Consulting

Geotechnical Design Report

M11 Junction 6 Site B

Highway Agency

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Executive Summary

Defects have been identified along the M11 between Junction 6 and Junction 9 including north of Junction 6 on earthwork numbers 6_M11_2238 & 2239 (as recorded on HAGDMS). These sections have been named Junction 6 Site B. This Geotechnical Design Report (GDR) presents the findings of the detailed design, undertaken by Amey for the permanent remedial Works.

The site can be divided into four sections (Sections B1, B2, B3 and B4) based on Class 1A geotechnical defects recorded on HAGDMS over a length of 430m. A walkover of the defects was undertaken by Atkins in May 2012 and a more recent inspection was undertaken by Amey personnel in August 2014. These defects are recorded on HAGDMS as 6_M11_2238_507510, 6_M11_2238_5444277, 6_M11_2238_544278 and 6_M11_2239_438109.

A Preliminary Sources Study Report (PSSR) and a Ground Investigation Report (GIR) were produced for this scheme previously by Atkins.

Possible remedial measures were considered in the GIR for mitigation of the identified geotechnical defects. The preferred solution devised as part of this GDR involves the following for Sections B1, B2, B3 and B4:

- Prevention of carriageway run-off onto the embankment slope face and reduce water content in Embankment Fill by restoring existing drainage assets;
- Replace embankment soil materials with imported Class 1A granular materials (imported materials will need to be benched in with a geotextile separator layer used at the boundary between existing and imported material); and
- Topsoiling and seeding on replaced embankment materials.
- Replacement of existing vehicle restraint system and resurfacing of hardshouder where required.

Slope stability of the proposed remedial solutions was assessed using the software SLOPE/W.

Earthworks specifications for the proposed solution are included within this GDR.

Contents

1 Introduction

1.1 Scope and Objective of Report

Atkins were commissioned by the Area 6 Managing Agent Contractor Skanska, on behalf of the Highways Agency (HA), to undertake geotechnical studies for the embankment slope defects located at the M11 Junction 6 Site B site.

In accordance with the requirements for Maintenance of Highways Geotechnical Assets HD41/03 [Ref 1], Atkins initially undertook Principal Geotechnical Inspections in April 2005, May 2009 and February 2010. Atkins then undertook a desk study of the area and issued a Preliminary Sources Study Report (PSSR) [Ref 2] in January 2011. Following the PSSR Atkins designed and commissioned a scheme specific ground investigation to investigate the earthworks defects identified during the Principal Geotechnical Inspections. The ground investigation was carried out by Nicholls Colton between the 24th January and the 4th February 2011. A final factual report was issued in May 2012 [Ref 3]. In accordance with HD 22/08 [Ref 4] the requirements to the end of Key Stage 2 were completed with the issue of the Ground Investigation Report (GIR) in July 2012 [Ref 5].

Amey have been commissioned by the HA to undertake the detailed design of the slope remediation at this site based on the information provided by the previous Area 6 Contractor. This Geotechnical Design Report (GDR) provides the information for Key Stage 3 of the Geotechnical Certification procedure according to HD 22/08 [Ref 4]. This report presents the results of the review of previous designs and the resultant detailed design undertaken by Amey.

1.2 Site Description

1.2.1 Site Location

Site B is located along the northbound carriageway of the M11 motorway approximately 1km north of Junction 6 and extends between marker posts 24/6A and 25/2A along 430m length of earthworks.

The construction of this part of the M11 dates to 1977 according to the Highways Agency Geotechnical Data Management System (HAGDMS) [Ref 6]. As recorded in the Atkins GIR [Ref 5], the M11 was originally two lanes with a hard shoulder constructed using jointed unreinforced concrete and during the 1980's the northbound and southbound carriageways were widened by the addition of a fully flexible hard shoulder. No 'As Built' drawings were available for this section of the M11 for preparation of this GDR.

1.2.2 Geotechnical Defects

Geotechnical defects, recorded on HAGDMS [Ref 6] were identified along the M11 between Junction 6 and Junction 9 including north of Junction 6 on earthwork numbers 6_M11_2238 & 2239 which have been named Site B. In accordance with HD22/08 [Ref 4] these defects are identified as Geotechnical Classification Category 2 (Class 1A).

The site can be divided into four sections (Sections B1, B2, B3 and B4) based on these Class 1A geotechnical defects recorded on HAGDMS [Ref 6]. A walkover of the defects was undertaken by Atkins in May 2012 and a more recent inspection was undertaken by Amey personnel in August 2014 and again as part of Principal Inspections in November 2014. Table 1.1 shows the geotechnical defects present on site as recorded on HAGDMS [Ref 6].

Table 1.1: Geotechnical defects as recorded on HAGDMS [Ref 6]

HAGDMS Reference	Geometry	Description	Features	Risk Level Now	Risk Level in 5 Years
6_M11_2238 _507510 [02/05/2012] Section B1	21m length, 22° slope angle, 4.5m high	"15m wide well developed soil slip. Tension crack between concrete verge and kerb, 40cm backscarp, tension cracking and undermining of safety fence foundation, well defined 40cm high toe bulge."	Subsidence, slip, toe debris, tension cracks, dislocated fence/barrier/ kerb	Class 1A, Loc. Index B, Risk Level Severe	Class 1A, Loc. Index B, Risk Level High
6_M11_2238 _5444277 [15/08/2014] Section B2	82m length, 15-17° slope angle, 8.3-8.9m high	"Tension crack between concrete verge and kerb, safety fence foundations and embankment fill [subs of comms trench?]. Earthwork slope heavily vegetated. Drainage defects at crest leading to surface run off eroding material at crest. Varioguard in place."	Subsidence, tension cracks, hydro vegetation, dislocated fence/barrier/ kerb	Class 1A, Loc. Index B, Risk Level Severe	Class 1A, Loc. Index B, Risk Level High

Table 1.1: Geotechnical defects as recorded on HAGDMS [Ref 6]					
HAGDMS Reference	**Geometry**	**Description**	**Features**	**Risk Level Now**	**Risk Level in 5 Years**
6_M11_2238 _544278 [15/08/2014] Section B3	90m length, 17° slope angle, 8.8m high	"Major tension cracking, max 50mm dilation between concrete verge and kerb, max 150mm dilation between soil of embankment and VRS foundations. Earthwork slope heavily vegetated. Drainage defects at crest leading to surface run off eroding material at crest. Varioguard."	Subsidence, tension cracks, dislocated fence/barrier/ kerb	Class 1A, Loc. Index B, Risk Level Severe	Class 1A, Loc. Index B, Risk Level High
6_M11_2239 _438109 [02/05/2012] Section B4	38m length, 19° slope angle, 5.9m high	"27m long tension crack and back scarp with a max height of 20cm. Lower half of slope affected by rilling and water erosion. Toe bulge not yet evident."	Tension cracks, erosion	Class 1A, Loc. Index B, Risk Level Severe	Class 1A, Loc. Index B, Risk Level High

1.2.3 Earthworks

A recent topographic survey, undertaken for Site B as part of the detailed design for Sections B3 and B4 indicated a differing geometry than that recorded on HAGDMS [Ref 6] and in the topographic survey mentioned in the Atkins GIR. The remedial works design will be based on the most recent topographical survey for Sections B3 and B4. For Sections B1 and B2, the topographic survey from the Atkins GIR will be used as the most recent survey was unable to pick out the embankment slope through dense vegetation. The measured geometry and section designations on the embankment slope at the location of the Class 1A defects are as shown in Table 1.2.

Table 1.2: Earthworks Geometry					
HAGDMS Reference	**Report Section**	**Slope Elevations**	**Maximum Slope Height**	**Average slope angle**	**Chainage (m)**
6_M11_2238 _507510	B1	At toe 44.81m AOD At crest 48.787m AOD	3.98m	21° (approx. 1V:2.6H)	580 to 655
6_M11_2238 _544277	B2	At toe 44.11m AOD At crest 50.28m AOD	6.17m	19° (approx. 1V:2.9H)	445 to 535
6_M11_2238 _507511	B3	At toe 46.53m AOD At crest 52.80m AOD	6.27m	19.5° (approx. 1V:2.8H)	350 to 445
6_M11_2239 _438109	B4	At toe 47.94m AOD At crest 53.74m AOD	5.80m	18° (approx. 1V:3H)	200 to 265

1.2.4 Drainage

Observations made during a CCTV drainage survey, undertaken as part of the ground investigation in 2011, appear to show that the drainage is not working effectively. The CCTV survey did not complete Site B and records that the "drainage north of the Green Road underbridge was found to be waterlogged, the camera was flooded and the survey abandoned". 'Green Road' is thought to refer to Stewards Green Road which becomes Mount Street and passes underneath the M11 between the two earthworks of Site B.

During principal inspections of earthworks along the M11 by Amey in November 2014, it was observed that the culvert present between Section B1 and B2 was blocked and overflowing. As a result, it is anticipated that Embankment Fill moisture contents will be locally elevated in close proximity of these culverts.

1.2.5 Earthworks Condition

Resurfacing of the M11 has evidently been undertaken at this location. Any resurfacing has not been carried out in conjunction with raising of the kerbs thus decreasing the effectiveness of the drainage. The existing failure movements are likely to continue given the poor state of the highway drainage. The probability of the continued failure impacting on the carriageway is considered likely. In addition, loss of drainage integrity due to undermining by slope movement is anticipated, which may accelerate the on-going movement.

Localised back scarps generally 0.4m in height (1.0m in one location) adjacent to the safety barrier foundation have removed lateral support. Further loss of support and settlement may be expected as slope movement continues. Varioguard has been installed to reduce the short term risk and protect the defective safety barrier.

Existing pavement subsidence and dilation between road surface and kerb are likely to continue with further deterioration of the embankment slope.

1.2.6 Site Structures

Garnon Brook culvert (structure number M11/24.80/Q, structure ID3018) crosses the carriageway at the southern end of Site B and carries a stream which flows in a northwest to southeast direction, running roughly perpendicular to the M11 road-side embankments. Thornhill relieving arch (structure number M11/24.70/Q, structure ID3017) crosses the M11 embankments approximately 80m south of Garnon Brook Culvert. It was identified during Principal Inspections by Amey personnel in November 2014 that this culvert is currently blocked and overflowing; repair of the culvert is required as part of the proposed remedial works.

Mount Street underbridge (structure number M11/24.90, structure ID3019) is located approximately at the centre of Site B. Fiddlers relieving arch (structure number M11/25.10/Q, structure ID3020) crosses the M11 embankment approximately 180m north of Mount Street underbridge.

2 Review of Existing Information

2.1 Ground Conditions

A summary of the existing conditions on site is provided in Table 2.1 below. An exploratory hole location plan combined with indicative geological long sections for this site are included as Drawing Nos. HA537529-AMEY-GE-DR-001 and HA537529-AMEY-GE-DR-002.

Table 2.1: Ground Conditions Summary for overall site

Stratum	General Description	Top of Stratum	Base of Stratum	Thickness
Topsoil	Soft to stiff slightly gravelly CLAY	0mbgl 44.07 to 49.59mAOD	0.15 to 0.60mbgl 43.87 to 49.34mAOD	0.15 to 0.60m
Made Ground	Gravelly fine to coarse SAND or sandy fine to coarse GRAVEL	0mbgl 48.75 to 55.65mAOD	0.64 to 1.60mbgl 47.65 to 54.65mAOD	0.30 to 1.60m
Embankment Fill	Soft to very stiff sometimes slightly sandy sometimes slightly gravelly SILT and/or CLAY	0 to 1.60mbgl 43.87 to 54.65mAOD	1.20* to 7.20mbgl 42.87* to 50.65mAOD	0.60* to 6.10m
Glacial Till	Firm and stiff slightly gravelly CLAY	0.15 to 7.20mbgl 42.96 to 50.65mAOD	1.20* to 12.00mbgl 35.19 to 49.20*mAOD	0.70* to 8.84m
London Clay	Stiff and very stiff CLAY	4.70 to 12.00mbgl 35.19 to 50.00mAOD	6.45* to 19.80*mbgl 24.38* to 48.55*mAOD	1.05* to 15.39*m

Notes

* Full depth of strata not penetrated

bgl = below ground level, AOD = Above Ordnance Datum

No groundwater was encountered during the ground investigation, but groundwater monitoring determined the presence of groundwater beneath the base of the embankments within boreholes B-BH1, B-BH2 and B-BH3. From the groundwater monitoring information, the following groundwater levels are applied for the ground model:

- Section B1 (B-BH1) 42.77mAOD;
- Sections B2 and B3 (B-BH2) 42.38mAOD; and
- Section B4 (B-BH3) 45.41mAOD.

2.2 Characteristic Geotechnical Parameters

The characteristic geotechnical parameters derived in the Atkins GIR [Ref 5] are reproduced as Table 2.2 below.

Table 2.2: Site B Soil Parameters					
Stratum	γ_{bulk} **(kN/m^3)**	**Φ' (°)**	**c' (kN/m^2)**	**c_u (kN/m^2)**	**r_u**
Embankment Fill	19	22	0.5	59	0.35 to 0.40
Glacial Till	20	21.5	1	90	Not given
London Clay	20	21	1	106	Not given

Notes

γ_{bulk} = bulk unit weight, **Φ'** = peak effective angle of shearing resistance, **c'** = peak effective cohesion, c_u = undrained shear strength, r_u = pore pressure ratio

These characteristic geotechnical parameters have been checked against published literature and relevant standards for consistency as part of this GDR.

Bulk unit weight and effective angle of shearing resistance correlate with guidance in BS8002 [Ref 7]. A cohesion of 1kN/m^2 for the natural strata is considered appropriate given the inherent plasticity within the Glacial Till and London Clay. A reduced cohesion of 0.5kN/m^2 is considered appropriate for the Embankment Fill considering it is a reworked equivalent of the underlying natural strata.

Shear strength (c_u) is based on correlations between SPT 'N' values and plasticity index results demonstrated by Stroud 1989 [Ref 8].

The following plots have been produced as part of this report and are based on the recent ground investigation outlined in the Atkins GIR [Ref 2]:

- Plots of moisture content against both elevation and depth below carriageway are presented as Figures 1 and 2 respectively.
- Plots of plasticity index against both elevation and depth below carriageways are presented as Figures 3 and 4 respectively.
- A plot of Atterberg limits is presented as Figure 5.
- Plots of SPT 'N' values against both elevation and depth below carriageway are presented as Figures 6 and 7 respectively.
- Plots of c_u against both elevation and depth below carriageway are presented as Figures 8 and 9 respectively. As a conservative approach, hand shear vane results were excluded as part of this analysis as these results were generally in excess of expected c_u values for the present ground conditions.
- A Particle Size Distribution (PSD) plot is presented as Figure 10 to demonstrate the typical composition of the materials encountered during the ground investigation.

Characteristic geotechnical design parameters derived by Atkins in their GIR [Ref 5] generally correlate well with the plots included as part of this GDR.

Based on ground investigation observations, the Embankment Fill is considered to have a high moisture content from surface water infiltration during periods of continued heavy rainfall. r_u values chosen by Atkins appear higher than those anticipated. However, the back analysis undertaken by Atkins to create a Factor of Safety close to (but still below) 1.00 shows that such high r_u values are required to replicate the current slope movement observed within the embankment. The back analysis undertaken by Atkins and replicated by Amey is presented and discussed further in Section 2.3.

Examination of moisture content and plasticity plots (Figures 1 to 5) show that, for design purposes, the 'wet' conditions observed for the Embankment Fill generally penetrates throughout the embankment as a whole and continues into the natural underlying strata. Therefore, an r_u value of 0.25 (derived in the back analysis in Section 2.3) is assigned for both the Embankment Fill as a whole and and the underlying natural strata.

2.3 Back Analysis

Back analysis of the existing slope stability was undertaken to check that the selected geotechnical parameters and ground model were suitable. Back analysis used fixed (as opposed to varying) geotechnical parameters to enable derivation of a realistic r_u value for the Embankment Fill and underlying strata.

2.3.1 Back Analysis Methodology

The back analysis of the existing slope stability adopts the principles of limit equilibrium using the software SLOPE/W to consider global stability adopting the Morgenstern-Price method of slices.

A uniformly distributed loading (UDL) based on Highways Agency BD37/01 [Ref 9] of 5kN/m^2 was applied across the soft verge to simulate loading from maintenance, emergency vehicles or a series of parked cars. A UDL of 10kN/m^2 was applied across the hardshoulder.

2.3.2 Previous Back Analysis Results

A back analysis undertaken by Atkins [Ref 5] used a selection of variables within the Embankment Fill to derive a Factor of Safety close to 1.00 (angle of shearing resistance, coefficient of pore water pressure and drained cohesion being the variables). Table 2.3 below reproduces the back analysis results produced by Atkins.

Table 2.3: Atkins GIR Back Analysis Results				
Φ′ (°)	**c' (kN/m²)**	**r_u**	**Factor of Safety**	**Comment**
22	0.5	0.35	0.96	Entry at crest, exit at toe
22	0	0	1.21	Factor of Safety too high
		0.2	0.94	Entry at crest, exit at toe
	2	0.2	1.22	Factor of Safety too high
		0.3	1.07	Factor of Safety too high
		0.35	1.01	Good entry geometry
		0.4	0.92	Factor of Safety too low
	3	0.4	1.03	Good entry geometry
	4	0.4	1.03	Entry too far beyond crest
24	0	0.2	1.03	Shallow slip
		0.3	0.88	Factor of Safety too low
	2	0.3	1.13	Factor of Safety too high
		0.4	0.97	Good entry geometry
26	0	0.2	1.13	Factor of Safety too high
		0.3	0.97	Shallow slip
23	2	0.35	1.02	Good entry geometry

Notes

Results which gave the closest match to the surveyed slip geometry and a factor of safety close to 1.0 (±0.05) are highlighted in red.

Φ' = peak effective angle of shearing resistance, **c'** = peak effective cohesion, **r_u** = pore pressure ratio.

These results demonstrate that an elevated r_u is required to recreate failed embankment conditions with a Factor of Safety close to ≤1.00. These back analysis results have a number of parameters used as variables to derive a suitable Factor of Safety. The geotechnical parameters derived by Atkins from their back analysis are included as Table 2.2.

2.3.3 Additional Back Analysis Results

Additional back analysis was undertaken by Amey with cohesion and angle of shearing resistance as fixed values and embankment r_u values as the variables. An embankment with the maximum recorded height of 6.3m and a typical slope angle of 19° was used as the ground model for this back analysis. The soil parameters (except for r_u) used are summarised in Table 2.2 of this report. Based on moisture content values recorded from the ground investigation laboratory testing (see Figures 1, 2 and 5), it is considered that there is an elevated r_u value present throughout the embankment and within the immediate underlying natural strata. This was modelled using SLOPE/W and is summarised in Table 2.4 below. This initial Amey back analysis model is presented as Figure 11.

Table 2.4: Amey GDR Back Analysis (Initial Model)		
r_u of Embankment Fill	**Factor of Safety**	**Comment**
0.10	1.152	FoS too high
0.15	1.084	FoS too high
0.20	1.017	FoS too high
0.25	0.949	FoS closest to (and less than) 1.00
0.30	0.882	FoS too low

Notes

The result which gave the closest match to the surveyed slip geometry and a factor of safety close to but lower than 1.00 is highlighted in red.

Based on ground investigation and recent walkover observations it is considered that the Embankment Fill has an elevated moisture content resulting from overflowing surface waters during periods of continued heavy rainfall. Therefore, Embankment Fill is assigned an elevated r_u for materials within 2m of ground surface. Table 2.5 below summarises the results of the back analysis.

