7 Road Drainage and the Water Environment

This chapter presents an assessment of impacts of the proposed A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement scheme (hereafter referred to as the proposed scheme) on the water environment including; flood risk, surface water quality and estuarine geomorphology.

The proposed scheme is partly located within an intertidal area of the Forth Estuary. Within the 500m study area two Water Framework Directive (WFD) surface water features have been identified, in addition to several drainage channels and tidal creeks. The largest feature within the study area is the Forth Estuary, which is split into the Upper Forth Estuary and Middle Forth Estuary under WFD.

The assessment has been informed by consultation, desk-based assessments and a site walkover. A detailed Flood Risk Assessment (FRA) and associated hydrodynamic modelling was scoped out following consultation with the Scottish Environment Protection Agency (SEPA).

Significant potential effects from the proposed scheme during construction, in the absence of mitigation, include risk of flooding to construction activities, deterioration in surface water quality and disturbance of estuarine geomorphological features. No effects have been assessed as significant for the operational phase as operational changes to hydrodynamics from baseline conditions are considered to be localised and negligible. Therefore, any changes to current baseline conditions during the operational phase of the new structure are generally considered to be negligible.

Measures required to mitigate construction impacts include the development and implementation of a Flood and Tidal Response Plan, Pollution Prevention Plan (PPP) and Saltmarsh Management Plan (SMP). With the implementation of proposed mitigation, no significant residual effects are anticipated for either construction or operation of the proposed scheme.

7.1 Introduction

7.1.1 This chapter of the Environmental Impact Assessment Report (EIA Report) presents the assessment of the proposed scheme in terms of the following aspects of the surface water environment:

- flood risk;
- surface water quality; and
- estuarine geomorphology.

7.1.2 The surface water environment is linked to ecological receptors, considered in Chapter 8 (Marine Ecology) and Chapter 9 (Terrestrial Ecology), as well as groundwater receptors, considered within Chapter 6 (Geology, Soils and Groundwater).

7.1.3 This chapter is supported by the following figures:

- Figure 7.1: Surface Water Features; and
- Figure 7.2: Coastal Water Flood Risk.

7.2 Legislation, Policies and Guidance

7.2.1 The assessment has been undertaken in accordance DMRB LA 113: Road Drainage and the Water Environment (formerly HD 45/09) (Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2020), hereafter referred to as DMRB LA 113.

7.2.2 Legislation, Policies and Guidance that are of relevance or have been adopted within the assessment, are further detailed in Table 7.1 below.

Table 7.1: Legislation, Policies and Guidance

Topic	Name
Legislation	European Union Water Framework Directive 2000/60/EC (European Commission 2000); Water Environment Water Services (WEWS) Act 2003 (Scottish Government 2003); Climate Change (Scotland) Act 2009 (Scottish Government 2009a); Flood Risk Management (Scotland) Act 2009 (Scottish Government 2009b); The Roads (Scotland) Act 1984 (Environmental Impact Assessment) (Scotland) Regulations 2017, hereafter referred to as the Roads EIA Regulations; and Marine Scotland Act 2010 (Scottish Government 2010)
Policy and Regulations	DMRB LA 113: Road Drainage and the Water Environment (formerly HD 45/09) (Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2020), hereafter referred to as DMRB LA 113; DMRB LA 104: Environment assessment and monitoring (formerly HA 205/08, HD 48/08, IAN 125/15, and IAN 133/10), Revision 1 (Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2019), hereafter referred to as DMRB LA 104; The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR) (Scottish Government 2013), hereafter referred to as 'CAR'; The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (Scottish Government 2017a); Water Environment (Miscellaneous) (Scotland) Regulations 2017 (Scottish Government 2017b); and Scottish Planning Policy (SPP) (Scottish Government 2014).
Guidance	The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide (SEPA 2019c); Technical Flood Risk Guidance for Stakeholders (SS-NFR-P-002) (SEPA 2019a); SEPA Guidance for Pollution Prevention (GPPs) or Pollution Prevention Guidelines (PPGs) (SEPA 2006-2019); and SEPA (2014). Land Use Planning System, SEPA Guidance Note 17 - Marine Development and Marine Aquaculture Planning Guidance, V.6.

7.3 Approach and Methods

Study Area

7.3.1 The baseline study area for the proposed scheme extends up to 500m from the footprint of the proposed scheme as shown on Figure 7.1 and includes any identified water features.

Baseline Conditions

Desk-based Assessment

7.3.2 Earlier versions of the proposed scheme were developed and assessed as part of the Upper Forth Crossing Environmental Statement (Scottish Executive 2003) and later the Kincardine Bridge Refurbishment Environmental Review Report (Jacobs 2009); hereafter referred to as the 2003 ES and 2009 ERR, respectively. These reports have informed the baseline and assessment within this chapter. All data sources that are of relevance or have been utilised to inform the baseline or assessment, are detailed in Table 7.2 below.

Table 7.2: Data Sources

Data Topic	Sources of Information
Previous reports	Upper Forth Crossing at Kincardine Environmental Statement (Scottish Executive 2003); and

Data Topic	Sources of Information
	Kincardine Bridge Refurbishment Environmental Review Report (Transport Scotland/ Jacobs 2009).
Mapping and Spatial Data	1:25,000 Ordnance Survey (OS) maps
Hydrological data	SEPA Flood Maps (2016a)
WFD Data	SEPA River Basin Management Plan (RBMP) data and latest classification results available on the SEPA Water Classification Hub (SEPA 2019d); and The River Basin Management Plan for the Scotland River Basin District: 2015 – 2027 (Scottish Government 2015).

Consultation

7.3.3 Details of the full consultation process for the proposed scheme are provided in Chapter 5 (Consultation and Scoping) and Appendix A5.1 (Summary of Consultation Responses).

7.3.4 Consultations and information requests of relevance to the assessment of Road Drainage and the Water Environment (RDWE) were undertaken with regulatory bodies and key stakeholders including SEPA, Falkirk Council and Fife Council. Specific consultation undertaken with SEPA is summarised in Table 7.3.

Table 7.3: Summary of Consultation with SEPA

Date	Comments
17 November 2017	A Technical Note was issued to SEPA outlining the proposed approach to the scope of the (RDWE) assessment of the EIA Report.
14 December 2017 and 15 December 2017	A teleconference was held with SEPA on 14 December 2017. SEPA provided comments in an email on 15 December 2017 which included: • SEPA advised that a Flood Risk Assessment is unlikely to be required and that it is not considered that the proposed scheme would increase flood risk to existing properties; • SEPA noted that no Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended (CAR) authorisation is required for construction of the proposed scheme as this would be covered in a Marine licence; and • SEPA advised that measures should be put in place to control any silt run-off during construction.
19 June 2018	A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement Scoping Report (Jacobs 2018) (Scoping Report) was issued to SEPA along with a request for relevant details of licenced groundwater abstractions and former and current contaminated land use.
15 August 2018	SEPA responded to the Scoping Report by email on 15 August 2018, comments included: • SEPA advised as per the previous response, as the proposal is to repair/replace existing bridge a Flood Risk Assessment (FRA) is not required. At this stage it is not considered that the proposal will increase flood risk to existing properties; and • SEPA considered that the Scoping Report raised no new issues beyond those discussed in our previous response dated 15 December 2017. SEPA added that the drainage would be authorised in CAR by way of General Binding Rules (GBR).
4 September 2018	Information on CAR licences/permits located within 1km of the proposed scheme was provided by SEPA.
14 January 2020	Following further development of likely construction methods for the proposed scheme, a report was issued to SEPA on 14 January 2020 and further confirmation on SEPA's position was sought. SEPA, in an email dated 7 February 2020, noted that SEPA's previous position remain unchanged and that SEPA may request that all levels are returned to existing levels after construction.
27 August 2020	SEPA provided comment on the draft EIA Report chapter by email on 27 August 2020, comments included: • SEPA advised that part of the application site lies within the medium likelihood (0.5% annual probability or 1 in 200 year) flood extent of the SEPA Flood Map and the approximate 1 in 200 year water level for the area is 4.75mAOD based on extreme still water level calculations using the Coastal Flood Boundary Method. This value does not take

Date	Comments
	into account the potential effects of climate change, wave action, funneling or local bathymetry at this location. • SEPA advised that as the works are temporary and the land raising will be within the coastal flood extent of the Firth of Forth there will be minimal impact on flood risk to nearby receptors.

Site Survey

7.3.5 A walkover survey in the vicinity of the proposed scheme was undertaken by Jacobs surveyors on 21 March 2019 to visually inspect surface water features in order to gain an understanding of local topography, hydrological regime and geomorphology.

