RDAgritech

ENGINEERED BY NATURE

GEOTECHNICAL COMPLETION REPORT

JOB TITLE	LINKSGATE GEOTECH
ADDRESS	MANSE ROAD, ARROWTOWN
JOB NUMBER	50350
	11 July 17

Client: Suburban Estates Limited

Po Box 13349
Christchurch 8141
New Zealand

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50350 Linksgate Geotech Completion Report REV2

1. INTRODUCTION

Suburban Estates Limited has developing Linksgate Subdivision, located off Manse Road in Arrowtown, north east of Queenstown. As part of the development, a geotechnical completion report has been prepared to identify the geotechnical conditions for each of the lots on the subdivision. This report describes earthworks involved within the development of Linksgate comprising Stage 1 – Lots 1 – 23, 28, 900 and 901.

The work was commissioned by Suburban Estates Limited in a signed SFA, dated 9 May 2016. Clark Fortune Macdonald and Associates provided a site plan of the proposed development.

The initial scope of work for the Geotechnical Completion Report included providing recommendations on:

- A summary of previous investigation information carried out as part of subdivision consent;
- A summary of the ground conditions encountered across the subdivision at the time of completion;
- The extent of earthworks on the lots;
- A summary of the findings and recommendations for residential building development for each lot.

The report has been based on investigations conducted before, during and following earthworks construction.

RDAgritech conducted the work in general accordance with our proposal, reference 50350 Linksgate Geotech dated 9 May 2016.

1.1. LIMITATIONS

Findings presented as a part of this report are for the sole use of Suburban Estates Limited in accordance with 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.

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.

1.2. RELATED DOCUMENTS

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 4431:1989 and amendments. Code of Practice for Earthfill for Residential Development.
- Geology of the Wakatipu area 1:250,000 QMap (Qm18), GNS Science: 2000

2. SITE INFORMATION

- The site is located off Manse Road, Arrowtown;
- The site covers an area of approximately 2.5 ha;
- The subdivision was previously used for agricultural purposes and was vegetated with grass and mature trees;
- The sites to the north, west and south are occupied by existing residential buildings, with construction of a residential development across the south boundary and Feehly Hill across the south east boundary;
- The south east portion of the site is located across the toe of Feehly Hill which is located directly across the site boundary.
- The site is accessed from Manse Road via two main site access points.

3. GEOLOGY

The geology of the site is mapped by the Qm18 as Late Pleistocene river deposits comprising: generally unweathered, well sorted, loose, sandy to boulder gravel forming large terraces and outwash plains. The Qmap is at a 1:250,000 scale so only details the larger units present. Site investigations have confirmed the alluvial deposits.

On the lower slopes of Feehly Hill on the boundary of the site, basement metamorphic rock is present comprising: Very well segregated and laminated; abundant politic and subordinate psammitic greyschist: minor greenschist and metachert: TZ4.

No active faults were mapped in the field, however, the active Cardrona fault shown on the published Qm 18 approximately 10km from the site. There is a significant seismic risk to the Wakatipu 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.

The site is located 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. When unconsolidated and in high groundwater situations, it is these sediments that can liquefy when subject to seismic shaking.

4. PRE-DEVELOPMENT GEOTECHNICAL WORK

4.1. GEOTECHNICAL INVESTIGATIONS

A Geotechnical Investigation Report (GIR) was prepared prior to the site development comprising test pits and scala penetrometer testing. The details of the investigation are found within the Tonkin and Taylor report issued November 2007, titled “Feehly Subdivision, Geotechnical Investigation”. The GIR is attached in Appendix C.

A letter prepared by Royden Thomson titled “RC Application RM070943: Assessment of Natural Hazards at the Proposed Feehly Hill Subdivision” dated 15 November 2007 was prepared prior to subdivision construction. The report concludes that while some hazards are present there are no major issues of concern associated with the subdivision. The final form of the subdivision with the cutoff trench and vegetation planting was expected to mitigate the minor rock hazard from above lots 15 to 23. The letter is attached in Appendix C. We have not assessed these hazards further.

4.2. INVESTIGATIONS DURING CONSTRUCTION

Additional Test pits were conducted along the south east boundary of the site at the toe of Feehly Hill as earthfill was required to be placed within close proximity. Scala penetrometers were conducted adjacent to each test pit. The test pits indicated Scree Deposit which were sourced from erosional processes on Feehly Hill. The description of the Scree Deposit is detailed in Table 1.

4.3. INTERPRETED SUBSURFACE CONDITIONS

The typical soil types encountered during the field investigations were divided into six geotechnical units as summarised in Table 1.

TABLE 1 – SUMMARY OF GEOLOGICAL UNITS AND SOIL TYPES

UNIT	SOIL TYPE	DESCRIPTION
1	Topsoil	SILT; organic; dark brown; moist
2	Scree Deposit	Silty GRAVEL with some sand; light brown; fine grain sand; fine to coarse angular schist gravel; forms a ball; loose to medium dense
3	Alluvial Sediments	SILT with minor sand; mottled brown; firm; moist; uniform; non plastic
4	Alluvial Deposits	SAND with minor silt; mottled brown; loose; moist; uniform; fine grain sand
5	Alluvial Gravels	Sandy Gravel; grey/brown; fine to coarse gravel; loose; moist; poorly graded; medium to coarse sand

6	Schist Rock	Highly to completely weathered grey psammitic SCHIST with quartz veins and iron staining; very weak; closely spaced joints and fractures; foliation dip direction 40° to 260° (SW) on north side of pit, 30° to 230° (SW) on E side of pit, 80° to 250° (SW) on south side of pit.

As detailed in the Tonkin and Taylor report, the general stratigraphy across the site was:

- 0.2 to 0.4 m of Topsoil; overlying
- 0.4 to 0.6 m of Alluvial Sediments (eastern side of site only); overlying
- 2.3 to 3.0 m of Alluvial Deposits (eastern side of site only); overlying
- An unconfirmed thickness of Alluvial Gravel (present in all test pits except TP1); overlying
- Otago Schist bedrock (TP1 only).

5. GROUNDWATER

Groundwater inflows were not observed in any of the test pits at the time of the field investigations.

It should be noted that fluctuations in the groundwater levels can occur as a result of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of investigation.

It is expected that minor seepage could be expected in the gravel horizons and locally typical perched levels are observed on the soil to rock contact. Perched groundwater or seepage is most likely during the winter months.

6. NATURAL HAZARDS

SITE SPECIFIC

Review of the Queenstown Lakes District Council Webmaps shows that there is one hazard identified for the site. The Webmaps indicate the site is encompassed by a stabilised – isolated alluvial fan. It is not considered that this fan is active and therefore is not a hazard for the site.

As per the letter attached in Appendix C, the site is not considered to be at risk from flooding. Overland flow is not expected either and this has been further mitigated by the cut-off swale prepared along the east boundary of the site. Vegetation has also been heavily planted with young shrubs which will assist further in mitigating overland flow as they develop.

A rockfall hazard assessment was conducted by Royden Thomson in regards to the Schist bluffs located at the top of Feehly Hill. The report suggests that the associated risk of rockfall hazard is effectively nil and is extremely unlikely that rockfall will occur within the lifetime of the subdivision. As mentioned above, the lower half of the Feehly Hill slope has received dense vegetation above and below the constructed cut off swale. It is expected that as the vegetation matures, it will assist with supressing the energy of unlikely small fretting run-out blocks. The upper half of the slope is vegetated heavily with mature gorse. The cut-off swale will act as an interceptor for run off as well. The letter in Appendix C further discusses the rockfall hazard.

REGIONAL HAZARDS

A seismic ground shaking risk for the Wakatipu region on the whole has been identified and prudent design to mitigate the risk of seismic ground shaking should be applied to all proposed structures. Design to the relevant structural and building codes is expected to mitigate this issue.

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

7. SUBDIVISION EARTHWORKS

7.1. CONTRACTORS

Wilson Contractors were the earthworks contractors who conducted the site works and services and pavement installations for the subdidivision. Several 6 wheel dump trucks, two 20 ton diggers, a 12 ton vibrating roller, grader and water cart were the main plant used for the fill placement across the lots.

Central Testing Services, an IANZ accredited laboratory conducted onsite Nuclear density testing and Laboratory testing for the earthfill placed.

Clark Fortune Macdonald were the engineers to the contract and registered surveyors and for the site design and asbuilting requirements.

7.2. SITE PREPARATION

All areas of proposed engineered fill placement were stripped of topsoil and organic or deleterious material. The fill subgrades were compacted and tested with approval by the inspecting engineer prior to fill placement.

Bulk earthworks were carried out across Linksgate subdivision in accordance with NZS4431:1989 "Code of Practice for Earthfill for Residential Development" and the NZS4404:2010 Queenstown Lakes District Court "Land Development and Subdivision Code of Practice".

7.3. AREAS OF FILL

The attached earthfill as built plan indicates the extent of requried earthfill across the site. The maximum depth of earthfill placed was up to depths of 2.9 m within Lot 22. This was to undercut soft soils present and replace with compacted hardfill. The maximum fill depth indicated on the as built plan across Lots 13 – 16, 23 - 900 is ~1.2 m. The attached as built plan confirms the fill extents and depths across the subdivision. The remaining lots on the as built plan where no certified earthfill has been placed, has either natural subgrade exposed below the topsoil or has a layer of non-certified fill placed to depths of ~300 mm for minor site releveling.

The engineered fill utilised was Shotover River gravels, AP40 and site won materials. The fill was placed in 150 mm loose lifts by an onsite excavator and compacted with a 12T drum roller in accordance with NZS4431:1989.

As the earthfill as built plan indicates, the south east boundary area of Lots 15, 16, 22, 23 and 900 didn't receive engineered earthfill. This is due to the building platforms bordering onto an Outstanding Natural feature (ONF) which governs the size of the building platform particularly across Lot 22 and 23. The interface between the earthfill and adjacent natural ground is indicated on the asbuilt plans.

TABLE 2 - LOTS WITH EARTHFILL PLACED

EARTHWORK	LOT NUMBER
ENGINEERED EARTHFILL	13, 14, 15, 16, 22, 23, 900

7.4. COMPACTION TESTING

As indicated above, the main earthfill types utilised across the site were Shotover River gravels, Fairlight AP40 or site won material which was sourced from areas of undercut onsite. NZ Standard and vibration Compaction testing in accordance with NZS4402:1986, were conducted on the site won material to provide the requried Maximum Dry Desnsity (MDD) of the material. The Shotover River gravels had a previous known MDD values and therefore further compaction testing was not required for the material prior to placement.

Nuclear Densometer Testing (NDM) was the primary method of earthfill testing. An independent entity, Central Testing Services are an IANZ accredited Laboratory and conducted the required earthfill testing. The results for the NDM testing are tabulated in Appendix B.

Scala Penetrometer testing was also conducted throughout the placement of earthfill between visits from Central Testing Services by RDAgritech Ltd as interim quality control checks. The scala testing was for confirmation to ensure the earthfill was placed and compacted to the required standards.

Finished ground level testing was also conducted across each of the lots utilising a scala penetromter to indicate the finished subgrade bearing capacity of the lots. The results of the tests are indicated in Appendix B and D. As previously indicated, locations with engineered earthfill placed, exceed 300 kPa Geotech Ultimate Bearing Capacity.

Central Testing Services conducted 36 NDM tests across the lots indicated on the earthfill as built throughout the placement and compaction of earthfill and consistently achieved greater than 92% (NZ Vibration Hammer Test) or 95% (NZ Standard Compaction) Relative Compaction (Appendix B).

7.5. COMPACTION RESULTS

The results in Appendix B generally indicate that 92% / 95% MDD or greater compaction has been consistently achieved across the areas requiring engineered earthfill. One test by Central Testing Services, indicates Relative Compaction value of 91.2% when utilising a NZ Vibrating Hammer Test. As the surrounding results conducted on 1 July 2016 within Lot 16 indicate greater than 92% Relative Compaction, the 91.2% result was accepted as it was 0.8% below the required value and was averaged out to a pass.

7.6. CERTIFICATION

A Statement of Suitability of earthfill for residential development by the inspecting engineer in accordance with NZS4431:1989 is included in Appendix G.

8. BUILDING DEVELOPMENT

8.1. SUBSOIL SUBCLASS FOR SEISMIC DESIGN

Soils in this site are considered to fall in the site subsoil 'Class C – Shallow Soil sites' in accordance with NZS 1170.5.2012.

8.2. SITE SOILS CHARACTERISTICS

As the Geotechnical Investigation Report indicates, the subdivision has a variety of subgrade materials present with varying composition, bearing capacity characteristics and origin (Appendix E). The Geotechnical Investigation Report indicated the natural soils on site are predominantely Alluvial sediments and gravels overlying Schist bedrock at varying depths. The depths of alluvial sand and silt vary in all locations and gravels were exposed beneath the silt and sand material mainly along the south west and south boundary of the site.

As mentioned, the Alluvials Gravels were the dominant subsurface material as the site progressed towards the south. Schist bedrock was encountered in one test pit within the south boundary of the site located on the toe of Feehly Hill. The unit dips moderately to the west as it was not encountered in other test pits conducted further from the toe of Feehly Hill.

During construction of the subdivision, the northern portion of the south east boundary had test pits conducted to expose the underlying subsurface material. Scree Deposits were encountered underlying topsoil. The base of the scree deposit was not encountered, nor was Schist bedrock although it is inferred that the scree deposit would taper out as it came into contact with the Alluvial sediments further out from the Feehly Hill toe. The scree deposits were predominantely located beyond the ONF (Outstanding Natural Feature) Boundary line which indicates the building foundations should not encounter the scree material.

The materials outlined above indicated varying depths of "Good Ground' in accordance with NZS3604:2011 or 300 kPa Geotech Ultimate Bearing Capacity. The depths of 300 kPa soils across each lot is outlined below in Appendix B and D.

Engineered earthfill has been placed across portions of the subdivision to raise lots to the required finished design ground levels before covering with topsoil. As the finished ground levels across the site varied, not all sites requried fill to reach the finished design levels. The earthfill was placed and compacted in accordance with NZS4431:1989.

All materials across the site were underlying 200 – 300 mm of topsoil. The references to "good ground" in this reporting excludes the upper topsoil material.

8.3. FOUNDATION DESIGN OPTIONS & PARAMETERS

At the time of preparation of this geotechnical completion report, there were no development plans of specific site buildings for each lot however it is anticipated that all lots will contain residential dwellings. The foundations for each residential lot are expected to be shallow strip, raft or waffle slab style foundations.

Many sites in the Wakatipu Basin have required Specific Engineering Design (SED) foundations due to presence of subsurface soils with less than 300 kPa Geotech Ultimate Bearing Capacity. Feasible options for specifically designed foundations are readily available and utilised regularly regardless of the subsoil bearing capacity.

Scala penetrometer testing following completion of earthworks, confirmed the soils within lots and depths to 300 kPa Geotech Ultimate Bearing Capacity soils as tested in accordance with NZS3604:2011. Table B1 in Appendix B details the lot and specific bearing capacities encountered.

Lots 1 – 8 and 900 along Manse Road have relatively shallow depths to 300 kPa Geotech Ultimate Bearing Capacity soils, shallow strip footings in accordance with NZS3604:2012 may be used as the foundation type. This does not limit these lots to these footings and other foundation types and systems can be utilised. No engineered fill was placed across these lots.

Lots 13 and 14 received almost full coverage of certified earthfill across the building platform areas and have greater than 300 kPa Geotech Ultimate Bearing Capacity below topsoil levels. These would also suit shallow strip footings in accordance with NZS3604:2012. This does not limit these lots to these footings and other foundation types and systems can be utilised.

Lots 15, 16, 22, 23 and 900 received engineered earthfill across a majority of the lots also, however a portion of the lot still consists of natural ground with less than 300 kPa Geotech Ultimate Bearing Capacity soils. The plan in Appendix A should be utilised when preparing foundation design to indicate whether foundations will be founded beyond the certified earthfill, into

low density natural subgrade. Bearing capacity testing within the natural ground indicated the areas generally require Specific Engineering and Design assessment for foundations if located within the natural subgrade areas.

Lots 9 – 12, 17 – 21 and 28 have soils less than 300kpa geotechnical ultimate bearing capacity within the upper shallow soil limits and would require Specific Engineering assessment and design of the foundation system for the lot.

Waffle slab or raft solutions would be feasible following removal of topsoil and any non-certified fill across areas where lower density sands and silts were encountered. This would require specific design by the purchaser or minor undercut and replacement with compacted earthfill also requiring some geotechnical professional involvement. The lots requiring a specific design foundation are Lots 9 – 12, 17 – 21 and 28. Specific design would generally favour a light weight structure which would assist the specific design foundation in being suitable to bear on lower density soils.

The attached Site Investigation Plan indicates an area spanning along the boundary of Lot 15 to Lot 23 as ONF (Outstanding Natural Feature) RM070943 this forms a boundary of the building platforms along this portion of the subdivision. If the ONF line was shifted in the future to create larger building platforms, the new area created would require Specific Engineering Investigation and Design (SED) of the foundations.

8.4. BEARING CAPACITY STRESSES AND SETTLEMENT

The scala penetrometer results of the final ground levels across the site indicate varying depths of "good ground" or low density soils. It is recommended that the recommendations with Section 9 below are adhered to when designing the proposed dwelling of each lot.

At the time of construction all foundation excavation subgrades should be inspected by a suitably qualified Geoprofessional to ensure foundation conditions are as reported and the appropriate design assumptions for bearing capacity by the structural engineer are met.

Any foundations on fill shall have the fill placed and compacted in accordance with NZS4431:1989 with certification by a suitable qualified engineer.

Settlement is expected to be within limits set by NZS3604:2011 where a Standard Timber Framed Building is proposed to be utilised on sites deemed to have "good ground".

All foundation excavation subgrades should be inspected by a suitable qualified geotechnical professional to ensure foundation conditions are as reported.

9. GEOTECHNICAL CONSIDERATIONS FOR DEVELOPMENT

The following table summarises the lots with recommendations for development with all lots also subject to Sections 7 and 8 above.

TABLE 4 - FOUNDATION RECOMMENDATIONS FOR LINKSGATE SUBDIVISION

LOT NUMBER	RECOMMENDATIONS
1, 2, 3, 4, 5, 6, 7, 8, 13, 14, 901	NZS3604:2011 foundations possible following topsoil strip
9, 10, 11, 12, 17, 18, 19, 20, 21, 28	Specific Geotechnical Engineering and Design assessment of foundation as per section 7 of this report
15, 16, 22, 23, 900	Sites with a combination of possible NZS3604:2011 foundations and areas of Specific Geotechnical Engineering and Design Assessment of foundation. Proposed dwelling location will determine if SED requried.

As detailed in previous sections, a Specific Engineering Design foundation is common within the Wakatipu Basin and are becoming regularly utilised for multiple reasons as well as low soil bearing capacity requirement.

10. CONCLUSIONS

The completed earthfills placed for the development are considered to have been placed in accordance with NZS4431:1989 and its amendments.

The natural ground not affected by earthfill are considered to have both NZS3604 good ground portions and other areas that do not have "good ground"; however as long as the above considerations in Sections 7, 8 and 9 above are followed for design and construction, no adverse geotechnical effects are expected.

11. APPLICABILITY

This report is only to be used by the parties named above for the purpose that it was prepared and shall not be relied upon or used for any other purpose without the express written consent of the suburban estates Limited and RDAgritech Ltd.

The extent of testing associated with this assessment is limited to discrete locations and variations in ground conditions can occur between and away from such locations. If subsurface conditions encountered during construction differ from those given in this report further advice should be sought without delay.

12. PHOTOS

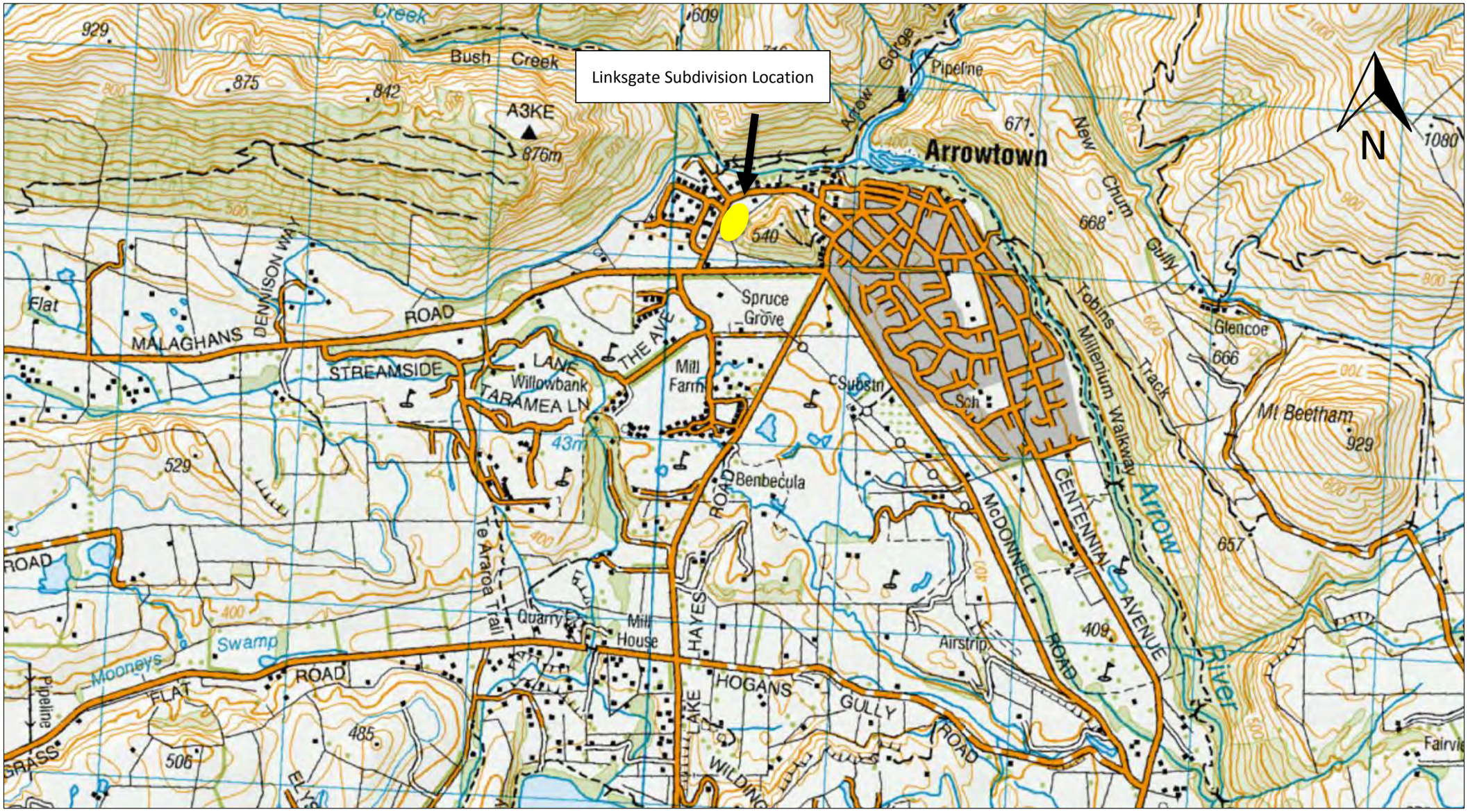
Photo 1: Looking north west across Lot 15, 14 and 13 following required undercuts.

Photo 2: Looking north across Lot 16 indicates finished fill level.

Photo 3: Looking North from Lot 12 towards Lot 13 where earthfill placement and compaction was occurring.

APPENDIX A. SITE PLANS

1. Site Location Plan
2. Testing Location Plan
3. Lot Subgrade Conditions For Foundation Design
4. Hazard Map
5. Earthfill As Built Plan – CFM
6. Cut Off Drain



RDAgritech ENGINEERED BY NATURE	**Engineering Firm:** RDAgritech Ltd Po Box 1880 Queenstown	**Project:** Linksgate Geotech, Manse Road, Arrowtown	**Client:** Suburban Estates Limited, Po Box 13349, Christchurch	**Drawing Title:** Site Location Plan	**Scale:** NTS **Job No.** 50350	**Drawing Number** Figure 1 **Revision:**

KEY:

- Proposed building platform
- Future lots
- Reserve links

MANSE ROAD (Legal Road)

Edge of Seal
Centre Line
Edge of Seal

201
602m²

1 707m² RL: 424.75
2 700m² RL: 425.20
3 700m² RL: 425.60
4 774m² RL: 426.10
5 593m²net 692m² RL: 427.10
6 576m² RL: 426.70
7 575m² RL: 427.0
8 648m²net 740m² RL: 427.80
9 700m²net 762m² RL: 428.50
10 600m² RL: 427.0
11 700m² RL: 426.80
12 700m²net 761m² RL: 428.50
13 800m² RL: 427.35
14 750m² RL: 427.23
15 868m² RL: 427.17
16 650m² RL: 426.88
17 650m² RL: 426.60
18 652m² RL: 426.60
19 710m² RL: 426.50
20 700m² RL: 426.30
21 722m² RL: 426.0
22 623m² RL: 425.60
23 600m² RL: 425.10
28 600m²net 663m² RL: 427.75

RES(E) 100 4,182m²

DUE(E) 100 4,182m²

901 1015m²

900 SP52

4.5m setback

Activity Area Bndry

New ONF

Sec 41
Blk XVIII
Shotover S.D.

1
D.P.21359

900
7.068ha

Pt Sec 7
Blk XVIII
Shotover SD

153°40'00" 78.00

60°45'05" 18.25

47°38'05" 44.43

Amalgamation Condition

Lot 901 and 900 will held in the same CFR

MEMORANDUM OF EASEMENTS			
PURPOSE	SHOWN	SERVIENT TENEMENT	DOMINANT TENEMENT
Right of way, right to convey water & right to drain waste water	A	Lot 5 hereon	Lot 7 & 8 hereon
	B	Lot 8 hereon	Lot 5 & 7 hereon
	C	Lot 28 hereon	Lot 9 and 12 hereon
	D	Lot 9 hereon	Lot 12 and 28 hereon
	E	Lot 12 hereon	Lot 9 and 28 hereon

MEMORANDUM OF EASEMENTS IN GROSS			
PURPOSE	SHOWN	SERVIENT TENEMENT	GRANTEE
Public Pedestrian Access	F	Lot 900 Hereon	QLDC

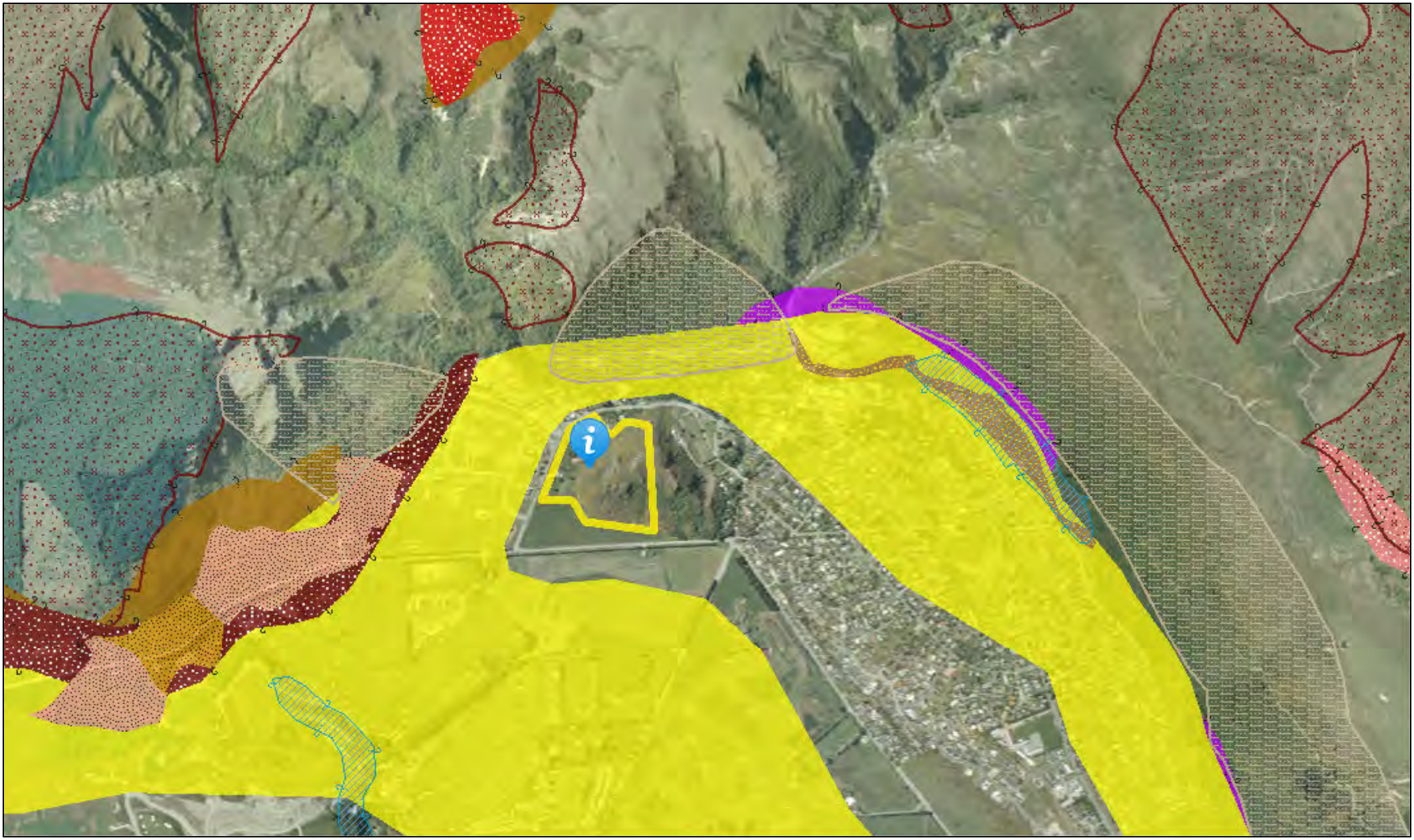
KEY:

- ONF line from Structure Plan
- ONF line as approved under RM070943

S:\JOBS\50350\SHSW\AC\50759_160_RESE\SUBDIVISION PLAN.DWG

RDAgritech ENGINEERED BY NATURE	Engineering Firm: RDAgritech Ltd Po Box 1880 Queenstown	Project: Linksgate Geotech, Manse Road, Arrowtown	Client: Suburban Estates Limited, Po Box 13349, Christchurch	Drawing Title: Site Investigation Plan – Scala Penetrometer Locations	Scale: NTS	Drawing Number Figure 1
					Job No. 50350	Revision:

RDAgritech ENGINEERED BY NATURE	Engineering Firm: RDAgritech Ltd Po Box 1880 Queenstown	Project: Linksgate Geotech, Manse Road, Arrowtown	Client: Suburban Estates Limited, Po Box 13349, Christchurch	Drawing Title: Lot Subgrade Conditions for Foundation Design	Scale: 1:1000 @A3	Drawing Number Figure 1
					Job No. 50350	Revision:



Queenstown Lakes District Council

Webmaps your view of your information

Linksgate Geotech - Hazard Map

12 June 2017

0 0.15 0.3 0.45 0.6 Kilometres

N

Linksgate Geotech - Hazard Map

Legend

Hazards

- Active Fault - Location approximate
- Inactive Fault - Location approximate
- Flooding due to Rainfall
- Flooding due to Damburst
- Landslide: Active Pre-existing Schist Debris Landslides
- Landslide: Pre-existing Schist Debris Landslides (Activity Unknown)
- Landslide: Dormant Pre-existing Schist Debris Landslides
- Landslide: Shallow Slips and Debris Flows in Colluvium
- Landslide: Debris Flow Hazards
- Landslide: Slope Failure Hazard in Superficial Deposits
- Landslide: Rockfall
- Landslide: Pre-existing or Potential Failure in Lake Sediments or Tertiary Sediments
- Landslide: Piping potential in the Artesian Zone of the Wanaka Aquifer
- Landslide: Potential Hazard - Debris Flood/Debris Flow
- Landslide Areas - non verified
- Erosion Areas
- Alluvial Fan - Incision Line
- Alluvial Fan - Channels
- Alluvial Fan - Source Area
- Alluvial Fan - Catchment Areas
- Alluvial Fan - Hazard Area
- Alluvial Fan - ORC: fan active bed
- Alluvial Fan - ORC: fan recently active
- Alluvial Fan - ORC: fan less recently active
- Alluvial Fan (Regional scale) Active, Composite
- Alluvial Fan (Regional scale) Active, Debris-dominated
- Alluvial Fan (Regional scale) Active, Floodwater-dominated
- Alluvial Fan (Regional scale) Inactive, Composite
- Alluvial Fan (Regional scale) Inactive, Debris-dominated
- Alluvial Fan (Regional scale) Inactive, Floodwater-dominated
- Avalanche Areas
- Liquefaction Risk: Nil to Low (T&T 2012)
- Liquefaction Risk: Probably Low (T&T 2012)
- Liquefaction Risk: Possibly Moderate (T&T 2012)
- Liquefaction Risk: Possibly High (T&T 2012)
- Liquefaction Risk: Possibly Susceptible (Opus 2002)
- Liquefaction Risk: Susceptible (Opus 2002)

Shotover Design Limited trading as
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Rev.	Date	Revision Details	By
A	01.05.17	Inclusion of undercut	SL
B	29.06.17	Inclusion of pitrun	JJ

LINKS GATE SUBDIVISION
STAGE 1
EARTHWORKS - FILL DEPTHS

Client

Surveyed	Signed	Date	Job No.	Drawing No.
BR		10.03.17	9759	24

Drawn	Signed	Date	Scale
SL		30.03.17	1:500 @ A1 1:1000 @ A3

Designed	Signed	Date	Datum & Level	Rev.
			Mt Nic 2000 & MSL	B

Notes:
All dimensions shown are in meters unless shown otherwise.
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- Using the drawings and other data in electronic form without requesting and checking them for accuracy against the original hard copy versions.
- Ensuring the information is the most recent issue.

STORMWATER CUTOFF DRAIN INSPECTION AND MAINTENANCE CHECKLIST

Location: Linksgate Subdivision, Manse Road Arrowtown

Owner: Suburban Estates Ltd

Address: Flynn Lane, Arrowtown

Date:_____ Time:_____ Site conditions:_____

Stormwater Type: **Grass swale/Overland Flowpath**

Inspection Frequency Key: A=annual; M=monthly; S=after major storms.

Inspection Items	**Inspection Frequency**	**Inspected? (yes/No)**	**Maintenance Needed? (Yes/No)**	**Comments/Description**
Inlet and Outlet clear of debris/sediment	M/S			
Dumping of yard waste into facility	M			
Visible pollution	M/S			
Litter (branches) removal within channel	M			
Surrounding area fully stabilised	M/S			
Animal burrows in swale embankment	M			
Undesirable vegetation growth within channel	M			
Reseed bare patches and water to establish, use coconut matting where necessary	M			
Erosion in swale base	M/S			
Erosion on swale embankment	M/S			
Evidence of sediment accumulation	M			
Swale clean out of sediment	A			
Check for boggy patches and ponding of water within channel	A			

Check for erosion downstream of outlet	A/S			
Have there been complaints from residents	M			
Any other maintenance items not listed	M/S/A			

Inspector Comments:

Overall Condition of Facility: □ Acceptable □ Unacceptable

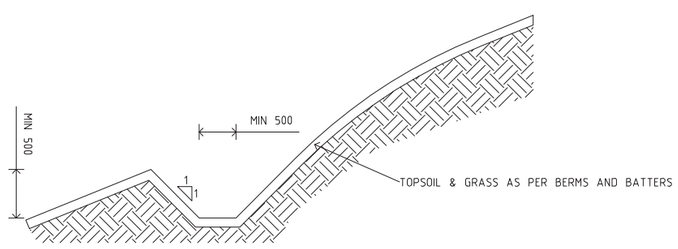
If any of the above inspection items are checked yes for Maintenance Needed, list Maintenance actions and their completion dates below:

Maintenance Action Needed	**Due Date**

The next routine inspection is scheduled for approximately:_____(date)

Inspected by: (signature)_____

Inspected by: (printed):_____



CUT-OFF TRENCH PROFILE

MINIMUM GRADIENT 1%
MINIMUM DEPTH 500mm
NOT TO SCALE

WORK IN PROGRESS 02.06.2016

Shotover Design Limited trading as
Clark Fortune McDonald & Associates
Licensed Cadastral Surveyors - Land Development - Planning Consultants

309 Lower Shotover Road, P.O.Box 553 Queenstown
Tel. (03)441-6044, Fax (03)442-1066, Email admin@cfma.co.nz
21 Reece Crescent, P.O.Box 550, Wanaka
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Shop 2, Otago House, 475 Moray Place, P.O. Box 5960
Tel. (03)470-1582, Fax (03)470-1583, Email admin@cfma.co.nz

Rev.	Date	Revision Details	By
M	24/04/2017	CUT OFF DRAIN LOCATION	TS

LINKS GATE SUBDIVISON
STAGE 1
STORMWATER CUT-OFF TRENCH

Client: SUBURBAN ESTATES LTD	Surveyed	Signed	Date	Job No. 9579	Drawing No. E003 SHEET 017
Notes: All dimensions shown are in meters unless shown otherwise. Any person using Clark Fortune McDonald drawings and other data accepts the risk of: - Using the drawings and other data in electronic form without requesting and checking them for accuracy against the original hard copy versions. - Copywrite on this drawing is reserved.	Drawn TPS	Signed	Date 07.15	Scale 1:500 @ A1 1:1,000 @ A3	
	Designed CCH	Signed	Date 07.15	Datum & Level MSL	Rev. M

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APPENDIX B. FINISHED SUBGRADE LEVEL AND EARTHFILL TESTING RESULTS

1. Table B1 - Finished Level Scala Penetrometer Testing Results
2. Table B2 - Summarised construction Nuclear Density Testing Results

Table B1

LOT	DEPTH TO 300 KPA SOIL (mm) below existing ground levels	FOUNDATION RECOMMENDED
1	300	NZS3604:2011
2	150	NZS3604:2011
3	200	NZS3604:2011
4	300	NZS3604:2011
5	200	NZS3604:2011
6	200	NZS3604:2011
7	100	NZS3604:2011
8	100	NZS3604:2011
9	1000	SED
10	850	SED
11	1800	SED
12	1050	SED
13	300	NZS3604:2011
14	300	NZS3604:2011
15	300	SED*
16	300	SED*
17	TBC	SED
18	>1800	SED
19	1800	SED
20	1800	SED
21	1200	SED
22	300	SED*
23	300	SED*
28	1000	SED
900	300	SED*
901	100	NZS3604:2011

* Existing building platforms with near full cover of engineered earthfill indicating greater than 300 kPa Geotech Ultimate Bearing Capacity Soils. However, the red hashed areas indicated on the “Lot Subgrade Conditions” plan in Appendix A, show areas where low density subgrade material are exposed outside of the earthfill areas within the lots.

Table B2

NZ STANDARD COMPACTION TEST – MINIMUM RELATIVE COMPACTION: 95%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
29 April 2016	900	1.89	2.14	13.2	98.3	PASS
29 April 2016	900	1.86	2.09	12.2	96.8	PASS
29 April 2016	900	1.83	2.07	12.7	95.5	PASS
29 April 2016	900	1.99	2.16	8.8	98.3	PASS
29 April 2016	900	1.99	2.13	7.3	98.4	PASS
29 April 2016	900	1.97	2.10	6.5	96.0	PASS

NZ VIBRATING HAMMER TEST – MINIMUM RELATIVE COMPACTION: 92%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
1 June 2016	22	2.12	2.24	5.8	94.7	PASS
1 June 2016	23	2.18	2.28	4.6	97.3	PASS
1 June 2016	900	2.13	2.27	6.8	95.0	PASS

NZ VIBRATING HAMMER TEST – MINIMUM RELATIVE COMPACTION: 92%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
17 June 2016	13	2.18	2.32	6.2	96.1	PASS
17 June 2016	13	2.18	2.33	6.7	96.3	PASS
17 June 2016	13	2.19	2.33	6.4	97.7	PASS
17 June 2016	14	2.13	2.30	7.8	95.1	PASS

NZ VIBRATING HAMMER TEST – MINIMUM RELATIVE COMPACTION: 92%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
21 June 2016	16	2.19	2.30	4.8	97.9	PASS
21 June 2016	16	2.20	2.32	5.3	97.1	PASS
21 June 2016	15	2.18	2.30	5.1	97.4	PASS
21 June 2016	15	2.23	2.34	4.7	99.6	PASS
21 June 2016	15	2.19	2.31	5.4	99.6	PASS

NZ VIBRATING HAMMER TEST – MINIMUM RELATIVE COMPACTION: 92%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
1 July 2016	13	2.19	2.31	5.5	96.4	PASS
1 July 2016	13	2.12	2.26	6.5	94.7	PASS
1 July 2016	14	2.11	2.22	5.2	94.0	PASS
1 July 2016	14	2.13	2.25	5.5	93.2	PASS
1 July 2016	15	2.16	2.27	5.1	94.4	PASS
1 July 2016	15	2.23	2.34	4.8	99.8	PASS
1 July 2016	16	2.19	2.26	3.4	95.5	PASS
1 July 2016	16	2.11	2.19	3.5	91.2	FAIL
1 July 2016	900	2.24	2.38	5.9	99.2	PASS
1 July 2016	900	2.20	2.34	6.3	98.3	PASS
1 July 2016	23	2.22	2.30	3.7	99.0	PASS
1 July 2016	23	2.26	2.35	4.1	98.5	PASS
1 July 2016	22	2.16	2.27	4.8	95.3	PASS
1 July 2016	22	2.16	2.26	4.8	95.2	PASS

NZ VIBRATING HAMMER TEST – MINIMUM RELATIVE COMPACTION: 92%						
DATE	LOT NUMBER	DRY DENSITY (Kg/m^3)	WET DENSITY (Kg/m^3)	MOISTURE (%)	RELATIVE COMPACTION (%)	COMPACTION RESULT
20 February 2017	901	2.26	2.32	2.7	94.0	PASS
20 February 2017	900	2.05	2.18	6.5	98.0	PASS
20 February 2017	900	2.03	2.15	5.5	95.9	PASS
20 February 2017	900	2.10	2.24	6.3	101.6	PASS

APPENDIX C. INSPECTING ENGINEERS SITE REPORTS

SITE REPORT	1
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	20 April 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Topsoil stripping and subgrade preparation.

Observations and Comments:

Thirteen (13) test pits had been conducted along the road alignment, down to subgrade for inspection. They confirmed the previous geotechncial reporting of the site conditions.

Isaac advised that filling was due to start the week of this visit and that plateau testing would be undertaken.

David Rider and Isaac discussed areas and soils to be used. A decision was made to obtain four (4) compaction curves – one for the silt material, two for composite material, and one for gravel – to be used for overall fill testing.

David was to arrange for scala penetrometer testing of the subgrade to be undertaken. This was subsequently completed later on the day of this visit.

Wilson Contractors were to arrange a pad foot roller, ideally of 6-8 tonne minimum, otherwise a smooth drum could be utilised for compaction of the fill materials.

David called Central Testing Services and arranged the collection of a compaction samples, on Wilson's behalf.

Recommendations:

Silt material will be useable if weather conditions are suitable and compaction curves confirm that a moisture percentage window exists.

Compaction trials and placement can commence once subgrade testing confirms adequate bearing is present.

Report Prepared by:

David Rider
BSc (Geol)
Senior Engineering
Geologist/Geoprofessional

Links Gate Fill Cert SR1.docx

☑ Issued, date sent 4/05/16

☑ Typed by: (DCS) ☑ Reviewed by: DWR **Attached:** Photos

☑ Typed by: (DCS) ☑ Reviewed by: DWR **Attached:** Photos

Photos:

Showing the silts and gravels identified within the test pits.

Looking approximately north across the site.

SITE REPORT	2
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	20 April 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Scala penetrometer testing of the subgrade, as per site report 1.

Observations and Comments:

Fourteen (14) scala penetrometer tests (SP1-SP14) were undertaken across the stripped area – scala logs and test location plan are attached.

SP1-SP7, SP13 & SP14 all encountered 'good ground' within the top 200mm below the surface. SP2 & SP6 were located in a low point, where silt was present, while SP1, SP3-SP5, SP13 & SP14 all encountered gravels.

The area around SP10 had not been completely stripped of topsoil and the test did not encounter refusal, however ultimate geotechnical bearing capacity was identified in the area between 500mm and 950mm below the surface.

SP8, SP9, SP11 & SP12 were conducted to 2.7, 1.95m, 1.90m & 1.85m respectively and showed poor results, with the material identified as silts or fine sand.

It would appear that against the side of the hill a pocket of aeolian soils is present, giving the softer results as well as the alluvial silts.

Gavin & Isaac from Wilson Contractors was present for all the testing, with Isaac undertaking scala tests alongside those done by RDAgritech, to ensure their equipment was calibrated against ours.

Ollie advised Gavin & Isaac that once the scala data had been logged, David Rider would be in touch to discuss bearing capacities.

Gavin advised that filling was to begin on Lots 25 & 26 the week of 26 April 2016.

David Requested a copy of the site's geotechnical investigation report completed for the subdivision for additional information.

Recommendations:

Filling on lots 25 to 26 is approved.

Filling on lots 13 and 14 in the gravel area is approved.

Filling on the remaining lots will need significant subgrade compaction prior to fill placement. RDAgritech propose the following regime to compact the subgrade as best possible given the depth of soft soils for these lots.

10 passes on heavy vibration (low frequency) then 10 passes on light vibration (high frequency) and then 10 static passes.

Continued over...

If a fully loaded Moxy is available, it can be used in addition to the roller and could track roll these areas as it conducts it's other dumping operations. This would increase the depth of compactive effort. The more passes, the better.

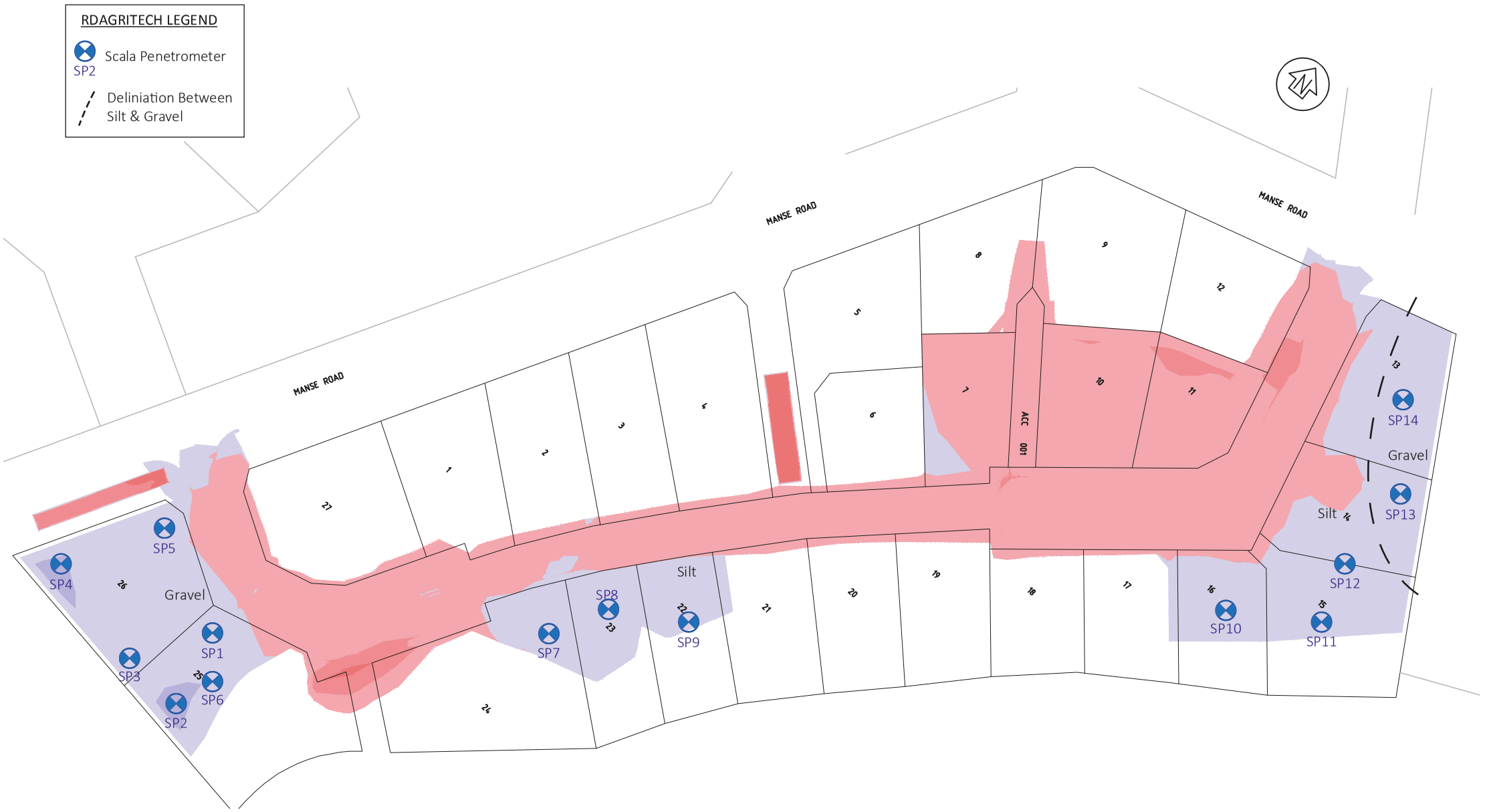
While the fill can be certified to NZS4431, it is still likely that most of the lots will still be subject to specific foundation design by the purchasers, due to differential settlement and soft soils on the natural portions of the sites.

