Future Water
Mackley & Jones Bros. JV

Portsmouth Water

Havant Thicket Reservoir

Control House Retaining Wall Management Plan

Phase 5 – Control House

Date: 26/11/25 | Rev: FW01

Document Reference: HTR-FUW-P5-CB-PL-W-1714

Document Control

REVISION	DATE	AUTHOR	APPROVED BY	REASON FOR ISSUE
P01	09/10/25	LS	PN	
FW01	26/11/25	LS	PN	For planning submission

Contents

1. Introduction 3
1.1 Purpose of Document 3
1.2 Scope of Document 4
2. Reinforced Earth Retaining Walls Overview 5
3. Planting Specification 7
4. Establishment 8
4.1 Establishment Phase Watering & Monitoring 8
5. Maintenance 8
5.1 Vegetation Control 9
5.2 Maintenance Phase Watering 9
5.2 Maintenance Phase Monitoring 10
Appendices 11
Appendix A - TensarTech® GreenSlope™ Earth Retaining Structures: Model Specification 12
Appendix B – Guidelines for the Maintenance of TensarTech® Slope Systems 13

1. Introduction

1.1 Purpose of Document

In 2021, planning permission (ref APP/20/00990 and 51680/001) was granted by Havant Borough Council (HBC) and East Hampshire District Council (EHDC) for development of a reservoir for raw water storage, subject to further planning conditions. Subsequently, a Section 73 application proposing a number of amendments to the design of the main embankment and related infrastructure was approved by both authorities in December 2024 (ref APP/24/00312 and 51680/012).

This Control House Retaining Wall Management Plan has been prepared to support the discharge of the Phase 5 Reserved Matters for the Havant Thicket Reservoir scheme. Phase 5 relates specifically to the Control House, which is an operational structure required to provide access to the culvert and house equipment necessary for the daily operation of the reservoir.

The Control House development comprises of two principal elements; the Control House building, and the Control House courtyard. The Control House building will be formed by a 6m above ground reinforced concrete outer structure with cladding to the front façade of the building, a composite roof slab with a green roof and a steel frame with blockwork internal walls. The building will be set back into the main (southern) embankment creating a courtyard in front of the Control House building which will be formed by naturally vegetated reinforced earth retaining walls which slope to follow the profile of the reservoir main (southern) embankment, as shown in Figure 1 below. Security fencing is present around the courtyard perimeter, with secure pedestrian and vehicle access gates on the southern fence line.

Figure 1 – Illustration of Phase 5 RMA – Control House Courtyard

1.2 Scope of Document

This Management Plan, submitted alongside the Phase 5 Reserved Matters, provides information on how the reinforced earth retaining walls will be established, maintained and manged in order to ensure the planting is successful and sustained in perpetuity. The plan is to be appended to the Landscape and Ecology Management Plan (LEMP) (doc ref. HTR-POR-ZZ-ZZ-RP-K-0004) during its next revision, as the LEMP sets out long-term management of landscape and biodiversity features site-wide.

Details of the reinforced earth retaining walls are provided on the following drawings submitted with the Phase 5 Reserved Matters application:

- HTR-GHD-CB-RE-DR-T-0001 P06 - Control Building Planning Site/Roof Plan
- HTR-GHD-CB-RE-DR-T-0002 P06 - Control Building Planning Ground Floor Plan
- HTR-GHD-CB-RE-DR-T-0004 P06 - Control Building Planning Building Sections
- HTR-GHD-CB-RE-DR-T-0005 P06 - Control Building Planning Front And Side Elevations

With further detail supplied as part of the Phase 5 Condition 28 Landscaping application, including drawings:

- HTR-GHD-CB-RE-DR-T-0022 P05 – Control Building Landscape Plan
- HTR-GHD-CB-RE-DR-T-0023 P03 – Control Building Landscape Cross Sections Sheet 1
- HTR-GHD-CB-RE-DR-T-0024 P04 – Control Building Landscape Cross Sections Sheet 2

2. Reinforced Earth Retaining Walls Overview

The Control House courtyard in front of the Control House building will be formed by naturally vegetated reinforced earth retaining walls which slope to follow the profile of the reservoir main (southern) embankment, as illustrated in Figure 1 above.

The reinforced earth retaining walls will be formed using TensarTech® GreenSlope System with a slope angle of 70 degrees. The reinforced earth retaining walls will be planted to provide enhanced biodiversity value for the Control House development and help to minimise the visibility of the Control House building and courtyard.

The TensarTech® GreenSlope System has been chosen as it allows slope face angles from 45° to 70° to be achieved (with 70° selected for the Control House courtyard) whilst enabling a naturally vegetated slope face. Figure 2 below provides a typical cross section of the system.

