# Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

October 30, 1987

Canadian Tire Corporation Ltd. P.O. Box 770, Station K Toronto, Ontario M4P 2V8 COPY

ATTENTION: Mr. John Scharrer

Architectural Project Co-ordinator/Site Planner

Dear John:

RE: Soil Analysis

Thank you very much for utilizing our services for the proposed expansion of your store in Brandon, Manitoba.

As discussed, an additional investigation for verifying the foundation type and the underlying soil conditions of the existing Brandon store is considered essential, in finalizing the selection of <u>foundation alternative</u> and <u>subgrade preparation</u> requirements for the proposed store expansion. Hopefully, we can have a positive response from you shortly, so that this extra fieldwork may be undertaken without facing potential frozen soil problems and snow removal requirements. The scope of this additional investigation will include 2 testholes drilled inside the store and 2 testpits dug outside and adjacent to the store at locations of the two proposed additions. To verify the possible existence of a thickened slab, the testholes will be advanced near the perimeter walls with a 2" diameter hand auger after the existing slab is cored through with a core barrel. Hydrocarbon testing of gasoline and visual checking for oil will be undertaken in the testholes, to determine if contaminated soils similar to those encountered in our earlier investigation, exist beneath the store. The testpits are put down mainly to determine the base elevation of the existing slab, type of surrounding materials, thickness and condition of the existing perimeter insulation (if any). The testholes will be backfilled with good quality grout while the testpits filled with the native excavated materials. We are prepared to undertake this additional work complete with a report for a firm price of \$1500.00, provided authorization to proceed is given in early November, 1987.



We would like to take this opportunity to express our interest in providing a proposal on the soil analysis for a proposed Canadian Tire Store in St. Vital, Winnipeq. We understand that several sites are being considered. In this regard, we would like to advise you that the writer is familiar with the soil conditions in the St. Vital area as he was directly involved in many major projects in the said area including the existing St. Vital Shopping Centre and the Meadowood Shopping Mall to the south. We are pleased to assist and provide you with any pertinent soils information on a regional basis, if desired.

Enclosed herewith is a copy of our company profile outlining our engineering expertise and typical projects recently completed.

You will note that our firm can undertake soil analysis and other geotechnical work in both Manitoba and Ontario. We have been involved in projects in northwestern Ontario, with our territory extending to Thunder Bay, Ontario. The writer has been a professional engineer registered with the Association of Professional Engineers of Ontario since January, 1976.

If you have any requirements or need assistance in the area of our expertise, we would appreciate the opportunity to be of service.

Yours truly,

Zon

GEOKWAN ENGINEERING LTD.

per

Walter Kwan, M. Eng., P. Eng.

President

WK:dh

Enclosure



ASSOCIATED LTD. ENGINEERING AND RESOURCE CONSULTANTS

REPORT NO. 229-02-01

PAGE 1 OF 1

# SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.

110 - 1294 Border Street

Winnipeg, Manitoba

R3H OM7

Attn: Mr. Walter Kwan, M. Eng., P. Eng.

Geokwan Project No. 221

METHODOLOGY: Soil Box Method

One trial per sample, as per your instructions.

## RESULTS:

Sample No.	Test Hole	Depth	Results (ohms/cu.cm.)
1	2	B-4 '	3 540
2	2	B-8'	1 046
3	2	B-10'	770
4	2	B-15'	491

### NOTES:

For measurement, the soil samples were pressed by hand into the soil box to a density judged to be approximately the same as the clumps of soil in the original samples.

TECHNICIAN: Wark Wonners

ai4/mdw



# Geokwan Engineering Ltd

REPORT TO

CANADIAN TIRE CORPORATION LTD.

GEOTECHNICAL INVESTIGATION

ADDITION TO CANADIAN TIRE STORE

BRANDON, MANITOBA

### Distribution:

6 copies - Canadian Tire Corporation Ltd.

1 copy - Geokwan Engineering Ltd.

October 16, 1987



221



October 16, 1987

Canadian Tire Corporation Ltd. 2180 Yonge Street P.O. Box 770, Station K Toronto, Ontario M4P 2VS

ATTENTION: Mr. John Scharrer

Architectural Project Co-ordinator/Site Planner

Dear Sir:

RE: Addition to Canadian Tire Store 18th Street, Brandon, Manitoba Our Project No. 221

This report summarizes the results of our geotechnical investigation conducted at the site of the proposed addition to the Canadian Tire Store (#286 Brandon) on 18th Street in the City of Brandon, Manitoba. The terms of reference for this work can be found in our proposal dated September 29, 1987 and Canadian Tire Corporation Ltd. Purchase Order No. BF14-161367.

# PROJECT DESCRIPTION

The present plans call for the construction of a new warehouse and a new service centre located immediately to the north and east of the existing store, respectively. The proposed structures are single storey, basementless with slabs on grade. New paved parking areas will be provided.

# FIELDWORK AND LABORATORY TESTING

On October 2, 1987, a total of 6 testholes were put down at the site using a 5" continuous truck-mounted flight auger. The testhole locations are shown on the site plan, Plate 1 appended.

The subsoils encountered in each testhole were visually logged and classified to its full depth, with special emphasis placed on the possible presence of gasoline and oil. Soil samples were recovered off the auger cuttings regularly and returned to our Winnipeg laboratory for further testing. Any ground water seepage in the testholes was noted.

Canadian Tire Store Addition Brandon, Manitoba Recommended Gradation Limits of Granular Fills For Slab-On Grade and Payement

	<u> </u>	assing
Sieve_Size	<u>Class_A_Base</u>	Class_C_Base
3"	-	100
1 "	100	=
3/4"	, 80 - 100	-
#4	40 - 70	40 - 80
#10	25 - 50	-
#40	15 - 30	-
#200	5 - 15	5 - 20

# NOTES

- 1) All fills should be free of organics, frozen soils, shale and consist of durable rock particles.
- 2) For the Class A base, at least 35% of the material retained on the No. 4 sieve should include <u>crushed</u> particles.

# SOIL AND GROUND WATER CONDITIONS

A detailed description of the soil and ground water conditions, together with the results of field and laboratory testing can be found on the testhole logs, Plate 2 to 7, inclusive.

Generally, the subsoil stratigraphy consisted of either a pavement section (i.e. 3" of asphaltic concrete over granular fill TH 2 & 4 only) or a granular fill of 3 to 5 ft. thick underlain by a stiff to very stiff black clay overlying a clayey sand and gravel deposit which extended to depths of 8 to 10 ft. from grade.

Below the clayey sand and gravel was a layer of stiff till-like clay 2 to 3 ft. thick followed by a glacial till deposit extending to the depths explored.

It should be noted that in all testholes, <u>petroleum like odour</u> was noted in the surficial black clay and the underlying clayey sand and gravel layer at depths of approximately between 3 to 9 ft. from grade. The strongest petroleum like odour was detected in the clayey sand and gravel layer which was located immediately below the surficial black clay. Gastec readings in this sand and gravel indicated gasoline concentrations in the range of 4000 to 4500 ppm. In addition, diesel-fuel-like stains were noted frequently in the surficial black clay and the underlying sand and gravel, at depths of approximately 3 to 9 ft. from grade.

The contaminated sand and gravel was moist to wet, indicating the possible presence of a perched water table and/or gasoline.

Wet sand layers of about 2" thick were noted occasionally in the underlying stiff brown clay and glacial clay till. In general, the glacial till was stiff and became very stiff with depth. It was initially brown in colour and became dark grey near the 16 foot depth from grade. The glacial till was clayey, with some sand, gravel, cobble and boulder. The boulder content and frequency appeared to increase with depth.

On completion of the test drilling, no free water was noted in the testholes. However, all testholes were backfilled immediately after drilling. If these testholes were left open for a longer period of time, perched water tables may exist in the surficial sand and gravel layer and the permeable zones of the

To determine the concentrations of gasoline, the Gastec Analyzer System fitted with a gasoline detection tube was utilized at TH 1 and 2. Prior to undertaking the in-situ gasoline testing, the testholes were capped at the ground surface for 2 hours. A gasoline detection tube connected to a suction tubing and a hand pump was then lowered into the testhole at a predetermined depth. Sampling of the gasoline vapour was obtained by applying an air suction towards the gasoline tube through the hand pump. A colour change from brown to green of the detection tube would indicate the presence of gasoline and the gasoline concentration could be directly determined from the said tube. Details of the measured gasoline concentrations are as follows:

Testhole	Tested Depth <u>From Grade (ft)</u>	Measured Gasoline <u>Concentrations (ppm)</u>
TH 1	3	150
	6 9	4000 zero
TH 2	3	200
	6	4500
	9	4250

To evaluate the stiffness and approximate bearing capacities of the overburden dynamic cone penetration tests were performed at TH 1 & 2. The test consisted of driving a 2" diameter steel cone with a 140 lb hammer falling freely 30 inches and measuring the number of blows per foot of cone penetration.

Layout and levels were determined by our survey crew. The ground surface elevations of the testholes were determined in relation to a temporary benchmark shown on the site plan, Plate 1.

In our laboratory, all soil samples were reclassified and tested for soil water contents. The undrained shear strengths of the cohesive samples were evaluated with a steel pocket penetrometer.

To assess the <u>corrosion</u> potential to buried steel or the like, typical soil samples recovered from TH 2 within the upper 15 ft. of the soil profile were sent to Norenco Associated Ltd. for <u>soil</u> <u>resistivity tests</u> using the soil box method. The pertinent results are shown on Plate 8.

brown clay and the underlying glacial till. Such water tables and the associated seepage volumes would likely fluctuate on a seasonal basis.

# CONCLUSIONS AND RECOMMENDATIONS

# Site Suitability

The results of our investigation have shown that there may be a post construction odour and fire hazard problems at this site due to the strong petroleum-like-odour and fairly high gasoline concentrations identified in our testholes, in the surficial black clay and the underlying sand & gravel which are located approximately between the depths of 3 and 9 ft. from the existing grade. If these potential odour and fire hazard problems are deemed tolerable to the owner, the following foundation recommendations may be considered.

# Foundation Considerations

Foundation alternatives which we have considered, include footings, a stiffened slab foundation, cast-in-place concrete caissons and driven prestressed precast concrete piles.

Judging the soil conditions encountered in our testholes, footings and cast-in-place concrete caissons are <u>not</u> considered geotechnically viable. The variability in density and composition of the surficial soils will likely lead to considerable footing settlements. The presence of gasoline and water seepage in the upper sand and gravel and permeable zones of the glacial till will make the caisson construction quite costly and difficult.

In our opinion, either a stiffened slab on engineered fill or driven prestressed precast concrete piles may be utilized for supporting the proposed store addition. Among the two, driven prestressed precast concrete piles are considered as the <u>preferred</u> foundation alternative.

It is our understanding that the existing Canadian Tire Store may have been supported on a stiffened slab foundation which is underlain by 3 ft. of well compacted granular fill and that petroleum-like-odour was encountered during the previous soils

investigation for the existing store. However, it is not confirmed as to the type of foundation which was actually used for supporting the existing store and whether the contaminated soils had been removed during the store construction. absence of this information, we are not in a position to properly evaluate the construction viability of a stiffened slab foundation at this site. On the basis of our on-site discussion with the store manager and our site observations, the existing store appears to perform satisfactorily. Therefore, significant foundation economies for the proposed addition may result, if it can be proved that the existing store is supported on a stiffened slab and that the hydrocarbon contaminated soils under the existing store had not been removed. In this regard, <u>an</u> additional soils investigation with testholes being drilled inside and immediately adjacent to the store will have to be carried out. Details of this can be provided if desired.

## Driven Piles

Driven prestressed precast concrete piles are considered as the preferred foundation type for supporting the proposed addition. These piles, when driven to practical refusal in the underlying very stiff dark grey clay till using a hammer capable of delivering at least 30,000 ft-lbs per blow, may be assigned the following allowable loads:

<u> File Size</u>	<u> Allowable_File_Loads</u>
12" Hex	50 tons
14" Hex	70 tons
16" Hex	90 tons

Pile spacings should not be less than 3 pile diameters centre to centre. Piles at groups should be monitored for heaving during the driving of adjacent units and redriving done, where pile heaving is found considerable.

One major draw back of the driven pile is that the pile driving will induce subsoil displacements and vibrations. Where piles are driven adjacent to the existing store, some structural damage

may result if precautions and proper driving procedures and sequence are not followed. To minimize this potential damage, the following should be considered:

- Where Piles are driven within 30 ft. of the existing store, reduced driving energy during initial driving and preboring to a minimum depth of 15 ft. from grade should be undertaken. Preboring should be conducted in such a manner that undermining of the existing store slab and foundations would not occur. In this regard, a temporary steel casing should be utilized where soil sloughing occurs within the proposed prebored depth. The annular space between the casing and the pile should be filled with properly tamped sand prior to casing removal.
- Settlement observation points should be established along the most northerly and easterly perimeter walls, <u>before and during pile driving</u>, to ensure that the pile induced vibrations and subsoil displacements have not adversely affected the existing store.

Even with the foregoing precautions, the potential for development of minor cosmetic cracks in the walls or slabs of the adjacent store may remain. The possible risk associated with the driven piles should be appreciated by the owner. For this reason, the viability of using a stiffened slab over engineered fill for the building addition should be assessed with an additional soils investigation, as recommended earlier.

