Province of British Columbia
Ministry of Environment
Inventory and Engineering Branch

CONSTRUCTION OF OBSERVATION WELL WR-261-80

WILLIAMS LAKE AREA

CONTRACT NO. 70

W.S. Hodge
Technician
Groundwater
Hydrology Section

Victoria, B.C.
Feb. 1981

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CONSTRUCTION OF OBSERVATION WELL WR 261-80
WILLIAMS LAKE AREA
Contract No. 70

1. INTRODUCTION

One 203 mm diameter observation well was drilled and completed to a depth of 79.2 metres (260 feet) off Dog Creek Road south of Williams Lake (Figure 1). The well was drilled by Manville Drillers of Williams Lake and tested by Ken Branscombe of Hillside Pumps, Williams Lake in September 1980. Total contract costs for well construction and testing were $8,092.00.

The area around Dog Creek Road was chosen as a high priority area for establishment of an observation well on the recommendations of Choy (1978). Groundwater exploration in this area had been previously recommended by our Ministry (Hodge, 1976) in a report to the Land Management Branch at Williams Lake.

As shown in Figure 1 well density along Dog Creek Road is very high with residents relying entirely on the local groundwater reserves. Figure 2 shows the well location in greater detail.

Construction of an observation well was required to monitor water level fluctuation and long term effects of groundwater extraction in the area. An automatic water level recorder and protective housing were installed on the well head. This equipment should remain in place for a minimum of 5 years.

2. WELL CONSTRUCTION AND TESTING

Drilling was carried out to a depth of 79.2 metres using an air rotary drill rig (Speedstar) with casing hammer. To allow for surface grouting, a 4.9 metre length of temporary casing was installed. This

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casing was later removed and the annular space around the 203 mm diameter casing was grouted. This 203 mm casing extends from ground surface to a depth of 61 metres through unconsolidated material comprised of brown and blue clay with gravel (Figure 3). A drilling foam was pumped into the hole while drilling through both the overburden and bedrock. The foam was used as a precaution against unstable or caving conditions. At times drilling 12.2 metres open hole ahead of the casing was possible in overburden. Although foam aided in keeping the hole open, materials were quite firm.

The major source of water is derived from bedrock. This source is likely supplemented from the water-bearing gravels above. Examination of the drill returns revealed the bedrock to be a highly fractured tertiary sandstone. Drilling action showed the sandstone to be firm but grading from soft to hard. The soft layering encountered appears to be compacted sand between layers of lithified bedrock.

The well was developed by surging and pumping with compressed air for a period of 1.5 hours. The water had cleared in this time and was visibly sand free.

The well was pumped with a 5 h.p. - 13 stage Jacuzzi submersible pump. The first test on September 3rd was terminated after only 70 minutes of pumping because of a pump failure. The second test on September 5th was completed without interruption and the well was pumped at a rate of between 4.13 litres/second and 4.54 litres/second (65.4 and 72 USgpm for a period of 560 minutes (9.3 hours). The pump intake was set at 42.7 metres below the top of the well casing during this test and the static water level was 25.5 metres. Test data is shown in Appendix A. A drawdown of 0.83 metres occurred over the test period representing approximately 5 percent of the total available drawdown. Using these figures and assuming stabilization of the pumping water level occurred during the test, a maximum specific capacity of 5.47 litres/second/metre of drawdown (26.5 USgpm/ft. of drawdown) can be calculated. If the lower

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pumping rate of 4.13 litres/second is used, a specific capacity of 4.92 litres/second/metre of drawdown is derived. This figure may be more realistic considering stabilization did not occur when the well was pumped at the higher rate of 4.5 litres/second (72 USgpm). On the basis of these calculations the well should theoretically be capable of sustaining a yield of 101 litres/second or 1600 USgpm if the pump were lowered to 61 metres, and the maximum available drawdown (at the time of testing) were utilized.

A long term pump test of minimum duration of 72 hours at higher pumping rates would have to be conducted in order to define more clearly the full capabilities of this well.

Water level recovery was rapid. The initial recovery reading 30 seconds after the pump was stopped was recorded as 0.13 metres (0.43 feet) above the original static water level. This excellent recovery response was due in part to the well construction (i.e. the well was completed open hole in the bedrock and thus no restrictions such as slotted casing were present). This response also indicates the aquifer is subject to recharge. A water level of 0.02 metres (0.07 feet) below the original static water level was recorded within one hour of stopping the pump. An automatic water level recorder was installed on the well head at this point and the remaining recovery was recorded.

3. GEOLOGY

Surficial and bedrock geology in the Williams Lake area has been mapped by Tipper (1959). Bedrock geology has been shown in Figure 4 of the text.

The glacial history in the Williams Lake valley is complex and involved at least two periods of glaciation. Each advance appears to have occurred in a westerly direction towards the Fraser River. According to Callan (1968) the first advance was more pronounced than the last, eroding

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the Williams Lake valley to at least an elevation of 1450 feet and depositing a thick sequence of sands, silts and gravels as it receded. The second advance was less severe and did not erode the valley below an elevation of 1800 feet.

Large meltwater or outwash channels of recent alluvium materials cover most of the Williams Lake valley and Chimney Creek areas with some pitted terrain to the north of Williams Lake. The alluvium consists of mainly till, sand, gravel and silt.

The study area is primarily underlain by a thin drift cover overlying bedrock. Geological logs of wells drilled within the immediate study area indicate bedrock varies between surface and 76 metres. The bedrock geology map shown in Figure 3 indicates surficial deposits of till, gravel, sand, clay and silt bounded by tertiary volcanic bedrock to the east and west (Figure 3). Surficial deposits were found to be 58.5 metres thick (192 feet) at the observation well drill site.

Recent hydrographs obtained from the monitoring of this observation well have shown water level movement in the well caused by earthquakes (Appendix B). A spike, 0.038 metres in length appeared at approximately 9:00 a.m., December 17th on the hydrograph shown in Appendix B. This spike was caused from the December 17th earthquake (9:20 a.m.) which originated approximately 200 kilometres west of Estevan Point on Vancouver Island.

Another spike, 0.072 metres in length occurred November 8th and this is believed to be caused from the southern Italy earthquake.

4. HYDROGEOLOGY

The Groundwater section has approximately 180 records of wells drilled along Dog Creek Road (Figure 1). The Dog Creek Road area was reviewed as part of a groundwater study done in July 1976. At that

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time the average depth of wells drilled along Dog Creek Road was determined at 31.4 metres (103 feet). Well depths ranged from shallow dug wells and drilled wells up to 94.5 metres (310 feet). Wells drilled recently are generally deeper than 31.4 metres. Through discussions with local residents and comparisons of dated and recent water levels in the area it is apparent that water levels may be declining. This may be due to the numerous wells being constructed in this area causing an ever increasing demand on the groundwater resource.

Until the construction of the observation well, the greatest recorded yield on Dog Creek Road was the Kendall Acres Mobile Home Park well (Figure 1). This well is 27 metres deep (88 feet) and reports a specific capacity of 3.0 litres/second/metre of drawdown (19.2 USgpm/ft.). The recommended pumping rate of this well was set conservatively at 50 USgpm by the driller. The majority of wells along Dog Creek Road are, however, capable of yielding 0.06 to 0.25 litres/second (1 to 4 USgpm). The major aquifer throughout the Dog Creek Road area appears to be a tertiary sandstone. Groundwater recharge to this area is likely supplied from higher elevations to the south. Groundwater discharge has been noted downslope near Shaw Auto by local residents. As mentioned in the 1976 report, glaciofluvial deposits surround Bond Lake. These deposits are free draining possibly supplying recharge to areas downslope to the north (observation well site).

Bond Lake is located on a knoll approximately 76 metres higher in elevation than the drill site and is located 1200 metres southwest of the drill site. Aerial photographs indicate Bond Lake could be a contributing source of recharge to this aquifer.

5. WATER QUALITY

Water samples were collected and submitted for complete chemical analysis at the beginning and the completion of the pump test. The

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analyses indicate the groundwater is hard (547 and 567 mg/ℓ) with corresponding pH values of 8.0, and moderately mineralized (T.D.S. 696 and 700 mg/ℓ). These results indicate the presence of primarily a calcium-magnesium bicarbonate type groundwater. The total iron content recorded at the start of pumping was 1.3 mg/ℓ. After 7 hours of pumping the dissolved iron content was reduced substantially and recorded as 0.1 mg/ℓ. No iron was recorded in suspension at the end of pumping.

Although below the recommended standard of 10 mg/ℓ, nitrite and nitrate levels are quite high (6.6 mg/ℓ). Levels as high as this could be an indication that the groundwater is receiving some organic constituents somewhere along its flow path. Hydrograph records have shown this aquifer is responsive to the effects of local pumping and earthquakes indicating the aquifer has a high transmissivity and good permeability. Although desirable in any aquifer these features also make an aquifer susceptible for movement of pollutants. It should be noted, however, that although a nitrite and nitrate level of 6.6 mg/ is above the normal amounts of these elements found in groundwater, these levels are still below the recommended standard and may be of little concern.

A water sample was also collected from the Kendall Acres Mobile Home Park located approximately 250 metres east of the observation well. This sample was submitted for complete chemical analysis. The analyses results for this well and the observation well were plotted using the Schoeller method (Appendix B) and the groundwaters were found to be different types and probably not of the same flow system. The Kendall Acres well is (26.8 metres) deep and the major water bearing zone is located between 11 metres and 25.3 metres. The water quality of this well is considerably lower in hardness (218 mg/ℓ) and less mineralized (484 mg/ℓ) than the water sampled at the observation well site.

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6. CONCLUSIONS AND RECOMMENDATIONS

- The aquifer encountered is a fractured rock, probably tertiary sandstone.

- Recharge to this aquifer likely occurs in the south. Geologic mapping and aerial photography indicate that Bond Lake may be hydraulically connected to this aquifer.

- This aquifer appears to have the potential for supporting a high capacity well or wells. The pump test data has indicated a properly designed and constructed well within this aquifer could theoretically sustain a yield of several hundred gallons per minute.

- A further long term pump test of a minimum duration of 72 hours is necessary, however, before any definite or final conclusions can be made regarding the capabilities or characteristics of this aquifer. Although recovery data suggests this aquifer is extensive, long term pumping could reveal hydraulic boundaries not evident from short duration tests. Long term, high rate pumping tests are not within the scope of the observation well establishment program under which the well was constructed.