Impact Assessment Methodology

7.3.6 The impact assessment reported in this chapter has been undertaken in accordance with the guidance provided in DMRB LA 113, whereby the level of significance of a potential effect on the existing baseline condition of the surface water environment is determined by factoring the environmental value (sensitivity) of the surface water feature and the magnitude of the impact. This assessment takes account of the impacts from construction and/or operational activities, both before and after the application of mitigation measures i.e. potential and residual effects respectively. In accordance with the most recent DMRB LA 113 guidance, embedded mitigation measures are to be integrated into design proposals. As a result, any applicable environmental effects related to them are outlined within the potential impact section.

7.3.7 A detailed FRA and associated hydrodynamic modelling were scoped out following consultation with SEPA (as per Table 7.3) and were therefore not undertaken as part of the assessment. Previous hydrodynamic modelling conducted, as presented in the 2003 Environmental Statement, was used to inform an understanding of hydrodynamics and flood risk in the study area. Impacts reported on flood risk have taken consideration of climate change, as required by DMRB LA 113.

7.3.8 The assessment of potential impacts on estuarine geomorphology has considered shoreline, intertidal and subtidal morphological features, and the sediment transport processes which form them (including erosion, transport and deposition of sediment).

Environmental Value (Sensitivity)

7.3.9 The environmental value (sensitivity) of water features was categorised on a scale of 'low' to 'very high', in accordance with the criteria provided in Table 7.4 and using professional judgement where appropriate.

7.3.10 For flood risk, the environmental value (sensitivity) was based on the vulnerability of receptors, which is a function of their susceptibility to flood damage as a result of exposure, in relation to their ability (or inability) to resist or adapt to the damage.

7.3.11 The environmental value (sensitivity) for surface water quality and estuarine geomorphology was informed by the WFD water body condition status published by SEPA (to meet Water Environment and Water Services (WEWS) Act requirements) on its Water Classification Hub (SEPA 2019d).

Table 7.4: Environmental Value (Sensitivity) Criteria

Environmental Value	Criteria	Examples
Very High	Attribute has a high importance and/or rarity on a national scale.	**Flood Risk**
		Water feature with direct flood risk to essential/ critical infrastructure or highly vulnerable development such

Environmental Value	Criteria	Examples
		as hospitals, schools or safe shelters during the design 0.5% Annual Exceedance Probability (AEP) (200-year) event.
		Surface Water Quality
		Water feature having a WFD classification shown in a RBMP and protected/designated under EC legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Wetland of International Importance (Ramsar) site).
		Estuarine Geomorphology
		'High' hydromorphology and morphology status. A water body supporting a range of species and habitats sensitive to changes in erosion, sediment transport and deposition. Water body appears in complete equilibrium with natural erosion and deposition occurring (i.e. sediments are deposited and eroded at approximately equal rates). Includes sites with international and UK statutory nature conservation designations due to water-dependent ecosystems. Includes a diverse range of shoreline/estuarine morphology, including a variety of natural features such as sand banks, creeks, intertidal mudflats and saltmarshes. Presents a lack of anthropogenic interruption and modification. Higher likelihood of morphological adjustment, such as excessive erosion and sediment deposition as a direct result of modification.
High	Attribute has a high importance and/or rarity on local scale.	**Flood Risk**
		Water feature with direct flood risk to residential properties during the 0.5% AEP (200-year) design flood event.
		Surface Water Quality
		Water feature having a WFD classification shown in a RBMP and designated at a regional or local level as identified in the Falkirk Biodiversity Action Plan (BAP) (Falkirk Council 2018).
		Estuarine Geomorphology
		'Good' hydromorphology and morphology status. A water body supporting a range of species and habitats sensitive to changes in erosion, sediment transport and deposition. Water body appears in equilibrium with natural erosion and deposition occurring (i.e. sediments are deposited and eroded at approximately equal rates). Includes non-statutory sites of regional or local importance designated for water-dependent ecosystems. Includes a range of shoreline/estuarine morphology, including some natural features such as sand banks, creeks, intertidal mudflats and saltmarshes. Presents a minor anthropogenic interruption and modification. Higher likelihood of morphological adjustment, such as

Environmental Value	Criteria	Examples
		excessive erosion and sediment deposition, as a direct result of modification.
Medium	Attribute has a moderate quality and/or rarity on a local scale	**Flood Risk**
		A water feature with a possibility of direct flood risk to less populated areas (no residential properties or critical infrastructure units at risk).
		Surface Water Quality
		Water feature not having a WFD classification shown in a RBMP but designated at a regional or local level as identified in the Falkirk BAP (Falkirk Council, 2018).
		Estuarine Geomorphology
		'Moderate' hydromorphology and morphology status. A water body supporting some species and habitats sensitive to changes in erosion, sediment transport and deposition. Includes non-statutory sites of regional or local importance designated for water-dependent ecosystems. Moderate morphological diversity (geodiversity). Evidence of localised modification such as shoreline protection, but natural features such as sand banks and intertidal flats are present.
Low	Attribute has a low quality and/or rarity on a local scale	**Flood Risk**
		Water feature passing through uncultivated agricultural land or a water feature passing through residential, industrial or commercial areas with no risk posed to properties.
		Surface Water Quality
		Water feature having a WFD classification shown in a RBMP and has no statutory or non-statutory protections / designations.
		Estuarine Geomorphology
		'Poor' hydromorphology and morphology status. A water body which does not support any significant species sensitive to changes in erosion, sediment transport and deposition. No designated sites within water body. Water bodies exhibiting no morphological diversity (geodiversity); shoreline type is uniform and stable. Evidence of modification such as a sea defense, realignment and/or deepening. Very limited potential for morphological adjustment, such as erosion and sediment deposition, as a direct result of modification.

Impact Magnitude

7.3.12 The magnitude of potential impacts was assessed on a scale of 'major', 'moderate', 'minor', 'negligible' and 'no change' for both adverse and beneficial impacts based on the likely effect of the proposed activities, guided by the criteria and examples provided in Table 7.5 and using professional judgement where necessary. The assessment of magnitude was influenced by the timing, scale, size and duration (long term, temporary or permanent) of changes to the baseline conditions, as well as the likelihood or probability of occurrence.

Table 7.5: Magnitude Criteria

Magnitude	Criteria	Examples
Major adverse	Results in loss of attribute and/ or quality and integrity of the attribute	**Flood Risk**
		Major displacement of floodwater or alteration of flood mechanisms leading to increased flood risk to sensitive receptors.
		Surface Water Quality
		Major shift away from baseline conditions, likely to result in a downgrade of WFD classification for all attributes (water supply/quality; dilution and removal of waste products; biodiversity) and/ or long-term loss or change to designated site.
		Estuarine Geomorphology
		Major adverse changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Major changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to impacts to habitats and/or sensitive species as a result of changes in erosion, transport and deposition of suspended sediment and/or bedload. **Shoreline, intertidal and subtidal morphology** Major changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to a reduction in morphological diversity with consequences for geodiversity or ecological quality. **Estuarine processes** Major changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition.
Moderate adverse	Results in effect on integrity of attribute, or loss of part of the attribute	**Flood Risk**
		Moderate displacement of floodwater or alteration of flood mechanisms leading to increased flood depths or frequency on land already susceptible to flooding. Static or high-risk construction activities located within the 'High' (10% AEP return period) likelihood coastal flooding extent.
		Surface Water Quality
		A moderate shift away from baseline conditions, such that it contributes to a reduction in water body WFD classification for all attributes (water supply/ quality; dilution and removal of waste products; biodiversity and or/ may result in temporary impacts on designated species/habitats)
		Estuarine Geomorphology
		Moderate adverse changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Moderate changes to any part of the shoreline, intertidal area and subtidal bed of the estuary caused by erosion (scour) and/or deposition leading to impacts to habitats and/or sensitive species as a result of changes in erosion, transport and deposition of suspended sediment and/or bedload. **Shoreline, intertidal and subtidal morphology** Moderate changes to estuarine morphological diversity. **Estuarine processes** Moderate changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition
Minor adverse	Results in some measurable	**Flood Risk**
		Minor displacement of floodwater or alteration of flood mechanisms leading to localised increases in flood depths or flow velocities.

