GROUNDWATER SURVEY FOR THREE BROOKS PICTOU COUNTY NOVA SCOTIA

PROVINCE OF NOVA SCOTIA
DEPARTMENT OF THE ENVIRONMENT

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WATER PLANNING AND MANAGEMENT DIVISION
PRELIMINARY REPORT

GROUNDWATER SURVEY FOR THREE BROOKS PICTOU COUNTY NOVA SCOTIA

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GROUNDWATER SURVEY FOR THE THREE BROOKS AREA, PICTOU COUNTY NOVA SCOTIA

A B S T R A C T

Sand and gravel deposits covering a small area have been delineated in the Three Brooks community. Test drilling and pumping on such a deposit located at the MacCarthy property indicate an excellent potential for high yields. The quality of the water from these deposits is generally good and they could be used for water supplies.

Several of the residents obtain their water supply from shallow, dug wells constructed in till. Most of these wells are subject to surface contamination and, in periods of prolonged drought, often fail to provide adequate yields for domestic supplies. The proper construction of dug wells in areas of sandy till and sand and gravel deposits should improve this situation.

The groundwater from bedrock aquifers such as shale, siltstone and sandstone located east of Highway 106, is of poor quality due to the occurrence of excessive amounts of chloride salts. Those located west of Highway 106, however, contain water of suitable quality. Although groundwater potential from bedrock aquifers for a large supply is small, sufficient volume is available for domestic purposes.

I N T R O D U C T I O N

PURPOSE AND SCOPE OF THE INVESTIGATION

The residents of the Three Brooks area have been experiencing unusually high chloride concentrations in their well water supply systems. In response to this problem, the Nova Scotia Department of the Environment initiated a hydrogeological study during 1974 and 1975. The primary purpose of the study was to determine the areal extent and seriousness of the chloride problem, and to evaluate the quality and quantity of the groundwater resources in the Three Brooks area. A water quality survey provided basic information on the groundwater chemistry of the bedrock and surficial aquifers. A comprehensive test drilling and pump testing program was used to assist in the geochemical interpretation, and in the location and evaluation of potential aquifers for use as an alternative groundwater supply.

LOCATION

The Three Brooks area is located in the northwestern section of Pictou County, on the westernmost extent of the Caribou Peninsula. The Three Brooks community is situated four miles northwest of the Town of Pictou along Highway 6 (Map 1 in pocket). The map area is included in the northeast portion of the New Glasgow map sheet 11-E-10 west half and 11-E-10 east half.

CLIMATE

The mean annual precipitation for Pictou is about 42.0 inches based on 30 years (1940-1970) of records. About 37 percent of this falls during the growing season. Total mean annual precipitation consists of 31.9 inches of rain and 80.9 inches of snow (Hennigar, 1968, p.3).

The mean annual temperatures range from a low of

-11.1°C in February to a high of 23.9°C in July. The overall mean temperature for Pictou is 6.1°C. The growing season in this area ranges from 180 to 190 days and the frost-free period from 100 to 120 days (Hennigar, 1968, p.3).

DRAINAGE AND PHYSIOGRAPHY

A watershed area of approximately eight square miles is drained by a brook system known as Three Brooks (Map 1). The central and largest of the three brooks is called Sheriff Brook, while the remaining two are unnamed. All three brooks run from the west-southwest to east-northeast and empty into Caribou Harbour. High tides reach inland to a point 1200 feet north of the Three Brooks Road and cross the MacKenzie Road, 0.6 mile north of the MacKenzie Road-Three Brooks Junction (Map 1). Topographic elevation ranges from a high of 250 feet in the western extent of the drainage area, to sea level in the east, along the Caribou Harbour.

G E O L O G Y

STRUCTURAL GEOLOGY

The structural trend of northwestern Pictou County is east northeast to northeast, which conforms with the trend of the northeastern Appalachian geosyncline and orogenic belt. A broad northeast plunging Scotsburn anticline and a number of high angle faults are the main structural elements of the map area (Map 1).

Dips on the limb of the Scotsburn anticline range from 25° to 55° to the southeast and from 20° to vertical and slightly overturned to the north. To the northeast, the structure plunges under the Northumberland Strait (Gillis, 1964, P. 96).

The Three Brooks area lies on the northern limb of the Scotsburn anticline. The Pictou-Riversdale contact lies north of the Three Brooks road striking southeast and crossing the Three Brooks road, approximately two miles east of the Three Brooks-Route 6 Juncion. The strata of the Riversdale Group strike east-southeast and dip 13° to 18° north-northeast. The overlying Pictou Group sediments strike easterly and dip approximately 8° north-northeast.

LITHOLOGY AND STRATIGRAPHY

In the northwestern Pictou County area the Boss Point Formation conformably overlies the Millsville conglomerate both of the Riversdale Group. The Boss Point-Millsville contact is transitional with the conglomerates of the Millsville grading upward into the sandstones of the Boss Point Formation. Angular discordances occur between the moderately-dipping sandstones and siltstones of the

Riversdale Group and the overlying low-dipping basal pebble conglomerate of the Pictou Group (Gillis, 1964, p. 53-57).

Detailed stratigraphical logs were prepared for the Three Brooks area based on continuous sampling of drill cuttings over five foot intervals and E-log records of two test wells. Graphical representation of detailed logs are shown in Figure 1 (in pocket).

Of a total of 888 feet of bedrock drilled, shale comprised 63% of the vertical section, siltstone 19% and sandstone 18%. Specifically, dark brown, red-brown and minor amounts of green, slightly calcarious, brittle to muddy textured shale predominated. Brown, red-brown and green interbedded sandstone and siltstone composed the remaining bedrock constituents. Individual layers ranged from a few inches to several feet in thickness.

Hydrocarbons and fossiliferous carbonaceous material was evident at various depths in the stratigraphic column.

E-log records of well #6 indicate a marked change in resitivity values at a depth of approximately 215 feet. The lower resitivity values between 215 feet and 410 feet coincide with a change in bedrock conditions from inter-bedded shales, siltstones and sandstones to mainly shales. More likely, however, the low resitivities are due to a change in water chemistry from a fresh or brackish water to a highly saline water, lower in the water column. This is discussed in a later section of this report.

Drill cuttings of the test wells indicate a bedrock type similar to the primary constituents of the Boss Point Formation of Riversdale Group. However, detailed petrological studies were not conducted on the cutting samples, nor was any of the fossiliferous material dated. Therefore, it is not known whether or not drilling operations have actually penetrated any bedrock constituent belonging to a sedimentary group other than Riversdale, i.e., Windsor Formation. There was no evidence in the drill cuttings to suggest the presence of salt deposits within the limits of the drill holes.

The presence of trace amounts of gypsum stringers are probably a result of groundwater dissolution, along fracture or bedding planes.

SURFICIAL DEPOSITS

Detailed well logs indicate the surficial deposits at the Three Brooks area consist of sandy till, silty till, clay till and stratified sand and gravel deposits, with an overall thickness ranging from 22 to 167 feet. Of a total of 376 feet of overburden drilled, 51% of the vertical section consisted of a silty till having varying amounts of cobbles and pebbles set in a compact, brown, silt and clay matrix. Sandy till comprised 25% and consisted of a mixture of fine gravel and red-brown, loosely consolidated sand and silt matrix. Clay till, encountered in test hole #3, accounted for 5.3% and consisted of a 20-foot thick compact mixture of boulders, cobbles and pebbles in a red-brown clay matrix.

Stratified sand and gravel deposits 1.5 to 30 feet thick, generally occur at 8 to 45 feet below ground surface. These deposits were found overlying bedrock in test wells

#4, 5 and 6. The extent of the sand and gravel deposits are not known, however, the presence of these deposits in well logs #3, 6, 18 and 22 (Table 1) and in test holes #1, 4, 5 and 6, suggest they occur throughout the area. The absence of these deposits in test holes #2 and 3, suggest these deposits are not laterally continuous.

HYDROLOGY

WELL INFORMATION

Records of 26 drilled and 6 dug wells have been compiled and verified for reference (Table 1). The drilled wells are set in shale and sandstone to depths ranging from 82 feet to 265 feet. Well yields are reported to range from 2.5 to 10 igpm with water levels averaging 20 feet below ground surface. Casing lengths vary from 28 feet to 85 feet. The dug wells are assumed to be set in the overburden; however, it is possible that some of them may be bottomed in bedrock. They range in depth from 18.5 feet to 24 feet and are rocked to the surface with the exception of well #34 which is tiled to the surface. Well yields may be classified qualitatively as adequate or inadequate based on information obtained from the well owners.

The dug wells that are reported to go dry during the summer months are assumed to have a lower yield relative to those dug wells that maintain an adequate supply year-round. However, well depth and construction details are probably the major contributing factors (Table 1). Low yields suggest that wells #1, 4 and 28 are set in a silty till, whereas those wells with high yields (#39 and 8) are probably set in a sandy till.

During detailed hydrogeological investigations of the Three Brooks area, six test wells were drilled by the Nova Scotia Department of the Environment (Map 1, Figure 1, Table 2). Of these, five were drilled into bedrock and one drilled into sand and gravel deposits within the overburden. The well depths range from 64 to 410 feet below ground surface with casing lengths ranging from 52-300 feet below ground surface. Well yields range from less than 0.5 to 5 igpm with water levels varying from 11 to 32 feet below surface. Further water level monitoring programs are being conducted. However, for the purpose of this report, the data is not included.

PUMP TESTS

Three short 10-hour pump tests were conducted on test wells #2, 4 and 5. Step drawdown tests were conducted prior to each pump test. The purpose of the pump tests were (1) to approximate the safe yield of the wells, (2) to observe water chemistry response to pumping stress and (3) to examine the relationships between groundwaters within bedrock and overburden aquifers. The test data are shown in Tables 3, 4 and 5. Graphical representation and interpretation of the test analyses are given in figures 2, 3 and 4 and the results are listed in Table 6. The coefficient of transmissibility of 15.1 igpd/ft in test well #4 and 44.7 igpm/ft in test well #2, indicate that the deep bedrock wells should yield between 1 and 2 igpm for 20 years of continuous pumping. Due to minor technical problems, interpretation of the drawdown curve for pump test #2, well #5, is difficult. The determined 20 years safe yield of 0.3 igpm should be considered conservative, due to the fact that the well reached equilibrium after only 210 minutes of pumping at a rate of 0.5 igpm. The sand and gravel aquifer was developed by a high pressure air jet for approximately 4 hours. It is expected that further development of this aquifer over a long period, perhaps 24 hours, will increase the present well yield to as much as 5 igpm.

SALT SOURCES

Extensive folding, faulting and fracturing of the bedrock during the formation of the Scotsburn Anticline may have provided a mechanism for salt water intrusion to occur in the underlying bedrock of the Three Brooks area.