- Development of this aquifer may now be an important consideration when concerned with the long term planning of areas along Dog Creek Road. The option of pumping water to this area from Williams Lake could be dismissed pending further testing of this aquifer.

- Water quality is acceptable and meets the standards set by the Canadian Drinking Water Quality Guidelines for all parameters tested. Nitrogen with respect to nitrite and nitrate was high, but below the recommended standard.

- This well should be sampled for complete chemical analysis at least

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twice during its monitoring period - once during the late summer months when water levels are historically at their lowest and once during the spring. Testing for iron and nitrogen levels should be of particular importance.

W.S. Hodge
Technician
Groundwater
Hydrology Section

WSH/dma

APPENDIX "A"

Well Log, Contract Costs, Pump Test Data,

Water Level Recorder Installation Specifications,

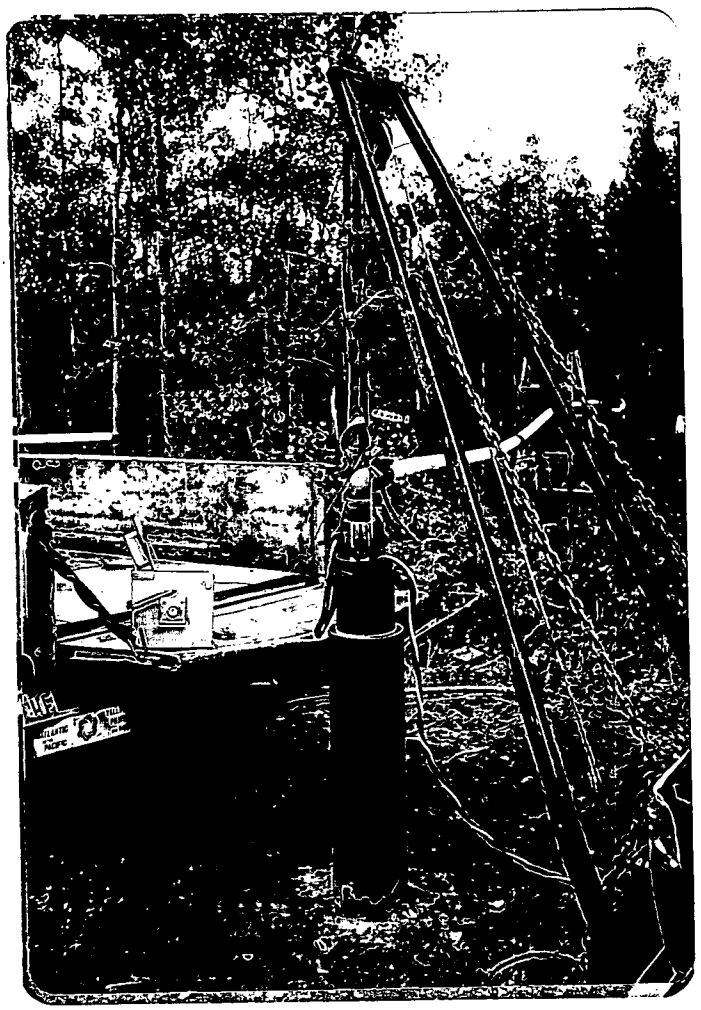
Application Form

Williams Lake Observation Well #261

(Note-Fish & Wildlife shed
to the left and Dog Creek road
in the background)

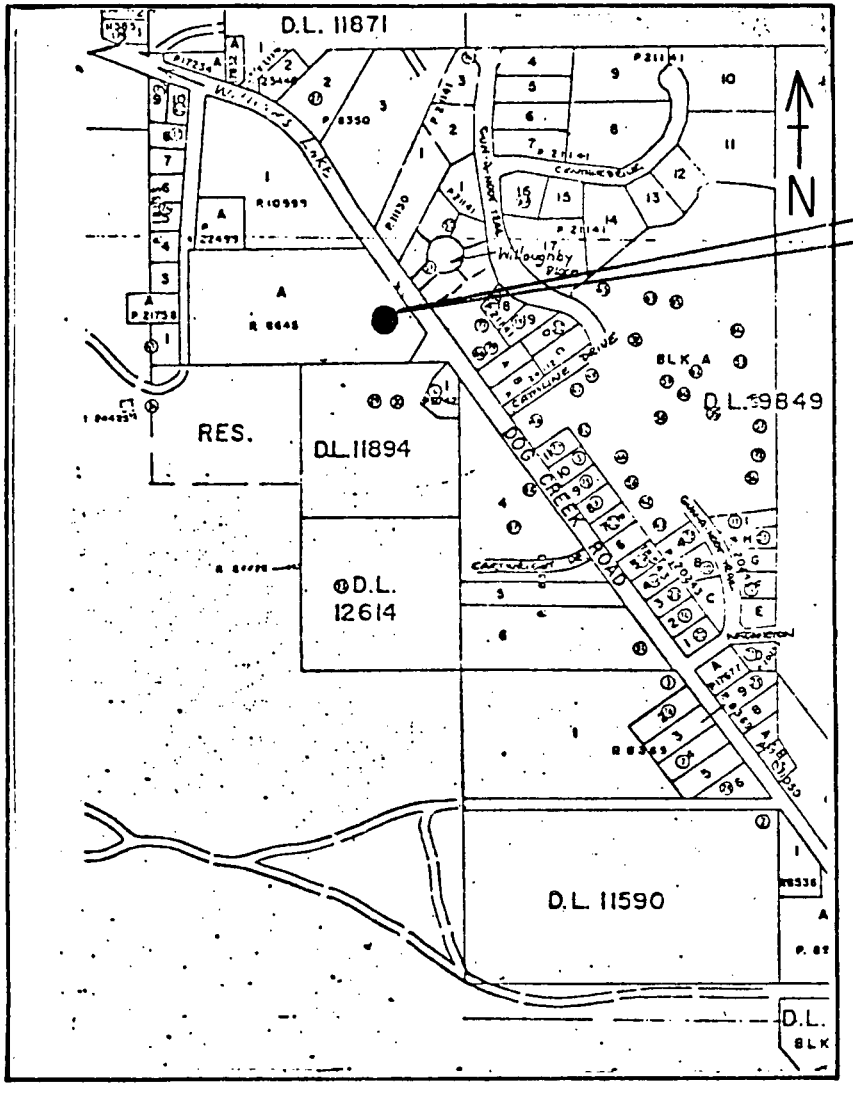
Williams Lake Observation Well WR 261-80

Pump Test - Sept. 5, 1980

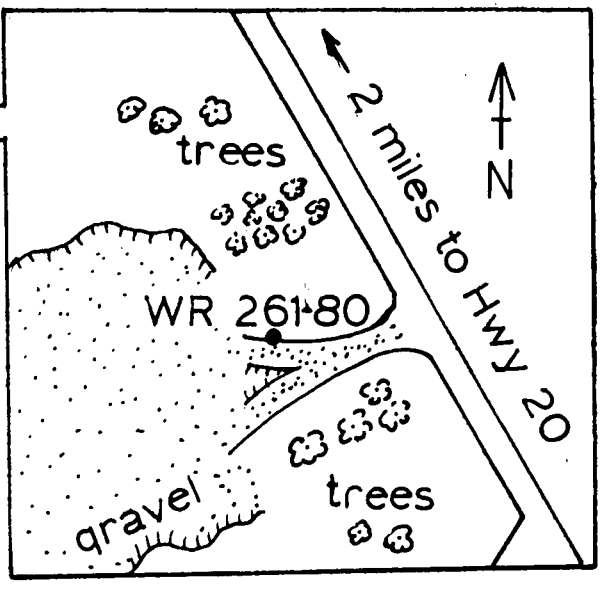


5 HP Submersible pump installed and pumping about to begin.

Discharge of 72 USgpm.



LOCATION PLAN



SITE PLAN

Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
Construction of Observation well
WR 261-80-Williams Lake Area

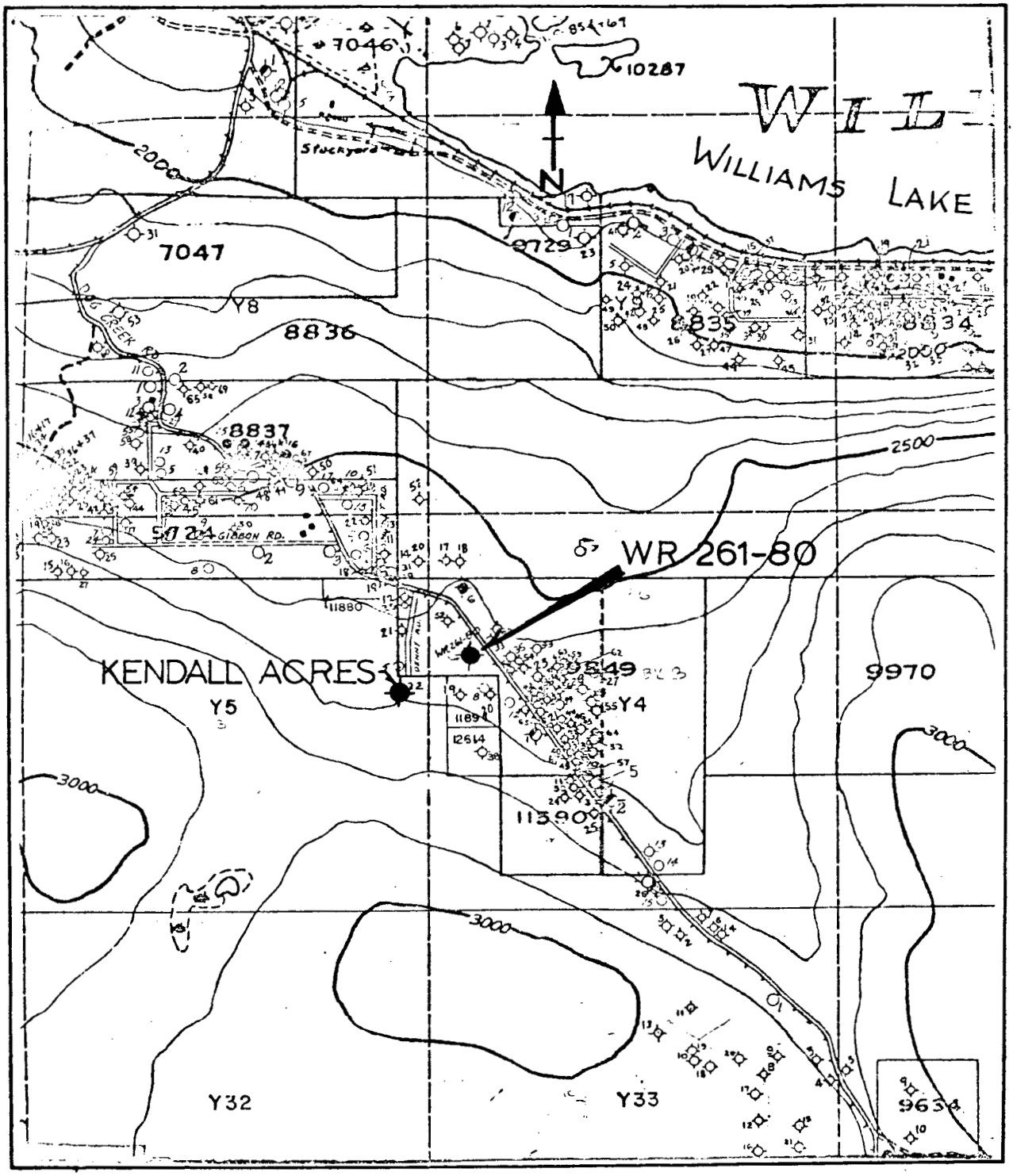
SCALE: VERT. 1 cm = 205 metres
HOR.

