GROUNDWATER SURVEY
BROOKFIELD AREA

Colchester County, Nova Scotia

OFR595

445148

By

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ABSTRACT

This report presents information on the nature and occurrences of groundwater in the Brookfield area, Colchester County, Nova Scotia. As a follow up of the feasibility study, carried out by W. N. Horner and Associates at the request of A. R. D. A., for a water supply for the village. This report also reveals the possibility of a groundwater supply for the village.

Field exploration was confined to the surficial deposits overlying the Windsor Group of sediments. It was found that these surficial deposits contain a water bearing strata of sand and gravel transmitting an excellent quality of groundwater. A screened test well developed in this sand-gravel aquifer yielded a flow in excess of 150 igpm.

An examination of the chemical analyses alone of water derived from the underlying Windsor bedrock and of water derived from the overlying surficial deposits indicates that development of the surficial aquifer is the most practical course to follow in obtaining a groundwater supply for this area. The best alternative being to develop a producing well in the Horton Aquifer which lies about 1/2 mile east of the village.

INTRODUCTION

A groundwater survey was carried out in the Brookfield area, Colchester County, Nova Scotia, in December 1967 at the request of the Nova Scotia Directorate of A. R. D. A.

This survey was undertaken to determine the feasibility of obtaining groundwater from the surficial deposits in the immediate area of Brookfield. The primary need for groundwater is to satisfy the water requirements of the domestic and commercial demands in that area, as the present supply is regarded inadequate for future growth. In the past, water from most wells in the Brookfield area has been found to be unsuitable for both domestic and commercial purposes. The groundwater potential, however, has never been studied in detail in the past.

In the Atlantic Development Board, Nova Scotia Water Resources Study (1967), the quality of water from existing bedrock wells in the Brookfield area is listed as "doubtful." This report brings to light some very promising facts concerning the potential of the surficial deposits and the Horton sediments as possible sources of a groundwater supply for the village of Brookfield.

Location and Population

The village of Brookfield is located approximately 5 miles south of the south boundary of Truro and lies on route 2 (See location map, scale 1" = 4 miles in Appendix A). Another map, scale 1:50000, outlining the groundwater geology of the immediate area under study is included in Appendix B. The map area is included in the south portion of Truro map sheet 11 E 6 and the north portion of Shubenacadie map sheet 11 E 3.

Census figures for the village of Brookfield showed a population of 746 people in 1951, 807 in 1956, 653 in 1961 and 654 people in 1966. Although these figures show an overall decrease in population between 1951 and 1961 and no change between 1964 and 1966, it is felt that the installation of water and sewerage system might be expected to attract industrial and/or housing development to the area (W. N. Horner and Associates).

Climate

The mean annual precipitation is about 44.04 inches, which is the mean value for Truro, Debert and Upper Stewiacke based on 20-30 years records of precipitation and data.

Evapotranspiration exceeds precipitation during some months of summer. In other words if groundwater is available near the surface during these months, more water would be evaporated from the soil and transpired by plants than would be replenished by precipitation.

The climate of the Brookfield area and Colchester County corresponds closely to that of the other northern counties of the province such as Cumberland and Pictou which together comprise a climatic region within the Maritime Provinces. This climate is described in general terms as humid and temperate.

Physiography and Drainage

The Brookfield area is part of the Nova Scotia lowlands. It is bordered on the northeast by the Camden Ridge which is part of the Atlantic upland belonging to the upland physiographic region of Nova Scotia. The map area varies in altitude

from less than 100 feet above sea level just south of the village up to 550 feet in the north part of the area.

Little River, the main stream and a small component of the Stewiacke River watershed, flows southward through the village. During its course it drops from about 500 feet elevation at its headwaters to less than 50 feet at its tributary with the Stewiacke River.

Water Use

At present the domestic and commercial water supply for Brookfield residents is obtained partly from Wilma's Lake but in large part from driven, dug and drilled wells.

The South Colchester Regional High School and some residents in the east end of the village use Wilma's Lake as a water supply source, but this water requires chlorinating treatment because of the presence of coliform bacteria.

Those people using well points to obtain groundwater from the surficial deposits report adequate supplies of good quality water.

Estimated water requirements to satisfy the domestic and commercial demands is approximately 60,000 imperial gallons per day (approximately 41 igpm)*. In addition, a reservoir capacity of 100,000 imperial gallons is required to satisfy the recommendations of the Canadian Underwriters Association standard of Municipal Fire Protection.

* igpm - imperial gallons per minute

Previous Work

During the summer of 1967, W. N. Horner and Associates, consulting engineers, Truro, Nova Scotia, carried out a feasibility study for a water system, sanitary sewage collection and treatment system for the village of Brookfield. This report was prepared for A. R. D. A. and the Nova Scotia Water Authority.

