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August 16, 1988

BY FAX

TO: ALL PARTIES TO THE
HALTON LANDFILL HEARING

We are forwarding herewith the Witness Statement of Brian R. Gray, M.Eng., P.Eng. Mr. Gray will be giving reply evidence for the Town of Milton.

Please note that as all parties will already have received copies of Appendices B and C, they are not included at this time. A copy of Mr. Gray's statement complete with Appendices B and C will be available at the hearing next week.

Yours very truly,

K. Clarke

K. Clarke

KC:sbr
encl.

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Toronto, Ontario M5C 1J5

Ms. Toby Vigod Barrister & Solicitor Canadian Environmental Law Association 243 Queen Street West 4th Floor Toronto, Ontario M5V 1Z4	West Burlington Citizens Group
Ms. E. Cronk Fasken & Calvin Barristers & Solicitors 30th Floor, Toronto-Dominion Bank Tower Box 30 Toronto-Dominion Centre Toronto, Ontario M5K 1C1	National Sewer Pipe Limited
Stephen R. Garrod, Esq. Barrister & Solicitor 337 Woolwich Street Guelph, Ontario N1H 3W4	Milton Area Citizens Coalition
Tom Lederer, Esq./D. Hodgson, Esq Osler, Hoskin & Harcourt Barristers & Solicitors Box 50 First Canadian Place Toronto, Ontario M5X 1B8	Regional Municipality of Halton
John Tidball, Esq. Barrister & Solicitor Legal Services Branch Ministry of the Environment 135 St. Clair Avenue West 12th Floor Toronto, Ontario M4V 1P5	Ontario Ministry of the Environment

Peto MacCallum Ltd.
CONSULTING ENGINEERS

WITNESS STATEMENT OF BRIAN R. GRAY, M.Eng., P.Eng.
(Reply Evidence)

RE: HALTON LANDFILL UNDERTAKING

Index of Tables, Figures and Appendices

165 Cartwright Avenue, Toronto, Ontario M6A 1V5
Tel: (416) 785-5110 Fax: (416) 785 5120

1. I am Vice-President, Geotechnical Engineering at Peto MacCallum Ltd., Consulting Engineers. I specialize in geotechnical and materials engineering relating to soil mechanics, foundation and earthworks construction. My curriculum vitae is attached as Appendix "A".

2. At the request of David Estrin, Barristers & Solicitors, I have reviewed evidence and reports presented by Conestoga Rovers and Associates (CRA) with respect to their position as to the need for a liner at Site F, and as to whether or not, assuming that a liner is deemed necessary, one could be constructed from on-site materials. I have also reviewed CRA's cost estimates for construction of a liner at Site F.

3. It is my professional opinion that, assuming a liner is deemed necessary at Site F, a 1-metre thick liner would be satisfactory.

4. I have reviewed a letter dated June 22, 1988 from the University of Western Ontario Geotechnical Research Centre to Geocon Inc. (Appendix "B"), reporting on laboratory testing of samples of weathered shale and Halton till taken at Site F. I have also reviewed a letter dated August 2, 1988 from Geocon Inc. to David Estrin, Barristers & Solicitors (Appendix "C"). I am satisfied

that at Site F on-site clay material is suitable for use in a liner, and on-site shale is suitable for use as intermediate and final cover.

5. With only some relatively straightforward changes to the Trow design of Site F, there would be sufficient materials available on-site to construct a 1-metre thick liner and to provide intermediate and final cover. Furthermore, the use of on-site materials as proposed would be operationally practicable.

6. Table IA shows the available site capacity and available volume of on-site materials at Site F if Trow's design is implemented.

7. Table IB shows the estimated additional volumes of material that would be generated if the Trow design base elevations were to be lowered by 1 metre. I estimate that an additional 373,000 m^3 of material would be generated, comprising approximately 50% clay (185,500 m^3) and 50% shale (187,500 m^3). The material required for infill of stream valleys would be reduced by approximately 117,000 m^3.

8. The estimates of additional volumes referred to in paragraph 7 above are derived from a review of the logs of

exploratory boreholes on Site F, as detailed in Table IV. With reference to Table IV, it is to be noted that there is substantial thickness of clay overburden below the proposed new landfill base: about 8 m at the north end of the property as represented by Borehole HC-1, and typically 4 to 8 m at the south end of the site, as represented by Boreholes HC-5, HC-6, HC-8. Elsewhere, in the central section of the site, shale outcrops occur.

9. Table IC shows the estimated total volumes of material that would be available if the base of the landfill is lowered by 1 metre.

