GOLDEN SUMMIT
GEOTECHNICAL ENGINEERING LTD.

April 4, 2022

Thiara Brothers Enterprises
Attn. Mr. Ryan Thiara
16979 Ford Rd
Pitt Meadows, BC V3Y 0A6

Ref.: 13000 Harris Rd, Pitt meadows, BC – Proposed Worker Housing
Geotechnical Report

Dear Sirs,

Golden Summit Geotechnical Engineering Ltd. (GSGE) was retained by Thiara Brothers Enterprises (The client), to conduct a subsoil investigation and geotechnical study at the above-referenced site for the construction of proposed worker building. The purpose of this study is to assess the geotechnical conditions existing at the property; evaluate the potential geotechnical hazards at the site and provide recommendations for the geotechnical design and construction of the proposed structure.

The scope of this study comprises the geotechnical assessment of the soils at the subject site only; the environmental aspects are beyond its scope. This report includes a general description of the site and of the proposed development, describes the office and field investigation activities conducted to collect the information used in our analyses, the geotechnical conditions of the site, the geotechnical recommendations for structural design and construction, and hazard assessment.

1. Site and Project Description

The project is located at 13000 Harris Road, in Pitt Meadows, BC on a parcel situated on the east side of the road (See Figure 1, attached), identified with the PID No. 004-845-307. The property is bounded by agricultural lots to the east and south, by Harris Road to the West and by Katzie Slough to the North.

The parcel, currently zoned as A-1, General Agricultural, is characterized by generally flat topography, has a total area of 11.4 Ha, and is currently occupied by an existing residential

dwelling, a barn and agricultural land (berry crops). The new dwelling is proposed towards the west end of the lot, just southwest of the existing barn (See Figures 2, 3, attached).

The proposed structure consists of a two-story duplex building containing four residential units to be used as temporary residence of agricultural workers. The building is anticipated to be built using conventional timber frame.

2. REVIEW OF INFORMATION

GSGE conducted the review of the following information relevant to the project:

- City of Pitt Meadows Building Bylaw No. 2131, 2003
- City of Pitt Meadows Zoning Bylaw No. 2505, 2011
- City of Pitt Meadows Floodplain Designation and Construction Control Bylaw No. 2384
- City of Pitt Meadows "Mapview" On-Line Map
- Geological Survey of Canada Map 1484A - Surficial Geology New Westminster
- Geotechnical information from nearby sites from our archives

3. SUBSOIL INVESTIGATION AND GEOTECHNICAL SITE ASSESSMENT

A GSGE's geotechnical engineer conducted a site reconnaissance and subsoil investigation on October 31, 2019. Four test holes (TH-01 through TH-04) were excavated using a track-mounted excavator supplied by the client to depths varying from 1.5 m to 3.6 m. Soil samples were collected for laboratory identification and moisture testing.

The soils information collected during the subsoil investigation was supplemented with that of nearby sites located within the same geological environment, obtained from our archives.

The approximate location of the test holes (TH) and that of representative observation points (waypoints - WP) were logged using a hand-held GPS. TH location is shown in Figure 2. The description of the soil stratigraphy observed at the test holes is shown in section 5.3 below.

4. SITE GEOLOGY, GEOMORPHOLOGY AND SUBSURFACE CONDITIONS

4.1 GEOLOGIC SETTING

According to the Geological Survey of Canada (GSC) geological map 1484A "Surficial Geology – New Westminster" the soils in the project area consist of Fraser River Sediments (Fc) which include overbank silty to silt clay loam up to 2m thick overlying deltaic and distributary channel

fill (Fd) consisting of sandy to silt loam interbedded with fine to medium sand and minor silt beds. Figure 4, below, shows the geologic setting at the area of interest.

