DOUBLE ELECTRODE RESISTIVITY SURVEY

ARDMORE AREA, NORTH SAANICH

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Resistivity profiles were run in conjunction with a groundwater study being carried out in the Ardmore area for the Ministry of Environment. The purposes were two fold:

1. To verify the presence of a shallow bedrock channel.
2. To detect variations in fractures in the bedrock.

In light of the results obtained, suggestions for further study in this area are made.

INTRODUCTION

LOCATION

The study area is located in the Saanich Peninsula on Vancouver Island, B.C. approximately 25 kilometers north of Victoria, B.C. (Figure 1) For the groundwater study being conducted it comprises only the land within the National Topographic Series map 92B-063-2-3, commonly known as the Ardmore area, but for resistivity study it has been expanded to take in also Range 1 west of map sheet 92B-063-2-4.

PURPOSE AND SCOPE

From plotting the drill log data available in the Ardmore area, it became apparent that a shallow bedrock channel may exist, extending from the head of Coles Bay and trending north-east through Section 6, Range 1 West of map sheet 92B-063-2-4.

During the groundwater study it was also observed that when a 586 ft. deep irrigation well, commonly known as Pendray's well, which penetrates the bedrock in Section 8, Range 1 west of map sheet 92B-063-2-4, was pumped it caused considerable interference with wells to the north-west in the area of the junction of West Saanich Road and Ardmore Drive. This interference indicates major fracturing or a fault is present in the rock connecting these locations.

An attempt to verify the presence of the bedrock channel and to detect variations in fracturing in the bedrock was made by running two resistivity profiles.

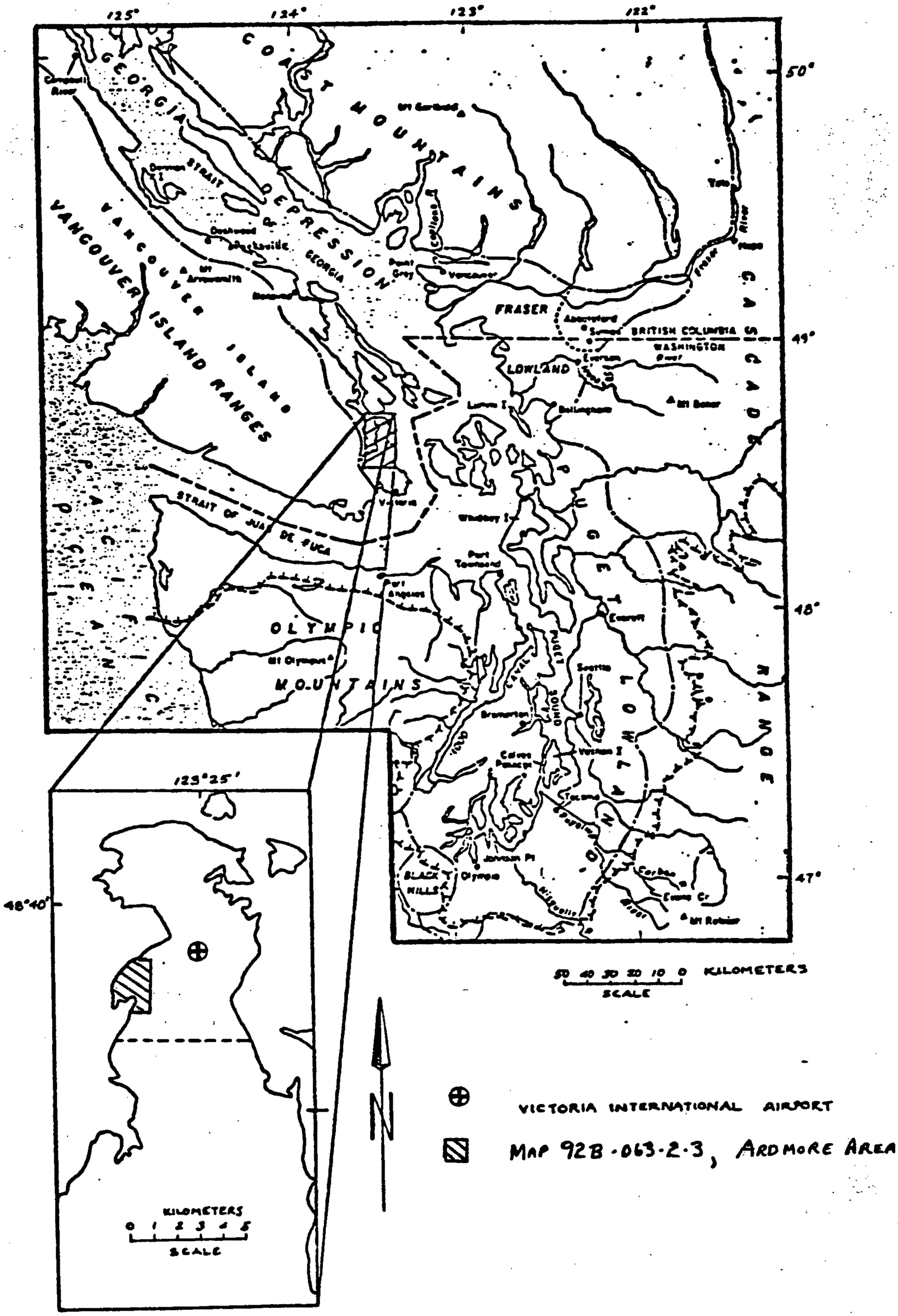


FIGURE 1 – INDEX MAP SHOWING LOCATION OF MAP 92B·063·2·3, ARDMORE AREA

Field work, using the University of Victoria Soiltest ER-2 electrical resistivity meter, was conducted over a period of four days in October, 1980.

PREVIOUS WORK

The bedrock geology of south Vancouver Island was originally mapped by Clapp (1912) at a scale of 1 inch to 6 miles. In the following year, Clapp mapped the surficial and bedrock geology of the Victoria and Saanich map areas at a scale of 1 inch to 1 mile (Clapp, 1913). Halstead (1967) prepared field maps of the surficial geology of Saanich, at a scale of 1:25000, and has a report in preparation on the hydrogeology of the coastal lowland of Vancouver Island south of Nanaimo.

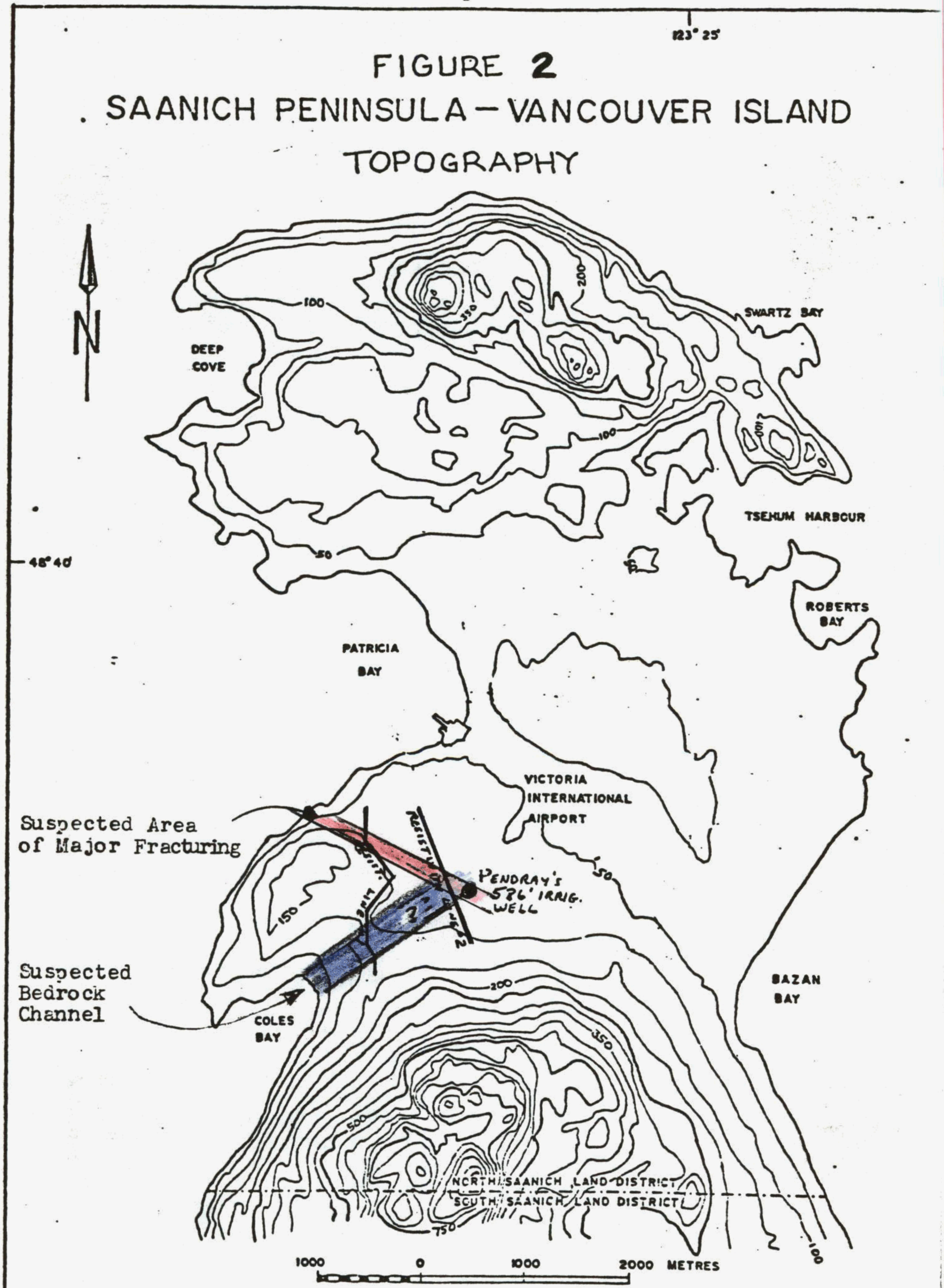
PHYSIOGRAPHY

TOPOGRAPHY

The topography of the peninsula has a subdued relief, with large lowland areas having elevations up to 200 feet above sea level that are flat to gently rolling. The hills that exist such as Cloake and North Hill at the north end of the peninsula and Mt. Newton, just to the south of the study area, rise with few steep slopes to elevations of over 400 and 1,000 feet respectively.

Where the resistivity profiles were run is an area of subdued relief, (Figure 2). Also on Figure 2, the suspected highly fractured zone and the bedrock channel have been shown.

FIGURE 2
SAANICH PENINSULA – VANCOUVER ISLAND
TOPOGRAPHY



SCALE
CONTOUR INTERVAL 50 FT.

CLIMATE

The climate can be described as a cool Mediterranean (Day, Farstad, and Laird, 1959) and represent the farthest north poleward advance of a true Mediterranean climate.

The climate is temperate with an average annual precipitation of 33 inches, 2,000 hours of sunshine, and a mean annual temperature of 10 degrees C.

SOILS

The soils for the Ardmore area are described in Report Number 6, of the British Columbia Soil Survey, 1959, by J. H. Day, L. Farstad and D.G. Laird. The soils maps can be an indicator of the underlying parent surficial geological materials. Figure 3 is a reproduction of the soil map of the Ardmore area at a larger scale.

GEOLOGY

BEDROCK GEOLOGY

The bedrock underlying the study area consists of a large batholith, called the Saanich Granodiorite (Clapp, 1913).

It is a light-coloured, medium grained granodiorite, grading towards quartz monzonite and quartz diorite. Extensive sills of dacite porphyry are also present in this unit (Muller, 1975). Potassium Argon age datings have placed this unit in the early to middle Jurassic time span (Muller, 1975).

The Saanich batholith is associated with the minor diorite and granodiorite porphyrites. These occur principally in the form of dykes (Clapp, 1913).

The granodiorite is very well exposed along the shore of the study area, where it is greatly jointed and fractured.

Clapp(1913) noted that all of the intrusive rocks were greatly jointed and fractured, but it was only the Saanich granodiorite that has regular and large joints; although all of the batholithic rocks are broken by joints which have a persistent north-south strike. He also noted the rocks have been more or less sheared, often greatly, developing wide shear zones and these usually correspond in strike with the foliation and have, therefore, a general northwest-southeast strike. Tranverse fractures also occur along which more or less movement has taken place.

Figure 4 shows how a well 3,800 ft. north west of the Pendray irrigation well was effected during the pumping periods of the Pendray well, suggesting major fracturing exists between them.

SURFICIAL GEOLOGY

For the most part, in the study area, the surficial deposits are thin. This can be observed by studying the isopach map of the surficial deposits (figure 5). This map was prepared from water well drill logs on file with the Hydrology Section of the British Columbia, Ministry of Environment. Table 1 is a schedule of these water well drill logs and Figure 6 is a location map for these wells.

