





#67-F-3

W.P.# 641-64-1

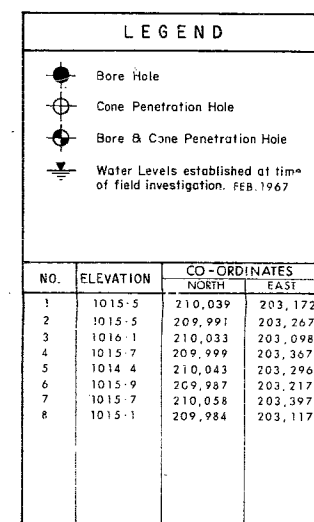
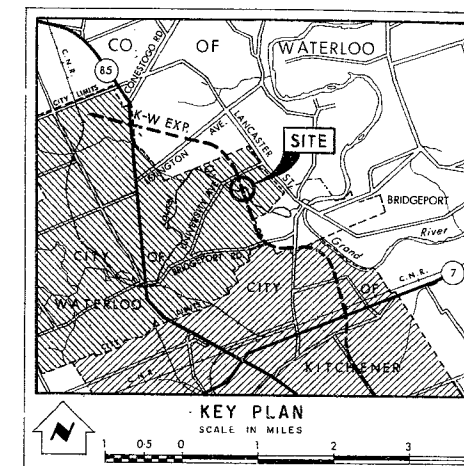
KITCHENER

WATERLOO

EXPRESSWAY

LAUREL

CREEK



- NOTE -

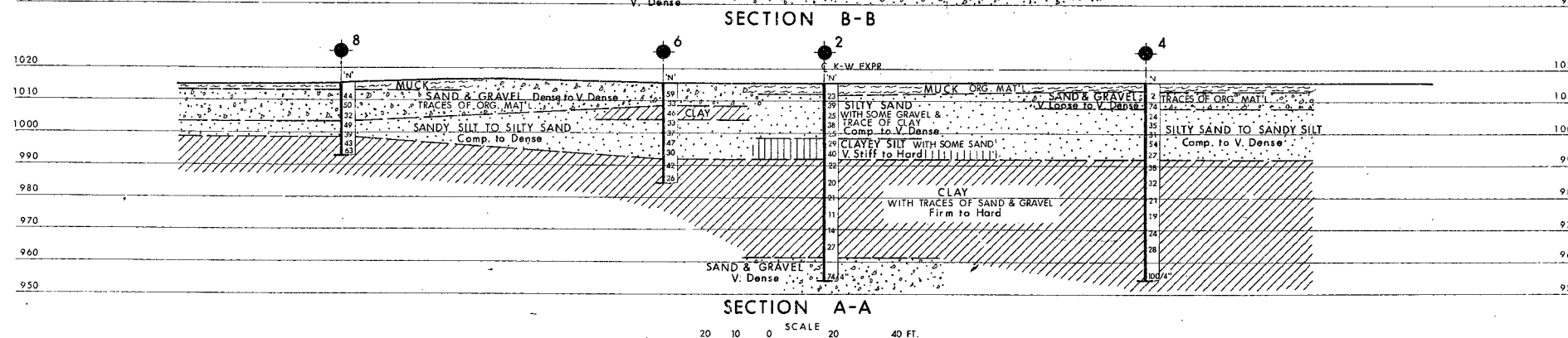
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

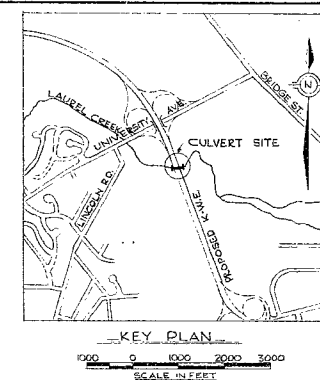
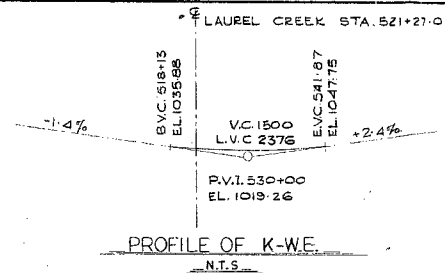
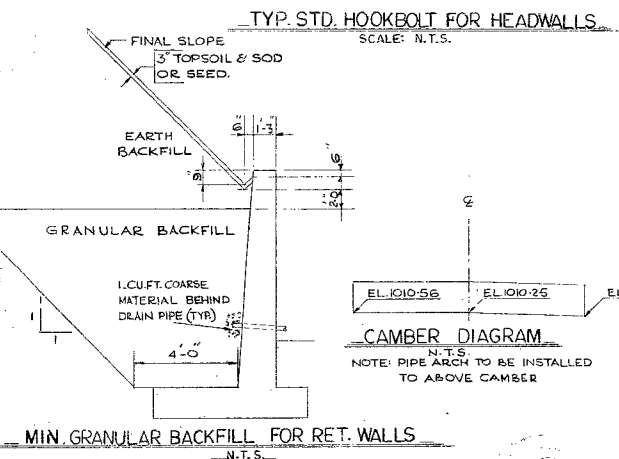
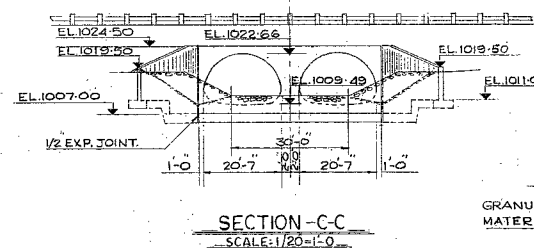
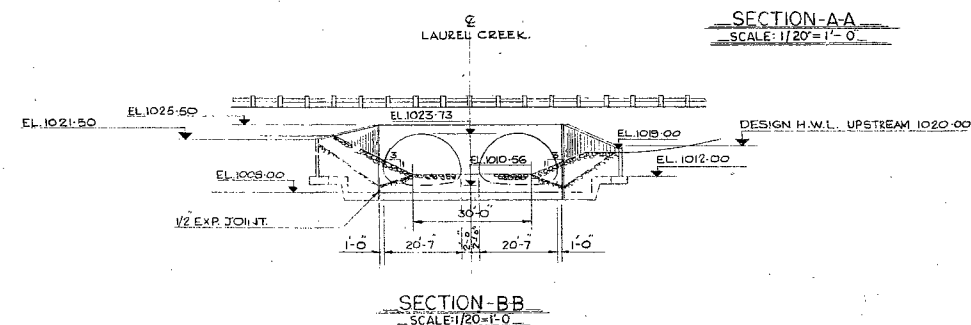
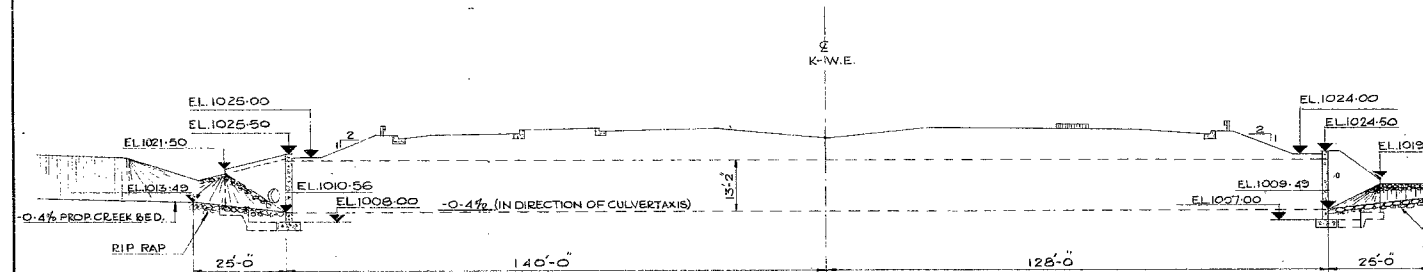
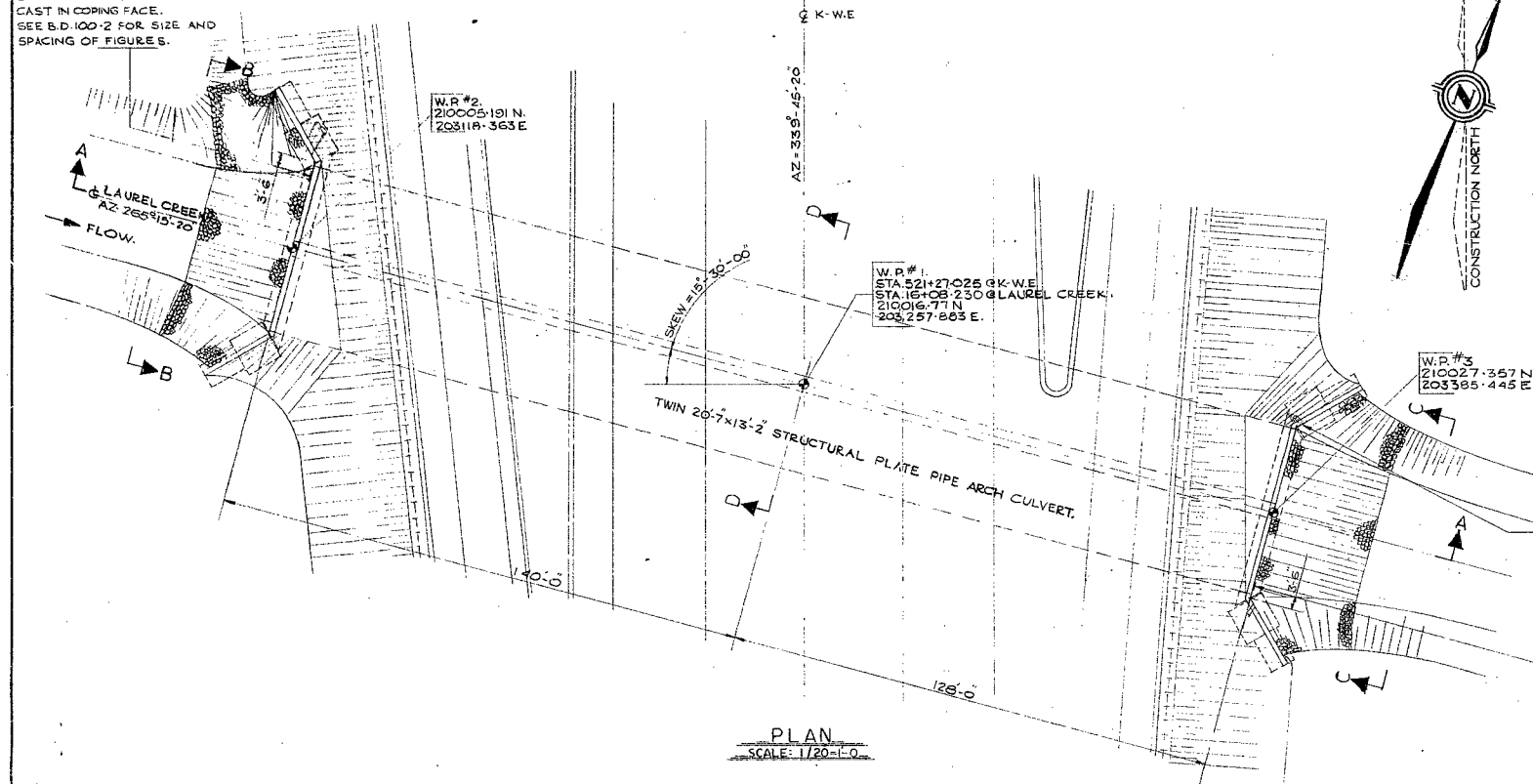
KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR. DIST. NO. 4  
CO. WATERLOO CITY OF WATERLOO  
TWP. LOT CON.