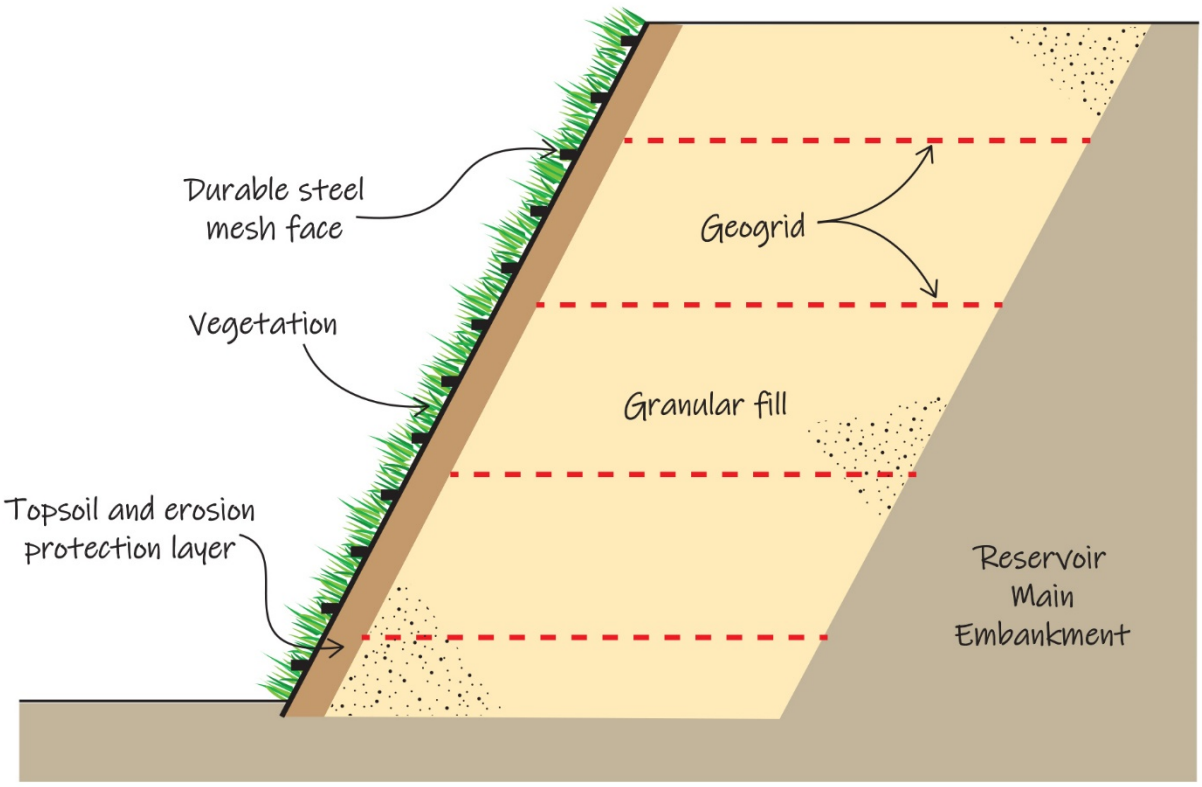

Figure 2 – Typical section through the TensarTech® GreenSlope System

The stability of the slope structure is provided by the granular fill interacting with the geogrid, whilst the steel mesh facing and erosion control applied to the facing units acts as a durable finish to the structure behind and the topsoil fill allows the vegetation to establish. Further detail regarding the specification of the TensarTech® GreenSlope product is included as Appendix A.

Once planted and established, the steel mesh facing and erosion control layer (shown prior to planting in Figure 3a below) will both be obscured by the vegetation. Examples of the finish provided by the system included as Figure 3b.

Figure 3a – Examples of TensarTech® GreenSlope System prior to planting with steel mesh facing and erosion control layer completed

Figure 3b – Examples of fully vegetated TensarTech® GreenSlope System

3. Planting Specification

The face of the reinforced earth retaining walls will be hydroseeded with EM5 Wildflower Mix, the same seed mix as approved for the Main Embankment and proposed for the Control House green roof.

The selected mix has been chosen to ensure cohesion with the wider reservoir site and due to its inclusion of both drought resistant species, to ensure maximum coverage of the vertical slope face, and Yellow Rattle to aid in wildflower meadow creation and restoration.

100% EM5 Wildflower Mix Emorsgate (or similar approved)

Wild Flowers 20%
0.60% *Achillea Millefolium* – Yarrow
0.80% *Agrimonia eupatoria* – Agrimony
1.60% *Betonica officinalis* – Betony
2.40% *Centaurea nigra* – Common Knapweed
0.60% *Daucus carota* – Wild Carrot
0.60% *Galium verum* – Lady's Bedstraw
0.60% *Geranium pratense* – Meadow Crane's-bill
0.40% *Lathyrus pratensis* – Meadow Vetchling
1.60% *Leucanthemum vulgare* – Oxeye Daisy
0.40% *Lotus corniculatus* – Birdsfoot Trefoil
1.00% *Malva moschata* – Musk Mallow
1.60% *Plantago lanceolata* – Ribwort Plantain
1.00% *Poterium sanguisorba* – Salad Burnet
1.00% *Primula versis* – Cowslip
1.60% *Prunella vulgaris* – Selfheal
2.00% *Ranunculus acris* – Meadow Buttercup
0.40% *Ranunculus bulbosus* – Bulbous Buttercup
0.40% *Rhinanthus minor* – Yellow Rattle
1.00% *Rumex acetosa* – Common Sorrel
0.60% *Taraxacum officinale* – Dandelion

Grasses 80%
6.00% *Agrostis capillaris* – Common Bent
1.60% *Alopecurus pratensis* – Meadow Foxtail (w)
0.80% *Anthoxanthum odoratum* – Sweet Vernal-grass (w)
36.00% *Cynosurus cristatus* – Crested Dogstail
4.00% *Festuca ovina* – Sheep's-fescue (w)
16.00% *Festuca rubra* – Red Fescue
8.00% *Phleum bertolonii* – Smaller Cat's-tail (w)
6.00% *Poa pratensis* – Smooth-stalked Meadow-grass
1.60% *Schedonorus arundinaceus* – Tall Fescue (w)

This seed mix is in line with recommendations of the slope system manufacturer.

4. Establishment

Seed is best sown in the Autumn or Spring, but could be sown at other times of the year if there are sufficient warmth and moisture. In this application, it is proposed that seeding takes place in the first Autumn or Spring following completion of the reinforced earth retaining walls, to provide the best opportunities for germination and growth.

To achieve a uniform finish across the retaining walls, hydroseeding will be undertaken using a standard mixture of seeds (as specified in Section 3), mulch, fertiliser, water and tackifiers spread over prepared soil on the vertical face. This technique promotes rapid and uniform germination, and is suitable for successful establishment on 70° slopes, with the mulch in the mix helping retain moisture and protect seeds from wind and pests.

4.1 Establishment Phase Watering & Monitoring

Watering during the establishment phase will be undertaken by the contractor (Future Water) following the below frequency and schedule. This will be undertaken using a hose and water supplies available within the Control House building.

Weeks 1-4 (Initial Phase)

- Frequency: Water 2-3 times per week (more often in hot/dry conditions).
- Monitoring: Visual checks to ensure there is no erosion and moisture remains consistent.
- Goal: Maintain consistent moisture in the topsoil to support root development.