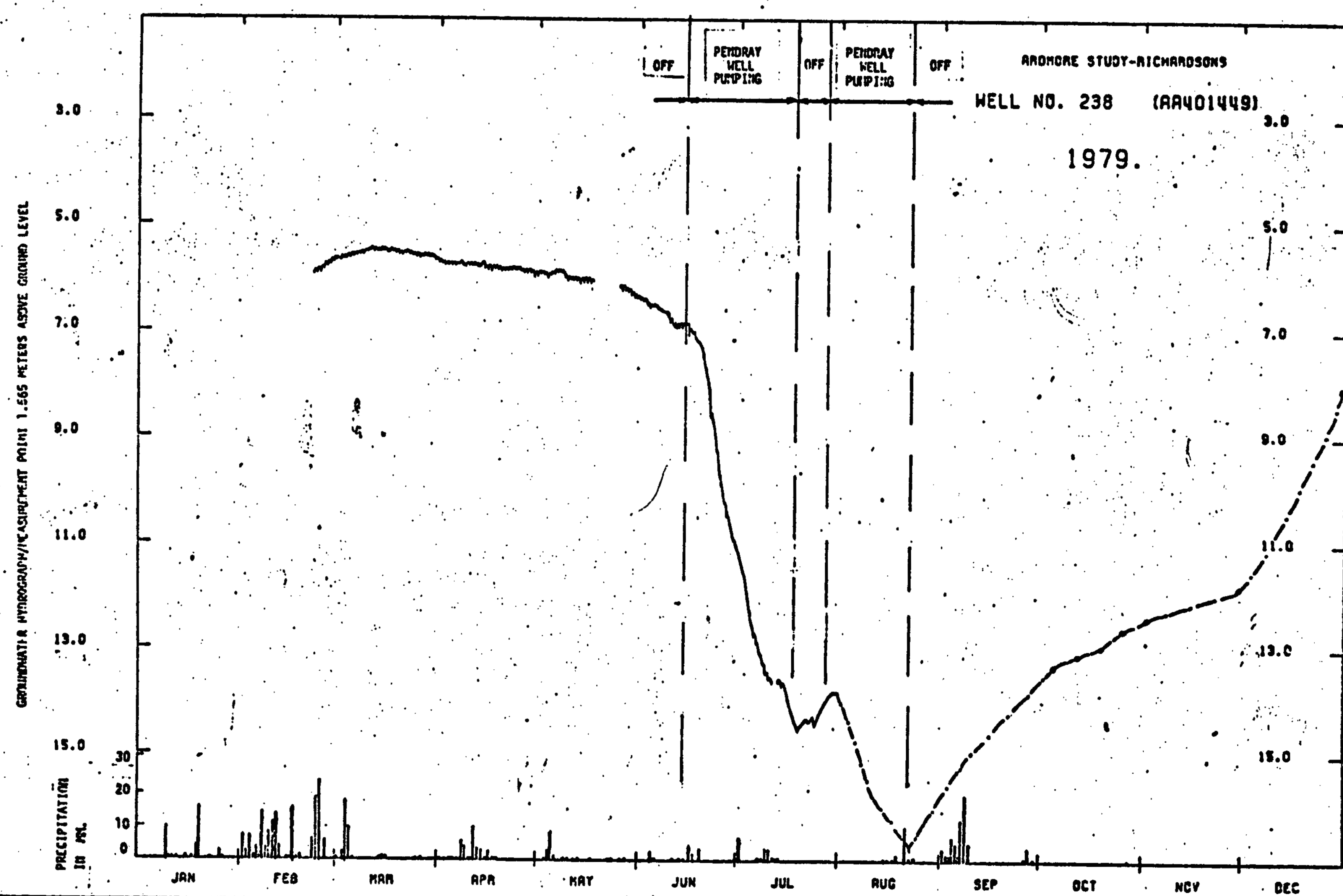


Figure 4 Hydrograph of Well #50 Sec. 9 R?W (See Fig. 6 for location and Table 1 for well log data). This Hydrograph shows a Marked 33 ft. drop in Groundwater level during the two periods of pumping in the Pendray well.

They are located by giving each well an unique number within the legal Section and Range it occurs in.

The isopach map shows readily the suspected bedrock channel, extending from the head of Coles Bay and trending north-east from there.

Along the shore-line it was found that commonly the deposition was clay over till over granodiorite. Often the till layer is missing though. This till would be the Cordova Till which Clapp (1913) and Halstead (1967) have described as a buff to yellowish sandy till found lying directly upon bedrock or in bedrock crevices and depressions. Halstead (1967) suggests that this unit may represent the earliest glaciation of the area.

Inspecting the schedule of wells (Table 1) shows that the sequence: clay over till over granodiorite with the till missing at times is common to much of the area, the picture (Fig. 7) is a good example of this sequence.

RESISTIVITY SURVEY

ELECTRIC RESISTIVITY SURVEYING

Electrical resistivity surveying is a geophysical prospecting operation, in which measurements of earth resistivity are made from the earths surface. Figure 8 is a picture of the resistivity equipment used for this project.

Because various types of earth materials generally exhibit characteristic values of resistivity, strata of differing materials can be identified; that is, highly resistive sands, gravels, and

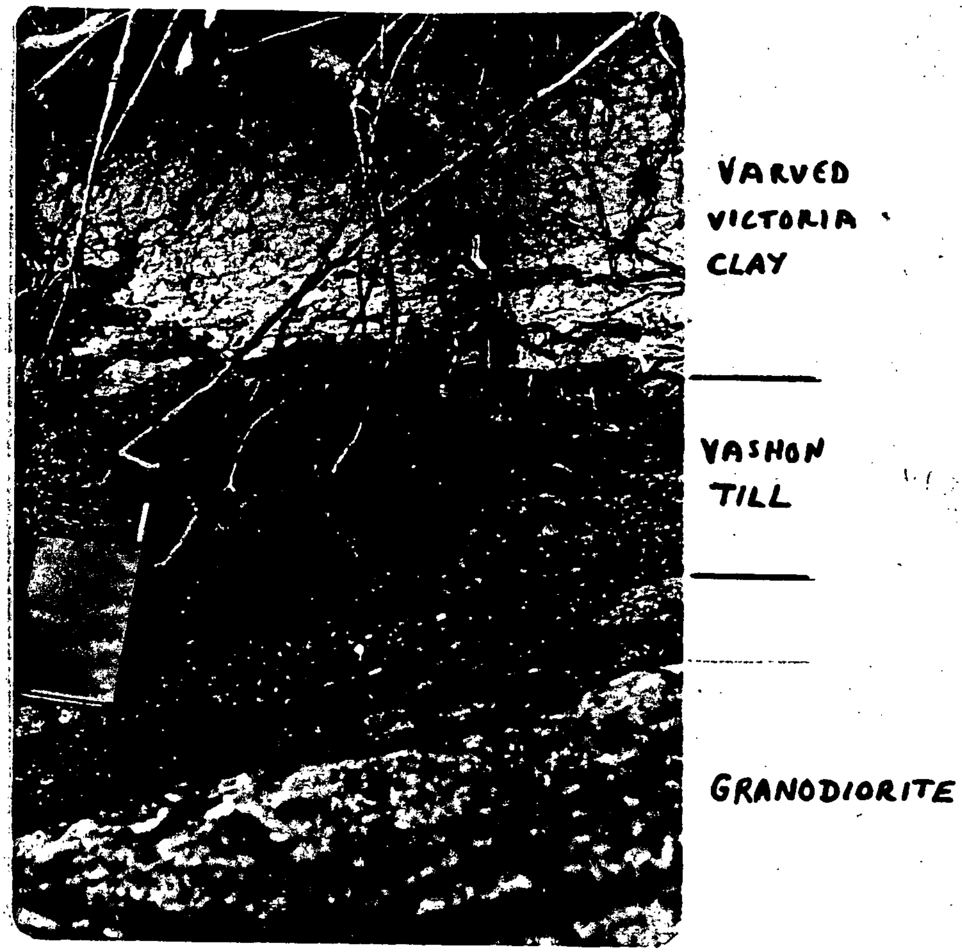


Figure 7 Shore-line picture showing the common geological sequence clay over till over granodiorite.

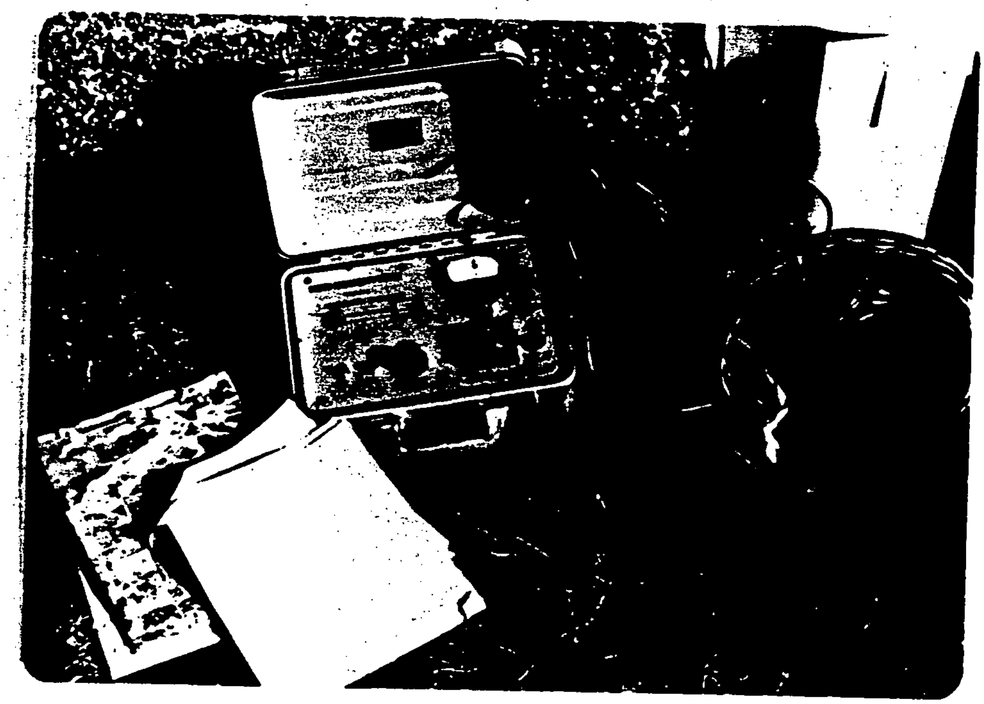


Figure 8 Soiltest ER-2 Electrical Resistivity Meter, Electrodes, Cable, and Data.

granite can be differentiated from low resistive materials such as clays, wet silty soils, and formations saturated with groundwater with a high salinity content. Table 2 gives a resistivity correlation of some types of materials.

Resistivity measurements are obtained by using four electrodes set in the ground. A current is applied to the ground through two of these and the voltage drop across the other two is recorded. The common arrangement is the Wenner configuration with the electrodes equally spaced along a straight line as shown in Figure 9.

The apparent resistivity of the earth materials penetrated are computed from the potential drop, the applied current, and the electrode spacing.

This value obtained is referred to as the apparent resistivity of all the materials down to a depth that is proportional to the electrode spacing. Apparent resistivity is a weighted average of the resistivities of the individual strata penetrated.

The depth of penetration, for depths above about 100 feet, indicate that the depth of current penetration is nearly equivalent to the distance between adjoining electrodes.

When applying the resistivity method, some data from test holes for geologic control are required. The various depths and thicknesses of strata penetrated by the test holes, help to determine empirically some rule that relates apparent resistivities to known subsurface conditions at the control points.

Electrical resistivity studies can be conducted in two ways: depth profile and the step-traverse procedures.

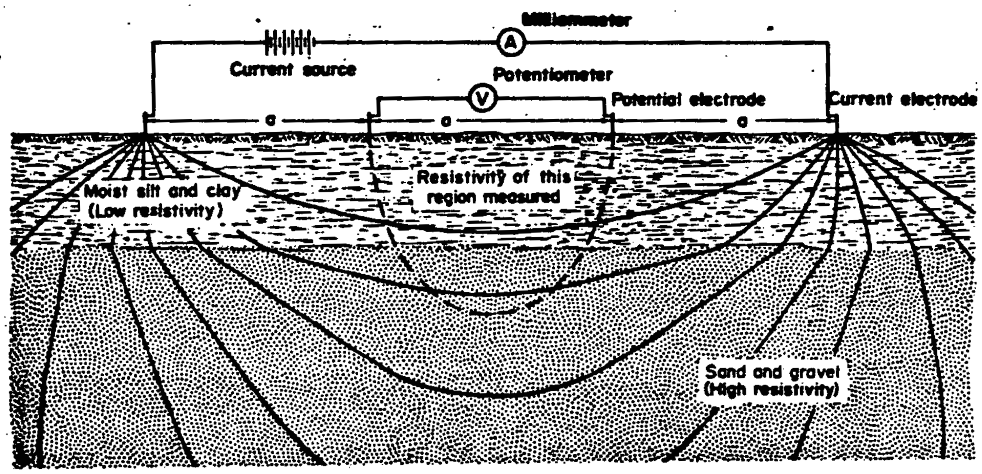


Figure 9 The Wenner Electrode Configuration used During the Project.

