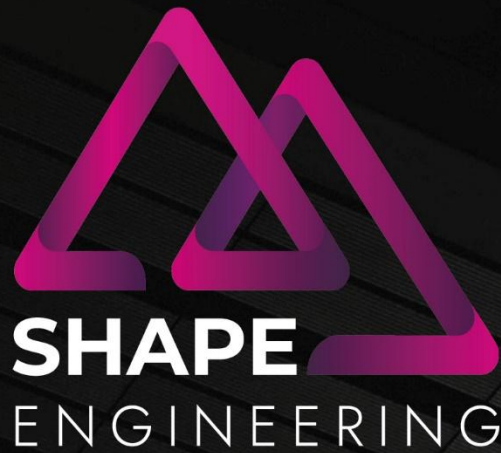




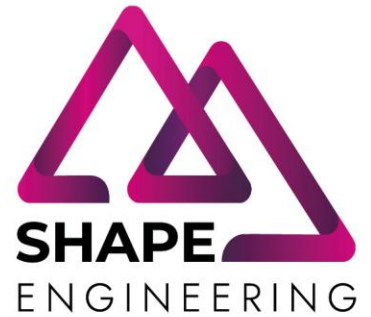
ROYLE ROAD, ROCHDALE

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

27th April 2026
Revision C

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1.0 INTRODUCTION

- 1.1 Shape Engineering have been commissioned by BMC Rochdale Limited to provide a Flood Risk Assessment (FRA) and Drainage Strategy (DS) in respect of a Planning Application for a residential development comprising a single apartment block providing 75 units and associated car parking at Royle Road, Rochdale. An approximate postcode for the site is OL11 3ET.
- 1.2 In accordance with national planning policy, the site-specific Flood Risk Assessment will review all sources of flood risk to both the proposed development and to the adjacent areas as a result of the development proposals
- 1.3 The flood risk assessment and drainage strategy will aim to mitigate any potential flood risk as a result of the development.

2.0 SITE DESCRIPTION

Existing Development

2.1 The site is located at Royle Road, Rochdale. An approximate postcode for the site is OL11 3ET and NGR SD887117. The location of the existing site is indicated in Appendix A.

Area	1.55 hectares or 15,530m ²
Existing Surfacing	The existing site is currently under construction in support of the adjacent development to the south.
General Topography	<i>A utilities survey has been completed by JLP Surveying in June 2018.</i> <i>At the west, the site boundary is identified as being 122.5m AOD. The eastern boundary of the site is identified as being circa 133.5m AOD.</i> <i>At the time of the survey, areas of greenspace were identified at the outer boundaries of the site and wooded areas and undergrowth were identified at the centre.</i> <i>Generally, the site falls from the southern extent which is also 133.5m AOD to the north where levels drop to circa 122.5m AOD.</i>
Current Use	At present, the southern extent of the site is operating to support construction of the adjacent development.
Previous Use	A large extent of the site has previously been associated with a Minky Works. This comprised a large industrial unit with associated highways. The rest of the site remained as greenspace.

		When the works was no longer in use, it was demolished leaving the site a mixture of greenfield and brownfield.
Watercourses		Approximately 250m north-west of the site is Sudden Brook which flows into the River Roch north-west of the site. Approximately 220m to the south of the site is Rochdale Canal. The canal appears to be culverted south-east of the site, transporting the canal beneath the A627 (highway).
Boundaries	North	Greenspace and Edinburgh Way (highway) beyond.
	East	Greenspace and a railway line beyond.
	South	Existing residential development and new residential development construction.
	West	Fuel station and supermarket with associated car parking and highways.
Access	Vehicular	Silk Street and Royle Road at the eastern boundary of the site.
	Pedestrian	Silk Street and Royle Road at the eastern boundary of the site.

2.2 The total site area is 1.55 hectares or 15,530m² and comprises a mixture of open greenspace at the northern extent. The southern extent is currently under construction to support an adjacent development to the south of the site.

The site can be seen from an aerial photograph in Figure 1 below.



Figure 1 - Site Plan (Source: Google Earth Pro, 2025)

Proposed Development

- 2.3 The development proposals are to provide a residential development providing 75 accommodation units in the form of a single apartment block with associated highways and car parking with a mixture of hard and soft landscaping. An extract of the development masterplan is provided below in Figure 2. The full masterplan is included in Appendix B.



Figure 2 - Development Masterplan

- 2.4 Vehicular access is proposed via the existing adjacent Royle Road and Silk Road, both providing an entrance at the western boundary of the site.

2.5 Pedestrian footpaths are located throughout the site.

3.0 POLICY & GUIDANCE

National Planning Policy Framework

- 3.1 The National Planning Policy Framework (NPPF) was published in England in March 2012 and the latest re-issue on 12th December 2024.
- 3.2 The NPPF is to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk.
- 3.3 This document has been prepared in accordance with the recommendations and the policies contained within the NPPF 2024.

Planning Policy Guidance

- 3.4 The Planning Policy Guidance for flood risk and coastal change advises how to take account of and address the risks associated with flooding and coastal change in the planning process.
- 3.5 Proposed developments are required to increase the promotion of Natural Flood Management (NFM) techniques in new developments with specific emphasis on de-culverting and re-naturalisation of watercourses.
- 3.6 More emphasis on SuDS providing the '4 pillars' of SuDS which are: water quantity, water quality, biodiversity and amenity is also required.

Flood and Water Management Act 2010

- 3.7 The Flood and Water Management Act 2010 received Royal Assent on 8th April 2010. This Act provides duties on the Environment Agency, Local Authorities, Developers and other bodies to manage flood risks.

LLFA Technical Requirements

- 3.8 The LLFA for the area is Rochdale Metropolitan Borough Council. An approach has been made to the LLFA for pre-development enquiry advice. Once advice is received, this should be incorporated into the flood risk consideration and proposed drainage strategy for the development.

4.0 EXISTING SITE CHARACTERISTICS

Greenfield runoff rate

- 4.1 The site currently is a mixture of greenfield and brownfield. However, at present the site is not positively drained. Therefore, the greenfield runoff rate will be used to inform the surface water discharge rate of the site.
- 4.2 The site has an area of 1.55ha. Using this area, an assessment of the existing greenfield runoff rates, has been undertaken using the UK SuDs website. Calculations are summarised in the table below.

Return Period (Yr.)	Existing Runoff Rate (l/s)
1 Year	0.40
30 Year	0.80
100 year	0.90
QBar	0.45

- 4.3 The greenfield runoff rate (QBar) for the 1.55ha development site has therefore been calculated as 0.45l/s. The greenfield runoff calculations are provided in Appendix C.
- 4.4 From the HR Wallingford research (SR580; HR Wallingford, 2002); "It is believed that the default value equivalent to Qbar or Qmed of 3 l/s/ha is adequate for general use for the purpose of estimating drainage runoff control"
- 4.5 Furthermore, as recommended in current guidance and SUDS Standards (UK SUDS) the 2l/s/ha should be considered a cut-off rate to avoid the lower flow rates resulting from the use of FSR soil types 1 and 2 in the greenfield equations.
- 4.6 Based on a 1.55ha site area, a 3l/s/ha greenfield rate would equate to 4.65l/s.
- 4.7 A rate of 4.5l/s has been proposed for the site to meet the requirements of a standard flow control unit.

Existing Public Sewers

- 4.8 Records from United Utilities show that there is a 300mm Combined water Sewer which flows west across the northern extent of the site. The sewer then upsizes to 600mm before flowing southwest at the western boundary of the site.
- 4.9 There is also a combined sewer that flows north in Royle Road to the west of the site. This sewer joins the 600mm sewer at the west of the site.
- 4.10 A surface water sewer and foul water sewer flow in Royle Road to the west of the site.
- 4.11 At the southern extent of the site, there is a 225mm surface water sewer and a foul water sewer that both flows south towards the new adjacent residential development. Both sewers appear to be serving dwellings as part of the adjacent development.
- 4.12 There is also a series of surface and foul water sewers at the eastern extent of the site which also appear to be serving the residential development to the south of the site.
- 4.13 See Appendix D for United Utilities records.

Watercourses, Land Drainage and other Waterbodies

- 4.14 Approximately 250m north-west of the site is Sudden Brook which flows north into the River Roch north-west of the site.
- 4.15 Circa 220m to the south of the site is Rochdale Canal. There appears to be a culvert south-east of the site which transports the canal beneath the A627 (highway).

Existing Flood Defences and Other Structures

- 4.16 There are no flood defences recorded within close proximity of the development.

Historical Land Use

- 4.17 The site was formerly greenfield.

Geology

- 4.18 A ground investigation was carried out by Remedy Geotechnics in 2022. Given the topography of the site, a reinforced soil slope is proposed as part of the development plans. Remedy Geotechnics were consulted for the detailed design of the slopes.
- 4.19 The investigation found that within boreholes at the vicinity of the slope, made ground was encountered to depths of between 112.93 m BGL (metres below ground level) to 133.83m BGL. Glacio fluvial deposits were encountered between 118.31m BGL and 129.33m BGL. These layers were found to be underlain by a layer of Weathered Pennine Lower Coal Measures Formation.
- 4.20 During the investigation, groundwater levels were measured over a 13 day period. The results show that the groundwater levels varied from 0.5m BGL to 8.1m BGL.
- 4.21 A summary of the site investigation can be found in Appendix E.

5.0 FLOOD RISK SOURCE

- 5.1 Shape Engineering has considered all forms of flooding in accordance with National Planning Policy. Information has been obtained from the Government Website relating to flood risk and is summarised below.
- 5.2 The Environment Agency (EA) were approached by Shape with regards to available Product 4 data for the site. The full details of the flood risk assessment data provided by the EA in their response is included in Appendix F.
- 5.3 The EA have no past flooding data for this location.

Fluvial Flood Risk

EA Flood Map for Planning

- 5.4 Fluvial flooding (River Flooding) is defined as flooding resulting from a river overflowing its banks onto adjacent land. This can be caused by heavy rainfall, blocked channels, high tide levels, urbanisation or a combination of these.

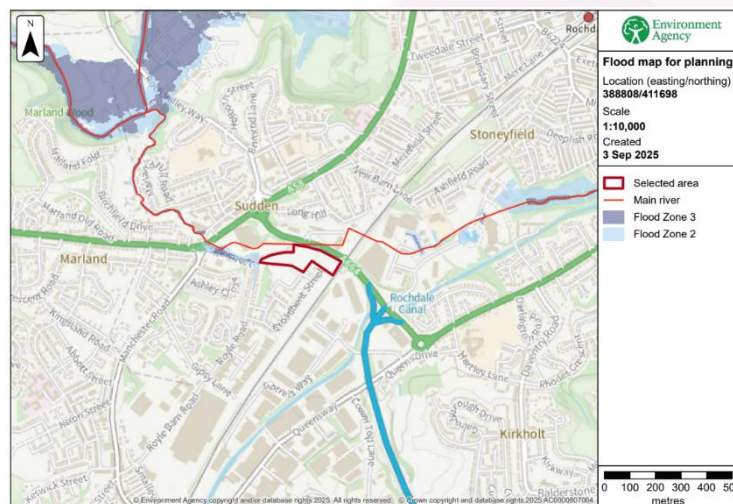


Figure 3 - Environment Agency's Flood Map for Planning (Source: EA Product 4 2025)

- 5.5 Examination of flood maps from the EA shows that the majority of the site is located within an area classified as Flood Zone 1. A small extent near the northern and western boundaries of the site are classified as Flood Zone 2.
- 5.6 The EA define Flood zone 2 as an area at risk of flooding for an undefended flood event with between a 0.1% and 0.5% probability of occurring in any year for flooding

from the sea or between a 0.1% and 1% probability of occurring in any year for fluvial (river) flooding.

EA Modelled Data

Modelled fluvial extents

- 5.7 The EA have modelled fluvial flood risk at the site for a range of Annual Exceedance Probability (AEP) events, with and without climate change (CC). The modelled outputs are provided in Appendix F.
- 5.8 Modelled scenarios have been completed for both – defended and defences removed storm events.
- 5.9 For defended and undefended fluvial modelled events;
 - 5.9.1 The site remains flood free for all events up to and including the 1 in 100 year (1% AEP) plus 70% climate change event
 - 5.9.2 The site remains flood free for all events up to and including the 1 in 1000 year (0.1% AEP) event

2013 Rochdale and Littleborough model

- 5.10 The 2013 Rochdale and Littleborough model produced by the EA, contains modelled nodes which lie within close proximity to the site. The modelled nodes are shown in Figure 4 below.



Figure 4 - Environment Agency's Rochdale and Littleborough Model Nodes (Source: EA Product 4 2025)

- 5.11 The site lies in between nodes 5 and 6. Node 5 is located approximately 250m west of the site and node 6 is located approximately 450m east of the site.
- 5.12 A summary of the flood level (mAOD) and flow rate (m³/s) for a range of undefended scenarios are shown in Table 1 below.
- 5.13 A summary of the flood level (mAOD) and flow rate (m³/s) for a range of defended scenarios are shown in Table 2 below.

	Node 5		Node 6	
	<u>Level</u>	<u>Flow</u>	<u>Level</u>	<u>Flow</u>
5% AEP	114.35	3.70	124.59	3.69
3.3% AEP	114.39	4.16	124.68	4.15
1.33% AEP	114.55	6.02	125.02	6.00
1% AEP	114.59	6.53	125.11	6.50
0.5% AEP	114.66	7.52	125.28	7.48
0.1% AEP	114.80	9.92	125.68	9.86
1% AEP + 20% CC	114.66	7.50	125.28	7.47
1% AEP + 35% CC	114.67	7.68	125.31	7.64
1% AEP + 70% CC	114.72	8.55	125.45	8.50

Table 1 - Environment Agency's Snipe Clough Model Undefended Events (Source: EA Product 4 2025)

	Node 5		Node 6	
	<u>Level</u>	<u>Flow</u>	<u>Level</u>	<u>Flow</u>
5% AEP	114.35	3.70	124.59	3.69
3.3% AEP	114.39	4.16	124.68	4.15
1.33% AEP	114.55	6.02	125.02	6.00
1% AEP	114.59	6.53	125.11	6.50
0.5% AEP	114.66	7.52	125.28	7.48
0.1% AEP	114.80	9.93	125.68	9.87
1% AEP + 20% CC	114.66	7.50	125.28	7.47
1% AEP + 35% CC	114.67	7.68	125.31	7.65
1% AEP + 70% CC	114.72	8.52	125.45	8.48

Table 2 - Environment Agency's Snipe Clough Model Defended Events (Source: EA Product 4 2025)

Assessment of Modelled Data

- 5.14 As shown in Figure 4 and Appendix F, a small extent at the northern and western boundaries of the site are located in Flood Zone 2.
- 5.15 As shown in Table 1, the highest flood level reached during undefended modelled scenarios is during the 1 in 100 year (1%) AEP plus 70% climate change event where levels reach 125.45m AOD at node 6.
- 5.16 As shown in Table 2, the highest flood level reached during defended modelled scenarios is during the 1 in 1000 year (0.1%) AEP event where levels reach 125.68m AOD at node 6.

Northern Extent Flood Zone 2

- 5.17 The topographical survey, included in Appendix G, shows that levels at the Flood Zone 2 extent at the northern boundary of the site are circa 122.5m AOD. The levels at this area rise after dense vegetation to circa 128m AOD.
- 5.18 The proposed development area at the site within the northern Flood Zone 2 extent is to remain as greenspace and highways.
- 5.19 Any potential flooding arising at this Flood Zone 2 extent, up to and including the 1% AEP plus 70% climate change event, would be remain in the open space before being directed away from the site following the natural topography.

Western Extent Flood Zone 2

- 5.20 The topographical survey, included in Appendix G, shows that levels at the Flood Zone 2 extent at the western boundary of the site are circa 121m AOD. There is then dense vegetation before levels then increase from circa 125.5m AOD to 128.5m AOD.
- 5.21 The proposed development area at the site adjacent to the northern Flood Zone 2 extent is to remain as greenspace and highways.
- 5.22 Any potential flooding arising at the western Flood Zone 2 extent, up to and including the 1% AEP plus 70% climate change event, would be located in open space before being directed away from the site following the natural topography.

Summary

- 5.23 The node 6 levels have been used to provide the worst-case modelled flood level scenarios for both the undefended and defended events. The site is downstream of node 6 and therefore the use of node 6 levels is conservative.
- 5.24 Given the topography of the site and the development proposals for the areas located in Flood Zone 2, water would remain in open space before being directed away from the site. Therefore, no flood mitigation measures are deemed necessary for this area of the site.

Pluvial Flood Risk

- 5.25 Pluvial flooding is defined as flooding resulting from rainfall-generated overland flow before runoff enters any watercourse or sewer.
- 5.26 The site is not at risk of surface water flooding during the 1 in 30 year (3.3%) AEP event.
- 5.27 At the northwestern extent of the site, the site is considered to be at risk of flooding from surface water during the 1 in 100 year (1% AEP) event, as shown in Figure 5.



Figure 5 - Environment Agency's flooding from surface water 1 in 100 AEP (Source: EA online maps 2025)

- 5.28 A large extent of the northern extent of the site is considered to be at risk of surface water flooding during the 1 in 1000 year (0.1%) AEP flood event, see Figure 6 below.
- 5.29 This area predominantly lies in the extent of the existing access road, which is to be improved as part of the development. All of the 'at risk' area is outside of any proposed habitable development area.

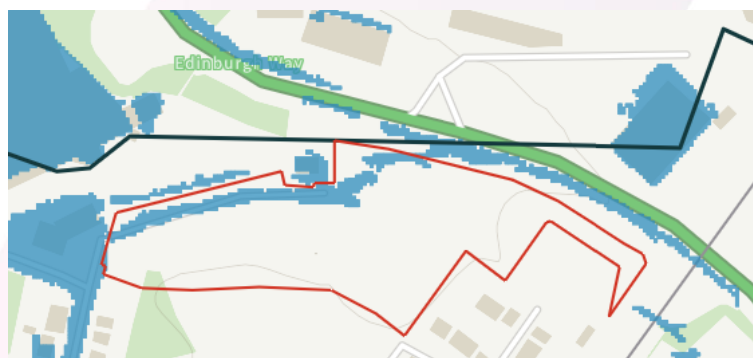


Figure 6 - Environment Agency's flooding from surface water 1 in 1000 AEP (Source: EA online maps 2025)

Environment Agency Reservoir or Canal Failure Flood Map

- 5.30 The Environment Agency website shows that the development site is not at risk of flooding from reservoirs or canal failures.

Groundwater Flood Risk

- 5.31 The Environment Agency define ground as: *'water that is usually held in rocks and soil underground. Groundwater flooding happens when this water rises and flows above the surface.'*
- 5.32 During the site investigation, groundwater was encountered across multiple boreholes. During the investigation groundwater levels were measured over a 13 day period. The results show that the groundwater levels varied from 0.5m BGL to 8.1m BGL. However, it should be noted that boreholes were only excavated within the vicinity of the proposed slope.
- 5.33 MagicMaps online indicates that the site is located within a medium-high groundwater vulnerability area.
- 5.34 MagicMaps also indicates that the site is not located within a groundwater source protection zone.
- 5.35 When natural groundwater levels are close to the surface, an increased risk of flooding can occur during intense rainfall.
- 5.36 The Rochdale Metropolitan Borough Council Flood Risk Management Strategy (2014-2024) indicates that the site is at risk of groundwater flooding.

Sewer Flood Risk

- 5.37 Sewer records indicate that there is a 300mm Combined water Sewer which flows west across the northern extent of the site. There is also a 375mm combined sewer that flows north in Royle Road to the west of the site.
- 5.38 At the southern and eastern extents of the site, there is a series of surface water and foul water sewers which appear to be serving the new residential development to the south of the site.

- 5.39 It is not known whether there are any existing flood issues with these existing sewers.
- 5.40 The Rochdale Metropolitan Borough Council Flood Risk Management Strategy (2014-2024) and Preliminary Flood Risk Assessment (2011), along with its 2017 addendum, contain no record of historical flooding at the site.
- 5.41 Given that areas of the site are greenspace, there is a possibility that unrecorded land drainage and/or culverts are present within the development boundary.

Summary of Flood Risk

Source	Definition	Likelihood
Fluvial	River Flood	Low
Pluvial	Surface Water Flooding	Medium
Coastal - Sea	Tidal Surge	Not Applicable
Coastal - Estuarine	Tidal Surge	Not Applicable
SWS, FWS, CS, CSO	Sewer Flooding	Low
Groundwater	Emergence from ground	Low

6.0 SURFACE WATER DRAINAGE STRATEGY

Methods of Surface Water Management

6.1 As set out in Part H of the Building Regulations, there are four methods that have been reviewed for the management and discharge of surface water for the site which are detailed below; these may be applied individually or collectively to form a complete strategy. They should be applied in the order of priority as listed:

- Discharge via infiltration
- Discharge via watercourse;
- Discharge via surface water system;
- Discharge via combined water system;

Proposed Site Drainage

Discharge by Infiltration

6.2 The information provided by the ground investigations at the site, as identified in Section 4, suggests that the cohesive underlying geology is not suitable for infiltration drainage techniques.

6.3 Testing in accordance with BRE365 will be required to determine if this is a viable option.

Discharge by watercourse

6.4 The nearest open watercourses within the vicinity of the site are circa 200m from the site and therefore it is not considered feasible to discharge surface water from the site to a nearby watercourse.

6.5 However, a culverted watercourse is indicated on the UU asset maps to the western boundary of the site. Records indicate this sewer is at a favourable depth for a gravity connection from the development site at circa 3.0m deep.

6.6 Therefore, discharge to the culverted watercourse will be considered as the preferred option for the development.

6.7 Flow will be restricted at the site using 2No. flow control chambers.

Discharge by Surface Water System

- 6.8 United Utilities Asset maps have been obtained, see Appendix D.
- 6.9 The UU asset plans and JLP survey show that there is a surface water sewer west of the site in Royle Road.

Discharge by Combined Water System

- 6.10 A 375mm combined sewer is located to the western boundary of the development site.
- 6.11 Additional information and confirmation regarding the condition of the sewers will be required regarding the surface water sewers in Royle Road prior to submitting a pre-development enquiry to United Utilities.

Climate Change

- 6.12 The updated EA allowances have now been directly linked to River Basin Catchments. The climate change allowance has been reviewed using the Environment Agency's website to locate the River Basin Catchment for the site's location.
- 6.13 The site is in the Irwell Management Catchment. The below Figure 7, an extract from the Environment Agency's website, indicates the climate change considerations for this catchment.

Irwell Management ⊗ Catchment peak rainfall allowances

3.3% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	25%	35%
2070s	30%	40%

1% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	25%	40%
2070s	30%	45%

*Use '2050s' for development with a lifetime up to 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.

Figure 7 - Environment Agency's climate change considerations (Source: EA website 2025)

- 6.14 As recommended by the EA, both the central and upper end allowances have been considered for the purpose of surface water drainage strategy and assessment of exceedance flow pathways.
- 6.15 Therefore, the climate change allowance for the site has been identified at 45%. This is due to the development having a lifetime between 2061 and 2125. Additionally, the 1% annual exceedance rainfall event is utilised as the 3.3% rainfall is not a requirement.

7.0 SUDS ASSESSMENT

7.1 As SUDS assessment for the proposed development site has been completed. SUDS techniques for the development site have been considered in the table below:

SuDS Technique	Suitable for This Development?	Reasoning
Green Roof	✗	Impractical due to minimal roof area available and residential nature of development.
Rainwater Harvesting	✗	Impractical due to the minimal roof area available.
Basins or Ponds	✓	Suitable in principle as a form of attenuation storage without infiltration. However, due to steep topography of the site, these are likely impractical within the constraints.
Filter Strips	✗	Ground investigation shows cohesive nature of underlying ground is not suitable for infiltration techniques and ground water was encounter at shallow depths.
Swales	✗	Generally not suitable due to the steep site topography.
Infiltration Techniques	✗	Ground investigation shows cohesive nature of underlying ground is not suitable for infiltration techniques and ground water was encounter at shallow depths.
Permeable Surfaces	✓	Ground investigation shows infiltration techniques are not feasible and ground water was encounter at shallow depths. However, lined permeable surfaces with positive discharges to the sewer could be utilised, in shared parking areas, to improve water quality, if needed, as a form of source control.
Tank / Oversized Pipe Systems	✓	Suitable.

7.2 The SUDS assessment suggests that several options are available for SUDS techniques on the site. Although the steep site topography is likely to limit the ability of above ground SUDS features to achieve their intended goals.

- 7.3 A review of the proposed site levels and topography, along with site constraints of the outfall locations and levels would further limit the usage of SUDS to buried features only, such as oversized pipes and tanks.
- 7.4 Permeable surfacing to shared parking areas to be maintained by a management company should be considered in the drainage design.
- 7.5 It is not considered practical to employ permeable surface to private properties due to the maintenance requirements.

8.0 SURFACE WATER DRAINAGE STRATEGY

- 8.1 A proposed Drainage Strategy drawing has been provided in Appendix H. The drainage strategy is subject to detailed design and coordination with other design elements of the proposed development.
- 8.2 As noted above in the hierarchy review, discharge of surface water runoff via surface and combined water sewers at the site are the preferred methods for the purpose of this report.
- 8.3 The proposed impermeable area for the site is estimated to be 0.229ha (subject to detailed design) which consists of an apartment block, private access, footpaths and highways. All these areas will generate surface runoff.
- 8.4 Due to the nature of the proposed development, urban creep is to be considered to allow for future urban expansion within the development. An increase in paved surface area of 10% is to be incorporated into the detailed surface water calculations.
- 8.5 The impermeable area of the site is 0.461ha when accounting for urban creep.
- 8.6 The surface water drainage strategy for the development will be to collect and convey the surface water runoff and mitigate flood risk to the site, surrounding areas and downstream, by restricting the discharge rate into the sewer system and providing suitable attenuation within the development boundary.
- 8.7 The surface water sewer network will be designed to ensure all flows from up to and including the 1 in 100 years plus 45% will be attenuated below ground, controlled surface ponding will be acceptable up to the 1 in 100-year event plus 45% climate change and no flooding off site will occur due to the development.
- 8.8 Due to the surface water flow being restricted, attenuation will be required for the site. The attenuation volume for the development site has been calculated based on an impermeable area of 0.461ha and will cater for up to the 1 in 100-year storm + 45% climate change.

- 8.9 A storage estimate for the development site has concluded that between 120m³ and 206m³ of storage will be required for the 30-year storm event, as Figure 8 below.

Storage Estimate

Return Period (years)	30
Climate Change (%)	0
Impermeable Area (ha)	0.461
Peak Discharge (l/s)	4.650
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m ³)	Calc
from	120
to	206

Figure 8 - Quick Storage Estimate for 30yr Storm event (Flow 2025)

- 8.10 A storage estimate for the development site has concluded that between 297m³ and 460m³ of storage will be required for the 100-years plus 45% climate change storm event, as Figure 9 below.

Storage Estimate

Return Period (years)	100
Climate Change (%)	45
Impermeable Area (ha)	0.461
Peak Discharge (l/s)	4.650
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m ³)	Calc
from	297
to	460

Figure 9 - Quick Storage Estimate for 100yr+45% Storm event (Flow 2025)

- 8.11 Attenuation will be provided in the form of 3No. attenuation tanks to be located at the western extent of the development to accommodate the development site prior to entering the existing surface water sewer network.
- 8.12 Attenuation tanks have been sized to accommodate the 1 in 100 year plus 45% CC event.

- 8.13 Additional storage will be provided in the form of oversized pipes. A series of 750mm surface water pipes will be used prior to surface water entering the attenuation storage tanks.
- 8.14 The discharge rates have been set to 2.5l/s and 4.5l/s for the 2no. flow control chambers.
- 8.15 Given attenuation is also to be provided in the form of oversized pipes with a 750mm diameter, a rate of 4.5l/s will ensure there are minimal blockages at the site.
- 8.16 The attenuation tanks have been sized up for the development requiring 3 tanks with volumes of 48m³, 168m³ and 219.6m³ and additional storage provided within oversized pipes before entering the attenuation tanks. Final attenuation size is to be determined at detailed design stage.
- 8.17 Surface water flood exceedance routes have been considered, and a flood exceedance plan has been provided in Appendix I. This will be refined following completion of the proposed finished levels strategy for the development.

9.0 FOUL WATER DRAINAGE STRATEGY

Foul Water Capacity and Point of Connection

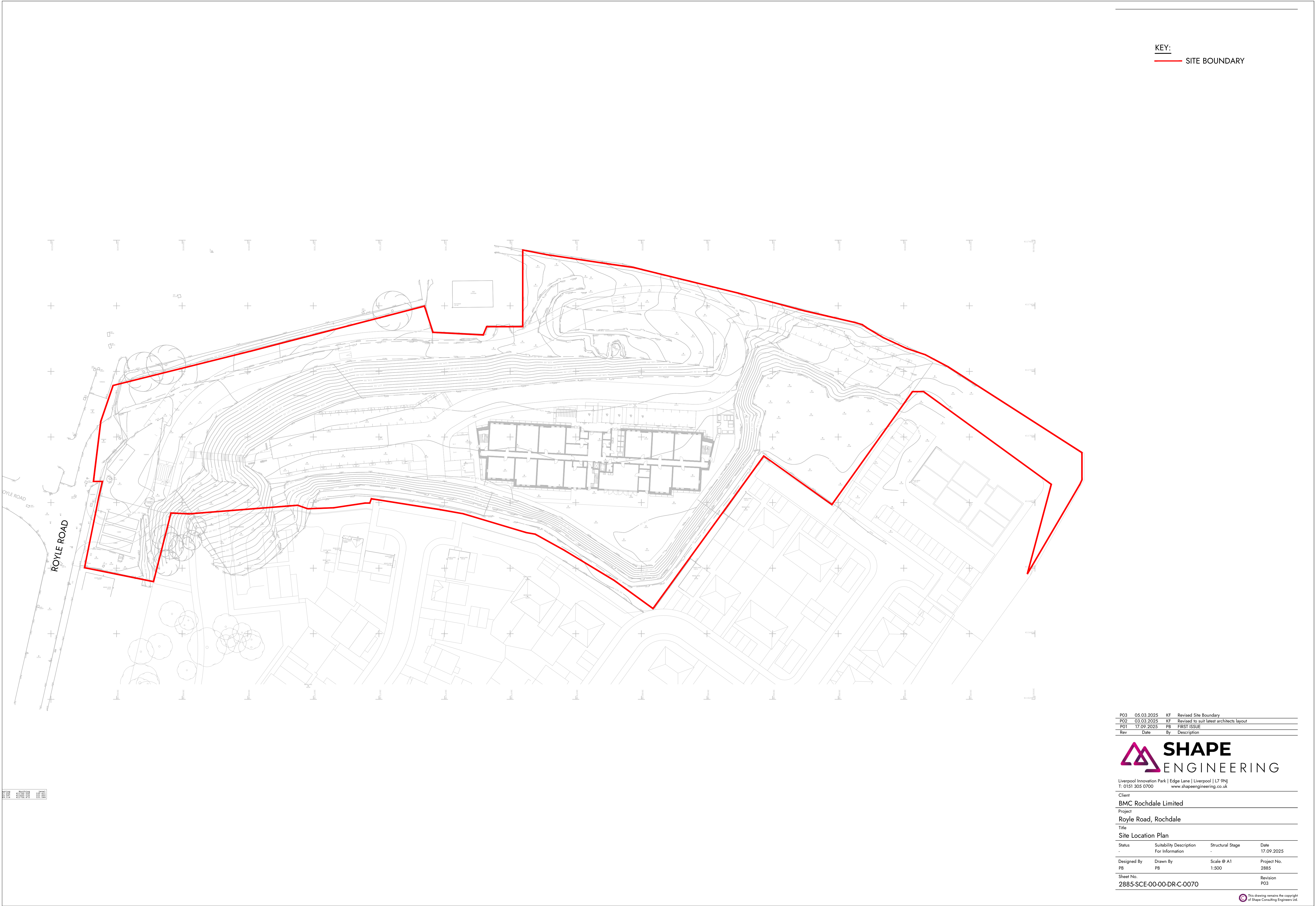
- 9.1 Foul water from the apartment block will be collected via a traditional piped network.
- 9.2 There is a foul water sewer flowing in Royle Road.
- 9.3 The foul water drainage from the apartment block is proposed to connect via a traditional piped network to the existing foul water sewer at the west of the site in Royle Road via gravity.
- 9.4 The exact outfall location is to be confirmed during detailed design once drainage surveys can confirm the existing sewer locations outfalls to the public sewer are agreed with the sewerage undertaker.
- 9.5 The proposed foul network is outlined within the proposed drainage strategy in Appendix H.
- 9.6 The proposed foul flows have been calculated using 4000 litres per dwelling per day as per the DCG, and therefore the proposed foul peak flow is 3.47l/s.

10.0 SUMMARY & RECOMMENDATIONS

- 10.1 Shape Engineering have been commissioned by BMC Rochdale Limited to provide a Flood Risk Assessment in respect of a planning application for 75 new accommodation units in the form of a single apartment block with associated landscaping, access road, highways and parking.
- 10.2 The existing site currently has a total area of 1.55ha.
- 10.3 The majority of the site is in an area with less than 0.1% risk of fluvial flooding (Flood Zone 1). Based on NPPF 2021 the development proposal is wholly suitable in terms of flood risk as it is a more vulnerable development.
- 10.4 The private drainage network will be designed for up to 1 in 100 year plus an allowance of 45% climate change storm events and consideration will be given to the use of sustainable urban drainage (SuDS) techniques.
- 10.5 Ground investigation information confirms that infiltration-based drainage techniques are not suitable for the site given the cohesive nature of the underlying ground.
- 10.6 There are no watercourses within the vicinity of the site therefore it is not considered feasible to discharge surface water runoff from the site via a waterbody.
- 10.7 The proposed surface water discharge rate for the development is restricted to 4.5l/s. The discharge rate will need to be accepted and confirmed by the LLFA. The discharge from the site will be controlled by 2no. flow control units.
- 10.8 Attenuation storage will be provided in the form of 3no. attenuation tanks to accommodate the development.
- 10.9 Additional storage will be provided in the form of 750mm oversized pipes to accommodate surface water prior to entering attenuation tank storage.
- 10.10 SuDS features are to be used on site with being implemented in the strategy to reduce surface water runoff rates. Further discussions and investigations are required to confirm the suitability of SuDS features for detailed design.

- 10.11 Foul water flows are to be collected via a traditional piped network and connect into the existing foul water sewer in Royle Road. The proposed peak flow is 3.61l/s, as per the 4000 litres per dwelling per day method.
- 10.12 Surface water and foul water proposals are subject to approval and agreement with the EA, LLFA and Sewerage Undertaker (United Utilities).
- 10.13 The flood risk and drainage strategy proposals will not increase flood risk to the site and surrounding areas.

11.0 APPENDIX A – SITE LOCATION PLAN



P03	05.03.2025	KF	Revised Site Boundary
P02	03.03.2025	KF	Revised to suit latest architects layout
P01	17.09.2025	PB	FIRST ISSUE
Rev	Date	By	Description

SHAPE
ENGINEERING

Liverpool Innovation Park | Edge Lane | Liverpool | L7 9NJ
T: 0151 305 0700 www.shapeengineering.co.uk

Client
BMC Rochdale Limited

Project
Royle Road, Rochdale

Title
Site Location Plan

Status	Suitability Description For Information	Structural Stage	Date 17.09.2025
Designed By PB	Drawn By PB	Scale @ A1 1:500	Project No. 2885
Sheet No. 2885-SCE-00-00-DR-C-0070			Revision P03

12.0 APPENDIX B – MASTERPLAN





01 Proposed Site Plan

Area Schedule		
Area	Type	Description
966.59 m ²	BTP - Adopted Footpath	Light Grey
2069.78 m ²	BTP - Adopted Road	Dark Grey
885.09 m ²	BTP - Car Park	Dark Brown
44.13 m ²	BTP - Gravelled Area	Light Brown
623.07 m ²	BTP - Paving	Light Grey
3101.12 m ²	BTP - POS Zone	Dark Green 2
595.73 m ²	BTP - Private Garden	Light Green
548.42 m ²	BTP - Unadopted Drive	Light Brown
8833.93 m ²		

Schedule of Accommodation

Apartment Building
1B2P - No. 38 units
2B3P - No. 37 units
Total: 75 units

GIA = 5,679 sqm

Car Parking
Total spaces **74 spaces**
including 5 disabled spaces

C	02.02.26	OM	Ramped access replaced by stair, adopted footpath added along one side of road per client request
B	27.01.26	OM	Site plan updated to S.E. road design, and recent top to which spoil mound is retained and plateau is widened.
A	20.08.25	OM	Apartment building revised, subsequent external works updated, EV charger provision added with amended parking layout where required. Substation added.
Rev	Date	Int	Description



CLIENT:
Mike McManus

PROJECT:
Royle Road, Rochdale

DESCRIPTION:

Proposed Site Plan

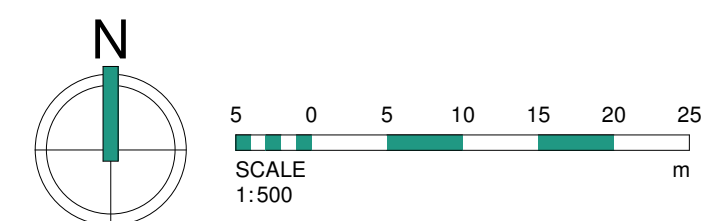
PURPOSE OF ISSUE:
Planning

DRAWN BY:	CHECKED	DATE:	SCALE @ A1:
OM	MA	02/05/24	1 : 500

JOB NO:	STATUS CODE:	DRAWING NO:	REV
4524	S0	105	C

FILE IDENTIFIER:
RR-BTP-00-SP-DR-A-4524_105.C

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13.0 APPENDIX C – GREENFIELD RUNOFF ESTIMATION

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Project details

Date	17/09/2025
Calculated by	PB
Reference	2885
Model version	2.1.2

Location

Site name	Royle Road
Site location	Rochdale



Site easting (British National Grid)	388844
Site northing (British National Grid)	411728

Site details

Total site area (ha)	1.55	ha
----------------------	-----------------------------------	----

Greenfield runoff

Method

Method	IH124
--------	-------

IH124

	<u>My value</u>		<u>Map value</u>
SAAR (mm)	1108	mm	1108
How should SPR be derived?	WRAP soil type		
WRAP soil type	1		1
SPR	0.1		
QBar (IH124) (l/s)	0.45	l/s	

Growth curve factors

	<u>My value</u>		<u>Map value</u>
Hydrological region	10		10
1 year growth factor	0.87		
2 year growth factor	0.93		
10 year growth factor	1.38		
30 year growth factor	1.7		
100 year growth factor	2.08		
200 year growth factor	2.37		

Results

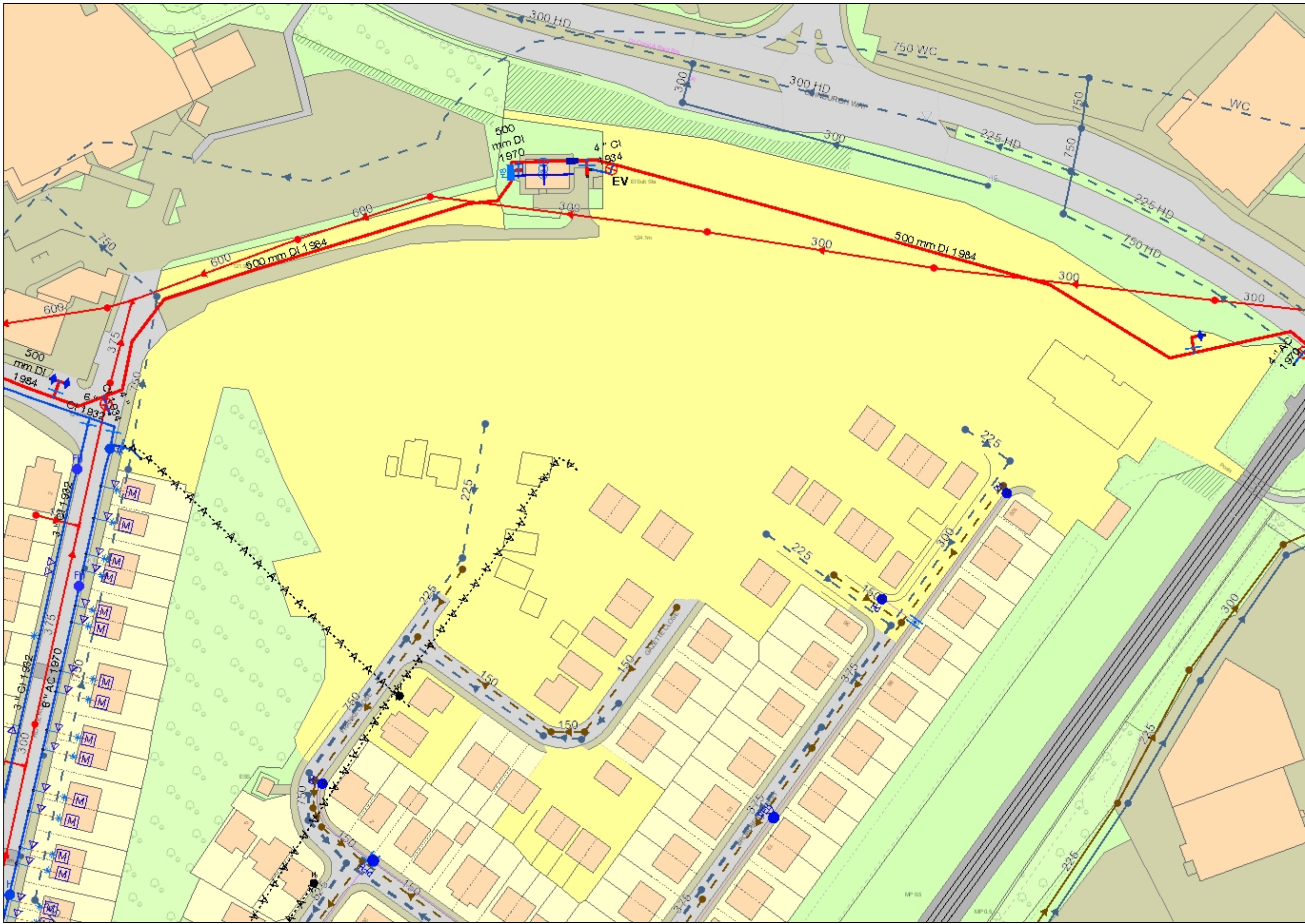
Method	IH124	
Flow rate 1 year (l/s)	0.4	l/s
Flow rate 2 year (l/s)	0.4	l/s
Flow rate 10 years (l/s)	0.6	l/s
Flow rate 30 years (l/s)	0.8	l/s
Flow rate 100 years (l/s)	0.9	l/s
Flow rate 200 years (l/s)	1.1	l/s

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent ‘zero’ figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

Disclaimer

This report was produced using the Greenfield runoff rate estimation tool (2.1.2) developed by HR Wallingford and available at uksuds.com (<https://www.uksuds.com/>). The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at uksuds.com/terms-conditions (<https://www.uksuds.com/terms-conditions>). The outputs from this tool have been used to estimate Greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, Centre for Ecology and Hydrology, Wallingford Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

14.0 APPENDIX D – UU / SURVEY SEWER RECORDS



United Utilities Maps
for SafeDig

Date :	19/08/2025 15:14:00
Centre X:	388778
Centre Y:	411662
Scale :	1000
UserName:	G4LG72Y

Extract from maps of United Utilities'
Underground Assets

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private service pipes may be shown by a blue broken line. United Utilities Water will not accept liability for any damage caused by the actual position being different from those shown.

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15.0 APPENDIX E – SITE INVESTIGATION



Project Title: Former Minky Works, Rochdale

Document Title: Geotechnical Design Report – North Boundary Reinforced Soil Slope Design

Client: Countryside Partnerships

Rev. C2 Dated: 09.06.23

Report Ref: 22.016_GDR_001



leave the ground to us

Remedy Geotechnics Ltd. Geotechnical Consultants

Document Control

Document: Geotechnical Design Report – North Boundary Reinforced Soil Slope Design

Project: Minky Works, Rochdale

Client: Countryside Partnerships

Report Number: 22.016_GDR_001

File Origin: C:\Users\DanielSimpson\RemGeo Dropbox\Dan Simpson\RemGeo Projects\2022
Projects\22.016_Rochdale, Former Minky Works_CP\5 Outgoing
Documents\GDR\22.016_GDR_001_C2_09_06_23.docx

Revision Number	Description	Prepared By	Date
C0	Issue 1	DS	07/04/22
C1	Lower (1v:2h) slope added	DS	17/05/22
C2	Slope sequencing revised	DS	09/06/23

Disclaimer: Please note 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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Appendices

Appendix A: Ground Investigation Information

Appendix B: Internal Slope Design and Bearing Capacity Calculations

Appendix C: Product Technical Specification

Statement on CDM Regulations (2015) and Residual Risks

CDM Regulations (2015)

The Client, Principal Designer and Principal Contractor for this project are subject to certain duties under the CDM (2015) Regulations. It is the duty of the Principal Designer to ensure that the client is aware of these duties prior to commencing the design. Remedy Geotechnics Ltd. is responsible for an elemental part of the design check only and is not undertaking the role of Principal Designer. This design has been undertaken on the premise that this duty has been carried out by others and no separate approach is required, in respect to this element of design, by Remedy Geotechnics Ltd.

Residual Risks

In accordance with the CDM (2015) Regulations, any specific design residual risks and construction sequences relevant to the reinforced soil slopes are given below. Whilst we have assessed the design risks for our works, we have only listed the risks we consider significant to the design of the reinforced soil slopes and which we consider are not likely to be obvious to a competent contractor or other designer. It is the responsibility of the Client and Principal Designer to ensure a competent Principal Contractor is appointed for these works.

The residual risks and construction sequences below should be added to any relevant construction drawing or method statements and copied to relevant designers and contractors on site.

Hazard	Potential effects	Mitigation
Falling from height	Injury to workforce	Temporary edge protection system which has been suitably designed and maintained must be provided by the reinforced slope contractor or the Principal Contractor during and following construction of the slope until permanent edge protection is in place.
Bearing failure of formation material	Excessive settlement / failure of the reinforced soil slopes	Imposed bearing pressures are provided within the report and compared with anticipated bearing resistances based on the limited information available within the ground investigation documents. The bearing resistance of the formation levels must be verified by testing.
Temporary excavation	Failure of temporary excavations leading to delay to site works, possible damage to plant or structures, injury to site workers.	Temporary works stability must be carried out by a suitably qualified geotechnical engineer. Earthworks shall be benched at a safe angle and shall be closely monitored on site and the heights of the excavations altered depending on the local site conditions. Unsupported excavations should be avoided during periods of wet weather
Unforeseen ground conditions	Adverse to the design	Ground conditions encountered during the excavation to the required formation levels should be checked against the assumed design profile and any variations from that assumed in the design must be reported immediately to the designer.

Hazard	Potential effects	Mitigation
Loading of reinforced soil slopes in excess of the design loads	Excessive movement or failure of the reinforced soil slopes	Access to the reinforced soil slopes must be restricted to prevent any loadings in excess of the design loading during construction, i.e. loading from piling rigs, cranes, etc. must be avoided as this will invalidate this design. Structures to the rear of the reinforced soil slopes cannot transfer any load to the reinforced soil slopes, including any traffic barriers.
Houses situated over the active wedge behind the reinforced soil walls with shallow foundations	Movement of the houses situated close to the back of the walls, leading to unacceptable differential settlement or total movement of houses.	Piled foundations are recommended where houses are proposed to be founded within the active wedge behind the retaining walls. This reduces the likelihood of movement.
Storage of heavy plant and machinery, including stockpiling behind the reinforced soil slopes.	Movement of the slopes and instability of the reinforced soil block.	Plant, equipment and stockpiles imposing a load exceeding 10kPa shall not be stored on the reinforced soil block, and shall remain a minimum of 10m from the back of the slope.
Poor quality reinforced soil infill	Failure or excessive deformation of reinforced soil slopes	The fill must comply to the project specification (Class 6i fill) with a minimum angle of friction of 37 degrees. The fill shall be placed and compacted in accordance with the SHW. Large shear box testing shall be carried out on samples of the fill prior to incorporation into the works (see project specification).
Poor quality reinforced soil backfill	Excessive deformation of the fill	The specification of the general fill within the proposed platform and to the rear of the reinforced soil slopes (outside the zone of the soil reinforcement) is also being carried out by others, who are understood to be appointed directly by Countryside Partnerships. The fill must be compatible with the fill requirements of the reinforced soil.
Incorrect sequencing / extent of temporary excavations	Temporary excavations that do not extend to an adequate distance beyond the geogrid reinforcements or are formed at an unstable angle leading to less engineered fill to the rear of the reinforced soil structures, therefore increasing the risk of overall failure.	The minimum extent of fill as shown in this geotechnical design report must be realised on site.
Incorrect sequencing	Excessive settlement or slope failure if the sequencing and timescales detailed in this report are not realised.	The construction sequence stipulated within this design report must be realised.
Failure to establish suitable face vegetation	Unightly looking slope face	The services of a qualified landscape architect should be sought to determine the correct planting of the slope without impacting on the

Hazard	Potential effects	Mitigation
		performance of the reinforced soil slope.
Deformation of the face of the slope	Settlement of the crest of the slope. Unsightly looking slope face.	The selection of a wrap around reinforced soil slope has been specified by others. Due to the soft nature of the facing and the specification to use site won fill deformation of the face is highly likely.
Inclement weather results in fill being unsuitable for use	Excessive deformation / settlement or failure of reinforced soil slopes. Delay to site works	Where the moisture content of the fill is above or below 2% of the optimum moisture content it shall not be used and an alternative granular source shall be sought (SHW Class 6I fill). Verification testing as required by the fill specification and this design report shall be carried out to verify that the fill has been supplied and placed in accordance with this design report.
Erosion of the 1:2 slope of the reinforced soil and 1:3 slope (unreinforced)	Unsightly looking slope face. Progressive failure of the slope	Suitable erosion protection to be provided around the face of the slope. Vegetation to be established on the slopes to provide suitable permanent surface erosion protection.
Slope built near to (but not over) over existing North West Water easement.	Damage or movement to the asset	Exact location of the pipe must be verified by the Principal Designer and must be adequately protected during the works. The effect of the slope surcharge on the sewer must be analysed by the Principal Designer and adequate protection measures put into place.
Settlement of the ground beneath the slope / fill	Differential settlement of the bund and the upper surface of the fill	The ground beneath the slope and fill is being improved by a contractor employed directly by Countryside Properties. The ground improvement design is being carried out by the contractor and is outside the scope of Remedy Geotechnics design. Immediate and consolidation settlement must be analysed by the ground improvement designer.
High porewater pressure build-up beneath the slope / fill due to rapid construction of the slope	Failure of the slope / embankment	Low strength parameters have been adopted for the insitu soils beneath the embankment, however, the ground improvement designer must consider drainage and the length of drainage pathways in the design of the ground improvement to ensure porewater pressures are rapidly dissipated during build up of the fill above. This is also related to consolidation settlement (see above).
Change in end use of the platform at the toe of the upper slope	Reinforced soil design incompatible with the requirements of the future development. Damage to the geogrids within the reinforced soil slope causing failure.	The area of fill downslope from the proposed 1:1 reinforced soil slope and behind the proposed 1:2 reinforced soil slope is up to 6m above existing ground levels and is currently intended to form a level platform to

Hazard	Potential effects	Mitigation
	Loading imposed behind the lower 1:2 reinforced soil slope in excess of those designed for, leading to excessive settlement and / or failure. Geogrid locations incompatible with future foundations and services.	accommodate a stock pile of site won material. It is understood that there are preliminary future plans to remove the stockpile of material from the platform and replace it with a further development, however, details of the proposed development have not been provided at this stage. The reinforced soil slopes covered by GDR therefore do not take into account any requirements of the future development (which at this stage are unknown). A separate design will be required by the future developer to take into account the requirements of the future development. It should be noted that any structures to the rear of the reinforced soil slopes should be piled and an assessment of the damage imposed by any such piling on the geogrids must be made by the future developer. This is beyond the current RGL scope.
Houses situated on fill / made ground to the rear of the walls	Settlement of houses leading to cracking	Design of the house foundations are outside the scope of this report. The house foundations should be designed by a suitably qualified geotechnical engineer and should consider the effects of building on engineered fill / existing made ground / glacial deposits. All fill should be adequately placed and compacted and verified on site by the Principal Contractor.
Poor drainage	Failure of the reinforced soil slope or any temporary works associated with the construction of the slope.	It is essential that crest drainage be provided to prevent any surface water run-off from above the reinforced soil slopes running onto the face of the slopes or percolating into the body of the reinforced soil. The crest drainage must capture any run-off and safely channel it to adequate discharge points located beyond the extents of the walls, for the design life of the structure. The reinforced soil block and backfill shall be drained using a geotextile wrapped flexible land drain located to the toe of the slopes and connected to the site drainage system so that any drainage water is safely transferred away from the reinforced soil slopes. The design of the site drainage system is outside the scope of this design report.

