WARREN LEWIS

GODLEY PEAKS STATION LODGE, LAKE TEKAPO

GEOTECHNICAL ASSESSMENT REPORT

NEW RESIDENTIAL LODGE

DATE: 16 JULY 2024

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geotago

Engineering Geology & Geotechnics

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Task	Geotago Personnel	Title	Date Signed
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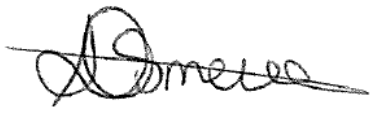

Signature of author of report

Signature of reviewer

Executive Summary

Scope of Work		Geotago Ltd has been engaged to conduct a geotechnical assessment of the ground conditions at the proposed lodge site on Godley peaks Road, and make appropriate recommendations for resource consent for foundations, earthworks, stormwater, and wastewater disposal.
Current Site Status		The site is located on the eastern perimeter of Godley Peaks Station, upslope of the western shore of Lake Tekapo. The site is located on part of the 14,493-hectare pastoral lease land, used for extensive sheep and beef farming.
Development Proposals		Large building platform to accommodate a single storey lodge development with external garaging, aircraft hanger, landscaped gardens and hardstand with onsite stormwater and effluent disposal systems.
Site Details	Location	Part Run 80 and Part Rural Section 42000 and Section 1 Survey Office Plan 19295.
	History	Open pasture, with no history or previous development.
Ground Conditions	Published Geology	Late Pleistocene to Holocene shoreline deposits, consisting of well sorted gravel and sand on modern and abandoned post-glacial lake beaches.
	Previous Investigations	None.
	Site Geology	Loose granular alluvial soils overlying very dense sandy gravels and cobble of glacial till.
	Hydrogeology	Depressed groundwater anticipated to be at least 10m below ground level.
	Environmental Condition	No environmental hazards are expected.
Natural Hazards	Liquefaction	Site investigations have proven dense soils and a depressed groundwater therefore not prone to liquefaction.
	Alluvial landforms	Nothing to influence the site.
	Seismic characteristics	Seismic Soil Class C considered appropriate. No active faults in proximity but design should be cognisant of NZS1170.5.
Geotechnical Considerations	Slope Stability	No stability issues.
	Building Platform	Earthworks anticipated in the realms of 2 to 4m cut required to form level platform.
	Foundations	NZS3604 “good ground’ present which will provide an ultimate bearing capacity of 300kPa for traditional shallow foundations or waffle slab-on-ground solutions.
	Earthworks	Standard conditions apply to align with NZS4404 and McKenzie District subdivision chapter. Site won material is suitable for reuse subject to appropriate screening.
Stormwater Disposal	Very poor drainage conditions. Stormwater disposal will likely require integrated water storage and detention tank with an overflow to a dispersal trench.	
Wastewater Disposal	Category 3 Soils. A package plant home aeration type system capable of the disposal of secondary treated effluent according to AS/NZS1547:2012 standards via a discharge control bed (or trench) is considered appropriate.	

Limitations

Geotago Ltd has undertaken this assessment in accordance with the brief as provided, based on the site and location as shown on Drawings 001 & 002. This report has been provided for the benefit of our client, and for the authoritative council to rely on for the purpose of processing the consent for the specific project described herein. No liability is accepted by this firm or any of its directors, servants or agents, in respect of its use by any other person, and any other person who relies upon information contained herein does so entirely at their own risk.

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1 Introduction

1.1 Project Brief

Geotago Ltd has been commissioned by the client Warren Lewis, in conjunction with Vivian & Espie to carry out a geotechnical assessment report (GAR) for the purposes of gaining resource consent for a new residential lodge on Godley Peaks Station (1729 Godley Peaks Road, Lake Tekapo).

This report will form part of the documentation submitted to Mackenzie District Council in support of the submission. This report includes a summary of the investigations undertaken in order to provide pertinent information on the following:

- Site Details
- Ground and groundwater conditions
- Natural hazards
- Building platform preparation
- Geotechnical engineering considerations for foundations, retention and earthworks
- Assessment of on-site stormwater management including soakage testing
- Assessment of on-site wastewater management and effluent disposal design

The site location is presented in Drawing 001.

1.2 Proposed Development

The property is currently a working sheep and beef station, located on the banks of Lake Tekapo, north of the Cass River. Access to the lodge will be from a proposed new driveway, heading out to Godley Peaks Road.

The conceptual design comprises an extensive residential lodge with associated outbuildings, driveway and infrastructure. The structure will be a one and two storey timber frame build with steel frame elements and stone cladding. The roof will be metal cladding. A total of five bedrooms are shown on the plans, with a swimming pool, spa, five ensuite bathrooms and a mudroom.

Earthworks are anticipated to be significant in terms of cut with excavations extending from 2 to 4m across the building area. Excavations beyond this will also be required for the swimming pool area.

The development will require on site stormwater and wastewater management systems.

The proposed scheme layout developed by Mason & Wales is presented in Appendix A.

2 Site Information

2.1 Site Description

The site is located on the eastern perimeter of Godley Peaks Station, upslope of the western shore of Lake Tekapo. The site is located on part of the 14,493-hectare pastoral lease land, used for extensive sheep and beef farming. The proposed residential site is located on the gentle moraine country at the south end of the property, between the Cass River and Lake Tekapo. The immediate surrounding area has been extensively modified through subdivision into paddocks, which contain

cultivated pasture, fodder crops or short tussock land, with views over Lake Tekapo, and the mountain ranges to the north and west.

The legal description of the property is Part Run 80 and Part Rural Section 42000 and Section 1 Survey Office Plan 19295.

2.2 Topography

The site has an easterly aspect forming gently rolling topography. The central section of the property sits at 743m AOD, falling to 739m at the eastern perimeter. The topographical plan is presented in Appendix A.

A shallow tarn is located downslope towards the east of the site and was dry at the time of the investigation. The feature is shown on Drawing 002.

2.3 Surface Water and Drainage

Site drainage will be via overland flow towards the east. There is a small ephemeral tarn downslope to the east of the site, which is proposed to be regenerated with native plantings. Given the topography, overland flow will report to the tarn to some extent.

2.4 Site History and Aerial Photography

Aerial photographs available from the Google Earth Images, Retrolens.nz and the council mapping data set dating from 1954 to 2019 were studied to observe the site over time and assess the geomorphological setting.

It is clear from the site history that the site has not been influenced by any rural development or geomorphological process, other than the formation of paddocks for pasture and cropping.

2.5 Services and Utilities

The site will require on-site stormwater and wastewater management systems as part of the development. The scheme plans indicate a solar farm for power generation, with potable water source not known at this stage.

2.6 Previous Site Investigations

Geotago has not identified any previous site investigation or geotechnical reporting for the project site. However, having undertaken site investigation within the vicinity of the Tekapo area we are familiar with the general ground conditions of the district.

3 Site Investigation Details

3.1 Site Assessment

Geotago Ltd completed an engineering geological assessment of the subject property on 9 February 2024, which included a general site walkover and subsurface investigations. The geotechnical investigation comprised eight test pits advanced to a maximum depth of 1.8m where they met with effective refusal from the excavator on dense material. Scala penetrometer tests were completed on each of the test pits within the building platform area where refusal on dense gravel was encountered.

The investigations were located in the vicinity of the building platform and downslope of the platform for the stormwater and wastewater assessment as shown on Drawing 002.

3.2 Investigation Logging

Soils recovered from the test pits have been logged and are presented in Appendix B. Logging of the soil encountered has been undertaken in accordance with NZ Geotechnical Society Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes.

The Scala penetrometer results have been plotted on logs as presented in Appendix B. Determination of the soil density as tested by the Scalas has been undertaken in accordance with NZ Geotechnical Society Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes, Table 2.8.

4 Subsurface Conditions

4.1 Geological Setting

The Geological Map of New Zealand, Sheet 15 (Aoraki), at a scale of 1:250,000 maps the site as being underlain by Late Pleistocene to Holocene shoreline deposits, consisting of well sorted gravel and sand on modern and abandoned post-glacial lake beaches.

Given the geological and topographical setting of the site, alluvial soils are anticipated to mantle much of the site.

4.2 Ground Conditions & Stratigraphy

Apart from the thin layer of surficial topsoil, the site is underlain by alluvial soil overlying glacial outwash deposits. The alluvium extends to a maximum depth of 1.4m in TP103, but generally to approximately 0.6m below the surface of the site. The underlying glacial till contained coarse cobbles and boulders and was excavated to approximately 1.8m before becoming too competent for the excavator to penetrate.

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

A summary of the sub-surface conditions identified in the investigations undertaken is presented below in order of depth from the ground surface. The sub-surface conditions have been extrapolated between the investigations undertaken and other available information.

4.2.1 Topsoil

Topsoil comprises organic sandy SILT, and gravelly sandy SILT, dark brown, with roots to depths of approximately 0.3 m.

4.2.2 Alluvium

Alluvium underlies the topsoil in all of the test pits to depths of between 0.5 and 1.4 m. The alluvium comprises sandy SILT and sand with gravels, being brown in colour and very stiff. There was evidence of topsoil mixing in the upper layer of the alluvial, likely from a long history of farming activity.

Scala penetrometer testing in the alluvial soils generally met with refusal between 400 and 600mm below ground level, with blow counts of >5/100mm in the upper soils.

4.2.3 Glacial Till

Glacial deposits were encountered in all test pits below the alluvial soils. The 'till' was described as silty SAND with gravels and cobbles, coarsening with depth to form sandy GRAVELS with cobbles. All the glacial till was described as dense to very dense with a 5T excavator failing to penetrate the material much beyond 2m.

4.3 Groundwater

Groundwater was not encountered in any of the test pits. Given the relatively elevated site position compared to nearby surrounding surface water bodies, the groundwater is anticipated to be relatively deep, such that it will not interfere with earthworks or foundations.

No borehole information was available from the Environment Canterbury borehole database.

5 Natural Hazards

5.1 General

The Environment Canterbury and Canterbury Maps Viewer Natural Hazards Portals have been reviewed for the purposes of identifying potential natural hazards that may impact the site. The information from the database is used together with our observations from the site investigation to inform the discussion below.

5.2 Alluvial Fan

The site is not underlain by any form of alluvial fan or alluvial landform.

5.3 Flooding

The site is not prone to flooding.

5.4 Liquefaction

The project site is described as having an unlikely probability of liquefaction damage, according to the report on "Revised liquefaction information for the Mackenzie District" by Environment Canterbury, and dated September 2023. This classification suggests that the ground is predominantly underlain by scree, glacier or fan deposits. This is aligned with our site investigation data, and there is no groundwater identified within 1.8m of ground level.

5.5 Slope Stability

The site is situated on gently rolling topography, which poses no slope stability issues. The hazard database does not zone the site for any form of landslide feature.

5.6 Seismic

The soil classification for the site is Class C, relating to shallow soils that are very dense or soft rock. Based on the investigations undertaken, this is considered an appropriate classification.

No active faults were mapped in the field, however, the active Irishman Creek Fault is shown on the published Qm 15 approximately 2.5km south from the site There is a significant seismic risk to the Mackenzie 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.

6 Geological Ground Model & Residual Risk

6.1 Ground Model

The geological ground model for the site is based on the collated information presented in this report including the desk top information, intrusive investigation and our interpretation. The ground model is summarised as:

- The site is presently undeveloped and does not appear to have been significantly modified in any form other than for farming.
- The site is located on gently sloping, rolling topography which does not display any slope instability features. In addition, the site is remote from steeper slopes and/or slopes prone to the development of slope instability features.
- The site is underlain by competent ground conditions consisting of alluvial silts sands and gravels which overlie dense glacial till. Topsoil mantles the alluvium to a depth of 300mm.
- The building platform has no surface water features. Given the site's topography surface water will flow to the east via overland flow. An ephemeral tarn is located downslope and east of the development site.
- Ground water was not encountered in any of the test pits indicating that the water table is at least 1.8m below ground level.
- Groundwater is susceptible to seasonal variations, and it is feasible that groundwater levels may rise, or seepage rates increase, over those observed following a period of prolonged rainfall and during the winter months, but not to the extent that it would interfere with foundations.
- The site is not located in the vicinity of an active fault zone but should be considered as seismically active in line with the wider Canterbury region.
- The site is not considered be risk of liquefaction due the relatively dense, coarse sediments, and generally depressed groundwater levels in the vicinity of the building platform.
- The site is not influenced or impacted from any other natural hazard.

6.2 Geotechnical Risk and Limitations

Geotechnical investigation and their interpretation are subject to limitations and inherent risk due to the spatial distribution of the investigation points relative to the property/site area and the residual uncertainties of the ground conditions that remains uninvestigated. Therefore the following should be noted:

- Ground conditions can vary between investigations undertaken and there is always some natural variability in ground conditions both laterally and vertically, particularly with recent deposits.
- Small-scale ground anomalies, particularly associated with human disturbance such as demolished buildings, buried services and landscaping works can often be missed by the investigations.
- Ground strength can change with variations in natural water/moisture content, soil type and ground loading. As such, our interpretation and assessments are cognisant that ground conditions may differ to those reported at the time of this investigation due to periods of wet weather and/or during the winter months.

- The impact of climate change and its influence on ground conditions from a geotechnical perspective is an area being currently researched. However, based on our current understanding effects will include changes in groundwater regimes, soil saturation and surface water characteristics all of which may have a future effect on any current site development.

7 Geotechnical Considerations

7.1 General

Based on our ground model developed for the site, we are of the opinion that the site is generally suitable for the proposed scheme as described in Section 1.2.

Earthworks and drainage should be undertaken in accordance with NZS4404 Land Development and Subdivision Infrastructure cognisant of specific District Council variations or Code of Practice, and NZS4431:2022 Engineered Fill Construction for Lightweight Structures.

When considering conventional light timber framed dwellings, developments should be in accordance with NZS3604, with provisions made for AS2870 expansive site class.

Other relevant Codes and Standards include but not restricted to those listed in Section 10 References.

Specific comments and recommendations are provided in the sections below.

7.2 Site Preparation

7.2.1 Building Platform

At this conceptual stage, no definitive earthworks plan has been developed for the site. However, it is understood that a large cut is proposed in order to create a level area to accommodate the single storey lodge and associated outbuildings. The cut is anticipated to range from 2 to 4m in depth across the platform.

7.2.2 Standard Preparation

During the earthworks operations and excavation to the required levels all topsoil, uncontrolled fill, organic matter and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:2022.

If foundation construction is not immediate following subgrade preparation, it is advisable to leave the excavation some 200mm proud of subgrade level to provide protection from the elements.

The final subgrade cut should be made as close to the construction period as possible and be inspected prior to fill being placed and/or foundations being constructed to establish it has suitable bearing capacity and is clear of unsuitable materials.

Subject to confirmation on site, aside from topsoil, site won material is considered suitable for placement as fill provided the following measures are taken:

- Fill areas to be benched/tied in.
- Free draining material and drainage system placed immediately behind any retaining walls.
- Appropriate lift height, compaction and certification for fill greater than 600mm.

