An Overview of Available Research Results Related to Lakes Located within the Arctic Coastal Plain and North Slope Foothills Region, 2009

Ribdon River (Photo by J. Gallagher)

by

Kristie Holland, Michael Lilly, William Schnabel,

Horacio Toniolo, and Peter Prokein

January 2010

Bullen Point/Kuparuk Foothills Hydrology Projects

Report No. INE/WERC 09.04

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A report on research sponsored by the

Alaska Department of Transportation and Public Facilities

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Recommended Citation:

Holland, K.M., Lilly, M.R., Schnabel, W., Toniolo, H., and Prokein, P., 2010. An Overview of Available Research Results Related to Lakes Located within the Arctic Coastal Plain and North Slope Foothills Region, 2009. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 09-04, Fairbanks, Alaska, 27 pp.

Fairbanks, Alaska
January 2010

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DISCLAIMER

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CONVERSION FACTORS, UNITS, WATER-QUALITY UNITS, VERTICAL AND HORIZONTAL DATUM, ABBREVIATIONS AND SYMBOLS

Conversion Factors

Multiply	By	To obtain
	Length	
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	43560.0	square feet (ft^2)
acre	0.405	hectare (ha)
square foot (ft^2)	3.587e-8	square mile (mi^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	3785.412	milliliter (mL)
cubic foot (ft^3)	28.317	liter (L)
acre-ft	1233.482	cubic meter (m^3)
acre-ft	325851.43	gallon(gal)
gallon(gal)	0.1337	cubic feet (ft^3)
	Velocity and Discharge	
foot per day (ft/d)	0.3048	meter per day (m/d)
square foot per day (ft^2/d)	0.0929	square meter per day (m^2/d)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/sec)
	Hydraulic Conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per day (ft/d)	0.00035	centimeter per second (cm/sec)
meter per day (m/d)	0.00116	centimeter per second (cm/sec)
	Hydraulic Gradient	
foot per foot (ft/ft)	5280	foot per mile (ft/mi)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Pressure	
pound per square inch (lb/in^2)	6.895	kilopascal (kPa)

Units

In this report, both English and metric (SI) units have been employed. The choice of primary units employed depended on common reporting standards for a particular property or parameter measured. Whenever possible, the approximate value in the secondary units was also provided in parentheses. Thus, for instance, streamflow was reported in cubic feet per second (cfs), followed by the value in cubic meters per second (m^3/s) in parentheses.

Physical and Chemical Water-Quality Units

Temperature:

Water and air temperature are given in degrees Celsius (°C) and in degrees Fahrenheit (°F). Degrees Celsius can be converted to degrees Fahrenheit by use of the following equation:

$$°F = 1.8(°C) + 32$$

Electrical Conductance (Actual Conductivity and Specific Conductance):

In this report, conductivity of water is expressed as Actual Conductivity (AC) in microSiemens per centimeter (µS/cm). This unit is equivalent to micromhos per centimeter. Elsewhere, conductivity is commonly expressed as Specific Conductance at 25°C (SC25) in µS/cm, which is temperature corrected. To convert AC to SC25 the following equation can be used:

Error! Bookmark not defined.

$$SC25 = \frac{AC}{1 + r(T - 25)}$$

where:

SC25 = specific conductance at 25°C, in µS/cm

AC = actual conductivity, in µS/cm

R = temperature correction coefficient for the sample, in °C

T = temperature of the sample, in °C

Milligrams per liter (mg/L) or micrograms per liter (μg/L):

Milligrams per liter is a unit of measurement indicating the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million (ppm).

Millivolt (mV):

A unit of electromotive force equal to one thousandth of a volt.

Vertical and Horizontal Datum

Vertical Datum:

"Sea level" in the following report refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929), a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called *Sea Level Datum of 1929*.

Horizontal Datum:

The horizontal datum for all locations in this report is the North American Datum of 1983 or North American Datum of 1927.

Abbreviations, Acronyms, and Symbols

AC	actual conductivity
ADOT&PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing and Materials
BLM	Bureau of Land Management
C	Celsius
DO	dissolved oxygen
DVM	digital voltage multi-meter
F	Fahrenheit (°F).
ft	feet
GWS	Geo-Watersheds Scientific
GWSI	USGS Ground-Water Site Inventory
km^2	square kilometers
kPa	kilopascal
lb/in^2	pounds per square inch
m	meters
mg/L	milligrams per liter, equivalent to ppm
µg/L	micrograms per liter
mi^2	square miles
mm	millimeters
µS/cm	microSiemens per centimeter
mV	millivolt
NOAA	National Oceanic and Atmospheric Administration
NPR-A	National Petroleum Reserve-Alaska
NTU	nephelometric turbidity units
NWIS	National Water Information System
ORP	oxygen-reduction potential
ppm	parts per million, equivalent to mg/L
SC25	specific conductance at 25°C
SWE	snow water equivalent
QA	quality assurance
QC	quality control
UAF	University of Alaska Fairbanks
USACE	U.S. Army Corps of Engineers, Alaska District
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WERC	Water and Environmental Research Center
WWW	World Wide Web
YSI	Yellow Springs Instruments

ABSTRACT

The purpose of this report is to provide background information for research regarding lake processes on Alaska's Arctic Coastal Plain and North Slope Foothills regions. This report is designed to provide an inventory and summary of information available to the public, and to direct the reader to further information based upon the citations provided. Studies referenced in this report encompass a variety of fields of study, including remote sensing, soils analysis, long-term hydrologic monitoring, fisheries research, and water quality research. As many of these fields are interconnected, most of the reports cited contain information relevant to more than one of these fields of study.

ACKNOWLEDGMENTS

This project was funded by grants AND#2562122 and AND#2562123, Alaska Department of Transportation and Public Facilities. The Department of Natural Resources provided background data for lakes in the study area. Information was also provided by Kuparuk Watershed projects funded by the National Science Foundation. Field coordination was provided by BP Exploration (Alaska) Inc.

An Overview of Available Research Results Related to Lakes Located within the Arctic Coastal Plain and North Slope Foothills Region, 2009

BACKGROUND

Geographers have studied the properties and distribution of lakes since the early 1800s. More recently, this area of study has emerged as a research interest among physical and biological scientists focusing on spatial or temporal processes (Arp and Jones, 2008). Interest in lakes ranges from their importance as ecosystems, to the crucial role they play in industrial development. Since the 1968 discovery of oil in Prudhoe Bay, Alaska, there has been an increasing effort to study lakes and ascertain related potential environmental impacts of development on the North Slope (Truett, 2000). Among the numerous studies that have been completed are some that specifically relate to the area between the Arctic Coastal Plain and the Central North Slope Foothills. Although the present report emphasizes lake research in this geographic area, the references cited are applicable to a variety of fields outside water resources. The intent of this project was to review and report key references on lake research for the benefit of users across a variety of disciplines. With the increasing interest in further exploration and natural resources that will be utilized and/or affected by it, it is important to be familiar with related information in preparation for future projects. Having at hand a compilation of references, maps, and other sources of information should minimize the time that researchers spend searching for references and assist in a more thorough evaluation of essential areas.

OBJECTIVES

The main objective of this report was to research available information pertaining to studies of lakes between the Arctic Coastal Plain and the Central North Slope Foothills. As research efforts and industrial growth in this region continue, it is important to gather and utilize information that provides additional insights into regional patterns and variations. With cooperation from the Department of Natural Resources, as well as independent research, we have reviewed previous studies, maps, and literature about lakes in this region and have compiled the information into a

report. Although we made every effort to be comprehensive in our search and reporting, we do not claim that this collection is complete. The general intent of this project was to provide an overview of lake research in the Arctic Coastal Plain and Central North Slope Foothills region and to provide references as a starting point for continuing research.

INTRODUCTION

Alaska's diverse landscape provides research opportunities in numerous disciplines. By overlapping these disciplines, researchers gain additional insight. For example, one may learn more about ecosystem functions by observing spatial and temporal patterns in another field of study. Research in soil analysis, hydrology, and climate, in particular, can provide essential background information that can be utilized in lake studies.

Lakes are abundant and important ecosystems in Alaska, but are unevenly distributed, with expansive lake-poor regions and several lake-rich regions (Arp and Jones, 2008). The U.S. Geological Survey (USGS) has recently designated lake-rich areas as lake districts, with one of the largest and most-sampled districts identified as the Arctic Coastal Plain Lake District (Arp and Jones, 2008). Such lake districts are currently being used to better understand patterns among lakes within and between districts. The National Petroleum Reserve-Alaska (NPR-A), which is managed by the Bureau of Land Management, comprises most of the Arctic Coastal Plain Lake District, with the remainder of the district consisting of state and refuge land, as seen in Figure 1. Due to extensive sampling in this area, some general characteristics have been established for the Arctic Coastal Plain and are presented in Tables 1 and 2.

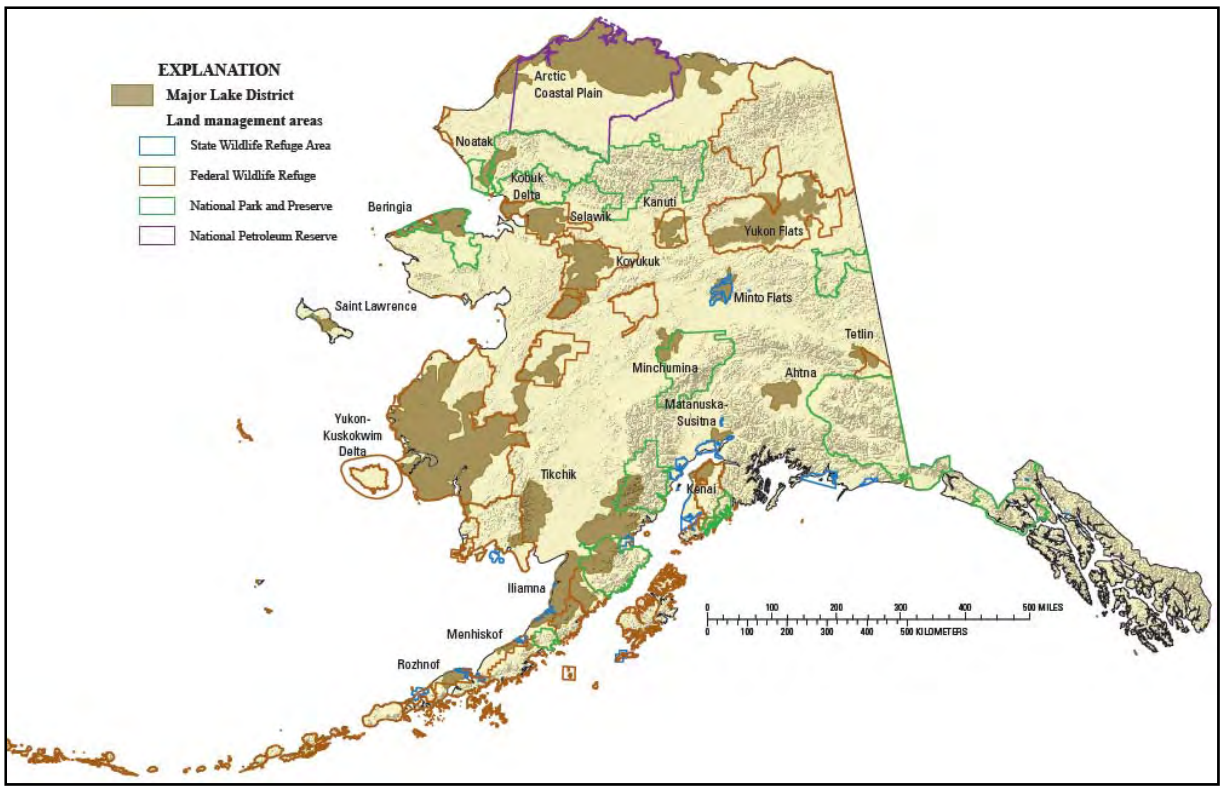

Figure 1. Land management areas and major lake districts of Alaska (Arp and Jones, 2008).

Table 1. Mean climatic conditions of the Arctic Coastal Plain Lake District (from Arp and Jones, 2008).

District	Precipitation (cm)				Mean temperature (°C)			
	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
Arctic Coastal Plain (ACP)	1	1	7	4	-26	-15	6	-9

Table 2. Structural and hydrographic characteristics of the Arctic Coastal Plain Lake District (from Arp and Jones, 2008).

District	Total area (km^2)	Mean land elevation (m)	Hypso-metric index	Lake area (km^2)	Mean lake elevation (m)	Limnetic ratio (percent)	Large lake limnetic ratio (percent)	Lake density (d_L)	Small lake density (d_L)	Shoreline density (km)	Drainage area (km^2)	External contributing area ratio
Arctic Coastal Plain (ACP)	55,964	28	0.11	9,545	–	17.1	3.0	898,951	54	0.04	111,837	2.0

APPLICATION OF IMAGERY

Several researchers have been utilizing various imagery systems to evaluate areas of interest in available water resources. Image comparisons can assist researchers with locating available water and the subsequent selection of study sites. To locate potential water sources, Duguay and others (Duguay et al., 2004) described an approach based on the use of synthetic aperture radar (SAR) imagery to identify unfrozen water bodies. Although their focus was on identifying potential overwintering habitat for anadromous fish in low-gradient areas of the Arctic Coastal Plain (Figure 2), this method has applications in a variety of areas. Using color coding as indicators, free-floating ice is easily recognizable (Figure 3). The detail provided by SAR imagery could help to locate deep lakes for potential use as long-term water resources, and could help developmental planning groups to eliminate potential complications associated with projects located near essential habitat.

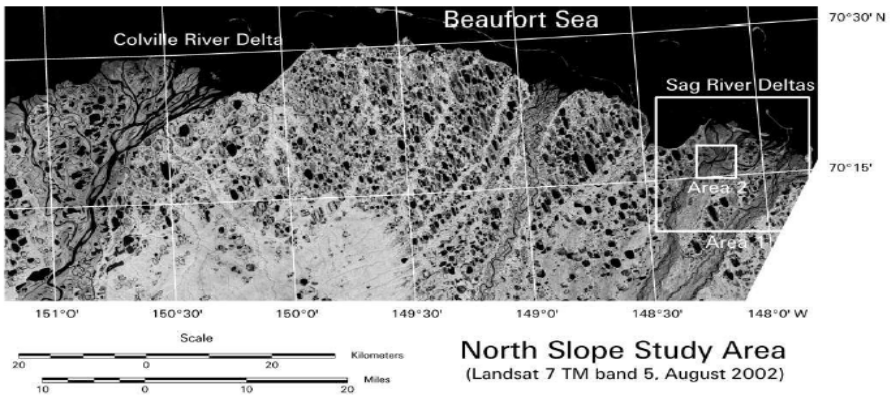

Figure 2. Study location for Duguay et al., 2004.

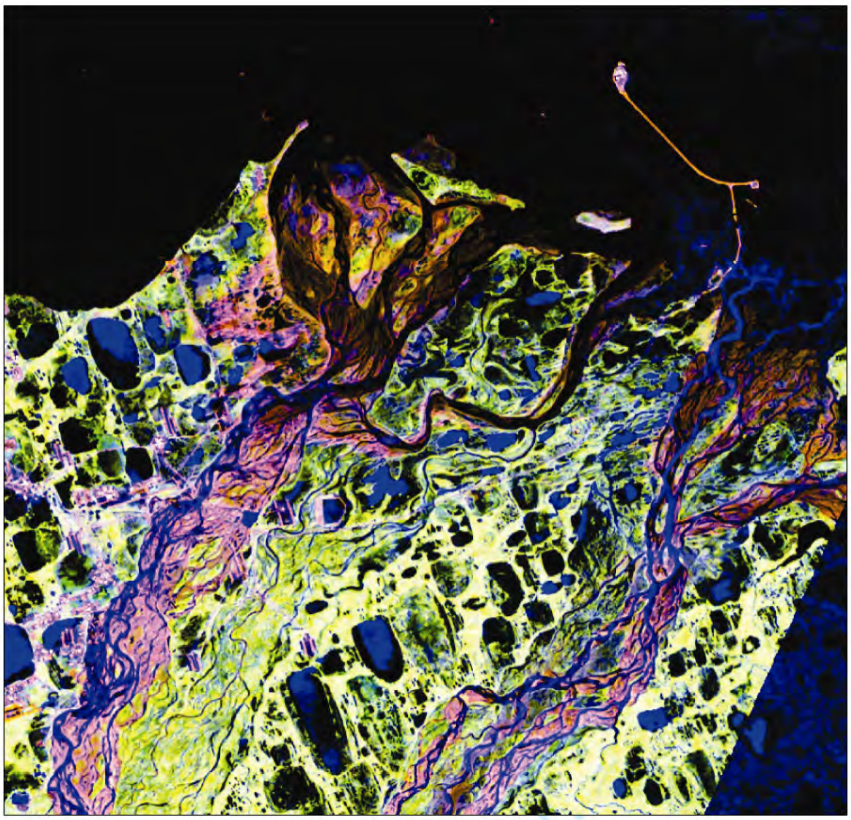

Figure 3. Color imagery of the Sagavanirktok River (original reference Duguay et al., 2004).
(The medium-blue tones in the lakes/ponds and rivers indicate areas where the ice cover is afloat.)

In 2006, this same theory was applied by the University of Alaska Fairbanks (UAF) to identify lakes with unfrozen water beneath the ice that could serve as potential water sources in late winter. Researchers used a comparison of Landsat images with SAR images to determine suitable sampling locations, as illustrated in Figure 4. The Landsat images (left, color) show the locations of sampling sites. The SAR images (right, grayscale) are from January or February of low-snow years (a, c: January 22, 1999; b: January 26, 1994; d: February 24, 1999). Dark areas on the SAR image during this stage of winter indicate grounded ice. Bright or white areas indicate liquid water under ice at the time of the image (White et al., 2006). Utilizing this information, researchers selected study lakes that did not completely freeze to the bottom by the end of winter and made subsequent visits to these sites in the following years. Table 3 outlines the locations and year of sampling during this project through 2008 (see appendices for additional information).

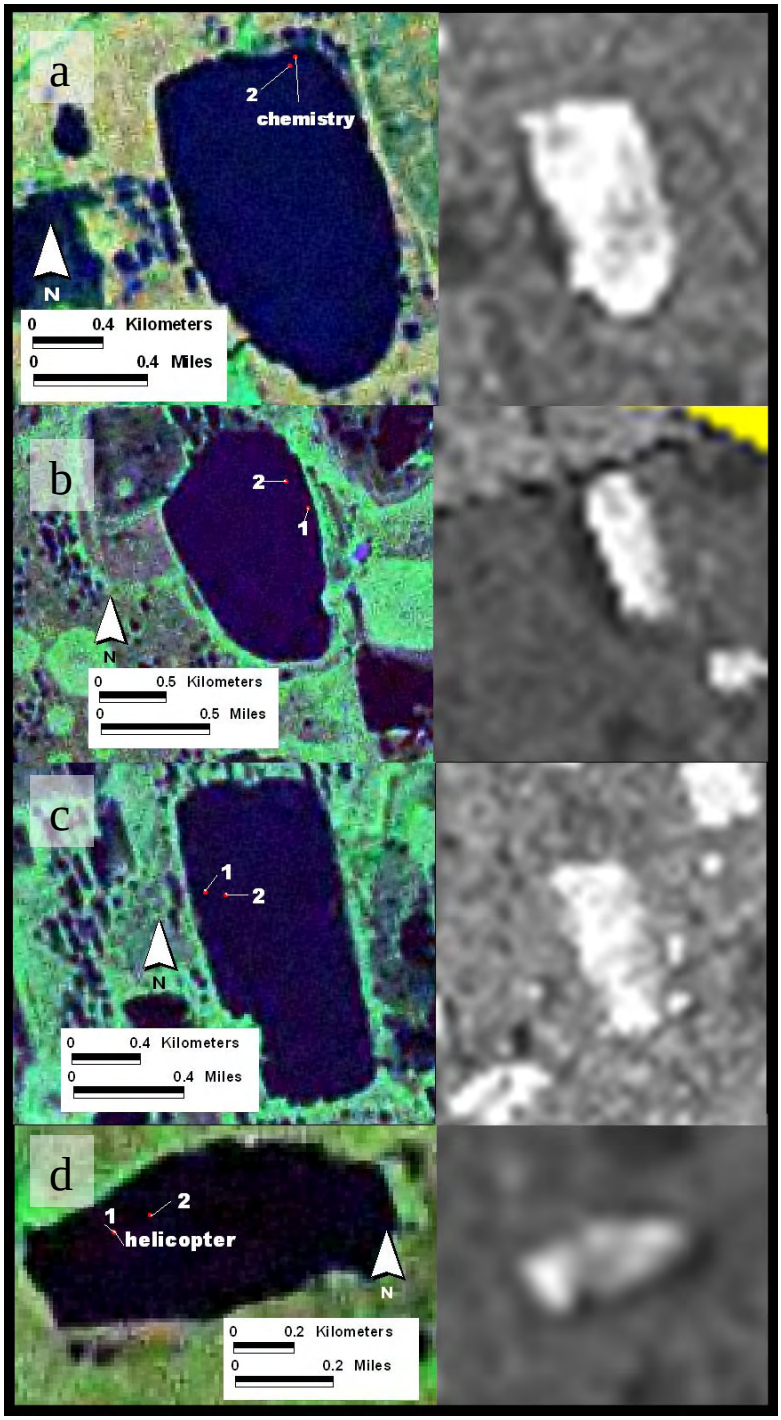

Figure 4. Satellite imagery of lakes: (a) W0609, (b) W0610, (c) W0611, and (d) W0612.

Table 3. Lakes sampled by UAF–WERC and the year in which they were visited (Compiled from INE/WERC report numbers: 06-02, 06-05, 07.14, 07.15, 08.04, 08.05 in reference list).

Project Lake ID	North Latitude (NAD83)	West Longitude (NAD83)	Year Site Visited
WO602	70.165	147.399	2006
WO603	70.143	148.07	2006
WO605	69.769	149.487	2006
WO606	69.747	149.229	2006
WO607	69.657	148.871	2006
WO608	70.155	148.478	2006
WO609	70.214	148.177	2006
WO610	70.082	147.78	2006
WO611	70.144	147.46	2006
WO612	70.014	146.899	2006
WO613	69.617	148.825	2006
WO701	69.844	149.7242	2007
WO702	69.703	149.811	2007, 2008
WO703	69.675	149.525	2007
WO704	69.768	149.413	2007
WO705	69.7483	149.252	2007, 2008
WO706	69.967	147.59	2007
WO707	70.0186	147.194	2007
WO708	70.162	147.419	2007
WO709	70.119	146.241	2007
WO710	70.086	148.184	2007
WO801	69.55	150.387	2008
WO802	69.553	150.345	2008
WO807	70.081	147.933	2008

Although lake studies based upon remote sensing techniques have broadened our understanding of remote lakes, corresponding field studies are still necessary to verify the results (Arp and Jones, 2008).

APPLICATION OF SOIL ANALYSIS

In 1988, L.D. Carter released a paper describing the sedimentary composition of the Alaska North Slope. Specifically, the author described the large discontinuous silt belt that stretches 5 to 70 km across northern Alaska (Figure 5). The silt at this location was originally interpreted to be

of fluvial-marine origin, but it was later determined that some of it was deposited by eolian processes. Because ground ice in this area formed as the loess accumulated, ice content does not decrease with depth as is expected in sediments that primarily contain epigenetic ice. Thus, there are thermokarst basins as deep as 20 m in the region, whereas outside of the loess area, thermokarst basins are typically only a few meters deep. The silt belt, which has been called "foothills silt" and, later, "upland silt" by a number of authors, stretches along the northern edge of the foothills region, extends up valleys into the foothills, and occupies lowlands within them (Figure 6). As ice-rich loess and silt belt soils are considered especially sensitive to anthropogenic disturbances, these areas require further study prior to extensive oil and gas exloration (Carter, 1988).

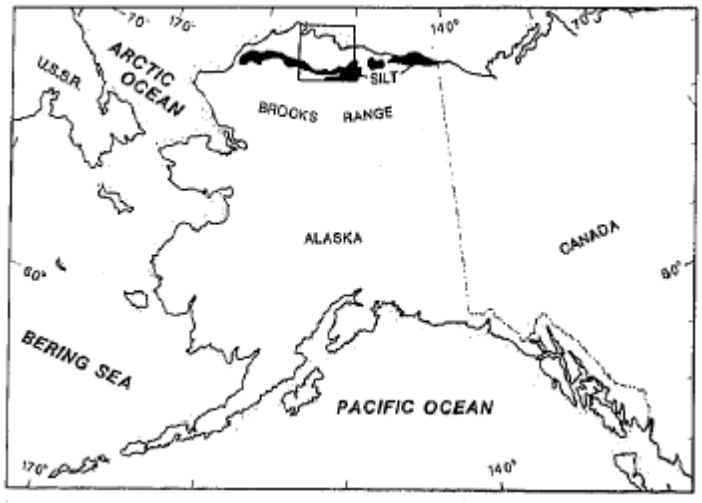

Figure 5. Distribution of thick silt deposits north of the Brooks Range (Carter, 1988).

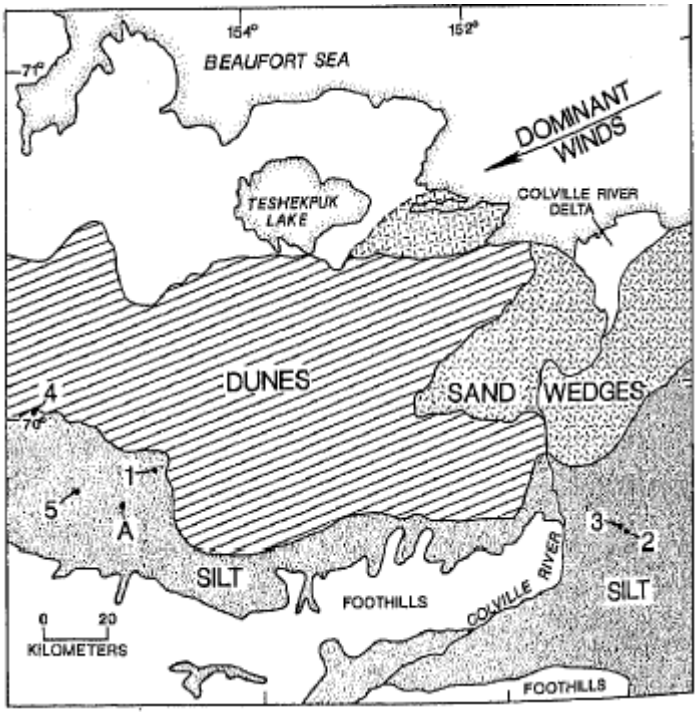

Figure 6. Distribution of silt, dunes, and sand wedges (Carter, 1988).

At Arizona State University, Jon Pelletier has been working to understand the orientation of lakes on the North Slope and what that information reveals about the area. Using his thaw-slumping model, Pelletier predicted that taller banks form in coarse-grained sediment and result in narrow, deep lakes due to minor sediment infilling (Pelletier, 2005). He also predicted that shorter banks form in fine-grained sediment, resulting in wide, shallow lakes due to sufficient sediment infilling. These results suggest that deeper lakes form in coarse-grained eolian deposits, whereas shallow lakes form in fine-grained fluvial deposits (Figure 7). By determining the sediment composition of an area and utilizing Pelletier's thaw-slumping model, researchers may be able to better predict suitable areas for water extraction in oilfield development areas.

