

# 69-F-205C

H.W.Y. #403

PERTH PARK

Mr. M.W. COOMBS

PROPERTY

# GEOCON LTD

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Rexdale, Ontario.  
May 26th, 1969

69-F-205C

Department of Highways, Ontario,  
Downsview,  
Ontario.

Attention: Mr. A. Rutka, P. Eng.  
Materials and Testing Engineer

re: Site Investigation,  
Mr. M. W. Coombs Property,  
Perth Park at Highway 403.  
Ancaster, Ontario

Dear Sirs:

This letter accompanies our detailed report on the above work

This report is divided into two parts. Part I describes the results of the subsurface exploration carried out at the site. By arrangement with you, the services of Dr. H. R. Kivisild of Foundation of Canada Engineering Corporation Limited, were retained for the hydrological aspects of this study, and report on this phase of the work is presented in Part II.

The findings and conclusions of the overall investigation are discussed in detail in the report. In summary, however, it is concluded that the settlement and cracking experienced by Mr. Coombs' house is due to progressive consolidation of underlying fill and natural organic soils, in the interval since the house was built. The distress is not considered a consequence of the construction of the adjacent Highway 403.

We trust that the information given herein is in sufficient detail for your purposes. Kindly give us a call, however, should you wish elaboration on any aspect of the report

Yours very truly,

GEOCON LTD

*M. A. J. Matich*  
M. A. J. Matich, P. Eng.  
President

T 9213

ST. JOHN'S

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T 9213  
REPORT  
TO  
DEPARTMENT OF HIGHWAYS, ONTARIO  
ON  
SITE INVESTIGATION  
MR. M. W. COOMBS PROPERTY  
PERTH PARK AT HIGHWAY 403  
ANCASTER                      ONTARIO

Distribution: 10 copies -- Department of Highways, Ontario,  
Downsview, Ontario.

2 copies -- Geocon Ltd.

1 copy -- Dr. H. R. Kivisild.

**GEOCON**

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WITH MR. M. W. COOMBS

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### PART II

REPORT BY FOUNDATION OF CANADA ENGINEERING  
CORPORATION LIMITED ON HYDROLOGY OF ANCASTER  
CREEK AT HIGHWAY 403.

PART I

GEOCON

Geocon Ltd has been retained by The Ontario Department of Highways by letter of March 12th, 1969, to carry out a site investigation on the property of Mr. M. W. Coombs at 381 Woodworth Drive, Ancaster, Ontario, in the immediate vicinity on Highway 403. Our terms of reference were to act as independent consultants in the review of two complaints presented by Mr. M. W. Coombs as follows:

- (a) that the settlement and cracking experienced by his house was a consequence of changes in groundwater levels caused by the construction of the adjacent Highway 403
- (b) that the construction of Highway 403 had similarly caused an increase in flow in the stream behind his house.

By arrangement with The Ontario Department of Highways, Geocon Ltd retained the specialist services of Dr. H. R. Kivisild and other Technical Staff of Foundation of Canada Engineering Corporation Limited, (FENCO) in connection with the hydrological aspects of this study.

Throughout the course of the work, interviews were held with Mr. M. W. Coombs and a study was made of available plans, profiles and other data supplied by The Ontario Department of Highways. The information so obtained is referred to herein as factual background.

This report is divided into two parts. Part I covers the findings of the study of subsurface conditions, and Part II comprises the report on hydrologic studies as prepared by FENCO.

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Two predominant soil strata were encountered in the area investigated. These consist of a surface deposit of generally soft fill containing organics, and an underlying stratum of dense silt stratified with sand layers. Between these two formations there are comparatively thin layers consisting of the original topsoil and muskeg, organic silt and sand, and clayey silt.

The inferred soil stratigraphy as shown on Drawing T 9213-1 attached, shows that the residence of Mr. M. W. Coombs and the lot to the immediate rear of the house, has been constructed on unconsolidated fill which has been formed in part by filling out over a former swamp area; the latter is believed to have comprised the westerly side of an earlier flood plain for the existing Ancaster Creek.

### 3.0 BACKGROUND INFORMATION

The property in question is located in Perth Park, Ancaster, Ontario, and fronts onto Woodworth Drive<sup>(1)</sup>. A small stream, Ancaster Creek, runs across the property to the rear of Mr. M. W. Coombs' house. The present flood plain of the creek locally is covered by muskeg and other swamp growth. Highway 403 is carried across the stream valley on an embankment about 17 feet high, and the stream together with flow from a tributary and a former spring,

(1) Hamilton Wentworth Planning Area Board, Dwg. No. A-92

and drainage from Highway 403, are carried through the embankment by culverts generally as shown on Drawing T 9213-1.

Other background information obtained is as follows. Where this was developed from discussions with Mr. M.W. Coombs, the discussions are recorded in detail by copies of Minutes of Meeting and letter from Mr. Coombs, appended hereto.

- (a) The topography of the natural ground in the immediate vicinity of Mr. Coombs' house was a gently rolling hillside slope, which was levelled along existing streets by some cutting and filling as required.

In this connection, a comparison of ground elevations along Woodworth Drive immediately adjacent to Mr. Coombs' property may be made using the present elevations as shown on Drawing T 9213-1 attached, and the contours prior to street construction, as shown on Hamilton Wentworth Planning Area Board Drawing No. A-92, dated March, 1958. This comparison indicates the present street elevation is about 10 feet higher than original ground level at this location. A similar elevation difference between original and present grade is noted, immediately to the rear of Mr. Coombs' house.

A revised version of the above Drawing No. A-92, shows that Calvin Street has been built by filling a former small valley which was tributary to Ancaster Creek, and oriented approximately parallel to Highway 403.

- (b) The lot on which Mr. Coombs' residence is located was bought by Mr. Coombs in 1958 (or 1959) and the 2 1/2 acres of additional property to the rear, comprising Parcel 'C' of Perth Park No. 2, was purchased later.
- (c) Mr. Coombs' house was begun in August 1962 and completed by December of the same year. The house immediately to the north was built in 1958 and, the adjoining house to the south constructed in 1960.
- (d) The garage section of the house is located on the north side,



## (d) Continued

and had a floor slab carried on fill at about street level and thus approximately 5 feet above basement floor level.

In the Spring of 1963, i. e. shortly after completion of the house, the garage floor in the north-east corner tilted and settled approximately 4 or 5 inches in the process, and there was cracking, (some of which is still visible) in the brickwork in the north-east corner of the house. Following this initial settlement, the Builder releveled the slab by adding a surface layer of concrete.

The slab continued to settle, however, and in the Summer of 1968, the floor slab in the garage was removed and a new slab constructed and supported peripherally on the walls and also on interior stub columns. Since this reconstruction, the garage floor slab has shown no settlement relative to the walls.

- (e) Construction of the Highway 403 embankment over Ancaster Creek began with excavation of muskeg early in 1967, during the Winter. Placement of culverts followed, the latter being backfilled in the latter part of May. The embankment was built essentially to full height, by the end of June 1967.

Some deposition of silt occurred in the bed of Ancaster Creek downstream of the Highway, during construction.

- (f) The first extensive flooding of the creek, in Mr. Coombs' recollection occurred during the Summer of 1967, and during this period some fairly well grown elm trees growing in the flood plain, died. Some trees were cut down in 1967, and in 1968 more trees died and were cut down.
- (g) The first visible signs of settlement and cracking in the house (other than the garage) showed up as hairline cracks in the basement floor slab in the Fall of 1967. Cracking in plaster and woodwork upstairs became evident later, and most of the major cracks present during a visit by the writer on March 16th, 1969, were apparently visible before the end of 1968 with a few cracks having appeared in the interval.

On December 12th, 1968, Mr. A. Rutka, P.Eng. of the Ontario Department of Highways observed that there were two cracks in the foundation walls, one at about the centre of

## (g) Continued

the recreation room under the front entrance and the other on the east side behind the laundry tubs. The cracks were widest at the top of the basement wall and disappeared at the foundation. There was also one crack on the inside block wall over the crawl space entrance, and cracking in the plaster throughout the rest of the house. The recreation room floor slab showed considerable random cracking with openings as much as  $1/4$  of an inch. There was also an area of local settlement in the south west corner of the recreation room floor near the crawl space entrance.

In March 1969, Mr. Rutka noted one additional crack in the north basement wall abutting the garage, as well as some additional cracking of the floor in the recreation room on the north side nearest the garage. It was further observed that the outside bearing walls, particularly on the west and north sides had settled an estimated total of about  $1/2$  of an inch, and that the floor slab in the recreation room sloped downwards towards the foundation walls from the interior of the recreation room. The north and south ends of the partition wall (fabricated of 4 inch by 2 inch timber uprights and supporting the centre beam under the recreation room ceiling) were also lower than the centre.

On March 16th, 1969, during a visit by the writer, the crack in the wall above the opening to the crawl space was about  $3/8$  inch maximum in width. The north and west edges of the recreation room floor slab were lower by about one inch relative to the central area and a similar pattern was evident in the wood frame partition wall separating the recreation room from the laundry area. At this time also, the evidence of cracking was much more pronounced in the north and north-east sections of the house, than elsewhere, and it is understood that this pattern of different degrees of cracking between the north and south ends of the house has been generally the case since cracking was first observed.

- (h) There is an unlined drainage ditch along Woodworth Drive bordering with Mr. Coombs' property. Water from eavestroughing in the south-west part of Mr. Coombs' house discharges into the front lawn immediately adjacent to the roadway ditch. Other drainage from the house, including the sump, is carried by pipes to Ancaster Creek. A septic tank and tile bed is located between the rear of the house and Ancaster Creek.

## (h) Continued

The sump pump, in Mr. Coombs' recollection, has only worked once since the house was built and on this occasion in the Summer of 1968 there was very heavy rain and a flash flood. Visual examination of the sump and pump in March, 1969, confirms that it has not operated for some time and that it has had little use.

At no time has water come into the basement. However, during a storm and flash flood on January 30th, 1969, at a time when the water level in the stream had risen a reported 5 or 6 feet, Mr. Coombs found that the water level under the basement slab was within 7 inches of the top of the slab. As the flood level dropped, Mr. Coombs also noted that the water level in the ground below the basement floor dropped in sympathy, and this trend was observed by him on a number of other occasions.

In this connection, it is noted that there was approximately 11 feet difference between the basement floor level and the elevation of the water in the stream during April and May 1969, i. e. the period of observation covered by this investigation.

Mr. Coombs drilled three one inch holes through the basement slab in December 1968. He was able to push a 1 inch pipe into the soil below the floor slab for a distance of 5 feet with one finger, and believed he could readily have pushed the pipe further had it been longer. Some soil was trapped in the pipe and on extraction, it was noted by Mr. Coombs that the sample of soil at a depth of 5 feet was wetter and softer than the soil higher up.

- (i) Construction of the Swimming Pool was begun in the Fall of 1968, and has yet to be completed at time of writing.

At the time the pool was built, the bed of the stream was estimated by Mr. Coombs to be about 2 feet higher than the level on March 31st, 1969. The pool is of prefabricated steel construction with a plastic lining. It is founded on 4 to 6 inches of sand placed over natural ground and surrounded on all sides by a narrow berm of earth with a height of up to a maximum of about 4 feet. Construction involved excavation of some 3 feet below ground level near the stream, to accommodate the deep end of the pool. Below the deep end of the pool, there is a drainage sump (a drum filled with crushed stone) which drains into the stream via a plastic pipe. This pipe exits into the

## (i) Continued

stream about one foot or so above stream level on March 31st, 1969. There is normally a small flow from this pipe according to Mr. Coombs.

## 4.0

## DISCUSSION

The discussion which follows will deal essentially only with the soil mechanics aspects of this investigation, and the reader is referred to Part II for the results of the hydrological studies.

From a study of all of the background information presented earlier in this report, and the results of the subsurface site investigation outlined in detail in Appendix I, two facts emerge as being by far the most significant in our opinion, in explaining the cause of the settlement and cracking experienced by Mr. M. W. Coombs' house. These are:

- (1) The house is built on fill which is of poor quality as structural fill not only in terms of its grain size characteristics and generally soft and loose nature, but also because it contains organic material and was placed on original topsoil and extends out over what is believed to have been the westerly edge of a former flood plain swamp of Ancaster Creek.
- (2) The house experienced serious settlement and distress in the garage section, almost immediately after it was completed in late 1962. Settlement in the garage section continued progressively until the Summer of 1968 at which time the garage floor was completely rebuilt. Progressive deformation of the house is still taking place as reflected in formation of new but comparatively minor cracks. It is considered particularly significant however insofar as this investigation is concerned, that the house had a history of settlement and accompanying distress for about 4 years prior to construction of the adjacent embankment and culverts for Highway 403.

In our opinion, the settlement and accompanying distress experienced by the house is not therefore a consequence of the construction of Highway 403, but results from the fact that the house was initially founded on poor quality fill which in turn is carried partly on former swamp organics.

Indirect evidence indicating the presence of filled ground, and possible swamp organics extending under the easterly side of the house, as inferred from reference to available contour plans and air photos, is in reasonably good agreement with the findings of the exploratory borings carried out during this investigation. It appears that the house was built with the greatest amount of grade raising in the north-east corner both as fill under the garage floor, and exterior fill used to raise grade in conjunction with low retaining walls. It is believed that the presence of this greater amount of fill explains why settlement of the garage area was greater in magnitude and more rapid than elsewhere, although this may also be partly due to the presence of more organic soil below the fill in this area. The settlement is considered to be due to consolidation of the soft and loose fill and underlying muskeg and other organic soil, and perhaps also partly to shear deformations in the fill and organic soil. The fact that bearing walls have settled more than lightly-loaded floor slabs, is consistent with this explanation, as is the pattern and progressive nature of the settlement in the garage area in the four year interval

between the initial large settlement and final reconstruction of the floor slab.

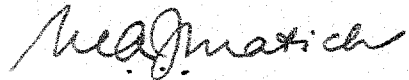
Because of the heterogeneous nature of both the fill and underlying organic soils, it is not possible in this instance to make accurate computations of the magnitude of settlement which the house would have undergone to date, and will eventually experience, or the time-rate at which such settlements would take place. At the same time, no accurate measurements of amount and time rate of settlement are available in the present case, which would be useful in analysing the distress experienced thus far and predicting further settlements which the house may undergo. In the writer's judgment, however, the data which is available relative to pattern of settlement as observed in the garage area and reflected by the cracking which has occurred elsewhere in the house, is in the order which could be reasonably expected due to consolidation of the fill and underlying organic soil. On the same basis, it is probable also that additional settlement of the house will occur for some time to come.

In Part II of this report, it is noted that there is no indication that the groundwater level and flow at Mr. Coombs' house has in any way been affected by Highway 403. The writer concurs with this view.

On the basis of the information obtained during this investigation, the following conclusions are drawn relative to the settlement and cracking experienced by Mr. M.W. Coombs' house.

1. The distress in terms of settlement and cracking of the house is a result of progressive consolidation of poor quality fill and underlying highly organic natural soil, which are located below foundation level and particularly to the rear of the house.
2. Settlement began essentially at time of completion of the house in late 1962, and has continued progressively ever since. It will probably continue to occur for some time to come.
3. The settlement and cracking experienced by the house is not considered to be a consequence of construction of Highway 403.

Respectfully submitted,



M. A. J. Matich, B. Eng. (Hons.), B. Sc.  
M. S., P. Eng.

T 9213

MAJM/em

MINUTES OF MEETING  
AND CORRESPONDENCE WITH  
MR. M. W. COOMBS

GEOCON



# GEOCON LTD

## HEAD OFFICE

420 MICHEL JASMIN, DORVAL, QUEBEC

TELEPHONE 631-9827

Rexdale, Ontario

April 2nd, 1969

## DISTRICT OFFICES

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TEL. 475-8967

Mr. M. Coombs,  
381 Woodworth Avenue,  
Perth Park,  
Ancaster, Ontario.

Dear Mr. Coombs:

Further to our meeting of March 31st, 1969, the writer has as arranged drafted out Minutes of Meeting and we are pleased to enclose herewith for your review one copy of these.

We trust that the Minutes accurately record your recollections of the discussions which took place, and we would be obliged if you would study them and advise us of revisions if any, which you consider should be made to these Minutes.

When we receive your comments we will finalize the Minutes accordingly. In the meantime may we express our appreciation for the excellent co-operation we have received from you in this matter.

Yours very truly,

GEOCON LTD



M. A. J. Matich, P. Eng.  
President

T 9213

c. c. Mr. A. Rutka, Department of Highways.

# MINUTES OF MEETING

Date: March 31st, 1969

Place: Residence of Mr. M. Coombs,  
Ancaster, Ontario.

