GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 64-51

ALDERGROVE TEST HOLE, FRASER VALLEY, B.C.

(Report and 8 figures)

E. C. Halstead

Price, 75 cents

1966

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ABSTRACT

A test hole was drilled at Aldergrove to a depth of 852 feet to determine the depth and nature of the unconsolidated deposits and the hydrologic properties of the principal aquifers. The stratigraphic section is complex, indicating repeated glaciations as well as enstatic changes of sea-level of greater magnitude than formerly realized. Prospecting for groundwater is probably best within the upper 400 feet of material filling Fraser Valley.

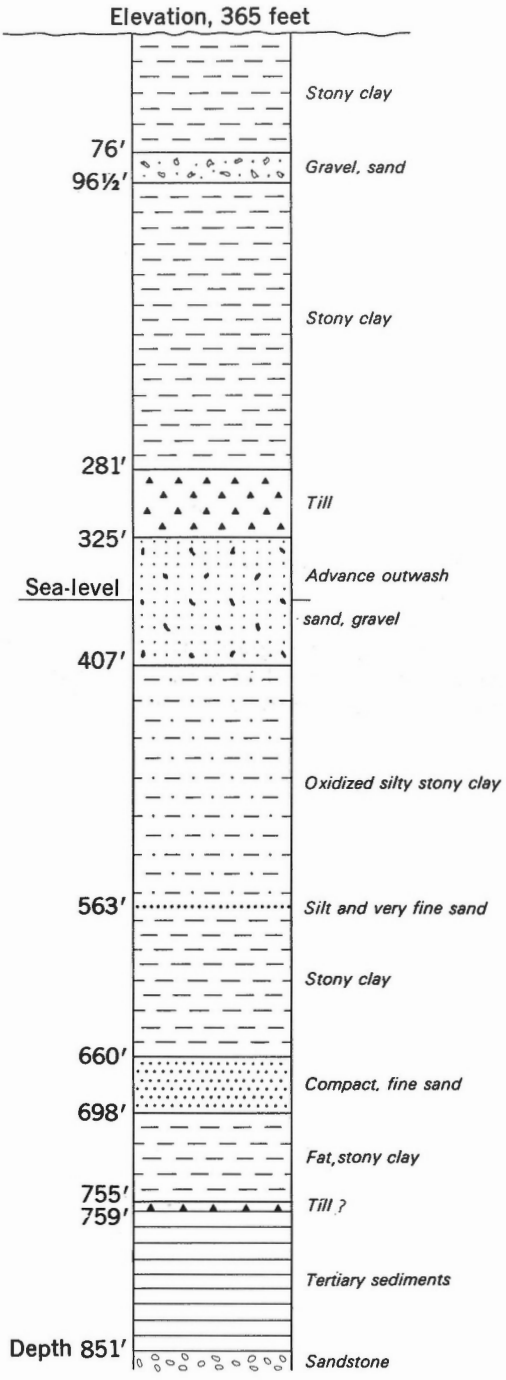

Figure 1. Log of Aldergrove test well.

ALDERGROVE TEST HOLE, FRASER VALLEY, B.C.

INTRODUCTION

Studies of both the succession of unconsolidated deposits and groundwater at depth in the Fraser Valley have been hampered by lack of adequate drill-hole records. During the winter of 1963-64 the first of several deep test holes was completed. The purpose of the drilling program is:

(a) to determine the stratigraphic sequence of unconsolidated deposits;

(b) to determine the depth and nature of bedrock; and

(c) to determine the hydrologic properties of the materials encountered and assess the capabilities of any potential aquifers.

SUMMARY OF DRILLING PROGRAM

1. Location of test hole: HMCS Aldergrove, Aldergrove, Fraser Valley, British Columbia (122°38'15"; 49°04'20").
   Ref. NTS; Aldergrove 92G/1d.
   Drainage basin '8MH.

2. Drilling began on October 30, 1963 and was discontinued on March 17, 1964. During the period March 17 to May 5 development procedures and test pumping were carried out.

3. The purpose of the drilling was to determine the depth and nature of the unconsolidated deposits and to determine hydrologic properties of principal aquifers encountered in drilling.

4. A cable tool rig, #71 Speed Star, was used for drilling the test hole.

5. The hole was drilled 12-inch diameter to 349 feet, 8-inch diameter to 683 feet, and 6-inch diameter to 852 feet. All casing was removed except for the 12-inch installed in the top 350 feet. A #30 Johnson well screen was installed for test purposes of the aquifer at a depth of 352 to 357 feet (Fig. 2). Upon conclusion of the pump test the screen was removed. Pump-surging methods were applied in the development of the aquifer.