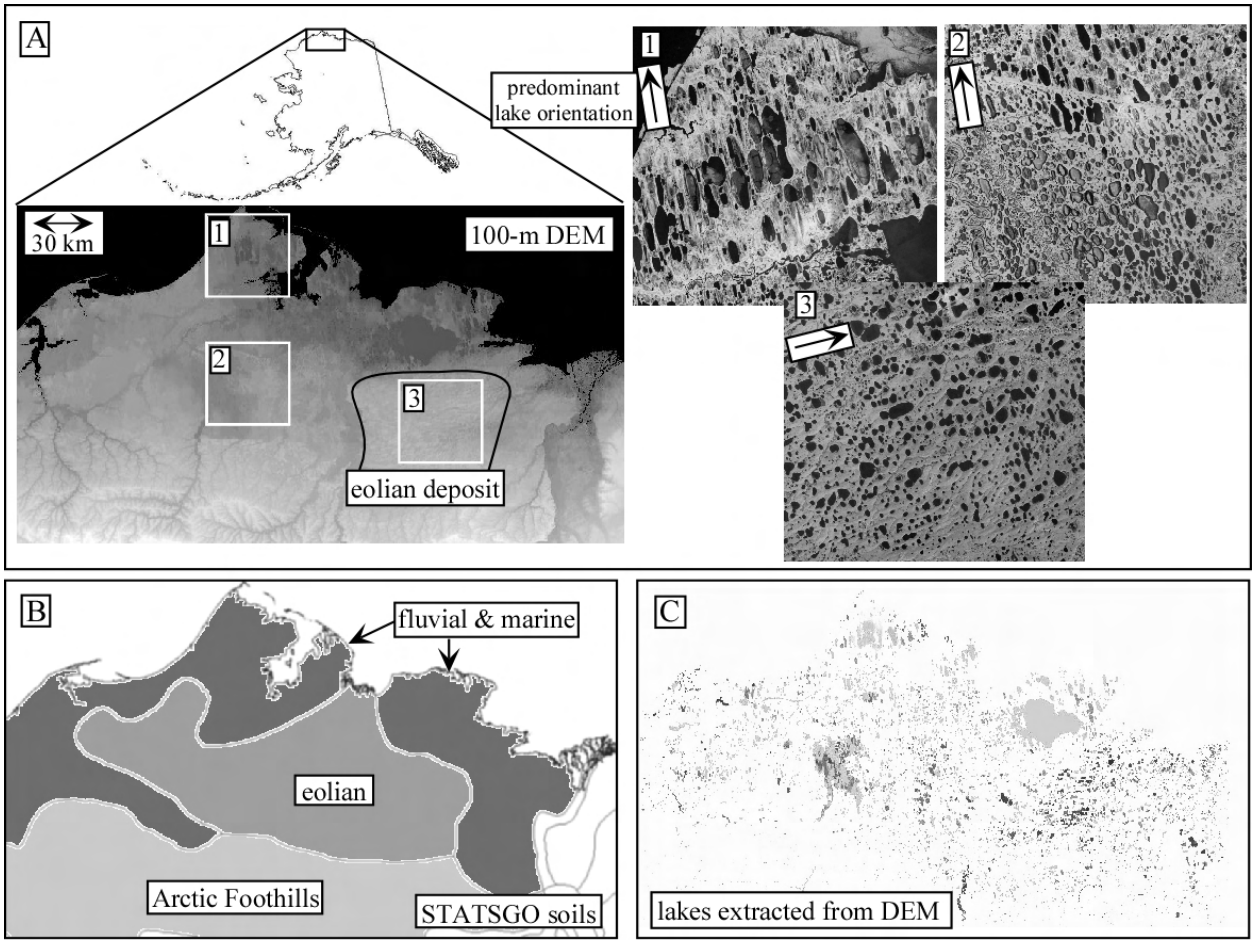

Figure 7. Figures from Jon Pelletier's thaw-slumping model (http://geomorphology.geo.arizona.edu).

LONG-TERM MONITORING

With the growing research interest in Alaska, a series of monitoring stations and long-term sampling sites have been established throughout the state. Stations may collect data on a number of parameters including those related to water quality, hydrology, and climate. Figure 8 shows the distribution of USGS and National Oceanic and Atmospheric Administration (NOAA) stations around the state, as well as U.S. Fish and Wildlife Service (USFWS) survey transects. Figures 9 and 10 show the UAF–WERC data stations (through 2008) and water-quality and/or snow-survey locations that are specifically in the Bullen and Foothills regions.

With the current number of stations and the large volume of data they provide, there is new information available on a daily basis. However, data is generally focused and applied in specific research areas, and data access may be limited to only those involved in the research effort. Websites that supply nearly real-time data and/or databases that store and archive this information would provide the efficiency needed to utilize the increasing wealth of available information. Some research groups already provide online access to their data. Real-time and/or archived information from data stations specifically in the Bullen and Foothills areas are available on the GWS website (www.gwscientific.com), the UAF website (http://www.uaf.edu/water/projects/nsm/introduction.html), and the USGS National Water Information System website (http://waterdata.usgs.gov/ak/nwis/current/?type=flow). Arp and Jones (2008) have also compiled tables of datasets that would be useful in a variety of projects. Modified versions of these tables are presented in Appendix A.

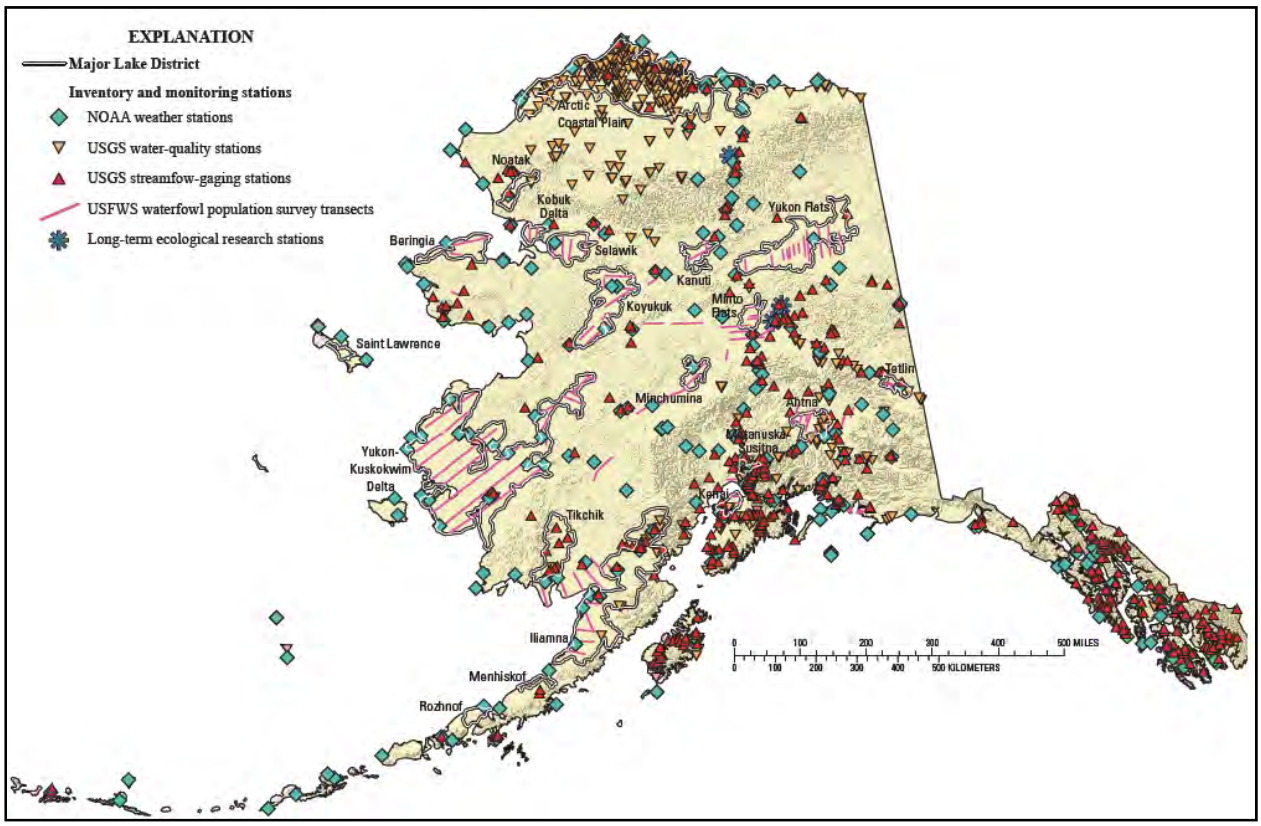

Figure 8. Selected federal monitoring stations in Alaska (Arp and Jones, 2008).

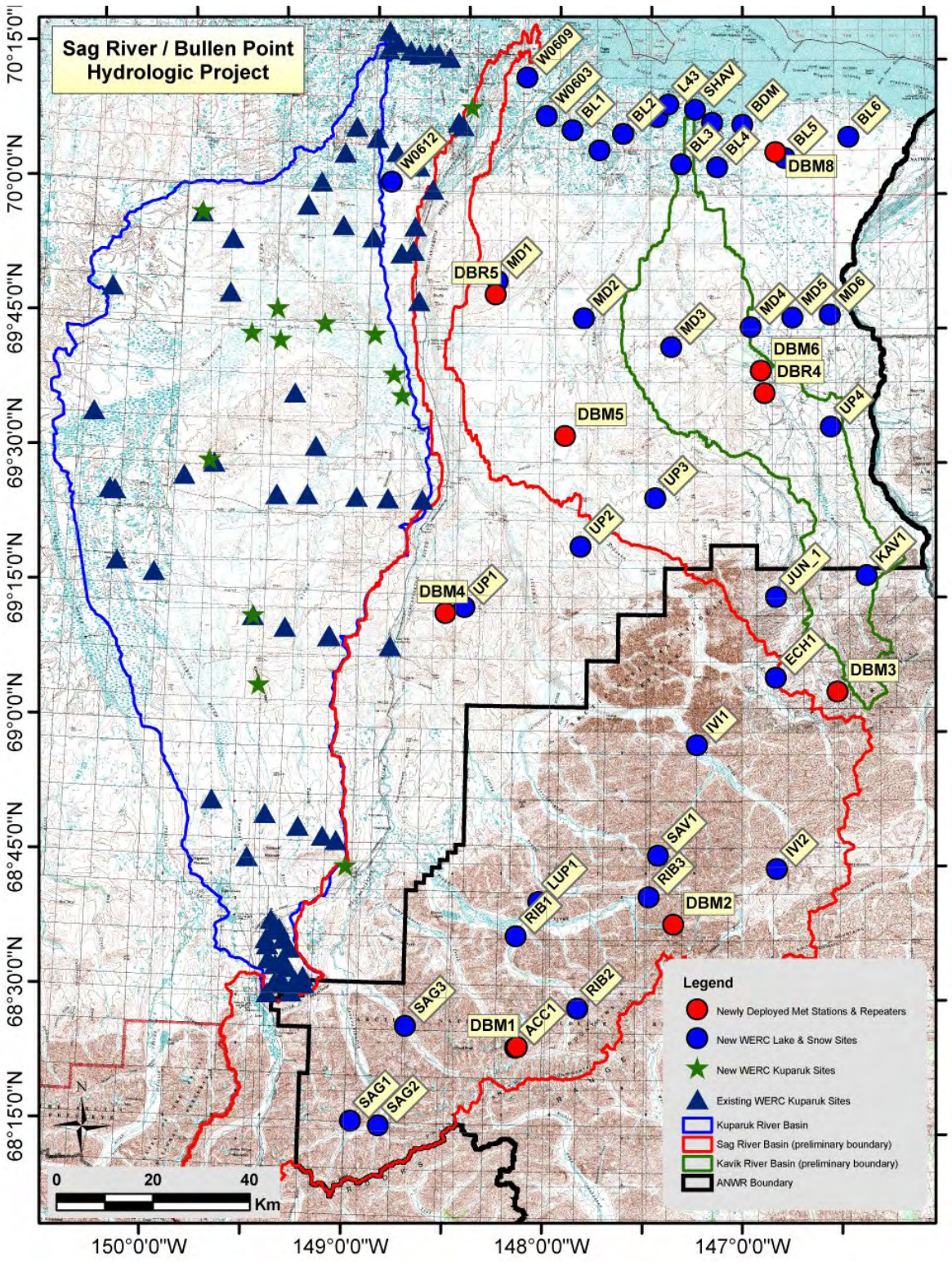

Figure 9. UAF-WERC study sites in the Sagavanirktok River/Bullen Point Region, North Slope, Alaska.

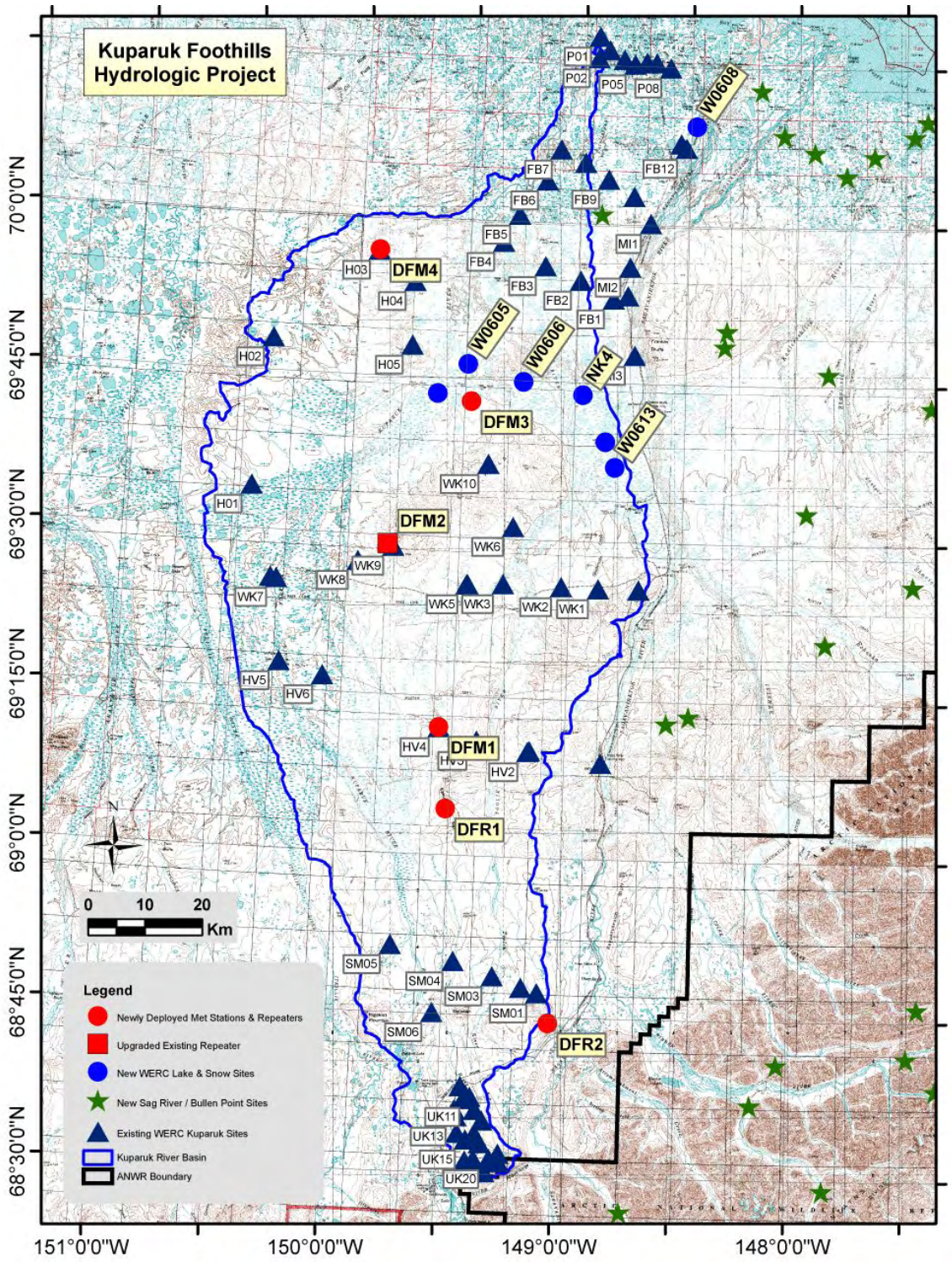

Figure 10. UAF-WERC study sites in the Kuparuk Foothills Region, North Slope, Alaska.

FISHERIES RESEARCH

Nearly all of the historical North Slope fisheries-related research has been related to oil and gas development projects (Hemming, 1996). Several studies have focused on fish location and identification in the larger rivers and streams; however, research on lake populations has not been as common. Using information obtained from rivers and streams can still be of great importance to those researchers interested in the fish that occupy lakes of interest. Populated lakes are not usually isolated ecosystems. A connection between a lake and any river or stream would allow for the direct movement of fish to the lake; and even without a connection, in times of flood, it is still possible for the fish from rivers and streams to be transferred into a lake. It is important, therefore, to understand the types of fish that are near or already included in the lake ecosystem to minimize the impact of further development.

In 1995, the Alaska Department of Fish and Game (ADF&G) conducted a survey to identify the fish use of six coastal streams in the proposed Badami development area. Fish sampling occurred at East Badami Creek, No Name River, Shaviovik River, West Shaviovik Creek, Kadleroshilik River, and East Sag River (Figure 11). Five different fish species of varying life histories were captured and identified, providing evidence of a wide range of fish usage. The freshwater fish included Arctic grayling (*Thymallus arcticus*) and round whitefish (*Prosopium cylindraceum*); the anadromous fish consisted of Dolly varden (*Salvelinus malma*) and ninespine stickleback (*Pungitius pungitius*); and the only marine species captured was fourhorn sculpin (*Myoxocephalus quadricornis*) (Table 4).

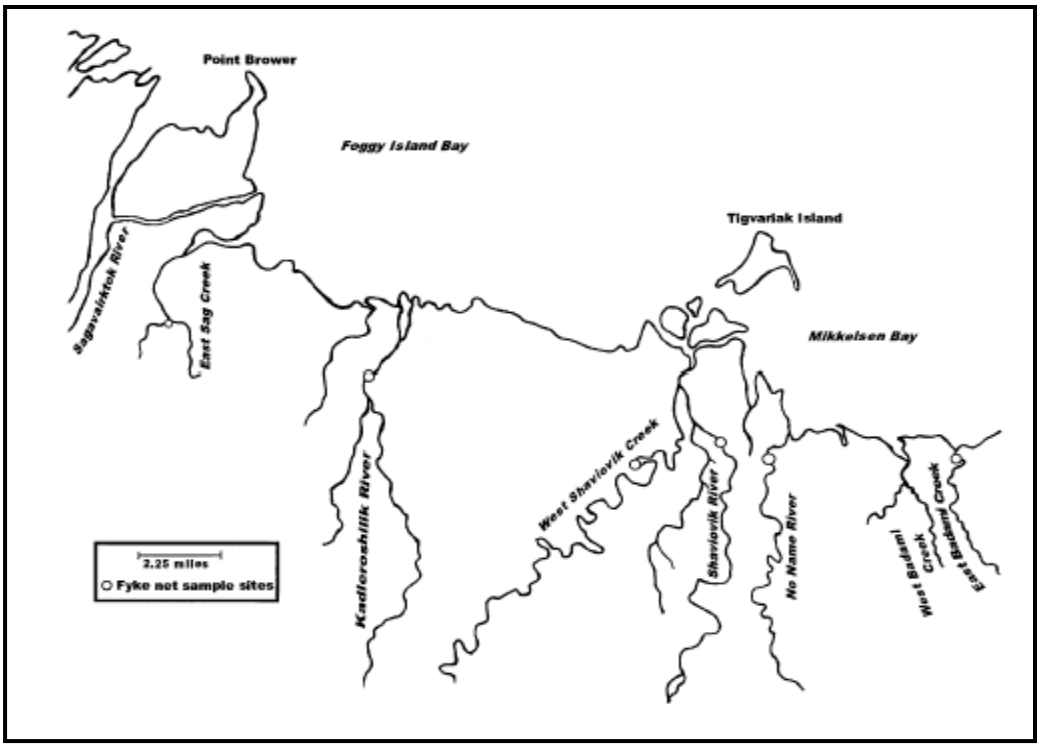

Figure 11. Location of 1995 ADF&G Fish Surveys (Hemming, 1996).

Table 4. Summarized fish sampling results of local rivers and creeks (from Ward and Craig, 1974, and Hemming, 1996).

River/Creek Name	North Latitude (NAD83)	West Longitude (NAD83)	Fish Species Present
East Badami Creek	70.1459	146.9912	NS, DV, FS
No Name River	70.1451	147.2098	NS, DV, AG, RW
Shaviovik River	70.1520	147.2684	NS, DV, AG
West Shaviovik Creek	70.1413	147.3577	NS, DV, AG
Kadleroshilik River	70.1747	147.6537	NS, DV, AG
East Sag Creek	70.1912	147.8791	NS, DV, AG
Juniper Creek- Tributary of Shaviovik River	69.6583	147.7458	AG
Unnamed Tributary of Shaviovik River	70.0750	147.5166	NS, AC

NS= Ninespine Stickleback, DV= Dolly Varden, AG= Arctic Grayling, AC= Arctic Char
Referenced from Ward and Craig, 1974 and Hemming, 1996

Streams that would be crossed by the proposed road linking Bullen Point and the Staines River were surveyed by Winters and Morris during the summers of 2002 and 2003. In these streams,

the authors observed Dolly varden, Arctic grayling, and ninespine stickleback. The streams were determined to be potentially valuable rearing grounds for Dolly varden and Arctic grayling (Brown et al., 2005). The study also examined the Sagavanirktok River, as the proposed road would cross it in two locations as well as crossing several tributaries. In the Sagavanirktok River, Arctic grayling, round whitefish, humpback whitefish, broad whitefish, burbot, slimy sculpin, and other fish species have been found during the spring and summer (Brown et al., 2005). Although the Sagavanirktok River has been studied for the past 30 years, little research has been conducted on the available overwintering habitat for fish near the proposed road crossings. It is important, therefore, to identify and research any lakes that could serve as suitable habitat for overwintering fish.

In the 2007 ASRC report to Chevron, a number of lakes were identified and sampled for fish populations. Table 5 outlines the fish species that were recorded on these visits. Please see the appendices for other sites that were visited but had no observable fish presence.

Table 5. Summarized lake information from ASRC 2007 report to Chevron.

Project Lake ID	North Latitude (NAD83)	West Longitude (NAD83)	Fish Species Present
W11	69.705	149.206	NS
W5	69.691	149.194	NS
W12	69.720	149.451	NS
W8	69.717	149.754	NS
W17	69.702	149.809	NS
W18	69.701	149.862	AG
W19	69.589	150.022	NS
W56	69.551	150.023	NS
W52	69.804	149.586	NS, AG
W2	69.840	149.722	NS

NS= Ninespine Stickleback, AG= Arctic Grayling
Referenced from ASRC, 2007

Figures 12 and 13 were created for this report to identify the sites that had sampling information for fish. Additional information about these sites can be found in the appendices.

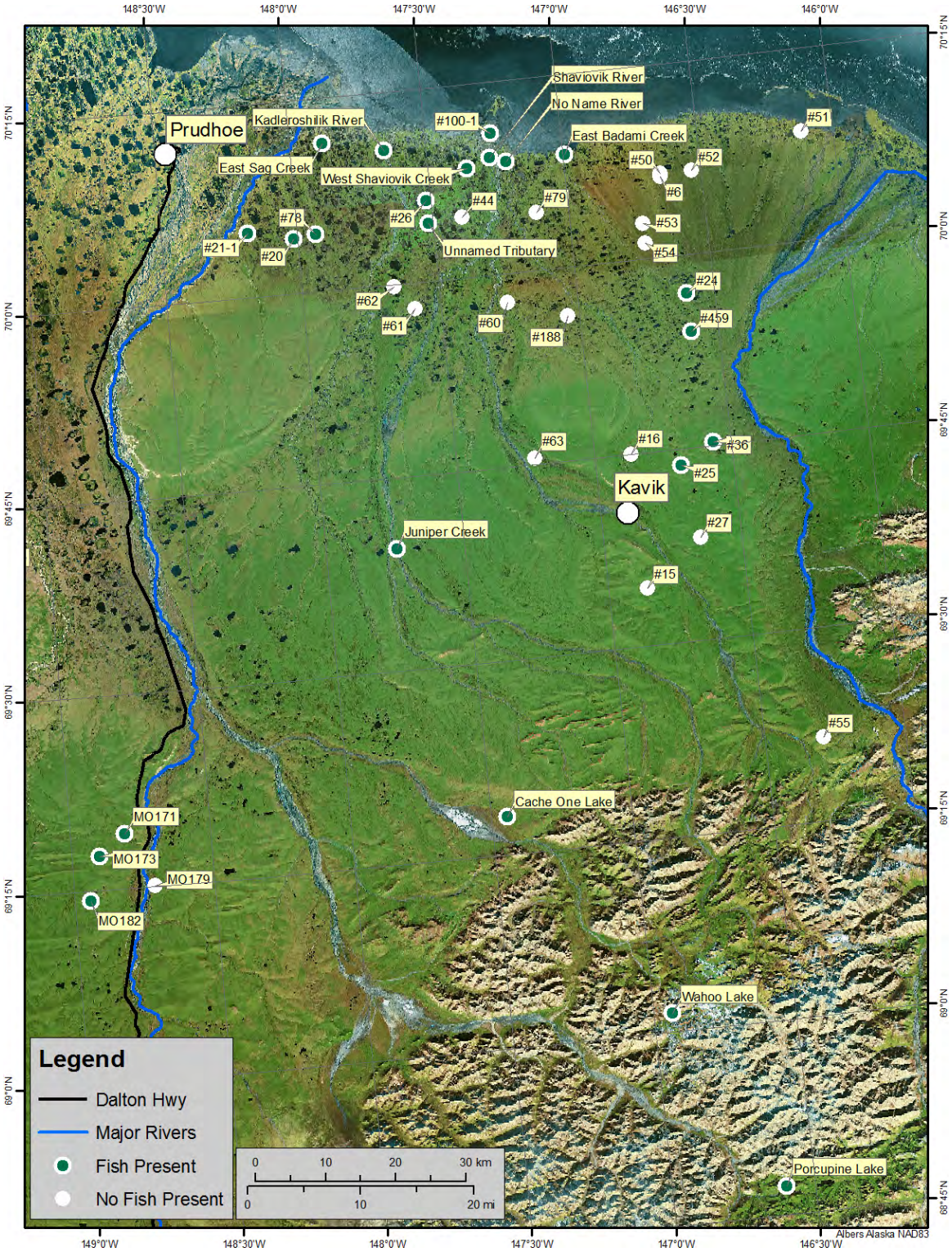

Figure 12. Locations within the Bullen Point area that have been sampled for fish.

