Buckton Vale Quarry Access Road

Waste Recovery Plan

Churchill Enviro Ltd

Report No. K4859-ENV-R001-00
08 November 2021
Revision 00

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Document Control

Document: Waste Recovery Plan

Project: Buckton Vale Quarry Access Road

Client: Churchill Enviro Ltd

Report Number: K4859-ENV-R001-00

Document Checking:

Revision	Revision/ Review Date	Details of Issue	Authorised		
			Prepared By	Checked By	Approved By
00	08 November 2021	Draft to Client	E Greenhalgh	J Baxter	P Roberts
Disclaimer: Please note that this report is based on specific information, instructions and information from our Client and should not be relied upon by third parties.					

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Contents

INTRODUCTION

Purpose of the Document

This Waste Recovery Plan (WRP) has been produced to support a Bespoke Permit application for a recovery activity by Churchill Enviro Ltd to construct an access road at Buckton Vale Quarry.

The WRP has been written with due regard to the following relevant guidance:

- Web based Environment Agency Guidance on Waste Recovery Plans and Deposit For Recovery Permits (Environment Agency April 2021);
- RGN 9: Showing that Land and Groundwater are protected at Waste Facilities (Environment Agency May 2013); and,
- Environmental Permitting Guidance: The Waste Framework Directive for the Environmental Permitting (England & Wales) Regulations 2007 (DEFRA 2009 v2.0).

This WRP will also demonstrate compliance with the published Environment Agency guidance on www.gov.uk and address the following factors that are raised within the guidance that determine if the proposals are a 'Waste Recovery Operation':

- The purpose of the work;
- Waste recovery activities i.e. would the project go ahead using non-waste;
- Quantity of waste used;
- Suitability of waste material; and
- That the proposal will meet relevant quality standards

The Purpose of the Work

A planning application was approved to extend the timescale for extraction of the remaining mineral reserve at Buckton Vale Quarry until 2042. The majority of the remaining reserve is located adjacent to the northern boundary of the site. The full depth of this material (approximately 32 m) has yet to be quarried and this represents a significant volume of valuable undisturbed material (approximately 960,000 m^3).

It is understood however that a substantial quantity of overburden from elsewhere in the quarry was placed above this location historically. Previous access roads have since been removed with progression of the quarrying activities elsewhere in the site and it is no longer possible to access the overburden which must be removed prior to quarrying the mineral in that area. The overburden will ultimately be used in the low-level restoration scheme for the site.

In order to access the overburden and the mineral underneath it a new road needs to be constructed within the north-western area of the site to enable suitable plant to safely access the overburden and then the mineral. This road will ascend along the northwest and north quarry wall following existing quarry features where possible. The estimated value of the mineral reserve is such that it would be financially viable to import non-waste material from another quarry to construct the road (Section 2.1 below). Alternatively, the Operator could use suitable waste for the construction of the road (Section 2.3) and demonstrate it is a suitable substitution (Section 2.4) for non-waste material.

Site Location and Description

The Site is situated in Carrbrook, approximately 4km North East of Stalybridge, Tameside. The Site is located at Grid Reference SD992327 01457. The Site is characterised by two large voids described as the eastern and western voids.

The Site office and weighbridge are located in the western void close to the Site entrance. The Site entrance is a private road linking the Site to Castle Lane.

Drawing reference 4859/1/002 shows the current ground levels around the proposed Site. The elevation of the lowest point of the proposed site is approximately 299 m AOD. This inclines in a north-east direction to around 342 m AOD.

The Site is a well-established gritstone and sandstone quarry operating under permission reference 04/01800/FUL. Significant mineral reserves remain at the Site and Planning Permission 18/00826/FUL which was approved on 14th December 2020 has extended the timescales for extraction for the remaining area of the quarry until 2042.

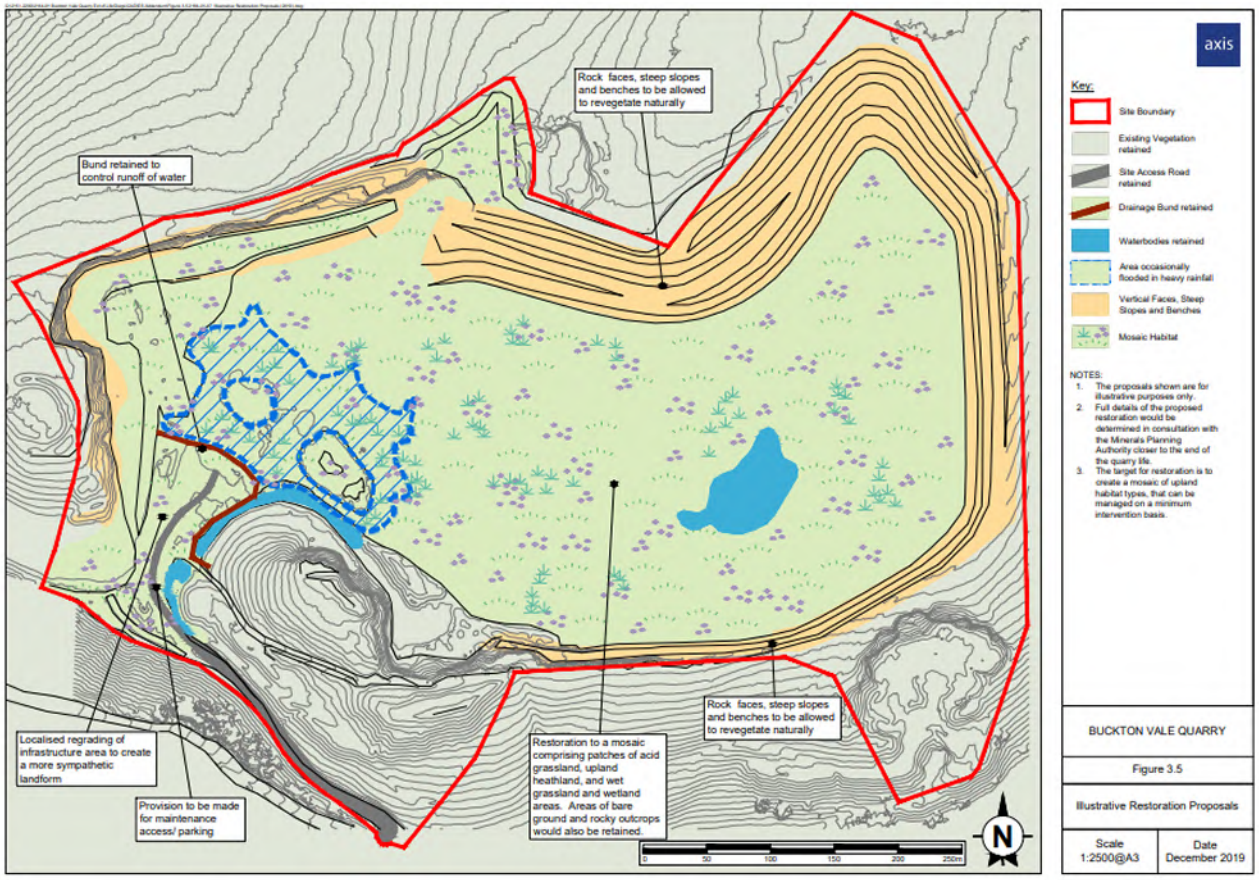
The low-level restoration proposals referred to in the planning application are illustrated in Figure 3.5, reproduced below.

The restoration proposals have been developed in line with the principles set out in the Greater Manchester Biodiversity & Geodiversity Action Plan. The proposals show a restored Site where a mosaic of upland habitat types is present.

Overall, the restored Quarry is likely to constitute an 'Open mosaic habitat on previously developed land', which is a UKBAP priority habitat. Such habitats tend to develop on brownfield sites, such as quarries, where these sites have previously been disturbed or severely modified by previous use, with spatial variation developing across the site. The resultant variation allows for a mosaic of different vegetation types and often patches of bare ground, to be supported in close proximity. This, combined with a low nutrient content of the soil which prevents fast growing plant species becoming dominant, provides a continuity of resources for invertebrates and other wildlife throughout the year.

It is proposed that site-won restoration material be used to provide a growing medium for some of the proposed vegetation types, including those currently confined atop the mineral reserve. This is likely to comprise aggregates and mineral waste, which would be low in nutrients and hence likely

to be suitable for the target vegetation types, preventing fast growing competitor species from developing. The landform of the existing infrastructure area would be regraded to create a restored landform that would be more sympathetic to the adjacent hillsides.



The proposed access road will be used to extract the quarry overburden which will be placed in stockpiles elsewhere in the quarry. The Operator will then either blast or mechanically extract the remaining reserve downwards. This will require the access road to also be gradually reduced in level assuming it will continue to be used to access the mineral. The material in the road will also be stockpiled on site with the overburden for eventual use in the low-level restoration scheme. The types of material needed to construct the road will require similar geotechnical and chemical properties i.e. inert as the overburden which will also make it suitable for use onsite.

Proposed Permitting Regime

The proposed activity would not meet the operational requirements of a standard rules recovery permit (SR2015No.39) due to its proximity to sensitive habitat and the volume of material required. Appropriate risk assessments will be provided with the permit application as required.

The Site currently has two Standard Rules (SR2015No39) Permits: CB3301TX/A001 and GB3004XN/A001. CB3301TX/A001 allows the operator to use suitable waste materials to undertake stabilisation works on a section of quarry face. GB3004XN/A001 allows the operator to construct a quarry rock trap at the Site. Material placed under this activity will be within the permit boundary

of the quarry rock trap. The Operator proposes to surrender both of these permits prior to construction of the access road to avoid uncertainty about the extent of each deposit. A permit application for a standard rules recovery permit has recently been submitted to construct a flood attenuation bund across the entrance to the quarry. This will be an independent feature to the access road.

WASTE RECOVERY PLAN

Financial gain by using non-waste materials: evidence

Current Environment Agency guidance[1] requires that Operators demonstrate the proposed operation would be undertaken using non-waste materials should the use of imported waste not be permitted. The guidance provides examples of the types of evidence that would demonstrate an activity is a recovery. The evidence most relevant to the proposed works at Buckton Vale Quarry is that of financial gain if non-waste materials were used.

The remaining stone reserve is located adjacent to the northern boundary of the site. This represents a significant depth of undisturbed material relative to the current quarry floor. It is understood that a substantial quantity of overburden from the quarry was placed above this location and previous access roads have been removed with progression of the quarrying activities.

The volume of stone that would be released by removal of overburden is approximately 960,000 m^3 equating to approximately 2,160,000 tonnes (conversion factor 2.25). Excluding the extraction and transport costs of approximately £3 / tonne, the net sale value of this material is £10 / tonne. This would represent an expected income to the Operator of £21,600,000. This is a conservative value which assumes all the stone is only suitable for aggregate and that there is no dimension stone which has a much higher value.

It has been calculated that around 140,158 m^3 of material will be required to complete the access road scheme (Section 2.2) which equates to a tonnage of 266,700 tonnes using a conversion factor of 1.8 tonnes / m^3. The cost to construct this road by importing non-waste material i.e. grit sand at £14.65 / tonne from their Fletcher Bank Quarry would be £3,907,155. Information demonstrating the value of the non-waste that would be used is commercially confidential and will be provided to the Agency separately.

Assuming a conservatively estimate reserve value to be £21,600,000, the Operator would generate 5 times that in income by removing the overburden and releasing the material. This means the Operator would consider it financially viable to import non-waste material to the site to construct the road i.e. they would construct the road regardless of whether they could use waste or not.

Quantity of Waste Required

Consideration has been given to using on-site material to complete the restoration scheme, however due to the age of the Site and demands of other quarrying activities, no reserves of overburden or other resources remain on Site. Other than the material the proposal seeks to access, the operator has advised that there is presently no other material on-site which would be appropriate to assist in the construction of the road under the recovery activity.

[1] www.gov.uk/guidance/waste-recovery-plans-andpermits

Attached drawing referenced 4859/1/002 shows the area of Site considered for restoration fill. The volume calculations for the Upper Bench Access Road are as follows:

- Cut: 10,635 m^3
- Fill: 150,794 m^3
- Balance: 140,158 m^3 (Fill)

Using a conversion factor of 1.8 tonnes to 1 m^3, this equates to approximately 266,700. tonnes.

Suitability of Waste Material

It is proposed to use waste classified under the EWC codes permitted by Standard Rules permit referenced SR2015 No.39 as the restoration fill proposed for Buckton Vale as detailed in Table 1. This would be very similar to the non-waste material sourced from aggregate or topsoil suppliers if non-wastes were used for the new road.

Table 1 - Proposed Recovery Activity Waste Types

01 Waste resulting from exploration, mining, quarrying and physical and chemical treatment of minerals	
01 01 02	Wastes from mineral non metalliferous excavation
01 04 08	Waste gravel and crushed rocks other than those mentioned in 01 04 06
01 04 09	Waste sand and clays
10 wastes from thermal processes	
10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)
10 13 14	Waste concrete
17 Construction and demolition wastes	
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 07	Mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 05 04	Soil and stones other than those mentioned in 17 05 03
19 Wastes from waste management facilities	
19 12 09	Minerals (for example sand, stones) only
20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions	
20 02 02	Soil and stones

All incoming materials will be subject to strict waste acceptance procedures as outlined in the Sites Environmental Management System (EMS). Waste acceptance is a structured hierarchy with appropriate points of control for the identification and validation of wastes for recovery at the site and is summarised as follows:

Level 1 Basic characterisation through pre-acceptance assessment of appropriate Information (EWC codes, site investigations etc);

Level 2 Compliance testing;

Level 3 On-site verification through retrospective analysis of samples taken from deposited materials.

Each stage in the proposed waste acceptance scheme is detailed further below.

Level 1: Waste Characterisation

Table 1 above details the list of wastes to be accepted at the Site.

The EWC code of wastes will be checked against any relevant available data provided (e.g. waste description, waste source or chemical testing) to confirm that the waste is non-hazardous, the coding is correct, it can be accepted under the permit and it is suitable for the proposed activity. The waste enquiry procedure requires the following information to be gathered from any potential waste load prior to acceptance:

- Full address where the waste was produced;
- The identity of the producer;
- Information on the waste production process;
- Source and origin of waste (e.g. site investigation reports, borehole logs);
- Description of the waste treatment applied, or a statement of reasons why treatment is not considered necessary;
- Code according to the European Waste Catalogue;
- Evidence the waste is free from contamination and not hazardous;
- Chemical analysis data on the composition of the waste (i.e. totals mg/kg) and the leaching behaviour (i.e. WAC) where necessary; and
- The nature of the waste i.e. smell, colour, physical form.

This data will be reviewed by a suitably qualified person to ensure that all sampling is representative of the source of the waste and an appraisal of the composition, including the likelihood of hazardous properties, will be undertaken.

Landfill Directive Inert wastes can be accepted without supporting analytical test data, if the waste meets the additional restriction imposed by Council Decision 2003/33/EC e.g. the waste is uncontaminated, a single-stream waste from a single source, and excludes where appropriate top soil and peat.

Level 2: Compliance testing

Additional onsite testing may be undertaken to validate compliance testing. This will be targeted at specific wastes should any suspicion of contamination be identified either as a result of Level 1 or subsequent Level 3 checks. This material will only be accepted if the appropriate testing confirms that the material is free from contamination and inert WAC testing confirms compliance with the inert WAC leachable limits.

In addition, non targeted sampling of emplaced wastes will be taken on a periodic basis (quarterly) to confirm that the Level 1 and 2 waste acceptance procedures have effectively precluded unsuitable materials.

Level 3: On-site verification

Assuming the initial checks have been completed to the satisfaction of the competent person the weighbridge clerk will be the second point of control prior to the deposit of wastes.

All incoming vehicles enter via the main site entrance and check in at the site office. The documentation accompanying the load shall be checked by the weighbridge clerk and shall include, but not be limited to, the Carriers Certificate of Registration and Duty of Care Waste Transfer Note.

The information to be recorded in respect of each load will be where appropriate:

- Pre-treatment details;
- Waste type;
- Date;
- Time;
- Customer name;
- Vehicle registration number and type;
- Ticket number; and
- Carriers registration number.

It is recognised that there are difficulties achieving a visual inspection of waste loads arriving at the weighbridge in compacted or bulky type vehicles. For these types of loads emphasis is placed on checking the documentation at the weighbridge and visual inspection at disposal.

Every load of waste delivered to site will be visually inspected, where possible, by the weighbridge clerk or other site staff prior to deposit and after deposit by the plant operatives in the working area.

The weighbridge clerk will confirm that the accompanying documentation (i.e. waste description or likely levels of contamination) demonstrates that the waste load is the same waste type described by the customer at the pre-acceptance stage. If the documentation is incorrect and the correct paperwork cannot be provided, the weighbridge clerk will inform the Technically Competent Person (TCP) and the load will be rejected.

Where practicable, the weighbridge operator or other site staff will then visually inspect the load for compliance with the documentation. If the inspection shows that the load differs from the description, the load will be rejected as above.

If everything is in order the weighbridge operator will instruct the driver to proceed to the working area following all site rules and procedures.

The operatives at the working area will undertake a visual inspection of all loads arriving at site. Should any load look or smell suspicious or appear unsuitable for disposal the operatives at the working area will contact the weighbridge operator to assess the waste load in question.

If the waste is not acceptable, the weighbridge operator will inform the TCP and the waste will be treated in accordance with the rejection procedure.

Rejection Procedure

The rejection procedure covers the system for controlling all actions needed for rejection of a load or part load of waste determined by inspection to be unsuitable for disposal at the site. The procedure outlines what is to be done in order to deal with wastes which have been rejected either at the weighbridge reception area or at the working area.

Site Records

All records will be maintained and kept on file in accordance with the EMS. Records can be made available to the Agency for inspection if required.

