A47/A11 Thickthorn Junction

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6.1 Environmental Statement
Chapter 13 – Road Drainage and the Water Environment

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The A47/A11 Thickthorn Junction Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT CHAPTER 13 ROAD DRAINAGE AND THE WATER ENVIRONMENT

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Table of contents

Tables

Figures (TR010037/APP/6.2)

Appendices (TR010037/APP6.3)

Appendix 13.1 Flood risk assessment
Appendix 13.2 Drainage strategy report
Appendix 13.3 Groundwater assessment
Appendix 13.4 Water quality assessment
Appendix 13.5 Geomorphology assessment report

13. Road drainage and the water environment

13.1. Introduction

13.1.1. Highways England (the Applicant) has applied for a development consent order (DCO) for the A47/A11 Thickthorn Junction (hereafter referred to as 'the Proposed Scheme'). The Proposed Scheme will create one new connector road between the A11 and A47 and provide a new link road between Cantley Lane South and the B1172 Norwich Road for continued access to the existing A47/A11 Thickthorn Junction. Two new underpasses and two new overbridges will also be constructed along with improvements to the roundabout at the existing A47/A11 Thickthorn Junction. The Proposed Scheme will reroute traffic away from the existing A47/A11 Thickthorn Junction, which currently experiences delays and high levels of congestion during peak hours.

13.1.2. Under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, the Proposed Scheme is an Environmental Impact Assessment (EIA) development and as such requires submission of an Environmental Statement presenting the likely significant environmental effects of the Proposed Scheme.

13.1.3. As part of the EIA process, this Environmental Statement (ES) chapter reports the potential significant effects for road drainage and the water environment as a result of the Proposed Scheme. This assessment includes a review of the existing baseline conditions, consideration of the potential impacts and identification of proportionate mitigation and enhancement.

13.1.4. The approach to this assessment follows the Scoping Report (February 2018) (**TR010037/APP/6.5**) and subsequent Scoping Opinion (March 2018) (**TR010037/APP/6.6**) for the Proposed Scheme, in combination with the most up to date guidance in the Design Manual for Roads and Bridges (DMRB), LA 113 (revision 1) Road Drainage and the Water Environment (Highways England, 2020a).

13.2. Competent expert evidence

13.2.1. The surface water and flood risk competent expert (Ph.D., B.Sc. (Hons.)) has 24 years of experience in the water sector and has successfully delivered many environmental impact assessments and supporting technical assessments for large infrastructure projects.

13.2.2. The hydrogeological competent expert (M.Sc., B.Sc. (Hons.), C.Geol.) has 17 years of experience in groundwater resources, including hydrogeological impact assessments and provision of technical support on large infrastructure projects.

13.2.3. Both competent experts have used their EIA knowledge, experience with DMRB and road infrastructure projects and professional judgement in identifying the likely significant impacts associated with the Proposed Scheme and providing technical guidance through the assessment process.

13.3. Legislative and policy framework

National legislation and policy

National Policy Statement for National Networks

13.3.1. The National Policy Statement for National Networks (NPS NN) (Department for Transport, 2014) sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects on the national road and rail networks in England. It provides planning guidance for promoters of nationally significant infrastructure projects on the road and rail networks, and the basis for the examination by the Examining Authority and decisions by the Secretary of State. NPS NN is used as the primary basis for making decisions on development consent applications for national networks nationally significant infrastructure projects in England.

13.3.2. NPS NN policies relevant to the road drainage and the water environment assessment are summarised below:

- Section 5.94: With regard to flood risk, if a Flood Risk Assessment (FRA) is required, the applicant should:
  - consider the risk of all forms of flooding arising from the project (including in adjacent parts of the United Kingdom), in addition to the risk of flooding to the project, and demonstrate how these risks will be managed and, where relevant, mitigated, so that the development remains safe throughout its lifetime
  - take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made
  - consider the vulnerability of those using the infrastructure including arrangements for safe access and exit
  - include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been considered and demonstrate that this is acceptable for the particular project
  - consider if there is a need to remain operational during a worst-case flood event over the development's lifetime
  - provide the evidence for the Secretary of State to apply the Sequential Test and Exception Test as appropriate
- Section 5.99: The Secretary of State should be satisfied that flood risk will not be increased elsewhere and should only consider development appropriate in areas at risk of flooding where it can be demonstrated that:

  - within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location
  - development is appropriately flood resilient and resistant, including safe access and escape routes where required; and that any residual risk can be safely managed, including by emergency planning; and that priority is given to the use of Sustainable Drainage Systems (SuDS)
- Section 5.226: With regards to water quality, the Secretary of State should be satisfied that the proposal considers the River Basin Management Plans and the requirements of the Water Framework Directive (WFD) (including Article 4.7) and its daughter directives. This includes requirements on priority substances and groundwater.
- Sections 5.221 and 5.223: Where a development is subject to EIA and the development is likely to have significant adverse effects on the water environment, the applicant should ascertain its existing status and carry out impact assessments. These are included as part of the environmental statement and describe:
  - the existing quality of waters affected by the proposed project
  - existing water resources affected by the proposed project and the impacts of the proposed project on water resources
  - existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project, and any impact of physical modifications to these characteristics
  - impacts of the proposed project on water bodies or protected under the Water Framework Directive and source protection zones (SPZs) around potable groundwater abstractions
  - cumulative effects

Water Framework Directive

13.3.3. The Water Framework Directive (WFD) (2000/60/EC), establishes a framework for the management of water resources throughout the European Union (EU). The WFD was transposed into UK law through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, which came into force in January 2004. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 came into force in April 2017. These replace the 2003 regulations, consolidating amendments made since then, and primarily affect the management of water quality by the Environment Agency. There has been no substantive change to these requirements as a result of the departure of the UK from the European Union. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 has been amended by the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019/558 so as to continue to have effect.

13.3.4. The key objectives of the WFD, provided for in the area River Basin Management Plan (RBMP), are to:

- Prevent deterioration, enhance and restore bodies of surface water, achieve good chemical and ecological status of such water and reduce pollution from discharges and emissions of hazardous substances.
- Protect, enhance and restore all bodies of groundwater, achieve good chemical and quantitative status of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment.
- Preserve protected areas, including drinking water safeguard zones for groundwater and surface water.

13.3.5. The Groundwater (Water Framework Directive) (England) Direction 2016 sets out specific measures to prevent and control groundwater pollution and achieve good groundwater chemical status. This includes hazardous substances that are considered to be harmful to groundwater.

The Environmental Permitting Regulations

13.3.6. The Environmental Permitting Regulations (EPR) 2016, and the 2018 amendment, aim to protect groundwater and surface waters from pollution by controlling the inputs of potentially harmful and polluting substances. The Environmental Permitting (England and Wales) Regulations 2016 have been amended by the Environmental Permitting (England and Wales) (Amendment) (EU Exit) Regulations 2019 so as to continue to function after EU Exit day.

The Highways Act

13.3.7. Under the Highways Act 1980 (Section 100), Highways England has a right to discharge runoff from highways into inland and tidal waters, subject to the requirement not to pollute controlled waters. This includes groundwaters, as defined under the Water Resources Act 1991.

The Water Resources Act

13.3.8. Section 93 of the Water Resources Act (1991) provides for the establishment of groundwater protection zones. The requirements of Section 93 are implemented and set out in the Environment Agency's approach to groundwater protection (Environment Agency, 2018a) and the Environment Agency's groundwater protection guides covering: requirements, permissions, risk assessments and controls (Environment Agency, 2017a, 2017b). These replace the Environment Agency's 2013 Groundwater protection: principles and practice (GP3).