SUBM'D P.P.	CHECKED <i>PP</i>	W.P. NO. 641-64-1	M.B.T. DRAWING NO.
DRAWN F.T.	CHECKED <i>PP</i>	JOB NO. 67-F-3	<b>67-F-3A</b>
DATE 28 FEB. 1967		SITE NO	BRIDGE DRAWING NO.
APPROVED <i>abott</i>	CONT. NO.		



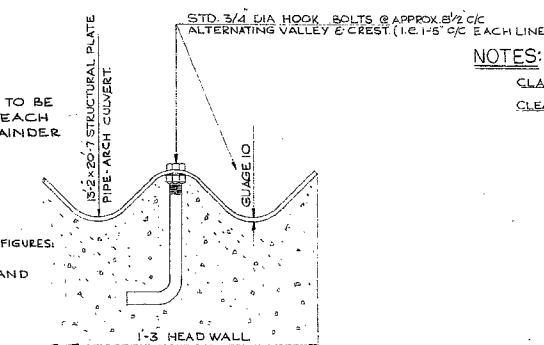


LOCATION OF SITE & DATE FIGURES  
CAST IN COPING FACE.  
SEE S.D. 100-2 FOR SIZE AND  
SPACING OF FIGURES.



# NOTES:

CLASS OF CONCRETE: ALL CONCRETE 3,000 PSI.  
CLEAR COVER TO REINF. = 3"



# CAMBER DIAGRAM

NOTE: PIPE ARCH TO BE INSTALLED  
TO ABOVE CAMBER

- LIST OF DRAWINGS:
- D-6190-1 - GENERAL ARRANGEMENT.
  - 2 - SORE HOLE LOCATION & SOIL STRATA.
  - 3 - LAYOUT OF FOOTINGS & WALLS.
  - 4 - REINF. " " " "

REVISIONS	DATE	BY	DESCRIPTION

# DEPARTMENT OF HIGHWAYS ONTARIO

BRIDGE DIVISION  
A. D. MARGISON AND ASSOCIATES LIMITED  
CONSULTING PROFESSIONAL ENGINEERS

# KITCHENER WATERLOO EXPRESSWAY LAUREL CREEK CULVERT AT K-W.E.

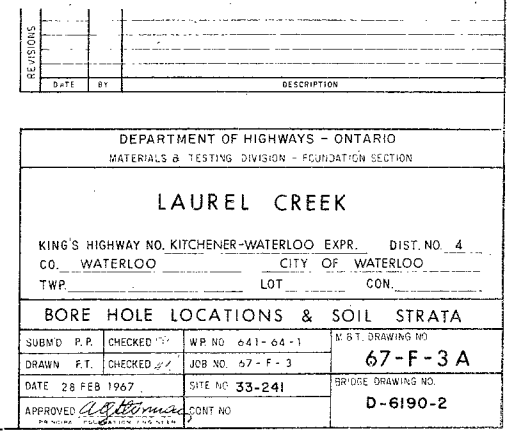
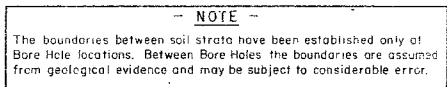
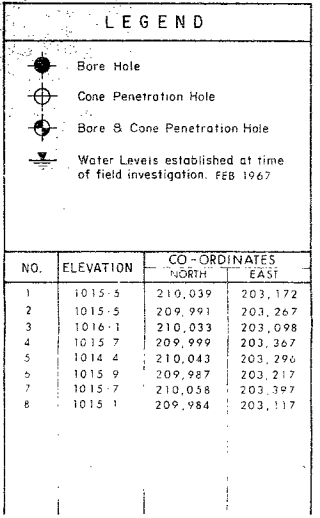
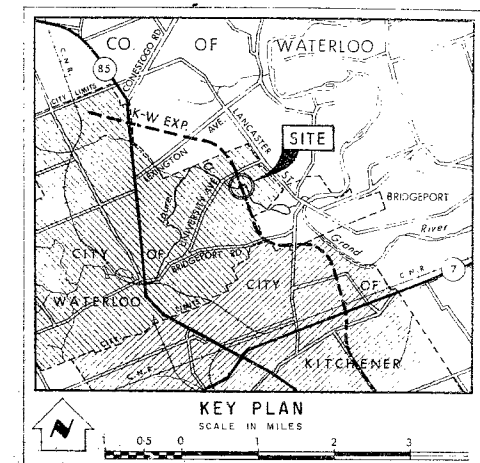
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CO. WATERLOO  
CITY OF WATERLOO LOT CON.

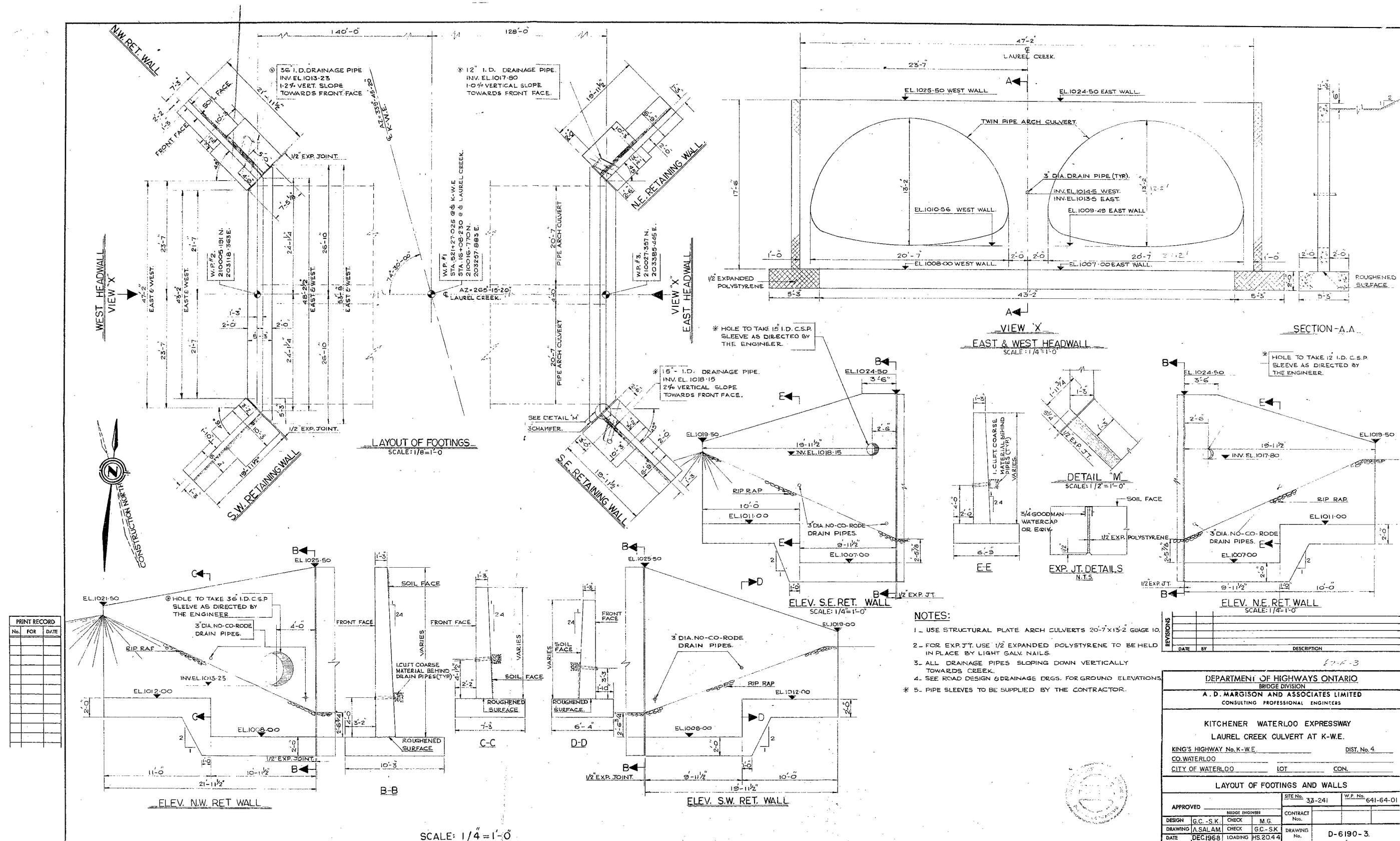
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APPROVED	BRIDGE ENGINEER	SITE No. 33-241	W.P. No. 641-64-01
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DRAWING A.S.A.M. CHECK G.C.-S.K.	DRAWING No.		
DATE DEC. 1968	LOADING HS. 20.44		

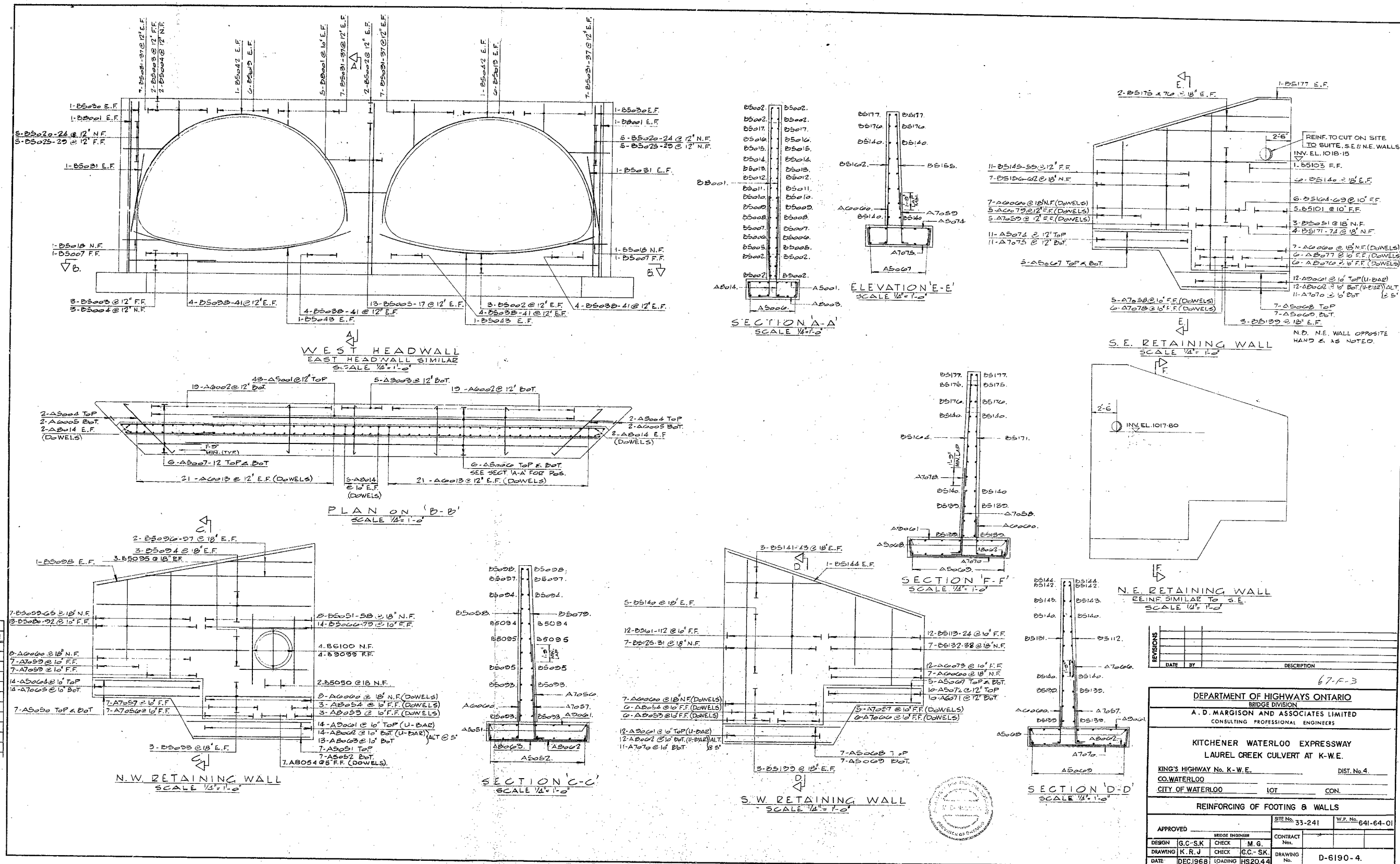
D-6190-1









[illegible]

