UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RESULTS OF EXPLORATORY DRILLING AT POINT MACKENZIE, ALASKA, 1981

By Leslie Patrick

U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 81-1072

Prepared in cooperation with the

MATANUSKA-SUSITNA BOROUGH and

ALASKA DEPARTMENT OF NATURAL RESOURCES,

DIVISION OF GEOLOGIC AND GEOPHYSICAL SURVEYS

Anchorage, Alaska
1981

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

Multiply inch-pound units	by	to obtain SI units
inches (in.)	25.40	millimeters (mm)
feet (ft)	0.3048	meters (m)
gallons per minute (gal/min)	0.06309	liters per second (L/s)

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 "Mean Sea Level." NGVD of 1929 is referred to as sea level in this report.

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ABSTRACT

The Matanuska-Susitna Borough anticipates industrial development near Point MacKenzie, Alaska. Because little hydrologic information is available for the area, the Borough contracted for the drilling of two test wells. It was found that:

- Both wells penetrated unconsolidated stratified clay, silt, sand, and gravel.
- Each well penetrated a shallow unconfined and deeper confined aquifers.
- The water levels in the wells rise and fall with the tide.
- The chemical analyses indicate that the water quality meets the Alaska Drinking Water Standards, except for slightly high levels of manganese and pH.
- The potential for saltwater intrusion should be evaluated as part of future studies.

INTRODUCTION

The Matanuska-Susitna Borough expects industrial development in the Point MacKenzie area, approximately 4 mi north of Anchorage, (fig. 1). Because little information has been available on the subsurface geology and aquifer conditions in the area, the Borough hired DOWL Engineers to initiate and monitor the drilling of test wells. As part of a cooperative program between the Borough and the U.S. Geological Survey, the Survey sampled the water for chemical analysis and helped monitor the drilling.

M-W Drilling Company of Anchorage constructed the wells in February and March 1981. Both wells were drilled using the air rotary method. However, a cable-tool rig was used to complete the final 20 feet of well 21586 because of heaving sand at approximately 340 ft below land surface datum (LSD). Well construction information is presented in table 1.

AQUIFERS

Both wells penetrated stratified unconsolidated clay, silt, sand, and gravel. Tables 2a and 2b present a synthesis of data recorded by the drillers and the author.

Both wells penetrated shallow and deep aquifers. The principal aquifer in well 21585 consists of layers of sand and gravel and of silty sand and gravel extending from 219 ft below LSD to an unknown depth. This well did not penetrate the bottom of the aquifer. The principal aquifer in well 21586 is similar in composition and extends from 219 to 349 ft below land surface.