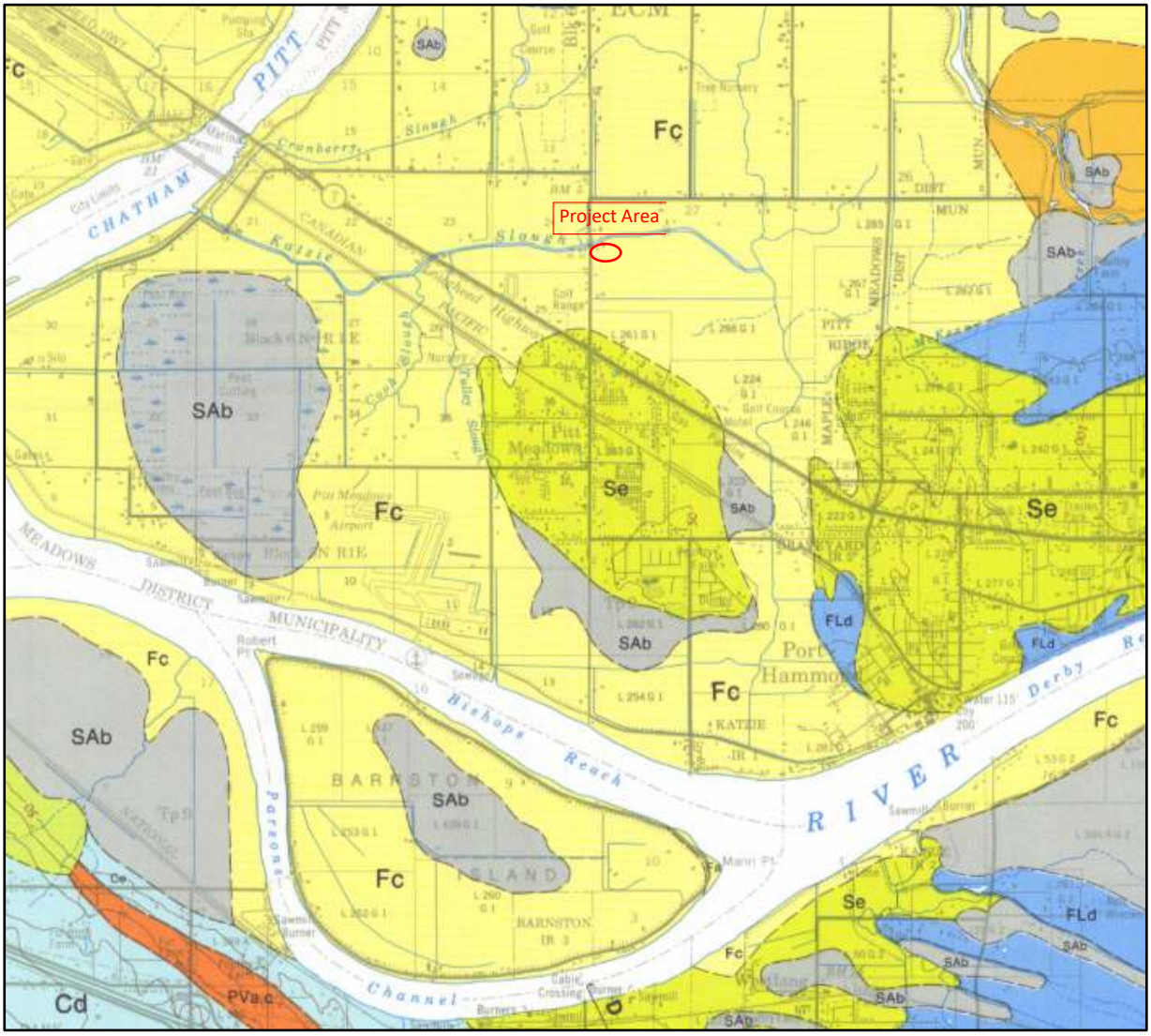


Figure 4. Geologic Setting at the Project Area (Taken from GSC Map 1484a)

4.2 SUBSOIL CONDITIONS

Based on the subsoil information from the Test Holes (TH), supplemented with information from boreholes at nearby sites, the soil stratigraphy at the area of the proposed structure consists of:

a. TOPSOIL: Observed to depths between 0.3 m and 0.6 m, overlying layer (b). Some fill & garbage was observed under the topsoil layer south of test hole TH-01.

b. SILT & SANDY SILT: Varying in consistency from very stiff at the top and decreasing to firm with depth and plasticity from medium, decreasing to low with depth as the fine sand contents increases. Observed to a maximum depth of 2.4 m, approximately, underlain by (c).

c. SILTY SAND / SANDY SILT: Observed to the depth of investigation, with firm/soft consistency.

d. SILT AND SAND: based on information from our archives and on the surficial geology map, as described previously, the presence of layers of sand, possibly interlayered with sandy silt / silty sand is anticipated underlying layer (c) from depths of 7 m to more than 20 m.

Groundwater seepage was observed at depths varying from 1.5 m at TH-01, where it may be influenced by seepage from the surface through adjacent garbage fill deposits, to between 1.6 m and 2.1 at the other test holes. The groundwater depth may be influenced by the level of Katzie Slough and may vary seasonally.