DATE Oct. 1980

D.A. Lowen ENGINEER

FILE No. DWG. No. Figure 2

bcil 6661 wrs



WELL LOCATION PLAN

PLAN SHOWS HIGH WELL DENSITY ALONG DOG CREEK ROAD

Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
Construction of Observation Well
WR 261-80-Williams Lake Area.

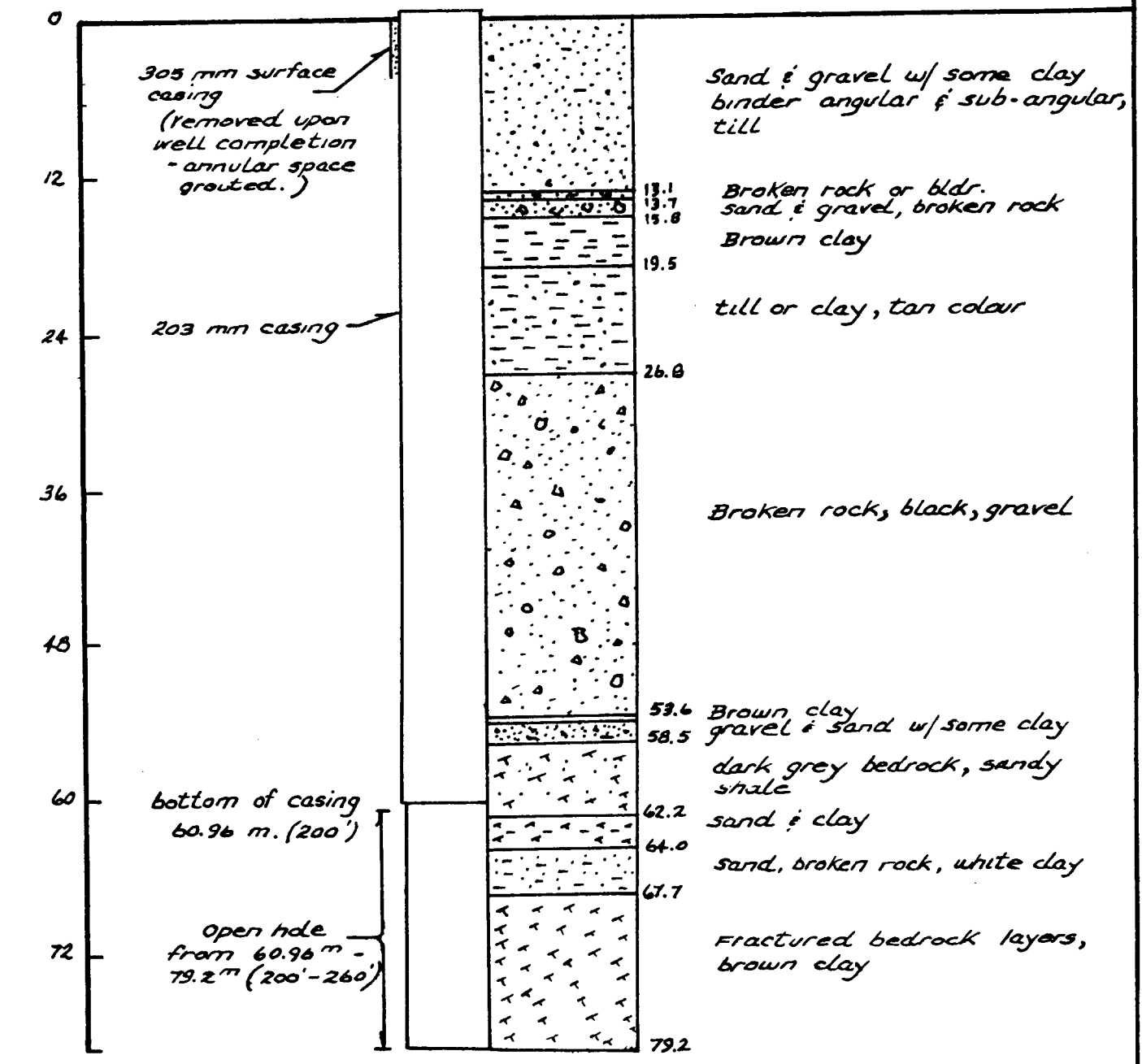
SCALE: VERT. 1 cm=240 metres
HOR.

DATE
Oct. 1980

D.A. Lowen ENGINEER

FILE No.

DWG. No. Figure 1



WELL DESIGN & GEOLOGY
Williams Lake Observation Well WR 261-80

Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

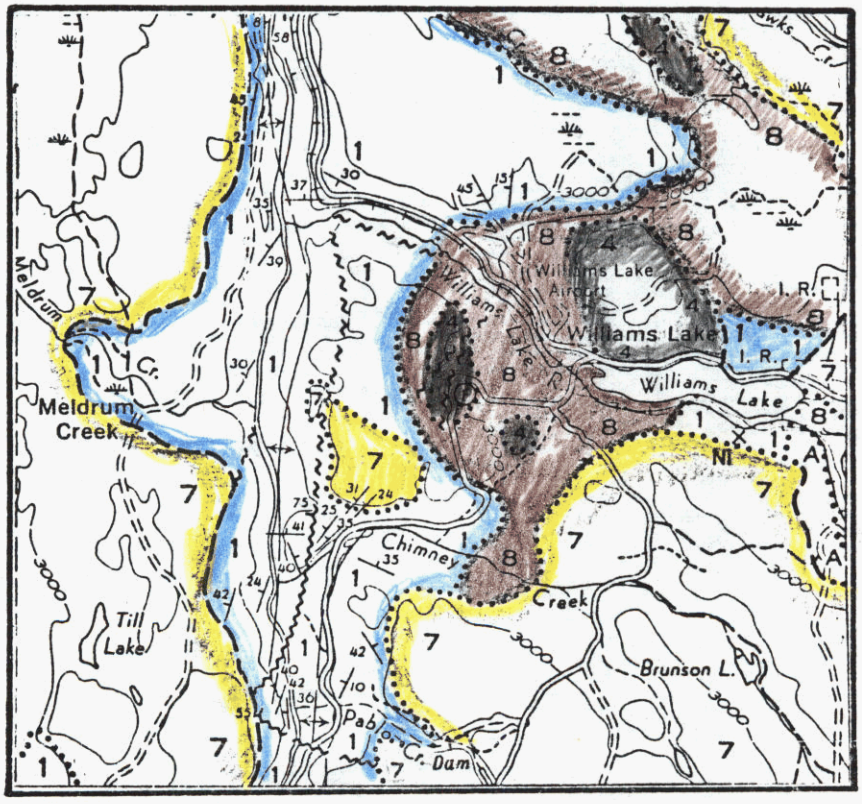
TO ACCOMPANY REPORT ON
Construction of Observation well
WR 261-80-Williams Lake Area

SCALE: VERT. 1 cm=4.7 metres
HOR. N/A

DATE Oct. 1980

D.A. Lowen ENGINEER

FILE No. DWG. No. Figure 3



LEGEND

1	CHERT ARGILLITE LIMESTONE GREENSTONE AND CONGLOMERATE
4	RHYOLITE ANDESITE DACITE TRACHYITE RELATED TUFF AND BRECCIA BASALT MINOR SEDIMENTS
7	BASALT ANDESITE RELATED TUFF AND BRECCIA MINOR CONGLOMERATE GREYWACKE SHALE AND DIATOMITE
8	TILL GRAVEL SAND CLAY AND SILT

(from Tipper, 1959)

Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
Construction of Observation Well
WR 261-80 - Williams Lake Area

SCALE: VERT.
HOR.

DATE
Oct. 1980

D.A. Lowen
ENGINEER

FILE No.
DWG. No. Figure 4

bcil 6660 wrs

APPENDIX "A"

Well Log, Contract Costs, Pump Test Data,

Water Level Recorder Installation Specifications,

Application Form

OBS. WELL #261

WATER WELL RECORD

DEPT. OF ENVIRONMENT, WATER RESOURCES SERVICE, WATER INVESTIGATIONS BRANCH VICTORIA, BRITISH COLUMBIA

LEGAL DESCRIPTION: LOT A SEC. ____ TP. ____ R. ____ D.L. 9849 LAND DISTRICT CARIBOO PLAN 8645

DESCRIPTIVE LOCATION OFF 70C CREEK ROAD, S.E. OF DENIVY RD., WILLIAMS LAKE LICENCE NO. ____ DATE ____

WELL NO. Z ____ E ____ N ____

Z 2 X 14 Y 4 NO.