#67-F-3

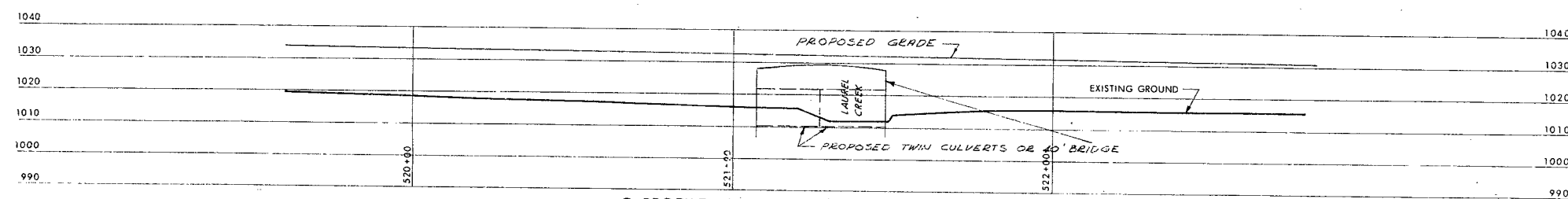
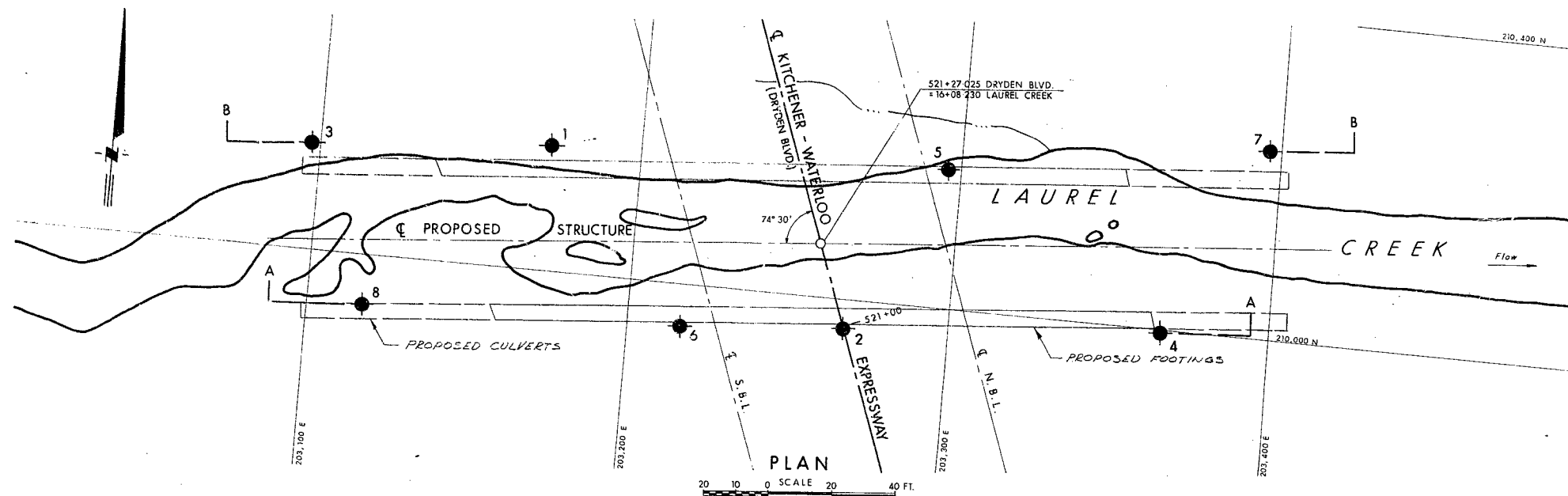
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KITCHENER

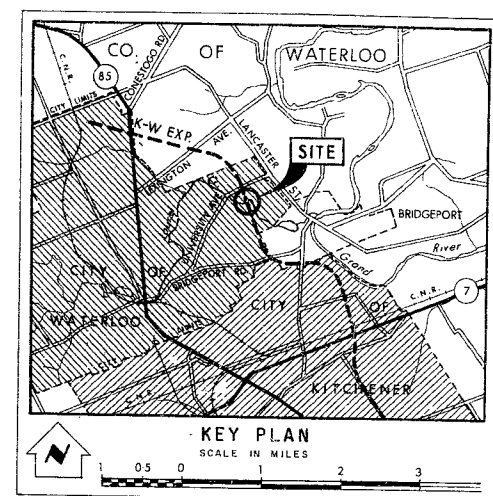
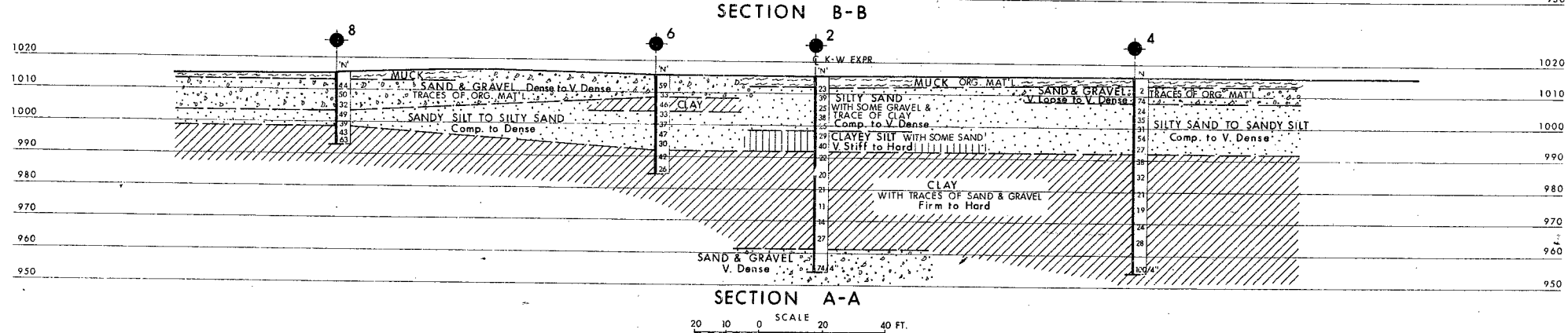
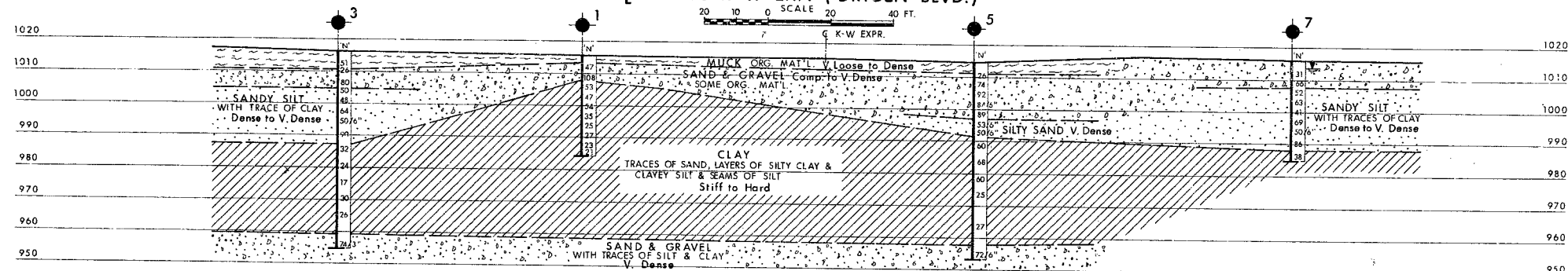
WATERLOO

EXPRESSWAY

LAUREL  
CREEK



PROFILE K-W EXP. (DRYDEN BLVD.)



# LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, FEB. 1967

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	1015.5	210,039	203,172
2	1015.5	209,991	203,267
3	1016.1	210,033	203,098
4	1015.7	209,999	203,367
5	1014.4	210,043	203,296
6	1015.9	209,987	203,217
7	1015.7	210,058	203,397
8	1015.1	209,984	203,117

