TETRA TECH

OQM CERTIFIED

March 21, 2019

ISSUED FOR USE
FILE: ENG.KGEO03138-01
Via Email: francis.zheng@dhiholdings.com

DHI Holding Inc.
3600 No. 3 Road
Richmond, BC V6X 2C1

Attention: Mr. Francis Zheng

Subject: Geotechnical Assessment for Proposed Development at Lake Okanagan Resort
2751 Westside Road, Kelowna, BC – Revision 2

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by DHI Holding Inc., to provide a geotechnical assessment for the proposed development at 2751 Westside Road in Kelowna, BC. This report presents the results of our assessment and provides preliminary recommendations for development.

2.0 PROPOSED DEVELOPMENT

The proposed development is located south of the Lake Okanagan Resort on the south side of an unnamed creek. A concept plan for the proposed development has been supplied by New Town Architecture and Engineering (New Town) on behalf of the client and is attached in Appendix A. Based on the supplied information it is our understanding that the proposed development may include:

- a paved access road;
- fourteen, two level rancher style chalet buildings
- cut and fill earthworks with various unspecified retaining walls;
- a golf cart path; and
- underground utilities.

3.0 DESKTOP STUDY AND SITE RECONNAISSANCE

A desktop study involving review of aerial photograph, geological maps and other information from Tetra Tech's archives has been undertaken. Aerial photographs have been sourced from Google Earth, the Regional District of the Central Okanagan (RDCO), and the Government of British Columbia. Site reconnaissance was undertaken on September 19, 2017 to evaluate geohazards and undertake geological mapping as well as to evaluate existing site utilities and suitable locations for testpits. A follow-up site reconnaissance was undertaken with a utility service locator on May 28, 2018. Results of the desktop study and site reconnaissance are presented in subsequent sections.

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4.0 FIELD INVESTIGATION

Field investigation included a testpit exploration program that included a total of six testpits that were excavated to depths of up to 3.5 m. Testpit excavation was undertaken on June 20, 2018 by Stone Creek Excavation using a Zaxis 120 excavator. Tetra Tech personnel were present during excavation to supervise, log and sample soil materials and direct additional excavation where necessary. Testpit locations are shown on Figure 1 and detailed testpit logs are presented in Appendix B.

Testpits could not be completed at all proposed locations due to the presence of unmarked services and a treated water leaching field. This is discussed further in Section 6.0.

5.0 LABORATORY TESTING

Laboratory tests were carried out on four of the soil samples collected during the testpit investigation to classify site soils and estimate material characteristics. The samples were tested at Tetra Tech's CCIL accredited materials testing laboratory in Kelowna. Laboratory test results are shown on the testpit logs and laboratory test reports provided in Appendix C.

6.0 SITE CONDITIONS

The following sections describes site conditions as observed during site reconnaissance and testpit investigation. Photographs taken during fieldwork are attached to this report to help illustrate some of the observations described below.

6.1 Site Setting

The site is located on relatively steep to very steep (20° to 40°) east facing slopes and is bounded to the north by a small unnamed creek, to the south by residential property, to the east by Lake Okanagan and to the west by Westside Road (see Figure 1).

A decommissioned building is present in the southwest corner of the property and has a fill embankment behind it (to the east of the building, see Figure 1). Aerial photographs show that a second building also previously stood next to the existing building. Aerial photographs indicate that the building still present on the property today was built in the late 1970's or early 1980's. Stone Creek Excavation have stated that the fill embankment at the decommissioned building of the property is comprised of uncontrolled fill and that the site has been previously used by many in the area as a disposal site for uncontrolled fill.

A force main, sand filters and leaching field for disposal of treated sanitary water from the Lake Okanagan Resort are present in the northern part of the site. Parts of the system are still in use and as a result, testpits could not be completed at or near these services. This means there is a significant geotechnical data gap in the subsurface information at the site representing approximately one third of the site area.

6.2 Site Geology

Existing geological data for the area is available from the British Columbia Geological Survey's online database (Cui et al 2017) as well as from the Geological Survey of Canada (Paradis 2010). These maps show the general area contains the following main geological units (from youngest to oldest):

- Alluvial Fan Sediments – Post-glacial poorly sorted gravel, sand silt and clay in fan-shaped forms.
- Glaciolacustrine Littoral & Sublittoral Sediments – laminated to massive, predominantly well sorted sand, silt and clayey silt.
- Bedrock – principally granodioritic intrusive rocks of Jurassic (145 – 201 Ma) age.

Site reconnaissance and testpit investigation shows that site geology is generally consistent with that shown on the geological maps with the exception that resolution on the maps is not detailed down to site level. In addition, the information gap resulting from the presence of existing utilities also makes it difficult to evaluate the contact between the alluvial fan sediments and the underlying glaciolacustrine sediments. Lastly, a final geological unit present at the site consists of uncontrolled fill placed around the decommissioned building as well as any disturbance and fill placed for the sanitary leaching field.

Geological mapping of bedrock outcrop shows that bedrock is present at or is likely very close to surface (< 1.0 m) in the southeast section of the site (see Figure 1). Site walkover observation and testpitting suggests the southern part of the site is situated on a bedrock ridge as observed west of Westside Road above the site. Bedrock from the middle to northern end of the site is dipping to the north and is buried by both glaciolacustrine and alluvial fan deposits. The approximate area where shallow bedrock (< 1.0 m) may be present is shown in Figure 1.

In general, the materials observed in testpits consist of up to approximately 0.5 m of organic topsoil overlying sand and gravel alluvial fan deposits. However, layers of clay, silt and sandy silt likely associated with glaciolacustrine or reworked glaciolacustrine deposits were found in TP18-01 and TP18-02. These materials are also exposed in the backscarp of two landslips observed in the northeastern portion of the site. The landslips are discussed further in Section 6.3. The contact between glaciolacustrine deposits and alluvial fan deposits could not be well defined by the investigation to date but it is likely that at least a veneer of alluvial fan deposits is present across most of the site with the thickest deposits present in the northern part of the site.

6.3 Geohazards

During site walkover the main geohazard observed on-site was relatively small-scale landsliding in wet and/or over-steepened soil slopes. In particular there were two locations (see Figure 1) where evidence of small-scale landslides were observed. In addition to landslides the uncontrolled fill east of the decommissioned building at the site presents a settlement hazard. These hazards are discussed further in the following sections.

6.3.1 Landslide 1

This landslide is located in the northwest corner of the property above the steep side gully separating the site from the main Lake Okanagan Resort. The area did not appear to be active at the time of investigation. However, historic movement is evidenced by a small concave depression in the slope with a potential backscarp that is approximately 10 m in width. Characteristic bending in the trunks of some of the trees in the area of the suspected instability was also observed. It is possible that this instability has occurred in overbank fill materials placed when sand filters for sanitary water disposal were constructed. In addition, the location of slip 1 is relatively close (~ 12 m) to the sand

filters and water loading from seepage of sanitary water into the ground may have contributed to historic slope movement.

6.3.2 Landslide 2

This landslide is located in the northeast corner of the property and is an active landslide that currently extends from lake level back to the track leading up from the sanitary water treatment plant (see Figure 1). The landslide is located directly below the location where it is suspected that the forcemain from the sanitary water treatment plant turns approximately 90 degrees to the west and heads straight uphill to the sand filters. Water has been observed seeping from the bottom of the main backscarp every time the site has been visited.

The landslide is not visible in 2016 aerial imagery on the RDCO website but is visible on Google Earth imagery dated August 4, 2017. At the time of initial inspection in September 2017, the landslide area was relatively free of vegetation when compared with vegetation present during testpitting in June 2018. Some additional failure has occurred since our September 2017 inspection.

The information presented above suggests that the main body of the landslide failed in 2017, likely in the spring or early summer during the unusually high lake levels experienced that year. It is our assessment that high lake levels likely caused shoreline erosion that removed toe support for the slope. In addition, groundwater seepage will have significantly reduced the shear strength of the soil. It is our assessment that removal of toe support coupled with loss of strength due to groundwater seepage were the two key contributing factors resulting in the main failure of the slope in 2017.

It is likely that groundwater seepage observed at the backscarp is directly related to the sanitary water seeping through the sand filters and leaching field. Much of the infiltrating sanitary water is likely channeled to the landslide 2 area by both the bedrock surface and a direct flow path along the forcemain trench. At least some of the groundwater flowing along and through the forcemain trench likely exits the trench at the 90 degree turn where the forcemain turns to the treatment plant as this corresponds with the apex point of the landslide.

6.3.3 Uncontrolled Fill

Filling of the area behind the decommissioned building has occurred in an uncontrolled manner meaning preparation of the base and compaction of the fill is unknown. Anecdotal evidence suggests that end dumping of fill has occurred here in the past meaning there is a risk that the fill may settle when loaded.

7.0 DISCUSSION AND RECOMMENDATIONS

Based on our understanding of the proposed development and observed site geology, Tetra Tech considers that, from a geotechnical perspective, the southern part of the site is generally suitable for the intended purpose. However, slope stability concerns and an information gap in the central and northern parts of the site mean that further geotechnical work is recommended during detailed design for the development to proceed in these areas. Figure 2 shows an area where we consider there to be insufficient information as well as a "no-build" zone pending further assessment.

Furthermore, geotechnical recommendations should be reassessed once detailed design information relating to proposed retaining wall heights and cut and fill slopes are established.

The following sections describe potential geotechnical issues and provides preliminary recommendations for remediation, further work, or more detailed assessment, if required.

7.1 Information Gap

The information gap created by restrictions on the extent of the testpit investigation due to the presence of operational sanitary water sand filters and leaching fields creates a geotechnical risk for development in this area. It is recommended that further investigation occurs once utilities are decommissioned. Alternatively, geotechnical design could be completed for the area during construction. However, design during construction will carry significantly more uncertainty and risk both in terms of potential impact to foundation cost and construction timeline.

7.2 Geohazards

7.2.1 Landslides

Currently the active landslide area of landslide 2 is not directly impacting proposed chalets locations. Preliminary slope stability analysis suggests that if infiltration of sanitary water is stopped and groundwater level is lowered, slopes at the site may be battered back and considered stable. However, more detailed slope stability analysis is needed to further evaluate the landslide and undertake mitigation measures to stabilise it.

7.2.2 Uncontrolled Fill

It is recommended that the uncontrolled fill located east of the decommissioned building be excavated and removed from site. If necessary, the area should be backfilled with structural fill as detailed in Section 7.4.

7.3 Site Preparation

For the southern area currently considered generally suitable for development the following recommendations for site preparation apply:

- Within the footprint of all buildings, roadways and proposed fill platforms it is recommended that all vegetation be cleared and all topsoil, loose soil, organics and any other unsuitable material be stripped to expose native undisturbed soils or bedrock. Despite removal of topsoil, the upper layers of native soil often contain rootlets and may need to be removed. The requirement for removal would be best determined on the site by Tetra Tech during the site preparation.
- Bedrock at the site is considered moderately strong to very strong. Geological mapping completed to date suggests that blasting will likely be required for rock excavations.
- Lacustrine silt and clay layers are considered unsuitable materials for founding and should be excavated and removed if encountered within building footprints.

