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Geotechnical Specification

Appendix 1

Appendix 6

Document No: COSTCDX8620-600-001

This document has been formulated with reference to the Manual of Contract Documents for Highway Works, Volume 1 Specifications for Highways Works

Version	Date	Change log	Author	Reviewed	Authorised
0	19 th Feb 2016	1 st Issue	MA	IT	TB

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

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

- (i) Unless otherwise stated, all sampling and testing in this Appendix shall be by the Contractor.
- (ii) 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).
- (iii) (N) Indicates that a UKAS or equivalent accredited laboratory sampling and test report or certificate is required.
- (iv) 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.
- (v) 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.
- (vi) 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.
- (vii) 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.
- (viii) Additionally all test results shall be presented in accordance with the relevant testing standard and shall incorporate the following information:
 - Specimen reference;
 - Material brief description;
 - Manufacturer's, supplier's name or origin as appropriate;
 - Batch reference number (proprietary material only);
 - Quantity of material;
 - Location of material in the works;
 - Date sampled, by whom and method used;
 - Date(s) tested;
 - Results of all tests.

TABLE NG 1/5

Clause	Work, Goods or Material		Test	Frequency of Testing	Test Certificate	Comments	
Series 600							
601, 631 to 637, 640	Acceptable material				required		
	Class	General Description					
	1A1	General granular fill	Grading / uniformity coefficient	3no. per source – then 1no. per 2,000m ³		For recycled aggregate, See sub- clauses 601.12 and 601.18	
			mc/OMC(N)	3no. per source – then 2no. per 2,000m ³			
			Drained shear parameters (N)	3no. per source – then 1 per 5000m ³			
			Contamination Testing	Frequency to fulfil requirements of App 6/14 and 6/15			Cross reference should be made to any requirements in contract specific Appendix 6/1
	2A1	General cohesive fill	Grading (N)	6no. per source – then 1no. per 2,000m ³		See App 6/2, 6/14 and 6/15	
			mc/OMC/PL drained shear strength (N)	6no. per source and then 1 per 1000m ³			Cross reference should be made to any requirements in contract specific Appendix 6/1
			Contamination Testing	Frequency to fulfil requirements of App 6/14 and 6/15			See App 6/2, 6/14 and 6/15
	4	Landscape Fill	Grading /mc/MCV (N)	1 per 250m ³ or 3no. per source			

			Contamination Testing	Frequency to fulfil requirements of App 6/14 and 6/15		See App 6/2, 6/14 and 6/15
	5	Topsoil	Grading (N)	1no. per 250m ³		
	6C	Selected granular material – Starter Layer	Grading/uniformity coefficient (N)	1 per 400 tonnes		
			PI/LL (N)	Daily		
			Resistance to fragmentation (N)	1 per source		LA Category
			Contamination Testing	Frequency to fulfil requirements of App 6/14 and 6/15		See App 6/2, 6/14 and 6/15
602	Earthworks material beneath surface of a road or paved central reserve		Frost heave (N)		required	
	1) 1A1 Fill			1 per source		
	2) 2A1 Fill			2 per source		
612	Compaction of Fills	Method compaction	Field dry density (N)	1 per layer per 50m section	required	
		End product compaction	Field dry density (N)	2 per layer per 50m section		Nuclear methods to be used in accordance with Appendix 6/3
			MC (N)	2 per layer per 50m section		
		Core Cutter	In-situ: 1no. In 10no. Nuclear Method Test Laboratory: 1no. In 25no. Nuclear Method Test	required		Calibration testing for Nuclear Density Method

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING ETC. OF EARTHWORKS MATERIALS**1. Acceptable Limits for Fills**