Weeks 5-12 (Root Expansion Phase)

- Frequency: Watering reduced to once per week (depending on rainfall)
- Monitoring: Checks to be carried out looking at soil moisture 5-10 cm below the surface, with watering undertaken if dry.
- Goal: Encourage deeper root growth and plant resilience.

Months 3-6 (Transition to Maintenance)

- Frequency: Water as needed, typically every 10-14 days.
- Monitoring: Increase frequency of watering during drought or heatwaves.
- Goal: Support vegetation maturity and coverage.

5. Maintenance

Ongoing management of the planting on the reinforced earth retaining walls will be in line with the Register of Environmental Actions and Commitments (REAC) LV9 and LV10 (detailed in Figure 4 below). It will also follow 'Guidelines for the Maintenance of TensarTech® Slope Systems' included as Appendix B.

Responsibility for the ongoing maintenance will initially sit with Future Water and then be formally handed over to Portsmouth Water as part of the site wide landscaping maintenance package. Portsmouth Water will then henceforth be responsible for the maintenance of the planting in accordance with the LEMP which this management plan is proposed to be appended to.

Ref	ES Ref	Objective	Actions/commitments
LV9	CH11	Successful establishment of mitigation planting and seeding.	A five-year aftercare period for all soft landscape is to be included within the construction contract to ensure successful establishment. Maintenance within the period to be carried out in accordance with an agreed management plan, maintenance specification and maintenance schedule, all to be developed and agreed in the detailed design stages. Records of all maintenance actions to be kept by the Contractor /management company and provided for regular inspection when requested. Regular inspection and site monitoring to be undertaken throughout the period to ensure establishment targets are being achieved.
LV10		Successful long-term management of landscape and habitats.	Management of the landscape and habitats during the years of operation (post five-year aftercare period) will be agreed in consultation with Portsmouth Water and captured in a long-term management plan. This will include measures to maintain and enhance the landscape and visual amenity of the area and to encourage ecological interest through habitat management (including the requirements set out in the Biodiversity section above)

Figure 4 – REAC Commitments Extract

5.1 Vegetation Control

Following establishment of the grass cover on the reinforced slope, it is anticipated that maintenance will be minimal. The established sward will naturally start to die back in the Autumn/ Winter and replenish in Spring/ Summer, following the same seasonal process as the Main Embankment and therefore remaining consistent across the reservoir site.

The vegetated slope will fully establish over a couple of growing seasons so should not be cut back as it forms the next year's low maintenance green facing. As detailed in Figure 5 below, any wind-blown or self-seeded vegetation not in accordance with the above planting specification will be removed during annual inspection.

5.2 Maintenance Phase Watering

Following the establishment phase detailed in Section 4, the planting on the reinforced earth retaining walls will not require regular watering, provided the vegetation is well-established and local rainfall is sufficient.

Occasional watering may still be necessary under the following conditions and can be facilitated using a hose and water supplies available within the Control House building:

- **Dry Spells or Drought**: Supplementary watering may be required every 2-3 weeks to prevent plant stress or dieback.
- **New Planting or Repairs**: Any reseeded or replanted areas should follow the initial watering schedule until re-established.

5.2 Maintenance Phase Monitoring

Annual maintenance checks will be undertaken each Spring to review the following:

- Coverage of vegetation
- Composition of vegetation
- Vegetation health
- Structural integrity of the slope system

The desired findings and associated remediation actions (if required) for each area is detailed below:

Area to be reviewed	Desired finding(s)	Remediation to take place (if necessary)
Coverage of vegetation	100% coverage of the reinforcing system	If there is a minor loss (<50%) in coverage on a single slope, re-seeding of areas of poor growth will take place in targeted areas. If there is >50% loss in coverage on a single slope, re-seeding of the full slope face will be undertaken.
Composition of vegetation	All vegetation should be as per the above specification	Any wind-blown or self-seeded vegetation will be removed during routine maintenance to ensure it does not establish.
Vegetation health	A healthy planted slope face with high diversity and dense coverage. Pollinator activity where expected.	As detailed above, loss of coverage will prompt re-seeding depending on level of coverage lost. Maintenance regimes will be adjusted based on the identified causes of vegetation decline, with the aim of improving overall plant health.
Structural integrity of the slope system	No topsoil erosion or settlement has occurred.	As part of routine maintenance, suitable fill material (topsoil) will be added to the slope to bring the face back to its correct profile. In the event of softening of structural fill, backfilling would still take place, however, closer monitoring of the slope system would be required to ensure successful remediation.

Figure 5 – Annual Check Outcomes and Remediations

Appendices

Appendix A – TensarTech® GreenSlope™ Earth Retaining Structures: Model Specification

Appendix B – Guidelines for the Maintenance of TensarTech® Slope Systems

Appendix A - TensarTech® GreenSlope™ Earth Retaining Structures: Model Specification

TensarTech® GreenSlope™ Earth Retaining Structures: Model Specification

This document is intended to form a basis for Tender documents where the TensarTech® GreenSlope™ reinforced soil system is required.

1. GENERAL

This work shall consist of constructing reinforced soil steep slopes (often referred to as strengthened embankments) typically using a proprietary system, constructed in accordance with the supplier's drawings and specifications and in conformity with the alignment, grades and dimensions shown on the contract documents or as established by the Engineer. Where necessary the Contractor shall provide complete set of drawings issued for construction, design calculations and complete specifications of the proposed system for the approval of the Engineer 90 days prior construction. Any particular requirements of approved detailed specifications for the approved proprietary system shall override any conflicting or incompatible requirement contained within this section.

The provider of the proposed solution must demonstrate previous International experience for design and construction of reinforced soil steep slopes with a minimum height of 20.0m and a minimum in service life of 20 years.

The geogrid soil reinforcement must have a current British Board of Agrèment (BBA) HAPAS certificate, demonstrating suitability for use in highways structures with a minimum 60-year design life.