13.3.9. The Environment Agency's approach to groundwater protection includes the Environment Agency's position statements, which provide information about its

approach to managing and protecting groundwater. They detail how the Environment Agency delivers government policy for groundwater and adopts a risk-based approach where legislation allows. Many of the approaches set out in the position statements are not statutory but may be included in, or referenced by, statutory guidance and legislation.

13.3.10. Source protection zones are defined for groundwater supplies used for human consumption. The Environment Agency's position statement relating to the use of sustainable drainage systems can be found in The Environment Agency's approach to groundwater protection (Environment Agency, 2018a).

Floods Directive

13.3.11. The European Floods Directive 2007/60/EC came into force in 2008 aiming to provide a consistent approach to flood risk management across all of Europe. The Directive provides a framework for managing all sources of flood risk which take place as part of a six year cycle and requires:

- preliminary flood risk assessments
- flood risk and flood hazard maps
- flood risk management plans
- co-ordination of flood risk management at a strategic level
- improved public participation in flood risk management
- co-ordination of flood risk management with the Water Framework Directive.

13.3.12. The Flood Risk Regulations 2009 transpose the EU Floods Directive into law in England and Wales.

Environmental Damage (Prevention and Remediation) Regulations

13.3.13. The Environmental Damage (Prevention and Remediation) (England) Regulations 2015 only apply to damage after the Regulations come into force, and they only apply to operators of economic activities. There is a legal duty to immediately notify regulators and to prevent damage. Environmental damage is classified as damage to:

- Adverse effects on the integrity of a Site of Special Scientific Interest (SSSI) or on the conservation status of species and habitats protected by EU legislation outside SSSIs
- Adverse effects on surface water or groundwater consistent with a deterioration in the water's status (Water Framework Directive term)
- Contamination of land that results in a significant risk of adverse effects on human health

13.3.14. Remediation of damage to species, habitats or water must remove any significant risk to health. The objective is to achieve the same level of natural resources or services as would have existed if the damage had not occurred. This may involve primary remediation, complementary remediation or compensatory remediation.

The National Planning Policy Framework

13.3.15. The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2019) applies to this Proposed Scheme under Chapter 14 “Meeting the challenge of climate change, flooding and coastal change”. This is supported by the Planning Practice Guidance (PPG), in relation to flood risk (Ministry of Housing, Communities and Local Government, 2016). It states that where development is located in areas which are vulnerable to flooding, care should be taken to ensure that risks can be managed.

13.3.16. The Land Drainage Act (1991) and Flood and Water Management Act (2010) are also relevant to manage flood risk for any works within 8m of ordinary watercourses and to the discharge of surface water drainage to ordinary watercourses.

Local policies

Joint Core Strategy for Broadland, Norwich and South Norfolk

13.3.17. The relevant policies within the strategy (Greater Norwich Development Partnership, 2014) in relation to the water environment are summarised below:

- Policy 1: addressing climate change and protecting environmental assets. Development should be located to minimise flood risk and mitigate any such risk through design and the implementation of sustainable drainage. Development should minimise water use and protect groundwater sources.
- Policy 3: energy and water. This policy ensures that, amongst other things, water quality is protected and improved with no significant detriment to areas of environmental performance.

South Norfolk Local Plan Development Management Development Planning Document (DPD)

13.3.18. The relevant policies within the DPD (South Norfolk Council, 2015) in relation to the water environment are summarised below:

- Policy DM 4.2 Sustainable drainage and water management. Sustainable drainage measures must be fully integrated within design to manage any surface water arising from development proposals, and to minimise the risk of

flooding on the development site and in the surrounding area. All developments:

- should include a sewerage capacity assessment
- should include drainage features that will slow the movement of water through the drainage system
- must not cause any deterioration in water quality and measures to treat surface water runoff must be included within the design of the drainage system

Norfolk County Council

13.3.19. Norfolk County Council also provide guidance to developers on their role as Lead Local Flood Authority (LLFA) (Norfolk County Council, 2019)

13.4. Assessment methodology

13.4.1. The methodology follows the guidance provided in DMRB LA 113 Road drainage and the water environment for assessing the significance of effects of proposed road schemes on the road drainage and the water environment. The procedures and the appropriate methods that must be used when assessing the potential impacts from the road projects on the water environment are described in the DMRB LA 113.

13.4.2. The following methods have been adopted:

- A simple assessment of groundwater levels and flow, as described in section 3.6 of DMRB LA 113. This is a qualitative assessment that identifies all potential features which are susceptible to groundwater level and flow impacts from the Proposed Scheme, based on a hydrogeological conceptualisation of the surrounding area and the regional groundwater body status. The results of this assessment are included in Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**).
- A detailed assessment of groundwater quality and runoff associated with unlined road drainage, as described in Appendix C of DMRB LA 113. The groundwater risk assessment matrix provided in Highways England Water Risk Assessment Tool (simple assessment) was used to identify medium risk catchments requiring a detailed assessment. The detailed assessment considers the baseline hydrogeological conditions, embedded treatment within the drainage design and a water quality assessment based on the Highways England Water Risk Assessment Tool (HEWRAT), as described in DMRB LA 113. The results of this assessment are included in Appendix 13.3 Groundwater assessment **(TR010037/APP/6.3)**.
- A simple assessment of groundwater dependent terrestrial ecosystems, as described in Appendix B of DMRB LA 113. This is a stepped, risk-based approach which establishes linkages between potential impacts from the Proposed Scheme on the hydrological and hydrogeological regime and a

groundwater dependent terrestrial ecosystem (GWDTE). The results of this assessment are included in Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**).

- A simple assessment of pollution impacts from routine runoff to surface waters using the Highways England Water Risk Assessment Tool (HEWRAT), as described in DMRB LA 113. The HEWRAT assessment uses information from the drainage design for the Proposed Scheme, the receiving local water environment and annual average daily traffic (AADT) data to establish potential impacts of pollutants in routine highway runoff, impacts of spillages from the Proposed Scheme upon the watercourses within the study area and the requirement for mitigation measures to adequately reduce the risk. The results of this assessment are included in Appendix 13.4 Water quality assessment (**TR010037/APP/6.3**).
- Assessment of pollution impacts from spillages using (HEWRAT) as described in Appendix D of DMRB LA 113. The method initially estimates the risk that there will be an incident causing the spillage of a potentially polluting substance somewhere on the length of road being assessed. It then calculates the risk, assuming a spillage has occurred, that the pollutant will reach and impact on the receiving watercourse or groundwater. The results of this assessment are included in Appendix 13.4 Water quality assessment (**TR010037/APP/6.3**).
- A Water Framework Directive (WFD) assessment for both surface water and groundwater, as described in section 3.50 of DMRB LA 113. This identifies how the Proposed Scheme has the potential to impact each of the waterbodies' quantity and quality elements and whether it could lead to non-compliance of the WFD. The WFD assessment is incorporated into this chapter and is based on the findings of the other assessments.
- A hydromorphological assessment, as described in Appendix E of DMRB LA 113. A simple assessment, supplemented by a site survey, identifies the natural river processes that would have operated before any development had affected the river or catchment and determines whether the degree of hydromorphological change is acceptable. If it is not, a detailed assessment shall be undertaken which should include further surveys and may include modelling. The results of this assessment are included in Appendix 13.5 Geomorphology assessment report (**TR010037/APP/6.3**).

13.4.3. The approach takes into consideration comments from the Planning Inspectorate in response to the Proposed Scheme's Scoping Report published in 2018 (**TR010037/APP/6.5**).