Report Prepared by:

Ollie Behrent
BAppSci (Geol)
PMEG

Links Gate Fill Cert SR2.docx

☑ Issued, date sent 4/05/16
☑ Typed by: (DCS)
☑ Reviewed by: DWR
Attached: Test Location Plan, Scala Logs SP1-SP14



RDAgritech
ENGINEERED BY NATURE

20-April-2016

TEST LOCATION PLAN

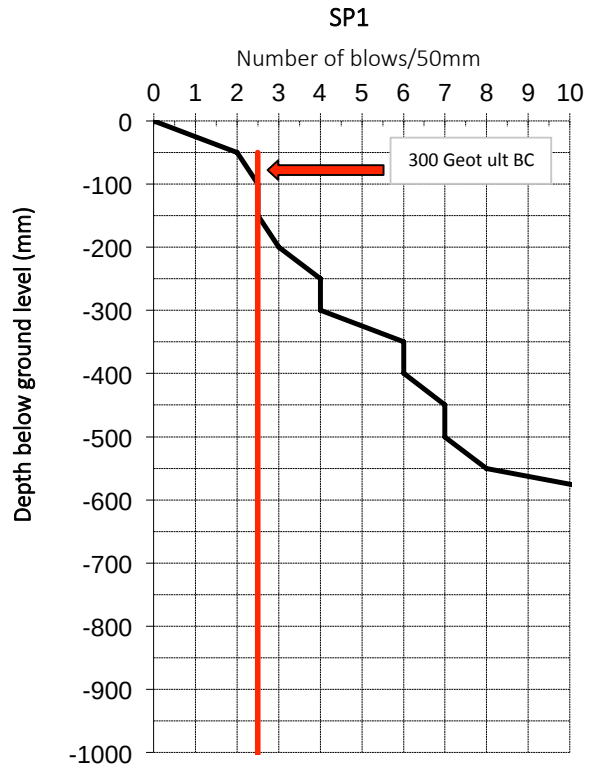
Not to scale

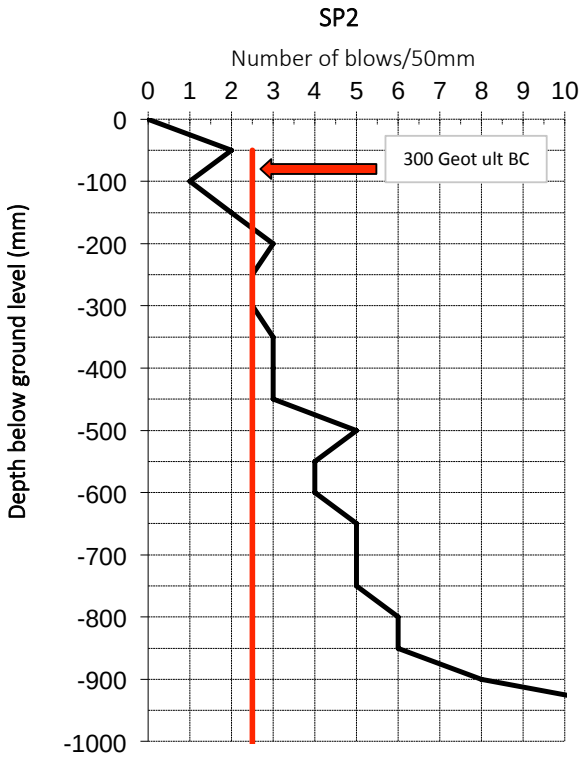
Links Gate Fill Cert
50338

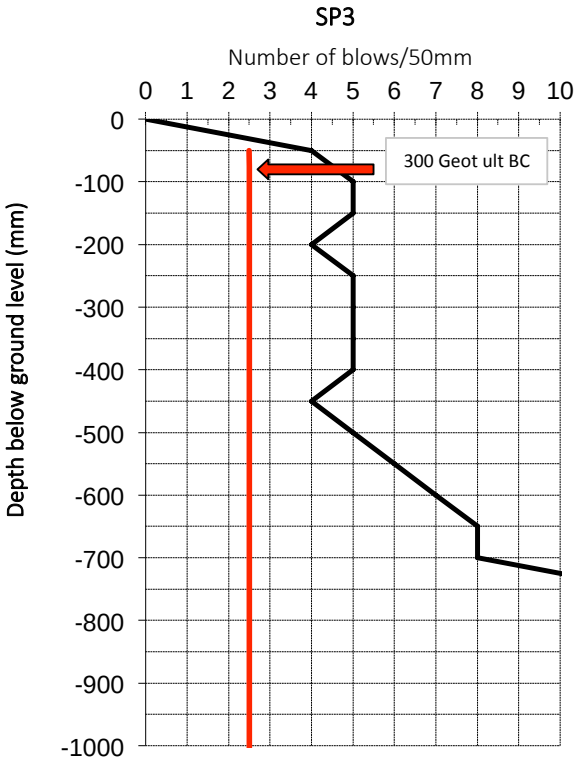
SCALA PENETROMETER RESULTS

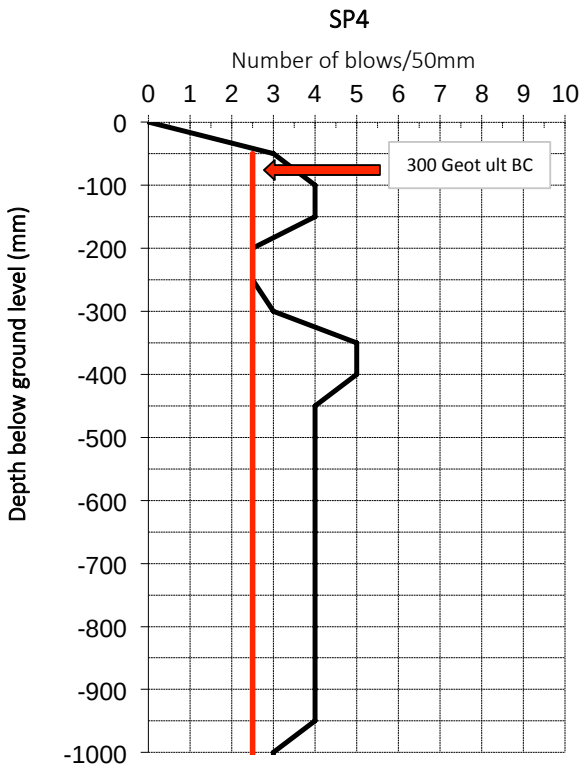
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Road, Arrowtown
CO-ORDINATES:	mE	DATE:	20-Apr-16
See attached plan	mN	OPERATOR:	OB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7







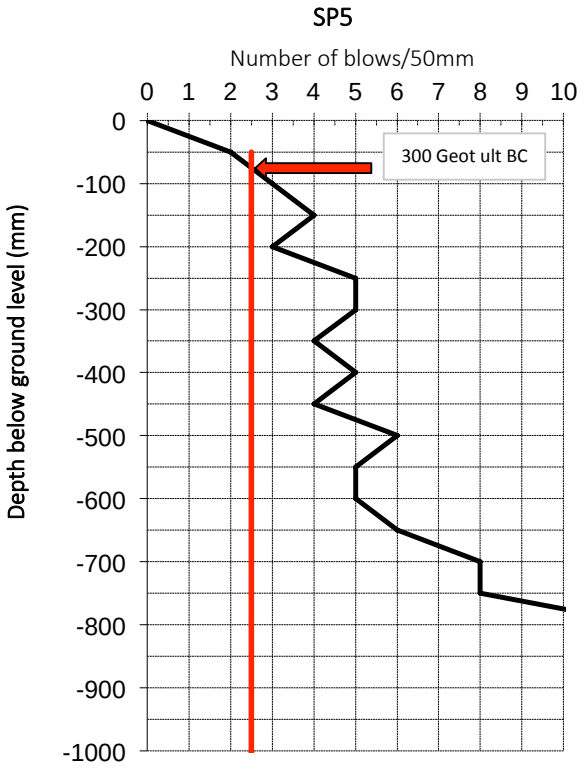


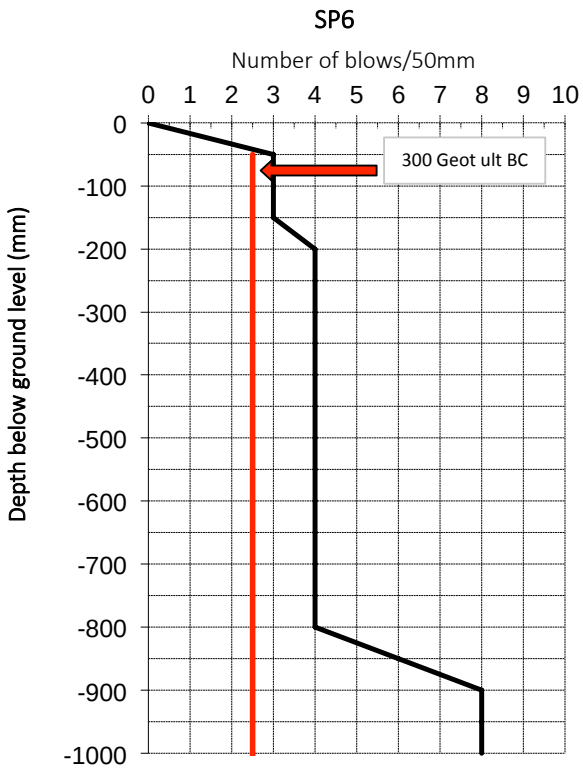
RDAgritech Ltd
PO Box 1711, Invercargill 9840 | PO Box 1880, Queenstown 9348 | 0800 RDAGRI (732474) | www.RDAgritech.co.nz

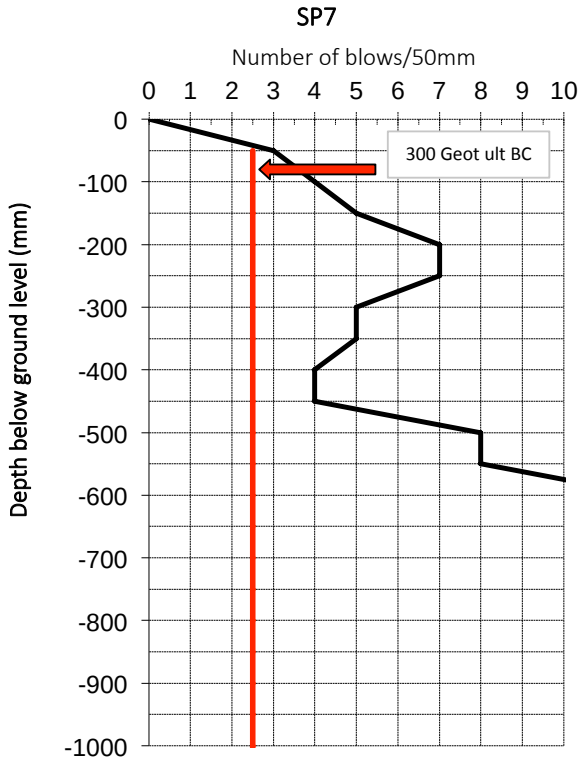
SCALA PENETROMETER RESULTS

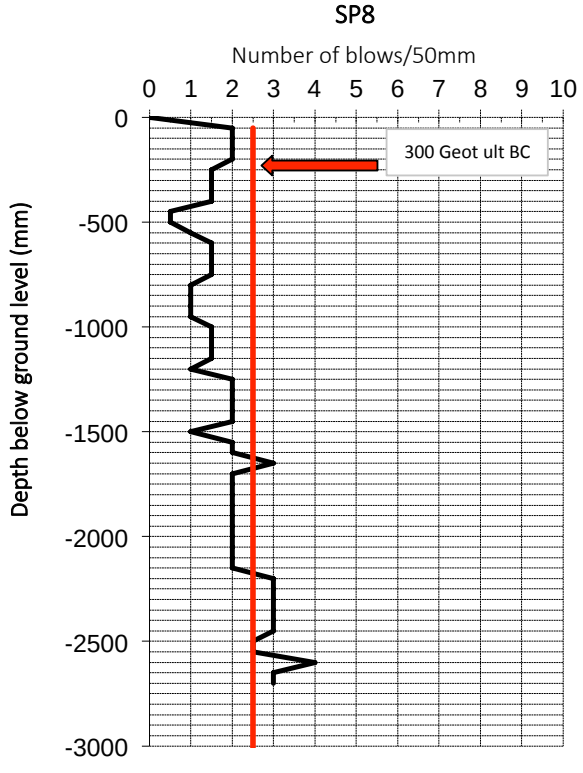
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Road, Arrowtown
CO-ORDINATES:	mE	DATE:	20-Apr-16
See attached plan	mN	OPERATOR:	OB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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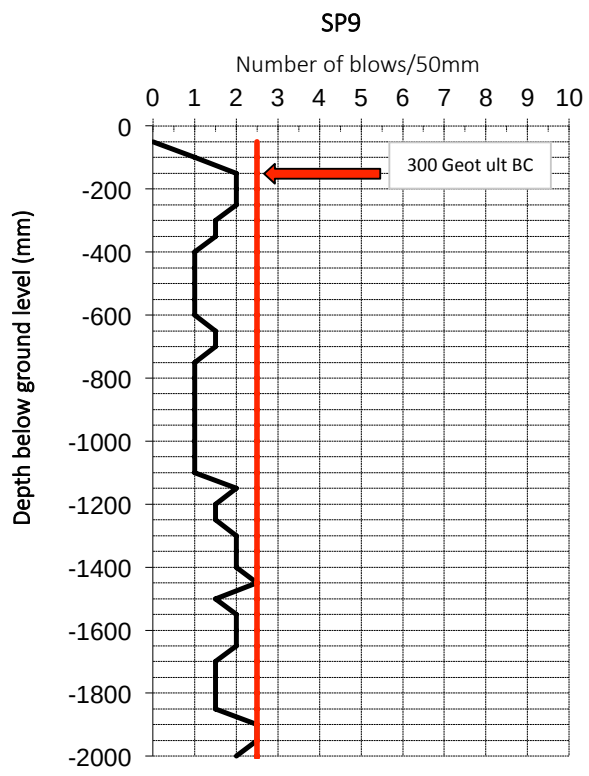
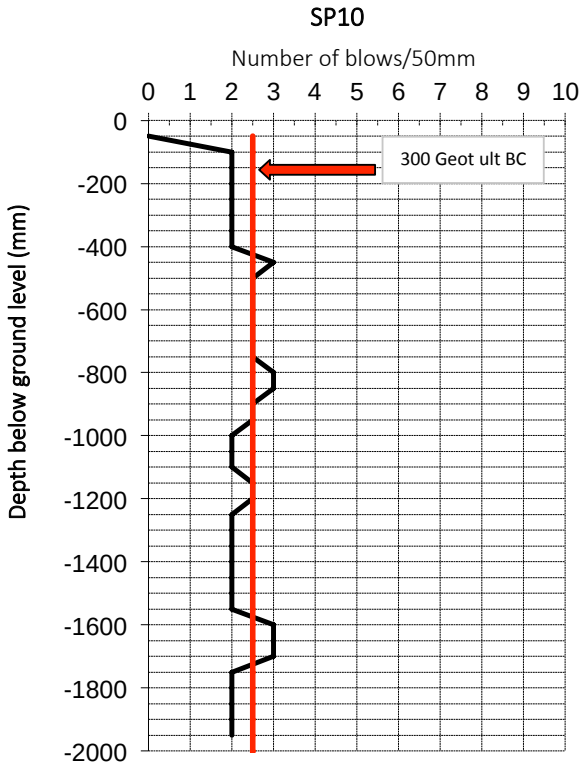
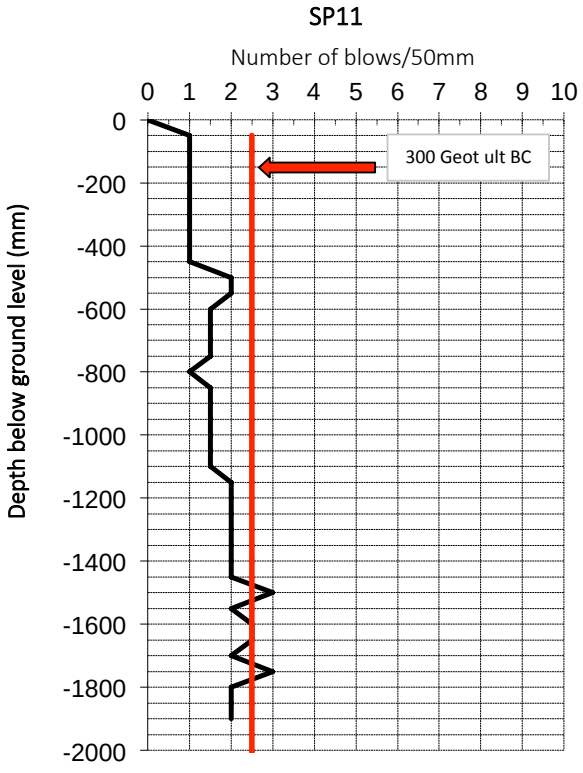
SCALA PENETROMETER RESULTS

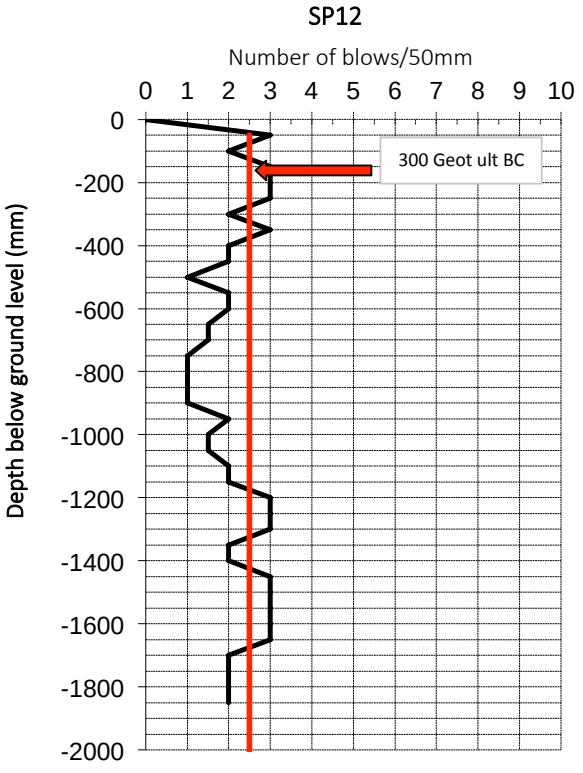
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Road, Arrowtown
CO-ORDINATES:	mE	DATE:	20-Apr-16
See attached plan	mN	OPERATOR:	OB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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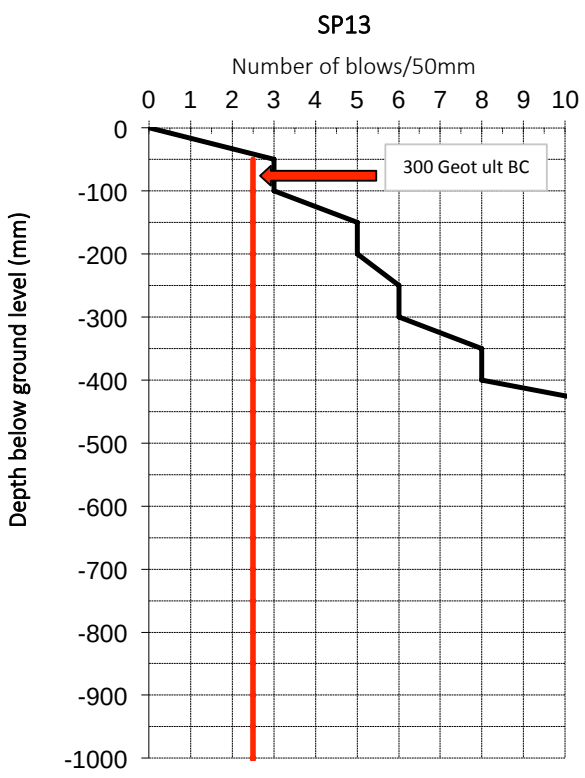
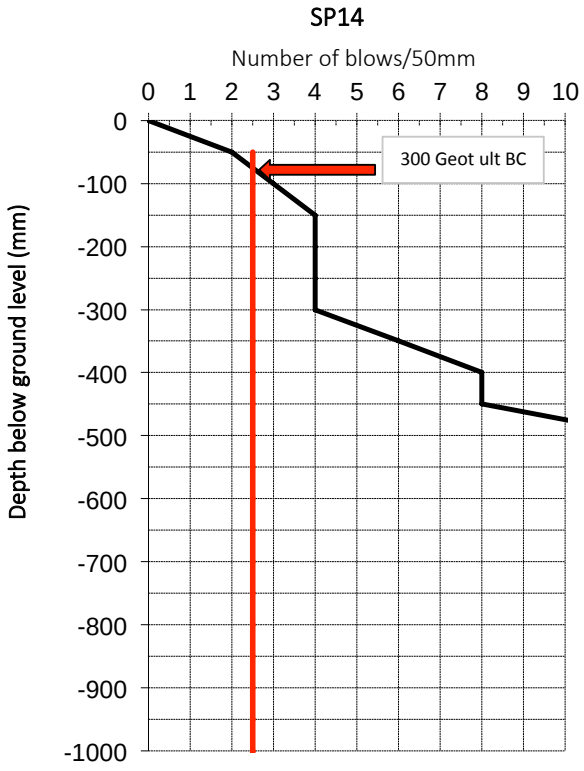
SCALA PENETROMETER RESULTS

JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Road, Arrowtown
CO-ORDINATES:	mE	DATE:	20-Apr-16
See attached plan	mN	OPERATOR:	OB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7





RDAgritech Ltd
PO Box 1711, Invercargill 9840 | PO Box 1880, Queenstown 9348 | 0800 RDAGRI (732474) | www.RDAgritech.co.nz

SITE REPORT	3
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	3 May 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Fill progress.

Observations and Comments:

Minor fill was being placed on Lots 25 & 26 and the undercut of the road 001C & 001B was complete to the shed.

The fill placed on Lot 25 appeared very good.

Fill was being spread by digger on Lot 26, and was ready for compaction.

A discussion was had between David Rider and Isaac, on the methodology being used – currently 300 mm loose layers placed, followed by 30 static passes with the 8 tonne roller.

David advised Isaac to thin the layers to 150 mm loose then conduct 15 static passes, and to keep minor falls across the site fill to shed the impending rain.

The digger driver was spreading fill to get one platform across Lots 25 & 26.

While onsite, David called Central Testing Services and they confirmed that all tests had passed > 95% from last Fridays testing and results would be forwarded in due coarse

Recommendations:

Place the fill material in 150 mm loose layers, then static roll 15 times for silty materials.

No more water should be applied to the material, as past & current forecasted rain should be enough.

Report Prepared by:

David Rider
BSc (Geol)
Senior Engineering
Geologist/Geoprofessional

Links Gate Fill Cert SR3.docx

☑ Issued, date sent 6/05/16
☑ Typed by: DCS
☑ Reviewed by: DWR
Attached: Photos

Photos:

looking approximately west across Lots 25 & 26

SITE REPORT	4
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	13 May 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Scala penetrometer testing of the lot balance subgrade and additional test pit investigations lots 13 to 16 and 22 to 24.

Observations and Comments:

Nineteen scala penetrometers (SP15-33) were conducted across Lots 13-16 and 22-24. 5 test pits (TP1-5) were also conducted along the up slope area towards the south east boundaries of lots 15-16 and 22-24. The balance of lots on the subdivision are not assessed as part of this report.

All of the test pits conducted indicated the slope consisted of a gravelly SILT or silty GRAVEL as shown in the appended Test Pit logs. TP1 was the only pit to not have topsoil exposed at the surface as it had been stripped. There was a lens of organic material between 0.6 m and 0.9 m below the surface in test Pit 1.

SP15 and 16 were conducted into exposed silt across the west boundary of lot 13. Both tests indicated variable subsurface densities. A dense layer was encountered in SP15 until the scala tip reached 650mm from the surface and then less than 300kPa values were achieved. SP13 and SP14 conducted during Site Report 2, indicated the exposed gravel along the east boundary of the site achieved good ground within 150mm of the surface and refusal was encountered at depths less than 0.5 m.

The remaining scala penetrometers indicated 300kPa soils had been encountered prior to the depth the scala test was terminated, between 2.5 m and 3.0 m. The depth 300kPa soils were encountered varied across all test locations beginning at 1.5 m.

SP20, 28 and 29 encountered refusal between depths of 0.8 m and 1.75 m. SP28 and 29 were conducted within close proximity to SP7 from Site Report 2. It is expected that the tests encountered gravel as previous test pits within the road alignment from Site Report 1, indicated gravel was present at depths of around 0.5 m below the surface.

The recommendations below have been compiled based on the previous discussions and with the aim to maximise the building platform area for lots 13 to 16 and 22 to 24 to as far as practical remove the need for specific design of the building foundations.

The majority of the lots have been largely undercut with minor to moderate areas of soft soil removal required to provide a satisfactory raft of fill for the prospective purchasers. The typical raft requirement has been for 1.0m of gravel fill under the design levels for each lot except were the bearing capacity has been satisfactory. The geometry for each lots platform shape and extent has been to maximum platform area while reducing engineering requirements and keeping the current design profiles to prevent any Consent variation requirements. We have also pushed the platforms as far as practical towards the ONF restriction line.

We have produced plans which show the target levels for the raft required based on the design levels of the lots provided. For lots 15, 16 and 22 to 24 as the lot rises to the rear the undercut steps up and is less than 1.0m to account for the better bearing capacity materials towards the rear of these lots.

In some instances the levels may already be achieved or within scratching distance of the current strip levels

Recommendations:

Lots 13 and 14 have minor undercuts required, but generally are able to have fill placed to the design levels.

Lots 15, 16, 22, 23 and 24 require various levels of undercut to achieve the required finished design building subgrade. For these lots, most of the undercut has been performed already as part of the general stripping operation. Given the current and past bad weather the upper 100 to 200mm of current subgrade may need to be removed to stockpile in the lots to dry prior to use as fill if possible. This would be prior to any further fill placement.

The non organic material can either be cut and placed as fill on lots 13 to 14 or stockpiled if conditions are unsuitable.

Due to the varying levels for stripping and finished design levels we would recommend the current asbuilt stripped surface have the proposed design cut surfaces as per the attached markup plans, inputted into the model to determine the volumes for cut to fill and gravel importation required.

No geotextile cloth is required on the cut subgrades prior to fill placement.

Report Prepared by:

David Rider
BSc (Geol)
Senior Engineering
Geologist/Geoprofessional
50338 Links Gate Fill Cert SR4

☑ Issued, date sent 20/05/2016
☑ Reviewed by: DWR

Attached: Photos, Test Location Plan, Scala Logs SP15-SP33

Photos:

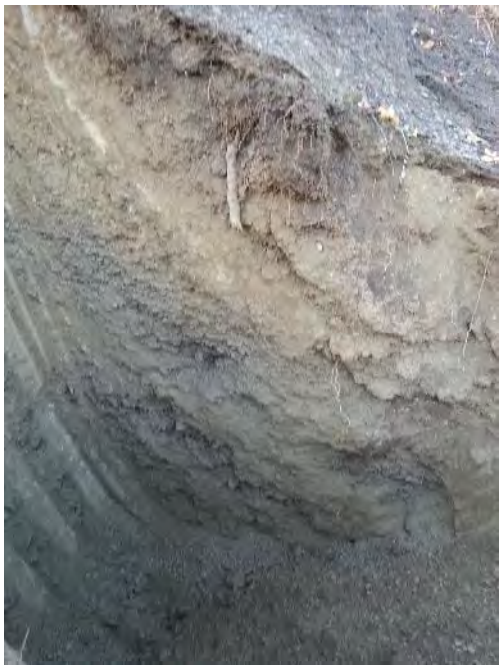


Photo 1: Test Pit 2 indicating surface topsoil and the gravely SILT/SAND subsurface material.

Photo 2: Standing on the road alignment looking west across lots 22-24.

1 RESIDENTIAL VEHICLE CROSSINGS:
150mm THICK 30 MPa EXPOSED AGGREGATE REINFORCED CONCRETE. 1 LAYER 665 MESH CENTRALLY PLACED. 200mm COMPACTED DEPTH GAP 40 BASE COURSE. CUT DOWN MOUNTABLE KERB AS PER QLDC STANDARD DETAILS.

2 SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 MIX AC.

3 THRESHOLDS:
HOLLAND PAVERS LAID IN 45° HERRINGBONE PATERN - COLOUR RIVERSTONE, WITH DOUBLE HEADER COURSE ALL AROUND. REFER BDG DETAILS.

CONCRETE NIB BEAM EDGE RESTRAINT TO BE LAID PERPENDICULAR TO KERB LINE. FINISHED LEVEL TO BE 30mm BELOW FINISHED AC LEVEL. AC TO BE LAID OVER NIB BEAM AND AGAINST PAVER HEADER COURSE. REFER STANDARD DETAILS.

4 CARPARKS:
HOLLAND PAVERS LAID IN 90° HERRINGBONE PATERN - COLOUR RIVERSTONE. NO DOUBLE HEADER COURSE. REFER BDG DETAILS.

5 LETTER BOX AS PER BAXTER DESIGN GROUP DETAILS.

6 WALL AS PER BAXTER DESIGN GROUP DETAILS

7 FOOTPATH AS PER BDG DETAILS

8 CONSTRUCT EARTHWORKS TO TIE END OF ACCESS INTO EXISTING GROUND LEVEL.

SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 MIX AC.

NOTES:

CONTOURS ARE DESIGN FINISHED LEVEL

MINOR INTERVAL 0.2m

MAJOR INTERVAL 1.0m

EXP. AGG. CONC. VEHICLE CROSSING

MANSE ROAD

MANSE ROAD SEAL EDGE

METAL SHOULDER

SWALE INVERT

TO VEST AS ROAD

TIE INTO EXISTING FOOTPATH

MANSE ROAD
CHIP SEAL CARRIAGEWAY

TIE INTO EXISTING SEAL

ROAD 001A

ROAD 001B

NIB KERB

MOUNTABLE KERB

AC CARRIAGEWAY

GRASS BERM

BUILDING PLATFORM
LEVEL 427.00

BUILDING PLATFORM
LEVEL 427.00

BUILDING PLATFORM
LEVEL 426.80

BUILDING PLATFORM
LEVEL 427.35

BUILDING PLATFORM
LEVEL 427.23

BUILDING PLATFORM
LEVEL 426.88

BUILDING PLATFORM
LEVEL 427.17

SP15

SP16

SP17

SP18

SP19

SP20

SP21

SP22

SP23

TP1

TP2

NORTH

ISSUED FOR TENDER 16.01.2016

RDAgritech ENGINEERED BY NATURE	**Engineering Firm:** RDAgritech Ltd, Po Box 1880, Queenstown	**Project:** Links Gate Fill Cert, Manse Road, Arrowtown	**Client:** Wilson Contractors, Po Box 24, Kingston	**Drawing Title:** Site Investigation Plan	Scale: 1:500 @ A3 Job No. 50338 Drawing Number Figure 2 Revision:

1 RESIDENTIAL VEHICLE CROSSINGS
150mm THICK 30 MPa EXPOSED AGGREGATE REINFORCED CONCRETE 1 LAYER 665 MESH CENTRALLY PLACED 200mm COMPACTED DEPTH GAP 40 BASE COURSE CUT DOWN MOUNTABLE KERB AS PER QLDC STANDARD DETAILS.

2 SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 MIX AC.

3 THRESHOLDS
HOLLAND PAVERS LAID IN 45° HERRINGBONE PATERN - COLOUR RIVERSTONE, WITH DOUBLE HEADER COURSE ALL AROUND. REFER BDG DETAILS.

CONCRETE NIB BEAM EDGE RESTRAINT TO BE LAID PERPENDICULAR TO KERB LINE. FINISHED LEVEL TO BE 30mm BELOW FINISHED AC LEVEL. AC TO BE LAID OVER NIB BEAM AND AGAINST PAVER HEADER COURSE. REFER STANDARD DETAILS.

4 CARPARKS
HOLLAND PAVERS LAID IN 90° HERRINGBONE PATERN - COLOUR RIVERSTONE. NO DOUBLE HEADER COURSE. REFER BDG DETAILS.

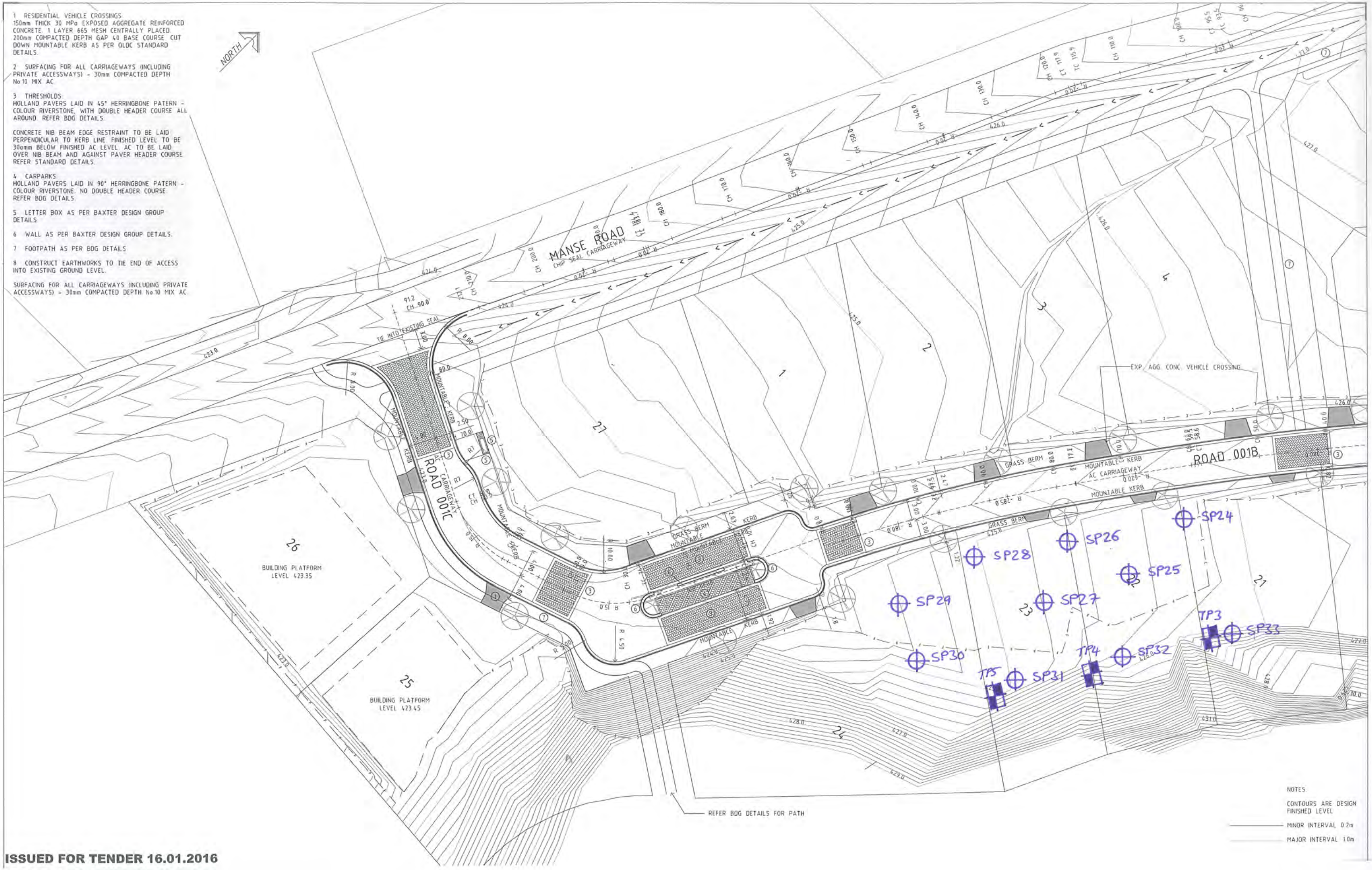
5 LETTER BOX AS PER BAXTER DESIGN GROUP DETAILS.

6 WALL AS PER BAXTER DESIGN GROUP DETAILS.

7 FOOTPATH AS PER BDG DETAILS

8 CONSTRUCT EARTHWORKS TO TIE END OF ACCESS INTO EXISTING GROUND LEVEL.

SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 MIX AC.



ISSUED FOR TENDER 16.01.2016

RDAgritech ENGINEERED BY NATURE	**Engineering Firm:** RDAgritech Ltd, Po Box 1880, Queenstown	**Project:** Links Gate Fill Cert, Manse Road, Arrowtown	**Client:** Wilson Contractors, Po Box 24, Kingston	**Drawing Title:** Site Investigation Plan	Scale: 1:500 @ A3 **Job No.** 50338	**Drawing Number** Figure 1 **Revision:**

TP-1

TEST PIT LOG

RDAgritech
ENGINEERED BY NATURE

JOB NUMBER: 50338	PROJECT:	Links Gate Fill Cert	
	LOCATION:	Manse Road	
CO-ORDINATES:	HOLE STARTED:	13-May-16	
Refer Investigation Site Plan	HOLE FINISHED:	13-May-16	
ELEVATION: m	OPERATOR:	Callum	
DATUM:	COMPANY:	Wilson Contractors	EQUIP.: 21T Excavator

ENGINEERING DESCRIPTIONS							GEOLOGICAL
STRENGTH TESTING	GROUNDWATER	SAMPLES	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PARTICLE SIZE CHARACTERISTICS,PLASTICITY, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SOIL / ROCK TYPE, ORIGIN, DEFECTS, STRUCTURE, FORMATION
			0.3	oxxxxo.ox.	Gravely SILT with some sand; light brown, fine grain sand, fine to coarse angular schist gravel, loose	D/M	Scree Deposit
			0.6	oxxxxo.ox.	Medium dense		
			0.9	ψψψψψψ	Gravely SILT with some sand; brown, organic, 50mm rootlets throughout, loose	M	Buried Topsoil
			1.2	oxxxxo.ox.	Gravely SILT with some sand; brown, fine grain sand, fine to coarse angular schist gravel, medium dense		Scree Deposit
			1.5	oxxxxo.ox.			
			1.8	oxxxxo.ox.			
			2.1		End of test pit, target depth. No groundwater encountered.		
			2.4				
			2.7				
			3.0				

OTHER COMMENTS:	Logged By:	OMB
	Checked Date:	20-May-16
PHOTO REF.:	Sheet:	1 of 1

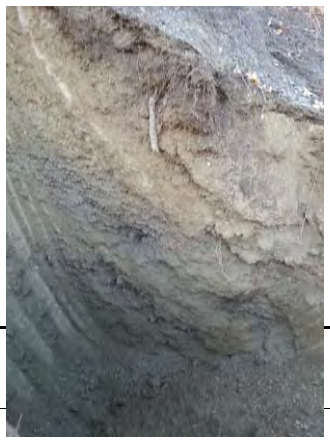
TP-2

TEST PIT LOG

RDAgritech
ENGINEERED BY NATURE

JOB NUMBER: 50338	PROJECT:	Links Gate Fill Cert	
	LOCATION:	Manse Road	
CO-ORDINATES:	HOLE STARTED:	13-May-16	
Refer Investigation Site Plan	HOLE FINISHED:	13-May-16	
ELEVATION: m	OPERATOR:	Callum	
DATUM:	COMPANY:	Wilson Contractors	EQUIP.: 21T Excavator

ENGINEERING DESCRIPTIONS							GEOLOGICAL
STRENGTH TESTING	GROUNDWATER	SAMPLES	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PARTICLE SIZE CHARACTERISTICS,PLASTICITY, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SOIL / ROCK TYPE, ORIGIN, DEFECTS, STRUCTURE, FORMATION
				ΨΨΨΨΨ ΨΨΨΨΨ	Gravely SILT/SAND; dark brown, Organic, fine grain sand,fine to coarse angular schist gravel, holds a ball, 50mm roots, 5mmØ root	M	Topsoil
			0.3	ox.x.x.ox.x	Gravely SILT/SAND; dark brown, fine grain sand,fine to coarse angular schist gravel, holds a ball, medium dense		Scree Deposit
			0.6	ox.x.x.ox.x	No organics present		
			0.9	ox.x.x.ox.x			
			1.2	ox.x.x.ox.x	Dark grey		
			1.5	ox.x.x.ox.x	Dense		
			1.8	ox.x.x.ox.x			
			2.1	ox.x.x.ox.x			
			2.4		End of test pit, target depth. No groundwater encountered.		
			2.7				
			3.0				



OTHER COMMENTS:	Logged By:	OMB
	Checked Date:	20-May-16
PHOTO REF.:	Sheet:	1 of 1

TP-3

TEST PIT LOG

JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Road
CO-ORDINATES:		HOLE STARTED:	13-May-16
Refer Investigation Site Plan		HOLE FINISHED:	13-May-16
ELEVATION:	m	OPERATOR:	Callum
DATUM:		COMPANY:	Wilson Contractors
		EQUIP.:	21T Excavator

STRENGTH TESTING	GROUNDWATER	SAMPLES	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PARTICLE SIZE CHARACTERISTICS, PLASTICITY, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SOIL / ROCK TYPE, ORIGIN, DEFECTS, STRUCTURE, FORMATION
				ΨΨΨΨΨΨ ΨΨΨΨΨΨ ΨΨΨΨΨΨ	SILT with some gravel; dark brown, organic, fine to medium angular schist gravel, fine to 50mm roots throughout, loose	M	Topsoil
			0.3	xoooxooxo	Silty GRAVEL with some sand; light brown, fine grain sand, fine to coarse angular schist gravel, forms a ball, chaotic, medium dense		Scree Deposit
			0.6	xoooxooxo			
			0.9	xoooxooxo			
			1.2	xoooxooxo			
			1.5	xoooxooxo	Dark grey		
			1.8	xoooxooxo			
			2.1	xoooxooxo			
					End of test pit, target depth. No groundwater encountered.		
			2.4				
			2.7				
			3.0				

OTHER COMMENTS:		Logged By:	OMB
		Checked Date:	20-May-16
PHOTO REF.:		Sheet:	1 of 1

TP-4

TEST PIT LOG

RDAgritech
ENGINEERED BY NATURE

JOB NUMBER: 50338	PROJECT:	Links Gate Fill Cert	
	LOCATION:	Manse Road	
CO-ORDINATES:	HOLE STARTED:	13-May-16	
Refer Investigation Site Plan	HOLE FINISHED:	13-May-16	
ELEVATION: m	OPERATOR:	Callum	
DATUM:	COMPANY:	Wilson Contractors	EQUIP.: 21T Excavator

ENGINEERING DESCRIPTIONS							GEOLOGICAL
STRENGTH TESTING	GROUNDWATER	SAMPLES	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PARTICLE SIZE CHARACTERISTICS,PLASTICITY, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SOIL / ROCK TYPE, ORIGIN, DEFECTS, STRUCTURE, FORMATION
			0.3	ΨΨΨΨΨΨ ΨΨΨΨΨΨ ΨΨΨΨΨΨ ΨΨΨΨΨΨ	SILT with some gravel; dark brown, organic, 50mm roots throughout, fine to coarse gravel	M	Topsoil
			0.6	xoxox.xoOx xoxox.xoOx xoxox.xoOx xoxox.xoOx	SILT/GRAVEL with some sand and minor cobbles; light brown, fine grain sand, fine to coarse angular schist gravel, angular cobbles, forms a ball, medium dense		Scree Deposit
			0.9	xoxox.xoOx xoxox.xoOx xoxox.xoOx xoxox.xoOx			
			1.2	xoxox.xoOx xoxox.xoOx xoxox.xoOx xoxox.xoOx			
			1.5	xoxox.xoOx xoxox.xoOx xoxox.xoOx xoxox.xoOx			
			1.8	xoxox.xoOx xoxox.xoOx xoxox.xoOx xoxox.xoOx	Loose		
			2.1	xoxox.xoOx xoxox.xoOx	Medium dense		
			2.4		End of test pit, target depth. No groundwater encountered.		
			2.7				
			3.0				

OTHER COMMENTS:	Logged By:	OMB
	Checked Date:	20-May-16
PHOTO REF.:	Sheet:	1 of 1

TP-5

TEST PIT LOG

RDAgritech
ENGINEERED BY NATURE

JOB NUMBER: 50338	PROJECT:	Links Gate Fill Cert	
	LOCATION:	Manse Road	
CO-ORDINATES:	HOLE STARTED:	13-May-16	
Refer Investigation Site Plan	HOLE FINISHED:	13-May-16	
ELEVATION: m	OPERATOR:	Callum	
DATUM:	COMPANY:	Wilson Contractors	EQUIP.: 21T Excavator

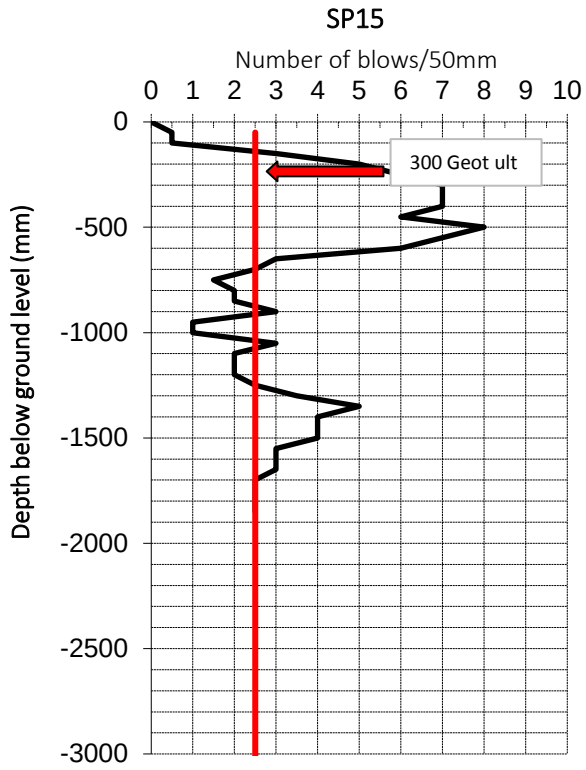
ENGINEERING DESCRIPTIONS							GEOLOGICAL
STRENGTH TESTING	GROUNDWATER	SAMPLES	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PARTICLE SIZE CHARACTERISTICS,PLASTICITY, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SOIL / ROCK TYPE, ORIGIN, DEFECTS, STRUCTURE, FORMATION
			0.3	ψψψψψψ ψψψψψψ ψψψψψψ ψψψψψψ ψψψψψψ ψψψψψψ	SILT with minor gravel; dark brown, organic, fine to medium coarse schist gravel, 50mm rootlets throughout, loose	M	Topsoil
			0.6 0.9 1.2 1.5	xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo. xoxoxo.xo.	Gravelly SILT with minor fine sand; light brown, fine grain sand, fine to coarse schist gravel, forms a ball, medium dense, chaotic		Scree Deposit
			1.8	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx	SILT; dark grey,massive, forms a ball, loose		Loess colluvium
			2.1	xooxooxo xooxooxo xooxooxo xooxooxo	Silty GRAVEL; dark grey, fine to coarse angular coarse gravel, medium dense		Scree Deposit
			2.4 2.7 3.0		End of test pit, target depth. No groundwater encountered.		

