Norwich Western Link Habitats Regulations Assessment Appendix 4: Integrity Matrices

Author: WSP UK Limited

Document Reference: 4.03.04

Version Number: 00

Date: March 2024

Contents

1 Introduction

1.1.1 Appendix 4 is requested by Natural England and follows a specific template dictated by the Planning Inspectorate and therefore have not been subject to accessibility review.

1.1.2 We have included a summary of key information shown in this document in an accessible format in section 1.1.1. However, some users may not be able to access all technical details that are included in the rest of this document. If you require this document in a more accessible format, please contact norwichwesternlink@norfolk.gov.uk

1.1.3 This document provides the Habitats Regulations Assessment (HRA) integrity matrices for the Norwich Western Link (NWL) Scheme. The matrices summarise information provided in the **Information to Inform a Habitats Regulations Assessment** (**Document Reference NCC/4.03.00**) (hereafter '**HRA report**').

2 Integrity Matrices

2.1.1 Following screening of potential impacts of the NWL on European sites (as presented in **Appendix C HRA Screening Matrices** (**Document Reference 4.03.03**) of the **HRA report** (**Document Reference NCC/4.03.00**)), the following features (Table 1) of European Sites were assessed in the **HRA report** to determine if there was a risk of Adverse Effects on Integrity (AEoI) on the sites or their qualifying features.

Table 1 - European Designated Sites and Qualifying Features Screened In

Site	Qualifying Feature(s)
River Wensum SAC	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation White-clawed (or Atlantic stream) crayfish Bullhead Brook lamprey Desmoulin's whorl snail
Norfolk Valley Fens SAC; Potter and Scarning Fen	Alkaline Fens

2.1.2 A summary of the evidence presented in the determination of the risk of AEoI on the relevant qualifying features is detailed within the footnotes to the integrity matrices below.

2.1.3 The following abbreviations are used within the integrity matrices:

Matrix Key:

✓ AEoI **cannot** be ruled out

× AEoI **can** be ruled out

C = construction

O = operation

2.1.4 Where effects are not applicable to a particular feature, they are shaded grey.

3 HRA Integrity Matrix 1: River Wensum SAC

Name of European site and designation: River Wensum SAC																		
EU Code: UK0012647																		
Distance to NWL Scheme: 0km																		
European site features	**Likely effects of NWL Scheme**																	
Effect	*Temporary and permanent loss of supporting floodplain habitat due to land-take*		*Changes in hydrological conditions – non-flood condition river flows and ground water levels*		*Changes in hydrological conditions – increased flood risk*		*Shading of in-channel vegetation from new structures*		*Localised changes in air quality due to emissions of vehicles*		*Sediment and chemical run-off*		*Fragmentation of the landscape by construction of the Proposed Scheme*		*Noise and vibrational disturbance*		*Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species*	
Stage of Development	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	×1		×2		×3		×4	×4	×5		×6	×7	×8				×9	
White-clawed (or Atlantic stream) crayfish								×10				×11				×12		

Name of European site and designation: River Wensum SAC																		
EU Code: UK0012647																		
Distance to NWL Scheme: 0km																		
European site features	**Likely effects of NWL Scheme**																	
Effect	*Temporary and permanent loss of supporting floodplain habitat due to land-take*		*Changes in hydrological conditions – non-flood condition river flows and ground water levels*		*Changes in hydrological conditions – increased flood risk*		*Shading of in-channel vegetation from new structures*		*Localised changes in air quality due to emissions of vehicles*		*Sediment and chemical run-off*		*Fragmentation of the landscape by construction of the Proposed Scheme*		*Noise and vibrational disturbance*		*Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species*	
Stage of Development	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*
Bullhead	×13		×14		×15		×16	×17			×18	×19			×20	×21	×22	
Brook lamprey	×23		×24		×25		×26	×27			×28	×29	×30		×31	×32	×33	
Desmoulin's whorl snail	×34		×35		×36					×37	×38	×39					×40	

