



**Environmental Statement**  
**CHAPTER 4 – Consideration of**  
**Alternatives**

Langstone FCERM Scheme

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# Langstone FCERM Scheme Environmental Statement

## Chapter 4

### Consideration of Alternatives

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## 4 Consideration of Alternatives

In accordance with the Environmental Impact Assessment (EIA) Regulations, this chapter sets out reasonable alternatives that have been identified and assessed in the development of the proposed Flood and Coastal Erosion Risk Management (FCERM) scheme design at Langstone. This chapter includes justification for the final proposed design and the alternatives that have been considered and discounted, following an assessment of the effects of each option on the environment (amongst other factors). Extensive consideration of environmental impacts and opportunities fundamentally shaped the final proposed design.

The strategic FCERM policy adopted for Langstone is to 'Hold the Line' (HTL). This was set by the North Solent Shoreline Management Plan (SMP), which is a high level, non-statutory plan. The Portchester Castle to Emsworth Flood and Erosion Management Strategy (PEMS) (Environment Agency, 2013) also confirmed that there was a strategic need to upgrade the existing defences to increase the current Standard of Protection (SoP) to a 1.3% Annual Exceedance Probability (AEP) (1 in 75 year) sustained for 100 years, therefore also adopting a policy of 'HTL'. To deliver the policy of 'HTL', various options were considered within PEMS, before confirming a preferred solution. The strategic context for the Langstone FCERM scheme is summarised in **Chapter 2 (Strategic Background)**.

Both the North Solent SMP and PEMS underwent a rigid option selection process to identify policy that is considered environmentally, technically, and economically viable. This Chapter will not repeat these policy decisions, as the policy option selection process is well reported within these strategic documents. This Chapter instead focuses on the option selection process to confirm an FCERM solution that delivers the strategic policy of 'HTL' at Langstone.

### 4.1 Overview of Option Selection Process

Following the FCERM Appraisal Guidance (FCERM-AG), The first stage of the option selection process was to develop a long list of FCERM options that could deliver a policy of 'HTL' at Langstone, regardless of their impacts, costs or buildability. Each of the long list FCERM options were then appraised and reduced to a short list of options and then finally to a leading option.

The Langstone coastal frontage was initially broken down into four Option Development Units (ODUs) to facilitate the development and appraisal of the long list of options. These are listed below and illustrated on **Figure 4.1** (although note that they are simply referred to as Units within this Figure).

- ODU 1: Langstone West, between the east bank of the Langbrook Stream to the edge of the formal defences and slipway at the northern end of Langstone Spit.
- ODU 2: Sailing club and Langstone Spit, including the spit, sailing club and defences to the Ship Inn car park.
- ODU 3: Langstone east, between the Ship Inn car park and the Mill.
- ODU 4: Mill and Mill Pond, between the Mill and the slipway to the northeast of the Mill Pond.



**Figure 4.1: Option development unit boundaries at Langstone (labelled as 'Units').**

ODU 1 was initially considered from the outset of the project, as a potential 'additional scheme' however works along this unit are no longer proposed as part of the 'core' Langstone FCERM scheme, therefore ODU1 will not be discussed further in this chapter. More information on the 'core' and 'additional' scheme is available here: <https://coastalpartners.org.uk/project/core-and-additional-scheme/>

ODUs 2, 3 and 4 were further divided into sub-units to assess options on a local level. See **Sections 4.2.2.2 to 4.2.2.4** for further information.

## 4.2 Option Development

### 4.2.1 Long list FCERM options

The first stage of the options appraisal process was to develop a long list of FCERM options that could deliver the strategic policy of 'HTL' at Langstone, regardless of their impacts, costs or buildability for each ODU.

Below is a summary of the long list of options that were considered. As part of the option appraisal process, in accordance with FCERM Appraisal Guidance (FCERM-AG), it is necessary to establish a baseline from which alternative options can be compared and appraised against. Therefore, Do Nothing (walk away) and Do Minimum (patch and repair reactive maintenance) scenarios were also considered and included in the long list of options for each ODU.

- Do nothing – no active intervention.
- Do minimum – patch and repair or small scale maintenance.
- Options to maintain:
  - o Capital refurbishment.
  - o Localised erosion protection.
  - o Beach recycling/management.
- Options to sustain/improve:
  - o Crest raising of existing defences.
  - o Setback floodwall.
  - o Glass floodwalls.
  - o Self-raising flood walls.
  - o Temporary barriers.
  - o Demountable flood walls.
  - o Reinforce de-facto defences, boundary walls and flood proof buildings.
  - o Flood gates.
  - o Wave return wall.
  - o Setback embankment.
  - o Land raising.
  - o Road raising.
  - o Concrete revetment / seawall.
  - o Sheet piling with capping beam.
  - o Beach nourishment.
  - o Beach groynes.
  - o Property level protection.
  - o Property level resilience.
  - o Vegetated buffer zones.
- Frontage wide measures:
  - o Tidal flood barrier.
  - o Lagoon.
  - o Community preparedness and resilience.
  - o Relocation.

The longlist of options fed into the next stage of the options appraisal process in developing the short list of options as described in **Section 4.2.2** below. Further information on the long listing process and options can be found in the ‘Longlist Options Report’ on the Coastal Partners website via the following link:

<https://coastalpartners.org.uk/static/media/resources/langstone-long-list-options-report-1.pdf>.

#### 4.2.2 Short list FCERM options

The second stage of the options appraisal process was to appraise the long list of options and reduce to a short list ready for further and more detailed assessment. Not all the long list options were appraised in detail, as they were considered either impractical, technically flawed, or environmentally unacceptable. However, the stage two multivariate appraisal identified the most suitable measures for each ODU.

The multivariate appraisal was undertaken for each ODU, with local constraints and opportunities considered. This resulted in a shortlist of measures being identified for each

ODU. The multivariate analysis appraised the long list of FCERM options against fourteen categories, which comprised of:

1. PEMS Strategy preferred option facilitation.
2. Residual flood risk.
3. Erosion risk management.
4. Ecology impacts.
5. Heritage impacts.
6. Landscape impacts.
7. Technical feasibility.
8. Stakeholder objectives and consenting.
9. Community support.
10. Broader outcomes, aspirations, and contributions.
11. Maintenance requirements.
12. Design life.
13. Coastal process impacts.
14. Relative cost.

The appraisal of options was supported by data and assessments, visual site inspections, stakeholder and community engagement and heritage, ecology and landscape objectives. For each of the 14 categories listed above, a score of 0 (red – doesn't support), 1 (amber - partially supports) or 2 (green – fully supports) was applied to each option.

#### 4.2.2.1 Scheme alignments

Throughout the short-listing stage, different combinations of scheme alignment were considered across the ODUs. These demonstrate how the defences in the different ODUs could be linked together and no alignments were ruled out during this stage of the scheme development. **Figure 4.2**, **Figure 4.3** and **Figure 4.4** illustrate three potential alignments that were considered at this stage. Please note that the final alignment for the proposed scheme now differs from those illustrated on these figures, as further refinements were made to the alignment during the outline design and detailed design stages.

**Figure 4.2** shows an alignment around the full frontage, extending from the Langbrook stream in the west to the Mill in the east. **Figure 4.3** shows an alignment around the main residential parts of the frontage, excluding protection to the Sailing Club and the Spit. The defence does not include the Mill and the area east of this. **Figure 4.4** shows an alignment around the east side of Langstone Village (which represents the Core scheme alignment). This involves constructing a defence along the National Cycle Route 2 and excluding the residential properties to the west (in Mill Lane and Harbourside). This alignment also does not include the Sailing Club, the Mill or the Spit.

Each ODU was further broken down into ODU sub-units. The following sections consider each ODU (except for ODU1 as that is outside of the Core scheme area) in more detail, including alignments at the local level. The characteristics, constraints and opportunities were identified for each ODU sub-unit, and the multi variate analysis applied. This process informed which options were scoped in and out of the shortlist for each ODU sub-unit. **Sections 4.2.2.2 to 4.2.2.4** provide a summary of this process, but further information can be found in the 'Short List Options Report' on the Coastal Partners website via the following link: <https://coastalpartners.org.uk/static/media/resources/langstone-short-list-options-report-1.pdf>.





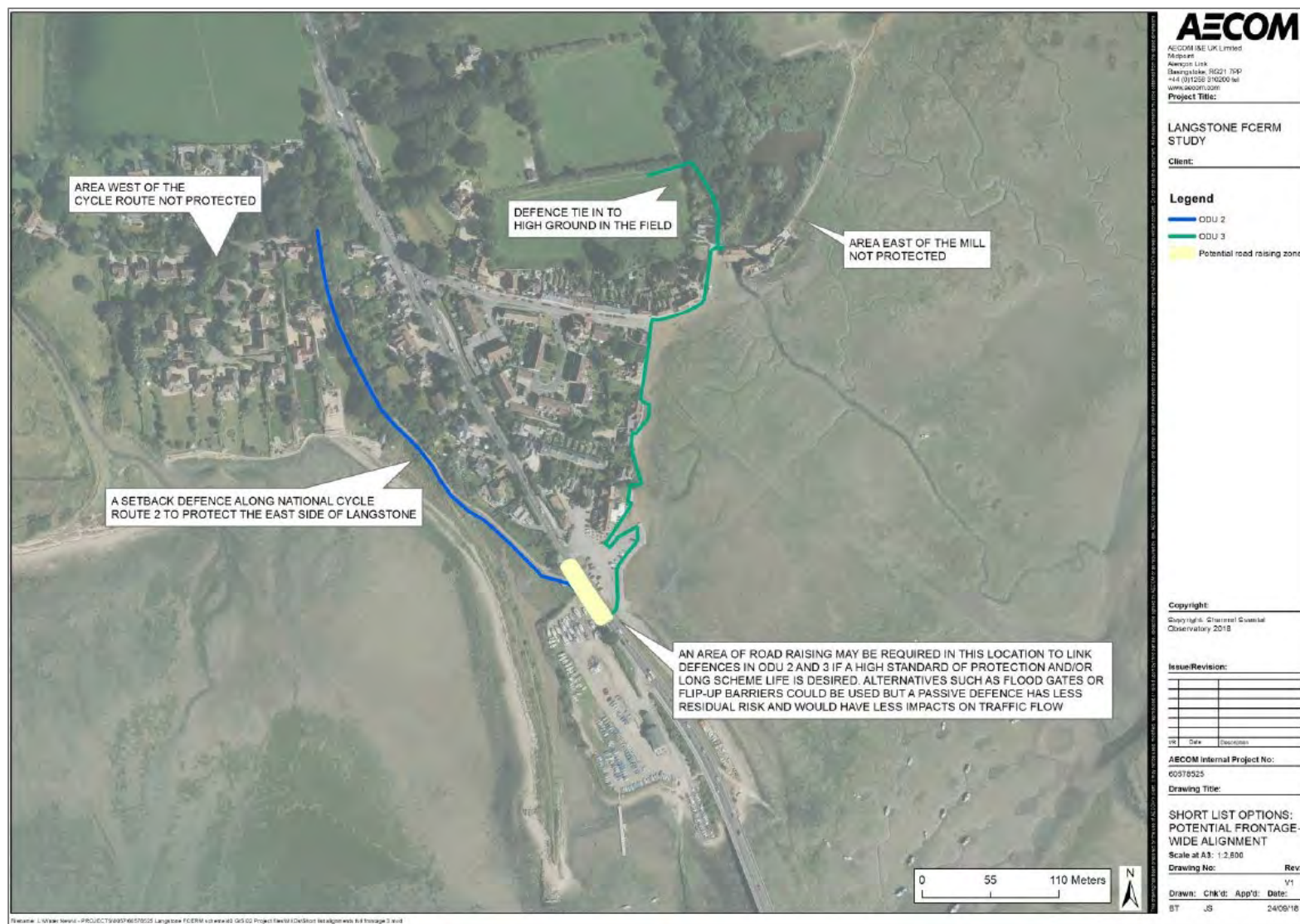


Figure 4.4: Potential alignment 3.

#### 4.2.2.2 ODU 2 – Sailing Club and Langstone Spit

ODU 2 was broken down into three sub-units; ODU 2a, ODU 2b and ODU 2c, the extents of which are shown on **Figure 4.5**. ODU 2a formed part of the original, potential additional scheme, however with this no longer being taken forward as part of the core scheme, ODU 2a will not be discussed further.



**Figure 4.5: ODU 2 sub-unit extents.**

Following the multivariate scoring process, the short-listed options were identified for each sub-unit. **Table 4.1** provides details of the short-listed options and the key reasons for their selection. The options shown facilitate an 'Improve' SoP option.