Apparent earth resistivity is determined by measuring the voltage drop between two interior electrodes when current is passed through the earth between outer electrodes. Sounding depth varies with the electrode spacing. Arrangement shown is known as the Wenner configuration.

In a depth-profile the data is obtained at a single station or site by taking a series of resistance readings at different electrode spacings and then one plots the apparent resistivity against electrode spacing.

The step-traverse procedure involves taking readings at a series of stations, with the same electrode separation at each station, along several parallel lines.

Certain field conditions can interfere with the use of electrical resistivity surveying, such as: buried conductors like pipelines and cables, fences with metal posts, overhead high-voltage transmission lines, and water perculating into the soil immediately after a rain.

RESISTIVITY PROFILES

For the two resistivity profile lines run for this project, the double electrode interval traverse method was used. This method employs two electrode spacings-thus, two readings-at each station on the survey line. The spacings used were 105 ft. and 52 ft. Using this method and spacing it was hoped that the materials lying near the surface would differ enough in resistivity characteristics, so that along the profile lines one could interpret the material at depth.

The location of resistivity lines 1 and 2 and wells used for control points are shown on Figure 10. Figure 11 and 12 are cross-sections drawn up from lithology data obtained from the wells used as control points. Below each cross-section, the appropriate resistivity profile has been positioned so that analysis can

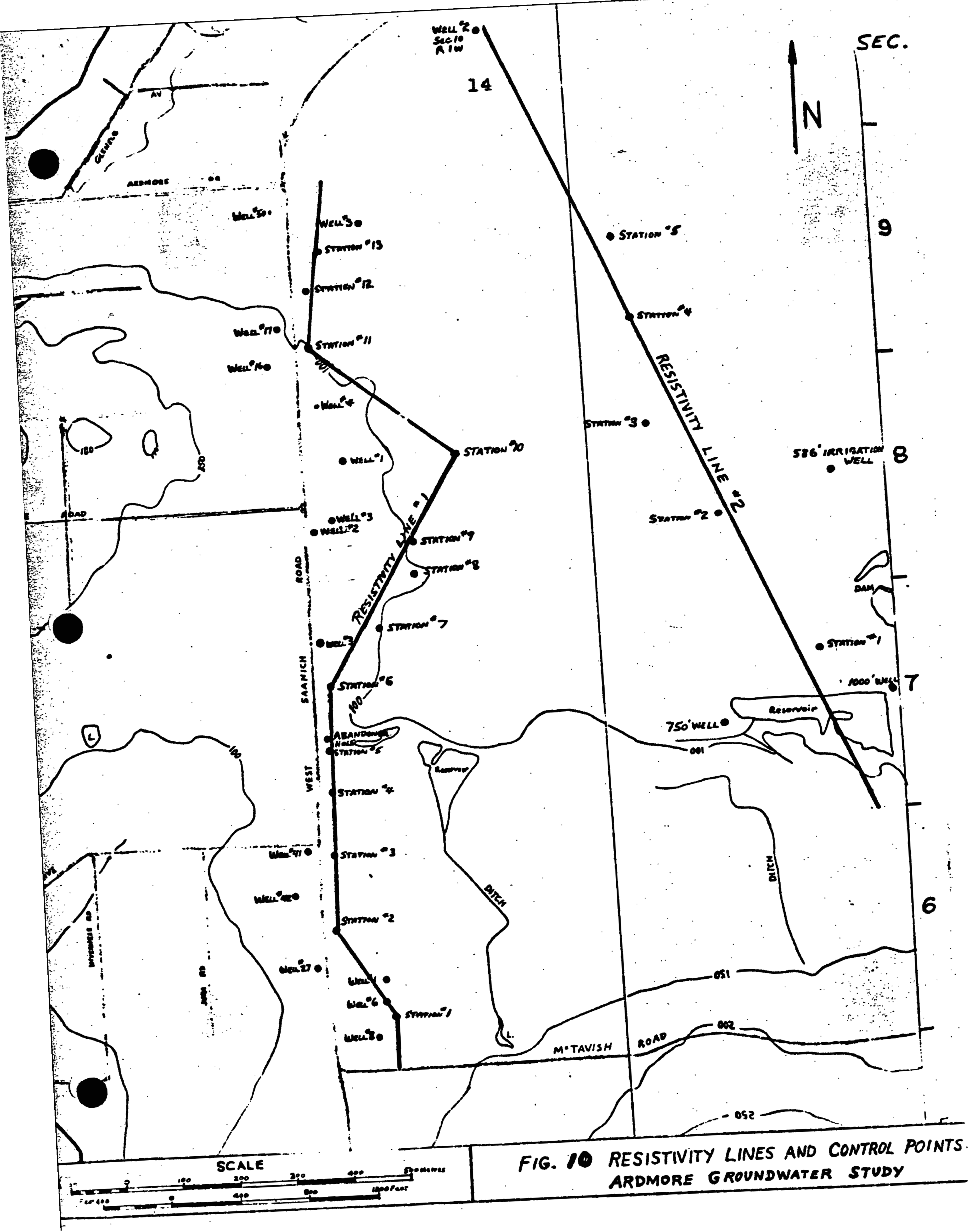


FIG. 10 RESISTIVITY LINES AND CONTROL POINTS.
ARDMORE GROUNDWATER STUDY

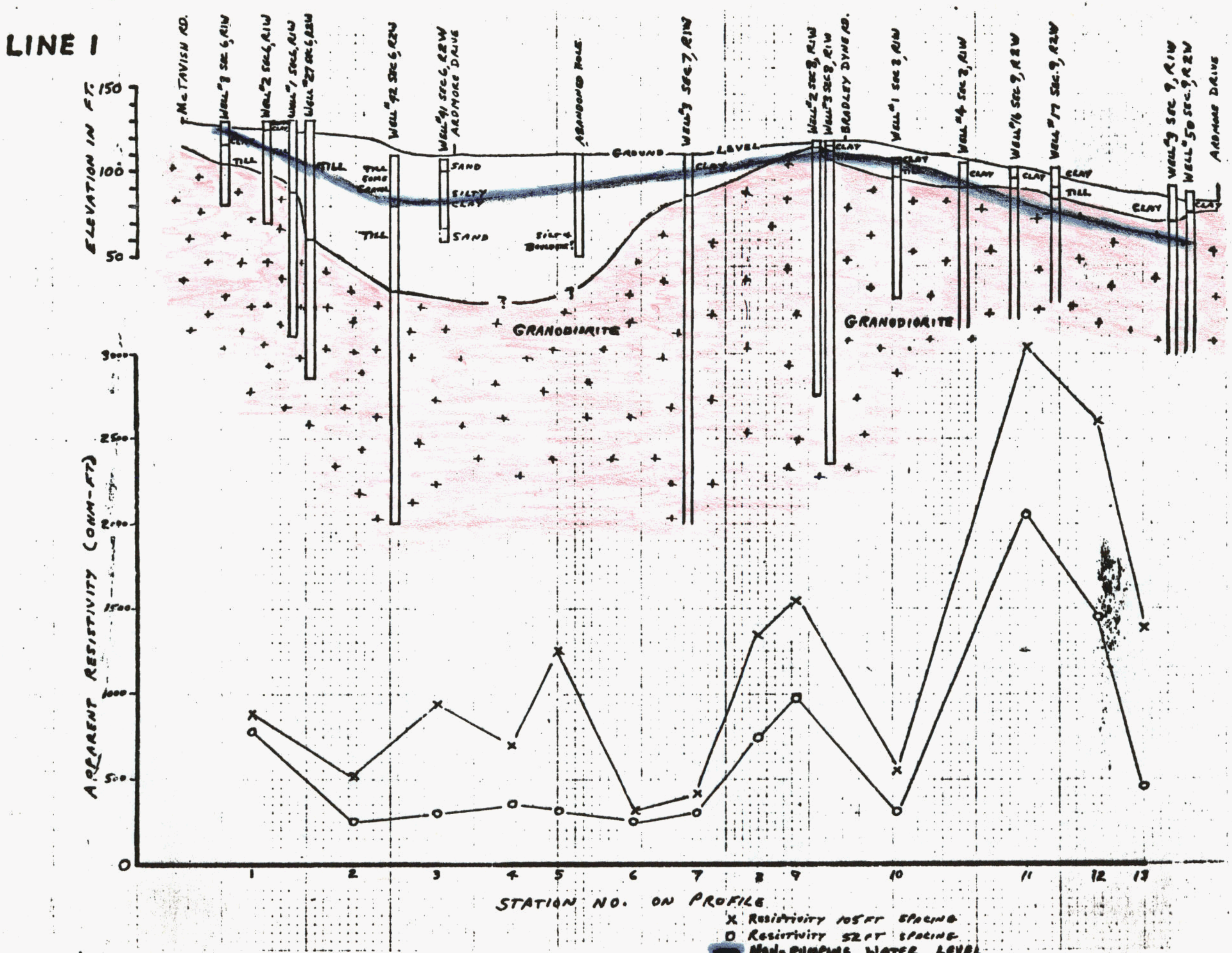


FIGURE 11. Cross Section for Resistivity Line 1

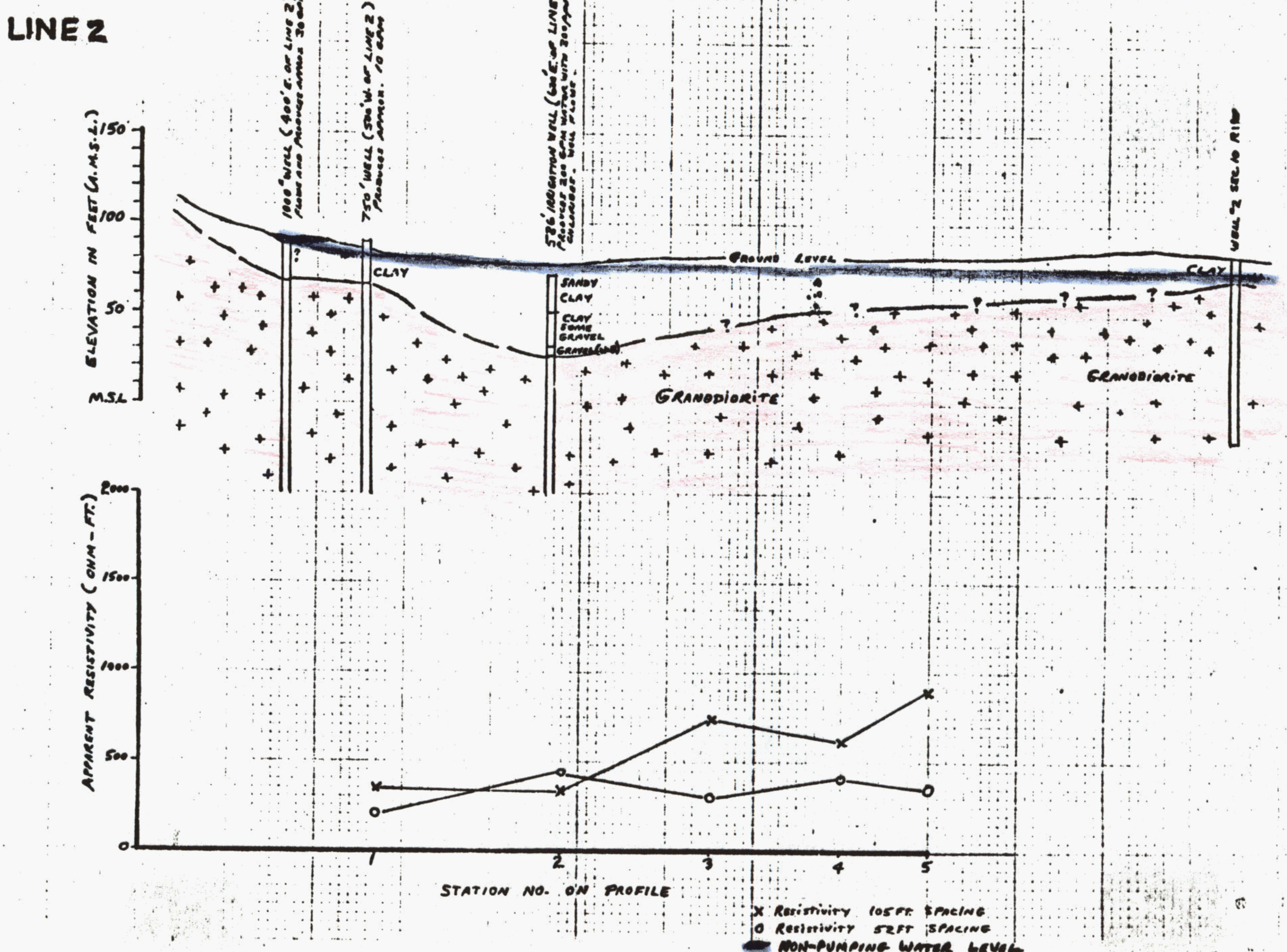


FIGURE 12. Cross Section for Resistivity Line 2

be more easily carried out. Table 3 is the field data used to construct the resistivity profiles.

