

GEOTECHNICAL INVESTIGATION REPORT

Project Details

PROJECT STREET ADDRESS	Northlake Subdivision, Special Zone, Wanaka
LEGAL ADDRESS	Lot 2000 DP 613751
CLIENT	Northlake Investments Ltd
PROJECT LOCATION	
REVISION NUMBER	0
ISSUED DATE	23/04/2026
RDA JOB NUMBER	54054
RDA JOB NAME	54054 Northlake Residual Geotech

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SUMMARY

This report provides the results of a geotechnical investigation undertaken by RDA Consulting. The investigation was undertaken to provide geotechnical parameters and foundation recommendations for the proposed private plan change application and assist with development planning. This report is intended to assist development design and support consent applications and is not a geotechnical design report.

The investigation results represent general subgrade conditions determined from individual investigation points. The subsoil conditions may vary between these points and contingencies for these occasions should always be considered during design and construction. If conditions vary from those in the reporting seek additional inspections and advice.

The results of the investigation are summarised below.

Site Description	Address: Northlake Subdivision, Activity Area, Wanaka Proposed Works: E1 Zone, Subdivision development Land Topography: Moderately Sloping to Steep Soil Profile: Topsoil over colluvium and glacial till. Areas of deep organic unsuitable fill and non-certified fill. Groundwater Depth: Not encountered
Geotechnical Hazards	Land instability is expected to be low to negligible provided earthworks are undertaken in accordance with the Queenstown Lakes District Council District Plan requirements. No other significant active geotechnical hazards were noted at the time of the investigation.
Geotechnical Design Parameters	Relevant geotechnical design parameters to be considered in design, are: • Except where deeper organic fill is encountered, it is envisioned that site will enable NZS3604:2011 type foundations. • Site won material may be used for filling provided an earthworks specification is provided as per the NZS4431:2022 by a qualified geoprofessional, and appropriate testing methods and controls are undertaken. • Subsoil Class C or Class D in accordance with NZS 1170.5:2012. It is recommended that Class D be adopted for structural design purposes.
Further Works	Additional investigations required: • Additional investigation of any fill area outlined in the earthfill as-built plan is required if residential development is proposed over these areas.

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1. INTRODUCTION

This report summarises and presents the results of a geotechnical investigation for the proposed plan change application located in the Northlake Special Zone as indicated on the site plan in Appendix A.

The purpose of this assessment is to investigate the subsurface conditions at the proposed site, evaluate the geotechnical properties of the subsurface materials and provide recommendations and any site constraints for development.

The work was commissioned by Winton dated 14 January 2026. Our assessment has been based on the proposed Northlake Special Zone Subdivision review plans produced by Patersons, dated 30 July 2025.

Based on the provided project details, typical build specifications, and plans for the proposed development, the following scope of work was proposed to provide a suitable Geotechnical Investigation Report (GIR) for the proposed site. As a minimum these included:

- Desktop review of geology, geomorphology, historic aerials, QLDC hazard maps.
- Site walkover by an engineering geologist.
- Field investigations (test pits, Scala tests, shear vanes).
- Ground model development including soil/rock stratigraphy and groundwater conditions.
- Assessment of key natural hazards:
 - Slope instability & landslides
 - Liquefaction & lateral spreading
 - Seismic hazards and NZS 1170.5 Site Class
 - Settlement and bearing constraints
- Natural hazard risk assessment per QLDC/ORC and MBIE/NZGS guidance.
- Recommendations on suitability for proposed zoning, including development constraints, mitigation needs, and any suggested controls or hazard overlays.
- Compliance with QLDC Code of Practice and NZGS Earthquake Geotechnical Practice Modules.

RDA Consulting conducted the work in general accordance with our proposal, reference Northlake Residual Geotech, dated 14 January 2026.

Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

2. SITE DESCRIPTION

The site description and characteristics are outlined below:

- The site is located in the Northlake Special Zone of the Operative District Plan.
- The legal title is Lot 2000 DP 613751.
- The lot is area 254781 m².
- The site is moderate sloping to steep and on the upper slopes and ridges of the Northlake subdivision.
- The subdivision is located adjacent on the western boundary to Sticky Forest. The north boundary not being developed, residential lots are adjacent to remaining site boundaries.
- Access is via Stonehenge Road or Carrickmore Crescent.
- The site is currently covered in grass, and some trees.

3. AREA GEOLOGY

The geology of the site is mapped by the Qm18 as Q2t Undifferentiated Till and associated outwash sand and gravels, from valley glaciers. The Qmap is at a 1:250,000 scale so only details the larger units present. Site investigations have confirmed the sand and gravel outwash deposits.

The site is in an area of past glacial activity with several advance and retreat events causing the underlying bedrock to be scoured by glacial ice sheets resulting in the deposition of glacial sediments such as till over the schist bedrock and lacustrine and deltaic alluvial fan deposits. The Lacustrine depositional environment has resulted in the deposition of lake sediments, which are typically sands and silts.

4. REVIEW OF AVAILABLE INFORMATION

4.1. NATURAL HAZARDS

RDA have assessed the risk of Natural Hazards as per the National Policy Statement for Natural Hazards (NPS-NH). The NPS-NH applies to the following natural hazards: flooding, landslips, coastal erosion, coastal inundation, active faults, liquefaction, and tsunami.

The risk level of each hazard, post development, has been assessed using the NPS-NH risk matrix, likelihood, and consequence, Tables 1 to 3, where very high natural hazard risk must be avoided.

The natural hazards of coastal erosion, coastal inundation, and Tsunami do not apply to this site. The other natural hazards have been assessed as outlined below.

4.1.1 FLOODING

Some small stormwater channels are present to control water runoff. Due to the overall slope and minimal catchment size flooding is not expected, therefore the assessed flood risk is unlikely with minor consequence (low risk).

It is expected that flood modelling and stormwater management/design will be carried out predevelopment, RDA do not expect extensive stormwater systems will be required.

4.1.2 LAND STABILITY

A site walkover by RDA found no natural instability features on site during our investigation, and very dense to stiff underlying soils. The slopes are considered moderate to steep (generally less than 25 degrees) and are not expected to experience landslides or subsidence. RDA consider landslips to be rare with moderate to minor consequence (low risk) pre and post development, provided earthworks are undertaken as per Section 7 of this report.

4.1.3 LIQUEFACTION

A review of the Queenstown Lakes District Council webmap shows that the liquefaction Risk is stated as being LIC 1 -Nil to low risk, refer to the Tonkin & Taylor Liquefaction Hazard Assessment attached in Appendix C. This site is also not expected to have groundwater in the upper 10 metres and relatively dense natural soils; therefore, very low liquefaction risk for the site is present due to the site soil conditions present.

4.1.4 SEISMIC HAZARDS AND ACTIVE FAULTS

The nearest active fault (Cardrona Fault) shown on the published Qm 18 approximately 3.0 km southeast from the site. There is a significant seismic risk to the Wanaka region when the rupture of the alpine fault system occurs; recent probability predictions estimate a magnitude 7.5 or greater is highly likely within the next 45 years. Significant ground shaking is expected from this type of event. Designing to the relevant structural and building codes is expected to mitigate this issue.

4.1.5 OTHER HAZARDS

Freeze and thaw effects are relevant for the region, and it is recommended that all NZS3604 strip foundations are embedded at least 0.4 m below finished ground levels with careful consideration given to final ground level clearances from exterior claddings.

4.2. PREVIOUS GEOTECHNICAL ASSESSMENTS

Previous geotechnical ground investigations were undertaken at the site by Geosolve. The details of these investigations are found within the Geosolve report titled “Geotechnical Report, Northlake Subdivision – Subzone Areas B2, B3 and C1, Outlet Road, Wanaka” dated August 2017. RDA have utilised several test pits from this report to supplement our investigation.

4.3. LAND CONTAMINATION

A review of the Otago Selected Land Use Sites (SLUS) found the site is not identified on the Hazardous Activities and Industries List (HAIL). However, while the site is not on the SLUS register, this does not mean that HAIL activity has not occurred near to or at this location.

For the subject land a Preliminary Site Investigation has been undertaken (Insight Engineering 30/1/26), and two historic HAIL activities were identified, neither of which are a risk to human health.

It is therefore considered highly unlikely that there will be a risk to human health if the activities of changing the land use to residential and subdividing the land for residential development are done to the piece of land.

If suspected contamination is encountered, RDA advise our clients to engage the services of a suitably qualified and experienced contaminated land specialist to carry out a detailed site investigation (DSI) to assess the potential for contamination.

5. GEOTECHNICAL INVESTIGATIONS

A site visit by an Engineering Geologist from RDA Consulting was completed on 4 February 2026. The investigation undertaken during the visit consisted of:

- A site walkover
- Six test pits, with shear vane testing at regular interval in cohesive soils.
- Six Scala penetrometer tests

The surface conditions at the time of site visit, were as follows:

- The site surface was dry
- No seepage was noted on site.

All field work was carried out in the fulltime presence of an RDA Consulting representative who located the test pits and Scala penetrometer sites and produced geological logs in accordance with the NZGS Field Description of Soil and Rock guidelines. The investigation logs are contained in Appendix B.

6. SUBSURFACE CONDITIONS

6.1. GROUND MODEL AND TYPICAL SOIL PROFILE

The expected soil types encountered during the field investigation have been divided into six geotechnical units as summarised in Table 1. Both RDA and the relevant Geosolve geological test pit logs are presented in Appendix B. The site stratigraphy is highly variable, and soil profiles are representative only.

Table 1: Summary of geological units and soil types.

UNIT	SOIL TYPE	DESCRIPTION	TYPICAL THICKNESS	RELATIVE DENSITY
1	TOPSOIL	Organic sandy SILT	0.4m to >0.5 m	N/A
2	FILL (uncontrolled)	Clayey SILT, with minor sand and gravel	Variable 0.1 to >1.0 m (as indicated in the As-built plans)	Dense to Very Dense
3	Organic Fill (Uncontrolled)	ORGANICS & SILT	Variable 1 to > 16 m (as indicated in the As-built plans)	N/A
4	LOESS	Clayey SILT	0.2m to >0.5 m	Hard

5	COLLUVIUM	Clayey SILT to Sandy SILT with some gravel	0.2m to >1.1 m	Very stiff
6	GALCIAL TILL	Silty, sandy, cobbly GRAVEL	0.1m to > 2.5	Very stiff / very dense

6.2. GROUNDWATER

Groundwater was not encountered during both RDA and Geosolve site investigations, extending to a maximum depth of 3.8 mbgl. The local groundwater table is anticipated to be well below anticipated foundation levels and is not expected to be encountered during construction. No registered wells on the ORC database are present in the immediate vicinity; however, well records from lower-lying areas of Wanaka indicate groundwater depths greater than 10 m. Accordingly, groundwater-related construction issues, including dewatering, are not expected.

A suitably qualified geotechnical engineer should be consulted if any seepage, spring flow, or perched groundwater is encountered during construction.

6.3. SITE SUBSOIL CLASS

The site soils are considered to fall within Subsoil Class C or Class D in accordance with NZS 1170.5:2012. At present, insufficient information is available to definitively assign a single subsoil class. As Class D results in more conservative seismic design parameters, it is recommended that Class D be adopted for structural design purposes.

The updated Technical Specification TS 1170.5:2025 further refines site classification based on the average shear wave velocity in the upper 30 m (V_{s30}), defining Site Classes I to VII. As V_{s30} has not been assessed for this site, the above subsoil classifications remain applicable unless further investigation is undertaken.

6.4. EXISTING EARTH FILL

An earth fill plan was provided to RDA by Patersons, showing existing earthfill depths, titled "Northlake Special Zone Review" Cut-Fill Depths". RDA undertook investigation within the fill areas to determine the fill properties. The deep area of fill in the centre of the investigation area consists of buried organic material, including wood, grass, and organic silt. Other areas of fill were tested and these indicated compacted gravely SILT.

The depth of fill is indicated to be greater than 16 m at the deepest point in the Earth Fill As-built Plan provided from Patersons. It has been suggested to RDA by a witness who observed the some of the fill being placed, that it may have tree stumps and other substantial buried organic material.

7. GEOTECHNICAL CONSIDERATIONS

7.1. SLOPE STABILITY

The slopes in their current state (in general <25 degrees) are considered to present a low risk of instability. All earthworks shall be undertaken in accordance with the Queenstown Lakes District Council District Plan requirements, unless otherwise specified and designed by a suitably qualified geotechnical professional.

7.2. EARTHWORKS

It is expected that an earthworks specification would be provided before subdivision development. The document will define the technical requirements for site preparation, excavation, filling, batter angles, and compaction.

7.2.1 SLOPE AND BATTER ANGLES

RDA recommend temporary and permanent batter slopes are provided in Table 2. Slopes steeper than those recommended, or cuts exceeding 3.0 m in height, or any cuts made in the deeper organic fill material, shall be structurally retained or subject to specific geotechnical design. All slopes should be regularly inspected during construction for signs of instability or erosion, with any necessary remedial measures implemented under the direction of a suitably qualified Chartered Professional Engineer.

Table 2: Earthworks batter angles.

MATERIAL TYPE	TEMPORARY CONSTRUCTION BATTERS (H):(V)	PERMANENT BATTERS (H):(V) (UNRETAINED)
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Engineered Fill	1:1	2:1
Topsoil/Fill and Colluvium	1:1	2:1
Glacial Till and Glacial outwash	1:1	2:1

7.2.2 EROSION AND SEDIMENT CONTROL

Earthworks shall be undertaken in a controlled manner so that erosion of disturbed areas is kept to a practical minimum and eroded material is confined on site as far as possible. Haul roads shall be treated as disturbed areas. Any stormwater from disturbed areas shall be directed to sediment control measures in accordance with the Queenstown Lakes District Council district plan for sediment control from construction sites and their Environmental Management Guidelines.