13.4.4. The flood risk assessment (Appendix 13.1) (**TR010037/APP/6.3**) has been undertaken in accordance with the requirements of the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2016; 2019), and the Environment Agency's climate change allowances (Environment Agency, 2020a). A detailed hydrological and hydraulic assessment

has been undertaken as part of the assessment due to the potential flood risk impacts to and from the Proposed Scheme.

13.4.5. A Drainage strategy report (Appendix 13.2) (**TR010037/APP/6.3**) has been undertaken in order to outline the proposed drainage design and mitigation measures to reduce impacts upon the water environment from the Proposed Scheme.

Update to guidance and scope of assessment

13.4.6. Following the EIA Scoping Report of the Proposed Scheme (February 2018) (**TR010037/APP/6.5**), an update to DMRB guidance was published in 2019 (DMRB LA 113). The methodology and scope presented in the Scoping Report is still valid for this guidance update and no change is required.

Determination of baseline conditions

13.4.7. This chapter has been completed based on the following sources of information:

- British Geological Survey (BGS) 1:50,000 superficial and bedrock geological map (British Geological Survey, 2020)
- Defra's 'Magic' interactive map (Defra, 2020)
- Environment Agency Catchment Data Explorer (Environment Agency, 2020b)
- Environment Agency Drinking Water Safeguard Zones and NVZs (Environment Agency, 2020c)
- Environment Agency Flood Map for Planning (Environment Agency, 2020d), surface water, reservoir and river flood risk (Environment Agency, 2020e) and historical flood maps (Environment Agency, 2020f)
- Environment Agency consented discharges and abstraction data
- Highways Agency Drainage Data Management System (HA DDMS) (Highways England, 2020b)
- Norfolk Local Flood Risk Management Strategy (LFRMS) Norfolk County Council (2015)
- The Greater Norwich Strategic Flood Risk Assessment (SFRA) (JBA, 2017)

Site walkover

13.4.8. Site walkovers were carried out in March 2018 and May 2020. The walkovers were undertaken to:

- ground truth surface water features identified within the study area from Ordnance Survey mapping which are to be included in the hydraulic model
- understand the hydraulic connectivity across the Proposed Scheme

- understand the geomorphology surrounding the Proposed Scheme

Consultation

13.4.9. The Environment Agency, Anglian Water and Norfolk County Council (as LLFA) responded to the EIA Scoping Report (**TR010037/APP/6.5**) via the Planning Inspectorate in March 2018. The Environment Agency, Anglian Water and Norfolk County Council (as LLFA) responses are summarised below:

13.4.10. For the Environment Agency:

- The potential pollution impact needs to be assessed along with any other changes to flow which may alter the dilution of discharges.
- Ground investigations are needed to determine the local geology in detail.
- A full groundwater flood risk assessment is needed if there is to be a significant change to drainage outfalls.
- The Environment Agency agree a drainage survey of the existing arrangements is required to confirm outfall locations and sizes.
- Full details of the proposed drainage should be submitted for review when available.
- Any realignment of the Cantley Stream will require a full hydrogeological assessment.
- Detailed assessment of groundwater level and quality will need to be undertaken prior to, as well as during any construction activities.
- The Environment Agency request to be consulted on any proposals to discharge groundwater to soakaway during dewatering.
- The Environment Agency confirm they do not hold any prior detailed hydraulic modelling for the Cantley Stream.
- The Environment Agency support the use of SuDS.
- The Environment Agency stated it was not appropriate to suggest the environmental impact magnitudes would vary with the WFD status of the water body.

13.4.11. The Environment Agency's comments have been addressed in the Environmental Statement. The majority of these have been addressed in due course by following the approaches set out in DMRB LA 113 and LA 104, although particular attention to the comments has also been made within the overall assessment process.

13.4.12. Anglian Water wish to be consulted on the content of the Flood Risk Assessment, particularly if connections to the public sewerage network are required. However, as there are no existing or proposed connections to the public sewerage network no additional consultation has been undertaken on this

matter. Information on utilities and sewer flooding has been requested from Anglian Water.

13.4.13. For Norfolk County Council (LLFA):

- A Flood Risk Assessment will be required as part of the Environmental Statement. The assessment must consider, and provide mitigation to, fluvial, surface water and groundwater flooding.
- Where SuDS are proposed, both surface water disposal location and the SuDS components used in the management train should be followed.
- Appropriate ground investigation should be carried out to ensure infiltration drainage is feasible, where this is proposed.
- Drainage mitigation should attenuate post-development runoff for a 1 in 100-year event plus an allowance for climate change.
- All watercourses, including tributaries, be included within any hydraulic model, to ensure that flood risk is not increased.
- The FRA should include a drainage strategy and the most up to date climate change allowances in accordance with current policy guidelines.
- Overland flow routes are expected to be considered, investigated and modelled to ensure that mitigation is proposed which may take the form of dry culverts. These will be designed to convey the 1 in 100-year plus climate change design event. Information on flowlines of surface water has been provided.
- The Drainage Strategy should include a Maintenance and Management Plan.
- Ordinary Watercourse Consents will be required for any works in close proximity to watercourses.

13.4.14. The Environment Agency and Norfolk County Council were consulted on issues related to flood risk, geomorphology and the WFD at meetings in May 2018, June 2020, August 2020 and November 2020 where discussions focused on the requirements for the Cantley Lane south culvert including freeboard, flood risk impacts, the realignment of Cantley Stream and WFD mitigation. A draft of the Drainage strategy report (Appendix 13.2) (**TR010037/APP/6.3**) was issued to the Environment Agency and Norfolk County Council in December 2020 and comments have been addressed.

13.4.15. The Environment Agency and Norfolk County Council have been issued a copy of the draft FRA (Appendix 13.1) (**TR010037/APP/6.3**). Consultation is ongoing to ensure all matters raised are addressed.

13.4.16. Consultation with the Environment Agency has also been undertaken regarding the drainage design of the Proposed Scheme with specific reference to infiltration to ground.

13.4.17. Consultation with Norfolk Rivers Internal Drainage Board has also taken place.

Assessment criteria

13.4.18. The assessment identifies the water features within the study area (and any downstream water bodies) and determines the importance (value) of the features as set out in DMRB LA 113.

Value of receptor

13.4.19. The conservation value of water resources is in part defined by legislation which protects all controlled waters in England and Wales and, in effect, protects all water bodies (surface water or groundwater). Therefore, there cannot be any water feature which has negligible value. The value of controlled waters was defined by considering the use and conservation importance of the waterbody. The criteria used in this assessment to determine the value and importance of each water feature and its attributes are set out in Table 13.1, based on the definitions provided in Table 3.70 in DMRB LA 113.

13.4.20. The value or importance of water environment attributes within the study area are presented within the baseline conditions section of this chapter (13.7) in Table 13.7, based on definitions provided in Table 13.1.

Table 13.1 Criteria for estimating the importance of water environment attributes

Value	Criteria	Examples
Very High	Nationally significant attribute of high importance	**Surface Water**: Watercourse having a WFD classification shown in a RBMP and Q95 ≥ 1.0m^3/s. Site protected or designated under EC or UK legislation (SAC, SPA, SSSI, Ramsar site, salmonid water) / Species protected by EC legislation Ecology and Nature Conservation. **Groundwater**: Principal aquifer providing a regionally important resource and / or supporting a site protected under EC and UK legislation Ecology and Nature Conservation. Groundwater locally supports GWDTE SPZ1. **Flood Risk**: Essential infrastructure or highly vulnerable development.
High	Locally significant attribute of high importance	**Surface Water**: Watercourse having a WFD classification shown in a RBMP and Q95 <1.0m^3/s. Species protected under EC or UK legislation Ecology and Nature Conservation. **Groundwater**: Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE SPZ2. **Flood Risk**: More vulnerable development.
Medium	Of moderate quality and rarity	**Surface Water**: Watercourses not having a WFD classification shown in a RBMP and Q95 >0.001m^3/s. **Groundwater**: Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3. **Flood Risk**: Less vulnerable development.