In addition to the reasons for selection, the potential impact that each short-listed option may have on compliance with the Habitat Regulations has also been included in **Table 4.1**. This assessment was based on the multivariate process findings and consideration of the ecology objectives. Note: green rows highlight where the proposed measure has a high likelihood of Habitats Regulations compliance.

**Table 4.1: Draft short list measures for ODU 2.**

| ODU sub-unit                        | Measure                                                                                            | Key reasons for selection                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ODU 2b<br>National<br>Cycle Route 2 | Set back flood wall                                                                                | <ul style="list-style-type: none"> <li>Scored highly in ecology, residual risk and design life.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                                                                                                                                                                                                |
|                                     | Earth embankment                                                                                   | <ul style="list-style-type: none"> <li>Technically feasible which makes use of the existing landscape and space availability.</li> <li>Likely to be supported by stakeholders and the community.</li> <li>Scored highly in ecology and design life.</li> </ul>                                                                                                                                                               |
| ODU 2c<br>Sailing Club              | Flood gate or a setback floodwall (& scheduled maintenance / refurbishment of frontline revetment) | <ul style="list-style-type: none"> <li>Limited impact on heritage and archaeology</li> <li>Technically feasible.</li> <li>Likely to be supported by stakeholders and the community.</li> <li>Potential for contributions.</li> <li>Makes use of the existing structure to provide erosion protection.</li> <li>The timescales whereby need for a setback wall is required is dependent of rates of sea level rise</li> </ul> |
|                                     | Refurbish & heighten existing revetment and extend it where required                               | <ul style="list-style-type: none"> <li>In keeping with the existing defence, although an extension to this could have ecology impacts due to encroachment.</li> <li>Scored highly in erosion, residual risk, maintenance, and design life.</li> <li>The timescales whereby need for raising the structure is required is dependent of rates of sea level rise.</li> </ul>                                                    |

For ODU 2c, none of the measures included within **Table 4.1** scored green on the ecology category, therefore Habitat Regulations compliance was expected to be unlikely, unless significant mitigation measures could be adopted.

Other measures were also assessed for each ODU but were scoped out for various reasons. **Table 4.2** summarises the improve options scoped out of further assessment of ODU sub-units 2b and 2c.

**Table 4.2: Options scoped out of further assessment for ODU sub-units 2b and 2c.**

| ODU sub-unit                           | Measure              | Key reasons for scoping out                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ODU 2b<br>National<br>Cycle<br>Route 2 | Demountable defences | <ul style="list-style-type: none"> <li>High maintenance and operational burden.</li> <li>Scored poorly in the residual flood risk and operational maintenance categories.</li> </ul>                                                                                                                                                                                                                 |
| ODU 2c<br>Sailing<br>Club              | Land raising         | <ul style="list-style-type: none"> <li>Could involve raising the entire area of the Sailing Club</li> <li>Does not address erosion risk.</li> <li>High cost.</li> <li>Overall score surpassed that of other more feasible measures.</li> </ul>                                                                                                                                                       |
|                                        | Seawall              | <ul style="list-style-type: none"> <li>Scored poorly in ecology, stakeholder objectives and cost.</li> <li>Other more feasible options e.g., extending the existing defence rather than replace it with a seawall.</li> <li>Could lead to further encroachment or damage to ecology.</li> <li>Community and stakeholders potentially less supportive of a widespread change in this area.</li> </ul> |

### *Potential alignments*

Potential alignments of the short list measures for each ODU sub-unit were identified. **Figure 4.6** illustrates the potential alignments as well as photographs of similar sites around the country, which give an indication of what the defence measures could potentially look like.

As shown in **Figure 4.6**, the alignment for ODU sub-unit 2b included an option to extend the alignment along the length of the National Cycle Route 2 path (dashed blue line within Figure 4.6), as it could present opportunities to reduce the overall cost of the defences for the proposed scheme e.g., if a defence was not considered viable at ODU 1, but it was in ODU 3, ODU2b alternative alignment could be taken forward as part of the core scheme and used to prevent outflanking of the defences in ODU 3.

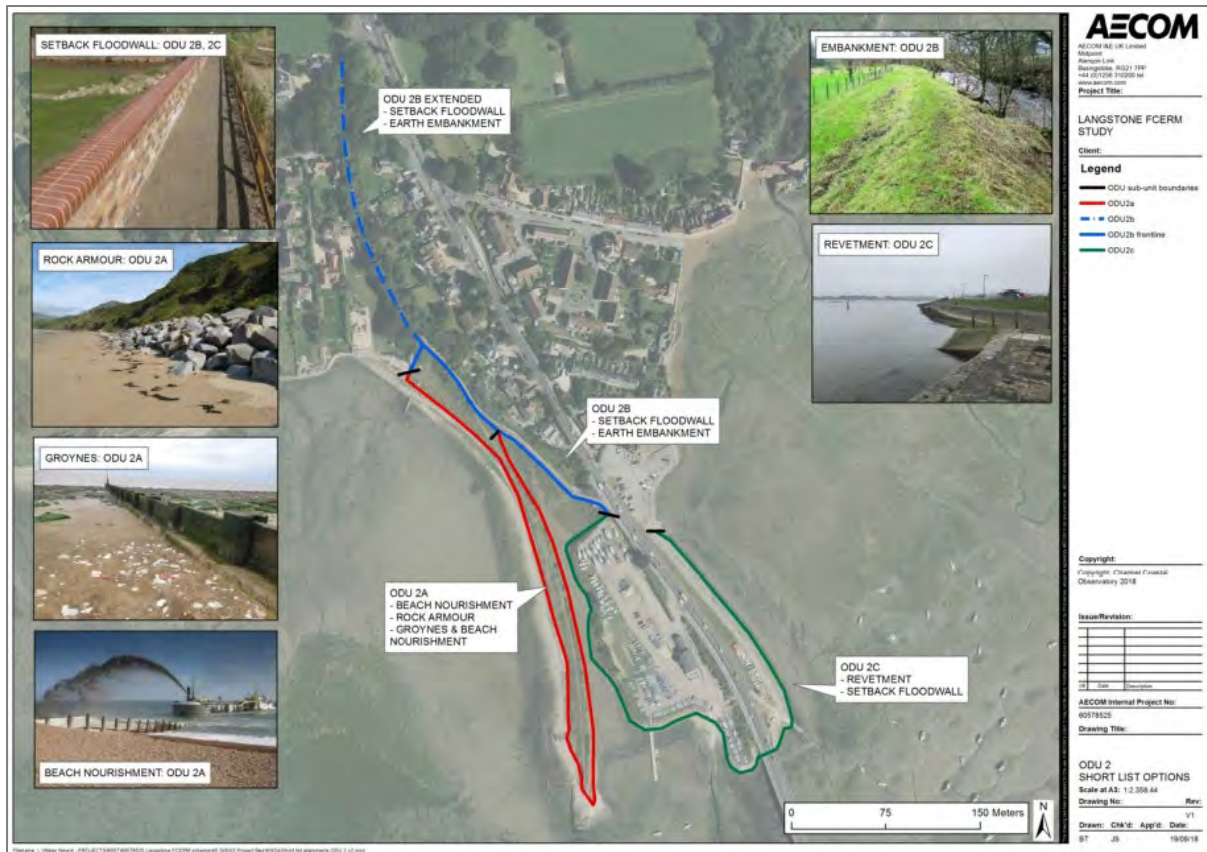


**Figure 4.6: Potential alignments and short list measures for sub-units in ODU 2.**

#### 4.2.2.3 ODU 3 - Langstone East

ODU 3 extends from the Ship Inn car park in the south to the Old Mill in the north. Due to there being a number of unique constraints and characteristics at the local level, this ODU was broken down in 12 sub-units (3a to 3l) to facilitate the options development process. The extents of each sub-unit are shown on **Figure 4.7**.



**Figure 4.7: ODU 3 sub-unit extents.**

**Table 4.3** provides details of the short-listed options and the key reasons for their selection. The options shown facilitate an 'Improve' SoP option.

In addition to the reasons for selection, the potential impact that each short-listed option may have on compliance with the Habitat Regulations has also been included in **Table 4.3**. This assessment was based on the multivariate process findings and consideration of the ecology objectives. Note: green rows highlight where the proposed measure has a high likelihood of Habitats Regulations compliance.

**Table 4.3: Draft short list measures for ODU 3.**

| ODU sub-unit                                                   | Measure              | Key reasons for selection                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ODU 3a<br/>Slipway<br/>(South of Ship<br/>Inn car park)</b> | Flip up floodwall    | <ul style="list-style-type: none"> <li>Technically feasible approach which would allow slipway access when not deployed.</li> <li>No ecology impacts.</li> <li>Likely to be supported by stakeholder and the community.</li> </ul>                                                                     |
|                                                                | Demountable defences | <ul style="list-style-type: none"> <li>Relatively low cost measure.</li> <li>Set back so no ecology impacts.</li> </ul>                                                                                                                                                                                |
|                                                                | Flood gate           | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Limited ecology impact.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                                                                            |
| <b>ODU 3b<br/>Ship Inn car<br/>park</b>                        | Setback floodwall    | <ul style="list-style-type: none"> <li>Scored highly in ecology.</li> <li>Low residual risk of flooding and long option life.</li> <li>Likely to be supported by stakeholders.</li> <li>Condition of existing frontline defences makes setback approaches more affordable in this location.</li> </ul> |

| ODU sub-unit                                             | Measure                                           | Key reasons for selection                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                          | Glass topped setback floodwall                    | <ul style="list-style-type: none"> <li>Scored highly in ecology.</li> <li>Low residual risk of flooding and long option life.</li> <li>Likely to be supported by stakeholders.</li> </ul>                                                                                                                                                                                        |
|                                                          | Flip-up floodwall across car park                 | <ul style="list-style-type: none"> <li>Scored highly in technical feasibility.</li> <li>Likely to be supported by stakeholders.</li> <li>Condition of existing frontline defences makes setback approaches more affordable in this location.</li> </ul>                                                                                                                          |
|                                                          | Road raising                                      | <ul style="list-style-type: none"> <li>Could be used to link ODU 2 and ODU 3 if a high standard of protection and/or long scheme life is desired.</li> <li>Would not replace but supplement other short list measures and be used to link defences to the west side of the frontage.</li> <li>Would not interrupt traffic flows and emergency access during flooding.</li> </ul> |
| <b>ODU 3c<br/>Slipway (north of Ship Inn car park)</b>   | Flip up floodwall                                 | <ul style="list-style-type: none"> <li>Technically feasible and would allow slipway access when not deployed.</li> <li>Setback so no ecology impacts.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                                                                                              |
|                                                          | Demountable defences                              | <ul style="list-style-type: none"> <li>Relatively low cost measure compared to alternatives.</li> <li>Setback so no ecology impacts.</li> </ul>                                                                                                                                                                                                                                  |
|                                                          | Flood gate                                        | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Limited ecology impacts.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                                                                                                                                                     |
|                                                          | Seawall (across slipway)                          | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Likely to have community support and potential for broader outcomes and placemaking opportunities.</li> </ul>                                                                                                                                                                                              |
| <b>ODU 3d<br/>Ship Inn</b>                               | Glass topped floodwall/glass wall                 | <ul style="list-style-type: none"> <li>Less of an impact on views from the Ship Inn compared to other options in this sub-unit.</li> <li>Low residual risk.</li> <li>Potential for broader outcomes/contributions.</li> </ul>                                                                                                                                                    |
|                                                          | Flip up floodwall (setback)                       | <ul style="list-style-type: none"> <li>Scored highly in ecology and stakeholder objectives.</li> <li>Viable alternative to a frontline scheme.</li> </ul>                                                                                                                                                                                                                        |
|                                                          | Demountable defences                              | <ul style="list-style-type: none"> <li>A low cost approach.</li> <li>Scored highly in ecology and technical feasibility.</li> </ul>                                                                                                                                                                                                                                              |
| <b>ODU 3e<br/>Fenced area adjacent to the Ship Inn</b>   | Glass topped setback floodwall and floodgate      | <ul style="list-style-type: none"> <li>Scored highly in ecology, technical feasibility and design life.</li> <li>Likely to be supported by stakeholders.</li> </ul>                                                                                                                                                                                                              |
|                                                          | Flip up floodwall                                 | <ul style="list-style-type: none"> <li>Reduced landscape impact compared to alternatives.</li> <li>Scored highly in ecology and landscape.</li> </ul>                                                                                                                                                                                                                            |
|                                                          | Demountable defences                              | <ul style="list-style-type: none"> <li>Relatively low cost compared to alternatives.</li> <li>Scored highly in ecology and landscape.</li> </ul>                                                                                                                                                                                                                                 |
| <b>ODU 3f<br/>Coastal footpath</b>                       | Setback floodwall and boardwalk                   | <ul style="list-style-type: none"> <li>Likely to be supported by the community as the use of a boardwalk would improve access.</li> <li>Scored highly in broader outcomes, technical feasibility.</li> </ul>                                                                                                                                                                     |
|                                                          | Reinforce/replace de-facto defences (garden wall) | <ul style="list-style-type: none"> <li>Little change to the frontage. Likely to be supported by stakeholders and the community.</li> <li>Scored highly in landscape, ecology and heritage.</li> <li>Potential technical difficulties in reinforcing the existing de-facto defences. However, a replacement on their existing alignments is technically feasible.</li> </ul>      |
| <b>ODU 3g<br/>Private Green/grassed area in front of</b> | Glass crest raising and refurb wall               | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Low residual risk.</li> <li>Long design life.</li> </ul>                                                                                                                                                                                                                                                   |
|                                                          | Setback floodwall and boardwalk                   | <ul style="list-style-type: none"> <li>Likely to be supported by the community as the use of a boardwalk would improve access .</li> </ul>                                                                                                                                                                                                                                       |