7.2.3 DUST

Earthmoving should be carried out and haul roads and cut/fill areas maintained so that dust is not raised near or blown over the working area and adjacent properties. The site shall be kept watered as necessary to meet this requirement until covered by dust-free materials, mulch, or established grass cover.

7.2.4 SITE WON MATERIAL

All site-won soils, excluding topsoil, and buried organic fill, are suitable for reuse as engineered fill material, subject to verification by laboratory testing and approval by the geotechnical certifier in accordance with NZS 4431:2022.

7.3. COMPRESSIBLE SOILS

Aside from the surficial organic topsoil, deeper organic fill encountered in TP2 and TP4 is considered compressible. See the Test Location Plan in Appendix A for expected extent of deep organic fill. Development on compressible soils is generally considered impractical. Further assessment would require more detailed site-specific investigations, such as drilling and cone penetration testing (CPT); however, the risk of differential settlement would remain, with the potential to adversely affect structures, pavement, and underground services.

7.4. STORMWATER

Stormwater drainage within the subdivision is expected to be provided via council reticulation, with flood modelling and stormwater management design to be completed by others.

7.5. BEARING CAPACITY

Scala penetrometers and shear vane tests were completed adjacent to each test pit. A 300 kPa Geotechnical Ultimate Bearing Capacity (GUBC) is encountered across the site, where natural soils are not encountered, settlement is expected to be within limits set by NZS3604 for 300 kPa GUBC stresses. Organic fill areas are not considered to have 300 kPa GUBC, except in the overlying capping layer.

7.6. PAVEMENT DESIGN

The dense/very stiff natural soils should generally allow for New Zealand standard pavement design methods. Pavement areas proposed over any organic fill will need further site-specific assessment.

7.7. BUILDING FOUNDATIONS

Except where deeper fill is encountered, the foundations suitable for the site are expected to be typical NZS3604 types, or waffle raft style slabs designs, such as, MAXRaft, Firth RibRaft, Allied Superslab, or other proprietary foundation systems, with subgrade remediation for the topsoil and fill encountered.

Freeze/thaw effects are relevant for the region, and it is recommended that all NZS3604 strip foundations are embedded at least 0.4 m below finished ground levels with careful consideration given to final ground level clearances from exterior

8. CONCLUSIONS

Most of the site is considered geotechnically suitable for development, subject to compliance with the recommendations outlined in Sections 4 to 7. However, areas of deep unsuitable organic fill are present and are likely to be cost prohibitive to develop. These areas will require further detailed investigation to assess development feasibility and to inform site-specific engineering design.

Additional investigation of all areas outlined in the Earth Fill As-built Plan shall be undertaken during subdivision development if residential lots are proposed over these areas.

9. LIMITATIONS

Findings presented as a part of this report are for the sole use within the specific scope and the purposes outlined above. While other parties may find this reporting useful the findings are not intended for use by other parties and may not contain sufficient information for the purposes of other parties or other uses.

The above recommendations and discussion are based on the findings in the test locations only at the time of our investigations and are used as a general representation on subgrade conditions across the site. It is possible and quite likely, that subsoil conditions could change between or below our investigation points, such as rubbish pits, old drain infills, buried organics and other fill materials not visible at the surface, or areas of softer soils present. Contingencies for these occasions should always be considered during design and construction stages of the project. Additional inspections and advice may be required if conditions vary from those found during this investigation.

10. HEALTH AND SAFETY

This report is not considered a detailed design report, it is a report for others to determine design elements and construction. Any party utilising this information is responsible for ensuring the safety in design considerations and risk framework are undertaken as well as health and safety in the workplace of all subsequent practitioners and contractors that would be considered to be encapsulated under the Health and Safety Act.

11. REFERENCES

In this report, reference is made to the following documents:

- NZS 3604:2011 Timber Framed Buildings.
- NZS 1170.5-2012 Structural design actions Part 5 Earthquake actions – New Zealand.
- NZS 4431:2022 Engineered fill construction for lightweight structures
- Geology of the Wakatipu area 1:250,000 QMap (Qm18), GNS Science: 2000
- Geosolve Geotechnical Report, Northlake Subdivision – Subzone Areas B2, B3 and C1, Outlet Road, Wanaka
- Queenstown District Plan <https://www.qldc.govt.nz/your-council/district-plan/>

12. APPENDICES

APPENDIX A – Site Plans

1. Testing Location Plan
2. Earth fill As Built Plan
3. Natural Hazard Map

APPENDIX B – Investigation Logs

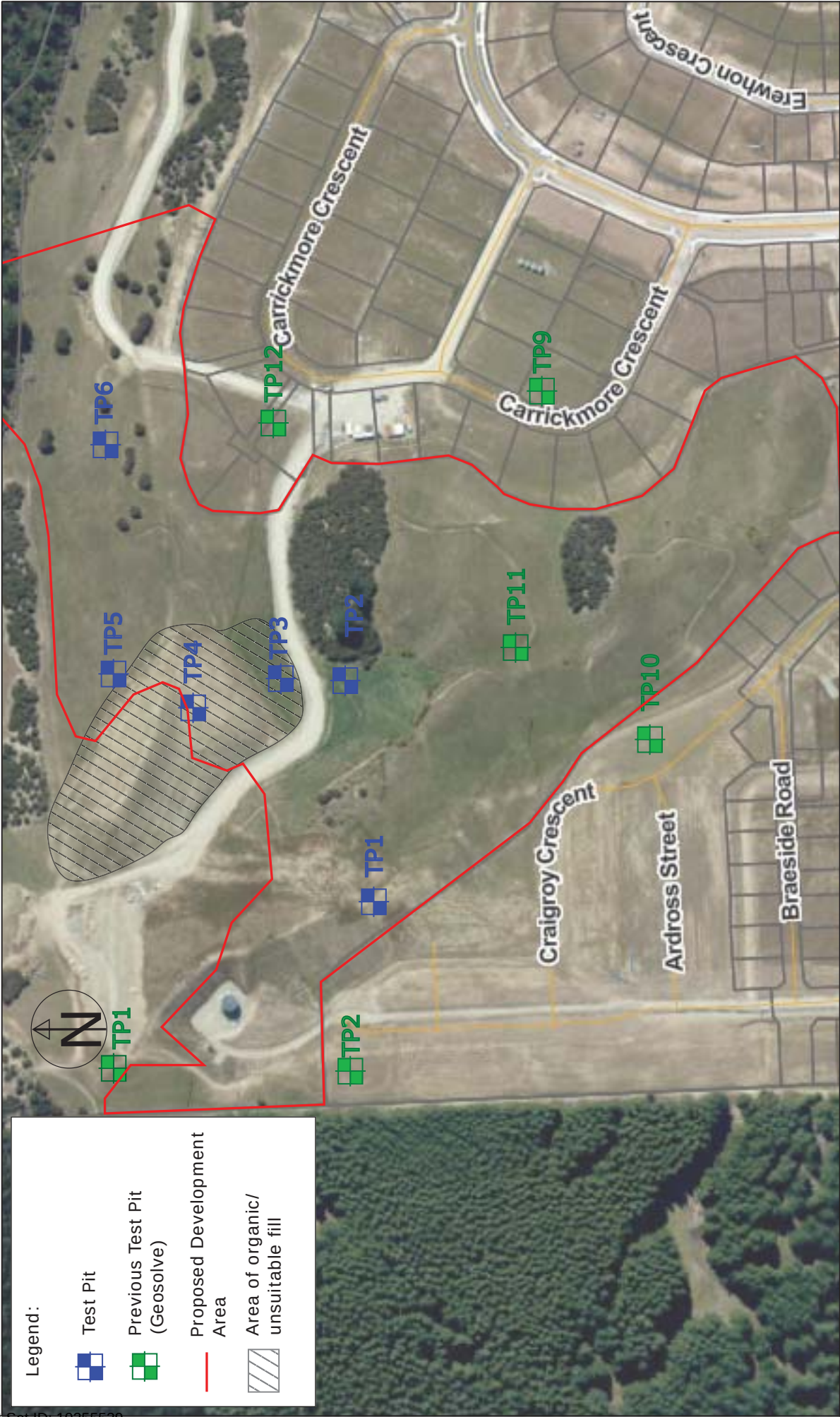
1. RDA Investigation Logs
2. Relevant Geosolve Investigation Logs

APPENDIX C – Previous Geotechnical Reporting

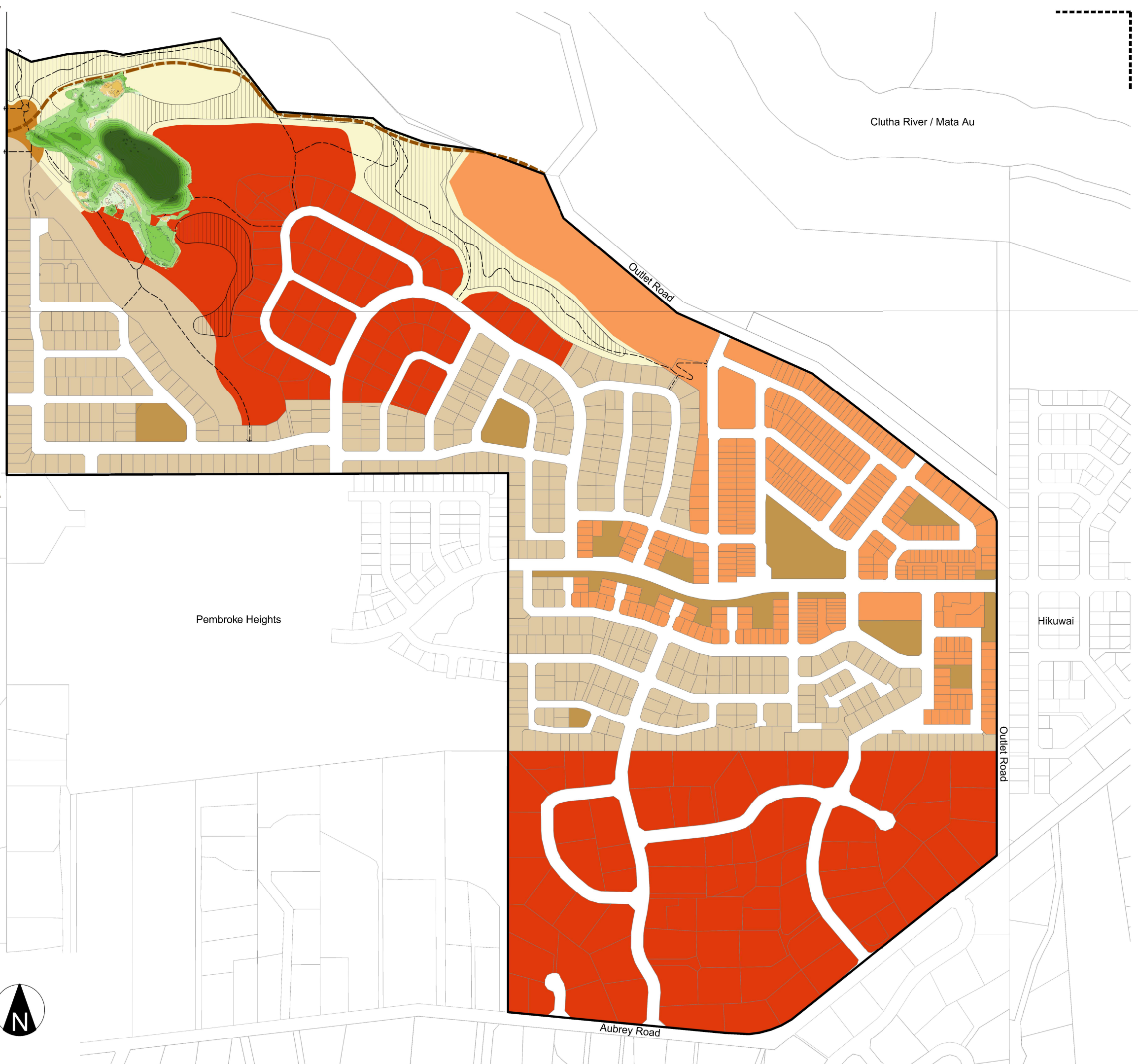
1. GeoSlove Geotech Report titled “Geotechnical Report Northlake Subdivision – Subzone Areas B2, B3 and C1, Outlet Road, Wanaka” dated August 2017
2. Tonkin & Taylor Summary Report titled “Queenstown Lakes District 2012 Liquefaction Hazard Assessment” dated 04 April 2013

APPENDIX A. SITE PLANS

3. Testing Location Plan
4. Earth fill As Built Plan
5. Natural Hazard Maps



Engineering firm: www.rda.co.nz RDA Consulting GEOTECHNICAL • CIVIL • ENVIRONMENTAL	Project: Northlake Residual Geotech Northlake Subdivision Residual Zone Wanaka	Client: Northlake Investments Limited	Drawing Title: Test Location Plan Job Number: 54054	Scale: NTS Date: 4/02/26 Drawing No. 1
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-  Informal Recreation
 Native Grey Shrubland
 Rural
 Large Lot A
 Suburban Residential
 Medium Density Residential
 Trails
 ONL Boundary

Northlake Structure Plan

1:6000@A3 19-Mar-26



Natural Hazards Map Print Out



3/25/2026, 6:15:29 PM

Liquefaction Awareness Areas Otago

A Domain

B1 Domain

Ground Classification Otago

D - Deep or Soft Soil

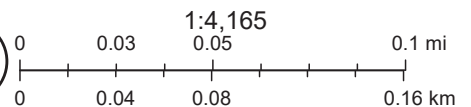
World Imagery

Low Resolution 15m Imagery

High Resolution 60cm Imagery

High Resolution 30cm Imagery

Citations



Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, LINZ, DCC, WDC, CDC, QLDC, CODC and ORC, Sources: Esri, Vantor, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, and the GIS user

APPENDIX B. INVESTIGATION LOGS

1. RDA Investigation Logs
2. Relevant Geosolve Investigation Logs

INVESTIGATION LOG

HOLE NO.:

TP1 & SP1

CLIENT: Northlake Investments Limited

PROJECT: Northlake Residual Geotech

JOB NO.:

54054

SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka

ELEVATION: Ground Level

DATE: 04/02/2026

CO-ORDINATES: 1294531mE, 5046503mN

LOGGED BY: SMA

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 50 mm)	UNDRAINED SHEAR STRENGTH (kPa)			VALUES Shear Residual	SENSITIVITY	WATER
				Calibration Constant: 1.665					
Silty sandy TOPSOIL, with some gravel; light brown. Dry; sand, fine to coarse; gravel, fine.		TS	1	50					
		TS	2	60					
		TS	3	70					
	0.2	TS	4	80					
		TS	5	90					
Clayey SILT; light brown. Hard; dry; low plasticity; LOESS.	0.4	TS	6	100				UTP	
		TS	7	110				-	
	0.6	TS	8	120					
		TS	9	130				UTP	
	0.8	TS	10	140				-	
Silty sandy cobbly GRAVEL; light brown. Very dense; dry; gravel, fine to coarse, subround; sand, fine to coarse, cobbles, subround; GLACIAL TILL.	1.0	TS	11	150					
		TS	12	160					
	1.2	TS	13	170					
		TS	14	180					
	1.4	TS	15	190					
		TS	16	200					
	1.6	TS	17	210					
		TS	18	220					
	1.8	TS	19	230					
		TS	20	240					
End Of Hole: 1.50m	2.0	TS	21	250					
		TS	22	260					
	2.2	TS	23	270					
		TS	24	280					
	2.4	TS	25	290					
		TS	26	300					
	2.6	TS	27	310					
		TS	28	320					
	2.8	TS	29	330					
		TS	30	340					

PHOTO(S)



LEGEND

--- SP1

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

- ▼ Standing Water Level
- ▷ Out flow
- ◁ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☒ Test Pit

CLIENT: Northlake Investments Limited
PROJECT: Northlake Residual Geotech

JOB NO.: 54054

SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka
CO-ORDINATES: 1294669mE. 5046514mN

ELEVATION: Ground Level

DATE: 04/02/2026

LOGGED BY: SMA

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 50 mm)	UNDRAINED SHEAR STRENGTH (kPa)	VALUES Shear Residual	SENSITIVITY	WATER
			Calibration Constant: 1.665				
Silty sandy TOPSOIL, with some gravel; light brown. Dry; sand, fine to coarse; gravel, fine.	0.0	TS	1	50			
	0.1	TS	2	100			
	0.2	TS	3	150			
	0.3	TS	4	200			
	0.4	TS	5	250			
	0.5	TS	6	300			
	0.6	TS	7	350			
	0.7	TS	8	400			
	0.8	TS	9	450			
	0.9	TS	10	500			
	1.0	TS	11	550			
	1.1	TS	12	600			
	1.2	TS	13	650			
	1.3	TS	14	700			
	1.4	TS	15	750			
	1.5	TS	16	800			
	1.6	TS	17	850			
	1.7	TS	18	900			
	1.8	TS	19	950			
	1.9	TS	20	1000			
	2.0	TS	21	1050			
	2.1	TS	22	1100			
	2.2	TS	23	1150			
	2.3	TS	24	1200			
	2.4	TS	25	1250			
	2.5	TS	26	1300			
	2.6	TS	27	1350			
	2.7	TS	28	1400			
	2.8	TS	29	1450			
	2.9	TS	30	1500			
	3.0	TS	31	1550			
	3.1	TS	32	1600			
	3.2	TS	33	1650			
	3.3	TS	34	1700			
	3.4	TS	35	1750			
	3.5	TS	36	1800			
	3.6	TS	37	1850			
	3.7	TS	38	1900			
	3.8	TS	39	1950			
	3.9	TS	40	2000			
	4.0	TS	41	2050			
	4.1	TS	42	2100			
	4.2	TS	43	2150			
	4.3	TS	44	2200			
	4.4	TS	45	2250			
	4.5	TS	46	2300			
	4.6	TS	47	2350			
	4.7	TS	48	2400			
	4.8	TS	49	2450			
	4.9	TS	50	2500			
	5.0	TS	51	2550			
	5.1	TS	52	2600			
	5.2	TS	53	2650			
	5.3	TS	54	2700			
	5.4	TS	55	2750			
	5.5	TS	56	2800			
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	5.7	TS	58	2900			
	5.8	TS	59	2950			
	5.9	TS	60	3000			
	6.0	TS	61	3050			
	6.1	TS	62	3100			
	6.2	TS	63	3150			
	6.3	TS	64	3200			
	6.4	TS	65	3250			
	6.5	TS	66	3300			
	6.6	TS	67	3350			
	6.7	TS	68	3400			
	6.8	TS	69	3450			
	6.9	TS	70	3500			
	7.0	TS	71	3550			
	7.1	TS	72	3600			
	7.2	TS	73	3650			
	7.3	TS	74	3700			
	7.4	TS	75	3750			
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	7.7	TS	78	3900			
	7.8	TS	79	3950			
	7.9	TS	80	4000			
	8.0	TS	81	4050			
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	8.3	TS	84	4200			
	8.4	TS	85	4250			
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	8.6	TS	87	4350			
	8.7	TS	88	4400			
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	8.9	TS	90	4500			
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	9.9	TS	100	5000			
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	10.1	TS	102	5100			
	10.2	TS	103	5150			
	10.3	TS	104	5200			
	10.4	TS	105	5250			
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	11.9	TS	120	6000			
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	12.2	TS	123	6150			
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	13.9	TS	140	7000			
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	14.2	TS	143	7150			
	14.3	TS	144	7200			
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	14.9	TS	150	7500			
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	15.1	TS	152	7600			
	15.2	TS	153	7650			
	15.3	TS	154	7700			
	15.4	TS	155	7750			
	15.5	TS	156	7800			
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	15.7	TS	158	7900			
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	15.9	TS	160	8000			
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	16.2	TS	163	8150			
	16.3	TS	164	8200			
	16.4	TS	165	8250			
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	17.0	TS	171	8550			
	17.1	TS	172	8600			
	17.2	TS	173	8650			
	17.3	TS	174	8700			
	17.4	TS	175	8750			
	17.5	TS	176	8800			
	17.6	TS	177	8850			
	17.7	TS	178	8900			
	17.8	TS	179	8950			
	17.9	TS	180	9000			
	18.0	TS	181	9050			
	18.1	TS	182	9100			
	18.2	TS	183	9150			
	18.3	TS	184	9200			
	18.4	TS	185	9250			
	18.5	TS	186	9300			
	18.6	TS	187	9350			
	18.7	TS	188	9400			
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	19.6	TS	197	9850			
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	19.8	TS	199	9950			
	19.9	TS	200	10000			
	20.0	TS	201	10050			
	20.1	TS	202	10100			
	20.2	TS	203	10150			
	20.3	TS	204	10200			
	20.4	TS	205	10250			
	20.5	TS	206	10300			
	20.6	TS	207	10350			
	20.7	TS	208	10400			
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	21.2	TS	213	10650			
	21.3	TS	214	10700			
	21.4	TS	215	10750			
	21.5	TS	216	10800			
	21.6	TS	217	10850			
	21.7	TS	218	10900			
	21.8	TS	219	10950			
	21.9	TS	220	11000			
	22.0	TS	221	11050			
	22.1	TS	222	11100			
	22.2	TS	223	11150			
	22.3	TS	224	11200			
	22.4	TS	225	11250			
	22.5	TS	226	11300			
	22.6	TS	227	11350			
	22.7	TS	228	11400			
	22.8	TS	229	11450			
	22.9	TS	230	11500			
	23.0	TS	231	11550			
	23.1	TS	232	11600			
	23.2	TS	233	11650			
	23.3	TS	234	11700			
	23.4	TS	235	11750			
	23.5	TS	236	11800			
	23.6	TS	237	11850			
	23.7	TS	238	11900			
	23.8						

PHOTO(S)



LEGEND

SP2

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

 Standing Water Level
 Out flow
 In flow

INVESTIGATION TYPE

☐ Hand Auger

☒ Test Pit

INVESTIGATION LOG

HOLE NO.:
TP3 & SP3

CLIENT: Northlake Investments Limited
PROJECT: Northlake Residual Geotech

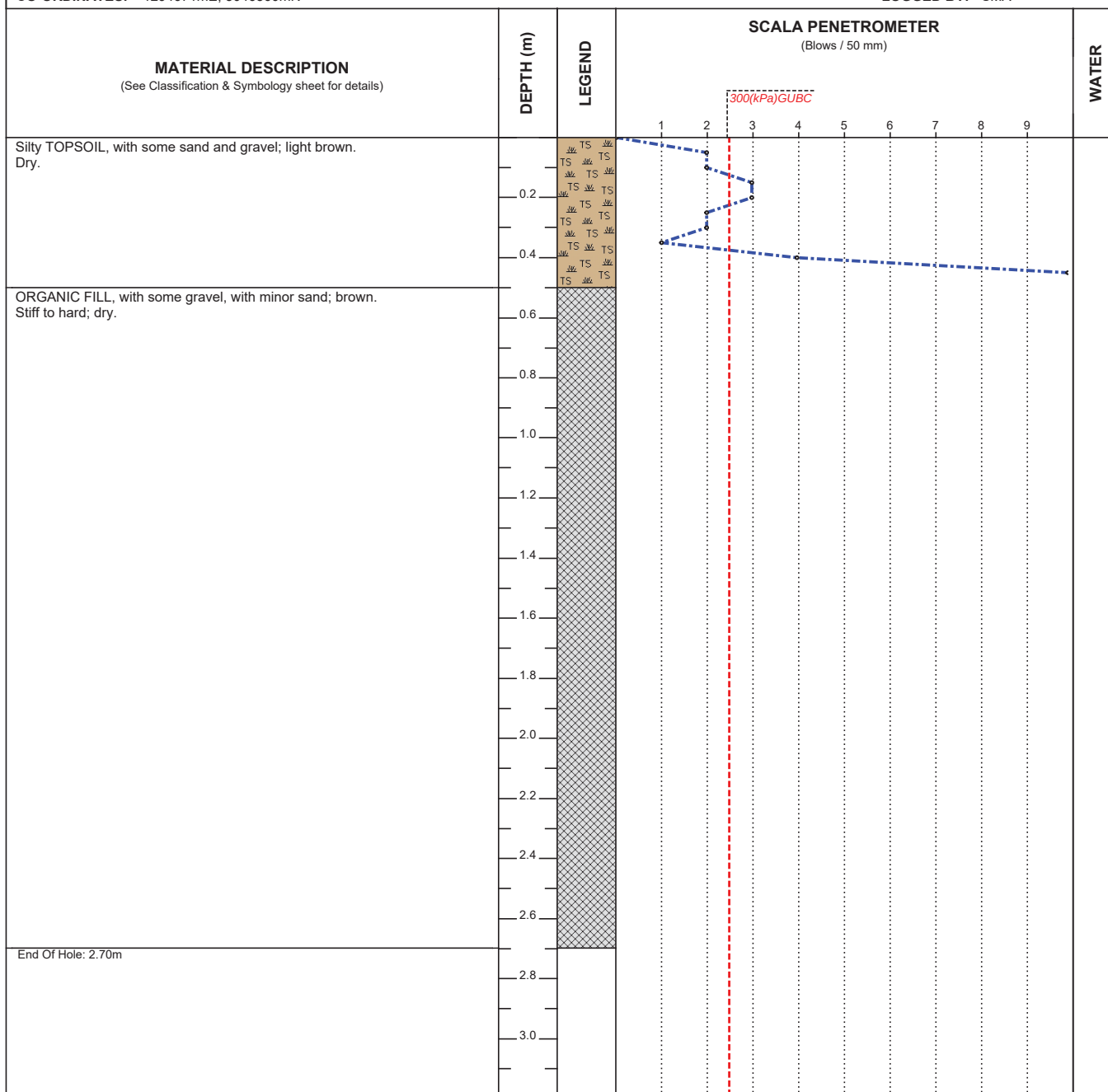
JOB NO.:
54054

SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka
CO-ORDINATES: 1294671mE, 5046560mN

ELEVATION: Ground Level

DATE: 04/02/2026

LOGGED BY: SMA



PHOTO(S)



LEGEND

--- SP3
--- TP3
--- TP3

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

- ▼ Standing Water Level
- ▷ Out flow
- ◁ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☒ Test Pit

INVESTIGATION LOG

HOLE NO.:

TP4 & SP4

CLIENT: Northlake Investments Limited

PROJECT: Northlake Residual Geotech

JOB NO.:

