Technical Report #24

GROUNDWATER SURVEY - FIELD INVESTIGATIONS SHUBENACADIE-STEWIACKE RIVER BASIN NOVA SCOTIA

by

T. Lay

SHUBENACADIE-STEWIACKE RIVER BASIN BOARD

a joint federal provincial project

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Prepared for

THE SHUBENACADIE-STEWIACKE RIVER BASIN BOARD

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NOTICE

This is one of a series of technical documents based on studies undertaken by Consultants at the request of the Shubenacadie-Stewiacke River Basin Board. The Board is publishing this series of reports in order to make its findings available to government agencies and interested members of the public at the earliest possible date. The Board does not, however, assume any responsibility for the content of these reports nor is it bound by any recommendations or conclusions contained therein. The Board will consider the findings of these reports within the context of multiple purpose water management objectives.

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i. SUMMARY

Existing reports and government and company files were perused to provide data on which to make decisions on further water quality and quantity exploration activities. Fourteen test hole locations were selected within the communities of Lantz-Elmsdale, Enfield and Hardwoodlands. An assessment was made of surficial and bedrock potential in the Shubenacadie to Milford and Milford Station areas.

Eighteen water samples were collected from drilled wells in the study area and they displayed varying degrees of quality with location. Results from Milford and Milford Station and Middle Stewiacke were generally acceptable, according to the Canadian Drinking Water Standards. Several wells from Nine Mile River and one from Brookfield displayed unacceptable levels, while the acceptability of levels in Shubenacadie varied, depending upon the materials penetrated and well depth.

Of the fourteen test holes drilled, holes number five, six and seven in Lantz-Elmsdale, hole number eleven in Enfield and hole number fourteen in Hardwoodlands produced evidence of surficial materials which are deemed to have water resources development potential. Conclusions as to the degree of saturation in the holes and water samples from all holes were unobtainable due to the drilling method employed. On the basis of the test hole information, a decision was made to proceed with a production well at Hardwoodlands and recommendations were made concerning the remaining areas with development potential.

The results of the production well drilling activity proved that the surficial materials from the section of the aquifer under study were capable of producing in excess of one hundred

gallons per minute of good quality water from a sixty-five foot well in silty, slightly gravelly sands. It was then decided to commit the well to test pumping.

The production well was subjected to a seventy-two hour test pumping, employing the step-drawdown technique. This produced a maximum pumping rate of 490 U.S. gallons per minute and a total drawdown of 4 feet in the production well.

Evidence is not conclusive as to the classification of the aquifer, so a conservative approach was adopted and it was tentatively designated a leaky artesian type aquifer. Results of pumping proved that there is a large volume of water in storage and the production well could have been pumped at a higher rate, if the equipment had permitted. Some conjecture arises as to the ratio of water volume in historical storage to the amount of continual recharge to the aquifer, and may only be reconciled by developing further information on the hydrology of the Hardwoodlands area of Hants County.

1. INTRODUCTION

This study was initiated as a supplement to the author's 1977 study entitled "Groundwater Resources Study, Shubenacadie - Stewiacke River Basin System". It endeavors to follow the recommendations of the 1977 study and follows from the terms of reference as set out in Schedule "A" of the contractual agreement between the Board and the consultant, dated February 15, 1978. The actual terms accompany this report as Appendix A.

The present report outlines existing information pertaining to surficial and bedrock hydrogeology, chemical analysis of surficial and bedrock well water samples, test hole drilling, production well drilling and test pumping. Conclusions and recommendations are drawn as to the availability and utility of surficial and bedrock groundwater resources in the study area.

2. INFORMATION REVIEW

2.1. PROCEDURE

The existing files and library of the Nova Scotia Department of the Environment were scanned to update previously obtained information on water quality and quantity and communications were also held with private concerns to secure pertinent data. Water chemistry analyses for the Basin area were obtained from the Water Chemistry Lab at the Nova Scotia Agricultural College and these values were compared with existing data. Water quality sampling sites were chosen. An assessment was made of the most appropriate research method to employ for acquiring information on surficial and bedrock materials within the Basin.

2.2. FINDINGS AND CONCLUSIONS

Pertinent data was obtained from a report prepared for the Department of Indian and Northern Affairs, entitled "Subsurface Conditions, Proposed Sand and Gravel Pit, Shubenacadie, Nova Scotia". Also, information on the depth and character of surficial materials at Nova Scotia Sand and Gravel property in Hardwoodlands was available directly from company files, which contained results of diamond drilling activities.

The files of Nova Scotia Sand and Gravel indicated that depths of sands and gravels average about 40 feet along the length of the esker, within their property lines. The average depth of materials below the water table was about 15 feet. Most of the boreholes displayed various grades of sand, with gravel showing in only a few columns. The eastern section of the aquifer was not considered for investigation during the programme due to: inaccessibility resulting from excavation activities; the lack of known gravel content and possible interference with the existing water supply of the Shubenacadie Indian Reserve. The report prepared for Northern and Indian Affairs indicated that the depth of materials ranged from 20 to 60 feet. Some hilly sections of the esker through which holes were drilled were about 40 feet above the surrounding land surface, while the static water level was about 5 feet below the land surface.

A report entitled, "Preliminary Report on the Groundwater Survey of the Elmsdale - Lantz Area, Hants County", prepared for the Department of Mines in 1969, provides data relating to the groundwater resources of the Enfield to Shubenacadie corridor. This report delineates confined and unconfined surficial deposits in Elmdsale and Lantz. This information was considered along with topographical information and existing well log information in selecting sites for the surficial materials test hole drilling programme. It refers to two wells in the Lantz Siding and Barney's Brook area which are bottomed in sand and gravel.

Information on the bedrock and surficial water bearing units in the Shubenacadie area was available from a report entitled, "A Groundwater Report on the Nova Scotia Department of Lands and Forests Complex at Shubenacadie". A well point system was constructed in shallow sands along an existing streambed (Map 3). This system is capable of producing at least 50 igpm of acceptable quality water (Canadian Drinking Standards). A similar geologic setting in other areas of the community could service a community of 20 homes. There is no further information on the existence of channelization in glaciofluvial materials. The log of one located well (A) indicated there was at least 142 feet of gravel to the east of a horseshoe in the Shubenacadie River (Map 3). Other well logs from Department of Environment files also indicate the presence of sands and gravels running in a north-south direction along the river. The wells are designated as B and C on Map 3 and the logs are respectively: 0 - 105' clay and boulders, 105 - 112' gravel; 1 - 40' clay, 40 - 42' gravel. These wells indicate the river may have flowed farther to the east at one time depositing the now buried sands and gravels. A chemical analysis (1970, not available) of well A indicated that the water from this well was very high in dissolved solids according to the Canadian Drinking Water Standards and basically untreatable (1970 technology). It is possible that a shallow well drilled in the area of well A could yield water of a more compatible nature. A well drilled in the area of wells B and C could prove to produce poor quality water as these wells are probably in direct contact with the underlying gypsum and limestone.

The Lands and Forests report describes three wells bottomed in limestone and gypsum (D, E, F of Map 3) which were located and sampled in 1970. The chemical analysis revealed that wells D and E had high sulfate and dissolved solids values and were 255 feet and 350' deep respectively, while well F was only 116 feet deep and displayed an acceptable level for all parameters. The quantity of water from these wells was estimated by drillers to be around 5 igpm. The yields of wells drilled into Windsor sediments are highly variable, due to solution channels in limestone and gypsum beds yielding large amounts of water and units like shale and massive limestone yielding small amounts. Wells drilled into these materials could provide sufficient water for small subdivisions (refer to pump test at West Hants Rural High which produced a 20 year safe yield of 45 igpm). The major problem that arises is to obtain appreciable amounts of water. Deep wells are often required and the closer they come to bedrock, the higher the content of dissolved solids they exhibit.

Water analyses for a few locations in Hants County, acquired from the Water Chemistry Lab of the Agricultrual College, proved to be consistent with existing information on values of the chemical parameters for which the samples were processed. The particular water well sampling sites were chosen from several communities in the Basin so as to provide information on groundwater within the Windsor bedrock in areas where little quality data was available. It was decided that a series of test holes should be drilled with subsequent surficial materials sampling, to provide information on surficial materials within the Basin. A decision on bedrock well drilling was to be partially based on the results of the well water sampling programme.

3. WELL WATER SAMPLING

3.1 PROCEDURE

The water quality sampling programme was conducted on December 14 and 15 of 1977. A total of 18 samples were taken from Nine Mile River, Milford and Milford Station, Shubenacadie, Middle Stewiacke and Brookfield. The sample locations are depicted on figure 1. All wells are drilled in Windsor bedrock except for wells 16 and 17 which were bottomed in sands and gravels. The well owner, sample location, and well characteristics are given in Appendix B. The samples were analyzed for a variety of chemical parameters at the Environmental Chemistry Division of the Pathology Lab in Halifax. The values of the various parameters are given in Appendix C. The level of acceptability attributed to various samples refers to the standard values set forth under the Canadian Drinking Water Standards for various chemical parameters. The conclusions drawn in this report regarding water quality are based on chemical parameter values as determined under this study, along with values from previously existing studies.

3.2 RESULTS

A. Nine Mile River

The three samples (#1, 2, 3) taken from drilled wells in the area displayed high calcium (> 200 ppm), sulphate (> 500 ppm) and hardness (>180 ppm) values, which is a common trait of the quality produced by the host Windsor bedrock.

B. Milford, Milford Station

Six of eight samples (#4, 6, 7, 8, 10, 11) taken from drilled wells in the area revealed high (greater than standard of 180 ppm) hardness values. Other parameters tested revealed acceptable levels.

C. Shubenacadie

Two samples (#12, 13) taken from drilled wells displayed high to very high (294 to 648 ppm) hardness values and high manganese (0.05 ppm.) values. One sample (#17) which was taken from a drilled well in surficial sands and gravels at the Wildlife Park in Shubenacadie, revealed acceptable quality water.

D. Middle Stewiacke

Three samples (#14, 15, 16) were collected from drilled wells. Wells # 14 and 15 were bottomed in Windsor bedrock and # 16 was in sands and gravels. The quality of water was acceptable in # 15 and 16, while # 14 exhibited high (above recommended limits) hardness, sulphate, iron (>0.3 ppm.) and chloride (>250 ppm.) values.

E. Brookfield

Water well sample # 18 displayed high hardness, sulphates, iron, manganese, turbidity (>5 J.T.U.), colour (>15 T.C.U.) and conductivity.

3.2 CONCLUSIONS

A. Nine Mile River

The water quality data available indicates that the Windsor bedrock in this area produces mainly poor quality water. The hardness values are too high to be economically treatable and the sulphates are not readily treatable by existing methods.

B. Milford and Milford Station

The Windsor bedrock in this area produces variable water quality. There are a number of wells which produce acceptable quality water. The high iron and hardness (calcium, magnesium) parameters found in the remaining wells, are treatable by existing methods.

C. Shubenacadie

In Shubenacadie, the chemical analysis of drilled well samples indicate high hardness values in bedrock samples. One well (648 ppm.) is not considered economically treatable, while the other at 294 ppm. is treatable. The surficial materials can produce good quality water, but the depth of well penetration must be minimal ($<$ 60 feet).

D. Middle Stewiacke

The Windsor bedrock can produce acceptable quality water for domestic and industrial purposes.

E. Brookfield

The one water quality analysis from the Brookfield - Alton area displays very poor water quality, but an accurate assessment cannot be made on the basis of this one sample. This is particularly true since previous data has indicated that acceptable quality water is available in the Brookfield area, depending on bedrock type.

4. TEST HOLE DRILLING PROGRAMME

4.1 PROCEDURE

On the basis of existing reports and physical conditions, fourteen test hole sites were selected within the communities of Enfield, Elmsdale, Lantz and Hardwoodlands. They are noted on Report Maps 1-4. Agreements were signed with various landowners to obtain the access rights needed to carry out drilling activities.

The drilling machine employed belonged to Scotia Diamond Drilling Limited and was track-mounted, which was a necessity so as to enable movement to the designated sites. It was also necessary to use a small caterpillar tractor to facilitate movement through the two to three feet of fallen snow. The original plan was to employ diamond drilling apparatus and split-spoon sampling to drill through surficial materials and collect samples. After drilling a few holes, it was decided to switch to a rotary bit and a water line to retrieve washed samples. Drilling in each hole was terminated when bedrock was encountered and identified.

Where possible, a plastic pipe was placed in each hole to permit present and future water sampling. Attempts at placing plastic pipe in most holes were fruitless due to clay or sands and gravels tending to close in very quickly before piping could be dropped. Material samples from five of the fourteen test holes were analyzed at the soils lab of Maritime Testing in Halifax and water samples from two holes were analyzed at the Environmental Chemistry Division of the Pathology Lab in Halifax.

4.2 RESULTS, CONCLUSIONS

A description of the drilling activity at each site and the written logs of each hole are contained in Appendix D of this report. A graphic log for each hole is contained in Appendix E. The lab analysis of material samplings from selected holes (# 5, 6, 11, 12, 13) is contained in Appendix F. The values of chemical parameters for water samples from holes # 11 and 14 are contained in Appendix G. The test holes and production well were surveyed and tied into existing land forms and man-made structures. The drafted results are contained in Appendix H.

A. Lantz - Elmsdale

Test holes # 1, 2 and 8 were drilled in surficial materials in the Lantz area. Hole # 8 indicates that there is no noticeable amount of sands and gravels in that part of the river floodplain. A definite conclusion cannot be drawn from hole # 1 since it did not reach bedrock, but it seems plausible that it may contain only clay till over bedrock, as does hole # 8. This indicates that any glacio-fluvial materials in the area will be basically channel deposits. This type of deposit is probably what was encountered in wells # 3 and 4 of the report, "Preliminary Report on the Groundwater Survey of the Elmsdale - Lantz Area, Hants County, Nova Scotia". This suggests that any further exploration drilling in this area should be in close proximity to these known domestic wells.

Test holes # 3, 4, 5, 6 & 7 were drilled in Elmsdale. Hole # 4 served to define the southeasterly extent of alluvial materials. It displayed no development potential. Hole # 5 encountered 75 feet of intermixed silts, sands and clays. It appears to have penetrated a thick section of the river floodplain. This floodplain probably extends southerly, a little beyond where the transmission lines pass through and up to the base of the low surrounding hills. The surficial materials decrease in thickness along a southerly trend. The materials in hole # 5 were classed as mainly sandy silts. The degree of saturation is not known, since a water line was used in the drilling technique. It is known that the drilling method would have washed a fair percentage of the fines from the processed samples. A shallow well drilled in the area of test hole # 5 may yield water of acceptable quality, as the underlying gypsum should contribute less dissolved solids as depth decreases. Due to the necessity of a shallow well and the fineness of materials, it would be difficult to produce large quantities of water from a screened well in these materials.

Test holes # 6 and 7 proved that surficial materials extend out at least 200 feet west of the Shubenacadie River and reach a depth of 65 feet below the surface, for a section along the river between Lantz and Elmsdale. The materials in hole # 6 were classed mainly as silty sands, although a few thin layers of boulders were detected. This evidence indicates that the river previously followed a more westerly route and perhaps a wider path. The degree of saturation of materials is not known. Considering a moderate degree of saturation, a properly constructed screened well could produce appreciable amounts of water. The underlying limestone will impart a certain amount of dissolved solids to the water, but it should be acceptable or at least treatable.

Test hole # 3 contains layers of fine to medium fine materials. The upper layers (5 - 88 feet) offer limited development potential. The materials in the 88 to 153 foot range could be screened to produce noticeable (> 20 igpm.) amounts of water, although there is a high risk that such a well would produce water high in dissolved solids, due to the close proximity of the gypsum bedrock.

B. Enfield

Test holes # 9, 10 and 11 were drilled in Enfield. Holes 9 and 10 prove that gypsum bedrock underlies the area of the drill sites to a depth of from 20 to 60 feet. The surficial materials sampled are mainly a mixture of clay and sand and boulders and they offer little development potential. The holes serve to show that there are no extensive sand and gravel deposits within the southern sector of the town.

Test hole #11 was drilled in a known gravel pit. The log suggests that the majority of underlying surficial sediments are lacustrine clays and silts, with layers of sand. Considering the surrounding topography, bedrock characteristics in the area and the path of the river, the borehole may be drilled into an ancient lake bed, as the samples appear to represent varve deposits (interlayered silts and clays found in lake beds). The water level (15 feet below surface) indicates that the sediments are saturated, but the high percentage of finegrained materials diminishes the permeability of the sediments considerably. A screened well in these materials would require a long length of screen and possibly a gravel pack. A water sample from the hole displayed high hardness, iron, manganese, colour and turbidity values. The high iron and manganese values may be due to the bedrock (Meguma) and/or drilling materials. The excesses of iron and manganese may also be the partial result of collodial suspensions of ferric iron and manganic manganese, which would be classed as a sporatic phenomena.

The high colour and turbidity are due to drilling which is not a problem. The water would be treatable for the high values of hardness, iron and manganese.

C. Hardwoodlands

Test holes # 12, 13 and 14 were drilled to surficial materials at Hardwoodlands. Hole # 12 showed red clay till at 12 feet, which delineates (Map 2) the southern extremity of the deposit. Hole # 13 was drilled on the north side and # 14 in the centre of the deposit. The water level in # 13 was about 7 feet and was 3 feet in # 14. A short, driller's pump test on hole # 14 produced about 10 gpm., with no noticeable drawdown from the surface along the 50 foot hole. A 55 foot iron cased well nearby was pump tested and produced only 2 gpm. It was concluded that the hole was clogged at the bottom with materials and when cleared could produce a greater yield. A water sample from hole # 14 indicated good quality water was available (Appendix G). Considering the available data on the characteristics of the materials and the physical structure of the deposit, it was decided that this site merited construction of a production well.

5. PRODUCTION WELL DRILLING PROGRAMME

5.1 APPROACH AND PROCEDURE

The site selected for the production well was determined from the evidence collected from test holes #12, 13 and 14 and from previously existing information. A vague log of a 50 foot well drilled and set with steel casing several years ago indicated that the chosen site was one of the few known vertical sections in the Hardwoodlands aquifer which contained an appreciable amount of gravel. This hole was selected as observation hole #2 (Map 2). Several weeks earlier this observation hole was pumped but produced only 2 gpm. A field analysis of sample materials from test hole #14 indicated that the geologic column contained mainly medium to coarse sand and fine gravel with a few boulders. These materials are often capable of producing noticeable quantities of water. Test hole #14 was bailed at 10 gpm. It is designated as observation hole #1 (Map 2). Other diamond drill-hole information produced by Nova Scotia Sand and Gravel for their own records indicate the presence of various grades of sand along the length of the esker, but show limited amounts of gravel present. For these reasons and because the existing drilled well on the site could serve as an observation well, the production well was placed about 90 feet from observation well #2. Due to the surrounding topography, it was not possible to locate the production well more than 15 feet from observation hole #1.

A cable tool drilling rig was employed for the project, since careful sampling of materials and detection of water-bearing zones were the prime objectives and this machine is particularly adept at producing an acceptable level of information for these purposes.

The production hole was drilled large enough to accommodate an 8 inch steel casing which was run to 80 feet. Material samples taken from the hole at five foot intervals were analyzed on the site. These samples were combined into 10 foot samples and sent to the soils lab at Maritime Testing for analysis.

The well was bailed at 35 gpm for 1½ hours at the 80 foot level and the static water level dropped from 3.0 feet to 3.9 feet. An 8 foot long telescopic type slot 40 screen was set with its bottom at 62.8 feet. The casing was raised to accommodate the screen. The well was developed for about 16 hours and bailed for 6 hours at approximately 100 gpm. There was only 2.5 feet of drawdown noted.

5.2 RESULTS AND CONCLUSIONS

A lithologic description and graphic log of the production well are contained in Appendix I and J respectively. The results of the soils lab analysis of the samples from the production hole are contained in Appendix K.

Noticeable amounts of water were encountered at the 40 to 50-foot, 55 to 63-foot and 70 to 75-foot levels of the geologic column. The static water level was at about 3 feet while drilling from the 0 to 40-foot depth. The materials analysis and on-site observations indicate that several layers of very fine or tightly packed materials were penetrated during drilling. This layering could account for changes in static water level at different depths of the geologic column.

The lab analysis of surficial material samples from the hole indicate that it contains red-brown silty sand with traces of fine gravel. Based on the driller's six hour bail test at 100 gpm., it was decided that the production well should have a formal test pumping.

6. TEST PUMPING

6.1 PROCEDURE AND RESULTS

The pump test was of 72 hours duration and the step drawdown method was employed. A turbine pump with a maximum capacity of 490 U.S. (408 imp.) gpm. and a water meter attached to a discharge pipe from the well head were employed for the aquifer test. The production well was pumped at four different rates over four successive steps. The rate was 102 gpm. (U.S.) for the first step. This was increased to 156 gpm., then to 200 gpm., and then to 490 gpm., after 180 minutes of elapsed time. The test was then continued up to the 72 hour mark at the maximum rate. These rates were chosen at random so that the test would involve at least four steps. The monitored results of the test are included in Appendix L.