NAT. TOPO. SHEET NO. 1

OWNER'S NAME MINISTRY OF ENVIRONMENT ADDRESS 765 DISCHTON - VICTORIA B.C

DRILLERS NAME MANVILLE DRILLING ADDRESS WILLIAMS LAKE DATE COMPLETED SEPT 1980

DEPTH 260' ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 8" LENGTH 200'

METHOD OF CONSTRUCTION AIR ROTARY CASING DIAM 8" LENGTH 200'

SCREEN LOCATION — SCREEN ☐ SIZE ____ LENGTH ____ TYPE ____

SANITARY SEAL YES ☑ NO ☐ SCREEN ☐ SIZE ____ LENGTH ____ TYPE ____

PERFORATED CASING ☐ LENGTH ____ PERFORATIONS FROM ____ TO ____

GRAVEL PACK ☐ LENGTH ____ DIAM. ____ SIZE GRAVEL, ETC. ____

DISTANCE TO WATER 83.64' ☐ ESTIMATED WATER LEVEL

FROM TOP CASING ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT SEPT 5/80 WATER USE OBSERVATION WELL

PRODUCTION TEST SUMMARY

DATE SEPT 5/80

TEST BY HILLSIDE PUMPS - WILLIAMS LAKE

BAIL TEST ☐ PUMP TEST ☑ DURATION OF TEST 9.5 hrs

RATE 72 USgpm DRAWDOWN 2.72'

WATER LEVEL AT COMPLETION OF TEST 86.36'

AVAILABLE DRAWDOWN ≥100 SPECIFIC CAPACITY ≥ 25 USgpm/ft

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

RECOMMENDED PUMPING RATE —

RECOMMENDED PUMP SETTING —

CHEMISTRY

TEST BY ____ DATE ____

TOTAL DISSOLVED SOLIDS ____ mg/l TEMPERATURE ____ °C pH ____ SILICA (SiO_2) ____ mg/l

CONDUCTANCE ____ μmhos/cm AT 25°C TOTAL IRON (Fe) ____ mg/l TOTAL HARDNESS ($CaCO_3$) ____ mg/l

TOTAL ALKALINITY ($CaCO_3$) ____ mg/l PHEN. ALKALINITY ($Ca CO_3$) ____ mg/l MANGANESE (Mn) ____ mg/l

COLOUR ____ ODOUR ____ TURBIDITY ____

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
$NO_2 + NO_3$ (NITROGEN)			IRON (DISSOLVED)		
• TKN. (NITROGEN)					
PHOSPHORUS (P)					

• TKN • TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ____

NO_2 • NITRITE NO_3 • NITRATE

CHEMISTRY FIELD TESTS

TEST BY W. HODEE DATE SEPT 5/80 EQUIPMENT USED HACH

TEMP = 7.6°C PH 7.8 HARDNESS 650

COND = 1000 IRON .8 - 1.1 ALK 632

CONTENTS OF FOLDER

☑ DRILL LOG ☐ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER LOCATION SKETCH

SOURCES OF INFORMATION ____

LITHOLOGY

FROM	TO	DESCRIPTION
0	43	S & G. W/ LITTLE CLAY binder VERY SOUPY ANGULAR & SUB-ANGULAR S & G GRAINS SOME ROUNDED, TILL
43	45	BROKEN ROCK LAYER OR BLDR., HARD
45	52	S & G. & BROKEN ROCK FRAGS., GREY
52	64	BROWN CLAY
64	88	LITTLE CLAY BINDER, LIGHTER TAN COLOUR, TILL OR CLAY
88	176	BROKEN ROCK BLACK GRAVEL
176	178	BROWN CLAY
178	192	GRAVEL & SAND W/ SOME CLAY
192	204	DARK GREY COLORED BEDROCK SOME S & G. (COULD BE S & G IN BEDROCK FRACTURES) SANDY GREY SHALE
204	210	SAND & CLAY, RED BROWN COLOUR PINKISH WATER
210	222	SAND & CLAY
222	223	SAND BROKEN ROCK AND WHITE CLAY SOME DIRTY SAND STONE
223	260	FRAG. ROCK & LAYERS OF BROWN CLAY.

MANVILLE DRILLING (B.C.) CO. LTD.

R.R. 2, BOX 25, COMMODORE CRESCENT, WILLIAMS LAKE, B.C. V2G 2P2
TELEPHONES: 989-4301 - 392-7562

No 125

Sept 2 19 80

N ACCOUNT WITH Ministry of Environment

ADDRESS Parliament Buildings, Victoria, B.C. V8V 1X4

2% Carrying Charge per month on overdue accounts, including interest and payment in arrears.

Re - water well construction contract No. 10		
Williams Lake, B.C.		
17' - 12" surface casing @ $38.00 per ft	646	00
183' - 8" drilling casing in overburden @ $27.00 per ft	4,941	00
8" drilling in bedrock 60 ft @ $15.00 per ft	900	00
17' - 8" overlap casing @ $12.00 per ft	204	00
1 - 8" drive shoe	130	00
3 hrs. developing & cementing @ $150.00 per hr.	450	00
capping well	50	00
SUB-TOTAL	7320	00
Mobilization & Demobilization of pump and equipment	280	00
12 hours pumping	456	00
1 hour recovery	35	00
TOTAL	8,091	00

TERMS:

Upon default of any payment the entire balance becomes due and payable and a Mechanics Lein may be filed.

In the event of non payment of the said total charge, the owner authorizes this company to take whatever legal steps may be deemed necessary to collect and agrees to pay all collection costs.

DRILLER: L.H. Beckett ACCEPTED BY W.S. Hodge Sept 6/80

APPENDIX

"CONSTANT RATE" PUMPING TEST DATA FROM WELL NO. 261

Date September 12, 1980

TEST #1

Time	Time (t) since start of pumping in mins.	Depth to water in well from top of casing in feet	Drawdown in well in feet (static =)	Height of water in tube on orifice pipe in inches	U.S.gals. per min. discharge from well	
9:50 AM	0	84.12				5HP Jacuzzi
	.5	87.27				(13 Stage)
	1	*				
	1.5	*			*	Soil Test M-Scope
	2	*				Not Working
	2.5	*				Correctly-Replaced
	3	*				W/Powers
	3.5	*				
	4	86.68				
	4.5	86.38				
	5	86.30			50.4-54	
	6	86.31				
	7	86.25				
	8	86.28				
	9	86.28				
	10	86.27				
	12	86.29				
	14	86.43				
	16	86.32				
	18	86.31				
	20	86.33			50.4-54	
	25	85.81				
	30	85.74				Hach Test @
	35	85.73				11:00 AM
	40	85.73				Temp-7.6
	45	85.72				Cond-1000 PM 7.8
	50	85.71				Iron 1.1
	60	85.70				Hardness 614
11:00 AM	70	84.69			* Pump Acting	up-Flow
11:00 AM	73	84.46			Reduced Greatly.	
					Shut Down and pump removed for repairs	

APPENDIX

RECOVERY READINGS IN WELL NO. 261 AFTER "CONSTANT RATE" PUMPING TEST #1

Date September 12, 1980

Time	Time (t) since start of pumping in mins.	Time (t') since Pumping stopped in mins.	Value of t / t'	Depth to water in well from top of casing in feet	Residual drawdown in well in feet (static =)	
11:03 AM		0		84.46		
		.5		-		Missed
		1		84.12		
		1.5		84.23		
		2		84.18		
		3		84.22		
		4		84.15		
		5		84.15		
		6		84.12		
11:13 AM.		10		84.12		Initial S.W.L.
						Pump removed to repair

APPENDIX

"CONSTANT RATE" PUMPING TEST DATA FROM WELL NO. 261

Date September 11, 1980

TEST #2

Time	Time (t) since start of pumping in mins.	Depth to water in well from top of casing in feet	Drawdown in well in feet (static =83.64)	Height of water in tube on orifice pipe in inches	U.S.gals. per min. discharge from well	Pump Set @ 140' Below Tob Casing
8:25 AM	0	83.64	0			Observer-Hodge
	.5	-				Missed Reading
	1	85.30	1.66			
	1.5	85.30	1.66			
	2	85.30	1.66			Powers M-Scope
	2.5	85.31	1.67			Used Throughout
	3.	85.31	1.67			Test
	3.5	85.31	1.67			
	4	85.33	1.69			
	4.5	85.35	1.71			
	5	85.36	1.72			
	6	85.69	2.05			
	7	85.68	2.04			
	8	85.62	1.98			
	9	85.55	1.91			
	10	85.58	1.94		65.4	
	12	85.61	1.91		(3.96 l/s)	Water Sample
	14	85.66	2.02			Collected For
	16	85.67	2.03			Complete Analysis
	18	85.67	2.03			@ 12 min into test
	20	85.68	2.04		65.4	
	25	86.22	2.58			
	30	85.82	2.18			
	35	85.86	2.22			
	40	85.87	2.23			Observer Change
	45	85.88	2.24		65.4	@ 70 min-Wilkinson
	50	85.88	2.24			
	55	85.88	2.24			Hach Test @
9:25 AM	60	85.88	2.24			11:15 AM
	70	85.87	2.23		72 (4.37 l/s)	Iron-.8--1.1
	80	85.84	2.20			Cond. - 1000
	90	85.92	2.28			PH - 7.8
	100	85.94	2.30		65.4	Hardness - 649.8
	120	85.98	2.34			Temp - 7.6
	140	86.01	2.37			Alkalinity - 632

APPENDIX

"CONSTANT RATE" PUMPING TEST DATA FROM WELL NO.____

Date _____

Time	Time (t) since start of pumping in mins.	Depth to water in well from top. of casing in feet	Drawdown in well in feet (static =)	Height of water in tube on orifice pipe in inches	U.S.gals. per min. discharge from well	
	160	86.00	2.36			
	180	86.08	2.44			
11.45	200	86.11	2.47			
	230	86.12	2.48	65.4 (3.96 l/s)		
	260	86.08	2.44			
	290	86.13	2.49			
	320	86.18	2.54			Temp-7.6 °C
	350	86.21	2.57	72 (4.37 l/s)		Cond-1010
	380	86.22	2.58			*
	400*					Pump Acting Up
	410	86.33	2.69			Flow Stopped Non
	440	86.33	2.69			Pumping Level
	480	86.38	2.74	72 (4.37 l/s)		Returned To 83.85
	500	86.38	2.74			Within 1/2 min.
	540	86.36	2.72			OK after 3 min.
5:45 PM	560	86.36	2.72	Pump Shut off		