According to the Ghyben-Herzberg coastal aquifer relation, the water table and/or piezometric surface (a) must be above sea level and (b) slope downward toward the ocean. Without these conditions, sea water will advance directly inland. Given conditions (a) and (b), the fresh/salt water interface occurs at approximately 40 times the height of the fresh water above sea level (Todd, 1959).

Preliminary information indicates that the piezometric surface in the Three Brooks area lies approximately 50 feet above the mean sea level and slopes toward the ocean. This suggests the salt/fresh water interface, if present, lies at a depth in excess of 1,500 feet.

Gillis (1964) suggests that the Windsor Group sediments appear to be in fault contact with the Boss Point Formation of Riversdale Group sediments in the northern part of Pictou County. The depths at which the contacts lie are not known. It is possible that saline water originating from Windsor bedrock has penetrated Riversdale sediments by fault contact, fractures, solution, salt diapir development or by some other mechanism. In addition, it is also possible that Riversdale Group sediments may contain salts.

C H E M I S T R Y

The chemical analyses indicate that of 26 domestic, drilled wells sampled during the survey, 10 have chloride concentrations greater than 250 mg/l. Of the remaining 16, 10 have chloride concentrations greater than an assumed background level of 60 mg/l. Of the six test wells, chemical analyses indicate that with the exception of test well #5, all have concentrations of chloride exceeding 250 mg/l (Table 8) the acceptable limit suggested in the Canadian Drinking Water Standards and Objectives, 1968. Interpretation of water samples taken from the dug wells was complicated and difficult due to interference from highway salts, animal wastes and stagnant water conditions. The location and reference numbers of these samples are shown in Map 1.

Tables 7, 8 and 9 summarize the chemical concentrations for the major ions for all the sample analysis in both mg/l and meq/l. The data indicates that the major portion of chlorides are associated with sodium. The remaining chloride is closely associated with calcium and magnesium.

Test drilling results indicate that there is an increase with depth of all major ions, with the exception of alkalinity. Alkalinity decreases slightly with increasing depth. Figures 5 to 9 (in pocket) show a plot of the major ion concentrations expressed in meq/l, versus well depth in test wells #1, 2, 3, 4 and 6. These graphs suggest the presence of NaCl, $CaCl_2$ and $MgCl_2$ with the major salt being NaCl.

The fact that chloride concentrations increase with increasing depth suggest that the salts are derived from a source within the bedrock and not from a surface source such as road salt. Additionally, test well #3 (maximum chloride concentration 2520 mg/l) is at least 1100 feet from highway #6 and 850 feet from the Three Brooks Road, the nearest source of highway salt. It is unlikely that road salt from these highways would travel such long distances to affect this well.

Test well #5 penetrated sand and gravel deposits between 48 and 64 feet below surface. Chemical analyses (Table 9) of groundwater contained in the sand and gravel indicated an average chloride concentration of 120 mg/l. The average concentrations of iron (0.6 mg/l), manganese (1.0 mg/l), colour (25 TCU) and turbidity (15 JTU), have slightly exceeded the recommended limits of 0.3 mg/l for iron, 0.05 mg/l for manganese, 15 TCU for colour and 5 JTU for turbidity in the Canadian Drinking Water Standards and Objectives, 1968. The high colour is probably associated with the excess iron and manganese in the groundwater. Excess turbidity may be associated with the inorganic suspended material. With minor treatment, the water contained in the sand and gravel deposits can be brought to within the acceptable limits outlined in the above-mentioned standards, and therefore, made suitable for human consumption.

The sandy till in front of Mr. L. MacCarthy's residence provides groundwater of sufficient quality to permit the development of a domestic water supply which will at least provide sufficient quanity for drinking and cooking. The water is of good chemical quality, suitable for drinking purposes (Table 7, #38).

Trilinear plots (after Piper, 1944) of the water analyses are given in figures 10 and 11. In these diagrams, the major cations in groundwater (calcium, magnesium and sodium plus potassium) are given as per cents of total meq/l in one triangular field; in the other, the major anions (carbonate plus bicarbonate, chloride and sulphate) are given as per cents of total meq/l; and the combined chemistry is plotted in the diamond-shaped field (Trescott, 1968).

Figure 10 represents the trilinear plot of the water chemistry of those samples taken from the domestic drilled and dug wells. The plot indicates a marked difference in water types between those wells located west of highway 106 and those located east of it. The wells west of the highway exhibit a groundwater similar to that of a freshwater type as opposed to that of a saline type east of the highway.

Figure 11 represents a trilinear plot of the water chemistry of those samples taken during the pump tests conducted on test wells #2, 4 and 5. The chloride concentration in test well #4 remained relatively constant throughout the test, decreasing only slightly from a high of 4130 mg/l at 0 minutes to 3880 mg/l at 600 minutes. The water is classified as one having "primary salinity" (after Palmer, 1911).

Chloride concentrations in test well #2 varied from a high of 1250 mg/l at 0 minutes decreasing to a low of 186 mg/l at 600 minutes. This substantial change in chloride concentrations suggests a mixing of two or more groundwater types, one characterized by primary salinity, the other by primary alkalinity.

It is apparent that the fresh water is higher in the stratigraphic column than the saline water. Since the pump was set at a depth of 180 feet below ground surface the first samples at 0 and 5 minutes were drawn from this depth range. With increasing drawdown, the fresh water higher in the water column was drawn toward the intake. It must be considered, however, that density stratification in the well may have taken place. Further to this, however, the results of chemical analyses of water samples taken during drilling operations, indicated an increase in chloride concentrations with increasing depth. At no time was there an opportunity for stratification to occur within the water column in the well during drilling operations, adding support to the conclusion that fresh water lies higher in the stratigraphic column.

The change in chemical composition further implies that test well #2 has penetrated both fresh and saline groundwater aquifers or that dilution, dispersion and/or density stratification of the water column has occurred throughout the bedrock and that separate confined aquifers are not present. The decrease in chloride concentration with decreasing depth probably reflects processes of upward dispersion and dilution effects from near surface, local fresh water flows.

Analytical results of the pump test samples of test well #5 indicate a consistant chemical composition characterized by primary alkalinity with strong salinity influence. The average chloride concentration of 120 mg/l is higher than the assumed background levels (Trescott, 1968, P. 151). However, it is relatively low in comparison to bedrock groundwaters. The presence of high chlorides suggests that some mixing between the water contained within the sands and gravels and that within the bedrock has taken place.

Analyses of groundwater samples collected in zones of sea water intrusion may show a chemical composition differing from a simple proportional mixing of sea water and groundwater. Modifications in composition of sea water entering an aquifer can occur due to (a) base exchange between the water and the minerals of the aquifer (b) sulphate reduction and substitution of carbonic or other weak acid radicals, and (c) solution and precipitation (Todd, 1959).

Revells (1941) recommended the chloride bicarbonate ratio as the criterion to evaluate sea water intrusion. It was indicated that the chloride-bicarbonate ratio, as well as the total salinity will increase as the source of the chloride, in this case, the coast, is approached.

Similar results were obtained from analyses done of groundwater sampled from selected wells in the Three Brooks area. Table 10 indicates an increase in the chloride/(carbonate + bicarbonate) ratio and total salinity (as NaCl) as the coastline along Caribou Harbour is approached. Well depth considerations were not taken into account, however, the depth range varies only slightly from 90 to 125 feet. The pattern of increase is not entirely true for all wells in the Three Brooks area. For example, well #29 has a $Cl/(CO_3 + HCO_3)$ ratio of 3.4; however, there is generally an increase in this ratio from west to east. There is significant increase in the

$Cl/(CO_3 + HCO_3)$ ratio and total salinity between those drilled wells located west of highway 6 relative to those located east of the highway. The increase in salinity toward the coast suggests that the source of the salts is a result of salt water intrusion of the bedrock. However, an examination of the $Cl/(CO_3 + HCO_3)$ ratio with increasing depth in test well #6, is shown in Table 11. It can be seen that the $Cl/(CO_3 + HCO_3)$ ratio and total salinity increases rapidly with increasing depth. The high ratios of sample #5 - 7 suggest the source of the saline water is at a relatively shallow depth. From this it can be concluded that deep wells drilled west of highway 6 may possibly encounter saline groundwater.

Primarily, high concentrations of salts in bedrock groundwater in Nova Scotia are often associated with Windsor sediments. Groundwater within these sediments is known to contain salts of NaCl, $CaCl_2$ and $CaSO_4$ and alkalinities are generally high. In other areas of the Province in which Windsor bedrock is predominant, sulphates (SO_4) are often present in anomalous concentrations (Trescott, 1968, P. 82). Chemical data in tables 8 and 9 indicate an absence of SO_4 and alkalinities are generally low, possibly a situation more characteristic of salt water intruded bedrock. The occurrence of hydrocarbons and fossiliferous carbonaceous material is indicative of a strong reducing environment. It is possible then, that sulphates have been reduced. Also, their concentrations may have been diluted by fresh groundwater moving through a formation salt source. Therefore, it is likely that the saline characteristics of the groundwater of the Three Brooks area is due to the presence of salt deposits within the Riversdale or Windsor sediments and not a result of salt water intrusion of the bedrock. To arrive at definite proof, further studies are necessary.

C O N C L U S I O N

1. Groundwater aquifers in the underlying bedrock in the Three Brooks area contain high concentrations of dissolved chloride salts. Chemical analyses indicate that of 26 domestic drilled wells sampled, 10 have chloride concentrations greater than 250 mg/l. Of the remaining 16, 10 have chloride concentrations greater than assumed background levels.

2. Analyses show that where chloride values are high, sodium concentrations are correspondingly high. Therefore, the greater part of the chlorides are associated with sodium. The remaining chloride is associated with calcium and magnesium.

3. Chemical analyses of water samples taken during test drilling operations indicate that chloride concentrations increase with depth. This suggests that the salt is not likely derived from a surface source such as highway de-icing salt. Also, the high chloride concentrations in test well #6, suggest the source of salts may be at a relatively shallow depth.

4. With minor treatment, the water contained in the sand and gravel aquifers can be brought to within the acceptable limits outlined in the Canadian Drinking Water Standards and Objectives, 1968.

5. The sandy till in front of Mr. L. MacCarthy's residence provides groundwater of sufficient quality to permit the development of a domestic water supply which will at least provide sufficient quantity for drinking and cooking. The water is of good chemical quality,

suitable for drinking purposes (Table 7, #38).

6. Drilled wells located to the west of highway 106 indicate a water similar to that of an alkaline type and are relatively free of excessive chloride concentrations.