Hazard	Potential effects	Mitigation
Poor working platform for ground improvement rig	Failure of construction plant	The ground improvement contractor must carry out an adequate working platform design for the intended construction plant. No work can start until a properly designed and maintained working platform is provided. Note: this design report refers to temporary levels to the toe of the slope, which will form the working platform of the ground improvement. These levels are provided for the purposes of slope stability analysis only. However, this GDR does not constitute a working platform design whatsoever as this is outside of RGL scope of works.
Existing services / Utilities beneath the proposed slopes	Additional surcharge due to the raised site levels within and behind the slopes causing movement or damage to the utilities	All permits and permissions should be obtained by

1 INTRODUCTION AND SCOPE

Remedy Geotechnics Ltd (RGL) has been instructed by Countryside Partnerships (CP) to carry out the detailed design of a reinforced soil slope that runs along the northern boundary of the site.

The CP site layout plan shows that two reinforced soil slopes are required; an upper 1:1 slope and a lower 1(v):2(h) slope, with the two slopes forming a terraced structure separated by a level platform, which is to be surcharged by a 3m high stockpile of site won material.

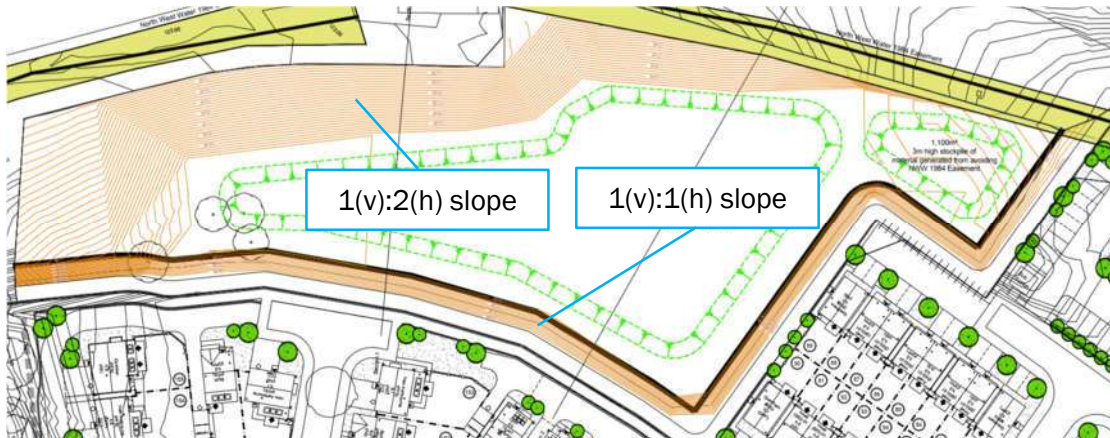


Figure 1: Proposed slope layout (extract from CP drawing PMCE-537-ENG-CF-01 Rev. C)

The lower 1:2 slope will be constructed first, followed by the upper 1:1 slope. The ground beneath the lower 1:2 slope has undergone ground improvement, which has been designed by others and is outside the scope of this design report.

It is understood that there are preliminary future plans to remove the stockpile of material from the platform and replace it with a further development, however, details of the proposed development have not been provided at this stage. It should be highlighted that the reinforced soil slopes covered by GDR do not take into account any requirements of the future development (which at this stage are unknown). A separate design will be required by the future developer to take into account the requirements of the future development on the platform. It should be noted that if any structures are proposed to the rear of the reinforced soil slopes, that they should be piled, and an assessment of the damage imposed by any such piling on the geogrids must be made by the future developer. This is beyond the current RGL scope.

The design of the ground improvement beneath the proposed filled platform, including the potential effects of immediate and long term settlements, is being carried out by others, who are understood to be appointed directly by Countryside Partnerships. The ground improvement designer must consider drainage and the length of drainage pathways in the design of the ground improvement to ensure porewater pressures are rapidly dissipated during build-up of the fill above. This is also related to consolidation settlement.

The specification of the general fill within the proposed platform (outside the zone of the soil reinforcement) is also being carried out by others, who are understood to be appointed directly by Countryside Partnerships.

The approximate overall slope dimensions along the NW boundary are summarised below:

Upper Slope (1:1):

- Length = 237m (approx.)
- Maximum Retained Height = 3.0m
- Vertical Area = 867m² (approx.)
- Slope area (at 45 degrees) = 1,226m² (approx.)

Lower Slope (1v:2h):

- Length = 186.5m (approx.)
- Maximum Retained Height = 8.0m
- Vertical Area = 904.2m² (approx.)
- Slope area (at 1v:2h) = 2,022m² (approx.)

The design of the reinforced soil slope is made on the basis that the upper slope will be constructed at a face angle of 45 degrees using Huesker Limited proprietary GRD Fortrac Natur reinforced soil system (or similar). The system utilises Fortrac Geogrids (BBA HAPAS Certificate 13/H197) for the main geogrids and a UV stabilised Huesker HaTe 23.142 (or similar) geogrid to retain the topsoil to allow for a 'green' vegetated face. The design of the planning and maintenance of the vegetated face is outside the scope of this design report.

A check has been carried out to ensure sufficient reinforcement is available to satisfy all modes of internal failure. Stability of the face is maintained by the geotextile wrap around anchorage into the slope. A check has been carried out to ensure there is sufficient length of geotextile embedded in the body of the slope to maintain stability against localised pull-out of the grid.

The lower 1v:2h slope is to be constructed using horizontal geogrid placed between the layers of compacted fill and overfilling then trimming the face and placing an erosion control mat over the face.

The reinforced soil slopes are to be backfilled, within the reinforced zone and beyond, with fill meeting the specification of class 6i fill in accordance with the Specification for Highways Works¹ (SHW) Series 600 and compacted using method compaction in accordance with Method 2 of SHW Table 6/4. A specification for the Class 6i material, incorporating the required verification testing, can be found on 22.016_DRG_001. Based on the limited testing carried out in the site investigation report, the fine to medium (sometimes gravelly) sand present across the majority of the site may provide a suitable source material for the Class 6i fill. RGL has not been provided with earthworks quantities for any cut and fill operation for the site, so it is not known at this stage whether there is excess fill available for filling the reinforced soil slopes.

A zone to the west, between the two reinforced soil slopes is proposed to be graded to a maximum slope gradient of up to 1v:3h (max), using fill material meeting the specification of Class 1A general granular fill in accordance with the Specification for Highways Works (SHW) Series 600 and compacted using the method compaction in accordance with Method 2 of the SHW Table 6/4.

The maximum design gradient of the unreinforced soil slopes is checked based on Bishop and Morgenstern charts of stability coefficients, described in further detail within this design report.

¹ Department of Transport, Manual of Contract Documents for Highway Works, Specification for Highways Works, Department of Transport. London: HMSO, 1993.

1.1 Limitations

Remedy Geotechnics Ltd (“RGL”) has prepared this Report for the sole use of CP (“Client”). No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by RGL. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of RGL. The proposals contained in this report rely upon information provided by others and upon the basis that this information is accurate and up to date. RGL have not been requested to independently verify the accuracy of information provided, and accordingly have no other option other than to place reliance on this information, as provided.

Construction of the works by the contractor will be taken as proof that all parties accept this design as complying with the project and approval requirements.

1.2 Responsibilities

Countryside Partnerships (Developer & Principal Designer):

- Provision of all information on ground conditions.
- Provision of the required site geometry, including determination of the earthworks.
- Design of adequate drainage to the toe and crest of the reinforced and unreinforced soil slopes, including drainage to prevent any water run-off to the rear of the slopes. The site drainage is to include provision for managing water flow to a safe discharge point away from the reinforced and unreinforced soil slopes.
- Design of landscaping / steep slopes / terraces beyond the crest or toe of the slopes, topsoiling, planting etc.
- Executing the main contract works in a manner that will not damage the reinforced and unreinforced soil slopes.
- Provision of suitable fill to the reinforced soil zone and backfill in accordance with SHW Series 600 6i material.
- Provision of suitable fill to the new and regraded slopes in accordance with SHW Series 600 class 1A material.
- Provision of suitable rear of slope drainage.
- Verification of the bearing resistance of formation soils.
- Design of the ground improvement (via a third party employed by CP).
- Specification of the fill material beyond the reinforced soil zone (via a third party employed by CP).
- Compliance with the sequencing of the works as set out in this GDR.
- Provision of an adequate working platform to the requirements of the ground improvement contractor.
- Protection of any utilities or assets that may be affected by or surcharged by the works.
- Obtaining all permissions, permits and approvals.
- Implementation of CDM mitigations described within this document.

Reinforced Slope / Earthworks Contractor – TBC :

- Placement of the geogrids and facing in accordance with the supplier's recommendations and the geogrid layout specified in this design report.
- Compaction of the infill and backfill within the reinforced soil structure and to the unreinforced slopes to achieve 95% dry density.
- Placement of the slope drainage.

- Verification that the proposed formation bearing resistance is adequate for the load imposed by the reinforced soil slope.
- Verification of the fill suitability in accordance with the earthworks specification.
- Verification testing to ensure that every layer of fill achieves 95% dry density.
- Presentation of the testing results in an earthworks validation report.

Remedy Geotechnics Ltd. (Reinforced Soil Slope and Designer)

- Determination of the strength, length and layout of the geogrids.
- Check overturning stability of the reinforced soil slopes.
- Check sliding resistance of the reinforced soil slopes.
- Calculation of imposed bearing pressures and check against the anticipated bearing resistances based on the limited information available within the ground investigation documents. (The bearing resistance of the formation levels must be verified by testing by the reinforced soil or earthworks contractor).

2 SPECIFICATION

In the absence of a particular specification, the design of the reinforced soil slopes will be carried out in accordance with BS8006-1:2010+A1:2016. The construction of the reinforced soil slopes and the materials used must comply with Section 3 of BS8006-1:2010+A1:2016, BS EN 14475:2006 and the geogrid supplier recommendations.

The design of the unreinforced soil slopes and overall stability of the reinforced soil slopes (failure planes passing beyond the majority of the main reinforced soil block) will be carried out in accordance with BS EN 1997-1:2004 'Eurocode 7: Geotechnical Design. Part 1: General Rules'.

2.1 Design Information

The design of the slope along the northern boundary has been based upon the following supplied information.

Site Investigation:

E3p; Supplementary Investigation Letter; Royle Road, Rochdale; Ref: 11-778-L5-2; April 2022

E3p; Phase I and Phase II Geoenvironmental Site Assessment; Royle Road, Rochdale; Ref: 11-778 - R1; October 2018

Drawings:

Countryside Properties; Royle Road, Rochdale; Off Site Regrading Works; PMCE-537-ENG-CF-01 Rev. C

Scope:

Email: 2022-03-10_161603_Matthew Brennen_RE Minky Works - Reinforced Earth Slope

3 SITE SETTING

The site is located approx. grid reference E388750, N411580. The site address is Former Royle Works, Royle Road, Rochdale, Lancashire OL11 3ET.



Figure 2: Site location Imagery © 2020 Google, Map data ©2020. Approximate site boundaries.

3.1 British Geological Survey (BGS) Map

The BGS online geology viewer based on the 1:50,000 geological map series records the site to be underlain by the following sequence of geology:

- Glaciofluvial deposits, Devensian – Sand and Gravel
- Pennine Lower Coal Measures Formation – Mudstone, siltstone and sandstone.

3.2 Site Investigation Data

The site investigation is described in the document listed in Section 2.1.

Table 1 describes the ground profile around the northern boundary slopes.

Table 1: Ground profile from boreholes near to Slope

Stratum	Top of Stratum mOD (mBGL)	Thickness m	General Description
Made Ground	133.83 to 112.93 (0)	0.6 to 4.8	Very loose to medium dense fine to coarse sand. Gravel is fine to coarse subangular to subrounded.
Glacio Fluvial	129.33 to 118.31 (0.6 -4.8)	1.0 to 11.2	Three general types: Very loose to Loose to medium dense fine to coarse SAND Firm very sandy very clayey SILT Firm to stiff very silty very sandy CLAY
Weathered Pennine Lower Coal Measures Formation	133.5 (approx. - BH level not provided on CP101) (19.95)	Not proven	Very stiff slightly gravelly sandy CLAY. Gravel is fine to medium subangular of sandstone and siltstone.

There is very little groundwater data from the available Ground Investigation data. Recent monitoring carried out over a period of 13 days from 26/11/21 to 9/12/21 shows ground water levels varying from 0.5m to 8.1mbgl. Refer to the ground investigation documents listed in Section 2.1 for further information.

See Appendix A for a plot of the ground investigation data and parameters.

4 GEOTECHNICAL PARAMETERS AND GROUNDWATER

4.1 Soil Strength Parameters

Table 2 reports the design parameters that have been used for the design of the slopes and bearing capacity calculations. These parameters have been derived from the available GI data, reported in Section 2.1. Refer to Appendix A for a geological long section in the area of the northern slopes and relevant plots of the ground investigation data.

Stratum	Density (γ) (kN/m ³)	c_u (kN/m ²)	c' (kPa)	ϕ' (°)
Made Ground	18	-	0	35
Loose SAND	18	-	0	35
Medium Dense SAND	19	-	0	36.5
Stiff CLAY	20	60	0	30
Firm CLAY / SILT	20	40	0	28
6I Fill	19	-	0	37

Table 2: Slope stability geotechnical design parameters

4.2 Design Groundwater level

Groundwater levels based on ground water strikes within the boreholes and the limited amount of monitoring data have been adopted in the design. These are shown within the Rocscience Slide 2 outputs presented in Appendix B.

A coefficient of porewater pressure (r_u) of 0.1 has been assumed within the made ground above the ground water level and 0.05 within the Class 6I fill to model the effects of partially saturated soil during wetter periods. A check using a r_u value of 0.2 is made for the lower slope due to the potential effects of water draining from the stockpile of material above and due the lower level of the slope, therefore nearer to the water levels recorded within the site investigation.

5 UNREINFORCED SLOPE DESIGN

5.1 Method of Analysis

A small section of the slope to the west of the reinforced soil slopes is to comprise a 1(v):3(h) slope approx. 11m high extending from the CP site down to approx. 122mAOD.

The slope fill will comprise the Class 6i material, however, simplifying the problem to a homogeneous soil for the slope and foundation and adopting a conservative angle of internal friction of 30 degrees (based on the in-situ formation soils), a preliminary analysis can be carried out for the unreinforced soil slope using Bishop and Morgenstern charts of stability coefficients. A slope angle of 1:3 is checked with r_u values of 0.1 & 0.2. The results are summarised below:

Slope gradient (v:h)	Coefficient of porewater pressure, r_u	Overall factor of safety (lump sum)	Comment
1:3	0.2	1.34	FoS > 1.3, therefore acceptable for permanent slopes
1:3	0.1	1.53	FoS > 1.3, therefore acceptable for permanent slopes

Table 3: Preliminary slope stability check of unreinforced section of slope using Bishop and Morgenstern charts of stability coefficients.

The above results are verified in further detail in accordance with BS EN 1997-1:2004 and presented in the main analysis of the slope in Appendix B.

6 REINFORCED SOIL SLOPE DESIGN

6.1 Method of Analysis

The design of the reinforced soil slopes is carried out in accordance with BS8006-1:2010+A1:2016. BS8006-1:2010+A1:2016 design methodology adopts soil peak shear strength parameters combined with various partial factors on loads and material strengths. The design is checked against SLS and ULS states.

RocScience Slide 2 software has been used to determine the internal stability of the slopes in accordance with BS8006-1:2010+A1:2016 cl 7.4.4.3. The results are presented in Appendix B.

Pull-out length of wrap-around is calculated based on the BS8006-1:2010+A1:2016 Section 7.4.8:

$$Z = T_j/3$$

Where:

Z = force applied to the reinforcement tail

T_j = load in the reinforcement.

Conservatively assuming that the load in the reinforcement is the same as the geogrid strength = 18.45kN/m (see Table 5) the pull out length is checked as follows:

$$L_e = Z \cdot f_p / 2 \cdot a_b \cdot \gamma \cdot d \cdot \tan \phi$$

Where:

L_e = pull-out length of reinforcement tail

f_p = Partial factor on pull-out resistance

a_b = coefficient of bond for reinforcement / soil interface

γ = Unit weight of soil

d = average depth of reinforcement under consideration

ϕ = angle of internal friction of fill

Therefore:

$$L_e = 6 \times 1.3 / 2 \times 0.5 \times 20 \times 0.5 \times \tan 37$$

$$L_e = 1.04\text{m}$$

Provided length of wrap around = 1.5m, therefore ok.

6.2 Partial Factors for Reinforced Earth Slopes

The following partial factors are taken from BS8006-1:2010+A1:2016.

Partial Factor Description	ULS	SLS
Load Factors		
Soil unit weight e.g., slope fill (f_{fs})	1.5	1.0
External dead loads eg. line or point loads (f_r)	1.2	1.0
External live loads eg. traffic loading (f_q)	1.3	1.0
Soil Material Factors		
Applied to $\tan \phi'_{\text{peak}}$ (f_{ms})	1.0	1.0
Applied to c'_{peak} (f_{ms})	1.6	1.0
Reinforcement Factor		
See Reinforcement data (f_m)	See below	
Soil Reinforcement Interaction		
Sliding across Reinforcement (f_s)	1.3	1.0
Pull-Out of Reinforcement (f_p)	1.3	1.0
Partial Factors of Safety		
Sliding along base where there is soil to soil contact (f_s)	1.2	N/A
Structure Category (Medium) (f_n)	1.0	1.0

Table 4: Partial factors for reinforced earth slopes

6.3 Partial Factors for Geogrids

The reinforced soil slope uses Fortrac T geogrids, the details of which can be found in BBA HAPAS Certificate 13/H197 – see Appendix D. The geogrid is manufactured in grades of various strengths. Grids are known by their individual approximate uniaxial ultimate strengths, i.e., Fortrac 35T has a short-term characteristic strength of 35kN in the warp direction. These ultimate strengths would give a grid strain of approximately 9.5% (+/-

1.5%). For design purposes the ultimate strength is first reduced to a creep limiting strength depending on the expected service life. For a 60-year service life the long-term strength is reduced to 67% of the characteristic short-term strength. With reference to the BBA certificate and BS8006-1:2010+A1:2016, this ultimate creep limited strength is then subject to the following partial factors to provide design strength, depending on the expected site conditions that the grids are to be subject to.

BS8006-1:2010 Reinforcement Material Factors, with partial material factors applied from BBA Certificate 13/H197:

Creep reduction factor - RF_{CR}

RF_{CR} is a reduction of the characteristic short-term strength (T_{char}). From BBA at 20°C, 60yr design life $RF_{CR} = 1.50$

Reduction factor for extrapolation of data - f_s

For the extrapolation of data for a 60yr design Life = 1.07

Reduction factor for installation damage - RF_{ID}

Installation damage (for particle size $D_{90} < 35\text{mm}$):
Fortrac 35T = 1.15

Reduction factor due to weathering - RF_W

Weathering = 1.0 (covered within 24 hours)

Reduction factor due to chemical effects - RF_{CH}

Chemical / Environmental effects = 1.03 (for fill pH 4 to 9)

Thus, the ULS design strength of the grids (T_D) is:

$$T_D = T_{CR} / f_m$$

Where: T_{CR} = Long term tensile creep rupture strength
 f_m = Reinforcement material factor

$$T_{CR} = T_{char} / RF_{CR}$$

Where: T_{char} = Characteristic short-term strength
 RF_{CR} = Reduction factor for creep

$$f_m = RF_{ID} \times RF_W \times RF_{CH} \times f_s$$

The following table summarises the resultant design strengths after the various factors have been applied.

Grade	T_{char} kN/m	RF_{CR}	RF_{ID} Installation damage	RF_W Weathering	RF_{CH} Environmental	f_s Extrapolation of data	T_D kN/m
35T	35	1.50	1.15	1.0	1.03	1.07	18.45

Table 5: Partial factors for geogrids

6.4 Reinforced Fill

The reinforced soil fill is assumed to comprise SHW Class 6i, which may be derived from site won fill sources, and comprise fine to medium sand, or alternatively may be imported to site. The fill must be supplied and placed in accordance with SHW Series 600. Based on

shear box testing carried out as part of the site investigation on potential on site sources for the Class 6I material, the parameters in Table 2 are adopted. These parameters must be validated as part of the construction testing requirements with large shear box tests (refer to the fill specification on drawing 22016_DRG_001).

It should be noted that the fill material could be susceptible to weather conditions and therefore requires control and monitoring during installation and compaction. The fill shall be supplied, placed and verified in accordance with the specification for 6i Fill.

6.5 Reinforced Soil Slope Geometry

The geometry of the proposed NW boundary slope is shown on drawings 22.016_DRG_001 to 007.

6.6 Internal Design and Geogrid Layout

The internal design for the reinforced soil slopes has been carried out in accordance with BS8006-1:2010+A1:2016 Section 7, using the Bishop's simplified method of slices described in Section 7.4.4.3. The method considers a rotational failing soil mass split into a number of slices and calculates the disturbing and restoring forces on each slice considering the mechanical equilibrium of the slices. The restoring moments of the combined effect of soil and reinforcements should not be less than the disturbing moment due to the weight of the soil.

RocScience Slide 2 has been used to complete the limit equilibrium analysis. Slide 2 software considers the restoring forces of the reinforcement and checks for tensile rupture, pull-out and overall length of reinforcement required.

The design outputs showing the required geogrid strength, length and layout are presented in Appendix B and on Drawings 22.016_DRG_001 to 007.

6.7 Bearing and Sliding

Bearing stability is checked in accordance with BS8006-1:2010+A1:2016 cl. 6.5.2 using the partial factors as shown below:

$$q_r < q_{ult} / f_{ms} + \gamma D_m$$

Where:

q_r	= Factored bearing pressure
q_{ult}	= net ultimate bearing capacity of foundation soil
f_{ms}	= 1.35 (Table 11 from BS8006-1:2010+A1:2016)
γ	= foundation soil density
D_m	= Slope embedment

The results are presented in Appendix B.

The stability against forward sliding of the structure along the interface between the reinforced fill and subsoil are checked in accordance with BS 8006-1:2010 section 6.5.3. The results are presented in Appendix B.

6.8 Construction Sequence

The following construction sequence must be observed, based on the maximum height section and lowest temporary excavation level at the toe of the slope (represented by Section 1 on drawings 22.016_DRG_002 to 007):

- 1) Carry out temporary excavation for upper and lower slopes.
- 2) Carry out ground improvement (designed by CP)
- 3) Carry out verification testing on the formation soils in accordance with the specification on 22.016_DRG_001.
- 4) Construct formation layer beneath lower slope footprint up to base of slope level (varies from 122mAOD to 129.5mAOD).
- 5) Construct the lower (1(v):2(h)) reinforced soil slope.
- 6) Construct the upper (1:1) reinforced soil slope.
- 7) Deposit stockpile of material on platform between the lower and upper reinforced soil slopes. Stockpile height must not exceed 3m and the toe must not encroach within 1m of the crest of the lower (1(v):2(h)) reinforced soil slope.

Refer to drawings 22.016_DRG_002 to 007 for full details.

It is important that where the reinforced soil slope is excavated into the existing soil, that the ground shall be benched at a safe angle.

The benching stages should be closely monitored on site and the heights of the excavations altered depending on the local site conditions. Unsupported excavations should be avoided during periods of wet weather. Prior to placing the first layers of geogrid and 6i fill, the existing ground should be excavated down to the proposed formation level and the foundation soils shall be proof rolled and checked to ensure that all weak, or otherwise unsuitable material is removed and that the design formation level is reached prior to placing the first layer of geogrid.

Where required, de-watering shall be carried out in order to maintain the required excavations. Once the formation level is prepared, the first layer of wrap around geogrid and permanent topsoil retention geosynthetic shall be placed followed by the first layer of Class 6i fill and 150mm (depth from face) of topsoil at the slope face. A sequence of geogrid placement, topsoil retention, 6i backfill and topsoil shall then be followed in appropriate layer thicknesses in accordance with the supplier's recommendations. The 6i fill and topsoil shall be supplied and placed in accordance with the earthworks specification. It is important to note that the 6i fill shall meet the minimum strength requirements shown in Table 2.

6.9 Verification testing

6.9.1 Plate Load Tests (formation)

Prior to placing the geogrid and granular fill, the strength of the formation shall be verified by plate load testing. Plate load tests shall be carried out at 10m intervals along the line of the reinforced soil slopes using 600mm plates. The details of the plate loading are provided in the specification on 22.016_DRG_001. The tests are to be carried out in accordance with BS 1377-9:1990: cl. 4.1; Soils for civil engineering purposes – In-situ tests.

The reaction of the tests is normally provided by plant on site. It is likely that a 21t machine will be required to provide the reaction load necessary. The loading arrangements shall be capable of transferring safely the maximum load required to the test area.

Following each application of the load, the settlement shall be measured at intervals of one minute until no change is detected and then at intervals of 5 minutes. The load shall be held for minimum 5 minutes or until two successive readings at 5 minute intervals are the same, whichever is the greater. The maximum load shall be held for minimum 15 minutes or (until three successive readings at 5 minute intervals are the same, whichever is greater). The settlement shall be measured on release of the load and again after 5 minutes. Allowable settlement for given load increments are given in on 22.016_DRG_001

to enable immediate assessment of the adequacy of the formation. The test data should be forwarded to the reinforced soil slope designer within 24 hours for review, and before the formation layer is placed.

If the results of the formation testing fall outside the limits of the above testing, the formation shall be excavated to expose a firmer formation and retested.

6.9.2 Fill placement verification

As a minimum, the strength of the fill shall be confirmed by five shear box tests (on 22.016_DRG_001) carried out on fill samples from the proposed fill stockpiles. Five compaction tests (BS 1377 Part 4) shall be carried out in advance of the site works to determine the 95% dry density and the fill shall be placed at the optimum moisture content, as determined by the compaction testing. Testing of the moisture content of the 6i fill shall be carried out for each layer of placed fill to ensure that the fill is supplied within $\pm 2\%$ of the optimum moisture content. Where the fill is found to be outside of these requirements it shall not be used.

Plate load testing, sand replacement density testing and nuclear densometer testing shall be carried out as required within the specification for 6i fill (on 22.016_DRG_001). Where the test results show that the layer of fill is below the minimum requirements the layer shall be removed completely and an alternative source of fill, complying with the specification shall be used and retested.

7 LANDSCAPING

Any landscaping should be specified by a suitably qualified landscape specialist and should be designed to ensure that there is no negative impact on the stability of the embankments. Where topsoil is required, it shall meet the requirements of Appendix 6/1 and be placed in accordance with SHW Series 600 cl. 618, and all landscaping shall be in accordance with SHW Series 600 cl. 620. Landscape design is outside the scope of this design report and RGL specification.

8 DRAINAGE

It is essential that robust crest drainage be provided to prevent any surface water run-off from above the reinforced soil slopes running onto the face of the slopes or percolating into the body of the reinforced soil. The crest drainage must capture any run-off and safely channel it to adequate discharge points located beyond the extents of the slopes, for the design life of the structures. Drainage at the slope toe must also be provided to prevent ponding water and rise in ground water above the level of the toe of the slope.

The toe of the reinforced soil slope shall be drained using a geotextile wrapped flexible land drain and connected to the site drainage system so that any drainage water is safely transferred away from the reinforced soil slopes. The design of the site drainage system is outside the scope of this design report.

Drawings

- 1.1 Topographical data, proposed levels and slope geometries have been taken from AutoCAD files Countryside Partnerships; Royle Road, Rochdale; Off Site Regrading Works; PMCE53-ENG-CF-01, Rev. C.
- 1.2 The drawings are based on information provided by others and upon the assumption that such information is accurate. Information provided to RGL has not been independently verified by RGL.
- 1.3 All lines and levels should be verified on site by Countryside Partnerships to ensure coherence with the overall proposals for the site.
- 1.4 A safe system of work to be followed by the reinforced soil contractor. The reinforced soil contractor shall provide risk assessments and method statements for approval prior to starting work.
- 1.5 A pedestrian guard rail must be designed and installed (Principal Designer/ Principal Contractor). A safety rail must be also used throughout construction of the slopes. A safe system of work to be developed by the Principal Contractor.

2.1 Formation levels to be verified on site by Principal Contractor and the Earthworks Contractor.

2.2 Topsoil shall be removed from under all areas of the filled slopes.

2.3 All areas of earthworks foundations shall be proof-rolled prior to fill placement.

2.4 The formation soils shall be inspected and verified to ensure that they comprise granular soils with a minimum CBR of 5%, proved with plate load tests. This shall be tested every 10m along the line of the walls, see details under the Earthworks Foundations heading.

2.5 Formation levels shall be protected at all times to prevent deterioration.

2.6 Where an excavation formation stratum and/or other conditions exist that are not compatible with the design assumptions then excavation shall continue until such material is met or a suitable alternative formation approved by the Designer is met.

- 3.1 Temporary works design by others.
- 3.2 All temporary cut slopes are to be battered back and benched at a safe angle.
- 3.3 Benching stages should be closely monitored and the height of excavations altered depending on the local site conditions. Unsupported excavations should be avoided during periods of wet weather.
- 3.4 No excavation shall be left unsupported at the end of a shift.

- 4.1 The following construction sequence must be observed (Based on the maximum height section and lowest temporary excavation level at the toe of the slope (represented by Section 1 on drawings 22.016_DRG_002 to 010)):
 - 4.1.1 Carry out temporary excavation for upper and lower slopes.
 - 4.1.2 Carry out ground improvement (designed by C/P).
 - 4.1.3 Carry out verification testing on the formation soils in accordance with the specification on 22.016_DRG_001.
 - 4.1.4 Construct formation layer beneath lowest level footprint up to base of slope level (varies from 122m AOD to 129.5m AOD).
 - 4.1.5 Construct the lower (1½v(2)h) reinforced soil slope.
 - 4.1.6 Construct the upper (1:1) reinforced soil slope.
 - 4.1.7 Deposit stockpile of material on platform between the lower and upper reinforced soil slopes. Stockpile height must not exceed 3m and the toe must not encroach within 1m of the crest of the lower (1½v(2)h) reinforced soil slope.
- 4.2 Refer to drawings 22.016_DRG_002 to 010 for full details.

- 5.1 The reinforced soil slope shall be installed in accordance with BS8006-1:2010+A1:2016, BS EN 14475:2006, and all manufacturers requirements.
- 5.2 The fill shall comprise Class B₆. Refer to drawings 22.016_DRG_002 to 010, see details under the Earthworks Specification heading.
- 5.3 The Principal Contractor shall ensure that the classification and certification of acceptability of the earthworks materials shall be carried out at the point of deposition for all infill material. For the avoidance of doubt, Remedy Geotechnics are not responsible for the approval of the materials or the classification of the infill material.
- 5.4 The geogrid must be installed at the proper elevation and orientation. Correct orientation of the geogrid shall be verified by the reinforced soil Contractor. The principal strength direction of the geogrid shall be laid perpendicular to the slope wall face (i.e. the roll direction shall be away from the face).
- 5.5 The geogrid must be installed tight by pulling the reinforcement to remove any slack and holding it in this position while it is covered with fill.
- 5.6 Tracked construction equipment shall not be operated directly on the geogrid. A minimum fill thickness of 150 mm is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- 5.7 Construction equipment and plant weighing more than 1500 kg shall be kept at least 1.5m away from the facing.
- 5.8 The thickness of the layers of backfill shall be determined by the Earthworks Contractor to achieve the level of compaction required. It should be a sub-multiple of or equal to the vertical reinforcement spacing.
- 5.9 The fill within 1.5m of the face should be compacted using adequate light compaction equipment and the thickness of the layers shall be adjusted to achieve the compaction requirements.
- 5.10 At the end of each day's work the surface of the compacted fill should be left at a slight inclination (2 % - 4 %) away from the facing or the sloped face and sealed with a smooth compound to ensure that any surface water is guided away to a suitable outlet.
- 5.11 On the 1v(2)h face of the slopes, the surface shall be protected by a biodegradable erosion protection membrane suitability pinned to the face in accordance with the manufacturers recommendations. The erosion control membrane shall remain in place until the establishment of suitable vegetation. The design of the erosion control membrane and vegetation is the responsibility of the earthworks contractor.
- 5.12 The slope face must be placed at a tolerance of +/- 100mm of the slope alignment.

6.1 Drainage stone shall be in accordance with SHW Series 500 cl. 513 and Type A material.

6.2 The slope toe drain must be connected to the site drainage system, the with connections designed by the site drainage designer (Countryside Partnerships). A 1% gradient on the toe drains is recommended. Rodding facilities should be provided at minimum 50m spacing along the toe drain.

- 7.1 Specification of all fill and earthworks beyond the reinforced soil slopes is the responsibility of the Principal Designer.
- 7.2 Vegetation of the reinforced soil face is outside the scope of RGL work. Countryside Partnerships is responsible for specifying a suitable seed mix and planting methodology to ensure suitable vegetation establishes on the faces of the reinforced soil slopes.
- 7.3 Topsoil should extend no greater than 150mm from the face of the slope and should be well tamped into place by foot.

- 8.1 The Specification for selection and placement of earthworks material shall generally be in accordance with the manual of Contract Documents for Highway Works Volume 1: Specification for Highway Works, Series 600, including Notes for Guidance 6.0/1. Specific testing and acceptance criteria are shown in Tables 6/1 to 6/5 below.
- 8.2 Where references to contract specific Appendices are made reference is to be made to these Notes.
- 8.3 Characteristic soil parameters have been defined for Class 6I based upon the material description and classification requirements defined within the SHW.
- 8.4 All fill materials within the slopes are to be in accordance with the Specification for Highway Works (SHW) Series 600 and compacted using method compaction in accordance with SHW Table 6/4, subject to verification testing of each layer of fill achieving 95% dry density. Compaction shall be continued until a state is reached such that no more than one result in ten consecutive tests fails to meet the specified compaction.
- 8.5 Method compaction or has been considered verified if minimum target dry densities are achieved as determined by 2.5kg rammer or 4.5kg rammer compaction tests in accordance with BS1371 (method dependent type of compaction plant used and to be determined by the earthworks contractor).
- 8.6 It is the responsibility of the earthworks contractor to assess if the fill, whether imported or sourced in situ, is suitable for the incorporation into the reinforced slopes (i.e. the earthworks contractor is responsible to drying/treating the material to ensure it meets the requirements of the specification). All material will therefore need to undergo testing in accordance with Table 1/5 and meet the earthworks acceptability criteria within the specification Table 6/1.
- 8.7 By its nature, the quality and composition of the site won material could be variable, both laterally and vertically across the site. The fill will therefore require continual testing and monitoring throughout the earthworks.
- 8.8 It should be noted that classification of potential hazardous material is outside the scope of the current Remedy Geotechnics Limited works and the advice of a geo-environmental specialist shall be sought by the contractor to provide a sampling and disposal strategy if hazardous material is encountered.
- 8.9 The earthworks contractor must carry out classification testing to establish the potential class of materials present on site if site won material is to be used within the slopes.
- 8.10 The results of all tests and sample locations undertaken during the works are required in accordance with Table 1/5 and Table 6/1. The results are to be compiled by the earthworks contractor and presented in an earthworks validation report which is to be submitted to the County Council.
- 8.11 Prior to the commencement of construction, a method for compaction of the fill shall be established by the reinforced soil contractor to achieve the compaction requirements of the design.
- 8.12 All unacceptable Class UB18 and U2 material and surplus materials shall be disposed of offsite.
- 8.13 Topsoil shall meet the requirements of SHW as detailed in Table 6/1 and SHW Series 600 cl. 618.

Appendix 1/5 (600-series) Testing to be carried out by the

Clause	Work, Goods or Material	Test	Frequency of Testing	Test Certificate	Comments
Series 600					
	Acceptable material				
	Class	General Description			
601 631	5	Topsoil	Grading / uniformity coefficient	500m ³	Required
632 633 635 636 640 644	6	Selected granular fill	Grading / uniformity coefficient (N) Dry density / moisture content relationship (N)	1 per 400m ³ Initial Testing: 5 tests (per source) following initial processing and prior to placing During works: 1 per 400m ³	Required
			Moisture Content (N)	Initial Testing: 5 tests (per source) following initial processing and prior to placing During works: 1 per 400m ³	BS 1377 Part 4 2.5kg rammer or 4.5kg rammer (to be specified by the earthworks contractor to resemble the energy of the plant proposed for the works)
			Los Angeles coefficient (N)	2 per source	
		pH / chloride ion content (N)	Initial Testing: 5 per source During works: Weekly		
		Effective angle of internal friction (ϕ') and effective cohesion (c') (N)	Initial Testing: 5 tests (per source) following initial processing and prior to placing During works: 1 per 400m ³		
612	Compaction of fills			Required	
		Method compaction Class G1 Class GF2	Field dry density (N) Sand Replacement (Large Pouring Cylinder) Method of BS1377: Part 9	1 per 400m ³ at evenly spaced vertical and lateral distances across the earthworks	To be carried out prior to placement of geogrid and at a sufficient height above the geogrid below to prevent damage to geogrid.
		Nuclear Density / Moisture Gauge Tests	Set of 10 every other compacted layer		Nuclear density tests to be calibrated against initial set of sand replacements tests and dry density / mc tests.
	Testing of existing ground formation strength beneath bunds		Plate Load Test	Every 30m along line of the bund.	Required
					BS 1377-9 See drawing notes below for loading schedule

Plate Diameter = 600mm

Upper 1:1 reinforced soil slope formation.

Increment	Percentage of Characteristic Bearing	Plate Bearing Pressure	Load on Plate	Acceptable Settlement
1	25%	13	4	
2	50%	25	7	
3	75%	38	11	
4	100%	50	14	5
5	125%	63	18	
6	150%	75	21	
7	175%	88	25	
8	200%	100	28	10
9	250%	125	35	
10	300%	150	42	

Lower 1:2 reinforced soil slope formation.

Increment	Percentage of Characteristic Bearing Pressure	Plate Bearing Pressure	Load on Plate	Acceptable Settlement
		kPa	kN	mm
1	25%	38	11	
2	50%	75	21	
3	75%	113	32	
4	100%	150	42	5
5	125%	188	53	
6	150%	225	64	
7	175%	263	74	
8	200%	300	85	10
9	250%	375	106	
10	300%	450	127	

Failure defined as the force causing a penetration of 15% of the plate diameter

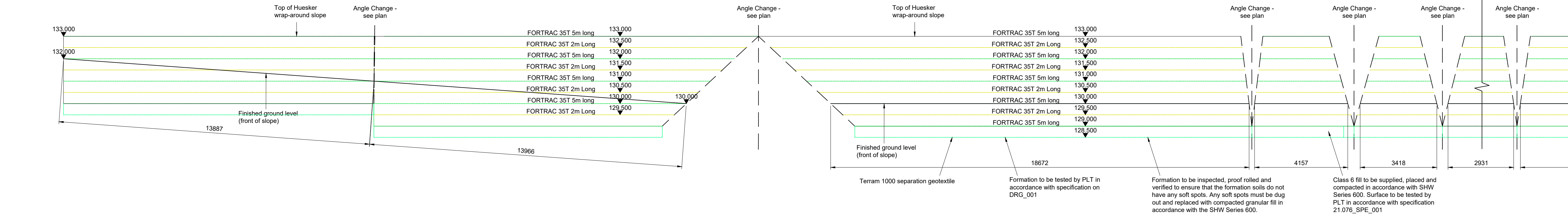
Following each application of the load, the settlement shall be measured at intervals of one minute until no change is detected and then at intervals of 5 minutes. The load shall be held for minimum 5 minutes or until two successive readings at 5 minute intervals are the same, whichever is the greater. The maximum load shall be held for minimum 15 minutes or (until three successive readings at 5 minute intervals are the same, whichever is greater). The settlement shall be measured on release of the load and again after 5 minutes

TABLE 6/1: (02/16) Acceptable Earthworks Materials: Classification and Compaction Requirements

CLASS	GENERAL MATERIAL DESCRIPTION	TYPICAL USE	PERMITTED CONSTITUENTS (All subject to requirements of Clause 601 (SHW) and Appendix 6/1)	MATERIAL PROPERTIES REQUIRED FOR ACCEPTABILITY (In addition to requirements on use of fill materials in Clause 601 (SHW) and testing in Clause 631 (SHW))				COMPACTION REQUIREMENTS IN CLAUSE 612 (SHW)
				PROPERTY (See exception in previous column)	DEFINED AND TESTED IN ACCORDANCE WITH:-	ACCEPTABLE LIMITS WITHIN:		
						Lower	Upper	
5A	Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A	(i) grading	Clause 618	-	Clause 618	-
6I	Selected well graded granular material	Fill to reinforced soil and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well-burnt colliery spoil, or any combination thereof except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (ii), (iii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt. Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes (see SHW Table 6/7) P (natural aggregates – except Limestone shale, siltstone or slate); A2 (crushed concrete) A3 (crushed bricks, masonry) D2 (air-cooled blast-furnace slag) G1 (red-coal shale)	(i) grading	BS1377 Part 2 (On site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 2
					BS EN 933-2 (Imported onto site)	Tab 6/5	Tab 6/5	
				(ii) uniformity coefficient	D60 / D10	10	-	
				(iii) SMC of chalk (chalk not permitted)	Clause 634	-	20%	
				(iv) mc	BS 1377: Part 2	OMC – 2% (as determined by dry density / moisture content relationship testing specified in Table 1/5)	OMC + 2% (as determined by dry density / moisture content relationship testing specified in Table 1/5)	
				(v) MCV	Clause 632	To be determined by the earthworks contractor following initial testing detailed in Table 1/5	To be determined by the earthworks contractor following initial testing detailed in Table 1/5	
				(vi) effective angle of friction (ϕ') and effective cohesion (c')	Clause 636	37 deg.		
	(vii) pH value	BS 1377: Part 3	4 (for Huesker Fortrac Geogrids)	9 (for Huesker Fortrac Geogrids)				
6F1	Selected granular material (fine grading)	Capping	Any material, or combination of materials with not less than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials that contain tar and tar-bitumen binders, unburnt colliery spoil and argillaceous rock and chalk. Property (vi) in next column shall not apply if the Ra (asphalt) content of any recycled aggregate is 20% or less. Where material in this Class is imported onto site it shall be classified as Class 6F4 and comply with the requirements for that material.	(i) grading	BS 1377 : Part 2 (on-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 6
			(ii) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-		
			(iii) mc	BS 1377 : Part 2	Optimum mc - 2%	Optimum mc		
			(iv) Los Angeles coefficient	Clause 635	-	60		
			(v) Class Ra (asphalt) content	Clause 710	-	50%		
			(vi) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2%		
			(vii) Effective angle of internal friction (ϕ')	Clause 636	$\phi' = 37$ deg.	-		

- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
- 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
- 3 Levels are shown in metres above ordnance datum (mOD).
- 4 Do not scale from this drawing.
- 5 Refer to drawing 22.016_DRG_001 for notes.

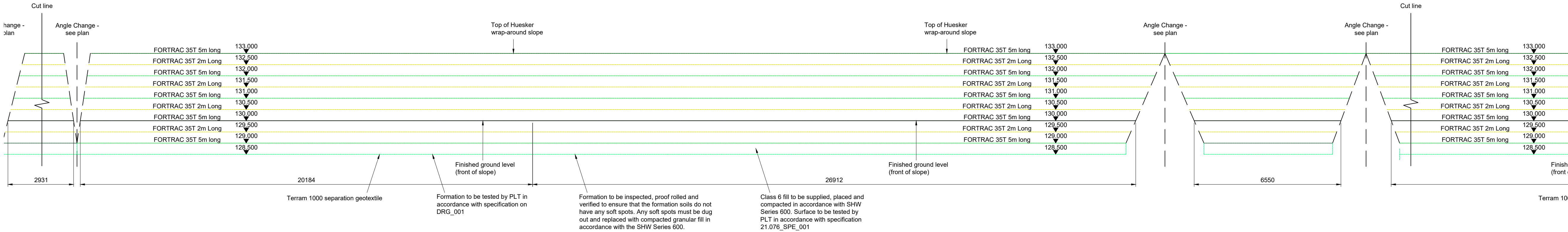
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P0	First issue			15.04.22	HD	DS			
Rev	Description			Date	By	Ckd			
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<u>Midlands Office</u> Tel: 01768 211778									
<u>Northern Office</u> Tel: 01423 589500									
www.Remedygeotechnics.com									
Client: Countryside Partnerships Plc									
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope									
Drawing Title: NOTES									
Scale:	Size:	Drawn by:	Checked by:	Date:					
1:100	A1	HD	DS	04/2022					
Job No.	Drawing no.			Revision:					
22.016	DRG_001			P1					



ELEVATION UPPER WALL

1/4

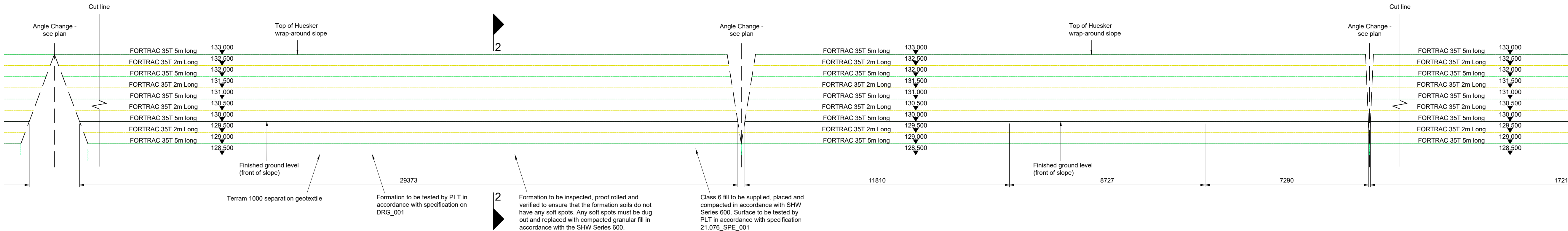
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ELEVATION UPPER WALL

CONTINUED 2/4

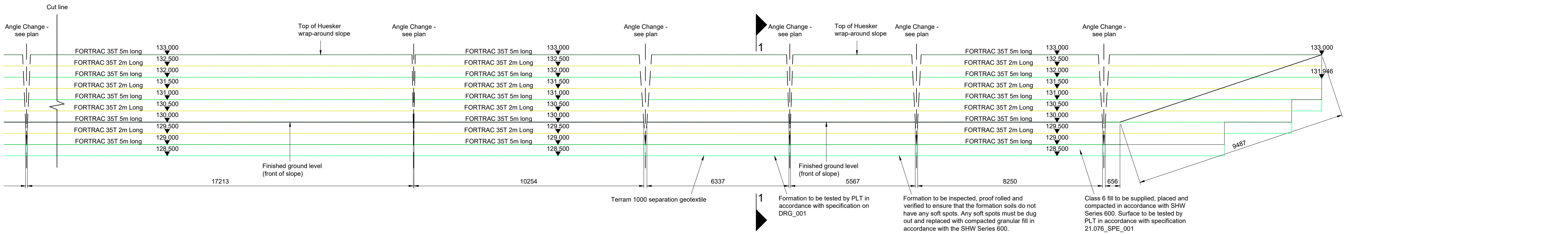
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ELEVATION UPPER WALL

CONTINUED 3/4

Scale 1:100.



ELEVATION UPPER WALL

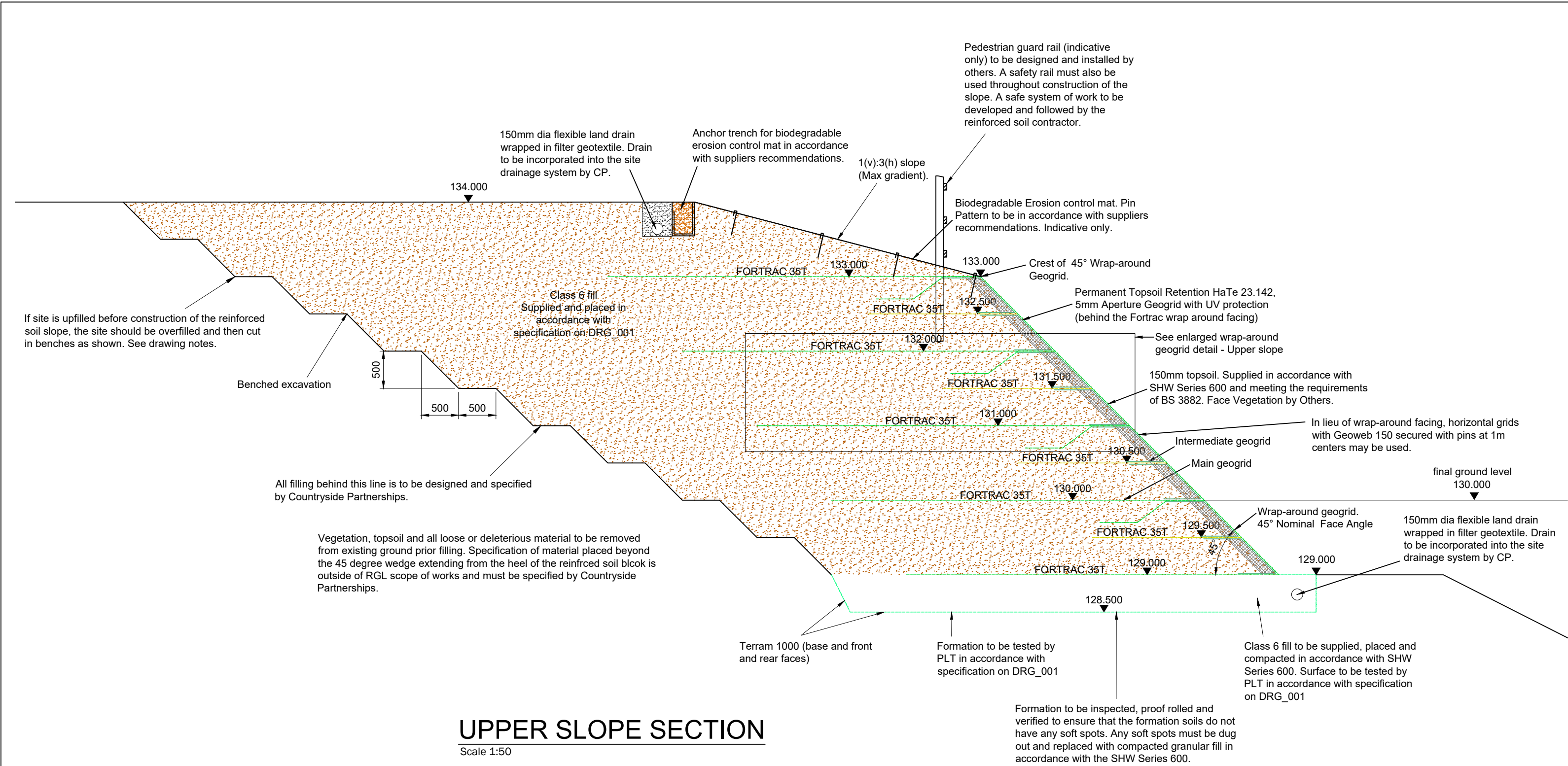
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Scale 1:100.

