northwest using low ground pressure rubber-tired vehicles over a winter trail.

The first phase of the C-130 airstrip construction was to remove the snow from the airstrip site and compact the tundra surface with repeated passes of the heavy equipment. Then approximately six inches of gravel were added, graded, and "cemented" in place with water. Once this first phase

was done the heavy airlift began for the buildup of fuel and supplies and to add some equipment. Then the airstrip was closed to heavy traffic and the second phase of construction was initiated. Only one-half the length of the runway was worked on at a time, reserving the other half for the use of the Twin Otter aircraft for resupply and emergency use.

A 2.5-inch thickness of high density Styrofoam insulation was installed in two overlapping layers (1.5-inch and 1.0-inch thickness) and covered with visqueen. A layer of 18 inches of pit run gravel was then installed followed by a 6-inch layer of crushed gravel. The use of insulation confined the thaw zone to the top two feet of surface.

An insulated apron-storage area approximately 300 feet by 600 feet was connected to the airstrip by an insulated 400 foot by 100 foot taxiway. An all-season road, 1.7 miles long, connected the airstrip to the drill site.

The gravel access road and the drilling pad were also special design problems. The road was 20 feet wide with five turnouts spaced along its length. Each turnout was 100 feet long and 12 feet wide. The road bed was built of four feet of pit run gravel topped by nine inches of graded gravel. While it was not anticipated that this would be sufficient thickness to prevent melting of the underlying permafrost, it was felt that the amount of subsidence could be easily repaired and did not constitute a real safety hazard such as would be encountered on the airstrip. Culverts were added where necessary. The crossing of Otuk Creek was done with a 100-foot long wooden-deck bridge with 50-foot spans on "glulam" beams. The bridge was supported by a pile and timber box abutment on the west end and a pile and timber wing wall on the east end. The edge of the roadway fill on each side of the abutments was protected from erosion by the installation of gabions (rock filled wire baskets). The barriers prevented the fast moving waters at flood stage from eroding the abutments.

The drilling site was located on a north-facing slope of the Ivotuk Hills. Because of the slope, the pad was divided into three sections with 17 to 20 feet differences in elevation. The upper (south) area was for camp and storage; the middle area was for the rig and drilling activity; and the lower area comprised the dikes and berms for the reserve and flare pits. The lowest portion of the reserve pit was about 10 feet below the crown elevation of the adjacent dikes. The upper layer of the drill pad had 2.5 inches of Styrofoam insulation installed and the central section in the area of the drill rig contained six inches of Styrofoam insulation. The rig was supported on 220 wooden pilings augered and frozen in to a depth of 25 to 28 feet below the finished grade. Those 15 piling immediately beneath the rig itself were frozen into a depth of 45 feet below finished grade.

The reserve pit volume was calculated to contain all of the anticipated fluids below the original tundra surface. Special care was taken with the dikes to insure their integrity. Gabions were used to protect the eastern edge of the reserve and flare pits in case spring or fall run-off swelled the nearby intermittent drainage.

Borrow material for all of the runway, apron, road and drilling pad was taken from two sources located in the flood plain of Otuk Creek. Overburden in these areas ranged from a few inches to as much as 1.5 feet of organic silts. The overburden was removed and stockpiled. After the material was removed and the borrow areas were contoured to blend in with the surroundings, the overburden was spread on the surface to aid in the rehabilitation and revegetation. A minimum 25-foot wide undisturbed area was maintained along the existing banks of the active channel of Otuk Creek.

The rig scheduled to drill Lisburne was Nabors Rig No. 17 which was "finishing" up at the Peard site. The rig move from Peard to Lisburne actually began on May 1 and required a total of 30 days due to poor weather and difficult runway conditions. Since the ice airstrip at Peard was deteriorating because of the warm weather, the rig had to be temporarily staged at Tunalik and Lonely as the Ivotuk runway was not always operational because of construction or was "socked" in due to weather. The distance from Peard to Tunalik was considerably less and this enabled the aircraft to move more cargo in a shorter period of time. Early in May the airlift was augmented with three rolligons to insure that all of the rig components were located at permanent strips prior to breakup. Rig move-in operations to Lisburne required a total of 220 Hercules C-130 loads. Rig-up began on May 19 and required a total of 23 days. The well was spudded on June 11, 1979 at 8:00 a.m.

There is some confusion concerning the nomenclature of the Lisburne wellsite because the air freight handlers used the symbol IVO (Ivotuk Hills) to designate freight for Lisburne in order to avoid confusion with the Lisburne DEW Line sites along the western Alaska Arctic coast. Because of this the airstrip was often called Ivotuk but the official name of the drilling operation was Lisburne Test Well No. 1.

Seismic Program - Spring 1979

Approximately 1,600 line miles of common-point-depth seismic surveys were scheduled to be accomplished during the mid-January to mid-May 1979 seismic season. Of this total, approximately 1,000 miles were to be additional fill-in reconnaissance and the remaining 600 miles were to be fill-in detail surveys. Three parties were fielded that season. One worked on the coastal plain in the area between Wainwright Village on the west and Smith Bay on the east. The two other parties worked the foothills area of the Reserve between Umiat and the western boundary near Icy Cape. One of these parties used the vibroseis method of imparting energy to the underlying formations and the second party used conventional explosives. Vibroseis transmits energy into the ground by the repeated impact of a heavy weight on the frozen tundra in lieu of explosive energy.

The transecting couplet seismic survey through Howard Pass of the Brooks Range was proposed again this season but using the vibroseis method of survey. On June 30, 1978 the National Park Service gave permission to conduct a survey through Howard Pass to the Noatak River for purposes of archaeological clearances but the actual DOI authorization for seismic survey was not forthcoming and the work was not accomplished.

By late April 1979, because of a somewhat early breakup, the two parties working in the southern foothills region were forced to terminate operations and the third party working on the Simpson Peninsula pulled off the tundra in early May. In spite of the foreshortened season, 1,872 line miles of seismic survey data acquisition were accomplished that season.

DRILLING SITE REHABILITATION - SPRING 1979

The civil work to fill in the reserve pits and erase "straight line outlines" was not too cost effective in the summer of 1978 because of excessive precipitation which bogged the Cats down in the deep mud. However, through diligence and persistence, and carefully watching the weather, six sites were finally ready for seeding by the fall when freeze-up began. These were South Harrison Bay, Atigaru Point, East Teshekpuk, West Fish Creek, W. T. Foran and South Simpson.

In January of 1979, a small party was sent to Drew Point about 18 miles east of Camp Lonely to try the civil work of rehabilitation under winter conditions. The work went better than expected and the frozen pads ripped relatively easily so that the material could be pushed into the reserve pit and the pad elevation lowered. Using the information learned at Drew Point and the cost data obtained, a program was initiated to do the civil work at South Meade, Kugrua and North Kalikpik. A small train left Lonely in mid-April and accomplished the work at North Kalikpik with no difficulty. A second train left Barrow at about the same time. It accomplished the work at South Meade and was en route to Kugrua when the work had to be postponed due to unusually warm temperatures around the first of May and a very sparse snow cover. The risk of tundra damage was simply too great.

In anticipation of the summer's effort to clean up old sites, an attempt was made to position a stockpile of fuel at Oumalik. A rolligon made two attempts to reach Oumalik but was stopped by deep and soft snow. The load of fuel was finally left at North Kalikpik in partial completion of the effort. These spring efforts were an excellent lesson on varying snow depths and surface conditions throughout the Reserve.

USGS/HUSKY - FIFTH SEASON: JUNE 1979 - MAY 1980

Summer Operations

The drilling program for 1979-1980 included the completion of Tunalik, Seabee, Lisburne and Ikpikpuk along with the drilling of three new Barrow wells (15, 18 and 20), three new exploratory wells, the initiation of a fourth exploratory well and possibly a fifth if time allowed. Although this was an extremely ambitious program the amount of field survey work required was not as great as the previous season. Most locations were decided upon prior to the field season and only five new sites were surveyed. These included a location near the Rogers-Post monument, 12 miles southwest of Barrow, a location on the west side of Dease Inlet, a location on the Simpson Peninsula, a proposed deep well just north of Lookout Ridge, and a location near the confluence of the Ikpikpuk and

Price Rivers. Autosurvey was used this season in addition to conventional survey methods and this speeded the work and shortened the field crew's time.

The cleanup program to environmentally rehabilitate old government sites began at the Old Brady site on the Kiligwa River with concurrent cleanup at Driftwood and Liberator Lake. Efforts were then concentrated in the southeast area of the Reserve. Combustibles that were stockpiled in 1978 were burned at Wolf Creek, Square Lake, Titaluk and East Oumalik. Cleanup was accomplished at Fish Creek, Oumalik, Grandstand and Gubic. The Navy drilled these latter two sites off the Reserve in 1951-1952. The area of the Gubic test wells proved to have a great deal more debris than was originally estimated and the crews worked in this area for 32 days, or better than one-third of the total summer's effort. Over twenty million pounds of debris were handled and a final 4,200,000 pounds were stockpiled for burial at a later time.

The policing of recent wellsites and then the seeding and fertilizing to revegetate those sites was accomplished on a "split" schedule during the summer of 1979. Because of wet and somewhat warmer weather than usual pick up was accomplished at the sites on an intermittant schedule throughout the summer. It was a rush to get to the sites while they were dry enough to walk on and before the next rain. Seeding and fertilizing was done later in the fall after the first frost. This dormant seeding had proved successful in the past and it appeared to be the only way to cope with the wet season.

Miscellaneous debris was accumulated and the pile caps cut and burned at:

W. T. Foran No. 1
Atigaru Point No. 1
Drew Point Test Well No. 1
North Kalikpuk Test Well No. 1
South Harrison Bay No. 1
South Simpson No. 1
East Teshekpuk No. 1
Halkett No. 1
West Fish Creek No. 1
South Meade Test Well No. 1

Germination of 1978's seeding efforts was successful at East Teshekpuk, South Harrison Bay, South Simpson and West Fish Creek. It was partially successful at W. T. Foran, Atigaru Point and Halkett. South Meade, Kugrua, East Simpson No. 1, Peard and North Kalikpik were seeded and fertilized this season and Halkett, Atigaru Point and W. T. Foran were refertilized.

The barges arrived at Camp Lonely on August 1, and unloaded a total of 20,530,000 pounds of dry cargo and 5,341,494 gallons of petroleum products. Nabors Rig No. 1 was loaded on the barges for transport to POW A. Construction train units were picked up at Barrow and Lonely and also delivered to the abandoned DEW Line site POW A in preparation for the construction of the East Simpson No. 2 drill site. POW A is only about six miles from the drilling location. All told there was a lateral movement of 8,141,315 pounds of dry cargo and 93,518 gallons of fuel.

Tunalik Test Well No. 1

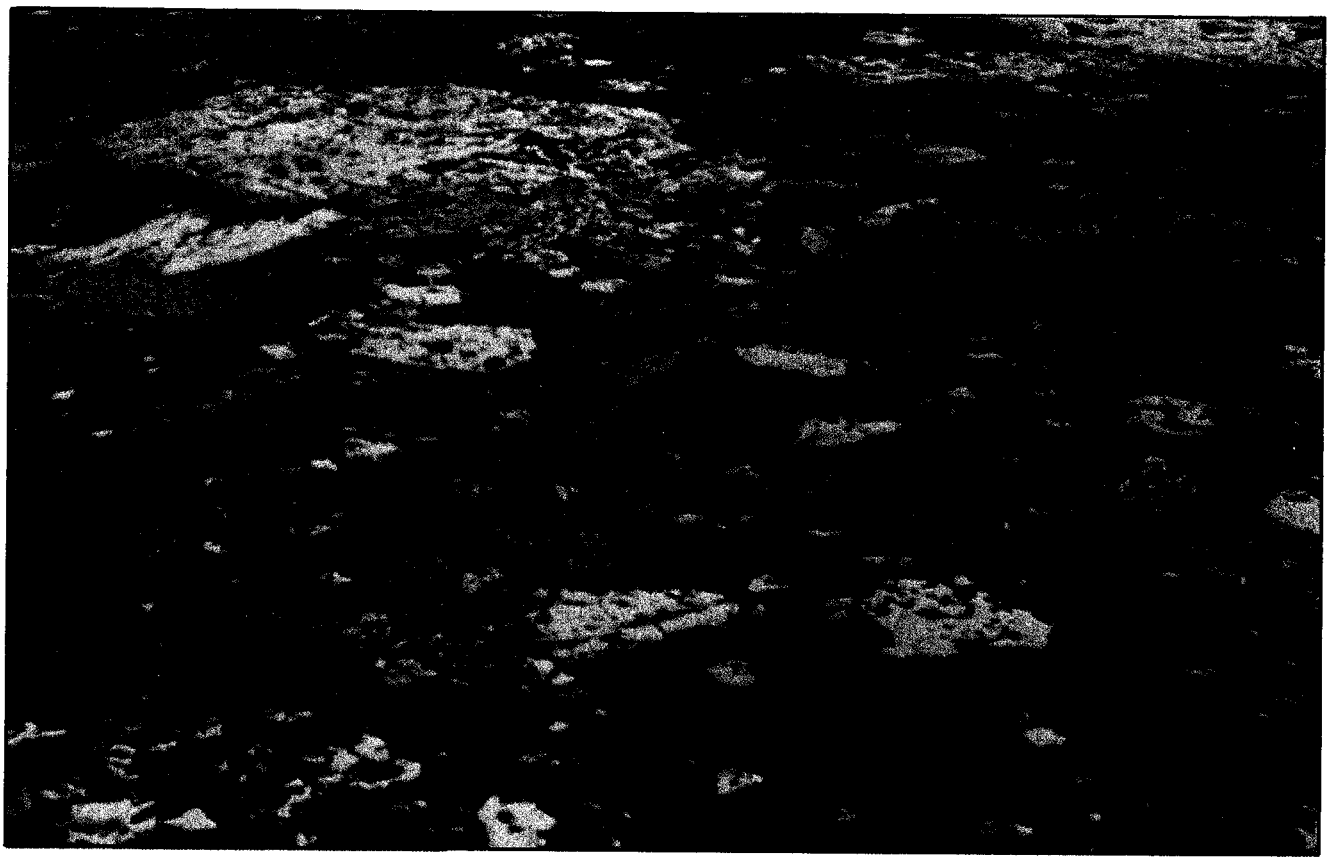
The primary objective of the Tunalik well was to test a seismically-defined structurally closed anticlinal trap in the Sadlerochit and Lisburne Groups. Secondary interest was in the "Pebble Shale" Formation and the Kingak sands. Numerous gas shows were encountered at both shallow and moderate depths in sandstones which had low porosity. High pressure gas, which was encountered at about 12,550 and 14,725 feet, created severe drilling problems. The heavy drilling mud and barite used to control the high pressure gas flows precluded the successful testing of the sands. An unexpected and geologically significant sequence of igneous rock was drilled within the sedimentary rocks. Most stratigraphic units penetrated by this well were found to be thicker than equivalent strata in wells to the east. The well was drilled to a depth of 20,335 feet (20,211.1 feet true vertical depth), a new depth record in Alaska. This depth was reached on December 22, 1980. After cementing, reversing out, nippling down and cleaning up, they pulled out of the hole for the last time on January 4, 1980. After laying down the kelly, rigging down the iron roughneck and cleaning the mud pits, the rig was released on January 7. As rig-down was accomplished the components were segregated into Herc-sized loads to await the completion of the Awuna airstrip. The air move to Awuna was begun on January 24, 1980.