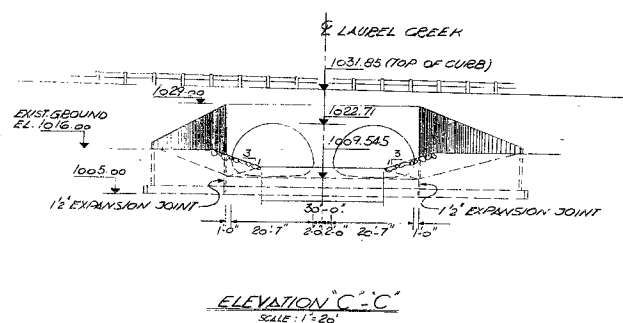
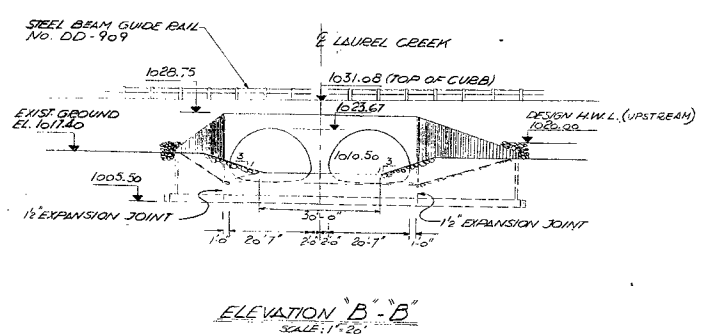
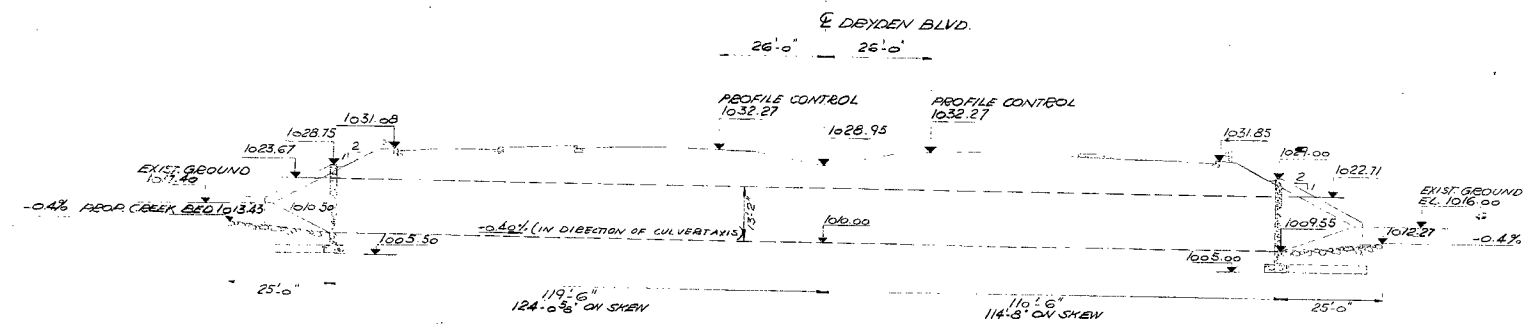
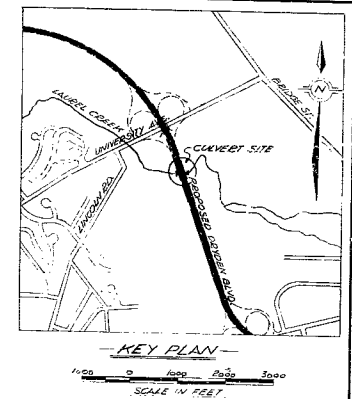
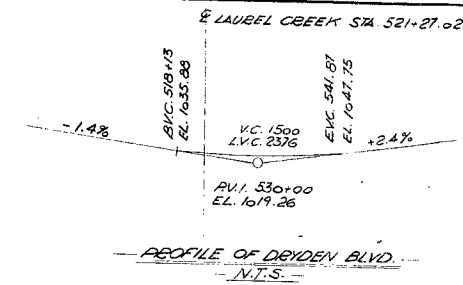
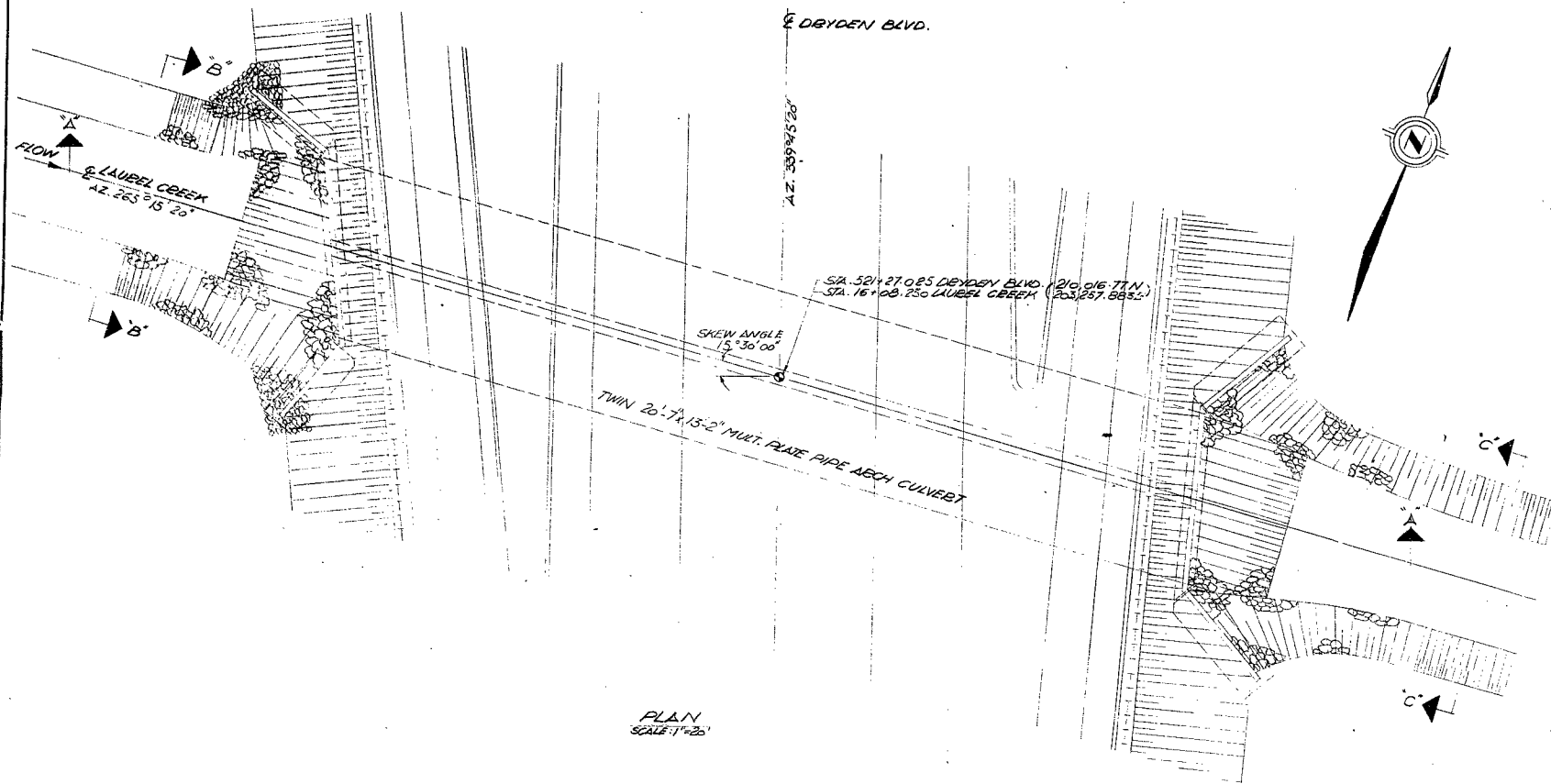
# NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
NO.	DATE	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
LAUREL CREEK			
KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR.		DIST. NO. 4	
CO. WATERLOO		CITY OF WATERLOO	
TWP.                      LOT                      CON.			
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D. P.P.	CHECKED <input checked="" type="checkbox"/>	W.P. NO. 641-64-1	S.G.T. DRAWING NO.
DRAWN F.T.	CHECKED <input checked="" type="checkbox"/>	JOB NO. 67-F-3	67-F-3A
DATE 28 FEB. 1967	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		



NOTE:  
THE CULVERTS AND SPILL HEADWALLS SHALL BE FOUNDED ON A MINIMUM THICKNESS OF 12" OF PROPERLY COMPACTED GRANULAR BACKFILL. COMPACTION SHALL BE CARRIED OUT IN THE DRY. DEWATERING PRECAUTIONS AGAINST "BOILING" WILL BE REQUIRED.

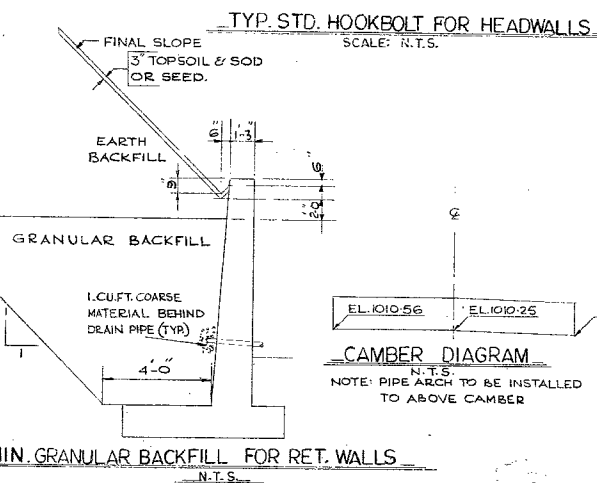
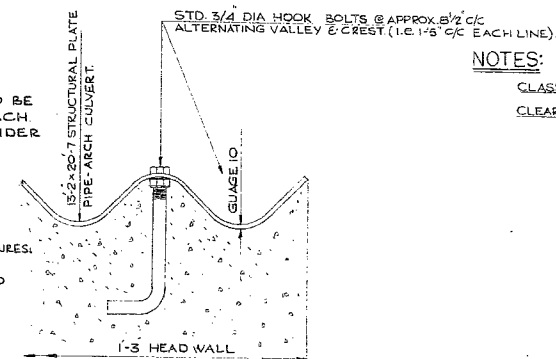
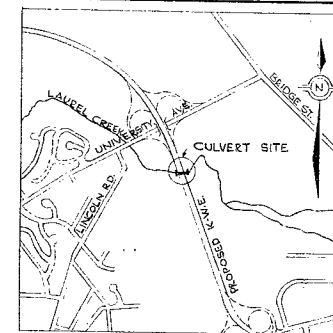
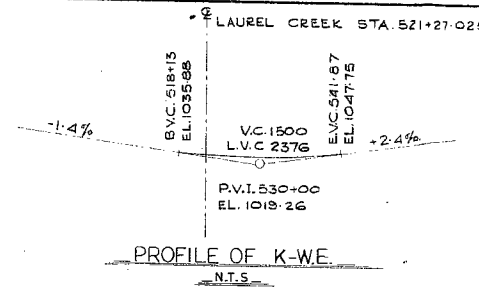
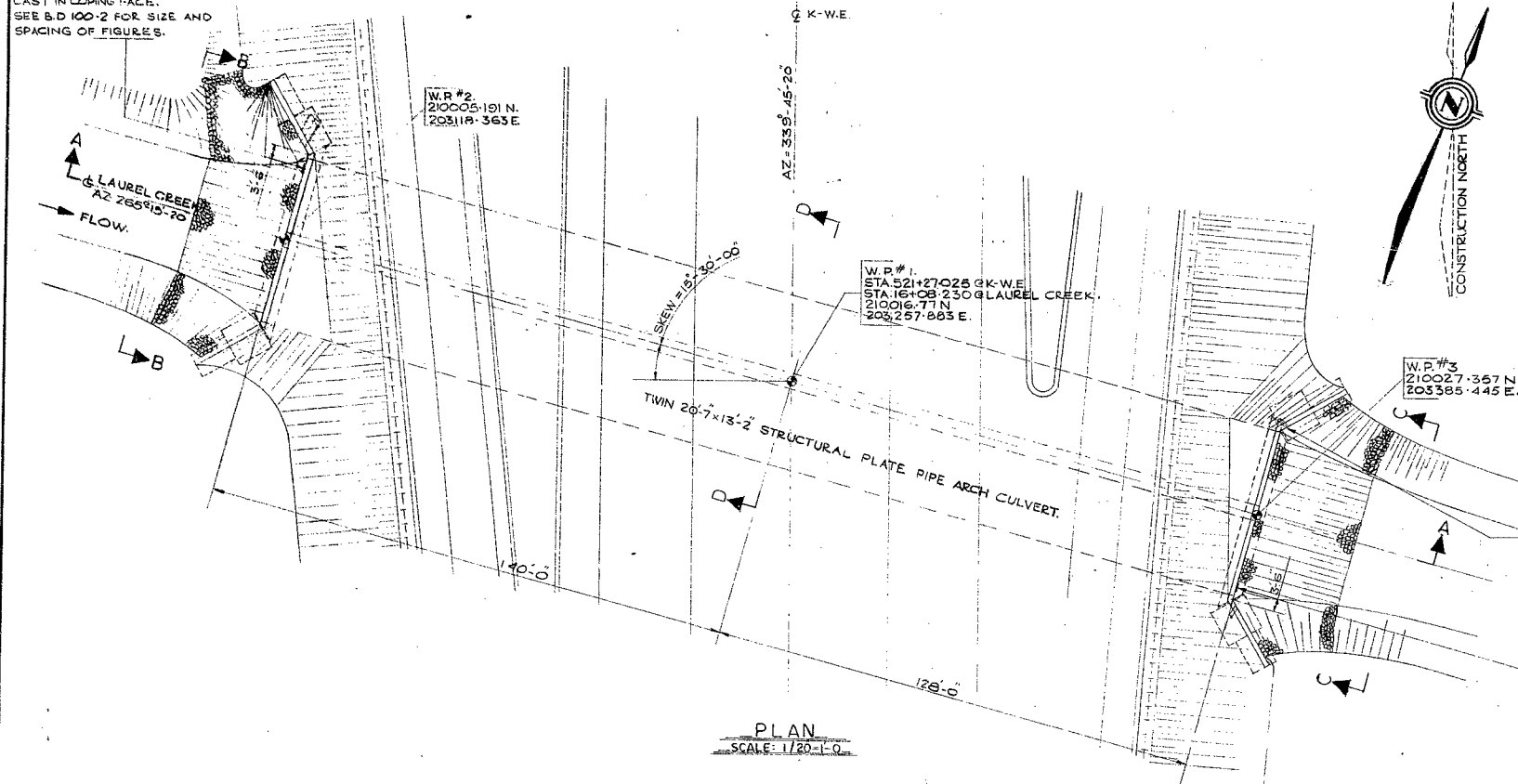
PRINT RECORD		
No.	FOR	DATE