Table 2.5: Amey GDR Back Analysis (Revised Model)			
r_u (0 to 2mbgl)	**r_u (>2mbgl)**	**Factor of Safety**	**Comment**
0.15	0.10	1.089	FoS too high
r_u (0 to 2mbgl)	**r_u (>2mbgl)**	**Factor of Safety**	**Comment**
0.20	0.10	1.024	FoS too high
	0.15	1.024	FoS too high
r_u (0 to 2mbgl)	**r_u (>2mbgl)**	**Factor of Safety**	**Comment**
0.25	0.10	0.959	FoS closest to (and less than) 1.00
	0.15	0.959	FoS closest to (and less than) 1.00
	0.20	0.959	FoS closest to (and less than) 1.00
r_u (0 to 2mbgl)	**r_u (>2mbgl)**	**Factor of Safety**	**Comment**
0.30	0.10	0.892	FoS too low
	0.15	0.892	FoS too low
	0.20	0.892	FoS too low
	0.25	0.892	FoS too low

Notes

FoS = Factor of Safety

Results which give the closest match to the surveyed slip geometry and anticipated Factor of Safety are highlighted in red.

The additional Amey back analysis for an r_u of 0.25 in 0 to 2mbgl Embankment Fill is presented as Figure 12. These additional back analyses demonstrate that the cause of slope movement is reflective of elevated r_u values in the Embankment Fill.

2.4 Preferred Solution

As evident from the back analysis, the major factor in slope movement is the pore water pressure regime. Elevated water content within the Embankment Fill is likely to have been caused by carriageway surface water run-off infiltrating the embankment and causing saturation and softening of materials. Elevated water conditions are therefore likely to have caused soil failure within the upper section of the embankment slope. The preferred remedial solution for the observed geotechnical defects would be to prevent further water ingress into the embankment and to restore the failed slope by the following means:

- Prevention of carriageway run-off onto the embankment slope face and reduce water content in Embankment Fill by restoring existing drainage assets and installing new drainage assets where none are present (as required). A CCTV drainage survey is required to determine the current condition of existing drainage assets and repair where necessary. Repair of Garnon Brook Culvert is also required as part of this works;
- Replace embankment soil materials with imported Class 1A granular materials as shown in Drawing No. HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005 (imported materials will need to be benched in with a geotextile separator layer used at the boundary between existing and imported material);
- Topsoiling and seeding on replaced upper embankment slope face and soft verge; and
- Replacement of existing vehicle restraint system and resurfacing of hardshouder where required.

Drawing No. HA537529-AMEY-GE-DR-003 to 005 shows details of the proposed remedial solution. The extents of the proposed remedial works are based around the extents of the observed geotechnical defects (refer to Drawing No. HA537529-AMEY-GE-DR-001 and HA537529-AMEY-GE-DR-002). It is proposed that the entire length of earthworks that encompass these defects are treated. This is considered necessary as the defects are closely spaced and the embankment profile is seen to be consistent between observed geotechnical defects as seen in the topographic surveys.

2.5 Remedial Options Study

Possible remedial measures were considered in the GIR [Ref 5] for mitigation of the identified geotechnical hazards. Proposed measures are summarised in Table 2.6 below, with a 'repair/restore embankment' option added as the preferred option by Amey.

Table 2.6: Remedial Options Study			
Risk Control Strategy	**Measures**	**Comment**	**Cost (1 Low – 5 High)**
Do Minimum	Install temporary Varioguard barrier. Continue visual inspections.	The slope will continue to fail in the long term.	1
Monitor Slopes	Install Inclinometers. Monitor movements and standpipe water levels. Maintain Varioguard barriers.	Gives early warning of further slope movements. Provides more data for eventual remediation.	2
Repair/Restore Embankment (Preferred)	Carry out a CCTV survey to determine condition of existing drainage assets and repair or install where necessary. Replace embankment materials with imported granular fill. Replace Varioguard with permanent VRS. Topsoiling and seeding of newly placed fill materials.	Remediates cause of slope movement. Tree clearance required. Some disruption to network.	3
Strengthen Slope	Install soil nails. Reconstruct top 0.5 to 1.0m of verge and/or pavement and restore slope profile. Renovate highway drainage including cross carriageway and central reserve drainage.	Tree clearance required. Disruption to network. The necessity of slope strengthening measures is not able to be proven.	4
Wholesale Embankment Reconstruction	Rebuild slope (dig out and replace) to give full crest width and acceptable Factor of Safety against slip failure. Reconstruct top 1-2m of verge and/or pavement. Renovate highway drainage.	Tree clearance required. Large volume of import/export of materials. Possible requirement for wayleave agreements. May need to use reinforced soil or retaining wall to avoid land take. Disruption to network. The necessity of wholesale embankment reconstruction is not able to be proven.	5

3 Earthworks

3.1 Cutting Stability

Cuttings do not form part of the works.

3.2 Embankment Stability

3.2.1 Design Methodology

Slope stability analysis of the preferred solution adopts the principles of limit equilibrium using the software SLOPE/W to consider global stability adopting the Morgenstern-Price method of slices. Design is in accordance with Eurocode 7 (EC7) [Ref 10] following Design Approach 1 Combination 2 (DA1 C2) adopting the partial factor method to achieve a Factor of Safety of 1.0 (considered representative of the current conditions on site). The slopes were designed to the critical DA1 C2 Ultimate Limit State (ULS) case. The EC7 partial factors for soil parameters adopted are summarised in Tables 3.1 and 3.2 below.

Table 3.1: EC7 Partial Factors for Soil Parameters

Soil Parameter	**ULS DA1 C2**
Effective angle of shear resistance, tan Φ'	1.25
Effective cohesion, c'	1.25
Undrained cohesion, c_u	1.4
Soil weight, γ	1.0
Surcharge	1.3
Groundwater Level	Highest recorded level

Table 3.2: Factored Characteristic Geotechnical Design Parameters

Stratum	γ_{bulk} **(kN/m^3)**		Φ' **(°)**		**c' (kN/m²)**		r_u
	C1	**C2**	**C1**	**C2**	**C1**	**C2**	
Imported Granular Fill	19	19	36	28.8	0	0	0.1
Embankment Fill	19	19	22	17.6	0.5	0.4	0.25
Glacial Till	20	20	21.5	17.2	1	0.8	0.25

Notes

γ_{bulk} = bulk unit weight, Φ' = peak effective angle of shearing resistance, c' = peak effective cohesion, r_u = pore pressure ratio

The sections used for design are based on the following topographic cross-sections:

- Embankment approximately 4m high, Chainage -100m, Drawing No. HA537529-AMEY-GE-DR -001 and 003;
- Embankment approximately 5m high, Chainage 350m, Drawing No. HA537529-AMEY-GE-DR -001 and 004; and
- Embankment approximately 6.3m high, Chainage 150m, Drawing No. HA537529-AMEY-GE-DR-001 and 005.

A UDL based on Highways Agency BD37/01 of 5kN/m² [Ref 9] was applied across the soft verge to simulate loading from maintenance, emergency vehicles or a series of parked cars. A UDL of 10kN/m² was applied across the hardshoulder. The surcharges are factored according to EC7 [Ref 10] as shown in Table 3.3 below.

Table 3.3: EC7 Partial Factors on Actions

Load Parameter		**ULS DA1 C2**
Variable	Unfavourable	1.3
Soft verge surcharge		5 x 1.3 = 6.5kN/m²
Traffic loading across carriageway		10 x 1.3 = 13kN/m²

3.2.2 Design Results

Figures 13 to 15 demonstrates the SLOPE/W output achieved when the above design for drainage restoration/enhancement and slope restoration is implemented for embankments of 4m height, 5m height and 6.3m height. The spread of embankment heights along the site is shown in Drawing No. HA537529-AMEY-GE-DR-001 and 002.

The following design results were produced:

- Embankment height approximately 4m – Factor of Safety >1.00 (1.01) when 1m of embankment slope and toe and 1.5m of embankment verge is replaced with imported Class 1A Granular material (see Figure 13 and Drawing No. HA537529-AMEY-GE-DR-003);
- Embankment height approximately 5m – Factor of Safety >1.00 (1.03) when 1.5m depth of embankment slope and verge is replaced with imported Class 1A Granular material (see Figure 14 and Drawing No. HA537529-AMEY-GE-DR-004); and
- Embankment height approximately 6.3m – Factor of Safety >1.00 (1.04) when 2m depth of embankment verge and 1.5m of embankment slope and toe is replaced with imported Class 1A Granular material (see Figure 15 and Drawing No. HA537529-AMEY-GE-DR-005).

A category 2 check has been undertaken by a different Amey geotechnical design team.

3.3 Re-use of Materials

Stripped Topsoil Class 5A is unlikely to be encountered on site due to washout, slope movement and 'wetting' of surface materials. Class 5B imported Topsoil will be required for the proposed remedial option, as shown in Drawing No. HA537529-AMEY-GE-DR-003 to HA537529-AMEY-GE-DR-005.

The excavated Embankment Fill and Topsoil materials are to be exported off site.

4 Highway Structures

4.1 Details of Highways Structures

The locations of highways structures within the scheme extents are shown in Drawing No. HA537529-AMEY-GE-DR-001 and HA537529-AMEY-GE-DR-002.

Excavation of existing material and deposition and compaction of imported Class 1A granular material is proposed on both sides and over the top of the relieving arch (Section B1), on both sides of the Garnon Brook culvert (Section B2) and on both sides of Mount Street overbridge (Section B4 and Section B3). The Contractor shall obtain sufficient information about the relieving arch culverts to allow suitable plant weight selection and weight restriction zones as required. Design of works to ensure highways structures are not damaged by proposed remedial works will be the responsibility of the Contractor.

5 Strengthened Earthwork

Not Used.

6 Drainage

A previous CCTV drainage survey for this scheme was abandoned (see Section 1.2) but indicated that at least one section of the surface water carrier drain was water-logged and defective.

As displayed on Highways Agency Drainage Data Management System (HADDMS) [Ref 11], there is drainage pipework present within the upper slope sections for all Sections of Site B, drainage ditches present at the toe of Sections B1 and B2 and filter drains present at the crest of Sections B1 and B2.

Full inspection and repair/remediation of the existing drainage is required as part of the remedial solution..

The carrier drain should be exposed and cleaned out/repaired or replaced as required during these works. The cross carriageway and central reservation drainage assets should also be checked and cleaned out as required.

Repair of Garnon Brook Culvert is also required as part of these remedial works.

The design of drainage remedial works and culvert repair do not form part of the geotechnical design but will be undertaken as part of the main works.

7 Pavement Design, Subgrade and Capping

Pavement design does not form part of this GDR.

8 Assessment of Potential Contamination

It has been reported that there was no visual or olfactory evidence of contaminated material present during the ground investigation [Ref 5]. Contamination may still be present on site and appropriate measures for detecting contamination and control of contamination are included in the specification, presented as Annex 1. Excavation of earthworks materials as part of the remedial works will result in waste which requires Waste Acceptance Criteria (WAC) testing to be performed for exportation off site and disposal.

9 Ground Treatment Including Treatment of Underground Voids Etc.

Not used.

10 Specification Appendices

Series 100 and 600 specification appendices are presented in Annex 1.

11 Instrumentation and Monitoring

Not used.

12 References

1. Highway Agency, 2003, Geotechnics and drainage. Earthworks. Maintenance of highway geotechnical assets HD41/03 Volume 4;
2. HAGDMS report no. 26140. January 2011. MAC Contract – Area 6, M11 J6 to J9 Earthwork Defects. Preliminary sources Study Report. Atkins;
3. HAGDMS report no. 27641. May 2012. MAC Contract – Area 6, M11 J6 to J9 Earthwork Defect Investigation. Ground Investigation Factual Report. Nicholls Colton;
4. Design Manual for Roads and Bridges (DMRB) Volume 4 Section 1 Part 1 HD22/08. Geotechnics and Drainage. Earthworks. Managing Geotechnical Risk;
5. HAGDMS report no. 27118. July 2012. MAC Contract – Area 6, M11 Junction 6-9 Earthwork Defects. Ground Investigation Report. Atkins;
6. Highways Agency Geotechnical Data Management System. www.hagdms.com [Accessed 12th December 2014];
7. BS8002: 1994, British Standard. Code of practice for earth retaining structures;
8. Stroud, M.A. 1989. The Standard Penetration Test – its application and interpretation. Proc ICE Conf. on Penetration Testing in the UK. Birmingham. Thomas Telford, London;
9. Highways Agency, 2001, DMRB. Loads for Highways Bridges BD 37/01 Volume 1, Section 3, Part 4;
10. BS EN 1997-1: 2004, British Standard. Eurocode 7: Geotechnical Design, Part 1: General Rules; and
11. Highways Agency Drainage Data Management System. www.hagdms.com [Accessed 12th December 2014].

13 Annex 1

SERIES 100

SERIES 600

Used/Not Used	Appendix No.	Title
USED	1/5	Testing to be carried out by the Contractor
		EARTHWORKS
USED	6/1	Requirements for Acceptability and Testing etc. of Earthworks Materials
USED	6/2	Requirements for Dealing with Class U1B and Class U2 Unacceptable Materials
USED	6/3	Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction)
NOT USED	6/4	Requirements for Class 3 Material
USED	6/5	Geotextiles Used to Separate Earthworks Materials
USED	6/6	Fill to Structures and Fill Above Structural Foundations
NOT USED	6/7	Sub-formation and Capping and Preparation and Surface Treatment of Formation
USED	6/8	Topsoiling
NOT USED	6/9	Earthwork Environmental Bunds, Landscape Areas, Strengthened Embankments
NOT USED	6/10	Ground Anchorages, Crib Walling and Gabions
NOT USED	6/11	Swallow Holes and Other Naturally Occurring Cavities and Disused Mine Workings
USED	6/12	Instrumentation and Monitoring
NOT USED	6/13	Ground Improvement
USED	6/14	Limiting Values for Pollution of Controlled Waters
USED	6/15	Limiting Values for Harm to Human Health and the Environment
USED	30/5	Grass Seeding, Wildflower Seeding and Turfing

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR

NOTES

1. Unless otherwise stated, all sampling and testing in this Appendix shall be by the Contractor.

2. Tests comparable to those specified in this Appendix will be necessary for any equivalent work, goods or materials proposed by the Contractor (See sub-Clause 105.4 of the Specification for Highway Works).

3. (N) indicates that a UKAS (NAMAS) test report or certificate is required.

4. Unless otherwise shown in this Appendix tests for work, goods or materials as scheduled under any one Clause are required for all such work, goods or materials in the Works.

5. Unless otherwise shown in this Appendix test certificates for work, goods or materials as scheduled under any one Clause are required for all such work, goods or materials in the Works.

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR (CONTINUED)

Clause	Work, Goods or Material		Test	Frequency of Testing	Test Certificate	Comments
Series 600						
601 631 to 637, 640	Acceptable Material Class	General Description				
	1A	Well Graded Granular Fill	Grading/uniformity coefficient	Source testing – 2 per source Compliance testing – 1 per 1500m³	Required	
			mc/MCV (N)	Compliance testing – 1 per 1000m³		
			Effective angle of internal friction	Source testing – 2 per source Compliance testing – 1 per 2000m³		
			Optimum mc (2.5kg rammer/ vibrating hammer method) (N)	Source testing – 2 per source Compliance testing – 1 per 2000m³		
			Chemical Testing Suite (Tables 6/14 and 6/15)	Source testing – 2 per source Compliance testing – 1 per 3000m³		
			Field dry density (N) (Sand Replacement Density (SRD) or nuclear density gauge (NDG))	Compliance testing – 1 per 1000m³		
			SRD tests (if NDG used as primary density test above)	Compliance testing – 1 per every 10 NDG tests		
	5B	Imported Topsoil	BS3882 Annex E Supplier's declaration of compliance	Visual inspection of whole surface of Topsoil placed		
	U1B	Unacceptable Material	Waste Acceptance Criteria (WAC) (Table 6/7)	WAC testing – 1 per 2000m³ of excavated materials (or as required by accepting landfill)		
609 621	Geotextiles (separator layer)		Tests and testing criteria as in Appendix 6/5 and 6/9 as appropriate	Source approval through manufacturer's QA testing and provide BBA certificate		

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR (Continued)

1. As part of the provision of samples and testing undertaken by the Contractor, the Contractor shall keep a daily record of samples of goods and materials taken by or on behalf of the Contractor for testing. Records shall be in sufficient detail to record the nature and the source of goods and materials, and shall identify the locations and means of selection and sampling. A copy of the daily record shall be provided by the Contractor on the next working day for retention and use by the Overseeing Organisation.

2. Test reports and certificates shall bear suitable identification compatible with the Contractors registration of samples tested and shall indicate the edition dates of specifications used for compliance evaluation.

Additionally all test results shall be presented in accordance with the relevant testing standard and shall incorporate the following information.

i. Specimen reference;
ii. Material brief description;
iii. Manufacturer's, supplier's name or origin as appropriate;
iv. Batch reference number (proprietary material only);
v. Quantity of material;
vi. Location of material in the works;
vii. Date sampled, by whom and method used;
viii. Date(s) tested; and
ix. Results of all tests.

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING ETC. OF EARTHWORKS MATERIAL

Acceptable Limits for Fills

1. The permitted classes of construction materials are defined in the following tables:

- Table 1/5 Testing Requirements
- Table 6/1 Classification and Compaction Requirements
- Table 6/2 Grading Requirements
- Table 6/4 Method of Compaction for Fill.

2. Granular fill material shall conform to the requirements of the Manual of Contract Documents for Highway Works (MCHW), Volume 1, Series 600, Table 6/1. Granular Fill is to replace excavated earthworks materials as shown in Drawing No. HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.

3. Granular Fill shall be Class 1A to meet the minimum end specification requirements in addition to the requirements of clauses 608, 609, 612 (of Series 600 specifications for earthworks) and Table 6/1.

4. Earthwork materials to be used are stated on the Contract Drawings and acceptability limits for earthworks materials are given in Table 6/1.

5. Imported Class 5B Topsoil is to be placed on the imported granular fill sections of the earthworks as shown in Drawing No. HA537529-AMEY-GE-DR-003 to HA537529-AMEY-GE-DR-005.

6. All excavated materials will be exported off site for disposal.

Requirements for Determining Acceptability

7. The Contractor shall carry out all necessary testing as detailed in Appendix 1/5 to demonstrate the proposed materials meet the requirements of the Specification. The classification and confirmation of acceptability of earthworks materials shall be carried out by the Contractor at the point of deposition for imported materials.

8. Source approval testing is required for all imported fill materials. To obtain source approval the Contractor shall notify the Overseeing Organisation of the location of the proposed source and provide details of the proposed material including the location, supplier, material type proposed for import, volume of material available, whether it will be from a stockpile or excavation and carry out a full range of the tests and at the frequency detailed in Tables 1/5, 6/1, 6/7, 6/14 and 6/15 for the class of fill to demonstrate compliance.

9. The Overseeing Organisation may additionally request a site visit to observe the proposed source prior to providing approval of the source.

10. The Contractor shall maintain full records relating to the export or import of fill materials to the site, including the disposal of Class U materials to licensed facilities.

11. Additional classification tests may be requested by the Overseeing Organisation if the imported material or site arising materials vary significantly. Also, if in the opinion of the Overseeing Organisation, the material at the time of compaction is not of the previously determined classification or has become unacceptable (Tables 6/1, 6/7, 6/14 and 6/15), the Overseeing Organisation may require the Contractor to repeat the classification and acceptability tests given in Table 1/5. The rate of further testing required shall be sufficient to ensure the correct classification of materials taking into account the variations in their properties.

