

SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION

PORTIONS OF LAUREL STAGE 10

SOUTH OF 23 AVENUE AND WEST OF 17 STREET NW EDMONTON, ALBERTA

Prepared for

CITY OF EDMONTON c/o DUNDEE DEVELOPMENTS

February 2014

CTA File No. 02-1746



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Prepared by,

CT & ASSOCIATES ENGINEERING INC.

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PERMIT CT & ASSOCIA

Signature

PERMIT NUMBER: P 7826

The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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1.0 INTRODUCTION

This report presents the results of a Subdivision Level Geotechnical Investigation for portions of the proposed Laurel Stage 10 lands, located to the south of 23 Avenue and west of 17 Street NW, Edmonton, Alberta.

Authorization to proceed with the project was provided by Mr. Ken Black of Dundee Developments, on behalf of the City of Edmonton, on January 8, 2014.

2.0 SITE AND PROJECT DESCRIPTION

The site contains two parcels of land, identified as 2511-23 Avenue NW and 1707-23 Avenue NW, Edmonton. They are situated on the south side of 23 Avenue and west of 17 Street, within the north half of the northeast quarter of Section 31-51-23-W4M, in southeast Edmonton. The two sites have previously been utilized as cultivated farmland and occupy approximately 20 and 7.6 Acres (8 and 3.1 ha) of land respectively.

An air photo of the development area is shown on Drawings No. A-1, Appendix A.

The investigation was completed for assessment of soils and groundwater conditions within the property, related to future development of the lands including site grading, residential development, infrastructure and roadways.

3.0 FIELD INVESTIGATION

3.1 SITE STUDY AND SITE RECONNAISSANCE

A review of historical air photos for the property was completed, with an initial site review completed on January 9, 2014, to plan the drilling program for the investigation of the soil and groundwater conditions in the subject site.



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3.2 DRILLING AND LAB PROGRAM

The field work was conducted on January 16, 2014, consisting of eleven (11) boreholes drilled to depths between 3.8 m and 8.8 m. During drilling, a piezometer was installed at eight (8) borehole locations (at each of the deep boreholes) for groundwater monitoring purposes.

Drilling was conducted with a B-61 truck-mounted drill rig and was supervised at all times by a CT & Associates Engineering Inc. engineer. Disturbed samples were taken from auger cuttings typically at 0.8 m intervals. Standard Penetration Testing (SPT) was conducted at 1.5 m intervals, from which disturbed samples were also taken.

Drawing No. A-1, Appendix A, shows the approximate borehole locations with logs of boreholes included in Appendix B.

Laboratory testing was also conducted on soil samples for the determination of natural moisture content, Atterberg Limits, and soluble sulphate concentrations. Test results are presented on the individual borehole logs contained in Appendix B.

4.0 SITE CONDITIONS

4.1 SURFACE FEATURES

The eastern parcel of land (1707-23 Ave.) is bounded by 23 Avenue to the north, and a stormwater pond to the east. Adjacent to the south and west of the property boundary are lands that have undergone rough grading as part of subdivision developments. The area has had site preparation recently completed under CTA supervision, including the stripping of organics and the placement of engineered clay fill (under CTA supervision). A large stockpile is located just to the west of the property.



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The western parcel (2511 23 Ave.) is also bordered by 23 Avenue to the North. Adjacent to the east and south of the property is cultivated farmland undergoing subdivision developments. To the west of the property is a utility right of way and a residential community. Similarly, this area has also had initial stages of site preparation completed, under CTA supervision, including the stripping of organics and the placement of engineered clay fill.

The topography of both sites are relatively flat, with some scattered stockpiles, as preliminary grading and stripping has already occurred.

4.2 REVIEW OF SITE HISTORY

A review of historical air photos was conducted for the subject site and surrounding properties for the period of 1950 through 2013, as available from the Province of Alberta Air Photo Archives and City of Edmonton Air Photo Archives. The review indicates the following:

- The earliest available air photo for the subject site and surrounding area, taken in 1950, shows the property to be undeveloped farmland with low-lying wet areas. The surrounding areas were utilized as cultivated farmland. A farmyard is situated between the parcels. A roadway extends in an east-west direction along the north property boundary (existing 23 Avenue) and in a north-south direction to the east of the eastern property (existing 17 Street);
- By 1976, a farmyard had been constructed on the north portion of the west parcel;
- By 1984, fill material had been placed on the northern portion of the west parcel;
- By 1988, the farmyard buildings situated on the north portion of the west parcel had been removed. Additional surface fill materials had been placed on the west parcel, with the fill material covering the northern one-third portion of this area;



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- By 1992, two dugouts, soil stockpiles, and a building had been situated in the area between the two subject parcels;
- By 2007, a commercial shopping centre complex was under construction to the north of the subject site across 23 Avenue;
- By 2011, a residential neighborhood had been constructed to the west of the west parcel;
- By 2012, a stormwater pond has been constructed to the east of the east parcel and soil is being stockpiled on the southern half of the east parcel;
- By the summer 2013, both sites are partially graded for development, with the topsoil and existing fill materials having been stripped and replaced with engineered fill.

In summary, unengineered fill has historically been placed on the northern portion of the west parcel, however in the summer of 2013 all unengineered fill and organic soils have been removed and replaced the engineered fill.

4.3 SOIL CONDITIONS

Both properties were stripped of topsoil and organic materials in the summer of 2013. Engineered clay fill was then placed, with thickness ranging from 0.5 m to 3.1 m. All engineered materials were placed under CTA supervision, to greater then 98% SPD.

Below the clay fill, a firm to stiff, medium plastic clay/clay till-like layer was encountered, on both properties, with a thickness ranging from 0.9 m to 5.2 m. Below the clay/clay till-like layer, a moist, stiff, medium plastic clay till was encountered to the remaining depth of the boreholes (occasional water bearing sand layers, up to 0.5 m thick, were encountered at depth within the clay till layer).



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At the location of Boreholes No. 5 and 9, the clay till deposit was encountered immediately below the clay fill.

A generalized soil stratigraphy is summarized in Table 1. Details of the soil stratigraphy can be found in the borehole logs in Appendix B.