Observation well # 1 was about 15 feet west of the production well and was fitted with a plastic pipe down to about 20 feet. Observation well # 2 was about 90 feet east of the production well and was previously fitted with a non-perforated steel casing to about 55 feet. The static water levels in the production well and in observation wells # 1 and 2 were measured prior to pumping, and subsequent drawdowns were monitored. The static water levels were 4.0 feet, 4.1 feet and 1 foot respectively. The total drawdown in the production well was 4.8 feet over the 72 hour period. Drawdown measurements in observation well # 1 were aborted when materials filled in part of the pipe. The total drawdown in observation well # 2 over the step drawdown phase was about 0.3 feet and over the whole test was about 1.3 feet. Calculations were performed to determine the hydraulic characteristics of the aquifer.

6.2 CONCLUSIONS

The step drawdown method was employed to ensure that the production well would be pumped at the maximum rate which the equipment would allow (490 U.S. gpm.). Observation well # 1 was only monitored for about 105 of the total 4,320 minutes since it became clogged with sand, thus the information collected is not usable to determine aquifer characteristics. Observation well # 2 was thought to be clogged with materials at the bottom, and thus the data produced may be less than accurate. The drawdown in the production well and in observation well # 2 did not change appreciably with increases in pumping rate. This indicates that there is a large volume of water in storage and that the pumping rate could have been set higher, if a larger capacity pump had been available. The total drawdown was only about 4.8 feet for the length of saturated sediments which the pump was drawing upon. This length of saturated materials could be as little as 20 feet or as great as 60 feet.

The transmissivity (T) or the capacity of the aquifer as a whole to transmit water, was found to be 448,340 gpd./ft., by the Theis Recovery Method. The values for recovery of the pumped well after the 72 hour test pumping were employed and transmissivity is expressed in Imperial measure. The storage coefficient or the amount of water the aquifer releases from or takes into storage was determined to be 0.23 by a time-drawdown analysis of observation well # 2 values produced over the 72 hour pumping period. Well loss is that part of the drawdown in a pumped well which results from resistance to turbulent flow in the zone adjacent to the well, and through the screen. Using the step-drawdown values for the pumped well, the well loss factor (C) was determined to be o.19 $sec.^2/foot^5$. The well loss (S_w) for a drawdown of 4.17 feet and a 490 U.S. gpm. pumping rate was found to be 0.23 feet. Thus, the well loss was 5.5% of the total drawdown for a pumping rate of 490 U.S. gpm. The specific capacity in Imperial gallons was determined to be 235.55 gpm./foot.

It should be emphasized that the values of transmissibility and specific capacity are unrealistically high, since the close promixity of a nearly swamp and Grant Brook would have provided recharge to the aquifer during pumping, as discharge was directed into the swamp and brook.

The results of the pump test are very promising, but must be held in some reservation. The reason is that it is not known what type of water reservoir this aquifer represents. Evidence indicates that the surficial materials being pumped may form a basin-type reservoir, where water has been accumulating over a number of years. Also, the aquifer would receive recharge from the surrounding land through precipitation and possibly via an influx of water from Grant Brook, which runs through the aquifer and about 600 feet west of the production well. The volumes contributed from these possible sources is unknown.

If the water has accumulated in the reservoir over a lengthy time, and assuming a limited recharge from the surrounding area, then the total volume in storage would dictate the amount of water which can be pumped at a certain rate over a particular period of time. This means that the rate would diminish considerably over time. On the other hand, if the aquifer is receiving continual recharge of a considerable magnitude, then the rate achieved during the test pumping, or possibly a higher pumping rate could be employed for an infinite length of time. Actual rates of reservoir recharge probably fall between these two extremes, but existing information does not permit a more in-depth examination.

One feature that seems to deny the movement of noticeable amounts of recharge water into the reservoir from the surrounding land is that the surficial materials seem to form a V-shaped deposit under the length of the identifiable esker. This surficial deposit is bordered on both sides by relatively impermeable clays. This means that outside of precipitation, most water entering the reservoir probably moves over the surface and then along channels like Grant Brook. This would limit the amount of available recharge to the aquifer. These factors make the prediction of the long-term safe yield of the aquifer an uncertain exercise.

7. RECOMMENDATIONS

A. LANTZ-ELMSDALE

The silty sands along the Shubenacadie River between Lantz and Elmsdale at the confluence of the Shubenacadie and Nine Mile Rivers and in the area opposing that part of the Shubenacadie River configuration known as the "horseshoe", offer development potential. These are the areas penetrated by observation holes number five, six and seven. Several additional test holes (Map 1) and/or seismic lines paralleling the holes are required to determine the depth, character and areal extent of these surficial deposits. The drilling of production wells would be contingent upon assessment of field data, particularly knowledge of the degree of saturation of materials. Test pumping would depend upon the results of these activities.

B. ENFIELD

The surficial sands, silts and clays contained in the deposit penetrated by observation hole number eleven offer the greatest known groundwater potential in the area. To exploit this potential, several additional boreholes are required with sampling to determine the overall depth, areal extent and materials character of this deposit (Map 1). Upon consideration of the results, a decision would be made regarding the drilling of a production well and subsequent test pumping of this deposit of unconfined materials.

C. HARDWOODLANDS

Information is required on the streamflow and hydrology of the Grant Brook drainage system and of the lands surrounding the Hardwoodlands aquifer. A test pumping programme employing a production well and two properly constructed observation wells is recommended to accurately assess the hydraulic characteristics of the aquifer. The test should cover a longer time frame, which could be up to one month's duration. Information should be produced on the possible effects that the existing garbage dump on Blois Road may have on water quality in the area.

D. MILFORD, MILFORD STATION

Data is required on water quantity yields from bedrock wells. This means drilling of several production wells and subsequent test pumping in locations where water quality is known to be acceptable, according to this study. Areas which are considered to possess development potential based on acceptable groundwater quality and delineated on the accompanying Report Maps.

E. SHUBENACADIE

Potential exists for development of the water resources from drilled wells in surficial and bedrock materials. It is recommended that several boreholes (Map Report 3) be drilled along the Shubenacadie River System from Shubenacadie East to Shubenacadie, to determine the depth, character, degree of saturation and water quality of the surficial and bedrock materials. Exploration should concentrate on shallow wells, short of Windsor bedrock (i.e., less than 60 feet from the surface).

APPENDIX A

The Shubenacadie-Stewiacke River Basin Board wishes to evaluate alternative potential groundwater supply sources within the Basin. This information will be incorporated with surface water data to determine future management strategies for the Basin's water resources.

The consultant shall evaluate certain potential water bearing aquifers in the Basin.

Water quality analyses, pump testing, test drilling and analyses of core samples will be employed in this evaluation.

Specifically, the Consultant shall:

(1) Analyze water samples from existing wells and review existing pertinent geological information.

(2) Identify site locations for test drilling operations in surficial deposits in the Enfield-Shubenacadie corridor and evaluate the data obtained.

(3) Identify suitable site locations for bedrock test wells in the Milford-Shubenacadie area and evaluate the data obtained.

(4) Supervise drilling and recommend to the Board any wells identified in (2) above which warrant pump testing. Pump testing of those wells approved by the Board will be supervised by the Consultant and the results analyzed.

(5) Undertake test drilling in the Hardwoodlands aquifer.

(6) Submit a full report of findings, including analyses and recommendations, to the Board.

APPENDIX B

SAMPLE NUMBER	OWNER AND LOCATION	GRID REFERENCE	U.T.M.	SOURCE
1	Ernest Harvie Nine Mile River	533 889		135' drilled well 120' casing, gravel ?
2	Murray MacMillan Nine Mile River	554 860		87' casing, sandstone
3	Harold Dalrymple Nine Mile River	573 859		180' drilled well, sandstone
4	Murray Rankin Milford	683 867		35' casing, sandstone
5	Paul Jackson Milford	653 877		77' drilled well, 55' casing, sandstone
6	Borden McLellan Milford	657 881		65' drilled well, 65' casing, shale
7	Wayne Born Milford	656 884		64' drilled well, 65' casing, shale
8	Dondale Milford	662 884		180'drilled well, shale
9	David Langille Milford	664 884		110' drilled well, 90' casing, limestone
10	Joseph Whyte Milford Station	655 890		80' well, 40' casing, limestone
11	Graves Milford Station	658 890		85' drilled well, 40' casing, limestone
12	D. Lamond Shubenacadie	679 907		150' drilled well, 120' casing
13	Carl Anthony Shubenacadie	668 926		drilled well, shale
14	Gerald Brenton Middle Stewiacke	832 080		140' drilled well, 100' casing, shale

SAMPLE NUMBER	OWNER AND LOCATION	GRID REFERENCE		SOURCE
15	Bruce Brenton Middle Stewiacke	838	033	70' drilled well, 51' casing, sandstone
16	Leon Fisher Middle Stewiacke	882	071	60' drilled well, 60' casing, sand and gravel
17	N.S. Lands & Forests Shubenacadie	700	933	surficial well
18	Donald Boomer Brookfield	779	094	drilled well

APPENDIX C

CHEMICAL PARAMETERS (ppm) **	1	2	3	4	5	6	7	8	9
Sodium	575	63	260*	37	37	22	9.9	14	30
Potassium	0.2	3.3	3.8	2.1	3.4	2.6	1.6	2.1	2.0
Calcium	1.6	290	237	92	52	92	64	65	54
Magnesium	0.4	4.3	44	16	11	16	10	15	9.0
Hardness (as $CaCO_3$)	--	906*	777*	298*	174	298*	202*	225*	173
Alk (as $CaCO_3$)	142	100	47	234	200	169	174	230	204
Sulfate	1110*	870*	1138*	47	52	180*	39	28	2.7
Chloride	4.0	14	144	57	5.0	5.7	3.9	4.8	4.8
Fluoride	0.3	0.3	0.1	0.2	0.3	0.1	0.2	0.1	0.2
Silica (reactive)	9.8	7.5	8.6	10	8.7	8.0	8.7	7.2	8.2
Phosphate (ortho)	0.4*	0.02	0.03	0.02	0.04	0.02	0.02	0.02	0.08
Nitrate + Nitrite (as N)	0.1	0.1	0.1	0.1	0.1	0.1	0.01	0.1	0.1
Ammonia - N	0.1	0.1	0.2	0.1	0.1	0.1	0.01	0.1	0.1
Arsenic	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.00[illegible]
Kjel-N	0.1	0.1	0.1	0.1	0.1	0.1	0.01	0.02	0.01
Mercury	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00[illegible]
Iron	0.1	2.3*	0.6*	0.1	0.1	0.6*	0.5*	0.1	0.1

APPENDIX C (page 2)

HEMICAL ARAMETERS (ppm) **	1	2	3	4	5	6	7	8	9
langanese	0.05	0.2*	0.1*	0.05	0.05	0.05	0.06*	0.05	0.05
ead	0.005	0.005	0.005	0.005	0.005	0.03	0.02	0.005	0.005
opper	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
inc	0.05	0.4	0.2	0.1	0.05	0.2	0.1	0.05	0.1
otal rganic arbon	2	2.5	8	5.5	5.5	4	4	8	4.5
olour (T.C.U.)[1]	5	30*	5	5	10	15	10	5	5
rub. (J.T.U.)[2]	2.4	26*	63*	3.3	3.8	7.3*	4.8	0.7	1.3
ond. (umho/cm.)[3]	2600*	1600*	2400*	660	440	590	360	460	410
H (units)[4]	7.3	7.4	7.7	7.5	7.7	7.5	7.7	7.2	7.6

CHEMICAL PARAMETERS (ppm) **	10	11	12	13	14	15	16	17	18
Sodium	11	9.4	23	14	650*	15	11	3.2	145
Potassium	1.3	1.7	1.5	0.8	5.5	3.2	0.5	0.7	4.0
Calcium	90	56	98	228*	312*	49	22	4.6	188
Magnesium	17	17	12	19	42	10	4.3	1.1	43
Hardness (as $CaCO_3$)	293*	209*	294*	648*	955*	166	73	16	648*
Alk (as $CaCO_3$)	230	193	215	155	100	178	39	10	70
Sulfate	50	16	140	450	753*	22	24	80	810*
Chloride	21	39	9.0	18	1250*	4.1	12	60	19
Fluoride	0.1	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.2
Silica (reactive)	6.8	8.5	15	6.4	10	13	17	5.5	8.8
Phosphate (ortho)	0.02	0.03	0.07	0.02	0.03	0.06	0.02	0.02	0.02
Nitrate + Nitrate (as N)	0.4	0.1	0.1	0.1	0.1	0.1	5.9	0.2	0.1
Ammonia - N	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Arsenic	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Kjel-N	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mercury	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.000
Iron	0.1	0.3	0.2	0.1	1.6*	0.2	0.1	0.1	0.3*

CHEMICAL PARAMETERS (ppm) **	10	11	12	13	14	15	16	17	18
Manganese	0105	0.05	0.2*	0.1*	0.9*	0.09	0.05	0.05	0.3*
Lead	0.02	0.005	0.005	0.005	0.02	0.005	0.005	0.998	0.00
Copper	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.02	0.05
Zinc	0.1	0.1	0.05	0.06	0.4	0.05	0.07	0.7	0.05
Total Organic Carbon	4.5	3.0	3.0	6	2.5	5.5	2.5	2.5	3
Colour (T.C.U.)[1]	5	5	5	5	20*	5	5	5	20*
Turb. (J.T.U.)[2]	1.5	2.4	20*	0.5	103*	1.8	0.6	0.6	101*
Cond. (umhc/cm.)[3]	540	460	580	1090*	4900*	350	240	55	1570*
PH (units)[4]	7.4	7.6	7.4	7.4	7.4	7.8	6.5	6.0*	7.7

* Values which are considered to be excessive according to the Canadian Drinking Water Standards and Objectives manual are marked by an asterisk.

** Notes - Except colour, turbidity, conductivity and PH, all parameters are expressed in ppm.
1 - True Colour Unit, Platinum and Cobalt Scale; 2 - Jackson Turbidity Unit;
3 - Micro Mhos/Cemtimeter; 4 - Has significance in controlling corrosion and scaling tendency of water.

APPENDIX D

HOLE # 1 - LANTZ - FEBRUARY 15, 1978

The hole was begun using diamond drilling equipment and a pushing type bit. Split-spoon sampling was attempted, which required that the rods be withdrawn from the hole. But when rods were removed, the clay immediately closed in, thus sampling was not practical. The hole was aborted, since it was too difficult to retrieve samples and too expensive to finish it. It was possible to complete it slowly with the punching bit, but it would not be possible to determine what materials were present.

LOG OF HOLE # 1

0 - 7.5' - medium grained brown sand
7.5 - 56' - red clay till (with rocks of pebble size)
Hydrology - water at 50' rose to 5' in 24 hours

HOLE # 2 - LANTS - FEBRUARY 17, 1978

The same tight clay till was encountered beyond 25' and drilling and sampling became too difficult; thus, hole was aborted. It was too cold to employ rotary equipment with water feed.

LOG OF HOLE # 2

0 - 10' - medium grained sand
10 - 25' - red silty clay
25 - 45' - red clay till (small to medium pebbles)

HOLE # 3 - ELMSDALE - FEBRUARY 21, 1978

It was decided that a rotary chopping bit and water would have to be employed to enable drilling through the clay till with any acceptable rate of speed. Samples would be taken from the wash. Caving of the hole prohibited the dropping of plastic pipe.

LOG OF HOLE # 3 - ALONG NINE MILE RIVER

0 - 5' - medium coarse gravel
5 - 55' - red silt and clay
55 - 88' - red clay till
88 - 153' - reddish brown silt and fine grained sand
153' - gypsum

HOLE # 4 - ELMSDALE - FEBRUARY 27, 1978

LOG OF HOLE # 4 - ABOUT 150' FROM SHUBENACADIE RIVER

0 - 5' - silt
5 - 28' - red clay till
28 - 32' - fine grained sand
32' - gypsum

HOLE # 5 - ABOUT 200' FROM SHUBENACADIE RIVER

0 - 10' - fine sand
10 - 20' - fine sand
20 - 30' - silt and sand
30 - 42' - silt and sand
42 - 49' - seam of sand and fine gravel
49 - 53' - medium to coarse sand and clay stringers, sand grains and homogeneous
53 - 60' - boulder and medium to coarse grained sand
60 - 64' - seams of clay and medium to coarse grained sand
64 - 70' - medium to coarse grained sand
70 - 75' - fine to medium grained sand
76' - gypsum

HOLE # 6 - ELMSDALE - MARCH 3, 1978

LOG OF HOLE # 6 - ABOUT 150' FROM SHUBENACADIE RIVER

0 - 12' - medium-coarse grained sand
12 - 20' - silt (alluvium)
20 - 30' - fine sand
30 - 40' - fine sand and silt
40 - 50' - coarse sand
41' - boulder
42 - 54' - coarse sand
54 - 60' - boulders and coarse sand
60 - 63' - medium grained sand

LOG OF HOLE # 6 (continued)

63 - 70' - silt
70 - 80' - fine to medium grained sand
80 - 90' - fine to medium grained sand
90' - limestone

Plastic pipe was put down the hole but could only be pushed to about 54', short of a bed of boulders. An attempt was made on March 27, 1978 to take a water sample from the pipe, but the sampling unit could not penetrate beyond about 8 feet. The reason is uncertain, as it seems improbable that the material was forced up through the pipe when it was originally put in place, and it is not likely that an individual would bother to throw material down the pipe. It is recommended that the pipe be cleaned out in the future and then tested for water quantity and quality.

HOLE # 7 - ELMSDALE - MARCH 6, 1978

LOG OF HOLE # 7 - ABOUT 200' FROM SHUBENACADIE RIVER

0 - 10' - fine grained sand
10 - 40' - silt
40 - 50' - fine-medium grained sand and few boulders and rocks
50 - 54' - large boulders
54 - 60' - boulders and sand
60 - 64.5' - boulders, sand and silt
64.5 - 66' - limestone
Plastic pipe was not put in, since hole was caving in.

HOLE # 8 - LANTZ - MARCH 8, 1978

Hole # 8 was drilled about two feet from Hole # 2 which was previously aborted due to difficulty in drilling caused mainly by weather conditions. Hole # 2 could not be re-drilled because a piece of casing had been lost in the hole.

LOG OF HOLE # 8

0 - 12' - fine sand
12 - 40' - clay
40 - 58' - clay and boulders
58' - gypsum

HOLE # 9 - ENFIELD - MARCH 9, 1978

LOG OF HOLE # 9

0 - 10' - coarse sand
10 - 20' - coarse sand
10 - 20' - sandy clay till
30 - 36' - sand, clay and boulders
36 - 38' - seam of coarse gravel
38 - 40' - clay, sand and boulders
40 - 66' - sandy clay till
66' - gypsum

HOLE # 10 - ENFIELD - MARCH 10, 1978

LOG OF HOLE # 10

0 - 9' - medium grained sand
9 - 20' - clay and sand
20' - gypsum

HOLE # 11 - ENFIELD - MARCH 13, 1978

LOG OF HOLE # 11

0 - 2" - coarse gravel
2 - 10' - clay till and fine sand
10 - 18' - clay till and fine sand
18 - 32' - fine sand and few rocks
32 - 35' - light brown clay
35 - 37' - coarse sand, fine sand and bands of grey silt
37 - 39' - dark brown silt
39 - 40' - medium grained sand and dark brown silt
40 - 50' - silt and clay, band of clay and rocks
50 - 64' - clay and 2-foot seam of gravel at 52'
64 - 68' - Meguma bedrock
A plastic standpipe was put into the bottom of the hole and a water sample taken. A short pump test was attempted with a 15 gpm. capacity pump, but the pump was unable to lift water below 20'. The water level recovered by 2' in 5 minutes.

HOLE # 12 - HARDWOODLANDS - MARCH 15, 1978

LOG OF HOLE # 12

0 - 2' - earth
2 - 8' - medium grained sand and rocks
8 - 10' - sand and large rocks
10 - 12½' - red clay till
This hole is on the southern extremity of the main deposit.

HOLE # 13 - HARDWOODLANDS - MARCH 16, 1978

LOG OF HOLE # 13

0 - 6' - medium grained sand
6 - 8" - gravel
8 - 10' - medium grained sand
10 - 20' - medium grained sand and few rocks (lost all the water into the formation)
20 - 40' - medium grained sand
Split-spoon sampling was not possible since hole was caving in and using casing would consume too much time. This hole was on the northern extremity of the main deposit.