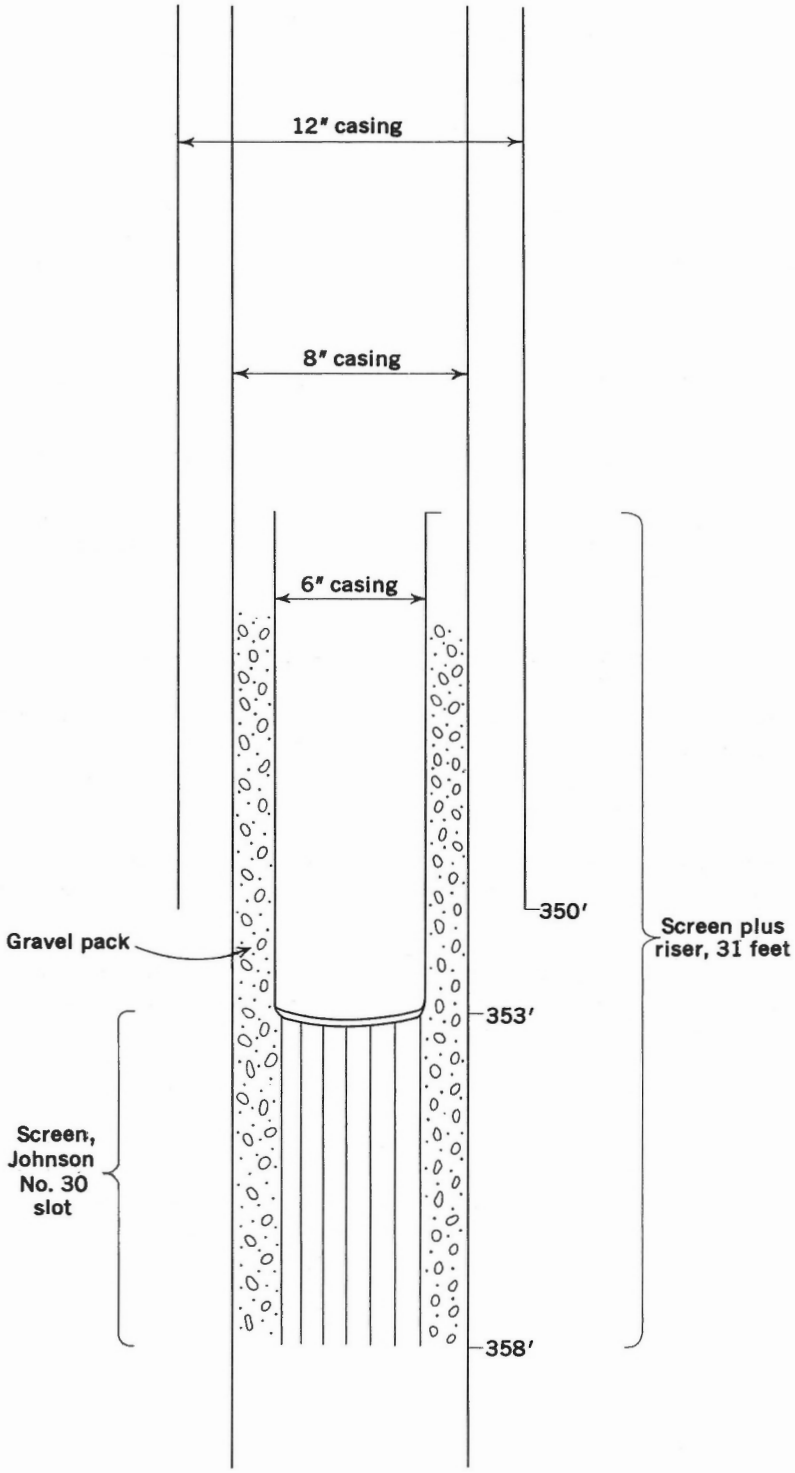

Figure 2. Screen installation for pump test.

6. Total cost of the test hole and of test pumping was $10,394.00.

LOG OF HOLE

The materials penetrated are as follows (Fig. 1). The elevation of the test hole is 365 feet above sea-level.

Material	Thickness (feet)	Depth (feet)
Oxidized stony clay	14	14
Blue stony clay, drilled open hole	62	76
Silty sand, water, static level, 40 ft.	8	84
Coarser sand, at 88 ft. clay lenses	4	88
Fine to coarse sand, some gravel, samples collected at 2 ft. intervals and a mechanical analysis run on a composite sample (Fig. 3)	8 1/2	96 1/2
Blue clay, stony, shell fragments at 120 ft.	113 1/2	210
Fine silty sand, some water	2	212
Stony blue clay	69	281
Till	46	325
Coarse sand, gravel, dirty outwash, water-bearing; sieve analysis of material 329 to 336 (Fig. 4); 338 to 344 (Fig. 5)	19	344
Medium to coarse sand, some gravel	21	365
Medium to coarse sand, clay lenses	19	384
Medium to coarse sand	4	388
Medium to fine sand, clay lenses	4	392
Medium to fine sand	8	406
Fine sand, silted	1	407
Silty, stony clay, oxidized	156	563
Silt and very fine sand	1	564
Blue clay, odd stones, hydrometer analysis of material 659 to 660 (Fig. 6)	96	660
Fine to medium sand, silted, compact	8	668
Fine to medium sand, clay lenses	4	672
Fine to medium sand, compact	9	681
Fine to medium sand	8	689
Boulder, granitic type	2	691
Hard packed fine sand	2	693
Fine sand, clay lenses	5	698
Stony fat blue clay	57	755
Till-like material; bailer samples mostly soled(?) pebbles and clayey silt	4	759

MECHANICAL ANALYSIS

Material *Sand, some gravel* Location *Test hole, Aldergrove 76'-96'* Date *1964*

DECANTATION TEST

Tare & Sm	412.5	g
Tare No. 35	150.7	g
Sm		g
S	261.8	g

AFTER WASHING AND DRYING

Tare & Sw	393.2	g
Sw		g
S-Sw	19.3	g
Passing No. 200	2.0	g
Total passing 200	21.3	g

SIEVE ANALYSIS

	Passing	Retained	Weight	%	Cum %	Final %	Spec's	Remarks
COARSE								
		Pan						
		TOTAL						
FINES	8					100		
		16	2.3	.9	.9	99.1		
		30	10.5	4.0	4.9	95.1		
		60	91.1	34.8	39.7	60.3		
		100	97.1	37.1	76.8	23.2		
		200	39.5	15.1	91.9	8.1		
		Pan	21.3	8.1	100.0			
		TOTAL	261.8	100.0				