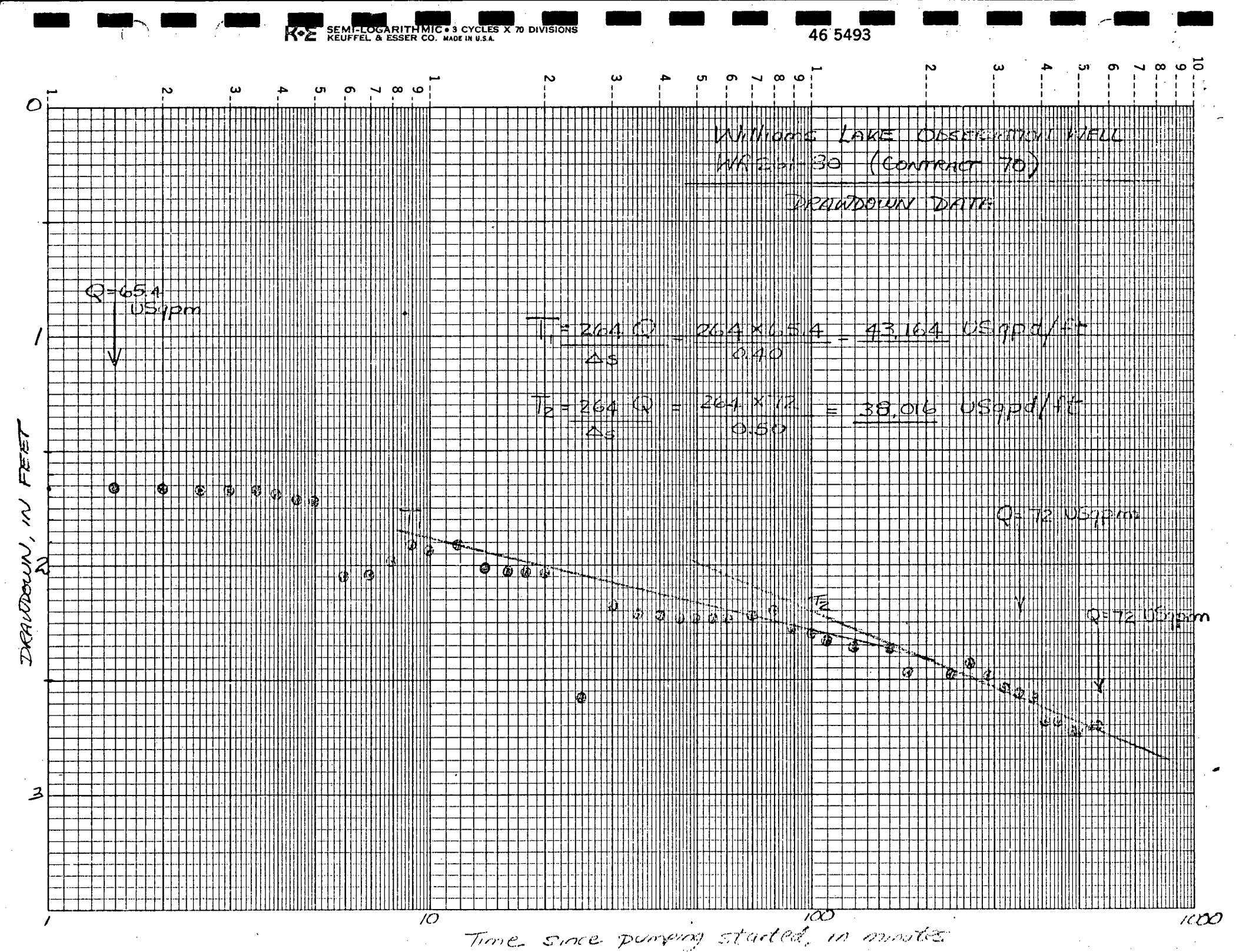
Note-Water Sample Collected for complete analysis @ 500 min into test.

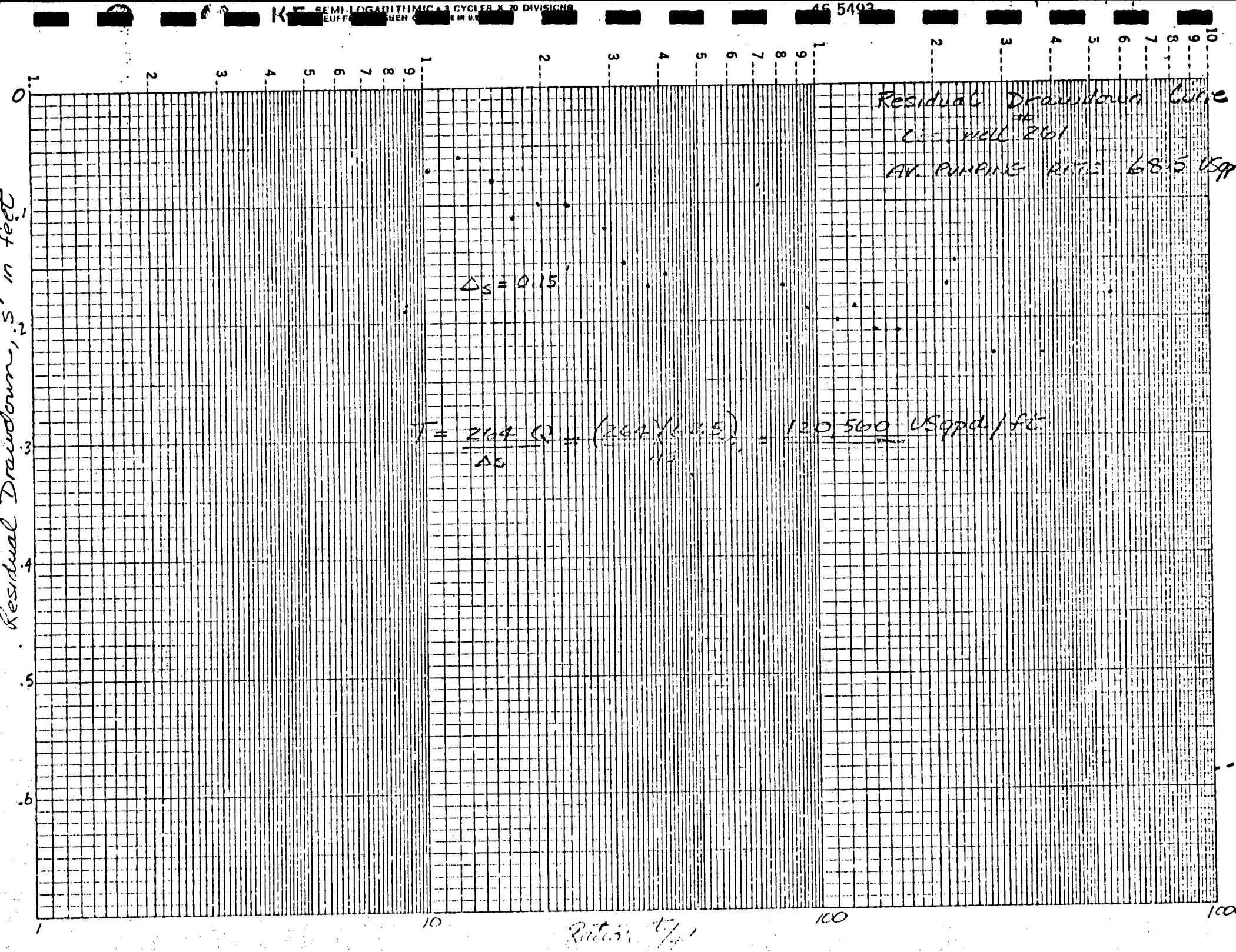
APPENDIX

RECOVERY READINGS IN WELL NO. 261 AFTER "CONSTANT RATE" PUMPING TEST #2

Date _____

Time	Time (t) since start of pumping in mins.	Time (t') since Pumping stopped in mins.	Value of t / t'	Depth to water in well from top of casing in feet	Residual drawdown in well in feet (static = 83.64)	
5:45 PM	560	0	—	86.36	2.57	
	560.5	.5	1120	83.21*	+ 0.43	*0.43' above initial SWL
	561	1	561	83.46	0.18	
	561.5	1.5	374.3	83.87	0.23	
	562	2	281	83.87	0.23	
	562.5	2.5	225	83.79	0.15	
	563	3	218	83.81	0.17	
	563.5	3.5	161	83.85	0.21	
	564	4	141	83.85	0.21	
	564.5	4.5	125.4	83.83	0.19	
	565	5	113	83.84	0.20	
	566	6	94.3	83.83	0.19	
	567	7	81.	83.81	0.17	
	568	8	71	83.71	0.07	
	569	9	63.2	83.95	0.31	
	570	10	57	83.94	0.30	
	572	12	47.6	83.97	0.33	
	574	14	41	83.80	0.16	
	576	16	36	83.81	0.17	
	578	18	32.1	83.79	0.15	
	580	20	29	83.76	0.12	
	585	25	23.4	83.74	0.10	
	590	30	19.6	83.74	0.10	
	595	35	17	83.75	0.11	
	600	40	15	83.72	0.08	
	610	50	12.2	83.70	0.06	
6:45 PM	620	60	10.3	83.71	0.07	.07' from initial S.W.L. recorder installed to record remainder of recovery


WILLIAMS LAKE OBSERVATION WELL
WR Dist. 30 (CONTRACT 70)
DRAWDOWN DATA
Q=65.4 USgpm
$T_1 = \frac{264\,(Q)}{\Delta s} = \frac{264 \times 65.4}{0.40} = 43,164$ USgpd/ft
$T_2 = \frac{264\,(Q)}{\Delta s} = \frac{264 \times 72}{0.50} = 38,016$ USgpd/ft
Q=72 USgpm
T_2
Q=72 USgpm
DRAWDOWN, IN FEET
Time since pumping started, in minutes


46 5102
SEMI-LOGARITHMIC 3 CYCLER X 70 DIVISIONS
Residual Drawdown Curve
Well 261
Av. Pumping Rate 6815 USgpm
Residual Drawdown, s' in feet
Δs = 0.15'
T = 264 Q / Δs = (264)(6815) / 0.15 = 120,500 USgpd/ft
Ratio t/t'

Province of British Columbia

Ministry of Environment

MEMORANDUM

To: D. Lowen
Geological Engineer
Groundwater
Hydrology Section

Date: September 11, 1980

File: 0183613-B-261

Re: Williams Lake (Dog Creek Road) Observation Well WR261-80, Site 1401769

Background Information:

It was recommended in 1977 that the Williams Lake area be included in the proposal for expansion of the observation well network (Choy, 1977). An attempt to locate a suitable abandoned drilled well along Dog Creek Road was made in June 1978 but proved unsuccessful. This area was designated as a high priority area for establishment of an observation well because of the very high density of water wells throughout this area. People in this area rely entirely on the groundwater resource for their domestic water supplies. Yields have been reported as great as 454 litres/minute (100 gpm) along Dog Creek Road. The purpose of this well was to monitor groundwater extraction in the area and determine if mining of the aquifer could be taking place. Numerous wells are constructed every year along Dog Creek Road with many drilled wells supplying water to 3 or more houses. Groundwater withdrawal around the drill site is considerable. An elementary school, neighbourhood pub, 2 trailer courts and numerous houses all exist within a 300 metre radius of the observation well.