Seabee Test Well No. 1

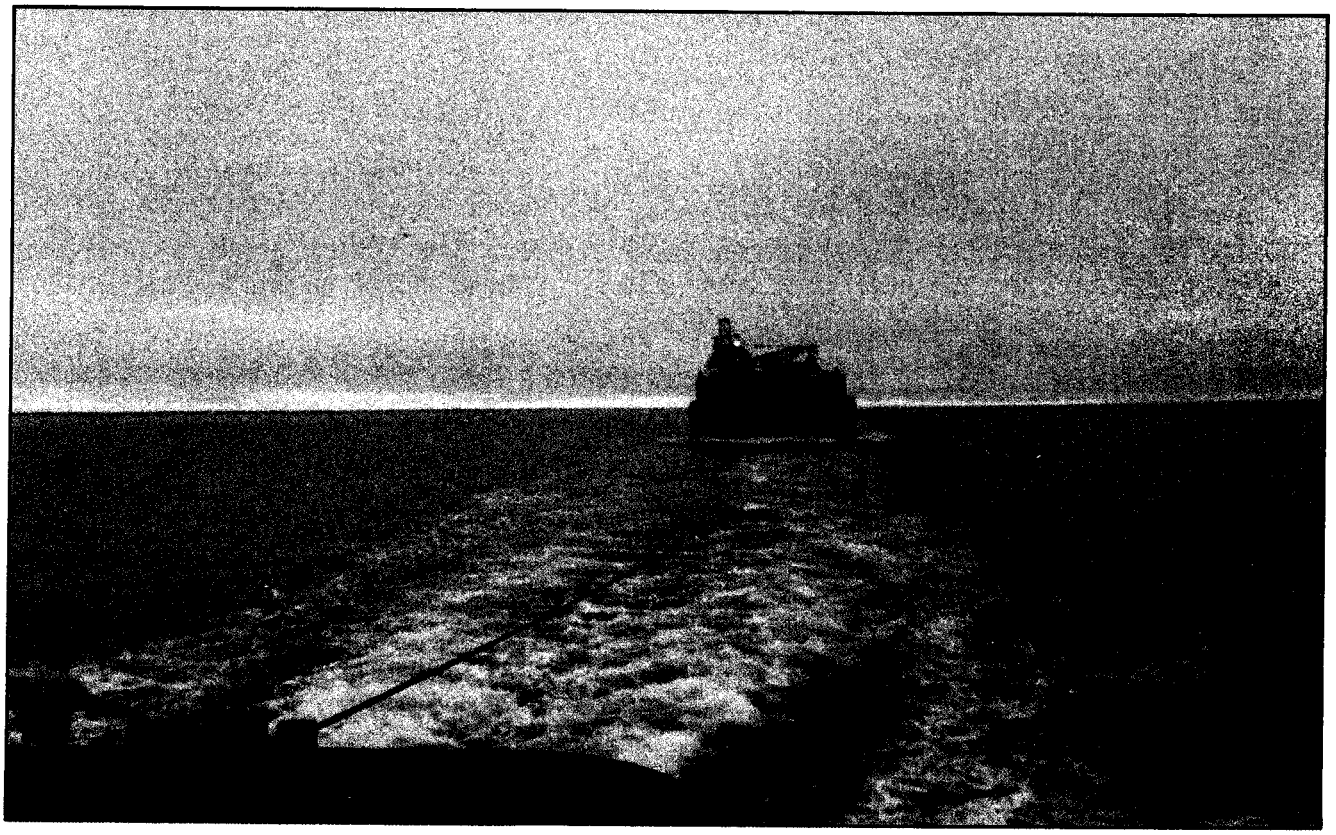
The rig to drill Seabee Test Well No. 1 was Nabors No. 25 and it was airlifted from Inigok beginning on June 14 and completed June 24, 1979. The all-season runways at each site allowed this flexibility of schedules. Rig-up operations began on June 15, and were completed in 18 days. The well was spudded on July 1, 1979 at 2:30 p.m. About six weeks later a labor dispute arose between the drilling subcontractor and the union which forced suspension of the drilling operations on August 21 at 6,551 feet of depth. Reentry was accomplished on October 16 after the labor dispute had been settled.

The Seabee test well was completed in the lower Cretaceous "Pebble Shale" at a total depth of 15,611 feet. This depth was reached in early April 1980. The well was drilled on the flank of the Umiat anticline, which contains the Umiat oil field discovered in 1950. The objective was to test for possible deeper hydrocarbon reservoirs in early Cretaceous (Fortress Mountain) strata. Oil and gas shows were encountered in the shallow Umiat oil zone, but testing was not possible because of the large sized borehole. Minor oil and gas shows were found at 5,430 feet in the Torok. Tests of this zone gave flows of two to six million cubic feet per day but detailed analysis of the test data indicate a limited depleting reservoir. Minor gas shows were found in deeper, thin, nonporous sandstones.

After testing and evaluating, the hole was plugged back with cement, the cement string pulled and reversed out. The mud was replaced with water and the water with diesel to a depth of 1,320 feet. The blowout preventers were nippled down and the abandonment marker set. The rig



Sealift in Elson Lagoon, off Point Barrow, waiting for ice to clear for trip eastward, August 1976.



Barge being towed; Sealift off Cape Simpson, August 1980.
(Photo by S. Krogstad)

was released on April 15, 1980 and rig-down and demobilization of the rig and drill camp began. The rig components themselves were stacked on the pad as the rig was scheduled for use in the 1980-1981 winter season.

Lisburne Test Well No. 1

The labor dispute which suspended the drilling activities at Seabee also affected the operations at Lisburne. Drilling was suspended on August 23 at 6,773 feet. Reentry was accomplished two months later on October 24, 1979.

Lisburne Test Well No. 1 was completed on June 2, 1980 at 17,000 feet in the fifth penetration of the Lisburne limestone. The well was located on a seismic closure in the disturbed-belt play, which borders the Brooks Range and is at least partly analogous to the overthrust play in the western United States. The well drilled about 7,000 feet of highly deformed rocks before reaching the Jurassic-to-Mississippian prospective section exposed at the surface immediately south of the wellsite. Ubiquitous dead oil occurrences demonstrated generation of hydrocarbons. Tests in two different Lisburne plates recovered only very small volumes of gas and some relatively fresh formation water. A test in the Shublik Formation flowed gas at a calculated rate of 213 thousand cubic feet per day, but indicated a depleting reservoir. Local porosity is indicated to at least 12,000 feet, and maturation analysis indicates prospective source rocks to total depth. This well will be fundamental to future disturbed-belt exploration.

The well was plugged and abandoned with cement and mechanical plugs set at selected intervals. The rig was released on June 2, 1980 at 12:00 midnight. The abandonment head was installed and the derrick laid down. The rig was partially broken down and stacked to await use in the 1980-1981 program.

Ikpikpuk Test Well No. 1

Personnel returned to the location on November 20, 1979 to open the camp. There was trouble starting the generator so the crew returned to Camp Lonely for the night and tried again successfully on the 21st. They rigged up the camp, started the support equipment, set the sewer plant, worked on the ice road to the water source, laid out the Twin Otter strip and began work on the C-130 ice-on-tundra airstrip. While raising the derrick the "A" frame legs were damaged and then needed repair but otherwise rig-up proceeded smoothly. Reentry was accomplished on December 25, 1979.

Ikpikpuk Test Well was drilled to a depth of 15,481 feet in the Kekiktuk Formation of Mississippian age. The well was drilled to test the Lisburne and Pre-Lisburne plays at their wedgeout on the north flank of the Ikpikpuk basin. Nearly 4,000 feet of tight, nonprospective Lisburne and Endicott beds were drilled with scattered minor gas shows. Two of the shallow sands, the basal "Pebble Shale" sand and a Torok sand, were tested primarily for productive capacity and fluid content. Some gas was

recovered on each test. The well was abandoned with cement and mechanical plugs set at selected intervals. The rig (Parco No. 96) was released on February 28, 1980 at midnight. Rig-down began on March 1 and by March 10 all components had been demobilized off the Reserve to Deadhorse by C-130 airlift.

Walakpa Test Well No. 1

The construction train left Barrow for the Walakpa site on November 25, 1979 arriving at the site, 15 miles southwest of Barrow, the following day. Travel was very slow as the tundra along the coast is quite hummocky and the trail is frequently intersected by small streams draining to the ocean. Walakpa No. 1 is located at latitude 71°06'N, longitude 156°53'W about 5.5 miles from the coast. The pad was built in a relatively flat, wet, sedge meadow. Construction of the thin-pad, associated ice road, and the Herc strip on a nearby lake proceeded on schedule. Construction was completed in two weeks and the train returned to Barrow on December 11, 1979.

The move of the Brinkerhoff Signal Rig No. 31 from the South Barrow No. 6 site began on December 2 and was completed by December 17. Rig-up began immediately and the well was spudded on Christmas Day. The well was drilled to a total depth of 3,666 feet bottoming in argillite of Pre-Carboniferous age. The objective of the well was a large structural stratigraphic trap in the Jurassic "Simpson" sand. The Jurassic sand was not present but gas that was found in the basal Cretaceous sand was promising and may have important implications for the Barrow gas supply. (Please refer to the Geological Findings section in the Summary.) At the conclusion of the drilling operations, casing and a cased hole drill-stem test were run. The rig was released on February 7, 1980 and preparations were begun for moving the rig to the West Dease Test Well No. 1 site.

East Simpson Test Well No. 2

The construction Cat train that was "stacked" at POW A the previous summer was activated the first week of December and set out for the East Simpson site on the morning of the 18th and arrived late that afternoon. The site was located at latitude 70°58'N, longitude 154°40'W. It was relatively easy travel because five of the six miles of the route were on the flat ice of shallow lakes and ponds. Snow cover was deep but was easy to clear on the flat ice. The drilling location was within a quarter of a mile of the edge of the lake upon which the C-130 airstrip was located. The water-source lake, although five miles distant, was fortuitously located so that only about a mile of ice road needed to be constructed. Construction started immediately and was completed by January 11, 1980. The construction train was airlifted to Barrow on January 18 to help in the construction of West Dease. The rig to be used was Nabors Rig No. 1 which had been prepositioned by barge the previous summer at POW A. Rig move-in operations began on the 13th, rig-up commenced concurrently with these moves and the well was spudded on January 29, 1980.

The East Simpson Test Well No. 2 was drilled into the argillite basement at a depth of 7,505 feet on March 15, 1980. The primary objective was to test the Permo-Triassic age Ivishak sandstone as it onlaps the Pre-Devonian age basement rock. This was believed present as a seismically sensed thickened section of the porous and oil-stained Sadlerochit strata that were found in East Simpson No. 1, four miles away. Minor oil and gas shows were found in the Torok and Sag River Sandstone Formation. A thin section of the Sadlerochit was cored with a good oil show, but a test of the sand recovered 161 barrels of formation water with a sheen of oil. Small-scale faulting is indicated between the wells in the area and may account for the thin Sadlerochit section. Sandstones of probable Endicott age were cored with poor to fair porosity and with dead oil shows. An Endicott play similar to that in the Prudhoe Bay area may lie updip from the East Simpson No. 2.

They pulled out of the hole for the last time on the 15th of March, laid down the drill pipe and began nippling down the blowout preventer. The rig was released on the 15th and rig-down commenced on March 16, in preparation for the demobilization of the rig to Lonely. The rig move was accomplished over the ice of Smith Bay and then over the trail from Drew Point to Lonely, with the last units arriving in the camp on the evening of March 25, 1980.

West Dease Test Well No. 1

The construction train that was airlifted from East Simpson No. 2 to Barrow on January 18, 1980 departed Barrow a few days later for the West Dease test wellsite located at latitude 71°09'N, longitude 155°37'W and approximately 28 miles east-southeast of Barrow. Conditions allowed travel over the ice of Elson Lagoon and the move was made uneventfully. Plans called for the construction of an ice airstrip on a lake about a half mile south of the wellsite. By connecting this lake with the proposed water-source lake a mile to the west, only 1.5 miles of ice road were built. The drilling pad itself was of the thin-pad design located partially on an area of high center polygons and partially on a low swampy area. Construction was somewhat hampered by a period of high winds and blowing snow but otherwise went well. The pad was completed and the train departed back over the ice for Barrow on February 18, 1980.

Also on February 18, around 2:30 in the afternoon, the Umiat Enterprises Pilatus Porter took off from the ice runway at West Dease en route to Camp Lonely. People on the ground reported that the take-off appeared normal until the plane reached about 200 feet in the air when it abruptly and unexplainedly dove and crashed at the side of the runway. The aircraft exploded into flames and was quickly consumed. The pilot, Charles Guesford (UEI) and his two passengers, William Frey and James Bowlin (both of Husky NPR) were killed instantly. The accident was investigated by the National Transportation Safety Board, but ascertaining the exact cause was not possible.

The Brinkerhoff Signal Rig No. 31 that drilled Walakpa No. 1 was used for West Dease and arrived overland via Barrow and the Elson Lagoon ice road

by the 15th of February. Rig-up ran concurrently with the later arrivals and the well was spudded on February 19, 1980.

The primary objective of the well was an updip stratigraphic pinchout of the "upper" Sag River Sandstone onto the Barrow Arch. The Jurassic Barrow and the Triassic Sag River sandstone were cored and contained oil and gas shows but the test of the Barrow sand recovered only mud with an oil sheen. Minor gas and oil shows were found in the Torok and "Pebble Shale".

The well was completed as a dry hole at a depth of 4,170 feet in the argillite basement of Pre-Carboniferous age. The rig was released on March 26, 1980 and rig-down began in preparation for the move to Barrow.

Barrow Construction

The Barrow 1979-80 winter construction season started with the building of an ice road from the gravel borrow pit immediately southwest of the City to a point near the South Barrow gas field. Water was taken mostly from Ikroavik Lake. The plan was to extend the all-season gravel road from its previous year's terminus at South Barrow Well No. 6, about 7.5 miles eastward to the new pressure reducing station and then on to the site proposed for South Barrow No. 18. Plans also called for spur roads from the main road to each of the two existing wells and to the two other wells (South Barrow Nos. 15 and 20) to be drilled during calendar 1980. The gravel road would allow drilling during the summer/fall season and also serve as a maintenance road during operation of the field. The actual gravel haul began in early February and was completed by May 1. Pads were also built at the proposed locations of South Barrow Nos. 15, 18 and 20.

On March 3, 1980 the construction train that built the Seabee pad and had been stacked at Umiat was demobilized off the Reserve. It was moved overland on approved trails across the Colville and then to Service City at Prudhoe Bay.

South Barrow Well No. 20

The drilling pad for South Barrow No. 20 was finished by the end of March and the Brinkerhoff Signal Rig No. 31 was moved in from the West Dease location. The move was by truck and low-boys over the sea ice of Elson Lagoon. Well No. 20 was located almost due south of Well No. 12, the "East Barrow" discovery well. Rig-up began on April 4 and proceeded without incident. The well was spudded on April 7 and drilled to its total depth of 2,356 feet in 16 days.

The primary objectives of the well were the Early to Mid-Jurassic age lower Barrow sand interval encountered between 2,064 and 2,082 feet and the upper Barrow sands encountered between 1,994 and 2,046 feet. The secondary objective was the Sag River Sandstone interval encountered between 2,117 and 2,313 feet. A third objective of the well was the "Pebble Shale" interval encountered at 1,558 to 1,574 feet and at 1,629 and 1,639 feet.

The secondary objective (the Sag River Sandstone) was cored and tested. The test indicated a weak gas sand flowing at a rate of 12 MCFGPD (thousand cubic feet gas per day). The primary objective, the Barrow gas sand, was not cored but electric log analysis and sample evaluation revealed typical reservoir characteristics. Because time was short, it was decided to set pipe through the sand and test it later through perforations. During cementing operations, no returns were observed at the surface although 80 sacks of cement and 25 barrels of water (spacer) were pumped down the hole. Although the cementing operation was the same as had been used on previous wells, the cement was obviously pumped into the Barrow sand. When the sand was perforated, it flowed only very small volumes of gas, and pressure build up tests were extremely slow. The well was plugged back and two sands within the Cretaceous "Pebble Shale" were perforated. The well was blown clear several times with gas from Well No. 19 and recovered a total of approximately 15 to 20 barrels of oil cut with gas and water. The well was suspended as a questionable oil well and the rig released on May 10, 1980.

Awuna Test Well No. 1

The Awuna wellsite was located about three miles north of Lookout Ridge at latitude 69°09'N, longitude 158°01'W, six miles inside the boundary of the Caribou Calving Grounds (Utukok River Uplands) Special Area. The location was 75 air miles from Ivotuk (Lisburne Drill Site) but about 110 miles over the approved overland route. In mid-December 1979, a small construction crew activated the train that was left at Ivotuk and set out over the staked trail for the Awuna site. They arrived on Christmas Eve, 1979. Work began immediately on clearing a runway on a shallow lake about one mile southeast of the wellsite. The lake was only 0.9 mile long so a portion of the runway was extended by icing the tundra off the west end of the lake. As soon as the airstrip was operational the rest of the construction equipment began arriving. The first Hercules C-130 arrived on January 22, 1980.

The Awuna well was planned with a target depth of 15,000 feet to test the closure of a huge dome-like structure six to nine miles wide and over 100 miles long. It was planned to drill that spring and suspend operations in May before the caribou arrived. The well would be Arctic packed for reentry the next fall. The equipment and supplies for reentry were to be stored for the summer on a specially insulated area of the drill pad.

The reserve pit was excavated to a minimum depth of six feet below the original tundra level. Prior to the second season of drilling it was planned to enlarge the pit to contain the additional fluids and cuttings and to use the excavated material to fill areas of the pad that settled during the summer thaw.