Present: Mr. M. Coombs  
Mr. A. Bergs, FENCO  
Mr. M.A.J. Matich, Geocon Ltd

Purpose: To set out the initial programme of exploratory boreholes on Mr. Coombs' property, and to discuss background information relating to the difficulties presently being experienced by Mr. Coombs' residence.

The various points covered are summarized below, as reported by Mr. Coombs.

1. The City of Hamilton Laboratory has analysed two pieces of soil taken by Mr. Coombs from beneath the basement of his residence. In their report of March, 1969, the City found that the soil samples were completely free of coliform, and thus conclude that there is no septic tank pollution present.
2. The lot on which the residence is now located was bought by Mr. Coombs in 1958 or 1959, from the firm of Lewis & Wood, who were builders of most of the houses in the immediate vicinity. The property to the rear of Mr. Coombs' residence, comprising Parcel 'C' of Perth Park No. 2 was originally bought by Mr. Coombs from a Mr. Adam Calder. This parcel is 2 1/2 acres in size.
3. Mr. Coombs' neighbours are a Mr. Reid immediately to the south and a Mrs. Rast immediately to the north. Mr. Reid's house was built in 1960 and the retaining wall between this house and the stream was built the following year. Mrs. Rast's house was built in 1958.

Construction of Mr. Coombs' house was started in August of 1962 and completed in December of the same year. Periodic inspections were made during construction, by the Hamilton Office of C.M.H.A. These reports showed that the excavation in progress in late August 1962 and that foundation construction was in progress in early September 1962. Framing and roof construction was in progress by the end of September.

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4. The topography of the natural ground in the immediate vicinity of Mr. Coombs house was apparently a gently rolling hillside slope, which was levelled along existing streets by some cutting and filling as required. The low lying ground near the stream was heavily treed in elms, most of the trees being cut last year.
5. In regard to the settlement and accompanying distress being experienced by Mr. Coombs' residence, the following were mentioned by Mr. Coombs:
  - (a) In the Spring of 1963 the garage floor tilted in the north east corner, and settled approximately 4 or 5 inches in the process. In this area apparently, the builder had over excavated beyond specified grade and thus had been obliged to use fill to restore grade beneath the garage floor. The floor slab was not tied into the walls. Following the initial settlement, the builder releveled the slab by adding a surface layer of concrete. The slab continued to settle however. In the Summer of 1968 the floor slab in the garage was removed and a new slab constructed with supports on a wall carried on the exterior wall footing at the east end of the slab, and on 4 pillars elsewhere. At the same time an expansion joint was left beneath the slab and the walls. Since this reconstruction, the garage floor slab has shown no further signs of settlement.

Accompanying the initial settlement of the floor slab there was distress to the north east corner of the house with resulting cracking in the brickwork which is still visible. In Mr. Coombs' opinion, this distress was due to excessive pressure which was being exerted by the slab and fill laterally against the foundation wall of the house in this area.
  - (b) The first visible signs of cracking in the basement floor showed up as hair line cracks in about the Fall of 1967. Cracking in plaster and woodwork upstairs became evident later. The cracking generally became particularly noticeable during the Summer of 1969. Some hair line cracks have opened up within the last 2 or 3 weeks in the plaster in the upstairs section of the house.
6. The sump pump as far as Mr. Coombs was aware has only worked once since the house was built and on this occasion there was very heavy rain and a flash flood, and the weather was coming from the east rather than from the west which is the prevailing direction. Visual examination of the sump and the pump confirms and it has not operated for sometime and that it has had little use.

At no time has water come into the basement. However, during January 1969, at a time when the water level in the creek had risen 5 or 6 feet during a flood, Mr. Coombs found that the water level under the basement slab was within 7 inches of the top of the slab. As the flood level in the stream dropped the water level in the ground beneath the basement floor also dropped. This tendency for the ground water under the basement slab to move up or down in sympathy with changes in water level in the stream has also been observed by Mr. Coombs on a number of other occasions, most recently in the readings taken by him during March of this year.

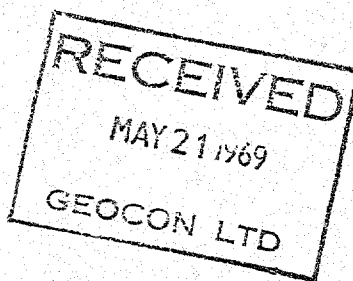
7. The three 1 inch holes were put down through the basement floor slab by Mr. Coombs in December of 1968. He found that 6 inches of crushed stone existed immediately below the slab with no void between the slab and this crushed stone base. Mr. Coombs was able to push a 1 inch pipe into the soil below the crushed stone base, for a distance of 5 feet with one finger and Mr. Coombs believed that had the pipe been longer than 5 ft. he could have readily pushed it deeper into the soil. On extraction of the pipe, the soil which had been trapped in it was extruded and examined by Mr. Coombs and he noted that the soil at the bottom i.e. at about the 5 ft. depth was softer than the soil higher up. The sample of the soil extruded from the pipe and given to Mr. A. Rutka of the Ontario Department of Highways came from a depth of about 2 feet below the floor slab level.
8. Construction of the Swimming Pool at the rear of the house was begun last Fall and has not yet been completed. At the time that the pool was built, the bed of the creek was about 2 ft. higher than its present level. The pool construction involved excavating about 3 ft. below ground level close to the stream, in order to accommodate the deep end of the pool. The pool is of prefabricated steel construction with a plastic lining. It is founded on 4 to 6 inches of sand placed over natural ground and surrounded on all sides by a narrow berm of earth with a height of up to about a maximum of 5 ft. The soil excavated was apparently similar in composition but firmer than that encountered in the holes put down by Mr. Coombs below the basement floor slab. Below the deep point of the Pool there is a drainage sump consisting of a drum filled with crushed stone. This is connected to the stream by a plastic discharge hose which exits from the existing stream bank just above the present water level in the stream and one foot or so above the present (March 31st, 1969) level of the stream. According to Mr. Coombs there is a small amount of water normally draining from this pipe.

*M. A. J. Matich*  
M. A. J. Matich

May 16th, 1969

381 Woodworth Avenue,  
Perth Park,  
Ancaster,  
Ontario

Geocon Limited,  
14 Haas Road,  
Rexdale,  
Toronto, Ontario.



Attention: Mr. M.A.J. Matich, P.Eng.

Dear Sirs:

This refers to your letters of April 2nd and May 12th, 1969, about our meeting of March 31st at my house. My purpose is to clarify a few minor points in the Minutes of that meeting.

In Paragraph 4 you state that most of the elm trees were cut last year. This is so, but I feel that the sequence of the problems which I have had with my house and property, should be established.

The first extensive flooding of the creek occurred during the summer of 1967. During this period some fairly well grown elm trees died. These trees had come into leaf in the spring of 1967 but the leaves fell prematurely in the summer. Some trees were cut down in 1967. In 1968 more trees died and were cut down. The apparent cause of the death of the trees was the flooding of the creek.

The first signs of settlement of the house were visible in the fall of 1967. By the fall of 1968 the cracking from the settlement had

become extensive. Most of the major cracks, which were visible when you visited the house, were present before the end of 1968. However a few more have occurred, which shows that the settlement is continuing.

In Paragraph 7 of the Minutes of the meeting, you state that the soil at the bottom of the pipe was softer than it was higher up. This "softness" appeared to be associated with the soil being wetter at this depth.

In Paragraph 8 of the Minutes, you indicate that the maximum depth of the berm around the swimming pool was 5 feet. It was actually approximately 4 feet.

At various points of the Minutes, you present my opinions on the reasons for various happenings. I trust that you will take into account the fact that I am not an engineer when you endeavour to determine the causes of the problems with my house and property.

Yours very truly,

A handwritten signature in cursive script, appearing to read "M. Coombs".

M. Coombs

APPENDIX I

PROCEDURE

SOIL CONDITIONS

GROUNDWATER CONDITIONS

OFFICE REPORTS ON SOIL EXPLORATION

The field work for this investigation was carried out between the dates of April 2nd and April 29th, 1969, with a set of water level observations being taken on May 14th, 1969. Because of space considerations and the generally shallow depth of the boreholes, the soil sampling was carried out using a portable motorized tripod type drill rig, and by hand auger and manually operated soil samplers. Sampling was usually continuous. Where casing was used, it was in BX size, although large diameter (3 inch nominal size) samples were recovered without the use of casing. Because of the manual nature of the operation and the soft soils encountered generally at the surface, the soil samplers and casing were sometimes pushed into the ground manually or with small blows of various sizes of hammer, as described later in this Appendix and on the individual Office Logs. Thus the standard 140 pound hammer was not always used to drive the soil samplers into the ground. Piezometers were installed in a number of boreholes, so that readings of groundwater level could be taken during the investigation, and in the future if desired.

Soil testing was carried out in the Soil Mechanics Laboratory of Geocon Ltd in Toronto, and samples remaining after testing will be retained pending further instructions regarding their disposal.



1.0 PROCEDURE - Continued

The soil and groundwater conditions encountered are described in detail herein, and the inferred stratigraphy is shown graphically on the Office Reports on Soil Exploration, in Appendix I, the Figures of Appendix II, and on Drawing T 9213-1 attached.

2.0 SOIL CONDITIONS

The stratigraphic sequence inferred from the samples recovered at borehole locations, consisted essentially of fill over a natural ground formation consisting of compact to very dense reddish grey brown silt with sand layers. In between these two strata are several comparatively thin layers of generally organic soil representing the original topsoil, and the muskeg cover in the swamp area. The main strata encountered are as follows:

2.1 Recent Topsoil

West of the stream, the property in question is in lawn and thus grass covered. There was thus about 4 inches of root-bound brown sandy and silty topsoil at the surface at most borehole locations, other than Boreholes 1 and 2 beneath the basement floor slab.

2.2 Loose and Soft Fill

Beneath the topsoil and under the floor slab, a stratum of fill was encountered at all boreholes located on the property west of the stream. The thickness of fill encountered varied from 1 to 10 feet approximately, with the greatest thickness occurring immediately adjacent to the house on its east and west sides. The lower boundary of the fill was generally established by identifying the original muskeg or original grey organic silt surface soil.

## 2.2 Loose and Soft Fill - Continued

The fill is of variable composition, although it may be broadly classified as being predominantly sandy near the surface on the front lawn and immediately to the rear of the house, and predominantly silty elsewhere. The inference drawn from these findings is that there had been general filling with silty soil of the site including part of the existing swamp, and later backfilling around the house foundations using predominantly fine sand fill and raising grade to present elevation with the same material. Many samples of both the silty and sandy fill contained a trace of coarse sand and occasional sub-rounded gravel sizes up to 1 inch in diameter. In some cases, what appeared to be fresh crushed stone with a 3/4 inch top size was encountered, and there were one or two pieces of angular weathered limestone up to 2 1/2 inches in maximum dimension. In some cases also, the samples gave the appearance of being a silty till, but very low in sand and gravel sizes. A trace of clay was present in all of the silty fill samples, imparting a low to medium dry strength. Grain size distribution curves are given on Figures 1 and 1A, Appendix II.

The fill is variable in colour, but is mostly grey and brown, often with mottling in these colours with some dark grey to black discolorations of organic silt. The structure of the fill is generally heterogeneous, particularly where the silty material was involved. Some samples of the predominantly sandy fill however, showed a tendency to be faintly horizontally stratified.

Perhaps the most striking characteristics of the fill are its generally loose or soft consistency and its high content of a wide assortment of organic material. From tactile examination, the fill was often soft and spongy especially where fully saturated. This soft spongy nature was particularly noticeable in Borehole 8. Samples were generally taken manually with little difficulty, or with a few taps of a sledge hammer. Where they were taken by an improvisation of the standard split spoon sampling techniques, equivalent "N" values obtained ranged from 1 to 8. Drill casing often penetrated the fill under its own weight, or by being pushed down manually, the most striking example being Borehole 8 immediately to the rear of the house. It was difficult to secure samples of the fill for strength testing, because of the generally soft consistency, heterogeneous character, and high content of

## 2.2 Loose and Soft Fill - Continued

organics. For the same reason, recovery of samples during the drilling operation was sometimes low, and several boreholes had to be repeated on this account, in fact continuous sampling by hand auger equipment had to be resorted to on occasion.

The considerable amount of organic material, some partly decayed, present in the fill especially in the predominantly silty soil included grass roots and leaves, pieces of straw, pieces of wood and twigs, and pockets of muskeg. The sections of fill containing the highest amounts of organics were soft and spongy.

No strength or consolidation tests were carried out on the fill since the heterogenous and soft composition precluded proper undisturbed sampling and selection of material which might be considered representative of the stratum as a whole. From tactile examination, however, the fill is judged to be unconsolidated and compressible. In this regard, there were voids in some samples which was further evidence of the unconsolidated nature of the fill.

A number of wet unit weight determinations were made on samples of the fill which were free of organics and intact enough for such tests and which thus represented the stiffer portions of the stratum. Values obtained were in the range of about 120 to 130 pounds per cubic foot. The natural moisture contents similarly obtained ranged from about 11 to 25 percent.

## 2.3 Muskeg, Original Topsoil, Organic Silt and Sand

Borehole 3 established that the surface cover on the swamp in the upper 2 feet or so, consists of muskeg, below which is soft, compressible grey organic silt with some thin layers of grey organic sand. Below this again is a thin stratum of loose grey organic sand with some gravel, which is described separately later. The sequence of muskeg, and grey organic silt and sand, however, was identified at a number of other boreholes e.g. Boreholes 6, 7 and 3 and would infer that the westerly limits of the present swamp once extended to the area presently occupied by Mr. Coombs' residence.

## 2.3 Muskeg, Original Topsoil, Organic Silt and Sand

The muskeg is generally black in colour, surficially contains pieces of wood, moss, roots and other fibrous material, but is mostly of an organic consistency perhaps most appropriately described as "muck". Some thin layers, 1 inch or less, of marl were present near the base of the muskeg. The muskeg is highly compressible as indicated by its spongy nature, natural moisture contents of 34 to 342 percent, and the results of a consolidation test as shown on Figure 2 of Appendix II.

The original topsoil on the high ground west of the swamp is inferred to have consisted of a thin veneer of light grey slightly sandy silt containing organics in the form of roots and stalks, and discolorations of dark grey organic silt. The topsoil was in some samples riddled with worm or ant holes, in others had a crumbly, blocky, appearance and sometimes a brown and grey mottling indicative of weathering. When wet, the organic silt was generally soft and spongy, and compressible as indicated by the results of the consolidation test given on Figure 3 of Appendix II. The organic silt was found to have natural moisture contents of 21 to 38 percent, and a grain size distribution as shown on Figure 4 in Appendix II.

In Boreholes 2, 5, 6, 7 and 8 the lower part of the organic silt was stratified with a few thin layers of grey sand containing organic material and some gravel sizes. Among the gravel sizes were a few white angular limestone fragments that appeared typical of the stream alluvium and which were particularly noted under the present bed of the stream. The organic material was in the form of individual pieces of wood, roots and fibres, and accumulations of muskeg and partially decayed vegetation. It gave the sand a soft and spongy consistency.

## 2.4 Loose Grey Organic Sand

In Boreholes 3 and 4, the sand which was present in layers within the organic silt as mentioned above, occurred as the predominant material in strata with overall thickness of about 2.5 and 3.5 feet thick, respectively.

In both boreholes, the stratum was irregularly stratified in a horizontal direction in layers one or two inches thick, with

## 2.4 Loose Grey Organic Sand

some layers consisting variously of black muskeg grey organic silt, and decaying vegetation. Some sub-rounded gravel sizes were present in sizes up to 1 inch across and there were pieces of white angular limestone present, being typical of the surface swamp deposits as noted previously. The sand is generally loose and spongy from tactile examination and ease of sampling, although one "N" value of 19 was recorded in Borehole 4.

## 2.5 Loose to Firm Grey-Brown Clayey and Sandy Silt

In Boreholes 9, 10 and 12, a layer of grey and brown sandy and clayey silt about 3 feet thick, was encountered directly beneath the surface silty fill or topsoil. The upper part of this layer in the top one foot approximately, contained worm holes and some roots, and was weathered to a crumbly consistency and mottled grey and brown colouration inferring that it represented original ground surface before filling. It was also fissured, with the fissuring in some cases filled with dark grey silt of the type encountered surficially elsewhere. The stratum is described separately since it is thicker at Boreholes 9 and 10 than locally elsewhere, and also did not contain the organic matter typical of the grey silt described above.

The results of a grain size distribution curve on the sandy portion of the silt is given on Figure 5 of Appendix II. Two undrained triaxial tests gave compressive strengths of about 0.25 tons per square foot. From tactile examination also, the upper part of the silt was firm and friable, the lower part of this stratum being soft and spongy. On the above basis, and also the ease of sampling, the relative density and consistency of the silt are variously described as loose to firm.