12. Any material imported shall not contain slag or burnt colliery shale. All material imported shall be tested at source for contaminants.

13. Material excavated as shown on the Contract Drawings will be removed off site or processed to render the material acceptable.

14. Prior to sampling of materials for the purpose of classification, the Contractor will give reasonable notice to the Overseeing Organisation, of the time and location of his sampling so as to afford the Overseeing Organisation an opportunity to witness the taking of any sample, and permit the Overseeing Organisation to take a joint sample to testing to confirm the results of the Contractor.

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING ETC. OF EARTHWORKS MATERIAL (CONTINUED)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL GRANULAR FILL	1	A	-	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract.	Grading	BS 1377: part 2 (on-site) BS EN 933-2 (off-site)	Table 6/2 Table 6/5	Table 6/2 Table 6/5	Table 6/4 Method 2	1	A	-
							Uniformity Coefficient	See Note 5	10	-				
							mc	BS 1377: part 2	N/A	N/A				
							MCV	Clause 632	N/A	N/A				
							omc	BS 1377: Part 4 (vibrating hammer method)	N/A	N/A				
							Bulk Density	BS 1377: Part 9	19	-				
							Effective Angle of Internal Friction (ϕ') and effective cohesion (c')	Clause 633	ϕ' = 36° c' = 0kPa	-				
							Compaction	BS 1924 / BS 1377, NDG/SRD testing	95	-				
							Soil Leachate	UK Environmental Quality Standards, The Surface Waters Regulations 1996, EU Environmental Quality Standards, COM(2006) 397 Final	Table 6/14 Table 6/15	Table 6/14 Table 6/15				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
TOPSOIL	5	B	-	Imported Topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-
WASTE	U	1	B	Unacceptable Materials	Waste	Material unacceptable for re-use on site. To be removed from site to landfill	Waste Acceptance Criteria	BS EN 12457-3	Table 6/7	Table 6/7	-	U	1	B

Footnotes to Table 6/1:

1. App = Appendix

2. Tab = Table

3. Where in the Acceptable Limits column reference is made to App 6/1, only Those properties having limits ascribed to them in Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table, Such limits shall also apply.

4. Where BS 1377: Part 2 is specified for moisture content, this shall mean BS 1377: Part 2 or BS 812: Part 3 as appropriate.

5. Uniformity coefficient is defined as the ratio of the particle diameters D_{60} to D_{10} on the particle size distribution curve, where:
   D_{60} = particle diameter at which 60% of the soil by weight is finer.
   D_{10} = particle diameter at which 10% of the soil by weight is finer.

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

1. If it becomes apparent during the works that contaminated materials are found, these should be immediately sampled and sent for laboratory testing. Disposal of these materials will be determined by the laboratory results and sent to a suitable soil washing or treatment facility or the appropriate landfill.

2. Notwithstanding the obligations under the Conditions of Contract, material suspected of being Class U2 and U1B material unsuitable for re-use on site shall be classified in accordance with 'European Waste Catalogue'.

3. In addition, where material is required to be disposed of to a Hazardous or Inert Landfill, Waste Acceptance Criteria testing shall be undertaken in accordance with the EA Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures (STWAP) Version 4.3a, December 2003, Interim Landfill waste acceptance criteria, see Table 6/7.

4. If any Class U2 material or contaminated water is encountered during excavation, the Contractor is to submit their proposals for excavation, handling, transport and disposal to the Overseeing Organisation for acceptance.

5. If any Class U2 material or contaminated water is encountered during excavation, the Contractor will obtain the agreement of the local Environmental Health Officer to his proposed arrangements for the handling and disposal of the substances described above.

6. If the Contractor deems that a Waste License Exemption is required for disposal of scaled material further to discussions with the local Environment Agency he shall be in receipt of this Exemption prior to mobilising to site. The Contractor shall notify the Overseeing Organisation of any Exemptions applied for.

Table 6/7 Interim Landfill waste acceptance criteria			
Parameter	**Inert waste landfill**	**Stable non-reactive hazardous waste in non-hazardous landfill****	**Hazardous waste landfill**
Parameters determined on the waste			
Total organic carbon (w/w%)	3%	5%	6%*
Loss on ignition			10%*
BTEX (mg kg^{-1})	6		
PCBs (7 congeners) (mg kg^{-1})	1		
Mineral oil C_{10}-C_{40}(mg kg^{-1})	500		
PAHs	To be set		
pH		>6	
Acid neutralisation capacity		To be evaluated	
Limit values (mg kg^{-1}) for compliance leaching test using BS EN 12457-3 at L/S 10 1 kg^{-1}			
As (arsenic)	0.5	2	25
Ba (barium)	20	100	300
Cd (cadmium)	0.04	1 (UK0.1) ~	5 (UK 1) ~
Cr (chromium) (total))	0.5	10	70
Cu (copper)	2	50	100
Hg (mercury)	0.01	0.2 (UK0.02)~	2 (UK0.4) ~
Mo (molybdenum)	0.5	10	30
Ni (nickel)	0.4	10	40
pB (lead)	0.5	10	50
Sb (antimony)	0.06	0.7	5
Se (selenium)	0.1	0.5	7
Zn (zinc)	4	50	200
Cl (chloride)	800	15,000	25,000
F (fluoride)	10	150	500
SO_4 (sulphate)	1,000#	20,000	50,000
Total dissolved solids (TDS)+	4,000	60,000	100,000
Phenol index	1		
Dissolved organic carbon at own pH or pH 7.5-8.0@	500	800	1,000

* Either TOC or LOI must be used for hazardous wastes

** And non-hazardous wastes deposited in the same cell

~ The lower limit values for Cd and Hg may apply within the UK (see above)

If an inert waste does not meet the SO_4 L/S10 limit, alternative limit values of 1500 mg 1^{-1} SO_4 at C_o (initial eluate from the percolation test (prEN 14405)) and 6000 mg kg^{-1} SO_4 at L/S10 (either from percolation test or batch test BS EN 12457-3), can be used to demonstrate compliance with the acceptable criteria for inert wastes.

+ The values for TDS can be used instead of the values for Cl and SO_4

@ DOC at pH 7.5-8.0 and L/S10 can be determined on eluate derived from a modified version of the pH dependence test, prEN 14429, if the limit value at own pH (BS EN 12457 eluate) is not met.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

Excavation

1. Any material which is excavated will need to be sent for off-site disposal and is subject to testing (see Appendix 1/5). Excavated material shall be removed from site by the Contractor and disposed of at a suitably licenced landfill or soil treatment facility.

2. Blasting is not permitted or required as an alternative to normal excavation.

3. Stockpiling of waste materials shall only be permitted at locations approved by the Overseeing Organisation.

4. Sections of the vehicle restraint barrier (VRS) and Varioguard are to be removed in order to allow access to undertake the proposed remedial works. The VRS will be reinstated in accordance with the works specification by the Contractor on completion of the works.

5. The Contractor shall strip the vegetation, turf and Topsoil from areas of proposed excavation. The vegetation shall be separated from the turf and Topsoil for disposal off site. The turf and Topsoil shall be stockpiled in accordance with Appendix 6/8.

Deposition

6. Acceptable earthworks material will be deposited in layers in accordance with Clause 612, Table 6/1 and Table 6/4 and the chosen compaction methods.

7. Existing slopes will be benched and graded evenly over their full width and their fullest possible extent as shown on the Contract Drawings. The Contractor will control and direct constructional plant and other vehicular traffic uniformly over them.

8. Damage by constructional plant and other vehicular traffic will be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Compaction

9. The adequacy of the extent of compaction on site will be checked and confirmed by the Overseeing Organisation.

10. Compaction shall be in accordance with Clause 612, Table 6/1 in Appendix 6/1 and Table 6/4.

11. For end-product compaction nuclear surface density gauges shall be permitted. Each instrument in use on the Contract shall be calibrated in accordance with BS 1377: Part 9.

12. If nuclear density gauges are used the Contractor shall undertake confirmatory sand replacement tests at a rate of not less than one per ten nuclear test.

13. The use of maximum particle size shall comply with sub-clause 601.13.

14. Fill interfaces shall be constructed such that drainage of the interface is towards the excavated face (see Contract Drawings).

15. Responsibility for temporary works stability and procedures will belong to the Contractor.

APPENDIX 6/4: REQUIREMENTS FOR CLASS 3 MATERIAL

Not Used.

APPENDIX 6/5: GEOTEXTILES

Materials

1. Geotextile separator layers shall be used where shown on the Contract Drawings and shall comply with Clause 609.

2. Geotextile separator layers shall have a life expectancy in excess of 100 years. The Contractor will need to obtain approval for their chosen geotextile separator layer prior to the start of the works.

3. All geotextile separator layers which are to be incorporated in the permanent works shall be BBA accredited.

4. All geotextile separator layers shall be laid and lapped in accordance with Clause 609.5 or with the manufacturers guidance whichever is the greater. Length of the securing pins shall be according to the manufacturer's guidance or 300mm whichever is the greater.

Testing Criteria

5. All geotextile separation layers shall meet the following criteria:

Property	**Acceptable Limit**	**Defined and tested in accordance with**
Mean wide width strip tensile strength	≥ 10kN/m	BS EN ISO 10319:1996
Mean CBR puncture resistance	≥ 3kN	BS EN ISO 12236:1996
Mean trapezoidal tear resistance	-	ASTM D4533
Mean AOS O_{90} pore size	> 30µm and < 180µm	BS EN ISO 12956:1999
Permeability, 5 cm head	10 $l/m^2.s$	BS EN ISO 11058:1999

6. Testing shall be as set out in Appendix 1/5.

7. The Contractor shall store samples for a minimum of 24 months.

APPENDIX 6/6: FILL TO STRUCTURES AND FILL ABOVE STRUCTURAL FOUNDATIONS

Highways Structures

1. The locations of highways structures within the scheme extents are shown in Drawing No. HA537529-AMEY-GE-DR-001 and HA537529-AMEY-GE-DR-002.

2. Excavation of existing material and deposition and compaction of imported Class 1A granular material is proposed on both sides and over the top of the relieving arch (Section B1), on both sides of the Garnon Brook culvert (Section B2) and on both sides of Mount Street overbridge (Section B4 and Section B3).

3. The Contractor shall obtain sufficient information about the relieving arch culverts to allow suitable plant weight selection and weight restriction zones as required. Design of works to ensure highways structures are not damaged by proposed remedial works will be the responsibility of the Contractor.

APPENDIX 6/7: SUB-FORMATION AND CAPPING AND PREPARATION AND SURFACE TREATMENT OF FORMATION

Not used.

APPENDIX 6/8: TOPSOILING

Topsoil

1. Following compaction of the imported granular fill materials, Topsoil is to be placed in accordance with the Contract Drawings and the Specification for Highway Works.

2. Vegetation will be stripped from areas of proposed remedial works.

3. Class 5B imported Topsoil will be placed as a covering layer over the top of the imported Class 1A granular fill material with a minimum thickness of 100mm.

4. The reference period of time for when Topsoil can be stockpiled is to be in accordance with sub-clause 602.10 of the Specification for Highways Works.

5. The requirement of Clause 618.3 will apply.

6. The Contractor will prevent imported Topsoil from being compacted, becoming adulterated with subsoil, rubbish, stone or hardcore, being contaminated with petrol, lime, cement or other injurious substances. The contractor will remove from site any adulterated or contaminated Topsoil as necessary.

7. The earthworks outline will be graded to smooth flowing contours to achieve tolerances specified for the finished level of Topsoil. All stone, wood and other hard material over 50mm in any dimension will be removed.

8. Surplus Topsoil is to be disposed of by the Contractor.

9. Multiple handling of Topsoil must be minimised.

10. Newly laid Topsoil shall be grass seeded as per Appendix 30/5 of this Specification.

11. A tracked excavator positioned on the hardshoulder may be used to spread imported Class 5B Topsoil. No tracked plant is to traffic across the imported Class 5B Topsoil.

Invasive Species

12. Attention is drawn to Section 14.2 of the Wildlife and Countryside Act 1981, which prohibits deposition of any plant material from any non-native invasive species listed in Part 2 of the Schedule 9 of the Act (e.g.) Giant Hogweed or Japanese Knotweed.

Grass and Wildflower Seed

13. The seed mix will contain grass wildflower seeds and shall be suitable for the local conditions, the sensitivity of the site, any impact on land uses surrounding the site and the occupier's requirements.

14. Grass seed within the seed mix shall be a tested blend of named varieties, and certificates of purity and germination shall be provided. The grass seed mix may be selected from Highways Agency DMRB 67/93 or accepted best practice source document (e.g.) CIRIA C708 for a predominantly dry site subject to periodic saturation.

15. The resulting grass coverage shall form a dense, even, tightly knit turf established after two growing seasons. The resulting grass coverage shall provide root reinforcement and soil restraint to resist erosion by occasional excessive run-off water events across the cutting slope.

16. The wildflower seed within the seed mix may contain both annual and perennial wildflowers. The wildflower seed shall be scattered at the appropriate time of year and watered according to the supplier's recommendation.

17. The seed mix shall be watered to achieve the germination and establishment noted in C/8.1 to C/8.4 above and hydroseeding may be considered if suitable.

APPENDIX 6/9: EARTHWORK ENVIRONMENTAL BUNDS, LANDSCAPE AREAS, STRENGTHENED EMBANKMENTS

Not Used.

APPENDIX 6/10: GROUND ANCHORAGES, CRIB WALLING AND GABIONS

Not Used.

APPENDIX 6/11: SWALLOW HOLES AND OTHER NATURALLY OCCURRING CAVITIES AND DISUSED MINE WORKINGS

Not Used.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

Not used.

APPENDIX 6/13: GROUND IMPROVEMENTS

Not Used.

APPENDIX 6/14: LIMITING VALUES FOR POLLUTION OF CONTROLLED WATERS

1. Based upon the assessment criteria given in this appendix, a soil can be classified as environmentally acceptable where the criteria for individual chemicals are not exceeded, or unacceptable (Class U1B), where criteria are exceeded. Excavated soil will not be suitable for re-use on site and will therefore be removed for off-site disposal.

2. Any material which exhibits gross visual evidence of hydrocarbon contamination (e.g. visible evidence of hydrocarbons such as free product) is unacceptable.

3. Any soil that is deemed, by visual and olfactory observations and confirmed by the Overseeing organisation and Environmental Specialist to be impacted by contaminants should be sampled and submitted for leachate analysis to UKAS/MCERT accredited laboratories. The relevant chemicals of concern to be included in laboratory testing suites and Limiting Values for class U1B soil are discussed in Section 6/2 and below within Table 6/14.1.

4. The leaching limit values are based on current Environmental Quality Standards and UK Drinking Water Standards. Consideration should be given to any future legislative changes.

5. General Testing requirements are as in Appendix 1/5.

6. The following limits apply to materials subjected to leaching tests:

Table 6/14.1 SOIL LEACHATE: CLASS U1B LIMITING VALUES (µg/l)

Contaminant	Class U1b Limit Value (µg/l)	Criteria Source
pH	6 - 9	UK EQS All freshwater Annual Average
Arsenic	50	
Cadmium	5	
Mercury	1	
Boron	2000	
Iron	1000	
Naphthalene	10	
Benzene	30	
Toluene	50	
Xylene	30	
Cyanide	50	UK Surface Water (Abstraction for Drinking) DW2
Sulphate (SO4)	250,000	
Phenols	5	
Dissolved/Emulsified Hydrocarbons **	200	
Selenium	10	
Anthracene	0.4	EU EQS Maximum Allowable Concentration – Inland surface water
Benzo(a)pyrene	0.1	
Indeno(1,2,3-cd)pyrene	0.002	
Benzo(ghi)fluoranthene		
Benzo(k)fluoranthene	0.03	
Benzo(b)fluoranthene		

** TPH/EPH C10-C40

UK Environmental Quality Standards. Available on Environment Agency Website.

The Surface Waters (Abstraction for Drinking) (Classification) Regulations 1996.

EU Environmental Quality Standards. COM(2006) 397 Final: on environmental quality standards in the field of water policy and amending Directive 2000/60/EC.

APPENDIX 6/15: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

1. Chemical acceptance criteria will determine whether a material is environmentally acceptable for use in the scheme or, if it is to be classed as U1B / U2 unacceptable. No soil present on site is anticipated to be suitable for re-use and will need to be tested for Waste Acceptance Criteria (WAC).

2. Based upon the assessment criteria given in this appendix, a soil can be classified as environmentally acceptable where the criteria for individual chemicals are not exceeded, or unacceptable (Class U1B), where criteria are exceeded.

3. Materials imported from off site will be chemically tested to demonstrate suitability for use at the intended location at a frequency outlined in Appendix 1/5. These tests will not exceed either leachate standard or soil standards in tables 6/15.1 and 6/15.2 respectively.

4. The limits on the concentration of contaminants in a material which, if exceeded, may lead to a significant possibility of significant harm to human health or the environment are presented in Table 6/15.2.

5. If concentrations of chemicals within materials exceed the limits shown in the table given in Table 6/15.2 then Quantitative Risk Assessment modelling may need to be undertaken by the Contractor to determine whether or not it is appropriate to classify the material as contaminated as defined in the Environmental Protection Act 1990 Part IIA. The risk assessment shall consider temporary conditions. This approach may restrict the locations where the material can be temporarily placed. Materials which exceed the limits shown and are subsequently classified as contaminated shall be classified as Class U1B (unless they are hazardous in which case they will be classified as U2).

6. Class U1B may be sent off-site to a licensed treatment facility prior to disposal.

7. It should be noted that these criteria do not affect the chemical acceptance criteria or testing for imported Topsoil. The Appendix 6/8 criteria are primarily based on the phytotoxicity of Topsoil and are not designed to reduce the risk to controlled waters, human health or the environment.

8. The criteria presented in the table given in Table 6/15.1 and 6/15.2 have been developed taking into account the concept of risk assessment and the definition of contamination, in accordance with Part 2A of the Environmental Protection Act (1990).

9. The criteria for the protection of human health are based on published Generic Assessment Criteria values (GACs) and Soil Guideline Values (SGVs).This assumes that no part of the scheme is to be returned to agricultural use.

10. SGV's are published by DEFRA for a number of different contaminants for use with such risk assessment modelling procedures, such as CLEA. However, SGVs have not yet been issued for many contaminants, and in the absence of these LQM-GAC and LQM-GAC/CIEH values are used. For the majority of the determinants this is for assessment of long term risk however for cyanide, an acute risk limit is indicated.

11. The Above criteria have been selected due to Series NG 600 Earth works Guidance stating: For general fills, the limiting values for harm to human health should normally be based on the 'commercial/industrial' end use category of guideline values, as there is a very low risk of exposure to the public from any contaminants in the fill. The appropriate category should be decided for each section or sub-section of the scheme.

