

WARM WATER WELL #2
HAINES JUNCTION, YUKON TERRITORY



Prepared by:

STANLEY ASSOCIATES ENGINEERING LTD.

JULY, 1980





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LETTER OF TRANSMITTAL

Department of Highways & Public Works
Yukon Territorial Government
P.O. Box 2703
Whitehorse, Yukon

Attention: Mr. J.A. Cormie, P. Eng.

Reference: Warm Water Well #2 Haines Junction, Yukon Territory

Dear Sir:

We are pleased to forward six (6) copies of our final report which describes the well drilling program and pump testing of the warm water aquifer in Haines Junction, Yukon Territory.

Should you have any questions on any aspect of this report we would be happy to meet with you at your convenience.

Yours very truly,

STANLEY ASSOCIATES ENGINEERING LTD.

A handwritten signature in dark ink, appearing to read "D.A. Hackbarth", written over a horizontal line.

D.A. Hackbarth, Ph.D.
Head - Groundwater Section

for A handwritten signature in dark ink, appearing to read "N.J. Nuttall", written over a horizontal line.

N.J. Nuttall, P. Eng.
Yukon Area Manager

RJS:sew

enclosure

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1.0 INTRODUCTION

1.1

The existing water supply for the Local Improvement District of Haines Junction, Yukon consists of a shallow cold water well which is in hydraulic contact with the Dezadeash River and a deep warm water well. The capacities of the shallow and deep well are 3.41 l/s (45 igpm) and 2.65 l/s (35 igpm), respectively. Due to silt problems associated with the deep well the LID operates the cold water well only.

It is anticipated that projects such as the Shakwak Highway construction and the proposed Alaska Highway Gas Pipeline will increase the population of Haines Junction to 1000 by 1985. In light of the limited water supply capabilities an investigation of alternate sources of water was conducted by Stanley Associates Engineering Ltd. on behalf of the Yukon Territorial Government.

Based upon the investigation and economic analysis of the various alternatives for water supply, as reported in the Haines Junction Water Supply Study, a new deep well was determined to be the most economical alternative. A recommendation was then made to the Yukon Territorial Government that additional development of a water supply for Haines Junction be secured from a deep water well to be located in the same aquifer as the existing warm water well.

Stanley Associates Engineering Ltd. were retained in May 1980 by the Yukon Territorial Government to implement this recommendation. The following sections describe the field program, aquifer characteristics, well yield, water quality and the conclusions and recommendations of the project.

2. FIELD PROGRAM

2.1 Well Construction

The construction of warm water well #2 (W.W.Well #2) commenced on May 29, 1980 with the drilling of a 27.3 cm (10.75 in) diameter testhole 18.6 m (61 ft.) west of Warm Water Well #1 (W.W.Well #1) (See index map and well location plans on following page). A Schram T64 air rotary rig equipped with a Tigre Terre casing hammer and operated by Midnight Sun Drilling Co. Ltd. of Whitehorse was employed for the work.

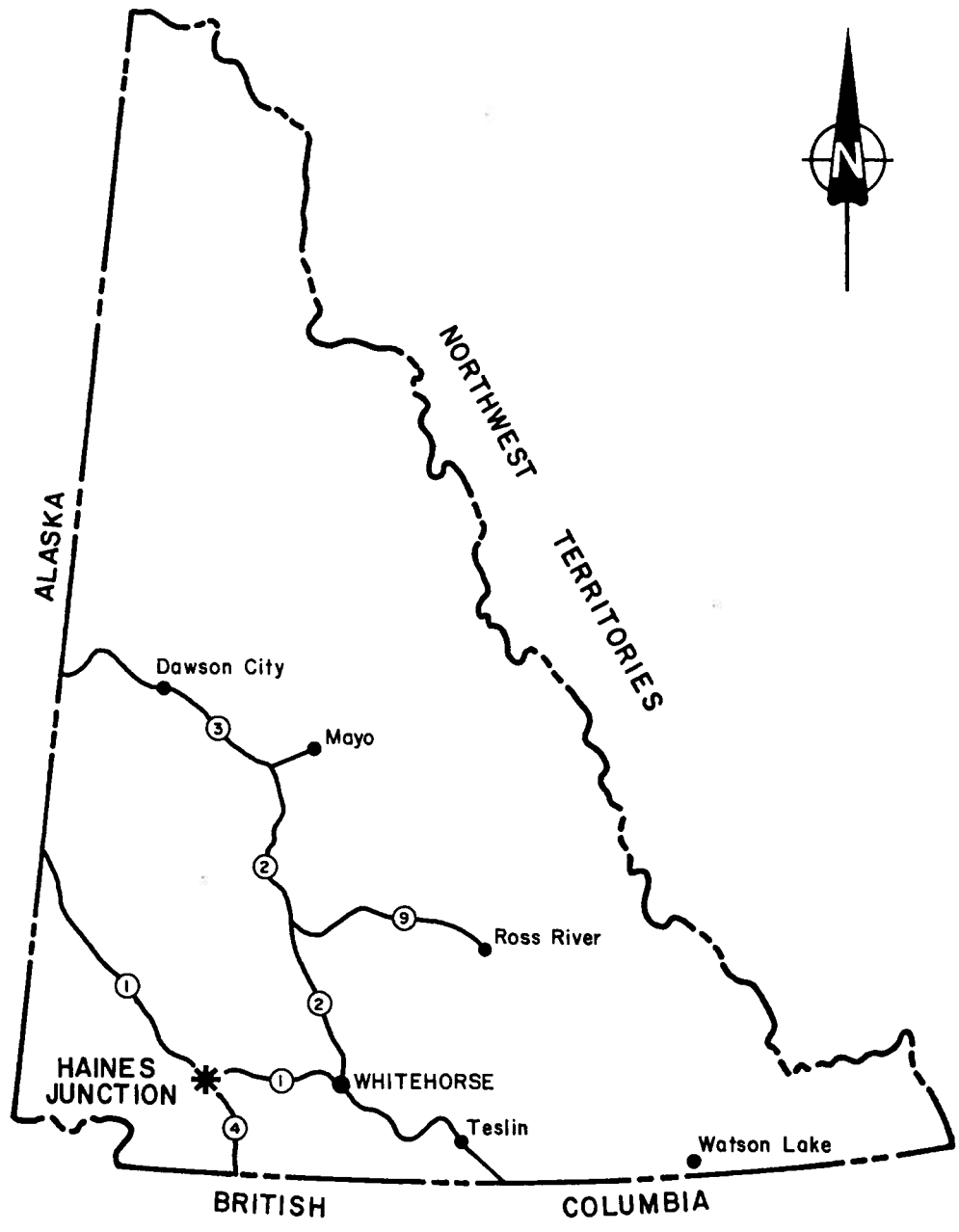
The 27.3 cm (10.75 in.) O.D. surface casing was drilled and driven to a depth of 13.6 m (44.6 ft.) in anticipation of possible flowing artesian conditions. Following the installation of surface casing a 21.9 cm (8.625 in.) O.D. cased hole was drilled to a depth of 85.4 m (280 ft.). An aquifer consisting of fine to coarse sand and gravel was identified in the interval from 78.4 m (257 ft.) to 83.2 m (273 ft.)