On August 1, 1980, Contract No. 70, drilling and construction of an observation well at Williams Lake was awarded to Manville Drilling of Williams Lake. Drilling was started on August 18, 1980 and completed on August 20, 1980 using an air rotary drill rig. The well is completed in fractured rock to a depth of 79.2 metres (note attached well log for complete details).

Well Location:

The well is located approximately 3.2 kilometres south of Highway 20 (Chilcotin Highway) along Dog Creek Road. The drilling site was allocated to our Section by the Ministry of Transportation and Highways in Williams Lake. The application for permission to construct works within Crown Lands has been completed and is attached to this memorandum. Mr. Jim Raven (Technician) and Mr. Stan Poloposki (District Highway Manager) assisted our staff in locating a suitable drilling site. Mr. Fred A. Baxter (Land Manager) of Ministry of Lands, Parks and Housing in Williams Lake assisted in the preliminary "footwork" involved. Mr. Zeke Withler (Regional Manager) of Fish and Wildlife was contacted and informed of the location of the observation well (Mr. Withler is responsible for the storage shed beside the well).

. . . 2

Monitoring Arrangement

As the application form stipulates water levels will be monitored for a minimum of 5 years.

Legal Location is:

Cariboo Land District, Plan 8645,
District Lot 9849, Lot A
Coordinates 22-X14-Y4
NTS 93-B-1

Well Drilling Specifications:

Depth	- 79.2 metres
Diameter	- 203 mm
Aquifer	- rock
Screen location	- n/a
Well yield	- *(Note pumping test discussion)
Well drilled by	- Manville Drilling
Static Water Level	- 25.49^{m} (83.64 feet) Sept. 5, 1980
Drilling method	- air rotary
Drilling time	- approx. 20 hours (Aug. 18-19th)
Drilling cost	- $8,092.00

Pumping Test:

The pumping test was initially started on September 3rd at a pumping rate of between 191 and 205 litres/minute (42 and 45 Igpm or 54 USgpm) with a 5 hp Jacuzzi pump set at a depth of 60 metres below the top of casing. This test had to be discontinued however, after a period of 70 minutes due to a pump failure. Another pump was purchased from the Jacuzzi office in Calgary and the test was continued September 5th. This time the pump was set at 42.7 metres below the top of casing resulting in an increased pumping rate of between 248 and 273 litres/minute (54.5 and 60 Igpm or 72 USgpm). This test was continued for a period of 9.5 hours resulting in a drawdown of 0.83 metres (2.72 feet). This well had approximately 33.5 metres (110 feet) of available drawdown at the time of testing. Recharge to the well is most likely occurring from higher elevations to the south (Bond Lake, Chimney Creek regions). This theory is discussed in greater detail in the report to follow this memorandum.

Equipment on Site:

Metric Recorder - RG-46 (1:2 Gears metric)
Weight Drive Clock - CG 11
152 mm diameter threaded nipple welded to casing
Weight Drive Pipe
0.5 kg Clock Weight
340 gr. of Counterweight
1 - 127 mm diameter Float
1 - 10 metre grad. tape
21.3 metres of braided nylon line
1 - recorder stand w/GE pulley
1 - year supply of metric recorder charts (F-4) stamped "on" and "off"
2 - cable clips
1 - viro lock

. . . 3

The recorder was painted dark green upon completion. Reference to ground level has been shown with an arrow on the well casing.

Observer Name and Particulars:

Harris Wilkinson
134 Mayfield Avenue
Williams Lake, B.C.
392-5286
SI 705-126-258

Mr. Wilkinson was chosen as the observer because he presently services the Scout Island Observation Well (WR 85-69) and has proven to be an excellent observer.

Ground Level Datum:

Casing stick-up from tape pointer to ground level - 1.22 metres (4.00 feet)

Distance to water level from tape pointer - 25.86 metres (84.86 feet)

Tape reading - 4.106 metres

Correction factor to be applied to tape reading is therefore +20.534 metres.

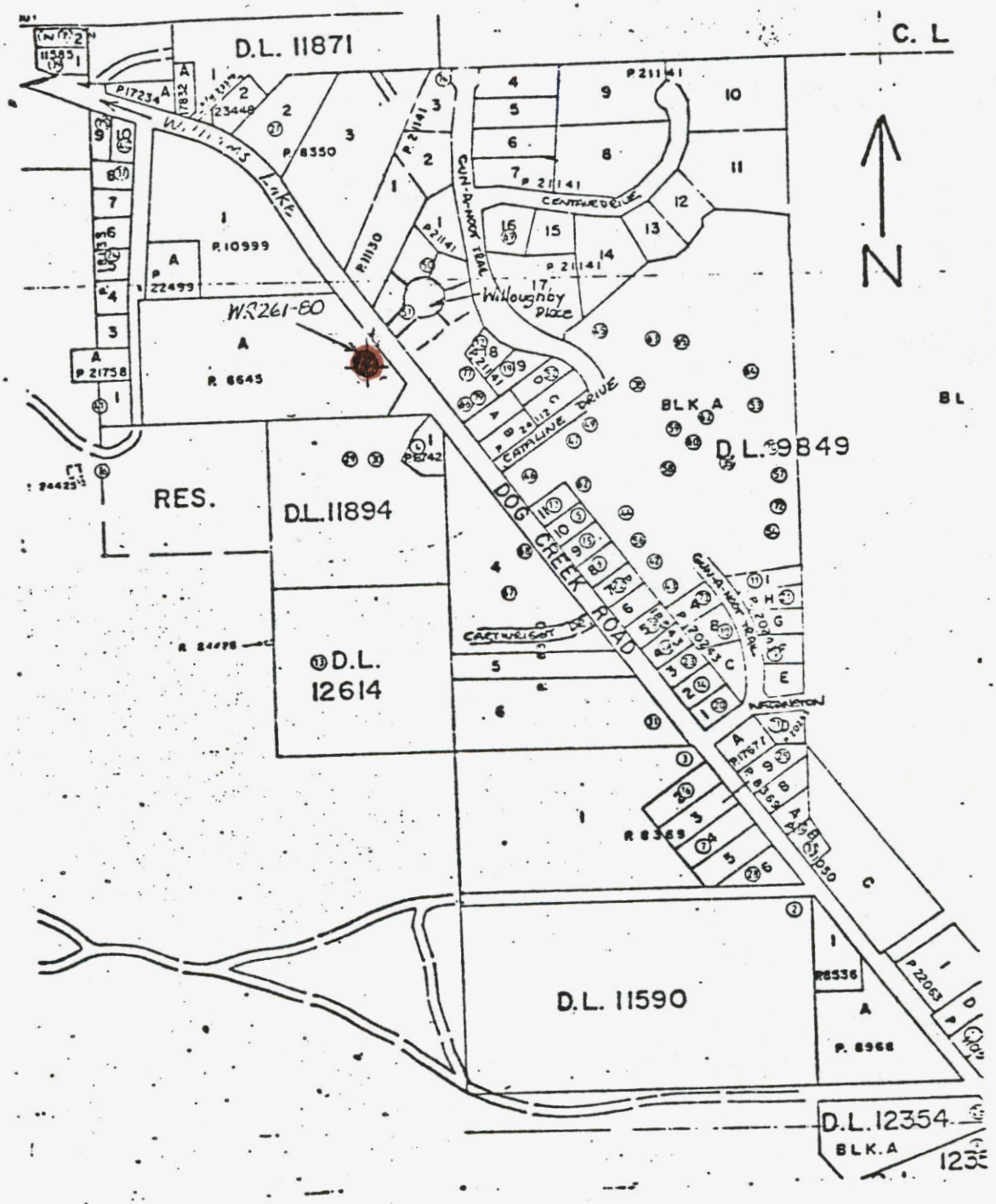
References

Choy, H.H. (1978) Preliminary preposal and cost estimates for Observation Well Network Program 1978. File 0183613-B Groundwater Section, Hydrology Division, Water Investigations Branch, Ministry of the Environment.