TABLE 1
GENERALIZED SOIL STRATIGRAPHY

Material	Soil Description	Approximate Depth to Top of Stratum (m)	Range in Thickness of Stratum (m)
CLAY FILL	Silty, some sand to very sandy, trace coal and pebbles, moist, low to medium plastic, dark greyish brown	0.0	0.5 - 3.1
CLAY*	Silty, trace to some sand, firm, medium plastic, moist, dark greyish brown	0.9 - 3.0	0.6 - 3.0
CLAY TILL- LIKE	Silty, some sand to sandy, trace coal and pebbles, moist to wet, medium plastic, firm to stiff, dark greyish brown	0.5 - 4.0	0 - 2.6
CLAY TILL	Silty, some sand to sandy, trace coal and pebbles, stiff, medium plastic, moist, dark greyish brown	1.2 - 6.1	> 6,1

Legend:

Encountered at the locations of Boreholes No. 1, 6, and 7

4.4 GROUNDWATER CONDITIONS

Eight (8) piezometers were installed during drilling for measurement of groundwater conditions. At the time of the installation, groundwater was only encountered at Borehole No. 1 and 6 at 2.4 m and 4.7 m depth respectively. No sloughing was encountered at any of the borehole locations.



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Twenty one (21) days after piezometers installation, the groundwater was encountered at depths between 1.0 m and 1.8 m below the ground surface on the west parcel of land, and 2.6 m to 5.1 m below ground surface on the east parcel of land.

TABLE 2
SUMMARY OF PIEZOMETER INSTALLATION
AND WATER TABLE READINGS

Piezo. Location	Piezo. Depth	Intersected Lithology	Ground Elevation	Depth to Water at Time		Level Readings , 2014
	(m)		(m)	of Installation (Jan. 16, 2014) (m)	Depth to Water (m)	Elevation (m)
BH-1	6.9	Clay Fill/ Clay / Clay Till-Like / Clay Till	716.22	2.4	1.4	714.8
BH-2	5.3	Clay Fill / Clay Till-Like / Clay Till	717.47	Dry	1.0	716.5
BH-3	5.3	Clay Fill / Clay Till-Like / Clay Till	718.09	Dry	1.4	716.7
BH-4	5.3	Clay Fill / Clay Till-Like / Clay Till	717.86	4.7	1.1	716.8
BH-5	6.9	Clay Fill / Clay Till	719.02	Dry	1.8	717.2
ВН-6	5.3	Clay Fill / Clay / Clay Till-Like	715.87	Dry	2.6	713.3
BH-7	6.9	Clay Fill / Clay / Clay Till-Like / Clay Till	717.32	Dry	3.2	714.1
ВН-8	5.3	Clay Fill / Clay Till-Like / Clay Till	717.27	Dry	5.1	712.2



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5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

5.1 GENERAL

Site preparations to date have included stripping and removal of organics and areas of deleterious materials, and initial stages of placement of engineered fill.

Based on the existing and prepared conditions of the site, standard construction practices for additional site grading, utility installation, building foundations, and roadway construction are generally applicable for the proposed development. No significant concerns are anticipated for the design and construction of utilities and house construction, though some drying of the trench backfill can be anticipated.

5.2 SITE PREPARATION AND SITE GRADING

Based on the existing site elevation, some additional site grading may be required. In view of the depth of ground water over the west parcel (groundwater at 1.0 m to 1.8 m depth below existing ground surface), it is recommended that the finished surface not be lowered to minimize effects of seasonal freezing.

The compaction of any additional engineered fill should be conducted according to the criteria presented in Table 3. Engineered fill construction requires full-time monitoring and testing by the geotechnical consultant during construction.



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TABLE 3

COMPACTION CRITERIA FOR SITE GRADING RESIDENTIAL DEVELOPMENT AREAS

Depth from Final Grade	Compaction Criteria							
(m)	Clay Fill	Granular Fill						
Resid	ential Building Footprint Areas							
0 to 1.0 m	95% Standard Proctor Density*	98% SPD						
1.0 to 3.0 m (building footing levels)	98% SPD **	100% SPD						
Below 3.0 m	95% SPD *	98 % SPD						
Comm	nercial Building Footprint Area							
Full Thickness	98% SPD **	100% SPD						
Roadwa	y Areas and Private Parking Area							
0 - 1.0 m depth	98% SPD **	100% SPD						
> 1.0 m depth	95% SPD *	98% SPD						

- Note: * at between optimum to 4% above optimum water content, in maximum 150 mm compacted thickness lifts
 - ** at between optimum to 2% above optimum water content, in 150 mm compacted thickness lifts

5.3 RESIDENTIAL HOUSING FOUNDATIONS AND LOT DEVELOPMENT

The native clay and engineered clay fill materials encountered over the site were found to be suitable for housing development. Strip and spread footings founded on undisturbed native clay may be designed on an allowable net bearing pressure of 90 kPa, exceeding the minimum 75 kPa required by the Alberta Building Code Section 9.



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Generally, no significant groundwater issues will be encountered for the building foundations over the site. Any groundwater flow will be minimal and can be handled effectively by normal weeping tile and sump operations.

Proper lot grading away from the houses must be provided to minimize the ingress of surface water into the subsoil. All houses must have at least 1.5 m of earthen cover over its footing elements to prevent potential frost heave problems.

Backfill material around building perimeters should consist of nominally compacted clay fill in order to prevent water from seeping into the basements.

Footings should be cast on a clean, undisturbed surface. No loose or disturbed material should be allowed on the bearing surface of footing excavation prior to pouring of concrete. If acceptable bearing surface can not be prepared using mechanical equipment, hand cleaning will be required.

A granular leveling or course base of at least 150 mm should be placed immediately below all floor slabs. The material should be of free draining sand or sand-gravel mixture compacted to 100% Standard Proctor Density.

Footing excavations should be protected from rain, snow, wetting, drying and inflow of surface and ground water at all times. Footings should not be cast directly onto or over frozen soil, nor should the soil beneath or adjacent to the footings be allowed to freeze subsequent to their installation.



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5.4 TRENCHING AND BACKFILL

It is expected that the utility trenches will be in the order of 3 m to 5 m deep. As such, the clayey materials can provide a stable trench for the short term utility installation, provided that the trench slope is no greater than 1(h): 1.5(v). Depending on the localized soil conditions and effect of groundwater seepage, the slope angle may be required to be less steep. Alternatively, shoring can be utilized.

