Appendix L – Engineering drawings, technical notes and designers risk assessments

DESIGN TECHNICAL NOTE

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1 Introduction

This Design Technical Note details the key assumptions and calculations used in the development of the concept designs of the shortlist options as part of the Helensburgh Coastal Options Appraisal (COA).

The Helensburgh COA is being developed to investigate the feasibility of a new coastal defence scheme to manage coastal flood risk at Helensburgh. Each option has been designed to protect residential and commercial properties along the Helensburgh frontage between Rhu and Craigendoran (excluding Rhu Marina and between the Marina and Helensburgh Sailing Club and Helensburgh Pier; see Figure 1). The purpose is to increase the protection from the risk of tidal inundation and wave overtopping, ensuring an appropriate standard of protection (taking climate change into account) and design life of all elements.

Figure 1 Frontages assessed within the Helensburgh COA

1.1 RIBA Plan of Work

The definition of the RIBA Plan of Work, from project conception to operation, can be summarised as follows:

- Stage 0 - Strategic Definition - to identify the client's core project requirements.
- Stage 1 - Preparation and Brief - to develop project objectives and initial project brief.
- Stage 2 - Concept Design - to prepare the concept design and preliminary cost information.
- Stage 3 - Developed Design - to prepare the outline design, cost information and project strategies.
- Stage 4 - Technical Design - to prepare the detailed design, to include structural detailing, specialist subcontractor design and specifications.
- Stage 5 - Construction - to manufacture offsite and construction onsite the Technical Design.
- Stage 6 - Handover and Close Out - to handover the finish structures.
- Stage 7 - In use - to utilise the structures as intended.

The Helensburgh COA has been commissioned under RIBA Stage 2 Concept Design [1] and thus the concept designs have been produced in accordance with such. Only high-level structural and geotechnical considerations have been made at this stage, with designs having been developed based on a typical profile through each section at Helensburgh, and do not consider access points or tie-in details.

1.2 Design development to shortlist options

As part of the COA, a range of longlist options have been assessed at a high level via PESTLE analysis (i.e. against political, economic, social, technical, legal and environmental considerations). From this some options were eliminated, with the following shortlist options determined and subsequently designed to concept design level:

- Rhu:
  - R1 - New sea wall
  - R2 - Sloped revetment
- Sailing Club:
  - S1 - New sea wall
  - S2 - Setback wall
- West Clyde Street:
  - W1 - New sea wall
  - W2 - Setback wall
- East Clyde Street:
  - E1 - Rock armour revetment

1 RIBA. 2013. www.ribaplanofwork.com/About/Concept.asp

- E2 - Advance the line (new sea wall)

- Craigendoran:
  - C1 - Rock armour revetment
  - C2 - Setback wall

All of the options have been designed to reduce the risk of tidal inundation and wave overtopping to the corresponding sections of Helensburgh.

2 Input data

The following input data, with listed assumptions, have been adopted during the development of the concept designs for the shortlist options at Helensburgh.

2.1 Datum

All elevations presented in the concept designs are given in metres Above Ordnance Datum (mAOD), based on the Ordnance Survey (OS) GPS Network.

2.2 Topographic data

Topographic data points were surveyed directly by JBA Consulting in September/October 2018 under the commission of the Helensburgh COA. This topographic data contains data on the elevations and schematisations of the existing defences and upper beach profiles.

2.3 Baseline conditions

The coastal defences at Helensburgh are frequently inundated and/or overtopped by waves during storm events. A review of historical flood events indicates that Helensburgh is subject to flooding ranging from the inundation of the roads and esplanade adjacent to the frontage to large wave conditions damaging the existing defences and flooding properties and residential gardens. A total of five events have been recorded between 2008-2018.

In order to develop a design which efficiently reduces the flood risk at Helensburgh, it has been crucial to investigate the baseline conditions, which are summarised below.

2.3.1 Existing defences

The Helensburgh frontage, including Rhu, is approximately 5.8km in length and is formally defended via a range of structures. A sand/shingle beach fronts the defences, although this offers little added protection against wave overtopping.

In August 2018, JBA Consulting undertook an asset condition survey of the Helensburgh coastal defences. This contains full details on the condition of the existing defences at Helensburgh. These assessments concluded that the majority of the frontage is in fair to poor condition, with a section of defences in good condition at East Clyde Street and sections of the Craigendoran frontage which is considered to have already reached failure.

Table 2-1 presents the type, condition and estimated residual life (i.e. time to failure) for each section included within the shortlist concept designs.

Table 2-1 Section details along the Helensburgh frontage

Section	Approx length (m)	Type	Condition	Residual life (years)
Rhu	425	Sections of masonry	3 (fair) - 4 (poor)	15-30

		wall, vegetated embankment with gabions, and concrete/masonry crest with rock armour revetment		
Sailing Club	718	Sections of earth and rock embankment, rock armour revetment, and vegetated embankment with concrete wall	3 (fair) - 4 (poor)	10-30
West Clyde Street	1,826	Sections of concrete wall and masonry wall	3 (fair) - 4 (poor)	15-30
East Clyde Street	1,653	Sections of masonry wall, concrete wall and concrete wall with rock armour revetment	2 (good) - 4 (poor)	10-55
Craigendoran	956	Sections of concrete wall, masonry wall and rock armour revetment	3 (fair) - 5 (very poor)	0-30 years (part of this defence has already reached failure)

2.3.2 Still water level flood risk

The present-day 0.5% AEP event maximum water level varies across the Helensburgh frontage. However, as a conservative design approach, the worst-case water levels across the frontage have been utilised. The primary defences have varying crest elevations along the Helensburgh frontage and, with the exception of sections of Craigendoran, are below the present day 0.5% AEP event maximum water level and thus have a standard of protection lower than the present day 0.5% AEP event.

Based on the predicted extreme water levels from Coastal Flood Boundary Dataset (CFBD; 2018), supplied by Scottish Environment Protection Agency (SEPA; see Table 2-2), sections of the Helensburgh frontage would experience tidal inundation caused solely by static water and tide levels over the existing defences in the future. It should be noted that the extreme water levels used are not constant along the frontage due to the interpolation of levels between two CFBD chainage points (1806_12 and 1806_17).

Further details on the still water level data, tidal inundation modelling and resulting baseline flood risk is contained within the Interim Modelling Report.

Table 2-2 Extreme water levels at Helensburgh, based upon 2018 CFBD chainage points 1806_12 and 1806_17

Epoch	Event (AEP)	Extreme Water Level (mAOD)
2018 - present-day	0.5%	3.98-4.10
2118 - with climate change	0.5%	4.64-4.76

2.3.3 Wave overtopping risk

Helensburgh is at risk of flooding caused by wave overtopping, as indicated by the wave overtopping modelling. Additionally, historical events evidence flooding as a result of waves overtopping the defences. This risk will increase when a 100-year climate change allowance is incorporated due to the increase in water level.

The wave overtopping has been derived from a joint probability approach, produced through a series of fetch-based calculations. All wave climate data (namely, water levels, significant wave heights and wave periods) for the 0.5% AEP event including a 100-year climate change allowance for each typical section has been utilised to develop the shortlist designs.

Further details on the wave data, wave transformation and wave overtopping modelling and resulting baseline risk is contained within the Interim Modelling Report.

2.4 Hydrodynamic data

The hydrodynamic data used to develop the options have been sources from two primary sources:

- Extreme sea levels - the 2018 CFBD, as supplied by SEPA.
- Extreme wave conditions - calculated using the McConnel formula utilising data from the Wave Watch III hindcast wave database and the British Oceanographic Data Centre gauge at Millport.

2.5 Climate change

Climate change projections for Helensburgh have been estimated using the UKCP18 medium emission 95th percentile scenario. Sea level rise is estimated as 0.66m for 100 years resulting in an extreme water level of between 4.64-4.76mAOD for the 0.5% AEP event. The range of values is to incorporate the interpolation between the two chainage points. These values have been applied for the 2118 epoch representing the end of the 100-year optimal design life within the shortlist options.

2.6 Design life and standard of protection

The design life and standard of protection varies throughout the shortlist options. With the exception of options at the Sailing Club, all options have been designed as long-term options, as such to have a design life of 100 years with a 0.5% AEP event standard of protection, including a 100-year allowance for climate change. Options at the Sailing Club have been designed to a 0.5% AEP event standard of protection with a 100-year allowance for climate change, although parts of the frontage will rely upon the existing sea wall structure as such that maintenance will be required to extend the residual life of the existing structure.

2.7 Performance standards

Due to the sections of the existing frontage at Helensburgh exceeding extreme water levels, the performance standards for all options is driven by both tidal inundation and by wave overtopping.

2.7.1 Still water level

The performance standard proposed for all shortlist options is to be a minimum of the 0.5% AEP event with 100-year allowance for climate change, to include a freeboard allowance. Environment Agency (2017) freeboard guidance [2] has been adopted, from which a 4-star confidence rating has been assumed to be achieved during the detailed design stage. As such, a 450mm minimum freeboard has been designed for to achieve zero still water level flooding during the design event and events with lower return periods.

2.7.2 Wave overtopping

Table 2-3 summarises the European Wave Overtopping Manual (EurOtop II; 2018) guidance on wave overtopping rates tolerable for pedestrians and vehicles [3]. At this stage, the tolerable discharge threshold proposed for all shortlist options is to be less than 1l/s/m for the 0.5% AEP event as this is considered to be safe for pedestrians. A threshold of up to 20l/s/m may be considered tolerable, subject to drainage and flood risk factors, providing Argyll & Bute Council are willing to take on the risk of raising this threshold in order to reduce designed defence sizes. This latter overtopping threshold is based upon a significant wave height of 1m as such that all structures will be considered safe for pedestrian access during regular storm events although the council will be required to close the adjacent promenade/pavements in larger events with overtopping rates of over 1l/s/m.

Table 2-3 Wave overtopping limits for pedestrian and vehicles, taken from EurOtop II (2018; pg54)[3]

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
People at seawall / dike crest. Clear view of the sea.		
H_{m0} = 3 m	0.3	600
H_{m0} = 2 m	1	600
H_{m0} = 1 m	10-20	600
H_{m0} < 0.5 m	No limit	No limit
Cars on seawall / dike crest, or railway close behind crest		
H_{m0} = 3 m	<5	2000
H_{m0} = 2 m	10-20	2000
H_{m0} = 1 m	<75	2000
Highways and roads, fast traffic	Close before debris in spray becomes dangerous	Close before debris in spray becomes dangerous

2 Environment Agency. 2017. Accounting for residual uncertainty - updating the freeboard guide (SC120014).

3 EurOtop. 2018. Manual on wave overtopping of sea defences and related structures.

2.8 Ground conditions

As part of the COA, a Geotechnical Desk Study was undertaken for Helensburgh. This contains full details on the ground conditions along with other geotechnical and geoenvironmental issues associated with the site. The ground conditions at Helensburgh are complex, however, can generally be summarised as follows:

- Bedrock geology - Bullrock Greywacke Member (psammite and pelite) at Rhu, Rosneath Conglomerate Formation (conglomerate) at Sailing Club and West Clyde Street, and Inverclyde Group (sandstone with subordinate argillaceous rocks and limestone) at East Clyde Street and Craigendoran.
- Superficial deposits - Beach and Tidal Flat Deposits (undifferentiated; clay, silt, sand and gravel)

No geotechnical analysis has been undertaken at concept design stage in line with RIBA Stage 2.

2.8.1 Contaminated land

The Helensburgh Geotechnical Desk Study investigated pollution incidents and historic, recorded and registered landfills at Helensburgh. The report concluded that there may be contamination issues at the site relating to current and previous land uses (including fuel stations, industrial sites, active railways and potentially infilled land locations) and made ground in the areas of reclaimed land and behind the existing retaining structures located in close proximity to the frontage.

2.8.2 Structural design

A full structural design has not been undertaken for the development of the shortlist options, although structural considerations have been made.

No allowance for settlement and consolidation has been made within the designs, and thus all levels presented in the concept design drawings represent the post-settlement and post-consolidation levels. This may need to be revised on the outcome of any ground investigations undertaken prior to detailed design.

2.9 Services data

As part of the COA, a PAS-128 Type D survey has been undertaken via a desktop utility record search of Helensburgh. The results indicated that at the time of the search, there are a range of services interacting with the frontage. All services have been included within the concept design drawings. Provisions for all services interacting with the frontage and construction zones will need to be made at detailed design.

2.10 Environmental impact

A Baseline Environmental Assessment was undertaken as part of the Helensburgh COA. The following are the most significant concluding remarks which may impact the development of the design options:

- Craigendoran is within the Inner Clyde Special Protection Area (SPA), Ramsar and Site of Special Scientific Interest (SSSI).
- Communication with Scottish Natural Heritage to assess the need for targeted species surveys and mitigation measures.

- Work within Craigendoran may require a Japanese Knotweed Management Plan.
- Work within Rhu will require additional biosecurity measures in regard to Himalayan Balsam.