Meeting Quality Standards

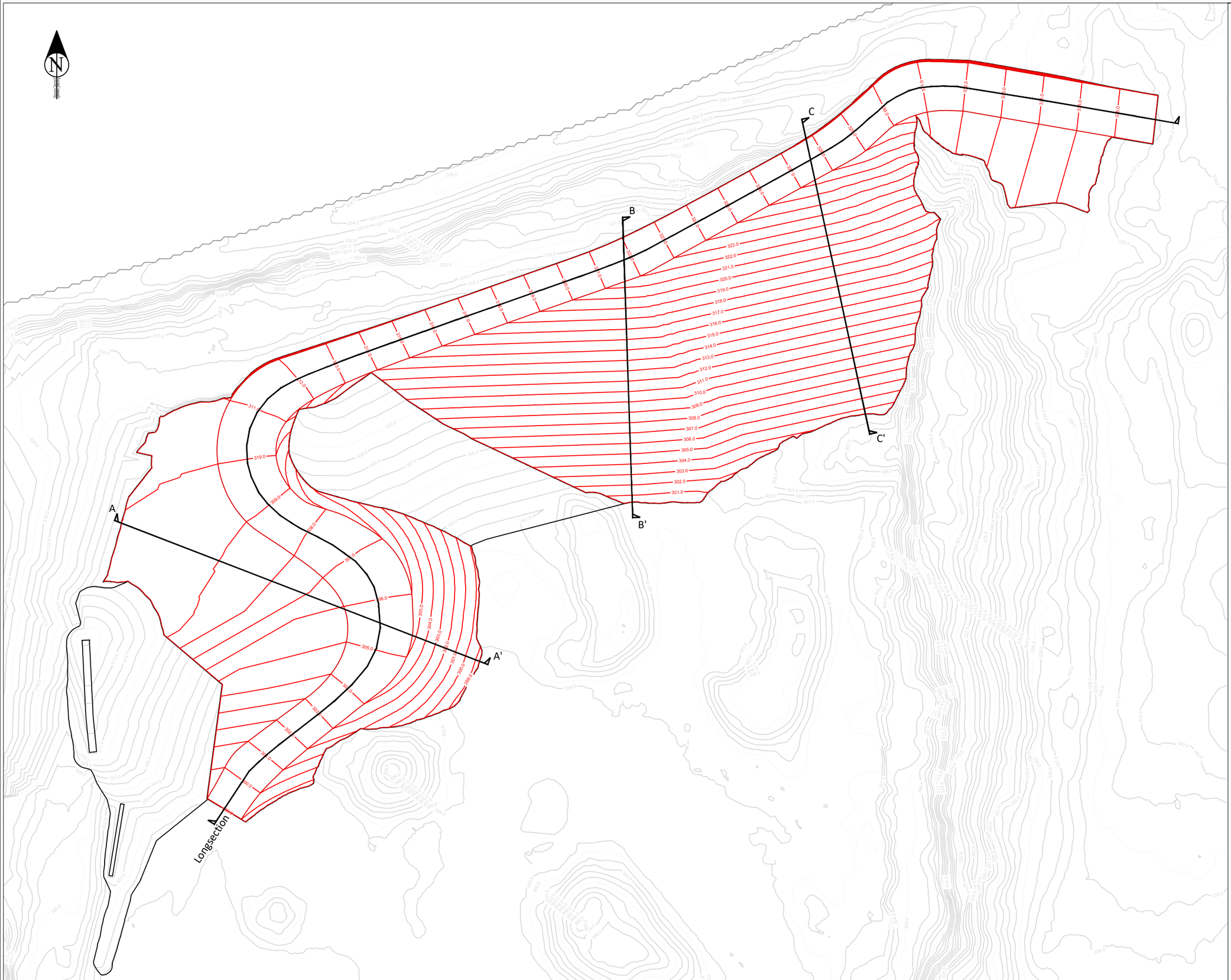
It is proposed to construct the site using imported reclaimed inert waste soils. The materials brought to site will have an inherently low pollution potential and will not contain substances at concentrations that are hazardous or may present a risk to surface water or groundwater. After its deposit and subsequent profiling, the already low permeability of this material is further reduced. This further restricting the leachability of any potential soluble components and mobilisation of solids from its compacted surface.

The fill specification for the access road is outlined in the accompanying Geotechnical Design Report (document reference 4859-R06 Issue 01, dated May 2021) attached in Appendix A. The Geotechnical Design report recommends that the Operator follows an end-product specification for the fill material which should require compaction of the fill at a water content range between optimum and optimum + 4.0%. The dry density should be 95% of maximum as measured in the

Proctor test, and have a maximum 5% air void value. The undrained shear strength of the material should be 55 kPa or greater. Source and compliance testing should be carried out at a rate of two tests per source or per 1,000 m^3 of material, whichever is greater. This testing should include determination of changes in undrained shear strength with increasing water content, in addition to Proctor testing.

The nature of the material to be used means it is unlikely to be subject to consolidation or settlement which may lead to instability. The likely cohesive nature of this material also makes it suitable for use in the steeper slope faces.

Appendix A – Drawings



Key

Existing Contours

Proposed Upper Bench Access Road Contours

TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client

Churchill Enviro Limited

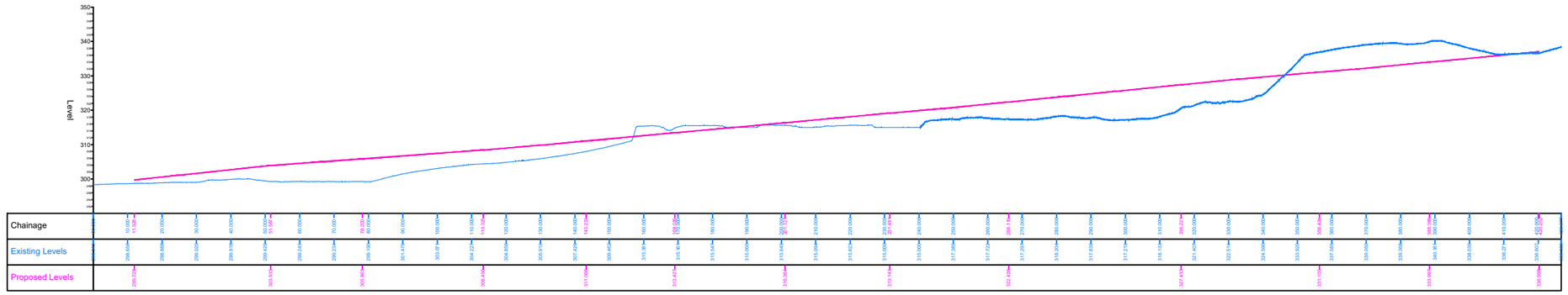
Site

Buckton Vale Quarry

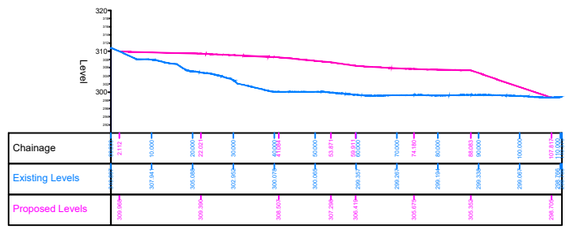
Title

Proposed Upper Bench Access Road Cross Section Locations

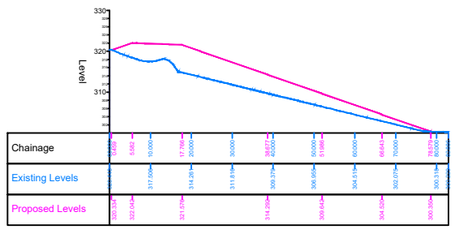
Scale	1:1,000	@ A3	
Drawing No.	4859/1/002		
Rev	Date	Description	
File	4859.1.002 Cross Section Locations		
Date	06/20	Engineer	PP
Drawn	PP GH	Checked	DRAFT



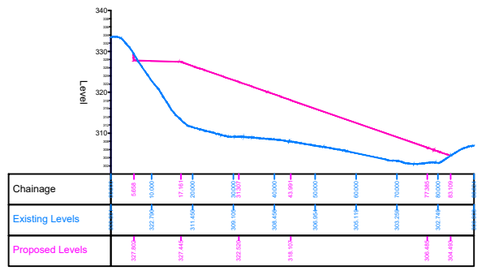
Longsection



Section A-A'



Section B-B'



Section C-C'

Key

TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client

Churchill Enviro Limited

Site

Buckton Vale Quarry

Title

Proposed Upper Bench Access Road Cross Sections

Scale	1:1,500	@ A3
Drawing No.	4859/1/003	

Rev	Date	Description

File	4859.1.003 Cross Sections		
Date	07/20	Engineer	PP
Drawn	PP GH	Checked	DRAFT

Appendix B – Access Road Geotechnical Design Report





TerraConsult

28th May 2021
Report No. 4859-R06 Issue 01

Buckton Vale Quarry, Mossley - Access Road Geotechnical Design Report

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Buckton Vale Quarry, Mossley - Access Road

Geotechnical Design Report

28th May 2021

Report No 4859-06 Issue 01

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DOCUMENT INFORMATION AND CONTROL SHEET

Document Status and Approval Schedule

Report No.	Title
4859-R06	**Buckton Vale Quarry, Mossley - Access Road – Geotechnical Design Report**

Issue History

Issue	Status	Date	Contributors	Signature	Date
1	Draft	**28/05/2021**	**Prepared By:** S.J.J.Ferley		**28/05/2021**
			Checked By: P.Roberts		**28/05/2021**
			Approved By:		**28/05/2021**

DISCLAIMER This report should be read with the Service Constraints Report Limitations & Planning Requirements set out in Appendix A.

Buckton Vale Quarry, Mossley - Access Road

Geotechnical Design Report

TABLE OF CONTENTS

1 INTRODUCTION

1.1 INTRODUCTION

1.1.1 At the request of Churchill Enviro Ltd., TerraConsult Ltd. was commissioned to carry out geotechnical design for a new access road at Buckton Vale Quarry, Mossley, Greater Manchester. The approximate Ordnance Survey grid reference for the area of interest is 399130E, 401715N.

1.1.2 The site forms part of an existing operational quarry, and it is proposed to construct a new access road to an area of available mineral resources, using imported reclaimed inert waste soil.

1.1.3 This document forms the Geotechnical Design Report as required by Section 2.8 of BS EN 1997-1:2004 + Amendment 1, 2013 (Eurocode 7) (1).

1.1.4 This document is for the private use of the Client (and their professional advisers) for whom it has been prepared and should not be relied upon by third parties for any use whatsoever without the written authority of a director of TerraConsult Ltd.

1.2 SOURCES OF INFORMATION

1.2.1 The following and reports have been relied upon in the preparation of the design:

- Geotechnical Assessment, Buckton Vale Quarry; Kevan Walton Associates report dated January 2018 (2).
- Buckton Vale Inert Landfill Site Environmental Permit Application: Environmental Setting and Installation Design; TerraConsult Ltd. report reference 3953/R03/01 dated December 2018 (3).
- Buckton Vale Quarry: Geology and Hydrogeology Conceptualisation Summary; TerraConsult Ltd. report reference 2104/R02/02, dated August 2019 (4).

1.2.2 The design of the proposed quarry access road is shown in the following drawings:

- Buckton Vale Quarry Proposed Upper Bench Access Cross Section; TerraConsult Ltd. drawing reference 4859/3/001, dated May 2021 (5).

1.2.3 Additional resources used in the interpretation are detailed in the relevant sections of this report. A full list of references is included in Section 5.

2 SUMMARY OF SITE CONDITIONS

2.1 TOPOGRAPHY

2.1.1 The site lies on the high ground of Buckton Moor above Mossley, Greater Manchester. The elevation of the quarry rim is approximately +350 m Ordnance Datum (O.D.). The quarry floor lies at a general elevation of approximately +300 m O.D.

2.1.2 An unreferenced CAD drawing provided by the Client gives more detail of the quarry, including contours of the existing void. This drawing was used to create the design cross-sections drawing (5).

2.1.3 Where local changes in stockpiles and the like are observed, the survey data was augmented using information obtained from open access Lidar data (6).

2.2 HISTORY AND MAN-MADE FEATURES

2.2.1 The site has been used for the quarrying of stone for at least 150 years, although extraction has not been continuous. No other mining is recorded within the vicinity of the site. The Coal Authority interactive map (7) shows that the site does not lie within a coal mining reporting area.

2.2.2 The Defra Magic Map (8) shows that Buckton Castle, a Scheduled monument, is located adjacent to the western edge of the site. As this is on land above the quarry high wall it will not be affected by the proposed works.

2.3 GEOLOGY AND GEOMORPHOLOGY

2.3.1 The British Geological Survey GeoIndex Onshore (9) shows that the quarry lies within sandstone of the Lower Kinder Scout Grit, part of the Hebden Formation of the Millstone Grit Group. The BGS lexicon of rock units describes the Hebden Formation as "*Fine- to very coarse-grained and pebbly, feldspathic sandstone interbedded with grey siltstone and mudstone, with subordinate marine black shales, thin coals and seatearths. The lower part of the formation is dominated by a turbiditic facies of thinly interbedded siltstone and fine-grained sandstone with laterally impersistent and locally thick, massive, coarse to very coarse-grained sandstones.; Coal and seatearth are largely restricted to the upper part of the formation*."

2.3.2 Exploratory holes drilled around the site for the purposes of groundwater monitoring (3) terminated in Sandstone at a depth of one hundred metres below ground level.

2.3.3 Discontinuity mapping was carried out as part of the geotechnical assessment reporting carried out by Kevan Walton Associates (2). The joint orientation and the face orientation of the high wall adjacent to the proposed access road indicate that any potential failures of the high wall are likely to be either steep wedge-type, or toppling, failures.

2.3.4 The BGS GeoIndex Onshore (9) shows superficial deposits to be thin or absent at the site. However, it is known that some overburden has been stripped from parts of the site during previous quarrying operations.

2.3.5 No natural cavities are anticipated at the site, as the bedrock is not subject to dissolution by groundwater.

2.4 HYDROLOGY AND HYDROGEOLOGY

2.4.1 The hydrology and hydrogeology of the quarry are discussed in detail in the TerraConsult reports referenced in Section 1.2.1 above. The following paragraphs are a summary of the relevant points, and reference should be made to the separate reports for more information.

2.4.2 There are no watercourses or bodies of open water on or adjacent to the site. The nearest water bodies are:

- Castle Clough 470m SW
- Near Harehill Clough, and Cowbury Reservoir 580m ESE
- Carr Brook, and Carrbrook Reservoir 650m S

2.4.3 None of the above water bodies will be affected by the scale of the proposed works.

2.4.4 The ESID report (3) and hydrogeological conceptualisation reports record the highest groundwater at the site occurs at an elevation of +291 m O.D. This is below the existing quarry floor, which lies at approximately 300 m O.D. A spring line is marked at an elevation of approximately +250 m O.D. on Ordnance Survey maps.

3 MODELLING PARAMETERS

3.1 GENERAL

3.1.1 No ground investigations have been carried out at the site, but monitoring boreholes encountered sandstone of the Kinder Scout Grit to a depth below ground level of at least one hundred metres.

3.1.2 Rock discontinuity measurements were undertaken as part of the Geotechnical Assessment reporting (2).

3.1.3 As yet, the source of imported material is unknown. The results of a previous stability risk assessment for a proposed inert landfill site in the quarry using assumed parameters were reported as part of the ESID referred to in Section 1.2.1 (3).

3.2 GEOTECHNICAL PARAMETERS – FILL

3.2.1 The previous SRA (3) assumed the characteristic parameters for the earthworks fill summarised in Table 3.1 below:

Parameter	Units	Value
Weight Density, γ_b	kN/m³	18
Undrained Shear Strength, c_u	kPa	75
Undrained Angle of Shearing Resistance, ϕ_u	°	0
Drained Shear Strength, **c'**	kPa	5
Drained Angle of Shearing Resistance, ϕ'	°	27

Table 3.1: Fill Parameters from SRA in ESID Report.

3.2.2 Upon inspection, the value of undrained shear strength of 75 kPa is considered somewhat optimistic, given the likely material types. A value of 55 kPa is therefore adopted, being the minimum value to ensure an ODF greater than 1.0.

3.2.3 The value of drained cohesion is also reduced, to a value of 2 kPa, to take account of the unreliability of effective cohesion and the possibility of variability of imported material.

3.2.4 The characteristic values of parameters adopted in the current analysis are summarised in Table 3.2 below.

Parameter	Units	Value
Weight Density, γ_b	kN/m³	18
Undrained Shear Strength, c_u	kPa	55
Undrained Angle of Shearing Resistance, ϕ_u	°	0
Drained Shear Strength, **c'**	kPa	2
Drained Angle of Shearing Resistance, ϕ'	°	27

Table 3.2: Fill Parameters Assumed in Current Analysis.

3.3 GEOTECHNICAL PARAMETERS – ROCK

3.3.1 The previous SRA (3) assumed the characteristic parameters for the earthworks fill summarised in Table 3.3 below:

Parameter	Units	Value
Weight Density, γ_b	kN/m³	20
Uniaxial Compressive Strength	kPa	8,000
Friction Angle Along Joint, ϕ_j	°	30
Joint Inclination, α	°	6

Table 3.3: Rock Parameters from SRA in ESID Report.

3.3.2 In the absence of site-specific data, these parameters are also adopted in the current analysis.

3.4 PHREATIC SURFACE

3.4.1 Groundwater monitoring at the site indicates an elevation of +291 m O.D., nine metres below the floor of the quarry. In order to allow for heavy infiltration and possible saturation, the elevation of the phreatic surface in the current analysis is assumed to be at +300 m O.D.

3.5 PLANT LOADING

3.5.1 Loading equivalent to a Caterpillar D6 is assumed in the analysis. This applies a ground pressure 59 kPa on track a 2.4 m long by 0.5 m wide.

3.5.2 The loading is applied at various locations on the cross-section between the crest of the embankment and towards the toe. It is assumed that only one machine will be permitted to work at any one location.

3.6 PARTIAL FACTORS

3.6.1 In accordance with the principles of BSEN 1997, 2004 + Am.1, 2013: Geotechnical Design: Part 1 - General Rules (1). (Eurocode 7) the loading and material resistances are factored during the analysis.

3.6.2 Design Approach 1 is used in accordance with the UK National Annex to Eurocode 7 Part 1 (11). This involves the analysis of two design situations, as follows:

- Combination 1: partial factors are applied to loading, and partial factors of unity are applied to material parameters.
- Combination 2: lower partial factors are applied to loading, and partial factors greater than unity are applied to material parameters.

3.6.3 The various partial factors used in the analysis are given in Table 3.4. These are combined as A1-M1 (Combination 1) and A2-M2 (Combination 2): the partial factor R1 is unity in all cases.

Parameter		**Symbol**	**GEO & STR - Partial factors**			
			A1	**A2**	**M1**	**M2**
Permanent action (G)	Unfavourable	$\gamma_{G;dst}$	1.35	1.00		
	Favourable	$\gamma_{G;stb}$	1.00	1.00		
Variable action (Q)	Unfavourable	$\gamma_{Q;dst}$	1.50	1.30		
	Favourable	-	0.00	0.00		
Accidental action (A)	Unfavourable	$\gamma_{A;dst}$	1.00	1.00		
	Favourable	-	0.00	0.00		
Angle of shearing resistance (tan ϕ')		$\gamma_{\phi'}$			1.00	1.25
Effective cohesion (c')		$\gamma_{c'}$			1.00	1.25
Undrained shear strength (c_u)		γ_{cu}			1.00	1.40
Weight density (γ) or unit weight		γ_{γ}			1.00	1.00

Table 3.4: Values of Partial Factors Used in Analysis

3.7 EMBANKMENT GEOMETRY

3.7.1 The embankment rises from the quarry floor at a level of approximately +300 m O.D. in the west of the site and rises to a level approaching +330 m O.D. in the east.

3.7.2 The slope of the outer face of the embankment becomes steeper from east to west, as the height increases, ranging from 1 in 3.2 to 1 in 2.87 at Section C-C'.

4 EARTHWORKS ANALYSIS

4.1 GENERAL

4.1.1 The analysis is carried out in accordance with the principles of BSEN 1997, 2004 + Am.1, 2013: Geotechnical Design: Part 1 - General Rules (1): Design Approach 1 is used in accordance with the UK National Annex to Eurocode 7 Part 1 (11).