Magnitude	Criteria	Examples
	change in attributes quality or vulnerability	**Surface Water Quality**
		Minor shift away from baseline conditions. Likely to result in a slight decline in water quality with no associated impacts on designated species/habitats or water supply, which is characterised by a temporary decline in water quality.
		Estuarine Geomorphology
		Minor adverse changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Minor changes to any part of the shoreline, intertidal area and subtidal bed of the estuary caused by erosion (scour) and/or deposition leading to impacts to habitats and/or sensitive species as a result of changes in erosion, transport and deposition of suspended sediment and/or bedload. **Shoreline, intertidal and subtidal morphology** Limited changes to estuarine morphological diversity. **Estuarine processes** Minor changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition any changes are likely to be localised.
Negligible adverse or beneficial	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	**Flood Risk**
		Negligible displacement of floodwater or alteration of flood mechanisms leading to imperceptible increases in flood depths or flow velocities.
		Surface Water Quality
		No perceptible changes to baseline conditions. No measurable change in water quality.
		Estuarine Geomorphology
		No substantial changes to the hydromorphological elements of the water body: **Estuarine sediment regime** No substantial changes to sediment transport resulting in negligible impacts on species or habitats as a result of changes to suspended sediment concentration or turbidity. No discernible impact to sediment patterns and behaviour over the development area due to either erosion or deposition. **Shoreline, intertidal and subtidal morphology** No substantial impact to estuarine morphological diversity. **Estuarine processes** No substantial changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition. Any changes are likely to be localised.
Minor beneficial	Results in some beneficial effect on attribute or a reduces risk of negative effect occurring	**Flood Risk**
		Minor alteration of flood mechanisms leading to localised decreases in flood depths or flow velocities.
		Surface Water Quality
		Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse, but not to the extent of influencing the water feature WFD classification.

Magnitude	Criteria	Examples
		Estuarine Geomorphology
		Minor beneficial changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Minor changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to improvements of habitats and/or sensitive species. **Shoreline, intertidal and subtidal morphology** Minor improvements to estuarine morphological diversity. **Estuarine processes** Minor localised improvements to estuarine processes such as shoreline evolution or erosion.
Moderate beneficial	Results in moderate improvement of attribute quality	**Flood Risk**
		Moderate alteration of flood mechanisms leading to decreased flood depths or frequency on land already susceptible to flooding.
		Surface Water Quality
		Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse, contributing to an improvement in water feature WFD classification.
		Estuarine Geomorphology
		Moderate changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Moderate changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to improvements of habitats and/or sensitive species. **Shoreline, intertidal and subtidal morphology** Moderate improvements to estuarine morphological diversity. **Estuarine processes** Moderate improvements to estuarine processes such as shoreline evolution or erosion and deposition
Major beneficial	Results in major improvement of attribute quality	**Flood Risk**
		Major alteration of flood mechanisms leading to decreased flood risk to sensitive receptors.
		Surface Water Quality
		Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse, resulting in an improvement in water feature WFD classification.
		Estuarine Geomorphology
		Major beneficial changes to the hydromorphological elements of the water body including: **Estuarine sediment regime** Major changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to improvements of habitats and/or sensitive species. **Shoreline, intertidal and subtidal morphology** Major improvements to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to an increase in morphological diversity with improvements to geodiversity or ecological quality. **Estuarine processes** Major improvements to estuarine processes such as shoreline evolution or erosion and deposition.

Magnitude	Criteria	Examples
No Change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Significance of Effects

7.3.13 The significance of effects (either with or without mitigation measures) was determined as a function of the environmental value (sensitivity) of the water feature and the magnitude of the predicted impact.

7.3.14 According to the environmental assessment methodology within DMRB LA 104, specifically for projects in Scotland, the significance of any effect shall be reported including embedded mitigation measures. Any residual effects shall be reported after assessment of the effectiveness of essential mitigation measures required to reduce and, if possible, offset likely significant adverse environmental effects. The matrix for the determination of significance, provided in the DMRB LA 104 guidance, is shown in Table 7.6.

7.3.15 Where the matrix indicates two alternative options (e.g. Slight/Moderate), the significance rating is selected using professional judgement, considering the sensitivity of receptor and duration or extent of works, in accordance with the DMRB LA 104 guidance.

7.3.16 For the purposes of this assessment, an effect significance of 'Moderate' or higher is considered significant in the context of The Roads (Scotland) Act 1984 (Environmental Impact Assessment) (Scotland) Regulations 2017 (hereafter referred to as the Roads EIA Regulations) and, therefore, is the focus of mitigation.

Table 7.6: Matrix for Determination of Significance

Magnitude / Environmental Value (Sensitivity)	No change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	**Moderate/Large**	**Large/Very Large**	**Very Large**
High	Neutral	Slight	Slight/**Moderate**	**Moderate/Large**	**Large/Very Large**
Medium	Neutral	Neutral/Slight	Slight	**Moderate**	**Moderate/Large**
Low	Neutral	Neutral/Slight	Neutral/Slight	Slight	Slight/**Moderate**

Embedded Mitigation

7.3.17 Within DMRB guidance LA 104 'embedded mitigation' is defined as *'design measures which are integrated into a project for the purpose of minimising environmental effects'*. Embedded mitigation has been factored into the project design principles and accounted for within potential impacts, in line with the Scotland National Application Annex to LA 104. As such, the significance of any effect (at both potential impact and residual impact stages) has been reported with embedded mitigation measures adopted.

7.3.18 Embedded mitigation measures which apply to this project are the piled viaduct design and operational drainage design. A description of each measure is provided in Section 7.5 (Potential Impacts).

Limitations and Assumptions

7.3.19 Baseline conditions described in Section 7.4 (Baseline Conditions) were informed by desk-based information, outlined in Table 7.2. It is recognised that some of the data presented may have limited applicability to the conditions today. However, any further modelling exercises would require a very high spatial resolution to detect changes from the baseline, and associated uncertainties are likely to outweigh any potential impacts. Therefore, based on the extent of the proposed works, the information provided in the 2003 ES and the subsequent 2009 ERR is considered to be adequate to inform the assessment.

7.3.20 Tide and flood levels were calculated using the Coastal Flood Boundary (CFB) dataset (Environment Agency 2020) and were derived from reported levels for the base year of 2017. This approach does not consider the potential effects of wave action, funneling or local bathymetry. The tide and flood levels were revised to account for sea level rise that has taken place between 2017 and 2020. Sea level rise was estimated using an approach based on the RCP 8.5 climate scenario and sea level rise allowances from the 95th percentile of UKCP18 (MetOffice 2020). The estimation of sea level rise between 2017 and 2020 is based on a conservative approach and therefore there is potential for an overestimation of actual current tidal levels. However, this conservative approach is deemed to be more appropriate for assessment purposes than assuming the 2017 levels. CFB data is produced at a strategic level, with points every 2km, and therefore it is recognised that the dataset has limitations in terms of detail provided. However, as the proposed scheme is not expected to permanently alter estuarine dynamics or cause a loss of floodplain storage, in this instance the CFB data is considered appropriate to inform the assessment.

7.3.21 No quantitative water quality assessment has been undertaken, as the impermeable areas associated with the replacement viaduct structure will remain the same as the current viaduct. Traffic levels are also not predicted to change from the baseline scenario as a result of the proposed scheme. Therefore, it is assumed that any discharges of road runoff or spillage risk will remain unchanged from the baseline conditions. In addition, any discharges would be to a coastal water body for which DMRB water quality assessments would not be appropriate.

7.3.22 No quantitative estuarine geomorphology assessment or modelling has been undertaken due to the lack of new permanent structures associated with the proposed scheme which could alter estuarine hydrodynamics.

7.3.23 For the purposes of the assessment of construction impacts it is assumed a temporary raised platform is required during construction to provide sufficient bearing capacity for the piling rig and to protect the works from daily tidal inundation. The extent of the raised platform will be subject to the Contractor's temporary works construction methodology, however for the purposes of this assessment, a worst-case scenario has been assessed whereby the raised platform corresponds with the Land Made Available (LMA) within the intertidal zone (as shown on Figure 7.1). The level of the raised platform construction will also be subject to the Contractor's temporary works construction methodology, however for the purposes of this assessment it is assumed the platform will be built to exceed the predicted 10% AEP (10-year) event flood level.

7.4 Baseline Conditions

Water Features

7.4.1 Within the 500m study area, two principal surface water features have been identified:

- Pow Burn; and
- Forth Estuary.

7.4.2 The Pow Burn enters the Forth Estuary approximately 290m west of the proposed scheme on the southern side of the estuary. The topography shows that there is no surface water hydraulic connectivity between the proposed scheme and the Pow Burn; therefore, this water feature has been scoped out of the assessment.

7.4.3 The Forth Estuary is composed of three WFD transitional water bodies and two of these are within the study area:

- the Upper Forth Estuary (ID: 200437), which is 9.7km^2; and
- the Middle Forth Estuary (ID: 200436), which is 38.2km^2.