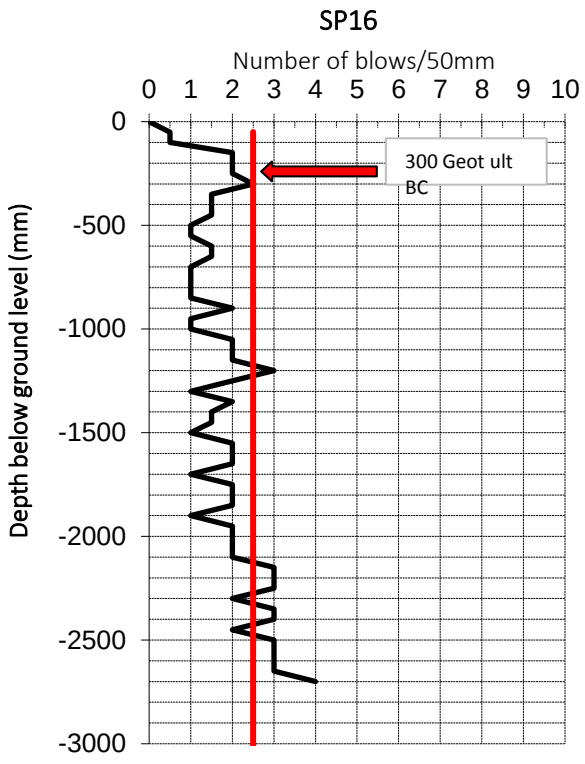
OTHER COMMENTS:	Logged By:	OMB
	Checked Date:	20-May-16
PHOTO REF.:	Sheet:	1 of 1

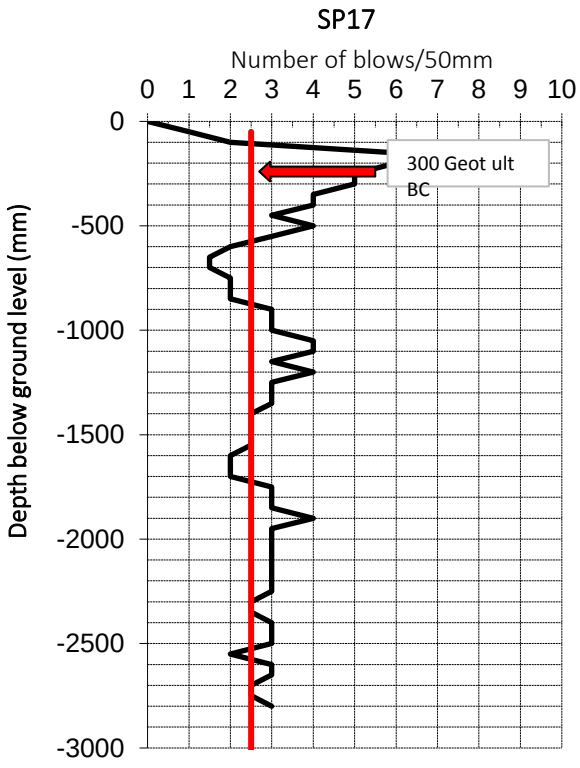
SCALA PENETROMETER RESULTS

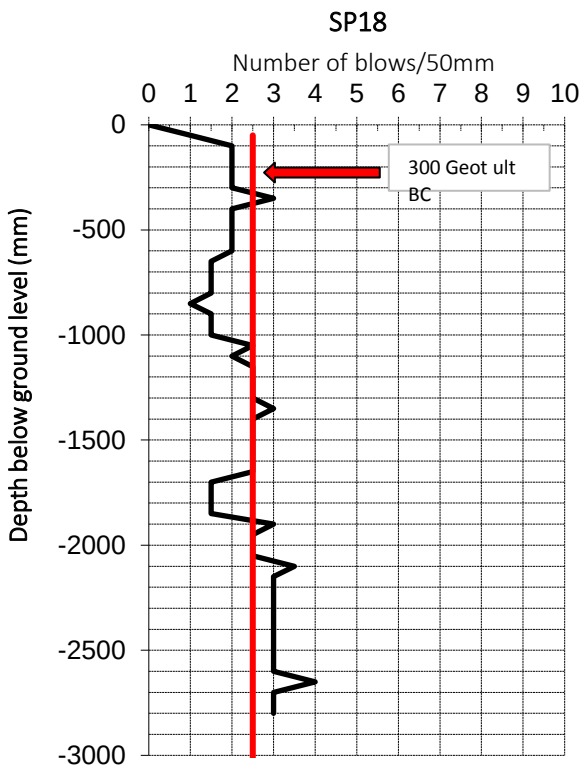
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Rd, Arrowtown
CO-ORDINATES:	mE	DATE:	16-May-16
See attached plan	mN	OPERATOR:	OMB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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SCALA PENETROMETER RESULTS

JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Rd, Arrowtown
CO-ORDINATES:	mE	DATE:	16-May-16
See attached plan	mN	OPERATOR:	OMB

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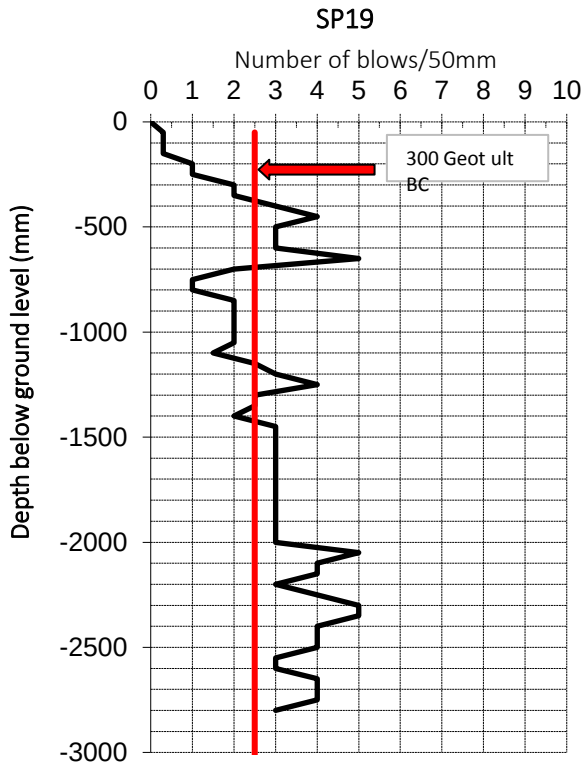

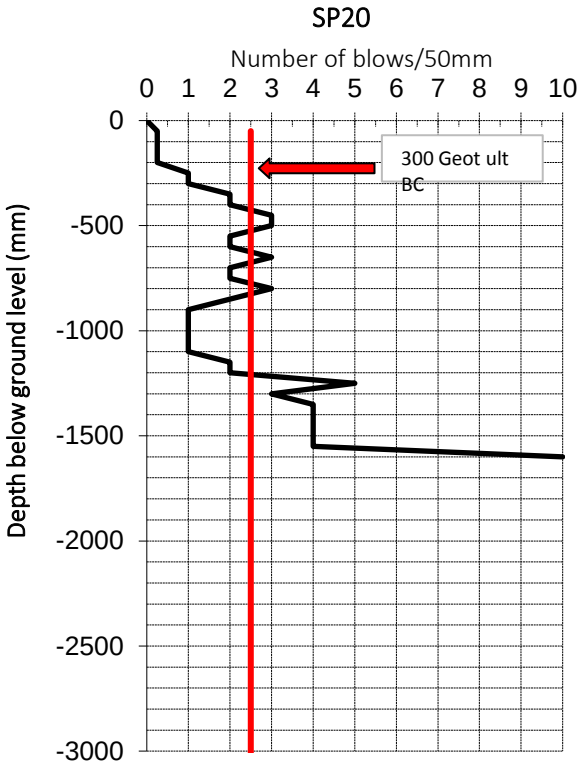

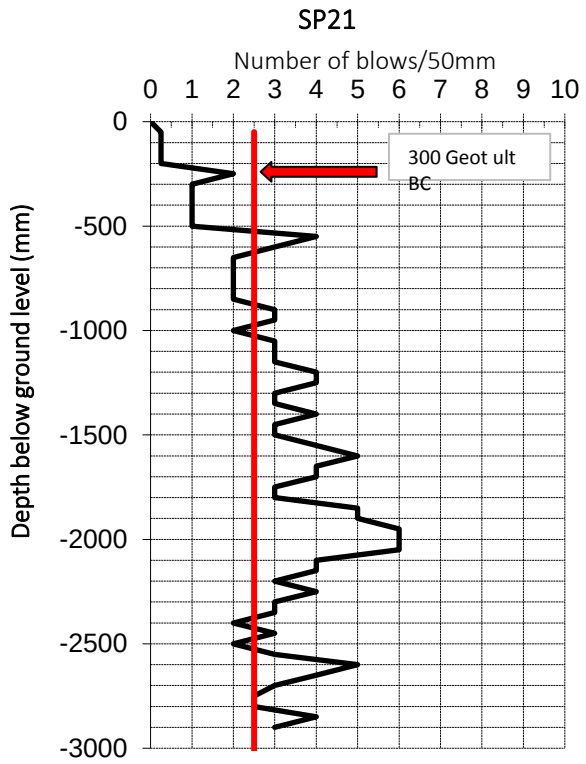

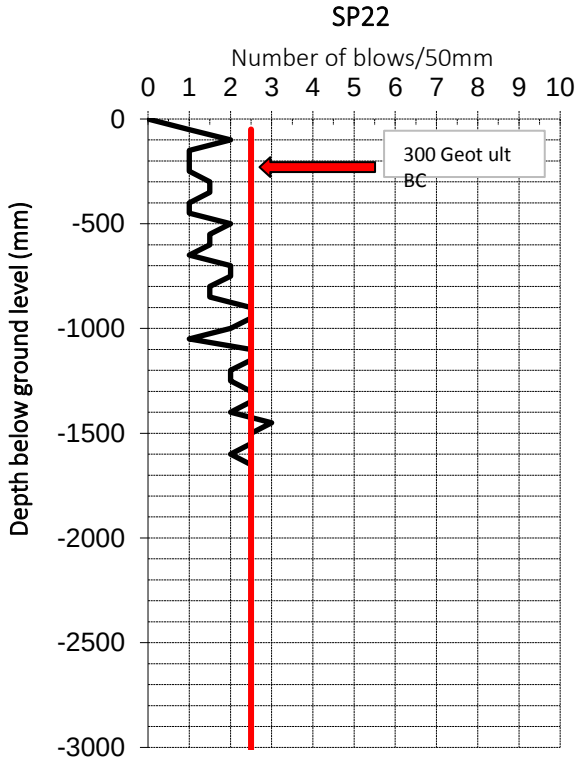

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SCALA PENETROMETER RESULTS

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		LOCATION:	Manse Rd, Arrowtown
CO-ORDINATES:	mE	DATE:	16-May-16
See attached plan	mN	OPERATOR:	OMB

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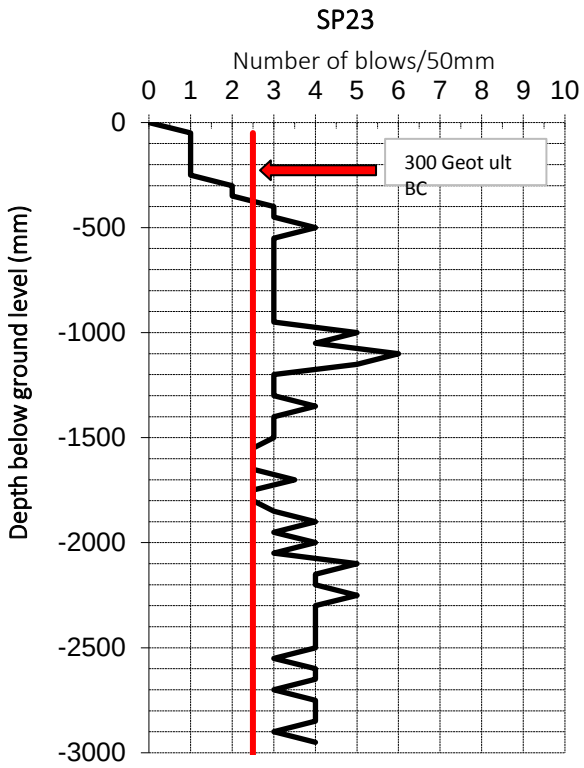

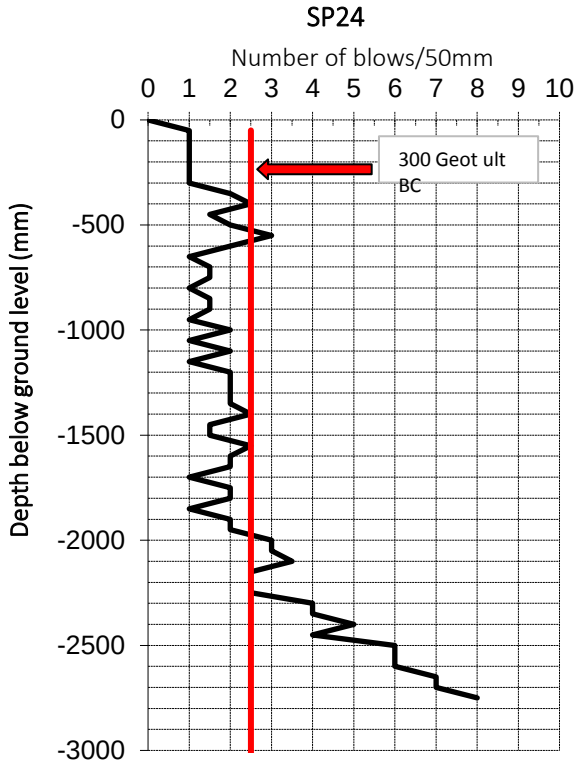

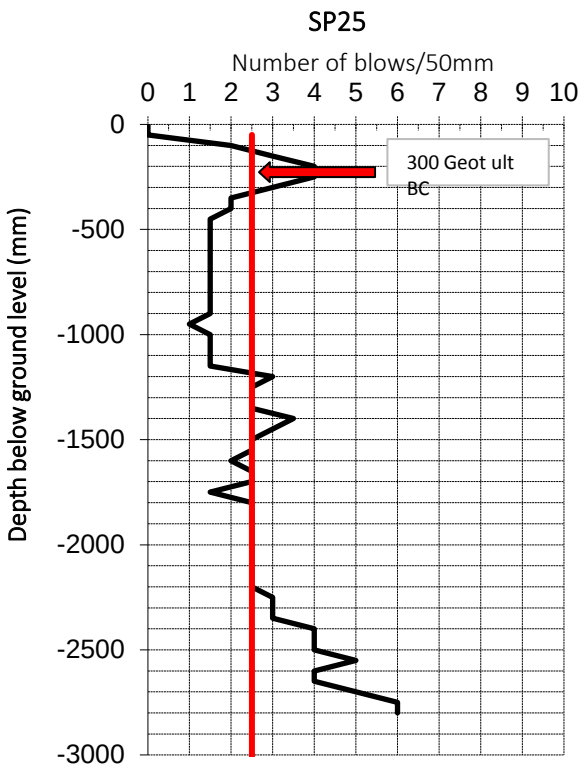

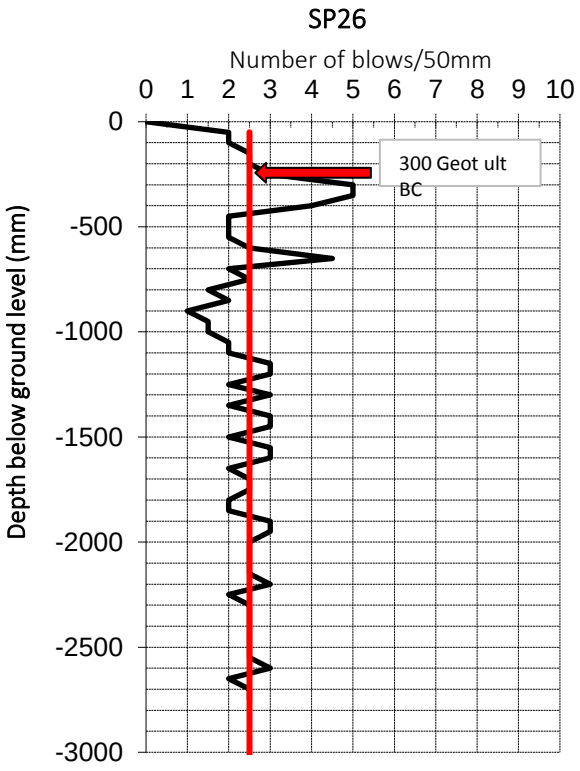

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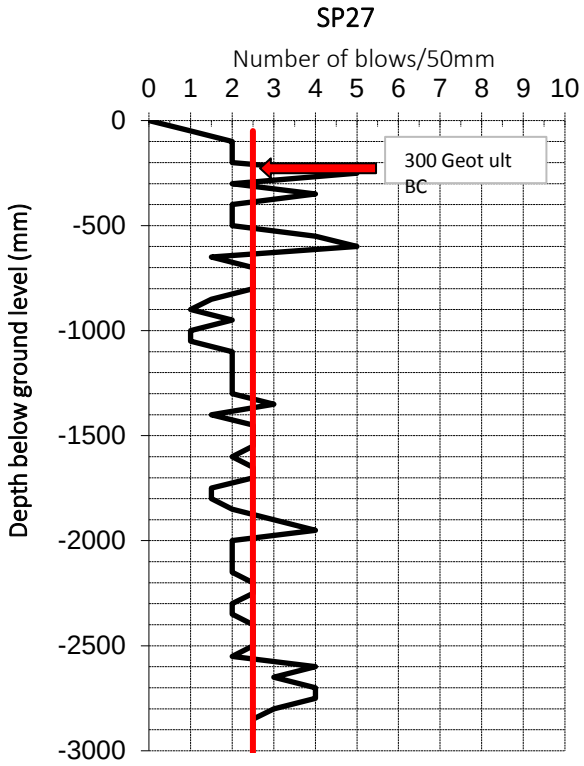
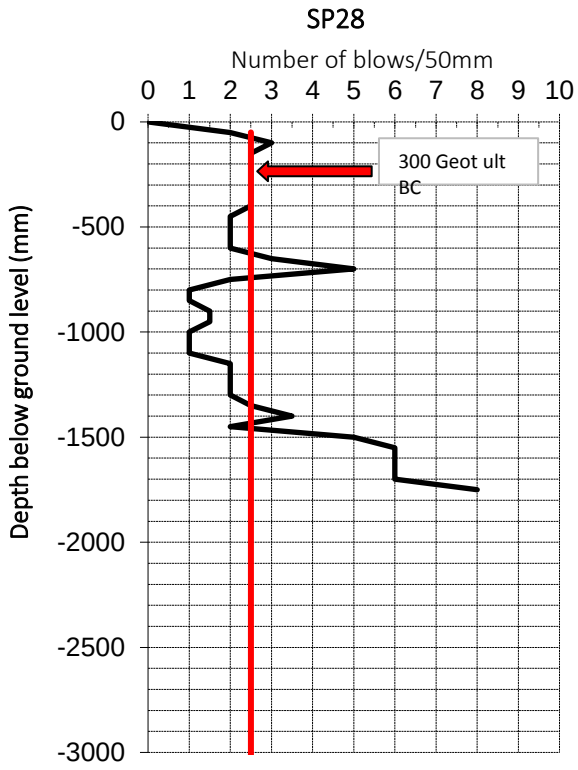
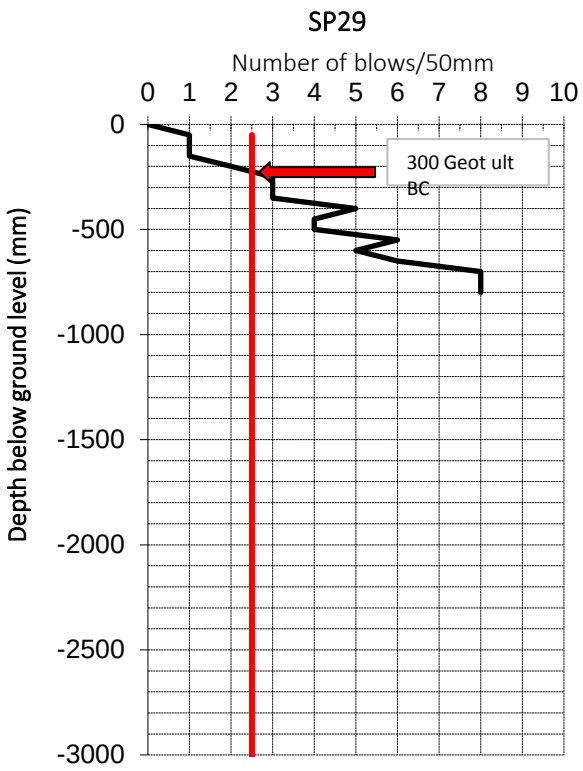
SCALA PENETROMETER RESULTS

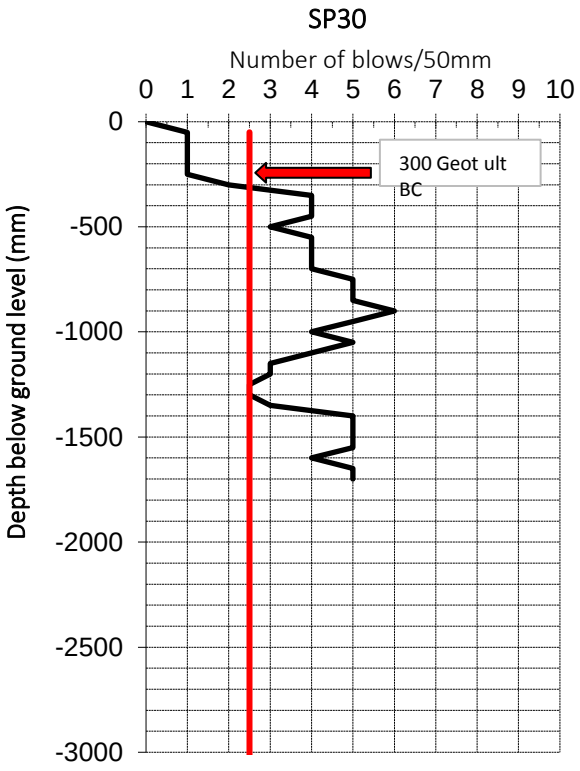
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Rd, Arrowtown
CO-ORDINATES:	mE	DATE:	16-May-16
See attached plan	mN	OPERATOR:	OMB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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SCALA PENETROMETER RESULTS

JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert
		LOCATION:	Manse Rd, Arrowtown
CO-ORDINATES:	mE	DATE:	16-May-16
See attached plan	mN	OPERATOR:	OMB

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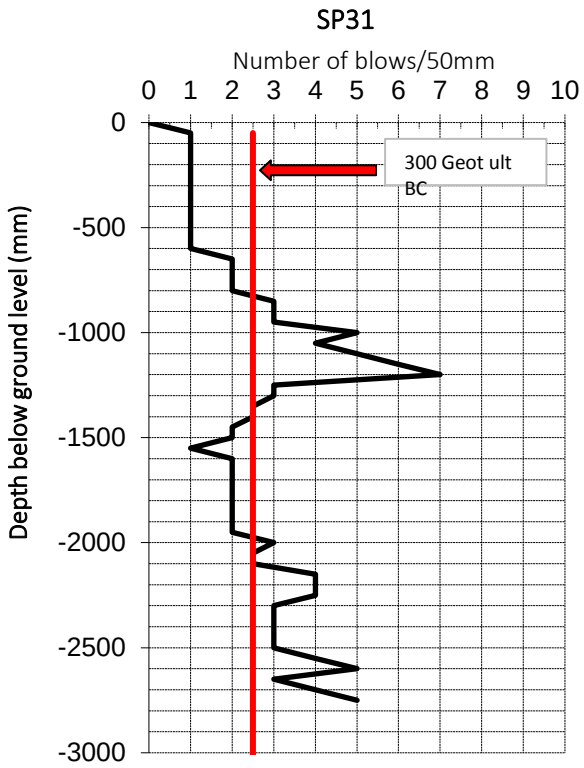
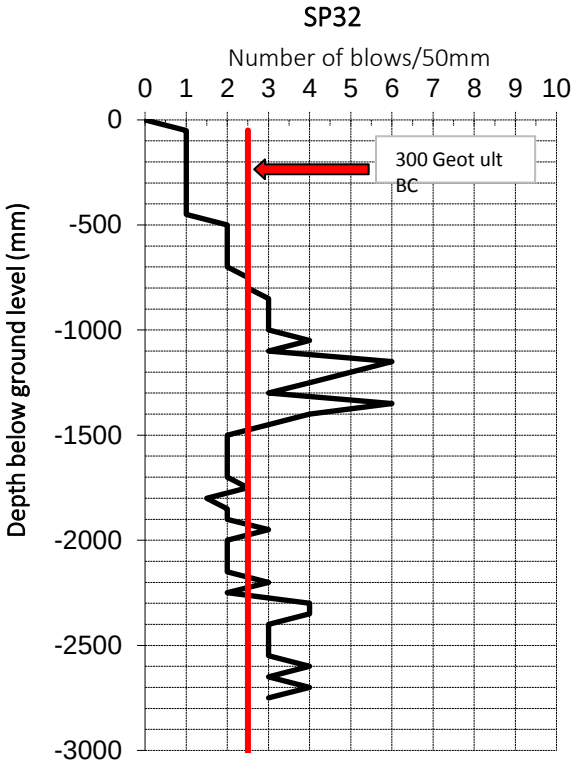
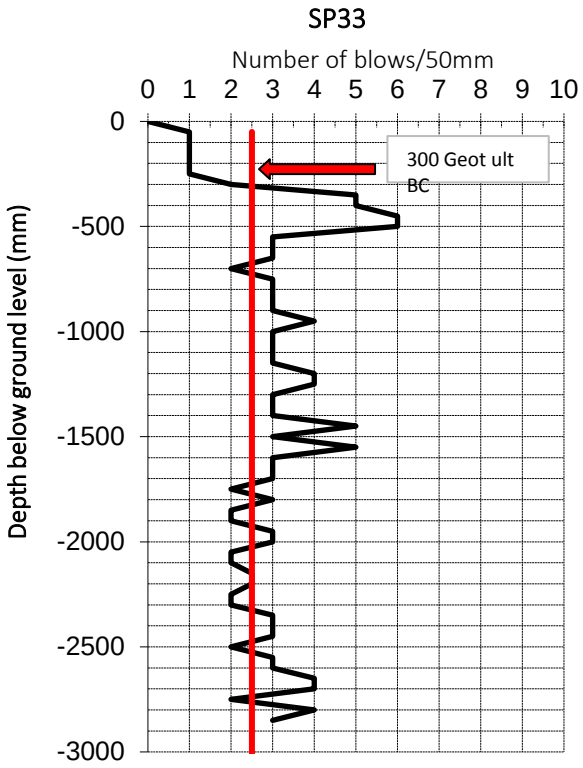




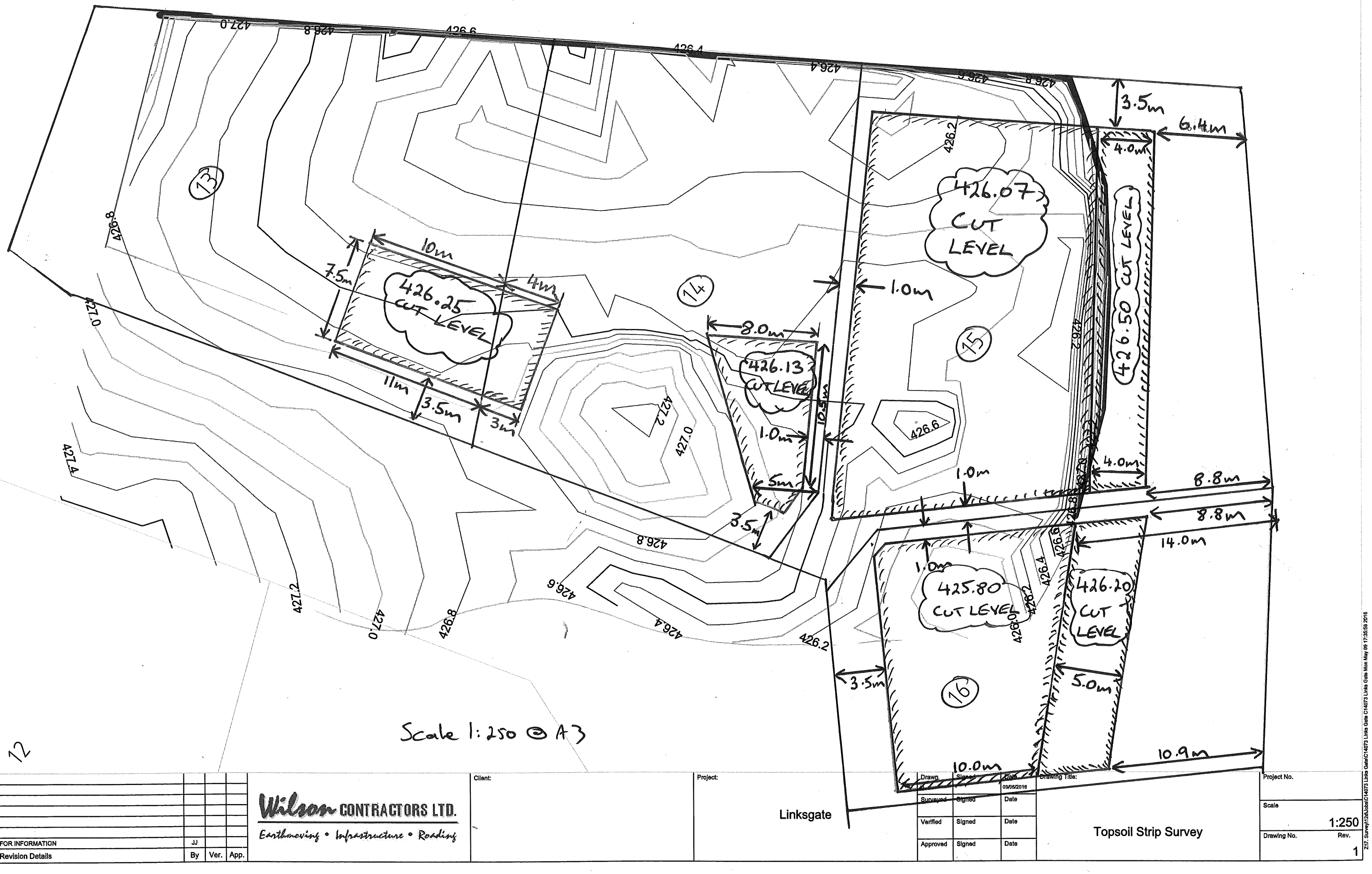


RDAgritech Ltd
PO Box 1711, Invercargill 9840 | PO Box 1880, Queenstown 9348 | 0800 RDAGRI (732474) | www.RDAgritech.co.nz

A3

Jwk RDAgridadm 20/5/16
50338 LINKS GATE

LOT 13 TO 16 DESIGN LEVELS FOR RAFTS



Scale 1:250 @ A3

12

Rev.	Date	Revision Details	By	Ver.	App.
1	09/05/2016	FOR INFORMATION	JJ		

Wilson CONTRACTORS LTD.
Earthmoving • Infrastructure • Roading

Client:

Project: Linksgate

Drawn	Signed	Date	09/05/2016
Surveyed	Signed	Date	
Verified	Signed	Date	
Approved	Signed	Date	

Drawing Title: Topsoil Strip Survey

Project No.

Scale 1:250

Drawing No. 1 Rev.

237: Survey\726\Jobs\C14073 Links Gate\C14073 Links Gate C14073 Links Gate Mon May 09 17:32:58 2016

A3

RDAgritech LTD 20/5/16

50338 LINKS GATE

LOTS 22 - 24 DESIGN LEVELS FOR RAFTS

Scale 1:250 @ A3

Rev.	Date	Revision Details	By	Ver.	App.
1	09/05/2016	FOR INFORMATION	JJ		

Wilson CONTRACTORS LTD.
Earthmoving • Infrastructure • Roading

Client:

Project: Linksgate

Drawn JJ	Signed	Date 09/05/2016
Surveyed	Signed	Date
Verified	Signed	Date
Approved	Signed	Date

Drawing Title: Topsoil Strip Survey

Project No.

Scale 1:250

Drawing No. Rev. 1

SITE REPORT	5
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	15 June 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Site visit for fill inspection, as requested by contractor.

Observations and Comments:

Filling of Lots 13 & 14 was underway, with Shotover gravels being utilised.

As the neighbour had complained about vibration from the compactors and digger, vibration had stopped and only static rolling was underway.

The new fill methodology being utilised was 100 mm loose layers & 15 static passes with the roller.

David advised that If a Moxy truck was available, then this could be used to roll fill as well.

Recommendations:

Fill is to be placed in 100 mm loose layers, followed by 15 static passes with the roller. If possible, additional rolling should be undertaken utilising Moxy trucks.

Once 500-600 mm of fill placed, CTS should be contacted to undertake NDM testing. Note - NZ static curve testing is to be used for compliance, not vibrating curve.

Report Prepared by:

David Rider
BSc (Geol)
Senior Engineering Geologist/Geoprofessional
50338 Links Gate Fill Cert SR5.docx
☑ Issued, date sent 20/06/2016
☑ Typed by DCS
☑ Reviewed by: DWR
Attached: Photos

Photos:

Photo 1: Showing rolling of the placed fill material underway

SITE REPORT	6
Job Title	Links Gate Fill Cert
Physical Address	Manse Road
	Arrowtown
Job No.	50338
Date	4 July 2016

To	Name	Company	Email
☑	John Sutherland	Wilson Contractors	john@wilsoncontractors.co.nz
☑	Isaac Harrison	Wilson Contractors	isaac@wilsoncontractors.co.nz

Work Reviewed:

Site visit for fill inspection, as requested by contractor.

Observations and Comments:

Thirteen (13) Scala Penetrometers were conducted across lots 13-16 and 22-24 inclusive, to provide a comprehensive representation of fill compaction. The fill material used was Shotover River Gravel. The results indicated adequate compaction had been achieved as indicated in SP34-SP46, attached.

The fill appeared well compacted and free of organics, and the site was generally tidy. Central Testing Services had been onsite and conducted NDM testing to confirm relative compaction efforts had been achieved.

At the time of this site visit, Wilson Contractors were installing services within the road carriageway.

Recommendations:

Continue compaction for all further filling, as current methodology is proving adequate.

Report Prepared by:

David Rider
BSc (Geol)
Senior Engineering Geologist/Geoprofessional

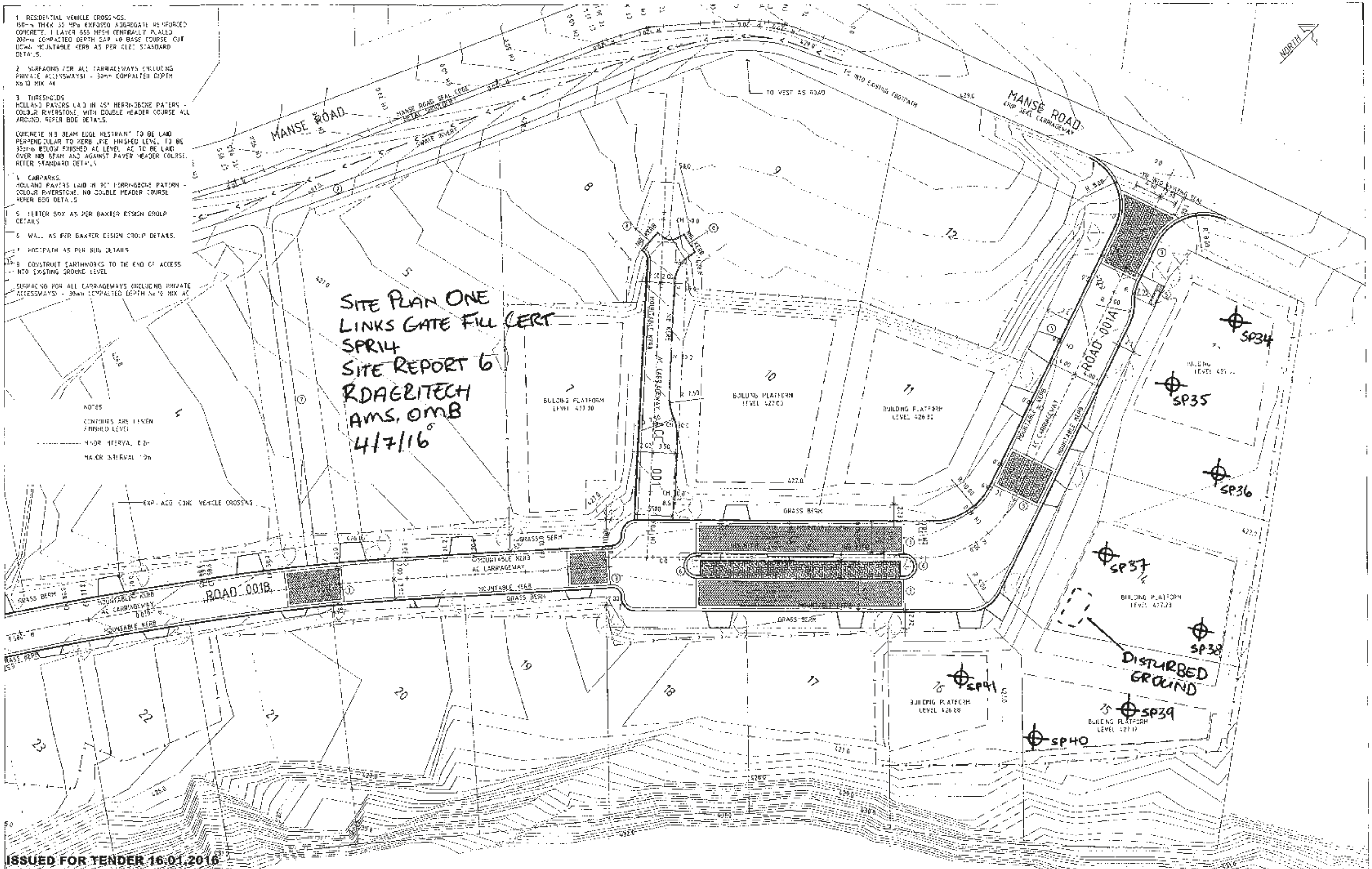
50338 Links Gate Fill Cert SR6.docx

☑ Issued, date sent 12/09/16
☑ Typed by AMS
☑ Reviewed by: DWR

Attached: Photos, Site Plans, SP34-46

Photos:

Photo 1: fill Area



Shotover Design Limited trading as

Clark Fortune McDonald & Associates

Licensed Cadastral Surveyors - Land Development - Planning Consultants

300 Lower Shotover Road, P.O.Box 553 Queenstown
Tel. (03)441-6044, Fax (03)442-1066, Email admin@cfma.co.nz
21 Reece Crescent, P.O.Box 550, Wanaka
Tel. (03)443-4446, Fax (03)443-4445, Email admin@cfma.co.nz
Shop 2, Otago House, 475 Moray Place, P.O. Box 5963
Tel. (03)470-1582, Fax (03)470-1583, Email admin@cfma.co.nz

Rev.	Date	Revision Details	By
A	21.9.2015	ROAD LAYOUT	TS
B	27.10.2015	ROAD LAYOUT, TOPO ETC	TS
C	05.11.2015	ROAD LAYOUT, SERVICES, DRAINAGE DETAILS ETC	TS
D	15.12.2015	ROAD LAYOUT, LOT BDYS, CONTOURS	TS

LINKS GATE SUBDIVISON
STAGE 1
ROAD LAYOUT

Client: **SUBURBAN ESTATES LTD**

Surveyed	Signed	Date	Job No.	Drawing No.
			9579	E003 SHEET 002
Drawn: TPS	Signed	Date: 07.15	Scale: 1:250 @ A1, 1:500 @ A3	
Designed: CCH	Signed	Date: 07.15	Datum & Level: MSL	Rev. D

1. RESIDENTIAL VEHICLE CROSSINGS
150mm THICK 30 MPa EXPOSED AGGREGATE REINFORCED CONCRETE 1 LAYER SA3 MESH CENTRALLY PLACED 200mm COMPACTED OPEN GAP A0 BASE COURSE CUT DOWN MOUNTABLE KERB AS PER QLDC STANDARD DETAILS

2. SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 HOT MIX AC.

3. THRESHOLDS
HOLLAND PAVERS LAID IN 45° HERRINGBONE PATERN - COLOUR RIVERSTONE, WITH DOUBLE HEADER COURSE ALL AROUND REFER BDG DETAILS

CONCRETE N/B BEAM EDGE RESTRAINT TO BE LAID PERPENDICULAR TO KERB THE FINISHED LEVEL TO BE 300mm BELOW FINISHED AC LEVEL. AC TO BE LAID OVER N/B BEAM AND AGAINST PAVER HEADER COURSE REFER STANDARD DETAILS

4. CARPARKS
HOLLAND PAVERS LAID IN 90° HERRINGBONE PATERN COLOUR RIVERSTONE NO DOUBLE HEADER COURSE. REFER BDG DETAILS

5. LETTER BOX AS PER BAXTER DESIGN GROUP DETAILS

6. WALL AS PER BAXTER DESIGN GROUP DETAILS.

7. FOOTPATH AS PER BDG DETAILS

8. CONSTRUCT EARTHWORKS TO TIE END OF ACCESS INTO EXISTING GROUND LEVEL

SURFACING FOR ALL CARRIAGEWAYS (INCLUDING PRIVATE ACCESSWAYS) - 30mm COMPACTED DEPTH No.10 HOT MIX AC.

NORTH

MANSE ROAD
CHIP SEAL CARRIAGEWAY

ROAD 001C

ROAD 001B

EXP. ASS CONC VEHICLE CROSSING

GRASS BERM

MOUNTABLE KERB

AC CARRIAGEWAY

BUILDING PLATFORM
LEVEL 423.15

BUILDING PLATFORM
LEVEL 423.45

SP43

SP46

SP44

SP42

SP45

REFER BDG DETAILS FOR PATH

Site Plan Two
Links Gate Fill Cert
SPR14
Site Report 6
RDAgritech
AMS, OMB
4/7/16

NOTES:

CONTOURS ARE DESIGN FINISHED LEVEL

MINOR INTERVAL 0.2m

MAJOR INTERVAL 1.0m

ISSUED FOR TENDER 16.01.2016

Rev	Date	Revision Details	By
A	21.10.2015	ROAD LAYOUT	TS
B	21.10.2015	ROAD LAYOUT, TDPC ETC	TS
C	29.11.2015	ROAD LAYOUT, SERVICES, DRAINAGE DETAILS ETC	TS
D	15.12.2015	ROAD LAYOUT, RET WALLS, CONTOURS	TS

Shotover Design Limited trading as
Clark Fortune McDonald & Associates
Licensed Cadastral Surveyors - Land Development - Planning Consultants
309 Lower Shotover Road, P.O.Box 553 Queenstown
Tel. (03)441-6044, Fax (03)442-1366, Email admin@cfma.co.nz
21 Reece Crescent, P.O.Box 555, Wanaka
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Shop 2, Otago House, 479 Moray Place, P.O. Box 5960
Tel. (03)470-1582, Fax (03)470-1583, Email admin@cfma.co.nz

LINKS GATE SUBDIVISON
STAGE 1
ROAD LAYOUT

Client: SUBURBAN ESTATES LTD

Job No: 9579 Drawing No: E003 SHEET 003

Surveyed: Signed: Date:

Drawn: TPS Signed: Date: 03.15 Scale: 1:250 @ A1, 1:500 @ A3

Designed: CCH Signed: Date: 03.15 Datum & Level: MSL Rev: D

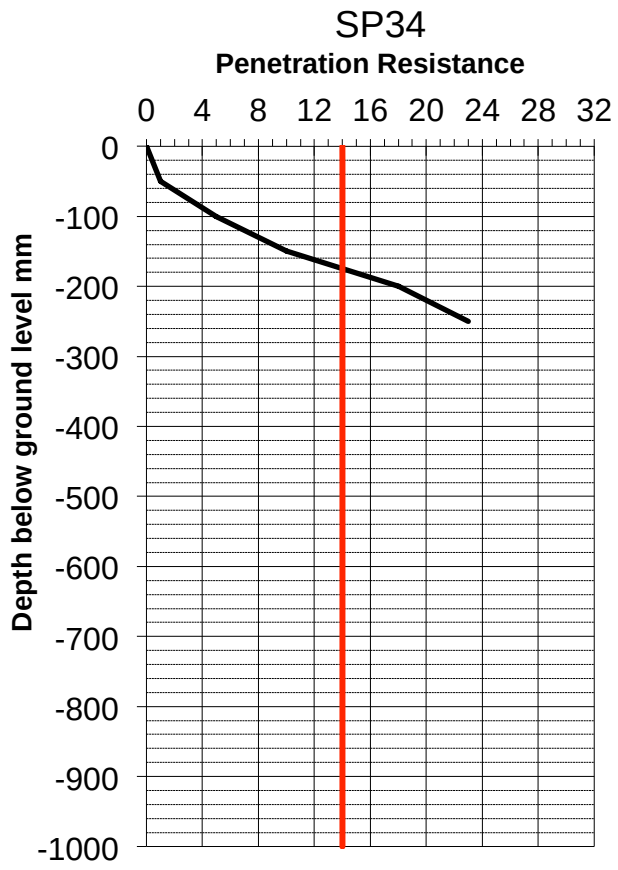
Issued for: All dimensions shown are in metres unless otherwise stated. Any person using Clark Fortune McDonald drawings and other data accepts the risk of: 1) using the drawings and other data in electronic form without requesting and checking them for accuracy against the original hard copy versions. 2) using the drawings and other data for any purpose not agreed to in writing by Clark Fortune McDonald. Copyright on this drawing is reserved.

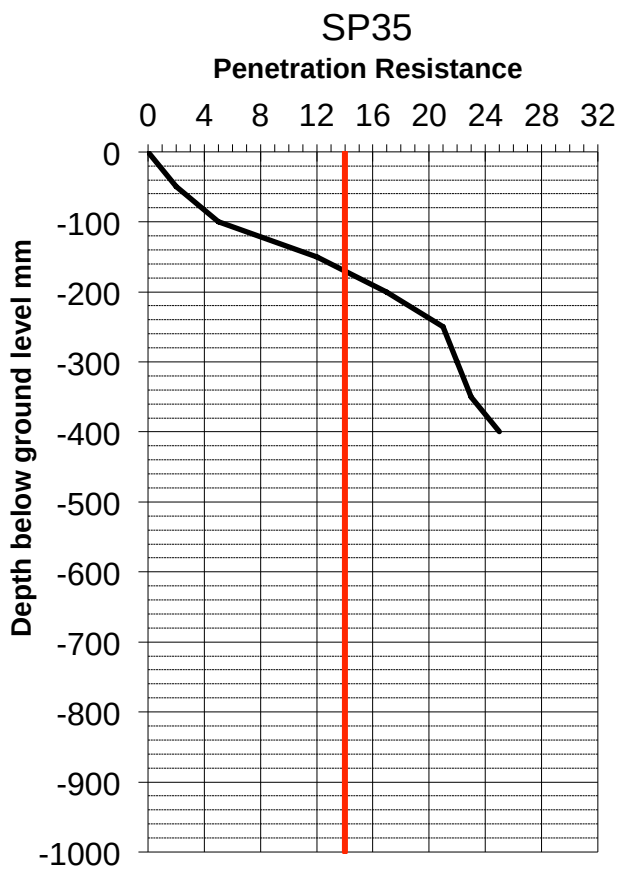
PENETRATION RESISTANCE TESTING

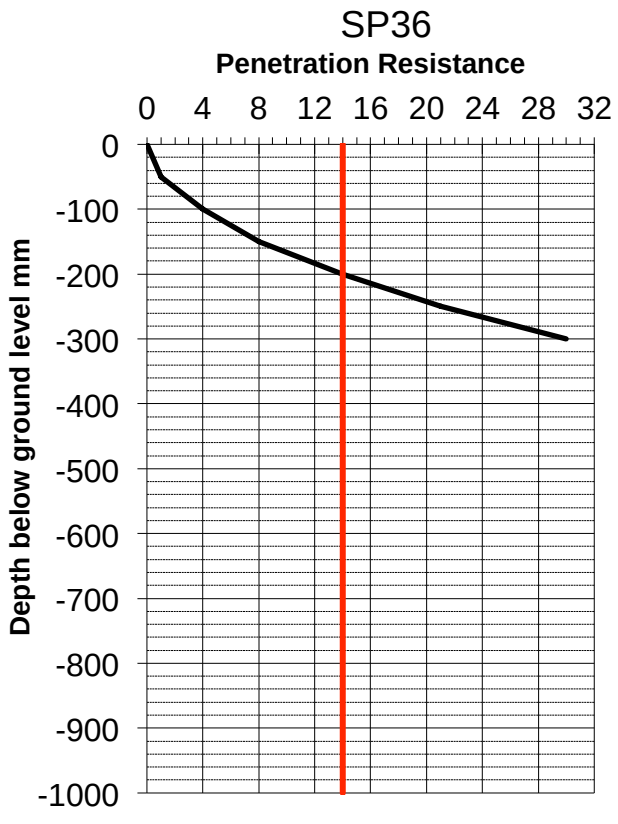
RDAgritech
ENGINEERED BY NATURE

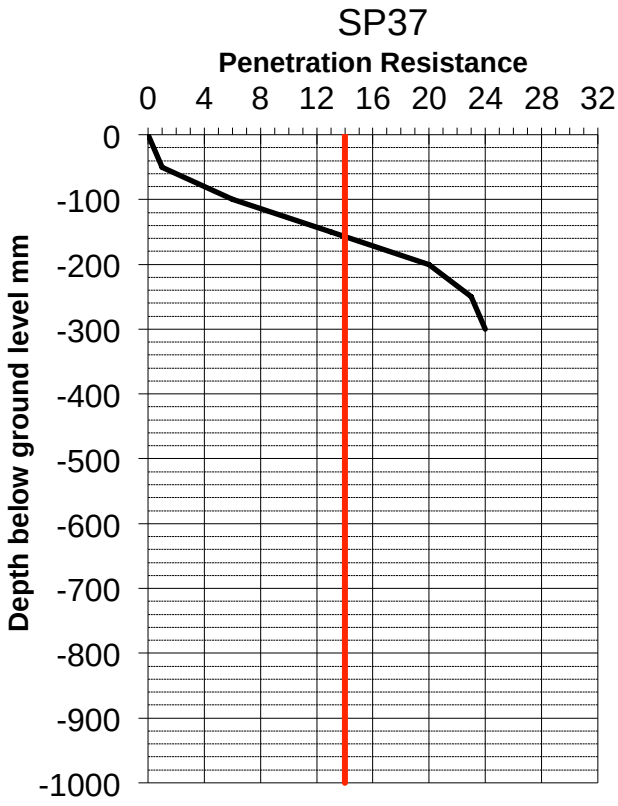
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert		
		LOCATION:	Manse Rd, Arrowtown	Weather:	
CO-ORDINATES:	mE	DATE:	4-Jul-16	Comments:	
Refer site plan attached	mN	OPERATOR:	OMB AMS		

Testing Location: Lots 13-16 and 22-24 Material: Shotover River Gravel Level: FFL