Temporary surcharge loads such as excavated soils and stockpiles of materials should be kept back from the excavation crest by a minimum distance of one half the excavation depth.

Because of the occasional sand layers within clay till, some groundwater seepage may occur during construction. Since such groundwater flow is anticipated to be nominal, the provision of a normal sump pump should be sufficient to adequately handle such water flow.

In the event the excavation for utility installation is to remain open for prolonged periods, such as due to inclement weather or other construction delays, the slope angle should be lessened to 1:1, or the excavation walls terraced. For the terraced trench, the slope angle should be no greater than 2(v):1(h).

Any groundwater flow is anticipated to be nominal, as such the provision of a normal sump pump should be sufficient to adequately handle such water flow.

The backfilling of the excavated materials may be conducted according to The City of Edmonton Standard Proctor Criteria of 95% at depth greater than 1.5 m below finished grade and 98% at depth less than 1.5 m below finished grade. Based on the existing moisture conditions of the clay at depth, some drying may be required to achieve the required compaction density.



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5.5 ROAD PAVEMENTS

It is anticipated that the major roadway systems in the proposed development are the 9.0 m local residential and 11.5 m local collectors.

Based on the anticipated traffic conditions for these types of roadways as defined by the City of Edmonton and the subsurface conditions encountered in this study, the following pavement designs are recommended for staged construction.

5.5.1 Pavement Structures - Residential and Collectors

STAGE 1

AL	TERNATIVE A - GRANULAF	R BASE
Material	Layer Thi	ickness (mm)
	9 m Local Residential	11.5 m Local Collectors (With bus route)
Asphalt Concrete (ACR)	65	75
Crushed Gravel (20 mm)*	200	325
Prepared Sub-grade **	150	150
ALTE	RNATIVE B - FULL DEPTH A	ASPHALT
Material	Layer Thi	ckness (mm)
	9 m Local Residential	11.5 m Local Collectors (With bus route)
Asphalt Concrete (ACR)	50	75
Asphalt Concrete (ACB)	100	150
Prepared Sub-grade **	150	150

Legend:

- Compacted to 100% of Standard Proctor Maximum Dry Density (ASTM D698)
- * * Compacted to 98% of SPD (ASTM D698)

ACR = City of Edmonton Designation Asphaltic Concrete Residential Course

ACB = City of Edmonton Designation Asphaltic Concrete Base Course



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STAGE 2 - OVERLAY @ FAC

The above alternatives are to be constructed with 35 mm Asphaltic Concrete Overlay (ACO) at FAC.

5.5.2 Sub-grade Preparation

The sub-grade should be proof-rolled to detect any soft spots prior to base construction. If soft areas are encountered, these locations should be further treated as presented for proper sub-grade preparation:

.1 Soil Drying or Material Replacement and Re-Compaction

The top 150 mm of the clay sub-grade should be scarified, dried, and recompacted to 98% Standard Proctor Density. The sub-grade preparation may have to be extended to 0.5 m depth in areas of disturbance such as utility line trenches.

.2 Cement Stabilization

Alternatively should the sub-grade not provide a non-deflected base through soil re-compaction, the sub-grade clayey soils may be cement treated by mixing a minimum of 10 kg of cement over 1 m² of surface area to a depth of 150 mm, and compacted to 100% of Standard Proctor Density. The cement quantity and depth should be reviewed in the field at time of roadway construction.



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5.6 SITE CLASSIFICATION FOR SEISMIC SITE RESPONSE

Based on the encountered soil conditions, the subject site can be classified as Class D (Table 4.1.8.4.A. of NBCC 2005) as the foundation systems of the buildings will be placed within soils of firm to stiff consistency.

5.7 CEMENT TYPE

Four (4) soil samples were tested for water soluble sulphate concentrations. The test results showed sulphate concentrations from < 0.01 % to 3 % (by weight), indicating a wide range of degree of sulphate attack on concrete ranging from negligible to very severe.

As such, exposure Class S-1 is applicable with Cement Type HS (Type 50) required for all concrete elements exposed to fill or native soils. Air entrainment of 4% to 6% by volume is recommended for all concrete exposed to freezing temperatures and/or native soils.

6.0 CLOSURE

This report has been prepared in accordance with generally accepted geotechnical practices and procedures.

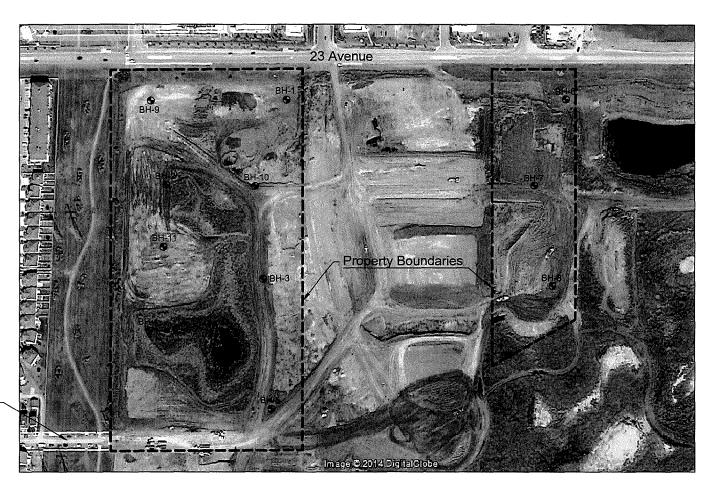
Classification of soil and groundwater conditions within the report have been based on generally accepted engineering practices in this area. Conditions identified during the field work, and thereby recommendations presented within this report are considered to be reasonably representative of the site. If however, conditions other than those presented are identified during any other work on the subject property, CT & Associates Engineering Inc. should be notified, and given an opportunity to review or modify our recommendations in light of new findings.



