



Appendix F - Materials Report

Materials Report

HAVANT BOROUGH COUNCIL

Langstone Flood and Coastal Erosion Risk Management Scheme
60656877
LANG-ACM-ZZ-ZZ-RP-ZZ-000110

14/03/2024

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Document Control

Document Ref.	Revision	Status	Suitability / Issue Purpose
LANG-ACM-ZZ-ZZ-RP-ZZ-000110	C01	A4	Published Design

Revision History

Revision	Revision date	Details	Prepared	Checked	Approved
C01	14/03/24	Approved Deliverable	HR	CP	JS
P03	28/02/24	Update to Client Comments	HR	CP	JScott
P02	08/02/24	100% Detailed Design Update	TJ	CP	JScott
P01	21/11/23	100% Detailed Design	TJ	HR	JS
P01.1	11/08/23	100% Draft Detailed Design for Client Comment	TJ	CP	JScott

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# Hard Copies	PDF Required	Association / Company Name

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1 Introduction

1.1 General

AECOM has been commissioned by Havant Borough Council (HBC), the coastal erosion and flood Risk Management Authority (RMA), to assist in implementing the Langstone Flood and Coastal Erosion Risk Management (FCERM) Scheme. The scheme, which will introduce new or upgraded defences, is required to provide improved protection against tidal flooding in the village of Langstone.

The 2010 North Solent Shoreline Management Plan (SMP) policy for Langstone is to 'Hold the Line' for the next 100 years. Following the publication of the SMP, the Portchester to Emsworth FCERM Strategy 2013 (PEMS) recognised the need to reduce the risk of coastal flooding and erosion to people and assets. The Strategy recommends a phased approach to improve the defences to give a minimum 1.3% Annual Exceedance Probability (AEP).

HBC previously commissioned AECOM via Coastal Partners - formally the Eastern Solent Coastal Partnership (ESCP), to undertake an options appraisal study, identify leading options, develop outline designs, and draft an outline business case for the scheme to support the application for Grant in Aid (GiA) funding.

The work to date provides the strategic and economic justification for the scheme, as well as outline design level detail on defence types, alignment, crest levels, geometry, flood equipment and access requirements for the proposed defences.

The objective of the current scope is to build upon the outline design of the preferred options to create the best fit detailed design solution for the Langstone FCERM scheme together with a construction scope of works.

1.2 Structure of the Report

The Materials Report (MR) sits alongside the suite of documents produced for the Langstone FCERM detailed design. It shall be read in conjunction with the Design Report (LANG-ACM-ZZ-ZZ-RP-ZZ-000001), the scheme drawings and all other relevant project information.

The MR documents and summarises the assessment of material sourcing, suitability for reuse for new defences, materials used in the design and mitigation of contamination risk. The reports' intent is to supplement the information provided with regards to materials within the design drawings, detailed design report and specification. The MR will be used by the third-party contactor at construction stage.

This report is structured as follows:

Chapter 2 – Project Background and Requirements

Chapter 3 – Source of Materials

Chapter 4 – Suitability for re-use of Materials

Chapter 5 – Contamination Risk and Mitigation.

2 Project Background and Requirements

2.1 Project Background

The Langstone FCERM scheme looks to provide improved protection against tidal flooding to the A3023 road and village of Langstone in Havant.

The Langstone FCERM scheme is split into seven frontages with the locations shown in Figure 2-1. The Core scheme of works is comprised of Frontages 1A, 2, 3, 4 and 5 and the Additional Scheme of works is comprised of Frontages 1B and 6. Whether both the Core and Additional schemes are constructed will depend on the funding secured.

A description of each frontage is provided below:

Core Scheme:

- Frontage 1A: Billy Line North. The flood defence comprises a raised earth embankment and follows the line of the existing Billy Line cycleway (A National Cycle Route 2 cycleway). The existing cycle path is to be upgraded to a new 3m wide cycle path which sits on top of the flood embankment.
- Frontage 2: Billy Line South. The design for Frontage 2 consists of a sheet-piled wall. Raised earth embankments are included where the defence alignment needs to cross existing utility pipes. The existing cycle path is to be upgraded to a new 3m wide cycle path which sits adjacent to the sheet-piled wall. Frontage 2 ties in with Frontages 1A and/or 1B and the existing higher levels on the A3023 road.
- Frontage 3: A3023 Road to 9 Coastguard Cottages (the Look Out). Frontage 3 consists of a continuous flood defence that largely comprises of 4 flood defence structures. These structures include the A3023 flood wall, Ship Inn car park raised earth bund, Ship Inn flood wall and Ship Inn Annex flood wall. A flood gate is also to be provided between the Ship Inn and Ship Inn Annex flood walls.
- Frontage 4: The Look Out to No. 24 Langstone High Street (the Winklemarket). Frontage 4 consists of new reinforced concrete walls in front of the existing garden walls that run along the frontage. This will also include a new quay wall with a buried apron toe. The existing footpath is to be upgraded to a new 1.5m wide footpath. 3 No. of demountable flood defences are provided at the wall transitions.
- Frontage 5: Langstone High Street to the field north of Royal Oak. Frontage 5 consists of a continuous flood defence that largely comprises of 5 structures. These structures include the High Street flood gates, the Royal Oak flood wall, the Allotment flood wall, the Footpath flood wall that runs west of the Mill Pond, and an earth embankment in the field north of Royal Oak. Demountable flood defences are provided between the section transitions.

Additional Scheme:

- Frontage 1B: Mill Lane and Harbourside. The design for Frontage 1B consists of capital refurbishment works to the existing concrete sea walls that run along the front of the Mill Lane and Harbourside properties. The works also consist of a sheet pile wall between 9 Harbourside and 7 Mill Lane and an earth embankment in the field to the west of the frontage. Separate to the Langstone FCERM scheme of works an Alternative Scheme of works for Frontage 1B exists where a lower cost staged approach is considered for this frontage only.
- Frontage 6: Langstone Spit. Frontage 6 consists of a rock armour revetment that provides erosion protection to Langstone spit.

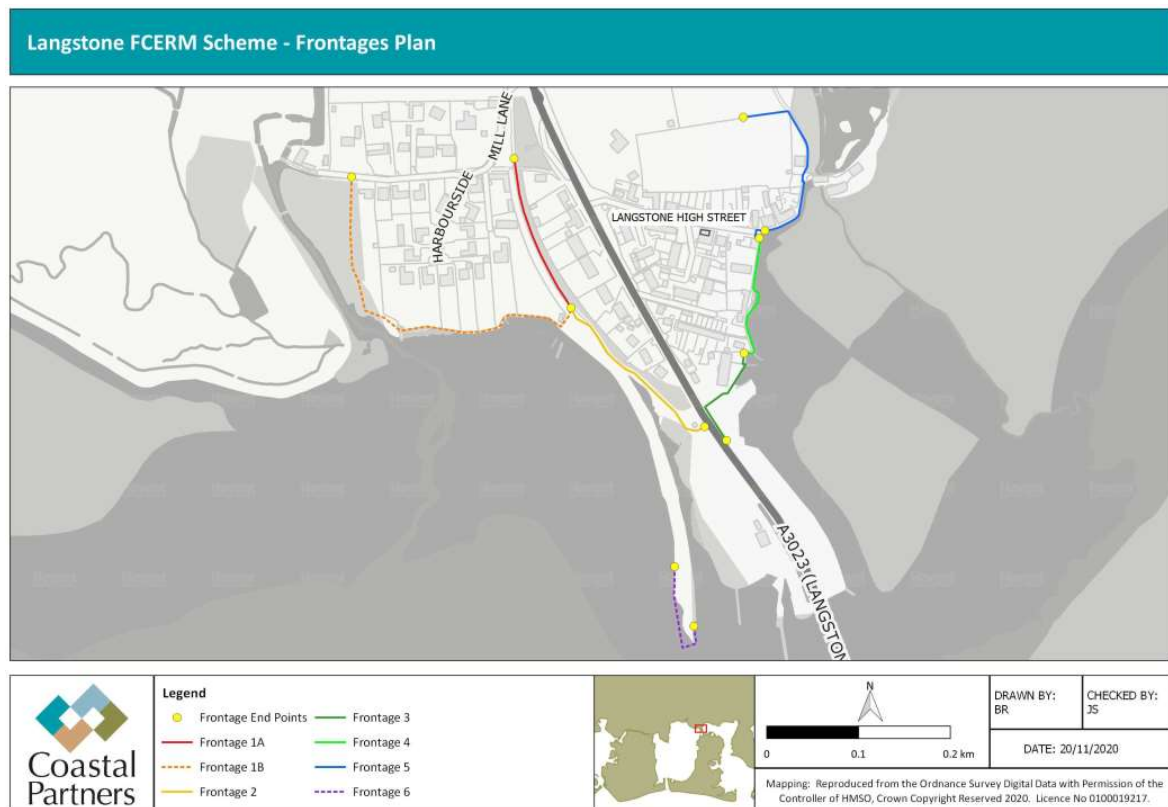


Figure 2-1. Map showing the six frontages for detailed design (Courtesy of Coastal Partners).