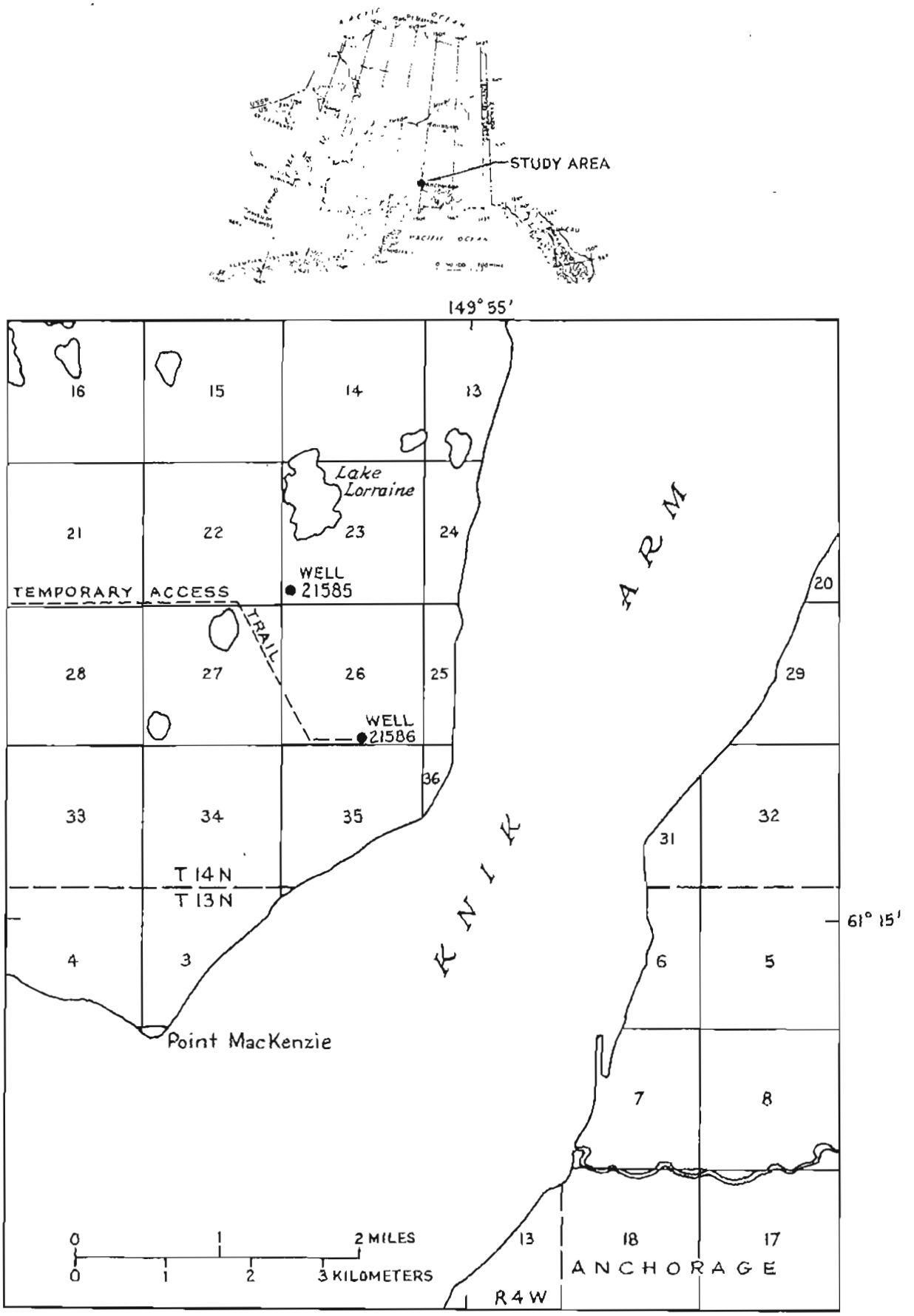

Figure 1. -- Location of the test wells in the Point MacKenzie area.

Table 1.--Well construction information

Well number	21585	21586
Land net location	Southwest 1/4 of the southwest 1/4 of the southwest 1/4 of Township 14 North, Range 4 West, Section 23 Seward Meridian	Southwest 1/4 of the southwest 1/4 of the southeast 1/4 of Township 14 North, Range 4 West, Section 26 Seward Meridian
Latitude/Longitude[1]	61°16'59"N 149°57'20"W	61°16'07"N 149°56'22"W
Altitude[2]	130 ft above sea level	152 ft above sea level
Maximum depth of hole	398 ft below LSD	358 ft below LSD
Finished depth of well	398 ft below LSD	358 ft below LSD
Diameter of casing	8 in. to 30 ft below LSD 6 in. to 380 ft below LSD	8 in. to 30 ft below LSD 6 in. to 352 ft below LSD
Well finish	100 slot, wire wound screen from 379 to 398 ft below LSD	12 shot perforations from 318 to 323 ft below LSD
Date begin construction	February 18, 1981	February 10, 1981
Date end construction	March 18, 1981	March 3, 1981

1 - Latitude and longitude are calculated for plotted points on a USGS reference map. These may not be the exact locations of the well sites.

2 - Altitude surveyed by DOWL Engineers.