## 2.6 Compact to Very Dense Grey-Brown Silt, with Fine Sand Layers

The basal stratum encountered in all of the boreholes is a grey-brown silt whose colouring often has a reddish hue. This stratum was penetrated for a depth of about 22 feet at Borehole 3. At Boreholes 1, 2, 9, 10, 11 and 12, the upper one or two feet show evidence of oxidation and weathering of randomly dispersed coarse sand sizes, and also some roots and traces

## 2.0 SOIL CONDITIONS - Continued

2.6 Compact to Very Dense Grey-Brown Silt, with Fine Sand Layers -  
Continued

of other organics. The stratum is stratified with layers of fine sand one or two inches thick occurring throughout at various elevations. The stratification is generally horizontal, although inclinations at up to 45 degrees occurred in places. A few gravel sizes from about 1/4 of an inch to 1 inch in size were observed here and there. A layer of what appeared to be weathered stream gravel, only a few inches thick occurred at the top of the stratum in Boreholes 6, 8, 9, 10 and 11.

The silt contained a trace of clay generally and sometimes enough clay sizes to give samples a low dry strength. Grain size distribution curves for composite samples from the stratum are given on Figures 6 and 6A in Appendix II.

Standard Penetration Tests gave "N" values ranging from 3 to in excess of 100 blows per foot and generally from 10 to in excess of 100 blows, indicating a generally compact to very dense relative density.

## 3.0 WATER CONDITIONS

Piezometers were installed in a number of selected boreholes.

Details of the piezometer installations and specifically the relative elevations of porous tips, sand backfill and bentonite seals are shown on the Office Reports on Soil Exploration.

Observations of water levels in the piezometers over an extended period of time are shown on Table I, immediately following the Office Reports on Soil Exploration.

## EXPLANATION OF THE FORM "OFFICE REPORT ON SOIL EXPLORATION"

The object of this form is to enable a comprehensive study of the soil to be made by combining on one sheet all of the information obtained from the boring. An explanation of the various columns of the report follows.

### ELEVATION AND DEPTH

This column gives the elevation and depth of boundaries between the various soil strata. The elevation is referred to the datum shown in the general heading.

### WATER CONDITIONS

In this column the water level in the casing at the time of boring or the water table in the ground, determined by a series of observations in a piezometer or standpipe, is indicated to scale by a horizontal line with the symbol W.L. or W.T. above the line. A notation of any complicated groundwater conditions will be made in this column.

### DESCRIPTION

A description of the soil, using standard terminology, is contained in this column. The consistency of cohesive soils and the relative density of non-cohesive soils are described by the following terms:

<u>Consistency</u>	<u>U-Strength Tons/sq. ft.</u>	<u>Relative Density</u>	<u>Standard Penetration Resistance. Blows/ft.</u>
Very soft	0.03 to 0.25	Very loose	0 to 4
Soft	0.25 to 0.5	Loose	4 to 10
Firm	0.5 to 1.0	Compact	10 to 30
Stiff	1.0 to 2.0	Dense	30 to 50
Very stiff	2.0 to 4.0	Very dense	over 50
Hard	over 4.0		

### STRATIGRAPHIC PLOT

The stratigraphic plot follows the standard symbols of the National Research Council, Canada.

### ELEVATION SCALE

The information in all columns is plotted to a true elevation scale which is shown in this column.

### GRAPHS

The main body of the report forms a graph which is used to plot to correct elevation the important soil properties which are obtained through field and laboratory tests. The scales and symbols for the plotting are shown at the head of the column.

### OTHER TESTS

In this column are shown, by symbol, the other field or laboratory tests which have been performed on the soil and for which the results have not been plotted on the above graph.

### SAMPLES

The first three columns describe the condition, type and number of each sample obtained from the boring. The location and extent of each sample is plotted to scale.

In the last column is shown the penetration resistance in blows of 4200 inch-pounds required to drive one foot of the sampler into the ground. When a 2 inch Drive Sampler is used the result obtained is termed the "Standard Penetration Resistance".

**GEOCON**

## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9213 BORING # Lead 2 DATUM GEODETIC CASING -  
 BORING DATE APR 23-24/69 REPORT DATE APR 28, 1969 COMPILED BY A.E.L. CHECKED BY MAJMA  
 SAMPLER HAMMER WT. 50 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

## SAMPLE CONDITION



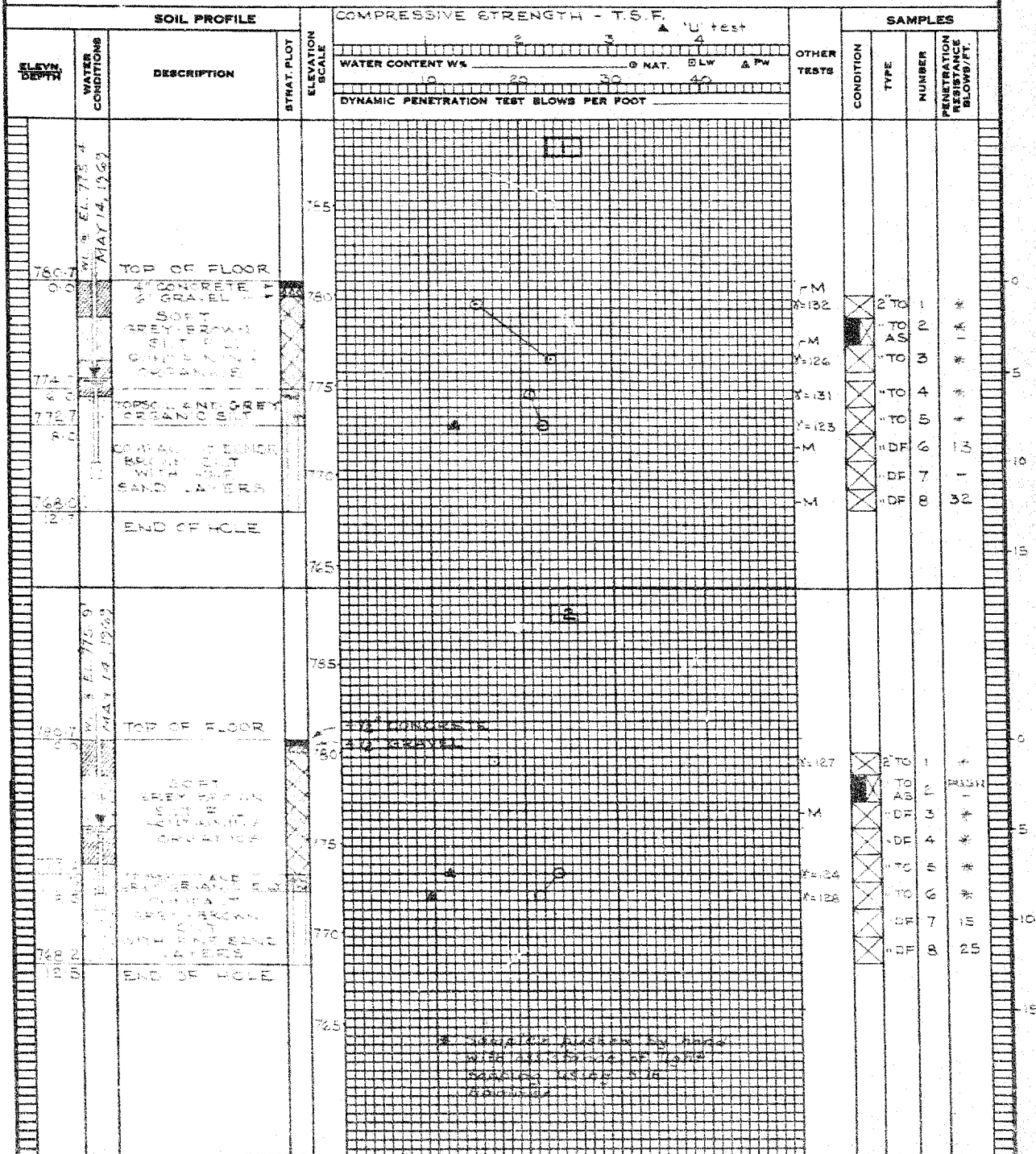
A.S. - AUGER SAMPLE  
 ST. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE

## SAMPLE TYPES

F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

## ABBREVIATIONS

V. - IN-SITU VANE TEST  
 M. - MECHANICAL ANALYSIS  
 U. - UNCONFINED COMPRESSION  
 QC. - TRIAXIAL CONSOLIDATED UNDRAINED  
 S. - TRIAXIAL UNDRAINED  
 S. - TRIAXIAL DRAINED  
 W. - WET UNIT WEIGHT - PCF  
 K. - PERMEABILITY  
 C. - CONSOLIDATION  
 WL. - WATER LEVEL IN CASING  
 WT. - WATER TABLE IN SOIL





CONTRACT T9213 BORING # 3 DATUM GEODETIC CASING BX  
BORING DATE APR. 2-8/69 REPORT DATE APR. 19, 1969 COMPILED BY AEL CHECKED BY MAIM  
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4320 IN - LBS. ENERGY)

### SAMPLE TYPES

### ABBREVIATIONS

A.S. - AUGER SAMPLE  
S.T. - SLOTTED TUBE  
W.S. - WASHED SAMPLE  
D.O. - DRIVE-OPEN  
D.F. - DRIVE-FOOT VALVE  
C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE  
S.O. - SLEEVE-OPEN  
S.F. - SLEEVE-FOOT VALVE  
T.O. - THIN WALLED OPEN  
R.C. - ROCK CORE

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 QC - TRIAXIAL CONSOLIDATED UN  
 Q - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED

7 - WET UNIT WEIGHT  
K - PERMEABILITY  
C - CONSOLIDATION

LINEO

WL - WATER LEVEL IN CASING  
WT - WATER TABLE IN SOIL

SOIL PROFILE				SAMPLES							
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT ELEVATION SCALE	WATER CONTENT W%			OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
				10	20	30					
				DYNAMIC PENETRATION TEST BLOWS PER FOOT							
77.5		GROUND LEVEL									
77.5											
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## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9213 BORING # 4 DATUM GEODETIC CASING BX  
 BORING DATE APR. 9-19/69 REPORT DATE APR. 21, 1969 COMPILED BY AEL CHECKED BY MAJ  
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

## SAMPLE CONDITION



A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE

## SAMPLE TYPES

F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

## ABBREVIATIONS

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 QC - TRIAXIAL CONSOLIDATED UNDRAINED  
 Q - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED  
 T - WET UNIT WEIGHT  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL

SOIL PROFILE				SAMPLES			
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT ELEVATION SCALE	WATER CONTENT W% O NAT. O LW A Pw	DYNAMIC PENETRATION TEST BLOWS PER FOOT	OTHER TESTS	CONDITION TYPE NUMBER PENETRATION RESISTANCE BLOWS/FT.
760	0.00	TO CREEK	770				2 TO 1 PWSH
760	0.00	TO CREEK	765				TO 2 "
760	0.00	TO CREEK	760				DF 3 19
760	0.00	TO CREEK	755				DF 4 18
760	0.00	TO CREEK	750				DF 5 18
760	0.00	TO CREEK	745				DF 6 17
760	0.00	TO CREEK	740				DF 7 15
760	0.00	TO CREEK	735				DF 8 17
760	0.00	TO CREEK	730				DF 9 19
760	0.00	TO CREEK	725				DF 10 22
760	0.00	TO CREEK	720				DF 11 23
760	0.00	TO CREEK	715				DF 12 22
760	0.00	TO CREEK	710				DF 13 32
760	0.00	TO CREEK	705				DF 14 67
760	0.00	TO CREEK	700				DF 15 24
760	0.00	TO CREEK	695				DF 16 23
760	0.00	TO CREEK	690				
760	0.00	TO CREEK	685				
760	0.00	TO CREEK	680				
760	0.00	TO CREEK	675				
760	0.00	TO CREEK	670				
760	0.00	TO CREEK	665				
760	0.00	TO CREEK	660				
760	0.00	TO CREEK	655				
760	0.00	TO CREEK	650				
760	0.00	TO CREEK	645				
760	0.00	TO CREEK	640				
760	0.00	TO CREEK	635				
760	0.00	TO CREEK	630				
760	0.00	TO CREEK	625				
760	0.00	TO CREEK	620				
760	0.00	TO CREEK	615				
760	0.00	TO CREEK	610				
760	0.00	TO CREEK	605				
760	0.00	TO CREEK	600				
760	0.00	TO CREEK	595				
760	0.00	TO CREEK	590				
760	0.00	TO CREEK	585				
760	0.00	TO CREEK	580				
760	0.00	TO CREEK	575				
760	0.00	TO CREEK	570				
760	0.00	TO CREEK	565				
760	0.00	TO CREEK	560				
760	0.00	TO CREEK	555				
760	0.00	TO CREEK	550				
760	0.00	TO CREEK	545				
760	0.00	TO CREEK	540				
760	0.00	TO CREEK	535				
760	0.00	TO CREEK	530				
760	0.00	TO CREEK	525				
760	0.00	TO CREEK	520				
760	0.00	TO CREEK	515				
760	0.00	TO CREEK	510				
760	0.00	TO CREEK	505				
760	0.00	TO CREEK	500				
760	0.00	TO CREEK	495				
760	0.00	TO CREEK	490				
760	0.00	TO CREEK	485				
760	0.00	TO CREEK	480				
760	0.00	TO CREEK	475				
760	0.00	TO CREEK	470				
760	0.00	TO CREEK	465				
760	0.00	TO CREEK	460				
760	0.00	TO CREEK	455				
760	0.00	TO CREEK	450				
760	0.00	TO CREEK	445				
760	0.00	TO CREEK	440				
760	0.00	TO CREEK	435				
760	0.00	TO CREEK	430				
760	0.00	TO CREEK	425				
760	0.00	TO CREEK	420				
760	0.00	TO CREEK	415				
760	0.00	TO CREEK	410				
760	0.00	TO CREEK	405				
760	0.00	TO CREEK	400				
760	0.00	TO CREEK	395				
760	0.00	TO CREEK	390				
760	0.00	TO CREEK	385				
760	0.00	TO CREEK	380				
760	0.00	TO CREEK	375				
760	0.00	TO CREEK	370				
760	0.00	TO CREEK	365				
760	0.00	TO CREEK	360				
760	0.00	TO CREEK	355				
760	0.00	TO CREEK	350				
760	0.00	TO CREEK	345				
760	0.00	TO CREEK	340				
760	0.00	TO CREEK	335				
760	0.00	TO CREEK	330				
760	0.00	TO CREEK	325				
760	0.00	TO CREEK	320				
760	0.00	TO CREEK	315				
760	0.00	TO CREEK	310				
760	0.00	TO CREEK	305				
760	0.00	TO CREEK	300				
760	0.00	TO CREEK	295				
760	0.00	TO CREEK	290				
760	0.00	TO CREEK	285				
760	0.00	TO CREEK	280				
760	0.00	TO CREEK	275				
760	0.00	TO CREEK	270				
760	0.00	TO CREEK	265				
760	0.00	TO CREEK	260				
760	0.00	TO CREEK	255				
760	0.00	TO CREEK	250				
760	0.00	TO CREEK	245				
760	0.00	TO CREEK	240				
760	0.00	TO CREEK	235				
760	0.00	TO CREEK	230				
760	0.00	TO CREEK	225				
760	0.00	TO CREEK	220				
760	0.00	TO CREEK	215				
760	0.00	TO CREEK	210				
760	0.00	TO CREEK	205				
760	0.00	TO CREEK	200				
760	0.00	TO CREEK	195				
760	0.00	TO CREEK	190				
760	0.00	TO CREEK	185				
760	0.00	TO CREEK	180				
760	0.00	TO CREEK	175				
760	0.00	TO CREEK	170				
760	0.00	TO CREEK	165				
760	0.00	TO CREEK	160				
760	0.00	TO CREEK	155				
760	0.00	TO CREEK	150				
760	0.00	TO CREEK	145				
760	0.00	TO CREEK	140				
760	0.00	TO CREEK	135				
760	0.00	TO CREEK	130				
760	0.00	TO CREEK	125				
760	0.00	TO CREEK	120				
760	0.00	TO CREEK	115				
760	0.00	TO CREEK	110				
760	0.00	TO CREEK	105				
760	0.00	TO CREEK	100				
760	0.00	TO CREEK	95				
760	0.00	TO CREEK	90				
760	0.00	TO CREEK	85				
760	0.00	TO CREEK	80				
760	0.00	TO CREEK	75				
760	0.00	TO CREEK	70				
760	0.00	TO CREEK	65				
760	0.00	TO CREEK	60				
760	0.00	TO CREEK	55				
760	0.00	TO CREEK	50				
760	0.00	TO CREEK	45				
760	0.00	TO CREEK	40				
760	0.00	TO CREEK	35				
760	0.00	TO CREEK	30				
760	0.00	TO CREEK	25				
760	0.00	TO CREEK	20				
760	0.00	TO CREEK	15				
760	0.00	TO CREEK	10				
760	0.00	TO CREEK	5				
760	0.00	TO CREEK	0				

## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T 9213 BORING # 5 DATUM GEODETIC CASING BX  
 BORING DATE APR 10-11/69 REPORT DATE APR 21 1969 COMPILED BY AEL CHECKED BY MAIM  
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

## SAMPLE CONDITION

☒ DISTURBED  
☐ FAIR  
☐ GOOD  
☐ LOST

A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE

## SAMPLE TYPES

F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

## ABBREVIATIONS

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 GC - TRIAXIAL CONSOLIDATED UNDRAINED  
 Q - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED  
 7 - WET UNIT WEIGHT  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL

SOIL PROFILE				OTHER TESTS		SAMPLES				
ELEV. DEPTH	WATER CONDITION	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	WATER CONTENT WK	OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
775		GROUND LEVEL								
770		GREY & BROWN ORGANIC SILT LAYERS								
767										
765										
760		COMPACT TO VERY DENSE REDDISH GREY-BROWN SILT WITH FINE SAND LAYERS								
755										
750										
748		END OF HOLE								

ARTESIAN WL @ 21 772.7 MAY 14, 1969

WATER CONTENT WK: 9 NAT. 10 LW 11 PW

DYNAMIC PENETRATION TEST BLOWS PER FOOT

2" DF 1 PUSH 0  
 "DF 2 " 1  
 "DF 3 10  
 "DF 4 17  
 "DF 5 19  
 "DF 6 29  
 "DF 7 24  
 "DF 8 22  
 "DF 9 38  
 "DF 10 20  
 "DF 11 18  
 "DF 12 18  
 "DF 13 24  
 "DF 14 60  
 "DF 15 21

CONTRACT T9213 BORING # 6 DATUM GEODETIC CASING EX  
BORING DATE APR 25 1969 REPORT DATE APR 21 1969 COMPILED BY DEL CHECKED BY MAN  
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

## SAMPLE TYPES

## ABBREVIATIONS

A.S. - AUGER SAMPLE  
S.T. - SLOTTED TUBE  
W.B. - WASHED SAMPLE  
D.O. - DRIVE-OPEN  
D.F. - DRIVE-FOOT VALVE  
C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE  
S.O. - SLEEVE-OPEN  
S.F. - SLEEVE-FOOT VALVE  
T.O. - THIN WALLED OPEN  
R.C. - ROCK CORE

V - IN-SITU VANE TEST  
M - MECHANICAL ANALYSIS  
U - UNCONFINED COMPRESSION  
QC - TRIAXIAL CONSOLIDATED UN  
O - TRIAXIAL UNDRAINED  
S - TRIAXIAL DRAINED

7. WET UNIT WEIGHT  
K. PERMEABILITY  
C. CONSOLIDATION  
WL. WATER LEVEL IN CASING  
WT. WATER TABLE IN SOIL

## SOIL PROFILE

[illegible]

## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9213 BORING # 7 DATUM GEODETIC CASING PX  
 BORING DATE APR 14-15/69 REPORT DATE APR 21 1969 COMPILED BY A.F.L. CHECKED BY MAIM  
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

## SAMPLE CONDITION

☒ DISTURBED  
☐ FAIR  
☐ GOOD  
☐ LOST

## SAMPLE TYPES

A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE  
 F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

## ABBREVIATIONS

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 QC - TRIAXIAL CONSOLIDATED UNDRAINED  
 Q - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED  
 T - WET UNIT WEIGHT - PCF  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL

SOIL PROFILE			COMPRESSION STRENGTH - TSE		OTHER TESTS	SAMPLES			
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE		CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOW/FT.
0.0		GROUND LEVEL		0.0					
0.1		VERY LOOSE		0.1					
0.2		VERY LOOSE		0.2					
0.3		VERY LOOSE		0.3					
0.4		VERY LOOSE		0.4					
0.5		VERY LOOSE		0.5					
0.6		VERY LOOSE		0.6					
0.7		VERY LOOSE		0.7					
0.8		VERY LOOSE		0.8					
0.9		VERY LOOSE		0.9					
1.0		VERY LOOSE		1.0					
1.1		VERY LOOSE		1.1					
1.2		VERY LOOSE		1.2					
1.3		VERY LOOSE		1.3					
1.4		VERY LOOSE		1.4					
1.5		VERY LOOSE		1.5					
1.6		VERY LOOSE		1.6					
1.7		VERY LOOSE		1.7					
1.8		VERY LOOSE		1.8					
1.9		VERY LOOSE		1.9					
2.0		VERY LOOSE		2.0					
2.1		VERY LOOSE		2.1					
2.2		VERY LOOSE		2.2					
2.3		VERY LOOSE		2.3					
2.4		VERY LOOSE		2.4					
2.5		VERY LOOSE		2.5					
2.6		VERY LOOSE		2.6					
2.7		VERY LOOSE		2.7					
2.8		VERY LOOSE		2.8					
2.9		VERY LOOSE		2.9					
3.0		VERY LOOSE		3.0					
3.1		VERY LOOSE		3.1					
3.2		VERY LOOSE		3.2					
3.3		VERY LOOSE		3.3					
3.4		VERY LOOSE		3.4					
3.5		VERY LOOSE		3.5					
3.6		VERY LOOSE		3.6					
3.7		VERY LOOSE		3.7					
3.8		VERY LOOSE		3.8					
3.9		VERY LOOSE		3.9					
4.0		VERY LOOSE		4.0					
4.1		VERY LOOSE		4.1					
4.2		VERY LOOSE		4.2					
4.3		VERY LOOSE		4.3					
4.4		VERY LOOSE		4.4					
4.5		VERY LOOSE		4.5					
4.6		VERY LOOSE		4.6					
4.7		VERY LOOSE		4.7					
4.8		VERY LOOSE		4.8					
4.9		VERY LOOSE		4.9					
5.0		VERY LOOSE		5.0					
5.1		VERY LOOSE		5.1					
5.2		VERY LOOSE		5.2					
5.3		VERY LOOSE		5.3					
5.4		VERY LOOSE		5.4					
5.5		VERY LOOSE		5.5					
5.6		VERY LOOSE		5.6					
5.7		VERY LOOSE		5.7					
5.8		VERY LOOSE		5.8					
5.9		VERY LOOSE		5.9					
6.0		VERY LOOSE		6.0					
6.1		VERY LOOSE		6.1					
6.2		VERY LOOSE		6.2					
6.3		VERY LOOSE		6.3					
6.4		VERY LOOSE		6.4					
6.5		VERY LOOSE		6.5					
6.6		VERY LOOSE		6.6					
6.7		VERY LOOSE		6.7					
6.8		VERY LOOSE		6.8					
6.9		VERY LOOSE		6.9					
7.0		VERY LOOSE		7.0					
7.1		VERY LOOSE		7.1					
7.2		VERY LOOSE		7.2					
7.3		VERY LOOSE		7.3					
7.4		VERY LOOSE		7.4					
7.5		VERY LOOSE		7.5					
7.6		VERY LOOSE		7.6					
7.7		VERY LOOSE		7.7					
7.8		VERY LOOSE		7.8					
7.9		VERY LOOSE		7.9					
8.0		VERY LOOSE		8.0					
8.1		VERY LOOSE		8.1					
8.2		VERY LOOSE		8.2					
8.3		VERY LOOSE		8.3					
8.4		VERY LOOSE		8.4					
8.5		VERY LOOSE		8.5					
8.6		VERY LOOSE		8.6					
8.7		VERY LOOSE		8.7					
8.8		VERY LOOSE		8.8					
8.9		VERY LOOSE		8.9					
9.0		VERY LOOSE		9.0					
9.1		VERY LOOSE		9.1					
9.2		VERY LOOSE		9.2					
9.3		VERY LOOSE		9.3					
9.4		VERY LOOSE		9.4					
9.5		VERY LOOSE		9.5					
9.6		VERY LOOSE		9.6					
9.7		VERY LOOSE		9.7					
9.8		VERY LOOSE		9.8					
9.9		VERY LOOSE		9.9					
10.0		VERY LOOSE		10.0					

3. Sample pushed by hand  
 4. In dissection of light  
 tapping using 3 lb  
 hammer



## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9213 BORING # 8 DATUM GEODETIC CASING BX  
 BORING DATE APR 15-16/69 REPORT DATE APR 21, 1969 COMPILED BY AEL CHECKED BY MAJM  
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

## SAMPLE CONDITION

☒ DISTURBED  
☐ FAIR  
☐ GOOD  
☐ LOST

## SAMPLE TYPES

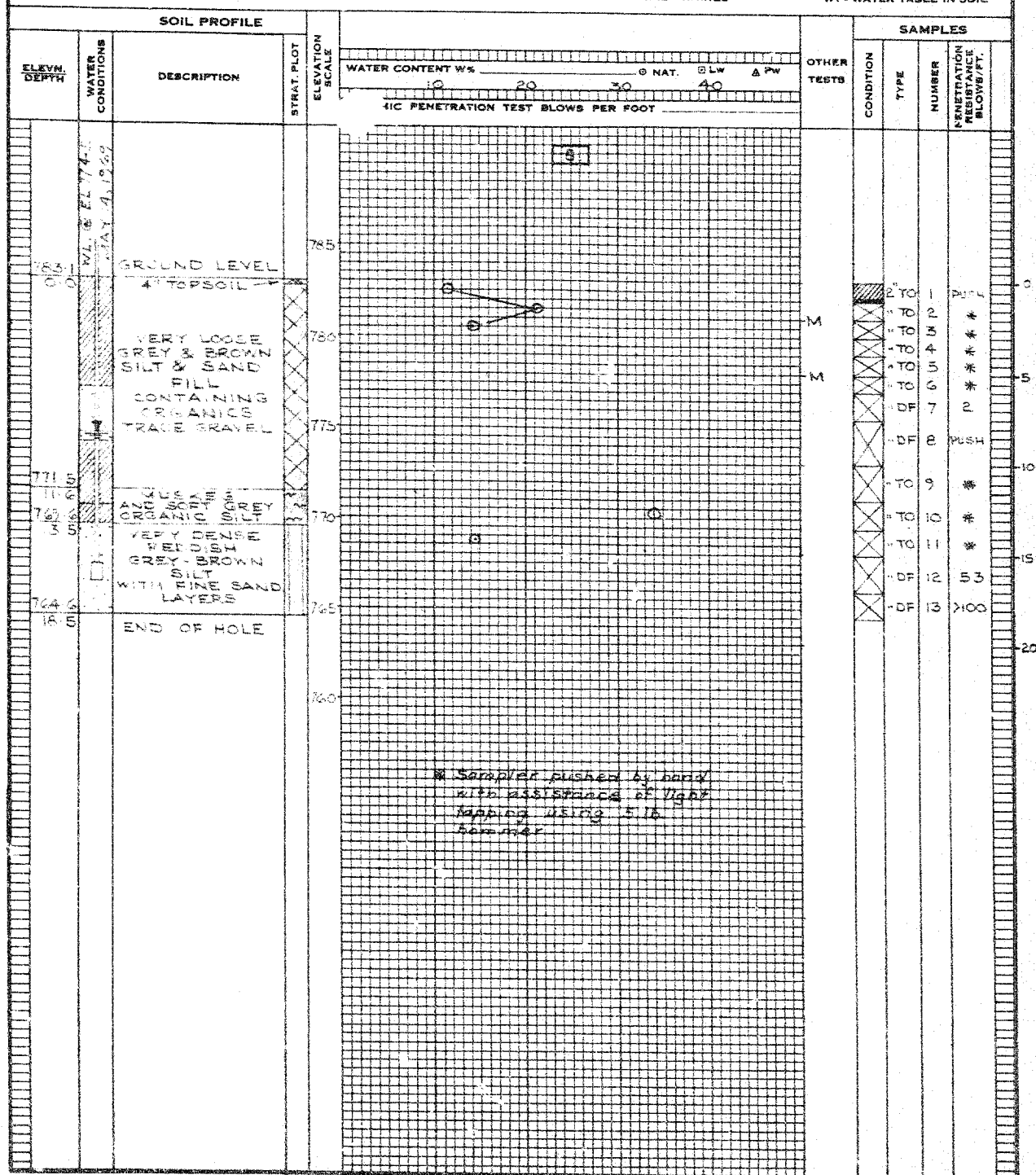
A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 QC - TRIAXIAL CONSOLIDATED UNDRAINED  
 Q - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED

## ABBREVIATIONS

1 - WET UNIT WEIGHT  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL



## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9213 BORING # 9 DATUM GEODETTIC CASING BK  
 BORING DATE APR 17 21/69 REPORT DATE APR 29, 1969 COMPILED BY AEL CHECKED BY MAIM  
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

## SAMPLE CONDITION

☒ DISTURBED  
☐ FAIR  
☐ GOOD  
☐ LOST

## SAMPLE TYPES

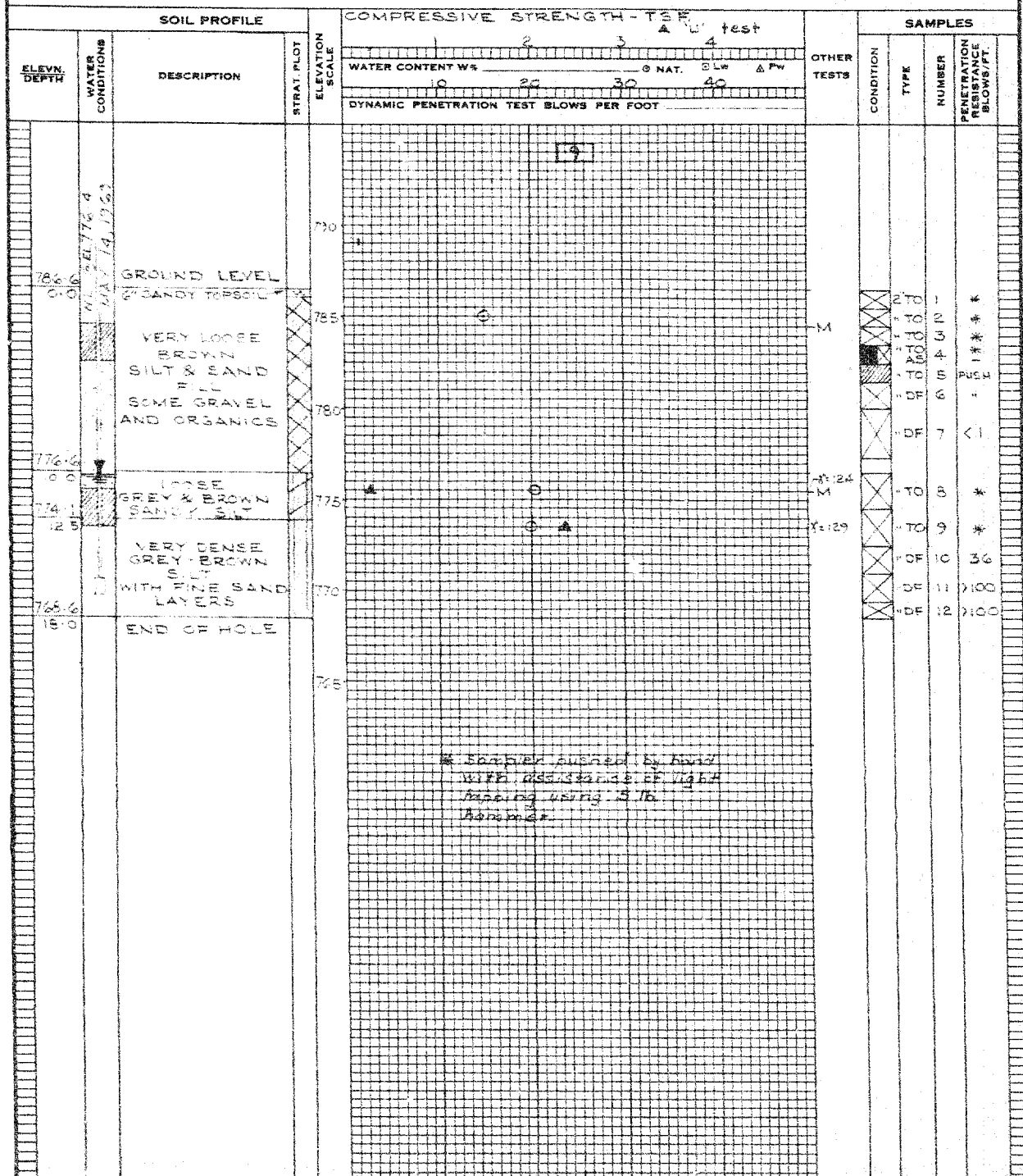
A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.F. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONFINED COMPRESSION  
 QC - TRIAXIAL CONSOLIDATED UNDRAINED  
 S - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINED

## ABBREVIATIONS

W - WET UNIT WEIGHT - PCF  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL



CONTRACT T9213 BORING # 10 and 11 DATUM GEODETIC CASING RX  
BORING DATE APR. 22, 1969 REPORT DATE APR. 29, 1969 COMPILED BY AEL CHECKED BY MAM  
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4300 IN - LBS. ENERGY)

## SAMPLE TYPES

### ABBREVIATIONS

A.S. - AUGER SAMPLE  
S.T. - SLOTTED TUBE  
W.S. - WASHED SAMPLE  
D.O. - DRIVE-OPEN  
D.F. - DRIVE-FOOT VALVE  
C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE  
S.O. - SLEEVE-OPEN  
S.F. - SLEEVE-FOOT VALVE  
T.O. - THIN WALLED OPEN  
R.C. - ROCK CORE

ABBREVIATIONS

V	. IN-SITU VANE TEST
M	. MECHANICAL ANALYSIS
U	. UNCONFINED COMPRESSION
QC	. TRIAXIAL CONSOLIDATED UN
Q	. TRIAXIAL UNDRAINED
S	. TRIAXIAL DRAINED

7. WET UNIT WEIGHT -  $\gamma_{wf}$   
 K. PERMEABILITY  
 C. CONSOLIDATION  
 RED  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL

SOIL PROFILE				STRAT. PLOT ELEVATION SCALE	OTHER TESTS	SAMPLES			
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	CONDITION			TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	
WATER CONTENT W% <span style="float:right">NAT. LW PW</span>									
DYNAMIC PENETRATION TEST BLOWS PER FOOT									
756.1 0.0	WL & EL. 777.3 1242	GROUND LEVEL CRUSHED STONE		790					
757.1 1.0		LOOSE LIGHT BROWN CLAYEY SILT		785	M	2 TO	1	*	
775.1 8.0		LOOSE VERY DENSE GREEN BROWN WITH SILT LAYERS		780	M	3 TO	2	*	
773.1 13.0		END OF HOLE		775		4 TO	3	*	
				770		5 TO	4	*	
						6 TO	5	*	
						7 TO	6	*	
						8 TO	7	*	
						9 TO	8	*	
						10 TO	9	2	
						11 TO	10	33	
						12 TO	11	>100	
752.2 0.0	WL & EL. 776.7 1241	GROUND LEVEL A TOPSOIL		790					
757.7 5.5		LOOSE BROWN CLAYEY SILT WITH ORGANICS AND GRAVEL		785	M	2 TO	1	*	
771.5 9.7		SOFT BROWN CLAYEY SILT WITH ORGANICS AND GRAVEL		780	M	3 TO	2	*	
775.2 13.2		CONTACT TO VERY DENSE GREEN BROWN SILT WITH SILT LAYERS		775	M	4 TO	3	*	
769.7 17.5		END OF HOLE		770		5 TO	4	*	
						6 TO	5	PUSH	
						7 TO	6	*	
						8 TO	7	*	
						9 TO	8	*	
						10 TO	9	2	
						11 TO	10	2	
						12 TO	11	PUSH	
						13 TO	12	*	
						14 TO	13	24	
						15 TO	14	88	

\* Samples pushed by hand with assistance of light tapping using 5 lb hammer



## GEOCON

## OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9212 BORING # 12 DATUM GEODETIC CASING ---  
 BORING DATE APR 28-29/68 REPORT DATE MAY 2, 1968 COMPILED BY A.E.L. CHECKED BY MAIM  
 SAMPLER HAMMER WT --- LBS. DROP --- INCHES PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY

## SAMPLE CONDITION

☒ DISTURBED  
☐ F.A.P.  
☐ GOOD  
☐ LOST

## SAMPLE TYPES

A.S. - AUGER SAMPLE  
 S.T. - SLOTTED TUBE  
 W.S. - WASHED SAMPLE  
 D.O. - DRIVE-OPEN  
 D.F. - DRIVE-FOOT VALVE  
 C.S. - CHURCH SAMPLE  
 F.S. - FOIL SAMPLE  
 S.O. - SLEEVE-OPEN  
 S.V. - SLEEVE-FOOT VALVE  
 T.O. - THIN WALLED OPEN  
 R.C. - ROCK CORE

## ABBREVIATIONS

V - IN-SITU VANE TEST  
 M - MECHANICAL ANALYSIS  
 U - UNCONSOLIDATED COMPRESSION  
 CC - TRIAXIAL CONSOLIDATED UNDRAINED  
 C - TRIAXIAL UNDRAINED  
 S - TRIAXIAL DRAINAGE  
 Y - WET UNIT WEIGHT  
 K - PERMEABILITY  
 C - CONSOLIDATION  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL

## SOIL PROFILE

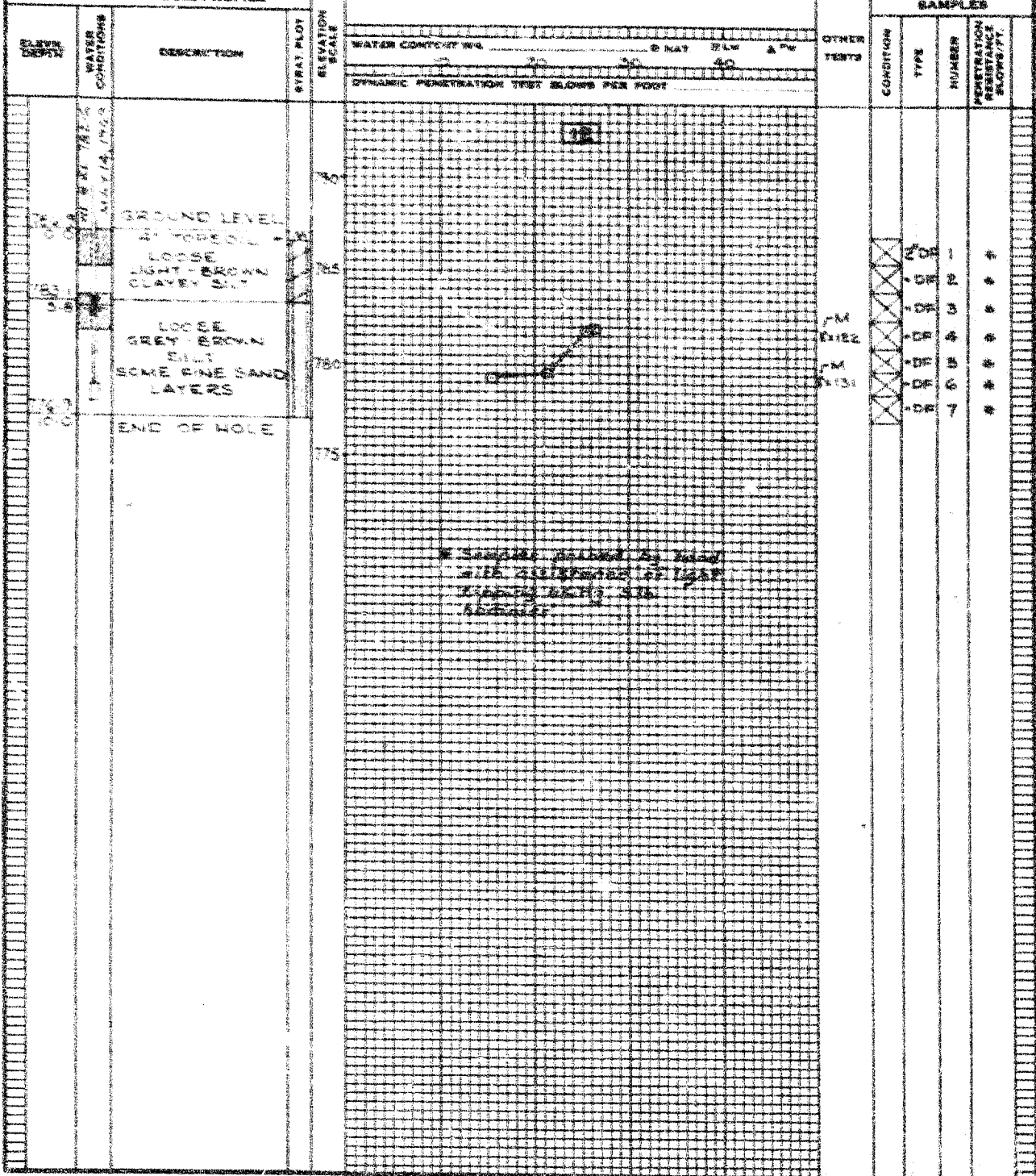


TABLE I

1969	CREEK WATER ELEVATION	DEPTH TO WATER LEVEL IN PIEZOMETERS BELOW GROUND LEVEL									
		FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	
		1	2	5	7	8	9	10	11	12	
April 7	769.8										
April 8	769.8										
April 9	769.8										
April 10	769.8			*1.3							
April 11	769.8										
April 12	769.8										
April 14	769.7										
April 15	769.7				*4.0						
April 16	769.8										
April 17						*8.5					
April 21	769.7						*9.1				
April 22	769.7							*7.4			
April 23	769.7										
April 24	769.7	*4.0	*5.0	+1.5	3.3	8.3	9.4	8.1	*10.5		
April 25	769.7	4.6	3.9	+1.5	3.3	8.3	9.6	8.3	9.8		
April 28	769.7	4.9	4.0	+1.5	3.3	8.4	9.8	8.8	10.3		
April 29	769.5	5.8	4.3	+1.4	3.5	8.6	10.0	9.0	10.4	*3.1	
May 14	769.3	5.3	4.8	+1.3	3.7	8.6	10.2	8.8	10.5	4.3	

\* Date of piezometer installation  
+ Height above ground level.

APPENDIX II

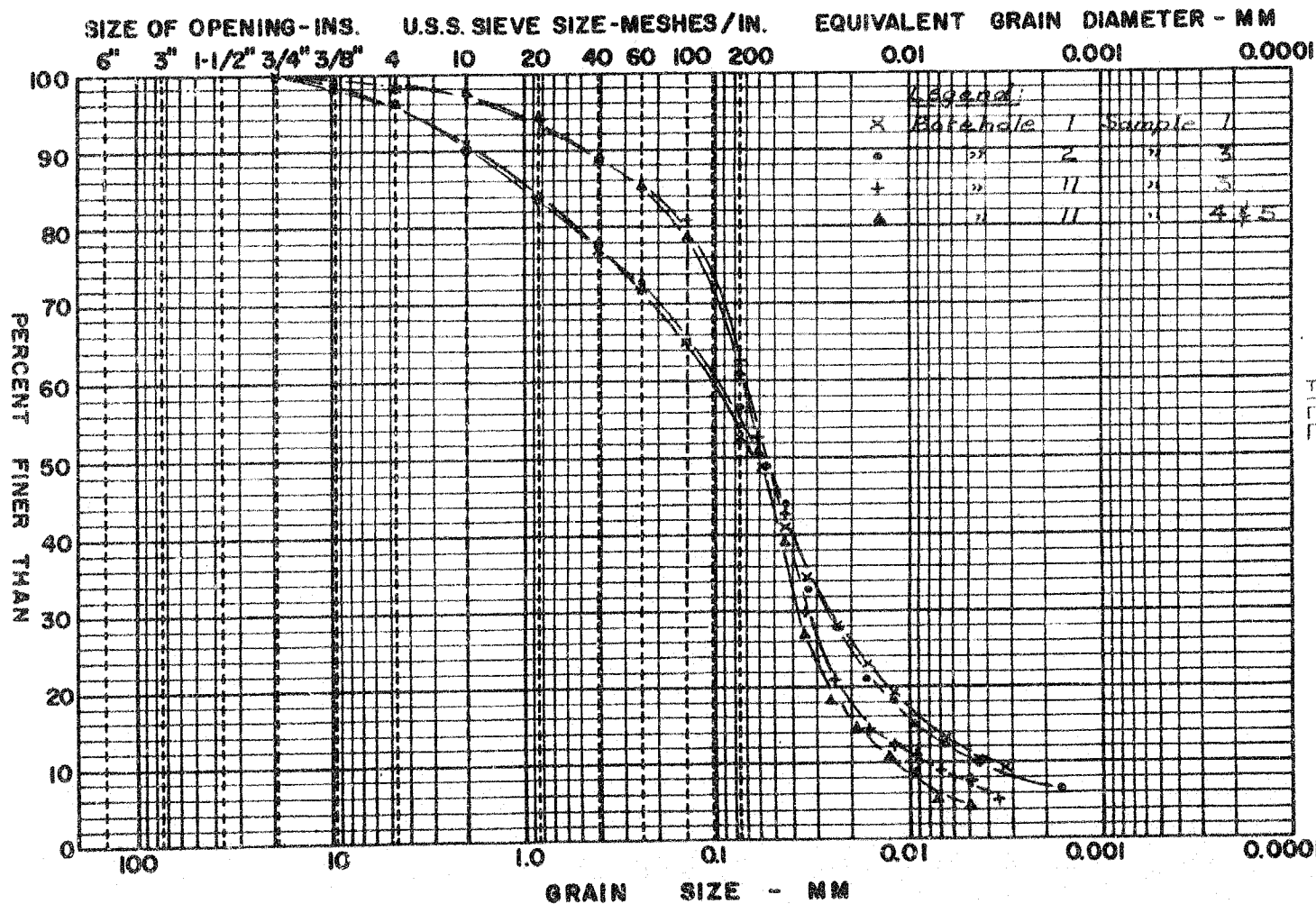
FIGURES -- LABORATORY TESTING

GEOCON

# GRAIN SIZE DISTRIBUTION

APPENDIX II  
FIGURE 1  
PROJECT T9213

COBBLE ← SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED		CLAY SIZE →
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE	



M.I.T. GRAIN SIZE SCALE

# GRAIN SIZE DISTRIBUTION

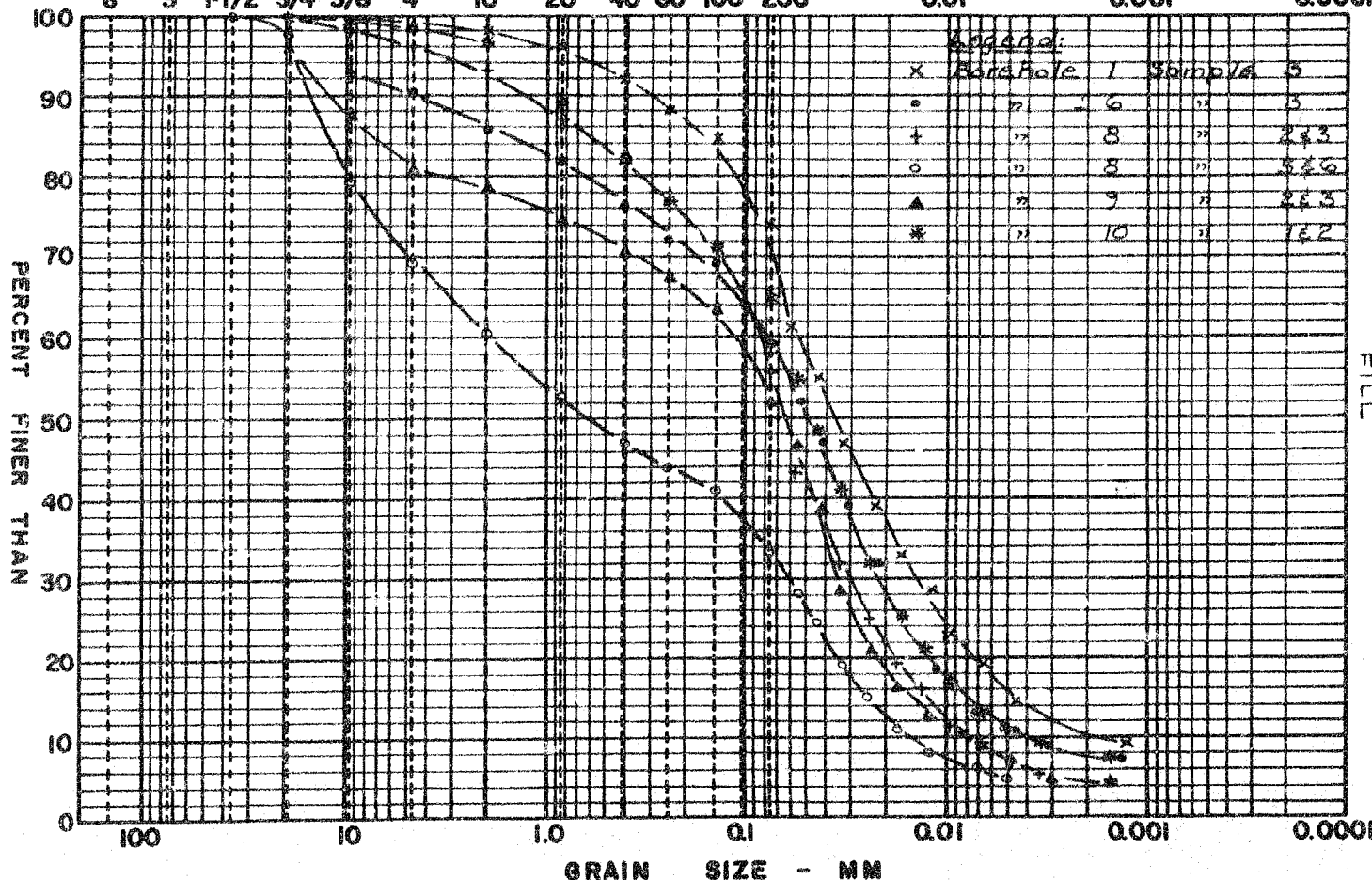
APPENDIX II  
FIGURE 1A  
PROJECT T9213

COBBLE ← SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED		CLAY SIZE →
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE	