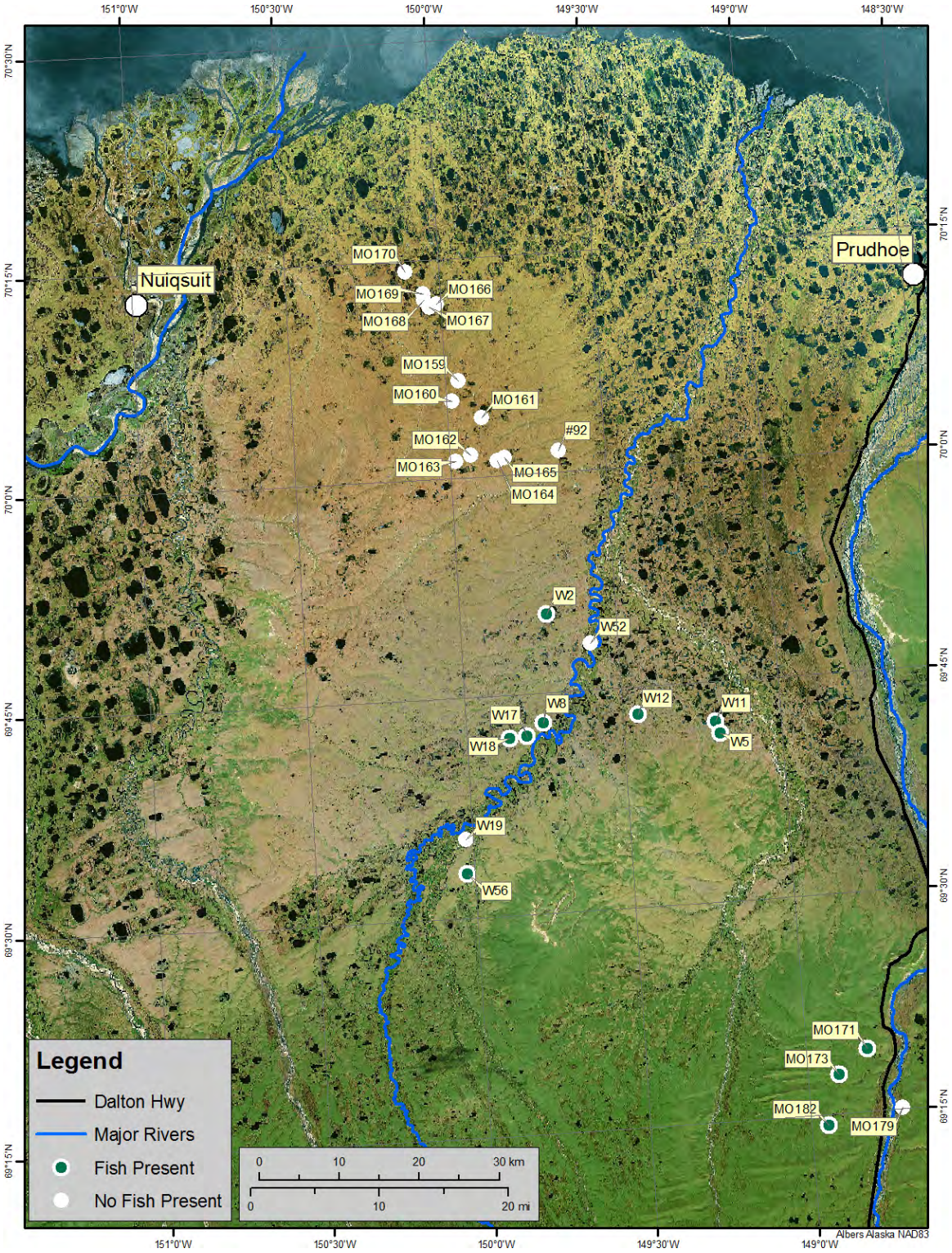

Figure 13. Locations within the Foothills area that have been sampled for fish.

WATER-QUALITY RESEARCH

USGS and other researchers have concentrated their efforts at water-quality sampling of lakes in three areas including the USGS-identified Arctic Coastal Plain, Matanuska-Susitna, and Iliamna Lake Districts (Arp and Jones, 2008). Figure 14 shows these major lake districts, lakes, and some of the relative studies for these areas. See appendices for additional reference information. Figures 15 and 16 illustrate locations of lakes sampled for water quality within the Bullen and Foothills areas, while Figures 17 and 18 show locations with both water-quality and fish-sampling information available in these areas.

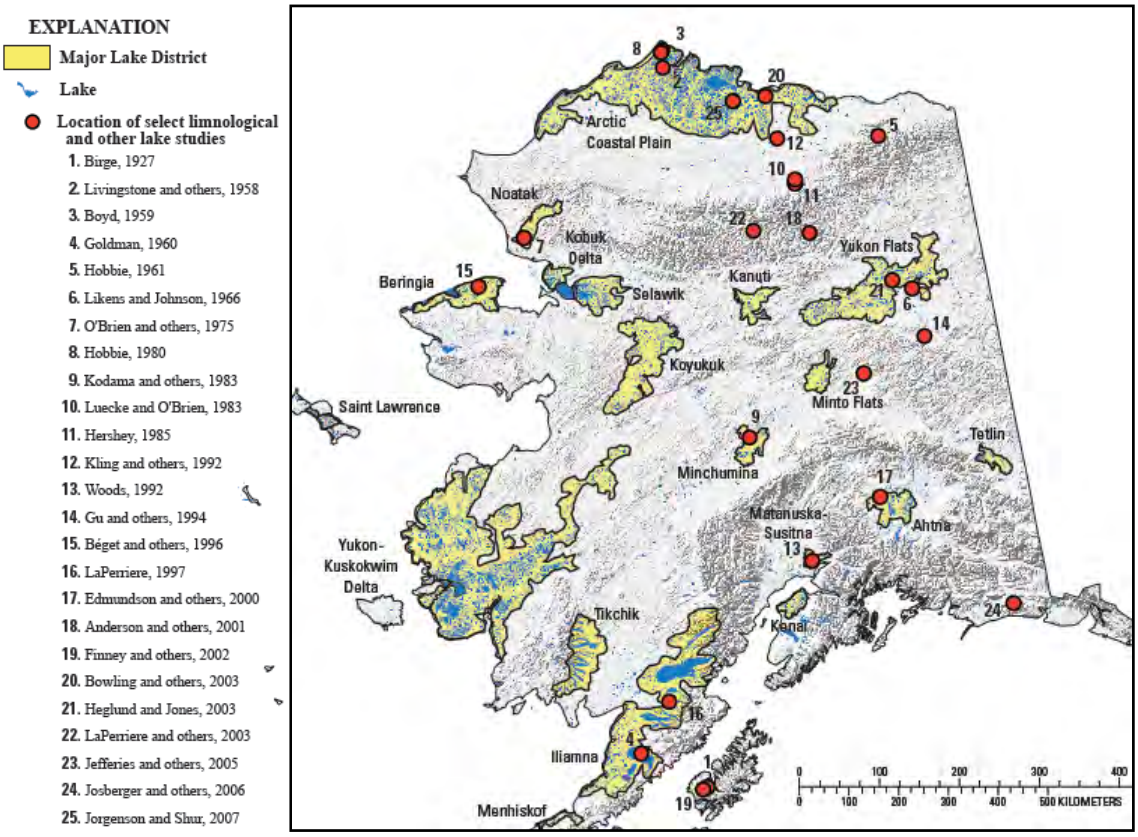

Figure 14. Major lake districts, lakes, and relative studies (Arp and Jones, 2008).

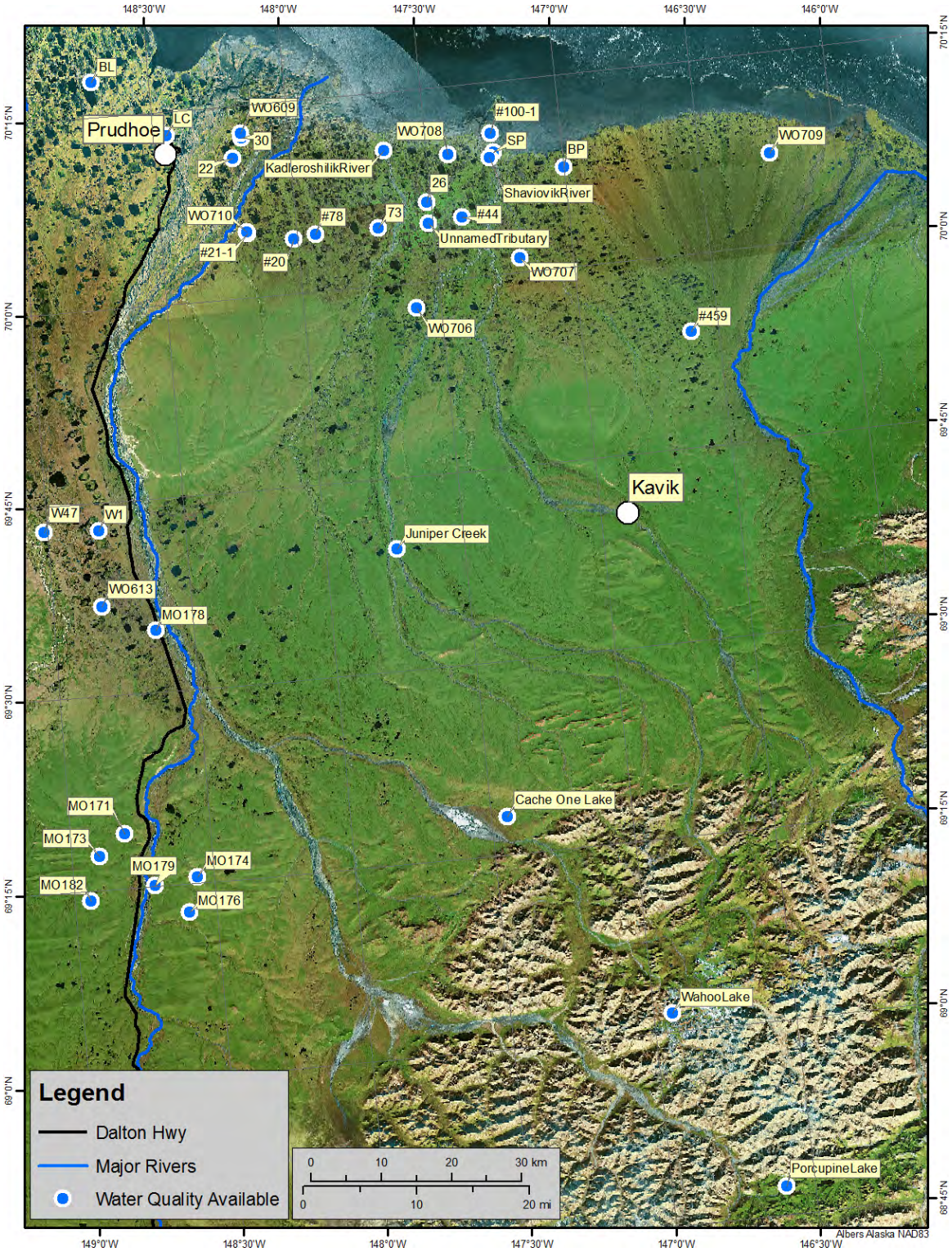

Figure 15. Locations within the Bullen area that have been sampled for water quality.

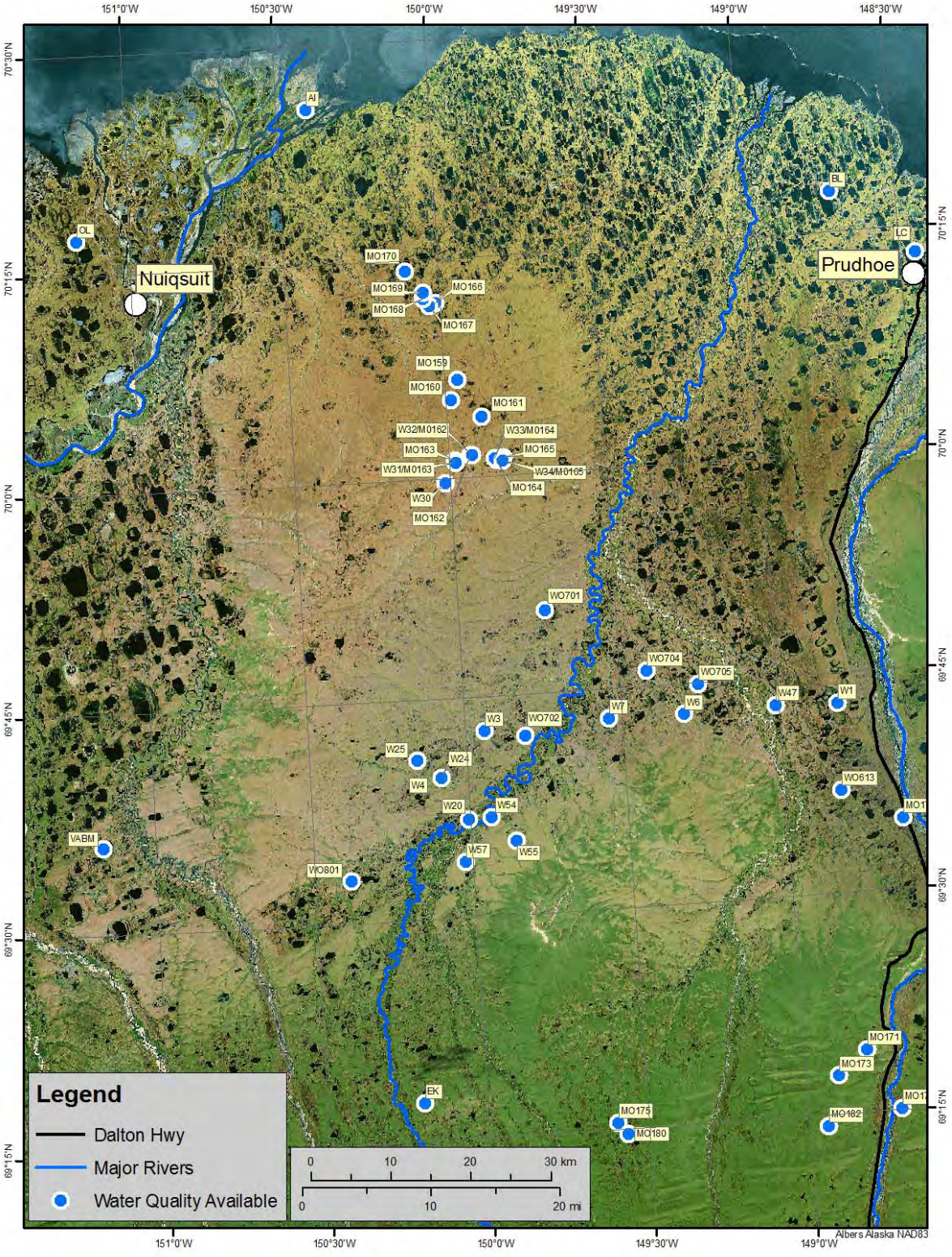

Figure 16. Locations within the Foothills area that have been sampled for water quality.

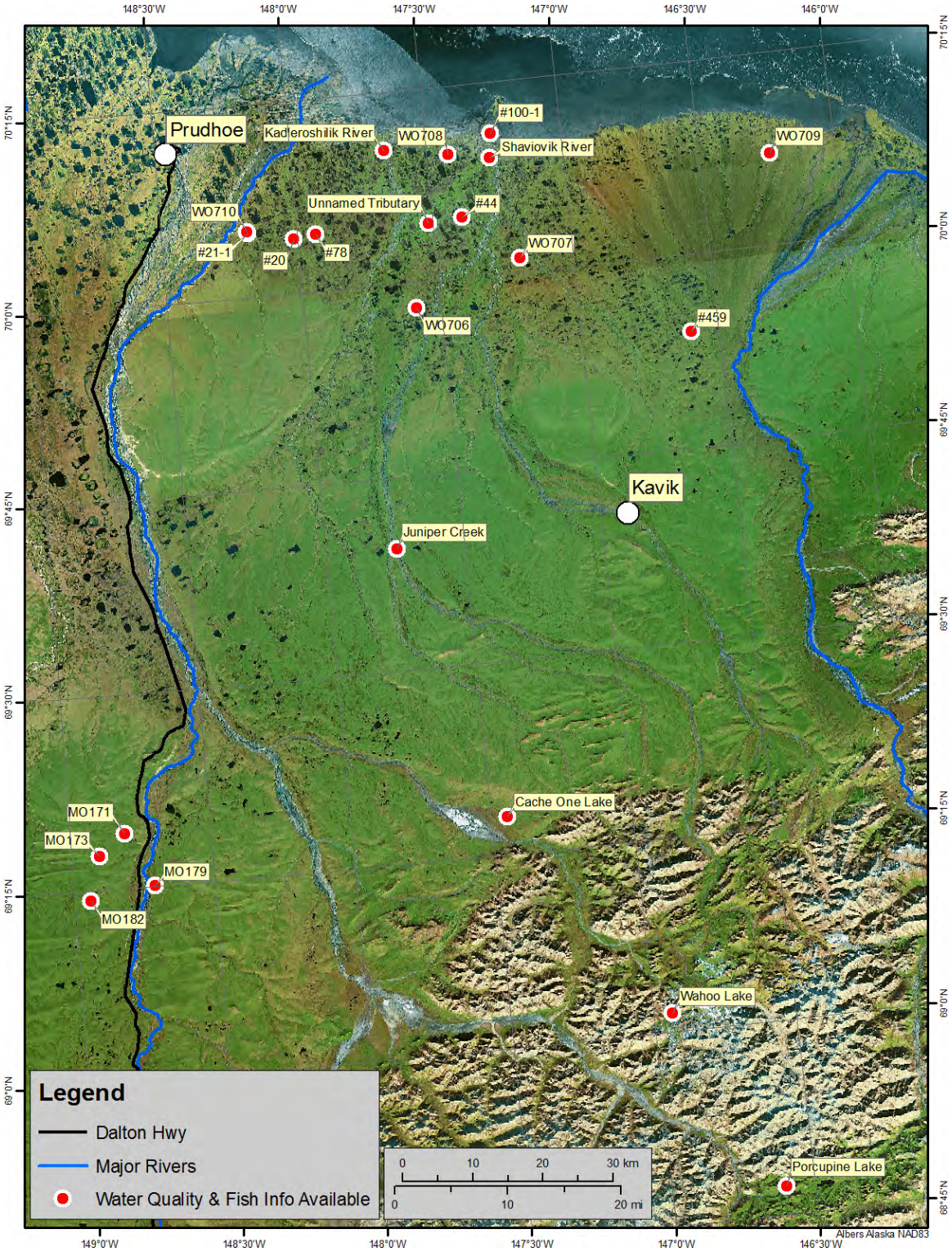

Figure 17. Locations within the Bullen area that have been sampled for water quality and fish.

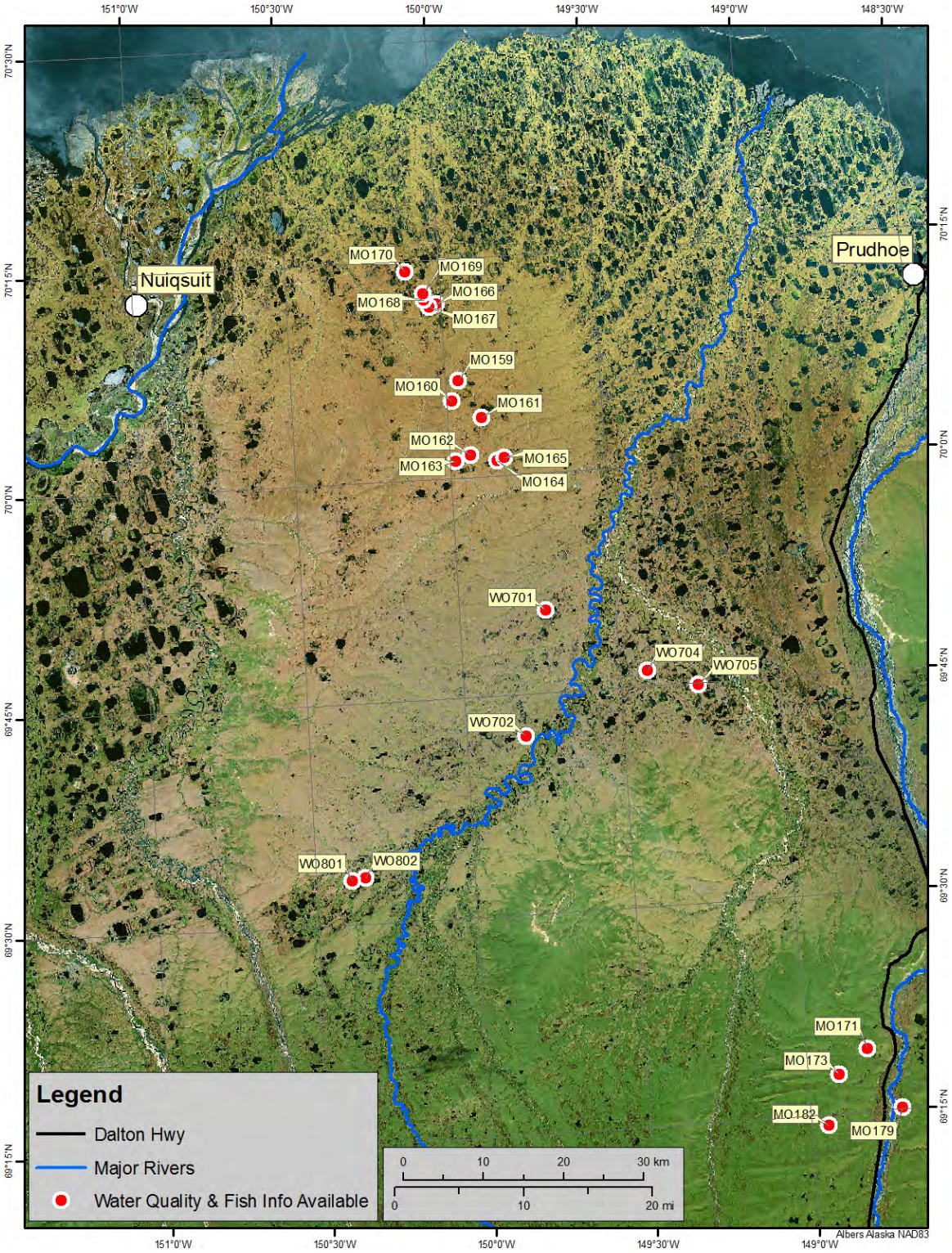

Figure 18. Locations within the Foothills area that have been sampled for water quality and fish.

SUMMARY

This report endeavors to provide an annotated bibliography of lake-related research in Alaska's Arctic Coastal Plain and North Slope Foothills regions. Although the studies presented here do not represent all of the lake research that has been conducted in the region, they do provide an overview of the major efforts that have been/are being conducted. The regions described in this report are vast, remote, and highly understudied. As new lake research will likely accompany planned industrial development in the region, similar efforts will be necessary in the future to summarize and make effective use of the growing body of research.

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APPENDIX A. Summaries of General Information and Datasets

These tables were pulled from the USGS report by Arp and Jones, 2008.

Summary of lake hydography datasets.

Dataset	Primary reference	Coverage	Census method	Minimum lake size (km^2)
Global Lake Census (GLC) / Word Digital Chart (WDG)	van der Leeden and others, 1987; Meybeck, 1995	Global	Compilation of multiple datasets with some size-frequency extrapolations	1
Global Lake and Wetland Database	Lehner and Döll, 2004	Global	Compilation of multiple datasets with intensive GIS processing	0.1
Lakes, 1 to 100,000	Alaska Department of Natural Resources http://nrdata.nps.gov/regions/akro/lk1mil.xml	Alaska	Processed Digital Chart of the World	1
USGS NHD Lakes	USGS National Hydrography Dataset http://nhd.usgs.gov/techref.html	Alaska	1:100,000 topographic maps derived from aerial photography (1950s) stereo pairs	<0.1

Summary of geospatial datasets used to characterize and compare lake districts.

Dataset	Source	Description	Resolution
Geologic Map of Alaska	Beikman, 1980 http://agdc.usgs.gov	Major geologic units of Alaska	1:2,500,000
Surficial Geology Map of Alaska	Karlstrom,1964 http://www.nps.gov/akso/gis/	Major surficial geologic features of Alaska	1:1,584,000
Permafrost Map of Alaska	Brown and others, 2001 http://nsidc.org/data/ggd318.html	Permafrost and ground ice data	1:10,000,000
Alaska PaleoGlacier Atlas	Manley and Kaufman, 2002 http://instaar.colorado.edu/QGISL/ak_paleoglacier_atlas	Geospatial summary of Pleistocene glaciation across Alaska	1:1,000,000
Gridded Alaska Climate Data	Leeman and Cramer, 1991 http://agdc.usgs.gov/data/projects/hlct/hlct.html#K	Mean (1961–90) monthly temperature and precipitation for Alaska based on interpolation of National Climate Data Center Global Historical Climate Network	1 km
Unified Ecoregions of Alaska	Nowacki and others, 2003 http://agdc.usgs.gov/data/usgs/erosafo/ecoreg/	Landscape-scale ecological units of Alaska	1:2,500,000

Several regional scale studies of Alaska lakes and their areas of focus.

Reference	Study area	Research focus
Likens and Johnson, 1968	Interior (Northway and Yukon Flats) and north slope (Barrow) Alaska	Limnological survey with inter-regional comparisons and functional analysis
Sellman and others, 1975	Alaskan arctic coastal plain	Regional analysis of thermokarst lake distribution and geomorphology in landscape context
Landers and others, 1995	Brooks Range, arctic coastal plain, and Denali National Park and Preserve (Wonder Lake)	Inventory and historic deposition. Reconstruction of mercury in lake sediments and vegetation
Jefferies and others, 1996	North Slope (Barrow and Meade River)	Analysis of lake ice dynamics in the context of climate and lake morphology
Sturm and Liston, 2003	North Slope (transect from Barrow to Brooks Range)	Characterization and analysis of snow on lakes
Hinkel and others, 2005	Inner Arctic Coastal Plain (North Slope)	Geographic analysis of thermokarst lake morphology and abundance
Riordan and others, 2006	Interior and Arctic Coastal Plain	Lake change in relation to climate change
Walter and others, 2007	Northern Alaska, Siberia, and Canada	Patterns of methane release from thermokarst lake in the Arctic

APPENDIX B. Previous Study Locations and Available Information

The following tables compile the available information from previous studies.

Water Quality Information is Available in the Following References:

Source Reference: 2002. Dolly Varden/Arctic Char Prospect: Permit Applications 2002-2003/2006-2007. State of Alaska Exploration Sites DV-1, DV-4, AC-1/ ASRC Exploration Sites DV-5, DV-7. Anadarko Petroleum Corp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)
MO159	9N/9E	19/30	1.038	204.2	2.225	70.112	149.959
MO160	9N/8E	36	0.571	104.7	2.103	70.089	149.982
MO161	8N/9E	4/9	0.503	97.7	2.225	70.068	149.889
MO162	8N/9E	20/29	0.545	127.4	2.682	70.025	149.932
MO163	8N/9E	30	0.260	57.4	2.529	70.020	149.982
MO164	8N/9E	27	0.276	57.3	2.377	70.018	149.849
MO165	8N/9E	26	0.651	110.7	1.950	70.020	149.826
MO166	10N/8E	23/24/25/26	0.522	27.8	0.6096	70.200	150.015
MO167	10N/8E	26	0.262	103.3	4.511	70.197	150.037
MO168	10N/8E	22/23	0.96	135.3	1.615	70.205	150.055
MO169	10N/8E	16/21	0.382	45.7	1.371	70.213	150.055
MO170	10N/8E	11	0.623	105.9	1.95	70.238	150.108
MO171	1S/14E	29	0.477	622.7	10.728	69.321	148.807
MO173	2S/13E	1/2	0.341	216.6	1.859	69.294	148.900
MO174	2S/11E	19	0.048	33.7	8.40;(2.56)	69.259	148.560
MO175	2S/11E	19	0.037	16.8	10.40;(3.17)	69.259	149.599
MO176	2S/11E	30	0.122	-	Shallow	69.213	148.599
MO178	2S/11E	29/30	0.322	-	Shallow	69.580	148.637
MO179	2S/10E	21	0.12	46	2.59	69.252	148.713
MO182	2S/13E	26/27	1.115	290.3	2.651	69.238	148.945
MO180	2S/10E	16/21	0.5	-	Shallow	69.245	149.568

Source Reference: USGS. 1998. Lake Water Quality Records and Lake Levels- Arctic Slope, Alaska.