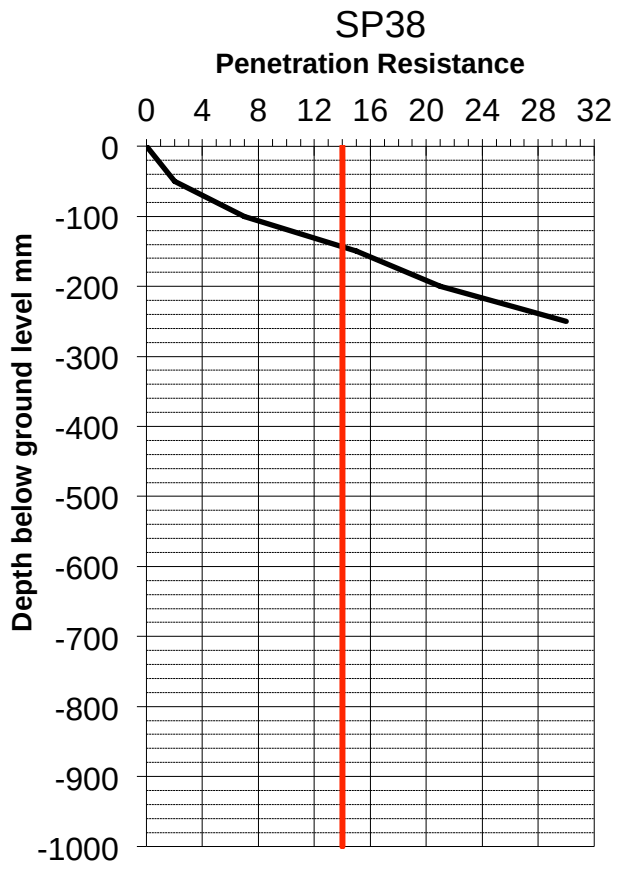


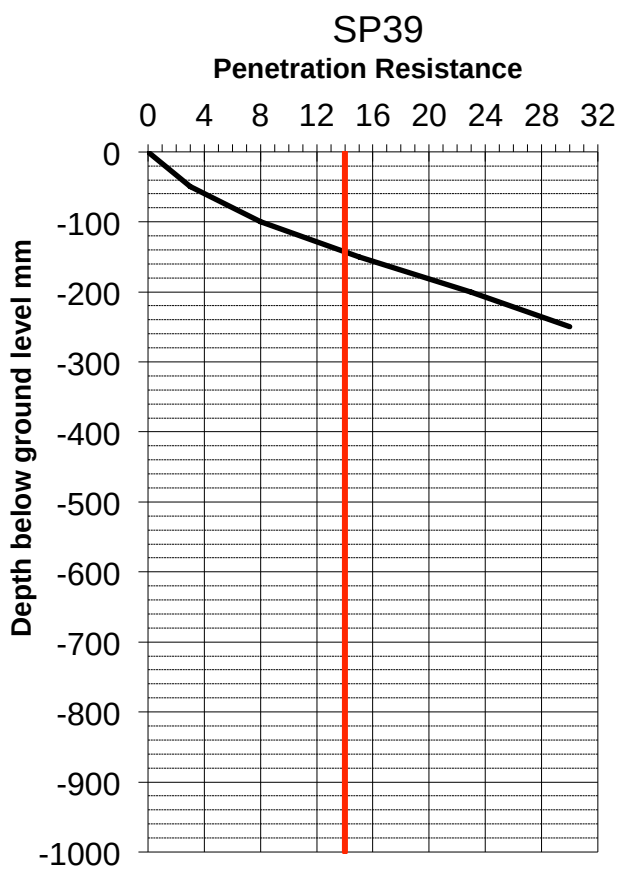
PENETRATION RESISTANCE TESTING

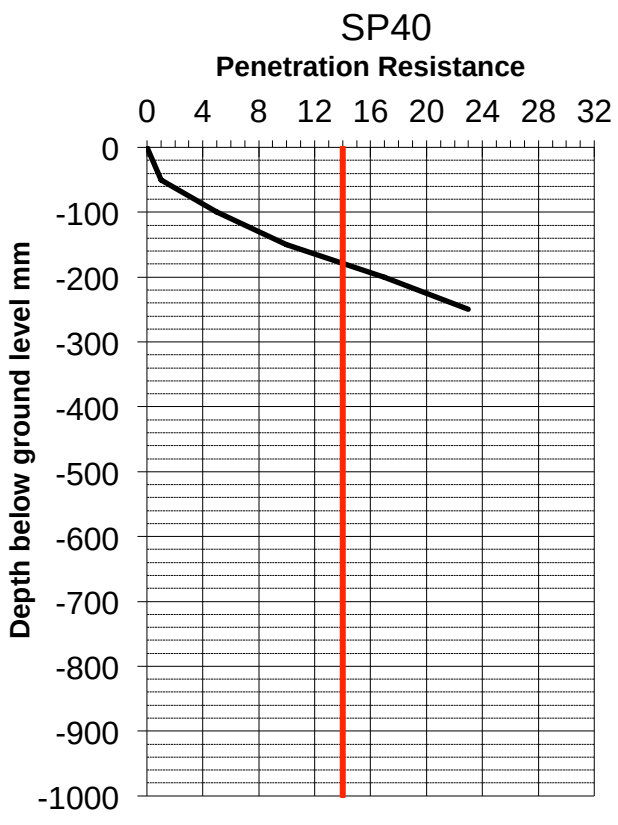
RDAgritech
ENGINEERED BY NATURE

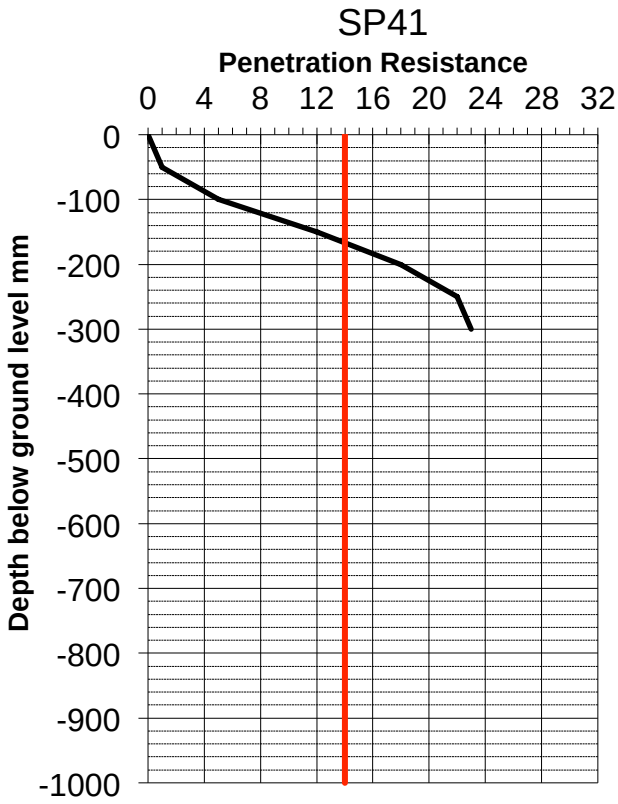
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert		
		LOCATION:	Manse Rd, Arrowtown	Weather:	
CO-ORDINATES:	mE	DATE:	4-Jul-16	Comments:	
Refer site plan attached	mN	OPERATOR:	OMB AMS		

Testing Location: Lots 13-16 and 22-24 Material: Shotover River Gravel Level: FFL







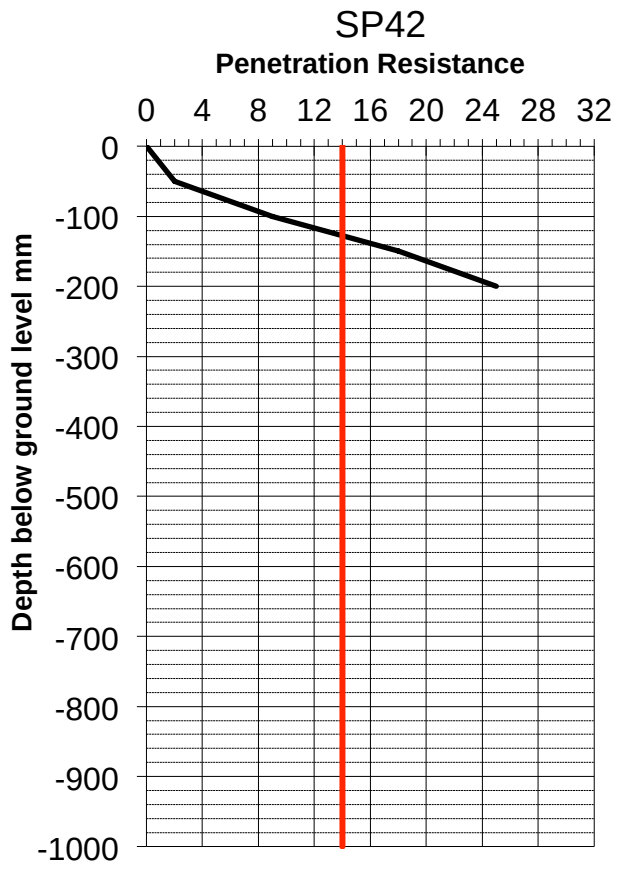


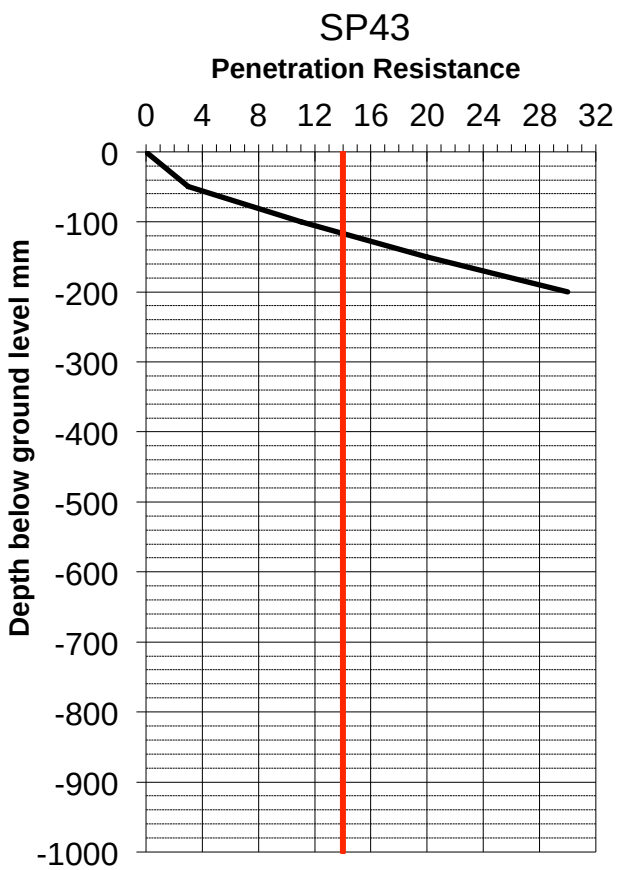
PENETRATION RESISTANCE TESTING

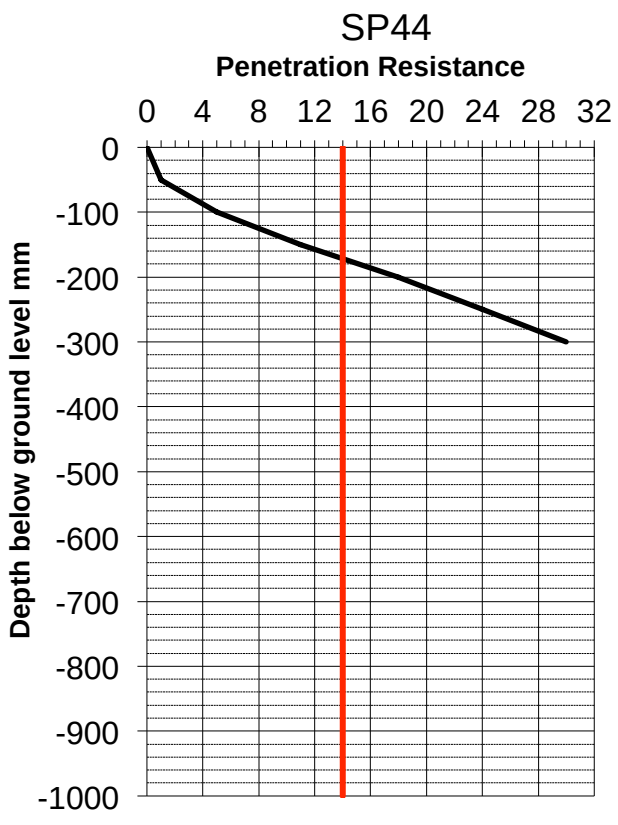
RDAgritech
ENGINEERED BY NATURE

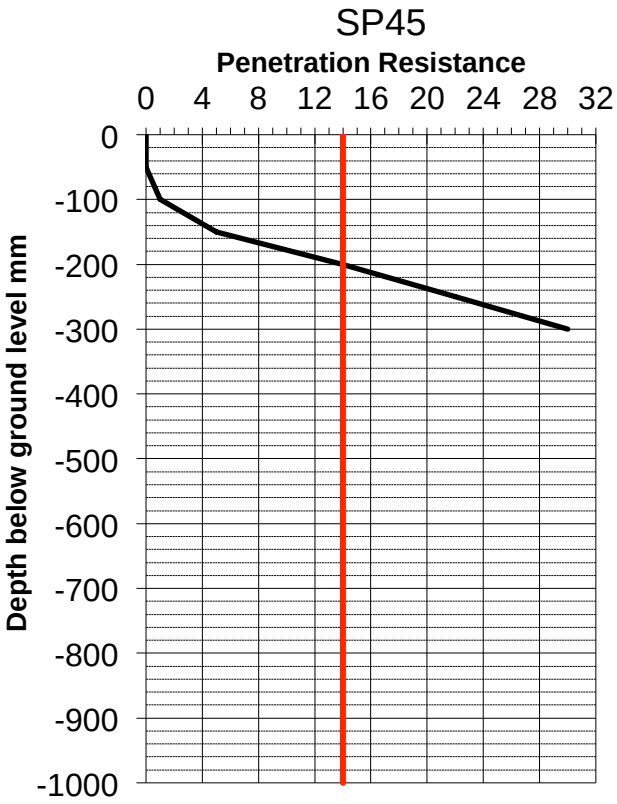
JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert		
		LOCATION:	Manse Rd, Arrowtown	Weather:	
CO-ORDINATES:	mE	DATE:	4-Jul-16	Comments:	
Refer site plan attached	mN	OPERATOR:	OMB AMS		

Testing Location: Lots 13-16 and 22-24 Material: Shotover River Gravel Level: FFL







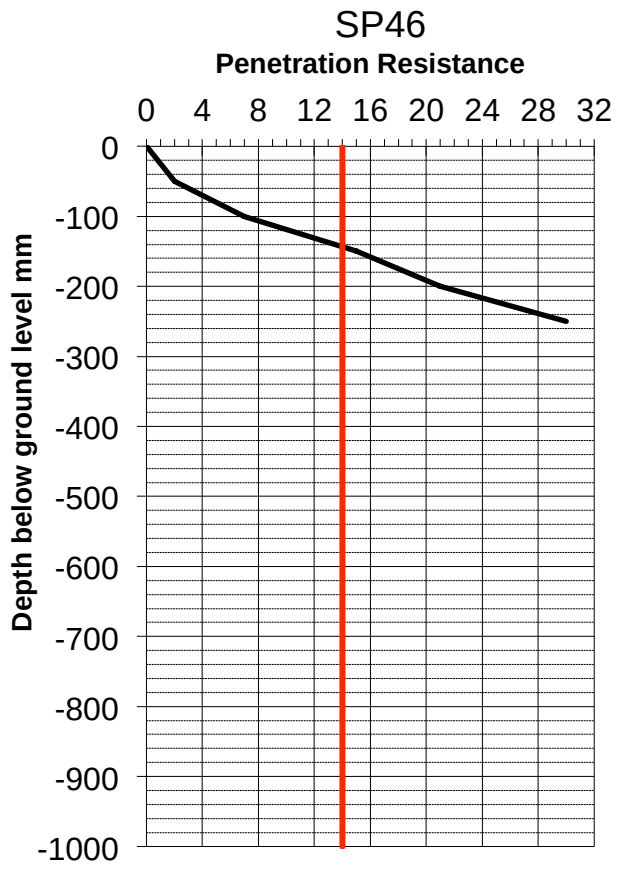


PENETRATION RESISTANCE TESTING

RDAgritech
ENGINEERED BY NATURE

JOB NUMBER:	50338	PROJECT:	Links Gate Fill Cert		
		LOCATION:	Manse Rd, Arrowtown	Weather:	
CO-ORDINATES:	mE	DATE:	4-Jul-16	Comments:	
Refer site plan attached	mN	OPERATOR:	OMB AMS		

Testing Location: Lots 13-16 and 22-24 Material: Shotover River Gravels Level: FFL



APPENDIX D. CENTRAL TESTING SERVICES TESTING RESULTS

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644 Fax (03) 448 7401 Email alan.julian@xtra.co.nz

Reference No: 16/1107

Date: 2 May 2016

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	**Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston**	**Attention:**	**I. Harrison**
Job Description:	**Links Gate Subdivision, Arrowtown – Stage 1**		
Sample Description:	**Gravelly SAND with minor / some silt**	**Sample Source:**	**Cut to Fill**
Sample Method:	**NZS 4407:1991, Test 2.4.8.2**	**Sampled By:**	**B.J. Lippers**
Test Methods:	**Field Density - NZS 4407:1991, Test 4.2.1; Water Content - NZS 4402:1986, Test 2.1**		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location (See Page 2)	Fill Depth							
1	Lot 26	See Page 2	300	2.14	1.89	13.2	98.3	6.4	31.3
2	Lot 26	See Page 2	300	2.09	1.86	12.2	96.8	9.6	32.4
3	Lot 26	See Page 2	300	2.07	1.83	12.7	95.5	10.1	33.3
4	Lot 25	See Page 3	300	2.16	1.99	8.8	98.3	10.1	27.6
5	Lot 25	See Page 3	300	2.13	1.99	7.3	98.4	13.2	27.6
6	Lot 25	See Page 3	300	2.10	1.97	6.5	96.0	15.4	28.2
Mean Values Sites: 1 to 6				**2.11**	**1.92**	**10.1**	**97.2**	**10.8**	**30.1**
NZS 4431:1989, Section 7.4.2.1 Specification:				**Minimum Relative Compaction: 95.0 %.**					

(1) Voids were calculated from an "all in" solid density based on % by dry mass of the ± 19.0mm fraction – See Reference No 16/1017 & 16/1078.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of the corrected maximum dry density, the calculation of % relative compaction and % voids and the sample description based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from the following maximum dry densities which were corrected in accordance with USBR Des-E38.*

   S:1 to S:3 - 1.92 t/m³ (no correction for oversize required)
   S:4 & S:5 - 2.02 t/m³ (no correction for oversize required)
   S:6 - 2.05 t/m³ (corrected for 6% +19mm fraction)

   See Reference No. 16/1078 for NZ standard compaction details for Sites 1 to 3.
   See Reference No. 16/1017 for NZ standard compaction details for Sites 4 to 6.

3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
4. *This report may not be reproduced except in full.*

Tested By: B.J. Lippers **Date:** 29-Apr-16 to 2-May-16

Checked By:

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY Accreditation No: 434

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 16/1107

Date: 2 May 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)

Approximate Test Locations

Notes

- *This report may not be reproduced except in full.*

Tested By: B.J. Lippers **Date:** 29-Apr-16 to 2-May-16

Checked By:

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY Accreditation No: 434

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 16/1107

Date: 2 May 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)

Approximate Test Locations

Notes

- *This report may not be reproduced except in full.*

Tested By: B.J. Lippers **Date:** 29-Apr-16 to 2-May-16

Checked By:

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

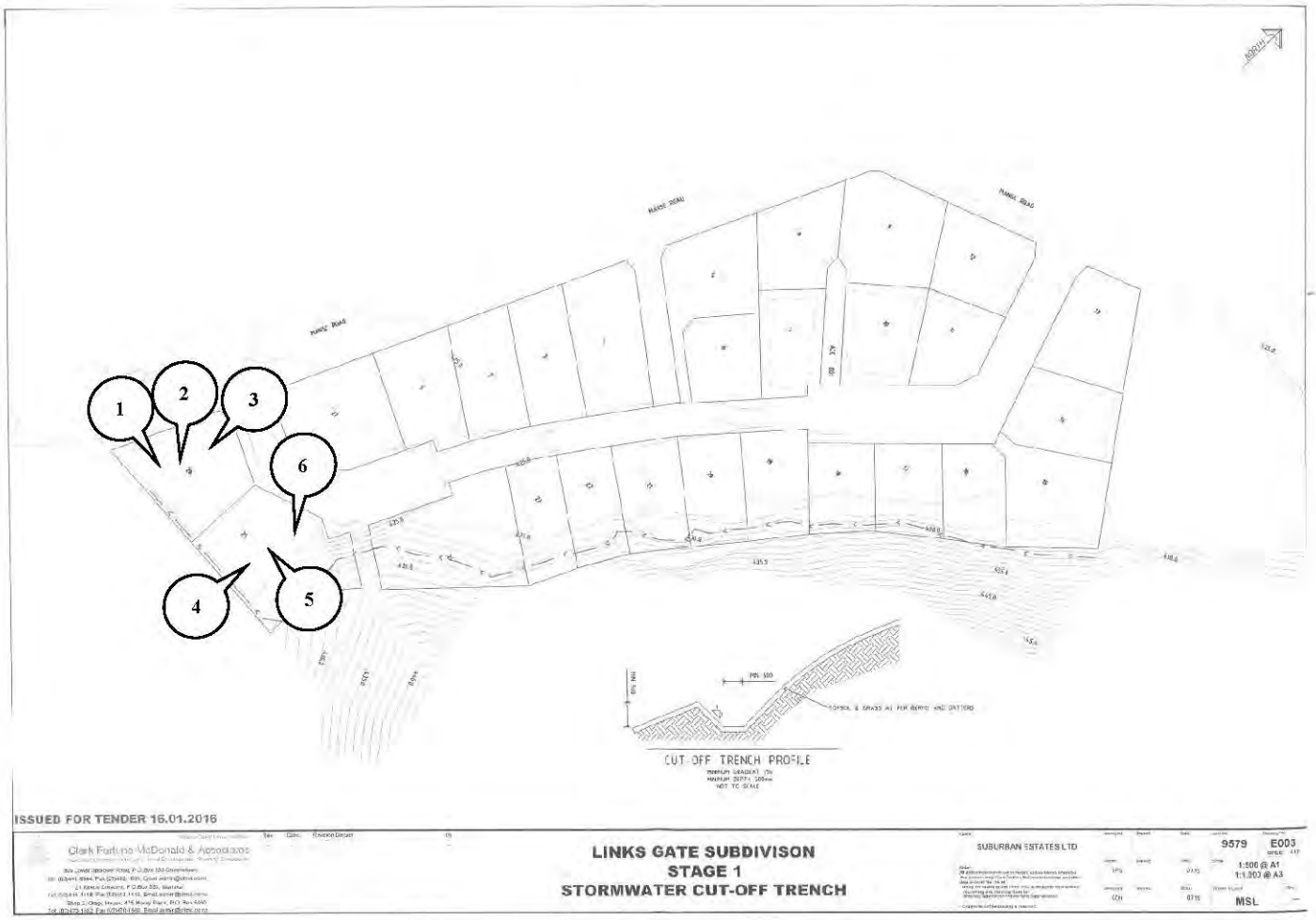
IANZ ACCREDITED LABORATORY Accreditation No: 434

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 16/1107

Date: 2 May 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



Approximate Test Locations

Notes

- ***This report may not be reproduced except in full.***

Tested By: B.J. Lippers **Date:** 29-Apr-16 to 2-May-16

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY Accreditation No: 434

Central Testing Services
18 Ngapara Street, P.O. Box 397, Alexandra, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 16/1330

Date: 3 June 2016

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	**Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston**	**Attention:**	**I. Harrison**
Job Description:	**Links Gate Subdivision, Arrowtown – Stage 1**		
Sample Description:	**Pit Run – Sandy GRAVEL with trace of silt**	**Sample Source:**	**Shotover River – Stalkers Pit**
Sample Method:	**NZS 4407:1991, Test 2.4.8.2**	**Sampled By:**	**B.J. Lippers**
Test Methods:	**Field Density - NZS 4407:1991, Test 4.2.1; Water Content - NZS 4402:1986, Test 2.1**		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location (See Page 2/3)	Fill Depth							
7	Lot 22	See Page 2	300	2.24	2.12	5.8	94.7	9.1	21.4
8	Lot 23	See Page 2	300	2.28	2.18	4.6	97.3	9.2	19.3
9	Lot 24	See Page 2	300	2.27	2.13	6.8	95.0	6.6	21.2
Mean Values Sites: 7 to 9				2.27	2.14	5.8	95.6	8.3	20.6
NZS 4431:1989, Section 7.4.3.2 (b) Specification:				**Minimum Relative Compaction: 92.0 %.**					

(1) Voids were calculated from an "all in" solid density based on % by dry mass of the ± 37.5mm fraction – See Reference No 15/497.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of % relative compaction and % voids and the sample description based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from a maximum dry density of 2.24 t/m³.*

   See Reference No. 15/497 for NZ vibrating hammer details.
3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
4. *This report may not be reproduced except in full.*

Tested By: B.J. Lippers & N.P. Danischewski **Date:** 1 & 2-Jun-16

Checked By:

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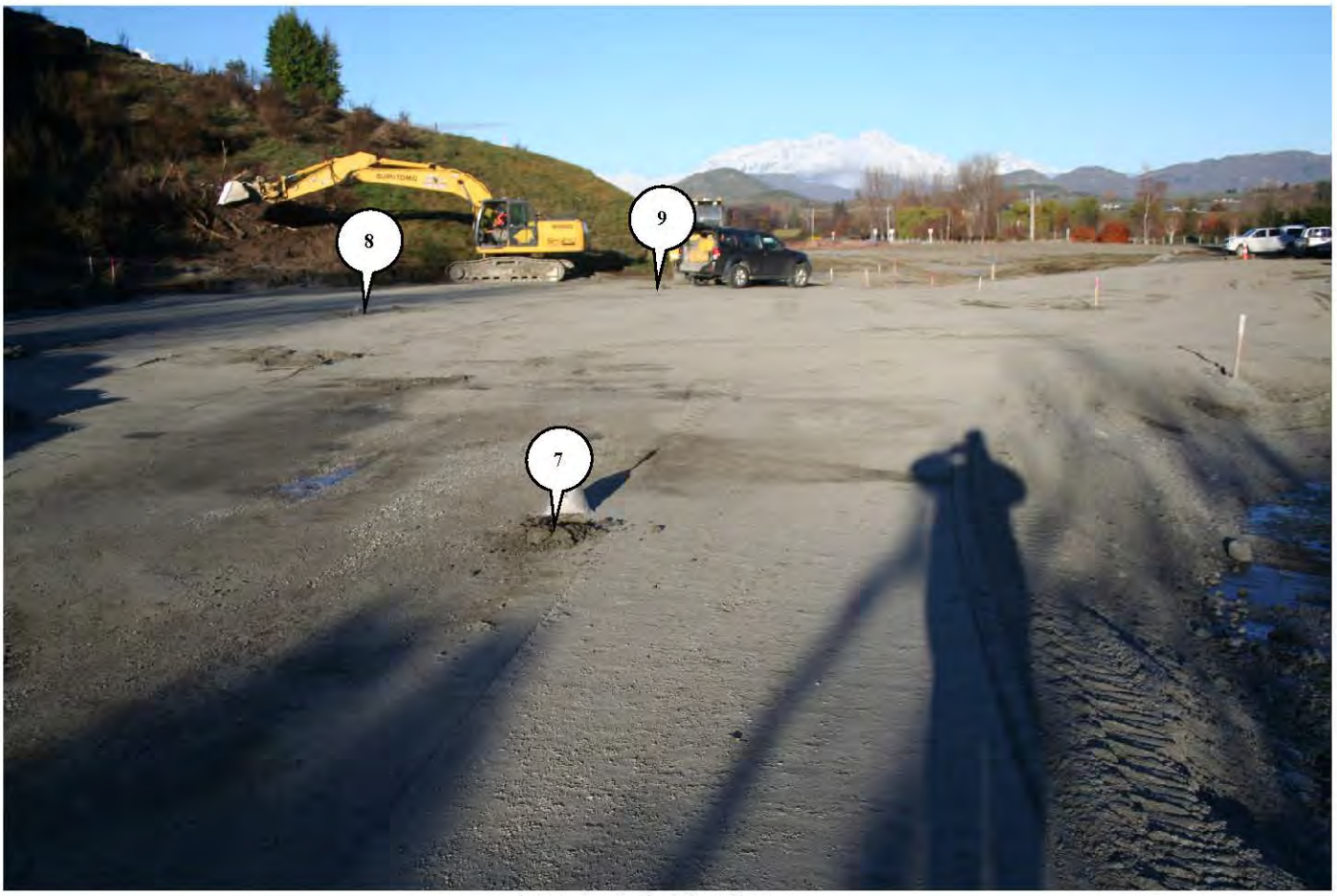
Reference No: 16/1330

Date: 3 June 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



Approximate Test Locations

Notes

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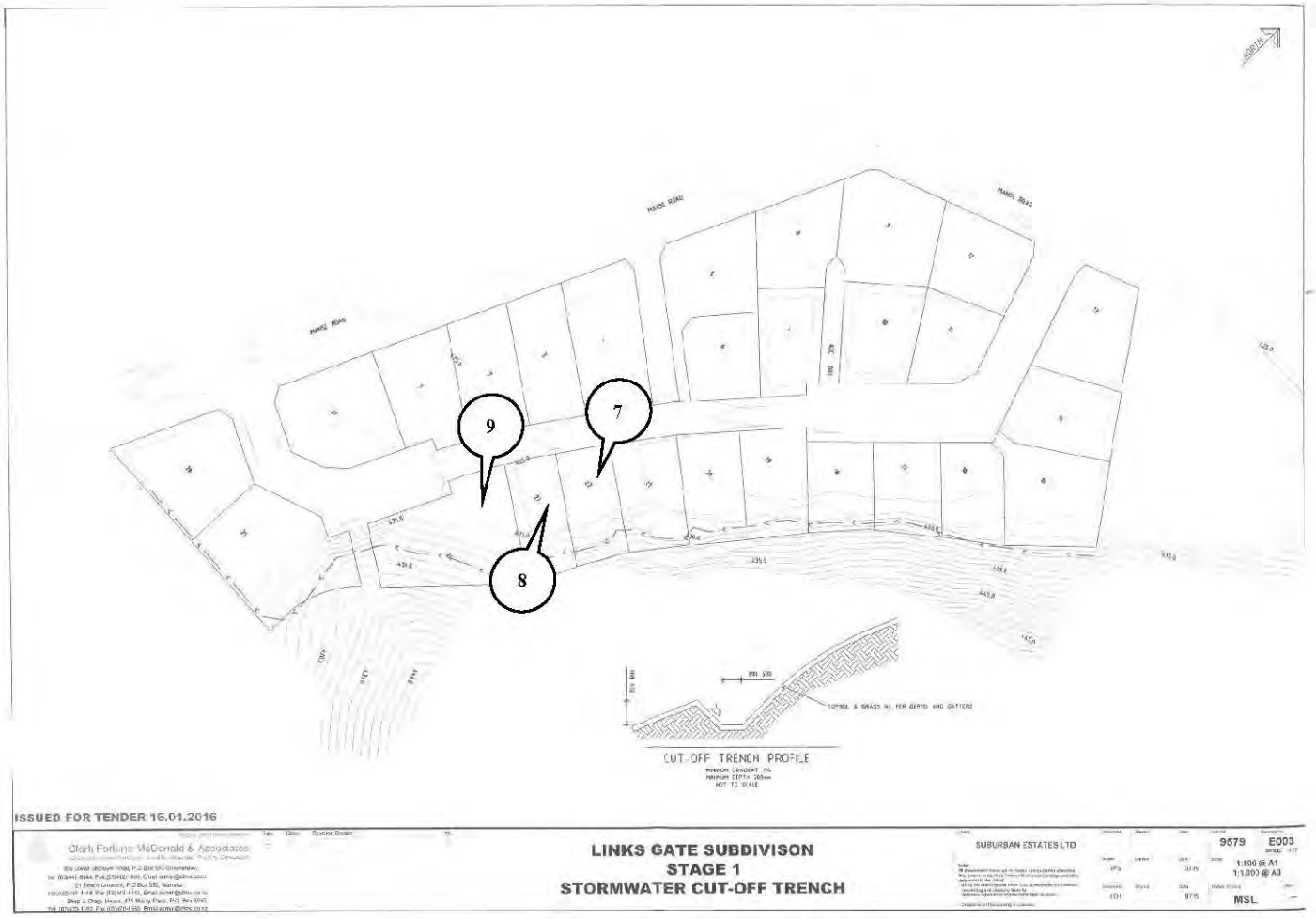
TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



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Tested By: B.J. Lippers & N.P. Danischewski **Date:** 1 & 2-Jun-16

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Reference No: 16/1440

Date: 23 June 2016

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	**Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston**	**Attention:**	**I. Harrison**
Job Description:	**Links Gate Subdivision, Arrowtown – Stage 1**		
Sample Description:	**Pit Run – Sandy GRAVEL with trace of silt**	**Sample Source:**	**Shotover River – Stalkers Pit**
Sample Method:	**NZS 4407:1991, Test 2.4.8.2**	**Sampled By:**	**B.J. Lippers**
Test Methods:	**Field Density - NZS 4407:1991, Test 4.2.1; Water Content - NZS 4402:1986, Test 2.1**		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location (See Page 2/3)	Fill Depth							
10	Lot 13	See Page 2/3	300	2.32	2.18	6.2	96.1	5.4	19.0
11	Lot 13	See Page 2/3	300	2.33	2.18	6.7	96.3	4.4	19.0
12	Lot 13	See Page 2/3	300	2.33	2.19	6.4	97.7	5.0	18.9
13	Lot 14	See Page 2/3	300	2.30	2.13	7.8	95.1	4.6	21.1
Mean Values Sites: 10 to 13				2.32	2.17	6.8	96.3	4.8	19.5
NZS 4431:1989, Section 7.4.3.2 (b) Specification:				**Minimum Relative Compaction: 92.0 %.**					

(1) Voids were calculated from an "all in" solid density based on % by dry mass of the ± 37.5mm fraction – See Reference No 15/497.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of % relative compaction and % voids and the sample description based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from the following maximum dry densities which were corrected in accordance with USBR Des-E38.*

   S:10 - 2.27 t/m³ (corrected for 9% +37.5mm fraction)
   S:11 - 2.27 t/m³ (corrected for 8% +37.5mm fraction)
   S:12 - 2.24 t/m³ (no correction for oversize required)
   S:13 - 2.24 t/m³ (no correction for oversize required)

   See Reference No. 15/497 for NZ Vibrating hammer details.
3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
4. *This report may not be reproduced except in full.*

Tested By: B.J. Lippers & L.T. Smith **Date: 17 & 18-Jun-16**

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Date: 23 June 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)

Approximate Test Locations

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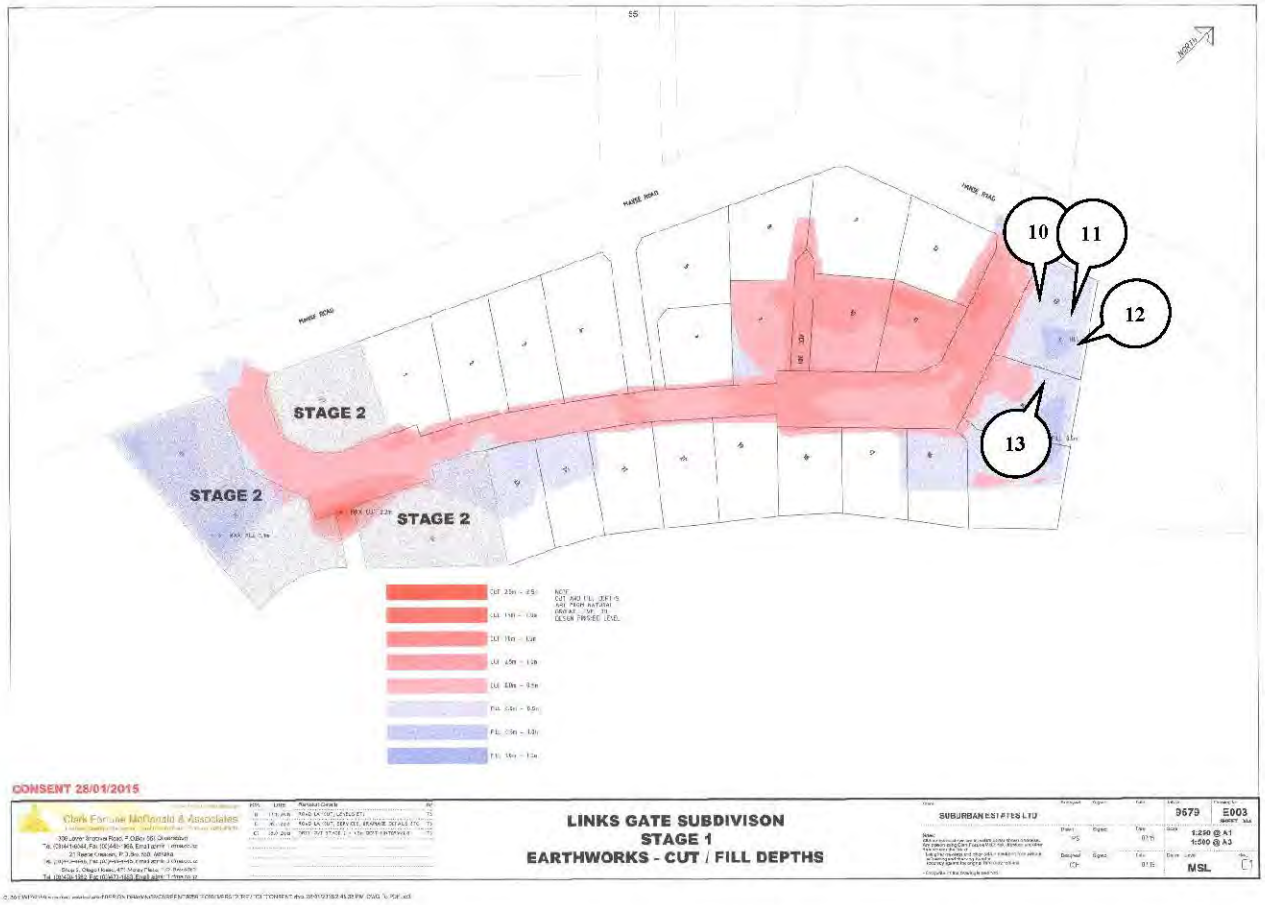
Reference No: 16/1440

Date: 23 June 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



Approximate Test Locations

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Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 16/1463

Date: 24 June 2016

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston	**Attention:**	I. Harrison
Job Description:	Links Gate Subdivision, Arrowtown – Stage 1		
Sample Description:	Pit Run – Sandy GRAVEL with trace of silt	**Sample Source:**	Shotover River – Stalkers Pit
Sample Method:	NZS 4407:1991, Test 2.4.8.2	**Sampled By:**	C. Maxwell
Test Methods:	Field Density - NZS 4407:1991, Test 4.2.1; Water Content - NZS 4402:1986, Test 2.1		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location (See Page 2/3)	Fill Depth							
14	Lot 16	See Page 2/3	250	2.30	2.19	4.8	97.9	8.2	18.8
15	Lot 16	See Page 2/3	250	2.32	2.20	5.3	97.1	6.8	18.5
16	Lot 15	See Page 2/3	250	2.30	2.18	5.1	97.4	7.9	19.1
17	Lot 15	See Page 2/3	250	2.34	2.23	4.7	99.6	6.8	17.4
18	Lot 15	See Page 2/3	200	2.31	2.19	5.4	97.8	7.0	18.8
Mean Values Sites: 14 to 18				2.31	2.20	5.1	98.0	7.4	18.5
NZS 4431:1989, Section 7.4.3.2 (b) Specification:				**Minimum Relative Compaction: 92.0 %.**					

(1) Voids were calculated from an "all in" solid density based on % by dry mass of the ± 37.5mm fraction – See Reference No 15/497.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of % relative compaction and % voids and the sample description based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from the following maximum dry densities which were corrected in accordance with USBR Des-E38.*

   S:14, S:16, S:17 & S:18 - 2.24 t/m³ (no correction for oversize required)
   S:15 - 2.26 t/m³ (corrected for 6% +37.5mm fraction)

   See Reference No. 15/497 for NZ Vibrating hammer details.
3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
4. *This report may not be reproduced except in full.*

Tested By: C. Maxwell & C. Julius **Date:** 21 & 22-Jun-16

Checked By:

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Reference No: 16/1463

Date: 24 June 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)

Approximate Test Locations

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TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)

Approximate Test Locations

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Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 16/1529

Date: 4 July 2016

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	**Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston**	**Attention:**	**I. Harrison**
Job Description:	**Links Gate Subdivision, Arrowtown – Stage 1**		
Sample Description:	**Pit Run – Sandy GRAVEL with trace of silt**	**Sample Source:**	**Shotover River – Stalkers Pit**
Sample Method:	**NZS 4407:1991, Test 2.4.8.2**	**Sampled By:**	**C. Maxwell**
Test Methods:	**Field Density - NZS 4407:1991, Test 4.2.1; Water Content - NZS 4402:1986, Test 2.1**		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location	Fill Depth							
19	Lot 13 - See P2 & P4	See Page 2	300	2.31	2.19	5.5	96.4	7.0	18.9
20	Lot 13 - See P2 & P4	See Page 2	250	2.26	2.12	6.5	94.7	7.6	21.4
21	Lot 14 - See P2 & P4	See Page 2	300	2.22	2.11	5.2	94.0	11.1	22.0
22	Lot 14 - See P2 & P4	See Page 2	250	2.25	2.13	5.5	93.2	9.2	21.0
23	Lot 15 - See P2 & P4	See Page 2	250	2.27	2.16	5.1	94.4	8.9	20.0
24	Lot 15 - See P2 & P4	See Page 2	250	2.34	2.23	4.8	99.8	6.4	17.2
25	Lot 16 - See P2 & P4	See Page 2	250	2.26	2.19	3.4	95.5	11.5	18.9
26	Lot 16 - See P2 & P4	See Page 2	250	2.19	2.11	3.5	91.2	14.1	21.6
27	Lot 24 - See P3 & P4	See Page 3	300	2.38	2.24	5.9	99.2	3.7	16.9
28	Lot 24 - See P3 & P4	See Page 3	250	2.34	2.20	6.3	98.3	4.5	18.5
29	Lot 23 - See P3 & P4	See Page 3	250	2.30	2.22	3.7	99.0	9.6	17.8
30	Lot 23 - See P3 & P4	See Page 3	250	2.35	2.26	4.1	98.5	7.2	16.4
31	Lot 22 - See P3 & P4	See Page 3	250	2.27	2.16	4.8	95.3	9.4	19.9
32	Lot 22 - See P3 & P4	See Page 3	250	2.26	2.16	4.8	95.2	9.6	20.0
Mean Values Sites: 19 to 32				2.28	2.18	4.9	96.1	8.6	19.3
NZS 4431:1989, Section 7.4.3.2 (b) Specification:				**Minimum Relative Compaction: 92.0 %.**					

(1) Voids were calculated from an "all in" solid density based on % by dry mass of the ± 37.5mm fraction – See Reference No 15/497.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of the corrected maximum dry density, the calculation of % relative compaction and % voids and the sample description based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from the following maximum dry densities which were corrected in accordance with USBR Des-E38.*
   - *S:19 - 2.27 t/m³ (corrected for 8% +37.5mm fraction)*
   - *S:20 - 2.24 t/m³ (no correction for oversize required)*
   - *S:21 - 2.24 t/m³ (no correction for oversize required)*
   - *S:22 - 2.29 t/m³ (corrected for 13% +37.5mm fraction)*
   - *S:23 - 2.29 t/m³ (corrected for 13% +37.5mm fraction)*
   - *S:24 - 2.24 t/m³ (no correction for oversize required)*
   - *S:25 - 2.29 t/m³ (corrected for 13% +37.5mm fraction)*
   - *S:26 - 2.32 t/m³ (corrected for 21% +37.5mm fraction)*
   - *S:27 - 2.26 t/m³ (corrected for 5% +37.5mm fraction)*
   - *S:28 - 2.24 t/m³ (no correction for oversize required)*
   - *S:29 - 2.24 t/m³ (no correction for oversize required)*
   - *S:30 - 2.29 t/m³ (corrected for 13% +37.5mm fraction)*
   - *S:31 - 2.27 t/m³ (corrected for 8% +37.5mm fraction)*
   - *S:32 - 2.27 t/m³ (corrected for 8% +37.5mm fraction)*

   See Reference No. 15/497 for NZ Vibrating hammer details.
3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
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Tested By: C. Maxwell & B.J. Lippers **Date:** 1 to 4-Jul-16

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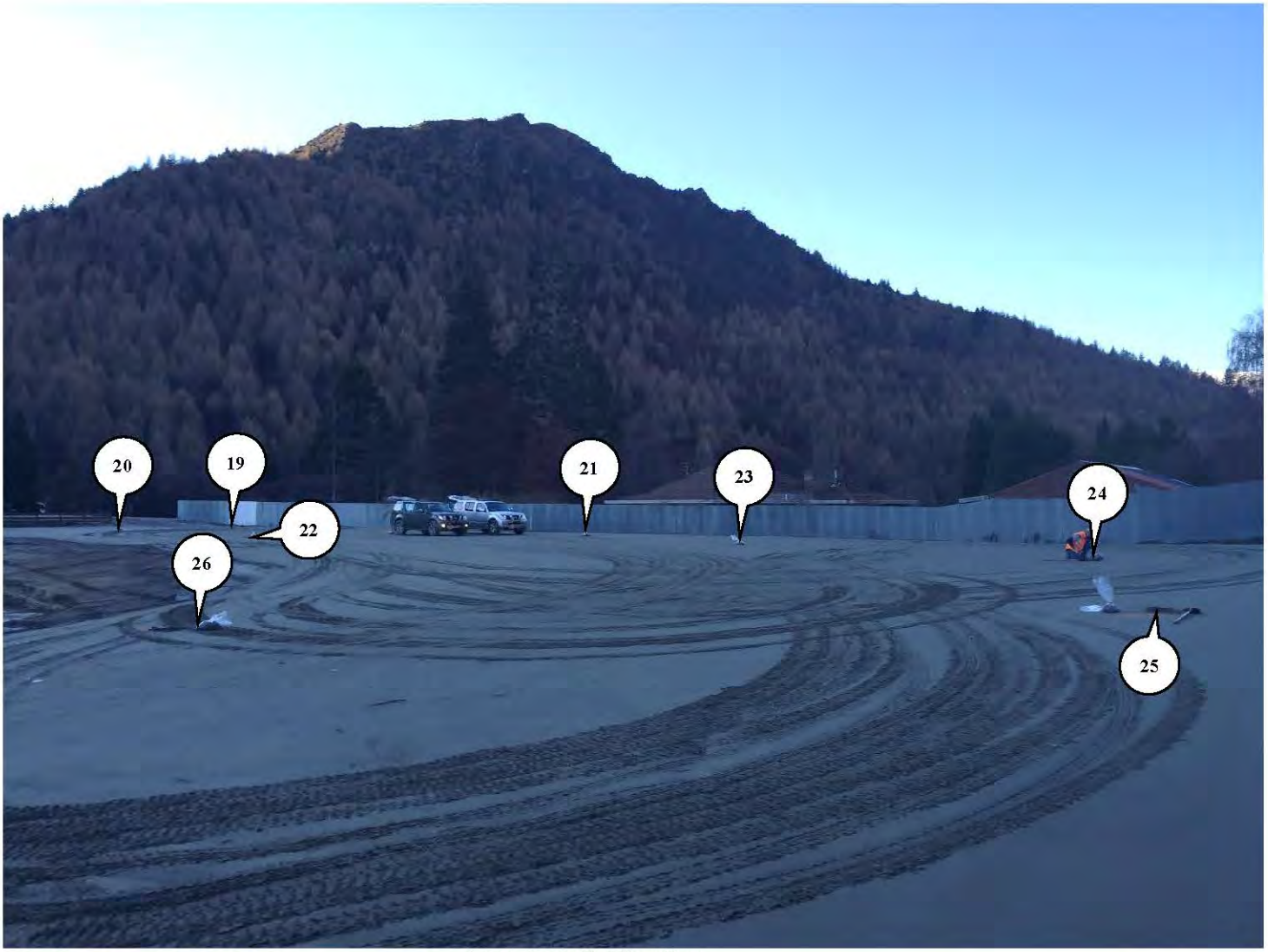
Reference No: 16/1529

Date: 4 July 2016

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



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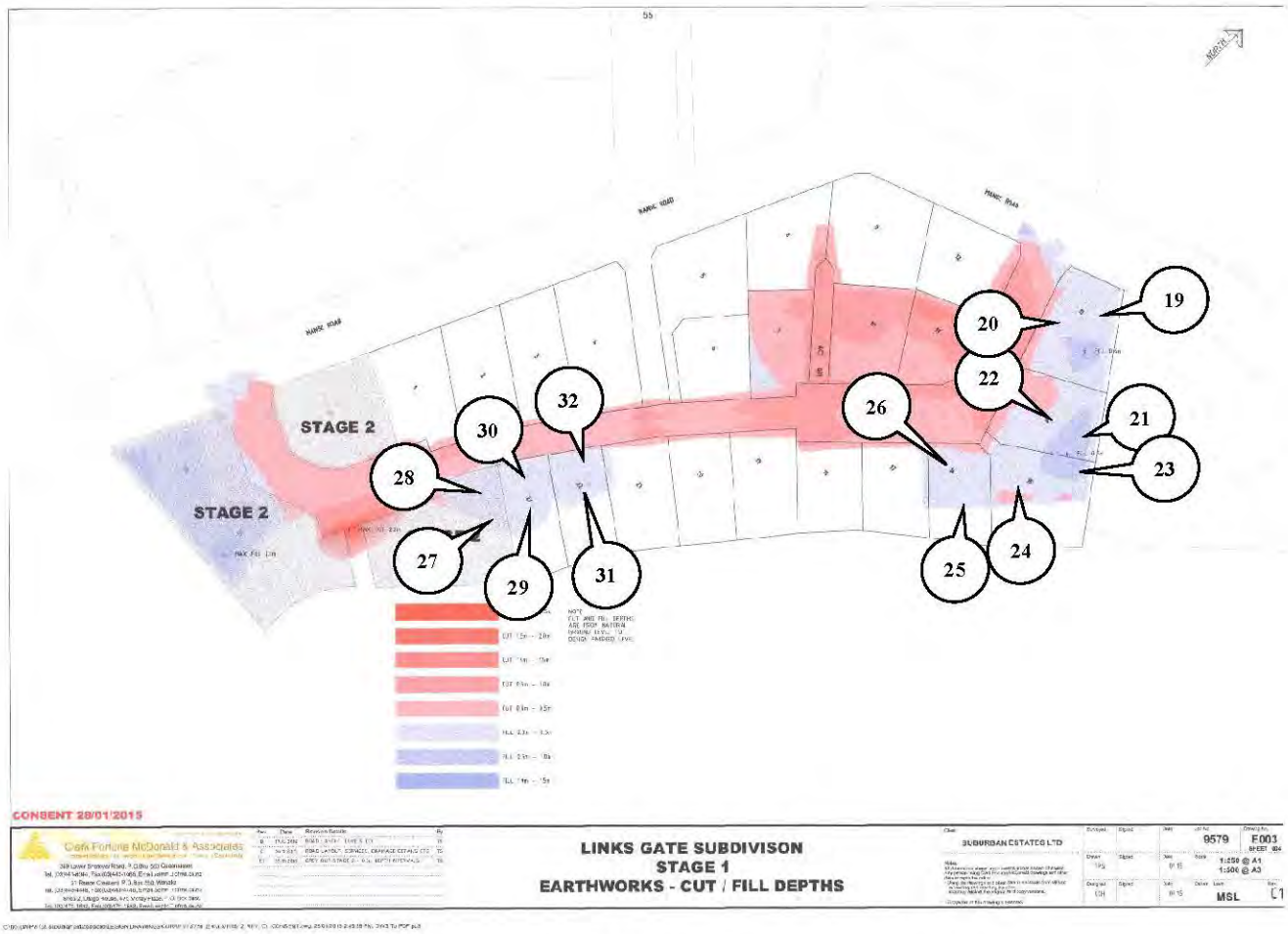

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Tested By: C. Maxwell & B.J. Lippers **Date:** 1 to 4-Jul-16

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Approved Signatory

A.P. Julius
Laboratory Manager

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 17/454

Date: 5 March 2017

TEST REPORT - FIELD DENSITY & WATER CONTENT

Client Details:	**Wilson Contractors (2003) Ltd, P.O. Box 24, Kingston**	**Attention:**	**I. Harrison**
Job Description:	**Links Gate Subdivision, Arrowtown – Stage 2**		
Sample Description:	**Basecourse AP40 & Sandy GRAVEL with minor / some silt**	**Sample Source:**	**Fairlight & Cut to Fill**
Sample Method:	**NZS 4407:2015, Test 2.4.8.3**	**Sampled By:**	**C. Maxwell**
Test Methods:	**Field Density - NZS 4407:2015, Test 4.2; Water Content - NZS 4402:1986, Test 2.1**		

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location	Fill Depth							
33	Lot 27 - See P2	Final Level	300	2.32	2.26	2.7	94.0	12.7	18.8

NZS 4431:1989, Section 7.4.3.2 (b) Specification: **Minimum Relative Compaction: 92.0 %.**

(1) Voids were calculated from a tested solid density of 2.78 t/m³ – See Reference No 17/292.