W.S. Hodge

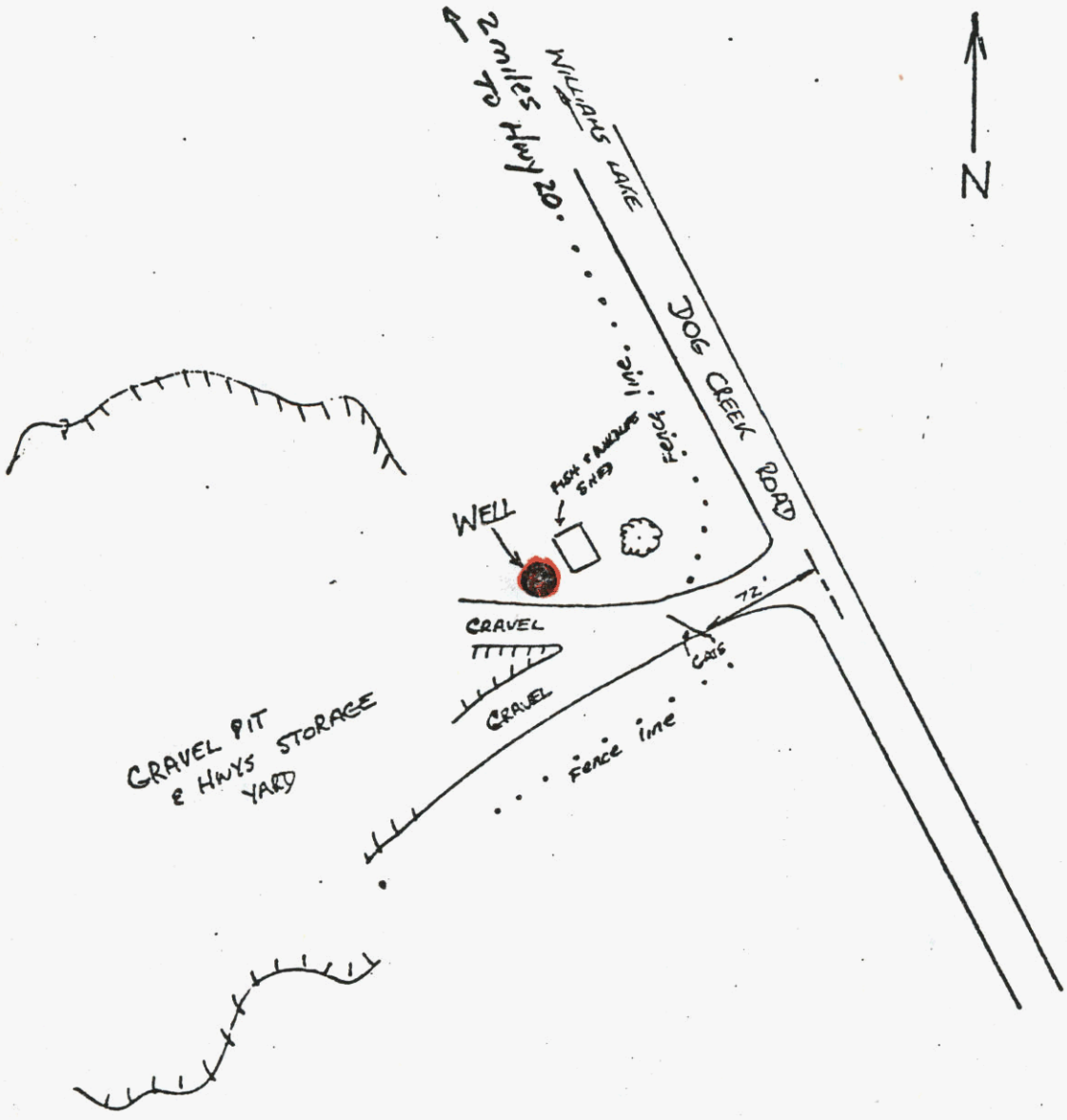
W.S. Hodge, Technician
Groundwater
Hydrology Section

WSH/jm



Province of British Columbia Ministry of the Environment ENVIRONMENTAL AND ENGINEERING SERVICE WATER INVESTIGATIONS BRANCH	TO ACCOMPANY Water Well Construction Contract No. 70
SCALE: VERT. 1" = 490' HOR. —	DATE June 1980
D.A. Lowen ENGINEER	
FILE No. 93-B-1 DWG. No. 1	

Williams Lake Observation Well
WR-261-80 — DOG CREEK ROAD



H. 20 (Revised May 1979)–o

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION, COMMUNICATIONS AND HIGHWAYS
(HIGHWAYS)

Application for Permission to Construct Works within Crown Lands

I (We) hereby apply for permission to construct, use, and maintain works within the limits of Crown lands under the jurisdiction of the Minister of Transportation, Communications and Highways (Highways), British Columbia, in accordance with the particulars, plans,* and specifications submitted herewith in *triplicate*. It is understood that the completion of this form constitutes an application only and that the works applied for will not be commenced until a covering permit has been issued. The proposed works consist of and are described as follows:

The drilling and completion of a six-inch diameter well near Williams Lake on Lot A, Plan 8645, D.L. 9849; the location of which is shown on the attached plan. After the completion of well construction, pumping test and water quality sampling, it is intended to install an automatic water level record to monitor the groundwater level for a minimum period of five (5) years. The recorder will be housed by a metal box (18" X 24" X 24") which is connected to a casing projecting approximately five feet above the ground surface. Servicing and maintenance of the recorder will be handled by Ministry of Environment staff or their representatives.

Have the necessary plans for approval been filed with the proper authorities? (See Note 2 on back)

Name of applicant Inventory and Engineering Branch, Ministry of Environment

P.O. address Parliament Buildings, Victoria, B.C. V8V 1X5

(Signed) _____
(Applicant.)

(Date) _____

To Local Office, Ministry of Transportation, Communications and Highways (Highways)

* *See* note No. 1 on back.

(OVER)

APPENDIX "B"

Water Quality Lab Reports, Schoeller Plots,

Water Level Recorder Graphs Showing Earthquake Response

SEPTEMBER 25, 1980 ENVIRONMENTAL LABORATORY

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 014539W

TO: INVENTORY & ENGIN. H.Q.
777 BROUGHTON ST. 4FLR.
VICTORIA BC

FOR SITE: 1401768 KENDALL ACRES WILLIAMS LK

SAMPLING DATE(S): AUG 25/80 1200 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 0
SAMPLED BY: INVENT. & ENGNRG BR., MOE
DATE RECEIVED BY LABORATORY: AUG 26/80

0040101	PH	8.3 REL UNIT	0071701	RES:FILT.105C	484. MG/L
0110101	SPECIFIC CONDUC	798. UMHO/CM	0300101	COMP.DIL.COND.	883. UMHO/CM
1010101	ALKALINITY:PHNL	L 0.5 MG/L	1020101	ALKALINITY:TOT	385. MG/L
1041702	CHLORIDE:DISSOL	5.7* MG/L	1070002	HARDNES.T:CACO3	218.* MG/L
1091703	NITROGN:NO2 NO3	0.38 MG/L	1130101	NITROGN:KJELDAH	0.10 MG/L
1191703	PHOSPHORUS :TOT DISSOLVED	0.058 MG/L	1190103	PHOSPHORUS :TOT	0.059 MG/L
1201702	SILICA:REACTIVE	22.4 MG/L	1211701	SULPHATE:DISSOL	56.4* MG/L
2541802	CALCIUM DISSOLVED	28.6* MG/L	2591801	MAGNESIUM DISSOLVED	35.5* MG/L
2641703	POTASSIUM DISSOLVED	3.8* MG/L	2651703	SODIUM DISSOLVED	107. MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 52.60

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

257U	IRON	E

SAMPLE NO. 014539W CONTINUED ON NEXT PAGE.

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 015277W

TO: INVENTORY & ENGIN. H.Q.
777 BROUGHTON ST. 4FLR.
VICTORIA BC

FOR SITE: 1401769 WILLIAMS LK +CONTRACT 70

SAMPLING DATE(S): SEP 8/80 1300 HRS

SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 83
SAMPLED BY: INVENT. & ENGNRG BR., MOE
DATE RECEIVED BY LABORATORY: SEP 09/80

0040101	PH	8.0 REL UNIT	0071701	RES:FILT,105C	696. MG/L
0110101	SPECIFIC CONDUC	1140. UMHO/CM	0300101	COMP.DIL.COND.	1310. UMHO/CM
1010101	ALKALINITY:PHNL	L 0.5 MG/L	1020101	ALKALINITY:TOT	553. MG/L
1041702	CHLORIDE:DISSOL	36.9 MG/L	1061701	FLUORIDE:DISSOL	0.19 MG/L
1070002	HARDNES.T:CACO3	547. MG/L	1091703	NITROGN:NO2 NO3	6.6 MG/L
1130101	NITROGN:KJELDAH	0.57 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	0.029 MG/L
1201702	SILICA:REACTIVE	22.0 MG/L	1211701	SULPHATE:DISSOL	30.2 MG/L
2541413	CALCIUM DISSOLVED	66.4 MG/L	2570209	IRON TOTAL	1.3 MG/L
2571413	IRON DISSOLVED	1.21 MG/L	2591413	MAGNESIUM DISSOLVED	92.7 MG/L
2600209	MANGANESE TOTAL	0.04 MG/L	2601401	MANGANESE DISSOLVED	0.03 MG/L
2641703	POTASSIUM DISSOLVED	7.2 MG/L	2651703	SODIUM DISSOLVED	38.6 MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 65.90

SAMPLE NO. 015277W CONTINUED ON NEXT PAGE.

ENVIRONMENTAL LABORATORY
MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 015278W

TO: INVENTORY & ENGIN. BR.
777 BROUGHTON ST.
VICTORIA, B.C.