Construction of the pad and reserve pit began immediately after the airlift of the additional equipment in late January 1980. Construction was being completed as the first units of the drill rig and camp began arriving on February 12. As the construction finished up, the train, except for the equipment required to enlarge the reserve pit the next season, was flown

out to Umiat and other locations including the demobilization of some pieces to points off the Reserve. It took 32 days and 152 Herc loads to move the rig (Parco No. 95) from Tunaiik. Weather was not cooperative.

Rig-up began on February 10 and the well was spudded on February 29, 1980. Drilling was slow; for many days they were drilling in approximately 30° dip formation and deviation was troublesome. Stuck pipe and a fishing operation contributed to the problems but they had reached 5,300 feet when they suspended operations on May 8. Preparations were made for the summer and the drill crew left the site on May 11, 1980 well in advance of the arrival of the caribou.

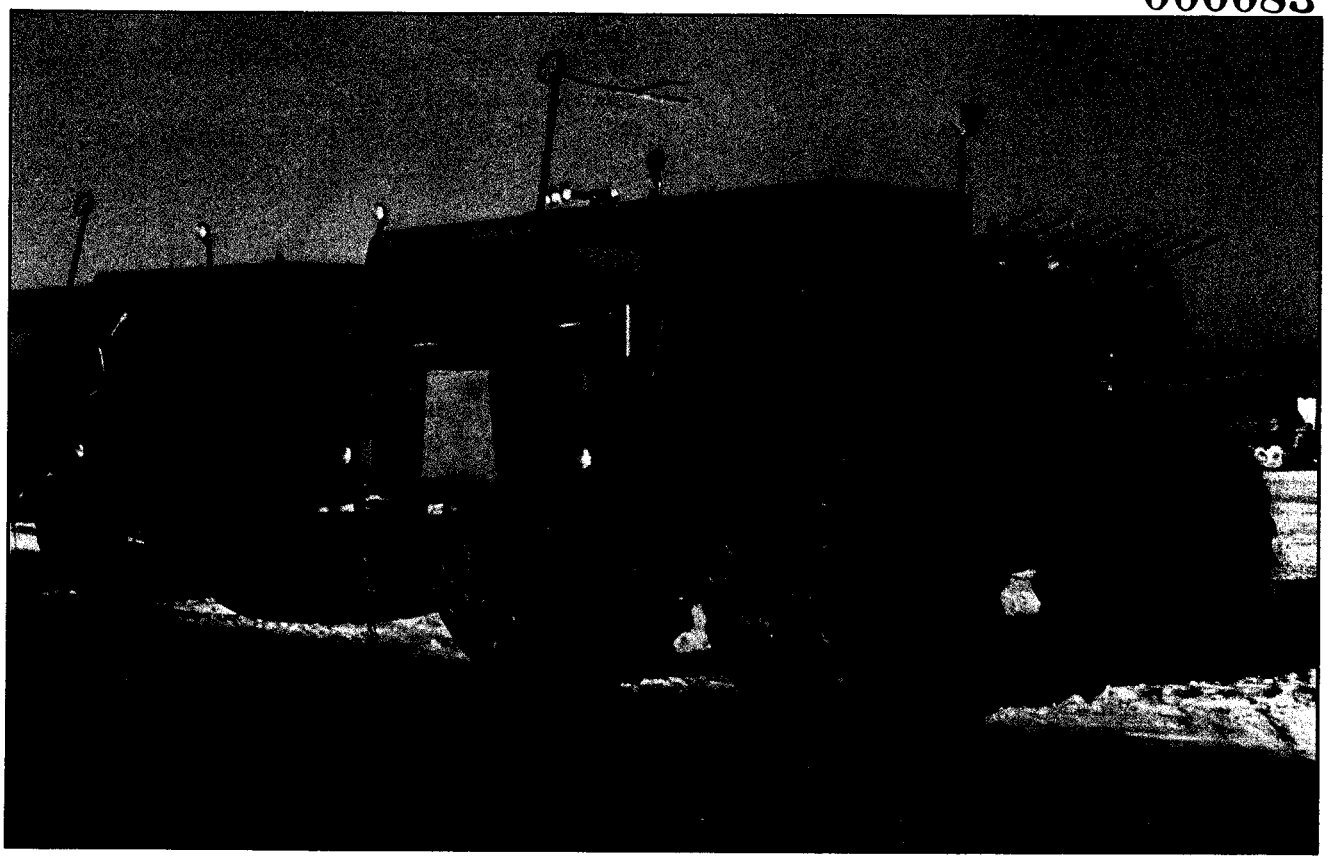
Koluktak Test Well No. 1

It was originally planned to build the Koluktak wellsite in the winter of 1980, fly in the rig, drill the well and then, if necessary, leave the rig on the site for the summer. However, the rig to be used was the Brinkerhoff Signal No. 31 which was used at Walakpa No. 1, West Dease and South Barrow No. 20. Many unexpected delays, not the least of which was the unusual amount of snow and the attendant warm weather that slowed down the thickening of the ice airstrips, delayed the schedule and only the construction of the Koluktak pad was accomplished in the spring of 1980.

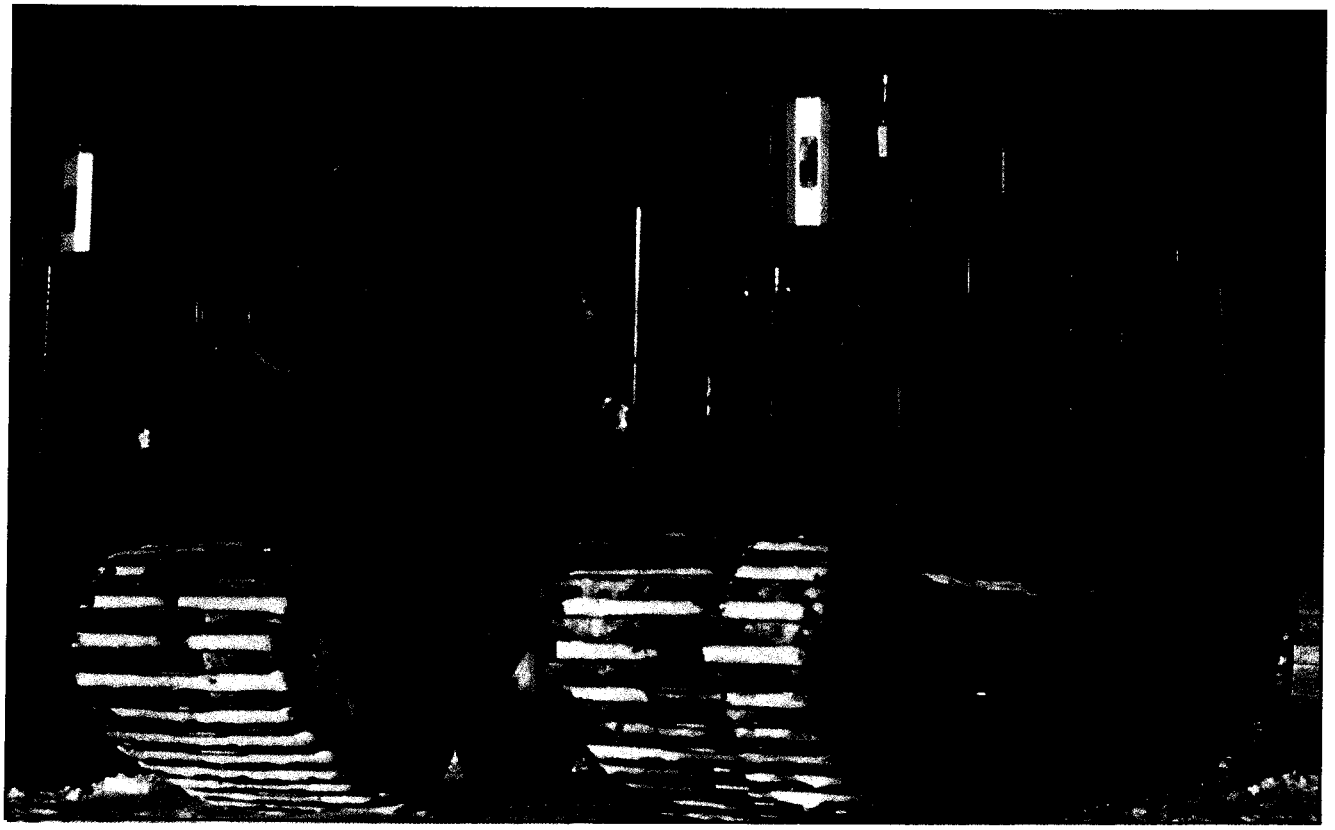
A small advance train and equipment was flown from Awuna to Umiat at the end of January 1980 and then proceeded overland via the old trail from Umiat to Wolf Creek and then over newly staked and cleared trail to Koluktak. They arrived on site at latitude 69°45'N, longitude 154°37'W on February 6, 1980. Construction proceeded in good order and the airstrip was ready in a few days but could only accept light aircraft until the ice thickened. During the month of February, the decision was made not to move the rig in that spring and the construction plans were adjusted accordingly. The reduced equipment needs meant a reduced number of Herc trips, and less time on the site, all contributing to considerable savings. The pad (thin pad design), reserve pit, and the flare pit were constructed and the rig piling installed. The ice road to the water-source lake was not built. The work was completed by March 19 and all construction gear demobilized; some overland to Umiat and other items were airlifted off the Reserve.

Environmental Rehabilitation - Spring 1980

In the fall of 1979, the disposition of the consolidated and stockpiled debris from the cleanup of old sites was still very much a question. It was decided to try burial at the two sites that were farthest from the ocean's edge and would be impossibly expensive to transport north for marine retrograde. These sites were Gubic (latitude 69°26'N, longitude 151°28'W) and Grandstand (latitude 68°58'N, longitude 152°05'W) both just off the Reserve to the east and southeast of Umiat. The sites were on "selected lands" so the prospect was discussed with the BLM and the Arctic Slope Regional Corporation. When they agreed to this method of disposal, the permission of the Alaska Department of Environmental Conservation was obtained. A contract was let early in March of 1980 for a Cat train to do the burial effort. The plan was to strip away the



All Terrain Vehicles used by Seismic trains. Note racks on rear bed to hold geophones, Spring 1975. (Navy Photo).



Seismic drill rig mounted on Nodwell vehicle, Spring 1975. (Navy Photo).

organic overburden and stockpile it to one side, to excavate the hole, push in the debris, compact it, and then cover to at least a depth of two feet. The overburden would then be spread over the site and seed and fertilizer distributed. The effort went very smoothly.

After completing the Gubic site, the contractor proceeded north to Inigok to perform some minor civil work on the pad and reserve pit. Because of the encounter of native sulfur and sulfur dioxide during the drilling operation the reserve pit contained exotic compounds in addition to the usual drilling muds and clays. The pit was scheduled to be carefully monitored for possible environmental problems. The outlines of the flare and fuel pits were changed and the edges of the pad feathered out to the tundra to blend some of the straight lines into more natural configurations but the integrity of the reserve pit was maintained. The Cat train traveled east over the Old Inigok Ice Road alignment and left the Reserve on April 24, 1980.

An attempt was also made at Ikpikpuk to utilize the KOH (Kodiak Oilfield Haulers) equipment that was on site during rig-down to contour the drilling pad. However, the pad was frozen too hard to be "ripped" by the available equipment (a D-7 Cat) and a D-8 Cat traveled overland from Camp Lonely to do the work. This was done in late March and early April and, in spite of a long siege of blowing snow, the work went smoothly.

In late April, after the Ikpikpuk rehabilitation work was completed, the Camp Lonely support crews began work on the gravel pad at J. W. Dalton. A considerable amount of this gravel was salvaged for use in the Lonely camp area and as cover for the sanitary land fill. The remainder of the gravel was pushed into the reserve pit and the remainder of the pad area levelled out.

Seismic - Spring 1980

A total of 980 line miles of common-depth-point seismic survey were scheduled to be accomplished in the spring of 1980. The surveys were run in the Icy Cape area, the Northern Foothills area from the western border to just off the Reserve east of Umiat and some isolated areas of the Brooks Range. Most of the surveys were for additional fill-in reconnaissance information but some closer spaced detailed surveys were run near Tunalik, Meat Mountain and the Lisburne wellsite. Only two crews were fielded that season, one working the coastal area and the other in the foothills and the Brooks. Both parties used dynamite as an energy source. Snow conditions and weather were better than usual and the parties finished up in April. The total of 1,110 seismic line miles were accomplished that season including 134 miles of a supplementary program.

USGS/HUSKY - SIXTH SEASON: JUNE 1980 - MAY 1981

Summer Operations

Summer survey for the 1980-81 season required the investigation of seven wellsites, three of which were alternates. These sites were:

Kuyanak	latitude 70°55'N, longitude 156°03'W
Walakpa No. 2	latitude 71°03'N, longitude 156°57'W
Avgunum (Alternate)	latitude 70°40'N, longitude 159°16'W
North Inigok	latitude 70°15'N, longitude 152°45'W
East Kealok (Alternate)	latitude 70°22'N, longitude 152°29'W
Carbon (Second Alternate)	latitude 69°31'N, longitude 160°18'W
Tulageak	latitude 70°11'N, longitude 155°44'W

Because of the program uncertainties resulting from somewhat differing positions by the Department of the Interior and the Congress, all seven sites were surveyed. The stated position of the Department of the Interior was to close out the NPRA exploration program in an orderly manner and to continue the exploration under a private leasing arrangement. However, the Congressional hearings on the program indicated that Congress wished to continue the government's exploration program until such time as a private leasing program was in effect. Consequently, the selection of potential wellsites was delayed by the administrative decision-making process, as well as the refinement of geophysical data. In preparation for a possible program of four wells, seven sites were investigated, four primary and three alternates, and archaeological, environmental and engineering studies were conducted at all sites. The completion work at Awuna and Koluktak scheduled for 1980-81 did not require additional field investigations.

The 1980 summer Cool Barge arrived at Lonely on August 15, and unloading of the piling, timber, dry cargo, drum stock and bulk fuel continued round-the-clock until August 20. A total of 7,134,848 pounds of dry cargo and 4,506,318 gallons of fuel were delivered. Lateral movements to Deadhorse, Cape Simpson and Peard Bay included 1,055,493 pounds of dry cargo and 28,616 gallons of fuel. In addition, 183,800 pounds of miscellaneous items were retrograded to Seattle. The barges left Camp Lonely the evening of August 21 to proceed to Barrow and then on to Seattle.

The 1980 summer cleanup of old Navy sites and the cleanup and revegetation of the drill sites of the current exploration program was combined under one contractor. The season's operations got underway with the arrival of equipment and personnel at Camp Lonely during the last week of May. An 18-man tent camp was set up at Oumalik and utilizing a Bell 205 helicopter for "lift" power, began the cleanup of Oumalik, East Oumalik, Brady, Mona Lisa, Lisburne (current drill site) and a number of new finds and explosive caches. The term "new finds" was used to designate any considerable amount of debris encountered locally within five or so miles of the site that was not scheduled in the work plan. The disposal of the explosives was coordinated with the ADEC (Alaska Department of Environmental Conservation), the USGS and other government authorities. By July 24, the tent camp was relocated to the Old Meade site and the crews helped with the "pick up" at Tunalik during the move.

Demobilization of the cleanup camp at Old Meade began August 20 and the operation was out of the field by August 25. Although this was early according to the schedule maintained in previous years, during the last

days of operation, the camp was plagued by freezing water pipes and excess condensation in the tents. This season a total of 2,647,620 pounds of debris was stockpiled for burial; 1,817,300 pounds consolidated at Oumalik and 830,320 pounds consolidated at Old Meade. New finds at Oumalik totalled an estimated 389,000 pounds and at Old Meade they totalled approximately 51,000 pounds.

Revegetation Operations

The revegetation crew consisted of 10 personnel based out of Camp Lonely, utilizing a Bell 205 helicopter. The plan was to seed and fertilize as many pads as possible in the spring until July 4, then go back and begin the cleanup at each site. Research and experience had shown that any seed planted after the beginning of July did not have sufficient time to germinate and establish adequate roots to survive the winter. Those sites not seeded in the spring were dormant seeded in late August after the first frost.