- (i) 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.
- (ii) Granular fill and cohesive fill materials shall conform to the requirements of the Manual of Contract Documents for Highway Works (MCHW), Volume 1, Series 600, Table 6/1. Areas where the granular fill and cohesive fill is to be used are shown on the drawing series CDX8620-R06-01 to 06.
- (iii) Where Class 2A1 material is being utilised in embankment construction a granular starter layer is required. Granular Fill used as a starter layer for earthworks construction will be of Class 6C to meet the minimum method specification requirements in addition to the requirements of clauses 608, 609, 612 (of Series 600 specifications for earthworks) and Table 6/1.
- (iv) Granular Fill used in embankment construction shall be Class 1A1 to meet the minimum method specification requirements in addition to the requirements of clauses 608, 609, 612 (of Series 600 specifications for earthworks) and Table 6/1. Class 1A1 material is to be placed using Method Compaction techniques (see Table 5/1, 6/1 and Clause 612)
- (v) Cohesive Fill shall be Class 2A1 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. Class 2A1 material is to be placed using End-Product Compaction techniques (see Table 5/1, 6/1 and Clause 612)
- (vi) Material recovered on site during benching operations may be used on site as Class 4 landscape fill subject to determination of acceptability (Table 6/1, App 6/14, 6/15).
- (vii) Class 5A and 5B fill shall be used for Topsoil.

2. Requirements for Determining Acceptability

- (i) The Contractor shall carry out all necessary testing as detailed in Appendix 1/5 to demonstrate the classification and acceptability of earthworks materials given in Table 6/1. The classification of on-site materials shall be undertaken at the point of excavation and the classification of imported materials shall be undertaken at the point of deposition.

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- (ii) Earthworks materials classification and acceptability test results shall be made available to the Overseeing Organisation within 3 days of scheduling the test. The Overseeing Organisation may request additional repeat testing in accordance to Table 6/1, if in their opinion, the imported materials or on-site materials vary in classification or become unacceptable for whatever reason. The rate of further testing required shall be sufficient to ensure the correct classification and acceptability of the materials taking into account the variations.
 - (iii) Source approval testing is required for all fill materials. To obtain source approval, the Contractor shall notify the Overseeing Organisation of the location, extraction method, supplier (for imported materials), material type, volume of material and carry out a full range of tests at the frequency detailed in Appendix 1/5 to demonstrate compliance to the acceptability criteria for a Class of fill given in Table 6/1.
 - (iv) Source approval testing shall be carried out at least 7 days prior to filling. The Overseeing Organisation may additionally request a site visit to the source of the material prior to providing approval. All imported materials shall be tested at the source for contaminants in accordance with Table 1/5 and App 6/14 and 6/15.
 - (v) Prior to the sampling of materials for any testing, the Contractor shall give reasonable notice to the Overseeing Organisation as to afford them an opportunity to witness the taking of the sample and to permit the Overseeing Organisation to take a joint sample to undertake confirmation testing.
 - (vi) The Contractor shall maintain full records relating to the import and export of materials to the site, including the disposal of Class U materials to licensed facilities. The Contractor shall also keep records as to identify stockpiles, and the movement and deposition of all materials on-site.
 - (vii) Compaction trials will be conducted on each new Class 2A1 source material prior to the use of material in construction in compliance clauses 612.11 to 612.15. Prior to carrying out any filling works the Contractor shall carry out a compaction trial to demonstrate that his elected plant and methods of compaction will achieve the requirements of the Specification. The Contractor shall provide the details and specification of the proposed compaction plant prior to commencing the trial. The trial embankment shall have a minimum vertical height of 600mm and a minimum horizontal length of 10m and shall be constructed to ensure that each layer complies with the Specification. The compaction trial may be incorporated into the permanent works provided that all layers of fill have been demonstrated to have passed the Specification requirements. The Overseeing Organisation is to be notified 1 week before the compaction trial is commenced and shall observe the trial and associated in situ compliance testing. Further compaction trials shall be carried out in the event that different compaction plant is used.
 - (viii) Field tests are required for the compacted fill to ensure the correct placement and compaction procedures are being applied. During the compaction trial, dry density tests shall be undertaken and the results obtained from correctly placed and compacted fill will be assessed and a minimum characteristic dry density for correctly placed and compacted fill shall be derived by
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the Overseeing Organisation. A maximum dry density of 95% following compaction is required. Subsequent dry density test results obtained during the earthworks shall exceed this characteristic value. Further geotechnical testing as detailed in Appendix 1/5 shall be used to further assess the quality and suitability of the imported earthworks materials. Testing of the trial is to be carried out as detailed in Table 1/5.