7. Pump test results indicate that the coefficient of transmissibility of the bedrock aquifer ranges from 15.1 igpd/ft to 44.7 igpd/ft. It is expected that bedrock wells in the order of 100 to 150 feet in depth should yield between 1 and 2 igpm for 20 years of continuous pumping. With proper development the sand and gravel deposits are expected to yield at least 5 igpm.

8. Available information suggests that there are two possible sources of saline water in the bedrock aquifers of the area:

(1) salt deposits contained within the underlying bedrock, and

(2) salt water intrusion of the bedrock.

Sodium chloride is probably derived from a salt bed within the Boss Point Formation, or from the underlying deposits within the Millsville Formation, both of the Riversdale Group. However, the salts within the Riversdale Group may originate from a deeper source such as the underlying salt formations related to Windsor Group. Fault contact with underlying Windsor sediments is another possibility. However, the chemical data suggests the absence of typical Windsor sediments due to the lack of sulphates (SO_4) and low alkalinity.

R E C O M M E N D A T I O N S

1. Future domestic groundwater supplies for the Three Brooks Community should be obtained from the following groundwater reserves:

   (a) sand and gravel deposits contained in the overburden;

   (b) sandy till exposed at or near ground surface;

   (c) the bedrock aquifers situated west of highway 106.

2. This could be best achieved by:

   (a) the proper construction and development of a screened well drilled into the underlying saturated sand and gravel deposits contained in the overburden;

   (b) the proper construction of a dug well in a suitable location, preferably away from the Three Brooks Road and other possible sources of contamination, such as a septic field and agricultural wastes. The sandy till is better suited for dug well construction, due to the higher yield of this material;

   (c) the proper construction of a bedrock well located west of highway 106 and drilled to a depth not to exceed 150 feet below ground surface.

3. The Municipal Planning Board of the County of Pictou should restrict future rural development along that

portion of the Three Brooks Road outlined in the study area, unless suitable resources can be located and properly developed. Future development in this area depends upon the availability of suitable groundwater reserves.

4. The Nova Scotia Department of the Environment, Water Planning and Management Division, should carry out further hydrogeological investigations into occurrence of groundwater with high salt concentrations. Results from such studies carry economic, mineralogical and hydrogeological implications and enable the Department to further develop and document an important groundwater phenomenon.

A C K N O W L E D G E M E N T S

On behalf of the Nova Scotia Department of the Environment, I would like to express my thanks to the residents of the Three Brooks Community for their kind co-operation and assistance during the survey period.

Assistance in field operations was provided by Heather J. Cross and Michael E. Rushton of the Nova Scotia Department of the Environment; drafting illustrations were prepared by Donald O. Hirtle also of the Nova Scotia Department of the Environment.

This paper was critically reviewed by Dr. C.L. Lin, P.Eng., of the Nova Scotia Department of the Environment and Mr. Ross F. McCurdy of the Nova Scotia Department of Health.

C O N V E R S I O N   F A C T O R S

A N D   S Y M B O L S

1 inch (in)	-	0.254 metres (m)
	-	2.540 centimetres (cm)
	-	25.40 millimetres (mm)
1 foot (ft) - 12 in	-	3.048 m
	-	30.48 cm
	-	304.8 mm
1 mile - 5280 ft	-	1.609 kilometres (km)
1 square mile ($mile^2$)	-	2.390 square kilometres (km^2)
1 acre - 43,560 ft^2	-	4.047×10^3 square metres (m^2)
1 cubic foot (ft^3)	-	0.02832 cubic metres (m^3)
-7.4805 U.S. Gallons(g)	-	28.317 litres (ℓ)
-6.233 imperial gallon (ig)	-	28,317 cubic centimetres (cm^3)
1 imperial gallon (ig) - 1.2 U.S. gallon (g)	-	0.00454 cubic metre (m^3)
	-	4.5425 litres (ℓ)
	-	4542.5 cubic centimetres (cm^3)
1 imperial gallon per minute (igpm) - 1.2 U.S. gallons per minute (gpm)	-	4.5425 litres per minute (ℓ/m)
1 cubic foot per minute (ft^3/min)	-	0.472 litre per second (ℓ/sec)
1 cubic foot per second (ft^3/sec or cfs)	-	28.3 litres per second (ℓ/sec)
1 imperial gallon per day per foot (igpd/ft)	-	0.0149 m^2day
1 imperial gallon per day per square foot (igpd/ft^2)		0.0488 m/day
1 pound per square inch (lb/in^2 or psi)	-	0.0703 kg/cm^2
1 pound per square foot (lb/ft^2 or psf)	-	4.882 kg/m^2
1 pound per cubic foot (lb/ft^3 or pcf)	-	16.02 kg/m^3

