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RESULTS OF AN AQUIFER TEST FOR A PROPOSED WATER SUPPLY AT ANCHOR POINT, ALASKA

By

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INTRODUCTION

Nine private and public water supply wells within a single plume of contamination at Anchor Point, Alaska (fig. 1) have become contaminated with fuel products during the past nine years (Alaska Department of Environmental Conservation, 1988). In an effort to develop an alternate water supply for local residents and businesses, eight test wells were drilled nearby. An aquifer encountered at one of these sites is under serious consideration as a possible source of water. This report presents the results of an evaluation of that aquifer for use as a public water supply.

ACKNOWLEDGMENTS

Eileen Olson and Kirsten Ballard of the Alaska Department of Environmental Conservation (DEC) and Darrell Hill of The Water Company contributed substantially to data collection during this investigation. Funding for this report was provided by DEC and Alaska Deparment of Natural Resources (DNR).

PHYSICAL SETTING

The six-inch diameter steel-cased well used for aquifer testing was drilled at the location shown in figure 2. The well was drilled to a total depth of 19 ft, encountering a gravel and sand aquifer at a depth interval of 9 to 19 ft below land surface. On November 7, 1988, the static water level was 9.5 ft below land surface. According to the log of an earlier exploration well drilled 3.5 ft away (see Appendix A), the aquifer is underlain by silty glacial or marine deposits to a depth of at least 61 ft. A review of area well records and conversations with local residents indicates that silty deposits extend to considerable depths, well yields from deep wells are