INTERPRETATION

Profiling is valuable when the readings from many stations can be analysed to establish trends, and can be correlated against known data from drill hole data.

Also it must be kept in mind that the material at a particular depth will not have a resistivity identical to the reading, as the reading represents a weighted average of all the resistivities present.

Figure 13 is a Sodium Chloride Isocon Map for map sheet 92B.063.2.3. It is included to aid in the interpretation as the relationship of salinity of groundwater can provide a basis for evaluating resistivities, as well as a basis for predicting the probable success of resistivity surveys for specific exploration problems.

From Figure 11, line #1 can be interpreted as:

Station 1-9 — The resistivity readings verify the profile drawn from the drill log data. The smaller electrode spacing (52 feet) shows higher resistivity on either side of the bedrock channel and much lower through the middle stations which would verify the existence of the channel as shown by the drill log data.

At station 6 and 7 the larger electrode spacing (105 feet) shows lower readings and this could be caused from the low resistivity clay located there. Also there is the possibility that major fracturing may exist in the bedrock.

Station 10 — This station is offset quite aways out into a field where the clay layer likely thickens and has caused the resistivity to be much lower than one would anticipate.

Station 11 — This shows a very resistive formation close to surface as the drill logs verify.

Station 12-13 — The resisitivity readings here are still showing a very resistive formation but getting less towards the north. This could be a sign of the highly fractured bedrock that is felt to exist in this area.

An interpretation of line #2 (Figure 12) is:

Station 1 — This appears to be like Station 6 and 7 of line #1 and this correlates with the nearby drill log.

Station 2 — It is hard to explain what occurs here, and it is the only station that shows a lower resistive layer under a more resistive one. I discussed this with personnel from the Geotechnical Section of the Highways Department and they felt either the bedrock was deeper and the wider spacing didn't reach that deep, or, what I feel is a more likely explanation, that the bedrock is very fractured and weathered and the groundwater contained in it may have a higher chloride content. Groundwater with a higher chloride content is known to exist in the bedrock in the nearby irrigation well. On October 1, 1980 the chloride content of the irrigation well water was tested as 171 mg/L.

Station 3 and 4 — These resistivity readings appear to show a low resistive clay over a shallow bedrock which is rising to the north. This would agree with the interpretation shown in the cross-section drawn.

CONCLUSIONS

SUMMARY AND CONCLUSIONS

Using resistivity equipment, two double electrode interval traverse lines were run and good correlation was obtained with cross-sections drawn for these areas from existing drill log data.

Indications of a shallow bedrock channel and variations in the bedrock fracturing were found with the resistivity equipment but due to equipment malfunctions it was not possible to do further resistivity work.

To delineate the extent of the bedrock channel and possibly obtain data on the variations in the bedrock fracturing more resistivity lines would have to be run between the two completed.

In conjunction with the resistivity equipment one should also take seismic readings as the two instruments are sensitive to different physical properties of the subsurface materials.

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TABLE [illegible] SCHEDULE OF WELLS FOR MAP SHEET 92B.063.2.3

RANGE #1 Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
5	2	500	180.	Flows in Winter Oct.20/76 13.70	?	21		2.0	50.	50.	50.	50.			A 55-hr.pump test was conducted on this well Oct. 1974. Initially the well was pumped at 60 Usgpm but after 92 minutes the flow had to be reduced to 40 Usgpm. After an additional 1800 minutes of pumping the flow rate had to be reduced to 30 Usgpm. Stabilization of the water level was not reached when pumping was terminated after 55 hours.
6	1	125	132.	?	till	42	6.6		6.6						
	2	60	133.	May 1967 9	1-5 sandy clay 5-31 till	31	4.2	4.2							
	3	67	135.	Oct.1965 8	1-10 clay 10-24 till	24	5.0	5.0							
	4	720	148.	flows		27		trace	2.0		4.0	7.0	35.	70.	This well was pump tested for 26 hours at a pumping rate which varied between 60 and 70 igpm. At completion of pumping the water level was 459.18 ft.
	6	200	145.		Soil & rock	12	12.	11	12						
	8	50	133.	7	1-13 clay 13-24 till	24	4.2	4.2							
	9	50	145	0	1-5 clay 5-31 till	31	3.3	3.3							
	12	510	130.			< 50	9	1.	3.		5.	9.			
7	1	26.5	108.	0 in winter											
	3	330	111.	16	red clay	23	20.	.25	.75	20.					
8	1	80	107.	0	0-2 clay 2-10 till	10									Yield reported as adequate for house, garden and stock.
	2	150	116.	Apr.1968 9	0-2 soil'	2	.3		.3						
	3	185	114.	7	1-4 clay 4-8 till	8	4.0		4.0						
	4	615	105.		0-15 clay	15	20			3.0	4.0	5.0	20.		
9	1	118.5	93.		0-6 soil & clay 6-27 clay	27	4.3		4.3						
	2	150	93.												
	3	205	93.		clay	21	100		2.0	100.					
10	1	445	90.	Approx.20	clay	16	20	1.1			15.	20.			
	2	105	85.	Apr. 1966 10	clay	12	6.6	6.6							This well went dry March 1979, so now they obtain water from neighbours.
	3	60	78.		till	1.6	3.3	3.3							

RANGE #1 Sec-tion	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pump-ing Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Repor-ted Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to:							Remarks
								100	200	300	400	500	600	700	
10	4	100	80.	July 1964 13	0-14 clay 14-17 till	17.	3.3	3.3							In 1978 or 1979 this well was deepened to approx. 350 ft.
	5	220	82.		0-45 clay&gravel	45 ?	50		.5	50					
	6	290	90.	Approx.80	clay	23	30	Trace	Very Little	30					
	7	195	80.		clay	25	30	2.0	30						
	8	323	92.	May 31/79 13.10	0-7 clay, till 7-13 sand, clay	13	1.25	1.25							
	9	530	92.	25	clay	15	40					1.5	40		
11	3	176	46.		clay	5	3.3		3.3						
	5	55	45.	12	soil	2	5.0	5.0							
	6	130	34.		clay & till	20	2.6		2.6						
	7	36	40.	12	0-4 clay 4-10 till	10	8.3	8.3							
	12	129 ?	70.												
RANGE 2W															
4	1	87	185.	0	?	?	18	18							Pump tested for 19.5 hrs. at 19.5-24 gpm
	3	7	60.	flows		7									Flows at 1 gpm and is reported to go dry in the fall
5	1	110	30.		0-12 clay 12-14 till	14	10		10						
	2	100	30.		clay	18	7.5	7.5							
8	1	118	120.		0-8 soil 8-49 till	49	2.5		2.5						
	2	261	114.		till & boulders	80	.6			.6					
	3	120	88.	18.	till & boulders	48	1.6		1.6						
	4	88	89.	2' in winter June 20/72 11.2	till	28	5.0	5.0							
	5	64	78.	June 20/72 2.5	0-6 clay 6-29 till	29									Flowed at 1.0 gpm when drilled in 1959
	6	101	90.	20	till	62	1.6	1.6							
	7	92	25		0.4 clay 4-24 till	24	5.8	5.8							
	8	90	38.	26	0-11 clay & till 11-24 clay	24	2.8	2.8							
	9	58	73.		0-20 clay 20-31 till	31	5.0	5.0							
	10	120	70	0 in winter	0-20 clay 20-23 till	23	5.0		5.0						
	11	140	80.		clay & till	19	1.4		1.4						

RANGE 2W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
6	12	48	68.		till	5	1.5	1.5							
	13	90	20		0-12 clay & till 12-21 till	21	8.3	8.3							
	14	130	45		clay	17.5	2.1		2.1						
	15	87	58	5-6	clay	17	20	20							
	16	54	26		till		3.3	3.3							
	17	60	28		0-4 clay 4-10 clay & till	10	5.0	5.0							5 gpm in winter but inadequate supply in summer.
	18	75	40	0	0-17 clay 17-22.5 till	22.5	4.3	4.3							
	19	135	75	flows	0-12 clay 12-37 clay & till	37	3.5		3.5						
	20	135	80	Sept.18/74 3.5	0-8 clay 8-19 till	19									This well was test pumped for 5 days at rates of 18.6, 23.4 and 25 igpm.
	21	95	78	Sept.1963 7	2-12 clay 12-66 till	66	15	15							
	22	45	78	June 1963, 5;Overflow in the spring	0-9 clay 9-14 till	14	3.3	3.3							
	23	153	110	April 1963 18	1-3 clay 3-30 till 30-46 silt 46-48 till	48	.7		.7						
	24	103	112	Oct.1964 10	1-20 clay 20-49 till	49	4.5	4.5							
	25	104	74	May 1973 8	1-24 clay 24-48 till	48	3.3	3.3							
	26	100	25	6	clay	20?	7.5	7.5							The bedrock is described as a soft red rock.
	27	150	118	Aug.1965 30	till	69	1.3		1.3						
	28	88	66	July 1967 11	2-43 clay 43-58 till	58	5.0	5.0							
	29	84	60	July 1965 flows +3	1-8 clay 8-49 till	49	10	10							This well would flow all year until 1971. Now in 1980 it does't flow even in the winter. The water level rises to about ground level in winter.
	30	107	69		clay with some gravel	52	10	10							
	31	109	121	Jan.1970 20	till	67	16.6	16.6							

RANGE 2W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
6	32	125	125	Aug.1973 25	0-7 clay 7-13 till	13	1.6		1.6						
	33	128	63	flows	1-5 clay 5-47 till	47	6.6		6.6						
	34	108	116	15	till	14	5.0	5.0							
	35	91	38				5.0								
	36	84	111												
	37	160	51												
	38	74	120	Aug.1972 15	0-2 clay 2-8 till	8	8.3	8.3							
	39	75	80	Oct'72—8; overflows in winter.	0-5 clay 5-14 till	14	6.6	6.6							
	40	300	107	15	0-18 sand, silt 18-45 clay 45-68 till	68	2.0			2,0					Initially this well was 68 ft deep but it produced cloudy water from the overburden.
	41	47	108	15	0-7 soil & sand 7-42 silty clay 42-47 sand		15								Produces from the overburden. Completed with 5 ft. of .040" slot screen from 42-47 ft.
	42	215	110	40	5-30 till, some gravel; 30-78 till	78	.5		.5						
	43	125	108		clay	42	10	.5	10						
	44	140	126	Jan'79—15 Aug.21/79-34.7	0-15 brown clay	15	30	0	30						
	45	75	100		0-10 clay & rock	10	12	12							
	46	47	66	7	1-21 clay 21-24 till	24	4.0	4.0							
	47	47	70	Sept.1973 8	1-17 clay 17-19 till	19	5.8	5.8							
	48	74	128	Jan,1973 17	1-12 clay 12-18 till	18	5.0	5.0							
	49	90	128		red clay	23	6.0	6.0							
	50	445	66		0-45 clay 45-68 some gravel (W.B)	68	2.0		1.0			2.0			
	51	425	105		0-15 clay 15-48 sand 48-80 clay	80	2.0					2.0			
	52	265	100		clay, gravel & sand	6	12.0		.5	12					
	53	150	44		clay	12	8.0		8.0						
	54	295	105			15	4.0		Trace	4.0					
	55	145	105		clay	4	6.0	3	6.0						
	56	135	88	3 approx. in winter	0-28 clay 28-30 sand 30-40 clay	40	2.5	.25	2.5						
	57	245	65	Feb.28/80 +14; Aug.21 '79 ground level.	1 soil 20 till 10 gravel 4 clay	35	4.0			4.0					

RANGE 2W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
6	58	150	128		red clay	13	30	Trace	30						
	59	105	60	Nov.2/79 7.64 Feb.29/80 +1.3	0-20 brown clay 20-69 blue clay and rocks	69	6.0	6.0							This well flowed 6 gpm when drilled in Oct. 1975.
	60	305	64	Feb.29/80 - 1.0; Nov.2/79 - 10.4.	0-69 clay, blue clay	2.0				2.0					Some water at 185'.
	61	150	45		0-11 red clay 11-16 gravel	16	3.0		3.0						
	62	150	30		0-18 red clay 17-20 sand&gravel	20	14	Trace @ 90'	14						
	63	300	34		0-7 clay 7-24 clay & gravel 24-43 gravel	43	2.0		.5	2.0					
	64	126	28	Nov.2/79 26.50	5-15 clay 15-34 till & granitic rock	34	20	Trace	20						The static water level may not be accurate as the well had been in use during the day of the reading.
	65	400	78		clay, blue clay	51	1.5				1.5				
	66	125	50		red clay & gravel	10	20		20						
	67	200	81		clay & rock	30	2.5	1.0	2.5						
	68	485	86		clay	29	6.0		.5		1.0	6.0			
	69	125	73		clay	40	6.0	1.0	6.0						
	70	425	66		0-40 brown clay 40-48 blue clay 48-66 till&gravel	66	2.0		.5		2.0				
7	1	147	88	Nov.12/68 6	1-7 sandy clay 7-27 blue clay 27-43 till	43	16.8		16.8						
	2	98	133		Clay & granite	27	3.5	3.5							
	3	198	130		clay	20	4.5		4.5						
	4	200	135		red clay, gravel & sand, boulders blue clay	38	7.5	Trace	7.5						
	5	500	140	Feb.21/79 5.9 Sept.7/79 21	red clay & boulders. gravel & sand blue clay	31	1.5			1.0	1.5	1.5			
	6	400	126	Feb.29/80 9.0 Oct.5/79 33.0	red clay boulders	4	1.5	.5	1.5						This well was pump tested at 1 igpm for 480 minutes. At the end of this time period the water level was 40.20 ft. A consultants report notes a granodiorite type rock was drilled from 6 to 125 feet and altered volcanics with granodiorite intrusions from 125 to 400 feet.
	7	250	122	Nov.2/79 23.5 Feb.29/80 4.7	Soil and granite	14	17	Trace	2.0	17					A pump test was run for a total of 1850 minutes at 12 igpm. The pumping level stabilized at a depth of 140.5 feet after 1500 minutes of pumping.