7.4 Structural Fill and Material Reuse

Recommendations for structural fill to be used to create fill slopes include:

- Imported granular fill consisting of well graded gravel, gravel and sand, or sand is considered suitable structural fill for the site. Depending on the compactor specifications, the structural fill materials should be placed in lifts not greater than 200 mm for imported granular materials.
- Most of the sand and gravel materials encountered in testpits are considered suitable for reuse as structural fill provided they are well graded and material greater than 150 mm in size are removed. However, there are interbedded layers of silt and clay, particularly in the central part of the site where glaciolacustrine deposits

were intersected in testpits. It is recommended that a geotechnical engineer or their representative be present during excavation to determine what materials are considered suitable for reuse as is, what will need to be blended to qualify for reuse and what will need to be removed from site.

- If blast rock is produced during excavation at the site it will likely be suitable for reuse as structural fill. If blast rock is used it should be well graded and placed in lifts not greater than the largest particle size and not exceeding 700 mm. Where fill height is less than 3.0 m maximum particle size should not exceed 300 mm and a smooth drum roller is recommended. Furthermore, the upper 1.0 m of blast rock fill shall be well graded with a maximum particle size of no greater than 100 mm.

- Structural fill should be placed within 2% of the optimum moisture content and uniformly compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) in accordance with ASTM D698 for the areas beneath building pads. Uniformity of compaction is of primary importance and a program of full time inspection and field density testing should be carried out by geotechnical personnel to verify compaction.

- If blast rock is used as structural fill, density testing may not be practical due to the oversize material. In this case an alternate method (e.g., proof-roll test) should be established to verify compaction. Visual inspections to verify lift thicknesses and confirm compaction should be completed for alternative methods.

- Where structural fill is placed on existing slopes of greater than 20% (~10°) within the building envelope, the existing slope should be terraced in a continuous series of steps that are a minimum of 2.0 m wide as the building pad rises. This 2.0 m step includes 0.5 m of overconstructed slope that should be excavated following slope construction. This overconstructed portion is recommended to ensure all portions of the finished slope are properly compacted.

- To minimize the risk of differential settlement, if both soil and bedrock are exposed in the building pad at founding level, the bedrock in the building pad should be excavated to a depth of at least 1.0 m below founding level and replaced with structural fill. This depth of structural fill over bedrock is only a guideline and thicker structural fill may be recommended depending on-site conditions. The thickness of structural fill over bedrock should be determined by geotechnical personnel on a lot specific basis. If blasting is required to reach the finished building pad elevation, over blasted material may be reused as structural fill provided it is approved by a geotechnical engineering or their representative.

- If founded completely on bedrock, the foundation should be dowelled into sound bedrock for a minimum depth of approximately 0.6 m at 0.5 m centers unless otherwise approved.

7.5 Foundation Design

Strip and spread footings founded on the undisturbed native soils or structural fill compacted to 100% SPMDD may be designed with a serviceability limit state (SLS) bearing pressure of 125 kPa and an unfactored ultimate limit state (ULS) geotechnical bearing resistance of 415 kPa. Foundations placed directly on unweathered sound rock may be designed with a SLS bearing pressure of 1 MPa and an unfactored ULS geotechnical bearing resistance of 3 MPa. Under these loads estimated maximum total settlement would be less than 25 mm with a deferential settlement of less than 1 in 500. This bearing resistance is based on the slope setbacks presented in 7.7.4.

The bearing soils or rock at each footing excavation should be inspected and approved by qualified geotechnical personnel prior to concrete placement. A minimum of 0.9 m of soil cover should be provided above the bottom of all exterior footings in order to ensure adequate protection from frost. Foundation elements placed on bedrock or on top of 1.0 m of blast rock with less than 5% fines content (considered non-frost susceptible material) do not require frost protection cover.

For footings placed on structural fill, the strip footing should be a minimum of 500 mm in width and contain nominal reinforcing steel. Spread footing should be a minimum of 900 mm.

Due to the risk associated with differential settlement, the foundation footings should be placed entirely on either bedrock or soil (includes natural soil or structural fill). If founded on bedrock, the foundation should be dowelled into sound bedrock for a minimum depth of approximately 0.6 m at 0.5 m centers unless otherwise approved.

7.6 Floor Slab

Prior to construction of a slab-on-grade floor, any topsoil, organic debris, soft, or disturbed soils should be removed to expose a suitable subgrade as outlined in Section 7.3 above. Tetra Tech recommends that the floor slab be directly underlain by a free draining gravel layer.

The free draining gravel should have a minimum thickness of 100 mm and consist of 19 mm plus gravel to interrupt capillary attraction. The gravel should be well graded and contain less than 3% fines passing the 0.075 mm sieve. The fill should be placed within 2% of optimum moisture content and compacted to 100% SPMDD as determined in accordance with ASTM D1557.

7.7 Slope Considerations

7.7.1 General Stability Recommendations

The following section outlines general recommendations that are intended to be used as a guide to minimize the impact of development on stability of slopes. Specific slope stability analysis will be required for previously outlined sections of the site. General recommendations include:

- The site should be graded such that surface water is collected and discharged in a controlled manner away from slopes. No water should be discharged or re-infiltrated on-site unless further geotechnical investigation verifies suitable conditions for an area.
- Any buried water and sewer lines positioned at the top of slopes should be located as far as possible from the slope crest and be carefully installed and closely monitored to ensure leakage does not occur.
- It is suggested that any shrubbery or grass to be planted as part of landscaping should be of a variety that has a deep root system and can grow with minimal watering. Excessive watering should not be permitted.
- Disturbance to the existing vegetation near the slope, on the slope, or near the toe of the slope should be avoided as much as possible. Fill, grass cuttings, or construction debris should not, in any circumstances, be disposed over the slope crest.

7.7.2 Fill Slope Angles

In general, fill slopes should be no steeper than 2H:1V. Steeper slope may be possible but will require further review of proposed structural fill material by a geotechnical engineer during construction.

7.7.3 Cut Slopes

In general, dry cut slopes in soil should be no steeper than 2H:1V. This would provide an acceptable factor of safety against potential slope instability considerations in most of the soils encountered on-site. However, more detailed slope stability analysis is needed to evaluate stable cut slopes for areas with groundwater seepage and existing slope instability.

Stable cut slope angles in bedrock will be dependent on-site specific rock mass characteristics (e.g., spacing and orientation of rock discontinuities). It is recommended that permanent and temporary rock cuts be evaluated on a

case by case basis during construction by a geotechnical engineer with expertise in rock mechanics. However, general recommendations for permanent rock cut design include:

- Permanent rock cut slopes as steep as 0.35H:1V (~70°) are considered suitable for design.
- Permanent rock cuts greater than 2 m within 10 m of buildings should have their long-term stability assessed by a geotechnical engineer.
- Use of catch areas for potential rockfall may represent the most cost-effective solution to address long-term stability of permanent rock cuts. Catch areas considered suitable for design purposes should have the following minimum dimensions based on height of rock cut:
  - Rock cuts less than 3 m in height; 1.5 m wide catch area.
  - Rock cuts between 3 m and 5 m; 2 m wide, 0.5 m deep catch ditch.
  - Rock cuts between 5 m and 10 m; 2.5 m wide, 0.5 m deep catch ditch.
- Catch ditches below rock cuts should be sloped such that the deepest part of the ditch intercepts the rock cut and not such that the deepest part of the ditch at its midpoint.
- Alternative options such as rock bolting, rockfall catch fence, shotcrete or rock mesh may be used instead of catch areas if permanent infrastructure needs to be placed closer to permanent rock cuts because of site constraints. These options can be evaluated once rock cuts are exposed and assessed.

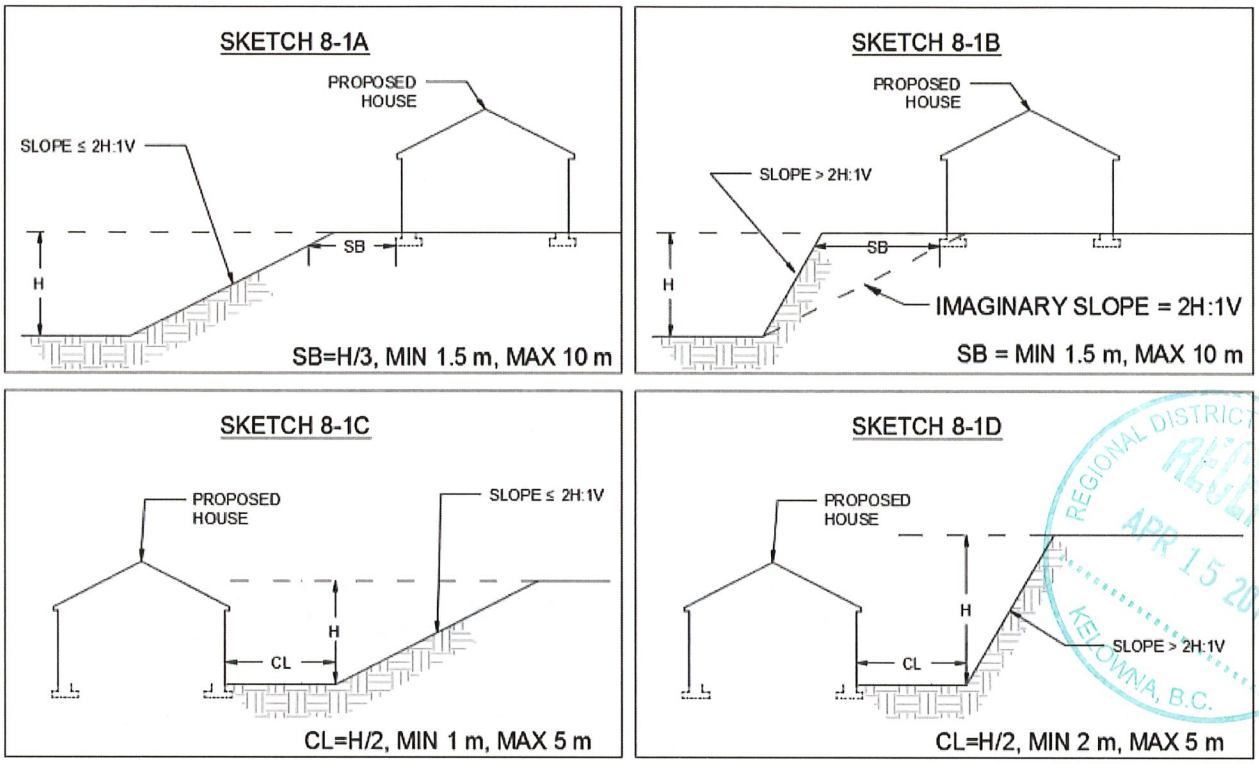
7.7.4 Slope Set-Back and Clearance

General set-back and clearance recommendations for permanent soils slopes provided are shown graphically in Sketch 7-1 below and include:

- Where a soil slope below a property is equal to or shallower than 2H:1V, the set-back distance between the outer edge of the foundation and the soil slope should be at least the height of the slope divided by 3 (see Sketch 8-1A) but no less than 1.5 m with no need to be greater than 10 m.
- Where a soil slope below a property is steeper than 2H:1V, the set-back should be such that an imaginary line between the outer edge of the foundation and the toe of the slope has an angle of 2H:1V or less (see Sketch 8-1B). In addition, the set-back distance between the outer edge of the foundation and the soil slope should be no less than 1.5 m horizontally from the face of the slope with no need to be greater than 10 m.
- Where a soil slope above a property is equal to or shallower than 2H:1V, the clearance from the edge of the house to the toe of the slope should be equal to the height of the slope divided by 2 (see Sketch 8-1C) but clearance should not be less than 1 m with no need to be greater than 5 m.
- Where a soil slope above a property is steeper than 2H:1V, the clearance from the edge of the house to the toe of the slope should be equal to the height of the slope divided by 2 (see Sketch 8-1D) but no less than 1 m with no need to be greater than 5 m.
- Other set-back and clearance distances for soil slopes may be possible but will require approval from a geotechnical engineer.
- If there are soil slopes above or below a property that are shallower than 3H:1V, then there are no set-back or clearance recommendations and construction elements can extent right to the toe or crest of slopes.