REVISIONS		DATE		BY		DESCRIPTION	

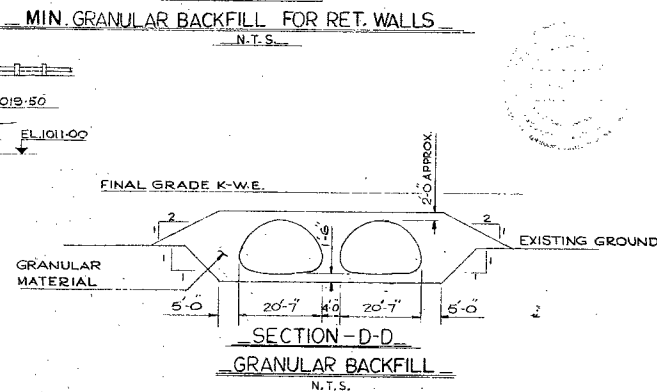
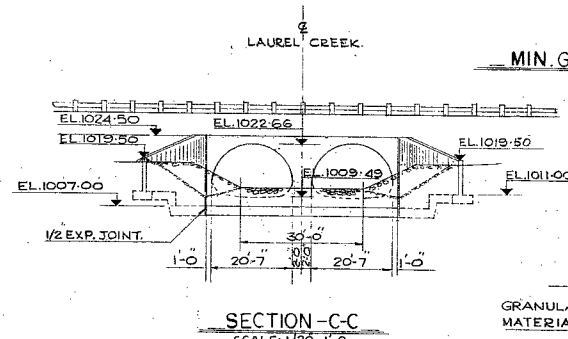
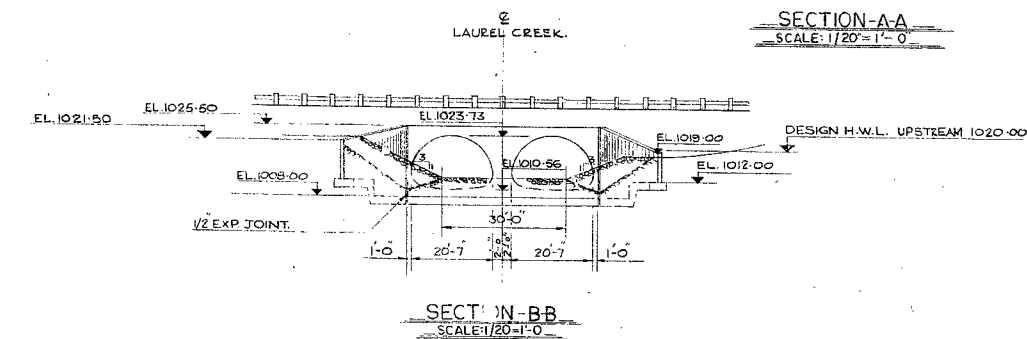
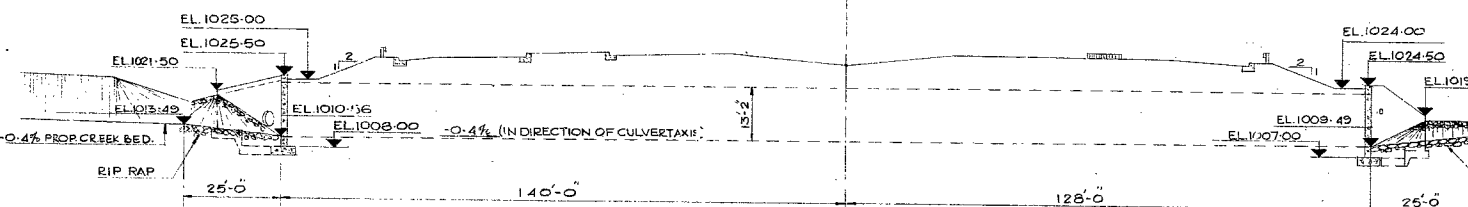
67-F-3

DEPARTMENT OF HIGHWAYS ONTARIO			
BRIDGE DIVISION			
KITCHENER-WATERLOO EXPRESSWAY			
LAUREL CREEK STRUCTURE AT DRYDEN BOULEVARD			
KING'S HIGHWAY No. DRYDEN BLVD.		DIST. No. 4	
CO. WATERLOO			
TWP. CITY OF WATERLOO	LOT	CON.	
PRELIMINARY PLAN			
APPROVED		SITE No. 33-241	
DESIGN H.E.F.		W.P. No. 641-64-01	
CHECK L.	CONTRACT No.		
DRAWING H.E.F.	DRAWING No.		
DATE MAY 1968	LOADING	0-6190-P1	

LOCATION OF SITE & DATE FIGURES  
CAST IN COPING FACE.  
SEE S.D. 100-2 FOR SIZE AND  
SPACING OF FIGURES.



- LIST OF DRAWINGS:
- 1 - GENERAL ARRANGEMENT.
  - 2 - BORE HOLE LOCATION & SOIL STRATA.
  - 3 - LAYOUT OF FOOTINGS & WALLS.
  - 4 - REINF. " " " "



REVISIONS	DATE	BY	DESCRIPTION

67-F-3

DEPARTMENT OF HIGHWAYS ONTARIO  
BRIDGE DIVISION

A.D. MARGISON AND ASSOCIATES LIMITED  
CONSULTING PROFESSIONAL ENGINEERS

KITCHENER WATERLOO EXPRESSWAY  
LAUREL CREEK CULVERT AT K-W.E.

KING'S HIGHWAY No. K-W.E. DIST. No. 4  
CO. WATERLOO  
CITY OF WATERLOO LOT CON.

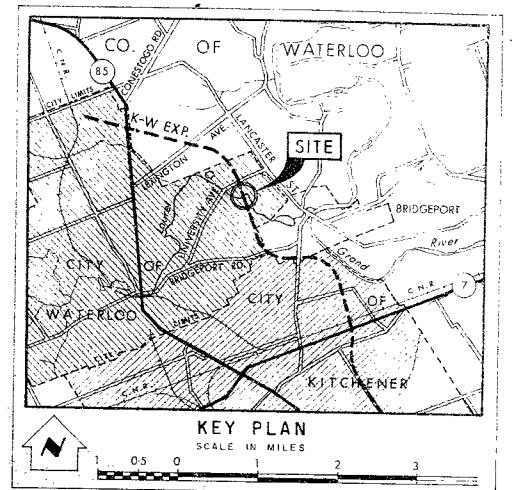
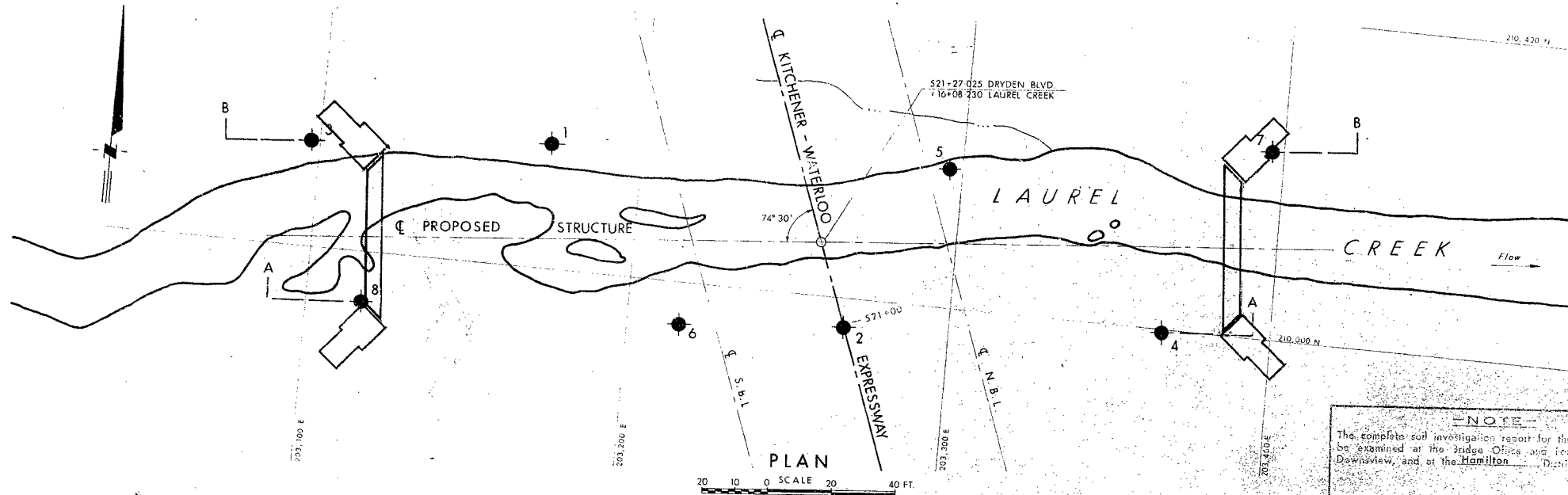
GENERAL ARRANGEMENT