An Environmental Impact Assessment may be required depending on the outcome of the Screening Opinion prior to detailed design.

3 General design development

3.1 Design methodology

The concept designs of shortlist options include the following documents:

- Design drawings showing the general arrangement, cross-sections and any critical details
- Design risk assessment
- Supporting design technical note detailing all assumptions made (i.e. this document)

3.2 Design standards, guidance and reference documents

The following material have been used as the point of reference for all engineering design assumptions:

- BS 6349-1; (2000) Marine Structures Part 1: Code of practice for general criteria
- BS EN 13383-1:2002 Armourstone – Part 1: Specification
- BS EN 13383-2:2002 Armourstone – Part 2: Test methods
- BS EN 1990; (2002) Basis of structural design (+A1:2005)
- BS EN 1997-1:2004 Geotechnical design - General Rules & National Annex (Eurocode 7)
- BS EN 1997-2:2007 Ground investigation and Testing & National Annex (Eurocode 7)
- CERC (1984) Shore Protection Manual
- CIRIA (2007), The Rock Manual: The Use of Rock in Hydraulic Engineering (second edition)
- CIRIA (2010), The use of concrete in maritime engineering – a guide to good practice
- Cobb, F (2015), Structural Engineer's Pocket Book: Eurocodes
- EurOtop II (2018), Manual on wave overtopping of sea defences and related structures, second edition
- McConnell, K (1998), Revetment Systems Against Wave Attack – A design manual
- Manual of Contract Documents for Highway Works (2019)
- US Army Corp of Engineers (2002), Coastal Engineering Manual

3.3 Key design elements

The key design elements which are transferable between options are described below. Option specific design elements are contained within the subsequent report sections.

All of the shortlist options have been optimised to try and achieve the best balance between the required design performance standards (see Section 2.7) and minimising material usage and, hence, carbon footprint as to develop a sustainable design.

3.3.1 General defence geometry

All of the shortlist options within the Helensburgh COA have been designed to protect Helensburgh from tidal inundation and from the residual risk of wave overtopping. The proposed defence geometries have been optimised by wave overtopping, as this methodology also incorporates protection to extreme sea levels. The wave conditions for the 0.5% AEP event, including an allowance for 100 years climate change, have been used for both maximum water levels and wave overtopping. The wave conditions used to calculate the wave overtopping at each frontage section is included within Appendix A.

A range of defence geometries were tested to determine which structure combination offers the most cost-efficient and sustainable solution for each section and design option, whilst meeting the required wave overtopping performance standard.

For each shortlist option at each section, schematisations for typical sections were assessed within the latest release of the Artificial Neural Network (ANN; 2016) [4]. A range of varying wall crest levels, revetment crest levels, crest widths and revetment slopes were assessed. The wave climate data used for each of the typical sections were the 2118 0.5% AEP overtopping for all options.

The outputs from the ANN for each option provided a comprehensive dataset of wave overtopping rates for the design event, defence footprint and above beach level cross-sectional area for each schematisation assessed. To determine the most efficient defence geometry, the following filtering criteria was applied to the dataset:

- Wave overtopping rates to be <1l/s/m, as determined in Section 2.7.
- Exposed height of the wall/freeboard raising to be limited for aesthetic reasons as to not restrict the view.
- Limit the volumes of material as far as reasonably practical whilst still achieving the project aims.

For each shortlist option, the design was developed further based upon the defence geometry obtained through this assessment driven by wave overtopping. The final defence geometry and additional design details are provided in the subsequent sections of this Design Technical Note.

It should be noted, however, that the EurOtop guidance suggests that this model is only suitable for the development of concept designs. Physical modelling is recommended at detailed design to optimise the design further and to control the key design criteria.

3.3.2 Access points

All slipway access points and public access points between the promenade and the beach are critical. At this stage, it is assumed that all access points across the Helensburgh frontage are to be maintained although design development of these features have not been included

4 Artificial Neural Network. 2016. http://overtopping.ing.unibo.it/overtopping/neuronet/net□solve/

within the concept design. Further details on this will require careful consideration during detailed design.

3.3.3 Tie-in details

Tie-ins between sections within the Helensburgh COA and at the western and eastern extents of the scheme will require careful consideration at detailed design. It is recommended that multiple cross-sections are analysed at detailed design to determine the exact location of the defence tie-in and tie-in details specific to each location.

3.4 Design risk and health and safety considerations

All design elements consider design risk as a fundamental requirement of the design process. The foreseen risks and the method of mitigation or risk reduction for each of the shortlist options have been recorded via a Designers Risk Assessment (DRA), in line with Construction Design and Management (CDM) Regulations (2015). This identifies any foreseeable potential hazards associated with the design, construction, operation and maintenance and decommissioning of any designed elements for each option. If the risk cannot be eliminated, measures will be considered to minimise the risk so far as reasonably practical. For any risks that cannot be mitigated, these will be described to ensure that they are brought to the attention of any other parties who may become involved in the Helensburgh project.

4 Concrete wall and promenade design philosophy

Several options for the protection of Helensburgh against extreme water levels and wave overtopping have been designed as a reinforced concrete retaining wall. A new sea wall has been proposed for options R1 (Rhu), S1 (Sailing Club), W1 (West Clyde Street) and E2 (East Clyde Street), with a new setback wall proposed for options S2 (Sailing Club), W2 (West Clyde Street) and C2 (Craigendoran). In addition, options R2 (Rhu) and E1 (East Clyde Street) also incorporate a wall to form the crest level of the designed revetments.

For all wall options, the optimal position and crest level have been determined through the process outlined in Section 3.3.1. The crest level of the walls for these options may vary along the frontage, depending on the option and typical sections used, and with the distance offset from the existing defence line.

Precast concrete should be used where appropriate in order to control the quality of the wall units due to fabrications in accordance with BS EN 13369:2018. A minimum reinforcement cover of 75mm should be achieved due to the exposure to the open coast.

All walls have been designed with masonry cladding and coping stone to be sympathetic with surrounding environment and structures. The development of the cladding within the design should be further considered during detailed design due to the risk of damage to and the loss of the cladding as a result of wave action.

The development of the wall units are to be further analysed during detailed design.

4.1 Reinforced concrete wall design

4.1.1 Sea walls

The new sea walls within options R1 and S1 have been designed as reinforced concrete retaining walls.

The base of the wall stem has been calculated at a minimum of 0.5m below beach level, to account for scour and scour protection in the case of option S1.

The sea walls have been designed to the Ultimate Limit State (ULS) as the worst condition whereby the wall is acting to retain the ground behind the defence with the tide being out. As standard with gravity retaining wall structures, the wall base slab widths have been designed as such to be the retained height multiplied by a factor of 1.2, as a conservative design approach to the typical 60-80% of retained height rule-of-thumb [5]. The heel and toe consist of two-thirds and one-third of the base slab respectively.

4.1.2 Setback walls

Similarly to the sea walls, the new setback walls within options S2, W2 and C2 have been designed as precast reinforced concrete retaining walls.

The base of the wall stem has been calculated at a minimum of 0.3m below existing ground level, to account for ground cover.

As standard with gravity retaining wall structures, the wall base slab widths have been designed based upon engineering judgement and previous project experience to be equal to the wall stem height. The heel and toe each consist of half of the base slab. The retained height has been taken as the full height of the wall stem from the top of the base slab to the crest level, as to account for the general stability of the wall as the dominant control, as to be conservative in the design.

4.1.3 Impermeable revetment walls

The walls within options R2 and E1 have been design as precast reinforced concrete retaining walls, as an impermeable backing to the associated designed revetments.

Within option R2, the base of the wall stem has been calculated at a minimum of 0.3m below the proposed extension of the asphalt road to account for 150mm thick layers of asphalt and sub-base material, in accordance with details contained within the Manual of Contract Documents for Highway Works (MCHW). No cover level has been accounted for within the design of option E1.

The geometry of the wall is as described in Section 4.1.1, with the retained height taken as the full height of the wall stem from the top of the base slab to the crest level. This is to account for the general stability of the wall as the dominant control, as to be conservative in the design. Due to the nature of the revetment design, there is no space for a base slab toe.

4.2 Concrete modular block wall design

Options W1 and E2 consist of a concrete modular block wall. At West Clyde Street, the new wall is to be constructed at the toe of the existing structure as to minimise excavation at the toe. At East Clyde Street the wall is offset (seaward) from the existing defence line by approximately 5m, as to Advance The Line with the construction of a new public promenade along the coast.

The wall will consist of multiple concrete blocks (Redi-Rock or similar) vertically stacked to achieve the desired crest level. Shear keys have been designed for between the blocks to provide resistance against lateral sliding due to wave loading-induced movement between the

5 Cobb, F. 2015. Structural Engineer's Pocket Book: Eurocodes.

blocks. The bottom block will sit on a reinforced concrete foundation with rock armour scour protection at the toe.

The design of the modular block wall has been developed through experience with previous projects, with dimensions verified using GEO5 software.

5 Concrete sloped revetment design philosophy

Option R2 (Rhu) incorporates the development of a design to include a concrete sloped revetment, in addition to the reinforced concrete wall described in Section 4.1.3. For the revetment, elements including the crest level and crest width have been determined through the process outlined in Section 3.3.1 for the typical section at Rhu.

Hillblock Basisblock has been designed for the construction of the revetment. This is due to the unique shape of the concrete blocks, in which the voids in-between the units dissipate and reduce the impact of waves, thus decreasing the wave overtopping volumes at the crest of the revetment. Hillblock units of 40cm in height have been included within the design. This is based on the significant wave height at Rhu and the maximum permission wave overtopping rate of 1l/s/m, to obtain the optimum roughness factor, as determined through the Hillblock wave reduction calculator [6].

A minimum slope of 1 in 4 is required for a Hillblock revetment, and thus has been utilised to reduce the volume of materials so far as reasonably practical without impacting the performance of the revetment. A concrete kerb at the base of the revetment has also been designed for to aid the Hillblock installation process.

As advised within the Hillblock Installation Specification, a granular sub-layer has been included within the design. This is to be compacted to enable an appropriate and even construction level.

5.1 Geotextile

Although it is the Hillblock units which will be directly impacted by the wave climate, critical conditions will occur at the interface between the Hillblock units and underlying granular sub-layer, and beach material beneath and may result in the failure of the revetment. As a result, a separation geotextile is required to prevent wash out of the beach material through the granular sub-layer and Hillblock units. HPS 12 has been included within the design due to its application of separation beneath the granular sub-layer in coastal defences and through engineering judgement. It is recommended that further analysis on the mechanical and physical properties of the geotextile required are undertaken at detailed design.

6 Rock armour design philosophy

Several options for the protection of Helensburgh against wave overtopping incorporate the development of a design to include rock armour. Rock armour revetments have been proposed for options E1 (East Clyde Street) and C1 (Craigendoran), with rock armour scour

6 Hillblock. 2019. Hillblock wave reduction calculator. Available at: https://www.hillblock.nl/site/en/eigenschappen/rekentool.html

protection is incorporated within the design of options R2 (Rhu), S1 (Sailing Club), W1 (West Clyde Street) and E2 (East Clyde Street).

For the rock armour revetment options, elements including the crest level, crest width and slope have been determined through the process outlined in Section 3.3.1 for each typical section within each option. The crest of the rock for these options may vary along the frontage, depending on the option and typical sections used, although will be above existing beach levels.

For options utilising rock as scour protection, the crest level of the rock may be buried beneath existing beach levels, with a shallow slope of 1 in 4 applied.

6.1 Rock armour sizing

The rock armour has been sized using ULS conditions, or the upper limit for the structural stability of the scour protection. The ULS is defined as the worst-case wave height from the 0.5% AEP event with an allowance for climate change within the joint probability analysis. This limit state ensures that the rock armour units will withstand the most extreme 0.5% AEP event wave conditions in combination with 0.5% AEP event extreme sea levels, including a climate change allowance for the 100-year appraisal period. The overall likelihood of this magnitude event occurring may have a greater combined probability than a 0.5% AEP event, incorporating a level of conservatism into the critical design elements.

In order to ensure that the correct sizing is used for the rock armour for each option, typical sections through each defence type has been used to calculate the rock armour sizing.

The following are the hydraulic input parameters which have been utilised within the Van der Meer shallow water equations [7].

- Permeability rating - a permeability rating of 0.1 has been assumed due to being recommended within CIRIA C683 [7; pg. 568] for structures which incorporate a geotextile between the rock armour and an impermeable surface, thus providing a conservation scenario for this design.
- Slope angle - the slope varies across the options designed. A slope of 1 in 2 and a slope of 1 in 3 have been designed for options E1 and C1 respectively, with a slope of 1 in 4 has been used for scour protection options as this is the flattest slope which can be accommodated within the Van der Meer shallow water equations calculations.
- Storm duration - a six-hour storm duration has been assumed. This provides a conservative estimate of the number of waves impacting the structure as in reality the tide range will limit the time waves are breaking against the structure.
- Significant wave height - the significant wave height has been directly extracted from the most extreme wave conditions for the 2118 0.5% AEP event at the corresponding typical section.
- Wave period - the wave period has been directly extracted from the most extreme wave conditions for the 2118 0.5% AEP event at the corresponding typical section.

