Calgary

Glenmore Trail East Interchanges Functional Planning Study

Appendix D - Geotechnical Input

Prepared By:

PARSONS

ISL Engineering and Land Services

THURBER ENGINEERING LTD.

January 26, 2016 File: 19-5538-7

Parsons
808 4th Street S.W., Suite 100
Calgary, Alberta, T2P 3E8

Attention: Mr. Stephen Power, P. Eng.

GEOTECHNICAL INPUT INTO FUNCTIONAL PLANNING STUDY FOR GLENMORE TRAIL SE & 100TH STREET SE INTERCHANGE AND GLENMORE TRAIL SE & CONRICH ROAD INTERCHANGE

Dear Sir:

Thurber Engineering Ltd. (Thurber) was retained by Parsons to provide preliminary geotechnical input into a Functional Planning Study (FPS) for the proposed interchanges along Glenmore Trail SE at the intersections of 100th Street SE and Conrich Road. Currently the 100th Street SE intersection consists of an at-grade intersection with traffic lights while the Conrich intersection is at-grade with stop signs on Conrich Road. The scope of the assignment was outlined in our letter of proposal to Parsons dated October 15, 2015 and our subsequent email on October 25, 2015 to Andrew Connell, P.Eng at Parsons.

The information in this report is subject to the Statement of Limitations and Conditions included at the end of the text. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1. SCOPE OF WORK

The scope of work for this assignment was as follows:

- Review existing geological information, including available geotechnical reports, soils maps etc. for the general project area;
- Provide a preliminary assessment of the soil and groundwater conditions at the proposed interchange;
- Identify any major geotechnical issues that could impact the project;
- Provide a preliminary assessment of grading requirements; and
- Identify potential foundation options for bridge structures at the future interchange; including preliminary foundation design parameters.

This preliminary assessment did not include any subsurface investigations, which would be required as part of detailed design. Also, assessment of any environmental issues is not within Thurber's scope of services for this project.

2. METHODOLOGY

The preliminary assessment of the geotechnical aspects at the intersection is based on information collected from surface geological maps and previous geotechnical studies in the surrounding areas. The following reports/information sources were reviewed as part of this study.

- S.R. Moran, Alberta Research Council, 1986, "Surface Materials of the Calgary Urban Area: Calgary Sheet";
- Southeast Stoney Trail Geotechnical Site Investigation, a report to the Southeast Calgary Connector Group, Thurber Engineering (2009);
- Enmax Shepard Energy Centre Geotechnical Investigation, a report to KBV Shepard Power Partners, Thurber Engineering (2010);
- Thurber In-House Test Hole Database; and
- Site reconnaissance conducted on March 13, 2015 and January 20, 2016.

3. SITE CONDITIONS

3.1 Regional Surface Conditions

3.1.1 Glenmore Trail SE & 100th Street SE Intersection

The topographic relief in the overall vicinity of the proposed interchange at Glenmore Trail SE & 100th Street SE can be described as flat to gently undulating. Small areas of wetland are present at some areas around the intersection, which is indicative of naturally poor drainage that is common on undeveloped land east of Calgary. The surficial drainage pattern is gently sloping from south to north.

Land use in the area consists of the Heather Glen Golf Course in the northeast quadrant of the intersection. A pond, associated with the golf course, is located directly adjacent the northeast corner of the intersection. The remaining quadrants of the intersection consist of farm land, including open grazing or cultivated fields. A high-voltage utility corridor also runs parallel to 100th Street SE on the west side of the road. Power lines were also observed on the east side of 100th Street SE and running along the north side of Glenmore Trail SE.

3.1.2 Glenmore Trail SE & Conrich Road

The topographic relief in the overall vicinity of the proposed interchange at Glenmore Trail SE & Conrich Road can be described as gently undulating. A large wetland is present at the northeast quadrant of the intersection. The surficial drainage pattern is also gently sloping from south to north.

Land use in the area consists of the Garden Scents Garden Centre in the northwest quadrant of the intersection. South of the intersection appears to be land used for open grazing or cultivated

fields.