APPENDIX A

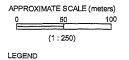
DRAWINGS





20 Avenue

1) SITE PHOTO (2013) OBTAINED FROM GOOGLE EARTH



◆ BOREHOLE LOCATION

CTA associates engineering inc.	PROJECT GEOTECHNICAL INVESTIGATION LAUREL STAGE 10 DEVELOPMENTS EDMONTON, ALBERTA
CLIENT CITY OF EDMONTON C/O DUNDEE DEVELOPMENTS	TITLE SITE PLAN AND BOREHOLE LOCATIONS
DATE FEB. 24, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746 DWG, NO. A-1



APPENDIX B

BOREHOLE LOGS

GEOTECHNICAL INVESTIGATI	ON	DUNDE	E DEV	ELOP	MENTS	BOREHOLE NO: BH-1			
AUREL STAGE 10		UTM ZC				PROJECT NO: 02-1746			
1707 AND 2511 23 AVE		SOLIDS				ELEVATION: 716.22 m			
	y Tube SPT		Dis				ed Sample		
BACKFILL TYPE BENT	ONITE PEA GRA	VEL	∭SL	OUGH	GROUT	DRILL CUTTINGS 🖸 SAN	ID 		
E 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	■ Pocket Pen (kPa) ■ 100 200 300 400 ◆ Soil Sulphates (%) ◆	SAMPLE TYPE SPT (N)	OSC	SOIL SYMBOL	SOI DESCRIF		SLOTTED PIEZOMETER		
10 20 30 40	0.2 0.4 0.6 0.8	5 12 5	CL CL	5	CLAY(FILL) - silty, sandy, trace of medium plastic, dark greyish brown 0.6 m, fabric on bottom CLAY - silty, trace to some sand, dark greyish brown - free water at 3.7 m CLAY(TILL-LIKE) - silty, sandy, trace of moist to wet, medium plastic, firm - sand lense, 450 mm thick, satur - sand lense, 100 mm thick at 5.8 CLAY(TILL) - silty, sandy, trace of medium plastic, stiff, dark grey END OF BOREHOLE AT 7.3 m Di Water encountered at 2.4 m depth No slough encountered at drilling of the same depth, with bottom of bentor GWL @ 21 days = 1.4 m	medium plastic, moist, firm, medium plastic, moist, firm, ace coal and pebbles, to stiff, dark grey ated at 5.3 m m pal and pebbles, moist, EPTH. at drilling completion. completion. depth, slotted from 3.9 to			
CTA CT & ASSOCIA	ATES ENGINEER	RING I	NC.		LOGGED BY: NR REVIEWED BY: DSN Fig. No: B-1	COMPLETION DEPTH: 7.			

	ECHNICAL INVE	STIGATIO	NC		DUNDE		LOP	MENTS		BOREHOLE NO: BH-2		
	EL STAGE 10				UTM ZC				PROJECT NO: 02-1746			
	AND 2511 23 AVE			CTT)	SOLID :				ELEVATION:		·········	
	LE TYPE	Shelby		SPT		Dis			A Casing			e
BACK	FILL TYPE	SENT	ONITE	PEA GRA	VEL	slo		GROUT	DRILL CUTTINGS :: SAN			
Depth (m)	PLASTIC M.C.	LIQUID	♦ Soil Sulp	Pen (kPa) 1 300 400 hates (%) •	SAMPLE TYPE SPT (N)	nsc	SOIL SYMBOL		DIL RIPTION		SLOTTED PIEZOMETER	FI FVATION (m)
0 -1 <u>▼</u> -2 -3 -4 -5 -6	10 20 30	40	0.2 0.4	0.6 0.8	6	FI CL	3	CLAY(FILL) - silty, some sand medium plastic, dark greyish b frozen top 150 mm - no organics, mottled reddish CLAY(TILL-LIKE) - silty, sandy moist, medium plastic, firm, da CLAY(TILL) - silty, sandy, trace medium plastic, stiff, dark grey - stiff to very stiff at 3.0 m - dark grey at 3.6 m END OF BOREHOLE AT 5.8 m No water or slough encountere Installed monitoring well to 5.3 5.3 m depth, with bottom of ber GWL @ 21 days = 1.0 m	brown and grey at the first trace coal and pet the greyish brown as coal and pet the greyish brown as coal and pebbles, ish brown at depth, slotted from the greyth at drilling complet metallic	on thick, o.2 m obles, moist,		7115
10												708
								LOGGED BY: NR	COMPLETIO			
N.	CT & AS	SOCI	ates en	IGINEE	RING	INC.		REVIEWED BY: DSN	COMPLETIO			
~								Fig. No: B-2			Page	1 of

	EOTECHNICAL INVESTIGATION UREL STAGE 10									LOP	MENTS		BOREHOLE NO: BH-3		
									NE: -		.	PROJECT NO: 02-1746 ELEVATION: 718.09 m			
	ND 2511				(11)-		SOL	LID S	TEM A						
	LE TYPE		Shelby		<u>∭</u> s				Dis			A Casing	Cored Samp)
BACKE	ILL TYPE		BENT	ONITE	<u>[-]</u> P	EA GRA	VEL	1	[[[]]SL	OUGH	GROUT	DRILL CUTTING	is 🖸 sani)	
Depth (π)	10 2 PLASTIC	M.C.	10 40 LIQUID 40		Pocket Pen (kPa 200 300 Soil Sulphates (%		SAMPLE TYPE	SPT (N)	OSO	SOIL SYMBOL		SOIL PRIPTION		SLOTTED PIEZOMETER	ELEVATION (m)
2								6	FI CL		CLAY(FILL) - silty, sandy, travet, medium plastic, dark group 150 mm CLAY(TILL-LIKE) - silty, san molst, medium plastic, firm, of the company of the compan	eyish brown, 0.7 m to day, trace coal and put dark greyish brown ace coal and pebbles	hick, frozen ebbles,		717
4			4					14	CL		- very sandy at 3.4 m - sandy, trace oxidations, ve	ry dark greyish brow	n at 3.7 m		-715 -714 -713
7									Andrew An		END OF BOREHOLE AT 5.8 No water or slough encounter Installed monitoring well to 5. 5.3 m depth, with bottom of b GWL @ 21 days = 1.4 m	red at drilling comple 3 m depth, slotted fr	om 2.3 to		-712 -711
								And the second s		and the state of t					-710 -709
0		<u> </u>		<u>: : :</u>	· · · · ·	· :					LOGGED BY: NR	COMPLETIO	ON DEPTH: 5.	8 m	
ĜŢ	CT 8	& AS	SOCIA	ATES	ENGI	NEE	RIN	G II	NC.		REVIEWED BY: DSN		ON DATE: 1/16	5/14	
											Fig. No: B-3			Page 1	of