2. DESIGN

The choice and specification of the system shall address the climatic and soil conditions existing specific to the site in question and provide a minimum design life of 60 years and up to 120 years if specifically required to do so. The specifications as presented to the Engineer shall state any requirements for or limitations on the backfill used in the structure to ensure the design life. The tender submission shall be accompanied by:

A. A copy of the current BBA certificate
B. Sample design calculations for the proposed walls in compliance with HA68/94 or BS8006 as appropriate
C. Soils test information of the proposed reinforced soil fill
D. Method statement for construction
E. Confirmation of the Professional Indemnity and Product Liability insurance cover provided by the Slope System Supplier

3. STANDARDS

The following standards and codes in their latest edition shall be particularly applied to work covered by this specification where applicable; together with any further standards or codes as described within the approved Specification for the approved reinforced soil wall system.

3.01 Steel Mesh Facing Units

A. **BS4483:1998** - Steel fabric for the reinforcement of concrete
B. **BS EN ISO 1461-2009** - Hot dip galvanized coatings on fabricated iron and steel articles

3.02 Geogrid Reinforcement

A	**ISO 2602: 1980**	Statistical Interpretation of Test Results
B	**BS EN ISO 9001: 2000**	Quality Systems – Model for Quality Assurance in Production, design and development installation & servicing
C	**BS 2782: Part 4**	Methods of Testing Plastics. Part 4: Chemical Properties
D	**GRI GG2 - 87**	Geogrid Junction Strength
E	**BS EN ISO 10321: 1996**	Geotextiles – Tensile Test for Joints-Seams by Wide-Width Method
F	**BS EN ISO 10319: 1996**	Wide-Width Tensile Test
G	**BS EN ISO 13431: 1999**	Geotextiles and geotextiles related products. Determination of tensile creep and creep rupture behaviour

3.03 Soils

A	**BS1377: 1990**	Moisture Density Relationship for Soils, Standard Method
B	**BS1377: 1990**	Gradation of Soils

C	**BS1377: 1990**	Atterberg Limits of Soil
D	**BS1377: 1990**	Shear Box Test
E	**BS3882: 1994**	Specification for topsoil

4. MATERIALS

The slope system will comprise proprietary structural steel mesh facing units, steel braces, approved face liner, uniaxially orientated high-density polyethylene (HDPE) geogrids and a high efficiency mechanical connection between facing and primary geogrid.

4.01 Steel Mesh Facing

A. Steel mesh should be welded high tensile steel mesh type structural fabric, manufactured in accordance with BS4483: 1998

B. Vertical bar diameter will be a minimum of 8mm at 100mm spacing and the horizontal bar diameter will be a minimum of 8mm at a 200mm spacing

C. Minimum weight shall be 5.93Kg/m^2

D. Where specified the steel mesh facing will be galvanised in accordance with BS EN ISO 1461 : 2009 with a minimum mean coating of 85 µm.

E. Mesh shall be supplied to site cut and bent to the required dimensions and angle.

4.02 Geogrid Reinforcement

A. The primary reinforcing element shall be a geogrid manufactured in accordance with a Quality Management System which complies with the requirements of BS EN ISO 9001:2000. If required by the Engineer, the Contractor shall provide evidence that the manufacturer's Quality Assurance System has been certified to conform with BS EN ISO 9001:2000 by an external authenticating authority approved by the Department of Trade and Industry.

B. The reinforcing element shall be a geogrid manufactured from High Density Polyethylene (HDPE) sheet, oriented in one direction so that the resulting ribs shall have a high degree of molecular orientation, which is continued through the integral transverse bar.

C. The long term creep rupture strength P_C (Ultimate Limit State), for a design life of 60 or 120 years, shall be in accordance with the following table at a mean temperature for design country (10°C, 20°C or 30°C). This shall be determined by application of standard extrapolation techniques to creep data obtained in accordance with BS EN ISO 13431:1999 and shall be a lower bound value. Values shall be based on a minimum 100,000 hour of continuous creep testing.

D. The geogrid shall have an appropriate partial factor for site installation and construction damage, determined by the particle size distribution of the reinforced fill and in accordance with the values used in the design. This factor shall be based on full-scale tests carried out in accordance with BS8006 Annex D and witnessed by an independent Approval Authority. If required by the Engineer, the Contractor shall provide supporting documented evidence of testing for this and any other partial factors assumed in the design. Partial factors for site installation and construction damage based on limited laboratory based testing are not acceptable.

E. The strength of the junctions between the longitudinal ribs and transverse bars, as determined by the Geosynthetics Research Institute, Drexel University, USA, Test Method GG2-87, shall be not less than 95% of the Quality Control Strength.

F. Any site joints in the reinforcement roll length shall be capable of carrying 100% of the geogrid Long Term Creep Rupture Strength. If required by the Engineer, the Contractor shall provide evidence of this.

G. The geogrid shall be inert to all chemicals naturally found in soils and shall have no solvents at ambient temperature. It shall not be susceptible to hydrolysis, shall be resistant to aqueous solutions of salts, acids and alkalis, shall be non-biodegradable and shall have a minimum of 2% finely divided carbon black, as determined by BS 2782 Part 4, Method 452B 1993, to inhibit attack by ultraviolet light.

H The geogrid shall have an independent test certificate proving resistance and durability in a pH range of 2.0 to 12.5. Specifically, 'The sample of the geogrid chosen shall have a test certificate from a recognised independent test authority, showing that when tested to ENV ISO 12960, March 1998, they can withstand immersion in a saturated solution of calcium hydroxide with a pH of 12.5, at 60 deg C for 3 days with no loss of tensile strength.'

I The geogrid shall be CE Marked by an independent, authorised Certification Body to demonstrate that the product has been tested in accordance with the relevant European Standard relating to its specific use in construction, in accordance with the EU Construction Products Directive.

J The product labelling must show the CE Mark, together with the Certification Body Number and the FPC (factory production control) number. 'Accompanying Documentation' indicating the relevant testing 'declared values', should be available on request.