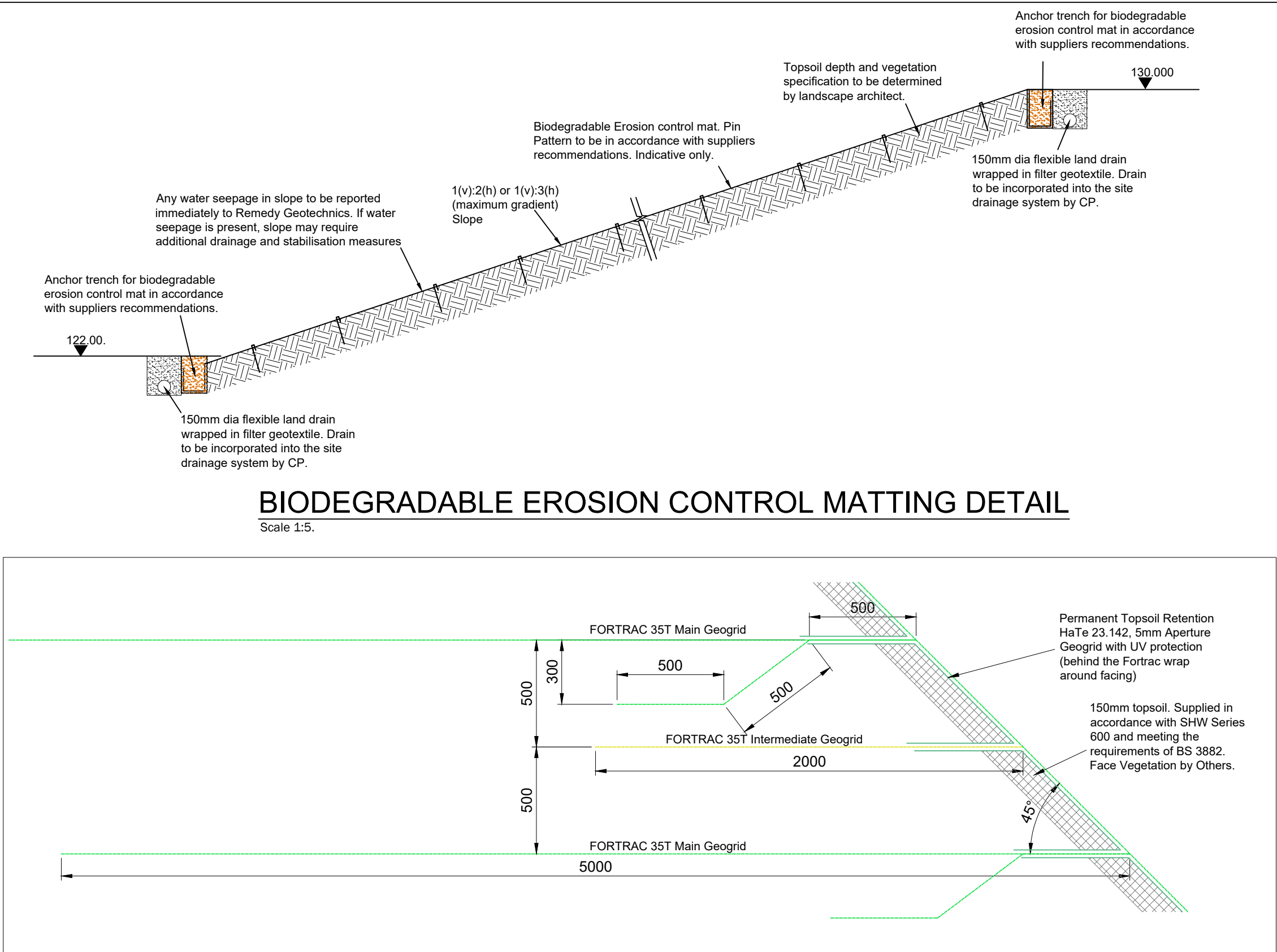
Notes:

- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
- 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
- 3 Levels are shown in metres above ordnance datum (mOD).
- 4 Do not scale from this drawing.
- 5 Refer to drawing 22.016_DRG_001 for notes.

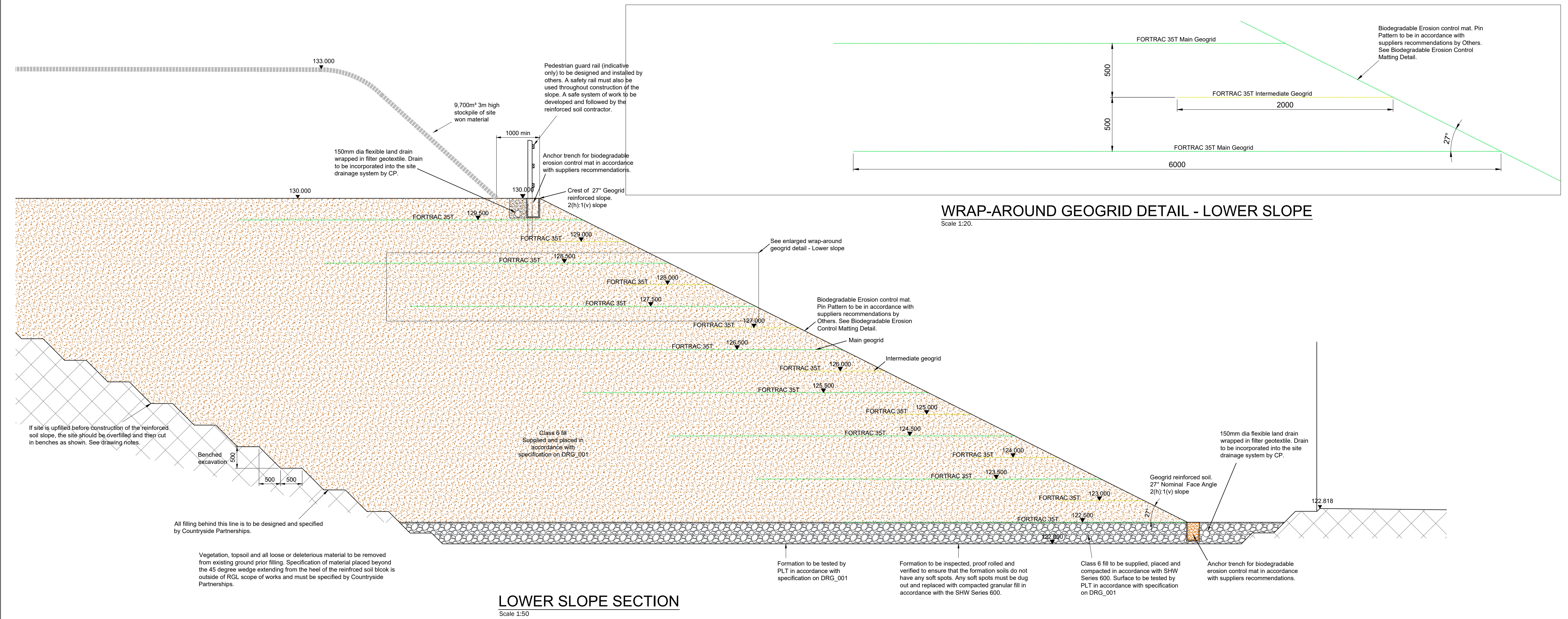
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P0	First issue	15.04.22	HD	DS
Rev	Description	Date	By	Out
Drawing Status: PRELIMINARY				
remedy geotechnics Midlands Office Tel: 01788 211778 Northern Office Tel: 01423 585900 www.Remedygeotechnics.com				
Client: Countryside Partnerships Plc				
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope				
Drawing Title: ELEVATION UPPER SLOPE				
Scale: 1:100	Size: A1	Drawn by: HD	Checked by: DS	Date: 04/2022
Job No. 22.016	Drawing no. DRG_002	Revision: P1		



UPPER SLOPE SECTION
Scale 1:50



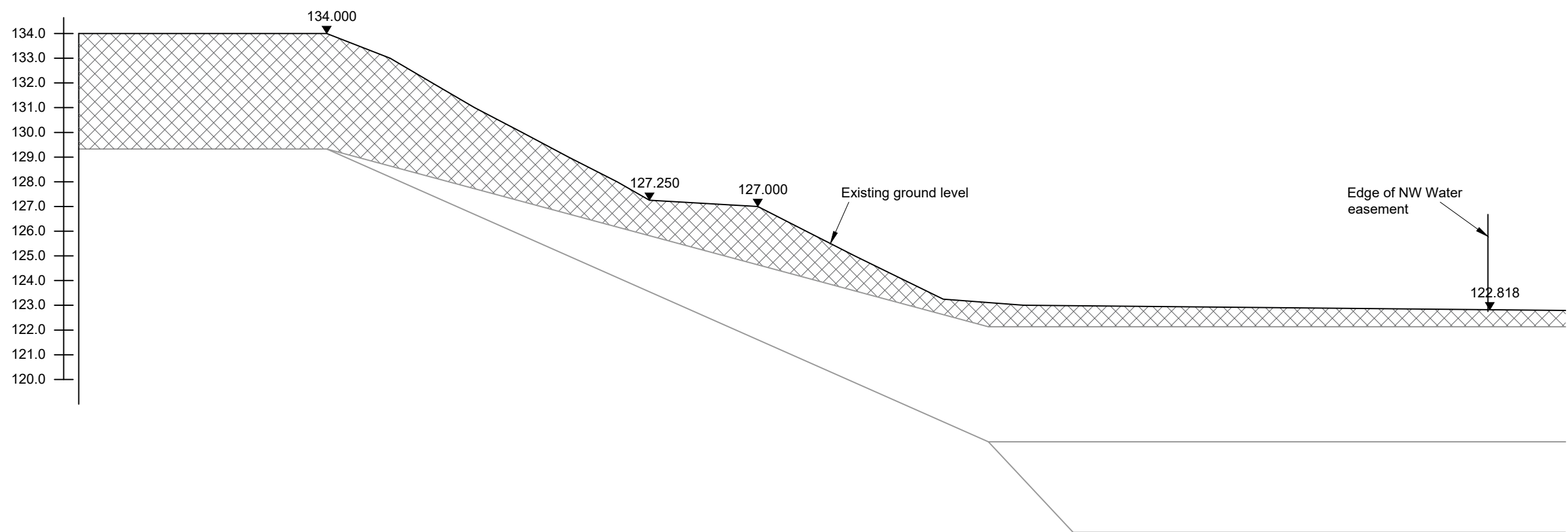
WRAP-AROUND GEOGRID DETAIL - UPPER SLOPE
Scale 1:20



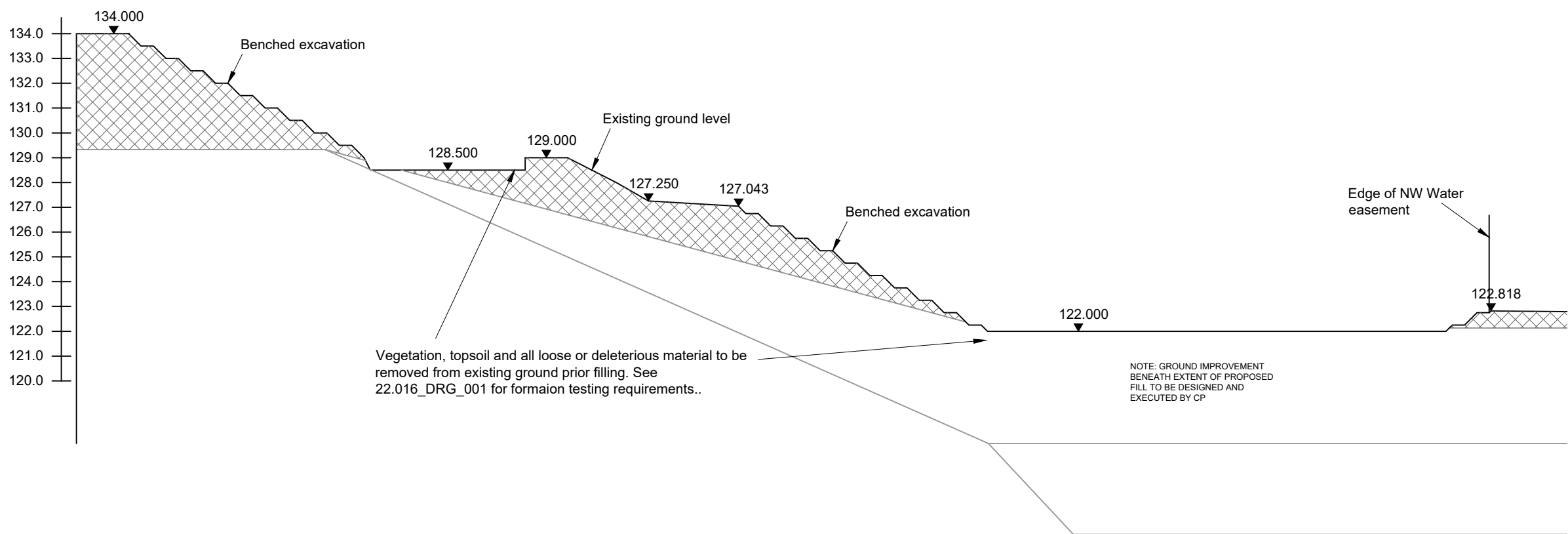
LOWER SLOPE SECTION
Scale 1:50

- Notes:
- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
 - 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
 - 3 Levels are shown in metres above ordnance datum (mOD).
 - 4 Do not scale from this drawing.
 - 5 Refer to drawing 22.016_DRG_001 for notes.

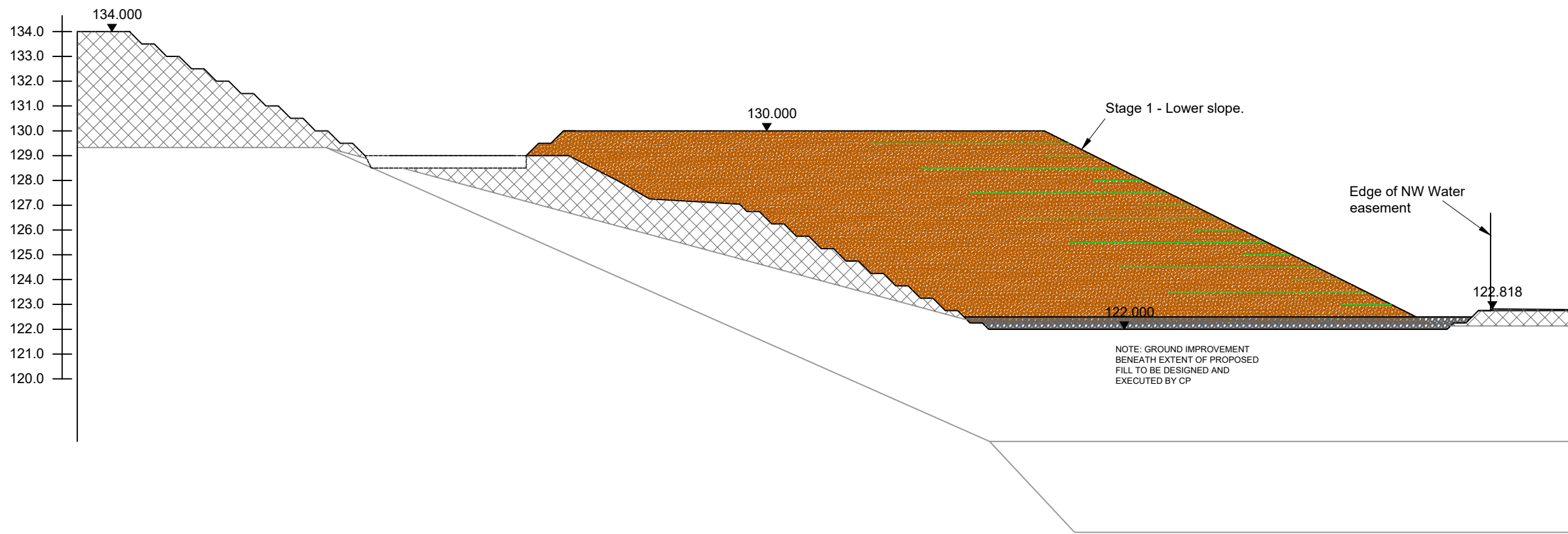
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P0	First issue	15.04.22	HD	DS
Rev	Description	Date	By	Ckd
Drawing Status: PRELIMINARY				
remedy geotechnics				
Midlands Office Tel: 01788 211778				
Northern Office Tel: 01423 589500				
www.Remedygeotechnics.com				
Client: Countryside Partnerships Plc				
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope				
Drawing Title: DETAILS				
Scale: Varies	Size: A1	Drawn by: HD	Checked by: DS	Date: 04/2022
Job No. 22.016	Drawing no. DRG_003		Revision: P1	



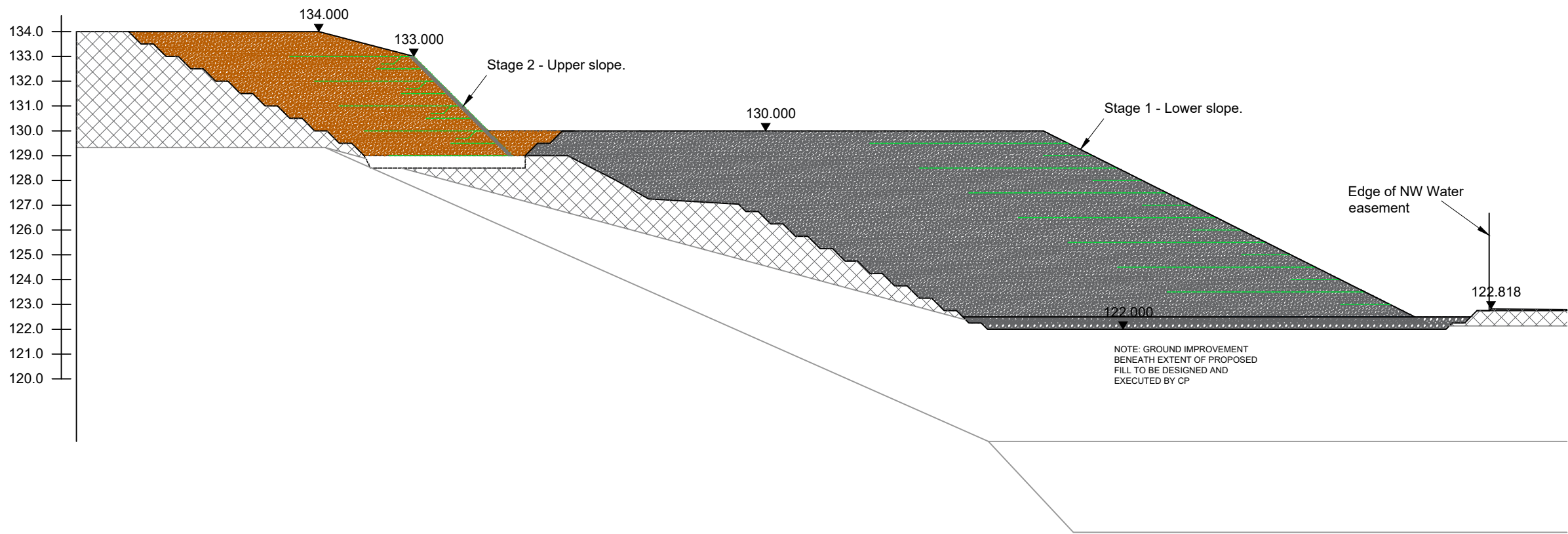
SECTION 1-1
EXISTING
Scale 1:200.



SECTION 1-1
BENCHED EXCAVATION
AND FORMATION TESTING
Scale 1:200.



SECTION 1-1
INSTALLATION LOWER SLOPE (STAGE 1)
Scale 1:200.



SECTION 1-1
INSTALLATION UPPER SLOPE (STAGE 2)
Scale 1:200.

Notes:

- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
- 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
- 3 Levels are shown in metres above ordnance datum (mOD).
- 4 Do not scale from this drawing.
- 5 Refer to drawing 22.016_DRG_001 for notes.

Rev	Description	Date	By	Chk
P2	Sequencing revised - lower slope first	12.06.23	DS	DS
P1	Lower wall elements updated	23.05.22	HD	DS
P0	First issue	15.04.22	HD	DS

Drawing Status: PRELIMINARY

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geotechnics

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Tel: 01423 589500

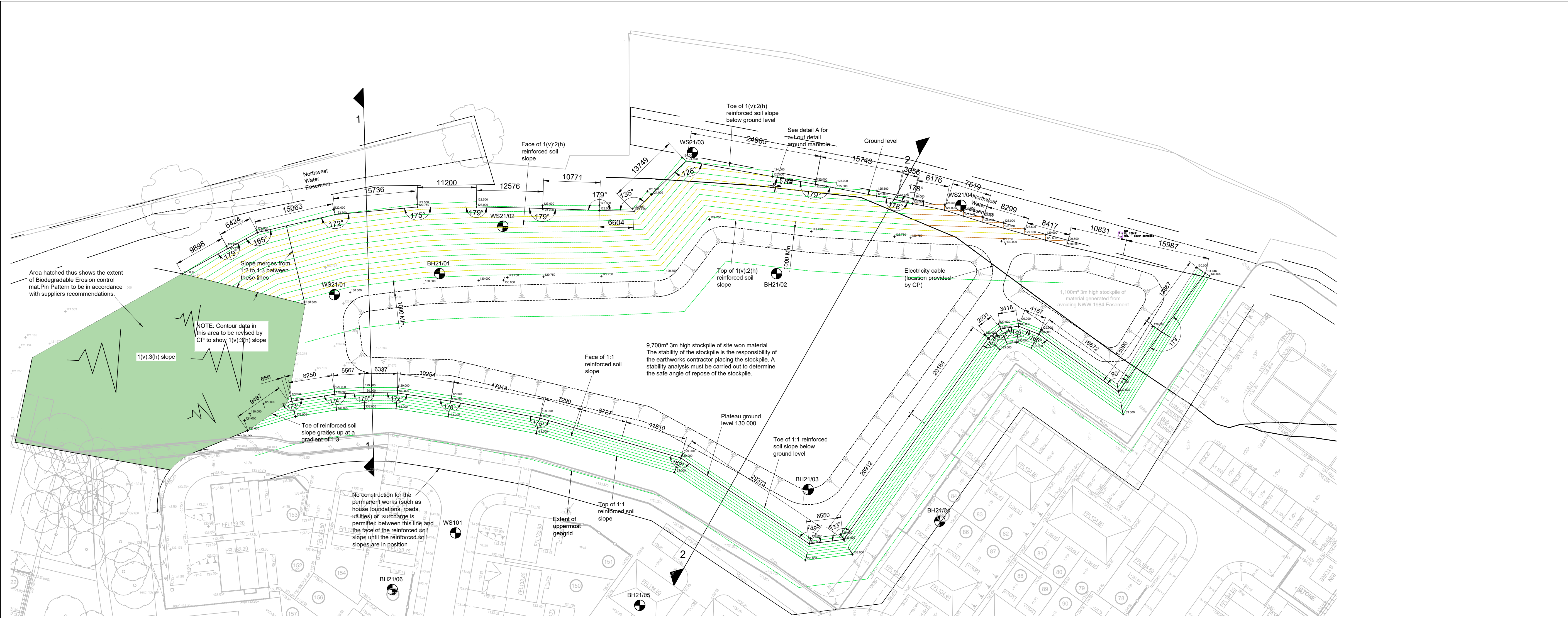
www.Remedygeotechnics.com

Client: Countryside Partnerships Plc

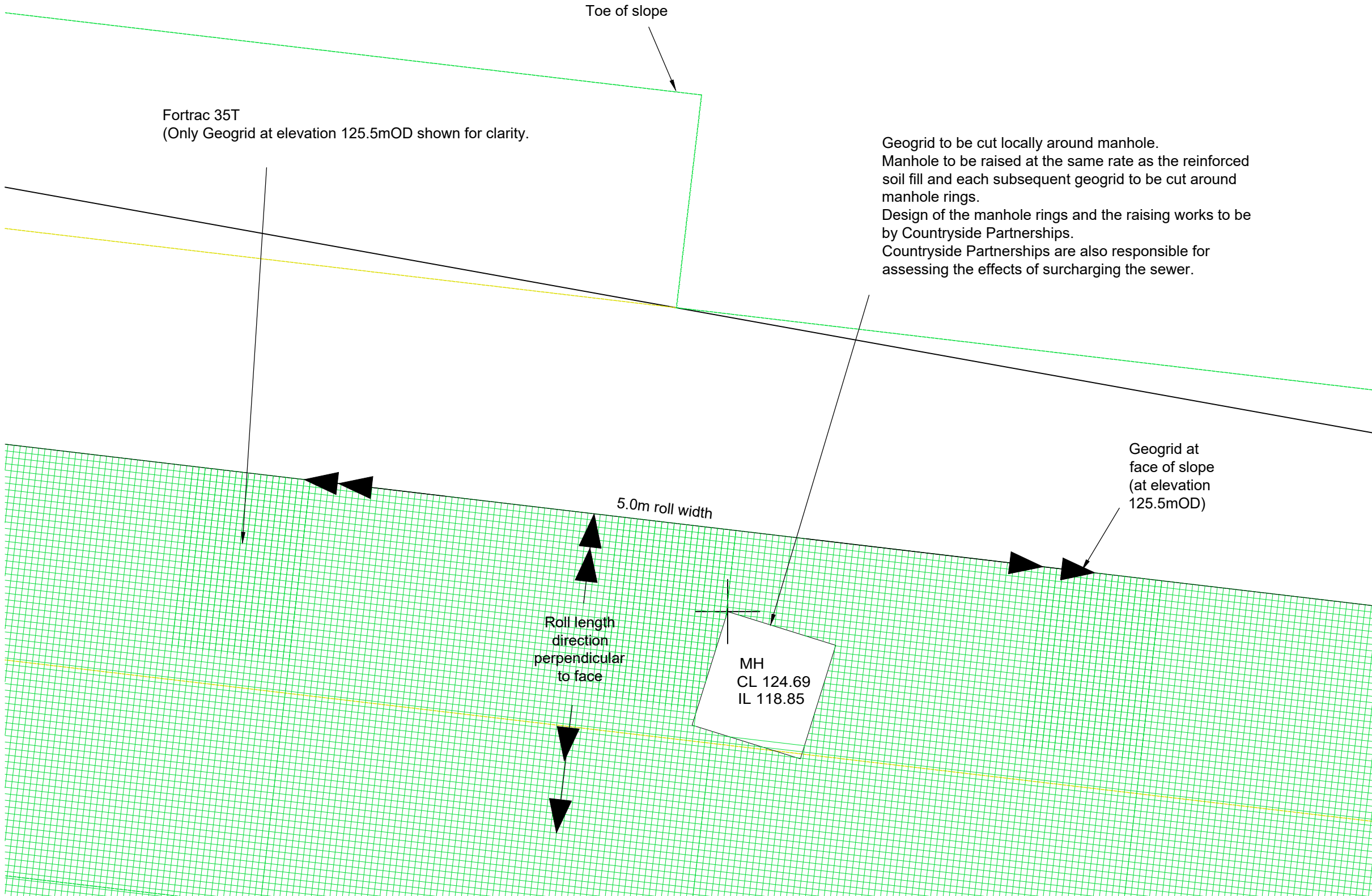
Job Title:
Rochdale, Former Minky Works
Reinforced Soil Slope

Drawing Title:
CONSTRUCTION SEQUENCE

Scale:	Size:	Drawn by:	Checked by:	Date:
1:200	A1	HD	DS	04/2022
Job No.	Drawing no.	Revision:		
22.016	DRG_004	P2		



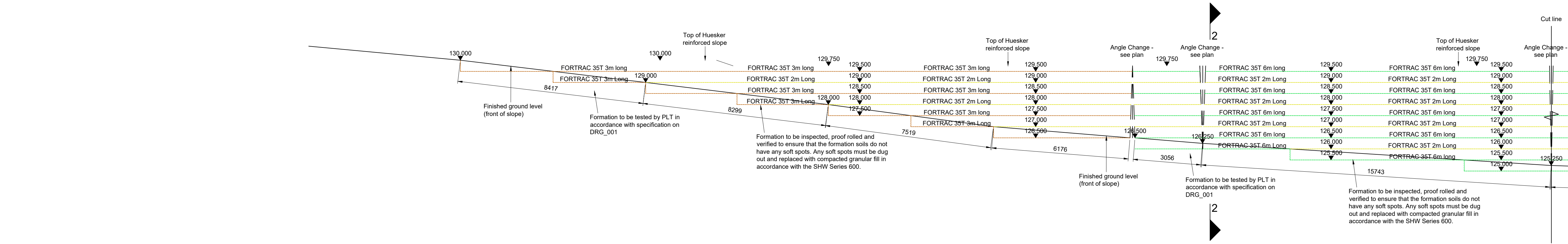
SITE PLAN
Scale 1:400.



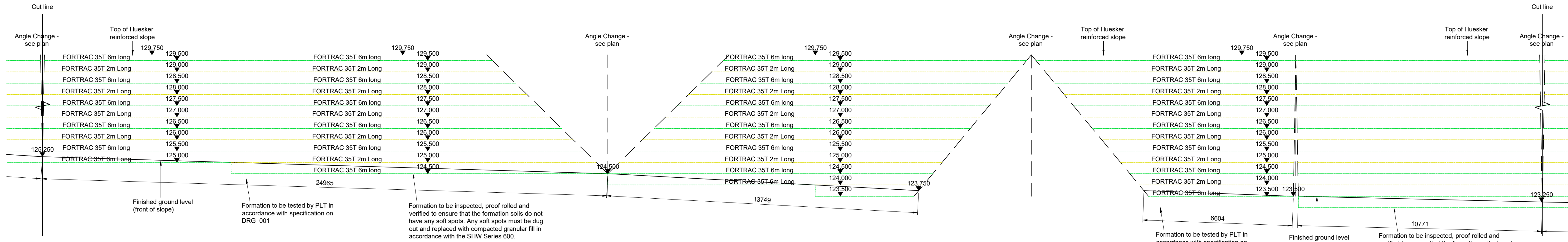
DETAIL A
GEOGRID CUTOUT AT ELEVATION 125.5mAOD
Scale 1:20.

- Notes:
- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
 - 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
 - 3 Levels are shown in metres above ordnance datum (mOD).
 - 4 Do not scale from this drawing.
 - 5 Refer to drawing 22.016_DRG_001 for notes.

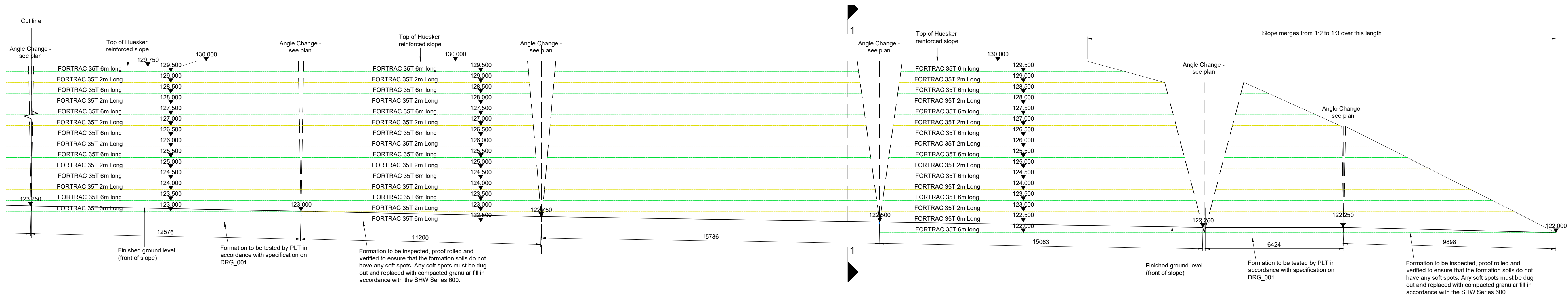
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P1	Spot levels added	10.06.22	HD	DS
P0	First issue	23.05.22	HD	DS
Rev	Description	Date	By	Ckd
Drawing Status: PRELIMINARY				
remedy geotechnics				
Midlands Office Tel: 01788 211778				
Northern Office Tel: 01423 589500				
www.Remedygeotechnics.com				
Client: Countryside Partnerships Plc				
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope				
Drawing Title: SITE PLAN - STAGE 2				
Scale: 1:400	Size: A1	Drawn by: HD	Checked by: DS	Date: 05/2022
Job No. 22.016	Drawing no. DRG_005	Revision: P2		



ELEVATION LOWER WALL
1/3
Scale 1:100.



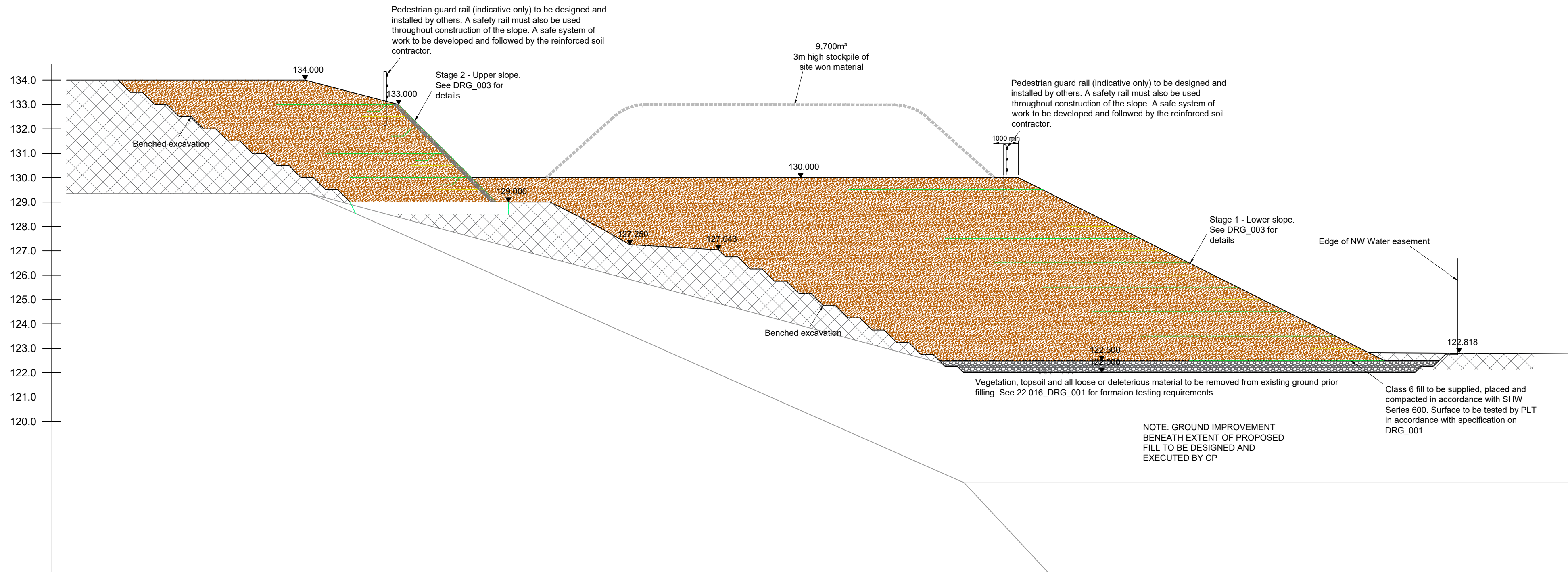
ELEVATION LOWER WALL
CONTINUED 2/3
Scale 1:100.



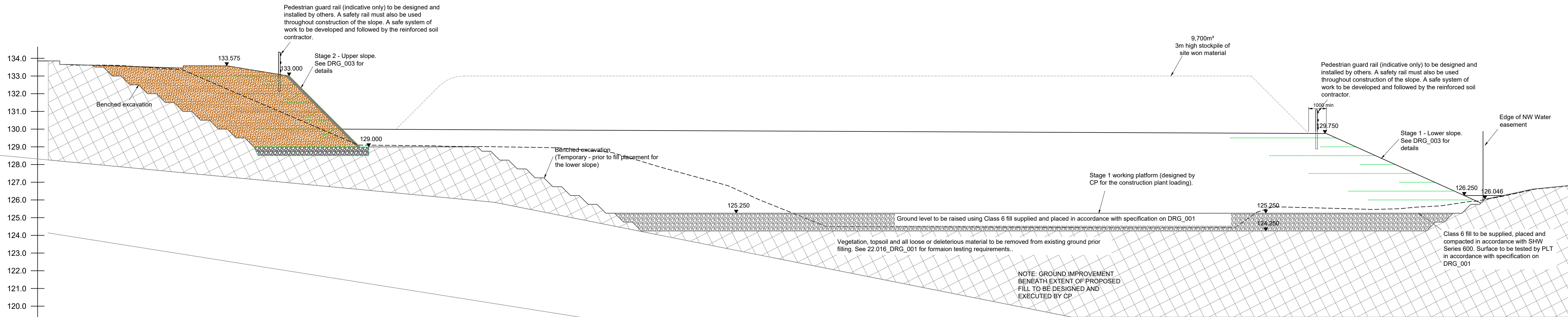
ELEVATION LOWER WALL
CONTINUED 3/3
Scale 1:100.

- Notes:
- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 037 and all other Engineer, Architect and Specialist drawings and specifications.
 - 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
 - 3 Levels are shown in metres above ordnance datum (mOD).
 - 4 Do not scale from this drawing.
 - 5 Refer to drawing 22.016_DRG_001 for notes.

P0	First issue	23.05.22	HD	DS
Rev	Description	Date	By	Ckd
Drawing Status: PRELIMINARY				
remedy geotechnics				
Midlands Office Tel: 01788 211778				
Northern Office Tel: 01423 58500				
www.Remedygeotechnics.com				
Client: Countryside Partnerships Plc				
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope				
Drawing Title: ELEVATION LOWER SLOPE				
Scale: 1:100	Size: A1	Drawn by: HD	Checked by: DS	Date: 05/2022
Job No. 22.016	Drawing no. DRG_006	Revision: P0		



SECTION 1-1
SEE DRAWING 003 FOR DETAILS
Scale 1:125



SECTION 2-2
SEE DRAWING 003 FOR DETAILS
Scale 1:125

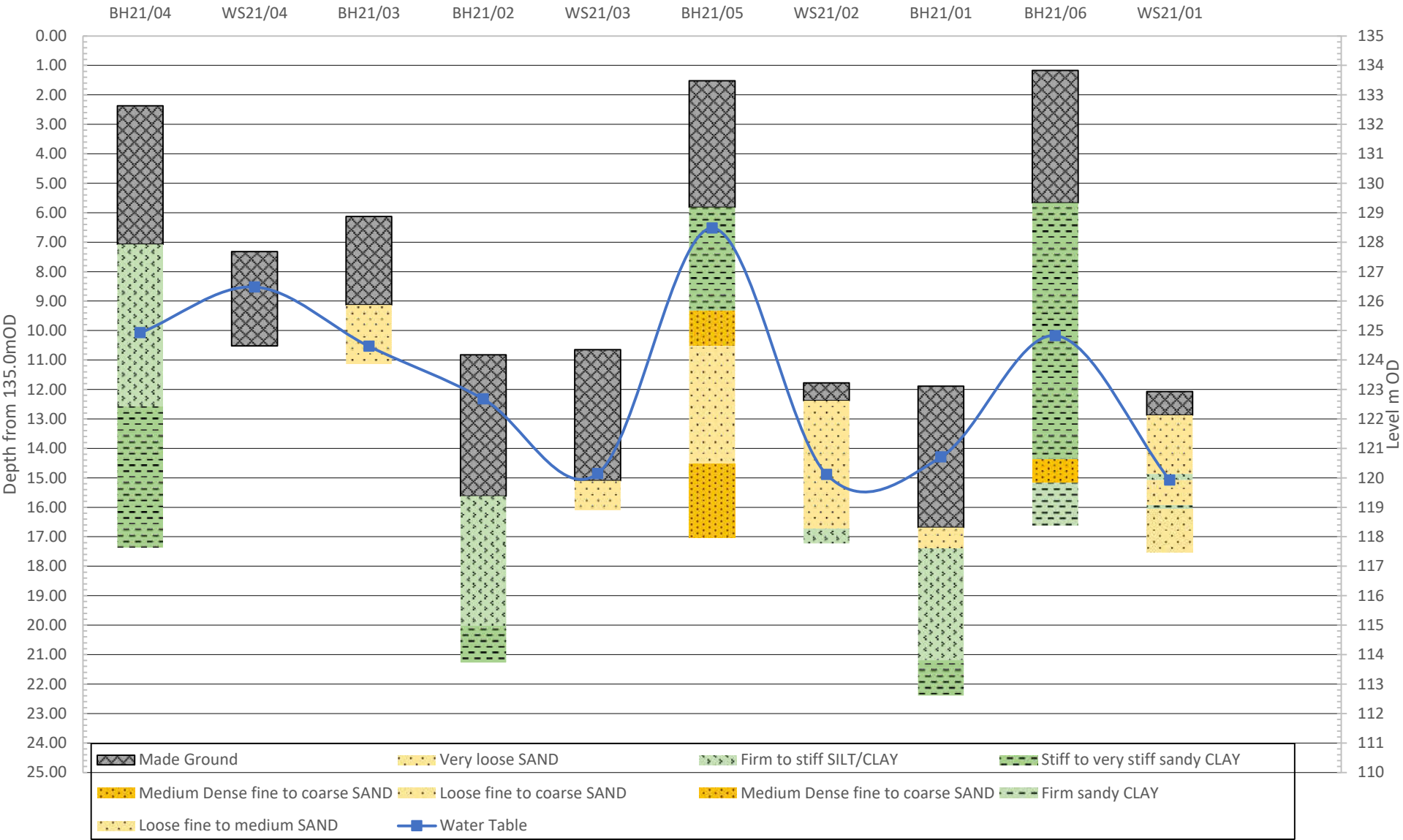
- Notes:
- 1 This drawing is to be read in conjunction with report 22.016_GDR_001, drawings 22.016_DRG_001 to 007 and all other Engineer, Architect and Specialist drawings and specifications.
 - 2 Dimensions on this drawing are shown in millimetres unless noted otherwise.
 - 3 Levels are shown in metres above ordnance datum (mOD).
 - 4 Do not scale from this drawing.
 - 5 Refer to drawing 22.016_DRG_001 for notes.

P1	Sequencing revised - lower slope first	12.06.23	DS	DS
P0	First issue	23.05.22	HD	DS
Rev	Description	Date	By	Ckd
Drawing Status: PRELIMINARY				
remedy geotechnics				
Midlands Office Tel: 01788 211778				
Northern Office Tel: 01423 589500				
www.Remedygeotechnics.com				
Client: Countryside Partnerships Plc				
Job Title: Rochdale, Former Minky Works Reinforced Soil Slope				
Drawing Title: SECTIONS				
Scale: 1:100	Size: A1	Drawn by: HD	Checked by: DS	Date: 05/2022
Job No. 22.016	Drawing no. DRG_007		Revision: P1	

Appendix A

Ground Investigation Data

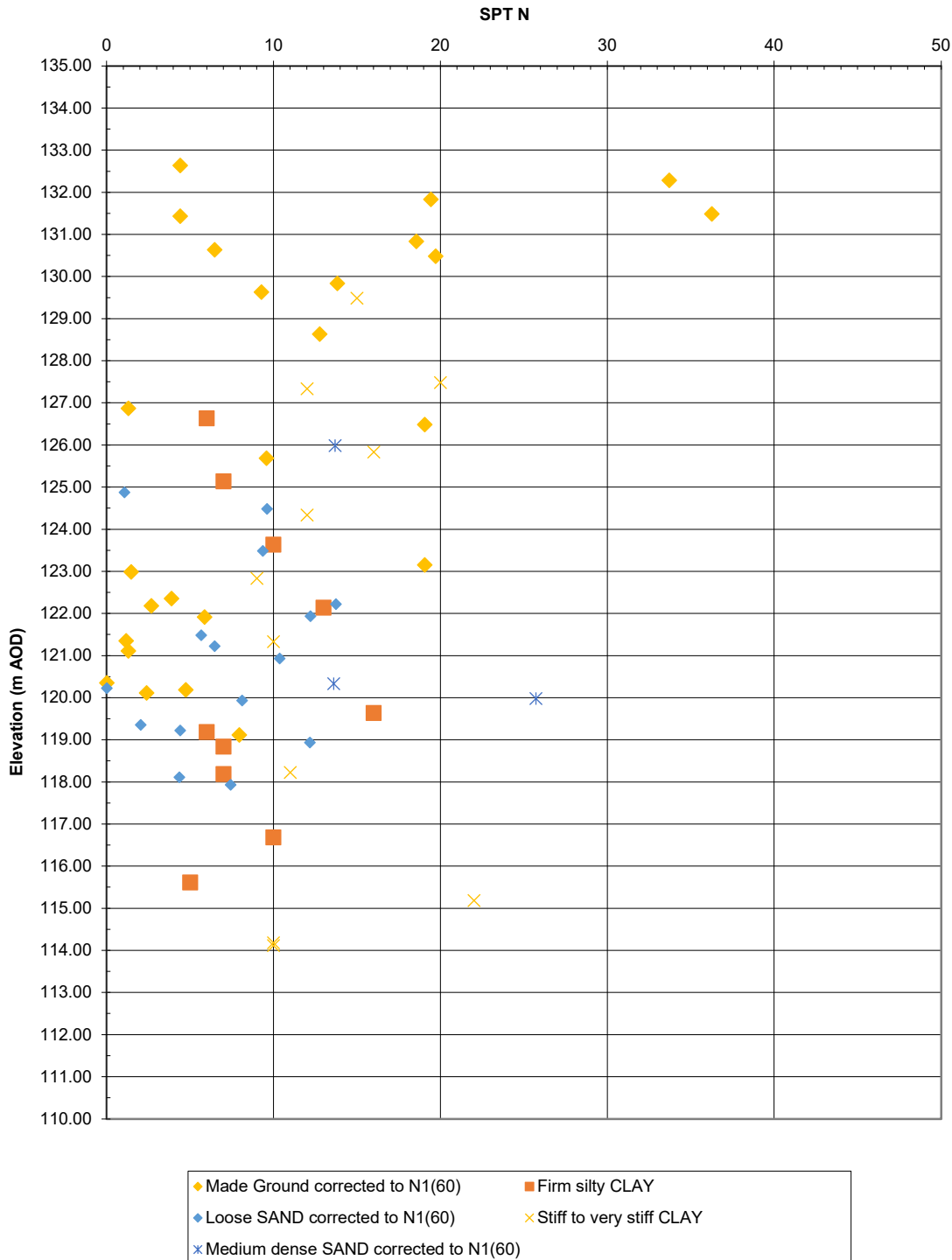
Rochdale, Former Minky Works



Project Number: 21.076
Project Name: Rochdale, Former Minky Works

Date: 08/04/2022
Revision: -

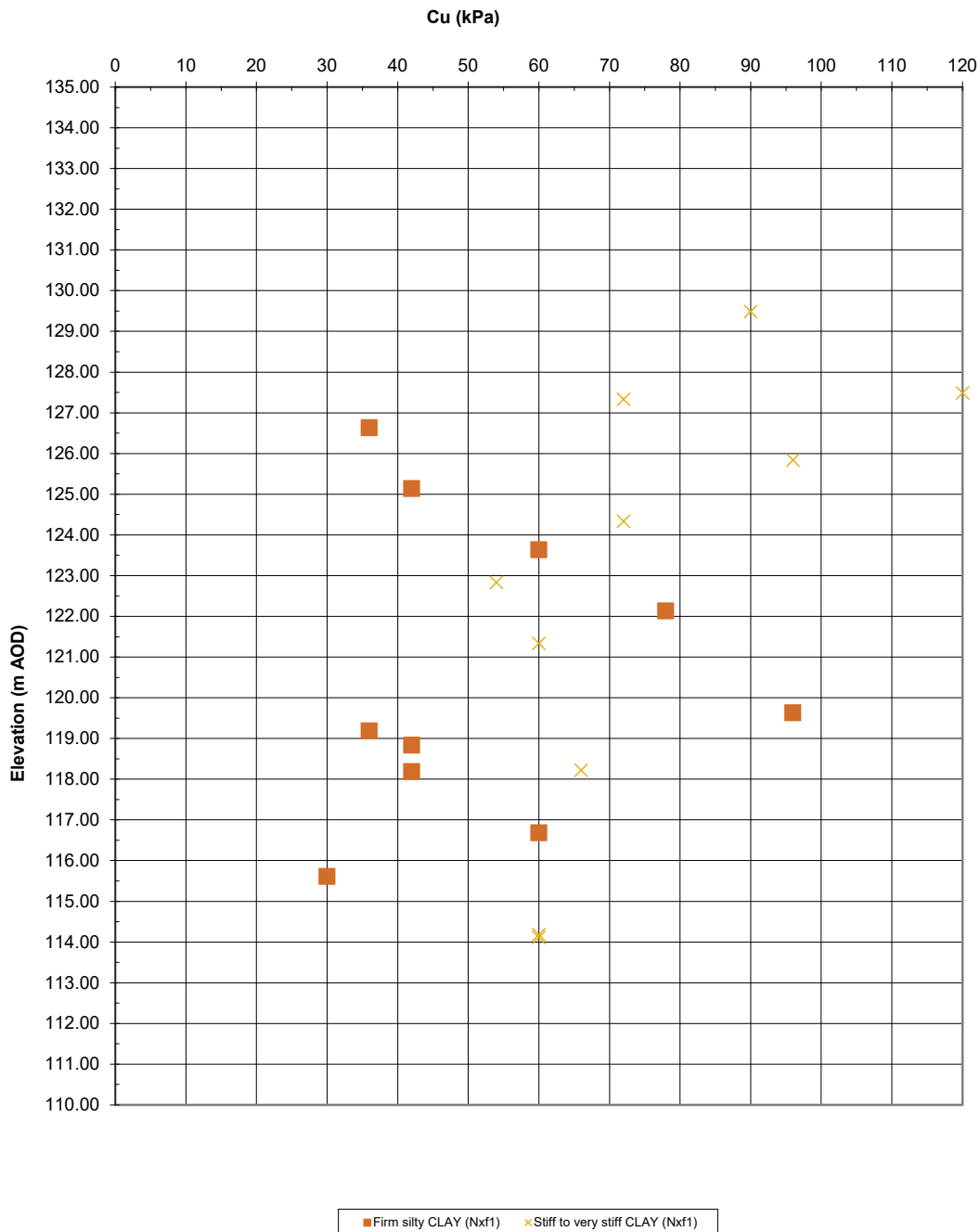
SPT vs. Elevation (All SPTs)



Project Number: 21.076
Project Name: Rochdale, Former Minky Works

Date: 08/04/2022
Revision: -

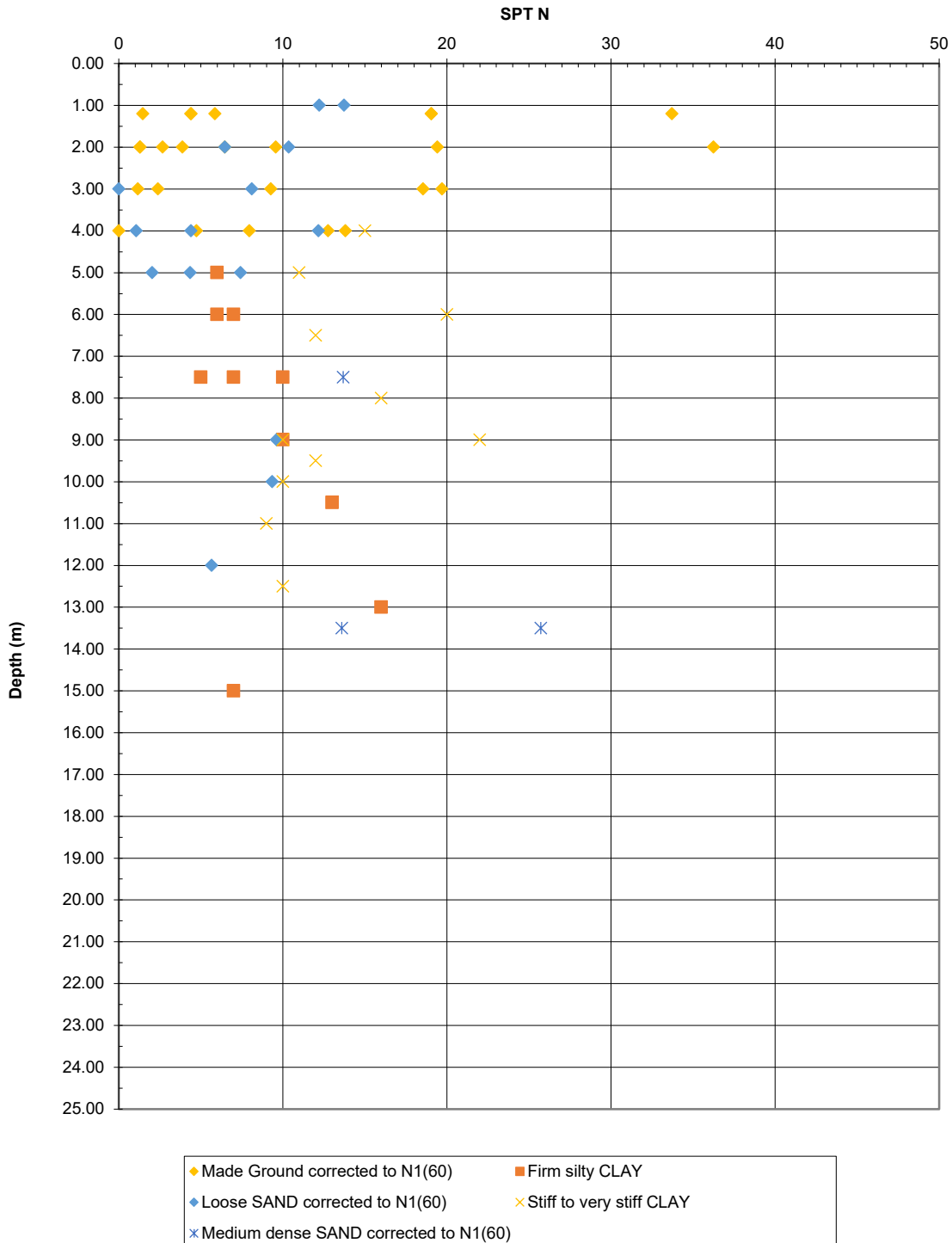
Cu vs. Elevation (from SPT data)