2.2 Employer's Aims and Objectives

The aims of the Langstone FCERM Scheme are:

- To reduce the impacts of flooding and erosion on residents, businesses, the local economy, and the A3023 at Langstone.
- To develop a detailed design that is affordable and represents best value for money, ensuring the optimal use of resources.
- To develop a detailed design which is acceptable to the employer, statutory and non-statutory consultees, wider stakeholders, and residents and to have engaged with the local community.
- Design buildable coastal defences that are sympathetic to the heritage and landscape of the area and achieve wider benefits such as place-making, regeneration and improved amenity.
- Enhance and improve the environment and provide a minimum of 10% biodiversity net gain through the scheme.
- Actively seek efficiencies in the design, construction and operation of the completed scheme.

The objectives for the Langstone FCERM Scheme are:

- To construct new coastal defences providing a present-day Standard of Protection (SoP) of 0.5% AEP from tidal still water for Langstone, including a freeboard for uncertainties. This SoP exceeds the minimum recommendation by the Portchester to Emsworth Strategy (1.3% AEP) at the outset (the SoP will decline over time as a function of sea level rise).
- To reduce the erosion risk along the Frontages.

- To provide a scheme that is fully compliant with current standards, guidance, and legislation relevant to the United Kingdom (UK) jurisdiction.
- To construct new coastal defences for 50-year design life with minimal maintenance and operation requirements.

2.3 Detailed Design Requirements

The detailed design requirements set by HBC are to further develop the design to allow a competent contractor to price and build the scheme, including all necessary interfaces, transitions, and tie-in details.

The detailed design shall also provide a sufficient level of detail to submit applications for planning permission, a marine licence, other required consents and the discharge of all design-related planning and licence conditions. The Outline Design and Decision Criteria Report (AECOM, 2019) leads into this design report regarding the technical design and materials specification. The detailed design aims to optimise the design wherever possible where such improvements may be advantageous to the success of the project and offer enhancement to the public realm and the environmental setting of the project.

3 Source and Type of Materials

Throughout the detailed design, advice has been sought from the ECI contractor and other relevant suppliers on the potential sourcing of materials. For some of the materials specified it may be that the appointed Contractor chooses a supplier different from those identified below. Additionally, some materials specified within the scheme are common construction materials and are readily available on the market. It is expected that the appointed Contractor shall identify appropriate sources/suppliers at the time of construction.

Please refer to the Design Report, Design Drawings and Specifications on the specified materials throughout the design.

For ease of construction, the design aims to incorporate consistent materials throughout the scheme. These materials are summarised in Section 3.1. Section's 3.2 through to 3.8 then detail any frontage specific material details.

3.1 Scheme Wide Materials

The following section covers the materials that are used throughout the scheme, including: concrete, steel – in the form of reinforcement and sheet piles, clay fill and granular fill.

3.1.1 Cast in Situ Concrete

Two specifications for structural concrete have been developed – the first for reinforced concrete (C40/50) and the second for mass concrete (FND3). ST1 Concrete has also been specified for concrete kerb and drainage bedding. The reinforced concrete specification recommends either cement types of IIB-V-SR (Portland cement with 25-35% fly ash) or IIIA+SR (Portland cement with 36-65% ground granulated blast-furnace (GGBS)).

Two potential sources of concrete for the scheme were identified by the ECI Contractor (DD RFI 004). Both sources use ggbs as a cement replacement. The first potential source for concrete is Kendall Ready Mixed Concrete¹, Kendalls Wharf, Hampshire, PO3 5LY. The batching plant distance to the project site is approximately five miles. Based on previous project experience, the ECI stated preference for Kendalls. An alternative potential source is Tarmac², Havant Concrete Plant, Harts Farm Way, Bedhampton Quay, Havant, PO9 1JN. The batching plant distance to the project site is two miles.

Consideration was also given to using EConcrete³ admixture within the concrete, to encourage ecological growth. This admixture is supplied as a powder and can be added to regular concrete mixes. The mixture is manufactured in Israel and typically supplied to either concrete batching plants in the UK or directly to site.

Consideration has also been given to use of concrete formliners to create textural niches within the concrete. Known as Ecoformliners these niches encourage ecological growth. The formliner themselves can be produced by Reckli. Refer to DD RFI 014.

3.1.2 Precast Concrete

Throughout the scheme precast concrete has been specified, specifically the Anderton Stepoc Blocks⁴. They form a hollow retaining wall system, that allows for reinforcement bars to be inserted and for concrete to be pumped through the cavities of the blocks. The blocks are sourced from Anderton concrete batching plant, Units 1 & 2, Cosgrove Business Park, Anderton, Northwich, is located approximately 250 miles from Langstone.

3.1.3 Steel Reinforcement

Steel reinforcement is a readily available construction material, and a precise source has not been identified at this time. Similar bar types and diameters have been specified throughout the scheme, e.g B16's are used throughout Frontages 1B, 3, 4 and 5. Refer to the reinforcement and bar bending schedules for bar types and quantities.

¹ <https://www.aggregate.com/kendalls>

² <https://tarmac.com/products/concrete/>

³ [EConcrete - We Bring Concrete To Life \(econcretetech.com\)](https://www.econcrete.com)

⁴ <https://www.ibstock.co.uk/products/retaining-walls/stepoc>

3.1.4 Cohesive Fill

The design for the embankments in Frontages 1B, 2 and 5 consists of an embankment with granular fill shoulders and a clay core. The clay core fill is specified as a Class 2A wet cohesive fill material.

Frontage 1A consists of a low embankment with granular fill shoulders and Class 2A wet cohesive fill or Class 2C stony cohesive fill material used to replace the topsoil strip over the footprint of the embankment and form the embankment subgrade.

Both Class 2A and Class 2C cohesive fill materials are specified in accordance with the Manual of Contract Documents for Highway Works (MCHW) Volume 1 Specification for Highway Works (SHW) Series 600 with detailed requirements set out in the project specific earthworks specification appendices.

Class 2A and Class 2C materials may be won from material excavated on site as part of the works or imported to site from an approved off-site source.

Two potential off site sources for imported cohesive fill material were identified by the ECI Contractor (DD RFI 005). These are Chantry Lane, Storrington and Kingsham Quarry, Hunston Road, Chichester. The Chantry Lane Sand Quarry source is located approximately 30 miles from the scheme site in Storrington. The Kingsham Quarry is located 12 miles from the project site in Chichester.

A summary of the properties of the two identified sources of imported cohesive material is shown in Table 3-1.

Table 3-1 Material property summary for off-site sourced cohesive fill

Source	Natural MC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Classification	Passing 425 micron (%)
Chantry Lane Sand Quarry	32	67	24	43	CH	100
Kingsham Quarry.	29	69	24	45	CH	100

3.1.5 Granular Fill

Type 1 Granular Fill, in accordance with MCHW SHW Series 800, has been specified as a pavement subbase material and material placed beneath formation level for a number of structures throughout the scheme. This is a readily available construction material, and a precise source has not been identified at this time.