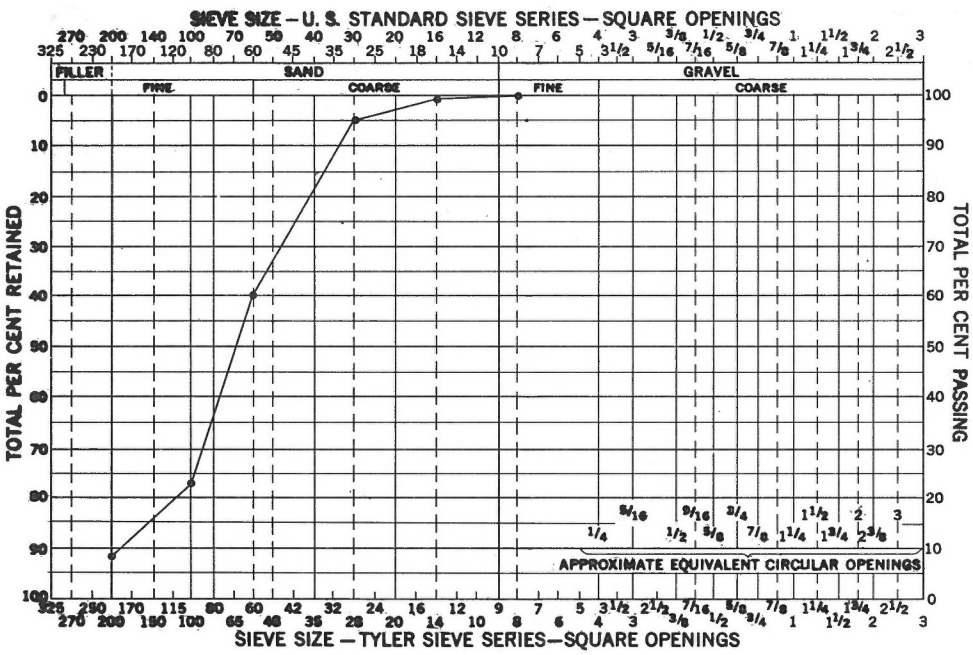

Figure 3. Mechanical analysis of sample 76 to 96 feet.

MECHANICAL ANALYSIS

Material *Sand, gravel, dirty outwash* Location *Test hole, Aldergrove 329'-336'* Date *1964*

DECANTATION TEST

Tare & Sm	567.0	g
Tare No. 81	151.1	g
Sm		g
S	415.9	g

AFTER WASHING AND DRYING

Tare & Sw	549.8	g
Sw		g
S-Sw	17.2	g
Passing No. 200	2.7	g
Total passing 200	19.9	g

SIEVE ANALYSIS

	Passing	Retained	Weight	%	Cum %	Final %	Spec's	Remarks
	2"					100.0		
COARSE		1½"	276	3.3	3.3	96.7		
		1"	481	5.8	9.1	90.9		
		¾"	254	3.1	12.2	87.8		
		½"	331	4.0	16.2	83.8		
		⅜"	169	2.1	18.3	81.7		
		No. 4	644	7.8	26.1	73.9	60% Rock chips	
		Pan	6089	73.9				
		TOTAL	8244	100.0				
FINES		8	109.3	19.5	45.6	54.4		
		16	85.5	15.2	60.8	39.2		
		30	57.6	10.3	71.1	28.9		
		60	104.9	18.6	89.7	10.3		
		100	27.1	4.8	94.5	5.5		
		200	11.2	2.0	96.5	3.5		
		Pan	19.9	3.5	100.0			
		TOTAL	415.5	73.9				

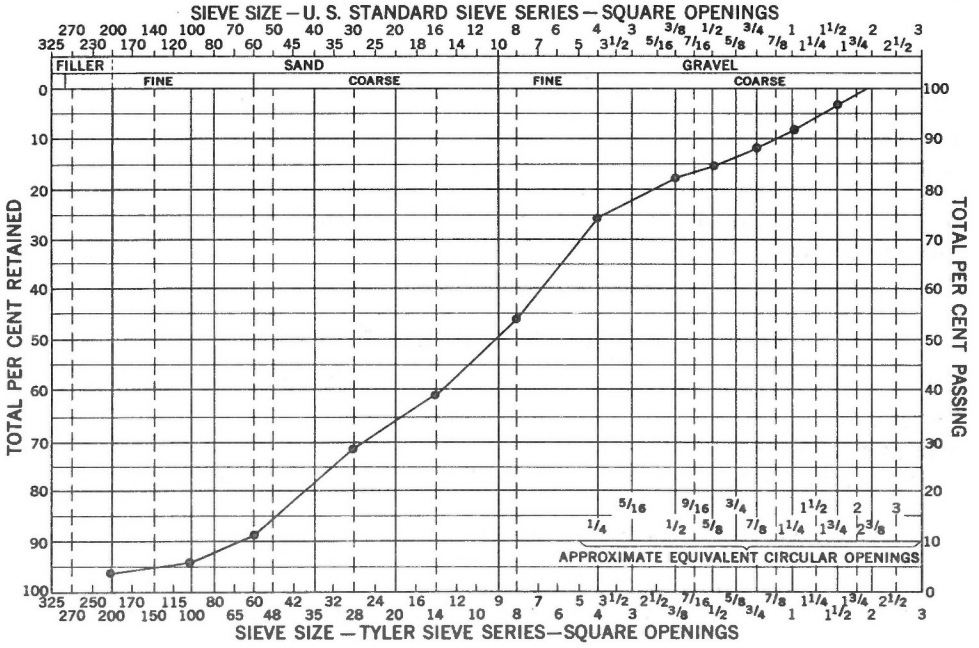

Figure 4. Mechanical analysis of sample 329 to 336 feet.