4.1.2 In the Eurocode 7 approach, as partial factors are applied to actions and resistance (i.e. soil strength), the Factor of Safety output by the analysis is an Overdesign Factor (ODF): the analysis is satisfactory if the ODF is greater than or equal to unity.

4.2 ANALYSIS METHODOLOGY

4.2.1 In the current analysis, Combinations 1 and 2 are applied to undrained (short-term) conditions, as the loading from construction plant is potentially significant for stability calculations: the loading is considered “transient”.

4.2.2 Combination 2 loading is applied to drained (long-term) conditions, for the slope post construction. In this condition, the strength and self-weight of the materials are the governing factor in the stability calculations.

4.2.3 The analysis of global stability of the earthworks to the access road was undertaken using the limit equilibrium computer programme SLOPE/W. The analysis method of Morgenstern and Price is used, as it satisfies both force and moment equilibrium.

4.2.4 The program has inbuilt functions to apply the relevant Eurocode 7 partial factors on loading and resistance during the analysis, and the output can be given in terms of Overdesign Factor (ODF) or degree of utilisation. For stability, the ODF should be greater than or equal to unity.

4.2.5 The critical potential failure surface is allowed to optimise, to give a minimum ODF by allowing deviation from a circular arc.

4.3 EMBANKMENT STABILITY

4.3.1 For all cross-sections and load cases, Combination 2 loading is the critical condition, giving the lowest ODF.

4.3.2 In the undrained condition, the lowest ODF occurs with the applied plant loading either on the crest of the slope, or near the top of the slope on the face of the embankment.

4.3.3 Cross-section C-C’ gives the lowest ODF, being the highest and steepest slope.

4.3.4 The stability calculations are contained in Appendix C and are summarised in Table 4.1 below.

Location	Drained/Undrained	Load Position	Combination	ODF
Cross Section A-A'	Drained	None	2	1.56
	Undrained	On Crest of Embankment	2	2.42
Cross Section B-B'	Drained	None	2	1.46
	Undrained	Near Top of Embankment	2	1.41
Cross Section C-C'	Drained	None	2	1.29
	Undrained	On Crest of Embankment	2	1.06

Table 4.1: Summary of Minimum Overdesign Factors for Each Cross Section

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 The proposed embankment is stable in both the short and long term.

5.2 RECOMMENDATIONS

5.2.1 In order for the embankment to be stable under all conditions, it is recommended that an end-product specification is adopted for the fill material. This should require, as a minimum, compaction of the fill at between optimum water content and optimum +4.0% to a dry density of 95% of maximum as measured in the Proctor test, and to 5% air voids or less. The undrained shear strength of the material should be 55 kPa or greater.

5.2.2 Source and compliance testing should be carried out at a rate of two tests per source or per 1,000 m^3 of material, whichever is greater. This testing should include determination of changes in undrained shear strength with increasing water content, in addition to Proctor testing.

5.2.3 If the embankment design or the anticipated construction plant differ from the assumptions made in this report, the results and conclusion of the stability analysis should be reviewed.

6 REFERENCES

1. **British Standards Institution.** BSEN 1997-1: Eurocode 7: Geotechnical Design. *Part 1: General Rules.* London, UK : BSI, 2004. Incorporating A1: 2013.

2. **Kevan Walton Associates.** *Geotechnical Assessment Buckton Vale Quarry.* January 2018.

3. **TerraConsult Ltd.** *Buckton Vale Inert Landfill Site Environmental Permit Application: Environmental Setting and Installation Design.* December 2018. Report 3953-R03-01.

4. —. *Buckton Vale Quarry Geology and Hydrogeology Conceptualisation Summary.* August 2019. Report 2104-R02/02.

5. —. Buckton Vale Quarry Proposed Upper Bench Access . *Cross Sections.* May 2021. Drawing 4859/3/001.

6. **Environment Agency.** Survey Open Data. [Online] https://environment.data.gov.uk/ds/survey/#/survey.

7. **The Coal Authority.** Interactive Map. [Online] http://mapapps2.bgs.ac.uk.

8. **DEFRA.** MagicMap. [Online] http://magic.defra.gov.uk/MagicMap.aspx.

9. **British Geological Survey.** GeoIndex Onshore. *British Geological Survey.* [Online] http://mapapps2.bgs.ac.uk/geoindex.

10. **British Standards Institution.** UK National Annex to BS EN 1997-1: Eurocode 7: Geotechnical Design. *Part 1: General Rules.* London : BSI, 2007. Incorporating A1, 2014.

Appendix A

Service Constraints & Report Limitations

Service Constraints & Report Limitations

This consultancy contract report and supporting work/services (together comprise the "Services") were carried out by TerraConsult Limited (TCL) for Churchill Enviro Ltd. (the "client") on the basis of a defined programme and scope of works and the terms of a contract between TCL and the "client." The Services were performed by TCL with all reasonable skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by TCL taking into account the limits of the scope of works required by the client, the works information, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between TCL and the client. TerraConsult Ltd cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outwith the agreed scope of works.

Other than that expressly contained in the above paragraph, TCL provides no other representation or warranty whether express or implied, is made in relation to the Services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of TCL. If a third party relies on this report, it does so wholly at its own and sole risk and TCL disclaims any liability to such parties.

It is TCL's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without TCL 's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of TerraConsult Limited.

The report was prepared in May 2021 and should be read in light of any subsequent changes in legislation, statutory requirements and industry practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of TCL. In the absence of such written advice of TCL, reliance on the report in the future shall be at the client's own and sole risk. Should TCL be requested to review the report in the future, TCL shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between TCL and the client.

The observations and conclusions described in this report are based solely upon the Services that were provided pursuant to the agreement between the client and TCL. TCL has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. TCL is not liable for the existence of any condition, the discovery

of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, TCL did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The Services are based upon TCL's observations of existing physical conditions at the site gained from a walkover survey of the site together with TCL's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst TerraConsult Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. Further TCL was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. TCL is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to TCL and including the doing of any independent investigation of the information provided to TCL save as otherwise provided in the terms of the contract between the client and TCL.

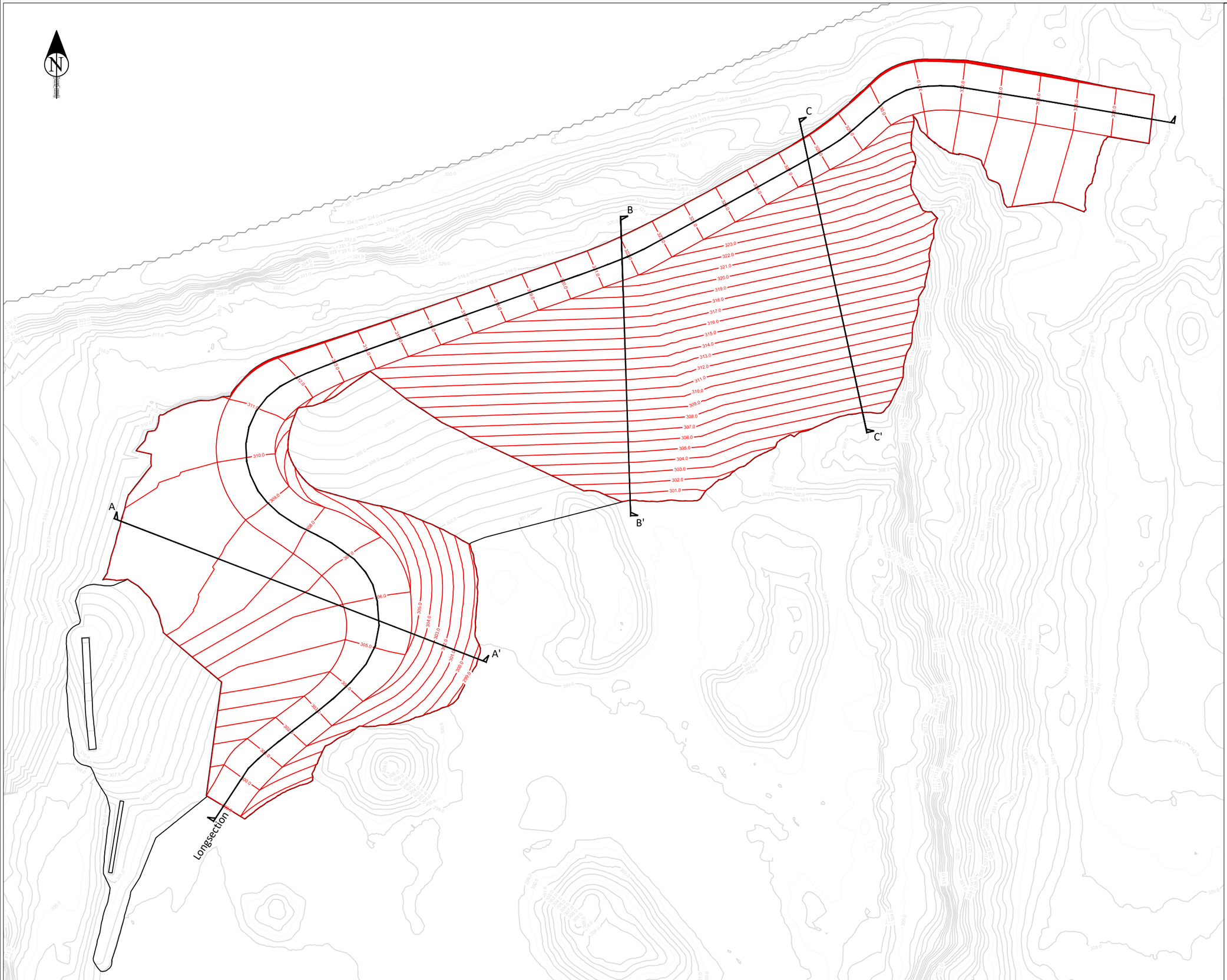
Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and TCL] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

Appendix B

Drawings



Key

Existing Contours

Proposed Upper Bench Access Road Contours

TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client

Churchill Enviro Limited

Site

Buckton Vale Quarry

Title

Proposed Upper Bench Access Road Cross Section Locations

Scale	1:1,000	@ A3	
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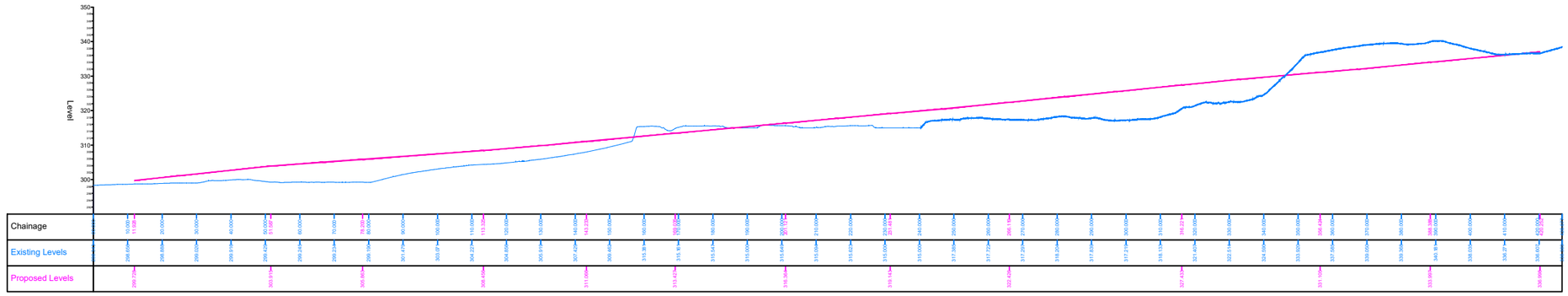
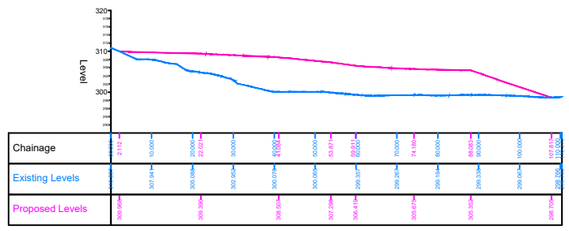
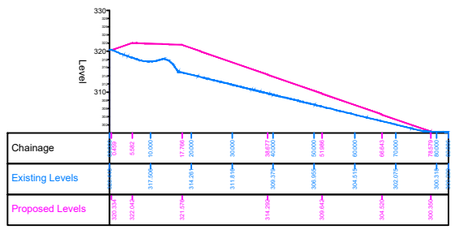
Rev	Date	Description	
File	4859.1.002 Cross Section Locations		
Date	06/20	Engineer	PP
Drawn	PP GH	Checked	DRAFT



Longsection



Section A-A'



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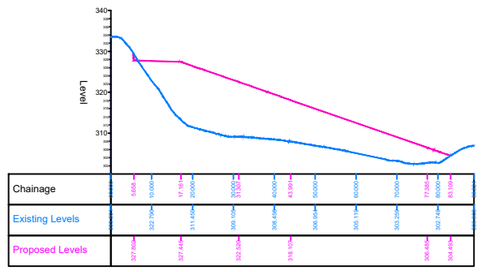


Section C-C'

Key

TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client

Churchill Enviro Limited

Site

Buckton Vale Quarry

Title

Proposed Upper Bench Access Road Cross Sections

Scale	1:1,500	@ A3
Drawing No.	4859/1/003	

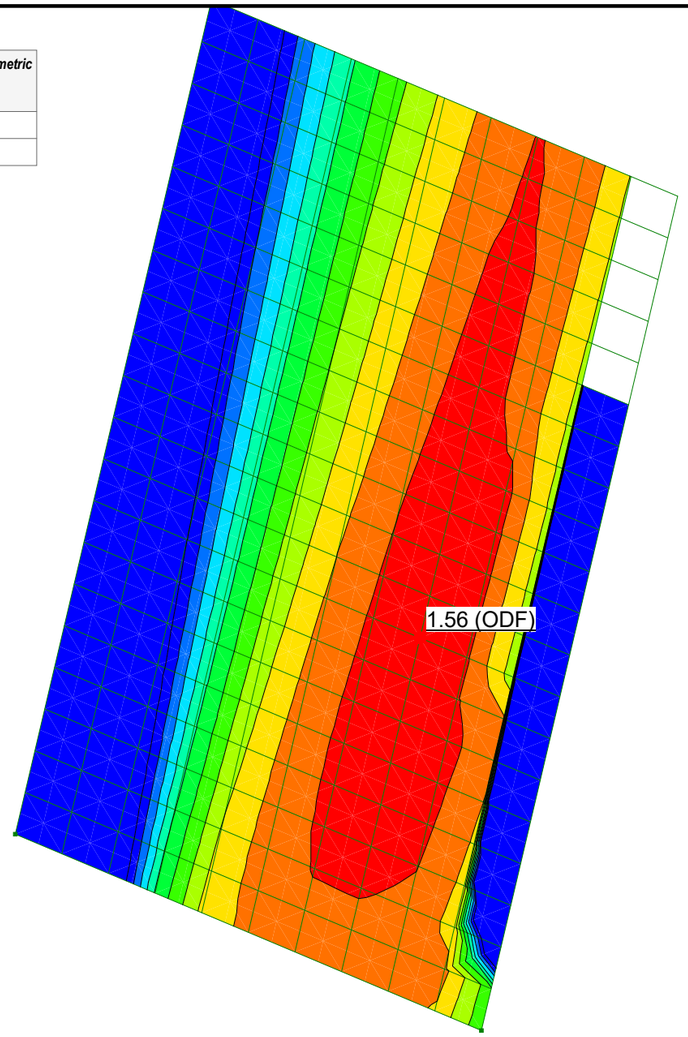
Rev	Date	Description

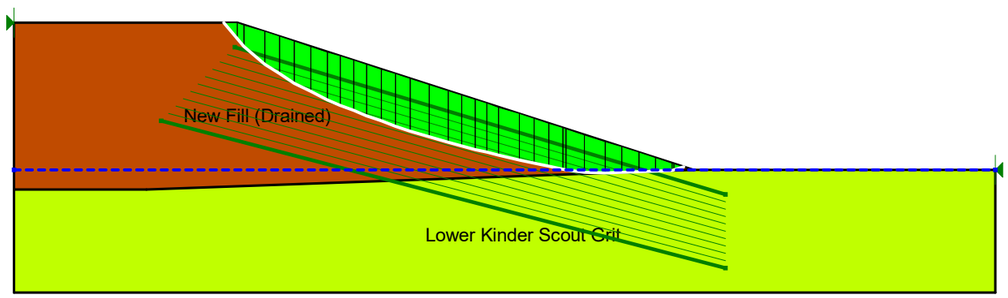
File	4859.1.003 Cross Sections		
Date	07/20	Engineer	PP
Drawn	PP GH	Checked	DRAFT

Appendix C

Calculations

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20			0	8,000	30	0	0	1
	New Fill (Drained)	Mohr-Coulomb	18	2	27					0	1





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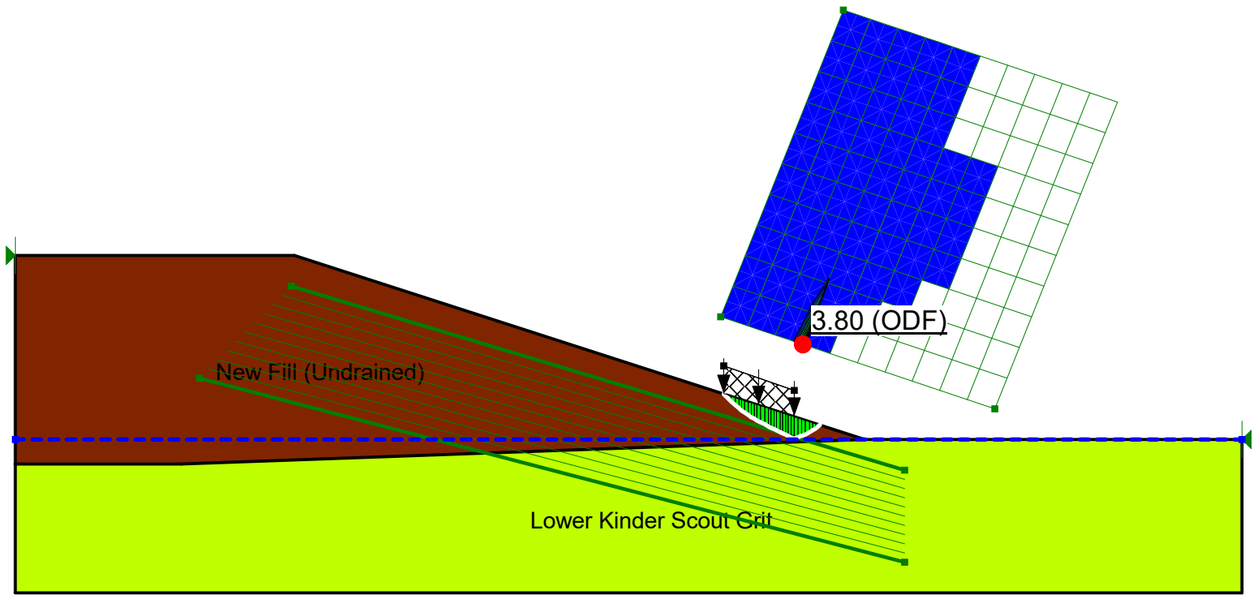
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	27/05/2021
Sheet Title:	Section A-A' Drained using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/01