The stratigraphy at each test hole is described below. The depths are measured from the existing ground surface at each test hole location.

Test Hole TH-01: (At possible septic field area)

From 0.0 m to 0.6 m	Topsoil
From 0.6 m to 1.5 m	Stiff, moist, grey, medium plasticity SILT
1.5 m	Sandy silt. End of Test Hole due to water seepage flooding the hole.

Test Hole TH-02:

From 0.0 m to 0.6 m	Topsoil
From 0.6 m to 1.0 m	Stiff, moist, mottled, light brown, medium plasticity SILT
From 1.0 m to 1.8 m	Firm to stiff, moist, greyish light brown, medium-low plasticity SILT
From 1.8 m to 2.8 m	Firm, grey, wet, low plasticity sandy SILT grading into silty fine SAND at 2.4 m, approximately.
2.8 m	End of Test Hole

Groundwater seepage observed at 2.1 m of depth.

Test Hole TH-03:

From 0.0 m to 0.4 m	Topsoil
From 0.4 m to 1.0 m	Stiff, moist, mottled, light brown, medium plasticity SILT
From 1.0 m to 1.8 m	Firm to stiff, moist, greyish light brown, medium-low plasticity SILT
From 1.8 m to 2.0 m	Firm, grey, wet, low plasticity sandy SILT
2.0 m	End of Test Hole

Groundwater seepage observed at 1.6 m of depth.

Test Hole TH-04:

From 0.0 m to 0.3 m	Topsoil
From 0.3 m to 1.0 m	Stiff, moist, mottled, light brown, medium plasticity SILT
From 1.0 m to 1.8 m	Firm to stiff, moist, greyish light brown, medium-low plasticity SILT
From 1.8 m to 2.2 m	Firm to soft, grey, wet, low plasticity sandy SILT
2.2 m	End of Test Hole

Groundwater seepage observed at 1.8 m of depth.

5. GEOTECHNICAL HAZARD ASSESSMENT

Area of Interest

The primary area to be assessed corresponds to the portion of terrain identified in Section 1 of this report, where the new structure is proposed.

Methodology

The identification of geotechnical hazards was carried out based on the guidelines presented in the Hazard Acceptability Thresholds document (Cave, 1993).

Seismic Hazard & Seismic Site Response

Per the NBC 2015 and BCBC 2018, the parameters used to represent hazard for specific geographical locations are the 5%-damped horizontal spectral acceleration values for 0.2, 0.5, 1.0, 2.0, 5.0 and 10.0 second periods and the horizontal Peak Ground Acceleration (PGA) value that have a 2% probability of being exceeded in 50 years.

The Site Classification for the purpose of structural design is **E – Soft Soil** per the National Building Code (NBC) 2015 and BC Building Code (BCBC) 2018.

The Peak Ground Acceleration and spectral values -for the reference ground **Site Class C**, as reported by the BCBC and NBC- to be used in the geotechnical and structural analysis, where required, for a 2% probability of exceedance in 50 years as provided by National Resources Canada (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php) are:

PGA (g)	PGA_{ref} (g)	PGV (m/s)	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)
0.311	0.311	0.469	0.715	0.625	0.361	0.223	0.073	0.026

Amplification factors F(T), F(PGA) and F(PGV) to be determined based on the above parameters and Site Classification, per the BC Building Code 2018, where applicable; see Section of 4.1.8.4(8) for the selection of F(T) on liquefiable sites.

Liquefaction

The phenomenon of soil liquefaction consists of the loss of strength and deformation of saturated, loose granular soils and low plasticity silts when subjected to earthquake shaking, resulting in settlement of buildings.

Some of the low plasticity silt and sandy soils underlying the project area are considered in general to exhibit high liquefaction susceptibility based on the criteria from the "Task Force Report - Geotechnical Design Guidelines for Buildings on Liquefiable Sites in Accordance with NBC 2005 for Greater Vancouver Region".

Based on analysis following the above Guidelines, liquefaction settlements of the order of 400 mm to 500 mm were estimated in case of occurrence of the design earthquake with a probability of exceedance of 2% in 50-years (2,475-yr return period) per the National Building Code and BC Building Code. For structural design, the Task Force reports recommends assuming that differential settlements with a magnitude of 50% of the total liquefaction settlement may occur.