7 CIRIA. 2007. The Rock Manual: The use of rock in hydraulic engineering.

- Storm damage level - the storm damage level has been set to 2 for E1 and C1 and 3 for the scour protection options, as these are the values of the start of damage for the corresponding slope angles [7; pg. 569].
- Rock density - the rock density has been assumed to be 2.65kg/m3.

Using the above parameters, the Van der Meer calculations provided median required rock masses at each typical section for each option. The analysis of these results indicates that the following rock size classes would be sufficient in providing adequate rock stability in which a maximum of 10% of the rock would be lighter than the median required for stability for each option:

- Rock armour revetment options (E1 and C1) - 1-3t rock
- Rock armour scour protection options (R2, S2, W1 and E2) - 0.3-1t rock

A filter layer is proposed within the design of option E1 and C1 only. Additionally, the largest rock at a minimum of 2t and 0.7t, for 1-3t rock and 0.3-1t rock respectively, is to be used as the keystone when geotextiles have been designed for (see Section 6.3).

6.2 Rock armour layer thickness

As recommended within CIRIA C683 [7], the theoretical orthogonal thickness has been calculated to determine the optimal thickness of the rock armour. This utilises the following input parameters.

- Permeability rating - as per Section 4.1.3.
- Rock density - as per Section 4.1.3.
- Median diameter - the median diameters used are 0.92m and 0.63m for 1-3t rock and 0.3-1t rock respectively.
- Number of layers - a double layer of rock armour has been assumed.
- Layer thickness coefficient - a value of 0.87 has been used based upon the assumption of a double standard or double dense layer with irregular rock.

These calculations resulted in a proposed rock armour thickness of 1.60m for the rock armour revetments options (E1 and C1) and 1.09m for the rock armour scour protection options (R2, S2, W1 and E2).

6.3 Geotextile

Although it is the rock amour which will be directly impacted by the wave climate, critical conditions will occur at the interface between the rock armour and beach material beneath and may result in the failure of the rock armour. As a result, a separation geotextile is required to prevent wash out of the beach material through the rock armour. HPS 12 has been included within the design due to its application of separation beneath rock armour in coastal defences and through engineering judgement. It is recommended that further analysis on the mechanical and physical properties of the geotextile required are undertaken at detailed design.

[End of Design Technical Note]

Appendix A - Wave conditions utilised for wave overtopping calculations

Cross section / Frontage	Event	Water Level (mAOD)	Significant wave height (m)	Wave period (s)
2 (Rhu)	0.5 AEP	3.928	0.562	2.303
2 (Rhu)	0.5 AEP	4.076	0.558	2.298
2 (Rhu)	0.5 AEP	4.250	0.535	2.265
2 (Rhu)	0.5 AEP	4.331	0.523	2.248
2 (Rhu)	0.5 AEP	4.385	0.515	2.236
2 (Rhu)	0.5 AEP	4.513	0.493	2.204
2 (Rhu)	0.5 AEP	3.954	0.567	2.381
2 (Rhu)	0.5 AEP	4.104	0.559	2.370
2 (Rhu)	0.5 AEP	4.158	0.549	2.355
2 (Rhu)	0.5 AEP	4.195	0.541	2.344
2 (Rhu)	0.5 AEP	4.277	0.521	2.314
2 (Rhu)	0.5 AEP	3.552	0.174	1.201
2 (Rhu)	0.5 AEP	3.672	0.173	1.200
2 (Rhu)	0.5 AEP	3.718	0.172	1.198
2 (Rhu)	0.5 AEP	3.752	0.172	1.196
2 (Rhu)	0.5 AEP	3.887	0.169	1.190
5 (Sailing Club)	0.5 AEP	4.158	0.189	1.065
5 (Sailing Club)	0.5 AEP	4.389	0.179	1.046
5 (Sailing Club)	0.5 AEP	4.478	0.173	1.034
5 (Sailing Club)	0.5 AEP	4.525	0.170	1.029
5 (Sailing Club)	0.5 AEP	4.639	0.159	1.006
5 (Sailing Club)	0.5 AEP	3.835	0.660	2.563
5 (Sailing Club)	0.5 AEP	3.976	0.656	2.558
5 (Sailing Club)	0.5 AEP	4.148	0.629	2.521
5 (Sailing Club)	0.5 AEP	4.224	0.616	2.502
5 (Sailing Club)	0.5 AEP	4.273	0.605	2.488
5 (Sailing Club)	0.5 AEP	4.393	0.580	2.453
5 (Sailing Club)	0.5 AEP	3.861	1.103	3.695
5 (Sailing Club)	0.5 AEP	4.004	1.088	3.678
5 (Sailing Club)	0.5 AEP	4.058	1.068	3.655
5 (Sailing Club)	0.5 AEP	4.095	1.053	3.637
5 (Sailing Club)	0.5 AEP	4.174	1.015	3.592
6 (Sailing Club)	0.5 AEP	4.158	0.817	2.805
6 (Sailing Club)	0.5 AEP	4.389	0.775	2.754
6 (Sailing Club)	0.5 AEP	4.478	0.749	2.723

6 (Sailing Club)	0.5□ AEP	4.525	0.737	2.708
6 (Sailing Club)	0.5□ AEP	4.639	0.690	2.649
6 (Sailing Club)	0.5□ AEP	3.835	0.510	2.161
6 (Sailing Club)	0.5□ AEP	3.976	0.507	2.156
6 (Sailing Club)	0.5□ AEP	4.148	0.486	2.125
6 (Sailing Club)	0.5□ AEP	4.224	0.475	2.110
6 (Sailing Club)	0.5□ AEP	4.273	0.467	2.098
6 (Sailing Club)	0.5□ AEP	4.393	0.448	2.068
6 (Sailing Club)	0.5□ AEP	3.861	1.093	3.673
6 (Sailing Club)	0.5□ AEP	4.004	1.078	3.656
6 (Sailing Club)	0.5□ AEP	4.058	1.058	3.632
6 (Sailing Club)	0.5□ AEP	4.095	1.043	3.615
6 (Sailing Club)	0.5□ AEP	4.174	1.005	3.570
10 (West Clyde Street)	0.5□ AEP	3.835	0.73	2.739
10 (West Clyde Street)	0.5□ AEP	3.976	0.726	2.734
10 (West Clyde Street)	0.5□ AEP	4.148	0.696	2.694
10 (West Clyde Street)	0.5□ AEP	4.224	0.681	2.675
10 (West Clyde Street)	0.5□ AEP	4.273	0.67	2.659
10 (West Clyde Street)	0.5□ AEP	4.393	0.642	2.622
10 (West Clyde Street)	0.5□ AEP	3.861	1.109	3.707
10 (West Clyde Street)	0.5□ AEP	4.004	1.094	3.69
10 (West Clyde Street)	0.5□ AEP	4.058	1.073	3.667
10 (West Clyde Street)	0.5□ AEP	4.095	1.058	3.649
10 (West Clyde Street)	0.5□ AEP	4.174	1.02	3.603
10 (West Clyde Street)	0.5□ AEP	3.472	0.931	3.637
10 (West Clyde Street)	0.5□ AEP	3.592	0.93	3.636
10 (West Clyde Street)	0.5□ AEP	3.638	0.925	3.629
10 (West Clyde Street)	0.5□ AEP	3.672	0.921	3.623
10 (West Clyde Street)	0.5□ AEP	3.797	0.907	3.605
21 (East Clyde Street)	0.5□ AEP	4.158	0.947	3.090
21 (East Clyde Street)	0.5□ AEP	4.389	0.897	3.034
21 (East Clyde Street)	0.5□ AEP	4.478	0.868	3.000
21 (East Clyde Street)	0.5□ AEP	4.525	0.854	2.983
21 (East Clyde Street)	0.5□ AEP	4.639	0.800	2.918
21 (East Clyde Street)	0.5□ AEP	3.835	0.707	2.892
21 (East Clyde Street)	0.5□ AEP	3.976	0.817	3.113
21 (East Clyde Street)	0.5□ AEP	4.148	0.951	3.382
21 (East Clyde Street)	0.5□ AEP	4.224	1.010	3.497

21 (East Clyde Street)	0.5□ AEP	4.273	1.044	3.565
21 (East Clyde Street)	0.5□ AEP	4.393	1.001	3.514
21 (East Clyde Street)	0.5□ AEP	3.861	0.727	2.991
21 (East Clyde Street)	0.5□ AEP	4.004	0.839	3.220
21 (East Clyde Street)	0.5□ AEP	4.058	0.881	3.309
21 (East Clyde Street)	0.5□ AEP	4.095	0.910	3.371
21 (East Clyde Street)	0.5□ AEP	4.174	0.971	3.504
30 (Craigendoran)	0.5□ AEP	4.158	1.08	3.371
30 (Craigendoran)	0.5□ AEP	4.389	1.023	3.31
30 (Craigendoran)	0.5□ AEP	4.478	0.99	3.273
30 (Craigendoran)	0.5□ AEP	4.525	0.974	3.255
30 (Craigendoran)	0.5□ AEP	4.639	0.912	3.183
30 (Craigendoran)	0.5□ AEP	3.835	1.865	5.085
30 (Craigendoran)	0.5□ AEP	3.976	1.854	5.075
30 (Craigendoran)	0.5□ AEP	4.148	1.776	5.002
30 (Craigendoran)	0.5□ AEP	4.224	1.738	4.965
30 (Craigendoran)	0.5□ AEP	4.273	1.71	4.937
30 (Craigendoran)	0.5□ AEP	4.393	1.639	4.867
30 (Craigendoran)	0.5□ AEP	3.861	1.062	3.603
30 (Craigendoran)	0.5□ AEP	4.004	1.047	3.586
30 (Craigendoran)	0.5□ AEP	4.058	1.028	3.563
30 (Craigendoran)	0.5□ AEP	4.095	1.013	3.546
30 (Craigendoran)	0.5□ AEP	4.174	0.976	3.501

*to include 100 years of climate change

Design Risk Assessment – Helensburgh Options

Document control					
Contributing designers	Revision	Purpose of issue	Checked	Reviewed	Date
Amelia Wright	P01	For information	Johan Skanberg-Tippen	Graham Kenn	27/06/19

This Design Risk Assessment identifies any foreseeable potential hazards associated with the design, construction, operation and maintenance and decommissioning of any designed elements for each of the shortlisted options at Helensburgh, in line with Construction Design and Management (CDM) Regulations (2015). If the risk cannot be eliminated, measures will be considered to minimise the risk so far as reasonably practical.
The options covered within the Design Risk Assessment include the following:

- New reinforced concrete sea wall at R1 (Rhu) and with rock armour scour protection at S1 (Sailing Club). Option specific risks are presented in **blue**.
- New concrete sloped revetment with rock armour scour protection at R2 (Rhu). Option specific risks are presented in **orange**.
- New reinforced concrete setback wall at S2 (Sailing Club), W2 (West Clyde Street) and C2 (Craigendoran). Option specific risks are presented in **purple**.
- New reinforced concrete modular block sea wall with rock armour scour protection at W1 (West Clyde Street) and E2 (East Clyde Street). Option specific risks are presented in **green**.
- New rock armour revetment at E1 (East Clyde Street) and C1 (Craigendoran). Option specific risks are presented in **burgundy**.