APPROVED \_\_\_\_\_ SITE No. 33-241 W.P. No. 641-64-01

DESIGN G.C.-S.K. CHECK M.G. CONTRACT No. \_\_\_\_\_

DRAWING A.S.A.M. CHECK G.C.-S.K. DRAWING No. D-6190-1

DATE DEC. 1968 LOADING HS. 20.44

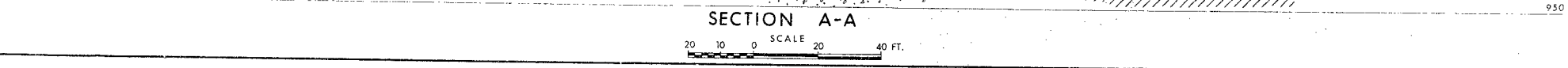
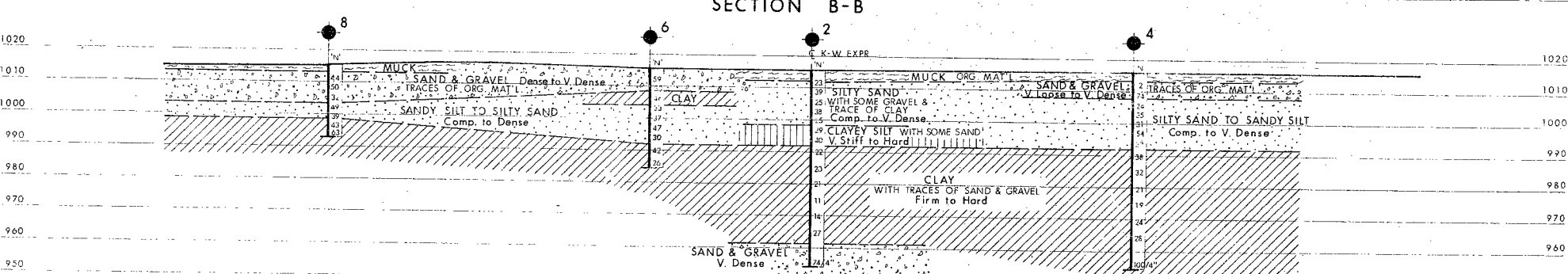
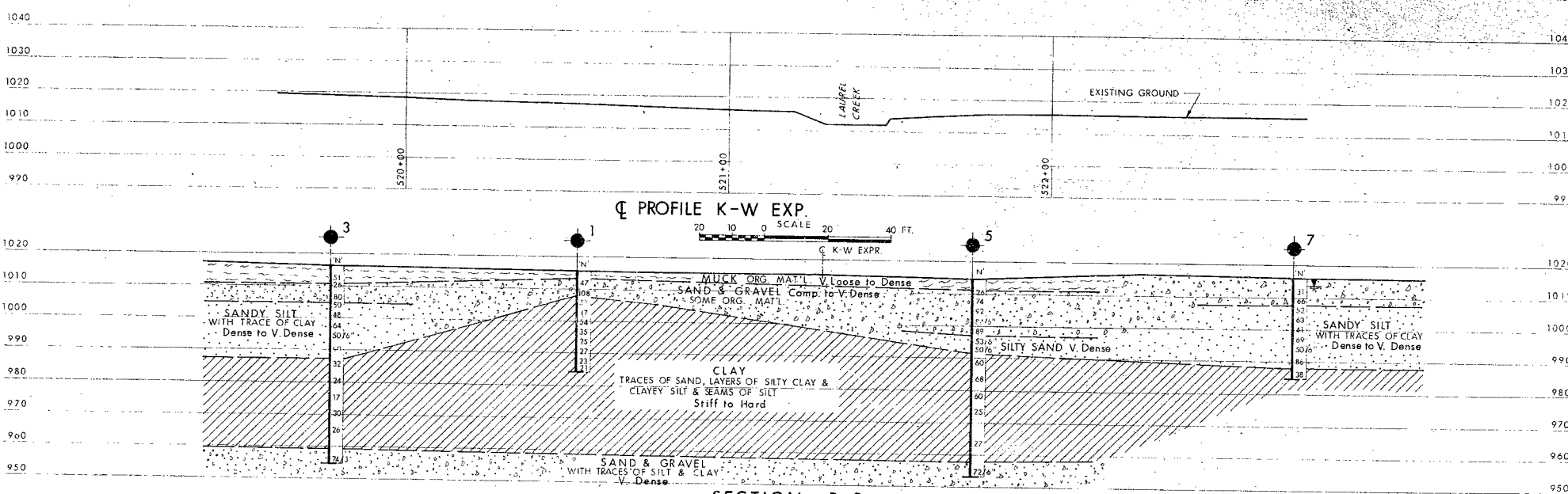


LEGEND			
●	Bore Hole		
⊕	Cone Penetration Hole		
⊗	Bore & Cone Penetration Hole		
—	Water Levels established at time of field investigation, FEB 1967		

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		NORTH	EAST
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NOTE  
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PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
LAUREL CREEK			
KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR. DIST. NO. 4			
CO. WATERLOO CITY OF WATERLOO			
TWP. LOT CON.			
BORE HOLE LOCATIONS & SOIL STRATA			
SUBMD. P.P.	CHECKED	W.P. NO. 641-64-1	M.B.T. DRAWING NO.
DRAWN F.T.	CHECKED	JOB NO. 67-F-3	67-F-3 A
DATE 28 FEB. 1967		SITE NO. 33-241	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	D-6190-2







DEPARTMENT OF HIGHWAYS ONTARIO

## MEMORANDUM

RE: INSPECTION  
MULTIPLATE PIPE  
ARCH CULVERT  
LAUREL CREEK  
CULVERT AT  
KITCHENER-WATERLOO  
EXPRESSWAY

**TO:** Mr. H. Greenland,  
District Engineer,  
District No. 4,  
HAMILTON.

**FROM:** Foundation Section,  
Materials & Testing Office, (67-F-3)  
Room 107, Lab. Bldg.

**ATTENTION:** Mr. D. Thrasher,  
Construction Engineer

**DATE:** March 19, 1970

**OUR FILE REF.**

**IN REPLY TO**

**SUBJECT:**

Laurel Creek Culvert at  
Kitchener-Waterloo Expressway  
District No. 4 (Hamilton)  
Contract 69-102 - W.J. 67-F-3

The above mentioned site was visited by the writer and Mr. J. Tansley, Project Supervisor, on March 16, 1970 at the request of Mr. K. Saarits, Construction Supervisor. The purpose of this visit was to inspect the above mentioned twin 20'-7" x 13'-2" multiplate pipe arch culvert presently being constructed. Following are our observations:

Both culverts were assembled and were in their final position, although no backfilling had yet been carried out. The concrete headwalls on both ends of the pipes had been constructed and were, in consequence, providing support to the pipe ends.

Prior to completion of the headwalls, but after assembling the structural plate pipes, the excavation was flooded to a depth of about 4 feet, which resulted in loss of foundation soil about 2 - 3 feet deep extending back from the pipe ends about 15 feet. In addition to this, several inches of silt were deposited on the foundation surface under the pipes.

According to the contract drawings, the clearance between the pipes should have been 4.0 ft. In actual fact the clearance ranges from about 3.0 ft. to 3.5 ft. This, of course, restricts working space for placing and compacting backfill.

The following questions were raised by Mr. Tansley:

(1) How should the washed-out foundation soil be replaced? - The Contractor had suggested packing in as much sand as possible and pressure-grouting in order to fill remaining voids.

(2) Due to the reduced clearance between the pipes, how should the backfilling be carried out? A suggestion has been made that the backfill in the zone between the pipes be 'washed' in as method of achieving compaction.

Mr. H. Greenland,  
District Engineer,  
Dist. No. 4 - Hamilton.

Attn: Mr. D. Thrasher, Const. Engr.

2  
March 19, 1970

Re: Laurel Creek Culvert - Kitchener-Waterloo Expressway  
Contract 69-102 - W.J. 67-F-3

With regard to (1) it should be noted that the foundation soil and backfill under the pipe, for a distance of about 5 ft. each side of the centre-line of each pipe, provides very little in the way of support for the pipe structure. It is therefore not necessary that the replacement for the 'lost' foundation soil in this zone be compacted to a high degree. In our view, this material should be packed in as carefully as possible by pushing it in from the edges manually. It is doubtful whether the grouting, as suggested by the Contractor, would be successful since too many escape routes for the grout would be present. Insofar as the fill material outside of the above mentioned zones is concerned, it is absolutely vital that full compaction be achieved since the full weight of the structure is supported on this material. It is believed, however, that adequate access does exist to achieve the necessary compactive effort.

With regard to (2) we would not recommend the washing-in of fill material as a means of compaction. Experience in the past has shown that extremely poor results will probably be achieved by this method. In our view, it is within the capability of the Contractor to place and compact the fill material satisfactorily provided he uses suitable mechanical aids. Prior to placing any fill material, all of the abovementioned silt deposits (washed in during the flood), should be removed.

The foregoing has been discussed with Mr. J. Keen, Regional Bridge Design Engineer, and Mr. J. Roy, Regional Materials Engineer, and they are in agreement with our recommendations and comments.

ALL/MKF

*K. G. 5-24*  
E. G. Selby,  
SUPERVISING FOUNDATION ENGR.  
For:  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. H. A. Tregaskes  
J. Keen  
A. McKim  
J. Roy

Foundations Files  
Gen. Files ✓

## MEMORANDUM

23-69-137  
RE: INVESTIGATION  
ON STABILITY OF  
N. RETAINING WALL  
C.N.R. O'HEAD - N.  
OF Hwy #20. Dist 406  
Line "F" (66-F-107)

To: Mr. C. R. Robertson,  
District Engineer,  
District No. 4 (Hamilton).

FROM: Foundation Section,  
Materials & Testing Office,  
Room 107, Lab. Bldg.

ATTENTION: Mr. D. Thrasher,  
Construction Engineer

DATE: April 23, 1970

OUR FILE REF.

IN REPLY TO

## SUBJECT:

C.N.R. Overhead - 1.3 Miles North  
Of Hwy. #20, Hwy. #406, Line 'F'  
District No. 4 (Hamilton)  
W.J. 66-F-107 - Contract 69-137

The above mentioned construction site was visited by the writer on April 20, 1970, following a request by Mr. A. E. McKim, Bridge Control Engineer. The purpose of this visit was to investigate the stability of the North Retaining Wall which had moved since construction.

The wall, as designed, is about 60 feet in length and runs parallel to the railway from the Northeast corner of the North abutment. At the abutment the wall is about 12 feet high (above finished ground) and zero at the northern extremity. The South 20 ft. of the wall is supported on piles, whilst the North 40 ft. is supported on spread footings constructed within the fill material. The Foundation Report (66-F-107) recommended that the structure and retaining walls be founded completely on piles, and the Preliminary Plan D 6187-1, reviewed by us, did in fact show the retaining walls in question to be founded entirely on piles driven to bedrock.

At the time of visiting the site, it was observed that the North portion of the North Retaining Wall had been pulled over backwards by means of cables attached to bulldozers. This had been done on orders from the District, since it was felt that there was a danger of the wall sliding down onto the railway track. It should be noted that no fill had yet been placed behind any of the retaining walls above footing level.

The construction history is as follows:

..... 2

ap  
1

Mr. C. B. Robertson,  
District Engineer,  
District No. 4 (Hamilton).

Attn: Mr. D. Thrasher, Const. Engr.

April 23, 1970

Re: C.W.R. Overhead - 1.3 Miles North of  
Hwy. #20, Hwy. #406, Line 'F' -  
W.J. 65-F-107 - Contract 69-137 ...

Oct. 29th - Dec. 5th (1969) -- Fill placed up to bottom of  
footing level at North  
Retaining Wall.

Jan. 7th - Jan. 10th (1970) -- Fill placed up to bottom of  
footing level at South  
Retaining Wall.

Jan. 7th - Jan. 10th (1970) -- Fill added at location of  
North Retaining Wall.

Jan. 10th - Jan. 15th (1970) -- Piles driven for both  
Retaining Walls.

Jan. 15th - Jan. 31st (1970) -- Concrete poured for both  
Retaining Walls.

End of March (1970) -- Movement of North Retaining  
Wall first observed.  
Movement of South Retaining  
Wall observed later.

At the time of the site visit, it was observed that the fill material in front of, and under the footing (now removed) of the North Retaining Wall, consisted of soft, very wet silty clay or clayey silt. Numerous cracks were visible in the fill in front of the wall. It was also observed that the footing base had had only a few inches of earth cover (measured from bottom of footing) to provide protection against frost. A thin cover of straw had been placed on the face of the earth slope, presumably to give protection from frost.

It seems fairly obvious that the wall movements can be attributed entirely to the soft, wet condition of the fill material. It also seems very likely that the North Retaining Wall footing was poured on frozen fill or, if not, that the fill below the wall froze soon after placing the concrete. It is also very possible that the fill material was frozen whilst being placed, thus preventing proper compaction and, also, causing it to appear to be much drier than it actually was. The consequences of the foregoing, of course, were not apparent until the frost came out of the ground.



Mr. C. R. Robertson,  
District Engineer,  
District No. 4 (Hamilton).

Attn: Mr. D. Thrasher, Const. Engr.

April 23, 1970

Re: J.N.R. Overhead - 1.3 Miles North of  
Hwy. #20, Hwy. #406, Line 'F' -  
W.J. 65-F-107 - Contract 69-137 ...

Recommendations:

In order to rectify the present situation, the following recommendations are made for your consideration:

1) All of the affected soft fill material should be removed and replaced with suitable well compacted material. In order to determine exactly how much fill material should be removed, it is suggested that the Regional Materials Engineer be contacted to assess the competency of the fill as a whole.

2) After the fill has been rebuilt up to the level shown on the drawing as 1st Stage (el. 603), the north 40 ft. length of the North Retaining Wall may be rebuilt, founded on piles as recommended in the foundation report.