Project Lake ID	Area (sq-km)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)
Big Lake near Prudhoe Bay	--	--	70.296	148.713
Galbraith Lake near Sagwon	--	--	68.459	149.409
Oil Lake near Nuiqsut	--	--	70.290	151.170
Lake Colleen near Prudhoe Bay	--	--	70.219	148.450
Unnamed Lake 22 near Deadhorse	--	--	70.183	148.213
Unnamed Lake 26 near Kadleroshilik River	--	--	70.103	147.514
Unnamed Lake 30 near Deadhorse	--	--	70.208	148.175
Unnamed Lake 73 near Kadleroshilik River	--	--	70.075	147.703
Unnamed Lake at East Kuparuk Rig near Umiat	--	--	69.294	150.197
Unnamed Lake on Anachlik Island near Nuiqsut	--	--	70.428	150.403
VABM Bowl Lake near Umiat	--	--	69.600	151.167

Source Reference: White, D., M. Lilly, M. Chambers, K. Hilton, and P. Prokein. 2006. Lake Survey Data for the Coastal Plain from the Sagavanirktok River to Bullen Point: Spring 2006. University of Alaska Fairbanks- Water and Environmental Research Center. Report INE/WERC 06-02.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO609	10N/16E	18	--	--	5.90	70.214	148.178

Source Reference: Chambers, M. Lilly, M.R., White, D.M., Hilton, K.M., and Prokein, P. 2006. Lake survey data for the Kuparuk foothills region: Spring 2006. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 06-05. Fairbanks, Alaska.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO613	3N/13E	13	--	--	4.43	69.617	148.825

Source Reference: Myerchin G.M., White, D.M., Lilly, M.R., Holland, K.M., and Prokein, P., 2007. Lake survey data for the coastal plain from the Sagavanirktok River to Bullen Point: Spring 2007. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 07.14, Fairbanks, Alaska, 14 pp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO706	7N/18E	14	--	--	7.51	69.967	147.59
WO707	8N/20E	29	--	--	5.51	70.0186	147.194
WO708	9N/19E	6	--	--	5.74	70.162	147.419
WO709	9N/23E	23	--	--	6.63	70.119	146.241
WO710	11N/16E	19	--	--	6.6	70.086	148.184

Source Reference: Myerchin G.M., White, D.M., Lilly, M.R., Holland, K.M., and Prokein, P., 2007. Lake survey data for the Kuparuk foothills region: Spring 2007. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 07.15, Fairbanks, Alaska, 10 pp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO701	6N/10E	30	--	--	5.61	69.844	149.7242
WO702	4N/9E	14	--	--	7.81	69.703	149.811
WO704	5N/11E	21	--	--	4.9	69.768	149.413
WO705	5N/12E	31	--	--	6.33	69.7483	149.252

Source Reference: Myerchin, G.M., White, D.M., Schnabel W.E., Lilly, M.R., Holland, K.M., and Prokein, P., 2008. Lake survey data for the Kuparuk Foothills region: Spring 2008. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 08.04, Fairbanks, Alaska, 9 pp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO801	2N/7E	10	--	--	6.26	69.55	150.387
WO702	4N/9E	13	--	--	7.88	69.703	149.811

Source Reference: Ward, D., and P. Craig. 1974. Catalogue of Streams, Lakes, and Coastal Areas in Alaska Along Routes of the Proposed Gas Pipeline from Prudhoe Bay, Alaska to the Alaskan/Canadian Border. Arctic Gas Biological Report Series Volume 19. Canadian Arctic Gas Study Ltd.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
#44	8N/19E	4	-	-	-	70.079	147.392
#78	8N/17E	5	-	-	-	70.075	147.933
#20	8N/16E	1	-	-	-	70.071	148.017
#459	6N/22E	3	-	-	-	69.900	146.600
#21-1	8N/16E	5	-	-	-	70.083	148.183
Cache One Lake	2S/19E	1	-	-	-	69.300	147.442
#100-1	10N/19E	35	-	-	-	70.183	147.258
Wahoo Lake	5S/22E	8	-	-	-	69.025	146.933
Porcupine Lake	7SN/23E	35	-	-	-	68.788	146.600

Fish Sampling Information is Available in the Following References:

Source Reference: 2002. Dolly Varden/Arctic Char Prospect: Permit Applications 2002-2003/2006-2007. State of Alaska Exploration Sites DV-1, DV-4, AC-1/ ASRC Exploration Sites DV-5, DV-7. Anadarko Petroleum Corp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)	Fish Present (Yes/No)
MO2114	9N/7E	13	0.174	26.96	2.79;(0.85)	-	-	No
MO2115	9N/8E	19	0.113	39.26	7.32;(2.23)	-	-	No

Source Reference: Ward, D., and P. Craig. 1974. Catalogue of Streams, Lakes, and Coastal Areas in Alaska Along Routes of the Proposed Gas Pipeline from Prudhoe Bay, Alaska to the Alaskan/Canadian Border. Arctic Gas Biological Report Series Volume 19. Canadian Arctic Gas Study Ltd.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)	Fish Present (Yes/No)
#92	8N/10E	28	--	--	--	70.025	149.650	No
#79	8N/20E	3	--	--	--	70.075	147.117	No
#62	7N/18E	4	--	--	--	69.997	147.667	No
#61	7N/18E	15	--	--	--	69.967	147.596	No
#60	7N/19E	13	--	--	--	69.963	147.258	No
#63	5N/20E	30	--	--	--	69.758	147.217	No
#16	5N/21E	34	--	--	--	69.750	146.867	No
#188	7N/20E	25	--	--	--	69.938	147.042	No
#15	3N/21E	36	--	--	--	69.575	146.858	No
#53	8N/22E	18	--	--	--	70.046	146.733	No
#6	9N/22E	30	--	--	--	70.104	146.650	No
#50	9N/22E	30	--	--	--	70.108	146.650	No
#54	8N/22E	30	--	--	--	70.021	146.733	No
#27	3N/22E	11	--	--	--	69.633	146.650	No
#52	9N/22E	27	--	--	--	70.108	146.533	No
#55	1S/24E	15	--	--	--	69.358	146.292	No
#51	9N/24E	8	--	--	--	70.142	146.117	No
#26	9N/18E	27	--	--	--	70.104	147.517	Yes
#25	4N/22E	3	--	--	--	69.729	146.692	Yes
#36	5N/22E	26	--	--	--	69.754	146.567	Yes
#24	7N/22E	22	--	--	--	69.950	146.600	Yes

Source Reference: ASRC Energy Service. 2007. White Hills Lake Study. Prepared for Chevron North American Exploration and Production Company, Anchorage, Alaska, October 2007.

Project Lake ID/MJM Lake Name	Township/ Range	Section	Area (acres)	Total Volume (million gallons)	Estimated Depth (feet)	North Latitude (NAD83)	West Longitude (NAD83)	Fish (Yes/No)
7	8N/9E	30	66.19	108.05	8.1	70.018	-149.980	NO
W32/M0162	8N/9E	29	136.77	216.56	8.3	70.025	-149.927	NO
W33/M0164	8N/9E	27	77.09	77.28	8.2	70.020	-149.853	NO
W34/M0165	8N/9E	26	181.85	250.73	6.5	70.017	-149.830	NO
W1	4N/13E	12	242.79	244.62	5.7	69.715	148.814	NO
W47	4N/13E	8	61.90	11.41	8.2	69.718	149.012	NO
W11	4N/12E	16	62.08	17.06	6.3	69.705	149.206	YES
W5	4N/12E	21	81.49	147.13	8.7	69.691	149.194	YES
W6	4N/12E	7	147.38	52.93	17.9	69.716	149.303	NO
W12	4N/11E	9	185.54	301.81	7.5	69.720	149.451	YES
W7	4N/10E	12	362.29	344.57	5.9	69.717	149.543	NO
W8	4N/10E	8	97.87	127.98	13.4	69.717	149.754	YES
W17	4N/9E	13	71.84	109.63	10.2	69.702	149.809	YES
W18	4N/9E	14	138.72	196.77	7	69.701	149.862	YES
W3	4N/9E	16	110.61	178.89	8.2	69.711	149.939	NO
W25	4N/8E	21	59.05	103.68	7.1	69.682	150.159	NO
W24	4N/8E	35	54.03	78.76	11	69.6607	150.08464	NO
W4	3N/9E	18	52.28	63.34	6.3	69.6607	150.08464	NO
W20	3N/9E	18	83.85	149.85	11.3	69.612	150.005	NO
W54	3N/9E	16	38.13	42.73	8	69.613	149.936	NO
W19	3N/9E	30	65.87	105.59	14	69.589	150.022	YES
W55	3N/9E	26	8.15	13.74	10	69.584	149.861	NO
W57	2N/9E	6	21.98	21.98	5	69.564	150.024	NO
W56	2N/9E	6	49.29	41.49	5.5	69.551	150.023	YES
W52	5N/10E	10	130.54	263.74	14	69.804	149.586	YES
W2	6N/10E	30	108.41	495.20	6.8	69.840	149.722	YES
W30	7N/8E	1	197.12	253.79	6	69.995	150.017	NO

Water Quality and Fish Sampling Information is Available in the Following References:

Source Reference: 2002. Dolly Varden/Arctic Char Prospect: Permit Applications 2002-2003/2006-2007. State of Alaska Exploration Sites DV-1, DV-4, AC-1/ ASRC Exploration Sites DV-5, DV-7. Anadarko Petroleum Corp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)	Fish Present (Yes/No)
MO159	9N/9E	19/30	1.038	204.2	7.31;(2.23)	70.112	149.959	No
MO160	9N/8E	36	0.571	104.7	6.88;(2.10)	70.089	149.982	No
MO161	8N/9E	4/9	0.503	97.7	7.28;(2.22)	70.068	149.889	No
MO162	8N/9E	20/29	0.545	127.4	8.79;(2.68)	70.025	149.932	No
MO163	8N/9E	30	0.260	57.4	8.29;(2.53)	70.020	149.982	No
MO164	8N/9E	27	0.276	57.3	7.80;(2.38)	70.018	149.849	No
MO165	8N/9E	26	0.651	110.7	6.40;(1.95)	70.020	149.826	No
MO166	10N/8E	23/24/25/26	0.522	27.8	2.00;(0.61)	70.200	150.015	No
MO167	10N/8E	26	0.262	103.3	14.79;(4.51)	70.197	150.037	No
MO168	10N/8E	22/23	0.96	135.3	5.31;(1.62)	70.205	150.055	No
MO169	10N/8E	16/21	0.382	45.7	4.50;(1.37)	70.213	150.055	No
MO170	10N/8E	11	0.623	105.9	6.40;(1.95)	70.238	150.108	No
MO171	1S/14E	29	0.477	622.7	35.19;(10.73)	69.321	148.807	Yes
MO173	2S/13E	1/2	0.341	216.6	6.10;(1.86)	69.294	148.900	Yes
MO179	2S/10E	21	0.12	46	8.50;(2.59)	69.252	148.713	No
MO182	2S/13E	26/27	1.115	290.3	8.70;(2.65)	69.238	148.945	Yes

Source Reference: ASRC Energy Service. 2007. White Hills Lake Study. Prepared for Chevron North American Exploration and Production Company, Anchorage, Alaska, October 2007.

Project Lake ID	Township/ Range	Section	Area (acres)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)	Fish Present (Yes/No)
W11	4N/12E	16	62.08	17.06	6.3;(1.92)	69.705	149.206	Yes
W5	4N/12E	21	81.49	147.13	8.7;(2.65)	69.691	149.194	Yes
W12	4N/11E	9	185.54	301.81	7.5;(2.28)	69.720	149.451	Yes
W8	4N/10E	8	97.87	127.98	13.4;(4.09)	69.717	149.754	Yes
W17	4N/9E	13	71.84	109.63	10.2;(3.11)	69.702	149.809	Yes
W18	4N/9E	14	138.72	196.77	7;(2.14)	69.701	149.862	Yes
W19	3N/9E	30	65.87	105.59	14;(4.27)	69.589	150.022	Yes
W56	2N/9E	6	49.29	41.49	5.5;(1.68)	69.551	150.023	Yes
W52	5N/10E	10	130.54	263.74	14;(4.27)	69.804	149.586	Yes
W2	6N/10E	30	108.41	495.20	6.8;(2.07)	69.840	149.722	Yes
W31/M0163	8N/9E	30	66.19	108.05	8.1;(2.47)	70.018	-149.980	Yes
W32/M0162	8N/9E	29	136.77	216.56	8.3;(2.53)	70.025	-149.927	Yes
W33/M0164	8N/9E	27	77.09	77.28	8.2;(2.50)	70.020	-149.853	Yes
W34/M0165	8N/9E	26	181.85	250.73	6.5;(1.98)	70.017	-149.830	Yes
W1	4N/13E	12	242.79	244.62	5.7;(1.74)	69.715	148.814	Yes
W47	4N/13E	8	61.90	11.41	8.2;(2.50)	69.718	149.012	Yes
W6	4N/12E	7	147.38	52.93	17.9;(5.46)	69.716	149.303	Yes
W7	4N/10E	12	362.29	344.57	5.9;(1.80)	69.717	149.543	Yes
W3	4N/9E	16	110.61	178.89	8.2;(2.50)	69.711	149.939	No
W25	4N/8E	21	59.05	103.68	7.1;(2.16)	69.682	150.159	No
W24	4N/8E	35	54.03	78.76	11;(3.36)	69.6607	150.08464	Yes
W4	3N/9E	18	52.28	63.34	6.3;(1.92)	69.6607	150.08464	Yes
W20	3N/9E	18	83.85	149.85	11.3;(3.45)	69.612	150.005	Yes
W54	3N/9E	16	38.13	42.73	8;(2.44)	69.613	149.936	Yes
W55	3N/9E	26	8.15	13.74	10;(3.05)	69.584	149.861	Yes
W57	2N/9E	6	21.98	21.98	5;(1.52)	69.564	150.024	Yes
W30	7N/8E	1	197.12	253.79	6;(1.83)	69.995	150.017	Yes

Site Location Information is Available in the Following References:

Source Reference: 2002. Dolly Varden/Arctic Char Prospect: Permit Applications 2002-2003/2006-2007. State of Alaska Exploration Sites DV-1, DV-4, AC-1/ ASRC Exploration Sites DV-5, DV-7. Anadarko Petroleum Corp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth feet;(meters)	North Latitude (NAD83)	West Longitude (NAD83)
161	3S/10E	1	-	-	Deep	69.587	148.680
164	2S/10E	25	-	-	Deep	69.235	149.544
203	1N/10E	34	0.124	-	Deep	69.396	149.652
204	1N/10E	35	0.029	-	Deep	69.394	149.597
205	1N/10E	36	0.05	-	Deep	69.395	149.565
206	1N/10E	36	0.012	-	Deep	69.398	149.570
207	1N/11E	19/20	0.114	-	Deep	69.429	149.506
209	1N/12E	5	0.049	-	Shallow	69.476	149.236
210	2N/13E	17/18/19/20	0.207	-	Shallow	69.521	149.007
211	2N/13E	8	0.576	-	Deep	69.543	149.988
212	2N(3N)/14E	4/5/(32/33)	0.868	-	Deep	69.563	148.731
213	3N/14E	28/29	0.868	-	Deep	69.586	148.735

Source Reference: ASRC Energy Service. 2007. White Hills Lake Study. Prepared for Chevron North American Exploration and Production Company, Anchorage, Alaska, October 2007.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
W58	3N/9E	26	-	-	0.5	69.587	149.871

Source Reference: Chambers, M. Lilly, M.R., White, D.M., Hilton, K.M., and Prokein, P. 2006. Lake survey data for the Kuparuk foothills region: Spring 2006. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 06-05. Fairbanks, Alaska.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
W0605	5N/11E	19	-	-	dry	69.769	149.487
W0606	5N/12E	31	-	-	dry	69.747	149.229
W0607	4N/13E	35	-	-	dry	69.657	148.871

Source Reference: White, D., M. Lilly, M. Chambers, K. Hilton, and P. Prokein. 2006. Lake Survey Data for the Coastal Plain from the Sagavanirktok River to Bullen Point: Spring 2006. University of Alaska Fairbanks- Water and Environmental Research Center. Report INE/WERC 06-02.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
W0602	9N/19E	6	-	-	dry	70.164	147.397
W0603	9N/16E	16	-	-	dry	70.141	148.075
W0610	9N/17E	34	-	-	5.87	70.084	147.785
W0611	9N/18E	12	-	-	5.6	70.144	147.457
W0612	8N/21E	28	-	-	3.78	70.014	146.899
W0608	9N/14E	12	-	-	dry	70.155	148.478

Source Reference: Myerchin G.M., White, D.M., Lilly, M.R., Holland, K.M., and Prokein, P., 2007. Lake survey data for the Kuparuk foothills region: Spring 2007. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 07.15, Fairbanks, Alaska, 10 pp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO703	4N/11E	30	-	-	4.99	69.675	149.525

Source Reference: Myerchin G.M., White, D.M., Schnabel W.E., Lilly, M.R., Holland, K.M., and Prokein, P., 2008. Lake survey data for the coastal plain from the Sagavanirktok River to Bullen Point: Spring 2008. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 08.04, Fairbanks, Alaska, 9 pp.

Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO807	8N/17E	5	-	-	dry	70.081	147.933

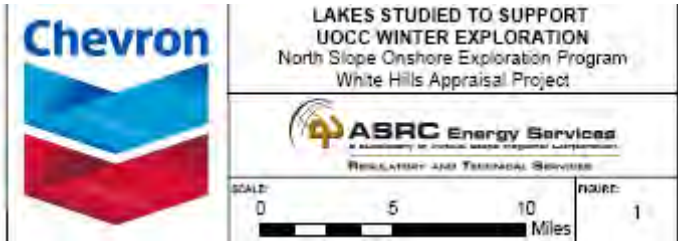
Source Reference: Myerchin, G.M., White, D.M., Schnabel W.E., Lilly, M.R., Holland, K.M., and Prokein, P., 2008. Lake survey data for the Kuparuk Foothills region: Spring 2008. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 08.04, Fairbanks, Alaska, 9 pp.

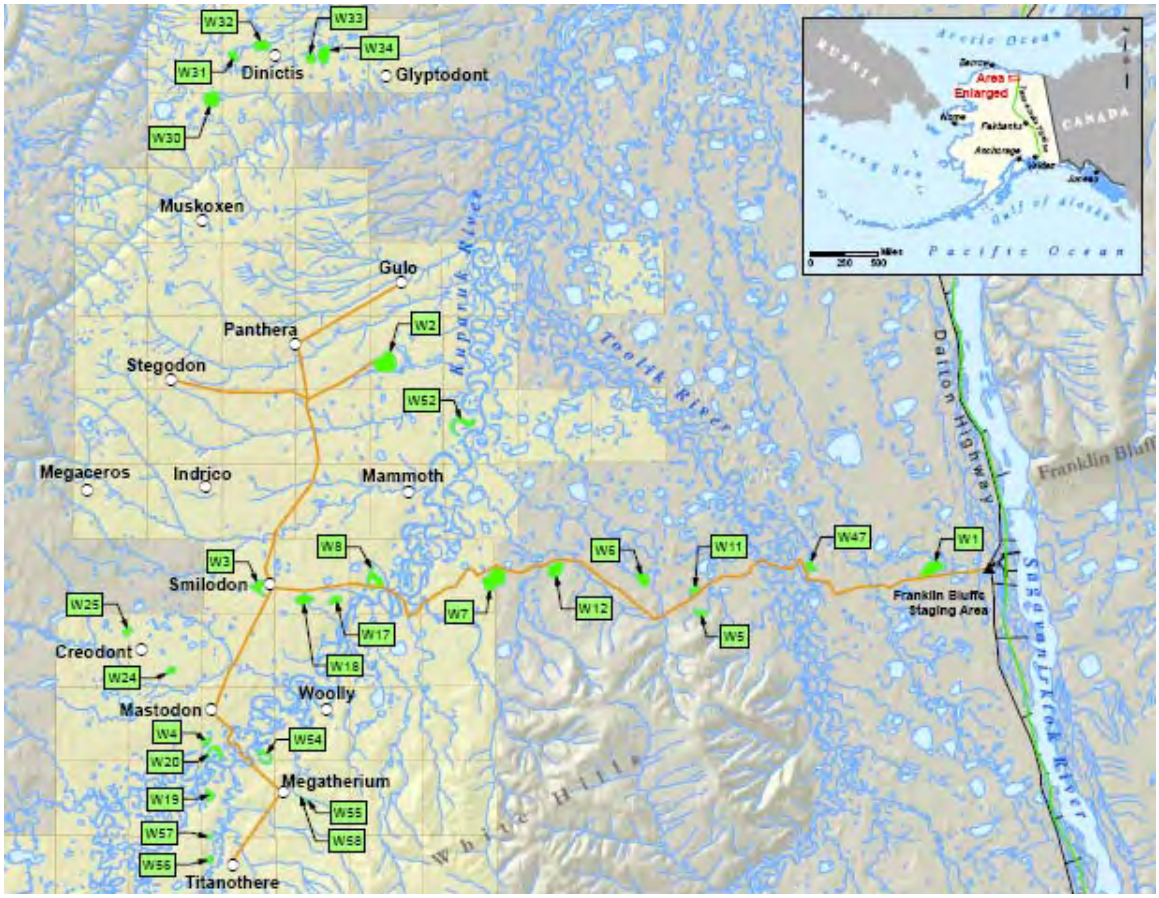
Project Lake ID	Township/ Range	Section	Area (sq-km)	Volume (million gallons)	Estimated Depth in ft	North Latitude (NAD83)	West Longitude (NAD83)
WO802	2N/7E	2			dry	69.553	150.345
WO705	5N/12E	31			dry	69.748	149.252

APPENDIX C. Figures from previous lake studies.

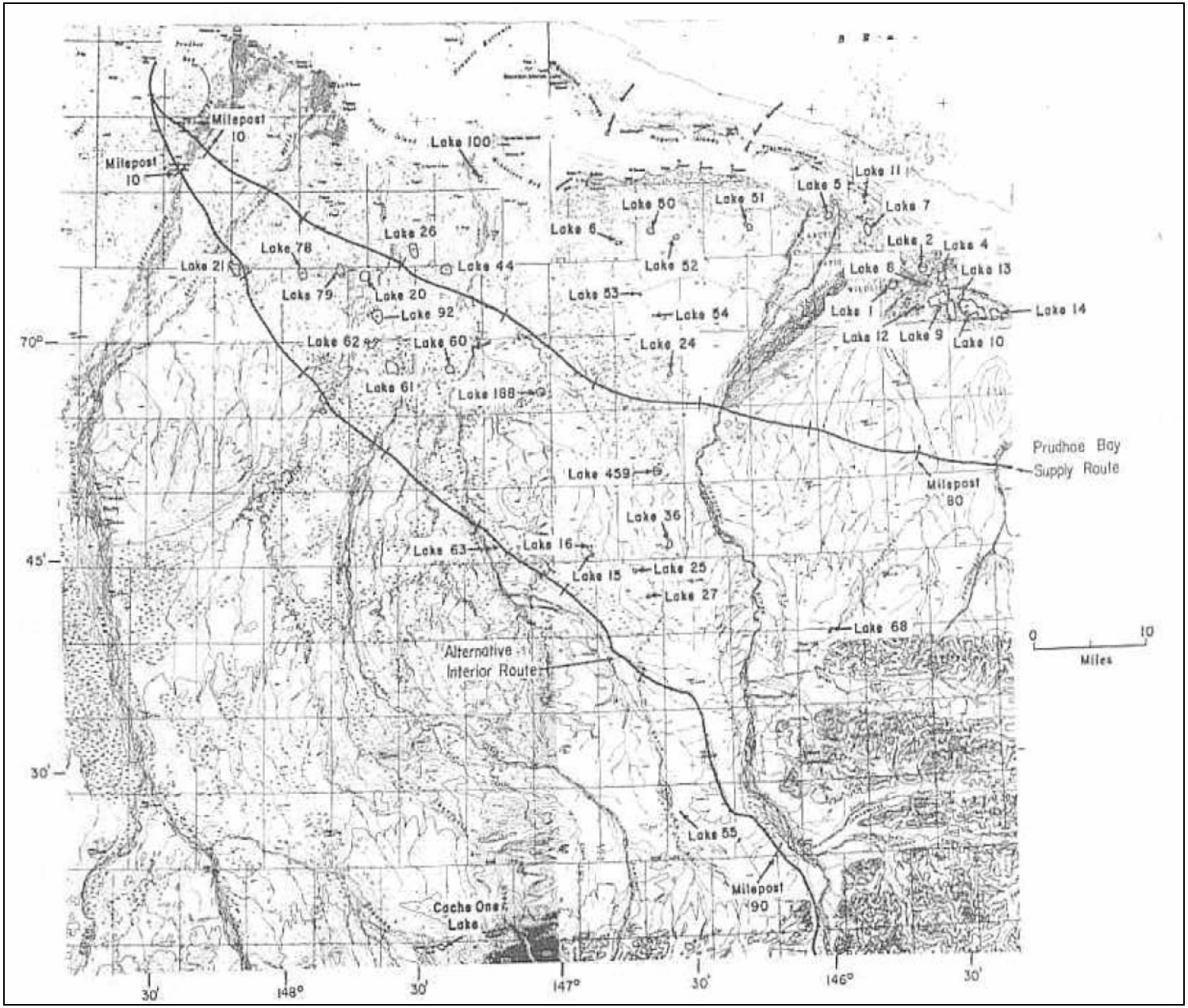
The following figures were part of previous lake studies in the area.