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
Guidance	Consider all aspects involved in each stage of interface with the site, environment and structure(s).	Record the key hazards and their potential conse□uences.	Identify the categories of people at risk.	Include obtaining ade□uate data for design certainty and any further studies carried out during the risk evaluation process. Proposed measures to be taken by constructors and operators are to be included in Stage 4.	Provide details of residual hazards and risks that will need to be communicated and managed.	Record how information is provided, whether on drawings, pre-construction information, buildability statement, specification, reports or H&S File	Record the name of designers, contractors, the client or other stakeholders who are to ensure the significant residual risk is minimised and controlled.	Recommend measures to be taken by the risk owner(s) to minimise and control the significant residual risk.
Design								
DES1	E□treme water levels	Flooding to Helensburgh as a result of e□treme water level inundation	Public, property, operatives, plant	Development of a design where the new structure increases the standard of protection against e□treme water levels at Helensburgh, with a minimum of a 450mm freeboard, in the long-term (2118). C1 – Development of a design which utilises the e□isting structure maintaining the e□isting standard of protection against e□treme water levels at Helensburgh, with a minimum of a 450mm freeboard.	As before - eliminated up to the 2118 0.5□ AEP design event C1 - As before - eliminated up to the 2118 0.5□ AEP design event	Drawings, pre-construction information	Client	Maintain the condition and usability of the proposed design structure(s) once constructed, and consider additional mitigation measures in the future
DES2	Wave overtopping	Flooding of Helensburgh as a result of wave overtopping	Public, property	Development of a design where the new structure reduces overtopping to 1l/s/m to the 2118 0.5□ AEP event	As before - eliminated up to the 2118 0.5□ AEP design event, although overtopping may still e□ceed 1l/s/m during more severe events	Drawings, pre-construction information	Client	Maintain the condition and usability of the proposed design structure(s) once constructed, and consider additional mitigation measures in the future

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
DES3	Unknown foundation depth of structures	Potential undermining and destabilisation of existing structures due to future beach drawdown, erosion and scour	Public, property	R1/S1/S2/W2/C2 – N/A R2/W1/E1/E2/C1 – Development of design where the toe of the existing structure will not be exposed, rather contained behind the proposed structure which incorporates a buried toe.	R1/S1/S2/W2/C2 – As before R2/W1/E1/E2/C1 – Eliminated	Drawings, pre-construction information	Designer(s) at detailed design	N/A
DES4	Erosion and scour of proposed structures Only applicable to R1, S1, S2, W2 and C2	Potential undermining and destabilisation of proposed structures due to erosion, future beach drawdown and scour	Public, property	Development of a design to incorporate concrete repairs to the existing structures and additional erosion embankment protection where appropriate	As before – risk reduced	Drawings, pre-construction information	Client	Monitor beach levels, erosion and scour, and consider additional mitigation measures in the future if required
DES5	Movement of emergency vehicles between the promenade and beach areas	Loss of emergency access to and from the beach	Public	Development of a design to maintain access points, including slipways	Eliminated	Drawings, pre-construction information	Client, designer(s) at detailed design, contractor(s)	Maintain the condition and usability of the emergency access
DES6	Movement of the public around the promenade and beach areas	Loss of access to and from the beach increasing the risk of cut-off during a rising tide	Public	Development of a design to maintain access points between the promenade and beach	As before – risk reduced	Drawings, pre-construction information	Client, designer(s) at detailed design, contractor(s)	Consider signage to raise awareness of hazards to the public, and maintain the condition and usability of public access

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
DES7	Movement of the public around rock armour Not applicable to R1, S2, W2 and C2	Slips, trips, falls and entrapment	Public	R2/S1/W1/E2 - Development of a design to limit the amount of rock e□posed by ensuring rock armour is buried below e□isting beach levels and where new crown walls have a minimum height of 1.1m to discourage access onto rock armour. E1 – Development of a design where new crown wall will have a minimum height of 1.1m to prevent falls onto the rock. However, no design measures have been undertaken to eliminate or reduce the risk from the beach, although signage is recommended to warn the public of the danger. C1 – Development of a design where a handrail/wall will have a minimum height of 1.2m to prevent access onto the rock (incorporating an additional factor of safety of 100mm to the re□uired 1.1m minimum height). However, no design measures have been undertaken to eliminate or reduce the risk from the beach, although signage is recommended to warn the public of the danger.	As before – risk reduced	Drawings, pre-construction information	Client, designer(s) at detailed design, contractor(s)	Consider signage, monitor the placement of rock and maintain the condition and usability of public access
Construction								
CON1	Construction in a public realm – working on an e□isting coastal defence	Flooding to Helensburgh during construction	Public, property	R1/R2/S1/E1 – N/A S2/W1/W2/E2/C1/C2 – Development of a design which does not include the demolition of the e□isting structures, as such that the coastline will maintain the e□isting standard of protection throughout construction.	R1/R2/S1/E1 – As before S2/W1/W2/E2/C1/C2 – As before – risk reduced	Drawings, pre-construction information	Client, designer(s) at detailed design, contractor(s)	Maintain the current design philosophy as to not demolish the e□isting structures where viable, otherwise consideration of phased construction, se□uencing of works and temporary defences to reduce the risk in areas which will result in reduced flood protection during construction.

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON2	Construction in a public realm – deliveries to site	Disturbances to traffic flow, damage to property, noise and dust	Public, property, operatives	Development of a design where volumes of materials have been minimised so far as reasonably practical to reduce traffic impact while achieving project aims	As before – risk reduced	Pre-construction information, EIA	Designer(s) at detailed design, contractor(s)	Delivery strategy and Traffic Management Plan to be developed detailing temporary diversions if appropriate and liaison with local resident groups to limit disturbance
CON3	Construction in a public realm – movement of site traffic on public rights of way	Disturbance to traffic flow and pedestrians/cyclists on the adjacent pavements/promenade	Public	N/A - Traffic Impact Assessment to be undertaken with recommendations carried forward into a Traffic Management Plan	As before	Pre-construction information, EIA	Designer(s) at detailed design, contractor(s)	Traffic Management Plan to be developed detailing temporary diversions if appropriate, and liaison with local resident groups to limit disturbance and public to be consulted early on in the programme to likely disturbances and public area closures
CON4	Construction in a public realm – public access to site	Disturbance to normal public use of pavements, the promenade and beach and public struck by plant	Public	Development of a design which allows works to be suitable for phased construction so that disturbances to the public realm can be limited to isolated areas	As before – risk isolated	Pre-construction information	Designer(s) at detailed design, contractor(s)	Site compound and working areas to be set up to ade□uately separate public from construction and public to be consulted early on in the programme to inform of likely disturbances and closures
CON5	Construction in a public realm – public access to site adjacent to private property	Disturbance to inhabitants and property owners, and struck by plant	Public	Development of a design which allows works to be suitable for phased construction so that disturbances to the private property can be limited to isolated areas	As before – risk isolated	Pre-construction information	Designer(s) at detailed design, contractor(s)	Site compound and working areas to be set up to ade□uately separate public from construction and liaison with local resident groups to limit disturbance
CON6	Construction in a public realm – public access and egress points between the promenade and beach closed for construction	Public stranded on the beach during a rising tide	Public	N/A - Works to be planned to limit the impact on e□isting access and egress routes, where practicable these routes should be maintained otherwise signage will be provided to direct the public to alternative routes to the promenade from the beach	As before	Pre-construction information	Designer(s) at detailed design, contractor(s)	Traffic Management Plan to be developed detailing access and egress routes during construction and public to be consulted early on in the programme to likely disturbances and promenade closures

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON7	Construction in a public realm – mud and sand on road	Hazards to other road users	Public	Development of a design where e□cavation, demolition and removal of material has been minimised so far as reasonably practical	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Impermeable surfaces to be reinstated as soon as possible to avoid churning up open ground and wheel washers at every e□it of the site compound and sweepers
CON8	Construction in a public realm – movement of site traffic on the beach	Plant becoming stuck or tip over in soft beach material resulting in inundation and potential injury and loss of plant	Plant	N/A – plant access on the beach will be re□uired	As before	Pre-construction information	Designer(s) at detailed design, contractor(s)	Contractor to use appropriate vehicle routes and adaptations including trackpads and consider associated temporary works re□uired
CON9	General construction-based risks – stability of e□isting structures	Destabilisation and/or collapse of e□isting structures due to increased loading on the structures and e□cavation at the toe	Public, property, operatives, plant	Development of designs which can be constructed from the beach so as to reduce plant loading on the e□isting structures, and where minimal (and in some options no) e□cavation at the toe has been designed to prevent destabilisation	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Geotechnical and structural investigations to be undertaken on e□isting structures prior to construction to determine safe loading threshold and associated temporary works re□uired
CON10	General construction-based risks – manual handling of materials	Injury to personnel	Operatives	N/A – Development of the detailed design as such that all elements to works to be designed such that they can be installed with mechanical means, with elements which are to be manually lifted designed to a safe weight	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Training, including Toolbo□Talks, to increase competency of operatives and suitable access routes to construction areas allowing delivery directly to working areas with lifting and handling e□uipment
CON11	General construction-based risks – adverse weather conditions, poor visibility (including low light), night working and soft beach	Injury to personnel with being hit by plant, personnel at risk of cold or heat e□posure and increased risk of slips, trips and falls	Operatives	N/A	As before	Pre-construction information	Contractor(s)	Consideration of summer working, appropriate lighting and task lighting to be installed if working during low light conditions, and all personnel to wear appropriate PPE to the weather conditions

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON12	General construction-based risks – fuel or hydraulic oil spillage	Fire hazards	Public, operatives, plant	N/A	As before	Pre-construction information	Contractor(s)	Fuel and hydraulic oil storage remote from the water edge at pre-designated site compound, with storage areas to be bunded and containers location on drip trays, provision of spill kits, and regular maintenance of plant
CON13	General construction-based risks – dust, noise and vibration	Health implications to public and operatives as a result of dust particulates and shards, noise and vibration	Public, operatives	Development of a design where volumes of materials have been minimised so far as reasonably practical while achieving project aims	As before – risk reduced	Pre-construction information, EIA	Designer(s) at detailed design, contractor(s)	Dust suppression, use of clean aggregates, Safe System of Work to be developed and liaison with local resident groups to limit disturbance
CON14	General construction-based risks – stockpiling of materials	Health implications to public and operatives as a result of dust particulates and shards, noise and vibration	Public, operatives	Development of a design where volumes of materials have been minimised so far as reasonably practical while achieving project aims	As before – risk reduced	Pre-construction information, EIA	Designer(s) at detailed design, contractor(s)	Safe System of Work to be developed and liaison with local resident groups to limit disturbance
CON15	General construction-based risks – UXO	Striking une□ploded ordnance whether through e□cavation or sheet piles	Operatives, plant	N/A	As before	Pre-construction information	Contractor(s)	Undertake a UXO search prior to detailed design and construction, and enforce the recommended procedures outlined within the UXO study
CON16	General construction-based risks – Utilities/services	Striking unknown services whether through e□cavation or sheet piles	Operatives, plant	Development of a design following a detailed utilities and services search. Further consideration of service spans re□uired at detailed design	As before – risk reduced	Drawings, pre-construction information	Designer(s) at detailed design	Updated utilities and services search to be carried out prior to construction, with service detection and avoidance methods to be utilised during construction

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON17	Working near water – working in an e□posed coastal environment	Flood of works, inundation of e□cavations, drowning and loss of plant	Operatives, plant	Development of design where e□cavation depths and widths have been minimised so far as reasonably practical while achieving project aims and which allows works to be suitable for phased construction around the tidal cycle	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Geotechnical investigations to be undertaken to determine any geotechnical variability and localised alternative designs to be developed where appropriate. Training, including Toolbo□Talks, to increase competency of operatives working in tidal environments, consideration of limited open e□cavations, material placement schedules to ensure materials at risk are protected at the earliest opportunity
CON18	Working near water – biological hazards	Leptospirosis, Psittacosis and other bacterial diseases	Operatives	N/A	As before	Pre-construction information	Contractor(s)	Training, including Toolbo□Talks, to increase operative awareness and knowledge to avoid contact and adopt good hygiene practices
CON19	E□cavation works – e□cavation of beach material Not applicable to R1, S2, W2 and C2	Collapse of e□cavation sides as a result of high ground water and low friction angle leading to injury to personal and loss of plant	Operatives, plant	Development of design where e□cavation depths and widths have been minimised so far as reasonably practical while achieving project aims.	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Geotechnical investigations to be undertaken to confirm beach parameters and analysis of capacity for temporary works re□uired
CON20	Demolition of e□isting structures – removal of e□isting concrete elements Only applicable to R1, R2, S1 and E1	Injury to personnel due to falling debris	Public, operatives	N/A	As before	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Consideration of phased construction and use of working areas to provide safe distance between operatives and anticipated direction of falling debris

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON21	Demolition of e□isting structures – removal of e□isting concrete elements Only applicable to R1, R2, S1 and E1	Hand arm vibration syndrome and associated injuries to personnel	Operatives	N/A	As before	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Consideration of alternative methods or techni□ues as appropriate, limiting daily e□posure for operatives, and training, including Toolbo□Talks, to increase operative awareness
CON22	Concrete works – lifting and placing of precast wall units	Injuries to personnel and damage to plant during lifting operations	Operatives, plant	Development of a design which minimises the weight of the units due to minimising the depth of the wall base units and additional dimensions. Further consideration of the precast wall units is re□uired at detailed design	As before – risk reduced	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Training, including Toolbo□Talks, to increase competency of operatives and suitable access routes to construction areas allowing delivery directly to working areas with lifting e□uipment
CON23	Concrete works – personnel safety Not applicable to W2 and C2	Falls from height whilst working on the construction of the sea wall	Operatives	Development of a design which ma□imises the potential use for precast concrete as to reduce the time working at height Further consideration of pre-cast and in-situ concrete elements re□uired at detailed design	As before – risk reduced	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Safe System of Work to be developed and consideration of phased construction and to reduce the spatial e□tent of the risk
CON24	Concrete works – wet concrete	Burns to personnel due to contact with wet concrete	Operatives	Development of a design where the use of in-situ concrete has been reduced due to much of the design being able to be precast or in-situ concrete. S2/W2/C2 - Further consideration of concrete repairs re□uired at detailed design.	As before – risk reduced	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Safe System of Work to be developed to including provision of spill kits and wet concrete clean-up procedures, training, including Toolbo□Talks, to increase competency of operatives, and all personnel to wear appropriate PPE
CON25	Geote□tile works – placement of geote□tile Not applicable to R1, S2, W2 or C2	Injury to personnel in deep e□cavations or struck by lifting e□uipment	Operatives	Development of a design where e□cavations have been minimised so far as reasonably practical while achieving project aims. Buildability to be further considered at detailed design as to specify a geote□tile to be delivered on rolls that can be placed by mechanical means	As before – risk reduced	Drawings, pre-construction information	Designer(s) at detailed design, contractor(s)	Training, including Toolbo□Talks, to increase competency of operatives