3. Designation of Material as Class 3

Not used

4. Rendering Unacceptable Material Acceptable

- (i) The processing of unacceptable material to render acceptable is permitted off-site. No surplus material (unacceptable or acceptable) shall be retained on-site. Surplus materials shall be disposed of in accordance to Appendix 6/2.

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements

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
						Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits		
								Lower	Upper	
1	A	1	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate	(i) grading	BS1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2
						(ii) uniformity coefficient	see Note 5	10	-	
						(iii) moisture content (see Note 4)	BS 1377: Part 2	App 6/1	App 6/1	
						(iv) Moisture Condition Value (MCV)	Clause 632	App 6/1	App 6/1	
						(v) IDD of chalk	Clause 634	-	App 6/1	
						(vi) Effective angle of shearing resistance and cohesion	Clause 633	Phi' - 26°	App 6/1	
2	A	1	Wet cohesive material	General Fill	Any material or combination of materials, other than chalk.	(i) grading	BS1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except for materials with liquid limit greater than 50, determined by BS1377 : Part 2, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used
						(ii) plastic limit (PL)	BS1377: Part 2	-	-	
						(iii) moisture content (see Note 4)	BS1377: Part 2	PL-4%	App 6/1	
						(iv) Moisture Condition Value (MCV)	Clause 632	App 6/1	App 6/1	

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		
				Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits				
						Lower	Upper			
				(v) Effective angle of shearing resistance and cohesion	Clause 633	Phi' - 26°	App 6/1			
4	-	-	Various	Fill to landscape areas	See App 6/1	(i) grading	BS1377: Part 2	App 6/1	App 6/1	See Clause 620 and App 6/1
						(ii) moisture content (see Note 4)	BS1377: Part 2	-	App 6/1	
						(iii) Moisture Condition Value (MCV)	Clause 632	App 6/1	App 6/1	
5	A	-	Topsoil or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the contract	(i) grading	Clause 618	App 6/1	App 6/1	Not Applicable
5	B	-	Imported Topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	Not Applicable
6	C	-	Selected Uniformly Graded Granular Material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (properties (iii) in the next column, shall not apply to	(i) grading	BS1377: Part 2 (On-Site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3
							BS EN 933-2 (Off-Site)	Tab 6/5	Tab 6/5	
						(ii) plasticity index	BS 1377 : Part 2	Non-plastic		
						(iii) Los Angeles coefficient	Clause 635	-	50	

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
				Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits		
						Lower	Upper	
			chalk.) Recycled aggregate	(iv) Uniformity Coefficient	See Note 5	-	10	
				(v) mc	BS 1377: part 2	App 6/1	App 6/1	

Footnotes to Table 6/1

1. App = Appendix
2. Tab = Table
3. Where in the Acceptable Limits column reference is made to Appendix 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 mc, 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 D60 to D10 on the particle-size distribution curve, where:
 - D60 = particle diameter at which 60% of the soil by weight is finer
 - D10 = particle diameter at which 10% of the soil by weight is finer
6. The moisture content of granular fills shall be determined on the material passing the 20mm BS sieve.
7. Where note 8 is referred to in Table 6/1 the moisture content shall lie in the range necessary to achieve 95% of maximum dry density to BS1377 with the compactive effort specified on omc-dry density relationship as defined by BS1377 Part 4.

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8. Where determination of the optimum moisture content of granular soils is required and the grading of the material places it in Zone 'X' as defined in BS1377 Part 4 Figure 1, then the omc shall be determined where > 35% of the material passes the 37.5mm BS sieve using a CBR mould. The procedures for soils susceptible to crushing during compaction shall be applied to all relevant soils (e.g. well burnt non-plastic shale).
 9. For all fills where MCV, moisture content and shear strength acceptability limits are provided, the MCV compliance criteria shall be used to control the acceptability of the fill material, subject to compliance with Clause 632, unless agreed otherwise with the Designer. The frequency of tests for moisture content and shear strength may be reduced following confirmation of correlation with MCV results as agreed with the Designer.
 10. Where undrained shear strength is specified as a method of material classification and control, a Hand Shear Vane may be used provided that it is initially calibrated by suitably qualified technician.