Figure 1 shows the overall location of the intersections with respect to the City of Calgary and surrounding areas, while Figure 2 and Figure 3 show 2013 aerial photographs of the 100th Street SE and Conrich Road intersections respectively.

3.2 Subsurface Conditions

The attached Figure 4 presents an interpretation of the surficial geology in the study area.

Based on the published geological reports, the overburden soils at the site are expected to consist of pebble clay till of the Crossfield Formation, although localized deposits in the form of “pond sediments” have been identified at various locations shown in Figure 3.

The underlying bedrock consists of claystone and siltstone of the Paskapoo Formation.

Based on the nearest available test holes, and consistent with the above, the predominant soil type expected at the two sites is clay till. The upper several meters of clay till is expected to be firm to stiff in consistency and generally becomes very stiff to hard clay till at greater depths. The local till deposits typically consist of a heterogeneous mix of clay, silt, sand and gravel with occasional boulders, containing discontinuous sand and gravel lenses as well as occasional deposits of sand and gravel associated with glacial meltwater channels.

Bedrock depth in the vicinity of the interchanges appears to be in the order of 10 m to 20 m below ground surface, based on previous test holes drilled approximately 1 km to the west and south of the intersection. It was noted however, that there was considerable variation in bedrock depth at these sites, so shallower or deeper bedrock may be encountered. As noted above, bedrock is likely to consist of claystone and siltstone.

Groundwater levels are expected to be relatively high in the area, although this should be confirmed. Some seasonal variations in groundwater level should also be expected.

4. PRELIMINARY GEOTECHNICAL ASSESSMENT

4.1 General

Based on existing information, there are no major geotechnical issues that are expected to significantly impact the construction of new interchanges at Glenmore Trail SE/100th Street SE and Glenmore Trail SE/Conrich Road. There may, however, be areas with soft subgrade conditions associated either with natural “pond sediments”, e.g., soft silts, sands and clays, or existing fill material that may require re-working or possibly replacement.

Preliminary recommendations relating to these and other geotechnical issues pertinent to a functional level planning study are included in the following sections.

4.2 Grading Requirements

As previously noted, soft subgrade conditions should be expected along the shoulder or ditch of the existing road and areas where “pond sediments’ have been identified on Figure 3. Depending on the design grades, it may be possible to “bridge” over these soft areas, possibly by using geotextiles and/or geo-grid to help stabilize the subgrade. However, it may be more practical to remove and replace the soft soil with imported fill. This will have to be assessed as part of detailed design and will require additional test holes. It should be noted, however, that if there is any flexibility in establishing the design road grade, it is beneficial to based the road alignment as high as possible to mitigate the effects of soft subgrade conditions.

It is recommended that any fill slopes also be designed no steeper than 4H:1V. It may be possible to have steeper fill slopes, for example 2H:1V bridge head slopes, but this possibly may require the use of a geo-grid reinforcement. This would have to be assessed as part of a detailed design.

In areas where “pond sediments” have been identified, or areas with uncontrolled fill, it will be important that site-specific test holes are drilled as part of detailed design to confirm that stable fill slopes can be constructed in these areas. As previously noted, it may also be necessary sub-excavate and replace at least some of these sediments.

The fill should be placed and compacted according to current standards. For preliminary design it is reasonable to assume that fill material will settle in the range of 1% to 2% of the fill height, though much of this settlement typically occurs during construction.

Very little, if any, cut sections are anticipated along this segment of the alignment. If cuts are required, however, it is anticipated that they can be achieved using conventional excavators or possibly scrapers. Some cobbles and boulders should be expected within the clay till. There could also be seams of water bearing sands and gravels.

For preliminary design, it is recommended that permanent cut slopes be designed no steeper than 4H:1V. If slopes steeper than this are required, they should be assessed for stability on an individual basis.

4.3 Suitability of Soil for Fill

Very little cut is expected along this section of the alignment so it is anticipated that most of the fill material will have to come from off-site sources.