Evidence supporting conclusion:

Water courses with *Ranunculion fluitantis* and C*allitricho-Batrachion* vegetation

1. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). The assessment demonstrates that functional interactions between the River Wensum and surrounding floodplain would not be affected by the Proposed Scheme. Compared to the wider floodplain, a relatively small area currently used for livestock grazing would fall under the RLB and be subject to construction phase effects, with piling forming the supports of the viaduct left following the completion of this phase, but which would not be located within the River itself. There would be no reduction in the extent of floodplain habitat that functionally supports the River Wensum, no effect of the dynamic environment of the river, and the riparian zone would be maintained by an 3m construction exclusion zone which would separate works from the river itself, and an 8m buffer for permanent structures. In addition, latitudinal connectivity of the floodplain with the river, via throughflow of ground water and surface water flow, and flow through floodplain drains and ditches would not be affected by the Proposed Scheme. Chalk rivers are reliant on organic matter inputs from outside the river channel ("allochthonous" organic matter) through autumn and winter, receiving this material from overhanging or adjacent trees and woodland in the floodplain via delivery of dead leaves in autumn (Berrie, 1992; Joyce and Wotton, 2008). Dead wood, important for river function as an organic matter resource and habitat for fish, also enters this way. The River Wensum, where it is crossed by the Proposed Scheme, is surrounded by flood plain grasslands grazed by cattle, with only limited sources of dead leaves or dead wood (some mature willow trees are present but there are few overhanging trees that would be lost) which enter the river from other parts of the floodplain, higher in the catchment. The limited floodplain adjacent to the River Wensum within the RLB is therefore not an important area of supporting habitat to the watercourse or it's associated in-channel *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. The loss of this habitat to temporary works areas, as well as permanent infrastructure associated with the Proposed Scheme viaduct would therefore not lead to adverse effects on this the water course or its associated vegetation communities. **Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
2. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Document Reference 3.12.00), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling

has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions within the River Wensum and the vegetation communities present within it, as well as its floodplain. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions within the River Wensum and the vegetation communities present within it, as well as its floodplain. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

3. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Temporary works structures including the bailey bridge across the River Wensum would result in a change to the flooding regime across the floodplain. There would be an increase in flood risk as the temporary works would

be acting to confine river discharge past the Proposed Scheme. Changes in velocities would vary across the floodplain, there would be a reduction in velocities in the southern half of the floodplain and an increase in the norther half towards the bailey bridge. Increases are limited and constrained to approximately 0.1m/s in the region closest to the bailey bridge. The funnelling effects taper out upstream with increases in velocities 0.05m/s or less from 200m upstream of the temporary work. Thus, flood conditions could lead to increased tendency of upstream areas to flood, and increased water velocity through the confined works area. However, modelling of river flows undertaken to support the Proposed Scheme's design and to inform the Environmental Statement (**Chapter 12: Road Drainage and Water Environment**) has shown that under a 1 in 2-year return period, which is the most likely scenario during construction, no change to geomorphological processes or receptors are anticipated during the construction phase, and that the channel is predicted to remain as a transport-dominated system with no morphological adjustments due to erosion. Modelling suggests that during the temporary works phase, there could be a localised change in habitat biotopes, with a change from glide habitat to riffle-run habitat within the zone of the temporary works. However, habitat biotopes would return to baseline during operation. Structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and to which vegetation is naturally adapted. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, the River Wensum and its vegetation would not be affected by hydrological changes through increased flood risk during the construction phase. **Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