Material	Thickness (feet)	Depth (feet)
Gritty, varicoloured clay with organic material; lenses of white material dissolve in HCl leaving shards of quartz; at 773 feet woody material and at 779 a shell fragment	24	783
As above with more coal, probably fusane	68	851
Sandstone	1	852

UNCONSOLIDATED DEPOSITS

Although only one till sheet can be positively identified in the 759 feet of Pleistocene deposits, the stony clays record repeated glacio-marine conditions indicating at least four glaciations. The top stony clays from 14 to 281 feet are correlated with the last ice advance, the Sumas Stade of the Fraser Glaciation, radio-carbon dated at about 11,000 to 12,800 years before present. The till found at a depth of 281 to 325 feet correlates with the Surrey till recognized throughout Fraser Valley. Beneath the till, advance outwash overlies a sand unit that perhaps correlates with the Quadra sediments recognized in cliff sections throughout the Strait of Georgia. If so, this represents a unit of the Olympia Interglaciation. The underlying oxidized silty stony clay from 407 to 563 is also tentatively included with the Quadra sediments. This thick oxidized section indicates a long period of continental conditions and no doubt an erosion interval of considerable time. The blue clay with stones from 564 to 660 represents an older glacio-marine deposit and evidence of a till is lacking. However, conditions may have been similar to those existing during the deposition of the top two stony clay units, that is, the ice advance at this time may have been mostly a valley phase rather than one of ice-sheet proportions. A stony fat blue clay lies at the base of the section and is underlain by a remnant till, which, it is believed, sits on the top of Tertiary sediments.

TERTIARY SEDIMENTS

Tertiary sediments were encountered at a depth of approximately 759 feet. This is the first time that such sediments have been identified in this part of Fraser Valley. A number of wildcat oil wells have been drilled in the region, but identification of Tertiary sediments in them was not possible because their logs were seldom adequate or else no records were kept and the base of the Pleistocene has been recognized in only a few of them. Identification of Tertiary sediments or of the Tertiary-Pleistocene boundary by interpretation of geophysical data has not proven reliable or accurate in this area. Although drilling was discontinued at 852 feet after

penetrating a little more than 1 foot of well indurated sandstone, it was felt that this sandstone was compact bedrock rather than a boulder.

GROUNDWATER

The potential of aquifers at depths of 400 feet or more has not been established in the uplands of Fraser Valley. In this test hole no aquifers of any significance were encountered below 407 feet. The aquifer existing between the two top stony clays is fairly well established but that below the major till sheet or top till as it appears throughout most of Fraser Valley is not as well known. Therefore test procedures were carried out on the lower aquifer and as much information as possible was collected on the quantity and quality of the groundwater. Pump test results and a report on the chemical quality of the water are attached. In order to observe the hydrological behaviour of the materials confined below the till, the test hole has been set up as an observation well with the approval of the Royal Canadian Navy.

SAMPLING

During drilling, samples of permeable water-bearing materials were collected for mechanical analysis. The gradation of the material 76 to 96 feet is shown in Figure 3 and a well screen of 9/1000 slot size would best suit this aquifer. That part of the aquifer at 338 to 344 feet (Fig. 5) would require a screen of 20/1000 slot size.

Stony clay at 659 to 660 was collected for an hydrometer analysis (Fig. 6). These samples were found to have the same percentage of sand, silt, and clay as the younger stony clays, Whatcom and Newton, described by Armstrong[1].

During the pump test, which lasted for 25 hours, samples were collected one hour after pumping started and again at the end of the test. During pumping the iron concentration dropped, but silica increased. The water has a high sodium bicarbonate content and this may be a characteristic useful in determining the direction of flow of confined groundwater in Fraser Valley. The high percentage of sodium may limit the use of the water for irrigation purposes. A water analysis report is attached.

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[1]Armstrong, J.E., Surficial geology of Vancouver area, British Columbia; Geol. Surv. Can., Paper 55-40 (1956).

MECHANICAL ANALYSIS

Material *Sand, gravel, dirty outwash* Location *Test hole, Aldergrove 338'-344'* Date *1964*

DECANTATION TEST

Tare & Sm	512.7	g
Tare No. 5	158.0	g
Sm		g
S	354.7	g

AFTER WASHING AND DRYING

Tare & Sw	503.2	g
Sw		g
S-Sw	9.5	g
Passing No. 200	2.6	g
Total passing 200	12.1	g

SIEVE ANALYSIS

	Passing	Retained	Weight	%	Cum %	Final %	Spec's	Remarks
	2"					100.0		
COARSE		1½"	1082	8.4	8.4	91.6		
		1"	1151	9.0	17.4	82.6		
		¾"	986	7.7	25.1	74.9		
		½"	1107	8.7	33.8	66.2		
		⅜"	675	5.3	39.1	60.9		
		No. 4	1857	14.5	53.6	46.4	40%	Rock chips
		Pan	5945	46.4				
		TOTAL	12803	100.0				
FINES		8	96.9	12.7	66.3	33.7		
		16	49.9	6.5	72.8	27.2		
		30	37.5	4.9	77.7	22.3		
		60	120.4	15.8	93.5	6.5		
		100	26.8	3.5	97.0	3.0		
		200	10.5	1.4	98.4	1.6		
		Pan	12.1	1.6	100.0			
		TOTAL	354.1	46.4				