FIELD DENSITY & WATER CONTENT RESULTS

Location Details			Probe Depth (mm)	Wet Density (t/m³)	Dry Density (t/m³)	Water Content (%)	Relative Compaction (%)	Air Voids (1) (%)	Total Voids (1) (%)
Site No.	Test Location	Fill Depth							
34	Lot 25 - See P2	Final Level	300	2.18	2.05	6.5	98.0	12.1	25.4
35	Lot 25 - See P2	Final Level	300	2.15	2.03	5.5	95.9	14.9	26.1
36	Lot 25 - See P2	Final Level	300	2.24	2.10	6.3	101.6	10.3	23.6
Mean Values Sites: 34 to 36				2.19	2.06	6.1	98.5	12.4	25.0

NZS 4431:1989, Section 7.4.2.1 Specification: **Minimum Relative Compaction: 95.0 %.**

(1) Voids were calculated from an assumed solid density of 2.75 t/m³ – See Reference No 16/1018.

Note:

1. *Information contained in this report which is Not IANZ Accredited relates to; the calculation of the corrected maximum dry density, the calculation of % relative compaction and % voids and the sample descriptions based on NZ Geotechnical Society Guidelines 2005.*
2. *Relative compaction values have been calculated from the following maximum dry densities which were corrected in accordance with USBR Des-E38.*
   S:33 - 2.40 t/m³ (no correction for oversize required)
   S:34 - 2.09 t/m³ (corrected for 5% +19.0mm fraction)
   S:35 - 2.12 t/m³ (corrected for 12% +19.0mm fraction)
   S:36 - 2.07 t/m³ (no correction for oversize required)

   See Reference No. 17/292 for NZ Vibrating hammer details for Site 33.
   See Reference No. 16/1018 for NZ standard compaction details for Sites 34 to 36.
3. *The results stated above are specific to the test locations as recorded. CTS accepts no liability for any extrapolated use of this data.*
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Tested By: B.J. Lippers **Date:** 20 & 21-Feb-17

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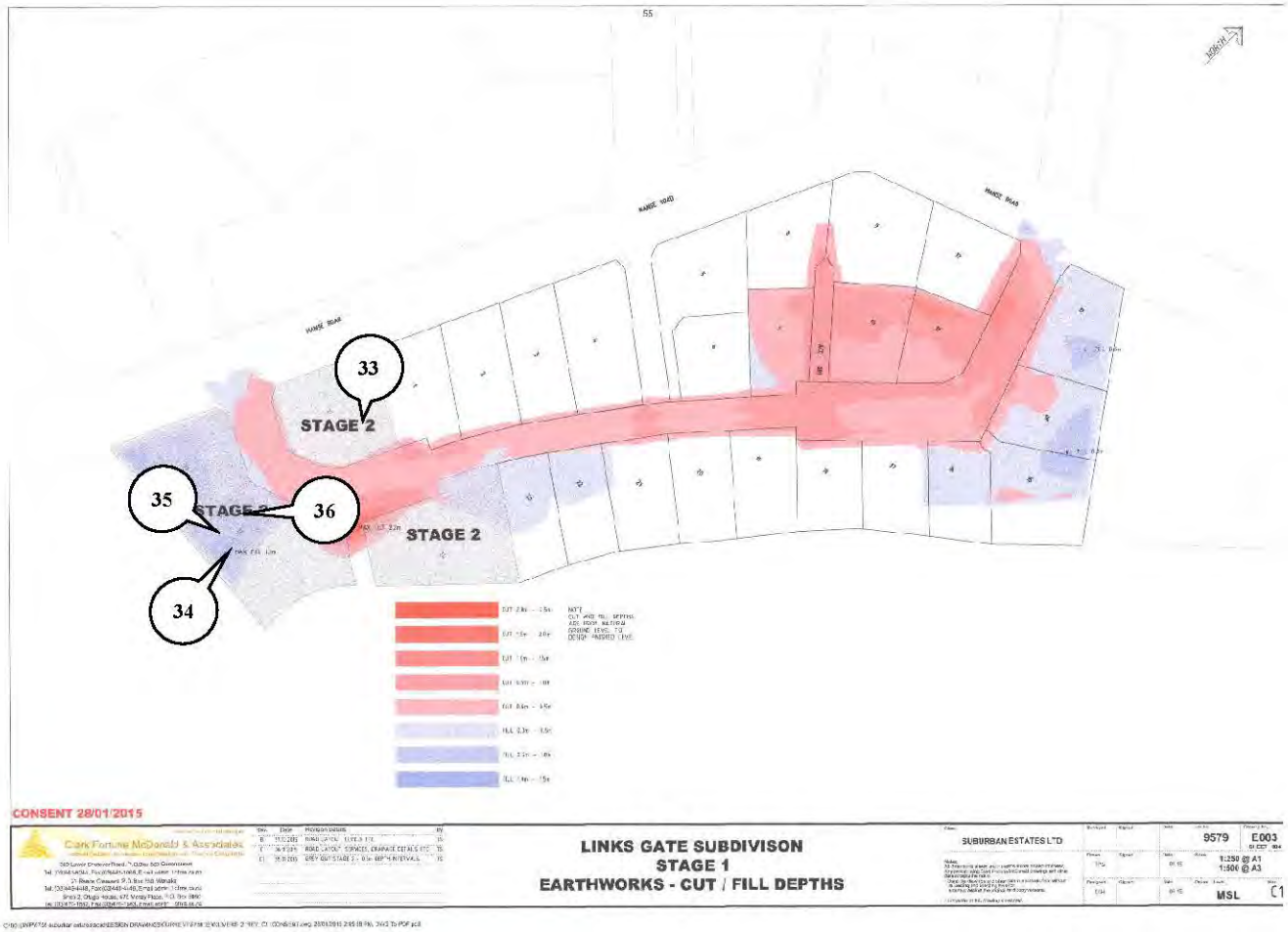
Reference No: 17/454

Date: 5 March 2017

TEST REPORT – FIELD DENSITY & WATER CONTENT (cont.)



Approximate Test Locations

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Approved Signatory

A.P. Julius
Laboratory Manager

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APPENDIX E. PREVIOUS GEOTECHNICAL REPORTING

1. Feehly Hill Subdivision Geotechnical Report
2. Assessment of Natural Hazards at the Proposed Feehly Hill Subdivision

REPORT

SUBURBAN ESTATES LIMITED

Feehly Hill Subdivision
Geotechnical Investigation

Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

REPORT

SUBURBAN ESTATES LIMITED

Feehly Hill Subdivision
Geotechnical Investigation

Report prepared for:

SUBURBAN ESTATES LIMITED

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

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November, 2007

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Table of contents

1 Introduction

1.1 General

This report presents the results of a geotechnical investigation that has been undertaken by Tonkin & Taylor Ltd (T&T) to support a Resource Consent application for the Feehly Hill Subdivision in Arrowtown, Central Otago.

This geotechnical report was commissioned by Suburban Estates Ltd (SEL) and has been completed in accordance with T&T's proposal dated 25th September 2007.

1.2 Proposed Development

Drawings of the Feehly Hill Subdivision indicate the proposed development comprises the construction of twenty eight residential lots over two development stages. Two access roads will also be constructed as part of the subdivision development.

The legal description of the proposed subdivision is Lots 1 to 28, 100, 101, 200 and 300, PT SEC 7, Block XVII, Shotover Survey District. Figure 1, Appendix A, presents a plan of the existing site boundaries.

2 Site Description

2.1 General

The site is situated in Arrowtown on the eastern side of Manse Road. The Feehly Hill Scenic Reserve is located beyond the south-eastern boundary and the Millbrook Resort is located approximately 150 metres beyond the southern site boundary. Figure 1, Appendix A, presents a plan of the existing site.

The site is generally flat and is located at the foot of Feehly Hill. The land is currently used as a working farmlet and is covered in grass. Three single storey residential houses are presently sited within the development area along with several farming related structures such as woolsheds, sheds and storage containers.

Residential areas are located to the north of the site and commercial and light industrial units are present north-west of the site.

Vehicle access to the proposed subdivision is good with direct access off Manse Road.

2.2 Topography and Surface Drainage

The site has been surveyed and topographic contours are shown on Figure 1, Appendix A.

The existing site topography largely comprises flat to gently sloping (<5°) ground at the foot of Feehly Hill. Proposed Lots 25 and 26 are partly located on the foot of Feehly Hill and at this location the existing ground surface comprises gently sloping ground which falls in an easterly to north-easterly direction at an angle of approximately 5°.

South of the proposed development site the ground surface comprises flat to gently sloping ground. Beyond the northern and eastern site boundaries the existing ground surface continues for some distance at a flat to gently sloping gradient towards Bush Creek and the Arrow River.

Drainage across the site is expected to be in a west to north-westerly direction towards Manse Road.

No existing watercourses or marshy ground was observed on site during the geotechnical site investigation works.

2.3 Neighbouring Structures

Manse Road is sparsely developed and is currently bounded by the occasional residential or commercial building. The closest neighbouring building currently comprises a single level residential dwelling located approximately 30 metres from the eastern boundary of the site.

3 Geotechnical Investigations

The following site investigation works have been completed by T&T for the purposes of this geotechnical report:

- A walkover site inspection by an Engineering Geologist.
- 8 investigation test pits excavated to a maximum depth of 3.8 m.
- 5 Scala penetrometer tests to a maximum depth of 1.4 m, where appropriate, to assess the density and consistency of the subsurface materials, and,
- 2 in-situ semi-constant head permeability tests, within Test Pits TP2 and TP7, to obtain an estimate of the soil permeability.

The test pit and Scala penetrometer locations are shown on Figure 2 Appendix A. Logs of the test pit and Scala penetrometer tests are presented in Appendix B.

4 Subsurface Conditions

4.1 Geological Setting

The site is located in the Wakatipu Basin, a feature formed predominately by glacial advances. Published references indicate the last glacial event occurred in the region between 10,000 and 20,000 years ago. The glaciations have left glacial till, glacial outwash and lake sediments over ice-scoured schist bedrock. Post glacial times have been dominated by the erosion of the bedrock and glacial sediments, with deposition of alluvial gravels and sediments by local watercourses. The site is located on alluvial material deposited during aggradation of the Arrow River.

No active faults are known to exist in the immediate vicinity of the site. However, a significant seismic risk exists in the Arrowtown region from potentially strong ground shaking associated with a rupture of the Alpine Fault which is located along the west coast of the South Island.

There is a high probability that an earthquake with a magnitude greater than 7.5 will occur along the Alpine Fault within the next 50 years. Such an earthquake would result in strong and prolonged shaking in Arrowtown.

4.2 Stratigraphy

The sub-surface materials that were encountered during the site investigation works typically comprised:

- 0.2 to 0.4 m of Topsoil; overlying
- 0.4 to 0.6 m of Alluvial Sediments (eastern side of site only); overlying
- 2.3 to 3.0 m of Alluvial Deposits (eastern side of site only); overlying
- An unconfirmed thickness of Alluvial Gravel (present in all test pits except TP1); overlying
- Otago Schist bedrock (TP1 only).

The base of the alluvial gravel deposit was not intercepted in any of the investigation test pits. Schist bedrock was only encountered in test pit TP1, however, several outcrops of Schist bedrock were observed adjacent to the south-eastern boundary of the site on the flanks of Feehly Hill.

Alluvial sediments were found to underlie the topsoil layer typically in the test pits on the eastern side of the site. The alluvial sediments are typically described as brown/grey, firm to stiff, moist, silt with minor sand or sandy silt.

Alluvial deposits were found to underlie the alluvial sediments typically in the test pits on the eastern side of the site. The alluvial deposits are generally described as brown/grey, loose to medium dense, moist, uniform fine sand.

Alluvial gravels were observed to underlie the alluvial sediments and alluvial deposits in the test pits on the eastern side of the site and to underlie the topsoil in the test pits on the centre and western sides of the site. The exception to this is TP1 where no alluvial gravel deposits were encountered. The alluvial gravels are typically described as mottled

grey/brown, loose to medium dense, poorly to well graded, moist, sandy gravel with sub-rounded to sub-angular, flat gravels and fine to coarse sands.

Schist rock was only encountered in Test Pit 1. The upper 1.3 m of schist showed signs of glacial disturbance. The upper schist comprised highly to completely weathered excavatable grey psamatic Schist with extensive folding, closely spaced joints and fractures, and an average foliation dip of 30 to 80 degrees on bearing 245 degrees (southwest). Folding has caused the foliation dip direction to vary by +/- 15 degrees either side of bearing 245 degrees. The weak schist exhibited soil like characteristics in the very weak zones. The Schist rock became moderately strong and unexcavatable with a 20t excavator at a depth of 1.3 m below the surface of the schist.

The soil profile encountered by the investigations is summarised in Table 4.1. For more detailed information the reader should refer to the test pit logs in Appendix B.

Table 4.1 - Summary of Ground Profile

Layer Name	Observed Extent of Layer (metres depth below the existing ground surface)						
	TP1	TP2	TP3	TP4	TP5	TP6	TP7
Topsoil	0.0 to 0.4	0.0 to 0.4	0.0 to 0.4	0.0 to 0.4	0.0 to 0.4	0.0 to 0.2	0.0 to 0.2
Alluvial Sediments	0.4 to 1.0	-	0.4 to 3.0	-	-	0.2 to 0.6	-
Alluvial Deposits	-	-	0.6 to 3.5	-	2.8 to 3.0	0.7 to 3.0	0.5 to 3.5
Alluvial Gravels	-	0.4 to 3.4	0.8 to 1.8	0.4 to 2.6	0.4 to 3.5	0.6 to 0.7	0.3 to 0.5
Schist Rock	1.0 to 2.3	-	-	-	-	-	-
Base of Test Pit	2.3	3.4	3.5	2.6	3.5	3.0	3.5

4.3 Groundwater

No groundwater was observed in any of the test pits at the time of excavation.

Based on past experience in this area, the regional groundwater table is expected to lie several meters below the existing ground surface.

5 Engineering Considerations

5.1 General

The recommendations and opinions contained in this report are based upon ground investigation data obtained at discrete locations and historical information held on the T&T database.

Inferences concerning the nature and continuity of the subsoil between investigation locations are inferred and cannot be guaranteed. The actual sub-surface conditions may show some variation from those described and all design recommendations contained in this report are subject to confirmation by inspection during construction.

5.2 Geotechnical Design Parameters

Table 5.1 provides a summary of the recommended geotechnical design parameters for the soil materials expected to be encountered during construction of the proposed development.

Table 5.1 Recommended Geotechnical Design Parameters

Unit Name	Unit Thickness (m)	Bulk Density γ (kN/m³)	Effective Cohesion c' (kPa)	Effective Friction ϕ' (deg)	Elastic Modulus E (MPa)	Poisson's Ratio v
Topsoil and roots	0.2 to 0.4	All topsoil is to be removed from the earthworks and building footprint areas as per the recommendations of Section 5.3 of this report.				
Alluvial Sediments	0.4 to 0.6	18.0	0	28	8 to 10	0.30
Alluvial Deposits	0.2 to 3.0	18.0	0	30	15 to 20	0.30
Alluvial Gravels	0 to < 3	20.0	0	32	20 to 25	0.30
Weak, highly weathered Otago Schist (See Note 1)	0 to 2	24.0	0 to 20	25 to 30	80	0.25
Moderately Strong, Competent Otago Schist (See Note 1)	Unknown	26.0	0 to < 100	25 to 40	< 1000	0.20

Note 1: The stability of cuts in Schist rock will be controlled by the nature and orientation of defects in the rock mass such as foliation plains, joints and fractures. Specific design of rock support measures will need to be completed if cuts higher than 1.0 m are required to construct the proposed development.

5.3 Earthworks Construction

During earthworks construction all topsoil, organic matter, uncertified fill and unsuitable materials should be removed from beneath the proposed fill earthworks and building footprint in accordance with the recommendations of NZS 4431:1989.

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 affect.

Appropriate measures for controlling silt run-off should be installed prior to commencing earthworks construction to ensure neighbouring properties and waterways are unaffected by silt-laden stormwater or surface water discharge. Should slope gradients in these soils exceed 4%, then lining of drainage channels is recommended, e.g. with geotextile and suitably graded rock, or similarly effective armouring.

The soils present at the site are prone to erosion, both by wind and water, and should be protected by hardfill capping or re-topsoiled/mulched and re-vegetated as soon as the finished batter or sub-grade levels are achieved.

Exposure to the elements should be limited for all soils. Excavations should be left proud of the finished Subgrade level by 200 to 300mm if a delay prior to construction is expected. The final cut to grade should be performed immediately prior to foundation construction. Alternatively, these areas can be undercut and rebuilt to formation level with hardfill should the Subgrade deteriorate due to exposure.

Covering the soils with polythene sheeting will reduce degradation due to rain and surface run-off.

The subsurface material is expected to be free draining and ponding of water in excavations is considered unlikely, however, under no circumstances should water be allowed to pond or collect near or under a foundation slab. Positive grading of the Subgrade should be undertaken to prevent water ingress or ponding.

5.4 Batter Slopes

5.4.1 General

Recommendations for temporary slope batter angles, if required, are described in the following sections. Slopes that are required to be steeper or higher than those described below should be structurally retained or subject to specific design by a Chartered Professional Engineer.

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

5.4.2 Cut slopes

Table 5.2 summarises the recommended batter angles for cut slopes at the site.

Table 5.2 Recommended batter angles for temporary cut slopes up to 3.0 metres high

Material Type	Maximum Temporary Batter Slope in Dry Ground (horizontal to vertical)	Maximum Temporary Batter Slope in Wet Ground (horizontal to vertical)
Topsoil and roots	-	-
Alluvial Sediments	1.5H : 1.0V	2.0H : 1.0V
Alluvial Deposits	1.5H : 1.0V	2.0H : 1.0V
Alluvial Gravels	1.5H : 1.0V	2.0H : 1.0V
Weak, highly weathered Otago Schist	To be confirmed based on an inspection of pilot cuts, an inspection of the as-built cut face and an assessment of the rock quality	
Moderately Strong, Competent Otago Schist	0.25H : 1.0V	0.25H : 1.0V

The batter slope recommendations for wet ground may be adopted for all permanent cut slopes. If wet soils are encountered during the construction of any permanent cut slope then drainage measures should be installed to the approval of a suitably qualified Geotechnical Engineer or Engineering Geologist.

All cut slopes which are greater than 3 metres high must have specific stability analysis and engineering design carried out by a suitably qualified Geotechnical Engineer or Engineering Geologist who is familiar with the on-site materials and contents of this report

5.4.3 Fill slopes

All fill should be placed and compacted in accordance with NZS 4431:1989 and certified in accordance with Queenstown Lakes District Council standards.

All unreinforced fill slopes that are between 0 and 3 metres high should be founded upon Engineer-approved, benched, competent ground and should be finished with a batter angle that is no steeper than 2.5H:1.0V (horizontal : vertical).

All reinforced fill slopes, and fill slopes which are greater than 3 metres high, must have specific stability analysis and engineering design carried out by a suitably qualified geotechnical engineer or engineering geologist who is familiar with the materials and contents of this report.

5.5 Ground Retention

All retaining walls should be designed by a Chartered Professional Engineer using the geotechnical design parameters that are presented in Table 5.1 of this report.

5.6 Groundwater Issues

The regional groundwater table is expected to be present several metres below the existing ground surface and is not expected to be encountered during construction.

5.7 Soil Permeability

Semi-constant head permeability tests were carried out in Test Pits TP2 and TP7 to obtain an indication of the in-situ permeability of the main soil groups. Table 5.3 summarises the results of these permeability tests.

Table 5.3: Permeability Test Results

Test Location	Material Tested	Test Depth (m)	Inferred Horizontal Permeability (m/s)
TP2	Sandy GRAVEL (Alluvial Gravels)	0.6 m	1×10^{-4} to 1×10^{-5} (4.9×10^{-5} measured)
TP7	Silty SAND (Alluvial Deposits)	0.6 m	1×10^{-5} to 1×10^{-6} (5.5×10^{-6} measured)

5.8 Existing Slope Stability

No evidence of existing slope instability was observed within or immediately adjacent to the site boundaries during T&T's walkover inspection of the site.

5.9 Future Building Foundations

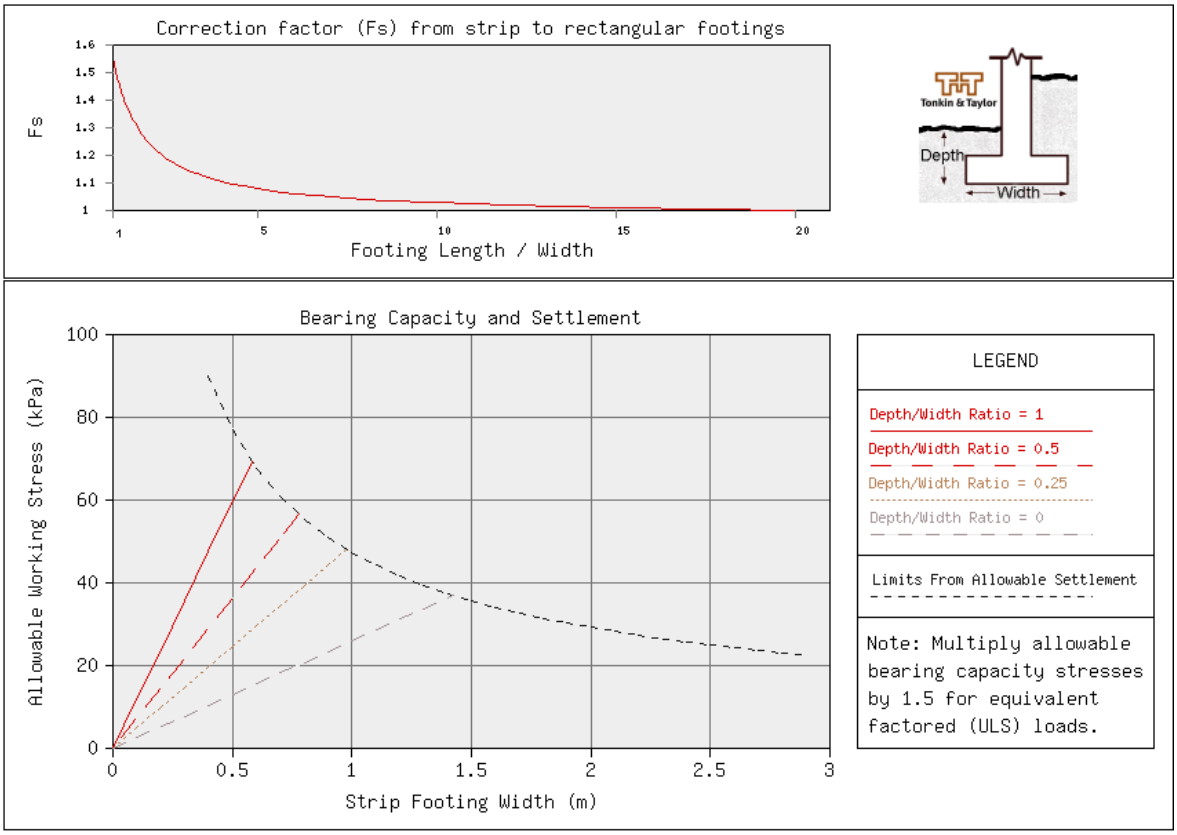
The most economic building foundation system for buildings that are constructed within the Feehly Hill subdivision are expected to comprise shallow strip and/or pad type footings which bear upon a combination of alluvial sediments, alluvial deposits and alluvial gravels.

Inspection of the materials exposed in the investigation test pits, CBR testing and assessment of the Scala penetrometer test results, indicates the existing alluvial sediment and alluvial deposit sub-grade materials will not meet the requirements of NZS 3604:1999 with respect to the 100 kPa minimum allowable bearing pressure. As such it is recommended that all foundations for structures which are built within the alluvial sediment and alluvial deposit soils at Feehly Hill subdivision be subject to specific engineering design by a Chartered Professional Engineer.

Figure 5.1 summarises the recommended working stresses for shallow footings which bear upon alluvial sediments and alluvial deposits. Figure 5.2 summarises the recommended working stresses for shallow footings which bear upon alluvial gravels. It should be noted the foundation working stresses presented on Figures 5.1 and 5.2 are governed by bearing capacity in the case of narrow footings and settlement in the case of

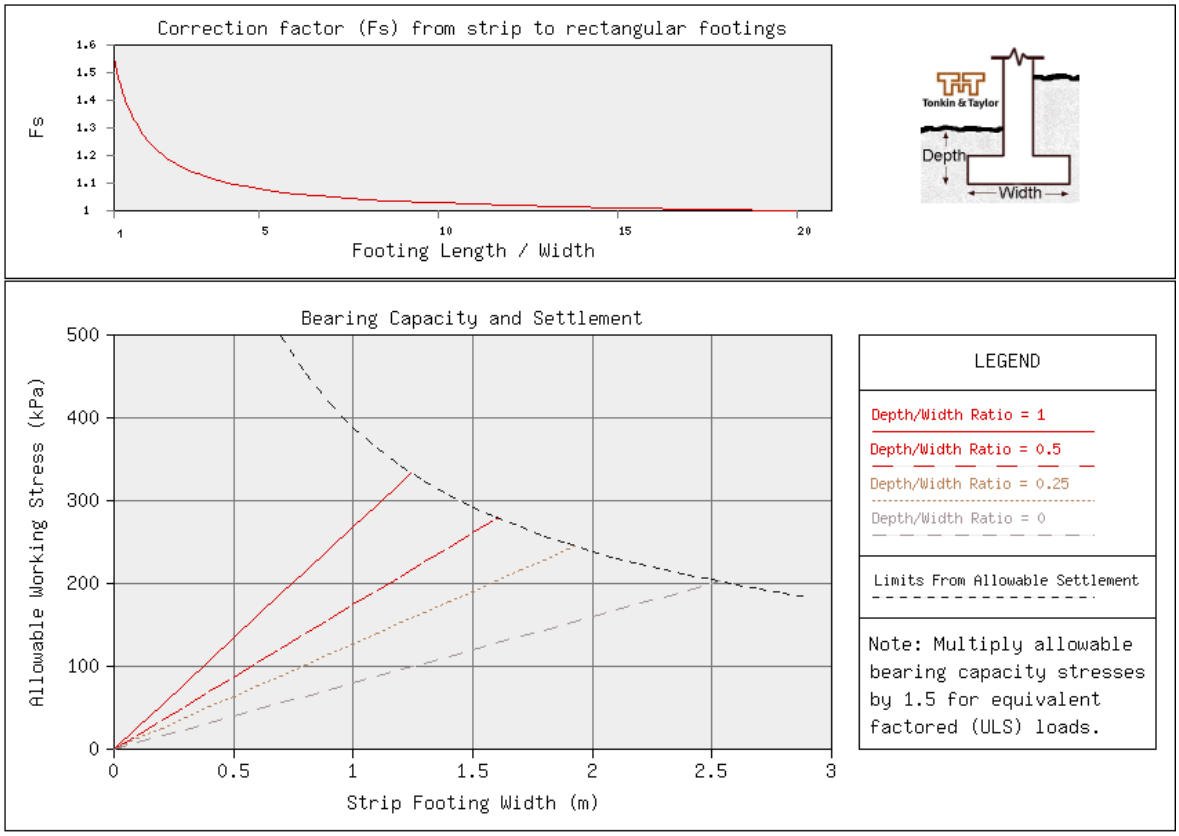
wide footings. To minimise the effects of freeze-thaw cycles, all shallow foundations should be founded a minimum of 0.5m below the adjacent finished ground surface.

Figure 5.1 Recommended working stresses for footings bearing upon alluvial sediments and alluvial deposits.



From Figure 5.1 it can be seen that a working bearing stress of 60 kPa is recommended for a 500mm wide by 500mm deep footing that bears upon alluvial sediment and alluvial deposits. This corresponds to a factored (ULS) bearing capacity of approximately 90kPa and an ultimate bearing capacity of 180kPa.

Figure 5.2 Recommended working stresses for footings bearing upon alluvial gravels.



From Figure 5.2 it can be seen that a working bearing stress of 100 kPa is recommended for a 400mm wide by 400mm deep footing that bears upon alluvial gravel. This corresponds to a factored (ULS) bearing capacity of approximately 150 kPa and an ultimate bearing capacity of 300 kPa.

All unsuitable materials that are identified in the foundation excavations, particularly those softened by 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 affect.

It is recommended that all future building foundation sub-grade be inspected, tested and certified by a suitably qualified and experienced geotechnical specialist to confirm the sub-grade conditions are in accordance with the assumptions and recommendations provided in this report. At the time of building construction, the bearing capacity of the exposed foundation sub-grade should be tested using a Scala penetrometer, and any soft areas identified should be sub-excavated and backfilled with compacted hardfill.

5.10 Subsoil Class for Seismic Design

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

Based on an assessment of the materials exposed in the test pit excavations, T&T recommends that "Class C" subsoil conditions be adopted for the purposes of estimating the magnitude of seismic acceleration.

5.11 Pavements

Two new roads are proposed to provide access the Feehly Hill subdivision.

The pavement sub-grade materials are expected to comprise a combination of alluvial sediments and alluvial gravels.

Table 5.4 summarises the in-situ design (10 percentile) CBR values that are recommended for detailed design of the road pavements. It should be noted that all CBR values presented in Table 5.4 are subject to confirmatory in-situ testing and inspection once the sub-grade is formed. Representative CBR lab testing results are displayed in Appendix C.

Table 5.4: Recommended 10 Percentile CBR Values for Road Pavement Design

Geologic Unit	**Recommended 10 Percentile CBR Value for Pavement Design** (See Note 1)
Engineered Fill	3 to 5
Unengineered Fill	1 to 3
Alluvial Sediments	2 to 3
Alluvial Deposits	2 to 4
Alluvial Gravels	4 to 10

Note 1: All CBR values which are presented in Table 5.4 are subject to confirmatory inspection and in-situ testing during construction by an appropriately qualified and experienced geotechnical specialist.

Topsoil and roots were found to be present across the site to a depth of up to 400 mm below the existing ground level. All topsoil material should be removed from beneath the road footprint prior to pavement construction.

All pavement sub-grades should be proof rolled with at least four passes of a heavy roller with a static weight of at least 12 tonnes. Any soft areas identified should be sub-excavated and replaced with either compacted hardfill or re-compacted cohesive fill.

All engineered fill beneath pavements should be placed in accordance with the requirements of Queenstown Lakes District Council. Inspections of the pavement sub-grade should be completed during construction by a suitably qualified Engineer or Engineering Geologist to confirm the geotechnical conditions are in accordance with the recommendations of this report.

A geotextile separation layer should be provided between the prepared sub-grade surface and the road sub-base layers where filter incompatibility is suspected.

The alluvial sediment soils typically exhibit moderate to high sensitivity. We recommend that trafficking of the finished formation levels is limited, and water is not permitted to pond on the sub-grade surface. The sediments are particularly prone to weaving if above optimum water content, and it is important that allowance is made for conditioning. Compaction of these silty sediments outside the normal earthworks season is likely to be impractical.

5.12 Existing Structures and Neighbouring Properties

The proposed development is flanked by the following existing structures or services:

- A private dwelling approximately 30 metres east of the eastern site boundary; and;
- A legal road (Manse Road) on the north-western boundary.

From a geotechnical perspective the proposed development is not expected to adversely affect neighbouring buildings or services providing appropriate silt and dust control measures are instigated during construction.

The neighbouring site is currently occupied. The affects of construction-related traffic movements, vibrations and noise should be considered and appropriate steps taken to minimise the impact of these issues.

5.13 Groundwater and Aquifers

Perched groundwater tables were not observed in any of the investigation test pits which were excavated for the purpose of this report.

Based on local experience and observations, the regional groundwater table is expected to lie several metres beneath the existing ground surface and no aquifer resource is expected to be adversely affected by the proposed subdivision development.

5.14 Natural Hazards

A risk of seismic activity has been identified for the region as a whole and appropriate allowance should be made for potential seismic loads during detailed design of the proposed buildings. No other natural hazards have been identified on site.

Some of the near-surface alluvial sediments materials may be susceptible to liquefaction if they are saturated and subjected to strong seismic shaking, however, the risk of liquefaction at the Feehly Hill subdivision is assessed to be nil to extremely low due to the near-surface location of the liquefaction susceptible materials and the expected depth to the regional groundwater table.

5.15 Environmental Issues during Construction

5.15.1 Erosion and Sediment control

Effective measures for erosion control are run-off diversion drains and contour drains. Options for the control of sediment run-off include earth bunds, silt fences, hay bales, vegetation buffer strips and sediment ponds.

The construction works should be staged to minimise the surface area of exposed ground at any one time. As much grass cover as possible shall be maintained throughout construction and vegetation of exposed surfaces shall be re-established as soon as possible or mulch applied.

Details for the implementation of erosion and sediment control measures can be accessed at the following internet link:

http://www.aucklandcity.govt.nz/council/documents/district/Ann14.pdf

Further detail related to construction sites can be found at:

http://www.itd.idaho.gov/manuals/Online_Manuals/BMP/

5.15.2 Noise

It is expected that conventional earthmoving equipment such as bulldozers, excavators, and dump-trucks, will be used during the earthworks construction.

The construction contractor should take appropriate measures to control construction noise, in accordance with QLDC requirements, as the site is located adjacent to occupied residential properties.

5.15.3 Dust

The on-site soils have the potential to generate dust and the Contractor should take appropriate measures to control dust in accordance with QLDC requirements. Regular damping with sprinklers is expected to be an effective measure to control airborne dust during the construction.

5.15.4 Hydrocarbon Pollution

An area of potential hydrocarbon pollution was identified by ground penetrating radar during service locations. We recommend the full extent of this pollution including its depth and proximity be identified more accurately with the ground penetrating radar. Following accurate mapping all effected soils should be excavated and replaced with suitable certified fill placed in accordance with NZS 4431:1989.

6 Conclusions and Recommendations

Proposed Development

- From a geotechnical perspective the proposed Feehly Hill subdivision is considered technically feasible provided the detailed design of all future building foundations, pavements, earthworks slopes and retaining structures is completed by a Chartered Professional Engineer in accordance with the recommendations provided in this report.

  The foundation soils are expected to comprise a combination of alluvial sediments, alluvial deposits and alluvial gravels that will not meet the requirements of NZS 3604:1999 with respect to the 100 kPa minimum foundation allowable bearing pressure. As such it is recommended that all foundations for structures which are constructed within the Feehly Hill subdivision be subject to specific engineering design by a Chartered Professional Engineer.

Existing Geotechnical Conditions:

- The results of site-specific geotechnical investigations indicate the subsurface conditions beneath the site comprise:
  - 0.2 to 0.4 m of Topsoil; overlying
  - 0.4 to 0.6 m of Alluvial Sediments (eastern side of site only); overlying
  - 2.3 to 3.0 m of Alluvial Deposits (eastern side of site only); overlying
  - An unconfirmed thickness of Alluvial Gravel (observed in all test pits except TP1); overlying
  - Otago Schist bedrock (encountered in TP1 only).
- The base of the Alluvial Deposits was not encountered during the site investigation works.
- Schist bedrock was only encountered in test pit TP1, however, several outcrops of Schist bedrock were observed adjacent to the south-eastern boundary of the site on the flanks of Feehly Hill.
- Table 4.1 of this report summarises the sub-surface stratigraphy which was observed in each of the 8 test pits which were excavated for the purposes of this report.
- No evidence of existing slope instability was identified within or in the immediate vicinity of the proposed subdivision during the site walkover inspection.
- The risk of liquefaction at the site is assessed to be nil to extremely low.
- The regional groundwater table was not encountered during the site investigation works and is not expected to be encountered during construction of the proposed subdivision development.
- Semi-constant head permeability tests were carried out in Test Pits TP2 and TP7 to obtain an indication of the in-situ permeability of the main soil groups. Table 5.3 summarises the results of these permeability tests.

Geotechnical Design Parameters:

- Table 5.1 of this report summarises the recommended geotechnical design parameters for the soil materials present on site.

Earthworks Construction:

- During the earthworks operations, all topsoil, organic matter and unsuitable materials should be removed from the affected areas in accordance with the recommendations of NZS 4431:1989 and the relevant Queenstown Lakes District Council standards.
- All fill should be engineered, placed and compacted in accordance with the recommendations of NZS4431:1989 and certified in accordance with QLDC standards.
- The on-site soils are prone to erosion by wind and water. Section 5.3 of this report outlines special measures that should be instigated to control these issues.

Cut and Fill Slopes:

- Table 5.2 of this report summarises the recommended batter angles for temporary cut slopes up to 3 metres high.
- The batter slope recommendations provided in Table 5.2 for wet ground may be adopted for all permanent cut slopes. Drainage measures should be installed to the approval of a suitably qualified Geotechnical Engineer or Engineering Geologist if wet soils are encountered during the construction of any permanent cut slope.
- All batter slopes steeper than those recommended in Table 5.2 should be structurally retained.
- All cut and fill slopes greater than 3.0 metres high should have specific slope stability analysis and design carried out by a suitably qualified and experienced geotechnical engineer or engineering geologist.
- Should wet soils be encountered during the excavation suitable drainage measures should be installed to the approval of a suitably experienced Geotechnical Engineer or Engineering Geologist.

Future Building Foundations:

- Some foundation soils are expected to comprise a combination of alluvial sediments and alluvial deposits which do not meet the requirements of NZS 3604:1999 with respect to the 100 kPa minimum allowable bearing pressure. As such it is recommended that all foundations for structures which are built within these soils at the Feehly Hill subdivision be subject to specific engineering design by a Chartered Professional Engineer.
- Figure 5.1 summarises the recommended working load bearing stress for shallow foundations that are constructed within alluvial sediment and alluvial deposits at the Feehly Hill subdivision.
- Figure 5.2 summarises the recommended working load bearing stress for shallow foundations that are constructed within alluvial gravel at the Feehly Hill subdivision.

- It is recommended that all future building foundation sub-grade be inspected, tested and certified by a suitably qualified and experienced geotechnical specialist to confirm the sub-grade conditions are in accordance with the assumptions and recommendations provided in this report.
- At the time of building construction, the bearing capacity of the exposed foundation sub-grade should be tested with a Scala penetrometer and any soft areas identified should be sub-excavated and backfilled with compacted hardfill.

Pavement Design and Construction:

- The sub-grade materials under the proposed access road footprint are expected to comprise alluvial deposits in the eastern part of the site and alluvial gravels and alluvial deposits in the western part of the site.
- Table 5.4 summarises the in-situ design (10 percentile) CBR values that are recommended for detailed design of the proposed road pavements. It should be noted that all CBR values presented in Table 5.4 are subject to confirmatory in-situ testing and inspection once the sub-grade is formed.
- All topsoil material should be removed from beneath the proposed road footprints prior to commencement of pavement construction.
- All pavement sub-grades should be proof rolled with at least four passes of a heavy roller with a static weight of at least 12 tonnes. Any soft areas identified should be sub-excavated and replaced with either compacted hardfill or re-compacted cohesive fill.
- All engineered fill beneath pavements should be placed in accordance with the requirements of Queenstown Lakes District Council. Inspections of the pavement sub-grade should be completed during construction by a suitably qualified Engineer or Engineering Geologist to confirm the geotechnical conditions are in accordance with the recommendations of this report.
- A geotextile separation layer should be provided between the prepared sub-grade surface and the road sub-base layers where filter incompatibility is suspected.
- The alluvial sediment soils typically exhibit moderate to high sensitivity. We recommend that trafficking of the finished formation levels is limited and water is not permitted to pond on the sub-grade surface. The silty alluvial sediments and deposits are particularly prone to weaving if above optimum water content, and it is important that allowance is made for soil conditioning during earthworks construction. Compaction of the silty alluvial sediments and deposits outside the normal earthworks season is likely to be impractical.

Seismic Design:

- A risk of seismic activity has been identified for the region as a whole and provision should be made for seismic ground accelerations during detailed design of all proposed structures.
- For detailed engineering design purposes it is recommended the magnitude of seismic acceleration be estimated in accordance with the recommendations of NZS 1170.5:2004 using "Class C" subsoil conditions.

7 Applicability

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

During excavation and construction, the site should be examined by an appropriately trained, qualified and experienced geotechnical specialist who is competent to judge whether the exposed subsoils are compatible with the inferred conditions on which this report has been based.

Tonkin and Taylor Ltd must be contacted immediately if there is any variation in subsoil condition from that which is described in this report.

TONKIN & TAYLOR LIMITED

Environmental and Engineering Consultants

Report Prepared By:

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Kylie Govan

Geotechnical Engineer

Report Reviewed By:

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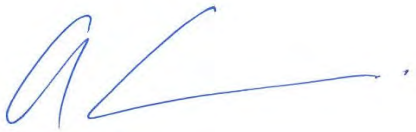
Fraser A Wilson

Engineering Geologist

Report Authorised for T&T by:



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Anthony Fairclough

Senior Geotechnical Engineer

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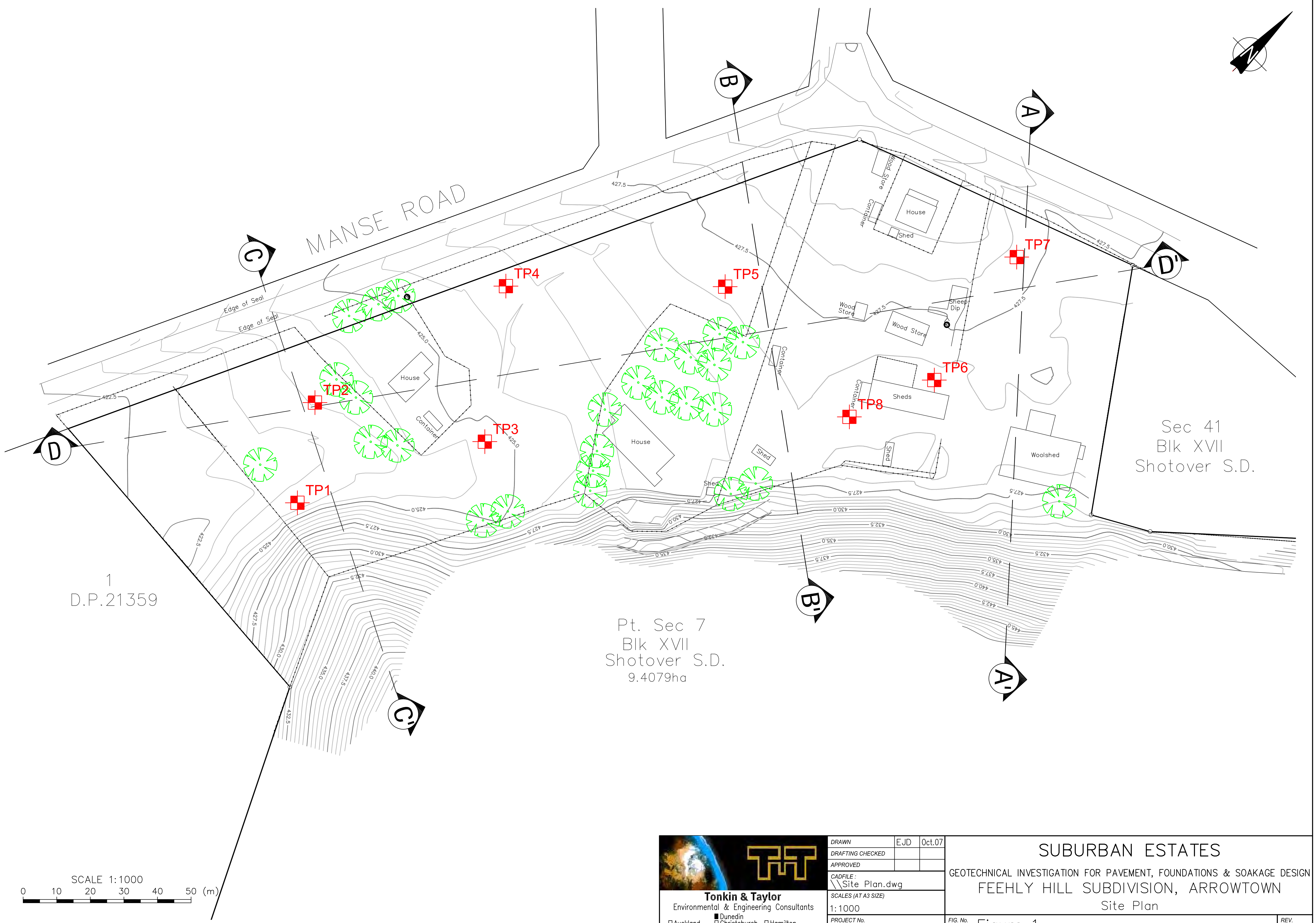
Appendix A: Site Plan and Cross Sections



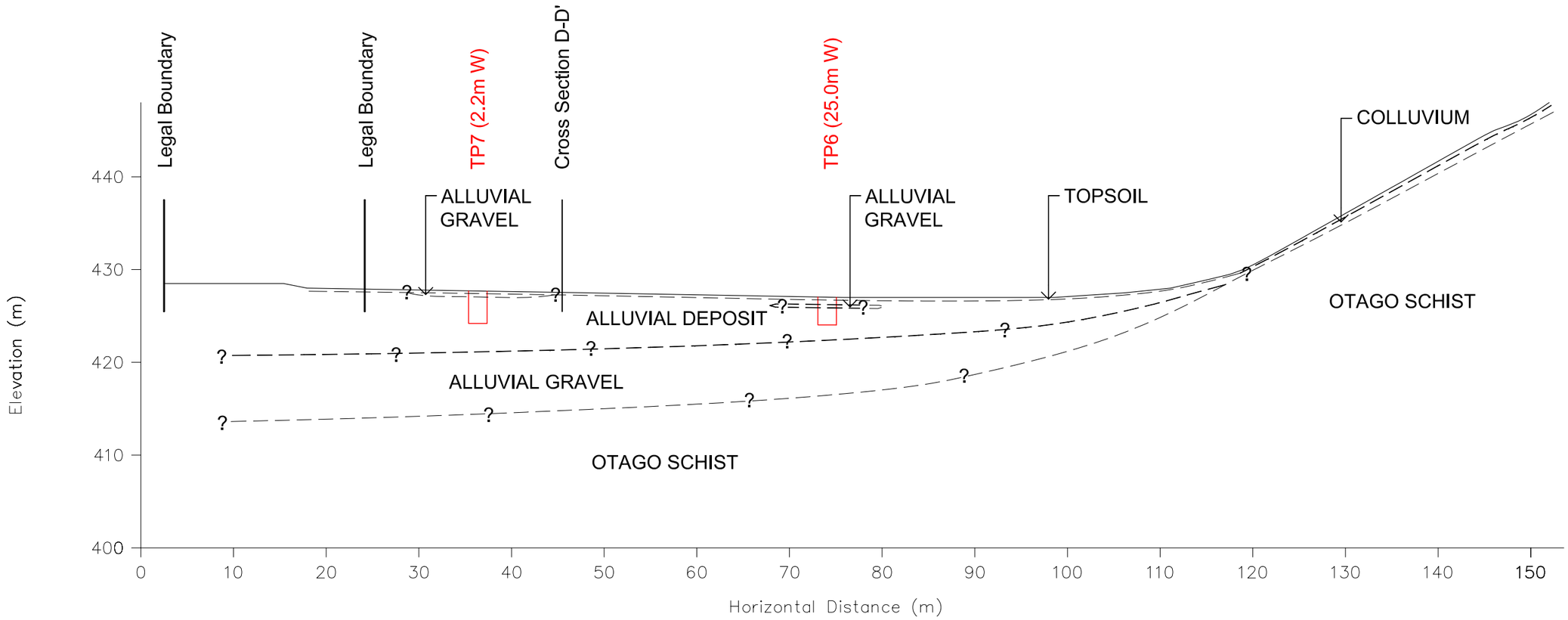
Tonkin & Taylor
Environmental & Engineering Consultants

☐ Auckland ☐ Nelson ■ Dunedin ☐ Christchurch ☐ Wellington ☐ Hamilton ☐ Tauranga

DRAWN	EJD	Oct.07
DRAFTING CHECKED		
APPROVED		
CADFILE : \\Site Plan.dwg		
SCALES (AT A3 SIZE) 1:1000		
PROJECT No. 880070		

SUBURBAN ESTATES
GEOTECHNICAL INVESTIGATION FOR PAVEMENT, FOUNDATIONS & SOAKAGE DESIGN
FEEHLY HILL SUBDIVISION, ARROWTOWN
Site Plan

FIG. No. Figure 1 REV. _



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DRAWN	EJD	Oct.07
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CADFILE: \\Site Plan.dwg		
SCALES (AT A3 SIZE) 1:500		
PROJECT No. 880070		