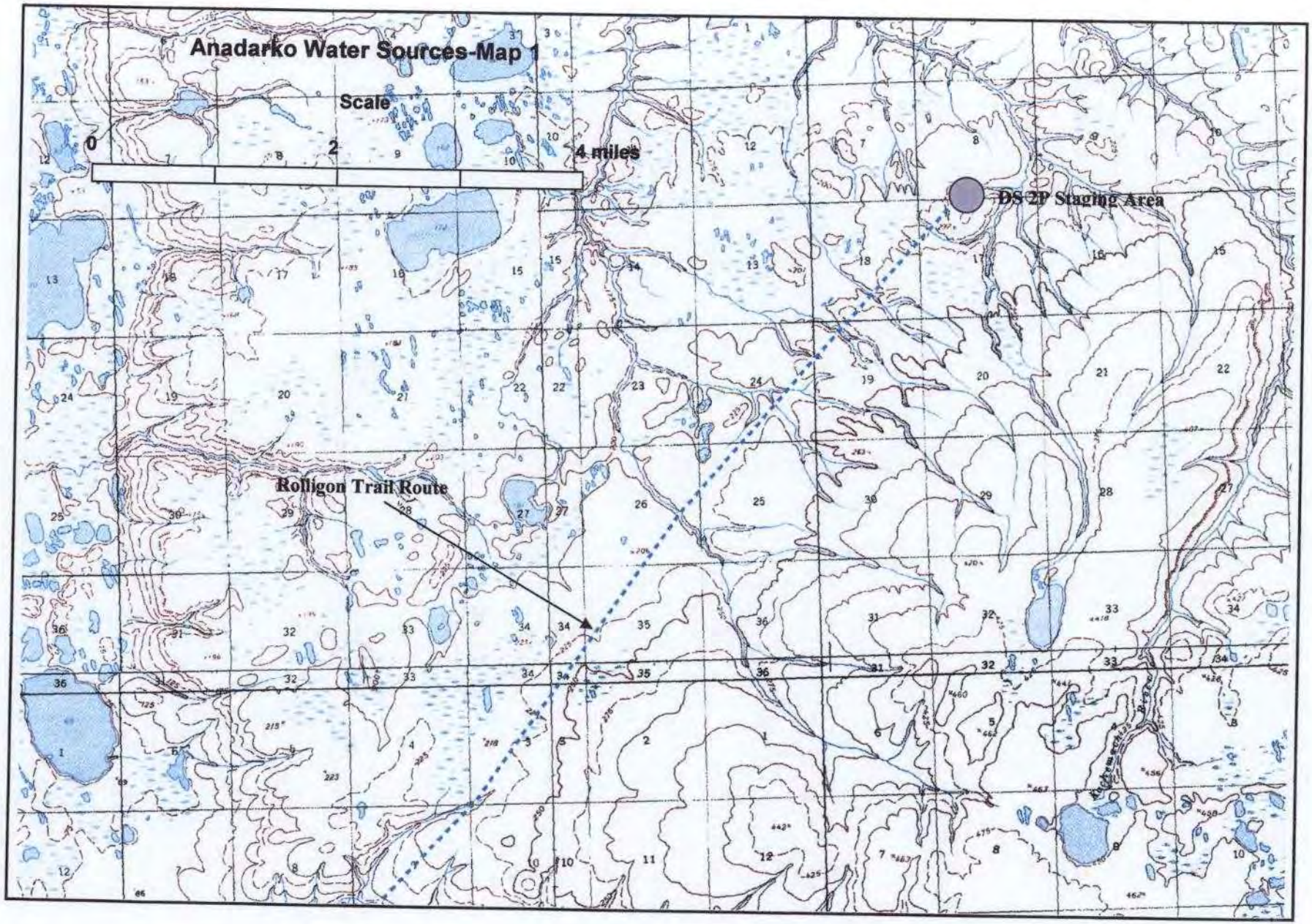
C-1: Original Reference: ASRC, 2007
C-2: Original Reference: Ward and Craig, 1974
C-3 (Figures 1-9): Original Reference: Anadarko, 2002



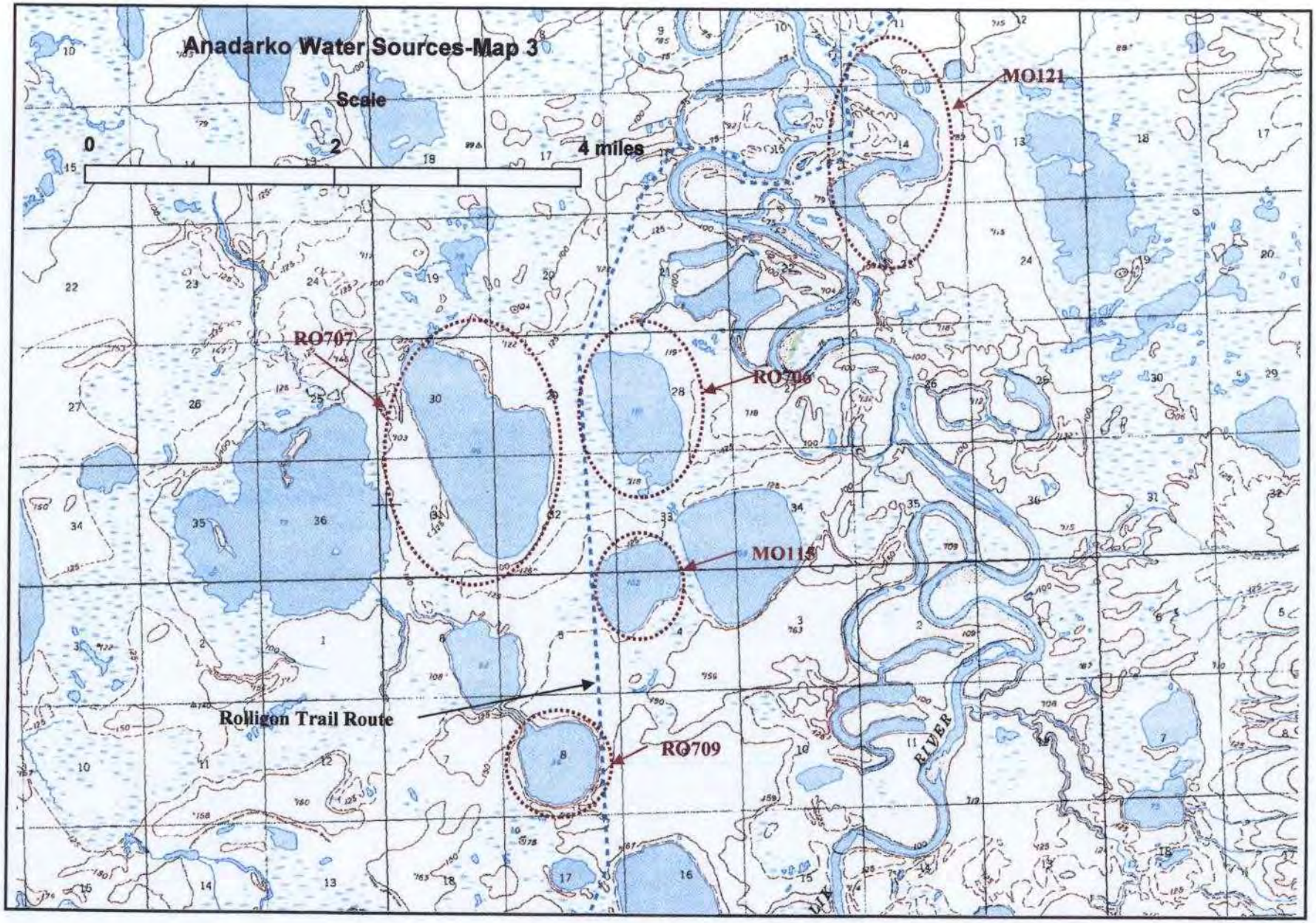


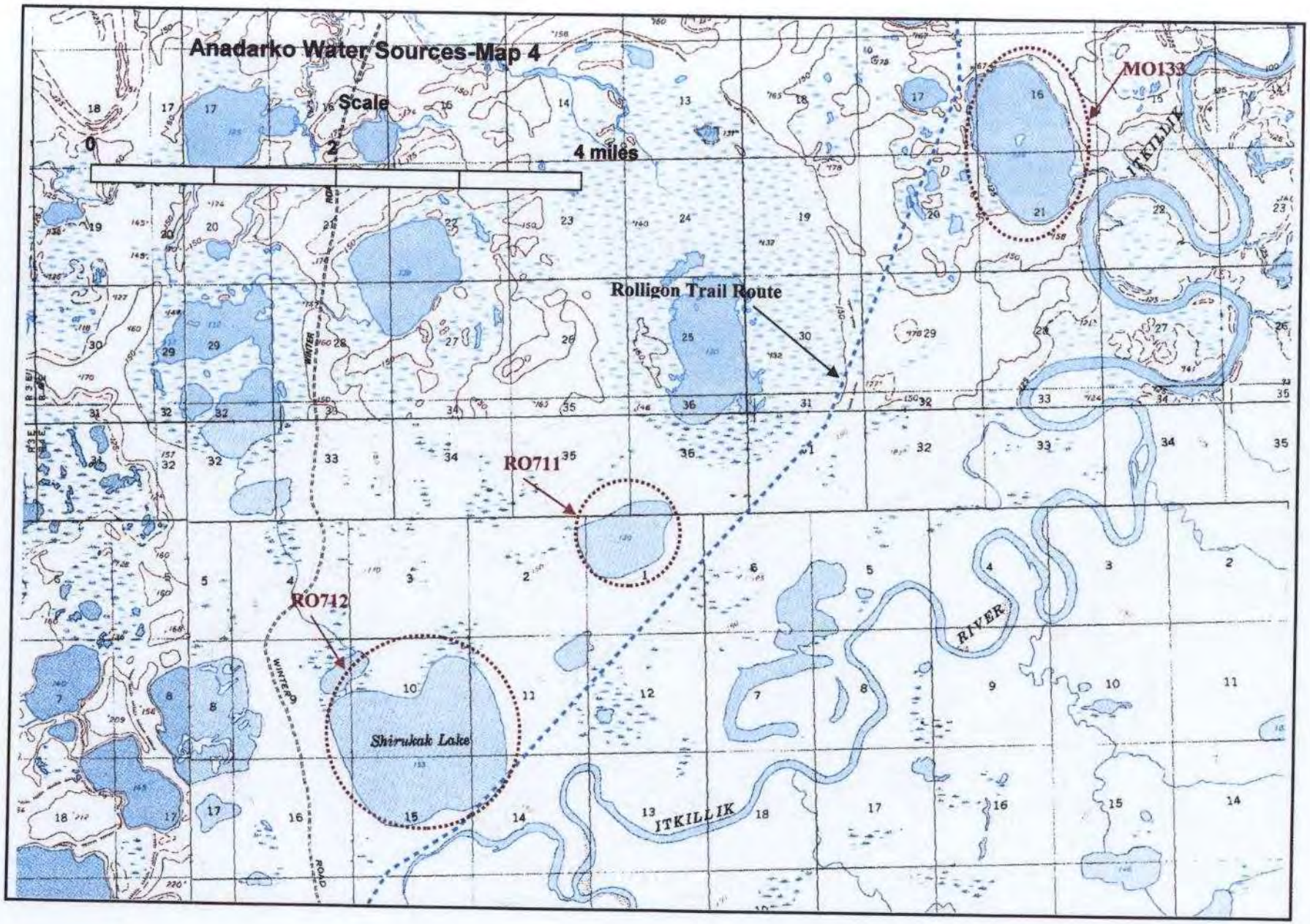
- Staked Well Location
- Lake Surveyed 2007
- Potential Road Alignment
- UOCC Lease Block
- Project Support Infrastructure
- Trans-Alaska Pipeline
- Road


Milepost 10
Milepost 10
Lake 100
Lake 11
Lake 5
Lake 7
Lake 50
Lake 51
Lake 6
Lake 26
Lake 2
Lake 4
Lake 78
Lake 21
Lake 44
Lake 52
Lake 8
Lake 13
Lake 79
Lake 20
Lake 53
Lake 1
Lake 14
Lake 92
Lake 54
70°
Lake 62
Lake 60
Lake 24
Lake 12
Lake 9
Lake 10
Lake 61
Lake 188
Prudhoe Bay
Supply Route
Lake 459
Milepost 80
Lake 36
Lake 63
Lake 16
45'
Lake 15
Lake 25
Lake 27
Lake 68
0
10
Miles
Alternative
Interior Route
30'
Lake 55
Milepost 90
Cache One Lake
30'
148°
30'
147°
30'
146°
30'


Anadarko Water Sources-Map 1
Scale
0
2
4 miles
DS 2P Staging Area
Rolligon Trail Route

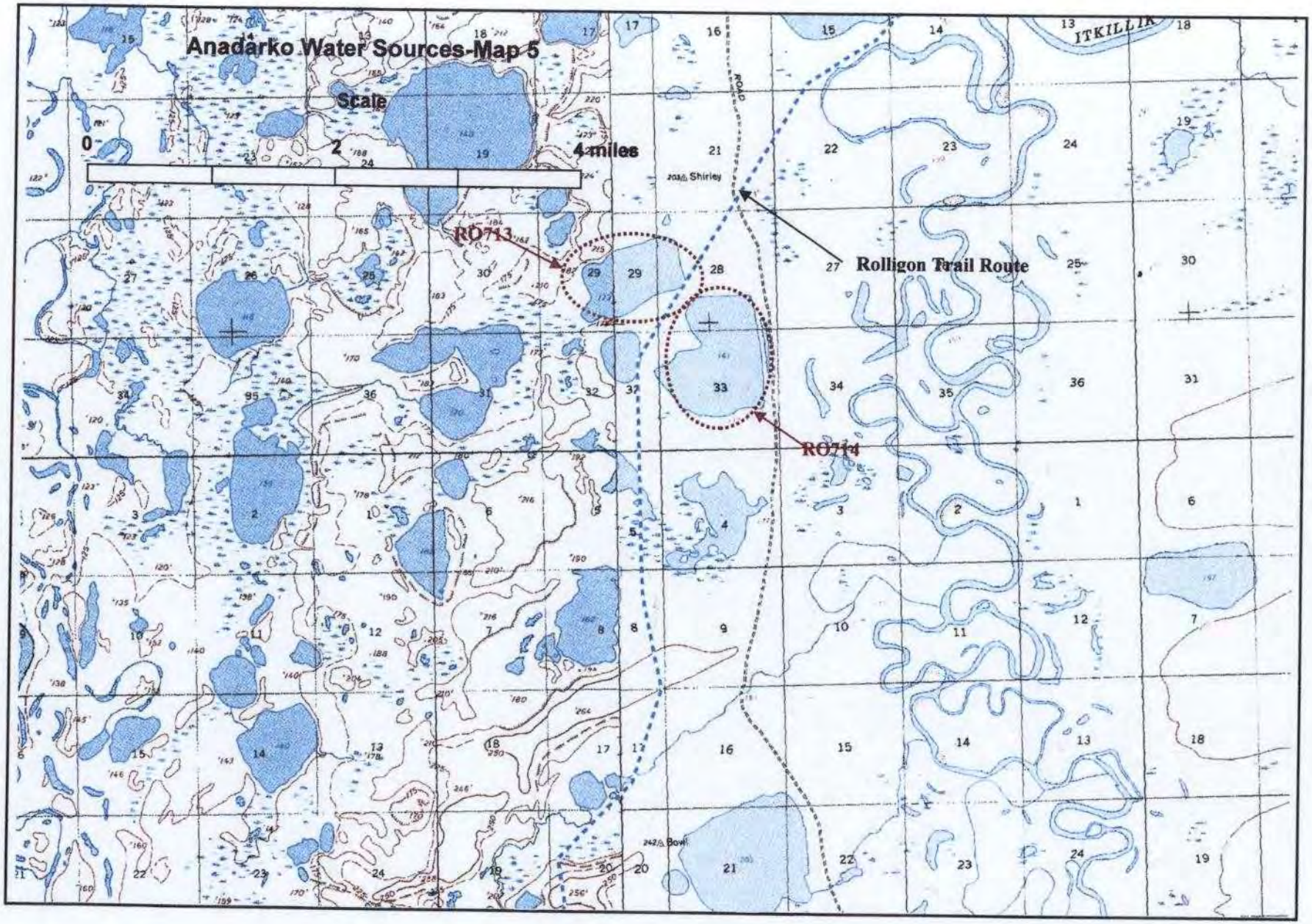

Anadarko Water Sources Map 2
Scale
0
2
4 miles
RØ701
L3
Rolligon Trail Route
A-3


Anadarko Water Sources-Map 3
Scale
0
2
4 miles
MO121
RO707
RO706
MO115
Rolligon Trail Route
RO709
RIVER


Anadarko Water Sources-Map 4
Scale
0
2
4 miles
MO133
ITKILLIK
Rolligon Trail Route
RO711
RO712
Shirukak Lake
WINTER ROAD
ITKILLIK
RIVER

4

C-7


Anadarko Water Sources-Map 5
Scale
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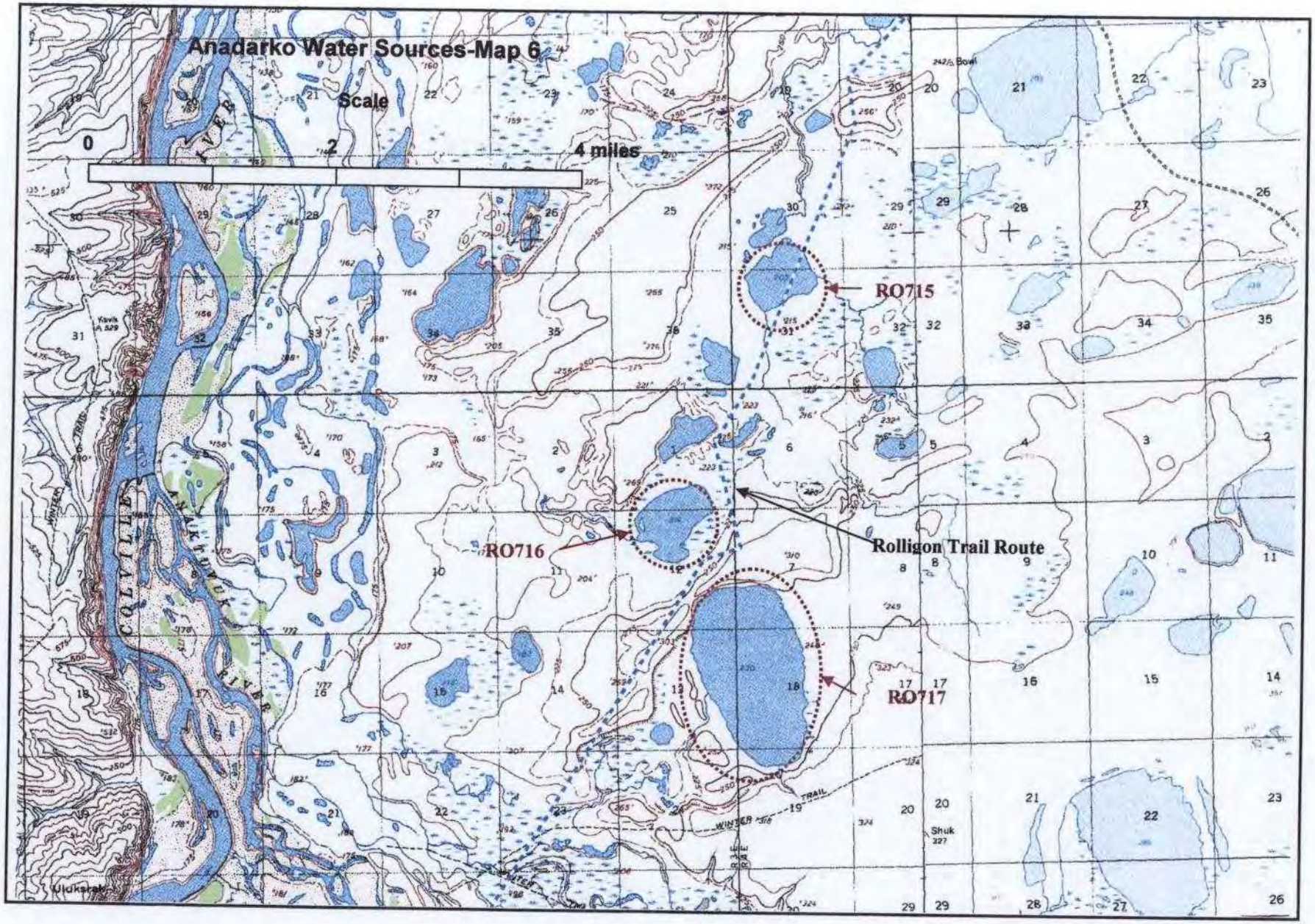
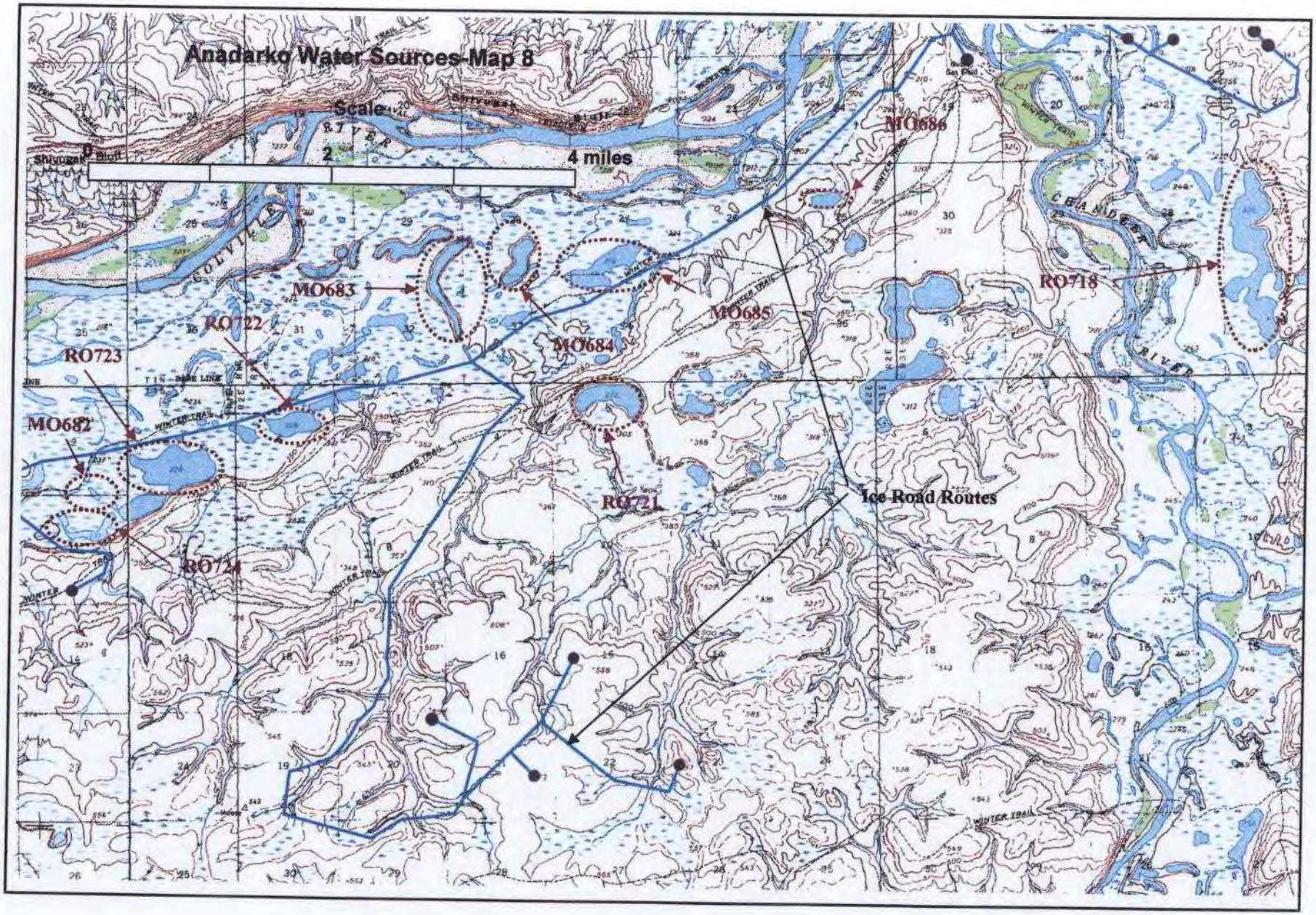
2
4 miles
RO713
RO714
Rolligon Trail Route
ITKILLIK
ROAD
Shirley
Bowl

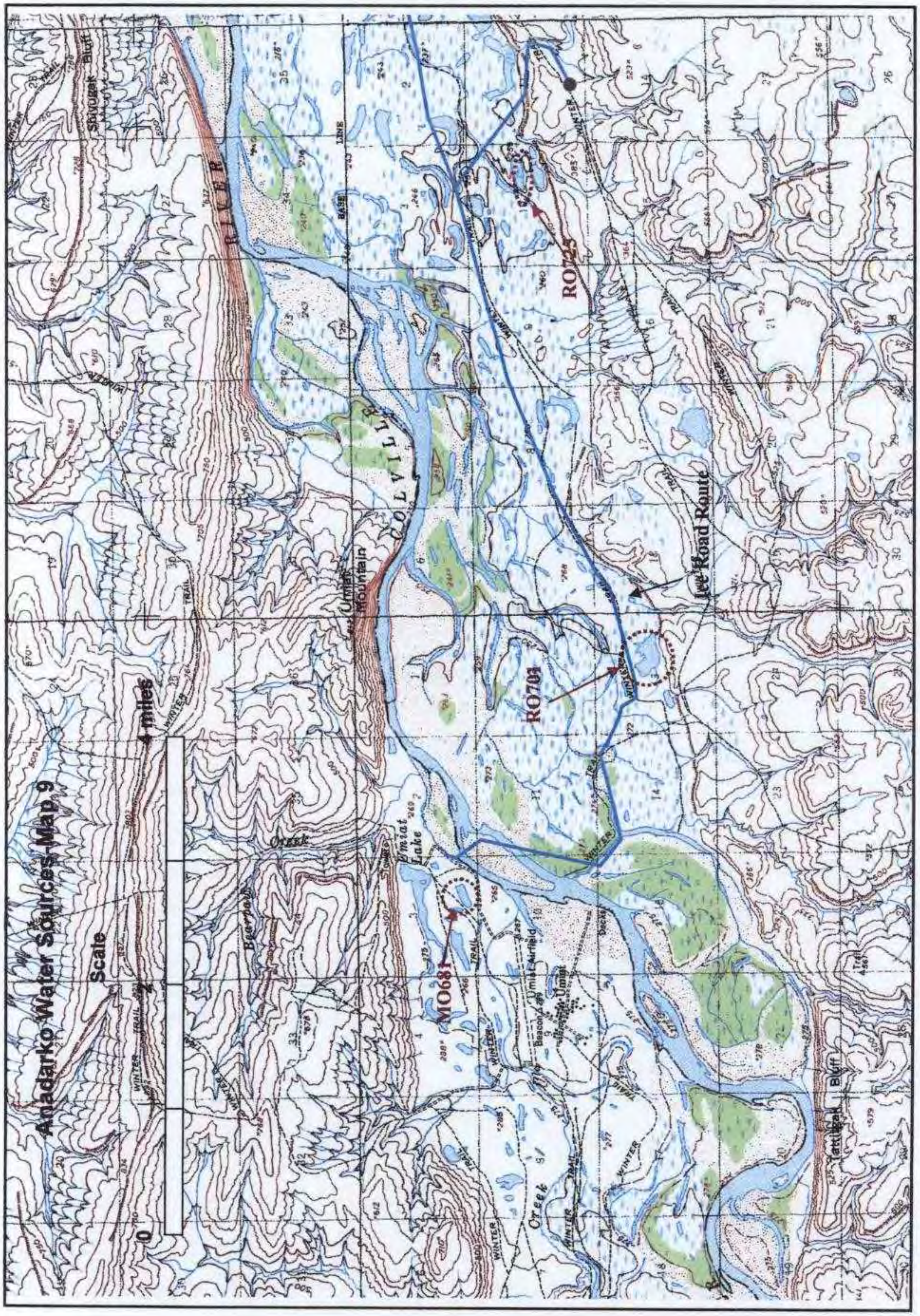
5


Anadarko Water Sources-Map 6
Scale
0
2
4 miles
RO715
RO716
RO717
Rolligon Trail Route
COLVILLE RIVER
ANAKTUVUK RIVER
WINTER TRAIL
Ulukstak
Shuk


Anadarko Water Sources-Map 7
Scale
0
2
4 miles
Rolligon Trail Route
MO688
MO689
RO720
MO691
MO690
MO687
Ice Road Route


Anadarko Water Sources-Map 8
Scale
4 miles
MO686
MO683
MO685
MO684
RO722
RO723
RO718
MO682
RO721
RO724
Ice Road Routes

8


Anadarko Water Sources Map 9
Scale
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4 miles
COLVILLE
RIVER
Umiat Mountain
Umiat Lake
MO681
RO704
Ice Road Route
Umiat Airfield
WINTER
TRAIL
Creek

APPENDIX D. Previous study reference lists.