Value	Criteria	Examples
Low	Lower quality	**Surface Water**: Watercourses not having a WFD classification shown in a RBMP and Q95 ≤0.001m^3/s. **Groundwater**: Unproductive strata. **Flood Risk**: Water compatible development.

Magnitude of impact

13.4.21. Definitions for the magnitude of impact are given in Table 13.2 and are based on values set out in Table 3.71 of DMRB guidance LA 113, and the typical examples should be used as a gauge.

Table 13.2 Estimating the magnitude of an impact on an attribute

Magnitude	Criteria	Examples
Major adverse	Results in loss of attribute and / or quality and integrity of attribute	**Surface water** Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT and compliance failure with environmental quality standards (EQS) values. Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). Loss or extensive change to a fishery. Loss of regionally important public water supply. Loss or extensive change to a designated nature conservation site. Reduction in water body WFD classification. **Groundwater** Loss of, or extensive change to, an aquifer. Loss of regionally important water supply. Potential high risk of pollution to groundwater from routine runoff - risk score >250 (Groundwater quality and runoff assessment). Calculated risk of pollution from spillages ≥2% annually (Spillage assessment). Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification. Loss or significant damage to major structures through subsidence or similar effects. **Flood Risk** Increase in peak flood level (> 100mm).
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute	**Surface Water** Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values. Calculated risk of pollution from spillages ≥1% annually and <2 % annually. Partial loss in productivity of a fishery. Degradation of regionally important public water supply or loss of major commercial / industrial / agricultural supplies. Contribution to reduction in water body WFD classification. **Groundwater** Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial / industrial / agricultural supplies. Potential medium risk of pollution to groundwater from routine runoff - risk score 150 to 50. Calculated risk of pollution from spillages ≥1% annually and <2 % annually. Partial loss of the integrity of GWDTE.

Magnitude	Criteria	Examples
		Contribution to reduction in water body WFD classification. Damage to major structures through subsidence or similar effects or loss of minor structures. **Flood Risk** Increase in peak flood level (> 50mm).
Minor adverse	Results in some measurable change in attribute's quality or vulnerability	**Surface Water** Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. Calculated risk of pollution from spillages ≥0.5% annually and < 1% annually. Minor effects on water supplies. **Groundwater** Potential low risk of pollution to groundwater from routine runoff - risk score <150. Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. Minor effects on an aquifer, GWDTEs, abstractions and structures. **Flood Risk** Increase in peak flood level (> 10mm).
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	The proposed project is unlikely to affect the integrity of the water environment. **Surface Water** No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <0.5%. **Groundwater** No measurable impact upon an aquifer and / or groundwater receptors and risk of pollution from spillages <0.5%. **Flood Risk** Negligible change to peak flood level (≤ + / - 10mm).
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	**Surface Water** HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually). **Groundwater** Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually). Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding. **Flood Risk** Creation of flood storage and decrease in peak flood level (> 10mm).
Moderate beneficial	Results in moderate improvement	**Surface Water**

Magnitude	Criteria	Examples
	of attribute quality	HEWRAT assessment of both acute-soluble and chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually). Contribution to improvement in water body WFD classification. **Groundwater** Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). Contribution to improvement in water body WFD classification. Improvement in water body catchment abstraction management strategy (CAMS) (or equivalent) classification. Support to significant improvements in damaged GWDTE. **Flood Risk** Creation of flood storage and decrease in peak flood level1 (> 50mm).
Major beneficial	Results in major improvement of attribute quality	**Surface Water** Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. Improvement in water body WFD classification. **Groundwater** Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in water body WFD classification. **Flood Risk** Creation of flood storage and decrease in peak flood level (> 100mm).
No Change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Significance

13.4.22. The overall significance of effect was determined using the significance matrix provided in Table 3.8.1 in DMRB LA104 (provided in Chapter 4 (Environmental Assessment Methodology) Table 4-2) using professional judgement to consider site specific factors that may be of relevance. Effects can be beneficial or adverse. Effects that are moderate or above are considered likely significant effects. Effects that are slight or neutral are not significant.

13.5. Assessment assumptions and limitations

13.5.1. This Environmental Statement has been prepared using publicly available information, with references carried out to previous reports and through the use of HA DDMS, (Highways England, 2020b). The assessment is a desk-based study informed by site walkovers and surveys to characterise selected water features, and the previous ground investigations. The 2018 ground investigation

provided detailed information on groundwater levels and quality and is generally considered to be representative of the site conditions.

13.5.2. Whilst this level of detail is considered appropriate at this stage, the design has evolved since the ground investigation was conducted and as such supplementary ground investigations and surveys are required to confirm construction and operation risks, particularly in relation to the Wards Wood underpass, works adjacent to the Cantley Stream (including the diversion) and the use of unlined road drainage. For Ward's Wood Underpass, two construction methods have been highlighted, the box push method of construction and the alternative top down method. Risks to groundwater have been considered for both construction methods, and based on an assessment of worst-case, although the supplementary ground investigation is required to confirm groundwater conditions in the chalk in this location. Any further design changes will be subject to environmental review. This will ensure that any residual effects to groundwater receptors would not be greater than those reported in the ES.

13.5.3. The groundwater assessment (Appendix 13.3) (**TR010037/APP/6.3**) is constrained by the information available; the ground investigation has provided comprehensive data relating to the geology and hydrogeology within the Site (Proposed Scheme DCO boundary), but data is limited outside of this. The data collected may therefore not necessarily fully represent the regional hydrogeological conditions, particularly with respect to hydraulic gradients and direction of groundwater flow. In addition, whilst almost two years of groundwater level monitoring data has been collected, there is the possibility that this does not reflect long term seasonal maximums and minimums.

13.5.4. Further limitations in the datasets used include the extents of the groundwater flooding susceptibility dataset, which is limited to a 500m corridor around the existing road, and restricted location descriptions for unlicensed groundwater abstractions due to General Data Protection Regulations. These restrictions do not have any effect on the assessment, however.

13.5.5. The assessment of overland surface water flood flow pathways intercepted by the Proposed Scheme and the location of cross-drains or 'dry culverts' is based on available LiDAR data. A tailored topographic survey will be undertaken at detailed design to reassess and confirm the location and sizing of cross-drains.

13.5.6. A drainage survey, to verify the locations of the existing discharge locations identified on HA DDMS (Highways England, 2020b), is to be completed.

13.5.7. The temporary drainage arrangements during construction are yet to be confirmed. A reasonable assumption is that the main site compound runoff will be collected within a ditch surrounding the compound and be redirected to

settlement ponds before being discharged to a surface watercourse or ground. Although it is assumed that satellite compounds and other worksite welfare and compound areas will not have temporary drainage systems, any welfare areas would have their own waste storage that would be cleaned out on a regular basis. A temporary works drainage strategy will be included in the Environmental Management Plan (EMP) (**TR010037/APP/7.4**).

13.5.8. It is assumed that no significant adverse effects are predicted deriving from the vulnerability of the Proposed Scheme to risks of major accidents or disasters (for example major road traffic accident, structure collapse, ground instability, terrorist attack, fire, chemical spillage). This is because the design, construction and operation of the Proposed Scheme must comply with relevant health and safety legislation and current design standards. Furthermore, a response to any major incident would be in accordance with Highways England's Traffic Incident Management and Contingency Planning framework.