Table 6/15.1: CLASS U1B SOIL LEACHATE ACCEPTANCE CRITERIA

Determinant Criteria	Concentration (µg/l)	Source
pH	6 - 9	EQS for fresh water
Ammonia (as N)	0.5	UK drinking water standard 1989
Arsenic	10	UK drinking water standard 2000
Cadmium	5	UK drinking water standard 2000
Chromium (dissolved)	0.01	UK drinking water standard 2000
Cobalt	3	EQS for fresh water
Conductivity (µs/cm)	1000	EA Leachate Quality threshold value 2001
Lead (total)	25	UK drinking water standard 2000
Mercury	1	UK drinking water standard 2000
Selenium	10	UK drinking water standard 2000
Boron (total)	1000	UK drinking water standard 2000
Copper	2000	UK drinking water standard 2000
Nickel	20	UK drinking water standard 2000
Zinc	5000	UK drinking water standard 1989
Cyanide (free)	50	UK drinking water standard 2000
Sulphate (SO4)	250	UK drinking water standard 1989
Sulphide	0.25	EQS for fresh water
Phenol (total)	0.5	UK drinking water standard 1989
Iron	0.2	UK drinking water standard 1989
Chloride	250	UK drinking water standard 2000
PAHs (total) #	0.1	UK drinking water standard 2000
Methylbenzene	50	EQS for fresh water
Naphthalene	10	EQS for fresh water
Anthracene	0.02	EQS for freshwater
Benzo(a)pyrene	0.01	UK drinking water standard 2000
Benzene	1	UK drinking water standard 2000
Toluene extract	50	EQS for fresh water
Ethylbenzene	20	EQS for fresh water
Xylene	30	EQS for freshwater

Sum of 4 PAHs (benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1/2/3-cd)pyrene and benzo(g/h/i)perylene.

Table 6/15.2: CLASS U1B SOIL ACCEPTANCE CRITERIA

Determinant Criteria	Concentration (mg/kg)*	Criteria Source
pH	Within range - above 6 and below 9	Commercial SSV
Phenols (total)	21,900	SGV
Naphthalene	200 (76) [sol]	GAC - LQM
Acenaphthene	85,000 (57) [sol]	GAC – LQM/CIEH
Anthracene	530,000	GAC – LQM/CIEH
Benzene	1220	GAC - LQM
Benzo(a)anthracene	90	GAC – LQM/CIEH
Benzo(a)pyrene	29.7	GAC - LQM
Benzo(bk)fluoranthene*	100	GAC – LQM/CIEH
Benzo(g,h,i)perylene	650	GAC – LQM/CIEH
Benzo(k)fluoranthene	140	GAC – LQM/CIEH
Chrysene	140	GAC – LQM/CIEH
Dibenzo(a,h)anthracene	13	GAC - LQM
Ethylbenzene	48,000	SGV
Fluoranthene	23,000	GAC – LQM/CIEH
Fluorene	64,000 (31) [sol]	GAC - LQM
Indeno(1,2,3,cd) pyrene	60	GAC – LQM/CIEH
Pyrene	54,000	GAC – LQM/CIEH
TPH Aromatic (C5 – C7) (benzene)	28,000 (1220) [sol]	GAC - LQM
TPH Aromatic (C7 – C8) (toluene)	59,000 (869) [vap]	GAC - LQM
TPH Aromatic (C8 – C10)	3,700 (613) [vap]	GAC - LQM
TPH Aromatic (C10 – C12)	17,000 (364) [sol]	GAC - LQM
TPH Aromatic (C12 – C16)	36,000 (169) [sol]	GAC - LQM
TPH Aromatic (C16 – C21)	28,000 [f]	GAC - LQM
TPH Aromatic (C21 – C35)	28,000 [f]	GAC - LQM
TPH Aliphatic (C5 – C6)	3,400 (304) [sol]	GAC - LQM
TPH Aliphatic (C6 – C8)	8,300 (144) [sol]	GAC - LQM
TPH Aliphatic (C8 – C10)	2,100 (78) [sol]	GAC - LQM
TPH Aliphatic (C10 – C12)	10,000 (48) [sol]	GAC - LQM
TPH Aliphatic (C12 – C16)	61,000 (24) [sol]	GAC - LQM
TPH Aliphatic (C16 – C35)	1,600,000[f]	GAC - LQM
Toluene	869	SGV
Xylene	340	GAC - LQM
Free Cyanide	13,900	SGV
Arsenic	500	SGV
Cadmium	1400	SGV
Chromium(III) (Chromium VI)	30,400 (35)	SGV
Lead	750	SGV
Mercury	480	SGV
Nickel	5000	SGV
Copper	71,700	GAC - LQM
Zinc	665,000	GAC - LQM
Selenium	8,000	SGV
Asbestos Screening	Absence of material, discernible by laboratory methods	

Key

[f] oral, dermal and inhalation exposure compared with oral HCV.

[sol] GAC presented exceeds the solubility saturation limit, which is presented in brackets.

[vap] GAC presented exceed the vapour saturation limit, which is presented in brackets.

[*] Selected value is for benzo(b)fluoranthene.

Notes

GACs are rounded to 2 significant figures.
GACs assume that free phase contamination is not present .
GACs based on a sub-surface soil to indoor air correction factor of 10 for TPH and 1 for PAH.
GACs above assume 1% Soil Organic Matter Content.

APPENDIX 30/5: GRASS SEEDING, WILDFLOWER SEEDING AND TURFING

1. Grass seeding is to be applied to the newly trimmed and topsoiled areas.

2. Only good quality Topsoil to BS3882 should be used in any backfill to a minimum finished depth of 100mm, consolidated and sown with grass seed and raked to incorporate grass seed into the seed bed.

3. All debris larger than 50mm should be removed from site and disposed of at an agreed tip.

4. The area should be left level and free from debris with any damage to existing vegetation being replaced by the contractor.

5. Grass seed should be sown in the months of April to September at the rate of 25g per m^2.

6. The seed mix is to be as follows:

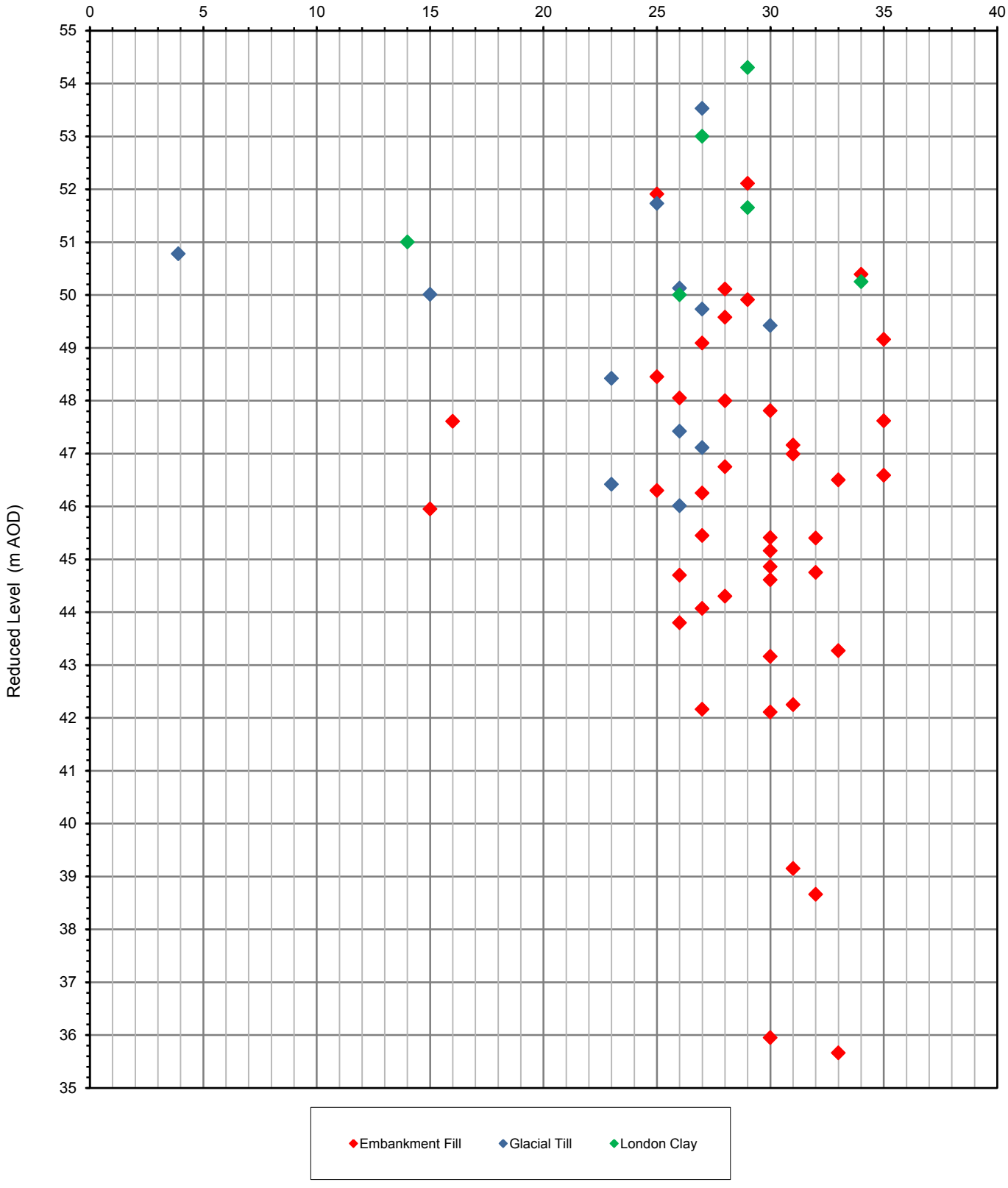
- 30% Creeping Red Fescue
- 20% Chewings Red Fescue
- 20% Hard Fescue
- 10% Crested Dogstail
- 10% Browntop Bent
- 10% Smooth stalked Meadow Grass
- or similar species of existing sward.

7. A pre-seed fertiliser should be used at time of grass seed sowing.

8. A site visit by a member of the landscape team should be arranged on completion of the works to ascertain if works have been completed to Specification.

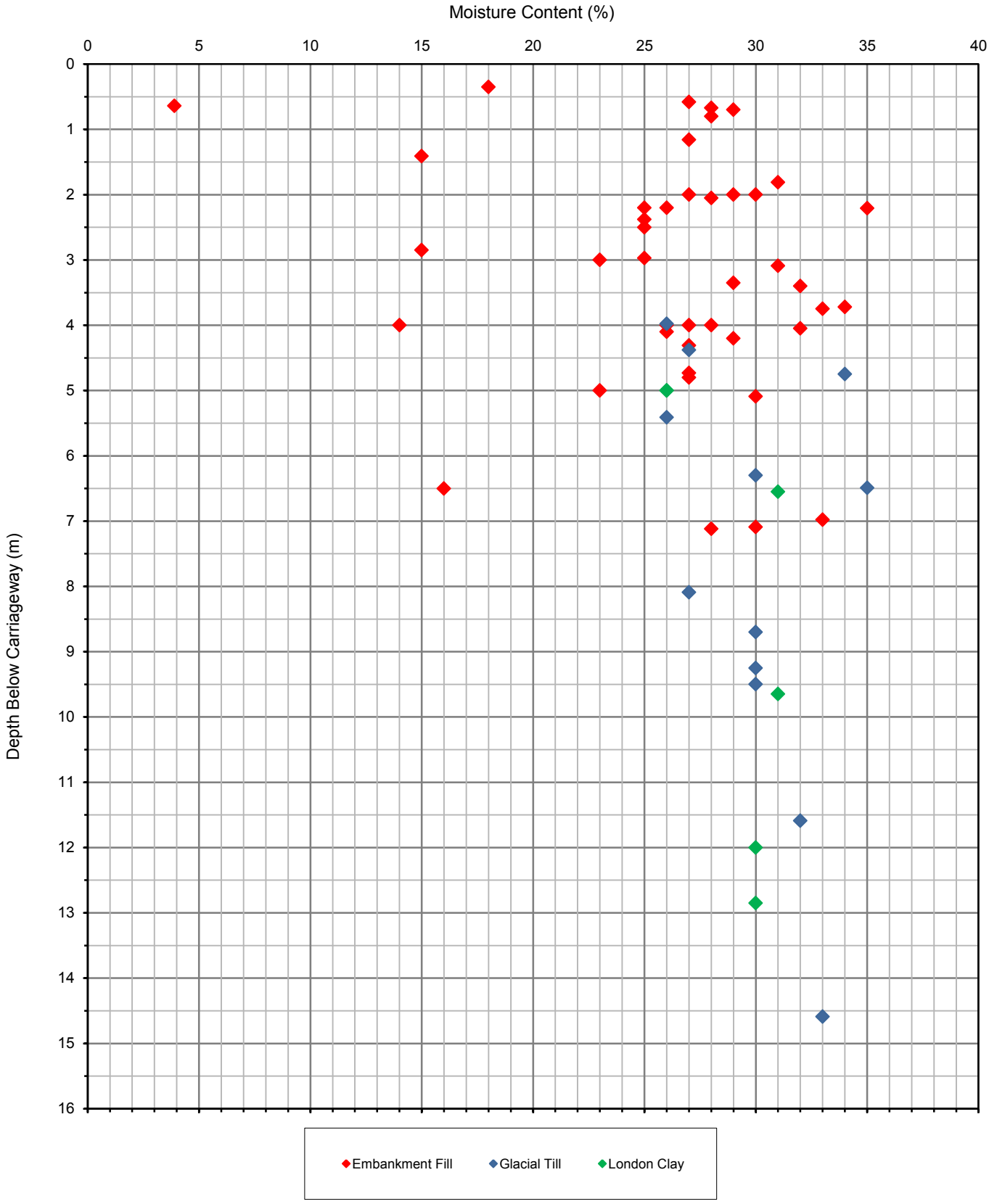
Figures

Moisture Content vs. Reduced Level



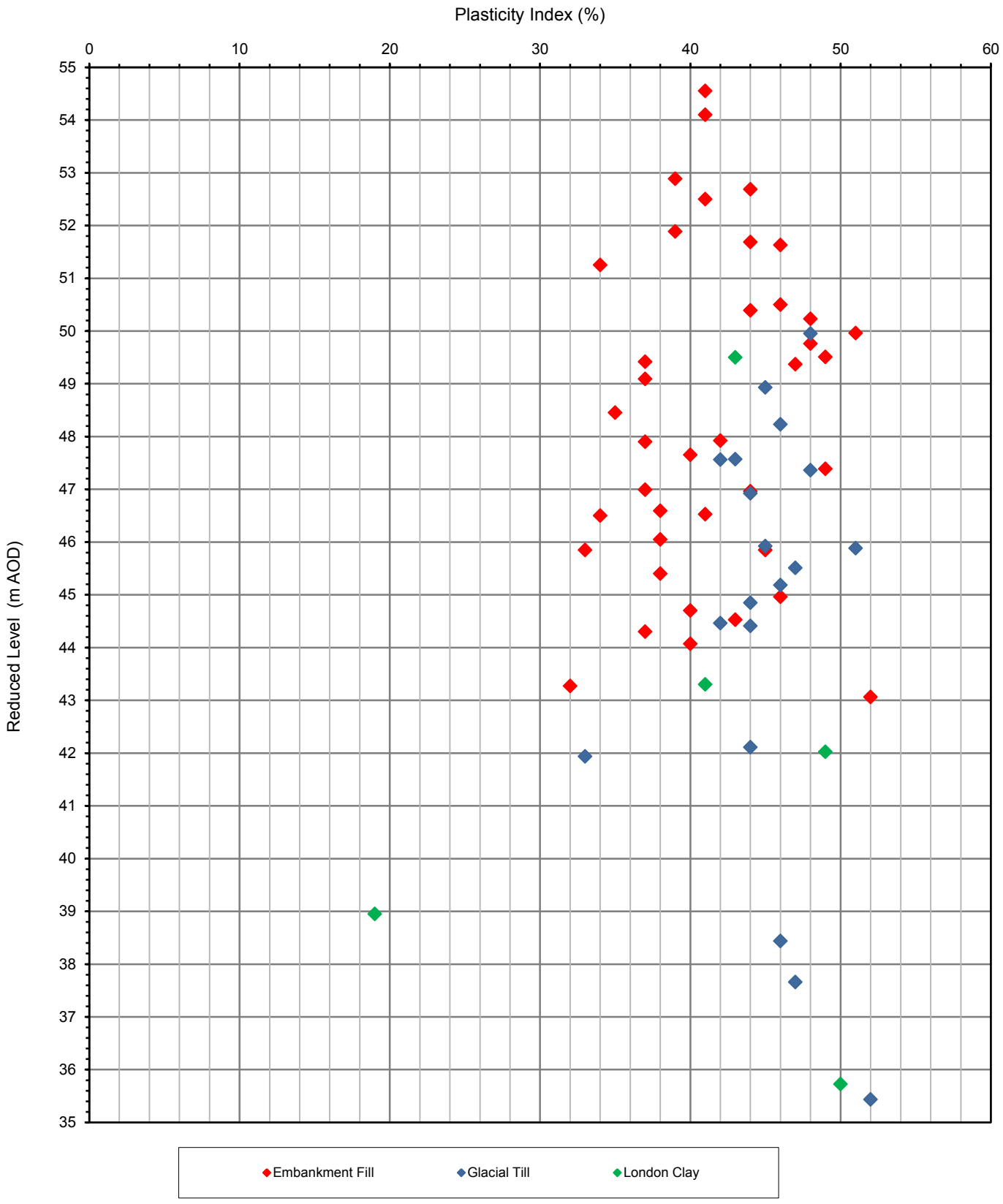
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Moisture Content vs. Reduced Level**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 1**

Moisture Content vs. Depth Below Carriageway



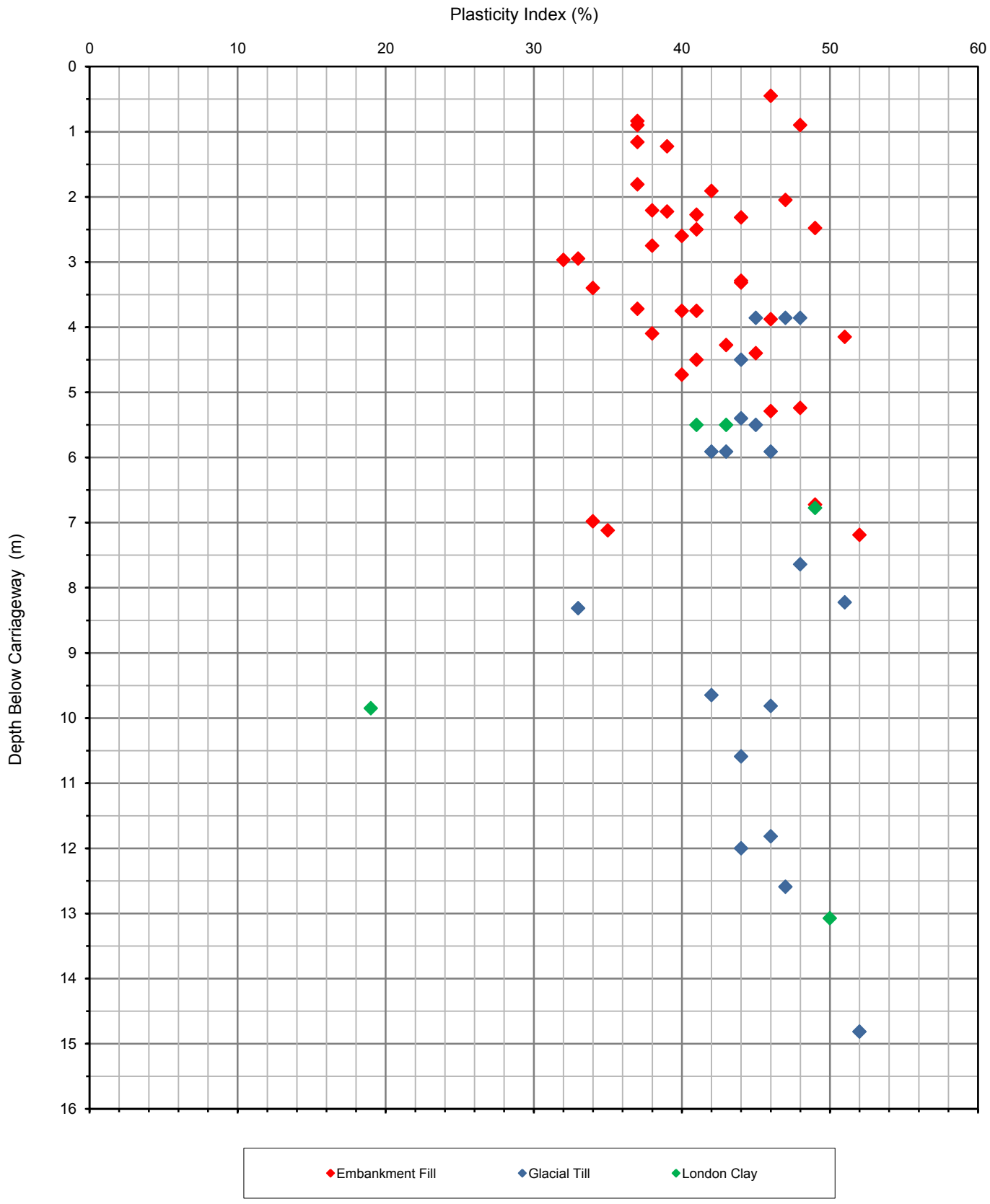
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Moisture Content vs. Depth Below Carriageway**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 2**