7.4.4 The proposed scheme is located directly adjacent to both the Upper Forth Estuary and the Middle Forth Estuary.

7.4.5 There are a number of saltmarsh creeks and artificial drainage channels in the vicinity of the proposed scheme, as shown in Photograph 1. The artificial drainage channels drain surrounding agricultural land and the existing Sustainable Drainage System (SuDS) pond located at the Higgins Neuk Roundabout. The drains are predominately located within the intertidal area for the Forth Estuary and drain directly or indirectly into the estuary. The creeks are either fluvial with limited salt water exchange (mainly at their mouths), or as in the case of the saltmarsh areas, dominated by tidal processes, and hence will ebb and flood with the tide. These minor water features are considered collectively within the baseline description and impact assessment of the Forth Estuary.

7.4.6 All surface water features within the study area are shown on Figure 7.1.

Photograph 1: Existing viaduct and modified creek on northern side of Kincardine Bridge (left) and natural tidal creek south of Kincardine Bridge (right).

Flood Risk

Surface Water Flood Risk

7.4.7 A review of SEPA surface water flood mapping indicated there are scattered areas at risk of up to moderate surface water flooding during a medium likelihood (0.5% AEP) event (SEPA 2016).

Coastal Flood Risk

7.4.8 The proposed scheme is located in the coastal functional floodplain (defined as the 0.5% AEP (200-year) flood extent as shown on SEPA flood mapping (SEPA 2016)) associated with the Forth Estuary. The proposed scheme is also partly located within the intertidal zone for the Forth Estuary, and the area below Mean High Water Springs (MHWS) will be subject to twice daily tidal inundation. Coastal flood risk

mapping (Figure 7.2) identifies the surrounding area above MHWS as having a high likelihood of coastal flooding (10% AEP (10-year)).

7.4.9 Tides in the Forth Estuary are semi-diurnal (two high tides and two low tides daily) which results in prolonged periods of weak currents around the time of slack water (Elliot and Clark 1998). Tides change in height with low-water level and high-water level varying throughout the month, building up to maximum and falling to a minimum twice a month. The mean spring and mean neap tidal range at Kincardine is summarised in Table 7.7, below (ABPmer 2018).

Table 7.7: Kincardine Mean Spring and Neap Tidal Levels (mAOD) (UKHO 2017)

Mean High Water Spring (MHWS)	Mean Low Water Spring (MLWS)	Mean High Water Neap (MHWN)	Mean Low Water Neap (MLWN)
2.95	-2.35	1.65	-1.15

7.4.10 The study area for the proposed scheme is located within two Potentially Vulnerable Areas (PVAs) as identified within SEPA's Flood Risk Management Strategy (SEPA 2015a). The majority of the study area is located within PVA 10/11, a large PVA of 215km^2 containing the towns of Grangemouth, Falkirk, Denny and Cumbernauld. PVA 10/11 has few properties in the vicinity of the study area (1-50 people at risk and one non-residential property).

7.4.11 PVA 10/09 is a significantly smaller coastal area of 4km^2 in the north of the study area, containing the village of Airth, located approximately 3km from Kincardine Bridge. There is a total of approximately 110 residential properties and <10 non-residential properties at risk of flooding within PVA 10/09, however these are located outwith the study area for the proposed scheme.

7.4.12 The Local Flood Risk Management Plan for the Forth Estuary Local Plan District (The Edinburgh City Council 2016) presents actions to avoid and reduce the risk of flooding for PVAs. This does not identify any significant flood events within the vicinity of the proposed scheme, and all proposed flood protection works are related to coastal flooding south of the proposed scheme at Grangemouth, Bonnybridge, Denny and Carron.

7.4.13 There are no commercial and industrial properties or community facilities within the study area. The land immediately surrounding the proposed scheme comprises non-prime agricultural land of Land Capability and Agriculture (LCA) Classes 3.2 and 5.3 (James Hutton Institute 2020). This is not currently used as productive agricultural land, however it does form part of the Firth of Forth Special Protection Area (SPA), Ramsar and Site of Special Scientific Interest (SSSI).

7.4.14 There are two residential properties within the study area, located north of Higgins Neuk Roundabout, approximately 150m north-west from the existing piled viaduct (as shown on Figure 11.2: Construction Dust Assessment Study Areas And Human And Ecological Receptors), which are partially at risk from a 0.5% AEP (200-year) coastal flood event, based on SEPA flood mapping. Based on the CFB dataset, flood levels indicate that the Kincardine Bridge and associated trunk roads within the study area are located above the 0.5% AEP (200-year) coastal flood level.

7.4.15 Due to two properties within the study area being at risk of flooding during the 0.5% AEP (200-year) coastal flood event, the Forth Estuary has been assigned an environmental value (sensitivity) of high in relation to flood risk.

Future Baseline

7.4.16 Long-term projected conditions for water features within the study area will be influenced by increases to flow conditions as a result of climate change. Increases to sea-levels for Edinburgh, located on the Firth of Forth, are predicted by the UK Climate Projections (UKCP) (Met Office 2018) as ranging from 0.49m to 1.13m by 2100 (dependent on the emission scenario). Specifically, for the Forth river basin

region, coastal waterbodies are predicted to experience a cumulative sea-level rise of 0.86m between 2017 to 2100 (SEPA 2019b).

Surface Water Quality

Licensed Abstractions and Discharges

7.4.17 As advised by SEPA in a consultation response received 4 September 2018, there are four Scottish Water sewage discharges licensed under CAR within 1km of the scheme. These are located at Kincardine, on the opposite side of the Forth Estuary from the proposed scheme.

Existing Road Drainage Network

7.4.18 The existing road drainage network on the piled viaduct comprises kerbs and gullies, which feed into carrier drains and discharge directly into the Forth Estuary. No treatment is currently provided for road runoff from the viaduct.

7.4.19 There is a SuDS pond located to the south of Higgins Neuk Roundabout which treats and attenuates runoff from the A876 South Approach Road. The SuDS pond discharges into an open drainage channel which runs adjacent to the existing piled viaduct before entering a modified saltmarsh creek and subsequently the Forth Estuary.

7.4.20 There are likely to be some pollutants (metals and hydrocarbons) associated with road runoff entering the saltmarsh creeks and the Forth Estuary.

Forth Estuary

7.4.21 Historically, water quality in the Forth Estuary has been heavily influenced by discharges of organic contaminants from agricultural and industrial outputs, resulting in low dissolved oxygen levels. Oxygen is predominately removed through the degradation of organic matter in the Maximum Turbidity Zone (MTZ), which is associated with a zone of high suspended solids in the low salinity zone of the upper estuary. Since 1980 however, dissolved oxygen concentrations have been increasing in line with a decrease of organic inputs into the estuary (Marine Scotland 2011).

7.4.22 The extent of the Forth Estuary within the study area is classified by SEPA under WFD as two separate transitional water bodies: Upper Forth Estuary (ID: 200437) and Middle Forth Estuary (ID: 200436). The Upper Forth Estuary also includes the lower reach of the Pow Burn (ID: 3205) within the study area, as shown on Figure 7.1.

7.4.23 The transitional water bodies both have an overall status of 'Moderate ecological potential' and overall ecology of 'Moderate' (SEPA 2019d). The physico-chemical status for both water bodies is classified as 'Good' (SEPA 2019d). The intertidal area (between MLWS and MHWS) of both water bodies form part of the Firth of Forth SPA, SSSI and Ramsar site (Figure 8.1).

7.4.24 The drainage channels feeding into the Forth Estuary within the study area are not monitored by SEPA, however according to the 2003 ES, SEPA stated that the water quality of these features is likely to be relatively poor due to low flows and ferruginous water from coal measures.

7.4.25 A tidally influenced drainage channel south and adjacent to the existing piled viaduct, identified as Tidal Ditch 1 in the 2003 ES, was sampled in April 2003. The water was described as turbid with a silt/mud substrate, substantial filamentous algae growth and oil flecks at the surface. Water quality testing carried out observed low dissolved oxygen levels of 7.15 mg/l and high electrical conductivity of >2000 uS/cm (consistent with being in a coastal environment).

7.4.26 Due to the associated international ecological designations, the Forth Estuary has been assigned an overall environmental value (sensitivity) of very high in terms of surface water quality.

Future Baseline

7.4.27 The SEPA Water Environment Hub (SEPA 2015b) provides target conditions for 2021 and 2027 for watercourses. The predicted Overall condition for both the Upper and Middle Forth estuary is targeted as Moderate for 2021 and Good for 2027. Water quality targets for these waterbodies are anticipated to remain as Good until 2027 and in the long term.