13.6. Study area

13.6.1. The study area encompasses groundwater and surface water features that could be affected by the Proposed Scheme. The study area is based on professional judgement to ensure that effects are sufficiently identified and comprises a 1km corridor surrounding the Proposed Scheme DCO boundary, extended to include features further downstream (surface water features), and focussing on the main features of the Proposed Scheme that are likely to have a potential significant impact. The surface water and groundwater study areas are shown in ES Figures 13.1 to 13.8 (**TR010037/APP/6.2**) along with key surface water and groundwater features. The surface water and groundwater features included in the assessment are also described in section 13.7.

13.7. Baseline conditions

Surface water

Surface water features

13.7.1. The main surface water features within the study area that have the potential to be either directly or indirectly affected by the Proposed Scheme are shown in ES Figure 13.1 (Surface water features, abstractions, consented discharges and fluvial flood risk) (**TR010037/APP/6.2**). A summary of these features is provided below.

13.7.2. Cantley Stream, an ordinary watercourse, passes through the study area and within the DCO boundary. It flows beneath both the A11 and A47 in an easterly direction where it joins Intwood Stream at the eastern edge of the study area. Cantley Stream lies upstream of the Norfolk Rivers Internal Drainage Board hydrological catchment.

13.7.3. An ordinary watercourse is usually a smaller river, ditch or stream, which is not a main river, and over which LLFAs, or Internal Drainage Boards have permissive powers to carry out flood defence works.

13.7.4. Intwood Stream, a tributary of the River Yare, is an Environment Agency designated main river and is located to the south east of the study area. It flows in a north-eastern direction through the study area where it meets the River Yare. Intwood Stream is not managed by Norfolk Rivers Internal Drainage Board as it is a main river which is the operational responsibility of the Environment Agency. However, it does lie within the Norfolk Rivers Internal Drainage Board's hydrological catchment (ES Figure 13.2 (WFD and Internal Drainage Board surface waterbodies) (**TR010037/APP/6.2**).

13.7.5. The confluence of Intwood Stream with the River Yare is approximately 1.5km downstream of the study area. As the River Yare, via Cantley Stream and Intwood Stream, is located 1.5km downstream of the main construction area, it is considered in the assessment as an indirect receptor. The catchment divide between the main River Yare catchment and the Cantley Stream / Intwood Stream catchment lies, in part, along the B1172 between Thickthorn Hall and the A47 / A11 Thickthorn Junction (ES Figure 13.2 (WFD and Internal Drainage Board surface waterbodies) (**TR010037/APP/6.2**).

13.7.6. An ordinary watercourse is located to the north of the study area. It flows in a easterly direction and is a tributary of the River Yare. The watercourse is not hydrologically linked to the Proposed Scheme and as such has been scoped out of this assessment.

13.7.7. There are no gauging stations near to the Proposed Scheme. The nearest gauging station was identified on the River Yare (34001 - Yare at Colney) approximately 6.5km upstream of the confluence with Intwood Stream. The Q95 at this location is 0.323 m^3/s (National River Flow Archive, 2021).

13.7.8. The desk-based study using OS mapping identified a number of ponds in the vicinity of Cantley Stream both upstream and downstream of the Proposed Scheme that may constitute potential receptors. Two notable ponds are located west (upstream) of the A11 and a further two ponds are located between the A11 and A47 on the north bank of Cantley Stream. The two ponds between the A11 and A47 appear to have fishing pontoon. However, there is no information regarding its use and it may be used for private fishing only.

13.7.9. A pond which has an area of approximately 5,000m^2 is located south-east of the existing A47 / A11 Thickthorn Junction. The pond appears to be 'offline' from the watercourse but is located within the floodplain and does not appear to be used recreationally. A further pond is located to the north of the A11 Newmarket Road

roundabout. This pond appears to be an attenuation SuDS feature and is part of the Cringleford residential development to the north of the A11.

13.7.10. There are a number of additional isolated ponds in the study area. However, these have been identified as not being used for angling or other recreational purposes.

13.7.11. There is no Environment Agency water quality data available for the water body or watercourses within the study area. However, a six month water quality sampling regime was started in September 2020 for the Cantley Stream; this has been completed and the results used to inform the HEWRAT water quality assessment (ES Appendix 13.4) (**TR010037/APP/6.3**).

Water Framework Directive

13.7.12. The study area is split between two WFD water body catchments, all of which are within the Anglian River Basin District:

- Intwood Stream WFD water body (WBID: GB105034051240) is located to the south of the Proposed Scheme and contains Intwood Stream main river and Cantley Stream ordinary watercourse. It is a heavily modified water body which is part of the Yare operational catchment.
- The Yare (Tiffey to Wensum) WFD water body (WBID: GB105034051281). There is one ordinary watercourse located within study area to the north of the Proposed Scheme. The main river lies just outside the study area approximately 1.1km downstream of the DCO boundary. It is a heavily modified water body which is part of the Yare operational catchment.

13.7.13. Both catchments are within the Anglian River Basin District and the Broadland Management Catchment. Their locations are identified in Figure 13.2 (WFD and Internal Drainage Board surface waterbodies) (**TR010037/APP/6.2**).

13.7.14. Table 13.3 summarises the WFD surface water bodies within the study area and indicates their targets and objectives. Based on the 2019 status, the current Anglian River Basin Management Plan (RBMP), as shown by the Environment Agency's Catchment Data Explorer (Environment Agency, 2020b) indicates that:

- Intwood Stream WFD water body (WBID: GB105034051240) ecological potential is limited to moderate by the physico-chemical quality elements (poor potential for phosphate). Reasons for not achieving good status include sewage discharges (continuous and intermittent) and poor soil management. The chemical status fails due to the presence of a priority hazardous substance, namely, polybrominated diphenyl ethers (PBDE)); all other aspects of chemical quality are at good status. The overall status is expected to remain at moderate due to unfavourable balance of costs and benefits.

- The Yare (Tiffey to Wensum) WFD water body (WBID: GB105034051281) ecological potential is limited to moderate by supporting elements (moderate or less mitigation measures assessment), the biological quality elements (moderate potential for macrophytes and phytobenthos combined) and physico-chemical quality elements (moderate potential for dissolved oxygen). Reasons for not achieving good status include surface and groundwater abstractions and flood protection. The chemical status fails due to the presence of the priority hazardous substance PBDE; all other aspects of chemical quality are at good status. The overall status is expected to remain at moderate due to disproportionate burdens.

Table 13.3 Summary of WFD surface water bodies within the study area

Water body name	Intwood Stream	Yare (Tiffey to Wensum)
Water body ID	GB105034051240	GB105034051281
Operational catchment	Yare	Yare
Management catchment	Broadland Rivers	Broadland Rivers
River basin district	Anglian	Anglian
Type	River	River
Hydromorphological status	Heavily modified	Heavily Modified
Overall classification (cycle 2 – 2019)	Moderate	Moderate
Current ecological quality (cycle 2 – 2019)	Moderate	Moderate
Current chemical quality (cycle 2 – 2019)	Fail	Fail
Ecological objective	Moderate by 2015 (that is, maintain moderate status)	Good by 2027
Chemical objective	Good by 2015	Good by 2015
Protected area (within the study area)	Yes- Nitrates Directive	Yes- Urban Wastewater Treatment and Nitrates Directive

13.7.15. The Proposed Scheme lies within the River Yare Nitrate Vulnerable Zone (NVZ) for surface water (Environment Agency, 2020c).

Groundwater

Geology

13.7.16. The bedrock and superficial geology within the study area is described in detail in ES Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3)** and briefly comprises variable sandy gravelly clays of the Lowestoft Formation and sands and gravels of the Sheringham Cliffs Formation, underlain by the Cretaceous Chalk. Alluvial deposits are also present along the course of the Cantley Stream.