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (B1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/02

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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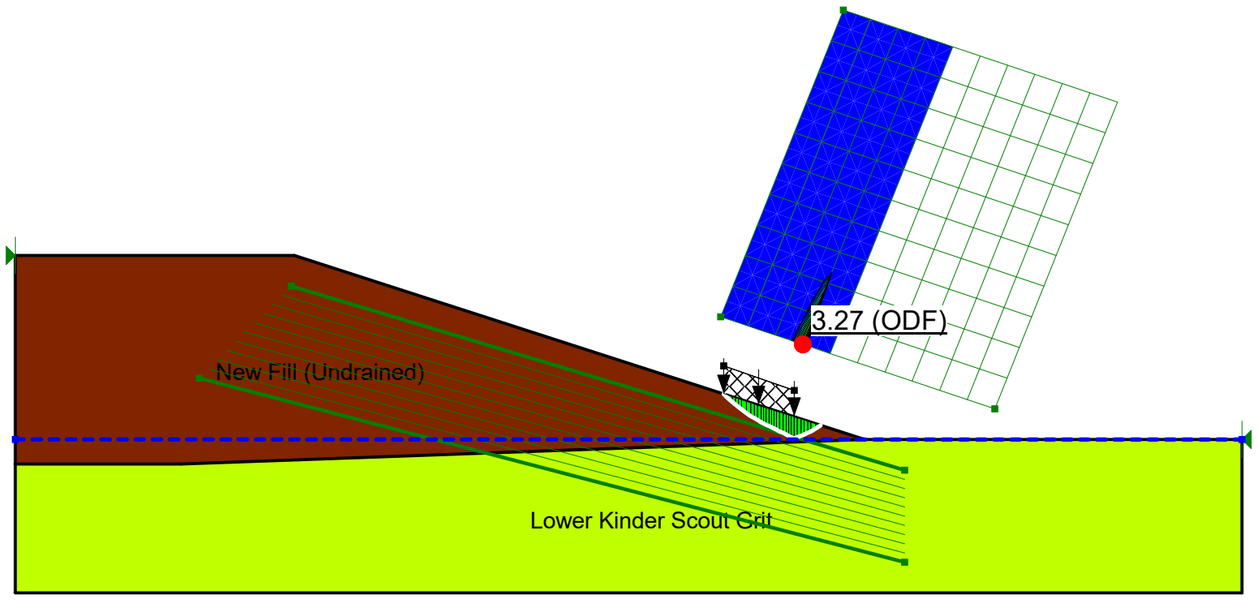
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (B2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/03

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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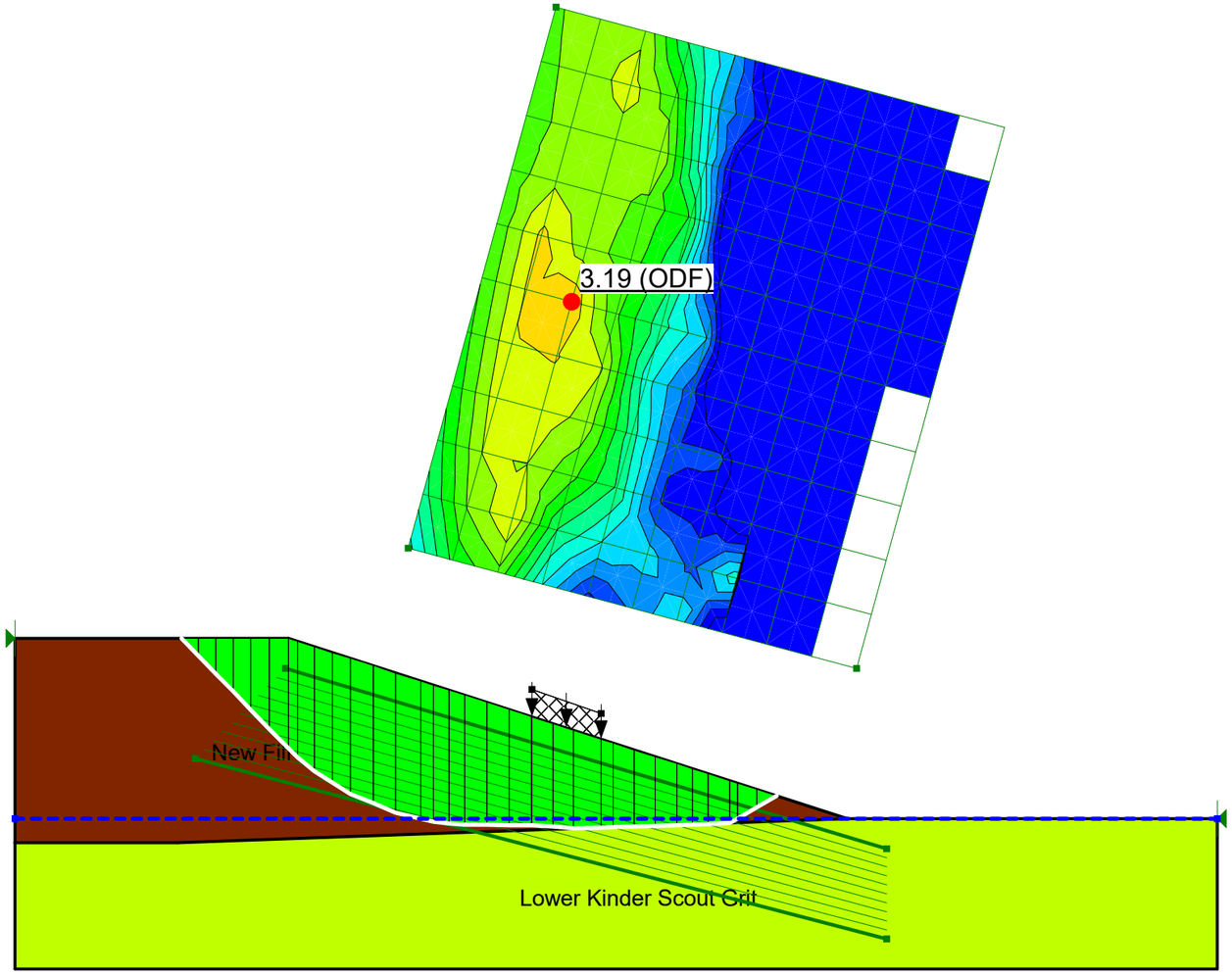

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Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (M1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/04

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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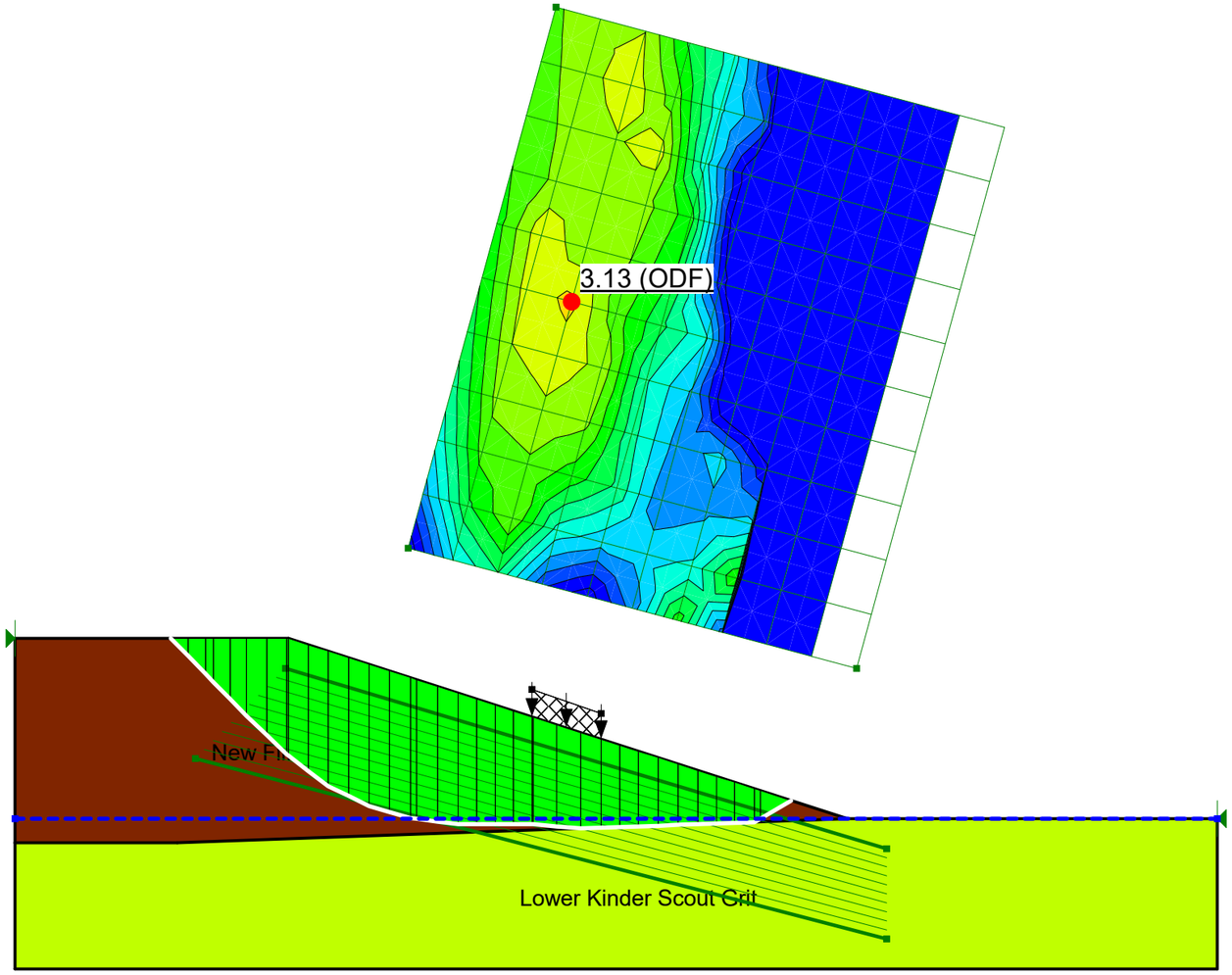

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Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (M2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/05

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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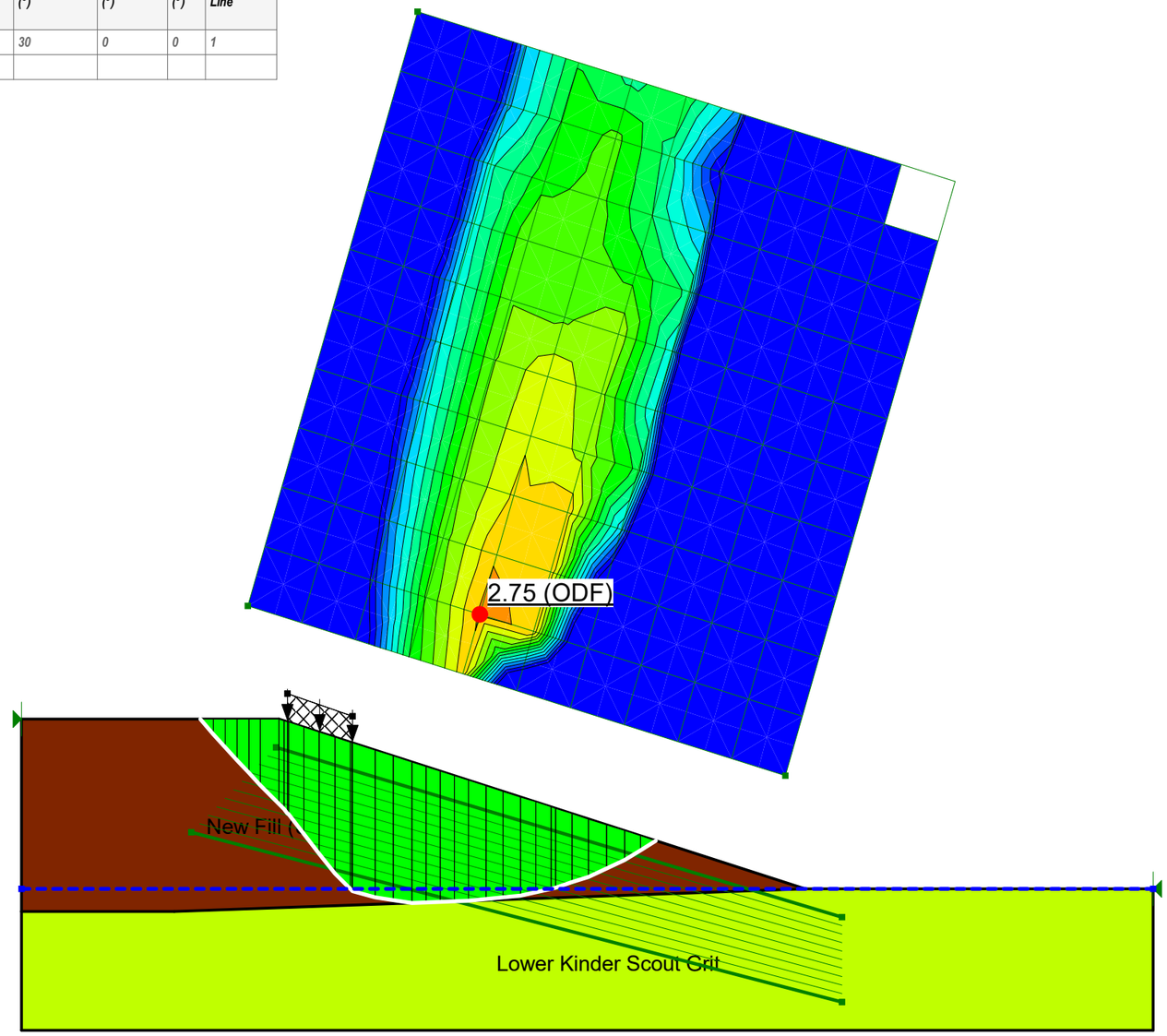
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (T1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/06

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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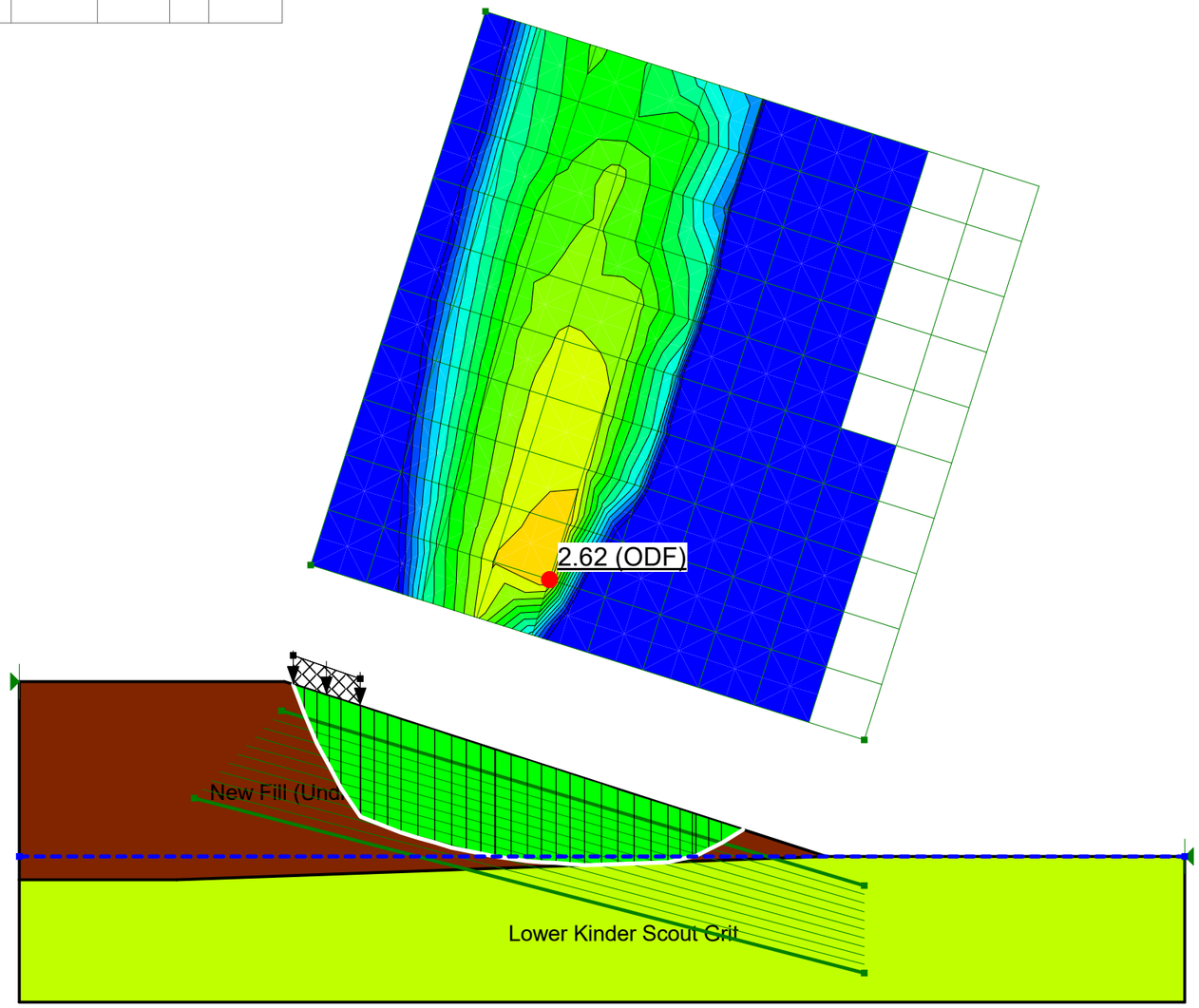
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (T2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/07