| ODU sub-unit                                                                | Measure                                                      | Key reasons for selection                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>heritage buildings</b>                                                   |                                                              | <ul style="list-style-type: none"> <li>Scored highly in broader outcomes and technical feasibility.</li> <li>Low residual risk.</li> </ul>                                                                                                      |
|                                                                             | Self raising floodwall and refurb wall                       | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Little impact on heritage and landscape as the wall would not be visible when not deployed.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul> |
|                                                                             | Flip up floodwall                                            | <ul style="list-style-type: none"> <li>Scored highly in ecology, heritage and landscape.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                          |
|                                                                             | Demountable defences                                         | <ul style="list-style-type: none"> <li>Relatively low-cost approach compared to alternatives.</li> <li>Scored highly in ecology and landscape.</li> </ul>                                                                                       |
| <b>ODU 3h Coastal footpath</b>                                              | Setback floodwall and boardwalk                              | <ul style="list-style-type: none"> <li>Likely to be supported by the community as the use of a boardwalk would improve access.</li> <li>Scored highly in broader outcomes and technical feasibility.</li> <li>Low residual risk.</li> </ul>     |
|                                                                             | Reinforce/replace de-facto defences (garden wall)            | <ul style="list-style-type: none"> <li>Little change to the frontage. Likely to be supported by stakeholders and the community.</li> <li>Scored highly in landscape, ecology and heritage.</li> </ul>                                           |
| <b>ODU 3i Coastal footpath immediately in front of residential building</b> | Setback floodwall and boardwalk                              | <ul style="list-style-type: none"> <li>Likely to be supported by the community as the use of a boardwalk would improve access.</li> <li>Scored highly in broader outcomes and technical feasibility.</li> <li>Low residual risk.</li> </ul>     |
|                                                                             | Demountable defences                                         | <ul style="list-style-type: none"> <li>Relatively low-cost approach compared to alternatives.</li> <li>Setback so no ecology impacts.</li> </ul>                                                                                                |
|                                                                             | Flood proof building                                         | <ul style="list-style-type: none"> <li>Little change to the frontage. Likely to be supported by stakeholders and the community.</li> <li>Scored highly in landscape, ecology and heritage.</li> </ul>                                           |
| <b>ODU 3j Slipway at Langstone High Street</b>                              | Flip up floodwall                                            | <ul style="list-style-type: none"> <li>Technically feasible</li> <li>Limited ecology impact</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                       |
|                                                                             | Demountable defences                                         | <ul style="list-style-type: none"> <li>Relatively low-cost approach compared to alternatives.</li> <li>Setback so no ecology impacts.</li> </ul>                                                                                                |
|                                                                             | Flood gate                                                   | <ul style="list-style-type: none"> <li>Technically feasible.</li> <li>Limited ecology impact.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                     |
| <b>ODU 3k Royal Oak and footpath</b>                                        | Frontline glass crested flood wall                           | <ul style="list-style-type: none"> <li>Sufficient space and footpath access maintained.</li> <li>Low residual risk once constructed.</li> <li>May require further investigation to assess options.</li> </ul>                                   |
|                                                                             | Flip up floodwall                                            | <ul style="list-style-type: none"> <li>Scored highly in ecology, heritage and landscape.</li> <li>Likely to be supported by stakeholders and the community.</li> </ul>                                                                          |
|                                                                             | Reinforce/replace de-facto defences and flood proof building | <ul style="list-style-type: none"> <li>Little change to the frontage. Likely to be supported by stakeholders and the community.</li> <li>Scored highly in landscape, ecology and heritage.</li> </ul>                                           |
| <b>ODU 3l Potential tie in location to high ground</b>                      | Setback floodwall                                            | <ul style="list-style-type: none"> <li>Scored highly on ecology, technical feasibility and stakeholder objectives.</li> <li>Low residual risk and a long service life.</li> </ul>                                                               |
|                                                                             | Earth embankment (tie in section only)                       | <ul style="list-style-type: none"> <li>Scored highly in a number of categories including ecology, residual risk and stakeholder objectives.</li> <li>Likely to have a long service life.</li> </ul>                                             |

Other measures were also assessed for each ODU but were scoped out for various reasons. **Table 4.4** summarises the 'Improve' options scoped out of further assessment for ODU sub-units 3a to 3l.

**Table 4.4: Options scoped out of further assessment for ODU sub-units 3a to 3l.**

| Measure                                                     | Sub-units considered           | Sub-units scoped out   | Key reasons for scoping out                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------|--------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Crest raising and refurb of existing walls (where required) | 3b, 3d, 3f, 3g, 3h, 3i, 3k     | All                    | <ul style="list-style-type: none"> <li>Scored poorly in a number of categories.</li> <li>Mostly likely to impact local landscape and heritage.</li> <li>Unlikely to be supported by stakeholder or the local community due to perceived loss of connection and access to the foreshore.</li> <li>Significant space constraints in some areas (notably 3f and 3h).</li> </ul>                                 |
| Setback floodwall                                           | 3b, 3d, 3f, 3g, 3h, 3k, 3l     | 3d, 3f, 3g, 3h, 3k     | <ul style="list-style-type: none"> <li>Scored poorly in a number of categories.</li> <li>Unlikely to be supported by the Ship Inn owners (3d).</li> <li>Significant space constraints in some areas (notably 3f and 3h).</li> <li>Visually obstructive to listed buildings in 3g.</li> <li>Unlikely to be visually or environmentally acceptable in 3k. Potential heritage and landscape impacts.</li> </ul> |
| Glass topped floodwalls/crest raising                       | 3b, 3d, 3e, 3f, 3g, 3h, 3i, 3k | 3f, 3h, 3i             | <ul style="list-style-type: none"> <li>Scored poorly on heritage and landscape impacts.</li> <li>Technically unfeasible due to space constraints.</li> <li>Unlikely to be supported by stakeholders or the community due to loss of footpath access and foreshore accessibility.</li> </ul>                                                                                                                  |
| Setback floodwall and advance the line walkway              | 3f, 3h, 3i, 3k                 | All                    | <ul style="list-style-type: none"> <li>Significant detrimental impact on ecology that cannot be mitigated.</li> </ul>                                                                                                                                                                                                                                                                                        |
| Setback floodwall and board walk                            | 3f, 3g, 3h, 3i, 3k             | 3k                     | <ul style="list-style-type: none"> <li>Potentially better solutions. Any shadowing on the foreshore caused by a boardwalk is likely to be viewed as avoidable and not necessary.</li> <li>Potentially visually unacceptable to due important views from the Royal Oak across the harbour.</li> <li>Affects the heritage setting.</li> </ul>                                                                  |
| Self raising floodwall and refurb of existing wall          | 3b, 3d, 3f, 3g, 3h, 3i, 3k     | 3b, 3d, 3f, 3h, 3i, 3k | <ul style="list-style-type: none"> <li>Generally scores poorly in technical feasibility and relative cost.</li> <li>Potential public health and safety issues at 3b and 3d.</li> <li>Space constraints for the remaining ODU sub-units and underground services which would be difficult to implement and lead to high costs.</li> </ul>                                                                     |
| Flip up floodwalls                                          | 3a to 3k                       | 3f, 3h, 3i             | <ul style="list-style-type: none"> <li>Insufficient space along the footpath for both placing and deployment of the defences.</li> </ul>                                                                                                                                                                                                                                                                     |
| Demountable defences                                        | 3a to 3k                       | 3b, 3f, 3h, 3k         | <ul style="list-style-type: none"> <li>For 3b, 3f and 3h, more feasible measures are available. This measure</li> </ul>                                                                                                                                                                                                                                                                                      |

| Measure                               | Sub-units considered               | Sub-units scoped out | Key reasons for scoping out                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------|------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                       |                                    |                      | <p>scored poorly on residual flood risk and maintenance.</p> <ul style="list-style-type: none"> <li>For 3k, this measure is not considered technically feasible and the residual risk of failure could be high. Difficult to store approximately 100m of demountable defence on site.</li> </ul>                                                                            |
| Seawall                               | 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i, 3k | 3b and 3d to 3k      | <ul style="list-style-type: none"> <li>Scored poorly across the vast majority of sub-units, with a red classification for ecology, heritage, landscape, stakeholder, community and cost categories.</li> <li>Could fundamentally change the character of the area, potentially encroach into environmental designations, lead to a loss of access and be costly.</li> </ul> |
| Sheet piling                          | 3b, 3d, 3e, 3f, 3g, 3h, 3i, 3k     | All                  | <ul style="list-style-type: none"> <li>Scored poorly on a number of categories, including ecology, heritage, landscape, community and cost.</li> <li>Similar impacts expected as the seawall measure above.</li> </ul>                                                                                                                                                      |
| Property Level Protection /Resilience | 3d, 3e, 3f, 3g, 3h, 3i, 3k         | All                  | <ul style="list-style-type: none"> <li>Scored poorly across a number of categories.</li> <li>The residual risk of flooding is likely to remain high after implementation.</li> <li>High operational requirements and pre-planning required in deploying these defences.</li> </ul>                                                                                          |
| Temporary defences                    | 3a to 3k                           | All                  | <ul style="list-style-type: none"> <li>Other measures more suitable, robust and reliable.</li> <li>High operational requirements and pre-planning to deploy defences.</li> </ul>                                                                                                                                                                                            |
| Vegetated buffer zones                | 3f, 3g, 3h, 3i, 3k                 | All                  | <ul style="list-style-type: none"> <li>Do not provide protection against inundation from still water levels.</li> </ul>                                                                                                                                                                                                                                                     |
| Embankment                            | 3e, 3l                             | 3e                   | <ul style="list-style-type: none"> <li>Not technically feasible in 3e due to space constraints.</li> <li>Potential impacts to the landscape.</li> <li>Unlikely to be supported by the community.</li> </ul>                                                                                                                                                                 |
| Land raising                          | 3b                                 | 3b                   | <ul style="list-style-type: none"> <li>Other measures are more feasible.</li> <li>Scored poorly on relative cost.</li> <li>Potential opposition to this measure from stakeholders.</li> </ul>                                                                                                                                                                               |

### *Potential alignments*

Potential alignments of the short-listed measures for each sub-unit were identified. **Figure 4.8** illustrates the potential alignments for ODU sub-units 3a to 3e and **Figure 4.9** illustrates the potential alignments for ODU sub-units 3f to 3l. Each figure includes photographs of similar sites around the country, which give an indication of what the defence measures could potentially look like. Note that ODU3b has two potential alignments, on the Quay or set back crossing the car park area.