	ECHNICAL INVESTIGATION	ON	DUNDE		LOP	MENTS	BOREHOLE NO: BH-4			
	EL STAGE 10		UTM ZC			· · · · · · · · · · · · · · · · · · ·	PROJECT NO: 02-1746			
	AND 2511 23 AVE		SOLID S				ELEVATION: 71			
	PLE TYPE Shelby			Dis			A Casing	Cored Samp	ole	
BACK	FILL TYPE BENTO	ONITE PEA GRA	VEL	∭ SL	OUGH	GROUT	GROUT			
Depth (m)	■ 'N' (blows / 300 mm) ■ 10 20 30 40 PLASTIC M.C. LIQUID 1 0 20 30 40	Pocket Pen (kPa) 100 200 300 400 Soil Sulphates (%) 0.2 0.4 0.6 0.8	SAMPLE TYPE SPT (N)	OSN	SOIL SYMBOL	SO DESCRI		SLOTTED	FI FVATION (m)	
0				FI		CLAY(FILL) - silty, some sand, mottled grey and brown, 0.5 m t CLAY(TILL-LIKE) - silty, some s	hick, frozen top 450	mm		
-1 <u>▼</u> -2	•		5	CL		firm, dark greyish brown	ano, wet, medium p	idistilo,	717	
3			9			CLAY(TILL) - silty, some sand, t plastic, stiff, dark greyish brown	race gravel, moist, n	nedium	715	
5			9	CL		- very dark greyish brown at 3.7	m		71/	
6			11			END OF BOREHOLE AT 5.8 m No water or slough encountered Installed monitoring well to 5.3 m 5.3 m depth, with bottom of bent GWL @ 21 days = 1.1 m	at drilling completion depth, slotted from	2.3 to	712	
8					The state of the s				710	
									<u>-</u> 708	
10 <u>l</u>	TA CT & ASSOCIA	ATES ENGINEE	RING	INC.	<u>L</u>	LOGGED BY: NR REVIEWED BY: DSN	COMPLETION I		F ,00	
U						Fig. No: B-4		Page	1 0	

GEOTECHNICAL INVESTIGATI	ON		DEVELOF	BOREHOLE NO: BH				
LAUREL STAGE 10		UTM ZON			PROJECT NO: 02-17			
1707 AND 2511 23 AVE			EM AUGE		ELEVATION: 719.02			
SAMPLE TYPE Shelb			Disturbed			Cored Sample		
BACKFILL TYPE BENT	ONITE PEA GRA	VEL	SLOUGH	I GROUT	DRILL CUTTINGS 🔀	SAND		
E 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	■ Pocket Pen (kPa) ■ 100 200 300 400 ◆ Soil Sulphates (%) ◆ 0.2 0.4 0.6 0.8	SAMPLE TYPE SPT (N)	USC SOIL SYMBOL	SOI DESCRII		SLOTTED PIEZOMETER		
2		10	FI	CLAY(FILL) - silty, sandy, trace of medium plastic, dark greyish brown frozen top 0.6 m - very sandy, moist to wet at 0.9 CLAY(TILL) - silty, sandy, trace of medium plastic, stiff, dark greyish	wn, reworked, 1.2 m thic m coal and pebbles, moist,	*,		
4		10	CL	- trace oxidation at 4.0 m		716		
5		11		- dark grey at 4.9 m		714		
7		11		END OF PORFUOIS AT 20	FOTH	713		
				END OF BOREHOLE AT 7.3 m D No water or slough encountered a Installed monitoring well to 6.9 m 6.9 m depth, with bottom of bento GWL @ 21 days = 1.8 m	it drilling completion. depth, slotted from 3.9 to	711		
	: : : : : : : : : : : : : : : : : : : :			LOGGED BY: NR	COMPLETION DEPTI	<u> </u>		
CT & ASSOCIA	ATES ENGINEEI	RING IN	IC.	REVIEWED BY: DSN	COMPLETION DATE			
				Fig. No: B-5		Page 1 of		

GEOTECHNICAL INVESTIGAT	ION		DUNDEE	DEVEL	OPN	MENTS	BOREHOLE NO: BH-6		
AUREL STAGE 10			JTM ZON				PROJECT NO: 02-1746		
707 AND 2511 23 AVE				rem aud			ELEVATION: 718		
	by Tube SPT			Distur			A Casing	Cored Sample)
BACKFILL TYPE BEN	TONITE PEA	A GRAVE	EL	∭SLOU	JGH	GROUT	DRILL CUTTINGS	SAND	1
PLASTIC M.C. LIQUID 10 20 30 40 PLASTIC 20 30 40	■ Pocket Pen (kPa) ■ 100 200 300 4 ◆ Soil Sulphates (%) ◆ 0.2 0.4 0.6 0		SAMPLE TYPE SPT (N)	OSN	SOIL SYMBOL	SOII DESCRIF		SLOTTED PIEZOMETER	FI FVATION (m)
10 20 30 40 1		0.8	5	CL.		CLAY(FILL) - silty, sandy, trace of medium plastic, dark greyish brown 1.1 m - moist to wet at 0.8 m CLAY - silty, some sand, trace comedium plastic, mottled brown and moist to wet, medium plastic, firm, sandy, trace to wet, medium plastic, firm, sandy to wet, s	al and pebbles, moid grey ace coal and pebble dark greyish brown EPTH. at drilling completic completion. depth, slotted from 2	st, en top	714
CT & ASSOC	IATES ENGINI	EER	ING I	NC.		LOGGED BY: NR REVIEWED BY: DSN Fig. No: B-6	COMPLETION D	EPTH: 5.8 m	-706