Plasticity Index vs. Reduced Level



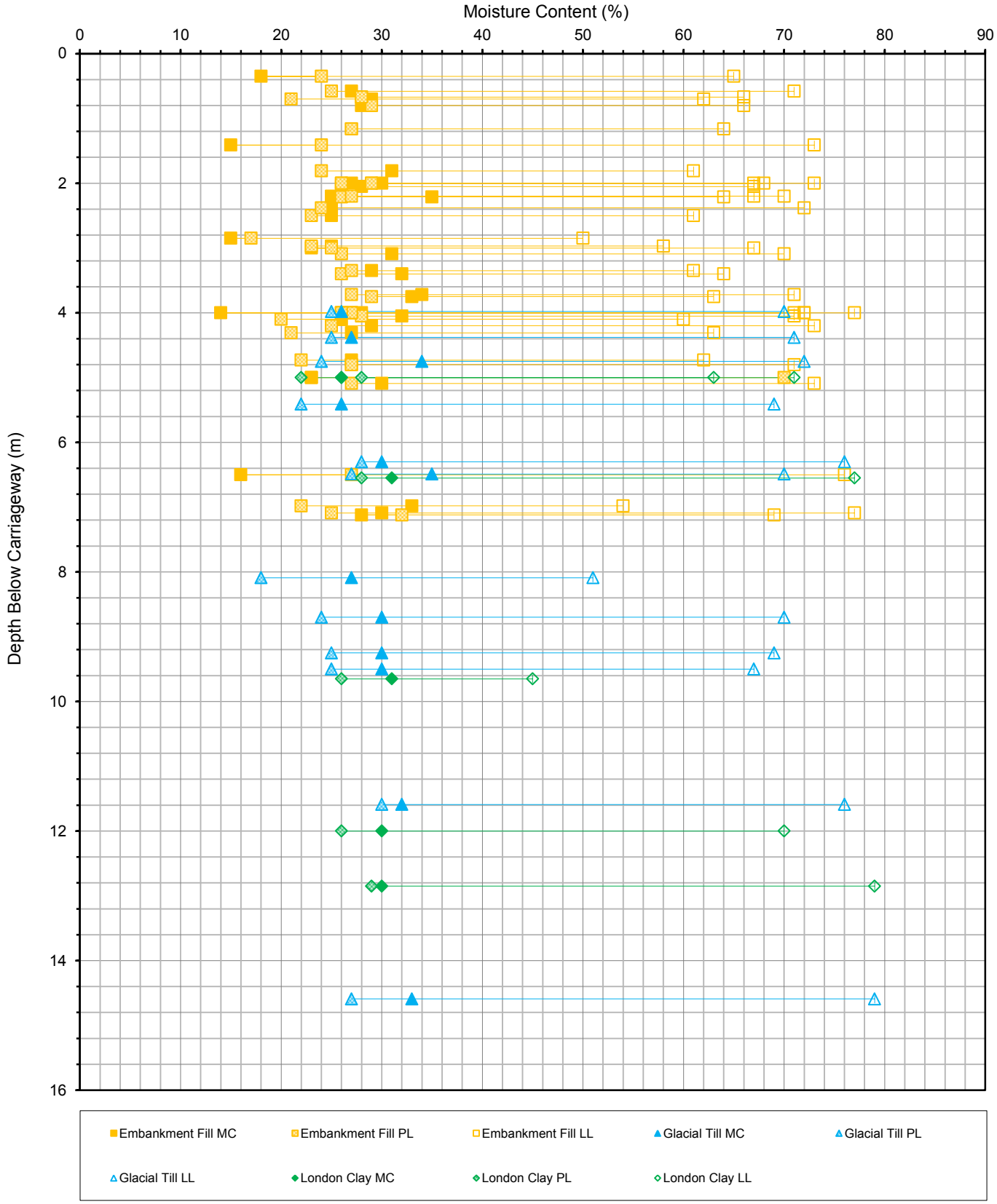
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Plasticity Index vs. Reduced Level**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 3**

Plasticity Index vs. Depth Below Carriageway



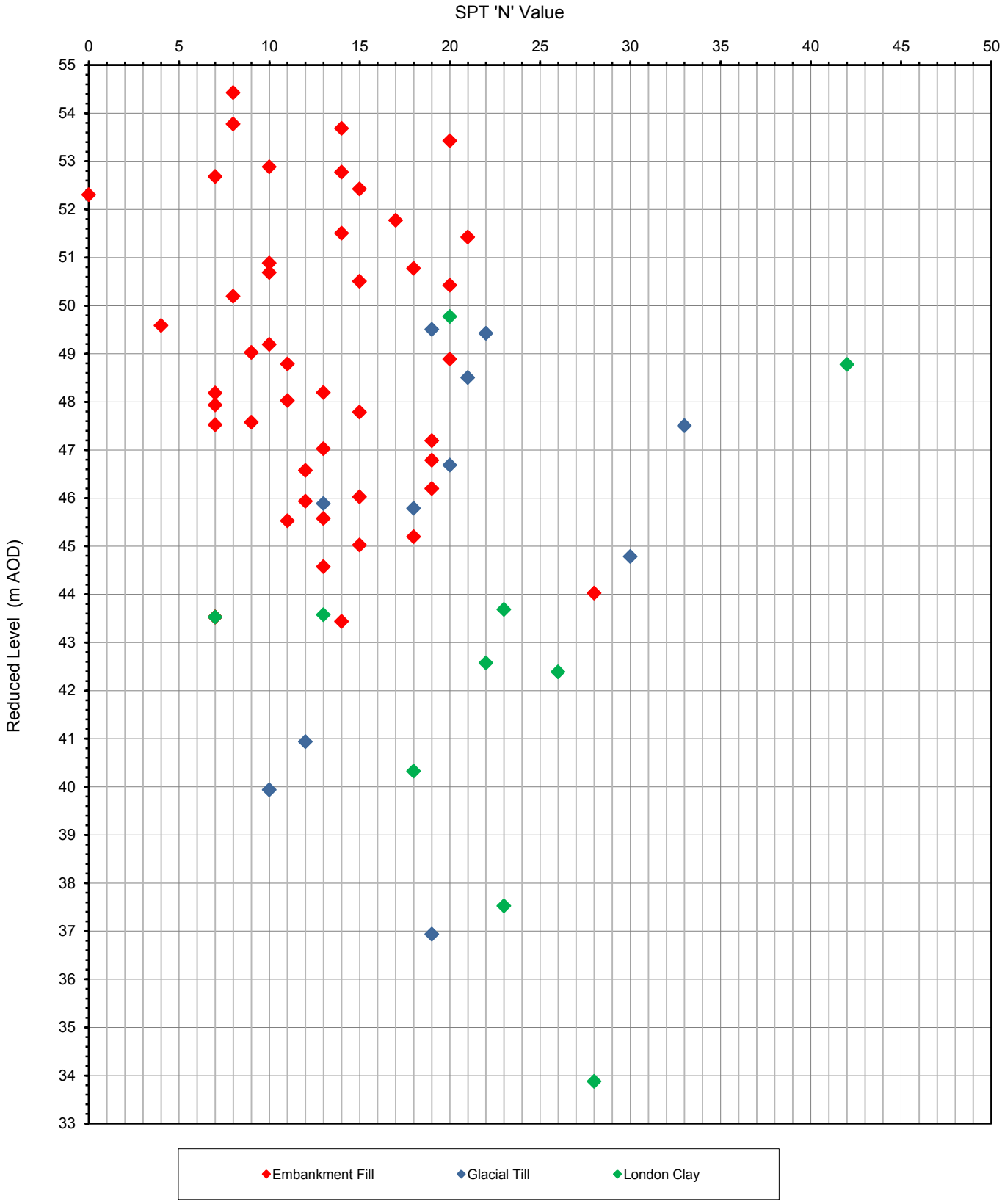
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Plasticity Index vs. Depth Below Carriageway**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 4**

Moisture Content, Plastic Limit and Liquid Limit vs. Depth Below Carriageway



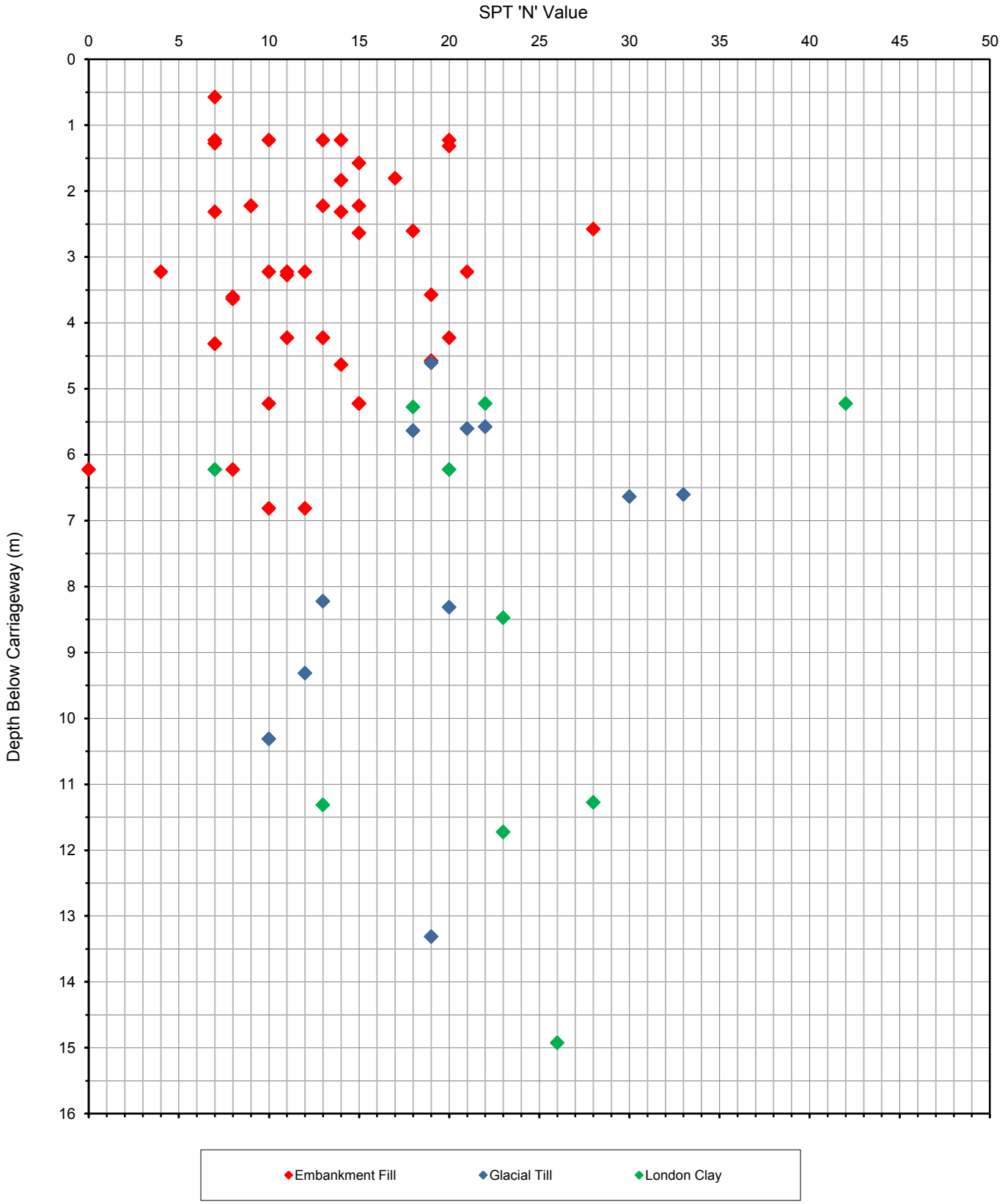
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Moisture Content, Plastic Limit and Liquid Limit vs. Depth Below Carriageway**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 5**

SPT 'N' Value vs. Reduced Level

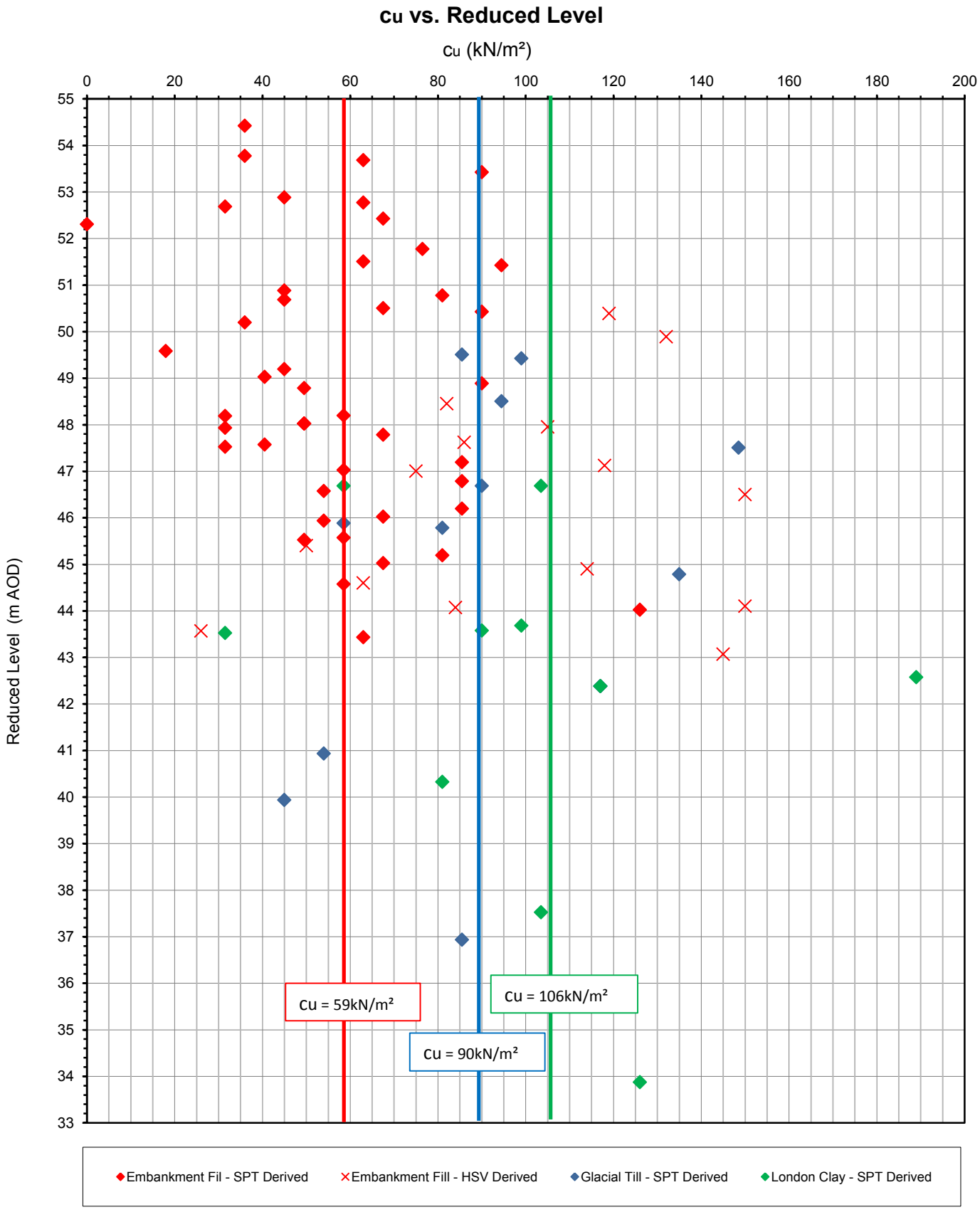


Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**SPT 'N' Value vs. Reduced Level**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 6**

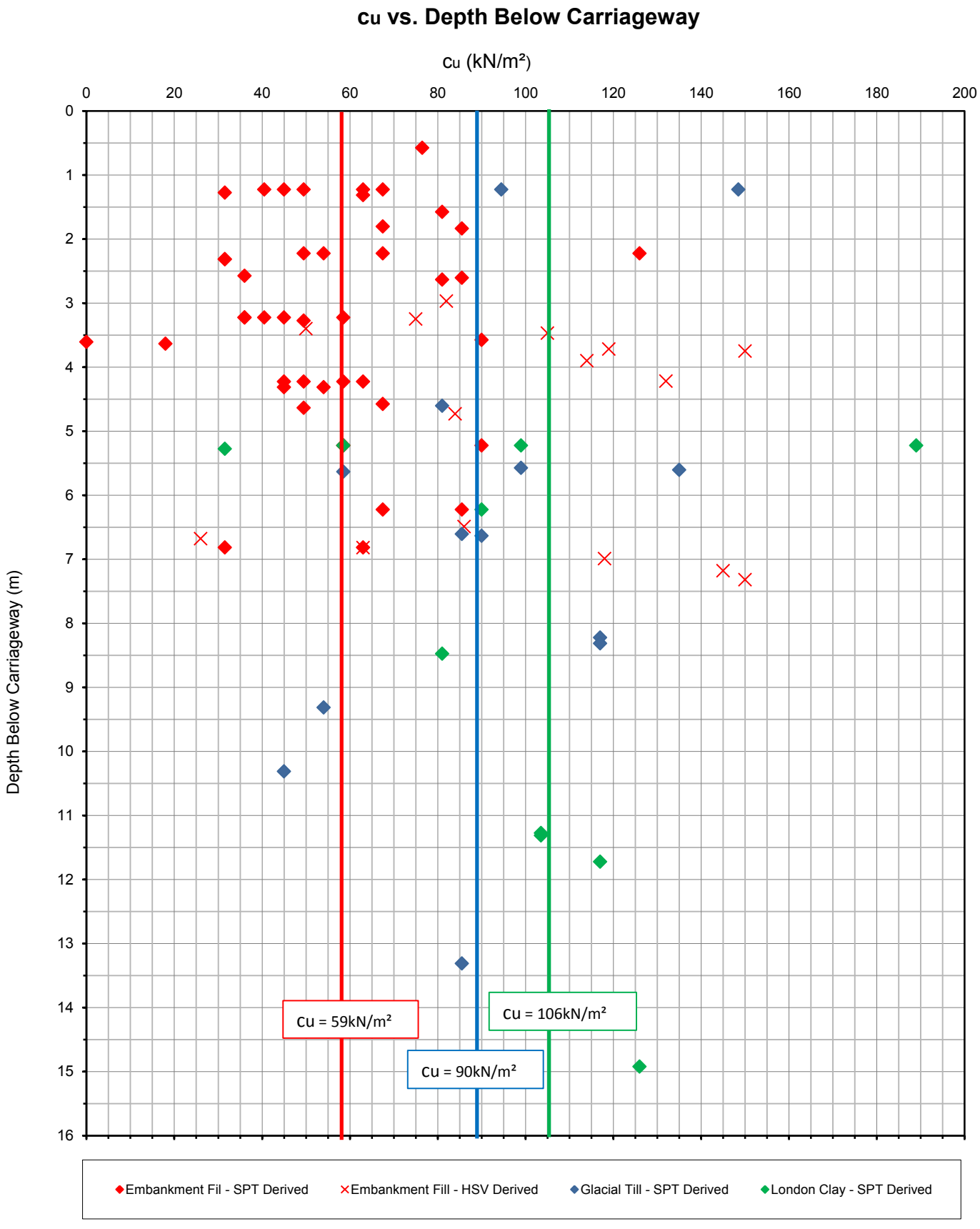
SPT 'N' Value vs. Depth Below Carriageway



Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**SPT 'N' Value vs. Depth Below Carriageway**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 7**

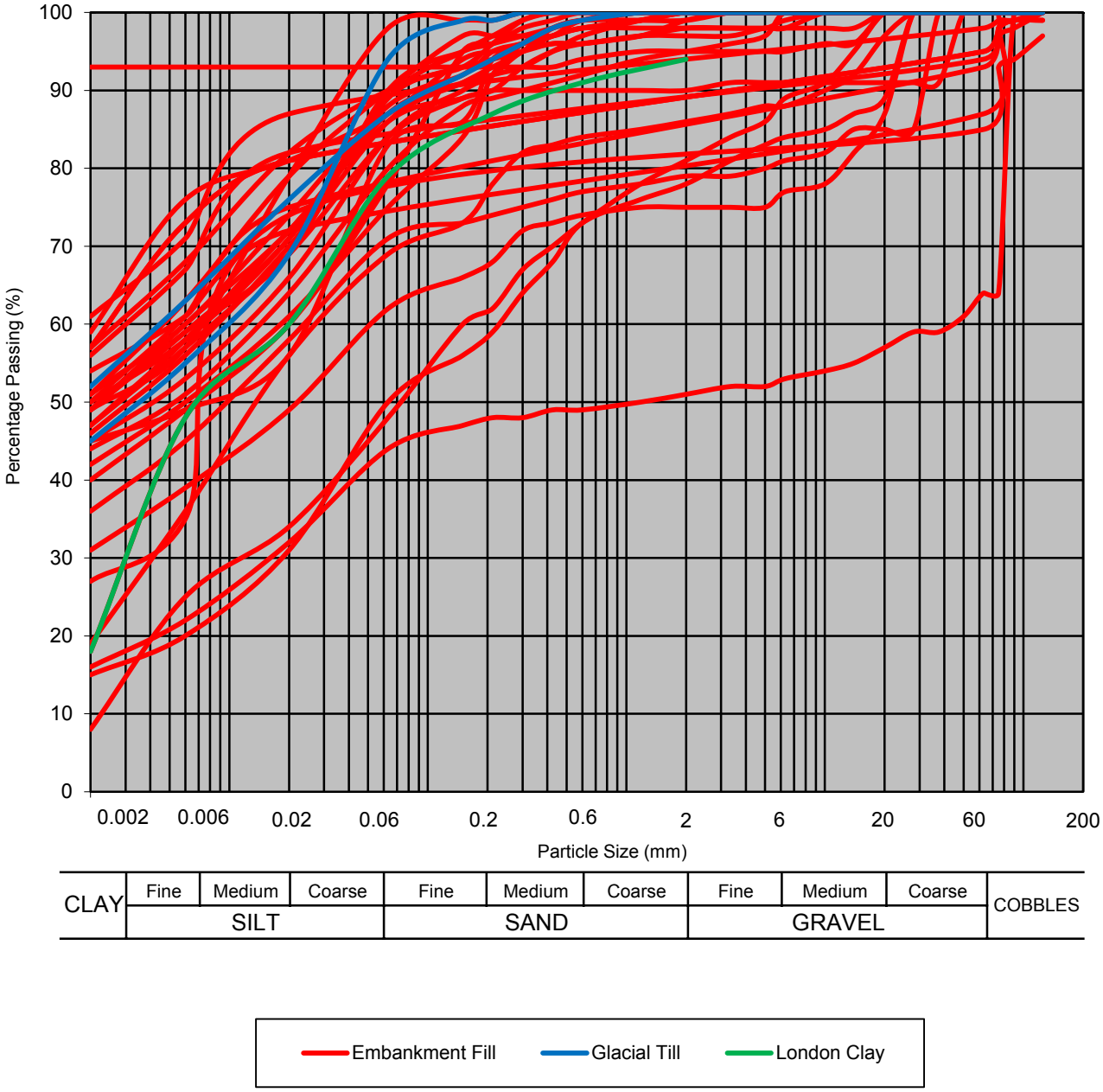


Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**cu vs. Reduced Level**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 8**



Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**cu vs. Depth Below Carriageway**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 9**

Particle Size Distribution - All Strata



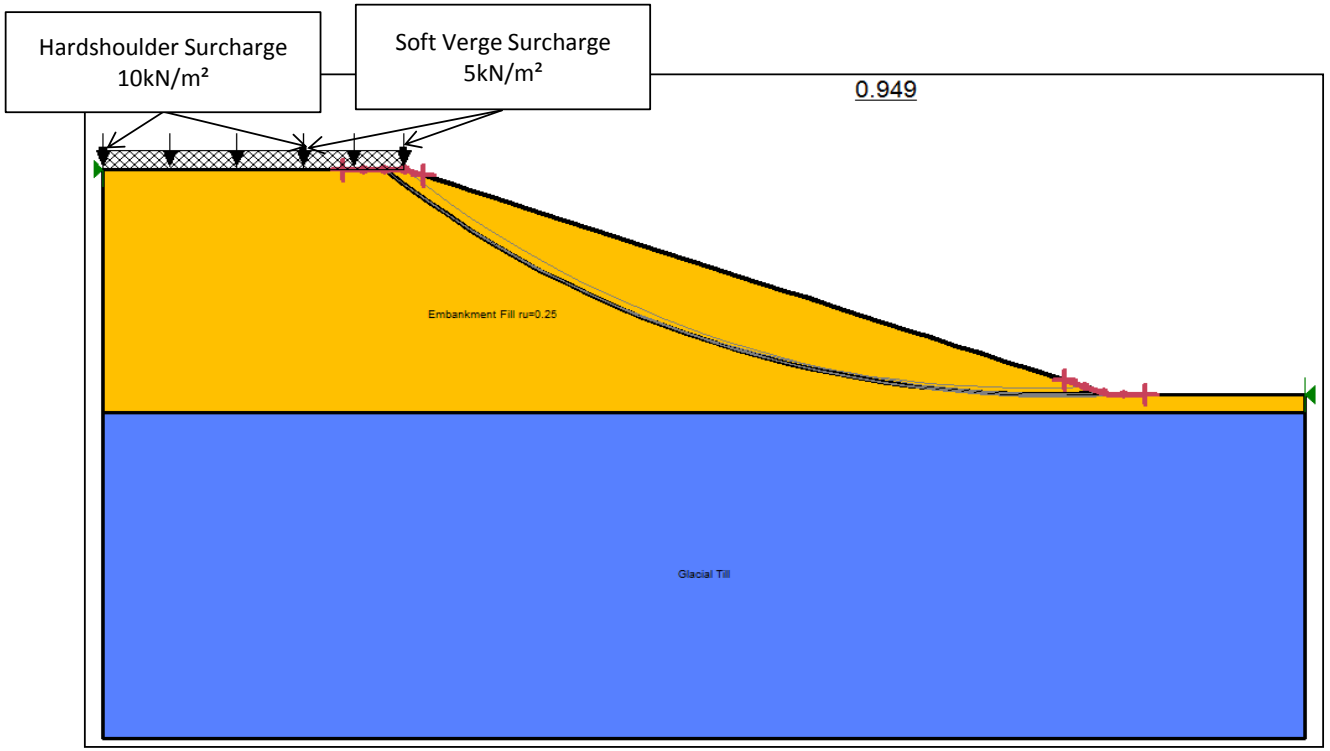
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Particle Size Distribution - All Strata**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 10**

Initial Amey Back Analysis Model

Geotechnical Design Parameters				
Stratum	**γ_{bulk} (kN/m^3)**	**Φ′ (°)**	**c' (kPa)**	**r_u**
Embankment Fill	19	22	0.5	0.25
Glacial Till	20	21.5	1	0.1

	Embankment Fill
	Glacial Till

Factor of Safety = 0.949



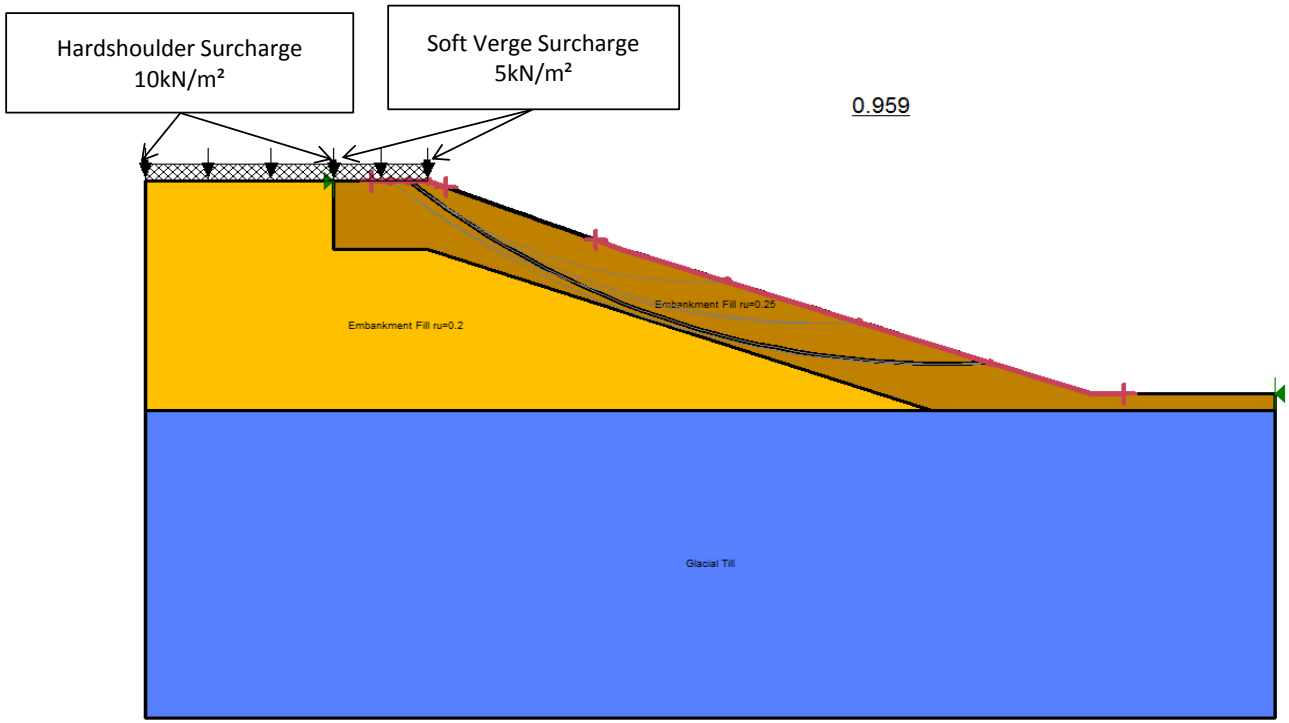
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Initial Amey Back Analysis Model**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 11**

Revised Amey Back Analysis Model

Geotechnical Design Parameters				
Stratum	**γ_{bulk} (kN/m^3)**	**Φ′ (°)**	**c' (kPa)**	**r_u**
Embankment Fill <2mbgl	19	22	0.5	0.25
Embankment Fill >2mbgl	19	22	0.5	0.2
Glacial Till	20	21.5	1	0.1

	Embankment Fill <2mbgl
	Embankment Fill >2mbgl
	Glacial Till

Factor of Safety = 0.959



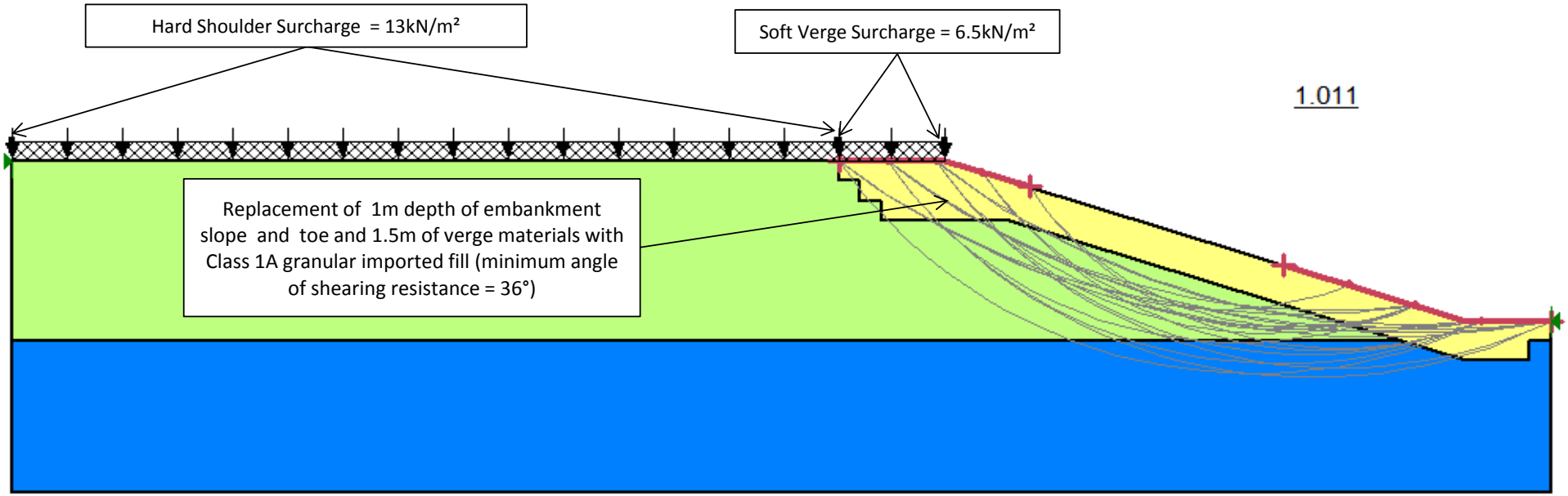
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Revised Amey Back Analysis Model**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 12**

Remedial Works Slope Stability Assessment for Embankments Approximately 4m High

Factored Geotechnical Design Parameters				
Stratum	**γ_{bulk} (kN/m^3)**	**Φ′ (°)**	**c' (kPa)**	**r_u**
Imported Granular Fill	19	24	0	0.1
Embankment Fill	19	17.6	0.4	0.25
Glacial Till	20	17.2	0.8	0.25

	Imported Class 1A Granular Fill
	Embankment Fill
	Glacial Till

Factor of Safety = 1.011



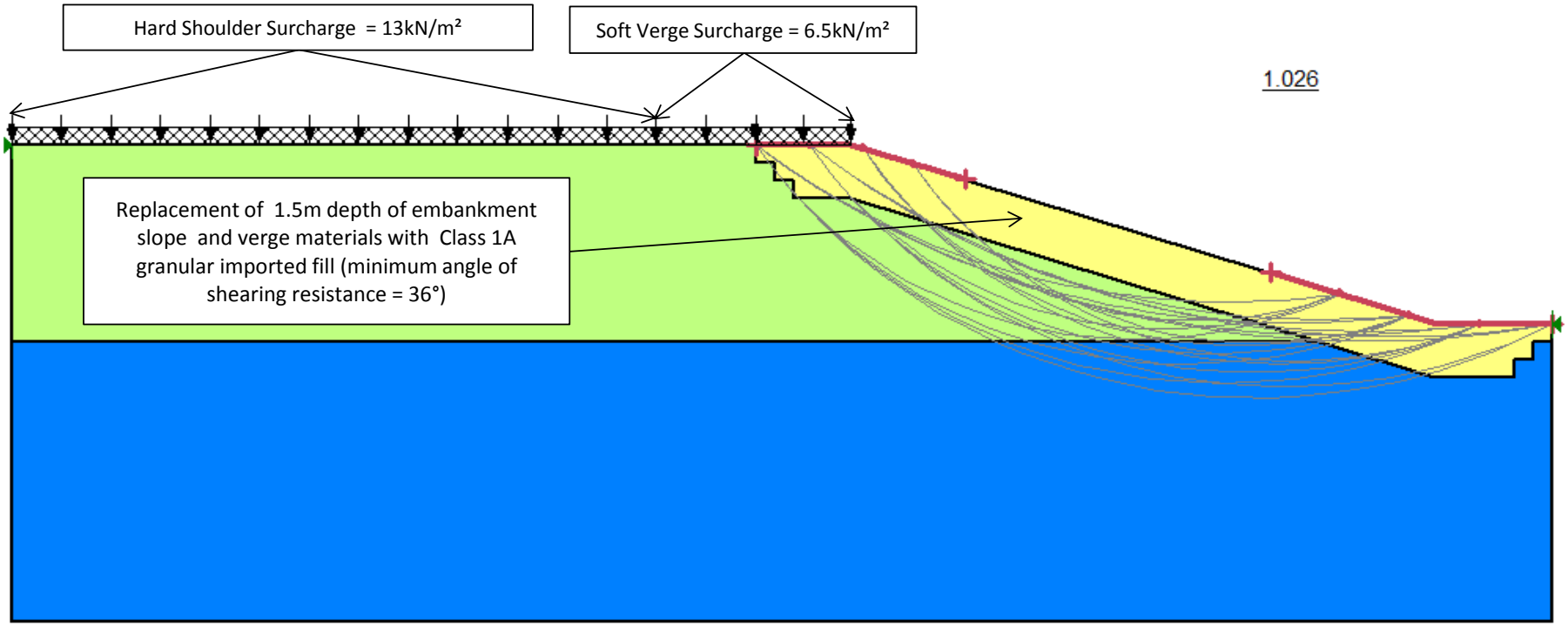
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Remedial Works Slope Stability Assessment for Embankments Approximately 4m High**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 13**

Remedial Works Slope Stability Assessment for Embankments Approximately 5m High

Factored Geotechnical Design Parameters				
Stratum	**γ_{bulk} (kN/m^3)**	**Φ′ (°)**	**c' (kPa)**	**r_u**
Imported Granular Fill	19	24	0	0.1
Embankment Fill	19	17.6	0.4	0.25
Glacial Till	20	17.2	0.8	0.25