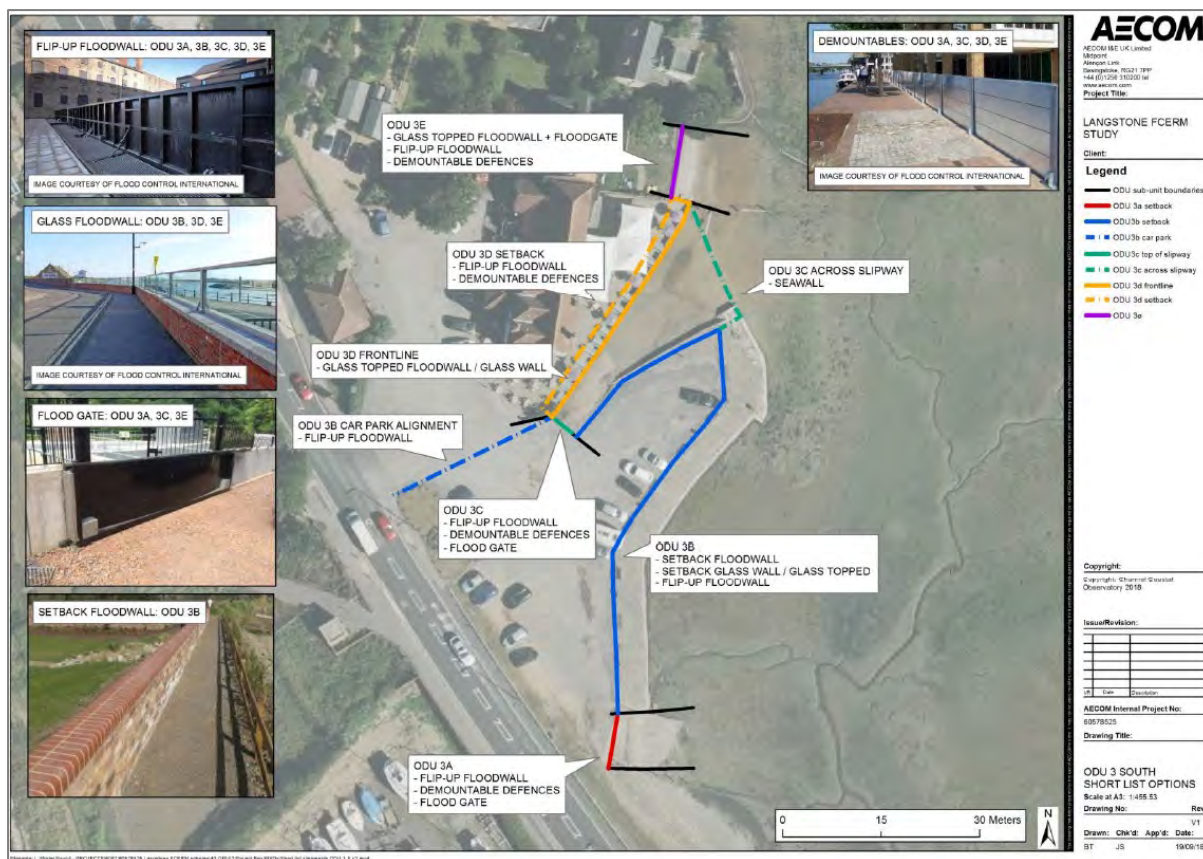


Figure 4.8: Potential alignments and short list measures for Sub-units ODU 3a-3e.



Figure 4.9: Potential alignments and short list measures for Sub-units ODU 3f-3l.

#### 4.2.2.4 ODU 4 – Mill and Mill Pond

ODU 4 extends from the Mill to the eastern end of the study frontage. This ODU was broken down into two sub-units; ODU 4a and 4b, the extents of which are illustrated on **Figure 4.10**.



**Figure 4.10: ODU 4 sub-unit extents.**

**Table 4.5** provides details of the short-listed options for ODU4 and the key reasons for their selection. The options shown facilitate an 'Improve' SoP option.

In addition to the reasons for selection, the potential impact that each short-listed option may have on compliance with the Habitat Regulations has also been included in **Table 4.5**. This assessment was based on the multivariate process findings and consideration of the ecology objectives. Note: green rows highlight where the proposed measure has a high likelihood of Habitats Regulations compliance.

**Table 4.5: Draft short list measures for ODU 4.**

| ODU sub-unit   | Measure                              | Key reasons for selection                                                                                                                                                          |
|----------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ODU 4a<br>Mill | Demountable defences                 | <ul style="list-style-type: none"> <li>Relatively low cost.</li> <li>Setback, limited ecological impact.</li> </ul>                                                                |
|                | Setback floodwall                    | <ul style="list-style-type: none"> <li>Included due to lack of alternatives.</li> <li>Setback limited ecological impact.</li> <li>Low residual risk after construction.</li> </ul> |
|                | Property level protection/resilience | <ul style="list-style-type: none"> <li>Low ecology and landscape impacts.</li> <li>Relatively low cost.</li> </ul>                                                                 |

| ODU sub-unit       | Measure                                 | Key reasons for selection                                                                                                                                                                                  |
|--------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    |                                         | <ul style="list-style-type: none"> <li>Would need to be combined with a formal defence elsewhere to ensure flood water cannot pass through the Mill area and flood other parts of the frontage.</li> </ul> |
| ODU 4b<br>Footpath | Setback floodwall                       | <ul style="list-style-type: none"> <li>Scored highly in ecology.</li> <li>Low residual risk and long option life.</li> </ul>                                                                               |
|                    | Crest raising and scheduled maintenance | <ul style="list-style-type: none"> <li>Scored highly in erosion risk and technical feasibility.</li> <li>Low residual risk.</li> </ul>                                                                     |
|                    | Setback floodwall and boardwalk         | <ul style="list-style-type: none"> <li>Scored highly in broader outcomes and technical feasibility.</li> <li>Low residual risk.</li> </ul>                                                                 |

Other measures were also assessed for ODU4 but were scoped out for various reasons. **Table 4.6** summarises the 'Improve' options scoped out of further assessment for ODU sub-unit 4b (no additional measures were considered for sub-unit 4a).

**Table 4.6: Options scoped out of further assessment for ODU sub-unit 4b.**

| Measure                                            | Key reason(s) for scoping out                                                                                                                                                                                                                                                                 |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sheet piling                                       | <ul style="list-style-type: none"> <li>Scored poorly for the ecology, heritage, landscape, stakeholder, community and cost categories.</li> <li>Could fundamentally change the character of the area, encroach into designated sites, lead to loss of access and be costly.</li> </ul>        |
| Glass topped floodwalls/crest raising              | <ul style="list-style-type: none"> <li>A glass structure does not score higher in the multivariate categories compared to a traditional set back wall.</li> <li>High cost.</li> </ul>                                                                                                         |
| Self-raising floodwall and refurb of existing wall | <ul style="list-style-type: none"> <li>Scored poorly in relative cost. Less costly and technically challenging measures are recommended.</li> </ul>                                                                                                                                           |
| Flip-up flood wall                                 | <ul style="list-style-type: none"> <li>Scored poorly in maintenance due to the length of defence that would be required and therefore the significant resources that would be required to deploy the defences.</li> </ul>                                                                     |
| Setback floodwall and advance the line walkway     | <ul style="list-style-type: none"> <li>Significant detrimental impacts to ecology.</li> </ul>                                                                                                                                                                                                 |
| Demountable defences                               | <ul style="list-style-type: none"> <li>Scored poorly in maintenance due to the length of defence that would be required and therefore the significant resources that would be required to deploy the defences.</li> </ul>                                                                     |
| Seawall                                            | <ul style="list-style-type: none"> <li>Scored poorly in ecology, heritage, landscape, stakeholder, community and cost categories.</li> <li>Could fundamentally change the character of the area, encroach into designated sites, lead to a loss and access and be costly.</li> </ul>          |
| Footpath raising                                   | <ul style="list-style-type: none"> <li>Scored poorly in cost. Existing footpath is likely to require reinforcement in order to support additional height.</li> <li>Perceived connection and access to the foreshore could reduce.</li> </ul>                                                  |
| Temporary defences                                 | <ul style="list-style-type: none"> <li>Other measures are more suitable and provide a more robust, reliable defence against flooding.</li> <li>Scored poorly in the maintenance category due to high operational requirements and pre-planning required in deploying the defences.</li> </ul> |

## Potential alignments

Potential alignments of the shortlisted measures for each sub-unit were identified. **Figure 4.11** illustrates the potential alignments for ODU sub-units 4a and 4b. **Figure 4.11** includes photographs of similar sites around the country, which give an indication of what the defence measures could potentially look like.

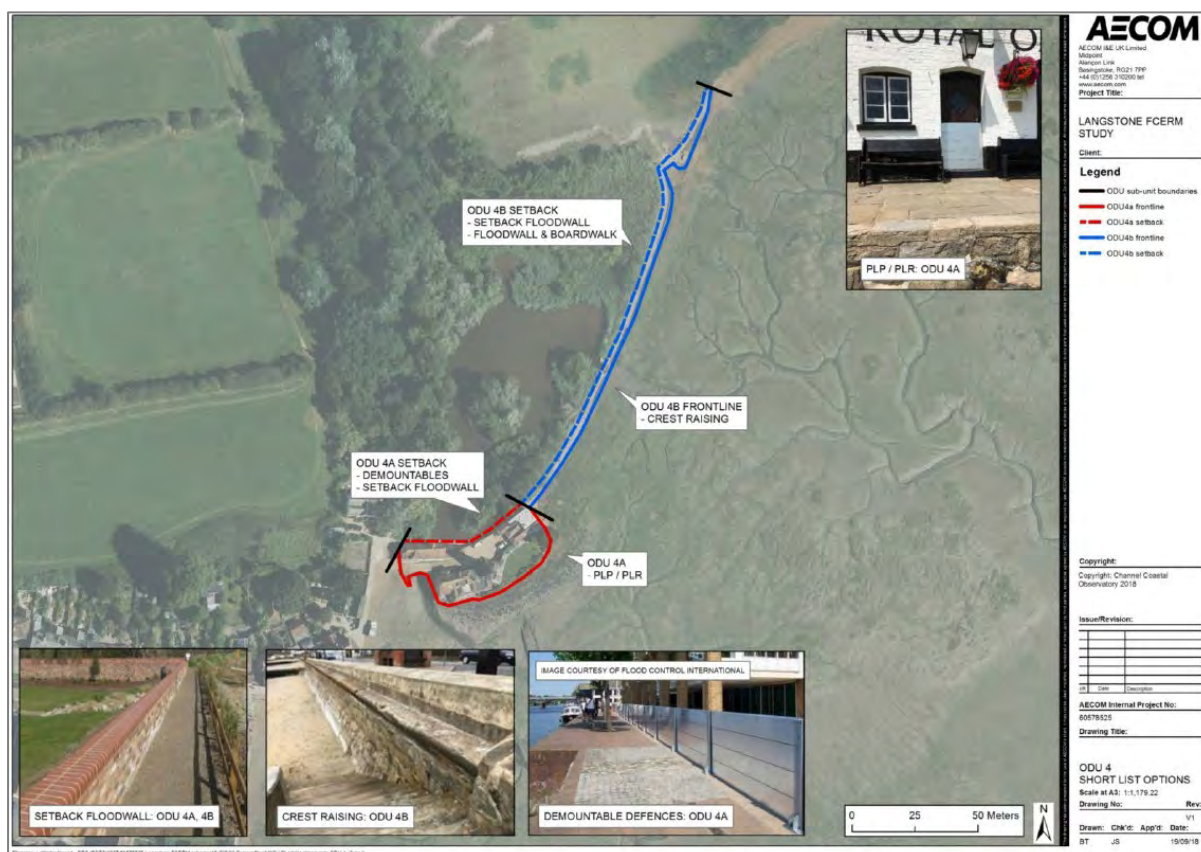


**Figure 4.11: Potential alignments and short list measures for ODU 4 sub-units.**

### 4.2.2.5 Frontage wide approaches

As mentioned in **Section 4.2.1**, frontage wide measures were considered during the long listing of options. The options considered were tidal flood barrier, tidal lagoon and property level protection/resilience. In addition, the frontage wide measure of road raising was identified as a potential opportunity during the short list stage. A summary of each of the frontage wide options considered at the short-listing stage is included in **Table 4.7** below.