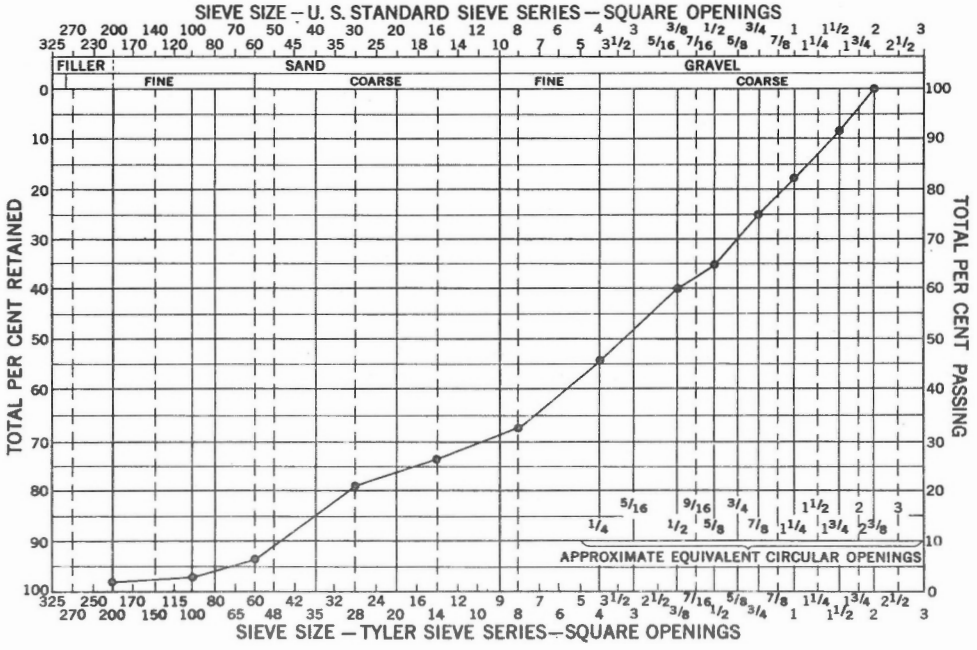

Figure 5. Mechanical analysis of sample 338 to 344 feet.

PUMP TEST

A 25-hour pump test was carried out starting at a rate of 63 IGPM and after 3 1/2 hours the rate was increased to 83 IGPM. The performance of the well, as developed, is indicated in Figures 7 and 8. The transmissibility was determined by using the recovery data, which give a better check of the pumping data, especially when the pumping rate has been stepped up and the duration of the test was short — in this case 25 hours. The transmissibility is evaluated as more than 15,000 gal/day/ft. The actual drawdown was measured as 52 feet, indicating a specific capacity of 1.5 gals. per foot drawdown. These values are probably not representative, however, as the test was carried out in only a 5-foot section near the top rather than the bottom, of the aquifer; in addition, that section and the screen that was installed were not the correct ones for the gradation of the material composing the aquifer, and further the development of the well was not complete. Therefore, our observed data are not too indicative of the hydrological properties of this aquifer. The theoretical drawdown is more likely in the order of 10 feet at this rate of pumping and it is reasonable to expect that wells producing 200 or more gallons a minute can be successfully developed in this aquifer.

CONCLUSIONS

Valuable information was obtained on the sequence of the Pleistocene deposits and on the boundary between the Pleistocene and Tertiary sediments in the central part of Fraser Valley. Further study of the Tertiary microfossils is expected to provide data for closer correlation.

At first glance the graphic log, Figure 1, appears to represent a simple section, but it is complex and repeated glaciations are indicated as well as eustatic changes of sea-level of greater magnitude than formerly realized. It is also concluded, on the basis of the one Aldergrove test hole that prospecting for groundwater is probably best if limited to the top 400 feet or so of the material filling Fraser Valley.

The drilling also provided a well in which hydrological behaviour of a confined aquifer can be observed over several years.

The cable tool drilling equipment did not perform as well as expected and would not have been able to drill to 1,000 feet, the expected depth to bedrock. Future drilling projects in Fraser Valley might better use rotary methods augmented by drive or Shelby tube sampling.