Project Number: 21.076
Project Name: Rochdale, Former Minky Works

Date: 08/04/2022
Revision: -

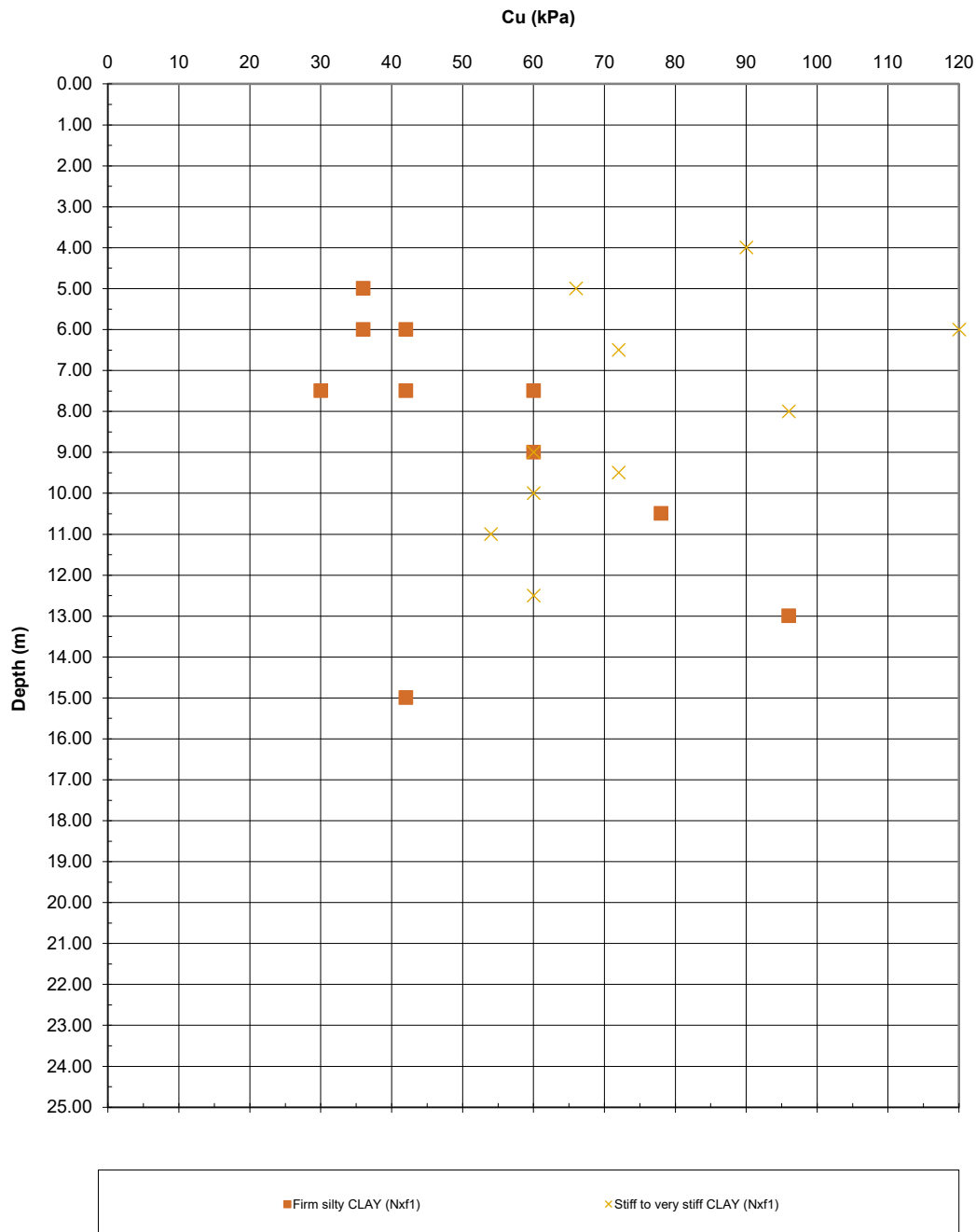
SPT vs. Depth (All SPTs)



Project Number: 21.076
Project Name: Rochdale, Former Minky Works

Date: 08/04/2022
Revision: -

Cu vs. Depth (from SPT data)



Shear Box Analysis

Rochdale, Former Minky Works

Made Ground / Gravelly clayey SAND

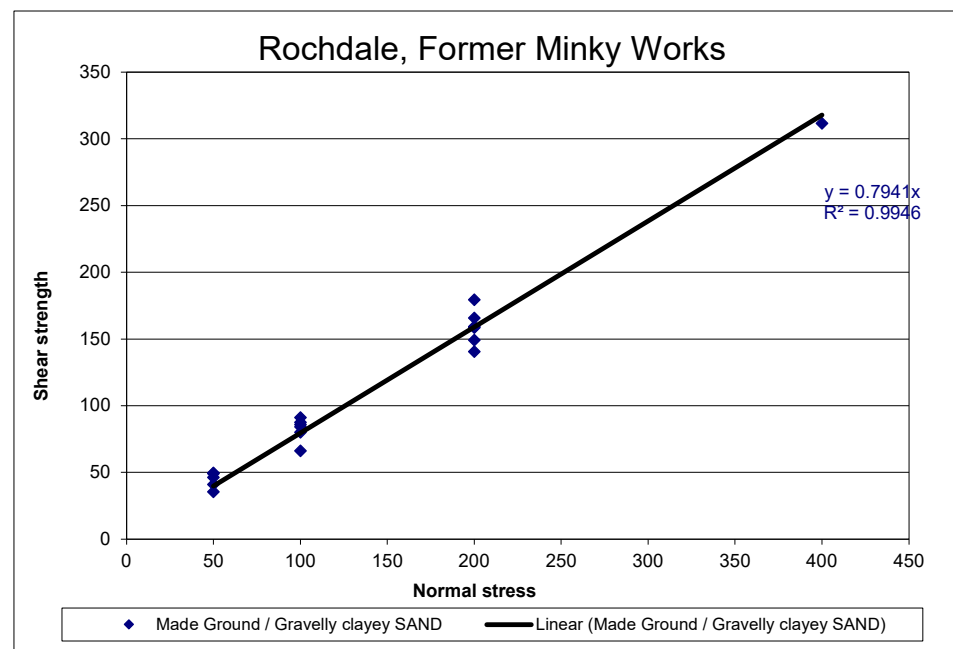
BH	Depth	Normal stress	Peak shear strength
SB101	50	50	48.96
	100	100	83.9
	200	200	159
SB102	50	50	49.4
	100	100	91
	200	200	179.3
SB103	100	100	80
	200	200	149
	400	400	311.3
SB104	50	50	46.1
	100	100	87.4
	200	200	165.6
SB106	50	50	35.3
	100	100	85.7
	200	200	158.3
SB105	50	50	40.7
	100	100	65.9
	200	200	140.3

With c'

$$\begin{aligned}\phi'_{\text{Peak}} &= \tan^{-1} 0.7633 \\ &= 37.4^\circ \\ c' &= 5.9 \text{ kN/m}^2\end{aligned}$$

No c'

$$\begin{aligned}\phi'_{\text{Peak}} &= \tan^{-1} 0.7941 \\ &= 38.5^\circ\end{aligned}$$

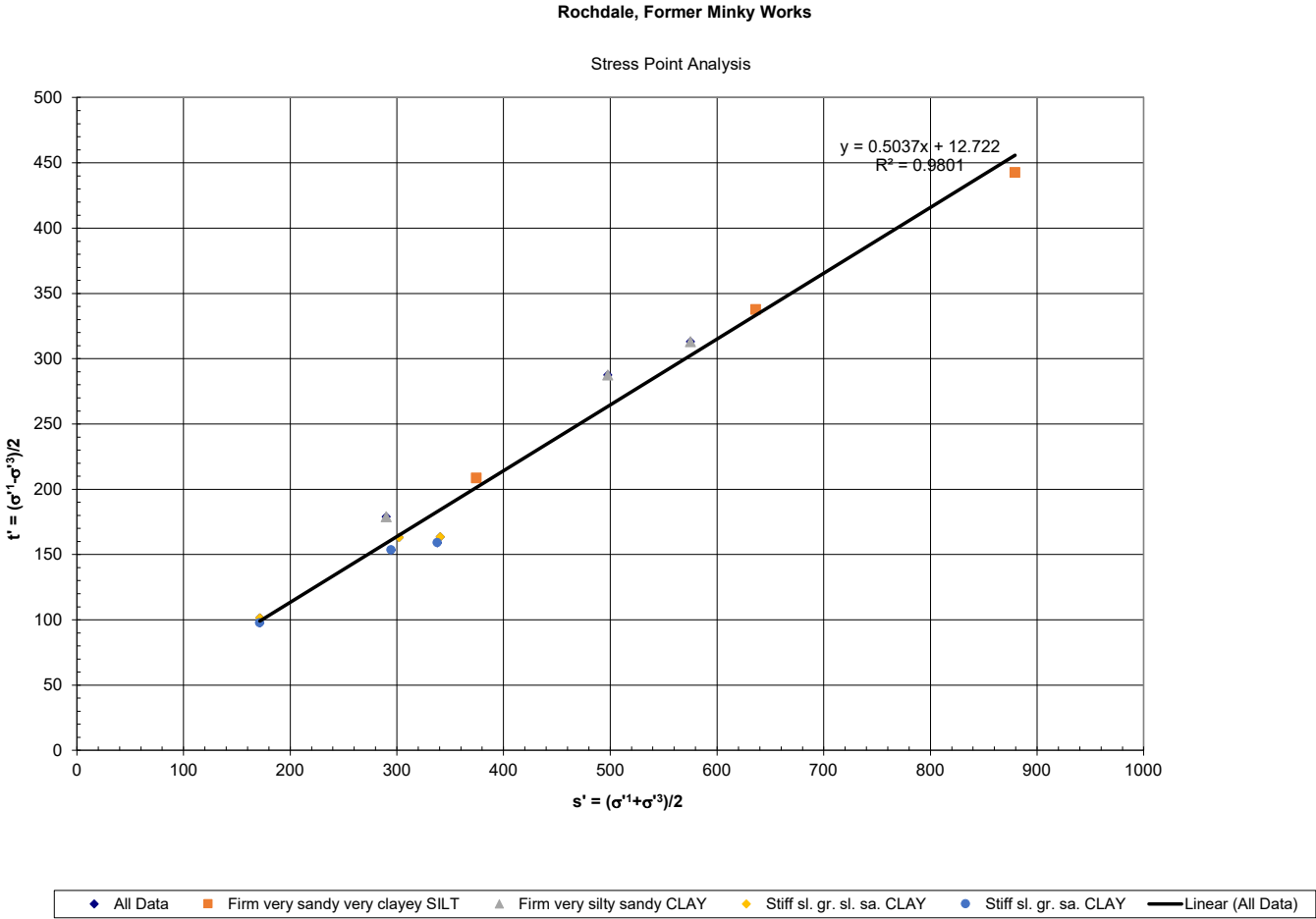


Stress point analysis

Site: Rochdale, Former Minky Works
Material: Sandy clayey silt

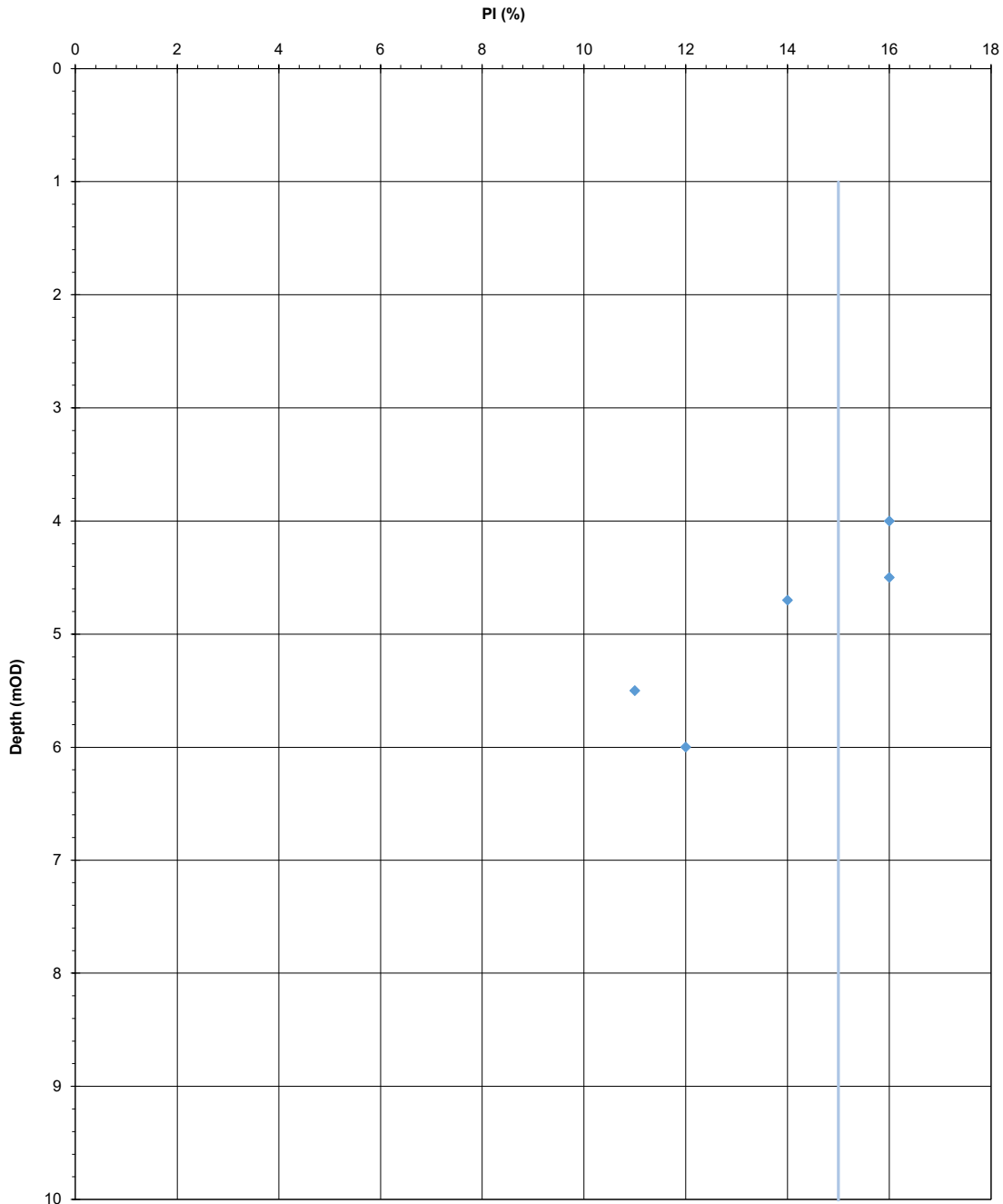
BH	Depth (m)	Elevation (mAOD)	Material	σ'_1	σ'_3	$(\sigma'_1 + \sigma'_3)/2$	$(\sigma'_1 - \sigma'_3)/2$	Angle of friction (ϕ')
BH21/01	6.5	116.61	Firm very sandy very clayey SILT	583	166	374.5	208.5	$\alpha' = \tan^{-1} 0.5037$ (Taken from equation on chart 1)
				974	299	636.5	337.5	$\alpha' = 26.7^\circ$
				1322	437	879.5	442.5	$\phi' = 30.2^\circ$
BH21/04	5.5	127.13	Firm very silty sandy CLAY	469	111	290	179	
				785	210	497.5	287.5	
				888	262	575	313	
BH21/05	5.5	127.98	Stiff sl. gr. sl. sa. CLAY	273	70	171.5	101.5	
				465	139	302	163	
				504	177	340.5	163.5	
BH21/06	5.5	128.33	Stiff sl. gr. sa. CLAY	269	74	171.5	97.5	
				448	141	294.5	153.5	
				497	179	338	159	

Cohesion (c')
 $a' = 12.722$ (Taken from equation on chart 1)
 $c' = 14.7$ kN/m²



Project Number:	21.076	Date:	04/02/2022
Project Name:	Rochdale, Former Minky Works	Revision:	-

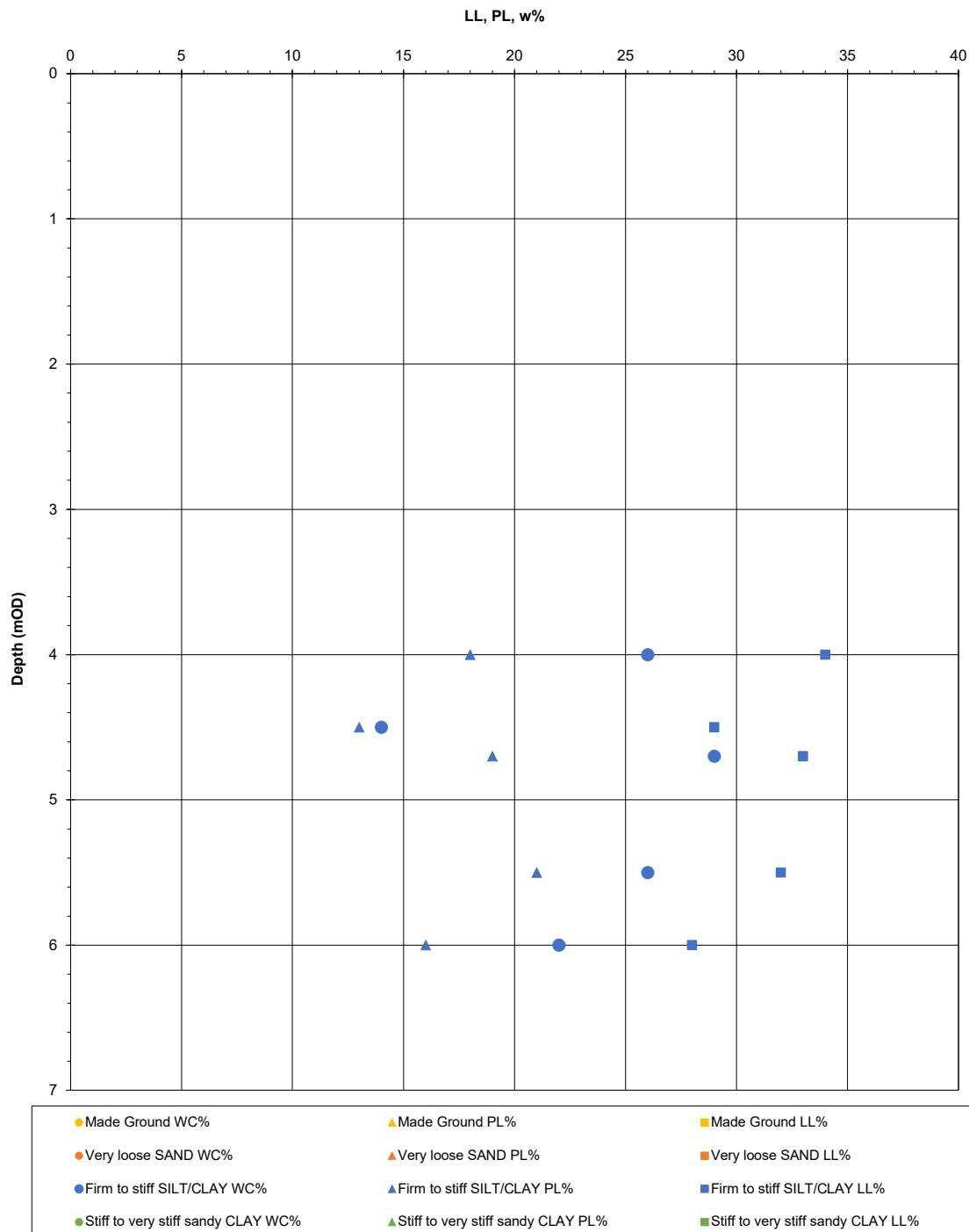
Rochdale, Former Minky Works - Plastic Limit Design Chart



- PI Design Line
- ◆ Made Ground PI%
- Very loose SAND PI%
- ◆ Firm to stiff SILT/CLAY PI%
- ◆ Stiff to very stiff sandy CLAY PI%

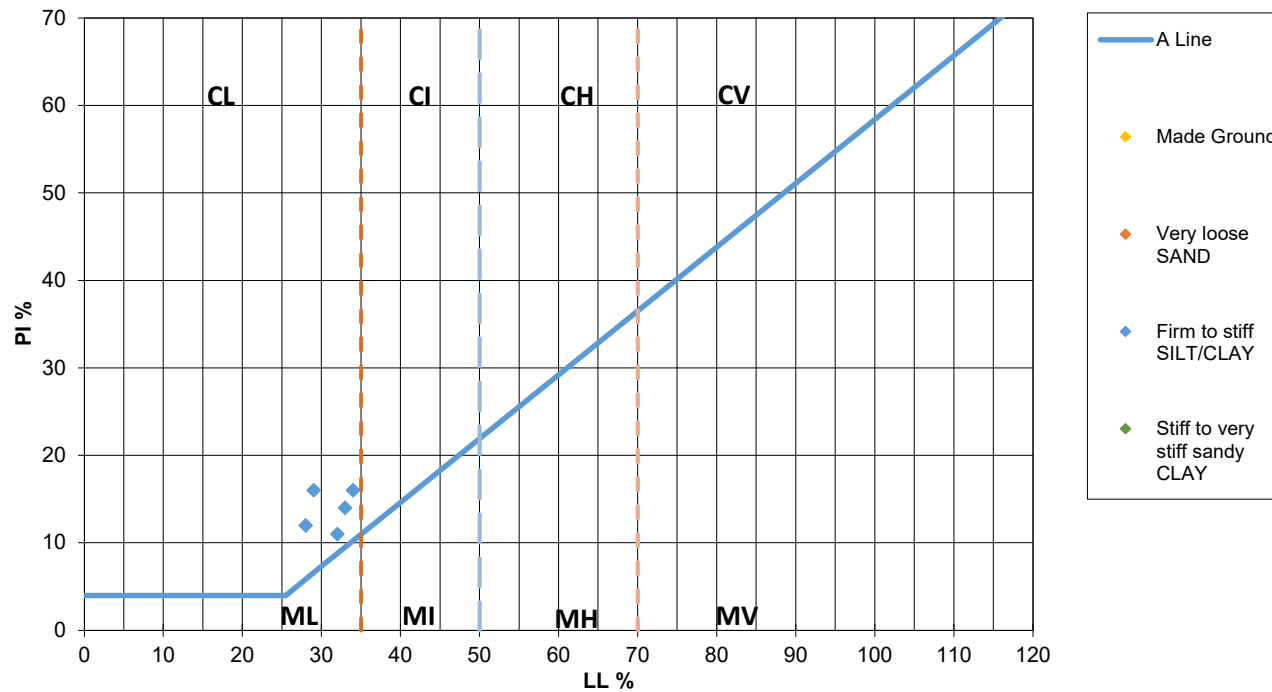
Project Number:	21.076	Date:	04/02/2022
Project Name:	Rochdale, Former Minky Works	Revision:	0

Rochdale, Former Minky Works - Index Limits & Moisture Content with Depth



Project Number:	21.076	Date:	04/02/2022	
Project Name:	Rochdale, Former Minky Works	Revision:	0	

Rochdale, Former Minky Works - Plasticity Chart



PSD - Former Minky Works, Rochdale

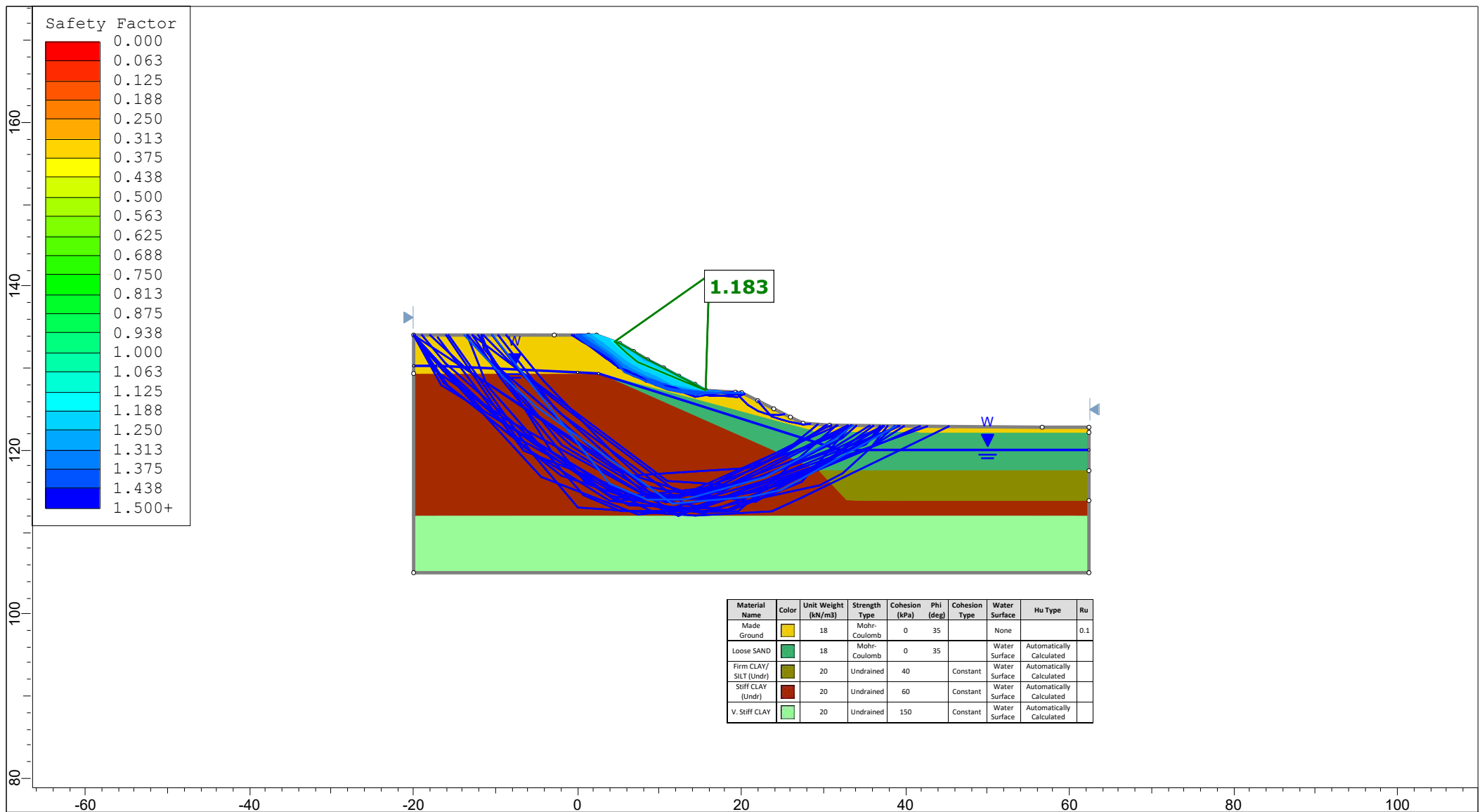
The graph displays the grain size distribution for various soil samples. The y-axis represents the Percent Passing (%), ranging from 0 to 100. The x-axis represents the Particle Size (mm) on a logarithmic scale, ranging from 0.002 to 200. The plot includes soil classification zones (CLAY, FINE SILT, MEDIUM SILT, COARSE SILT, FINE SAND, MEDIUM SAND, COARSE SAND, FINE GRAVEL, MEDIUM GRAVEL, COARSE GRAVEL, COBBLES) and two dashed lines for 6I / 6J (Upper) and 6I / 6J (Lower) limits. Data series include SB101, SB102, SB103, BH21/04 2.2, BH21/05 2.3, BH21/06 4, SB104, SB105, and SB106.

Appendix B

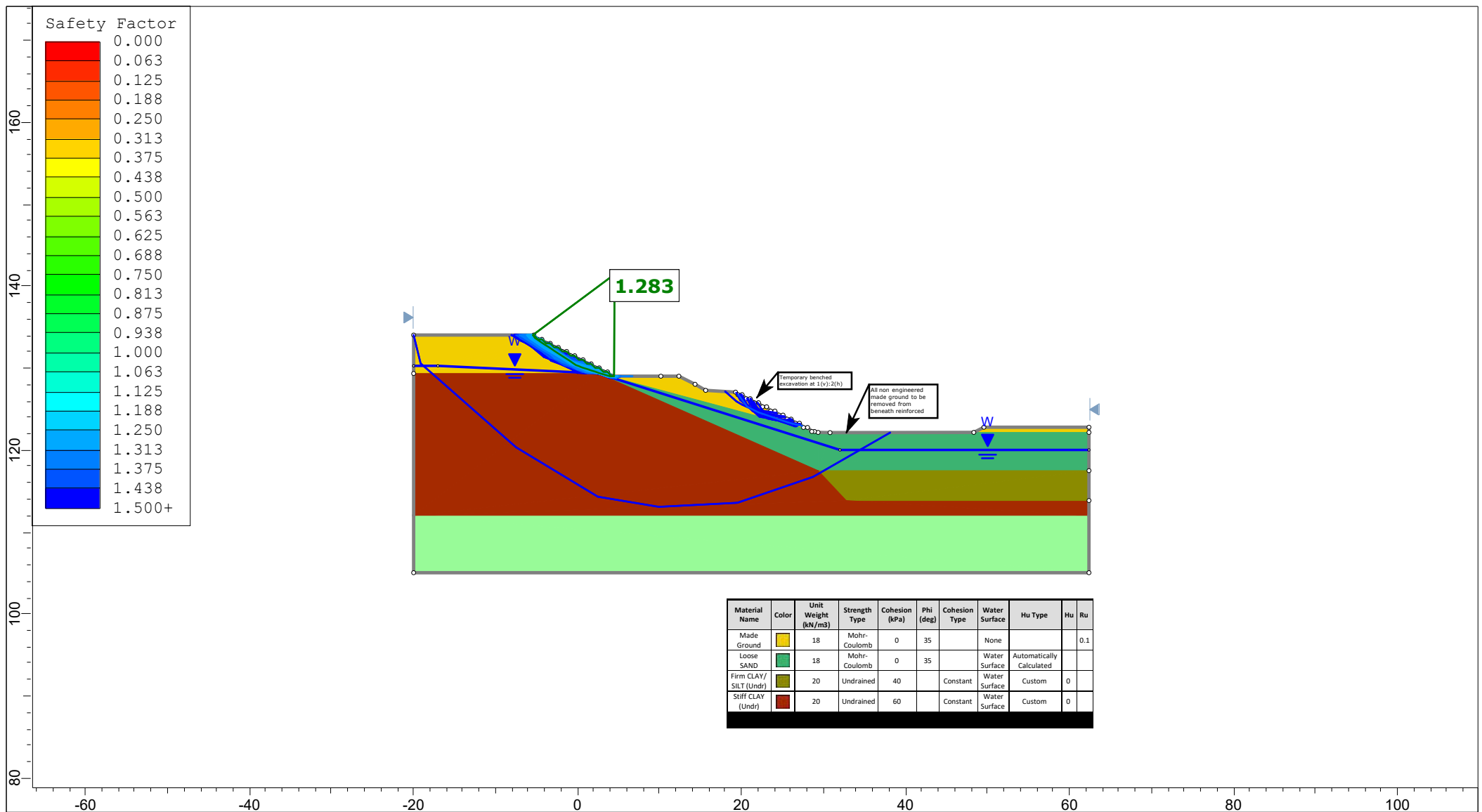
Reinforced Soil Slope Design and Bearing Capacity Calculations

Appendix B1

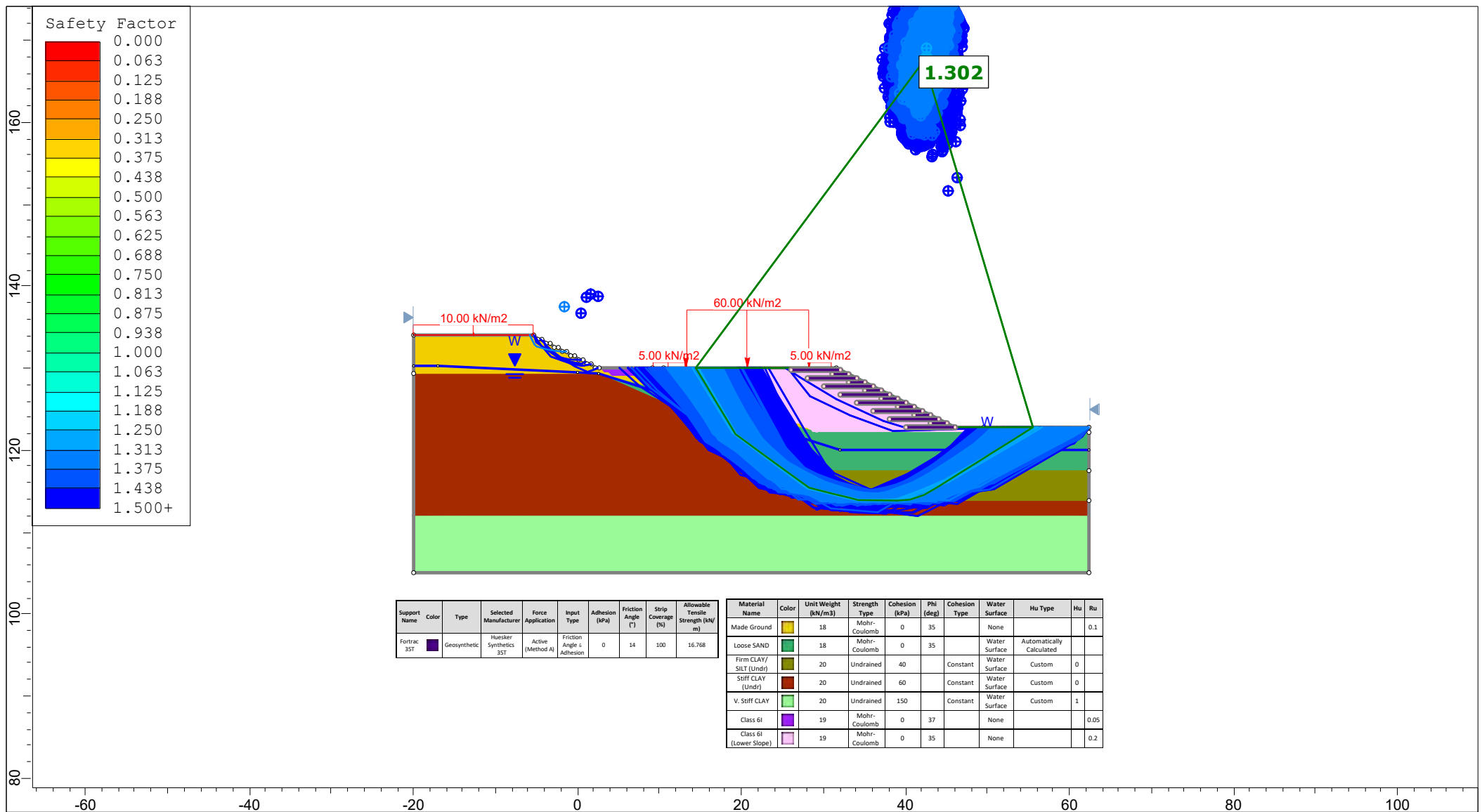
Section 1



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Group		Stage 0 - Existing	Scenario Master Scenario
Drawn By		Company	
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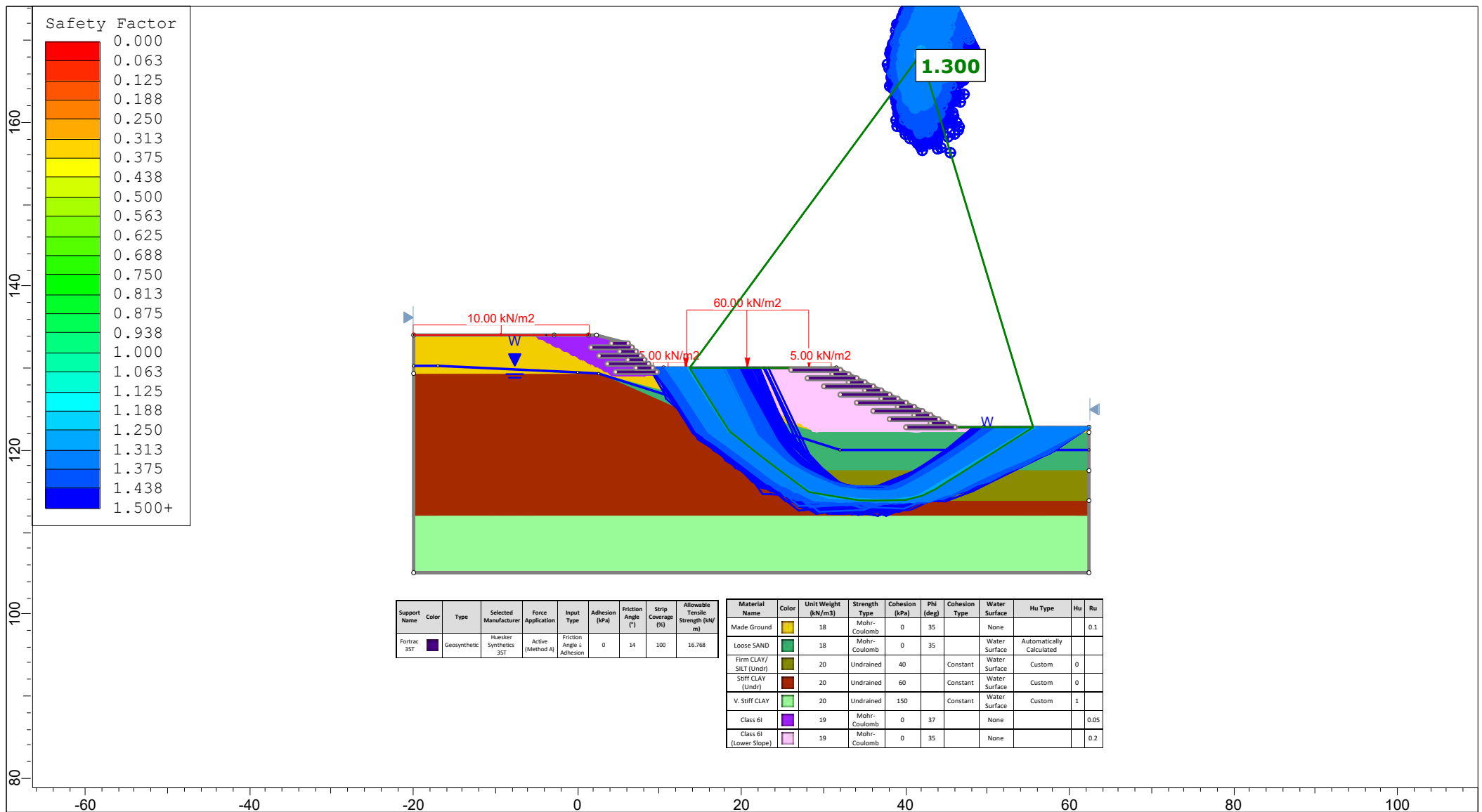


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Group		Stage 1 - Temp (Undr.)		Scenario	
Master Scenario		Company		File Name	
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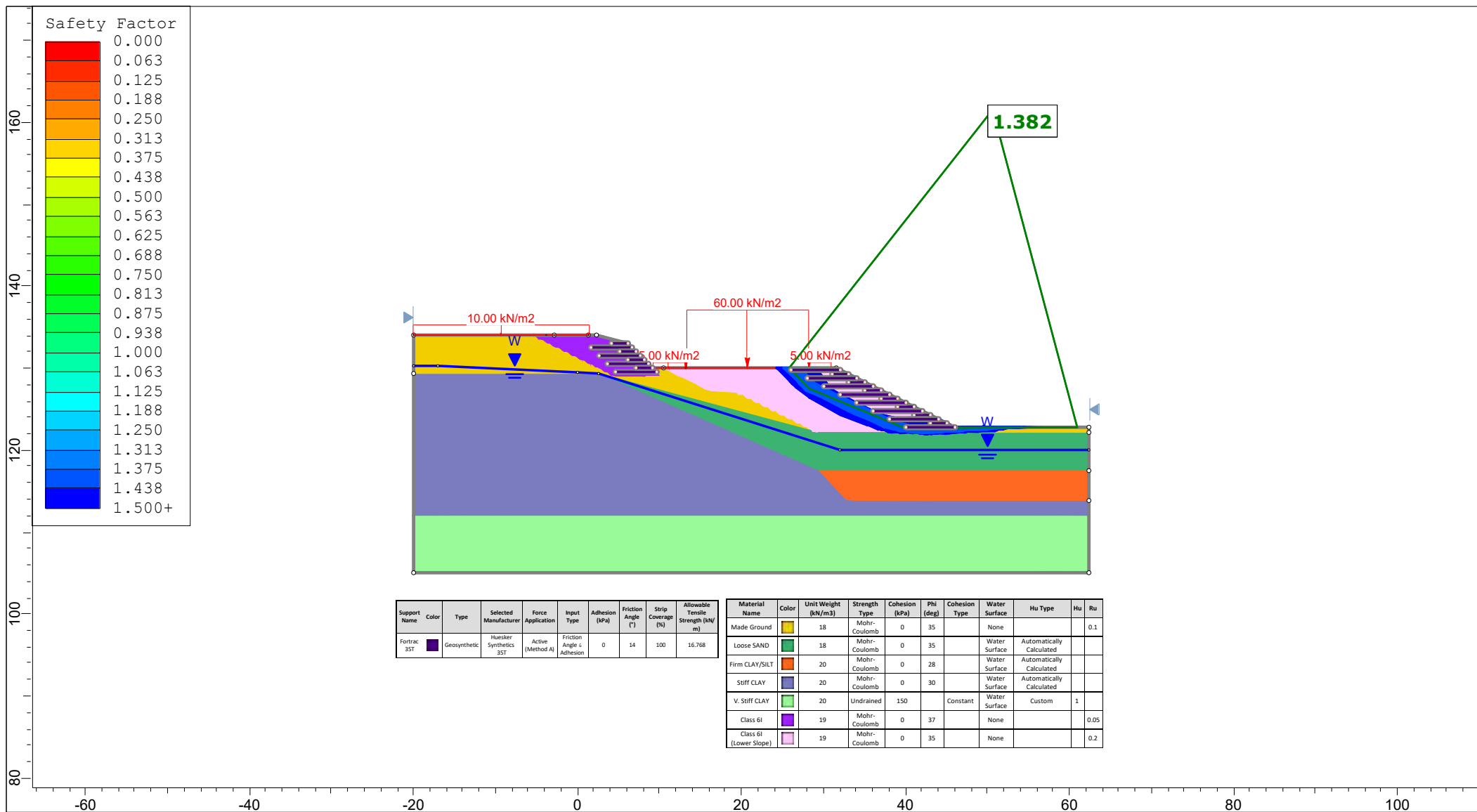
SLIDEINTERPRET 9.027

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Drawn By				Company	
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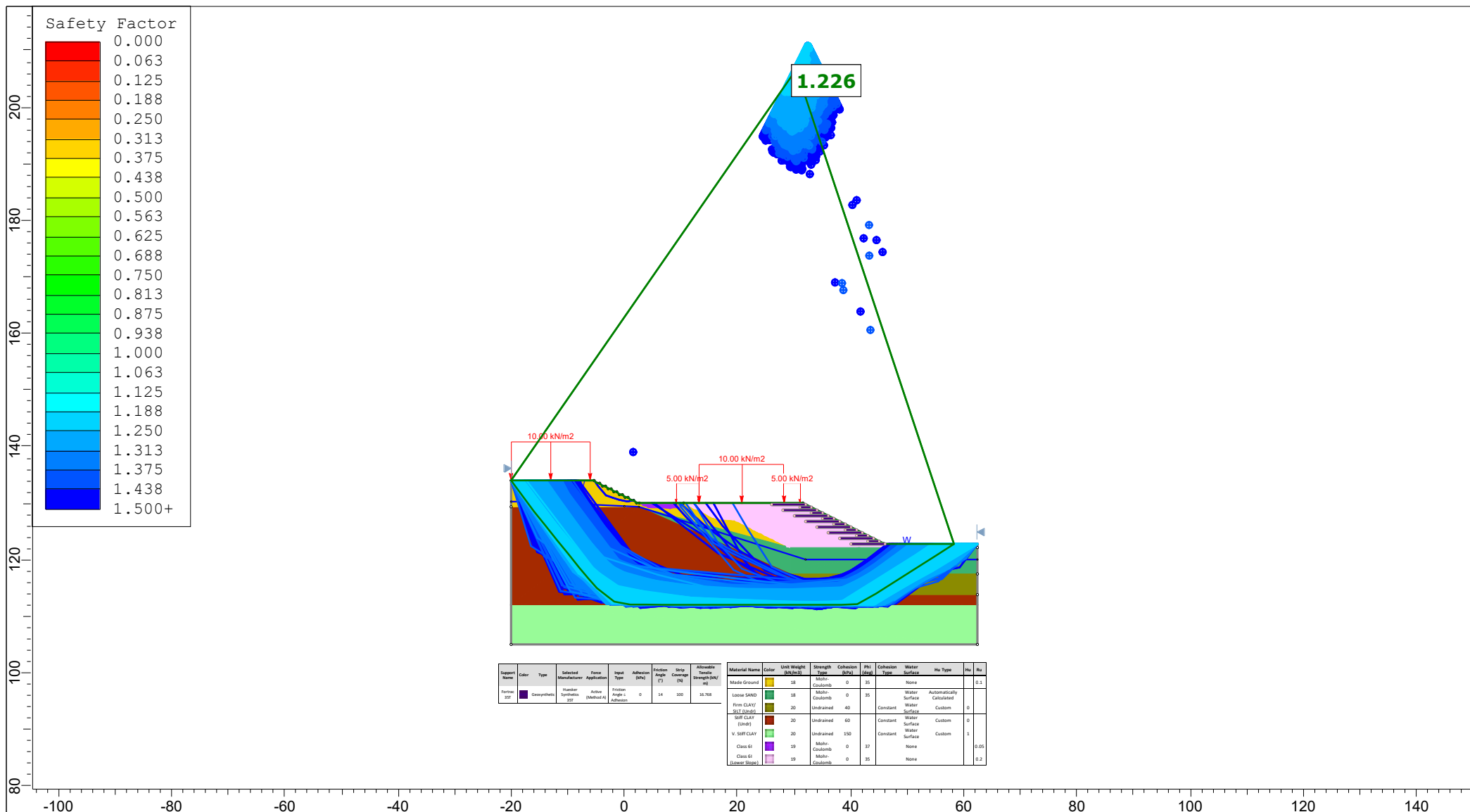
SLIDEINTERPRET 9.027

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Drawn By				Company	
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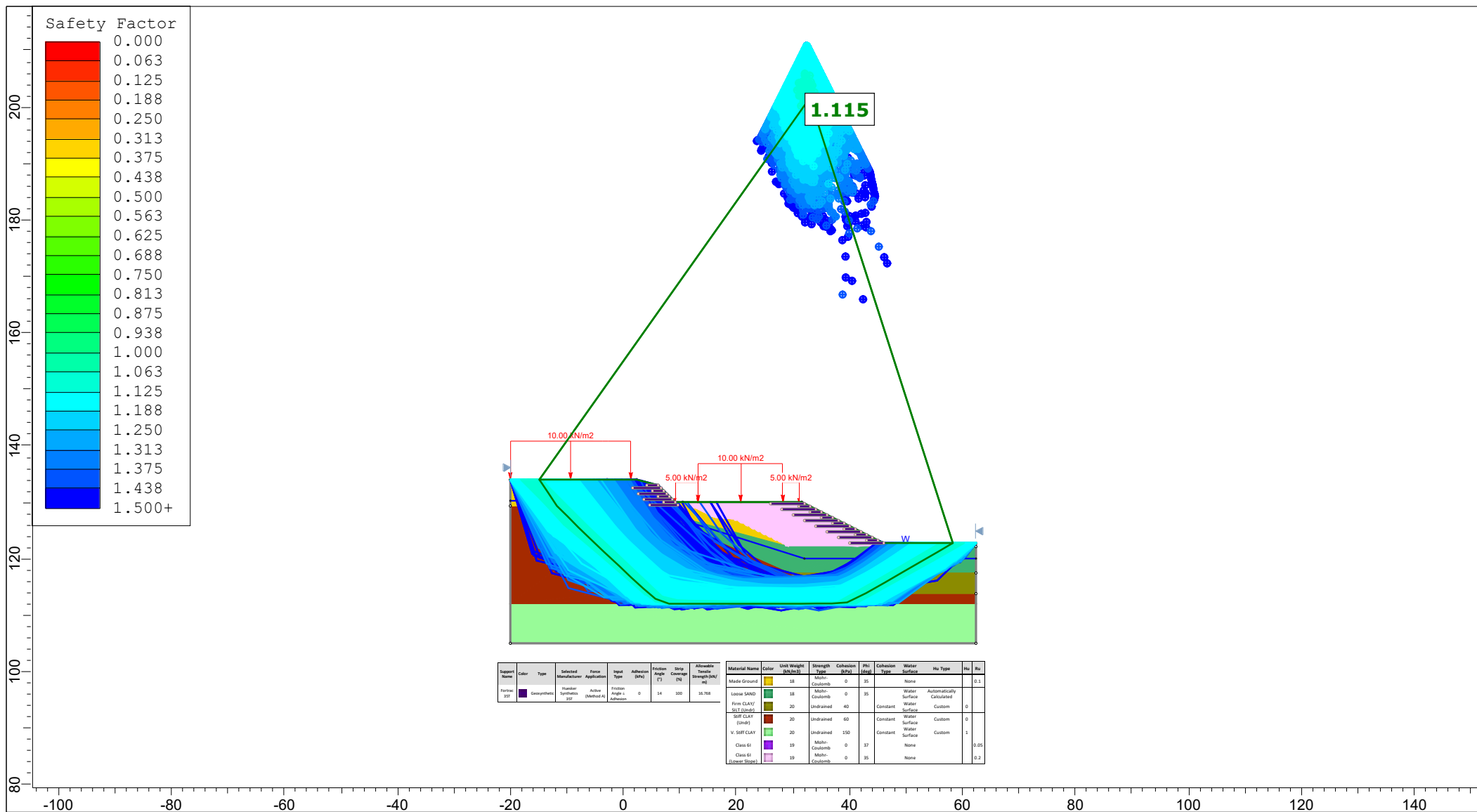