A 3 m (10 ft.) length of stainless steel well screen was bottomed at a depth of 82.3 m (270 ft.) and well development was accomplished by means of compressed air. Production with air during well development was estimated at 980 - 1300 m³/day (150 - 200 igpm).

The construction of W.W.Well #2 was complete and the drilling rig was off site on June 2, 1980. Appendix A contains details of well construction.

2.2 Aquifer Testing

A step drawdown test was conducted on Warm Water Well #2 on June 4, 1980 at rates of 655 m³/day (100 igpm), 983 m³/day (150 igpm) and 1310 m³/day (200 igpm). This test was performed prior to the constant rate test so that the efficiency of the new well could be determined and a proper flow rate could be selected for the main test.



HAINES JUNCTION, YUKON TERRITORY
INDEX MAP



PARCEL B

EXISTING 150" W.M.

WARM WATER WELL No. 2



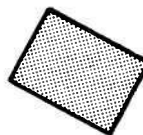
WARM WATER WELL No. 1



EXISTING HEATER HOUSE

HAINES ROAD

COLD WATER WELL No. 1



ABANDONED PUMPHOUSE

← DEZADEASH RIVER

BRIDGE



SCALE IN METRES

HAINES JUNCTION, YUKON TERRITORY
PRODUCTION WATER WELL No. 2
LOCATION PLAN



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A 20-horsepower, 230 volt, 4 stage 15.25 cm (6 in.) submersible turbine pump was employed for the test. A 30 kw diesel generator provided 3 phase power to the pump. Discharge rates were controlled through use of a 10.16 cm (4 in.) diameter gate valve and rates were monitored by means of a 10.16 cm (4 in.) diameter flow meter and digital readout. Groundwater level readings were obtained through use of an electric well sounder.

The step drawdown test was conducted for 20 minutes at each of the above rates. Total recorded drawdown at the end of 60 minutes was 57.75 m (189.4 ft.) assuming an initial nonpumping level of about 3 m (10 ft.) above the top of the well casing. The average 20-minute specific capacity of the well for each of the rate steps was about $1.7 \times 10^{-2} \text{ m}^2/\text{min}$ (1.14 igpm/ft.). The similarity of response for each of the steps indicates that the well has been properly completed and has good contact with the aquifer. Appendix B contains details of the step drawdown test.

The constant rate test was started following recovery of groundwater levels. The pumping rate was set at $983 \text{ m}^3/\text{day}$ (150 igpm) and the test was conducted for 24 hours. The amount of drawdown available to a well constructed in the aquifer at this location is about 76.2 (250 ft.) and by the end of the test 51.88 m (170 ft.) of drawdown had been realized, corresponding to about 68% of that available. Total recorded drawdown in W.W.Well #1 at the end of 24 hours was 18.10 m (59.4 ft.) assuming an initial head of about 4 m (13 ft.) above ground. The specific capacity of W.W.Well #2 at the end of 24 hours was $1.3 \times 10^{-2} \text{ m}^2/\text{min}$ (0.88 igpm/ft.). Throughout the test the groundwater was sand and silt-free.

Recovery readings were taken on both wells for 24 hours following the pumping interval. Groundwater levels returned to within 4.90 m (16.07 ft.) of original level in the production well in this time representing a recovery of about 90%. Groundwater levels in the observation well (W.W.Well #1) returned to within 5.19 m (17.02 ft.) assuming an initial head of 4 m (13 ft.) above ground.

Although a flowing condition will return to both wells it appears that pumping at rates of 983 m³/day (150 igpm) will result in aquifer depletion; that is, groundwater withdrawal in excess of the capacity of the aquifer to recharge itself.

The well was capped following the recovery period and field operations were complete on June 6, 1980.

Appendix B contains aquifer test readings and analyses.

3. AQUIFER CHARACTERISTICS AND WELL YIELD

Test drilling and aquifer testing have revealed the Haines Junction aquifer to be a confined glacial deposit of fine to coarse sand and gravel. The results of the aquifer test demonstrate that the deposit is bounded by glacial clay and tills of low hydraulic conductivity and therefore is subject to limited recharge.

Time drawdown and residual drawdown data indicate an average aquifer transmissivity of $60 \text{ m}^2/\text{day}$ (4023 igpd/ft.) and that aquifer transmissivity decreases significantly nearby. Readings obtained by means of the observation well suggest that possibly two barrier boundaries were intercepted by the cone of drawdown during the test. Such boundaries serve to decrease the maximum safe continuous yield to a well constructed within the aquifer.

Recovery data show conclusively that the aquifer will deplete rapidly at continuous pumping rates of $983 \text{ m}^3/\text{day}$ (150 igpm). The maximum continuous safe yield available from the aquifer is therefore estimated at $690 \text{ m}^3/\text{day}$ (105 igpm). The well can be pumped for short periods of time at a rate of $983 \text{ m}^3/\text{day}$ (150 igpm), however, the average daily rate of withdrawal should not exceed $690 \text{ m}^3/\text{day}$ (150,000 igpd). The intake of the well pump should not be placed at a depth greater than 76 m below ground to avoid aquifer dewatering.

