ACT Geotechnical Engineers Pty Ltd

Department of Planning
Housing and Infrastructure

Issued under the Environmental Planning and Assessment Act 1979

Approved Application No DA 22/12013

Granted on the 29 February 2024

Signed D James

Sheet No 4 of 60

BLYTON GROUP

GUTHRIE'S DOUBLE CHAIR LIFT

CHARLOTTE PASS SNOW RESORT

GEOTECHNICAL INVESTIGATION REPORT

MAY 2021

ACT Geotechnical Engineers

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5 May 2021
Our ref: JM/C11763

Blyton Group
Via email: amurdoch@blytongroup.com.au

Attention: Angela Murdoch

GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT

GEOTECHNICAL INVESTIGATION REPORT

We are pleased to present our geotechnical investigation report for the proposed Guthrie's Double Chair Lift at Charlotte Pass Snow Resort, in Charlotte Pass, NSW.

The report outlines the methods and results of field investigations, describes site subsurface conditions, and provides design and construction recommendations for the chair lift tower footings.

Should you require any further information regarding this report, please do not hesitate to contact our office.

Yours faithfully
ACT Geotechnical Engineers Pty Ltd

Jeremy Murray
Director
Senior Geotechnical Engineer
FIEAust CPEng EngExec RPEQ NER APEC Engineer IntPE (Aust)

BLYTON GROUP

GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT

GEOTECHNICAL INVESTIGATION REPORT

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GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT

GEOTECHNICAL INVESTIGATION REPORT

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BLYTON GROUP

GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT

GEOTECHNICAL INVESTIGATION REPORT

1 INTRODUCTION

At the request of Blyton Group, ACT Geotechnical Engineers Pty Ltd carried out a geotechnical investigation for the proposed Guthrie's Double Chair Lift at Charlotte Pass Snow Resort, in Charlotte Pass, NSW.

The project involves the construction of a ~500m long chair lift, which will have 7 towers spaced along the alignment. It has been indicated that each tower will be founded on a ~3m wide x ~3.3m long x 600mm deep pad footing, embedded about 1m into the ground, requiring the foundation to have an allowable bearing pressure of 200kPa. The aim of the investigation was to:

i) Identify subsurface conditions including extent and nature of any fill materials, soil strata, bedrock type and depth, and groundwater presence.
ii) Provide soil properties for each soil/rock layer
iii) Recommend suitable footing systems for the buildings including types, founding depths and allowable bearing pressures.
iv) Recommended lateral resistance parameters
v) Advise on excavation conditions and suitability of excavated materials for use as structural fill.
vi) Advise on excavation batters support.
vii) Advise on site drainage, and other relevant geotechnical issues.

2 SITE DESCRIPTION & GEOLOGY

The ~500m long chair lift starts at Charlotte Way, about 200m NE of the resort visitor's centre, and runs north up the hill and crosses Kosciuszko Road. The alignment follows the alignment of the existing Guthrie's Poma. Figure 1 shows the site locality and Figure 2 shows the profile of the proposed chair lift. The groundsurface dips south at about 10o, and is covered by grass and alpine shrubs, with many large granite outcrops. Figures 3 and 4 are recent aerial photograph showing the existing site layout and proposed chair lift alignment. Figures 9 to 11 are photos of the site taken at the time of investigation.

The 1:500,000 Monaro Geology map documents the site to be underlain by Silurian age Bullenbalong Supersuite bedrock, part of the Mowambah Granodiorite, which includes granodiorite and granite.

3 INVESTIGATION METHODS

The site investigation was conducted on 3 May 2021, comprising 4 (four) test pits, designated 1T to 4T, dug by a 5T excavator, terminating at refusal in bedrock at 1.0m/2.0m depth. The locations of the test pits are shown on Figured 2 and 3, and the detailed excavation logs are included in Appendix A.

The soil profiles were visually logged in accordance with the Unified Soil Classification System (USCS). Definitions of geotechnical engineering terms used in the report on the logs, including a copy of the USCS chart, are provided in Appendix B.

4 INVESTIGATION RESULTS

4.1 Subsurface Conditions

The subsurface conditions of the proposed development were investigated by four test pits, designated 1T to 4T. The excavation logs in Appendix A can be referred to for more detail. The investigation test pits found the subsurface profile to comprise:

Geological Profile	Typical Depth Interval	Description
TOPSOIL	0m to 0.5m/0.6m	Gravelly Silty SAND; fine to coarse sand, low plasticity silt, angular granite cobbles and boulders to 500mm size, black, grass and plant roots, dry to moist, loose.
COLLUVIAL & RESIDUAL SOIL	0.5m/0.6m to 0.9/1.9m	Gravelly Clayey SAND, Clayey SAND, & Sandy CLAY; low and medium plasticity clay, fine to coarse sand, angular granite gravel to 60mm size, occasional cobbles to 100mm size, yellow-grey, yellow-brown, orange-brown, dry to moist, medium dense or stiff.
WEATHERED BEDROCK	Below 0.9m/1.8m	GRANITE; fine to coarse grained, extremely weathered (EW), highly weathered (HW), highly to moderately weathered (HW/MW), and moderately weathered (MW), extremely weak to medium strong rock, pale yellow-grey, yellow-brown, speckled white, dry.

The depth to weathered granite bedrock is summarised in Table 1 below.

Table 1 - Depth to Bedrock

Test Pit No.	Depth to Weathered Granite Bedrock
1T	1.8m
2T	1.2m
3T	0.9m
4T	1.1m

Table 2 below shows the estimates of soil strength properties for the soil based on our visual assessment.

Table 2 - Estimate of Soil Strength Properties

Layer	Depth Interval (m)	D_d (kN/m³)	C_u (kPa)	Ø (degrees)
Colluvial & Residual Soils (stiff/medium dense)	0.5/0.6m to 0.9/1.8m	19	10	30
Weathered Granite Bedrock	Below 0.9m/1.8m	22	50	40

where,
D_d is the in-situ, dry unit weight, in kN/m^3
C_u is the cohesion, in kPa
$\varnothing$ is the internal friction angle, in degrees

4.2 Groundwater

The soils were generally dry to moist, however, a temporary perched seepage was encountered in test pit 1T at 0.6m depth. Permanent groundwater is expected to be well below footing excavation depths, however, temporary, perched seepages could occur within the more pervious soils following rainfall.