The following sites were visited during the 1980 season:

1. Drew Point - policed pad, cut pilings, applied seed and fertilizer - seeded in spring.
2. J. W. Dalton - policed pad, cut pilings, applied seed and fertilizer - seeded in spring.
3. W. T. Foran - reseeded and fertilized - seeded in spring.
4. Atigaru Point - reseeded and fertilized - seeded in spring.
5. East Simpson No. 1 - reseeded and fertilized - seeded in spring.
6. South Simpson - cut pilings, policed pad - germination of last season's seed was successful.
7. South Harrison Bay - reseeded and fertilized - seeded in spring.
8. North Kalikpik - policed pad, cut piling, applied seed and fertilizer - seeded in spring.
9. East Simpson No. 2 - policed pad, cut pilings and applied seed and fertilizer - seeded in spring.
10. Ikpikpuk - policed pad and airstrip, cut pilings, applied seed and fertilizer - seeded in spring.
11. Inigok - applied seed and fertilize to pad and runway edges - seeded in spring.
12. Grandstand and Gubic - applied seed and fertilizer - seeded in spring.
13. Seabee - applied seed and fertilizer to the borrow site and the construction camp site - seeded in spring.
14. West Dease - policed pad, cut pilings, applied seed and fertilizer to pad - seeded in spring.
15. POW A (Cape Simpson) - picked up debris where construction train and drilling rig were stacked the previous season.
16. Walakpa No. 1 - policed pad, cut pilings, and applied seed and fertilizer - seeded in spring.
17. Peard - policed pad, cut pilings, and applied seed and fertilizer - seeded in fall.
18. Kugrua - policed pad, cut pilings and applied seed and fertilizer - seeded in fall.
19. Tunalik - policed pad and airstrip, applied seed and fertilizer to pad

and edges of runway - seeded in fall.

20. South Meade - policed pad, cut pilings and applied seed and fertilizer - seeded in fall.

The East Teshekpuk and West Fish Creek sites were inspected during the summer. Germination of the seed spread the previous season was deemed successful and no further work was done. On "weather days" when the helicopter was restricted from flying the revegetation crews policed about 30,000 pounds of miscellaneous debris from the gravel and tundra areas around Camp Lonely. In addition, the Lisburne site was visited and policed of loose debris.

The 1980 summer season was not a good one for grass germination as it was exceptionally wet and foggy and almost all grasses suffered from fungus and mold. The native species used in the revegetation exhibited fungal infestations but they did not appear to be fatal to the stand. The "Alyeska" mixture did not fare as well. This puts in question the rate of winter survival and how many seasons of "follow-up" are necessary to insure adequate vegetative cover.

Camp Lonely

Upgrading of the facilities continued at Camp Lonely, mostly to bring the camp into compliance with the safety standards of OSHA (Occupational, Safety, and Health Administration) and the Alaska Department of Labor. Climbing cages were added to ladders on the sides of the Mogas tanks. An exhaust vent/hose system was installed in the mechanic's shop to remove fumes from the immediate area of the welder. In addition, the old incinerator was removed and a new one installed that had the capacity to handle all the garbage, sewer plant sludge and waste oil generated by the program.

Barrow Gas Fields

The work to upgrade the Barrow gas facility continued during the summer of 1980. The Barrow Gas Field Power Generation facility was built; the new road to the field was bladed and compacted for the entire month of June and most of July; and a culvert washed out during the spring breakup was replaced with one of larger capacity.

South Barrow No. 15

The pad for South Barrow No. 15 had been constructed the previous March but the rig (Brinkerhoff Signal No. 31) was occupied at South Barrow No. 20 for the remainder of the spring season. The rig move and rig-up for South Barrow No. 15 began on August 12 and was completed in 11 days. The well was spudded on August 23, 1980.

The objective sand was found much lower than expected in this northernmost well indicating a very steep north flank of the structure or the presence of faulting. Total depth was 2,278 feet in Jurassic sediments. The Upper Barrow sand was cored and an open hole drill-stem test recovered gas. A test in the lower Barrow sand recovered water. Minor oil and gas shows were found in Cretaceous Torok and the "Pebble

Shale". Casing was set through the Upper Barrow sand and perforated from 2,054 to 2,064 feet and from 2,110 to 2,151 feet. On a production test the well flowed gas at a rate of 1 MMCFPD and was completed on September 18, 1980.

South Barrow No. 18

The pad for South Barrow No. 18 was also constructed in March of 1980. When the Brinkerhoff Signal rig finished with South Barrow No. 15 in early September, the rig was moved over the gravel roads to the new location. Rig-up began on September 19 and the well was spudded on September 22, 1980.

South Barrow No. 18 was drilled on the east flank of the east Barrow structure, reaching a total depth of 2,135 feet about 50 feet below the objective Barrow sand. Minor oil and gas shows were found in Cretaceous Torok and "Pebble Shale" thin sand stringers. The upper and lower Barrow sands were cored with a show and casing was set through the sands. The entire lower Barrow sand was perforated and tested at a maximum flow rate of 1.4 MMCFGPD. The well was completed and the rig released on October 14, 1980. The rig was stacked out temporarily on the pad.

Awuna Test Well No. 1

The drilling camp at Awuna was re-opened in mid-October of 1980 and it was discovered that the camp had sustained a sizeable amount of water damage over the summer. Considerable effort had to be expended to repair floors, ceilings and insulation and this delayed the initiation of construction by about one week. By the end of the month the construction crew was on-site, assembling the insulated pipe necessary to build the on-tundra Herc ice airstrip and servicing the equipment needed to enlarge the reserve pit.

During the month of November, over six million gallons of water were frozen to form the Awuna airstrip, the reserve pit was enlarged, and the connecting ice roads from the pad to the airstrip and the water-source lake were constructed. Operations were hindered by high winds, blowing snow, and warm temperatures but the airstrip was operational on December 5. Mobilization of drilling equipment had begun and reentry was accomplished immediately.

Awuna Test Well No. 1 was drilled to test for potential oil and gas accumulations on one of the highest structural positions along the Carbon Creek-Awuna anticline which extends across much of the Reserve. The well was designed to test sands of the Torok and Fortress Mountain Formations of Cretaceous age. It was drilled to a total depth of 11,200 feet. The well was spudded in the Torok and encountered the top of the Fortress Mountain at 7,886 feet. The Torok was mainly shale with some thin, nonporous sands, many of them with gas shows. The upper part of the Fortress Mountain Formation was more sandy than the Torok but the sands were fine-grained, calcareous, argillaceous and generally exhibited poor porosity. Gas shows were indicated by the mud logger in many of the sands. A drill-stem test near the top of the Fortress Mountain flowed

water at the rate of 2,057 barrels per day. There is evidence of fracturing in some of the sands and the high water flow was probably due to fracture porosity. Very minor amounts of asphaltic material were found in the lower part of the well.

The rig was released on April 20, 1981 at 2:00 a.m. and demobilization began. Weather shack, beacons, communications gear and a few miscellaneous pieces of equipment were demobilized to Lonely and the camp and drill rig were returned to Deadhorse and Fairbanks. Demobilization required 132 Hercules C-130 loads. Everything was off the site by April 28, 1981.

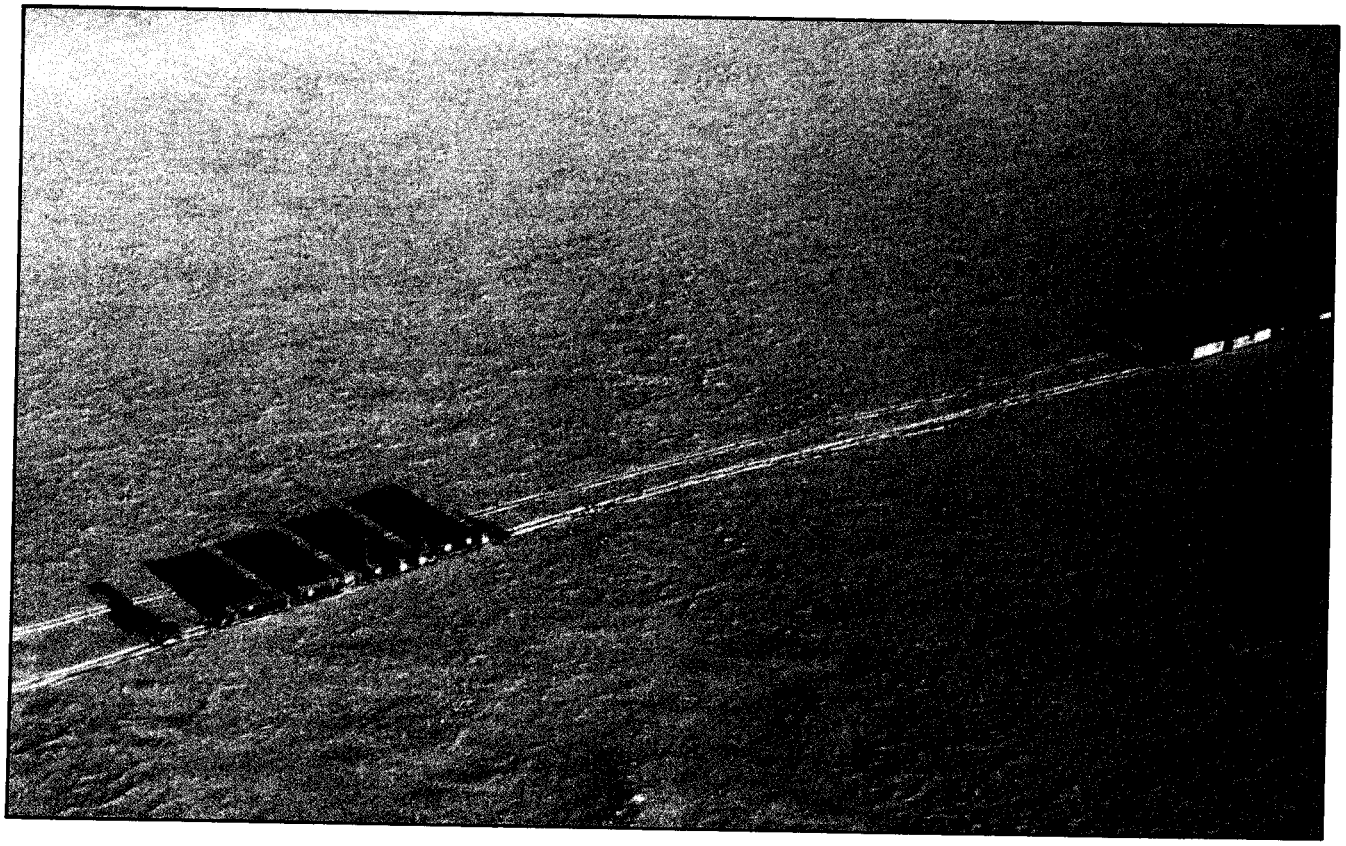
Walakpa Test Well No. 2

The construction crews left Barrow early on December 8, 1980 and arrived on location that night. Construction began the next day. Walakpa No. 2 is located at latitude 71°03'N, longitude 156°57'W, about four miles south and 1.5 miles west of Walakpa No. 1, and 7.5 miles south and east of the Rogers-Post monument. Walakpa No. 2 was constructed to the thin pad design in a low, marshy tundra area. To speed up the schedule a two-foot deep unnamed lake south of the wellsite was used for the ice airstrip. The lake immediately east of the site served as the water-source lake. Using the shallow frozen-to-bottom lake meant there would be no delay waiting for the airstrip ice to reach sufficient thickness to support the Hercules aircraft. Construction was completed by December 23 and the Cat train departed for the Kuyanak site.

The drilling camp was opened December 11 and utilized in the Barrow gas field while the rig was prepared for move. Also during this time the trail to the drill site was traveled to dress up the unusually rough locations. The camp was moved to the drill site and was operational by December 22. The rig (Brinkerhoff Signal No. 31) was on location by December 25. During rig-up a derrick leg buckled while the rig was being raised and repairs were accomplished concurrently with the completion of rig-up. The well was spudded on January 3, 1981 at 7:00 p.m.

Walakpa Test Well No. 2 was drilled to a total depth of 4,360 feet and following testing was completed on February 15, 1981. The well was designed to test the Jurassic Simpson sand near its updip truncation, and a Lower Cretaceous sand (the "Walakpa" sand) which tested gas in the Walakpa No. 1 well. The well spudded in the Torok Formation which consisted mainly of shale with thin sand streaks containing minor gas shows. Below the Torok a normal sequence of lower Cretaceous "Pebble Shale", Jurassic Kingak shale, Triassic Sag River Sandstone and Shublik shale, sand and limestone beds was penetrated and drilling was terminated in argillite basement. The lower Cretaceous Walakpa sand, found 532 feet lower than in the Walakpa No. 1 well, was cored from 2,611 to 2,640 feet, recovering fine-grained, glauconitic sand with poor to good porosity and a show of hydrocarbons. A drill-stem test of the sand recovered gas at the rate of 2.3 million cubic feet per day. The sand is 32 feet thick versus 18 feet in Walakpa No. 1 and established a minimum gas column of 550 feet. Walakpa No. 2 was temporarily abandoned and the rig released the evening of February 14 and preparations began for the move to the Tulageak site.

Seismic train along a "cleared runway", waiting for supplies, Spring 1975.
(Navy Photo)



Seismic train crossing tundra just north of Umiat, January 1978.

North Inigok Test Well No. 1

The construction train to build the North Inigok drill site was mobilized from Barrow to Lonely via air during the early part of December 1980. The train departed Lonely on December 18 and arrived on site December 21, 1980. The North Inigok site was located at latitude 70°15'N, longitude 152°45'W, about 48 miles south-southeast of Camp Lonely.

The drilling pad was of the "thin pad" type with a couple of fortuitous advantages that were peculiar to the site. The well was so located that a shallow nearby pond was the site of the reserve pit. This pond was excavated to a depth approximately 5.5 feet below the original elevation of the water surface. The drilling camp pad was located on two low sandy knolls, one in the middle of the pad and one in the southwestern corner. The leveling of these knolls provided the additional material necessary for the pad and reserve pit dike construction. The airstrip was located on a lake about 1.75 miles northwest of the drill site. The water-source lake was one quarter mile north of the pad.

Construction of the airstrip was finished by January 1, but the ice was too thin to support fully loaded Hercules aircraft. Thus landing restrictions were imposed until the 15th of the month. Site construction was completed by the first week in January and the contractor prepared to demobilize his equipment via air to Deadhorse.

The movement of Nabors Rig No. 25 from Seabee to North Inigok was accomplished via air beginning January 7. The thickness of the ice on the North Inigok airstrip and a few days of bad weather hampered the move. The entire 152 loads were flown in 18 days in spite of the ice and weather problems.

North Inigok Test Well No. 1 was spudded on February 13, 1981 and drilled to a total depth of 10,170 feet in the Triassic Shublik Formation. Seismic records indicated an anomaly at the upper Jurassic "C" datum level which was interpreted as an offshore bar. In addition the anomaly was correlated both seismically and by well logs with the Walakpa gas sand tested in the Walakpa No. 1 well. The test began drilling in Tertiary Paleocene beds, then penetrated Cretaceous Colville, Nanushuk and Torok shales, siltstones and sandstones and the "Pebble Shale". No sands were found in the Jurassic section although a silty zone, perhaps representing the seismic anomaly, was drilled from 8,145 to about 8,400 feet. A thin Triassic Sag River siltstone was drilled and the well then reached total depth in Shublik limestone. Gas shows as logged by the wellsite geologist were encountered only in the lowermost Torok Formation and a single show was indicated in the Jurassic siltstone. Surprisingly, a drill-stem test of the later zone produced gas at an estimated rate of 30 MCFPD and recovered 310 feet of gas-cut mud. The gas was quite rich, analyzing 73% methane, 12.8% ethane, 7.3% propane, 3.2% butane and 3.7% pentanes and heavier hydrocarbons. Such an analysis has important implications for a possible oil column downdip.

The well reached a total depth of 10,170 feet and the rig was released at 11:00 a.m. on April 4, 1981. The Hercs started the demobilization of the Nabors Rig No. 25 on April 6, and with some flights shared with Chevron, 140 loads were flown to Cobblestone (a Chevron strip) Lonely and Deadhorse. The demobilization move was completed by April 17, 1981.

Kuyanak Test Well No. 1

The construction crews departed the Walakpa No. 2 site on December 23, 1980 for Kuyanak at latitude 70°55'N, longitude 156°03'W. The location was on the edge of a drained lake basin, about one mile north of Kuyanak Bay, an arm of Admiralty Bay. Construction was hampered during the last week of December by extreme cold accompanied by winds. Wind chill factors of -110° F were experienced twice.