Appropriate shallow graded sediment control measures should be installed during construction where rainwater and drainage run-off over exposed soils is likely. If slope gradients in excess of 5%

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

Exposure to the elements should be limited for all soils and covering the soils with polythene sheeting will reduce degradation due to wind, rain and surface run-off. Under no circumstances should water be allowed to pond or collect near or under a foundation or slab. This can be avoided with shaping of the subgrade to prevent water ingress or ponding.

If fill is utilised as bearing for foundations it should be placed and compacted in accordance with the recommendations of NZS 4431:2022 and certification provided to that effect.

The upper 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 subgrade levels are achieved.

7.3 Geotechnical Parameters

Table 1 presents the geotechnical parameters for the ground conditions and fill materials anticipated to be encountered during site preparation and construction. The parameters are based on the site observations, on-site testing, and our knowledge of soil behaviour and materials within the district.

Table 1: Geotechnical Design Parameters

Unit	Cohesion (c')	Friction Angle (ϕ')	Ultimate Bearing Capacity (kPa)	Unit Weight (γ)
Topsoil	-	-	-	16kN/m^3
Alluvium	0 kPa	28-32°	300 kPa	18kN/m^3
Glacial Till	0 kPa	28-32°	>300 kPa	19kN/m^3

7.4 Batter Slopes

As per section 7.2.1, potential earthworks generating cuts of up to 4m may be required, although it is unlikely these will generate steep batters as there is sufficient room to lay them back at sympathetic angles.

Recommended temporary and permanent batter angles for cut slopes up to a maximum of 3.0m in both wet and dry conditions are presented below in Table 2 for future reference. Batters provided should be adhered to where more than one soil type is present within the slope or defaulted to the shallower angle where appropriate.

Slopes that are required to be steeper than those described below should be structurally retained or subject to specific geotechnical design.

Table 2: Batter angles for soil slopes

Material Type	Recommended Maximum Batter Angles for Temporary Cut Slopes Formed in Soils		Recommended Maximum Batter Angles for Permanent Cut Slopes Formed in Dry (Drained) Soils
	Wet ground	Dry Ground	
Topsoil	2H:1V	1H:2V	2H:1V (grassed/planted)
Alluvium	1H:1V	1H:2V	2H:1V
Glacial Till	1H:2V	1H:3V	1H:2V
Engineered Fill	1H:1V	1H:2V	2H:1V (unretained, drained)

All slopes should be periodically monitored during construction for signs of instability and excessive erosion, and, where necessary, corrective measures should be implemented to the satisfaction of a Geotechnical Engineer or Engineering Geologist. Should construction and earthworks be undertaken during the winter period, the frequency of the inspections should increase, with site inspections being made after any significant weather event.

Inspections of soil cuts will be required during construction to confirm the above recommendations and based on the site observations a reduction in batter angles from those provided above may be required and conversely, if materials are preforming, may be steepened if site conditions and construction sequencing/programme are favourable.

7.5 Engineered Fill Slopes

As recommended in Table 2 above, unretained engineered fill slopes should be formed at 2H:1V (or flatter) providing they are well drained and compacted to the appropriate specification based on NZS4431:2022. If steeper grades are required, the fill will require geogrid reinforcement to form slopes up to 45° but subject to specific engineering design from a Chartered Professional Engineer (CPEng).

7.6 Construction Monitoring & Certification

Any earthworks and placement of fill should be undertaken in general accordance with Mackenzie District Council's Subdivision, Development and Financial Contribution Rules (incorporating NZS4404) and NZS4431:2022.

With reference to NZS3604, Section 3.1.2 (c) fill, including hard fill, placed over undisturbed ground or certified fill, shall not exceed 600mm in depth above natural ground level, if within 3m of a foundation. Where this condition cannot be met, the fill shall be tested and certified to be of appropriate density/strength.

Of particular importance are the inspection and certification of the following:

- Subgrade inspection.
- Suitability of site won material for reuse as engineered fill.
- Performance of temporary cut batters.
- Foundation inspections.
- Fill >600mm depth or built as a slope >2H:1V.

7.7 Services

We recommend that all underground services are backfilled with adequately compacted backfill to minimise the risk of significant trench consolidation and settlement.

Trench excavations should be shored or battered appropriately in accordance with the OSH/DOL Approved Code of Practice for Safety in Excavations and Shafts for Foundations (April 2000).

The contractor is expected to employ the appropriate plant and machinery to undertake the excavation and retaining wall construction.

7.8 Slope Stability

The proposed building platform is located on gently sloping topography which is underlain by competent ground conditions and is remote from steeper slopes and/or slopes prone to the development of slope instability features.

The modest overall slope angles and underlying competent ground conditions in the vicinity of the proposed building platform should provide safe and stable ground with respect to slope stability conditions.

A safe and stable building platform is defined as having a low to negligible risk of failure over the lifetime of the dwelling and is assessed as a factor of safety where a quantitative slope stability assessment is undertaken. Given the modest slope angles in the vicinity of the site, we consider that a qualitative assessment of slope stability (as provided above) is acceptable for defining risk for this site and that a more rigorous quantitative analysis is not required.

Site earthworks are required to provide a suitable level building platform within the existing slopes, and we consider that appropriate site development constraints are required in order to maintain safe and stable conditions. This is addressed in Section 7.4 of this report.

7.9 Retaining Walls

Engineered retaining walls will be required on site under the following circumstances:

- where the retention height is greater than 1.5m.
- where retaining wall supports any surcharged loads such as sloping ground and structure/traffic loads.
- where retaining wall failure will affect the stability and integrity of adjacent structures and neighbouring properties.

Table 2 provides geotechnical parameters for the engineered retaining wall design as required.

All retaining walls should be constructed with appropriate toe drainage and backfilled to their full height with lightly compacted free draining granular material or other appropriate drainage solution. Toe drainage should be discharged at a point that will not impact or influence the construction works on site or alternatively be connected to the reticulated stormwater system.

7.10 Foundation Recommendations

7.10.1 Foundation Design Options

Both the alluvial soils and glacial till are considered suitable for foundations. Based on potential earthworks cut, all foundations will be bearing on glacial till (unless rockhead is encountered within the 4m cut depth).

On the grounds that the recommendations made in this report are followed and the appropriate standards adhered to, then the foundations suitable for the site are typical NZS3604 types or alternatively could be in the form of a waffle slab-on-ground. The latter can offer increased thermal insulating properties and provide easier construction.

7.10.2 Bearing Capacity

The bearing capacity has been determined from our interpretation of the engineering description of the soil conditions, observations from the test pits on the soil behaviour and relative density measurements based on the site-specific testing undertaken. The values presented take into consideration natural variability of ground strength likely between investigations undertaken and potential strength reduction associated with saturated soil conditions.

To be compliant with ultimate limit state design methods outlined in AS/NZS 1170, this report provides ultimate bearing capacity values and a strength reduction factor in order to allow calculation of design foundation bearing capacity.

We have adopted a strength reduction factor of 0.5 (i.e.. a factor of safety of 2) which is in general accordance with the requirements of AS/NZS 1170.

On this basis, the glacial till meets the criteria of NZS3604 Good Ground and as such will provide an geotechnical Ultimate Bearing Capacity of 300 kPa.

If rockhead is encountered, site specific assessment would be required to determine its bearing capacity and stability but it would more than likely provide in excess of 900kPa ultimate bearing capacity.

It is anticipated that engineered fill placed in accordance with NZS4431:2022 will achieve 300 kPa geotechnical Ultimate Bearing Capacity in accordance with NZS3604 section 3 testing requirements.

7.10.3 Ground Settlement

The proposed building platform is underlain by competent ground conditions which are considered to be at least normally consolidated. The soils should therefore accommodate the low to moderate loads associated with the proposed scheme without inducing significant ground consolidation and associated differential ground settlement within Building Code limits (i.e. a maximum differential settlement ratio of 1 in 240).

However, the following recommendations and limits are made to further safeguard against settlement:

- A maximum building UDL of 10kPa (includes live + dead loads).
- A maximum footing width of 1.0m.
- A maximum fill depth of 1.5m.

Should the proposed development exceed these constraints, we recommend that a specific settlement analysis be undertaken for the development and may require more extensive investigations than that undertaken to date.

7.11 Soil Expansivity

There is no specific engineered foundation design required to resist shrink/swell associated with the non-expansive soils encountered on site.

7.12 Site Subsoil Category

For detailed design purposes it is recommended the magnitude of seismic acceleration be estimated in accordance with the recommendations provided in NZS 1170.5:2004 assuming Class C subsoil conditions exists across the site. It is also recommended to refer to the guidelines set out in NZGS/MBIE Earthquake Engineering Module 1 Appendix A.

7.13 Unsuitable Materials

Recommendations for foundation design provided in Section 7 of this report are based on foundations embedded within 'Good Ground' according to NZS 3604:2011. In order to achieve 'Good Ground' we recommend the following:

- A suitably qualified person should inspect all foundation excavations.
- Care should be taken to ensure that all unsuitable material such as the topsoil layer, weak ground, areas of non-engineered fill and or hard spots are removed from the building platform prior to building construction.

- The undercut for the building footprint should extend for a horizontal distance equivalent to the undercut depth beyond the footprint. Where this is not possible excavation should be staged and retention structures constructed in a timely manner. The undercut should be backfilled with engineered fill up to the required formation level unless specified otherwise by a suitably qualified person.

8 Stormwater Management

8.1 General

Stormwater disposal should be in compliance with the operative District & Regional Plans, the Building Code and recognised New Zealand standards and guidelines. In summary this requires the following:

- Hydrogeological neutrality should be provided within receiving environments (such as overland flow paths, streams and reticulated stormwater systems) with the addition of impervious surfaces. In addition, the disposal of stormwater should not provide a nuisance to neighbouring properties and public infrastructure.
- Stormwater should be managed in such a way as to avoid slope erosion, earthworks batters, retaining walls, building structures and effluent disposal areas.
- Stormwater should be managed in such a way as to have no significant effect on overall slope stability conditions.
- Stormwater should be directed to a public reticulated stormwater system where possible.
- Site development should be mindful of existing surface water features including overland flow paths and appropriate remedial measures should be provided where required.

In particular, we note the following documents pertinent to stormwater management for the proposed development:

- New Zealand Building Code, Clause E1 'Surface Water': E1/VM1.
- New Zealand Water Environment Research Foundation (NZWERF): 'On-site Stormwater Management Guideline'.

8.2 Site Suitability for Stormwater Disposal

Preliminary soakage testing was undertaken in test pit TP101/SK1. The testing comprised the excavation and measured dimensions of an open test pit and the rapid discharge of approximately 1000L of potable water from a water bowser to the open pit. The results of the test are presented on the respective test sheets in Appendix C, with a summary of the results and commentary provided in Table 3 below.

Table 3: Soakage Test Results Summary

Soakage Test	Volume Added	Time to Empty	Calculated Soakage Rate	Factored Soakage Rate	Comments
TP101/SK1	~1000L	>6hrs and no reduction in level	<50 mm/hr	<25 mm/hr	The initial drop in water level can be attributed to the very dry soils absorbing a discrete volume of water. A static level was then recorded for the duration of the site investigation period.

Based on the preliminary testing, it is apparent that soakage to ground is unlikely to be a suitable method for on-site stormwater management. Therefore, any stormwater management system must rely on the philosophy of retention and detention to ensure that pre and post development rates are maintained by employing dual purpose retention/detention water tanks.

8.3 System Design Information

8.3.1 Design Criteria

In order to maintain pre development rates of discharge, stormwater will have to be captured from the roof and other surface areas. Capturing stormwater into a tank or series of tanks will allow for detention and slow release of stormwater from the development with harvesting (retaining) the water for irrigation use. The stormwater from the access driveway would be managed through appropriate shaping of the road such that stormwater would be encouraged into adjacent swales.

Stormwater can be harvested to supplement potable water source, with any such water being treated so that it complies with New Zealand drinking water standards. This would also restrict the harvesting of stormwater to the roof areas only.

On-site stormwater disposal is ultimately required to meet New Zealand Building Code (NZBC), E1 VM1. Therefore, the following stormwater design has been completed in accordance with NZBC E1/VM1 code. It is however appreciated that at this stage of Resource Consent , there may be other parameters to be taken into consideration at detailed design stage not accounted for in this preliminary design.

The rainfall intensities utilised have been chosen for the 10 year (10% AEP) 1-hour duration event with a climate change RCP of 6.5 2081-2100 included, as determine by HIRDS V4 data.

The design rainfall event has a rainfall intensity of 21.1mm/hr for a duration of 60 minutes.

8.3.2 Stormwater Catchment

Architectural plans by Mason & Wales Architects, dated 17 November 2023 were utilised for developing the preliminary design. The architectural plans are presented in Appendix A. In summary, the stormwater management system is required to effectively manage stormwater derived from the following surfaces as shown on Table 4.

Table 4: Stormwater Management Development Areas

Surface	Roof Areas	Paved Areas	Unsealed Surfaces	Garden and Lawn	Unsealed Drive [2]
Elements	House, garages, hanger, cabana pool area.	Winter garden, patio areas and terraces	Heli landing area, forecourt and car parking	Two lawn areas and garden	Access driveway extending to solar garden
Area	1660m^2	180m^2	1020m^2	304m^2	>220m^2
Run-off coefficient [1]	0.9	0.6	0.5	0.25	0.5

1. Curve numbers derived from the Building Code E1/VM1.
2. The access driveway is assumed to be gravelled.

For the purposes of this exercise, only the footprint of the development area is calculated for the assessment of pre and post development run-off. The wider site is too large to consider and include in the pre-development calculations. In addition, the access road has not been incorporated into the design as the actual length is not currently known and is also more appropriately managed by

shaping the metal road to encourage surface flow to shed to the lateral swales. See Appendix C for a typical swale design.

8.4 Detention and Retention Tank – Rainwater Harvesting

The purpose of the stormwater detention and retention system is to temporarily store stormwater prior to discharge to the receiving system. It is also an opportunity to capture and retain stormwater for irrigation purposes. The site is considered inappropriate for large scale soakage devices (rock filled pits or chamber devices) due to the very poor soakage characteristics of the soils encountered. As such a detention and retention tank(s) are proposed for the development.

The design of the detention and retention tank and outlet sizing should be such that the post development stormwater flows are equal to or less than the pre-development stormwater flows. The size of the detention tank is governed by the stormwater event flows and outlet orifice size.

Given the size of the catchment areas, multiple tanks are required to manage the volumes being generated. Appendix C presents the calculations which demonstrate a minimum of two tanks are required for this development (based on the Stormwater Management in the Auckland Region Section C5 – Water Tanks guidance notes).

Table 5 presents a summary of concrete tank dimensions and the tank storage information. We have made the assumptions that concrete tanks will be used as these can be buried to help with the aesthetics of the development. Table 6 presents a summary of the orifice/outlet and pre & post development flow rates for each tank.