It is suggested that w.w. well #1 be sealed at the surface to prevent loss of artesian head even though it is expected that it will cease to flow once W.W. Well #2 is put into production. Significant reduction in artesian pressure is to be expected in other wells tapping this same aquifer in this area because almost all of the available drawdown of W.W. Well#2 is expected to be utilized over the life of the well. Therefore, further development of this aquifer is not recommended in the Haines Junction area. The aquifer does not have the capacity to provide large quantities of groundwater to two production wells and standby capacity will have to be developed elsewhere. Past drilling programs suggest that another aquifer exists at depths of 125 - 150 m (410 - 490 ft.) in this area and since both aquifers appear to be sufficiently hydraulically isolated it is suggested this source be investigated for standby use.

4. GROUNDWATER QUALITY

Two water samples were obtained during the aquifer test for laboratory chemical analyses. One sample was collected 200 minutes into the test and the second was taken at 1330 minutes. The results of the chemical analyses are given in Tables 1 and 2 and are compared to the Canadian Drinking Water Quality Guidelines, 1978 (CDWG, 1978). The quality of water is very good and no problems with encrustation or corrosion are expected.

An odourless gas was released from the water during pumping. It is possible that this is dissolved carbon dioxide gas which comes out of solution upon release of pressure. Some venting of supply lines and facilities may be necessary.

The temperature of the groundwater was measured to be 6.5 to 7.0°C (43.3 - 44.6°F). It is recommended that groundwater temperature be monitored during the life of the well.

5. PROJECT SUMMARY AND CONCLUSIONS

Warm Water Well #2 for Haines Junction, Yukon Territory is capable of a sustained yield of 690 m³/day (105 igpm). The quality of groundwater produced is very good and will require only a minimum of treatment.

The aquifer is confined by glacial clays and tills which limit recharge. Additional production wells should not be constructed within this aquifer.

Table 3 is a summary of aquifer and well performance.

6. RECOMMENDATIONS

1. Warm Water Well #2 should be pumped at an average rate not exceeding $690 \text{ m}^3/\text{day}$ (150,000 igpd) for the life of the well.
2. No additional production wells should be constructed within this aquifer. Deeper exploration and well testing is recommended.
3. The intake of the pump should not be placed below 76 m (250 ft.) to avoid dewatering of the aquifer.
4. Warm Water Well #1 should be sealed to prevent loss of groundwater from the aquifer. It may also be possible to use this well for future aquifer monitoring.
5. Monitoring of groundwater temperatures, aquifer water levels and production rates is recommended so that the history of the well and aquifer can be documented.

7. REFERENCES

1. "Guidelines for Canadian Drinking Water Quality, 1978" published by: the Minister of National Health and Welfare.

Table 1 - Groundwater Quality - Haines Junction, Y.T.

Laboratory: Western Industrial Laboratories Ltd., Edmonton, Alberta
 Lab. No.: 80-1933
 Sampling Date: June 4, 1980 - after 200 minutes of pumping
 Well No.: Warm Water Well #2


<u>Constituent or Parameter</u>	<u>Groundwater Sample</u>	<u>CDWG 1978 Max. Acceptable Limit</u>	<u>CDWG 1978 Objective Limit</u>
pH	8.38	6.5 - 8.5	-
Conductivity	210 micromhos/cm.	-	-
Turbidity	1.0 NTU	5 NTU	less than 1 NTU
Colour	less than 5 units	15 units	less than 15 units
	<u>Mg/L.</u>	<u>Mg/L.</u>	<u>Mg/L.</u>
Total Dissolved Solids	171	500	-
Ignition loss	127	-	-
Nitrate & Nitrite N.	less than 0.2	10	less than 0.001
Calcium	8	-	-
Magnesium	3	-	-
Total Hardness (as CaCO ₃)	32	-	-
Sodium	42	-	-
Potassium	3	-	-
Sulphate	15	500	less than 150
Chloride	1	250	less than 250
Fluoride	0.28	1.5	1.0
Carbonate	5	-	-
Bicarbonate	120	-	-
Total Alkalinity (as CaCO ₃)	107	-	-
Total iron	0.06	0.3	less than 0.05
Total Manganese	less than 0.005	0.05	less than 0.01



CORPORATE AUTHORIZATION

This document entitled WARM WATER WELL #2
HAINES JUNCTION, YUKON TERRITORY

was prepared by Stanley Associates Engineering Ltd.



Robert J. Stewart Aug 9/80
signature/date

PROFESSIONAL SEAL



[Signature]

signature/date *Aug 11/80*

COMPANY PERMIT

Table 2 - Groundwater Quality - Haines Junction, Y.T.

Laboratory: Western Industrial Laboratories Ltd., Edmonton, Alberta
 Lab. No.: 80-1934
 Sampling Date: June 5, 1980 - after 1330 minutes of pumping
 Well No.: Warm Water Well #2

<u>Constituent or Parameter</u>	<u>Groundwater Sample</u>	<u>CDWG 1978 Max. Acceptable Limit</u>	<u>CDWG 1978 Objective Limit</u>
pH	8.44	6.5 - 8.5	-
Conductivity	210 micromhos/cm.	-	-
Turbidity	1.0 NTU	5 NTU	less than 1 NTU
Colour	less than 5 units	15 units	less than 15 units
	<u>Mg/L.</u>	<u>Mg/L.</u>	<u>Mg/L.</u>
Total Dissolved Solids	175	500	-
Ignition loss	125	-	-
Nitrate & Nitrite N	less than 0.2	10	less than 0.001
Calcium	8	-	-
Magnesium	2	-	-
Total Hardness (as CaCO ₃)	28	-	-
Sodium	41	-	-
Potassium	3	-	-
Sulphate	15	500	less than 150
Chloride	2	250	less than 250
Fluoride	0.28	1.5	1.0
Carbonate	7	-	-
Bicarbonate	114	-	-
Total Alkalinity (as CaCO ₃)	105	-	-
Total iron	0.06	0.3	less than 0.05
Total Manganese	less than 0.005	0.05	less than 0.01

Table 3 - Summary of Aquifer and Well Performance

Well No.: W.W.Well #2, Haines Junction, Y. T.