SUBURBAN ESTATES

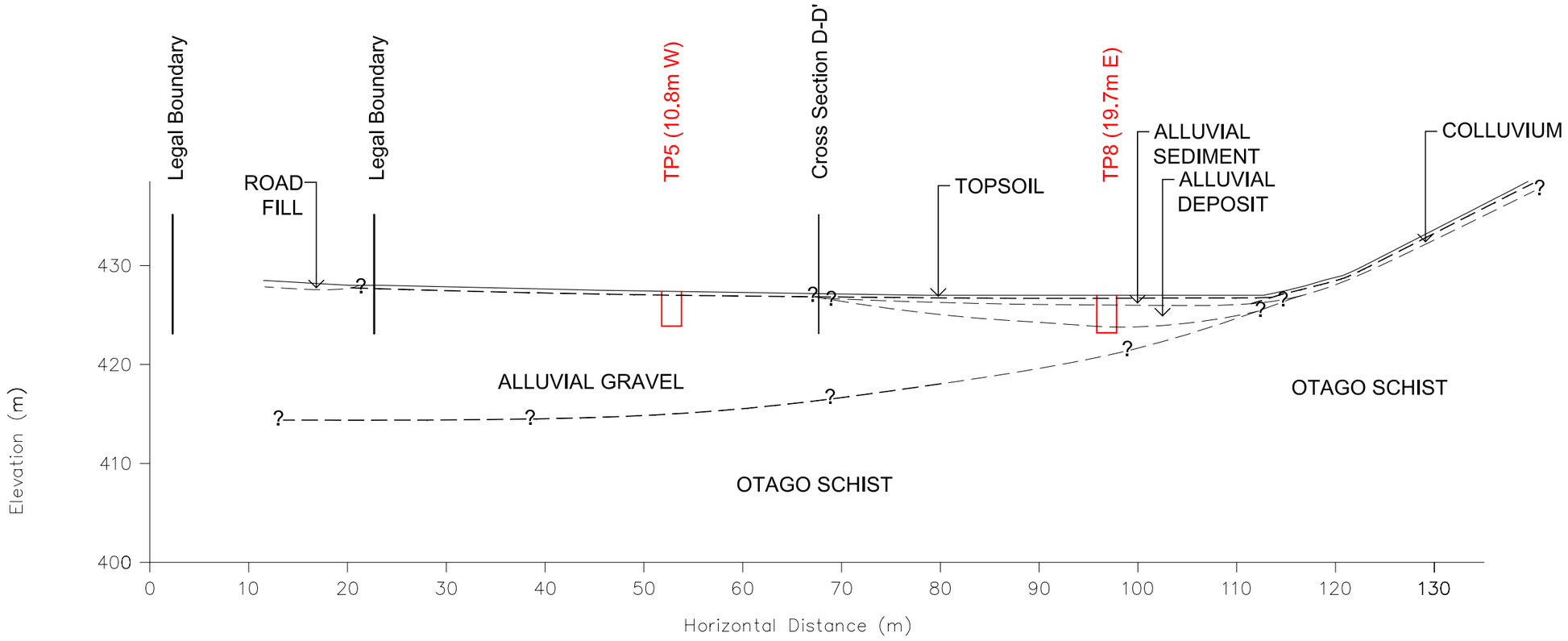
GEOTECHNICAL INVESTIGATION FOR PAVEMENT, FOUNDATIONS & SOAKAGE DESIGN

FEEHLY HILL SUBDIVISION, ARROWTOWN

Cross Section A–A'

FIG. No. Figure 2a

REV. –



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SCALES (AT A3 SIZE) 1:500		
PROJECT No. 880070		

SUBURBAN ESTATES

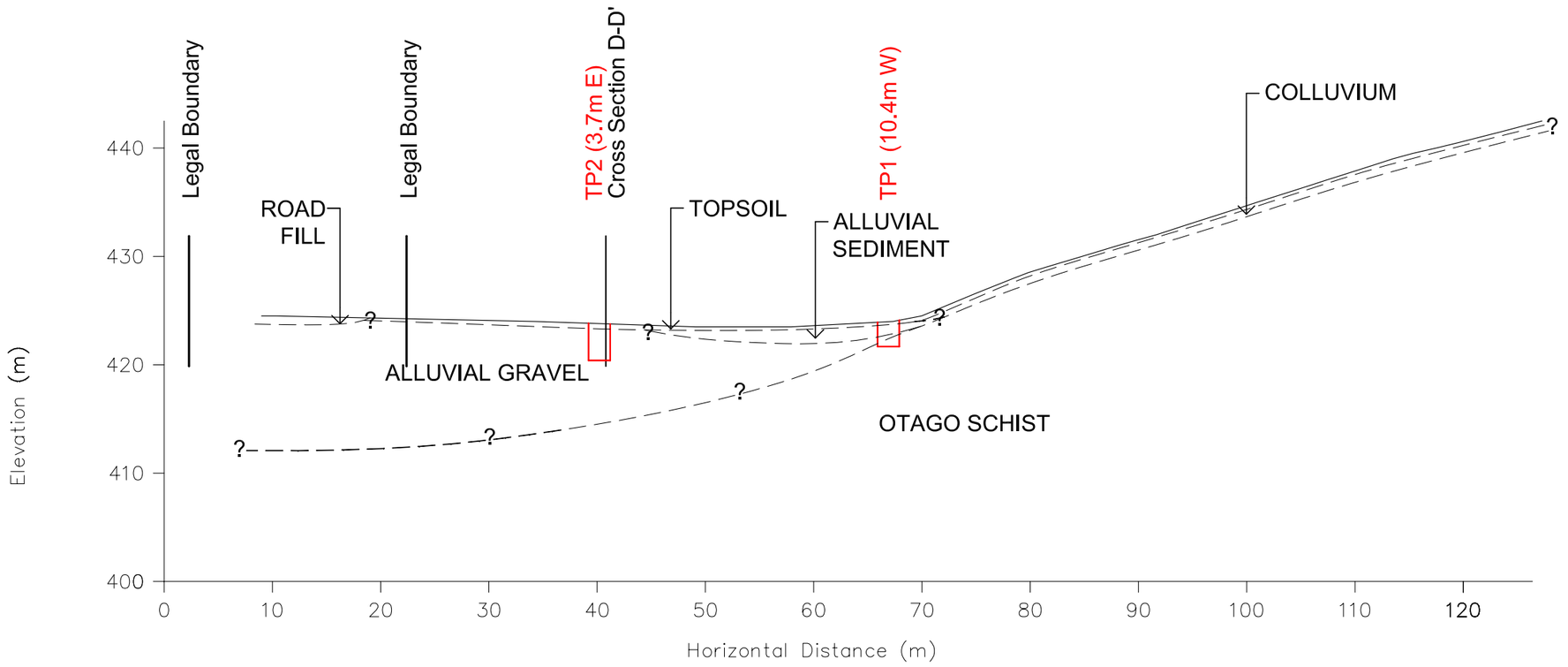
GEOTECHNICAL INVESTIGATION FOR PAVEMENT, FOUNDATIONS & SOAKAGE DESIGN

FEEHLY HILI SUBDIVISION, ARROWTOWN

Cross Section B–B'

FIG. No. Figure 2b

REV. –



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	DRAFTING CHECKED		
	APPROVED		
	CADFILE: \\Site Plan.dwg		
	SCALES (AT A3 SIZE) 1:500		
	PROJECT No. 880070		

SUBURBAN ESTATES

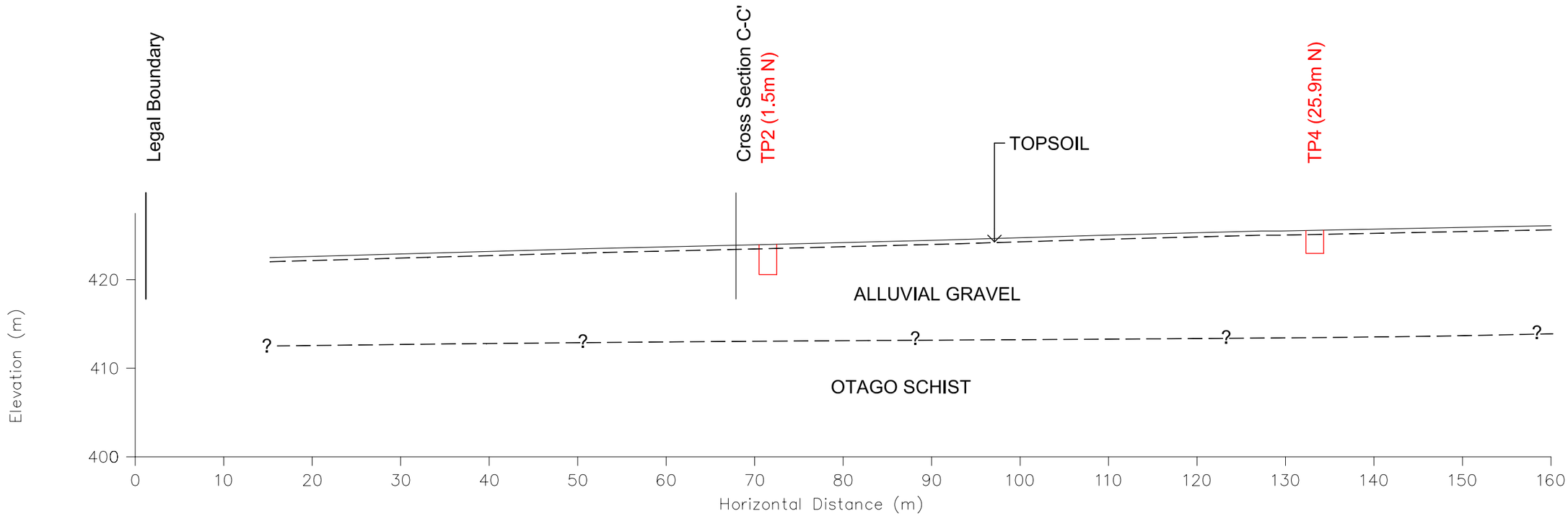
GEOTECHNICAL INVESTIGATION FOR PAVEMENT, FOUNDATIONS & SOAKAGE DESIGN

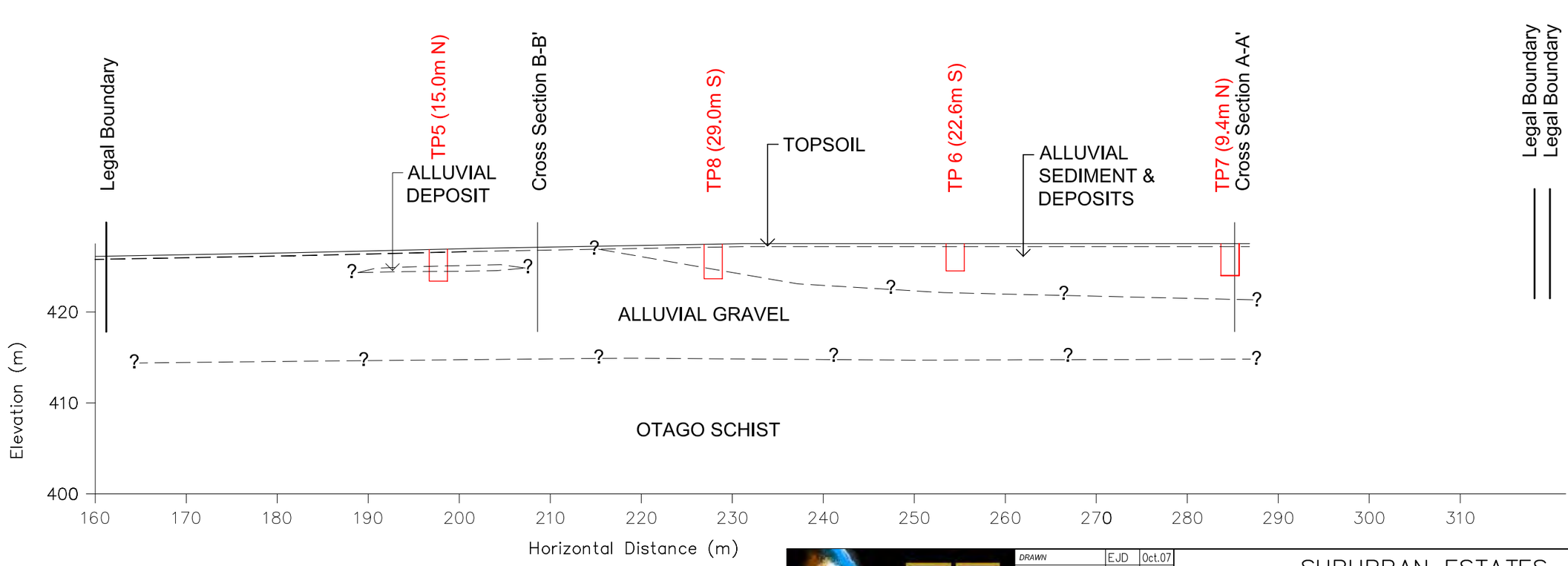
FEEHLY HIIL SUBDIVISION, ARROWTOWN

Cross Section C–C'

FIG. No. Figure 2c

REV. –





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APPROVED		
CADFILE : \\Site Plan.dwg		
SCALES (AT A3 SIZE) 1:500		
PROJECT No. 880070		

SUBURBAN ESTATES

GEOTECHNICAL INVESTIGATION FOR PAVEMENT, FOUNDATIONS & SOAKAGE DESIGN

FEEHLY HIIL SUBDIVISION, ARROWTOWN

Cross Section D–D'

FIG. No. Figure 2d

REV. –

Appendix B: Test Pit and Scala Logs

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EXCAVATION LOG

EXCAVATION No: TP01
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	427.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	2.3 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, dark brown, moist	M			TOPSOIL	
							ML	slightly sandy SILT, mottled brown, soft to firm, moist, uniform, sand is fine	M	S - F		ALLUVIAL SEDIMENT	
				426	1		GM	highly to completely weathered grey psamatic SCHIST with quartz veins and iron staining, very weak, closely spaced joints and fractures, foliation dip direction 40° to 260° (SW) on N side of pit, 30° to 230° (SW) on E side of pit, 80° to 250° (SW) on S side of pit	M	L		WEAK OTAGO SCHIST	
				425	2								
				424	3		GM	**END OF TRIAL PIT AT 2.3m in Otago SCHIST**					

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EXCAVATION LOG

EXCAVATION No: TP02
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	430.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.4 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200		ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT	M				TOPSOIL	
							GP	sandy fine to coarse GRAVEL, grey/brown, loose to medium dense, moist, poorly graded, subangular to subrounded, elongated, sand is fine to medium	M	L-MD			ALLUVIAL GRAVELS	
				429	1									
				428	2									
							GP	sandy fine to coarse GRAVEL, grey/brown, medium dense, moist to wet, poorly graded, subangular to subrounded, elongated, sand is fine to coarse	M-W	MD				
				427	3									
								END OF TRIAL PIT AT 3.4 m in sandy GRAVEL						

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EXCAVATION LOG

EXCAVATION No: TP03
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	432.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.5 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200		ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, dark brown	M				TOPSOIL	
			SV = 32 PP = 172 PP = 147				ML	SILT with minor sand, mottled brown, firm, moist, uniform, non plastic	M	F			ALLUVIAL SEDIMENT	
							SP	SAND with minor silt, mottled brown, loose, moist, uniform, sand is fine	M	L			ALLUVIAL DEPOSIT	
							GP	sandy fine to coarse GRAVEL, grey/brown, loose, moist, poorly graded, sand is medium to coarse	M	L			ALLUVIAL GRAVELS	
				431	1									
			PP = 74 PP = 49				SM	silty fine SAND, brown/grey, loose, moist, uniform	M	L			ALLUVIAL DEPOSIT	
							GP	sandy fine to coarse GRAVEL, grey/brown, loose, moist, poorly graded, sand is medium to coarse	M	L			ALLUVIAL GRAVELS	
							SM	silty fine SAND, brown/grey, loose, moist, uniform	M	L			ALLUVIAL DEPOSIT	
				430	2									
							GP	sandy fine to coarse GRAVEL, grey/brown, loose, moist, poorly graded, sand is medium to coarse	M	L			ALLUVIAL GRAVELS	
							ML	sandy SILT, brown/grey, firm, moist, uniform, sand is fine	M	F			ALLUVIAL SEDIMENT	
				429	3		SP	silty gravelly fine to medium SAND, brown/grey, loose to medium dense, moist, poorly graded, gravel is fine to medium	M	L-MD			ALLUVIAL DEPOSIT	
								END OF TRIAL PIT AT 3.5 m in silty gravelly SAND						

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EXCAVATION LOG

EXCAVATION No: TP04
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	432.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	2.6 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, dark brown	M			TOPSOIL	
							GP	sandy fine to coarse GRAVEL, grey/brown, loose, moist, poorly graded, sub angular to subrounded, flat and elongated, sand is medium to coarse	M	L-MD		ALLUVIAL GRAVELS	
				431	1		GW	sandy fine to coarse GRAVEL, grey/brown, medium dense, moist, well graded, sub angular to subrounded, flat and elongated, sand is medium to coarse	M	MD			
				430	2								
								END OF TRIAL PIT AT 2.6 m in sandy GRAVEL					
				429	3								

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EXCAVATION LOG

EXCAVATION No: TP05
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	434.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.5 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200		ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, brown	M				TOPSOIL	
							GP	slightly sandy fine to coarse GRAVEL, brown, loose, moist, poorly graded, sub angular to sub rounded, elongated and flat, sand is medium	M	L			ALLUVIAL GRAVELS	
							GP	slightly sandy fine to coarse GRAVEL, brown, loose to medium dense, moist, poorly graded, sub angular to sub rounded, elongated and flat, sand is medium	M	L-MD				
				433	1				M	L-MD				
								-sand lenses, 0.3 m thick, moist, fine, slightly silty						
				432	2		GW	sandy fine to medium GRAVEL, grey/brown, medium dense, moist, well graded, sand is medium to coarse	M	MD				
							SM	slightly silty fine to coarse SAND with rare gravels, grey/brown, edium dense, moist, poorly graded, gravels are fine to medium, sub angular to subrounded	M	MD			ALLUVIAL DEPOSIT	
				431	3		GW	sandy fine to medium GRAVEL, grey/brown, medium dense, moist, well graded, sand is fine to coarse	M	MD			ALLUVIAL GRAVELS	
							GW	sandy fine to coarse GRAVEL with rear cobbles, medium dense, moist, well graded, sand is medium to coarse, gravels and cobbles are subrounded to subangular and elongated	M	MD				
								END OF TRIAL PIT AT 3.5 m in sandy GRAVEL						

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EXCAVATION LOG

EXCAVATION No: TP06
Location:

SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	437.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.0 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200		ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, dark brown	M				TOPSOIL	
							ML	sandy SILT, mottled brown, soft to firm, moist, uniform, sand is fine	M	F			ALLUVIAL SEDIMENT	
							GP	sandy fine to medium GRAVEL, brown/grey, loose to medium dense, moist , dips with slope, poorly graded, subrounded to subangular, flat and elongated	M	L-MD			ALLUVIAL GRAVELS	
							SP	fine SAND, grey, loose, moist, uniform	M	L			ALLUVIAL DEPOSIT	
				436	1									
				435	2									
							SP	very slightly silty fine SAND, grey, loose, moist, uniform	M	L				
				434	3			**END OF TRIAL PIT AT 3.0 m in very slightly silty SAND**						

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EXCAVATION LOG

EXCAVATION No: TP07
Location:
SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	432.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.5 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS				ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							OL	organic SILT, brown,	M			TOPSOIL	
							GP	sandy fine to medium GRAVEL, brown, loose, moist, poorly graded, subangular to subrounded, flat and elongated clasts, slightly weathered	M	L		ALLUVIAL GRAVELS	
							SM	silty fine SAND, brown/grey with some iron staining, loose to medium dense, moist, uniform	M	L-MD		ALLUVIAL DEPOSIT	
				431	1		SP	slighlty silty fine SAND, brown/grey with some iron staining, loose to medium dense, moist, uniform	M	L-MD			
				430	2		SP	fine SAND, mottled brown, medium dense, moist, uniform	M	MD			
				429	3		SP	fine to medium SAND with rare gravels, mottled brown, medium dense, moist to wet, gravels are fine to medium, subangular to subrounded, flat and elongated	M-W	MD			
								END OF TRIAL PIT AT 3.5 m in SAND with rare gravels					

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EXCAVATION LOG

EXCAVATION No: TP08
Location:

SHEET 1 OF 1

PROJECT:	Feehly Hill Subdivision	LOCATION:	Manse Road, Arrowtown	JOB No:	880070
CO-ORDINATES	mN mE	EXPOSURE TYPE:	Trial Pit	HOLE STARTED:	28/09/07
		EQUIPMENT:	12 tonne wheeled excavator	HOLE FINISHED:	28/09/07
R.L.	436.00 m	OPERATOR:	Pete	LOGGED BY:	KGG
DATUM		DIMENSIONS:	3.8 x 0.9 x 2.5	CHECKED BY:	

EXCAVATION TESTS						ENGINEERING DESCRIPTION							GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH 10 25 50 100 200		ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
		None encountered	PP = 294 PP = 368 PP = 392 SV = 48 PP = 294 PP = 245 SV = 26				OL	organic SILT, dark brown, moist	M				TOPSOIL	
							OL	SILT with minor organics, dark brown, firm, moist	M	F			ALLUVIAL SEDIMENT	
							ML	SILT, mottled brown, firm to stiff, moist, uniform, non plastic	M	F-St				
							ML	SILT with minor sand, mottled brown, firm to stiff, moist, uniform, slightly plastic, non-dilatant,	M	F-St				
				435	1		SW	fine SAND, mottled brown, loose to medium dense, moist, uniform	M	L-MD			ALLUVIAL DEPOSIT	
				434	2		SM	slightly silty fine SAND, mottled brown with rare iron staining, loose to medium dense, moist, uniform	M	L-MD				
				433	3		SP	gravelly fine to coarse SAND with minor silt, brown/grey, medium dense, moist, poorly graded, gravel is fine to medium	M	MD				
							GW	sandy fine to coarse GRAVEL, brown/grey, medium dense, moist, well graded, sand is fine to coarse	M	MD			ALLUVIAL GRAVELS	
								END OF TRIAL PIT AT 3.8 m in sandy GRAVEL						

TONKIN & TAYLOR
151 Kilmore Street
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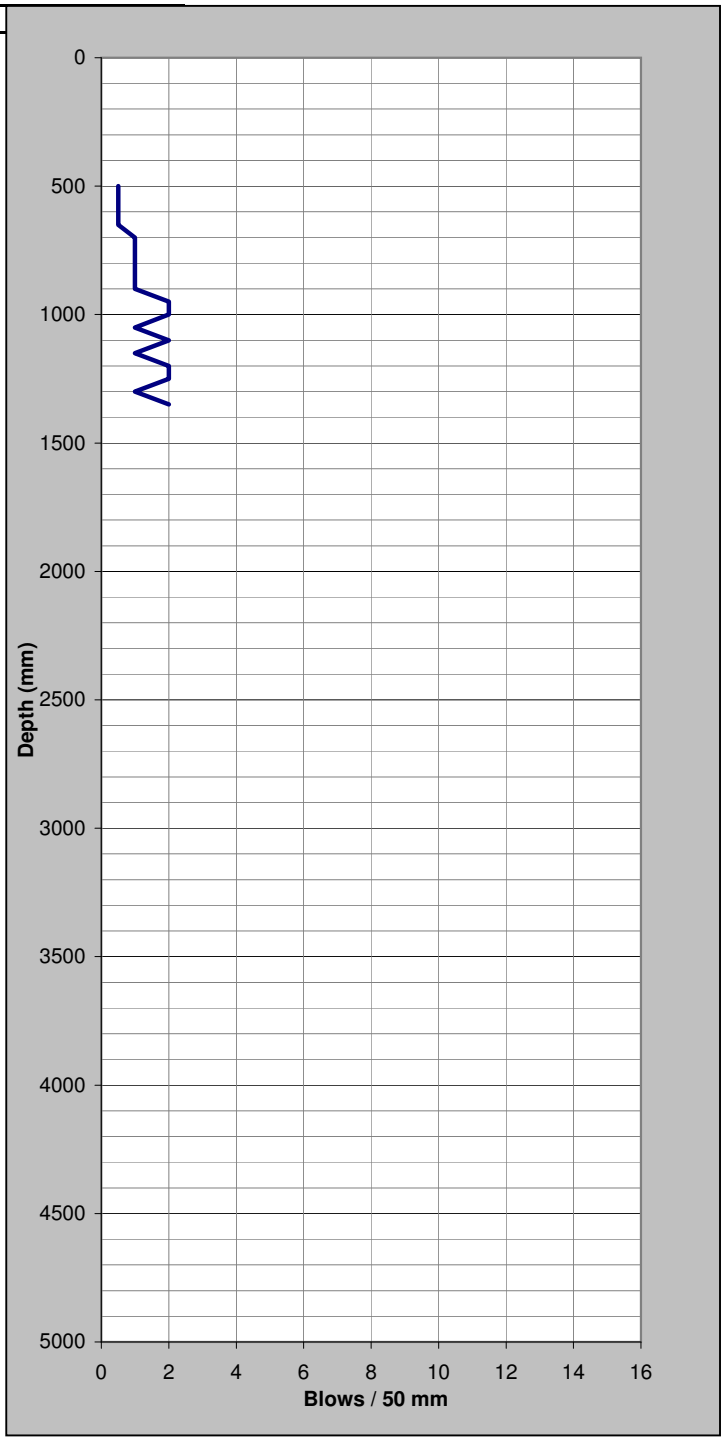
CHRISTCHURCH
Tel: (03) 3534400
Fax: (03) 3534401

SCALA PENETROMETER LOG

Job No:	*880070*	Date:	*28/09/2007*	**Test No.**	***SC 1***
Project:	*Feehly Hill Subdivision*	Operated by:	*FAW*		***TP 2***
Location:	*Refer Site Plan*	Logged by:	*KGG*	**Sheet**	***1***
Level:	*0.5 m*	Checked by:		**of**	***1***

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	
100		2600	
150		2650	
200		2700	
250		2750	
300		2800	
350		2850	
400		2900	
450		2950	
500	*0.5*	3000	
550	*0.5*	3050	
600	*0.5*	3100	
650	*0.5*	3150	
700	*1*	3200	
750	*1*	3250	
800	*1*	3300	
850	*1*	3350	
900	*1*	3400	
950	*2*	3450	
1000	*2*	3500	
1050	*1*	3550	
1100	*2*	3600	
1150	*1*	3650	
1200	*2*	3700	
1250	*2*	3750	
1300	*1*	3800	
1350	*2*	3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
1700		4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

TONKIN & TAYLOR

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CHRISTCHURCH
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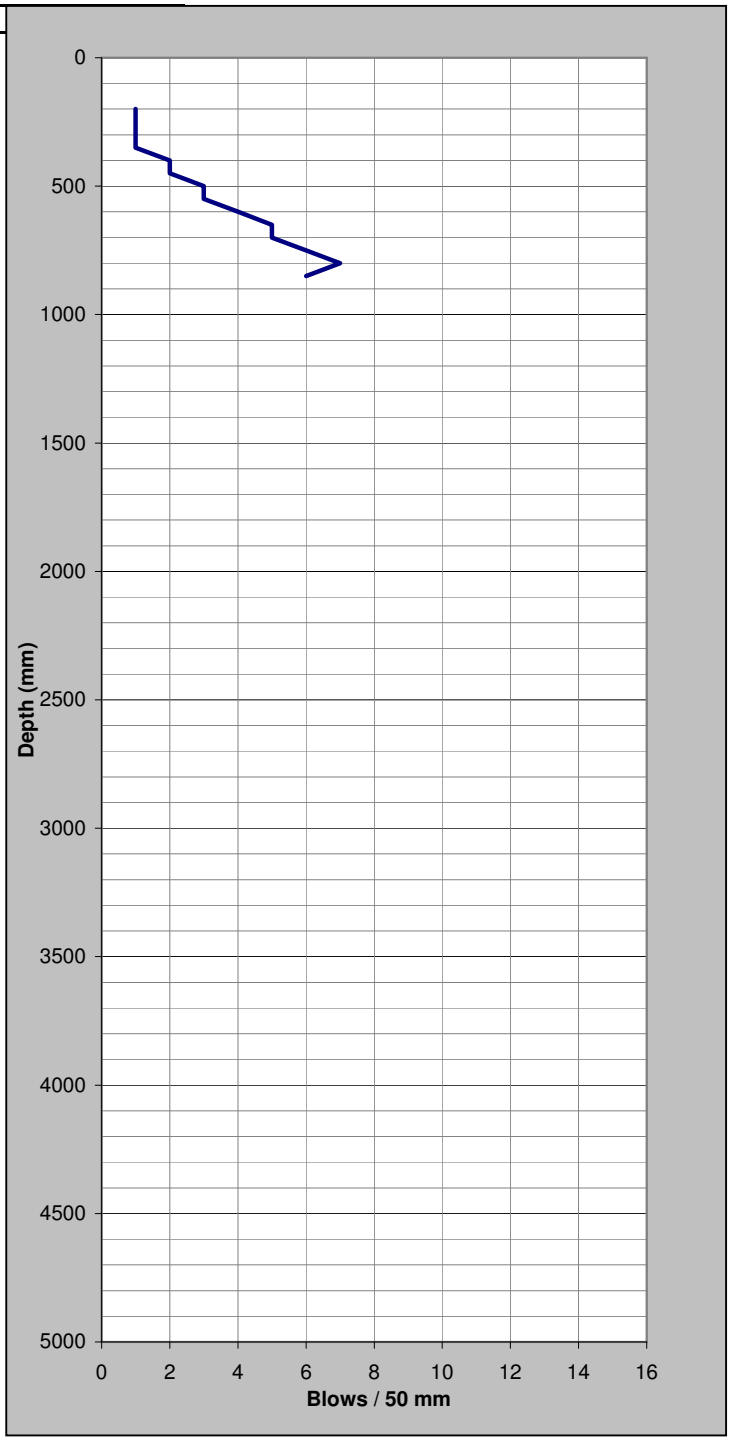
Fax: (03) 3534401

SCALA PENETROMETER LOG

Job No:	*880070*	Date:	*28/09/2007*	**Test No.**	***SC 2 TP4***
Project:	*Feehly Hill Subdivision*	Operated by:	*FAW*		
Location:	*Refer Site Plan*	Logged by:	*KGG*	**Sheet**	***1***
Level:	*0.2 m*	Checked by:		**of**	***1***

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	
100		2600	
150		2650	
200	*1*	2700	
250	*1*	2750	
300	*1*	2800	
350	*1*	2850	
400	*2*	2900	
450	*2*	2950	
500	*3*	3000	
550	*3*	3050	
600	*4*	3100	
650	*5*	3150	
700	*5*	3200	
750	*6*	3250	
800	*7*	3300	
850	*6*	3350	
900		3400	
950		3450	
1000		3500	
1050		3550	
1100		3600	
1150		3650	
1200		3700	
1250		3750	
1300		3800	
1350		3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
1700		4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

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SCALA PENETROMETER LOG

Job No:	880070	Date:	28/09/2007	Test No.	SC 3 TP6
Project:	Feehly Hill Subdivision	Operated by:	FAW		
Location:	Refer Site Plan	Logged by:	KGG	Sheet	1
Level:	0.3 m	Checked by:		of	1

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	
100		2600	
150		2650	
200		2700	
250		2750	
300	1	2800	
350	1	2850	
400	1	2900	
450	1	2950	
500	1	3000	
550	1	3050	
600	2	3100	
650	2	3150	
700	1	3200	
750	1	3250	
800	1	3300	
850	1	3350	
900	1	3400	
950	0.5	3450	
1000	0.5	3500	
1050	1	3550	
1100	2	3600	
1150	1	3650	
1200		3700	
1250		3750	
1300		3800	
1350		3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
1700		4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
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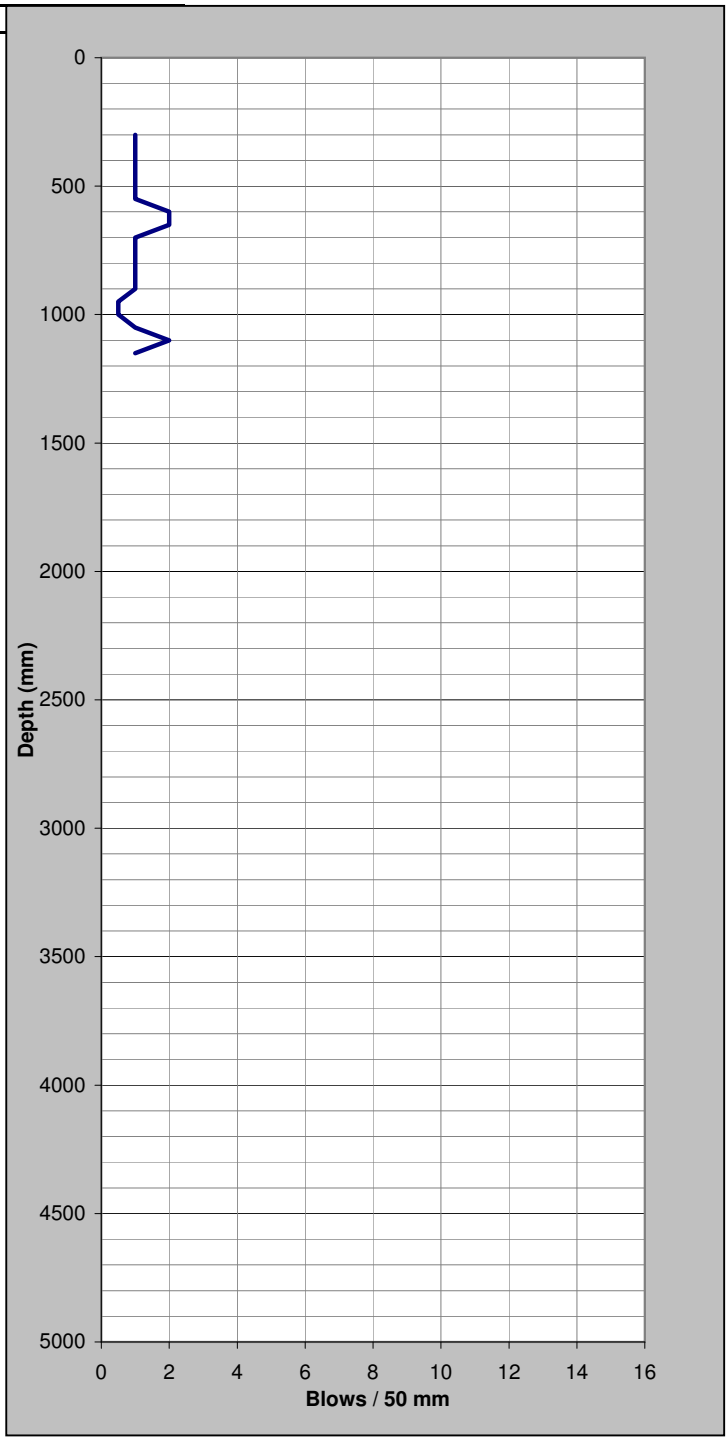

Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

TONKIN & TAYLOR

151 Kilmore Street
P O Box 13-055
CHRISTCHURCH
Tel: (03) 3534400
Fax: (03) 3534401

SCALA PENETROMETER LOG

Job No:	*880070*	Date:	*28/09/2007*	**Test No.**	***SC 4 TP7***
Project:	*Feehly Hill Subdivision*	Operated by:	*FAW*		
Location:	*Refer Site Plan*	Logged by:	*KGG*	**Sheet**	***1***
Level:	*0.4 m*	Checked by:		**of**	***1***

mm Driven	No. of Blows	mm Driven	No. of Blows
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100		2600	
150		2650	
200		2700	
250		2750	
300		2800	
350		2850	
400	*1*	2900	
450	*1*	2950	
500	*2*	3000	
550	*1*	3050	
600	*1*	3100	
650	*1*	3150	
700	*1*	3200	
750	*0.5*	3250	
800	*0.5*	3300	
850	*1*	3350	
900	*1*	3400	
950	*0.5*	3450	
1000	*0.5*	3500	
1050	*1*	3550	
1100	*1*	3600	
1150	*1*	3650	
1200	*1*	3700	
1250	*1*	3750	
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2150		4650	
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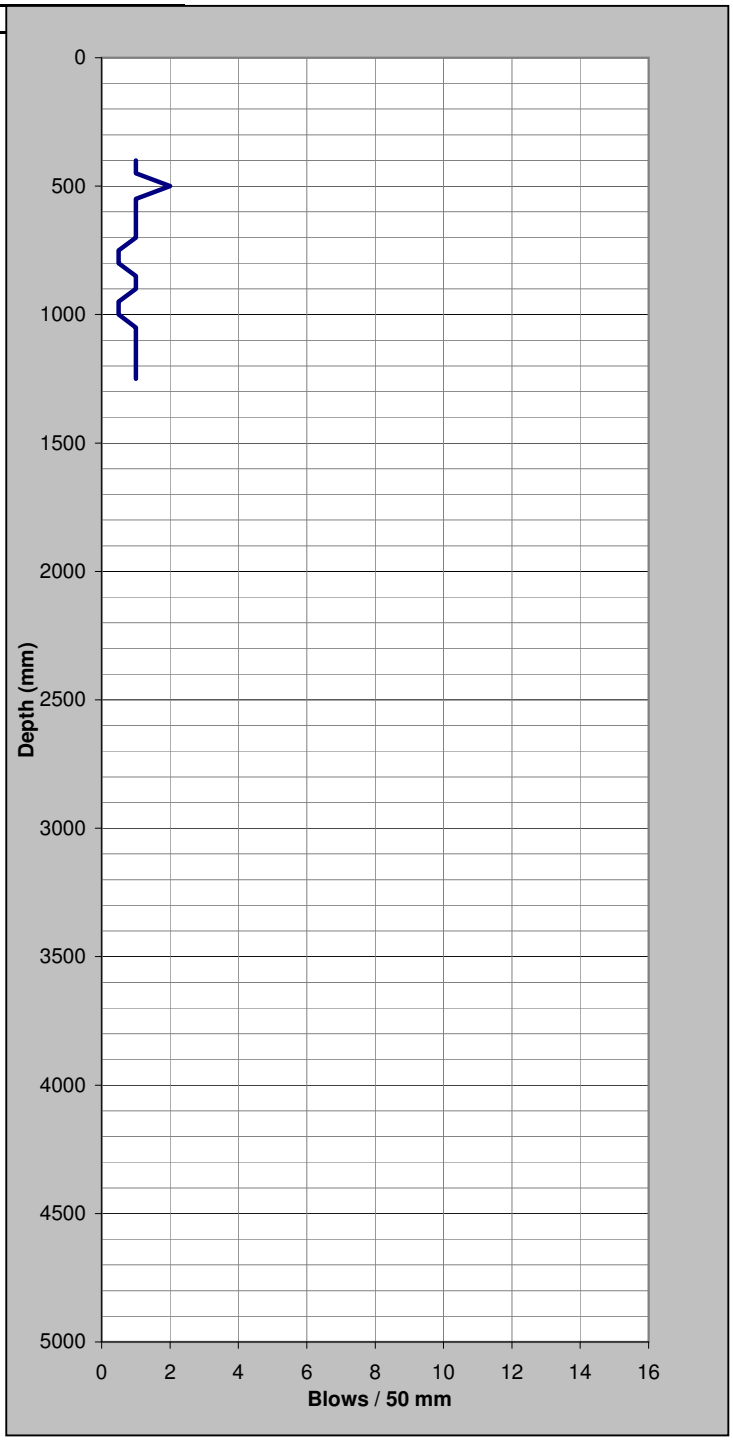

Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

TONKIN & TAYLOR
151 Kilmore Street
P O Box 13-055
CHRISTCHURCH
Tel: (03) 3534400
Fax: (03) 3534401

SCALA PENETROMETER LOG

Job No:	*880070*	Date:	*28/09/2007*	**Test No.**	***SC 5 TP8***
Project:	*Feehly Hill Subdivision*	Operated by:	*FAW*		
Location:	*Refer Site Plan*	Logged by:	*KGG*	**Sheet**	***1***
Level:	*0.5 m*	Checked by:		**of**	***1***

mm Driven	No. of Blows	mm Driven	No. of Blows
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100		2600	
150		2650	
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250		2750	
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500	*1*	3000	
550	*1*	3050	
600	*1*	3100	
650	*1*	3150	
700	*1*	3200	
750	*1*	3250	
800	*1*	3300	
850	*2*	3350	
900	*2*	3400	
950	*1*	3450	
1000	*1*	3500	
1050	*1*	3550	
1100	*1*	3600	
1150	*2*	3650	
1200	*1*	3700	
1250	*1*	3750	
1300	*0.5*	3800	
1350	*0.5*	3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
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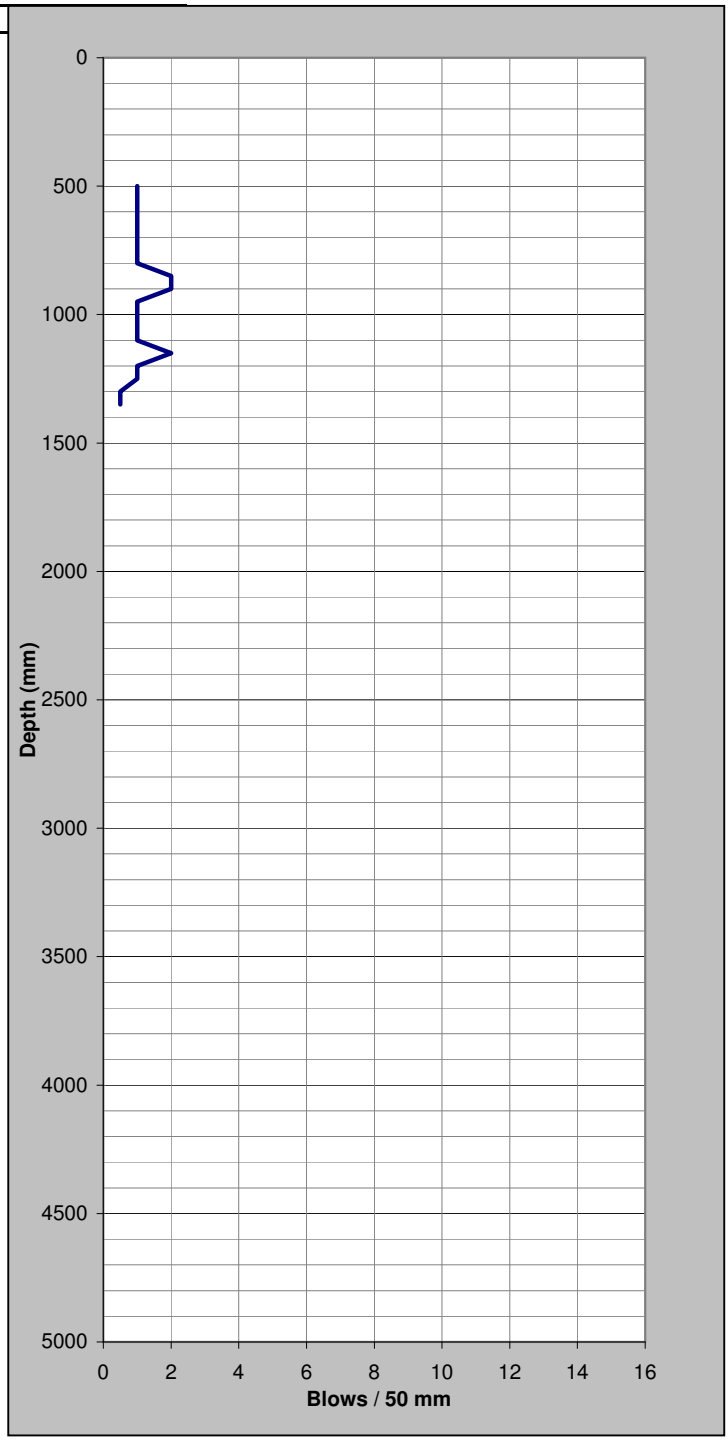


Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

Appendix C: CBR Lab Testing Results

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 07/2426-B

Date: 21 November 2007

TEST REPORT - LABORATORY SOAKED CBR's

Client Details:	**Tonkin & Taylor, P.O. Box 1780, Queenstown**	**Attention:**	**F. Wilson**
Job Description:	**Feehly Subdivsion**	**Client Order No:**	**890070**
Sample Description:	**See Below**	**Sample Source:**	**See Below**
Sampled By:	**Fraser Wilson**	**Date & Time Sampled:**	**See Below**
Sample Method:	**Unknown**		
Test Method:	**NZS 4402:1986, Test 6.1.1 – Laboratory CBR**		

LABORATORY SOAKED CBR RESULTS		
Sample label No:	**20757**	**20758**
Date & Time Sampled:	**28-Sep-07 @ 1.00pm**	**28-Sep-07 @ 12.00pm**
Sample Description:	**Silty Sand**	**Sandy Silt**
Sample Source:	**TP7**	**TP6**
Sample Depth:	**0.6m - 0.7m**	**0.4m - 0.5m**
Condition of Sample:	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**
Time Soaked:	**8 days**	**8 days**
Swell: (%)	**0.2**	**1.0**
Water Content as Compacted: (%)	**19.0**	**23.3**
Water Content From Under Plunger: (%)	**28.8**	**23.9**
Dry Density As Compacted: (t/m^3)	**1.54**	**1.63**
CBR Value @ 2.5 mm Penetration:	**3.0**	**1.5**
CBR Value @ 5.0 mm Penetration:	**4.0**	**2.0**
Reported CBR Value:	**4.0**	**2.0**

Notes:

- *The material received was in a natural state.*
- *The material tested was the fraction passing the 19.0mm test sieve.*
- *The sample was compacted to NZ Standard Compaction at the water content as received.*
- *The rate of penetration was 1.14 mm / min.*
- *IANZ endorsement of this report applies to the sample as received.*
- *This report may not be reproduced except in full.*

Tested By: **L. Smith** **Date:** **8 to 16-Oct-07**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

434 new zealand accredited laboratory

www.tonkin.co.nz

ROYDEN THOMSON, GEOLOGIST

11 Leitrum Street
Cromwell
Phone 03 445 0025
Fax 03 445 0029

15 Nov '07

Chris Ferguson
Clark, Fortune, McDonald and Assoc
P.O. Box 553
QUEENSTOWN

Dear Chris

RC APPLICATION RM070943: ASSESSMENT OF NATURAL HAZARDS AT THE PROPOSED FEEHLY HILL SUBDIVISION

Please find below a discussion on perceived hazards to the subdivision, in line with the request by Lakes Environmental Ltd. (18 October 2007) for further information relating to the application. The item of greatest concern is potential rockfall, but all prospective hazard types are to be addressed. (Note that there are no natural hazards in the area of interest on QLDC Hazard Register Map 27.)
Attached are several plans, sections and photos. These are largely to illustrate the rockfall risk, but other hazard types are covered to some extent.

Geological Setting

a) Physiography
Feehly Hill is a roche moutonnée, shaped by glaciers flowing more-or-less west to east. An estimated age for the most recent overtopping glacier is 140,000 years.
Flanking Feehly Hill to the west and south is a large fan (Fig. 1) which was constructed by Bush Creek, perhaps during the 18,000 year Before Present glacial event. The fan is of interest for several reasons, most notably:

- because a segment of it intrudes into the subdivision.
- Bush Creek has more recently incised, and now flows east from the fan apex to the Arrow River.

b) Rock Types and Distribution

i/ Schist
This is the basement rock in the region and locally comprises a mica-rich, thinly laminated lithology resulting from metamorphism of rather muddy marine sediments.
Schist forms Feehly Hill and other higher level features. It also underlies all other rocks at varying depths.

ii/ Glacial Till
Glacially-derived and associated deposits probably underlie the stream fan but have no surface presence in the subdivision.

iii/ Fan Alluvium
As mentioned above, a palaeofan underlies much of the subdivision. Test pitting has established it is composed of a well-graded, sandy gravel derived from the schist uplands. Fragments tend platey and there is some variation in grain size across the subdivision.

iv/ Colluvium
Present as coalescing fans formed on the north-west flank of Feehly Hill. Fan toes locally intrude into part of the subdivision.

c) Groundwater
No information has been made available on groundwater levels but it is assumed the water table lies many metres below the subdivision ground level.

Prospective Hazards
Multiple hazard types impact on the Arrowtown region but their presence and influence on the proposed subdivision and surrounds are more restrictive. Perceived hazards of all types include the following.

a) Seismotectonic Hazards

i/ Surface Rupture by Faulting
Although there will be numerous faults in the Arrowtown region, resulting from multiple phases of tectonic deformation, there are no known displacements of cover beds, suggesting all faults are effectively benign. By implication, any faults present beneath the area of interest are interpreted as being nonactive, hence there is no perceived direct rupture hazard at the site.

ii/ Shaking Effects
Arrowtown is relatively unique as being in the epicentral region of periodic swarms of micro- and small-scale macro-seismic activity. Event depths are in the order of 5 – 15km and media reports suggest many are felt by local residents.
As there are no known active faults, it is assumed that there is local strain developing at the intersection of crustal blocks, the exact geometries of which are unknown. The implications for the subdivision are the same as for the surrounding regions; seismic shaking effects are adequately controlled by building codes developed by the local territorial authority.

b) Flooding
Bush Creek has previously flowed towards Feehly Hill, constructing a fan in the process, but the stream is now deeply incised in an east-flowing channel (Fig. 1) and poses no flooding hazard to the subdivision. No other streams intrude into the area, nor have the potential to do so. (Water race excepted.)
There remains a perceived potential for minor surface flooding to occur near the south-east fringe of the subdivision during storm events. With reference to Figure 3, it can be deduced that:

- small-scale sheetflow could occur during heavy rain within the subdivision area. This would be directed to the low topographic axis at the toe of the colluvial fan, from where it would flow in a south-westerly direction.
  The impact would, of course, be reduced by the presence of intermediary roads, which will have built-in stormwater collection and disposal systems.
- sheetflow could also be derived off the north-west flank of Feehly Hill. This would collect along the topographic low at the junction of the alluvial and colluvial fans (Fig. 3).
  It is of interest to note that:

  A) There are no incised channels on the surface of the colluvial fan complex, suggesting runoff from Feehly Hill is rare and minor.

  B) The neighbour to the north-east of the subdivision did not observe any runoff onto his property during the 1999 storm event.

  Potential adverse impacts from storm runoff could occur in Lots 13-15, 18, 19, 21, 23 and 24 (Attachment 1) as the low topographic axis passes through those properties. Although there is a perceived low risk of significant surface flooding occurring in the future, platforms within the lots should be serviced with adequate soakage-to-ground facilities.

c) Liquefaction
Fine, glacially-derived sediments could underlie the subdivision area, but, if present:

- they are expected to be covered by a significant thickness of clastic, fan alluvium.
- there is no surface expression of liquefaction occurrences on aerial photos of the subdivision area, or on the ground.
- the prospective hazard has not been flagged for other nearby developments.

For the purposes of the Feehly Hill subdivision, it is assumed liquefaction is not a realistic hazard.

d) Landslide/Rockslide
Feehly Hill has not been affected by mass movement since its sculpturing by ice, an estimated 140,000 years ago. There was some initial concern that the rounded spur at low levels at the west end of the hill (Photo 3) may have been a slide block but mapping has established it is in situ schist (Fig. 3), albeit with some surficial flexuring.
Again, for the purposes of the hazard assessment of the Feehly Hill subdivision, landsliding and rocksliding have not occurred in the past and it is extremely unlikely that they will occur in the lifetime of the subdivision. The associated hazard is effectively nil.

e) Rockfall
The Lakes Environmental letter referenced previous reporting on a Manse St. property, east of the subdivision, where a proposed platform was sited near the base of a bluff. From surface observations it was concluded that the rockfall risk, under nonseismic condition, is low, although some bluff-derived schist slabs lie on the ground nearby.