10. Table II is a summary of the total materials required and total materials available after allowing for bulking of clay (10%) and shale (15%) if the base of the landfill is lowered by 1 metre and a 1.0 metre thick clay liner is constructed.

For Cell 1, the total volume required (clay for liner, clay and/or shale for cover) is 1,364,970 m^3. Total material available in Cell 1 is 1,612,549 m^3. Of this, about 388,619 m^3 is clay. This is more than sufficient to meet the requirement of 325,500 m^3 of clay for the Cell 1 liner. It would not be necessary to haul clay from the Cell 2 area, which could therefore be left unworked until it is actually needed for landfill at a much later date.

The total volume of material required for Cell 2 is 1,018,245 m^3 and a total of 842,520 m^3 is available. With the surplus material from Cell 1, there would be no shortage. Cell 2 would generate more than sufficient clay (618,904 m^3) to meet the requirements for liner construction (234,500 m^3) in that cell.

11. In my opinion, based on estimates I received from four earthworks contractors, CRA's estimate of \$6.25 per m^3 for the cost of using on-site clay to construct a liner is a conservative (high) estimate but it is not unreasonable. This price would include excavation, hauling, spreading and recompaction of the clay on-site. Contractors from whom estimates were received are: Dufferin Construction, Toronto; Rumble Construction, Mississauga; Costa Earth Movers Inc., Concord; and Graham Brothers, Brampton.

12. Based on estimates from the above noted earthworks contractors, I estimate the cost of using on-site shale for intermediate and final cover, including excavation, hauling, processing, spreading and recompaction, to be approximately \$8.00 per m^3. This is a conservative (high) estimate.

13. Table III summarizes the costs of the various liner-construction scenarios at Site F. The Table shows that by reducing the liner thickness from 1.2 m to 1.0 m, and by using only on-site clay, as I propose (Case #4), there would be a cost saving of $4,075,000 over CRA's proposal (Case #1). If, in addition to these modifications, the sand underdrain pad and associated monitoring/contingency pumping equipment were to be eliminated, a further $3,702,300 would be saved for a total cost savings of $7,777,300 over CRA's Case #1 scenario.

14. Figure 1 with attached Commentary illustrates how development of Site F could proceed if the base elevations are lowered by 1m and only on-site material is used for liner and cover.

15. A sand blanket under the liner is not required. It would be another level of redundancy.

16. I do not agree with Mr. Sheppard's position that the Hazen formula for determining the permeability of sand is not applicable to sand. In my opinion, the formula is primarily applicable to sand.

17. Figure 2 presents the results of a grain size analysis of a sample of "winter sand" that was obtained from Sherman

Sand & Gravel Ltd. and delivered to our laboratory. As shown on Figure 2, the sample meets the MTC gradation requirements for winter sand (Ontario Provincial Standard Specification #1004).

18. Figure 3 presents the results of a standard Proctor compaction test conducted on the same sample of winter sand. The results of a falling head permeability test on a sample prepared in our lab at 95% standard Proctor compaction density yielded a coefficient of permeability of 2×10^{-2} cm/sec. This correlates well with the estimate of the coefficient of permeability using Hazen's formula which would give about 8×10^{-1} cm/sec to 1×10^{-2} cm/sec.

19. Assuming that a sand blanket is deemed necessary at Site F, Sherman Sand & Gravel's "winter sand" would be suitable material for the purpose.

TABLE I A

AVAILABLE VOLUMES (TROW DESIGN) *

CELL No.	PARCEL No.	TOTAL ** GROSS LANDFILL CAPACITY (m^3)	TOTAL MATERIAL TO BE EXCAVATED (m^3)	ESTIMATED CLAY (m^3)	ESTIMATED SHALE (m^3)	ESTIMATED TOPSOIL (m^3)	ESTIMATED INFILL REQUIRED (m^3)
1.	1-4	4,703,740	1,232,090	306,790	920,600	4,700	173,120
2.	5-7	3,379,860	570,270	423,640	146,010	620	150,370
TOTAL		8,083,600	1,802,360	730,430	1,066,610	5,320	323,490

* Data from Ex. H42-B, Addendum to the Site F Design and Operations Report (Trow, May 1987), Table 3-r

TABLE I B

ESTIMATED ADDITIONAL VOLUMES BY LOWERING LANDFILL BASE 1 M

CELL No.	PARCEL No.	TOTAL ** GROSS LANDFILL CAPACITY (m^3)	TOTAL MATERIAL TO BE EXCAVATED (m^3)	ESTIMATED CLAY (m^3)	ESTIMATED SHALE (m^3)	ESTIMATED TOPSOIL (m^3)	ESTIMATED INFILL REQUIRED (m^3)
1.	1-4	260,500	186,100	46,500	139,600	0	-74,400
2.	5-7	229,500	186,900	139,000	47,900	0	-42,600
TOTAL		490,000	373,000	185,500	187,500	0	-117,000