The drilling pad was of the thin pad design and, other than bad weather delays, construction proceeded on schedule. The water source and a temporary Twin Otter strip were located on a lake one mile southwest of the site. The heavy aircraft airstrip was located on a lake four miles north of the site. The connecting road followed the edges of lakes and ponds and although five miles in length only two miles of overland ice road construction were required. The construction crew finished in mid-January but their departure was delayed assisting the drilling crews in getting established. The rig move was off schedule because the ice of the Herc strip was too thin for heavy loads. The construction train finally moved on to Tulageak on January 26, 1981.

Rolligons began moving Nabors Rig No. 1 from Lonely to Kuyanak on January 17. The drilling camp was in operation by January 24 and the rig move was completed by January 27. Rig-up was hampered by inclement weather but was finally completed and the well spudded on February 13.

The Kuyanak test well reached its total depth of 6,690 feet on March 31, 1981. Located 22 miles southeast of Walakpa No. 2, the well was drilled to explore primarily for the Simpson sandstone within the Jurassic Kingak shale. This sand has been found in wells to the southeast, south, and southwest with good reservoir characteristics. It is best developed in the Kugrua No. 1 test well and seismic information indicated similar conditions could be expected at the Kuyanak location. A trap was postulated because of the truncation of the sand against the Barrow Arch by the basal Cretaceous unconformity and by facies change to the northwest. A secondary objective was the Sag River Sandstone of Triassic age. Drilling was begun in the Cretaceous Nanushuk and a normal sequence of Cretaceous Torok and "Pebble Shale", Jurassic Kingak, Triassic Sag River Sandstone and Shublik was penetrated before drilling terminated in argillite basement. A sand tentatively correlated as the Walakpa sand was found at 5,092 feet and cored from 5,093 to 5,186 feet. There were no hydrocarbon shows in the sand but porosity determined from core analyses ranged from 15% to 22%, and permeabilities as high as 318 millidarcies were measured. The Walakpa sand thus occurs more than 2,500 feet structurally low to the Walakpa No. 2 well and possibly indicates a continuous sand with good reservoir characteristics below a proven gas column. A possible Simpson

sand equivalent occurs in the Kuyanak well from 5,378 to 5,656 feet and consists mostly of siltstone with minor gas shows near the top. Possible equivalents of the Jurassic Barrow and Triassic Sag River Sandstone of the East Barrow field were cored; the latter indicated a minor gas show. The rig was released at 6:00 p.m. on March 31, 1981.

The rig was demobilized overland by rolligon to Lonely for later retrograde by barge and the camp was demobilized via air off the Reserve to Deadhorse.

Tulageak Test Well No. 1

The construction train moved overland from Kuyanak to the Tulageak site on January 26, 1981. The wellsite was located at latitude 71°11'N, longitude 155°44'W, about one quarter mile south of Tulageak Point and two miles north of Reindeer Lake. The area of the wellsite was relatively flat coastal tundra with indistinct polygon development. Reindeer Lake was the platform upon which to build the ice runway and also served as a water-source lake until the ice thickness became too great and the water impotable. The alternate water source was an unnamed lake two miles west of Reindeer Lake.

Construction was completed in early February but the crews maintained the site until the drilling camp was in place and habitable. Demobilization of the construction equipment was overland via rolligon to Barrow and then via Herc off the Reserve to Deadhorse. The move was completed by March 5, 1981.

The move of the drilling camp and the Brinkerhoff Signal Rig No. 31 was accomplished overland from Walakpa No. 2 to Tulageak. The move took 30 rolligon loads from February 15 to February 20. Rig-up proceeded without snags and the well was spudded on February 26, 1981 at 3:00 p.m.

The Tulageak Test Well was drilled to a depth of 4,015 feet to test a combination structural-stratigraphic prospect. Detailed seismic studies indicated an east-west trending graben structure north of the West Dease No. 1 well and separated from it by the Iko fault. Closure to the west was afforded by cross faulting and stratigraphic pinchout while regional dip was maintained to the northeast. It was believed that Simpson sand equivalents and older sands would be preserved in the structurally low area. Four objectives were considered; the "Pebble Shale"-Walakpa, Simpson, Barrow, and Sag River Sandstone. The well was spudded in probable Torok claystone and drilled mostly shale with thin sand and some limestone streaks before reaching the "Pebble Shale". The lower Cretaceous unconformity was indicated at approximately 2,950 feet. From that point the Jurassic Kingak shale and the Triassic Sag River Sandstone and Shublik sand and shale sequence were drilled until an unconformity surface was reached at 3,947 feet. Argillite was drilled and cored from this unconformity to the total depth of 4,015 feet. No sand was found in the "Pebble Shale" or at the Jurassic Simpson sand level. The Barrow sand appeared to be present along with the Sag River Sandstone and some

thin Shublik sands. The Sag River Sandstone contained the only hydrocarbon show and a drill-stem test recovered slightly water-cut drilling mud with no evidence of hydrocarbons.

The rig was released on March 31, 1981 at 6:00 p.m. The drilling camp was moved via rolligon to the South Barrow Gas Field and the rig was demobilized to Fairbanks in 32 Herc loads. Demobilization was completed by April 8, 1981.

Koluktak Test Well No. 1

The Koluktak drilling pad was built in the spring of 1980, and at that time, the well was scheduled to be drilled with Brinkerhoff Signal Rig No. 31. When scheduling needs made this impractical Nabors Rig No. 17 was substituted. To accommodate the new rig configuration 170 additional piling had to be set in the pad.

The construction contractor mobilized overland on January 5, 1981 from off the Reserve to Inigok via the trail of the former Inigok ice road and from Inigok to Koluktak over a new staked trail. Work began immediately to install the needed piling and to rebuild the ice runway and connecting ice road. Slope weather was unfavorably warm that season and this retarded the thickness of the lake ice. In early January, there was less than 30 inches of ice on the Herc strip and with temperatures in the plus 20° F, the ice was not thickening. The contractor had to artificially flood the lake surface to build ice thickness and even with these methods, the Herc strip was not ready until late February. Once ready the airlift of Nabors Rig No. 17 could begin. A total of 180 Herc loads were flown in February and March between Ivotuk (Lisburne) and Koluktak. Once the drilling camp was in place, the construction contractor demobilized via rolligon during the month of March on a back haul arrangement. Rig-up began during the air move and the well was spudded on March 23, 1981.

The primary objective of the well was the Nanushuk Group sands which had gas and oil shows in several of the older wells drilled during the Pet 4 program. Reservoir conditions were indicated to be good at the east end of the Oumalik anticlinal trend where a low velocity anomaly interpreted as a possible gas accumulation was indicated by seismic records. The well drilled a Nanushuk age sequence from the surface to about 4,200 feet. The upper two-thirds of this section was predominantly sandstone, but with thin shale, siltstone, limestone and coal beds and many minor gas shows and a few oil shows. The lower one-third was much more shaly and with only a few gas shows. The top of the Torok was estimated at about 4,200 feet and from this point to total depth shale with minor amounts of sandstone and siltstone was drilled. Only one minor gas show was indicated in this interval. The well was completed as a dry hole on April 19, 1981 after reaching a total depth of 5,882 feet.

The demobilization of the rig by air was started on April 16 and consisted of 162 loads flown to Deadhorse, Lonely and Fairbanks. The move was completed by April 28, 1981.

Barrow Construction - Spring 1981

The major construction efforts at Barrow during the spring of 1981 were actually the completion of the 1980 program. The Barrow gas field generating facility was completed and performance tested. The gathering lines for South Barrow Nos. 12, 15 and 18 were completed and connected to a new pressure reducing station that was constructed in the East Field. The crossarms and power line were added to the power poles placed the previous year. Each power pole was 105 feet apart and the system was so designed that it could also carry the gas line on a special support at its base. Gas line supports were 35 feet apart. All these efforts were part of the overall design to integrate the East Barrow Gas Field into the natural gas delivery system.

Seismic Program - Spring 1981

Early in the 1980-81 planning, on the assumption that Congress would also mandate a continued geophysical exploration program, a four crew effort for approximately 1,800 line miles of seismic exploration were planned. However, when it became evident that it was the intent of Congress to open the Reserve for private exploration as soon as possible, this target was drastically reduced. Also the Reserve was open that spring to allow industry to mount their own field data acquisition efforts. The Government's seismic program that year consisted of 581 line miles. One hundred of these miles were refraction data in the vicinity of the Brady anticline; an area that has intrigued petroleum geologists for more than 30 years but where reflection technique has yielded "no-return" data. In addition, "nearshore" lines on the Beaufort Sea Coast area were accomplished to serve the dual purpose of providing information required for the leasing program as well as tying the data from the Outer Continental Shelf program to the land based data.

The 1981 geophysical data acquisition program was accomplished by the government through its technical services contractor, not through the general exploration contractor.

Burial Program - Spring 1981

The spring 1980 burial efforts were so successful, the decision was made to bury all the stockpiled debris. During the last few days of February, the burial contractor mobilized his Cat train and equipment to Koluktak via rolligon following previously cleared trails. Koluktak was chosen for a "jumping off point" because the ongoing drilling operation there, complete with camp and runway, was convenient to the first burial site. The program got underway on March 9.

The contractor's task was to travel overland to the sites where the debris from previous cleanup programs had been stockpiled. Locations for burial were designated and archaeological and environmental clearances had been obtained earlier. The contractor would strip the tundra overburden and stockpile it to one side. He would then proceed to excavate the pit, push in the metallic debris, compact it as much as possible and cover it to a depth of two or more feet. The tundra overburden would then be spread

over the burial site and seed and fertilizer distributed and "walked in" with a Cat. This was accomplished at:

East Oumalik
Oumalik
Old Meade
Titaluk
Wolf Creek
Square Lake
Old Fish Creek
POW B (Kogru)
POW A (Cape Simpson)

Because deep snow conditions prevented the train from reaching Brady, the POW A site was substituted at the end of the season. The program was finished by April 19 and the contractor demobilized the train overland to Deadhorse.

USGS/HUSKY - SEVENTH SEASON: JUNE 1981 to MAY 1982

Summer Operations

No drilling was planned for the 1981-82 season because the first oil lease sale in the Reserve was scheduled for December of 1981. Therefore, no site surveying was required that summer.

The summer work focused on environmental rehabilitation efforts and the preparation of Camp Lonely for closure. Decisions had to be reached and carried out concerning the disposition of equipment, supplies, the communications system and the camp itself. The environmental effort was less complicated.

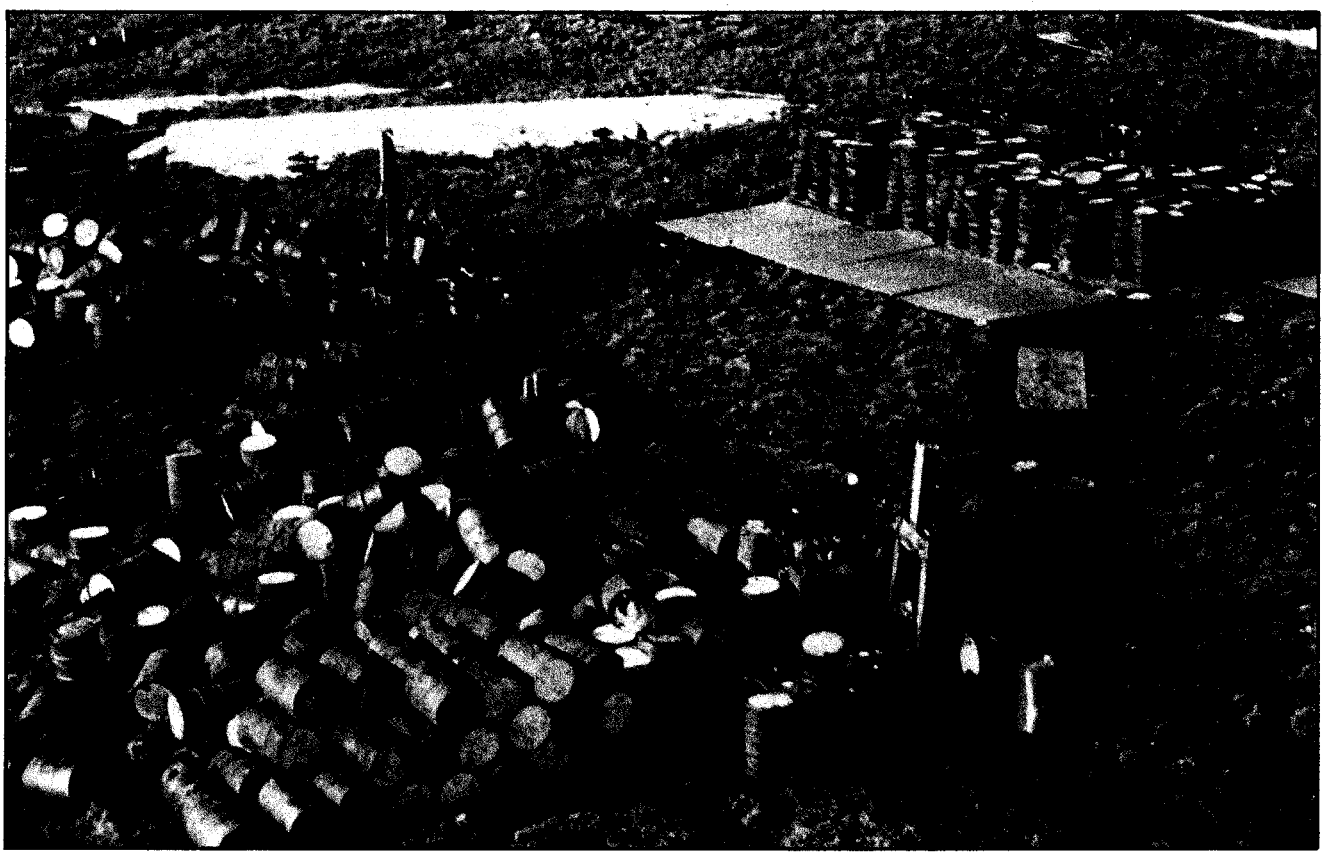
Since it was very possibly the last opportunity to accomplish environmental work under the exploration program, an extra effort was made to do as much as time and weather would allow. Cleanup began at the recent drilling sites on June 18. Removal of the pile caps and the piling tops below pad level was the primary effort as such work was easier to do before the summer thaw melted the frozen pads and made conditions less desirable.

High winds and fog in the western part of the Reserve slowed down the establishment of the cleanup tent camp at Icy Cape but the operation was finally in place by July 2. A second siege of winds of up to 50 knots then hampered work for another week. Icy Cape was finished by July 28 and the Camp was moved to the Kaolik site. The old sites cleaned that season were Icy Cape (LIZ B), Peard Bay (LIZ C), Kaolik and numerous smaller "finds".

Revegetation Operations

The following current drill sites were cleaned up and seeded with native grasses:

Walakpa No. 2
North Inigok
Kuyanak
Tulageak
Koluktak
Awuna



Barrel crushing operation at the Oumalik site, June 1980.

Helicopter transporting debris to the burial location, Grandstand site. July 1979.

Also further cleanup work was accomplished at Seabee (Umiat) and Lisburne (Ivotuk).

The decision was made to utilize fixed wing aerial application to fertilize trails and pads as the distances to be covered were great and aerial distribution was much more cost effective. The services of two Cessna AgWagons were procured by contract and the first arrived at Lonely by July 10 and the second by July 23. Fertilizer was aerially applied to the following trails and abandoned drill pads:

Trails

Lonely to Drew Point - 18 miles
Drew Point to Ikpikpuk - 36 miles
Ikpikpuk to Inigok - 58 miles
Inigok to North Kalikpik - 50 miles
North Kalikpik to West Fish Creek - 17 miles
North Kalikpik to South Harrison - 9 miles
North Kalikpik to Atigaru Point - 15 miles
North Kalikpik to W. T. Foran - 24 miles
W. T. Foran to Lonely - 32 miles
North Kalikpik to Lonely - 42 miles
Drew Point to South Simpson - 25 miles
South Simpson to East Simpson No. 2 - 33 miles
Barrow to Walakpa No. 1 - 14 miles

Many trails were wider than anticipated and often required two or three passes of the aircraft to ensure complete fertilizer coverage.

Abandoned Drill Pads

Drew Point
Ikpikpuk (plus on tundra ice runway area)
Inigok (plus road & airstrip edges)
North Kalikpik
West Fish Creek
South Harrison Bay
Atigaru Point
W. T. Foran
Cape Halkett
South Simpson
East Simpson No. 1
East Simpson No. 2
South Meade
Kugrua
East Teshekpuk
Peard
Tunalik (plus road & airstrip edges)
Walakpa No. 1
West Dease
Koluktak
Tulageak
Walakpa No. 2
Awuna
Lisburne (plus road & airstrip edges)
Kuyanak
North Inigok

The Camp Lonely Control Center personnel provided communications for all the cleanup and revegetation operations as well as the USGS field parties.