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
CON26	Rock armour revetment works – placement of rock Not applicable to R1, S2, W2 or C2	Health implications to operatives as a result of dust particulates and shards, noise and vibration	Operatives	Development of a design where rock armour is specified to be 'picked and placed'	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Rocks to be mechanically picked and placed opposed to dropped at any height, with works to be undertaken within specified planning limits and noise monitoring to be undertaken throughout construction
CON27	Rock armour revetment works – placement of rock Not applicable to R1, S2, W2 or C2	Injury to personnel due to unstable e□cavations and working at height during levelling operations	Operatives	N/A – Buildability to be further considered at detailed design as to incorporate mechanical placement of rock for placement and levelling operations to reduce the need for any personal undertaking levelling	As before	Pre-construction information	Designer(s) at detailed design, contractor(s)	Rocks to be mechanically placed and all levelling operations to be undertaken with plant-based e□uipment or remote survey e□uipment
CON28	Embankment works – placement of coir matting Only applicable to R1 and C2	Injury to personnel or struck by lifting e□uipment	Operatives	N/A - Buildability to be further considered at detailed design as to specify a coir matting that can be placed by mechanical means	As before	Pre-construction information	Designer(s) at detailed design, contractor(s)	Consideration to construction methodology and training, including Toolbo□Talks, to increase competency of operatives
CON29	In-situ asphalt works – hot works Only applicable to R1, R2, S2 and W1	Hot work operations resulting in fire hazards and injury to personnel via burns and inhalation of fumes	Operatives	N/A – further consideration of asphalt pavements re□uired at detailed design.	As before	Pre-construction information	Designer(s) at detailed design, contractor(s)	Safe System of Work to be developed, training, including Toolbo□Talks, to increase competency of operatives, and all personnel to wear appropriate PPE (including respiratory protective e□uipment) for hot works

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
Operation & Maintenance								
O&M1	Standing water on the adjacent pavements/promenade and transport infrastructure	Slips and falls on surfaces with surface water	Public	Further consideration of drainage, including cross fall gradient seawards, will be re□uired at detailed design	As before	N/A	Client, designer(s) at detailed design	Further consideration of drainage will be re□uired at detailed design to determine whether additional drainage is re□uired and consider additional drainage measures if standing water landward of the defence or on the promenade becomes a recurring issue
O&M2	Use of adjacent pavements/promenade and transport infrastructure during storm event when overtopping e□ceeds 1l/s/m	Injury to public and damage to property	Public, property	N/A – Further consideration of flood gates and associated structures re□uired at detailed design	As before	N/A	Client, designer(s) at detailed design	Use of flood gates and associated structures at access points, signage to raise awareness of hazards to the public and client to close adjacent pavements/promenade in events e□ceeding 1l/s/m
O&M3	Flooding of the adjacent roads where new defences are not re□uired along the whole section frontage Not applicable to R1, R2, E2 and C1	Inconvenience and injury to public and damage to property	Public, property	N/A – Further consideration of flood gates and associated structures re□uired at detailed design	As before	N/A	Client, designer(s) at detailed design	Use of flood gates and associated structures at access points, signage to raise awareness of hazards to the public and client to close adjacent roads in severe events

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
O&M4	General public safety	Slips, trips and falls (including falls from height) and risk of drowning due to cut-off from a rising tide	Public	R1/R2/S1/W1/E1/E2 - Development of a design where new crown walls have a minimum height of 1.1m to prevent falls and access points between the promenade and beach are to be maintained. S2/W2/C2 – Development of a design where access points between the promenade and beach are to be maintained. C1 – Development of a design where a handrail/wall will have a minimum height of 1.2m to prevent falls (incorporating an additional factor of safety of 100mm to the re□uired 1.1m minimum height) and access points between the promenade and beach are to be maintained.	As before – risk reduced	H&S file	Client, designer(s) at detailed design, contractor(s)	Further consideration of safety measures including installation of lifebuoy rings, handrails and periodic signage to raise awareness of hazards to the public will be re□uired at detailed design
O&M5	Movement of the public around the rock armour where e□posed Not applicable to R1, S2, W2 or C2	Slips, trips, falls and entrapment	Public	R2/S1/W1/E2 - Development of a design to limit the amount of rock e□posed by ensuring rock armour is buried below e□isting beach levels and where new crown walls have a minimum height of 1.1m to prevent falls. E1 – Development of a design where new crown wall will have a minimum height of 1.1m to prevent falls onto the rock. However, no design measures have been undertaken to eliminate or reduce the risk from the beach, although signage is recommended to warn the public of the danger. C1 – Development of a design where a handrail/wall will have a minimum height of 1.2m (incorporating an additional factor of safety of 100mm to the re□uired 1.1m minimum height) to prevent access onto the rock. However, no design measures have been undertaken to eliminate or reduce the risk from the beach, although signage is recommended to warn the public of the danger.	As before – risk reduced	H&S file	Client	Consider signage, and monitor the placement of rock

Design Risk Assessment – Helensburgh Options

Health and Safety Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key health and safety hazards and their possible effects	People at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
O&M6	Replacement of displaced rock armour Not applicable to R1, S2, W2 or C2	Injury to personnel due to picking, lifting and replacement of rock	Operatives	Development of a design where the rock armour has been designed to be stable up to and including the 2118 0.5□ AEP event	As before – risk reduced	H&S file	Client, contractor(s)	Safe System of Work to be developed for maintenance work to the rock armour
O&M7	Reduction of access between the adjacent pavement/promenade and the beach	Loss of access to and from the beach increasing the risk of cut-off during the tide coming in, slips, trips, falls and entrapment	Public	Development of a design to maintain access points between the promenade and beach	As before – risk reduced	H&S file	Client, designer(s) at detailed design, contractor(s)	Consider handrails and signage to raise awareness of hazards to the public, and maintain the condition and usability of public access
O&M8	In-situ concrete repairs Not applicable to C1	Burns to personnel due to contact with wet concrete	Operatives	N/A – further consideration of maintenance and concrete repairs re□uired at detailed design	As before	H&S file	Client, contractor(s)	Safe System of Work to be developed to including provision of spill kits and wet concrete clean-up procedures, training, including Toolbo□Talks, to increase competency of operatives, and all personnel to wear appropriate PPE
O&M9	Inspection and repairs of new concrete structures Not applicable to C1	Slips, trips, fall and entrapment when inspecting section of e□isting structures location behind the rock armour revetment	Operatives	N/A	As before	H&S file	Client	Risk assessments, including Safe Systems of Work where appropriate, and appropriate surveying methods should be adopted to undertake inspection and repairs
Demolition								
DEM1	Demolition of structures	Difficulty of demolition causing health and safety issues	Operatives	Development of a design in which no hazardous substances have been designed for and all designed elements are easily removable with standard construction techni□ues	As before – risk reduced	H&S file	Client, contractor(s)	Ensure that no hazardous substances are used during construction and are safe for demolition and removal

Design Risk Assessment – Helensburgh Options

Environmental Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key environmental hazards and their possible effects	Who or what is at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
Guidance	Consider all aspects involved in each stage of interface with the site, environment and structure(s).	Record the key hazards and their potential conse□uences.	Identify the categories of people, animals or environments at risk.	Include obtaining ade□uate data for design certainty and any further studies carried out during the risk evaluation process. Proposed measures to be taken by constructors and operators are to be included in Stage 4.	Provide details of residual hazards and risks that will need to be communicated and managed.	Record how information is provided, whether on drawings, pre-construction information, buildability statement, specification, reports or H&S File	Record the name of designers, contractors, the client or other stakeholders who are to ensure the significant residual risk is minimised and controlled.	Recommend measures to be taken by the risk owner(s) to minimise and control the significant residual risk.
Environment – Construction								
ENV1	General construction-based risks – permanent and temporary works Not applicable to S2, W2 and C2	Detrimentally affecting the e□isting foreshore marine habitat	Environment	N/A – cannot eliminate	As before	Pre-construction information, EIA	Client, designer(s) at detailed design, contractor(s)	Environmental Impact Assessment to be developed to include mitigation and enhancement opportunities
ENV2	General construction-based risks – permanent works	Adverse impact to the environment during and post-works	Environment	N/A – further consideration at detailed design, especially if an Environmental Impact Assessment is re□uired with the outcome of the Screening Opinion prior to detailed design to establish impact, mitigation and enhancement where possible	As before	Pre-construction information, EIA	Client, designer(s) at detailed design	Environmental Impact Assessment to be developed to include mitigation and enhancement opportunities
ENV3	General construction-based risks – fuel or hydraulic oil spillage	Fire hazards, damage to flora and fauna and pollution to the sea	Environment	N/A – cannot eliminate	As before	Pre-construction information	Contractor(s)	Fuel and hydraulic oil storage remote from the water edge at pre-designated site compound, with storage areas to be bunded and containers located on drip trays, provision of spill kits, regular maintenance of plant and consideration of biodegradable oils

Design Risk Assessment – Helensburgh Options

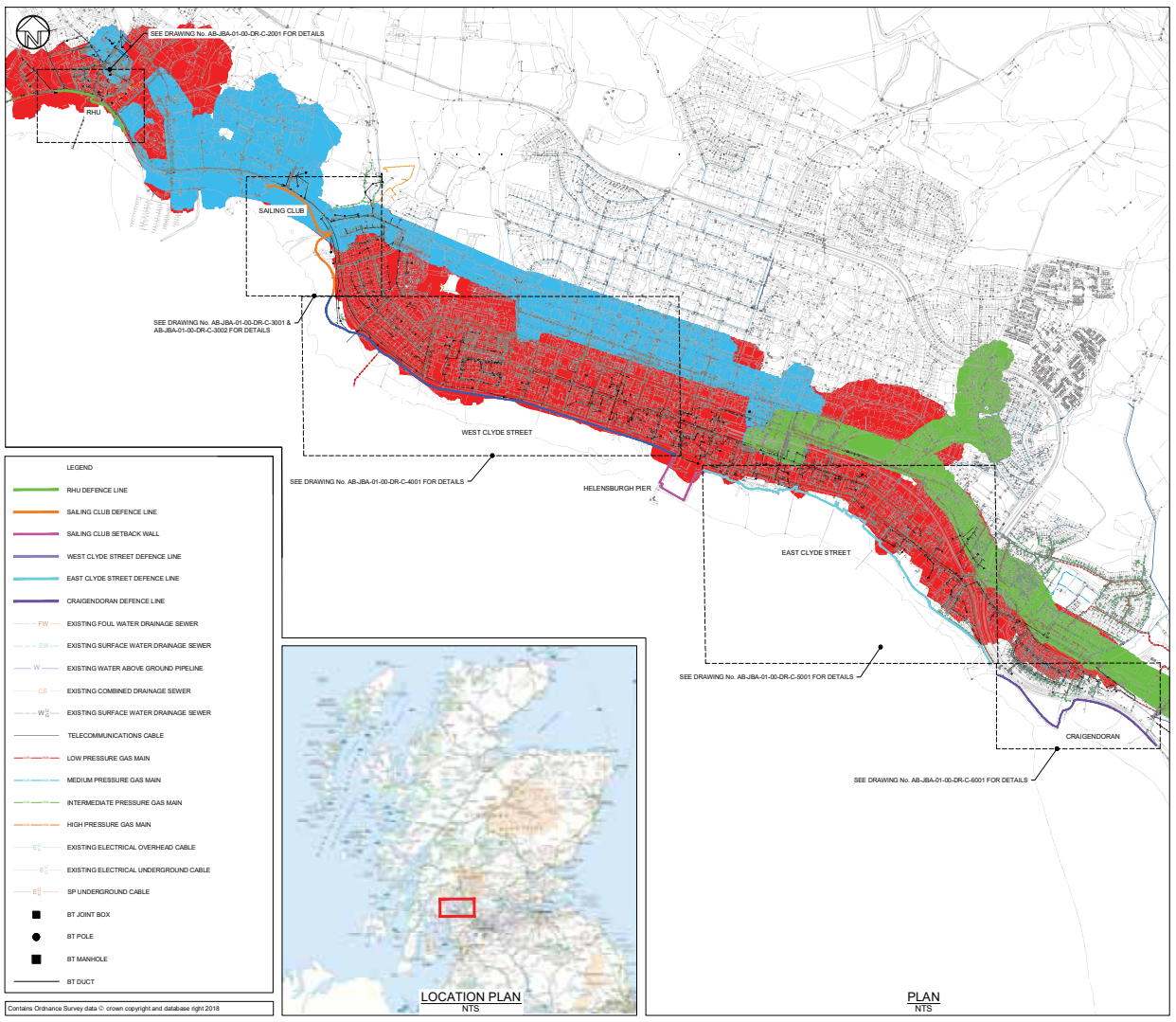
Environmental Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key environmental hazards and their possible effects	Who or what is at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
ENV4	General construction-based risks – dust, noise and vibration	Adverse impact to the environment during works and maintenance	Environment	Development of a design where sections of existing structures demolished and volumes of new materials have been minimised so far as reasonably practical while achieving project aims. Further consideration at detailed design, especially if an Environmental Impact Assessment is required with the outcome of the Screening Opinion prior to detailed design to establish impact, mitigation and enhancement where possible	As before – risk reduced	Pre-construction information, EIA	Designer(s) at detailed design, contractor(s)	Construction methodology to comply with requirements of EIA, dust suppression, use of clean aggregates, Safe System of Work to be developed and liaison with local resident groups to limit disturbance
ENV5	General construction-based risks – contaminants brought onto site via imported material	Contaminants and invasive non-native species brought on site resulting in a change in localised biodiversity	Environment	Development of a design where volumes of materials have been minimised so far as reasonably practical while achieving project aims	As before – risk reduced	Pre-construction information	Contractor(s)	All imported material to be sourced from clean, certified sources
ENV6	Excavation works – excavation of beach material Not applicable to S2, W2 and C2	Uncovering and exposing contaminated material	Environment	Development of design where excavation depths and widths have been minimised so far as reasonably practical while achieving project aims as well as undertaking a Geotechnical and Geo-environmental Desk Study which concluded that there are no significant contamination issues at the site	As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Geotechnical Design Report, including intrusive ground investigations, to be developed to detail any contamination issues uncovered
ENV7	Concrete works – wet concrete	Spillage or surplus concrete resulting in damage to flora and fauna and pollution to the sea	Environment	N/A - Further consideration of concrete repairs required at detailed design. R2/W1/E2 – Development of a design where the use of in-situ concrete has been significantly reduced by using precast concrete modular blocks	As before R2/W1/E2 – As before – risk reduced	Pre-construction information	Designer(s) at detailed design, contractor(s)	Safe System of Work to be developed to include provision of spill kits and wet concrete clean-up procedures, training, including Toolbox Talks, to increase competency of operatives, and all personnel to wear appropriate PPE
Environment - Operation & Maintenance								
ENV8	In-situ concrete repairs required as part of anticipated maintenance programme	Spillage or surplus concrete resulting in damage to flora and fauna and pollution to the sea	Environment	N/A – further consideration of maintenance and concrete repairs required at detailed design, and developing concrete specification to ensure sufficient curing prior to tidal inundation	As before	H&S file	Client, contractor(s)	Safe System of Work to be developed, training, including Toolbox Talks, to increase competency of operatives, and all personnel to wear appropriate PPE