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APPENDIX A

FIGURES 2, 3, 4, 10, 11

FIGURE 2 PUMP TEST #1 THREE BROOKS TEST WELL #4

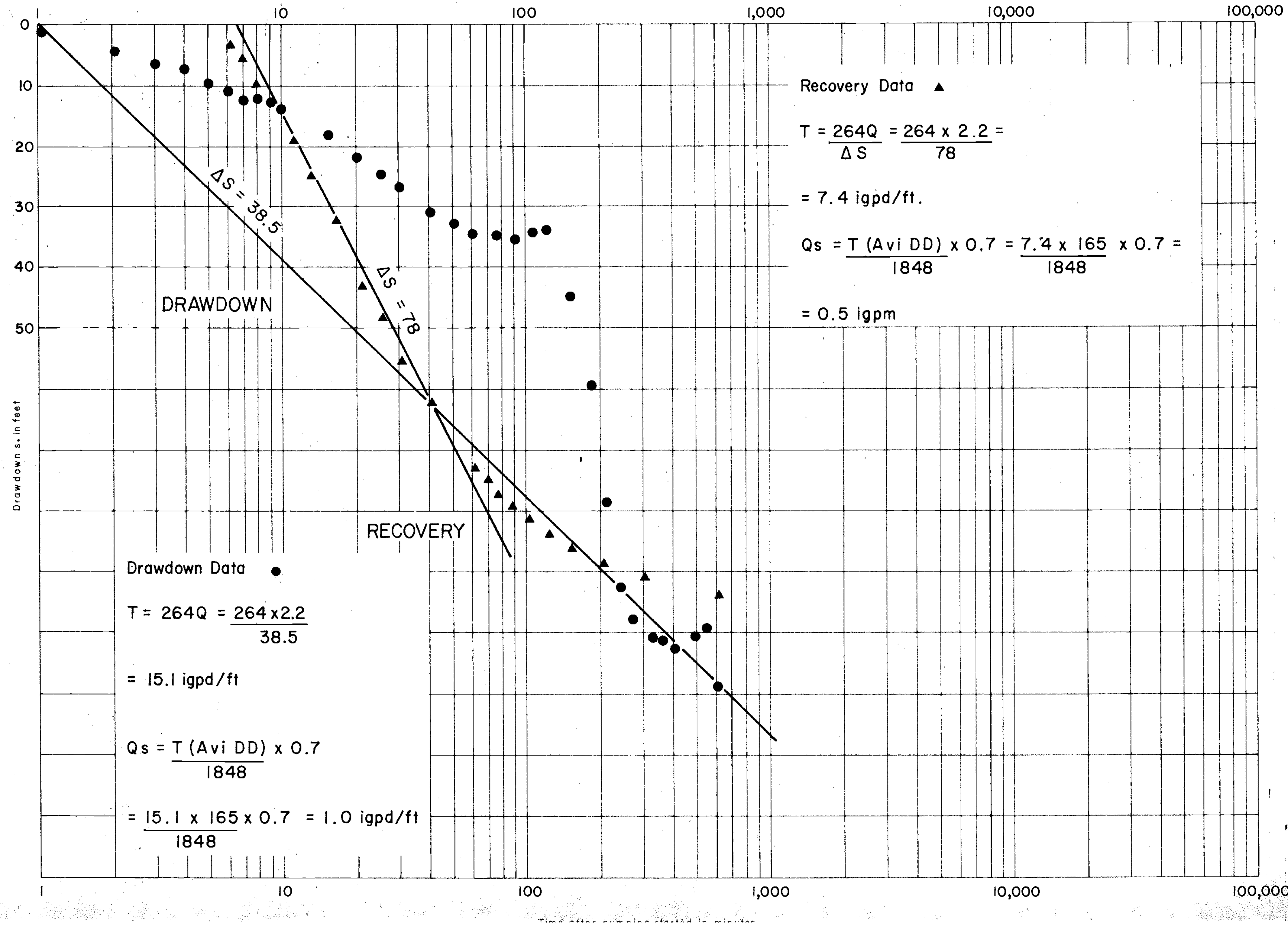


FIGURE 3 PUMP TEST #2 THREE BROOKS TEST WELL #5

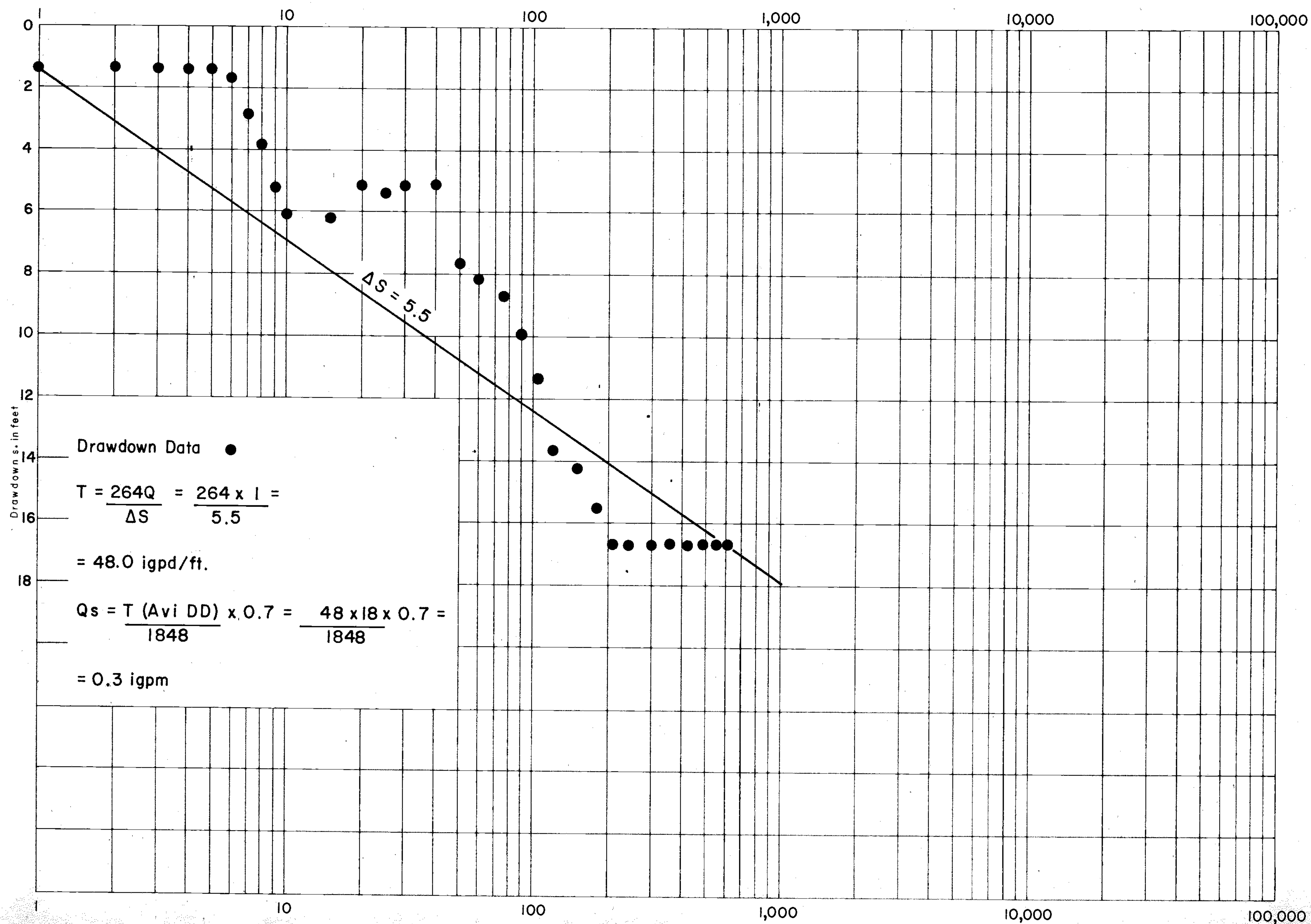
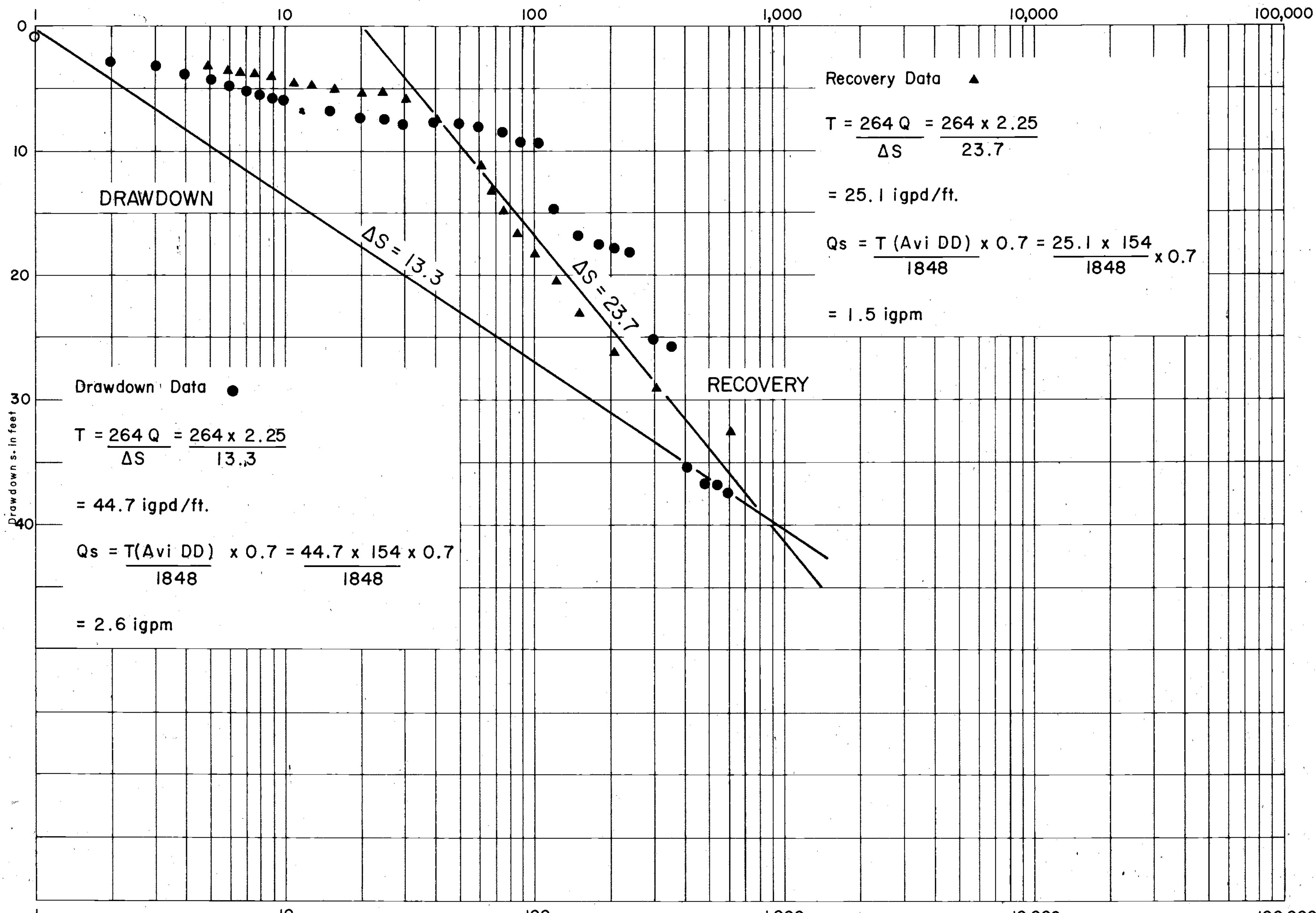
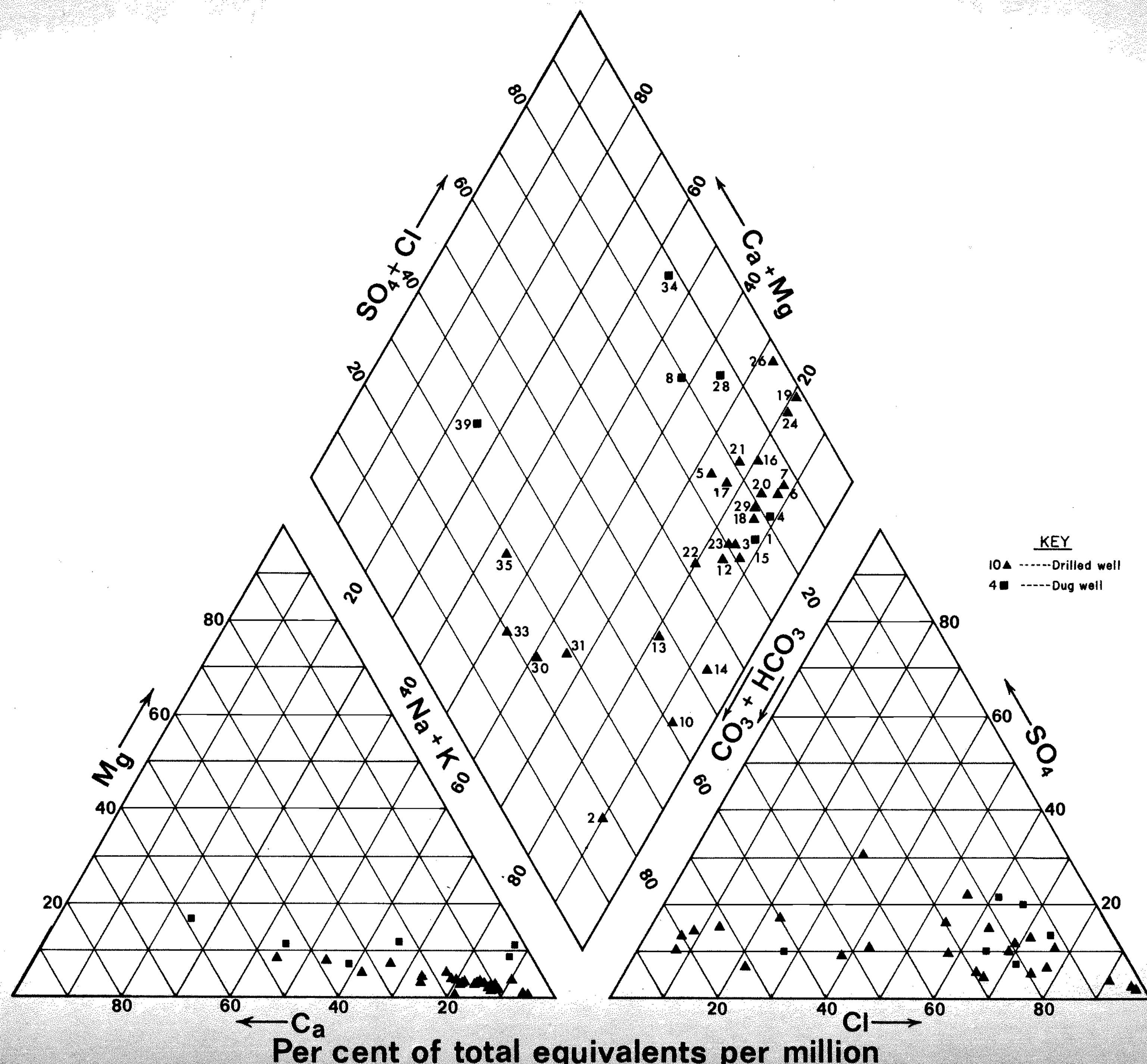
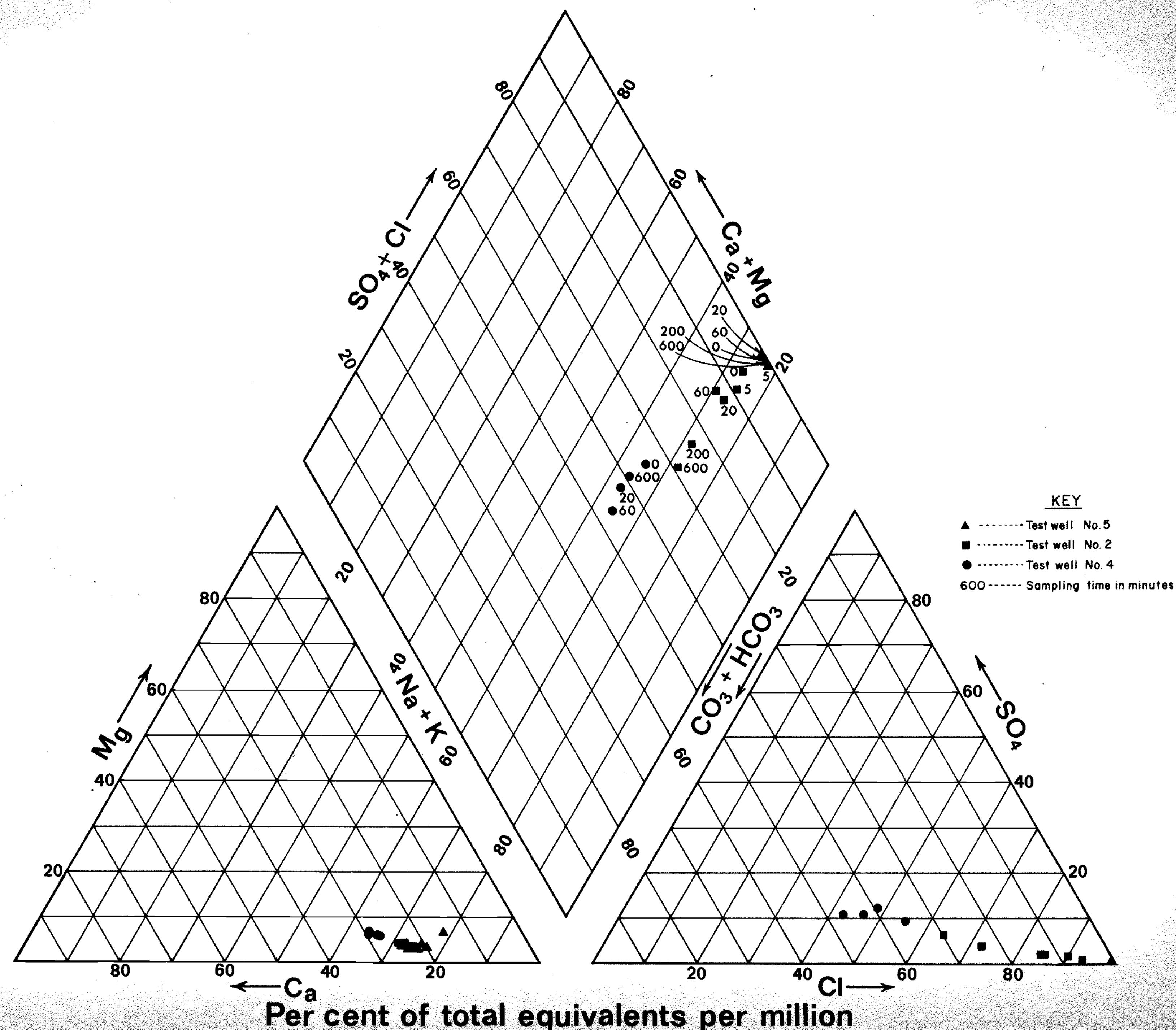