There may be some fill generated from the excavations for storm ponds or other borrow sites. It is expected that some of this material should be suitable for use as engineered fill, though shallow soils are expected to be wet and some moisture conditioning should be expected. It must be recognized, however, that storm ponds typically are located in low lying areas, and at these

locations the upper soils are often of poor quality, i.e., wet, and possibly containing organics. Such material should not be used in any structural fills.

Some excavations for utilities could potentially encounter bedrock. It is expected that some of the bedrock material, e.g, claystone should be suitable for re-use as structural fill.

4.4 Ponds

If storm ponds are to be considered on this site, consideration must be given to the possibly of a high groundwater table. It is expected that the water table is near the ground surface, and therefore, “infiltration ponds” should not be considered at this site.

4.5 Bedrock Excavations

Based on the available information, bedrock is not anticipated within the typical depths for utility excavation and/or storm ponds. However, this will need to be confirmed by a drilling program during detailed design.

If bedrock is found to be shallow enough that excavations are expected to extend into it, the ability to excavate into it should be assessed at that time. However, experience with most bedrock in the Calgary area is that it can be excavated without blasting. Consideration should also be given to conducting a seismic survey to provide additional information on bedrock excavation requirements.

4.6 Frost Susceptibility

The soils in this area are expected to be moderately frost susceptible but generally no more severe than what is experienced in most areas in and around Calgary. Hence at this stage there is not expected to be a requirement for any extraordinary measures to address frost action, e.g., insulation of pavements, deep material replacement, etc., though this should be confirmed at the time of detailed design.

That being said, it will be important that any foundations be designed to resist frost action, e.g., minimum pile length of 6 m; footings kept below anticipated depth of frost penetration, etc.

4.7 Foundation Conditions at Interchange

Specific details of the design of the grade separated interchange are not known at this time but it is expected that a bridge or bridges will be required.

It is anticipated that the bridge abutments and any intermediate piers will be founded on piles. These could be steel H-piles or pipe piles driven to practical refusal in bedrock. Alternatively, cast-in-place concrete piles founded in bedrock could also be considered.

Further details on the above pile options are provided below.

4.7.3 Driven Steel H-piles

Driven steel H-piles are usually most suitable for locations where bedrock is present at depths in the order of 10 m to 20 m below grade, which appears to be the case at this site.

Heavy section H-piles, when driven to practical refusal into the bedrock with a heavy pile driver, can carry factored vertical loads up to 1500 kN. It is, however, recommended that a maximum factored vertical load of 1000 kN be used for preliminary estimating purposes. It should also be assumed that the piles will have to be driven about 3 m into bedrock to reach practical refusal.

Unless driven into bedrock, the allowable vertical load capacity of steel H-piles would be relatively low.

High horizontal loads acting on steel driven H-piles can be resisted by batter piles, installed at inclinations up to 1H:4V. Smaller horizontal loads can also be resisted by vertical driven H-piles.

4.7.4 Bored Cast-in-Place Concrete Piles

Bored cast-in-place concrete piles are suitable in areas of relatively shallow bedrock, where the piles can be designed with rock sockets. The term rock socket refers to bored cast-in-place concrete piles that are subject to higher standards of construction and inspection required to warrant the high bearing parameters usually associated with this type of foundation.

Bored cast-in-place concrete piles founded in clay till are also possible. In clay soils the piles could be belled, thus providing larger end areas allowing greater vertical load carrying capacities. However, belling of piles may not be practical if groundwater seepage or sloughing conditions are encountered.

Bored cast-in-place concrete piles have been constructed with lengths in the order of 30 m, and factored capacities in excess of 5 MN are possible when socketed in bedrock.

4.8 Limitations and Use of Report

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before final design or construction details have been prepared or issued. Therefore differences may exist between the report recommendations and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedules, safety, and equipment capabilities.