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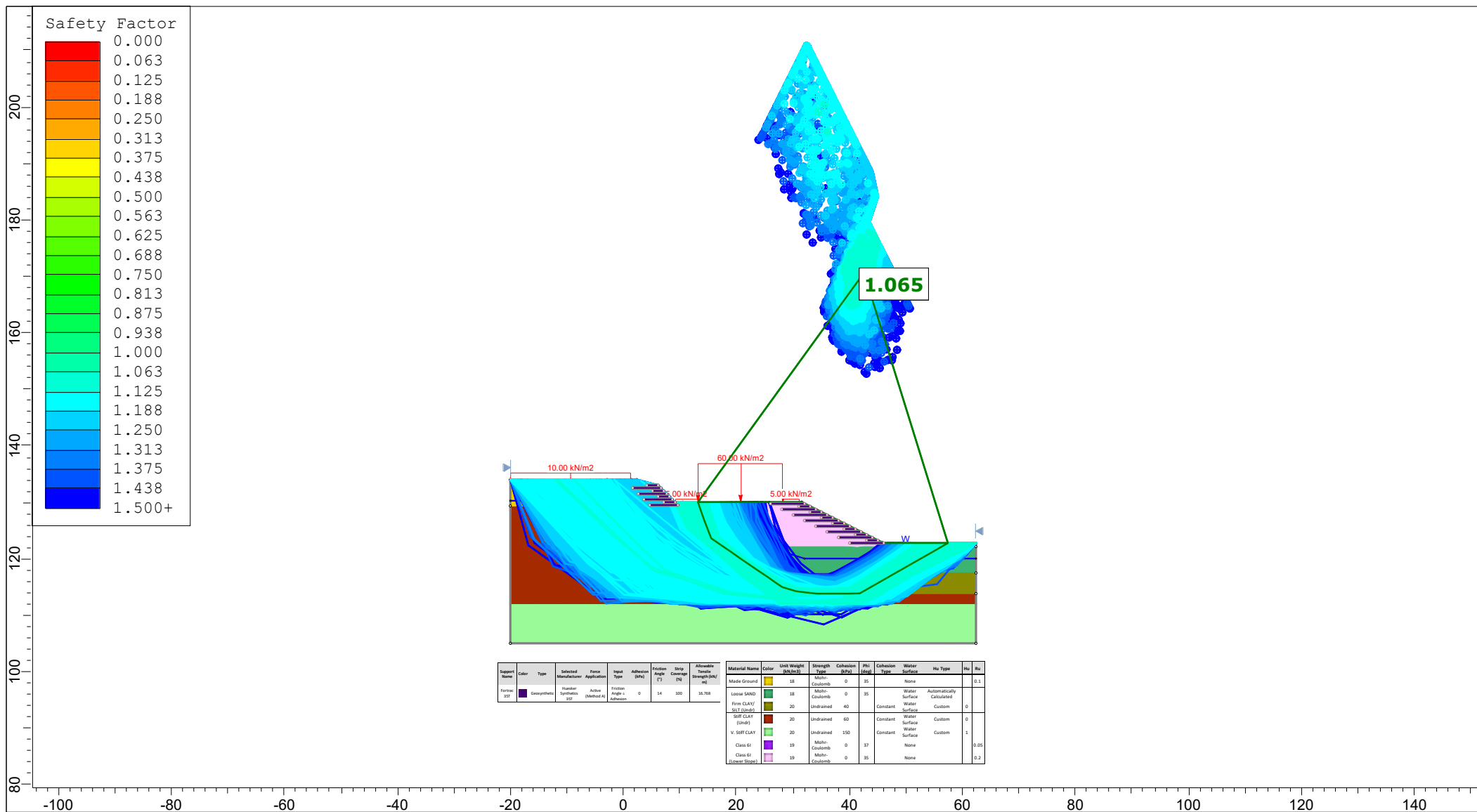
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Group		Permanent (Dr.)		Scenario	
Master Scenario		Company		File Name	
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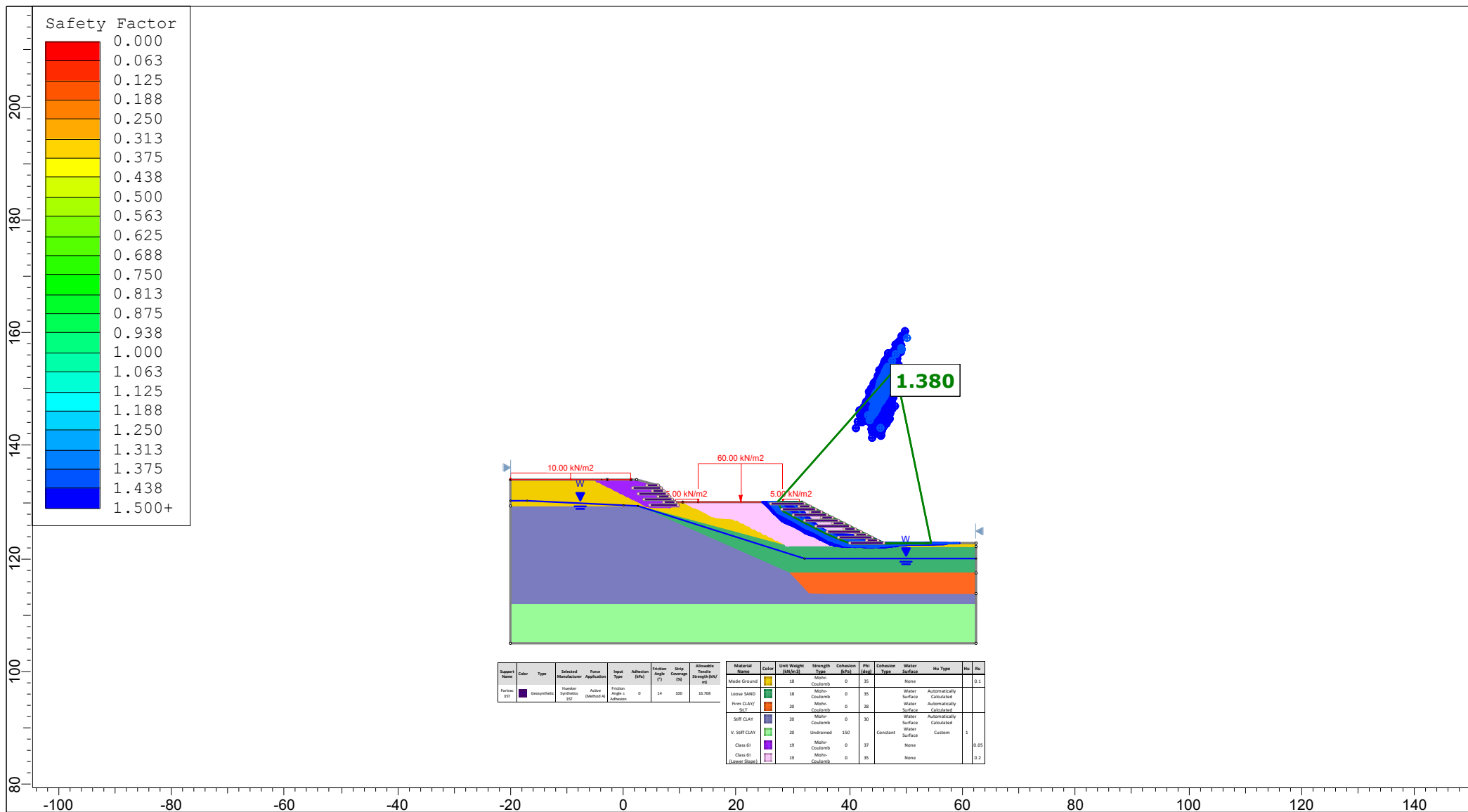
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Group			Stage 2 - Lower Slope		
Scenario			Master Scenario		
Drawn By			Company		
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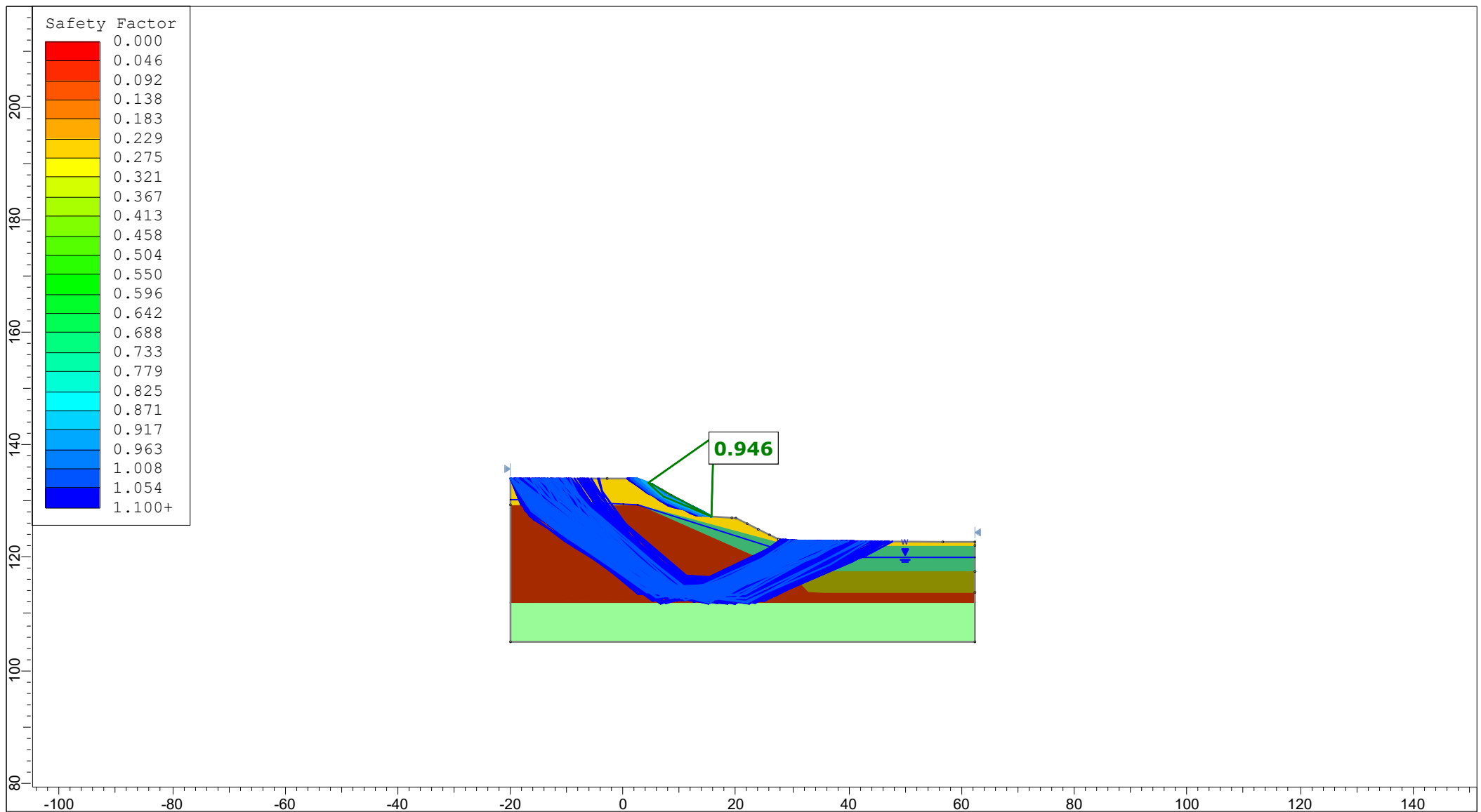
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Scenario			Master Scenario		
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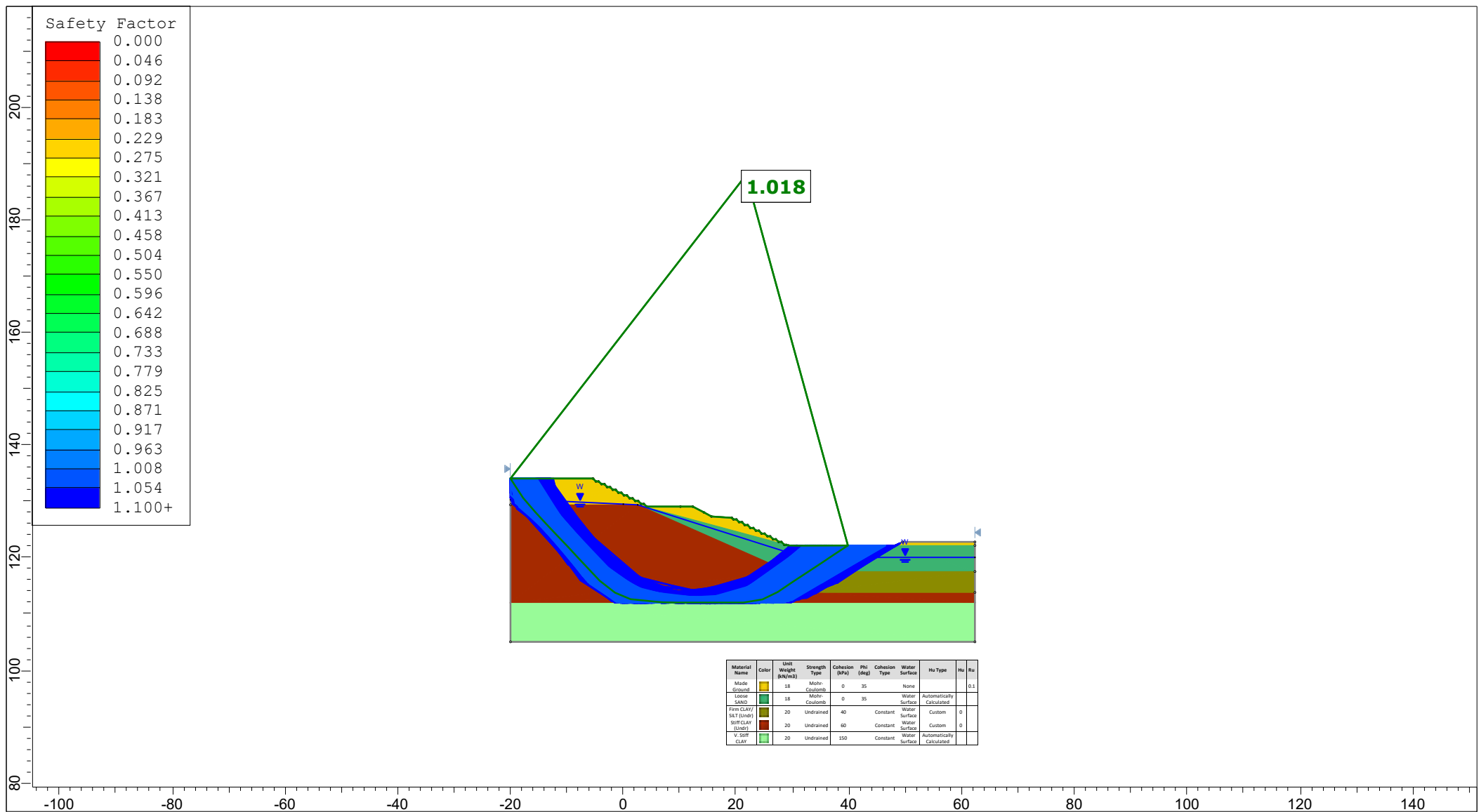
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Group			Stage 4 - Top and bottom slope (Undr.) with s/c		Scenario
Drawn By					Master Scenario
Date			10/02/2022, 11:54:46		Company
					File Name
					21.076_Section3_LowerSlopeFirst_HighGW_ULS_24_04_23.slmd



Project			SLIDE - An Interactive Slope Stability Program		
Group			Permanent (Dr.)		
Scenario			Master Scenario		
Drawn By			Company		
Date			10/02/2022, 11:54:46		
File Name			21.076_Section3_LowerSlopeFirst__HighGW_ULS_24_04_23.slmd		



Project		SLIDE - An Interactive Slope Stability Program	
Group	Stage 0 - Existing	Scenario	Master Scenario
Drawn By		Company	
Date	10/02/2022, 11:54:46	File Name	21.076_Section3_LowerSlopeFirst__HighGW_EC7_24_04_23.slmd



Project

SLIDE - An Interactive Slope Stability Program

Group

Stage 1 - Temp (Undr.)

Scenario

Master Scenario

Drawn By

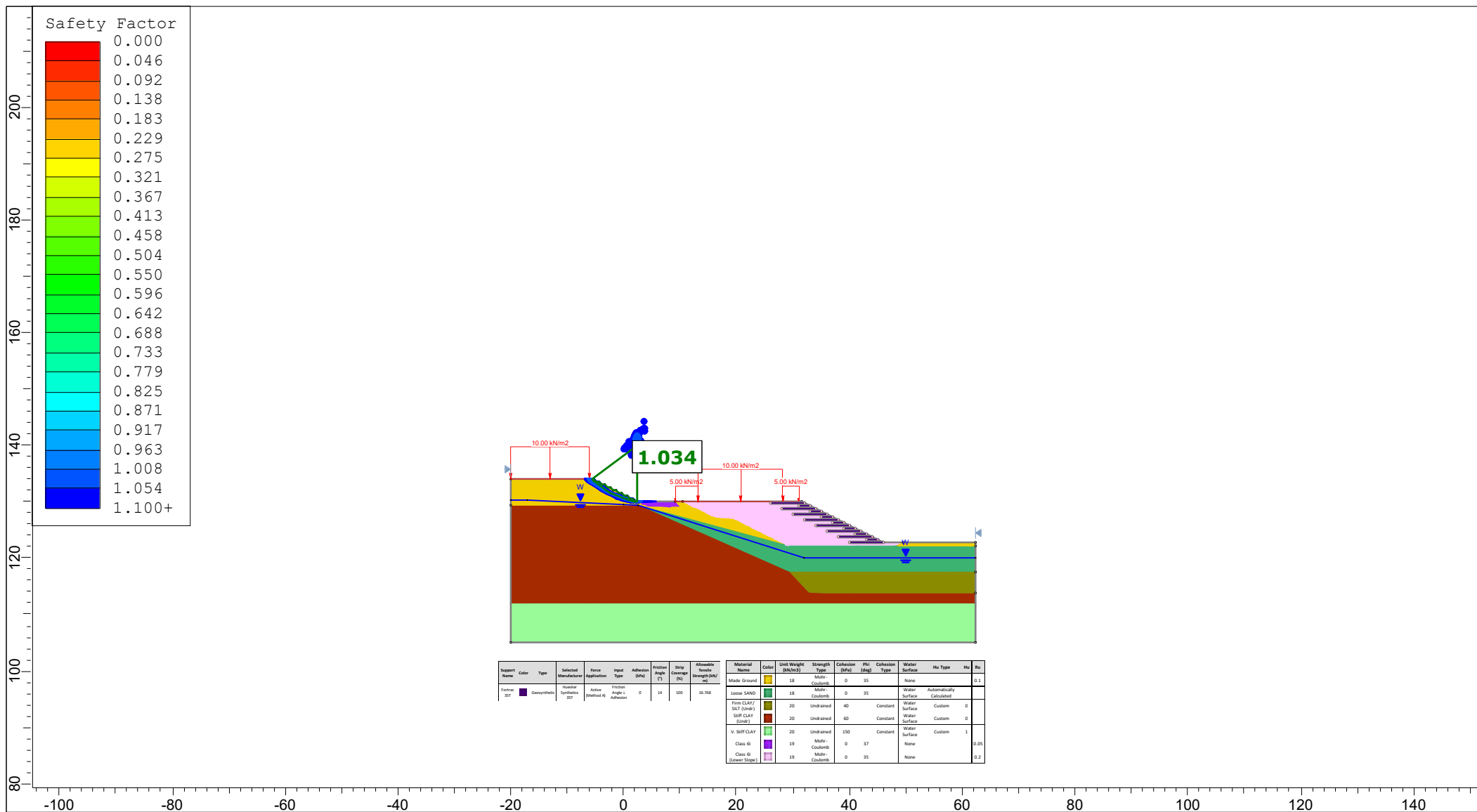
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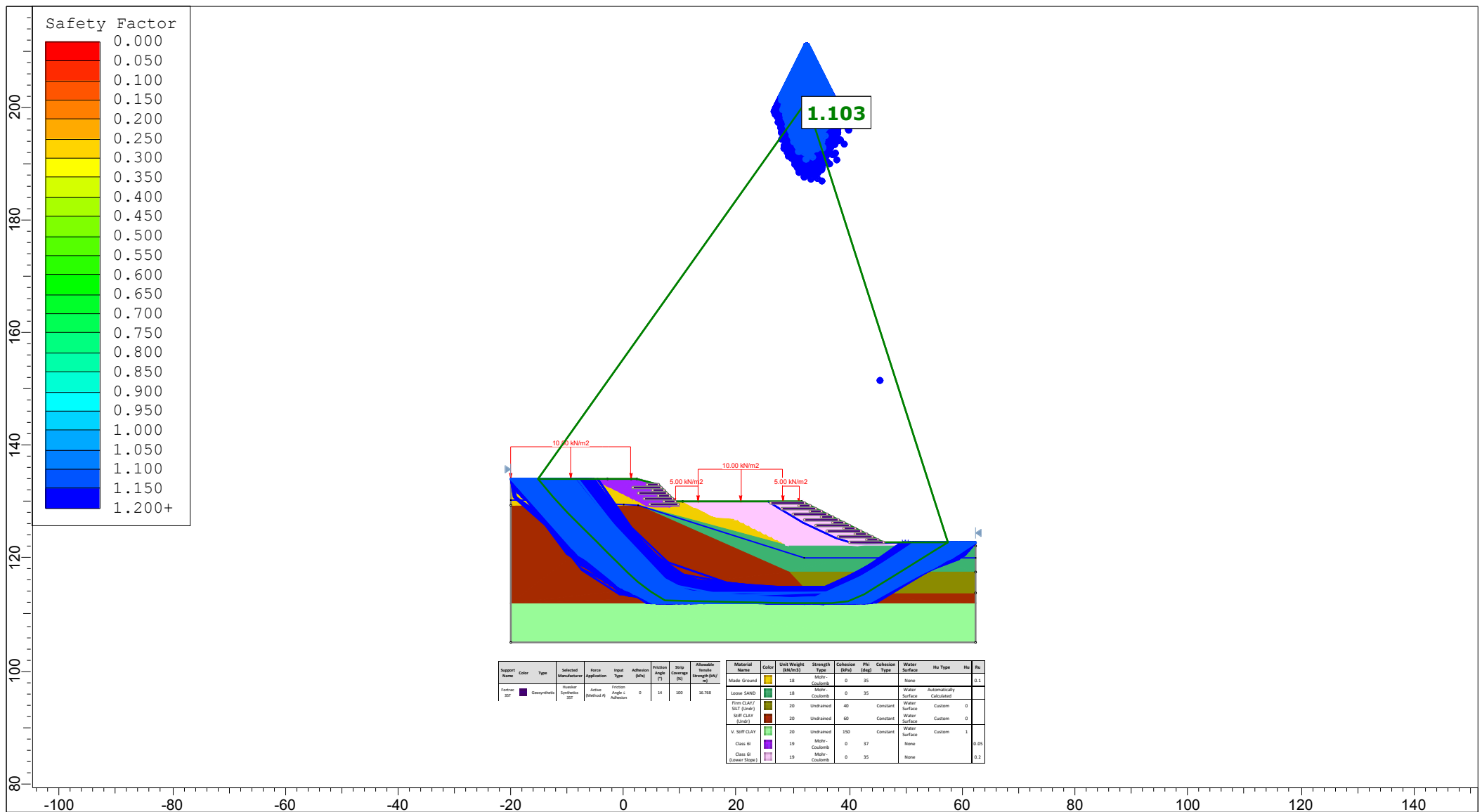
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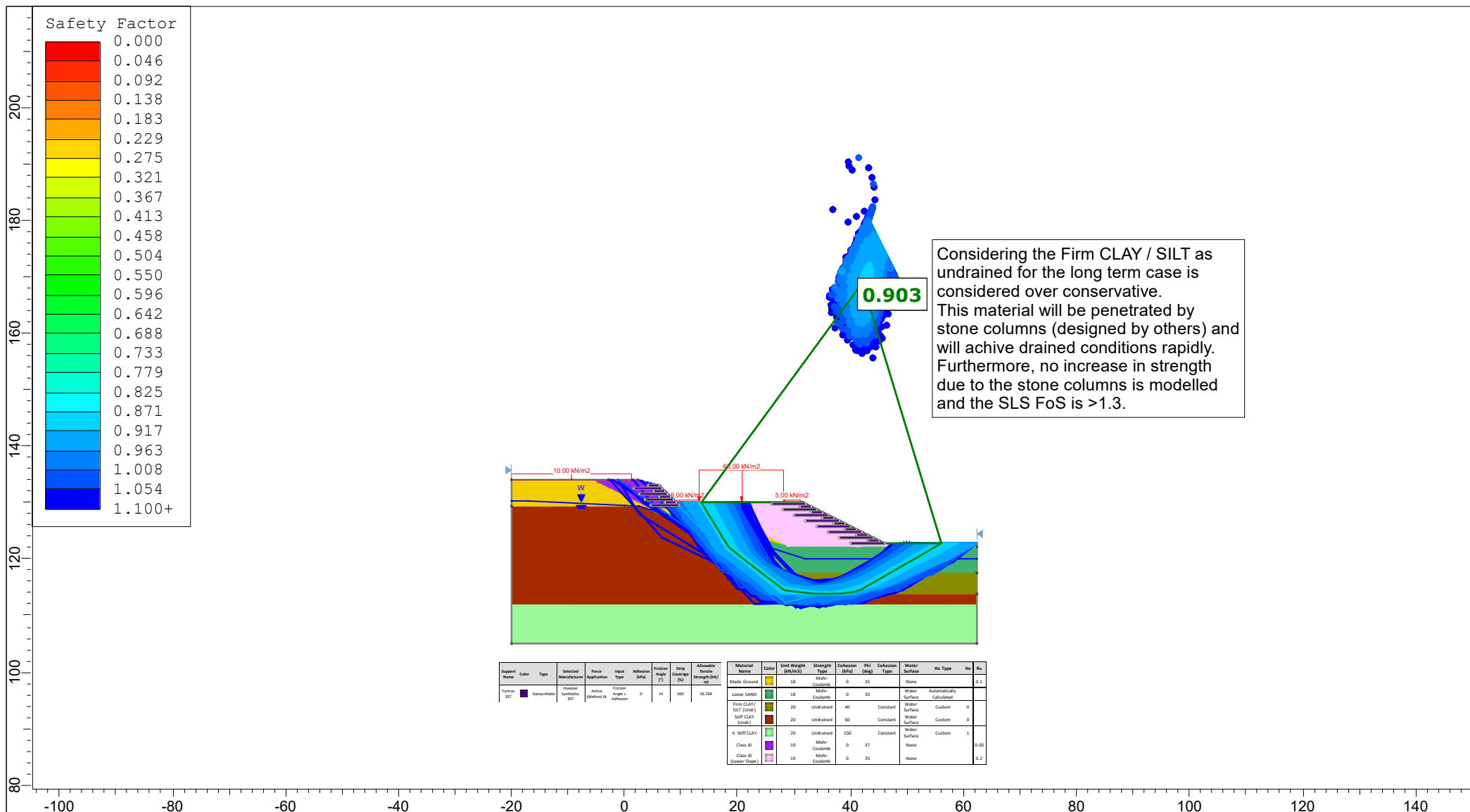
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Group	Stage 2 - Lower Slope	Scenario	Master Scenario
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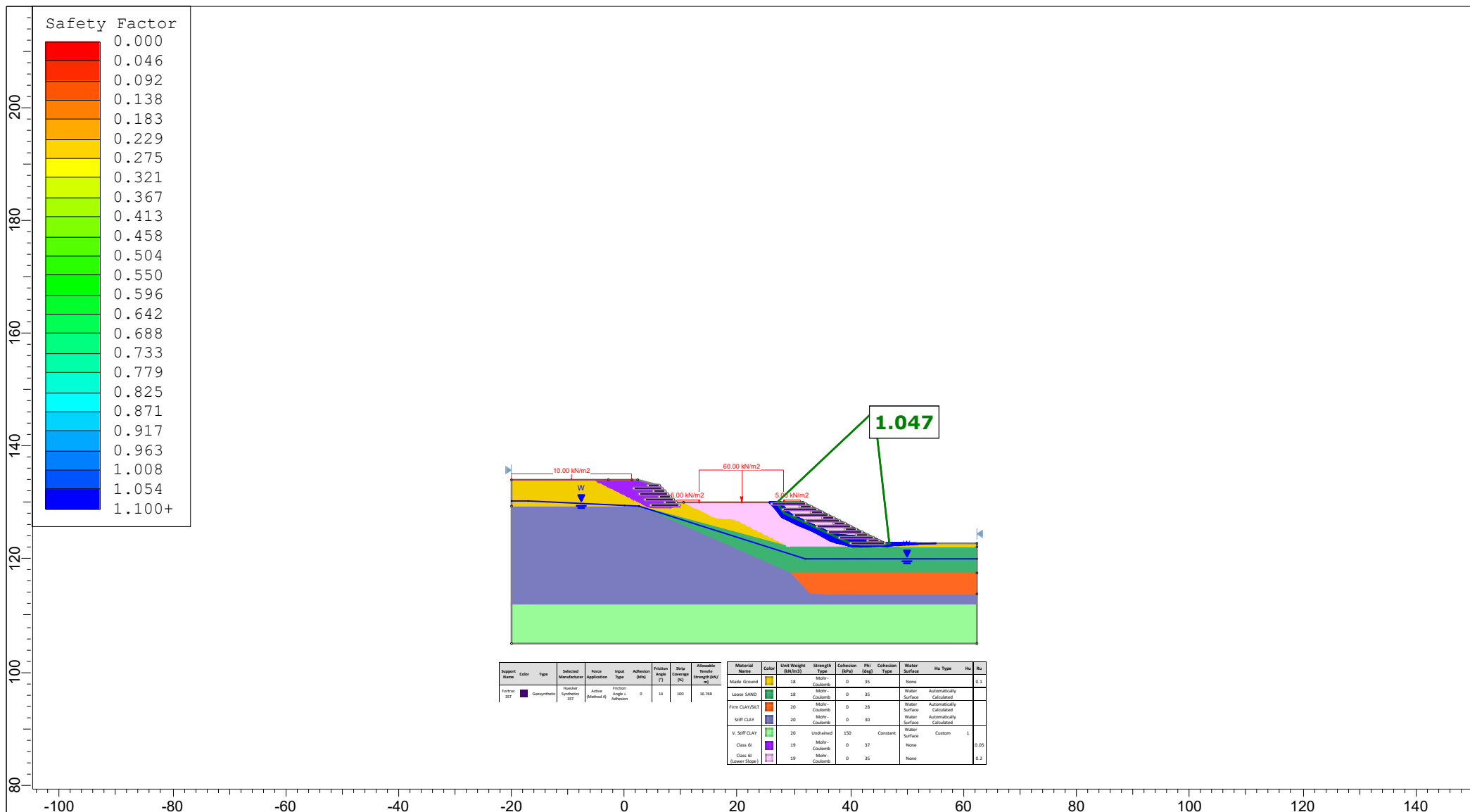


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Group			Stage 3 - Top and bottom slope (Undr.)		
Scenario			Master Scenario		
Drawn By			Company		
Date			File Name		
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SLIDEINTERPRET 9.027

Project			SLIDE - An Interactive Slope Stability Program		
Group		Stage 4 - Top and bottom slope (Undr.) with s/c			Scenario
Drawn By					Master Scenario
Date		10/02/2022, 11:54:46			Company
					File Name
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Project			SLIDE - An Interactive Slope Stability Program		
Group			Permanent (Dr.)		
Scenario			Master Scenario		
Drawn By			Company		
Date			File Name		
10/02/2022, 11:54:46			21.076_Section3_LowerSlopeFirst_HighGW_EC7_24_04_23.slmd		

Reinforced Soil Slope Trapezoidal - External Stability Check
In accordance with BS8006:2010

No.	22.016
Job	Rochdale

Case	Max Ht
------	--------

Geometry	
H	5 m
L	5 m
Angle	45 deg.
L1	5.00 m
L2	0.00 m

Infill/Backfill	
ϕ_{peak}	37 deg.
γ	19 kN/m ³
Ka	0.249

Formation	
ϕ_{peak}	35 deg.
α_{ds}	0.85

Loads	
W _s	10 kN/m ²

Combinations			
Case	A	B	C
Mass of RE block	1.5	1.0	1.0
Earth Pressure	1.5	1.5	1.0
Traffic Load (on R/E)	1.5	0	0
Traffic Load (behind R/E)	1.5	1.5	1
Bearing f _{ms}	1.35	1.35	1.35
Soil Material f _{ms}	1.0	1.0	1.0
Base Sliding f _s	1.3	1.3	1.3

Bearing & Tilt Failure

Case A		
Active Earth Pressure	P _a	107.20 kN
Vertical Load 1	R _{v1}	356.25 kN
Vertical Load 2	R _{v2}	15.00 kN
Total Vertical Load	R _v	371.25 kN
Moment about toe 1	M ₁	1262.50 kN/m
Moment about toe 2	M ₂	178.67 kN/m
Eccentricity	e	-0.42
Bearing Pressure	q _r	74.25 kN/m ²
Minimum Bearing Capacity	q _{ult}	100.24 kN/m ²

Case B		
Active Earth Pressure	P _a	107.20 kN
Vertical Load 1	R _{v1}	237.50 kN
Vertical Load 2	R _{v2}	0.00 kN
Vertical Load	R _v	237.50 kN
Moment about toe 1	M ₁	791.67 kN/m
Moment about toe 2	M ₂	178.67 kN/m
Eccentricity	e	-0.08
Bearing Pressure	q _r	47.50 kN/m ²
Minimum Bearing Capacity	q _{ult}	64.13 kN/m ²

Case C		
Active Earth Pressure	P _a	71.47 kN
Vertical Load 1	R _{v1}	237.50 kN
Vertical Load 2	R _{v2}	0.00 kN
Vertical Load	R _v	237.50 kN
Moment about toe 1	M ₁	791.67 kN/m
Moment about toe 2	M ₂	119.11 kN/m
Eccentricity	e	-0.33
Bearing Pressure	q _r	47.50 kN/m ²
Minimum Bearing Capacity	q _{ult}	64.13 kN/m ²

Sliding Along Base

Case A		
Factor of Safety	f _s	2.06

>1.3, therefore sliding ok

Case B		
Factor of Safety	f _s	1.32

>1.3, therefore sliding ok

Case C		
Factor of Safety	f _s	1.98

>1.3, therefore sliding ok

$q_{ult} = c N_c S_c i_c b_c d_c + q N_q S_q i_q b_q d_q + 0.5 \gamma B N_\gamma S_\gamma i_\gamma b_\gamma d_\gamma$

Foundation Conditions

Shape of Foundation

Strip

Load Direction

H Load acts in the direction of B'

Foundation Geometry

			SLS - Dr.	SLS - Undr.
Depth	D	m	0.000	0.000
Unplanned Excavation		m	0.000	0.000
Effective Depth	D'	m	0.000	0.000
Effective Length	L'	m	100.000	100.000
Effective Breadth	B'	m	5.000	5.000
Base Inclination	α	$deg.$	0.000	0.000

Soil Conditions

			SLS	DA1-1
Angle shearing resistance	ϕ	$deg.$	35.00	0.00
Cohesion	c	$kIN/m2$	0.00	40.00
Depth WL	WL	m	0.00	0.00
Bulk Density	γ	kN/m^3	19.00	19.00
Effective Density	γ'	kN/m^3	9.19	19.00
Effective Overburden	q'	kN/m^2	0.00	0.00

Foundation Loads

			Case A	Case A
Horizontal Thrust	T_{Ed}	kN	107.2	107.2
Vertical Action	V_d	kN	371.2	371.2

Bearing Capacity Factors	N_c		46.12	5.14
	N_q		33.30	1.00
	N_γ		45.23	0.00
Shape Factors (Strip)	S_c		1.00	1.00
	S_q		1.00	1.00
	S_γ		1.00	1.00
Inclination Factors	i_c		0.49	1.00
	i_q		0.51	1.00
	i_γ		0.36	1.00
Eponent m_B for inclination factors			2.00	2.00
Base Inclincation	b_c		1.00	1.00
	b_q		1.00	1.00
	b_γ		1.00	1.00
Depth Factors	D'/B'		0.00	0.00
	d_c		1.00	1.00
	d_q		1.00	1.00
	d_γ		1.00	1.00
Ult. bearing resistance	q_{ult}	kN/m^2	373.8	205.2
Net ult. bearing resistance	$net\ q_{ult}$	kN/m^2	373.8	205.2

Strip

Rectangle

Square

H Load acts in the direction of B'

H Load acts in the direction of L'

Drained Conditions

Undrained Conditions

Rev 1 Effective overburden revised to pro rata difference between

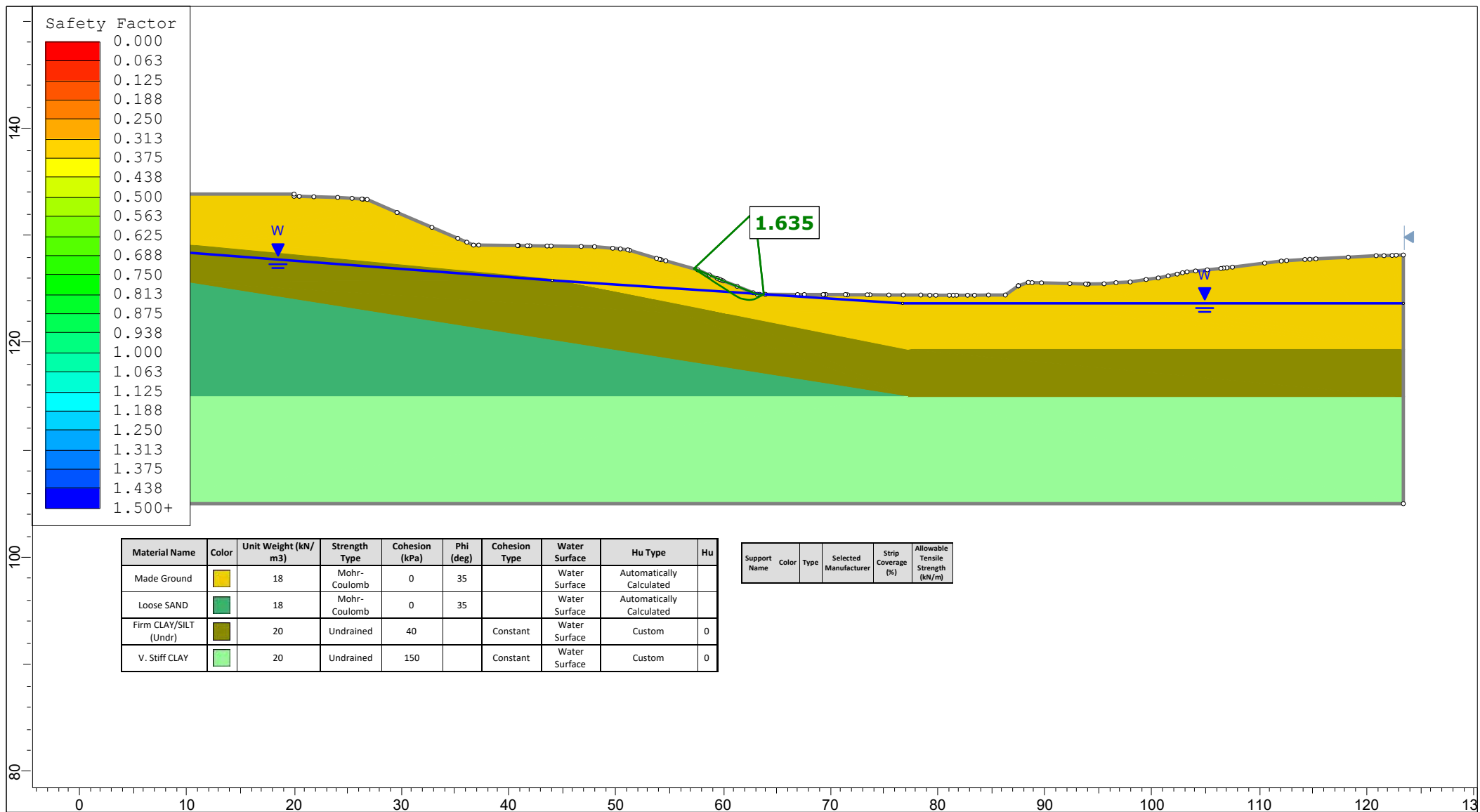
$N_c = (N_q - 1) \cot \phi$
 $N_q = \exp (\pi \tan \phi) \tan ^2 (45 + (\phi / 2))$
 $N_\gamma = 2 (Nq - 1) \tan \phi$ for $\phi > 0$; 0 for $\phi = 0$

$i_c = i_q - (1 - i_q) / (N_c \tan \phi)$ for $\phi > 0$; $1 - (mH / c' Nc A')$ for $\phi = 0$
 $i_q = (1 - (H / V_T + B' L' c' \cot \phi))^m$
 $i_\gamma = (1 - (H / V_T + B' L' c' \cot \phi))^{m+1}$
For Strip, $L = \infty$, therefore $mB = 2$, $m = (2 + B' / L') / (1 + B' / L')$ when H acts in the direction of B', $m = (2 + L' / B') / (1 + L' / B')$ when H acts in the direction of L'
 $b_c = b_q - (1 - b_q) / (N_c \tan \phi)$ for $\phi > 0$; $1 - (2\alpha / \pi + 2)$ for $\phi = 0$
 $b_q = (1 - \alpha . \tan \phi)^2$
 $b_\gamma = b_q$

$d_c = d_q - ((1 - d_q) / (N_c * \tan \phi))$ for $\phi > 0$; $1 + 0.33 \tan ^{-1} (D / B)$ for $\phi = 0$
 $d_q = IF\ D / B' < 1, 1 + 2 \tan \phi (1 - \sin \phi)^2 \tan ^{-1} (D / B')$, IF $D / B' > 1, 1 + 2 \tan \phi (1 - \sin \phi)^2 (D / B')$
 $d_\gamma = 1$

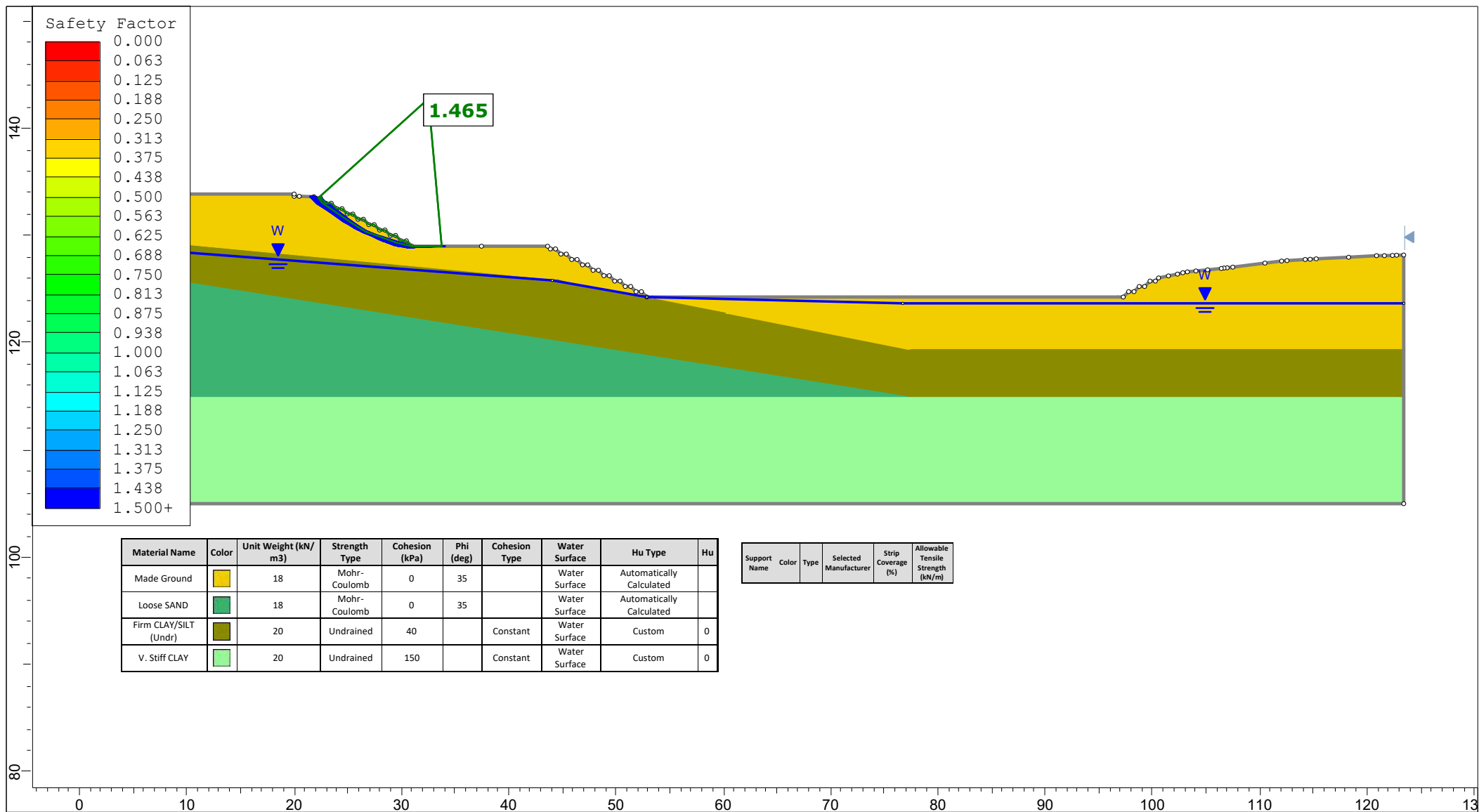
Appendix B2

Section 2



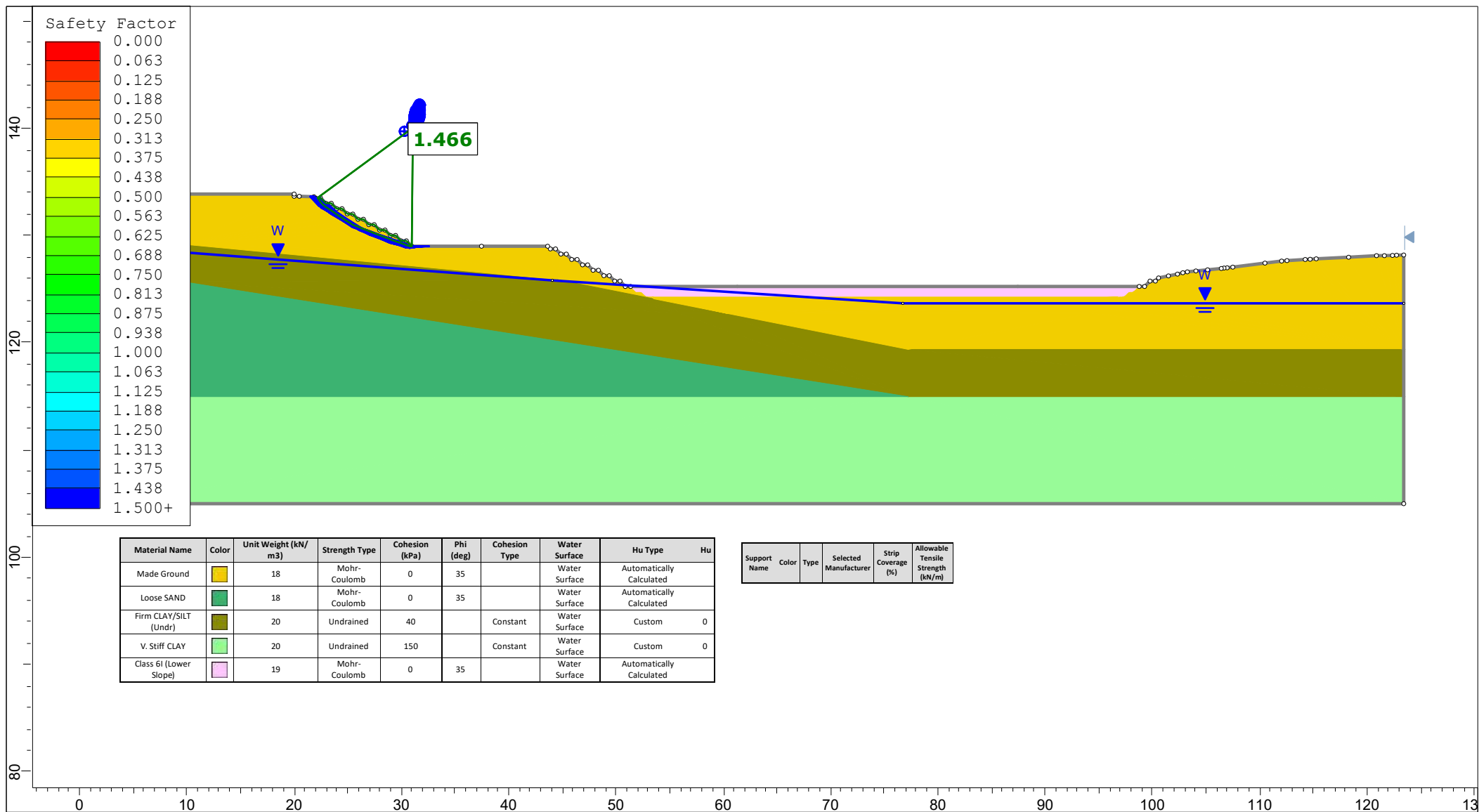
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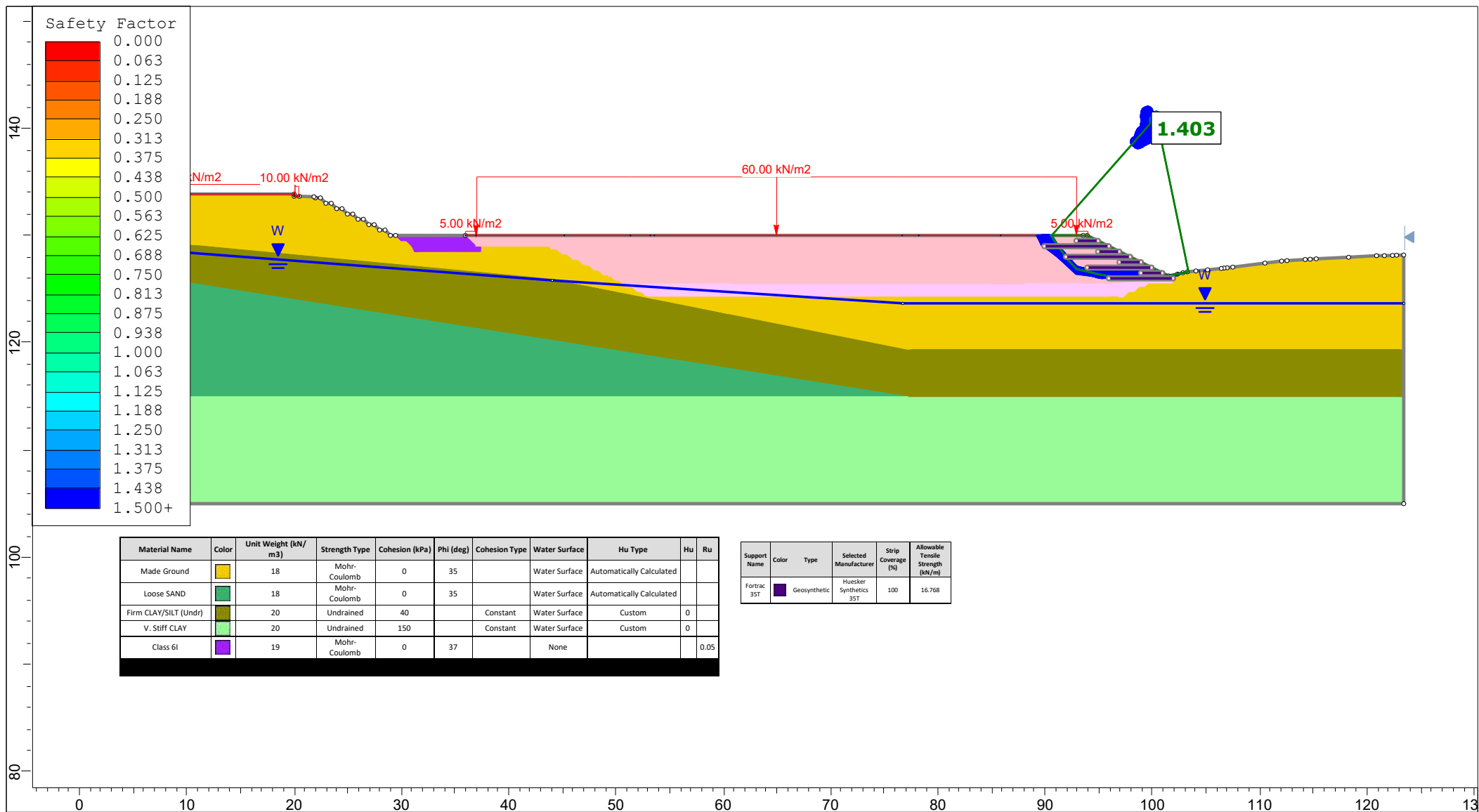