5 DISCUSSION & RECOMMENDATIONS

5.1 Footings

It has been indicated that each chair lift tower will be founded on a ~3m wide x ~3.3m long x 600mm deep pad footing, embedded about 1m into the ground.

Footing systems for the chair lift towers, dimensioned to resist anticipated overturning moments can include:

- multiple or single monolithic pad footing, founding in overburden soils or weathered bedrock (but preferably in bedrock).
- Bored piers socketing deeper into the stronger bedrock

Recommended allowable end-bearing pressures and shaft adhesion values for various footing systems are provided in Table 3 below.

Table 3 - Recommended Allowable End-bearing Pressures for Footings

Foundation Material Type	Depth Interval (m)	Allowable End-Bearing Pressure			Allowable Side Adhesion
		Strips	Pads	Bulk or Bored Piers	Downward Loading & Uplift
Colluvial & Residual Soils	0.5/0.6m to 0.9/1.8m	150kPa	200kPa	250kPa	20kPa / 10kPa
Weathered Granite Bedrock	Below 0.9m/1.8m	600kPa	750kPa	1000kPa	100kPa / 50kPa

All footing excavations should be inspected and approved by an experienced geotechnical engineer to confirm the foundation material and design values, and to ensure the excavations are clean and stable.

5.2 Lateral Resistance

The allowable horizontal passive resistance provided by the socketed sections of pad and pier footings in colluvial/residual soils and underlying weathered bedrock can be calculated as:

$\sigma_p = 50z$ (Colluvial & Residual soil)
$\sigma_p = 100z$ (Weathered Granite Bedrock – below 0.9m/1.8m)

where,
σ_p is the allowable passive pressure acting on the front of the footing at depth z, in kPa
z is the pad socket length below ground level, in metres

Where tower footings are located on slopes, the soils located above the toe of the slope should be assumed to provide half the lateral resistance stated above.

5.3 Excavation Conditions & Use of Excavated Materials

Proposed excavation depths for the tower footings are understood to be in the order of 1m/2m below existing ground level. Excavations would be through topsoil, colluvial/residual soils and into weathered granite bedrock. The soils and weak bedrock to ~1m/2m depth, including EW and HW bedrock can all be dug by medium-sized backhoe and excavator. However, medium strong, MW bedrock will require ripping or rock hammering to excavate.

Overburden soils generally comprise gravelly/sandy/clayey soils and are suitable for use in controlled fill construction. Any excavated bedrock can be used for controlled fill, provided it is broken down to less than 75mm maximum particle size.

Any topsoil is not typically suitable for controlled fill, but could be used in non-structural applications such as landscaping. Any predominately high plasticity clay or wet material is not suitable for controlled fill construction.

5.4 Stable Batter Slopes

Temporary site excavations to 1.5m depth can be formed near-vertical, although the loose material topsoil should be cut at 1(H):1(V). If required, deeper temporary cuts can be benched or formed at 1(H):1(V). Exposed temporary batters in soil should be protected from the weather by black plastic or similar, and should be inspected during construction by a geotechnical engineer.

Permanent cut and fill batters should be formed at no steeper than 2(H):1(V), although cut batters in weathered bedrock (if found) could be formed at 1(H):1(V). All soil cut and fill surfaces should be protected against erosion by topsoiling and grassing, or other suitable means. It is advisable that permanent batters are inspected during excavation by an experienced geotechnical engineer to confirm stability.

5.5 Earthquake Site Factor

Table 2.3 of AS1170.4 "Minimum Design Loads on Structures - Part 4: Earthquake Loads" (Reference 4) lists the earthquake acceleration coefficients for major centres to be considered in structural design. The Charlotte Pass area has an acceleration coefficient of 0.08.

Section 4 of AS1170.4 summarises the Site Subsoil Class which depends on the subsurface conditions at the site in question. A Site Subsoil Class C_e is applicable.

5.6 Drainage

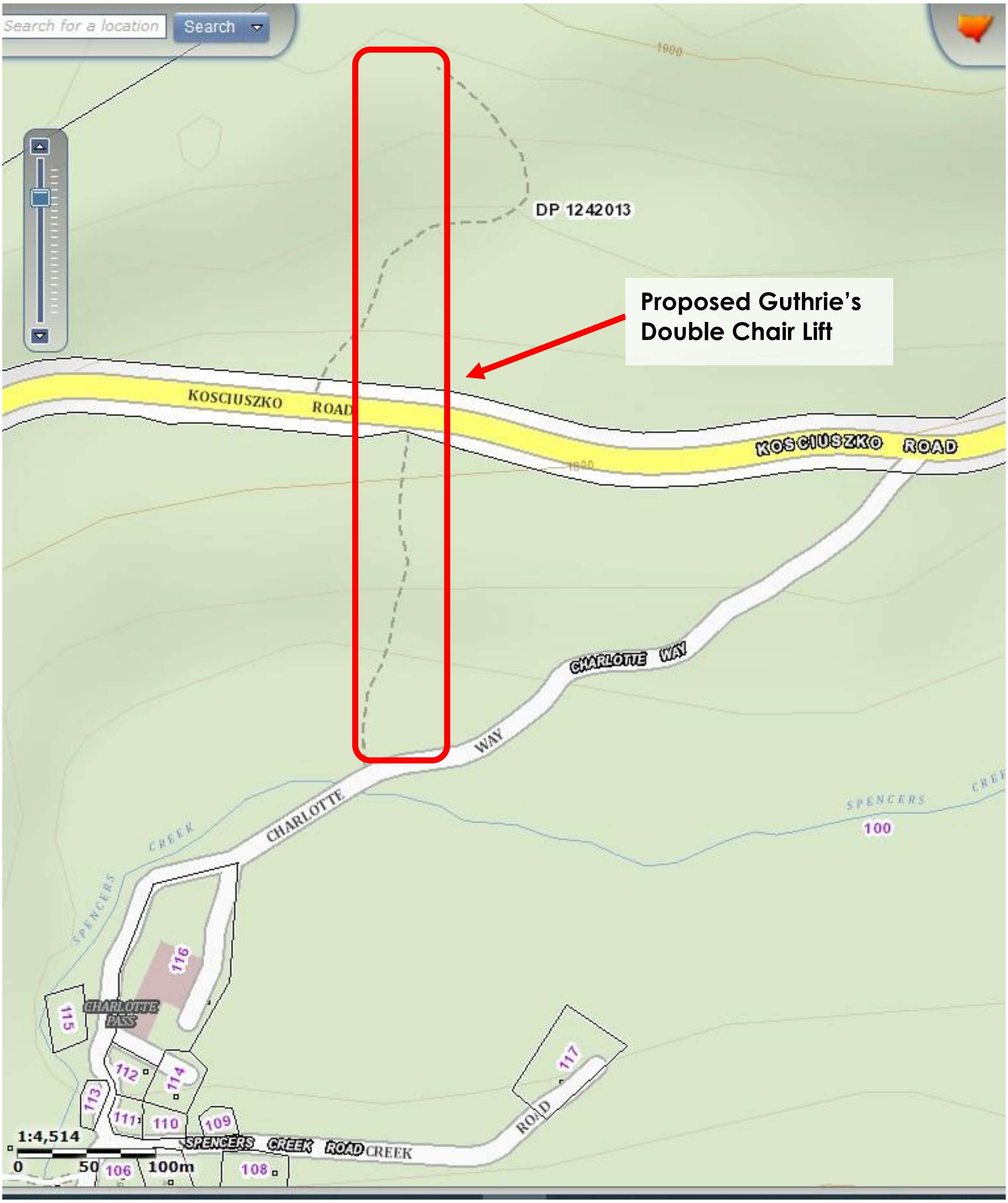
Suitable surface drainage should be provided to ensure rainfall run-off or other surface water cannot pond against concrete or steel structures.