The object of that study was four fold:

1. To examine existing water and sewer services and to propose a suitable sanitary sewage collection and treatment system as well as a water supply and distribution system for the village of Brookfield.

2. To determine the existing degree of pollution of the Little River in that portion of the river which passes through Brookfield.

3. To examine flooding conditions of the Little River in regard to the effect of such flooding in Brookfield.

4. To recommend how Brookfield should develop so as to be most economical to the village from the standpoint of water and sewer services.

To date, the bedrock geology of the area has been mapped by I.M. Stevenson 1950 and 1951 on a scale 1" = 1 mile. This map was used to locate geologic contacts in the area.

A groundwater probability map of the Truro map sheet (1" = 4 miles) west half was compiled in 1963 by L. V. Brandon. This map outlined the major hydrogeologic units in the area and indicates the probable quality and quantity of the groundwater yielded by wells drilled into the various water bearing rock units.

A complete soil survey was carried out in the area in 1948 by the Dominion Department of Agriculture.

Acknowledgements

The Groundwater Section, Geology Division, Nova Scotia Department of Mines, would like to acknowledge the co-operation of the inhabitants of the area for supplying information on their own water supplies.

GEOLOGY

Introduction

Underlying the Brookfield area are two different rock types deposited during the Mississippian age. The first and oldest rocks are the shales, siltstones and sandstones of the Horton Group. Secondly are the red and green shales, limestones, gypsum and anhydrite of the Windsor Group.

Surficial deposits of till, sand and gravel, silt and clay of varying thickness are found in the area overlying the bedrock. These deposits being thinner in the uplands and thickest in the lowlands.

Bedrock Deposits

The Horton Strata consist of a sequence of conglomerates, grits, sandstones, siltstones and shales. These sediments underlie about 1/3 of the map area and are confined to the north and east portions of the Brookfield map area. The Horton-Windsor contact being in the area of Wilma's Lake. East of Brookfield, the Horton strata strike north and dip approximately 40° west; while north of Brookfield the strata strike west and dip approximately 40° south. In both cases, the strike being parallel to, and the dip being in the direction of, the Horton-Windsor contact. The Horton strata in the area are folded in an open parallel form and are cut by numerous faults which show only small stratigraphic displacement.

The Windsor strata consist of a series of marine sedimentary rocks that conformably overlie continental deposits of Horton Age. These red and green shales, marine limestone, gypsum and anhydrite underlie about 2/3 of the map area.

Surficial Deposits

Mantling the bedrock are deposits of glacial drift. Glacial drift includes unsorted till (unstratified drift) deposited during the Pleistocene Epoch (ice age), and washed material consisting of ice contact stratified drift and lacustrine sediments, deposited by glacial melt water. Till is composed of a mixture of clay, silt, sand and gravel. Outwash, esker, kame and kame terrace are genetic terms applied to sand and gravel deposited by glacial melt water.

The material found in this area was probably deposited while the remains of the glacier still occupied the Camden ridge portion of the Carboniferous uplands. The most common surficial material is in the form of a clay till which was derived from the underlying shales, siltstones, limestones and gypsum.

In the central map area, there exists two types of stratified surficial deposits that were deposited by glacial melt water. The first unit known as ice contact stratified drift lies immediately under the village. Beginning just south of the Upper Brookfield road this deposit is about 1/2 mile wide and extends northward about 1 mile. The material consists of washed sands and gravel with a high content of fine sand and silt. T. H. #125 drilled into these deposits indicated a depth of 65 feet before underlying Windsor bedrock sediments were reached.

The second deposit is a belt of lacustrine sediments ranging in width from approximately 1/4 of a mile to 3/4 mile. It is in these deposits that the Little River has cut its channel while meandering through the area. Test holes drilled into these lacustrine deposits indicate a thickness of at least 137 feet at a site just west of the village. Located in the silts and clays are interbedded strata of sand which was found to occur at various depths in the area. These sand deposits are believed to be buried alluvial sediments and hence are referred to as the lacustrine-alluvial aquifers.

Recent Deposits

Since the disappearance of the glaciers, the pleistocene deposits,as well as the bedrock in some areas, have been eroded to some extent. The presence of bottomland alluvium, which includes silt, clay, especially along Little River above Brookfield and along the streams west of Brookfield, indicates recent deposition which followed the initial erosion of the stream beds.

HYDROLOGY

Introduction

The shales, siltstones and till seldom yield more than a domestic water supply in one well. The limestones and gypsums are capable of yielding large amounts of groundwater but only with undesirable chemical characteristics. These waters are extremely hard and contain high amounts of total dissolved solids.