The following list was generated in a previous report. Original Reference: PND, Inc. 2005. 2005 Spring Breakup and Hydrologic Assessment: Bullen Point Road Project. Prepared for ADOT & PF, AKSAS Project No. 75960.

Bullen Point Road Project
Hydrology References

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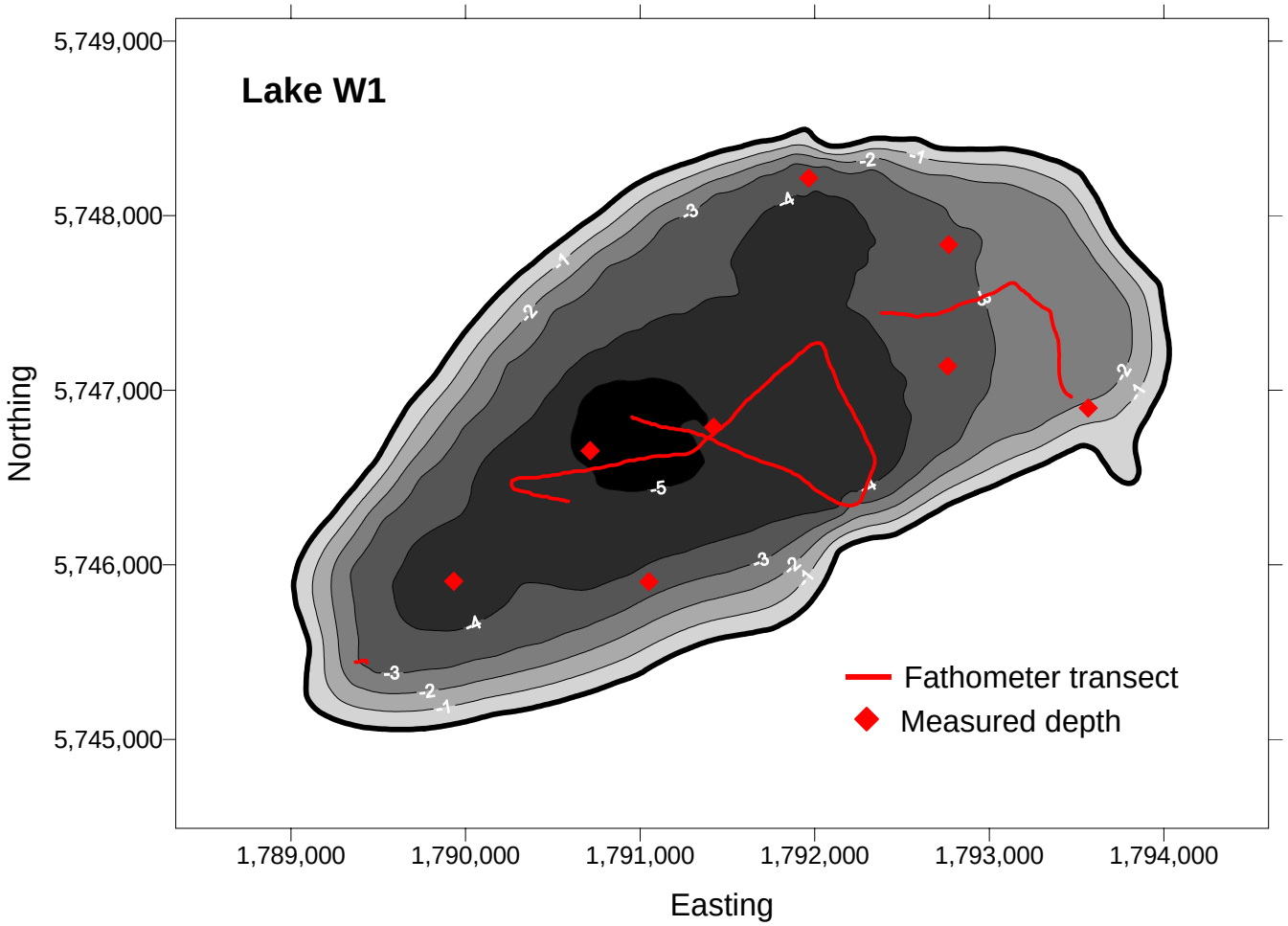
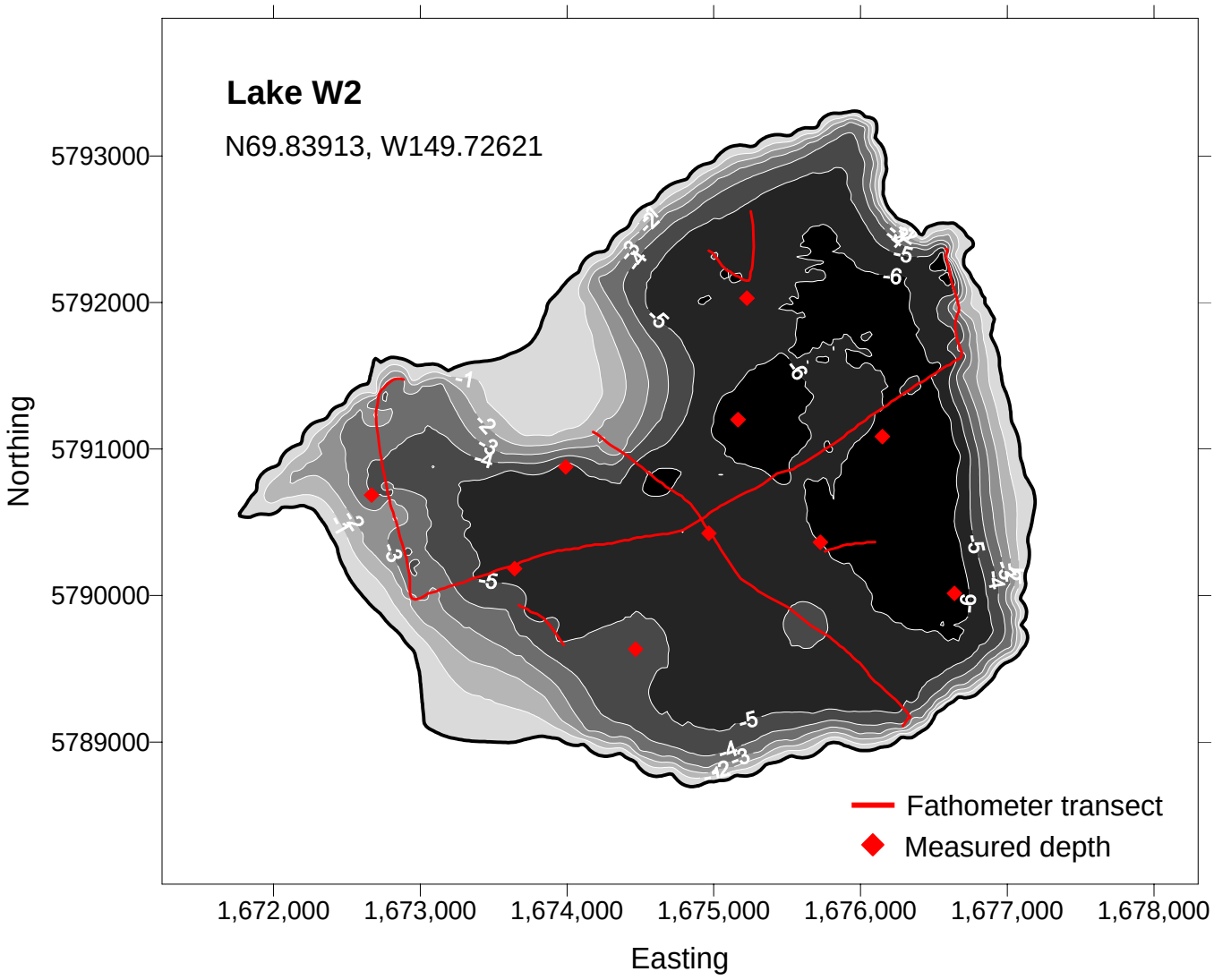
APPENDIX E. Previous study bathymetry maps



Bathymetric map of Lake W1, contour interval 1 foot
(NAD83, ASP4, Survey feet)



Bathymetric map of Lake W2, contour interval 1 foot
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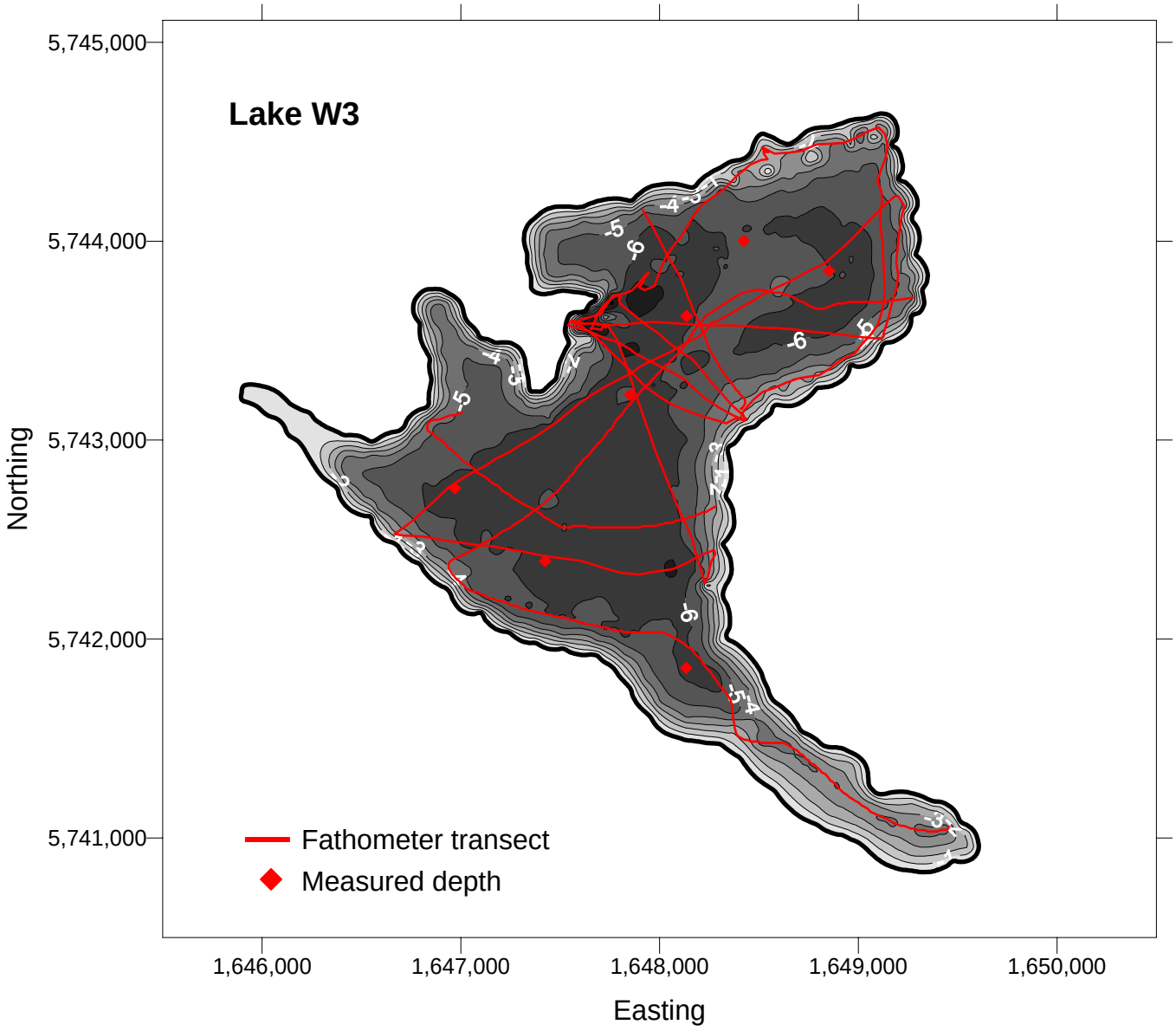
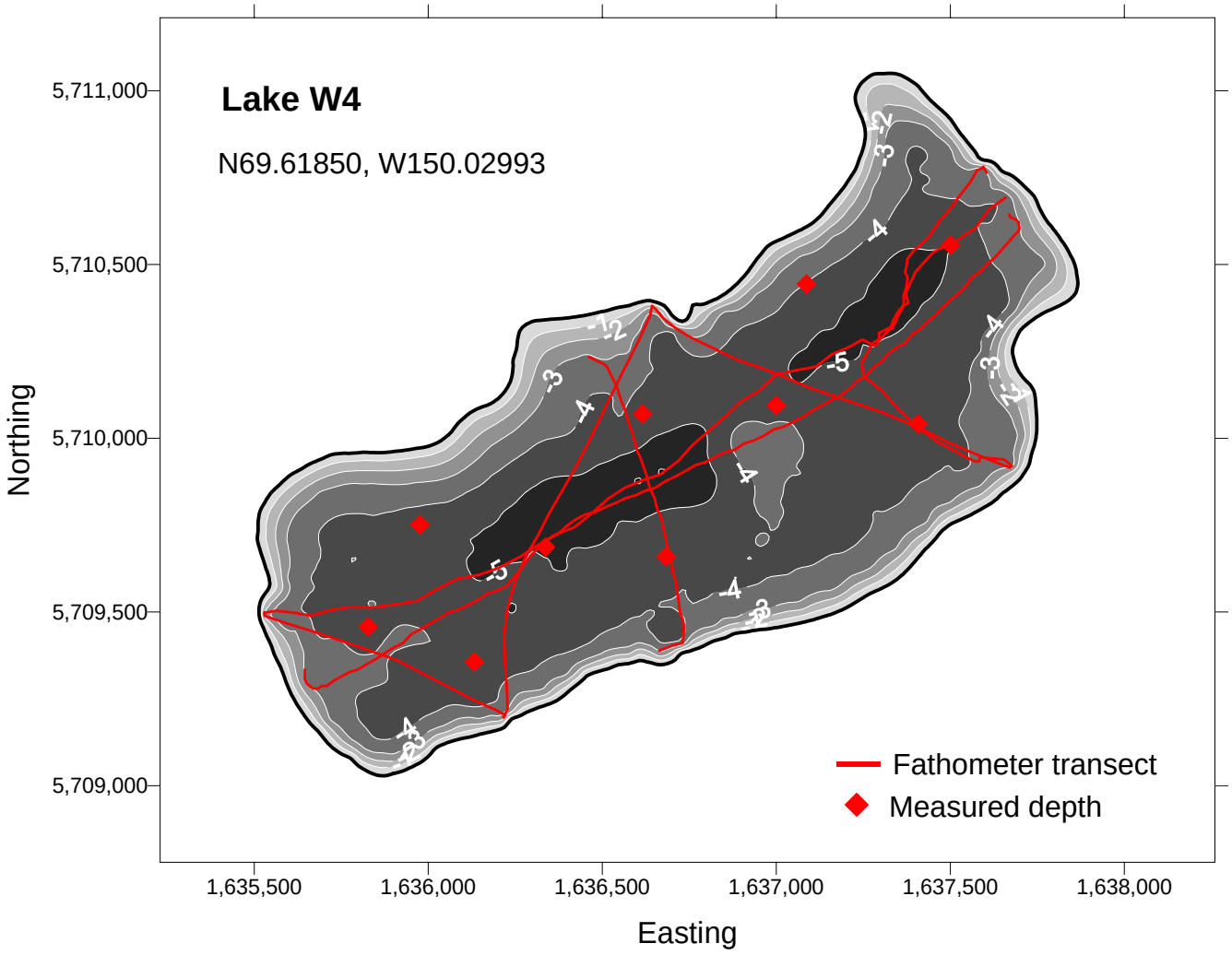
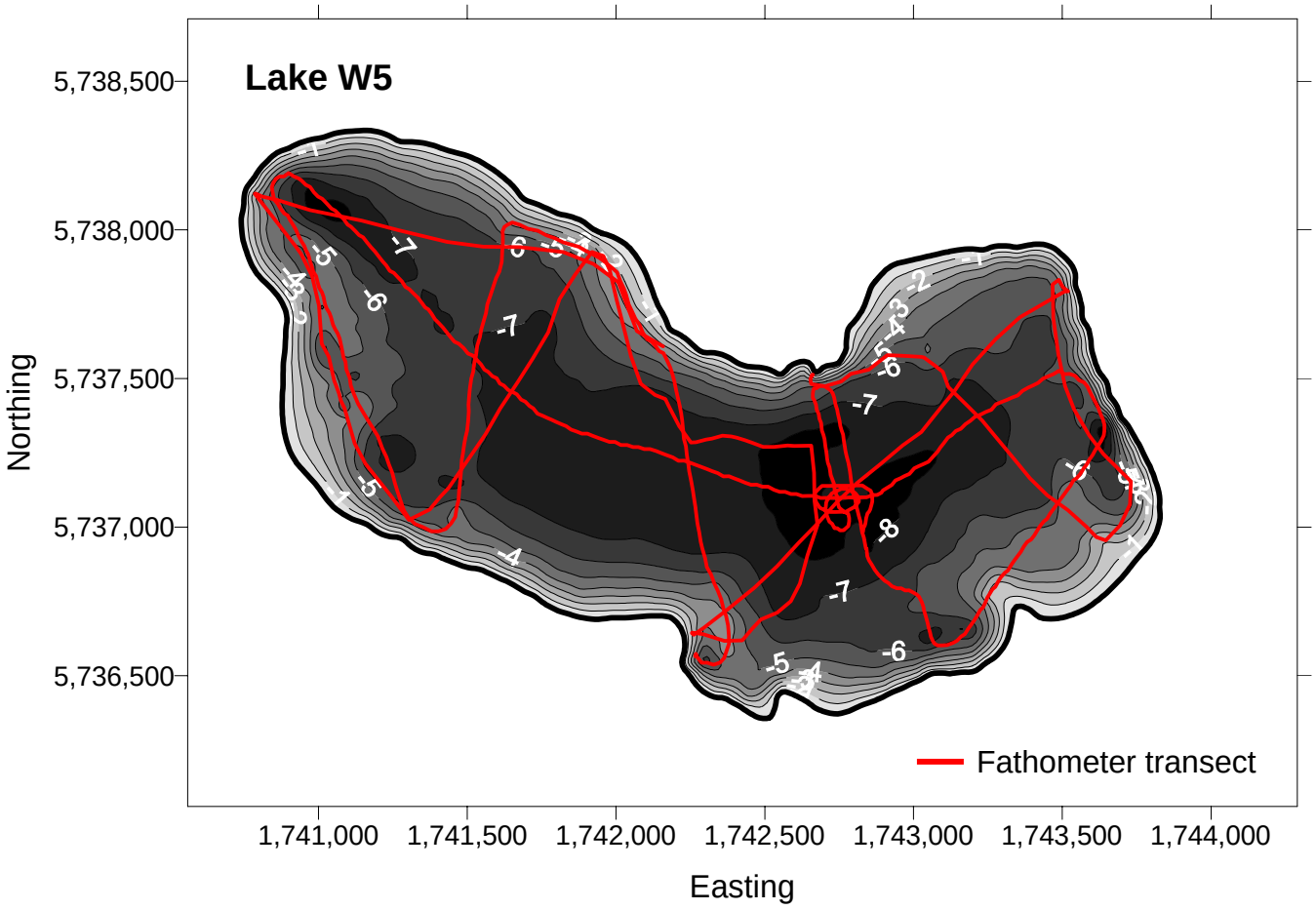


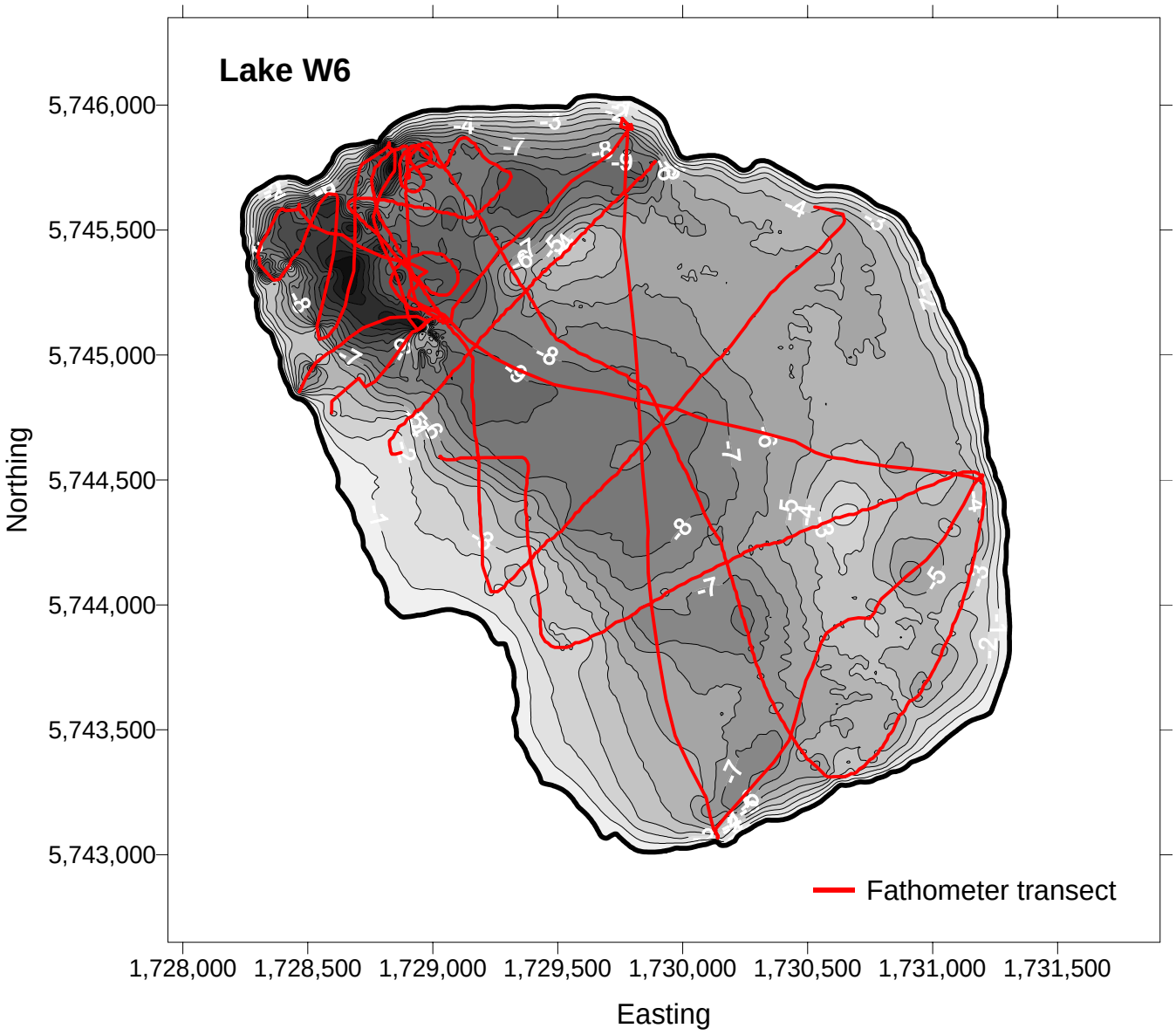
Bathymetric map of Lake W3, contour interval 1 foot
(NAD83, ASP4, Survey feet)



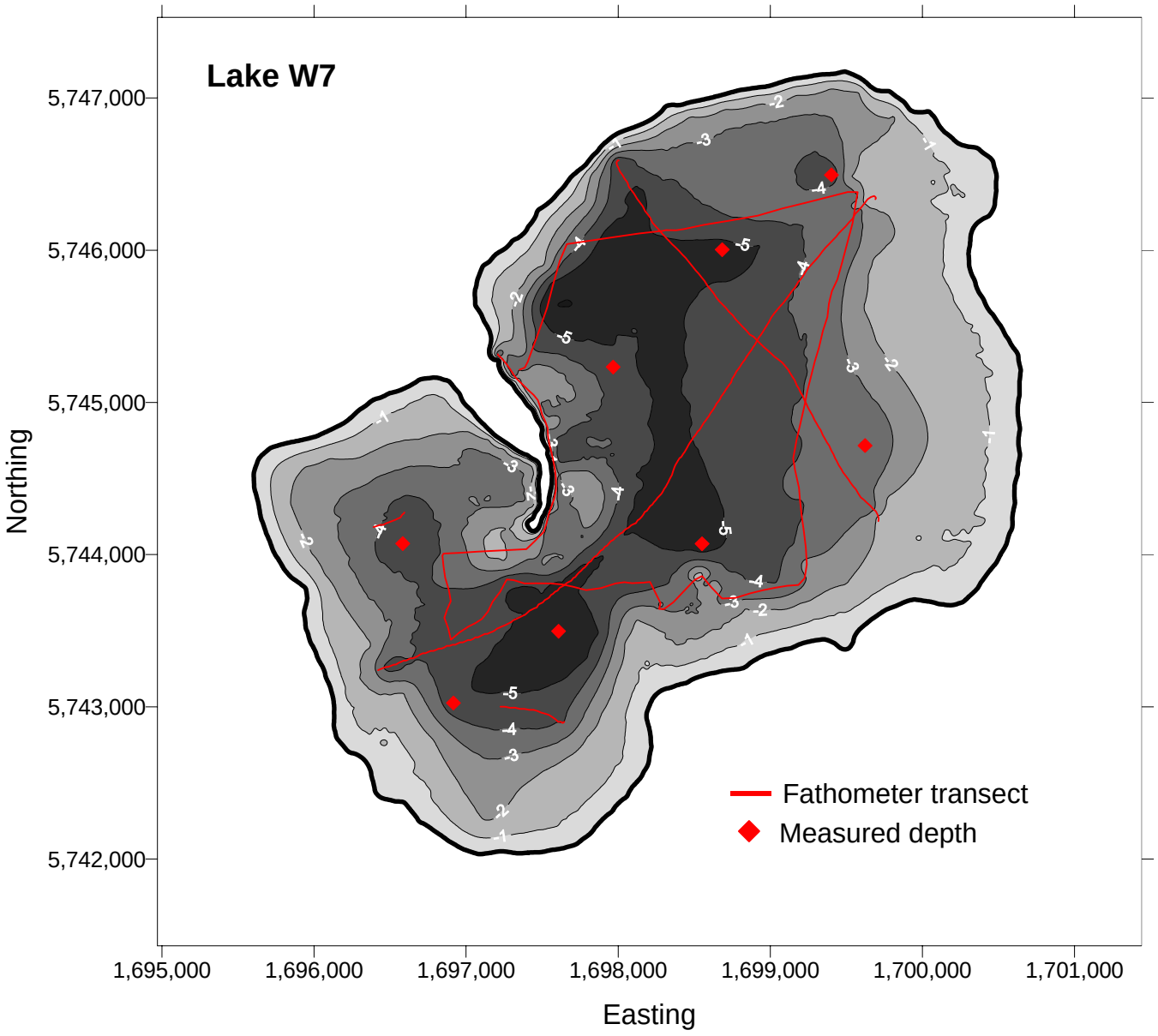
Bathymetric map of Lake W4, contour interval 1 foot
(NAD83, ASP4, Survey feet)