FIGURE 4 PUMP TEST #3 THREE BROOKS TEST WELL #2





SO4 + Cl
Ca + Mg
Mg
Na + K
CO3 + HCO3
SO4
Ca
Cl
80
60
40
20
KEY
10▲ ------Drilled well
4■ ------Dug well
Per cent of total equivalents per million



SO4 + Cl
Ca + Mg
Na + K
CO3 + HCO3
Mg
Ca
Cl
SO4
KEY
Test well No. 5
Test well No. 2
Test well No. 4
600 ------ Sampling time in minutes
Per cent of total equivalents per million

FIGURE 11

APPENDIX B

TABLES 1 to 11 inclusive

TABLE #1

11 E

Well No.	M.T.	Ref. Map	S.T. Map	Year Drilled	Owner	Driller Lic.No.	Well Depth (ft.)	Water Depth (ft.)	Hole Dia.(in.)	Csg.Lgth.(ft.)	Use Quality	Pump or Bail Test	Lithologic Log and Remarks
15	74	C	10	'68	Heighton	4 21	78 82	20	4	5	D slt	3 gpm - 1 hr DD-82' Rec - 20'	0-30 dr 30-50 cl 50-82 sh
24	74	C	10	'73	MacCarthy,L.	5	140	18	6	77	D slt	7 gpm - 1 hr DD - 140' - 1 hr Rec - 40' -20 mins	
26	74	C	10	'66	MacCarthy, Jack (Tom)	6	185	35	4	77	D slt	4 gpm - 1 hr	0-80 till 80-185 bedrock (sandst.?) many different colours, cl, sd, sh
3	74	C	10	'66	Baird, Ed.	73	92	25	4	80	D slt	4 gpm	0-92 cl, sd, sh
14	74	C	10	'52	MacCarthy, Laurie	73	109	20			D		
19	74	C	10		Hayman (Sch.Hse.)	4	265	45			P slt	3 gpm DD- 97' - 1 hr Rec - 67'-10 mins	167-265 sh
20	74	C	10		Fraser, Jim	73	78				D slt		
21	96	C	10	'44	Munro, R.	11	94		5	28	D slt oil	2.5 gpm	0-32 dr 32-94 cl & ss
39	74	C	10		MacFarlane,R.		107		6		D slt	2.5 gpm	32-94 cl & ss
5	96	C	10	'50	Usher	73							
10	74	C	10		Young, S.	21	98	10	4	47	D	10 gpm	0-28 cl; 28-85s 85-98 ss
12	74	C	10		Young, A.		109	25		39	D		bedrk at 34' (possibly ss)
13	74	C	10		Shanty Rest.								
16	74	C	10		MacFarlane, J.	73	98	20		65	D slt		
17	96	C	10		Wilda Landry		99		4	65			

11 E

Well No.	M.T.	Ref. Map	S.T. Map	Year Drilled	Owner	Driller Lic. No.	Well Depth (ft.)	Water Depth (ft.)	Hole Dia. (in.)	Csg. Lgth. (ft.)	Use Quality	Pump or Bail Test	Lithologic Log and Remarks
18	96	C	10	73	Williams, N.	2	114	5	4	34		5 gpm - 1 hr Rec 40' - 1 min DD-50' - 1 hr	0-8 mud;8-22 gra 22-50 red sh 50-114 gr sh
22	74	C	10	71	Lovett, E.	21	130	25	4	85		3 gpm - 1 hr DD-80' - 20 mins Rec-30' - 35 mins	0-30 cl 30-50 loose grnd 50-75 sh;80-133 ss
23	74	C	10		Shea, Fred	100							
29	84	D	10		Nichol		96	20		Csg. Lgth: Shallow			
30	75	C	10	40	Matheson, H.		90			30			
31	75	C	10	40	Matheson, R.	2	70	to	90	feet		- well depth	
33	94	C	10	69	MacCarthy, G.		85				D		
35	94	C	10		Ross, Roy		200				D		
6	74	C	10	73	Pitts, Paul	2	125	20	5	65	D	4 gpm - 1 hr DD-75' - 1 hr Rec-70' - 1 min	0-62 mud, bldrs quicksand 62-125 grey sh
7	84	C	10	55	Pitts, Leo		125			80	D		
2	74	C	10	73	George B.		98				D		

TABLE # 1

11 E

DUG WELLS

Well	M.T.	Ref. Map	S.T. Map	Year Drilled	Owner	Driller Lic.No.	Well Depth (ft.)	Water Depth (ft.)	Hole Dia.(ft.)	Csg.Lgth.(ft.)	Use Quality	Pump or Bail Test	Lithologic Log and Remark
									(ft.)				
21'	96	C	10		Munro, R.		21	7	3	R	D	Adequate yield	0-21 sandy till (assumed)
8	96	C	10		MacKenzie		24	10	3	R	D	Adequate yield	0-24 sandy till (assumed)
1	74	C	10		MacCarthy, T.		28	24	4	R	D	Inadequate yield	0-28 cl till (assumed)
4	96	C	10		Hartling, L.		18	10	6	R	D	Inadequate yield in summer	0-18.5 cl till (assumed)
28	84	D	10		MacFarlane, R.		20			R	D	Inadequate yield in summer	cl till (assumed
34	94	C	10		Faulkner		24			T	D	Adequate yield	0-24 sandy till (assumed)

Legend: R = rocked
T = tiled
cl = clay
gra = gravel
sh = shale
ss = sandstone
sd = sand

gpm = gallons per minute
DD = drawdown
Rec = recovery
slt = salt

TABLE # 2

TEST WELLS

Well No.	M.T.	Ref. Map	S.T. Map	Year Drilled	Owner	Driller Lic.No.	Well Depth (ft.)	Water Depth (ft.)	Hole Dia.(in.)	Csg.Lgth.(ft.)	Use Quality	Pump or Bail Test	Lithologic Log and Remarks
Test Well #													
TB	1			'75	N.S.D.O.E.	4	200	23	5	67		B-5 gpm - 2 hrs	See Lithologic Figure 1
TB	2			'75	N.S.D.O.E.	4	200	27	5	71		See Pump Test	" "
TB	3			'75	N.S.D.O.E.	4	200	11	5	52		B-25 gpm - 2 hrs	" "
TB	4			'75	N.S.D.O.E.	4	195	30	5	100.3		See Pump Test	" "
TB	5			'75	N.S.D.O.E.	4	55	27	4	50		See Pump Test	" "
TB	6			'75	N.S.D.O.E.	4	410	32	4	300		B- <0.5 gpm-2 hrs	" "

Legend: N.S.D.O.E. = Nova Scotia Department of the Environment

B = Bailed

TABLE # 3

Time Drawdown Data

Three Brooks

Pump Test #1

Pumping Well #4		Pumping Well #4		Observation Well #5	
Time after Pumping Started (Mins.)	Drawdown (Feet)	Time after Pumping Stopped (Mins.)	Residual Drawdown (Feet)	Time after Pumping Std. (Mins.)	R = 16' Drawdown (Feet)
0	37.0	600	146.2	0	29.8
1	38.8	601	130.7	1	29.8
2	41.3	602	128.0	2	29.7
3	43.6	603	125.7	3	29.7
4	44.6	604	123.3	4	29.7
5	46.9	605	121.3	5	29.6
6	48.0	606	118.7	6	29.6
7	49.7	607	116.6	7	29.6
8	49.2	608	114.4	8	29.6
9	50.2	609	112.2	9	29.6
10	51.0	610	110.3	10	29.6
15	55.4	615	99.2	15	29.6
20	59.0	620	92.8	20	29.6
25	61.8	625	85.3	25	29.6
30	64.0	630	80.0	30	29.6
40	67.4	640	69.5	40	29.6
50	69.7	650	61.8	50	29.6
60	71.2	660	56.1	60	29.6
75	71.7	675	49.8	75	29.6
90	72.4	690	46.9	90	29.6
105	71.5	705	41.8	105	29.6
120	71.0	720	40.2	120	29.6
150	81.7			150	29.6
180	96.8			180	29.6
210	115.8			210	29.6
240	129.7			240	29.6
300	135.0			300	29.6
360	138.4			360	29.6
420	138.4			420	29.6
480	139.9			480	29.6
540	136.5			540	29.6
600	146.2			600	29.6