5.7 Form 4 - Minimal Impact Certification

It is understood the site is within "Zone G" of the Kosciusko National Parks Alpine Resorts, so under the NSW Department of Planning Geotechnical Policy, a geotechnical investigation and slope instability risk assessment is required. However, as per Section 10.4 of The Policy, where only minor construction works are proposed, that present minimal or no geotechnical impact on the site or related land, then a "Form 4 - Minimal Impact Certification" can be provided instead. The completed and signed "Form 4 - Minimal Impact Certification" is attached to the end of this report.

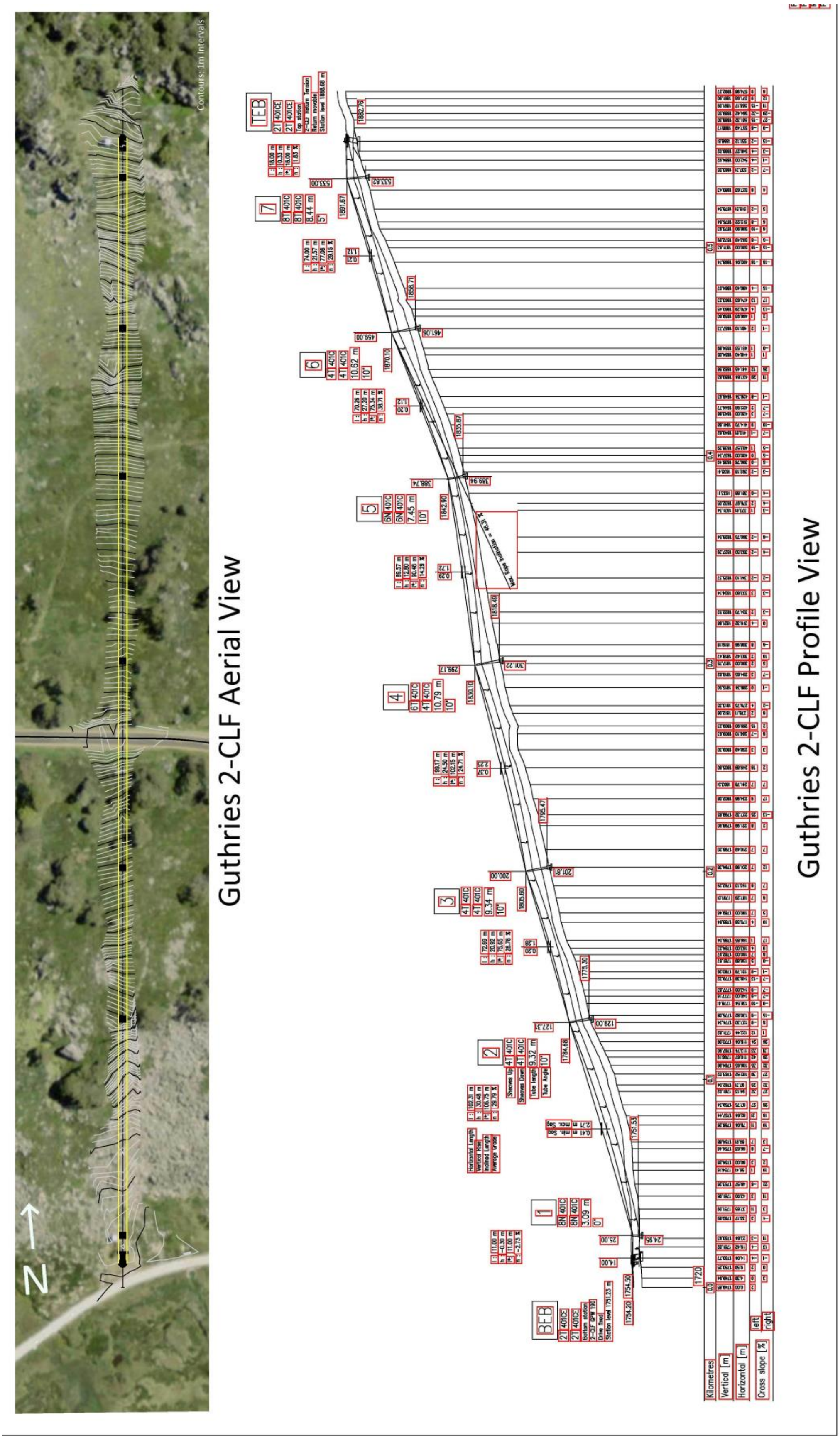
A site inspection was carried out by Jeremy Murray, an experienced, Chartered, senior geotechnical engineer, and a geotechnical investigation was conducted. Based on this, and a review of the design drawings, the following conclusions have been drawn:

- the proposed works are of such minor nature that the requirement for geotechnical advice in the form of a geotechnical report, prepared in accordance with the "Policy", is considered unnecessary for the adequate and safe design of the structural elements to be incorporated into the new works, and
- in accordance with AS2870 "Residential slabs & footings", the site is classified as a Class "S" (slightly reactive) site.