Although the level of field activity for the summer of 1981 was less than half that of previous summers, Camp Lonely was a busy place. The Skyvan aircraft and four helicopters were flying in support of the Barrow gas field work, the cleanup, and the Technical Services Contractor and

there were many lateral shuttles by the Hercs, moving materials between Lonely and Barrow. The operations at NARL were being greatly reduced in response to decreased Navy interest and planned closure of that facility. To fulfill the Secretary of the Interior's legal requirements to operate and maintain the Barrow gas fields, the USGS planned to move the Camp Lonely exploration equipment and materials to Barrow because the government exploration program was over.

All of this sorting, crating, and transfer of equipment for an orderly closure of Camp Lonely consumed a great deal of time and effort. USGS and Husky property management personnel inventoried all the materials and equipment, particularly the communications gear, and identified items for lateral barge movement to Barrow. The Nabors Rig No. 1 was readied for retrograde to Seattle.

In late July, the construction of the heater buildings in the East Barrow gas field was begun and the radiographic inspection of the gas line gathering system got underway. A telephone line between the East and South Barrow gas field was installed on the gas line itself. In Camp Lonely, the work was started to add urethane to the roofs of the camp units to seal and insulate them prior to closing up. Generators were overhauled, some on site and others that were sent out to Fairbanks and Anchorage. The 23,000 double-walled fuel tanks were drained and cleaning begun in preparation for painting and shipping them to Barrow.

In August, the barges arrived and the fuel deliveries and lateral movements immediately got underway. At Lonely, 801,500 gallons of Arctic Diesel were off-loaded and another 299,500 gallons were received at Barrow. Three barge loads of equipment were shipped to Barrow in August and two more in September. Also in September, Lonely received 4,800 gallons of MoGas and 64,000 gallons of Arctic Diesel for the DEW Line and stored it in the USGS tanks.

Inigok Reserve Pit

After Inigok Test Well No. 1 was abandoned in May of 1979, the spring flush of runoff added considerably to the fluid volume of the reserve pit. The resultant increased "head" pressure allowed some of the fluids in the reserve pit to seep through the sands of the retaining berm. During the growing season problems with the reserve pit were indicated by an area of dead vegetation around the toe of the berm along the western edge. Samples were obtained to evaluate for toxic and potentially toxic substances. Chemical analysis of the fluids proved to be extremely difficult because of their complex nature. Tests indicated that the material had high oxygen demand characteristics but was only mildly toxic. Containment within the existing berm was determined to be the best present alternative. The reserve pit was field tested during the summer of 1980, but this cursory examination indicated limited change. In the early summer of 1981 a full analysis was again done to "up-date" the record and it was discovered that a number of significant chemical changes had occurred. A radical downward shift in pH was noted as was a substantial decrease in organic strength.

When first examined in June of 1979, the reserve pit material was found to have a pH of 9.0. During that summer, the pH dropped slowly into the 8.2 - 8.3 range. The cursory examination in 1980 indicated that the pH remained relatively unchanged. In September of 1981 the pH was found to be 3.3. At that time a program was instigated to neutralize the reserve pit material. Laboratory tests indicated it was possible to neutralize the reserve pit fluids with sodium hydroxide (NaOH). Approximately 5,000 pounds of NaOH solid was added to the reserve pit fluids, through the ice cover on October 2 and 3, 1981. Plans were made to test the pit again during the 1982 season.

Closure of Camp Lonely

After the barges had been loaded and departed Lonely, the materials to be stored on the camp pad were rearranged and restacked to make best use of space and minimize the snow drifting problems. All of the equipment and supplies that were stored along the road to the summer water supply lake were brought in and either stored in the warehouse or on the pad. Vehicles and other equipment were shipped to Barrow via C-130 Hercules aircraft. The 23,000 gallon double-walled steel tanks were also moved to Barrow where the sanding and painting would be completed. Industrial gases, the man-lift, and miscellaneous files were back-hauled to Anchorage. A new hook up of the runway lights and beacon to the DEW Line electrical system was accomplished to keep them operational after the Camp Lonely power plant was closed down.

Camp Lonely was completely shut down on December 5, 1981. The camp was left in excellent condition and well secured. All windows were boarded up, locks secured on all doors and fuel valves, and no trespassing signs were placed on all doors and at representative locations on the drill pipe, mud products and other items stored on the pad. The USGS made arrangements with the DEW Line for periodic surveillance of the camp.

Construction in the Barrow Gas Fields/Winter 1981-1982

Gas field construction of modernization improvements and modifications continued throughout the winter although progress was hampered frequently by blowing snow in the October through February period. Electric power for the East Field was supplied as of November, 1981 by the new generating facility in the South Field. The East Field start-up occurred in December and was turned over to the gas field operator. Construction continued throughout the spring with a building over the Metering and Regulation bypass facility, the installation of instrument panels in both fields, the installation of ratio control valves, and the installation, on piling, of emergency fuel tanks and generators in the East Field.

Burial Program - Spring 1982

The last major effort of the cleanup/burial program was the spring 1982 field work. The contractor utilized two Cat trains of equipment; the larger one doing the work at Skull Cliff and Peard Bay, and the smaller

more easily mobile train worked briefly at Skull Cliff before acomplishing the burial work at Brady, Kaolik, and Icy Cape. The Skull Cliff operations were a major effort because the estimated 4,350,000 pounds of debris that had been stockpiled on the beach in hopes of marine retrograde, had to be moved one mile inland to the burial site. However, even with this large task, the effort proceeded on schedule.

The second train departed Skull Cliff for Brady and although some deep snow was encountered, it was nowhere near the depth that thwarted the efforts to reach Brady a year earlier.

The contractor was in the field, with both crews working at the Skull Cliff site on March 15th and the program was completed and all equipment began demobilization off the Reserve on April 17th. Seed and fertilizer was spread at all sites prior to the departure of the work crews.

Camp Lonely - Spring 1982

On June 2nd the DEW Line personnel, acting as Caretaker/Watchman for Camp Lonely, reported that a center section of roof over the recreation area had collapsed. Apparently,a six foot (plus) snow drift had formed on the roof, downwind of the weather observation tower and the weight of this dense packed snow collapsed the roof. Clean up of the debris and the necessary repairs to the roof were accomplished late that summer to keep the camp weathertight.

Summer Operations - 1982

The Revegetation/cleanup crews accomplished the final cleanup of miscellaneous debris at the current drill sites during the summer of 1982. During the activities of the summer, many abandoned barrels, both full and empty, were found along the old Navy trails throughout the Reserve. The cleanup efforts had concentrated on abandoned wellsites and their immediate area and no survey of trails was accomplished until this year. The number of barrels found was a surprise to even those people who had often flown over the Reserve, so after the drill sites were given a final policing, efforts turned to clean up as many barrels as possible. In addition, considerable time was spent in the Barrow and Lonely areas as these sites were active after freeze-up in the fall of 1981. As usual the snows had concealed a considerable amount of debris. Cleanup efforts ceased on September 28, 1982. No one claimed that the NPRA was "clean" of debris, but over 7,000 tons of debris were picked up and burned or consolidated and buried, and the current exploration effort left the entire area in much better environmental condition than was the case prior to 1975.

Samples were again taken from the Inigok reserve pit fluids on June 29, 1982 and the results indicated that the pit has attained near stabilization and neutralization. PH values of 6.4 and 6.5 were measured in the various samples taken around the inside perimeter of the pit. Color was still high due to the fulvic and humic acids that are the naturally occurring polymers, the products of biological degradation. Another sample for analysis was taken on September 23, 1982. The pH for each of

three samples from the reserve pit was 7.4, 7.6 and 7.6. This compared quite well with the 7.4 and 7.5 measured in the natural lake waters nearby. The conductivity of the pit was still somewhat high (7,600 microohms per centimeter) but the alkalinity measured as calcium carbonate was quite low (120 milligrams per liter). All these measurements were taken when there was approximately one inch of ice cover on the surface. This change was somewhat surprising as it was expected that the spring values would decrease as the previous season evidenced.
However, they represented the pit under completely mixed conditions after a summer of wind action and the June 25th samples were obtained when the contained fluids were probably still "winter stratified".

SUMMARY

The modern Petroleum Reserve exploration program was initiated in the spring of 1975 with the drilling of Cape Halkett No. 1 and continued in the spring of 1976 with the drilling of East Teshekpuk No. 1. The program reached "full operation" status in the winter of 1976-1977 when five exploratory wells* were drilled, the Lonely Camp enlarged, construction trains assembled and overland trails established. During the program total of twenty-eight exploratory wells were drilled; six under the direction of the U. S. Navy and 22 under the direction of the Department of the Interior, U. S. Geological Survey. In addition, as an adjunct to the exploration program eight additional wells were drilled in the Barrow gas field. Over the seven year life of the program, a total of 14,770 line miles of seismic survey were accomplished and interpreted.

Geological Findings

The NPRA program discovered an apparent natural gas field (Walakpa) about 15 miles south of Barrow. The gas found in the Walakpa Test Well No. 1 is in a Lower Cretaceous sandstone reservoir about 18 feet (gross) thick at a depth of about 2,070 feet. Original gas in place was calculated to be 428 thousand cubic feet per acre foot of reservoir, according to an engineering study of drill-stem test and core-analysis data. The areal extent of this field was not determined but it might be fairly large. Gas was found in a correlative sandstone in Walakpa Test Well No. 2, located about 4 miles to the south-southwest of the discovery well. In Well No. 2, the gas bearing sandstone is 32 feet (gross) thick and is 523 feet structurally lower than in Well No. 1. A cased-hole drill-stem test of the sandstone in Well No. 2 gave a maximum flow rate of 2.293 million cubic feet per day. None of these test flow rates were considered stable because there was evidence that gas hydrates formed in the wellbore during all the flow periods.

Most other exploratory wells drilled during the program found gas shows, and several wells had oil shows. The shows were generally evaluated as they were encountered on the basis of sample analysis, mudlogger gas

*South Harrison Bay, Atigaru Point, West Fish Creek, South Simpson and W. T. Foran

shows, and cores. When feasible, the better shows were further evaluated with drill-stem tests after electric log interpretations, if available, had indicated possible reservoir parameters.

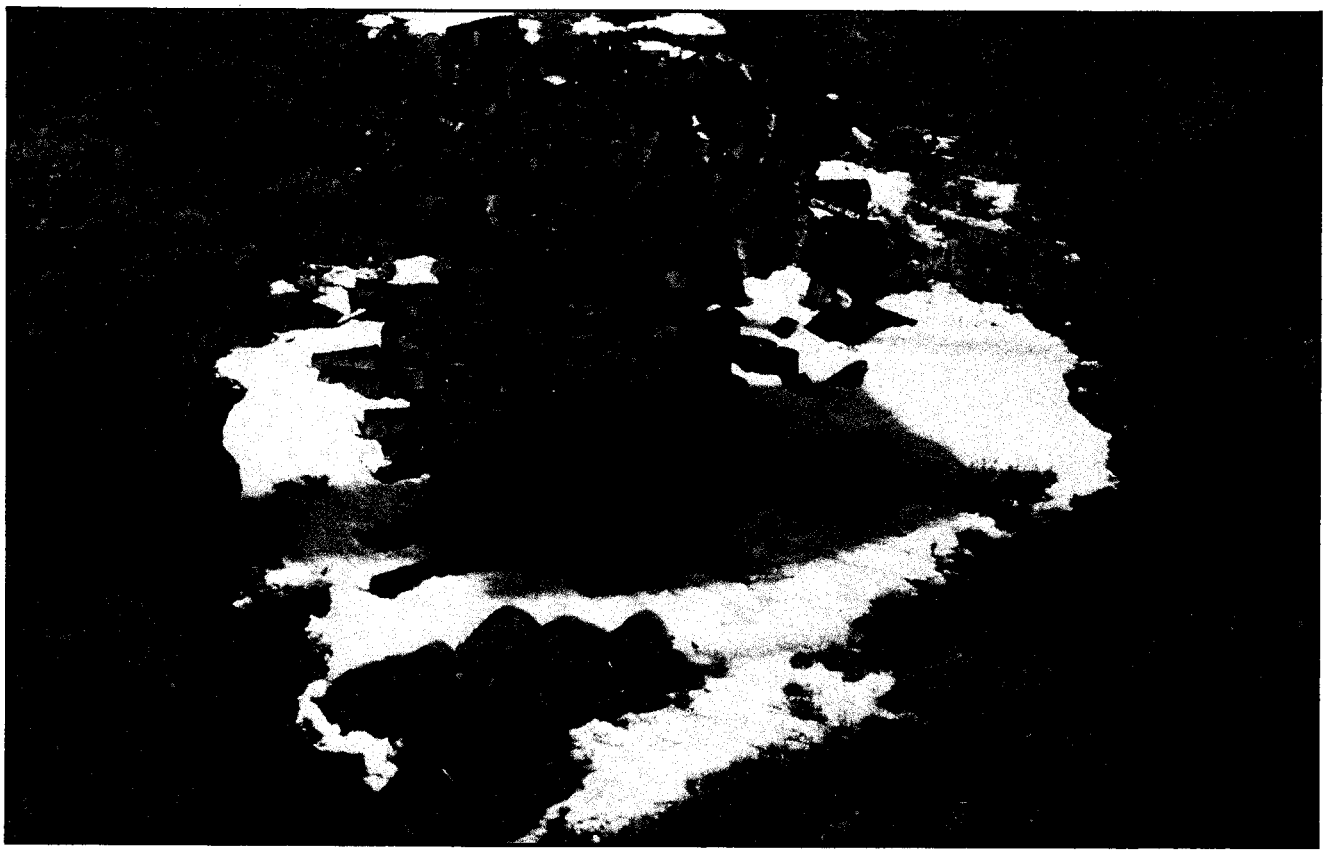
The Seabee Test Well No. 1, located near Umiat in the southeastern part of the Reserve, tested gas from a thin (14 feet net) Cretaceous sandstone at a depth of 5,366 feet. According to an analysis of the test data by H. J. Gruy and Associates, Inc., the gas reservoir is small and closed, and the total gas originally in place is estimated to be on the order of 330 million cubic feet.

Several gas shows were encountered in Cretaceous rocks in the Tunalik Test Well No. 1 which was drilled in the northwest part of the Reserve about 40 miles southwest of Wainwright. The most significant show was from an overpressured sequence of interbedded sandstone and shale between 12,550 and 12,600 feet. This zone required prolonged well-control procedures which resulted in barite plugging much of the porosity of the sandstone. Because of the formation damage, a conventional drill-stem test was not attempted; wireline tests to obtain pressures and fluid samples were unsuccessful.