Table 2a.--Lithologic log of well 21585

Depth below LSD (ft)		Depth below above sea level (ft)		Thickness (ft)	*Water level below LSD (ft)	*Water level above sea level (ft)	Significant aquifers	Lithologic description
from	to	from	to					
1	4	129	126	3	4	126		Silty, sand and gravel
4	15	126	115	11			Unconfined	Silty, sand and gravel - water
15	26	115	104	11				Silty sand - water
26	35	104	95	9				Clay
35	55	95	75	20				Silty, sandy clay - damp
55	63	75	67	8				Clay
63	125	67	5	62				Hardpan
125	130	5	0	5				Silty, sand and gravel - water
130	170	0	-40	40	113	17	Confined	Sand and gravel - water
170	188	-40	-58	18				Clay
188	197	-58	-67	9				Gravelly clay
197	219	-67	-89	22				Clayey, silty sandy gravel
219	284	-89	-154	65	112	19		Sand and gravel - water
284	294	-154	-164	10				Sand - water
294	309	-164	-179	15			Confined	Sand and gravel - water
309	312	-179	-182	3				Gravelly sand - water
312	323	-182	-193	11				Silty sand - water
323	338	-193	-208	15				Silty, sand and gravel - water
338	398	-208	-268	60	106	24		Sand and gravel - water

*Water level measured when the well was drilled to the depth indicated. This water level was taken approximately one-half an hour after drilling and blowing the formation with air. Therefore, this measurement may not reflect the true static level.

Table 2b.--Lithologic log of well 21586

Depth below LSD (ft)		Depth below above sea level (ft)		Thickness (ft)	*Water level below LSD (ft)	*Water level above sea level (ft)	Signficant aquifer	Lithologic description
from	to	from	to					
1	8	151	144	7				Sand and gravel
8	18	144	134	10				Silty sand
18	23	134	129	5			Unconfined	Sand - water
23	31	129	121	8				Grey clay
31	106	121	46	75				Grey gravelly clay
106	116	46	36	10				Clayey gravel
116	156	36	-4	40				Silty gravel
156	166	-4	-14	10	136	16	Confined	Sand and gravel - water
166	185	-14	-33	19				Hard dry silt
185	198	-33	-46	13			Confined	Sand and gravel - water
198	203	-46	-51	5				Sand - water
203	219	-51	-67	16				Silt, sand and gravel
219	225	-67	-73	6			Confined	Gravelly sand - water
225	238	-73	-86	13				Gravel - water
238	328	-86	-176	90	142	10		Sand and gravel - water
328	339	-176	-187	11				Heaving sand - water
339	349	-187	-197	10	151	1		Heaving silty, sand and gravel - wate
349	351	-197	-199	2				Silty gravel
351	352	-199	-200	1				Cemented, sand and gravel
352	358	-200	-206	6				Sticky clay

*Water level measured when the well was drilled to the depth indicated. This water level was taken approximately one-half an hour after drilling and blowing the formation with air. Therefore, this measurement may not reflect the true static level.

Prior to test pumping, a recorder continuously monitored the water levels in each well for about a week. The records indicate a tidal fluctuation effect in the order of 0.2 ft in well 21585 and 2 ft in well 21586 (fig. 2).

Well 21585 was pumped at a constant rate of 310 gal/min for 24 hours. This resulted in a maximum drawdown of 27.28 ft in well 21585 and no discernable drawdown in well 21586 located 1 mi away. However, the information from the test is not sufficient to calculate the storage coefficient and transmissivity of the aquifer.

WATER QUALITY

A ½-horsepower submersible pump was used to collect water samples from several depths in each well as drilling progressed. Water was pumped from the open-end casing, without, screen or perforations, at about 5-6 gal/min for 45-165 minutes prior to sampling. The samples were analyzed at the U.S. Geological Survey laboratory in Denver, Colo. Table 3 lists the results of the analyses.