Table 6/2: Grading Requirements for Acceptable Earthworks Materials Other Than Classes 6F4, 6F5 and 6S

Percentage by Mass Passing the Size Shown																					
Class	Size (mm)		Size(mm) BS Series													Size (microns) BS Series				Size (microns)	Class
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2	
1A		100	95-100																<15		1A
2A			100											80-100					15-100		1B
6C			100			0-100					0-100		0-35	0-10		0-2					6N

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS**1. General**

- 1.1 Material excavated from existing earthworks or earthwork foundation areas may be used as Class 4 Landscaping Fill subject to determination of acceptability. If the material is classed as unacceptable for re-use on-site, on the basis of contamination or condition, it shall be removed from the site unless otherwise agreed with the Overseeing Organisation and relevant authorities.
- 1.2 Notwithstanding the obligations under the Conditions of Contract, material suspected of being Class U2 and U1B material unsuitable for reuse on site shall be classified in accordance with the 'European Waste Catalogue'.
- 1.3 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.

2. Material Handling, Classification and Disposal

- (i) 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.
- (ii) 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.
- (iii) 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.

3. Identification of Potentially Contaminated Materials

- (i) The Construction team shall ensure that the working faces and arisings from excavations are closely observed for signs of potential contamination such as:
- fuel and oil contamination, including the presence of free phase hydrocarbon product;
 - tar and tarry wastes;

- putrescible waste materials;
- medical waste;
- suspected ordnance;
- drums, tanks, underground structures, redundant services, canisters or other containers
- containing unknown materials;
- ash, clinker, bricks and other indicators of made ground;
- asbestos containing materials (ACM); and
- Other visually or olfactory impacted material, including contaminated liquids or sludge.

(ii) If suspected contamination or unusual materials are identified, the Overseeing Organisation shall be notified immediately.

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

- ** And non-hazardous wastes deposited in the same cell
- * Either TOC or LOI must be used for hazardous wastes
- ~ The lower limit values for Cd and Hg may apply within the UK (see above)
- # If an inert waste does not meet the SO₄ L/S10 limit, alternative limit values of 1500 mg l⁻¹ SO₄ at C_o (initial eluate from the percolation test (prEN 14405)) and 6000 mg kg⁻¹ SO₄ 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 SO₄
- @ 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)****1. General**

- (i) Earthworks Requirements are shown on the Earthworks Drawings series CDX8620-R06-01 to 06. Details of existing and proposed road and land elevations are provided on the Pavement Drawings.
- (ii) For details of any required topsoil strip refer to Appendix 6/8.

2. Blasting

Blasting is not permitted, conventional excavation only.

3. Cutting Faces

- (i) Undercutting not required.

4. Watercourses (including Ditches)

- (i) Requirements for redundant, new or modified ditches and culvert are shown on Contract Drawing CDX8605-R05-01.
- (ii) Redundant ditches shall be cleared in accordance to Clause 606.4 and excavated where necessary in the locations shown on the contract drawings. Any openings shall be infilled with Class 61A in accordance to Table 6/1. Acceptable earthworks materials shall be deposited in accordance to Clause 612.

5. Embankment Construction

- (i) The extent of excavation for embankment widening sections is as defined on the series COSTCDX8620-600.
- (ii) Where existing earthworks are being widened the excavation shall be benched, and benching will be formed as indicated on the Contract Drawings series COSTCDX8620-600.
- (iii) The extents and limitations for benched excavation prior to backfilling and compaction for re-engineered slopes taking account the position of existing and proposed services is as per the contract drawings and should to be confirmed on-site.
- (iv) Minimum thickness of capping or of sub-base as appropriate for weather protection of sub-formation or formation in accordance to Clause 608.9i.