SIZE OF OPENING - INS.    U.S.S. SIEVE SIZE - MESHES/IN.    EQUIVALENT GRAIN DIAMETER - MM

6"   3"   1-1/2"   3/4"   3/8"   4   10   20   40   60   100   200   0.01   0.001   0.0001

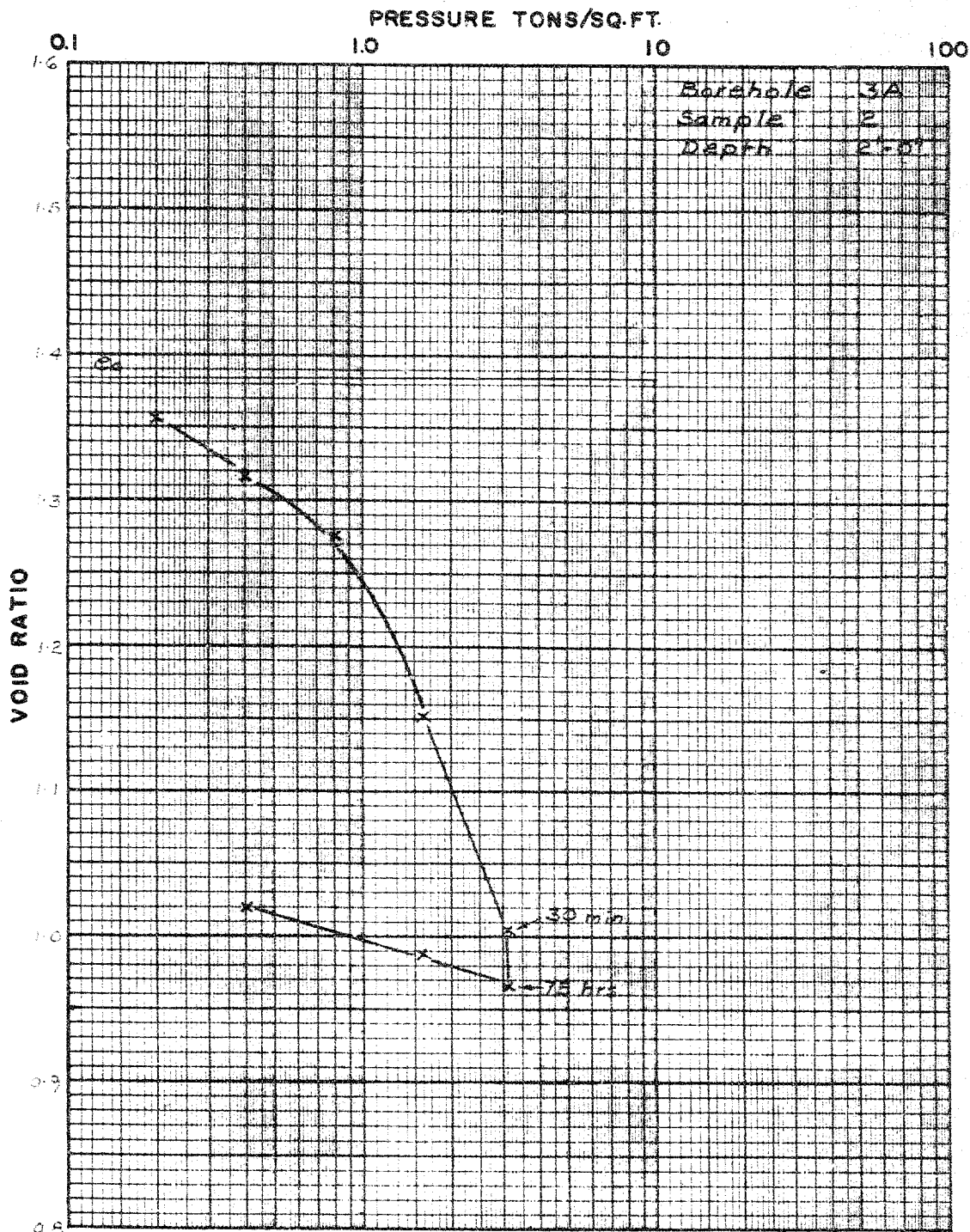
GEOCON



M.I.T. GRAIN SIZE SCALE

# VOID RATIO-PRESSURE DIAGRAM CONSOLIDATION TEST

APPENDIX II  
FIGURE 2  
PROJECT T9213

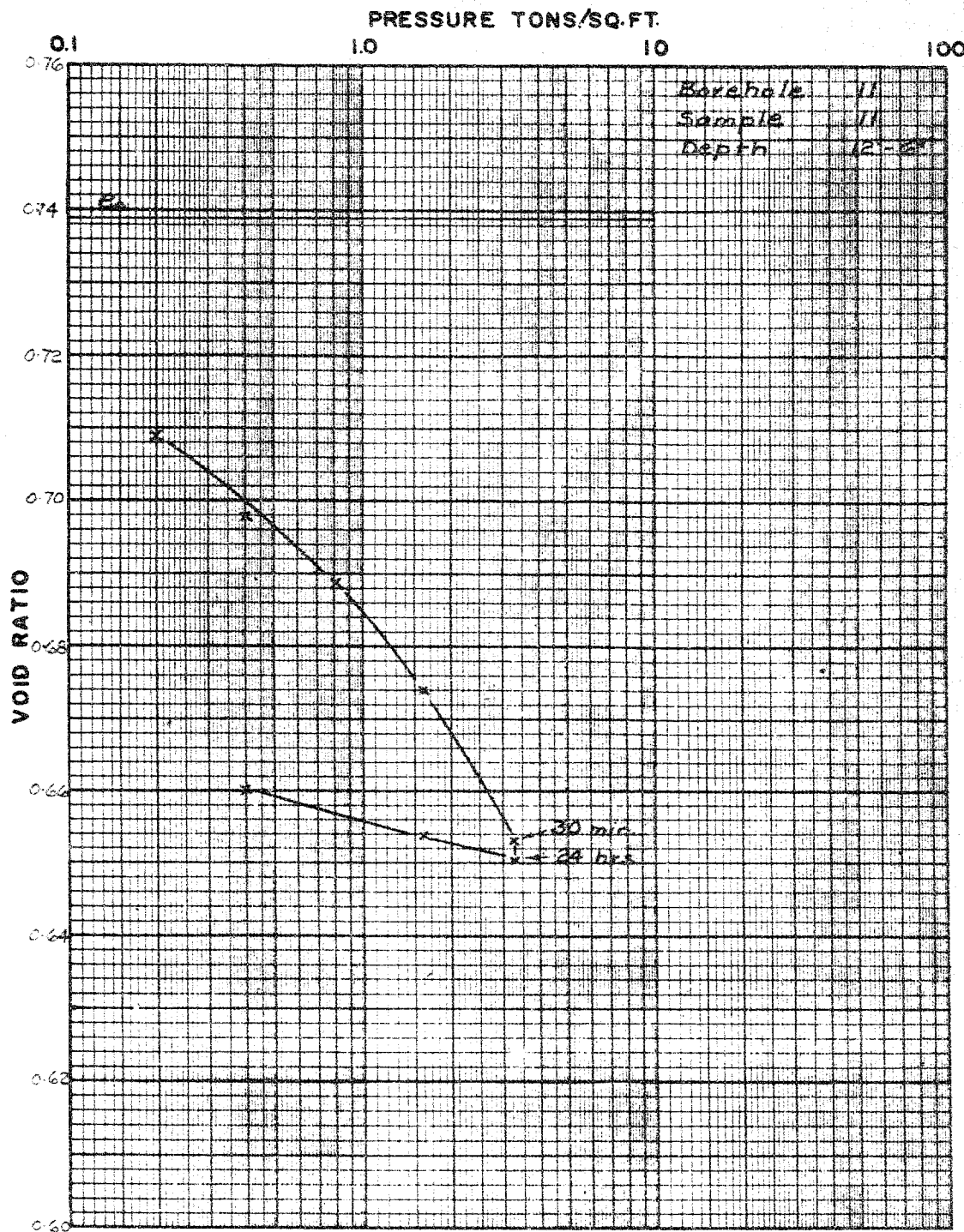


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# VOID RATIO-PRESSURE DIAGRAM CONSOLIDATION TEST

APPENDIX II  
FIGURE 3  
PROJECT T9213

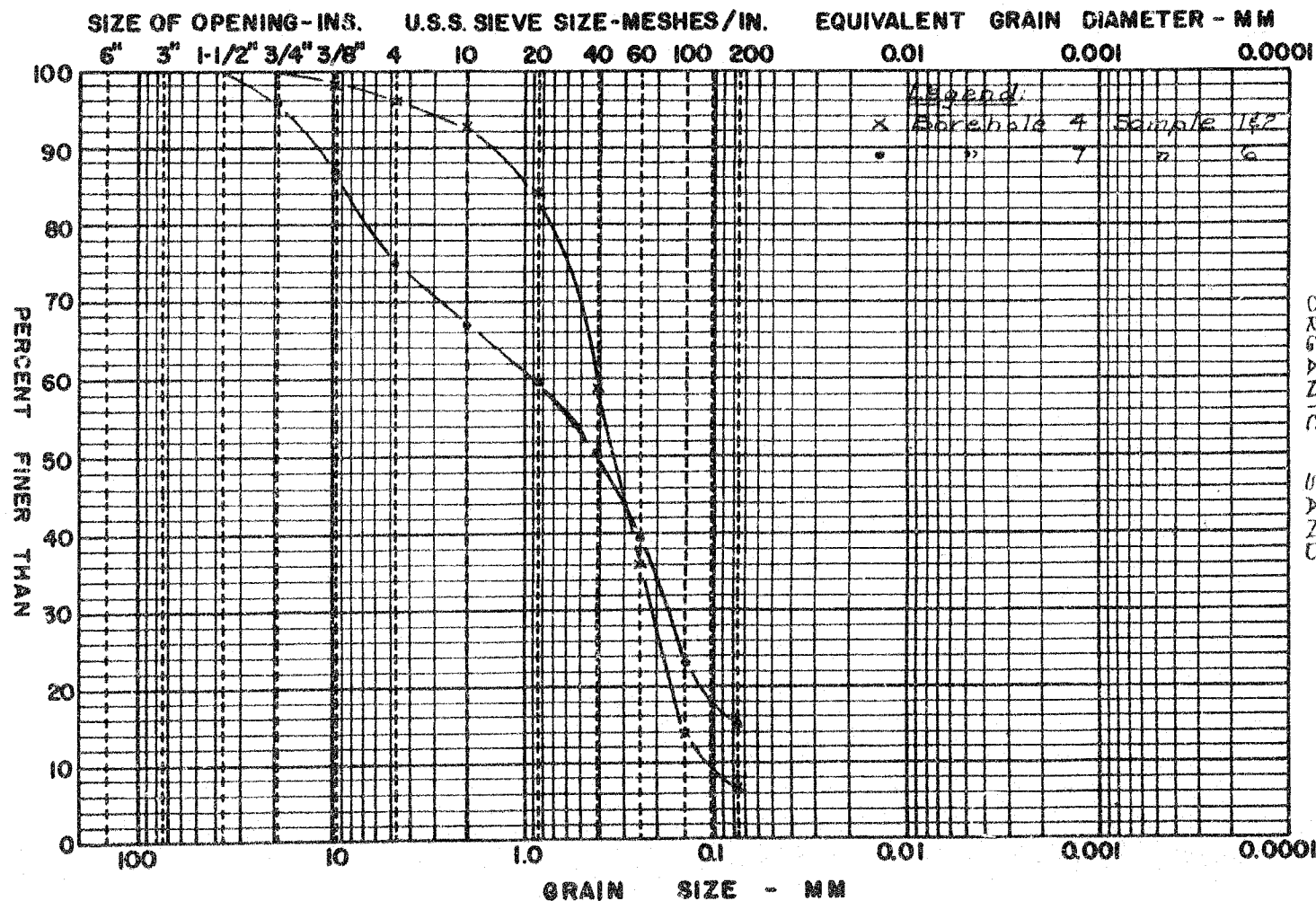


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# GRAIN SIZE DISTRIBUTION

APPENDIX 11  
FIGURE 4  
PROJECT T9213

COBBLE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
← SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE →



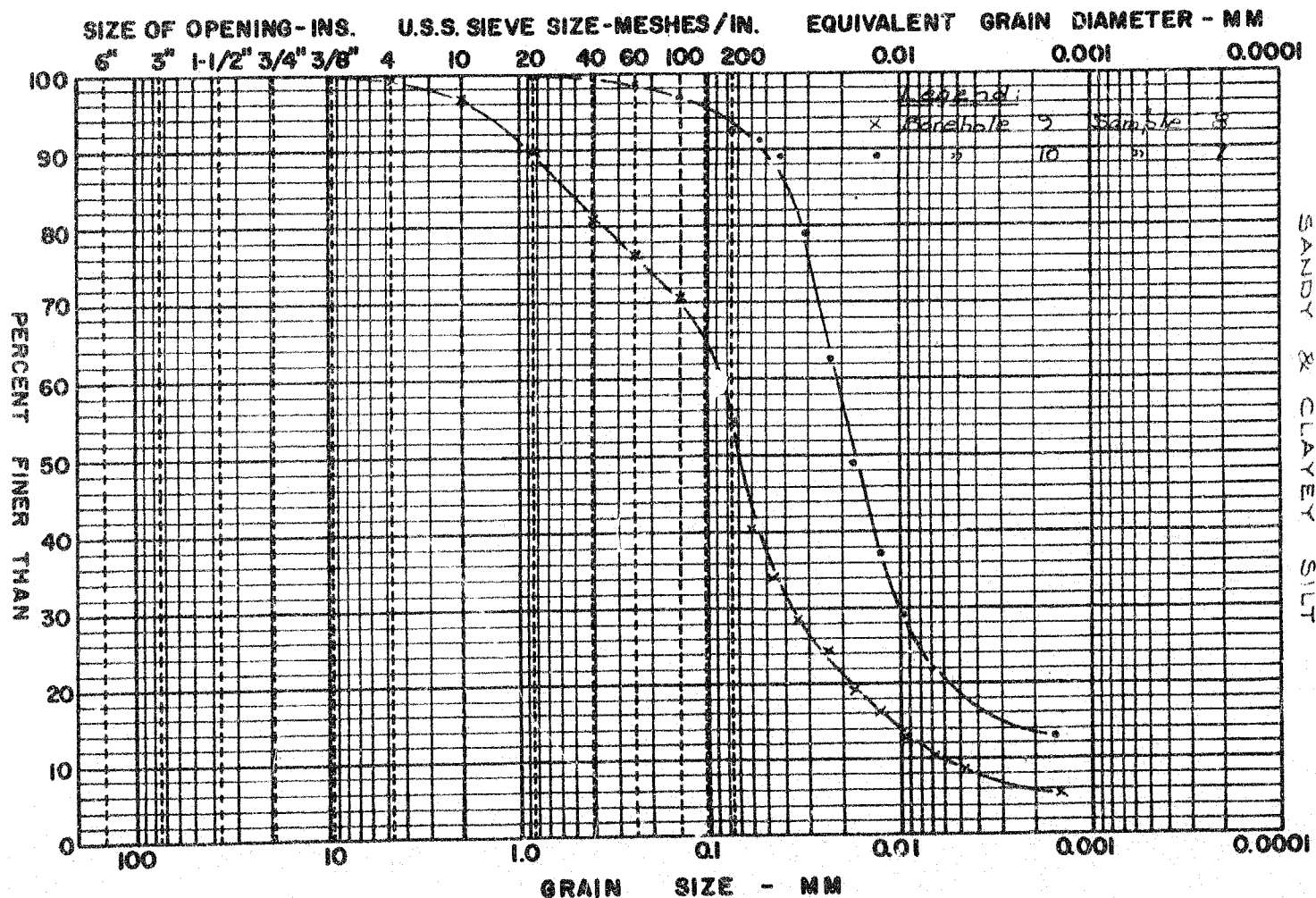
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# GRAIN SIZE DISTRIBUTION