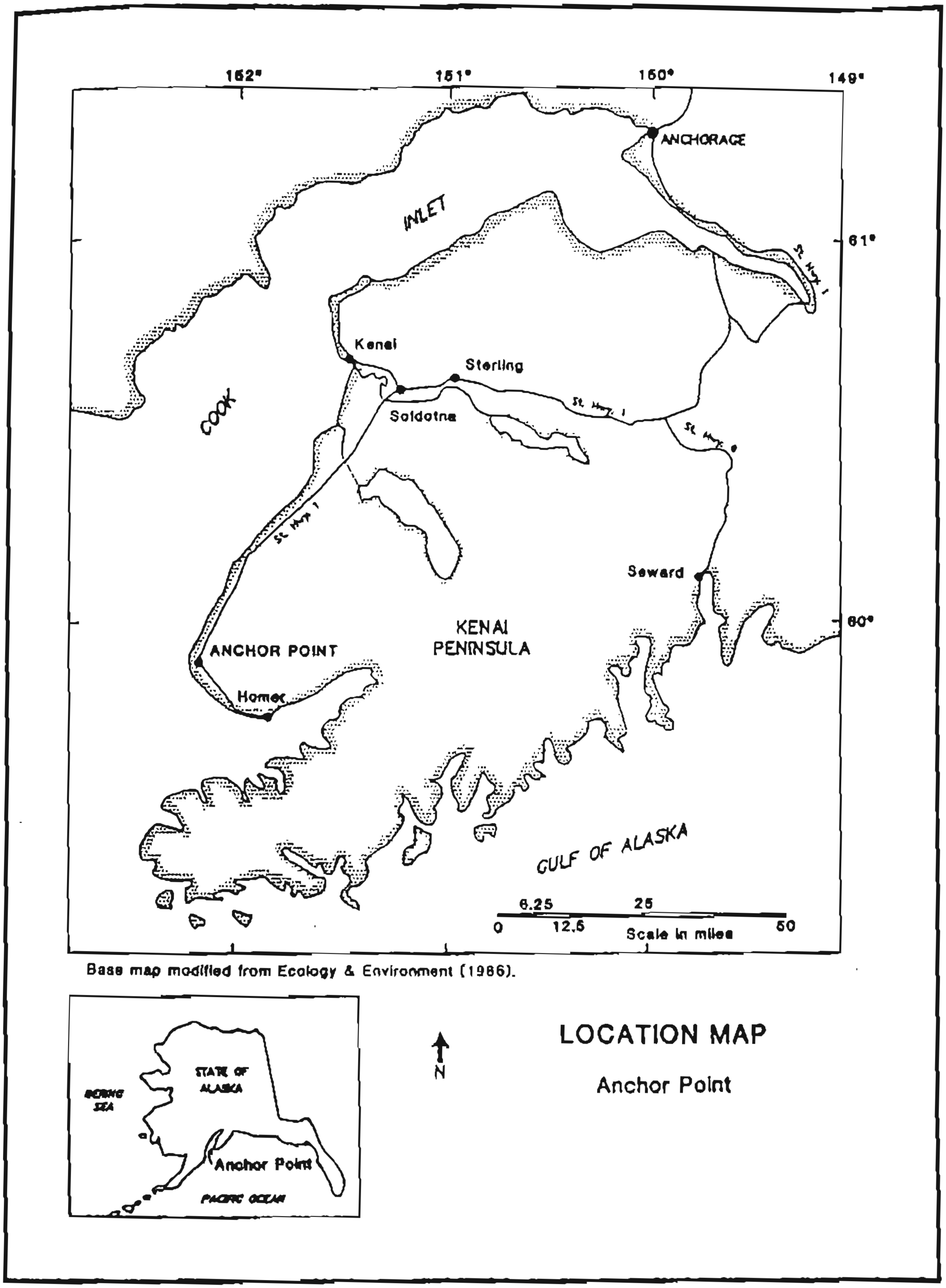

Figure 1. Location of Anchor Point, Alaska.