Three geological deposits in the area present very favorable conditions for obtaining grountwater (map - Appendix B). These are the ice contact, stratified sands and gravels, the lacustrine-alluvial deposits and the Horton sediments

which underlie the eastern part of the map area. These are possible aquifers or water bearing zones. In the past, wells have not been drilled into the sand and gravel deposits because methods of screening wells in unconsolidated deposits were not known by local drillers until recently. The absence of wells drilled in the Horton sediments may be explained by the fact that this aquifer lies east of the center of population of the area.

Horton Aquifer

The Horton sediments may be a very good aquifer. To date, however, there is little information available on aquifer characteristics of the Horton Formation in the immediate Brookfield area. However there are wells drilled into this aquifer just south of Truro which yield up to 25 igpm. It should be born in mind that these types of sediments may have a significant natural permeability while at the same time yield large volumes of water by a secondary permeability due to fractures, cracks, etc. It is suggested that this second type is the most promising in this area since the Horton sediments have been gently folded and cut by numerous small faults or fracture planes along which water may move.

Surficial Aquifers

In some places pleistocene sands and gravels are very good aquifers. For example in 1965 a well was completed in a sand and gravel aquifer near Inverness. This well indicated a yield of close to 1000 igpm.

Information on the aquifer in the ice contact stratified sands and gravels in Brookfield indicates that shallow screened wells using sand points can be developed easily. Yields in excess of 20 igpm can be expected from a well of this type. Two farms located on the south portion of these deposits each use a simple well point to supply water to their herds of 40 dairy cattle each as well as supplying their domestic demands.

The most favorable aquifer in the area appears to be in the lacustrine-alluvial sediments. At a point just east of the Little River and south of the Upper Brookfield road.

T. H. #319 indicated a sand-gravel aquifer with a saturated thickness of approximately 25 feet. Three observation wells were drilled at various distances from this test hole (see map showing well layout, Appendix E), and all three penetrated the aquifer.

A well point was developed in each of the observation wells with a minimum of effort, requiring an average of about 2 hours per well (this includes drilling with a power auger, installation of the point and developing). Upon pumping, each well yielded 25 igpm for over an hour without any appreciable drawdown of the water table.

A 6" diameter 10 ft. length of 40 slot screen was installed in T.H. #319 and developed by surging and pumping. Following a day of developing the water cleared sufficiently upon steady pumping to conduct a pump test. A 42 hour pump test was conducted at a pumping rate of 164 igpm. At the end of this test only 35% of the available drawdown had been used, in other words the water table

could be lowered almost twice as much before it reached the top of the screen. It should also be pointed out that the well had not been completely developed and that movement of water through the screen could have been retarded by the bridging action of fine sand particles. A summary of the water bearing characteristics determined from the pump test data is included in Table IV. From analysis of the test data it is obvious that a longer pumping test should be carried out to a point where water levels in the wells stabilize. After this is achieved more accurate and reliable conclusions may be drawn regarding the safe yield of the aquifer.

WATER QUALITY

Surface Water

A surface water supply is available from the Little River watershed. However, before domestic use this water would require filtration and chlorination.

Samples collected by W. N. Horner and Associates during the summer of 1967 indicated undesirable chemical and bacterial constituents. During the test period stream stage was high and in light of the dilution factor these values must be considered as being low. An overall mean value of the BOD was found to be 1.2 (mg/l). In accordance with the stream standards adopted by the British Royal Commission on sewage disposal, streams with this BOD level are considered clean. However all samples analyzed for bacterial content contained a most probable number (MPN) of coliform bacteria of greater than 240. This indicates pollution of the surface water by human and/or animal waste.

GROUNDWATER QUALITY

Horton Aquifers

Chemical analyses of 3 samples (Nos. 55, 56, 59) collected from wells drilled into the Horton sediments between Brookfield and Truro indicate a good quality water with a moderate hardness.* (See Table 1.) The mean values of the more critical constituents are: total hardness 92 parts per million (ppm); Iron = 0.06 ppm; Nitrates = 4.0 ppm. All three values being well below the recommended upper limits set by the U. S. Health Service (1962) Standards.

Surficial Aquifers

Ice Contact Stratified Drift

Two samples were collected from the ice-contact stratified drift, both from well points. One driven about 22 feet the other driven only 14 feet. These locations numbered 1 and 2 are plotted on the accompanying map of the area (Appendix B).

The analyses indicated the water to be of high quality, with low total dissolved solids, low iron and slightly moderate hardness.

Lacustrine-Alluvial Complex

Two samples were collected from the lacustrine-alluvial sand aquifer during the course of the pump test. Analyses showed the content of chemical

* 50 ppm is taken as the boundary between hard and soft water.

constituents to be very low, the water being of a very good quality. Average values of the more critical chemical constituents obtained from the analyses are as follows: Total Hardness = 52.1 ppm; Iron = 0.04 ppm; Nitrate = less than 0.01 ppm. Analyses of these samples numbered 3 and 4 are included in the Appendix.