Class 1A well graded granular fill material has been specified to form the granular fill shoulders of embankments in Frontages 1B and 5 and to form embankments in Frontages 1A and 2. Class 1A granular fill material is also specified as general granular fill to raise ground levels in Frontage 3.

Class 1A fill material has been specified in accordance with the MCHW SHW Series 600 with detailed requirements set out in the project specific earthworks specification appendices.

It is not anticipated that site-won material will be suitable for use as Class 1A fill material. As a result, it is expected that Class 1A fill will need to be imported to site from an approved off-site source. Class 1A granular fill is a readily available construction material, and a precise source has not been identified at this time.

Class 6T lightweight fill has been specified for use in the construction of Frontage 4. The material has been specified in accordance with the MCHW SHW Series 600 with detailed requirements set out in the project specific earthworks specification appendices. One potential source for lightweight fill is Leca® Lightweight Aggregate 10mm – 20mm. This lightweight fill is manufactured in Norway and shipped to UK shipping ports (Kings Lynn, Garston or Newport) from either Portugal or Denmark.

3.1.6 Landscape Fill

Class 4 landscape fill has been specified for use in the construction of Frontage 2. The material has been specified in accordance with the MCHW SHW Series 600 with detailed requirements set out in the project specific earthworks specification appendices. Class 4 material is expected to be sourced material excavated on site as part of the works.

3.1.7 Topsoil

Class 5 topsoil has been specified for use in the construction of Frontage 1A, Frontage 1B, Frontage 2 and Frontage 5. The material has been specified in accordance with the MCHW SHW Series 600 with detailed requirements set out in the project specific earthworks specification appendices.

Class 5A site won topsoil shall be stripped from the footprint of all working areas and locations of new earthworks, structures and pavements and stockpiled on site for re-use. Class 5B imported topsoil complying with BS 3882 may be imported to site if volumes of site won Class 5A are not sufficient to complete the permanent works. Topsoil is a readily available construction material, and a precise source has not been identified at this time.

3.1.8 Steel Sheet Piles

Sheet piles are included within the design of Frontages 1B, 2, 3, 4 and 5. To improve buildability the number of different section sizes has been kept to a minimum and consists of PU12s, PU22s and PU28s. The leading supplier and producer of sheet piles within Europe and therefore an appropriate source for the scheme is ArcelorMittal. ArcelorMittal are based in Luxembourg, approximately 420 miles from the scheme site. The types of sheet piles used within the scheme are produced in a steel plant located in Belval, Luxembourg.

Consideration has also been given to whether AZ28-700 sheet piles left over from another scheme of the Client could be utilised in the design. However, based on advice from the ECI, U-shaped piles were deemed more appropriate for the scheme. This is firstly because the U-shaped piles are driven in as single piles as opposed to AZ piles which are driven in in pairs and allows for a smaller plant to be used to drive the piles (DD RFI 013). Secondly, the U-shaped piles can also be used to form a temporary access track along the foreshore for the contractor to track along, reducing the requirements for temporary works.

The scheme design also consists of galvanised L8 interlocking sheet piles. These are a readily available construction material, and a precise source has not been identified at this time.

3.1.9 Rock Armour

Rock armour is included within the design for Frontage 6 within the rock revetment design and Frontage 1B to provide scour protection beneath the outfalls. Consideration was given to using granite rock armour and limestone rock armour, due to the increased ecological benefits using a limestone rock offers. Granite rock was specified given its higher density and therefore lower required rock-armour size which in turn reduces the amount of encroachment into the designated foreshore.

The ECI identified two potential sources of rock armour that comply with the required specification (DD RFI 011). The first source was Dudman Aggregates sourced from the West of England Quarry, Porthoustock (TR12 6QW) in Cornwall located 250 miles from the project site. The alternative option presented was Lawer Bros from Chywoon Quarry in Longdowns, Cornwall, located 230 miles from the site. In both cases there is potential to either deliver the rock armour to site by barge or truck.

3.1.10 Geosynthetics

Geosynthetic materials have been included within the design for all Frontages. Six types of geosynthetics have been specified:

- Terram 1000 geotextile separator⁵, or equivalent approved
- ABG Terrex SNW40UV geotextile protection layer⁶, or equivalent approved

⁵ <https://terram.com/products/standard-geotextiles/>

⁶ <https://abg-geosynthetics.com/products/geotextile/terrex-snw-geotextile/>

- ABG Alphaline 1mm geomembrane, or equivalent approved⁷
- Terram Bodpave 40 interlocking porous plastic paving system, or equivalent approved⁸
- Tensar Glasstex P50 asphalt reinforcement, or equivalent approved⁹
- Salix BioNet C125BN Erosion Control Blanket, or equivalent approved¹⁰

Terram 1000 geotextile is made from high tenacity UV stabilised invert virgin polypropylene fibres. The product properties are summarised in Table 3-2. The geotextile product is manufactured at the Berry Global Production Facility in Maldon, Essex, 140 miles from the Scheme.

Table 3-2. Terram 1000 Geotextile product properties.

Properties	Test Standard	Unit	Value
Tensile Strength	BS EN ISO 10319	kN/m	8
Elongation at maximum load	BS EN ISO 10319	%	60
Static Puncture Resistance (CBR test)	BS EN ISO 12236	N	1500
Cone Drop		mm	38
Characteristic Opening Size	BS EN ISO 12956	µm	90
Water Permeability Normal to the Plane	BS EN ISO 11058	l/m ² s	90

ABG Terrex SNW geotextiles are made from non-woven needle punch fabrics constructed from polypropylene staple fibre. The geotextile manufacturing plant is located approximately 250 miles from the site in Meltham, Holmfirth, HD9 4DS. The product properties are summarised in Table 3-3.

Table 3-3 ABG Terrex SNW40UV product properties.

Properties	Test Standard	Unit	Value
Tensile Strength	BS EN ISO 10319	kN/m	22.0
Elongation at Maximum Load	BS EN ISO 10319	%	50 (machine direction) 55 (cross machine direction)
Static Puncture Resistance (CBR test)	BS EN ISO 12236	N	4000
Dynamic Perforation Resistance (cone drop test)	BS EN ISO 13433	mm	12
Characteristic Opening Size	BS EN ISO 12956	µm	90
Water Permeability Normal to the Plane	BS EN ISO 11058	litres/m ² s	60

ABG Alphaline geomembranes are polyethylene membranes engineered to provide liquid and gas containment barriers. The product is manufactured in Holmfirth, approximately 250 miles from the site. The product properties are summarised in Table 3-4.

⁷ <https://www.tensar.co.uk/solutions/asphalt-reinforcement-products/glasstex>

⁸ <https://terram.com/products/bodpave-40/>

⁹ <https://www.tensar.co.uk/solutions/asphalt-reinforcement-products/glasstex>

¹⁰ <https://www.salixr.com/product/bionet-c125bn-biodegradable-blanket/>

Table 3-4: ABG Alphaline geomembrane product properties.

Properties	Test Standard	Unit	Value
Thickness	ASTM D5199	mm	1.00
Tensile Strength	ASTM D6693	kN/m	26.0
Elongation at Maximum Load	ASTM D6693	%	700
Static Puncture Resistance (CBR test)	ASTM D4833	N	305

The life expectancy of geotextiles and geomembranes shall be a minimum of 30 years under exposure to ultra-violet light and 100 years on incorporation into the works.

Terram Bodpave 40 is an interlocking plastic porous paving system made from 100% UV stabilised recycled and recyclable polymers for ground stabilisation. The product is 100% manufactured in the UK, at the Berry Global Production Facility in Maldon, Essex, 140 miles from the Scheme.

Tensar Glasstex P50 is a glass filament grid structure stitched with PET yarn onto a polypropylene paving fabric used as an asphalt reinforcement interlayer to mitigate pavement cracking. The product is manufactured in Blackburn, approximately 270 miles from the site. The product properties are summarised in Table 3-5.

