

August 15, 2017

City of Kelowna
1435 Water Street
Kelowna, BC V1Y 1J4

ISSUED FOR REVIEW
FILE: ENG.KGEO03079-27
Email: tkowal@kelowna.ca

Attention: Mr. Terry Kowal

Subject: 424 Gibson Road, Kelowna, BC - Retaining Wall Geotechnical Assessment

This 'Issued for Review' document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an 'Issued for Use' document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the 'Issued for Review' document should be either returned to Tetra Tech Canada Inc. (Tetra Tech) or destroyed.

1.0 INTRODUCTION

The City of Kelowna (the City) has retained Tetra Tech Canada Inc. (Tetra Tech) to carry out a geotechnical assessment of two retaining walls constructed on the west area of the property located at 424 Gibson Road in Kelowna, BC. Tetra Tech understands that these walls do not comply with the requirements of the City. Therefore, the intent of the City is to present this assessment to City council to aid in the assessment of the amount of action that the City should engage with the owner to achieve compliance. Figure 1 shows the location of the project and the section of wall assessed.

This report presents findings and observations from a site visit and provides an opinion and recommendations regarding the two retaining walls.

2.0 SCOPE OF WORK

The scope of work provided to the City via email on June 27, 2017, and approved by the City by email on July 18, 2017, includes:

- Attend the property on Gibson Road and conduct a visual geotechnical assessment of the retaining walls that were constructed.
- Prepare a technical memo with our findings, opinions, and recommendations.

3.0 SITE OBSERVATIONS

Tetra Tech visited the property with Mr. Terry Kowal, the City representative, and Mr. Paul Heinrichs, structural engineer from RJC Engineers Ltd., on July 24, 2017. The lot has an approximate area of 0.35 acres and its legal address is Township 26 Plan KAP17167 Section 25 Lot 4. We understand that the owner of the property has implemented some updates to the property and lot area through the years without proper applications to the City. We also understand that the original lot landscape sloped downhill from east to west and that the west area has

been altered by building retaining walls and backfilling to raise the ground elevation. Construction of these retaining walls has creating two terrace levels (see attached photos).

The first terrace is supported by the most westerly wall running along the west property line. This wall is approximately 0.80 m high and supports an approximately 2.0 m high backslope inclined at about 70° (Photos 9, 10, and 11). Following the backslope there is a flat terrace that is approximately 10 m wide (Photo 12) that ends on the base of the upper wall (Photo 1).

The upper wall is approximately 2.6 m high (Photos 1 and 2). It has been built on a concrete footing founded on fill material. A weeping tile (Big “O”) of unknown length has been placed on the front part of the footing (Photo 5). The footing and wall have been constructed using rounded to subrounded gravel to boulder-sized rocks bound with mortar (Photos 6 and 7). The wall is inclined approximately 78° and is buttressed at the south end by a return wall approximately 5 m long that ends on the access for the lower terrace (Photo 4). A flat terrace approximately 15 m wide sits on top of this second wall (Photo 8).

4.0 DISCUSSION AND RECOMMENDATIONS

Based on field observations and experience in design/construction of retaining wall systems our comments include:

- Retaining walls are structures that support backfill and allow for a change of grade. Retaining wall structures can be gravity-type structures, semi-gravity type structures, and counterfort-type structures. It is difficult to establish the type of structure constructed at 424 Gibson without a design scheme, record drawings, or knowing the existing soil conditions. It is recommended that a subsurface investigation be carried out to define the soil conditions of the backfill material and establish shear resistance parameters to determine the stability of the walls.
- Considering the observed elements used for the construction of the retaining walls we may classify both walls as semi-gravity retaining walls.
- The lower wall (approximately 0.80 m high) seems to be bulging about midway along the length of the wall. The surcharge caused by approximately 2.0 m fill material inclined about 70° may, therefore, be exceeding the capacity of the retention system.
- Likely the Factor of Safety against overturning and sliding on the lower wall is close to 1.0. Therefore, it is recommended that the fill slope be reduced to a 1.5(H):1(V) slope (33.7°). If the fill slope is not reduced a setback distance of 3.0 m should be established from the edge of the slope to any load applied on the flat area above the wall.
- The upper wall is a semi-gravity cast-in-place wall that is made with oversized aggregate (gravel to boulder sizes). It seems that this wall was built by framing, dumping the aggregate materials and filling it up with wet concrete. Due to the construction method extreme honeycombing is observed mainly on the bottom third of the wall. The segregation has caused significant voids that have little or no filling material (concrete) so the bond between the coarse aggregate appears to be very weak.
- Due to the likely weak bond between aggregate on the bottom of the wall, there is a risk that the all may fail and collapse. Therefore it is recommended that workers not be allowed to within 2.5 m of the wall without further shoring or protection.
- Due to the unknown construction methods and foundation conditions of the upper wall, it is recommended that a setback distance from the edge of the wall of twice the height of the wall (~ 5.0m) should be established for load applied on the flat area above the wall.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Kelowna and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the City of Kelowna, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech Canada Inc.'s Services Agreement. Tetra Tech's General Conditions are provided in Appendix A of this report.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