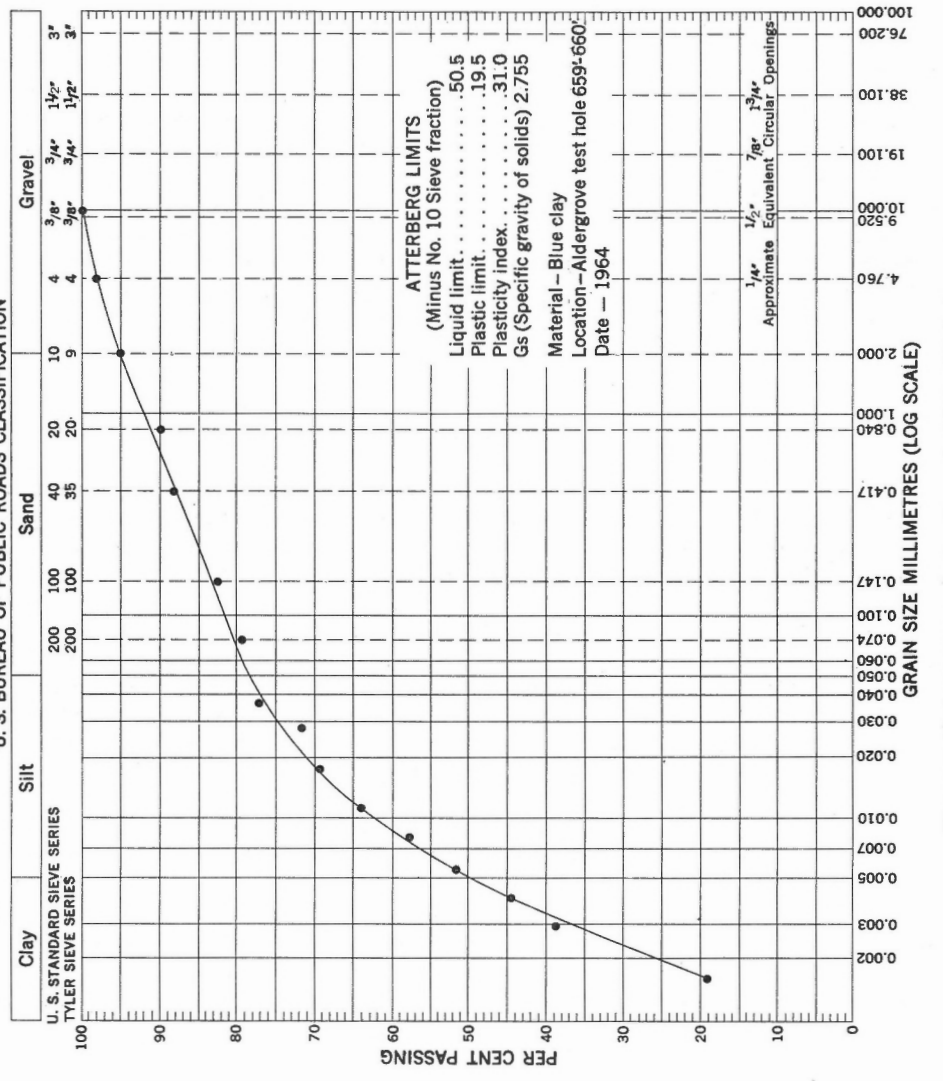

Figure 6. Hydrometer analysis of sample 659 to 660 feet.

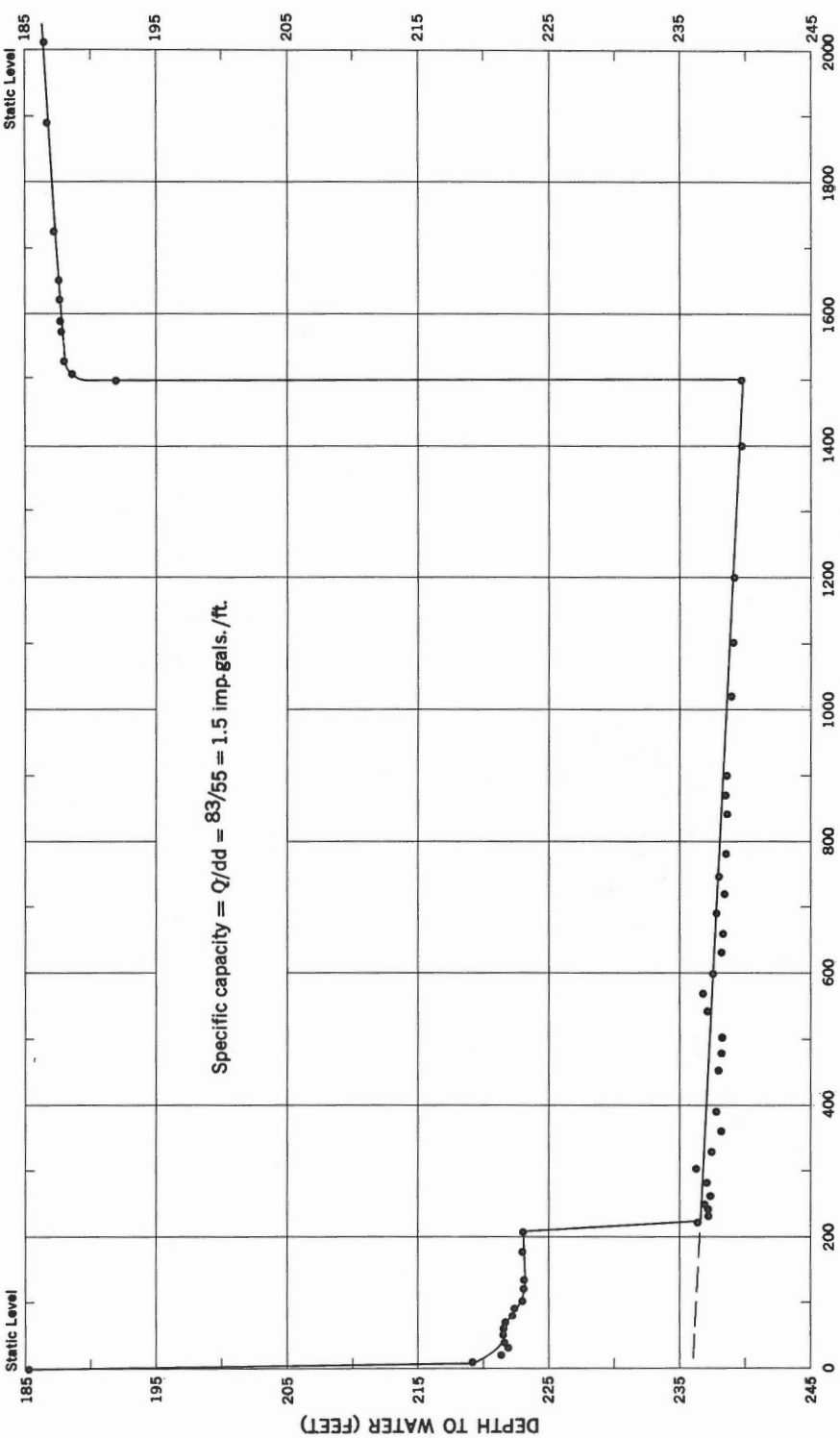

Figure 7. Well performance during pump test.