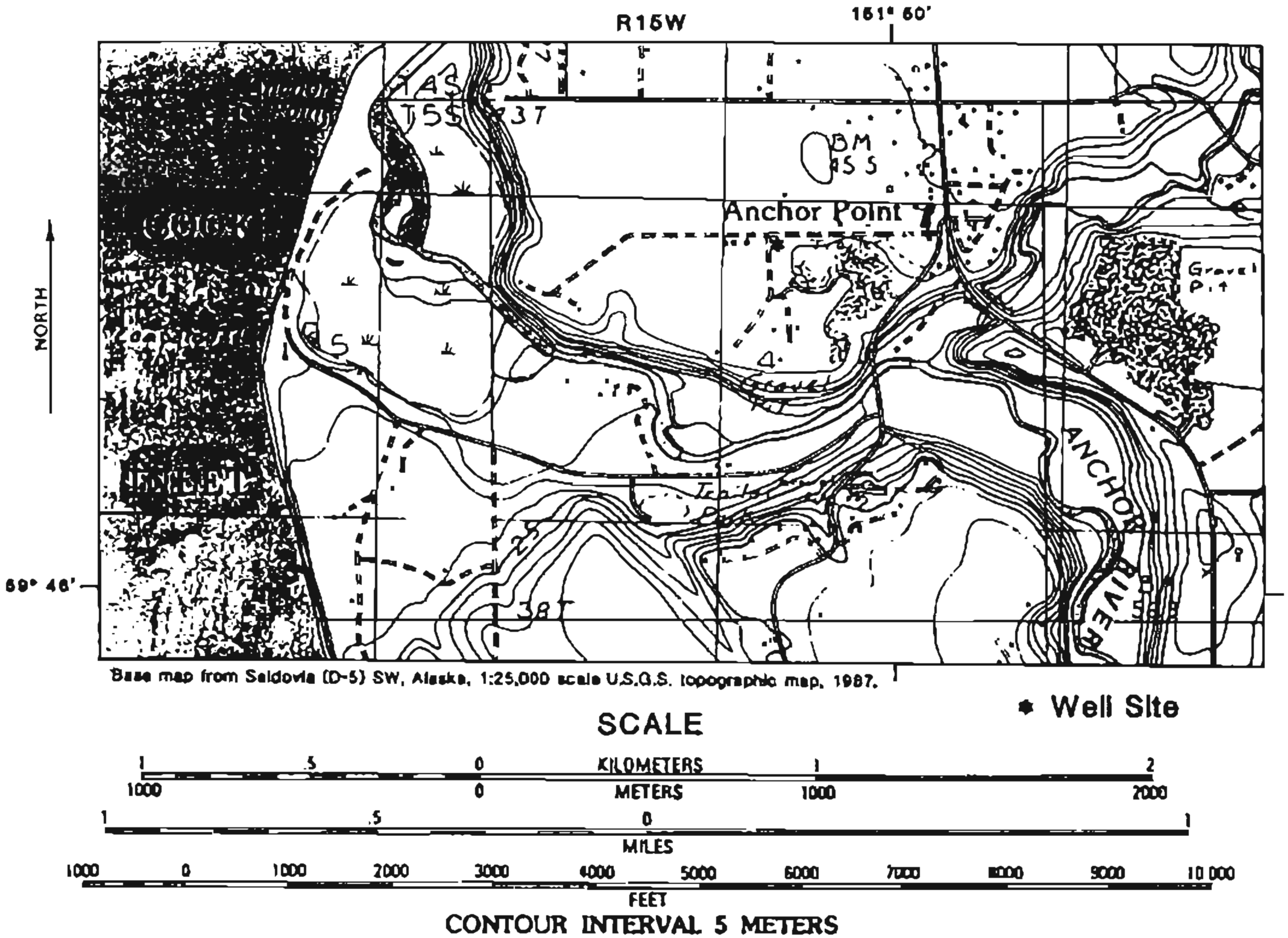

Figure 2. Location of aquifer test well site.

typically low, and the quality of water from deep wells is commonly poor, with high levels of dissolved minerals.

The well site is located on a terrace deposit of the Anchor River. A gravel pit located southeast of the well site is excavated to the approximate depth of the water table in sandy and gravelly materials. A review of available boring and well logs in the area, and local exposures indicates that the aquifer may be 100 or more acres in areal extent. Near the aquifer test site, however, the maximum known thickness of the terrace deposits is 20 ft and the maximum known saturated thickness of the deposits is 10 ft. Although the terrace deposits are thicker near the Sterling Highway, ground water is contaminated with fuel products in that area (Alaska Department of Environmental Conservation, 1988).

AQUIFER TEST CONDITIONS AND METHODS

The production well used for the aquifer test was screened from a depth of 14 to 19 ft, with a 1 horsepower submersible pump installed at a depth of 13.6 ft (to the top of the pump). The pump was powered by an 8.8 kilowatt diesel generator. The well head was equipped with a pressure gage, a discharge valve, and a totalizing flow meter. Discharge was routed through a 2 in. flexible hose into a gravel pit pond located 370 ft southeast of the production well. Water levels in the production well were measured through a 3/4 in. diameter perforated PVC tube extending from the well head to the well bottom.

Water levels were also measured in a 2 in. diameter observation well located 15.4 ft south-southwest of the production well (see Appendix A).

Water levels in both wells were measured throughout the test with dedicated two-conductor electric water level indicators and 10 ft steel tapes.

On October 28, 1988 a step drawdown test was conducted (Eileen Olson, Alaska Department of Environment Conservation, written commun., 1988). The flow rate varied from 12 to 60 gallons per minute (gpm) with a total duration of pumping of 4.4 hours.

On November 7, 1988, a constant-rate aquifer test was initiated at a flow rate of 24 gallons per minute. Pumping continued for 64.6 hours with two interruptions totalling 16 minutes. Flow rates were verified with a bucket and watch. After 64.6 hours of pumping, the pump was shut down for 48 minutes, restarted, and run for another 191 minutes prior to final shutdown.

RESULTS

Figure 3 presents the results of the step drawdown test conducted on October 28, 1988. Although the maximum total drawdown during the test was only 2.1 ft in the production well and 0.85 ft in the observation well, drawdowns did not stabilize at each flow rate as normally occurs. Calculations of specific capacity ranged from 20 to 29 gallons per minute per foot of drawdown during the test. Although the data are somewhat irregular, the well efficiency is in the range of 80 to 116 percent according to the method of Todd (1980, p. 152-159).