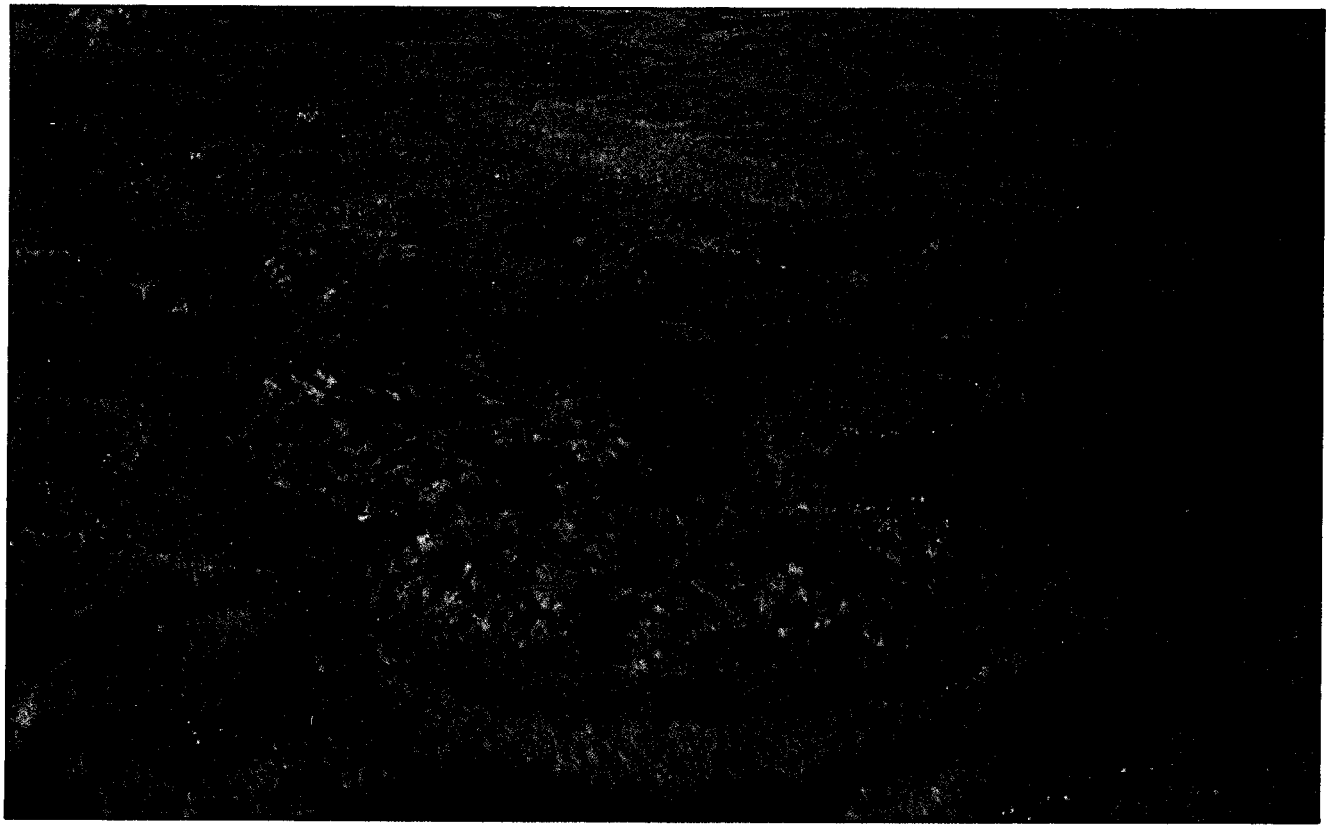
Many gas shows were noted in drilling the Awuna Test Well No. 1, located in the southcentral part of the Reserve about 152 miles south of Barrow. This test of Cretaceous rocks had severe drilling problems, and it did not reach the planned total depth of 15,000 feet. The only drill-stem test, between 8,297 and 8,412 feet, recovered salty water at the rate of 2,057 barrels per day. This flow was probably from fracture porosity in the tested interval.

The Inigok Test Well No. 1 was a deep exploratory effort in the eastern part of the Reserve about 60 miles south of Lonely. The well had numerous poor gas shows, and none were tested. At a depth of 17,570 feet the Inigok well encountered a considerable amount of hydrogen sulfide gas and sulfur while drilling Mississippian carbonate rocks of the Lisburne Group. The unexpected occurrence of hydrogen sulfide, one of the very few known on the North Slope, caused a major delay in the drilling of the Inigok well.

In the northeast part of the Reserve, near the coast, most wells had at least poor shows of oil and/or gas. The South Simpson Well No. 1, a U. S. Navy well (1977), recovered small amounts of gas on drill-stem tests of Lower Cretaceous and Jurassic sandstones between depths of 5,807 and 6,568 feet. The East Simpson Test Well No. 2 flowed formation water at a rate of 24 barrels per hour, with traces of oil and gas from a drill-stem test of Triassic-Permian sandstone between 7,152 and 7,197 feet. Tests of another Navy well (1977), the W. T. Foran No. 1, recovered formation water with a trace of oil from Lower Cretaceous rocks (7,512-7,520 feet), slightly gas-cut water from Triassic-Permian rocks (7,587-7,676 feet), and some slightly oil-cut water from Pennsylvanian carbonate beds of the Lisburne Group (8,206-8,283 feet). In the J. W. Dalton Test Well No. 1, the Lisburne carbonates yielded five barrels of asphalt on one test (8,558-8,665 feet) and five barrels of asphalt and water emulsion on a



Barrel pile at the Oumalik site before clean-up, June 1980.



Barrel pile at the Oumalik site after clean-up, July 1980.

different test (8,482-8,538 feet). Salt water was produced on both tests. A test of Triassic-Permian rocks (7,812-8,140 feet) in the J. W. Dalton well flowed salt water, with a light sheen of oil, at a rate of 1,218 barrels per day.

Environmental Rehabilitation

The modern exploration program included cleanup work of some degree of activity throughout its seven-year history with the major efforts being accomplished in the later years. All of the major wellsites from the original Navy exploration program (1944-1953) were cleaned up along with the sites from the current program. Four abandoned DEW Line "I" (Intermediate) sites were also cleaned as well as the Skull Cliff Communication Site and many of the incidental operational locations such as fuel and explosive caches and seismic and Cat train mechanic's camp sites. Combustible debris was burned and non-combustible debris was collected, consolidated, and buried. The entire Reserve was left in much better environmental "housekeeping" condition at the end of the program than was prevalent at the inception of the program.

In the 23,680,000 acre reserve an estimated 545 acres of surface experienced greater than transient disturbance from the program as follows: wellpads - 250 acres, borrow sites - 170 acres, debris burials - 16 acres, roads - four acres, and aircraft runways - 105 acres. Revegetation was attempted of all disturbed areas exclusive of the aircraft runways. Of the 440 acres seeded, the vegetation on an estimated 395 acres was well established at the end of the program and on its way to the restoration of the natural cover. The recovery on the remaining 45 acres, which were mostly coastal sites with high salt content from ocean spray, was happening, but at a much slower rate. However, even these sites were rapidly "blending" with the surroundings and becoming ever more difficult for the casual observer to distinguish.

The exploration program spanned seven years of time and engaged over 700 government and contract and subcontract industry personnel at the peak of activity. The efforts provided the United States domestic petroleum exploration program with a wealth of knowledge and information about the hydrocarbon potential of the Arctic Slope and the National Petroleum Reserve in Alaska. All of the knowledge and information gained was made part of the public domain as rapidly as possible to maximize all possible savings on future energy costs to the United States consumer.

GLOSSARY

ARCTIC SLOPE - Area north of the drainage divide of the Brooks Range.

ATV - Abbreviation commonly used for "all-terrain-vehicle".

BEAVER - (or Single Engine Beaver) A single engine turbo-prop aircraft with "STOL" characteristics used to transport passengers and light cargo often on a ski-wheel configuration. Manufactured by the DeHaviland Corporation of Canada.

BLM - Bureau of Land Management, U. S. Department of the Interior.

BLOWDOWN - Periodic flowing of a well to remove the accumulation of dirt, rocks, water, ice (and oil in a gas well) which settle out and reduce the flow.

BOTTOMS-UP - Circulation of the mud to drill the well with returns to the surface indicating that the hole is sealed by drilling mud to help prevent cave-ins.

C-130 - (or Hercules C-130) A multi-engine turbo prop aircraft for freight transport manufactured by the Martin Marietta Corporation of Marietta, Georgia.

CALCULATED DEPTH - (or true vertical depth) The calculated distance from the surface to the bottom of the hole taking into consideration the drift angle from the verticle.

D-8 CAT - A large tractor type vehicle for support work or hauling heavy loads, manufactured by the Caterpillar Corporation.

DELTA - An all terrain vehicle used to haul freight or heavy loads manufactured by the Foremost Manufacturing Company, Calgary, Canada. Various models are the Delta-3, Delta-Commander, and Delta-Magnum.

DOI - United States Department of the Interior.

JOINT - A length of pipe or tubing.

KELLY - A long steel forging which makes the torque connection from the drill rig to the top joint of the drill stem in the drill string.

LCC - An acronym to designate the Camp Lonely Control Center. This group was responsible for the coordination of all freight and passenger movements to, from, and within the Reserve.

LOWBOY - A trailer, on tires, built very low to the ground, usually used to transport tracked vehicles or other large equipment.

MEASURED DEPTH - The depth as reflected in the length of the drill stem or a wire line to reach the bottom of the hole.

MOBILIZATION - All the activity associated with the assembly and moving to the site of the equipment and personnel to be employed in the operation. Sometimes called "move-in". Demobilization (or move-out) is all the activity associated with withdrawal from the site.

MOUSE HOLE - (also see rat hole) A second, usually smaller or shallower hole in addition to the rat hole used for the temporary placement of tools.

NARL - Naval Arctic Research Laboratory.

NDB - Non-directional beacon; a navigation aid at each airstrip that provides a pulsating radio frequency that aircraft can home on.

NPRA - National Petroleum Reserve in Alaska; the name given to Naval Petroleum Reserve No. 4 by Public Law 94-258 upon the transfer of jurisdiction from the Secretary of the Navy to the Secretary of the Interior.

OPEN HOLE - The portion of the well bore without casing.

PERFORATE - To make holes in the casing (and cement if present) to allow formation fluids to enter the well bore.

PERMAFROST - Any naturally occurring material that has been below the freezing point of fresh water (32° F) for two or more years.

PERMEABILITY - A measure of the resistance offered by rock to the movement of fluids through it.

PET 4 - (also NPR 4 and NPR No. 4) Naval Petroleum Reserve No. 4 or the Navy's exploration program in Pet 4 and the adjacent areas.

POLYGONS - The surface manifestation of the pattern of ice wedges below the surface. High center polygons are formed in areas where surface drainage is extant. Low center polygons are formed in areas of poor surface drainage.

POROSITY - The relative volume of pore spaces between mineral grains as compared to total rock volume.

RAT HOLE - A shallow hole drilled adjacent to the well hole for the temporary placement of certain tools or parts of the drilling rig equipment during rig operation.

RETROGRADE - To return or go backwards; here means to return materials or equipment to their source, usually by barge to Seattle, Washington.

RIG-UP and RIG-DOWN - The general terms used to refer to assembly and disassembly of the entire drill rig equipment complex.

ROLLIGON - An all-terrain vehicle on large balloon-like tires used to transport heavy loads with little damage to the environment. Manufactured in Texas.

SNO CAT - A personnel all-terrain vehicle manufactured by the Tucker Corporation in Medford, Oregon.

SPUD - The initial boring of the hole in the drilling of a well.

STACK-OUT - A term used to refer to the orderly storage of mobile equipment during a period of non use. "The seismic trains used Umiat for their summer stack-out."

STRING SHOT - An explosive device used to loosen a tool joint for downhole backoff (unscrew) associated with a stuck pipe.

STRIP CHECK - The inspection and resulting certification of an airstrip by a qualified pilot of the airline planning to use the airstrip.

TD - Usually the target depth of a well but also used to mean the total depth reached.

TWIN OTTER - A two-engine turbo prop aircraft for personnel and cargo transport. Manufactured by the DeHavilland Corporation of Canada.

USGS - The United States Geological Survey, Department of the Interior.

BIBLIOGRAPHY

1. Black, R. F., 1954. Permafrost-A. Review, Geological Society of America Bulletin 65: 839-56.

2. Britton, M.E., 1957. Vegetation of the Arctic Tundra. In H.P. Hasen Ed. Arctic Biology. Corvallis, Oregon State Univ. Press. p.26-61.

3. Brooks, A. H., 1906. The Geography and Geology of Alaska. U.S. Geological Survey. Profes. Paper No. 45.

4. Hulten, Eric, 1968. Flora of Alaska and Neighboring Territories. Stanford, Stanford University Press. 1009 pp.

5. Lachenbruch, A.J., 1962. Mechanics of Thermal Contractor Cracks and Ice Wedge Polygons in Permafrost. Geologic Society of America Special Paper No. 70. 69 pp.

6. Reed, John C., 1958. Exploration of Naval Petroleum Reserve No. 4 and Adjacent Areas Northern Alaska, 1944-53. Part I, History of the Exploration, Geological Survey Prof. Paper No. 301, G.P.O., Washington D.C. 192 pp.

7. Riverain, Jean, 1966. Concise Encyclopedia of Explorations. Follett Publ. Co., Chicago. 279 pp.

8. Williams, H. R., and Meyers, C.J., 1976. Manual of Oil and Gas Terms. Mathew and Bender, N.Y. 657 pp.

REPORTS of HUSKY OIL - NPR Operations, Inc., 1983, Anchorage, Ak.

Drilling

9. History of Drilling Operations, East Teshekpuk No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

10. History of Drilling Operations, South Harrison Bay No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

11. History of Drilling Operations, Atigaru Point No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

12. History of Drilling Operations, West Fish Creek No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

13. History of Drilling Operations, South Simpson No. 1, Prepared by S. L. Hewitt, Edited by G. W. Legg and R. G. Brockway.

14. History of Drilling Operations, W. T. Foran No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

15. History of Drilling Operations, Drew Point Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

16. History of Drilling Operations, South Meade Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

17. History of Drilling Operations, Kugrua Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt and C. C. Livingston.

18. History of Drilling Operations, North Kalikpik Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

19. History of Drilling Operations, Inigok Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

20. History of Drilling Operations, Tunalik Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

21. History of Drilling Operations, Ikpikpuk Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

22. History of Drilling Operations, Peard Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt and C. C. Livingston.

23. History of Drilling Operations, East Simpson Test Well No. 1, Prepared by S. L. Hewitt, Edited by G. W. Legg.

24. History of Drilling Operations, J. W. Dalton Test Well No. 1, Prepared by S. L. Hewitt, Edited by G. W. Legg.

25. History of Drilling Operations, Lisburne Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

26. History of Drilling Operations, Seabee Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

27. History of Drilling Operations, Walakpa Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

28. History of Drilling Operations, East Simpson Test Well No. 2, Prepared by Drilling Department, Edited by S. L. Hewitt.

29. History of Drilling Operations, West Dease Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt.

30. History of Drilling Operations, Awuna Test Well No. 1, Prepared by C. C. Livingston and G. W. Legg.

31. History of Drilling Operations, Walakpa Test Well No. 2, Prepared by Drilling Deprtment, Edited by S. L. Hewitt and C. C. Livingston.

32. History of Drilling Operations, North Inigok Test Well No. 1, Prepared by Drilling Department, Edited by S. L. Hewitt and C. C. Livingston.

33. History of Drilling Operations, Kuyanak Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

34. History of Drilling Operations, Tulageak Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

35. History of Drilling Operations, Koluktak Test Well No. 1, Prepared by S. L. Hewitt, Edited by R. G. Brockway.

36. History of Drilling Operations, South Barrow Well No. 13, Prepared by Drilling Department, Edited by S. L. Hewitt and G. W. Legg.

37. History of Drilling Operations, South Barrow Well No. 14, (East Area), Prepared by Drilling Department, Edited by S. L. Hewitt and G. W. Legg.

38. History of Drilling Operations, South Barrow Well No. 15 (East Area), Prepared by Drilling Department, Edited by S. L. Hewitt and G. W. Legg.

39. History of Drilling Operations, South Barrow Well no. 16 (North Area), Prepared by Drilling Department, Edited by S. L. Hewitt and G. W. Legg.

40. History of Drilling Operations, South Barrow Well No. 17 (East Area), Prepared by S. L. Hewitt, Edited by G. W. Legg.

41. History of Drilling Operations, South Barrow Well No. 18 (East Area), Prepared by S. L. Hewitt, Edited by G. W. Legg.

42. History of Drilling Operations, South Barrow Well No. 19 (East Area), Prepared by S. L. Hewitt, Edited by R. G. Brockway.

43. History of Drilling Operations, South Barrow Well No. 20 (East Area), Prepared by S. L. Hewitt, Edited by G. W. Legg.