			STIGATI	UN			DUNDEE DEVELOPMENTS UTM ZONE: -						BOREHOLE NO: BH-7			
	STAGE					.,	-						PROJECT NO: (ELEVATION: 71		-	
	ID 2511 2	3 AVE			П	Порт	SOL	וט צ	TEM A			A Casing			4 Commi	
SAMPLE			Shelb			∏SPT		Dis					Corect Core			8
BACKFI	LL TYPE		₩ SENT	TONIE	<u>Ŀ</u>	PEA GRA	VEL		∭SL ⊺	OUGH	GROUT	Μn	NOWILL COLLINGS F. JOHN) 	Т	
Depth (m)	PLASTIC	M.C.	LIQUID	• 5	Soil Sulphat		SAMPLE TYPE	SPT (N)	OSC	SOIL SYMBOL	DESC	SOIL CRIPT	ION		SLOTTED PIEZOMETER	FI FVATION (m)
-1 -2 -3 <u>▼</u> -4 -4	10 20	30	40		0.4	0.6 0.8		7	CL		CLAY(FILL) - silty, sandy, trace organics, wet at 2.3 - trace organics, wet at 2.3 - trace organics at 2.7 m CLAY - silty, some sand, moderate organics at 2.7 m CLAY - silty, some sand, moderate organics at 2.7 m CLAY(TILL_LIKE) - silty, samoust to wet, medium plastic organics at 2.7 m CLAY(TILL_LIKE) - silty, sandy, trace organics at 2.7 m CLAY(TILL_LIKE) - silty, sandy, trace organics at 2.7 m CLAY(TILL_LIKE) - silty, sandy, trace organics at 2.7 m CLAY(TILL) - silty, sa	m moist, med ace coal ace sylvah brown,	ium plastic, firm e coal and pebb ark greyish brow TH. illing completior th, slotted from	brown les, n		7715 -716 -717 -717 -710
10											LOGGED BY: NR		COMPLETION	DEPTH: 7.	3 m	708
	TCT 8	k AS	SOCI	ATES	ENC	SINEE	RIN	G II	NC.		REVIEWED BY: DSN		COMPLETION			
Oli.	1					· · ·					Fig. No: B-7				Page 1	1 of

	AL INVESTIGATIO	ON			E DEVI	ELOPI	MENTS	BOREHOLE NO:	
LAUREL STAG		·		UTM Z				PROJECT NO: (
1707 AND 2511			TD	SOLID	STEM A			ELEVATION: 71	
SAMPLE TYPE			∭SPT			sturbed		A Casing	Cored Sample
BACKFILL TYP	E BENT	ONITE	PEA GRA	VEL	SL	.OUGH	GROUT	DRILL CUTTINGS	∷ SAND
(E) thought to the property of	blows / 300 mm) = 20 30 40	■ Pocket Pe 100 200 ◆ Soil Suiph	, ,	SAMPLE TYPE	USC ,	SOIL SYMBOL	SC DESCR		SLOTTED PIEZOMETER
1					FI		CLAY(FILL) - silty, very sandy, greyish brown, 1.0 m thick, froz	en top 0.9 m	717
2					CL		CLAY(TILL-LIKE) - silty, sandy, moist, medium plastic, firm, dar CLAY(TILL) - silty, sandy, trace	k greyish brown	
3				8			medium plastic, stiff, dark greyi	sh brown	715
4				13	CL				714
5 💆				14			- dark grey, moist, at 4.9 m		712
6							END OF BOREHOLE AT 5.8 m No water or slough encountered Installed monitoring well to 5.3 r 5.3 m depth, with bottom of ben GWL @ 21 days = 5.1 m	l at drilling completion n depth, slotted from	2.3 to -711
7									-710
9									-709 709
10									
OTA OT	0 400001	ATEC EN		DIMO	INIC		LOGGED BY: NR	COMPLETION	
CTA CT	& ASSOCIA	41E9 EN	GINEE	KING	INC.		REVIEWED BY: DSN Fig. No: B-8	COMPLETION	DATE: 1/16/14 Page 1 of

	TECHNI			ES	TIG	ΑŢΙ	ON											LOP	MENTS		BOREHOLE NO:		
	REL STA													-		ONE:					PROJECT NO: (
<u> </u>	AND 25		3 A\	/E	-						СП			SO	LID :	STEN					LEVATION: 71		
	LE TYP		-			helb						SPT						turbed	No Recovery		Casing	Cored Sam	ple
BACK	(FILL TY	PE			В	ENT	T	IIE			لـا	PEA	GRA	VEL	T	Щ	SLC	DUGH T	GROUT		RILL CUTTINGS	JSAND	
Depth (m)	PLASTI		M.C.	L	.IQUI			•	⊳ Soi	l Sulp	Pen (k 30(shates 0.6	(%) ◀	•	SAMPI F TYPE	SPT (N)	001) SO	SOIL SYMBOL	D	SOII ESCRIF			ELEVATION (m)
-0 -1 -2 -3 -6		20	3		40			0.2		0.4	0.6		0.8			CI			CLAY(FILL) - silty, sandy plastic, dark greyish brown clay control of the control	vn, 2.1 m th	and pebbles, m	oist, medium	-718 -717 -716 -714 -713 -711
10	TA CT	: - &	A	SS	0	CI/	ΑT	E	3 I	EN	IGI	N	_ <u>:</u> EE	RIN	IG	INC	 >.		LOGGED BY: NR REVIEWED BY: DSN Fig. No: B-9		COMPLETION D	ATE: 1/16/14	1 of 1

GEO 02-1746.GPJ EDMONTON.GDT 2/26/14

GEOTECH			STIGA	TION	1							ELOPI	MENTS	BOREHOLE NO		
LAUREL S											NE: -			PROJECT NO:		
1707 AND		23 AVE					m		SO	LID S	TEM A			ELEVATION: 7		
SAMPLE 1				elby T			∭s		*****		Dis		No Recovery	A Casing	Cored Samp	ole
Depth (m)		ws/300 n 0 30		ENTON		Pocket		PEA GR	SAMPLE TYPE	SPT (N)	USC SS	SOIL SYMBOL		SOIL	[··]SAND	ELEVATION (m)
- 0 :	ASTIC 10 20	M.C.	LIQUID 40)	0.2	Soil Sul	phates (9		SAMP	S ₂		SOIL	CLAY(FILL) - silty, sandy, trace	CRIPTION	moint modium	ELEV
								٠.			FI		plastic, dark greyish brown, 0.8	3 m thick, frozen top	0.6 m	717
-1	· · · · · · · · · · · · · · · · · · ·						: :				CL		CLAY(TILL-LIKE) - silty, sandy medium plastic, firm to stiff, da	rk greyish brown	bies, moist,	-716
-2									=				- silt lense, 100 mm thick at 1.0 END OF BOREHOLE AT 2.3 m No water or slough encountere	n DEPTH.	on.	-715
3						:										-714
-5																- -713
-6				, , , , , ,		?		5								-712 -712
-7						: :	•									711
-8																-710
-g																709
10						<u> </u>							LOGGED BY: NR	COMPLETION	I DEPTH: 2.3 m	
CTA	CT 8	& AS	SO	CIA	TE	S EI	VGI	NE	ERI	NG I	NC.		REVIEWED BY: DSN Fig. No: B-10		DATE: 1/16/14	1 of