13.7.17. The majority of the study area has a cover of superficial geology. However, in the vicinity of Cantley Stream the chalk bedrock is close to surface and potentially outcrops in the riverbed.

Aquifer designations

13.7.18. Aquifer designations and the extents of individual superficial deposits are presented in ES Figure 13.3 (Aquifer and environmental designations) (**TR010037/APP/6.2**). The Chalk is classified by the Environment Agency as a Principal aquifer. Principal aquifers supply water resources and / or base flow at a strategic scale.

13.7.19. The Sheringham Cliffs Formation is classified by the Environment Agency as a Secondary A aquifer, which are described as formations that provide locally important water resources and may support base flow to rivers.

13.7.20. The Lowestoft Formation and alluvium are classified by the Environment Agency as a Secondary (undifferentiated) aquifer. Secondary (undifferentiated) aquifers are classified as such due to the formation previously designated as both a minor aquifer and non-productive strata in different locations due to variable characteristics.

Aquifer properties

13.7.21. The properties of the aquifer define its capacity to release water and the ability of groundwater flow to be transmitted with ease.

13.7.22. The Lowestoft Formation is impermeable within the study area and semi-confines the underlying the Sheringham Cliffs Formation and the Chalk. The Lowestoft Formation has been found to be dry in the study area.

13.7.23. The Sheringham Cliffs Formation is a locally important Secondary A aquifer. In the study area it is approximately 5 to 6m in thickness. It consists of sand and gravels and, in some areas, clayey gravels. These deposits generally underlie the Lowestoft Formation and are known to outcrop towards the Cantley Stream.

13.7.24. Permeability in the Sheringham Cliffs Formation is likely to be variable depending on local characteristics; with high permeability in areas with a high sand content, but lower permeability in areas where clay content is higher.

13.7.25. The Chalk is a locally important Principal aquifer, and in the study area it ranges from less than one metre to more than 35m in thickness as structureless fine chalk. This is underlain by structureless coarse chalk, the thickness of which is not proven. The Chalk is sub-artesian, especially adjacent to the Cantley Stream.

13.7.26. The permeability of the Chalk is likely to have significant variability depending on local characteristics (such as fracturing) and the structure of the Chalk, which varies with depth. It is possible that in areas of low permeability the Chalk may actually impede groundwater flow at the top of the Chalk and either confine the lower aquifer or restrict groundwater flow between the overlying sand and gravels and the Chalk.

13.7.27. Further details of aquifer properties are included in ES Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**).

Groundwater levels and flows

13.7.28. Groundwater level monitoring was carried out as part of the 2018 ground investigation. This is detailed further in ES Appendix 13.3 (Groundwater assessment) (**TR010037/APP/6.3**), with a summary of findings given below.

13.7.29. The Sheringham Cliffs Formation is found to largely be dry across the study area but is found to contain groundwater close to ground level adjacent to Cantley Stream.

13.7.30. Chalk groundwater levels range between 0m and 18m below ground level across the site. They are generally found to coincide with the top of the upper structureless Chalk. Adjacent to Cantley Stream, Chalk groundwater levels are found to be above the top of the Chalk and higher than groundwater levels within the Sheringham Cliffs Formation. Chalk groundwater flow is interpreted to be predominately towards the south and southeast and towards Cantley Stream.

13.7.31. Where the Sheringham Cliffs Formation is saturated, adjacent to Cantley Stream, these are considered to be in hydraulic continuity with the underlying Chalk. Chalk groundwater levels are generally higher in this location, and supply baseflow to Cantley Stream.

Groundwater quality

13.7.32. Surface water, groundwater and soil quality sampling was carried out as part of the 2018 ground investigation. A total of 10 groundwater samples were analysed for suites including metals, inorganics, polycyclic aromatic hydrocarbons and total petroleum hydrocarbons, phenols, volatile organic compounds and semi-volatile organic carbons. Nine groundwater samples exceeded the screening limits for inorganics including cyanide (total), nitrate, and nitrite at relatively low levels. The assessment of risk to controlled waters in the Ground Investigation Report concluded that there is no unacceptable risk to controlled waters. It is possible that high nitrates reported are due to the largely agricultural land use in the area.

13.7.33. Dissolved copper concentrations in groundwater samples across the site were low (<0.4 to 1.1µg/l) and dissolved zinc concentrations ranged between 8 and 48µg/l, exceeding the EQS for dissolved bioavailable zinc. The zinc concentrations are in agreement with the range observed within the Chalk in north Norfolk, however (0.25 – 114mg/l; Ander et al, 2006).

13.7.34. A surface water sample was also taken during the 2018 GI and also had high zinc concentrations (18µg/l), although subsequent surface water quality sampling undertaken over a six month period in 2020 with significantly lower dissolved zinc concentrations (2 to 3µg/l).

Groundwater vulnerability

13.7.35. The bedrock and superficial aquifers have a combined groundwater vulnerability classification of medium risk. Soluble rock risk associated with the Chalk is also noted.

Surface water features supplied by groundwater

13.7.36. Designated sites that are potentially hydraulically linked to the study area are included in this assessment and illustrated in ES Figure 13.3 (Aquifer designations) (**TR010037/APP/6.2**).

13.7.37. Cantley Stream flows south east from the western boundary to the south eastern corner of the study area. It is a chalk stream that receives baseflow from the underlying Chalk and Sheringham Cliffs Formation.

13.7.38. The nearest Lowland Fen Priority Habitat is located along Cantley Stream in the south-eastern corner of the Site. Lowland fens receive water and nutrients from the underlying soil, rock and groundwater. At this location, the fen is underlain by Alluvium and may be in hydraulic continuity with the underlying Secondary A and Principal Aquifers.

13.7.39. A second Lowland Fen Priority Habitat is located within the study area, a further 0.5km east along Cantley Stream. At this location, the fen is also underlain by Alluvium.

13.7.40. Two County Wildlife Sites have been identified which are both associated with the fen habitats listed above. These are Meadow Farm Meadow County Wildlife Site and Intwood Carr County Wildlife Site.

13.7.41. As there is a likely hydrogeological connection between the study area and these sites, they have been considered in the Groundwater Dependent Terrestrial Ecosystems assessment (see ES Appendix 13.3 Groundwater

assessment) (**TR010037/APP/6.3**) and all assessed to be of moderate importance.

13.7.42. There are no Sites of Special Scientific Interest (SSSIs) or sites of geological interest within 2km of the Proposed Scheme.

13.7.43. Sites situated further east of those discussed above have not been considered further as these are at a significant distance from any feature of the Proposed Scheme that could have a potential significant impact.

Water Framework Directive

13.7.44. The study area is found within the Broadland Rivers Chalk and Crag groundwater body (GB40501G400300) and is part of the Broadland Rivers Chalk and Crag Operational Catchment and the Anglian Groundwater Management Catchment. The location of the groundwater body can be seen in ES Figure 13.4 (WFD groundwater bodies) (**TR010037/APP/6.2**).