Aquifer Test Date: June 4 - 6, 1980

	<u>S.I. UNITS</u>	<u>N.A. UNITS</u>
Pumping rate	983 m ³ /day	150 igpm
Non-pumping water level (estimated)	+4 m above ground	+13 ft. above ground
Available drawdown (to top of aquifer)	76 m	250 feet
Pumping time	1440 min.	1440 min.
Drawdown	51.88 m	170 feet
Percent total drawdown realized	68%	68%
Specific capacity of well	1.3 x 10 ⁻² m ² /day	0.88 igpm/ft.
Groundwater temperature	6.5 - 7° C	43.3 - 44.6° F
Recovery	90% @ 1440 min.	90% @ 1440 min.
Safe continuous daily rate for 20 years	690 m ³ /day	150,000 igpd
Drawdown at well in 20 years	75 m	246 feet
Suggested pump intake	76 m	250 feet
Average value of aquifer transmissivity	60 m ² /day	4023 igpd/ft.

APPENDIX A

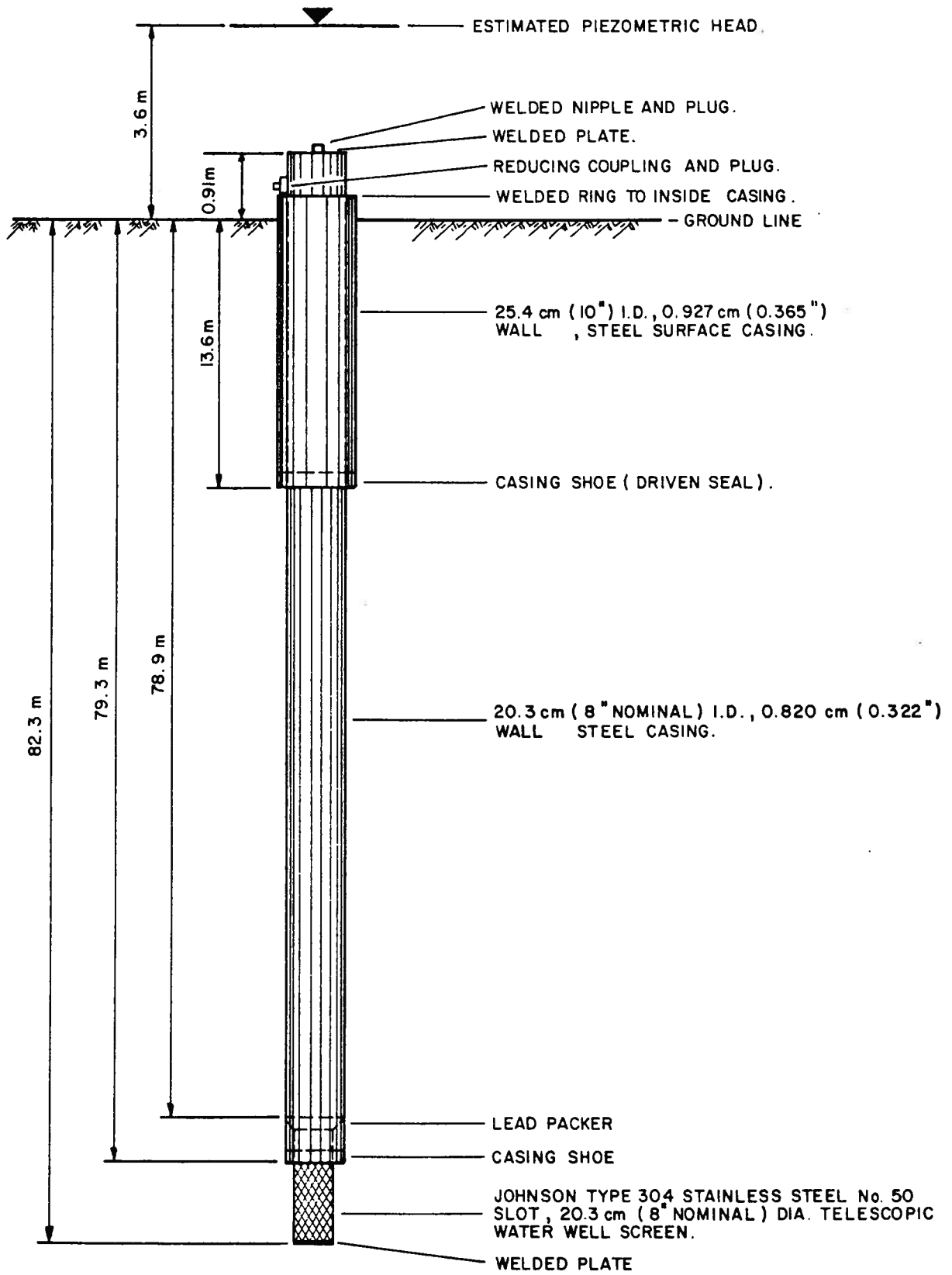
WELL CONSTRUCTION DETAILS

Warm Water Well #2 - Haines Junction Y.T.

Testhole Log

Drilling Dates: May 29 to May 31, 1980
Drilling Company: Midnight Sun Drilling Co. Ltd., Whitehorse, Yukon Territory
Location: 18.5 m west of Warm Water Well #1

<u>Depth (m)</u>	<u>Lithologic Description</u>
0.0 - 0.3	gravel
0.3 - 2.5	clay
2.4 - 6.0	gravel
6.0 - 7.3	clay
7.3 - 15.0	till, gravelly, grey, some cobbles
15.0 - 38.5	till, pebbly, grey
38.5 - 53.6	clay, grey
53.6 - 60.0	clay, and silt, interbedded, grey
60.0 - 63.0	silt, compact, grey
63.0 - 66.5	silt, compact, gravelly
66.5 - 71.5	till, grey, increasing gravel content with depth
71.5 - 78.4	gravel, coarse, angular, silty containing colluvial grey till and hard clay
78.4 - 83.2	gravel and coarse sand, some fine sand (aquifer)
83.2 - 85.3	sand, fine to medium, silty