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- (v) Unless otherwise approved by the Overseeing Organisation, the Contractor shall restrict the time between excavation and deposition in areas of sequential excavation and backfilling to 24 hours.
 - (vi) Benched excavation is required to tie in the new earthworks. The extents and limitations for benched excavation prior to backfilling and compaction for re-engineered slopes, taking account the position of existing and proposed services, is as per the contract drawings and should to be confirmed on-site.
 - (vii) Where a suitable formation stratum and/or other conditions exist that are not compatible with the design assumptions then excavation shall continue until such material is met or a suitable alternative formation approved by the Overseeing Organisation Designer is met.
 - (viii) Soft spots in the embankment foundation formation level shall be defined as areas where the soil does not meet the minimum assumed shear strength requirements of 40 kN/m² and should be identifiable by the fact that the soil does not support the roller weight during proof-rolling without excessive deformation. The extent of soft spots shall be determined by inspection during proof-rolling.
 - (ix) Soft spots identified in the embankment foundation formation shall be excavated and replaced with suitably compacted granular material.
 - (x) Cohesive/granular fill interfaces shall be constructed such that drainage of the interface is towards the edge of the embankment. The slope of the interface shall be such that any water drains to the outside of the embankment. No pockets of granular material shall be formed within cohesive material.
 - (xi) Any excavated materials that is removed from site by the contractor as waste must be disposed of at a suitably licenced landfill.
 - (xii) Earthworks materials for deposition shall be either Class 1A1 or Class 2A1 material in accordance to Table 6/1.
 - (xiii) Where Class 2A1 material is used in earthworks construction a 500mm starter layer of Class 6C material is required.
 - (xiv) Sequential excavation and benching shall be adopted where unsupported lengths of over-steepened excavated faces are exposed.
 - (xv) The Contractor shall restrict the unsupported lengths of over-steepened excavated faces to 20m where possible.

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- (xvi) Surcharging of embankments other than as specified by the Designer and as indicated on the construction drawings is not permitted.
 - (xvii) The Contractor shall phase excavations such that temporary works stability is ensured. The Contractor shall undertake sufficient temporary works design to satisfy the Overseeing Organisation that the risk of temporary works instability has been minimised.
 - (xviii) Acceptable earthworks materials shall be deposited to form layers no greater than 0.25m thick.
 - (xix) Construction of the re-engineered slope shall be to the extents and levels defined on the Contract Drawings except to permit adequate compaction (to allow for settlement if required) at the edges before trimming back to the final profile.
 - (xx) Where the new embankment profile meets the existing embankment slope a 20m transition zone within the new embankment will be used to grade the slope angle from the existing embankment slope angle of 28° (1 in 2 v:h) to 21° (1 in 2.5 v:h).
 - (xxi) During periods of inclement weather (heavy precipitation, hot, dry or frosty conditions) the Contractor will protect formed layers to ensure the integrity of the placed materials.
 - (xxii) After poor weather conditions compliance testing of the last layer deposited must be undertaken.
 - (xxiii) Where material type 2A1 is used to form earthworks machine movements must be controlled to ensure rutting of deposited layers does not occur.
 - (xxiv) Class 6M material not required.

6. Compaction

- (i) General:
 - (a) The Contractor's attention is drawn to Clause 612 and Table 6/4 of the Specification for Highway Works which gives the approved methods of compaction for the highway embankments.
 - (b) Requirements of compaction shall comply with Clause 612 to form layers no greater than 0.25m thick.
 - (ii) Method Compaction:
 - (a) Where the contract drawings define areas of widening of existing earthworks extra compaction of the top 600mm for Classes 1A1 is required over the full extent of the
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widening in accordance with Clause 612.10. Temporary over-widening to achieve adequate compaction of the shoulders of the embankment will be permitted.

- (b) The frequency of field dry density testing shall be as set out in Appendix 1/5.
 - (c) Nuclear Density Testing will not be used on granular fill material
- (iii) End Product Compaction:
- (a) The Contractor's attention is drawn to Clause 612.11 to 612.15 with regards to end-product compaction.
 - (b) Nuclear Density Testing is to be carried out 2no. times per layer per 50m section earthworks constructed from Class 2A1 material as described in Table 1/5.
 - (c) Nuclear Density Testing will be calibrated using on-site core cutter testing which will be performed for 1no. in 10no. Nuclear Density Tests as described in Table 1/5.
 - (d) Nuclear Density Testing will be calibrated using laboratory core cutter testing which will be performed for 1no. in 25no. Nuclear Density Tests as described in Table 1/5.