RANGE 2W																
Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to:							Remarks
								100	200	300	400	500	600	700	
7	8	870	110	Flows in winter	clay	18	15		1.0			4.0		15	From 870-760' there were more fractures and the capacity increased from 4.gpm to 15.gpm. In May 1977 this well was pumped for 510 minutes. The last 465 minutes was at 13.igpm. At the end of this time the water level was 348.17 ft.
	9	108	136	Apr.20/77 10.37		2	5.0	5.0							April 1977 this well was pump tested at 2 igpm for 480 minutes. The water level at completion of pumping was 16.61 ft.
	10	86	148	Apr.19/77 17.10		2	6.0	6.0							April 1977 the well was pump tested at 2 igpm for 480 minutes. At the end of this period the pumping water level was 25.02 ft.
	11	450	138	Feb.29/80 4.8 Sep.7/79 21.2	red clay boulders	4	1.0		.5			1.0			March 1977 this well was pumped at 2 igpm for 480 minutes and the water level drewdown to 178.32 ft. at completion.
	12	350	132	Feb.29/80 4.3 Sep. 7/79 15.0	0-10 red clay 10-12 sand & gravel	12	2.0	Trace	1.0		2.0				Pump tested March 1977 for 480 minutes at 2 igpm and at completion of testing the water level was 74.08 ft.
	13	275	122	Feb.20/79 7.5 Oct.13/78 13.1	red clay & boulders	8	2.5	.5	1.0	2.5					Pump tested April 1977 for 480 minutes at 2.0 igpm. On completion of testing the water level was 31.37 ft.
	14	300	114	Apr.25/77 12.42	red clay & boulders	13	3.0		1.0	3.0					Pump tested April 1977 at 2 igpm for 480 minutes. The pumping water level was 28.63 ft. at completion.
	15	100	110	Mar.25/77 Flowing	red clay sand & gravel	4	6.0	6.0							Pump tested March 1977 for 480 minutes at 2 igpm. At completion of pumping the water level was 11.07 ft.
	16	475	104	May 13/77 8.94	red clay	18	1.5		.5	1.0	1.5				Pump tested May 1977 for 480 minutes at 1 igpm. The final water level measurement was 41.20 ft.
	17	200	111	Mar.25/77 13.78	soil	14	4.0	2.5	4.0						Pump tested March 1977 at 2 igpm for 480 minutes. The final water level reading was 19.16 ft.
	18	468	124	Apr.22/77 5.15	0-14.5 clay till 14.5-35 till	35	2.0	Trace	1.0			2.0			Pump tested April 77 for 480 minutes at 1.0 igpm and at completion of testing the water level was 41.70 ft.
	19	228	131	Apr.23/77 12.63	clay	11	2.0		2.0						April 1977 this well was pumped for 480 minutes at 2 igpm and the water level drew down to 30.66 ft.
	20	450	134	Apr. 23/77 8.65	red clay	17	1.5	.5			1.0	1.5			Pumped in April 1977 at 1 igpm for 480 minutes with a final water level of 30.85 ft.
	21	600	148	Dec. 6/77 24.1 Mar.14/79 8.8	clay	29	.5						.5		Pumped in May 1977 at 1 igpm for 480 minutes with a final water level reading of 109.01 ft.
	22	125	142	Nov.30/79 28.6 Feb.29/80 7.7	red clay	10	4.0	3.0	4.0						March 1977 this well was pumped for 480 minutes at 2 igpm with a final water level measurements of 19.39 ft.
	23	227	138	Apr.20/77 13.90	clay and rock	15	2-3	2.0		3.0					Pump tested April 1977 at 2 igpm for 480 minutes with a final water level reading of 53.17 ft.
	24	500	152	Apr.25/77 23.75	red clay & boulders	25	1.0	.5			.75	1.0			Pumped in April 1977 at 1 igpm for 480 minutes. The final water level measurement was 54.00 ft.
	25	200	160	May 5/77 29.19	red clay	12	30	.5	30						May 1977 this well was pumped for 480 minutes at 4 igpm with a final water level reading of 43.73 ft.

RANGE 2W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
7	26	408	168	Mar.30/77 27.61	clay and rock	15	1.5			.75	1.5				In March 1977 this well was pumped at 1 igpm for 480 minutes with a final pumping water level of 125.77 ft.
	27	525	172	Mar.30/77 24.77	red clay and boulders	17	1.0		.5		.75	1.0			This well was pumped March 1977 for 480 minutes at 1 igpm with a final water level reading of 126.81 ft.
	28	300	148			12	4.0			4.0					
8	1	325	172		red clay	5	1.0		Trace	.5	1.0				
	2	120	120	Oct. 1962 16	soil	2	8.3		8.3						
	3	175	172	Nov.30/79 29.5 Feb.29/80 11.0	clay	11	8.0		8.0						
	4	108	178	May 1965 17	clay	11	7.5	7.5							
	5	139	175	June 1968 14	1-4 clay 4-6 till	6	3.0		3.0						
	6	45	160	Oct.1968 18	1-10 clay 10-13 till	13	20	20							
	7	160	165	Aug. 1968 26	till	11	.66		.66						
	8	132	136	June 1969 11	1-12 clay 12-17 till	17	2.0		2.0						
	9	300	136	Flows in winter		9	12			12					Broken brown rock near the bottom of the well. The well flows about 5 gpm in the winter.
	10	65	118	June 22/72 11.5		20	10	10							
	11	82	145				4.2								
	12	150	150	July 1971 20	till	2	3.0		3.0						
	13	320	118	8 Approx.		12	3				3.0				
	14	200	166		clay	15	4.0	Trace	4.0						
	15	147	140		soil & soft granite	15	3.0	.5	3.0						
	16	395	177	Approx.18	clay	19.5	2.5	Trace			2.5				
	17	125	170			12.5	4.5	1.0	4.5						
	18	200	120			25	5.0	2.0	5.0						
	19	125	181			17	7.0	7.0							
	20	165	122	Feb.1973 3	1-10 clay 10-12 till	12	1.3		1.3						
	21	330	94		clay & rock	17	4.0	1-2	2	4					
	22	175	132	May 1976 10	brown clay	8	4.0	.75	4						
	23	160	142	Nov.7/79 32.5	brown clay	10	25	.25	25						
	24	300	158		0-2 soil 2-10 clay 10-13 till	13	3.0	1.0	2.0	3.0					
	25	120	128		red clay & boulder	17	8.0	7.0	8.0						

Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
8	26	575	128		red & blue clay & boulders	12	1.0	.5		1.0	1.0		2.0		
	27	125	120	Approx.15	clay	12	5.0	1.0	5.0						
	28	155	116	Approx. 10-15		18	15		15						
	29	325	118	Approx.15		20	6.0			2.75	6.0				
	30	175	151	Nov.1/79 Approx.32	clay	9	7.0	Trace	7.0						
	31	350	172		red clay		2.0	nil	2.0						
	32	348	177		clay & till	17	2.0	Trace		1.5	2.0				
	33	298	181		clay	12	15		.25	15					
	34	173	182		clay	20	5.0	Trace	5.0						
	35	135	170		clay	9	5.0	2.0	5.0						
	36	130	129	Nov.6/79 20.0 Feb.29/80 +.50	clay	19	8.0	8.0							
	37	255	175		clay	19	6.0	nil	1.0		6.0				
	38	405	167			3	1-1.5	nil				1.5			
	39	275	168		red clay	4	4.5	Trace		4.5					
9	1	83	100	4	clay	21	4.1	4.1							
	2	160	118			0	1.6		1.6						
	3	57	50	Oct.19/79 8.70* Flows in the winter	0-21 clay 21-25 till	25	1.6	1.6							*This well had been in use during the day of this reading
	4	160	80			2	1.6		1.6						
	5	275	50	31		0	8.0		.5	8.0					
	6	78	74	9		0	1.6	1.6							
	7	40	78			0	>20	>20							
	8	116	54			2	.5		.5						
	9	100	70	June 14/72 9.5 Oct.19/79 29.5*	clay	6.5	2.0	2.0							*The well had been in use during the day of the reading.
	10	150	123	Nov.1962 10		1	1.1		1.1						
	11	92	50	Mar.1963 8	2-17 clay 17-20 till	20	3.3	3.3							
	12	109	68	Dec.1963 2 Oct.1978 8-10	clay	8	5.0		5.0						

RANGE 2W Sec-tion	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
9	13	78	166	May 1969 16		1	7.5	7.5							
	14	104	110	Nov.1967 17		2	3.6	3.6							
	15	150	104	July 1968 7	till	2	3.3		3.3						
	16	225	106	Aug.1969 22 Aug.21/79 52.7	1-3 till 3-7 clay	7	7.0		2.5	7.0					
	17	140	102	Oct.1969 26	2-12 clay 12-18 till	18	50	30	50						
	18	105	122	Apr.1969 15	1-4 till	4	3.0	3.0							
	19	150	42	Sept.1971 30	0-24 clay 24-36 till	36	2.0		2.0						
	20	85	150	Mar.1970 17	till	4	5.8	5.8							
	21	120	78	May 1970 8	clay	5	5.0		5.0						
	22	60	68	Flows	1-18 clay 18-27 till	27	20	20							
	23	70	70	July 1971 7	1-12 clay 12-13 till	13	4.1	4.1							
	24	150	52	Flows in winter. Oct.17/79 7.0	clay	33	25	Trace	25						
	25	77	45												
	26	18	60	Flows part of year. Oct.19/79 approx.10.											[illegible]g well.
	27	70	79	July 1973 20	1-12 clay 12-13 till	13	3.0	3.0							
	28	150	152	June 1977 approx.12			2.0	1.5	2.0						
	29	275	122		red clay	2	3.5	Trace	2.5	3.5					
	30	100	68			25	65	65							
	31	150	125		clay	10	2.0	1.0	2.0						
	32	185	155			6.0	2.0	Trace	2.0						
	33	275	50			8.0	4.0	Trace		4.0					
	34	440	115		clay & rock	16	4.0		1.0			4.0			
	35	41	50	Oct.1973 8 Flows in winter	clay	8	3.0	3.0							

Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
9	36	125	84	Mar.1973 9.0	1-4 clay 4-10 till	10	8.3		8.3						
	37	100	60	+8.0 in winter; ground level in fall.	0-3 soil 3-8 gravel and sand 7-30 clay	30	30	30							
	38	220	70		red clay	5.0	2.0	Trace	1.5	2.0					
	39	325	75		red clay	1.0	6.0	Trace	2.0	6.0					
	40	385	110			5.0	12	Trace	.25	12					
	41	360	175			4.0	50				50				50 gpm was obtained within 35 ft. of surface but it was cemented off.
	42	450	144	Oct.31/79 77*		24	6.0		.5		1.0	6.0			*Owner felt this was a true non-pumping water level as this well had been pumped very little during the day.
	43	173	124	July 1973 20		0	.5		.5						
	44	285	65		red clay and boulders.	9	30	Trace	.5	30					
	45	355	55		4-18 red clay 18-20 sand & gravel	20	20	Trace	1.5	2.0	20				
	46	300	84		0-16 red clay 16-26 blue clay	26	5.0	.5	1.0	5.0					
	47	440	145			9	60		Trace	.5	1.0	60			
	48	200	80		red clay and boulders	7	4.0	Trace	4.0						
	49	425	71	Flows?	clay & gravel at 28	30-40	8.0		.5			8.0			
	50	245	89	Mar.13/79 12.8 Aug.21/79 50.4	red clay	11	75	Trace		75					
	51	275	55			8	15	nil	.5	15					
	52	350	172		red clay and boulders	18	10	.5		2.0	10				
	53	280	105	Sept.7/79 51.5 Feb.29/80 2.7	0-6 clay 6-8 till	8	20	8.0		20					
	54	325	110		soil	16	1.25				1.25				When initially drilled in April 1978 this well obtained 12 gpm at 55-60 feet but in Sept. of 1979 the owner had quantity problems and had the well deepened.
	55	273	145		soil	7	3.0		3.0						
	56	620	156	Approx.80	soil	4	20						20		
	57	90	55	Apr.4/79 43.7	clay	35	2.9	2.9							
	58	75	77	Apr. 1973 5	1-31 clay 31-44 till	44	7.0	7.0							

Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in feet from 0 to: 100	200	300	400	500	600	700	Remarks
10	1	70	35		clay	13	5.8	5.8							
	2	133	32	Sept.1962 9 Oct. 7/79 27.0*	1-19 clay 19-22 till	22	5.8		5.8						*Well may not have fully recovered as it was pumped for domestic purposes prior to this reading.
	3	77	45	June 1962 7	1-10 clay 10-15 till	15	5.8	5.8							
	4	75	25	July 1963 23	0-2 clay 2-11 till	11	3.1	3.1							
	5	85	33	Nov. 1963 6	0-14 clay 14-18 till	18	15	15							
	6	60	32	Dec.1964 6	clay	9	10	10							
	7	130	30	April 1965 20	0-11 clay 11-19 till	19	3.8		3.8						
	8	155	34	April 1965 8	2-16 clay 16-18 till	18	2.5		2.5						
	9	124	35	Aug.1966 19	1-16 clay 16-22 till	22	5.0		5.0						
	10	100	31	June 1967 20 Oct.11/79 28.3	0-9 clay 9-22 till	22	5.0	5.0							
	11	122	34	Sept.1968 15	1-8 clay 8-12 till	12	6.6		6.6						
	12	225	35	Sept.1967 15	2-11 clay 11-14 till	14	10	1.5	10						
	13	125	43	June 1972 10	1-21 clay 21-22	22	16.6		16.6						
	14	90	34	June 1970 20	1-10 clay 10-14 till	14	8.3	8.3							
	15	139	33	Mar.1970 6	0-6 clay 6-9 till	9	13		13						
	16	155	82	Oct.1972 22	1-16 clay 16-19 till	19	1.2		1.2						
	17	150	50	Oct.17/79 15.2 Feb.29/80 flowing	0-23 brown clay 23-26 gravel & sand	26	30	Trace	30						
	18	175	36		0-27 clay & gravel	27	6.0	nil	6.0						
	19	300	65		0-19.5 clay & gravel	19.5	8.0	Trace	4.0	8.0					
	20	100	42	Oct.12/79 26.5 Feb.29/80 10.9	0-22 brown clay 22-25.5 gravel	25.5	6.0	6.0							

RANGE 2W Sec-tion	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pump-ing Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Repor-ted Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
10	21	250	85	Apr.28/80 12.8 Oct.15/70 25.60	clay	10	4.0	.5	4.0						
	22	250	34		0-16 soil & clay	16	4.5	Trace	2.0	4.5					
	23	250	32		0-13 soil & clay	13	10	Trace	4.0	10					
	24	150	40		0-29 soil & clay 29-38 gravel & broken granite	38	4.0	Trace	4.0						
	25	150	35		0-13 clay	13	6.0	1.5	6.0						
	26	125	50	Flows in winter	0-14 clay	14	10	2.0	10						
	27	250	48	Aug.10/79 48.6 Feb.29/80 18.8	0-2 soil 2-10 till 10-15 clay & gravel	15	3.75		1.0	3.75					
	28	270	50	Aug.16/79 34.8 Feb.29/80 +.4	0-5 clay 5-11 gravel 11-16 till	16	4.0	.5	2.0	4.0					
	29	425	55	Flows in winter	0-15 brown soil	15	2.0			.5	.5	2.0			
	30	90	34	Oct.12/79 22.6 Apr.28/80 8.1											
RANGE 3W															
5	1	105	33	23	clay	10	+10	+10							Large flow at 95-100 ft. At 10 gpm bailing made little impression on water level.
	2	110	33	June 19/72 26.3	clay & till	14	+14		+14						Between 103-110 ft. a very large flow of water is reported.
	3	91	41		0-23 clay & till 23-42 till	42	5.0	5.0							
	4	130	20		0-16 clay 16-35 till	35	8.3		8.3						
	5	200	28	Approx.30	0-25 clay & till	25	3.3		3.3						
	6	120	22		0-4 clay 4-15 clay & till	15	1.25	1.25							
	7	112	30	Dec.10/79 27.5	0-19 clay	19	5.8		5.8						
	8	143	30			0	2.3		2.3						
	9	125	40		0-11 clay 11-14 till	14	1.0	1.0							
	10	145	26	10											Salt water problem occurs if well is pumped too long.
	11	150	30	—			.3		.3						

RANGE 3W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
5	12	100	43	Mar.1967 13	0-7 clay 7-14 till	14	4.1	4.1							
	13	225	30		0-10 soil and broken rock	10	8.0	Trace	.75	8.0					
	14	220	41	Apr. 2/80 22.4 Sept.19/80 40.3	0-17 clay	17	2.5	Trace	2.0	2.5					
	15	110	32		clay	22	5.8		5.8						
	16	84	30		clay, till	12	2.0	2.0							
	17	280	41		0-19 clay	19	50	nil	2.0	50					Approx. 50 gpm of salt water at fracture at 280 ft.
6	1	125	36	Dec.1973 37	till	6	4.3		4.3						
	2	94.5	24		clay	6	1.6	1.6							
	3	100	30		soil	5	5.0	5.0							
	4	167	24			0	5.0		5.0						
	5	110	28	Approx. 12	till	5	1.8	1.8							
	6	115	26		clay	9.5	2.5		2.5						
	7	86	28		clay	6	10	10							
	8	142	21	Feb.1962 27	0-4 clay 4-9 till	9	3.0	.5	3.0						
	9	100	96	Oct.1965 16	0-13 clay 13-15 till	15	12	12							
	10	103	80	Nov.1965 16	clay	8	3.3	3.3							
	11	96	53	July 1967 8	0-15 clay 15-16 till	16	7.5	7.5							
	12	81	68	Aug.1967 18	clay	11	10	10							
	13	125	54	Mar.1972 8	1-17 clay 17-45 till	45	7.5		7.5						
	14	55	63	Sept.1968 20	1-10 clay 10-12 till	12	20	20							
	15	105	61	Oct.1968 18	1-20 clay 20-34 till	34	6.6		6.6						
	16	178	66	Dec.1969 8	1-15 clay 15-23 till	23	5.0		5.0						
	17	80	110	July 1969 14	0-4 clay 4-8 till	8	6.3	6.3							
	18	200	48	June 23/80 18.2	clay	8	1.5	.5	1.5						
	19	225	73		red clay & boulders	12	2.0	.25	2.0						

RANGE 3W Sec-tion	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
6	20	130	95		brown clay	8	7.0	Trace	7.0						
	21	200	118		red clay	8?	4.5	1.0	4.5						
	22	335	64		clay	16	8.0	Trace	Trace	3.0	8.0				
	23	85	56	Approx.15	red clay	5	4.0	4.0							
	24	175	75		clay	13	5.0	1.0	5.0						
7	1	67	60	Overflow in winter	0-13 clay 13-20 clay, gravel	20	5.0	5.0							
	2	82	38		clay	10	3.3	3.3							
	3	110	24		0-5 clay 5-15 clay & till	15	5.0		5.0						
	4	90	30	15	0-13.5 clay 13.5-25 till	25	6.0	6.0							
	5	114	28	June23/80 3.9	0-16 clay 16-30 til	30	4.1		4.1						
	6	45	28		0-8 clay 8-23 till	23	1.3	1.3							
	7	120	50		clay	12	4.5		4.5						
	8	94	70	Aug.21/79 40.8 Feb.29/70 9.9	1-2 clay 2-9 till	9	1.6	1.6							
	9	140	91	June19/72 15.6			5.0		5.0						
	10	173	58	Sept.1969 15	0-23 clay 23-30 till	30	4.1		4.1						
	11	272	66			0	4.0		.75	4.0					
	12	200	122		clay & sand	30	1.0		1.0						
	13	44	70	Aug. 1972 10	soil	2	4.1	4.1							
	14	275	104		red clay	6	8	1.0	8.0						
	15	180	58	Flows in winter	red clay and boulders	9	5.0	1.0	5.0						
	16	220	72		red clay	7	3.0	Trace	1.25	3.0					
	17	175	70		red clay and boulders	3	4.0	2.5	4.0						
	18	150	100		red clay	5	4.0	Trace	4.0						
	19	402	100			11	3.0			1.5	3.0				
	20	272	70	Sept.79 Approx.5.0 July 8/80 flowing	0-2 soil 2-22 brown clay 22-25 blue clay & gravel	25	60		.75	60					

RANGE 3W Section	Well No.	Depth (ft)	Surf. Elev. (AMSL) (ft)	Depth to Non-pumping Wtr. Level (ft)	Surficial Material (ft)	Depth to Bedrock (ft)	Reported Yield (igpm)	Cumulative Yield (igpm) of Fractures in Depth Ranges in Feet from 0 to: 100	200	300	400	500	600	700	Remarks
7	21	303	128		0-12 clay	12	60		.25	60					
	22	200	136			10	4.0		4.0						
	23	243	114	May 1979 15	clay & brown soil	5	3.0	1.0	2.0	3.0					
8	1	87	60		soil	2	3.3	3.3							
	2	100	50		soil	1	3.3	3.3							
	3	65	60	20	soil	2	1.3	1.3							
	4	52	50		clay	16	7.5	7.5							Goes dry in summer
	5	280	60				4.0		2.0	4.0					
	6	64	40		soil	2	1.6	1.6							
	7	118	96	Jan.1965 16	0-5 clay 5-14 till	14	4.1		4.1						
	8	93	110	Sept.1971 20	1-8 clay 8-20 till	20	5.0	5.0							
	9	152	98				2.8		2.8						
	10	325	98		clay	17	5.5	5.5	5.5	5.5	5.5				
	11	300	110			26 ?	1.25		1.0	1.25					
	12	295	110		gravel & sand	25	5.0			5.0					
	13	275	122			27	1.0			1.0					
	14	250	115			12	4.0	.25	1.5	4.0					
	15	272	48				4.0		.5	4.0					
	16	325	50		soil & loose rock	12	12			.5	12				
	17	230	75		soil	4	25	Trace	25.?	25					
	18	380	90		clay & soft rock	27	5.0		Trace		5.0				
	19	230	75			6	15			15					
9	1	120	65	June22/72 43.5											
	2	70	45		soil	6	8.3	8.3							
	3	60	45	April 4/79 33.90		0	10	10							The water level reading may be in error as the well had been pumped during the day and full recovery may not have occurred.

TABLE 2

RESISTIVITIES OF IGNEOUS & METAMORPHIC ROCKS

Rock	Locality	Investigator	Dir.	Freq.	Resistivity in ohm-cm: Intermediate Conductors							
					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Specimens												
Diabase	Idaho	Sundberg	3				3.1					
Granite	Bavaria	Hunkel	3							1		
Dev·· ian slate	Harz	Ebert					2					
"	"	"						6.5				
Porphyry, schistose	S. Australia	Edge & Laby		100			3					
Serpentine		Eve & Keys					3–	–2				
Diorite	Bavaria	Hunkel	3					1				
Gabbro	Mineville	Lee & Boyer		D.C.					1.0	—	1.4	
Garnet gneiss	Bavaria	Hunkel	3						2			
Hornblende gneiss	Mineville	Lee		D.C.						1-6		
Gray biotite gneiss	"	Lee & Boyer		D.C.						4		
Syenite	Bavaria	Hunkel	3							1		
In Situ												
Graphitic schist	Normandy	Schlumberger		16	1–	1						
Schists	Missouri	Poldini			2–	6						
Hard calc. schist	Belgian Congo	Geoffroy & Charrin				2–	1.1					
Mica schist (hard packed)	Washington, D. C.	Gish & Rooney		16			1.3					
Quartz porphyry (slightly altered)	Newfoundland	Kihlstedt				3.4						
Keweenawan lavas	Michigan	Hotchkiss, *et. al.*		10–15		1.2	—	4.4				
Greenstone	"	Rooney		16			1.1					
Porous traprock	"	"		16		1.6						
Pre-Cambrian	Sweden	Sundberg					3-6					
Granite	Washington, D. C.	Gish & Rooney		16			5					
Slightly altered syenite	Ontario	Kihlstedt		200			2.4 3.7					
Massive vein quartz	"	"		200				2				
Diabase	Michigan	Rooney		16		4.5						
Serpentine	Ontario	Kihlstedt		200		2.1 5.3						

TABLE 2 (CONT'D)

RESISTIVITIES OF CONSOLIDATED SEDIMENTS[a]