HOLE # 14 - HARDWOODLANDS - MARCH 20, 1978

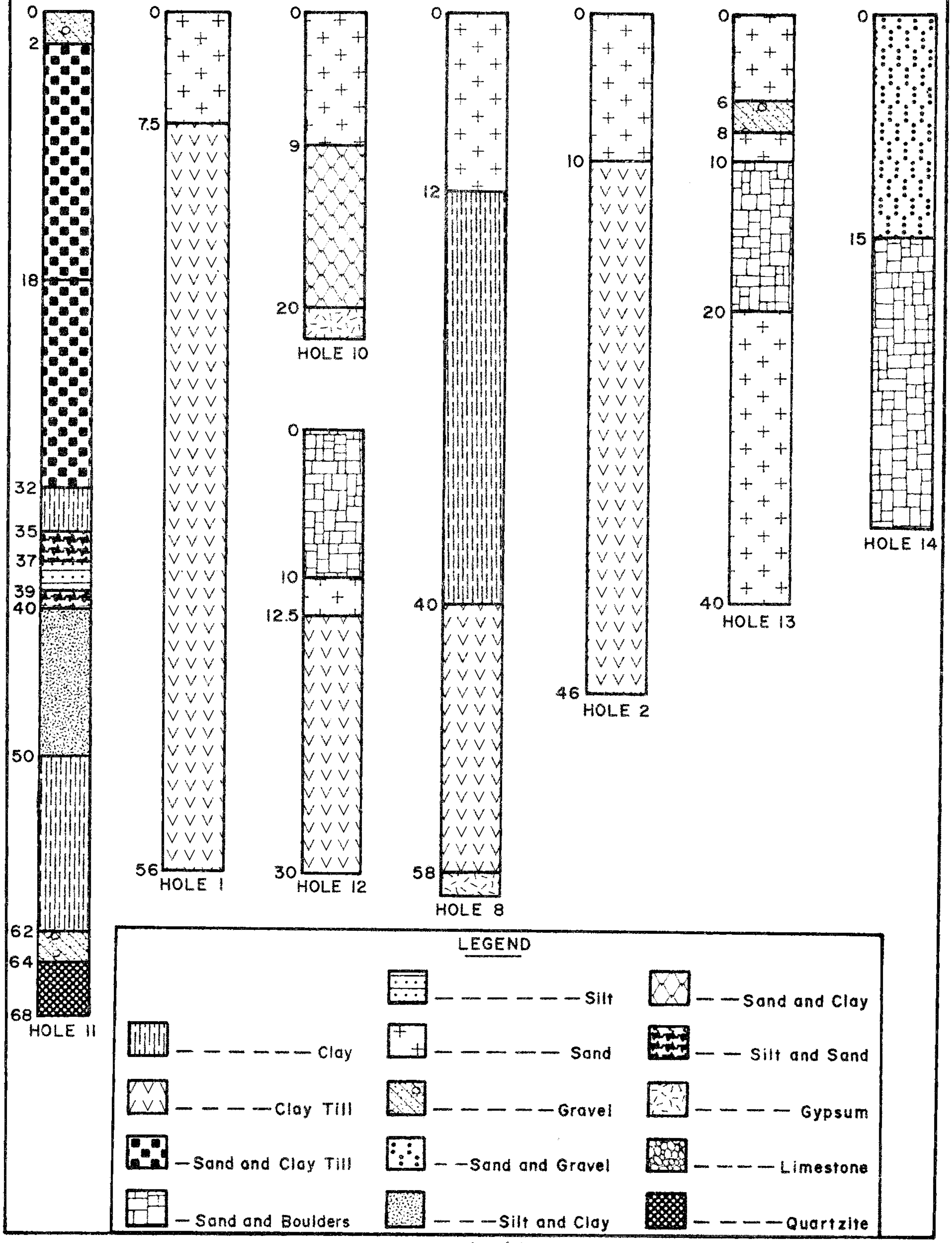
LOG OF HOLE # 14

0 - 15' - gravel, medium coarse sand
Casing put in to 15' but broke at about 5' from surface.
15 - 33' - medium to coarse sand and few boulders
33' - boulders
Hole pumped at 10 gpm. for one hour with no decline in water level.
34 - 35' - sand
No sample available since water lost to formation and caving in of hole prevented split-spoon sampling.
35' - boulders or bedrock
Very slow drilling. Hole completed at 35' since even with diamond bit, drilling was too slow and thus costly. Previous hole indicated that bedrock was at about 45' and boulders, sand and clay from 35 to 45'.
Plastic pipe was put down to about 15' and a water sample was taken.
A hole previously drilled to 45' by Messervey was cased to 45' in various grades of sand, gravel and boulders. This well was about 80' from hole # 14. It was pump tested at only 2 gpm., thus must have been plugged at bottom of casing.

Appendix E

Graphic Logs of Test Holes

Scale 1" = 10'



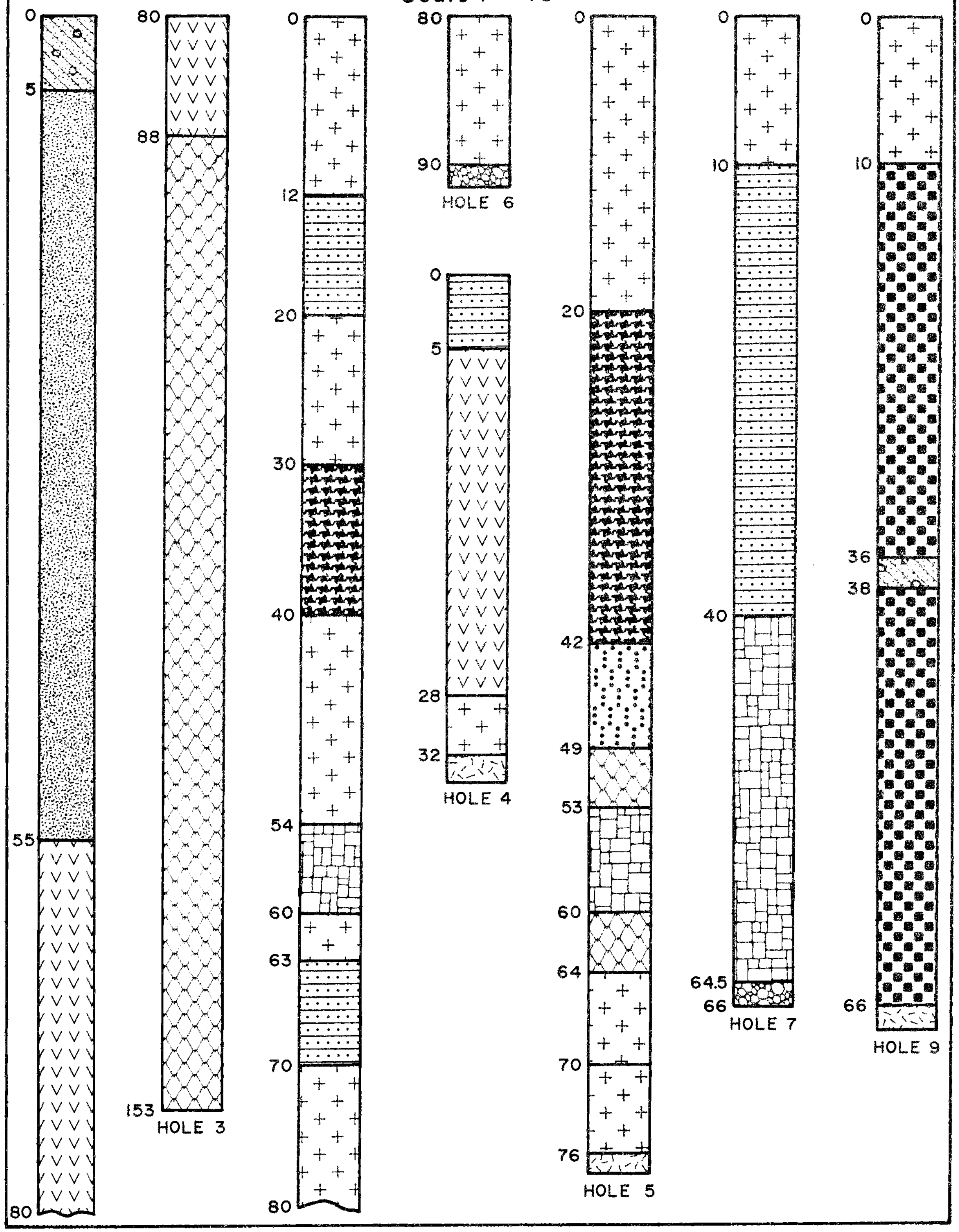
(con't)

DRH/79

Appendix E

Graphic Logs of Test Holes (con't)

Scale 1" = 10'



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APPENDIX F

PERMEABILITY IN SOILS AND ROCKS

Soil Description	Permeability Value		Rock Mass Description
	Term	k in cm/sec units	
Clean Gravels	Highly Permeable	$10^{2} - 1$	Very Closely to Extremely Closely spaced joints
Clean Sands, Sandy Gravels and Gravelly Sands	Moderately Permeable	$1 - 10^{-3}$	Closely to Moderately Widely spaced joints
Fine Sands, Silts, some weathered Clays	Slightly Permeable	$10^{-3} - 10^{-7}$	Widely to Very Widely spacedjjoints
Clays	Effectively Permeable	$< 10^{-7}$	Unjointed, Solid

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO. 81355
CLIENT T. LAY
SAMPLE
SOURCE ELMSDALE
HOLE 5 DEPTH 20'-30' DATE REC'D.
TECHNICIAN DATE TESTED

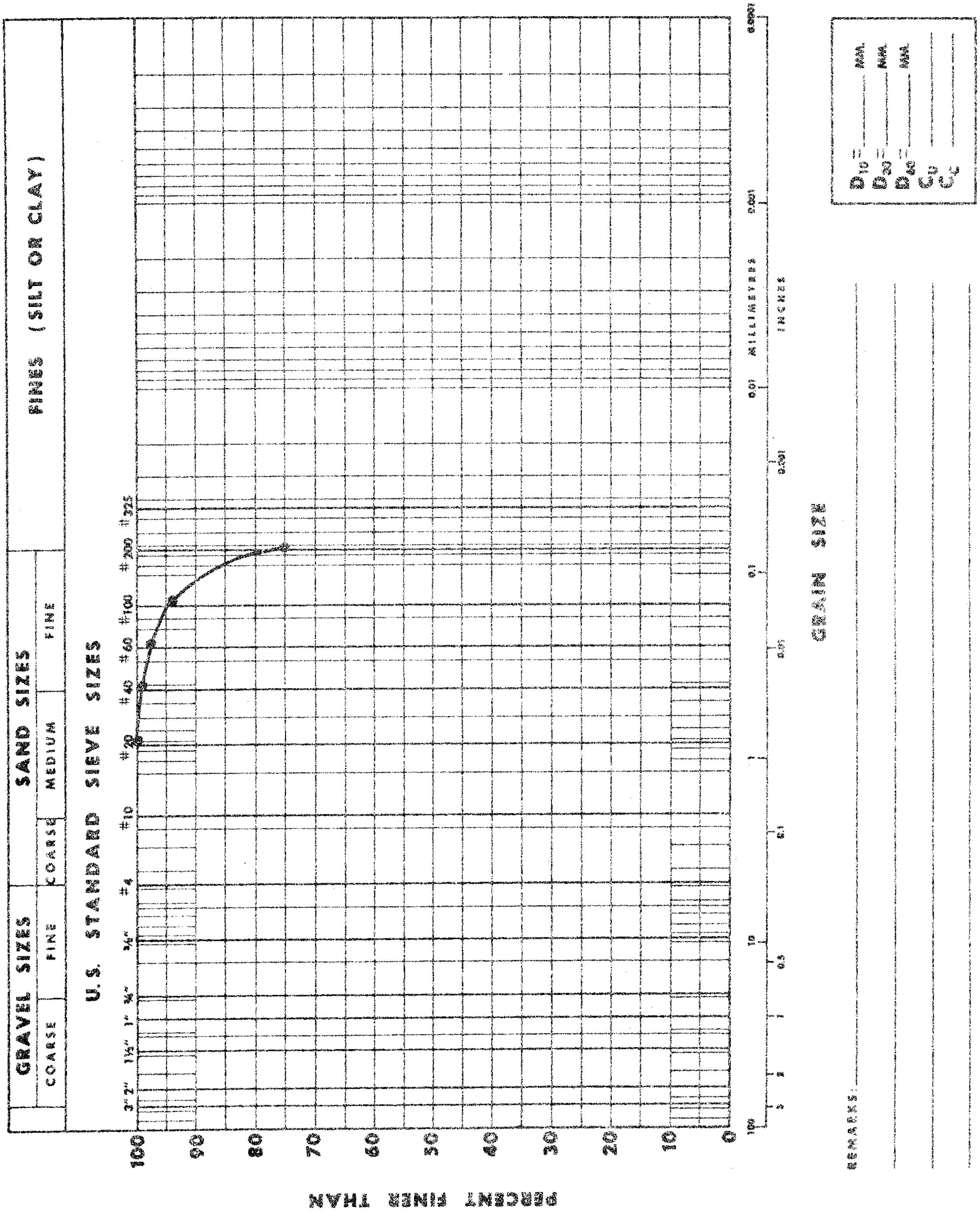
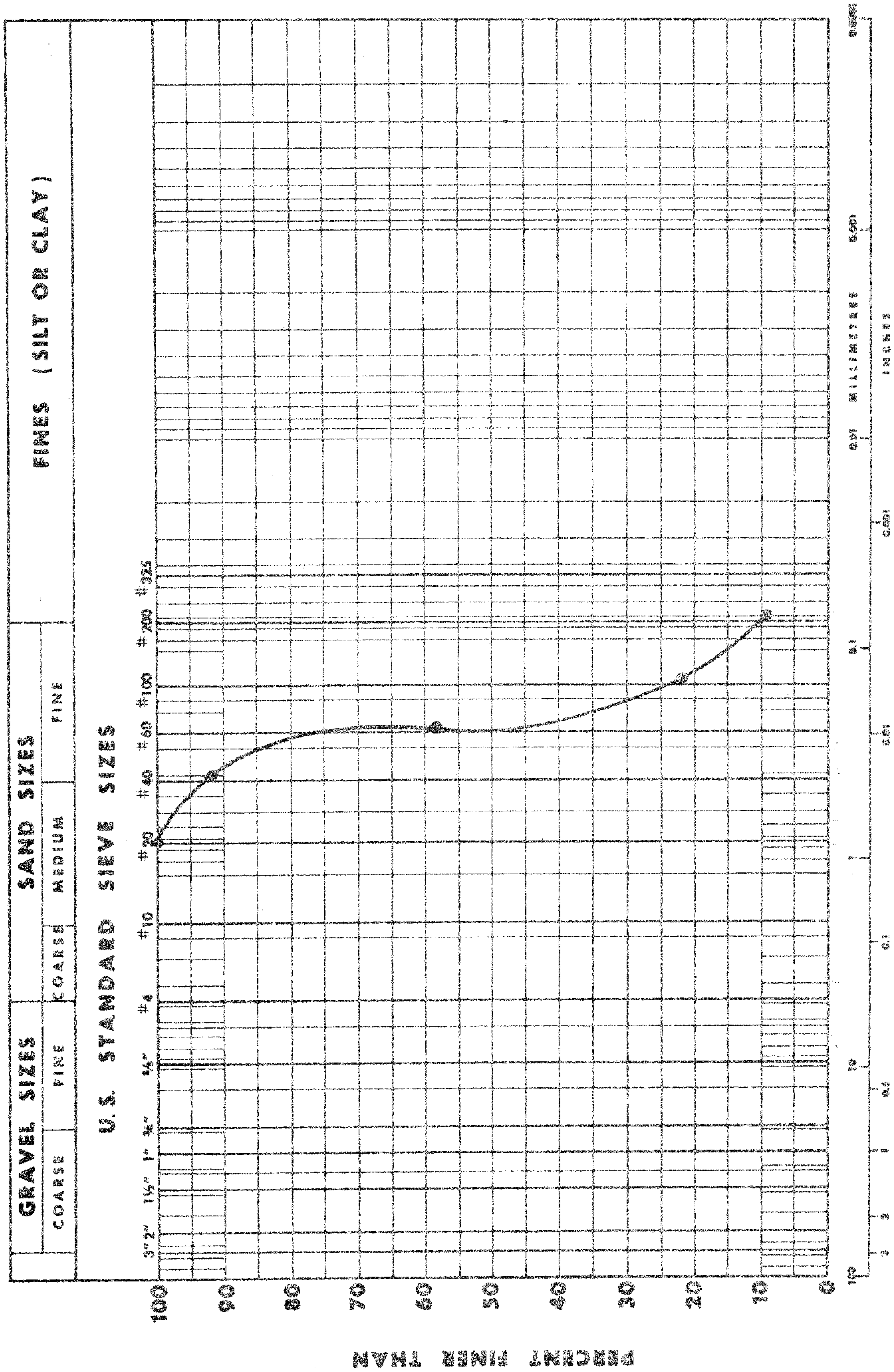


PLATE 1

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO.	S1355
CLIENT	T. LAY
SAMPLE	
SOURCE	ELMSDALE
HOLE 5	DEPTH 60'-70' DATE REC'D.
TECHNICIAN	DATE TESTED



D_{10} = ____ MM.
D_{30} = ____ MM.
D_{60} = ____ MM.
C_U = ____
C_C = ____

REMARKS: ____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 2

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO. 31355	
CLIENT T. LAY	
SAMPLE	
SOURCE ELMSDALE	
HOLE 6 DEPTH 40'-50'	DATE REC'D.
TECHNICIAN	DATE TESTED

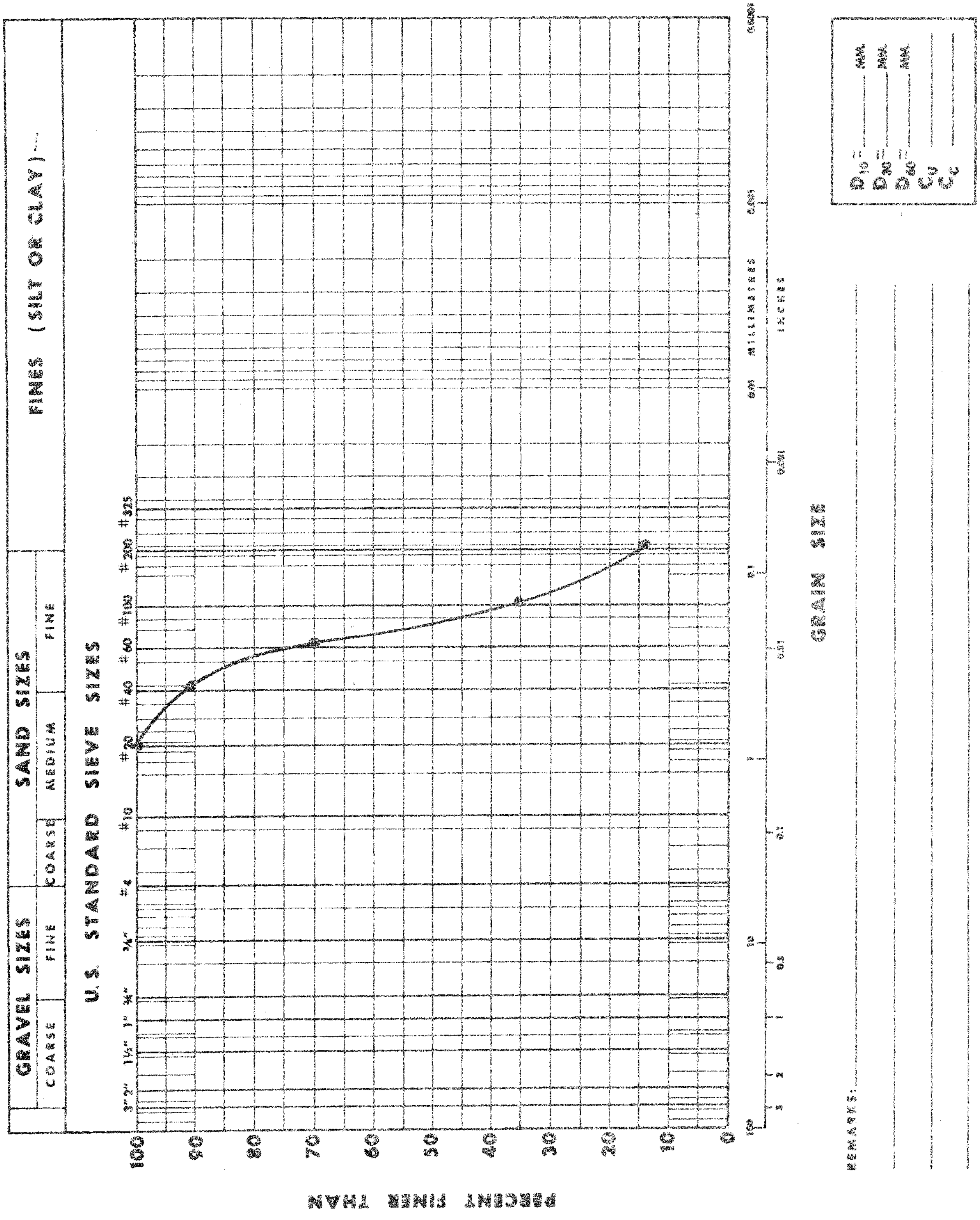


PLATE 3

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO. 31355
CLIENT T. LAY
SAMPLE
SOURCE ENFIELD
HOLE 11 DEPTH 35'-39' DATE REC'D.
TECHNICIAN DATE TESTED