Estuarine Geomorphology

Forth Estuary

7.4.28 The Forth Estuary is a ria-type estuary which is described as an indented drowned feature fringing rocky, glaciated lowlands (Department for Environment, Food and Rural Affairs (Defra) 2008). The estuary was formed largely by glacial action excavating deep basins as ice scoured the landscape, exploiting present river valleys. Following the last ice age (approximately 12,000 years ago), the ice retreated, and sea-levels rose flooding the Forth valley up to Menteith and Aberfoyle. Subsequently, the land rose through a process of glacio-isostatic readjustment and flat fertile lands at the head of the Firth of Forth emerged. The varied morphological features of the Forth Estuary comprise saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle and brackish lagoons.

7.4.29 The Firth of Forth is predominantly characterised by fine sediments (silts and clays) with coarser grained sands and gravels occurring around constrictions in the estuary where scour may occur, such as the Kincardine Bridge and Grangemouth Docks. Fine sediment is supplied from fluvial systems entering the Firth of Forth, which may contribute to the extensive mudflats in the region (Firth *et al*. 1997).

7.4.30 The Middle Forth Estuary and Upper Forth Estuary transitional water bodies are both currently classified as being at an overall 'Moderate' status for hydromorphology according to SEPA's Water Classification Hub (SEPA 2019d).

7.4.31 The water bodies are failing to achieve 'Good' status on morphology primarily due to man-made physical alterations that cannot be addressed without a significant impact on navigation and from an increased risk of subsidence or flooding.

7.4.32 Within the study area, intertidal saltmarsh and mudflats exist. The mudflats are mainly supplied with fine material on each tide from the relatively high suspended sediment concentrations within the estuary, in particular through the areas of channel restriction at Kincardine Bridge, either side of the `proposed scheme. At this location in the estuary the constriction leads to turbulent flows and a resuspension of sediment (ABPmer 2014). The large intertidal area contributes to the estuary's flood storage at high tide and forms a large sediment sink. This creates a 'soft', gently sloping surface mud layer which is easily eroded by tidal action and wave disturbance, creating high suspended sediment loads within the area.

7.4.33 Historically, land claim for primarily agricultural and industrial uses has occurred on much of the natural intertidal zone, which would previously have consisted mainly of creeks, inlets, saltmarsh and mudflats. It has been estimated that, across the whole estuary, this has resulted in an intertidal habitat loss of between 33% and 50% of the pre-existing area over the last 160 years (RSPB 2012).

7.4.34 The Forth Estuary intertidal zone is a designated SSSI due to its notified natural features including saltmarsh, sand dunes and mudflats (SNH 2020) and is also classified as a Ramsar and the water body qualifies as a SPA due to its recognised estuarine and coastal habitat which supports various species of European importance.

7.4.35 Overall, due to the associated designations, the Forth Estuary has been assessed as having a very high environmental value (sensitivity) in terms of estuarine geomorphology.

Future Baseline

7.4.36 SEPA's Water Environment Hub (SEPA 2015b) states the target for the Physical condition of both the Upper Forth and Middle Forth are Moderate for 2021 and Good for 2027 and in the long-term. Due to the extent of modification and scale of the programme of work required on these waterbodies requiring improvement to their physical condition, SEPA have cited technical infeasibility for reaching a target of Good in 2021.

7.4.37 As mentioned in paragraph 7.4.16 long-term projected conditions for coastal waterbodies within the Forth river basin region are predicted to experience a cumulative sea-level rise (SEPA 2019b). This may cause marsh vegetation to move upward and migrate further inland in a process of roll-back. Due to the land use forming a barrier with the saltmarsh environment at its landward boundary, and also the A876 (South Approach Road), this may be prevented from occurring. This can lead to coastal squeeze and loss of marsh area (Hughes 2004) due to progressive narrowing of the foreshore and lowering of the saltmarsh profile which promulgates this process. Another potential consequence of this is that vertical accretion of the saltmarsh becomes diminished or is prevented because accretion/sediment deposition cannot keep pace with the increase in water levels, which ultimately drowns out the saltmarsh.

7.4.38 Climate change may also increase the rate of evaporation on the soil surface and hence increase salt concentration, making it hypersaline, or alternatively by increasing the rate of precipitation, reducing the salinity of the soil and making it hyposaline. High soil salinities may lead to the death of plants, even halophytic (salt tolerant) plants and the formation of salt pans. This further promotes areas of bare mud that may, or may not, retain water (Hughes 2004). In both cases the habitat in the area may become unsuitable for further colonisation and cause these areas of unprotected sediment to become more susceptible to physical erosion than the surrounding vegetated marsh prone to over wash further promoting their size.

7.5 Potential Impacts

7.5.1 Throughout the design process, a number of 'embedded mitigation' features have been included in the proposed scheme design.

7.5.2 These embedded mitigation features are considered within the context of the impact assessment as providing mitigation to avoid or reduce environmental impacts. These measures are detailed in Chapter 3 (The Proposed Scheme).

7.5.3 Those specific opportunities identified at the time of assessment, with the potential to reduce impacts on the water environment, and which have been incorporated into the design include those identified below:

- Piled viaduct design: The proposed piled viaduct replacement structure will comprise spans of a similar size and appearance to the existing 15m spans of the adjacent Kincardine Bridge structure. This will result in minimal potential for local alterations to flow patterns, increased erosion and sedimentation, and flood storage losses.
- Operational drainage design: The current drainage system for Kincardine Bridge discharges directly into the Forth Estuary with no treatment or attenuation. The new drainage associated with the proposed scheme will discharge to the existing SuDS basin at the Higgins Neuk Roundabout, prior to discharging to the Forth Estuary. The new drainage system has been designed to accommodate the 20% AEP (5-year) return period rainfall event, including a 35% allowance for climate change in line with the latest SEPA guidance (SEPA 2019b). Sensitivity testing has confirmed the existing SuDS basin capacity is not exceeded by the proposed design flow.

7.5.4 The following key activities associated with the proposed scheme are considered to have the potential to cause adverse impacts on the water environment:

- Site preparation including formation of a site compound in the area of an existing SuDS pond south of the A876 South Approach Road;
- Construction of a temporary raised working platform to facilitate construction and support a temporary bridge, required to maintain traffic flow during construction;
- Demolition of the existing 80m piled viaduct and construction of new piled viaduct; and
- Removal of the working platform, site compounds and associated hardstanding.

7.5.5 The majority of the existing piled viaduct is located below MHWS on the south bank of the Forth Estuary.

Flood Risk

Construction

7.5.6 Tidal movements may be restricted during construction due to the use of a raised temporary working platform. The temporary working platform will also involve land raising within the coastal floodplain, therefore resulting in a loss of floodplain storage and potential subsequent increases in flood depth due to the displacement of floodwater. The temporary working platform would be in place for an indicative period of approximately 18-24 months, and so the likelihood of a flood event is low.

7.5.7 The LMA for construction represents the worst-case scenario for the extent of any temporary working platform, though it is likely that the platform would be smaller. The LMA for construction has been estimated to be 3.87ha, of which 3.16ha is located within the indicative 10% AEP (10-year) floodplain based on the CFB dataset. The platform may potentially result in a loss of 3.16ha of the 10% AEP (10-year) floodplain area, representing 2.79% of the overall 10% AEP (10-year) floodplain area within the 500m study area for the proposed scheme. However, the percentage of floodplain storage volume loss that this represents is likely to be far smaller, given the shallow floodwater depths where the platform is proposed.

7.5.8 Should a flood event occur during construction, the displacement of coastal floodwater from the temporary working platform is unlikely to result in any discernible increase in flood depth or extent, due to the size of the Forth Estuary and the nature of the surrounding topography. It is also considered that the land raising required for the temporary working platform will not have a measurable impact on the existing flood conveyance and existing flooding pathways in the vicinity of the proposed scheme. No flood risk impacts are anticipated to sensitive receptors as a result of the construction of the proposed scheme, and only very localised increases in flood depths may occur on adjacent intertidal agricultural land.

7.5.9 There will be an inherent risk of flooding to the proposed construction activities that are located below MHWS. The inundation protection to be adopted during construction will be subject to the Contractor's temporary works construction methodology. The magnitude of impact of flood risk during construction has been assessed as moderate adverse, resulting in a Moderate adverse significance of effect.

Operation

7.5.10 The proposed piled viaduct will allow the continued free movement of tidal waters in this area. No additional permanent structures or earthworks are proposed which would result in a net loss of floodplain storage compared to the existing conditions. As a result, it has been assessed that the new piled viaduct structure will not cause a change from current conditions with regards to tidal movement and flood risk and will therefore not result in any change to flood risk to sensitive receptors within the study area.

7.5.11 An increase of 0.86m is predicted in Forth Estuary sea levels by 2100 as a result of climate change (SEPA 2019b). An assessment of proposed scheme levels against flood levels has not been undertaken, as the road levels will not be changing from the existing conditions. However, flood level data provided by the

Coastal Flood Boundary Method has indicated that the proposed scheme will be above the 0.5% AEP year event including the 0.86m uplift for climate change.