54054

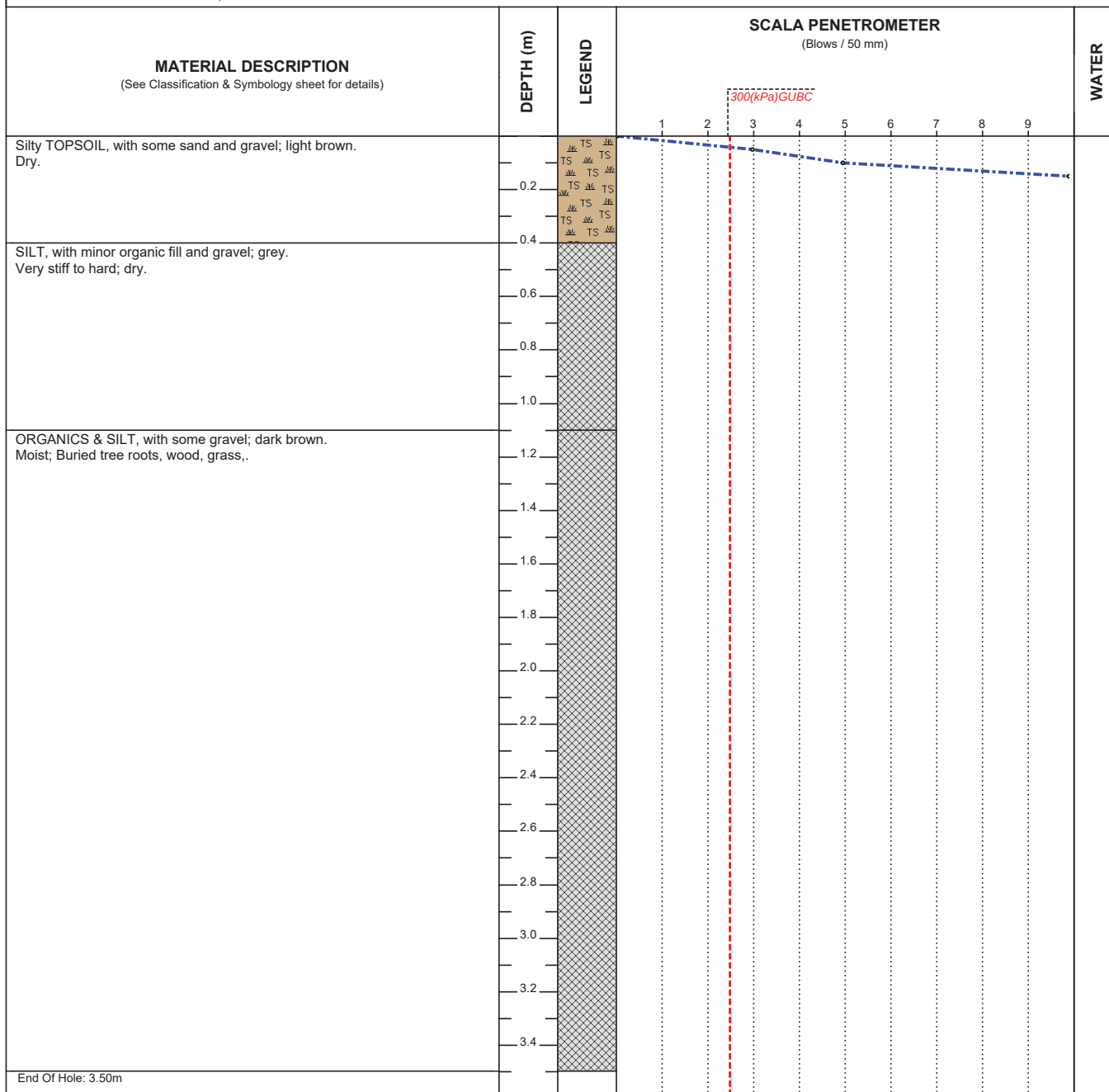
SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka

ELEVATION: Ground Level

DATE: 04/02/2026

CO-ORDINATES: 1294652mE, 5046611mN

LOGGED BY: SMA



PHOTO(S)



LEGEND

--- SP4

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

- ▼ Standing Water Level
- ▷ Out flow
- ◁ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☒ Test Pit

INVESTIGATION LOG

HOLE NO.:

TP5 & SP5

CLIENT: Northlake Investments Limited

PROJECT: Northlake Residual Geotech

JOB NO.:

54054

SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka

ELEVATION: Ground Level

DATE: 04/02/2026

CO-ORDINATES: 1294667mE, 5046655mN

LOGGED BY: SMA

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 50 mm)	UNDRAINED SHEAR STRENGTH (kPa)		VALUES Shear Residual	SENSITIVITY	WATER
				Calibration Constant: 1.665				
			300(kPa)GUBC	300(kPa)GUBC				
Silty sandy TOPSOIL, with some gravel; light brown. Dry; sand, fine to coarse; gravel, fine.	0.0	TS	1	50				
	0.1	TS	2	60				
	0.2	TS	3	70				
	0.3	TS	4	80				
	0.4	TS	5	90				
	0.5	TS	6	100				
	0.6	TS	7	110				
	0.7	TS	8	120				
	0.8	TS	9	130				
	0.9	TS		140				
	1.0	TS		150				
	1.1	TS		160				
	1.2	TS		170				
	1.3	TS		180				
	1.4	TS		190				
	1.5	TS		200				
	1.6	TS		210				
	1.7	TS		220				
	1.8	TS		230				
	1.9	TS		240				
	2.0	TS		250				
	2.1	TS		260				
	2.2	TS		270				
	2.3	TS		280				
	2.4	TS		290				
	2.5	TS		300				
	2.6	TS		310				
	2.7	TS		320				
	2.8	TS		330				
	2.9	TS		340				
	3.0	TS		350				
	3.1	TS		360				
	3.2	TS		370				
	3.3	TS		380				
	3.4	TS		390				
	3.5	TS		400				
	3.6	TS		410				
	3.7	TS		420				
	3.8	TS		430				
	3.9	TS		440				
	4.0	TS		450				
	4.1	TS		460				
	4.2	TS		470				
	4.3	TS		480				
	4.4	TS		490				
	4.5	TS		500				
	4.6	TS		510				
	4.7	TS		520				
	4.8	TS		530				
	4.9	TS		540				
	5.0	TS		550				
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	5.3	TS		580				
	5.4	TS		590				
	5.5	TS		600				
	5.6	TS		610				
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	5.8	TS		630				
	5.9	TS		640				
	6.0	TS		650				
	6.1	TS		660				
	6.2	TS		670				
	6.3	TS		680				
	6.4	TS		690				
	6.5	TS		700				
	6.6	TS		710				
	6.7	TS		720				
	6.8	TS		730				
	6.9	TS		740				
	7.0	TS		750				
	7.1	TS		760				
	7.2	TS		770				
	7.3	TS		780				
	7.4	TS		790				
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	7.6	TS		810				
	7.7	TS		820				
	7.8	TS		830				
	7.9	TS		840				
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	8.1	TS		860				
	8.2	TS		870				
	8.3	TS		880				
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	8.5	TS		900				
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	8.7	TS		920				
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	9.1	TS		960				
	9.2	TS		970				
	9.3	TS		980				
	9.4	TS		990				
	9.5	TS		1000				
	9.6	TS		1010				
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	10.6	TS		1110				
	10.7	TS		1120				
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	10.9	TS		1140				
	11.0	TS		1150				
	11.1	TS		1160				
	11.2	TS		1170				
	11.3	TS		1180				
	11.4	TS		1190				
	11.5	TS		1200				
	11.6	TS		1210				
	11.7	TS		1220				
	11.8	TS		1230				
	11.9	TS		1240				
	12.0	TS		1250				
	12.1	TS		1260				
	12.2	TS		1270				
	12.3	TS		1280				
	12.4	TS		1290				
	12.5	TS		1300				
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	13.0	TS		1350				
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	13.2	TS		1370				
	13.3	TS		1380				
	13.4	TS		1390				
	13.5	TS		1400				
	13.6	TS		1410				
	13.7	TS		1420				
	13.8	TS		1430				
	13.9	TS		1440				
	14.0	TS		1450				
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	14.2	TS		1470				
	14.3	TS		1480				
	14.4	TS		1490				
	14.5	TS		1500				
	14.6	TS		1510				
	14.7	TS		1520				
	14.8	TS		1530				
	14.9	TS		1540				
	15.0	TS		1550				
	15.1	TS		1560				
	15.2	TS		1570				
	15.3	TS		1580				
	15.4	TS		1590				
	15.5	TS		1600				
	15.6	TS		1610				
	15.7	TS		1620				
	15.8	TS		1630				
	15.9	TS		1640				
	16.0	TS		1650				
	16.1	TS		1660				
	16.2	TS		1670				
	16.3	TS		1680				
	16.4	TS		1690				
	16.5	TS		1700				
	16.6	TS		1710				
	16.7	TS		1720				
	16.8	TS		1730				
	16.9	TS		1740				
	17.0	TS		1750				
	17.1	TS		1760				
	17.2	TS		1770				
	17.3	TS		1780				
	17.4	TS		1790				
	17.5	TS		1800				
	17.6	TS		1810				
	17.7	TS		1820				
	17.8	TS		1830				
	17.9	TS		1840				
	18.0	TS		1850				
	18.1	TS		1860				
	18.2	TS		1870				
	18.3	TS		1880				
	18.4	TS		1890				
	18.5	TS		1900				
	18.6	TS		1910				
	18.7	TS		1920				
	18.8	TS		1930				
	18.9	TS		1940				
	19.0	TS		1950				
	19.1	TS		1960				
	19.2	TS		1970				
	19.3	TS		1980				
	19.4	TS		1990				
	19.5	TS		2000				
	19.6	TS		2010				
	19.7	TS		2020				
	19.8	TS		2030				
	19.9	TS		2040				
	20.0	TS		2050				
	20.1	TS		2060				
	20.2	TS		2070				
	20.3	TS		2080				
	20.4	TS		2090				
	20.5	TS		2100				
	20.6	TS		2110				
	20.7	TS		2120				
	20.8	TS		2130				
	20.9	TS		2140				
	21.0	TS		2150				
	21.1	TS		2160				
	21.2	TS		2170				
	21.3	TS		2180				
	21.4	TS		2190				
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	21.6	TS		2210				
	21.7	TS		2220				
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	22.2	TS		2270				
	22.3	TS		2280				
	22.4	TS		2290				
	22.5	TS		2300				
	22.6	TS		2310				
	22.7	TS		2320				
	22.8	TS		2330				
	22.9	TS		2340				
	23.0	TS		2350				
	23.1	TS		2360				
	23.2	TS		2370				
	23.3	TS		2380				
	23.4	TS		2390				
	23.5	TS		2400				
	23.6	TS		2410				

PHOTO(S)



LEGEND

--- SP5

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

- ▼ Standing Water Level
- ▷ Out flow
- ◁ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☒ Test Pit

INVESTIGATION LOG

HOLE NO.:

TP6 & SP6

CLIENT: Northlake Investments Limited

PROJECT: Northlake Residual Geotech

JOB NO.:

54054

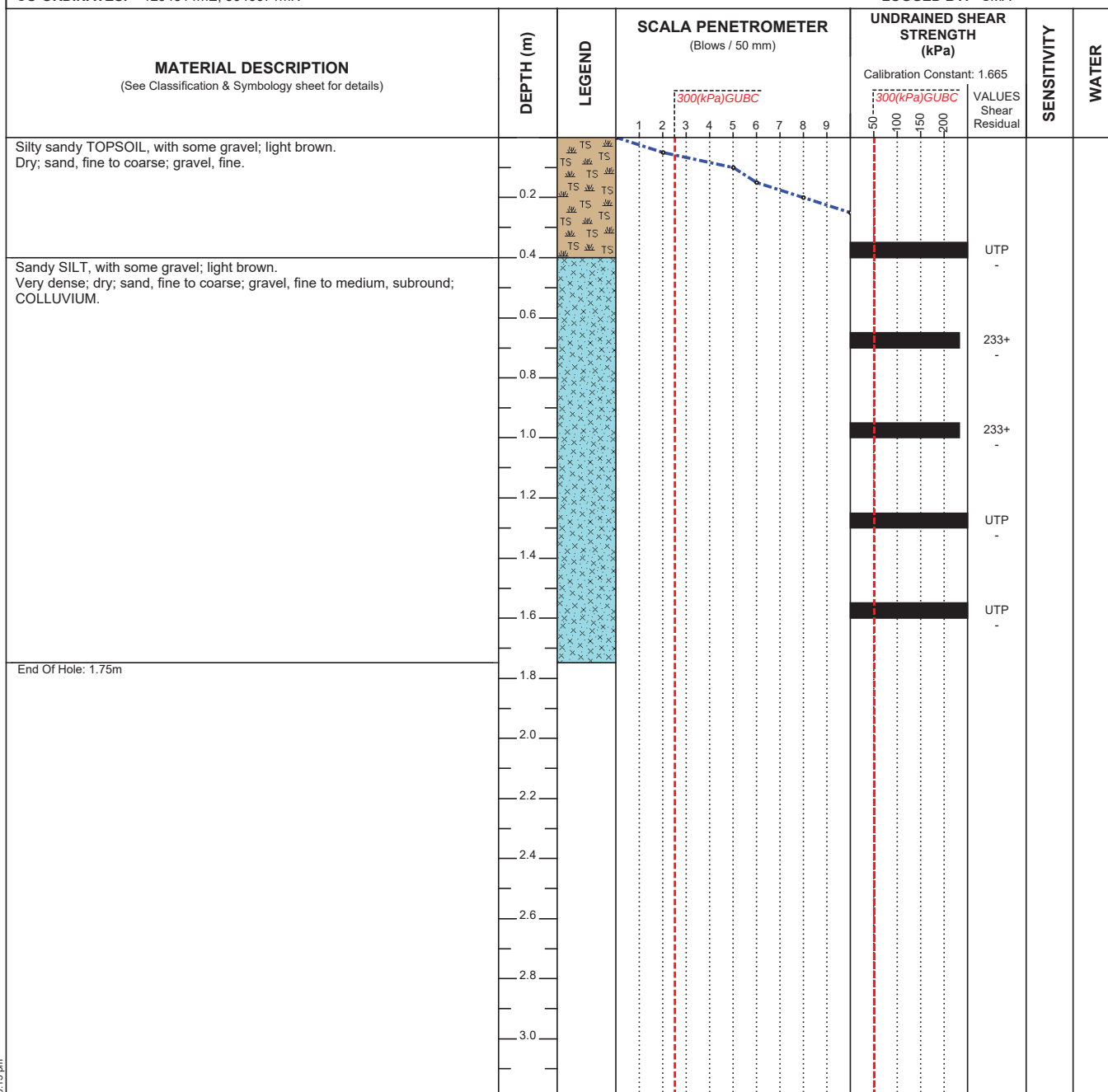
SITE LOCATION: Northlake Subdivision, Residual Zone, Wanaka

ELEVATION: Ground Level

DATE: 04/02/2026

CO-ORDINATES: 1294814mE, 5046671mN

LOGGED BY: SMA



PHOTO(S)



LEGEND

--- SP6

REMARKS

End of Test Pit - Target depth achieved
No groundwater encountered

WATER

- ▼ Standing Water Level
- ▷ Out flow
- ◁ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☒ Test Pit



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 1

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brownish grey, sandy SILT. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	LOESS
		0.9		Brown, sandy gravelly SILT. Gravel is fine to coarse. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
	NO SEEPAGE	3.8		Grey, silty SAND with some gravel and sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 2

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.2		organic SILT with some rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, sandy SILT with some gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.2		Grey, silty SAND with some gravel and a trace of boulders. Sand is fine to medium. Boulders up to 250mm. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3.2 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 9

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.8		Brown, sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		2.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.1		Grey, silty sandy GRAVEL with minor boulders and some cobbles. Sand is fine to medium. Gravel is fine to coarse. Boulders up to 300mm. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.1 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 10

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown/orange, sandy SILT with some gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
	NO SEEPAGE	3.8		Grey, silty SAND with some gravel. 300 mm sand with some silt at 0.9 m. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT: Hole stood well during excavation.

