17 COASTAL PROTECTION AND FLOOD DEFENCE

17.1 Introduction

17.1.1 This section of the ES describes the existing environment in relation to coastal protection and flood defence and assesses the potential impacts of the construction, operation and decommissioning phases of the proposed scheme. Where relevant, mitigation measures are detailed and a discussion of the residual impacts presented.

17.1.2 Impacts to the water environment as a result of the proposed scheme are addressed separately within **Section 6** (hydrology, hydrogeology and land quality) and **Section 7** (marine sediment quality and water quality). Cross reference to the findings of the numerical modelling undertaken to predict the effects of the proposed scheme on the hydrodynamic and sedimentary regime (reported in **Section 5**) has been undertaken throughout this section, where appropriate.

17.1.3 This section satisfies the Regulation 5(2)(e) of the Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009.

17.2 Policy and consultation

National Policy Statement for Ports (NPS for Ports); Department for Transport, January 2012

17.2.1 The assessment of potential impacts to coastal protection and flood defence has been made with reference to the NPS for Ports. The NPS for Ports states that all applications for port development of 1 hectare or greater in Flood Zone 1, as well as all proposals for projects in Flood Zone 2 and 3, should be accompanied by a Flood Risk Assessment (FRA). Given the location of the proposed scheme within Flood Zone 1, 2 and 3, an FRA has been undertaken for the proposed scheme (see **Appendix 17.1**). The FRA satisfies the requirement under Regulation 5 (2)(e) of the Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009 to submit an FRA.

17.2.2 The minimum requirements for FRAs (as outlined within the Paragraph 5.2.5 of the NPS for Ports) are that they should:

- be proportionate to the risk and appropriate to the scale, nature and location of the project;
- consider the risk of flooding arising from the project, in addition to the risk of flooding to the project;
- take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;
- be undertaken by a competent person, as early as possible in the process of preparing the proposal;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure;
- consider the vulnerability of those using the site, including arrangements for safe access;

- consider and quantify the different types of flooding (whether from natural or human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events, (including extreme events) on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;
- consider if there is a need to be safe and remain operational during a worst case flood event over the development's lifetime; and
- be supported by appropriate data and information, including historical information on previous events.

17.2.3 The requirements identified above were incorporated into the FRA undertaken for the proposed scheme. The FRA has been guided and informed by relevant policy, legislation, standards, guidance documents and consultation. This subsection summarises the key guidance and consultation relevant to the FRA process.

17.2.4 The NPS for Ports (Paragraph 5.2.3) remains consistent with the NPPF and sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

17.2.5 The NPS (Paragraph 5.2.13) states that the sequential test, and when deemed necessary the exception test, should be used when locating projects, to minimise flood risk.

The Sequential Test

17.2.6 Paragraph 5.2.13 of the NPS for Ports states, that preference should be given to locating projects in Flood Zone 1[7]. If there is no reasonably available site in Flood Zone 1, then projects can be located in Flood Zone 2. If there is no reasonably available site in Flood Zones 1 or 2, then essential infrastructure (including nationally significant infrastructure) projects can be located in Flood Zone 3 subject to the Exception Test.

The Exception Test

17.2.7 Paragraph 5.2.14 of the NPS for Ports states, that if following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the project to be located in zones of lower probability of flooding than Flood Zone 3, the Exception Test can be applied. The test provides a method of managing flood risk while still allowing necessary development to occur.

[7] The Flood Zones are defined in NPPF, see paragraph 17.2.12 of this Chapter.

17.2.8 Paragraph 5.2.15 of the NPS for Ports states that the Exception Test is only appropriate for use where the Sequential Test alone cannot deliver an acceptable site, taking into account the need for essential infrastructure to remain operational during floods. It may also be appropriate to use it where, as a result of the alternative site(s) at lower risk of flooding being subject to national designations such as landscape, heritage and nature conservation designations (e.g. Areas of Outstanding Natural Beauty (AONBs), SSSIs and World Heritage Sites (WHS)), it would not be appropriate to require the development to be located on the alternative site(s).