7.5.12 Impacts to flood risk as a result of the new structure have been assessed as having a magnitude of no change, resulting in a Neutral significance of effect.

Surface Water Quality

Construction

7.5.13 Due to the location of the proposed works, and requirement for in-water working, there is a potential risk of pollutants entering the marine environment as a result of disturbance of estuarine sediments, storage of excavated soils on site, and accidental spillages. The re-suspension of estuarine sediment may release previously contained contaminants and nutrients into the water environment. Spillages may involve oils, chemicals and concrete which can cause subsequent toxic effects on marine ecology.

7.5.14 Ground Investigation information found no evidence of contamination within the saltmarsh, as described in Chapter 6 (Geology, Soils and Groundwater). Therefore, impacts to water quality from mobilisation of pollutants from the saltmarsh is considered to be unlikely.

7.5.15 The risk of spillages and pollutants entering the marine environment may be exacerbated by inappropriate storage of materials within the intertidal zone. As highlighted in paragraphs 7.5.6 to 7.5.9 the construction activities will be at risk of flooding and subsequently flood events may result in pollution incidents through the mobilisation of materials and chemicals stored within the coastal floodplain. Pollutants may also enter the marine environment through poor management and storage of runoff and waste materials during controlled construction works such as the demolition of the existing viaduct.

7.5.16 Any impacts would be temporary, and the extent of construction activities and potential associated pollutant sources are limited in comparison to the size of the Forth Estuary and the number of existing pollutant sources. Nonetheless, as the proposed scheme is located within the Firth of Forth SSSI, Ramsar and SPA, potential impacts on surface water quality are considered to be of a moderate adverse magnitude, resulting in a Large adverse significance of effect prior to mitigation.

Operation

7.5.17 Drainage associated with the existing piled viaduct comprises a road gully which discharges directly to the Forth Estuary, with no attenuation or treatment of road runoff.

7.5.18 The proposed drainage for the new structure would comprise kerb and gully arrangements connecting with carrier drains. These would feed into an existing manhole which drains to the existing SuDS pond adjacent to the Higgins Neuk Roundabout. There is no predicted increase in impermeable area or traffic flows associated with the proposed scheme, therefore overall pollutant loadings from the routine runoff and potential spillage incidents would remain unchanged from the baseline scenario.

7.5.19 As the road runoff associated with proposed scheme will undergo additional SuDS treatment compared to the current situation, the proposed scheme is anticipated to result in a beneficial impact on surface water quality during operation. However, the drainage catchment associated with the proposed scheme is small in comparison to the overall surrounding trunk road network draining to the Forth Estuary and the beneficial impacts are likely to be imperceptible. Therefore, impacts have been assessed as negligible beneficial, resulting in a Slight beneficial significance of effect.

Estuarine Geomorphology

Construction

7.5.20 Potential impacts during the construction phase would generally relate to localised and temporary changes in shoreline morphology associated with the temporary works for the existing viaduct. These works include construction of the temporary raised platform, piers and approach piers supporting the temporary bridge structure, the temporary infilling of saltmarsh creeks and temporary realignment of the south side drainage channel to accommodate the raised platform.

7.5.21 The temporary realignment of the south side drainage channel/modified saltmarsh creek under the proposed working platform could lead to changes of the morphological features present (notably the natural saltmarsh creeks) and a temporary increase in fine sediment delivery. Erosion is likely to be most prevalent at the seaward boundary of the platform at the juxtaposition with the saltmarsh boundary, which also coincides with the tide level.

7.5.22 The lining and infilling required for the saltmarsh creeks, along with the drainage channels, may result in impacts to (creek) bed morphology, sediment transportation and tidal flows. This is assumed to be temporary, however it may result in long-term or permanent changes to the creeks. The likelihood is that there may be some channel widening of the creeks due to progressive winnowing away of material at the boundary with the infilled section, predominantly on the ebb and the flood through flow and drain out as slack water condition changes. This process is likely to operate slowly. A loss of vegetation, due to the requirement for the working platform, could result in increased erosion and sediment loss, causing subsequent ecological impacts from habitat degradation and disturbance.

7.5.23 There is also likely to be a release of sediment into the water column during piling for the temporary bridge and new viaduct structures, which has the potential to temporarily and locally increase suspended sediment concentrations above normal background levels.

7.5.24 However, these changes, in terms of their spatial and temporal extent during the tidal cycle, are not considered to be large enough to significantly increase the potential for scour, erosion, transport or deposition (i.e. morphological change). The temporary works are therefore considered to result in a minor impact magnitude and a Moderate adverse significance of effect on the estuarine geomorphology of the Forth Estuary, prior to essential mitigation.

Operation

7.5.25 There would potentially be localised changes to the bed and shoreline morphology of the Forth Estuary due to increased scour and erosion as a result of changes in tidal flow velocities and inundation associated with the new piers for the piled viaduct replacement structure. Piers have been positioned to be similar to the adjacent existing structure as part of the embedded mitigation associated with the proposed scheme. Flows are anticipated to be similar to the baseline scenario and therefore scour and the effect on the rate of accretion/erosion of sediment within the site would be unlikely to be increased from the baseline conditions during the operational phase.

7.5.26 The new viaduct structure is therefore considered to have a negligible impact magnitude and Slight adverse significance of effect on the estuarine geomorphology of the Forth Estuary.

7.6 Mitigation

Introduction

7.6.1 In line with DMRB LA 104 guidance, essential mitigation is defined as those that are *'critical for the delivery of a project which can be acquired through statutory powers'*. Furthermore, in this chapter essential mitigation is defined as measures not embedded in the scheme design but measures

committed to during later stages of the project to avoid and reduce significant effects. The objective of this section is the identification of essential mitigation measures that are required to avoid, prevent, reduce or offset all impacts (i.e. not just significance of effect of Moderate or above).

7.6.2 The proposed essential mitigation measures consider current best practice, legislation and guidance during both construction and operational phases of the proposed scheme. The mitigation measures outlined in this section will be included within an Environmental Management Plan (EMP) for the proposed scheme (in accordance with DMRB guidance LA 120 'Environmental management plans' (formerly IAN 183/14 and 183/16 – Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2019).

7.6.3 The mitigation measures are outlined with the expectation and assumption that the appointed Contractor of the proposed scheme will adhere to the following practices:

- According to DMRB LA 120, the project EMP should be refined in advance of construction when the proposed scheme has been consented. Along with the refined EMP, Construction Method Statements (CMS) will be prepared for each construction activity which will provide clear linkage to the proposed methods and mitigation measures as set out within this chapter as well as the original EMP; and
- In all applicable instances, SEPA Guidance for Pollution Prevention (GPPs) (NetRegs 2020) and other good practice guidance (refer to Table 7.8) will be followed.

7.6.4 Essential mitigation commitments that are to be implemented during construction and operation are detailed below.

Flood Risk

7.6.5 **Mitigation Item W1:** To mitigate the potential significant effects from flood risk during construction, a Flood and Tidal Response Plan will be developed by the Contractor which will include:

- Detail on expected tidal levels, nature and timings during the construction phase;
- Inundation protection of construction activities located within the intertidal zone and 10% AEP (10-year) flood extent (where appropriate). Inundation protection for temporary works should be provided up to the 10% AEP (10-year) flood level in line with CIRIA C648 (Construction Industry Research and Information Association (CIRIA) 2006a);
- Use of Met Office construction specific forecasting services and SEPA's Floodline Scotland to predict adverse weather and tidal conditions;
- Systems and protocols to follow in the event of adverse weather and tidal conditions including evacuation plans;
- Programming and phasing of works to reflect the intertidal conditions and time when land-based plant will likely be unavailable for work; and
- Erosion protection measures for temporary works and structures located within the intertidal zone and 10% AEP flood extent (where appropriate).

Surface Water Quality

7.6.6 **Mitigation Item W2**: Compliance with the conditions of the Marine licence, Construction Site Licence (if required) and any CAR authorisation (if required);

7.6.7 **Mitigation Item W3:** To mitigate the potentially significant effects on water quality during the construction phase, a Pollution Prevention Plan will be developed by the Contractor, which will include:

- A Pollution Incident Response Plan for all on-site activities including specific measures for intertidal works and spillage response procedures;

- Spillage kits to be stored at key locations on site and an appropriate temporary boom (such as a shore sealing boom) to be implemented in the case of a pollution event;
- Minimisation of disturbance of potentially contaminated estuarine sediments, for example through the use of raised platform and minimising the extent of temporary work areas;
- Isolation of any works in the intertidal zone that are intended to continue to operate during high tide, likely using a raised platform;
- Details of appropriate collection of water within excavations or isolated work areas and delivery to treatment facilities as per **Mitigation Item W4**;
- Rehabilitation of disturbed ground in line with the Saltmarsh Management Plan (described in **Mitigation Item W12**) as soon as possible after the work has been completed to reduce the risk of erosion and mobilisation of contaminants; and
- Plans showing the storage of fuels, chemicals, oils, concrete washes, water storage and treatment systems plant and any other potentially polluting materials outside of the intertidal zone and 10% AEP flood extent.
- Plans showing the storage of fuels, chemicals, oils, concrete washes, water storage and treatment systems and any other potentially polluting materials at least 10m from any drainage channel, saltmarsh creek or intertidal area, where practicable.