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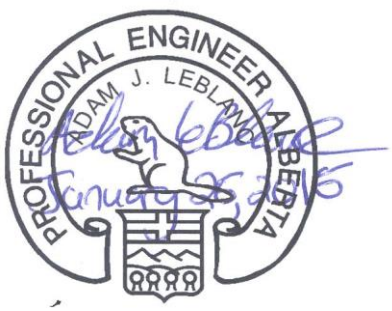
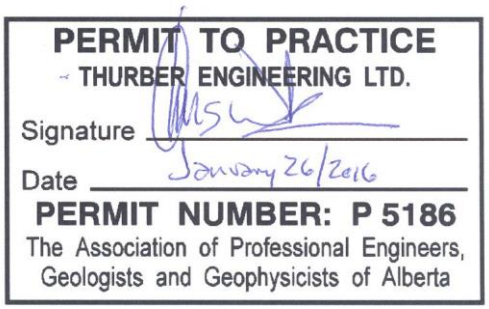
5. CLOSURE

We trust that this letter provides the information you require at present. Once more information about the planned upgrades to the intersections are available, a geotechnical drilling program will be required to delineate subsurface conditions and to provide site specific geotechnical recommendations. If you have any questions or if you require further information, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.
Chris Workman, P.Eng.
Review Principal





Adam LeBlanc, P.Eng.
Project Engineer

Attachment

- Statement of Limitations and Conditions
- Figure 1 Site Location Plan
- Figure 2 Glenmore Trail SE & 100th Street Site Plan
- Figure 3 Glenmore Trail SE & Conrich Road Site Plan
- Figure 4 Surficial Geology Plan

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

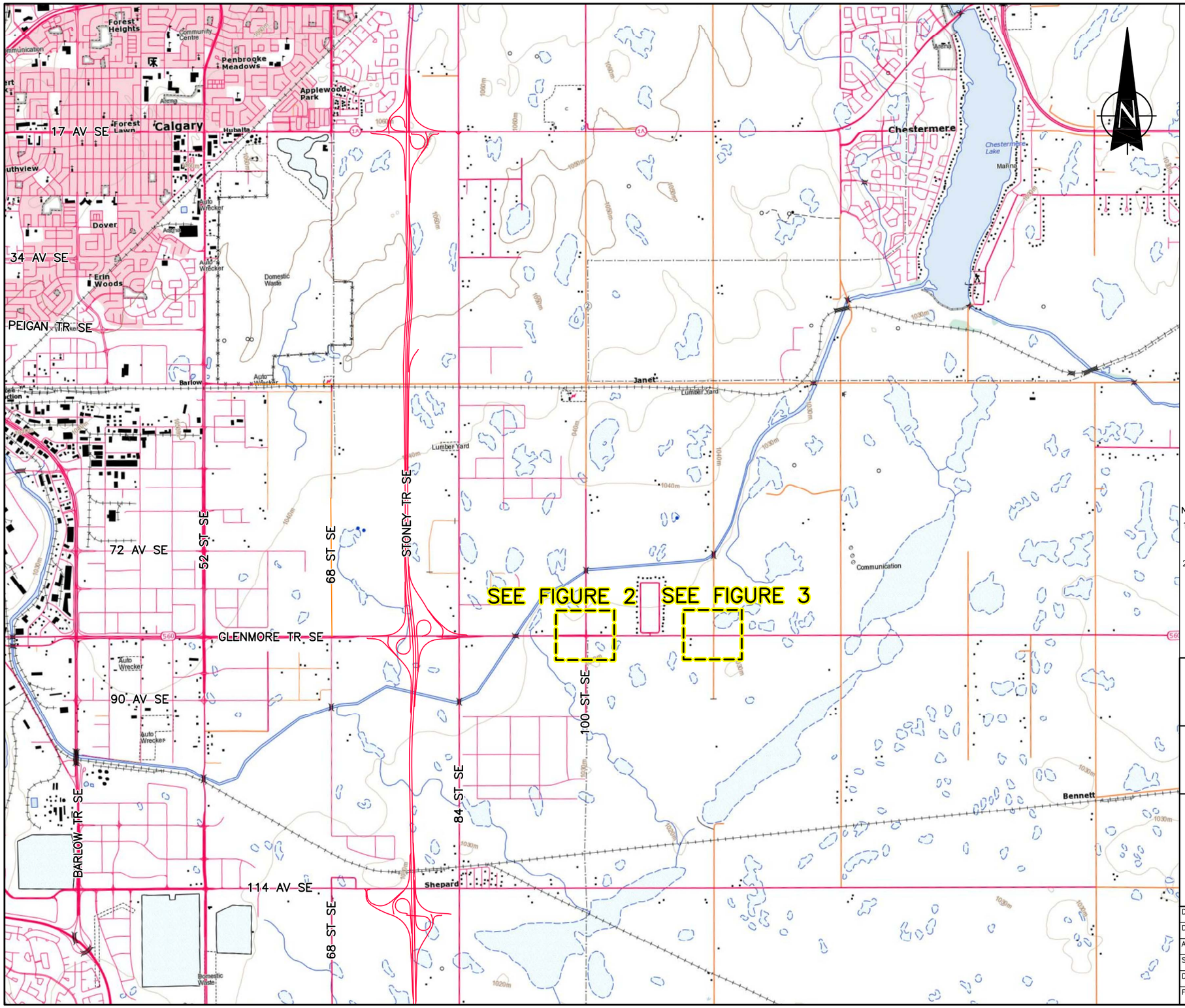
d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