Set-back distances for rock cuts may be less than those of soil slopes but will need to be evaluated on a lot specific basis by a geotechnical engineer.

Set-back distance for foundations near no-build zone can be evaluated once more detailed assessment of the active landslide 2 is undertaken.



Sketch 7-1: Illustration Showing Set-Back and Clearance Distance for Soil Slopes

7.8 Drainage

As outlined in Section 7.7.1, all stormwater at the site should be collected and discharged off-site with no re-infiltration of water on-site unless further geotechnical investigation verifies suitable conditions for an area. Therefore, Tetra Tech recommends that a perimeter drainage system is installed at footing grade for all buildings and stormwater is collected and discharged to the stormwater disposal system off-site.

Furthermore, the position, alignment and backfill materials for utility trenches should be review by a geotechnical engineer to ensure that utility trenches do not provide a preferential flow path for groundwater or infiltrating rainwater at the site.

7.9 Underground Utility Installation

All work conducted in and around excavations should be carried out in accordance with requirements specified by the WorkSafeBC BC Occupational Health & Safety Regulations, Part 20 (referred to herein as OHS Guidelines).

It is anticipated that utility installation will encounter native soils and bedrock. Minor groundwater seepage into utility installation trenches that may occur can likely be controlled using conventional sump and pump methods.

We recommend the following maximum slopes for unsupported temporary trenches for utility installation:

- bedrock - 0.5H:1V;
- dense sand, sand and gravel - 0.75H:1V to a maximum depth of 1.2 m;
- loose sand, sand and gravel - 1H:1V to a maximum depth of 1.2 m.

Unsupported excavations in soil deeper than 1.2 m, should have slopes no steeper than 1.5H:1V, and should be reviewed by a professional engineer in accordance with OHS Guidelines. Alternatively, service line trenches or excavations may be shored or caged in accordance with OHS Guidelines.

To maintain the stability of the trench, all material excavated from the trench should be placed a minimum distance away from the excavation, equal to the depth of the excavation.

The materials excavated during trenching may be reused as general trench backfill unless otherwise required by the RDCO and provided that particles greater than 500 mm be removed and it can be compacted to the specifications outlined below. Alternatively, imported granular fill material should be used for general trench backfill.

Soil or imported fill should be placed in maximum 300 mm thick lifts. Blast rock should be placed in lifts not greater than 1.5 times the largest particle size, and each lift should be compacted to a minimum of 95% of SPMDD.

8.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of New Town 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 New Town, 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 document is subject to the Limitations on the Use of this Document attached in the Appendix D or Contractual Terms and Conditions executed by both parties.

9.0 CLOSURE

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

Respectfully submitted,
Tetra Tech Canada Inc.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
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March 21, 2019

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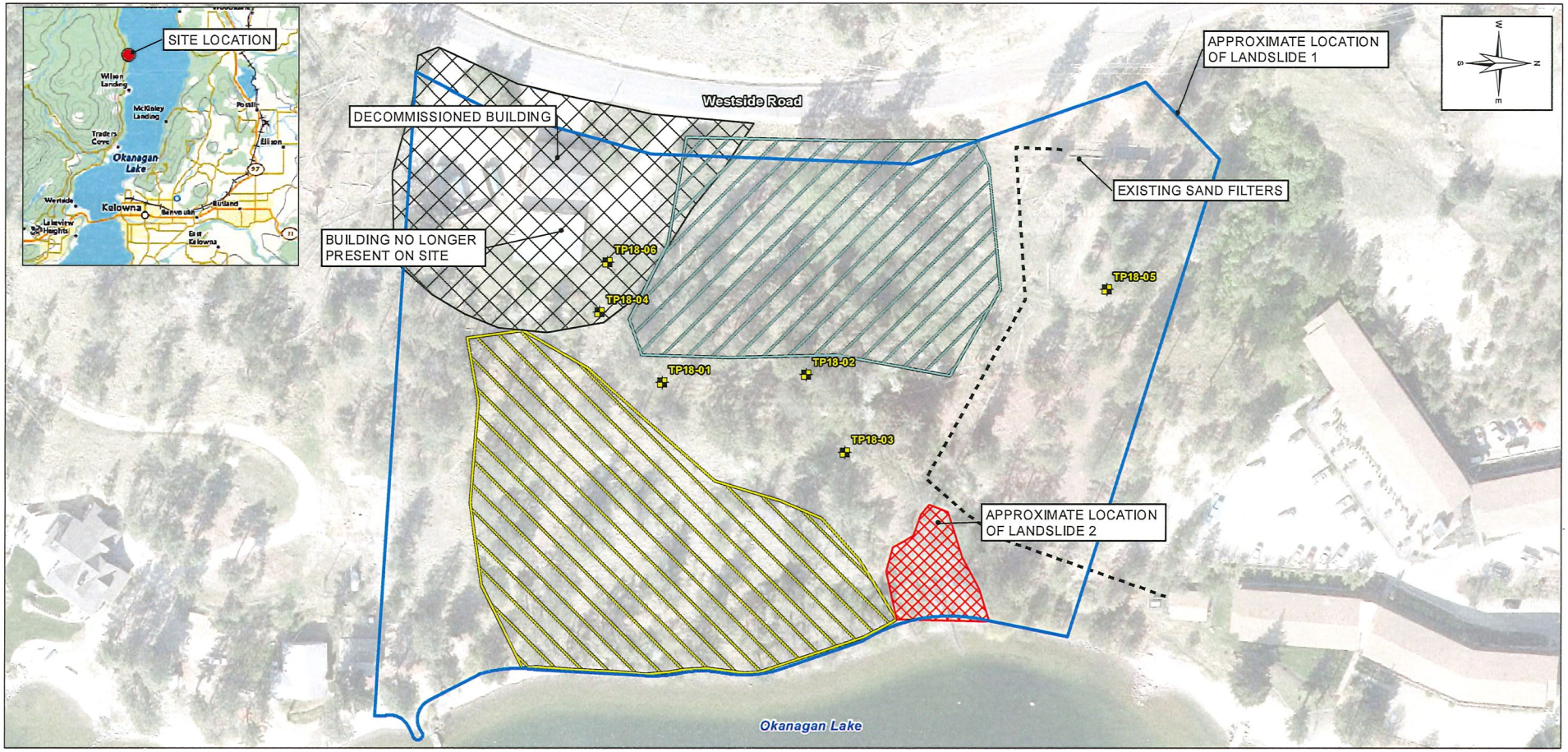
Attachments:

Figure 1	Site Layout, Testpit Locations and Geological Features
Figure 2	Information Gap and No-Build Zone
Photographs	
Appendix A	Concept Plan Supplied Information
Appendix B	Testpit Logs
Appendix C	Laboratory Results

FIGURES



LEGEND

- 2018_Completed_Testpit_Locations
- Proposed Property Boundary
- Approximate Forcemain Position
- Approximate Area of Leaching Field
- Approximate Extent of Landslide 2
- Approximate Extent of Uncontrolled Fill
- Estimated Area of Shallow (< 1.0 m depth) Bedrock

NOTES
Base data source:
- Imagery sourced from Regional District of Central Okanagan
Date of imagery 2014.

STATUS
ISSUED FOR USE

LAKE OKANAGAN RESORT CHALET DEVELOPMENT

Site Layout, Testpit Locations and Geological Features

PROJECTION: UTM Zone 11N		DATUM: NAD83			CLIENT: DHI Holdings Ltd
Scale: 1:1,000 (20 10 0 20 Meters)					TETRA TECH
FILE NO.: ENG.KGEO03138-01 Figure 1 Rev 2.mxd					
OFFICE: TI-KGEO	DWN: LM	CKD: SWG	APVD: GM	REV: 2	Figure 1
DATE: March 20, 2019	PROJECT NO.: ENG.KGEO03138-01				