Maximum drawdowns recorded in the pumped and observation wells at the termination of the constant rate test were 1.79 ft and 1.17 ft, respectively. Figure 4 illustrates the trend of the drawdown data collected in the pumped

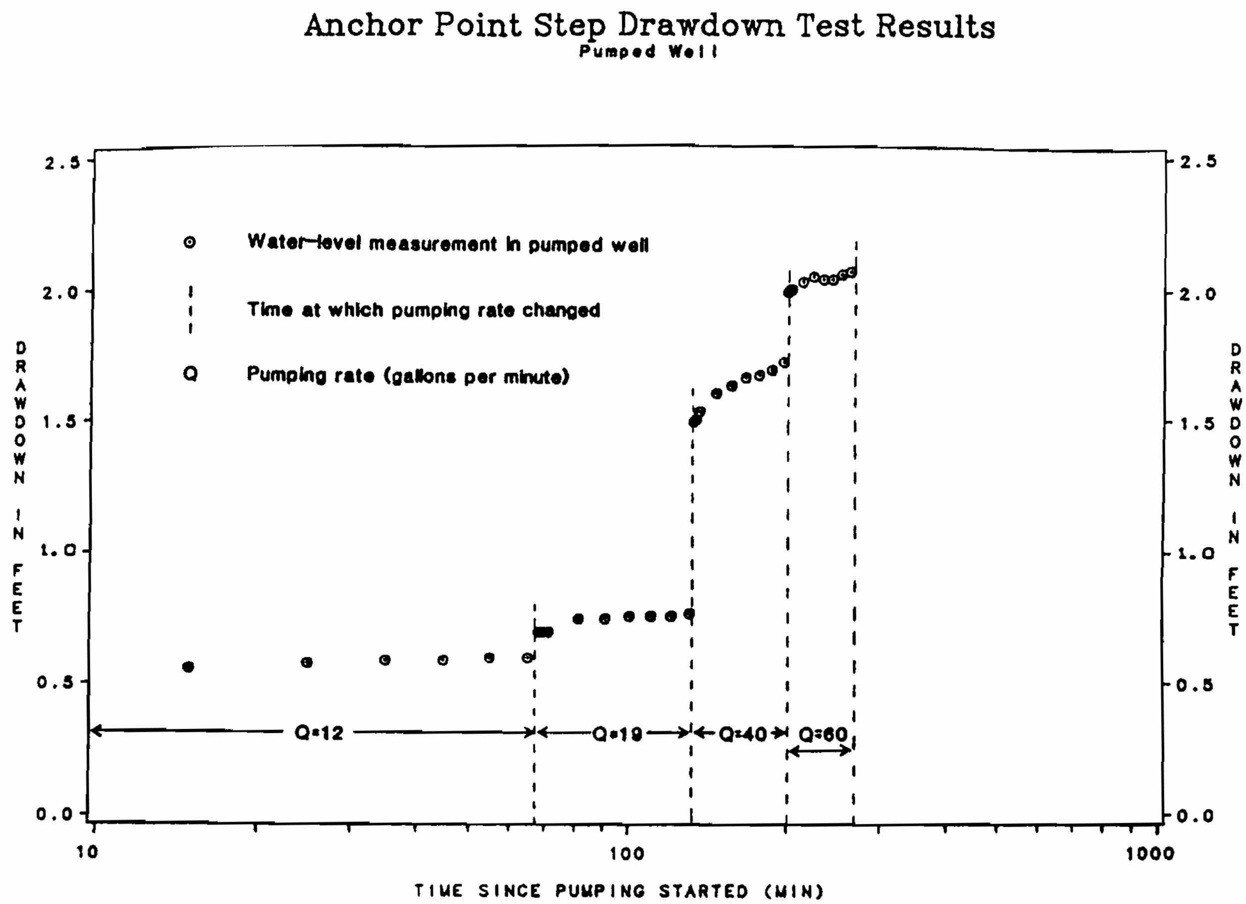

Figure 3. Plot of step-drawdown data collected at the pumped well.

well and Table 1 summarizes the results of analyses performed on data collected during the drawdown and recovery phases of the test. A particularly important feature of the data shown in figure 4 is the increasing slope of the trend of the data with increasing time of pumping. This is interpreted to be a result of aquifer boundaries encountered by the cone of depression during pumping. Transmissivity values calculated from the recovery data (Table 1) were found to be somewhat lower than comparable values calculated from the drawdown data. After three days of recovery, water levels in the aquifer were 0.2 to 0.3 ft below pre-pumping water levels.