HAINES JUNCTION, YUKON TERRITORY
 WARM WATER WELL No. 2

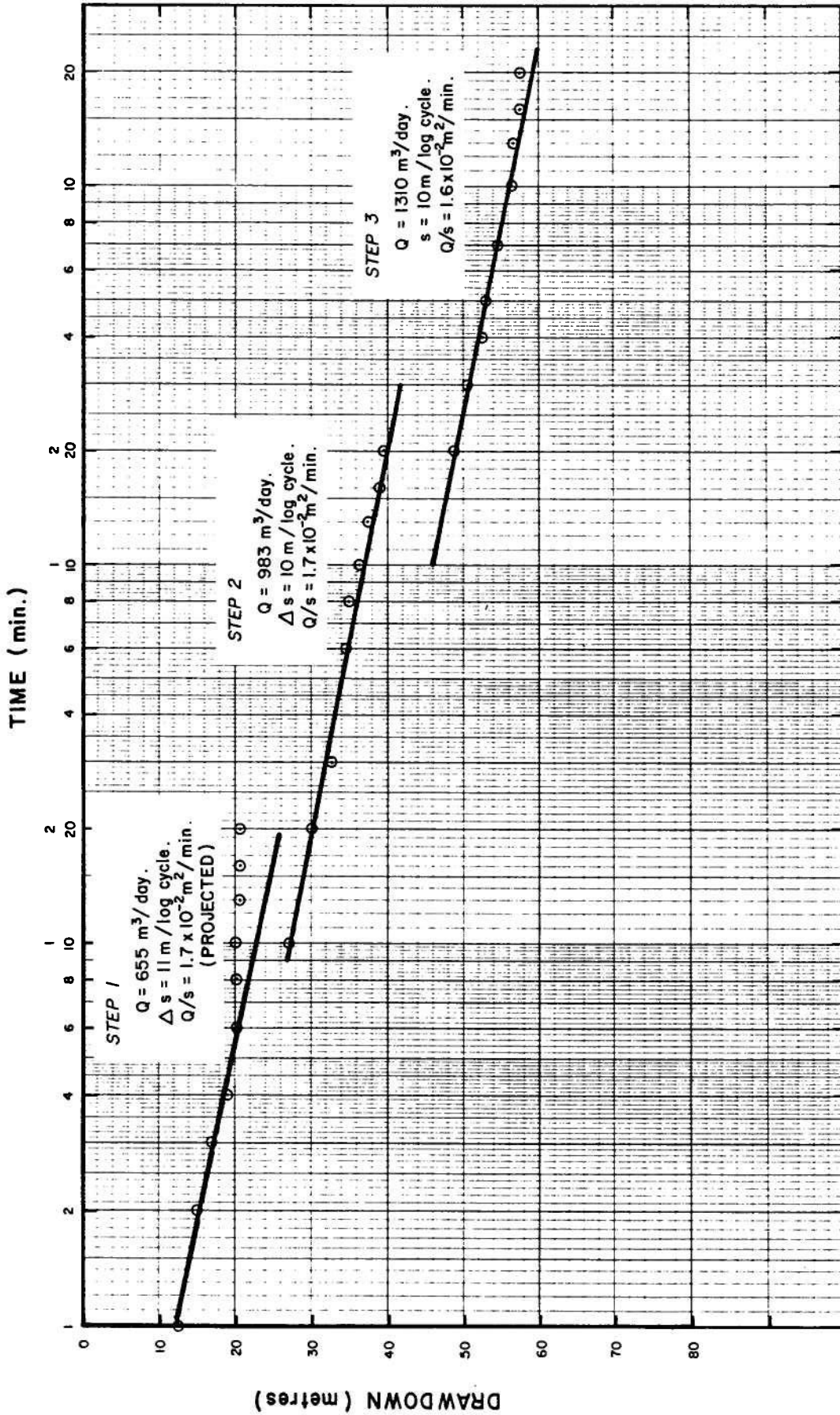


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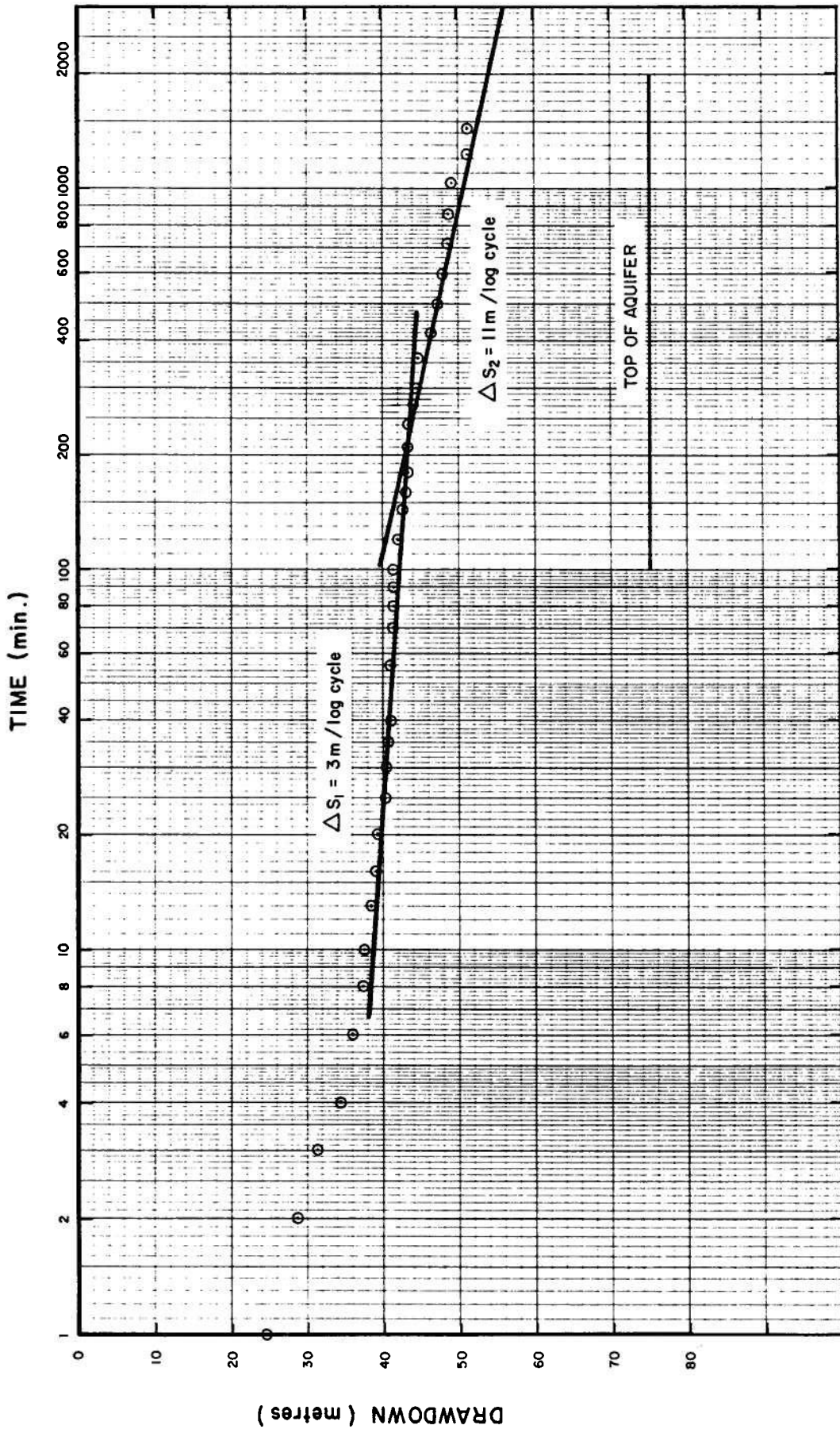
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APPENDIX B