Table 3-5 Tensar Glasstex product properties

Properties	Test Standard	Unit	Value
Tensile Strength	BS EN ISO 10319	kN/m	50
Elongation at Maximum Load	BS EN ISO 10319	%	3.0

Salix BioNet C125BN Erosion Control Blanket is required for the embankments within Frontage 1B and 5 and in front of the Sheet Pile wall in Frontage 1B. The biodegradable blanket is made from coconut fibres and designed to provide erosion protection and aid vegetation establishment. Once vegetated is established and the underlying soil stabilised, the blanket is then designed to degrade. The functional longevity of the blanket is 24 months. The product is sourced from Sri Lanka.

Table 3-6 Salix BioNet C125BN Erosion Control Blanket product properties

Properties	Test Standard	Unit	Value
Thickness	ASTM D6525	mm	5.84
Tensile Strength	ASTM D6818	kN/m	3.06
Elongation at Maximum Load	ASTM D6818	%	15.3

3.1.11 Flood Glass

The flood glass is a Proprietary Product designed by others. As such, the source will depend on the Contractors chosen supplier.

The Civils works are based on design information provided by Flood Control International. They have an office/manufacturing unit in the UK at Tavistock, Devon, PL19 0FZ located 175 miles from Langstone.

3.1.12 Flood Gates

The flood gates are a Proprietary Product designed by others. As such, the source will depend on the Contractors chosen supplier.

The Civils works are based on design information provided by Flood Control International. They have an office/manufacturing unit in the UK at Tavistock, Devon, PL19 0FZ located 175 miles from Langstone.

3.1.13 Handrails

Broxap Weaver Ductile Iron 3 Rail Handrails have been proposed in detailed design for both frontages 3 and 4. Broxap is based in Staffordshire with manufacturing in Chesterton. The distance from source to project is 210 miles. The handrail is a slimline 3 rail ductile iron post available with galvanised only or stainless-steel rails.

The Broxap handrails are supplied with a primer undercoat and two pack acrylic paint finish, which provides added protection from the elements of the coastal environment. The handrail will be black, as per the standard colour specified in the finishes specification¹¹.

Handrails are also to be fitted to the emergency egress steps in frontage 5. It is proposed that Kee Klamp railing system, or similar approved, is used for these steps. The Kee Klamp fitting system securely joins standard sizes of structural tubes, constructed of galvanised cast iron, into the required configuration. There are several distributors of the Kee Klamp system across the UK.

3.1.14 Cladding

Various cladding finishes have been considered throughout the scheme including brick cladding, stone cladding, and flint cladding.

The engineering brick type proposed throughout the Scheme is the Ketley Staffordshire Red Class A Engineering¹². One source to supply them is Travis and Perkins, the closest branch to the scheme is in Portsmouth, PO3 5QH, 5 miles from source to project site.

The other brick cladding used throughout the Scheme is the Wienerberger Heritage Brick¹³. Sourcing options were reviewed and the most appropriate and convenient was proposed to be Travis and Perkins. The closest branch of Travis and Perkins is 5 miles from site. All Brick and Stone Heritage Range bricks were also considered; however, this option was disregarded due to the bricks being sourced from Nova Scotia, Canada.

Flint Cladding is specified within the design for Frontage 4. The walls can either be cladded using a traditional method or with pre-cast flint panels. The proposed sourcing option for Flint Panels is from All Brick and Stone¹⁴. All Brick and Stone are based in Winnerish, Wokingham, RG41 5LB, approximately 75 miles from Langstone.

Stone cladding is also specified for the walls in Frontage 4 and 5. The selected supplier for the various types of stone is the Black Mountain Quarries¹⁵, located 160 miles from the site.

Timber cladding is specified in Frontage 2. The specified sourcing option is Accoya wood, a modified timber manufactured using a non-toxic treatment and sourced from sustainable forests. Accoya was chosen as a suitable cladding choice given its relative long life and low maintenance requirements compared to conventional timber. The closest branch of Accoya timber from the supplier James Latham is in Fareham, Hampshire, PO15 5AP, 15 miles from Langstone. The timber itself is grown in New Zealand and is an alternative to tropical hardwoods.

3.1.15 Coping

Reconstituted stone coping has been designed for the new flood walls in Frontages 3 and 4. The coping stones have been designed based on preferences from stakeholders, including the Conversation Officer, for a flat coping stone. A crossfall is incorporated in the coping design to prevent pooling of water. They will be cast using moulds off site. Four variations of the design have been specified throughout the scheme. A RFI was raised to the ECI contractor with regards to potential sourcing of the coping stones (see DD RFI 020).

¹¹ Weaver Ductile Iron Single Rail: BX 1530-1 | Broxap.

¹² <https://www.travisperkins.co.uk/engineering-bricks/ketley-engineering-brick-red-solid-class-a-pack-of-400/p/870953>

¹³ <https://www.travisperkins.co.uk/facing-bricks/wienerberger-olde-heritage-antique-brick-65mm-pack-of-500/p/424656>

¹⁴ <https://www.allbrickandstone.com/productrange/flint/>

¹⁵ <https://www.blackmountainquarries.co.uk/facing-stone/>

3.1.16 Drainage

The proposed tidal flood defences will prevent the drainage of rainwater and wave overtopping water from land areas that previously free discharged into the sea. Therefore, surface water drainage is proposed to be installed in conjunction with the defences across Frontages 1B, 2, 3, 4 and 5. No formalised drainage is proposed for Frontages 1A and 6, where the drainage pathways with the new defences are like the existing drainage pathways. Refer to the Drainage Strategy Report for further details.

Filter Drains have been specified in Frontages 1B, 2, 3, 4 and 5. These drains are composed of perforated pipes, granular material and filter material wrapped in a geotextile. Either topsoil or chippings are then placed on top of the drain. These are readily available construction materials.

ACO MultiDrain MD Channel Drainage has been specified within Frontages 2, 3 and 5. The drainage system is manufactured from Vienite®, a polymeric based recycled material produced by ACO. The product is a strong and lightweight design with a low water absorption rate. The channel system is supplied with either galvanised or stainless-steel edge rails. Gratings are available in a range of materials, including galvanised, stainless steel, composite and ductile iron and for a range of load ratings. The units are manufactured in Shefford, Bedfordshire, SG17 5TE, 110 miles from Langstone.

3.1.17 Paving

Improvement to and reinstatement of the existing pavements is included within the design for Frontages 1A, 2, 3, 4 and 5.

Within Frontages 1A, 2 and 3 asphalt concretes are specified for the cyclepath and car park surface and binder courses. Asphalt concretes are a readily available construction material, and a precise source has not been identified at this time.

Within Frontages 3 and 4 an exposed aggregate surface is given to the reinforced concrete footpath. The aggregates specified are of golden buff colour.

The design incorporates reinstatement of the existing paving slabs within the Ship Inn courtyard (Frontage 3) and in front of the Royal Oak (Frontage 5). Where necessary, the paving slabs should be supplemented with Marshalls Sylvern Limestone Paving slabs, or similar approved. Marshalls source and manufacture their products within the UK.

3.2 Frontage 1A

Frontage 1A consists of a new flood embankment and cycle path. The materials for the embankment and cyclepath are displayed in Table 3-7.

Table 3-7. Frontage 1A specific materials and potential sources.

Asset	Material	Potential Source
Embankment	Class 2A or Class 2C cohesive fill	See section 3.1.4
	Class 1A granular fill	Readily Available Construction Material (See Section 3.1.5)
	Class 5 topsoil	Site won / Readily Available Construction Material Additional seed planting to a coastal seed mix.
	Geotextile – Terram 1000 Geotextile	See Section 3.1.10
	Geotextile – ABG Terrex SNW40UV	See Section 3.1.10
	Geomembrane - ABG Alphaline	ABG (See Section 3.1.10)
	Type 1 Granular Material	Readily Available Construction Material
Cyclepath	50mm Dense Asphalt Concrete Binder	Readily Available Construction Material. See Section 3.1.17
	20mm Dense Asphalt Concrete Surface	Readily Available Construction Material. See Section 3.1.17
	Mix ST1 Concrete	Readily Available Construction Material See Section 3.1.1
	Precast Concrete Edgings	Readily Available Construction Material

3.3 Frontage 1B

The assets within Frontage 1B include a reinforced concrete seawall, an embankment and sheet piled wall. The materials for Frontage 1B are displayed in Table 3-8.