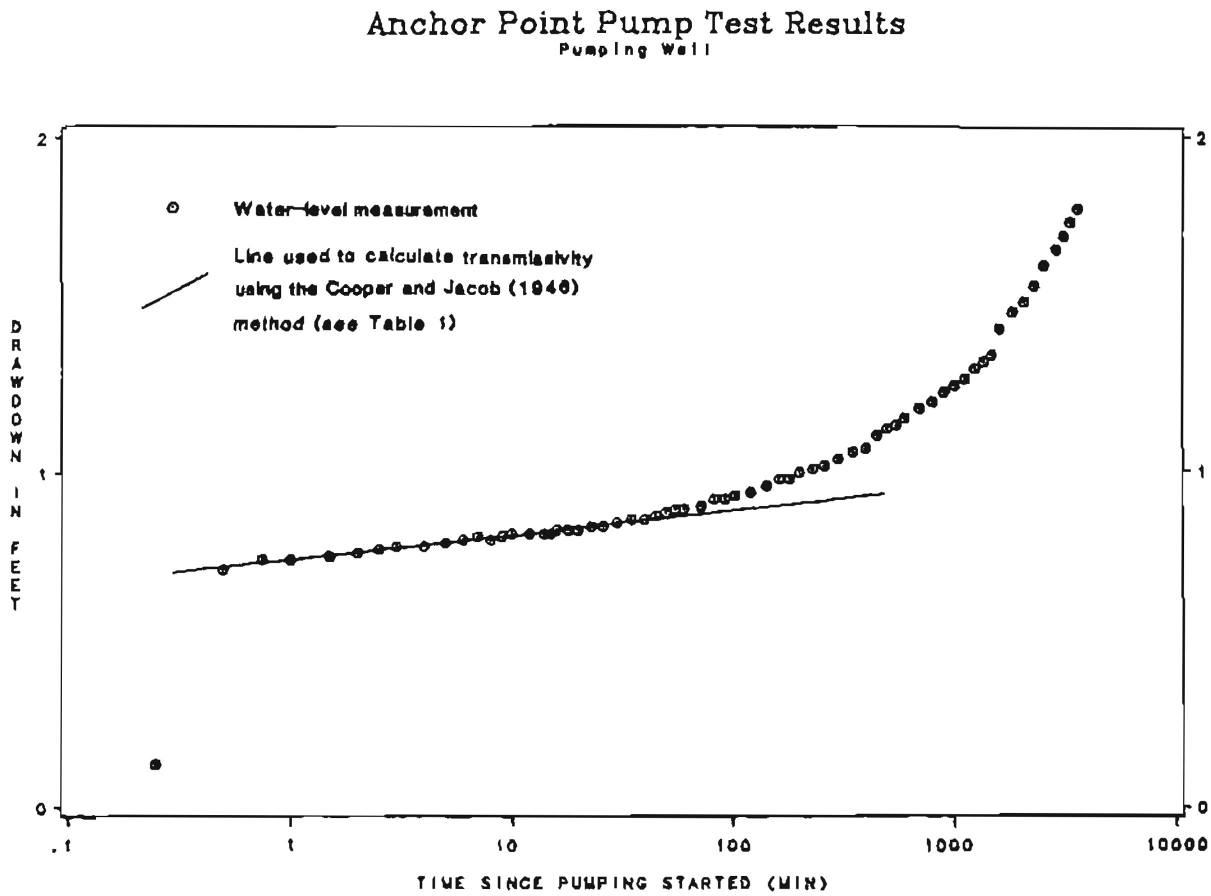

Figure 4. Plot of drawdown data collected during the constant rate test at the pumped well.

Table 1. Summary of analyses of aquifer test data.

Well	Type of data	Data used (t=time since pumping started/stopped, in min.)	Calculated trans-missivity (ft^2/day	Calculated specific yield	Method
Pumped	drawdown	0.5 < t < 70	11,000	-	Cooper & Jacob (1946)
Observa-tion	drawdown	5 < t < 150	5,000	0.037	Theis (1935)
Pumped	recovery	8 < t < 123	4,400	-	Calculated re-covery (Johnson Div., UOP, 1966)
Observa-tion	recovery	10 < t < 150	3,400	0.025	Calculated re-covery (Johnson Div., UOP, 1966)

DISCUSSION OF RESULTS

The aquifer test results show a relatively large range of transmissivity values for wells located only 15.4 ft apart. This is interpreted to be a result of relatively high transmissivity of deposits in the immediate vicinity of the production well, with a substantial decrease in permeability or saturated thickness or both in one or more radial directions from the well. The near-complete recovery of water level three days after pumping ceased indicates the aquifer receives recharge from surrounding deposits.