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
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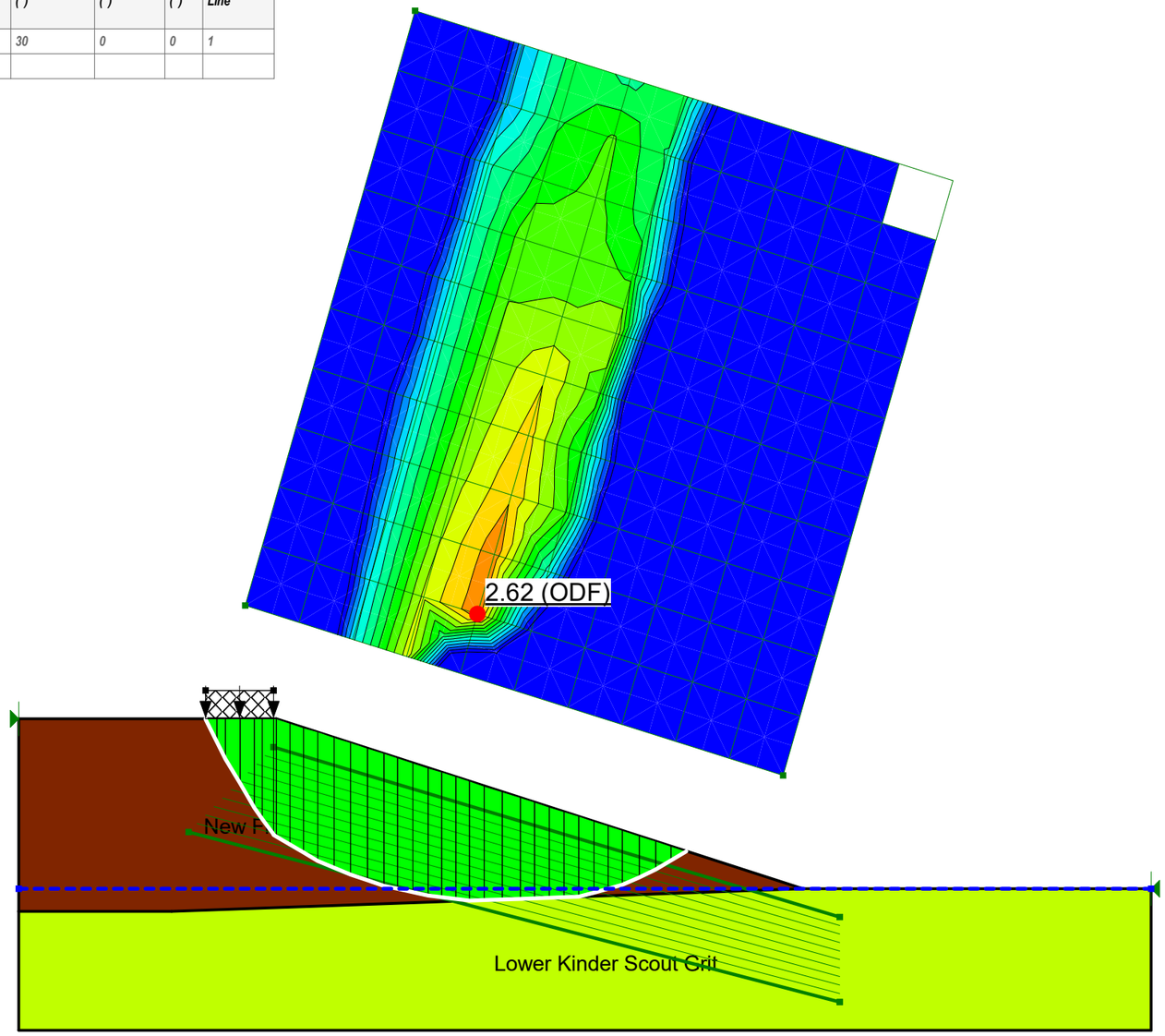
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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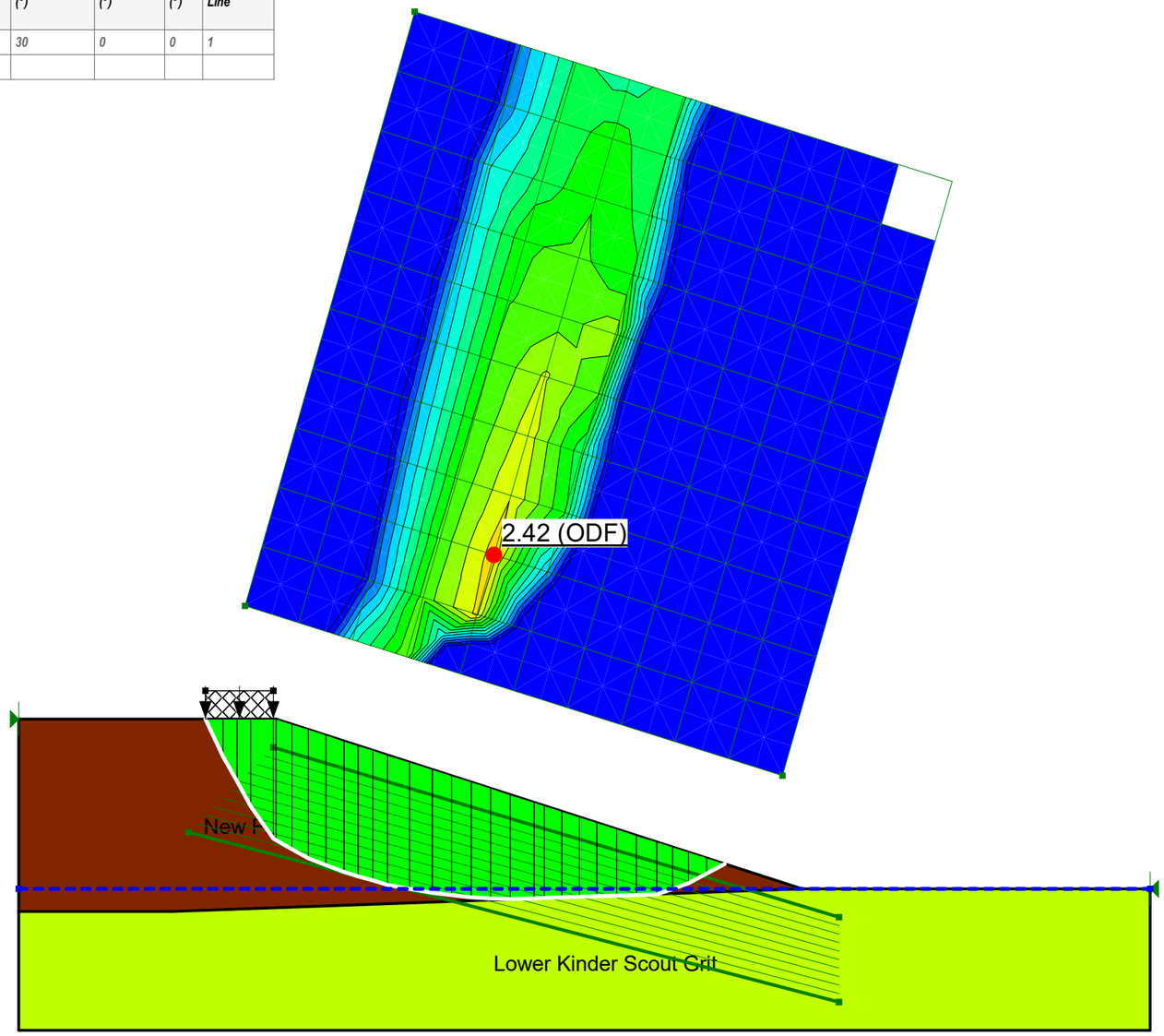
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (C1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/08

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



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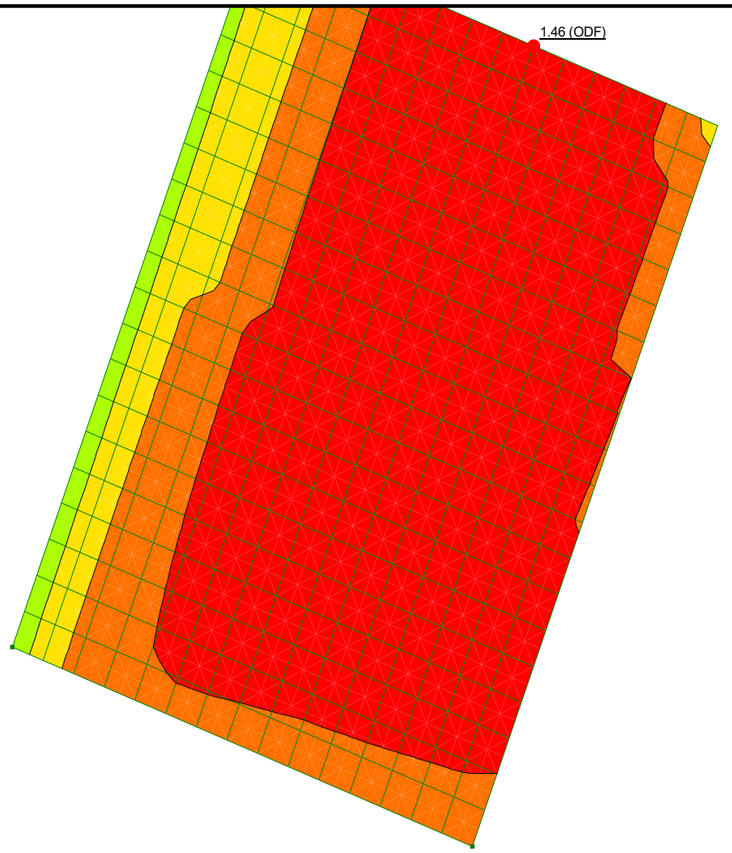
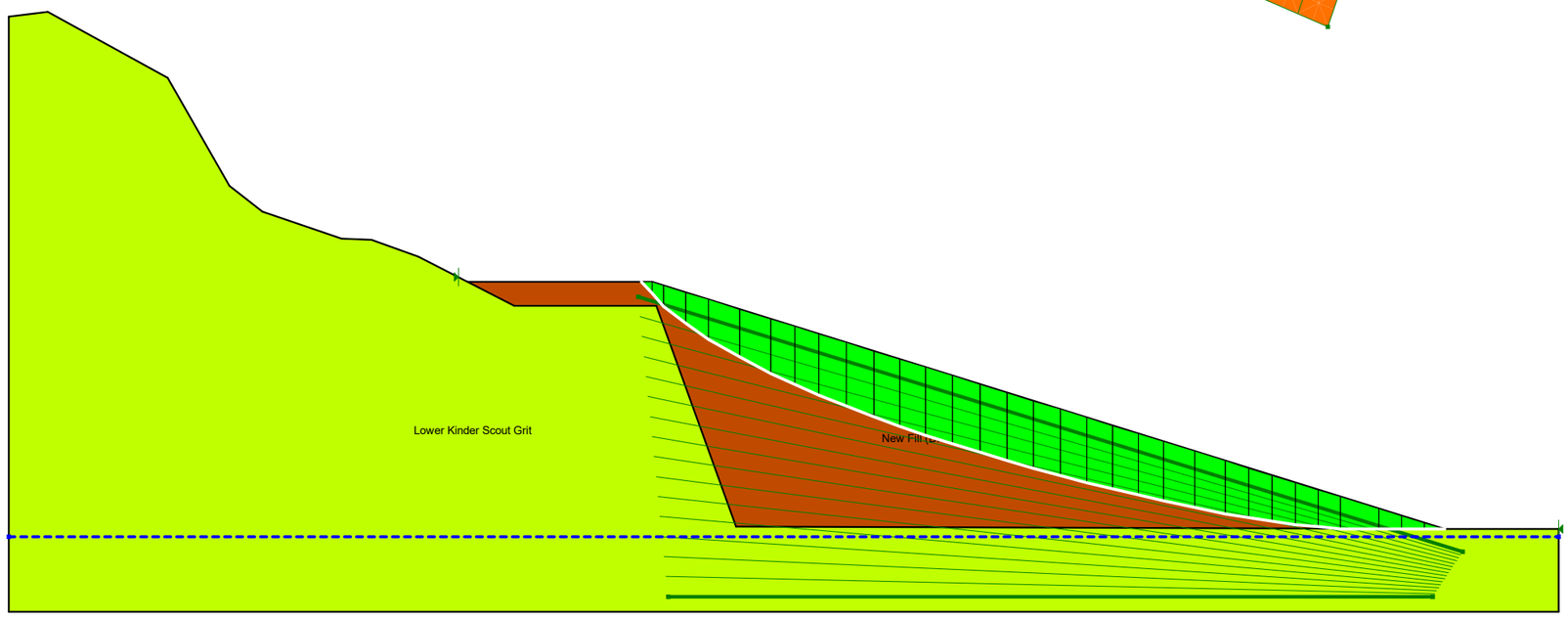
Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section A-A' Undrained (C2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/09

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20			0	8,000	30	0	0	1
	New Fill (Drained)	Mohr-Coulomb	18	2	27					0	1

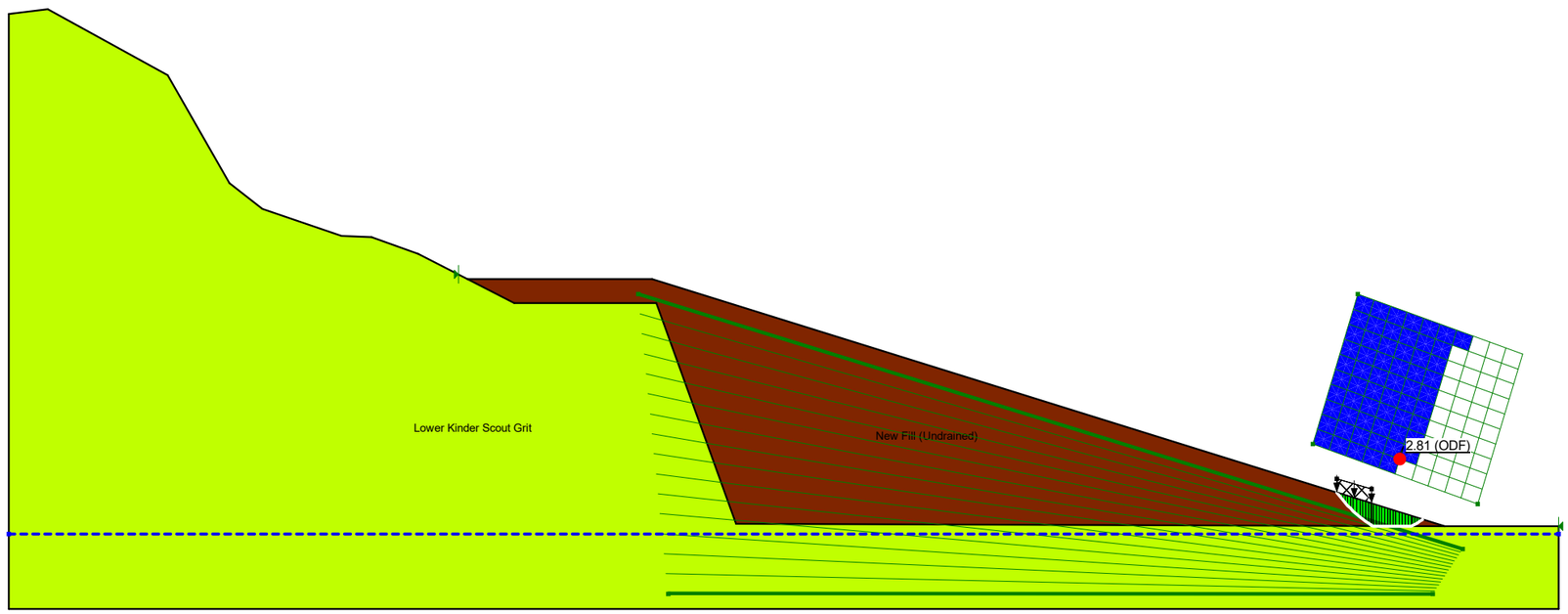




Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	27/05/2021
Sheet Title:	Section B-B' Drained using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/10

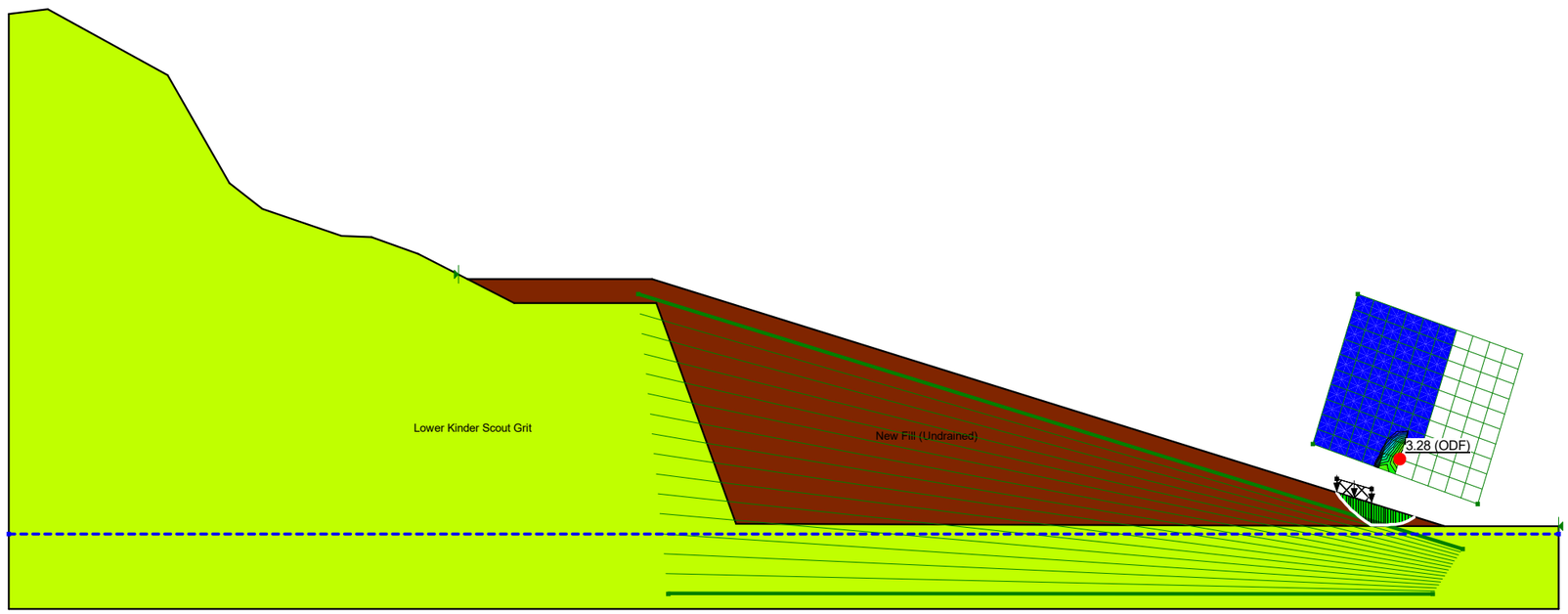
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (B1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/11