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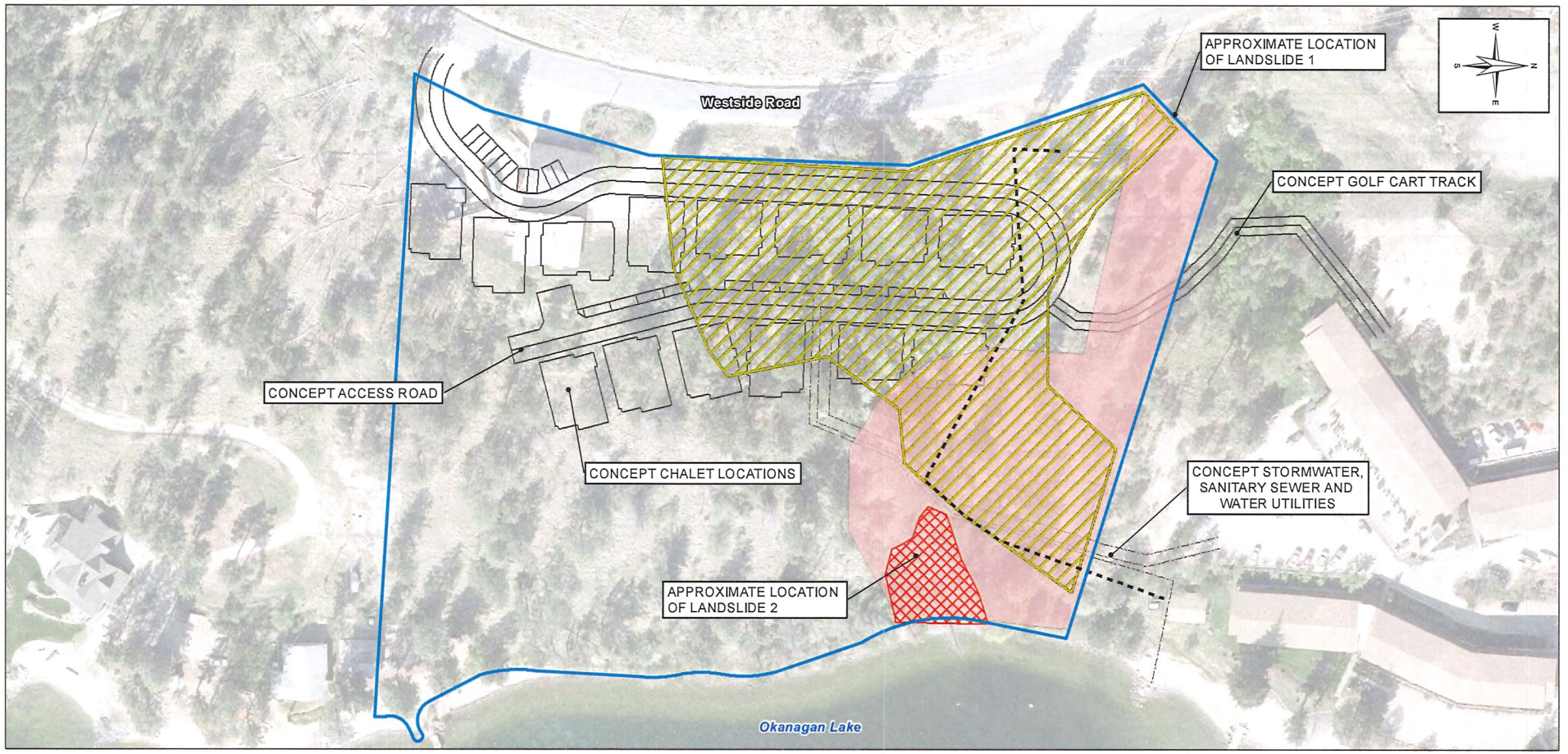


LEGEND

- Proposed Property Boundary
- Approximate Forcemain Position
- Approximate Extent of Landslide 2
- Information Gap - Additional Assessment Required
- No Build Zone - Pending Additional Assessment

NOTES
Base data source:
- Imagery sourced from Regional District of Central Okanagan Date of imagery 2014.
- Subdivision Site Plan supplied by Newtown Architecture and Engineering dated March 14, 2019

STATUS
ISSUED FOR USE

LAKE OAKANAGAN RESORT CHALET DEVELOPMENT

Information Gap and No-Build Zone

PROJECTION UTM Zone 11N	**DATUM** NAD83	**CLIENT** DHI Holdings Ltd
Scale: 1:1,000 (20 10 0 20 Meters)		TETRA TECH
FILE NO. ENG.KGEO03138-01 Figure 2 Rev 2.mxd		
OFFICE TI-KGEO	**DWN** LM / **CKD** SWG / **APVD** GM / **REV** 2	Figure 2
DATE March 20, 2019	**PROJECT NO.** ENG.KGEO03138-01	

PHOTOGRAPHS

Photo 1: Looking northeast across the area of uncontrolled fill with the decommissioned building shown at the left. (Date of Photo – September 19, 2017).

Photo 2: Looking north across the existing sand filters. (Date of Photo – September 19, 2017).

Photo 3: Looking west and uphill from near the bottom of part of the leaching field. Dug terraces are visible along with black PVC pipe (circled in red). (Date of Photo – September 19, 2017).

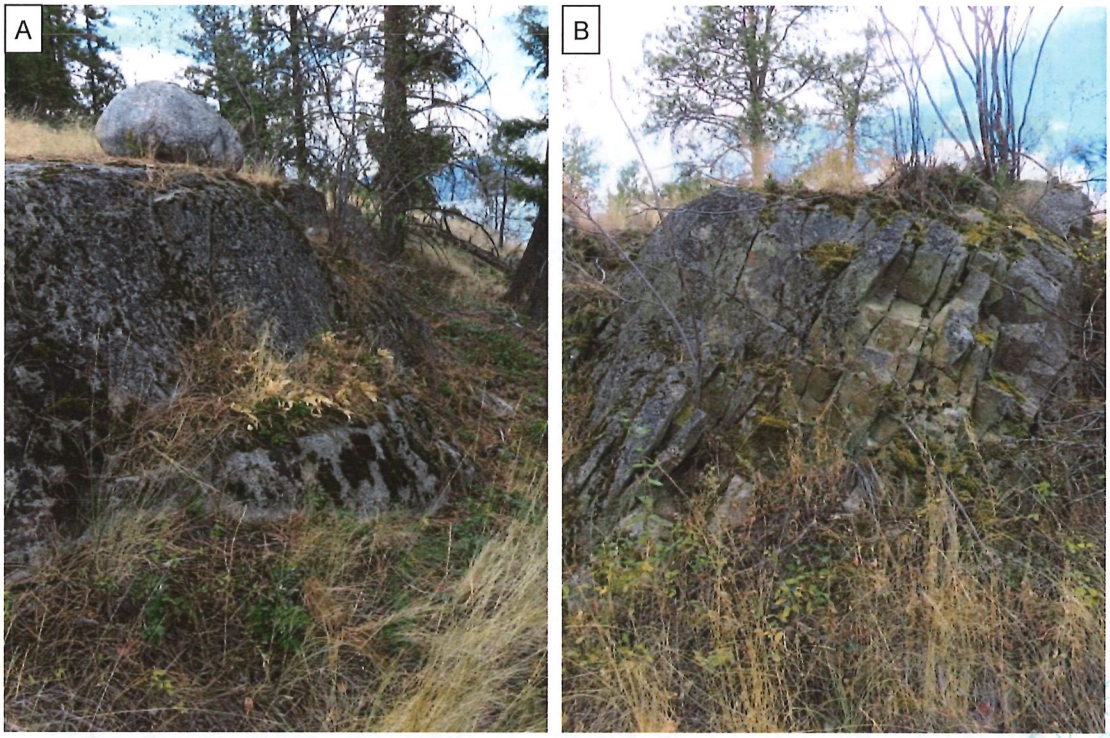


Photo 4: Bedrock outcrop A) looking northwest from the southern area of the site next to the edge of uncontrolled fill. B) Looking west and uphill from near the southern extent of bedrock outcrop close to lake level. (Date of Photos – September 19, 2017).

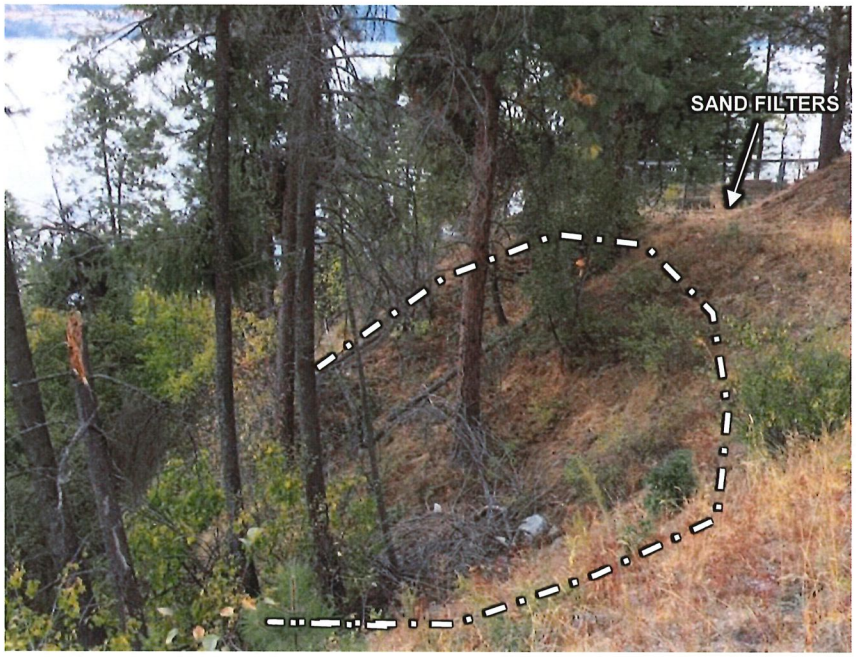


Photo 5: Looking east from Westside Road at landslide 1 area. The concave area where historical movement may have occurred is indicated. (Date of Photo – September 19, 2017).

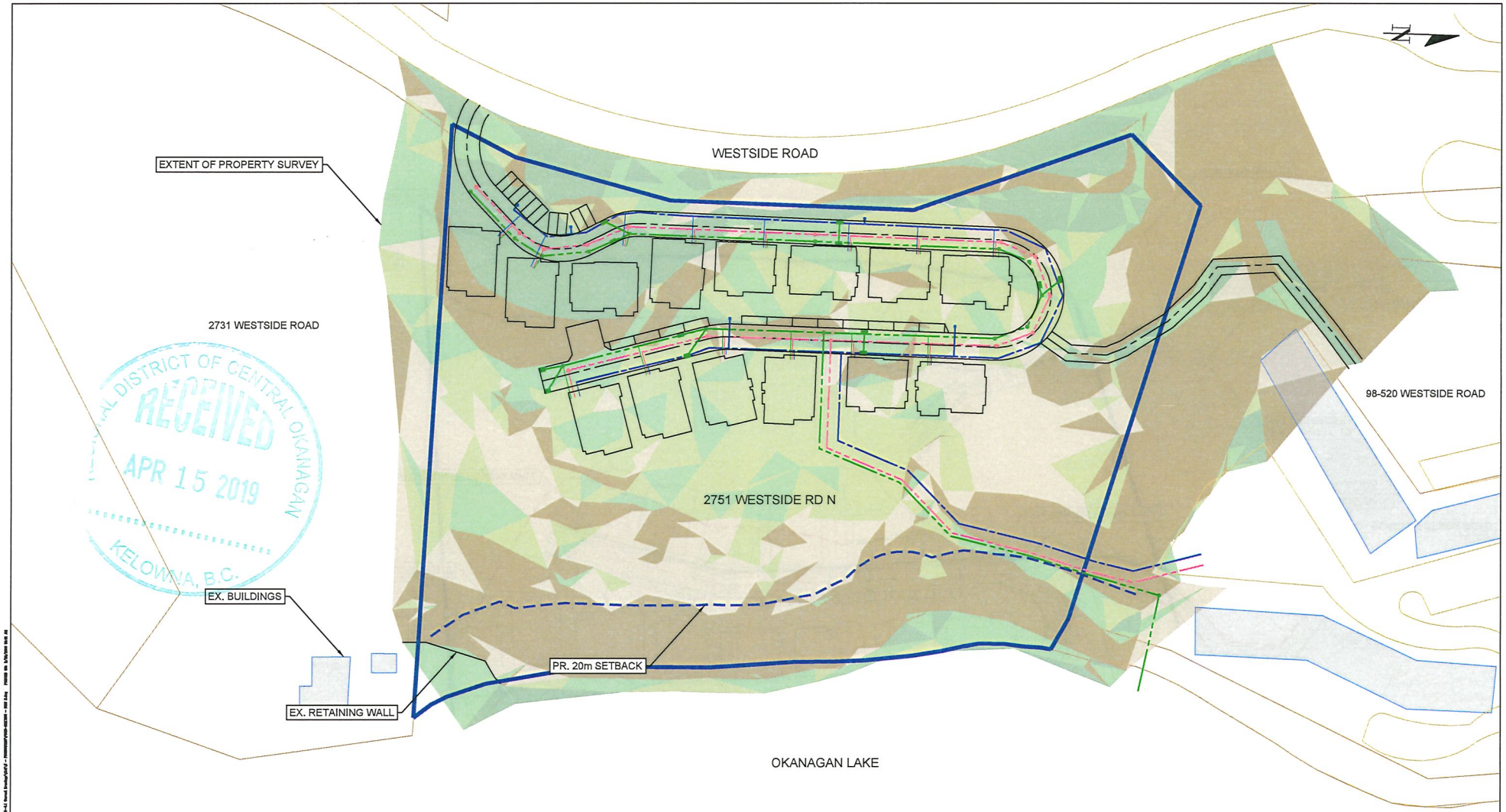
Photo 6: Looking west toward landslide 1 area. The concave area where historical movement may have occurred is indicated along with curved tree trunks that often indicate slope movement. (Date of Photo – September 19, 2017).