It has been our experience that driven precast concrete piles will refuse at varying levels in the very stiff to hard clay till. The pile length selection would be best left for the piling contractors who are experienced in driven piles in the Brandon area. Our previous piling projects in Brandon would suggest that the required pile lengths were usually in the 20 to 40 foot range.

To ensure a satisfactory pile installation, <u>full time driven pile</u> <u>inspection</u> by qualified geotechnical personnel is strongly recommended.

### Floor Support

Floor slabs on grade are permissible at this location, provided that subgrade preparation for floor construction is undertaken as follows:

- Remove and waste existing asphaltic concrete, organic, disturbed and softened soils.
- Excavate the existing granular fill with weeds/organics removed, to a minimum depth of 2' from existing grade. Store this fill at a suitable location for subsequent backfilling of the excavation.
- At the 2 foot excavation level, compact the exposed granular fill to 100% Standard Proctor density (ASTM D698).
- Remove soft spots, as directed by a qualified geotechnical engineer at the 2 foot excavation level and replace with on site granular fill compacted to at least 95% Standard Proctor density.
- After the subgrade is compacted and approved by a qualified geotechnical engineer, backfill the slab excavation with the granular fill previously excavated, which should be compacted in maximum 6" lifts, with a heavy vibratory roller and in a surface wet condition, to 100% Standard Proctor density. Immediately underneath the slab, a 6" thick layer of compacted, well-graded Class A base (3/4" crushed gravel) should be placed, the gradation limits of which are shown on Plate 9.

It should be noted that removal and the potential requirements for cleaning up of the underlying contaminated soils under the new slabs of the addition should be investigated by Canadian Tire Corporation Ltd. There are existing methods for extracting gasoline vapor or liquid from the contaminated subsoils. However, these "clean up" aspects are beyond the scope of this report.

# Unheated Structures

Where driven piles are used for supporting lightly loaded unheated structures such as elevated propane tanks, adequate provisions for preventing <u>frost jacking</u> of piles should be considered. As a general rule, a driven pile should have a minimum embedment depth of 27 ft. If this cannot be accomplished due to high pile refusal, the piles should be insulated with high quality rigid insulation panels which should extend at least 8' from the piles in all directions. The required thickness of the rigid insulation panel will depend on the actual pile embedment depth. It is expected that the panel thickness required may range from 2 to 4". The insulation panels should be protected

onto the contaminated sand and gravel and may encounter water seepage. Some dewatering requirements should therefore be expected. Precautions should be taken to properly remove and dispose of the gasoline, if encountered. Open flame such as welding in the tank excavations should be prohibited, unless adequate safety measures are undertaken to avoid potential fire hazard and explosion associated with the gasoline. Similar precautions should be observed for the excavation and installation of underground utilities.

The underground tanks should be supported on a concrete pad bearing on the native undisturbed stiff clay till. The safety of empty tanks against <u>buoyancy</u> should be checked, with the ground water table assumed at the ground surface. The tanks should be back-filled with free draining pit run sand and fine gravel which should be compacted in uniform 6" lifts to 95% Standard Proctor density.

For the underground pipes (i.e. water, sewer, plumbing lines etc.), they should be made leak proof and resistant against gasoline vapour and other hydrocarbon, if the said gasoline and hydrocarbon are not removed from the subsoils identified in our testholes. Leakage of gasoline or hydrocarbon to sewer and water lines may create an environmental hazard.

It is likely that excavation for the underground utilities may carry to the contaminated sand and gravel. In this case, the removal of the gasoline and contaminated soils under and above these pipes should be considered. Replacement fill may include well graded pit run sand and gravel compacted to at least 95% Standard Proctor density.

# Additional Considerations

All concrete in contact with the native subsoils should be manufactured with sulphate resistant cement and should be of high quality. Concrete subject to periodic freezing and thawing effects such as exterior sidewalk, curb and concrete slab should be air entrained in accordance with Table 8 of CSA Standard CAN3-A23.1-M77.

For design considerations, the maximum frost penetration depth may be taken as 5 and 9 ft. for heated and unheated structures, respectively.

with at least 1' and 2' of earth cover for landscaped and traffic areas, respectively. Further details can be provided during construction, if needed.

# Payement Design

Suitable pavement sections at this location may consist of the following:

rollowing:	Heavy Duty <u>Truck Route</u>	Light Duty <u>Car Parking</u>
Asphaltic Concrete	3"	2"
Class A Base (3/4" crushed gravel)	6"	3"
Security and Control of Securi	•	
Class C Base (3" down pit run gravel)	9"	6"

It should be noted that the <u>existing granular fill may be used as Class C base</u>, provided that the organic and softened portion of the fill is wasted. The Class A base should be in conformity with the gradation limits shown on Plate 9.

Pavements should be constructed on a <u>prepared</u> subgrade, which should be prepared in a manner recommended previously for the slab-on-grade. In this regard, the existing granular fill in the pavement area should be scarified, reworked and recompacted to a minimum depth of <u>2'</u> from the existing grade, prior to actual pavement construction.

Percent compaction for the existing granular fill, class C and A base materials should be 100% Standard Proctor density.

## Underground Tanks and Utilities

Results of the soil resistivity tests show that the subsoils are highly corrosive to steel (especially test results for samples at 8', 10' & 15' - Plate 8). Therefore, corrosion protection for buried steel tanks or the like will be required.

Underground storage tanks are usually founded at depths of 12 to 14 feet from grade. The tank excavations will likely encroach

...

Retaining structures should be designed against unit lateral earth stresses as follows;

P = k (q + wh) psf

p = unit lateral earth pressure at any depth of wall, h (psf)

k = estimated earth pressure coefficient

= 0.35 for yielding walls

= 0.5 for rigid walls

q = any surcharge adjacent to the wall (psf)

w = average soil unit weight

= 130 pcf

The above expression assumes that filter protected perforated drains will be installed at the base of the wall, so that there will be no build up of hydrostatic pressures behind the said wall.

For winter construction requirements, all newly poured foundations and bearing soils in all loaded areas should be adequately protected against frost action. Concrete should not be poured on frozen ground nor should frost be allowed to penetrate the foundations after construction.

Final site grading should ensure that all surface runoff is adequately drained away from the addition using gradients of 1 and 2% for paved and landscaped areas, respectively.

To ensure that the slabs on grade and pavements are constructed in the manner recommended, subgrade inspection and compaction testing of the granular fills (Class A & C base) should be undertaken by qualified geotechnical personnel during construction.

We trust that the foregoing is sufficient as per our terms of reference for the work. If you, however, have any further questions, please advise.

Yours truly,

GEOKWAN ENGINEERING LTD.

per:

Walter Kwan, M. Eng., P. Eng. Chief Engineer

WK:dh

Enclosure





REPORT NO. 229-02-01

PAGE 1 OF 1

# SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.

110 - 1294 Border Street

Winnipeg, Manitoba

R3H OM7

Attn: Mr. Walter Kwan, M. Eng., P. Eng.

Geokwan Project No. 221

METHODOLOGY: Soil Box Method

One trial per sample, as per your instructions.

# RESULTS:

Sample No.	Test Hole	Depth	Results (ohms/cu.cm.)
1	2	B-4 *	3 540
2	2	B-8'	1 046
3	2	B-10'	770
4	2	B-15'	491

# NOTES:

For measurement, the soil samples were pressed by hand into the soil box to a density judged to be approximately the same as the clumps of soil in the original samples.

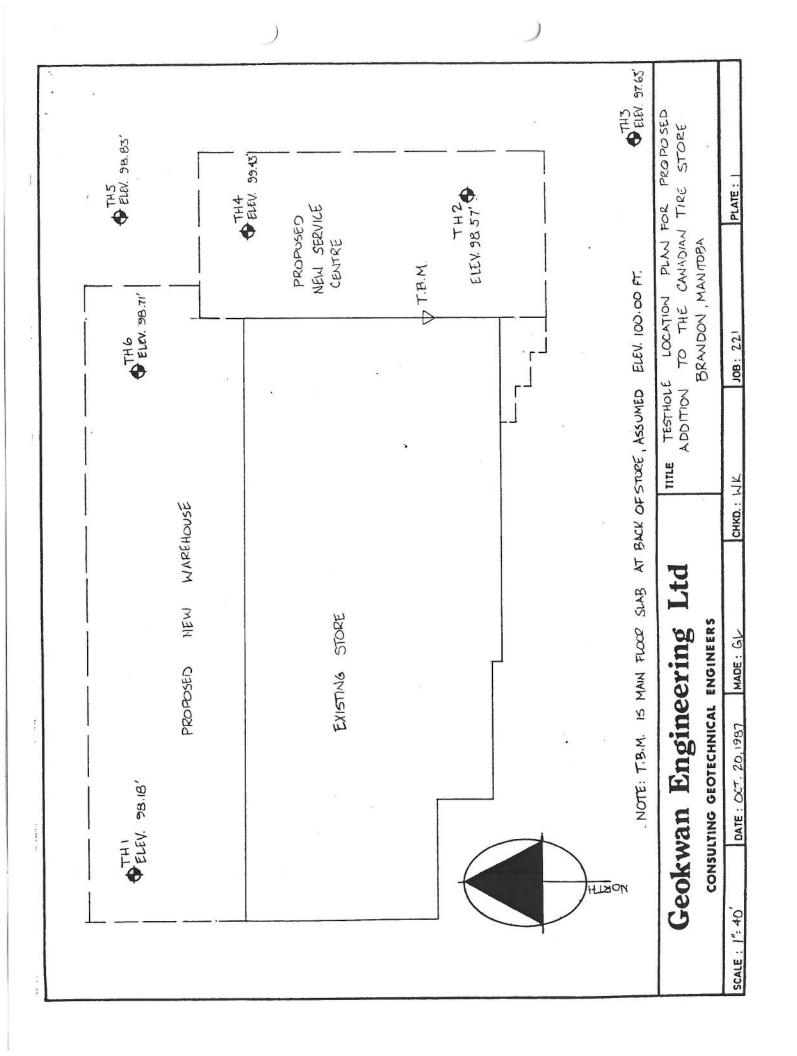
TECHNICIAN:

Wark Warner

ai4/mdw

-- ----

PLATE 8 PROJECT 221



# Geokwan Engineering Ltd CONSULTING GEOTECHNICAL ENGINEERS TESTHOLE LOG PROJECT PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

		7.50			BRAND	ON, M	IANTIOBA	A	
GGED / DWN : GL	CHKD.: WK		DATE OF INV. : Oc	t 2/87	JOB: 22	21		TH 1	
10 20 30 40 50	60 (ft.)		· soll	DESCRIPTION		SOIL	SAMPLE	DRILL TYP	02300
		1 .	DATUM			J	$\neg T$	5" Ø A	
	,, E	SOIL	CATOL!			COND	TYPE	OTHER TE	STS
WATER CONTENT	% 5	20.00	SURFACE ELEVATION	ON 98.18 ft.		ö	F	PP* (t	sf)
	0	1	FILL - sand &	gravel					
		IX	- loose, brow						
7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		$V\setminus$	- weed covere	d				C- 150	
	$\Pi\Pi$		CLAY - stiff, b	lack, trace	rootlets			G= 150	ppn
1411111	<del></del>		sandy, silty	, diesel fue	l-like/s	tain		2.40	
<del>1111111</del>	5.0	34	SAND & GRAVEL	- fine moi	st				
<del>  193                                      </del>	1111		- clayey	Tine, noi	.50			-0.63 $G = 4000$	) nn
	++++		- some "diesel	-like" fuel	stains			G- 4000	PP
<del>                                      </del>	++++	7							
<del>                                      </del>	++++	1/	CLAY - stiff,	orown, silt	у			1	38
<del>                                      </del>	10.0	1	- 2" sand lay	er & seepage	at 9'6'		1	1.68	
1	+++-	111	CLAY TILL						
	444		- very stiff						
		M	- silty, some	Tine gravel					
	15.0	HIL	- dark grey at					1.38	
IMILA	1 1 15.0	MI	- trace cobble						
		11	1	_ ~ Doditel					
		TH	1				1		
TITITI		nle	Į				·	1 05	
<del>                                      </del>	20.0	A.		93				-1.25	
<del>                                     </del>	++++	11/2	1						
<del>                                      </del>	+++	1							
<del>                                      </del>	+++								
<del>                                      </del>	++++	Hi	l					1	
<del>19-1-1-1-1-1</del>	25.0	تإرا ا	1					-2.42	
╅╫╅╂┾┼╂╃╀	+++-	MI	ł						
<del>                                     </del>	+++	111	1						
╅╅╂╂┼┼┼	+++-	111	l						
+ + + + + + + + + + + + + + + + + + +	++++	1							
$+ \Phi + + + + + + + + + + + + + + + + + +$	30.0	٠, ٠	<b>1</b>		Section 200	-		2.58	
+			End hole at 30	)' in very s	tiff			1	
		1	clay till.					1	
0 10 20 30 40	50		NOTES						
		1	NOTES						
□ □ Dynamic Cone			1) PP* = small						
(blows per fo			readings or	augered cu	ttings.				
			2) G = Gastec	Gasoline Ana	alyzer				
			readings in	hole after	hole		1		
			was sealed	for 2 hours					
	TTT1		3) Petroleum 1	ike odor fo	rm 3 to				
	40.0		8', very st	rong odor b					
			6 and 8'.						
<del></del>	<del></del>		1			1		PLATE 2	

# Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

OGGED / DWN : GL	CHKD.:	WK	DATE OF INV. : Oct	2/87	JOB: 2	221		$\perp$	TH 2	
10 20 30 40 50	60	(ft.)	SOIL D	ESCRIPTION		S	OIL SAI	MPLE	DRILL TYPE	
	<del></del>	± 3	DATUM			0	ш		5" Ø Aug	
	w O	DEPTH SOIL	SURFACE ELEVATION	98 57 ft		COND.	TYPE		PP* (tsf	
WATER CONTENT	1110		ASPHALT	70.57 10					IFF (LSI	
<del>                                     </del>	$\pm \pm \pm \pm 1$	Λ,								
9 1 1 1 1 1 1	++++	ΙX	FILL - sand & g	gravel					- G= 200 p	ma
	+1+1	//	- compact						0 200 p	· P ····
9 1111		5.0	CLAY - stiff, t							-
			- sandy, silty	diesel fu	el-like	st	ains		0.57	
		17	SAND & GRAVEL						G= 4500	ppi
H	+++	5.	- fine, moist t							
		5	- "diesel-like		ins				G= 4250	ppi
130111	<del>                                     </del>	10.0	<del> </del>						1	•
		F	CLAY - stiff, l							
		V	- trace sand	TIKE SUTUC	Lure					
111111111111		Fi	CLAY TILL							
		11	- very stiff to	stiff h	าดพาก			1	- 1.50	
1914		15.0	- silty, sandy	J SCIII, DI	OWN				1.50	
			- some gravel							
		H	- occasional g	rey fine, m	noist	1				
			sand layers - dark grey at	16'						
1 6 1 1 1 1 1		20.0	- trace cobble						-1.12	
	HHH	H					Ì			
	++++		H							
	HH	H								
	HH		H			1			- 2.22	
<del>                                     </del>	++++	25.0							7.22	
<del>                                     </del>	$\Box$	1								
			H	¥						
	$\coprod$	30.0	5.	<i>c.</i> .		+	+-	-	+	
$\Box$	++++		End hole at 30 stiff clay til		гу					
0 20 30	40 30		Still Clay til	••						
1 1 1 1 1 1 1 1		1	NOTE							
	┸╫┼┼┤		petroleum like	cmo11 fro	m 3 +0		1			
Dynamic Cone		-35.0	9', very stron							
	<del>ĭĭ</del> ĬHH		from 6 to 9'.	G F						
			200							
						1				
		-40.0	1							
	++++								PLATE	3
	11111	1.					1		ILTIE	,

# Geokwan Engineering Ltd PROJECT

# TESTHOLE LOG

CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECH	NICAL E	:NG	NEERS	BRAN	DON	, MANI	ОВА
LOGGED / DWN : GL CHKD.	: WK		DATE OF INV.: Oct 2/87	JOB:	22	1	TH 3
10 20 30 40 50 60	(ft.)		SOIL DESCRIPTION		S	OIL SAMPL	
	₹	ğ	DATUM SURFACE ELEVATION 97.63 ft				5" Ø Auger
w <sub>p</sub> □ w <sub>i</sub> △ w ○	DEPTH	YME	SUPPLIES ELEVATION 07 63 6+		COND.	TYPE	OTHER TESTS
WATER CONTENT %	6	0,01	FILL		-		PP* (tsf)
<del>-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1</del>	$\dashv$	$\Lambda$	- sand & gravel				
<del>+++++++</del>		I۷	- loose				
<del></del>	1	$\Lambda$	- 3/4" max. size approx.				
<del>++++++</del>	1	$/ \setminus$	- dry				
	5.0	1	CLAY - stiff, black, sandy	v			-
<del>                                      </del>	1	1	\-trace diesel fuel like	stain			
<del></del>	1	0	SAND AND GRAVEL				
	1.		- wet to saturated, brown				
<del></del>	Ħ.	د	- slight seepage at 7'8" - clayey below 8'				
	10.0						
	1	1	End Hole at 10 ft.				
			NOTE				
	]						_
	15.0		Strong petroleum like smel noted from 3 ft. to 8 ft.				
			grade.	irom			
	_		81440				
	_						
	20.0						-
	4					-	
<del></del>	4						
<del></del>	4						
<del></del>	4						
<del></del>	25.0						-
<del></del>	-						
<del></del>	1		*				
<del>++++++</del>	$\dashv$						
<del>                                      </del>							
<del>                                      </del>	30.0						_
<del></del>							1
	1						
	1						
	35.0						_
	1						
	1						
<del></del>	40.0						-
<del>-{-{-}}-}-}-</del>	-						-
<del></del>	-						PLATE 4
1111111111111	i	1					Ireate .

# Geokwan Engineering Ltd PROJECT

CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

CONSOLINIO OLI					BRANDO	ON,	MANI	TOBA		
LOGGED / DWN : GL	CHKD.: WI	(	DATE OF INV. : Oct	2/87	JOB: 22	21			TH 4	
10 20 30 40 50	60 (ft.)		SOIL D	ESCRIPTION		50	DIL SA	MPLE	DRILL 1	
$W_{P} \bigcirc W_{I} \triangle W$	5 =	80F	DATUM			o.	w		OTHER	Auger
Wp  W <sub>t</sub>	101	SOIL	DATUM SURFACE ELEVATION	99.43 ft	: <b>.</b>	COND.	TYPE		JOHN LIN	10010
	1110	000	ASPHALT							
		IV	FILL - sand & g	ravel						
		//	- loose	,						
			CLAY - stiff							
	5.0	. 0.	- diesel f		stains					-
<del></del>	+++	200	- fine, moist					1		12
<del></del>	+++		- some clay							
		7	- diesel fuel l		5					
	10.0	ľ	- silty, sandy	ν. υπ11						-
	10.0	1	CLAY TILL							
			- very stiff, h	rown						
	+++	W	- silty - firm, wet sam	nd lavers						
	+++		- some fine gra							
<del>++++++</del>	15.0	$ \mathcal{U} $	- dark grey at	15'						
+++++++++	1111	1111	- trace cobble	& boulder						
		M								
		111	1							
	20.0		<u> </u>			$\vdash$		-	-	15-
<del></del>	+++		End Hole at 20	ft. from	grade.			1		
<del></del>										
++++++	+HH		NOTE							
	25.0		Petroleum like	odour from	m 3 +0			1		_
	25.0	1	8 ft., very st							
	Ш		between 5 and 8	8 ft.				1		
	+++									
	++++									
+++++++	30.0									) (c
<del>-                                     </del>	++++								i	
<del>-                                      </del>	+++									
					67					
	35.0		· ·							
	1111									
	444									
	+++-									
	++++									
<del>├┤┼┼┼┼┼┼┼┼</del>	40.0									
	1111									
									PLATE	`5

# Geokwan Engineering Ltd CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

		<b></b>			BRANDO	N,	MAN1	TOBA	
OGGED / DWN :	GL	CHKD.: WK		DATE OF INV.: Oct 2/87	JOB: 22	1			TH 5
10 20 3	0 40 50	60 (ft.)		SOIL DESCRIPTION		S	OIL SA	MPLE	DRILL TYPE
	W <sub>1</sub> △ V	·/•	SOIL	DATUM SURFACE ELEVATION 98.83 ft.		COND.	TYPE		5" Ø Auger OTHER TESTS
		5.0		FILL - sand & gravel - weed covered  CLAY - stiff, black - some diesel fuel like st - grey at 6 ft till like structure & br at 9 ft.  CLAY TILL - stiff to very stiff - brown, dark grey at 16' - occasional 2" thick satu sand layers - some gravel, trace cobbl	rown				
		20.0		End Hole at 20 ft. from gr	rade.		/30		
		30.0		Petroleum like odour from 3 to 7 ft. from grade.					
		35.0							
		40.0							PLATE 6

# Geokwan Engineering Ltd PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECHNICAL ENGINEERS

BRANDON, MANITOBA

LOGGED / DWN: GL CHKD.: WK		DATE OF INV.: Oct 2/87	JOB: 22	21			TH 6
10 20 30 40 50 60 (ft.)		SOIL DESCRIPTION		S	OIL SAN	APLE	DRILL TYPE
	30.	DATUM		6	101		5" Ø Auger OTHER TESTS
Wp Wi A WO d	SOIL	SURFACE ELEVATION 98.71	£ L	COND.	TYPE		OTHER TESTS
	So		LL.	0			<b> </b>
0	$\backslash /$	FILL - sand & gravel					-
	IX	- brown					_
	$V \setminus$	D10#11					-
		CLAY - stiff					-
5.0		- diesel fuel like stai	ns				
<del></del>		SAND & GRAVEL					-
<del></del>		- fine, moist					-
<del>-\-1-\-1-\-1-\-1-\-1</del>	7	- some clay CLAY - stiff, brown		-			-
<del>┤┤╏┩╏╏</del>	r	- silty, sandy					-
10.0	1/1	CLAY TILL		1			_
<del></del>		- stiff to very stiff					1
<del>                                      </del>		- brown, some fine grav	el				
<del>                                     </del>		- dark grey at 15 ft.		1			
+++++	1	- occasional wet sand l - trace cobble & boulde					
15.0		- trace copple & boulde	r				
+++++	111			1			
		3					
	P.						_
20.0			4				_
		End Hole at 20 ft. from	grade.				
		İ					-
							_
25.0		NOTE					_
		D					
		Petroleum like odour be 3 and 7 ft. from grade,					
	1	strong odour from 5 to	7 ft.				
				1			
30.0					1		-
35.0							-
<del>                                     </del>							
<del>╒┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋┋</del>							
┠┼┼┼┼┼┼┼┼┼┼							
┠┼╂┼┼┼┼┼┼┼┼┼┼┼┼┼							1
40.0							
┠┼┼┼┼┼┼┼┼┼┼┼┼┼┼							
<del>┠┤┼┼┼┼┼┼┼┼┼┼┼┼┼</del> ┼						1	PLATE 7

# Geokwan Engineering Ltd

\_CONSULTING GEOTECHNICAL ENGINEERS

October 30, 1987

Canadian Tire Corporation Ltd. P.O. Box 770, Station K Toronto, Ontario M4P 2V8



ATTENTION: Mr. John Scharrer

Architectural Project Co-ordinator/Site Planner

Dear John:

RE: Soil Analysis

Thank you very much for utilizing our services for the proposed expansion of your store in Brandon, Manitoba.

As discussed, an additional investigation for verifying the foundation type and the underlying soil conditions of the existing Brandon store is considered essential, in finalizing the selection of foundation alternative and subgrade preparation requirements for the proposed store expansion. Hopefully, we can have a positive response from you shortly, so that this extra fieldwork may be undertaken without facing potential frozen soil problems and snow removal requirements. The scope of this additional investigation will include 2 testholes drilled inside the store and 2 testpits dug outside and adjacent to the store at locations of the two proposed additions. To verify the possible existence of a thickened slab, the testholes will be advanced near the perimeter walls with a 2" diameter hand auger after the existing slab is cored through with a core barrel. Hydrocarbon testing of gasoline and visual checking for oil will undertaken in the testholes, to determine if contaminated soils similar to those encountered in our earlier investigation, exist beneath the store. The testpits are put down mainly to determine the base elevation of the existing slab, type of surrounding materials, thickness and condition of the existing perimeter insulation (if any). The testholes will be backfilled with good quality grout while the testpits filled with the native excavated materials. We are prepared to undertake this additional work complete with a report for a firm price of \$1500.00, provided authorization to proceed is given in early November, 1987.



We would like to take this opportunity to express our interest in providing a proposal on the soil analysis for a proposed Canadian Tire Store in St. Vital, Winnipeq. We understand that several sites are being considered. In this regard, we would like to advise you that the writer is familiar with the soil conditions in the St. Vital area as he was directly involved in many major projects in the said area including the existing St. Vital Shopping Centre and the Meadowood Shopping Mall to the south. We are pleased to assist and provide you with any pertinent soils information on a regional basis, if desired.

Enclosed herewith is a copy of our company profile outlining our engineering expertise and typical projects recently completed.

You will note that our firm can undertake soil analysis and other geotechnical work in both Manitoba and Ontario. We have been involved in projects in northwestern Ontario, with our territory extending to Thunder Bay, Ontario. The writer has been a professional engineer registered with the Association of Professional Engineers of Ontario since January, 1976.

If you have any requirements or need assistance in the area of our expertise, we would appreciate the opportunity to be of service.

Yours truly,

Zoa

GEOKWAN ENGINEERING LTD.

per

Walter Kwan, M. Eng., P. Eng.

President

WK:dh

Enclosure



REPORT NO. 229-02-01

PAGE 1 OF 1

# SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR:

Geokwan Engineering Ltd. 110 - 1294 Border Street Winnipeg, Manitoba

R3H OM7

Attn: Mr. Walter Kwan, M. Eng., P. Eng.

Geokwan Project No. 221

METHODOLOGY: Soil Box Method

One trial per sample, as per your instructions.

# RESULTS:

Sample No.	Test Hole	Depth	Results (ohms/cu.cm.)
1	2	B-4 *	3 540
2	2	B-8'	1 046
3	2	B-10'	770
4	2	B-15'	491

# NOTES:

For measurement, the soil samples were pressed by hand into the soil box to a density judged to be approximately the same as the clumps of soil in the original samples.

TECHNICIAN: Harb Warners

ai4/mdw



# Geokwan Engineering Ltd CONSULTING GEOTECHNICAL ENGINEERS

REPORT TO

CANADIAN TIRE CORPORATION LTD.

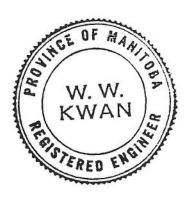
GEOTECHNICAL INVESTIGATION
.
ADDITION TO CANADIAN TIRE STORE
BRANDON, MANITOBA

# Distribution:

6 copies - Canadian Tire Corporation Ltd.

1 copy - Geokwan Engineering Ltd.

October 16, 1987



221



October 16, 1987

Canadian Tire Corporation Ltd. 2180 Yonge Street P.O. Box 770, Station K Toronto, Ontario M4P 2VS

ATTENTION: Mr. John Scharrer

Architectural Project Co-ordinator/Site Planner

Dear Sir:

RE: Addition to Canadian Tire Store 18th Street, Brandon, Manitoba Our Project No. 221

This report summarizes the results of our geotechnical investigation conducted at the site of the proposed addition to the Canadian Tire Store (#286 Brandon) on 18th Street in the City of Brandon, Manitoba. The terms of reference for this work can be found in our proposal dated September 29, 1987 and Canadian Tire Corporation Ltd. Purchase Order No. BF14-161367.

# PROJECT\_DESCRIPTION

The present plans call for the construction of a new warehouse and a new service centre located immediately to the north and east of the existing store, respectively. The proposed structures are single storey, basementless with slabs on grade. New paved parking areas will be provided.

# FIELDWORK AND LABORATORY TESTING

On October 2, 1987, a total of 6 testholes were put down at the site using a 5" continuous truck-mounted flight auger. The testhole locations are shown on the site plan, Plate 1 appended.

The subsoils encountered in each testhole were visually logged and classified to its full depth, with special emphasis placed on the possible presence of gasoline and oil. Soil samples were recovered off the auger cuttings regularly and returned to our Winnipeg laboratory for further testing. Any ground water seepage in the testholes was noted.

Canadian Tire Store Addition
Brandon, Manitoba
Recommended Gradation Limits
of Granular Fills For
Slab-On Grade and Payement

	Persent_E	Percent Passing	
Sieve_Size	Class_A_Base	Class_C_Base	
3"	-	100	
1"	100	-	
3/4"	. 80 - 100	(***)	
#4	40 - 70	40 - 80	
#10	25 - 50	-	
#40	15 - 30	****	
#200	5 - 15	5 - 20	

# NOTES

- All fills should be free of organics, frozen soils, shale and consist of durable rock particles.
- 2) For the Class A base, at least 35% of the material retained on the No. 4 sieve should include <u>crushed</u> particles.

To determine the concentrations of gasoline, the Gastec Analyzer System fitted with a gasoline detection tube was utilized at TH 1 and 2. Prior to undertaking the in-situ gasoline testing, the testholes were capped at the ground surface for 2 hours. A gasoline detection tube connected to a suction tubing and a hand pump was then lowered into the testhole at a predetermined depth. Sampling of the gasoline vapour was obtained by applying an air suction towards the gasoline tube through the hand pump. A colour change from brown to green of the detection tube would indicate the presence of gasoline and the gasoline concentration could be directly determined from the said tube. Details of the measured gasoline concentrations are as follows:

Testhole	Tested Depth <u>From Grade (ft)</u>	Measured Gasoline Concentrations (ppm)
TH 1	3 6 9	150 4000 zero
TH 2	3 6 9	200 4500 4250

To evaluate the stiffness and approximate bearing capacities of the overburden dynamic cone penetration tests were performed at TH 1 & 2. The test consisted of driving a 2" diameter steel cone with a 140 lb hammer falling freely 30 inches and measuring the number of blows per foot of cone penetration.

Layout and levels were determined by our survey crew. The ground surface elevations of the testholes were determined in relation to a temporary benchmark shown on the site plan, Plate 1.

In our laboratory, all soil samples were reclassified and tested for soil water contents. The undrained shear strengths of the cohesive samples were evaluated with a steel pocket penetrometer.

To assess the <u>corrosion</u> potential to buried steel or the like, typical soil samples recovered from TH 2 within the upper 15 ft. of the soil profile were sent to Norenco Associated Ltd. for <u>soil</u> <u>resistivity\_tests</u> using the soil box method. The pertinent results are shown on Plate 8.

## SOIL AND GROUND WATER CONDITIONS

A detailed description of the soil and ground water conditions, together with the results of field and laboratory testing can be found on the testhole logs, Plate 2 to 7, inclusive.

Generally, the subsoil stratigraphy consisted of either a pavement section (i.e. 3" of asphaltic concrete over granular fill TH 2 & 4 only) or a granular fill of 3 to 5 ft. thick underlain by a stiff to very stiff black clay overlying a clayey sand and gravel deposit which extended to depths of 8 to 10 ft. from grade.

Below the clayey sand and gravel was a layer of stiff till-like clay 2 to 3 ft. thick followed by a glacial till deposit extending to the depths explored.

It should be noted that in all testholes, <u>petroleum like odour</u> was noted in the surficial black clay and the underlying clayey sand and gravel layer at depths of approximately between 3 to 9 ft. from grade. The strongest petroleum like odour was detected in the clayey sand and gravel layer which was located immediately below the surficial black clay. Gastec readings in this sand and gravel indicated gasoline concentrations in the range of 4000 to 4500 ppm. In addition, diesel-fuel-like stains were noted frequently in the surficial black clay and the underlying sand and gravel, at depths of approximately 3 to 9 ft. from grade.

The contaminated sand and gravel was moist to wet, indicating the possible presence of a perched water table and/or gasoline.

Wet sand layers of about 2" thick were noted occasionally in the underlying stiff brown clay and glacial clay till. In general, the glacial till was stiff and became very stiff with depth. It was initially brown in colour and became dark grey near the 16 foot depth from grade. The glacial till was clayey, with some sand, gravel, cobble and boulder. The boulder content and frequency appeared to increase with depth.

On completion of the test drilling, no free water was noted in the testholes. However, all testholes were backfilled immediately after drilling. If these testholes were left open for a longer period of time, perched water tables may exist in the surficial sand and gravel layer and the permeable zones of the

brown clay and the underlying glacial till. Such water tables and the associated seepage volumes would likely fluctuate on a seasonal basis.

# CONCLUSIONS AND RECOMMENDATIONS

## Site Suitability

The results of our investigation have shown that there may be a post construction odour and fire hazard problems at this site due to the strong petroleum-like-odour and fairly high gasoline concentrations identified in our testholes, in the surficial black clay and the underlying sand & gravel which are located approximately between the depths of 3 and 9 ft. from the existing grade. If these potential odour and fire hazard problems are deemed tolerable to the owner, the following foundation recommendations may be considered.

# Foundation Considerations

Foundation alternatives which we have considered, include footings, a stiffened slab foundation, cast-in-place concrete caissons and driven prestressed precast concrete piles.

Judging the soil conditions encountered in our testholes, footings and cast-in-place concrete caissons are  $\underline{not}$  considered geotechnically viable. The variability in density and composition of the surficial soils will likely lead to considerable footing settlements. The presence of gasoline and water seepage in the upper sand and gravel and permeable zones of the glacial till will make the caisson construction quite costly and difficult.

In our opinion, either a stiffened slab on engineered fill or driven prestressed precast concrete piles may be utilized for supporting the proposed store addition. Among the two, driven prestressed precast concrete piles are considered as the <u>preferred</u> foundation alternative.

It is our understanding that the existing Canadian Tire Store may have been supported on a stiffened slab foundation which is underlain by 3 ft. of well compacted granular fill and that petroleum-like-odour was encountered during the previous soils

investigation for the existing store. However, it is not confirmed as to the type of foundation which was actually used for supporting the existing store and whether the contaminated soils had been removed during the store construction. In the absence of this information, we are not in a position to properly evaluate the construction viability of a stiffened slab foundation at this site. On the basis of our on-site discussion with the store manager and our site observations, the existing store appears to perform satisfactorily. Therefore, significant foundation economies for the proposed addition may result, if it can be proved that the existing store is supported on a stiffened slab and that the hydrocarbon contaminated soils under the existing store had not been removed. In this regard, an additional soils investigation with testholes being drilled inside and immediately adjacent to the store will have to be carried out. Details of this can be provided if desired.

# Driven Piles

Driven prestressed precast concrete piles are considered as the preferred foundation type for supporting the proposed addition. These piles, when driven to practical refusal in the underlying very stiff dark grey clay till using a hammer capable of delivering at least 30,000 ft-lbs per blow, may be assigned the following allowable loads:

Pile Size	<u>Allowable_File_Loads</u>
12" Hex	50 tons
14" Hex	70 tons
16" Hex	90 tons

Pile spacings should not be less than 3 pile diameters centre to centre. Piles at groups should be monitored for heaving during the driving of adjacent units and redriving done, where pile heaving is found considerable.

One major draw back of the driven pile is that the pile driving will induce subsoil displacements and vibrations. Where piles are driven adjacent to the existing store, some structural damage

may result if precautions and proper driving procedures and sequence are not followed. To minimize this potential damage, the following should be considered:

- Where Files are driven within 30 ft. of the existing store, reduced driving energy during initial driving and preboring to a minimum depth of 15 ft. from grade should be undertaken. Preboring should be conducted in such a manner that undermining of the existing store slab and foundations would not occur. In this regard, a temporary steel casing should be utilized where soil sloughing occurs within the proposed prebored depth. The annular space between the casing and the pile should be filled with properly tamped sand prior to casing removal.
- Settlement observation points should be established along the most northerly and easterly perimeter walls, <u>before and during pile driving</u>, to ensure that the pile induced vibrations and subsoil displacements have not adversely affected the existing store.

Even with the foregoing precautions, the potential for development of minor cosmetic cracks in the walls or slabs of the adjacent store may remain. The possible risk associated with the driven piles should be appreciated by the owner. For this reason, the viability of using a stiffened slab over engineered fill for the building addition should be assessed with an additional soils investigation, as recommended earlier.

It has been our experience that driven precast concrete piles will refuse at varying levels in the very stiff to hard clay till. The pile length selection would be best left for the piling contractors who are experienced in driven piles in the Brandon area. Our previous piling projects in Brandon would suggest that the required pile lengths were usually in the 20 to 40 foot range.

To ensure a satisfactory pile installation, <u>full time driven pile inspection</u> by qualified geotechnical personnel is strongly recommended.

# Floor Support

Floor slabs on grade are permissible at this location, provided that subgrade preparation for floor construction is undertaken as follows:

- Remove and waste existing asphaltic concrete, organic, disturbed and softened soils.
- Excavate the existing granular fill with weeds/organics removed, to a minimum depth of 2' from existing grade. Store this fill at a suitable location for subsequent backfilling of the excavation.
- At the 2 foot excavation level, compact the exposed granular fill to 100% Standard Proctor density (ASTM D698).
- Remove soft spots, as directed by a qualified geotechnical engineer at the 2 foot excavation level and replace with on site granular fill compacted to at least 95% Standard Proctor density.
- After the subgrade is compacted and approved by a qualified geotechnical engineer, backfill the slab excavation with the granular fill previously excavated, which should be compacted in maximum 6" lifts, with a heavy vibratory roller and in a surface wet condition, to 100% Standard Proctor density. Immediately underneath the slab, a 6" thick layer of compacted, well-graded Class A base (3/4" crushed gravel) should be placed, the gradation limits of which are shown on Plate 9.

It should be noted that removal and the potential requirements for cleaning up of the underlying contaminated soils under the new slabs of the addition should be investigated by Canadian Tire Corporation Ltd. There are existing methods for extracting gasoline vapor or liquid from the contaminated subsoils. However, these "clean up" aspects are beyond the scope of this report.

# Unheated Structures

Where driven piles are used for supporting lightly loaded unheated structures such as elevated propane tanks, adequate provisions for preventing <u>frost jacking</u> of piles should be considered. As a general rule, a driven pile should have a minimum embedment depth of 27 ft. If this cannot be accomplished due to high pile refusal, the piles should be insulated with high quality rigid insulation panels which should extend at least 8' from the piles in all directions. The required thickness of the rigid insulation panel will depend on the actual pile embedment depth. It is expected that the panel thickness required may range from 2 to 4". The insulation panels should be protected

with at least 1' and 2' of earth cover for landscaped and traffic areas, respectively. Further details can be provided during construction, if needed.

#### Payement Design

Suitable pavement sections at this location may consist of the following:

rozzowing.	Heavy Duty <u>Truck Route</u>	Light Duty <u>Car Parking</u>
Asphaltic Concrete	3"	2"
Class A Base (3/4" crushed gravel)	6"	3"
	*	
Class C Base (3" down pit run gravel)	9"	6"

It should be noted that the <u>existing granular fill may be used as Class C base</u>, provided that the organic and softened portion of the fill is wasted. The Class A base should be in conformity with the gradation limits shown on Plate 9.

Pavements should be constructed on a <u>prepared</u> subgrade, which should be prepared in a manner recommended previously for the slab-on-grade. In this regard, the existing granular fill in the pavement area should be scarified, reworked and recompacted to a minimum depth of 2' from the existing grade, prior to actual pavement construction.

Percent compaction for the existing granular fill, class C and A base materials should be 100% Standard Proctor density.

#### Underground Tanks and Utilities

Results of the soil resistivity tests show that the subsoils are highly corrosive to steel (especially test results for samples at 8', 10' & 15' - Plate 8). Therefore, corrosion protection for buried steel tanks or the like will be required.

Underground storage tanks are usually founded at depths of 12 to 14 feet from grade. The tank excavations will likely encroach

onto the contaminated sand and gravel and may encounter water seepage. Some dewatering requirements should therefore be expected. Precautions should be taken to properly remove and dispose of the gasoline, if encountered. Qpen\_flame such as welding in the tank excavations should be prohibited, unless adequate safety measures are undertaken to avoid potential fire hazard and explosion associated with the gasoline. Similar precautions should be observed for the excavation and installation of underground utilities.

The underground tanks should be supported on a concrete pad bearing on the native undisturbed stiff clay till. The safety of empty tanks against <u>buoyancy</u> should be checked, with the ground water table assumed at the ground surface. The tanks should be back-filled with free draining pit run sand and fine gravel which should be compacted in uniform 6" lifts to 95% Standard Proctor density.

For the underground pipes (i.e. water, sewer, plumbing lines etc.), they should be made <u>leak proof and resistant against gasoline vapour and other hydrocarbon</u>, if the said gasoline and hydrocarbon are not removed from the subsoils identified in our testholes. Leakage of gasoline or hydrocarbon to sewer and water lines may create an environmental hazard.

It is likely that excavation for the underground utilities may carry to the contaminated sand and gravel. In this case, the removal of the gasoline and contaminated soils under and above these pipes should be considered. Replacement fill may include well graded pit run sand and gravel compacted to at least 95% Standard Proctor density.

#### Additional Considerations

All concrete in contact with the native subsoils should be manufactured with sulphate resistant cement and should be of high quality. Concrete subject to periodic freezing and thawing effects such as exterior sidewalk, curb and concrete slab should be air entrained in accordance with Table 8 of CSA Standard CAN3-A23.1-M77.

For design considerations, the maximum frost penetration depth may be taken as 5 and 9 ft. for heated and unheated structures, respectively.

Retaining structures should be designed against unit lateral earth stresses as follows;

P = k (q + wh) psf

p = unit lateral earth pressure at any depth of wall, h (psf)

k = estimated earth pressure coefficient

= 0.35 for yielding walls

= 0.5 for rigid walls

q = any surcharge adjacent to the wall (psf)

w = average soil unit weight

= 130 pcf

The above expression assumes that filter protected perforated drains will be installed at the base of the wall, so that there will be no build up of hydrostatic pressures behind the said wall.

For winter construction requirements, all newly poured foundations and bearing soils in all loaded areas should be adequately protected against frost action. Concrete should not be poured on frozen ground nor should frost be allowed to penetrate the foundations after construction.

Final site grading should ensure that all surface runoff is adequately drained away from the addition using gradients of 1 and 2% for paved and landscaped areas, respectively.

To ensure that the slabs on grade and pavements are constructed in the manner recommended, subgrade inspection and compaction testing of the granular fills (Class A & C base) should be undertaken by qualified geotechnical personnel during construction.

We trust that the foregoing is sufficient as per our terms of reference for the work. If you, however, have any further questions, please advise.

Yours truly,

GEOKWAN ENGINEERING LTD.

per:

Walter Kwan, M. Eng., F. Eng. Chief Engineer

WK:dh

Enclosure





REPORT NO. 229-02-01

PAGE 1 OF 1

#### SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR:

Geokwan Engineering Ltd. 110 - 1294 Border Street

Winnipeg, Manitoba

R3H OM7

Attn: Mr. Walter Kwan, M. Eng., P. Eng.

Geokwan Project No. 221

METHODOLOGY: Soil Box Method

One trial per sample, as per your instructions.

#### RESULTS:

Sample No.	Test Hole	Depth	Results (ohms/cu.cm.)	
1	2	B-4 '	3 540	
2	2	B-8'	1 046	
3	2	B-10'	770	
4	2	B-15'	491	

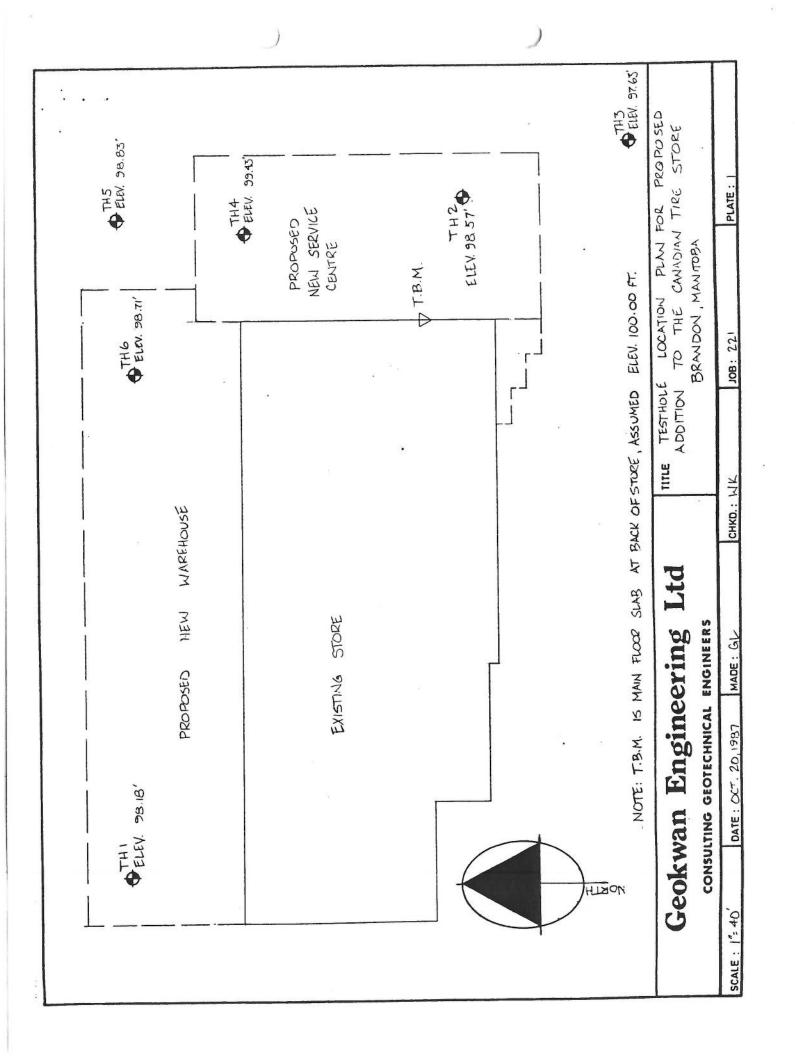
#### NOTES:

For measurement, the soil samples were pressed by hand into the soil box to a density judged to be approximately the same as the clumps of soil in the original samples.

TECHNICIAN:

Wark Worners

ai4/mdw



# Geokwan Engineering Ltd | IESITIULL LUC | PROJECT PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECHNICAL ENGINEERS

BRANDON, MANITOBA

GGED / DWN :	GL	CHKD.:	WK		DATE OF INV. : Oct	2/87	JOB: 22	21		TH 1
10 20 30	40 50	60	(ft.)		- soil	DESCRIPTION		so	DIL SAMPLE	
<del></del>	, ,	日	Ŧ	30L	DATUM					5" Ø Auge
		0	ОЕРТН	SOIL SYMBOL	SURFACE ELEVATIO	N 08 18 f+		COND.	TYPE	
WATER	CONTENT */			S				0		PP* (tsf)
	++++	Ш	0	$\setminus /$	FILL - sand &	A57.				
++++	++++	HH		X	- loose, brown - weed covered					1
$\gamma_{+++}$		Ш		$\triangle$						- G= 150 ppп
		Ш		//	CLAY - stiff, b					- 2.40
1411	$\perp \perp \perp$	$\coprod$	5.0	1	- sandy, silty	, diesel lue	el-like/s	tau	n	
		Ш		,	SAND & GRAVEL	- fine, moi	ist			-0.63
144					- clayey					G= 4000 pp
1					- some "diesel	_like" fuel	stains			
		Ш		//	CLAY - stiff,					
1 2 1			10.0		- 2" sand laye	r & seepage	e at 9'6'			1.68
			10.0	XI						1.00
T M					CLAY TILL					U. U.
TIM	4-111				- very stiff t					1
	KIII	$\Box\Box$		W	- silty, some					
11/11	NI.	HH		nil.	- dark grey at					1.38
<del>+ 19 + 1</del>	11/1	HH	15.0	M	- occasional s					1.50
+#1++	TRL	HH			- trace connie	& boulder				1
<del>             </del>	1181	HH		MI						
1,11	1 1	HH								
1111	111	HH		111						1 25
<del>1 P1 1 1</del>	1117	$\Box\Box$	20.0	H.						-1.25
++++	+++	HH								
<del>           </del>	+++	HH		<b>M</b> .					1	1
++++	1111	HH		الأالا						1
++++	+++	HH		HI						2 42
19111	++++	+++	- 25.0							-2.42
<del>                                     </del>	+++	+++		111.						
<del>                                     </del>	++++	HH		111						
+i++	++++	++++								
<del>             </del>	++++	+++		3:				П		2.50
<del>         </del>	++++	HH	-30.0	7	End hole at 30	' in work o	+:ff	П		2.58
++++	++++	++++			clay till.	TH AGIN S	) L L L L			
0 10 20	30 40	5b		1						
1111	++++	+			NOTES					
D	ic Cone	<del>         </del>			1) PP* = small	scale nene	trometer			
	s per fo		-35.0		readings on					
1111	7 PET 10	<del>11</del>			2) G = Gastec (					- ×
++++	++++	++++			readings in					
+++++	++++	HH		1	was sealed					
++++	++++	++++			3) Petroleum 1					
+++++	++++	++++	-40.0		8', very st					
+++++		++++			6 and 8'.		CCMCCII			
	-	$\perp$		1	CONTRACTOR OF S			1	1	PLATE 2

# Geokwan Engineering Ltd PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECHNICAL ENGINEERS

BRANDON, MANITOBA

CONSULTING GEOT	ECHINICAL L	110.	WEEKS		DIAME	, on,	IIIIII	10011		-
OGGED / DWN : GL	CHKO.: WK		DATE OF INV. : Oct	2/87	JOB: 2	221_		<u></u>	TH 2	$\dashv$
10 20 30 40 50	60 (ft.)		SOIL	DESCRIPTION		50	IL SAM	PLE	RILL TYPE	1
		ي ا	DATUM			o l	w	_	THER TEST	
$w_{p} \square w_{l} \triangle w C$	EP TH	YME	DATUM SURFACE ELEVATION	N 08 57 f+		COND.	TYPE		PP* (tsf	1
WATER CONTENT %		& <sup>₹</sup> .ρ° Ω Ω		90.57 11		+	-		PP (LSI	$\leftarrow$
Dynamic Cone To (blows per foor	es 35.0		FILL - sand & - brown - compact  CLAY - stiff, - sandy, silty  SAND & GRAVEL - fine, moist - clayey belo - "diesel-lik  CLAY - stiff, - silty, 'till - trace sand  CLAY TILL - very stiff - silty, sand - some gravel - occasional sand layers - dark grey a - trace cobbl  End hole at 3 stiff clay ti  NOTE  petroleum lik 9', very strofrom 6 to 9'.	trace rootly, diesel fur to wet w 8' e" fuel state brown -like struct to stiff, bry grey fine, rot 16' e & boulder w 80 ft. in ve. 11.	ins ture ry		nins		- G= 200 p - 0.57 - G= 4500 - G= 4250 - 1.50 - 1.12	 ppm

### Geokwan Engineering Ltd PROJECT

CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECH	MICAL E	1401	NEEKS		BRAN	IDON	I, MAI	NITOI	BA
LOGGED / DWN : GL CHKD.	: WK		DATE OF INV. : Oc	t 2/87	JOB:	22	1		TH 3
10 20 30 40 50 60	(ft.)		SOIL	DESCRIPTION		S	OIL SAI	MPLE	DRILL TYPE
		占	DATUM						5" Ø Auger
Wp□ W(△ W ○	ОЕРТН	SOIL	0.70			COND.	TYPE		OTHER TESTS
WATER CONTENT %.		S (S		ON 97.63 ft	t.	Ö			PP* (tsf)
	0	\ /	FILL	1					_
		$  \setminus  $	- sand & grav - loose	eT					_
	1	X	- 3/4" max. s	ize approx					_
		/	- dry	Luc appront					_
	5.0								_
		_	CLAY - stiff,						_
		0	- trace diese		_stain/				-
			SAND AND GRAV						-
	4.	.3.	- slight seep	age at 7'8"					-
	10.0		- slight seep	w 8'		_			
	4		End Hole at 1	0 ft.					-
	4								-
	-								-
	-		NOTE						-
	15.0	1	Strong petrol	eum like eme	all was				-
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	4		noted from 3						-
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	4		grade.						-
H + H + H + H + H + H + H + H + H + H +	4								-
<del></del>	-					1			-
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	20.0	l							-
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	-								-
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	4								_
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	-							l	_
F + F + F + F + F + F + F + F + F + F +	1								-
	25.0								_
	┨								_
	1	1	11	× 5		1			_
	-					1			_
	1								
	30.0								
	1								
	7								_
	1								
	35.0								
	J-35.0					1			_
									i _
									_
	40.0								-
	-						1		-
	4								PLATE 4
11111111111111	1	1	1			1			FLATE 7

### Geokwan Engineering Ltd

TESTHOLE LOG

CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION
BRANDON MANITOBA

CONSOLIING GEOTECH	MICHE EN	IOTHER W		BRANDO	ON,	MANIT	OBA
LOGGED / DWN : GL CHKD.	: WK	DATE OF INV. : OC	t 2/87	JOB: 22	21		TH 4
10 20 30 40 50 60	(ft.)		DESCRIPTION		sc	IL SAM	
		DATUM		-	[]	[	5" Ø Auger OTHER TESTS
w <sub>p</sub> □ w <sub>l</sub> △ w ○	ОЕРТН	DATUM  SURFACE ELEVATI	ON OO Y3 E+		COND.	TYPE	OTHER TESTS
WATER CONTENT %			57.43 IL		1	-	<del></del> .
<del>                                      </del>	4° 17	ASPHALT					-
<del>                                     </del>	-	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	gravel				_
<del>                                     </del>	- I						_
<del>┠┤╏╏╏</del> ┼	1 /	CLAY - stiff	fuel like s	stains		1	_
	5.0	SAND AND GRAV			1	1	
┠╅┼┼┼┼┼┼┼┼┼┼	7	- fine, mois	st to wet				_
	]	- some clay - diesel fuel	l like etains	2		- 1	_
	]	CLAY - stiff			1		-
	10.0	- silty, sand					_
	- 5	CLAY TILL					-
$\mathbf{L} + \mathbf{L} + $	-  l	- very stiff	, brown			. 1	_
	- I	- silty - firm, wet	sand lavers				_
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	-	- some fine					_
1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	15.0	- dark grey a	at 15'				_
	- 1	- trace cobb	le & boulder				
	7	<b>1</b> 111		St.			_
		111					_
	20.0	XI)					
		End Hole at	20 ft. from	grade.			-
	4						-
	$\dashv$ $\mid$	NOTE					_
111111111111	H			2			_
++++++++++++++++++++++++++++++++++++	25.0	Petroleum li					
		8 ft., very between 5 an	d 8 ft.	•0			_
	Η '					1	_
							-
	30.0					i	
							-
	Ц						-
	H			50			
<del></del>	Н						
<del></del>	35.0						
<del></del>	H						
<del></del>	H						]
<del>}                                      </del>	H						-
<del>                                     </del>	40.0			*0			-
	1 40.0						-
							PLATE 5
		1 1					PLATE 5

#### Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION CONSULTING GEOTECHNICAL ENGINEERS BRANDON, MANITOBA DATE OF INV. : Oct 2/87 JOB: 221 LOGGED / DWN : CHKD.: WK TH 5 GL DRILL TYPE SOIL SAMPLE 40 50 SOIL DESCRIPTION 20 30 (ft.) 5" Ø Auger DEPTH DATUM OTHER TESTS Wp 🗌 $W_i \triangle$ SURFACE ELEVATION 98.83 ft. WATER CONTENT % FILL - sand & gravel - weed covered CLAY - stiff, black 5.0 - some diesel fuel like stain - grey at 6 ft. - till like structure & brown at 9 ft. 10.0 CLAY TILL stiff to very stiff - brown, dark grey at 16' - occasional 2" thick saturated sand layers - some gravel, trace cobble -15.0 20.0 End Hole at 20 ft. from grade. NOTE 25.0 Petroleum like odour from 3 to 7 ft. from grade. -30.0 -35.0 40.0

# Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECHNICAL ENGINEERS

BRANDON, MANITOBA

OGGED / DWN: GL	CHKD.: WK	T	DATE OF INV.: Oct 2/87	JOB: 22	1		L	тн 6
10 20 30 40	50 60 (ft.)		SOIL DESCRIPTION		S	DIL SAM	PLE	DRILL TYPE
<del>,                                     </del>		히	DATUM					5" Ø Auger OTHER TESTS
$w_p \square w_i \triangle$	w O	152			COND.	TYPE		OTHER TESTS
WATER CONTEN		S S	SURFACE ELEVATION 98.71 ft	•	-	+		ļ. ———
	0	$\Lambda$	FILL .					
		IXI	- sand & gravel - brown					
		$V \setminus V$	Diown					
			CLAY - stiff					
	5.0	1/	- diesel fuel like stains	: 				· -
		200	SAND & GRAVEL					
			- fine, moist					
<del>                                     </del>		17	- some clay CLAY - stiff, brown		1			
<del>                                     </del>	<del>                                     </del>	1	- silty, sandy					
┼┼┼┼┼┼┼	10.0	141	CLAY TILL		1			
┼┼┼┼┼┼┼	<del>                                     </del>		- stiff to very stiff					
┼┼┼┼┼┼	<del>                                     </del>		- brown, some fine gravel	l				
<del>                                     </del>	<del>                                     </del>		- dark grey at 15 ft.	rorc				
+++++		111	<ul> <li>occasional wet sand lay</li> <li>trace cobble &amp; boulder</li> </ul>	yers				-
<del>                                     </del>	15.0		trace coppie a pourcer					
<del>                                     </del>	++++	Un	× ×					
			8					
	20.0	37			_			
	20.0		End Hole at 20 ft. from a	arada				
			End note at 20 ft. from a	grade.		1		
		1						
	25.0		NOTE		1			1-
	+++++		Petroleum like odour bet	ween	1			
	11111		3 and 7 ft. from grade,	very		1		
<del></del>	+++++		strong odour from 5 to 7	<u>ft</u> .			1	
<del></del>	<del>                                     </del>					1		
┼┼┼┼┼┼┼	30.0				1		1	
<del>                                     </del>	++++							
<del>- - - - - - -</del>	+++++		1					
<del>-++++++</del>	++++	1		80				
<del>                                     </del>	+++++		1					
<del>                                      </del>	35.0					1		
<del></del>								
		ļ			1		1	
	40.0							
								PLATE 7
		1			L_			TLATE /

## Geokwan Engineering Ltd \_\_\_\_\_consulting Geotechnical Engineers

#### REPORT TO

CANADIAN TIRE CORPORATION LTD.

GEOTECHNICAL INVESTIGATION

ADDITION TO CANADIAN TIRE STORE

BRANDON, MANITOBA

#### Distribution:

6 copies - Canadian Tire Corporation Ltd.

1 copy - Geokwan Engineering Ltd.

October 16, 1987



221



October 16, 1987

Canadian Tire Corporation Ltd. 2180 Yonge Street P.O. Box 770, Station K Toronto, Ontario M4P 2V8

ATTENTION: Mr. John Scharrer

Architectural Project Co-ordinator/Site Planner

Dear Sir:

RE: Addition to Canadian Tire Store 18th Street, Brandon, Manitoba Our Project No. 221

This report summarizes the results of our geotechnical investigation conducted at the site of the proposed addition to the Canadian Tire Store (#286 Brandon) on 18th Street in the City of Brandon, Manitoba. The terms of reference for this work can be found in our proposal dated September 29, 1987 and Canadian Tire Corporation Ltd. Purchase Order No. BF14-161367.

#### PROJECT DESCRIPTION

The present plans call for the construction of a new warehouse and a new service centre located immediately to the north and east of the existing store, respectively. The proposed structures are single storey, basementless with slabs on grade. New paved parking areas will be provided.

#### FIELDWORK AND LABORATORY TESTING

On October 2, 1987, a total of 6 testholes were put down at the site using a 5" continuous truck-mounted flight auger. The testhole locations are shown on the site plan, Plate 1 appended.

The subsoils encountered in each testhole were visually logged and classified to its full depth, with special emphasis placed on the possible presence of gasoline and oil. Soil samples were recovered off the auger cuttings regularly and returned to our Winnipeg laboratory for further testing. Any ground water seepage in the testholes was noted.

Canadian Tire Store Addition Brandon, Manitoba Recommended Gradation Limits of Granular Fills For Slab-On Grade and Payement

	Percent E	assing
Sieve_Size	Class_A_Base	<u>Class_C_Base</u>
3"	Mar	100
1"	100	mx
3/4"	80 - 100	-
#4	40 - 70	40 - 80
#10	25 - 50	
#40	15 - 30	-
#200	5 - 15	5 - 20

#### NOTES

- All fills should be free of organics, frozen soils, shale and consist of durable rock particles.
- 2) For the Class A base, at least 35% of the material retained on the No. 4 sieve should include <u>crushed</u> particles.

To determine the concentrations of gasoline, the Gastec Analyzer System fitted with a gasoline detection tube was utilized at TH 1 and 2. Prior to undertaking the in-situ gasoline testing, the testholes were capped at the ground surface for 2 hours. A gasoline detection tube connected to a suction tubing and a hand pump was then lowered into the testhole at a predetermined depth. Sampling of the gasoline vapour was obtained by applying an air suction towards the gasoline tube through the hand pump. A colour change from brown to green of the detection tube would indicate the presence of gasoline and the gasoline concentration could be directly determined from the said tube. Details of the measured gasoline concentrations are as follows:

<u>Testhole</u>	Tested Depth From Grade (ft)	Measured Gasoline <u>Concentrations (ppm)</u>
TH 1	3 6	150 4000
	9	zero
TH 2	3 6 9	200 4500 4250

To evaluate the stiffness and approximate bearing capacities of the overburden dynamic cone penetration tests were performed at TH 1 & 2. The test consisted of driving a 2" diameter steel cone with a 140 lb hammer falling freely 30 inches and measuring the number of blows per foot of cone penetration.

Layout and levels were determined by our survey crew. The ground surface elevations of the testholes were determined in relation to a temporary benchmark shown on the site plan, Plate 1.

In our laboratory, all soil samples were reclassified and tested for soil water contents. The undrained shear strengths of the cohesive samples were evaluated with a steel pocket penetrometer.

To assess the <u>corrosion</u> potential to buried steel or the like, typical soil samples recovered from TH 2 within the upper 15 ft. of the soil profile were sent to Norenco Associated Ltd. for <u>soil</u> <u>resistivity tests</u> using the soil box method. The pertinent results are shown on Plate 8.

#### SOIL AND GROUND WATER CONDITIONS

A detailed description of the soil and ground water conditions, together with the results of field and laboratory testing can be found on the testhole logs, Plate 2 to 7, inclusive.

Generally, the subsoil stratigraphy consisted of either a pavement section (i.e. 3" of asphaltic concrete over granular fill TH 2 & 4 only) or a granular fill of 3 to 5 ft. thick underlain by a stiff to very stiff black clay overlying a clayey sand and gravel deposit which extended to depths of 8 to 10 ft. from grade.

Below the clayey sand and gravel was a layer of stiff till-like clay 2 to 3 ft. thick followed by a glacial till deposit extending to the depths explored.

It should be noted that in all testholes, <u>petroleum like odour</u> was noted in the surficial black clay and the underlying clayey sand and gravel layer at depths of approximately between 3 to 9 ft. from grade. The strongest petroleum like odour was detected in the clayey sand and gravel layer which was located immediately below the surficial black clay. Gastec readings in this sand and gravel indicated gasoline concentrations in the range of 4000 to 4500 ppm. In addition, diesel-fuel-like stains were noted frequently in the surficial black clay and the underlying sand and gravel, at depths of approximately 3 to 9 ft. from grade.

The contaminated sand and gravel was moist to wet, indicating the possible presence of a perched water table and/or gasoline.

Wet sand layers of about 2" thick were noted occasionally in the underlying stiff brown clay and glacial clay till. In general, the glacial till was stiff and became very stiff with depth. It was initially brown in colour and became dark grey near the 16 foot depth from grade. The glacial till was clayey, with some sand, gravel, cobble and boulder. The boulder content and frequency appeared to increase with depth.

On completion of the test drilling, no free water was noted in the testholes. However, all testholes were backfilled immediately after drilling. If these testholes were left open for a longer period of time, perched water tables may exist in the surficial sand and gravel layer and the permeable zones of the

brown clay and the underlying glacial till. Such water tables and the associated seepage volumes would likely fluctuate on a seasonal basis.

#### CONCLUSIONS AND RECOMMENDATIONS

#### Site Suitability

The results of our investigation have shown that there may be a post construction odour and fire hazard problems at this site due to the strong petroleum-like-odour and fairly high gasoline concentrations identified in our testholes, in the surficial black clay and the underlying sand & gravel which are located approximately between the depths of 3 and 9 ft. from the existing grade. If these potential odour and fire hazard problems are deemed tolerable to the owner, the following foundation recommendations may be considered.

#### Foundation Considerations

Foundation alternatives which we have considered, include footings, a stiffened slab foundation, cast-in-place concrete caissons and driven prestressed precast concrete piles.

Judging the soil conditions encountered in our testholes, footings and cast-in-place concrete caissons are <u>not</u> considered geotechnically viable. The variability in density and composition of the surficial soils will likely lead to considerable footing settlements. The presence of gasoline and water seepage in the upper sand and gravel and permeable zones of the glacial till will make the caisson construction quite costly and difficult.

In our opinion, either a stiffened slab on engineered fill or driven prestressed precast concrete piles may be utilized for supporting the proposed store addition. Among the two, driven prestressed precast concrete piles are considered as the <u>preferred</u> foundation alternative.

It is our understanding that the existing Canadian Tire Store may have been supported on a stiffened slab foundation which is underlain by 3 ft. of well compacted granular fill and that petroleum-like-odour was encountered during the previous soils

investigation for the existing store. However, it is not confirmed as to the type of foundation which was actually used for supporting the existing store and whether the contaminated soils had been removed during the store construction. In the absence of this information, we are not in a position to properly evaluate the construction viability of a stiffered slab foundation at this site. On the basis of our on-site discussion with the store manager and our site observations, the existing store appears to perform satisfactorily. Therefore, significant foundation economies for the proposed addition may result, if it can be proved that the existing store is supported on a stiffened slab and that the hydrocarbon contaminated soils under the existing store had not been removed. In this regard, an additional soils investigation with testholes being drilled inside and immediately adjacent to the store will have to be carried out. Details of this can be provided if desired.

#### Driven Piles

Driven prestressed precast concrete piles are considered as the preferred foundation type for supporting the proposed addition. These piles, when driven to practical refusal in the underlying very stiff dark grey clay till using a hammer capable of delivering at least 30,000 ft-lbs per blow, may be assigned the following allowable loads:

Pile_	Size	<u>Allowable_f</u>	<u> Pile Loads</u>
12"	Hex	50	tons
14"	Hex	70	tons
16"	Hex	90	tons

Pile spacings should not be less than 3 pile diameters centre to centre. Piles at groups should be monitored for heaving during the driving of adjacent units and redriving done, where pile heaving is found considerable.

One major draw back of the driven pile is that the pile driving will induce subsoil displacements and vibrations. Where piles are driven adjacent to the existing store, some structural damage

may result if precautions and proper driving procedures and sequence are not followed. To minimize this potential damage, the following should be considered:

- Where Piles are driven within 30 ft. of the existing store, reduced driving energy during initial driving and pre-boring to a minimum depth of 15 ft. from grade should be undertaken. Preboring should be conducted in such a manner that undermining of the existing store slab and foundations would not occur. In this regard, a temporary steel casing should be utilized where soil sloughing occurs within the proposed prebored depth. The annular space between the casing and the pile should be filled with properly tamped sand prior to casing removal.
- Settlement observation points should be established along the most northerly and easterly perimeter walls, <u>before and during pile driving</u>, to ensure that the pile induced vibrations and subsoil displacements have not adversely affected the existing store.

Even with the foregoing precautions, the potential for development of minor cosmetic cracks in the walls or slabs of the adjacent store may remain. The possible risk associated with the driven piles should be appreciated by the owner. For this reason, the viability of using a stiffened slab over engineered fill for the building addition should be assessed with an additional soils investigation, as recommended earlier.

It has been our experience that driven precast concrete piles will refuse at varying levels in the very stiff to hard clay till. The pile length selection would be best left for the piling contractors who are experienced in driven piles in the Brandon area. Our previous piling projects in Brandon would suggest that the required pile lengths were usually in the 20 to 40 foot range.

To ensure a satisfactory pile installation, <u>full time driven pile</u> <u>inspection</u> by qualified geotechnical personnel is strongly recommended.

#### Floor Support

Floor slabs on grade are permissible at this location, provided that subgrade preparation for floor construction is undertaken as follows:

- Remove and waste existing asphaltic concrete, organic, disturbed and softened soils.
- Excavate the existing granular fill with weeds/organics removed, to a minimum depth of 2' from existing grade. Store this fill at a suitable location for subsequent backfilling of the excavation.
- At the 2 foot excavation level, compact the exposed granular fill to 100% Standard Proctor density (ASTM D698).
- Remove soft spots, as directed by a qualified geotechnical engineer at the 2 foot excavation level and replace with on site granular fill compacted to at least 95% Standard Proctor density.
- After the subgrade is compacted and approved by a qualified geotechnical engineer, backfill the slab excavation with the granular fill previously excavated, which should be compacted in maximum 6" lifts, with a heavy vibratory roller and in a surface wet condition, to 100% Standard Proctor density. Immediately underneath the slab, a 6" thick layer of compacted, well-graded Class A base (3/4" crushed gravel) should be placed, the gradation limits of which are shown on Plate 9.

It should be noted that removal and the potential requirements for cleaning up of the underlying contaminated soils under the new slabs of the addition should be investigated by Canadian Tire Corporation Ltd. There are existing methods for extracting gasoline vapor or liquid from the contaminated subsoils. However, these "clean up" aspects are beyond the scope of this report.

#### Unheated Structures

Where driven piles are used for supporting lightly loaded unheated structures such as elevated propane tanks, adequate provisions for preventing <a href="frost\_jacking">frost\_jacking</a> of piles should be considered. As a general rule, a driven pile should have a minimum embedment depth of 27 ft. If this cannot be accomplished due to high pile refusal, the piles should be insulated with high quality rigid insulation panels which should extend at least 8' from the piles in all directions. The required thickness of the rigid insulation panel will depend on the actual pile embedment depth. It is expected that the panel thickness required may range from 2 to 4". The insulation panels should be protected

with at least 1' and 2' of earth cover for landscaped and traffic areas, respectively. Further details can be provided during construction, if needed.

#### Pavement Design

Suitable pavement sections at this location may consist of the following:

Torrowing.	Heavy Duty Truck_Route	Light Duty <u>Car_Parking</u>
Asphaltic Concrete	3"	2"
Class A Base (3/4" crushed gravel)	6"	3"
Class C Base (3" down pit run gravel)	9"	6"

It should be noted that the <u>existing granular fill may be used as Class C base</u>, provided that the organic and softened portion of the fill is wasted. The Class A base should be in conformity with the gradation limits shown on Plate 9.

Pavements should be constructed on a <u>prepared</u> subgrade, which should be prepared in a manner recommended previously for the slab-on-grade. In this regard, the existing granular fill in the pavement area should be scarified, reworked and recompacted to a minimum depth of 2' from the existing grade, prior to actual pavement construction.

Percent compaction for the existing granular fill, class C and A base materials should be 100% Standard Proctor density.

#### Underground Tanks and Utilities

Results of the soil resistivity tests show that the subsoils are highly corrosive to steel (especially test results for samples at 8', 10' & 15' - Plate 8). Therefore, corrosion protection for buried steel tanks or the like will be required.

Underground storage tanks are usually founded at depths of 12 to 14 feet from grade. The tank excavations will likely encroach

#### GEOKWAN ENGINEERING LTD.

onto the contaminated sand and gravel and may encounter water seepage. Some dewatering requirements should therefore be expected. Precautions should be taken to properly remove and dispose of the gasoline, if encountered. Open flame such as welding in the tank excavations should be prohibited, unless adequate safety measures are undertaken to avoid potential fire hazard and explosion associated with the gasoline. Similar precautions should be observed for the excavation and installation of underground utilities.

The underground tanks should be supported on a concrete pad bearing on the native undisturbed stiff clay till. The safety of empty tanks against <u>buoyancy</u> should be checked, with the ground water table assumed at the ground surface. The tanks should be back-filled with free draining pit run sand and fine gravel which should be compacted in uniform 6" lifts to 95% Standard Proctor density.

For the underground pipes (i.e. water, sewer, plumbing lines etc.), they should be made <u>leak proof and resistant against gasoline vapour and other hydrocarbon</u>, if the said gasoline and hydrocarbon are not removed from the subsoils identified in our testholes. Leakage of gasoline or hydrocarbon to sewer and water lines may create an environmental hazard.

It is likely that excavation for the underground utilities may carry to the contaminated sand and gravel. In this case, the removal of the gasoline and contaminated soils under and above these pipes should be considered. Replacement fill may include well graded pit run sand and gravel compacted to at least 95% Standard Proctor density.

#### Additional Considerations

All concrete in contact with the native subsoils should be manufactured with sulphate resistant cement and should be of high quality. Concrete subject to periodic freezing and thawing effects such as exterior sidewalk, curb and concrete slab should be air entrained in accordance with Table 8 of CSA Standard CAN3-A23.1-M77.

For design considerations, the maximum frost penetration depth may be taken as 5 and 9 ft. for heated and unheated structures, respectively.

Retaining structures should be designed against unit lateral earth stresses as follows;

P = k (q + wh) psf

p = unit lateral earth pressure at any depth of wall, h (psf)

k = estimated earth pressure coefficient

= 0.35 for yielding walls

= 0.5 for rigid walls

q = any surcharge adjacent to the wall (psf)

w = average soil unit weight

= 130 pcf

The above expression assumes that filter protected perforated drains will be installed at the base of the wall, so that there will be no build up of hydrostatic pressures behind the said wall.

For winter construction requirements, all newly poured foundations and bearing soils in all loaded areas should be adequately protected against frost action. Concrete should not be poured on frozen ground nor should frost be allowed to penetrate the foundations after construction.

Final site grading should ensure that all surface runoff is adequately drained away from the addition using gradients of 1 and 2% for paved and landscaped areas, respectively.

To ensure that the slabs on grade and pavements are constructed in the manner recommended, subgrade inspection and compaction testing of the granular fills (Class A & C base) should be undertaken by qualified geotechnical personnel during construction.

We trust that the foregoing is sufficient as per our terms of reference for the work. If you, however, have any further questions, please advise.

Yours truly,

GEOKWAN ENGINEERING LTD.

per:

Walter Kwan, M. Eng., P. Eng. Chief Engineer

WK:dh

Enclosure





REPORT NO. 229-02-01

PAGE 1 OF 1

#### SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.

110 - 1294 Border Street

Winnipeg, Manitoba

R3H OM7

Attn: Mr. Walter Kwan, M. Eng., P. Eng.

Geokwan Project No. 221

METHODOLOGY: Soil Box Method

One trial per sample, as per your instructions.

#### RESULTS:

Sample No.	Test Hole	Depth	Results	(ohms/cu.cm.)	
1	2	B-4 *	3	540	
2	2	B-8'	1	046	
3	2	B-10'		770	
4	2	B-15'		491	

#### NOTES:

For measurement, the soil samples were pressed by hand into the soil box to a density judged to be approximately the same as the clumps of soil in the original samples.

TECHNICIAN:

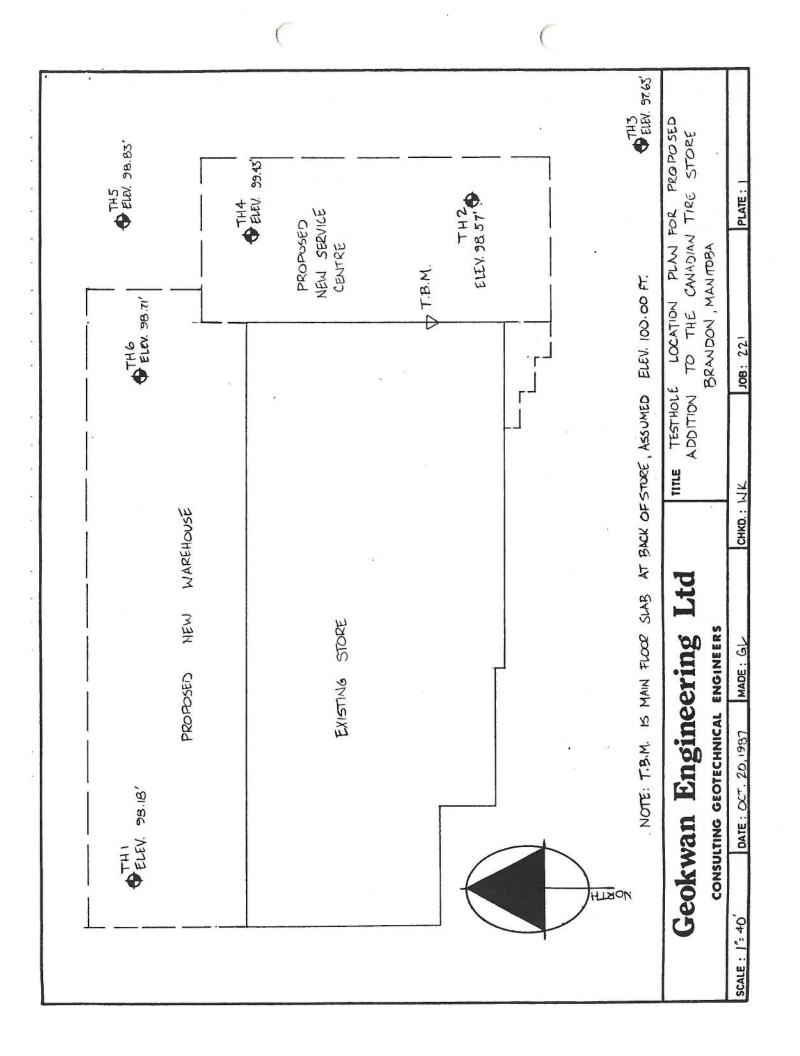
Wark Wormers

ai4/mdw

TELEVOT EEADS

PLATE 8

PROJECT 221



# Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

									,			
OGGED / DWN :	GL	СНКО. :	WK		DATE OF INV.: Oct 2/8	7	JOB:	221			TH 2	
10 20 3	0 40 50	60	(ft.)		SOIL DESCR	IPTION		S	OIL SA	MPLE	DRILL TYP	
W <sub>P</sub>	w <sub>L</sub> \( \triangle \) w	0	Ξ	90r	DATUM			ď	ш		5" Ø Au	
N 9255	CONTENT %		DEPTH	SOIL	SURFACE ELEVATION 9	8.57 ft	-	COND.	TYPE		PP* (ts	
		in	0	8.6.6	-ASPHALT						TITE LES	
		+++	1	$\Lambda$		•						
19 1 1		+++	1	IX	FILL - sand & grav - brown	eı					- G= 200	DDM
		+++	1	//	- compact						- 0- 200	PPIII
1911			5.0		CLAY - stiff, trac	e root]	lets					
			]	L	- sandy, silty, di	esel fu	iel-like	st	ains		0.57	
				94	SAND & GRAVEL						G= 450	0 рр
		$\sqcup$	4	5	- fine, moist to w	et						
		+++	1	5	- clayey below 8' - "diesel-like" fu	iel sta	ine				- G= 425	0 рр
11/9/9	$\cdots$	+++	10.0	2	diesei like le	ici sta	1113	-				
1111	++++	+++		V	<u>CLAY</u> - stiff, brow							
		+++	1	V	- silty, till-like - trace sand	struc	ture					
<del>                                     </del>		+++	1	1				1	,			
<del>                                     </del>		+++	┨	M	CLAY TILL	572820 2				1		
		+++	15.0	111	- very stiff to st	iff, b	rown				1.50	
+++//-		+++	1	M	- silty, sandy - some gravel				1		1	
++++		+++	1	W	- occasional grey	fine, n	noist			1		
111/11	111/1	.111	1	H	sand layers							
ПДП			1	KI	- dark grey at 16'						1.12	
THI	ППТ	141	20.0	1	- trace cobble & 1	ourder					1.12	
			]									
			]	111	.1							
											1	
			25.0	W							-2.22	
								1				
		$\perp \downarrow \downarrow$	1	KII	•							
ШШ	Ш	+++	1		1				1			
$\square$	++++	+++	-					1			1	
<del>                                     </del>	++++	+++	30.0	1	F-1 1-1 20 ft			+	<del> </del>	-	+	
+++++	++++	+++	-		End hole at 30 ft. stiff clay till.	in ve	гу			1		
b   10	<del>20   30   4</del> 0	1 50			Julia Cia, Cill.				1		1	
<del>  <b>         </b>                           </del>		+11	-{		NOTE		18				1	
	لللال		-					1		1		
→ Dynai	mic Cone '	Test	35.0		petroleum like sme 9', very strong pe					1		
1 1 1 1	ws per 10	1	1		from 6 to 9'.	crored	" Smell		1			
++++	++++	+++	1								1	
++++	++++	+++	1									
	<del>           </del>	+++	٦,,,									
++++	11111	111	40.0	1								
	11111	+	7									
++++	<del>                                     </del>	+++	7								PLATE	3

# Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION

CONSULTING GEOTECHNICAL ENGINEERS

BRANDON, MANITOBA

LOCATE LEWIS OF	Tours in		DAYE OF INV . O .	0.407	JOB: 22			$\top$	mu 1	
LOGGED / DWN: GL	CHKD.: W		DATE OF INV. : Oct	DESCRIPTION	JOB: 22		OIL SAN	DI E	TH 1	
10 20 30 40 50	,,,,			DESCRIPTION				irte	5" Ø A	uger
Wp □ W <sub>I</sub> △ W	OEP7H	SOIL	DATUM	00 10 6.	4	COND.	TYPE		OTHER TE	District (
WATER CONTENT %		N W				٥	-		PP* (t	sf)
		$\mathbb{N}$	FILL - sand & - loose, brown							-
	+++	$\Lambda$	- weed covered							-
	++++		CLAY - stiff, b	lack, trace	rootlets				- G= 150 - 2.40	ppm —
<del>                                     </del>	5.0	1	sandy, silty				n		2.40	
	1111 3.0	٦	SAND & GRAVEL	- fine, moi	st				-0.63	_
40/-			- clayey - some "diesel	_1:1!! £1					G= 4000	) ppm_
	4444	13.3		eat						-
	<del></del>		CLAY - stiff, - 2" sand laye							
H-1-1-1	10.0	WI	2 Sand Tay	a seepage	; at 9 0	1			1.68	-
		111	CLAY TILL							
		MI.	- very stiff t							
	Ш	W	- silty, some - dark grey at							-
7	15.0	11	- occasional s						1.38	
	++++	11/1	- trace cobble	& boulder						-
<del></del>	++++	H1							1	V-
	+		1							_
	20.0		1				- (2)		-1.25	_
	20.0	1	•			1				_
			1							_
1	+++									-
	+H+	$\mathbb{H}$				ĺ				-
<del>                                     </del>	25.0		1						-2.42	-
			,							
		11	:							_
			1							× <del></del>
1-1-61-1-1-1-1	30.0	,	P 11 1 2	<u> </u>		$\vdash$			2.58	
	+++		End hole at 30 clay till.	) in very s	stiff					-
0 10 20 30 40	50									_
	+++1		NOTES							12 Table 1
□ ∇ Dynamic Cone	Test 35.0		1) PP* = small							
(blows per fo	oot)			augered cu	<i>5</i> 70.					_
	++++		2) G = Gastec	Gasoline An n hole after						-
	++++			for 2 hours						
	++++		3) Petroleum 1							Alternative Control
	40.0		8', very st	rong odor b					1	
			6 and 8'.							2
						L			PLATE	

### Geokwan Engineering Ltd

PROPOSED CANADIAN TIRE ADDITION

TESTHOLE LOG

CONSULTING GEOTECHNICAL ENGINEERS  BRANDON, MANITOBA										
GGED / DWN :	GL CHK	).: WK		DATE OF INV. : Oct	2/87	JOB:	22	1		TH 3
10 20 30	40 50 60	(ft.)		. SOIL D	ESCRIPTION		50	DIL SAN	<b>IPLE</b>	DRILL TYPE
		(A) 10 (A) 10 (A) 10 (A)	ğ	DATUM			o l	ш		5" Ø Auger
Wp Wi Z		DEPTH	YME	DATUM SURFACE ELEVATION	97 63 ft		COND.	TYPE		1
WATER CO	NTENT %	0	0,01	FILL	37.03 10	- •	H	_		PP* (tsf)
+++++	++++	H	1\ /	- sand & gravel				1		
	++++	Н	11	- loose						
++++++	++++	H	$I\Lambda$	- 3/4" max. siz	e approx.					
	++++	5.0	1	- dry						
	1111	73.0		CLAY - stiff, h						
				\- trace diesel		stain				
				SAND AND GRAVEI						
		Ц.	2	- wet to satura	e at 7'8"	1				
		10.0		- slight seepag - clayey below	8'		_		_	-
	++++	H		End Hole at 10	ft.					
	++++	H								
	++++	H		NOTE						
++++++	++++	H		HOLE						
<del>┞╏╏╏</del>	++++	15.0		Strong petrole	um like sme	ell was				
<del>├┼╎</del> ┼┼┼┤	<del></del>	H		noted from 3 ft	t. to 8 ft	. from				
+++++++	++++	Ħ		grade.						1
	1111	П							1	
	1111	20.0							1	
		T 20.0							1	
		П								1
		Ц							1	
	++++	Н							1	
	++++	25.0							1	
+++++	++++	H								
+++++	++++	H			E.			1	1	
+++++	+++++	H								
<del>                                     </del>	++++	Ħ						1		
<del>                                     </del>		30.0								
		Ш								
		35.0		1				1		
		H								
+++++	+++++	H					1		1	1
++++	HHH	+								
++++-	++++	+								
<del>     </del>	+++++	40.0								
+++++	+++++	$\forall$								
<del>                                     </del>	<del>                                     </del>	11								PLATE 4

## Geokwan Engineering Ltd PROJECT

#### TESTHOLE LOG

CONSULTING GEOTECHNICAL ENGINEERS

PROPOSED CANADIAN TIRE ADDITION

Wp W1 A W O B SURFACE ELEVATION 99.43 ft. SURFACE ELEVATION 99.43 ft. SURFACE ELEVATION 99.43 ft. CLAY - stiff	TH 4 DRILL TYPE 5" Ø Auger DTHER TESTS
Wp W1 A W O W SURFACE ELEVATION 99.43 ft. O SPANNED O ASPHALT FILL - sand & gravel CLAY - stiff	5" Ø Auger
WATER CONTENT %.  WATER CONTENT %.  O  SURFACE ELEVATION 99.43 ft.  O  CLAY - stiff	
O ASPHALT  FILL - sand & gravel  - loose  CLAY - stiff	JIHER TESTS
O ASPHALT  FILL - sand & gravel  - loose  CLAY - stiff	
FILL - sand & gravel - loose  CLAY - stiff	
- loose  CLAY - stiff	
CLAY - stiff	
5.0 - diesel fuel like stains	
SAND AND GRAVEL	•
- fine, moist to wet	
- some clay - diesel fuel like stains	
CLAY - stiff, brown	* *
- silty, sandy	-
CLAY TILL	
- very stiff, brown	
- silty	
- firm, wet sand layers - some fine gravel	
15.0   - dark grey at 15'	
- trace cobble & boulder	
20.0 End Hole at 20 ft. from grade.	
NOTE:	
NOTE	
Petroleum like odour from 3 to	
8 ft., very strong odour	
between 5 and 8 ft.	
<del>                                     </del>	
35.0	
	_
<del>                                     </del>	_
<del>                                      </del>	
<del>╎╎╎╎╎╎╎╎╎╎</del>	PLATE 5

Geokwan I	Indinger	ing Itd	TESTH	OLI	E LC	)G
	OTECHNICAL ENG		PROPOSED CAN		TIRE A	DDITION
OGGED / DWN: GL	CHKD.: WK	DATE OF INV. : Oct 2/	37 JOB: 22	1		TH 5
10 20 30 40 50	60 (ft.)	SOIL DESC	RIPTION	SOIL	SAMPLE	DRILL TYPE
	T III	DATUM SURFACE ELEVATION	98.83 ft.	COND.		5" Ø Auger OTHER TESTS
	5.0 10.0 15.0 20.0 25.0 35.0	FILL - sand & gravel - weed covered  CLAY - stiff, black - some diesel fue - grey at 6 ft till like struc at 9 ft.  CLAY TILL - stiff to very s - brown, dark gre - occasional 2" t sand layers - some gravel, tr  End Hole at 20 ft  NOTE  Petroleum like of 3 to 7 ft. from g	tiff y at 16' hick saturated ace cobble  from grade.			PLATE 6

# Geokwan Engineering Ltd PROJECT PROPOSED CANADIAN TIRE ADDITION BRANDON, MANITOBA

	T	-		T				
LOGGED / DWN : GL	CHKD.: WK	_	DATE OF INV.: Oct 2/87	JOB: 22	Т		丄	TH 6
10 20 30 40 50	60 (ft.)		SOIL DESCRIPTION		S	DIL SA	MPLE	DRILL TYPE
Wp W W W	<del></del>	80 F	DATUM SURFACE ELEVATION 98.71 f		اه	ш		5" Ø Auger OTHER TESTS
WATER CONTENT %	Ιū	SOIL	SURFACE ELEVATION 98.71 f	t.	COND.	TYPE		OTTLER TESTS
	1110	1	FILL		$\Box$		0	
<del>                                      </del>	HH	IV	- sand & gravel					
<del>+++++++</del>			- brown					
	$\Pi\Pi$		CLAY - stiff					
	5.0	1/	- diesel fuel like stain	s				_
		1.5	SAND & GRAVEL		1			-
			- fine, moist					i
	1111	-	- some clay					-
<del></del>	+++-1	Y	<u>CLAY</u> - stiff, brown - silty, sandy					-
<del></del>	10.0	1/1						_
<del>                                     </del>	++-+-	III.	CLAY TILL - stiff to very stiff					-
<del>          </del>	<del>       </del>	J.W	- brown, some fine grave	1				-
<del>                                     </del>	+++	M	- dark grey at 15 ft.					
	1111	JH.	- occasional wet sand la - trace cobble & boulder					
	15.0		trace copple a boarder					
		M						_
	+++							-
	4444	M	=					_
+++++++	20.0	b X			Н			
+++++++	++++		End Hole at 20 ft. from	grade.				
<del>+++++++++++++++++++++++++++++++++++++</del>	++++		,					-
<del></del>	+++							-
<del>11111111</del>	25.0		NOTE					_
	25.0							_
			Petroleum like odour bet 3 and 7 ft. from grade,					_
			strong odour from 5 to 7	ft.				_
	444							_
<del></del>	30.0							
<del></del>	++++							-
<del>++++++</del>	++++							_
<del></del>	+++	1						_
<del>++++++</del>	++++	1						_
	35.0							
								_
	4444							
<del>-{                                    </del>	40.0							
╅	+++							-
<del></del>	+++	1						PLATE 7