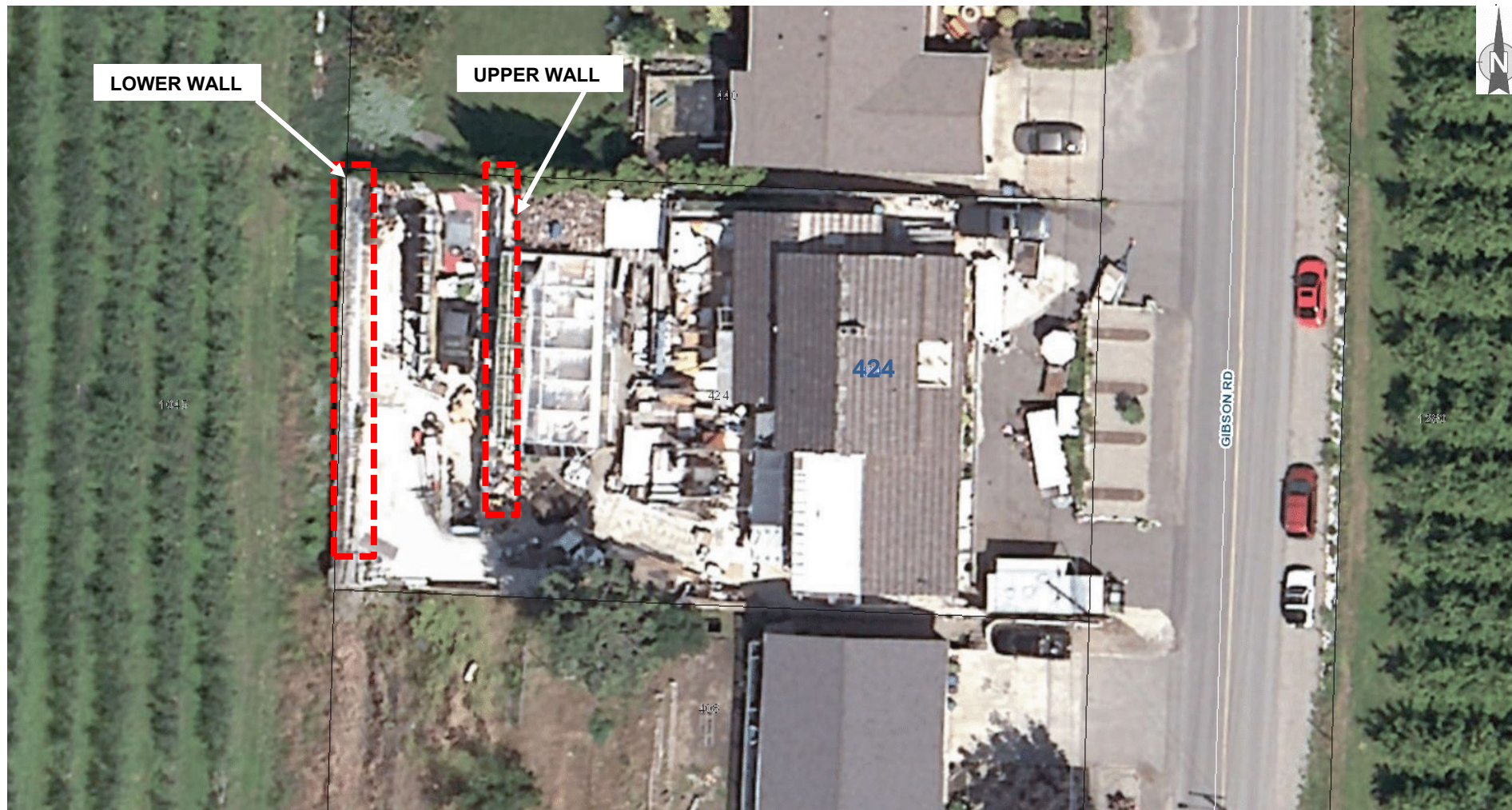
Prepared by:
German Martinez, P.Eng.
Senior Geotechnical Engineer
Engineering Practice
Direct Line: 250.862.3026 x255
german.martinez@tetrattech.com