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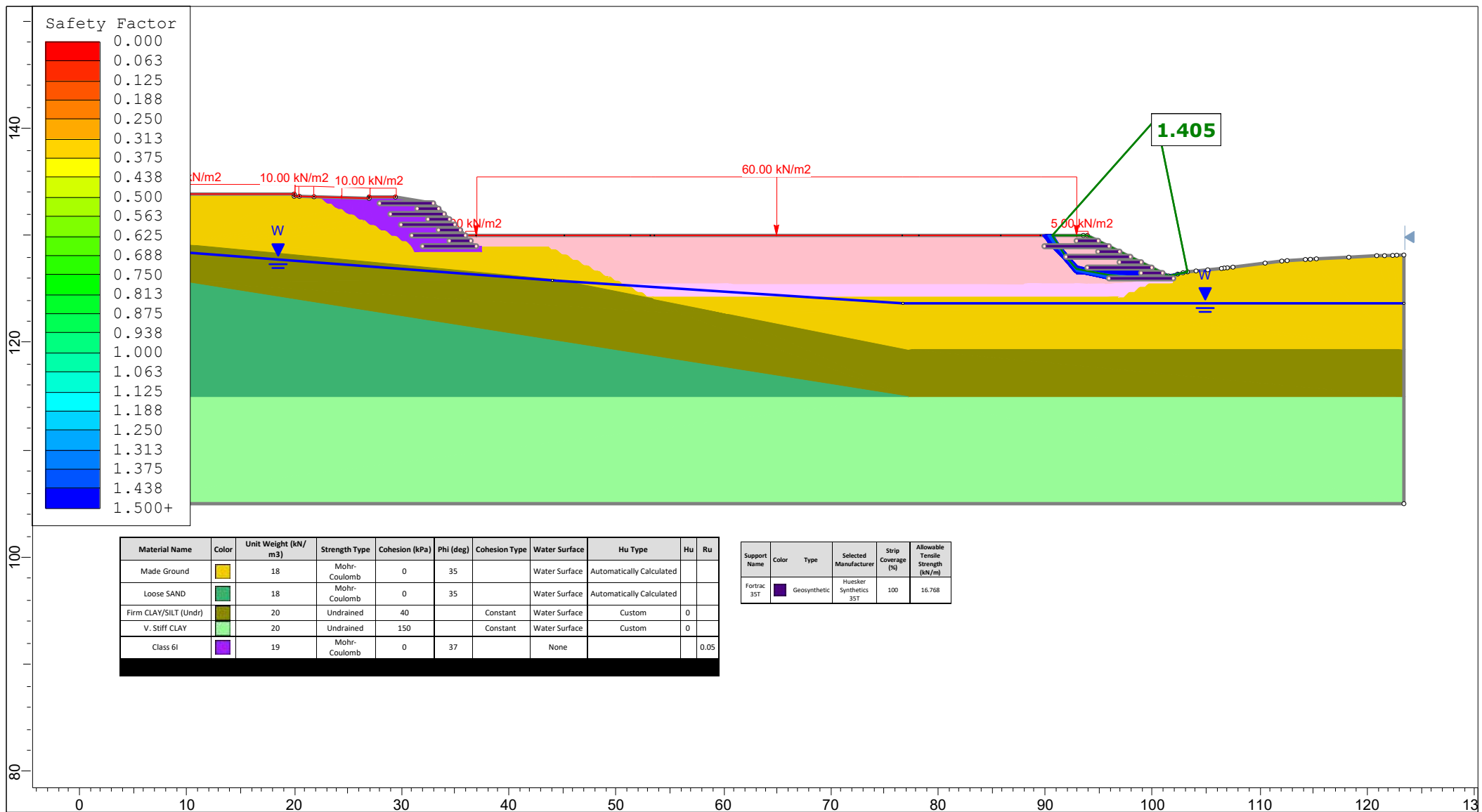
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Group		Stage 1 - Temp (Undr.)	Scenario Master Scenario
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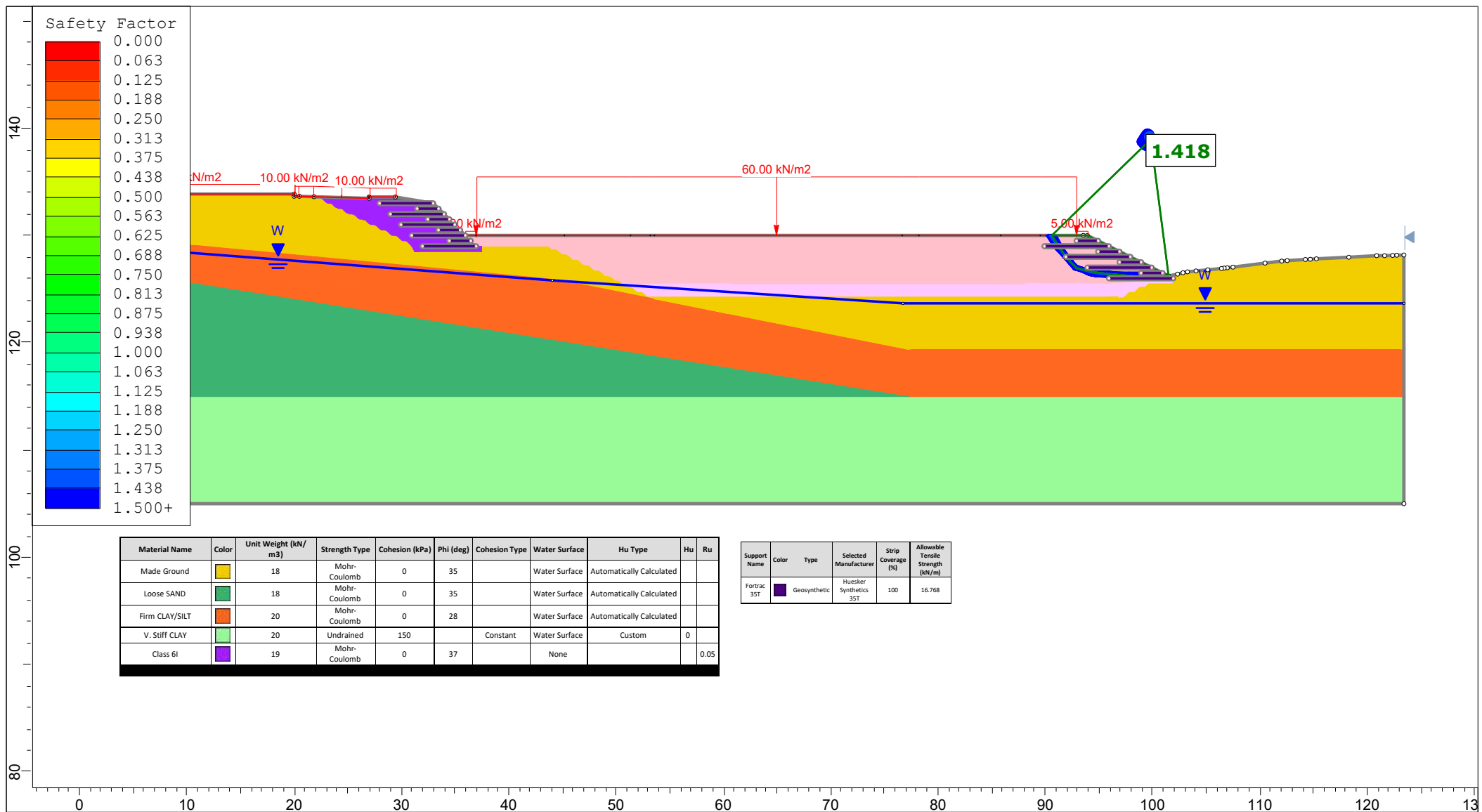
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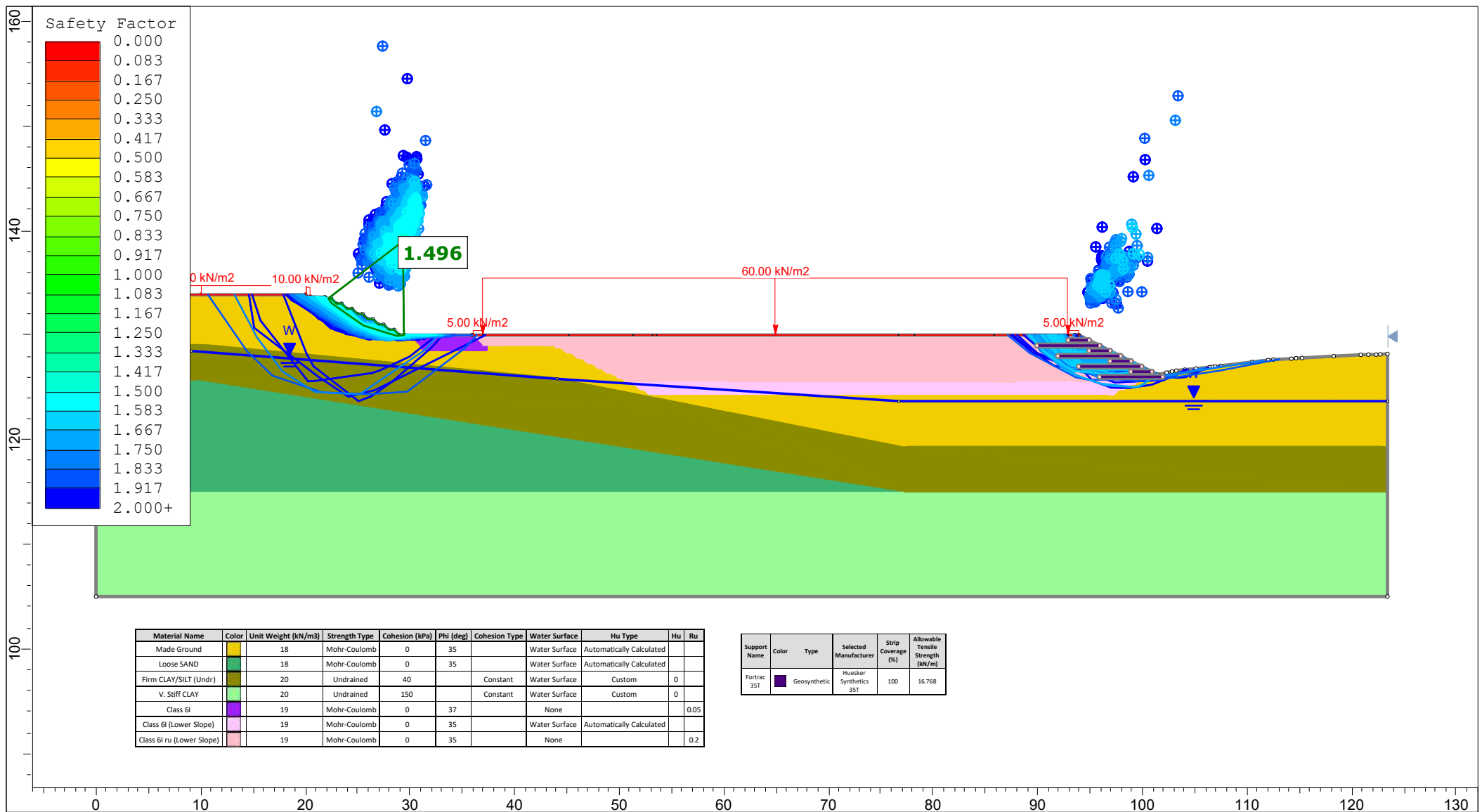
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Group			Stage 4 - Top and bottom slope (Undr.)		Scenario
Drawn By			Master Scenario		
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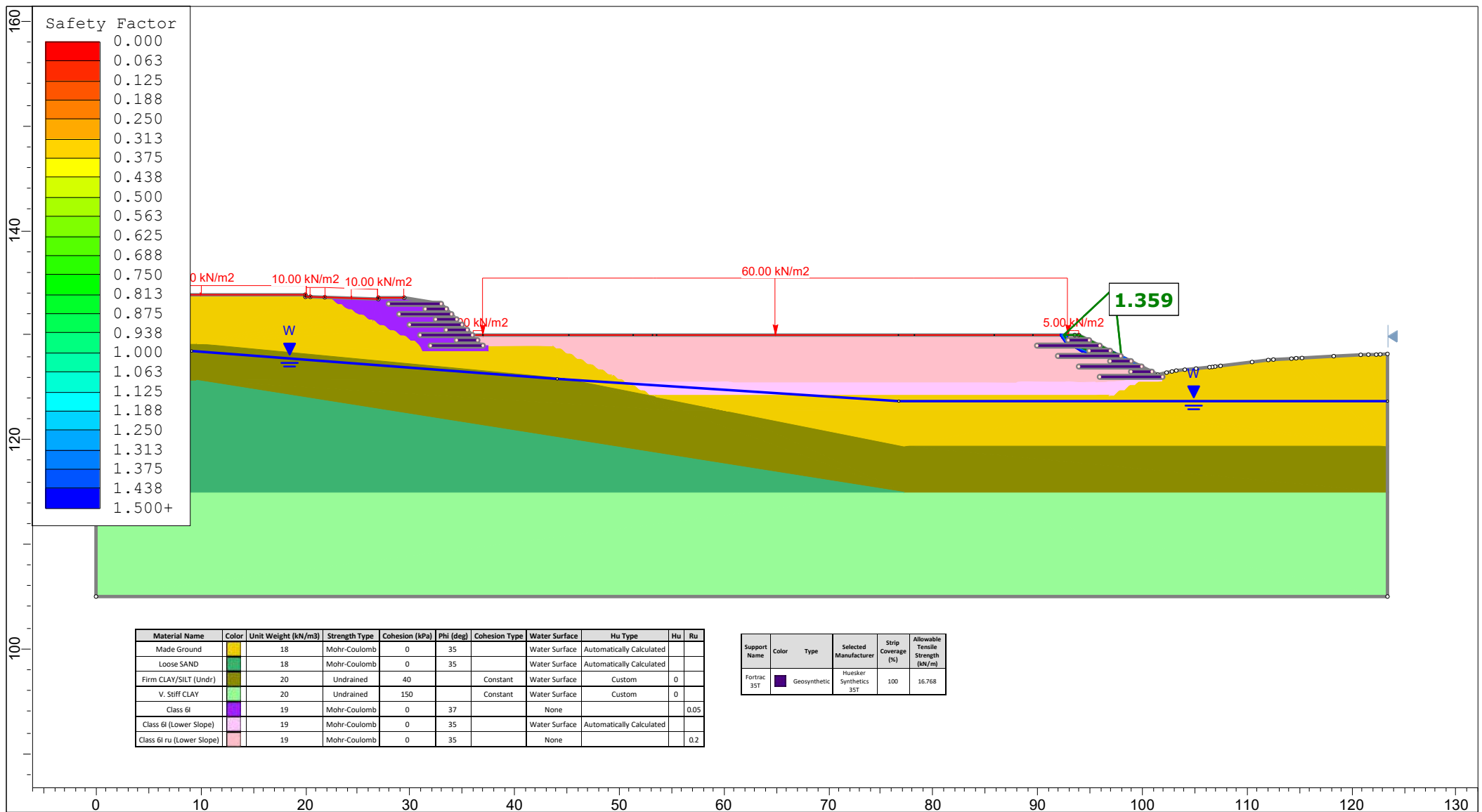


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Group		Permanent (Dr.)	Scenario Master Scenario
Drawn By			Company
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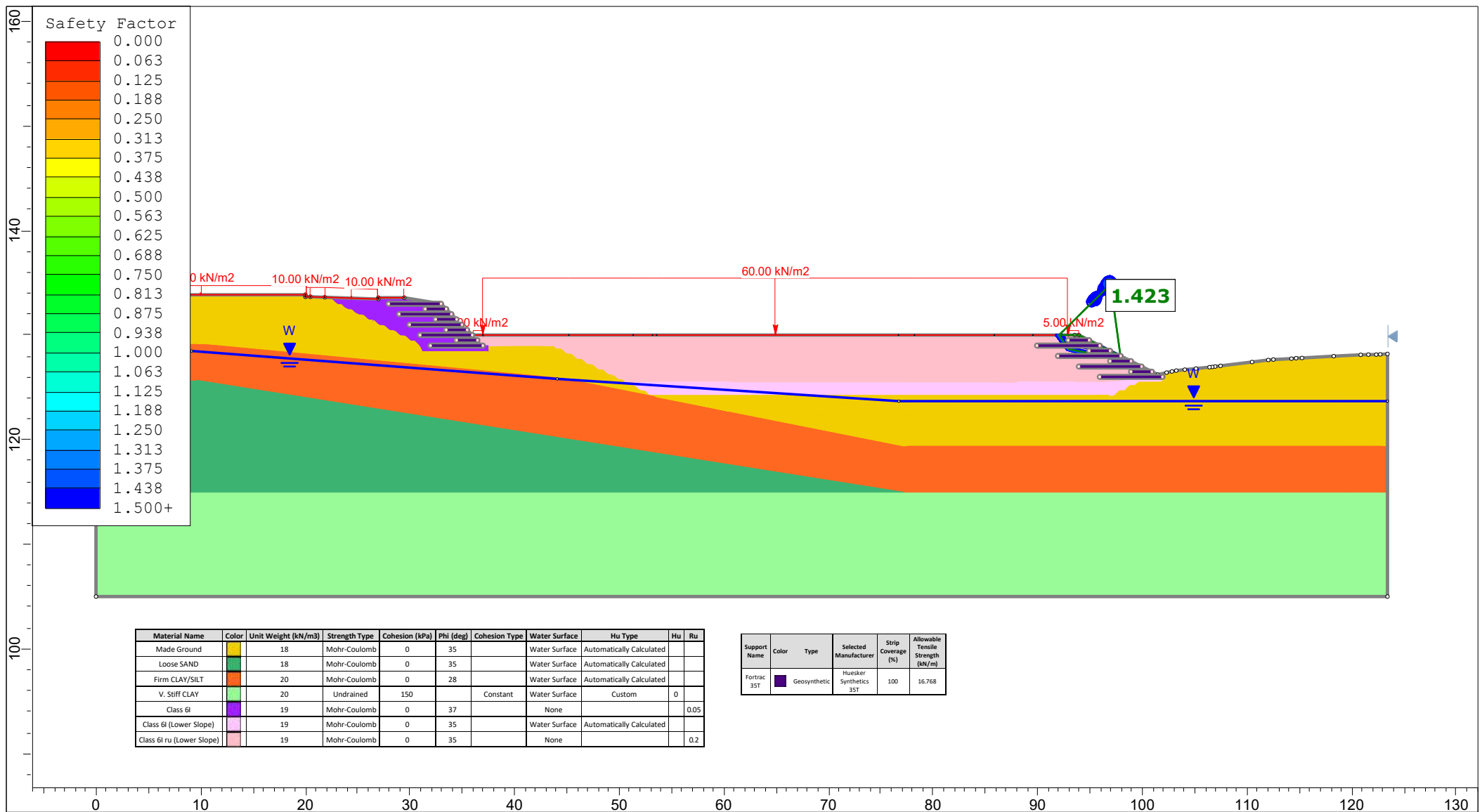


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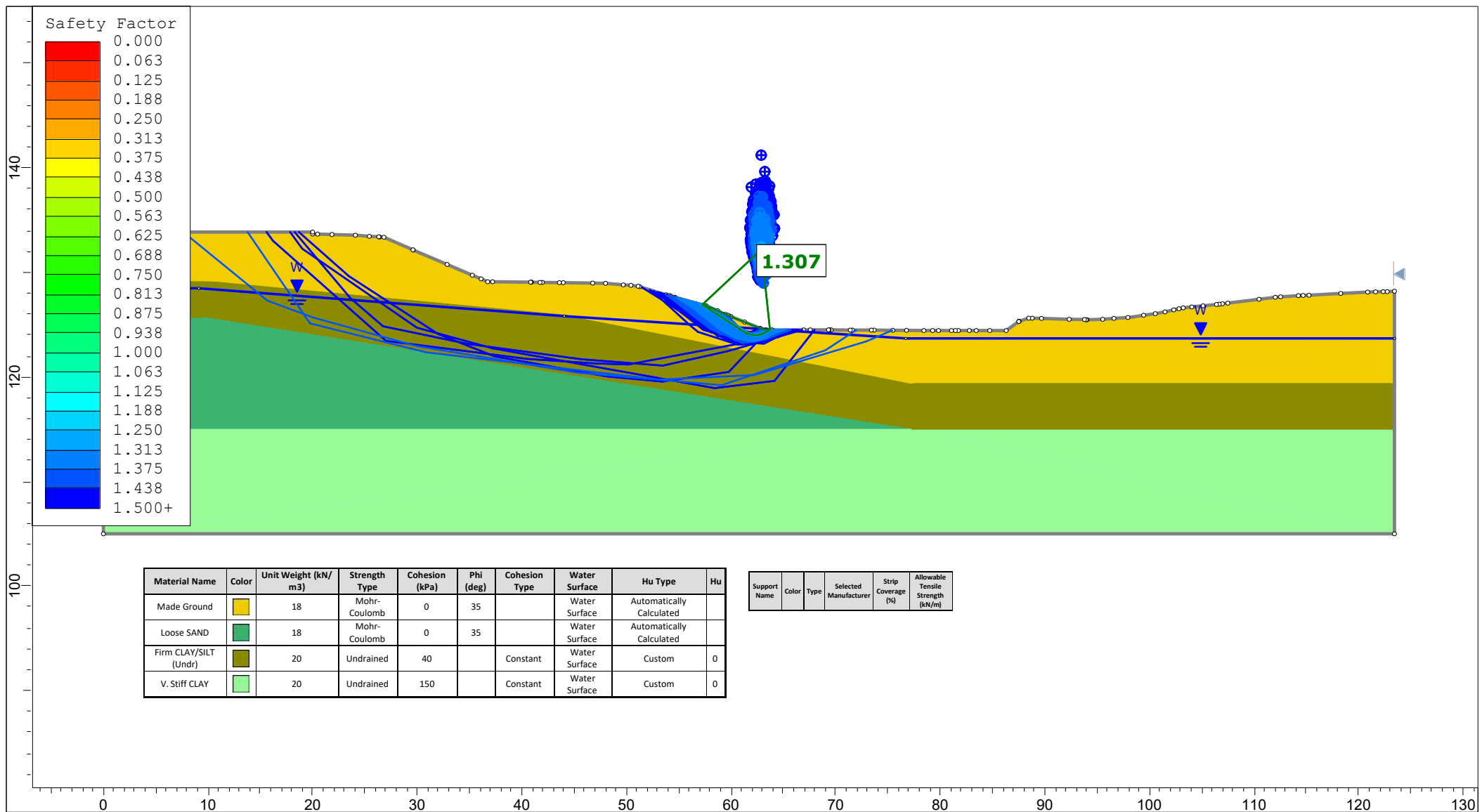
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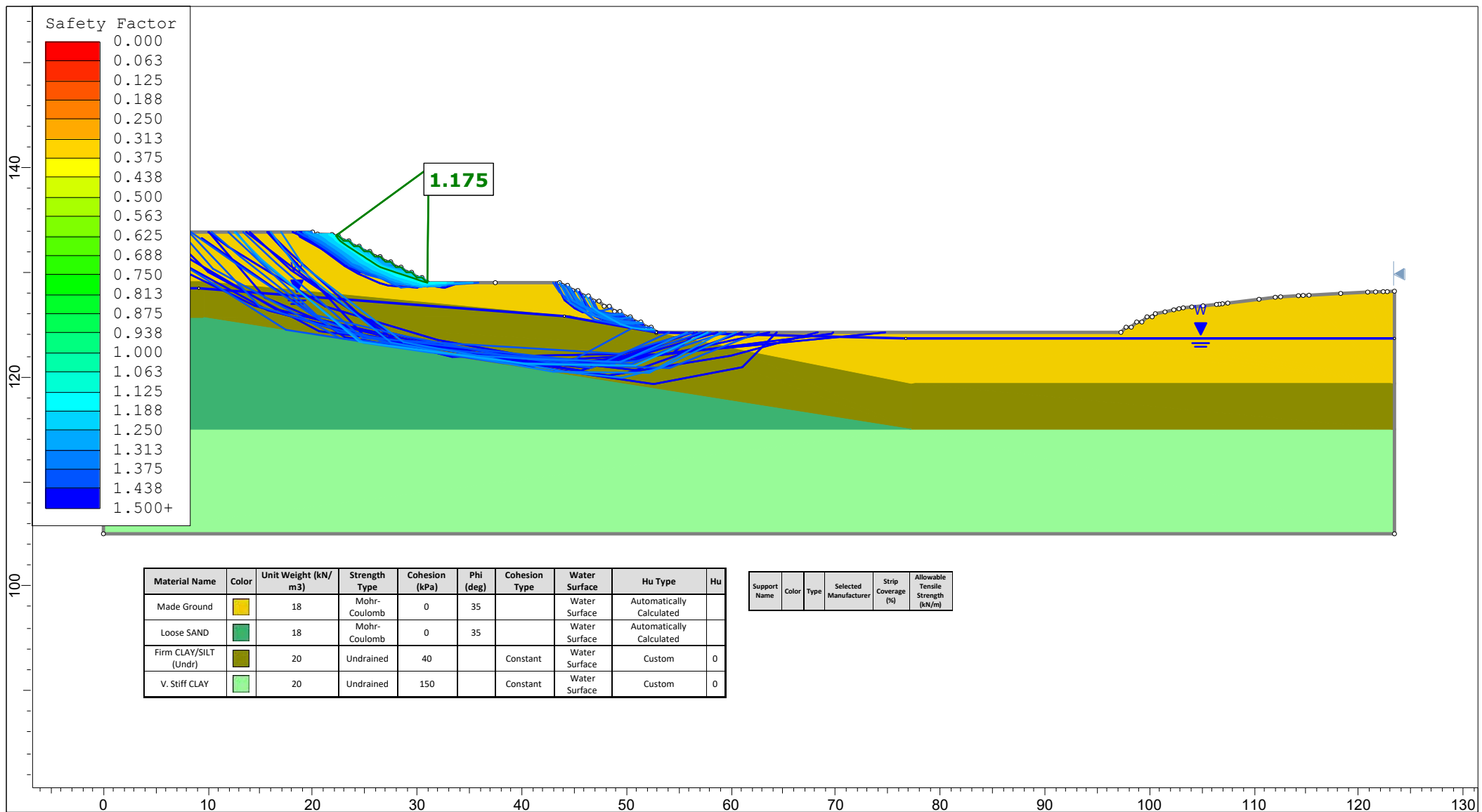
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Drawn By			Master Scenario		
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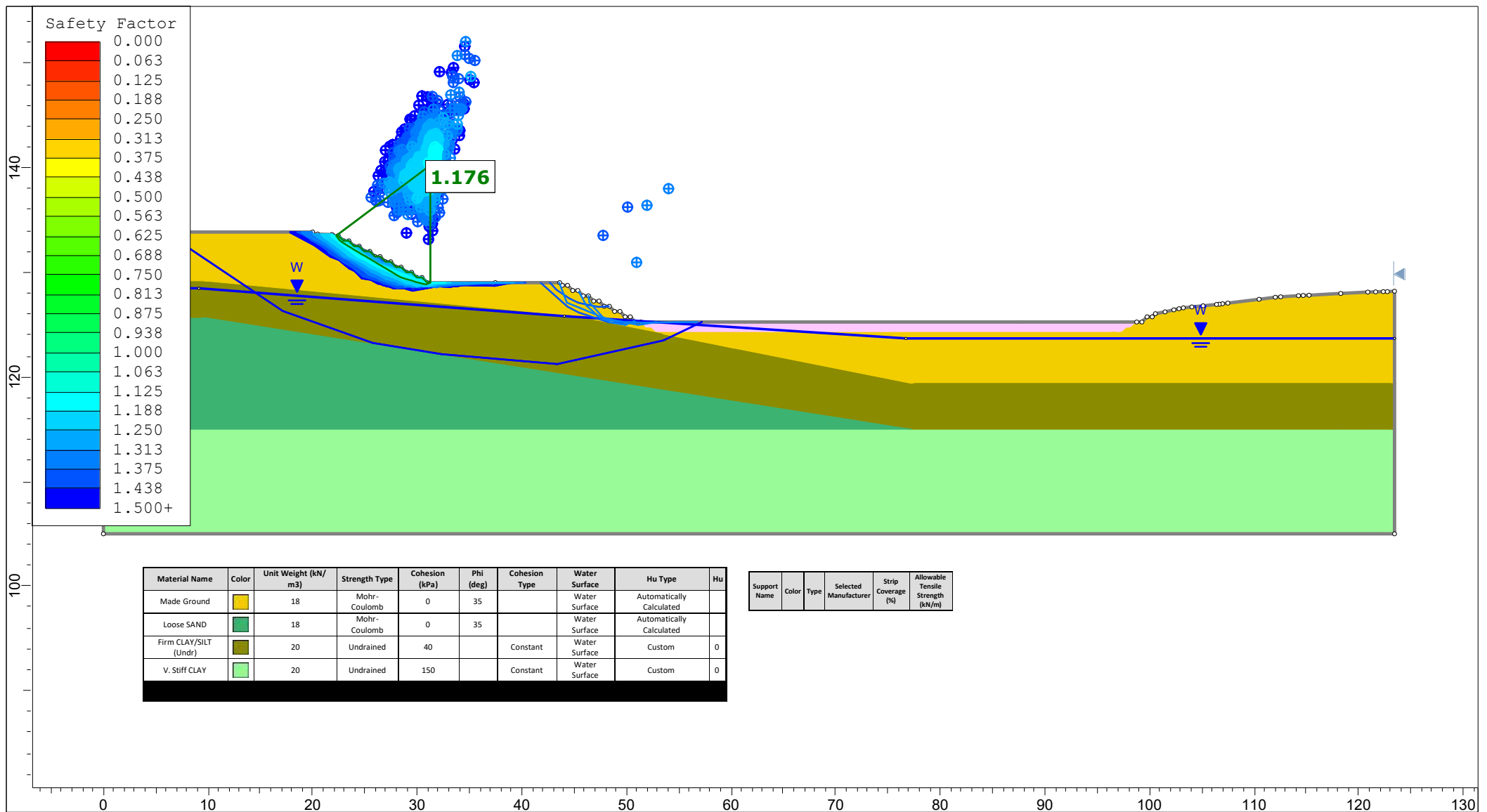
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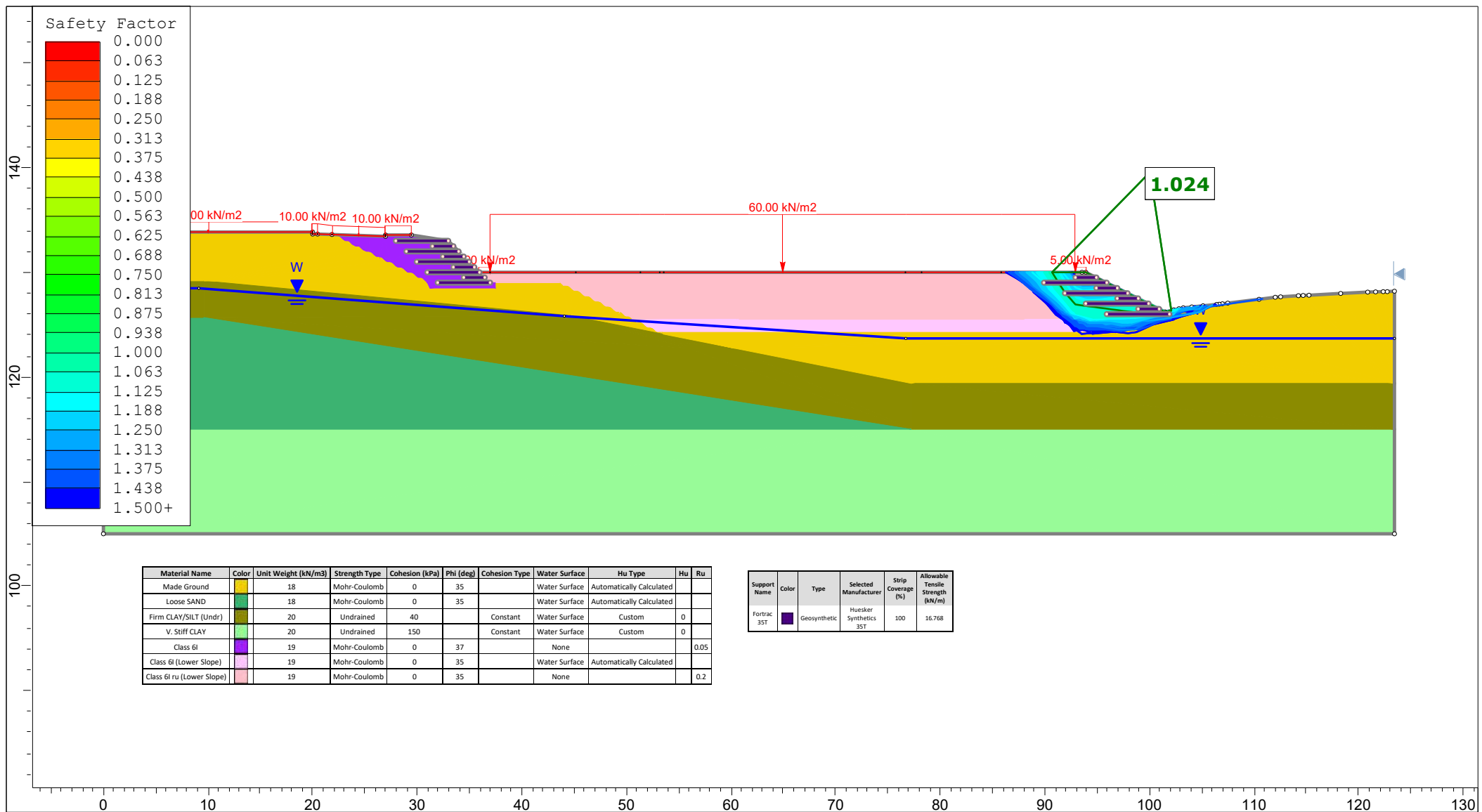
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Group		Stage 0 - Existing	Scenario
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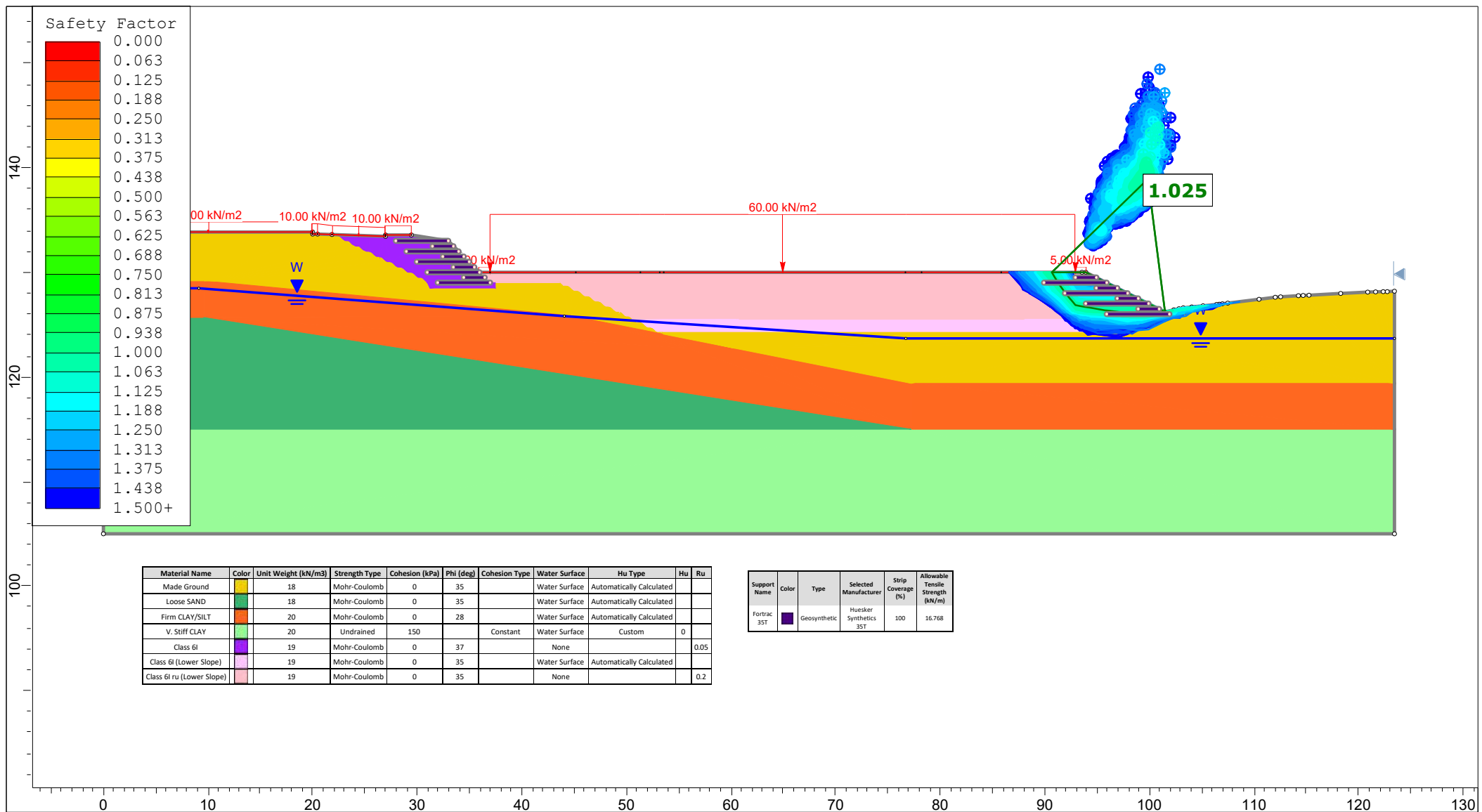
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Group		Stage 1 - Temp (Undr.)	Scenario Master Scenario
Drawn By			Company
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Project		SLIDE - An Interactive Slope Stability Program	
Group		Stage 2 - Working platform (Undr.)	Scenario
Drawn By			Company
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Project			SLIDE - An Interactive Slope Stability Program		
Group			Stage 4 - Top and bottom slope (Undr.)		Scenario
Drawn By			Master Scenario		
Date			Company		
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Project		SLIDE - An Interactive Slope Stability Program	
Group		Permanent (Dr.)	Scenario Master Scenario
Drawn By			Company
Date		10/02/2022, 11:54:46	File Name 21.076_Section2_LowerSlopeFirst_EC7_09_06_23.slmd

Appendix C

Product Specification Data

FORTRAC GEOSYNTHETICS

FORTRAC T AND R-T GEOGRIDS

This HAPAS Certificate Product Sheet⁽¹⁾ is issued by the British Board of Agrément (BBA), supported by the Highways Agency (HA) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Assembly Government and the Department for Regional Development, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every five years.
(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to Fortrac T and R-T Geogrids, polymeric geogrids consisting of polyester fibres coated with a black styrene butadiene polymer for use as reinforcement in embankments with slope angles up to 70°.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal five-yearly review.



KEY FACTORS ASSESSED

Soil/geogrid interaction — interaction between the soil and geogrids has been considered and coefficients relating to direct sliding and pull-out resistance proposed (see section 6).

Mechanical properties — short- and long-term tensile strength and elongation properties of the geogrids and loss of strength due to installation damage have been assessed and reduction factors established for use in design (see section 7).

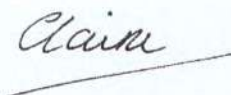
Durability — the resistance of the geogrids to the effects of hydrolysis, chemical and biological degradation, UV exposure and temperature conditions normally encountered in civil engineering practice have been assessed and reduction factors established for use in design (see sections 8 and 11).

The BBA has awarded this Certificate to the company named above for the products described herein. These products have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément



Brian Chamberlain
Head of Approvals — Engineering



Claire Curtis-Thomas
Chief Executive

Date of Second issue: 5 September 2014

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

Requirements

In the opinion of the BBA, Fortrac T and R-T Geogrids when used in accordance with the provisions of this Certificate, will meet the requirements of the Highways Agency and local Highway Authorities for the design and construction of reinforced soil embankments with slope angles up to 70°.

Regulations

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 1 *Description* (1.2), 3 *Delivery and site handling* (3.1, 3.4 and 3.5) and the *Installation* part of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the products in accordance with harmonised European Standard BS EN 13251 : 2001. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer's Declaration of Performance.

Technical Specification

1 Description

1.1 Fortrac T and R-T Geogrids are planar structures consisting of a regular open network of woven, integrally-connected tensile elements of yarn. The yarn is made from high modulus polyester fibres of polyethylene terephthalate (PET). The woven grid is coated with a protective layer of black styrene butadiene polymer.

1.2 The geogrids are manufactured in sixteen standard grades of various strengths and mesh sizes. A typical geogrid is illustrated in Figure 1 and the range and specification of the geogrids assessed by the BBA are listed in Tables 1 and 2.

1.3 The warp (machine) direction is along the roll length and is indicated by a paper tape (see Figure 1).

Figure 1 Fortrac T and R-T Geogrids

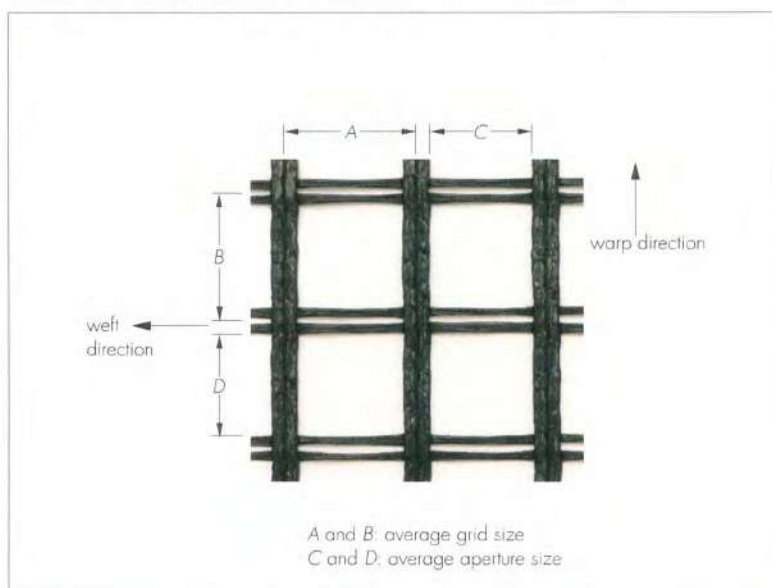


Table 1 General specification

Grade ⁽¹⁾	Nominal mass ⁽²⁾ (g·m ⁻²)	Average grid size ⁽³⁾ warp/weft (mm) A x B	Average aperture size ⁽³⁾ warp/weft (mm) C x D	Colour code ⁽⁴⁾	Nominal roll weight for standard 5 m width rolls	Standard roll length (m)
35T	185	29.0 x 30.0	26.0 x 24.0	Red	190	200
55T	240	29.0 x 30.0	25.0 x 24.0	Green	250	200
65T	280	29.0 x 30.0	25.0 x 23.0	Orange	290	200
80T	320	29.0 x 30.0	25.0 x 23.0	Pink	330	200
110T	350	29.0 x 30.0	24.0 x 23.0	White	360	200
150T	440	29.0 x 30.0	23.0 x 23.0	No colour	450	200
200T	530	30.0 x 30.0	23.0 x 23.0	No colour	540	200
35/20-20T	210	23.1 x 23.0	21.0 x 18.0	Red	230	200
55/30-20T	280	23.0 x 25.5	20.0 x 20.5	Green	300	200
80/30-20T	350	25.0 x 23.0	20.0 x 18.0	Pink	370	200
110/30-20T	420	25.1 x 22.8	20.0 x 18.0	White	480	200
R150/30-30T	520	41.7 x 32.8	33.0 x 27.0	No colour	630	200
R200/30-30T	630	40.0 x 32.5	31.0 x 27.0	No colour	750	200
R400/50-30T	1200	67.0 x 33.5	37.0 x 27.5	No colour	650	100
R600/50-30T	1650	50.0 x 33.0	30.0 x 28.0	No colour	900	100
R800-100-30T	2400	90.0 x 30.0	30.0 x 25.0	No colour	1250	100

(1) R denotes the goegrid is knitted.

(2) Mass/unit area measured in accordance with BS EN ISO 9864 : 2005.

(3) Reference dimensions (see Figure 1).

(4) In accordance with BS EN ISO 10320 : 1999

Table 2 Performance characteristics

Grade	Machine Direction (MD)				Cross Machine Direction (CMD)			
	Short term tensile strength ⁽¹⁾ kN·m ⁻¹			Strain at maximum tensile strength ⁽¹⁾ (%) (*)	Short term tensile strength ⁽¹⁾ kN·m ⁻¹			Strain at maximum tensile strength ⁽¹⁾ (%) (*)
	Mean value (*)	Tolerance (*)	T _{char}		Mean value (*)	Tolerance (*)	T _{char}	
35T	35	-0	35	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
55T	55	-0	55	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
65T	65	-0	65	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
80T	80	-0	80	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
110T	110	-0	110	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
150T	150	-0	150	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
200T	200	-0	200	9.5 (±1.5)	20	-0	20	9.5 (±1.5)
35/20-20T	35	-0	35	10 (+0/-3)	20	-0	20	10 (+0/-3)
55/30-20T	55	-0	55	10 (+0/-3)	30	-0	30	10 (+0/-3)
80/30-20T	80	-0	80	11 (+0/-3)	30	-0	30	11 (+0/-3)
110/30-20T	110	-0	110	11 (+0/-3)	30	-0	30	10 (+0/-3)
R150/30-30T	150	-0	150	11 (+0/-3)	30	-0	30	11 (+0/-3)
R200/30-30T	200	-0	200	10 (+0/-3)	30	-0	30	10 (+0/-3)
R400/50-30T	400	-0	400	10 (+0/-3)	50	-0	50	10 (+0/-3)
R600/50-30T	600	-0	600	10 (+0/-3)	50	-0	50	10 (+0/-3)
R800-100-30T	800	-0	800	10 (+0/-3)	100	-0	100	10 (+0/-3)

(1) Tests in accordance with BS EN ISO 10319 : 2008, the values given are the mean and tolerance values in accordance with BS EN 13251 : 2001.

2 Manufacture

2.1 Fortrac T and R-T Geogrids are manufactured from yarn woven or knitted into grids and coated with a protective layer of black styrene butadiene polymer.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials

- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.3 The management system of Huesker Synthetic GmbH has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by TÜV NORD CERT GmbH, Germany (Certificate 04 100 970084).

3 Delivery and site handling

3.1 The rolls of geogrid are delivered to site stacked and strapped to timber pallets. The rolls are 5.0 metres wide and between 0.5 m to 0.9 m diameter dependent on the product grade and roll length (see Table 1).

3.2 Each roll is wrapped for transit and site protection in black polythene film and is labelled with the geogrid grade and identification (see Figure 2).

Figure 2 Label

 0799-CPR-17		Stueckkarte Piece-Label/Fiche-Produit		 HUESKER Ideen. Ingenieure. Innovationen. HUESKER Synthetic GmbH Fabrikstr. 13-15 D-48712 Gescher/Germany	
Produkt/Product FORTRAC® 35 T					
Klassifikation/classification Geogitter					
Breite/width/largeur 500,0 cm					
Flächenmasse/unit weight 185,0 g/m ²					
Produktionsauftrag PR000430001					
Datum/date 19.8.14					
Name/name 214					
Sonstiges/others					
Laenge/length 200,00 m					
Rollengewicht/weight 201,00 kg					
Artikelnummer FR35/20-25TA					
					
HSCL 1400107132					
Made in Germany					
Fabrique en Allemagne					

3.3 The ends of the rolls are sprayed with colour-coded paint to assist identification of a particular grade of geogrid on site (Table 1) in accordance with BS EN ISO 10320 : 1999.

3.4 Rolls should be stored in clean, dry conditions and protected from mechanical or chemical damage, exposure to direct sunlight and extreme temperatures. When laid horizontally, the rolls may be stacked up to five high. No other loads should be stored on top of the stack. The packaging should not be removed until immediately prior to installation.

3.5 Toxic fumes are given off if the geogrids catch fire and therefore the necessary precautions should be taken following the instructions of the material safety data sheet for the product.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Fortrac T and R-T Geogrids.

Design Considerations

4 General

4.1 When designed and installed in accordance with this Certificate, Fortrac T and R-T Geogrids are satisfactory for the reinforcement of soil embankments with maximum slope angles of 70°.

4.2 Structural stability is achieved through the frictional interaction of soil particles and the geogrids and the tensile strength of the geogrids.

4.3 The fill specification and method of placement and compaction, design strength of the reinforcement and length of reinforcement embedded within the compacted fill are the key design factors.

4.4 Prior to the commencement of work, the designer must satisfy the design approval and certification procedures of the relevant Highway Authority.

4.5 Particular attention should be paid in design to the following issues:

- site preparation and embankment construction
- fill material properties

- drainage
- protection of the product against damage from site traffic and installation equipment
- the stability of existing structures in close proximity
- design of the embankment facing.

4.6 The working drawings should show the correct orientation of the geogrids. Each layer of reinforcement must be continuous in the direction of load, ie without overlaps.

5 Practicability of installation

The products are designed to be installed by trained contractors in accordance with the specifications and construction drawings (see the *Installation* part of this Certificate).

Design methodology

6.1 Reinforced soil embankments constructed using Fortrac T and R-T Geogrids should be designed in accordance with BS 8006-1 : 2010 and the Specification for Highway Works.

6.2 The typical service life given in Table 7 of BS 8006-1 : 2010 for reinforced soil embankments is 60 years.

Geogrid reinforcement

6.3 In accordance with the methodology set out in BS 8006-1 : 2010, Annex 3, the design strength of the reinforcement (T_D) is calculated as:

$$T_D = T_{CR} / f_m$$

where:

T_{CR} is the long-term tensile creep rupture strength of the reinforcement at the specified design life and design temperature.

f_m is the material safety factor to allow for the strength reducing effects of installation damage, weathering (including exposure to sunlight), chemical and other environmental effects and to allow for the extrapolation of data required to establish the above reduction factors.

6.4 The long-term tensile creep rupture strength (T_{CR}) for each grade of geogrid is calculated using the formula:

$$T_{CR} = T_{char} / RF_{CR}$$

where:

T_{char} is the characteristic short-term strength of the geogrid taken from Table 2.

RF_{CR} is the reduction factor for creep (see Section 7).

6.5 The material safety factor (f_m) is calculated as:

$$f_m = RF_{ID} \times RF_W \times RF_{CH} \times f_s$$

where:

RF_{ID} is the reduction factor for installation damage.

RF_W is the reduction factor for weathering, including exposure to ultra violet light.

RF_{CH} is the reduction factor for chemical/environmental effects.

f_s is the factor of safety for the extrapolation of data.

6.6 Recommended values for RF_{CR} , RF_{ID} , RF_W , RF_{CH} and f_s , are given in sections 7, 8 and 9 of this Certificate.

Conditions of use outside the scope for which the reduction factors are defined are not covered by this Certificate and advice should be sought from the Certificate holder.

Soil/geogrid interaction

6.7 There are two limiting modes of interaction between the soil and the reinforcement that need to be considered and for which the length of reinforcement necessary to maintain equilibrium needs to be determined:

- direct sliding — in which the soil slides over the layer of reinforcement
- pullout — in which the layer of reinforcement pulls out of the soil after it has mobilised the maximum available bond stress.

6.8 In CIRIA SP123, 1996, sections 4.5 and 4.6 describe the following methods for determining resistance to direct sliding and maximum available bond, to which the appropriate partial factors should be applied in accordance with BS 8006-1 : 2010.

6.9 The theoretical expression for resistance to direct sliding is:

$$f_{ds} \times \tan \phi'$$

where:

f_{ds} is the direct sliding coefficient.

ϕ' is the effective angle of friction of soil.

6.10 The direct sliding coefficient (f_{ds}) is calculated as:

$$f_{ds} = \alpha_s \times (\tan \delta / \tan \phi') + (1 - \alpha_s)$$

where:

α_s is the proportion of plane sliding area that is solid.

δ is the angle of skin friction soil on planar reinforcement surface.

$\tan \delta / \tan \phi'$ is the coefficient of skin friction between the soil and geogrid material.

6.11 For initial design purposes, the coefficient of skin friction ($\tan \delta / \tan \phi'$) for determining the resistance to direct sliding for the product when buried in compacted frictional fill may be conservatively assumed to be 0.6. Values for the proportion of plane sliding area that is solid (α_s) are given in Table 3.

Table 3 Soil geogrid interaction parameters for T and R-T Fortrac Geogrids

Grade	$\alpha_s^{(1)}$	Ratio of bearing ⁽²⁾ surface to plan area $\alpha_b \times B/2S$
35T	0.28	0.009
55T	0.31	0.009
65T	0.34	0.009
80T	0.34	0.009
110T	0.37	0.008
150T	0.39	0.008
200T	0.41	0.008
35/20-20T	0.29	0.014
55/30-20T	0.30	0.014
80/30-20T	0.37	0.017
110/30-20T	0.37	0.016
R150/30-30T	0.35	0.014
R200/30-30T	0.36	0.016
R400/50-30T	0.55	0.013
R600/50-30T	0.49	0.015
R800-100-30T	0.72	0.017

(1) α_s is the proportion of the plane sliding area that is solid and is required for the calculation of the bond coefficient (f_b) and the direct sliding coefficient (f_{ds}) (see sections 6.10 and 6.13).

(2) The ratio is required to calculate the bond coefficient in accordance with CIRIA SP123 : 1996 (see section 6.13):
 α_b is the proportion of the grid width available for bearing
 B is the thickness of a transverse member of a grid taking bearing
 S is the spacing between transverse members taking bearing.

6.12 For detailed design, the resistance to direct sliding should be determined from soil and geogrid specific shear box testing.

6.13 The theoretical expression for maximum available bond stress is:

$$f_b \times \tan \phi'$$

where:

f_b is the bond coefficient.