Design Risk Assessment – Helensburgh Options

Environmental Considerations

Stage 1 **Identify**				Stage 2 **Eliminate / Reduce**	Stage 3 **Inform**		Stage 4 **Control**	
Ref. no.	Project element, material or activity	Key environmental hazards and their possible effects	Who or what is at risk from the hazard	Design measures taken to eliminate the hazard or reduce the risk	Significant residual hazards and risks	Communication method	Risk owner(s)	Proposed control measures
Demolition								
ENV9	Demolition of structures	Hazardous materials used in permanent works causing pollution to the sea during demolition	Environment	Development of a design in which no hazardous substances have been designed for and all designed elements are easily removable with standard construction techni□ues	As before – risk reduced	H&S file	Client, contractor(s)	Ensure that no hazardous substances are used during construction and are safe for demolition and removal



No.	Construction Risk	Public Risk	Environmental Risk
1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations	Disruptions to Sailing Club operations	
5	Excavations in beach material		
6	Unknown ground conditions		
7	Demolition works		
8	Hazardous debris on coastline at Craigendoran		

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING TAKE NOTE OF THE ABOVE.
IT IS ASSUMED THAT ALL WORKS DETAILED ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

General Notes

A. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
B. Do not scale from this drawing. All dimensions must be checked/verified on site.
C. Any discrepancies noted on site are to be reported to the Supervisor immediately.
D. The locations of any known services shown on drawing are approx.3mate and for guidance only. The Contractor will confirm the location of any services prior to the commencement of any works.
E. The electronic version of this drawing is not to be used for setting out.
F. Refer to Contract Specification for details of materials and workmanship to be used for the works shown on this drawing.

Rev.	Date	Comments	Drawn	Designed	Checked	Approved

Client Approval
A - Approved
B - Approved with Revisions
C - Do Not Use

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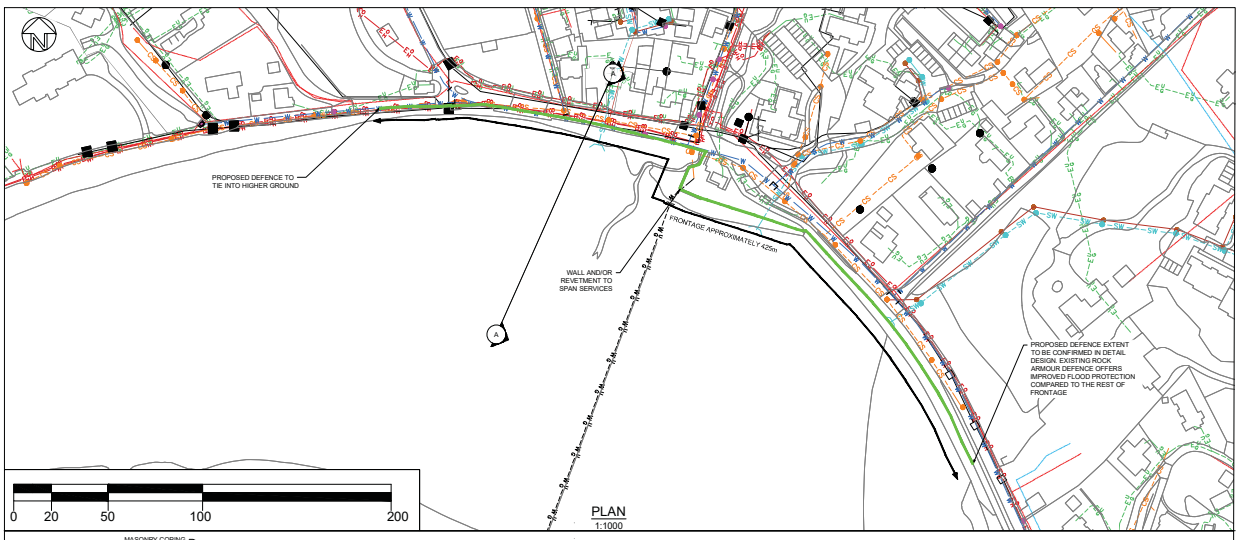
Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
GENERAL ARRANGEMENT
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad	30/05/19	Designed:	A Wright	24/05/19
Checked:	J Skanberg-Tippen	30/05/19	Approved:	G Kenn	21/06/19
Project Reference:	2018s0549		Scale:	not to scale @ A1	
Drawing Number:	AB-JBA-01-00-DR-C-1001		Status: S3	Revision: P01	Sheet Size: A1



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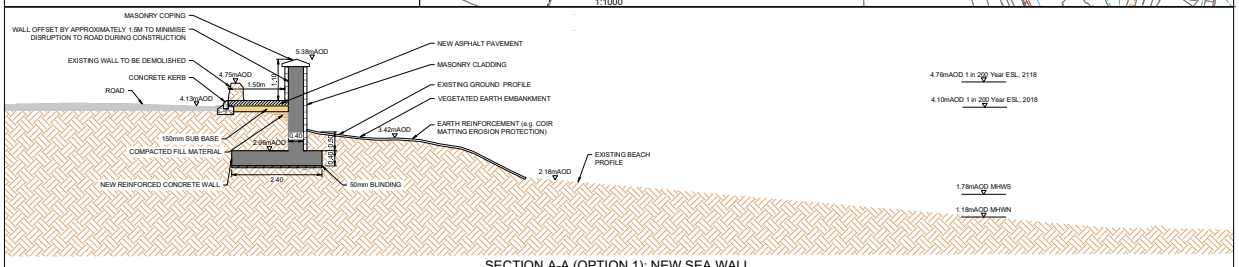
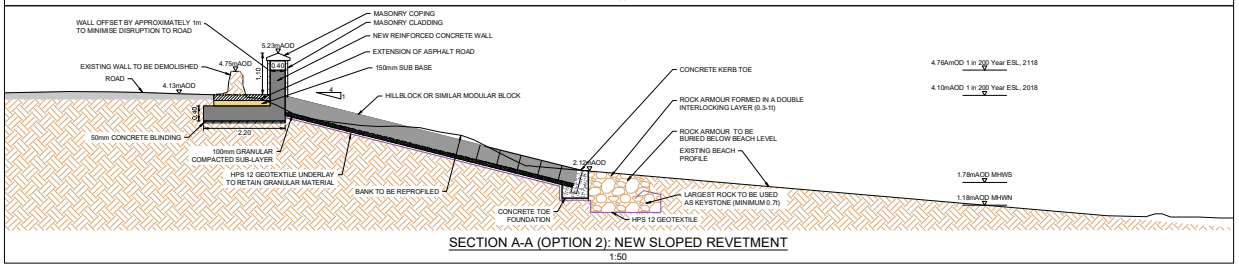


SECTION A-A (OPTION 1): NEW SEA WALL
1:50



SECTION A-A (OPTION 2): NEW SLOPED REVETMENT
1:50

No.	Construction Risk	Public Risk	Environmental Risk
1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations		
5	Excavations in beach material		
6	Unknown ground conditions		

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING TAKE NOTE OF THE ABOVE.
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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

General Notes

A. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
B. Do not scale from this drawing. All dimensions must be checked/verified on site.
C. All works on the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
D. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
E. Levels presented in the sections are post settlement and consolidation.
F. All dimensions and levels are conceptual.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unkown.
I. Topographic survey undertaken by JBA Consulting in September /October 2018.
J. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.

LEGEND

RHU WALL DEFENCE LINE

Rev.	Date	Drawn	Designed	Checked	Approved	Comments

Rev.	Date	Drawn	Designed	Checked	Approved	Comments

Client Approval
A - Approved
B - Approved with Revisions
C - Do Not Use

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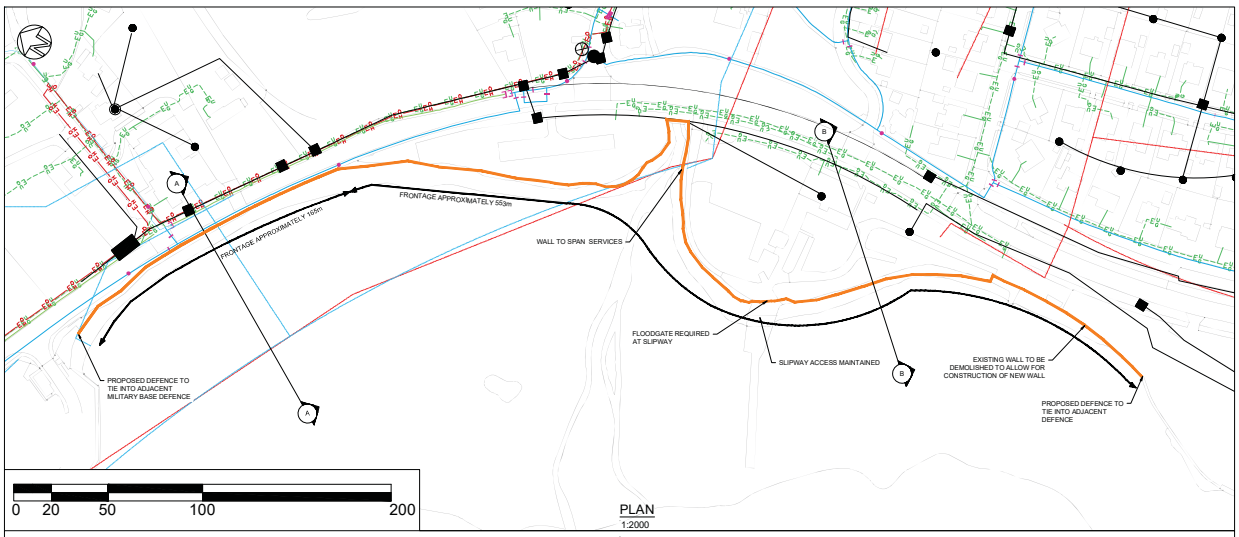
Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
RHU: NEW SEA WALL AND NEW SLOPED REVETMENT
PLAN & SECTIONS
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad	08/05/19	Designed:	A Wright	08/05/19
Checked:	J Skanberg-Tippen	28/05/19	Approved:	G Kenn	21/06/19
Project Reference:	2018s0549		Scale:	As Shown @ A1	