APPENDIX 11  
FIGURE 5  
PROJECT T9213

COBBLE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
→ SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE →



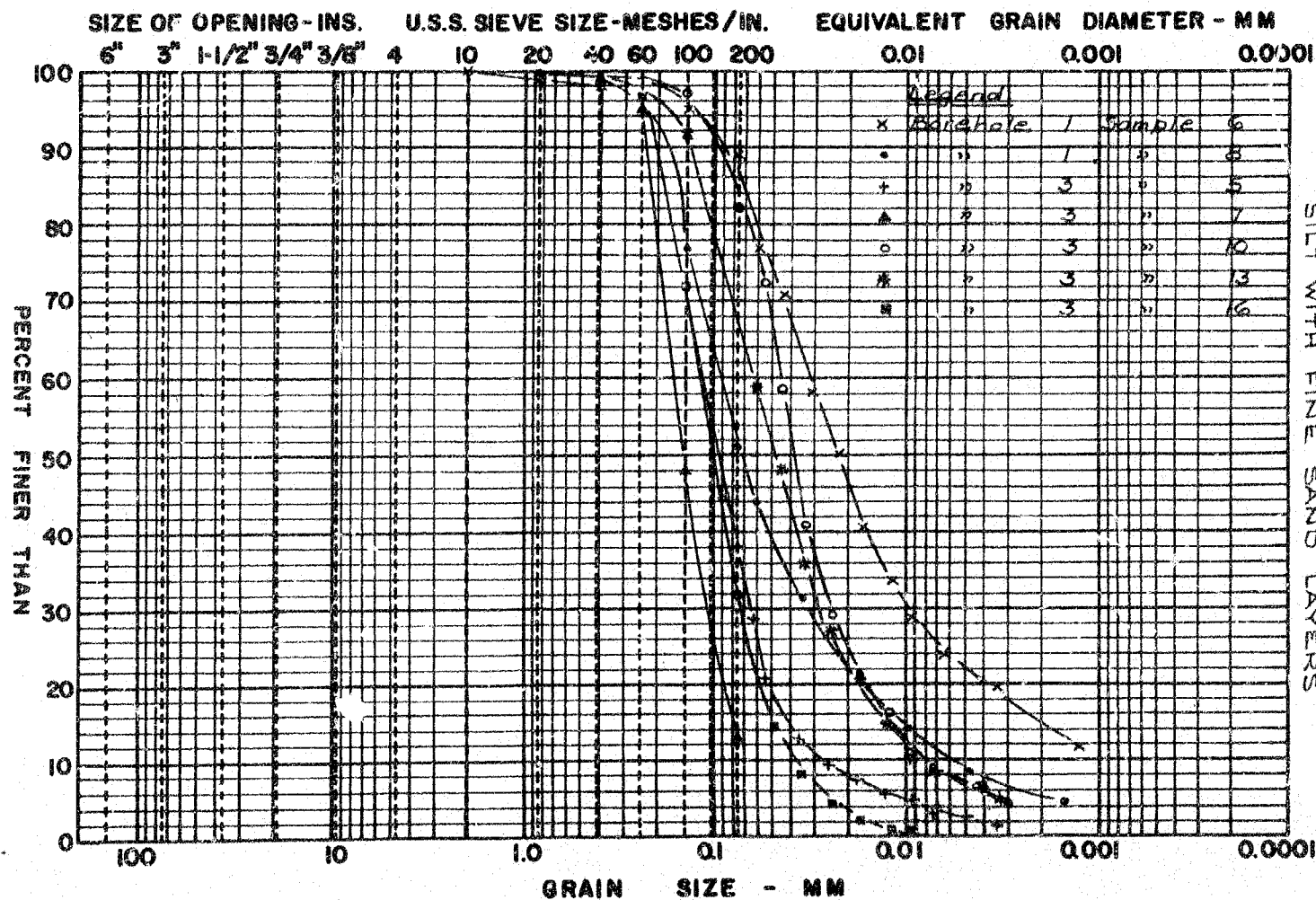
M.I.T. GRAIN SIZE SCALE

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# GRAIN SIZE DISTRIBUTION

APPENDIX II  
FIGURE 6  
PROJECT T9213

COBBLE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
→ SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE →



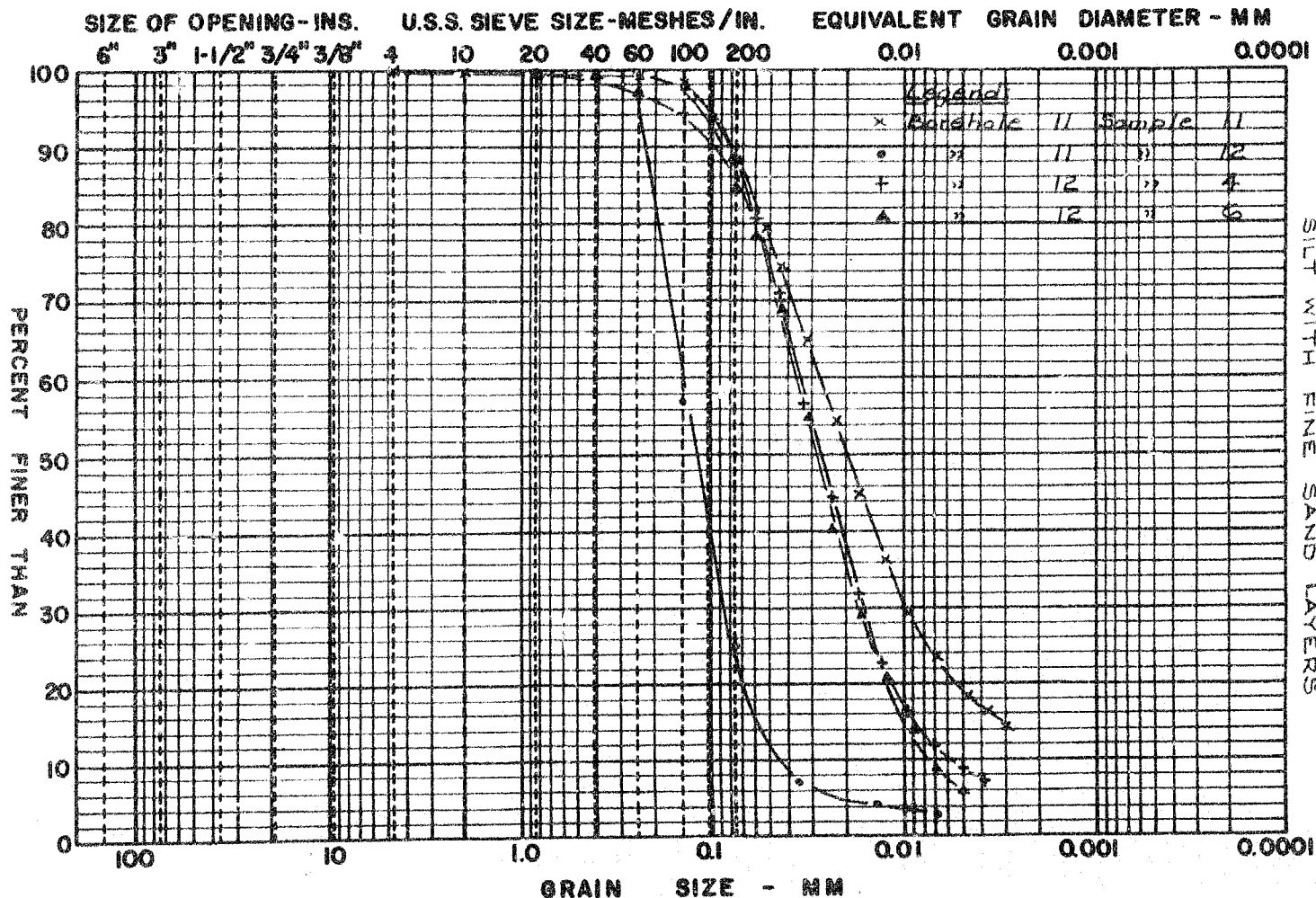
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M.I.T. GRAIN SIZE SCALE

# GRAIN SIZE DISTRIBUTION

APPENDIX II  
FIGURE 6A  
PROJECT T9213

COBBLE - SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE →



M.I.T. GRAIN SIZE SCALE

GEOCON

WENTWORTH COUNTY  
ANCASTER TOWNSHIP

LOT 44  
CON. III

Residence of  
Mr. M.W. Coombs

WOODWORTH DRIVE

CALVIN STREET

WHALEY'S  
BORROW PIT

HIGHWAY 403

GENERAL LOCATION PLAN

Scale: 1" = 100'

(Reference drawing, C.C. Parker & Associates Ltd.  
Form DB-RD-36A, Contract No. 68-51, W.P. No. 192-52)

WOODWORTH DRIVE

Residence of  
Mr. M.W. Coombs

LOT 85

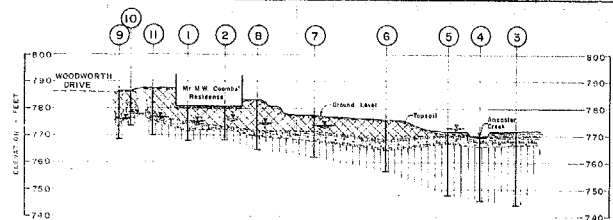
PARCEL "C"

Ancaster Creek

BORING PLAN

Scale: 1" = 20'

(Reference drawing, Registered  
plan 1051, Perth Park)



INFERRED STRATIGRAPHIC SECTION A-A

Scale: 1" = 20'

LEGEND

- ② BOREHOLE IN PLAN
- ② BOREHOLE IN SECTION
- WATER LEVEL (May 14, 1969)
- WATER LEVEL (Affection)

STRATIGRAPHY

- LOOSE & SOFT SILTY & SANDY FILL CONTAINING ORGANICS
- MUSKEG, ORIGINAL TOPSOIL, ORGANIC SILT & SAND
- LOOSE GREY ORGANIC SAND, SOME GRAVEL
- LOOSE TO FIRM SANDY & CLAYEY SILT
- COMPACT TO VERY DENSE GREY-BROWN SILT WITH FINE SAND LAYERS

**SPECIAL NOTES**  
DATA CONCERNING THE VARIOUS STRATIGRAPHIC  
LAYER BOUNDARIES AT BOREHOLE LOCATIONS SHOWN  
ON THE STRATIGRAPHY BETWEEN BOREHOLES  
IS INTERPOLATED FROM DATA WHICH COULD BE  
OBTAINED FROM OTHER BOREHOLES.  
  
THIS DRAWING IS TO BE READ IN CONJUNCTION  
WITH ALL LIMITING REPORTS.

REFERENCE		DEPARTMENT OF HIGHWAYS, ONTARIO		GEOCON LTD.	
DWG. NO.	DESCRIPTION	SITE INVESTIGATION		DATE May 22, 1969 SCALE As shown	
	As shown	MR. M.W. COOMBS' PROPERTY		PERTH PARK AT HIGHWAY 403, ANCASTER, ONT.	
		BORING PLAN & SOIL STRATIGRAPHY		No. T 9213-1	

PART II

GEOCON

FOUNDATION OF CANADA ENGINEERING  
CORPORATION LIMITED

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CABLE ADDRESS  
"FOUNDANENG" TORONTO

May 23, 1969

Geocon Limited  
14 Haas Road  
Rexdale, Ontario

Attention: Mr. M.A.J. Matich, P. Eng.,  
President

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Dear Sirs,

SITE INVESTIGATION  
Mr. M. Coombs' Property  
PERTH PARK, ANCASTER

We are submitting herewith our findings on Ancaster Creek hydrology at Highway No. 403. We understand that this information will form a part of your report on Mr. M. Coombs' property.

We have found that although the new developments and the highway will contribute to future flood peaks, their effects are less than the reduction of peaks by the highway culverts. The culverts restrict the flow as compared with the open valley. Thus the flood water levels in the stream flowing through Mr. Coombs' property, immediately downstream of the highway, are in fact reduced.

The slope of the groundwater, as ascertained from the boreholes, shows that groundwater flow lines are in general parallel with the highway and therefore not noticeably influenced by the highway.

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Geocon Limited  
May 23, 1969  
Page two

We conclude therefore that no detrimental effects to Mr. Coombs' property can be attributed to the highway. In fact, some beneficial effects can be credited to the highway mitigating future severe floods.

We trust that this information will adequately show the water conditions at the site. Should additional information be required, please do not hesitate to contact us.

Yours very truly,  
FOUNDATION OF CANADA ENGINEERING  
CORPORATION LIMITED

*Hans R. Kivisild*

Hans R. Kivisild, D. Eng., P. Eng.  
CHIEF CIVIL ENGINEER

HRK/lef  
I-3527-1  
Encl.

## 1.0 HYDROLOGY

The hydrology of the watershed draining into Ancaster Creek at Highway No. 403 has been investigated. Direct runoff has been calculated for three different watershed conditions, namely,

- i. Prior to the construction of Highway 403.
- ii. Present unpaved Highway 403.
- iii. Future paved Highway 403.

Peak flood flows and corresponding water levels in the creek downstream of the highway, alongside Woodworth Drive, have also been estimated.

The basic conclusion has been reached that the highway is acting as a flow restriction and is therefore instrumental in reducing downstream peak flows.

No groundwater level measurements for the vicinity of Woodworth Drive prior to the highway construction have been available. Measurements in the boreholes made for this report show that the groundwater flow lines are in general parallel with the highway and would not be significantly influenced by the highway.

## 2.0 DIRECT RUNOFF

The highway embankment crossing the valley has been constructed essentially perpendicular to the contour lines of the valley sides. Therefore the highway has not materially affected the flow lines of the overland flow adjacent to the highway.

The drainage basin discharging flow past Woodworth Drive is approximately circular in shape (Drawing 3527-1). Its time of peak discharge will therefore coincide with the time of concentration, which has been calculated at one hour.

The maximum rainfall intensity for a one-hour duration for the site has been obtained from the Meteorological Branch Publication CIR-3243, as follows:



<u>Average Return Period</u>	<u>Maximum Rainfall in one hour</u>
2.3 years	1.10 inches
5.0 "	1.50 "
10.0 "	1.83 "
25.0 "	2.25 "
50.0 "	2.55 "
100.0 "	2.85 "

The area-runoff factors for the various areas (Drawing 3527-1) are tabulated in Figure 1. The increase in runoff that can be attributed to the highway is 6% with the present unpaved highway, and 9½% when the highway is paved.

The rapid runoff from the highway will produce a peak flow at approximately 25 minutes from the start of the rainfall. However, since the area of the highway is only a small fraction of the total watershed area, this peak is insignificant compared to the main peak flow of the whole watershed.

The peak runoff quantities from one-hour maximum rainfalls of various return periods are shown on Figure 2.

The watershed runoff, including runoff from the highway proper, is conveyed to the upstream side of the highway. A small amount, approximately 10 per cent, of the runoff from the western section of the highway, actually passes through a 12 inch diameter opening to the downstream side of the highway. However, this small amount is negligible when compared to the total flows, and therefore need not be considered separately in the flow calculations. Culverts passing through the highway embankment convey the runoff from the upstream to the downstream side of the highway. The general configuration of the culverts is such that they act as a restriction in the natural flow channel. The highway thus acts as a dam, storing some water behind it, and reducing peak flows in the downstream channel. This effect is illustrated in Figure 2.

Figure 3 shows the calculated downstream water levels in the creek adjacent to Woodworth Drive, both before and after the highway construction. The graph shows that for equal rainfall recurrence intervals the downstream flood stage has been decreased as a result of the highway. Consequently, even though peak runoff from the watershed may be increased by nearly 10% as a result of the highway, the maximum flood levels at Woodworth Drive are reduced.

3.