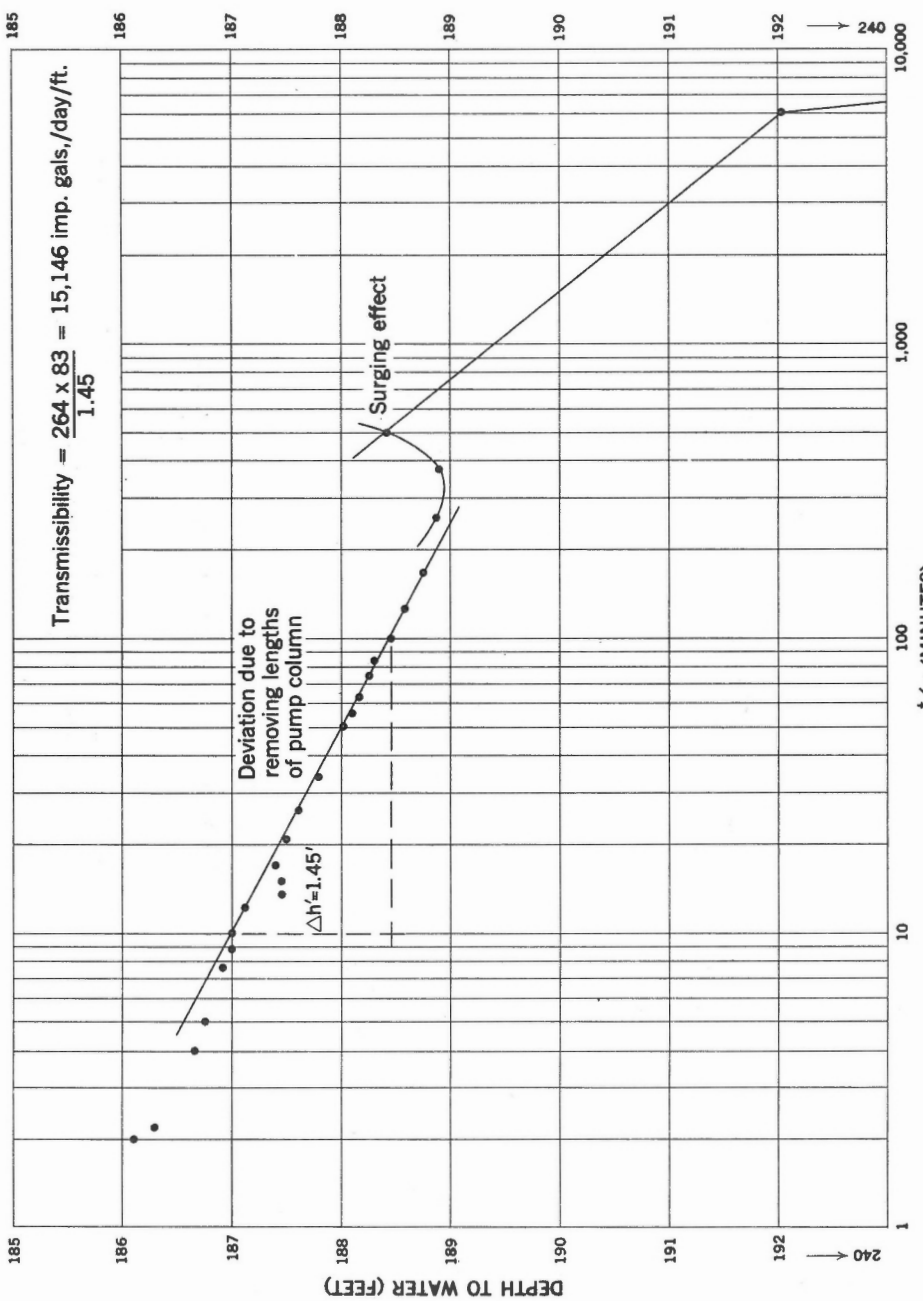

Figure 8. Well performance during pump test.

ACKNOWLEDGMENTS

Mechanical and hydrometer analyses included in this report were carried out under the supervision of Angus MacLean at the Regional Materials Laboratory, Department of Transport, Richmond, B.C.

Material from 787 to 850 feet was examined by J. Terasmae, R.J. Mott and D.C. MacGregor, of the Geological Survey of Canada, Ottawa, who determined that no Pleistocene microfossils were present but recognized Tertiary microfossils.

Water analyses were carried out at the Industrial Waters Section, Department of Mines and Technical Surveys, Ottawa.