Drawing Number:	Status:	Revision:	Sheet Size:
AB-JBA-01-00-DR-C-2001	S3	P01	A1



PLAN
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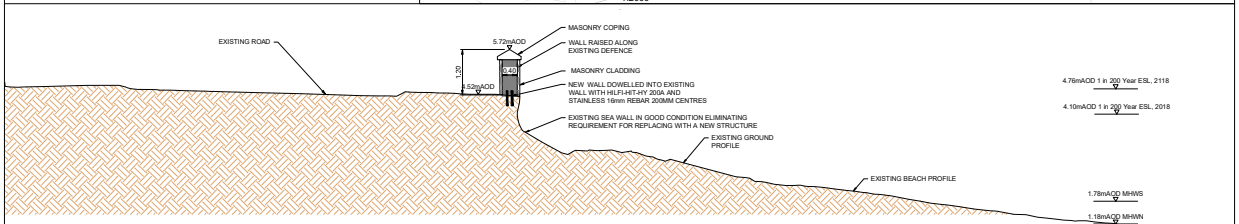
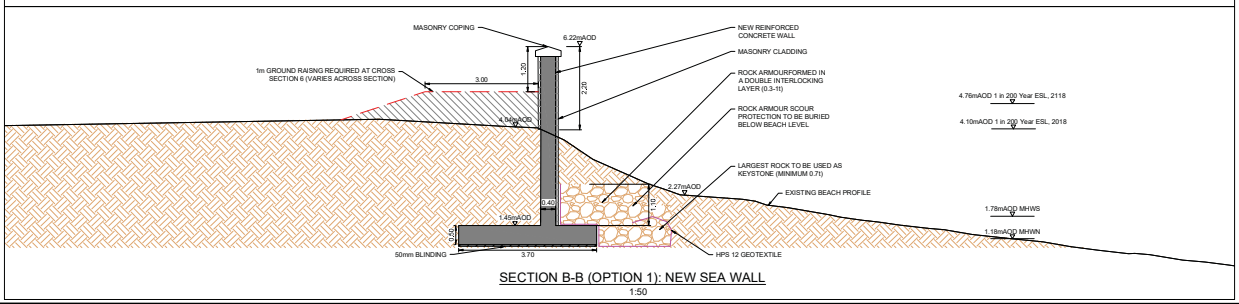


SECTION A-A : WALL RAISE
1:50



SECTION B-B (OPTION 1): NEW SEA WALL
1:50

No.	Construction Risk	Public Risk	Environmental Risk
1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations	Disruption to sailing club	
5	Excavations in beach material		
6	Unknown ground conditions		
7	Demolition works		

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING TAKE NOTE OF THE ABOVE.
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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

General Notes

A. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
B. Do not scale from this drawing. All dimensions must be checked/verified on site.
C. All works on the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
D. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
E. Levels presented in the sections are post settlement and consolidation.
F. All dimensions and levels are subject to change.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unkown.
I. Topographic survey undertaken by JBA Consulting in September/October 2018.
J. Land raising of the new sea wall (Section B-B) will be required, although levels will vary across the frontage.
K. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.
L. The existing sea wall in section A-A is in good condition, and thus it is assumed that the existing wall is stable enough for the dowelled solution. Overall structural stability and suitability of dowels required should be further considered at detailed design.

LEGEND

SAILING CLUB DEFENCE LINE

Rev.	Date	Drawn	Designed	Checked	Approved	Comments

Client Approval
A - Approved
B - Approved with Revisions
C - Do Not Use

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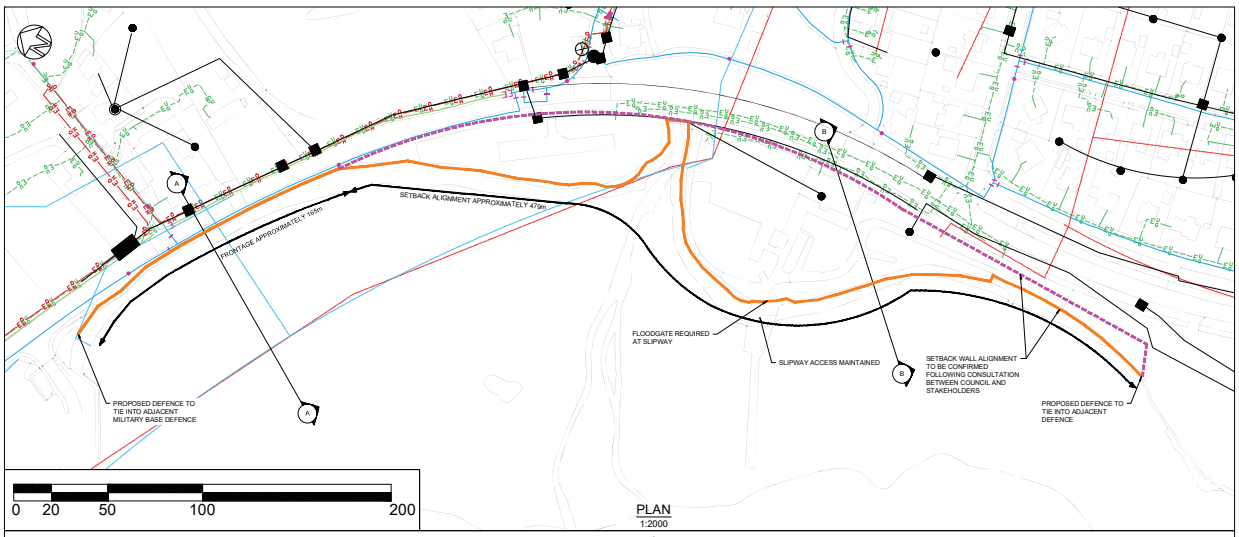
Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
SAILING CLUB
NEW SEA WALL PLAN AND SECTIONS
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad	08/05/19	Designed:	A Wright	08/05/19
Checked:	J Skanberg-Tippen	28/05/19	Approved:	G Kenn	21/06/19
Project Reference:	2018s0549		Scale:	As Shown @ A1	

Drawing Number:	Status:	Revision:	Sheet Size:
AB-JBA-01-00-DR-C-3001	S3	P01	A1



PLAN
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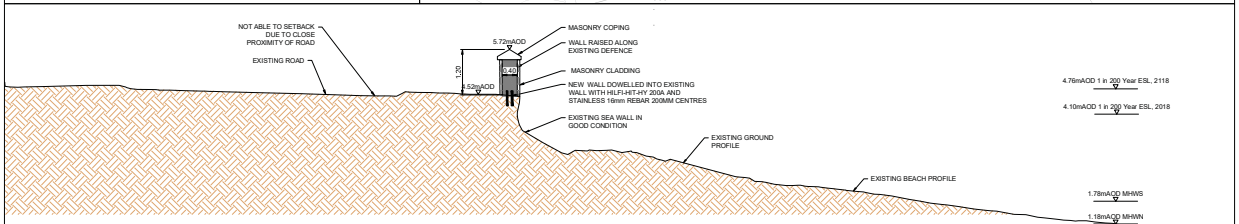
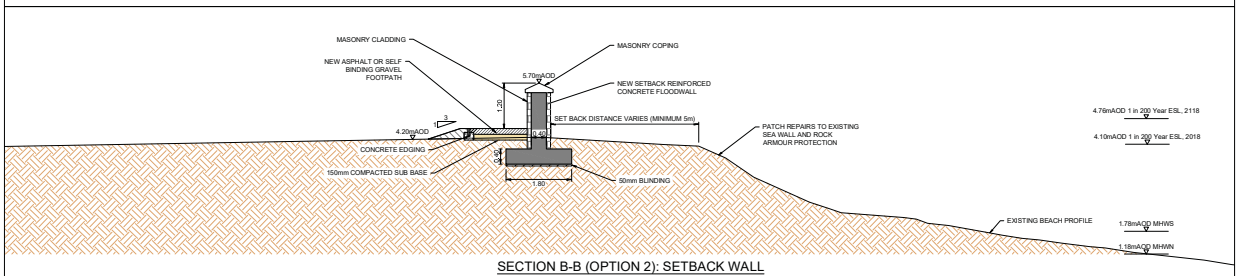


SECTION A-A : WALL RAISE
1:50



SECTION B-B (OPTION 2): SETBACK WALL
1:50

No.	Construction Risk	Public Risk	Environmental Risk
1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations	Disruption to sailing club	
5	Excavations in beach material		
6	Unknown ground conditions		
7	Demolition works		

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING TAKE NOTE OF THE ABOVE.
IT IS ASSUMED THAT ALL WORKS DETAILED ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

General Notes

A. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
B. Do not scale from this drawing. All dimensions must be checked/verified on site.
C. All works on the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
D. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
E. Levels presented in the sections are post settlement and consolidation.
F. All dimensions and levels are conceptual.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unknown.
I. Topographic survey undertaken by JBA Consulting in September/October 2018.
J. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.
K. The existing sea wall in section A-A is in good condition, and thus it is assumed that the existing wall is stable enough for the dowelled solution. Overall structural stability and suitability of dowels required should be further considered at detailed design.

LEGEND

SAILING CLUB DEFENCE LINE

MAXIMUM SETBACK WALL ALIGNMENT

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Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
SAILING CLUB
SETBACK WALL PLAN AND SECTIONS
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad 19/04/19	Designed:	A Wright 19/04/19
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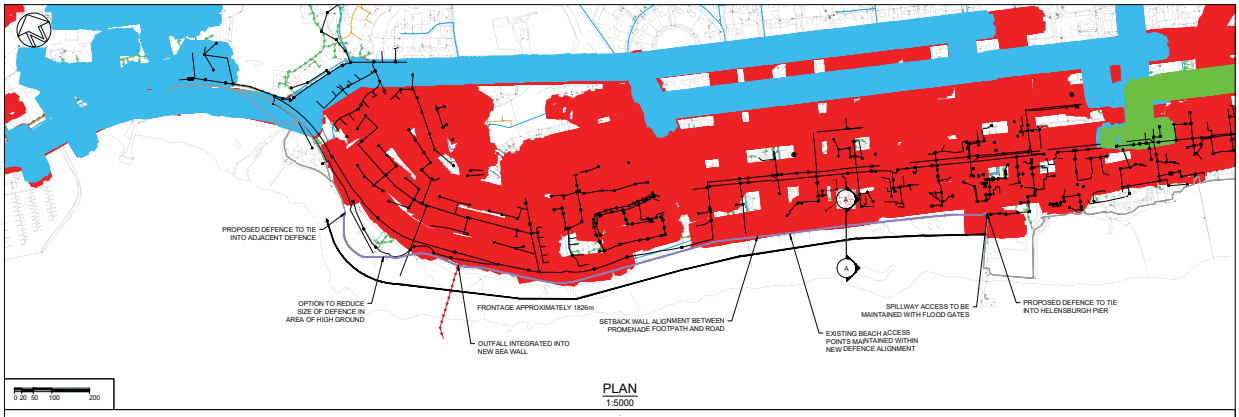
Project Reference:	2018s0549	Scale:	As Shown @ A1
Drawing Number:	AB-JBA-01-00-DR-C-3002	Status: S3	Revision: P01
			Sheet Size: A1



PLAN
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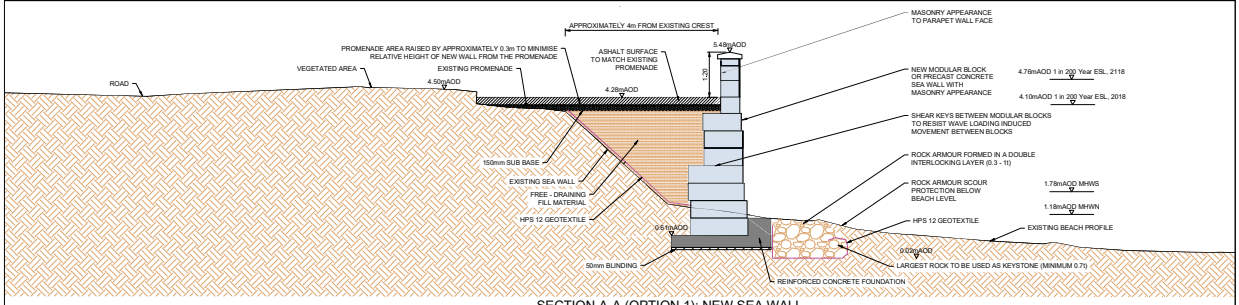
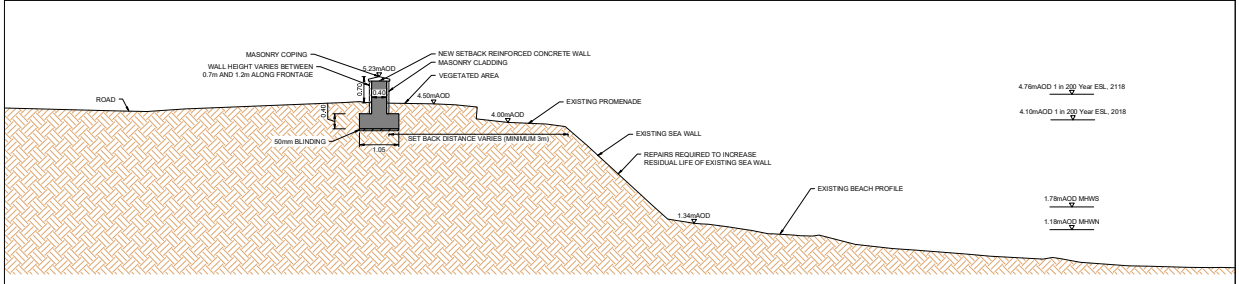


SECTION A-A (OPTION 1): NEW SEA WALL
1:50



SECTION A-A (OPTION 2): SET-BACK WALL
1:50

No.	Construction Risk	Public Risk	Environmental Risk
1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations		
5	Excavations in beach material at base of existing wall		
6	Unknown ground conditions		

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E. Levels presented in the sections are post settlement and consolidation.
F. All dimensions and levels are conceptual.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unknown.
I. Topographic survey undertaken by JBA Consulting in September /October 2018.
J. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.