Logged By: GSH/MDP

Checked Date:

Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 11

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, silty SAND with some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.6		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.6 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 12

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, sandy SILT. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	LOESS
		1.3		Brown, silty SAND with minor gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		1.8		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		2.1		Grey, gravelly silty SAND to sandy silty GRAVEL. Gravel is fine to coarse. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		3.8		Grey/brown, silty SAND with minor gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1

APPENDIX C. PREVIOUS GEOTECHNICAL REPORTING

6. GeoSlove Geotech Report titled “Geotechnical Report Northlake Subdivision – Subzone Areas B2, B3 and C1, Outlet Road, Wanaka” dated August 2017
7. Tonkin & Taylor Summary Report titled “Queenstown Lakes District 2012 Liquefaction Hazard Assessment” dated 04 April 2013



Geotechnical Report

Northlake Subdivision – Subzone Areas
B2, B3 and C1, Outlet Road, Wanaka

Report prepared for:

Northlake Investments Limited

Report prepared by:

GeoSolve Ltd

Distribution:

Northlake Investments Limited

GeoSolve Limited (File)

Paterson Pitts Group Wanaka

August 2017

GeoSolve Ref: 170372



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1 Introduction

1.1 General

This report presents the results of a geotechnical investigation carried out by GeoSolve Ltd in order to determine subsoil conditions and earthworks recommendations at Outlet Road, Wanaka. Geotechnical design parameters and foundation bearing parameters are provided. The proposed development area has been provided by Paterson Pitts Group.



Photo 1. View of the site looking northwest from TP23.

The investigation was carried out for Northlake Investments Limited in accordance with GeoSolve Ltd.'s proposal dated the 31st of May 2017, which outlines the scope of work and conditions of engagement. This report will supplement a resource and earthworks consent application.

1.2 Proposed Development

We understand the above property is being subdivided and this requires geotechnical assessment of the site to assess suitability for development and to identify any geotechnical issues.

Earthworks plans for the site have been provided to GeoSolve with a proposed maximum cut depth of 8.7 m and a maximum fill depth of 5.8 m. Topsoil stripping of 131,250 m³ and cut to fill of 390,500 m³ is proposed as part of the earthworks design.

Figure 1, Appendix A shows the proposed subdivision area.

2 Site Description

2.1 General

The subject property, legally described as Lots 65-66 DP 371470, is located approximately 3 km northeast of central Wanaka, as shown in Figure 1 below.



Figure 1. Site location (blue symbol) in relation to Wanaka township (Source: <http://maps.qldc.govt.nz/qldcviewer/>)

The property is accessed off Outlet Road and is situated to the northwest of Mt Iron.

The site is currently undeveloped with ground cover comprising grass, shrubs and pine trees.

The site is bounded by Aubrey Road and the Allenby Farms development to the south, SEC 2 of 5 BLK XIV to the west, the Hikuwai subdivision to the east and Outlet Road and the outlet camping ground to the north.

2.2 Topography and Surface Drainage

The site topography is generally undulating sloping from the northwest corner of the lot to the southeast. Various shallow gullies run through the property from the high point at the northwest corner of the section towards the eastern extent of the section.

Earthworks plans have been developed by Paterson Pitts Group, which include a maximum cut of 8.7 m and a maximum fill depth of 5.8 m.

Spring flows or seepages were not observed during any of the site investigations completed.

Topographic contours are shown in Figure 1, Appendix A.

3 Geotechnical Investigations

GeoSolve Ltd visited the subject property on 7-8th April 2017 undertaking an engineering geological site appraisal with confirmatory subsurface investigations.

The subsurface investigations carried out for the purposes of this report are as follows:

- 25 Test pits (TP 1-25), extending to a maximum depth of 3.8 m below ground level (bgl) to produce geological logs of the subsoils;

Investigation locations and logs are presented in Appendices A and B respectively.

4 Subsurface Conditions

4.1 Geological Setting

The site is located in the Wanaka Basin, a feature formed predominantly by glacial advances. The schist bedrock within the basin has been extensively scoured by ice and lies at considerable depth below this site. Overburden material above the schist in this region includes glacial till, alluvial outwash sediments, lake sediments and beach deposits.

During the Mt Iron and Hawea Glacial Advances 20-30,000 years before present, the glaciers terminated upstream from Albert Town forming moraine loops and outwash terraces. Well-consolidated glacial till gravels were laid down on the flanks and beds of the glaciers. With the final retreat of the ice, about 15,000 years ago, Lake Wanaka formed and the Clutha River became entrenched in the glacial deposits.

Schist bedrock outcrops on the slopes of Mt Iron and Tertiary sediments outcrop to the east at Halliday's Bluff.

No active fault traces were observed on the property, however several seismically active faults are mapped in the Wanaka area, including the Cardrona Fault, which is located approximately 3 km east of the property and is considered capable of earthquakes of Magnitude 7.3. The Alpine Fault, located approximately 70 km away, runs along the western foothills of the Southern Alps, and is likely to present a more significant seismic risk in the short term. There is a high probability that an earthquake of Magnitude 7.5 or more will occur along the Alpine Fault within the next 50 years and such a rupture is likely to result in strong ground shaking in the vicinity of Wanaka.

4.2 Stratigraphy

Results from the test pitting indicate the sub-surface stratigraphy comprises:

- 0.2 to 0.3 m of **topsoil**, overlying;
- 0.2 to 0.4 m of **loess**, overlying;
- 0.2 to 0.8 m of **colluvium**, overlying;
- 0.1 to 1.9 m of **outwash sand and gravel**, overlying;
- 0.2-3.2 m+ thickness of **glacial till**.

Topsoil was observed at the surface of all test pits and predominately comprises dark brown, organic SILT with roots.

Loess was observed to underlie the topsoil in four test pits (TP 1, 4, 7 and 12). The loess predominately comprises brown firm, sandy SILT and extends to 0.5 to 0.7 m bgl.

Colluvium was observed to underlie the topsoil and loess in all test pits and extended to a depth of between 0.5 and 1.3 m bgl. The colluvium predominately comprises loose/firm silty GRAVEL, silty SAND with some gravel, gravelly SILT and sandy SILT with some gravel.

Outwash Sand and Gravel was observed to underlie the colluvium and glacial till in 4 out of 25 test pits (TP 5, 6, 7 and 16). Outwash sand and gravel typically comprises grey, medium dense sandy GRAVEL and gravelly SAND with minor to some cobbles and boulders. The outwash sand and gravel extends to depths of between 0.7 and 2.7 m.

Glacial till was observed to underlie the colluvium, outwash sand and gravel in all test pits at 0.5 to 2.7 m bgl. The glacial till predominantly comprises medium dense/very stiff grey, silty SAND with some gravel, silty sandy GRAVEL with some cobbles and boulders, gravelly silty SAND and sandy SILT with some gravel.

Full details of the observed subsurface stratigraphy can be found within the test pit logs contained in Appendix B.

4.3 Groundwater

Groundwater seepage was not observed during test pit investigations. Soils were observed to be in a predominately moist condition. The regional groundwater table is expected to lie more than 15 metres below the ground surface of this site, as it was not intercepted within a borehole completed by Rileys in December 2015 to this depth. Minor groundwater seepages may be observed in gullies following heavy or prolonged rainfall.

4.4 Slope Stability

No instability features were observed on the site during investigations. This is supported by the absence of a shallow groundwater table and the predominately very stiff/medium dense condition of the soils observed in test pits.

During site investigations it was noted that the terrain is generally undulating and varies from horizontal to moderately sloping. Earthworks plans have been reviewed by GeoSolve and slope stability is not considered an issue as long as the temporary and permanent cut and fill batters are in accordance with section 5 of this report and that fill is engineered and certified in accordance with NZS 4431.

5 Earthworks Considerations

5.1 General

The recommendations and opinions contained in this report are based upon ground investigation data obtained at discrete locations on site and historical information held on the GeoSolve database. The nature and continuity of subsoil conditions away from the investigation locations is inferred and cannot be guaranteed.

5.2 Geotechnical Parameters

Table 1 provides a summary of the recommended geotechnical design parameters for the soils expected to be encountered during construction of any future dwellings and retaining walls.

Table 1 Recommended Geotechnical Design Parameters

Unit	Thickness (m)	Bulk Density γ (kN/m ³)	Effective Cohesion c' (kPa)	Effective Friction ϕ' (deg)	Elastic Modulus E (kPa)	Poissons Ratio ν
Topsoil (organic SILT with roots)	0.2-0.3	16	To be removed from engineered fill footprints			
Loess (firm, sandy SILT)	0.2-0.5	18	To be removed from engineered fill footprints or blended with suitable material and re-compacted			
Colluvium (firm/loose gravelly SILT and silty GRAVEL, silty SAND and sandy SILT with some gravel)	0.2-0.8	18	0	32-34	5,000	0.3
Outwash Sand and Gravel (medium dense, sandy GRAVEL and gravelly SAND with minor to some cobbles and boulders, silty SAND and SAND)	0.1-3.7	18	0	36 (32 in Sand)	10,000-20,000	0.3
Glacial Till (very stiff/medium dense sandy SILT to silty SAND with minor to some gravel, silty gravelly SAND)	0.2-2.7	19	2	34	20,000-30,000	0.3

5.3 Site Preparation/Earthworks

During the earthworks operations all topsoil, organic matter and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:1989. These soil types will also need to be removed from areas where engineered fill is proposed. Loess in its natural state will not be suitable as an engineered fill subsoil and should either be removed or blended with other suitable material and re-compacted.

Robust, shallow graded sediment control measures should be instigated during construction where rainwater and drainage run-off across exposed soils is anticipated. If slope gradients in excess of 4%

are proposed in colluvium or silt soils then the construction and lining of drainage channels is recommended, e.g. with geotextile and suitably graded rock, or similarly effective armouring.

Topsoil coverage is recommended upon completion of engineered fill placement.

All fill that is utilised as bearing for foundations should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect. The loess, colluvium, glacial till, and outwash soils can be used as engineered fill on site. The topsoil is not suitable as a fill source. To use the loess material as a fill source it will have to be blended with a more granular soil source to be satisfactory. Due to the changeable grain size of the natural soil materials on site, a range of compaction reference tests will be required. Maximum density and optimum moisture content will vary. Compaction of the fill sources at lab tested optimum moisture content is critical for these soil types. In areas where significant amounts of cobbles over 100 mm are observed the material should be blended with fine grained soil materials to create a well graded fill.

5.4 Excavations

Earthworks plans have been provided by Paterson Pitts with cuts expected to be made within topsoil, loess, colluvium, outwash soils and glacial till.

Recommendations for temporary and permanent batter slope angles are described below in Table 2. Slopes that are required to be steeper than those described below should be structurally retained or subject to specific geotechnical design.

All slopes should be periodically monitored during construction for signs of instability and excessive erosion, and, where necessary, corrective measures should be implemented to the satisfaction of a suitably qualified Chartered Professional Engineer.

No seepage was encountered during any of the test pits and hence groundwater is unlikely to be encountered during excavations. However, a geotechnical or civil engineer should inspect any seepage, spring flow or under-runners if they are encountered during construction.

The soils are anticipated to be excavated by conventional methods, however boulders are likely to be encountered within the glacial till and outwash gravels.

5.4.1 Cut Slopes in Soil Materials

Table 2 summarises the recommended batter angles for temporary and permanent slopes up to 9 m high, which are formed in the soil materials identified at the site.

Table 2 Recommended maximum batter angles for cut slopes up to 9 m high in site soils.

Material Type	Recommended Maximum Batter Angles for Temporary Cut Slopes Formed in Soil (horizontal to vertical)		Recommended Maximum Batter Angles for Permanent Cut Slopes Formed in Soil – dry ground only (horizontal to vertical)
	Dry Ground	Wet Ground	
Topsoil/Loess	2H: 1V	3H: 1V	3H: 1V
Colluvium	1.5H: 1V	2.5H: 1V	2.5H: 1V
Glacial Till and Outwash	1H: 1V	2H: 1V	2H: 1V

5.5 Engineered Fill Slopes

All fill should be placed and compacted in accordance with the recommendations of NZS4431: 1989 and Queenstown Lakes District Council Standards. All cut and fill earthworks should be inspected and tested as appropriate during construction and certified by a Chartered Professional Engineer.

All un-retained fill slopes which are less than 6.0 m high should be constructed with a batter slope angle of 2.0H: 1.0V (horizontal to vertical) or flatter and be benched into sloping ground.

Reinforced earth slopes can be considered if batters need to be steeper than 2H:1V.

6 Engineering Considerations

6.1 Ground Retention

All retaining walls should be designed by a Chartered Professional Engineer using the geotechnical parameters recommended in Table 1 of this report. Due allowance should be made during the detailed design of all retaining walls for forces such as surcharge due to the sloping ground surface behind the retaining walls, groundwater, seismic and traffic loads.

All temporary slopes for retaining wall construction should be battered in accordance with the recommendations outlined in Table 2 of this report. Where these batter slopes cannot be achieved temporary retaining will be required.