Rock	Locality	Investigator	Dir.	Freq.	a°	Resistivity in ohm-cm 10[illegible]	10[illegible]	10[illegible]	10[illegible]	10[illegible]	10[illegible]
Shales and Slates											
Chattanooga shale (Dev.)	Cent. & south Illinois	Hubbert		50			2—	—	1.4		
Shale & glacial drift	"	"		50			5				
Nonesuch shale	Houghton Co., Mich.	Hotchkiss, *et. al.*		10-15				1.8			
Shale	W. Hancock, Mich.	Rooney		60					2		
Slate		Lee, Joyce, & Boyer		0				6.4			
Clay (wet)	Jugoslavia	Lochnberg & Stern		D.C.			2.1				
Grinneld argillite	N½ sec. 23, T32N R20W, Flathead Co., Montana	Erdmann	dip 32°	16							
					10			1.7			
			∥ to stratification		20		9.6				
					20			1.1			
					30			1.0			
			⊥ to strike		10		8.7				
					20		7.4				
					40			1.1			
Grinneld argillite	" (Water's Edge)	"	dip 32°	16							
								1.3			
			∥ to strike		15			1.4			
					30			8.0			
								8.2			
					10			7.7			
Argillite (Missoula group); pre-Cambrian, thin-bedded, platy argillite; resembles Grinneld	Sec. 27, T 32N R20W, Flathead Co., Montana	"	dip 31°	16							
					10			1.4			
					20			1.6			
			⊥ to strike		30			1.5			
					40			1.4			
					50			1.5			
									1.1		
Conglomerates											
Great conglomerate outcrop	Eagle Harbor, Mich.	Hotchkiss, *et. al.*		10-15							
Calumet & Hecla conglomerates	Michigan	Rooney		60					2	1.3	
Sandstone											
Eastern sandstone	Michigan	Hotchkiss, *et. al.*		10-15			3.5–	1.2			
Eastern sandstone	"	Rooney		16			4.3				
Muschelkalk ss. (Triassic)	Lorraine	Schlumberger		16			7				
Sandstone (Tertiary Oligocene); soft, friable; extremely fine grained ss.; pale green to yellowish and buff; contains thin beds of lignite	Coal Creek Road, Flat head Co., Montana	Erdmann	dip = almost 0	16	10		8.8				
							9.8				
					20		6.2				
							6.7				
					30		4.8				

TABLE 2 cont'd

RESISTIVITIES OF CONSOLIDATED SEDIMENTS

Rock	Locality	Investigator	Dir.	Freq.	$t°$	Resistivity in ohm-cm 10^3	10^4	10^5	10^6	10^7	10^8
Armorican ss. compact Siliceous-Ordovician	Normandy	Schlumberger						1			
Ferruginous sandstone (Jurassic)	Switzerland	Koenigsberger						4			
Limestone											
Muschelkalk ls. (Triassic)	Lorraine	Schlumberger		16		6					
Limestone with lenses of hematite	Algeria	"					1.2–4				
Muschelkalk oolitic ls. (Triassic)	Lorraine	"		16			1.8				
Limestone	Mississippian (Missouri)	Poldini					3–4				
Siyeh ls., hard homogeneous, dark bluish-gray, siliceous magnesium ls.; pre-Camb.	SW cor. sec. 5 T29N R18W Flathead Co., Montana	Erdmann	dip 54°	16							
			‖ to strike		10		6.8–	1.4			
					20			1.5			
					30			1.4			
			⊥ to strike		10		3.6				
					20		5.4				
							7.9				
					30		6.6				
							6.9				
					60		6.1				
							8.1				

RESISTIVITY CORRELATION

Ohm-ft.	2π ohm-cm (For Barnes Method)	Types of Materials
5 to 10	1000 to 2,000	Wet to moist clayey soils
10 to 50	3,000 to 15,000	Wet to moist silty clay and and silty soils
50 to 500	15,000 to 75,000	Moist to dry silty and sandy soils
500 to 1,000	30,000 to 100,000	Well-fractured to slightly-fractured bedrock with moist soil filled cracks
1,000	100,000	Sand and gravel with silt
1,000 to 8,000	100,000 to 300,000	Slightly fractured bedrock with dry soil filled cracks. Sand and gravel with layers of silt.
8,000 (plus)	300,000 (plus)	Massive bedded and hard bedrock. Coarse dry sand and gravel deposits.

TABLE 2 (CONT'D)

RESISTIVITIES OF UNCONSOLIDATED FORMATIONS (MOSTLY QUARTERNARY)

Formation	Locality	Investigator	t°	Freq.	Resistivity in ohm-cm 10^2	10^3	10^4	10^5	10^6	10^7
Marls										
Marl & gypsum	Germany	Schlumberger		16	3-	1.2				
Marl & gypsum	Algeria	"		16		1-3				
Jarnisy marls	Lorraine	"		16		5				
Marls	"	Geoffroy				7				
Clay										
Clays with Mg salts	Australia	Rooney		16	1-2					
Clay (wet)	Palestine	Lochnberg		D.C.	5—	4				
Boulder clay (no gravel)	Montana	Erdmann	10			2.1				
			20			2.8				
Marine clay	Ontario	Hawkins				3.6				
Dry clay	New Jersey	Feldman		40 mc.[a]		5.1				
Wet clay	" "	"				8				
Boulder clay (wet)	Montana	Erdmann	20				1.1			
Alluvium and Silt										
Alluvium (moist)	Montana	"	10			2.3				
Silt (dry)	"	"	5			2.0				
			10			1.3				
			20			1.4				
Glacial out-wash (dry)	Washington (state)	"	10				1.3			
" "	"	"	10				1.6			
" "	"	"	10				2.1			
Fluvio glacial till (wet)	"	"	20				8.4			
			40				5.7			
			60				4.9			
			100				3.9			
Glacial	Connecticut	Leonardon					5			
River gravel (wet)	Montana	Erdmann	10				1.2			
" " "	"	"	10				1.4			
Yellow river sand (3.3% moisture)		Sundberg					1.7			
Yellow river sand (0.86% moisture)		"					8.3			
Stream gravel (wet)	Montana	Erdmann	10				3.3			
			15				3.3			
			20				3.2			
River gravel (wet)	Colorado	"	10				4.8			
			10				6.5			
			10				4.8			
							8.9			

[a] mc. = megacycles = 10^6 cycles.

TABLE 3 RESISTIVITY SURVEY FIELD DATA

OPERATOR: D. Johanson

EQUIPMENT DESCRIPTION: Soiltest Incorporated Model ER-2, Earth Resistivity Meter

LOCATION OF SURVEY: Ardmore Area, Saanich Peninsula

TYPE OF ELECTRODE CONFIGURATION: Wenner

PROFILING SURVEY: Double Electrode Interval Traverse using 105 ft. and 52 ft. Electrode Spacing

LINE #1 **DATE: OCT. 4, 1980**

STATION NO.	SPACING	INST. DIAL READING	INST. MULT FACTOR	COMPUTED APPARENT RESISTIVITY IN OHM-FEET	COMMENTS
1	105ft.	850	.01	892.5	In front of tennis courts and line passes over a stave wire wound pipe and electric line. Reading on meter fairly stable.
	52ft.	1475	.01	774.4	Over time it drifted a little.
2	105ft.	490	.01	514.5	Reading a little insensitive.
	52ft.	470	.01	246.75	Reading a little insensitive.

LINE#1 Cont.

STATION NO.	SPACING	INST. DIAL READING	INST. MULT FACTOR	COMPUTED APPARENT RESISTIVITY IN OHM-FEET	COMMENTS
3	105ft.	890	.01	934.5	Very good null.
	52ft.	550	.01	288.75	Very good null.
4	105ft.	66	.1	693	Very good null at .1.
	52ft.	680	.01	357	Very good null.
5	105ft.	1183	.01	1242.15	Good null.
		600	.01	315	Good null.
					DATE: OCT. 9, 1980
6	105ft.	30	.1	315	In pasture about 40 ft. from wire fence. Good null.
	52ft.	53	.1	278.25	Good null.
7	105ft.	575	.01	422.6	Good null.
	52ft.	586	.01	307.65	Good null
8	105ft.	1271	.01	1334.5	Good null.
	52ft.	1420	.01	745.5	Good null.
9	105ft.	1461	.01	1534.05	Very good null.
	52ft.	1842	.01	967.05	Good null.

LINE # 1 Cont.

STATION No.	SPACING	INST. DIAL READING	INST. MULT FACTOR	COMPUTED APPARENT RESISTIVITY IN OHM-FEET	COMMENTS
10	105ft.	524	.01	550.2	Good null.
	52ft.	602	.01	316.05	Good null.
11	105ft.	290	.1	3045.	Good null.
	52ft.	390	.1	2047.5	Good null.
12	105ft.	2475	.01	2598.75	Good null.
	52ft.	2747	.01	1442.17	Good null.
13	105ft.	1330	.01	1396.5	Good null.
	52ft.	888	.01	466.2	Hard to repeat readings.

LINE #2

OCT. 11, 1980

1	105ft.	325	.01	341.25	Some drifting.
	52ft.	384	.01	201.6	Good null.
2	105ft.	318	.01	333.9	Good null.
	52ft.	819	.01	429.97	Good null.
3	105ft.	700	.01	735.	Good null.
	52ft.	568	.01	298.2	Good null.
4	105ft.	587	.01	616.35	Good null.

LINE #2 Cont.

STATION NO.	SPACING	INST.DIAL READING	INST. MULT FACTOR	COMPUTED APPARENT RESISTIVITY IN OHM-FEET	COMMENTS
4	52ft.	768	.01	403.2	Good null (slight drifting)
5	105ft.	838	.01	879,9	Good null (Began to rain).
	52ft.	663	.01	348.07	Good null.

43

Province of British Columbia

Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: J.C. Foweraker, Head
Groundwater Section
Water Management Branch

Date: April 29, 1985

Our File: 92 B/11

Re: Resistivity Survey Ardmore Area, North Saanich

Please find attached a report completed for Geography.476 at the University of Victoria in the fall of 1980, entitled "Double Electrode Resistivity Survey Ardmore Area, North Saanich."

It draws much of its data from my report "Hydrogeology of Ardmore Area, North Saanich" and was initially to be incorporated into that report.

This copy of the report was prepared for the Groundwater Section N.T.S. file and I hope it is found to be of interest.

Dave Johanson
Technician
Groundwater Section
Water Management Branch
387-1115

DJ/dma
Attach.

(1) Mr. Kohut
You will be interested in this!
(2) Mr. Yakel Z. (interesting survey!)
(3) file
Mike MW
JF. 2/5/85

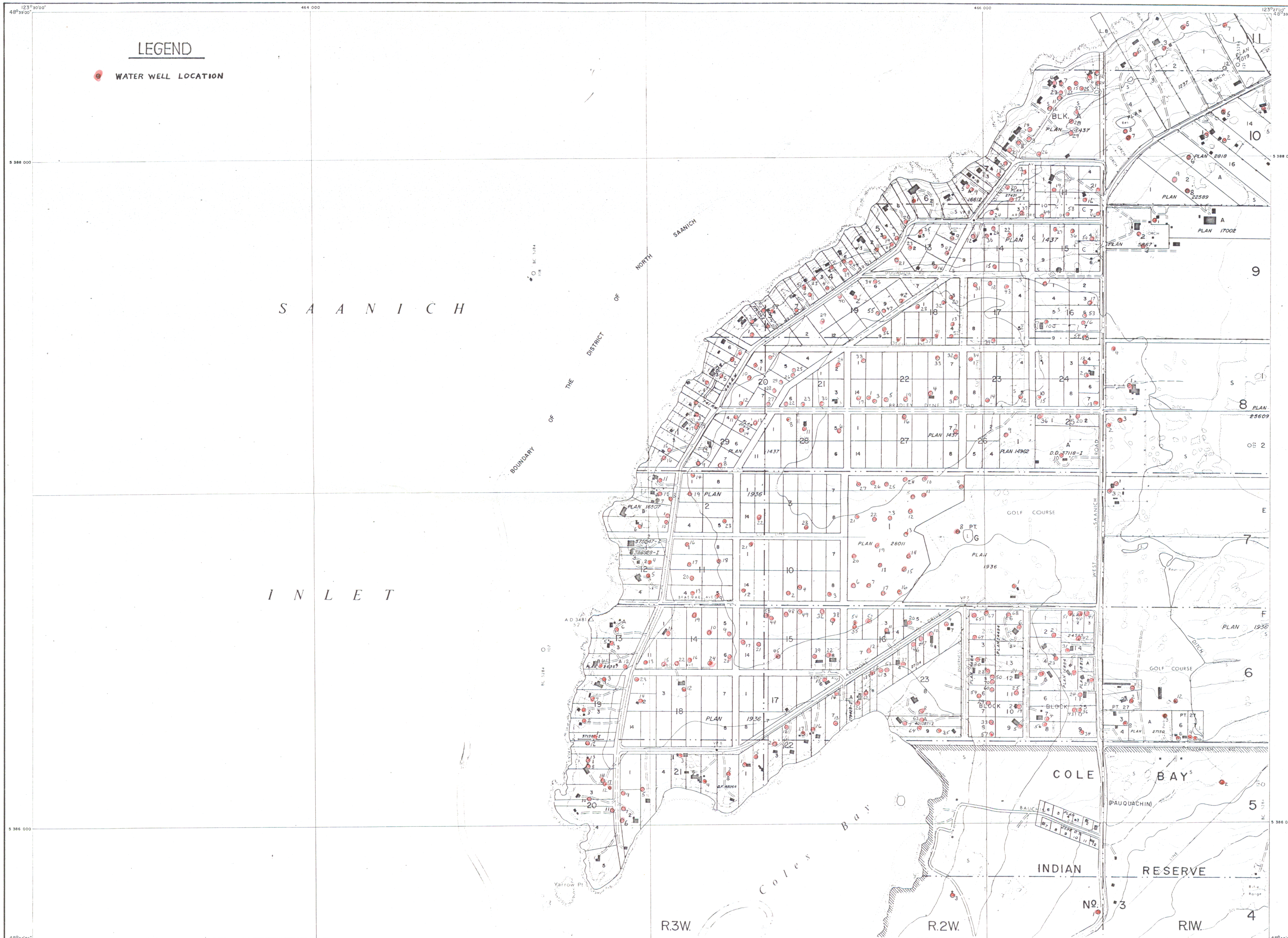
W-372

SCALE
Metres 100 0 100 200 300 400 500 Metres
Feet 400 0 400 800 1200 Feet

FIG.5 ISOPACHS OF SURFICIAL DEPOSITS
ARDMORE GROUNDWATER STUDY

92B·063·2·3

WESTERN PART OF:
92B·063·2·4



SURVEYS AND MAPPING BRANCH B. C. LANDS SERVICE, VICTORIA B. C. DEPARTMENT OF ENVIRONMENT.	U.T.M. GRID ZONE 10 (1975) BASE CONTROLLED PHOTOGRAMMETRIC SEE INDEX FOR ADDITIONAL INFORMATION	LATEST PLAN: 28011 REVISION DATE: OCT 20, 1975	FIGURE 6 WELL LOCATION MAP ARDMORE GROUNDWATER STUDY	SCALE – 1:5000	CADASTRAL 92 B · 063 · 2 · 3