LONG-TERM PROJECTIONS

As a result of the presence of aquifer boundaries and the lack of information about their exact location, specific projections of drawdown in response to long-term pumping cannot be made. By extrapolating the drawdown curve as shown in figure 5, however, a general indication of aquifer performance is possible. By assuming an initial available drawdown of 4 ft and a continuation of the steepening drawdown trend exhibited by the late-time drawdown data, the aquifer is projected to be able to sustain a yield of 24 gpm for 11 days. Alternatively, by assuming a semi-logarithmically linear rate of drawdown (as would be expected in the absence of aquifer boundaries), a 24 gpm aquifer yield would continue for 6 months. The former set of assumptions can be considered conservative, and the latter should not be considered realistic, in consideration of actual aquifer conditions. Both scenarios assume the absence of recharge to the aquifer from precipitation or snowmelt.

Because of the shallow depth of the aquifer and the seasonal pattern of available recharge at Anchor Point, the aquifer yield may vary significantly

Anchor Point Pump Test Results

Pumping Well

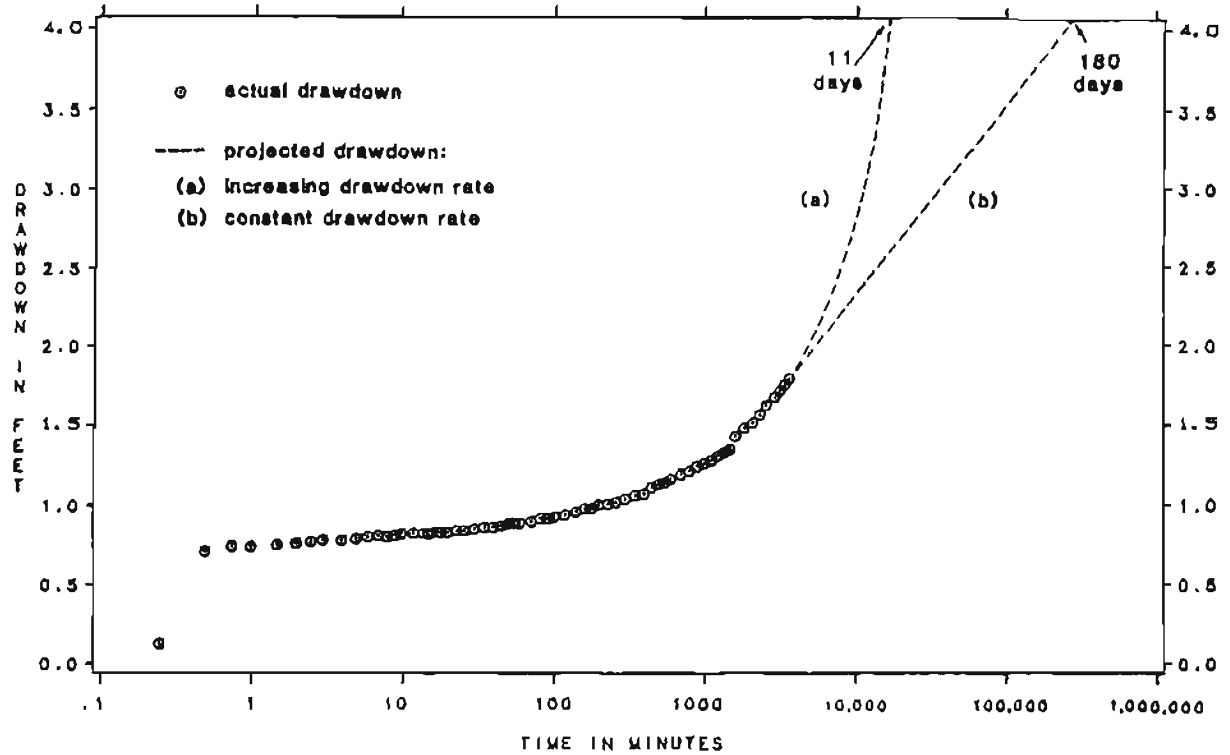

Figure 5. Projection of possible water-level responses to long-term pumping at a rate of 24 gpm.