GEO				_					Έ	S1	TI(ЭA	TI	01	<u> </u>									-+							Pl	MENTS		BOREHO				
LAUF				_					_															_				NE:					_	PROJEC				
1707			_		_		3	A١	/E											11					SC	DLI	D S			AUG				ELEVAT	ION: 71			
SAMI						_	_		_		=			y T						-]SI									sturb				A Casing		Cor		ple
BACH	(FI	LL	. T	ΥI	PE	=						BE	NT	ON	ITE	_			_	<u>.</u>	PE	ΞA	GR	/AS	/EL			Ш	SL	OUG	H	GROUT		DRILL CUT	TINGS	∷ SAI	ID .	
Depth (m)		PL.		TIC	;		M.(). 	0 r 80	nm)		JID				•	Soll	Su	ípha	ates	(%) 41			SAMPI E TVDE	מסייון דיין ווע ווע	SPT (N)		OSC	SOII SYMBOI	COIL OTHER	S DESC		IL PTION	l			
0	1	:	:	:		. (P			:		:				2_	:	0.4	:	0.0	:	0	.0	:		+			 Fl			CLAY(FILL) - silty, some sand, dark greyish brown, frozen top (trad 0.6	ce gravel, m	moist, ı	nedium į	olastic,	E
1			· · · · · · · · · · · · · · · · · · ·								***************************************																		XL.			CLAY(TILL-LIKE) - silty, sandy, plastic, firm, dark greyish brown	tra	ce gravel	, moist t	o wet, m	edium	
?							•									•				:												END OF BOREHOLE AT 2.3 m						
				***************************************															:	:												No water or slough encountered	l at	drilling co	mpletio	n.		
																			•	•	:																	
			:																•	•																		
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				•	• • • • • • • • • • • • • • • • • • • •													,																			İ	
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	CPA-S	Ī			_		_	_								_				_												LOGGED BY: NR		COMPL	ETION D	EPTH: 2	.3 m	_
	TA	(C,	T	8	ጷ	A	15	38	30	C	C	ľ	17	Ε	S	E	٩E	10	31	N	E	E	R	١N	IC)	NC) ,			REVIEWED BY: DSN				ATE: 1/1	6/14	
Ü		ĺ																														Fig. No: B-11					Page	10



APPENDIX C

HISTORICAL AIR PHOTOS





NOTE: BASED ON PROVINCE OF ALBERTA AIR PHOTO (1950) APPROXIMATE SCALE 1:10 000

CTA CT & ASS	SOCIA	TES EN	IGINEER	RING INC	SUE	BDIVISION LEVEL GEOTE 2511-23 AVENUE NW ANI EDMONTON	- ,
CLIENT	UNDEE I	DEVELOPI	MENTS		TITLE	SITE AIR PH	OTO - 1950
DATE FEB. 27, 2014	DWN.	NR	CHKD.	DSN	FILE NO.	02-1746-C1	DWG. NO. C-1

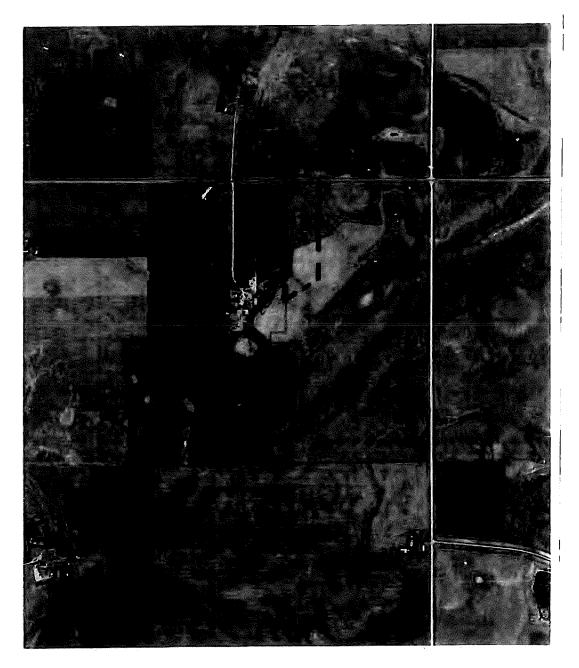




NOTE: BASED ON PROVINCE OF ALBERTA AIR PHOTO (1962)

CTA CT & ASS	SOCIA	TES EN	GINEERING		OJECT	SUBDIVISION LEVEL GEOTECHNIC 2511-23 AVENUE NW AND 1707 EDMONTON, ALBE	7-23 AVENUE NW
CLIENT	UNDEE	DEVELOP	MENTS	Till	TLE	SITE AIR PHOTO -	1962
DATE FEB. 27, 2014	DWN.	NR	CHKD. DSI	N FIL	E NO.	02-1746-C2	DWG. NO. C-2





NOTE: BASED ON PROVINCE OF ALBERTA AIR PHOTO (1967)

CTA CT & ASS	SOCIA	TES EN	IGINEEF	RING INC	SUI	BDIVISION LEVEL GEOTE 2511-23 AVENUE NW AN EDMONTON	=
CLIENT	UNDEE	DEVELOPI	MENTS		TITLE	SITE AIR PH	ЮТО -1967
DATE FEB. 27, 2014	DWN.	NR	CHKD.	DSN	FILE NO.	02-1746-C3	DWG. NO. C-3