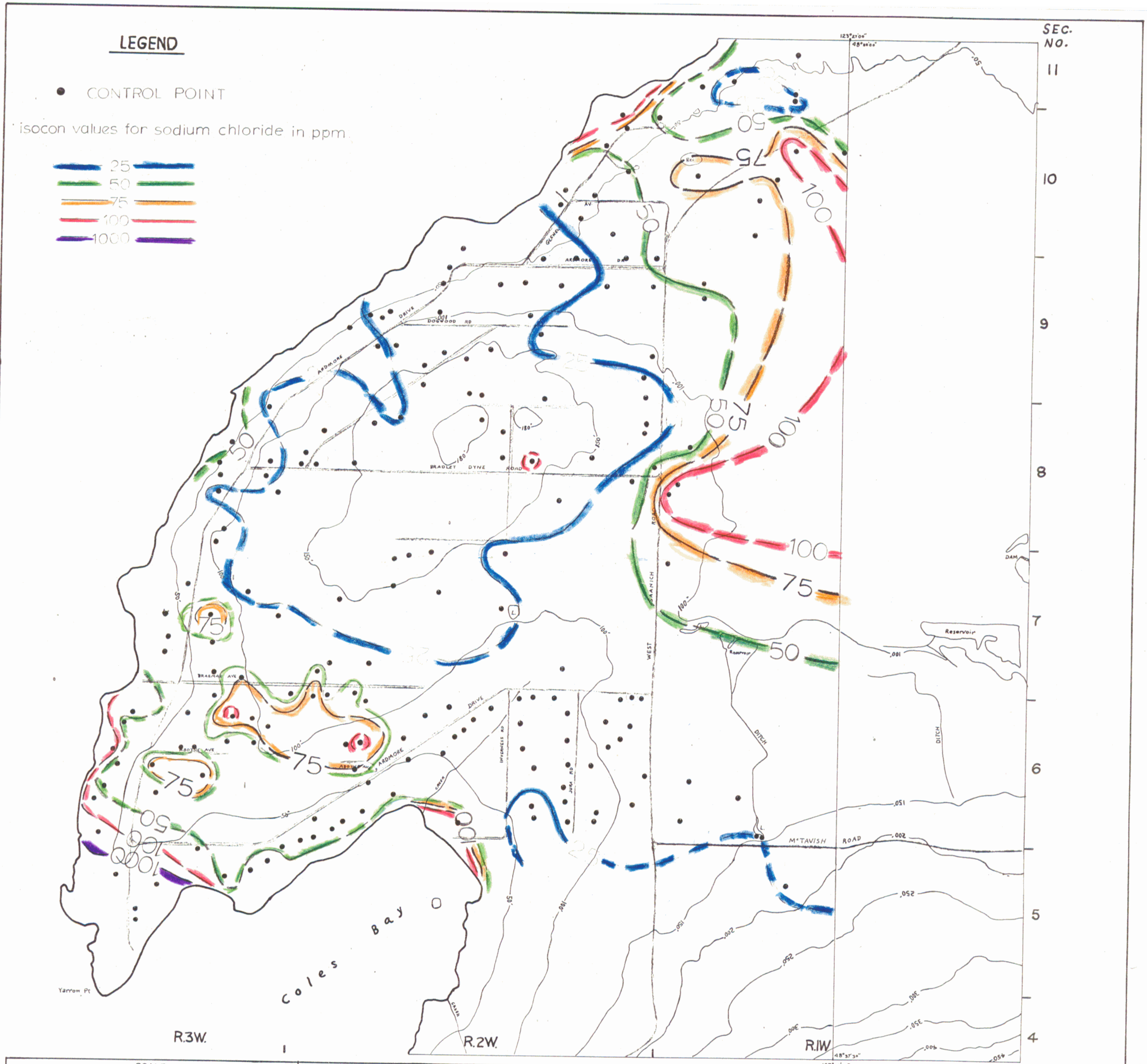


FIG. 13 SODIUM CHLORIDE ISOCON MAP

ARDMORE GROUNDWATER STUDY

92B·063·2·3

WESTERN PART OF: 92B·063·2·4

DATE DEC. 1980

D. JOHANSON TECHNICIAN

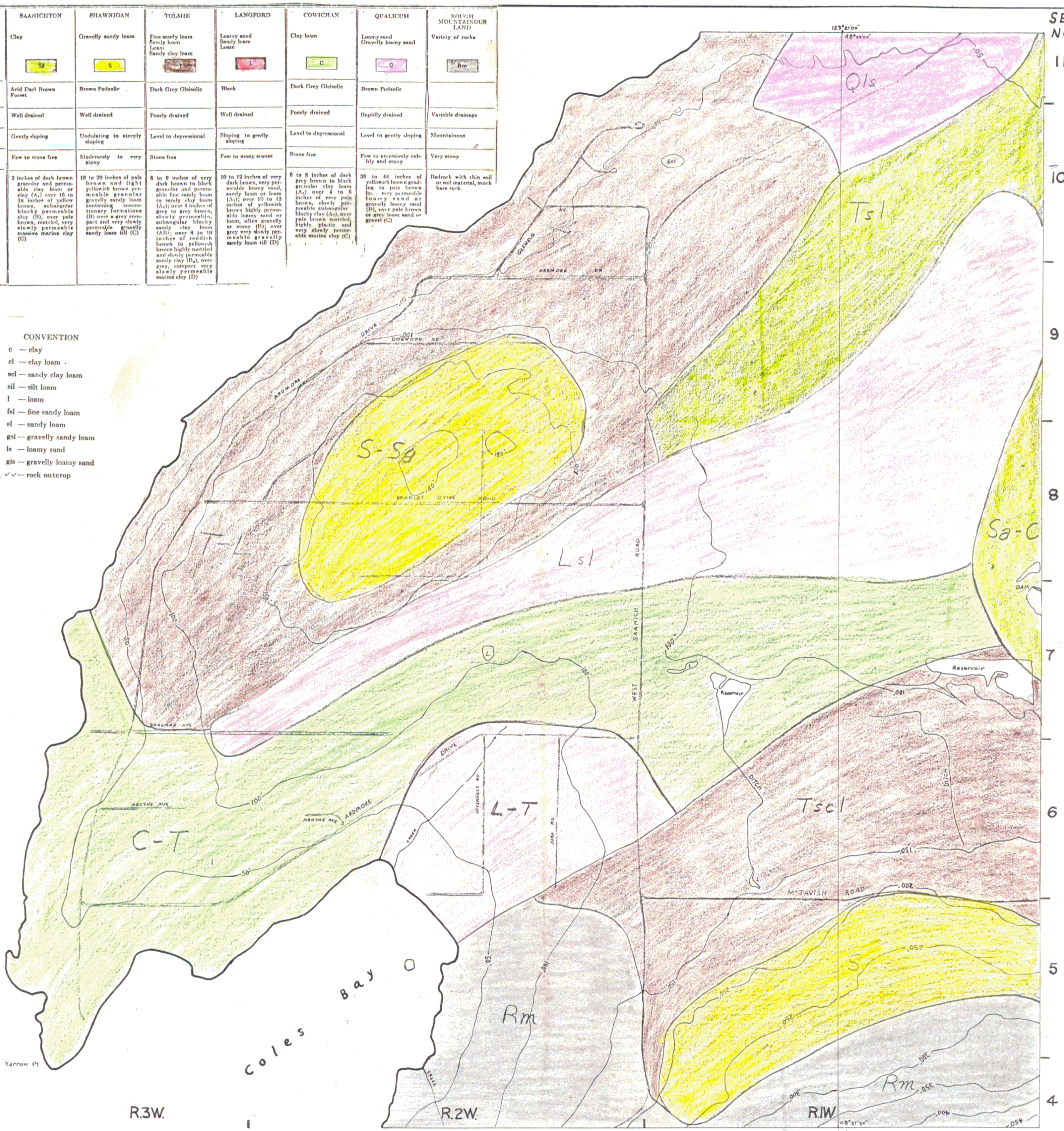
Ministry of the Environment

LEGEND

SERIES	SAANICHTON	SHAWNIGAN	TOLMIE	LANGFORD	COWICHAN	QUALICUM	ROUGH MOUNTAINOUS LAND
TYPE AND SYMBOL	Clay Sa	Gravelly sandy loam S	Fine sandy loam Sandy loam Loam Sandy clay loam T	Loamy sand Sandy loam Loam L	Clay loam C	Loamy sand Gravelly loamy sand Q	Variety of rocks Rm
SOIL GROUP	Acid Dark Brown Forest	Brown Podzolic	Dark Grey Gleisolic	Black	Dark Grey Gleisolic	Brown Podzolic	
DRAINAGE	Well drained	Well drained	Poorly drained	Well drained	Poorly drained	Rapidly drained	Variable drainage
DOMINANT TOPOGRAPHY	Gently sloping	Undulating to steeply sloping	Level to depressional	Sloping to gently sloping	Level to depressional	Level to gently sloping	Mountainous
STONINESS	Few to stone free	Moderately to very stony	Stone free	Few to many stones	Stone free	Few to excessively cobbly and stony	Very stony
DESCRIPTION OF VIRGIN SOIL	2 inches of dark brown granular and permeable clay loam or clay (A_1) over 16 to 18 inches of yellow brown, subangular blocky permeable clay (B), over pale brown, mottled, very slowly permeable massive marine clay (C)	18 to 20 inches of pale brown and light yellowish brown permeable granular gravelly sandy loam containing concretionary formations (B) over a grey compact and very slowly permeable gravelly sandy loam till (C)	6 to 9 inches of very dark brown to black granular and permeable fine sandy loam to sandy clay loam (A_1); over 4 inches of grey to grey brown, slowly permeable, subangular blocky sandy clay loam (AB); over 8 to 10 inches of reddish brown to yellowish brown highly mottled and slowly permeable sandy clay (B_2), over grey, compact very slowly permeable marine clay (D)	10 to 12 inches of very dark brown, very permeable loamy sand, sandy loam or loam (A_1); over 10 to 12 inches of yellowish brown highly permeable loamy sand or loam, often gravelly or stony (B); over grey very slowly permeable gravelly sandy loam till (D)	6 to 8 inches of dark grey brown to black granular clay loam (A_1) over 4 to 6 inches of very pale brown, slowly permeable subangular blocky clay (A_2), over pale brown mottled, highly plastic and very slowly permeable marine clay (C)	36 to 44 inches of yellowish brown grading to pale brown loose very permeable loamy sand or gravelly loamy sand (B), over pale brown or grey loose sand or gravel (C)	Bedrock with thin soil or soil material, much bare rock.

CONVENTION

- c — clay
- cl — clay loam
- scl — sandy clay loam
- sil — silt loam
- l — loam
- fsl — fine sandy loam
- sl — sandy loam
- gsl — gravelly sandy loam
- ls — loamy sand
- gls — gravelly loamy sand
- ✓✓— rock outcrop



SCALE	FIG. 3 SOIL MAP ARDMORE GROUNDWATER STUDY	92B·063·2·3	WESTERN PART OF: 92B·063·2·4	File No. ____ Dwg. No. ____ Date ____ D. Johanson Technician Ministry of the Environment
Metres 100 0 100 200 300 400 500 Metres Feet 400 0 400 800 1200 Feet				