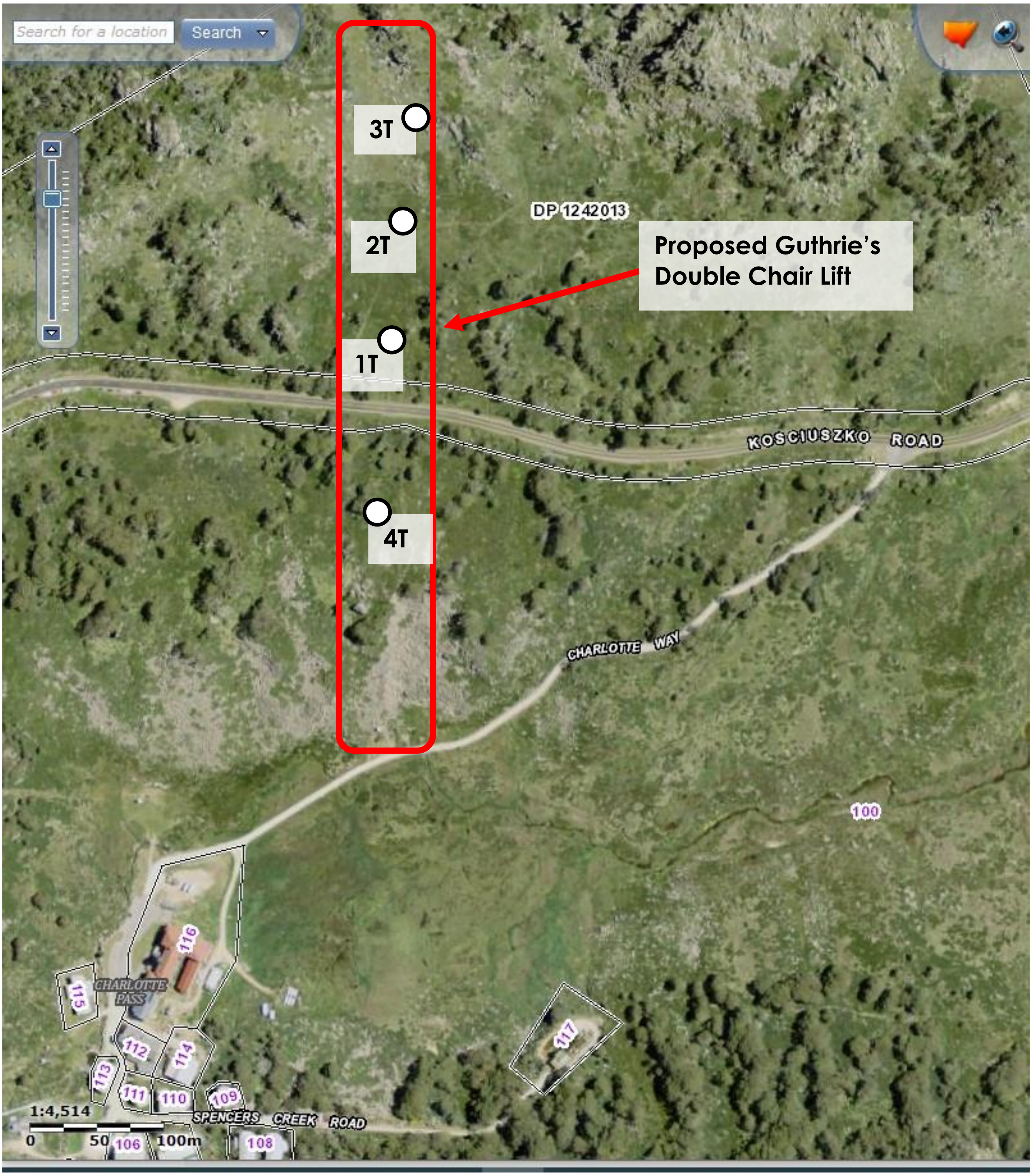
BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE LOCALITY

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 1**



BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
PROPOSED CHAIR LIFT PROFILE