TABLE I C

TOTAL ESTIMATED VOLUME FOR LANDFILL BASE LOWERED 1 M

CELL No.	PARCEL No.	TOTAL ** GROSS LANDFILL CAPACITY (m^3)	TOTAL MATERIAL TO BE EXCAVATED (m^3)	ESTIMATED CLAY (m^3)	ESTIMATED SHALE (m^3)	ESTIMATED TOPSOIL (m^3)	ESTIMATED INFILL REQUIRED (m^3)
1.	1-4	4,703,740	1,418,190	353,290	1,060,200	4,700	98,720
2.	5-7	3,379,860	757,170	562,640	193,910	620	107,770
TOTAL		8,083,600	2,175,360	915,930	1,254,110	5,320	206,490

** **Total Gross Landfill Capacity** includes total available volume for wastes and for intermediate and final cover, at 4:1 waste to cover ratio.

NOTES:
(1) All volumes are in-situ. (assume no bulking)
(2) Quantities listed assume a vertical separation between ajacent cells.
(3) Stream valleys to be infilled with clean fill.
(4) Cells 1 and 2, and Parcels 1 to 7 are as shown on Ex. H-42B, Addendum to the Site F Design and Operations Report (Trow, May 1987)

TABLE II

SUMMARY FILL REQUIREMENTS

Cell No.	Total Materials Required (m^3)	Total Materials Available (m^3)	Total Clay Required (m^3)	Total Clay Available (m^3)
1.	1,364,970	1,612,549	325,500	388,619
2.	1,018,245	842,520	234,500	618,904
TOTAL	2,383,215	2,455,069	560,000	1,007,523

NOTES:

1) **Total Materials** and **Clay** volumes required and available assumes landfill base lowered 1.0m.

2) **Total Materials Required** includes volumes for daily and final cover, clay liner, dykes and berms, and infill areas.

3) **Total Clay Required** includes volumes for 1.0m thick liner and 70,000m^3 for dykes and berms.

4) Assume bulking - clay 10%, shale 15%.

TABLE III

COST COMPARISON

Case	Liner Details	Clay Liner Cost	Clay Liner Cost Savings from CRA Design	Total Potential Cost Savings from CRA Design *
1.	CRA Estimate •$600,000m^3$ clay required (half on-site/half imported) •liner thickness 1.2m	$(300,000m^3 \times \$6.25/m^3) +$ $(300,000m^3 \times \$17.75/m^3)$ = \$7,200,000	\$0	\$3,702,300
2.	Trow Estimate •$550,000m^3$ clay required ($480,000m^3$ clay liner, $70,000m^3$ dykes/berms) •liner thickness 1.0m •use site clay entirely	$480,000m^3 \times \$8.50/m^3$ = \$4,080,000	\$3,120,000	\$6,822,300
3.	CRA Estimate Modified (a) reduce liner thickness to 1.0m •$500,000m^3$ clay required ($300,000m^3$ onsite - balance imported)	$(300,000m^3 \times \$6.25/m^3) +$ $(200,000m^3 \times \$17.75/m^3)$ = \$5,425,000	\$1,775,000	\$5,477,300
	(b) Use on-site clay entirely •$600,000m^3$ clay required •liner thickness 1.2m	$600,000m^3 \times \$6.25/m^3$ = \$3,750,000	\$3,450,000	\$7,152,300

TABLE III CONTINUED

COST COMPARISON

Case	Liner Details	Clay Liner Cost	Clay Liner Cost Savings from CRA Design	Total Potential Cost Savings from CRA Design *
4.	Peto MacCallum Estimate •Use on-site clay entirely and reduce liner to 1.0m •500,000m^3 clay required •liner thickness 1.0m	500,000m^3 x \$6.25/m^3 = \$3,125,000	\$4,075,000	\$7,777,300

* **Total Potential Cost Savings** assumes sand underdrain pad and associated monitoring/contingency pumping equipment is eliminated, for a saving \$3,702,300 (CRA's estimated cost).

This potential saving is reflected in all totals in this column.