Photo 7: Looking south along the main backscarp of landslide 2. A) September 19, 2017. B) June 29, 2018.

Photo 8: Looking west from lake level uphill to the area of landslide 2. A) September 19, 2017. B) June 29, 2018.

APPENDIX A

CONCEPT PLAN SUPPLIED INFORMATION



LEGEND

WATER
SAN. SEWER
STORM SEWER
GAS
U/G TELEPHONE
U/G ELECTRICAL

MANHOLE M.H.
UTILITY POLE U.P.
POWER POLE P.P.
LAMP STANDARD L.S.
CATCH BASIN C.B.
HYDRANT HYD
TREES T
SURVEY MONUMENT

LEGEND

SLOPES 0–15%
SLOPES 15-30%
SLOPES 30-40%
SLOPES 40-50%
SLOPES ≥ 50%

INSERTION BASE POINT= 300,000 , 5,500,000

Locations and effects of existing utilities shown on this plan are not guaranteed to be accurate and must be verified in the field PRIOR TO CONSTRUCTION. The REGIONAL DISTRICT OF CENTRAL OKANAGAN does not guarantee their accuracy. Concerned persons should not rely on these documents and should verify all information shown by way of site survey and other appropriate methods. The REGIONAL DISTRICT OF CENTRAL OKANAGAN accepts no liability for use of these files or information.

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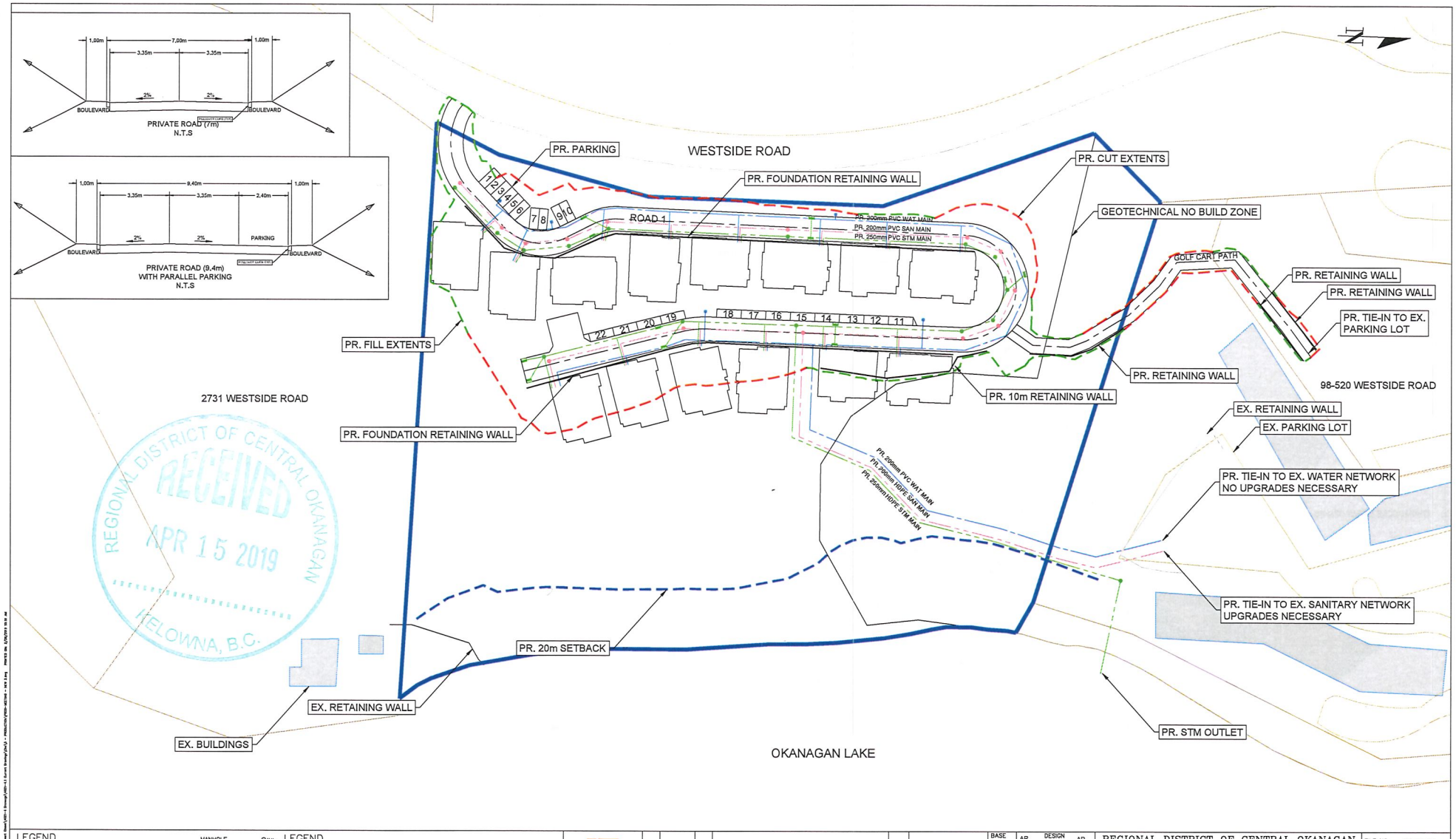
APPROVED	JP		
DATE	2019/02/28		
SCALE	HORIZ.1: 500 VERT.		

SCALE NOT ACCURATE OVER LONG DISTANCES

REGIONAL DISTRICT OF CENTRAL OKANAGAN
DESIGN AND CONSTRUCTION

EXISTING SLOPE ANALYSIS
LAKE OKANAGAN RESORT CHALET
2751 WESTSIDE RD N

FILE NO.	DP-18-13
SHEET NO.	1 OF 5
DRAWING NO.	001
REV NO.	



LEGEND

WATER
SAN. SEWER
STORM SEWER
GAS
U/G TELEPHONE
U/G ELECTRICAL

MANHOLE M.H.
UTILITY POLE U.P.
POWER POLE P.P.
LAMP STANDARD L.S.
CATCH BASIN C.B.
HYDRANT HYD
TREES T
SURVEY MONUMENT

LEGEND

INSERTION BASE POINT= 300,000 , 5,500,000

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DATE	2019/02/28		
SCALE	HORIZ.1:500 VERT.		

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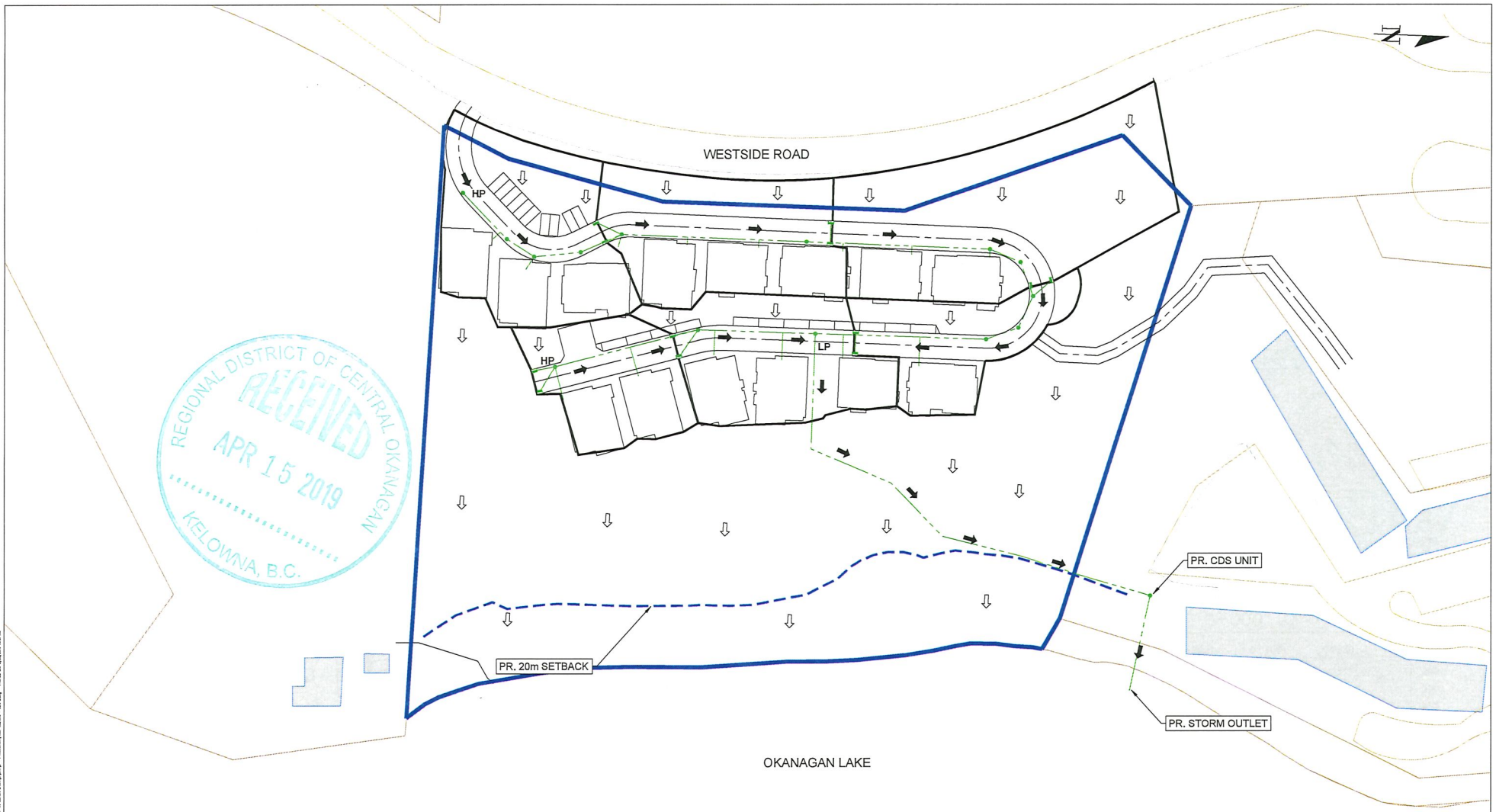
REGIONAL DISTRICT OF CENTRAL OKANAGAN
DESIGN AND CONSTRUCTION

SERVICING PLAN
LAKE OKANAGAN RESORT CHALET
2751 WESTSIDE RD N

FILE NO.	DP-18-13
SHEET NO.	2 OF 5
DRAWING NO.	002
REV NO.	