Table 13.4 Summary of WFD groundwater bodies within the study area

Water body name	Broadland Rivers Chalk and Crag groundwater body
Water body ID	GB40501G400300
Operational catchment	Broadland Rivers Chalk and Crag Operational Catchment
Management catchment	Anglian GW Management Catchment
River basin district	Anglian
Type	Groundwater body
Hydromorphological status	N/A
Overall classification (cycle 2 – 2016)	Poor
Current chemical quality (cycle 2 – 2016)	Poor
Chemical objective	Good (by 2027)
Protected area (within the study area)	Yes, Nitrates Directive

13.7.45. The Broadland Rivers Chalk and Crag groundwater body (GB40501G400300) has poor chemical and quantitative status (2016 cycle 2). The quantitative status is limited by the Groundwater Dependent Terrestrial Ecosystems test which scored poorly due to agricultural abstractions lowering the natural flow and levels of the groundwater. The objective is to achieve 'good' quantitative status by 2021. The chemical status is limited by the chemical Drinking Water Protected Area criteria, which scored poorly although data is reportedly suspect. With specific relevance to the Proposed Scheme, there is a drinking water safeguard zone situated along the southern and south eastern boundary of the study area. This relates to a public water supply abstraction outside the study area at Bixley (Trowse Newton), which suffers from high nitrates. Objectives are to achieve good chemical status by 2027 by natural recovery. The site is located within the Norwich Crag and Gravels groundwater Nitrate Vulnerable Zone.

Licensed and unlicensed abstractions

13.7.46. Details of the source protection zones and licensed and unlicensed abstractions are given in ES Figure 13.5 (Groundwater abstractions, discharges and source protection zones) (**TR010037/APP/6.2**) and ES Figure 13.1 (Surface water features, abstractions, discharges and fluvial flood risk) (**TR010037/APP/6.2**).

13.7.47. The Proposed Scheme and study area are located entirely within Source Protection Zone (SPZ) 3 (Total Catchment). This is associated with groundwater abstractions for public water supply in Norwich, 5km to the east and 2.5km to the north.

13.7.48. There are 10 licensed groundwater abstractions within the 1km of the study area. These are used for agricultural and domestic water supply purposes and are listed below in Table 13.5. None of the licensed abstractions have been identified to be directly down hydraulic gradient of the Proposed Scheme.

Table 13.5 Summary of licensed groundwater abstractions.

Licensed groundwater abstraction Location	Abstraction Type	Grid reference	Geology	Use
Intwood Hall, Keswick	Borehole	619350 304240	Chalk	Drink, cooking, sanitary- Household
Intwood Hall, Keswick	Borehole	619120 304130	Chalk	Spray irrigation- Direct
Hall Farm, Keswick	Borehole	618880 304130	Chalk	General farming & domestic
Little Melton	Borehole	617001 306601	Chalk	Spray irrigation- Direct
Training ground, Colney	Borehole	617260 306669	Chalk	Spray irrigation- Direct
Hethersett	Borehole	616500 304960	Chalk	Spray irrigation- Storage
Hethersett	Borehole	616330 305020	Chalk	General farming & domestic
Hethersett	Borehole	616330 305020	Chalk	General use relating to secondary category (medium loss)
Thickthorn Farm	Well	617210 305880	Glacial sands/gravels	General farming & domestic
Thickthorn Farm	Borehole	617680 305750	Chalk	Spray irrigation- Direct

13.7.49. There are two surface water abstractions within the study area located to the west, and upstream, of the Proposed Scheme. These are summarised below in Table 13.6.

Table 13.6 Summary of licenced surface water abstractions

Licensed surface water abstraction	Grid reference	Use
Ketteringham Stream, Hethersett	616560 304970	Spray irrigation- Storage
Tributary of the Ketteringham Stream, Hethersett	616540 304980	Spray irrigation- Storage

13.7.50. A request was made to the South Norfolk Council (July 2020) for information on private water supplies (unlicensed groundwater and surface water abstractions) within the study area. Exact locations could not be provided due to General Data Protection Regulations, however abstractions in relation to their general directions are provided below.

13.7.51. Abstractions identified to be close to, and specifically down-gradient, of the Proposed Scheme are as follows:

- four abstractions around 450m south of the A11-A47 connector road
- one abstraction around 150m south of the A11-A47 connector road
- four abstractions around 300m east of the Cantley Lane overbridge

- one abstraction around 1km south west of the A11-A47 connector road

13.7.52. Other unlicensed abstractions within 1km of the study area include:

- one abstraction around 600m north east of the A11-A47 connector road
- one abstraction 1km north of Norwich Road, Hethersett

Consented and unconsented discharges

13.7.53. Data provided by the Environment Agency indicates there is one consented discharge to surface water within the study area:

- Discharge of secondary treated sewage effluent to a tributary of the River Yare at grid reference 617557, 306241 (easting and northing)

13.7.54. There are two consented discharges to groundwater and land within the study area:

- Discharge of surface water runoff from the hard standing (concrete slab) at Ketteringham Household Waste Recycling Centre via groundwater infiltration (after treatment of settlement) at grid reference 617296, 303981 (easting and northing)
- Discharge of biologically treated sewage effluent to land at grid reference 617250, 303850 (easting and northing)

13.7.55. As of September 2020, there have been no unconsented discharges identified from consultation. A request has been made to South Norfolk Council (July 2020) to supply information on unconsented discharges to the study area.

Existing drainage

13.7.56. HA DDMS (Highways England, 2020b) provides details on the existing drainage network which is summarised below:

- The catchment draining the south west of the Proposed Scheme which discharges runoff from the A11 south of Cantley Stream, is drained via a cluster of three outfalls currently classified as low pollution risk according to HADDMS (2020b).
- The catchment draining the A11 north of Cantley Stream and A47 / A11 Thickthorn Junction is drained via a cluster of nine outfalls currently classified as low pollution risk.
- The catchment draining the south east of the Proposed Scheme discharges runoff from the A47 to Cantley Stream. It is drained via a cluster of 13 outfalls currently classified as low pollution risk.

- HADDMS also identified 19 soakaways all currently classified as low pollution risk within the study area, these receive runoff from the A47 / A11 Thickthorn Junction and the A47 between the junction and Cantley Stream.

13.7.57. All of the outfalls identified appear to discharge to Cantley Stream. The existing drainage network, including the outfalls and soakaways identified above, require verification through drainage survey.

13.7.58. A number of catch-pits were identified on HA DDMS (Highways England, 2020b) across the Proposed Scheme, within the DCO boundary. No other surface water outfalls, soakaways or attenuation features were identified within the study area. Furthermore, HADDMS did not indicate the presence of any additional pollution control devices or oil - petrol interceptors within the study area.

13.7.59. The Proposed Scheme lies within a partly urbanised catchment, particularly to the east of the A47 where surface water drainage is governed by Local Authority (Norfolk County Council) highways drainage and Anglian Water's sewerage drainage network. Subject to the outcome of the drainage survey, the Proposed Scheme drainage does not appear to connect to the local network.

Flood risk

13.7.60. The risk of flooding to and from the Proposed Scheme has been assessed and discussed in detail in the Flood risk assessment (see ES Appendix 13.1) (**TR010037/APP/6.3**).

13.7.61. According to the Environment Agency's Flood Map for Planning (Environment Agency, 2020d), the majority of the study area is located within Flood Zone 1. This can be seen in ES Figure 13.1 (Surface water features, abstractions, discharges and fluvial flood risk) (**TR010037/APP/6.2**). Flood Zone 1 is associated with a low risk of flooding from fluvial sources (an annual probability of less than 1 in 1,000 (0.1%) of river and sea flooding).

13.7.62. There are localised areas of Flood Zones 2 and 3 within the study area which are associated with Cantley Stream and Intwood Stream. Flood Zones 2 and 3 associated with Cantley Stream are also located within the Proposed Scheme DCO boundary. For fluvial flooding Flood Zones 2 and 3 are defined as:

- Flood Zone 2 is associated with a medium risk of flooding (land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% to 0.1%)
- Flood Zone 3 is associated with high risk of flooding (land assessed as having a 1 in 100-year or greater annual probability of river flooding (>1%)

13.7.63. The Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (JBA Consulting, 2017) identifies areas of Flood Zone 3 as being Flood Zone 3a and indicative 3b:

- Flood Zone 3a comprises of land assessed as having a 1 in 100 or greater annual probability of river flooding
- Flood Zone 3b comprises as land where water has to flow or be stored in times of flood.