FOR SITE: 1401769 WILLIAMS LK -CONTRACT 70

SAMPLING DATE(S): SEP 8/80 2000 HRS

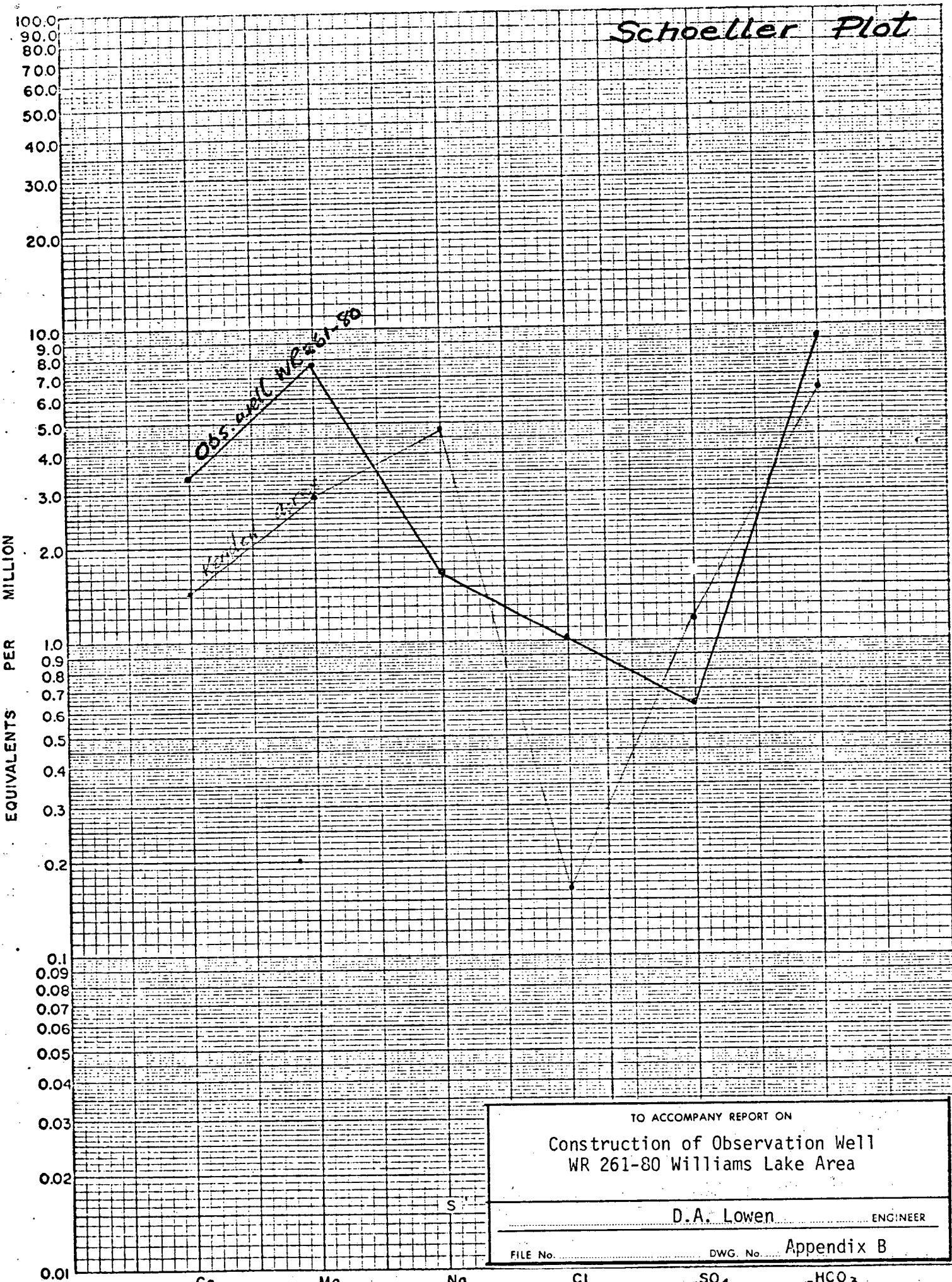
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 83
SAMPLED BY: INVENT. & ENGNRG BR., MOE
DATE RECEIVED BY LABORATORY: SEP 09/80

0040101	PH	8.0 REL UNIT	0071701	RES:FILT,105C	700. MG/L
0110101	SPECIFIC CONDUC	1140. UMHO/CM	0300101	COMP.DIL.COND.	1310. UMHO/CM
1010101	ALKALINITY:PHNL	L 0.5 MG/L	1020101	ALKALINITY:TOT	553. MG/L
1041702	CHLORIDE:DISSOL	35.5 MG/L	1061701	FLUORIDE:DISSOL	0.29 MG/L
1070002	HARDNES.T:CACO3	567.* MG/L	1091703	NITROGN:NO2 NO3	6.70 MG/L
1130101	NITROGN:KJELDAH	0.58 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	0.066 MG/L
1201702	SILICA:REACTIVE	22.6 MG/L	1211701	SULPHATE:DISSOL	29.7 MG/L
2541802	CALCIUM DISSOLVED	68.8* MG/L	2570209	IRON TOTAL	0.1 MG/L
2571413	IRON DISSOLVED	0.: MG/L	2591801	MAGNESIUM DISSOLVED	96.* MG/L
2600209	MANGANESE TOTAL	0.02 MG/L	2601401	MANGANESE DISSOLVED	L 0.02 MG/L
2641703	POTASSIUM DISSOLVED	7.3 MG/L	2651703	SODIUM DISSOLVED	37.9 MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 65.90

SAMPLE NO. 015278W CONTINUED ON NEXT PAGE.

Schoeller Plot



TO ACCOMPANY REPORT ON

Construction of Observation Well
WR 261-80 Williams Lake Area

D.A. Lowen ENGINEER

FILE No. DWG. No. Appendix B

Water Investigations Branch
Ministry of the Environment
Parliament Buildings
Victoria, B.C.
V8V 1X5

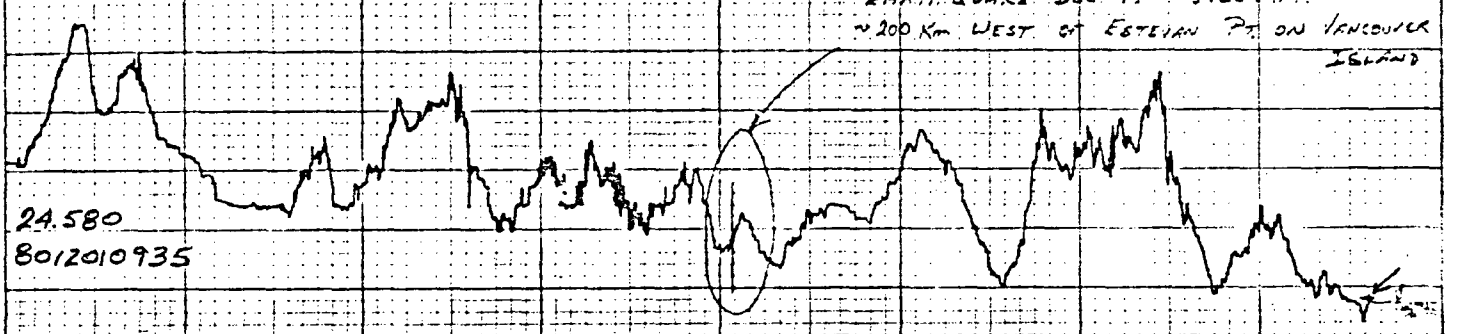
STN. NAME [illegible] NO [illegible]

ON
DATE [illegible] TIME 935 LEVEL 4.076 metres

OFF
DATE Dec 31 TIME 430 PM LEVEL 4.013
1980

(6¼-6½ hrs)

EARTHQUAKE DEC 17TH 7:20 P.M.
~200 Km WEST OF ESTEVAN PT. ON VANCOUVER ISLAND



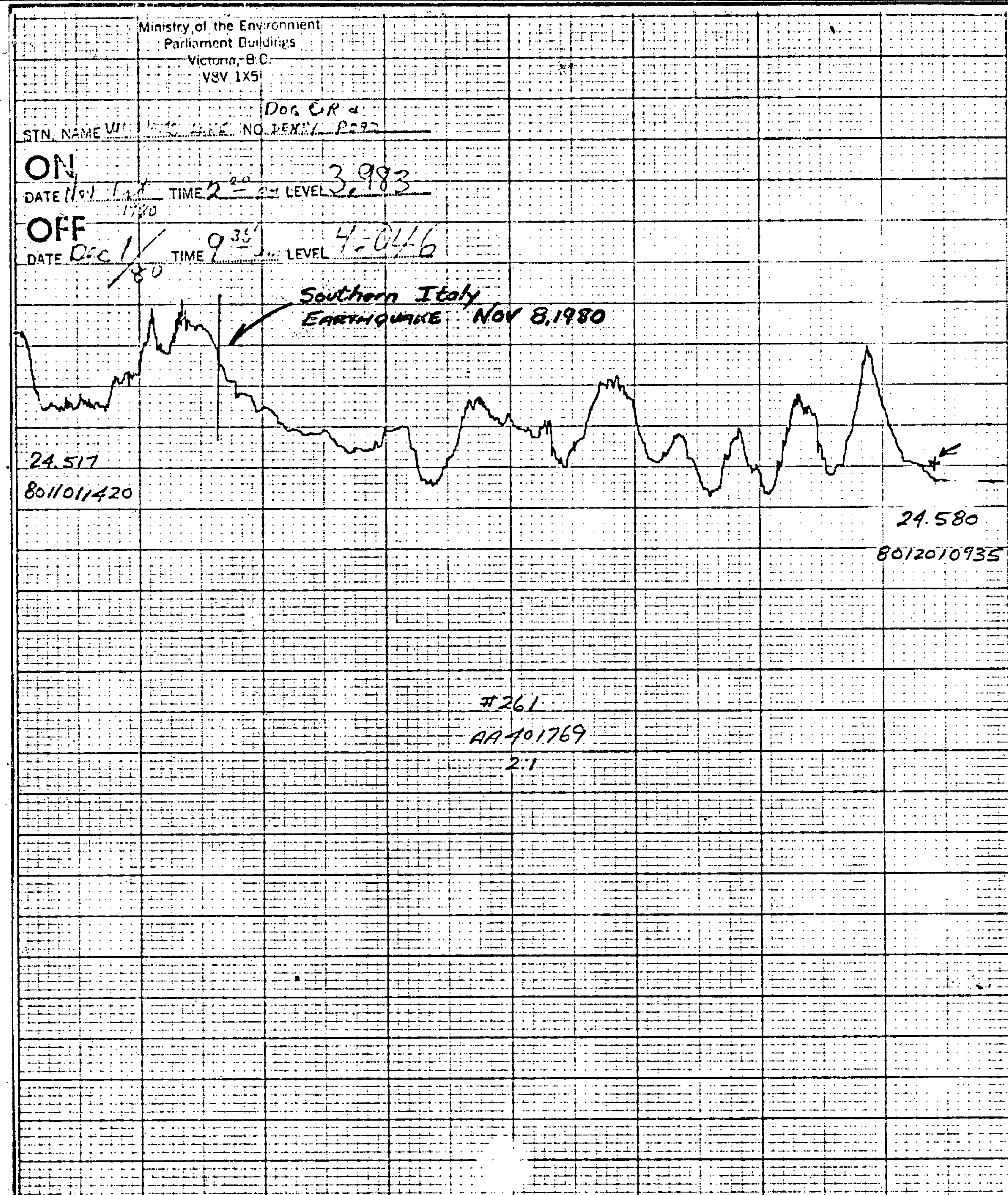
24.580
8012010935

24.327
8012311630

#261
AA401769
2:1

Province of British Columbia Ministry of Environment INVENTORY AND ENGINEERING BRANCH		TO ACCOMPANY REPORT ON Construction of Observation Well WR 261-80 Williams Lake Area
SCALE: VERT. HOR.	DATE October 1980	D.A. Lowen ENGINEER FILE No DWG. No Appendix B

bcil 6660 wrs



Province of British Columbia Ministry of Environment INVENTORY AND ENGINEERING BRANCH	TO ACCOMPANY REPORT ON Construction of Observation Well WR 261-80 Williams Lake Area
SCALE: VERT. ...... HOR.	DATE October 1980	D.A. Lowen ENGINEER FILE No	DWG No Appendix B

bcil 6660 wrs