17.2.9 Paragraph 5.2.16 of the NPS for Ports states that all three elements of the Exception Test have to be passed for development to be consented. For the Exception Test to be passed:

- it must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk;
- the project should be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and,
- an FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

National Planning Policy Framework (2012), Department for Communities and Local Government (DCLG); and; Planning Practice Guidance: Flood Risk and Coastal Change (2014), DCLG.

17.2.10 The publication of the NPPF revoked Planning Policy Statement 25 (PPS 25): Development and Flood Risk (which previously set out the requirements for FRA). However, the technical guidance to the NPPF includes flood risk guidance and retains key elements of PPS 25, including the Sequential and Exception Tests, climate change allowances and development classifications. The information contained in the new technical guidance, together with the NPPF, guidance contained in PPS 25: Development and Flood Risk Practice Guide and the British Standard BS 8533-2011 form the basis of flood risk documentation. Due consideration has also been given to the Floods and Water Management Act, 2010.

17.2.11 The NPPF sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. However, where development is necessary in areas at risk of flooding, the development must be made safe and must not increase flood risk elsewhere (paragraph 100 of the NPPF). The key definitions that come from Section 1 of the Planning Practice Guidance: Flood Risk and Coastal Change (DCLG, 2014) are:

- “Areas at risk of flooding” for fluvial (river) and sea flooding means land within Flood Zones 2 and 3 or land within Flood Zone 1 that has critical drainage problems and has been notified to the local planning authority by the Environment Agency; and,
- “Flood risk” is a combination of the probability and potential consequences of flooding from all sources, including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

17.2.12 The Environment Agency's Flood Zones categorises flood risk from rivers and the sea into three zones, as defined below:

- **Flood Zone 3** represents areas with a high probability of flooding which may flood from a 1 in 100 year fluvial (1 in 200 tidal) event or more (i.e. with an annual probability of flooding of >1% (>0.5% tidal)).
- **Flood Zone 2** has a medium flood risk classification and refers to areas that may flood from between a 1 in 100 and 1 in 1,000 year fluvial event (1 in 200 and 1 in 1,000 tidal) (i.e. with an annual probability of flooding of 1%-0.1% (0.5%-0.1% tidal)).
- Any areas not shown in Environment Agency Flood Zones 2 or 3 are classed as **Flood Zone 1**, low fluvial and tidal flood risk.

17.2.13 The Environment Agency Flood Zones show the probability of flooding, without taking account of the beneficial impacts of flood risk management infrastructure or the presence of significant manmade structures such as bridges.

Flood and Water Management Act 2010

17.2.14 The Flood and Water Management Act combines and progresses principles from three previously published UK Government papers: Future Water (2008); Making Space for Water (2004); and the Pitt Review (2008).

17.2.15 In conjunction with the Environment Agency's strategic role in flood risk management, the Act gives Local Authorities responsibility for managing flood risk from groundwater, surface water, and ordinary watercourses in their areas. In particular, the Act emphasises the importance of understanding the impacts of surface water flooding and ensuring effective management of surface water runoff.

Strategic Flood Risk Assessment

17.2.16 A Strategic Flood Risk Assessment (SFRA) is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change. The SFRA also assess the impacts that land use changes and development in the area is predicted to have on flood risk.

17.2.17 A Level 1 SFRA is produced for planning purposes, assisting a local planning authority in identifying planning policy relevant to their area and identifying general areas of flood risk from all sources of flooding. The assessment should be applied to local authority areas where flooding is not a major issue and where development pressures are low. However, the assessment should be thorough enough to allow for the application of the Sequential Test and to identify whether the development can be located outside of high and medium flood risk areas (i.e. towards Flood Zone 1).

17.2.18 A Level 2 SFRA is less strategic and provides more detailed guidance on appropriate flood risk management measures for adoption on potential sites within Flood Zones 2 and 3. A Level 2 SFRA should consider the detailed nature of the flood characteristics within a Flood Zone including flood probability, depth, velocity, and the rate of onset and duration of flooding. This detailed information

should allow for the application of the Exception Test where appropriate. The Redcar and Cleveland SFRA has been used to inform the description of the existing environment (**Section 17.3**).

Catchment Flood Management Plan

17.2.19 Catchment Flood Management Plans (CFMPs) consider all types of inland flooding from rivers, ground water, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding, which is covered in Shoreline Management Plans). CFMPs also take into account the likely impacts of climate change, the effects of how we use and manage the land and how areas could be developed to meet our present day needs without compromising the ability of future generations to meet their own needs.