4. See **Table 8-1** and **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Garbey et al. (2006) demonstrated that a 50% reduction in light intensity leads to a reduction in biomass of pond water-crowfoot *Ranunculus peltatus*. Therefore, it is considered that the viaduct would result in levels of shading that could reduce water-crowfoot abundance directly underneath the structure, albeit at present their density is low. However, it should be noted that *Ranunculus spp*. are still able to regenerate under such conditions and other species, also characteristic of the qualifying feature, are able to grow under such levels of shading. Stream water-crowfoot, and clasping-leaved pondweed were the most abundant species found within the River Wensum at the viaduct location from macrophyte surveys carried out 2022 (**Document Reference 3.10.12**). Like pond water-crowfoot, both species have Ellenberg light indicator values of 7 (Ellenberg, 1991). As such, it is likely that these species would respond similarly to pond water-crowfoot and

would still be able to regenerate and adapt to a reduction in light intensity. Clasping-leaved pondweed, and other submerged macrophyte species, are known to alter their physiology and morphology as an adaptation in response to low light conditions (Twilley and Barko, 1990; Asaeda et al., 2004; Sultana et al., 2009). For the above reasons, it is concluded there would be a potential change in the composition of the plant community in areas affected by shading from the under-construction and then operational viaduct. However, some of the plants within the vegetation community which are more shade tolerant could still grow, while others which are less tolerant of shade may be eventually replaced. Additionally, the plasticity observed in the morphology of many macrophyte species in response to lower light conditions would enable plants to adapt (Garbey et al. 2006). The presence of the temporary bailey bridge would likely result in localised shading and temporary loss of the macrophyte community within the immediate vicinity of the crossing. As the temporary crossing is transient in nature, no long-term vegetation loss, including those designated under the qualifying feature, is foreseen. Following removal of the temporary bailey bridge it is expected that the vegetation community would recolonise areas affected by shading. Overall, there would be no adverse effect on the qualifying feature (i.e. the river as a whole) due to their temporary and localised nature, with potential effects in an area <0.1ha, when compared to the total area of the River Wensum SAC (306.79ha). Indirect effects on vegetation through poaching of soil as a result of livestock sheltering under the viaduct are not expected, as this would occur only infrequently in response to rain, with the length of the viaduct offering shelter would avoid congregation at high densities. **Thus, shading of in-channel vegetation from the under-construction viaduct, temporary bailey bridge and then operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

5. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the main channel as a result of the Proposed Scheme. The temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. WC5 does not share the same characteristics of the River Wensum and does not support *Ranunuclus* within the Site Boundary (**Document Reference: 3.10.12**). Thus, it is not characteristic of a watercourse with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. However, WC5 has a supporting function for the River Wensum SAC, where temporary fragmentation may have a minor effect on the feature. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, and contributes to the targets of the qualifying feature, by restoring natural river

habitat function and processes, and the extent of in-channel riparian habitats. This would balance temporary or permanent losses in the floodplain aquatic habitats and contribute to the targets for the feature. **Thus, fragmentation of the landscape by construction of the Proposed Scheme would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

6. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Stands of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off that could smother and kill vegetation in the area surrounding the Proposed Scheme, as well as downstream. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the extent of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and maintain supporting habitat structure / function (through achieving favourable chemical status of water quality and a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
7. **See Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Stands of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off that could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream. There are no conservation objective attributes and

targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the extent of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and maintain supporting habitat structure / function (through achieving favourable chemical status of water quality and a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (**Section 7.3**) would attenuate nitrogen inputs to the River Wensum in such cases negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (**Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in **Section 7.3**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

8. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the main channel as a result of the Proposed Scheme. The temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. WC5 does not share the same characteristics of the River Wensum and does not support *Ranunuclus* within the Site Boundary (**Document Reference: 3.10.12**). Thus, it is not characteristic of a watercourse with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. However, WC5 has a supporting function for the River Wensum SAC, where temporary fragmentation may have a minor effect on the feature. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, and contributes to the targets of the qualifying feature, by restoring natural river habitat function and processes, and the extent of in-channel riparian habitats. This would balance temporary or permanent losses in the floodplain aquatic habitats and contribute to the targets for the feature. **Thus, fragmentation of the landscape by construction of the Proposed Scheme would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
9. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Stands of Ranunculion fluitantis and Callitricho-Batrachion vegetation grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by the introduction of invasive non-native plant and animal species that could kill vegetation up and downstream of the Proposed Scheme and change conditions within the river degrading habitats. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants (e.g.,**