Table I

ALDERGROVE PUMP TEST DATA

Measuring Pt. - 3 feet above ground level
SL - 185 ft. at measuring pt.
4" diameter tube; 2 1/2" orifice

Time (Min.)	Time Since Pumping Began (Min.)	Rate	Depth to Water (feet)	
May 4/64	11:00 A.M. - Start pump @ 76 US GPM (63 IMP)			
11:02 A.M.	2			
11:05	5		219	
11:07	7		220	
11:09	9		220.5	
11:11	11		221.6	
11:13	13		221.6	
11:15	15		221.5	
11:17	17		221.2	
11:19	19		221.1	
11:21	21		221.0	
11:23	23		220.8	
11:25	25		221.2	
11:27	27		221.5	
11:30	30		221.9	
11:40	40		221.5	Temp. 52°F
11:45	45		221.3	
11:50	50		221.5	Sample #1
12:00	60		221.7	
12:10	70		221.7	
12:20	80		222.3	
12:30	90		222.2	
12:45	105		223.4	
1:00 P.M.	120		223.1	
1:30	150		223.1	
2:00	180		223.0	
2:30	210		223.0	
	increase pump rate to 100 US GPM (83 IMP)			
2:32	212		230.0	
2:34	214		233.0	
2:36	216		235.5	
2:38	218		236.4	

Time (Min.)	Time Since Pumping Began (Min.)	Rate	Depth to Water (feet)
2:40	220		236.3
2:45	225		236.9
2:50	230		237.0
3:00	240		237.3
3:10	250		236.9
3:20	260		237.2
3:35	275		237.1
4:00	300		236.1
4:30	330		237.1
5:00	360		238.1
5:30	390		237.9
6:00	420		238.25
6:30	450		237.9
7:00	480		238.2
7:30	510		238.1
8:00	540		237.1
8:30	570		236.8
9:00	600		237.5
9:30	630		238.2
10:00	660		238.1
10:30	690		237.8
11:00	720		238.2
11:30	750		237.9
12:00 midnight	780		238.5
May 5/64			
12:30	810		239.2
1:00	840		238.5
1:30	870		238.2
2:00	900		238.4
2:30	930		238.6
3:00	960		238.5
3:30	990		238.6
4:00	1,020		238.9
4:30	1,050		239.0
5:00	1,080		239.1
5:30	1,110		239.0
6:00	1,140		238.8
6:30	1,170		238.9
7:00	1,200		239.1
7:30	1,230		238.6

Time (Min.)	Time Since Pumping Began (Min.)	Rate	Depth to Water (feet)	
8:00	1,260		238.7	
8:30	1,290		238.7	
9:00	1,320		238.6	
9:30	1,350		239.0	
10:00	1,380		240.0	Temp. 52°F
10:30	1,410		239.8	Sample #2
11:00	1,440		239.4	
11:30	1,470		239.7	
12:00	1,500		239.6	
Recovery - pump off		t' time since pump stopped		t/t'
12:01	1,501	1	192.0	1,501
12:03	1,503	3	188.4	501
12:04	1,504	4	188.9	376
12:06	1,506	6	188.85	251
12:09	1,509	9	188.75	167.6
12:12	1,512	12	188.55	126
12:15	1,515	15	188.45	101
12:18	1,518	18	188.30	84.3
12:21	1,521	21	188.25	74.1
12:24	1,524	24	188.15	63.5
12:27	1,527	27	188.10	56.5
12:30	1,530	30	188.0	51
12:45	1,545	45	187.8	34.3
1:00	1,560	60	187.6	26
1:15	1,575	75	187.5	21
1:30	1,590	90	187.4	17.06
1:45	1,605	105	187.45	15.3
2:00	1,620	120	187.44	13.5
2:15	1,635	135	187.1	12.1
2:45	1,665	165	187.0	10.1
3:15	1,695	195	187.0	8.7
3:45	1,725	225	186.9	7.6
6:00	1,860	360	186.85	5.1
8:00	1,980	480	186.75	4.1
May 6/64				
8:00 A.M.	2,700	1,200	186.3	2.2
12:00 noon	2,940	1,440	186.1	2.0

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Aldergrove	
Source of water	Drill-hole - aquifer at 358 ft.	
Sampling point GSC No.	At pump after 1 hr. pumping (1)	At pump after 25 hr. pumping (2)
Reference	E. C. Halstead, GSC, Vancouver, British Columbia	
Laboratory number	64-265	64-266
Date of sampling	Mar. 4/64	May 5/64
Storage period (days)	18	17
Temp. at sampling (°C)	-	-
Temp. at testing (°C)	23.9	23.7
Appearance, odour, etc.		
Organic matter:		
Oxygen consumed ($KMnO_4$)		
Chem. oxygen demand (C.O.D.)		
Ultra violet absorption (mu)		
Carbon dioxide (CO_2), calculated	7	6
pH	8.2	8.3
Colour (Hazen units)	90	85
Turbidity (Units)		
Alkalinity as (-Phenolphthalein	0.0	0.0
$CaCO_3$ (-Total	556	557
Susp. matter, dried at 105°C		
" " ignited at 550°C		
Res. on evap., dried at 105°C		
Loss on ignition at 550°C		
Sp. conductance, micromhos at 25°C	1,283	1,293
Hardness as (Total	29.8	29.2
$CaCO_3$ (Non-carbonate	0.0	0.0
Calcium (Ca)	2.4	2.4
Magnesium (Mg)	5.8	5.6
Iron (Fe) Total	1.3	0.37
Dissolved		
Aluminum (Al)		
Manganese (Mn) Total	0.02	0.06
Dissolved		
Copper (Cu)	0.046	0.032
Zinc (Zn)		
Sodium (Na)	305	302
Potassium (K)	6.1	6.7
Ammonia (NH_3)		
Carbonate (CO_3)	0.0	0.0
Bicarbonate (HCO_3)	678	679
Sulphate (SO_4)	24.5	23.6
Chloride (Cl)	71.5	74.6
Fluoride (F)	1.4	1.4
Phosphate (PO_4) Total		
Dissolved		
Nitrate (NO_3)	0.0	0.0
Silica (SiO_2)	18.	24.
Sum of constituents	769.	775.
% Sodium	95.	95.
Saturation index at test temperature	-0.4	-0.1
Stability index at test temperature	8.6	8.5
Sodium Absorption Ratio (SAR)	24.3	24.3