As a result of the above, it is recommended that the footings be tied together to preserve the structure stability. The selection of the structural solution by the structural engineer should take in consideration the applicable seismic design objectives and expected performance as stated by the National Building Code (User's Guide – NBC 2015 Structural Commentaries [Part 4 of Division B]):

1. To protect the life and safety of building occupants and the general public as the building responds to strong ground shaking,
2. To limit building damage during low to moderate levels of ground shaking.

Among the common alternatives recommended by the Task Force are, but not limited to, the use of flexible and rigid raft slabs.

Flooding

The subject site is within the designated Rural Floodplain, per the Floodplain Designation and Construction Control Bylaw No. 2384, 2008.

According to the above, the underside of any wooden floor system or top of any concrete slab of the habitable area of the proposed dwelling cannot be built at an elevation below 2.45 m (Geodetic Survey of Canada).

No topographic survey information was available at the time of writing this report. The elevations of the property at the proposed building area must be verified by a licensed surveyor.

Other Hazards

Other potential geotechnical hazards including small-scale localized landslip, mountain stream erosion or avulsion, debris flood, debris flow, major catastrophic landslide, were considered in our assessment and are deemed to be inexistent on this property.

6. DISCUSSION AND RECOMMENDATIONS

6.1 GENERAL

It is our professional opinion that the subject site is suitable for the proposed development provided that the recommendations described below are followed.

6.2 HAZARD ASSESSMENT

Based on the estimated likelihood of the hazard events described above, it is our professional opinion that the land may be used safely for the use intended provided that the recommendations described below are implemented. The above is based on the comparison

of the assigned probabilities of occurrence of the hazards assessed to the Cave (1993) acceptability criteria.

6.3 SITE PREPARATION

General

Topsoil, lose or soft fills, organic or any unsuitable soils must be stripped to the depth of the upper layer of the native, stiff, medium plasticity silt (Layer b), observed at depths between 0.3 m to 0.6 m below the existing ground surface. The foundation soil must be approved by GSGE prior to placement of footings or structural fills.

Due to the potential compressibility of the foundation soils underlying the stiffer upper crust, the placement of grading fills to meet the flood construction levels would cause unacceptable long-term settlements. One common approach under this situation is to raise the grade by structural means, i.e., by creating a crawl space under the building footprint. However, it is our understanding that the use of crawl spaces is not acceptable in temporary residence buildings by the City of Pitt meadows.

Therefore, the grade must be raised using a granular pad. Based on the average ground elevation, the height of the proposed granular pad is 1.0 m above the existing ground surface.

The granular pad shall be built using structural fill consisting of sound, durable, well graded granular material, free of earth lumps or deleterious materials, with a maximum size of 75 mm and fine contents (material passing sieve 0.075 mm/No. 200) less than 12% and plasticity index measured on the fraction of soil passing sieve No. 40 lower than 6 percent. The structural fill must be approved by GSGE prior to its use.

The structural fill must be compacted to a minimum density of 95% Modified Proctor Maximum Dry Density (SPMDD) and must extend to a minimum horizontal distance beyond the edges of the footings equal to the greater of: (i) two times the footing width; (ii) the thickness of the structural fill or (iii) 2.0 m. Fill must be placed in 300 mm (1 ft.) thick loose lifts when compacted using large compaction equipment such as vibrating rollers. Lift thickness must be reduced to 150 mm if smaller plate compactors are used.

Perimeter footing drain tiles (to be designed by others) are required and must be connected to the storm management system.

The slopes of the granular pad must be vegetated with grass and a layer of permanent Erosion Control Mat (ECM) with a capacity to resist a flow velocity of

Temporary Preload

In order to minimize the consolidation settlements due to the construction of the granular pad, the installation of a temporary preload surcharge is recommended. The height of the preload must be 1.5 m above the top of the proposed building granular pad, as shown in the cross section of Figure 3.

The fill material shall consist of non-structural granular fill (sand or silty sand / sandy silt) with a minimum compacted unit weight of 18 kN/m^3. The goal of the preload is to accelerate the consolidation settlements and must be placed over the granular pad footprint. The estimated duration of the preload is 90 days, approximately, depending on the evolution of the soil consolidation rate.

In order to monitor the surcharge fill settlement, a minimum of six settlement gages must be installed prior to the placement of the preload at the top elevation of the granular pad and topographically surveyed to monitor the settlement at their installation and immediately after the placement of the preload. Further monitoring must be required on a weekly basis for the first month and then the frequency can be reduced to monthly readings. Survey readings must be submitted to GSGE for analysis. Removal of the preload will be subject to our approval.