TABLE IV

SITE F
CLAY-SHALE BOUNDARY ELEVATION
FROM LOGS OF EXPLORATORY BOREHOLES
AND WATER SUPPLY WELLS *

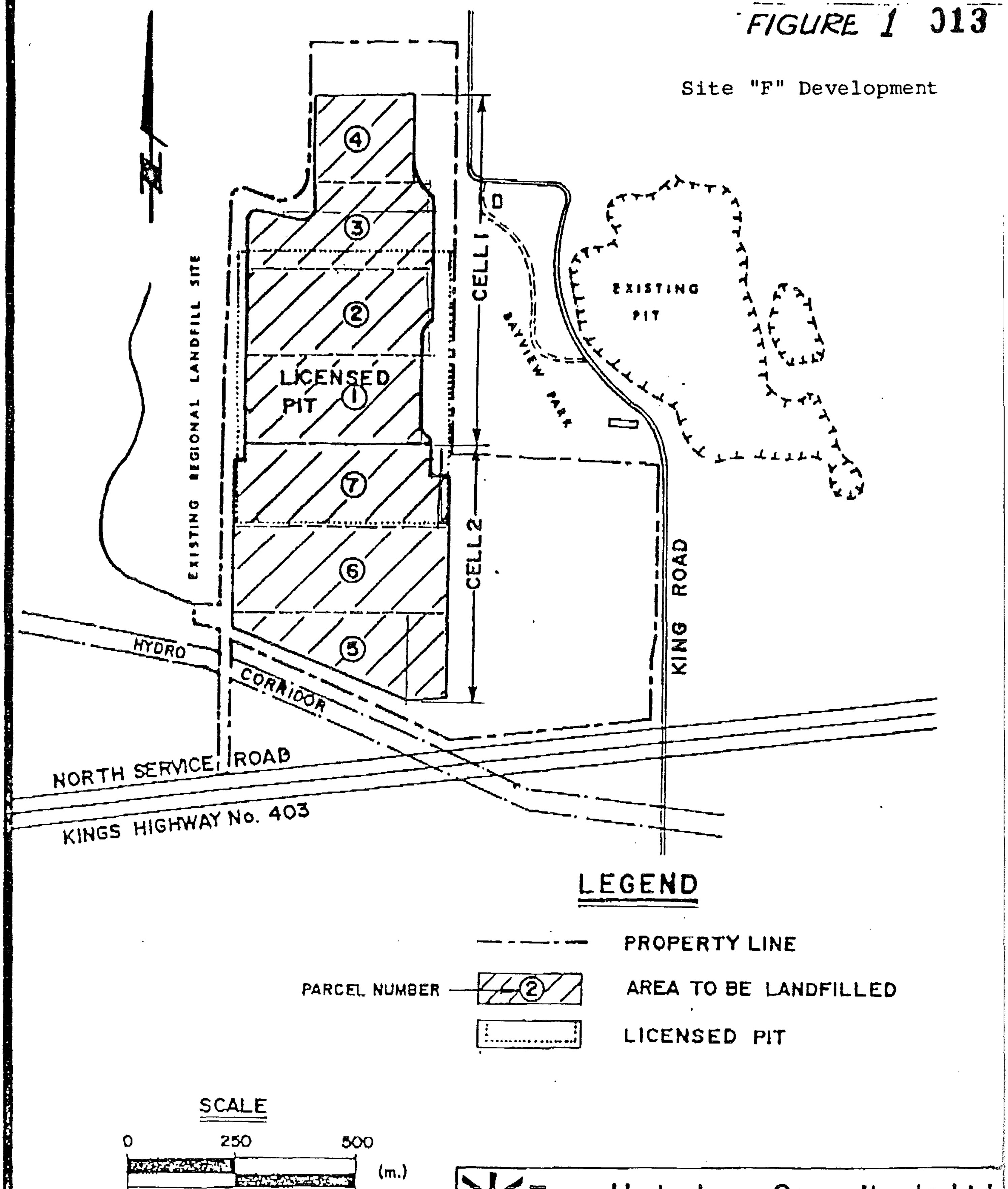
Borehole Designation	Ground Surface Elevation	Elevation Clay Shale Boundary	Proposed Base Elevation**
HC-1	187.1	167.8	176
HC-2	175.5	170.9	170
MB-4	168.0	165.0	153
HC-4	137.4	137.4	141
HC-3	140.3	140.3	139
MB-5	127.0	123.4	127
HC-5	125.9	117.8	127
HC-6	127.8	122.9	127
HC-8	118.0	112.4	119

HC - Trow Hydrology Consults Ltd.
MB - Morrison Beatty

* Logs of Exploratory Boreholes and Water Supply Wells contained in Ex. H-40A, Site F: Appendices to Hydrogeological Report (Trow, Sept., 1986)

** Proposed base elevation is 1 m lower than Trow's design base elevation

Site "F" Development



Trow Hydrology Consultants Ltd.