LEGEND

WATER
SAN. SEWER
STORM SEWER
CATCH BASIN
GAS
U/G TELEPHONE
U/G ELECTRICAL

MANHOLE M.H.
UTILITY POLE U.P.
POWER POLE P.P.
LAMP STANDARD L.S.
CATCH BASIN C.B.
HYDRANT HYD
TREES T
SURVEY MONUMENT

LEGEND

IN PIPE FLOW DIRECTION
OVERLAND FLOW DIRECTION
CATCHMENT BOUNDARY
HP HIGH POINT
LP LOW POINT

INSERTION BASE POINT= 300,000 , 5,500,000

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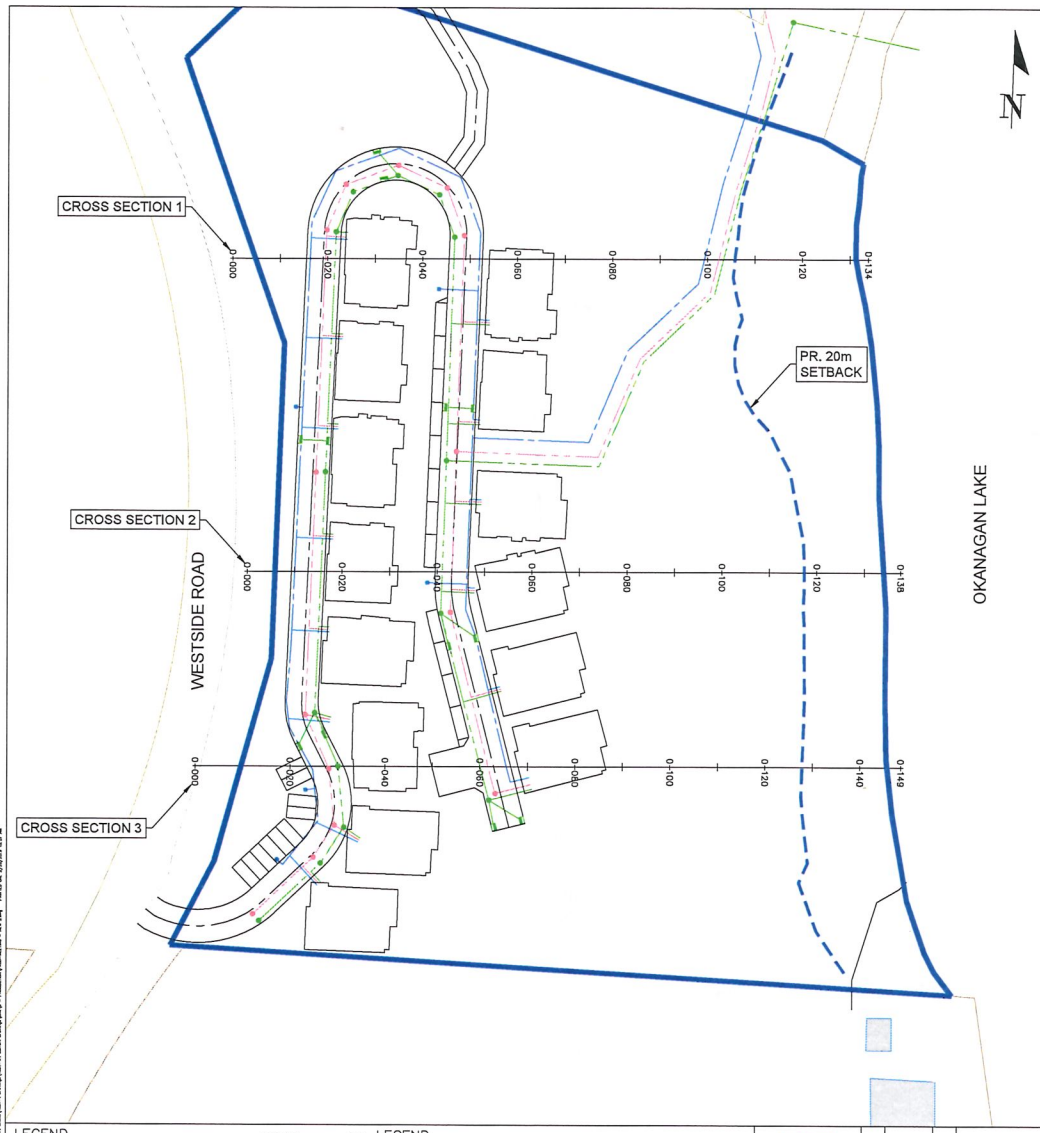
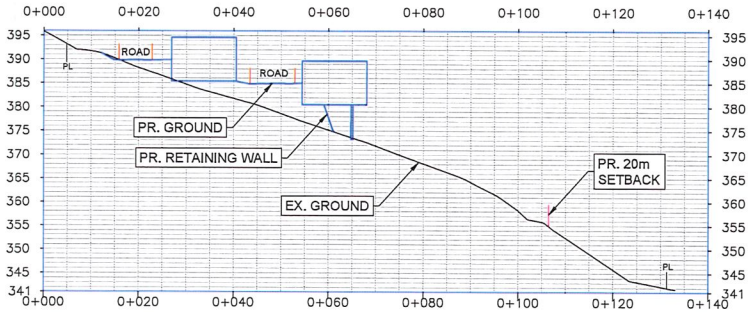
REGIONAL DISTRICT OF CENTRAL OKANAGAN
DESIGN AND CONSTRUCTION

STORMWATER MANAGEMENT PLAN
LAKE OKANAGAN RESORT CHALET
2751 WESTSIDE RD N

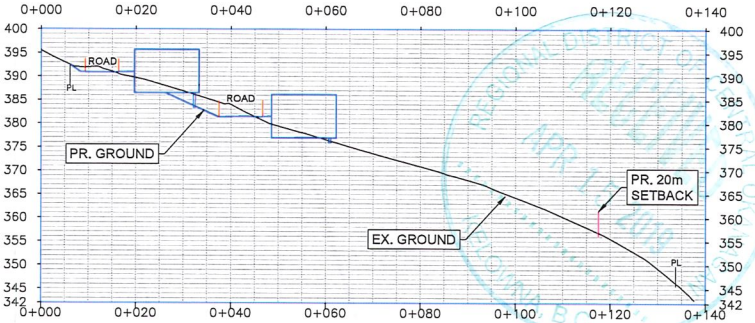
FILE NO.	DP-18-13
SHEET NO.	3 OF 5
DRAWING NO.	003
REV NO.	



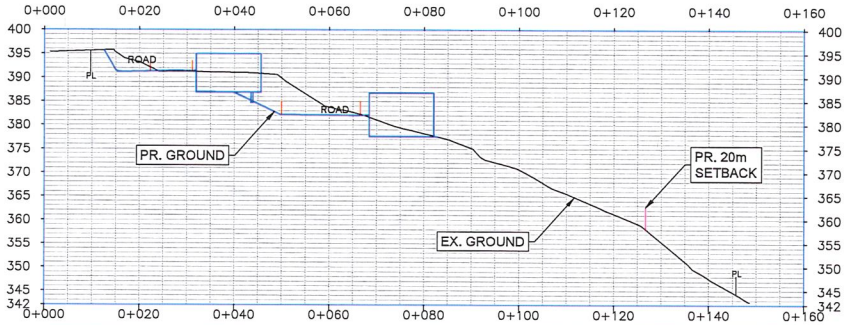
CROSS SECTION 1 PROFILE 0+000 TO 0+140



CROSS SECTION 2 PROFILE 0+000 TO 0+140



CROSS SECTION 3 PROFILE 0+000 TO 0+160



LEGEND

WATER	MANHOLE	LEGEND	
SAN. SEWER	UTILITY POLE		
STORM SEWER	POWER POLE		
GAS	LAMP STANDARD		
U/G TELEPHONE	CATCH BASIN		
U/G ELECTRICAL	HYDRANT		
	TREES		
	SURVEY MONUMENT		

INSERTION BASE POINT= 300,000 , 5,500,000

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DATE	2019/02/28
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SCALE NOT ACCURATE OVER LONG DISTANCES

REGIONAL DISTRICT OF CENTRAL OKANAGAN
DESIGN AND CONSTRUCTION

CROSS SECTION PLAN & PROFILE
LAKE OKANAGAN RESORT CHALET
2751 WESTSIDE RD N

FILE NO.	DP-18-13
SHEET NO.	4 OF 5
DRAWING NO.	004
REV NO.	

LEGEND

WATER
SAN. SEWER
STORM SEWER
GAS
U/G TELEPHONE
U/G ELECTRICAL

MANHOLE M.H.
UTILITY POLE U.P.
POWER POLE P.P.
LAMP STANDARD L.S.
CATCH BASIN C.B.
HYDRANT HYD
TREES T
SURVEY MONUMENT

LEGEND

INSERTION BASE POINT= 300,000 , 5,500,000

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APPROVED	JP		
DATE	2019/02/28		
SCALE	HORIZ.1:500 VERT.		

SCALE NOT ACCURATE OVER LONG DISTANCES

REGIONAL DISTRICT OF CENTRAL OKANAGAN
DESIGN AND CONSTRUCTION

SITE PLAN WITH AERIAL
LAKE OKANAGAN RESORT CHALET
2751 WESTSIDE RD N

FILE NO.	DP-18-13
SHEET NO.	5 OF 5
DRAWING NO.	005
REV NO.	

APPENDIX B

TESTPIT LOGS

New Town Architecture and Engineering Inc.