Table 3-8. Frontage 1B specific materials and potential sources.

Asset	Material	Potential Source
Seawall	Sheet Piles – PU22	ArcelorMittal or similar (See Section 3.1.8)
	Concrete – C40/50	Kendalls (See Section 3.1.1)
	Reinforcement	Readily Available Construction Material
	PVC Drainage Pipes	Readily Available Construction Material
	Ecoformliner	Reckli See (See Section 3.1.1)
	Rock Armour – Scour Protection	The rock armour could be sourced from 2 sources; Dudman aggregates 250 miles from the site or Lawer Bros located 230 miles from the site (See Section 3.1.9).
Sheet Piled Wall	Sheet Piles – PU28	ArcelorMittal or similar. See Section 3.1.8
	Chestnut post and rail fencing.	Chestnut Woodsman or similar. Chestnut Woodsmen are located 120 miles from the site, Torry Hill Chestnut Fencing Ltd, The Chalkpit/Lade Wood Hill, Sittingbourne ME9 0ED ¹⁶ .
	Coir netting	Salix or similar. See Section 3.1.10
Embankment	Class 1A granular fill	Readily Available Construction Material (See Section 3.1.5)
	Class 2A cohesive fill	See section 3.1.5
	Terram 1000 Geotextile	Terram (See Section 3.1.10)
	Topsoil / Class 5 topsoil	Site won / Readily Available Construction Material. Additional seed planting to a coastal seed mix.
	Coir Netting	Salix or similar. See Section 3.1.10

¹⁶ <http://chestnutwoodsman.co.uk/chestnut-fencing/>

3.4 Frontage 2

The flood defence assets within Frontage 2 (Table 3-9) include sheet piled walls and raised earth embankments where the defence crosses existing services. The design for Frontage 2 also includes an upgrade to the existing cyclepath.

Table 3-9. Frontage 2 specific materials and potential sources

Asset	Material	Potential Source
Sheet pile wall tie in F1B (Chainage 0 – 10)	Sheet Piles – PU12	ArcelorMittal or similar (See Section 3.1.8)
	150mm Class 5 Topsoil	Site won / Readily Available Construction Material Additional seed planting to a coastal seed mix.
	Excavated material	Reuse from existing.
Tie in embankment (Chainage 10 – 25)	ABG Terrex SNW40UV Geotextile	ABG (See Section 3.1.10).
	Class 1A Granular Fill	Readily Available Construction Material (See Section 3.1.5)
	Class 2A Thick Cohesive Fill	See section 3.1.4
	150mm Class 5 Topsoil	Site won / Readily Available Construction Material Additional seed planting to a coastal seed mix.
	Waterproof membrane ABG Alphaline	ABG (See Section 3.1.10).
Seaward sheet pile wall (Chainage 25 – 100)	Sheet Piles – PU12	ArcelorMittal or similar (See Section 3.1.8)
	150mm Class 5 Topsoil	Readily Available Construction Material.
	Excavated material	Reuse from existing
Cyclepath (Chainage 29 – 201)	Class 5 Topsoil	Site won / Readily Available Construction Material Additional seed planting to a coastal seed mix.
	20mm Dense Asphalt Surface Course	Readily Available Construction Material. See Section 3.1.17
	50mm Dense Asphalt Binder Course	Readily Available Construction Material. See Section 3.1.17
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Geotextile (Terram 1000 or similar approved)	Terram (See Section 3.1.10)
Drainage	Filter Drainage (Chainage 29 – 105)	See Section 3.1.16
	Channel Drainage (Chainage 155+) - ACO M200DS No.00 with Load Class Heelguard Ductile Iron Grating	ACO (see Section 3.1.16)
	Headwall – ACO SuDs Swale Inlet	ACO (see Section 3.1.16)
	Non-Return Valve – Tideflex Checkmate Inline Valve	Althon.

	Concrete Plinth - Concrete – C40/50	Kendalls (See Section 3.1.1)
	Concrete Plinth - Reinforcement	Readily Available Construction Material
Cross over embankment at Chainage 105	Class 5 Topsoil	Site won / Readily Available Construction Material Additional seed planting to a coastal seed mix.
	ABG Alphaline 1mm	ABG (See Section 3.1.10).
	Class 1A Granular Fill	Readily Available Construction Material (See Section 3.1.5)
	Class 2 A Cohesive Fill	Readily Available Construction Material.
	ABG Terrex SNW40UV	ABG (See Section 3.1.10).
	Chestnut post and rail fencing.	Chestnut Woodsman or similar. Chestnut Woodsmen are located 120 miles from site, Torry Hill Chestnut Fencing Ltd, The Chalkpit/Lade Wood Hill, Sittingbourne ME9 0ED ¹⁷ .
Landward sheet pile (Chainage 110 – 150)	Sheet Piles – PU12	ArcelorMittal or similar (See Section 3.1.8)
	Cladding – Timber Cladding and Capping	Accoya Timber (see Section 3.1.14)
	Filter Drain	See Section 3.1.16.
Cross over embankment at Chainage 155	Asphalt Reinforcement – Tensar Glasstex	Tensar (see Section 3.1.10)
	Class 1A Granular Fill	Readily Available Construction Material (See Section 3.1.5)
	Class 2 A Cohesive Fill	Readily Available Construction Material.
	40mm Dense Asphalt Surface Course	Readily Available Construction Material.
	50mm Dense Asphalt Binder Course	Readily Available Construction Material.
	Chestnut post and rail fencing.	Chestnut Woodsman or similar. Chestnut Woodsmen are located 120 miles from site, Torry Hill Chestnut Fencing Ltd, The Chalkpit/Lade Wood Hill, Sittingbourne ME9 0ED ¹⁸ .
Seaward sheet pile (Chainage 160+)	Sheet Piles – PU12	ArcelorMittal or similar (See Section 3.1.8)
	Cladding – Timber Cladding and Capping	Accoya Timber (see Section 3.1.14)

¹⁷ <http://chestnutwoodsman.co.uk/chestnut-fencing/>¹⁸ <http://chestnutwoodsman.co.uk/chestnut-fencing/>

3.5 Frontage 3

Frontage 3 includes various assets of a Sheet Piled Wall along the A3023, a Raised Car Park Bund, Retaining Wall, Steps to Courtyard, Glass Topped Flood Wall (in front of the Ship Inn), a Cladded Flood Wall and Flood Gate 4 (in front of the High Street). The specific materials and sources can be seen in Table 3-10.

Table 3-10. Frontage 3 specific materials and potential sources.

Asset	Material	Potential Source
Sheet Piled Wall along A3023	L8 Interlocking Sheet Pile	Readily Available Construction Material.
	C40/50 Concrete	Kendalls (See Section 3.1.1)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Geotextile - ABG Terrex SNW40UV	ABG (See Section 3.1.10).
	Geomembrane - ABG Alphaline	ABG (See Section 3.1.10)
Car Park Bund	Geotextile - ABG Terrex SNW40UV	ABG (See Section 3.1.10).
	Geomembrane - ABG Alphaline	ABG (See Section 3.1.10)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Base Course AC 32 Base 100/150	Readily Available Construction Material
	60mm Binder Course AC 32 dense bin	Readily Available Construction Material
	40mm surface course HRA 30/14	Readily Available Construction Material
	Granite Setts	Granite Setts UK or similar, supplier based in Orpington, BR5 3AA, 90 miles from the site.
	Handrails – Broxap Weaver Post	Broxap (See Section 3.1.13).
Ship Inn Courtyard Retaining Wall	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	C40/50 Concrete	Kendalls (See Section 3.1.1)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Paving	Reinstate existing and supplement with Marshalls Sylvern Limestone Paving slabs, or similar approved. (See Section 3.1.17)
Steps to courtyard/Cladded flood wall	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Mass Concrete – FND3	Readily Available Construction Material
	Precast Concrete Singe Solid Step Units – textured conservation	Marshalls ¹⁹ will be the supplier of these step units. The closest production/manufacturing plant of the paving is in Bristol, Shepton Mallet, BA4 4SQ (90 miles from site).
Ship Inn Flood Wall	Sheet Piles – PU28	ArcelorMittal or similar. See Section 3.1.8
	C40/50 Concrete	Kendalls (See Section 3.1.1)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Glass barrier consisting of: - Toughened Glass - Framing Steel	The flood glass barrier is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.11)
	Brick Cladding – Ketley Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Paving	Reinstate existing and supplement with Marshalls Sylvern Limestone Paving slabs, or similar approved. (See Section 3.1.17)