SITE F
OPTION No. 3

Proj. No.	T 6600-HY
Scale	AS SHOWN
Drawn by	D.K
Appr. by	J.J.C
Revised	
Date	APRIL, 1987

FIGURE 3-1

Figure 1 Commentary
"Site 'F' Development"

(a) Commence cell 1 construction by stripping topsoil and excavating shale proceeding in south to north direction (parcels 1 to 4).

(b) Haul clay fill borrow from parcels 3 and 4, spread and compact to form berms and dykes.

(c) Haul, spread and compact cut fill material (shale and/or clay) at all infill areas (parcels 1, 2, and 3).

(d) Haul clay fill borrow from parcels 3 and 4, spread and compact to form liner, initially parcels 1 and 2.

(e) Stockpile of surplus cut material only in later stage of cell 1 construction. Deficit of available materials in parcels 1 and 2 to meet requirements.

(f) Proceed with clay liner construction in parcels 3 and 4 and placement of daily and final cover as landfill development progress.

(g) Commence cell 2 construction by stripping topsoil and excavating shale proceeding in south to north direction (parcels 5 to 7).

(h) Haul clay fill borrow from parcel 5, spread and compact to form berms and dykes.

(i) Haul, spread and compact cut fill material (shale and/or clay) at all infill areas (parcels 5, 6, and 7).

(j) Haul, spread and compact clay fill borrow in parcels 5 and 6 to form liner.

(k) Stockpile of surplus cut material only in later stage of cell 2 construction.

(l) Proceed with clay liner construction in parcel 7 and placement of daily and final cover as landfill development progress.