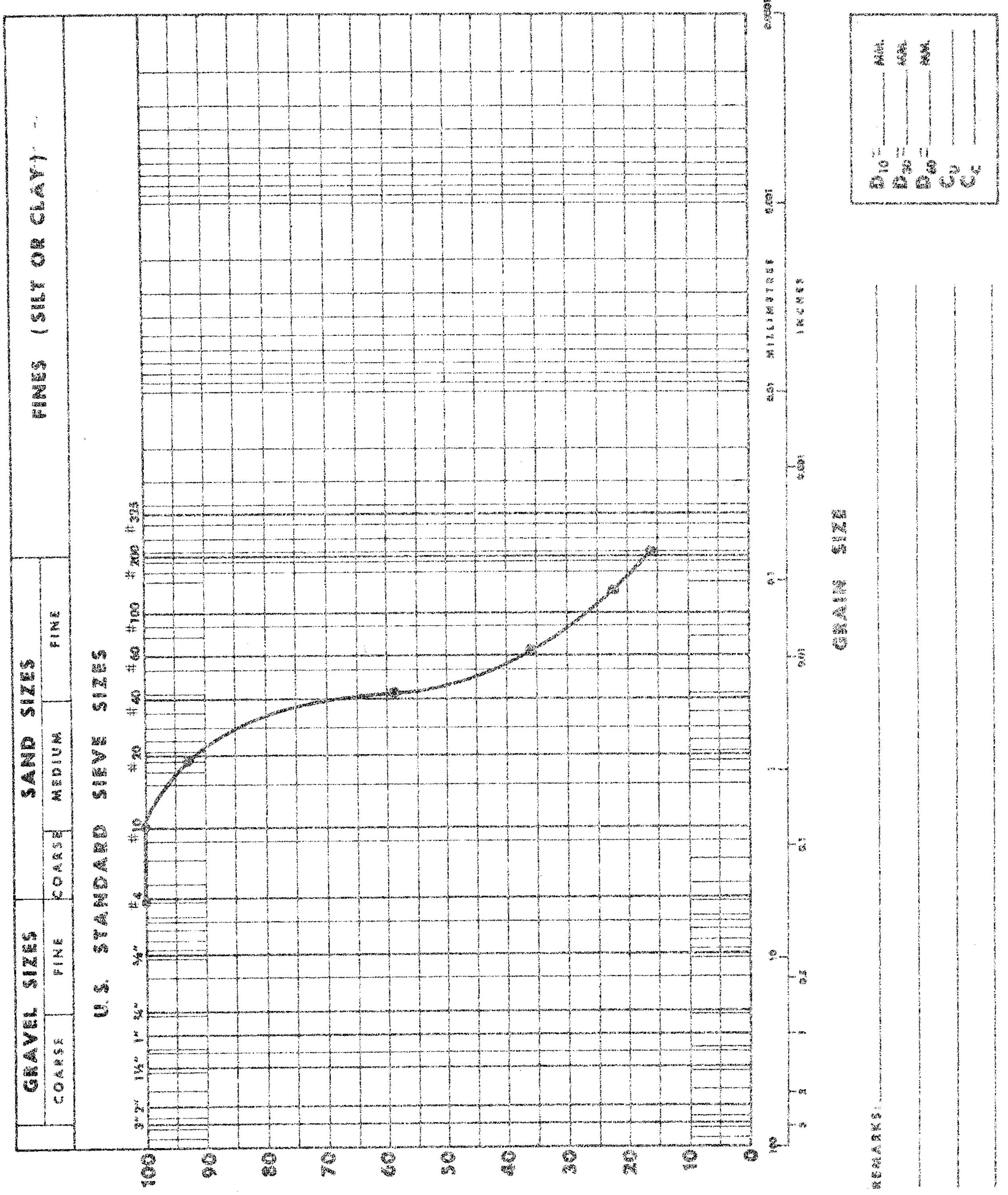
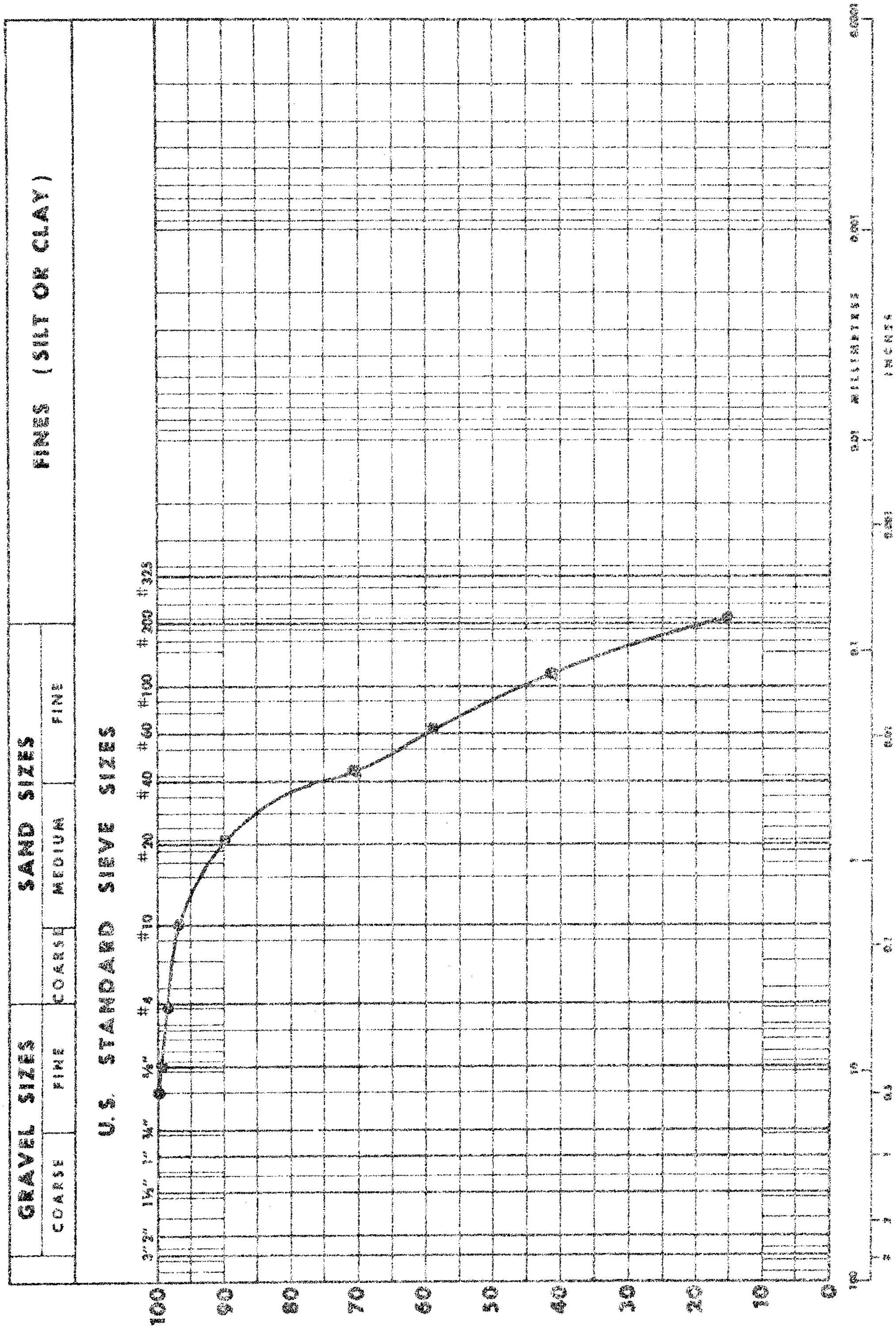


PLATE 4

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO.	S1355
CLIENT	T. LAY
SAMPLE	
SOURCE	HARDWOODLANDS
HOLE 13 DEPTH 20'	DATE REC'D.
TECHNICIAN	DATE TESTED



D_{10} = ——— MM.
D_{30} = ——— MM.
D_{60} = ——— MM.
C_U = ———
C_C = ———

REMARKS:

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 5

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO. S1355
CLIENT T. LAY
SAMPLE
SOURCE HARDWOODLANDS
HOLE 14 DEPTH 11'-13½' DATE REC'D.
TECHNICIAN DATE TESTED

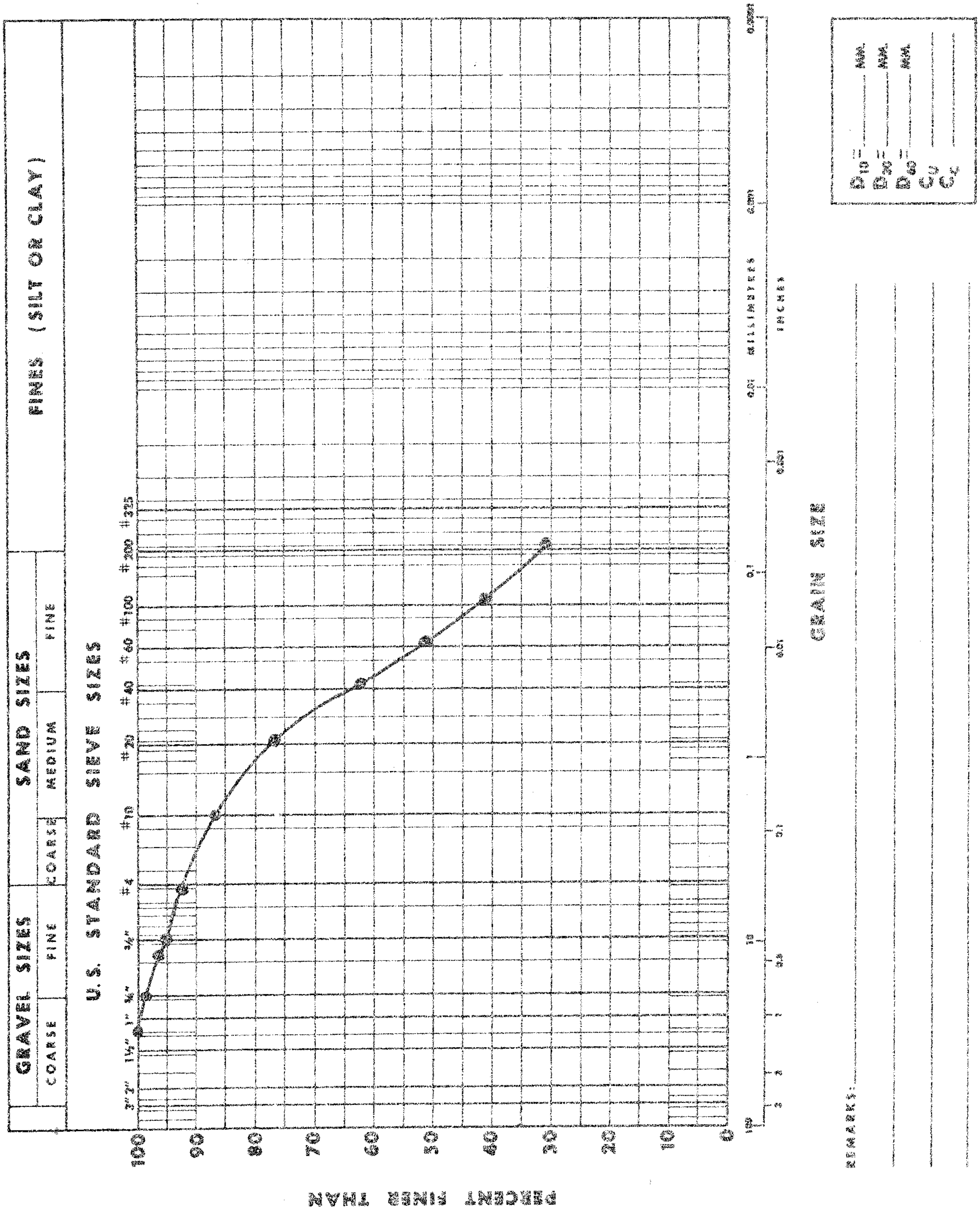


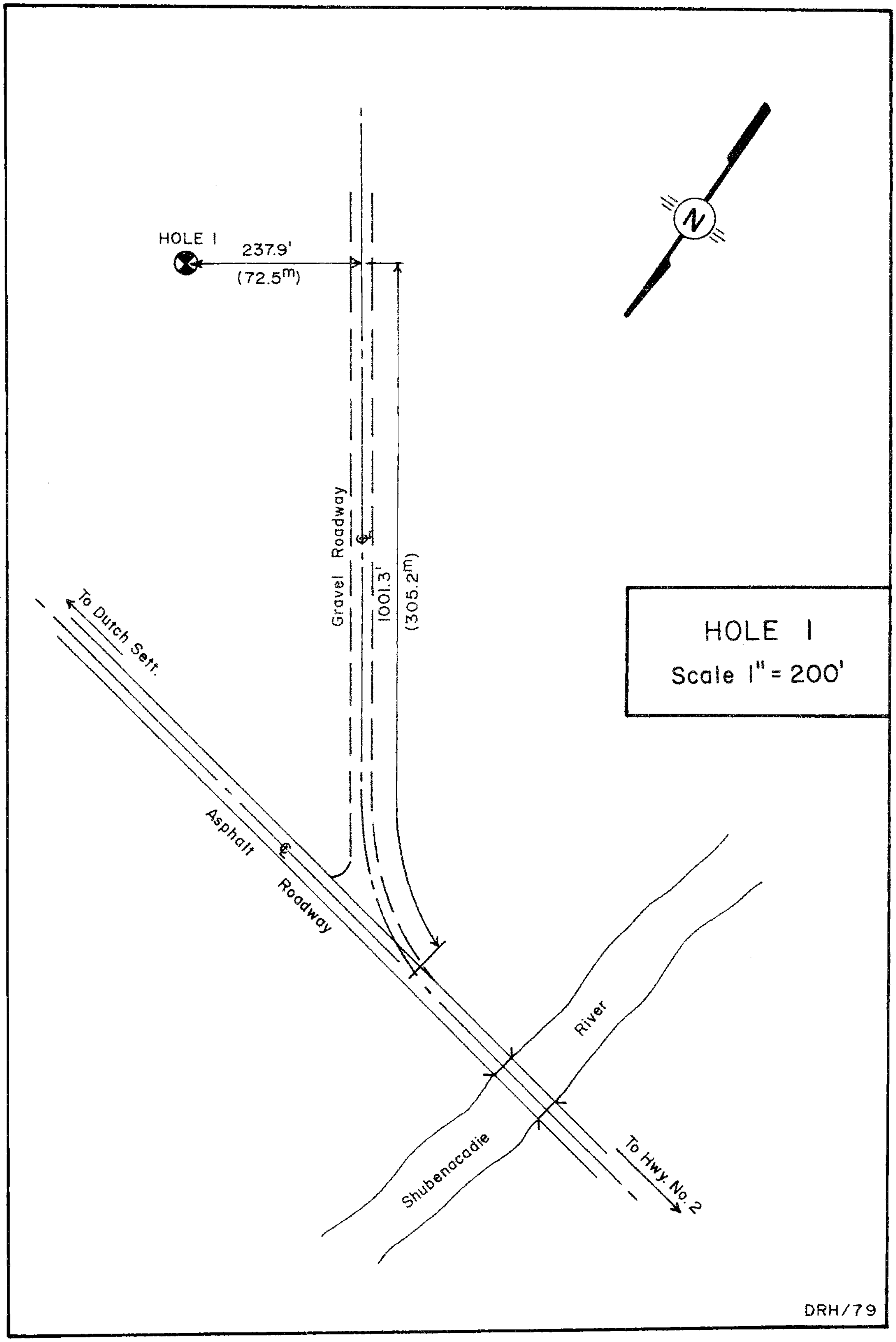
PLATE 6

APPENDIX G

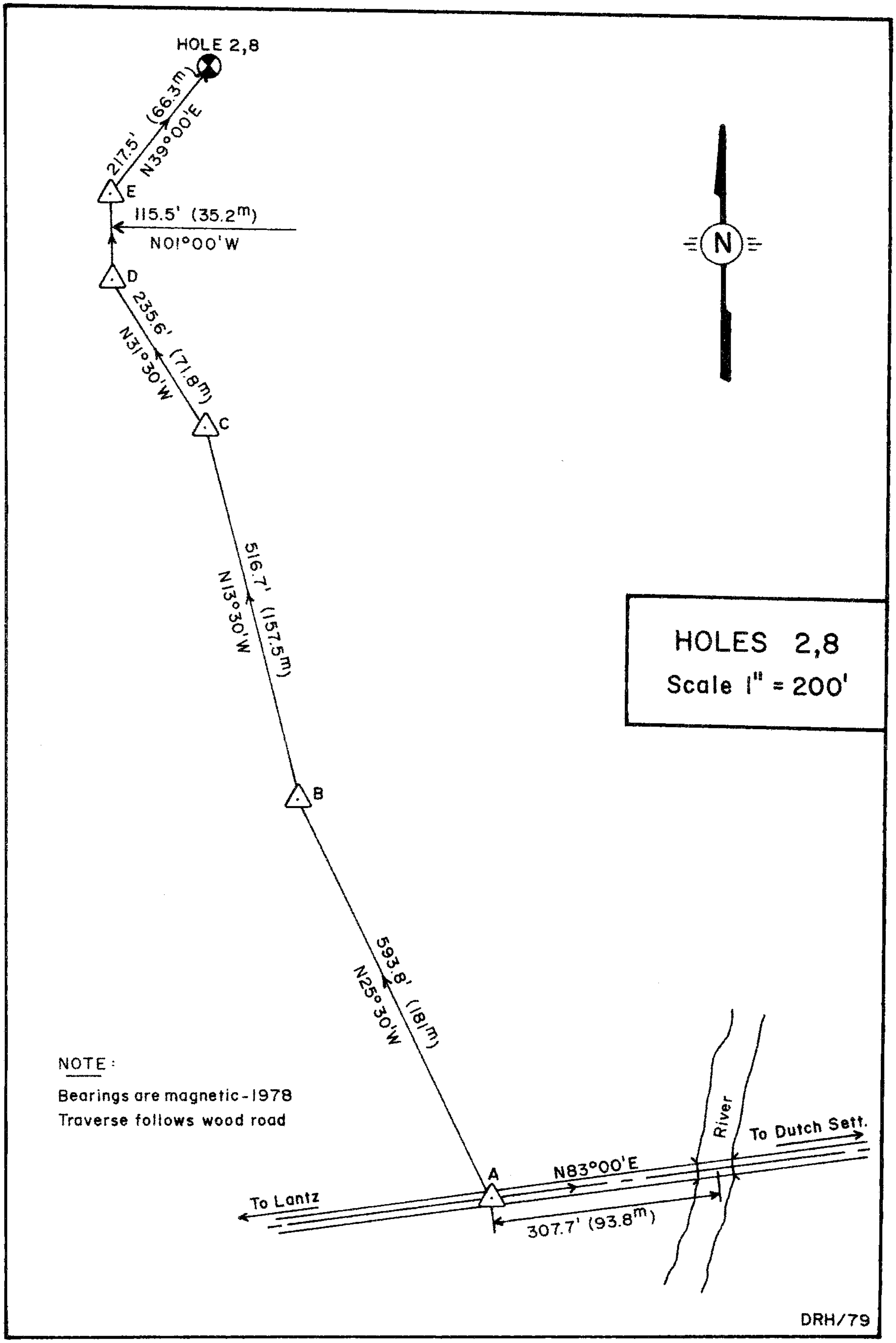
LOCATION:	TEST WELL # 11 ENFIELD, HALIFAX CO. 568 756	TEST WELL # 14 HARDWOODLANDS, HANTS CO. 591 908
SOURCE:	50' drilled well no casing, plastic pipe	33' drilled well no casing, plastic 10 gpm.
TIME:	March 29, 1978	March 21, 1978
<u>CHEMICAL PARAMETERS</u>		
Sodium	30	3.4
Potassium	3.5	0.5
Calcium	125	48
Mg	14	3.8
Hd (as Ca CO_3)	*371	135
Alkalinity (as Ca CO_3)	126	110
Sulphate	240	31
Chloride	27	6.5
Fluoride	0.2	0.1
Silica	9.7	6.8
Phospate, ortho	0.04	0.02
Nitrate + Nitrite (as N)	0.1	0.4
Ammonia (as N)	0.2	0.1
Arsenic	0.01	0.005
Iron	*3.	0.16
Manganese	*1.8	0.04