Table 5: Summary of Tank Design Information

Tank Information	Individual Tank Dimensions			Dual Tank Storage		
	Tank Diameter (m)	Tank Height (m)	Tank Volume (L)	Detention Volume (L)	Retention Volume (L)	Dead Storage Volume (L)
Two tanks required to capture design surfaces as per Table 4. [1]	3.50	2.64	22,500	32,803	9,311	2,886

1. Tanks are installed in series and plumbed appropriately to ensure equilibrium.

Table 6: Orifice/Outlet and Pre & Post Development Flow Rates Information

Tank Information	Outlet/Orifice Details				Pre & Post Development Flow Rates	
	Orifice Diameter (mm)	Orifice Height above base of tank (m)	Orifice discharge rate (L/s)	Orifice discharge time (hrs)	Pre-Development(L/s)	Post-Development (L/s)
Single tank details	50	0.63	2.11	4.31	12.13	7.72

The design demonstrates that a minimum of two 22,500L storage tanks employed for both detention (stormwater) and retention (domestic purposes - garden irrigation, wash down of vehicles and equipment etc) can accommodate the excess storage volume as stormwater detention. It is acknowledged that more than two tanks can be used in order to increase the retained volume of water for domestic use.

In summary:

- The pre-development flow has been calculated at 12.13 L/s.

- To achieve a post development flow rate of less than the pre-development rate an orifice diameter of 50mm is required and achieves a total peak post-development flow rate of 7.72 L/s.
- Therefore 7.72 L/s (post development) < 12.13 L/s (pre-development).

8.5 Practicalities

The design provided is only preliminary and developed to demonstrate that on-site stormwater management is achievable. It is acknowledged that the development is large and has several elements that could be managed independently (e.g. the hanger) and that alternative methods for the management of surface waters could be employed. These could include but not be restricted to swales, discharge trenches and even surface basins to attenuate flows.

The array of water tanks would need to be placed down slope of the house so that they could be gravity fed. Landscape and drainage design must be cognisant that fully buried tanks (assumed given the nature of the development) requires a 3m excavation depth. This must be factored in to the overall earthworks schemes and anticipated cut depths of 2 – 4m.

One benefit of buried concrete tanks is the possibility to place under trafficked areas, allowing tanks to be buried below the large forecourt area in front of the house.

The capture of surface waters from gravel and paved areas would also need to pass through a mud tank and sand filter to ensure sufficient solids and contaminants are removed from the water before entering any storage tank.

8.6 Stormwater Discharge Considerations

To address super design events above the 10-year ARI, a secondary flow path shall be provided via an overflow pipe from the tank)(s) with flows directed towards existing overland flow paths or to a delineated area identified for this purpose.

9 Wastewater Management

9.1 General

The proposed lodge comprises five double bedrooms. Given the nature of the lodge, none of the remaining rooms and facilities would be used for a bedroom. As such, we have assumed a maximum occupancy of ten people based on Table J1 of AS/NZS 1547:2012.

Water will be sourced from a private supply (details not known) , which means a design flow rate of 200 litres per person per day, assuming standard household fixtures (including a washing machine) based on Table H3 of AS/NZS 1547:2012.

The ground conditions dictate the use of secondary treatment and a discharge control bed solution due to the presence of loose granular soils in the upper 1m soil profile and the Environment Canterbury's risk profile for pathogen and nitrate level accumulation. There is insufficient topsoil of suitable soil quality to be conducive to in-ground drip irrigation.

Given the site layout, surface water bodies, and topography, the most appropriate position for the effluent disposal area is in the area to the immediate north and north east of the dwelling, to meet the various separation criteria. The proposed position of the discharge control bed and septic tank is shown on Drawing 003. It is however recognised that without the benefit of earthworks plans and detailed layout, the proposed location may be inappropriate come detailed design stage.

9.2 Site & Soil Evaluation

The project site is significant in area (>4ha) which will provide sufficient physical room for a land application system to be designed.

During the winter months the area is subject to frost, snow and potential ground freezing. Ground water levels are anticipated to be deep (>5m).

Based on the soil profiles observed in the test pits, the upper alluvial soils (<800mm from the surface) can be generally categorised as Class 3 (sands and gravels with silt) in accordance with AS/NZS 1547:2012 Table E1. This reflects the coarse non-cohesive nature of the alluvial deposits in this location. It is also recognised that the underlying glacial till is very tight and as such would be considered Class 5.

As the subject site is outside of any special catchment area, is remote from open water courses or boreholes and the discharge volume will not exceed 2,000 litres/day, under Rule 5.8 of Canterbury Land and Water Regional Plan, discharge of human sewage is a permitted activity in this area and will not require consent from the Environment Canterbury.

A preliminary site and soils assessment based on the requirements of AS/NZS1547:2012 is presented in Appendix D.

9.3 Evaluation Against Rule 5.8 (Canterbury Land and Water Regional Plan)

Rule 5.8 sets out all conditions that must be met for discharges from new, modified or upgraded systems to be permitted without the need for a resource consent from Environment Canterbury. Table 7 summarises the rules and the projects sites' compliance:

Table 7: Rule 5.8 Evaluation

Rule	Site Conditions	Commentary	Permitted Activity
The discharge volume does not exceed two cubic metres per day.	Ten people occupancy at 200L/day/pax. = 2000l/day or 2m^3	Compliant at current design level	Yes
The discharge is onto or into a site that is 4 ha or more in area.	14,000 ha property	Compliant	Yes
The discharge is not located in an area where the residential density exceeds 1.5 dwellings per hectare and the total population is greater than 1000 persons.	Stand-alone rural property	Compliant	Yes
The discharge is not onto or into land:			
(a) where there is an available sewerage network.	None, rural property remote from council infrastructure	Compliant	Yes
(b) that is contaminated or potentially contaminated.	Not anticipated due to past use being pastural and cropping for winter fodder	Compliant at this stage of investigation	Yes
(c) that is listed as an archaeological site.	Not anticipated	Compliant at this stage of investigation	Yes
(d) in circumstances where the discharge would enter any surface waterbody.	No – No surface water in proximity or can be placed at sufficient distance	Compliant	Yes
(e) within 20 m of any surface waterbody or the Coastal Marine Area.	No	Compliant	Yes

Rule	Site Conditions	Commentary	Permitted Activity
(f) within 50 m of a bore used for water abstraction.	No boreholes in the vicinity. Any future boreholes can be designed to be compliant with abstraction zone	Compliant	Yes
(g) within a Community Drinking-water Protection Zone.	No	Compliant	Yes
(h) where there is, at any time, less than one metre of vertical separation between the discharge point and groundwater.	No groundwater encountered in the upper 3m of ground level. Anticipated to be >10m bgl.	Compliant	Yes
The treatment and disposal system is designed and installed in accordance with Sections 5 and 6 of New Zealand Standard AS/NZS 1547:2012 – On-site Domestic Wastewater Management.	NA	Preliminary design provided in Section 9.4 of this report	Yes
The treatment and disposal system is operated and maintained in accordance with the system's design specification for maintenance or, if there is no design specification for maintenance, Section 6.3 of New Zealand Standard AS/NZS 1547:2012 – On-site Domestic Wastewater Management.	NA	Can be compliant	Yes
The discharge does not result in wastewater being visible on the ground surface.	Design will comprise a discharge control bed	Compliant	Yes
The discharge does not contain any hazardous substance.	No – secondary treatment of wastewater	Compliant	Yes

As Table 7 demonstrates, the proposed wastewater system as described in the following sections is compliant with Rule 5.8 on all counts and as such is a permitted activity under the Regional Plan.

9.4 Potential Wastewater System

The lodge will have five double bedrooms. In general accordance with AS/NZS1547:2012 this equates to a maximum design occupancy of ten people. Based upon a typical wastewater flow of 200 L/person/day (AS/NZS 1547:2012 Table H3 – Typical domestic wastewater design flow allowances – New Zealand) this would produce a daily wastewater flow of 2,000 L/day.

If the owners of the property choose to have additional or fewer bedrooms, or to integrate water-reduction features in to their design, then a redesign of this initial wastewater sizing can be carried out at the Building Consent level.

Due to the restricted receiving environment, a system with secondary treatment is recommended and is indeed expected by Environment Canterbury for all domestic application.

The secondary treatment system will incorporate a septic tank stage where heavy solids will undergo anaerobic digestion.

Secondary treatment through physical and aerobic biological processes to meet the following limits presented in Table 8 below:

Table 8: Guidance on Effluent Quality

Contaminant	Concentration
Biochemical oxygen demand (BOD_5)	20 mg/L
Total suspended solids	30 mg/L
Total nitrogen (Adequate disposal area should be provided to limit nitrogen loading to 150 kgN/ha per year or less).	25 mg/L
Faecal coliforms/ Escherichia coli (E. Coli)	1,000 cfu/100 mls

AS/NZS 1547:2012 requires the size of the septic tank to be 4,500 litres for a population equivalent of ten people. This sizing also applies to the primary treatment stage of a secondary treatment system. It is proposed that a discharge control trench or bed is used to apply the treated wastewater to the ground.

9.4.1 Discharge Control Trench or Bed

Table L1 in AS/NZS 1547:2012 states that the Design Loading Rate (DLR) for trenches/beds with secondary treated effluent on Category 3 (weakly structured) soils is 30 mm/day. Based on this design criteria and a 1m wide trench, a total of 67 liner metres of pipe (4 x ~17m lengths) will be required over and area of 67m^2. Including a 100% reserve area the total trench area will therefore be 134m^2.

Alternatively, this could be constructed as a standard trench 4m wide by 17m length.

Other restrictions and constraints to be cognisant of to be compliant with District, Regional and NZS standards require the effluent disposal area to be

- 1.5m from a property boundary
- 3.0m from a dwelling
- 50m from a water bore
- 50m from an open water course
- 3.0m from an embankment or cutting
- >0.9m groundwater clearance

Drawing 003 present a potential set out for the wastewater system and identifies some of the constraints to the land application area.

10 References

10.1 Related Documents and Standards

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

- Canterbury Maps Viewer natural hazard GIS based database portals
- GNS Geology Mapping Q Series (https://data.gns.cri.nz/geology)
- Regional Council borehole and consent databases
- New Zealand Geotechnical Society 2005: Field Description for Soil and Rock.
- NZS4404 Land Development and Subdivision Infrastructure (and District Council variations thereof)

- Mackenzie District Council District Plan Section 13: Subdivision, Development and Financial Contribution Rules
- NZS4431:2022: Engineered Fill Construction for Lightweight Structures.
- NZS 3604: 2011 Timber Framed Buildings.
- NZS 1170.5-2012: Structural design actions Part 5 Earthquake actions – New Zealand.
- Auckland Council: Stormwater Management in the Auckland Region Section C5 – Water Tanks

Drawings

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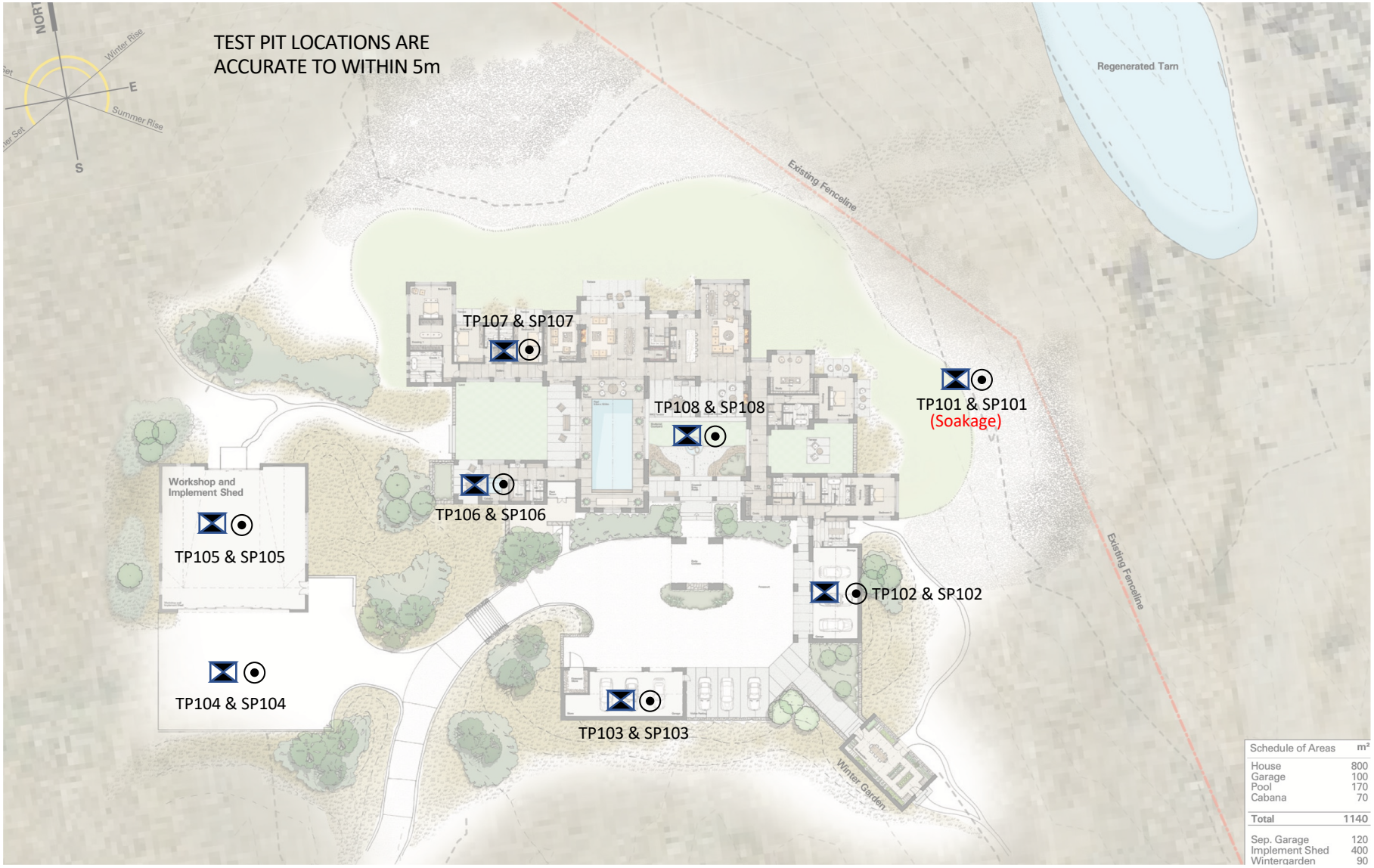
WARREN LEWIS