PARTICLE SIZE DISTRIBUTION CHART

OUR PROJECT NO. 87 F 374

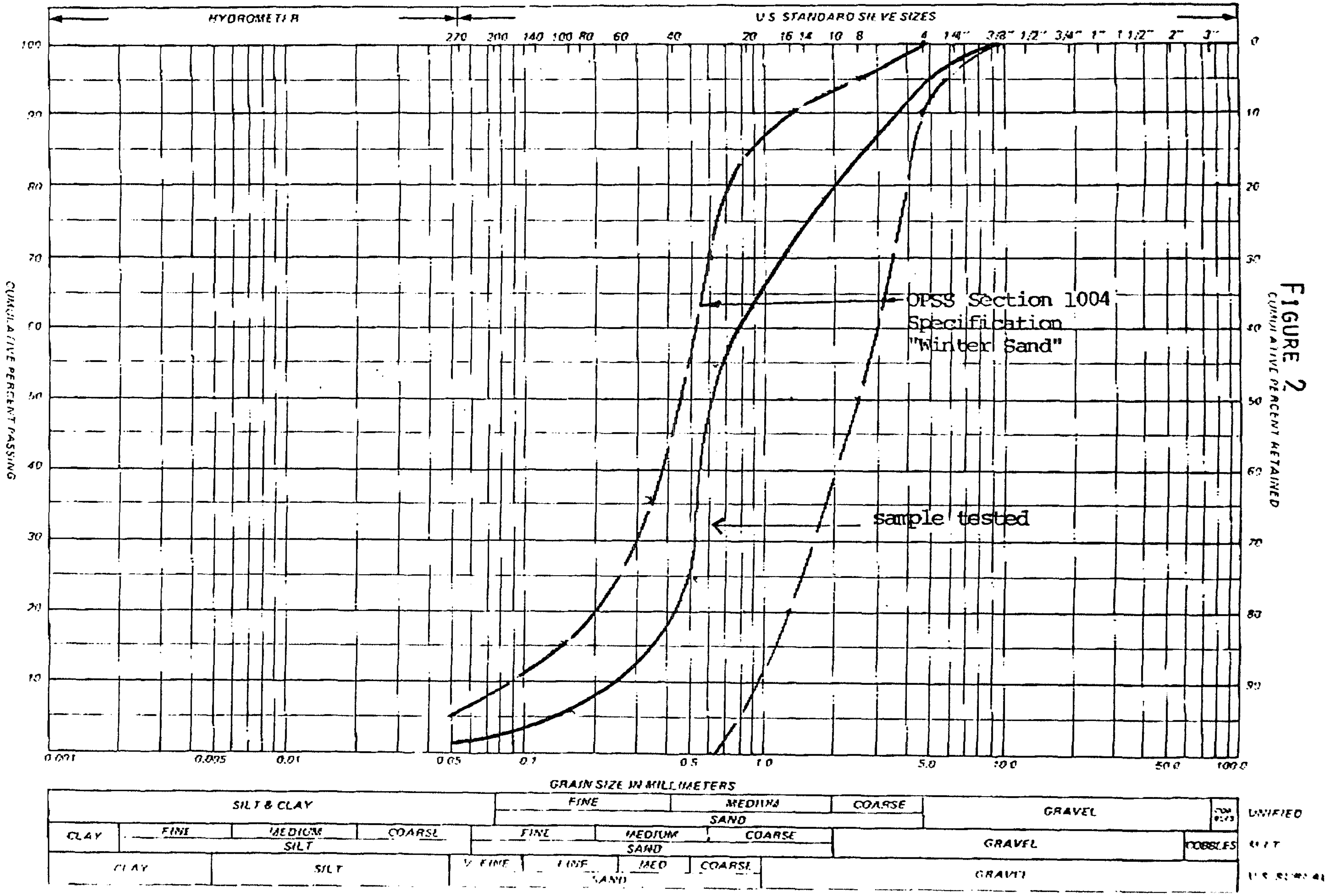


FIGURE 2

REMARKS Sample L 702 - SHERMAN SAND & GRAVEL

WINTER SAND

MOISTURE DENSITY RELATIONSHIP TEST REPORT

CLIENT TOWN OF MILTON

PROJECT SITE 'F' BURLINGTON

OUR PROJECT NO. 88 F 374

REPORT NO.