		Geogrid Type - design life of 60 years					
	Units	RE510	RE520	RE540	RE560	RE570	RE580
$P_{C\ 10°C}$	kN/m	21.10	27.85	34.02	46.78	62.44	72.41
$P_{C\ 20°C}$	kN/m	19.37	25.56	31.23	42.95	57.33	66.48
$P_{C\ 30°C}$	kN/m	17.56	23.18	28.32	38.94	51.98	60.27

		Geogrid Type - design life of 120 years					
	Units	RE510	RE520	RE540	RE560	RE570	RE580
$P_{C\ 10°C}$	kN/m	20.71	27.34	33.40	45.93	61.31	71.09
$P_{C\ 20°C}$	kN/m	19.01	25.10	30.66	42.16	56.28	65.27
$P_{C\ 30°C}$	kN/m	17.24	22.76	27.80	38.23	51.03	59.17

4.03.1 Face to geogrid connection

A. The connection between the steel mesh facing units and the geogrid shall be a continuous mechanical connection. The full width of geogrid is connected to the horizontal portion of the facing unit using a HDPE bodkin. Friction only connection will not be allowed.

4.04 Face Liner

A. To establish a grass cover to the finished structure by dry seeding, the inside face of the steel mesh should be lined with either of the following as determined by the Engineer:

i. Rolled erosion protection product - The material shall be of consistent thickness with the coconut fibre evenly distributed over the entire area of the blanket. The blanket shall be covered on the top and bottom with heavyweight polypropylene netting having ultraviolet additives to delay the breakdown and approximate 1.59x1.59cm mesh size. The blanket shall be sewn together on 3.81cm centres with UV stable polypropylene thread. Nominal weight per m2 = 271 grams.

ii. Geomesh - The material shall be manufactured from Low density polyethylene (LDPE) with an aperture size of 8mmx6mm and thickness of 2.9mm. UV protection shall be provided by 2% minimum of well dispersed finely divided particles of carbon black. Nominal weight per m2 = 495 grams.

B. Where ground cover and/or climbing vegetation is the only vegetation, the face may be lined with a black needle punched geotextile manufactured from 100% virgin polypropylene in compliance with the following specification:

C. Any face liner shall be manufactured in accordance with a Quality Management System which complies with the requirements of BS EN ISO 9001:2000.

Polymer	100% virgin black polypropylene
Thickness (mm) under 2kPa according to BS4501:1987	3.50
Unit weight (gm^{-2})	400
Maximum Tensile Strength (kN/m) according to BS EN ISO 10319:1996	
MD	16
TD	32
Elongation at Maximum Tensile Strength(%) according to BS EN ISO 10319:1996	
MD	110
TD	75
Puncture Resistance (CBR) according to BS EN ISO 12236	
Maximum Force (kN) (5)	3.5
Maximum Displacement (mm) (6)	67
Metal Detector test for broken needles	YES
Roll size (m)	2.1 x 50

Roll weight (kg)	44

4.05 Infill Soil

The infill soil material proposed should comply with the specification for 6I/6J material as detailed in Tables 6/1 and 6/2 of the 'MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS (MCHW) VOLUME 1 SPECIFICATION FOR HIGHWAY WORKS (MCHW1) – Series 600 for Earthworks, Highways Agency document November 2009'
This preferred material should be well graded crushed and granular not sub-rounded, and should also comply with the following:

A. Minimum angle of friction ($ø_{cv}$') of 30 degrees

B. The contractor should provide the Slope System supplier and the Engineer/Client with Effective Stress Parameters soil test information including soil density to allow completion and checking of the final design.

C. The contractor may propose the use of an alternative fill material such as a consistent good quality cohesive or semi cohesive material as well as recycled materials. Proposals should also include provision for any additional drainage materials that may be necessary along with the design properties for use in the design.

4.06 Plantable Fill or Horticultural Topsoil Layer

A. The horticultural soil layer shall be a medium loam with a workable 'crumb-like' consistency placed immediately behind the face liner for the purpose of supporting vegetation and in accordance with BS3882:2007 'Specification for topsoil'

B. It shall have moisture content in the range 20 to 25% when placed.

4.07 Vegetation

4.07.01 Grass Cover

A. Where indicated on the drawing grass cover will be established by introducing the specified grass seed mix at the specified rate(typically 60g/m^2) in to the horticultural topsoil layer during placement. In addition grass should be spread in to the biodegradable face liner upon completion of the structure.

B. A typical specification of the seed mix for sewing into the topsoil and biodegradable matting may be:

75%	Creeping Red Fescue
25%	Smooth Stalked Meadow Grass

Or as specified by the Engineer

4.07.02 Ground cover and/or climbing vegetation

A. Ground cover and/or climbing vegetation will be established by planting healthy plants from an approved supplier at the base and on the face of the structure.

B. Plants along the base will be planted into the approved horticultural topsoil and carefully tied in to the face at 1m centres.

C. Plants on the face should be planted on a minimum 2m square grid pattern. This may be carried out either during or post construction but with the approval and agreement of the engineer.

D. All plants should be well established in 75mm pots prior to planting and should be seen to have a good quality rootball.

E. All plants should be correctly irrigated when necessary up to the first 12 months after completion of the structure either by carefully monitored hand watering or by installation of an approved irrigation system using perforated polymer pipes and delivering water to the root system in a controlled manner.

F. A typical specification for the ground cover plant specification is: Hedera Colchica (Persian Ivy) or similar approved

5. CONSTRUCTION

5.01 Excavation

A. Contractor shall excavate to the lines and grades shown on the Contract Drawings. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted approved infill material, or as directed by the Engineer.

B. Contractor shall verify the location of existing structures and utilities prior to excavation. Contractor shall ensure all surrounding structures are protected from the effects of any excavation. Excavation support, if required, is the responsibility of the Contractor.