during the year. At the time of testing, water levels in the aquifer were probably near their annual maximum. In consideration of these factors, and the previously described information about the thickness, permeability, and lateral extent of the aquifer, an average long-term potential yield of the aquifer is suggested to be in the range of 5-15 gpm at the tested site. An important but unknown factor in refining estimates of potential yield is the level to which water-levels naturally fall during various seasons of the year. Late winter and mid to late summer are expected to be the seasons with lowest water levels (Brunett, 1986; and Still and Brunett, 1987).

SUGGESTIONS FOR AQUIFER DEVELOPMENT

1. If feasible, water levels should be measured monthly at the pumped well or observation well through the late winter and late summer seasons. If water levels drop more than two feet from early November conditions, additional aquifer testing should be considered. In consideration of aquifer boundaries, the test should be conducted for at least a week at a constant rate in the range of 10 to 15 gpm using automatic water level recording equipment. Automatic water-level recording equipment can be installed on the observation well to monitor both pre- and post-development water levels in the aquifer.

2. Should aquifer development proceed and the existing well prove insufficient to meet demand, supplemental water could probably be developed by constructing additional wells or infiltration galleries in the area. In order to design an optimal system, further test drilling or excavation may be needed, and records would need to be maintained on water use and water levels in the aquifer. Depending on property accessibility, a shallow resistivity or seismic reflection survey may be warranted in order to identify favorable locations for additional exploratory holes.

3. Detailed information about peak short-term or seasonal water use may be critical to successful development of the aquifer. Although summertime demand may be substantially higher than year-round use, water availability, especially in early summer, may also be higher. The aquifer would be expected to respond rapidly to recharge events, causing concerns about long-term water level declines to be minimal.

4. The aquifer may be vulnerable to contamination because of its shallow depth. An assessment of existing and future land uses and the local direction of ground-water flow in the vicinity of the well field would aid planning for ground-water protection.

SUMMARY AND CONCLUSIONS

A shallow sand and gravel aquifer at Anchor Point, Alaska, was evaluated for suitability as a public water supply. Although the aquifer yield is likely to be seasonally variable, the source may be suitable for year-round local residential and light commercial use in the range of 5 - 15 gpm (or 7,200 to 22,000 gallons per day). The aquifer does not appear to be a viable long-term source of water at the tested flow rate of 24 gpm (or 35,000 gallons per day). Final decisions regarding development of the aquifer should be based on alternate potential or current sources of water, development costs, natural seasonal water-level fluctuations, and contingency plans in the event of failure of the source to meet demands.

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APPENDIX

Well Logs

SENT BY: :12-15-88 : 15:47 : DEC - SCRO→ 6960078;# 2

WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

JIM HOOVER
Owner

(907) 776-8443

P. O. BOX 1292
KENAI, ALASKA 99611

water well association

LOCATION OF WELL (Please complete either 1a, 1b or 1c.)

1a. Borough | Subdivision | Lot | Block

1b. ¼ ¼ ¼ etc. ___ of ___ of ___ of ___ | Section No. | Township N☐ S☐ | Range E☐ W☐ | Meridian

1c. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS

well # ~~2~~ 1

Street Address and Area of Well Location

3. OWNER OF WELL: Anchor Point

Address:

2. WELL LOG

Material Type	Feet Below Surface Top	Feet Below Surface Bottom
Top soil	0	3
sand	3	4
sand & gravel	4	10
gravel w/sandstone Rock	10	15
w/ Traces of Brown clay		
gravel w/sand Traces of water	15	20
Rock & clay	20	43
Blue clay & silt	43	61

* Note: abundant water present 12-20' cased off as drilling progressed ED 12-1-88

4. WELL DEPTH: (final) 61 ft.

5. DATE OF COMPLETION 10 - 12 - 88

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other

7. USE: ☐ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Recharge ☐ Commercial ☐ Test Well ☒ Other: monitor well

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to 61 ft. Depth Weight 17 lbs./ft
diam. ___ in. to ___ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: dry Diameter: ___
Slot/Mesh Size: ___ Length: ___
Set between ___ ft. and ___ ft.
Backfilling ___ Gravel pack ___

10. STATIC WATER LEVEL: ___ ft. _/_/_ Date
☐ Above or ☐ Below land surface
Equipment used: ___

11. PUMPING LEVEL below land surface and YIELD
___ ft. after ___ hrs. pumping ___ g.p.m.
___ ft. after ___ hrs. pumping ___ g.p.m.