17.2.20 CFMPs will be used to help the Environment Agency and partners to plan and agree the most effective way to manage flood risk in the future. The role of the CFMP is to establish flood risk management policies which will deliver sustainable flood risk management over a long term timescale.

River Tees Catchment Flood Management Plan

17.2.21 The River Tees CFMP sets out various strategies for the management of the River Tees catchment for the future, based on current information and the anticipated future situation. The CFMP identifies the major flood risk in the catchment as generated by large frontal storm events.

17.2.22 The CFMP identifies the coastal areas of the catchment as most at risk to future flood risk changes due to their low lying nature, the tidal influence, building development and the increased rainfall intensity increase the risk of surface water flooding.

17.3 Consultation

Formal consultation

17.3.1 A summary of the responses received in the PINS Scoping Opinion (**Appendix 4.2**) and through consultation under Section 42 of the Planning Act 2008 of relevance to coastal protection and flood defence is presented in **Table 17-1**.

17.3.2 The only comment relevant to the FRA raised by PINS for the assessment of impacts on flood defences was that it should also consider the potential for breaching / overtopping of the flood defence under present and projected sea level scenarios.

Table 17-1 Summary of comments in the PINS Scoping Opinion and received during consultation under Section 42 of the Planning Act 2008 with regard to coastal protection and flood defence

Consultation Comment	Section of ES in which comment has been addressed (or justification why the comment has not been addressed)
Scoping Opinion, January 2014	
Secretary of State	
The Secretary of State notes the presence of existing flood defences within the estuary and is pleased to note the applicant's intention to provide an assessment of the potential impacts on flood defences, in particular the effects resulting from changes to the hydrodynamic and sedimentary regime. The assessment of impacts on flood defences should also consider the potential for breaching / overtopping of the flood defence under present and project sea level scenarios.	**Section 17.7** and **Appendix 17.1**
The Secretary of State recommends that the sections considering the water environment should be cross referenced within this chapter.	**Section 17.1**
Environment Agency	
As set out in the NPPF, development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.	This comment has been considered further within the FRA (**Appendix 17.1**) and **Sections 17.4 17.5 and 17.6**
The Scoping Report makes reference to carrying out an FRA to assess and mitigate current and future flood risk. We agree with these proposals, but would request a Flood Risk Sequential Test to steer the most vulnerable development to areas with the lowest probability of flooding.	The Sequential Test was not applied during production of the FRA, as the proposed site had to be located in its present position due to site specific requirements. Although the site does lie within Flood Zones 2 and 3, it is considered to be water compatible development under the NPS for Ports.
The Environment Agency wish to promote the use of Sustainable Urban Drainage Systems (SuDS) and draw attention to Paragraph 103 of the NPPF. The Environment Agency seeks to promote the use of SuDS techniques for any permanent above ground elements of the development, and expect the developer of the site to submit detailed investigations such that the use of SuDS has been fully explored.	The FRA notes that the River Tees and Dabholm Gut provide sufficient capacity for the site discharge without the requirement for SuDS. This has been agreed through consultation with RCBC (see **Section 17.2**).

Consultation Comment	Section of ES in which comment has been addressed (or justification why the comment has not been addressed)
Section 42 comments	
Redcar and Cleveland Borough Council	
There is a known flood risk in the area. The construction of tunnels under the road would, therefore, be at flood risk. It is recommended that the disadvantages of the tunnel options are assessed against the visual impact of a conveyor bridge.	**Section 3** and **Appendix 3.2**

Additional consultation undertaken

17.3.3 An initial consultation meeting on flood risk was carried out with the Environment Agency on 7 January 2014 to introduce the proposed scheme (the meeting also covered the proposed YPP MHF at Wilton). The key points raised were as follows:

- The Environment Agency was not aware of any recent flood impacts to / around the proposed scheme footprint from tidal events during December 2013 and January 2014.
- The Environment Agency was aware of local flood issues within the Tees estuary, including a recent (December 2013 and January 2014) breach at Greatham South embankment (north Tees / Seal Sands) and recent flooding at Port Clarence (north Tees). The Environment Agency was not aware of any flooding experienced along the south side of the Tees estuary or within Teesport during these events.
- The Environment Agency confirmed that it has completed an update of the tidal Flood Zones along the Tees estuary.
- The Environment Agency stated that in accordance with PPS25 requirements, a sequential and exception test will be required and it was recognised that the port facility would be water compatible development.
- The FRA undertaken for the NGCT predicted an increase of 1 to 2mm on upstream tidal levels. The Environment Agency confirmed that this order of impact would be considered negligible.
- The Environment Agency stated that free discharge of water would be acceptable at the proposed estuarine location, as this would not have any flood risk implications elsewhere.
- The Environment Agency stated that the drainage design for the proposed scheme would need to address tidal-locking.

17.3.4 Following discussion with the Environment Agency during January 2014, initial consultation was also carried out with RCBC Senior Drainage Officer in relation to both the Harbour facilities and MHF on 14 January 2014. The key points from the discussion were as follows:

- RCBC stated that it was in general agreement with the proposed approach to the FRA.
- RCBC confirmed that SuDS would not be obligatory for the drainage for flood risk purposes and that direct discharge of surface water drainage into the Tees estuary would likely be acceptable, on the basis that this would not exacerbate flood risk elsewhere.
- RCBC stated that surface water attenuation may be required with regard to water quality.
- RCBC stated that drainage attenuation may be required if discharging from the proposed scheme footprint into Dabholm Gut.

17.3.5 A further meeting was held on the 25 June 2014 with RCBC staff (namely their Development Manager, Flood Risk Officer and Transport Strategy Officer) to discuss the Conveyor route crossing over the A1085 and operational access from Steel House Roundabout. The purpose of the meeting was to review the design options for the conveyor route from the MHF at Wilton to the Port. The opportunities and constraints associated with each of the options were discussed.

17.3.6 Two issues were discussed with respect to flood risk. Firstly, the product's sensitivity to water and therefore flooding and, secondly, the potential introduction of flood water pathways associated with the

conveyor, potentially exacerbating flooding and extending the flood routing and extents. **Section 3** provides further details on the proposed route of the conveyor.

17.4 Methodology

Study area

17.4.1 The study area for this section of the ES comprises the area which has the potential to be directly impacted (i.e. the proposed scheme footprint) and adjacent areas that could be indirectly impacted. The ES, therefore, addresses flood risk at the site itself and the effect of the proposed scheme on flood risk in adjacent areas.

Existing environment

17.4.2 The existing environment information presented within this section of the ES has been based on desk review of existing information, including the Environment Agency's Tees Tidal Flood Risk Management Strategy (Environment Agency, 2009) and the Tidal Tees Integrated Flood Risk Modelling Study (JBA, September 2011). A review of the Redcar and Cleveland SFRA has also been undertaken to inform this section of the ES.

Methodology for assessment of potential impacts

17.4.3 The assessment methodology used for determining the potential environmental impacts on coastal protection and flood defence associated with the proposed scheme is provided within **Section 4**. The findings of the FRA undertaken specifically for the proposed scheme have been used to inform the impact assessment. The following paragraphs provide specific details relevant to the assessment of effects on coast protection, flood defence, tidal, fluvial and pluvial (surface water) flood risk and site drainage and conveyance.

Assessment of receptor sensitivity and magnitude

17.4.4 In this context, receptor sensitivity was defined with reference to adaptability, tolerance and recoverability (refer to **Section 4**), examples of which are provided in **Table 17-2**. The examples provided for levels of sensitivity have been selected using professional judgement.

17.4.5 Receptor magnitude has been defined with consideration to the spatial extent, duration, frequency and severity of the effect (refer to **Section 4**), examples of which are provided in **Table 17-3**. The examples provided have been selected using professional judgement based on knowledge of the relevant policy and guidance identified in **Section 17.2**.