The water quality meets the Alaska Drinking Water Standards, except for slightly high pH in well 21585, and for slightly high manganese levels in all samples except the shallow sample from well 21586. The analyses from well 21585 indicate calcium bicarbonate water in the shallow sample trending toward sodium bicarbonate type in the deepest sample. Both samples from well 21586 are generally sodium bicarbonate water. The water in well 21585 ranges from moderately hard to hard. Both samples from well 21586 are moderately hard (Hem, 1970).

SALTWATER INTRUSION

The 24-hour test pumping of well 21585 lowered the water level in the well to approximately 3 ft below sea level. This is cause for concern because pumping industrial quantities of water might produce a greater drawdown, and possibly could induce saltwater intrusion into the present freshwater zone. Current data are not sufficient to calculate either the rate of the possible saltwater migration or pumping rates that would preclude this migration. However, because the actual movement of the saltwater would be slow, the appearance of saltwater in a well would probably not occur for several years. The potential for saltwater intrusion should be evaluated as part of future studies.

SUMMARY

- Two wells were drilled
- Both wells penetrated unconsolidated stratified clay, silt, sand and gravel.
- Each well penetrated a shallow unconfined and deeper confined aquifers.
- The water levels in the wells rise and fall with the tide.
- The chemical analyses indicate that the water quality meets the Alaska Drinking Water Standards, except for slightly high levels of manganese and pH.
- The potential for saltwater intrusion should be evaluted as part of future studies.

REFERENCE CITED

Hem, J. D., Study and interpretation of the chemical characteristics of natural water, Second Edition: U.S. Geological Survey Water-Supply Paper 1473, 363 p.