Reviewed by:
Shane Greene, M.Sc.
Geotechnical Engineer
Engineering Practice
Direct Line: 250.862.3026 x230
german.martinez@tetrattech.com

/mj

FIGURES

Figure 1 Site Location Plan



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT



**RETAINING WALL ASSESSMENT
424 GIBSON ROAD, KELOWNA, BC**

Site Location Plan

PROJECT NO. ENG.KGEO03079-27	DWN GM	CKD GM	APVD GM	REV 0
OFFICE EBA-KEL	DATE August 11, 2017			

Figure 1

PHOTOGRAPHS

- Photo 1 Upper wall view to north.
- Photo 2 Upper wall center area. Gravel to boulder size rocks bound with mortar.
- Photo 3 Upper wall north end. Coble to boulder size rocks bound with mortar.
- Photo 4 Upper wall south end approximately 2.6 m high. Coble to boulder size rocks bound with mortar.
- Photo 5 Upper wall south end. Weeping tile below footing wall.
- Photo 6 Upper wall cobble to boulder size rocks bounded with mortar. Significant voids shown.
- Photo 7 Upper wall gravel to boulder size rocks bounded with mortar.
- Photo 8 Flat slope above upper wall.
- Photo 9 Lower wall and steep (~70°) 2.0 m high backslope.
- Photo 10 Lower wall. Approximately 0.80 m high wall. Looking to the north.
- Photo 11 Lower wall looking south from top of backslope.
- Photo 12 Surcharge flat area above steep backslope of lower wall.



Photo 1: Upper wall view to north.



Photo 2: Upper wall center area. Gravel to boulder size rocks bound with mortar.



Photo 3: Upper wall north end. Coble to boulder size rocks bound with mortar.



Photo 4: Upper wall south end approximately 2.6 m high. Coble to boulder size rocks bound with mortar.



Photo 5: Upper wall south end. Weeping tile below footing wall.



Photo 6: Upper wall cobble to boulder size rocks bounded with mortar. Significant voids shown.



Photo 7: Upper wall gravel to boulder size rocks bounded with mortar.



Photo 8: Flat slope above upper wall.



Photo 9: Lower wall and steep (~70°) 2.0 m high backslope.



Photo 10: Lower wall. Approximately 0.80 m high wall. Looking to the north.



Photo 11: Lower wall looking south from top of backslope.



Photo 12: Surcharge flat area above steep backslope of lower wall.

APPENDIX A

TETRA TECH'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these "General Conditions".

1.1 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of TETRA TECH's Client. TETRA TECH does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than TETRA TECH's Client unless otherwise authorized in writing by TETRA TECH. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the report, if required, may be obtained upon request.

1.2 ALTERNATE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed TETRA TECH's instruments of professional service); only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of TETRA TECH's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except TETRA TECH. TETRA TECH's instruments of professional service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.4 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.5 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.6 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.7 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.8 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.9 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.10 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.11 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.12 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.13 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.14 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of the report, TETRA TECH may rely on information provided by persons other than the Client. While TETRA TECH endeavours to verify the accuracy of such information when instructed to do so by the Client, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information which may affect the report.