NOTES:

1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 19-5538-7 DATED JANUARY 2016 AND IS SUBJECT TO THE STATEMENT OF LIMITATIONS AND CONDITIONS INCLUDED IN THE REPORT.

2 BASE MAP FROM NATURAL RESOURCES CANADA TOPORAMA FILES: 082I13, DALEMEAD, 082P04, DALROY, 082J16, PRIDDIS (PUBLISHED DATE 2013-07-19 EDITION 7.0) AND 082001, CALGARY (PUBLISHED DATE 2013-07-23 EDITION 8.0).

0 0.5 1.0 1.5 2.0 2.5 km

THE CITY OF CALGARY

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GLENMORE TRAIL SE AND 100 STREET SE FUNCTIONAL PLANNING STUDY

SITE LOCATION PLAN

FIGURE 1

DRAWN BY	ICB
DESIGNED BY	AJL
APPROVED BY	WCW
SCALE	1:50 000
DATE	DECEMBER 8, 2015
FILE No.	19-5538-7-A2A

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2 AIR PHOTO BASE FROM TARIN RESOURCE SERVICES LTD. 0.4 m/PIXEL (2013).

0 50 100 150 200 m

THE CITY OF CALGARY

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GLENMORE TRAIL SE AND 100 STREET SE FUNCTIONAL PLANNING STUDY

SITE PLAN

FIGURE 2

DRAWN BY	ICB
DESIGNED BY	AJL
APPROVED BY	WCW
SCALE	1:2 500
DATE	DECEMBER 8, 2015
FILE No.	19-5538-7-A3B

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2 AIR PHOTO BASE FROM TARIN RESOURCE SERVICES LTD. 0.4 m/PIXEL (2013).