Table 17-2 Sensitivity of receptor

Sensitivity	Flood risk sensitivity example description
Very High	Nationally and locally significant infrastructure at risk of flooding due to scheme Major residential and commercial development in the vicinity of the scheme not currently at risk from flooding Risk to life associated with significant flood depth and flow velocity Internationally or nationally designated planning policy areas.
High	Locally significant infrastructure at risk of flooding due to scheme Residential and Commercial development in the vicinity of the scheme not currently at risk from flooding Potential risk to life associated with flood depth and flow velocity
Medium	Residential property in existing flood zones Commercially farmed agricultural land Local planning policy designated sites.
Low	Drainage that does not discharge to high sensitivity sites Existing functional floodplain
Very Low	Drainage that does not discharge to sites of any significance or sensitivity to flood risk Existing functional floodplain

Table 17-3 Magnitude of effect

Magnitude	Flood risk magnitude of effect example description
Very High	A significant number of properties at flood risk during construction and operation Putting existing and proposed residential and commercial developments at permanent risk of flooding as a result of the mine surface Development Increase in surface water runoff from the mine surface development site having a significant permanent impact on the catchment hydrology in the vicinity
High	A significant number of properties at flood risk during construction Putting existing residential and commercial properties at permanent risk of flooding as a result of the mine surface Development Increase in surface water runoff from the mine surface development site having a permanent impact on the catchment hydrology in the vicinity
Medium	A small number of properties at flood risk during construction Increase in surface water runoff from the mine surface development site having a moderate permanent impact on the catchment hydrology in the vicinity
Low	Minor temporary increases in flood depths with no new flooding internally in properties expected (minor increases that do not breach existing property threshold levels).
Very Low	No impact on the long term land use or no material change to land use of any duration has been identified.

The determination and qualification of impact significance

17.4.6 The significance of an impact on flood risk and surface water receptors has been determined by combining the predicted magnitude of the effect with the sensitivity of the receptor. As noted in **Section 4**, impact statements carry a degree of subjectivity, as they are based on expert judgement regarding the effect-receptor interaction that occurs and on the data that is available.

Existing environment

17.4.7 There are 11km of flood defences located on the Tees estuary, which contribute to minimising the risk of flooding (Environment Agency, 2009). These include defences along the Tees at the confluence with Lustrum Beck and Billingham Beck, and at Port Clarence. There are also defences along Greatham Creek and at Hartlepool Power Station, along the Old River Tees around Teesside Park and the tidal barrier across Marton West Beck. The Tees Barrage is not a flood defence asset. In addition to the above, there are many informal defences which provide a range of levels of protection, such as sand dunes, embankments and also quays and wharves.

17.4.8 The Environment Agency's Tees Tidal Flood Risk Management Strategy (Environment Agency, 2009) identified the need for improvements or raising of existing flood defences within the Tees estuary, up to the Tees Barrage. This report also highlighted areas which may be at risk of flooding, either at present or in the future. Areas identified as being at risk are referred to as 'flood cells', and are located where ground levels are less than 5.0m above OD. This level carries a 0.1% (1 in 1,000) probability of a flood event occurring in any one year. The highest recorded flood event along the Tees occurred in 1953 and reached a level of 4.0m above OD. A water level with a 0.5% (1 in 200) probability of occurrence in any one year is 4.19m above OD (Environment Agency, 2009). The existing cope level at Tees Dock is 7.39m above CD, which equates to 4.54m above OD (CD is 2.85m below OD in the Tees estuary).

17.4.9 The Environment Agency's Tidal Tees Integrated Flood Risk Modelling Study (JBA, September 2011) has expanded on this strategy understanding and developed an ESTRY-TUFLOW model that covers the Tees estuary from Teesmouth at the coast upstream to the Tees Barrage. The report concludes the differences between the existing Flood Zones and the undefended scenario indicates that a reduction in Flood Zones 2 and 3 is recommended particularly towards the coast However, the footprint of the proposed port terminal is identified as still being at Flood Zone 3, 1 in 200 year return period tidal flood risk.

Redcar and Cleveland Strategic Flood Risk Assessment

17.4.10 The Redcar and Cleveland SFRA describes the Borough as being made up of a number of small river catchments that originate in the northern tip of the North York Moors. As the catchments are small, so are the rivers. However, due to the physical characteristics of the catchment, the rivers have a rapid hydrological response time to rainfall events, which can be hazardous when the rivers are in flood. Consequently, the main fluvial flood risk comes from these small watercourses which pass through towns and villages within the Borough. However, the flood extents from these watercourses are generally confined to relatively small areas.