Fill Quantities

It is anticipated that imported fill material is required for the construction of the permanent building granular pad and the temporary preload surcharge. The fill quantities for each of those fills are summarized in the table below. Equivalent fill horizontal plan area and height are calculated to be used for the fill placement permits.

GRANULAR PAD & TEMPORARY PRELOAD SURCHARGE
FILL VOLUME CALCULATION

	GRANULAR PAD	TEMPORARY PRELOAD
Cross Section Area, m2	27	26
Average Fill width, m'	16.1	16.6
Average Fill Length, m	26.2	26.7
Fill Volume, m3	707.4	694.2
Equivalent Fill Height, m	1.6	1.5
Equivalent Fill Length, m	26.2	26.7
Equivalent Plan Area, m2	442.1	462.8

6.4 BEARING CAPACITY

Footings founded on granular pad, as described in Section 6.3 of this report can be designed based on a factored bearing pressure (ULS condition) of 112 kPa (~2,250 psf.), for a resistance factor ϕ of 0.5. Applied bearing pressures must be limited to a serviceability bearing pressure (SLS condition) of 75 kPa (~1,500 psf.).

The above bearing capacity values do not consider the effect of eccentric or inclined loads; for those cases or for footings placed on top of fill GSGE must verify the validity of those values.

The footing widths must be selected based on the loads assessed by the structural engineer, and the above bearing pressures. The minimum footing width must comply with the requirements of BCBC 2018, Table 9.15.3.4 shown below:

BCBC 2018, Table 9.15.3.4

No. of Floors Supported	Minimum Width of Strip Footings, mm		Minimum Footing Area for Columns Spaced 3 m o.c.,(1) m^2
	Supporting Exterior Walls(2)	Supporting Interior Walls(3)	
1	250	200	0.40
2	350	350	0.75
3	450	500	1.0

Notes to BCBC 2018, Table 9.15.3.4:

(1) See Sentence 9.15.3.7.(1).
(2) See Sentence 9.15.3.5.(1).
(3) See Sentence 9.15.3.6.(1).

Minimum footing burial depth for frost protection is 450 mm.

In order to minimize the building damage or prevent the collapse of the building due to the occurrence of large differential settlements caused by soil liquefaction in the case of occurrence of the design earthquake, as described previously, the structural engineer may choose to design the building foundation using a flexible or a rigid raft slab built on top of the granular pad.

6.5 INFILTRATION SYSTEMS

The use of infiltration systems for septic and storm management is considered feasible from a geotechnical point of view.

A percolation test was conducted using the procedure outlined in the Sewarage System Standard Practice Manual of the BC Ministry of Health (BCOSSA, 2007).

The test was conducted adjacent to TH-01 at a depth of 0.3 m into the upper, medium plasticity silt layer (Layer b). The measured percolation rate was 23 min / 2.54 cm (no factors of safety applied to measured value).

7. REVIEW AND INSPECTION

We recommend retaining GSGE to conduct the following activities:

- Approval of foundation soil
- Fill placement inspection

8. LIMITATIONS AND CLOSURE

The recommendations provided in this report are based on the engineering analysis of the information collected, of the results of the subsoil investigation and on our engineering judgement. Due the variable nature of the subsoil and limitations inherent to the subsoil investigation, unexpected conditions may be found; Golden Summit Geotechnical Engineering Ltd. must be informed by the client in this event to conduct the necessary revisions. This report has been prepared in accordance with general accepted engineering practice for the exclusive use of the client for the purposes stated. No other warranty expressed or implied is made.

German A. Cajigas, M.Eng., P.Eng.
Principal – Senior Geotechnical Engineer

ATTACHMENTS

- Figure 1 – General Site Location
- Figure 2 – General Site Topography and Test Hole Location
- Figure 3. – Site Plan and Fill Cross Section
- Photographs