7. Temporary Works

- (i) The Contractor is to be responsible for the stability, safety and practicality of any temporary works necessary for the Contract.
- (ii) The Contractor is to be liable for additional costs or any damage caused by inadequate temporary works.
- (iii) Details of temporary works proposals to be submitted for the approval of the Overseeing Organisation prior to construction.
- (iv) No excavation shall be left unsupported at the end of a shift.

8. Benching

- (i) Where existing embankments are to be extended and where embankments are to be constructed on ground with a slope, such slope being measured at right angles across the width of the embankment, benches shall be constructed as shown on the Contract Drawings series COSTCDX8620-R06.
- (ii) Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.

- (iii) Placing and compaction of the fill material shall continue to a level above an adjacent bench before material is placed upon that bench.
- (iv) Benches formed in sidelong ground shall be inspected by the Designer for signs of seepage.

9. Refer to Contract Drawings for benching requirements.

APPENDIX 6/4: REQUIREMENTS FOR CLASS 3 MATERIAL

Not Used

APPENDIX 6/5: GEOTEXTILES USED TO SEPARATE EARTHWORKS MATERIALS

1. A geotextile separator is required between the Class 6C starter layer and Class 2A1 fill if used.
2. A geotextile separator is required where new embankment material of Class 1A1 or 2A1 type is to be emplaced on existing embankment slopes.
3. The locations of geotextiles to be used as a material/filter separator are shown on the Contract Drawings series 600.
4. Material/filter geotextiles shall have a life expectancy in excess of 120 years meet the following minimum performance characteristics:

Property	Test Method	Minimum Value
Tensile Strength	EN ISO 10319	6.0 kN/m (-0.6)
Tensile Elongation	EN ISO 10319	60% (+/-20)
CBR Puncture Resistance	EN ISO 12236	1050 N (-1050)
Cone Drop	EN ISO 13433	42 mm (+8)
Pore Size – Mean AOS	EN ISO 12956	95 µm (+/-20)
Permeability – (H ₅₀)	EN ISO 11058	100l/m ² s (-30)

The Contractor shall seek approval of the geotextile to be used prior to the start of the works. All geotextile separator layers and reinforcement geogrids shall be laid and lapped in accordance with Clause 609.5 or with the manufacturers guidance whichever is the greater.

5. All geotextile separator layers which are to be incorporated in the permanent works shall be BBA or CE accredited.
6. No sampling or testing for material/filter geotextiles is required subsequent to approval.

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

1. Details of fill to structures and above structural foundations see Drawings No. CDX8620/R06/10

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

1. All pavements shall be constructed in accordance with the Specification and in particular Appendix 7/1 in the locations illustrated in the Contract Drawings COSTCDX8620/R07/01.
2. The Contractor's particular attention is also drawn to Clauses 613 to 617.
3. Sub-base requirements have been assessed on 'Design' CBR values based on anticipated sub-grade strata. The Contractor is required to check that the 'Design' CBR values are satisfied by the sub-grade and groundwater conditions encountered by undertaking in-situ TRL CBR probe testing and sub-grade inspections by a suitably qualified engineer. If the sub-grade is deemed not to be suitable, then pavement foundation design options shall be re-assessed adopting the recorded in-situ CBR value. Any revised design CBR value and pavement foundation requirements shall be suitably recorded.
4. Preparation and surface treatment of the sub-formation, including tolerances, shall be in accordance with Clause 616.1 as for formation.
5. Capping not required.
6. Demonstration area not required.
7. Sub-formation to have the same longitudinal gradient, crossfall and surface level tolerances as the formation (Clause 613.8).
8. Lime stabilisation not to be used.
9. Preparation and surface treatment of formation to be in general accordance with Clause 616.