RECOMMENDATIONS AND CONCLUSIONS

1. From the results of the 42 hour shallow well pumping test conducted at a rate of 164 igpm (Nova Scotia Department of Mines Test-Hole #319) at Brookfield, it appears that a very favourable site has been located from which to develop a supply of good quality water for the village.

2. Some additional testing should be carried out at this site, which would involve an extended pumping test and possibly a few more test holes. This would help delineate the boundaries of the aquifer further and aid in the ultimate design of a production well and/or well field.

3. Two other areas in the vicinity of Brookfield also appear to be favourable for testing for additional groundwater if required. These are:

   a. sand and gravel deposits (ice-contact stratified drift) as designated in the report and on the geological map;

   b. sediments designated as the Horton aquifer and located on the upper Brookfield road about 2000 feet northeast of Wilma's Lake.

4. It is recommended that during any pumping test conducted on a well in the Brookfield area, a water sample should be taken after the first hour of pumping and again towards the end of the pump test to thoroughly check the chemistry of the water.

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Soil Survey of Colchester County, Report No. 3, Nova Scotia Soil Survey.

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Truro Map-Area Colchester and Hants Counties, Nova Scotia, Geological Survey of Canada, Memoir 297.

3. Atlantic Development Board (April 1967):
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5. Hennigar, T. W. (1967):
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Groundwater Survey, Falmouth area, Hants County, Nova Scotia, N. S. Department of Mines, unpublished report.

7. Brandon, L. V. (1963):
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TABLE #1

CHEMICAL COMPOSITION OF GROUNDWATER FROM THE HORTON AQUIFER NEAR BROOKFIELD

Sample No.	Location	Chemical Composition								
		Calcium	Magnesium	Sodium	Total Iron	Manganese	Sulphate	Nitrate	Chloride	Total Hardness
#55	11-E-6-B-95-N.E. . Truro	41.7	11.7	21.6	0.06	0.01	56.0	9	33.7	147.3
#56	11-E-6-B-72-E-S Hilden	28.9	8.0	15.9	0.04	0.20	7.0	3.0	24.8	105.2
#59	11-E-6-B-75-Q-SE Truro	7.6	1.0	182.7	0.08	T	78.0	T	285.5	23.0
Average		22.7	6.9	73.5	0.06	0.07	47.0	4.0	115.0	92.0
Range		34.1	10.7	166.8	0.04	0.20	72.0	9.0	260.7	124.3

N.B. Analyses in parts per million (ppm)
T indicates an amount < 0.01 ppm

TABLE II

CHEMICAL COMPOSITION OF GROUNDWATER FROM THE ICE-CONTACT SAND AND GRAVEL AQUIFER

Sample No.	Grid Location	Chemical Composition								
		Calcium	Magnesium	Sodium	Total Iron	Total Manganese	Sulphate	Nitrate	Chloride	Total Hardness
#1	11-E-6-B-2-H center	23.5	1.2	6.0	0.22	0.01	51	1	12.4	63.6
#2	11-#-6-B-2-H-E	25.4	1.0	7.0	0.28	0.01	59	1	21.3	68.4
Average		24.5	1.1	6.5	0.25	0.01	55	1	16.8	65.5
Range		1.9	0.2	1.0	0.06	0.0	8.0	0.0	8.9	4.8

TABLE III

CHEMICAL COMPOSITION OF WATER FROM THE LACUSTRINE-ALLUVIAL AQUIFER

Sample No.	Grid Location	Calcium	Magnesium	Sodium	Total Iron	Total Manganese	Sulphate	Nitrate	Chloride	Total Hardness	pH
#1 After 1 hr. of pumping	11E6A2H East	17.5	2.2		0.04	tr	21	tr	6.2	52.8	6.6
#2 After 36 hrs. of pumping		17.3	2.0		0.05	tr	18	tr	8.0	51.4	6.6

TABLE IV. WATER BEARING CHARACTERISTICS OF THE LACUSTRINE ALLUVIAL AQUIFER

DATA USED	VALUES* T (igpd/ft.)	P (igpd/ft.^{2})	S	Q_s (igpm)
SEMI LOG PLOT time vs. drawdown pumping well #319	56,300	2,250		320
	28,000	1,120		160
	15,000	600		85
LOG - LOG PLOT time vs. drawdown observation well #1	75,000	3,000	0.220	450
LOG - LOG PLOT time vs. drawdown observation well #2	59,000	2,360	0.189	350
LOG - LOG PLOT time vs. drawdown observation well #3	48,000	1,920	0.018	260
SEMI LOG PLOT t/t' vs. drawdown pumping well	60,000	2,400		340
	23,000	920		130
LOG - LOG PLOT distance vs. drawdown	99,000	3,950	0.17	570
MEAN VALUES	51,400	2,060	0.111	295