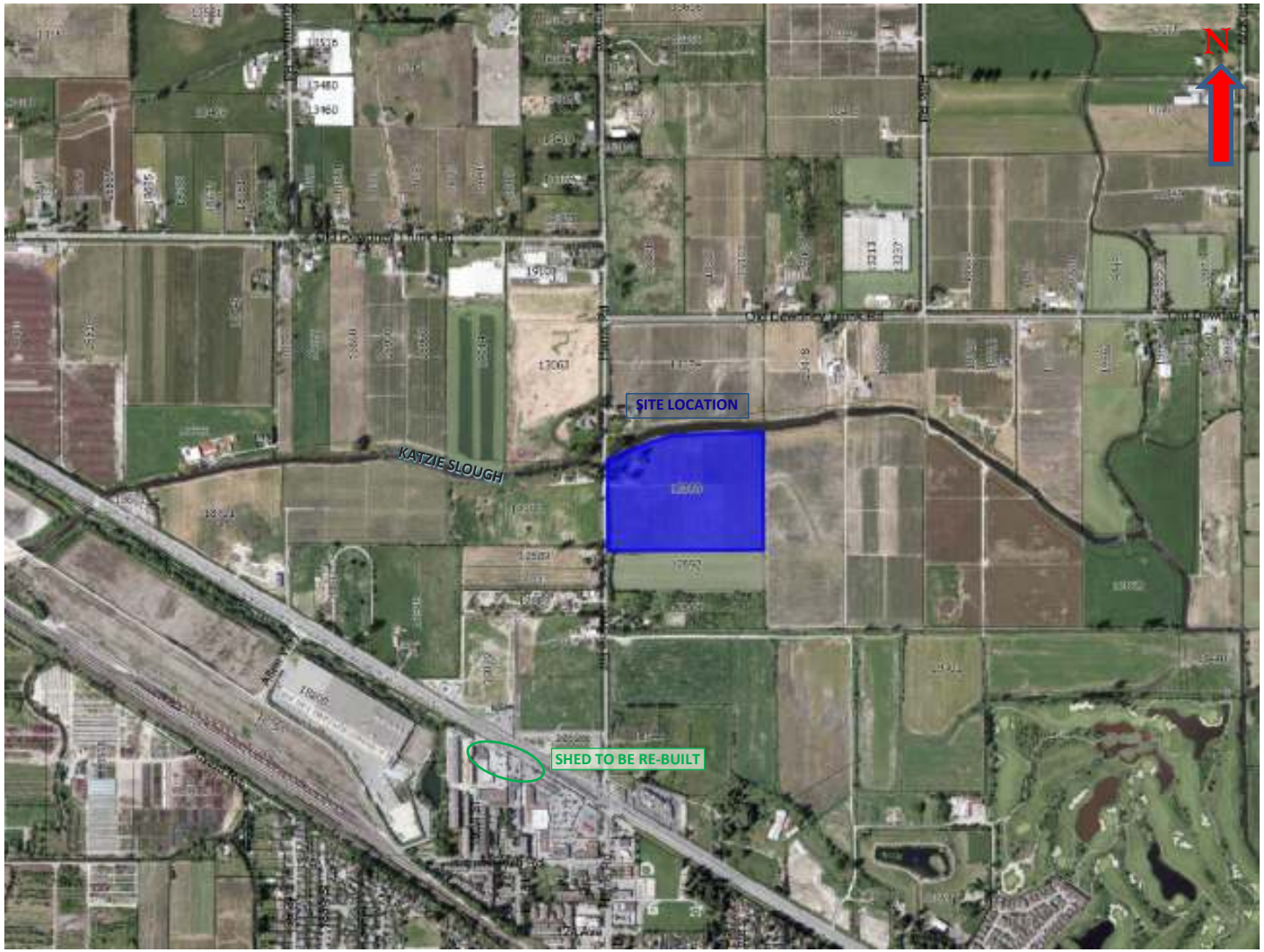


Figure 1. General Site Location (Adapted from Pitt Meadows MapView - NTS)