ENCLOSURE

FIGURE 3

SAMPLE TYPE WINTER SAND

SAMPLED FROM –

SAMPLE NO. L 702

DATE SAMPLED Aug 4/88

SAMPLED BY PB OF

DATE RECEIVED Aug 3/88

MOISTURE CONTENT AS RECEIVED 4.0%

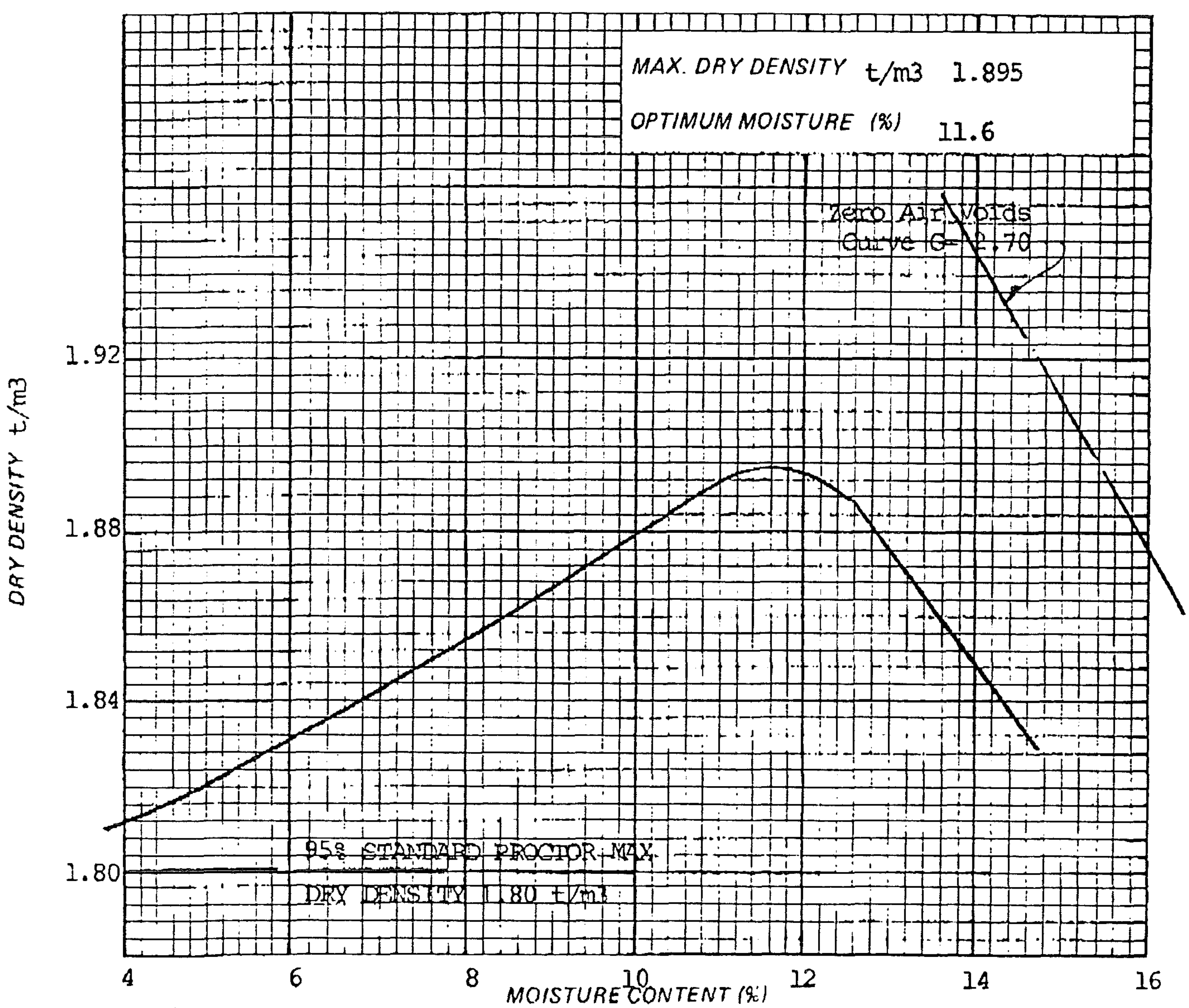
REMARKS

STANDARD PROCTOR – ASTM D698-70

METHOD – A ☐ B ☐ C ☒ D ☐

MODIFIED PROCTOR – ASTM D1557-70

METHOD – A ☐ B ☐ C ☐ D ☐



PML 122

APPENDIX "A"

BRIAN R. GRAY, P.Eng.
B.A.Sc., M.Eng.

VICE PRESIDENT, GEOTECHNICAL ENGINEERING

BACKGROUND

1968	B.A. Sc. Civil Engineering University of Toronto
1968	Soils Laboratory Engineer Ontario Hydro
1971	M.Eng. Geotechnical Engineering University of Toronto
1970-75	Project Engineer/Assistant Branch Manager-Windsor/Senior Geotechnical Engineer, Golder Associates, Toronto
1975 to Present	Regional Geotechnical Engineer/Managing Director, Geotechnical Engineer/Vice President, Geotechnical Engineering, Peto MacCallum Ltd., Toronto

EXPERIENCE

Mr. Gray has specialized in geotechnical and materials engineering relating to soil mechanics, foundation and earthwork construction. He has executed numerous assignments involving landslide and slope stability studies; subgrade and pavement evaluations and design; Benkelman beam studies; and soil stabilization programs.

Mr. Gray is Vice President, Geotechnical Engineering. He is responsible for the overall direction and supervision of the company's geotechnical engineering activities, including professional and technical staff, administration, business development and client liaison. The following is a resume of his career.

In the summer of 1968, Mr. Gray was employed by Ontario Hydro as a Soils Laboratory Engineer. He carried out routine soil classification; performed laboratory tests; and prepared foundation reports for several transmission towers, as well as generating, transformer, and switching stations, including Mississagi TS and Well GS. He prepared an instrumentation report for the research program on the uplift capacity of augered caissons at the Nanticoke Generating Station site, Lake Erie.

Mr. Gray joined Golder Associates in 1970 as a Project Engineer. He was involved with several mining projects, including:

- Fraser River dyke study
- Tailings Dam, Elliot Lake, Ontario
- Copper/lead/zinc mine, Ignace, Ontario
- Coal mine, Elk River, British Columbia.

He was also engaged as Resident Geotechnical Engineer for foundation and construction inspection at the Mattabi Mine site.

BRIAN R. GRAY, P.Eng.
B.A.Sc., M.Eng.

VICE PRESIDENT, GEOTECHNICAL ENGINEERING

EXPERIENCE (Continued)

From 1972 to 1974, Mr. Gray served as Project Engineer and Assistant Branch Manager of the Windsor office of Golder Associates. He was responsible for site investigations and the preparation of geotechnical reports for commercial, industrial, residential, and highrise building projects. He also devised shore protection measures and undertook geotechnical studies for the following projects:

- Sewage Works, Windsor
- Pumping Stations, Collector Sewers, and Outfall Sewers in Lake St. Clair
- Two Mile Long, 60 inch diameter trunk sanitary sewer requiring soft ground tunnelling with compressed air.

As Senior Geotechnical Engineer for Golder Associates from 1974 to 1975, Mr. Gray supervised and prepared geotechnical reports for a variety of major projects, such as:

- 1,200 m bulk materials handling wharf at Stelco, Nanticoke, Ontario
- Thirty bridge sites for a 102 km all-weather highway in the Sultanate of Oman and Emirate of Abu Dhabi (U.A.E.)
- Evaluation of local rock for rip rap sources in the Sultanate of Oman
- 550 kV transmission line from Nanticoke Generating Station to proposed Stelco Steel Mill on Lake Erie
- Conceptual layout and design of Tailings Dam Retention Scheme for a northern Ontario mining company

In 1975, Mr. Gray joined Peto MacCallum Ltd. as Regional Geotechnical Engineer. He was responsible for all geotechnical engineering operations and business development throughout southwestern Ontario for the Hamilton and Kitchener branch offices.