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 2**

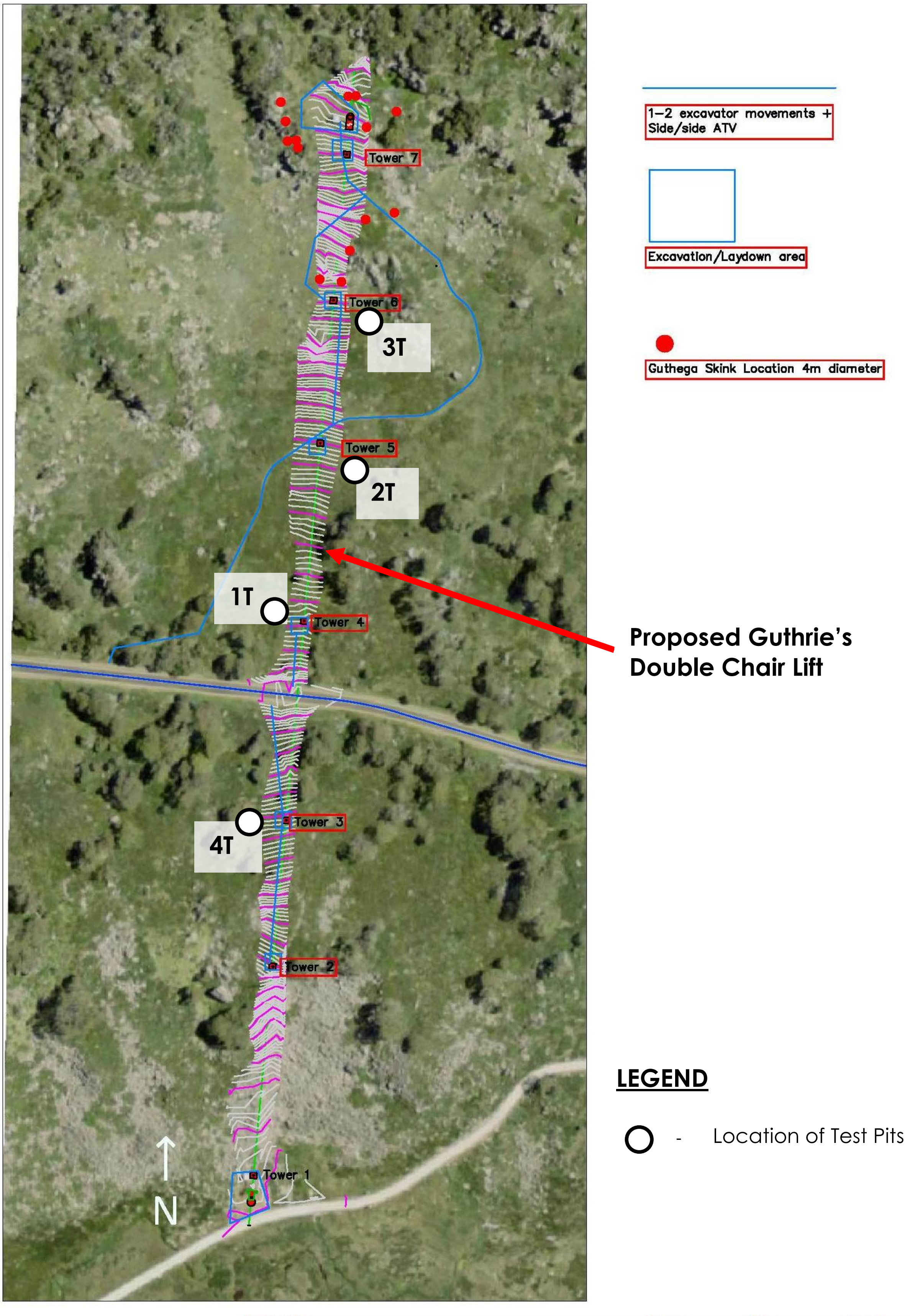


LEGEND

○ - Location of Test Pits

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
AERIAL PHOTOGRAPH & LOCATION OF TEST PITS

ACT Geotechnical Engineers Pty Ltd	C11763	FIGURE 3



LEGEND

○ - Location of Test Pits

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
LAYOUT PLAN & LOCATION OF TEST PITS

ACT Geotechnical Engineers Pty Ltd	C11763	FIGURE 4

Photo 1 – 3/5/2021 – View of the test pit 1T, showing boulder topsoil to 0.6m depth, then Gravelly Clayey Sand Colluvium to 1.1m depth, then Sandy Clay/Clayey Sand Residual Soil to 1.8m depth, underlain by weathered granite bedrock.

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO – TEST PIT 1T

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 5**

Photo 2 – 3/5/2021 – View of the test pit 2T, showing boulder topsoil to 0.5m depth, then Gravelly Clayey Sand Colluvium to 1.2m depth, underlain by weathered granite bedrock.

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO – TEST PIT 2T

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 6**

Photo 3 – 3/5/2021 – View of the test pit 3T, showing boulder topsoil to 0.6m depth, then Gravelly Clayey Sand Colluvium to 0.9m depth, underlain by weathered granite bedrock.

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO – TEST PIT 3T

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 7**

Photo 4 – 3/5/2021 – View of the test pit 4T, showing boulder topsoil to 0.5m depth, then Gravelly Clayey Sand Colluvium to 1.1m depth, underlain by weathered granite bedrock.

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GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO – TEST PIT 4T

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 8**

Photo 5 – 3/5/2021 – View of the proposed chair lift site looking south from Kosciuszko Road.

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GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 9**

Photo 6 – 3/5/2021 – View of the proposed chair lift site looking nortth from Kosciuszko Road.

BLYTON GROUP
GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 10**

Photo 7 – 3/5/2021 – View of the proposed chair lift site looking south from test pit 3T (Tower 6).

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GUTHRIE'S DOUBLE CHAIR LIFT – CHARLOTTE PASS SNOW RESORT
SITE PHOTO

ACT Geotechnical Engineers Pty Ltd	**C11763**	**FIGURE 11**

NSW GOVERNMENT | Planning & Environment

Geotechnical Policy
Kosciuszko Alpine Resorts

Form 4 – Minimal Impact Certification

DA Number: ______________________

This form may be used where minor construction works which present minimal or no geotechnical impact on the site or related land are proposed to be erected within the "G" line area of the geotechnical maps.

A geotechnical engineer or engineering geologist must inspect the site and/or review the proposed development documentation to determine if the proposed development requires a geotechnical report to be prepared to accompany the development application. Where the geotechnical engineer determines that such a report is not required then they must complete this form and attach design recommendations where required. A copy of Form 4 with design recommendation, if required, must be submitted with the development application.

Please contact the Alpine Resorts Team in Jindabyne for further information - phone 02 6456 1733.

To complete this form, please place a cross in the appropriate boxes ☐ and complete all sections.

1. Declaration made by geotechnical engineer or engineering geologist in relation to a nil or minimal geotechnical impact assessment and site classification

I,

Mr ☑ Ms ☐ Mrs ☐ Dr ☐ Other ☐

First Name	Family Name
JEREMY	MURRAY

OF

Company/organisation

ACT Geotechnical Engineers

certify that I am a geotechnical engineer /engineering geologist as defined by the "Policy" and I have inspected the site and reviewed the proposed development known as

Guthrie's Double Chair Lift – Charlotte Pass Snow Resort

As a result of my site inspection and review of the following documentation

(List of documentation reviewed)

Doppelmayr – Guthries Layout
" – Top Station Layout
" – Tubular Tower Foundation
" – Profile View

I have determined that;

- ☑ the current load-bearing capacity of the existing building will not be exceeded or adversely impacted by the proposed development, and
- ☑ the proposed works are of such a minor nature that the requirement for geotechnical advice in the form of a geotechnical report, prepared in accordance with the "Policy", is considered unnecessary for the adequate and safe design of the structural elements to be incorporated into the new works, and
- ☑ in accordance with AS 2870.1 Residential Slabs and Footings, the site is to be classified as a type

  (insert classification type)

  "S"

- ☑ I have attached design recommendations to be incorporated in the structural design in accordance with this site classification.