APPENDIX 6/8: TOPSOILING

1. The locations and details of topsoiling will be carried out in accordance to Series 3000 Specifications.
2. Topsoil shall be Class 5A or 5B material in accordance to Table 6/1.
3. Topsoil is to be stripped off and stockpiled for re-use (pending acceptability testing) in accordance to Clause 602.10. Surplus or unacceptable materials shall be disposed of by the Contractor. The Contractor shall provide a method statement for the stripping and stockpiling of topsoil on-site to the Overseeing Organisation prior to the start of works.
4. Topsoil shall be stored separately from other excavated materials. The depth to be stripped in each area shall be determined on site.
5. Topsoil shall be stored in mounds not exceeding 2.0 metres in height with maximum side slopes of 1 (vertical) in 1.5 (horizontal).
6. Topsoil mounds to be stored for periods of greater than six months shall be seeded with a mix of slow growth grass seed.
7. No stockpiles of topsoil, or any other material shall be stored within the root zone of mature trees or in areas where existing trees/habitats may be damaged or where surface run off to watercourses would be detrimental to water quality.
8. Topsoil shall have all materials exceeding 50mm removed and disposed off-site in accordance to Appendix 6/2.
9. The requirements of Clause 618.3 apply.
10. Topsoil depths and ground preparation/seeding are defined in Appendix 30/4 and 30/5.
11. Topsoil shall be in accordance with BS 4428.

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

1. Earthworks material acceptability is outlined in Appendix 6/1. Excavation, deposition and compaction requirements are provided in Appendix 6/3.

APPENDIX 6/10: GROUND ANCHORAGES, CRIBWALLING AND GABIONS

1. Details of Gabion Wall design and specifications are provided in Drawing no. CDX8620/S/22

**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 IMPROVEMENT

Not Used

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

- (i) The suitability of soil for re-use in another area of the site will depend upon its chemical quality and therefore the potential for pollution to controlled waters.
- (ii) 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. Class U1B soils may be improved by treatment and re-assessment of suitability for re-use in specific locations. If excavated soil is not suitable for re-use on site, it must be removed for off-site disposal.
- (iii) Any material which exhibits gross visual evidence of contamination (e.g. visible evidence of hydrocarbons such as free product) is unacceptable.
- (iv) 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.
- (v) 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.
- (vi) General Testing requirements are as in Appendix 1/5.
- (vii) As an alternative to off-site disposal, any soil with chemical concentrations in excess of the Class U1b Limiting Values should be considered for treatment and re-assessment of its suitability for re-use at its intended location.
- (viii) 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	
Sulphate (SO ₄)	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	0.03	
Benzo(k)fluoranthene		
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. All Made Ground or Engineered Fill which is to be moved and re-used on the site will be chemically tested. The suitability of a given volume of soil for re-use in another area of the site will depend upon its chemical quality and therefore the potential for harm to Human Health and the Environment.
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. Class U1B soils may be improved by treatment and re-assessment of suitability for re-use in specific locations. If excavated soil is not suitable for re-use on site, it must be removed for off-site disposal.
3. Materials re-deposited or imported from off site will be chemically tested to demonstrate suitability for use at the intended location at a frequency of one test per 2000 m³ subject to a minimum of three for each material from a distinct source as is 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 shall 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 be focused upon the materials being positioned at their final location in the permanent works, but shall also consider temporary conditions. This approach may restrict the locations where the material can be 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 either be rendered acceptable by treatment or 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 Topsoil. The Appendix 6/8 criteria are primarily based on the phytotoxicity of the 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 6/15.3 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 ($\mu\text{g/l}$)	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 ($\mu\text{s/cm}$)	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 (SO_4)	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 [†]	GAC - LQM
TPH Aromatic (C21 - C35)	28,000 [†]	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 [†]	GAC - LQM
Toluene	869	SGV
Xylene	340	GAC - LQM
Free Cyanide	13,900	SGV
Arsenic	500	SGV
Chromium(III) (Chromium VI)	30,400 (35)	SGV
Cadmium	1400	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.