An independent, visual assessment was made of the bluff, and subjacent slopes, directly above the proposed subdivision. As illustrated by various photos, and Figures 2a and b, it is interpreted that:

- the schist forming the bluff is sound. It is grey, with minor greenschist, has a well-developed planar foliation, but tends to be coarsely layered (Photo 11).
- foliation dips steeply to the WNW at steep angles (Fig. 2a). As such, there is only a very small component of dip out of the slope in the direction of the subdivision i.e. foliation does not significantly affect the integrity of the bluff in the segment with impact potential.
- there is a marked variation in bluff surface morphology and height (Fig. 2b; various photos). This will be, in part, a product of glacial erosion, but foliation will have an influence and wedge-shaped re-entrants are likely to be influenced by foliation shears. Note that no large slope irregularities are attributed to post-glacial rockfall.
- geological discontinuities, such as joints, tend to be widely to very widely spaced. In some outcrops they are essentially absent. Foliation shears are probably tens of metres apart.
- from remote viewing, and observations along a ridge traverse, there are only two locations where there is disturbed schist that could obviously generate rockfall. these localities are ringed on Photos 5 and 7 (local, toppled blocks), and Photos 8, 9 and 13 (slightly displaced, but wedged, block).
- colluvial fans below the bluffs contain mostly finer, platey, schist detritus but there are some disseminated boulders. The latter are also platey, reflecting the planar, pelitic schist fabric, and are assumed to have slid/washed down the slope rather than being moved by rolling processes.
  There are no obvious boulder piles at the toe of the colluvial slope but historic changes here cannot be determined.
- the lack of boulders, or even collections of coarser debris, can be viewed as a measure of bluff integrity. One has to keep in mind the nominal 140,000 year exposure of the schist, during which it will have experienced untold, large seismic events.

It is my view that while a rockfall hazard exists – obviously, in such a terrain – the risk of detachment of coarse, individual blocks from the bluffs above the subdivision in its lifetime is assessed as low, while the risk of a failure leading to a cluster of falling blocks is assessed as extremely low in the same timeframe. There is an additional qualification in that the exposed schist on the bluffs tends to be slightly to moderately weathered (Photos 9, 13, 17) which adversely affects rock strength; falling fragments will tend to disintegrate into thin slabs that are not prone to rolling.

Conclusions and Recommendations

a) Most of the proposed subdivision is sited on a low relief, palaeofan constructed by Bush Creek. A part of the lots fringing the subdivision on the south-east side mantle the toe of a colluvial fan complex formed on the flank of Feehly Hill.

b) There is no evidence for past adverse impacts from seismotectonic events in or near the site, and landsliding/rocksliding has not previously occurred on Feehly Hill since last sculpturing by ice some 140,000 years (estimated) ago. The risk of these hazards impacting on the subdivision in its life are assessed as extremely low. Likewise for any liquefaction effects within the fan alluvium segment where the presence of susceptible sediments is speculative.

c) Flooding from existing streams is a non-issue but there is potential for minor flooding along the axis of the depression, where the colluvial and alluvial fans converge, during rainstorms. Runoff from flanking surfaces should only adversely affect lots along the south-east margin of the subdivision.
Some provision for adequate soakage-to-ground should be arranged in potentially affected lots.

c) There is a rockfall hazard due to the presence of the steep, schist bluffs on the north-west flank of Feehly Hill but the risk to the subdivision in its lifetime is assessed a low to very low due to:

- the lack of evidence for previous rockfalls of significance in the large timeframe that the bluffs have been exposed.
- a general competency of the schist forming the bluffs. Discontinuities are widely spaced and foliation is not adversely oriented.
- few areas of distress in the schist. Only two sites, with minimal rock mass, have been identified where potential for rockfall is evident.
- a tendency for rockfall to break into thin slabs. This minimises an ability to roll down the slopes. The latter are actually quite long between the base of the bluffs and the subdivision boundary, which would tend to delay, then stop, the transport of falling debris. (Vegetation also assists in this regard.)

From a perspective of hazards and risks, I don't consider there are major issues of concern with regard to the subdivision, and then it is only the south-east fringe properties that have a slight residual risk of flooding and rockfall incursion. For the latter, I am comfortable with a "do-nothing" option, but a debris fence, located part way up the colluvial fan complex, would be a conservative mitigating structure. Especially if all vegetation is removed.
I trust the above discussion has adequately addressed the Lakes Environmental Ltd. concerns and that your resource consent application is approved in due course.

Regards

APPENDIX F. FINISHED GROUND LEVEL SCALA PENETROMETER LOGS

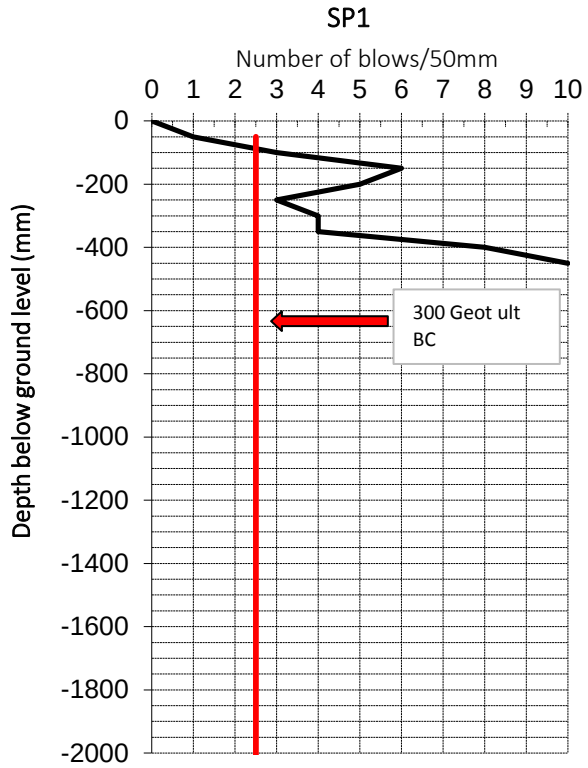
1. Scala Penetrometer Logs

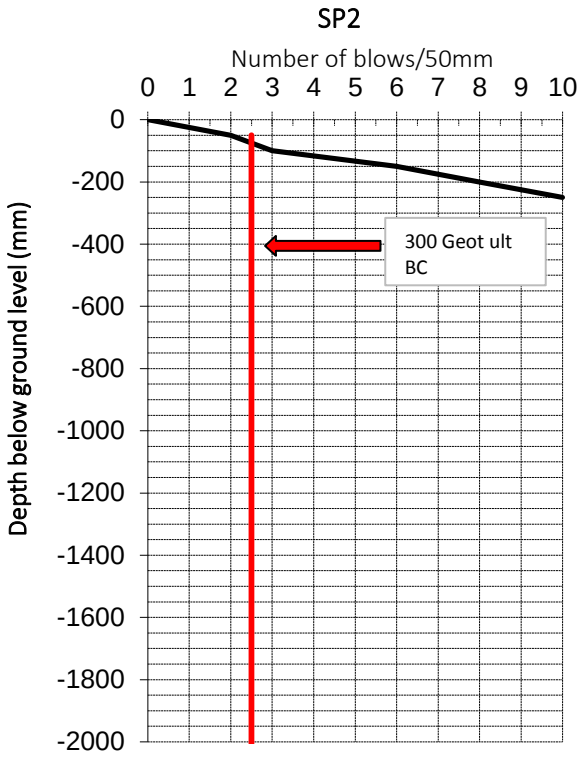
SCALA PENETROMETER RESULTS

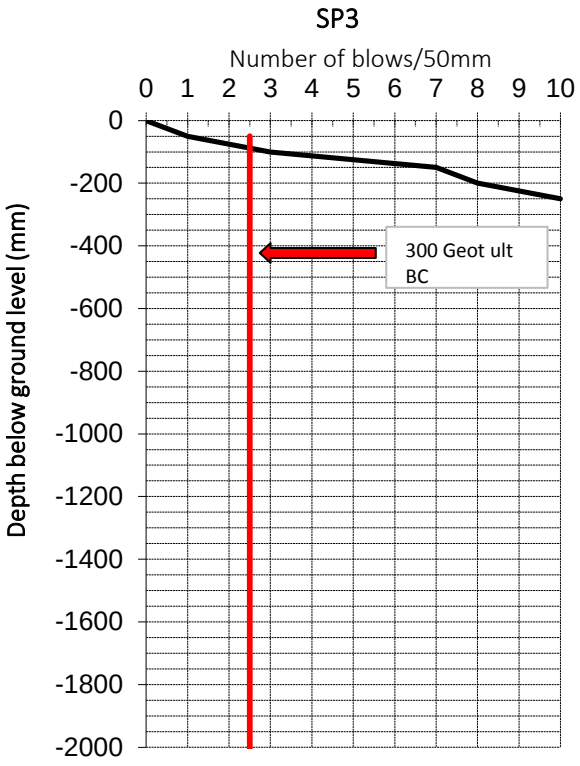
JOB NUMBER:	50350	PROJECT:	Linksgate Geotech
		LOCATION:	Linksgate Subdivision
CO-ORDINATES:	mE	DATE:	6-Apr-17
See attached plan	mN	OPERATOR:	OMB

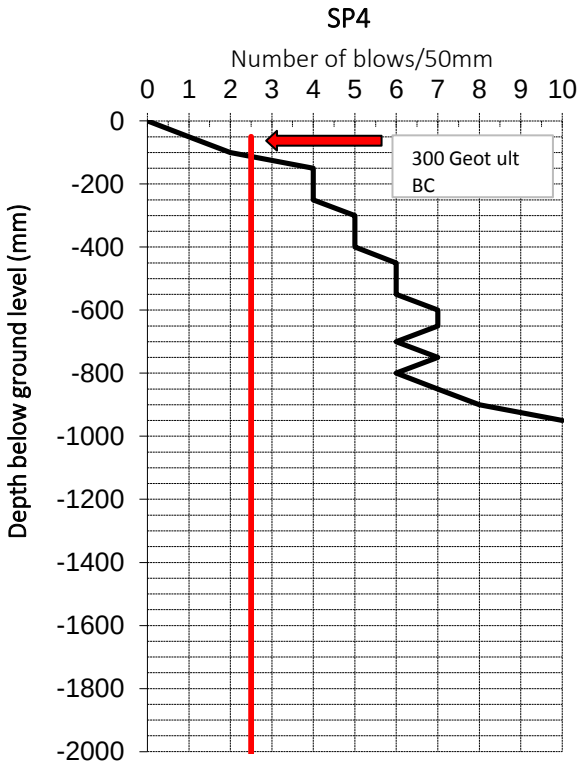
RDAgritech
ENGINEERED BY NATURE

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7







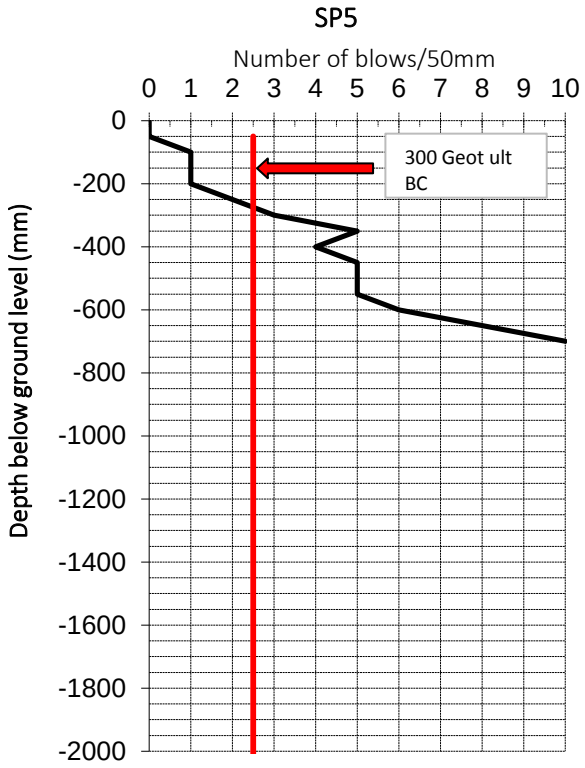


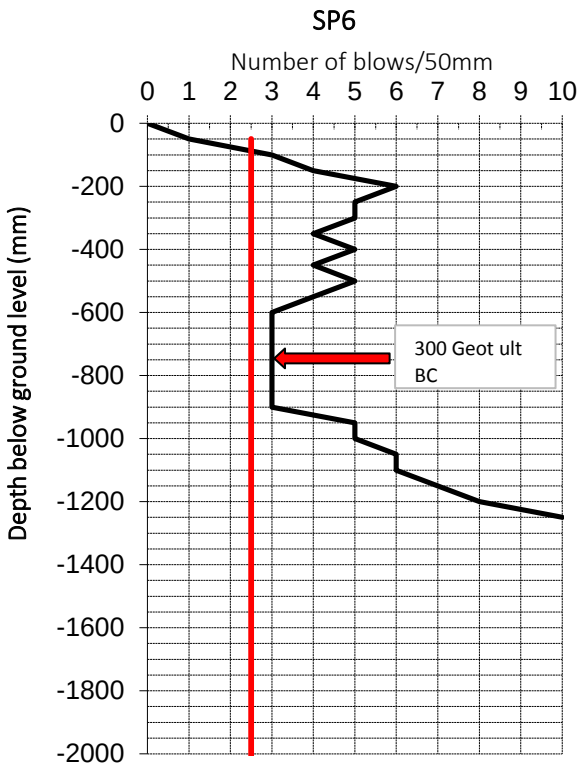
RDAgritech Ltd
PO Box 1711, Invercargill 9840 | PO Box 1880, Queenstown 9348 | 0800 RDAGRI (732474) | www.RDAgritech.co.nz

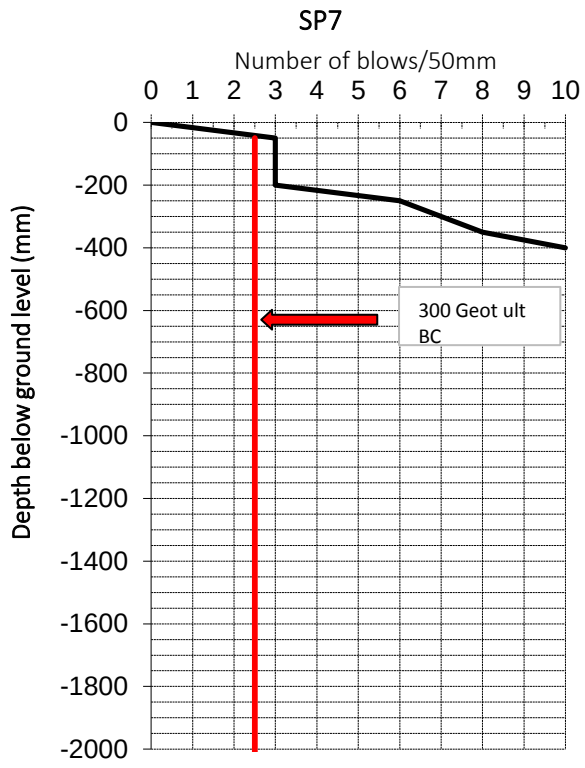
SCALA PENETROMETER RESULTS

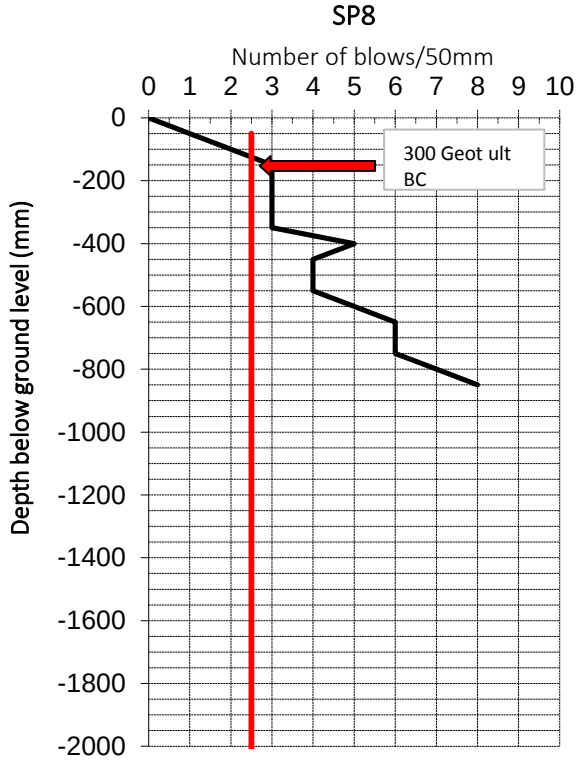
JOB NUMBER:	50350	PROJECT:	Linksgate Geotech
		LOCATION:	Linksgate Subdivision
CO-ORDINATES:	mE	DATE:	6-Apr-17
See attached plan	mN	OPERATOR:	OMB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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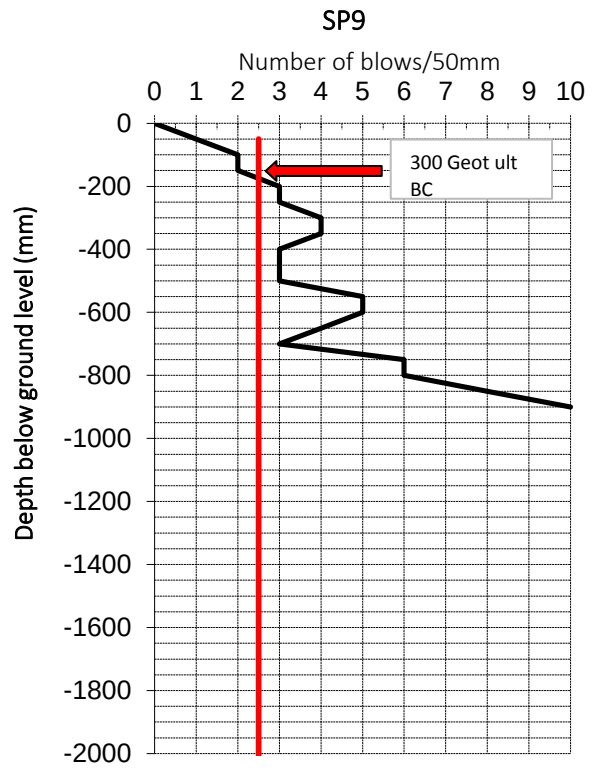
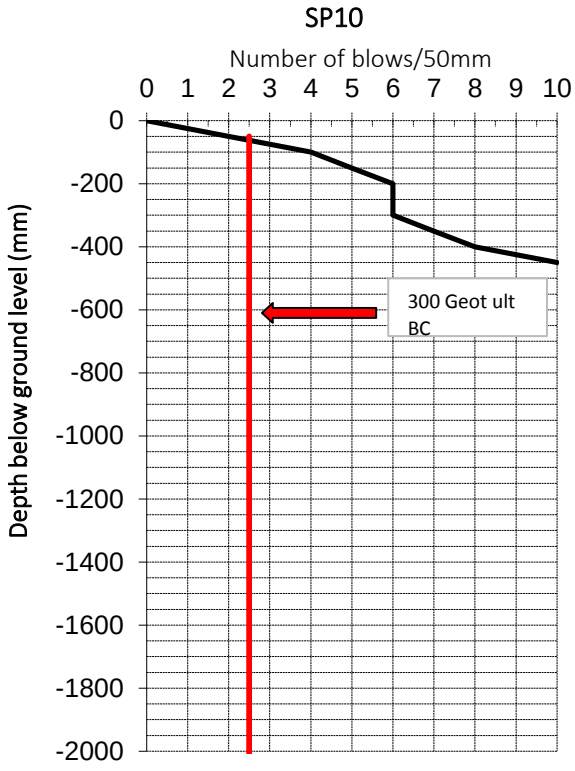
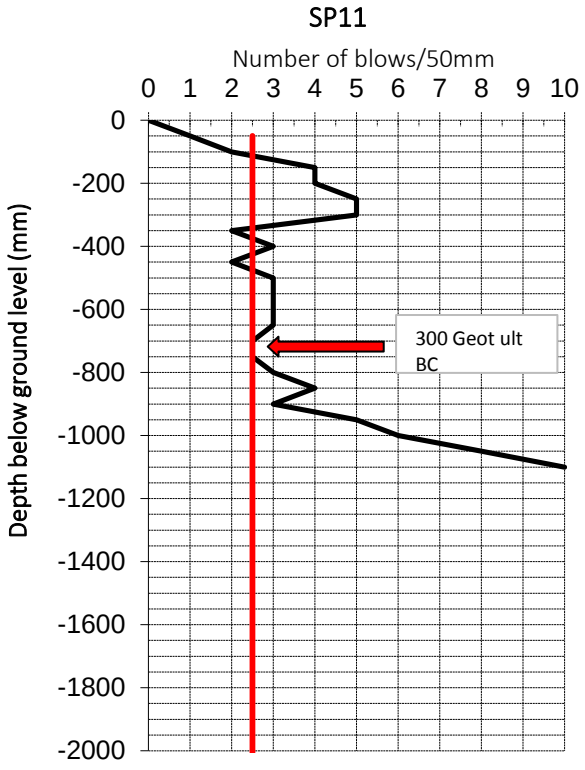
SCALA PENETROMETER RESULTS

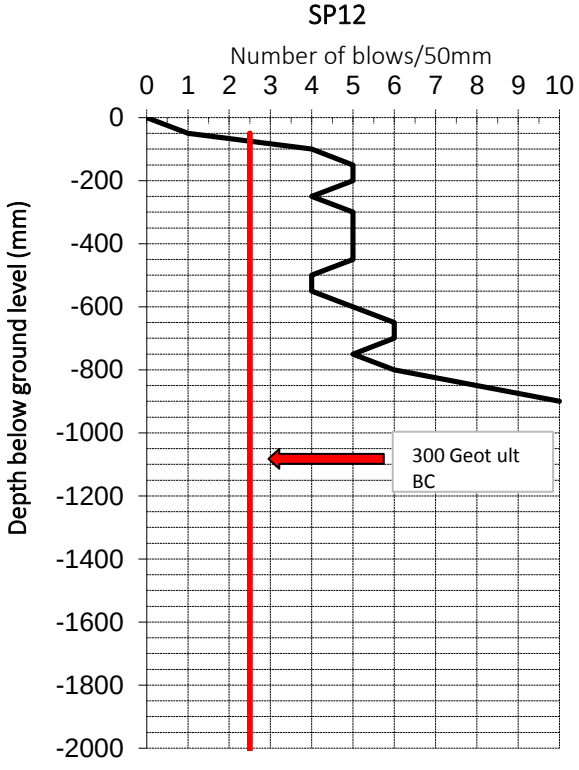
JOB NUMBER:	50350	PROJECT:	Linksgate Geotech
		LOCATION:	Linksgate Subdivision
CO-ORDINATES:	mE	DATE:	6-Apr-17
See attached plan	mN	OPERATOR:	OMB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7









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SCALA PENETROMETER RESULTS

JOB NUMBER:	50350	PROJECT:	Linksgate Geotech
		LOCATION:	Linksgate Subdivision
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See attached plan	mN	OPERATOR:	OMB

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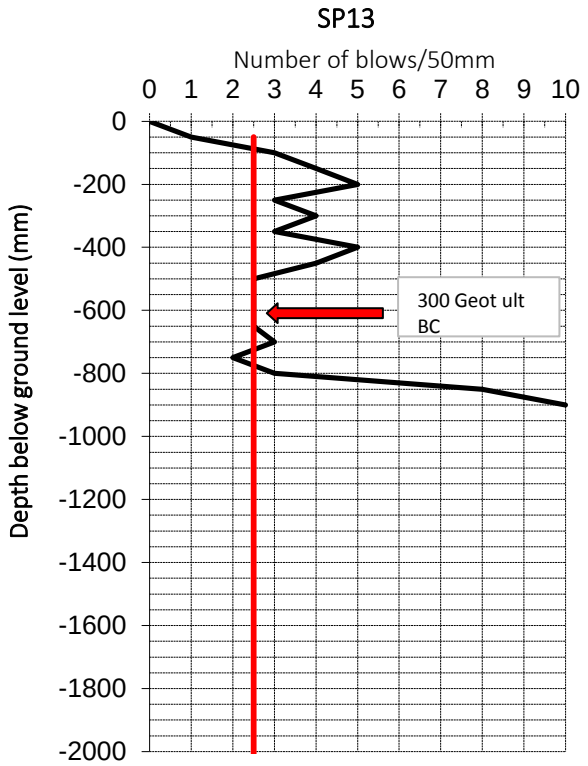

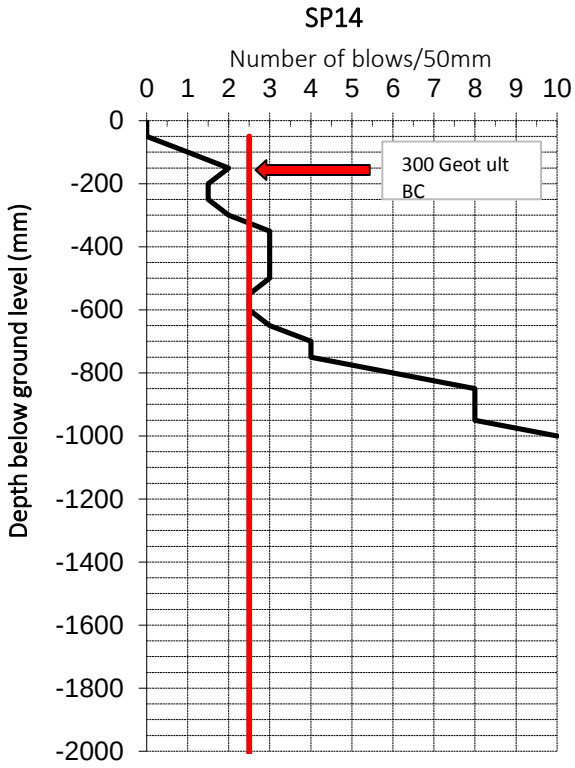

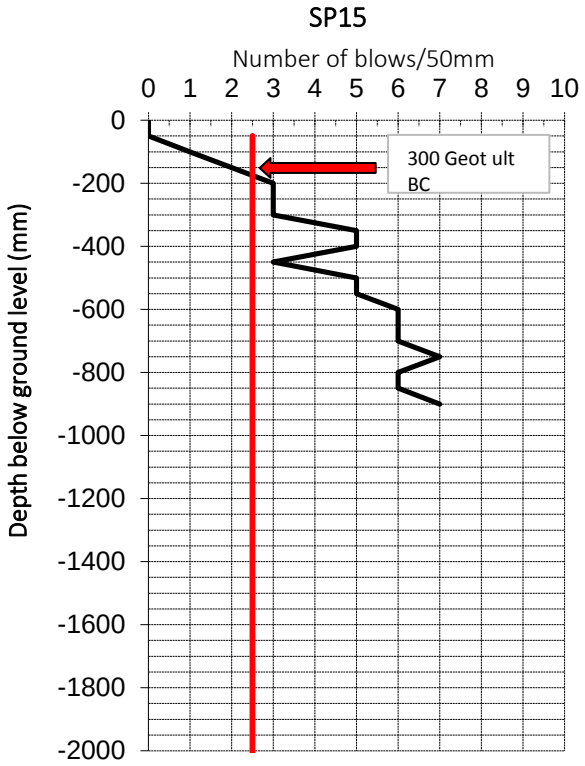

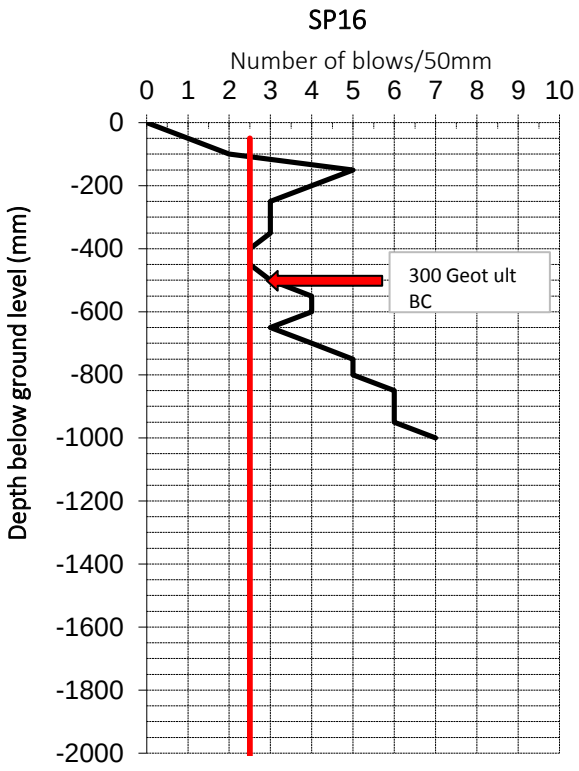

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SCALA PENETROMETER RESULTS

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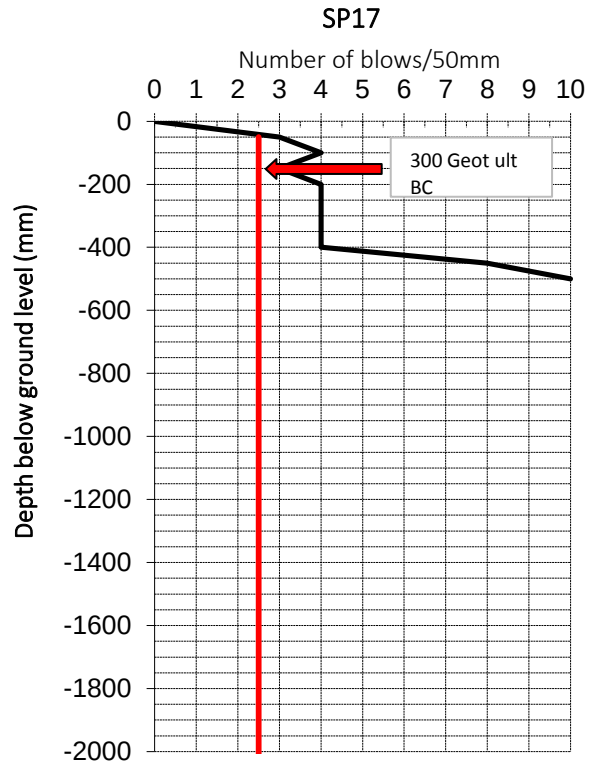

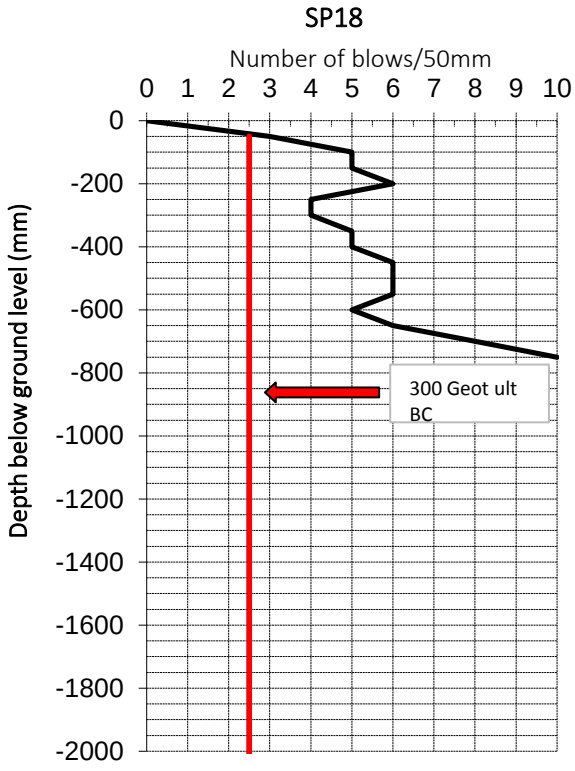

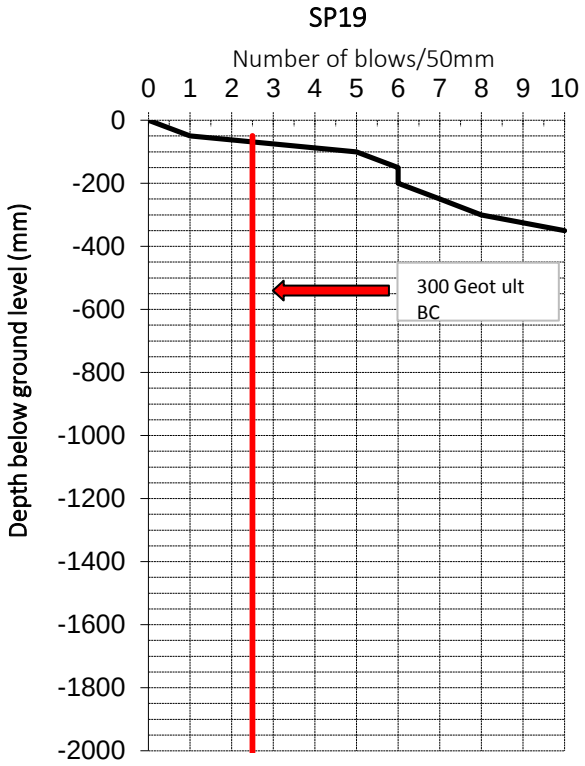

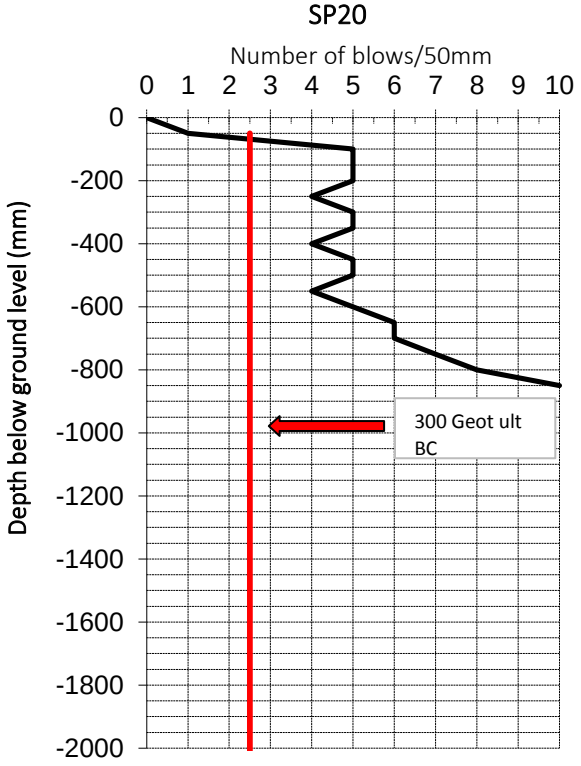

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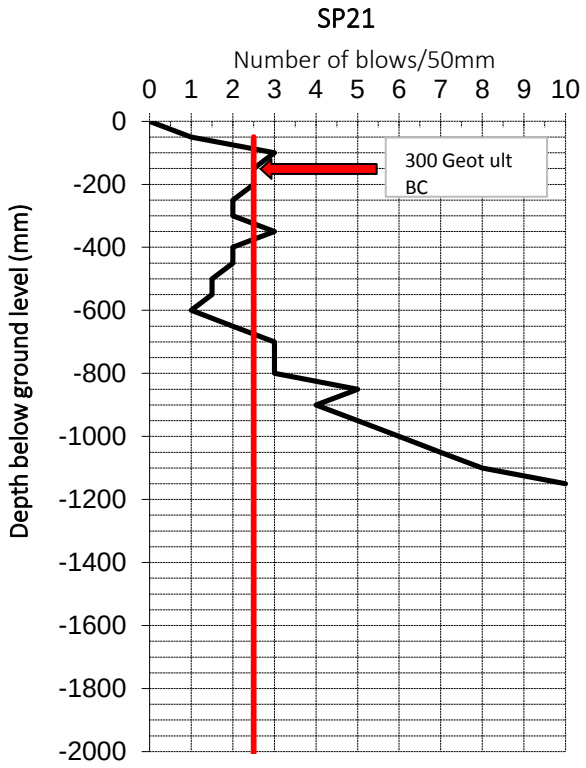

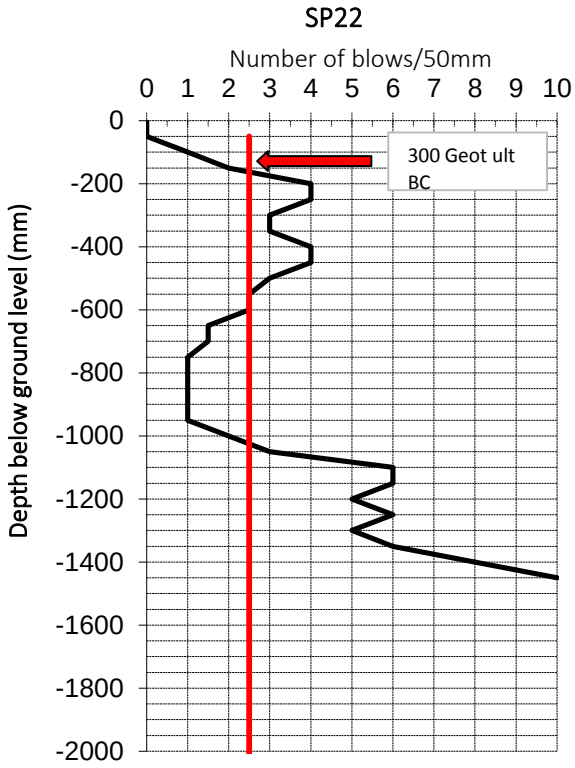

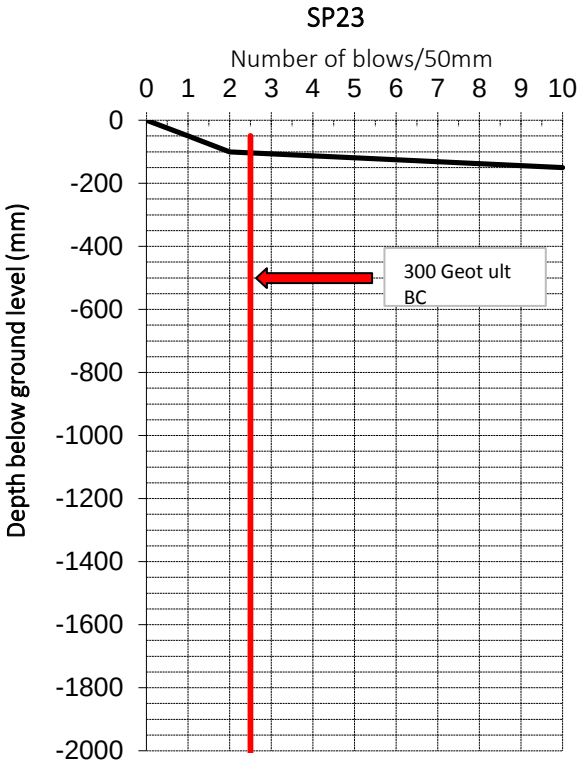

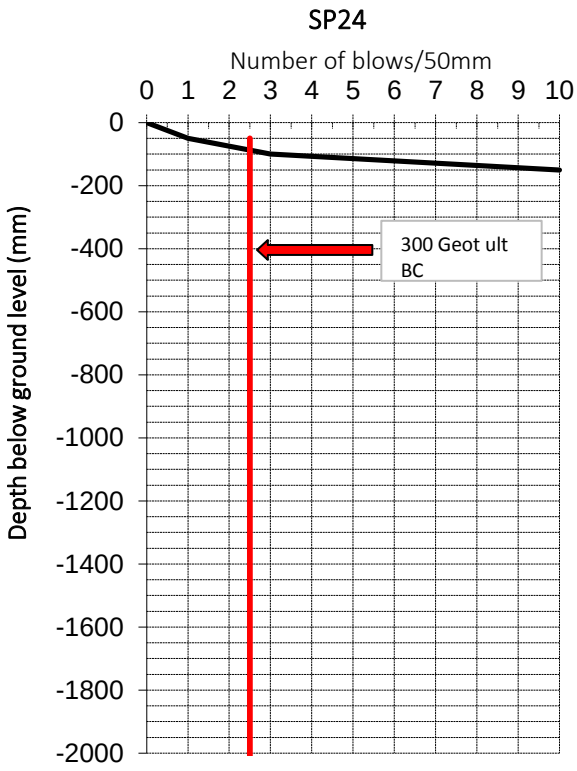

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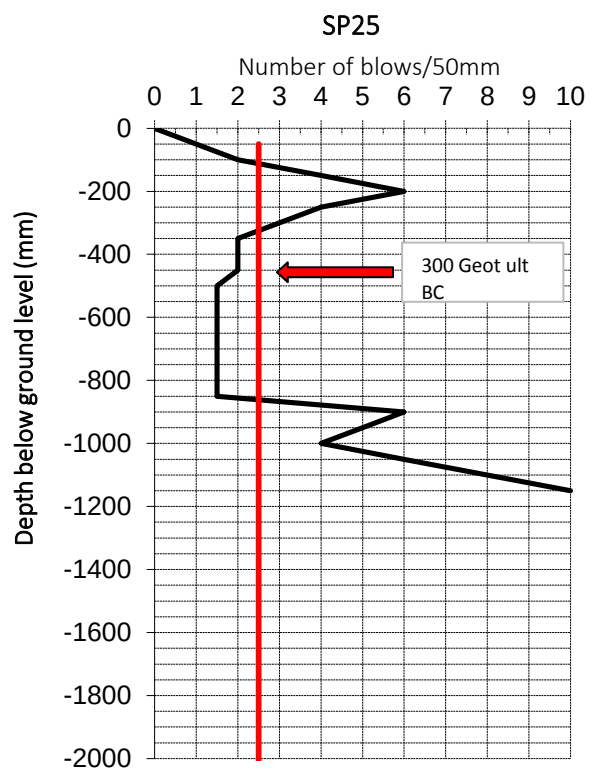

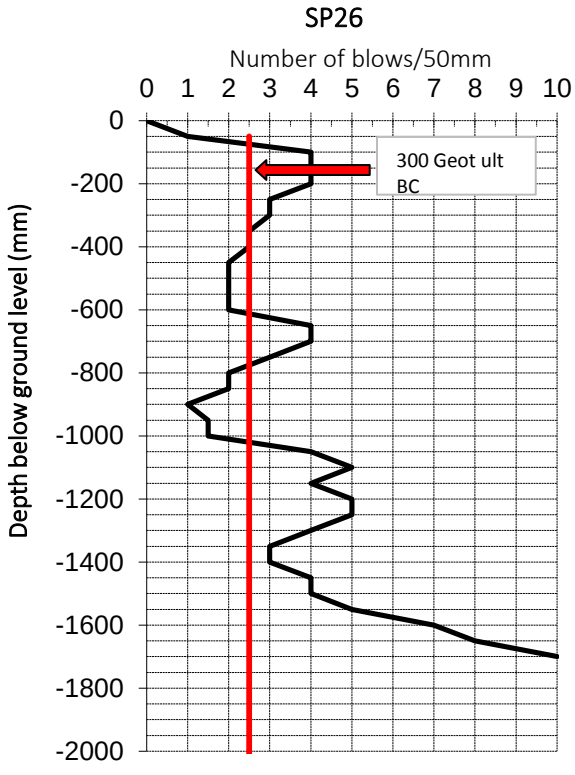

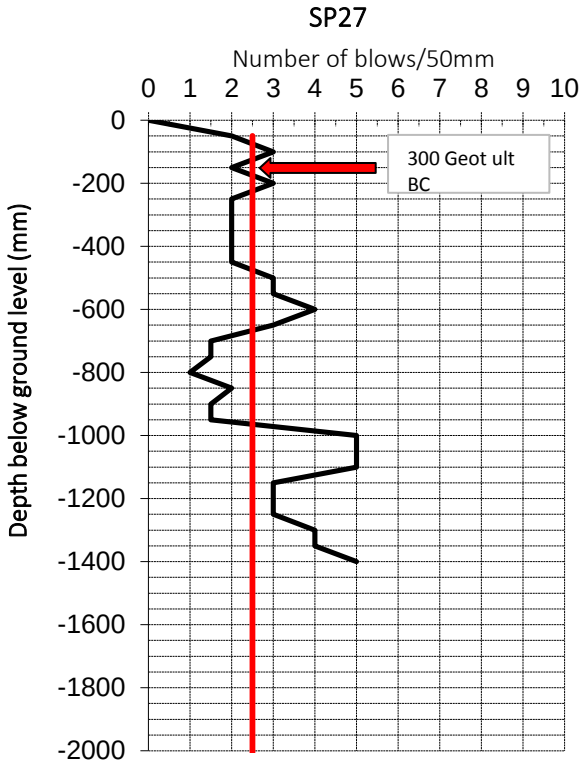

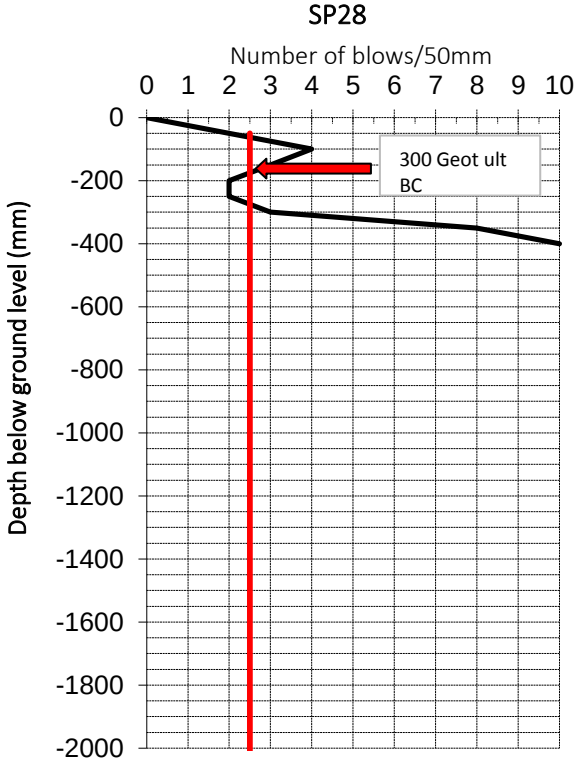

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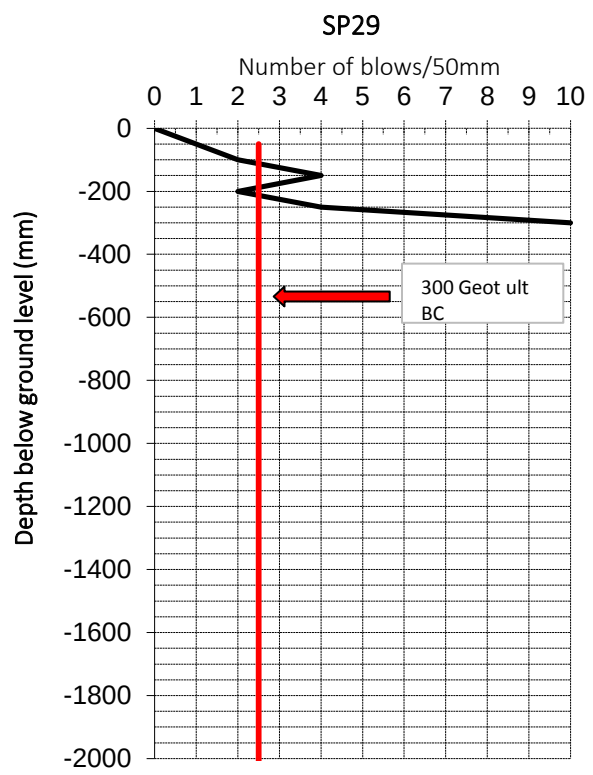