12. GROUTING Well Grouted? ☒ Yes ☐ No
Material: ☐ Neat Cement ☒ Other: Bentonite

13. PUMP: (if available) HP
Length of Drop Pipe ___ ft. capacity ___ g.p.m.
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS: installed locking Cap

15. Water Temperature ___° ☐ F ☐ C

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling — Registered Business Name
DAJ301 — Contract License Number

Address: PO Box 1292 Kenai AK 99611

and: Maralee McHoover — Authorized Representative

Date: 10-21-88

WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

JIM HOOVER
Owner

(907) 776-8443

P. O. BOX 1292
KENAI, ALASKA 99611

water well association

LOCATION OF WELL (Please complete either 1a, 1b or 1c.)

1a. Borough	Subdivision	Lot	Block	1b. 1/4 qtrs. —of—of—of—	Section No.	Township N☐ S☐	Range E☐ W☐	Meridian

1c. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS

well #4

Street Address and Area of Well Location

3. OWNER OF WELL: Anchor Point

Address:

2. WELL LOG

Material Type	Feet Below Surface Top	Feet Below Surface Bottom
Top soil	0	3
sandy clay	3	5
clay	5	9
gravel w/sand	9	19

4. WELL DEPTH: (final) 19 ft.

5. DATE OF COMPLETION 10-13-88

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☐ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Recharge ☐ Commerical ☒ Test Well ☐ Other:

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to 16 ft. Depth Weight 17 lbs./ft
diam. ___ in. to ___ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: Stainless sand screen Diameter: 6
Slot/Mesh Size: 20TH Length: 5'
Set between 14 ft. and 19 ft.
Backfilling ___ Gravel pack ___

10. STATIC WATER LEVEL: 11'8" ft. 10/ /88 Date
☐ Above or ☒ Below land surface
Equipment used: Electronic

11. PUMPING LEVEL below land surface and YIELD
___ ft. after ___ hrs. pumping ___ g.p.m.
___ ft. after ___ hrs. pumping ___ g.p.m.

12. GROUTING Well Grouted: ☒ Yes ☐ No
Material: ☐ Neat Cement ☒ Other: Bentonite

13. PUMP: (If available) HP ___
Length of Drop Pipe ___ ft. capacity ___ g.p.m.
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS: Screened + pump tested installed locking cap

15. Water Temperature ___ ° ☐ F ☐ C

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name

AA4201
Contract License Number

Address: PO Box 1292 Kenai, Ak 99611

Signed: Maralee M Hoover
Authorized Representative

Date: 10-21-88

11-22-88

OBSERVATION WELL DRILLED 10-20-88

(AS PER PHONE CONVERSATION W/ HART-CROWSER'S STEVE ROG ON 11-22-88) by Eileen Olson, DEC

2" PVC 0'-20'
SLOTTED 5'-20' INTERVAL : .020 SLOTS, 20 SLOTS / FT
FLUSH THREADED PVC
SAND PACKED W/ # 16 SILICA SAND
4' BURIED 6" CASING W/ VOLCLAY SURFACE SEAL 0'-4'

0-1.5 SURFACE ORGANIC LAYER & GRASS

1.5-5 TAN SILT, MOIST, SOFT

5-6.5 BROWN SAND (SP-SM)
MOIST, MED. DENSE
(GRAVELLY DRILLING FROM 6.5)
(COBBLES @ 9.5' & 10.0')

WATER TABLE
▽ WD @ 9.5'

6.5-15.5 BROWN GRAVELLY SAND (SP)
WET

15.5-20 BROWN SANDY GRAVEL
wet, DENSE

(EASY DRILLING AFTER 18') → H-C's S. ROG SAYS PROBABLY BECOMING SILTY

20-21 GRAY SANDY SILT OR SILTY SAND
SATURATED, MEDIUM STIFF, TRACE CLAY