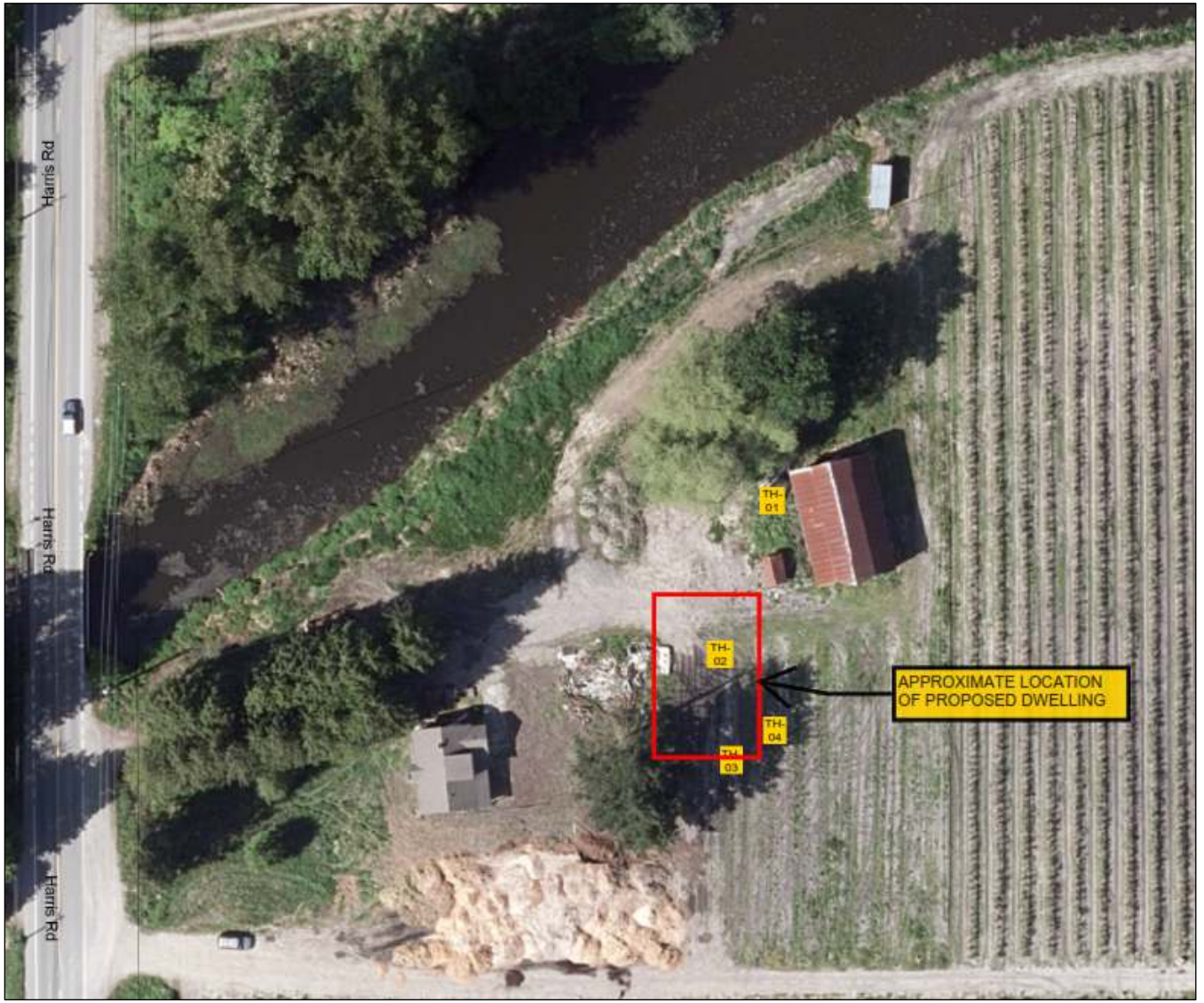
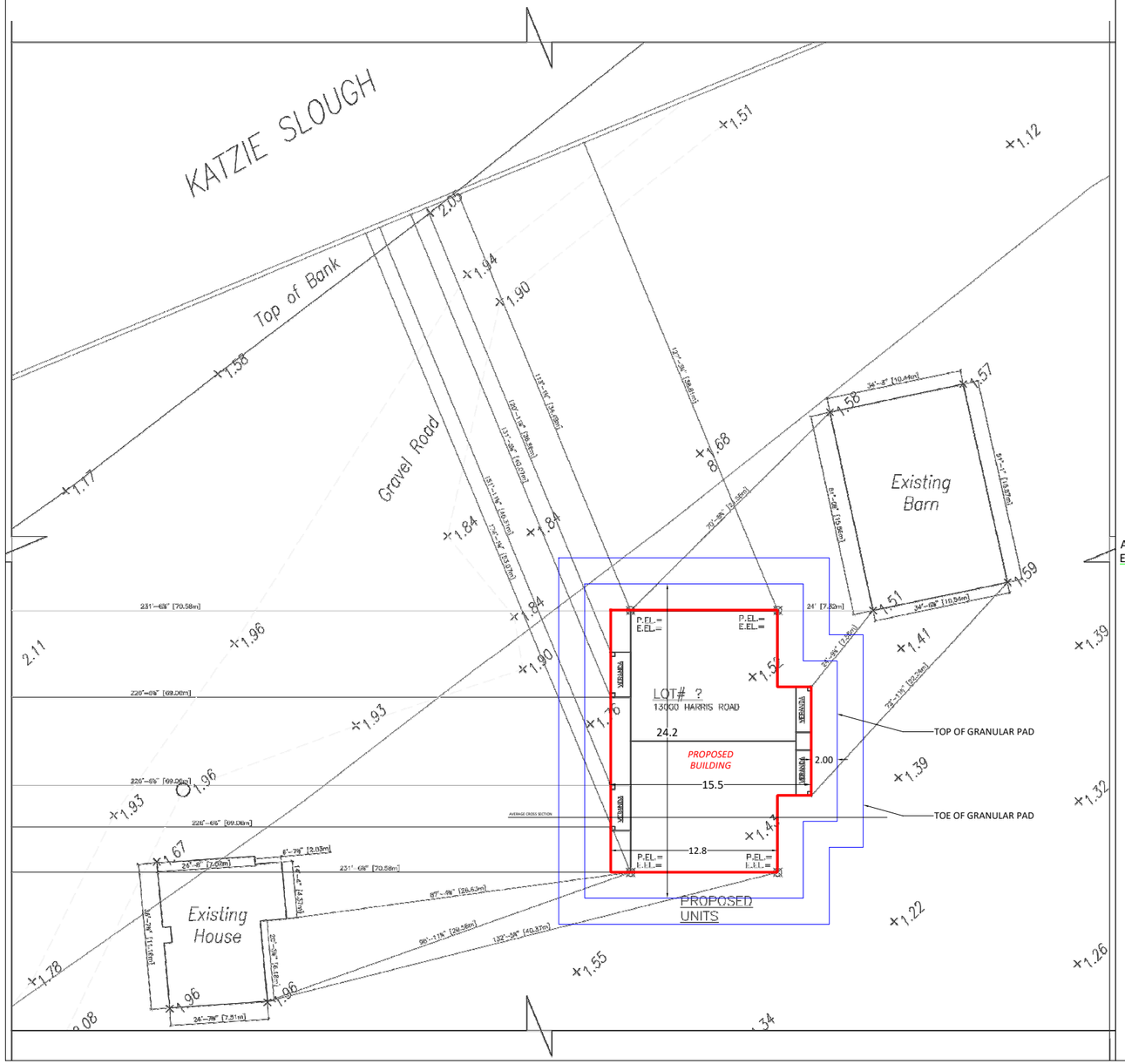
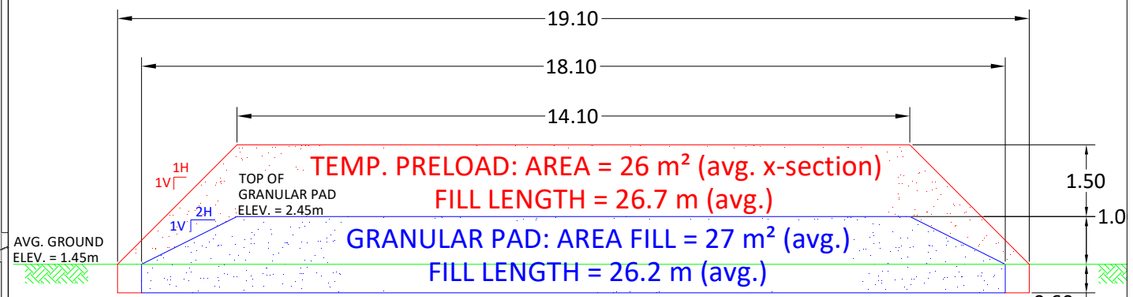


Figure 2. Approximate Location of Proposed Dwelling and Test Holes (TH)



SITE PLAN (SCALE 1:400)

AVERAGE CROSS SECTION GRANULAR PAD & PRELOAD
SCALE 1:125



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Equivalent Fill Height, m	1.6	1.5
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REV.	DATE	DESCRIPTION	BY
0	2022-04-11	ISSUED FOR BUILDING PERMIT	G. CAJIGAS

GOLDEN SUMMIT
GEOTECHNICAL ENGINEERING LTD.
EGBC PERMIT TO PRACTICE # 1003222

DRAWN: MF	REV: GC
DATE: 11 APRIL 2022	SCALE: AS SHOWN
FIGURE 3	1 / 1

SITE: 13000 HARRIS RD, PITT MEADOWS, BC

SITE PLAN AND FILL CROSS SECTION

CLIENT: **THIARA BROTHERS ENTERPRISES**

PHOTOGRAPHS

Photo 1. View of prosed building area at TH-02 (looking northeast)

Photo 2. Typical soil stratigraphy at the site as observed at TH-03