5.02 Foundation Preparation

A. Following the excavation, the foundation soil shall be examined by the Engineer to assure actual foundation soil strength meets or exceeds the design bearing strength. Soils not meeting the required strength shall be removed and replaced with infill soils, as directed by the Engineer.

B. Foundation soil shall be proof rolled and compacted to 95% standard Proctor density and inspected by the Clients Engineer prior to placement of the steel facing units and reinforced fill.

5.03 Steel facing units and geogrid installation

A. The Steel Facing Units are delivered to site bundled together and tied using steel tying wire, together with brace bars (3 per unit) and anchor pins. They may be stored outside.

B. The primary geogrid reinforcement is delivered in either 75m or 50m long x 1.3m wide rolls and may be stored outside.

C. HDPE bodkins are delivered in cardboard boxes of 40No. These may be stored outside but may benefit from being stored undercover to prevent water damage to the cardboard box.

D. Prepare the formation to line and level in accordance with the contract documents.

E. Cut the lengths of the required grade of geogrid from the roll as indicated by the design drawings. Place on to the formation with the leading edge at the front edge of the structure. Ensure that the geogrid is orientated in the correct direction.

F. Position the facing units along the line of the structure, overlapping longitudinally by 100mm. Connect adjacent units using steel tying wire to locate.

G. The system must be constructed in accordance with the contract drawings using the required number of grid layers.

H. Lay the geogrid flat and pulling it by hand to ensure that no slack is left in the bodkin connection. Drive in to the ground two anchor pins behind the longitudinal bars on the base of the facing unit. This will ensure no movement of the steel facing unit when the geogrid is lightly tensioned using the beam supplied. Adjacent lengths of geogrid need only be butt-jointed, there is no necessity for overlap.

I. Using the polymer bodkin, connect the uniaxial geogrid reinforcement to the horizontal base of the steel facing unit, at the first aperture away from the face. The geogrid should be lightly tensioned using the tensioning beam supplied so that all slack is removed from the bodkin joint. Whilst maintaining tension, place a layer of fill on the grid which is sufficient to restrain it in position when the load is released or alternatively retain the tension by driving 2 steel pins through the last row of apertures at the rear end of the geogrid.

J. Cut and place the biodegradable mat or geotextile/net supplied inside the face, locating it temporarily with cable ties or tying wire if necessary. The face liner should lap back horizontally in to the structure by a minimum of 100mm. Care should be taken at this stage if using the biodegradable mat to avoid exposing it to naked flame or spark, as it may be readily flammable until it has had the opportunity to absorb moisture. It is recommended that positive measures are taken to ensure the establishment of vegetation within 4 months of installation if the biodegradable mat liner option is chosen.

K. Fix the brace bars in to position at a rate of 3 per facing unit. They should hook around a steel bar junction in the uppermost horizontal bar of the face and a junction point at the rear-most horizontal bar of the base.

L. Where a vegetated face is specified, place horticultural topsoil in accordance with BS3882, behind the face lining at lift heights compatible with the structural fill compaction. This is continued up to the level of the next layer of reinforcement in tandem with the structural fill material, to a typical width in cross section not exceeding 150mm. If the Landscape Architects require a greater topsoil thickness than 150mm then they should consult Tensar International Ltd in advance who can then advise on an appropriate construction approach and facing detail.

M. The topsoil should be consolidated by hand tamping or 'heeling–in' so as to avoid over compaction.

N. Selected suitable fill material should be in full compliance with the needs of the design and have the approval of the engineer. Place and compact the fill in accordance with Contract specification, up to the level of the next geogrid layer. Fill should be placed by plant such as an excavator bucket or a dozer with an opening bucket, which causes the fill to cascade onto the grids. A minimum of 150mm thick cover of fill must be maintained between the tracks of any plant and the geogrid to avoid damage. Care should be taken during this operation to maintain the alignment of the facing units.

O. Care should be taken to avoid compaction of the topsoil layer and contact with the facing units by any of the compaction plant.

P. All construction plant, including compaction equipment with a mass exceeding 1000kg should be kept at least 2m from the face of the wall. Compaction plant within 2m of the wall should be restricted to vibrating rollers having a mass per metre width not exceeding 1300kg or plate compactors with a mass less than 1000kg.

Q. Compaction should always commence nearest the facing units, working away towards the free end of the grid.

R. If secondary reinforcement is specified, this should be cut from the roll and laid in to the face area as required. The geogrid should be butted-up to the face of the steel facing unit but no connection is necessary.

S. Placement of the topsoil layer and fill material should be continued as described in steps L-R up to the level of the next layer of primary reinforcement. At this point the next course of steel facing units may be installed to stretcher bond and construction of the reinforced slope continues to the required height.

T. Upon completion further grass seed may be scattered on to the finished face of the structure.

U. Where there is step back or terrace to the next facing unit, it is recommended that the protruding vertical bars are bent down to the horizontal. This is to prevent the possibility snagging when operatives are climbing on or abseiling down the face for planting or maintenance purposes. A short piece of scaffold tube may be improvised to bend the bars in question.

V. The Contractor must fully assess the safety risk associated with working at height and where appropriate install any necessary temporary edge protection.

W. As well as following procedures for health and safety, it is essential when handling wire products that suitable protective glasses and gloves are worn.

6. Submission of Alternatives

6.01 Any alternative to the specified system for Reinforced Steep Slopes proposed by the Tenderer shall be submitted with the tender and shall include:

- the names of the supplier and designer
- a full set of calculations
- outline drawings
- product samples and specifications
- test certificates for the reinforcing elements

The outline drawings must be sufficient to indicate the details of the construction of the Reinforced Steep Slopes including:

- typical plans
- elevations and section drawings
- foundations
- facing details (including vegetation if appropriate)
- anchoring reinforcing elements at the face
- reinforcing element joints and overlaps

The width and length of the soil reinforcing elements should be clearly shown along with details of their orientation in the works.