Himalayan balsam) and animal (e.g. signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

White-clawed (or Atlantic stream) crayfish

10. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Recolonising white-clawed crayfish would use stands of vegetation including (but not limited to) the Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel to during its life cycle. Vegetation stands typically provide shelter and foraging areas for juveniles, but they also use the physical structure of the river banks for this purpose. Adults use larger structures in river margins such as rocks, woody debris and tree roots, but can also find shelter amongst marginal vegetation. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items for that could potentially be used by recolonising white-clawed crayfish within the immediate vicinity of the operational viaduct. However, as the species is not reliant on vegetation for shelter, and the fact the shading area is relatively small, direct effects of the operational viaduct on recolonising white-clawed crayfish would be negligible. **Thus, shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
11. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Recolonising white-clawed crayfish would primarily use physical structures within the River Wensum as habitat, but juveniles may also use stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel for shelter and foraging. Sediment and chemical run-off threatens individual recolonising white-clawed crayfish directly as well as through vegetation used for foraging or shelter, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and recolonising white-clawed crayfish directly. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation

communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (**Section 7.3**) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (**Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in **Section 7.3**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

12. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Embedded mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. **No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance.**

Bullhead

13. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead use marginal and mid-channel stands of vegetation as places to forage and as places of shelter from predators. However, as demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, floodplain habitat within the Proposed Scheme provides very limited support to habitat within the River Wensum. Additionally, the habitats within WC5 are unlikely to support bullhead. Fish surveys recorded an absence of bullhead in WC5 and poor suitability to support bullhead. Bullhead require coarse substrates with large stones for breeding, and prefer natural, sinuous channel forms with associated riffle and pool and substrates (Tomlinson and Perrow, 2003). Therefore, temporary and permanent loss of floodplain habitat as a result of the Proposed Scheme would not lead to adverse effects on bullhead. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum or species living within it (including bullhead) and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
14. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Document Reference 3.12.00), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe

of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by bullhead or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by bullhead or its habitat. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

15. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead use marginal and mid-channel stands of vegetation as places to forage and as places of shelter from predators. As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and are part of bullhead's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, bullhead would not be affected by hydrological changes through increased flood risk during the construction phase. **Thus, changes in hydrological conditions-increased flood risk during**

construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

16. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead uses stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items for bullhead within the immediate vicinity of the under-construction viaduct and temporary bailey bridge. However, the bridges themselves would provide some shelter, as would other forms of shelter, such as submerged branches, tree roots, pebbles and cobble. The direct effects of the temporary crossing and the under-construction viaduct on bullhead would be negligible due to their tolerance of shade (Tomlinson and Perrow, 2003) and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Following recolonisation by macrophytes after the removal of the temporary bailey bridge, shelter, food items and breeding habitat would be restored to their original or similar state. Similarly, effects from the change in vegetation structure localised below the under-construction viaduct, such as changes to shelter, food items and breeding habitat would be negligible. **Thus, shading of in-channel vegetation from the under-construction viaduct and temporary bailey bridge would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
17. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead use stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items for bullhead within the immediate vicinity of the operational viaduct. The direct effects of the operational viaduct on bullhead would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Effects from the change in vegetation structure localised below the operational viaduct, such as changes to shelter and food availability would be negligible. Should there be any changes in livestock behaviour as a result of the viaduct leading to further indirect impacts, this would be monitored, and Natural England consulted on the requirement for remedial measures. **Thus, shading of in-channel vegetation from operational viaduct**

would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

18. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead use stands of vegetation including (but not limited to) the Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel during their life cycle. These vegetation stands provide shelter and foraging areas for both adults and juveniles. Sediment and chemical run-off threatens individual bullhead as well as the vegetation they rely on, as accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and bullhead themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile bullhead and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
19. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead uses stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. Sediment and chemical run-off threatens individual bullhead as well as the vegetation they use, as accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and bullhead themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the abundance of

both adult and juvenile bullhead and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (**Section 7.3**) would attenuate nitrogen inputs to the River Wensum in such cases negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (**Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in **Section 7.3**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

20. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Fish, including bullhead, are sensitive to noise and vibration disturbances from construction activities such as pile driving and movement of heavy machinery. The extent to which intense underwater sound might adversely impact on fish is dependent upon the level of noise, its frequency, duration and / or the repetition rate of the sound (Hastings and Popper, 2005). The

range of potential impacts from intense sound sources, such as pile driving, includes immediate death, permanent or temporary tissue damage and hearing loss, behavioural changes and masking effects. Lethal effects may occur to fish species where source levels of noise exceed between 207 and 213 dB re 1 µPa for fish with high and low hearing sensitivity respectively (Popper et al., 2014). Physical injury may occur when source levels of noise exceed 186 dB re 1 µPa (Popper et al. 2014). Fish may exhibit a behavioural response to noise which is above 135 dB re 1 µPa (Hawkins et al. 2014). Mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce noise and vibration from construction to negligible levels. Additionally, effects on bullhead would be negligible due to their ability to move away from any disturbances temporarily. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, noise and vibrational disturbance would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

21. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Fish, including bullhead, are sensitive to noise and vibration from anthropogenic sources. The extent to which intense underwater sound might adversely impact on fish is dependent upon the level of noise, its frequency, duration and / or the repetition rate of the sound (Hastings and Popper, 2005). Most damaging effects of sound pressures come from a range of intense sound sources such as pile driving, and behaviours can be affected by intense signals from boats and sonar systems. Lethal effects may occur to fish species where source levels of noise exceed between 207 and 213 dB re 1 µPa for fish with high and low hearing sensitivity respectively (Popper et al., 2014). Physical injury may occur when source levels of noise exceed 186 dB re 1 µPa (Popper et al. 2014). Fish may exhibit a behavioural response to noise which is above 135 dB re 1 µPa (Hawkins et al. 2014). The noise levels from road traffic predicted in the immediate vicinity of the operational viaduct (as shown in **Figure 7.5 of the Chapter 7: Noise and Vibration**) are 55-60 dB LA10,18h (re 20 µPa). Even adopting worst-case assumptions for the transfer of noise from the air into the water, the operational road traffic noise levels are much lower than the level than what would be expected to have lethal impact, cause damage or influence behaviours in bullhead. Embedded mitigation measures that

would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, noise and vibrational disturbance from the operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

22. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Bullhead are threatened by the introduction of invasive non-native plant and animal species which could negatively interact with this species directly to reduce populations and their viability and change conditions within the river degrading the habitat. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in **Section 7**. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

Brook lamprey

23. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Culverting of WC5 would require temporary dewatering and diversion of a section of the existing watercourse. Aquatic ecology surveys of the ditch in 2022 found the presence of lamprey ammocetes using the silt deposits

within the channel as shelter. Brook lamprey larvae feed and grow in organic sediments in marginal and mid-channel stands of vegetation. The temporary realignment of WC5 would result in access to silt deposits being temporarily limited during the construction period. Authorisation from the Environment Agency would be sought to allow fish translocation of lamprey larvae and other fish present within WC5 to a safe location, with appropriate habitat to support them. This would be carried out by a trained ecologist and would avoid fish and lamprey entrapment within the ditch during construction. Temporary and permanent culverts would be placed so that the invert level is below the existing bed level, to prevent impedance of fish movement. Once construction is complete, WC5 would be returned to its original alignment, with an expectation that habitat would naturally reinstate itself with flow regimes and recovery of macrophyte cover over time. Permanent culverts on WC5 that remain to allow maintenance access to the viaduct would be designed so that fish and lamprey movement is not inhibited by the structure, with an oversized design and natural substrate. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, including brook lamprey. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

24. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Document Reference 3.12.00), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe

of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by brook lamprey or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by brook lamprey or its habitat. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

25. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey larvae feed and grow in organic sediments in marginal and mid-channel stands of vegetation, and adults use them as places shelter from predators. As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and are part of brook lamprey's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, brook lamprey would not be affected by hydrological changes through increased flood risk during the construction phase. **Thus, changes in**

hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

26. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey benefit from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. Temporary loss of macrophyte biomass as described above may result in a temporary loss of shelter and food items for brook lamprey within the immediate vicinity of the under-construction viaduct and temporary bailey bridge. The direct effects of this temporary crossing and the under-construction viaduct on brook lamprey would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Following recolonisation by macrophytes after the removal of the temporary bailey bridge, shelter and food availability would be restored to their original or similar state. Similarly, effects from the change in vegetation structure localised below the under-construction viaduct, such as changes to shelter and food availability would be negligible. **Thus, shading of in-channel vegetation from the under-construction viaduct and temporary bailey bridge would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
27. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey benefits from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. The temporary loss of macrophyte biomass as described above may result in a temporary loss of shelter and food items for brook lamprey within the immediate vicinity of the operational viaduct. The direct effects of shading from the operational viaduct on brook lamprey would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Effects from the change in vegetation structure localised below the operational viaduct, such as changes to shelter and food availability would be negligible. Should there be any changes in livestock behaviour as a result of the viaduct leading to further indirect impacts, this would be monitored, and Natural England consulted on the requirement for remedial measures. **Thus,**

shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

28. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey benefit from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. Sediment and chemical run-off threatens individual brook lamprey as well as the vegetation they rely on, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and brook lamprey themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile brook lamprey and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
29. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey benefits from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands provide shelter for adults and juveniles and traps sediments in which ammocoete larvae feed. Sediment and chemical run-off threatens individual brook lamprey as well as the vegetation they rely on, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and brook lamprey themselves directly. There are no conservation

objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the abundance of both adult and juvenile brook lamprey and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (**Section 7.3**) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (**Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

30. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting

(both permanent and temporary) would occur within the River Wensum floodplain on WC5, resulting in potential fragmentation of habitat for brook lamprey. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, including brook lamprey. This would replace any loss of available habitat to temporary or permanent structures in the floodplain aquatic habitats and contribute to the targets for this species. **Thus, fragmentation of the landscape by construction of the Proposed Scheme would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

31. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). As previously stated, fish are sensitive to noise and vibration disturbances from construction activities such as pile driving and movement of heavy machinery. Brook lamprey have no swim bladder, and therefore have a lower sensitivity to sound pressure (Turnpenny and Nedwell, 1994). Excessive and repetitive noise and vibration levels may still have an effect in disturbing brook lamprey behaviours. Mitigation measures that would avoid noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce noise and vibration from construction to negligible levels. Additionally, effects on brook lamprey would be negligible due to their ability to move away from any disturbances temporarily. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, noise and vibrational disturbance would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
32. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). As previously stated, fish are sensitive to noise and vibration disturbances from anthropogenic sources. Brook lamprey have no swim bladder, and therefore have a lower sensitivity to sound pressure (Turnpenny and Nedwell, 1994). Embedded mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. Additionally, effects on bullhead would be negligible due to their ability to move away from any disturbances

temporarily. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance**. Thus, noise and vibrational disturbance from the operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

33. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Brook lamprey are threatened by the introduction of invasive non-native plant and animal species which could negatively interact with this species directly to reduce populations and their viability, and change conditions within the river degrading the habitat. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in **Section 7**. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, due to the implementation of mitigation measures, the risk of introduction of invasive non-native plant (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