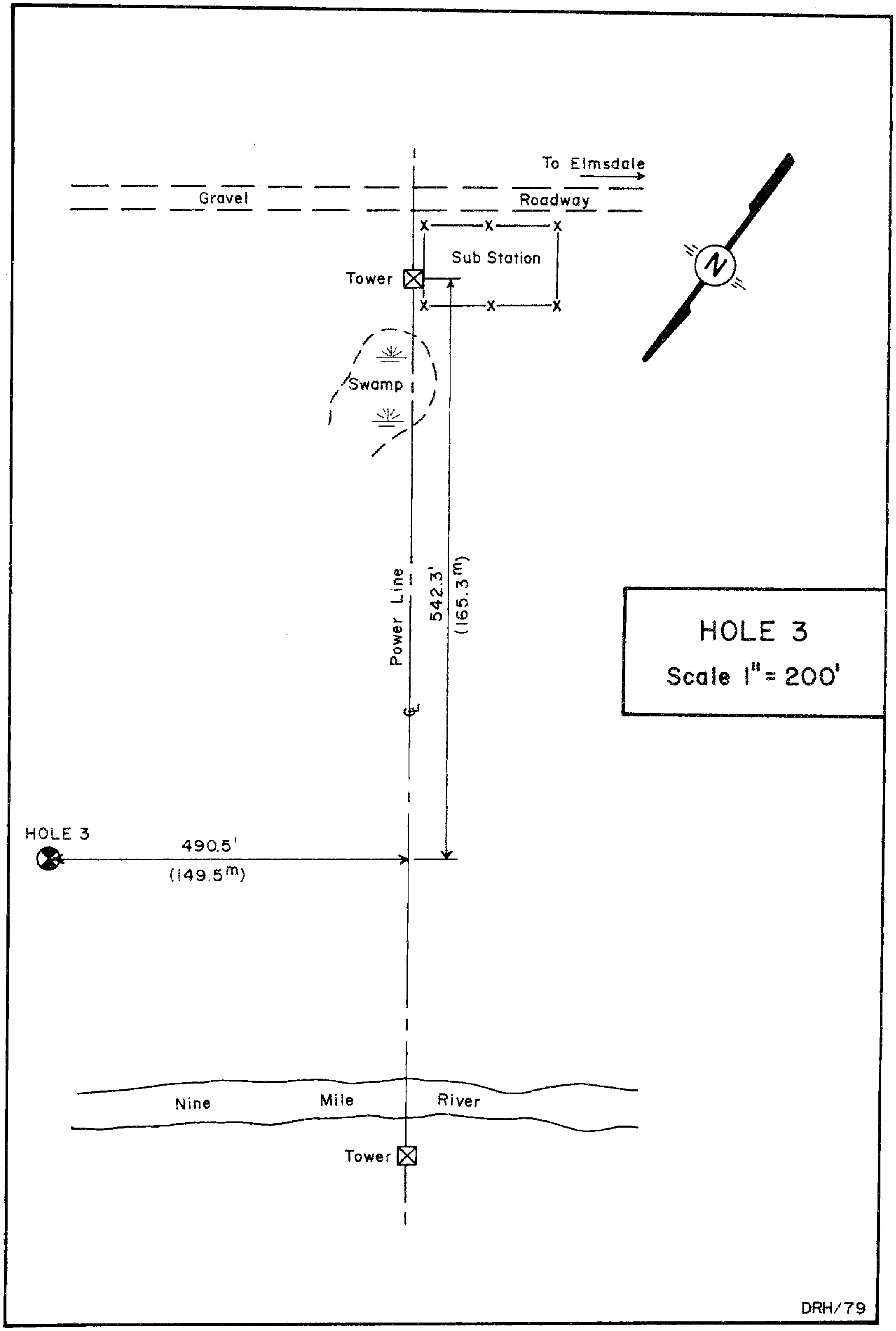
LOCATION	TEST WELL # 11 ENFIELD, HALIFAX CO. 568 756	TEST WELL # 14 HARDWOODLANDS, HANTS CO. 591 908
SOURCE:	50' drilled well no casing, plastic pipe	33' drilled well no casing, pumped 10 gpm.
TIME	March 29, 1978	March 21, 1978
CHEMICAL PARAMETERS		
Lead	0.16	0.005
Copper	0.06	0.01
Zinc	0.26	0.01
Total Solids		185
Total Dissolved Solids	578	176
Colour	30*	10*
Turbidity	28*	5.0
Conductivity	790	270
PH	74	8.0

* Note - The high iron, colour and turbidity values are probably due to the drilling activity, while high iron, manganese, hardness and sulphate values are due to the geologic formation.

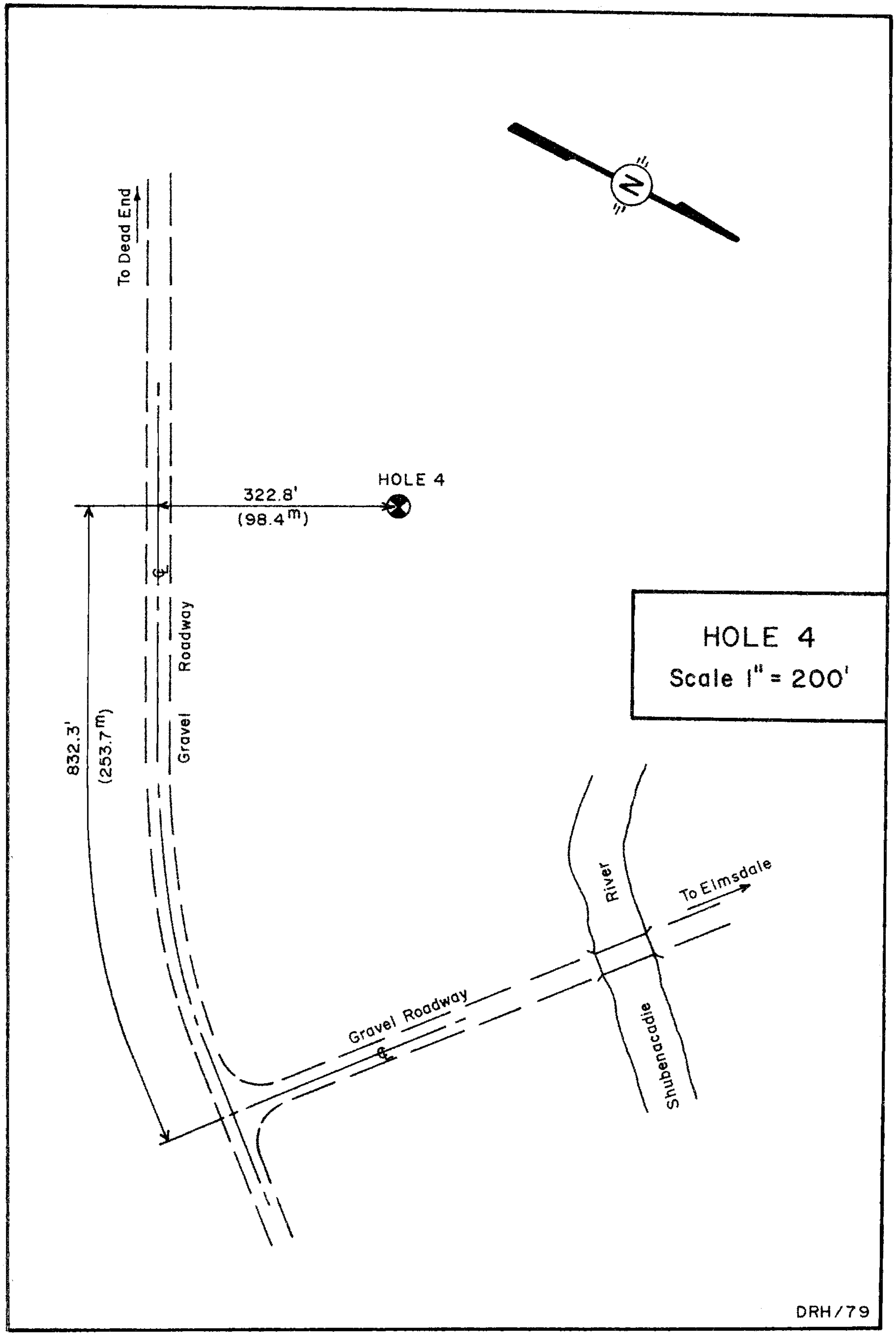


HOLE I
237.9'
(72.5m)
N
Gravel Roadway
℄
1001.3'
(305.2m)
To Dutch Sett.
HOLE I
Scale 1" = 200'
Asphalt ℄ Roadway
River
Shubenacadie
To Hwy. No. 2
DRH/79

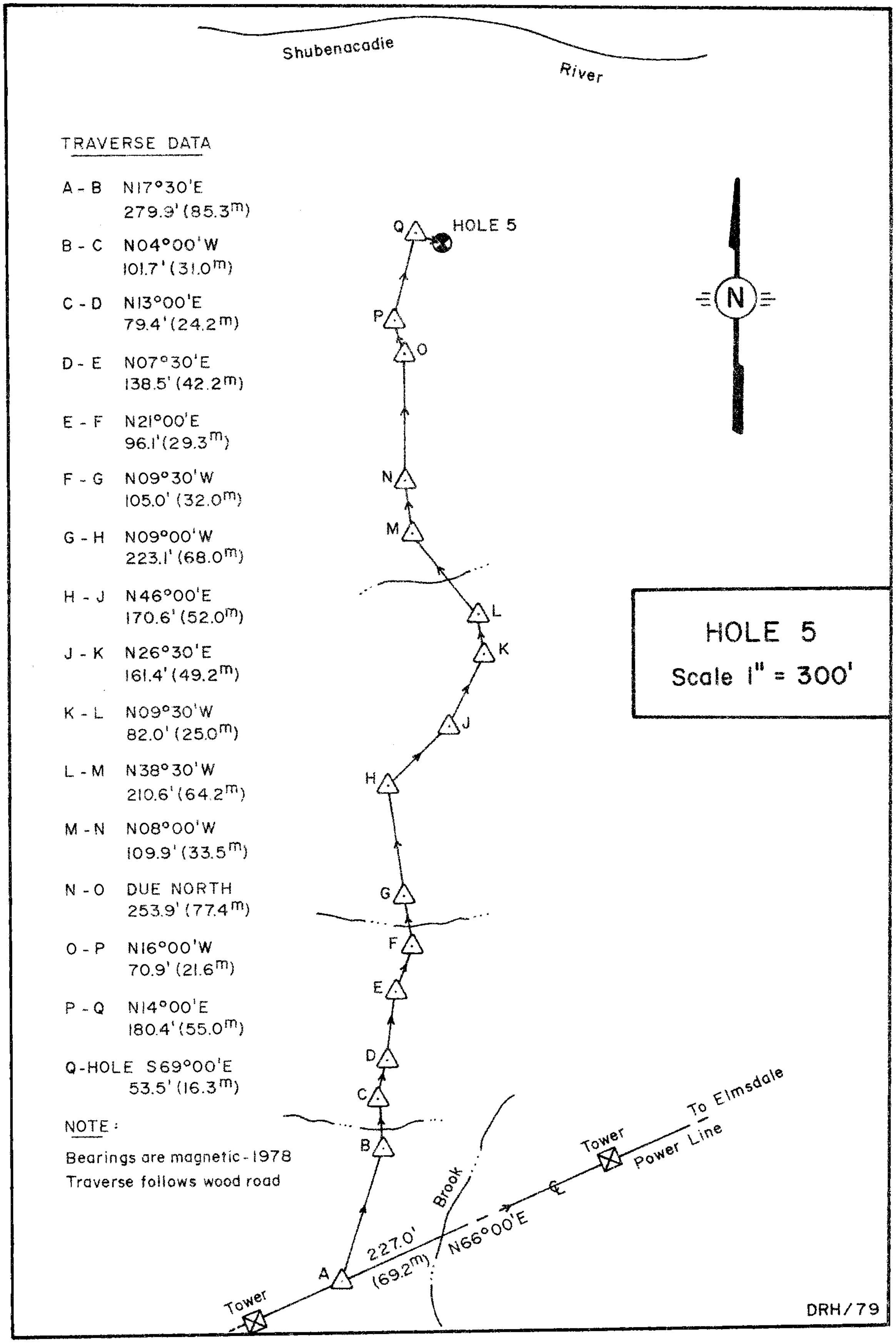

HOLE 2,8
217.5' (66.3m)
N39°00'E
E
115.5' (35.2m)
N01°00'W
D
235.6' (71.8m)
N31°30'W
C
516.7' (157.5m)
N13°30'W
B
593.8' (181m)
N25°30'W
A
N83°00'E
307.7' (93.8m)
To Lantz
River
To Dutch Sett.
N
HOLES 2,8
Scale 1" = 200'
NOTE:
Bearings are magnetic - 1978
Traverse follows wood road
DRH/79



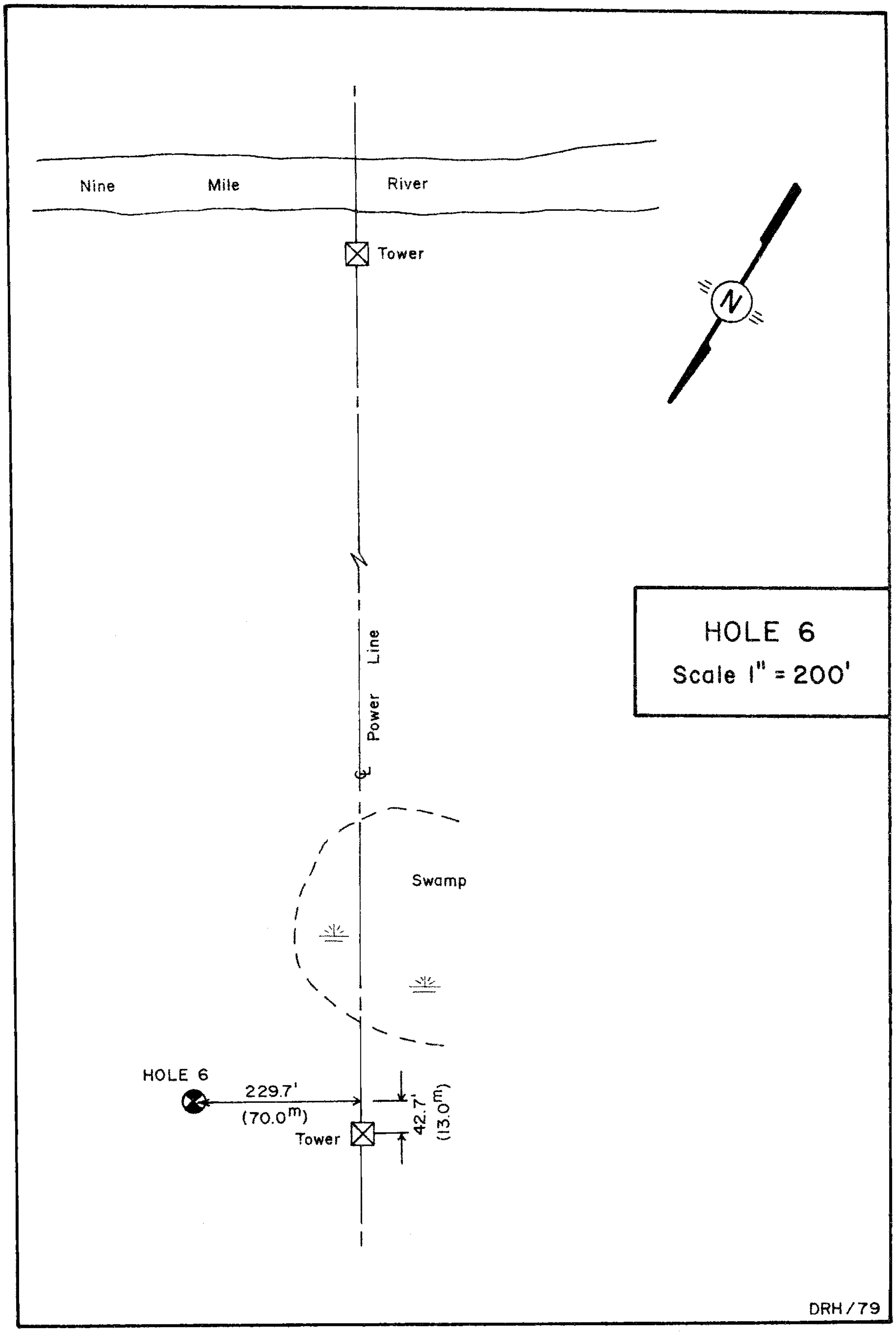
To Elmsdale
Gravel
Roadway
Sub Station
Tower
Swamp
Power Line
542.3'
(165.3m)
HOLE 3
490.5'
(149.5m)
Nine
Mile
River
Tower
N
HOLE 3
Scale 1" = 200'
DRH/79