3) As an alternative to a piled foundation, the North portion of the North Retaining Wall may be founded on spread footings placed on well compacted granular fill. The attached standard has been prepared by the Foundation Section, showing the pertinent details. This method has been used successfully on a number of projects. For design purposes, a net safe footing pressure of 2 t.s.f. may be assumed. In computing frictional resistance to sliding, a coefficient of 0.55 may be assumed to apply between the Granular 'A' material and the footing base.

4) It is recommended that the above measures be applied to the South half of the South Retaining Wall, since a similar situation prevails there, also.

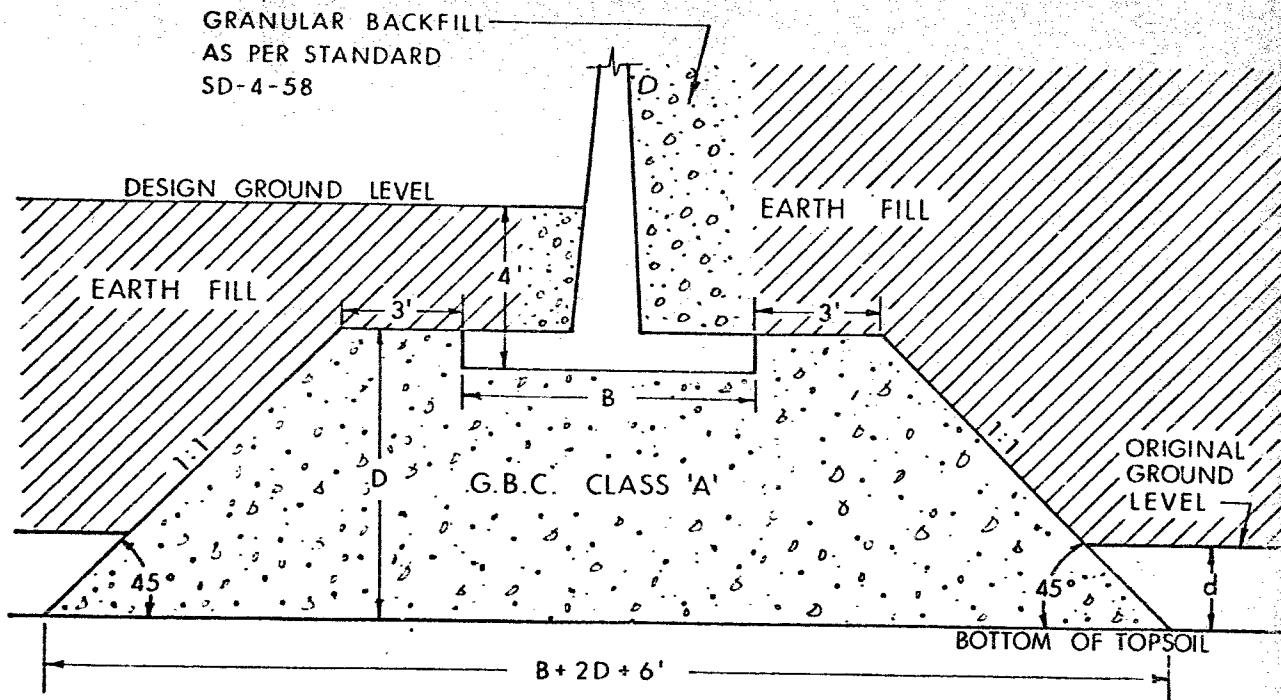
KCS/ndef  
Attach.

cc: Messrs. C. R. Robertson (2)  
B. R. Davis (2)  
H. A. Tregaskes  
D. W. Farren  
A. E. McKim  
G. K. Hunter (2)  
F. J. Kovich  
D. Hopper

Foundations Files  
Gen. Files

K. G. Selby,  
SUPERVISING FOUNDATION ENGR.  
For:  
A. G. Starnac,  
PRINCIPAL FOUNDATION ENGR.

FIGURE 1



### LEGEND

- B = BREADTH OF FOOTINGS
- D = DEPTH OF G.B.C. CLASS 'A' BACKFILL
- d = DEPTH OF TOPSOIL

### SEQUENCE OF OPERATION

- 1 - STRIP TOPSOIL
- 2 - CONSTRUCT G.B.C. CLASS 'A' TO FULL HEIGHT AS SHOWN
- 3 - CONSTRUCT REMAINDER OF FILL TO CONVENIENT HEIGHT
- 4 - RE-EXCAVATE FOR RETAINING WALL FOOTING

TYPICAL SECTION OF A RETAINING WALL SUPPORTED ON  
SPREAD FOOTINGS WITHIN THE FILL MATERIAL

MEMORANDUM

To: Mr. B. R. Davis,  
Bridge Engineer,  
Bridge Division.  
Attention: Mr. S. McCombie

FROM: Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

DATE: March 6, 1967

OUR FILE REF.

IN REPLY TO:

MAR - 9 1967

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For Proposed Crossing At  
Laurel Creek and Dryden Blvd.  
Kitchener-Waterloo Expressway  
City of Waterloo; Co. of Waterloo  
District #4 (Hamilton)  
W.J. 67-F-3 - W.P. 641-64-1

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/KdeF  
Attach.

cc: Messrs. B. R. Davis (2)  
H. A. Tregaskes  
D. W. Farren  
A. Gater  
H. Greenland  
W. S. Melinyshyn  
J. Roy  
W. D. Bradley  
A. D. Margison  
University of Waterloo  
Foundations Files  
Gen. Files ✓

*A. G. Stermac*  
A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER

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-

FOUNDATION INVESTIGATION REPORT  
For Proposed Crossing At  
Laurel Creek and Dryden Blvd.  
Kitchener-Waterloo Expressway  
City of Waterloo; Co. of Waterloo  
District #4 (Hamilton)  
W.J. 67-F-3 - W.P. 641-64-1

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1. INTRODUCTION:

A foundation investigation for the proposed crossing at Laurel Creek and Dryden Blvd. (Kitchener-Waterloo Expressway), was requested by Mr. W. S. Melinyshyn, Regional Bridge Location Engineer, in a memorandum dated December 9, 1966.

Following this request, a field investigation was subsequently carried out by the Foundation Section, to determine the subsoil conditions existing at the proposed structure site.

This report contains the information resulting from the field investigation, together with recommendations pertaining to the design of the proposed structure foundations.

2. DESCRIPTION OF THE SITE:

The proposed structure site is located at the crossing of Laurel Creek and Dryden Blvd. in the City of Waterloo. Dryden Blvd. is part of the Kitchener-Waterloo Expressway.

The surrounding area is flat on one side of the creek and undulating on the other.

Physiographically, the site is situated in the area referred to as the 'Waterloo Hills' region.

cont'd. /2 ...

#### FIELD INVESTIGATION PROCEDURE:

The field work consisted of eight sampled boreholes.

Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. During the field work, disturbed samples were obtained at various intervals. The samples were recovered by a split-spoon sampler and the number of blows required to drive it were recorded. The energy used in driving it, conformed to the requirements of the Standard Penetration Test.

The locations and elevations are shown on Dwg. 67-F-3A which forms part of this report.

#### 4. LABORATORY TESTS:

The samples were visually examined and classified at the site as well as in the laboratory. Tests were carried out in the laboratory for classification purposes. These tests consisted of natural moisture content, Atterberg limits and grain-size distribution determinations. The test results are shown on the Borehole Record sheets.

#### 5. SOIL TYPES AND SOIL CONDITIONS:

##### 5.1) General:

Subsoil at the site consists of a shallow deposit of muck at the surface, followed by a compact to very dense sand and gravel zone, followed by compact to very dense sandy silt to silty sand stratum, followed by an extensive deposit of stiff to hard clay with traces of sand, followed by a very dense sand and gravel layer.

Detailed descriptions of the various soil types observed are shown on the Borelog sheets contained in the Appendix.

cont'd. /3 ...



5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.1) General: (cont'd.) ...

The estimated stratigraphical profile is shown on Dwg. 67-F-3A. The various soil types are described in detail as follows:

5.2) Muck:

This deposit was encountered in all boreholes except No. 6 and 7, and extended from ground level for a maximum depth of 5 ft. to Elev. 1010.5.

The material consists of decayed and undecayed organic matter and fine sand.

The relative density ranges from very loose to dense.

5.3) Sand and Gravel with Traces of Silt, Clay and Organic Material:

This material was found to underlie the muck deposit in all boreholes with the exception of B.H. #2, where the sand and gravel is replaced by a silty sand deposit. The lower boundary was found to vary between El. 997 and El. 1009. The chief components are sand and gravel with traces of organic substances, silt and clay, with the following average proportions: gravel 44%, sand 44%, silt and clay 12%. The 'N' values ranged from 2 to over 100 blows per foot. The relative density may be described as very loose to very dense.

5.4) Sandy Silt to Silty Sand:

This stratum, in general, underlies the sand and gravel deposit. In Borehole No. 1, this layer was not encountered. The lower boundary was found to vary from El. 987 to El. 998.

The material consists of sandy silt to silty sand with traces of clay, and some gravel.

Standard Penetration Tests, carried out in this zone, gave 'N' values of 27 to over 100 blows per foot.

cont'd. /4 ...

5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.4) Sandy Silt to Silty Sand: (cont'd.) ...

The moisture content was found to vary from 8% to 23%.

Typical grain-size distribution curves are included in the Appendix of this report.

5.5) Clay:

This material was encountered in all boreholes between the lower boundary of the sandy silt to silty sand, and at El. 959. The exact boundaries for this zone are plotted on the Borelog sheets.

The material in the deposit consists of clay with traces of sand and gravel, pockets and seams of silt, and also contains layers of silty clay and clayey silt.

The 'N' values ranged from 11 to 86 blows per foot, which indicate a firm to hard consistency.

Physical properties as determined from laboratory tests, are as follows:

Natural Moisture Content	:	13	to	41%
Liquid Limit	:	59	to	70%
Plastic Limit	:	24	to	29%

5.6) Sand and Gravel - Glacial Till:

The clay deposit is underlain by a very dense sand and gravel with traces of silt and clay (glacial till) in Boreholes No. 2, 3, and 5. The lower boundary was not determined since the borings were terminated in this layer.

6. GROUNDWATER CONDITIONS:

The water levels in the boreholes were found to correspond with the elevation of the water level in the creek at a given time.

cont'd. /5 ...

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a single 40-ft. span bridge or a twin 20-ft. box culvert at the proposed crossing of Laurel Creek and Dryden Blvd.

It was observed from the preliminary plan, that the proposed grade of Dryden Blvd. will be some 23 ft. above the existing ground level.

Due to the nature of subsoil and groundwater conditions, it is recommended that the proposed single-span bridge be supported on large displacement piles. It is estimated that embedded pile lengths of about 50 ft. should be sufficient to support a safe load of 40 tons for 12-3/4" O.D. steel tubes.

If excavations are carried out below the groundwater level, it will be necessary to employ a dewatering scheme. The most suitable method is to drive sheet piling down to a depth below the excavation base equal to the height of the prevailing groundwater above it.

No special problems are anticipated for a culvert type structure, provided the construction methods are in accordance with the current D.H.O. Specifications.

Material recovered in the boreholes indicated that a certain portion of the subsoil is susceptible to scour; therefore, preventative measures should be carried out.

No stability problems are anticipated for the proposed embankment constructed with standard 2:1 slopes. All soft, organic material should be removed within the construction area prior to placing fill.

8. SUMMARY:

A foundation investigation at the site of Laurel Creek on Dryden Blvd. is reported.

cont'd. /6 ...