ϕ' is the effective angle of friction of soil.

6.14 The bond coefficient may be calculated as:

$$f_b = \alpha_s \times (\tan \delta / \tan \phi') + (\sigma'_b / \sigma'_n) \times (\alpha_b \times B / 2S) \times (1 / \tan \phi')$$

where:

α_s is the proportion of plane sliding area that is solid.

ϕ' is the effective angle of friction of soil.

$\tan \delta / \tan \phi'$ is the coefficient of skin friction between the soil and geogrid material.

σ'_b / σ'_n is the bearing stress ratio.

$\alpha_b \times B / 2S$ is the ratio of bearing surface to plan area.

δ is the angle of skin friction, soil on planar reinforcement surface

σ'_b is the effective bearing stress on the reinforcement

σ'_n is the nominal effective stress

6.15 For initial design purposes the coefficient of skin friction ($\tan \delta / \tan \phi'$) for determining the bond coefficient for the product when buried in frictional fill may be conservatively assumed to be 0.6. Values for the ratio of bearing surface to plan area ($\alpha_b \times B / 2S$) are given in Table 3. Typical values for the bearing stress ratio (σ'_b / σ'_n) are given in CIRIA SP123, 1996, Table 4.1.

6.16 The BBA recommends that site-specific pull-out tests are carried out to confirm the value of bond coefficient (f_b) used in the final design.

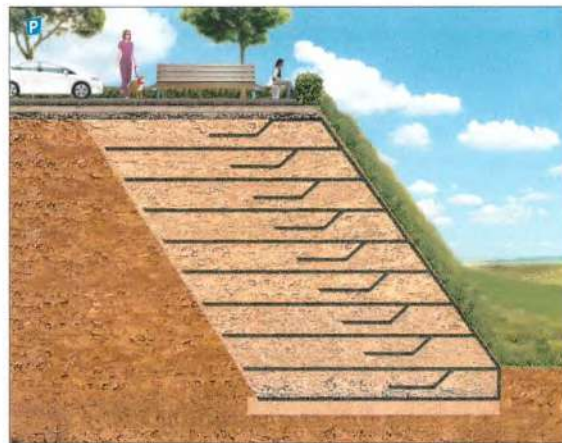
Fill material

6.17 The designer should specify the relevant properties of fill material deemed acceptable for the purpose of the design. Acceptable materials should meet the requirements of BS 8006-1 : 2010. and the Highways Agency's Specification for Highway Works.

Facings

6.18 A typical wrap around facing detail formed using the geogrid is shown in Figure 3. Where the geogrids are used to form the facing, natural or artificial protection must be provided to the grids and fill material to protect the products against damage from ultraviolet light (UV), fire and vandalism, and to protect the fill material from erosion.

Figure 3 Facings



6.19 Other types of facing including preformed panels, gabions/gabion sacks and other proprietary systems may be used, but are outside the scope of this Certificate. Further guidance is given in BS 8006-1 : 2010.

7 Mechanical properties

Tensile strength — short-term

7.1 Characteristic short-term tensile strength (T_{char}) and strain at maximum strength for the product range are given in Table 2.

Tensile strength — long-term

7.2 The long-term creep performance of the geogrids has been determined in accordance with the principles of PD ISO/TR 20432 : 2007 using conventional and stepped isothermal method (SIM) creep rupture test data. The resultant creep rupture diagram is shown in Figure 4.

7.3 For a 60-year design life and design temperature of 20°C, the long-term tensile strength (T_{CR}) of Fortrac T and R-T Geogrids is 66.8% of the characteristic short-term tensile strength (T_{char}), giving a long-term creep reduction factor (RF_{CR}) of 1.50.

7.4 For a 120-year design life and design temperature of 20°C, the long-term tensile strength (T_{CR}) of Fortrac T and R-T Geogrids is 66.0% of characteristic short-term tensile strength (T_{char}) giving a long-term creep reduction factor (RF_{CR}) of 1.52.

Installation damage

7.5 To allow for loss of strength due to mechanical damage that may be sustained during installation, the appropriate value for RF_{ID} should be selected from Table 4. These reduction factors have been established from full-scale installation damage tests using a range of materials whose gradings can be seen in Figure 5. For fills not covered by Table 4, appropriate values of RF_{ID} may be determined from site-specific trials or the engineer may exercise engineering judgment to interpolate between the values given.

Figure 4 Creep rupture diagram — Regression line for the expectancy at constant stress defined by % of characteristic short-term strength at 20°C

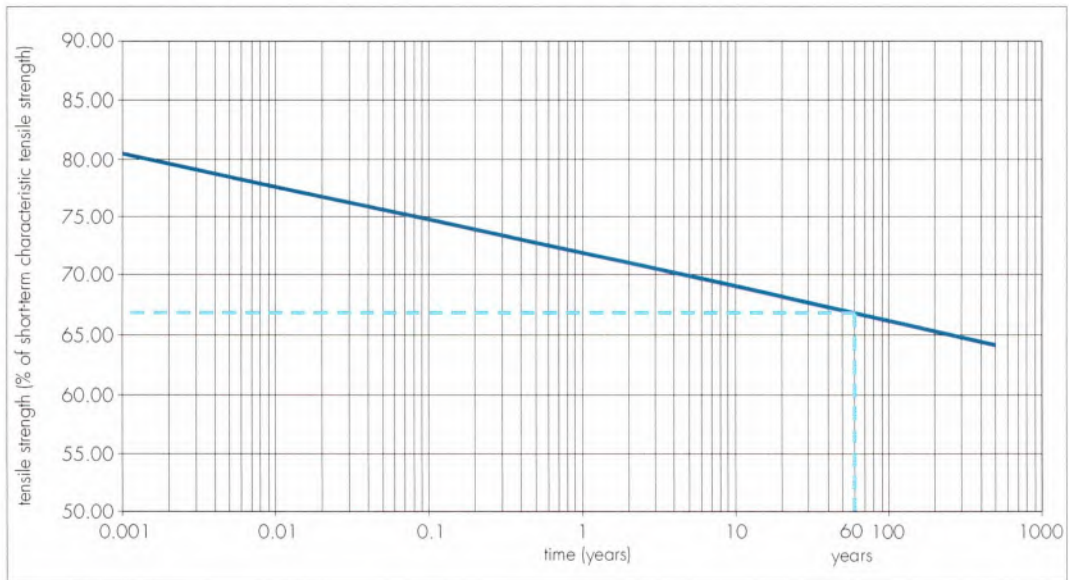


Figure 5 Particle size distributions of fills used in installation damage testing

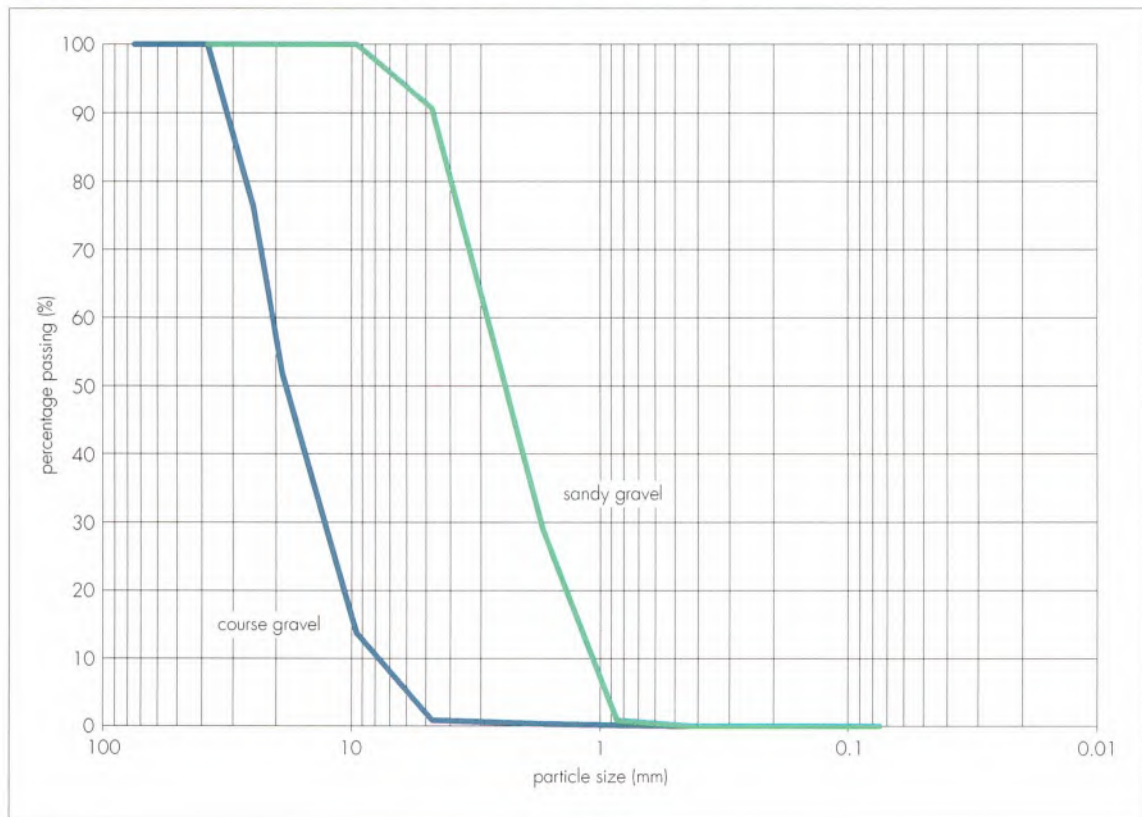


Table 4 Partial safety factor – installation damage (RF_{ID})

Soil type ⁽¹⁾	D_{90} particle size ⁽²⁾ (mm)	Grade	RF_{ID}
Sandy gravel	≤ 10	35T	1.15
		55T	1.15
		65T	1.15
		80T	1.15
		110T	1.10
		150T	1.10
		200T	1.10
		35/20-20T	1.15
		55/30-20T	1.15
		80/30-20T	1.15
		110/30-20T	1.10
		R150/30-30T	1.10
		R200/30-30T	1.10
		R400/50-30T	1.10
		R600/50-30T	1.05
		R800-100-30T	1.05
Coarse gravel	≤ 35	35T	1.20
		55T	1.20
		65T	1.20
		80T	1.15
		110T	1.10
		150T	1.10
		200T	1.10
		35/20-20T	1.20
		55/30-20T	1.20
		80/30-20T	1.15
		110/30-20T	1.10
		R150/30-30T	1.10
		R200/30-30T	1.10
		R400/50-30T	1.05
		R600/50-30T	1.05
		R800-100-30T	1.05

(1) Compacted soil thickness: 200 mm, weight of vibrating roll: 4550 kg.

(2) Detailed particle size distributions are shown in Figure 5

8 Effects of environmental conditions

Weathering (including exposure to sunlight)

8.1 The geogrids have adequate resistance to weathering and exposure to sunlight, when protected from exposure in accordance with recommendations of this Certificate. A reduction factor (RF_w) of 1.13 may be used for design provided the periods of exposure are limited to a maximum of one month. A reduction Factor (RF_w) of 1.00 may be used where the product is covered within one day.

Chemical/environmental effects

8.2 Within a soil environment where pH ranges from 4.0 to 9.0, the geogrids have adequate resistance to hydrolysis for applications where sustained soil temperatures are not higher than 25°C.

8.3 The geogrids are highly resistant to microbiological attack.

8.4 When designed and installed in accordance with the requirements of BS 8006-1 : 2010, BS EN 14475 : 2006 and this Certificate, the geogrids are suitable for use in soils at temperatures normally encountered in reinforced soil embankments in the UK. Long-term resistance to chemical and microbiological attack at temperatures greater than 25°C or lower than 0°C are outside the scope of this Certificate. Where geogrids may be exposed to temperatures outside this range, the advice of the Certificate holder should be sought.

8.5 To take account of chemical/environmental effects including hydrolysis, resistance to acids and alkaline liquids and biological/microbial attack, the appropriate value for RF_{CH} shown in Table 5 may be used for design temperatures up to 25°C and pH levels in the range 4.0 to 9.0.

Table 5 Reduction factor RF_{CH}

Design life (years)	RF_{CH}
60	1.03
120	1.06

9 Factor of safety for the extrapolation of data (f_s)

9.1 For Fortrac T and R-T Geogrids, the factor of safety for the extrapolation of data (f_s) should be taken as:

Table 6 Factor of safety for extrapolation of data

Design life (years)	f_s
60	1.07
120	1.11

9.2 The above values has been calculated in accordance with PD ISO/TR 20432 : 2007, using the R_1 and R_2 values given in Table 7:

Table 7 R_1 and R_2

Factor	Taking account of:	Design life (years)	
		60	120
R_1	Extrapolation of creep rupture data	1.05	1.05
R_2	Extrapolation of chemical data	1.05	1.10

10 Maintenance

As the product is confined within the soil and has suitable durability, maintenance is not required.

11 Durability

The geogrids will have adequate durability for a design life of up to 120 years when used and installed in accordance with this Certificate.

Installation

12 General

12.1 The construction of reinforced soil embankments incorporating the geogrids should be in accordance with the Certificate holder's *Installation instructions*, BS EN 14475 : 2006 and the *Specification for Highway Works*.

12.2 Care should be exercised to ensure Fortrac T and R-T Geogrids are laid with the warp (longitudinal) direction parallel to the direction of principal stress. Design drawings should indicate geogrid orientation (see section 4.6).

13 Procedure

13.1 The geogrid is laid by unrolling the grid to the length required and cutting with a sharp knife or scissors. The unrolling of the grid may be carried out manually or mechanically.

13.2 The grids should be laid flat without folds, parallel with widths in contact to each other. Each reinforcing layer must be continuous in the direction of loading and there should be no overlapping of the grids. Strip misalignment must not exceed 50 mm over a distance of 5 m. Pins or a stretching device may be used to control alignment and also to induce a small prestressing load prior to filling.

13.3 Particular care should be taken to ensure that the grids are adequately covered before compaction or trafficking. Construction traffic will damage unprotected geogrids.

13.4 Fill materials and the thickness and compaction of the fill should be in accordance with Highways Agency's *Specification for Highway Works* and in line with those conditions used to determine the installation damage partial safety factors in the design (see section 7.5).

13.5 Facings are positioned as detailed on the engineer's design drawing. Where the geogrids are used as part of the facing, the geogrid must be wrapped around and anchored back into the fill and must be protected from exposure to ultra violet (UV) light as detailed in Sections 6.18 and 8.1. Formwork is used to assist in maintaining the shape of the facing. Facings, prefabricated or otherwise, are beyond the scope of this Certificate. A typical example is shown in Figure 3.

Technical Investigations

14.1 The manufacturing process of the geogrids was examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

14.2 An examination was made of data relating to:

- evaluation of long- and short-term tensile properties
- chemical degradation
- resistance to hydrolysis
- resistance to biological attack
- resistance to weathering
- effects of temperature
- site damage trials and resistance to mechanical damage
- coefficients of interaction between the geogrids and the soil fill
- installation procedures and typical details

14.3 Calculations were made to establish the plane sliding area that is solid and the ratio of bearing surface to plane area.

14.4 The practicability and ease of handling and installation were assessed.

Bibliography

BS 8006-1 : 2010 *Code of practice for strengthened/reinforced soils and other fills*

BS EN 12224 : 2000 *Geotextiles and geotextile-related products. Determination of the resistance to weathering*

BS EN 12225 : 2000 *Geotextiles and geotextile-related products. Method for determining the microbiological resistance by a soil burial test*

BS EN 12447 : 2000

BS EN 13251 : 2001 *Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9001 : 2008 *Quality Management systems — Requirements*

BS EN ISO 9864 : 2005 *Geosynthetics — Test method for the determination of mass per unit area of geotextiles and geotextile-related products*

BS EN ISO 10319 : 2008 *Geotextiles — Wide-width tensile test*

BS EN ISO 10320 : 1999 *Geotextiles and geotextile-related products— Identification on site*

CIRIA SP123 : 1996 *Soil Reinforcement with Geotextiles* : Jewel R A

PD ISO/TR 20432 : 2007 *Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*

Manual of Contract Documents for Highway Works, Volume 2 *Notes for Guidance on the Specification for Highway Works*

15 Conditions

15.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

15.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

15.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

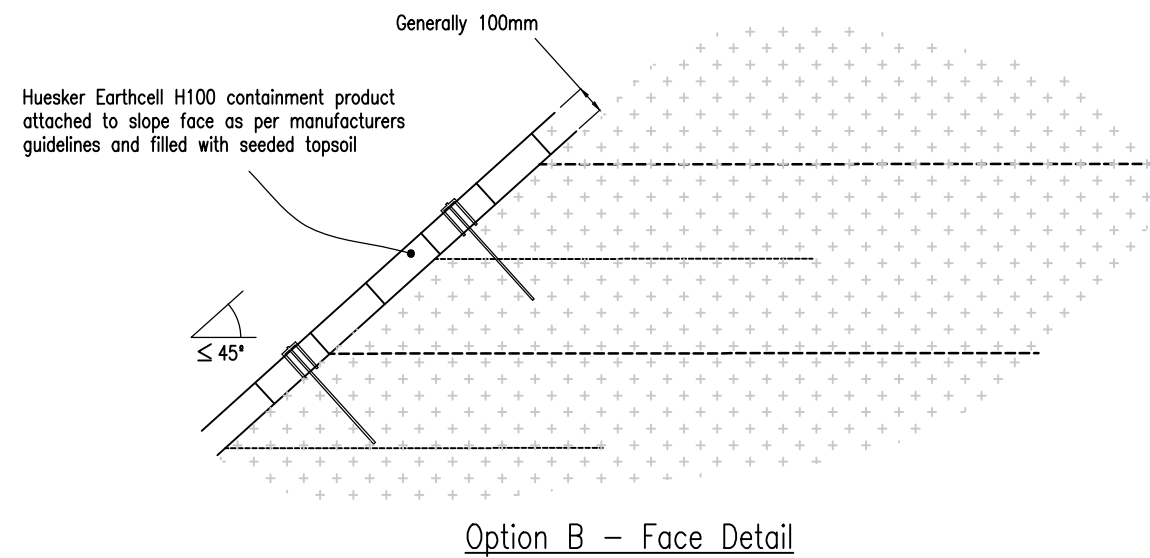
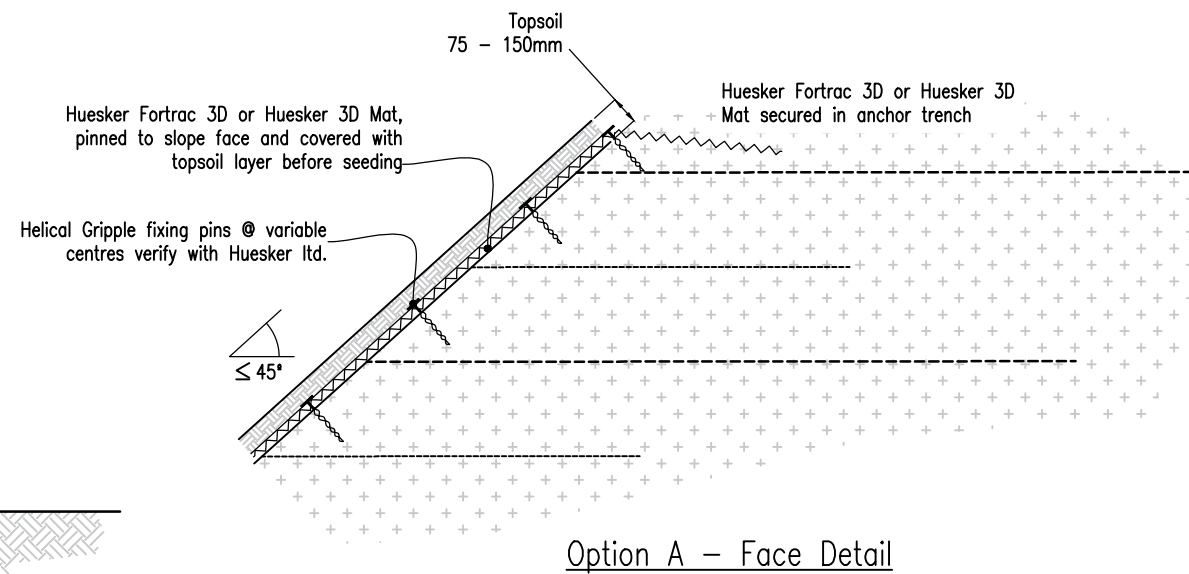
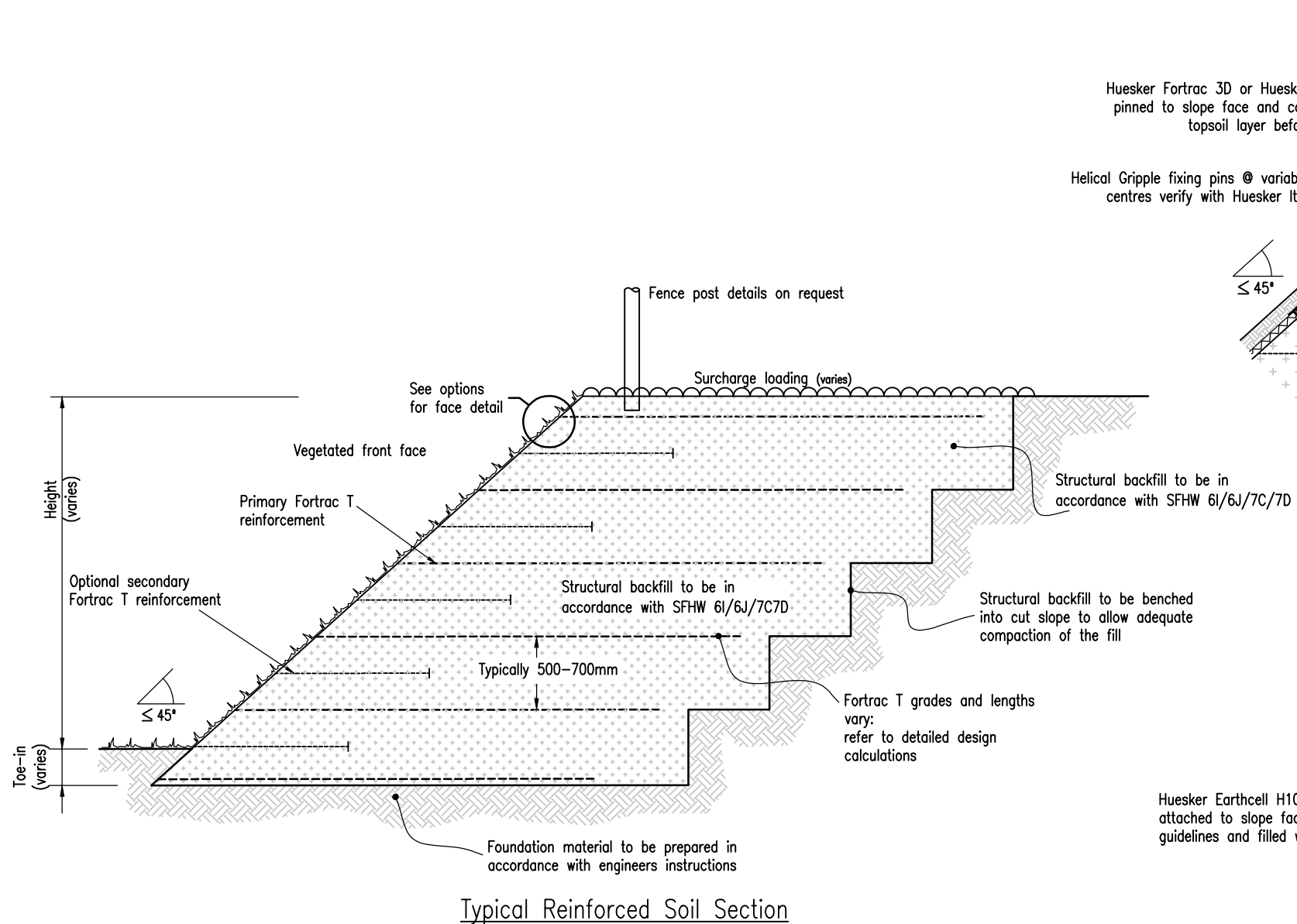
- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

15.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

15.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal.
- any claims by the manufacturer relating to CE marking.

15.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.



DRAWN	JLA	SCALE	0 A3	NTS
REV	DESCRIPTION	DATE		

PROJECT TITLE			
Typical Section and Details			
Huesker Fortrac Nature System			
Reinforced Soil Slopes ≤45°			
PROJECT REF	DRAWING REF	REVISION	DATE
N/A	03	00	11.05.20

**HUESKER**
Ideas. Engineers. Innovations.

1 Quay Business Centre, Units 1.3 & 1.4 Harvard Court
Warrington, Cheshire WA2 8LT, Great Britain
Tel.: +44 (0) 1925/629-383
E-Mail: info@HUESKER.co.uk

STATUS
NOT FOR CONSTRUCTION

16.0 APPENDIX F – EA FLOOD MAP FOR PLANNING AND PRODUCT 4 DATA

Flood map for planning

Your reference	Location (easting/northing)	Created
Unspecified	388772/411705	1 September 2025 11:30

Your selected location is in flood zone 3, an area with a high probability of flooding.

This means:

- you must complete a flood risk assessment for development in this area
- you should follow the Environment Agency's standing advice for carrying out a flood risk assessment (see <https://www.gov.uk/guidance/flood-risk-assessment-standing-advice>)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence which sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2025 AC0000807064. <https://flood-map-for-planning.service.gov.uk/os-terms>



Flood map for planning

Your reference

Unspecified

Location (easting/northing)

388772/411705

Scale

1:2,500

Created

1 Sep 2025 11:30

-  Selected area
-  Flood zone 3
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area



0 20 40 60m

Flood risk assessment data



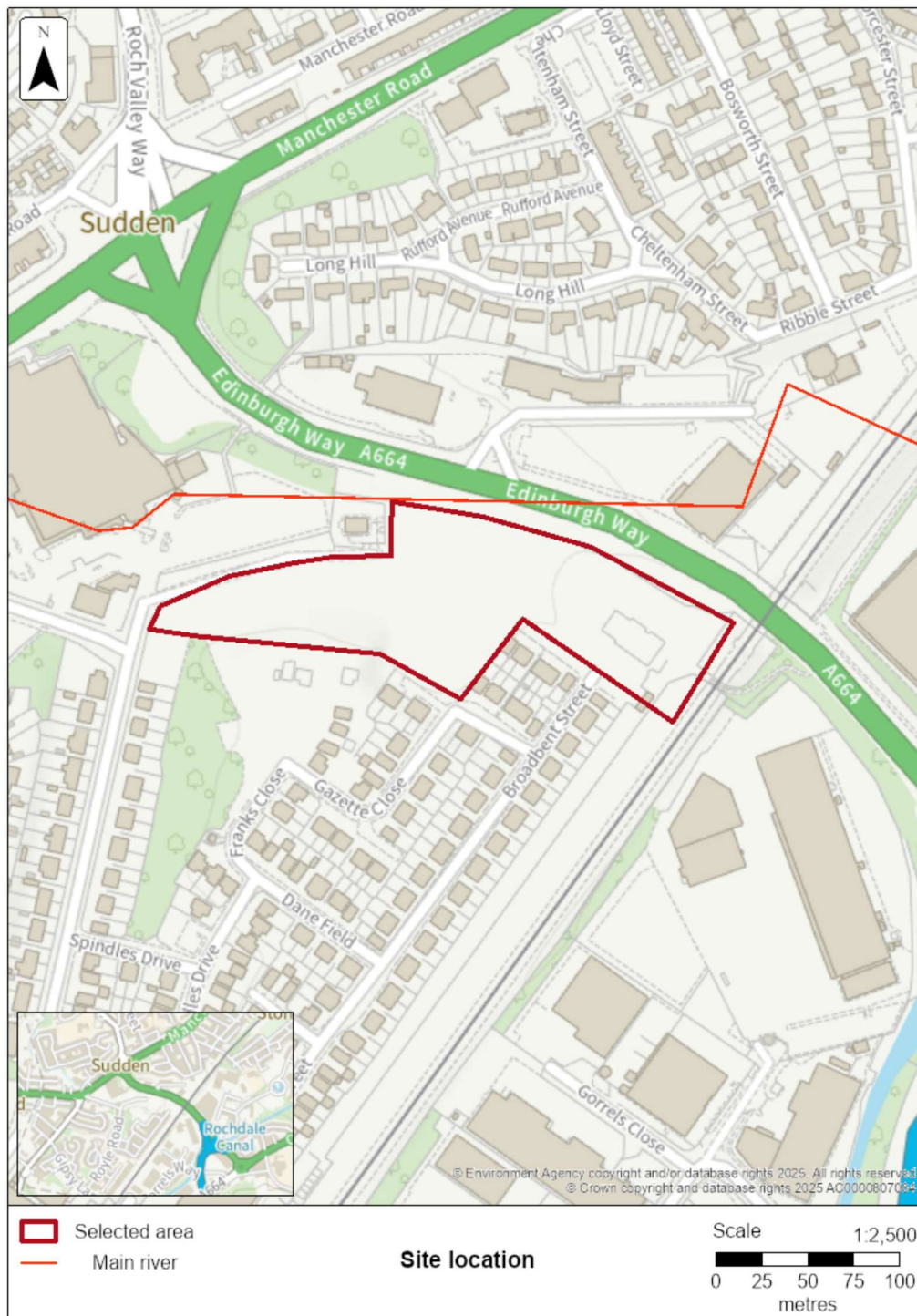
Location of site: 388808 / 411698 (shown as easting and northing coordinates)

Document created on: 3 September 2025

This information was previously known as a product 4.

Customer reference number: MR6YMTTHBGCF

Map showing the location that flood risk assessment data has been requested for.



How to use this information

You can use this information as part of a flood risk assessment for a planning application. To do this, you should include it in the appendix of your flood risk assessment.

We recommend that you work with a flood risk consultant to get your flood risk assessment.

Included in this document

In this document you'll find:

- how to find information about surface water and other sources of flooding
- information on the models used
- definitions for the terminology used throughout
- flood map for planning (rivers and the sea)
- past floods
- modelled data
- information about strategic flood risk assessments
- information about this data
- information about flood risk activity permits
- help and advice

Information that's unavailable

This document **does not** contain:

- flood defences and attributes

We aren't able to display flood defence locations and attributes as there are no formal flood defences in the area of interest.

Surface water and other sources of flooding

When using the surface water map on the [check your long term flood risk service](#) the following considerations apply:

- surface water extents are suitable for use in planning
- surface water climate change scenarios may help to inform risk assessments, but the available data fall short of what is required to assess planned development
- surface water depth information should not be used for planning purposes

To find out about other factors that might affect the flood risk of this location, you should also check:

- [reservoir flood risk](#)
- groundwater flood risk - you could use the [British Geological Survey groundwater flooding data](#), [groundwater: current status and flood risk](#) and the guide on [mining and groundwater constraints for development](#) - further information may be available from the lead local flood authority (LLFA)
- your local planning authority's SFRA, which includes future flood risk

Your Lead Local Flood Authority is Rochdale District.

For information about sewer flooding, contact the relevant water company for the area.

About the models used

Model name: Rochdale and Littleborough 2013

Scenario(s): Defended fluvial, defences removed fluvial, defended climate change fluvial, defences removed climate change fluvial

Date: 1 June 2013

These models contain the most relevant data for your area of interest.

Terminology used

Annual exceedance probability (AEP)

This refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. For example, a large flood which is calculated to have a 1% chance of occurring in any one year, is described as 1% AEP.

Metres above ordnance datum (mAOD)

All flood levels are given in metres above ordnance datum which is defined as the mean sea level at Newlyn, Cornwall.

Flood map for planning (rivers and the sea)

Your selected location is in flood zone 2.

Flood zone 3 shows the area at risk of flooding for an undefended flood event with a:

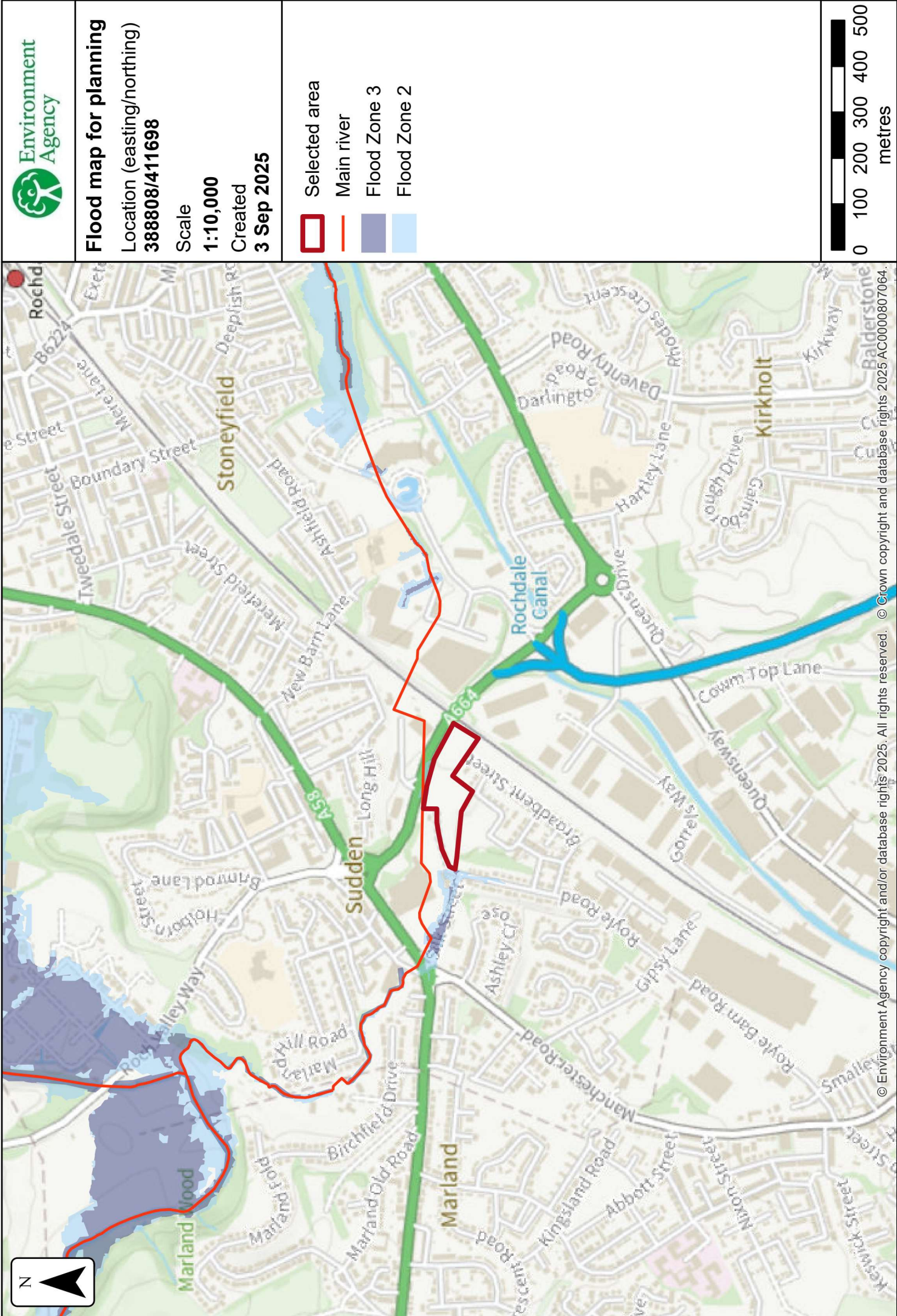
- 0.5% or greater probability of occurring in any year for flooding from the sea
- 1% or greater probability of occurring in any year for fluvial (river) flooding

Flood zone 2 shows the area at risk of flooding for an undefended flood event with:

- between a 0.1% and 0.5% probability of occurring in any year for flooding from the sea
- between a 0.1% and 1% probability of occurring in any year for fluvial (river) flooding

It's important to remember that the flood zones on this map:

- refer to the land at risk of flooding and do not refer to individual properties
- refer to the probability of river and sea flooding, ignoring the presence of defences
- do not take into account potential impacts of climate change



Modelled data

This section provides details of different scenarios we have modelled and includes the following (where available):

- outline maps showing the area at risk from flooding in different modelled scenarios
- modelled node point map(s) showing the points used to get the data to model the scenarios and table(s) providing details of the flood risk for different return periods
- map(s) showing the approximate water levels for the return period with the largest flood extent for a scenario and table(s) of sample points providing details of the flood risk for different return periods

Climate change

The climate change data included in the models may not include the latest [flood risk assessment climate change allowances](#). Where the new allowances are not available you will need to consider this data and factor in the new allowances to demonstrate the development will be safe from flooding.

The Environment Agency will incorporate the new allowances into future modelling studies. For now, it's your responsibility to demonstrate that new developments will be safe in flood risk terms for their lifetime.

Modelled scenarios

The following scenarios are included:

- Defended modelled fluvial: risk of flooding from rivers where there are flood defences
- Defences removed modelled fluvial: risk of flooding from rivers where flood defences have been removed
- No defences exist modelled fluvial: risk of flooding from rivers where there are no flood defences
- Defended climate change modelled fluvial: risk of flooding from rivers where there are flood defences, including estimated impact of climate change
- Defences removed climate change modelled fluvial: risk of flooding from rivers where flood defences have been removed, including estimated impact of climate change
- No defences exist climate change modelled fluvial: risk of flooding from rivers where there are no flood defences, including estimated impact of climate change



Defences removed

climate change

modelled fluvial extent

Location (easting/northing)
388808/411698

Scale
1:10,000

Created
3 Sep 2025

Model name
Rochdale and Littleborough 2013

Selected area

Modelled flood extent

1% AEP (+20%)

1% AEP (+35%)

1% AEP (+70%)

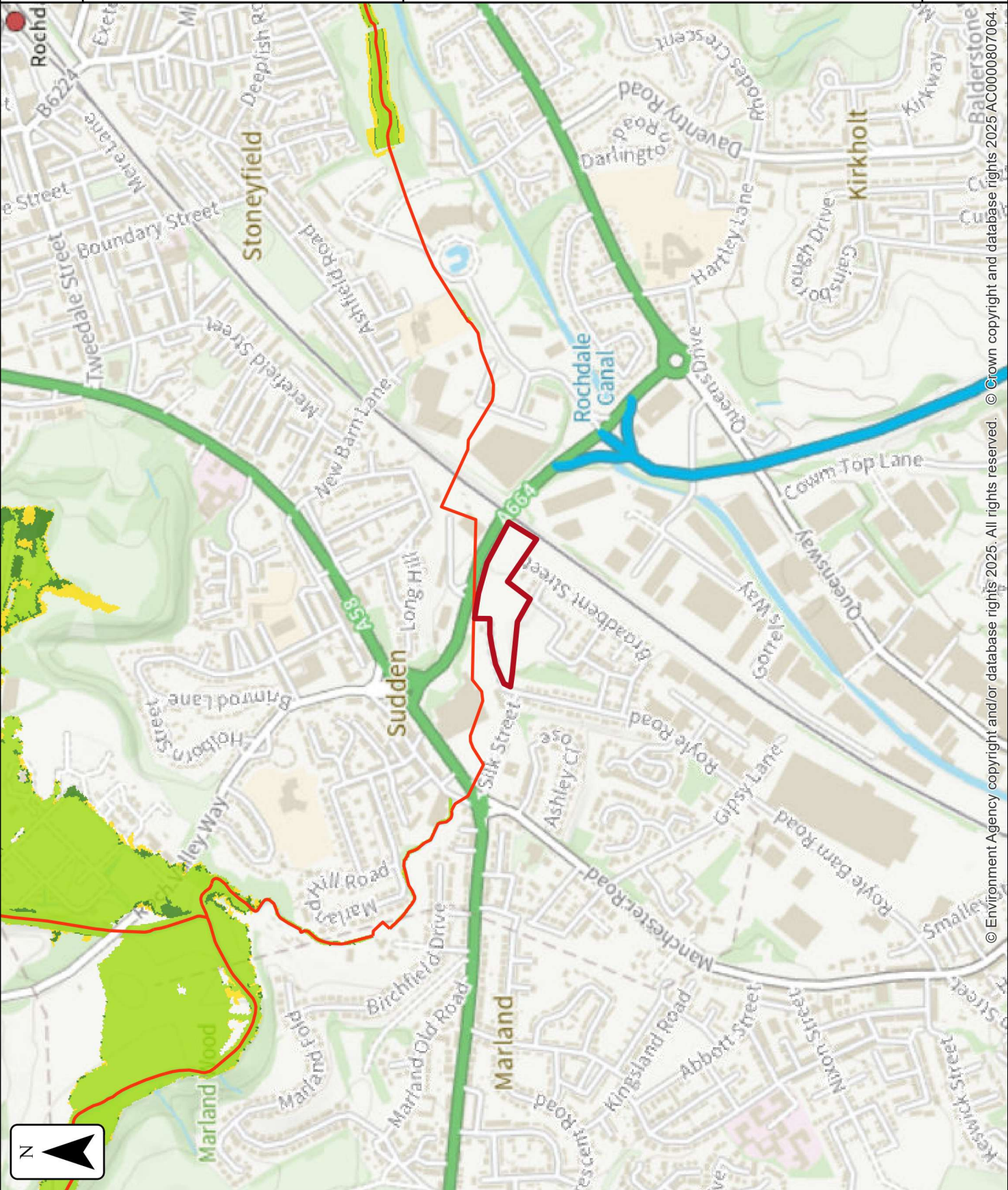
Selected area

Main river

Flood extents may not be visible where they overlap other return periods

0100200300400500

metres



The map displays the Rochdale Canal and surrounding urban areas, including Stoneyfield, Sudden, Marland, and Kirkholt. The modelled flood extents are shown in three colors: green for 1% AEP (+20%), yellow for 1% AEP (+35%), and orange for 1% AEP (+70%). The flood extents are shown along the canal and in some surrounding areas. The map includes a legend, a scale bar, and a north arrow.

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Defences removed
modelled fluvial extent

Location (easting/northing)
388808/411698

Scale
1:10,000

Created
3 Sep 2025

Model name
Rochdale and
Littleborough 2013

Selected area

Main river

Modelled flood extent

5% AEP

1.33% AEP

1% AEP

0.5% AEP

0.1% AEP

Flood extents may not be
visible where they overlap
other return periods

0100200300400500

metres

The map displays the Rochdale and Littleborough area, showing the main river (Rochdale Canal) and modelled flood extents for various Annual Exceedance Probabilities (AEPs). The flood extents are color-coded: 5% AEP (light green), 1.33% AEP (yellow), 1% AEP (light blue), 0.5% AEP (dark blue), and 0.1% AEP (red). The main river is shown in orange. The map includes street names such as Stoneyfield, Sudden, Marland, and Kirkholt, and a scale bar from 0 to 500 metres. A north arrow is located in the bottom left corner.

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Environment Agency

Defended climate change modelled fluvial extent

Location (easting/northing)
388808/411698

Scale
1:10,000

Created
3 Sep 2025

Model name
Rochdale and Littleborough 2013

Selected area

Main river

Modelled flood extent

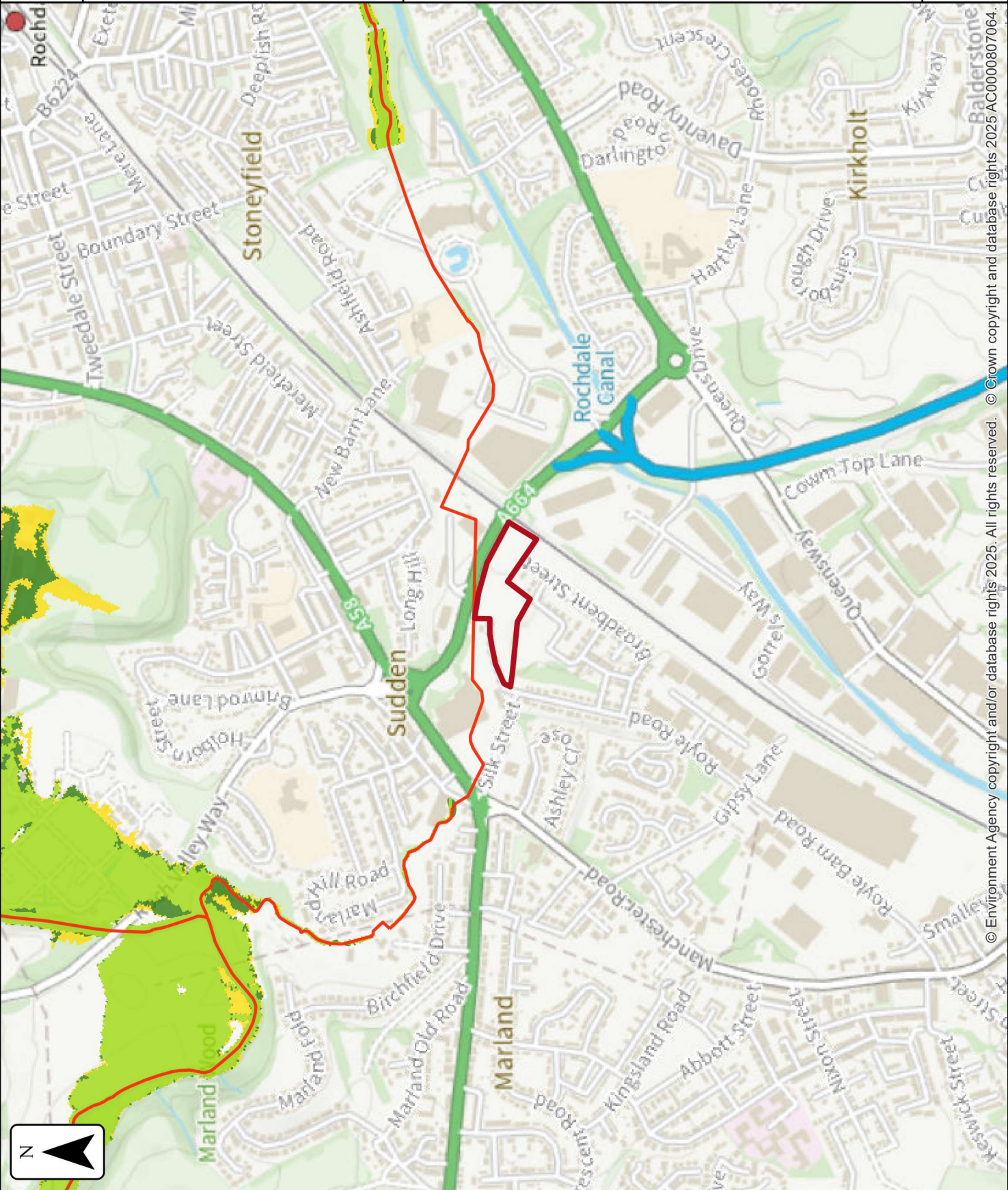
1% AEP (+20%)

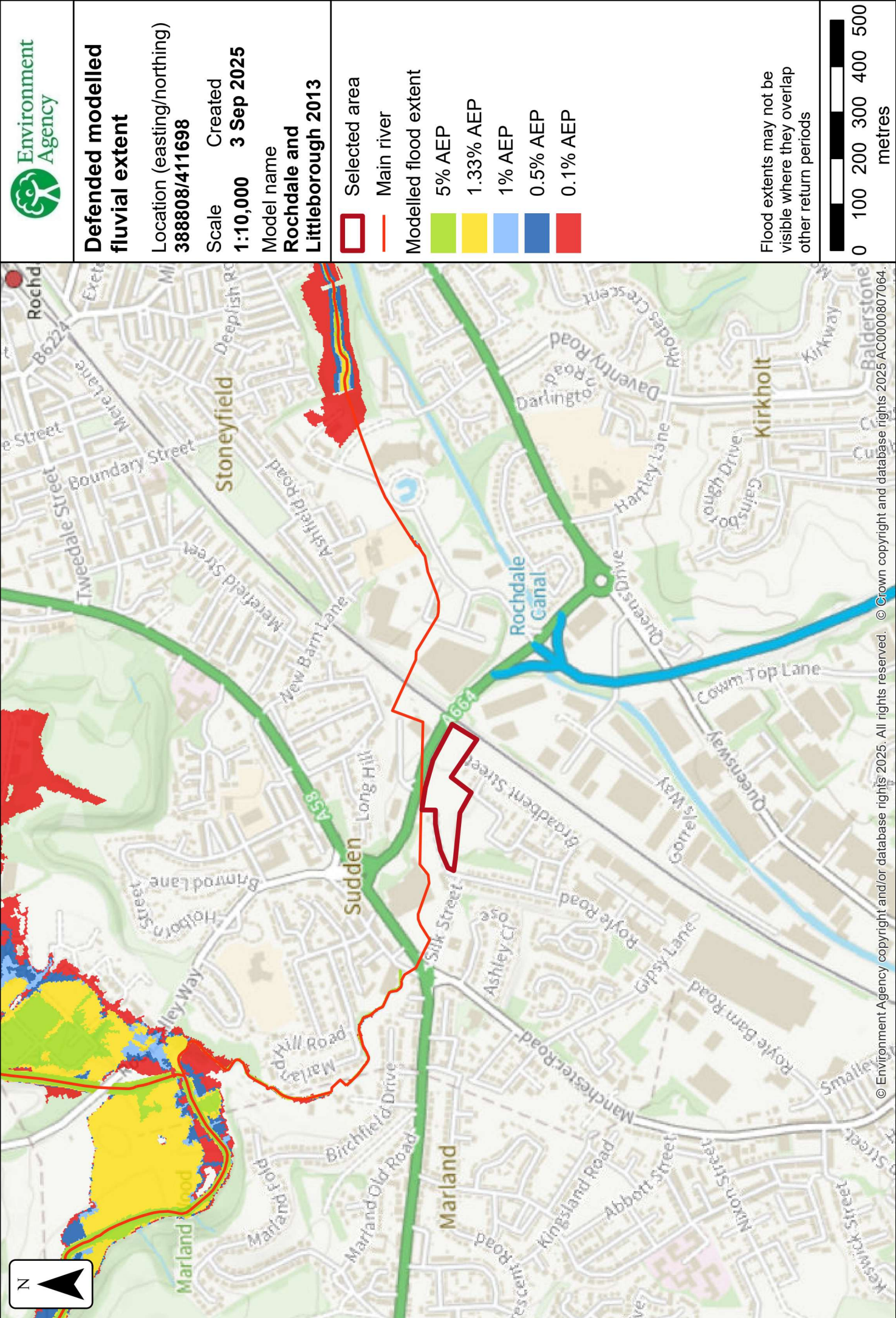
1% AEP (+35%)

1% AEP (+70%)

Flood extents may not be visible where they overlap other return periods

0 100 200 300 400 500 metres







Modelled node locations data

Defences removed climate change

Label	Modelled location ID	Easting	Northing	1% AEP (+20%)	1% AEP (+35%)	1% AEP (+70%)	1% AEP (+20%)	1% AEP (+35%)	1% AEP (+70%)
				Level	Level	Level	Flow	Flow	Flow
1	1674731	388266	411886	112.97	112.99	113.08	7.74	7.92	8.82
2	1674710	388305	411886	113.29	113.31	113.38	7.59	7.77	8.65
3	1674223	388339	411840	113.89	113.90	113.98	7.54	7.72	8.59
4	1674302	388372	411819	114.20	114.22	114.29	7.50	7.68	8.55
5	1673906	388420	411800	114.66	114.67	114.72	7.50	7.68	8.55
6	1674638	389327	411755	125.28	125.31	125.45	7.47	7.64	8.50
7	1674623	389352	411775	125.49	125.50	125.55	7.35	7.53	8.37
8	1673966	389375	411790	126.01	126.02	126.09	7.28	7.46	8.29

Data in this table comes from the Rochdale and Littleborough 2013 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Modelled node locations data

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP	3.33% AEP	1.33% AEP	1% AEP	0.5% AEP	0.1% AEP
				Level	Level	Level	Level	Level	Level
1	1674731	388266	411886	112.58	112.63	112.82	112.88	112.98	113.26
2	1674710	388305	411886	112.93	112.99	113.17	113.21	113.29	113.50
3	1674223	388339	411840	113.46	113.52	113.74	113.79	113.89	114.10
4	1674302	388372	411819	113.89	113.93	114.08	114.12	114.20	114.40
5	1673906	388420	411800	114.35	114.39	114.55	114.59	114.66	114.80
6	1674638	389327	411755	124.59	124.68	125.02	125.11	125.28	125.68
7	1674623	389352	411775	125.09	125.14	125.34	125.39	125.49	125.68
8	1673966	389375	411790	125.59	125.65	125.85	125.91	126.01	126.23

Data in this table comes from the Rochdale and Littleborough 2013 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP	3.33% AEP	1.33% AEP	1% AEP	0.5% AEP	0.1% AEP
				Flow	Flow	Flow	Flow	Flow	Flow
1	1674731	388266	411886	3.81	4.29	6.20	6.73	7.76	10.32
2	1674710	388305	411886	3.74	4.21	6.09	6.60	7.61	10.07
3	1674223	388339	411840	3.72	4.18	6.05	6.56	7.56	9.98
4	1674302	388372	411819	3.70	4.16	6.02	6.53	7.52	9.92
5	1673906	388420	411800	3.70	4.16	6.02	6.53	7.52	9.92
6	1674638	389327	411755	3.69	4.15	6.0	6.50	7.48	9.86
7	1674623	389352	411775	3.63	4.08	5.91	6.40	7.36	9.66
8	1673966	389375	411790	3.60	4.05	5.86	6.34	7.29	9.50

Data in this table comes from the Rochdale and Littleborough 2013 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Modelled node locations data

Defended climate change

Label	Modelled location ID	Easting	Northing	1% AEP (+20%)	1% AEP (+35%)	1% AEP (+70%)	1% AEP (+20%)	1% AEP (+35%)	1% AEP (+70%)
				Level	Level	Level	Flow	Flow	Flow
1	1674731	388266	411886	112.97	112.99	113.08	7.74	7.92	8.79
2	1674710	388305	411886	113.29	113.31	113.37	7.59	7.78	8.63
3	1674223	388339	411840	113.89	113.90	113.98	7.54	7.72	8.56
4	1674302	388372	411819	114.20	114.22	114.29	7.50	7.68	8.52
5	1673906	388420	411800	114.66	114.67	114.72	7.50	7.68	8.52
6	1674638	389327	411755	125.28	125.31	125.45	7.47	7.65	8.48
7	1674623	389352	411775	125.49	125.50	125.55	7.36	7.53	8.35
8	1673966	389375	411790	126.0	126.02	126.09	7.29	7.46	8.27

Data in this table comes from the Rochdale and Littleborough 2013 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Modelled node locations data

Defended

Label	Modelled location ID	Easting	Northing	5% AEP	3.33% AEP	1.33% AEP	1% AEP	0.5% AEP	0.1% AEP
				Level	Level	Level	Level	Level	Level
1	1674731	388266	411886	112.58	112.63	112.82	112.88	112.98	113.26
2	1674710	388305	411886	112.93	112.99	113.17	113.21	113.29	113.50
3	1674223	388339	411840	113.46	113.52	113.74	113.79	113.89	114.11
4	1674302	388372	411819	113.89	113.93	114.08	114.12	114.20	114.40
5	1673906	388420	411800	114.35	114.39	114.55	114.59	114.66	114.80
6	1674638	389327	411755	124.59	124.68	125.02	125.11	125.28	125.68
7	1674623	389352	411775	125.09	125.14	125.34	125.39	125.49	125.68
8	1673966	389375	411790	125.59	125.65	125.85	125.91	126.01	126.23

Data in this table comes from the Rochdale and Littleborough 2013 model.
 Level values are shown in mAOD, and flow values are shown in cubic metres per second.
 Any blank cells show where a particular scenario has not been modelled for this location.