AQUIFER TEST DATA



Well No. (Status) : PRODUCTION WELL No. 2 Date : JUNE 4, 1980.
 Aquifer Test : STEP DRAWDOWN Discharge (Q) : VARIABLE
 Pre-test Water Level : FLOWING APPROX. + 3m Reference Point : TOP OF CASING.
 Remarks : HAINES JUNCTION, YUKON TERRITORY



Well No. (Status) : PRODUCTION WELL No. 2 Date : JUNE 4-5, 1980.

Aquifer Test : CONSTANT RATE. Discharge (Q) : 983 m³/day.

Pre-test Water Level : FLOWING +3m Reference Point : TOP OF CASING.

Remarks : HAINES JUNCTION , YUKON TERRITORY .

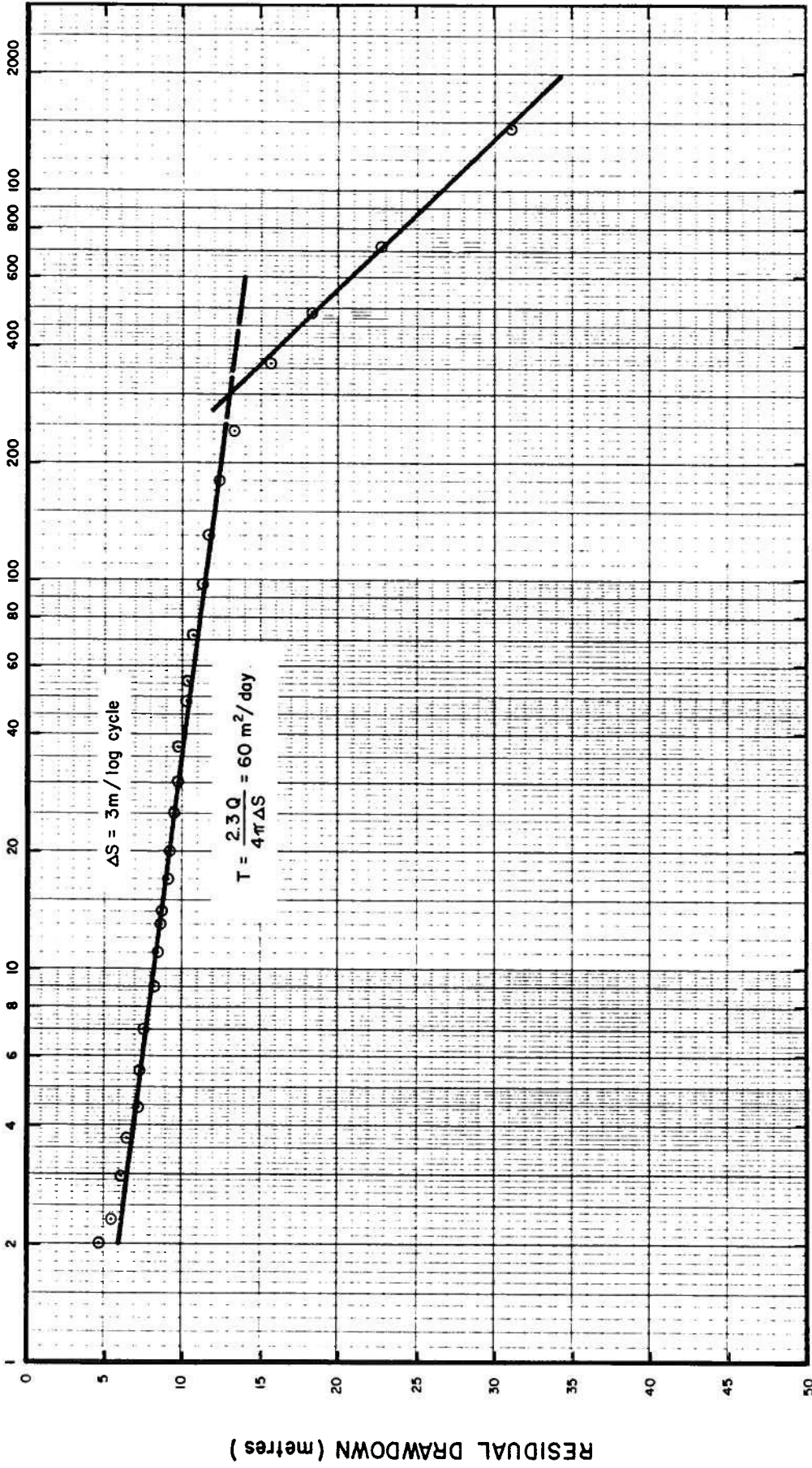
Project: Haines Junction
Groundwater Supply
 Location: Haines Junction Y.T.
 Date: June 5, 6 1980
 Well Number: Production Well #2