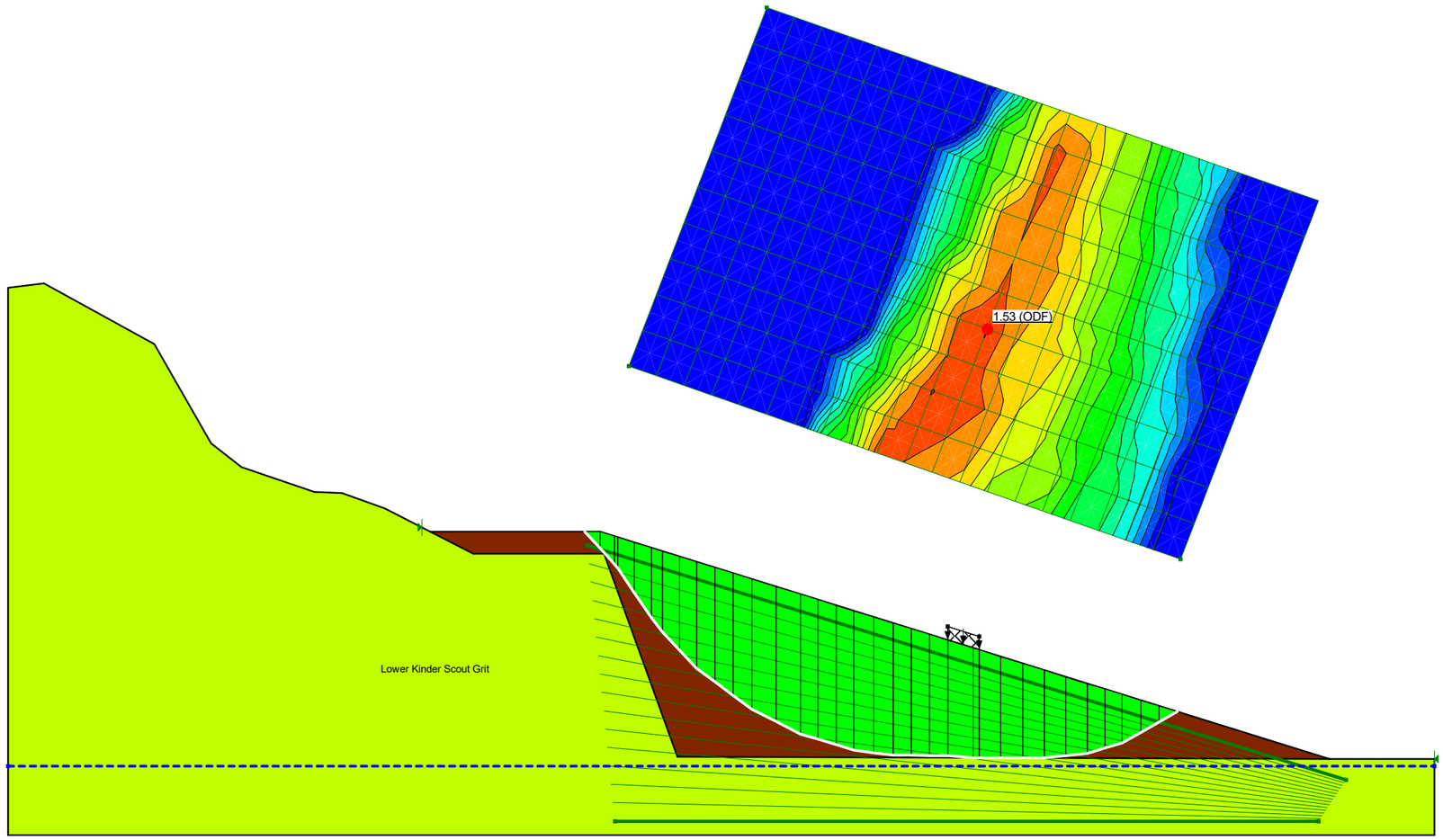
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	**Churchill Enviro**	*TerraConsult Ltd.*	*Suite 104, Mere Grange Business Park St. Helens, WA9 5GG*		
Project:	**Buckton Vale Quarry Access Road**	**Prepared By:**	*Simon Ferley*	**Date:**	**28/05/2021**
Sheet Title:	**Section B-B' Undrained (B2)** using Eurocode 7 - DA1, C2	**Project No:**	**4859**	**Sheet No:**	**Fig. C/12**

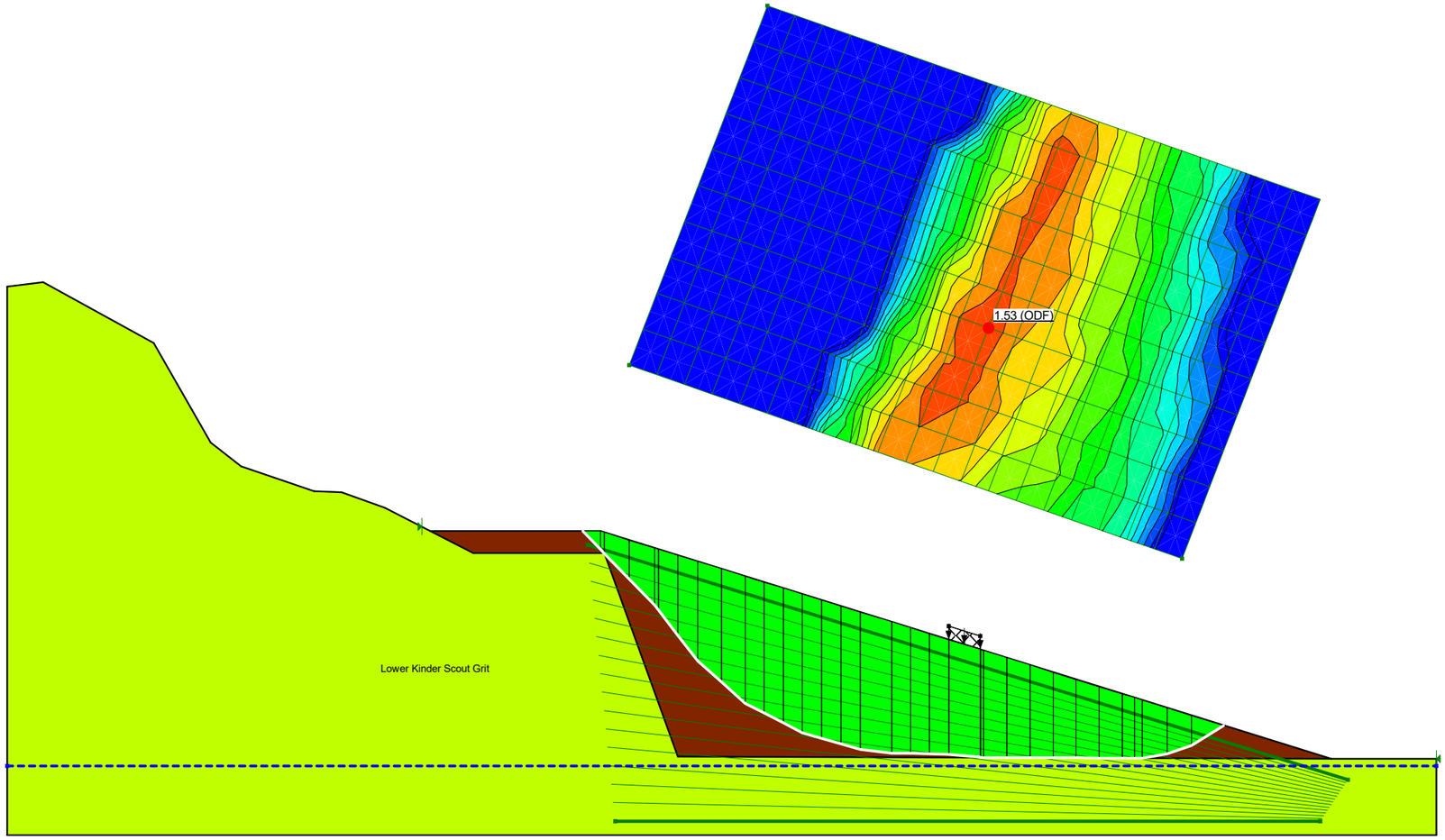
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (M1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/13

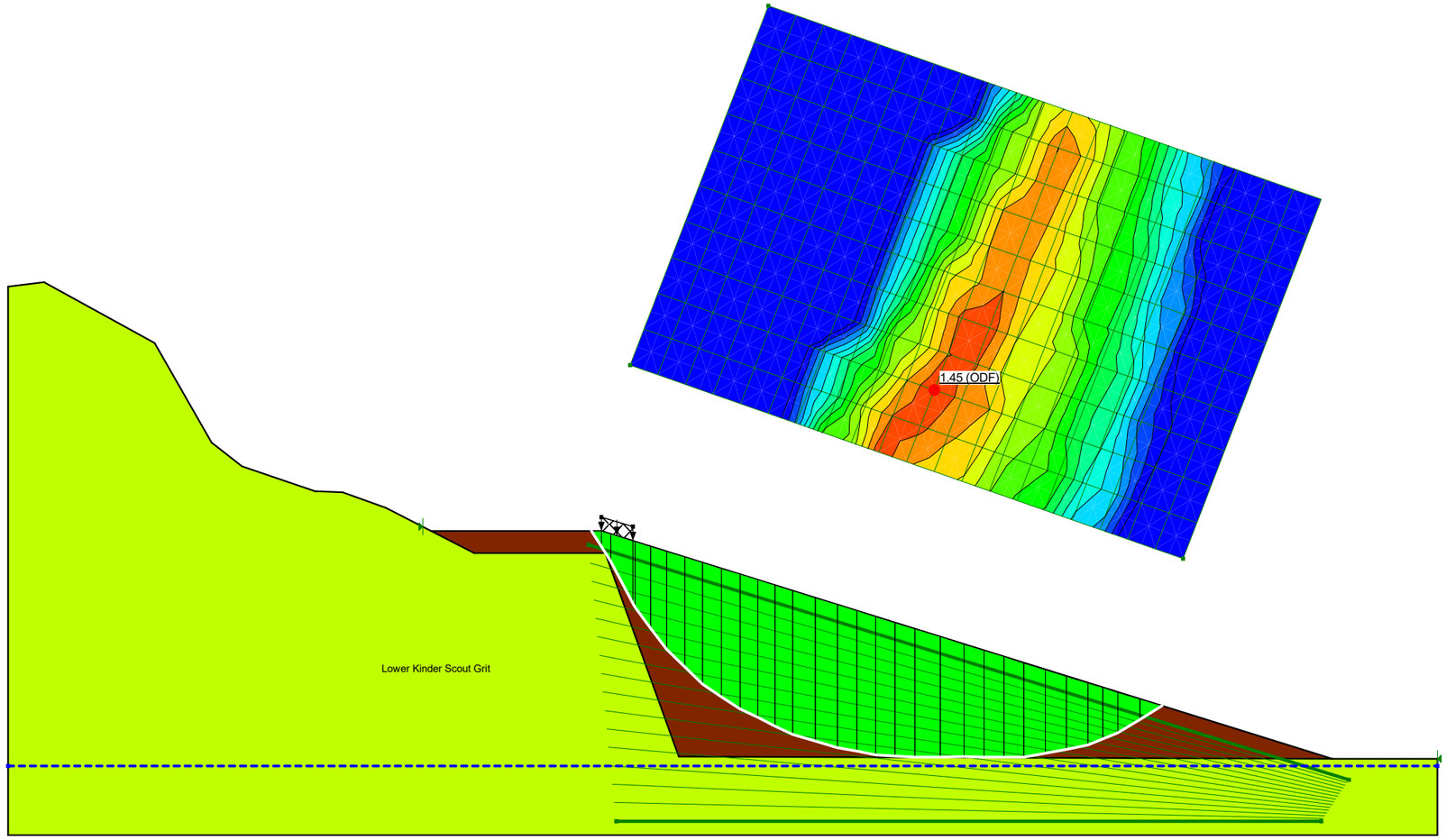
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (M2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/14

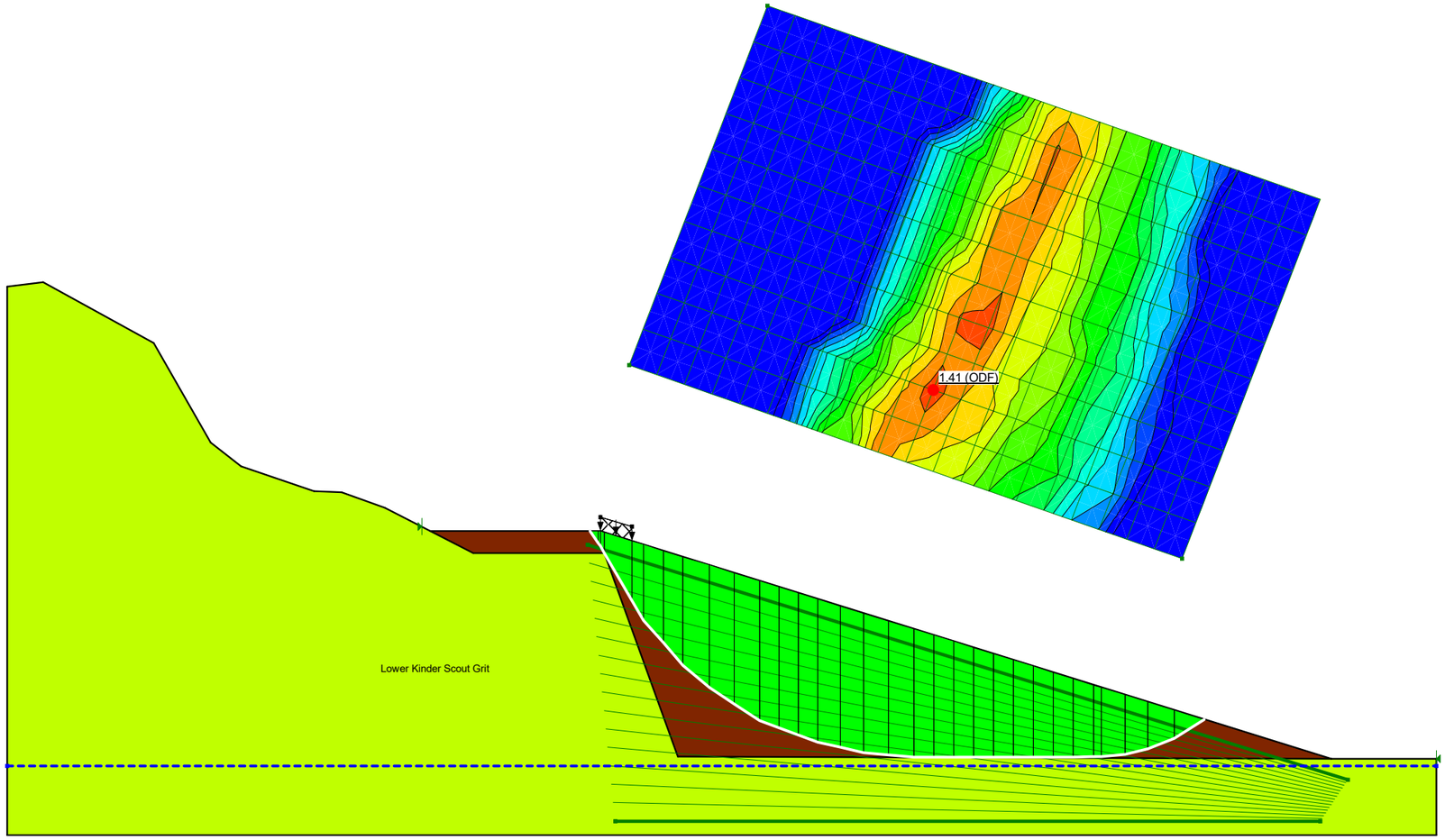
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (T1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/15

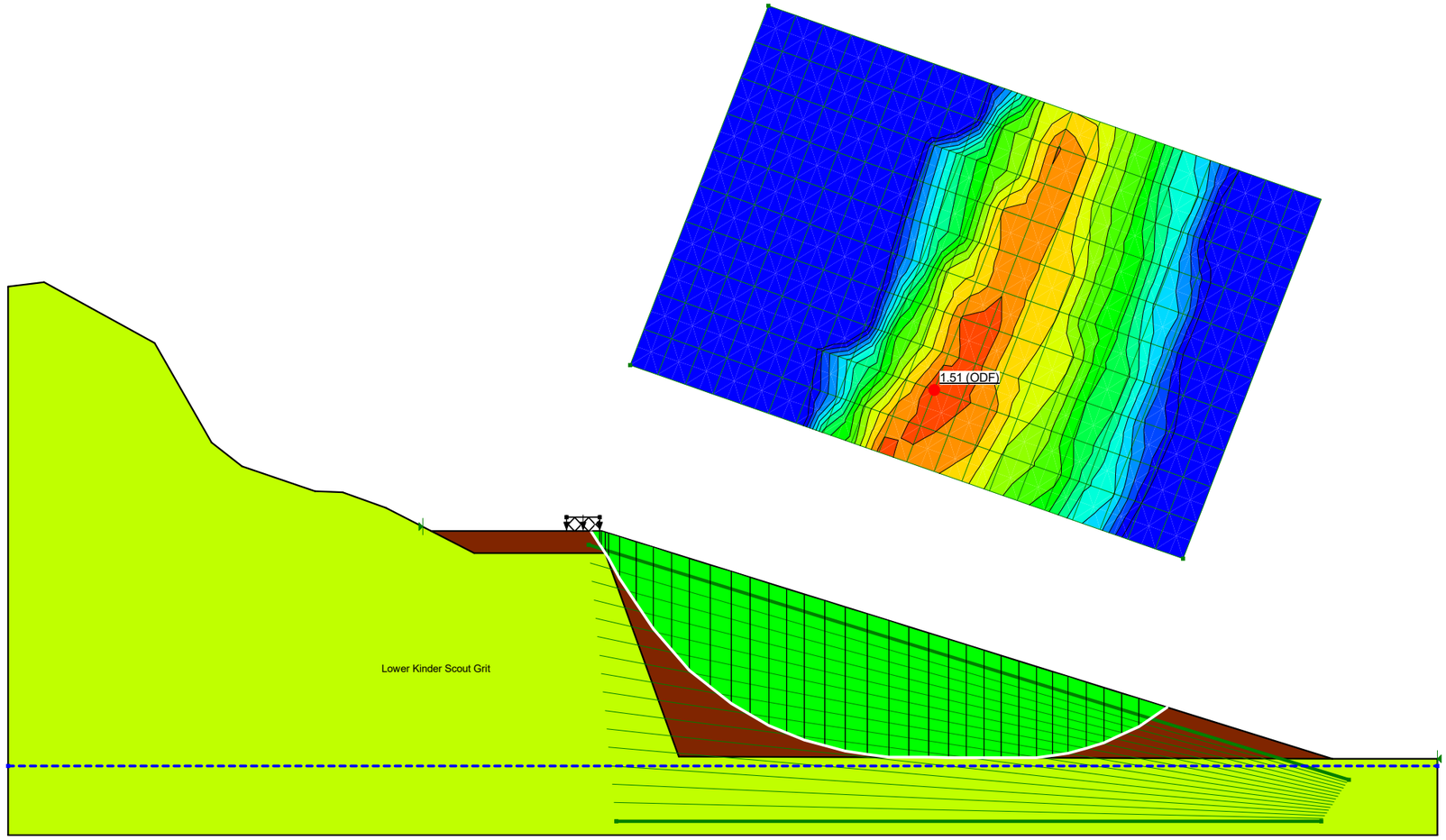
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (T2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/16