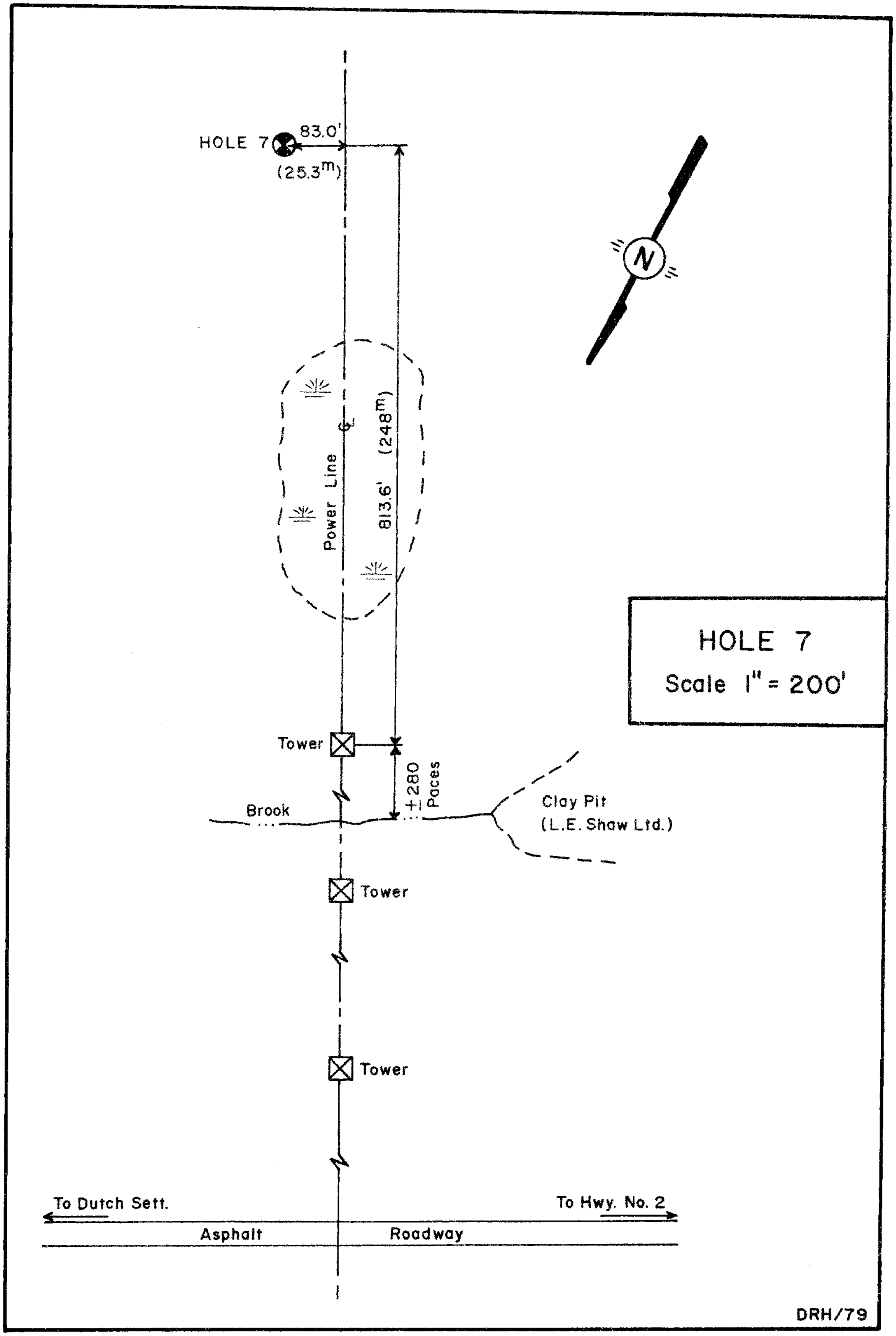


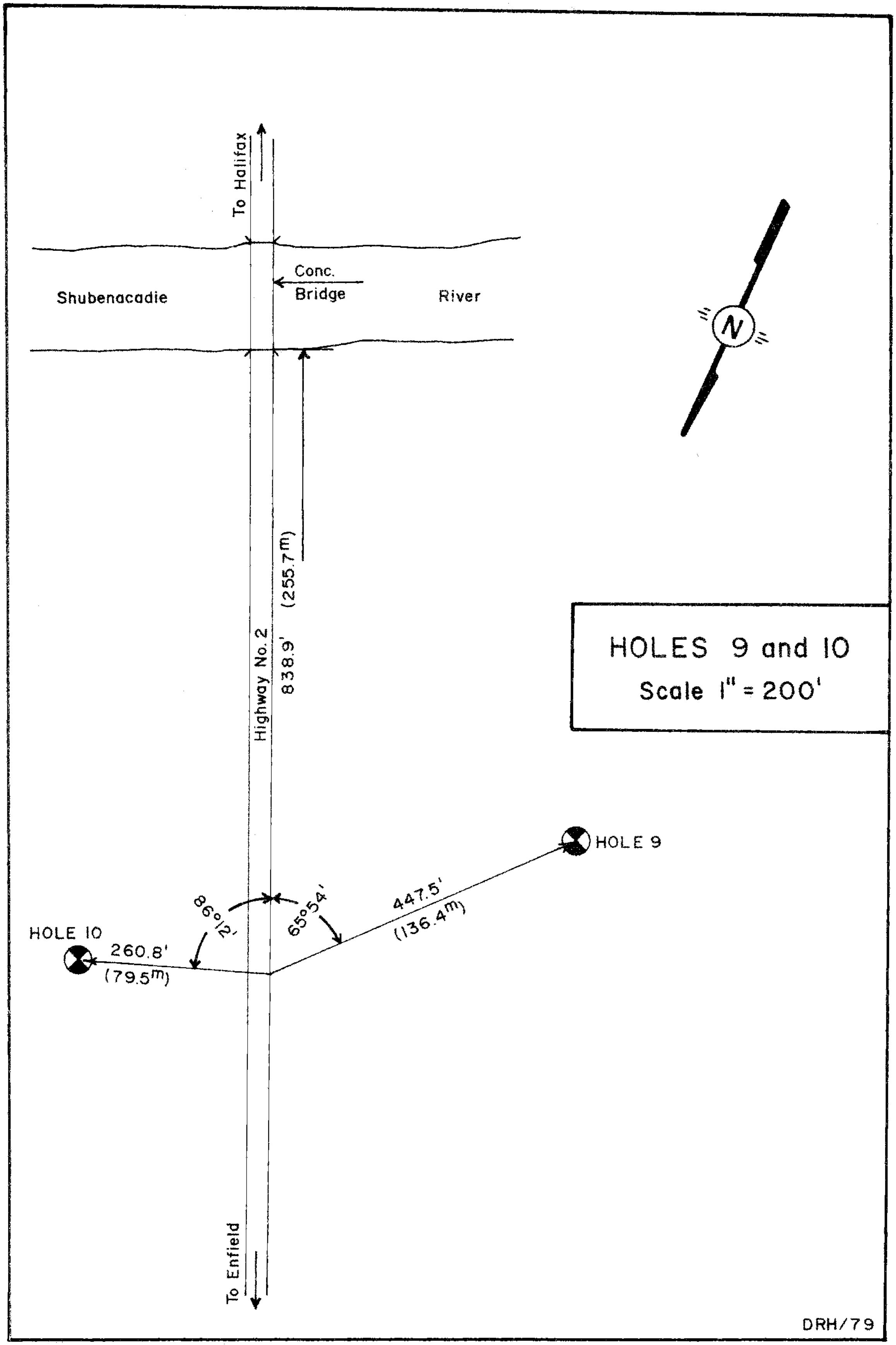
To Dead End
HOLE 4
322.8'
(98.4 m)
Gravel Roadway
832.3'
(253.7 m)
HOLE 4
Scale 1" = 200'
River
Shubenacadie
To Elmsdale
Gravel Roadway
DRH/79

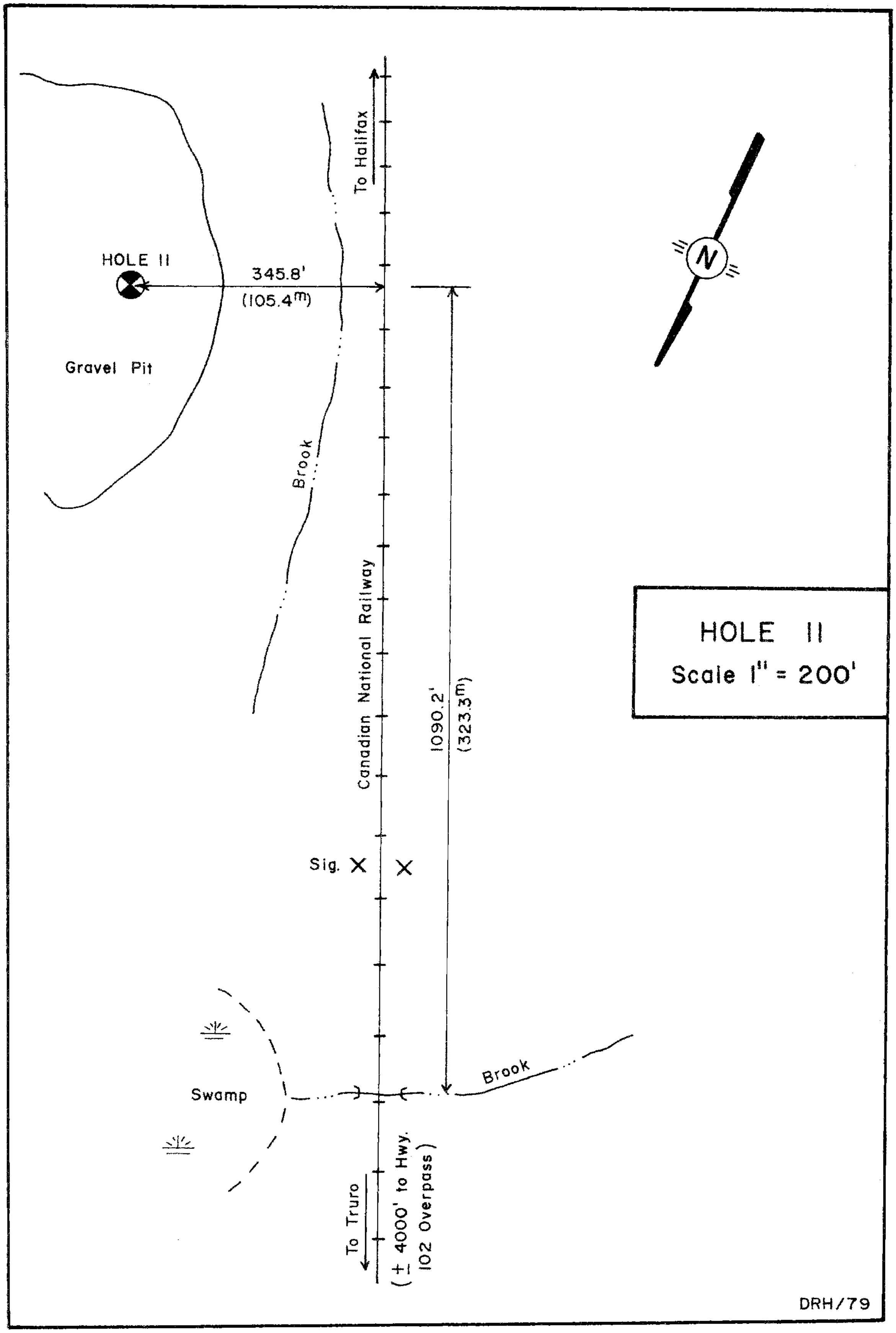


Shubenacadie
River
TRAVERSE DATA
A - B N17°30'E 279.9' (85.3m)
B - C N04°00'W 101.7' (31.0m)
C - D N13°00'E 79.4' (24.2m)
D - E N07°30'E 138.5' (42.2m)
E - F N21°00'E 96.1' (29.3m)
F - G N09°30'W 105.0' (32.0m)
G - H N09°00'W 223.1' (68.0m)
H - J N46°00'E 170.6' (52.0m)
J - K N26°30'E 161.4' (49.2m)
K - L N09°30'W 82.0' (25.0m)
L - M N38°30'W 210.6' (64.2m)
M - N N08°00'W 109.9' (33.5m)
N - O DUE NORTH 253.9' (77.4m)
O - P N16°00'W 70.9' (21.6m)
P - Q N14°00'E 180.4' (55.0m)
Q-HOLE S69°00'E 53.5' (16.3m)
NOTE:
Bearings are magnetic - 1978
Traverse follows wood road
HOLE 5
N
HOLE 5
Scale 1" = 300'
Q
P
O
N
M
L
K
J
H
G
F
E
D
C
B
A
Brook
Tower
Tower
To Elmsdale
Power Line
227.0'
(69.2m)
N66°00'E
DRH/79

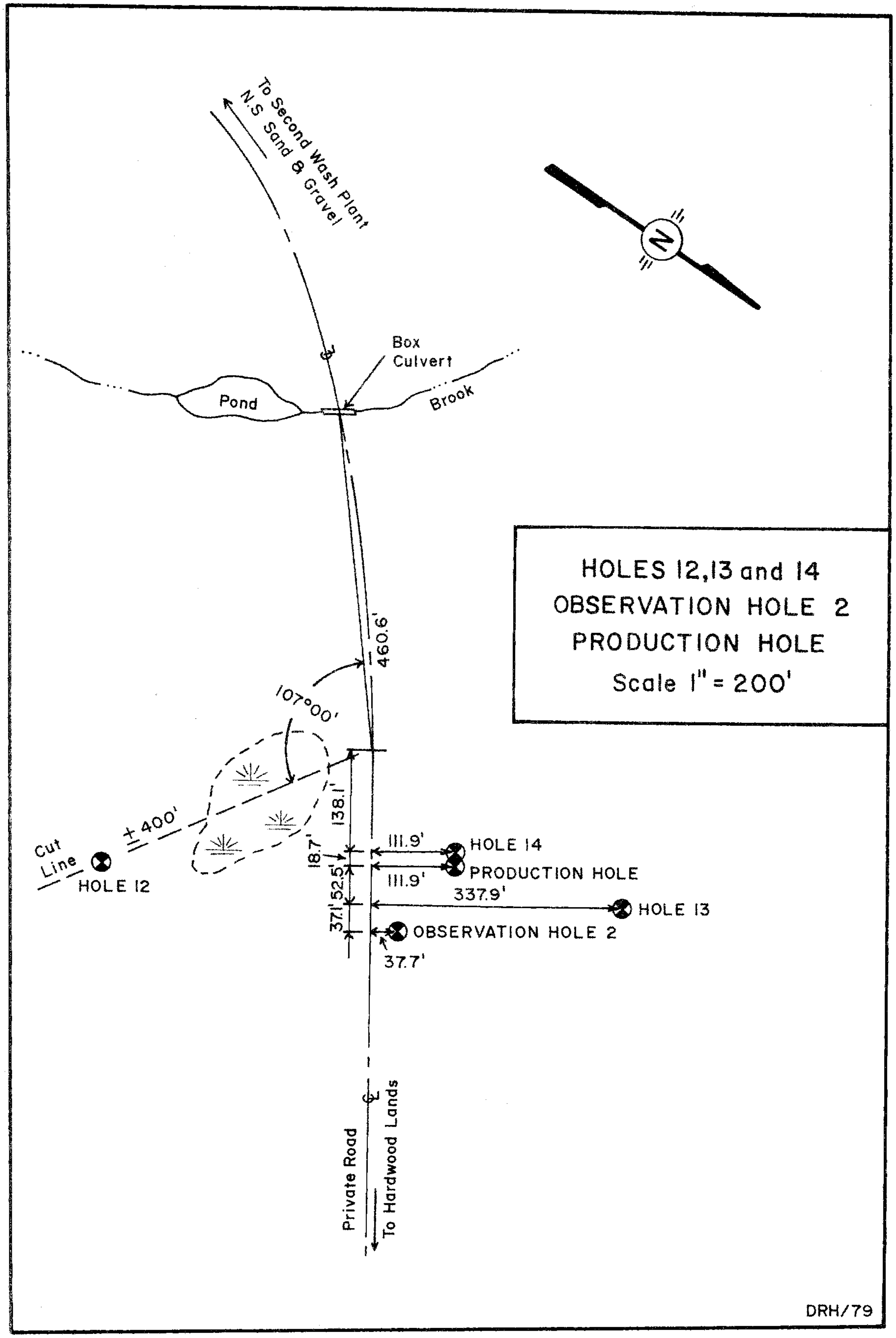

Nine Mile River
Tower
Power Line
Swamp
HOLE 6
229.7'
(70.0m)
Tower
42.7'
(13.0m)
N
HOLE 6
Scale 1" = 200'
DRH/79


HOLE 7
83.0'
(25.3m)
813.6' (248m)
Power Line
Tower
± 280 Paces
Brook
Clay Pit
(L.E. Shaw Ltd.)
Tower
Tower
To Dutch Sett.
To Hwy. No. 2
Asphalt Roadway
N
HOLE 7
Scale 1" = 200'
DRH/79


To Halifax
Conc.
Bridge
Shubenacadie
River
N
(255.7m)
838.9'
Highway No. 2
HOLES 9 and 10
Scale 1" = 200'
HOLE 9
447.5'
(136.4m)
86°12'
65°54'
HOLE 10
260.8'
(79.5m)
To Enfield
DRH/79



HOLE 11
345.8'
(105.4m)
Gravel Pit
To Halifax
Brook
Canadian National Railway
1090.2'
(323.3m)
HOLE 11
Scale 1" = 200'
Sig.
Swamp
Brook
To Truro
(± 4000' to Hwy. 102 Overpass)
DRH/79


To Second Wash Plant
N.S Sand & Gravel
N
Box
Culvert
Pond
Brook
HOLES 12,13 and 14
OBSERVATION HOLE 2
PRODUCTION HOLE
Scale 1" = 200'
460.6'
107°00'
±400'
Cut
Line
HOLE 12
138.1'
18.7'
52.5'
37.1'
111.9'
HOLE 14
111.9'
PRODUCTION HOLE
337.9'
HOLE 13
OBSERVATION HOLE 2
37.7'
Private Road
To Hardwood Lands
DRH/79

APPENDIX I

The log of the production well hole revealed the following information:

0 - 5' - fine to medium grained sand and silt

5 - 10' - medium grained sand to fine gravel, some pebbles up to one inch

10 - 15' - fine gravel with silt and sand, pebbles range from ¼" to ½", some clay stringers

15 - 20' - fine to medium sized gravel, mainly range in size from 1/16" to ¼", homogeneous, subrounded

20 - 25' - mainly gravel ranging from 1/8" to ¼" with some fine grained sand, mianly homogeneous, subangular to subrounded, some large rocks at 23 feet.

25 - 30' - coarse sand to fine gravel, of mainly 1/16" to ¼" in size, subrounded to subangular

35 - 40' - finer than 30 - 35' and more homogeneous than previous sections of column, size averages from 1/8" to 3/8", some tight sand

40 - 45' - mainly homogeneous, average grain size is from ¼" to ½", subangular

45 - 50' - more homogeneous than previous column sections, fine gravel average grain size of ¼", subangular

50 - 53' - average grain size of 1/16", fine gravel and medium grained sand, mainly homogeneous, layer of tight sand

53 - 55' - average grain size of 1/16" to ¼", fine gravel and medium grained sand, few ½" pebbles subrounded

55 - 60' - less homogeneous than 40 - 50', grain size ranges from 1/16" to 3/8", fine gravel, subangular

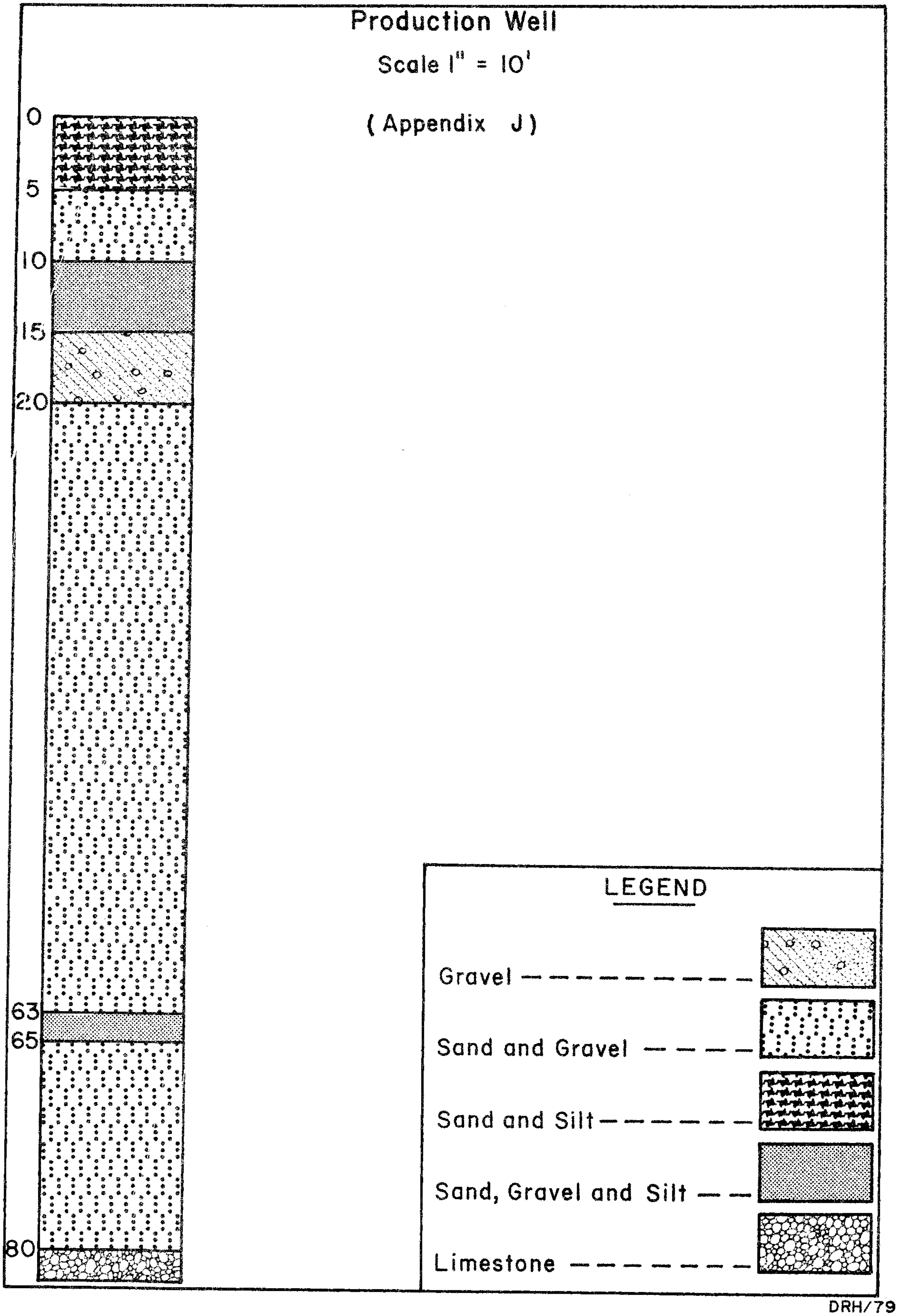
60 - 63' - size ranges from 1/16" to ½", non-homogeneous, fine to medium gravel, subrounded

63 - 65' - same as 60 - 63' with a greater percentage of larger pebbles, fair amount of silt and mud, layers of tight sand

65 - 70' - finer gravel than 60 - 65' and more uniform, average particle size of 1/8" and ranging from 1/16" to 3/8", subrounded, fine gravel

70 - 75' - less uniform gravel, ranges in size from 1/8" to ½", subrounded to subangular, greater average size than other samplings except the 10' to 15' level

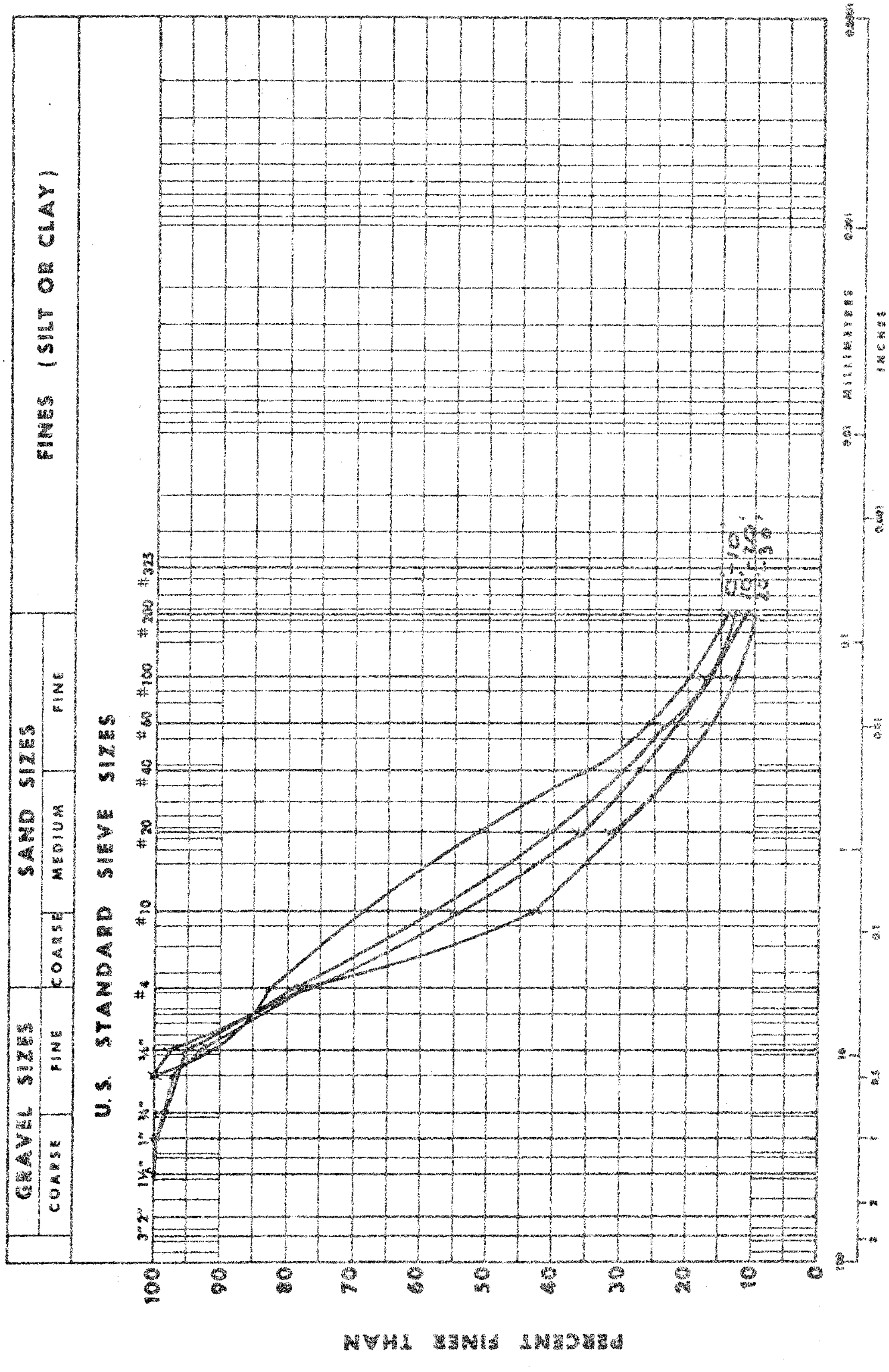
75 - 80' - medium sized gravel and bedrock, average size about ¼", limestone bedrock


Production Well
Scale 1" = 10'
(Appendix J)
0
5
10
15
20
63
65
80
LEGEND
Gravel
Sand and Gravel
Sand and Silt
Sand, Gravel and Silt
Limestone
DRH/79

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO. 51355
CLIENT TERRY LAY
SAMPLE 0'-10', 10'-20', 20'-30', 30'-40'
SOURCE S. HUB. - STEWIACKE
HOLE 4 DEPTH 0'-40' DATE REC'D June 15/78
TECHNICIAN T. WHITE DATE TESTED June 16/78



D_{10} = ______ MM.
D_{30} = ______ MM.
D_{60} = ______ MM.
C_u = ______
C_c = ______

REMARKS: Red-brown silty sand SM
with a little fine gravel, Traces of organic material

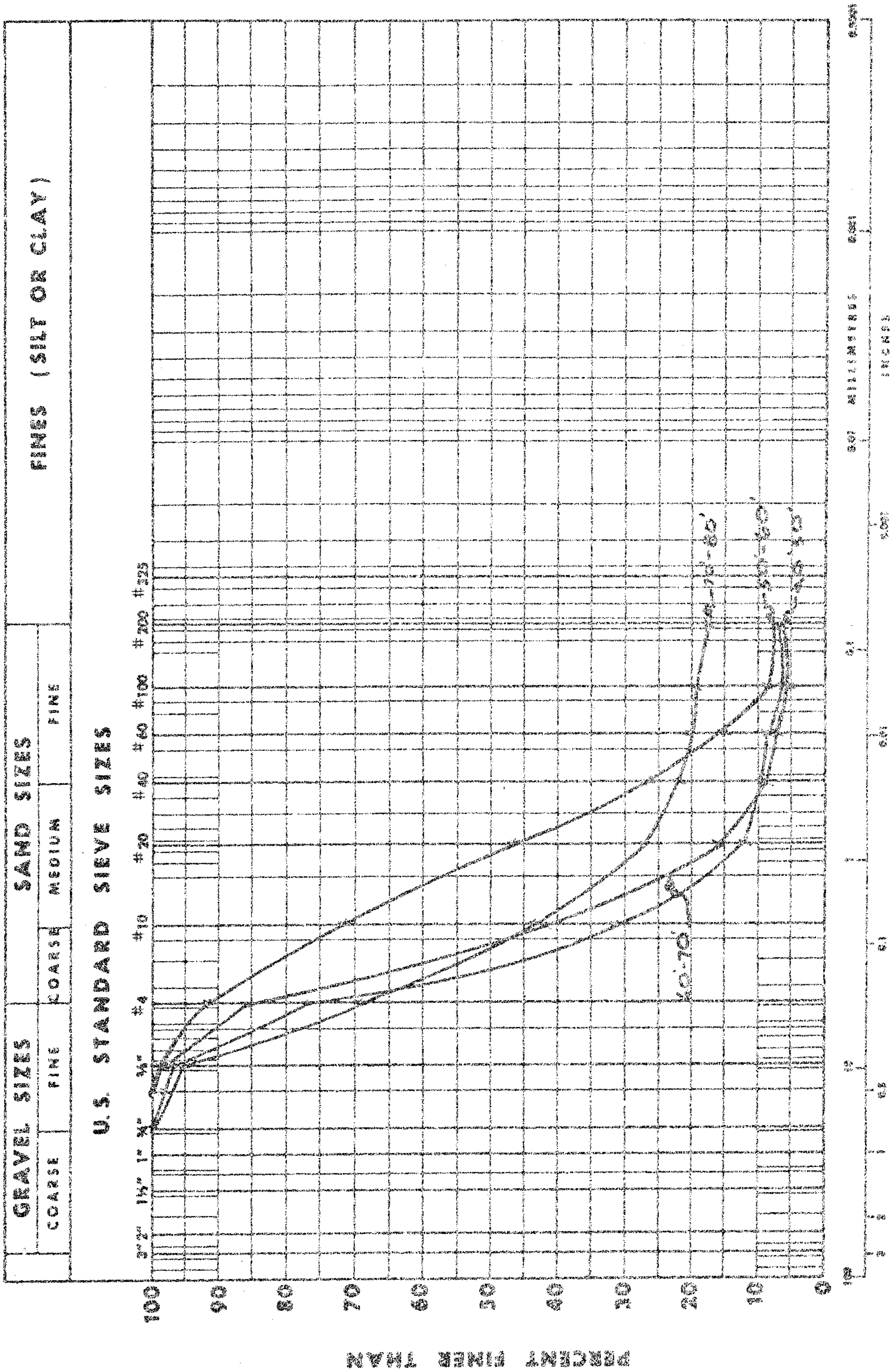
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 1

MARITIME TESTING LIMITED
3232 BARRINGTON STREET
HALIFAX, N. S.

GRAIN SIZE CURVE

LAB ORDER NO.	S/356
CLIENT	TERRY LAY
SAMPLE	40'-50', 50'-60', 60'-70', 70'-80'
SOURCE	SHUB. - STEWIACKE
HOLE 4	DEPTH 40'-80' DATE REC'D June 15/78
TECHNICIAN T. WHITE	DATE TESTED June 16/78



D_{10} = ____ MM.
D_{30} = ____ MM.
D_{60} = ____ MM.
C_U = ____
C_C = ____

REMARKS: Red-brown silty sand SM

with a little fine gravel. Traces of organic material

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 2

... . ENL ... L

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: Walter Chappell **MEASURED BY:** Jerry Freeman

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** Near Second Wash Plant, Swamp

STATUS Production Well
(pumping or observation well)

R = ____
(distance from pumping well in feet and direction)

DATE June 14/78 **PAGE** 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	6:30 p.m.	0	1'9½"	4'			102		Step # 1
14							U.S.		
	1			4' 4"					
	2			4' 4¼"					
	3			4' 4½"					
	4			4' 4½"					
	5			4'4 3/4"					
	6			4'4 3/4"					
	7			4'4 3/4"					
	8			4' 5"					
	9			4' 5"					
	10			4' 5"					
	15			4' 5"					
	20			4' 5½"					
	25			4' 5½"					
	30			4' 5½"					
	40			4' 5½"					
	50			4' 5½"					
	7:30	60		4' 9"			156		Step # 2
				4' 9¼"			U.S.		
				4' 9½"					
				4' 10"					
				4' 11"					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ MEASURED BY: ______

LOCATION OF PROJECT ______ WELL LOCATION: ______

STATUS Production Well (pumping or observation well) R = ______ (distance from pumping well in feet and direction) DATE June 14/78 PAGE 2

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at		Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
			Meas. Point	Water level					
	6			4'11 3/4"			156		
	7			5'			U.S.		
	8			5'					
	9			5'					
	10			5'					
	15			5'					
	20			5'					
	25			4' 11"					Well was
	30			4' 11"					developed while
	40			4' 11"					pumping.
	50			4' 11"					
	8:30 p.m.	120		4'11 3/4"			200		Step # 3
	1			5' 1½"			U.S.		
	2			5'2 3/4"					
	3			5' 2½"					
	4			5' 2"					
	5			5' 2"					
	6			5' 2"					
	7			5' 2"					
	8			5'1 3/4"					
	9			5'1 3/4"					
	10			5'1 3/4"					
	15			5' 2¼"					

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NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT ______ **WELL LOCATION:** ______

STATUS Production Well
(pumping or observation well)

R = ______
(distance from pumping well in feet and direction)

DATE June 14/78 **PAGE** 3

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	20			5' 2"			200		
	25			5' 2"			U.S.		
	30			5' 2"					
	40			5' 2"					
	50			5' 2"					
	9:30 p.m.	180		5' 2"			490		
	1			7' 5"			U.S.		Step # 4
	2			7' 5"					
	3			7' 7"					Noticeable Drop
	4			7' 7"					in Water
	5			7' 7½"					Level.
	6			7' 7½"					
	7			7' 8"					
	8			7' 9"					
	9			7' 9¼"					
	10			7' 9¼"					
	15			7' 10"					
	20			8'					
	25			8'					
	30			8'					
	40			8'					Levelling
	50			8'					Off.
	10:30 p.m.	240							

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: MEASURED BY:

LOCATION OF PROJECT WELL LOCATION:

STATUS Production Well R = DATE June 14/78 PAGE 4

(pumping or observation well) (distance from pumping well in feet and direction)

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	10:30 p.m.			8'					Recovery after
	1			3' 6"					4th Step.
	2			3' 5"					
	3			3'4 3/4"					
	4			3'4 3/4"					
	5			3'4 3/4"					
	6			3'4 3/4"					
	7			3'4 3/4"					
	8			3' 4½"					
	9			3'3 3/4"					
	10			3'3 3/4"					
	15			3'3 3/4"					
	20			3'3 3/4"					
	25			3'3 3/4"					
	30			3'3 3/4"					
	40			3'3 3/4"					
	50			3'3 3/4"					
	60			3'3 3/4"					

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ MEASURED BY: ______

LOCATION OF PROJECT N.S.S.G. WELL LOCATION: ______

STATUS Production Well (pumping or observation well) R = ______ (distance from pumping well in feet and direction) DATE June 14/78 PAGE 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	11:30 p.m.			3.3 3/4			490		72 Hour Test
14	1			7.6			U.S.		
	2			7.6 3/4					
	3			7.7¼					
	4			7.7½					
	5			7.7½					
	6			7.7½					
	7			7.7½					
	8			7.7 3/4					
	9			7.7 3/4					
	11:40 p.m.			7.7 3/4					
	11:45 p.m.			7.8					
	11:50 p.m.			7.8½					
June	12:00 a.m.			7.9					
15	12:10 a.m.			7.9½					
	12:20			7.10					
	12:30	60		7.10½					
	12:45	75		7.10½					
	1:00	90		7.11					
	1:15	105		7.11					
	1:30	120		7.11					
	2:00	150		7.11					
	2:30	180		7.11¼					
	3:00	210		7.11¼					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT ______ **WELL LOCATION:** ______

STATUS Production Well
(pumping or observation well)

R = ______
(distance from pumping well in feet and direction)

DATE June 15/78 **PAGE** 2

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	3:30	240		7.11 3/4					
	4:30	300		8.1					
	5:30	360		8.1½					
	6:30	420		8.1 3/4					
	7:30	480		8.1					
	8:30	540		8.2					
	9:30	600		8.2					
	10:30	660		8.2					
	11:30	720		8.2					12 Hrs.
	1:30	840		8.2¼					
	3:30	960		8.2½					
	5:30	1080		8.3					
	7:30	1200		8.3½					
	9:30	1320		8.4¼					
June	11:30 p.m.	1440		8.5					24 Hrs.
16	3:30	1680		8.5½					
	7:30	1920		8.5½					
	11:30	2160		8.5½					36 Hrs.
	5:30	2520		8.5½					
June	11:30 p.m.	2880		8.6½					48 Hrs.
17	11:30 a.m.	3600		8.7					
	11:30 p.m.	4320		8.7					72 Hrs.

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ____________ **MEASURED BY:** ____________

LOCATION OF PROJECT ____________ **WELL LOCATION:** ____________

STATUS Production Well
(pumping or observation well)

R = ____________
(distance from pumping well in feet and direction)

DATE June 17/78 **PAGE** 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	11:30 p.m.			8.10					Recovery for
17	1			4".9"					Production Well
	2			4" 5"					After 72 Hour
	3			4" 5"					Pump Test.
	4			4" 3/4"					
	5			4' 4¼"					
	6			4' 3 3/4"					
	7			4' 3½"					
	8			4' 3½"					
	9			4' 3¼"					
	10			4' 3¼"					
	15			4' 3"					
	20			4' 2¼"					
	25			4' 2¼"					
	30			4' 2					
	40			4' 1					
	50			4' ½"					
June	12:30			4' ¼"					
18	12:45			4' ¼"					
	1:00			4'					
	2:45			3' 11"					
	4:30			3' 11"					
	5:30			3' 11"					
	6:30			3' 11"					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT ______ **WELL LOCATION:** ______

STATUS Production Well (pumping or observation well) **R =** ______ (distance from pumping well in feet and direction) **DATE** June 17/78 **PAGE** 2

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June 17	7:30			3' 11"					
	8:30			3' 11"					
	9:30			3' 11"					

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NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: Walter Chappell **MEASURED BY:** Ron White

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** Near Second Wash Plant, Swamp, Road

STATUS Observation Well # 2 (pumping or observation well) **R =** 90' East (distance from pumping well in feet and direction) **DATE** June 14/78 **PAGE** 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at		Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
			Meas. Point	Water level					
	6:30	0	9½"	12"					Q = 102 U.S. gpm.
	1			1' 6"					
	2			1' 6"					
	3			1' 6"					
	4			1' 6"					
	5			1' 6"					
	6			1' 6"					
	7			1' 6"					
	8			1' 6"					
	9			1' 6"					
	10			1' 6"					
	15			1' 6"					
	20	20		1' 6"					
	25			11"					
	30			11"					
	40			11"					
	50			11"					
	7:30	60		11"					Step # 2
	1			11"					Q = 156 U.S. gpm.
	2			11"					
	3			11"					
	4			11"					
	5			11"					
	6			11"					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** ______

STATUS Observation Well # 2 **R =** 90' East **DATE** June 14/78 **PAGE** 2
(pumping or observation well) (distance from pumping well in feet and direction)

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	7			11"					Sufficient
	8			11"					Drawdown to
	9			11"					Warrant Plotting.
	10	70		11"					
	15			11"					
	20			11½"					
	25			11½"					
	30			11 3/4"					
	40			11 3/4"					
	50			11 3/4"					
	60			11 3/4"					
	8:30 p.m.			11 3/4"					Step # 3
	1	121		12"					200 U.S. gpm
	2			12"					
	3			12"					
	4			12"					
	5			12¼"					
	6			12¼"					
	7			12¼"					
	8			12¼"					
	9			12¼"					
	10	130		12¼"					
	15			12¼"					
	20	140		12¼"					

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** ______

STATUS Observation Well # 2 (pumping or observation well) **R =** 90' East (distance from pumping well in feet and direction) **DATE** June 14/78 **PAGE** 3

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	25	145		12½"					
	30			12 1/3"					
	40			12½"					
	50			12½"					
	60	180		12½"					
9:30	1			12½"					Step # 4
	2			12 3/4"					490 U.S. gpm.
	3			13"					
	4			13¼"					Still sufficient
	5			13½"					drawdown to
	6			13½"					Plot. Continuous
	7			13 3/4"					fall in water
	8			13 3/4"					level now noted.
	9			14					
	10			14¼"					
	15			14½"					
	20			1'2 3/4"					
	25			1' 3"					
	30			1' 4"					
	40			1' 4"					
	50	230		1' 4"					
	10:30	240		1' 4"					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: MEASURED BY:

LOCATION OF PROJECT N.S.S.G. WELL LOCATION:

STATUS Observation Well # 2 (pumping or observation well) R = 90' East (distance from pumping well in feet and direction) DATE June 14/78 PAGE 4

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	10:30	240		1.4					Recovery after
	1			1.3½					4th Step.
	2			1.3					
	3			1.2¼					
	4			1.2					
	5			1.2					
	6			1.1¼					
	7			1.1					
	8			1.1					
	9			1.1					
	10	250		1.1					
	15			1.1					
	20	260		1.1					
	25			1.1					
	30			1.1					
	40	280		1.½					
	50			1.½					
	11:30	300		1"					

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** ______

STATUS Observation Well # 2 (pumping or observation well) **R =** ______ (distance from pumping well in feet and direction) **DATE** June 14/78 **PAGE** 5

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	11:30 p.m	300		1'					72 Hour Pump Test
14	1			1					
	2			1.¼					
	3			1.3/4					Sufficient
	4			1.1					drawndown to
	5			1.1½					warrant plotting.
	6			1.2¼					
	7			1.2½					
	8			1.2½					
	9			1.3					
	11:40	310		1.3½					
	11:45			1.3½					
	11:55			1.3½					
June	12:00	330		1.4					
15	12:10			1.4					
	12:20	350		1.4					
	12:30	360		1.4					
	12:45	375		1.4 3/4					
	1:00	390		1.5					
	1.:15	405		1.5					
	1.:30	420		1.5					
	2:00	450		1.5½					
	2:30	480		1.5½					
	3:00	510		1.6					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ MEASURED BY: ______

LOCATION OF PROJECT ______ WELL LOCATION: ______

STATUS Observation Well # 2 (pumping or observation well) R = ______ (distance from pumping well in feet and direction) DATE June 15/78 PAGE 6

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	3:30			1.6¼					Noticeable
15	4:00			1.6½					Continuous drop
	5:30			1.7					in water level.
	6:30			1.7					
	7:30			1.7					
	8:30			1.8					
	9:30			1.8					
	10:30			1.8					
	11:30			1.8					
	1:30			1.8					
	3:30			1.8¼					
	5:30			1.8 3/4					
	7:30			1.9¼					
	9:30			1.9½					
June	11:30			1.10½					
16	3:30			1.11					
	7:30			1.11					
	11:30			1.11					
	5:30			1.11					
	11:30			2.1					

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT - WATER PLANNING & MANAGEMENT DIVISION

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: ______ **MEASURED BY:** ______

LOCATION OF PROJECT N.S.S.G. **WELL LOCATION:** ______

STATUS Observation Well # 2 (pumping or observation well) **R =** 90' East (distance from pumping well in feet and direction) **DATE** June 17/78 **PAGE** 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at: Meas. Point	Tape Reading at: Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
June	11:30 p.m			2.2½					Recovery for
17	1			2' 2"					Observation Well # 2
	2			2' 2"					after 72 hour
	3			2' 2"					pump test.
	4			2' 1½"					
	5			2'.1					
	6			2.½					
	7			2.0					
	8			2.0					
	9			2.0					
	10			1'.11 3/4					
	15			1.1¼					
	20			1' 11					
	25			1' 11					
12:00	30			1.10 3/4					
	40			1.10					
	50			1.9 3/4					
1:00	60			1'9½					
				1'9					
	4:30			1'9					
	5:00			1'9					
	5:30			1'9					
	6:30			1'9					
	7:30			1'9					

WATER LEVEL MEASUREMENTS (FIELD)

TEST CONDUCTED BY: **MEASURED BY:**

LOCATION OF PROJECT **WELL LOCATION:**

STATUS Observation Well # 2 (pumping or observation well) **R =** 90' East (distance from pumping well in feet and direction) **DATE** June 17/78 **PAGE** 2

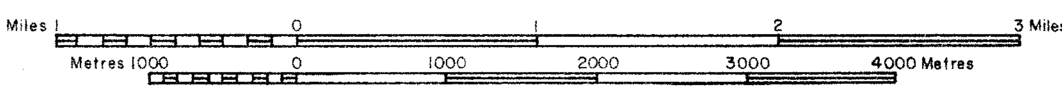
Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water level	Depth to water in feet	Draw-down in feet	Q = discharge gals/min		REMARKS (i.e. pump adjustments, water temp. static levels, etc.)
	8:30			1' 9"					Recovery after
	9:30			1' 9"					72 hour dump test.