**Table 4.7: Summary of the frontage wide approaches considered during the short list stage.**

| Frontage wide measure | Summary and further recommendations during the short list stage                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Road raising          | <ul style="list-style-type: none"> <li>Could be used along the A3023 (Langstone Road) to split the flood cell in two and used alongside a primary defence in another location to prevent 'backdoor' flooding and outflanking of the new primary defence.</li> <li>Provides potential benefits e.g., providing increased level of protection to the roadway itself.</li> <li>An expensive approach and would cause widespread disruption during construction to the A3023 with no alternative access available.</li> </ul> |

| Frontage wide measure                | Summary and further recommendations during the short list stage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      | <ul style="list-style-type: none"> <li>• In isolation it would only seek to protect the road, with limited property benefit.</li> <li>• A primary defence along the Langstone frontage is the preferred outcome, however road raising could be considered if primary defences could not be justified.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Tidal flood barrier                  | <ul style="list-style-type: none"> <li>• This measure was suggested during early consultation with the community.</li> <li>• A tidal barrier could be located in various locations e.g., the entrance to Langstone and Chichester Harbours.</li> <li>• The width of the barrier is key in determining the cost and feasibility of it. The width would need to be approx. 300m wide for Langstone Harbour entrance (approx. £500m to 1bn in cost) and in excess of 1.1km wide for the Chichester Harbour entrance (billions of pounds).</li> <li>• Unfeasible due to cost, plus navigation issues, significant environmental impacts, residual fluvial flood risk, geomorphology impacts and security issues.</li> <li>• Scoped out of further consideration.</li> <li>• Further information here: <a href="https://coastalpartners.org.uk/project/community-proposed-options-120">https://coastalpartners.org.uk/project/community-proposed-options-120</a></li> </ul> |
| Tidal lagoon                         | <ul style="list-style-type: none"> <li>• Would involve the construction of a ring of impermeable offshore breakwaters to create a sheltered lagoon which would protect from tidal surge and waves.</li> <li>• Very high cost solution which would likely exceed the benefits. Not feasible from a funding perspective and unlikely to be supported by stakeholders when less costly approaches are feasible.</li> <li>• Significant impacts to environmentally designated sites. Consent unlikely to be granted from key stakeholders.</li> <li>• Will likely significantly change the character of the foreshore and frontage.</li> <li>• Scoped out of further consideration</li> </ul>                                                                                                                                                                                                                                                                              |
| Property level protection/resilience | <ul style="list-style-type: none"> <li>• This measure has been considered in a number of the ODU sub-units but was scoped out of all sub-units except for 4a (the Mill – see <b>Table 4.5</b>).</li> <li>• This measure is only deemed a suitable approach up to flood depths of approx. 0.6m. Flood depths are likely to exceed the 0.6m level more frequently in the future (due to sea level rise).</li> <li>• Not considered to be a suitable long-term approach as a frontage wide measure.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

#### 4.2.2.6 Next steps

Following on from the short-listing stage, further work was undertaken to develop the short listed options, including, but not limited to, developing costs, undertaking an economic and benefits assessment, undertaking a comprehensive environmental appraisal and appraising the short list options in line with FCERM appraisal guidance. **Section 4.2.3** provides information regarding this next stage.

#### 4.2.3 Leading options

The short-listing stage, as describe in **Section 4.2.2**, identified a range of options for each ODU and ODU sub-unit. Several different defence measures were identified on the short list. Further appraisal work was undertaken to identify the leading option from the short list for each ODU / ODU sub-unit, a summary of which in included below.

#### 4.2.3.1 Basis for selecting the leading options

Outlined in the FCERM appraisal guidance (FCERM-Ag) are five stages which outline the process of the selection of the leading options.

- **Stage 1 – Establish the whole life costs and benefits of the short list options.** Each option taken forward has an Average Benefit Cost Ratio (ABCR) >1.
- **Stage 2a – Organise the options.** The options are organised by their standard of protection. If two or more options provide the same standard of protection, then the options should be organised by ABCR.
- **Stage 2b – Identify the leading economic option.** Once the options are organised, the decision process is started by selecting the option with the highest ABCR. Following this, the Incremental Benefit Cost Ratio (IBCR) between options helps to decide how far the probability of flooding can be reduced.
- **Stage 3 – Accounting for contributions.** Consider any financial contributions which may have been secured and the impact this has on the ABCR and IBCR of options and the choice of the leading economic option (as identified in stage 2b).
- **Stage 4 – Testing uncertainty.** Undertake sensitivity tests to determine whether uncertainty would influence the choice of the leading economic option e.g., would significant cost increases/decreases largely alter the ABCR or IBCR and therefore the leading option?
- **Stage 5 – Consider other factors to determine if an alternative option would be preferred.** E.g., costs and benefits of delivering more of the objectives, providing enhancements, or approaches that are adaptable to future changes in risk. Factors could also include both monetised and non-monetised benefits and the sustainability of an option should be considered. Wider factors include:
  - o Environmental impacts e.g., ecology, landscape, and heritage
  - o Social impacts (information regarding consultation and engagement can be found in ES Chapter 5 (Consultation))
  - o Technical feasibility
  - o Cost comparison
  - o Option scoring/ranking

This stage is important to ensure that the recommended leading option is supported by the stakeholders involved in the project.

#### 4.2.3.2 Short List option appraisal

Each of the short-listed options for each ODU sub-unit were compared to a Do Nothing scenario. Depending on the impact of the short list options relative to a Do Nothing scenario, scores were assigned to each for the environmental, social, technical and cost categories. Further information on the scoring criteria and ranking of the short list options can be viewed in the 'Preferred Options Report' which can be found on the Coastal Partners website via the following link: <https://coastalpartners.org.uk/static/media/resources/langstone-preferred-option-report.pdf>.

Following the scoring and ranking of the short list options for each sub-unit, a leading option for each sub-unit was identified as shown in **Table 4.8**.

**Table 4.8: Leading option identified for each ODU sub-unit.**

| ODU sub-unit | Leading option                                                          |
|--------------|-------------------------------------------------------------------------|
| 2b           | Setback floodwall (north section) and earth embankment (south section)  |
| 2c           | Flood gate or a setback floodwall (depending on SoP required)           |
| 3a           | Flood gate                                                              |
| 3b           | Flip-up floodwall across car park and setback floodwall (south section) |
| 3c           | Flood gate                                                              |
| 3d           | Floodwall with glass top                                                |
| 3e           |                                                                         |
| 3f           | Floodwall with boardwalk                                                |
| 3g           |                                                                         |
| 3h           |                                                                         |
| 3i           | Flood proof residential building                                        |
| 3j           | Flood gate                                                              |
| 3k           | Frontline floodwall                                                     |
| 3l           | Setback floodwall (footpath section) and earth embankment (field area)  |
| 4a           | Demountable defences<br>Property level protection                       |
| 4b           | Setback floodwall                                                       |

#### 4.2.3.3 Scheme alignments

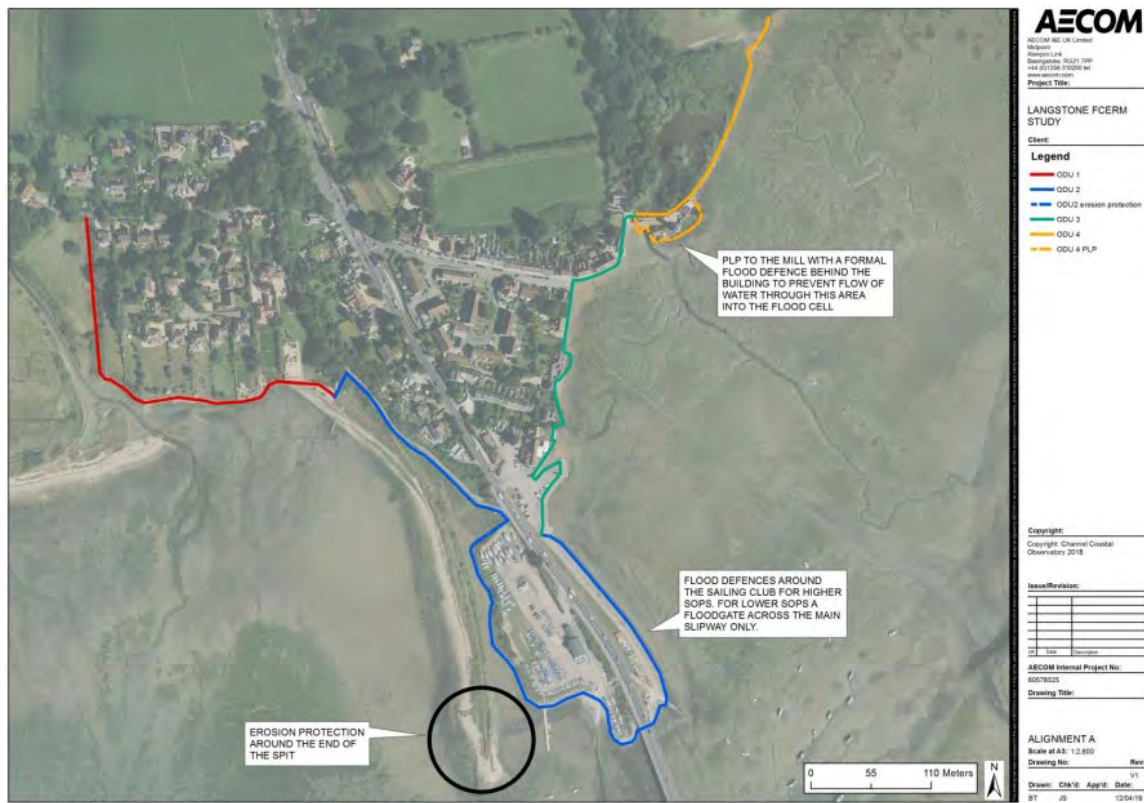
As described in **Section 4.2.2.1**, various alignments were considered during the shortlisting stage. Additional alignments were also explored alongside the selection of the leading option for each ODU sub-unit. Four potential alignments were identified whereby the leading options in **Table 4.8** could be combined. The alignments put forward considered the number of properties each would protect, cost, environmental impact and stakeholder objectives/ community aspirations. The following alignments were considered and are illustrated on **Figure 4.12**.

- Alignment A – a defence around the full length of the frontage, including the protection of all ODUs.
- Alignment B – a defence for ODUs 1-3 but excluding ODU 4 from the benefit area.
- Alignment C – a defence between ODUs 2-3, excluding ODUs 1 and 4 from the benefit area.
- Alignment D – same alignment as Alignment C, except for at the Ship Inn car park in ODU 3b, where the alignment goes across the car park rather than around the front edge (excluding ODU3a and 3c).

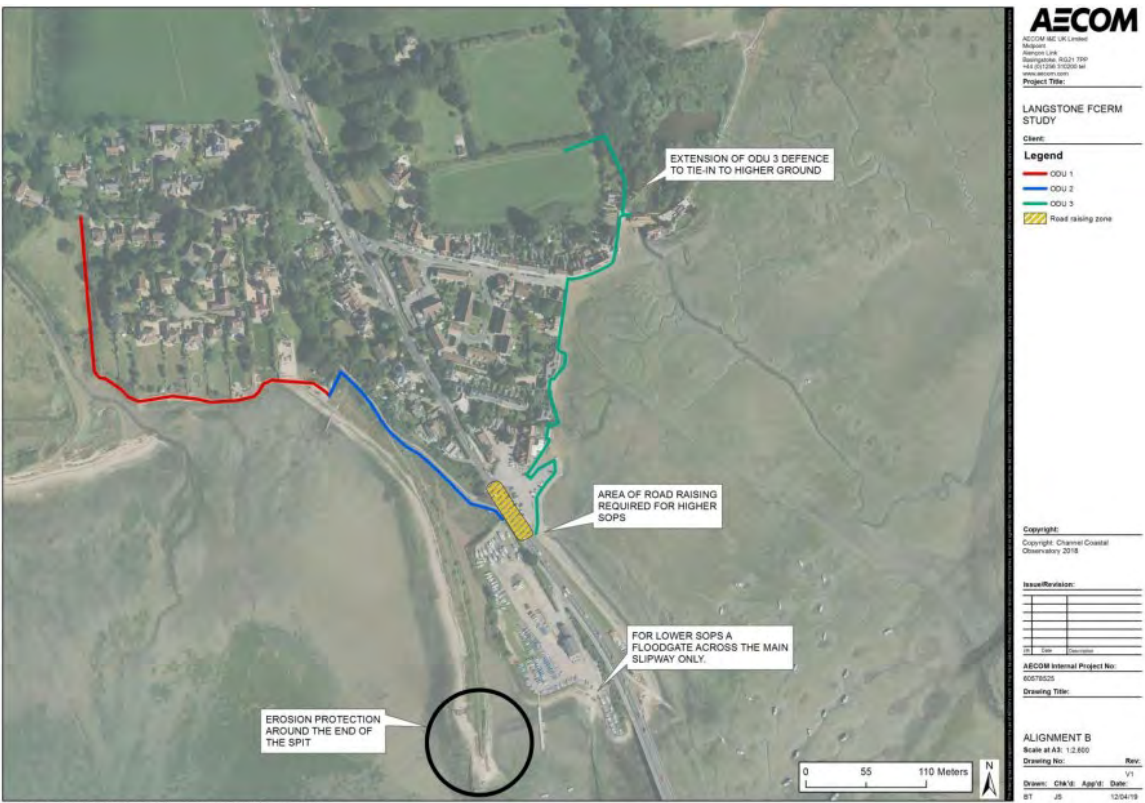
At this stage **Alignment D** (spanning ODU 2 and 3) was chosen as the leading alignment for the core scheme as this resulted in the lowest cost.