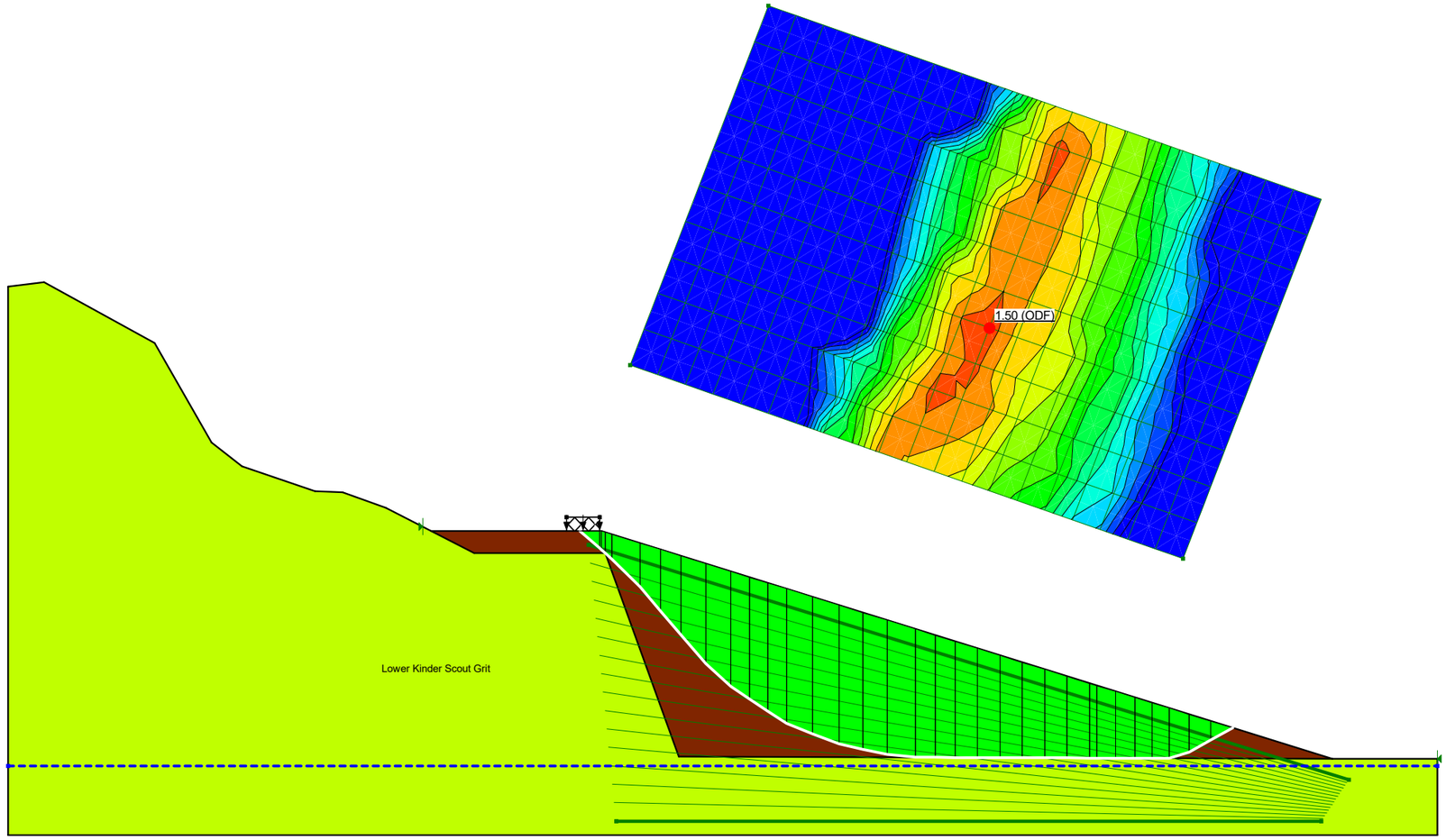
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						



Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (C1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/17

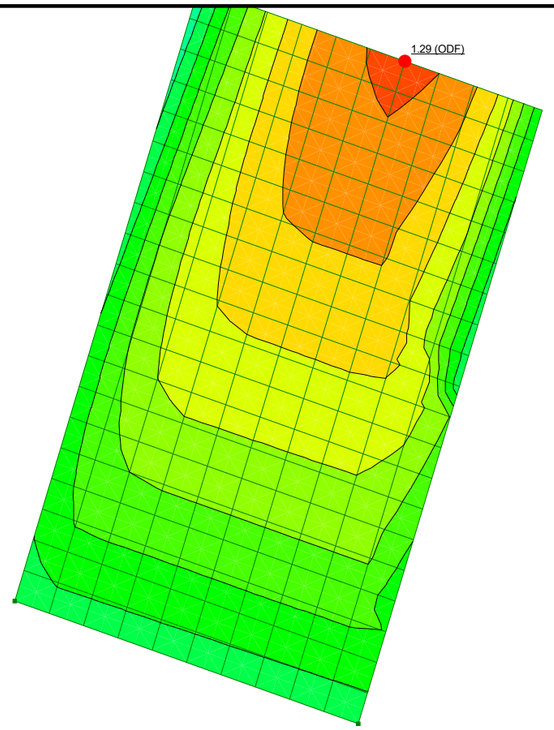
Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

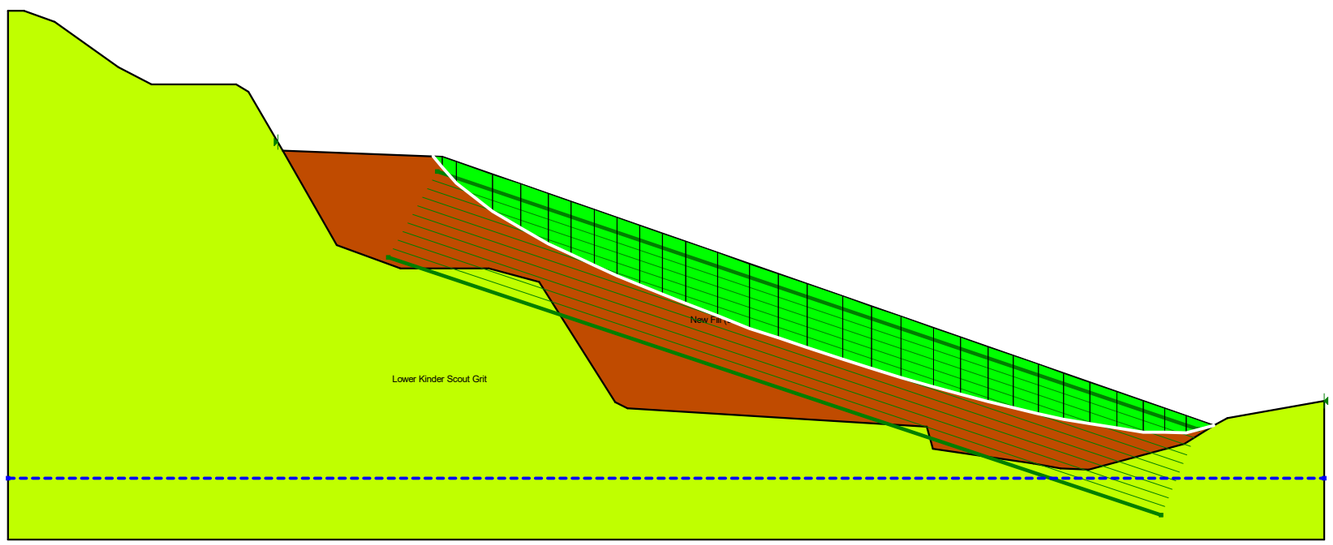


Scale: 1:400

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section B-B' Undrained (C2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/18

Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20			0	8,000	30	0	0	1
	New Fill (Drained)	Mohr-Coulomb	18	2	27					0	1

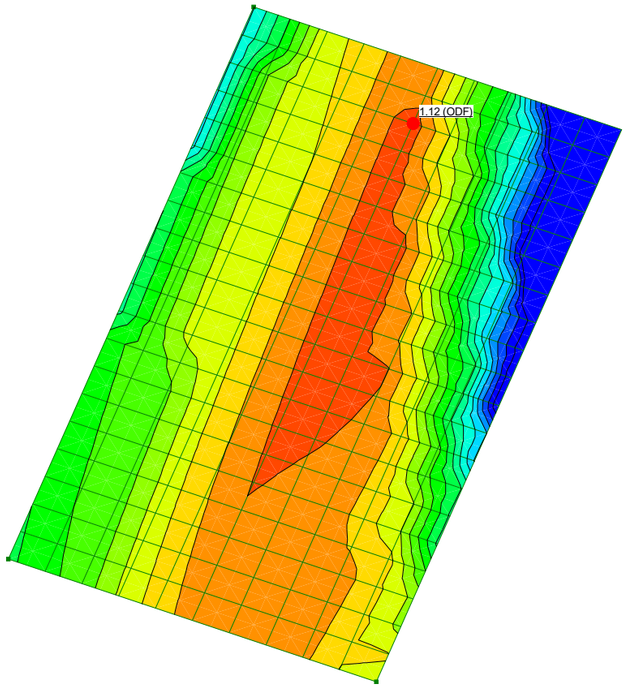


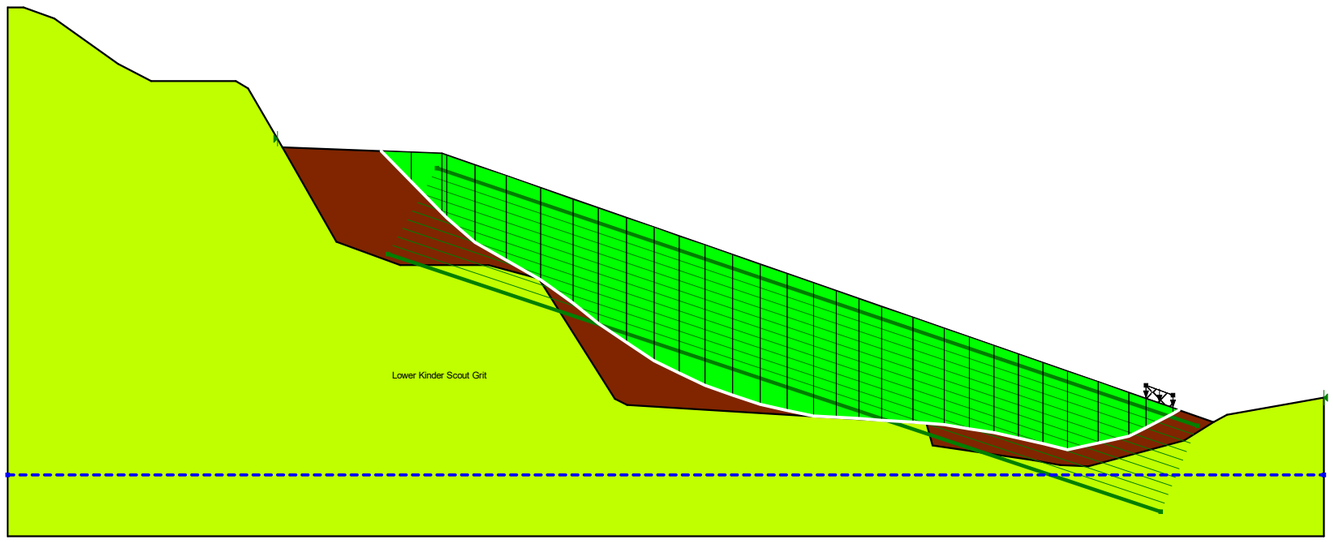


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	27/05/2021
Sheet Title:	Section C-C' Drained using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/19

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Vertical (kPa)	C-Horizontal (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

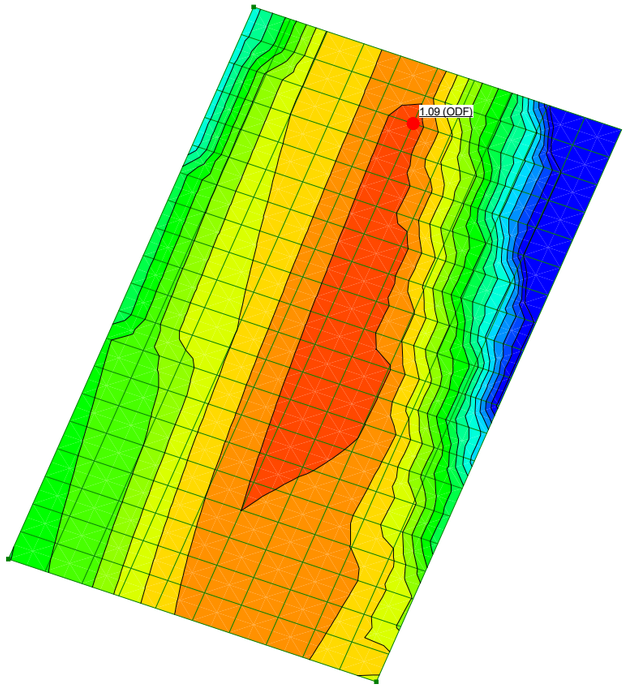


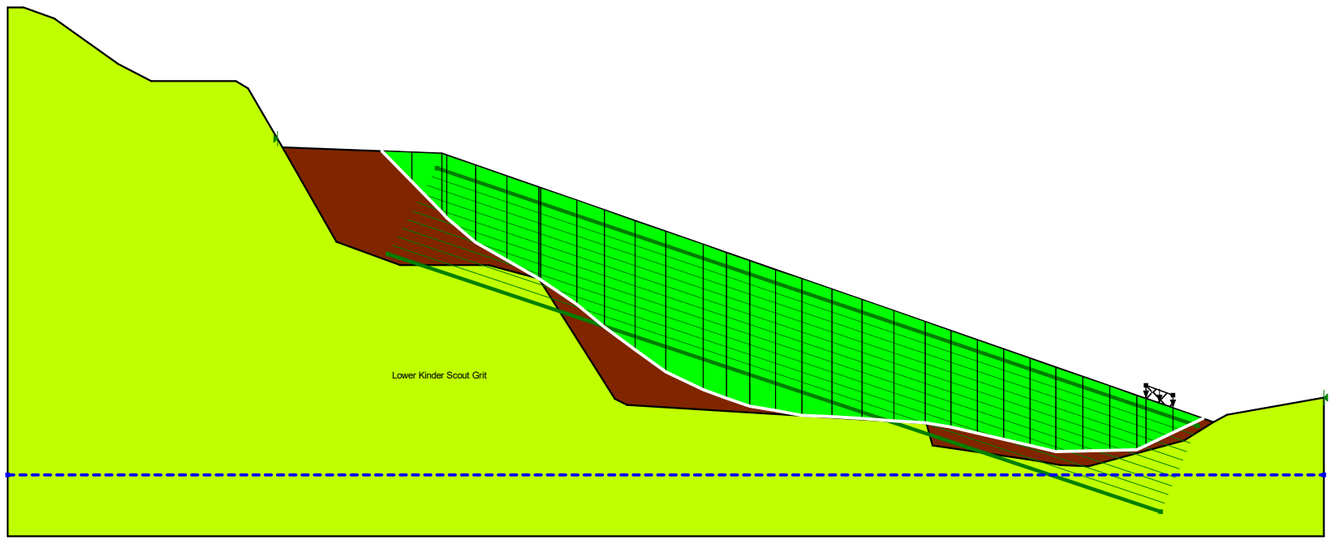


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (B1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/20

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

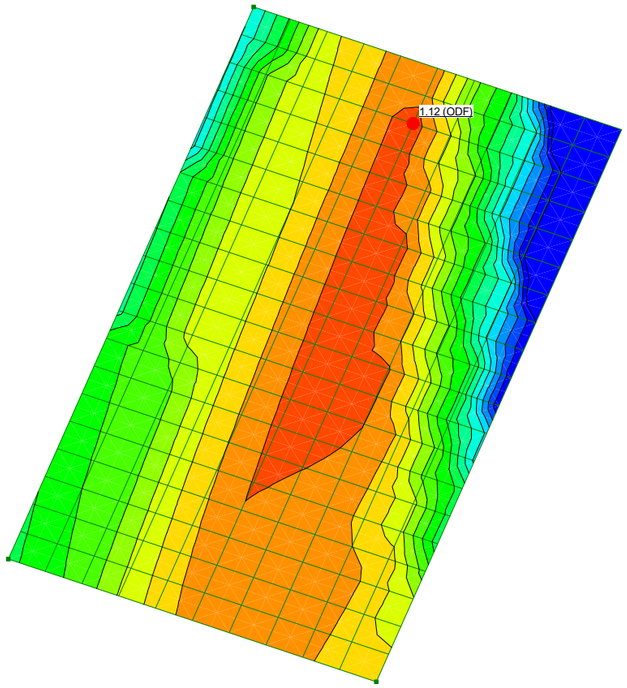


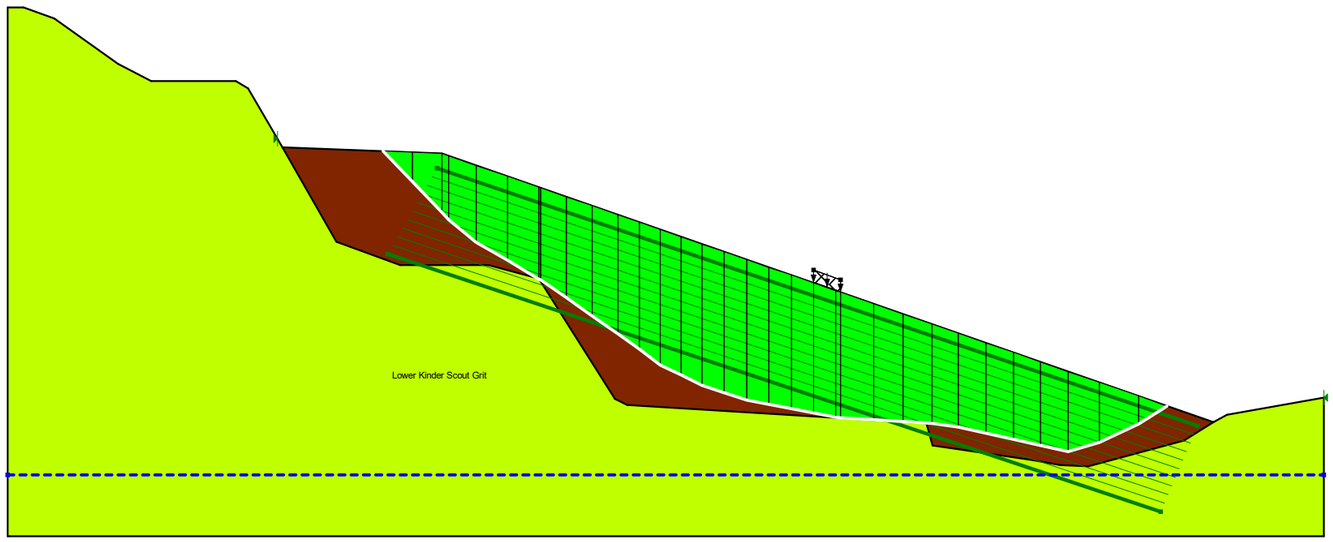


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (B2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/21