0 50 100 150 200 m

THE CITY OF CALGARY

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GLENMORE TRAIL SE AND 100 STREET SE FUNCTIONAL PLANNING STUDY

SITE PLAN

FIGURE 3

DRAWN BY	ICB
DESIGNED BY	AJL
APPROVED BY	WCW
SCALE	1:2500
DATE	DECEMBER 8, 2015
FILE No.	19–5538–7–A3B

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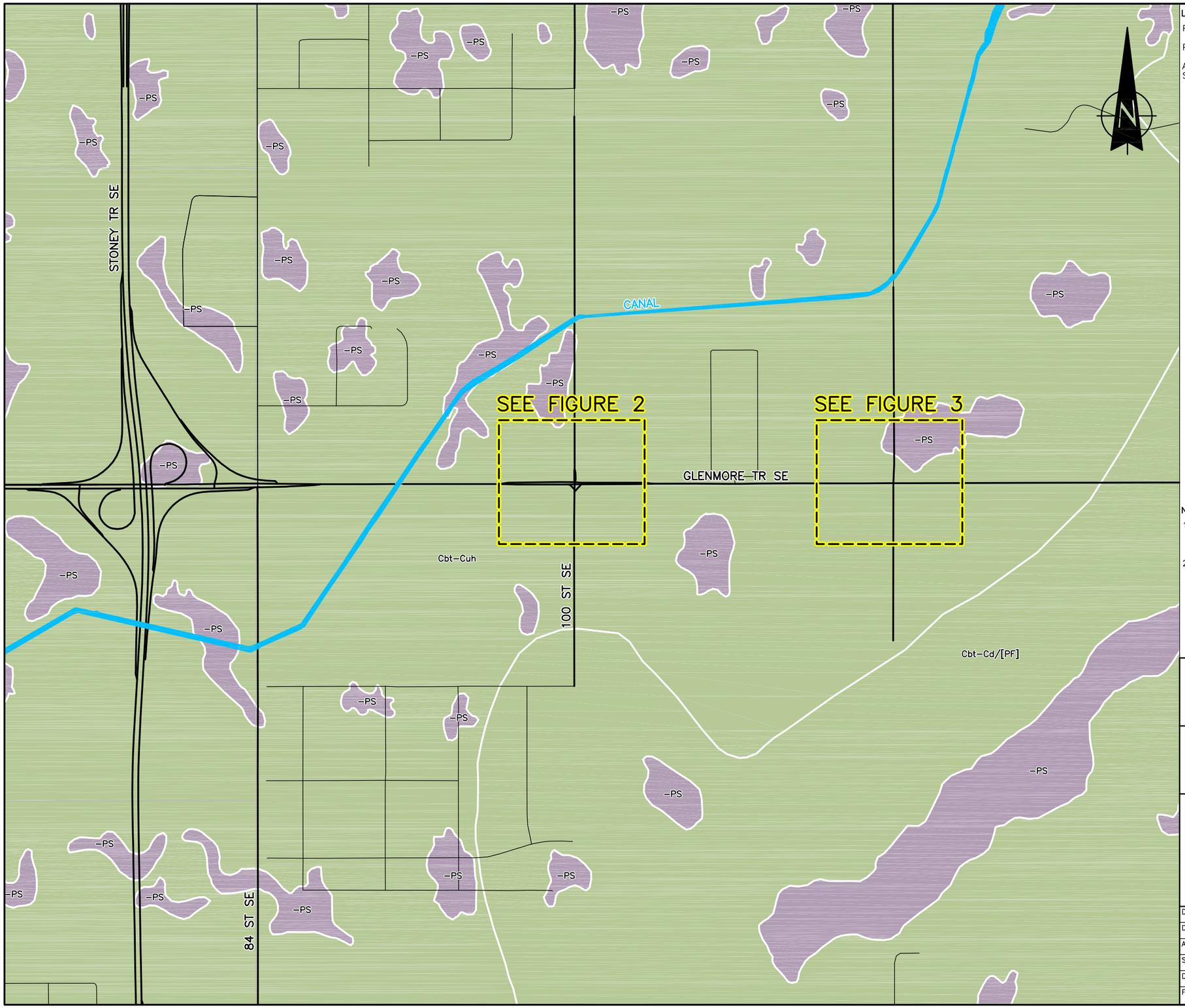

LEGEND:

PEBBLE LOAM (TILL), CROSSFIELD DRIFT	Cbt-Cuh
PEBBLE LOAM (TILL), CROSSFIELD DRIFT	Cbt-Cd/[PF]
A MIXTURE OF POORLY SORTED SILT, SAND AND ORGANIC MATTER	-PS

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2 SURFICIAL GEOLOGY BASE MAP MORAN, S.R., ALBERTA GEOLOGICAL SURVEY, DIG 2008-0874, 2008.

0 0.25 0.50 0.75 1.00 km

THE CITY OF CALGARY

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GLENMORE TRAIL SE AND 100 STREET SE FUNCTIONAL PLANNING STUDY

SURFICIAL GEOLOGY PLAN

FIGURE 4

DRAWN BY	ICB
DESIGNED BY	AJL
APPROVED BY	WCW
SCALE	1:20 000
DATE	DECEMBER 8, 2015
FILE No.	19-5538-7-A3B

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