TABLE # 4

Time Drawdown Data

Three Brooks

Pump Test #2

Pumping Well #5		Pumping Well #5		Observation Well #4	
Time after Pumping Started (Mins.)	Drawdown (Feet)	Time after Pumping Stopped (Mins.)	Residual Drawdown (Feet)	Time after Pumping Std. (Mins.)	R = 16' Drawdown (Feet)
0	27.1	601	43.5	0	28.4
1	28.3	640		1	28.4
2	28.3	650		2	28.4
3	28.35	660	30.4	3	28.4
4	28.4	675	30.15	4	28.4
5	28.25	690	30.05	5	28.4
6	28.5	705	29.95	6	28.4
7	29.7	720	29.9	7	28.4
8	30.7	750	29.7	8	28.4
9	32.2			9	28.4
10	33.0			10	28.4
15	33.05			15	28.4
20	32.1			20	28.4
25	32.3			25	28.4
30	31.9			30	28.4
40	32.1			40	28.4
50	34.6			50	28.4
60	35.1			60	28.4
75	35.6			75	28.4
90	36.8			90	28.4
105	38.3			105	28.4
120	40.6			120	28.4
150	41.3			150	28.4
180	42.5			180	28.4
210	43.6			210	28.4
240	43.6			240	28.4
300	43.6			300	28.4
360	43.5			360	28.4
420	43.6			420	28.4
480	43.5			480	28.4
540	43.5			540	28.4
600	43.55			600	28.4

TABLE #5

Time Drawdown Data

Three Brooks

Pump Test #3

Pumping Well #2		Pumping Well #2		Observation Well	
Time After Pumping Started (Mins.)	Drawdown (Feet)	Time After Pumping Stopped (Mins.)	Residual Drawdown (Feet)	Time After Pumping Std. (Mins.)	Drawdown (Feet)
0	27.5	600	64.55	Nil	
1	28.7	601	60.00		
2	30.0	602	56.3		
3	30.4	603	53.5		
4	30.95	604	50.4		
5	31.5	605	97.7		
6	32.1	606	45.55		
7	32.3	607	43.9		
8	32.6	608	42.0		
9	32.9	609	40.5		
10	33.15	610	38.9		
15	34.1	615	34.8		
20	34.55	620	33.3		
25	34.8	625	32.7		
30	35.0	630	32.8		
40	35.05	640	32.4		
50	35.1	650	52.0		
60	35.4	660	31.7		
75	35.7	675	31.75		
90	36.55	690	31.15		
105	36.55	705	30.8		
120	42.0	720	30.65		
150	44.0	750	30.30		
180	44.75				
210	45.2				
240	45.4				
300	52.5				
360	52.9				
420	62.7				
480	63.9				
540	64.2				
600	64.55				

TABLE 6

<u>Pump Test Data</u>

Test #	Well #	Well Depth (ft.)	Depth to Water (ft.)	Trans-missibility T(igpd/ft.)	Long Term Safe Pumping Rate(igpm)	Short Term Safe Pumping Rate(igpm)
1	4	195	37.0	15.1	1.0	1.3
2	5	55	27.1	48	0.3	0.5
3	2	200	27.5	44.7	2.6	3.7

TABLE 7

CHEMICAL ANALYSES OF GROUNDWATERS AND SURFACE WATERS IN THE THREE BROOKS AREA, NOVA SCOTIA

Index No.	Sample No.	Grid Location	Present Owner	Depth of Sample	Depth of Well	Aquifer	Date Sampled	Ca	Mg	Na	K	SO_4	Cl	F	Si
								Analyses in mg/litre							
3	3	11E10C74	Baird		92	Riversdale	Sept.4/74	22.6	2.2	190	2.2	21	250	0.3	7.7
5	5	11E10C96	Usher			"	Sept.5/74	39	5.1	140	3.6	48	215	0.4	7.1
6	6	11E10C74	Pitts, P.		125	"	Sept.5/74	24	3.4	250	3.2	82	360	0.9	7.5
7	7	11E10D84	Pitts, L.		125	"	Sept.5/74	31	4.1	320	3.9	82	475	0.9	6.9
10	10	11E10C74	Young, S.		93	"	Sept.5/74	7.4	1.0	140	1.7	55	54	1.6	6.5
2	2	11E10C74	Bennis, George		98	"	Aug.7/74	3.2	1.3	61	2.3	22	11	0.6	8.3
12	12	11E10C74	Young, A.		109	"	Sept.5/74	22	2.5	170	2.5	37	190	0.7	7.7
13	13	11E10C74	Shanty Res.			"	Sept.5/74	19.6	3	120	2.5	25	89	0.6	7.8
14	14	11E10C74	McCarthy, Laurie		109	"	Sept.5/74	7.4	0.7	170	1.7	38	117	1.0	6.7
15	15	11E10C74	Heighton		78	"	Sept.5/74	37	3.6	340	3.2	50	470	0.8	6.9
16	16	11E10C74	MacFarlane, J.		98	"	Sept.5/74	41	5.2	230	3.4	37	400	0.4	6.4
17	17	11E10C96	Landry, W.		99	"	Sept.6/74	30	4.5	145	4.4	65	136	0.4	8.3
18	18	11E10C96	Williams, N.		114	"	Sept.6/74	19.6	2.9	170	3.4	59	200	0.4	7.8
19	19	11E10C74	Hayman		265	"	Sept.6/74	313	29.5	1800	9.5	75	3600	1.2	4.3
20	20	11E10C74	Fraser, J.		78	"	Sept.6/74	38	4.7	300	3.4	41	460	0.6	7.2
21	21	11E10C96	Munro, R.		94	"	Sept.6/74	38	4.4	200	3.2	58	270	0.4	6.0
22	22	11E10C74	Lovett		130	"	Sept.6/74	19.4	2.2	110	2.2	81	65	0.3	7.9
23	23	11E10C74	Shea, F.			"	Sept.6/74	20	2.2	170	2.3	64	170	0.8	7.5
24	24	11E10C74	McCarthy, Lyle		90	"	Sept.8/74	130	0.4	650	15	50	1200	0.6	6.3
26	26	11E10C74	McCarthy, T.		185	"	Sept.7/74	212	17	750	8	51	1600	0.4	5.6
29	29	11E10D84	Nichol		96	"	Sept.12/74	20.2	2.6	152	4.3	38	220	0.9	8.7
30	30	11E10C75	Matheson, H.		90	"	Sept.12/74	26	3.8	57	2.5	27	15	0.3	12
31	31	11E10C75	Matheson, R.		70	"	Sept.12/74	25.2	3.4	71	2.5	34	20	0.3	11
33	33	11E10C94	McCarthy, G.		85	"	Sept.12/74	18.4	2.0	27	2.0	13	7	0.3	11
35	35	11E10C94	Ross, Roy		200	"	Sept.12/74	48	5.2	15	3.5	13	33	0.1	13
39	39	11E10C74	MacFarlane, R.		107	"	March 12/75	21	1.9	150	2.0	23	164	0.2	9
9	9	11E10C96			0.5	stream	Sept.5/74	11.4	2.3	16	1.7	13	27	<0.1	3.4
11	11	11E10C74			sur	spring	Aug.7/74	6.7	2.6	23	9.2	13	45	0.1	8.5
18	18	11E10C96			sur	spring	Sept.6/74	40	2.3	8.0	1.0	12	20	<0.1	5.1
25	25	11E10C74			sur	swamp	Sept.11/74	2.2	0.6	42	1.1	10	49	<0.1	1.6
31	31	11E10C75			sur	spring	Sept.12/74	18.1	2.3	73	2.4	36	28	0.3	12
32	32	11E10C94			0.5	stream	Sept.12/74	12.0	1.8	12	1.6	14	18	<0.1	4.8
37	37	11E10C74			sur	swamp	Sept.12/74	15.9	4.5	60	1.3	34	145	<0.1	3.8
36	36	11E10C74			sur	spring	Sept.12/74	9.6	2.4	7.0	4.2	7	13	<0.1	9.2
1	1	11E10C74	MacCarthy T.		28	clay till	Sept.4/74	46	6.6	120	3.0	34	200	0.2	6.2
4	4	11E10C96	Hartling L.		18	clay till	Sept.4/74	23	7.1	100	9.6	37	83	<0.1	4.7
8	8	11E10C96	MacKenzie		24	sandy till	Sept.5/74	36	5.4	70	3.0	18	140	<0.1	3.5
21	21	11E10C96	Munro R.		21	sandy till	Sept.6/74	34	6.1	17	2.5	14	30	0.1	4.7
28	28	11E10D84	McFarlane R.		24	sandy till	Sept.12/74	16.5	4.4	49	9.0	28	72	<0.1	6.9
34	34	11E10C94	Faulkner		24	sandy till	Sept.12/74	41.2	7.6	42	13	29	130	0.1	11
38	38	11E10C74	MacCarthy		6	sandy till excavation	Oct.24/74	22.5	1.5	27	11	7.5	41	0.2	9.8