Sub-unit 2c (Sailing Club) was not considered further as this fell outside of the core scheme alignment.

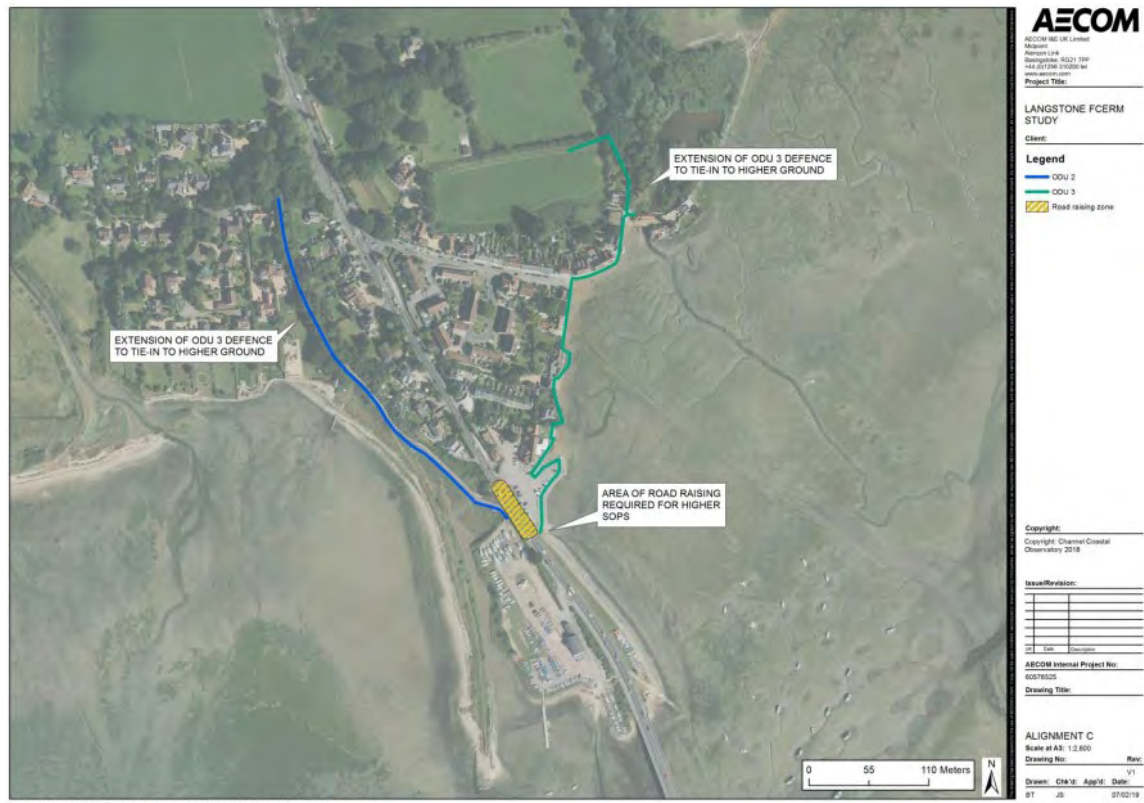
### Alignment A



### Alignment B



### Alignment C



### Alignment D – selected as the Leading Alignment for core scheme



Figure 4.12: Potential scheme alignments.

## 4.3 Outline design

Following on from the selection of the leading options for each ODU sub-unit and the leading scheme alignment, further work was undertaken to develop the leading options, determine the required defence heights, optimise the alignments, identify risks throughout construction and operation and undertake buildability and cost estimates for the scheme. The detail of the outline design can be found in the Outline Design and Criteria Decision Report, which is available as **Appendix H1** to the ES.

The following sections provide a summary of the key points, as detailed in the report.

### 4.3.1 Core Scheme and Additional Scheme

As noted in **Section 4.1**, and **ES Chapter 1 (Introduction)**, the scheme has been split into the 'core' and 'additional' schemes. The core scheme only is being taken forward at this time, however **Figure 4.13** illustrates the two schemes and the ODU sub-units. Additional information can also be found on the Coastal Partners website via the following link: <https://coastalpartners.org.uk/project/core-and-additional-scheme/>.



**Figure 4.13: Core Scheme (solid lines) and Additional Scheme (dashed lines) alignments and ODU sub-units**

### 4.3.2 Core Scheme Outline Design

Following the identification of the leading options for each ODU sub-unit as listed in **Table 4.8** and summarised in **Figure 4.13**, additional work was undertaken to develop the leading

options further. Below is a summary of the frontages where further considerations or changes were made, as a result of this.

#### 4.3.2.1 Sub-unit 2b

The leading option for sub-unit 2b was revised along the northern section, from a setback floodwall to raising the level of the footpath. This change was made due to the required increase in levels being less than originally expected, therefore significant vegetation clearance is no longer required. The raised footpath follows the alignment of the existing footpath and will taper down at the northern and southern ends to tie into the existing levels of the footpath.

The proposed alignment of the earth embankment along the southern section makes use of the existing raised ground, and at the northern end no raising would be required, as the existing ground level is above the design level. At the southern end, the embankment ties into the edge of the pavement at the A3023.

#### 4.3.2.2 Sub-unit 3b

A topographic survey confirmed the need to extend the western end of the flood defence to the south, parallel with the road. This is to prevent floodwater flowing over the southwest edge of the car park reaching Langstone Road. Given the high unit cost, the outline design indicated that the flip up barrier should span the shortest distance possible from the end of the Ship Inn existing wall to the edge of the grass area to the south of the entrance. To reduce the length of the flip up barrier, the outline design increased the length of the adjacent floodwall.

#### 4.3.2.3 Sub-units 3f, 3g and 3h

Due to the existing narrow footpath in this location which cuts between Green Cottage and the Green, plus the proposed seawall contributing to narrowing the footpath further, the inclusion of a boardwalk formed part of the leading option and outline design at this stage. The alignment of the proposed seawall was aligned to the footpath, except for in front of Green Cottage where the wall followed a new alignment around The Green (and existing seawall) to reduce the visual impact on the listed building. The alignment of the boardwalk extended seawards from this, overhanging the foreshore to avoid encroachment, as shown in **Figure 4.14**.



**Figure 4.14: Sketch plan of the outline design seawall and boardwalk alignment at Green Cottage**

The Outline Design also considered an alternative alignment around Green Cottage with the seawall further landward on the alignment of the existing footpath, with the new footpath placed over the existing land to remove any encroachment of the new sea wall or timber

boardwalk on the environmentally designated foreshore. However, further investigation was required to understand the viability of this option due to private ownership of the land in front of Green Cottage and consequent exclusion from this land. This is discussed further in **Section 4.4.1** below.

#### 4.3.2.4 Sub-unit 3i

The leading option for this sub-unit was to use the current property as the flood defence. The Outline Design and Criteria Decision report recommended that further investigation of the existing building was required to confirm if use of the property as a flood defence is appropriate. If the use of the building is not appropriate, the Outline Design included the option to extend the leading option in sub-units 3f to 3h to 3i i.e., a floodwall with a boardwalk.

#### 4.3.2.5 Sub-unit 3j

The proposed position of the flood gates in the Outline Design was approximately 3m in from the edge of Langstone High Street. The position of the gates along the alignment of the existing timber posts (i.e., further seaward) was reviewed however, this would mean the gates would be located near the Mean High Water Springs (MHWS) level and the risk of build-up of debris could interfere with the operation of the gates (therefore preventing the gates being closed safely in a flooding event). **Figure 4.15** illustrates the alignment proposed at Outline Design, as well as how this would tie into the adjacent ODU sub-units.

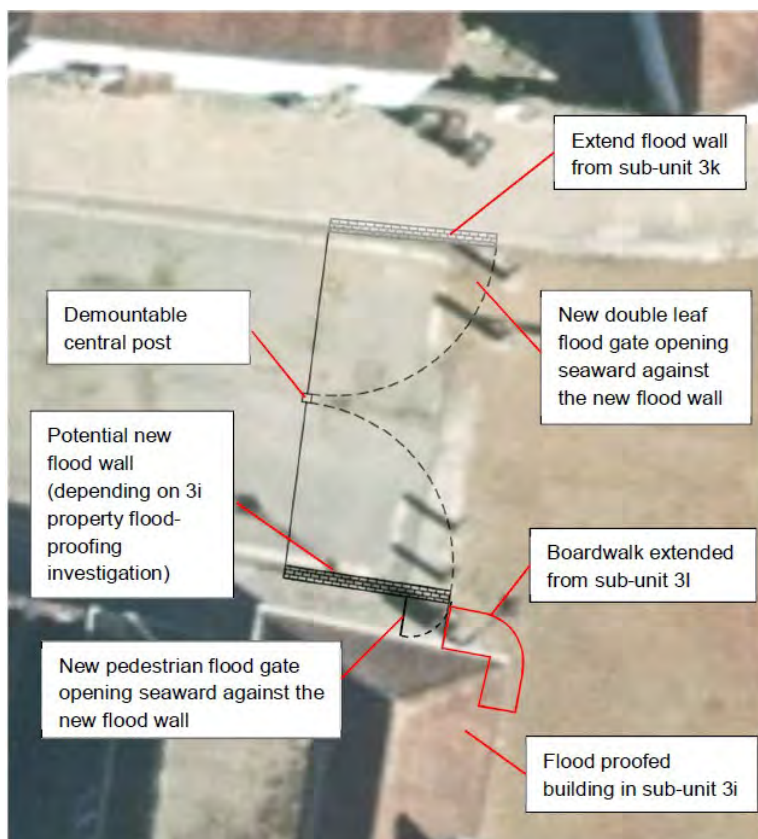


**Figure 4.15: Sub-unit 3j potential flood gate alignment**

#### 4.3.2.6 Sub-unit 3k

During Outline Design, the leading option for the Royal Oak was revised from a sheet piled wall to a parapet wall. At the options appraisal stage it was assumed that the existing wall was not suitable to support another structure, and any new structure would require significant foundations that would not be possible given the buried services that exist within the footpath. However, stability calculations and geometric checks that were undertaken as part of Outline Design confirmed that the parapet wall option was feasible without significant foundations. Despite this, further structural assessment of the existing wall was recommended to provide further certainty.

To maximise the width of the footpath, the alignment of the parapet option was proposed as being along the front of the existing seawall, however it noted that the final alignment will be dependent on further structural assessment of the existing wall. To avoid the existing wall foundations, the other flood defence option of a sheet piled wall would need to be offset from the existing wall.

#### 4.3.2.7 Sub-unit 3l

The leading option for this sub-unit during the outline design stage was a setback floodwall (footpath section) and earth embankment (field area). The alignment of the floodwall was designed to run along the private property boundary, which would result in a loss of 300mm to the property garden, however this alignment required further discussion with the property owner. Other alignments were considered, e.g., reducing the footpath width, however given the footpath is already extremely narrow, this could potentially lead to issues with accessibility to it.

The Outline Design included a flood gate across the footpath at the southern end of the sub-unit, which would connect to sub-unit 3k. To the northern end of the sub-unit, the earth embankment continued until it ties in with the appropriate existing ground level.

### 4.3.3 Alternative alignments considered at the Royal Oak (ODU 3k)

During public consultation events in 2020 (see ES **Chapter 5 (Consultation)** for further information), community feedback raised concerns regarding the leading option of a seawall along the Royal Oak frontage (sub-unit 3k). Key concerns related to impacts on views and heritage associated with a higher seawall. This led to further consultation on the options available specifically for this frontage.

A review of alternative alignments for the southern and northern sections was undertaken and the following alignments were considered:

Southern section:

- **Alignment 1:** This alignment consists of a deployable defence, such as a flood gate, across the pavement at the eastern end of the Old Winklemarket building to allow access onto the boardwalk section of the frontline defence. A flood wall along the edge of the pavement and a deployable defence, such as a flood gate or flip-up barrier, across Langstone High Street. A deployable defence would be required across the north pavement. If a flood gate is used it could swing out and be positioned against the new flood wall to the north when not deployed.