7.6.8 **Mitigation Item W4:** A detailed construction site run-off drainage design should be developed by the Contractor. This should comprise a closed-loop system, to ensure run-off or spillages do not enter the inter-tidal habitat surrounding the site, and should pump any collected water within excavations or isolated works to appropriate treatment facilities (likely comprising a proprietary treatment system and dosing system and supporting header tanks to store excess capacity). Water discharged from treatment facilities must be of an acceptable quality, in line with SEPA's GBR10 and should the Contractor propose to discharge to the Firth of Forth SEPA must be satisfied that an appropriate discharge quality is achieved.

7.6.9 During construction the proposed scheme will require mitigation in the form of good practice to reduce the impact to the water environment during construction. These should include:

- **Mitigation Item W5**: Adherence to SEPA's Guidance for Pollution Prevention (GPPs) and CIRIA's Coastal and Marine Environmental Site Guide (C744) (CIRIA 2015b) and Environmental good practice on site guide (C741) (CIRIA 2015a). Appropriate measures will include, but may not be limited to:
  - avoiding unnecessary stockpiling of materials and exposure of bare surfaces;
  - use of an appropriate grade of material on temporary surfaces that will be clean and will be durable under heavy trafficking;
  - maintenance and regrading of temporary surfaces where issues are encountered with the breakdown of the existing surface and generation of fine sediment; and
  - provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10m from water features where practicable.
- **Mitigation Item W6:** Installation of temporary treatment facilities to protect water quality and promote flow attenuation during construction following CIRIA's guidance including C648 (CIRIA 2006a), C649 (CIRIA 2006b) and C744 (CIRIA 2015b) and compliance with GBR 10 of The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR);
- **Mitigation Item W7:** Preparation of a Construction Environmental Management Plan (CEMP) prior to commencement of works;
- **Mitigation Item W8:** Compliance of any chemical, fuel and oil storage with the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) and SEPA GPP02, including a secondary containment system providing a capacity of at least 110% of the volume of the tank.

Storage of excavated soils and made ground should be minimised and all storage areas appropriately lined, in line with **Mitigation Item G11** within Chapter 6 (Geology, Soils and Groundwater); and

- **Mitigation Item W9:** A suitably qualified and experienced Environment Clerk of Work (EnvCoW) shall be appointed by the Contractor to oversee the implementation of mitigation and monitoring of the water environment.

Estuarine Geomorphology

7.6.10 **Mitigation Item W10:** Any further refinement of the permanent piled viaduct replacement structure design will be undertaken in accordance with environmental good practice guidance (CIRIA 744) (CIRIA 2015c) and will receive input from the appropriate environmental specialists to ensure no significant effects on the water environment will occur during the operational phase.

7.6.11 **Mitigation Item W11:** The working area located on saltmarsh should be minimised as far as practicable in order to limit the extent of impact to saltmarsh creeks.

7.6.12 **Mitigation Item W12**: Prior to construction the Contractor will develop a Saltmarsh Management Plan, as outlined in Chapter 8 (Marine Ecology) **Mitigation Item ME6**. This should include the following measures to mitigate potential impacts on estuarine geomorphology during the construction and operational phase:

- Methodology for restoration of saltmarsh geomorphological features (including creeks) post-construction;
- Pre and post construction monitoring of saltmarsh habitat, by a suitably qualified Environmental Clerk of Works (EnvCoW), to include photographic record of existing creeks, habitat types and extent, species diversity and scour assessments around new or removed structures; and
- Measures to minimise future scour and erosion and promote recovery of saltmarsh vegetation.

Schedule of Environmental Commitments

7.6.13 A summary of the essential mitigation measures, to be implemented in constructing and operating the proposed scheme relevant to road drainage and the water environment, is provided in Table 7.8. Chapter 17 (Schedule of Environmental Commitments) contains the complete schedule of measures for the proposed scheme.

Table 7.8: Schedule of Environmental Commitments - Road Drainage and the Water Environment

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
W1	Contractor	Pre-construction and Construction	To mitigate the potential significant effects from flood risk during construction, a Flood and Tidal Response Plan will be developed by the Contractor which will include: • Detail on expected tidal levels, nature and timings during the construction phase; • Inundation protection of construction activities located within the intertidal zone and 10% AEP (10-year) flood extent (where appropriate). Inundation protection for temporary works should be provided up to the 10% AEP (10-year) flood level in line with CIRIA C648 (CIRIA 2006a); • Use of Met Office construction specific forecasting services and SEPA's Floodline Scotland to predict adverse weather and tidal conditions; • Systems and protocols to follow in the event of adverse weather and tidal conditions including evacuation plans; • Programming and phasing of works to reflect the intertidal conditions and time when land-based plant will likely be unavailable for work; and • Erosion protection measures for temporary works and structures located within the intertidal zone and 10% AEP flood extent (where appropriate).	Prevent flood incidents during construction	Plans will be linked to Environmental Management Plan (EMP) and Construction Site License (CSL) (if required) so will need approval by SEPA	Duties and responsibilities of hired EnvCoW may include monitoring implementation of Flood and Tidal Response Plan. Site visits from SEPA staff will likely check compliance Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.
W2	Contractor	Pre-construction and Construction	Compliance with the conditions of the Marine licence, CSL (if required) and any CAR authorisation (if required).	Good practical guidance followed during design, construction and post-construction	CAR Licence approval for new or changes to existing engineering structures by SEPA (if required)	Duties and responsibilities of hired EnvCoW may include monitoring of CAR licence compliance. Site visits from SEPA staff will likely check compliance. Requirement for EnvCoW supervision will be included as an

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
						Employer's Requirement in Contract.
W3	Contractor	Pre-construction and Construction	To mitigate the potentially significant effects on water quality during the construction phase, a Pollution Prevention Plan will be developed by the Contractor, which will include: • A Pollution Incident Response Plan for all on-site activities including specific measures for intertidal works and spillage response procedures. • Spillage kits to be stored at key locations on site and an appropriate temporary boom (such as a shore sealing boom) to be implemented in the case of a pollution event. • Minimisation of disturbance of potentially contaminated estuarine sediments, for example through the use of floating track and minimising the extent of temporary work areas. • Isolation of any works in the intertidal zone that are intended to continue to operate during high tide, likely using a raised platform. • Details of appropriate collection of water within excavations or isolated work areas and delivery to treatment facilities as per **Mitigation Item W4**. • Rehabilitation of disturbed ground in line with the Saltmarsh Management Plan (described **in Mitigation Item W12**) as soon as possible after the work has been completed to reduce the risk of erosion and mobilisation of contaminants. • Plans showing the storage of fuels, chemicals, oils, concrete washes, water storage and treatment systems and any other potentially polluting materials outside of the intertidal zone and 10% AEP flood extent. • Plans showing the storage of fuels, chemicals, oils, concrete washes, water storage and treatment systems and any other potentially polluting materials at least 10m from any drainage channel, saltmarsh creek or intertidal area, where practicable.	Prevent pollution incidents during construction	PPP proposals will be linked to EMP and CSL (if required) so will need approval by SEPA	Duties and responsibilities of hired EnvCoW may include monitoring implementation of PPP. Site visits from SEPA staff will likely check compliance. Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
W4	Contractor	Pre-construction and Construction	A detailed site run-off construction drainage design should be developed by the Contractor. This should comprise a closed-loop system, to ensure run-off or spillages do not enter the inter-tidal habitat surrounding the site, and should pump any collected water within excavations or isolated works to appropriate treatment facilities (likely comprising a proprietary treatment system and dosing system and supporting header tanks to store excess capacity). Water discharged from treatment facilities must be of an acceptable quality, in line with General Binding Rule (GBR) 10 (Scottish Government 2017b) and should the Contractor propose to discharge to the Firth of Forth SEPA must be satisfied that an appropriate discharge quality has been achieved.	Prevent pollution incidents during construction	Proposals will be linked to PPP, EMP and CSL (if required) so will need approval by SEPA.	Duties and responsibilities of hired EnvCoW may include monitoring of water quality of discharge. Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.
W5	Contractor	Pre-construction and Construction	Adherence to SEPA's Guidance for Pollution Prevention (GPPs) and CIRIA's Coastal and Marine Environmental Site Guide (C744) and Environmental good practice on site guide (C741). Appropriate measures will include, but may not be limited to: • avoiding unnecessary stockpiling of materials and exposure of bare surfaces; • use of an appropriate grade of material on temporary surfaces that will be clean and will be durable under heavy trafficking; • maintenance and regrading of temporary surfaces where issues are encountered with the breakdown of the existing surface and generation of fine sediment; and • provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10m from water features where practicable.	To protect the water environment and ecology.	None required	Duties and responsibilities of hired EnvCoW may include monitoring implementation of good practice guidance. Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.
W6	Contractor	Pre-construction and Construction	Installation of temporary treatment facilities to protect water quality and promote flow attenuation during construction following CIRIA's guidance including C648 (CIRIA 2006a) and C744 (CIRIA 2015c) and compliance with GBR 10 of The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR).	Prevent sediment laden runoff discharging from site.	None required	Duties and responsibilities of hired EnvCoW may include monitoring this aspect of construction. Requirement for EnvCoW supervision