LEGEND

WEST CLYDE STREET DEFENCE LINE

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Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
WEST CLYDE STREET: PLAN AND SECTIONS
NEW SEA WALL AND NEW SETBACK WALL

for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad 19/04/19	Designed:	A Wright 19/04/19
Checked:	J Skenberg-Tippen 28/05/19	Approved:	G Kenn 21/06/19
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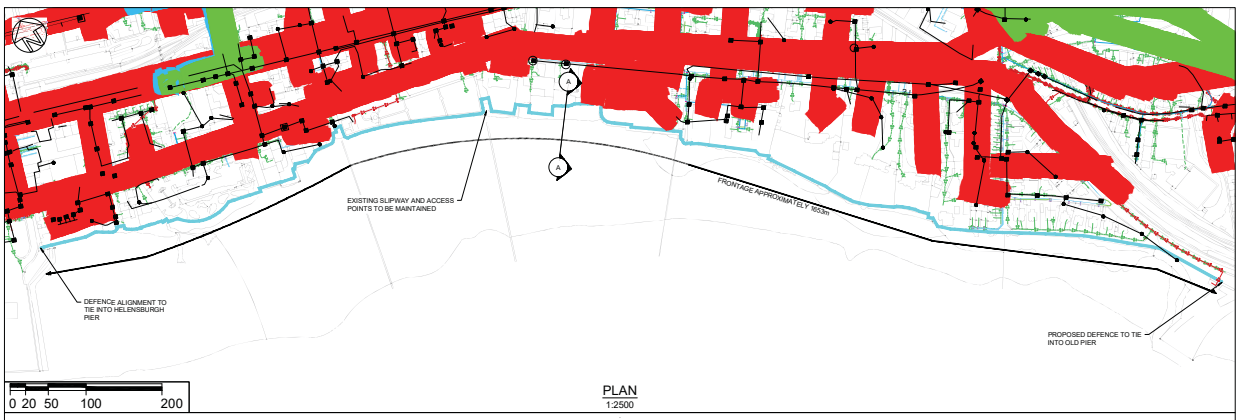
			Sheet Size: A1



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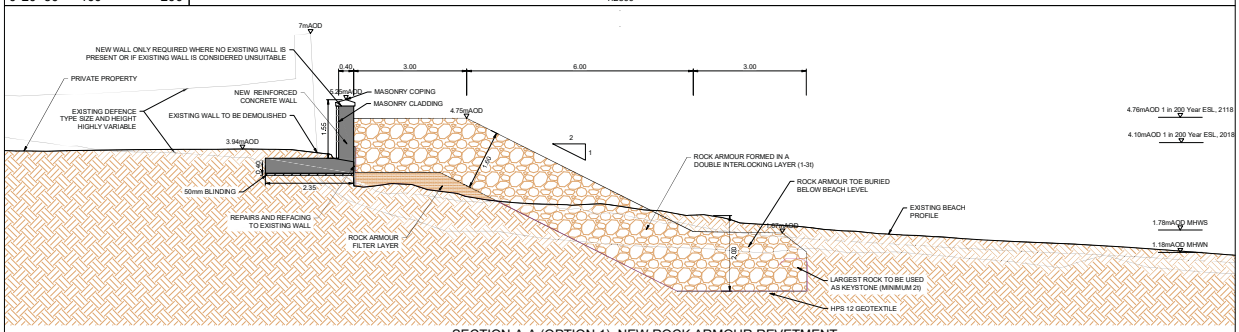
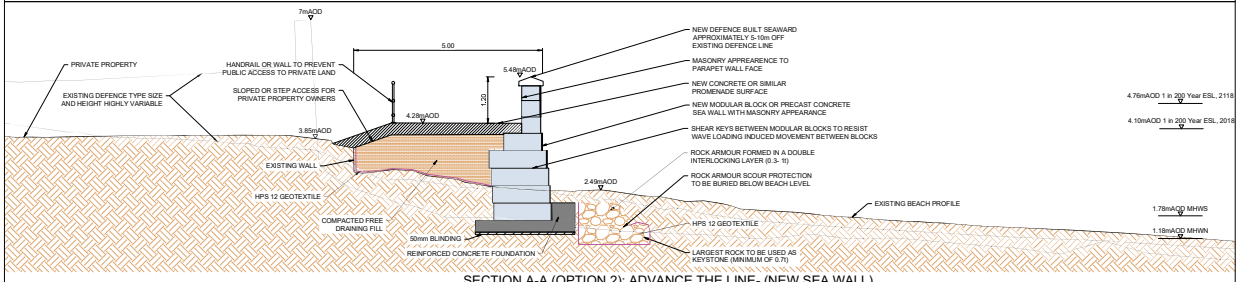


SECTION A-A (OPTION 1): NEW ROCK ARMOUR REVETMENT
1:50



SECTION A-A (OPTION 2): ADVANCE THE LINE- (NEW SEA WALL)
1:50

1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations		
5	Excavations in beach material		
6	Unknown ground conditions		
7	Demolition works		
	Construction Risk	Public Risk	Environmental Risk

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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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E. Levels presented in the sections are post settlement and consolidation.
F. All dimensions and levels are conceptual.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unknown.
I. Topographic survey undertaken by JBA Consulting in September /October 2018.
J. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.

LEGEND

EAST CLYDE STREET DEFENCE LINE

Rev.	Comments / Date	Drawn	Designed	Checked	Approved
	Comments				
Rev.:	Date	Drawn	Designed	Checked	Approved

Client Approval

A - Approved
B - Approved with Revisions
C - Do Not Use

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Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
EAST CLYDE STREET: PLAN AND SECTIONS
NEW ROCK ARMOUR REVETMENT & ADVANCE THE LINE
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad	08/05/19	Designed:	A Wright	08/05/19
Checked:	J Skanberg-Tippen	28/05/19	Approved:	G Kenn	21/06/19
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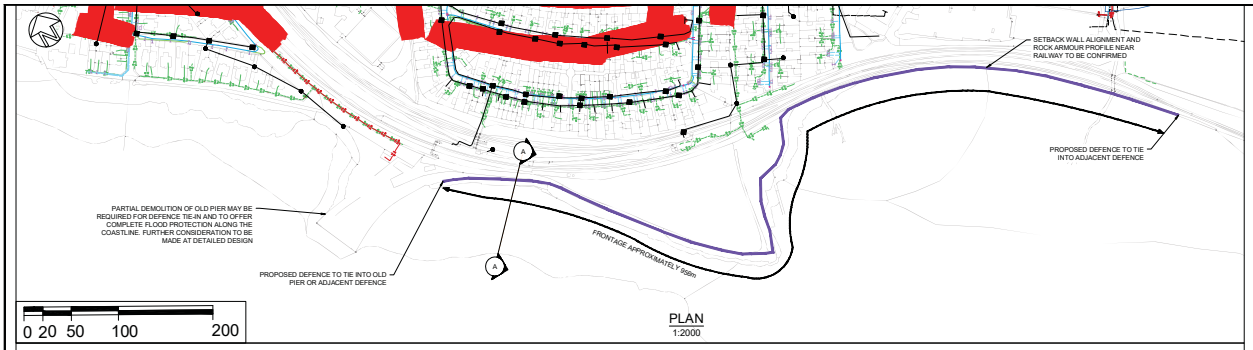
			Revision:	P01	
			Sheet Size:	A1	



PLAN
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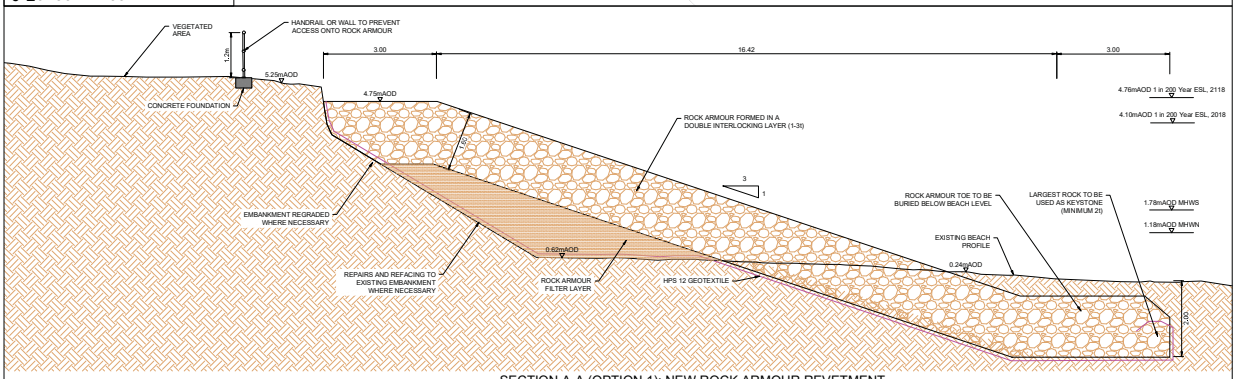
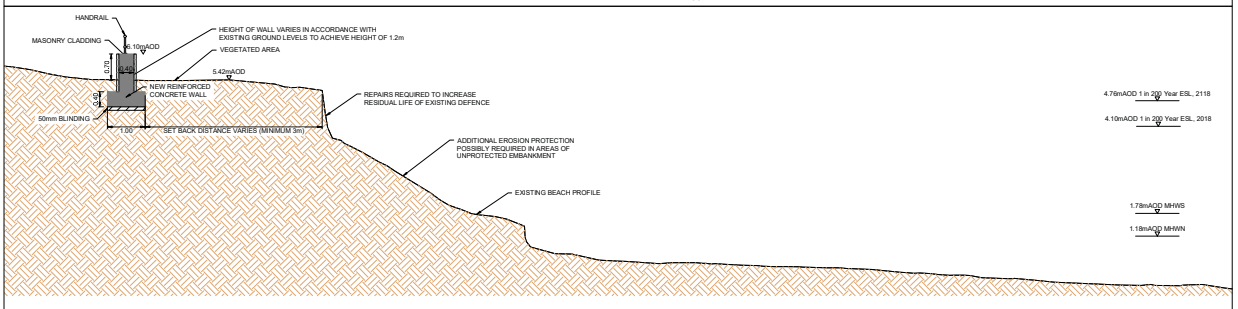


SECTION A-A (OPTION 1): NEW ROCK ARMOUR REVETMENT
1:50



SECTION A-A (OPTION 2): SETBACK WALL
1:50

1	Unknown UXO risk	Plant movement on beach, road and pavement	Debris and dust from construction work
2	Working in tidal conditions	Disturbance to traffic flow due to construction zone including road	Plant working in tidal area
3	Working at height	Disturbance to public by plant noise	Pollution hazards
4	Lifting operations		
5	Excavations in beach material		
6	Unknown ground conditions		
7	Hazardous debris on coastline		
	Construction Risk	Public Risk	Environmental Risk

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F. All dimensions and levels are conceptual.
G. All existing slipways and access points between the beach and landward of the defences to be maintained.
H. Ground conditions unkown.
I. Topographic survey undertaken by JBA Consulting in September/October 2018.
J. Cladding detail to be carefully considered at detailed design. Risk of damage to and loss of cladding due to wave action.

LEGEND

CRAIGENDORAN DEFENCE LINE

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Project: Clyde and Loch Lomond LFRMP
Helensburgh Coastal Flood Study

Title: HELENSBURGH COASTAL OPTIONS APPRAISAL
CRAIGENDORAN: PLAN & SECTIONS
NEW ROCK ARMOUR REVETMENT & NEW SETBACK WALL
for

Client: ARGYLL AND BUTE COUNCIL

Drawn:	A Coad 19/04/19	Designed:	A Wright 19/04/19
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