Testpit No: **TP18-01**

Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 377.5 m
Kelowna	UTM: 321425 E; 5542664 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Vane (kPa) Post-Peak / Peak; Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0			TOPSOIL, organic rich, dark brown to black					377
			SILT, trace sand, low plasticity, moist, light brown					
			SILT, clayey, gravelly, some cobble, medium plasticity, moist, grey; gravel is coarse, sub-angular, up to 25 mm			DS1		
1			CLAY, silty, medium plasticity, moist, grey			DS2		
			SAND and GRAVEL, some cobbles, sand is coarse, moist, brown; gravel is coarse, sub-rounded, poorly sorted, up to 25 mm; cobbles are rounded, poorly sorted, up to 150 mm; alternating layers of sand and gravel with depth					376
2						DS3		
								375
3			END OF TESTPIT @ 3.0 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED					
								374
4								

Vane (kPa): Post-Peak ◇ — Peak ◆; 10 20 30 40

Plastic Limit — Moisture Content ● — Liquid Limit; 20 40 60 80

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 3 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-01

New Town Architecture and Engineering Inc.

Testpit No: TP18-02

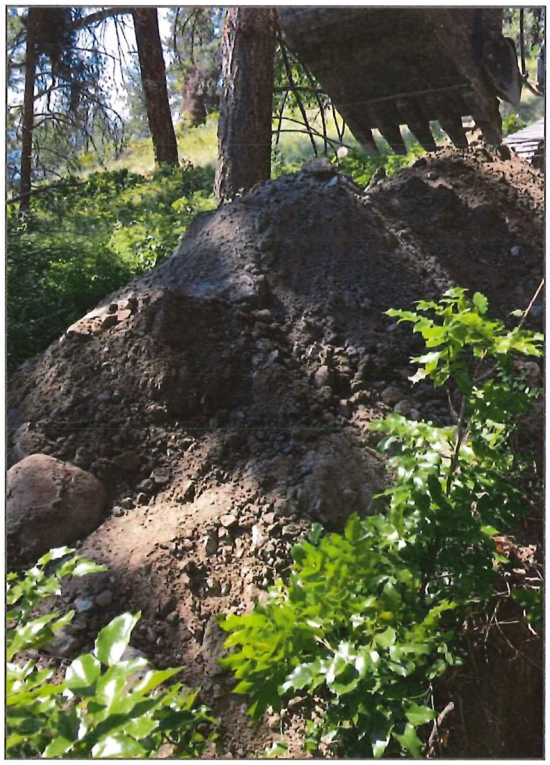
Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 374.15 m
Kelowna	UTM: 321423 E; 5542701 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Vane (kPa) Post-Peak / Peak; Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0			TOPSOIL, organic rich, dark brown to black									374
			SAND and GRAVEL, trace cobbles, trace silt, sand is medium to coarse, dry to moist, brown; gravel is coarse, sub-rounded, poorly sorted, up to 30 mm; cobbles are angular, poorly sorted, up to 650 mm			DS1						
1												373
2												372
			CLAY, sandy, silty, medium plasticity, dry, brown; sand is medium to coarse, moist, brown; increasing cobble content with depth; boulders present at 2.8 m depth			DS2						
3			SAND, silty, some gravel, medium to coarse, moist to damp, brown; gravel is coarse, sub-angular to sub-rounded, poorly sorted, up to 50 mm; increasing gravel content with depth			DS3	19	55	26			
			BEDROCK, dioritic, medium grained, grey, moderately strong to strong									371
			END OF TESTPIT @ 3.1 m depth EQUIPMENT REFUSAL ON BEDROCK GROUNDWATER NOT ENCOUNTERED									
4												

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 3.1 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-02



New Town Architecture and Engineering Inc.

Testpit No: **TP18-03**

Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 366.8 m
Kelowna	UTM: 321443 E; 5542711 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Vane (kPa) Post-Peak 10 20 30 40 Peak; Plastic Limit 20 40 60 80 Liquid Limit; Moisture Content	Elevation (m)
0			TOPSOIL, organic rich, dark brown to black			
			SAND, some silt, some gravel, occasional boulders, coarse, very dense, moist, brown; gravel is coarse, sub-angular, poorly sorted, up to 50 mm			366
1						
			BEDROCK, dioritic, medium grained, grey, moderately strong to strong			365
2			END OF TESTPIT @ 1.9 m EQUIPMENT REFUSAL ON BEDROCK GROUNDWATER NOT ENCOUNTERED			
						364
3						
						363
4						

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 1.9 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-03

New Town Architecture and Engineering Inc.

Testpit No: TP18-04

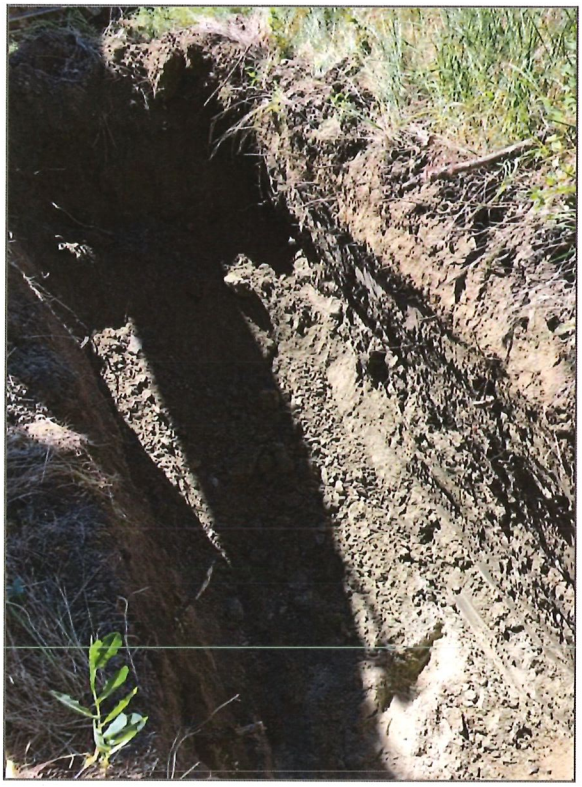
Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 385.4 m
Kelowna	UTM: 321407 E; 5542648 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Vane (kPa) Post-Peak / Peak 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80	Elevation (m)
0			TOPSOIL, organic rich, dark brown to black			
			SILT (FILL?), gravelly, clayey, medium plasticity, loose, damp, grey			385
1			SAND, some silt, fine, dry, grey to brown			384
			END OF TESTPIT @ 1.5 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED			
2						383
3						382
4						

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 1.5 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-04



New Town Architecture and Engineering Inc.

Testpit No: **TP18-05**

Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 387.5 m
Kelowna	UTM: 321401 E; 5542778 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Vane (kPa) Post-Peak / Peak 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80	Elevation (m)
0			TOPSOIL, organic rich, dark brown to black					387
			SAND, gravelly, trace cobbles, medium to coarse, loose, dry to moist, light brown; coarse gravel, sub-angular, poorly sorted, up to 50 mm; sub-angular cobbles, up to 250 mm; rounded to sub-rounded boulders, poorly sorted, up to 700 mm			DS1		
1								386
2								385
3			END OF TESTPIT @ 3.0 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED					384
4								

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 3 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-05

New Town Architecture and Engineering Inc.

Testpit No: TP18-06

Project: Lake Okanagan Resort Chalets	Project No: KGEO03138-01
Location: 2751 Westside Road	Ground Elev: 391.3 m
Kelowna	UTM: 321394 E; 5542650 N; Z 11

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Vane (kPa) Post-Peak 10 20 30 40 Peak / Plastic Limit 20 40 60 80 Moisture Content / Liquid Limit	Elevation (m)
0			SAND and GRAVEL (FILL), silty, some cobbles, boulders, concrete, wire, plastic pipe, rebar, coarse, dry to damp, brown.			391
1						390
2						389
3						388
4			END OF TESTPIT @ 3.5 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED			

TETRA TECH

Contractor: Stone Creek Excavation	Completion Depth: 3.5 m
Drilling Rig Type: ZAXIS 120 Excavator	Start Date: 2018 June 20
Logged By: KK	Completion Date: 2018 June 20
Reviewed By: SG	Page 1 of 1

TP18-06

APPENDIX C

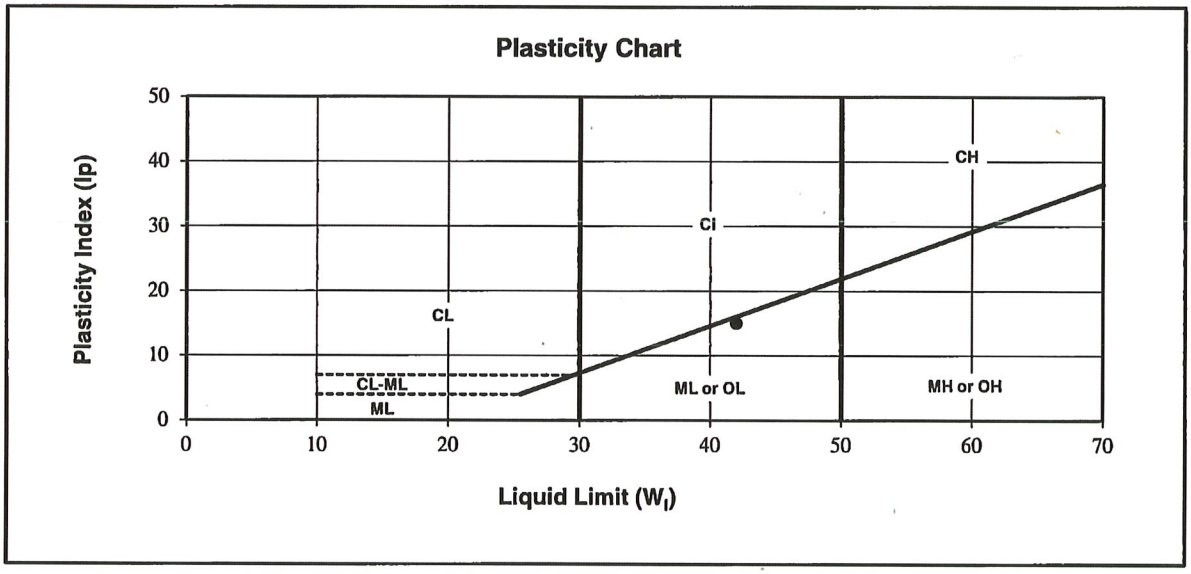
LABORATORY TEST RESULTS

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Lake Okanagan Resort Chalets, Geotechnical Consultant Services	Sample Number:	KS-8092
		Borehole Number:	TP18-01
Project No:	ENG.KGEO03138-01	Depth:	0.7 - 0.8 m
Client:	DHI Holdings Inc.	Sampled By:	KK Tested By: MD
Attention:	See e-mail distribution	Date Sampled:	June 20, 2018
Email:	See e-mail distribution	Date Tested:	June 26, 2018

Sample Description: SILT, Medium Plasticity (ML)