Pretest Water Level: flowing (approx +3m toc)
 Casing Height: 0.915 m above ground
 Distance From Pumped Well: xxxxx
 Average Pump Rate: 983 m³/day
 Start Of Test: 2:00 p.m. End: 2:00 pm

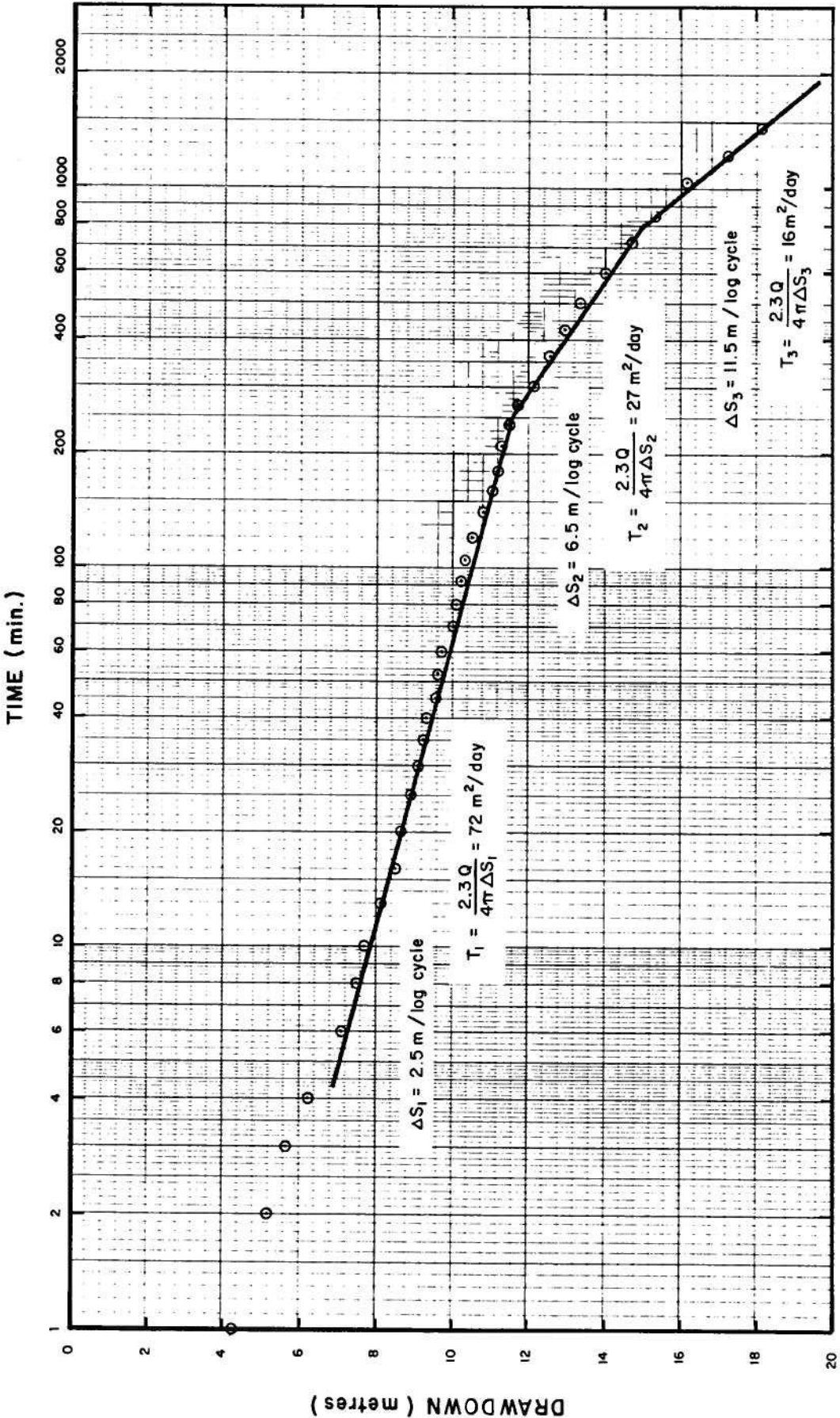
Water Levels Measured With electric sounder

TIME (t) since pump start (min)	TIME (t') since pump stopped (min)	RATIO t/t'	DEPTH TO WATER (metres)	RESIDUAL DRAWDOWN (metres)
1440	0	-	48.88	51.88
1441	1	1441	28.06	31.06
1442	2	721	19.93	22.93
1443	3	481	15.24	18.24
1444	4	361	12.54	15.54
1446	6	241	10.30	13.30
1448	8	181	9.34	12.34
1451	11	131.9	8.80	11.80
1455	15	97	8.19	11.19
1460	20	73	7.76	10.76
1466	26	56.4	7.41	10.41
1470	30	49	7.25	10.25
1480	40	37	6.94	9.94
1490	50	29.8	6.71	9.71
1500	60	25	6.49	9.49
1515	75	20.2	6.27	9.27
1530	90	17	6.07	9.07
1549	109	14.2	5.86	8.86
1560	120	13	5.74	8.74
1580	140	11.3	5.54	8.54
1620	180	9	5.20	8.20
1680	240	7	4.88	7.88
1760	320	5.5	4.35	7.35
1860	420	4.4	4.05	7.05
1980	540	3.7	3.56	6.56
2190	750	2.9	3.11	6.11
2520	1080	2.3	2.46	5.46
2660	1220	2.2	2.23	5.23
2880	1440	2	1.90	4.90
Note: 3m added to residual drawdown to compensate for flowing condition.				

1/t



Well No. (Status) : PRODUCTION WELL No.2 Date : JUNE 5-6, 1980
Aquifer Test : RESIDUAL DRAWDOWN Discharge (Q) : 983 m³/day
Pre-test Water Level : FLOWING + 3m Reference Point : TOP OF CASING
Remarks : HAINES JUNCTION, YUKON TERRITORY .