17.4.11 The north-west part of the Borough is bounded by the Tees Estuary, which is the main source of tidal flooding. Water levels within the estuary and its associated tributaries are influenced by high tides and wave action. The Borough also has an extensive coastline, and in low lying areas there is a risk of coastal flooding.

17.4.12 The SFRA identifies surface water flooding as a potentially significant source of flood risk within the Borough. In rural areas, surface water flooding is associated with the rapid runoff generated from the steep, small catchments with overland flows reaching low-lying developed areas following heavy rainfall events. Although this type of surface water flooding is localised, there is the potential for fast flowing surface water flow pathways. Secondly, in urbanised areas, surface water can pass through a series of sewers, culverted, straightened or confined watercourses, sometimes with inadequate capacity, further increasing the flood risk. Due to the flatter landscape in the urban areas, the flooding is more widespread, but fast flowing surface water pathways are generally less of a hazard.

SFRA Critical Drainage Areas

17.4.13 Critical Drainage Areas (CDAs) are identified within the SFRA as areas recognised for suffering from historical flood events or areas where modelled data suggests they are at significant risk from surface water flooding. The proposed scheme footprint does not fall within a CDA, although it is close to CDAs located at Eston (to the south-west) and Dormanstown (to the north-east).

Flood vulnerability

17.4.14 In terms of flood risk and vulnerability, Table 2 of the NPPF Technical Guidance classifies the proposed port terminal as 'water compatible'. Table 3 of this guidance document indicates that developments of this classification are considered appropriate in all Flood Zones. The guidance classifies the type of development planned for the conveyor route as 'less vulnerable'. The NPPF states that developments of this classification are considered to be appropriate in Flood Zones 1, 2 and 3a. However, under this classification, no development is permitted within the Functional Floodplain (Flood Zone 3b).

17.4.15 As set out above, the NPS for Ports states that all applications for port development of 1 hectare or greater in Flood Zone 1, as well as all proposals for projects in Flood Zone 2 and 3, should be accompanied by a FRA. Given the location of the proposed scheme within Flood Zone 2 and Flood Zone 3, an FRA has been undertaken for the proposed scheme (**Appendix 17.1**).

Assessment of potential impacts during construction

Potential for effect on risk of flooding at and adjacent to the proposed development site

17.4.16 The principal issue in relation to coastal protection and flood defence is whether the proposed scheme could alter the risk of flooding during the construction as a result of temporary works within the floodplain, both to the development site and other areas within the Tees estuary.

17.4.17 The FRA has identified that the port terminal and conveyor route is at risk from tidal flooding, and this represents the predominant source of flood risk in the vicinity of the proposed scheme. It is considered that the flood risk during construction will be not be exacerbated beyond the existing flood risk as identified in the FRA.

17.4.18 The receptor sensitivity is identified as low and the baseline tidal flood risk (as defined in the FRA) has a potential low magnitude of effect. Hence a **negligible** impact is predicted.

Mitigation measures and residual impact

17.4.19 No mitigation measures are required. The residual impact would be of **negligible** significance with regard to tidal or coastal flooding; there would be **no residual impact** with regard to pluvial or fluvial flooding.

Flood hazard to construction workers

17.4.20 The location of the proposed scheme footprint (within and immediately adjacent to the Tees estuary) inherently presents risks to construction workers associated with drowning or accidents during flood or storm events within the estuary.

17.4.21 As it is difficult to quantify the likely severity of any flood events / storms in the estuary, it is not possible to predict the significance of a potential impact in this case. However, the risk of a flood event occurring and its impact on human health can be controlled through the implementation of the mitigation measures outlined below.

Mitigation measures and residual impact

17.4.22 All construction workers would undergo site induction training prior to being allowed access to the Teesport Estate. This would include actions required in the event of a number of emergency incidents, including flood risk; such as warning sirens and escape routes in the event of a site evacuation. No workers would be allowed on site unless they have undergone such an induction. These measures would minimise the potential risk to human health as far as possible.

17.4.23 On this basis, the residual risk with regard to tidal or coastal flooding would be **low**; and there would be **no risk** with regard to pluvial or fluvial flooding.