- **Alignment 2:** Similar to Alignment 1, this alignment consists of a deployable defence, such as a flood gate, across the pavement at the eastern end of the Old Winklemarket building and a flood wall along the edge of the pavement. Compared to Alignment 1, the deployable defence across Langstone High Street and the north pavement (either a flood gate or flip-up barriers) would be positioned further east. Another deployable defence would then be required across the driveway of Number 15 Langstone High Street. If a gate is used, this could swing back adjacent to the house when not deployed.
- **Alignment 3:** This alignment is again similar to Alignment 1, the only exception being the wall on the edge of the south pavement would be placed adjacent to the Old Winklemarket building and boundary wall and the deployable defence across the pavement would be placed further to the west. This would narrow the footpath but there would still be sufficient space for pedestrian and single file disabled access. There is less confidence in the technical viability of this alignment because placement of a floodwall adjacent to the Old Winklemarket building may risk the existing structure becoming unstable.
- **Alignment 4:** This alignment is similar to Alignment 2, the only exception being the wall on the edge of the south pavement would be placed adjacent to the Old Winklemarket building and boundary wall and the deployable defence across the pavement would be placed further to the west. As with Alignment 3, there is less confidence in the technical viability of this alignment due to the placement of the wall adjacent to the existing structure.

Northern section:

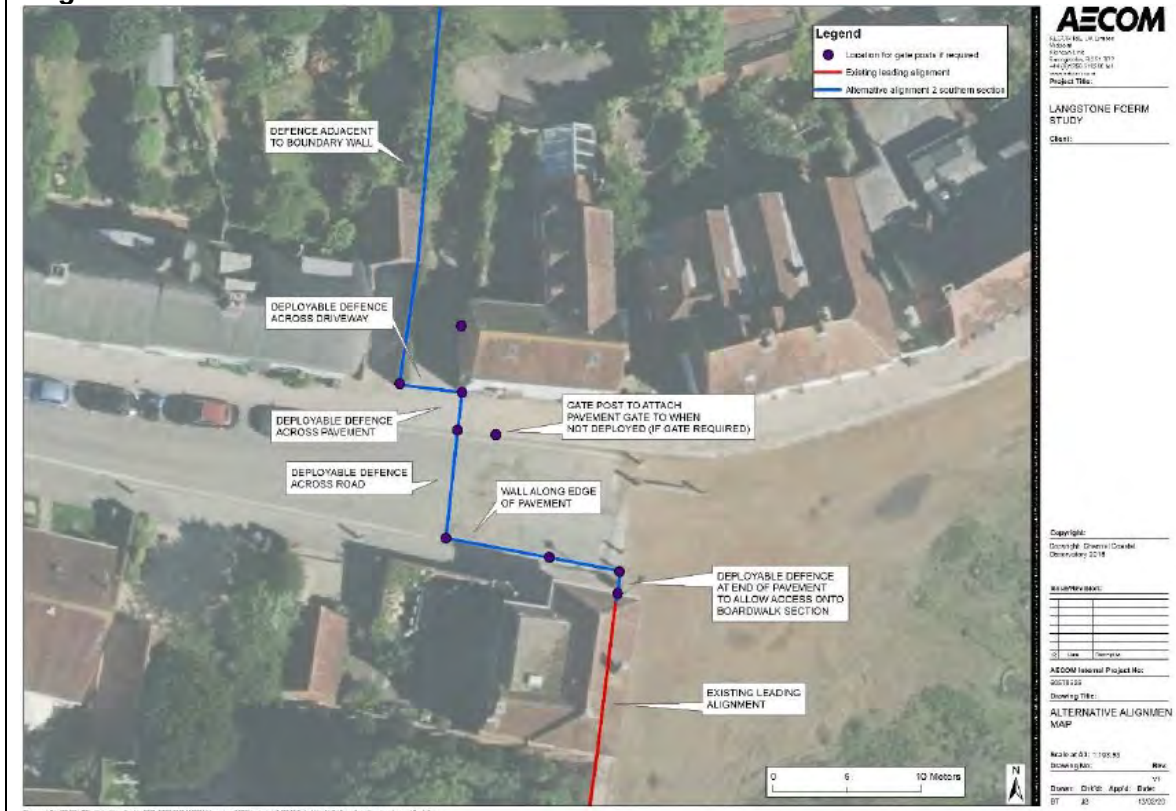
- **Alignment 1:** This alignment involves constructing a defence adjacent to the existing boundary wall and outbuildings between Number 14 and 15 Langstone High Street. At the end of the wall, the alignment passes into the field to the north, with the defence gradually tapering down in height relative to ground level until high ground is reached to tie in and provide the required standard of protection.
- **Alignment 2:** This alignment is similar to Alignment 1, with the only exception being in the field to the north where the alignment extends around the south side of the field to the end of the flood cell. This alignment is approximately 90m longer than Alignment 1 but would prevent a defence extending towards the centre of the field (as it does in Alignment 1) which may limit the field's uses.

The alignments described above are illustrated in **Figure 4.16** (southern section) and **Figure 4.17** (northern section).

### Alignment 1



### Alignment 2



### Alignment 3



### Alignment 4



Figure 4.16: Alternative alignments considered for the southern section of sub-unit 3k



**Figure 4.17: Alternative alignments considered for the northern section of sub-unit 3k.**

For each alignment, a technical, environmental, social and economic appraisal was undertaken for different defence types (flood gates, flip up barriers and demountable defences). The key considerations identified during the appraisal were:

- Buried utilities and services.
- Driveway access.
- Residual risk.
- Construction adjacent to existing buildings.
- Environmental considerations.
- Public/stakeholder opinion.
- Economic appraisal.

Based on the key considerations, Alignment 2 for the southern section was identified as the leading alignment. This avoided the need to construct immediately adjacent to the Old Winklemarket and minimised the impact to Number 15 Langstone High Street. For the northern section, Alignment 2 was identified as the leading option as this would potentially have a lesser impact on land use.

Following the appraisal of the alignment options, public consultation was carried out with the local community to clarify which alignment option (of the technically feasible ones) for the southern section was most supported by the community.

Further detail on this consultation is available here:

<https://coastalpartners.org.uk/news/langstone-alternative-alignment-options-report/>

Of the 109 responses to the survey, 61% of the responders preferred the existing leading option alignment, i.e., the defence alignment around the Royal Oak, rather than the alternative

alignments considered. This was largely since this alignment protects the greatest number of properties, provides protections of the heritage buildings of Langstone into the future and provides emergency access along the Quayside.

#### 4.3.4 Offshore breakwater – an alternative to the leading options

Following community engagement in 2019, an alternative option was put forward by a resident involving the creation of an offshore breakwater and flood gates on the eastern side of the village. An offshore breakwater was included as an option during the long list option appraisal stage but was discounted primarily on environmental and cost grounds. Despite this, the project team revisited the option to undertake further assessment to assess its viability, as described on the project webpages here: <https://coastalpartners.org.uk/project/community-proposed-options-120>.

In summary, the appraisal undertaken on this defence option highlighted the significant technical, social, environmental and cost issues associated with an offshore breakwater, and the decision was made to not progress this option any further for the following reasons:

##### **Technical:**

- Health and safety concerns associated with members of the public accessing the breakwater.
- Difficulties with accessing for maintenance and operation.
- Additional resource and training to operate and test the tidal gates.
- Defences west of Langstone village would still be required.

##### **Social:**

- Detrimental impacts to navigation.
- Potential risk of sedimentation in the area behind the structure
- Visual impacts from Langstone village.
- Landscape impacts to the Chichester Harbour Area of Outstanding Natural Beauty (AONB), now known as the Chichester Harbour National Landscape, and the Langstone Conservation Area.

##### **Environmental:**

- Significant detrimental impact on the intertidal habitats and ecological designations.
- Unlikely that the 'Imperative Reasons of Overriding Public Interest' (IROPI) could be used to justify this option as a viable alternative exists.
- There would be a requirement to deliver compensatory saltmarsh/mudflat habitat elsewhere to mitigate losses.
- Greater impact to Habitats of Principal Importance under S41 of the Natural Environment and Rural Communities (NERC) Act 2006 and species listed under Schedule 5 of the Wildlife and Countryside Act 1981.
- Contrary to the Local Plan policy to conserving biodiversity.

Consultation was undertaken with Natural England (NE) and Chichester Harbour Conservancy regarding the offshore breakwater proposal, in which both organisations confirmed that the option of an offshore breakwater would not be supported by them, and other alternative, less damaging solutions should be pursued.

##### **Costs:**

- The estimated cost is considerably greater than the leading options. At the time that the offshore breakwater option was considered further (2019), the costs were estimated to be the following:
  - o Construction costs £10-20 million.
  - o Maintenance costs over a 50 year period £5-10 million.
  - o Operational costs of the tidal gates would also be incurred.
- There would be an estimated shortfall of between £12-25 million.

## 4.4 Detailed Design

### 4.4.1 Review and Refinement of the Outline Design

During 2021 and early 2022, for the first stage of the detailed design process, further development and refinement of the outline design was undertaken incorporating information received from additional Ground Investigation works, Structural Investigation findings, more detailed utilities data, seepage analysis, community input, views of statutory consultees (including Natural England and the HBC Conservation Officer) and Early Contractor Involvement (ECI).

As part of the transition from Outline Design to Detailed Design, the Option Development Units (ODUs) used during the option appraisal work became Frontages for the detailed design work. **Table 4.9** below provides a summary of ODUs and frontages for ease of conversion.

**Table 4.9: A summary of ODUs used in option appraisal and frontages used in detailed design.**

| Option Development Unit (ODU)                                 | Frontage                                    |
|---------------------------------------------------------------|---------------------------------------------|
| 2b - National Cycle Route 2                                   | 1A – Billy Line North                       |
|                                                               | 2 – Billy Line South                        |
| 3b – Ship Inn car park                                        | 3 – A3023 to The Look Out                   |
| 3d and 3e – Ship Inn beer garden and Annex                    |                                             |
| 3f, 3g and 3h – Lookout to No. 25 High Street                 | 4 - The Look Out to The Winklemarket        |
| 3i – The Winklemarket                                         |                                             |
| 3j – High Street                                              | 5 - High Street to Field North of Royal Oak |
| 3k – Royal Oak and Allotment                                  |                                             |
| 3l – Footpath to west of Mill Pond & field north of Royal Oak |                                             |

Two community working days were held in July 2021, and the feedback from this resulted in the following influences on the design refinement for Frontages 3, 4 and 5:

- **Frontage 3 - Car park at Ship Inn** – preparation of an alternative design to include land raising instead of a flip up flood barrier.
- **Frontage 4 - Lookout to High Street** – consideration of alternative solutions to replace the proposed boardwalk whilst minimising encroachment into the protected intertidal habitat.
- **Frontage 5 - High Street** – consideration of the positioning of the flood gates.
- **Frontage 5 - Royal Oak** – preparation of an alternative design with potential to include flood glass.

Structural Investigations (SI) and additional Ground Investigations (GI) were undertaken in Autumn 2021. The findings of the SI indicated that the scheme could not rely on the existing walls and other structures as they would not provide the necessary standard of flood protection and, therefore, they could not form part of the design of the new structures. The findings of the GI indicated that seepage cut off was required as part of the design of the new structures due to the permeable nature of the existing ground which could cause flooding on the landward side of the flood wall if not addressed.

Reducing flood and erosion risk to property and important infrastructure (like the A3023) is an 'imperative reason of overriding public interest' (IROPI), but it must be demonstrated there are no feasible alternative solutions which are less damaging, and further environmental improvements will be required in order to deliver biodiversity net gain. This has been accounted for within the proposals.

Taking account of this additional information, the outline design was refined and updated as set out in **Table 4.10** below. Locations not listed in **Table 4.10** had no changes between outline design and refined outline design. For further details of other alternative design options considered, please refer to the briefing note produced for Natural England in **Appendix H2**.