GODLEY PEAKS STATION LODGE, LAKE TEKAPO

SITE LOCATION PLAN

SCALE: NOT TO SCALE

REF:	DATE:
GL24-026 DRW001	9 FEBRUARY 2024



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WARREN LEWIS

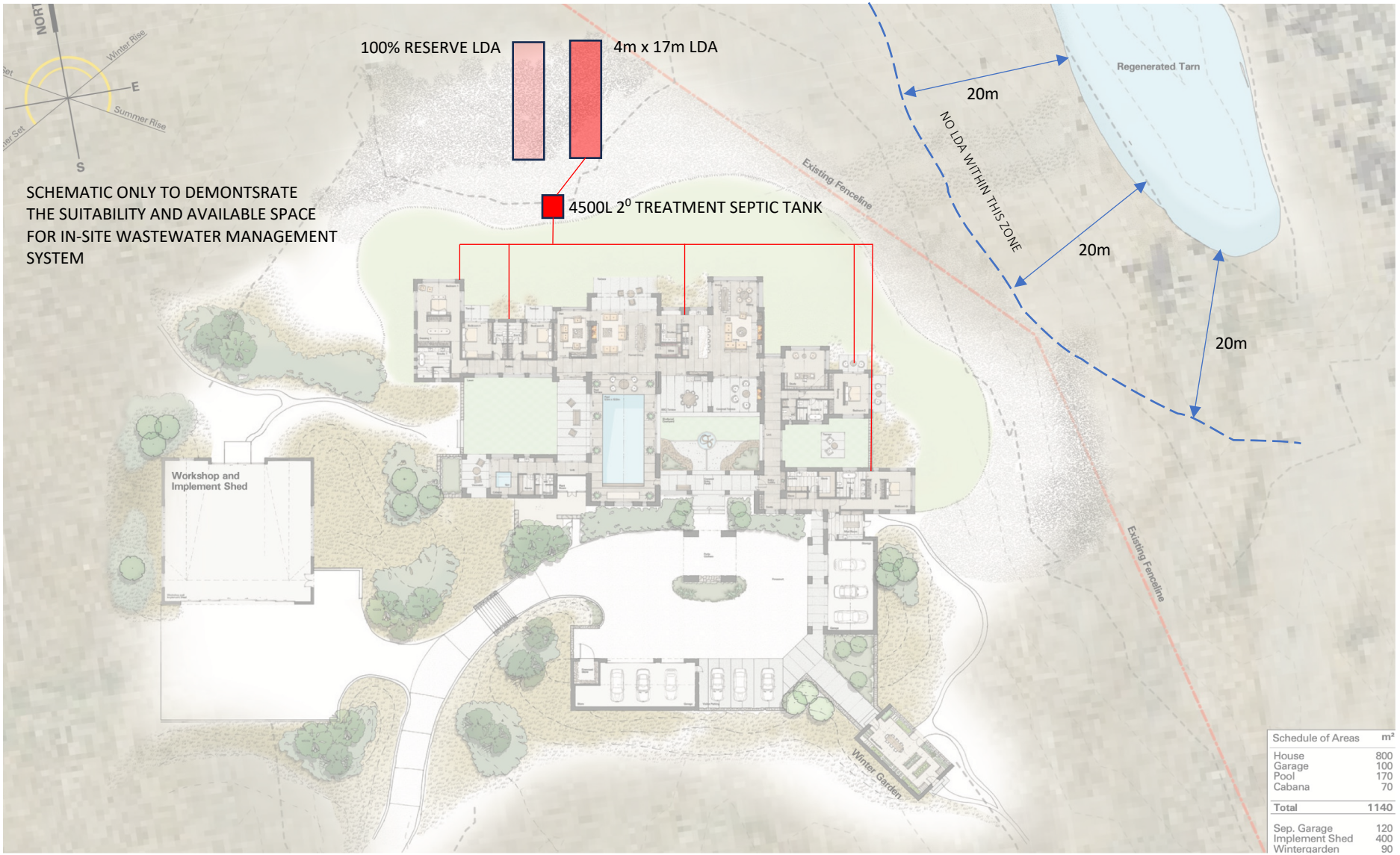
GODLEY PEAKS STATION LODGE, LAKE TEKAPO

SITE INVESTIGATION PLAN

SCALE: NOT TO SCALE

REF:
GL24-026 DRW002 Rev 1

DATE:
16 JULY 2024



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WARREN LEWIS

GODLEY PEAKS STATION LODGE, LAKE TEKAPO

WASTEWATER LAYOUT PLAN

SCALE: AS SHOWN

REF:
GL24-026 DRW003 Rev 1

DATE:
16 JULY 2024

Appendix A – Scheme Layout

6643-GODLEY-PEAKS-STN-HOMESTEAD-TEK-RC1-240620

Schedule of Areas	m²
House	800
Garage	100
Pool	170
Cabana	70
Total	**1140**
Sep. Garage	120
Implement Shed	400
Wintergarden	90

Site and Overall Floor Plan

ORIGINAL SIZE A3

MASON&WALES
ARCHITECTS

GODLEY PEAKS STATION HOMESTEAD
LAKE TEKAPO

Project 6643
Designed by: Mason and Wales
Scale: 1:500 @ A3, 1:250 @ A1
20 June 2024

REV RC
SHEET 02

6643-GODLEY-PEAKS-STN-HOMESTEAD-TEK-RC1-240620

Schedule of Areas	m²
House	800
Garage	100
Pool	170
Cabana	70
Total	**1140**
Sep. Garage	120
Implement Shed	400
Wintergarden	90

ORIGINAL SIZE A3

Part Overall Floor Plan

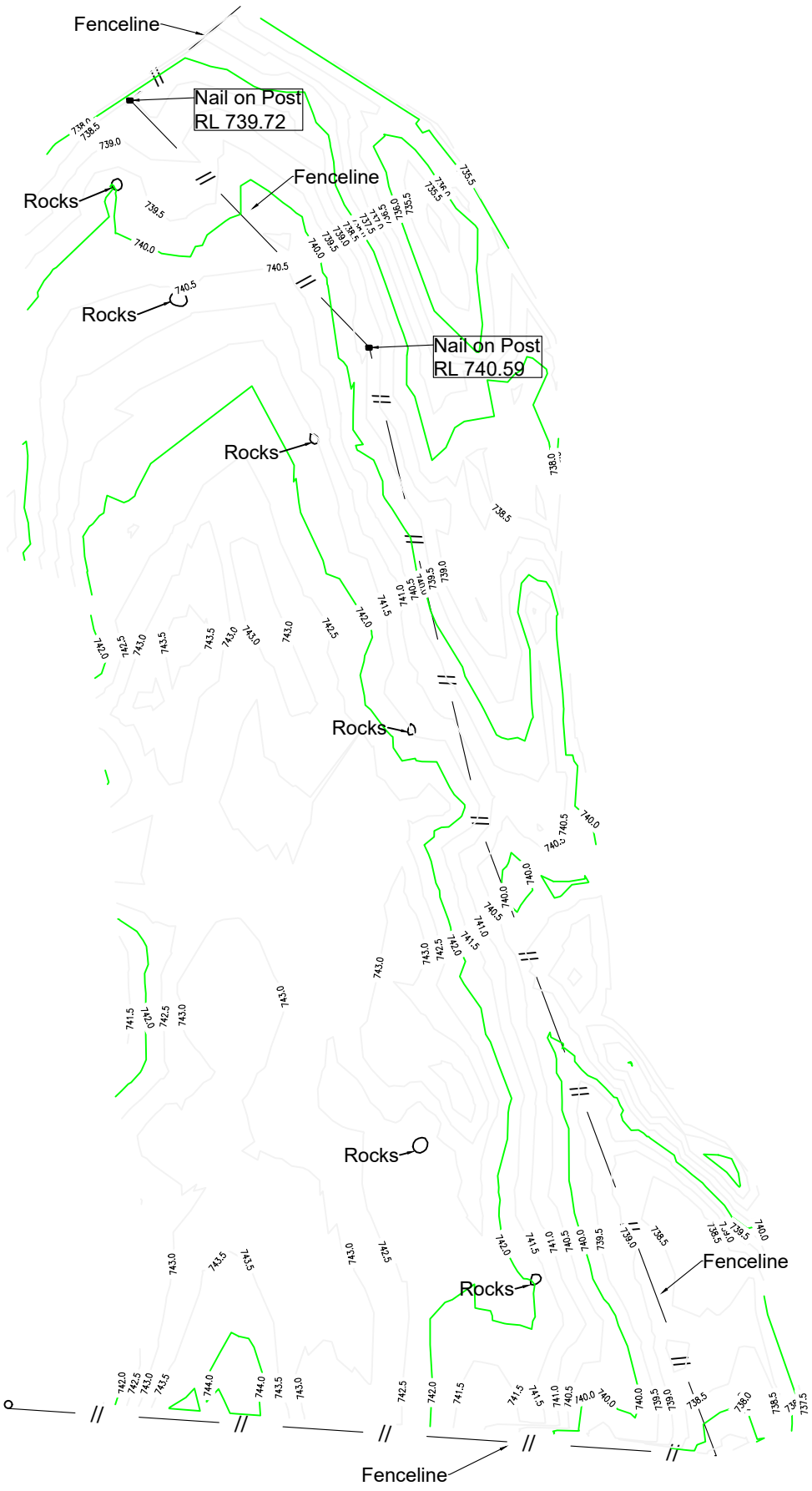
MASON&WALES
ARCHITECTS

GODLEY PEAKS STATION HOMESTEAD
LAKE TEKAPO

Project 6643
Designed by: Mason and Wales
Scale: 1:200 @ A3, 1:100 @ A1
20 June 2024

REV RC
SHEET 03

LAKE TEKAPO



Pt Run 80
(Godley Peaks)

SCALE 1:2000 @A3	Date :September 2023		
Applicant: Godley Peaks Station Ltd		Surveyed	
		Drawn	
		Amended	
		Amended	

Topographical Survey
Godley Peaks Station (Pt Run 79)

milward finlay lobb
PLANNERS | SURVEYORS | ENGINEERS
6 THE TERRACE
PO BOX 434
TIMARU 7940
PH 03 684 7688
ADMIN@MFLNZ.CO.NZ
WWW.MFLNZ.CO.NZ

Client/Job No.
159116/01
Sheet 1 of 1

Appendix B – Engineering Logs

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP101		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Silty SAND; brown; very stiff; moist; low plasticity; sand, fine		0.5
1.0		Glacial Till		Silty SAND with gravel and cobbles; brown; dense; moist		1.0
1.5				Silty SAND with gravel and cobbles; grey; dense; moist; sand, fine to medium; gravel; fine to coarse; subangular to rounded; occasional boulders		1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.0

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered. Soakage testing completed

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP102		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Silty SAND; brown; very stiff; moist; low plasticity; sand, fine; small gravel lense		0.5
1.0		Glacial Till		Silty SAND with gravel and cobbles; brown; dense; moist; sand, fine to medium; gravel, fine to coarse; subangular to rounded		1.0
1.5				Sandy GRAVEL with cobbles; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP103		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Gravelly sandy SILT and cobbles; brown; very stiff; moist; sand, fine to medium; gravel, fine to coarse; subangular to rounded		0.5
1.0				Gravelly SAND with silt and occasional cobbles; brown; dense; moist; sand, fine to medium; gravel, fine to coarse; subangular to rounded		1.0
1.5		Glacial Till		Sandy GRAVEL with cobbles; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP104		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Silty SAND; brown; very stiff; moist; low plasticity; sand, fine		0.5
1.0		Glacial Till		Sandy GRAVEL with silt and cobbles; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.0
1.5				End of test pit - unable to penetrate further		1.5
2.0						2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP105		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic gravelly sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; gravel, fine to coarse; subangular to subrounded; rootlets		
0.5		Alluvial		Silty SAND; brown; very stiff; dry to moist; low plasticity; sand, fine		0.5
1.0		Glacial Till		Sandy GRAVEL with silt and cobbles, some boulders; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.0
1.5						1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes:

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP106		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic gravelly sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; gravel, fine to coarse; subangular to subrounded; rootlets		
0.5		Alluvial		Silty SAND; brown; very stiff; dry to moist; low plasticity; sand, fine		0.5
1.0		Glacial Till		Sandy GRAVEL with silt and cobbles, some boulders; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.0
1.5						1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP107		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Gravelly sandy SILT and cobbles; brown; very stiff; moist; sand, fine to medium; gravel, fine to coarse; subangular to rounded		0.5
1.0		Glacial Till		Sandy GRAVEL with silt and cobbles, some boulders; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.0
1.5						1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Test Pit Log

Project:	Godley Peaks Station Lodge	Project Number:	GL24-026 OM
Site Location:	Lake Tekapo	Client:	Warren Lewis
Test Pit Number:	TP108		Sheet 1 of 1

Depth (m)	Water Level	Geological Unit	Sample	Soil Rock Description	Legend	Depth
		Topsoil		Organic sandy SILT; dark brown; firm; dry to moist; sand; fine to medium; rootlets		
0.5		Alluvial		Gravelly sandy SILT and cobbles; brown; very stiff; moist; sand, fine to medium; gravel, fine to coarse; subangular to rounded		0.5
1.0		Glacial Till		Sandy GRAVEL with silt and cobbles, some boulders; grey; dense; moist; sand, fine to coarse; gravel; fine to coarse; subangular to rounded		1.0
1.5						1.5
2.0				End of test pit - unable to penetrate further		2.0
2.5						2.5
3.0						3.0
3.5						3.5

Date Excavated: 9 Feb 2024	Equipment: 5T tracked excavator with smooth bucket
Logged By: SJO	Contractor: High Country Earthworks

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Notes: No groundwater encountered

Notes:

Depth (mm)	Blows (no.)
100	1
200	2
300	3
400	4
500	6
600	6
700	12
800	20
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
2100	
2200	
2300	
2400	
2500	
2600	
2700	
2800	
2900	
3000	
3100	
3200	
3300	
3400	
3500	
3600	
3700	
3800	
3900	
4000	
4100	
4200	
4300	
4400	
4500	
4600	
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4900	
5000	
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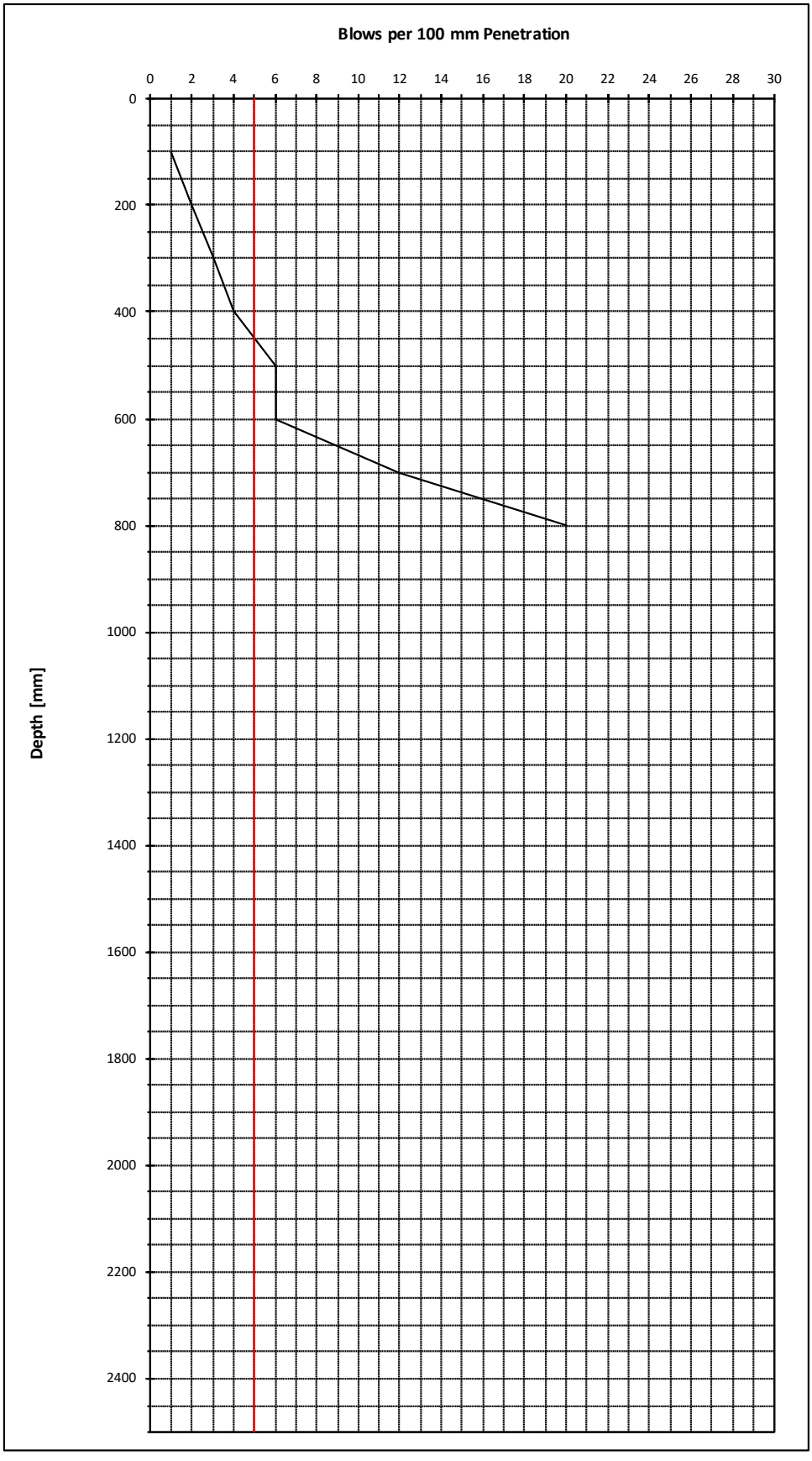
5200	



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Client: WARREN LEWIS		SCALA PROBE	
Location: GODLEY PEAKS LODGE		No: SPT 101	
Tester: STEPHANIE OSMERS	Date: 9/02/24	Job Number: GL24-026	Rev: 1

Notes:

Depth (mm)	Blows (no.)
100	2
200	4
300	3
400	4
500	6
600	16
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
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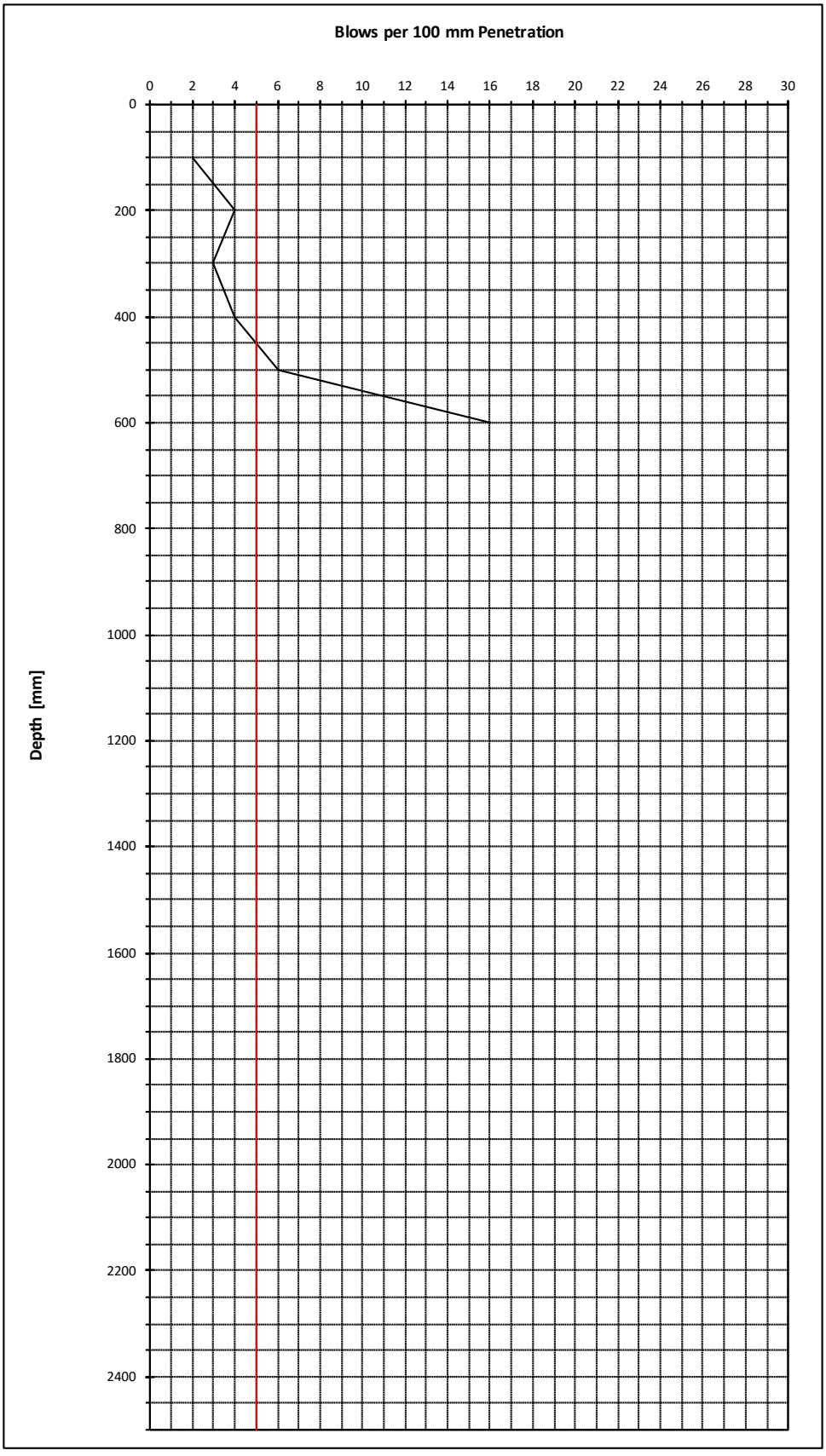

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 102**	
Tester: **STEPHANIE OSMERS**	Date: **09/02/24**	Job Number: **GL24-026**	Rev: **1**

Notes:

Depth (mm)	Blows (no.)
100	4
200	6
300	7
400	12
500	20
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
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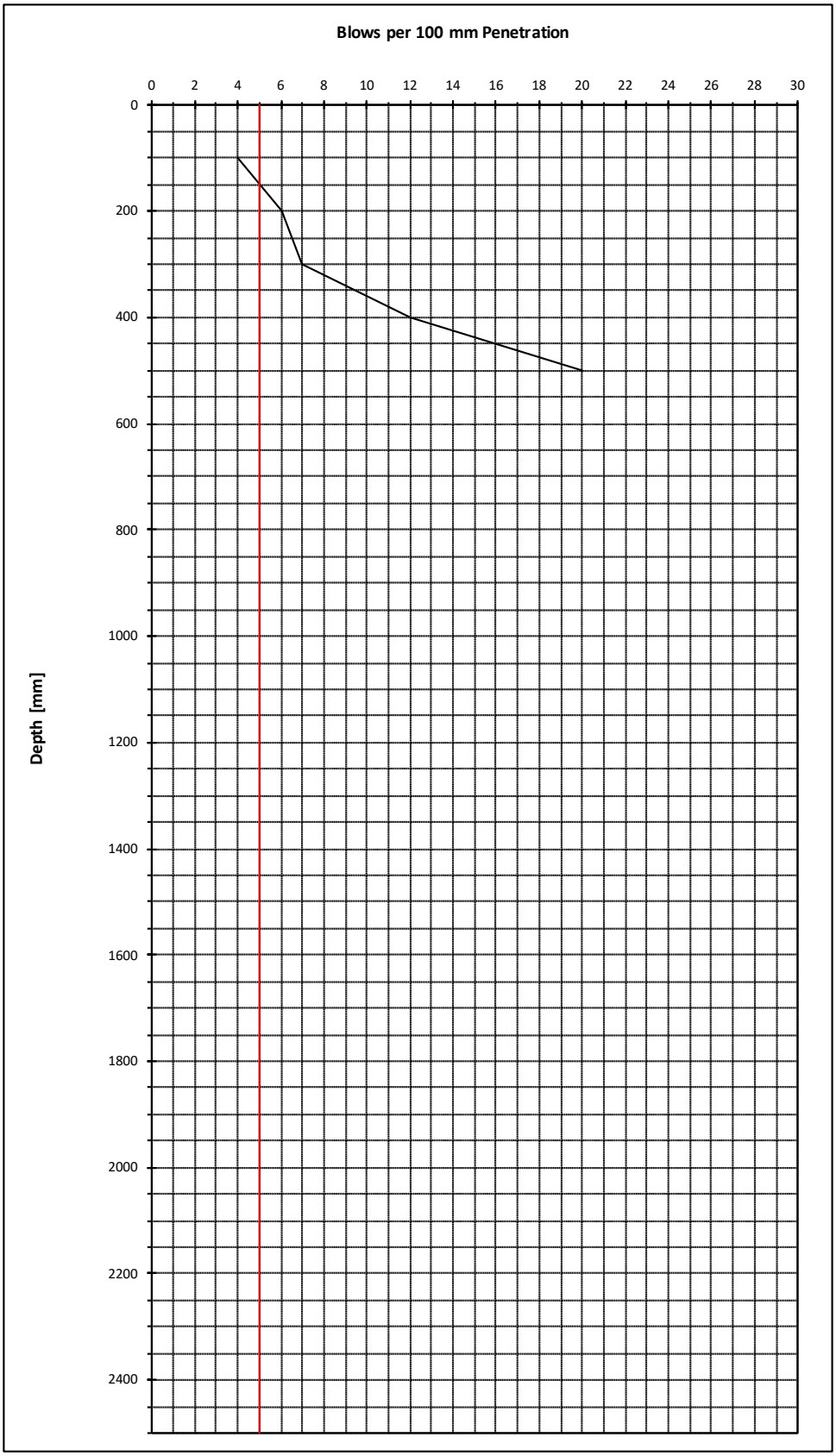

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 103**	
Tester: **STEPHANIE OSMERS**	Date: **9/02/24**	Job Number: **GL24-026**	Rev: **1**

Notes:

Depth (mm)	Blows (no.)
100	4
200	4
300	9
400	20
500	
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
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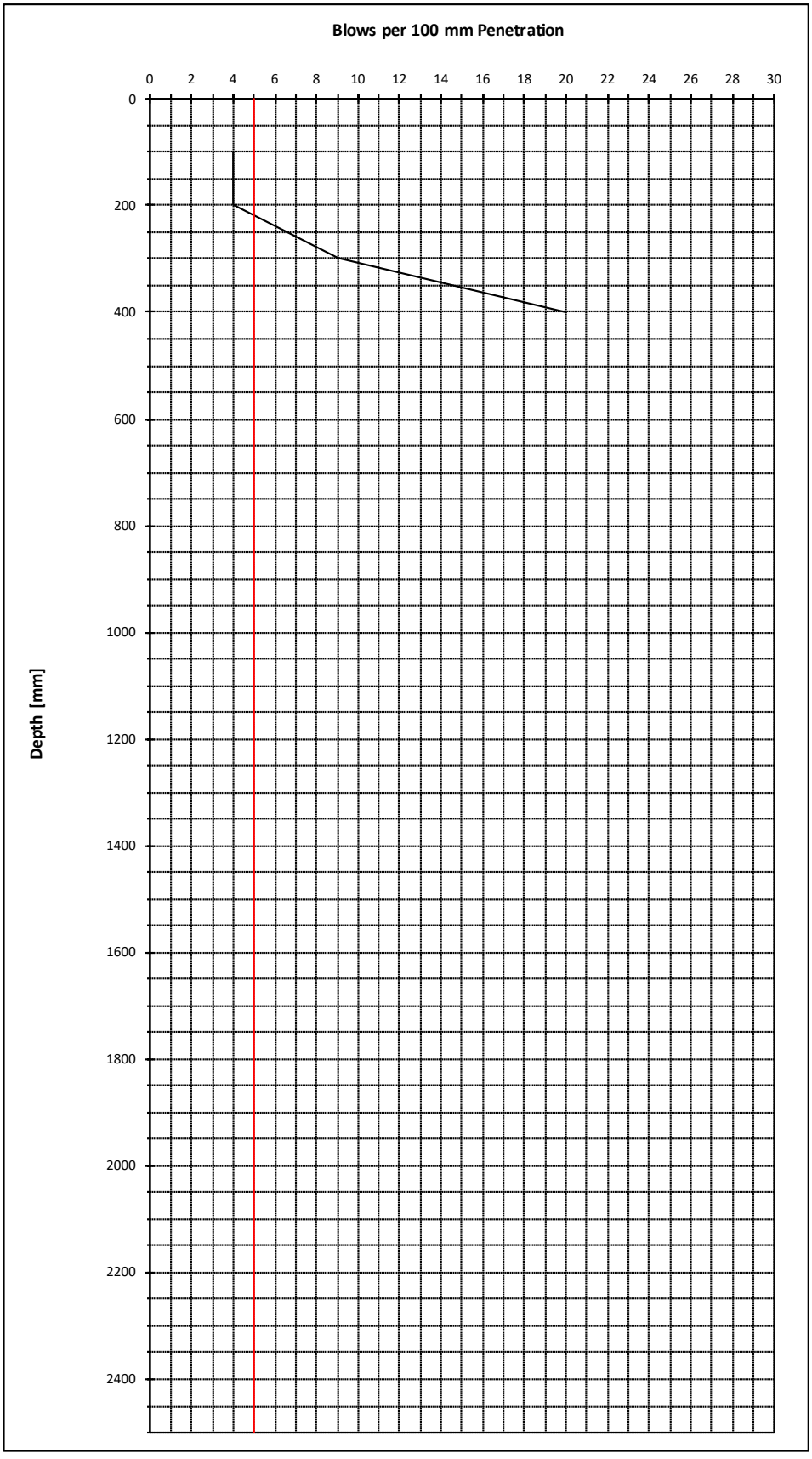

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 104**	
Tester: **STEPHANIE OSMERS**	Date: **9/02/24**	Job Number: **GL24-026**	Rev: **1**