I am aware that this declaration shall be used by the Department as an essential component in granting development consent for a structure to be erected within the "G" line area (as identified on the geotechnical maps) of Kosciuszko Alpine Resorts without requiring the submission of a geotechnical report in support of the development application.

2. Signatures

Signature	Chartered professional status
[signature]	CPEng #2122247
Name	**Date**
Jeremy Murray	5/5/21

3. Contact details

Alpine Resorts Team
Shop 5A, 19 Snowy River Avenue
P O Box 36, JINDABYNE NSW 2627
Telephone: 02 6456 1733
Facsimile: 02 6456 1736
Email: alpineresorts@planning.nsw.gov.au

APPENDIX A

Test Pit Logs 1T to 4T

Excavation Log

Excavation No.	1T
Sheet	1 of 1
Job No.	C11763

CLIENT: BLYTON GROUP

PROJECT: GUTHRIE'S DOUBLE CHAIR LIFT
CHARLOTTE PASS SKI RESORT

Location : See Site Plan

Surface Level : Not Known

Equipment Type : 5 tonne excavator
Excavation Dimensions : 0.45m wide x 1.5m long

Samples	Water	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
					SM	GRAVELLY SILTY SAND; fine to coarse sand, low plasticity silt, angular granite cobbles and boulders to 500mm size, black, grass and plant roots, moist.	LOOSE		TOPSOIL
	slow seepage		0.6		SC	GRAVELLY CLAYEY SAND; fine to coarse sand, medium plasticity clay, angular granite gravel to 60mm size, yellow-grey, moist.	MEDIUM DENSE		COLLUVIUM
			1.0						
			1.1		CL/SC	SANDY CLAY/CLAYEY SAND; medium plasticity clay, fine to coarse sand, yellow-brown, moist.	STIFF		RESIDUAL
			1.8			EW GRANITE; fine to coarse grained, pale yellow-grey, speckled white, dry.	EXT. WEAK ROCK		EW BEDROCK
			2.0 (2)			EXCAVATION TERMINATED AT 2m AT NEAR REFUSAL IN WEATHERED BEDROCK			
			2.5						

Logged By : JM Date : 3/5/21 Checked By : Date :

Excavation Log

Excavation No.	2T
Sheet	1 of 1
Job No.	C11763
Location	See Site Plan
Surface Level	Not Known

CLIENT: BLYTON GROUP

PROJECT: GUTHRIE'S DOUBLE CHAIR LIFT
CHARLOTTE PASS SKI RESORT

Equipment Type : 5 tonne excavator
Excavation Dimensions : 0.45m wide x 1.5m long

Samples	Water	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	None Encountered		0.0–0.5		SM	GRAVELLY SILTY SAND; fine to coarse sand, low plasticity silt, angular granite cobbles and boulders to 500mm size, black, grass and plant roots, dry to moist.	LOOSE		TOPSOIL
			0.5–1.2		SC	GRAVELLY CLAYEY SAND; fine to coarse sand, medium plasticity clay, angular granite gravel to 60mm size, occasional cobbles to 100mm size, orange-brown, dry to moist.	MEDIUM DENSE		COLLUVIUM
			1.2–1.5			HW/MW GRANITE; fine to coarse grained, grey-brown, speckled white, dry.	WEAK/ MEDIUM STRONG ROCK		HW/MW BEDROCK
			1.5			EXCAVATION TERMINATED AT 1.5m AT NEAR REFUSAL IN WEATHERED BEDROCK			

Depth scale: 0.5, 1.0, 1.2, 1.5, 2.0, 2.5

Logged By : JM	Date : 3/5/21	Checked By :	Date :

BOREHOLE/EXCAVATION LOG C11763 - CHARLOTTE PASS.GPJ ACT GEO.GDT 4/5/21

Excavation Log

Excavation No.	3T
Sheet	1 of 1
Job No.	C11763

CLIENT: BLYTON GROUP

PROJECT GUTHRIE'S DOUBLE CHAIR LIFT
CHARLOTTE PASS SKI RESORT

Location : See Site Plan

Surface Level : Not Known

Equipment Type : 5 tonne excavator
Excavation Dimensions : 0.45m wide x 1.5m long

Samples	Water	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	None Encountered		0.6		SM	GRAVELLY SILTY SAND; fine to coarse sand, low plasticity silt, angular granite cobbles and boulders to 500mm size, black, grass and plant roots, dry to moist.	LOOSE		TOPSOIL
			0.9		SC	GRAVELLY CLAYEY SAND; fine to coarse sand, medium plasticity clay, angular granite gravel to 60mm size, occasional cobbles to 100mm size, yellow-brown, dry to moist.	MEDIUM DENSE		COLLUVIUM
			1.0			MW GRANITE; fine to coarse grained, yellow-brown, speckled white, dry.	MEDIUM STRONG ROCK		MW BEDROCK
			2.0			EXCAVATION TERMINATED AT 1m AT NEAR REFUSAL IN WEATHERED BEDROCK			
			2.5						

Logged By : JM	Date : 3/5/21	Checked By :	Date :

Excavation Log

Excavation No.	4T
Sheet	1 of 1
Job No.	C11763

CLIENT: BLYTON GROUP

PROJECT: GUTHRIE'S DOUBLE CHAIR LIFT
CHARLOTTE PASS SKI RESORT

Location : See Site Plan

Surface Level : Not Known

Equipment Type : 5 tonne excavator
Excavation Dimensions : 0.45m wide x 1.5m long