No groundwater seepage was observed during investigations, but infiltration of surface water behind retention structures, in particular as a result of heavy or prolonged rainfall, can occur. To ensure potential water seepage or flows are properly controlled behind retaining walls, the following recommendations are provided:

- A minimum 0.3 m width of durable free draining granular material should be placed behind all retaining structures;
- A heavy duty non-woven geotextile cloth, such as Bidim A14, should be installed between the natural ground surface and the free draining granular material to prevent siltation and blockage of the drainage media;
- A heavy-duty (TNZ F/2 Class 500) perforated pipe should be installed within the drainage material at the base of all retaining structures to minimise the risk of excessive groundwater pressures developing. This drainage pipe should be connected to the permanent piped storm water system, and;
- Comprehensive waterproofing measures should be provided to the back face of all retaining walls forming changes in floor level within the dwelling to minimise groundwater seepage into the finished buildings.

It is recommended that the retaining wall excavation batters are inspected by a suitably qualified and experienced Geotechnical Engineer or Engineering Geologist.

6.2 Slope Stability

No evidence of existing slope instability was identified during our walkover inspection of the site. Earthworks plans have been provided to GeoSolve. Slope stability is not considered to be an issue for this development assuming the recommendations of Section 5 are implemented during construction.

6.3 Groundwater Issues

The regional water table is expected to lie at depth below any future foundation levels and is not expected to be encountered during any future construction on this site. Dewatering or other groundwater-related construction issues are therefore unlikely to be required.

It is important that a geotechnical engineer be contacted should there be any seepage, spring flow or under-runners encountered during construction.

6.4 Foundation Considerations

Topsoil and loess should be stripped from the buildable areas. Foundation loads will be transferred to the outwash gravel and glacial till deposits or engineered fill in most cases.

All unsuitable soil materials identified in foundation excavations, particularly those softened by exposure to water, should be undercut and replaced with engineered fill during foundation construction. Any fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS 4431:1989 and certification provided to that effect.

To minimise the effects of freeze-thaw cycles in footings founded on soil, all shallow foundations should be founded a minimum of 0.4 m below the adjacent finished ground surface.

Figure 2 summarises the recommended working stresses for shallow footings, which bear upon glacial till, outwash gravel and engineered fill. It should be noted the foundation working stresses presented on Figure 2 are governed by bearing capacity in the case of narrow footings and settlement in the case of wide footings.

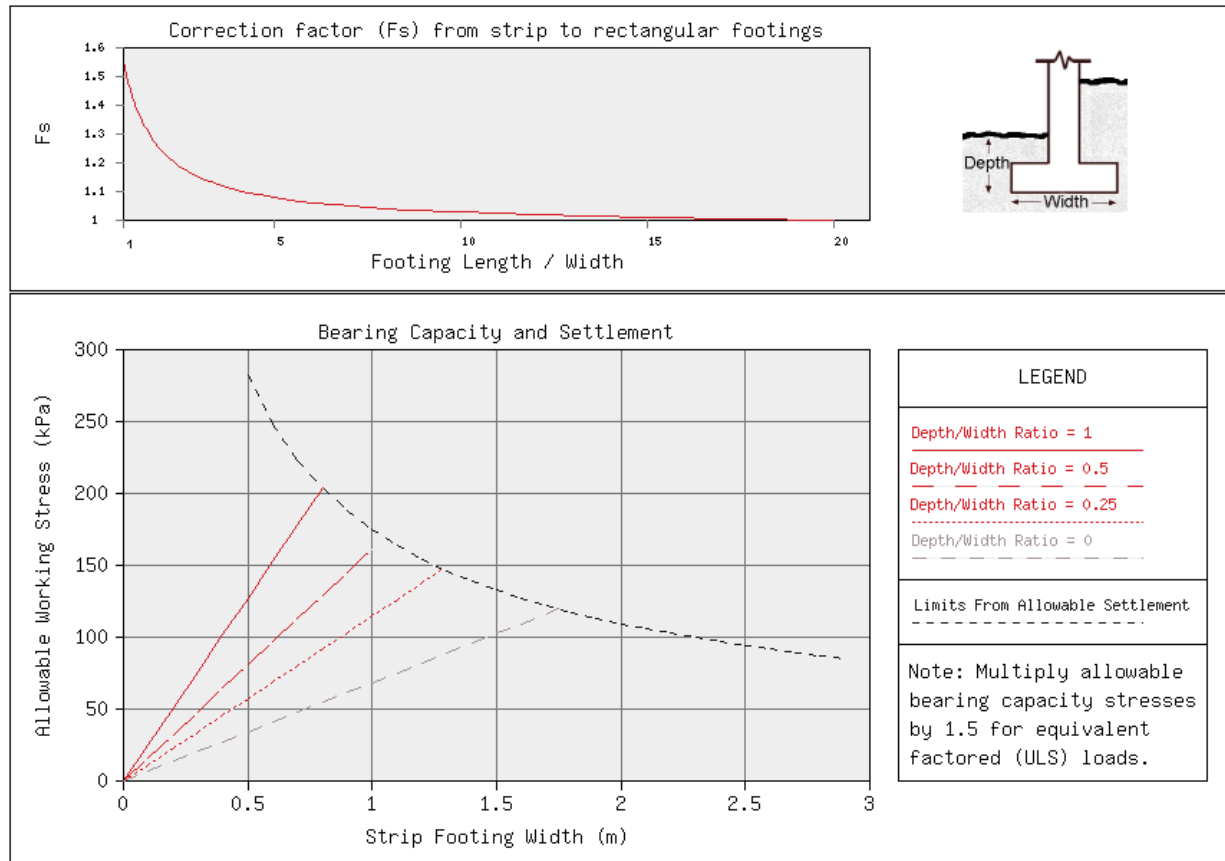


Figure 2. Recommended Bearing for Shallow Footings on Glacial Till, Outwash Gravel and Engineered Fill.

From Figure 2 it can be seen an allowable working stress of approximately 100 kPa is recommended for a 400 mm wide by 400 mm deep strip footing founded within glacial till, outwash gravel and engineered fill. This corresponds to a factored (ULS) bearing capacity of approximately 150 kPa and an ultimate geotechnical bearing capacity of 300 kPa.

Inspection and testing (dynamic probe/Scala penetrometers) should be completed along footing alignments during construction to confirm the above values are applicable and that the soil has not been softened by weather or excavation, particularly in the glacial till. Plate compaction or rolling is recommended following building platform and footing excavation.

6.4.1 Outwash Sand and Colluvium Bearing

Thin lenses of outwash sand and silty sand and colluvium have been observed in test pits. If substantial outwash sand and silty sand or colluvium is observed under a buildable area the bearing capacity should be assessed on a case by case basis. Colluvium was observed to underlie the topsoil and loess in all test pits to depths of between 0.5 and 1.3 m bgl. This should be evaluated where engineered fill earthworks have not been completed.

6.5 Settlement

Settlement and differential settlement of shallow foundations are expected to be within structurally acceptable limits provided the recommendations of Section 6.4 and 6.4.1 are followed and all unsuitable materials, particularly those softened by water, are undercut and replaced with engineered fill during construction.

6.6 Site Subsoil Category

For detailed design purposes it is recommended the magnitude of seismic acceleration be estimated in accordance with the recommendations provided in NZS 1170.5:2004.

The site is "Class D" (Deep soil site) in accordance with NZS 1170.5:2004 seismic provisions. The soil parameters for static conditions given above require no downgrading for seismic bearing. The soil materials are not subject to liquefaction or other strength loss on cyclic loading.

7 Neighbouring Structures/Hazards

Natural Hazards: Known seismic hazards affecting the development are detailed in Section 4.1 and appropriate allowance should be made for seismic loading during detailed design of the future building, foundations, and retaining walls. The development is not located within any mapped slope instability features, liquefaction susceptibility areas or any other hazard features on the QLDC or GeoSolve databases. There is no liquefaction risk due to the depth to groundwater and observed relative density of the site subsoils.

Flooding has not been assessed as part of this assessment, although assuming natural drainage paths are controlled following earthworks this is not considered a risk. The development is significantly higher than the closest body of flowing water that runs to the north of the site.

Distances to adjoining structures: No adverse geotechnical implications apply for neighbouring properties during construction provided appropriate vibration and dust mitigation measures are taken during construction.

Aquifers: No aquifer resource will be adversely affected by the development.

Erosion and Sediment Control: The site presents some potential to generate silt runoff during heavy rainfall events and this would naturally drain downslope. Effective systems for erosion control are runoff diversion drains and contour drains, while for sediment control, options are earth bunds, silt fences, hay bales, vegetation buffer strips and sediment ponds.

Noise: It is expected that conventional earthmoving equipment, such as excavators, trucks and rollers will be required during construction. The earthworks contractor should take appropriate measures to control the construction noise, and ensure QLDC requirements are met in regard to this issue.

Dust: Regular dampening of soil materials to meet QLDC standards should be completed where required.

Vibration: No vibration induced settlement is expected in these soil types. The effects of vibrations from rollers and plate compactors on adjacent structures will need to be considered if fill is compacted within 10 m of an existing structure.

8 Conclusions and Recommendations

- The site is underlain by surficial topsoil, loess and colluvium, which overlies outwash sand and gravel and glacial till, which extends to at least 4 m beneath the surface of the subdivision.
- No groundwater seepage was observed during site investigations and therefore it is unlikely to be encountered during earthworks.
- No evidence of existing slope instability has been identified on site. Earthworks plans have been developed by Paterson Pitts Group that include cuts of up to 8.7 m and engineered fills of up to 5.8 m. Assuming cut and fill slopes are implemented as per Section 5 of this report slope stability is not considered to be an issue.
- Bearing on the site will predominantly be governed by the outwash gravel, glacial till and engineered fill. The outwash gravel, glacial till and engineered fill will provide good bearing (100 kPa allowable), for 400 mm wide by 400 mm deep shallow footings.
- Foundation bearing capacity on outwash sand and colluvium will need to be assessed on a case by case basis if not re-worked as engineered fill as part of the bulk earthworks.
- Recommendations for temporary and permanent batter slope angles are described in Table 2. Slopes that are required to be steeper than those described should be structurally retained or subject to specific geotechnical design.
- All retaining walls should be designed by a Chartered Professional Engineer using the geotechnical parameters recommended in Table 1 of this report.
- The colluvium, glacial till and outwash soils are considered suitable for use as engineered fill (in accordance with an earthfill specification).
- Loess soil will need to be mixed with granular soils prior to use as an engineered fill source.
- In areas where significant amounts of cobbles over 100 mm are observed the material should be blended with fine grained soil materials to create a well graded fill.
- All unsuitable soils identified in foundation excavations, particularly those softened by exposure to water, should be undercut and replaced with engineered fill during construction.
- Any fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS 4431:1989 and certification provided to that effect.
- For detailed design purposes it is recommended that the site is classified “Class D – Deep subsoil” in accordance with NZS 1170.5:2004 seismic provisions.
- A Chartered Professional Engineer should inspect all excavations, batters and spring flow or under-runners that may be encountered during construction.

9 Applicability

This report has been prepared for the benefit of Northlake Investments Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

It is important that we be contacted if there is any variation in subsoil conditions from those described in this report.

Please don't hesitate to contact the undersigned if we can provide any further assistance with this project.

Report prepared by:

A handwritten signature in black ink, appearing to read 'Mike Plunket'.

.....
Mike Plunket

Geotechnical Engineer

Reviewed for GeoSolve Ltd by:

A handwritten signature in black ink, appearing to read 'Graeme Halliday'.

.....
Graeme Halliday

Senior Engineering Geologist

Reviewed for GeoSolve Ltd by:

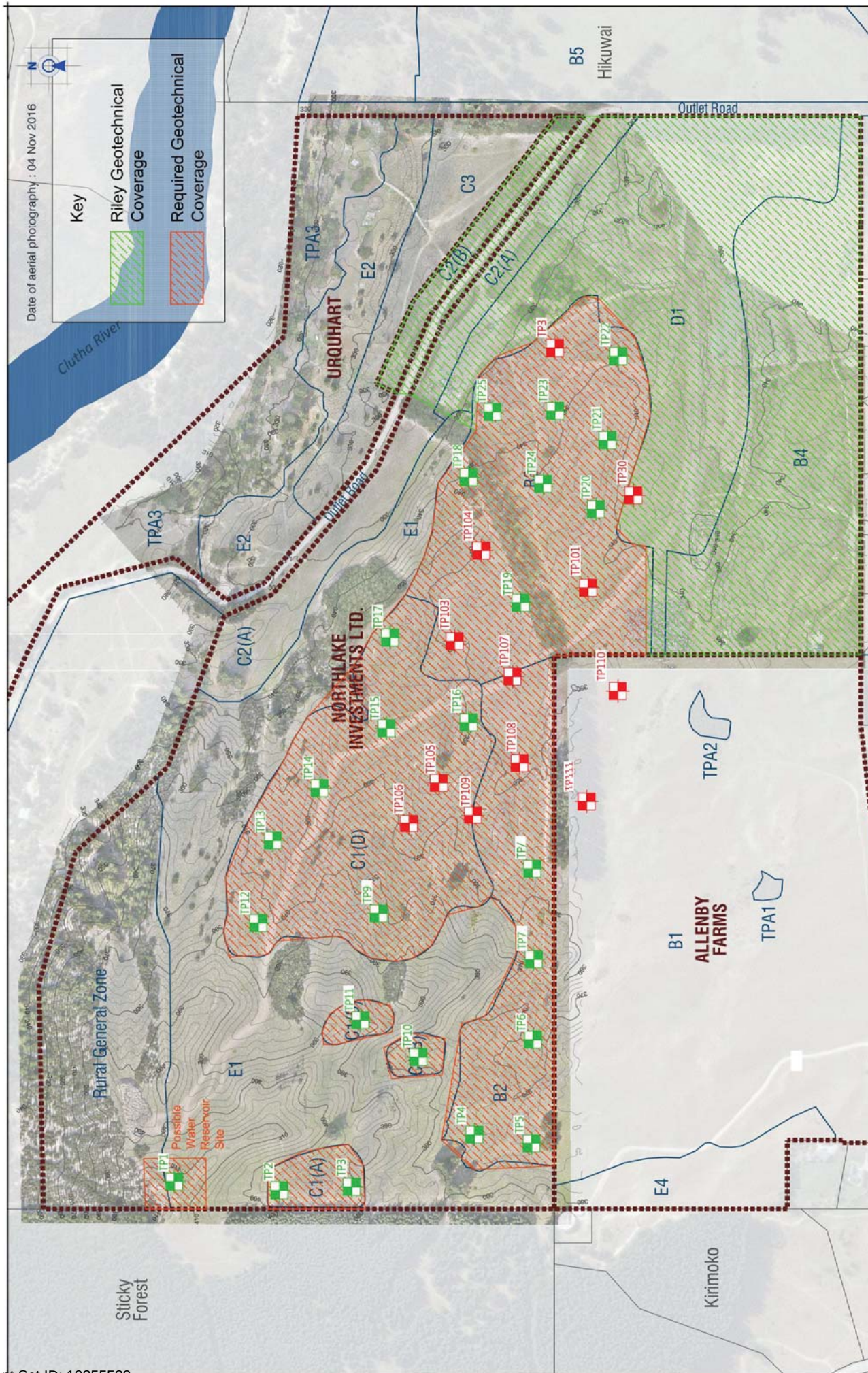
A handwritten signature in black ink, appearing to read 'Fraser Wilson'.