Notes:

Depth (mm)	Blows (no.)
100	2
200	5
300	9
400	24
500	
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
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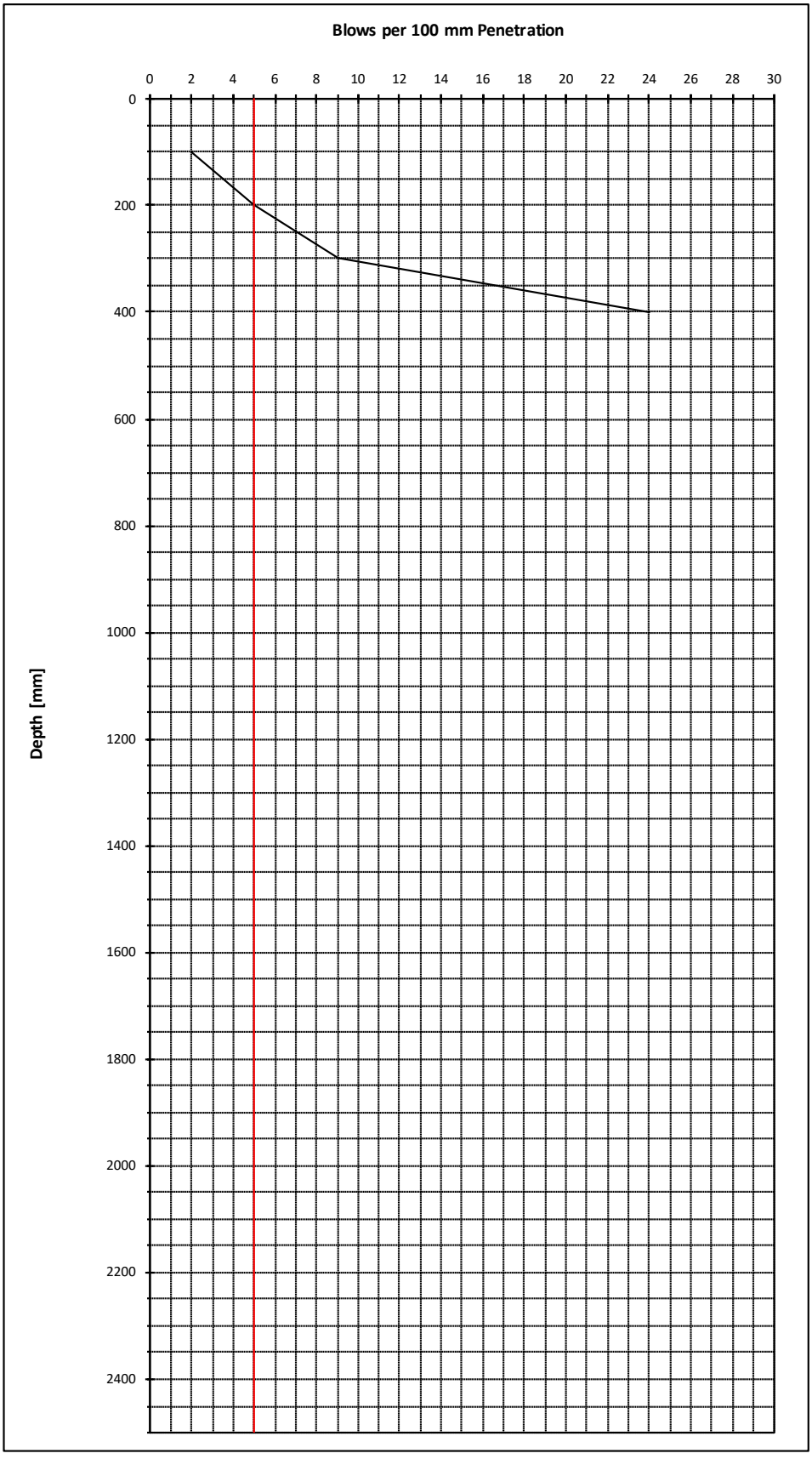

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Client: WARREN LEWIS		SCALA PROBE	
Location: GODLEY PEAKS LODGE		No: SPT 105	
Tester: STEPHANIE OSMERS	Date: 9/02/24	Job Number: GL24-026	Rev: 1

Notes:

Depth (mm)	Blows (no.)
100	3
200	4
300	16
400	24
500	
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
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2200	
2300	
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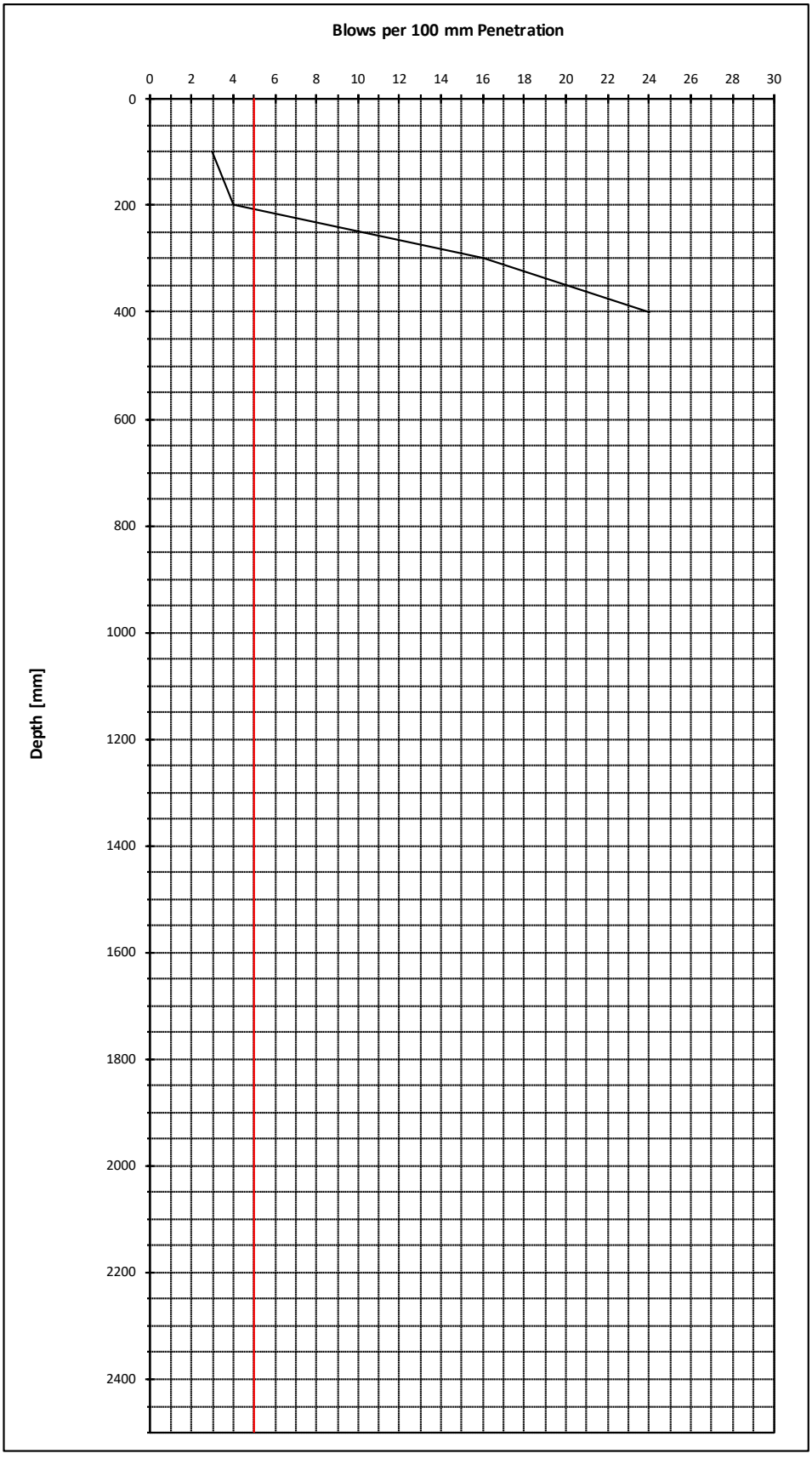

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 106**	
Tester: **STEPHANIE OSMERS**	Date: **9/02/24**	Job Number: **GL24-026**	Rev: **1**

Notes:

Depth (mm)	Blows (no.)
100	2
200	6
300	11
400	24
500	
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
2100	
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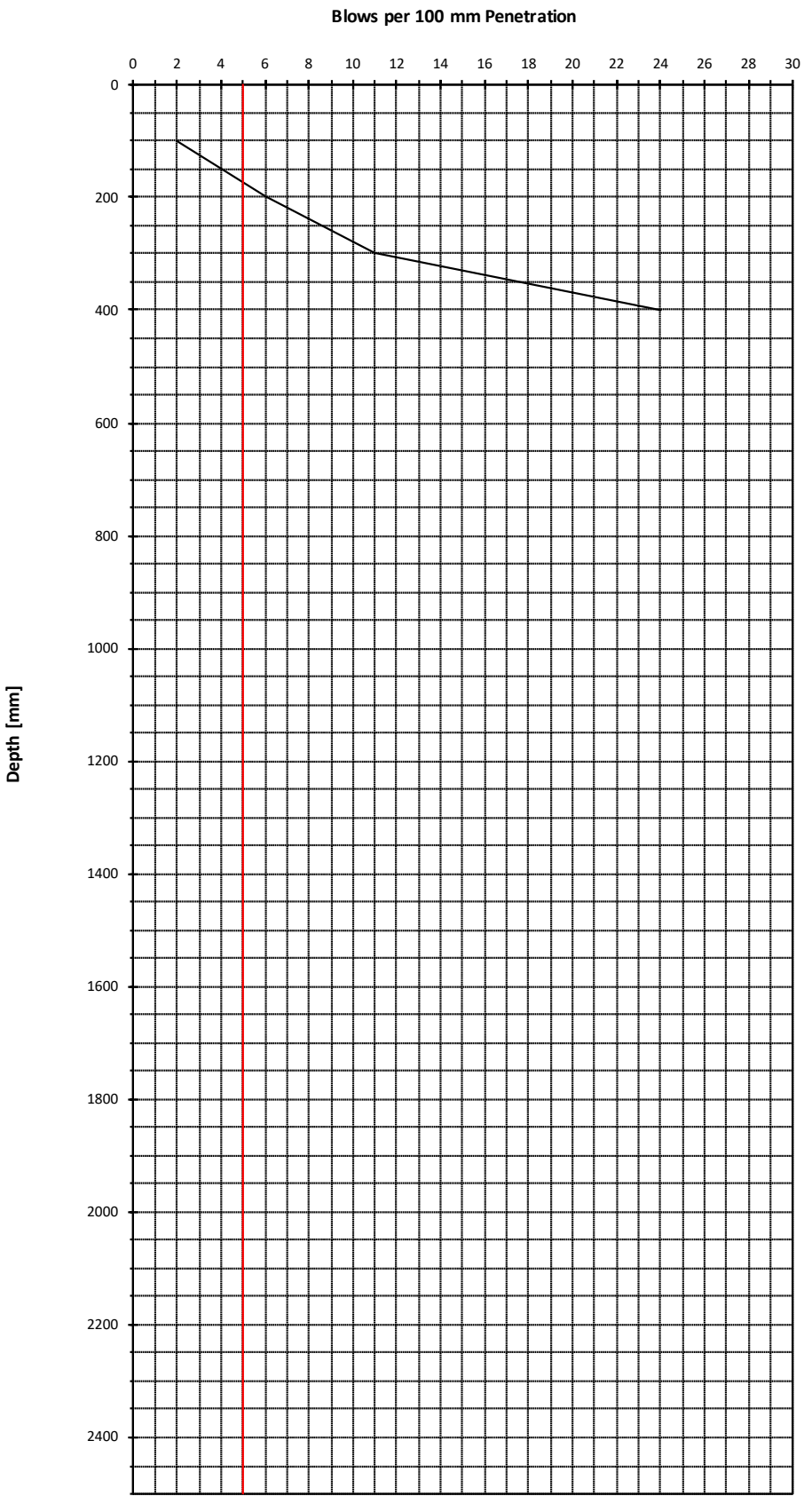

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 107**	
Tester: **PETER FORREST**	Date: **9/02/24**	Job Number: **GL22-014.2**	Rev: **1**

Notes:

Depth (mm)	Blows (no.)
100	3
200	7
300	16
400	24
500	
600	
700	
800	
900	
1000	
1100	
1200	
1300	
1400	
1500	
1600	
1700	
1800	
1900	
2000	
2100	
2200	
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2400	
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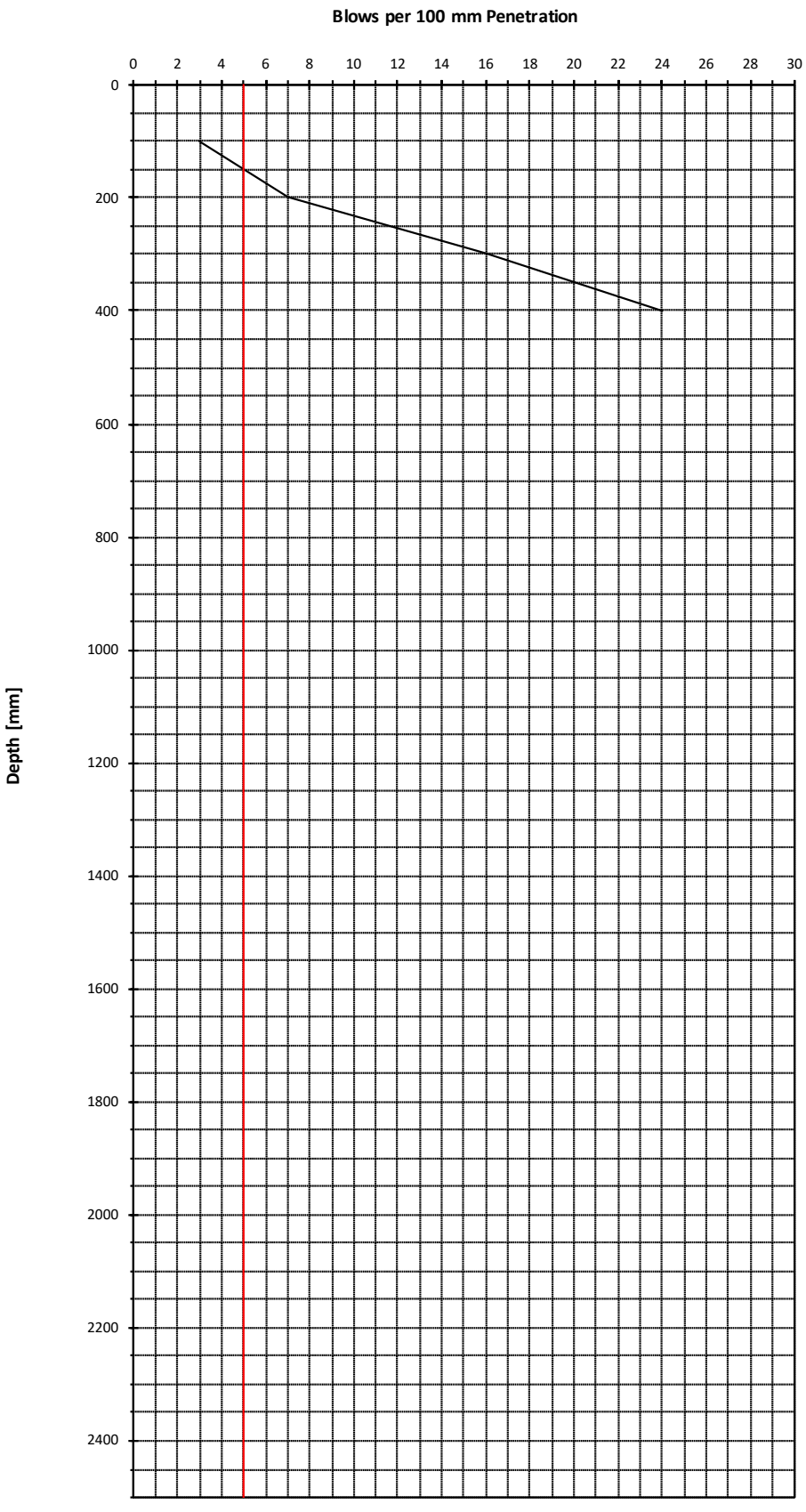