	Imported Class 1A Granular Fill
	Embankment Fill
	Glacial Till

Factor of Safety = 1.026



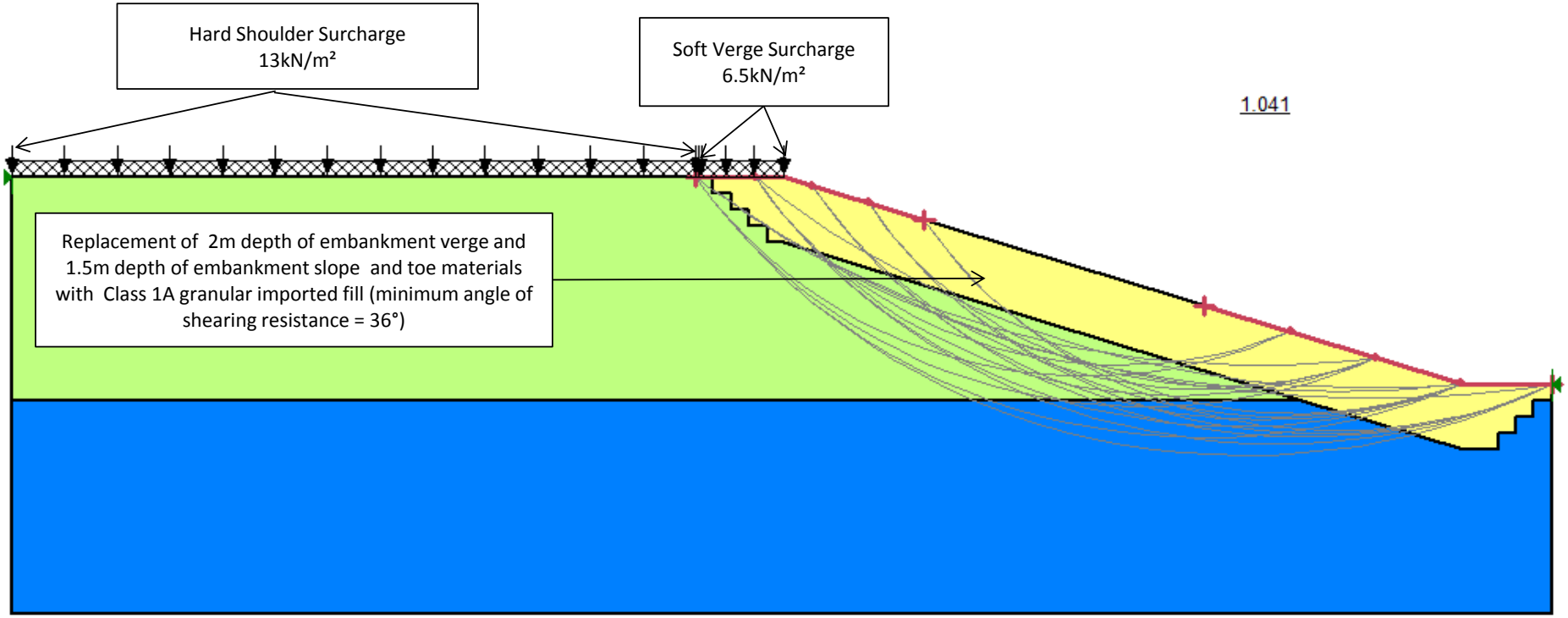
Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Remedial Works Slope Stability Assessment for Embankments Approximately 5m High**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 14**

Remedial Works Slope Stability Assessment for Embankments Approximately 6.3m High

Factored Geotechnical Design Parameters				
Stratum	**γ_{bulk} (kN/m^3)**	**Φ′ (°)**	**c' (kPa)**	**r_u**
Imported Granular Fill	19	24	0	0.1
Embankment Fill	19	17.6	0.4	0.25
Glacial Till	20	17.2	0.8	0.25

	Imported Class 1A Granular Fill
	Embankment Fill
	Glacial Till

Factor of Safety = 1.041



Project:	**M11 Junction 6 Site B**		
Report:	**Geotechnical Design Report**		
Title:	**Remedial Works Slope Stability Assessment for Embankments Approximately 6.3m High**		
Report Reference:	**CON-GE-BHAM-52200806-001**	Figure Reference:	**Figure 15**

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Appendix A– Drawings

HA537529-AMEY-GE-DR-001	Exploratory Hole Location Plan and Indicative Long Sections [Sheet 1 of 2]
HA537529-AMEY-GE-DR-002	Exploratory Hole Location Plan and Indicative Long Sections [Sheet 2 of 2]
HA537529-AMEY-GE-DR-003	Proposed Remedial Solution for 4m Height Sections
HA537529-AMEY-GE-DR-004	Proposed Remedial Solution for 5m Height Sections
HA537529-AMEY-GE-DR-005	Proposed Remedial Solution for 6.3m Height Sections

File ref - p:\projects\area 6 & 8 asc\area 6 asc - geotechnical\m11\m11 site b j6\drawings\wip\1 live drgs\ha537529-amey-ge-dr-001& 002.dwg

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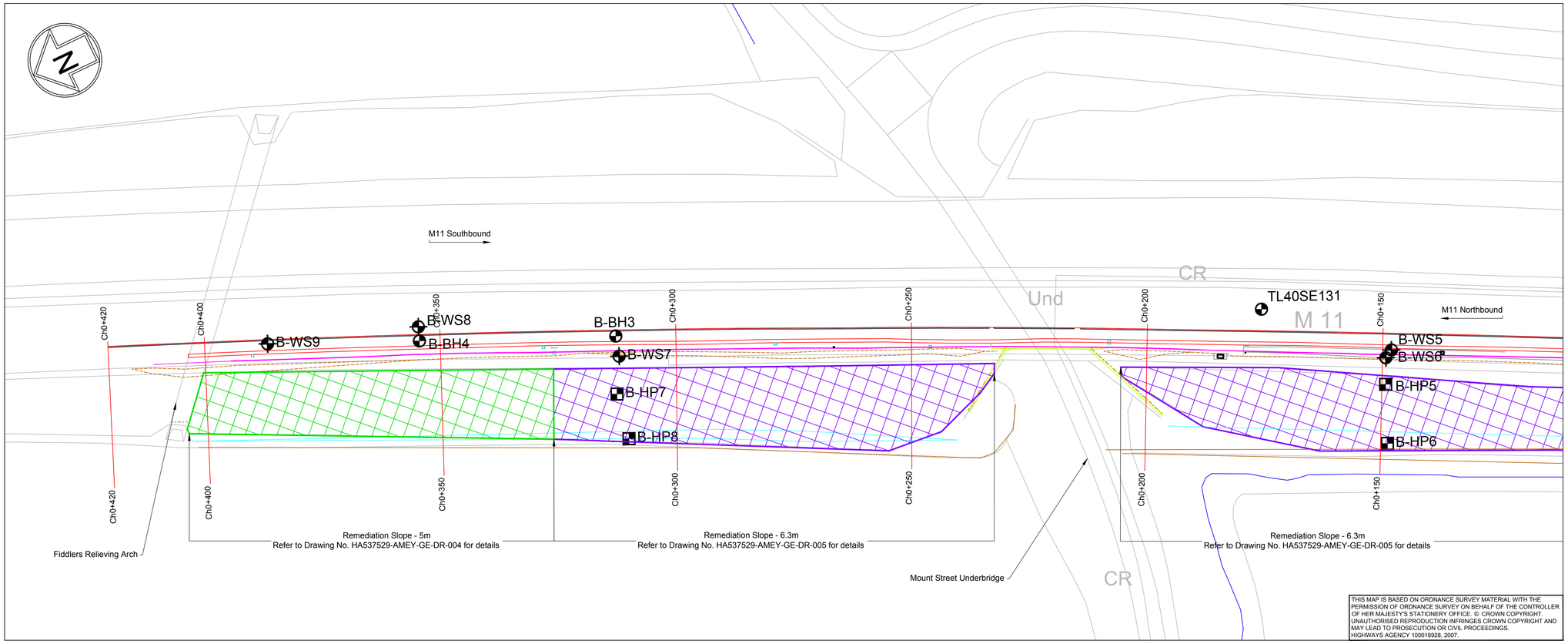

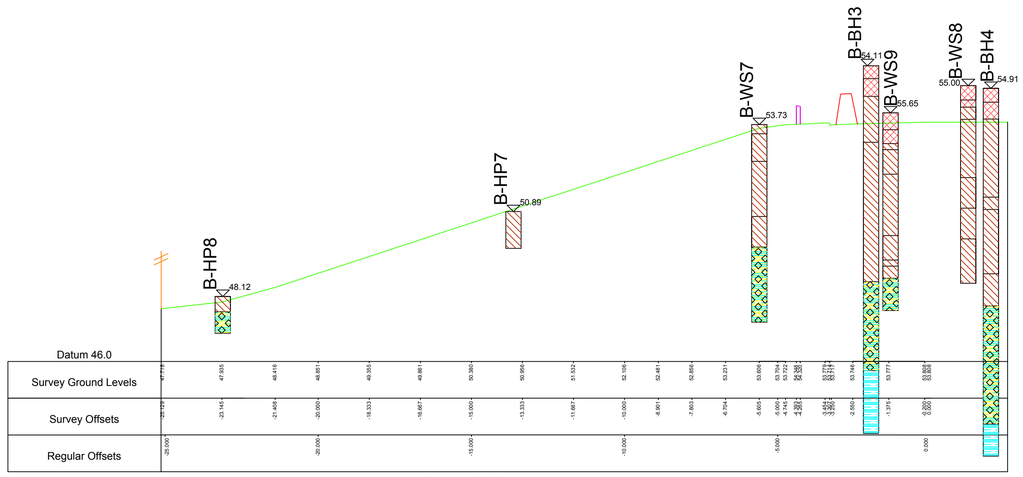

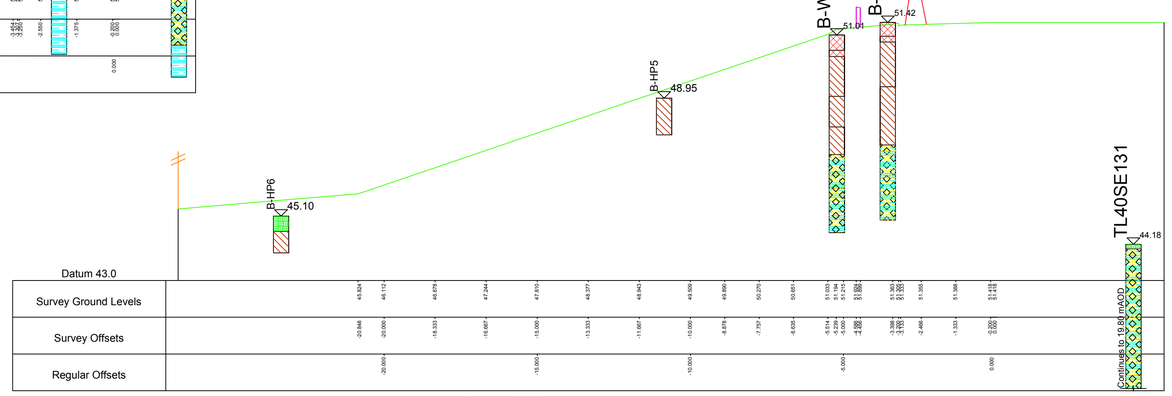

NOTES

1. All levels indicated on the sections are in mAOD.
2. It should be noted that some exploratory hole data used may be offset laterally from the section line.
3. This drawing should be read in conjunction with the Geotechnical Design Report (GDR) report number: CON-GE-BHAM-52200806-001.
4. This drawing is to be read as part of drawing series: HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.
5. Sections are based on the recent topographic survey undertaken on behalf of Amey in November 2014.
6. For typical section of proposed Remedial Works refer to drawing numbers: HA537529-AMEY-GE-DR-003 to 005.
7. For details of proposed Remedial Works refer to Series 100 and 600 Specifications.
8. For borehole details see Appendix B of the Geotechnical Design Report (GDR).
9. Cross Sections are indicative only.
10. No recent topographic survey between chainages ch.000 and ch.-120 is available.

RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Working in the Proximity of Watercourse/Culvert
2. Working within temporary works

PLAN LEGEND

- B-BH1 — Cable Percussive Exploratory Hole
- B-WS1 — Window Sampler Exploratory Hole
- B-HP1 — Trial Pit Exploratory Hole
- Extents of Remedial Works - 5m Slope
- Extents of Remedial Works - 6.3m Slope
- Extents of Remedial Works - 4m Slope
- Top of Slope
- Bottom of Slope
- Armco Barrier
- Varioguard Barrier
- Watercourse

SECTION LEGEND

- Existing Ground Level
- Topsoil
- Made Ground
- Embankment Fill
- Glacial Till
- London Clay Formation
- Anticipated Highways Agency Boundary Fence
- Armco Barrier
- Varioguard

Rev	Revision details	Chkd	Appd	Date

Drawn:	NM	Preliminary	
Design:	SB	For comment	
Chkd:	IT	For tender	
Appd:	TB	For construction	
Date:	27.11.14	As constructed	
		Other	

amey

Client: HIGHWAYS AGENCY

Project Name: M11 Site B - Junction 6

Drawing Title: Geotechnical
Exploratory Hole Location Plan and Indicative Cross Sections [Sheet 1 of 2]

Original Drawing Size :	A1
Scale : 1:500m@A1, 1:1000m@A3	Dimensions : 594x841

Drawing No	Rev
HA537529-AMEY-GE-DR-001	-

File ref - p:\projects\area 6 & 8 asc\area 6 asc - geotechnical\m11\m11 site b j6\drawings\wip\1 live drgs\ha537529-amey-ge-dr-001& 002.dwg

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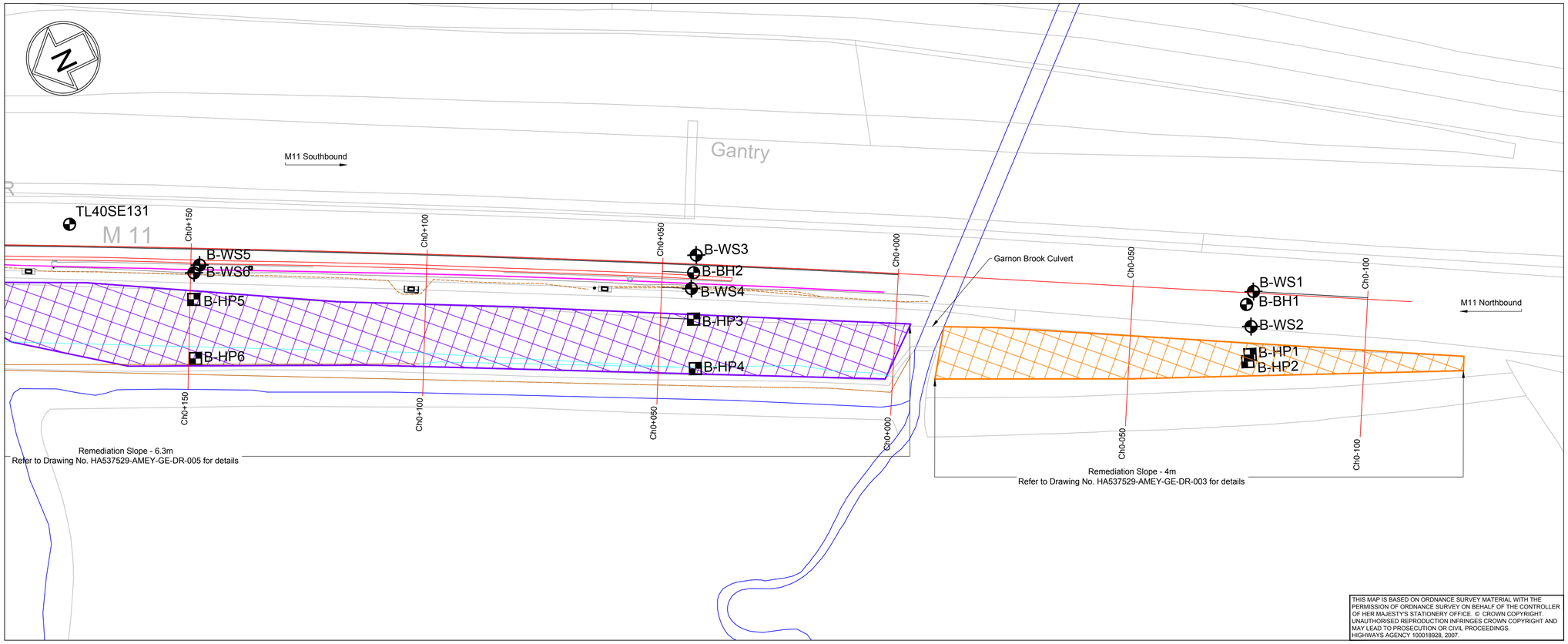

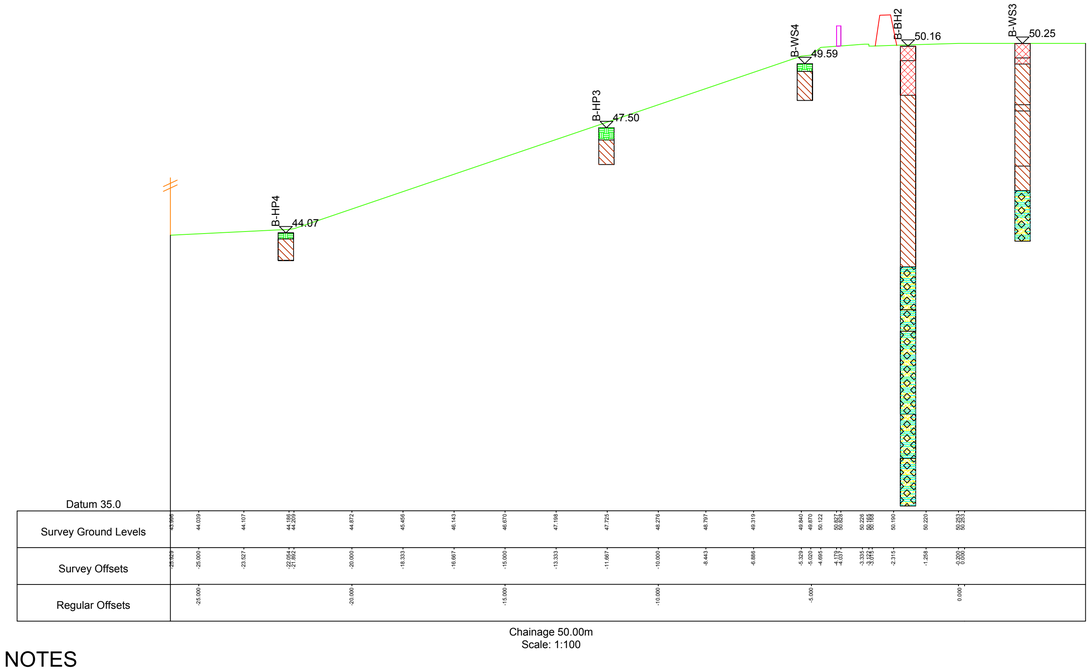

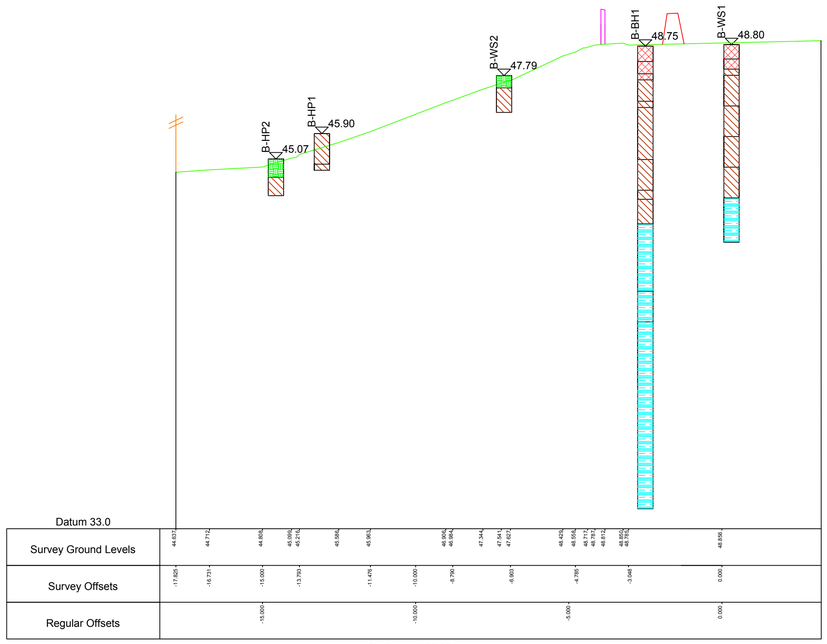

NOTES

1. All levels indicated on the sections are in mAOD.
2. It should be noted that some exploratory hole data used may be offset laterally from the section line.
3. This drawing should be read in conjunction with the Geotechnical Design Report (GDR) report number: CON-GE-BHAM-52200806-001.
4. This drawing is to be read as part of drawing series: HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.
5. Sections are based on the recent topographic survey undertaken on behalf of Amey in November 2014.
6. For typical section of proposed Remedial Works refer to drawing numbers: HA537529-AMEY-GE-DR-003 to 005.
7. For details of proposed Remedial Works refer to Series 100 and 600 Specifications.
8. For borehole details see Appendix B of the Geotechnical Design Report (GDR).
9. Cross Sections are indicative only.
10. No recent topographic survey between chainages ch.000 and ch.-120 is available.