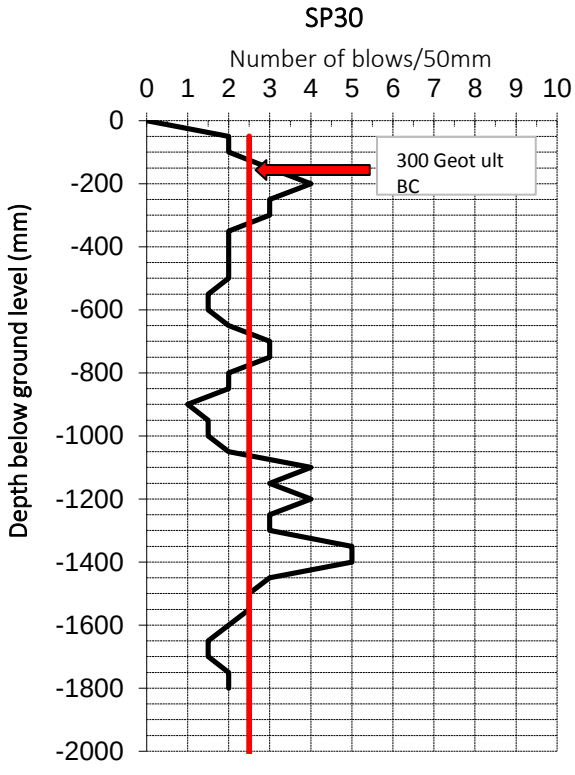

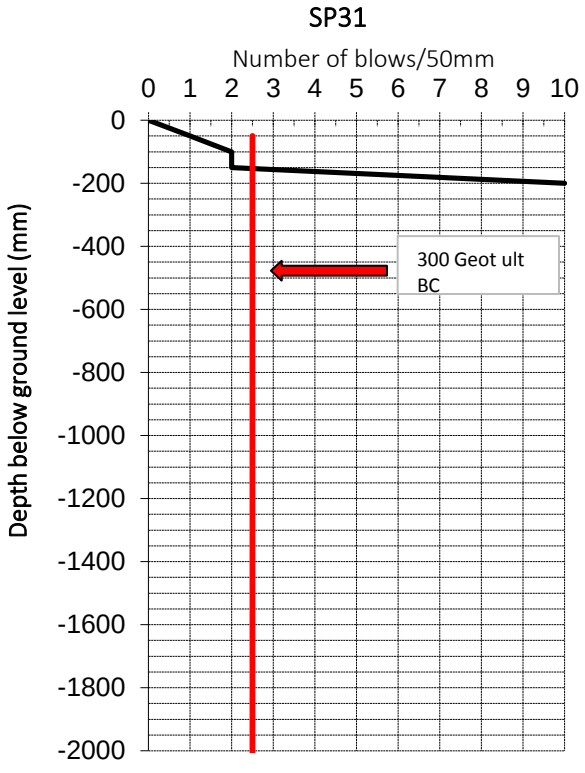

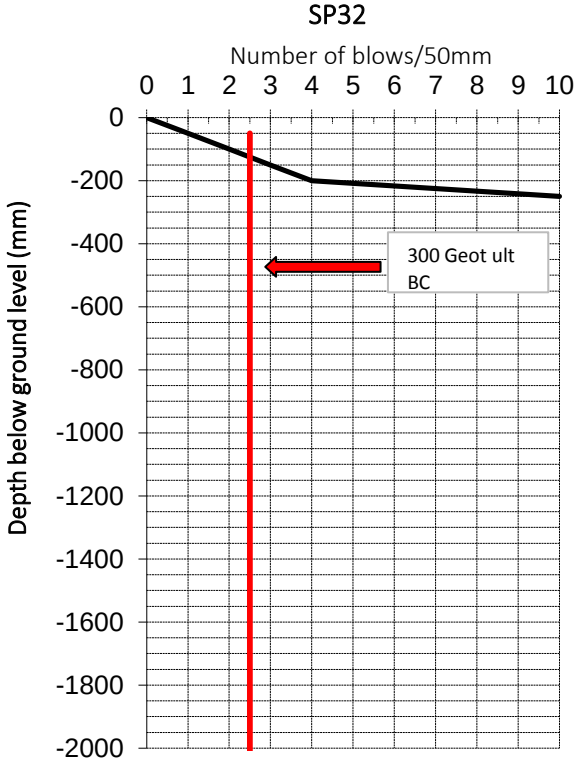

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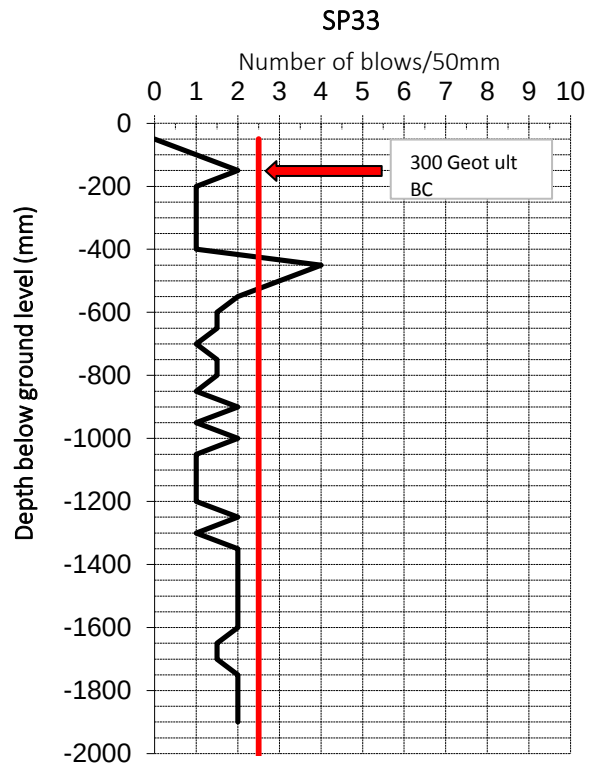

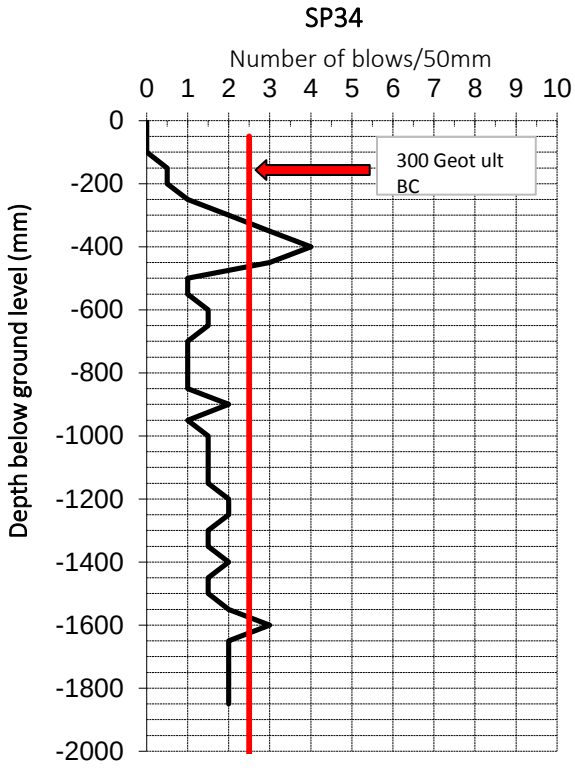

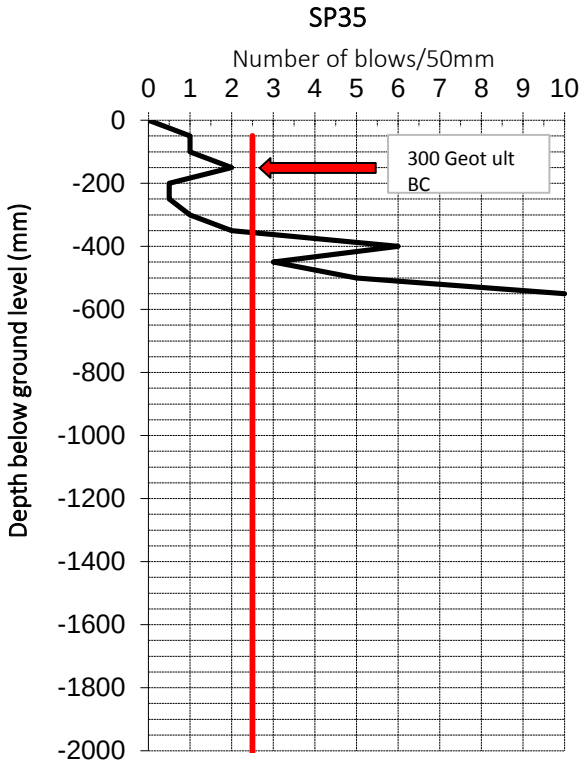

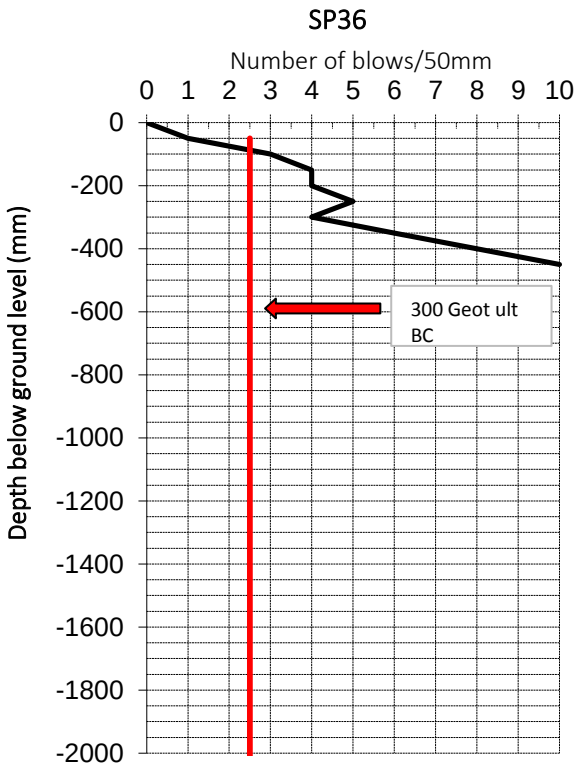

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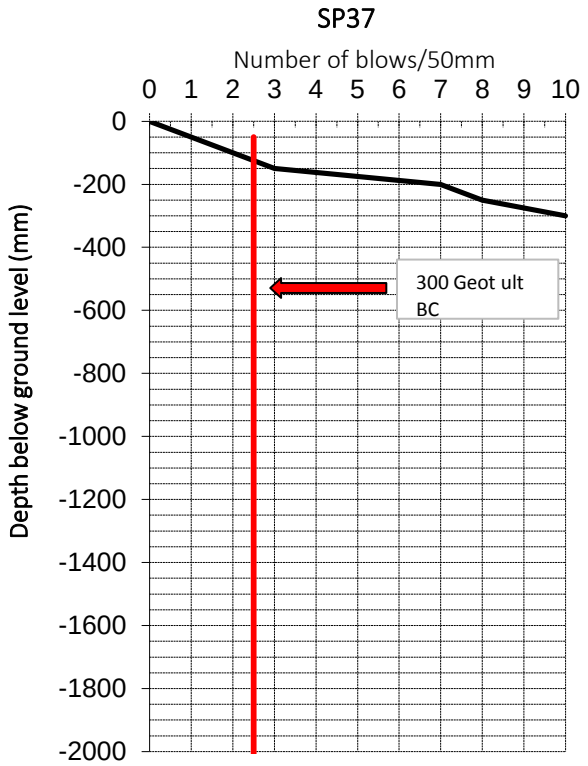

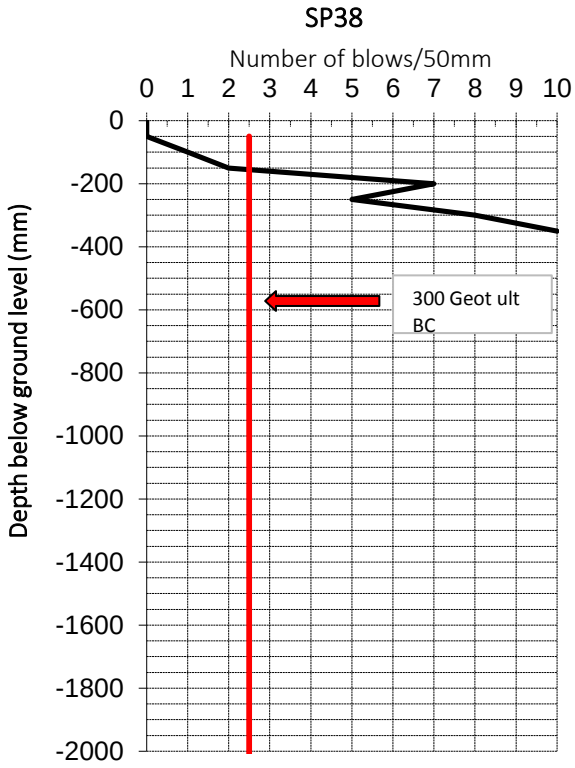

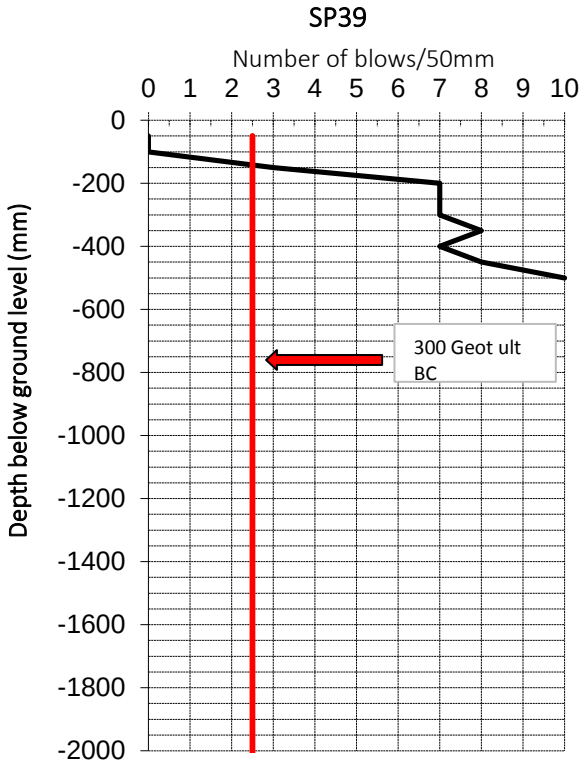

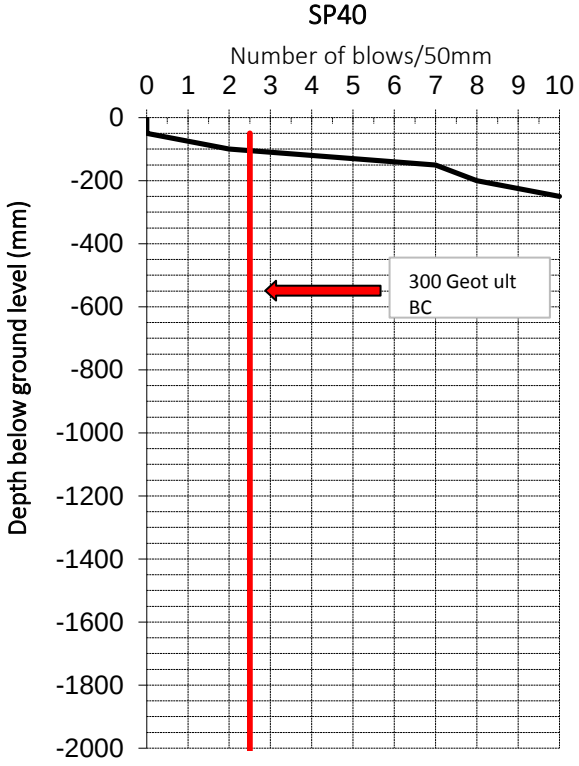

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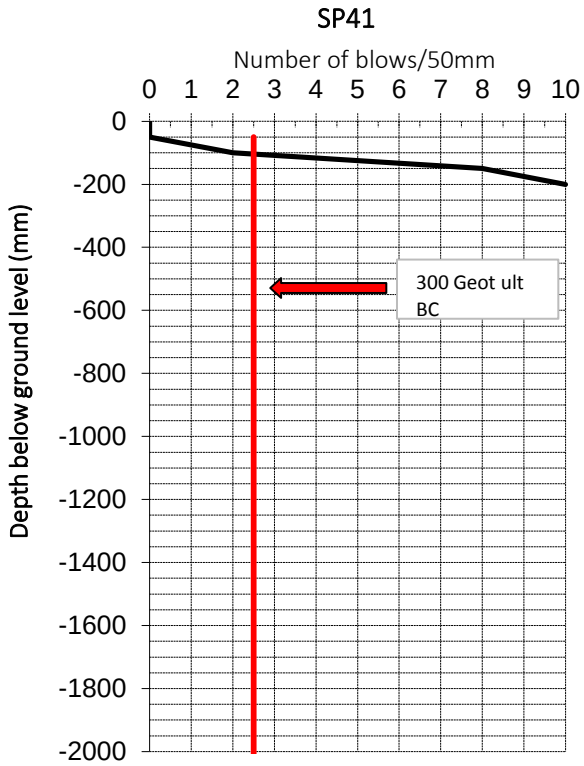

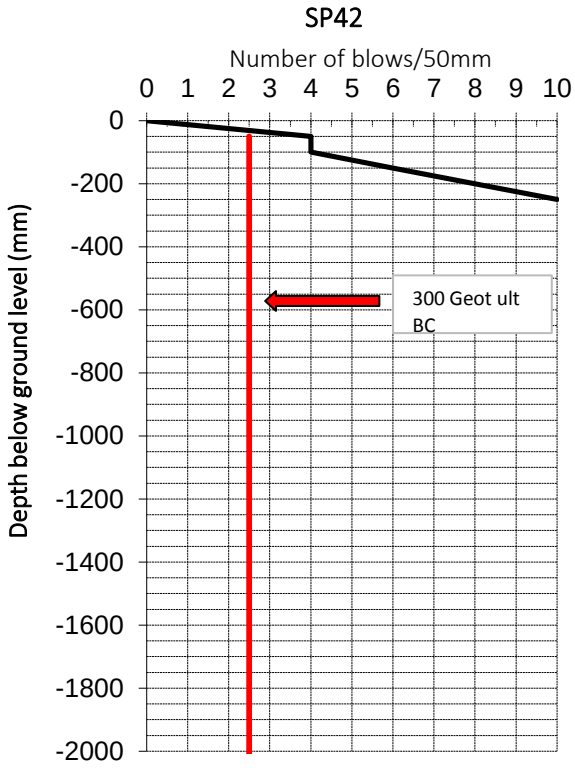

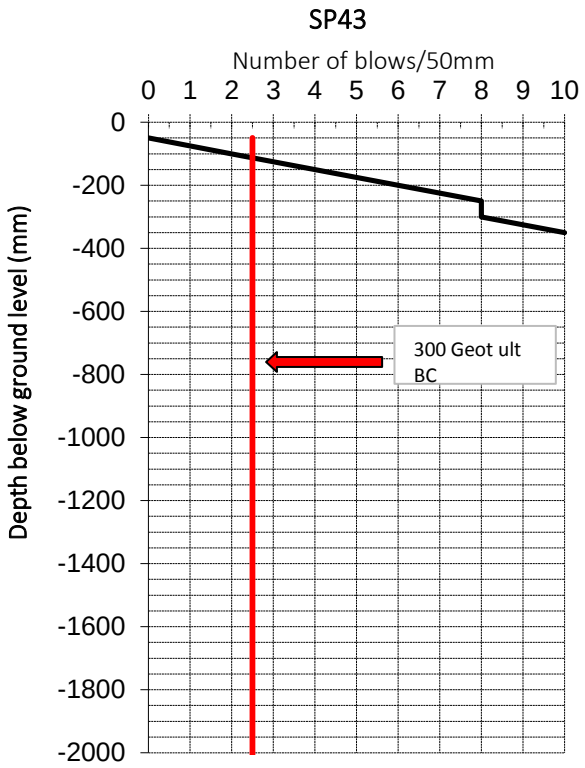

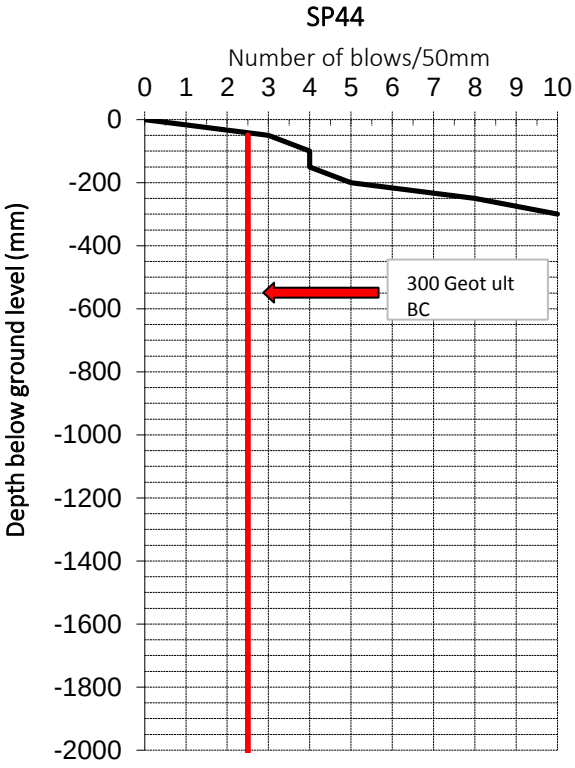

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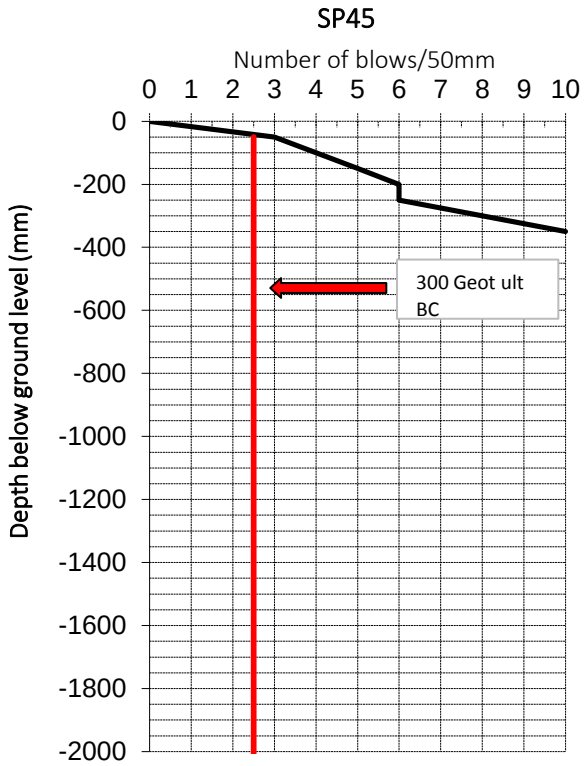

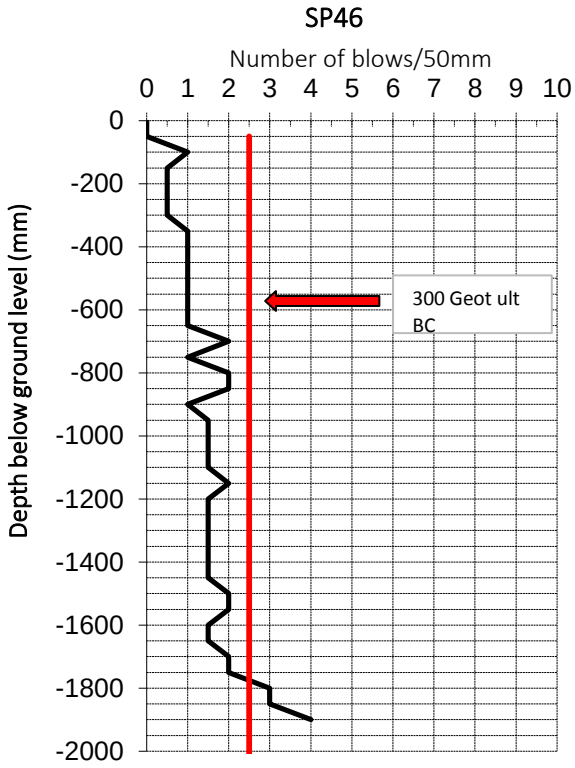

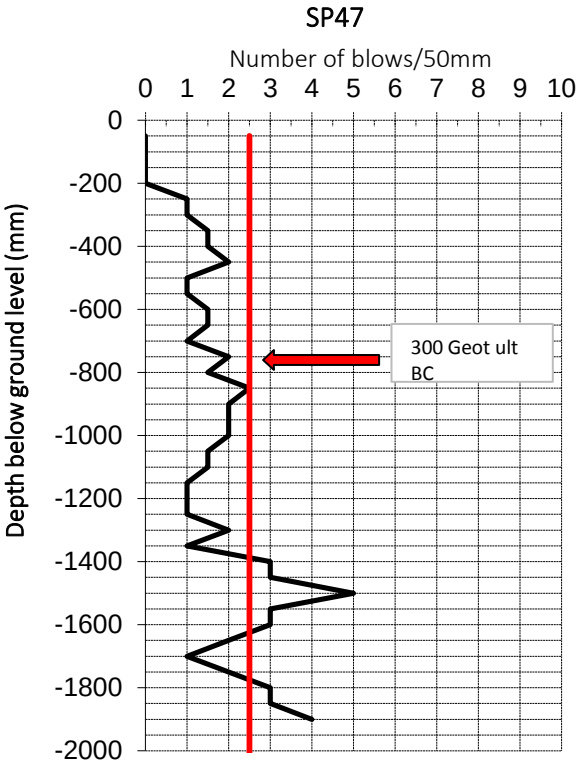

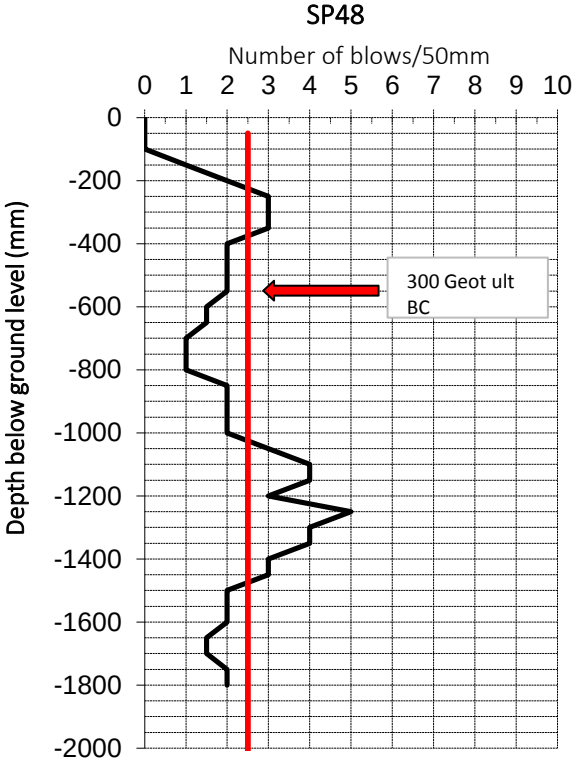

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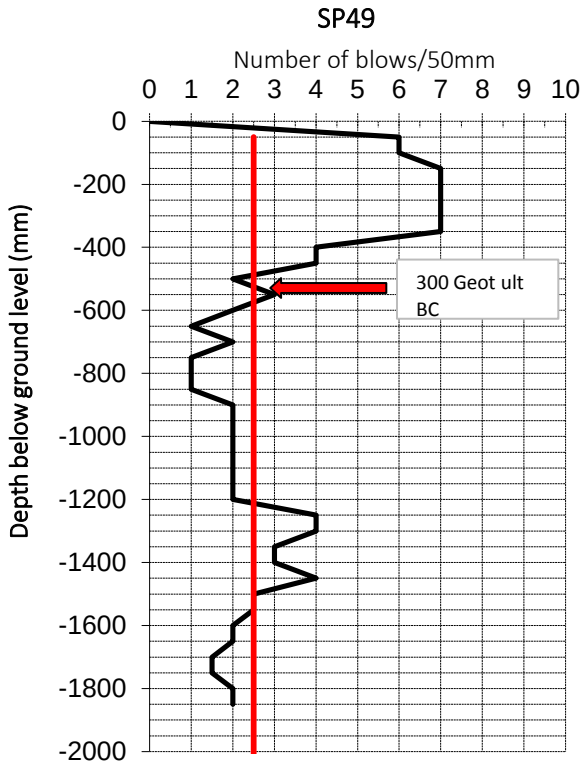

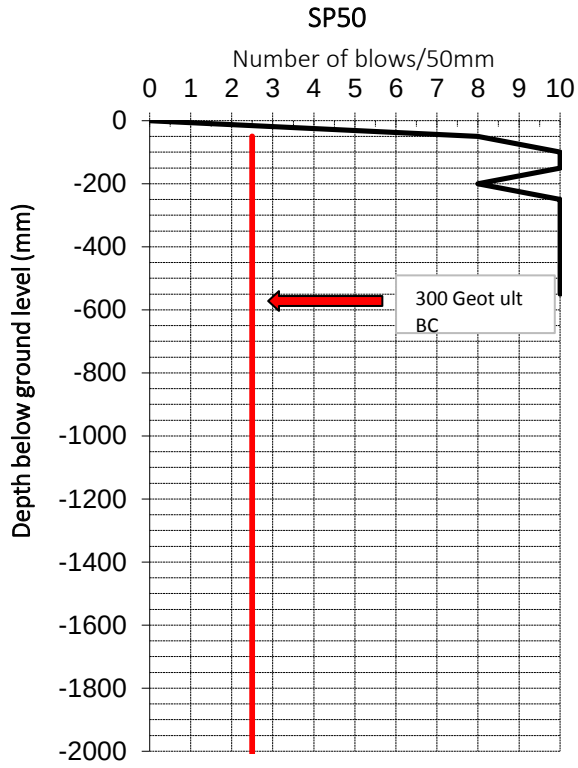

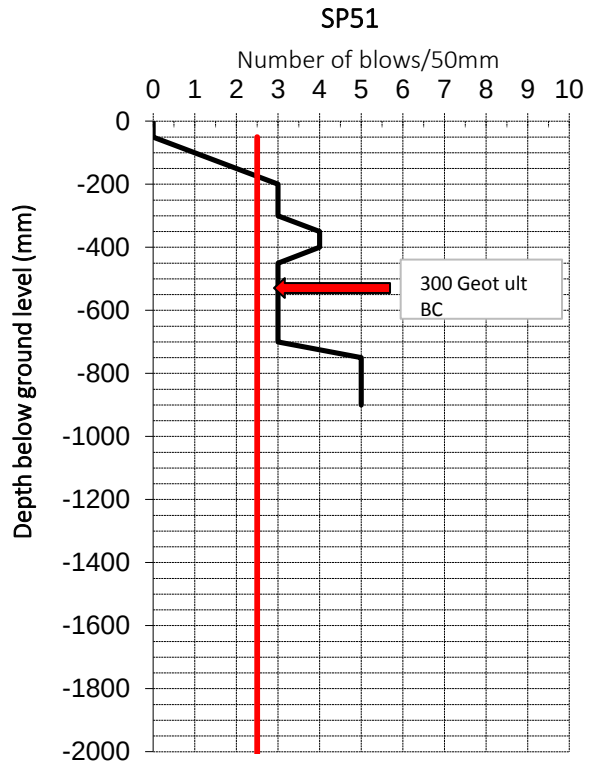

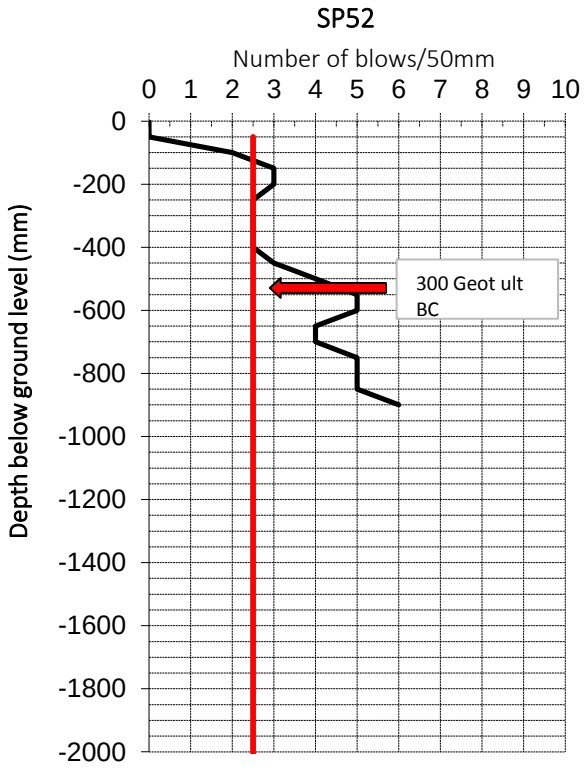

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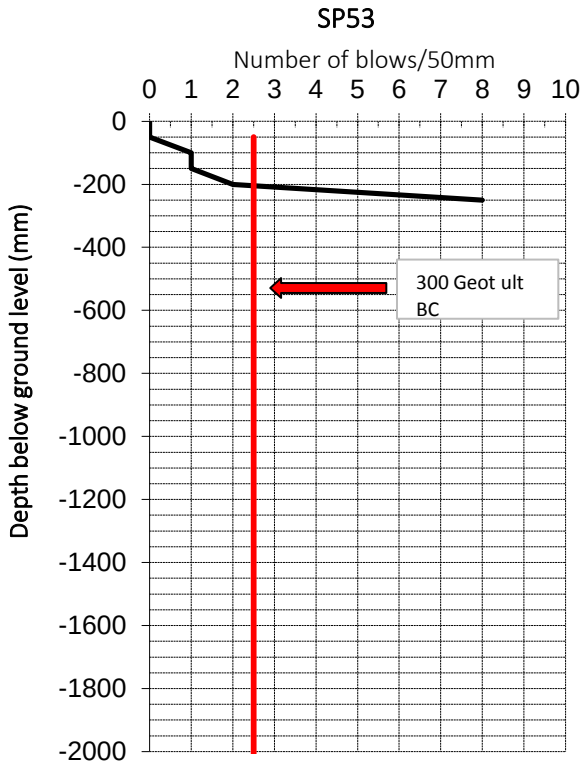

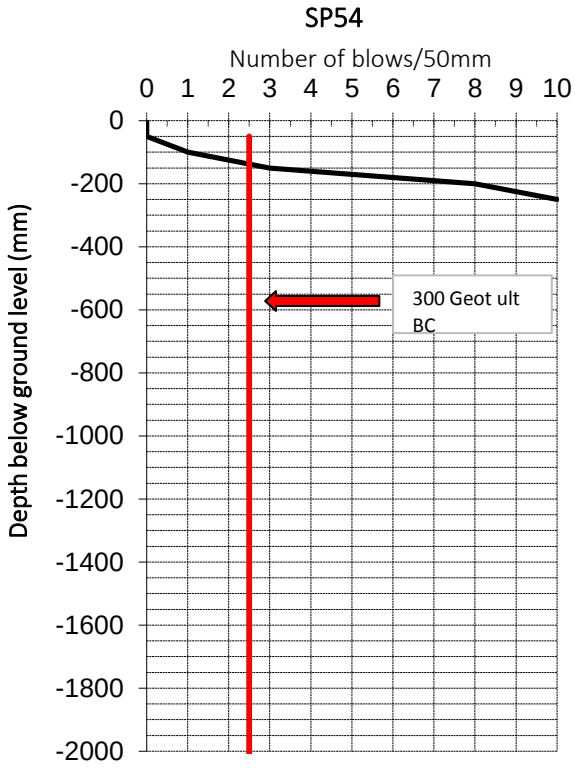

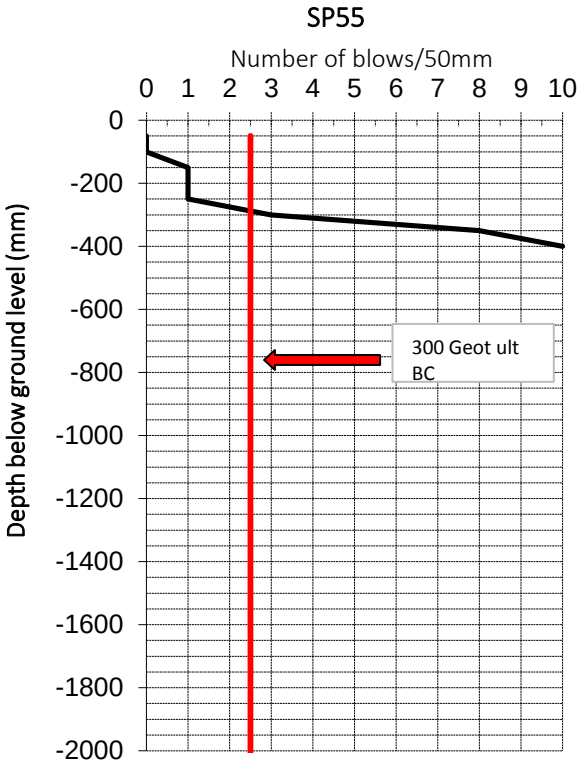

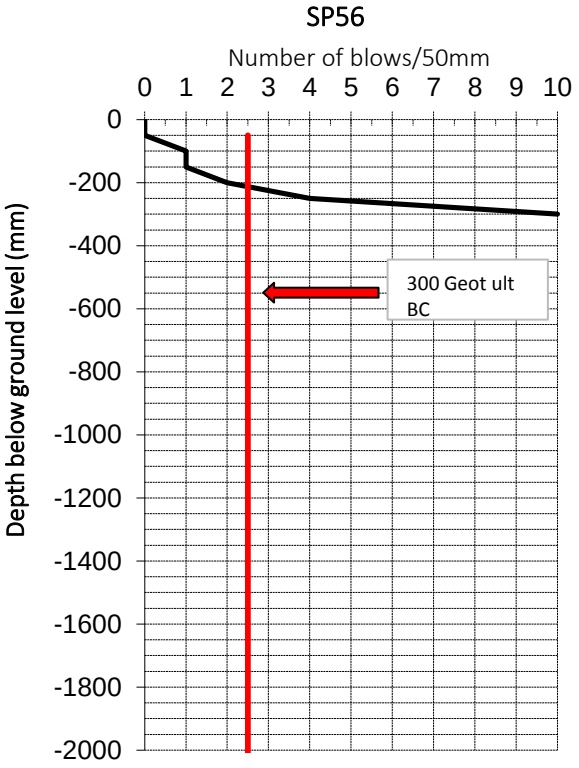

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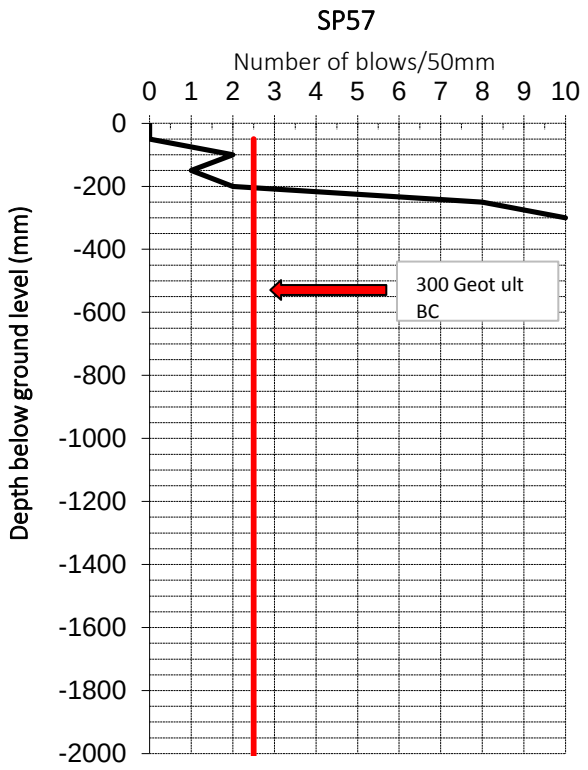

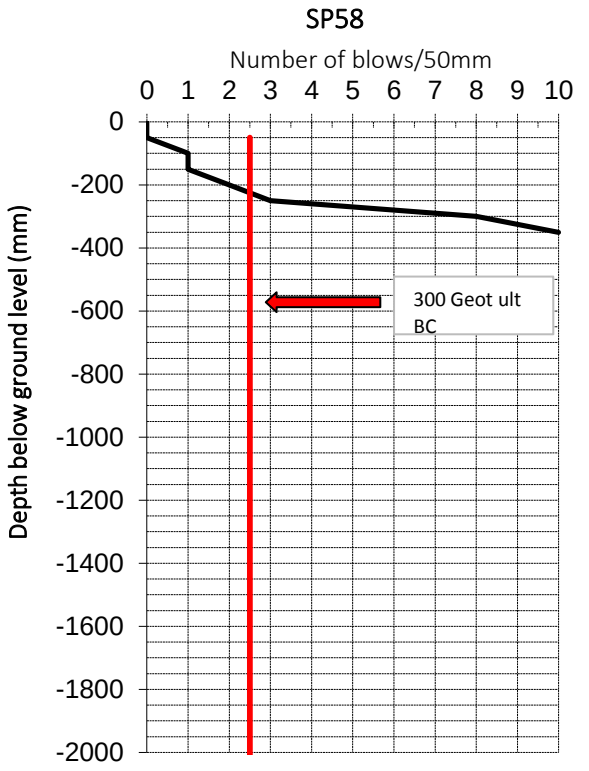

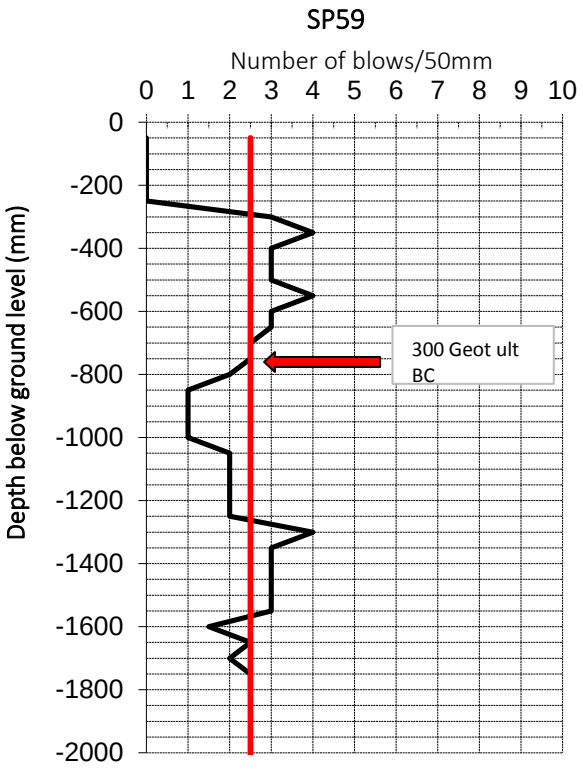

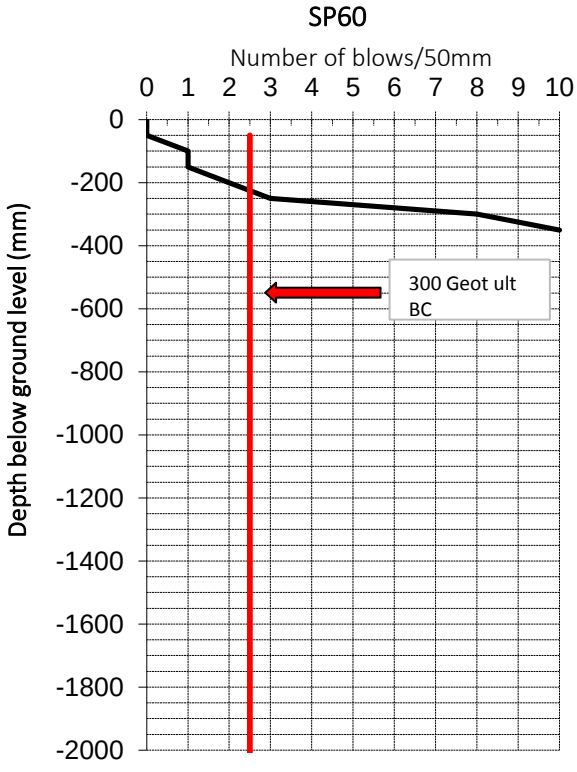

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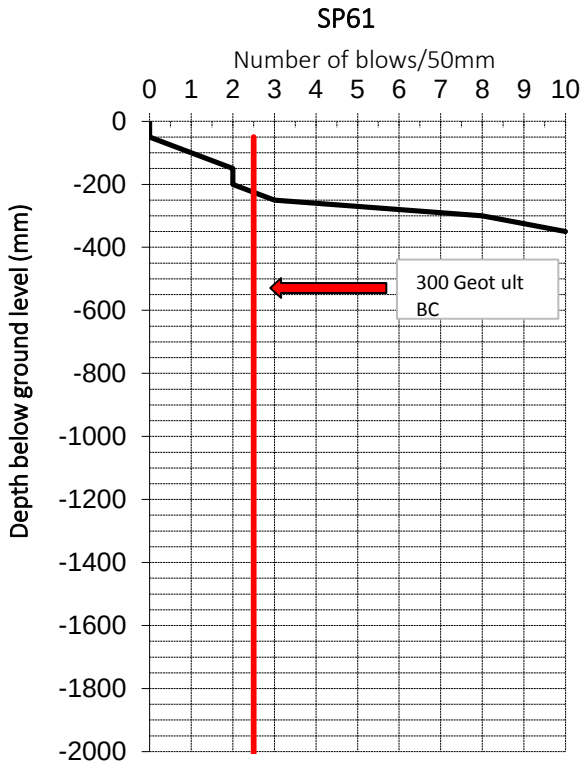
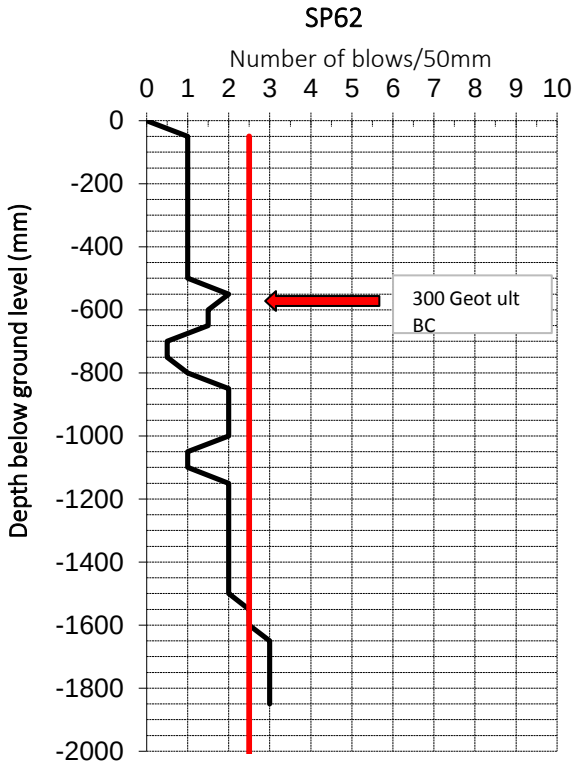
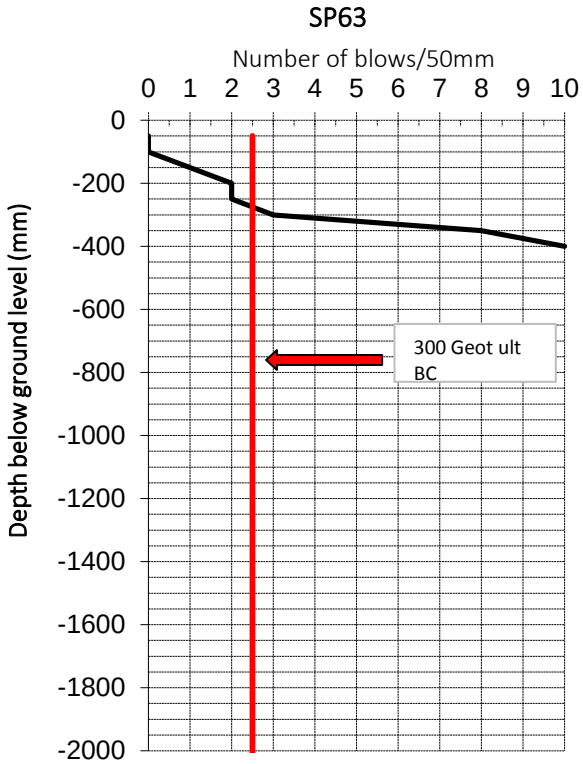
SCALA PENETROMETER RESULTS

JOB NUMBER:	50350	PROJECT:	Linksgate Geotech
		LOCATION:	Linksgate Subdivision
CO-ORDINATES:	mE	DATE:	6-Apr-17
See attached plan	mN	OPERATOR:	OMB

Note: No Friction correction has been applied to the field results. 5 Blows per 100mm is considered compliance with NZS3604 3.3.7







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APPENDIX G. CERTIFICATION

1. Statement Of Suitability
2. Schedule 2A

RDAgritech
ENGINEERED BY NATURE

STATEMENT OF SUITABILITY OF EARTHFILL FOR RESIDENTIAL DEVELOPMENT

ISSUED BY:	RDAGRITECH LTD (Design Firm)
TO:	SUBURBAN ESTATES LIMITED (Consent Applicant)
SUPPLIED TO:	QUEENSTOWN LAKES DISTRICT COUNCIL (Building Consent Authority)
IN RESPECT OF:	EARTHFILL FOR RESIDENTIAL DEVELOPMENT (Description of Building Work)
AT:	MANSE ROAD, ARROWTOWN (Address)
LEGAL DESCRIPTION:	PART SECTION 7 BLOCK XVII SHOTOVER SURVEY DISTRICT HELD IN COMPUTER FREEHOLD REGISTER OT13B/98

This document certifies that the structural earthfill shown on the Clark Fortune Macdonald and Associates as-built plan "Linksgate Subdivision, Stage 1, Earthworks – Fill Depths" dated 29 June 2017 included in the Geotechnical Completion Report 11 July 2017 has been placed in accordance with NZS 4431:1989, industry best practice and sound engineering principles.

During the structural earth fill construction works, David Rider of RDAgritech Ltd was retained as the Inspecting Engineer as defined in NZS 4431:1989. RDAgritech Ltd were engaged by Wilson Contractors Limited.

During the work, the inspecting engineer and his representative made periodic visits of inspection to the site. Inspection results are detailed in the RDAgritech Ltd Geotechnical Completion Report, Titled "Linksgate Geotechnical Completion Report REV2" dated 11 July 2017

Details of the soil testing carried out by the inspecting engineer and others on the project to check the quality of the fill are contained in this report.

This certifies that the structural earth fill covered by this report has been placed in compliance with the terms of NZS:4431:1989. This does not remove the necessity for proper engineering investigation, inspection, assessment and design of all future foundations.

Signed by DAVID WINSTON RIDER on behalf of RDAgritech LTD

GeoProfessional

Senior Engineering Geologist

(Date Issued) 11 July 17

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $100,000 or five times the fees charged to the client, whichever is the lesser amount.

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RDAgritech
ENGINEERED BY NATURE

11 July 2017

SCHEDULE 2A

STATEMENT OF PROFESSIONAL OPINION AS TO SUITABILITY

OF LAND FOR BUILDING CONSTRUCTION

Development: Linksgate Subdivision

Developer: Suburban Estates Limited

Location: Manse Road, Arrowtown

I David Rider of RDAgritech Limited hereby confirm that:

1. I am a geo-professional as defined in section 1.2.3 of NZS 4404 and was retained by the developer as the geo-professional on the above development.
2. Geotechnical investigation reporting was prepared for the development by Tonkin &Tonkin ltd. The reporting is attached in the geotechnical completion report titled "Feehly Hill Subdivision Geotechnical Report" dated November 2007.
3. In my professional opinion, not to be construed as a guarantee, I consider that:
   (a) The earth fills shown on the attached Plan titled "Linksgate Subdivision, Stage 1, Earthworks – Fill Depths" dated 29 June 2017 have been placed in compliance with the requirements of the Queenstown Lakes District Council and my specification and instructions.
   (b) The original ground not affected by filling is suitable for the erection thereon of buildings designed according to NZS 3604 provided that
      (i) Recommendations in the geotechnical completion report for the foundation conditions and limitations present across each lot are adhered to.
   (c) Subject to 3(a) and 3(b) of this Schedule, the filled ground is suitable for the erection thereon of buildings designed according to NZS 3604.
   (d) The original ground that was not affected by the filling and the filled ground are not subject to erosion, subsidence or slippage in accordance with provisions of section 106 of the Resource Management Act 1991.
4. This professional opinion is furnished to the TA and the developer for their purposes alone on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.
5. This certificate shall be read in conjunction with my geotechnical report referred to in clause 2 above and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

Yours sincerely

David Rider
Senior Engineer Geologist/ Geoprofessional