* T = Transmissibility in gallons per day per ft. (igpd/ft.)
P = Permeability in gallons per day per square ft. (igpd/ft.^{2})
S = Storage coefficient (Dimensionless)
Q_s = Estimated safe continuous pumping rate for 20 years of pumping in imperial gallons per minute (igpm)

LOCATION MAP

PUMP TEST SITE

T.H. #19

N

SCALE : 1" = 4 Miles

Londonderry Station
Brapples Brook
East Mines Station
Great Village
Highland Village
Glenholme
Spencer Pt
Masstown
Lower Onslow
Central Onslow
Crowe Mills
Upper Onslow
Bible Hill
Valley
Murray
Greenfield
Union Sta
Riverdale
CANADIAN
West River Station
Gordon Summit
Lansdowne Station
TRURO
Truro Heights
Lyons Hd
Old Barns
Clifton
Millbrook
Harmony
Camden
Hilden
Burnside
Selmah
Maitland
Noel Shore
Lower Selmah
Stirling Brook
Beaver Brook
Princeport
Pembroke
Eastville
Stewiacke Cross Roads
Newton Mills
Upper Stewiacke
Chaplin
Brookfield
Pleasant Valley
Otter Brook
Middle Stewiacke
Brentwood
Green Oaks
South Maitland
Green Creek
Latties Brook
Five Mile River
PACIFIC
Urbania
Doddridge
Upper Kennetcook
Georgefield
Alton
Cloverdale
Admiral Rock
Fort Ellis
Barr Settlement
North Salem
Stewiacke
Stewiacke East
Lanesville
Upper Musquodoboit
McPhee Corner
CASABIAS
Miller
West St Andrews
Wittenburg
Centre Musquodoboit
Elmvale
Roulston Corner
IR No 14
Upper Nine Mile River
Shubenacadie
Coldstream
Glenmore
Newcomb Corner
Nine Mile River
Milford Station
Hardwood Lands
Carroll Corner
Gays River
Cook Brook
Chaswood
Middle Musquodoboit
Brookvale
Renfrew