17.5 Assessment of potential impacts during operation

Potential for effect on risk of flooding at and adjacent to the proposed development site

17.5.1 The principal issue in relation to coastal protection and flood defence is whether the proposed scheme could alter the risk of flooding, both to the development site and other areas within the Tees estuary.

17.5.2 The NPPF Technical Guidance document states that there are a number of sources of flooding which need to be considered within an FRA. The potential flood risk to the proposed scheme from all potential sources has been summarised below using information from the FRA (**Appendix 17.1**).

Flooding from rivers (fluvial)

17.5.3 The FRA has concluded that the proposed development footprint is not at risk of fluvial flooding. Furthermore, the proposed development of the port terminal and conveyor system is not predicted to alter flood risk. It is, therefore, predicted that there would be **no impact** due to or on fluvial flooding.

Flooding from the sea (tidal or coastal)

17.5.4 The FRA has identified that the port terminal and conveyor route is at risk from tidal flooding, and this represents the predominant source of flood risk to the proposed scheme. The south and western areas of the proposed port terminal lie within Flood Zones 2 and 3; the rest of the site is in Flood Zone 1 at or above 5.5mAOD, approximately 2m above present day Highest Astronomical Tide (HAT).

17.5.5 The southern conveyor envelope follows Dabholm Gut and is in Flood Zones 2 and 3; the northern conveyor envelope lies within Flood Zone 1. However, the invert of the conveyor (in either case) is proposed to be raised to a minimum of 5.25mAOD above the predicted extreme flood level and, therefore, the conveyor is not deemed to be at risk from tidal flooding.

17.5.6 The FRA confirms that the development is classified as 'water compatible' development in accordance with the NPS for Ports (Department for Transport, 2012). Therefore, the receptor sensitivity is low. The baseline tidal flood risk, as defined in the FRA, has the potential to have a low magnitude effect.

17.5.7 The tidal flood risk would be reduced as a result of the building of the quay structure at the water's edge, proposed to be at a level above the HAT. The conveyor structure and associated supports would be positioned within the known floodplain, but are not deemed to affect the flood risk in the vicinity. Based on the above, a residual impact of **minor beneficial** significance is predicted due to the reduction in tidal flood risk afforded by the construction of the port terminal.

Pluvial flooding

17.5.8 Pluvial flooding was found to affect the site, particularly in extreme conditions, with potential exacerbation in the future as a result of climate change. For the majority of the site, the surface water flood risk was defined as very low. This means that the site is only likely to flood during a 1 in 1,000 years or greater flood event.

17.5.9 The pluvial flood risk maps indicate that the southern conveyor envelope is at pluvial flood risk; and the northern conveyor envelope is not at pluvial flood risk. However, the conveyor is proposed to be elevated to a minimum invert level of 5.25mAOD (i.e. above the extreme tidal water level). The supports for the conveyor system would have a negligible impact on the surface area of the floodplain. It is, therefore, predicted that there would be **no impact** as a result of the proposed development with regard to pluvial flooding.

Mitigation measures and residual impact

17.5.10 No mitigation measures are required. The residual impact would be of **minor beneficial** significance with regard to tidal or coastal flooding; and there would be **no residual impact** with regard to pluvial or fluvial flooding.

Potential for effect on flood risk due to changes to the hydrodynamic regime

17.5.11 The potential for increased overtopping frequency has been informed by the studies into the effects of the proposed development on wave climate throughout the estuary system (**Section 5**). The modelling

predicted the effects arising from the proposed dredging and both options for the quay; simulations of the effect were undertaken for three return period winds from two directions, anticipated to generate waves from the south-west and three return period for incoming waves from Tees Bay.

17.5.12 Given that no capital dredging of the approach channel is proposed seawards of the section channel adjacent to the proposed port terminal, there would be no effect on the penetration of waves into the Tees estuary. The primary focus of the wave modelling was, therefore, to predict changes in wind generated wave conditions due to the change of the form of the shore of the estuary associated with the construction of the proposed port terminal (open and solid quay options).

17.5.13 Results from the wave modelling show a relatively localised predict effect on existing wave heights. The open quay structure is predicted to fully transmit wave energy through to the shore protection behind the proposed quay. The shore protection would have similar reflection characteristics to the existing shoreline and, therefore, no increase in wave energy is predicted within the estuary.