**Table 4.10: Summary of changes between outline design and refined outline design.**

| Location |                         | Outline Design                                                                                                                                       | Refined Outline Design                                                                                                    | Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F3       | Ship Inn car park verge | Reinforced concrete L-shaped floodwall                                                                                                               | Car park raising with new retaining wall adjacent to Ship Inn boundary.                                                   | <p>The car park raising provides a passive defence in this location. This is considered an improvement on the flip-up barrier defence included as part of the outline design because the passive defence does not require emergency operation or as much / any maintenance.</p> <p>The residual risk associated with not deploying the flip-up barrier is eliminated.</p> <p>Potentially less disruption to car park users during periods when the barriers would have otherwise been deployed.</p> <p>Potentially less restrictive to Hampshire County Council during bridge maintenance.</p> |
|          | Ship Inn car park       | Flip-up flood barrier                                                                                                                                |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|          | Ship Inn courtyard wall | Reinforced concrete floodwall with glass barrier top, built behind existing blockwork wall to provide a flood defence and support the glass barrier. | A full sheet pile wall with cladding on the landward and seaward side above ground level. Ability to add flood glass top. | Evidence from the SI and GI raised concerns about the condition of the existing blockwork wall and the requirement to provide a seepage cut-off in this location. As a result, the design was updated to a full sheet pile wall in this location. This wall will have no reliance on the existing blockwork (which will be replaced) which will reduce                                                                                                                                                                                                                                         |

| Location |                               | Outline Design                                                                                                                                                                                                              | Refined Outline Design                                                                                                                                                                                                                                                                                                                                                                                                         | Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                               |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                | residual risk of failure. It will also provide a seepage cut-off.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| F4       | The Look Out to Green Cottage | Reinforced concrete floodwall and boardwalk. Floodwall constructed immediately seaward of the existing brickwork wall. Trench sheeting and new brick wall constructed directly seaward of the existing quay wall footpath.  | Reinforced concrete floodwall immediately seaward of existing brickwork wall and masonry wall, clad in appropriate material. New brick quay wall seaward of existing quay wall with sheet pile foundations and buried concrete apron / slab. No boardwalk.                                                                                                                                                                     | <p>Boardwalk removed due to community feedback and operation and maintenance implications.</p> <p>Seepage cut-off provided by sheet pile foundation.</p> <p>New quay wall seaward of existing provides adequate footpath width to meet HBC accessibility requirements for minimum 1.5m width.</p> <p>Apron/slab buried beneath foreshore, reducing permanent encroachment.</p> <p>Buried apron/slab as far seaward as possible moves sheet piles away from listed buildings / existing structures to reduce risk of obstructions and vibration risks.</p> <p>At Green Cottage: Wall set around quay wall minimises number of flood gates required, minimising maintenance and operation requirements and residual risk of failure during an extreme event.</p> |
|          | Green Cottage                 | Reinforced concrete T-shaped floodwall around the edge of the green area with boardwalk to preserve footpath width. New brick wall and mass concrete fill constructed seaward of the existing quay wall and apron.          | Reinforced concrete T-shaped floodwall around the edge of the green area. No boardwalk included. Footpath constructed seaward of the T-shaped floodwall with the landward extent of the design limited to the 1:1 ratio land-take of the existing footpath to be diverted. New brick quay wall constructed seaward of the existing quay wall with sheet pile foundations and concrete apron/slab buried beneath the foreshore. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|          | Green Cottage to Winklemarket | Reinforced concrete floodwall and boardwalk. Floodwall constructed immediately seaward of the existing brickwork wall. Trench sheeting and new brick wall constructed directly seaward of the existing brick wall footpath. | Reinforced concrete floodwall immediately seaward of the existing flint wall, clad in an appropriate material. No boardwalk included. New lower brick quay wall seaward of the existing quay wall, to provide adequate footpath width, with sheet pile foundations and buried concrete apron/slab. Handrail along extent.                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Location |              | Outline Design                                                                                                                                  | Refined Outline Design                                                                                                                                                                                                                                                                                            | Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | Winklemarket | Use building as part of the flood defence, with flood proofing measures. Boardwalk.                                                             | Continue the adjacent reinforced concrete floodwall immediately seaward of the building wall, clad in appropriate material.<br>New brick quay wall constructed seaward of the existing quay wall to provide adequate footpath width, with sheet pile foundations and buried concrete apron/slab.<br>No boardwalk. | Continuation of defence from adjacent area.<br>Seepage cut-off provided by sheet pile foundation.<br>Robust solution, long design life.<br>New quay wall seaward of existing provides adequate footpath width to meet HBC accessibility requirements for minimum 1.5m width.<br>Apron/slab buried beneath foreshore, reducing permanent encroachment.                                                                                               |
| F5       | Royal Oak    | Either:<br>A new parapet wall on the alignment of existing wall.<br>Or:<br>King post wall with precast reinforced concrete panels and cladding. | Sheet pile wall (clad in appropriate material) with base slab/apron buried beneath the foreshore.<br>Glass top (subject to funding) will be designed to accommodate full height clad wall should funding not be secured.                                                                                          | Seepage cut-off provided by sheet pile foundation, thereby providing a continuous impermeable barrier.<br>The buried slab/apron enabled the sheet pile foundations to be moved further away from the existing structure, allowing a thinner wall and reducing permanent foreshore encroachment width as well as moving piling further away from potentially vulnerable historic buildings (vibration risk) and also away from foundation obstacles. |

A summary of the outputs of the outline design review and refinement is available on the scheme webpage here: <https://coastalpartners.org.uk/static/media/resources/design-review-leaflet-final.pdf>.

**Figure 4.18** illustrates the extent of the Frontages, their alignment and summary of the leading solutions taken forward into detailed design. Frontages 1A, 2, 3, 4 and 5 comprise the Core scheme (which this ES relates to) and Frontages 1B and 6 are the Additional scheme, all of which were taken through the detailed design process (but are not part of this EIA or the planning and marine licence applications which this ES supports).



to ensure an iterative design approach taking into account and minimising any potentially significant impacts as far as possible.

- **Requirements of Utilities providers and Highways** – working with utility providers and Hampshire Highways to obtain a more detailed understanding of the location of utilities and highway requirements to ensure that they could be incorporated into the design as far as possible and avoid disruption of services.

This iterative and integrated approach to the detailed design resulted in the following changes during the detailed design development:

- **Frontage 1A Billy Line North** – the inclusion of a seepage cut off significantly compromised the buildability of the design for this frontage due to the presence of water utility service assets on either side of the footpath and their associated easements / restrictions. As such, the decision was taken to accept the low risk of seepage flooding on this frontage to enable the utility disturbing works to be removed from the design.
- **Frontage 2 Billy Line South** – at 80% detailed design, it became apparent that the earth embankment option was no longer viable for this frontage as the footprint required for the embankment design, alongside the highways and utility constraints, meant that it resulted in significant encroachment into the saltmarsh priority habitat (of national importance) within the creek, which was environmentally unacceptable.

Therefore, the embankment option was changed to a sheet pile flood wall, set back where possible to accommodate future roll back of the saltmarsh habitat with sea level rise, but also ensures avoidance of defence alignment clashes with the Portsmouth Water services pipe (which feeds Hayling Island).

The opportunity was also taken to rationalise the footpath/cycleway layout at the southern end, realigning it landward, removing 130m<sup>2</sup> of hard standing and replacing it with soft landscaping (coastal wildflower meadow for biodiversity improvement).

Further refinement of the alignment of the sheet pile line was made during 2024 where it crosses the Portsmouth Water services pipe following engagement with adjacent landowners at 100% design. The utilities/sheet pile cross over point was relocated further north-west by 16m optimising use of limited space available. This design amendment reduced the sheet pile length on the seaward edge of the path which resulted in further reduction in foreshore encroachment area by 11m<sup>2</sup> (to zero so complete avoidance of this impact on this frontage with the revised design).

- **Frontage 3 (A3023 to The Look Out), Frontage 4 (The Look Out to The Winklemarket) and Frontage 5 (High Street to Field North of Royal Oak)** – following engagement with the owner of the Ship Inn, incorporation of flood glass into the floodwall west of the courtyard was requested. Additional discussions were held with Havant Brough Council's Conservation Officer regarding cladding materials and finishes to ensure that any potential impact to the appearance of Listed Buildings and the Conservation Area were minimised as far as technically possible. Discussions with the Conservation Officer included an agreement to also utilise flood glass in Frontage 5, plus the proposed cladding finishes of the wall structures at Frontages 3, 4 and 5.

- Frontage 4 (The Look Out to The Winklemarket)** – Following stakeholder feedback at the 50% detailed design stage, a potential alternative design was considered from Green Cottage to the Winklemarket. The alternative design proposed a solid seawall, in place of the leading option of a railing along the seaward edge and a new flood wall in front of the existing buildings along this frontage. **Figure 4.19** below illustrates both the leading option and the alternative design. The alternative option (solid seawall) was ruled out on heritage grounds and aesthetics, due to the narrow path / tunnelling effect this option would create.

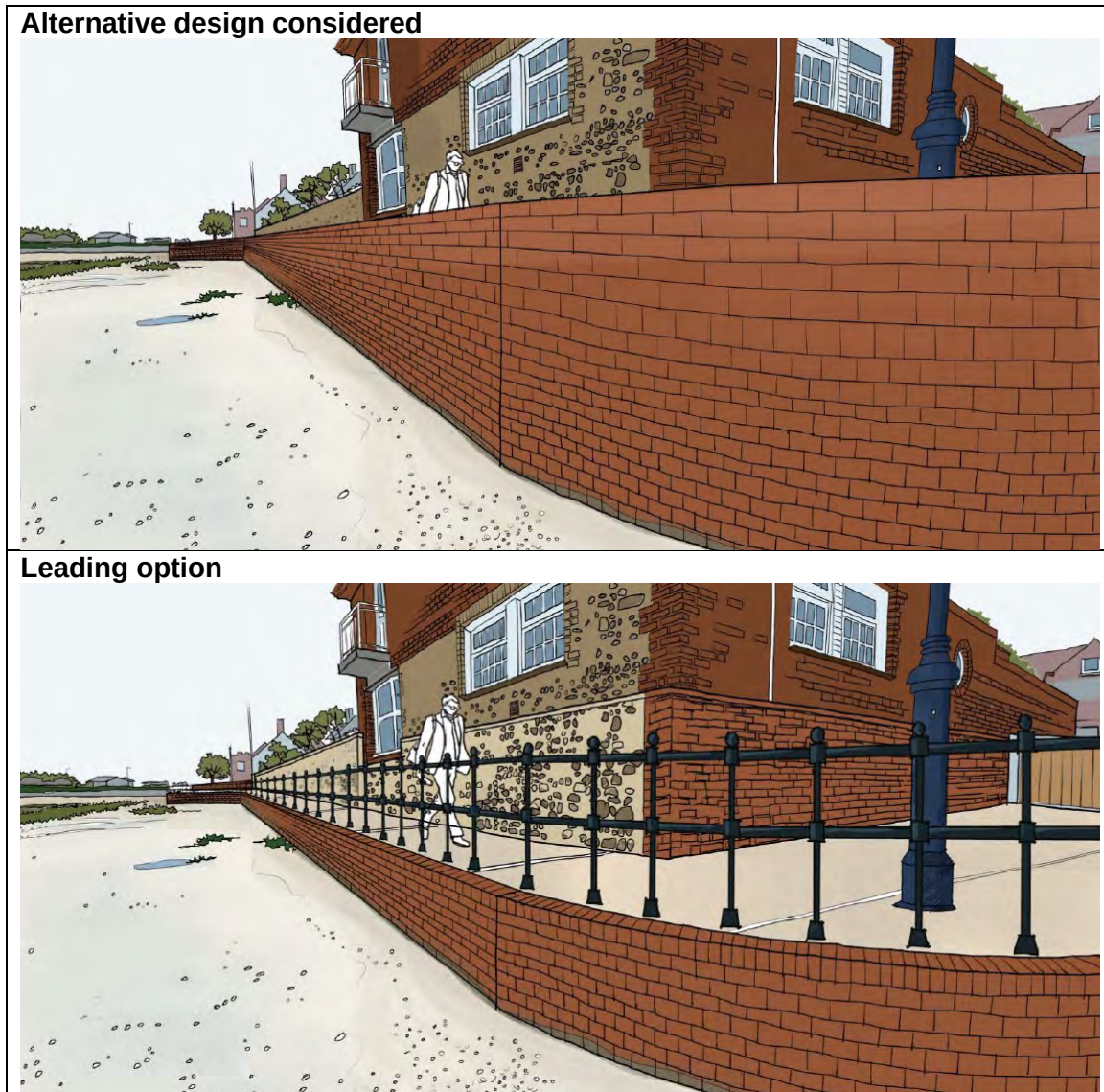


**Figure 4.19: Alternative seaward wall design considered around Green Cottage / Winklemarket and the leading option.**

- Frontage 5 Embankment (Field North of Royal Oak)** – A decision was made to move the field opening/gate to the west to reduce the engineering specification of the embankment in this location. The embankment was originally designed to allow for vehicle movements over it. By moving the field gate, the embankment design could be simplified, thereby reducing its footprint, materials and cost, as it no longer needed to meet engineering design requirements for allowing farm vehicles to pass over it.

This chapter has summarised the various alternative options, designs and alignments that were considered to provide a flood defence solution for Langstone during the long-list, short list, outline design and detailed design stages of the project. The various constraints and opportunities identified have led to the selection of final design proposals for each Frontage, as described in **Chapter 3 (Proposed Scheme)** of this ES.

## 4.5 References

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