This document is drafted on an entirely generic basis and its use in any tender documentation in any way must be reviewed by the user and made specific to their project

The information in this document supersedes any and all prior specifications for the product(s) designated above, is of an illustrative nature and supplied by Tensar International Limited free of charge for general information purposes only. Tensar reserves the right to amend product descriptions, properties and specifications at any time and without prior notice. This document does not form part of any contract or intended contract. Tensar International Limited excludes to the fullest extent lawfully permitted any and all liability whatsoever for any loss or damage howsoever arising out of the use of and reliance upon this information. It is your sole responsibility and you must assume all risk and liability for the final determination as to the suitability of any Tensar International Limited product and/or design for the use and in the manner contemplated by you in connection with a particular project.

Tensar and **TriAx** are registered trademarks

Copyright © Tensar International Limited 2020

Tensar International Limited

Tel: **+44 (0) 1254 262431**
Fax: **+44 (0) 1254 266867**
E-mail: **sales@tensar.co.uk**
www.tensar-international.com

UK Head Office
Units 2 - 4 Cunningham Court
Shadsworth Business Park
Blackburn
BB1 2QX
United Kingdom

bsi. ISO 9001:2015 Quality Management
Cert – QM505288
Applicable to Tensar International and Tensar Manufacturing Ltd

bsi. ISO 14001:2015 Environmental Management
Cert – EMS86463
Applicable to Tensar Manufacturing Ltd

Appendix B – Guidelines for the Maintenance of TensarTech® Slope Systems

Guidelines for the Maintenance of TensarTech® Slope Systems

Tensar International Limited has been involved in the design and construction of vegetated reinforced soil slope systems worldwide since the 1980's. When it comes to selection of the facing, the designer has a choice of several different options which enables a low maintenance facing to be designed to suit the physical environment in terms of aspect, face angle and anticipated annual rainfall. Dependent on the country concerned, there are a number of TensarTech® slope systems that may be utilised; the most common are TensarTech® GreenSlope™ and TensarTech® NaturalGreen™. However, there is a similarity between them all in that they involve the use of Tensar uniaxial geogrids, rolled erosion control products, and a topsoil detail to aid vegetation establishment. In general, these systems are low maintenance and will require no more attention throughout their design life other than routine maintenance that would occur with conventional vegetated slopes where reinforced soil construction is not used. This document aims to give some guidance on the maintenance factors to consider during the typical life of a TensarTech reinforced soil vegetated slope system.

Figure 1. TensarTech GreenSlope for construction between 45 & 70 degrees

Figure 2. TensarTech NaturalGreen for construction up to 45 degrees

Introduction

Construction of TensarTech slope systems involves the placing and compaction of an engineering grade structural fill material onto designed layers of Tensar uniaxial geogrid. The rolled erosion control product used on the face is selected depending on the face angle. For shallower slopes up to 45 degrees, Tensar recommend NAG C350 or similar; on steeper slopes between 45 and 70 degrees a steel mesh facing panel is used as a formwork together with NAG C125 or similar. Additionally, where hydra-seed mulch is used, Tensar CE111 geomesh is recommended. All TensarTech slope systems incorporate a topsoil detail to provide a suitable growing medium to encourage vegetation establishment. The stability of the structure is provided by the fill interacting with the uniaxial geogrid, whilst the rolled erosion control product applied to the facing acts as a durable finish to the soil structure behind to help prevent erosion whilst the vegetation is allowed to establish. The TensarTech slope system as a whole must be designed to withstand any loading imposed upon it, together with suitable drainage to prevent surface water storm flows from entering the reinforced soil structure or facing system.

The reinforced soil mass which provides both the internal and external stability. Consequently, in-service damage to the face does not equate to structural failure. However, it may be essential to perform remedial repairs to the TensarTech slope system should it become damaged to prevent erosion and damage to the reinforced soil mass.

Maintenance Factors

The performance and aesthetics of the TensarTech slope system can be adversely affected by a number of factors including:

1. Excessive run-off causing erosion due to inappropriate landscaping.
2. Vegetation growth and inappropriate planting or self-seeding of larger plants and trees which can grow to an unsuitable size during the design life of the TensarTech slope system.
3. Salt spray from treatment of the road surface in cold climates (where steel mesh is used as a facing system).
4. Small amounts of localised settlement.
5. Blockage of the surface drainage system and sub-surface drainage outlets due to accumulation of debris from surface run-off or excessive growth of vegetation.
6. Leakage from a water main or sewer pipe resulting in saturation and/or erosion of the reinforced soil mass. Fire risk, either climatic or by vandalism.
7. Scouring of the toe of the TensarTech slope system causing washout of backfill and localised erosion of facing.
8. Accidental loading such as vehicular impact that could lead to damage of facing.

Items 1, 2 and 3 may be dealt with at the design and construction stage or by regular maintenance. However, the conditions in points 4 to 9 (inclusive) may require vital repairs to be carried out to ensure continued satisfactory performance of the slope system.

1. Excessive Run-off

Consideration during the design and construction stages should be given to ensure the landscape does not cause storm or flood flows to be directed towards the TensarTech slope system facing. Drainage channels and adjacent slope batters should be designed to prevent run-off and flooding.

2. Vegetation Growth

The face of the TensarTech slope system is designed to be low maintenance but will need to be checked to ensure that wind-blown or self-seeded vegetation does not establish and grow uncontrolled during the design life of the structure. An example of this would be small trees which during a 60-year design life could grow into larger trees which would be unsuitable on the face of the TensarTech slope system.

For TensarTech slope systems, grass or ground cover plants are the preferred option to allow vegetation establishment. The grass cover will go through an annual growing cycle whereby vegetation will flourish during the spring and early summer months and then start to die back in late summer and winter months. The vegetation mantle that establishes over several growing seasons should not be cut back as this forms the low maintenance facing for subsequent growing seasons.

Where the preferred option is to use pocket planted shrubs as ground cover, a horticulture specialist should be consulted at design stage to ensure the selected vegetation type is suitable for the design life and aspect of the TensarTech slope system.

The areas surrounding the TensarTech slope system may require some landscape treatment. This might include hard paving, landscape plantings, mulch, turf or seeded grass, or some type of ground cover. These surface treatments may provide an important function for the surrounding areas, e.g. they help reduce or eliminate erosion during each rainfall. These surface treatments should be checked each spring as part of routine maintenance. Bare areas of vegetation should be re-seeded or re-planted to encourage growth and total coverage. Areas of erosion, rills and channels on the surface, must be repaired as necessary. A little work each spring in the areas surrounding the TensarTech slope system will prevent erosion from becoming a problem and will also enhance the landscape around the TensarTech slope system.

3. Salt Spray

In cold climates, use of de-icing salts around a slope may cause enhanced corrosion to any steel mesh faced TensarTech slope systems. Avoid using salt de-icers on or around TensarTech slope systems if possible. In cases where salt spray may exist, design the slope in such a manner that melt water from snow and ice containing the salts are directed away from the slope facing. Consideration can include the use of galvanised steel facing components which are available from Tensar International.

4. Localised Settlement

Small amounts of settlement are considered quite normal after the TensarTech slope system is completed. If the upper surface of the structure is unpaved, inspecting the slope each spring for any water run-off damage will help prevent future problems. Reinforced soil TensarTech slope systems should be designed and built to route storm water away from the finished surfaces above the slope or around the slope face. However, once an area above the slope has settled, water may start to enlarge any unprotected areas. If a low spot is neglected above the slope, each new rainfall may create areas of standing water which if left unchecked may start to soften the soil. Preventing this potential issue should be considered as part of the routine inspection and maintenance of the area surrounding the slope. Inspect slopes each year and look for low spots and areas that may have settled or been eroded. Add enough

suitable fill to bring the profile back to its proper level thereby ensuring good drainage and trouble-free performance for the TensarTech slope system.

5. Blocked Drainage

Both surface water and sub-surface drainage of the TensarTech slope system should have been considered at design stage. Any blockage of the drainage system due to the accumulation of debris from surface run-off or excessive growth of vegetation should be looked for during the annual inspection and cleared as soon as possible.

6. Water Leakage

Services carrying water may be located in the upper levels of, or immediately behind the TensarTech reinforced soil slope. Any leakage of water from water mains and sewer pipes carrying foul and surface water should be identified as soon as possible and repairs carried out to both the pipe or sewer and also any parts of the reinforced soil slope system washed away in the vicinity of the leakage.

7. Fire Risk

Fire risk either due to vandalism or inadvertently during periods of drought can be a problem during the design life. TensarTech slope systems are generally at higher risk during vegetation establishment where damage to the erosion control product could require replacement. Fire damage tends to occur at the face and normally causes localised damage rather than damage to the geogrid reinforcement which is buried within the reinforced soil fill. Care should be taken during the construction phase to ensure sources of sparks or flames are kept away from the facing system. Once vegetation is established grass cover could ignite due to sources of sparks or flames during periods of drought, which may cause damage to the erosion control product. The designer and/or supplier of the TensarTech slope system should be contacted immediately for advice on repair of the damage.

8. Scour

Scour protection should have been considered and detailed at design stage. Any scour of the foundation soils at the toe of the TensarTech slope system should be dealt with and repaired as soon as possible. Failure to do so may lead to the TensarTech slope system being undermined and the loss of facing or structural soils together with the geogrids may lead to structural failure in the vicinity of the scour if left unattended. If dealt with promptly and correctly, failure of the TensarTech slope system will be avoided. The designer and/or supplier of the TensarTech slope system should be contacted immediately for advice on repair of the damage.

9. Vehicle Impact

Localised damage to the face such as crushing or bending of steel facing mesh is unlikely to cause any threat to overall structural stability and may be easily dealt with. The damaged facing may be left alone if the damage is considered of no threat to the structural integrity of the TensarTech slope system overall or if the aesthetics of such damage is considered non-critical. If necessary, the damaged facing in question may be replaced with a similar grade of either steel where used or rolled erosion control product fastened in accordance with the TensarTech slope system supplier's recommendations specific to the repair required. The designer and/or supplier of the TensarTech slope system should be contacted immediately for advice on repair of the damage.

10. Other Potential Issues

It is recommended that advice is sought directly with Tensar International or the local Tensar Distributor if any of the following occur during the design life of the TensarTech reinforced soil slope system:

1. Requirement to de-construct any area of the TensarTech slope system.
2. Excavation behind the TensarTech slope system – the geogrid reinforcement layers should not be cut or intercepted to gain access behind the reinforced fill.
3. Excavation at the toe of the TensarTech slope system.
4. Changes/increase to surcharge loading including temporary surcharges from heavy plant, cranes or piling equipment.
5. Piling operations and/or vibration within 5m of the TensarTech slope system toe or within the area covered by the geogrid reinforcement layers.

This document was formerly published with the reference: IB/Slope_Maintain

The information in this document supersedes any previous bulletins in relation to this subject matter and is supplied by Tensar International Limited free of charge for general information purposes only. This document does not form part of any contract or intended contract. Tensar International Limited excludes to the fullest extent lawfully permitted any and all liability whatsoever for any loss or damage howsoever arising out of the use of and reliance upon this information. It is your sole responsibility and you must assume all risk and liability for the final determination as to the suitability of any Tensar International Limited product and/or design for the use and in the manner contemplated by you in connection with a particular project.

Tensar, Tensartech and **TriAx** are registered trademarks

Copyright © Tensar International Limited 2020

Tensar International Limited

Tel: **+44 (0) 1254 262431**
Fax: **+44 (0) 1254 266867**
E-mail: **sales@tensar.co.uk**
www.tensar-international.com

UK Head Office
Units 2 - 4 Cunningham Court
Shadsworth Business Park
Blackburn
BB1 2QX
United Kingdom

bsi. ISO 9001:2015 Quality Management
Cert – QM505288
Applicable to Tensar International and Tensar Manufacturing Ltd

bsi. ISO 14001:2015 Environmental Management
Cert – EMS86463
Applicable to Tensar Manufacturing Ltd