Samples	Water	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	None Encountered		0.0–0.5		SM	GRAVELLY SILTY SAND; fine to coarse sand, low plasticity silt, angular granite cobbles and boulders to 500mm size, black, grass and plant roots, moist.	LOOSE		TOPSOIL
			0.5–1.1		SC	GRAVELLY CLAYEY SAND; fine to coarse sand, medium plasticity clay, angular granite gravel to 60mm size, occasional cobbles to 100mm size, yellow-brown, dry to moist.	MEDIUM DENSE		COLLUVIUM
			1.1–1.3			MW GRANITE; fine to coarse grained, yellow-brown, speckled white, dry.	MEDIUM STRONG ROCK		MW BEDROCK
						EXCAVATION TERMINATED AT 1.3m AT NEAR REFUSAL IN WEATHERED BEDROCK			

Depth scale: 0.5, 1.0, 1.1, 1.3, 2.0, 2.5

Logged By : JM Date : 3/5/21 Checked By : Date :

ACT Geotechnical Engineers

ACT Geo Emg

APPENDIX B

Definitions of Geotechnical Engineering Terms

DESCRIPTION AND CLASSIFICATION OF SOILS

The methods of description and classification of soils used in this report are based on the Australian Standard 1726 – 1993, Geotechnical site investigations. In general, descriptions cover the following properties – soil type, colour, secondary grain size, structure, inclusions, strength or density and geological description.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy clay) on the following basis:

Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002mm to 0.06mm
Sand	0.06mm to 2.00mm
Gravel	2.00mm to 60.00mm
Cobbles	60mm (63mm) to 200mm
Boulders	>200mm

Soils are also classified according to the Unified Soil Classifications System which is included in this Appendix. Rock types are classified by their geological names.

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The terms are defined as follows:

Consistency	Shear Strength su(kPa) (Representative Undrained Shear)	
Very soft	< 12	<2 (~SPT "N")
Soft	12 - 25	2-4
Firm	25 - 50	4-8
Stiff	50 – 100	8-15
Very Stiff	100 – 200	15-30
Hard	> 200	>30

Non-cohesive soils are classified on the basis of relative density, generally from the results of in-situ standard penetration tests as below:

Term	Relative Density (%)	SPT Blows/300mm 'N'
Very loose	< 15	<4
Loose	15-35	4-10
Medium dense	35-65	10-30
Dense	65-85	30-50
Very Dense	>85	>50

SAMPLING

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are generally taken by one of two methods:

1. Driving or pushing a thin walled sample tube into the soil and withdrawing with a sample of soil in a relatively undisturbed state.

2. Core drilling using a retractable inner tube (R.I.T.) core barrel.

Such samples yield information on structure and strength in additions to that obtained from disturbed samples and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

PENETRATION TESTING

The relative density of non-cohesive soils is generally assessed by in-situ penetration tests, the most common of which is the standard penetration test. The test procedure is described in Australian Standard 1289 "Testing Soils for Engineering Purposes" Testing Soils for Engineering Purposes" – Test No. F3.1.

The standard penetration test is carried out by driving a 50mm diameter split tube penetrometer of standard dimensions under the impact of a 63 kg hammer having a free fall of 750mm.

The "N" value is determined as the number of blows to achieve 300mm of penetration (generally after disregarding the first 150mm penetration through possibly disturbed material). The results of these tests can be related empirically to the engineering properties of the soil.

The test is also used to provide useful information in cohesive soils under certain conditions, a good quality disturbed sample being recovered with each test. Other forms of in situ testing are used under certain conditions and where this occurs, details are given in the report.

DEFINITIONS OF ROCK, SOIL, AND DEGREES OF CHEMICAL WEATHERING

GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since "strong" and "permanent" are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water, can be remoulded and can be classified according to the Unified Soil Classification System. Three principal classes of soil recognized are:

Residual soils: soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

Transported soils: soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind and gravity. Two important types of transported soil in engineering geology and materials investigations are:

Colluvium – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principle forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

Lateritic soils: soils which have formed in situ under the effects of tropical weathering include all reddish residual and non residual soils which genetically form a chain of material ranging from decomposed rock through clay to sesqui-oxide rich crusts. The term does not necessarily imply any compositional, textural or morphological definition; all distinctions useful for engineering purposes are based on the differences in geotechnical characteristics.

ROCK WEATHERING DEFINITIONS

Extremely Weathered (EW)	Rock substance affected by weathering to the extent that the rock exhibits soil properties, i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered (HW)	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of the chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered (MW)	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered (SW)	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by limonite, has taken place. The colour and texture of the fresh rock is recognisable.
Fresh (Fr)	Rock substance unaffected by weathering.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the prominent degree of weathering first (e.g. EW-HW).

The various degrees of weathering do not necessarily define strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric, and some rocks may increase in strength during the weathering process.

Fresh drill cores of some rock types, such as basalt and shale may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS

This classification system provides a standardised terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable. Where other rock types are encountered, such as in dykes, standard geological descriptions are used for rock types and the same descriptions as below are used for strength, fracturing and weathering.

Under this system rocks are classified by Rock Type, Strength, Stratification Spacing, Degree of Fracturing and Degree of Weathering. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc) where these are relevant.

ROCK TYPE DEFINITIONS

ROCK TYPE	DEFINITION
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments.
Sandstone:	More than 50% of the rock consists of sand sized (0.06 to 2mm) grains.
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated.
Claystone:	More than 50% of the rock consists of silt or clay sized particles and the rock is not laminated.
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

STRATIFICATION SPACING

Term	Separation of Stratification Planes
Thinly Laminated	< 6mm
Laminated	6mm to 20mm
Very thinly bedded	20mm to 60mm
Thinly bedded	60mm to 0.2m
Medium bedded	0.2m to 0.6m
Thickly bedded	0.6m to 2m
Very thickly bedded	> 2m

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks.

Term	**Description**
Fragmented:	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
Highly Fractured:	Core lengths are generally less than 20mm – 40mm with occasional fragments.
Fractured:	Core lengths are mainly 30mm – 100mm with occasional shorter and longer section.
Slightly Fractured:	Core lengths are generally 300mm – 1000mm with occasional longer sections and occasional sections of 100mm – 300mm.
Unbroken:	The core does not contain any fracture.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	**Point Load Index Is(50) MPa**	**Field Guide**	**Approx qu MPa***
Extremely Weak:	0.03	Easily remoulded by hand to a material with soil properties.	0.7
Very Weak:	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.	2.4
Weak:	0.3	A piece of core 150mm long x 50mm dia. May be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium Strong:	1	A piece of core 150mm long x 50mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
Strong: (SW)	3	A piece of core 150mm long x 50mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very Strong (SW)	10	A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely Strong (Fr)	>10	A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	>240

The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ration to the point load index of 24:1. This ratio may vary widely.