LEGEND

SURFICIAL GEOLOGY

RECENT ALLUVIUM

ICE-CONTACT DEPOSITS

LACUSTRINE DEPOSITS

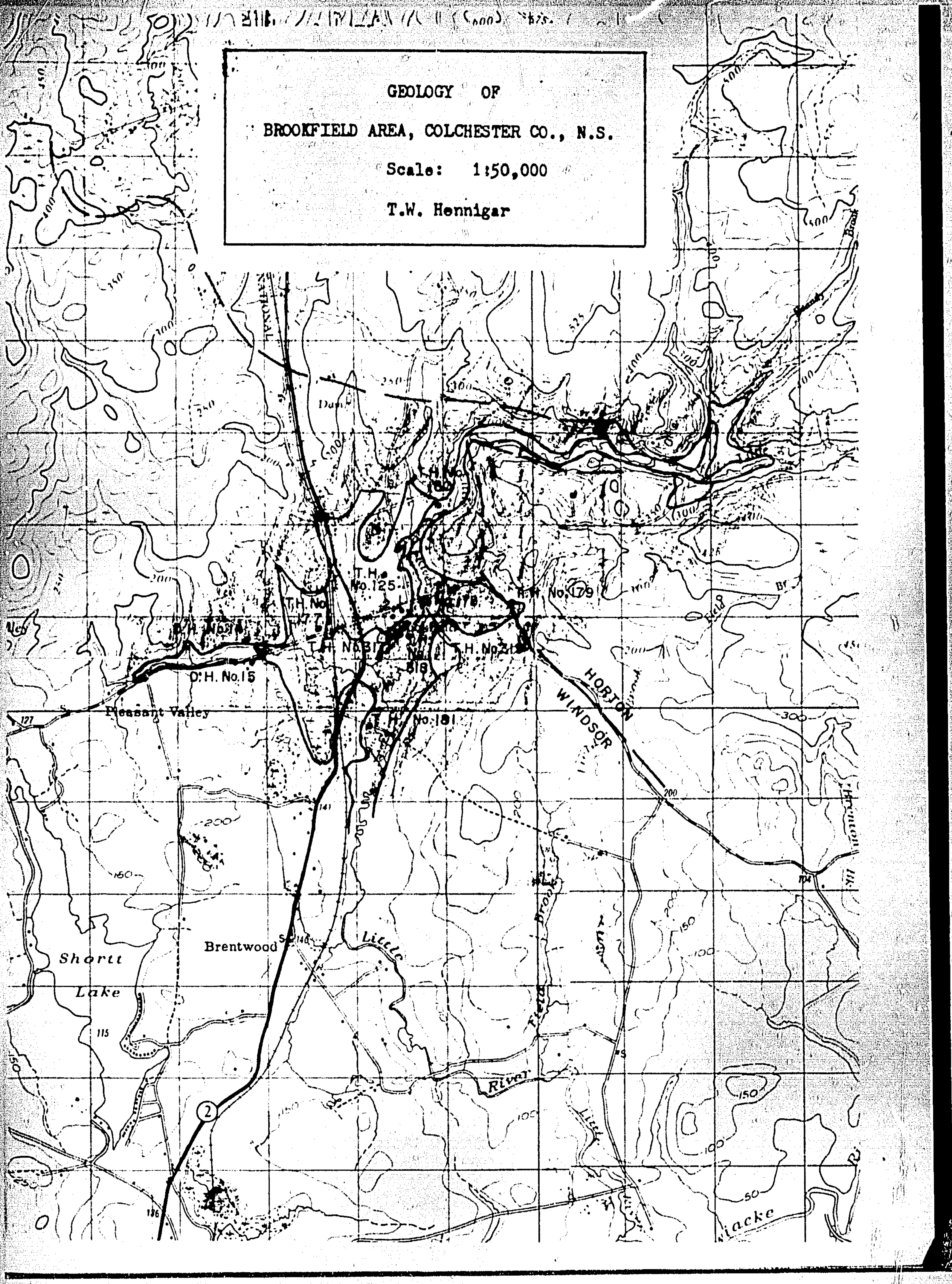
CLAY TILL

D.H. No. 14 ..... Dept. of Highway Test Hole

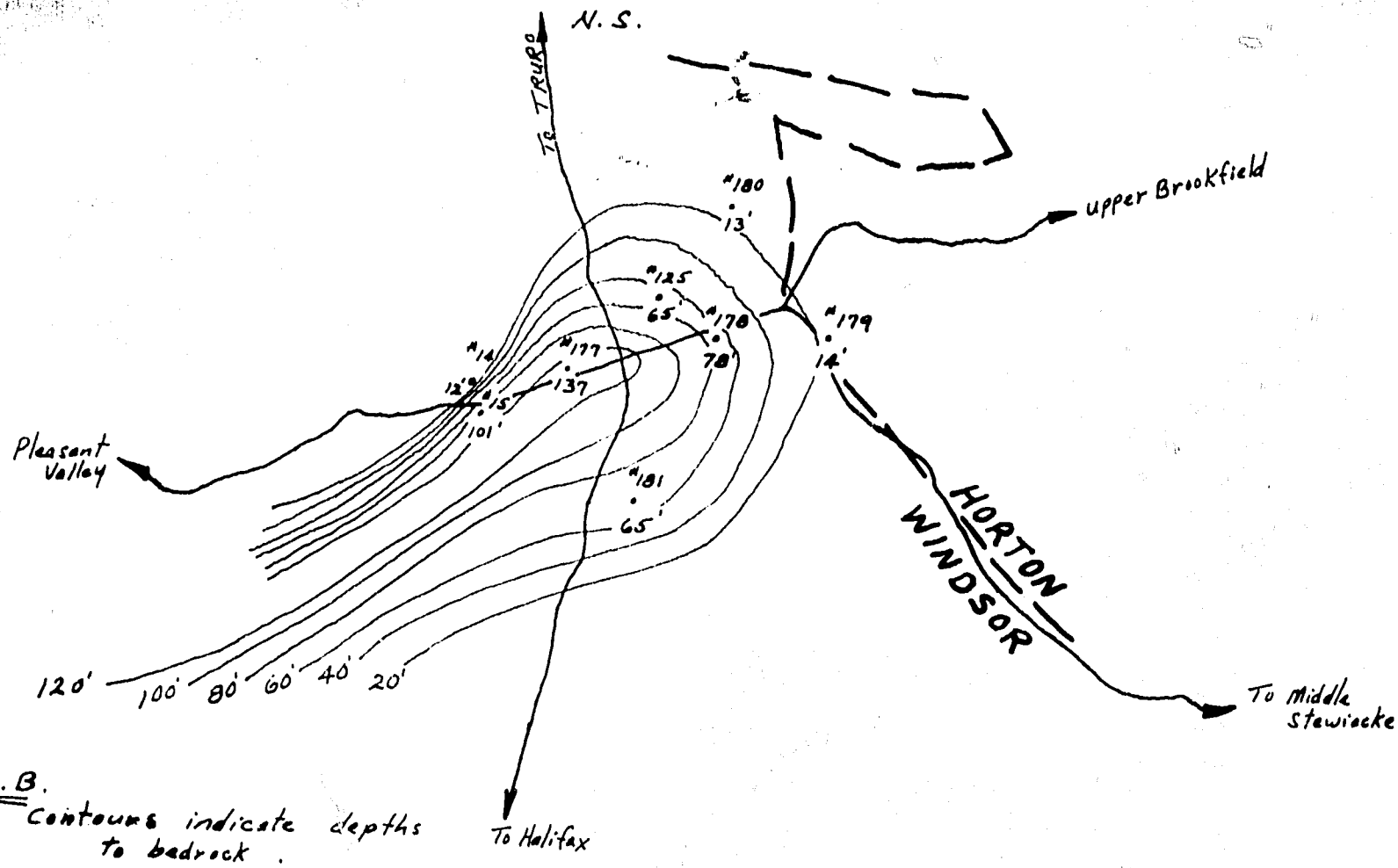
T.H. No. 177..... Dept. of Mines Test Hole