¹⁹ <https://www.marshalls.co.uk/commercial/product/conservation-x-paving>

Asset	Material	Potential Source
Flood Gate 1	Steel	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
Ship Inn Annex Flood Wall	Sheet Piles – PU28	ArcelorMittal or similar. See Section 3.1.8
	C40/50 Concrete	Kendalls (See Section 3.1.1)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Brick Cladding – Ketley Red Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Brick Cladding - Wienerberger Olde Heritage	Travis and Perkins or similar (See Section 3.1.14)
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)
Drainage	Channel Drain – ACO M200DS	ACO See Section 3.1.16
	Sump – ACO M200DS Universal Sump with Plastic Silt Bucket	ACO See Section 3.1.16
	Gully and Bucket – ACO Universal Gully Assembly and Bucket 601D	ACO See Section 3.1.16
	300mm Diameter Sub Surface Pipe Connection	Readily Available Construction Material.

3.6 Frontage 4

Frontage 4 is a series of flood walls and gates, these are labelled as; the Watchtower Flood Wall, Flood Gate 2 (Watchtower), Green Cottage Annex Flood Wall, Green Cottage Flood Wall, Flood Gate 3 (Green Cottage Vehicle), Flint Wall Flood Wall, and Winkle Market Flood Wall. The materials and specific sourcing have been detailed in Table 3-11 where appropriate.

Table 3-11. Frontage 4 specific materials and potential sources.

Asset	Material	Potential Source
Watchtower Flood Wall	Brick Cladding (Quay Wall) - Ketley Red Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Brick Cladding (Garden Wall) - Wienerberger Olde Heritage	Travis and Perkins or similar (See Section 3.1.14)
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Stone Cladding – Sandstone Rubble Facing Stone or similar	Black Mountain Quarries, see Section 3.1.14
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
	Anderton Stepoc Blocks	Anderton (See Section 3.1.2)
	Geotextile – Terram 1000 Geotextile	Terram (See Section 3.1.10)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Class 6T lightweight fill	See Section 3.1.5
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)
Watchtower Access Steps	20 Compressible Closed Cell Filler – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Mass Concrete – FND3	Readily Available Construction Material.
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
Flood Gate 2 – Watchtower drop in flood boards	Dowels	Readily Available Construction Material (See Section 3.1.3).
	Aluminium barrier panels	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
Green Cottage Annex Flood Wall	Brick Cladding (Quay Wall) - Ketley Red Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Flint Cladding (Garden Wall)	All Brick and Stone, see Section 3.1.14
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	20 Compressible Closed Cell Filler – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)

Asset	Material	Potential Source
Flood Gate 3 – Green Cottage Gate	Flood gate with Timber Cladding	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
Green Cottage Flood Wall	Brick Cladding (Quay Wall) - Ketley Red Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Flint Cladding (Garden Wall)	All Brick and Stone, see Section 3.1.14
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	20 Compressible Closed Cell Filler – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)
Flint Flood Wall	Filter Drain and Outfall	See Section 3.1.16
	Brick Cladding (Quay Wall) – Ketley Red Engineering Brick	Travis and Perkins or similar. (See Section 3.1.14)
	Flint Cladding	All Brick and Stone, see Section 3.1.14
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
	Anderton Stepoc Blocks	Anderton (See Section 3.1.2)
	Geotextile – Terram 1000 Geotextile	Terram (See Section 3.1.10)
	Class 6T lightweight fill	See Section 3.1.5
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	20 Compressible Closed Cell Filler – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)
Winklemarket Flood Wall	Brick Cladding (Quay Wall) – Ketley Red Engineering Brick	Travis and Perkins or similar (See Section 3.1.14)
	Brick Cladding (Building Wall North) - Wienerberger Olde Heritage	Travis and Perkins or similar (See Section 3.1.14)
	Flint Cladding (Building Wall East)	All Brick and Stone, see Section 3.1.14
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Broxap Weaver Post Handrail	Broxap (See Section 3.1.13)
	Anderton Stepoc Blocks	Anderton (See Section 3.1.2)
	Geotextile – Terram 1000 Geotextile	Terram (See Section 3.1.10)
	Class 6T lightweight fill	See Section 3.1.5
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).

Asset	Material	Potential Source
	20 Compressible Closed Cell Filler – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Coping – Precast Reconstituted Stone Coping	To be confirmed by the Appointed Contractor. (See DD RFI 020)

3.7 Frontage 5

Frontage 5 also consists of a series of flood gates and flood walls. These are labelled as follows: Flood Gate 4, High Street Flood Gate 5, Royal Oak Flood Wall, Royal Oak Flood Gate 6, Allotment Flood Wall, Flood Gate 7, Flood Gate 8 (No 21. Vehicle), Footpath Flood Wall and an Embankment. The specific materials used in the Flood Gates and other assets are detailed in Table 3-12.

Table 3-12. Frontage 5 specific materials and potential sources.

Asset	Material	Potential Source
Flood Gate 4 (high street)	Concrete C40/50	Kendalls (See Section 3.1.1)
	Brick Cladding – Wienerberger Olde Heritage	Travis and Perkins or similar (See Section 3.1.14)
	Steel flood gate with Timber Cladding	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
Flood Gate 5 (high street)	Concrete C40/50	Kendalls (See Section 3.1.1)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Stone Cladding	Black Mountain Quarries, see Section 3.1.14
	Steel flood Gate with Timber Cladding	The flood gate is a Proprietary Product designed by others. As such, the source will depend on the Contractors chosen supplier. (See Section 3.1.12)
Royal Oak Flood Wall	Glass Flood Barrier	The Glass Barrier is a Proprietary Product designed by others. As such, the source will depend on the Contractors chosen supplier. (See Section 3.1.11)
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Sheet Piles – PU12	ArcelorMittal or similar. See Section 3.1.8
	Stone Cladding – Blue Sandstone, Cream Limestone, Gloucester Green Random Rubble Facing Stone	Black Mountain Quarries, see Section 3.1.14
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Cobbles	Readily Available Construction Material.
	Paving	Reinstate existing and supplement with Marshalls Sylvern Limestone Paving slabs, or similar approved. (See Section 3.1.17)
	Drainage – Channel Drain M150DS, Gully and Bucket and Outfalls Connections	ACO See Section 3.1.16
Flood gate 6 (Drop in Flood Boards)	Drop in Flood Boards (Aluminium panels)	The drop in flood boards is a Proprietary Product designed by others. As such, the source will depend on the Contractors chosen supplier. (See Section 3.1.12)

Asset	Material	Potential Source
Emergency Egress Steps	Mass Concrete – FND3	Readily Available Construction Material
	50 Compressible Closed cell board – Aerofill 2	Aerofill is manufactured by GCP. Manufacturing and distribution centres are located worldwide. The UK branch is located in Slough.
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Handrails	Kee Klamp or similar approved.
Allotment Flood Wall	Sheet Piles – L8	ArcelorMittal or similar. See Section 3.1.8
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Brick Cladding – Wienerberger Olde Heritage	Travis and Perkins or similar (See Section 3.1.14)
	Filter Drain	See Section 3.1.16
Flood Gate 7	Flood Gate with Timber Cladding	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
Flood Gate 8 (No.21)	Flood Gate with Timber Cladding	The flood gate is a Proprietary Product designed by others. As such, source will depend on the Contractors chosen supplier. (See Section 3.1.12)
	Sheet Piles – L8	ArcelorMittal or similar. See Section 3.1.8
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Drainage – ACO M100DS Channel Drain and Sump	ACO See Section 3.1.16
Footpath Wall and Pathway	Type 1 Granular Material	Readily Available Construction Material (See Section 3.1.5)
	Sheet Piles – L8	ArcelorMittal or similar. See Section 3.1.8
	Type B Filter Material	Readily Available Construction Material
	Concrete C40/50	Kendalls (See Section 3.1.1)
	Bodpave 40	Terram source Bodpave, interlocking plastic porous paving. The sourcing location is located in Essex, 140 miles from the Scheme (see Section 3.1.10).
	Reinforcement	Readily Available Construction Material (See Section 3.1.3).
	Drainage – ACO M100DS Channel Drain	ACO See Section 3.1.16

Asset	Material	Potential Source
Embankment	Class 2A cohesive fill	See section 3.1.5
	Class 1A granular fill	Readily Available Construction Material (See Section 3.1.5)
	Class 5 topsoil	Site won / Readily Available Construction Material. Additional seed planting to a coastal seed mix.
	Coir Netting	See Section 3.1.10)
	Geotextile – Terram 1000	Terram (See Section 3.1.10)

3.8 Frontage 6

Frontage 6 is a rock armour defence to the old railway spit, the materials required consist of primary and secondary rock armour and a geotextile layer. The details of materials and sourcing can be seen in Table 3-3-13.

Table 3-3-13: Frontage 6 specific materials and potential sources.

Asset	Material	Source
Rock Revetment	Rock Armour	The rock armour could be sourced from 2 sources; Dudman aggregates 250 miles from the site or Lower Bros located 230 miles from the site (See Section 3.1.9).
	- Granite Rock Armour	
	Geotextile – Terram 1000	Terram, see Section 3.1.10.
	Overtopping Protection – Armor flex mat	Armorflex could be supplied from Armortec UK. The company is based in Wales and the mats are manufactured and distributed in the UK.

4 Suitability for Re-Use of Materials

The suitability of reusing materials and/or using materials that have previously been used and can be recycled is detailed in the following section.

Structural Investigations were carried out to determine whether existing structures could be incorporated into the Scheme. Whether the existing structure could be incorporated into the flood defence depended on the structural stability of the structure and the water tightness. Refer to the Structural Investigations Report (AECOM 2021) and the Design Report for more details with regards to these investigations. Given the age and condition of the existing structures, it was deemed unsuitable to re-use the existing structures as a flood defence with a design life of 50 years.

The design also investigated whether the existing structures could be retained and used as cladding for the new flood defence structures. For the Allotment Wall in Frontage 5 it was deemed that the existing wall could be retained in front of the new reinforced concrete wall. Where the existing quay wall is to be broken out in frontage 4 there is also potential for the existing bricks to be carefully removed and re-incorporated into the cladding for the new flood walls in front of the Frontage 4 gardens. The suitability of the re-use of these bricks can be confirmed by the contractor on site.

The design also investigated whether the sheet piles could first be used to form a temporary access track along the foreshore before being incorporated into the permanent works (See DD RFI 013). The pile sections specified across the scheme are PU sections which can be laid flat on the foreshore to form an access track. This thereby negates the need for piling mats to be constructed.

Throughout the scheme, re-use of excavated material as earthworks fill is an option, where excavated material meets the specification requirements. This includes re-use of arisings from excavation required to facilitate the works and excavation of the topsoil from the footprint of all working areas and locations of new earthworks, structures, and pavements. The suitability of site won material for re-use in the scheme shall be determined by the contractor in accordance with the project specific earthworks specification appendices. Under the Waste Framework Directive, any uncontaminated natural soils that are excavated in the course of construction and that are to be re-used for the purposes of construction on the site of origin are not considered to be a waste and can therefore be reused on the same site. For the re-use of site won non-natural or contaminated natural materials, a regulatory mechanism should be adopted to ensure compliance with the waste regulations. Made Ground or soils with some level of contamination may be re-used on site provided it can be demonstrated that no harm to receptors or the environment will occur, and subject to there being a genuine need to accommodate the materials in the development. In this scenario a waste exemption, environmental permit or adoption of the CL:AIRE Definition of Waste: Development Industry Code of Practice should be adopted.

Fixtures and fittings throughout the scheme including benches and the lamppost at Winklemarket are to be carefully removed and reinstated upon completion of the works.

5 Mitigation of Contamination Risk

The Langstone Flood & Coastal Erosion Management Scheme Ground Investigation Report (GIR) (Report No: LANG-ACM-XX-ZZ-RP-GT-000001, AECOM, February 2022) presents a contamination assessment of the site to evaluate potential risks to human health, controlled waters and infrastructure. A summary of the assessment findings is presented below.

A contaminated land strategy and materials management plan will be developed by Coastal Partners as part of the planning application for approval by the local authority.

Should contaminated soils be observed during construction development works, the assessment of risk will need to be reassessed.

5.1 Risk to Human Health

The assessment of risk to human health concluded that, based on the screening assessment of available chemical data, no contaminants exceeded the evaluation criteria for the proposed public open space end use. Therefore, the risk to future users is deemed negligible and thus acceptable with regard to the contaminants analysed and the contamination pathways identified within the conceptual site model.

No exceedances were identified of the acute construction worker evaluation criteria. However, minor isolated exceedances of the chronic construction worker evaluation criteria were identified for lead at Frontage 3 (exploratory hole DS101) and Frontage 4 (exploratory hole HDTP108 553mg/kg for lead) and a location of potentially corrosive pH value was recorded at Frontage 3 (exploratory hole BH104).

Whilst the potential risks to construction workers is considered to be Low it is recommended that appropriate PPE is worn by all construction workers and that the planning of construction works is undertaken in accordance with relevant statutory health and safety requirements.

5.2 Risk to Surface Water

Arsenic, copper, lead and PAHs (anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene and benzo(k)fluoranthene) were detected in soil leachate at concentrations which exceeded their Environmental Quality Standards (EQS) evaluation criteria. However, these were not subsequently detected with the groundwater at concentrations which may pose a risk to surface water.

A soil leachate concentration of 7080 µg/l of lead was recorded from DS101 compared with the EQS evaluation criteria of 1.3 µg/l. Made Ground including brick and mortar was located at this location but it was not notably different composition to Made Ground encountered at the rest of the Site. The greatest concentrations of lead within the soil were also noted to be within this area of the site (Frontage 3 and Frontage 4), with concentrations above 500 mg/kg being recorded along this section of the site. The highest concentrations of Lead were from DS101 and HDTP08 where concentrations of 782 and 533 mg/kg were recorded compared to background soil concentrations (UK Soil Observatory data) of 55 mg/kg.

Groundwater results did not indicate a lead impact from the location of the third highest concentration of lead, which was 168 mg/kg in DS107. The groundwater sample from the same location did not record lead above the limit of detection (1 µg/l). No groundwater data was available for the two highest concentrations of lead in soils at DS101 and HDTP108, however lead was not detected in any of the other groundwater samples above the limit of detection.

Nickel and zinc were also elevated in the soil leachate in the Made Ground at DS101 in comparison to the EQS evaluation criteria (one to two orders of magnitude greater) and compared to other soil leachate sample concentrations within the Made Ground. As with lead, the elevated concentrations of these metals coincide with the higher concentrations of these contaminants within the soil, again generally confined to Frontage 3 and 4. The greatest soil concentrations were recorded higher than background soil concentrations for these contaminants, 211 mg/kg for zinc (HDTP08) compared to 60.89 mg/kg and 72 mg/kg for nickel (HDTP105) compared to 14.84 mg/kg. Although, HDTP105 is located in the southwest of the site on the opposite side of the harbour. Average concentrations of zinc and nickel in the soils across the site are comparable to background concentrations.

Although exceedances of nickel and zinc were recorded in the groundwater, the concentrations are considered marginal as they were within the same order of magnitude as the EQS. Nickel was an isolated exceedance in groundwater, only being encountered greater than the EQS evaluation criteria in BH105 in the deeper chalk aquifer. Zinc exceedances within the groundwater were more widespread, exceeding the EQS evaluation criteria of 6.8 µg/l in six of the nine sampled locations. The greatest concentrations were observed within the chalk aquifer monitoring wells. However, all were marginal, with a maximum concentration of 27 µg/l recorded (BH105).

Within the groundwater, PAHs (fluoranthene), cyanide and ammoniacal nitrogen (based on unionised ammonia as N) also exceeded the EQS evaluation criteria protective of surface water in more than one groundwater sample obtained from the Site. These are all considered to be marginal exceedances as they were recorded to be within the same order of magnitude as their EQS evaluation criteria.

Cyanide and fluoranthene were isolated exceedances, only detected at concentrations in the groundwater greater than the EQS evaluation criteria within the alluvial deposits and within individual locations DS105(S) and DS103, respectively.

Soil leachate PAH exceedances (other than fluoranthene) from the Made Ground were generally confined to the southeast section of the Site (DS101 and BH104) (Frontage 1B). However, PAHs (other than fluoranthene) were also detected in BH106 (Frontage 1B) within the Chalk. The chalk was at shallow depth, with no covering superficial deposits observed at this location.

On the basis of the general limited exceedances of EQS in groundwater compared to soil leachate, the magnitude of exceedances in relation to the EQS, the spatial distribution of the exceedances across the site and expected attenuation, it is considered that the soil and groundwater quality beneath the site is unlikely to pose a significant risk to surface water quality during or post construction works. However, it is notable that there is a potential for mobilisation of contaminants (metals and PAHs) during construction in the area of Frontage 3 and Frontage 4 and in particular around DS101 and HDTP108 with soil and leachate concentrations generally higher in this area compared to the rest of the site. This area of the site is possibly associated of reclaimed land during development of the area.

Although the risk is low, given the potential for mobilisation of contaminants into groundwater during construction works within the vicinity of Frontage 3 and Frontage 4, it would be prudent to undertake groundwater chemical analysis prior to discharge into the surface water. Chemical analysis of the receiving water is also suggested prior to works and to be monitored during the works. As part of the CEMP mitigation for the potential for contaminated groundwater to be encountered should be included and any water control measures required during construction should include assessment of groundwater quality to ascertain appropriate discharge options and discharge consents. These options should be discussed with the Environment Agency and/or local water company to understand their requirements and ensure compliance and consent prior to any works being undertaken.

For the purpose of materials management, any excavated material from the vicinity of DS101 and HDTP108 would not be suitable for reuse on the Site. This is due to the potential mobilisation of contaminants from excavated material within the top 1.7m bgl within DS101 and 0.65m bgl within the vicinity of HDTP108.

It is also proposed that the Contractor uses a silt curtain during the works to limit any dispersion of the suspended sediments in the water column into the wider harbour.

5.3 Risk to Groundwater

No metals (with the exception of sodium) or PAHs were detected at concentrations within the groundwater water which would impact on groundwater quality as all were recorded below the England & Wales Drinking Water Standards (DWS).

Ammoniacal nitrogen, chloride, sulphate, boron and sodium were recorded to exceed the DWS evaluation criteria protective of groundwater quality in more than one groundwater sample obtained from the site. The concentrations of chloride, sulphate and sodium are likely to reflect sea water intrusion. It was also noted that the locations further inland recorded lower concentrations of chloride, sulphate and sodium compared to those close or on the shoreline. The groundwater concentrations detected for the determinands detailed above were recorded to be within the same order of magnitude or 1 order of magnitude greater than their DWS evaluation criteria. Therefore, these are all considered to be marginal exceedances given the context of the site and surroundings, with the groundwater being tidally influenced and the site not being located within a groundwater source protection zone (SPZ).

Hydrocarbons were detected in the groundwater within DS104 that exceeded DWS evaluation criteria. There is no indication within the exploratory log / observations within the soil at this location to suggest a potential source. However, within DS105 to the north of DS104, a hydrocarbon odour was noted within the alluvial deposits. Although, the concentrations recorded for hydrocarbons from the soil samples obtained from DS105 do not indicate particularly elevated concentrations (total hydrocarbon concentration of 62 mg/kg). Therefore, the TPH concentrations observed within DS104 are considered to be an isolated location and not related to a known ongoing source.

With regards to soil leachate, as with the risk to surface water, the greatest soil leachate concentrations and the greatest number of different determinands exceeding the DWS evaluation criteria at one location were from soils obtained from DS101. The following determinands only exceeded the DWS EC from soil leachate samples obtained from DS101: boron, nickel, benzo(b)fluoranthene, benzo(ghi)perylene benzo(k)fluoranthene, dibenzo(ah)anthracene, fluoranthene, indeno(123-cd)pyrene and PAH (sum of 4). Ammoniacal nitrogen as N, antimony, arsenic, lead, chloride, sulphate, sodium, chloride, sodium, benzo(a)pyrene and PAH (sum of 4) also exceeded the DWS EC from soil leachate samples obtained from DS101, but these also exceeded in other isolated locations across the Site.

Leachate exceedances from DS101 were isolated within the Made Ground sample at 0.5m bgl. Subsequent sampling within the same location at 1.7m bgl within the Alluvium demonstrated that the contamination is likely to be within the Made Ground only. No metals or PAHs were noted to exceed the DWS evaluation criteria from soil leachate samples obtained within the Alluvium.

For the purpose of materials management, any excavated material from the vicinity of DS101 and HDTP108 would not be suitable for reuse on the Site. This is due to the potential mobilisation of contaminants from excavated material within the top 1.7m bgl within DS101 and 0.65m bgl within the vicinity of HDTP108.

Given only ammoniacal nitrogen, chloride, sulphate boron and sodium were identified within the groundwater at concentrations greater than the DWS evaluation criteria and these can be partially explained by tidal influence, it is not considered that the soils at the site are a potential source of unacceptable contamination which would result in potential harm to groundwater quality in the context of the site and its surroundings and its potential use as a potable supply.

It is unlikely that the Principal chalk aquifer (or Secondary A aquifer) will be exploited as a potable water in the future within this area, given the tidal influence, and also noting that SPZ associated with the Principal Chalk aquifer are all further inland. Therefore, the exceedances in the groundwater or soil leachate are unlikely to result in unacceptable harm or damage to potable water resources during or post construction works.

5.4 Preliminary Waste Assessment

The waste classification and assessment identified 39 of the 40 samples tested to be 'Non-Hazardous' and 1 sample was reported as "Hazardous". The single "Hazardous" sample was from BH104 at 1mbgl. The sample was from the Made Ground strata and was described in the exploratory hole log as "Soft to firm brown locally mottled brownish grey slightly sandy slightly gravelly Clay. Sand is fine to coarse. Gravel is angular to subangular fine to coarse flint and rare brick fragments and chalk".

The "Hazardous" classification for the samples was only raised by the pH value for the sample which was 11.92. This flagged as being "assumed to be irritant / corrosive because of pH value" with relation to the Hazardous Property 8 Corrosive 'waste which on application can cause skin corrosion'.

Three other samples taken from this borehole location; one in the made ground (0.2mbgl), one in the alluvium (2.8mbgl) and one in the underlying Chalk (4.9mbgl) are classified as Non-Hazardous with pH recorded between 8.92 and 9.8. These remain slightly elevated relative to the other samples obtained from the other exploratory locations which are typically around pH 8.

The initial hazardous waste classification does not replace waste acceptance analysis for off-site disposal. The hazardous waste assessment only identifies the material as 'Hazardous' or 'Non-Hazardous' under the classifications in Environment Agency WM3 Technical Guidance. Material classed as 'Non-Hazardous' may potentially be taken off site to a 'Non-Hazardous' landfill, but not an 'Inert' landfill without additional Waste Acceptance Criteria (WAC) analysis. Materials sent off site as Non-Hazardous typically incur higher disposal costs than that of 'Inert' materials. Additional WAC analysis of material destined for off-site disposal could reduce the overall costs associated and provide a more environmentally responsible transfer of waste.

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