8. SUMMARY: (cont'd.) ...

In general, the subsoil was found to consist of muck at the surface, followed by sand and gravel, followed by sandy silt to silty sand, followed by clay, followed by sand and gravel - till deposits.

Two types of structures are being considered:

1) 40-ft. single-span bridge, supported on 50-ft. steel tube piles with a safe design load of 40 tons per pile.

2) Twin 20-ft. box culverts: should be constructed according to current D.H.O. Standards.

A dewatering scheme should be used if excavation is carried below the existing groundwater level. The effect of the possible scour should be investigated.

No special problems are anticipated for the proposed 23-ft. high fill provided with 2:1 slopes.

All soft, organic material should be removed within the construction area prior to placing fill.

9. MISCELLANEOUS:

The field work was carried out from February 6 to February 17, 1967. The equipment used for the subsoil exploration was owned and operated by Canadian Longyear Ltd.

The field investigation was supervised directly by Mr. P. Payer, Project Foundation Engineer, who also prepared this report.

The report was reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

March 1967

APPENDIX I.

### FOUNDATION SECTION

ORIGINATED BY PP

COMPILED BY PP

CHECKED BY     

--



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

# RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 67-F-3 LOCATION 209,991N, 203,267E ORIGINATED BY PP  
W.P. 641-64-1 BORING DATE February 9 & 10, 1967 COMPILED BY PP  
DATUM Geodetic BOREHOLE TYPE Washbore, EX Casing CHECKED BY KL

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.						wp	w	wL		
1015.5	GROUND LEVEL																
0.0	Muck																
1011.6	(organic material)		1	SS	23	1010											
3.9	Silty sand with some gravel and trace of clay.		2	SS	39												
	Brown		3	SS	25												
			4	SS	38												
998.5	Compact to dense.		5	SS	25	1000											
17.0	Clayey silt with some sand.		6	SS	29												
992.0	Grey Very stiff to hard.		7	SS	40												
23.5	Clay with some sand and occasional silt seams.		8	SS	22	990											
	Grey		9	SS	20												
	Firm to very stiff.		10	SS	21	980											
			11	SS	11												
			12	SS	14	970											
			13	SS	27												
961.5						960											
54.0	Sand & Gravel Very dense																
954.0			14	SS	7 1/2"												
61.5	End of Borehole					950											

Gr.15, Sa.63  
Si.42, Cl.22

Gr.0, Sa.56  
Si.42, Cl.2

Gr.0, Sa.3  
Si.16, Cl.81

58.9

61.5



DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO. 4				FOUNDATION SECTION				
MATERIALS & TESTING DIVISION											
JOB <u>67-F-3</u>		LOCATION <u>209.999N, 203.367E</u>		ORIGINATED BY <u>PP</u>							
W.P. <u>641-64-1</u>		BORING DATE <u>February 10 &amp; 13, 1967</u>		COMPILED BY <u>PP</u>							
DATUM <u>Geodetic</u>		BOREHOLE TYPE <u>Washbome, BX Casing</u>		CHECKED BY <u>HL</u>							
SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.		WATER CONTENT % wp — w — WL 10 20 30		
1015.7	GROUND LEVEL										
0.0	Muck & sand										
	Sand & gravel, traces of org.mat'l. V.Loose to V.Dense		1	SS	2	1010					
1007.7			2	SS	74						
8.0	Silty sand to sandy silt.		3	SS	24						
	Brown		4	SS	35						
	Compact to V.Dense		5	SS	31	1000					
			6	SS	54						
			7	SS	27						
991.7											
24.0	Clay with traces of sand and gravel pockets and seams of silt. Grey Stiff to Hard		8	SS	38	990					
			9	SS	32						
			10	SS	21	980					
			11	SS	19						
			12	SS	24	970					
			13	SS	28						
						960					
954.2			14	SS	100/4"						
61.5	End of Borehole					950					

Gr. 0  
Sa. 27  
Si. 68  
Cl. 5

51.1

57.8

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 67-F-3 LOCATION 210.043N. 203.296E ORIGINATED BY PP  
W.P. 641-64-1 BORING DATE February 13 & 14, 1967 COMPILED BY PP  
DATUM Geodetic BOREHOLE TYPE Washbore, BX Casing CHECKED BY SR

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — wp WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					wp — w — WL 10 20 30				
1014.4	GROUND LEVEL															
0.0	Muck															
1010.9	Black		1	SS	26	1010										
3.5	Sand and gravel		2	SS	74											
	Very dense		3	SS	92											
			4	SS	84/6"	1000										
996.9			5	SS	89											
17.5	Silty sand. Brown		6	SS	53/6"											
991.4	Very Dense.		7	SS	50/6"											
23.0	Clay with traces of sand. Occ. seams of silt. Layers of silty clay. Grey		8	SS	60	990										
			9	SS	68											
			10	SS	60	980										
			11	SS	25	970										
	Very stiff to hard		12	SS	27											
957.4						960										
57.0	Sand & gravel with traces of silt & clay. Very dense.		13	SS	72/6"											
952.9																
61.5	End of Borehole					950										

Gr. 54, Sa. 34  
Sl. & Cl. 12

Sa. 81  
Sl. 19  
Cl. 19

Gr. 23, Sa. 67  
Sl. & Cl. 10

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 67-F-3 LOCATION 209,987N, 203,217E ORIGINATED BY PP  
W.P. 641-64-1 BORING DATE February 14, 1967 COMPILED BY PP  
DATUM Geodetic BOREHOLE TYPE Washbore CHECKED BY HR.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — wp WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT % wp — w — WL 10 20 30				
1015.9	GROUND LEVEL															
0.0	Sand & gravel with traces of org.mat'l.	Dense to Very dense.	1	SS	59	1010									Gr.O,Sa.83 Si.&Cl.17  Gr.O,Sa.47 Si.49,Cl.4	
1008.9			2	SS	33											
7.0	Clay with traces of sand.		3	SS	46											
1004.9		Sandy silt to Silty sand	4	SS	33	1000										
11.0			5	SS	37											
	Compact to Dense		6	SS	47											
	Brown		7	SS	72											
992.4		Clay with traces of sand.	8	SS	42	990										
23.5																
984.4	Very stiff to hard.		9	SS	26											
31.5	End of Borehole					980										

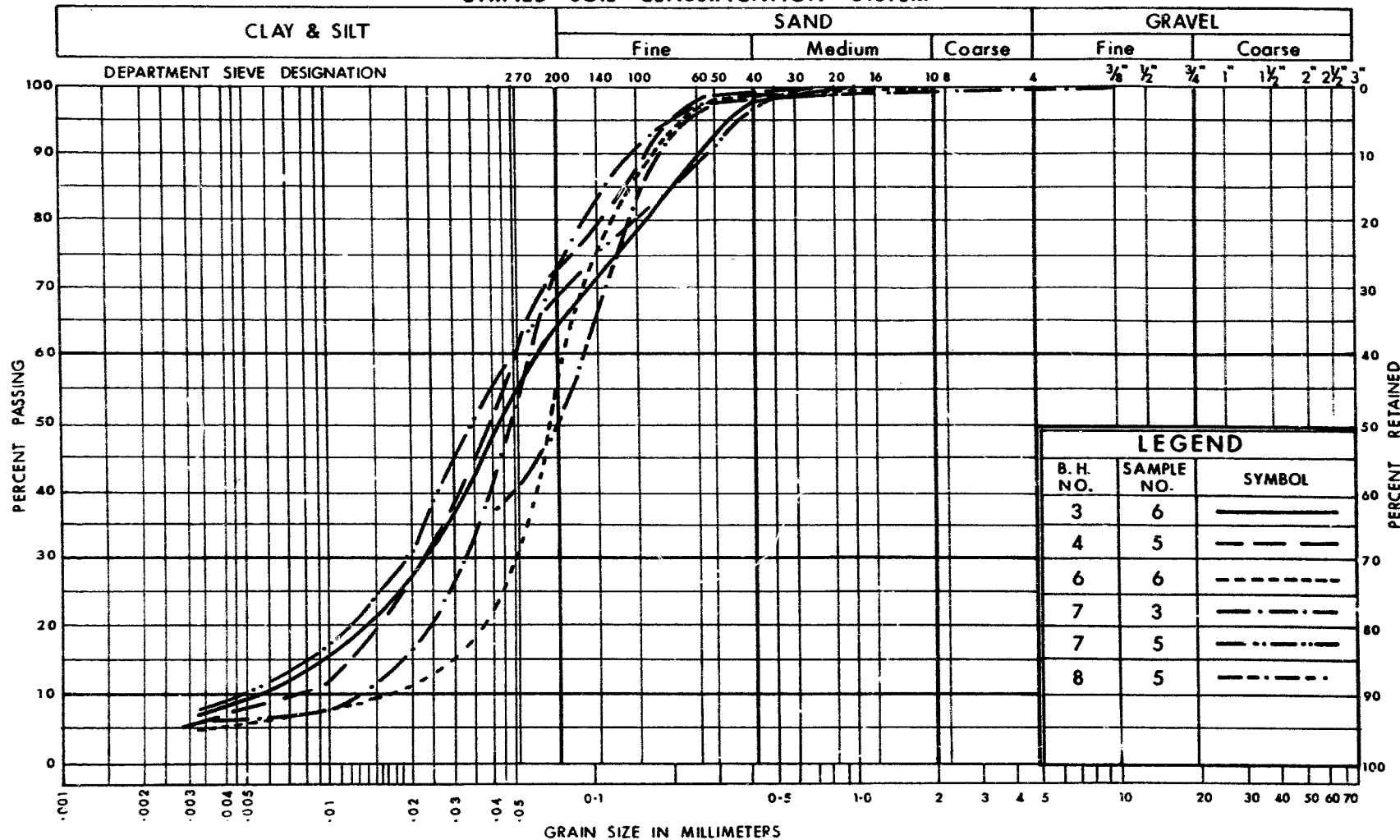
Gr.O,Sa.83  
Sl.&Cl.17  
  
Gr.O,Sa.47  
Sl.49,Cl.4



DEPARTMENT OF HIGHWAYS - CIVIL		<b>RECORD OF BOREHOLE NO. 8</b>		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION					
JOB <u>67-P-3</u>	LOCATION <u>209,984N, 203,117E</u>	ORIGINATED BY <u>PP</u>			
W.P. <u>641-64-1</u>	BORING DATE <u>February 15, 1967</u>	COMPILED BY <u>PP</u>			
DATUM <u>Geodetic</u>	BOREHOLE TYPE <u>Washbore, BX Casing</u>	CHECKED BY <u>SLR</u>			

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.				
1015.1	GROUND LEVEL															
0.0	Muck & Sand															
2.5	Sand & Gravel		1	SS	44	1010										
	Dense to very dense		2	SS	50											
	Brown		3	SS	32											
1003.1			4	SS	49	1000										
12.0	Sandy silt to silty sand.		5	SS	39											
998.1	Brown - Dense		6	SS	43											
17.0	Clay with layers of fine sand.		7	SS	63											
992.6	Hard - Brown															
22.5	End of Borehole					990										

# UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO

DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

## GRAIN SIZE DISTRIBUTION

W.P. No.

JOB No. 67-F-3



## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

### TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.B	SCRAPER BUCKET SAMPLE	O.S	OESTERBERG SAMPLE
A.S	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		
	P.H	SAMPLE ADVANCED HYDRAULICALLY	
	P.M	SAMPLE ADVANCED MANUALLY	

### SOIL TESTS

Q <sub>u</sub>	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V	FIELD VANE
Q <sub>cu</sub>	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q <sub>d</sub>	DRAINED TRIAXIAL	S	SENSITIVITY

## ABBREVIATIONS USED IN THIS REPORT

### SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
s	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_C$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$c_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

### GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

### STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

### FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL