Geokwan Engineering Ltd
CONSULTING GEOTECHNICAL ENGINEERS

October 30, 1987

COPY

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 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.

GE
110—1294 BORDER STREET WINNIPEG CANADA R3H 0M7
TELEPHONE (204) 694-4835 TELEX 07—587873

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, Winnipeg. 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,

GEOKWAN ENGINEERING LTD.
per:

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

WK:dh

Enclosure

NORENCO
ASSOCIATED LTD.
ENGINEERING AND
RESOURCE CONSULTANTS

REPORT NO. 229-02-01

SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.
110 - 1294 Border Street
Winnipeg, Manitoba
R3H 0M7

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: Mark Wanner

ai4/mdw

PLATE 8

PROJECT 221

COPY

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

GE

110—1294 BORDER STREET WINNIPEG CANADA R3H 0M7
TELEPHONE (204) 694-4835 TELEX 07—587873

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 Pavement

	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

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 crushed 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, petroleum like odour 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 From Grade (ft)	Measured Gasoline Concentrations (ppm)
TH 1	3	150
	6	4000
	9	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 corrosion 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 soil resistivity tests 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 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 preferred 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	Allowable Pile Loads
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, before and during pile driving, 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, full time driven pile inspection 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 frost jacking 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 buoyancy 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.

Pavement Design

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

	Heavy Duty Truck Route	Light Duty Car Parking
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 existing granular fill may be used as Class C base, 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 prepared 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

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

PROVINCE OF MANITOBA
W. W. KWAN
oct. 21/87
REGISTERED ENGINEER

NORENCO
ASSOCIATED LTD
ENGINEERING AND
RESOURCE CONSULTANTS

REPORT NO. 229-02-01

SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.
110 - 1294 Border Street
Winnipeg, Manitoba
R3H 0M7

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

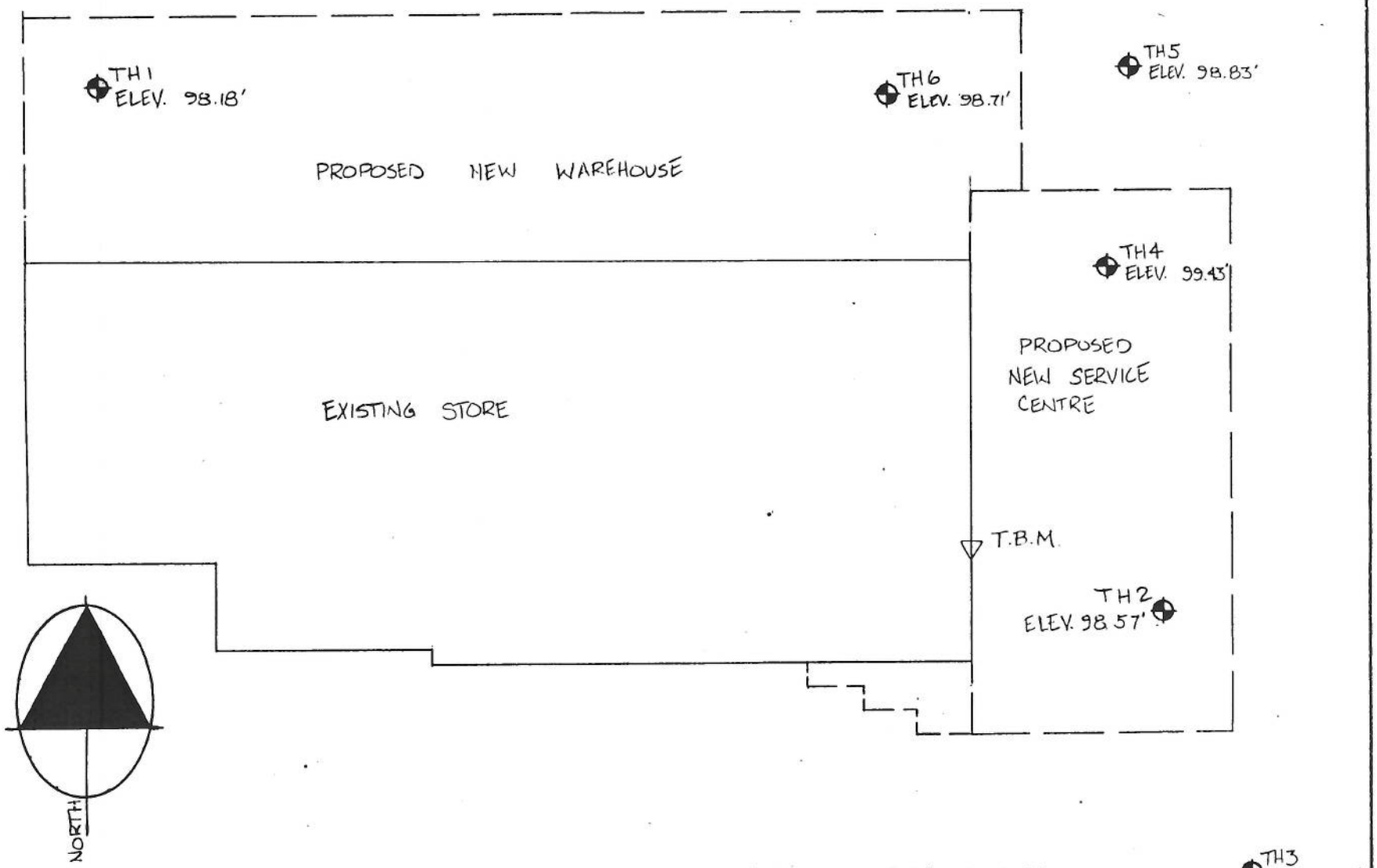
NOTES:

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: Mark Wannek

ai4/mdw

PLATE 8
PROJECT 221



NOTE: T.B.M. IS MAIN FLOOR SLAB AT BACK OF STORE, ASSUMED ELEV. 100.00 FT.

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TITLE TESTHOLE LOCATION PLAN FOR PROPOSED ADDITION TO THE CANADIAN TIRE STORE BRANDON, MANITOBA

SCALE : 1" = 40'	DATE : OCT. 20, 1987	MADE : GL	CHKD. : WK	JOB : 221	PLATE : 1

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

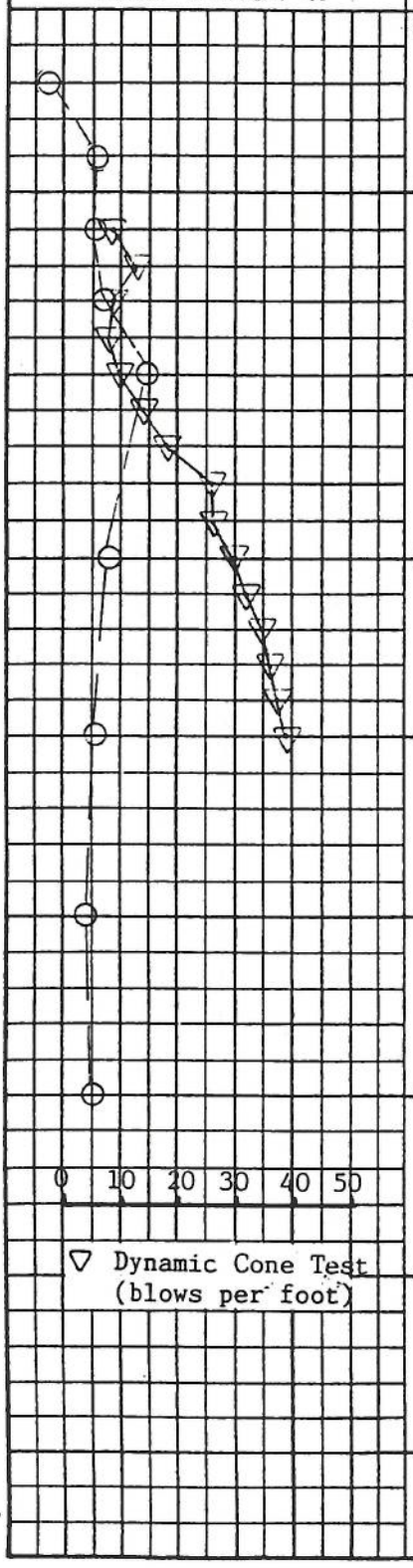
TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL | CHKD.: WK | DATE OF INV.: Oct 2/87 | JOB: 221 | TH 1

DRILL TYPE: 5" Ø Auger

OTHER TESTS: PP* (tsf)



SOIL SYMBOL	SOIL DESCRIPTION	COND.	TYPE	PP* (tsf)
	DATUM SURFACE ELEVATION 98.18 ft.			
	FILL - sand & gravel - loose, brown - weed covered			
	CLAY - stiff, black, trace rootlets - sandy, silty, diesel fuel-like stain			G= 150 ppm 2.40
	SAND & GRAVEL - fine, moist - clayey - some "diesel-like" fuel stains			0.63 G= 4000 ppm
	CLAY - stiff, brown, silty - 2" sand layer & seepage at 9'6"			1.68
	CLAY TILL - very stiff to stiff, brown - silty, some fine gravel - dark grey at 16' - occasional sand layers - trace cobble & boulder			1.38 1.25 2.42
	End hole at 30' in very stiff clay till.			2.58

NOTES

1) PP* = small scale penetrometer readings on augered cuttings.
2) G = Gastec Gasoline Analyzer readings in hole after hole was sealed for 2 hours.
3) Petroleum like odor form 3 to 8', very strong odor between 6 and 8'.

PLATE 2

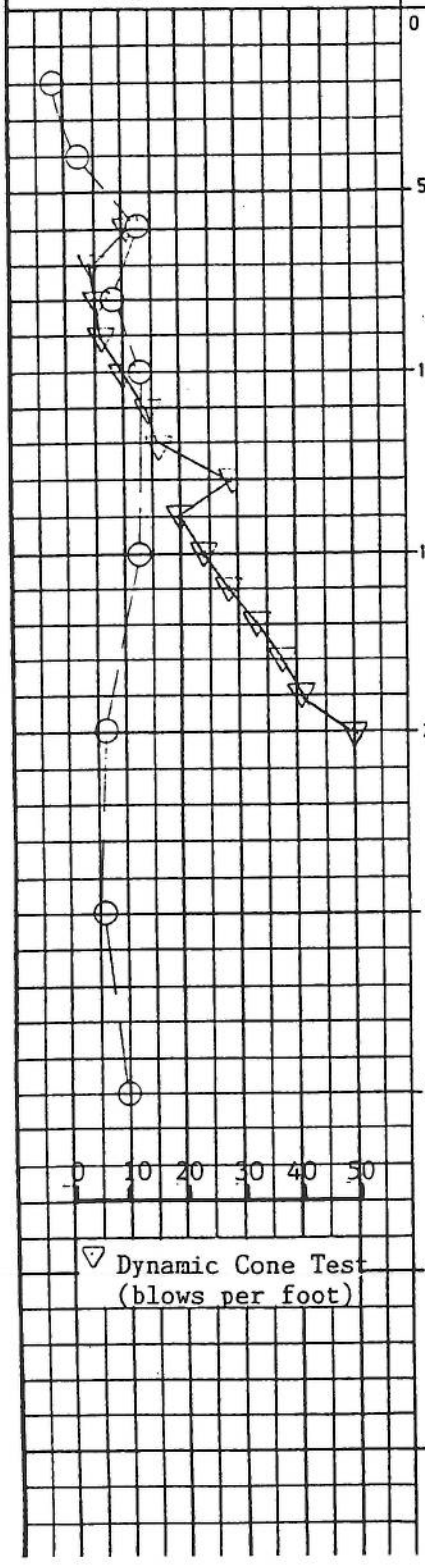
Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 2



SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
	DATUM SURFACE ELEVATION 98.57 ft.			
	ASPHALT			
	FILL - sand & gravel - brown - compact			G= 200 ppm
	CLAY - stiff, trace rootlets - sandy, silty, diesel fuel-like stains			0.57 G= 4500 ppm
	SAND & GRAVEL - fine, moist to wet - clayey below 8' - "diesel-like" fuel stains			G= 4250 ppm
	CLAY - stiff, brown - silty, till-like structure - trace sand			
	CLAY TILL - very stiff to stiff, brown - silty, sandy - some gravel - occasional grey fine, moist sand layers - dark grey at 16' - trace cobble & boulder			1.50 1.12 2.22
	End hole at 30 ft. in very stiff clay till. NOTE petroleum like smell from 3 to 9', very strong petroleum smell from 6 to 9'.			

PLATE 3

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 3

WATER CONTENT %: 10 20 30 40 50 60 — W_p □ W_l △ W ○

DRILL TYPE: 5" Ø Auger

OTHER TESTS: PP* (tsf)

DATUM

SURFACE ELEVATION 97.63 ft.

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE
0		FILL - sand & gravel - loose - 3/4" max. size approx. - dry		
5.0		CLAY - stiff, black, sandy - trace diesel fuel like stain		
		SAND AND GRAVEL - wet to saturated, brown - slight seepage at 7'8" - clayey below 8'		
10.0		End Hole at 10 ft.		
		NOTE Strong petroleum like smell was noted from 3 ft. to 8 ft. from grade.		
15.0				
20.0				
25.0				
30.0				
35.0				
40.0				

PLATE 4

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT

PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 4

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 99.43 ft.			5" Ø Auger
0		ASPHALT			
		FILL - sand & gravel - loose			
5.0		CLAY - stiff - diesel fuel like stains			
		SAND AND GRAVEL - fine, moist to wet - some clay - diesel fuel like stains			
10.0		CLAY - stiff, brown - silty, sandy			
		CLAY TILL - very stiff, brown - silty - firm, wet sand layers - some fine gravel - dark grey at 15' - trace cobble & boulder			
15.0					
20.0		End Hole at 20 ft. from grade.			
		NOTE Petroleum like odour from 3 to 8 ft., very strong odour between 5 and 8 ft.			
25.0					
30.0					
35.0					
40.0					

PLATE 5

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT

PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 5

10 20 30 40 50 60

W_p □ W_l △ W ○

WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
0		DATUM SURFACE ELEVATION 98.83 ft.			5" Ø Auger
0		FILL - sand & gravel - weed covered			
5.0		CLAY - stiff, black - 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			
20.0		End Hole at 20 ft. from grade.			
25.0		NOTE Petroleum like odour from 3 to 7 ft. from grade.			
30.0					
35.0					
40.0					

PLATE 6

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 6

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 98.71 ft.			DRILL TYPE: 5" Ø Auger OTHER TESTS
0		FILL - sand & gravel - brown			
5.0		CLAY - stiff - diesel fuel like stains			
		SAND & GRAVEL - fine, moist - some clay			
10.0		CLAY - stiff, brown - silty, sandy			
		CLAY TILL - stiff to very stiff - brown, some fine gravel - dark grey at 15 ft. - occasional wet sand layers - trace cobble & boulder			
15.0					
20.0		End Hole at 20 ft. from grade.			
25.0		NOTE Petroleum like odour between 3 and 7 ft. from grade, very strong odour from 5 to 7 ft.			
30.0					
35.0					
40.0					

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

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 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 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.

GE

110—1294 BORDER STREET WINNIPEG CANADA R3H 0M7
TELEPHONE (204) 694-4835 TELEX 07—587873

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, Winnipeg. 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,

GEOKWAN ENGINEERING LTD.
per:

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

WK:dh

Enclosure

NORENCO
ASSOCIATED LTD.
ENGINEERING AND
RESOURCE CONSULTANTS

REPORT NO. 229-02-01

SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.
110 - 1294 Border Street
Winnipeg, Manitoba
R3H 0M7

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: Mark Wanner

ai4/mdw

COPY

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

GE
110—1294 BORDER STREET WINNIPEG CANADA R3H 0M7
TELEPHONE (204) 694-4835 TELEX 07—587873

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 Pavement

	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

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 crushed 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 From Grade (ft)	Measured Gasoline Concentrations (ppm)
TH 1	3	150
	6	4000
	9	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 corrosion 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 soil resistivity tests 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, petroleum like odour 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 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 preferred 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	Allowable Pile Loads
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, before and during pile driving, 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, full time driven pile inspection 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 frost jacking 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:

	Heavy Duty Truck Route	Light Duty Car Parking
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 existing granular fill may be used as Class C base, 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 prepared 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. 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 buoyancy 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.

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

PROVINCE OF MANITOBA
W. W. KWAN
OCT. 21/87
REGISTERED ENGINEER

NORENCO
ASSOCIATED LTD.
ENGINEERING AND
RESOURCE CONSULTANTS

REPORT NO. 229-02-01

SOIL RESISTIVITY TEST RESULTS

DATE: OCTOBER 7, 1987

FOR: Geokwan Engineering Ltd.
110 - 1294 Border Street
Winnipeg, Manitoba
R3H 0M7

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

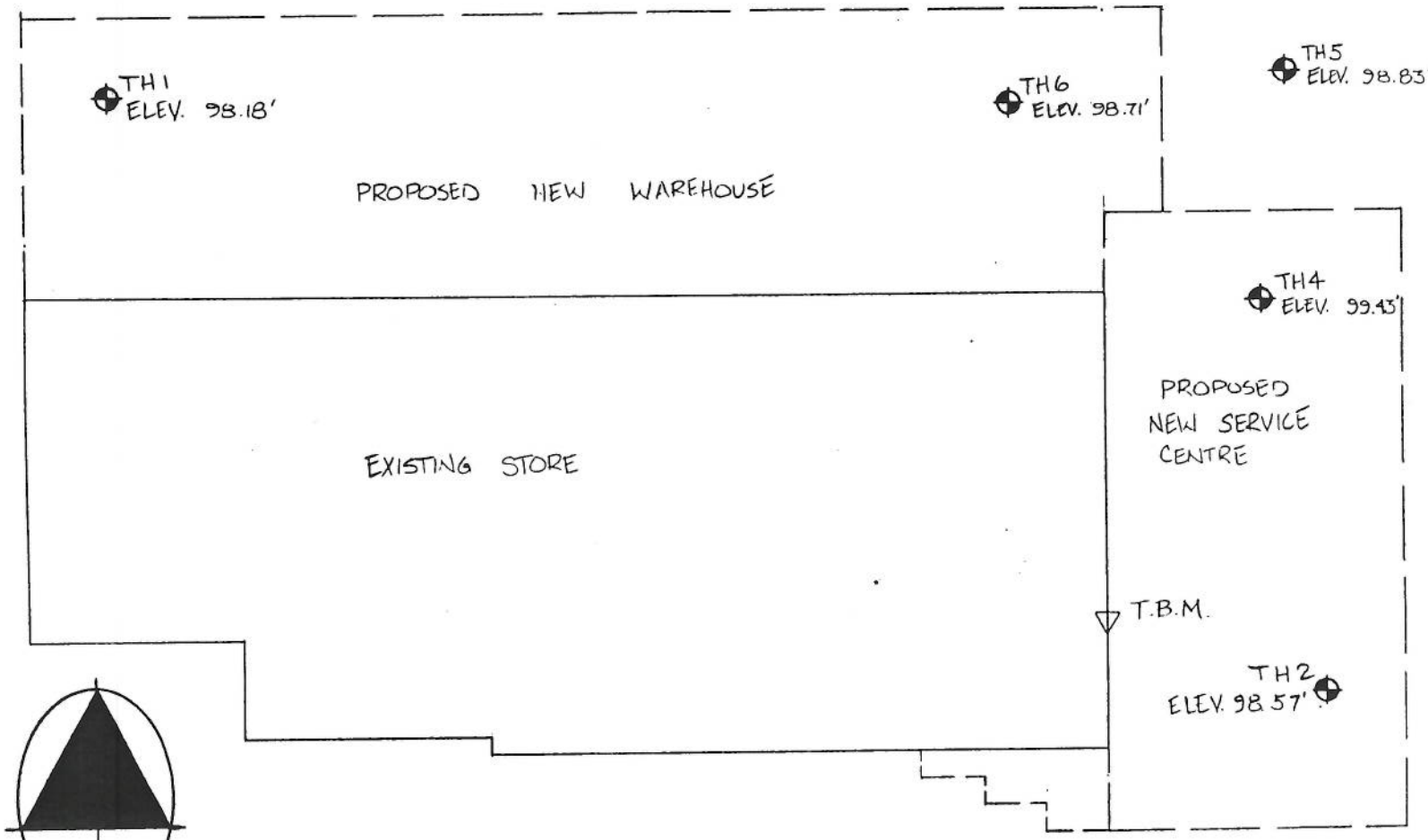
NOTES:

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: Mark Wenneck

ai4/mdw

PLATE 8
PROJECT 221



NOTE: T.B.M. IS MAIN FLOOR SLAB AT BACK OF STORE, ASSUMED ELEV. 100.00 FT.

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TITLE TESTHOLE LOCATION PLAN FOR PROPOSED ADDITION TO THE CANADIAN TIRE STORE BRANDON, MANITOBA

SCALE : 1"=40'	DATE : OCT. 20, 1987	MADE : GL	CHKD. : WK	JOB : 221	PLATE : 1

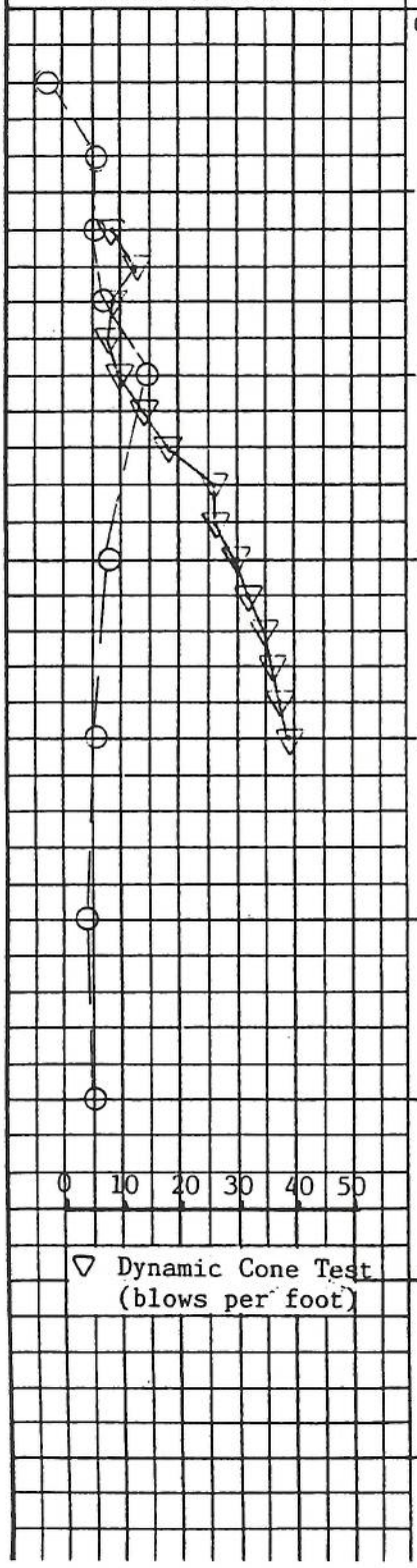
Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 1



SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
	DATUM SURFACE ELEVATION 98.18 ft.			
	FILL – sand & gravel – loose, brown – weed covered			G= 150 ppm
	CLAY – stiff, black, trace rootlets – sandy, silty, diesel fuel-like stain			2.40
	SAND & GRAVEL – fine, moist – clayey – some "diesel-like" fuel stains			0.63 G= 4000 ppm
	CLAY – stiff, brown, silty – 2" sand layer & seepage at 9'6"			1.68
	CLAY TILL – very stiff to stiff, brown – silty, some fine gravel – dark grey at 16' – occasional sand layers – trace cobble & boulder			1.38 1.25 2.42
	End hole at 30' in very stiff clay till.			2.58

NOTES

1) PP* = small scale penetrometer readings on augered cuttings.
2) G = Gastec Gasoline Analyzer readings in hole after hole was sealed for 2 hours.
3) Petroleum like odor form 3 to 8', very strong odor between 6 and 8'.

PLATE 2

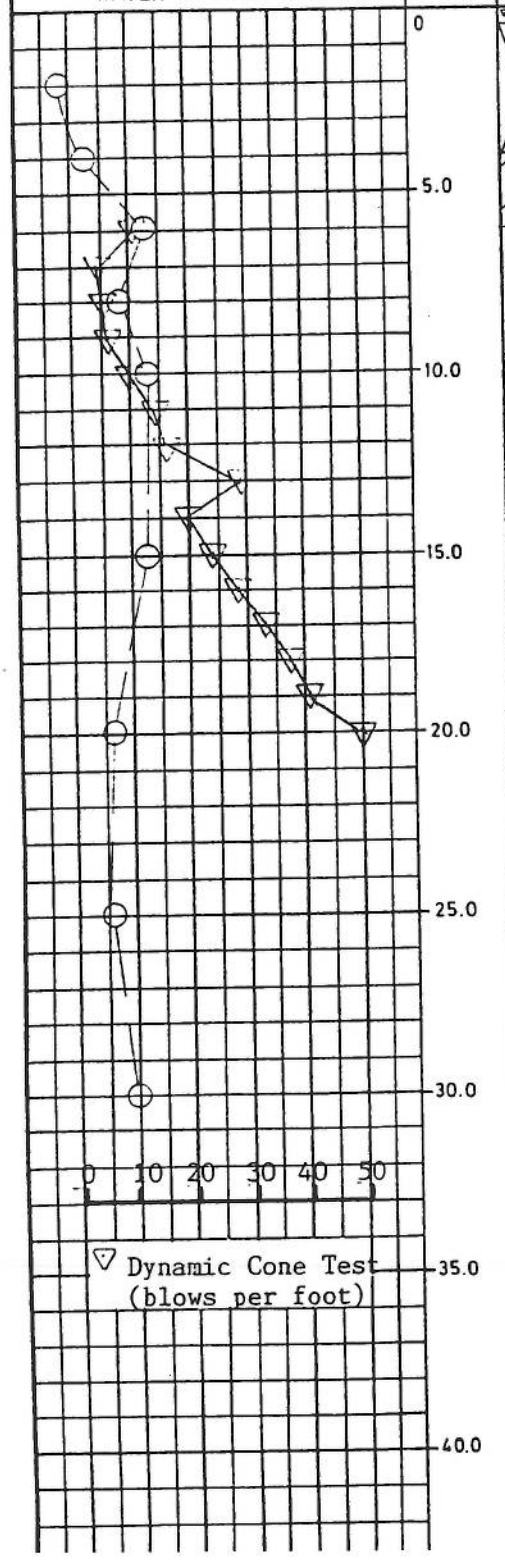
Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 2



SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
	DATUM SURFACE ELEVATION 98.57 ft.			
	ASPHALT			
	FILL - sand & gravel - brown - compact			G= 200 ppm
	CLAY - stiff, trace rootlets - sandy, silty, diesel fuel-like stains			0.57 G= 4500 ppm
	SAND & GRAVEL - fine, moist to wet - clayey below 8' - "diesel-like" fuel stains			G= 4250 ppm
	CLAY - stiff, brown - silty, till-like structure - trace sand			
	CLAY TILL - very stiff to stiff, brown - silty, sandy - some gravel - occasional grey fine, moist sand layers - dark grey at 16' - trace cobble & boulder			1.50 1.12 2.22
	End hole at 30 ft. in very stiff clay till.			
	NOTE petroleum like smell from 3 to 9', very strong petroleum smell from 6 to 9'.			

PLATE 3

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 3

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DRILL TYPE: 5" Ø Auger
OTHER TESTS: PP* (tsf)

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE
		DATUM SURFACE ELEVATION 97.63 ft.		
0		FILL - sand & gravel - loose - 3/4" max. size approx. - dry		
5.0		CLAY - stiff, black, sandy - trace diesel fuel like stain		
10.0		SAND AND GRAVEL - wet to saturated, brown - slight seepage at 7'8" - clayey below 8'		
		End Hole at 10 ft.		
15.0		NOTE Strong petroleum like smell was noted from 3 ft. to 8 ft. from grade.		
20.0				
25.0				
30.0				
35.0				
40.0				

PLATE 4

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT

PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 4

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 99.43 ft.			5" Ø Auger
0		ASPHALT			
		FILL - sand & gravel - loose			
		CLAY - stiff - diesel fuel like stains			
5.0		SAND AND GRAVEL - fine, moist to wet - some clay - diesel fuel like stains			
		CLAY - stiff, brown - silty, sandy			
10.0		CLAY TILL - very stiff, brown - silty - firm, wet sand layers - some fine gravel - dark grey at 15' - trace cobble & boulder			
15.0					
20.0		End Hole at 20 ft. from grade.			
		NOTE Petroleum like odour from 3 to 8 ft., very strong odour between 5 and 8 ft.			
25.0					
30.0					
35.0					
40.0					

PLATE 5

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT

PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 5

10 20 30 40 50 60

W_p □ W_l △ W ○

WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 98.83 ft.			5" Ø Auger
0		FILL - sand & gravel - weed covered			
5.0		CLAY - stiff, black - 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.			
25.0		NOTE Petroleum like odour from 3 to 7 ft. from grade.			
30.0					
35.0					
40.0					

PLATE 6

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 6

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DRILL TYPE: 5" Ø Auger

OTHER TESTS

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE
		DATUM SURFACE ELEVATION 98.71 ft.		
0		FILL - sand & gravel - brown		
5.0		CLAY - stiff - diesel fuel like stains		
		SAND & GRAVEL - fine, moist - some clay		
		CLAY - stiff, brown - silty, sandy		
10.0		CLAY TILL - stiff to very stiff - brown, some fine gravel - dark grey at 15 ft. - occasional wet sand layers - trace cobble & boulder		
15.0				
20.0		End Hole at 20 ft. from grade.		
25.0		NOTE Petroleum like odour between 3 and 7 ft. from grade, very strong odour from 5 to 7 ft.		
30.0				
35.0				
40.0				

PLATE 7

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

GE
110—1284 BORDER STREET WINNIPEG CANADA R3H 0M7
TELEPHONE (204) 694-4835 TELEX 07—587873

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 Pavement

	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

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 crushed 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 From Grade (ft)	Measured Gasoline Concentrations (ppm)
TH 1	3	150
	6	4000
	9	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 corrosion 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 soil resistivity tests 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, petroleum like odour 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 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 preferred 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	Allowable Pile Loads
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, before and during pile driving, 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, full time driven pile inspection 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 frost jacking 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:

	Heavy Duty Truck Route	Light Duty Car Parking
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 existing granular fill may be used as Class C base, 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 prepared 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. 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 buoyancy 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.

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.

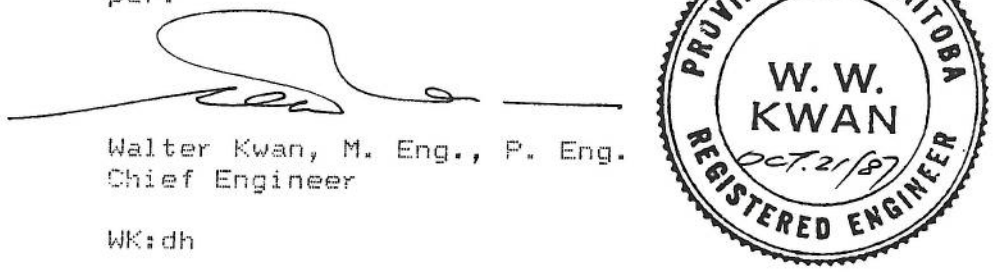
Final site grading should ensure that all surface runoff is adequately drained away from the addition using gradients of 1 and 2% for paved and landscaped areas, respectively.

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

NORENCO
ASSOCIATED LTD
ENGINEERING AND
RESOURCE CONSULTANTS

REPORT NO. 229-02-01

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

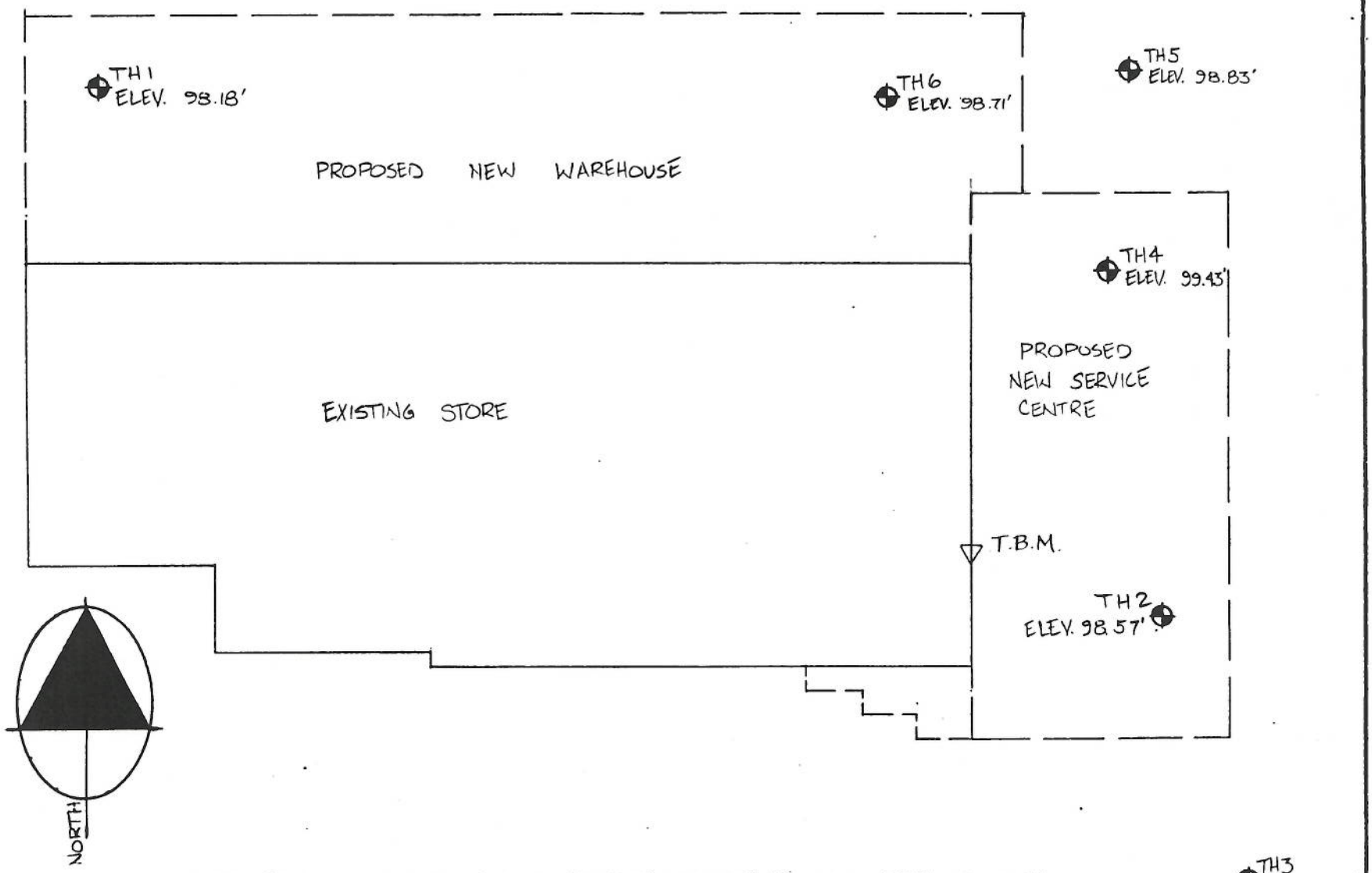
NOTES:

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: Mark Wennerth

ai4/mdw

PLATE 8
PROJECT 221



NOTE: T.B.M. IS MAIN FLOOR SLAB AT BACK OF STORE, ASSUMED ELEV. 100.00 FT.

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TITLE TESTHOLE LOCATION PLAN FOR PROPOSED ADDITION TO THE CANADIAN TIRE STORE BRANDON, MANITOBA

SCALE : 1"= 40'	DATE : OCT. 20, 1987	MADE : GL	CHKD. : WK	JOB : 221	PLATE : 1

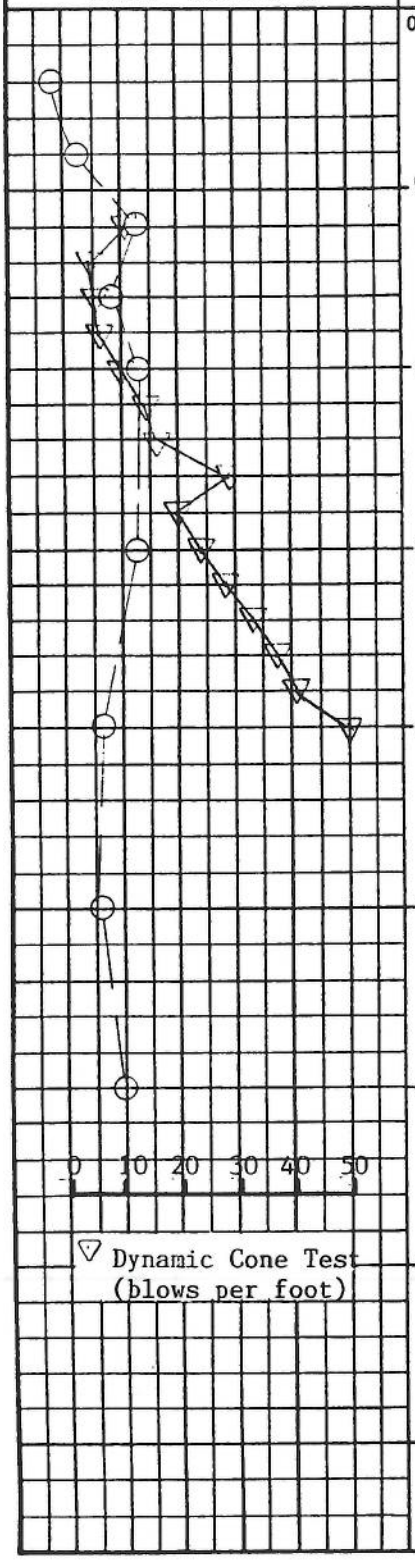
Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 2



SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
	DATUM SURFACE ELEVATION 98.57 ft.			
	ASPHALT			
	FILL - sand & gravel - brown - compact			G= 200 ppm
	CLAY - stiff, trace rootlets - sandy, silty, diesel fuel-like stains			0.57 G= 4500 ppm
	SAND & GRAVEL - fine, moist to wet - clayey below 8' - "diesel-like" fuel stains			G= 4250 ppm
	CLAY - stiff, brown - silty, till-like structure - trace sand			
	CLAY TILL - very stiff to stiff, brown - silty, sandy - some gravel - occasional grey fine, moist sand layers - dark grey at 16' - trace cobble & boulder			1.50 1.12 2.22
	End hole at 30 ft. in very stiff clay till. NOTE petroleum like smell from 3 to 9', very strong petroleum smell from 6 to 9'.			

PLATE 3

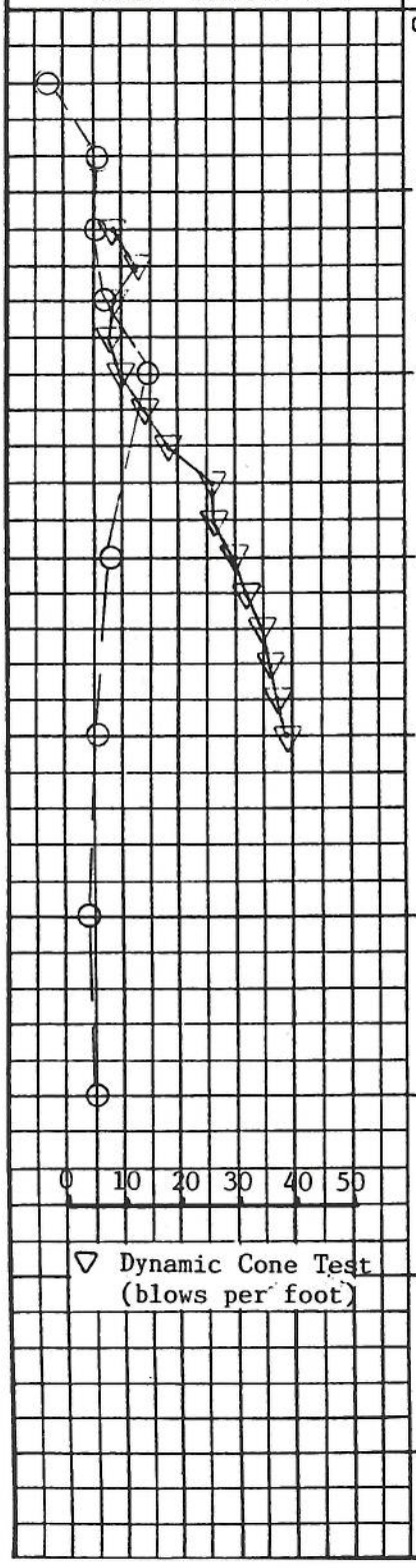
Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 1



DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
		DATUM SURFACE ELEVATION 98.18 ft.			
0		FILL - sand & gravel - loose, brown - weed covered			
		CLAY - stiff, black, trace rootlets - sandy, silty, diesel fuel-like stain			G= 150 ppm 2.40
5.0		SAND & GRAVEL - fine, moist - clayey - some "diesel-like" fuel stains			0.63 G= 4000 ppm
		CLAY - stiff, brown, silty - 2" sand layer & seepage at 9'6"			
10.0		CLAY TILL - very stiff to stiff, brown - silty, some fine gravel - dark grey at 16' - occasional sand layers - trace cobble & boulder			1.68
15.0					1.38
20.0					1.25
25.0					2.42
30.0		End hole at 30' in very stiff clay till.			2.58
35.0		NOTES 1) PP* = small scale penetrometer readings on augered cuttings. 2) G = Gastec Gasoline Analyzer readings in hole after hole was sealed for 2 hours. 3) Petroleum like odor form 3 to 8', very strong odor between 6 and 8'.			
40.0					

PLATE 2

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 3

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 97.63 ft.			DRILL TYPE: 5" Ø Auger OTHER TESTS: PP* (tsf)
0		FILL - sand & gravel - loose - 3/4" max. size approx. - dry			
5.0		CLAY - stiff, black, sandy - trace diesel fuel like stain			
		SAND AND GRAVEL - wet to saturated, brown - slight seepage at 7'8" - clayey below 8'			
10.0		End Hole at 10 ft.			
		NOTE Strong petroleum like smell was noted from 3 ft. to 8 ft. from grade.			
15.0					
20.0					
25.0					
30.0					
35.0					
40.0					

PLATE 4

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 4

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

(ft.) DEPTH	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 99.43 ft.			DRILL TYPE: 5" Ø Auger OTHER TESTS
0		ASPHALT			
		FILL - sand & gravel - loose			
5.0		CLAY - stiff - diesel fuel like stains			
		SAND AND GRAVEL - fine, moist to wet - some clay - diesel fuel like stains			
10.0		CLAY - stiff, brown - silty, sandy			
		CLAY TILL - very stiff, brown - silty - firm, wet sand layers - some fine gravel - dark grey at 15' - trace cobble & boulder			
15.0					
20.0		End Hole at 20 ft. from grade.			
		NOTE Petroleum like odour from 3 to 8 ft., very strong odour between 5 and 8 ft.			
25.0					
30.0					
35.0					
40.0					

PLATE 5

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 5

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE	DRILL TYPE / OTHER TESTS
		DATUM SURFACE ELEVATION 98.83 ft.			DRILL TYPE: 5" Ø Auger OTHER TESTS
0		FILL - sand & gravel - weed covered			
5.0		CLAY - stiff, black - 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.			
25.0		NOTE Petroleum like odour from 3 to 7 ft. from grade.			
30.0					
35.0					
40.0					

PLATE 6

Geokwan Engineering Ltd

CONSULTING GEOTECHNICAL ENGINEERS

TESTHOLE LOG

PROJECT: PROPOSED CANADIAN TIRE ADDITION
BRANDON, MANITOBA

LOGGED / DWN: GL	CHKD.: WK	DATE OF INV.: Oct 2/87	JOB: 221	TH 6

10 20 30 40 50 60
W_p □ W_l △ W ○
WATER CONTENT %

DRILL TYPE: 5" Ø Auger
OTHER TESTS

DEPTH (ft.)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE COND.	SOIL SAMPLE TYPE
		DATUM SURFACE ELEVATION 98.71 ft.		
0		FILL - sand & gravel - brown		
5.0		CLAY - stiff - diesel fuel like stains		
		SAND & GRAVEL - fine, moist - some clay		
10.0		CLAY - stiff, brown - silty, sandy		
		CLAY TILL - stiff to very stiff - brown, some fine gravel - dark grey at 15 ft. - occasional wet sand layers - trace cobble & boulder		
15.0				
20.0		End Hole at 20 ft. from grade.		
25.0		NOTE Petroleum like odour between 3 and 7 ft. from grade, very strong odour from 5 to 7 ft.		
30.0				
35.0				
40.0				

PLATE 7