Bathymetric map of Lake W5, contour interval 1 foot
(NAD83, ASP4, Survey feet)



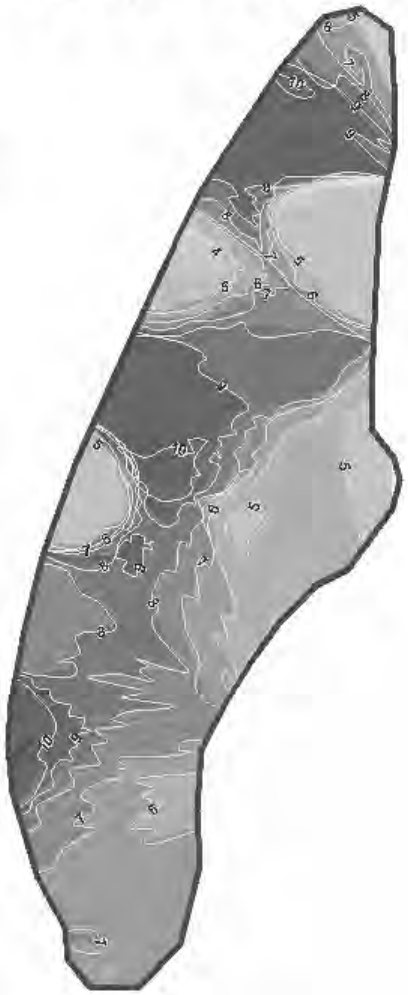
Bathymetric map of Lake W6, contour interval 1 foot
(NAD83, ASP4, Survey feet)



Bathymetric map of Lake W7, contour interval 1 foot
(NAD83, ASP4, Survey feet)

White Hills Lake Volume Estimations

Lake:	D
Total Volume (Gal):	164,472,726
Volume Below 4ft Ice (Gal):	72,482,735
Volume Below 7ft Ice (Gal):	18,902,303



OASIS ENVIRONMENTAL

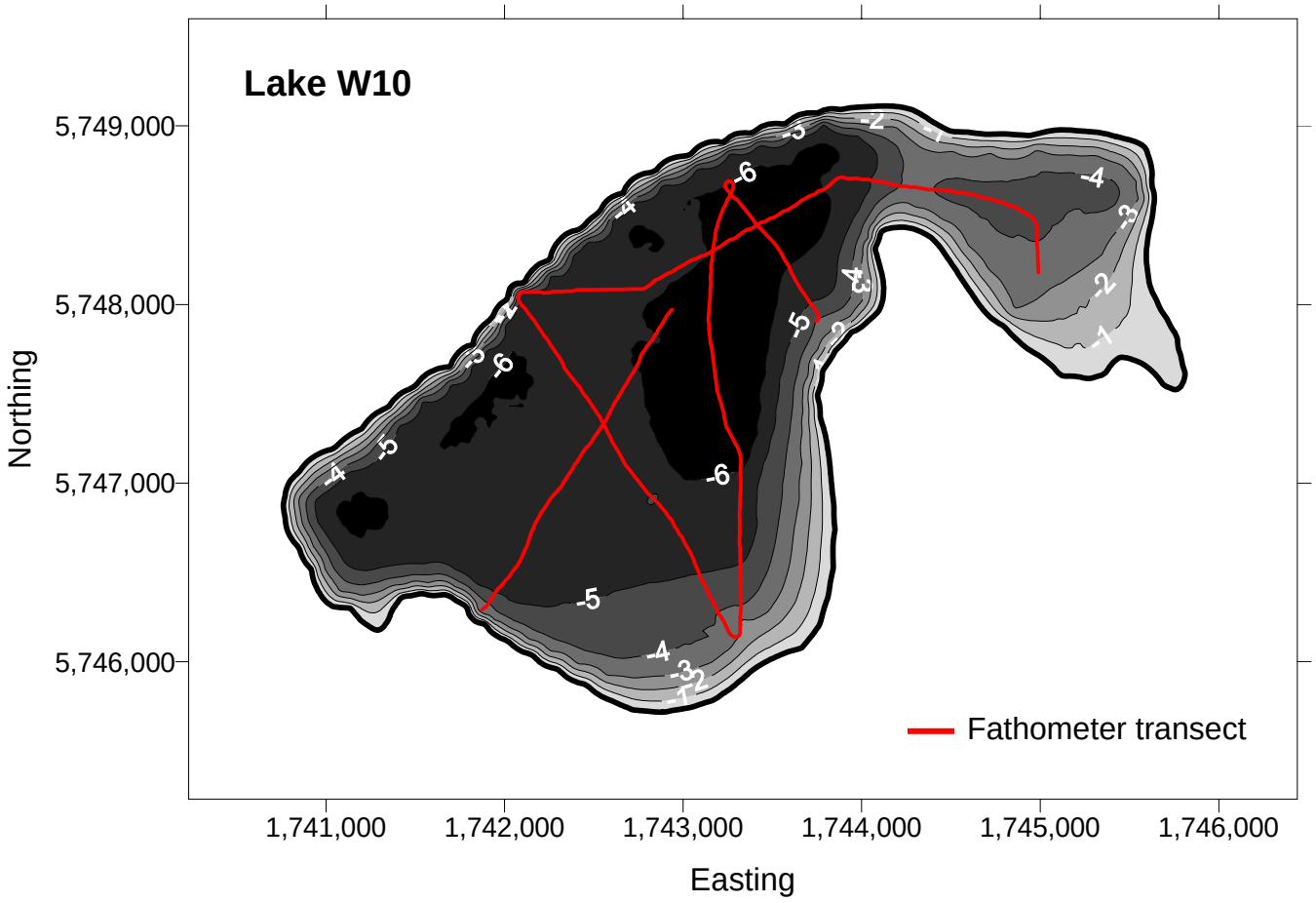
N

1 Foot Contours

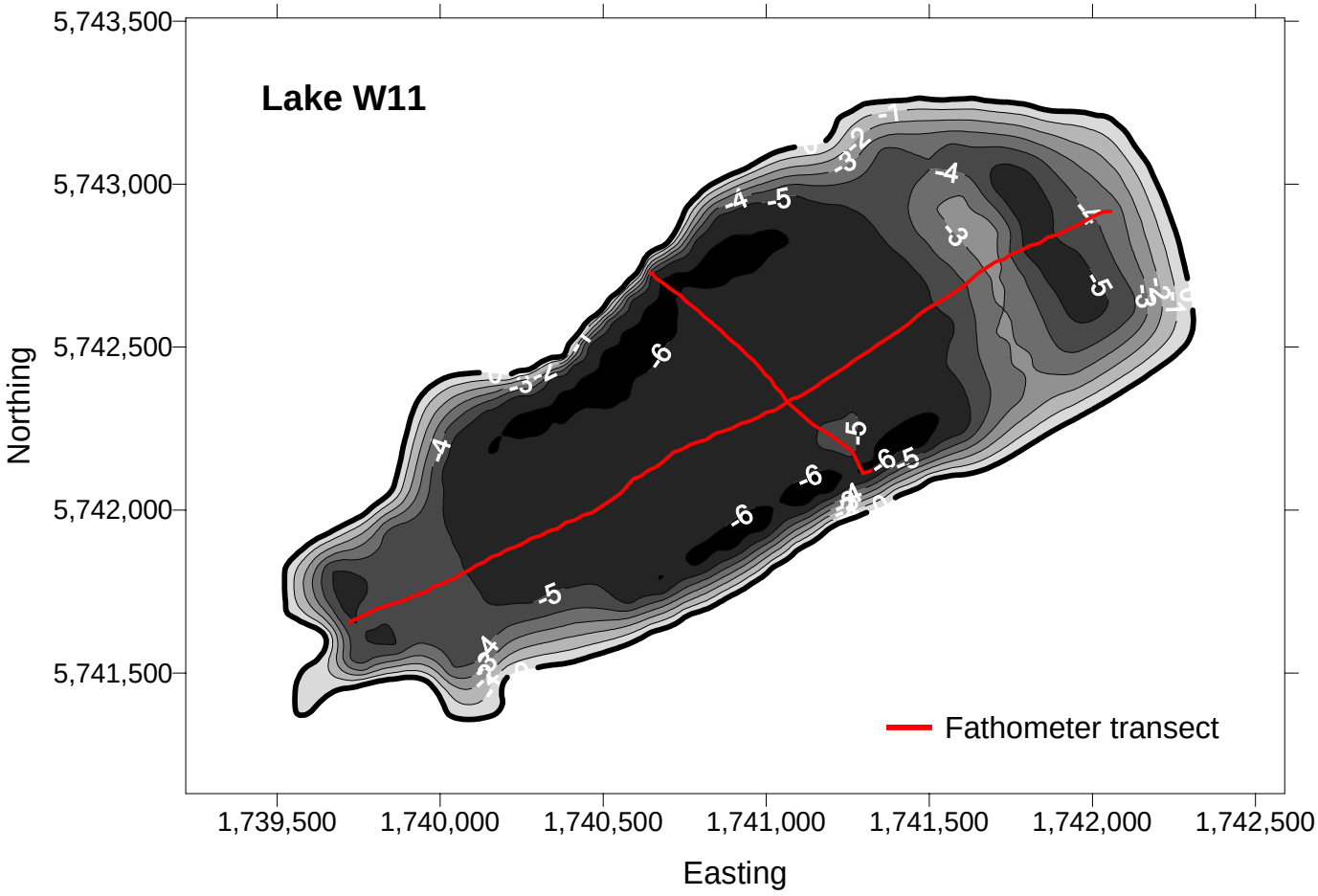
Feet

0 250 500 1,000

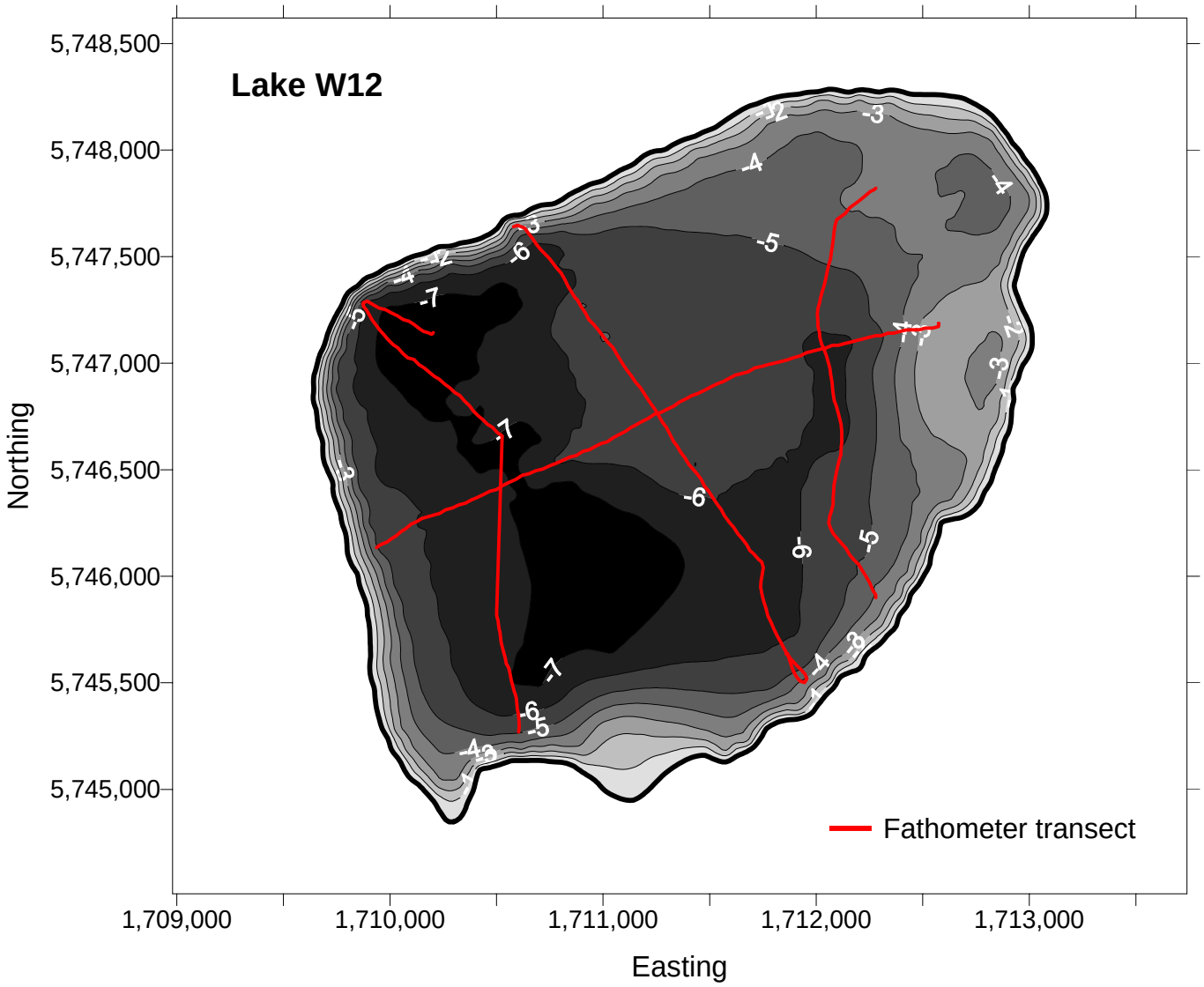
W8/Lake D



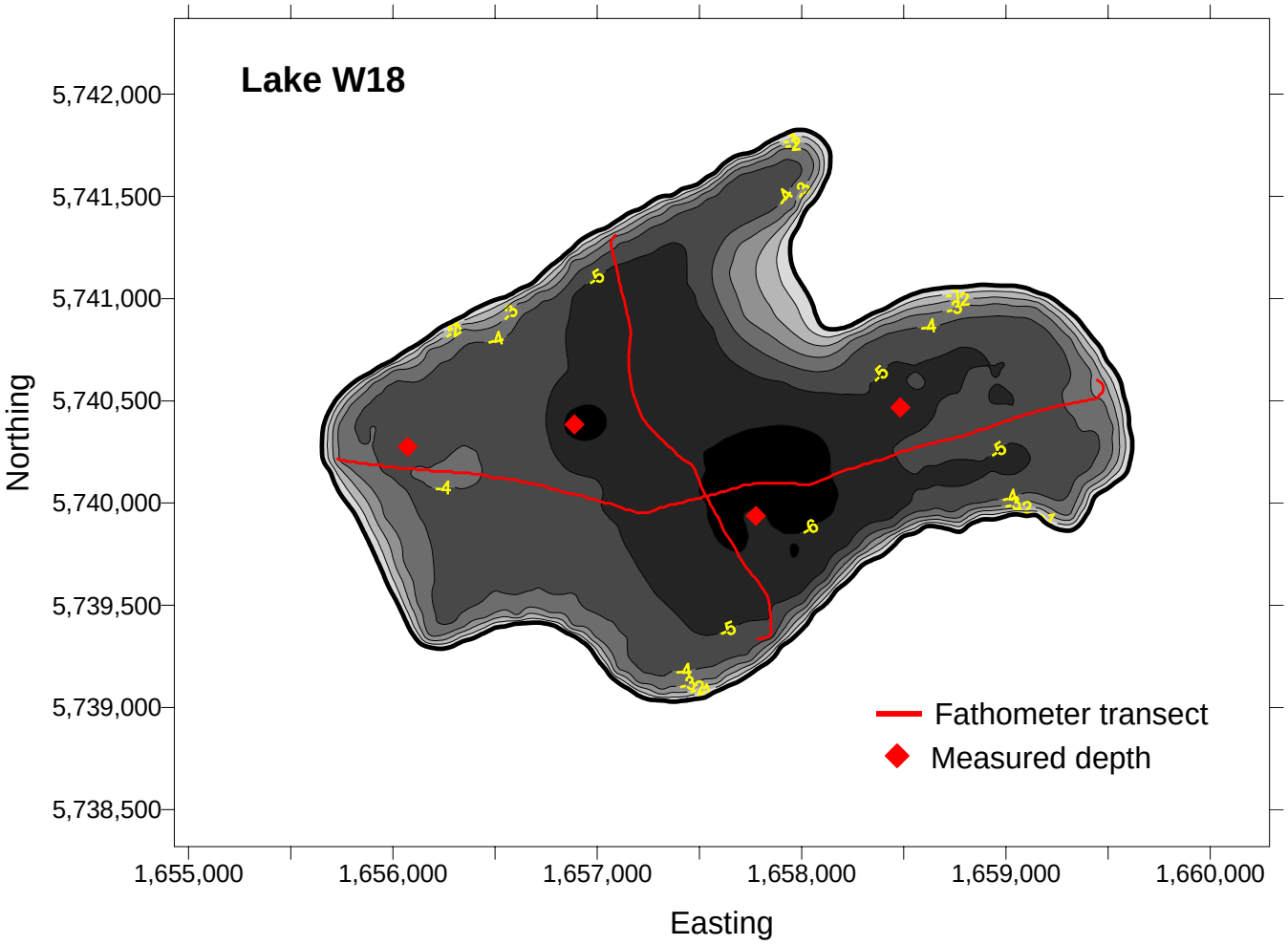
Bathymetric map of Lake W10, contour interval 1 foot
(NAD83, ASP4, Survey feet)



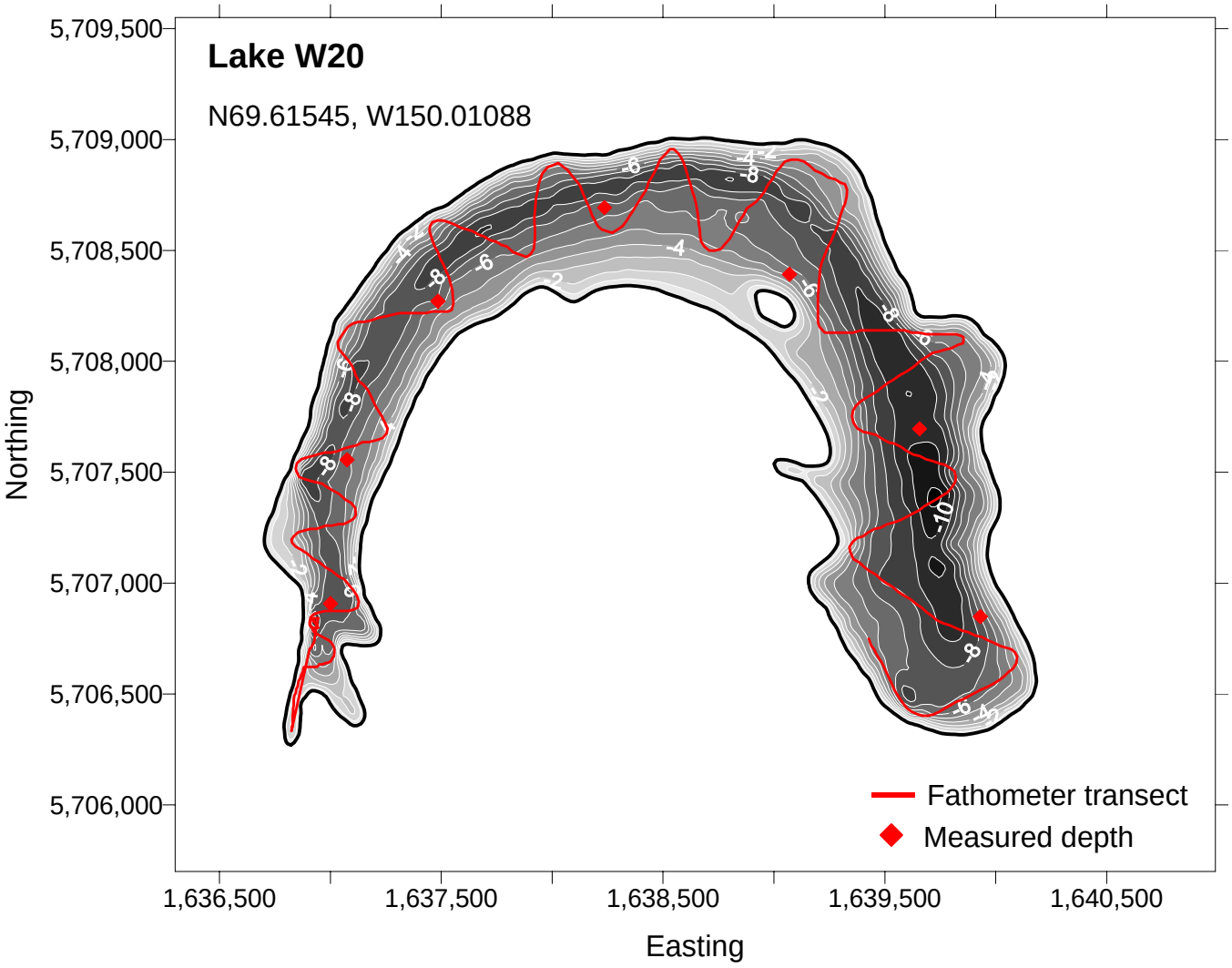
Bathymetric map of Lake W11, contour interval 1 foot
(NAD83, ASP4, Survey feet)



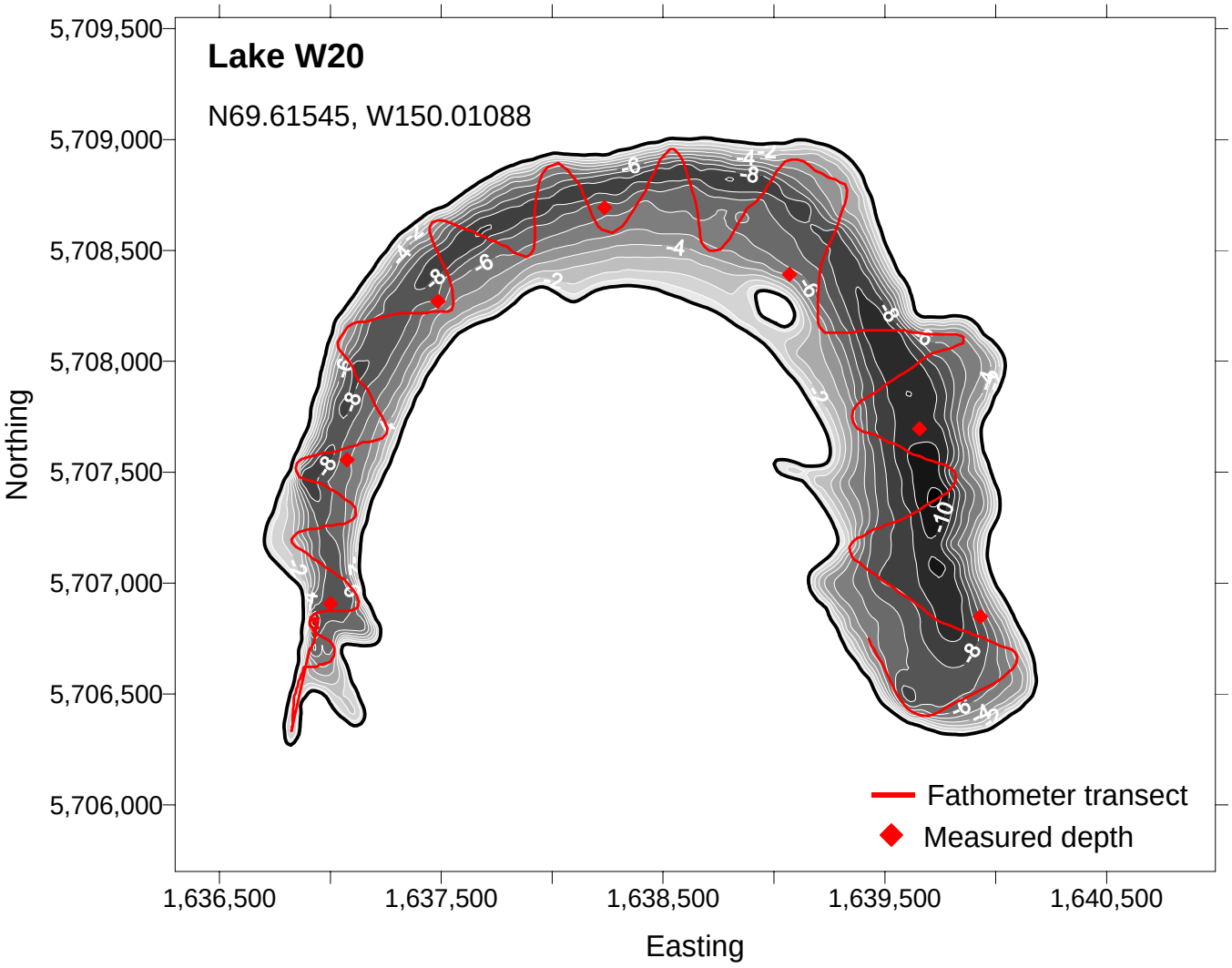
Bathymetric map of Lake W12, contour interval 1 foot
(NAD83, ASP4, Survey feet)



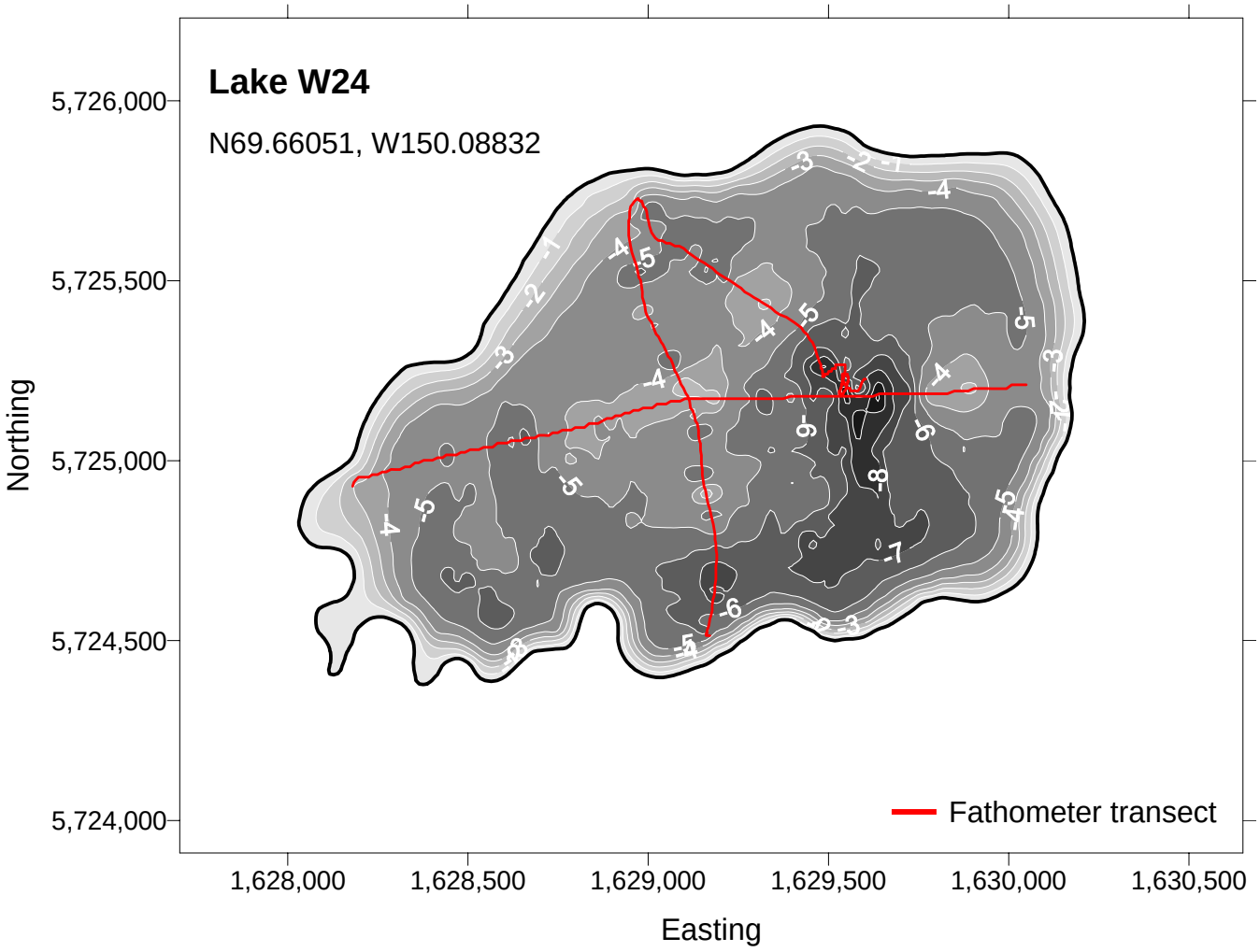
Bathymetric map of Lake W18, contour interval 1 foot
(NAD83, ASP4, Survey feet)