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Client: **WARREN LEWIS**		SCALA PROBE	
Location: **GODLEY PEAKS LODGE**		No: **SPT 108**	
Tester: **PETER FORREST**	Date: **9/02/24**	Job Number: **GL22-014.2**	Rev: **1**

Appendix C – Stormwater Calculations

DESIGN EVENT

Rainstorm duration	=	60	mins
Design rainfall event	=	10% AEP	
Rainfall intensity I	=	21.5	mm/hr
Peak Rainfall Intensity I (Peak)	=	43	mm/hr

RCP6.0 2081-2100

POST DEVELOPMENT CATCHMENT DETAILS

Total Roof Area	=	1660	m^2
Run Off Coefficient (ROC) roof	=	0.9	%
Total Paved Areas	=	180	m^2
ROC paved	=	0.6	%
Total Unsealed Surfaces Area	=	1020	m^2
ROC Unsealed surfaces	=	0.5	%
Total Garden and LawnArea	=	304	m^2
ROC Garden and Lawn	=	0.25	%
Total Unsealed Road Area	=	220	m^2
ROC Unsealed Road	=	0.5	%
Total Area -Post development		3384.00	m2

Only considering development area footprint

iterative input parameter
input parameter
calculated parameter
Manual selection required

PREDEVELOPMENT DETAILS

Total Pre Development Area	=	3384.00	m^2
ROC Predevelopment Area	=	0.3	%
Peak Pre-development rate	=	12.13	L/s

Change ROC depending on predeveloped site conditions and soil type

DETENTION DETAILS

		Volume (L)	
Average Flow Rate (Roof)	=	8.92	L/s
Average Flow Rate (Paved Areas)	=	0.65	L/s
Average Flow Rate (Unsealed surfaces)	=	3.05	L/s
Average Flow Rate (Gaeden and Lawn)	=	0.45	L/s
Average Flow Rate (Undsealed road)	=	0.66	L/s
Total Storage Volume Required (All surfaces)	=	13.72	L/s

Average Flow Rate of Areas Captured by Detention Tank and Overflow Devices	=	13.07	L/s
Peak Flow Rate of Areas Captured by Detention Tank and Soakage Devices	=	26.13	L/s
Average Flow Rate of Areas Not Captured by Detention or Soakage Devices	=	0.66	L/s
Peak Flow Rate of Areas Not Captured by Detention or Soakage Devices	=	1.31	L/s
Average Flow going to soakage device (attenuation device and or pond)	=		L/s
Peak Flow going to soakage device (attenuation device and or pond)		0.00	L/s
Total Average flows Post Development	=	13.72	L/s
Total Peak flows Post Development		27.45	L/s

All flows are accounted for correctly — TRUE

DESIGN TANK

		Design Tank *(Enter Typical Tank Dimensions)*	
Number of tanks	=	2	
Tank Volume	=	22,500	L
Retention Volume Requirement	=	0	L
Tank Diameter	=	3.5	m
Tank Basal Area	=	9.62	m2
Height (Calculated)	=	2.34	m
Orifice Dia	=	50.00	mm
Minimum Detention Storage	=	32803	L
Calculated Storage height		1.73	m
Retention Volume (Less Dead Storage, typically 150mm above base of tank)	=	9311	L
Dead Storage Volume	=	2886	L
Water Supply Outlet height	=	0.15	m
Height of Orifice (above base of tank)	=	0.63	m
Average Orifice discharge flow rate	=	2.11	L/s
Orifice discharging time to empty detention volume	=	4.31	Hrs

Refer to typical tank manufacturing dimensions

Refer to typical tank manufacturing dimensions

Minimum 10mm

Tank Has Enough Storage — TRUE

Does the system have enough retention volume — TRUE

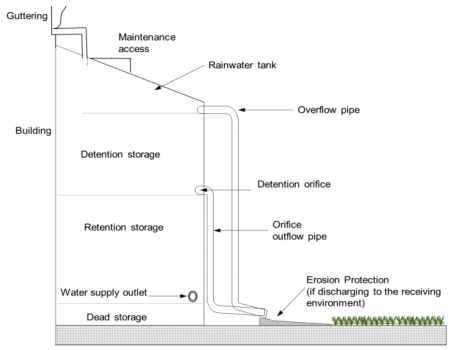
Typically 150mm outlet accounts for dead storage for tank, check design specification of tank for variance

Release time is less than 24hrs — TRUE

FLOW RATE

Peak Pre-development Flow Rate	=	12.13	L/s
Peak Post Development Unattenuated Flow Rate	=	27.45	L/s
Peak Post Development Flow Rate	=	7.72	L/s

Flow Rate has been sufficiently reduced — TRUE

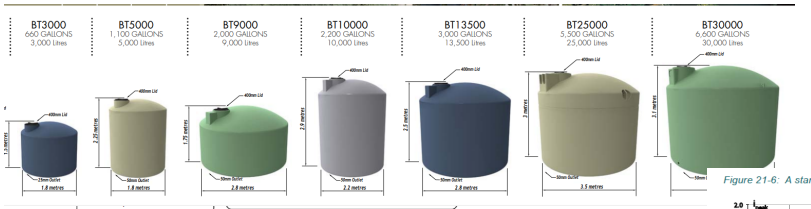


Design Notes

Design is based on the use of one tank only
Areas discharging to other soakage devices(Rock filled Pits or Chambers) have been excluded from this calculation
Assumed 100% use of tank volume with overflow outlet at top of tank
All gutters to have leaf collection/diversion systems installed. All pipe work to pass through silt traps prior to discharge to pit.
Intensity data from Hirds v4 based on the RCP6.5 Scenario as an reasonable assumption of climate change for the period 2081-2100
All plumbing and pipe work shall be in accordance with the NZ Building Code and installed by a registered drainlayer/plumber

This table calculates the required storage volume in the tank, allowing for the loss of water from the orifice over the design storm event based on C5-Auckland Council Guideline Document GD2017/001 equations for calculation orifice sizes.

	Step 1				*Step 2*		*Step 3/4*			
Time	Rain Fall Intensity Ratio	Flow Rate from Collected surfaces (Split between number of tanks)	Volume Per time interval	Cumulative Volume	Water level Head (in tank)	Av. water level between time points	Orifice Discharge Flow Rate	Volume in tank (after discharge)	Flow Rate (Areas not captured by detention tank)	Flow Rate of Orifice and non captured areas
mins		L/s	L	L	m	m	L/s	L	L/s	L/s
0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000000	0.00	0.00	0.000000
1.0	0.048	0.311	18.667	18.67	0.00	0.00	0.083976	13.63	0.03	0.199235
2.0	0.095	0.622	37.335	50.96	0.01	0.00	0.162187	41.23	0.06	0.386940
3.0	0.143	0.933	56.002	97.23	0.01	0.01	0.236611	83.04	0.09	0.567072
4.0	0.190	1.244	74.670	157.71	0.02	0.01	0.310338	139.09	0.13	0.745808
5.0	0.238	1.556	93.337	232.43	0.02	0.02	0.383901	209.39	0.16	0.924218
6.0	0.286	1.867	112.005	321.40	0.03	0.03	0.457402	293.95	0.19	1.102502
7.0	0.333	2.178	130.672	424.62	0.04	0.04	0.530870	392.77	0.22	1.280722
8.0	0.381	2.489	149.340	542.11	0.06	0.05	0.604320	505.85	0.25	1.458904
9.0	0.429	2.800	168.007	673.86	0.07	0.06	0.677758	633.19	0.28	1.637064
10.0	0.476	3.111	186.675	819.87	0.09	0.08	0.751188	774.80	0.31	1.815207
11.0	0.524	3.422	205.342	980.14	0.10	0.09	0.824613	930.66	0.34	1.993340
12.0	0.571	3.733	224.010	1154.67	0.12	0.11	0.898034	1100.79	0.38	2.171465
13.0	0.619	4.045	242.677	1343.47	0.14	0.13	0.971452	1285.18	0.41	2.349584
14.0	0.667	4.356	261.344	1546.52	0.16	0.15	1.044868	1483.83	0.44	2.527699
15.0	0.714	4.667	280.012	1763.84	0.18	0.17	1.118282	1696.75	0.47	2.705810
16.0	0.762	4.978	298.679	1995.43	0.21	0.20	1.191694	1923.92	0.50	2.883918
17.0	0.810	5.289	317.347	2241.27	0.23	0.22	1.265106	2165.37	0.53	3.062024
18.0	0.857	5.600	336.014	2501.38	0.26	0.25	1.338516	2421.07	0.56	3.240128
19.0	0.905	5.911	354.682	2775.75	0.29	0.27	1.411926	2691.03	0.59	3.418231
20.0	0.952	6.222	373.349	3064.38	0.32	0.30	1.485335	2975.26	0.63	3.596332
21.0	1.000	6.534	392.017	3367.28	0.35	0.33	1.558744	3273.76	0.66	3.774432
22.0	1.048	6.845	410.684	3684.44	0.38	0.37	1.632152	3586.51	0.69	3.952532
23.0	1.095	7.156	429.352	4015.86	0.42	0.40	1.705560	3913.53	0.72	4.130631
24.0	1.143	7.467	448.019	4361.55	0.45	0.44	1.778967	4254.81	0.75	4.308729
25.0	1.190	7.778	466.687	4721.50	0.49	0.47	1.852375	4610.35	0.78	4.486826
26.0	1.238	8.089	485.354	5095.71	0.53	0.51	1.925782	4980.16	0.81	4.664923
27.0	1.286	8.400	504.021	5484.18	0.57	0.55	1.999188	5364.23	0.84	4.843019
28.0	1.333	8.711	522.689	5886.92	0.61	0.59	2.072595	5762.56	0.88	5.021115
29.0	1.381	9.023	541.356	6303.92	0.66	0.63	2.146001	6175.16	0.91	5.199211
30.0	1.429	9.334	560.024	6735.18	0.70	0.68	2.219407	6602.02	0.94	5.377307
31.0	1.476	9.645	578.691	7180.71	0.75	0.72	2.292813	7043.14	0.97	5.555402
32.0	1.524	9.956	597.359	7640.50	0.79	0.77	2.366219	7498.53	1.00	5.733497
33.0	1.571	10.267	616.026	8114.55	0.84	0.82	2.439625	7968.18	1.03	5.911591
34.0	1.619	10.578	634.694	8602.87	0.89	0.87	2.513031	8452.09	1.06	6.089686
35.0	1.667	10.889	653.361	9105.45	0.95	0.92	2.586436	8950.26	1.09	6.267780
36.0	1.714	11.200	672.029	9622.29	1.00	0.97	2.659842	9462.70	1.13	6.445874
37.0	1.762	11.512	690.696	10153.40	1.06	1.03	2.733247	9989.40	1.16	6.623968
38.0	1.810	11.823	709.363	10698.77	1.11	1.08	2.806653	10530.37	1.19	6.802062
39.0	1.857	12.134	728.031	11258.40	1.17	1.14	2.880058	11085.59	1.22	6.980156
40.0	1.905	12.445	746.698	11832.29	1.23	1.20	2.953463	11655.09	1.25	7.158249
41.0	1.952	12.756	765.366	12420.45	1.29	1.26	3.026868	12238.84	1.28	7.336343
42.0	2.000	13.067	784.033	13022.87	1.35	1.32	3.100274	12836.86	1.31	7.514436
43.0	1.889	12.341	740.476	13577.33	1.41	1.38	3.169973	13387.13	1.24	7.580841
44.0	1.778	11.615	696.919	14084.05	1.46	1.44	3.232586	13890.10	1.17	7.633073
45.0	1.667	10.889	653.361	14543.46	1.51	1.49	3.288553	14346.14	1.09	7.672014
46.0	1.556	10.163	609.804	14955.95	1.55	1.53	3.338257	14755.65	1.02	7.698427
47.0	1.444	9.437	566.246	15321.90	1.59	1.57	3.382016	15118.98	0.95	7.712951
48.0	1.333	8.711	522.689	15641.67	1.63	1.61	3.420098	15436.46	0.88	7.716123
49.0	1.222	7.986	479.131	15915.59	1.65	1.64	3.452731	15708.43	0.80	7.708394
50.0	1.111	7.260	435.574	16144.00	1.68	1.67	3.480103	15935.20	0.73	7.690145
51.0	1.000	6.534	392.017	16327.21	1.70	1.69	3.502373	16117.07	0.66	7.661690
52.0	0.889	5.808	348.459	16465.53	1.71	1.70	3.519670	16254.35	0.58	7.623291
53.0	0.778	5.082	304.902	16559.25	1.72	1.72	3.532101	16347.33	0.51	7.575158
54.0	0.667	4.356	261.344	16608.67	1.73	1.72	3.539747	16396.29	0.44	7.517457
55.0	0.556	3.630	217.787	16614.07	1.73	1.73	3.542671	16401.51	0.36	7.450312
56.0	0.444	2.904	174.230	16575.74	1.72	1.72	3.540915	16363.29	0.29	7.373806
57.0	0.333	2.178	130.672	16493.96	1.71	1.72	3.534502	16281.89	0.22	7.287986
58.0	0.222	1.452	87.115	16369.00	1.70	1.71	3.523437	16157.60	0.15	7.192861
59.0	0.111	0.726	43.557	16201.16	1.68	1.69	3.507705	15990.69	0.07	7.088404
60.0	0.000	0.000	0.000	15990.69	1.66	1.67	3.487274	15781.46	0.00	6.974548



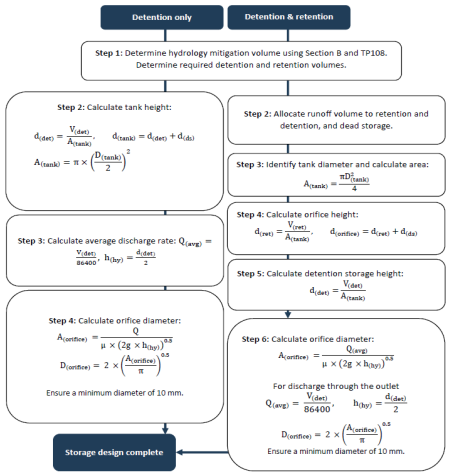


Figure 21-6: A standard dimensionless hyetograph for rainfall intensity.