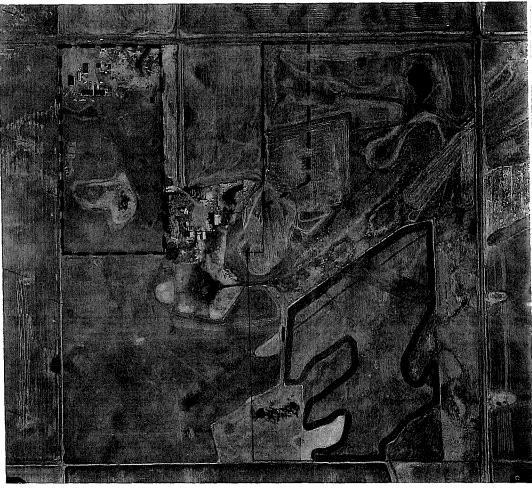




NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1971)

CTA CT & ASSOCIATES ENGINEERING INC.	PROJECT SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION 2511-23 AVENUE NW AND 1707-23 AVENUE NW EDMONTON, ALBERTA
DUNDEE DEVELOPMENTS	SITE AIR PHOTO -1971
DATE FEB. 27, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746-C 4 DWG. NO. C-4

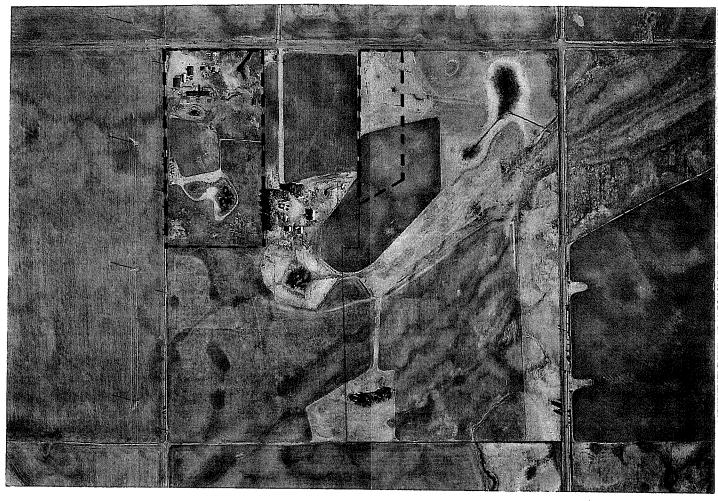




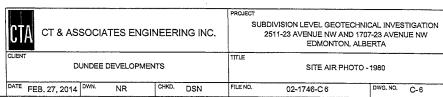
NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1976)

CTA CT & ASSOCIATES ENGINEERING INC.	PROJECT SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION 2511-23 AVENUE NW AND 1707-23 AVENUE NW EDMONTON, ALBERTA
CLIENT DUNDEE DEVELOPMENTS	SITE AIR PHOTO -1976
DATE FEB. 27, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746-C5 DWG. NO. C-5





NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1980)







NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1984)

APPROXIMATE SCALE 1:5000

CT & ASSOCIATES ENGINEERING INC.

CLIENT

DUNDEE DEVELOPMENTS

CHKD. DSN

PROJECT

SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION
2511-23 AVENUE NW AND 1707-23 AVENUE NW
EDMONTON, ALBERTA

TITLE

SITE AIR PHOTO -1984

DATE FEB. 27, 2014

DWN. NR

CHKD. DSN

FILE NO. 02-1746-C7

DWG. NO. C-7

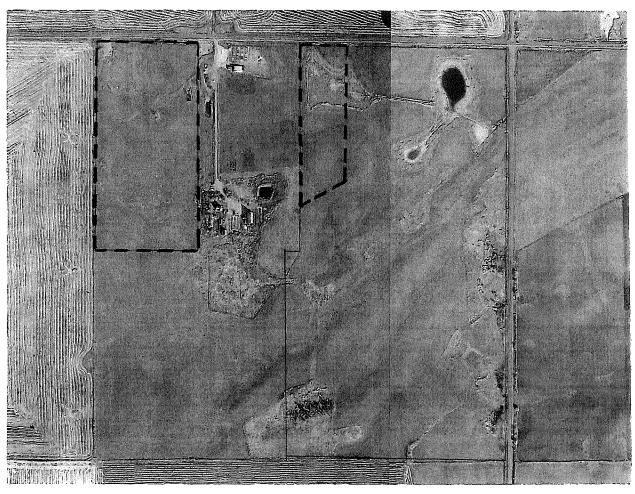




NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1988)

CTA CT & ASSOCIATES ENGINEERING INC.	PROJECT SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION 2511-23 AVENUE NW AND 1707-23 AVENUE NW EDMONTON, ALBERTA
DUNDEE DEVELOPMENTS	TITLE SITE AIR PHOTO -1988
DATE FEB. 27, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746-C8 DWG, NO. C-8





NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1992)

	CT	Д ста	& AS	SOCIAT	ES ENGIN	NEERI	NG INC.		DIVISION LEVEL GEOTECH 511-23 AVENUE NW AND 1 EDMONTON, A	1707-23 AVEN	
ľ	CLIENT		DU	JNDEE DE	EVELOPMEN	тѕ		TITLE	SITE AIR PHOT	O -1992	
	DATE	FEB. 27,	2014	DWN.	NR	CHKD.	DSN	FILE NO.	02-1746-C9	DWG. NO.	C-9



NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (1998)

CTA CT & ASSOCIATES ENGINEERING INC.	PROJECT SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION 2511-23 AVENUE NW AND 1707-23 AVENUE NW EDMONTON, ALBERTA
CLIENT DUNDEE DEVELOPMENTS	TITLE SITE AIR PHOTO -1998
DATE FEB. 27, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746-C10 DWG. NO. C-10





NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (2003)

	PROJECT		
CTA CT & ASSOCIATES ENGINEERING INC.	SUBDIVISION LEVEL GEOTECHNICAL INVESTIGATION 2511-23 AVENUE NW AND 1707-23 AVENUE NW EDMONTON, ALBERTA		
DUNDEE DEVELOPMENTS	TITLE SITE AIR PHOTO -2003		
DATE FEB. 27, 2014 DWN. NR CHKD. DSN	FILE NO. 02-1746-C11 DWG. NO. C-11		





NOTE: BASED ON CITY OF EDMONTON ARCHIVES AIR PHOTO (2007)