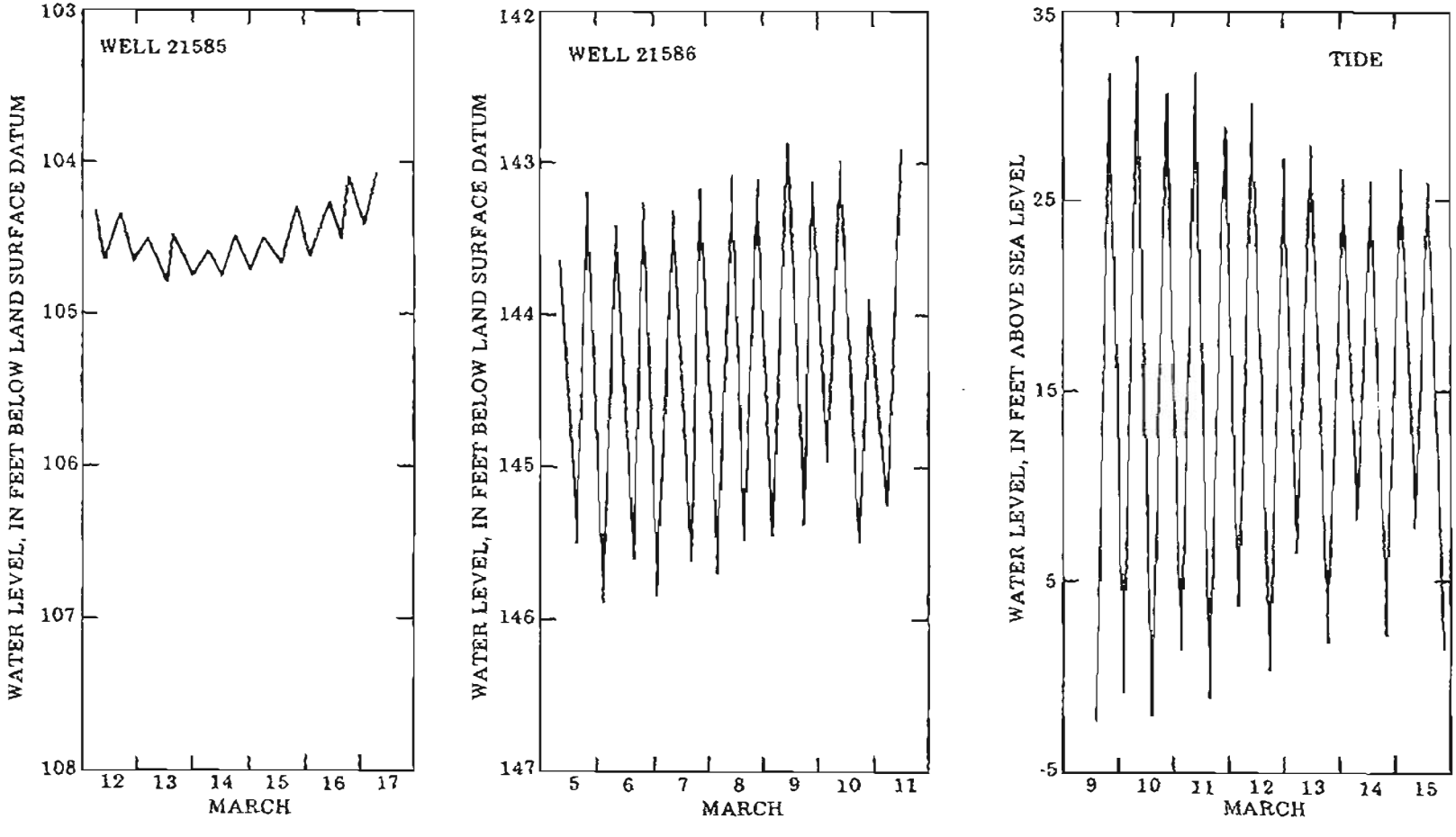

Figure 2. -- Water-level fluctuation for wells 21585 and 21586 and tidal fluctuations in Knik Arm, The well graphs are computer generated from the high and low values which were picked from continuous recorder readings. The tide graph is computer generated for the high and low tide values reported in the 1981 tide tables published by Elliott Sales Corporation, Tacoma, Washington.

Table 3.--Chemical analysis of water from the test wells. All values are dissolved except where noted.

Well	Depth - top of water zone (ft)	Depth - bottom of water zone (ft)	Depth of sample (ft)	Pump period, estimated (minutes)	Conductance, field (µmhos)	Water temperature (°C)	pH, field (units)	Silica (mg/L)	Sum of dissolved solids (mg/L)	Hardness as $CaCO_3$ (mg/L)	Hardness, noncarbonate as $CaCO_3$ (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Sodium (percent)	Potassium (mg/L)	Alkalinity as $CaCO_3$ (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrogen NO_2+NO_3 as N (mg/L)	Phosphorus (mg/L)	Arsenic (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Selenium (µg/L)	Zinc (µg/L)	Sodium absorption ratio
21585	130	170	137	60	250	3.0	8.3	13	150	110	0	24	13	12	18	2.9	130	9.5	3.1	0.1	0.00	0.06	13	90	<1	20	3	30	0	100	0.0	0	7	.5
21585	219	--	277	45	400	4.0	8.8	12	252	140	0	31	15	45	41	3.1	210	8.7	16	0.2	0.00	.07	22	170	<1	20	2	40	0	90	0.0	0	20	1.7
21585	219	--	347	165	675	4.0	8.8	11	388	83	0	22	6.8	120	75	2.5	200	14	97	0.2	0.00	.06	6	200	<1	0	1	60	1	60	0.0	0	330	5.7
21586	156	166	158	45	340	3.5	8.2	9.1	204	72	0	15	8.5	54	61	1.9	180	9.1	3.3	0.5	0.00	.04	8	410	<1	10	1	20	1	40	0.0	0	20	2.8
21586	219	349	240	70	340	3.5	8.1	12	204	93	0	22	9.2	43	49	2.9	150	7.3	17	0.2	0.00	.04	9	160	<1	10	2	40	2	80	0.0	0	20	1.9