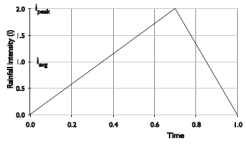
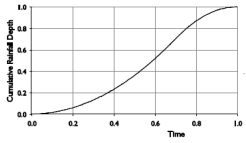


Figure 21-7: A dimensionless cumulative depth hyetograph for rainfall intensity



Rainfall intensity (i) at any time (t) during a storm event of duration (D) can be determined from the following:

$i_{avg} = RainDepth / D$ Eqn (21-6)

$i_{peak} = 2\, i_{avg}$ Eqn (21-7)

For t = 0 to 0.7D

$i_t = \frac{i_{peak}}{0.7D} t$ Eqn (21-8)

For t = 0.7D to D

$i_t = \frac{i_{peak}}{0.3}\left(1 - \frac{t}{D}\right)$ Eqn (21-9)

Appendix D – Wastewater Site & Soils assessment

SITE SOILS EVALUATION & ASSESSMENT		
GENERAL INFORMATION		
Project Brief	Geotago Ltd has been commissioned by the client Warren Lewis Ltd to carry out Site & Soils assessment for wastewater disposal to ground.	
Related Documents & Information Sources	• AS/NZS 1547:2012 Onsite Domestic-wastewater management. • New Zealand Geotechnical Society, 2005: Field Description for Soil and Rock. • Canterbury (ECan) and Mackenzie District Council (MDC) Online Mapping Services, including: • (https://mapviewer.canterburymaps.govt.nz/) - Property Information. • (https://mapviewer.canterburymaps.govt.nz/) – Hazard Information. • (https://mapviewer.canterburymaps.govt.nz/) – Bore Location Information. • (https://apps.canterburymaps.govt.nz/lrisupport/) – Soil Information. • (https://data.gns.cri.nz/geology/) - Regional Geology Information. • (https://www.ecan.govt.nz/data/rainfall-data/) – Rainfall and Evapotranspiration Information. • (https://www.mackenzie.govt.nz/do-it-online/maps) – Mackenzie District Maps. • Google Earth Images. • Land Information NZ (LINZ) Maps. • Moore C, Nokes C, Low B, Close M, Pang L, Smith V, et al 2010. "Guidelines for Separation Distances Based on Virus Transport Between Onsite Domestic Wastewater Systems and Wells". ESR Crown Research Report No.CSR1001; and • Leonard M, Pang L, 2006 "Approaches for Assessing Bacterial Removal in Soils", ESR Client Report FW0642.	
Assessment / Design Criteria	Geotago has conducted an onsite soils assessment in accordance with AS/NZS 1547:2012. Although the Otago Regional Council do not set specific limits for wastewater discharges, recent changes to freshwater legislation, the National Policy Statement for Freshwater 2020 and the principles of Te Mana o te Wai mean that as a minimum, secondary-level wastewater treatment is recommended in the Canterbury Region.	
Previous Investigations	No previous investigations or data were available or available at the time of reporting.	
Limitations	Geotago Ltd has undertaken this assessment in accordance with the brief as provided, based on the site and location as shown in the GIR Report (Drawings 001, 002 & 003). This assessment has been provided for the benefit of our client, and for the authoritative council to rely on for the purpose of processing the resource consent for the specific project described herein. No liability is accepted by this firm or any of its directors, servants or agents, in respect of its use by any other person, and any other person who relies upon information contained herein does so entirely at their own risk.	
SITE EVALUATOR(S)		
Primary Evaluator	Name (principal evaluator)	Peter Forrest
	Designation	Principal Engineering Geologist
	Company/agency	Geotago Ltd
	Address	309 Lower Shotover Road, Speargrass Flat, Queenstown
	Email	Pete@geotago.nz
Additional Staff Involved	Name(s)	Stephanie Osmers
	Designation	Professional Engineering Geologist
	Involvement	Field data collection
	Email	stephanie@geotago.nz

SITE/PROJECT INFORMATION		
Location Details	Locality	Lake Tekapo, Canterbury.
	Owner	Warren Lewis.
	Address	1729 Godley Peaks Road, Lake Tekapo.
	Survey Plan Details	Refer to Appendix A of GAR – Milward Finlay Lobb Topographical Survey.
	Grid Reference E & N	Approximately X=1399123m Y=5139363m.
	Lot No.	Part Run 80 and Part Rural Section 42000 and Section 1 Survey Office Plan 19295.
	Topographic Map	Refer to Drawing 001 of GAR.
	Aerial photo Map	Refer to Drawing 002 of GAR.
	District Authority	Mackenzie District Council (MDC).
	Regional Authority	Environment Canterbury (ECan).
	Site Plan Details Attached	Refer to Drawing 001 of GAR and Appendix A of GAR – Mason & Wales proposed building platform plans.
	Area	1750m²
Development Proposal	Accommodation lodge, consisting of five bedrooms and ensuites, with swimming pool, garage and terrace, with additional parking, wintergarden and helicopter hangar with onsite stormwater and effluent disposal systems. Earthworks are expected to develop a building platform but are not anticipated to influence the area of land application.	
DESKTOP EVALUATION		
Topography & Elevation	The site has an easterly aspect forming gently rolling topography. The western section of the property sits at 743m AOD, falling to 739m at the eastern perimeter.	
Soil Type and Major Soil Considerations from Soil Maps, or Similar	Soil information (ECan)	Forkf - very stony sand. This soil belongs to the Brown soil order of the New Zealand soil classification. Brown soils have a brown or yellow-brown subsoil below a dark grey-brown topsoil. The brown colour is caused by thin coatings of iron oxides weathered from the parent material. It is formed in alluvial sand silt or gravel deposited by running water, from hard sandstone parent material. The topsoil typically has sand texture and is very stony. The subsoil has dominantly sand textures, with a very gravelly layer from less than 45cm mineral soil depth to more than 100cm. The plant rooting depth is 20-50cm, due to an extremely gravelly horizon with extremely low water storage capacity. Generally, the soil is well drained with very low vulnerability of water logging in non-irrigated conditions and has low soil water holding capacity. Inherently these soils have a high structural vulnerability and a very high N leaching potential, which should be accounted for when making land management decisions.
	Published Geology (GNS)	Much of the site is shown to be underlain by Late Pleistocene to Holocene shoreline deposits, consisting of well sorted gravel and sand on modern and abandoned post-glacial lake beaches.
Climate Conditions (ECan)	Evapotranspiration	To be confirmed
	Average Rainfall	591mm/year
Water Sources	Intended Water Supply Source	Private Scheme yet to be confirmed.
	Nearby Water Bores:	None within 50m of land application area.

DESKTOP EVALUATION		
Surface Water Bodies	Lake Tekapo is located approximately 400m east of the site.	
Environmental Concerns	Ephemeral tarns – Refer to Drawing 002 of GAR for the approximate location. Ground freezing.	
Natural Hazards	Liquefaction	Site investigations have proven the ground is underlain by glacier or fan deposits and a depressed groundwater table, ECan classification – unlikely probability of liquefaction damage.
	Alluvial Landforms	Nothing to influence the site.
	Flood Hazards	None
Depth to Regional Ground Water	No desktop information available – however a depressed ground water table is expected due to the elevated nature of the site and the nearby water bodies (Lake Tekapo).	
Author Knowledge of Nearby Systems	Local Experience with Existing On-site Systems	None in the immediate area of the site.
	Number of Systems in Locality	Unknown
	Performance (%)	Unknown
	Reasons/descriptions	NA
	Problems evident	NA
	Preliminary Evaluation of Feasible Solutions	Secondary treated aerated wastewater treatment system (AWTS) with conventional bed discharge.
ON-SITE EVALUATION		
Site Plan	Please refer to Drawing 002 of GAR	
Site Description	The site is located on the eastern perimeter of Godley Peaks Station, upslope of the western shore of Lake Tekapo. The site is located on part of the 14,493-hectare pastoral lease land, used for extensive sheep and beef farming. The proposed residential site is located on the gentle moraine country at the south end of the property, between the Cass River and Lake Tekapo. The immediate surrounding area has been extensively modified through subdivision into paddocks, which contain cultivated pasture, fodder crops or short tussock land, with views over Lake Tekapo, and the mountain ranges to the north and west.	
Property Information	Waterways	Ephemeral tarns are located to the east of the building platform.
	Wells / Bores	None within 50m of site.
	Fill Material Encountered on Site (certified or uncontrolled)	None
	Vegetation	Fodder crops and grasses.
	Retaining Walls, Embankment, Escarpments, Excavations (cut)	None.
	Buildings, Swimming Pools., In-ground Water Tanks	None.
	Site History	Open pasture and farmland, with no history or previous development.
	Other	NA.
Site Exposure	Site Aspect	East facing.
	Prescence of Shelter Belts	None.
	Presence of Topographic Features, Landmarks or Structures	Lake Tekapo Located approximately 400m east of the site.
Environmental Concerns	Ephemeral tarns. Ground freezing.	
Slope Stability Assessment	Not required - Refer to Section 7.8 of GAR	

ON-SITE EVALUATION		
Site Investigations Undertaken	Details	Eight (8) Test pits (TP101 to TP108). One (1) soakage test (SK1). Please refer to Appendix B (logs) of GAR.
	Date	9 February 2024.
	Weather	Sunny.
	Investigation Locations	Refer to Drawing 002 of GAR.
On-site Landscape Observations	Topography	Gently sloping, rolling topography.
	Vegetation	Fodder crops and grasses.
Geology, and Groundwater / Surface Water Features	Site Geology	Topsoil overlying alluvial silts sands and gravel. Refer to Section 4 of the GAR.
	Regional Groundwater Table	Anticipated to be >5.0m during winter and summer.
	Perched Groundwater / Surface Water and Drainage Features	Small, shallow ephemeral tarn located to the east of the site.
SOAKAGE TESTING & SOIL CLASSIFICATION (IN ACCORDANCE WITH NZS1547:2012)		
Soakage Testing and Soil Profile	Method	Test pit falling head test. However, not in soil profile that would be used for effluent disposal
	Location of Soakage Test	Refer to Drawing 002 of GAR, TP101/SK1.
	Soil Profile	Refer to test pit falling head log in Appendix B of GAR.
	Other	Dimensions of soakage test 1.4W x 2.5L x 1.8D
Soakage Results	mm/hr	TBC
	m/day	TBC
	L/min/m2	TBC
	Additional Comments	The upper 1m of alluvial soils comprises a sandy gravel that will be conducive to effluent disposal. Underlain by very tight glacial till.
Soil Classification	Soil Structure	Weakly structured
	Soil Texture	Gravelly sand.
	Soil Category	Category 3
	Indicative permeability	0.12-0.5 m/day

LAND APPLICATION AREA (LAA)		
Site Constraint Mitigation	Ground Freezing.	Topsoil cover minimum 450mm required for disposal system to mitigate against the 'alpine environment conditions'.
	Bedrock/hardpan/schist (shallow soil).	NA
	Ephemeral Drainage Gully.	NA.
	Perched Groundwater / Seasonal Shallow Water Logging of Soils	NA.
	Sloping Ground 15°-20° (25%-37%)	NA
Possible LAA System to be Utilised. Advantages and Limitations.	Conventional Seepage Trench or Bed System	Site advantageous conditions: • Soil category: Suitable for Category 3 soils. • Plenty of space. Site limitations: • No limitations based on current investigation
	Mounded System	Site advantageous conditions: • Shallow Soil: Designed to overcome shallow soil limitations. • Seasonal water table: Can overcome shallow seasonal water tables / perched water tables. >0.6m preferrable. • Soil Category: Designed to overcome Category 4 to 6 limitations (low permeability). Site limitations: • Slope gradient: not recommended to exceed 9° degrees or 15%. • Imported materials: large volumes of specific materials (sand) to form mounded feature for disposal.
	Subsurface Dripline Irrigation System	Site advantageous conditions: • Slope gradient: Can overcome strong to steep slopes limitations up to a maximum slope of 30% (requires SED to exceed this). • Seasonal water table: Due to shallow application of effluent and lower areal loading rates. Site limitations: • Shallow Soil: Typically require a minimum of 0.60m below bottom of dripper lines desirable. • LAA Size: Requires more space than conventional trench or bed systems. • Cover: Depth of cover (topsoil) may be an issue in freezing conditions
	Other	NA
Potential LAA System	At this stage conventional bed is the preferred LAA that should be further investigated. Further design should be completed once detailed designs for dwelling have been provided.	
Recommended DLR / DIR (Secondary Treated System)	DLR = 30mm/day (Conventional trench / bed disposal).	
Suitable Location LAA	Refer to Drawing 003 of GAR – Wastewater layout Plan.	
Drainage Controls	Depth of surface water / perched water tables (seasonal shallow water logging)	To be expected to be beyond 5m depth
	Need for cut-off drains	Unlikely to be required.
	Diversion drains / swales	Unlikely to be required.
Availability of Reserve/Setback Areas	Reserve area available for extensions:	Refer to the attached Drawing 003 LAA location plan indicating the potential LAA locations.

LAND APPLICATION AREA (LAA)		
(show details on sketch plan)	LAA Reserve % of design area:	100%. Refer to the attached Drawing 003 LAA Location Plan.
	Setback distance (between site development and on-site disposal design and reserve areas):	No constraints
Sloping Ground Mitigation	Not required	
GENERAL COMMENTS		
Best Suited Land-Application Method / Irrigation System.	Conventional discharge bed.	
Other comments	If the development generates more than the currently calculated 2000L/day ($2m^3$), then a consent form Environment Canterbury will be required.	

Appendix E - Site Photographs

Test Pit 101 – Pit (Soakage Pit) 	Test Pit 101 - Arisings 
Test Pit 102 – Pit 	Test Pit 102 - Arisings 

Test Pit 103 - Pit 	Test Pit 103 - Arisings 
Test Pit 104 - Pit 	Test Pit 104 - Arisings 

Test Pit 105 - Pit 	Test Pit 105 - Arisings 
Test Pit 106 - Pit 	Test Pit 106 - Arisings 

Test Pit 107 – Pit (Soakage Pit) 	Test Pit 107 - Arisings 
Test Pit 108 – Pit 	Test Pit 108 – Arisings 

Permeability Borehole

Overview of the site

Overview of the site showing the remediated tarn