Liquid Limit ($W_{1)}$:	42	Natural Moisture (%)	12.9
Plastic Limit :	27	Soil Plasticity:	Medium
Plasticity Index (Ip) :	15	Mod.USCS Symbol:	ML

Remarks:

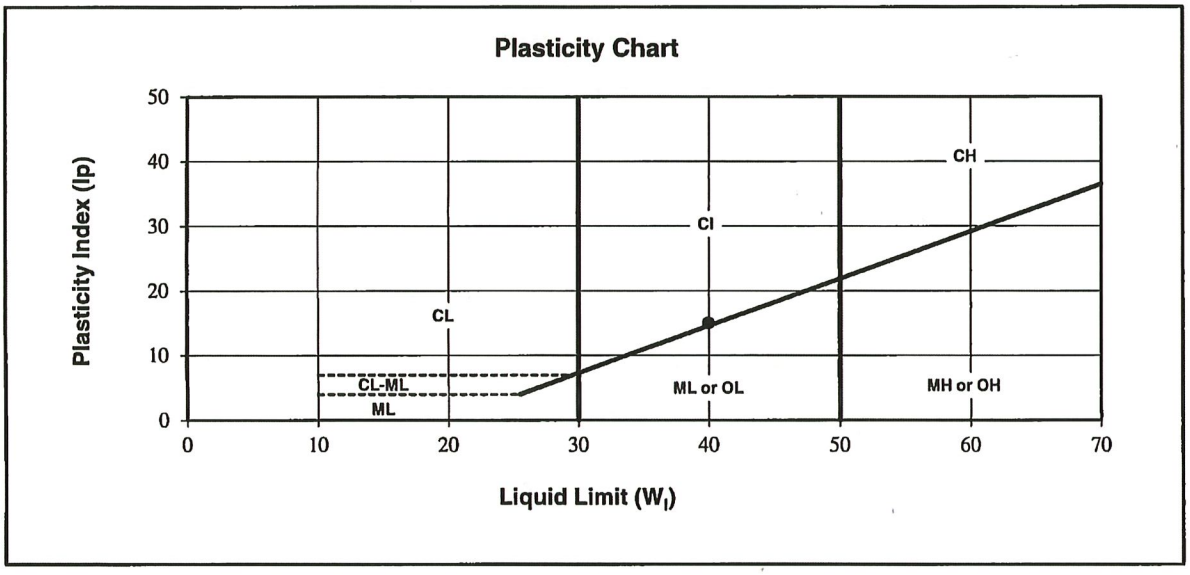
Reviewed By:

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Lake Okanagan Resort Chalets, Geotechnical Consultant Services	Sample Number:	KS-8093
		Borehole Number:	TP18-01
Project No:	ENG.KGEO03138-01	Depth:	0.9 - 1.0 m
Client:	DHI Holdings Inc.	Sampled By:	KK Tested By: MD
Attention:	See e-mail distribution	Date Sampled:	June 20, 2018
Email:	See e-mail distribution	Date Tested:	June 26, 2018

Sample Description: CLAY, Medium Plasticity (CI)



Liquid Limit ($W_{1)}$:	40	Natural Moisture (%)	31.9
Plastic Limit :	25	Soil Plasticity:	Medium
Plasticity Index (Ip) :	15	Mod.USCS Symbol:	CI

Remarks:

Reviewed By:

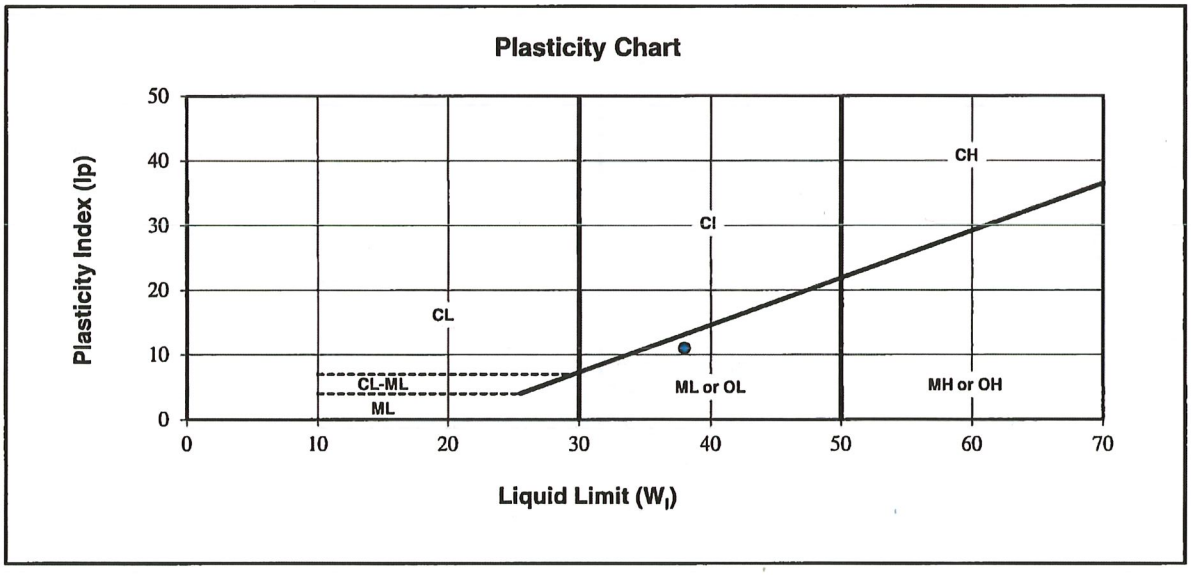
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Lake Okanagan Resort Chalets, Geotechnical Consultant Services	Sample Number:	KS-8094
		Borehole Number:	TP18-02
Project No:	ENG.KGEO03138-01	Depth:	2.6 - 2.7 m
Client:	DHI Holdings Inc.	Sampled By:	KK Tested By: MD
Attention:	See e-mail distribution	Date Sampled:	June 20, 2018
Email:	See e-mail distribution	Date Tested:	June 26, 2018

Sample Description: SILT, Medium Plasticity (ML)



Liquid Limit ($W_{1)}$:	38	Natural Moisture (%)	37.8
Plastic Limit :	27	Soil Plasticity:	Medium
Plasticity Index (Ip) :	11	Mod.USCS Symbol:	ML

Remarks:

Reviewed By:

TETRA TECH

SIEVE ANALYSIS TEST DATA

ASTM C136 & C117

Project: Lake Okanagan Resort Chalets, Geotechnical Consultant Services

Project Number: ENG.KGEO03138-01

Sample Number: KS-8095

Borehole Number: TP18-02

Depth: 2.9 - 3.0 m

Soil Description: 37.5 mm (-) SAND, silty, some gravel

Cu: N/A

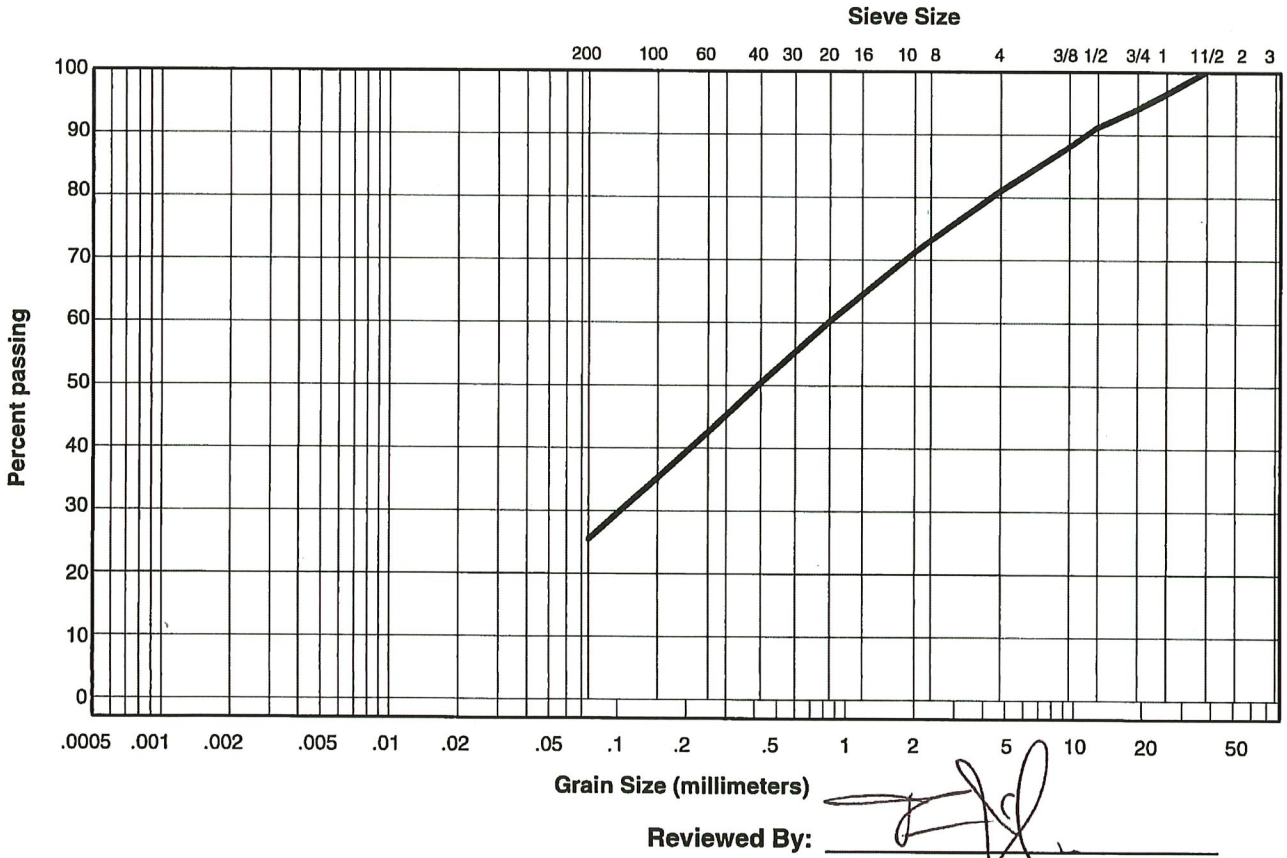
Cc: N/A

Natural Moisture Content: 7.6%

Remarks: Sand (55%) Fines (26%) Gravel (19%)

Sieve Size (mm)	Percent Passing
50	
37.5	100
25	96
19	94
12.5	91
9.5	88
4.75	81
2.00	71
0.850	60
0.425	50
0.250	43
0.150	35
0.075	25.5

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: _____

TETRA TECH

APPENDIX D

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

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

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards 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.

1.9 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.

1.10 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 historical 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 exploration and review may be necessary.

1.11 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.

1.12 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.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact 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, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and 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.

1.15 DRAINAGE SYSTEMS

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. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters 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 used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 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.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.