His areas of responsibility expanded to include Toronto and eastern Ontario when he was made Manager, Geotechnical Engineering in 1978. During this period Mr. Gray directed the successful completion of many major assignments, including:

- Study of earth dyke improvements extending 17 miles, Holland Marsh, Bradford, Ontario
- Lloyd D. Jackson Square, Phase II, Hamilton
- Slope stability investigations Weir Crescent, Oshawa and Hyland Creek, Scarborough
- Plant Additions for DeHavilland Aircraft, Downsview

Mr. Gray was appointed a Managing Director of Peto MacCallum Ltd. in 1979 and Vice President, Geotechnical Engineering in 1986. He has provided the overall direction and supervision of the geotechnical engineering aspects for the following representative assignments:

BRIAN R. GRAY, P.Eng.
B.A.Sc., M.Eng.

VICE PRESIDENT, GEOTECHNICAL ENGINEERING

EXPERIENCE (Continued)

Airports

- New Terminal 3 Development, Lester B. Pearson International Airport, Toronto
- B720 Hangar St. Hubert Airport, Quebec
- Pavement Evaluation Toronto Buttonville Airport, Markham, Ontario
- New 767 Flight Simulator DeHavilland Aircraft, Downsview
- New Municipal Airports/Upgrades Townships of Stanhope, Manitouwadge, and Marathon, Ontario

Automotive

- Numerous General Motors of Canada Ltd. Plant additions, Oshawa
- New GM-Suzuki Plant, Ingersoll
- New Hyundai Plant, Markham
- Ford Motor Company of Canada Ltd. Plant Expansions, Oakville and St. Thomas
- New F&P Mfg. Inc. Plant, Tottenham

Commercial

Additions to Shopping Malls:
- Georgian Mall, Barrie
- Place Vertu, Montreal
- Quinte Mall, Belleville
- Penn Centre, St. Catharines
- Yorkdale, Toronto

Government

- North York Civic Centre and Library
- Mississauga Civic Centre
- Town of Markham Civic Centre
- Town of Halton Hills Municipal Office

Highrises

- Renaissance Place, King's Landing and Harbour Terrace, Toronto
- Somerset Place, Eagle Ridge
- Granite Gates, Mississauga
- Concorde Place, 5000 Yonge St., Toronto

Industrial

- Terrain evaluation for a 117 km natural gas pipeline route, Niagara Loop (Milton to Niagara Falls)
- A $440M Ammonia II Plant for the C-I-L Inc. Cryogenic Plant, Courtright

Industrial/Residential Subdivisions

- Elgin West Community, Town of Richmond Hill
- Olde English Lane, Credit Pointe Village, Creditview Heights, Erin Mills Neighborhood, Mississauga
- Meadowvale Business Park
- Tudor Valley Business Park, Vaughan
- Glen Abbey, Oakville

Institutional

- New Credit Valley Hospital and Parking Garage, Mississauga
- New St. Joseph's Hospital, Guelph
- New YMCA Building, Mississauga

BRIAN R. GRAY, P.Eng.
B.A.Sc., M.Eng.

VICE PRESIDENT, GEOTECHNICAL ENGINEERING

EXPERIENCE (Continued)

Landfill Projects

- Keele Valley, Maple
- City of Niagara
- Britannia Road landfill, Mississauga
- Harold and Grace Baker Centre, Northwestern Hospital
- North York Hydro Office, Toryork Drive, North York

Municipal

- York-Durham Sewer, Oak Ridges Section, involving 3,500 m of 1.7 m diameter sewer pipe in tunnel construction as deep as 30 m below grade
- Trunk sewer involving 32 m vertical and 3 m diameter shaft with extensive in-situ instrumentation to monitor rock stress for tunnel under Sixteen Mile Creek, Oakville, Ontario

Sewer Tunnels
- Molson Park Drive, Barrie
- Scarlett Road, Toronto

Slope Stability Studies

- Denison Avenue (Humber River), Weston
- Mavis Road (Wolfedale Creek), Mississauga
- Armstrong Avenue, Irwin and Dawson Crescents (Credit River and Silver Creek)
- Town of Halton Hills
- Alder Road (Massey Creek) Borough of East York

Transportation

- Burlington Street Reconstruction, elevated expressway extending one mile through the industrial centre of Hamilton
- Park Road Grade Separation, Oshawa

Waterfront Development

- City of Orillia
- Toronto Island
- Hamilton Harbour
- Kenora

AFFILIATIONS

- Association of Professional Engineers of Ontario, designated Consulting Engineer
- Canadian Geotechnical Society