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
						will be included as an Employer's Requirement in Contract.
W7	Contractor	Pre-construction and Construction	Preparation of a Construction Environmental Management Plan (CEMP) prior to commencement of works.	To provide a framework for the implementation of construction activities in accordance with the environmental commitments and mitigation measures in the EIA Report. It will be developed and evolve to avoid, reduce or mitigate construction impacts on the environment and the surrounding community.	None required	Duties and responsibilities of hired EnvCoW may include monitoring implementation of the CEMP. Requirement for CEMP and EnvCoW supervision will be included as an Employer's Requirement in Contract.
W8	Contractor	Pre-construction and Construction	Compliance of any chemicals, fuel and oil storage required under CAR and SEPA PPG02, including a secondary containment system providing a capacity of at least 110% of the volume of the tank. Storage of excavated soils and made ground should be minimised and all storage areas appropriately lined, in line with **Mitigation Item G11** within Chapter 6 (Geology, Soils and Groundwater).	To reduce impacts on the water environment in relation to oil/fuel leaks and spillages.	None required	Duties and responsibilities of hired EnvCoW may include monitoring this aspect of construction. Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.
W9	Contractor	Pre-construction and Construction	A suitably qualified and experienced EnvCow shall be appointed by the Contractor to oversee the implementation of mitigation and monitoring of water environment	To monitor the implementation of the mitigation measures identified and ensure that activities are carried out in such a manner to prevent or reduce	Approval by Transport Scotland	Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
				impacts on the environment.		
W10	Contractor	Pre-construction, Construction and Post-construction phases	Any further refinement of the permanent piled viaduct replacement structure design will be undertaken in accordance with environmental good practice guidance (CIRIA 2015c) and will receive input from the appropriate environmental specialists to ensure no significant effects on the water environment will occur during the operational phase.	To ensure no significant effects on the water environment arise.	Consultation with SEPA and Marine Scotland	None required.
W11	Contractor	Construction	The working area located on saltmarsh should be minimised as far as practicable.	To limit the extend of impacts to saltmarsh creeks	None required.	None required.
W12	Contractor	Pre-construction, Construction and Post-construction phases	Prior to construction, the Contractor will develop a Saltmarsh Management Plan, outlined in Chapter 8 (Marine Ecology) **Mitigation Item ME6**. This should include the following measures to mitigate potential impacts on estuarine geomorphology during the construction and operational phase: • Methodology for restoration of saltmarsh geomorphological features (including creeks) post-construction; • Pre and post construction monitoring of saltmarsh habitat, by a suitably qualified Environmental Clerk of Works (EnvCoW), to include photographic record of existing creeks, habitat types and extent, species diversity and scour assessments around new or removed structures; and • Measures to minimise future scour and erosion and promote recovery of saltmarsh vegetation.	To mitigate the potential impacts on estuarine geomorphology during the construction and operational phase	Consultation with Scottish Natural Heritage (SNH)	Duties and responsibilities of hired EnvCoW include monitoring of saltmarsh habitat pre and post construction and monitoring of implementation of Saltmarsh Management Plan. Requirement for EnvCoW supervision will be included as an Employer's Requirement in Contract.

7.7 Residual Effects

7.7.1 Following the implementation of both embedded and essential mitigation measures outlined in Section 7.5 (Potential Impacts) and Section 7.6 (Mitigation) respectively, the potential for significant effects on the surface water environment would be avoided/prevented, reduced or offset.

7.7.2 During the construction phase, significant effects would have been reduced through the adoption of essential mitigation, including pollution prevention measures, flood inundation protection and a commitment for the restoration of saltmarsh geomorphological features. Residual effects for the operational phase remain unchanged, as embedded mitigation in the form of replacing the existing piled viaduct structure with a structure of similar size and appearance as the adjacent spans of the Kincardine Bridge has already reduced the potential for significant effects.

7.7.3 In summary, no residual effects of Moderate significance or above are expected during either construction or operation. The residual effects on the Forth Estuary, in terms of flood risk, surface water quality and estuarine geomorphology, are summarised in Table 7.9.

Table 7.9: Residual Effects

Attribute	Potential Impact	Environmental Value (Sensitivity)	Magnitude	Significance	Key Mitigation	Residual Magnitude	Residual Significance
Construction							
Flood Risk	Coastal flood risk to construction activities	High	Moderate Adverse	**Moderate Adverse**	The Contractor will be required to develop and implement a Flood and Tidal Response Plan in accordance with **Mitigation Item W1**.	Negligible	**Slight Adverse**
Surface Water Quality	Chemical pollution	Very High	Moderate Adverse	**Large Adverse**	The Contractor will be required to develop and implement a Pollution Prevention Plan in accordance with **Mitigation Item W3**. During construction, the Contractor should adhere to appropriate guidance and licensing as per **Mitigation Items W4-W8**.	Negligible	**Slight Adverse**
Estuarine Geomorphology	Disturbance to geomorphological features	Very High	Minor Adverse	**Moderate Adverse**	Further refinement of the design should be carried out in accordance with **Mitigation Items W9** and **W10**. The Contractor will be required to develop and implement a Saltmarsh Management Plan in accordance with **Mitigation Item W12**.	Negligible	**Slight Adverse**
Operation							
Flood Risk	Changes to flood mechanisms	High	No Change	**Neutral**	N/A	No Change	**Neutral**
Surface Water Quality	Highways routine run off	Very High	Negligible Beneficial	**Slight Beneficial**	N/A	Negligible Beneficial	**Slight Beneficial**
Estuarine Geomorphology	Changes to coastal processes	Very High	Negligible Adverse	**Slight Adverse**	N/A	Negligible Adverse	**Slight Adverse**

7.8 Assessment of Policy Compliance

7.8.1 DMRB LA 104 states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant Overseeing Organisation.

7.8.2 Appendix A4.1 (Assessment of Policy Compliance) provides a review of national and local policy documents which are of relevance to the assessment undertaken and reported in this chapter in accordance with DMRB guidance.

7.8.3 National planning policy objectives (and accompanying best practice guidance) of relevance to this assessment are provided in National Planning Framework 3 (Scottish Government 2014b), Scottish Planning Policy (SPP) (Scottish Government 2014b) themes *Valuing the Natural Environment and Managing Flood Risk and Drainage*, as well as Scottish National Marine Plan (SNMP) (Scottish Government 2015b) Policies GEN 8 (Coastal Process and Flooding) and GEN 12 (Water Quality and Resources) and PAN 61 (Planning & SuDS) and PAN 79 (Water & Drainage). In addition, Falkirk Local Development Plan 2 (FLDP2) Policies IR10 (Drainage Infrastructure), PE22 (The Water Environment), PE23 (Marine Planning and the Coastal Zone) and PE24 (Flood Management) are of relevance (Falkirk Council 2020).

Summary of Policy Compliance

7.8.4 Overall, the design and assessment of the proposed scheme has had regard to, and is compliant with policy objectives to minimise road drainage and water environment effects. A full policy compliance assessment can be found in Table 2 of Appendix A4.1 (Assessment of Policy Compliance).

7.9 Statement of Significance

An assessment of potential significant effects on the surface water environment was undertaken for the proposed scheme at both construction and operation phases.

Hydrology and Flood Risk

7.9.1 No residual significant effects are reported for hydrology and flood risk.

Surface Water Quality

7.9.2 No residual significant effects are reported for surface water quality.

Estuarine Geomorphology

7.9.3 No residual significant effects are reported for estuarine geomorphology.

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