Analyses in mg/litre																	Ions in meq/litre						
															pH		Cations				Anions		
NO_3 + NO_2 as N	NH_3 as N	PO_4 ortho	Fe	Mn	Pb	Cu	Zn	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Total Solids	Total Dissolved Solids	Color T.C.U.	Turbidity J.T.U.	Conductivity µmhos/cm	Lab	Field	Ca	Mg	Na	K	SO_4	Cl	CO_3 + HCO_3
<0.1	<0.1	<0.1	0.2	0.07	<0.005	0.01	0.06	126	66	592	592	20	1.8	1220	8.2		1.1	0.2	8.3	.06	0.4	7.1	2.52
<0.1	<0.1	<0.1	<0.1	0.3	<0.005	0.03	0.02	114	119	566	562	5	0.23	1115	8.1		1.9	0.42	6.1	0.04	1	6.1	2.28
<0.1	<0.1	0.1	0.2	0.06	<0.005	0.06	0.06	104	75	832	829	15	1.1	1690	8.1		1.2	0.3	10.9	0.08	1.7	10.2	2.09
<0.1	<0.1	<0.1	0.1	0.2	<0.005	0.04	0.02	100	94	1056	1052	10	0.82	2040	8.1		1.5	0.3	13.9	0.1	1.7	13.4	2.0
<0.1	<0.1	<0.1	<0.1	<0.05	<0.005	0.007	0.03	189	23	403	400	5	0.6	716	8.6		0.4	0.08	6.1	0.04	1.1	1.5	3.78
<0.1	<0.1	<0.1	0.2	0.2	<0.005	<0.005	<0.005	121	13	193	189	20	32	295	8.6		0.2	0.1	2.7	0.06	0.4	0.3	2.42
0.4	<0.1	<0.1	<0.1	0.03	<0.005	0.006	0.07	146	65	810	809	10	0.74	1060	8.2		1.1	0.2	7.4	0.06	0.8	5.4	2.52
<0.1	<0.1	<0.1	<0.1	0.07	<0.005	0.03	0.01	164	62	386	384	10	0.5	716	8.2		1.0	0.2	5.2	0.06	0.5	2.5	3.28
<0.1	<0.1	<0.1	<0.1	0.03	0.005	0.006	0.02	179	22	456	453	10	3.3	875	8.5		0.4	0.06	7.4	0.04	0.8	3.3	3.58
<0.1	<0.1	<0.1	<0.1	0.07	<0.005	0.02	0.04	250	107	1042	1040	5	0.84	2100	8.0		1.8	0.2	14.8	.08	1	13.3	5.0
<0.1	<0.1	<0.1	0.3	0.3	<0.005	0.02	0.07	110	124	836	832	10	2.6	1645	8.0		2	0.4	10	0.09	0.8	11.3	2.2
<0.1	<0.1	<0.1	<0.1	0.09	<0.005	0.02	0.02	78	93	519	517	5	0.46	1010	8.2		1.5	0.4	6.3	0.1	1.4	3.8	1.56
<0.1	<0.1	0.1	<0.1	0.05	<0.005	0.01	0.02	100	61	8.1	540	10	0.55	1160	8.1		1	0.2	7.4	0.09	1.2	5.6	2.0
0.3	0.2	<0.1	0.7	2.7	0.14	0.22	6.05	76	906	6680	6620	5	44	15000	7.0		15.6	2.4	78	0.2	1.6	101.5	1.52
<0.1	<0.1	<0.1	2.2	0.3	<0.005	0.006	0.06	145	116	950	940	30	16	1965	7.5		1.9	0.4	13	0.09	0.9	13	2.9
<0.1	<0.1	<0.1	0.3	0.3	<0.005	0.01	0.04	110	114	649	646	5	2.0	1350	8.1		1.9	0.4	8.7	0.08	1.2	7.6	2.2
<0.1	<0.1	<0.1	0.1	0.09	<0.005	0.02	0.06	107	58	365	362	0	1.4	664	8.1		1.0	0.2	4.8	0.06	1.7	1.8	2.14
<0.1	<0.1	<0.1	<0.1	0.13	<0.005	0.02	0.02	126	59	516	513	5	0.42	1035	7.4		1.0	0.2	7.4	0.06	1.4	4.8	2.52
0.8		<0.1	0.2	0.02	<0.005	0.01	0.08	140	326	2530	2505	35	20	4600	6.8		6.5	0.3	28.3	0.36	1.0	33.8	2.8
<0.1	0.2	0.1	2.2	0.6	<0.005	0.01	0.08	57	600	2917	2896	40	30	5030	7.7		10.6	1.4	32.6	0.2	1.0	45.1	1.14
<0.1	<0.1	<0.1	<0.1	0.02	<0.001	0.01	0.02	90	61	498	496	35	0.88	582	8.0		1.0	0.2	6.6	0.1	0.8	6.2	1.8
<0.1	<0.1	<0.1	0.2	0.09	0.006	0.02	0.11	170	80	269	254	10	1.03	524	7.7		1.3	0.3	2.5	0.06	0.6	0.4	3.4
<0.1	<0.1	<0.1	0.1	0.4	0.008	0.02	0.05	170	77	280	270	5	0.26	428	7.9		3.1	0.06	1.3	0.3	0.7	0.6	3.4
<0.1	<0.1	<0.1	<0.1	0.01	0.006	0.02	0.03	100	54	150	146	5	0.27	233	7.7		0.9	0.2	1.2	0.05	0.3	0.2	2.0
0.5	<0.1	<0.1	<0.1	0.1	<0.005	<0.005	0.50	145	141	237	237	15	0.42	257	7.5		2.4	0.4	2.2	0.9	0.3	0.9	2.9
<0.1	<0.1	0.02	0.2	0.05	0.006	<0.005	0.06	143	60		470			788	7.9		1.04	0.166	6.52	0.05	0.48	4.63	2.86
<0.1		<0.1	0.1	0.1	<0.005	0.05	0.02	24	38	130	125	60	1.3	173	7.3		0.56	0.19	0.70	0.43	0.27	0.76	0.48
2.4		<0.1	<0.1	0.03	<0.005	0.01	0.05	13	28	139	138	5	0.3	220	6.2		0.33	0.21	1.00	0.24	0.27	1.30	0.26
<0.1		1.0	<0.1	0.03	<0.005	0.01	0.02	92	110	160	154	10	0.43	300	7.8		1.99	0.21	0.35	0.02	0.25	0.56	1.84
<0.1		0.1	1.1	0.3	0.01	0.11	0.03	27	8	188	184	240	2.0	255	6.7		0.11	0.05	1.83	0.03	0.21	1.38	0.54
<0.1		<0.1	<0.1	2.3	<0.005	0.007	0.01	190	55	290	290	5	3.2	400	7.9		0.90	0.21	3.18	0.06	0.75	0.79	3.8
<0.1		<0.1	0.2	0.1	<0.005	0.01	0.03	25	38	118	118	55	3.0	144	7.1		0.60	0.15	0.52	0.04	0.29	0.51	0.50
<0.1		<0.1	4.6	5.5	0.06	0.02	0.06	13	58	369	233	120	1.0	246	5.5		0.79	0.37	2.61	0.03	0.71	4.09	0.26
<0.1		<0.1	3.6	0.5	<0.005	0.03	0.01	36	34	141	120	1.0	8	158	6.8		0.48	0.20	.30	0.11	0.15	0.37	0.72
0.4		<0.1	0.7	0.06	0.006	0.13	0.23	97	142	638	629	30	4.1	1060	7.5		2.30	0.55	5.22	0.08	0.71	5.64	1.94
1.6		<0.1	0.4	0.09	<0.005	0.03	1.89	33	87	493	488	20	2.6	796	6.5		1.15	0.58	4.53	0.25	0.77	2.34	0.66
6.4		<0.1	0.2	<0.01	0.005	0.08	0.90	54	114	484	479	0	0.76	838	7.3		1.80	0.44	3.01	0.08	0.37	3.95	1.08
2.8		<0.1	0.1	<0.01	<0.005	0.01	0.03	92	109	359	199	15	0.37	200	7.6		1.70	0.50	0.74	0.06	0.29	0.84	1.84
9.6		<0.1	<0.1	0.05	<0.005	0.02	0.34	19	59	274	272	20	4.0	423	6.5		0.82	0.36	2.13	0.23	0.58	2.03	0.38
7.8		<0.1	0.2	0.3	0.01	0.01	0.06	29	134	374	325	5	0.16	510	6.1		2.05	0.62	1.83	0.33	0.60	3.66	0.58
2.2		<0.1	<0.05	0.02	<0.005	0.002	<0.005	56	62	195	182	90	61	297	8.5		1.12	0.12	1.22	0.28	0.156	1.15	1.12

CHEMICAL ANALYSES OF GROUNDWATERS FROM TEST WELLS IN THE THREE BROOKS AREA, NOVA SCOTIA

Index No.	Sample No.	Grid Location	Present Owner	Depth of Sample	Depth of Well	Aquifer	Date Sampled	Analyses in mg/litre Ca	Mg	Na	K	SO_4	Cl	F	Si
TB-1-75	1	11E10C74	Nova Scotia Department of Environment	13	200	Riversdale	6/3/75	15	2.8	10.5	2.5	11	36	<0.1	5
	2		•	55	•	•	6/3/75			84			110		
	3		•	77	•	•	6/3/75	52	7.3	76	7.0	23	110	0.1	6
	4		•	122	•	•	6/3/75	14	1.8	125	11.0	25	123	0.5	5
	5		•	145	•	•	7/3/75						240		
	6		•	200	•	•	7/3/75	260	24	1000	10.0	4.5	2120	0.4	5
TB-2-75	1	11EDC74	Nova Scotia Department of Environment	87	200	Riversdale	12/3/75	20	2.5	51	3.5	12	22	0.2	1
	2		•	120	•	•	12/3/75			78			46		
	3		•	200	•	•	12/3/75			150			172		
	4		•	200	•	•	12/3/75	40	41	190	9.0	9.5	285	0.3	7
TB-3-75	1	11E10C74	Nova Scotia Department of Environment	69	200	Riversdale	18/3/75	125	11	750	9.6	3.5	1520		
	2		•	200	•	•	18/3/75	137	12	1000	17	4.5	1840	0.7	4
	3		•	200	•	•	18/3/75	182	16	1210	12	6.0	2520	0.8	3
TB-4-75	1	11E10C74	Nova Scotia Department of Environment	80	195	Riversdale	25/3/75	34	4.8	108	6.5	32	99	0.3	8
	2		•	98	•	•	31/3/75	32	4.6	98	6.5	34	103	0.3	5
	3		•	165	•	•	31/3/75	82	8.4	560			1180		
	4		•	195	•	•	31/3/75	398	36	1650		5	3380		
	5		•	195	•	•	31/3/75	462	41	1920	15.0	8	4000	0.8	1
TB-5-75	1	11E10C74	Nova Scotia Department of Environment	48	55	Riversdale	3/4/75	56	7.2	110	9	16	126	0.3	8
	2		•	55	•	•	3/4/75	39	5.5	92	5.5	29	100	0.3	7
TB-6-75	1	11E10C74	Nova Scotia Department of Environment	173	410	Riversdale	15/4/75	23	2.4	313	15	19	500	1.1	6
	2		•	199	•	•	15/4/75	224	22	1200	28	10	2380	0.8	3
	3		•	247	•	•	15/4/75	585	54	2480	43	14	5100	1.0	3
	4		•	290	•	•	15/4/75	550	50	2140	33	8	4580	0.9	4
	5		•	327	•	•	21/4/75	3520	315	5500	60	<10	16,600	1.4	3
	6		•	340	•	•	21/4/75	5130	440	8200	56	<10	23,700	1.8	5
	7		•	370	•	•	21/4/75	4210	390	7500	59	<10	21,400	1.7	4
	8		•	400	•	•	24/4/75	4050	360	7000	70	<10	21,200	1.8	3
	9		•	410	•	•	18/7/75	6800	420	8630	30	<10	25,500	1.9	3