The Following Legend and Scale apply to Report Maps 1 to 5 of Appendix M

LEGEND

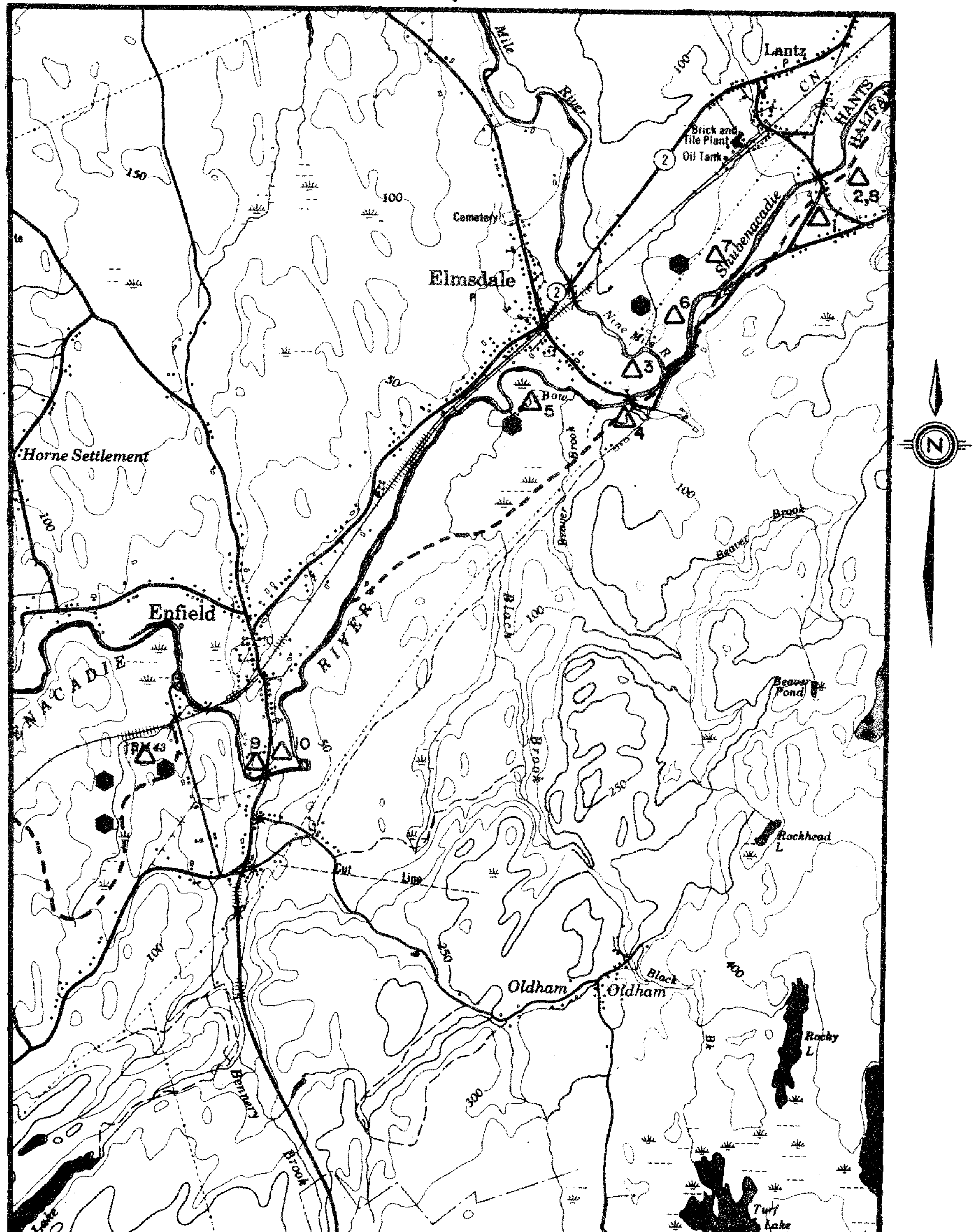
Logged wells	■ A
Limits of bedrock testing	
Future observation, production holes	⬢
Test holes	△ 12
Sampled wells	⬡ 9
Test pumping observation holes	▲ 1
Extent of superficial deposits	
Production wells	□

SCALE 1:50,000



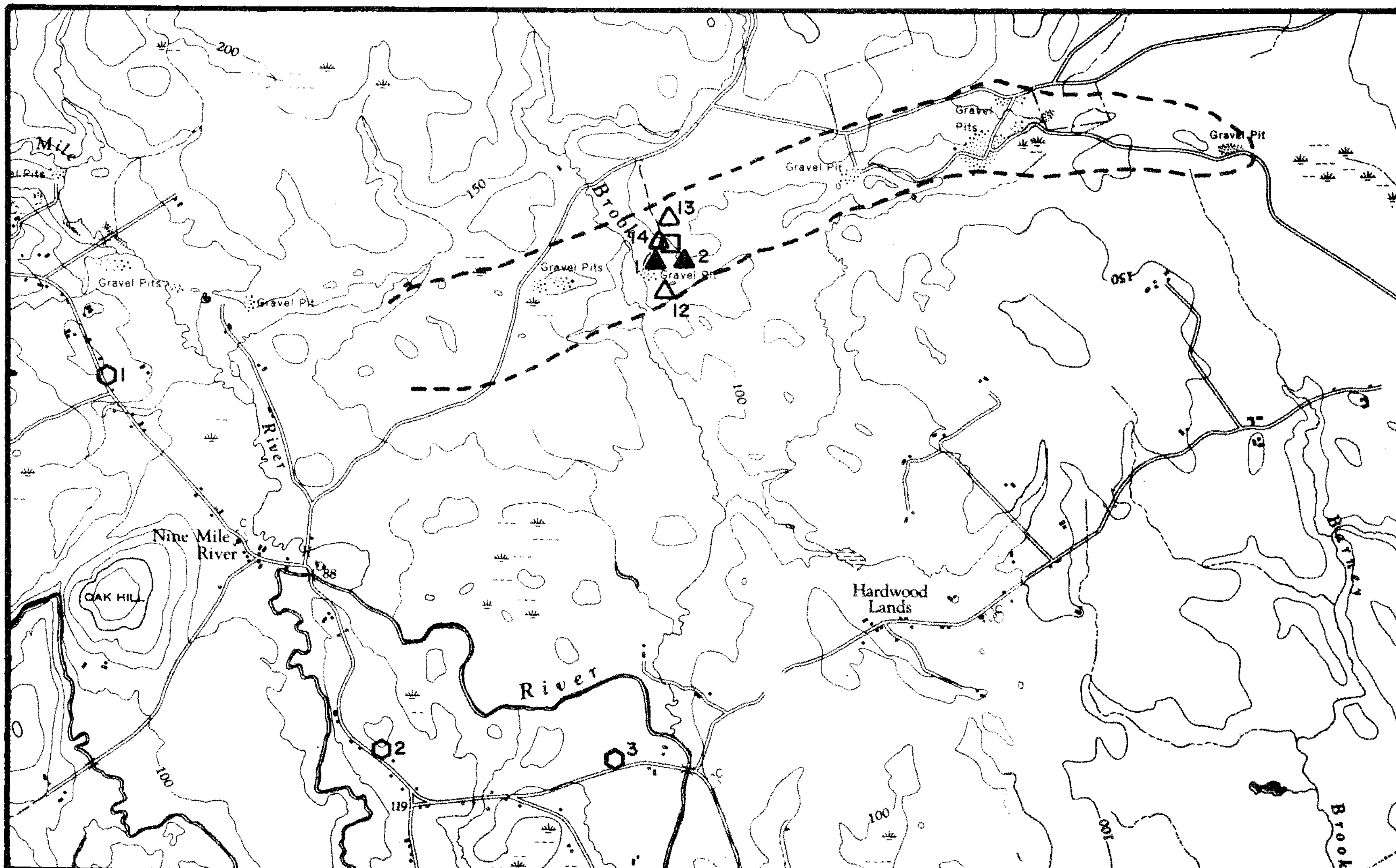
D.R.H./79

Map I



Base Map Compiled from NTS 11D/13E and 11D/14W DRH./79

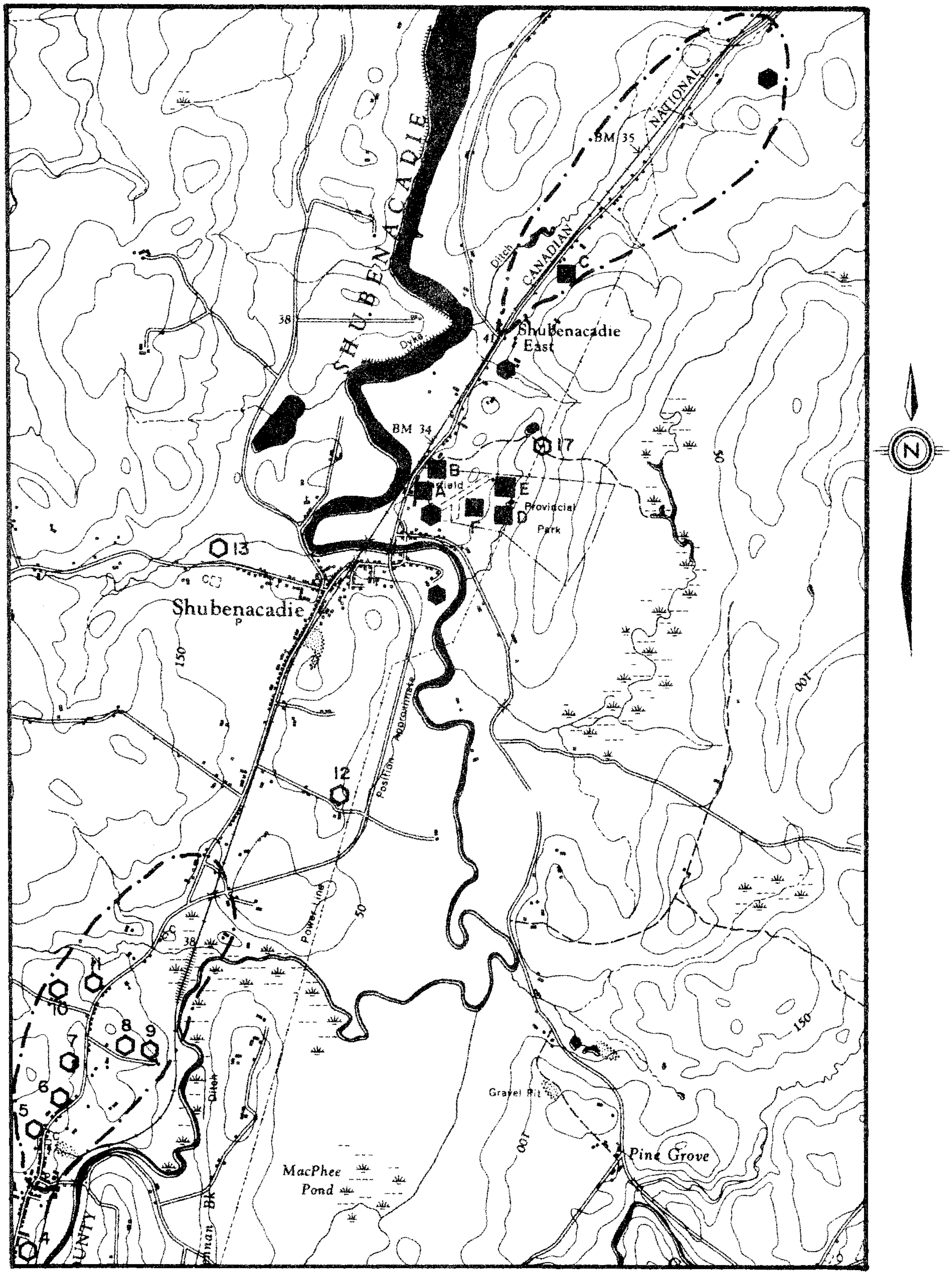
Map 2



Base Map Compiled from NTS 11E/4E and 11E/3W

D.R.H./79

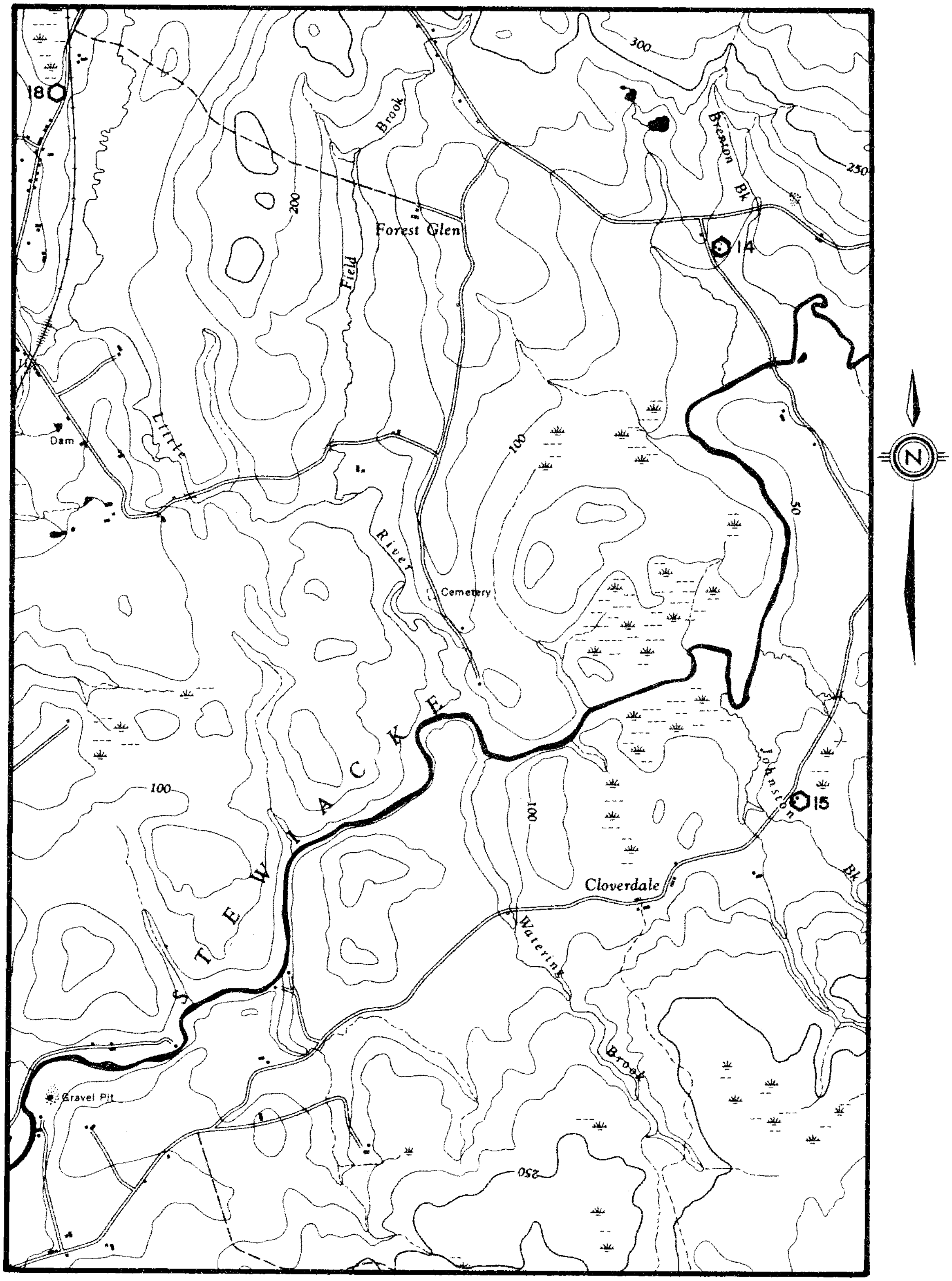
Map 3



Base Map Compiled from NTS 11E/3W

D.R.H./79

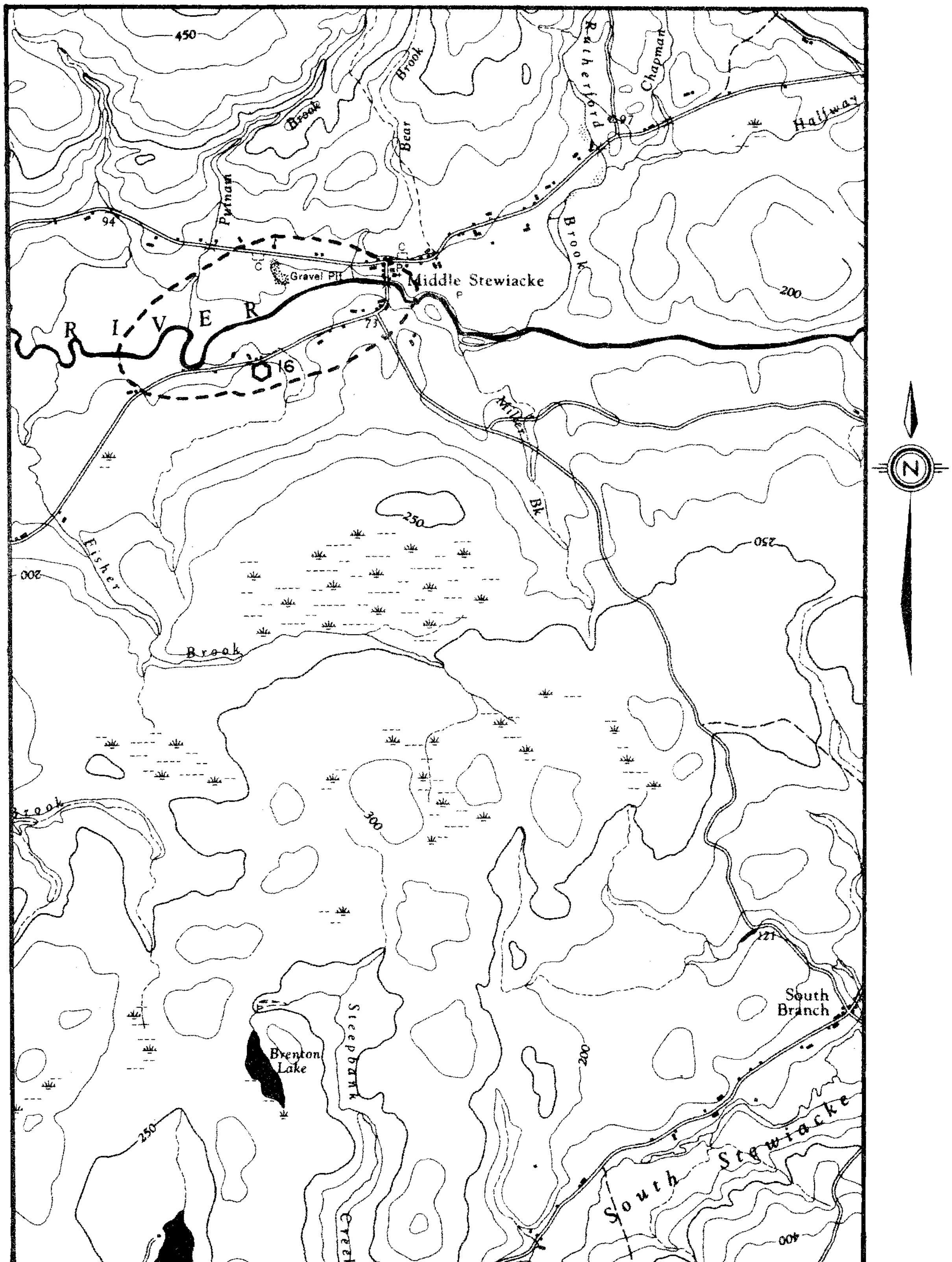
Map 4



Base Map Compiled from NTS 11E/3

D.R.H./79

Map 5



Base Map Compiled from NTS 11E/3E

D.R.H./79

APPENDIX N

REFERENCE REPORTS

"A Groundwater Report on the Nova Scotia Department of Lands and Forests Complex at Shubenacadie", Terry W. Hennigar, N. S. Department of Mines, November 26, 1979.

"Groundwater Resources Study, Shubenacadie-Stewiacke River Basin System", Terry Lay, 1978.

"Preliminary Report on the Groundwater Survey of the Elmsdale-Lantz Area, Hants County, Nova Scotia", Terry W. Hennigar, N. S. Department of Mines, June, 1969.

"Subsurface Conditions, Proposed Sand and Gravel Pit, Shubenacadie, Nova Scotia", Geocon Consultants, October , 1972.

"Water Supply Study, Elmsdale and Lantz, East Hants County", Canadian British Consultants, July, 1969.