.....
Fraser Wilson

Senior Engineering Geologist

GeoSolve Ltd

Appendix A: Site Investigation Plan



PATERSONPITTSGROUP
Your Land Professionals
www.ppgroup.co.nz
0800 PPGROUP

Client & Location:
NORTH LAKE
v 3.14.1.2

Purpose & Drawing Title:
**Overview
Geotechnical Coverage**

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Drawn by:	LMV	Original Size:	A3	Scale:	1:5000 @ A3
Checked by:	MJB				
Approved by:	AST				
Job No.	W481-7	Drawing No.	078	Sheet No.	101
				Revision No.	0
				Date Created	23/05/2017

Appendix B: Investigation Data



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 1

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brownish grey, sandy SILT. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	LOESS
		0.9		Brown, sandy gravelly SILT. Gravel is fine to coarse. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
	NO SEEPAGE	3.8		Grey, silty SAND with some gravel and sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 2

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.2		organic SILT with some rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, sandy SILT with some gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.2		Grey, silty SAND with some gravel and a trace of boulders. Sand is fine to medium. Boulders up to 250mm. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3.2 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 3

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, silty SAND with minor boulders. Sand is fine to coarse. Boulder to 900mm. Silt is non-plastic. Loose.	Moist	COLLUVIUM
	NO SEEPAGE	3.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 4

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brown, sandy SILT. Sand is fine to medium. Silt is non-plastic. Firm.	Moist	LOESS
		0.8		Light brown/orange, silty SAND with some gravel to gravelly silty SAND. Sand is fine to coarse.. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		2.1		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.0		Grey, cobbly gravelly silty SAND. Gravel is fine to coarse. Sand is fine to medium. Schist and greywacke present in unit cobbles to 150mm. Silt is non-plastic. Dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 5

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brown, gravelly SILT. Gravel is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		0.7		Brown/grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse. Gravel sub-angular to sub-rounded. Medium dense.	Moist	OUTWASH GRAVEL
		1.4		Grey, silty SAND. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		1.5		Grey, SAND with minor gravel. Sand is fine to coarse. Medium dense.	Moist	OUTWASH SAND
		2.7		Grey, sandy GRAVEL and gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse. Medium dense.	Moist	OUTWASH SAND & GRAVEL
	NO SEEPAGE	3.1		Grey, gravelly silty SAND. Sand is fine to medium. Gravel is fine to coarse. Silt is non-plastic. Dense to medium dense.	Moist	GLACIAL TILL

Total Depth = 3.1 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 6

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, silty GRAVEL. Gravel is fine to coarse. Sub-rounded to sub-angular. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		0.9		Grey, silty SAND. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		2.2		Grey/brown, SAND and sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse. Gravel is sub-angular to sub-rounded. Medium dense.	Moist	OUTWASH SAND & GRAVEL
		3.2		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.2 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 7

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, sandy SILT. Sand is fine to medium. Silt is non-plastic. Firm.	Moist	LOESS
		1.1		Brown, silty GRAVEL. Gravel is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		1.6		Grey, SAND with some gravel and silt. Sand is fine to medium. Medium dense.	Moist	GLACIAL TILL
		2.4		Grey, sandy GRAVEL with some cobbles and boulders. Sand is fine to coarse. Gravel is fine to coarse. Boulders up to 500mm. Medium dense.	Moist	OUTWASH GRAVEL
	NO SEEPAGE	3.0		Grey, silty SAND to SAND with some silt and gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 8

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, sandy SILT minor gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.8		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 9

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.8		Brown, sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		2.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.1		Grey, silty sandy GRAVEL with minor boulders and some cobbles. Sand is fine to medium. Gravel is fine to coarse. Boulders up to 300mm. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.1 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 10

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown/orange, sandy SILT with some gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
	NO SEEPAGE	3.8		Grey, silty SAND with some gravel. 300 mm sand with some silt at 0.9 m. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT: Hole stood well during excavation.

Logged By: GSH/MDP

Checked Date:

Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 11

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, silty SAND with some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.6		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.6 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 12

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, sandy SILT. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	LOESS
		1.3		Brown, silty SAND with minor gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		1.8		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		2.1		Grey, gravelly silty SAND to sandy silty GRAVEL. Gravel is fine to coarse. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
		3.8		Grey/brown, silty SAND with minor gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 13

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		organic SILT with roots and rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.8		Brown, sandy SILT with some gravel and minor rootlets. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		2.3		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.0		Grey, sandy silty GRAVEL with some cobbles and boulders to cobbly sandy silty GRAVEL with some boulders. Sand is fine to coarse. Gravel is fine to coarse. Gravel is sub-rounded to sub-angular. Boulders up to 500mm. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 14

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown/orange, silty SAND with gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.7		Grey, silty SAND with minor to some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.7 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 15

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brown, silty SAND with some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.0		Grey, silty SAND with some gravel to sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense to very stiff.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 16

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with rootlets. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, silty SAND with some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		1.3		Grey, sandy GRAVEL and gravelly SAND with some cobbles and boulders. Gravel is fine to coarse. Sand is fine to coarse. Boulders up to 300mm. Medium dense.	Moist	OUTWASH GRAVEL
		3.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.5		Grey, silty sandy GRAVEL with some cobbles and minor boulders. Sand is fine to medium. Gravel is fine to coarse. Boulders up to 200mm. Silt is non-plastic. Medium dense to dense.	Moist	GLACIAL TILL

Total Depth = 3.5 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 17

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, gravelly SILT with some sand. Gravel is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
	NO SEEPAGE	3.8		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.8 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd

EXCAVATION LOG

EXCAVATION NUMBER:

TP 18

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, gravelly SILT with some sand. Gravel is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL
	NO SEEPAGE	3.0		Grey, gravelly silty SAND. Gravel is fine to coarse. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 19

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, silty SAND with some to minor gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.5		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.5 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 20

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.6		Brown, silty SAND with some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.6		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.6 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 21

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, silty SAND some gravel. Sand is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
		3.3		Grey, silty SAND and sandy SILT with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense/very stiff.	Moist	GLACIAL TILL

Total Depth = 3.3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 22

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT with roots. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, gravelly silty SAND. Sand is fine to coarse. Gravel is fine to coarse. Silt is non-plastic. Loose.	Moist	COLLUVIUM
	NO SEEPAGE	3.6		Grey, silty SAND with minor to some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.6 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 23

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.2		organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.7		Brown, sandy SILT with some gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.3		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 24

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		0.5		Brown, sandy SILT with minor gravel. Sand is fine to coarse. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.2		Grey, silty SAND with minor to some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3.2 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:

TP 25

PROJECT: NorthlakeStage2		Job Number: 170372	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING:	mE	EQUIPMENT: 5T	OPERATOR: Ethan
NORTHING:	mN	INFOMAP NO.	COMPANY: Diverse Works
ELEVATION:	m	DIMENSIONS:	HOLE STARTED: 7-Jun-17
METHOD:		EXCAV. DATUM:	HOLE FINISHED: 7-Jun-17

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
						SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, organic SILT. Silt is non-plastic.	Moist	TOPSOIL
		1.1		Brown, sandy SILT with some gravel and schist clasts. Sand is fine to coarse. Schist to 700mm. Silt is non-plastic. Firm.	Moist	COLLUVIUM
		3.0		Grey, silty SAND with some gravel. Sand is fine to medium. Silt is non-plastic. Medium dense.	Moist	GLACIAL TILL

Total Depth = 3 m

COMMENT:	Logged By: GSH/MDP
	Checked Date:
	Sheet: 1 of 1



4.0 Proposed Liquefaction Categories and Mapping

Liquefaction Investigation Categories (LIC) have been developed to provide guidelines on the liquefaction risk and recommended level of further investigation for a particular area. The categories range from LIC 1, for areas with an assessed low to nil risk of liquefaction, to LIC 3 (P), for areas which are assessed to have a 'possibly high' risk of liquefaction. The different categories reflect the level of information available for a particular area, and, where feasible, if liquefaction is expected to occur. Guidelines on the minimum requirements for ground investigation, and general comments/recommendations are also provided for each category.

Full details of the proposed liquefaction categories are provided on the attached table.

5.0 Department of Building and Housing Guidelines

This assessment correlates closely with work undertaken in Canterbury following the 2010 and 2011 earthquake events. In Canterbury a method to categorise the land based on the potential for vertical settlement and lateral spread (liquefaction deformation limits) has been developed. Department of Building and Housing (DBH) guidelines identify Technical Categories TC1, TC2 and TC3 with respect to ground movement in the Canterbury area, and also identify the minimum requirements for site investigation and appropriate methodologies for liquefaction analysis. (These 3 categories relate to the corresponding Liquefaction Investigation Categories.)

The engineering requirements outlined by the DBH are considered appropriate for use in the Queenstown Lakes District and reference should be made to the DBH document "Guidelines for the investigation and assessment of sub-divisions on the flat in Canterbury – Minimum requirements for geotechnical assessment for land development ('flatland areas' of Canterbury region).

6.0 Limitations

The information presented on the attached table and maps is limited by the availability of actual ground investigation data. It should be noted that the information used in this assessment was obtained in discrete locations and was not always obtained specifically for the purposes of completing liquefaction assessment work. A certain level of extrapolation was therefore required to determine the extent of the zones shown on the attached maps. It is therefore possible that areas at risk of liquefaction exist outside the mapped areas, and the mapped areas may be subject to a change of category if further ground investigation data becomes available.

The summary maps are provided to give a quick overview of the mapped areas only. It is recommended that the QLDC GIS mapping be consulted for actual assessments of any particular area.

7.0 Further Work

Specific geotechnical investigations would be required to further refine the mapping and extents of the categories as shown on the attached summary maps. All investigations should be completed in accordance with the DBH guidelines and are likely to comprise a combination of the following:

- Field mapping;
- Test pitting;
- SWS (Swedish Weight Sounding) testing
- Heavy Dynamic Cone Penetrometer testing
- Cone Penetrometer testing, and;
- Geotechnical drilling with standard penetration testing.

It should be noted that field mapping and test pitting can only assess the ground at shallow depths and are therefore only suitable in limited cases for the purposes of assessing liquefaction potential. In accordance with the DBH requirements, light penetrometer testing (Scala) is not considered appropriate to be the primary method to determine the liquefaction potential. Appropriate ground investigation techniques are outlined in the DBH document "Guidelines for the investigation and assessment of sub-divisions on the flat in Canterbury – Minimum requirements for geotechnical assessment for land development ('flatland areas' of Canterbury region).

Site investigations should extend to sufficient depth to identify potentially liquefiable formations that may lie beneath surficial deposits such as beach gravels and alluvium.

Refining the maps on an on-going basis may be feasible as ground investigations are periodically completed across the Lakes District area for private developments, however this approach is likely to take many years to address problem areas.

8.0 Applicability

This report has been prepared for the benefit of Queenstown Lakes District Council with respect to the particular brief given to us and may not be relied upon in other contexts or for any other purpose without our prior written review and agreement.