TABLE 6

NO3 + NO2 as N	NH3 as N	PO4 ortho	Fe	Mn	Pb	Cu	Zn	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Total Solids	Total Dissolved Solids	Color T.C.U.	Turbidity J.T.U.	Conductivity µmhos/cm	pH Lab	pH Field	Ca	Mg	Na	K	SO_4	Cl	CO_3 + HCO_3
Analyses in mg/litre																	Ions in meq/litre						
																	Cations				Anions		
0.3	0.2	0.02	0.3	0.6	0.006	0.03	<0.05	14	50		116	20			6.8		0.748	0.23	0.46	0.64	0.23	1.02	0.28
<0.1								152											3.65			3.10	3.04
0.1	< 0.1	<0.02	0.2	0.9	0.006	0.02	<0.005	159	160		391	20			7.3		2.59	0.6	3.31	0.178	0.48	3.10	3.18
	0.2	<0.04	<0.1	0.1	<0.005	0.02	0.01	145	42		439				8.4		0.7	0.15	5.43	0.28	0.52	3.46	2.9
																						6.77	
<0.1	0.4	0.02	0.6	1.4	<0.006	0.03	0.009	73	750		3842	20			7.3		12.97	1.97	43.5	0.26	0.09	59.81	1.46
0.1	< 0.1	0.02	0.4	0.7	<0.005	0.006	0.02	144	59		209			355	7.5		1.0	0.21	2.22	0.09	0.25	0.62	2.88
																			3.39			1.29	
																			6.53			4.85	
0.03	0.1	7	0.3	0.2	<0.005	<0.006	0.06	130	116		630			1880	8.1		2.0	0.34	8.27	0.23	0.2	8.04	2.6
<0.1								58	354					4520	7.8		6.24	0.90	32.62	0.25	0.07	42.87	1.16
<0.1	0.4	0.02	1.8	2.0	0.009	<0.005		62	393		3470	60		5400	7.7		6.84	0.99	43.5	0.43	0.94	51.9	1.24
	0.4	0.02	0.5	0.8	0.007	0.04		53	510		4480	70		7020	7.6		9.08	1.32	52.64	0.31	0.12	71.09	1.06
<0.1	0.1	0.05	0.1	0.4	0.005	0.005	<0.005	155	105		187	15		626	7.8		1.69	0.39	4.7	0.17	0.67	2.79	3.1
0.1	0.4	<0.02	0.1	0.7	0.01	0.02	0.01	143	99		398			684	7.8		1.59	0.38	4.26	0.17	0.71	2.91	2.86
																	4.09	0.69	24.36			31.25	
															7.6		19.86	2.96	71.77		0.10	95.34	
0.1	0.6	0.02	0.3	1.9	0.01	0.008	0.005	38	1325		7442	35		11880	6.9		23.05	3.37	83.52	0.38	0.17	112.84	0.76
0.1	<0.1	0.08						178	170		424			972	8.1		2.79	0.59	4.78	0.23	0.33	3.55	3.56
<0.1	<0.1	0.06	0.4	0.9	<0.005	<0.005	<0.008	184	121		382	15		648	8.2		1.95	0.45	4.0	0.14	0.60	2.82	3.68
0.1	0.3	<0.02	0.9	0.9	<0.005	0.008	0.005	90	67		962			1890	8.5		1.15	0.2	13.62	0.38	0.4	14.11	1.8
<0.1	0.6	<0.02	0.1	0.5	<0.005	0.008	<0.005	49	653		4248			6480	7.7		11.18	1.81	52.9	0.72	0.21	67.14	0.98
0.1	0.9	0.02	<0.1	1.2	<0.005	0.01	<0.005	39	1687		9016			12420	7.8		29.19	4.44	107.88	1.1	0.29	143.87	0.78
<0.1	0.8	0.03	<0.1	1.4	<0.005	0.005	0.009	44	1585		8038			11990	7.6		27.44	4.11	93.09	0.84	0.17	129.20	0.88
0.1	1.5	0.4	2.9	11.0	<0.005	0.02	0.02	12	10,100		24,380			39360	7.3		175.64	25.91	239.25	1.53		468.29	0.24
<0.1	2.0	0.04	0.6	18.4	<0.005	0.03	0.03	9	14,600		41,940			54000	6.9		255.99	36.19	356.7	1.43		667.6	0.18
0.1	1.8	0.04	1.8	10.0	<0.005	0.04	0.01	7	12,120		37,780	10		51840	7.2		210.08	32.06	326.25	1.51		603.69	0.14
0.1	1.8	0.04	1.1	10.7	0.005	0.03	0.02	12	1280		40,670			50760	6.9		202	29.6	304.5	1.79		598.05	0.24
<0.1	2.5	0.05	12	26.8	0.02	0.54	0.15	30	18,750		43,380			56000	6.6		339.32	34.55	375.4	0.77		719.0	0.6

CHEMICAL ANALYSES OF GROUNDWATERS PUMP TEST RESULTS IN THE THREE BROOKS AREA, NOVA SCOTIA

Index No.	Sample No.	Grid Location	Present Owner	Depth of Sample	Depth of Well	Aquifer	Date Sampled	Ca	Mg	Na	K	SO_4	Cl	F	Si
								Analyses in mg/litre							
TB-2-75	0	11E10C74	Nova Scotia Department of Environment		200	Riversdale	1/5/75	160	16	590	6.8	9.0	1250	0.3	6
	5	•	•		•	•	•	102	10	405	5.5	9.0	835	0.3	6
	20	•	•		•	•	•	76	8.4	302	4.8	10	602	0.3	6
	60	•	•		•	•	•	73	8.2	242	4.6	9.5	542	0.3	7
	200	•	•		•	•	•	45	5.5	160	3.8	13	272	0.2	9
	600	•	•		•	•	•	38	4.4	125	3.0	19	186	0.3	9
TB-4-75	0	11E10C74	Nova Scotia Department of Environment		200	Riversdale	23/4/75	460	39	1950	12	<10	4130	0.8	5
	5	•	•		•	•	•	370	98	2150	12	<10	4360		
	20	•	•		•	•	•	509	43	1850	11	<10	3760		
	60	•	•		•	•	•	480	43	1950	12	<10	4180	0.8	4
	200	•	•		•	•	•	451	39	1900	11	<10	3930		
	600	•	•		•	•	•	452	36	1900	11	<10	3880	0.8	4
TB-5-75	0	11E10C74	Nova Scotia Department of Environment		55	Riversdale	30/4/75	42	5.6	115	4.4	27	163	0.2	7
	20	•	•		•	•	•	40	5.4	97	5.3	27	121	0.3	7
	60	•	•		•	•	•	39	5.2	98	4.6	26	106	0.2	8
	600	•	•		•	•	•	39	5.1	96	3.8	28	89	0.2	8

Analyses in mg/litre																	Ions in meq/litre						
															pH		Cations				Anions		
NO_3 + NO_2 as N	NH_3 as N	PO_4 ortho	Fe	Mn	Pb	Cu	Zn	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Total Solids	Total Dissolved Solids	Color T.C.U.	Turbidity J.T.U.	Conductivity µmhos/cm	Lab	Field	Ca	Mg	Na	K	SO_4	Cl	CO_3 + HCO_3
<0.1	0.2	<0.02	0.8	0.7	0.005	0.04	0.11	98	464	2382	2360	20	1.5	3888	7.8		7.98	1.31	25.66	0.17	0.25	35.26	1.96
<0.1	0.2	<0.02	6.7	0.6	0.04	0.12	0.66	108	297	2004	1760	20	10	2700	7.7		5.09	0.82	17.62	0.14	0.25	23.55	2.16
<0.1	0.1	0.02	4.1	0.7	0.01	0.04	0.12	117	225	1307	1220	20	20	2052	7.8		3.79	0.69	13.14	0.12	0.28	16.98	2.34
<0.1	<0.1	0.02	2.6	0.6	0.008	0.04	0.11	118	216	1226	1176	30	14 —	1944	7.9		3.64	0.67	10.53	0.12	0.27	15.29	2.36
<0.1	<0.1	<0.02	1.2	0.4	0.005	0.03	0.06	129	136	653	621	25	1.5	1080	8.1		2.24	0.45	6.96	0.1	0.37	7.67	2.58
<0.1	0.5	<0.02	0.7	0.4	0.01	0.04	0.03	121	113	497	459	15	5.5	821	8.1		1.89	0.36	5.43	0.08	0.53	5.24	2.42
<0.1	0.6	0.02	0.6	1.9	0.005	0.05	0.43	32	1310	7617	7590	20	25	12420	7.1		22.95	3.2	84.82	0.31		116.51	0.64
<0.1								32	1320		7282				7.3		18.46	8.06	93.52	0.31		122.99	0.64
<0.1								24	1450		6360				7.4		25.40	3.54	80.47	0.28		106.07	0.48
<0.1	0.05	0.04	5.8	2.4	0.005	0.05	0.69	28	1370	7818	7741	20	60	11880	7.1		23.95	3.54	84.82	0.31		117.92	0.56
<0.1								27	1290		7144				7.3		22.50	3.2	82.65	0.28		110.87	0.54
<0.1	0.6	<0.02	1.4	1.7	<0.005	0.03	0.11	27	1280						6.8		22.55	2.96	82.65	0.28		109.45	0.54
<0.1	<0.1	0.04	0.5	0.8	0.006	0.05	1.2	146	130	2375	456	25		788	7.9		2.1	0.46	5.0	0.11	0.76	4.6	2.92
<0.1	<0.1	0.08	0.7	1.0	0.005	0.03	0.12	153	123	2520	402	25		648	8.0		2.0	0.44	4.23	0.14	0.76	3.41	3.06
<0.1	<0.1	0.12	7.5	1.8	0.19	0.4	0.58	154	119	2451	404	25		594	8.0		1.95	0.43	4.26	0.12	0.73	2.99	3.08
<0.1	<0.1	<0.02	0.4	0.5	0.06	0.05	0.08	156	118	368	354	25	15	594	8.1		1.95	0.42	4.17	0.1	0.79	2.51	3.12

TABLE # 10

Total Salinity and Ratio of
Chloride/Carbonate + Bicarbonate from
Selected Well Water Supplies

Well Number	Sample Number	Distance from Coast(in feet)	$Cl/CO_3 + HCO_3$ (ppm)	Total Salinity as NaCl
30	30	10,000	0.12	23.4
10	10	6,000	0.396	87.8
16	16	3,000	5.14	596.7
7	7	1,500	6.7	783.9

TABLE # 11

Total Salinity and Ratio of
Chloride/Carbonate + Bicarbonate of Test Well #6

Test Well #6	Sample Number	Sample Depth	$Cl/CO_3 + HCO_3$	Total Salinity as NaCl
#6	1	173	7.8	823
	2	199	68.5	3921
	3	247	184.4	8404
	4	290	146.81	7547
	5	327	1951.2	27354
	6	340	3788	39054
	7	370	4312	35264
	8	400	2491	34935

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