•1 ..... Water Sample Location

..... Horton - Windsor - Contact


GEOLOGY OF
BROOKFIELD AREA, COLCHESTER CO., N.S.
Scale: 1:50,000
T.W. Hennigar
T.H. No.125
T.H. No.179
O.H. No.15
T.H. No.181
Pleasant Valley
HORTON
WINDSOR
Shortt
Lake
Brentwood
Little
River

BEDROCK CONTOUR MAP
OF
TOWN OF BROOKFIELD



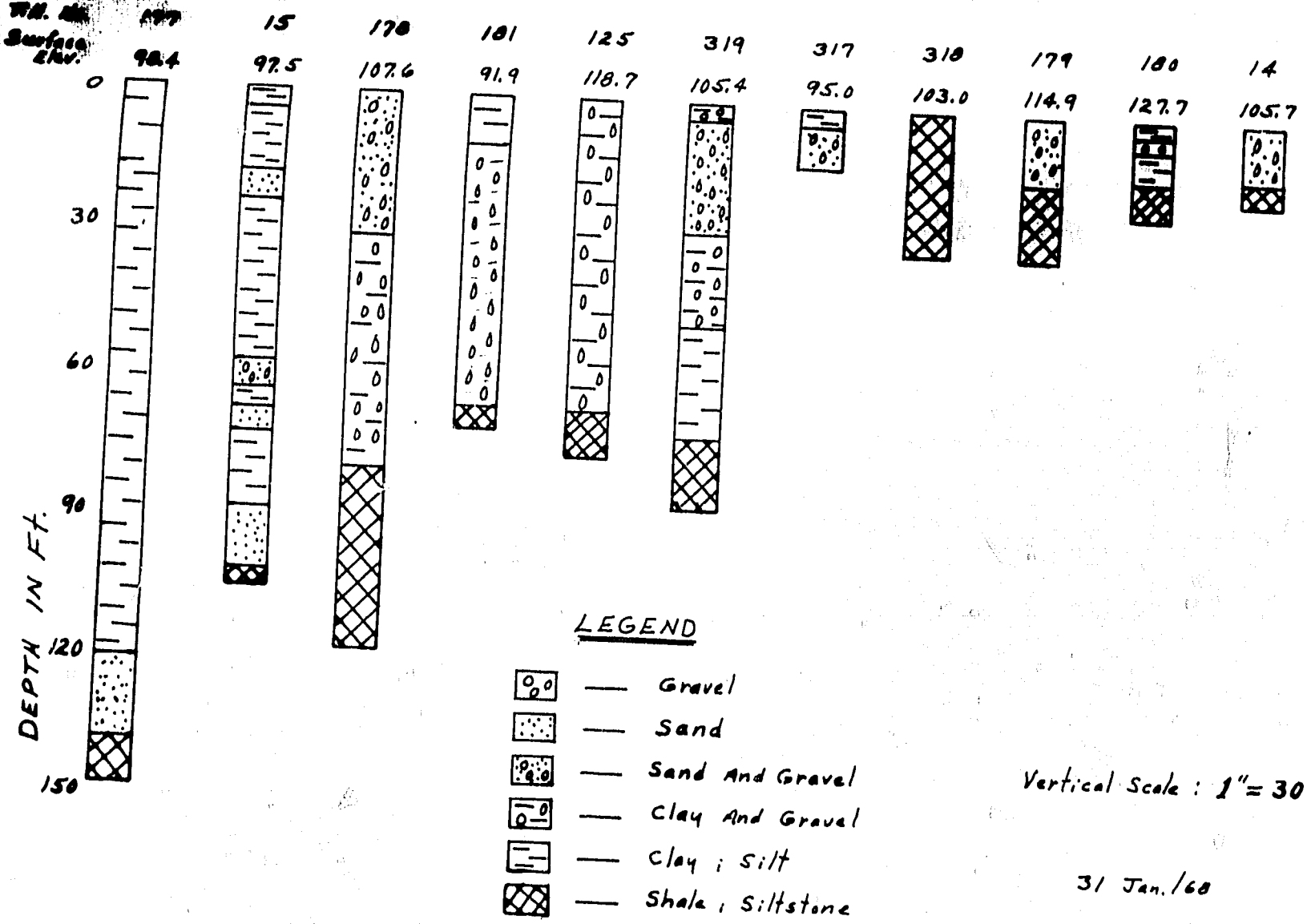
N.B.
Contours indicate depths to bedrock.