Geology

44. Geological Report, Drew Point Test Well No. 1, Prepared by S. L. Hewitt, Edited by G. W. Legg.

45. Geological Report, South Meade Test Well No. 1, Prepared by Geology Department.

46. Geological Report, Kugrua Test Well No. 1, Prepared by G. W. Legg.

47. Geological Report, North Kalikpik Test Well No. 1, Prepared by G. W. Legg, Edited by R. G. Brockway.

48. Geological Report, Inigok Test Well No. 2, Prepared by H. Haywood, Edited by R. G. Brockway.

49. Geological Report, Tunalik Test Well No. 1, Prepared by H. Haywood, Edited by G. W. Legg.

50. Geological Report, Ikpikpuk Test Well No. 1, Prepared by R. G. Brockway.

51. Geological Report, Peard Test Well No. 1, Prepared by Geology Department.

52. Geological Report, East Simpson Test Well No. 1, Prepared by H. Haywood, Edited by R. G. Brockway.

53. Geological Report, J. W. Dalton Test Well No. 1, Prepared by H. Haywood, Edited by G. W. Legg.

54. Geological Report, Lisburne Test Well No. 1, Prepared by G. W. Legg.

55. Geological Report, Seabee Test Well No. 1, Prepared by G. W. Legg and R. G. Brockway.

56. Geological Report, Walakpa Test Well No. 1, Prepared by H. Haywood and G. W. Legg, Edited by R. G. Brockway.

57. Geological Report, East Simpson No. 2, Prepared by H. Haywood, Edited by R. G. Brockway.

58. Geological Report, West Dease Test Well No. 1, Prepared by H. Haywood, Edited by R. G. Brockway.

59. Geological Report, Awuna Test Well No. 1, Prepared by G. W. Legg.

60. Geological Report, Koluktak Test Well No. 1, Prepared by R. G. Brockway, Edited by G. W. Legg.

61. Geological Report, South Barrow Well No. 13, Prepared by R. G. Brockway, Edited by G. W. Legg.

62. Geological Report, South Barrow Well No. 14, (East Area), Prepared by G. W. Legg.

63. Geological Report, South Barrow Well No. 15 (East Area), Prepared by R. G. Brockway.

64. Geological Report, South Barrow Well No. 16 (North Area), Prepared by G. W. Legg.

65. Geological Report, South Barrow Well No. 17 (East Area), Prepared by G. W. Legg.

66. Geological Report, South Barrow Well No. 18 (East Area), Prepared by R. G. Brockway.

67. Geological Report, South Barrow Well No. 19 (East Area), Prepared by R. G. Brockway.

68. Geological Report, South Barrow Well No. 20 (East Area), Prepared by G. W. Legg.

69. Geological Report, South Harrison Bay No. 1, Prepared by R. G. Brockway, Edited by G. W. Legg.

70. Geological Report, Atigaru Point No. 1, Prepared by G. W. Legg.

71. Geological Report, West Fish Creek No. 1, Prepared by G. W. Legg, Edited by R. G. Brockway.

72. Geological Report, South Simpson No. 1, Prepared by R. G. Brockway.

73. Geological Report, W. T. Foran No. 1, Prepared by G. W. Legg.

74. Geological Report, East Teshekpuk No. 1, Prepared by G. W. Legg.

Construction

75. Design and Construction of the Lisburne Wellsite, Prepared by T. E. Brooks.

76. NPRA Construction Cost Estimating System, Prepared by D. W. Mitchell and T. E. Brooks.

77. Design of NPRA Winter Drilling Pads, 1976 - 1978, Prepared by T. E. Brooks.

78. Design of NPRA Winter Drilling Pads, 1979 - 1981, Prepared by D. W. Mitchell.

79. Design and Construction of the Awuna Wellsite, Prepared by T. E. Brooks.

80. On-Tundra Ice Airstrips, Prepared by D. W. Mitchell.

81. Design and Construction of the Inigok Wellsite, Prepared by D. W. Mitchell.

82. Design and Construction of the Tunalik Wellsite, Prepared by D. W. Mitchell.

83. Design and Construction of the Seabee Wellsite, Prepared by D. W. Mitchell.

84. Design and Construciton of the North Inigok Wellsite, Prepared by D. W. Mitchell.

Transportation and Communications

85. Operations Report for Transportation and Communciations for Fiscal Years 1976 - 1982, Prepared by J. D. Anderson and C. H. DeSpain, Edited by J. F. Schindler.

86. Communications Engineering, Prepared by L. E. Parsons.

Support Services

87. Camp Lonely, Support Services, 1975 - 1981, Prepared by C. K. Lee, Edited by J. F. Schindler.

Environmental

88. Environmental Rehabilitation, 1975 - 1982, Prepared by J. F. Schindler.

Miscellaneous

89. Cost Summary of Exploratory Wells, 1976 - 1981, Prepared by J. F. Schindler and D. W. Mitchell.

90. History of the Second Exploration, 1975 - 1982, Prepared by J. F. Schindler.

APPENDIX I

STIPULATIONS CONCERNING WINTER SEISMIC AND RELATED GEOPHYSICAL OPERATIONS WITHIN NAVAL PETROLEUM RESERVE NO. 4
(from Navy, 1975)

The conditions listed below are those which successful bidders will be required to follow in order to minimize damage to the surface of the land, to the surface waters, and to the fish and wildlife on NPR-4.

1. Seismic Survey Operations are to begin only after the seasonal frost in the tundra and underlying mineral soils has reached a depth of 12 inches; the average snow cover a depth of six inches. Normally this condition will not prevail until about 15 October, occasionally not until 1 November.

2. Seismic operations will cease when the spring melt of snow begins; approximately 5 May in the foothill areas exceeding 300 feet in elevation; approximately 15 May in the northern coastal areas.

3. No bulldozing of tundra areas, trails, or seismic lines will be allowed. This stipulation, however, does not prohibit the clearing of drifted snow along a trail or seismic line nor in a camp, to the extent that the tundra mat is not disturbed. Also, it does not prohibit the clearing of snow on a lake or river ice surface in order to prepare an aircraft runway.

4. Camps will be situated on gravel bars, sand, or other durable lands. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling will be accomplished with blocking rather than leveling with a bulldozer.

5. Camps will not be located on frozen lakes or on river ice. The location of camps on river sand or gravel bars is allowed and, where feasible, encouraged.

6. Exploration activities will employ low-ground-pressure vehicles of the rolligon, ARDCO, Trackmaster, Nodwell or similar type. The limited use of tractors, equipped with wide tracks or "shoes", will be allowed for the ploughing of snow or to pull the camp trailers. Any exceptions to this stipulation will require the written approval of the Officer in Charge, NPR-4.

7. All operations shall be conducted with due regard for good resource management and in such a manner as to not block any stream, or drainage system, or change the character or course of a stream, or cause the pollution or siltation of any stream or lake.

8. Crossing of waterway courses shall be made using a low angle approach in order not to disrupt the naturally occurring stream or lake banks.

9. All operations will be conducted in such a manner as to not cause damage or disturbance to any fish or wildlife resource. This includes, but is not limited to, the following:

a. No seismic shooting or vehicle operations within one-half mile of any denning barren ground grizzly (in the upland area) or of any denning polar bear (near the sea coast or in the lower reaches of major rivers or estuaries).

b. No chasing by vehicles or buzzing by aircraft of any wildlife. Particular attention will be given to not disturbing caribou.

c. Shot holes must be a minimum of 300 feet from any designated anadromous stream except where these waters, at the time of seismic shooting, may be frozen to bottom and the underlying gravels or sands also are frozen. Where required for the completion of critical surveys or tie-ins, variances may be requested, through the Officer in Charge, NPR-4, from the appropriate regulatory authority.

10. No hunting will be allowed within a radius of five miles from a geophysical camp, explosives, cache, fuel cache, or seismic operation.

11. All oil spills will be reported to the Officer in Charge, NPR-4, at the time of the first solid radio contact or other communication occurring after the oil spill incident. Additional fuel handling requirements are:

a. All fuel spills will be cleaned up immediately, taking precedence over all other matters, except the health and safety of personnel.

b. Oil spills will be incinerated in approved receptacles but not on lake or river ice.

c. Although fuels may be off-loaded from aircraft on the ice there will be no storage of fuels on lake or river ice, even on a temporary basis.

12. All fuel containers used, including barrels, must be marked with the contractor's name and date, i.e. 1975.

13. All combustible solid waste, including seismic cartons, drilling mud sacks if any, and used lubricating oils will be incinerated or returned to the base of operations for approved disposal. All noncombustible solid waste, including fuel drums, will be returned to the base of operations for approved disposal. An exception would be incinerated ash which may be deposited in a seismic hole which has vented. There will be no burial of garbage or the dozing up of any area for the burial of any matter of thing.

14. All retrievable shot hole wire will be picked up and returned to the base of operations for approved disposal. Records shall be kept of the amount of shot hole wire used and of that returned for disposal.

15. Shot lines shall be left clean of all foreign debris. This shall include, but is not limited to, shot wire, explosive boxes, and drilling mud sacks.

16. A snow melter system shall be present with each mobile camp to provide potable water at dry camp sites. In addition, a tank or tanks capable of storing 1,000 gallons of potable water for camp use shall be a part of each camp's equipment, together with necessary hoses, fittings, and water pump.

17. Waste water shall receive treatment conforming to federal requirements for secondary treatment if Arctic-tested package treatment facilities are used. If chemical recirculating sewage facilities are employed, they shall be kept separate from the gray wash and kitchen waste water. The chemical effluent may be drained into a shot hole that has vented or into a land-drilled hole. The liquid level should not be less than five feet from the surface of the ground and, after freezing, shall be filled with cuttings or other clean fill to the surface. Gray wash water and kitchen waste water may be filtered to remove the solids and the liquid discharged to the land surface. All solids and sludges shall be incinerated.

18. The contractor shall protect all survey monuments, witness corners, and reference monuments against destruction, obliteration, or damage. He shall, at his expense, reestablish damaged, destroyed, or obliterated monuments and corners in their original exact position. A record of the reestablishment shall be submitted to the Officer in Charge, NPR-4.

19. The Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C.431-433) prohibits the appropriation, excavation, injury, or destruction of any historic or prehistoric ruin or monument, or any other object of antiquity situated on lands owned or controlled by the United States. No historic site, archaeological site, or camp, either active or abandoned, shall be disturbed in any manner nor shall any item be removed therefrom. Should such sites be discovered during the course of field operations, the Officer in Charge, NPR-4, will be promptly notified.

20. The contractor shall report the location and depths and enter on the appropriate seismic log any occurrences of water found in seismic drill holes. Samples will be tested for brine content and, when feasible, a small sample will be taken for delivery to the Officer in Charge, NPR-4.

21. The foregoing provisions do not relieve the contractor or his subcontractors of any responsibilities or provisions required by any applicable laws or regulations.

22. A copy of these stipulations shall be posted in a conspicuous place in each camp site established for the purpose of geophysical exploration within NPR-4.

APPENDIX II

STIPULATIONS CONCERNING WINTER ROAD AND TRAIL CONSTRUCTION AND USE WITHIN THE NATIONAL PETROLEUM RESERVE IN ALASKA

The conditions listed below are those which contractors or subcontractors, at any tier, will be required to follow in order to minimize damage to the surface of the land, to the surface waters, and to the fish and wildlife on the National Petroleum Reserve in Alaska (NPRA).

1. Winter road or trail construction and use, involving heavy equipment are to begin only after the seasonal frost in the tundra and in the underlying mineral soils over the route has reached a depth of 12 inches; the average snow cover a thickness of 6 inches. Normally this condition will not prevail until about October 15, occasionally not until November 1. These requirements may be modified by the Chief of Operations, ONPRA, for the use of light weight equipment specialized for use in tundra environments. Such modification, for specific uses, shall be in writing with a copy provided to the contractor or subcontractor and to the Bureau of Land Management.

2. Winter road or trail use, involving heavy equipment, will cease when the daytime spring melt of snow begins; approximately May 5 in the foothill areas exceeding 300 feet in elevation; approximately May 15 in the northern coastal areas.

3. No bulldozing of tundra areas for roads or trails will be allowed. This prohibition against the bulldozing of tundra areas includes the organic ridges outlining low-centered polygonal areas. This stipulation, however, does not prohibit the clearing of drifted snow along a trail or road nor in a camp, to the extent that the tundra mat is not disturbed. Also, it does not prohibit the clearing of snow on a lake or on a river ice surface, or on an unvegetated gravel bar or beach, in order to prepare an aircraft runway.

4. Camps used for road construction will be situated on gravel bars, sand or other durable lands. Where leveling for trailers or modules is required and the surface has a vegetative mat, leveling will be accomplished with blocking rather than by leveling with a bulldozer.

5. Camps may be located on pond or lake ice which is determined to be frozen to the bottom provided that no sewage effluent, filtered waste water, toxic or hazardous materials, petroleum products or solid wastes are allowed to be dumped onto the ice. Such locations will be specifically approved in writing by the Chief of Operations, ONPRA, with a copy of the approval provided to the contractor or subcontractor and to the Bureau of Land Management.

6. Exploration activities will employ low ground pressure vehicles of the Rolligon, ARDCO, Trackmaster, Nodwell, Flextrac, or a similar type. The limited use of tractors, equipped with wide snow tracks, will be allowed for the plowing of snow or to pull heavy camp equipment and drilling rigs. Blades may be used to plow unusually deep snow, but,

when used, must be kept sufficiently high so that they do not "clip" the tops of tussocks or polygonal ridges. Blade "shoes" or similar elevation-guide type blade attachments are not required. Experience has shown that such "guides" concentrate pressures on the tundra and tend to "clip" off tussock tops, especially in the drier tundra-type areas. Any exceptions to this stipulation, which could result in damage to the tundra, will require the written approval of the Chief of Operations, ONPRA. Should true "ice" roads be used, their construction shall be sufficiently substantial, for the specific use intended, that there is no breaking through the ice, by wheel or track, to the underlying tundra surface.

7. All operations shall be conducted with due regard for good resource management and in such a manner so as to not block any stream, or drainage system, or change the character or course of a stream, or cause the pollution or siltation of any stream or lake.

8. Crossing of waterway courses shall be made using a low angle approach in order not to disrupt the naturally occurring stream or lake banks. There will be no bulldozing of stream or lake banks.

9. All operations shall be conducted in such a manner as to not cause damage or disturbance to any fish or wildlife resource. This includes, but is not limited to the following:

a. No vehicle operations within one-half mile of any denning barren ground grizzly (in the upland area) or of any denning polar bear (near the sea coast or in the lower reaches of major rivers or estuaries).

b. No chasing by vehicles or buzzing by aircraft of any wildlife. Particular attention will be given to not disturbing caribou. In this regard, it is assumed, and experience has shown, that small groups of caribou, which habitually hang around airstrips and airstrip approaches, are not unduly disturbed by normal aircraft operation.

c. There will be no feeding of wildlife. Camps will be so managed that no garbage is left uncovered while waiting incineration.

10. No hunting will be allowed within a radius of five miles from a mobile construction camp, fuel cache, drilling operation, or from a road or trail under construction or use.

11. All oil spills will be reported to the Chief of Operations, ONPRA, at the time of the first solid radio contact or other communication occurring after the oil spill incident. The Chief of Operations, ONPRA, will inform the respective agencies having cognizant jurisdiction in such matters. Additional fuel handling requirements are:

a. All fuel spills will be cleaned up immediately, taking precedence over all other matters, except the health and safety of personnel.

b. Oil spills will be incinerated in approved receptacles but not on lake or river ice.

c. Although fuels may be off-loaded from aircraft on the ice, there will be no storage of fuels on lake or river ice, even on a temporary basis.

12. All fuel containers used, including drums, shall be marked with the contractor's name and date, i.e., 1977 or 1978.

13. All combustible solid waste, including cartons, dunnage, drilling mud sacks, if any, and used lubricating oils, will be incinerated or returned to the base of operations for approved disposal. All noncombustible solid waste, including fuel drums, will be returned to the base of operations for approved disposal. An exception would be incinerated ash which may be deposited as part of a drilling pad or gravel road. There will be no burial of garbage or the dozing up of any area for the burial of any matter of thing.

14. Waste water from any mobile camp used during road construction will receive treatment conforming to federal requirements for secondary treatment if Arctic-tested package treatment facilities are used. If chemical recirculating sewage facilities are employed, they will be kept separate from the gray wash and kitchen waste water. The chemical effluent will be carried until an approved waste disposal facility is reached. Gray wash water and kitchen waste water will be filtered to remove the solids and grease after which the liquid may be discharged to the land surface. All solids and sludges will be incinerated.

15. The contractor will protect all survey monuments, witness corners and reference monuments against destruction, obliteration or damage. He will, at his expense, re-establish damaged, destroyed, or obliterated monuments and corners in their original exact position. A record of the reestablishment will be submitted to the Chief of Operations, ONPRA, who in turn will inform the respective agencies having cognizant jurisdiction.

16. The Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C. 431-433), prohibits the appropriation, excavation, injury, or destruction of any historic or prehistoric ruin or monument, or any other object of antiquity, situated on lands owned or controlled by the United States. No historic site, archaeological site, or camp, either active or abandoned, shall be disturbed in any manner nor shall any item be removed therefrom. Should such sites be discovered during the course of field operations, the Chief of Operations, ONPRA, will be promptly notified. The Chief of Operations, ONPRA, in turn will promptly notify the BLM of such discovery.

17. Should gravel borrow be required for the construction of a winter road or trail, or for any portion thereof, a plan for both the borrow of the gravel and for the subsequent rehabilitation of the borrow area, with a time schedule for the rehabilitation, shall be submitted to the Chief of Operations, ONPRA.

18. The foregoing provisions do not relieve the contractor or his subcontractors of any responsibilities or provisions required by any applicable laws or regulations.

19. A copy of these stipulations shall be posted in a conspicuous place in any mobile site established for the purpose of winter road construction and at all base camps within the National Petroleum Reserve in Alaska.

October 28, 1977