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

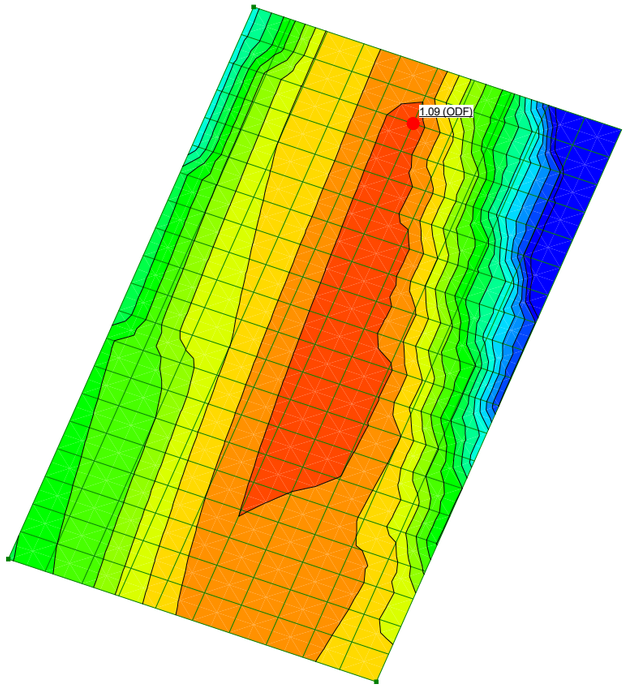


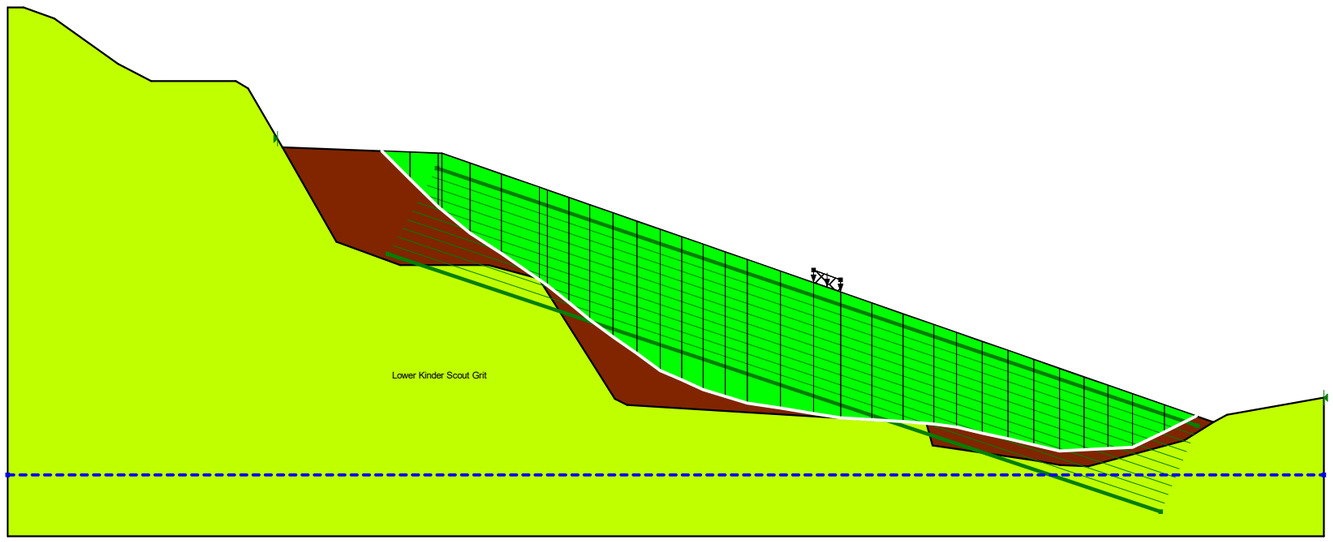


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (M1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/22

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Vertical (kPa)	C-Horizontal (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

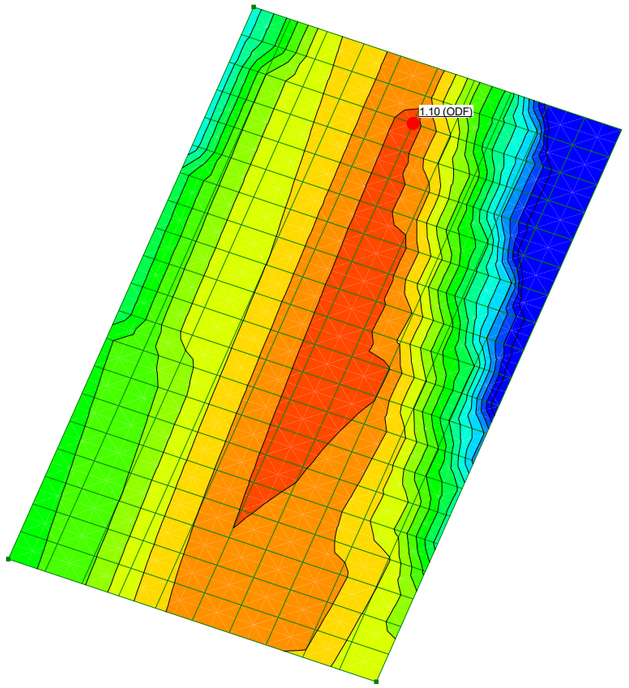


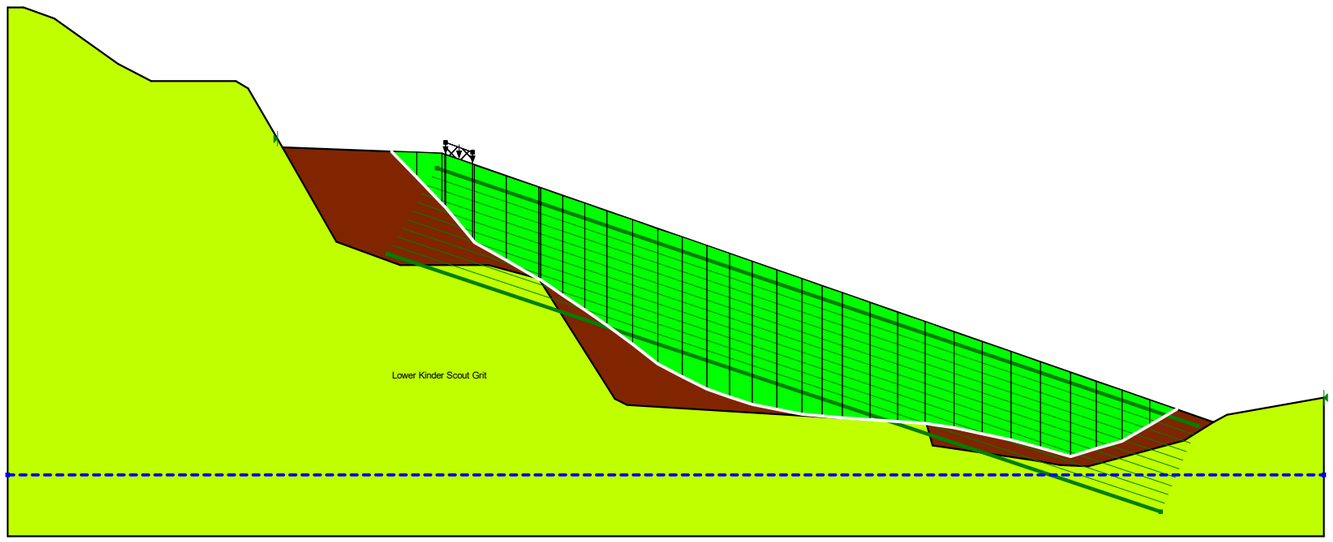


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (M2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/23

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Vertical (kPa)	C-Horizontal (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

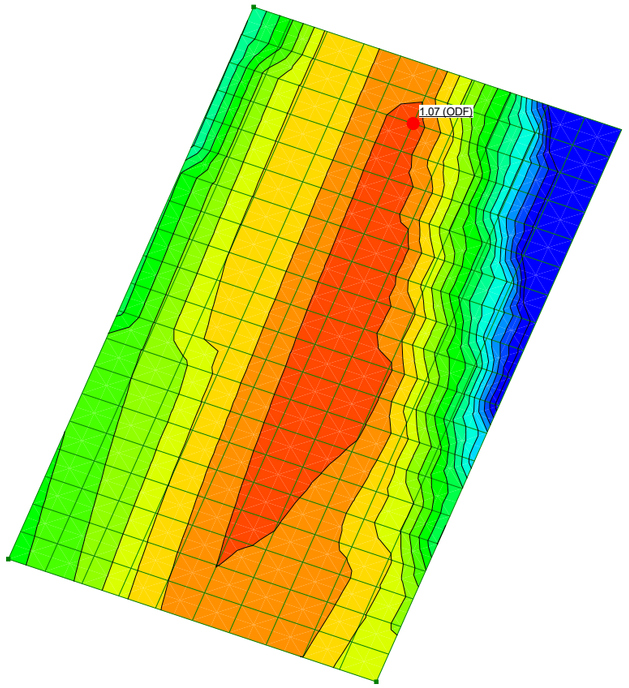


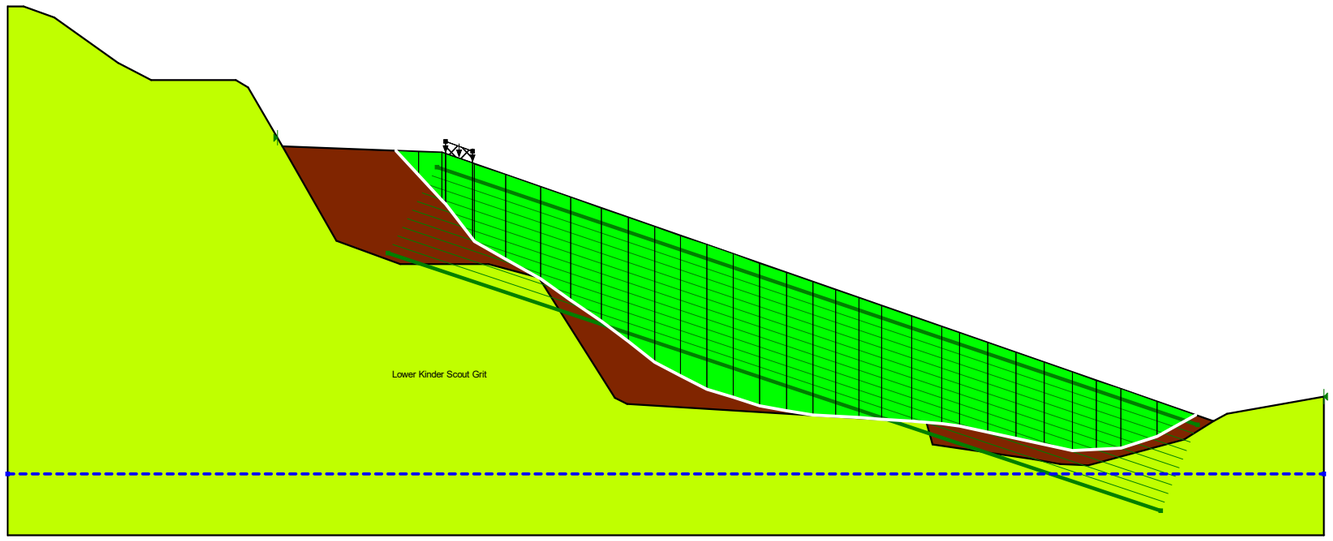


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (T1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/24

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

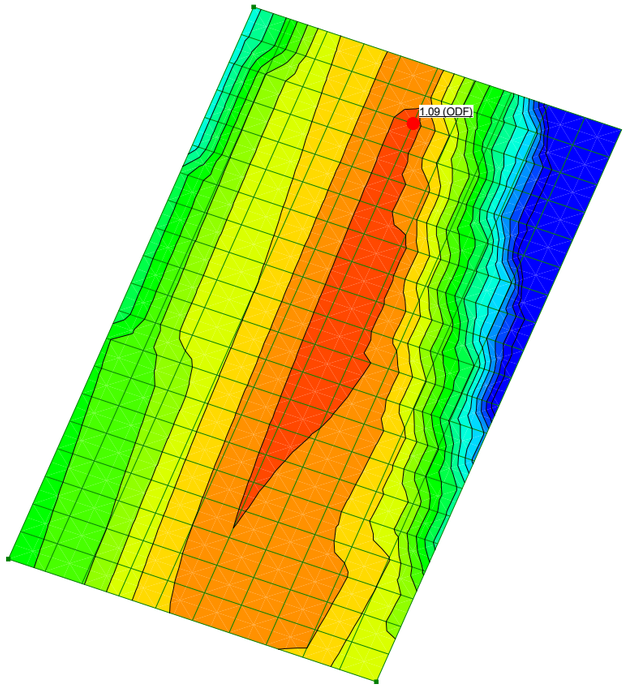


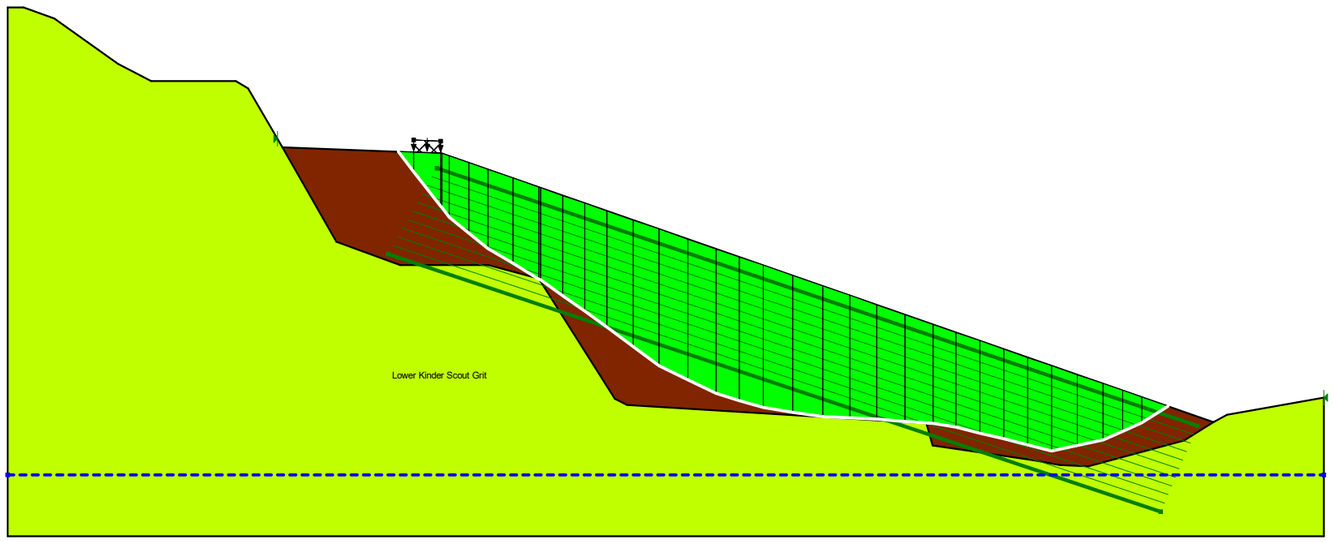


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (T2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/25

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						

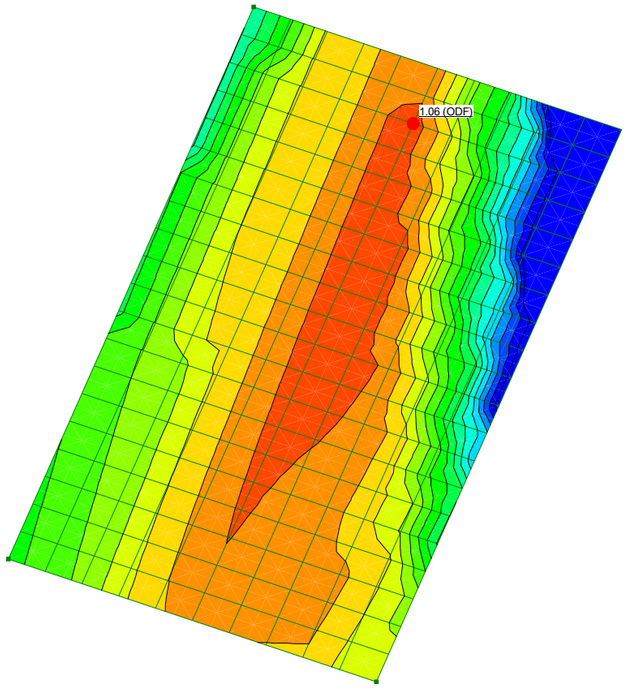


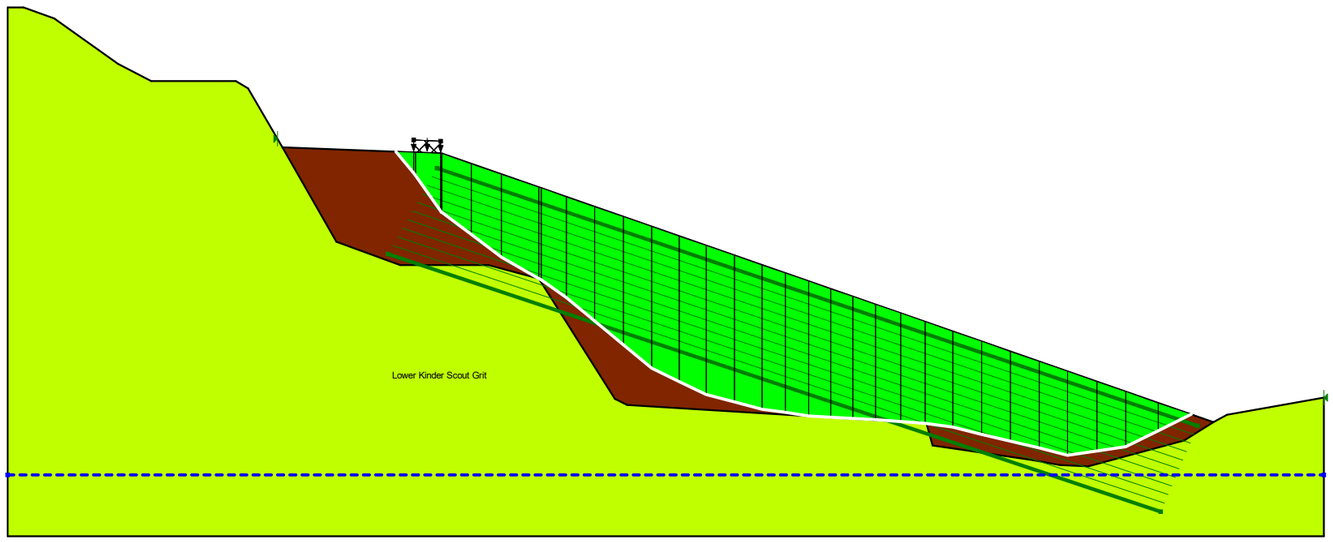


Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (C1) using Eurocode 7 - DA1, C1	Project No:	4859	Sheet No:	Fig. C/26

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	C-Horizontal (kPa)	C-Vertical (kPa)	Phi-Horizontal (°)	Phi-Vertical (°)	Phi-B (°)	Piezometric Line
	Lower Kinder Scout Grit	Anisotropic Strength	20		0	8,000	30	0	0	1
	New Fill (Undrained)	Undrained (Phi=0)	18	55						





Scale: 1:500

Client:	Churchill Enviro	TerraConsult Ltd.	Suite 104, Mere Grange Business Park St. Helens, WA9 5GG		
Project:	Buckton Vale Quarry Access Road	Prepared By:	Simon Ferley	Date:	28/05/2021
Sheet Title:	Section C-C' Undrained (C2) using Eurocode 7 - DA1, C2	Project No:	4859	Sheet No:	Fig. C/27







TerraConsult

Leaders in waste management environmental & ground engineering consultancy

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