Desmoulin's whorl snail

34. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle but is not found within the Wensum channel. This species is present within the RLB in watercourses WC3 and WC4 (WC1 not suitable habitat). It is also present outside of the RLB in the Wensum floodplain 1km to the south-east. The Desmoulin's whorl snail population present within WC3 and WC4 would not be affected by temporary or permanent loss of supporting floodplain habitat due to land-take as

only habitat enhancement work is proposed for them, undertaken to benefit Desmoulin's whorl snail and other species. Enhancement works would be undertaken using sensitive working methods and under ecological supervision to ensure there would be no effect on the Desmoulin's whorl snails found in WC3 and WC4. Thus, there would be no temporary or permanent loss of habitat supporting this species, either from permanent loss of habitat (such as piers or the maintenance track) or from temporary construction areas (such as laydown areas or access tracks). Watercourses and floodplain habitat outside of WC3 and WC4 are not currently occupied by Desmoulin's whorl snail , and so temporary and permanent works in the floodplain would not affect this species a. The permanent habitat loss would be restricted to viaduct piers and a maintenance track, allowing for reinstatement and retention of the majority of floodplain habitat beneath the viaduct. This would allow for the potential future colonisation of Desmoulin's whorl snail as part of a shift away from agricultural management practices. However, it should be noted there are currently no plans or proposals for such a change available, and it has been assumed areas currently managed for agriculture would continue to be managed in such a manner. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum or species living within it (including Desmoulin's whorl snail) and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

35. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Document Reference 3.12.00), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe

of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by Desmoulin's whorl snail or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by Desmoulin's whorl snail or its habitat. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

36. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and which are part of Desmoulin's whorl snail's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, Desmoulin's whorl snail would not be affected by hydrological changes through increased flood risk during the construction phase. **Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

37. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. The website www.apis.ac.uk does not specify critical loads of levels or provide detail on effects of aerial pollutants on Desmoulin's whorl snail. The closest population to the Proposed Scheme viaduct occurs in a ditch system on the south-western bank of the River Wensum approximately 80m away (ditches and river margins within the Site Boundary are not suitable to support Desmoulin's whorl snail, **Section 5**). Other elements of the Desmoulin's whorl snail metapopulation in the River Wensum floodplain occur at a distance (**Section 5**) and their habitat would not be subject to air quality changes. In the area where air quality changes would occur (up to 200m from the operational Proposed Scheme) Desmoulin's whorl snail exists in habitat comprising mostly intensively managed grassland cultivated for hay / sileage and that are grazed, intersected with smaller areas of less intensive management and grazing; ditches are mostly dry and associated with scrub **Section 5**). No fen, marsh and swamp habitats are present where this metapopulation is found. The habitats supporting the Desmoulin's whorl snail metapopulation within the zone of air quality change are subject to agricultural improvement, involving nutrient enrichment (e.g., from nitrogen inputs from grazing animals) and not sensitive to the limited increase in nutrients as would result from air quality changes from road emissions (Air Pollution Information System (APIS, 2023). The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail, and their specific zones of air quality change do not therefore overlap where this species exists. Interactions in traffic volume have been taken into account through consideration of the ARN, which incorporates the Proposed Scheme's crossing of the River Wensum. **Thus, Localised changes in air quality as a result of emissions from vehicles using the completed viaduct would not lead adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**
38. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle and is not found within the Wensum itself nor within the Site Boundary where it crosses the Wensum floodplain as habitat here is not suitable however, it is found in the wider floodplain surrounding the Proposed Scheme with the closest population identified by survey being ~80m to the west of the Site Boundary (**Section 5**), and within the Red Line Boundary. The Proposed Scheme threatens Desmoulin's whorl snail through sediment and chemical run-off into the surrounding floodplain habitat, such as the drainage ditch network. There are no

conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile Desmoulin's whorl snail and maintain supporting processes on which they rely (specifically water quality) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