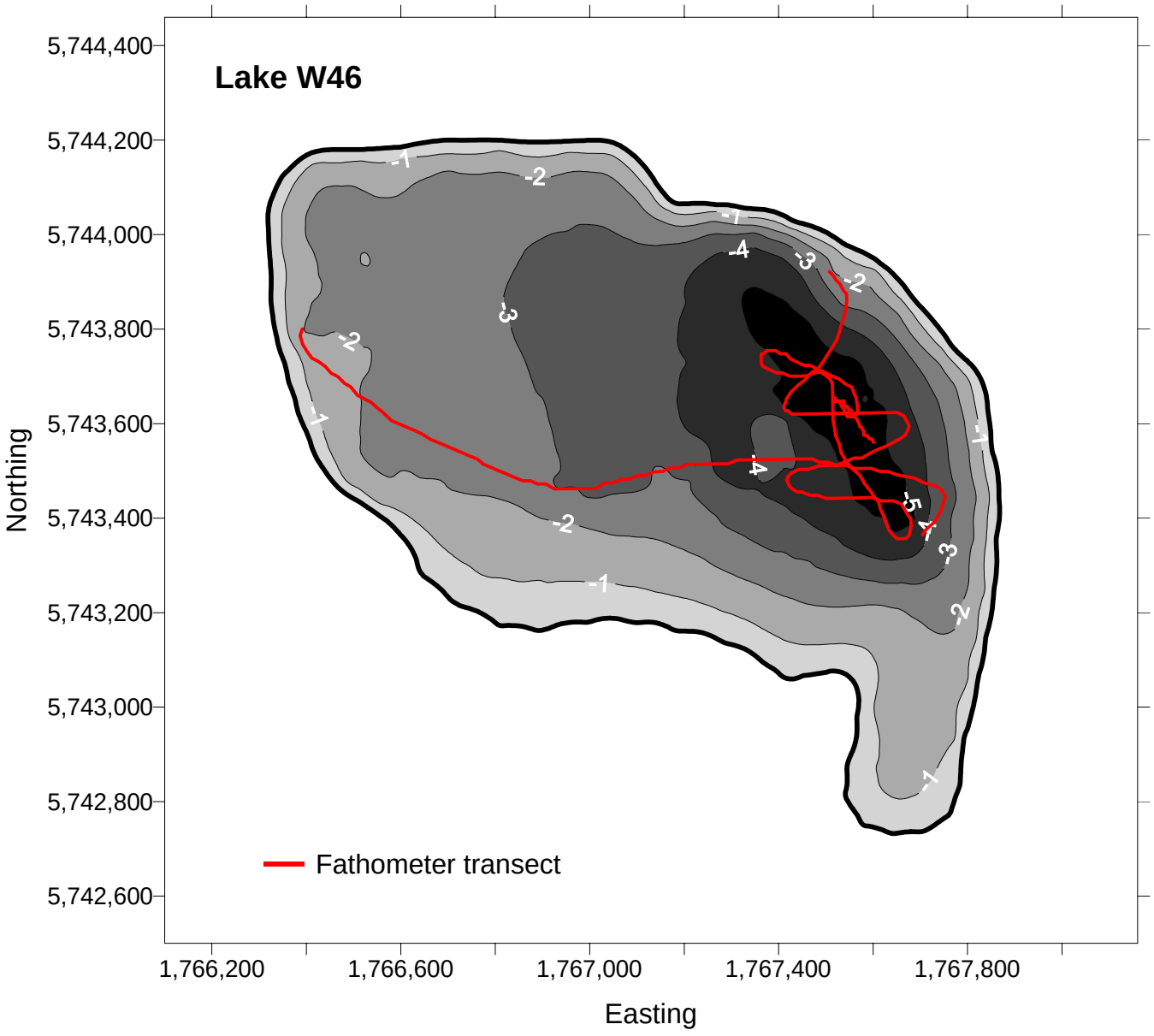
Bathymetric map of Lake W20, contour interval 1 foot
(NAD83, ASP4, Survey feet)



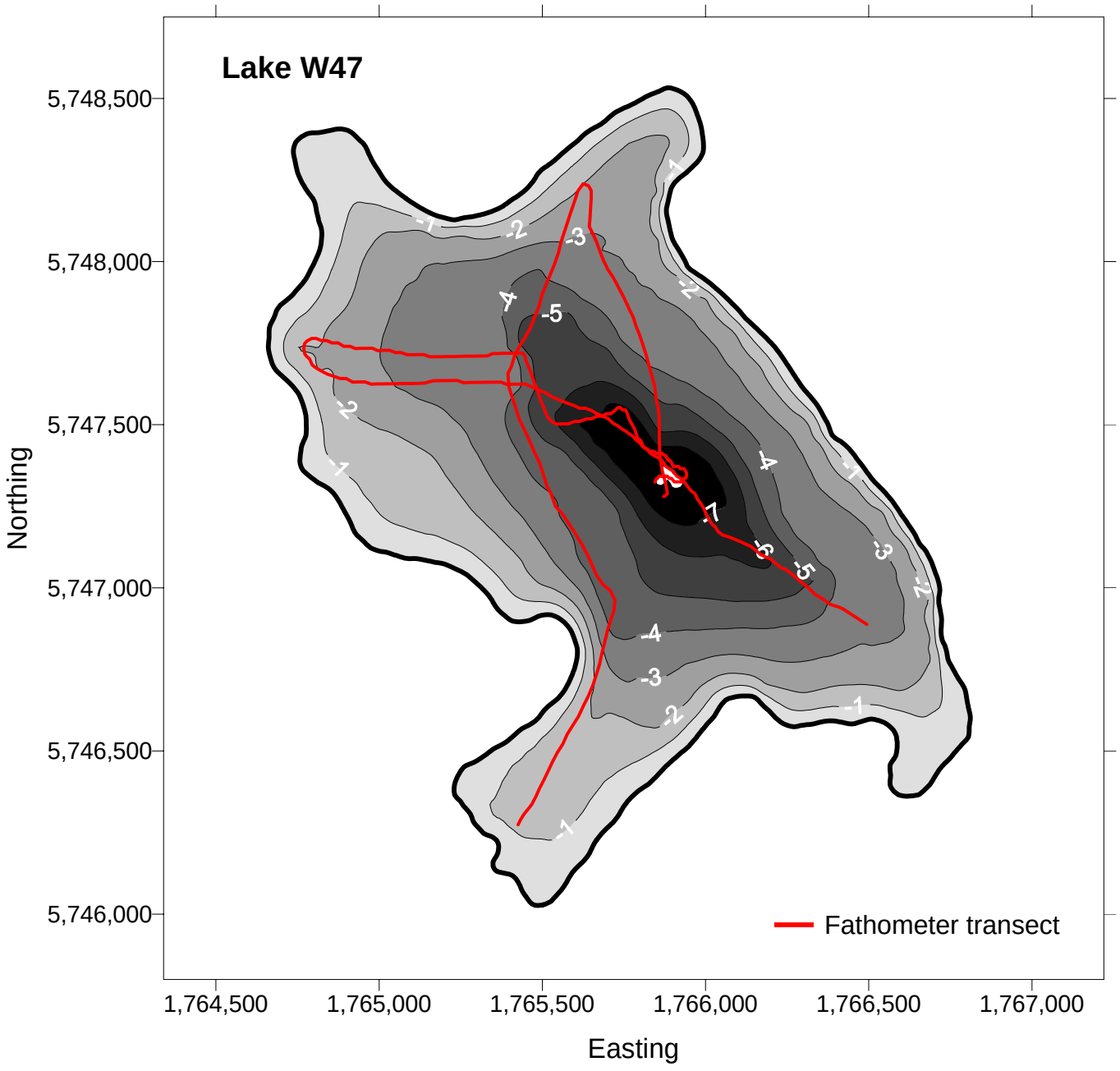
Bathymetric map of Lake W20, contour interval 1 foot
(NAD83, ASP4, Survey feet)



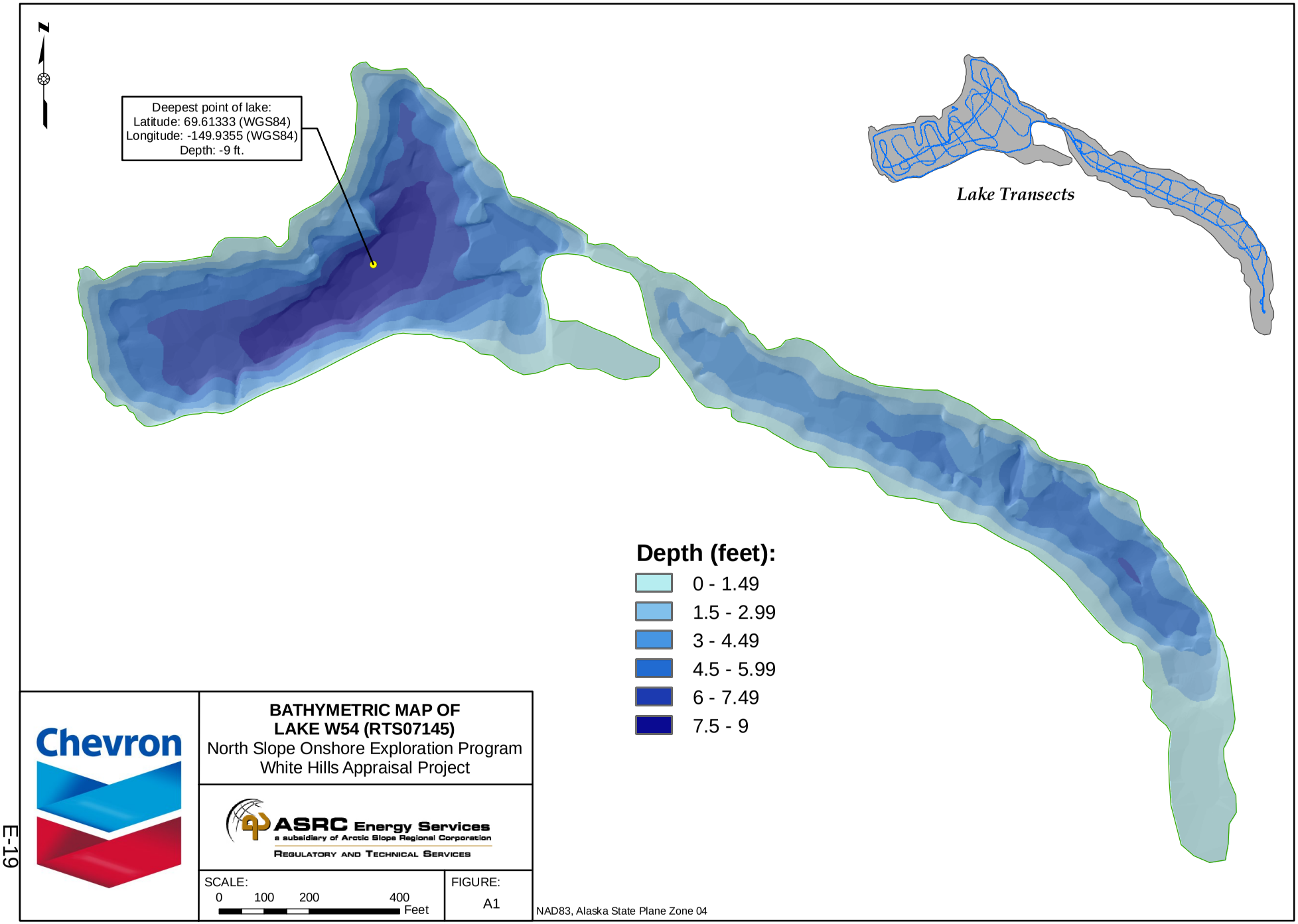
Bathymetric map of Lake W24, contour interval 1 foot
(NAD83, ASP4, Survey feet)



Bathymetric map of Lake W46, contour interval 1 foot
(NAD83, ASP4, Survey feet)



Bathymetric map of Lake W47, contour interval 1 foot
(NAD83, ASP4, Survey feet)



BATHYMETRIC MAP OF LAKE W54 (RTS07145)
North Slope Onshore Exploration Program
White Hills Appraisal Project

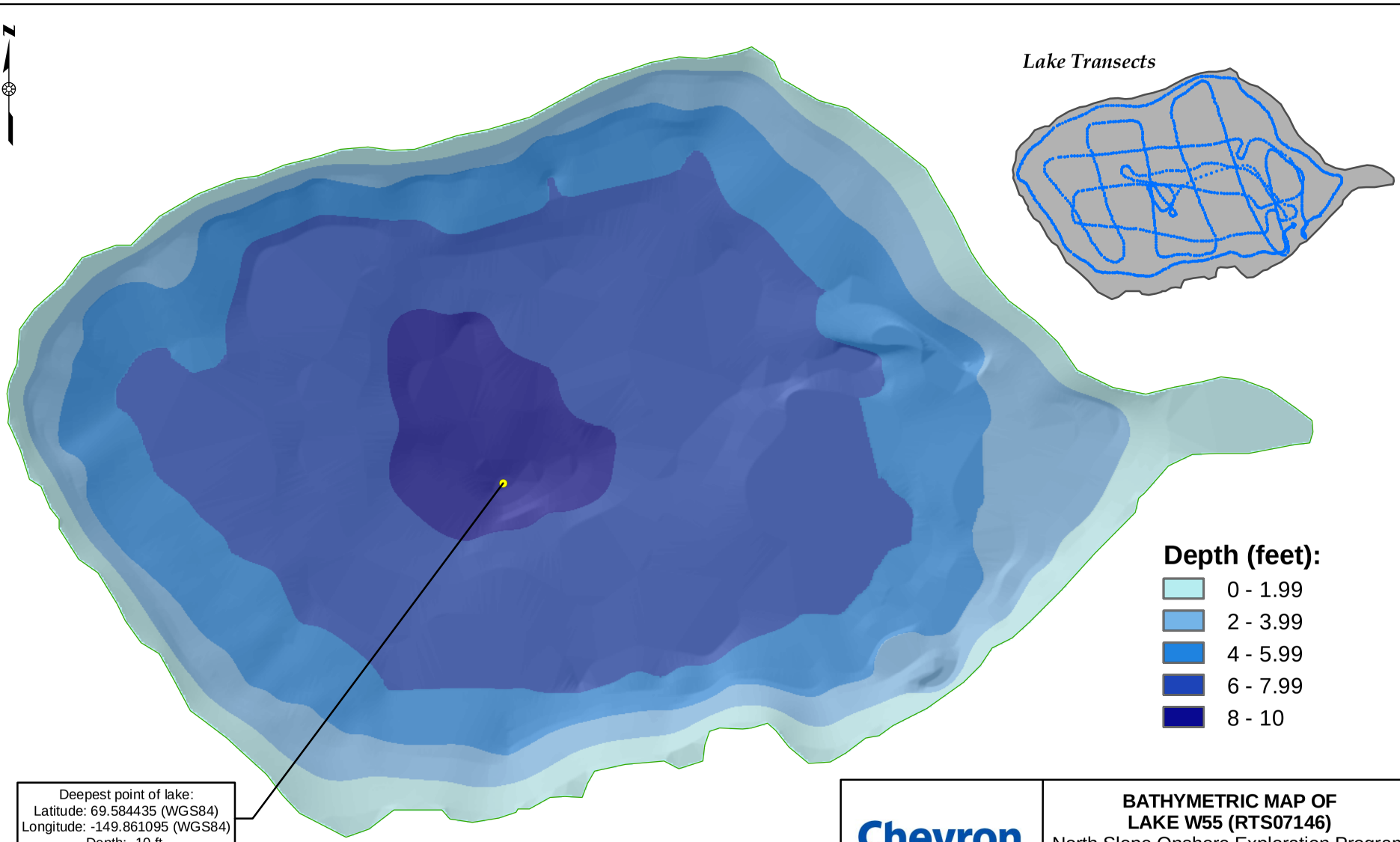
ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

SCALE: 0 100 200 400 Feet

FIGURE: A1

NAD83, Alaska State Plane Zone 04

AES-RTS: 07-391-002.mxd, 09/17/07, R00



BATHYMETRIC MAP OF LAKE W55 (RTS07146)
North Slope Onshore Exploration Program
White Hills Appraisal Project

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

SCALE: 0 37.5 75 150 Feet

FIGURE: A2

NAD83, Alaska State Plane Zone 04

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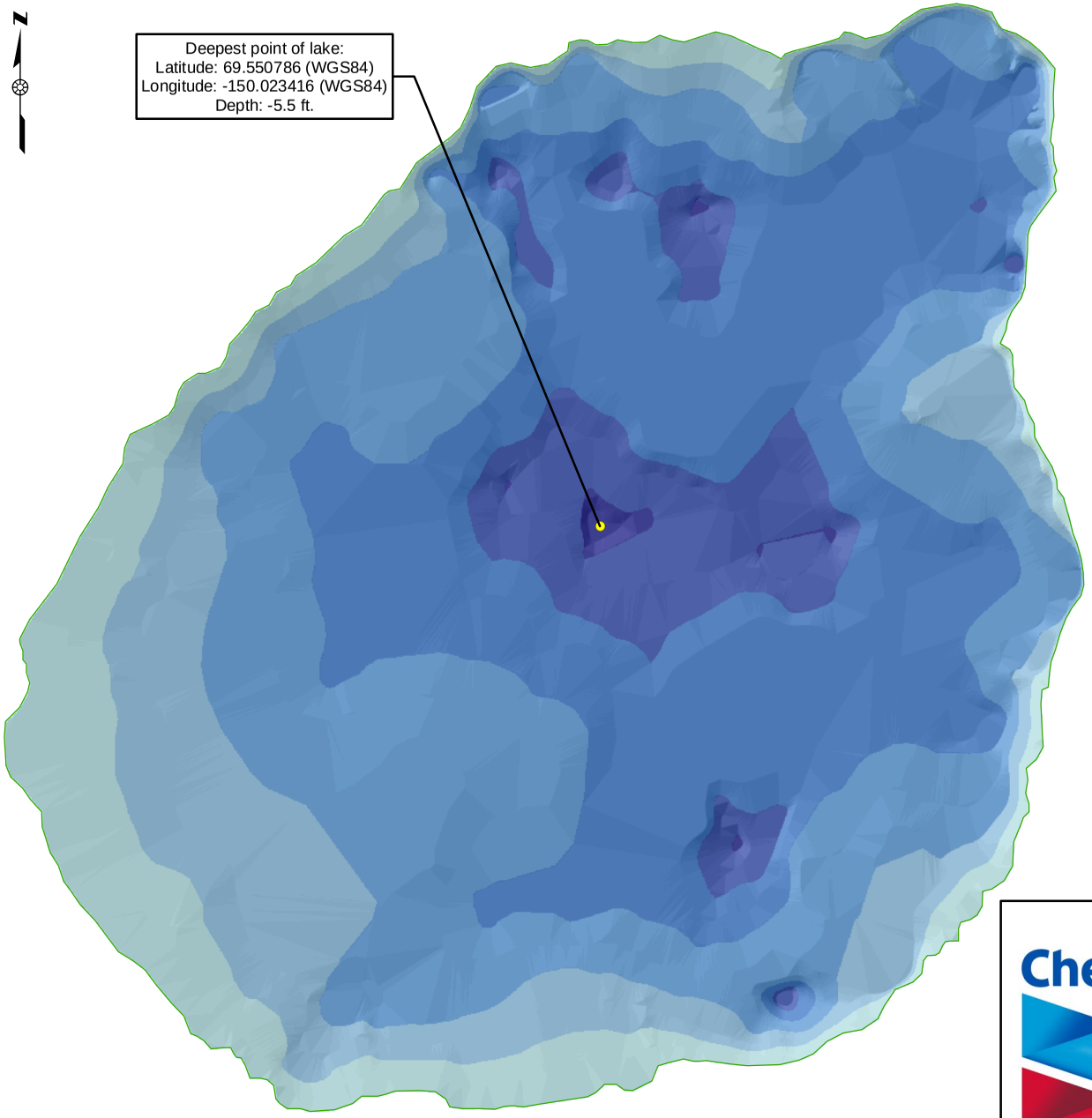
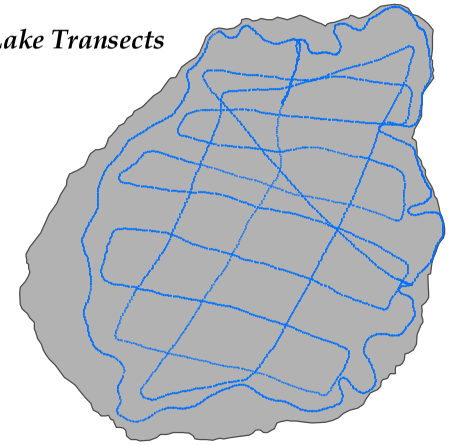


Lake Transects



Depth (feet):

- 0 - 0.99
- 1 - 1.99
- 2 - 2.99
- 3 - 3.99
- 4 - 4.99
- 5 - 5.5

Chevron

BATHYMETRIC MAP OF
LAKE W56 (RTS07147)
North Slope Onshore Exploration Program
White Hills Appraisal Project

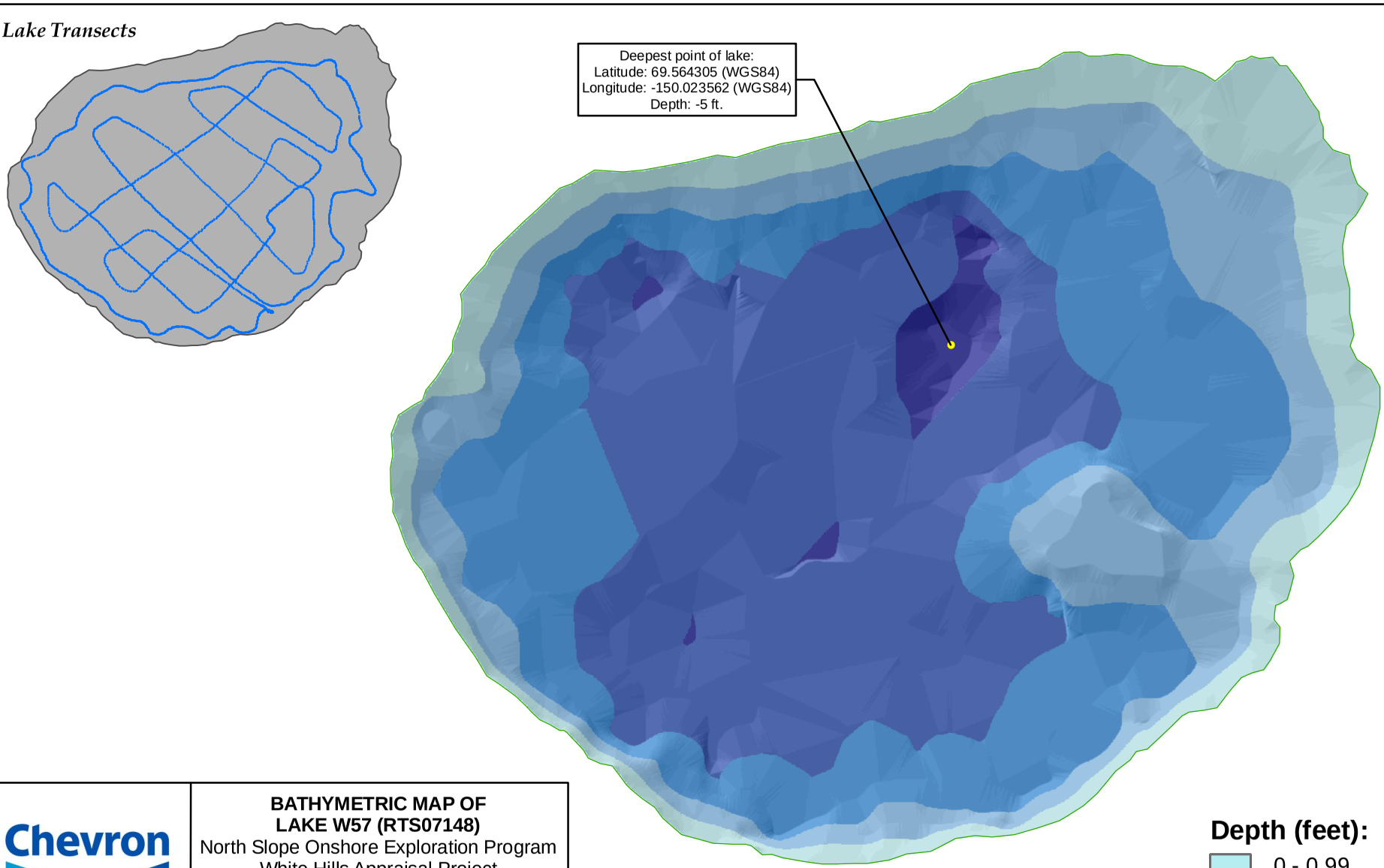
ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

SCALE:
0 100 200 400
Feet

FIGURE:
A3

NAD83, Alaska State Plane Zone 04

AES-RTS: 07-391-004.mxd, 09/18/07, R00



BATHYMETRIC MAP OF LAKE W57 (RTS07148)
North Slope Onshore Exploration Program
White Hills Appraisal Project

Chevron

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

SCALE: 0 75 150 300 Feet

FIGURE: A4

NAD83, Alaska State Plane Zone 04

AES-RTS: 07-391-005.mxd, 09/18/07, R00

APPENDIX F. Cross reference of alternate lake names

This table was generated as a cross reference guide between reports that identify the same lake with different names.

Cross Reference of Alternative Names:

Chevron Lake Names	MJM Lake Names	Reanier and AES-RTS Lake Names	Miscellaneous Names
W1		R0616	
W2		R0623	
W3		R0624	E
W4		R0634	F
W5		R0620	A
W6		R0622	B
W7		R0629	C
W8		R0633	D
W11		R0619	
W12		R0630	
W17		R0626	
W18		R0625	
W19		R0636	
W20		R0635	
W24		W0641	
W25		R0640	
W30		R0663	
W31	M0163	R0663	
W32	M0162	R0664	
W33	M0164	R0665	
W34	M0165	R0667	
W47		R0644	
W52		R0656	
W54			RTS07145
W55			RTS07146
W56			RTS07147
W57			RTS07148
W58			RTS07149
	MO182		B7917