Runoff from snowmelt is also affected by the highway. However, the highway will reduce rather than increase the peak runoff from this source for the following reasons:

1. The highway is continuously cleared of snow during snowfall periods and will therefore not contribute to the flow, and
11. The runoff coefficient for the highway is not greatly different from that of frozen ground.

Recent residential development within the watershed has increased the peak runoff by approximately the same amount as the paved highway. This increase over the original agricultural watershed is included in the calculations of flow for the condition "before Highway 403". Any additional development within the watershed will increase the flows over the present.

### 3.0 GROUNDWATER

No groundwater level measurements for the site prior to the highway construction have been available. In general, groundwater flow lines occur perpendicular to the surface contour lines. The present groundwater levels in the boreholes have therefore been investigated in order to ascertain the direction of the groundwater flow lines.

It was found that the flow lines are essentially perpendicular to the surface contour lines. The flow of groundwater is therefore approximately parallel to the highway. There is no indication that the groundwater level and flow at Mr. Coomb's house has in any way been affected by the highway.

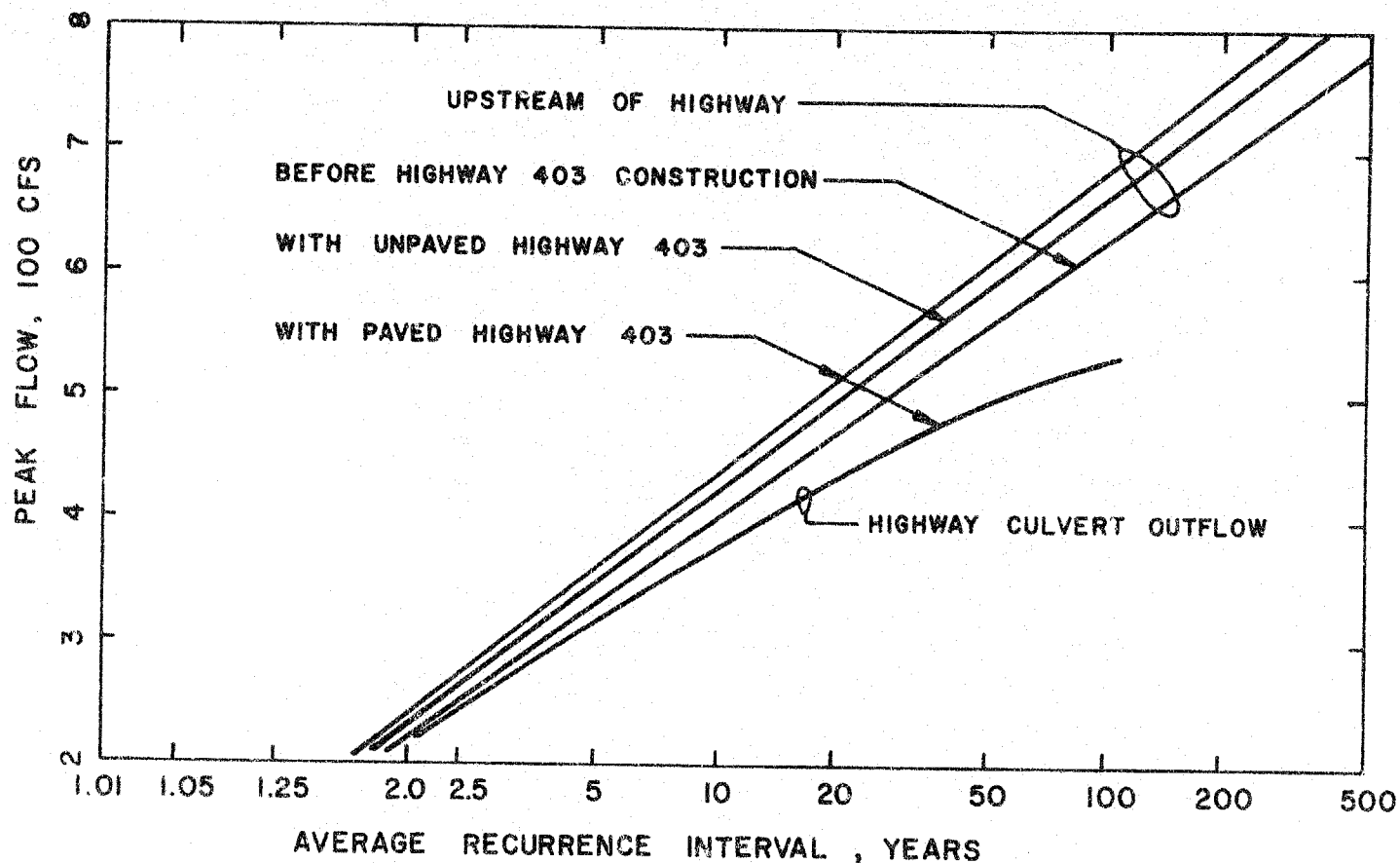
Artesian springs are said to have existed on the site of the present highway embankment. The flow from these sources appears to be adequately collected by the highway drainage system. This is deduced from visual observations of discharge from the highway drainage system with no surface flow into the catch basins.

Drainage Area		Before #403		#403 Unpaved		#403 Paved	
Sub Area	Size, Acres	Runoff Coeff.	AxC	Runoff Coeff.	AxC	Runoff Coeff.	AxC
No.	"A"	"C"		"C"		"C"	
A <sub>1</sub>	13.3	0.2	2.7	0.4	5.3	0.6	8.0
A <sub>2</sub>	24.0	0.4	9.6	0.4	9.6	0.4	9.6
A <sub>3</sub>	651.0	0.2	130.2	0.2	130.2	0.2	130.2
A <sub>4</sub>	313.0	0.2	62.6	0.2	62.6	0.2	62.6
A <sub>5</sub>	27.6	0.4	11.0	0.4	11.0	0.4	11.0
A <sub>6</sub>	10.0	-	-	0.4	4.0	0.6	6.0
A <sub>7</sub>	13.5	0.2	2.7	0.4	5.4	0.6	8.1
A <sub>8</sub>	18.9	-	-	0.2	3.8	0.2	3.8
Total							
	1042.4		218.8		-		-
	1071.3		-		231.9		239.3

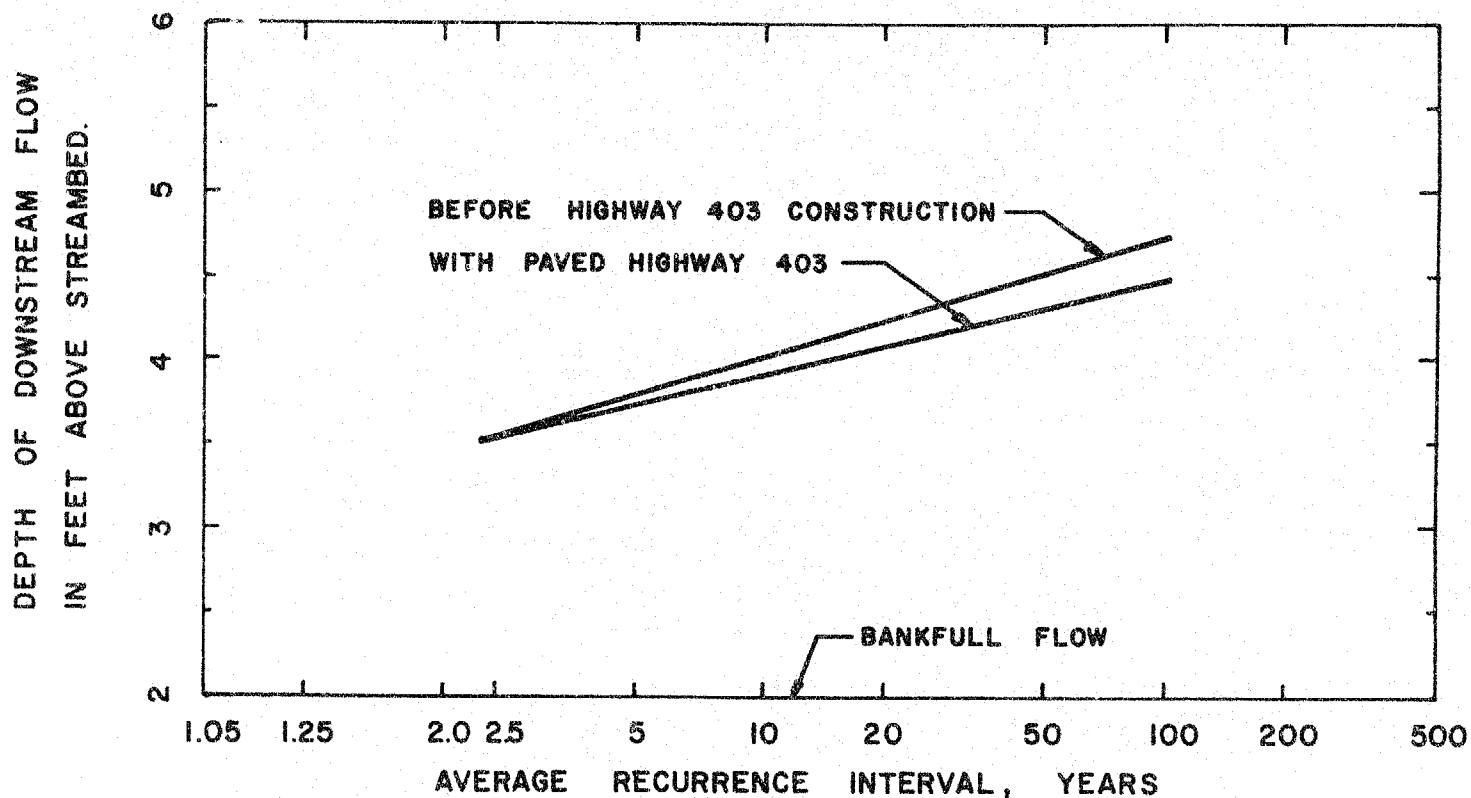
$$\text{Increase in runoff due to unpaved highway} = \frac{231.9 - 218.8}{218.8} \times 100 = 6\%$$

$$\text{Increase in runoff due to paved highway} = \frac{239.3 - 218.8}{218.8} \times 100 = 9\frac{1}{2}\%$$

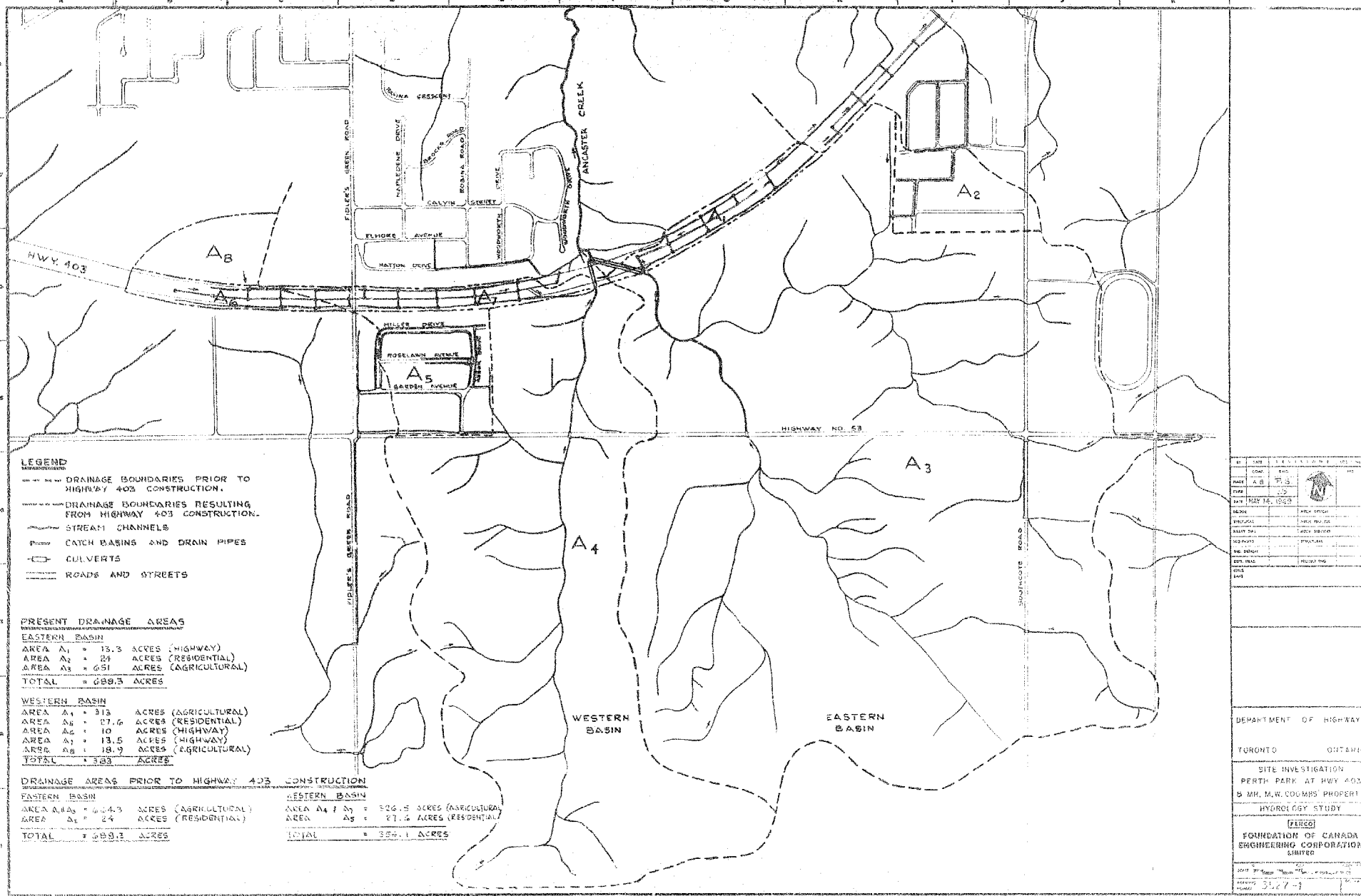
Figure 1 - AREA-RUNOFF FACTORS FOR THE WATERSHED



**FIG. 2** FLOOD - FREQUENCY CURVES FOR ANCASTER CREEK AT HIGHWAY NO. 403. CURVES SHOW REDUCTION IN DOWNSTREAM PEAK FLOW DUE TO HIGHWAY.



**FIG. 3** ESTIMATED MAXIMUM FLOW DEPTHS IN FLOOD CHANNEL DOWNSTREAM OF HIGHWAY 403, CAUSED BY FLOODS OF VARIOUS AVERAGE RECURRENCE INTERVALS. CURVES SHOW REDUCTION IN DOWNSTREAM FLOOD LEVELS DUE TO HIGHWAY.



DATE	1968	1968	1968	1968	1968
FILE	AB	TS			
DATE	MAY 16, 1968				
SCALE	1" = 100'				
DESIGNED BY	M. W. COUMBS				
CHECKED BY	M. W. COUMBS				
APPROVED BY	M. W. COUMBS				
DATE	MAY 16, 1968				
FILE	AB				

DEPARTMENT OF HIGHWAYS

TORONTO ONTARIO

SITE INVESTIGATION  
PERTH PARK AT HWY 403  
B. M. M. W. COUMBS PROPERTY

HYDROLOGY STUDY

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FOUNDATION OF CANADA  
ENGINEERING CORPORATION  
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# GEOCON LTD

HEAD OFFICE

420 MICHEL JASMIN, DORVAL, QUEBEC  
TELEPHONE 631-9827

Rexdale, Ontario  
December 14, 1970

Department of Highways, Ontario  
Downsview  
Ontario

Attention: Mr. A. Rutka, P. Eng.

Re: Site Investigation  
Mr. M.W. Coombs Property (23-44-200)  
Perth Park at Highway 403  
Ancaster, Ontario

Dear Sirs:

With reference to our report dated May 26, 1969 on the above job, we mentioned therein that we would be contacting you for instructions regarding the disposal of the soil samples stored for you in our Toronto Laboratory.

We shall retain your samples in our Laboratory until such time as we have received written permission from you to do otherwise. However, since our facilities are limited, we would appreciate hearing from you as soon as possible with regard to disposal instructions.

Would you please complete the bottom portion of this letter and return same to us at your earliest convenience.

Yours very truly,  
GEOCON LTD

*F. N. Franssen*  
F. N. Franssen  
Laboratory Technician

*ar*  
FNF/sb  
Job No. T9213, *Please destroy, ar*

*The District of*  
*South York*  
DISTRICT OFFICES

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REXDALE, TORONTO, ONT.  
TEL. 244-6476

295 EAST 11TH AVENUE  
VANCOUVER 10, B.C.  
TEL. 879-2620

✓  
P.O. BOX 351  
FREDERICTON, N.B.  
TEL. 475-8967

*Perth Park at Hwy*  
*403*