⚠ RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Working in the Proximity of Watercourse/Culvert
2. Working within temporary works

PLAN LEGEND

- B-BH1 — Cable Percussive Exploratory Hole
- B-WS1 — Window Sampler Exploratory Hole
- B-HP1 — Trial Pit Exploratory Hole
- Extents of Remedial Works - 5m Slope
- Extents of Remedial Works - 6.3m Slope
- Extents of Remedial Works - 4m Slope
- Top of Slope
- Bottom of Slope
- Armco Barrier
- Varioguard Barrier
- Watercourse

SECTION LEGEND

- Existing Ground Level
- Topsoil
- Made Ground
- Embankment Fill
- Glacial Till
- London Clay Formation
- Anticipated Highways Agency Boundary Fence
- Armco Barrier
- Varioguard

Rev	Revision details	Chkd	Appd	Date

Drawn:	NM	Preliminary	
Design:	SB	For comment	
Chkd:	IT	For tender	
Appd:	TB	For construction	
Date:	27.11.14	As constructed	
		Other	

amey

Client: HIGHWAYS AGENCY

Project Name: M11 Site B - Junction 6

Drawing Title: Geotechnical
Exploratory Hole Location Plan and Indicative Cross Sections [Sheet 2 of 2]

Original Drawing Size :	A1
Scale : 1:500m@A1, 1:1000m@A3	Dimensions : 594x841

Drawing No	Rev
HA537529-AMEY-GE-DR-002	-

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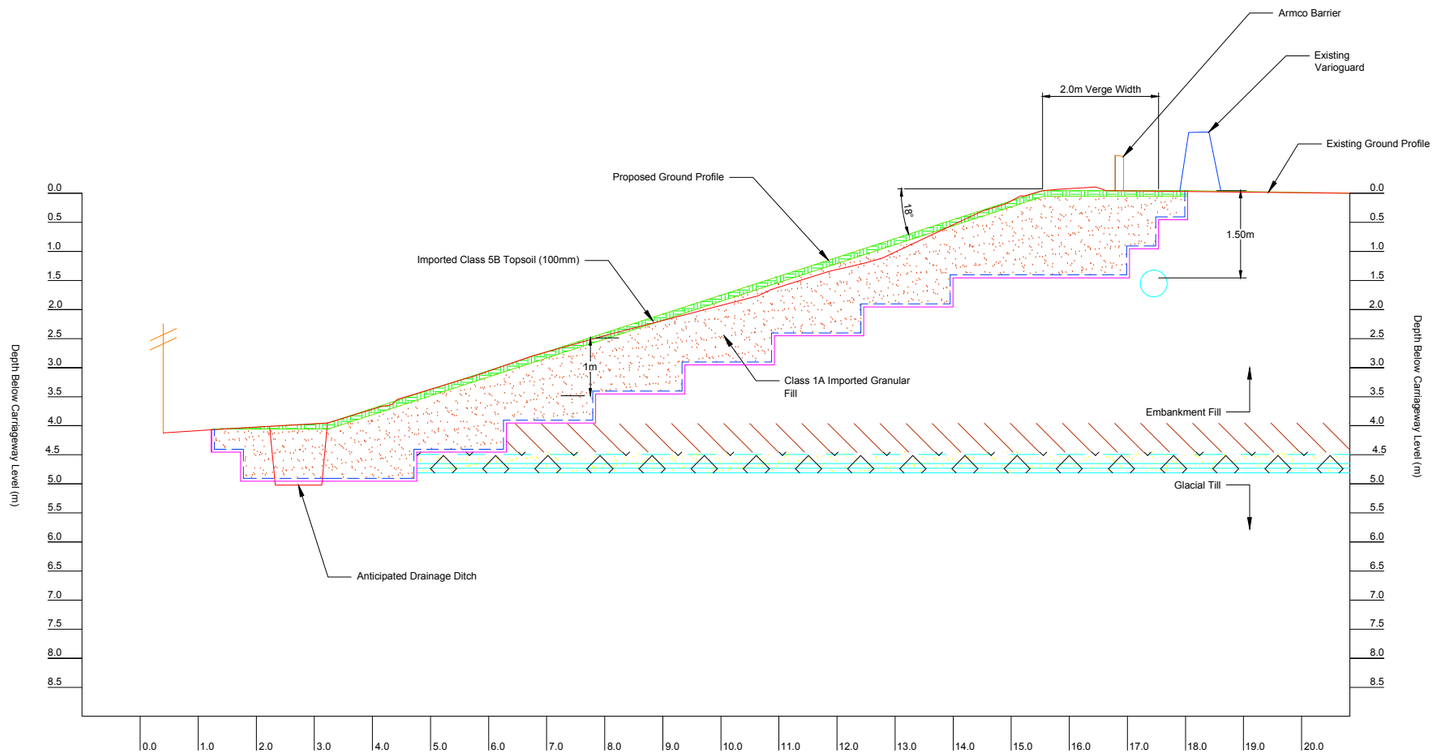

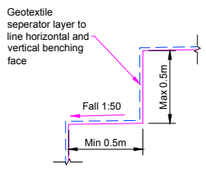

Benching Detail
Scale 1:20

RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Working in the Proximity of Watercourse/Culvert
2. Working within temporary works

NOTES

1. This drawing should be read in conjunction with the Geotechnical Design Report (GDR) report number: CON-GE-BHAM-52200806-001.
2. This drawing is to be read as part of drawing series: HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.
3. For Exploratory Hole Location Plan, works extents and Indicative Cross Sections refer to drawing numbers: HA537529-AMEY-GE-DR-001 & HA537529-AMEY-GE-DR-002.
4. For details of proposed Remedial Works refer to Series 100 and 600 Specifications.
5. Extent of Imported Granular Fill is indicative and is to be confirmed by the overseeing organisation after further investigation.
6. A CCTV drainage survey and renovation of defective drainage is to be completed as part of remedial works
7. Existing Vehicle Restraint Barriers are to be replaced as part of the remedial works.
8. A further survey of the landscape may be required to determine the ground slope profile beneath the areas of dense vegetation.
9. Earthworks are to be completed in compliance with Ameys Series 100 and 600 specifications.
10. Fill interfaces shall be constructed such that drainage of the interface is towards the excavated face at approximately 5° to the horizontal.

LEGEND

- Existing Ground Profile
- Proposed Ground Profile
- Geotextile Separator Layer
- Excavation Profile
- Armco Barrier
- Varioguard Barrier
- Granular Fill Replacement
- 100mm Topsoil/Seeding
- Anticipated Crest Drainage
- Anticipated Drainage Ditch
- Embankment Fill
- London Clay

Rev	Revision details	Chkd	Appd	Date

Design:	SB	Preliminary	✓
Drawn:	RF	For comment	
Chkd:	IJT	For tender	
Appd:	TB	For construction	
Date:	15.12.14	As constructed	
		Other	

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Client
HIGHWAYS AGENCY

Project Name
M11 Junction 6 - Site B

Drawing Title
Geotechnical
Proposed Remedial Solution for 4m Height Sections

Original Drawing Size : A1	Dimensions : -
Scale : 1:50@A1, 1:100@A3	Copyright © Amey

Drawing No	Rev
HA537529-AMEY-GE-DR-003	-

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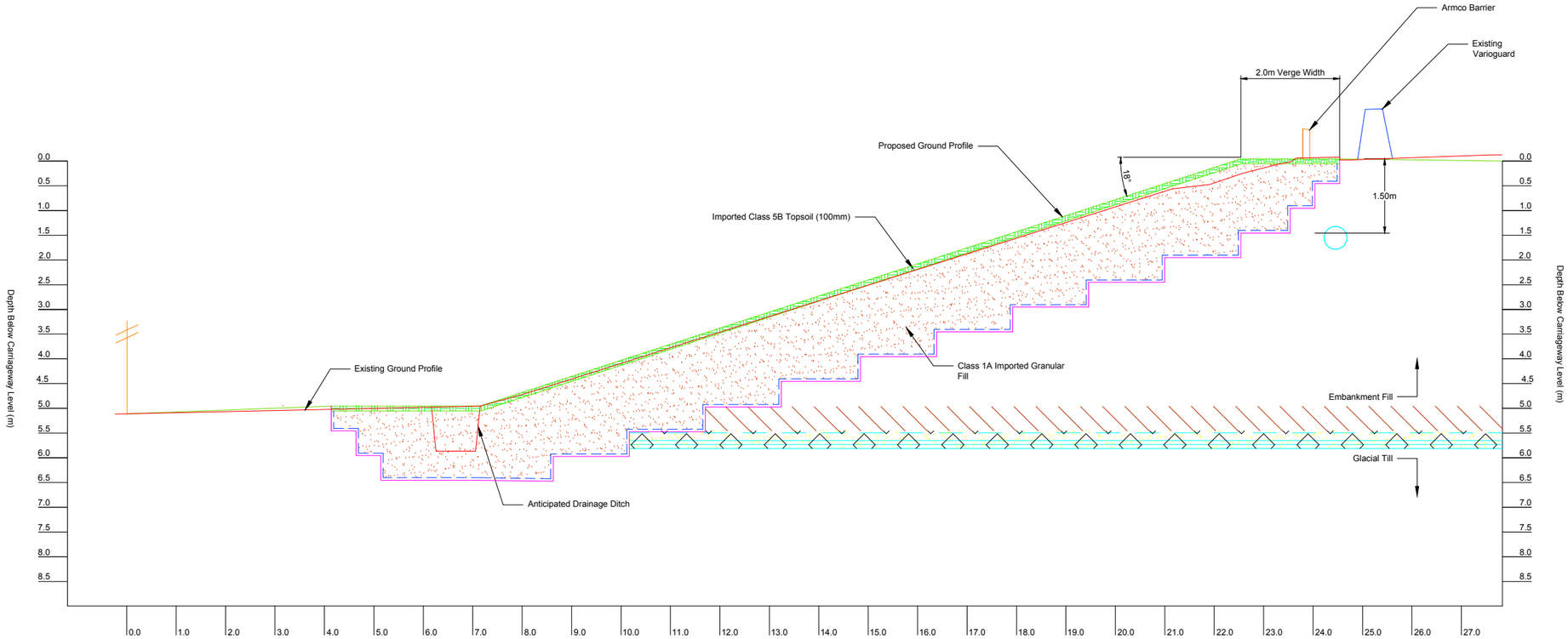

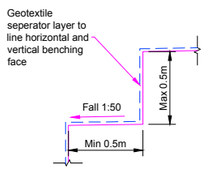

Benching Detail
Scale 1:20

RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Working in the Proximity of Watercourse/Culvert
2. Working within temporary works

NOTES

1. This drawing should be read in conjunction with the Geotechnical Design Report (GDR) report number: CON-GE-BHAM-52200806-001.
2. This drawing is to be read as part of drawing series: HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.
3. For Exploratory Hole Location Plan, works extents and Indicative Cross Sections refer to drawing numbers: HA537529-AMEY-GE-DR-001 & HA537529-AMEY-GE-DR-002.
4. For details of proposed Remedial Works refer to Series 100 and 600 Specifications.
5. Extent of Imported Granular Fill is indicative and is to be confirmed by the overseeing organisation after further investigation.
6. A CCTV drainage survey and renovation of defective drainage is to be completed as part of remedial works
7. Existing Vehicle Restraint Barriers are to be replaced as part of the remedial works.
8. A further survey of the landscape may be required to determine the ground slope profile beneath the areas of dense vegetation.
9. Earthworks are to be completed in compliance with Ameys Series 100 and 600 specifications.
10. Fill interfaces shall be constructed such that drainage of the interface is towards the excavated face at approximately 5° to the horizontal.

LEGEND

- Existing Ground Profile
- Proposed Ground Profile
- Geotextile Separator Layer
- Excavation Profile
- Armco Barrier
- Varioguard Barrier
- Granular Fill Replacement
- 100mm Topsoil/Seeding
- Anticipated Crest Drainage
- Anticipated Drainage Ditch
- Embankment Fill
- London Clay

Rev	Revision details	Chkd	Appd	Date

Design:	SB	Preliminary	✓
Drawn:	RF	For comment	
Chkd:	IJT	For tender	
Appd:	TB	For construction	
Date:	15.12.14	As constructed	
		Other	

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Client
HIGHWAYS AGENCY

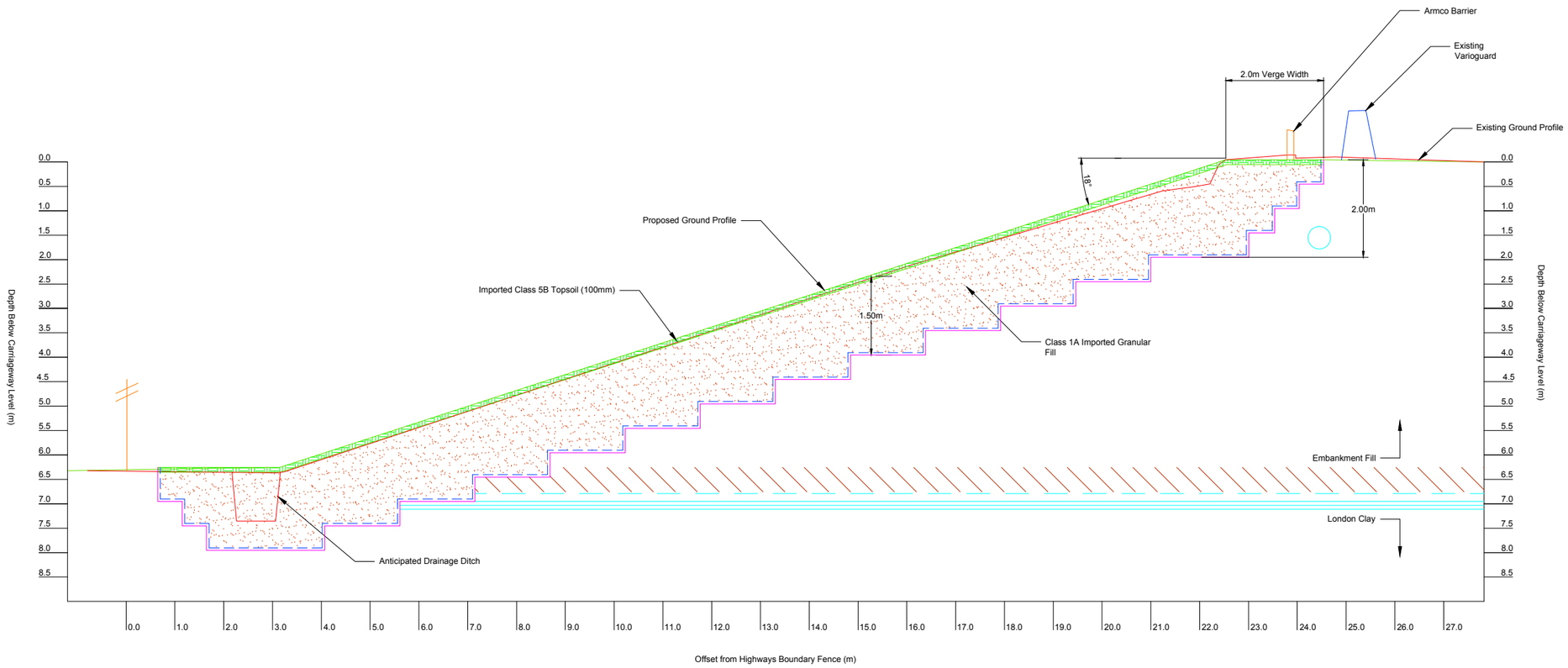
Project Name
M11 Junction 6 - Site B

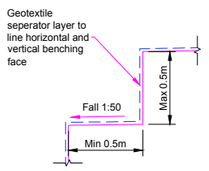
Drawing Title
Geotechnical
Proposed Remedial Solution for 5m Height Sections

Original Drawing Size : A1	Dimensions : -
Scale : 1:50@A1, 1:100@A3	Copyright © Amey

Drawing No	Rev
HA537529-AMEY-GE-DR-004	-

File ref - p:\projects\area 6 & 8 asc\area 6 asc - geotechnical\m11\m11 site b j6\drawings\wip\1 live drgs\ha537529-amey-ge-dr-003 to 005.dwg





Benching Detail
Scale 1:20

RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Working in the Proximity of Watercourse/Culvert
2. Working within temporary works

NOTES

1. This drawing should be read in conjunction with the Geotechnical Design Report (GDR) report number: CON-GE-BHAM-52200806-001.
2. This drawing is to be read as part of drawing series: HA537529-AMEY-GE-DR-001 to HA537529-AMEY-GE-DR-005.
3. For Exploratory Hole Location Plan, works extents and Indicative Cross Sections refer to drawing numbers: HA537529-AMEY-GE-DR-001 & HA537529-AMEY-GE-DR-002.
4. For details of proposed Remedial Works refer to Series 100 and 600 Specifications.
5. Extent of Imported Granular Fill is indicative and is to be confirmed by the overseeing organisation after further investigation.
6. A CCTV drainage survey and renovation of defective drainage is to be completed as part of remedial works
7. Existing Vehicle Restraint Barriers are to be replaced as part of the remedial works.
8. A further survey of the landscape may be required to determine the ground slope profile beneath the areas of dense vegetation.
9. Earthworks are to be completed in compliance with Ameys Series 100 and 600 specifications.
10. Fill interfaces shall be constructed such that drainage of the interface is towards the excavated face at approximately 5° to the horizontal.

LEGEND

- Existing Ground Profile
- Proposed Ground Profile
- Geotextile Separator Layer
- Excavation Profile
- Armco Barrier
- Varioguard Barrier
- Granular Fill Replacement
- 100mm Topsoil/Seeding
- Anticipated Crest Drainage
- Anticipated Drainage Ditch
- Embankment Fill
- London Clay

Rev	Revision details	Chkd	Appd	Date

Design:	SB	Preliminary	✓
Drawn:	RF	For comment	
Chkd:	IJT	For tender	
Appd:	TB	For construction	
Date:	15.12.14	As constructed	
		Other	

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Client
HIGHWAYS AGENCY

Project Name
M11 Junction 6 - Site B

Drawing Title
Geotechnical
Proposed Remedial Solution for 6.3m Height Sections

Original Drawing Size : A1	Dimensions : -
Scale : 1:50@A1, 1:100@A3	Copyright © Amey

Drawing No	Rev
HA537529-AMEY-GE-DR-005	-

Produced by Amey on behalf of the Highways Agency

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