TONKIN & TAYLOR LTD
Environmental & Engineering Consultants

Report Prepared By:



.....
Paul Faulkner
Engineering Geologist

Authorised for Tonkin & Taylor Ltd by:



.....
Graham Salt
Project Director, Dunedin Group Manager

Attachments: Table detailing the Categories for the Liquefaction Mapping
Summary Maps of the Queenstown, Wanaka, Glenorchy and Kingston areas

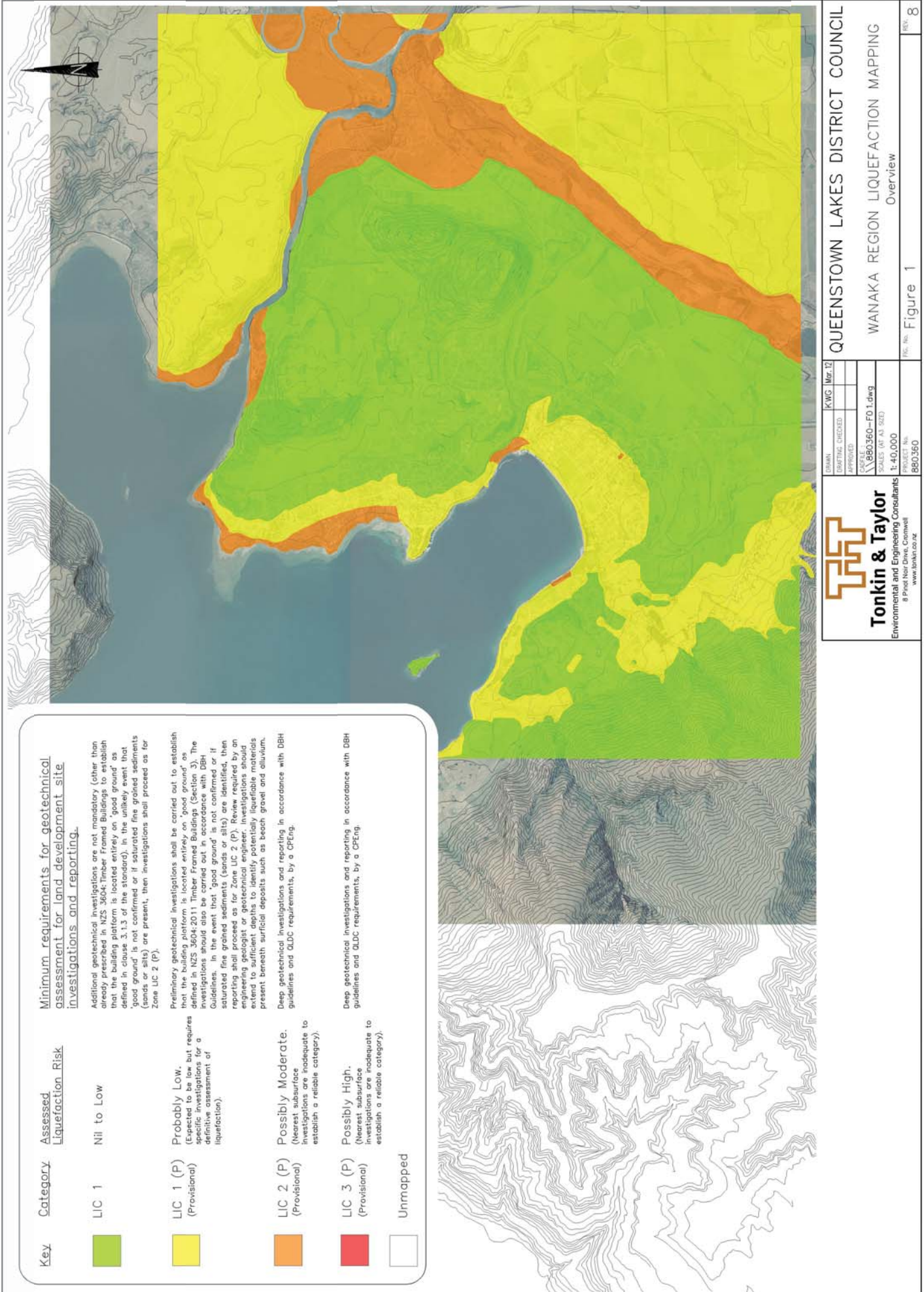
4-Apr-13
p:\880360\qldc hazards\workingmaterial\880360.00 lr001 gas rev.docx

Table showing the Categories for the Liquefaction Mapping, related to DBH requirements in response to Canterbury earthquakes

Liquefaction Investigation Category	Level of Data Available	Assessed Liquefaction Risk	Minimum requirements for geotechnical assessment for land development site investigations and reporting.	Comments	Probable Foundation Solution
LIC 1	Good knowledge of subsurface conditions from nearby sites in same geological terrain with no reported hazards.	Nil to Low	Additional geotechnical investigations are not mandatory (other than already prescribed in NZS 3604: Timber Framed Buildings) to establish that the building platform is located entirely on good ground as defined in clause 3.1.3 of that standard). In the unlikely event that good ground is not confirmed or if saturated fine grained sediments (sands or silts) are present, then investigations shall proceed as for Zone LIC 2 (P).	Corresponds to DBH Technical Category 1 adopted for liquefaction following the Canterbury earthquakes. (LIC 1: Land damage from liquefaction is unlikely, and seismic ground deformations are expected to be within normally accepted tolerances.) Detailed investigations may still be required for non liquefaction related geotechnical aspects of the development, e.g. soft ground, deep cuts, fill placement, retaining wall design etc.	Use foundations as detailed in NZS 3604:2011 Timber Framed Buildings, as modified by B1/AS1 which requires ductile reinforcing in slabs (refer to the DBH's information sheet at http://www.dbh.govt.nz/seismicity-info)
LIC 1 Provisional LIC 1 (P)	Surrounding sites investigated with generally no reported hazards but there is limited ability to project stratigraphy because of variable geomorphology or distance from sites with subsurface investigations.	Probably Low. (Expected to be low but requires specific investigations for a definitive assessment of liquefaction).	Investigations shall be in accordance with NZS 3604: Timber Framed Buildings and with DBH Guidelines (see Note 1 below). In the event that good ground is not confirmed or if saturated fine grained sediments (sands or silts) are identified, then reporting shall proceed as for Zone LIC 2(P). Review required by an engineering Geologist or geotechnical engineer. Site investigations should extend to sufficient depth to identify potentially liquefiable formations that may lie beneath surficial deposits, such as beach gravels. If lake silts or sands, or other materials prone to liquefaction are identified then proceed to LIC2 (P).	LIC 1 is probable but uncertain. Depths of investigation may be reduced once stratigraphy is demonstrated to be consistent with surrounding sites.	If LIC 1 is confirmed, use foundations as detailed in NZS 3604:2011 Timber Framed Buildings, as modified by B1/AS1 which requires ductile reinforcing in slabs http://www.dbh.govt.nz/seismicity-info
LIC 2 (P)	Marginal to moderate liquefaction conditions identified elsewhere in the vicinity in similar terrain.	Possibly Moderate. (Nearest subsurface investigations are inadequate to establish a reliable category)	Deep geotechnical investigations and reporting in accordance with NZS 3604, DBH guidelines (see Note 1) and QLDC requirements, by a Certified Professional Engineer (CPEng).	LIC 2 is possible. (LIC 2: Minor to moderate land damage from liquefaction is possible in future large earthquakes.) Independent peer review recommended if any report recommends a solution without a recognised solution for liquefaction.	If LIC 2 is confirmed, use light- or medium-weight cladding, light-weight roofing with suspended timber floors and foundations in accordance with NZS 3604 Or Use foundation with enhanced slab (DBH Options 1 to 4, http://www.dbh.govt.nz/seismicity-info)
LIC 3 (P)	Severe liquefaction conditions identified elsewhere in similar terrain	Possibly High. (Nearest subsurface investigations are inadequate to establish a reliable category)	Deep geotechnical investigations and reporting in accordance with NZS 3604, DBH guidelines (see Note 1) and QLDC requirements, by a recognised geotechnical practitioner (CPEng).	LIC 3 is possible. (LIC 3: Moderate to significant land damage from liquefaction is possible in future large earthquakes) Independent peer review recommended.	If LIC 3 is confirmed, specific geotechnical engineering design required. Ground improvement or deep piles if suitable bearing layer <10 m. Slab support also required.

Notes

- 1) In view of the significance of the Alpine Fault to Queenstown, liquefaction considerations should now acknowledge procedures recently adopted in Canterbury. Engineering requirements should therefore be as in the Department of Building and Housing document "Guidelines for the investigation and assessment of subdivisions on the flat in Canterbury - minimum requirements for geotechnical assessment for land development ('flatland areas' of the Canterbury region)" <http://www.dbh.govt.nz/subdivisions-assessment-guide>
- 2) DBH requires that for each individual site, "visual assessment and reasonable enquiry does not suggest that the original classification (for liquefaction) is inappropriate and that normal geotechnical investigations are undertaken for the purposes of evaluating all other potential geotechnical issues". For areas not yet categorised for liquefaction, site specific investigations are required. Note that DBH considers: "Scala Penetrometer testing (refer NZS 4402:1998 Test 6.5.2) is often useful as a shallow investigation tool in conjunction with the methods outlined above. **However, Scala Penetrometer testing is not considered appropriate as the primary ground characterisation method for liquefaction purposes.**"
- 3) Categories assigned in these maps assume founding within a metre of 2011 ground level or higher. For deeper excavations, site specific investigations are required.
- 4) Sections of the map that are not coloured have not yet been mapped for liquefaction in relation to current DBH criteria.



Key

Category

Assessed Liquefaction Risk

LIC 1

Nil to Low

LIC 1 (P)

Probably Low.
(Expected to be low but requires specific investigations for a definitive assessment of liquefaction).

LIC 2 (P)

Possibly Moderate.
(Nearest subsurface investigations are inadequate to establish a reliable category).

LIC 3 (P)

Possibly High.
(Nearest subsurface investigations are inadequate to establish a reliable category).

Unmapped

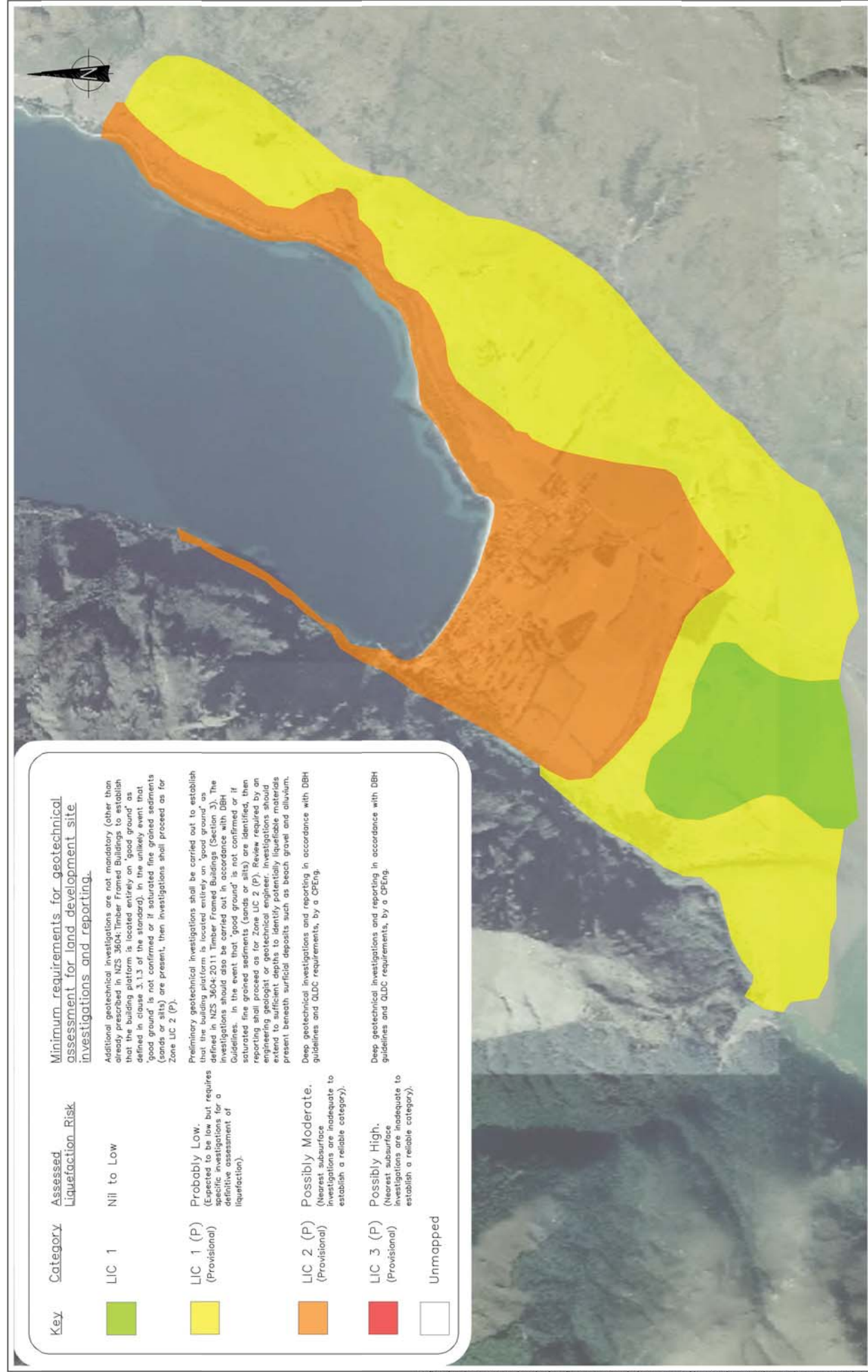
Minimum requirements for geotechnical assessment for land development site investigations and reporting.

Additional geotechnical investigations are not mandatory (other than already prescribed in NZS 3604: Timber Framed Buildings) to establish that the building platform is located entirely on 'good ground' as defined in clause 3.1.3 of the standard). In the unlikely event that 'good ground' is not confirmed or if saturated fine grained sediments (sands or silts) are present, then investigations shall proceed as for Zone LIC 2 (P).

Preliminary geotechnical investigations shall be carried out to establish that the building platform is located entirely on 'good ground' as defined in NZS 3604:2011 Timber Framed Buildings (Section 3). The investigations should also be carried out in accordance with DBH Guidelines. In the event that 'good ground' is not confirmed or if saturated fine grained sediments (sands or silts) are identified, then reporting shall proceed as for Zone LIC 2 (P). Review required by an engineering geologist or geotechnical engineer. Investigations should extend to sufficient depths to identify potentially liquefiable materials present beneath surficial deposits such as beach gravel and dune/silt.

Deep geotechnical investigations and reporting in accordance with DBH guidelines and QLDC requirements, by a CPEng.

Deep geotechnical investigations and reporting in accordance with DBH guidelines and QLDC requirements, by a CPEng.





Tonkin & Taylor

Environmental and Engineering Consultants

8 Pinet Hill Drive, Cromwell

www.tonkintaylor.co.nz

OWNER: KWG Max 13

DESIGNING: CHECKED

APPROVED:

SCALE: 1:20,000

SALES (AT A3 SIZE): 880360-F03.dwg

PROJECT No: 880360

QUEENSTOWN LAKES DISTRICT COUNCIL

QUEENSTOWN REGION LIQUEFACTION MAPPING

Overview – Kingston

REV: 2

Figure 3