Unified Soil Classification System (Metricated)
Data for Description Indentification and Classification of Soils

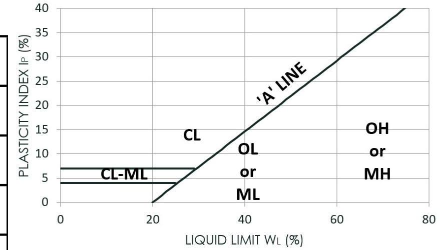
MAJOR DIVISIONS			DESCRIPTION: Group Symbol	Graphic Symbol	TYPICAL NAME	DESCRIPTIVE DATA	FIELD IDENTIFICATION	GRAVELS AND SANDS: GRADATIONS		NATURE OF FINES	DRY STRENGTH	Group Symbol	LABORATORY CLASSIFICATION: % [2] < 0.06mm	PLASTICITY OF FINE FRACTION			NOTES
COARSE GRAINED SOILS More than 50% by dry mass, less than 60mm is greater than 0.06mm.	GRAVELS	More than 50% of coarse grains are greater than 2.0mm	GW		Well graded gravels and gravel-sand mixtures, little or no fines	Give typical name, indicate approximate percentages of sand and gravel, maximum size, angularity, surface condition and hardness of the coarse grains, local or geological name and other perfinent descriptive information, symbols in parenthesis. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. EXAMPLE: Silty Sand, gravelly, about 20% hard, angular gravel particles, 10mm maximum size, rounded and sub angular sand grains coarse to fine, about 15% non-plastic fines with low dry strength, well compacted and moist in place, light brown alluvial sand, (SM)	Determine approximate percentages of material over 60mm size, maximum size, shape, surface texture, hardness of material, geological description. Identify on estimated percentage mass of the various fractions. COARSE GRAINED SOILS More than half of the material less than 60mm is larger than 0.06mm. 0.05mm is about the smallest particle visible to the naked eye	GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	GW	0-5	-	>4	Between 1 and 3	1. Identify Fines by the method given for fine grained soils. 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols eg SP-SM GW-GC
			GP		Poorly graded gravels and gravel-sand mixtures, little or no fines			POOR	Predominantly one size or range of sizes			GP	0-5	-	Fails to comply with above		
	GRAVELLY SOILS		GM		Silty gravels, gravel-sand-silt mixtures			GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	GM	12-50	Below 'A' line and Ip >7	-	-	
			GC		Clayey gravels gravel-sand-clay mixtures					Fines are plastic (1)		GC	12-50	Above 'A' line and Ip > 7	-	-	
	SANDS	More than 50% of coarse grains are greater than 2.0mm	SW		Well graded sands and gravelly sands, little or no fines			GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	SW	0-5	-	>6	between 1 and 3	
			SP		Poorly graded sands and gravelly sands, little or no fines			POOR	Predominantly one size or range of sizes			SP	0-5	-	Fails to comply with above		
	SANDY SOILS		SM		Silty sand, sand-silt mixtures			GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	SM	12-50	Below 'A' line or Ip < 4	-	-	
			SC		Clayey sands, sand-clay mixtures					Fines are plastic (1)		SC	12-50	Above 'A' line and Ip > 7	-	-	

SILT AND CLAY FRACTION

Fraction smaller than 0 20mm AS sieve size

MAJOR DIVISIONS		Group Symbol	Graphic Symbol	TYPICAL NAME	DESCRIPTIVE DATA	FIELD IDENTIFICATION	DRY STRENGTH	DILATANCY	TOUGHNESS	Group Symbol	LABORATORY CLASSIFICATION	
FINE GRAINED SOILS More than 50% by dry mass, less than 6mm is less than 0.06mm	Liquid Limit less than 50%	ML		Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, colour in wet condition, odour if any, local or geological name and r pertinent descriptive information, symbols in parenthesis. For undisturbed soil add information on structure, stratification, consistancy in undisturbed and remoulded states, moisture and drainage conditions. EXAMPLE Clayey Silt, brown, low plasticity, small percentage of fine sand, numerous vertical root-holes, firm and dry in place, fill, (ML).	FINE GRAINED SOILS More than half of the material less than 50mm is less than 0.06mm	None to low	Quick to slow	None	ML	Use the gradation curve of material passing 60mm for classification of fractions according to criteria given under "Major Division". More than 50% passing 0.06mm	Below 'A' line
		CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.			Medium to high	None to very slow	Medium	CL		Above 'A' line
		OL		Organic silts and organic silty clays of low plasticity			Low to medium	Slow	Low	OL		Below 'A' line
	Liquid Limit more than 50%	MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.			Low to medium	Slow to none	Low to medium	MH		Below 'A' line
		CH		Inorganic clays of high plasticity, fat clays.			High to very high	None	High	CH		Above 'A' line
		OH		Organic clays of medium to high plasticity.			Medium to high	None to very slow	Low to medium	OH		Below 'A' line

	Group Symbol	Graphic Symbol	TYPICAL NAME	FIELD IDENTIFICATION	Group Symbol	LABORATORY CLASSIFICATION
	Pt		Peat muck and other highly organic soils.	Readily identified by colour, odour, spongy feel and generally by fibrous texture	Pt*	*Effervescence with H2O2



PLASTICITY CHART

FOR CLASSIFICATION OF FINE GRAINED SOILS

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Limitations in the Use and Interpretation of this Geotechnical Report

Our Professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject development and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive borehole and test pit logs, cross- sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory bore holes, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory bore holes and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between conducting this investigation and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and the recommendations considering the changed conditions and time lapse.

The summary bore hole and test pit logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the test holes progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The bore hole and test pit logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at the other locations may differ from conditions occurring at these bore hole and test pit locations. Also, the passage of time may result in a change in the soil conditions at these test locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, bore holes or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report: nor can our company be responsible for any construction activity on sites other than the specific site referred to in this report.