39. See **Table 8-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle and is not found within the Wensum itself nor within the Red Line Boundary where it crosses the Wensum floodplain as habitat here is not suitable; however, it is found in the wider floodplain surrounding the Proposed Scheme with the closest population identified by survey being ~80m to the west of the Site Boundary (**Section 5**). The Proposed Scheme threatens Desmoulin's whorl snail through sediment and chemical run-off into the surrounding floodplain habitat, such as the drainage ditch network. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the abundance of both adult and juvenile Desmoulin's whorl snail and maintain supporting processes on which they rely (specifically water quality) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent

acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (**Section 7.3**) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (**Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05).** Modelling predicts localised increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in **Section 7**. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.**

40. See **Table 8-1** of the **HRA report** (**Document Reference NCC/4.03.00**). The Proposed Scheme threatens Desmoulin's whorl snail through introduction of invasive non-native plant and animal species during construction into the surrounding floodplain habitat, such as the drainage ditch network, and their spread into habitat occupied by this species. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the floodplain of the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in **Section 7**. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton Proposed scheme lies over 5km from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. **Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants**

(e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

4 HRA Integrity Matrix 2: Norfolk Valley Fens SAC; Potter and Scarning Fen

Name of European site and designation: Norfolk Valley Fens SAC: Potter and Scarning Fen		
EU Code: UK0012892		
Distance to NWL Scheme: 11.2 km		
European site features	**Likely effects of NWL Scheme**	
Effect	*Wide-scale air quality changes within the ARN*	
Stage of Development	*C*	*O*
Alkaline Fens		×1

Evidence supporting conclusions:

Alkaline fens

1. Fen habitat lies within the 200m zone adjacent to the A47 where effects of air quality changes would occur as a result of the ARN, with modelling predicting an increase in the deposition of aerial pollutants above 1% of the critical load for this habitat type up to ~60m away from the A47 roadside (as shown by transect modelling of air quality changes, see **Document Reference 3.06.00** as well as its **supporting appendices, 3.06.05**, and **3.06.07**. The 1% of critical load measurement is used as a threshold to differentiate between significant and non-significant effects (Natural England,

2018). Modelled effects would occur through the deposition of nitrogen compounds including ammonia (NH3) and nitrogen oxides (NOx) that could affect habitats through nutrient enrichment and consequent plant community change, and through direct toxicity. The model predicts changes for the Proposed Scheme opening year (2027) and for them to persist (the effect is still present as a result of the model in 2041, representing the future effect of the ARN). Fen habitat within this 60m area (and therefore exceeding 1% of critical load) represents 5% of that present at Potter and Scarning Fen. Despite the changes predicted by the model, in reality air quality changes would not lead to effects on fen habitat. Several factors not incorporated in the model would attenuate air quality changes as a result of the ARN, so nitrogen compound deposition would not exceed 1% of the critical load for fen habitat:

a. Woodland approximately 30m deep from the road edge is present along the A47 between it and fen habitat within Potter and Scarning Fen. This would attenuate changes in air quality by acting as a barrier to and aid dispersion of emissions, and although won't exclude deposition of nitrogen compounds from the ARN completely, would significantly reduce their concentration. These barrier effects are not accounted for in the ARN model (**Environmental Statement Chapter 6: Air Quality**).
b. Alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Potter and Scarning Fen is not limited in terms of plant growth by nitrogen. Rather, it is phosphorus-limited. Therefore, an increase in nitrogen availability would not result in a deleterious effect on vegetation as a result of nutrient enrichment, as the growth-limiting nutrient would not be elevated by the predicted air quality change (McBride et al., 2011).

Taking these factors into account, despite the predictions of the ARN model, fen habitat would not receive a significant increase in deposition of nitrogen compounds as a result of air quality changes due to the Proposed Scheme's ARN. Emissions as a result of the A47 North Tuddenham to Easton were modelled as part of the ARN, and thus in combination effects have been considered as part of this assessment. **In conclusion, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the A47 North Tuddenham to Easton scheme.**