Well No. (Status) : OBSERVATION WELL No.1 Date : JUNE 4-5, 1980
 Aquifer Test : CONSTANT RATE Discharge (Q) : 983 m³/day
 Pre-test Water Level : FLOWING +4 m Reference Point : TOP OF CASING

Remarks : HAINES JUNCTION , YUKON TERRITORY

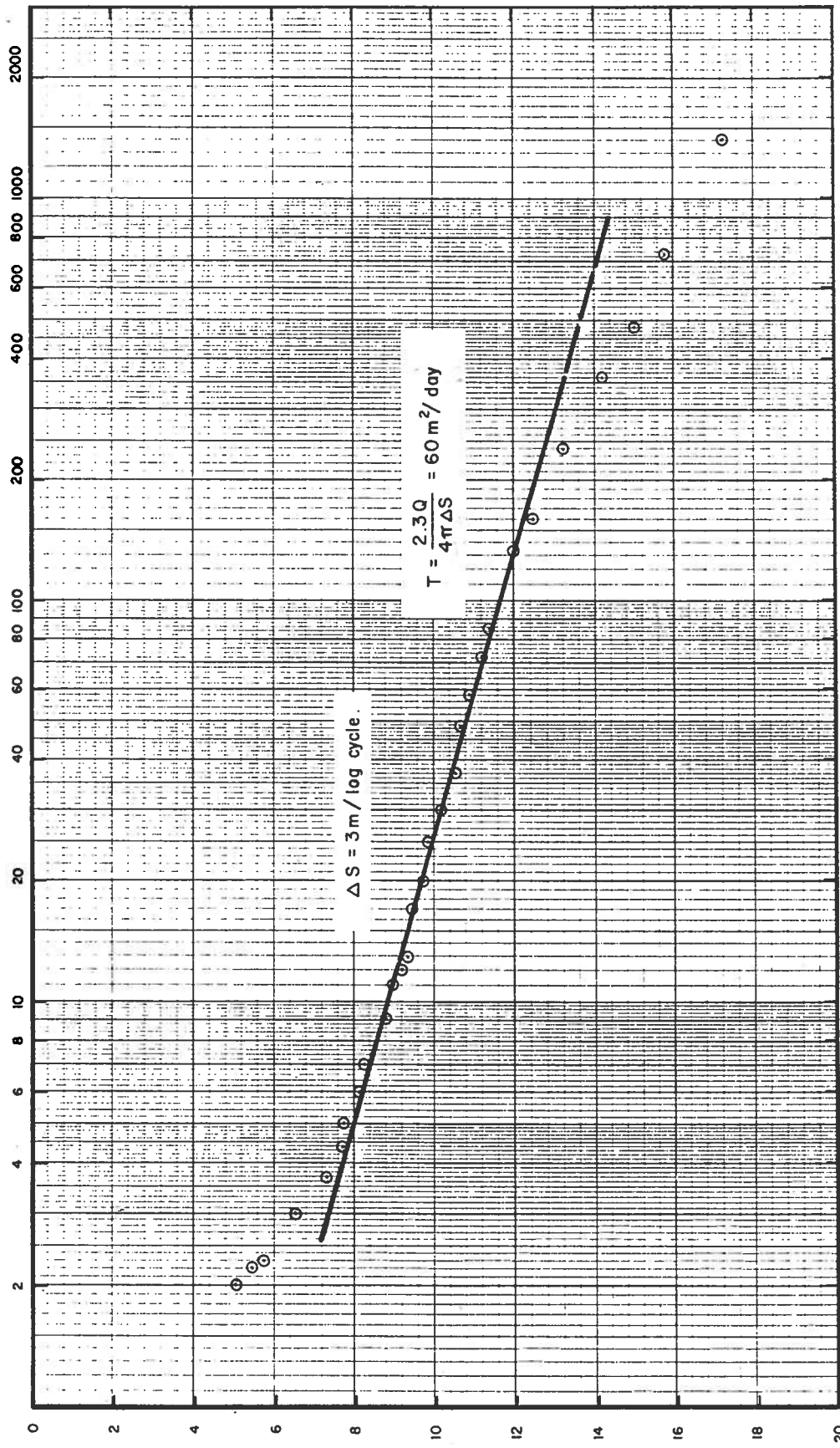
Project: Haines Junction
Groundwater Supply
 Location Haines Junction
 Date June 5, 6 1980
 Well Number Observation (Well #1)

Pretest Water Level flowing (approx +4m toc)
 Casing Height even with ground level (in pit)
 Distance From Pumped Well 18.6 m
 Average Pump Rate 983 m³/day from Well #3
 Start Of Test 2:00 pm End 2:00 pm

Water Levels Measured With electric sounder

TIME (t) since pump start (min)	TIME (t') since pump stopped (min)	RATIO t/t'	DEPTH TO WATER (metres)	RESIDUAL DRAWDOWN (metres)
1440	0	-	14.10	18.10
1441	1	1441	13.17	17.17
1442	2	721	11.89	15.89
1443	3	481	11.01	15.01
1444	4	361	10.24	14.24
1446	6	241	9.24	13.25
1449	9	161	8.40	12.40
1451	11	131.9	8.09	12.09
1457	17	85.7	7.48	11.48
1460	20	73	7.24	11.24
1465	25	58.6	6.96	10.96
1470	30	49	6.72	10.72
1480	40	37	6.42	10.42
1490	50	29.8	6.17	10.17
1500	60	25	5.95	9.95
1515	75	20.2	5.74	9.74
1530	90	17	5.56	9.56
1548	108	14.3	5.34	9.34
1560	120	13	5.20	9.20
1580	140	11.3	5.01	9.01
1620	180	9	4.73	8.73
1680	240	7	4.35	8.35
1710	270	6.3	4.17	8.17
1785	345	5.2	3.83	7.83
1860	420	4.4	3.77	7.77
1980	540	3.7	3.26	7.26
2190	750	2.9	2.53	6.53
2520	1080	2.3	1.78	5.78
2660	1220	2.2	1.55	5.55
2880	1440	2	1.19	5.19

1/4'



Well No. (Status) : OBSERVATION No. 1 Date : JUNE 5 - 6, 1980.
Aquifer Test : RESIDUAL DRAWDOWN Discharge (Q) : 983 m³/day FROM P.W. No. 3.
Pre-test Water Level : FLOWING + 4 m Reference Point : TOP OF CASING .

Remarks : HAINES JUNCTION , YUKON TERRITORY