Defended

Label	Modelled location ID	Easting	Northing	5% AEP	3.33% AEP	1.33% AEP	1% AEP	0.5% AEP	0.1% AEP
				Flow	Flow	Flow	Flow	Flow	Flow
1	1674731	388266	411886	3.81	4.29	6.20	6.73	7.76	10.33
2	1674710	388305	411886	3.74	4.21	6.09	6.60	7.61	10.09
3	1674223	388339	411840	3.72	4.18	6.05	6.56	7.56	9.99
4	1674302	388372	411819	3.70	4.16	6.02	6.53	7.52	9.93
5	1673906	388420	411800	3.70	4.16	6.02	6.53	7.52	9.93
6	1674638	389327	411755	3.69	4.15	6.0	6.50	7.48	9.87
7	1674623	389352	411775	3.63	4.08	5.91	6.40	7.37	9.68
8	1673966	389375	411790	3.60	4.05	5.86	6.34	7.29	9.51

Data in this table comes from the Rochdale and Littleborough 2013 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Strategic flood risk assessments

We recommend that you check the relevant local authority's strategic flood risk assessment (SFRA) as part of your work to prepare a site specific flood risk assessment.

This should give you information about:

- the potential impacts of climate change in this catchment
- areas defined as functional floodplain
- flooding from other sources, such as surface water, ground water and reservoirs

Your Lead Local Flood Authority is Rochdale District.

About this data

This data has been generated by strategic scale flood models and is not intended for use at the individual property scale. If you're intending to use this data as part of a flood risk assessment, please include an appropriate modelling tolerance as part of your assessment. The Environment Agency regularly updates its modelling. We recommend that you check the data provided is the most recent, before submitting your flood risk assessment.

Flood risk activity permits

Under the Environmental Permitting (England and Wales) Regulations 2016 some developments may require an environmental permit for flood risk activities from the Environment Agency. This includes any permanent or temporary works that are in, over, under, or nearby a designated main river or flood defence structure.

[Find out more about flood risk activity permits](#)

Help and advice

Contact the Greater Manchester Merseyside and Cheshire Environment Agency team at inforequests.gmmc@environment-agency.gov.uk for:

- [more information about getting a product 5, 6, 7 or 8](#)
- general help and advice about the site you're requesting data for

17.0 APPENDIX G – TOPOGRAPHICAL SURVEY

KEY:
SITE BOUNDARY



P02	03.03.2025	KF	Revised to suit latest topo
P01	17.09.2025	PB	FIRST ISSUE
Rev	Date	By	Description

SHAPE
ENGINEERING

Liverpool Innovation Park | Edge Lane | Liverpool | L7 9NJ
T: 0151 305 0700
www.shapeengineering.co.uk

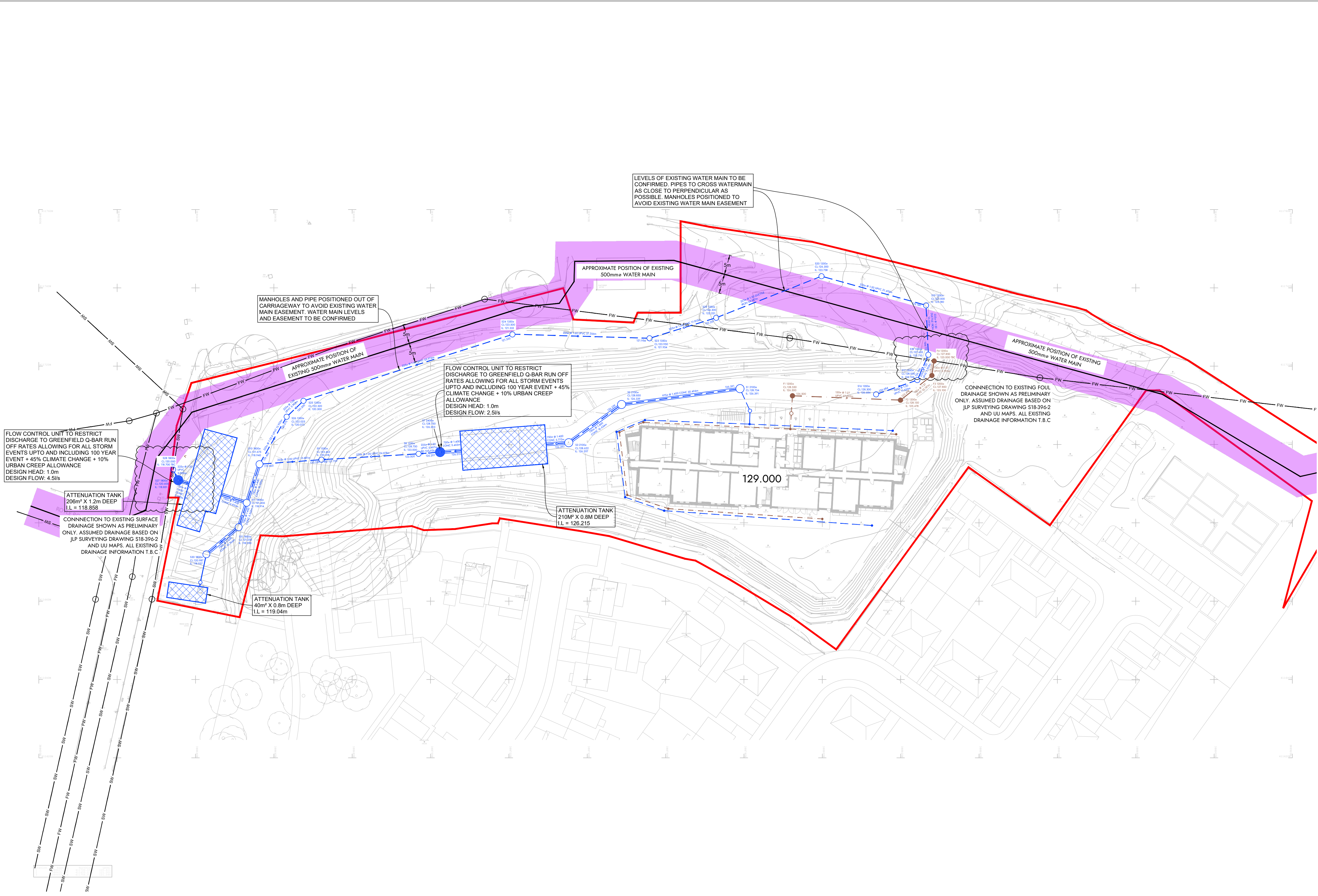
Client
BMC Rochdale Limited

Project
Royle Road, Rochdale

Title
Topographical Survey

Status	Suitability Description For Information	Structural Stage	Date 17.09.2025
Designed By PB	Drawn By PB	Scale @ A1 1:500	Project No. 2885
Sheet No. 2885-SCE-00-00-DR-C-0004			Revision P02

18.0 APPENDIX H – DRAINAGE LAYOUT



- NOTES**
- SETTING OUT SHALL BE UNDERTAKEN USING ONLY THE INFORMATION GIVEN. DISTANCES SHOULD NOT BE SCALED FROM THIS DRAWING.
 - ALL SEWERS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE DESIGN AND CONSTRUCTION GUIDANCE AND WHERE APPLICABLE UNITED UTILITIES DETAILS
 - THE MINIMUM GRAVITY PIPE DIAMETER UNDER ADOPTABLE HIGHWAYS SHALL BE 150mm
 - IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION GIVEN WITH REGARDS TO EXISTING SERVICES AND DRAINAGE CONNECTIONS ETC. PRIOR TO COMMENCING THE WORKS. THE RATES SHALL INCLUDE FOR HAND DIG AROUND SERVICES WHERE NECESSARY. THE CONTRACTOR SHALL ADHERE TO THE CDM REGULATIONS AT ALL TIMES
 - EXISTING FLOWS IN WATERCOURSES, SEWERS AND LAND DRAINS SHALL BE MAINTAINED AT ALL TIMES
 - ALL MATERIALS TO BEAR THE RELEVANT B.S. KITEMARK AND COMPLY FULLY WITH THE SPECIFICATIONS. ALL CONCRETE & CONCRETE PRODUCTS MUST USE SULPHATE RESISTANT CEMENT (UNLESS THE SITE INVESTIGATION REPORT PROVES THAT SULPHATE ATTACK FROM SOILS AND GROUNDWATER WILL NOT OCCUR TO WITHSTAND A CLASS
 - ALL OPENING NOTICES ETC. AS REQUIRED UNDER HIGHWAYS ACTS ETC. ARE TO BE OBTAINED PRIOR TO COMMENCEMENT OF WORKS. ALL WORKS ARE TO BE INSPECTED BY L.A., NHBC OR THE NETWORK OPERATOR AS APPLICABLE.
 - WHERE "ULTRA RIB" UPVC PIPES (OR SIMILAR APPROVED) ARE USED IN ADOPTABLE DRAINAGE THEY SHALL STILL BE HANDLED AND LAID IN ACCORDANCE WITH THE SPECIFICATION AND GUIDANCE ISSUED BY THE HIGH-PERFORMANCE PIPE ASSOCIATION.
 - A CLASS 5 BED AND SURROUND MUST BE USED FOR SUCH PIPES. TRENCH BACKFILL IN HIGHWAYS TO WITHIN 1m OF HIGHWAY SHALL, AS DIRECTED BY THE HIGHWAY AUTHORITY BE A SUITABLE GRANULAR MATERIAL ALL IN ACCORDANCE WITH SEWERS FOR ADOPTION CL. 4.3.4.
 - DOMESTIC DRAINAGE SHALL BE TO BUILDING REGULATIONS APPROVED DOCUMENT H. 110mm U.P.V.C. PIPES LAID TO THE FOLLOWING MINIMUM FALLS UNLESS OTHERWISE SHOWN.

	FOUL	S.W.
HEAD RUN	1 IN 40	1 IN 60
ELSEWHERE	1 IN 80	1 IN 100
 - ALL GULLY CONNECTIONS TO BE 150mm VITRIFIED UPVC UNLESS NOTED OTHERWISE
 - MINIMUM COVER TO DRAINAGE SOFFIT LEVEL;

LANDSCAPING	TRAFFICKED AREAS	HIGHWAYS
0.600m	0.900m	1.200m
 - CLASS 'S' BEDDING AND SURROUND TO BE USED WHERE MINIMUM COVER IS ACHIEVED.
 - WHERE MINIMUM COVER IS NOT ACHIEVED CLASS 'Z' BEDDING AND SURROUND (CONCRETE ENCASEMENT) IS TO BE USED.
- KEY:**
- SURFACE WATER SEWER
 - SURFACE WATER FLOW CONTROL
 - FOUL WATER SEWER
 - RISING MAIN
 - EXISTING SEWER
 - EXISTING 5M WATER MAIN EASEMENT
 - SITE BOUNDARY
 - DEVELOPMENT BOUNDARY

DRAWING SUBMITTED FOR
INFORMATION PURPOSES ONLY

PO4	27.04.26	PB	Client comments
PO3	05.03.26	KF	Revised Site Boundary
PO2	03.03.26	KF	Revised to suit latest Architects layout
PO1	15.09.25	KF	Preliminary Issue
Rev	Date	By	Description

SHAPE ENGINEERING

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Client
BMC Rochdale Limited

Project
Royle Road, Rochdale

Title
Drainage Strategy - Masterplan

Status	Suitability Description For Information	Structural Stage	Date
			15.09.25

Designed By	Drawn By	Scale @ A1	Project No.
KF	KF	1:500	2885

Sheet No.	Revision
2885-SCE-00-00-DR-C-0003	PO4

DETAILS OF EXISTING WATER MAIN AND ALL EXISTING DRAINAGE TO BE CONFIRMED PRIOR TO WORKS ON SITE. DRAINAGE LAYOUT HAS BEEN SHOWN FOR INFORMATION PURPOSES ONLY AND IS SUBJECT TO CHANGE UPON RECEIVAL OF SUPPORTING INFORMATION

FLOW CONTROL UNIT TO RESTRICT DISCHARGE TO GREENFIELD Q-BAR RUN OFF RATES ALLOWING FOR ALL STORM EVENTS UPTO AND INCLUDING 100 YEAR EVENT + 45% CLIMATE CHANGE + 10% URBAN CREEP ALLOWANCE
DESIGN HEAD: 1.0m
DESIGN FLOW: 4.5l/s

ATTENUATION TANK
206m² X 1.2m DEEP
I.L = 118.858

CONNECTION TO EXISTING SURFACE DRAINAGE SHOWN AS PRELIMINARY ONLY. ASSUMED DRAINAGE BASED ON JLP SURVEYING DRAWING S18-396-2 AND UU MAPS. ALL EXISTING DRAINAGE INFORMATION T.B.C

MANHOLES AND PIPE POSITIONED OUT OF CARRIAGEWAY TO AVOID EXISTING WATER MAIN EASEMENT. WATER MAIN LEVELS AND EASEMENT TO BE CONFIRMED

APPROXIMATE POSITION OF EXISTING 500mm $\varnothing$ WATER MAIN

FLOW CONTROL UNIT TO RESTRICT DISCHARGE TO GREENFIELD Q-BAR RUN OFF RATES ALLOWING FOR ALL STORM EVENTS UPTO AND INCLUDING 100 YEAR EVENT + 45% CLIMATE CHANGE + 10% URBAN CREEP ALLOWANCE
DESIGN HEAD: 1.0m
DESIGN FLOW: 2.5l/s

ATTENUATION TANK
210M² X 0.8M DEEP
I.L = 126.215

ATTENUATION TANK
40m² X 0.8m DEEP
I.L = 119.04m

NOTES

- SETTING OUT SHALL BE UNDERTAKEN USING ONLY THE INFORMATION GIVEN. DISTANCES SHOULD NOT BE SCALED FROM THIS DRAWING.
 - ALL SEWERS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE DESIGN AND CONSTRUCTION GUIDANCE AND WHERE APPLICABLE UNITED UTILITIES DETAILS
 - THE MINIMUM GRAVITY PIPE DIAMETER UNDER ADOPATABLE HIGHWAYS SHALL BE 150mm
 - IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION GIVEN WITH REGARDS TO EXISTING SERVICES AND DRAINAGE CONNECTIONS ETC. PRIOR TO COMMENCING THE WORKS. THE RATES SHALL INCLUDE FOR HAND DIG AROUND SERVICES WHERE NECESSARY. THE CONTRACTOR SHALL ADHERE TO THE CDM REGULATIONS AT ALL TIMES
 - EXISTING FLOWS IN WATERCOURSES, SEWERS AND LAND DRAINS SHALL BE MAINTAINED AT ALL TIMES
 - ALL MATERIALS TO BEAR THE RELEVANT B.S. KITEMARK AND COMPLY FULLY WITH THE SPECIFICATIONS. ALL CONCRETE & CONCRETE PRODUCTS MUST USE SULPHATE RESISTANT CEMENT (UNLESS THE SITE INVESTIGATION REPORT PROVES THAT SULPHATE ATTACK FROM SOILS AND GROUNDWATER WILL NOT OCCUR TO WITHSTAND A CLASS
 - ALL OPENING NOTICES ETC. AS REQUIRED UNDER HIGHWAYS ACTS ETC. ARE TO BE OBTAINED PRIOR TO COMMENCEMENT OF WORKS. ALL WORKS ARE TO BE INSPECTED BY L.A., NHBC OR THE NETWORK OPERATOR AS APPLICABLE.
 - WHERE "ULTRA RIB" UPVC PIPES (OR SIMILAR APPROVED) ARE USED IN ADOPATABLE DRAINAGE THEY SHALL STILL BE HANDLED AND LAID IN ACCORDANCE WITH THE SPECIFICATION AND GUIDANCE ISSUED BY THE HIGH-PERFORMANCE PIPE ASSOCIATION.
 - A CLASS 5 BED AND SURROUND MUST BE USED FOR SUCH PIPES. TRENCH BACKFILL IN HIGHWAYS TO WITHIN 1m OF HIGHWAY SHALL, AS DIRECTED BY THE HIGHWAY AUTHORITY BE A SUITABLE GRANULAR MATERIAL ALL IN ACCORDANCE WITH SEWERS FOR ADOPTION CL. 4.3.4.
 - DOMESTIC DRAINAGE SHALL BE TO BUILDING REGULATIONS APPROVED DOCUMENT H. 110mm U.P.V.C. PIPES LAID TO THE FOLLOWING MINIMUM FALLS UNLESS OTHERWISE SHOWN.

	FOUL	S.W.
HEAD RUN	1 IN 40	1 IN 60
ELSEWHERE	1 IN 80	1 IN 100
 - ALL GULLY CONNECTIONS TO BE 150mm VITRIFIED UPVC UNLESS NOTED OTHERWISE
 - MINIMUM COVER TO DRAINAGE SOFFIT LEVEL;

	LANDSCAPING	TRAFFICKED AREAS	HIGHWAYS
	0.600m	0.900m	1.200m
- CLASS 'S' BEDDING AND SURROUND MUST BE USED WHERE MINIMUM COVER IS ACHIEVED.
 - WHERE MINIMUM COVER IS NOT ACHIEVED CLASS 'Z' BEDDING AND SURROUND (CONCRETE ENCASEMENT) IS TO BE USED.

KEY:

- SURFACE WATER SEWER
- SURFACE WATER FLOW CONTROL
- FOUL WATER SEWER
- RISING MAIN
- EXISTING SEWER
- EXISTING 5M WATER MAIN EASEMENT
- SITE BOUNDARY
- DEVELOPMENT BOUNDARY

DRAWING SUBMITTED FOR INFORMATION PURPOSES ONLY

PO4	27.04.26	PB	Client comments
PO3	05.03.26	KF	Revised Site Boundary
PO2	03.03.26	KF	Revised to suit latest Architects layout
PO1	15.09.25	KF	Preliminary Issue
Rev	Date	By	Description

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Client

BMC Rochdale Limited

Project

Royle Road, Rochdale

Title

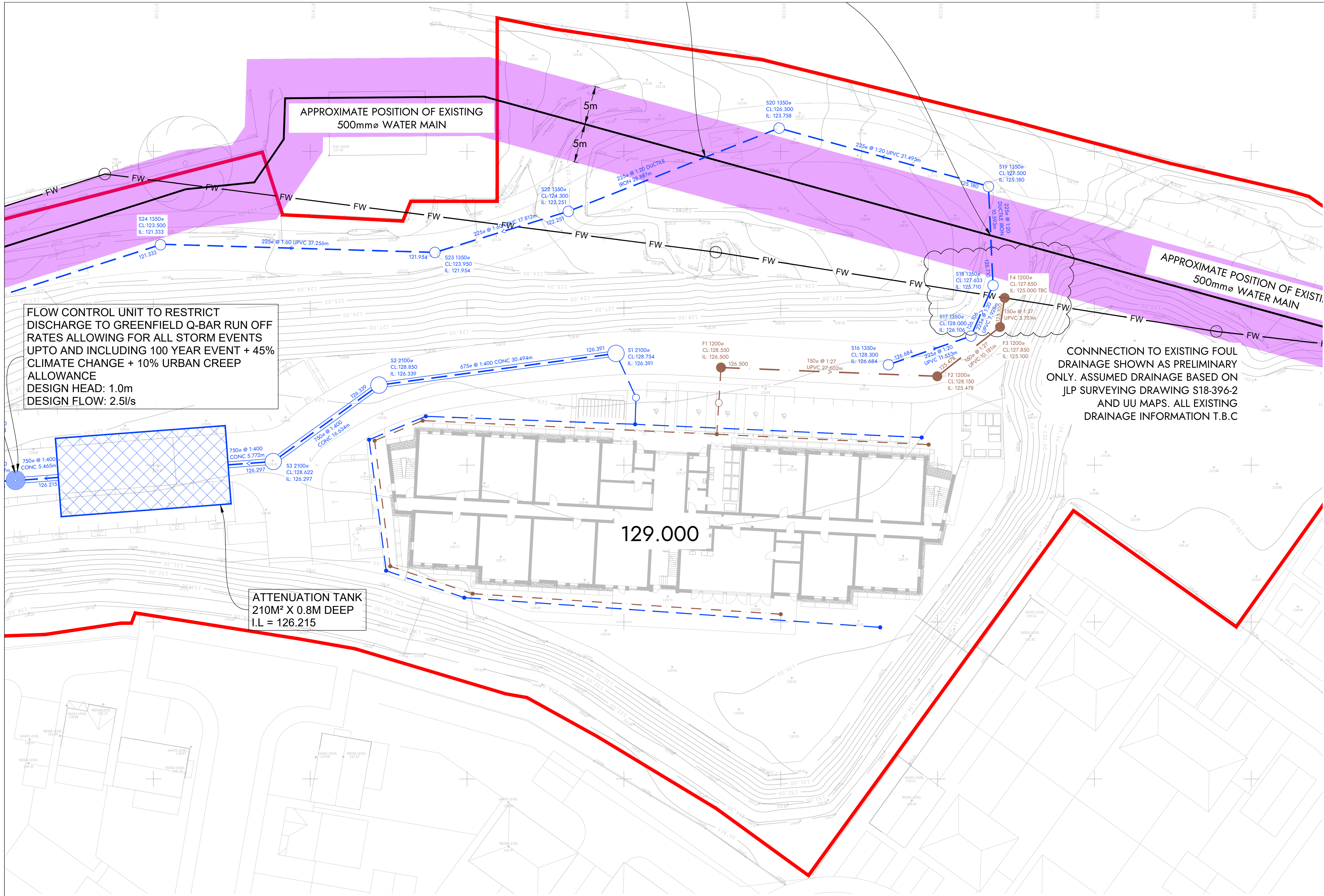
Drainage Strategy - Sheet 1

Status	Suitability Description For Information	Structural Stage	Date
			15.09.25

Designed By	Drawn By	Scale @ A1	Project No.
KF	KF	1:250	2885

Sheet No.	Revision
2885-SCE-00-00-DR-C-0001	PO4

DETAILS OF EXISTING WATER MAIN AND ALL EXISTING DRAINAGE TO BE CONFIRMED PRIOR TO WORKS ON SITE. DRAINAGE LAYOUT HAS BEEN SHOWN FOR INFORMATION PURPOSES ONLY AND IS SUBJECT TO CHANGE UPON RECEIVAL OF SUPPORTING INFORMATION



- NOTES**
- SETTING OUT SHALL BE UNDERTAKEN USING ONLY THE INFORMATION GIVEN. DISTANCES SHOULD NOT BE SCALED FROM THIS DRAWING.
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 - EXISTING FLOWS IN WATERCOURSES, SEWERS AND LAND DRAINS SHALL BE MAINTAINED AT ALL TIMES
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 - ALL OPENING NOTICES ETC. AS REQUIRED UNDER HIGHWAYS ACTS ETC. ARE TO BE OBTAINED PRIOR TO COMMENCEMENT OF WORKS. ALL WORKS ARE TO BE INSPECTED BY L.A., NHBC OR THE NETWORK OPERATOR AS APPLICABLE.
 - WHERE "ULTRA RIB" UPVC PIPES (OR SIMILAR APPROVED) ARE USED IN ADOPTABLE DRAINAGE THEY SHALL STILL BE HANDLED AND LAID IN ACCORDANCE WITH THE SPECIFICATION AND GUIDANCE ISSUED BY THE HIGH-PERFORMANCE PIPE ASSOCIATION.
 - A CLASS 5 BED AND SURROUND MUST BE USED FOR SUCH PIPES. TRENCH BACKFILL IN HIGHWAYS TO WITHIN 1m OF HIGHWAY SHALL, AS DIRECTED BY THE HIGHWAY AUTHORITY BE A SUITABLE GRANULAR MATERIAL ALL IN ACCORDANCE WITH SEWERS FOR ADOPTION CL. 4.3.4.
 - DOMESTIC DRAINAGE SHALL BE TO BUILDING REGULATIONS APPROVED DOCUMENT H. 110mm U.P.V.C. PIPES LAID TO THE FOLLOWING MINIMUM FALLS UNLESS OTHERWISE SHOWN.

	FOUL	S.W.
HEAD RUN	1 IN 40	1 IN 60
ELSEWHERE	1 IN 80	1 IN 100
 - ALL GULLY CONNECTIONS TO BE 150mm VITRIFIED UPVC UNLESS NOTED OTHERWISE
 - MINIMUM COVER TO DRAINAGE SOFFIT LEVEL;

	TRAFFICKED AREAS	HIGHWAYS
LANDSCAPING	0.900m	1.200m
 - CLASS 'S' BEDDING AND SURROUND TO BE USED WHERE MINIMUM COVER IS ACHIEVED.
 - WHERE MINIMUM COVER IS NOT ACHIEVED CLASS 'Z' BEDDING AND SURROUND (CONCRETE ENCASEMENT) IS TO BE USED.

- KEY:**
- SURFACE WATER SEWER
 - SURFACE WATER FLOW CONTROL
 - FOUL WATER SEWER
 - RISING MAIN
 - EXISTING SEWER
 - EXISTING 5M WATER MAIN EASEMENT
 - SITE BOUNDARY
 - DEVELOPMENT BOUNDARY

DRAWING SUBMITTED FOR
INFORMATION PURPOSES ONLY

PO4	27.04.26	PB	Client comments
PO3	05.03.26	KF	Revised Site Boundary
PO2	03.03.26	KF	Revised to suit latest Architects layout
PO1	15.09.25	KF	Preliminary Issue
Rev	Date	By	Description

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Client
BMC Rochdale Limited

Project
Royle Road, Rochdale

Title
Drainage Strategy - Sheet 2

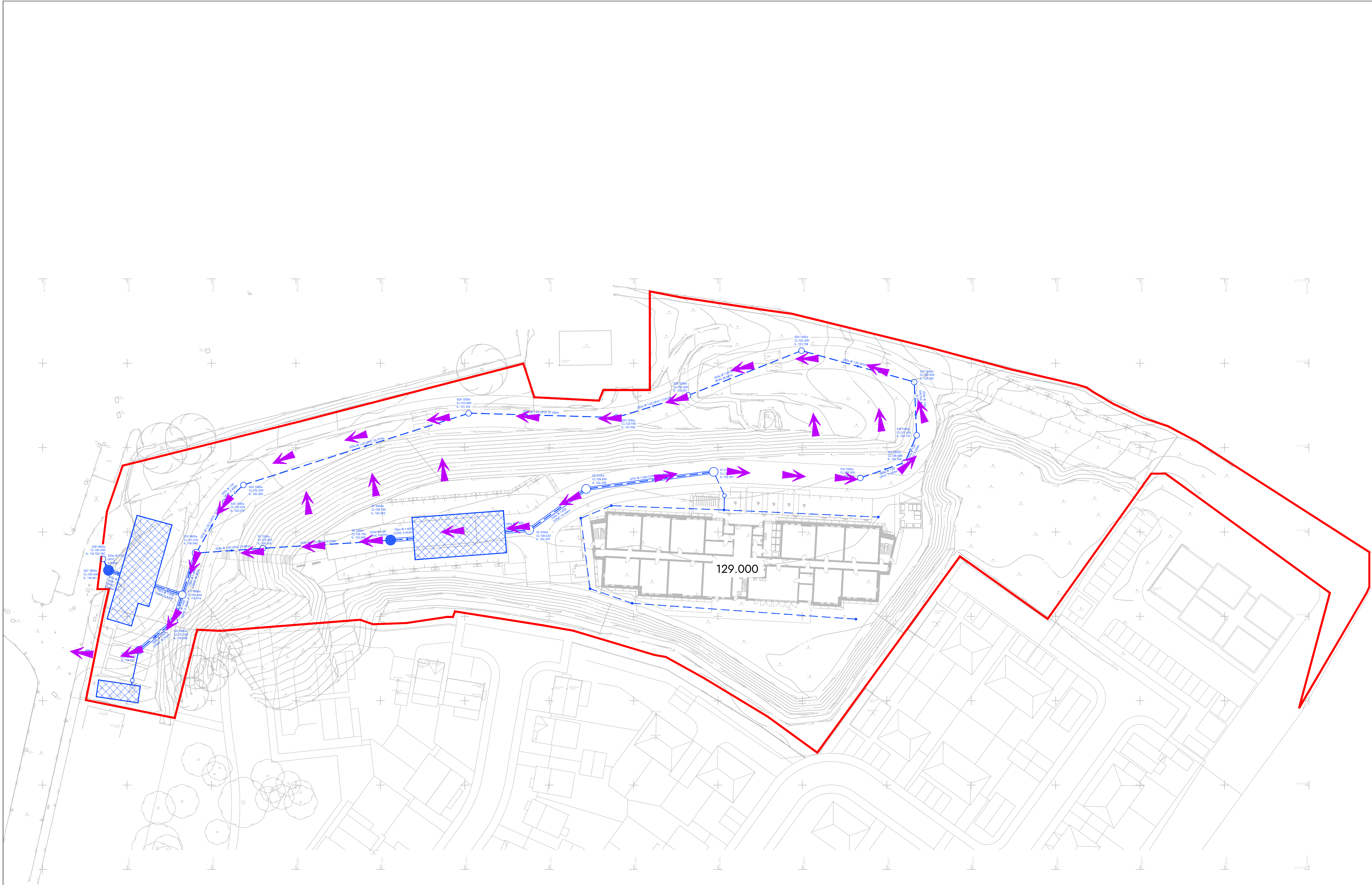
Status	Suitability Description For Information	Structural Stage	Date
			15.09.25

Designed By	Drawn By	Scale @ A1	Project No.
KF	KF	1:250	2885

Sheet No.	Revision
2885-SCE-00-00-DR-C-0002	PO4

DETAILS OF EXISTING WATER MAIN AND ALL EXISTING DRAINAGE TO BE CONFIRMED PRIOR TO WORKS ON SITE. DRAINAGE LAYOUT HAS BEEN SHOWN FOR INFORMATION PURPOSES ONLY AND IS SUBJECT TO CHANGE UPON RECEIVAL OF SUPPORTING INFORMATION

19.0 APPENDIX I – FLOOD EXCEEDANCE ROUTE



- GENERAL NOTES
- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
 - ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM (OD) UNLESS NOTED OTHERWISE
 - ALL COORDINATES ARE IN METRES RELATED TO ORDNANCE SURVEY NATIONAL GRID
 - ALL MATERIALS AND WORKMANSHIP WILL BE AS DEFINED IN THE SPECIFICATION UNLESS NOTED OTHERWISE.
 - THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL DRAWINGS AND DOCUMENTATION ASSOCIATED WITH THE PROJECT.
 - THIS DRAWING HAS BEEN BASED UPON SURVEY/OS INFORMATION SUPPLIED BY A THIRD PARTY AND SCP SHALL NOT BE LIABLE FOR ANY INACCURACY OR DEFICIENCIES ARISING FROM IT.
 - ALL LEVELS, DIMENSIONS AND LOCATIONS ARE TO BE CHECKED BY THE MAIN CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK ON SITE.
 - ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH LOCAL AUTHORITY ADOPTABLE RESIDENTIAL ROAD SPECIFICATION AND STANDARD DETAILS.

KEY:

OVERLAND FLOOD EXCEEDANCE ROUTE

PRIVATE SURFACE WATER SEWER

IN THE UNLIKELY EVENT OF BLOCKAGES/FAILURE OVERLAND FLOW ROUTES WILL BE CONTAINED WITHIN KERBS AND RE-ENTER THE SYSTEM VIA GULLIES.

IN PRIVATE AREAS, SUCH AS DRIVEWAYS, RUN-OFF WILL BE CAPTURED BY ACO DRAINS TO ENSURE THERE IS NO RISK TO PROPERTIES.

ALL PROPERTIES FFL'S ARE SET 150mm ABOVE ADJACENT GROUND LEVELS AND ABOVE THOSE OF THE CONNECTING ADOPTABLE MANHOLES.

P03	27.04.26	PB	Client comments
P02	02.03.26	KF	Revised to suit latest layout
P01	15.09.25	KF	Preliminary Issue
Rev	Date	By	Description

SHAPE ENGINEERING

Liverpool Innovation Park | Edge Lane | Liverpool | L7 9NJ
T: 0151 305 0700 www.shapeengineering.co.uk

Client
BMC Rochdale Limited

Project
Royle Road, Rochdale

Title
Flood Exceedance Plan

Status	Suitability Description For Information	Structural Stage	Date
-	-	-	15.09.25

Designed By	Drawn By	Scale @ A1	Project No.
KF	KF	1:500	2885

Sheet No.	Revision
2885-SCE-00-00-DR-C-0020	P03

20.0 APPENDIX J – PROPOSED HYDROBRAKE® DETAILS

Technical Specification

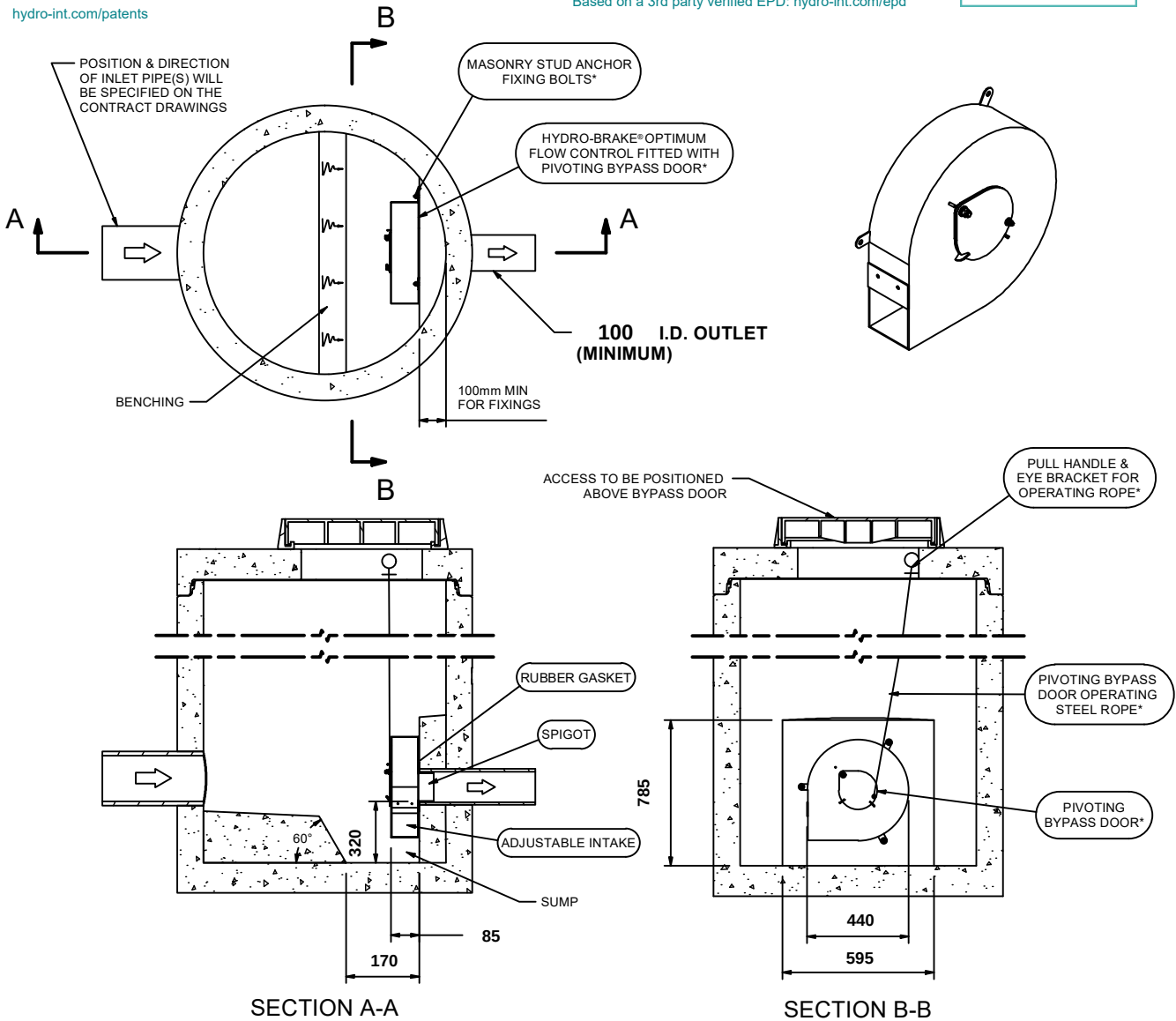
Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	2.500
Flush-Flo™	0.307	2.492
Kick-Flo®	0.627	2.020
Mean Flow		2.192

hydro-int.com/patents

This Hydro-Brake® Optimum includes:

- All in 3 mm Grade 304L stainless steel
- Integral pivoting by-pass door allowing clear line of sight through to outlet, c/w operating rope
- Media blasted for corrosion resistance
- Variable flow rate post installation via adjustable inlet (if necessary)
- Indicative Weight: 10 kg
- Product Carbon Footprint: 44.35 kgCO2e

Based on a 3rd party verified EPD: hydro-int.com/epd



IMPORTANT: LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® IS A REGISTERED TRADEMARK FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY
HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE

The head/flow characteristics of this SHE-0075-2500-1000-2500 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.



DATE	17/09/2025 09:54
SITE	Royle Road
DESIGNER	Paige Blundell
REF	2885

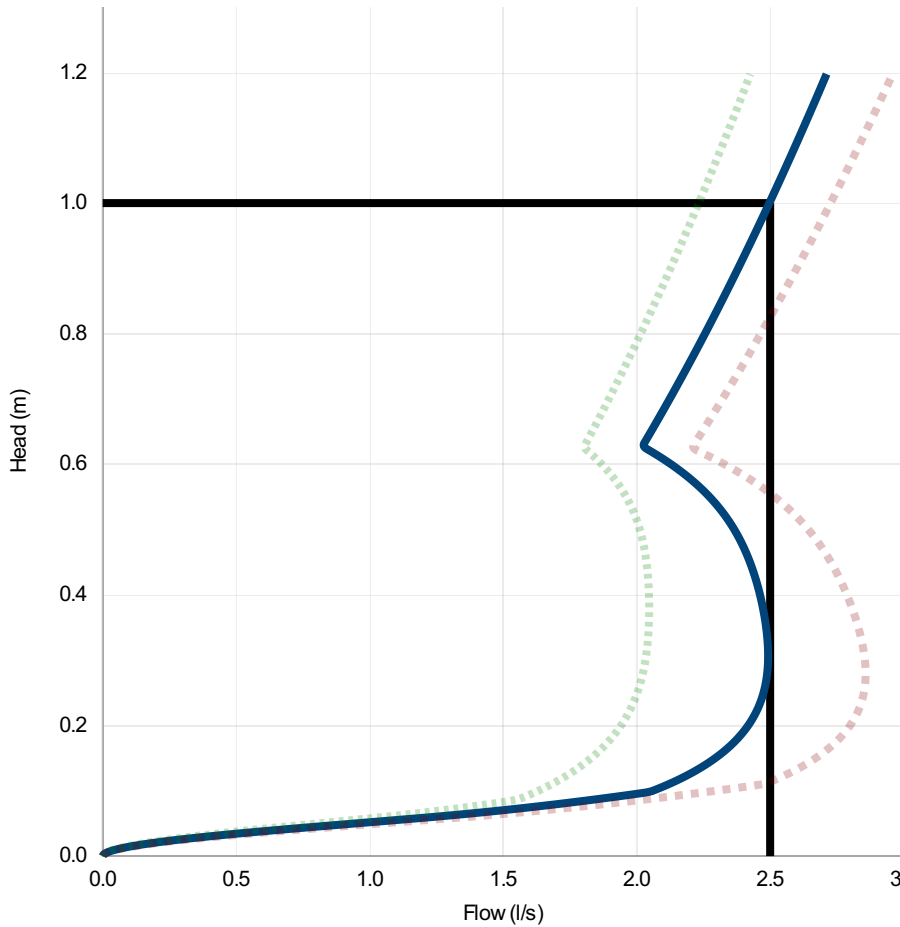
SHE-0075-2500-1000-2500
Hydro-Brake® Optimum

Technical Specification

	Original Setting		Minimum Setting		Maximum Setting	
Control Point	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
Primary Design	1.000	2.500	1.000	2.232	1.000	2.726
Flush-Flo™	0.307	2.492	0.380	2.047	0.279	2.857
Kick-Flo®	0.627	2.020	0.625	1.800	0.624	2.205
Mean Flow		2.192		1.873		2.449



hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.034	0.504
0.069	1.468
0.103	2.081
0.138	2.250
0.172	2.360
0.207	2.429
0.241	2.469
0.276	2.488
0.310	2.492
0.345	2.487
0.379	2.473
0.414	2.453
0.448	2.426
0.483	2.389
0.517	2.338
0.552	2.269
0.586	2.175
0.621	2.050
0.655	2.061
0.690	2.109
0.724	2.156
0.759	2.202
0.793	2.247
0.828	2.291
0.862	2.334
0.897	2.376
0.931	2.417
0.966	2.457
1.000	2.497

DESIGN ADVICE



The head/flow characteristics of this SHE-0075-2500-1000-2500 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro
International
A CRH COMPANY

DATE 17/09/2025 09:54

Site Royle Road

DESIGNER Paige Blundell

Ref 2885

SHE-0075-2500-1000-2500

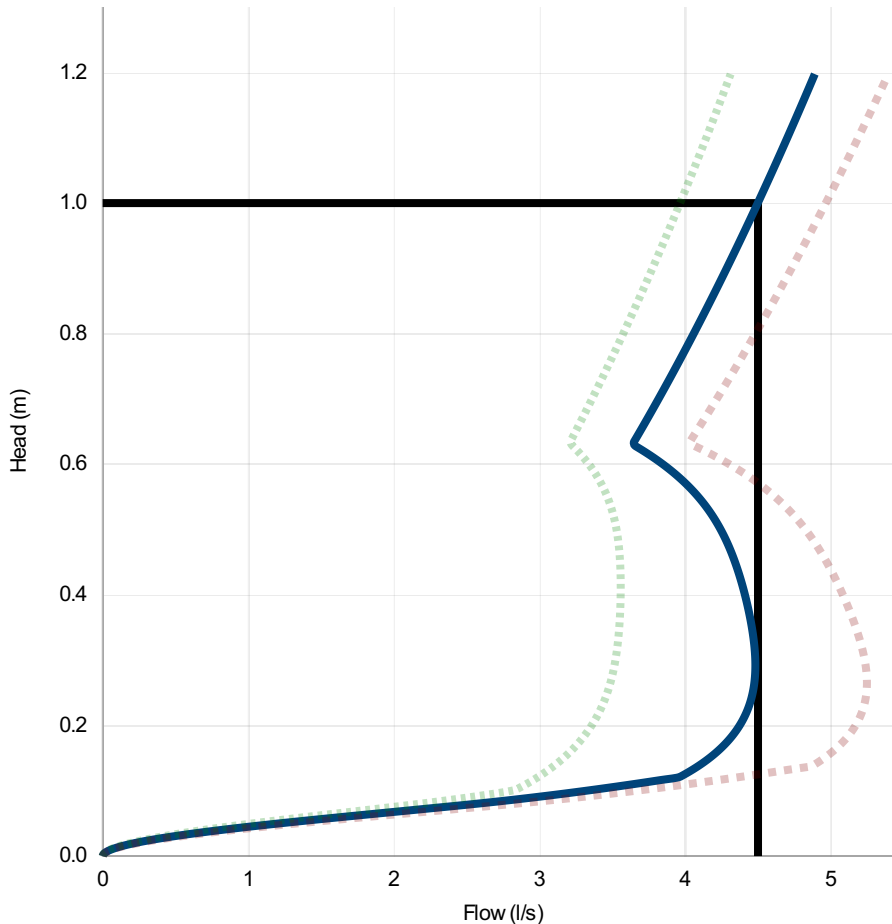
Hydro-Brake® Optimum

Technical Specification

	Original Setting		Minimum Setting		Maximum Setting	
Control Point	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
Primary Design	1.000	4.500	1.000	3.964	1.000	4.965
Flush-Flo™	0.292	4.482	0.412	3.557	0.265	5.248
Kick-Flo®	0.630	3.636	0.632	3.204	0.631	4.023
Mean Flow		3.906		3.264		4.423



hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.034	0.617
0.069	2.057
0.103	3.430
0.138	4.090
0.172	4.277
0.207	4.392
0.241	4.454
0.276	4.479
0.310	4.479
0.345	4.462
0.379	4.432
0.414	4.394
0.448	4.345
0.483	4.282
0.517	4.199
0.552	4.084
0.586	3.926
0.621	3.711
0.655	3.702
0.690	3.791
0.724	3.876
0.759	3.960
0.793	4.042
0.828	4.122
0.862	4.200
0.897	4.277
0.931	4.352
0.966	4.426
1.000	4.498

DESIGN ADVICE



The head/flow characteristics of this SHE-0100-4500-1000-4500 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro
International
A CRH COMPANY

DATE 27/04/2026 13:42

Site Royle Road

DESIGNER Paige Blundell

Ref 2885

SHE-0100-4500-1000-4500

Hydro-Brake® Optimum

Technical Specification

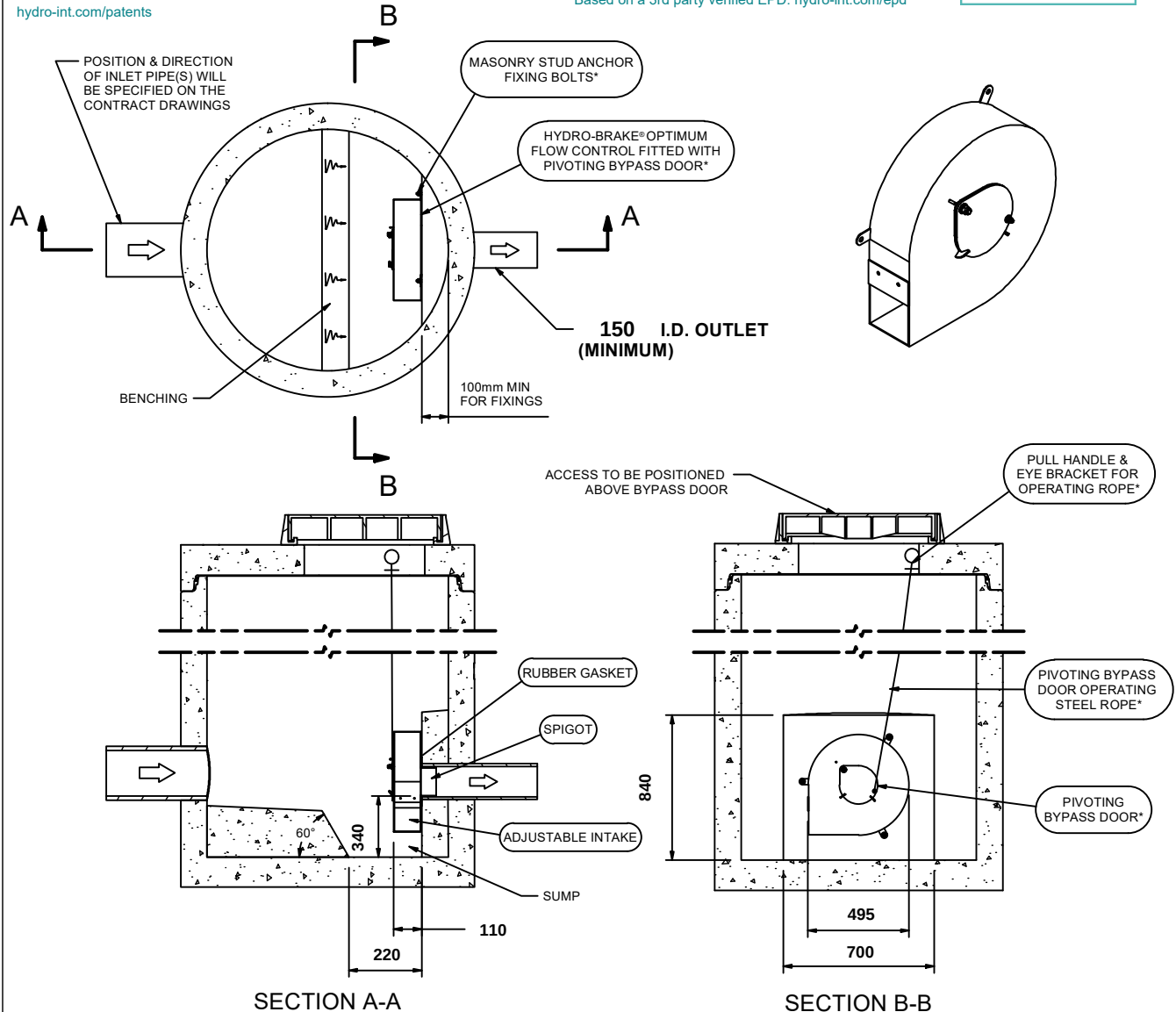
Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	4.500
Flush-Flo™	0.292	4.482
Kick-Flo®	0.630	3.636
Mean Flow		3.906

hydro-int.com/patents

This Hydro-Brake® Optimum includes:

- All in 3 mm Grade 304L stainless steel
- Integral pivoting by-pass door allowing clear line of sight through to outlet, c/w operating rope
- Media blasted for corrosion resistance
- Variable flow rate post installation via adjustable inlet (if necessary)
- Indicative Weight: 15 kg
- Product Carbon Footprint: 58.35 kgCO2e

Based on a 3rd party verified EPD: hydro-int.com/epd



IMPORTANT: ○ LIMIT OF HYDRO INTERNATIONAL SUPPLY
 THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
 FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
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Hydro International
 A CRH COMPANY

DATE	27/04/2026 13:42	SHE-0100-4500-1000-4500 Hydro-Brake® Optimum
SITE	Royle Road	
DESIGNER	Paige Blundell	
REF	2885	