#180 — Test Hole No.
13' — Depth to bedrock in ft.

Scale: 1:50000

T. W. Hannigan

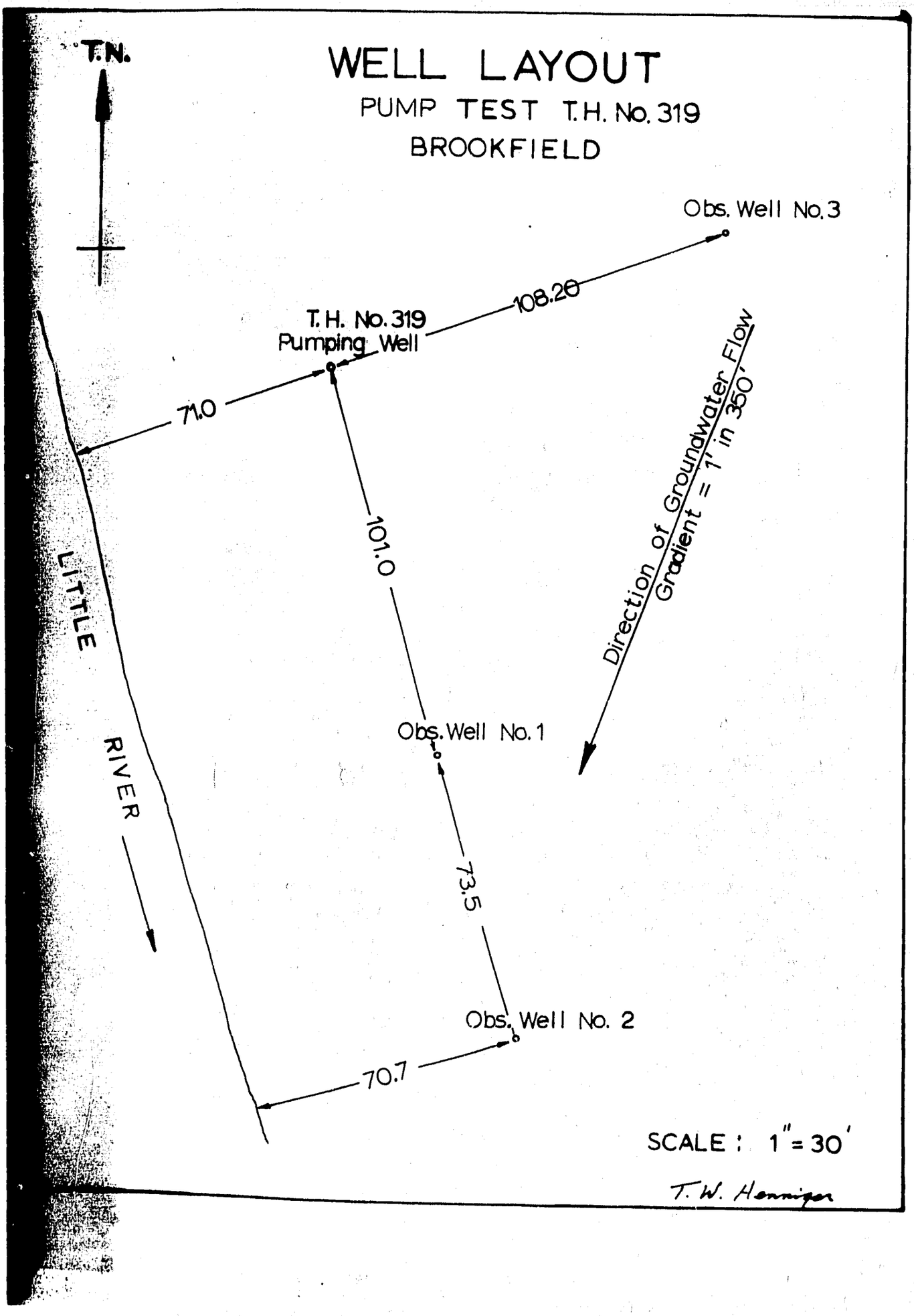
LOGS OF TEST HOLES IN THE BROOKFIELD AREA



Vertical Scale : 1" = 30'

31 Jan./60

T. W. Hennigan


T.N.
WELL LAYOUT
PUMP TEST T.H. No. 319
BROOKFIELD
Obs. Well No. 3
108.20
T. H. No. 319
Pumping Well
71.0
101.0
Direction of Groundwater Flow
Gradient = 1' in 350'
LITTLE
RIVER
Obs. Well No. 1
73.5
Obs. Well No. 2
70.7
SCALE : 1" = 30'
T. W. Hannigan