17.5.14 The proposed dredging is not predicted to change the overall pattern of wave conditions throughout the estuary; however, the model results have shown that a highly localised strip of increased wave heights is predicted (in the range of 0.03m to 0.1m) adjacent to the open quay structure. This small increase is considered to be a result of the dredging required for the scheme.

17.5.15 The vertical face of the solid quay structure is considered to have higher reflection properties than the existing shoreline and, therefore, less wave energy would be absorbed following construction of the solid quay structure. Hence, the effect of the solid quay structure in reflecting wave energy towards the north provides localised increases in significant wave height in the range 0.05m to 0.1m.

17.5.16 Based on the localised and very minor increases in wave heights anticipated to occur within the estuary due to the proposed dredging and quay construction, an impact of **negligible** significance is anticipated (for both quay construction options).

Mitigation measures and residual impact

17.5.17 No mitigation measures are required. The residual impact would be of **negligible** significance.

17.6 Assessment of impacts during decommissioning

Potential for effect on risk of flooding at and adjacent to the proposed development site

17.6.1 As noted in **Section 17.7** (operational phase), the FRA has identified that the port terminal and conveyor route are at risk from tidal flooding, which represents the predominant source of flood risk in the vicinity of the scheme.

17.6.2 During decommissioning, it is not considered that any works associated with the removal of the conveyor and port facility would exacerbate the existing flood risk as identified in the FRA. Hence the significance of the potential impact is predicted to be **negligible**.

Mitigation measures and residual impact

17.6.3 No mitigation measures are required. The residual impact would be of **negligible** significance with regard to tidal or coastal flooding. There would be **no residual impact** with regard to pluvial or fluvial flooding.

17.7 Summary

17.7.1 The Tees estuary contains both formal and informal flood defences which contribute to minimising the risk of flooding to adjacent developments. The Tees Tidal Flood Risk Management Strategy identified the requirement to raise existing flood defences within the estuary, upstream to the Tees Barrage.

17.7.2 The footprint of the proposed port terminal is within Flood Zone 3. It is accepted that the proposed port terminal comprises 'water-compatible' development and would be constructed in a high flood risk area.

17.7.3 The Harbour facilities overall would fall within Flood Zones 1, 2 and 3. The key flood risks to the site are from tidal sources, particularly in the southern and western areas. The other major flood risk is from pluvial flooding. The conveyor route is also shown to be in Flood Zones 1, 2 and 3; however it would be elevated to a minimum invert level of +5.25mAOD and would not be at risk of flooding. Furthermore, the proposed scheme would not affect flood risk elsewhere.

17.7.4 Hydrodynamic modelling has shown that the open quay structure is predicted to fully transmit wave energy through to the shore protection behind the quay. The solid quay structure has higher reflection properties than the existing shoreline. A highly localised strip of increased wave height is predicted adjacent to the open quay structure. This small increase would arise as a result of the dredging required for the scheme. The effect of the solid quay structure in reflecting wave energy towards the north provides localised increases in significant wave height. However, based on the predicted increases in wave height, an impact of negligible significance is anticipated with regard to increased flood risk due to alternations to the hydrodynamic regime.

17.7.5 **Table 17-4** provides a summary of the impacts predicted in this section.

Table 17-4 Summary of Impacts

Impact	Sensitivity of receptor	Magnitude of effect	Significance of impact	Mitigation	Residual impact
Construction					
Flooding at and adjacent to the proposed development site	Low	Low	Negligible	No mitigation required	No residual impact
Flood hazard to construction workers	Medium	Medium	Minor adverse	All construction workers would undergo site induction training prior to being allowed access to the Teesport Estate Warning sirens and escape routes in the event of a site evacuation	No residual impact
Operation					
Flooding at and adjacent to the proposed development site	Low	Low	Negligible	Quay construction provides an improved level of protection from tidal flooding / overtopping	Minor beneficial
Potential for effect on flood risk due to changes to the hydrodynamic regime	Low	Low	Negligible	No mitigation required	Negligible
Decommissioning					
Flooding at and adjacent to the proposed development site	Low	Low	Negligible	No mitigation required	Negligible (tidal/coastal flooding); no residual impact (pluvial/fluvial)

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