13.7.64. The SFRA (JBA Consulting, 2017) states the term 'indicative extent of Flood Zone 3b' is a precautionary approach that was adopted due to the absence of detailed hydraulic model information.

13.7.65. There are no designated flood defences, areas benefitting from defences or flood storage areas with the study area. The Environment Agency's Historic Flood Map (Environment Agency, 2020f) does not indicate any areas of previous flooding within the study area.

13.7.66. Hydraulic modelling has been undertaken to characterise the baseline conditions of Cantley Stream and the respective floodplain (ES Appendix 13.1 Flood risk assessment) (**TR010037/APP/6.3**). Predictions from the flood risk model confirm that under baseline conditions:

- For all events, residential properties in the floodplain are predicted to be at low risk of flooding. Floodwaters intercepted a residential receptor adjacent to Intwood Road (close to the downstream extent of the model), however, the property was not predicted to be flooded above the threshold level.
- The model also predicts that the culvert beneath Cantley Lane South is overtopped where flow is throttled by the structure. During a 100-year event the maximum depth in this reach (A11 to Cantley Lane South) is predicted to be 0.92m. This increases to a maximum depth of 1.08m when 65% climate change is also considered. The maximum depths downstream of this culvert are lower, being 0.66m and 0.84m respectively, after returning over the banks or overtopping Cantley Lane South. Cantley Lane South is predicted to experience water depths of approximately 0.2m for several hours during a large flood event.
- Out of bank flow is predicted to overtop Intwood Road, just north of the culvert near the downstream extent of the model. During a 100-year event the maximum depth in this reach (A47 to downstream of Intwood Road bridge) is predicted to be 0.98m. This increases to a maximum depth of 1.13m when 65% climate change is added.

13.7.67. The Environment Agency's indicative long term flood risk map (Environment Agency, 2020e) indicates most the study area is at very low risk of pluvial (surface water) flooding. This can be seen in ES Figure 13.6 (Surface water

flood risk) (**TR010037/APP/6.2**). The Environment Agency classify very low flood risk as less than 1 in 1000 (0.1%) chance of flooding in any given year.

13.7.68. However, there are areas of low to high risk of surface water flooding within both the Proposed Scheme DCO boundary and the study area. The Environment Agency classify the low to high risk as:

- Low - the area has between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of pluvial flooding in any given year
- Medium - the area between 1 in 100 (1%) and 1 in 30 (3.3%) chance of pluvial flooding in any given year
- High - the area has greater than 1 in 30 (3.3%) chance of pluvial flooding in any given year

13.7.69. These areas are predominantly associated with the Cantley Stream, Intwood Stream and the smaller watercourse to the north of the Proposed Scheme. A number of medium to high risk surface water flow paths are identified along the carriageway and crossing the A11. There are isolated areas of ponding not linked to watercourses identified at the existing A47 / A11 Thickthorn Junction and to the north of the B1172 Norwich road.

13.7.70. HA DDMS (Highways England, 2020b) identified a number of instances of historic carriageway flooding on the A47 and the A47 / A11 Thickthorn Junction within the study area. Five of these historic instances were identified to be of medium severity and 19 low severity. Details of these instances of flooding can be found in the Flood risk assessment (see ES Appendix 13.1) (**TR010037/APP/6.3**).

13.7.71. Norfolk County Council Highways team confirmed that there has been no flooding on county road approaches to the roundabout. However, there has been flooding on the A47 / A11 Thickthorn Junction itself. Highways England are addressing existing highway flooding issues on the junction as part of a drainage renewal project separate to the Proposed Scheme.

13.7.72. The LFRMS (Norfolk County Council, 2015) indicated that 10 residential properties in Cringleford to the east of the Proposed Scheme are at risk of surface water flooding and 20 residential properties in Hethersett to the west of the Proposed Scheme are at risk of surface water flooding.

13.7.73. The Greater Norwich SFRA (JBA Consulting, 2017) indicates that there have been 11 incidents of flooding from the ‘properties at risk of flooding’ (known as ‘DG5’) register in the Norwich and Cringleford area. No further detail on the precise locations, dates or extents of these flood events was available. Anglian

Water confirm that there have been instances of flooding within the vicinity of the Proposed Scheme.

13.7.74. The Proposed Scheme is not at risk of flooding from canals, the sea or as a result of reservoir failure (Environment Agency, 2020e).

Groundwater flooding

13.7.75. There is potential for groundwater flooding to occur in the south west and south east of the study area generally along the line of Cantley Stream. Chalk is found close to surface in this area and is thought to outcrop in the riverbed. Sub artesian groundwater conditions have been noted in boreholes closest to Cantley Stream. Areas susceptibility to groundwater flooding are shown in ES Figure 13.7 (Susceptibility to groundwater flooding) (**TR010037/APP/6.2**).

Aquatic ecology

13.7.76. Through potential impacts on the water environment, the Proposed Scheme has the potential to have an indirect impact on the aquatic ecology of the study area. The impact on such features has been assessed in detail in ES Chapter 8, Biodiversity (**TR010037/APP/6.1**).

13.7.77. Water dependent Priority Habitat sites located within the study area along Cantley Stream are shown in ES Figure 13.3 (Aquifer designations) and summarised below:

- One Coastal and Floodplain Grazing Marsh Priority Habitat is located along Cantley Stream immediately upstream of, and adjacent to, the DCO boundary
- South of this, adjacent to the DCO boundary, a Lowland Fen Priority Habitat is located along south bank of Cantley Stream.
- A second Lowland Fen Priority Habitat is located within the study area 0.93km east of DCO boundary, south of Cantley Stream.
- One Coastal and Floodplain Grazing Marsh Priority Habitat is located 0.9km south east the DCO boundary on the study area boundary.

13.7.78. There are also two County Wildlife Sites adjacent to Cantley Stream (Meadow Farm Meadow County Wildlife Site and Intwood Carr County Wildlife Site).

13.7.79. Areas of lowland Fen Priority Habitat and the County Wildlife Sites have been included in the Groundwater Dependent Terrestrial Ecosystem Assessment (ES Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**)).

13.7.80. The presence of water voles has been confirmed along Cantley Stream within the DCO boundary and signs of otter activity (commuting only) were observed within the study area.

13.7.81. There are no Ramsar sites, Special Areas of Conservation (SAC), Local Nature Reserves (LNR) or National Nature Reserves (NNR) within the study area or immediately downstream of the study area. The closest statutory designated nature conservation sites outside of the 1km study area are:

- Eaton Common LNR located 350m from the western extent of the study area adjacent to the River Yare.
- Marston Marshes LNR located 800m from the western extent of the study area adjacent to the River Yare.
- Lowland Meadows and Coastal and Floodplain Grazing Marsh Priority Habitats are located adjacent to the River Yare 2km downstream of the study area.

13.7.82. There are two additional Coastal and Floodplain Grazing Marsh Priority Habitats, one Lowland Fen Priority Habitat and one County Wildlife Site located to the east of the study area. However, they have not been considered within this assessment as they are at a significant distance (greater than 1km) from any main construction works of the Proposed Scheme that could have a potential significant impact.

Recreation and human health

13.7.83. The Proposed Scheme lies within a largely rural, predominantly agricultural area with sporadic farm and residential buildings either adjacent to the A47, A11 or along minor side roads. Cringleford residential area is located to the east of the Proposed Scheme.

13.7.84. There is no information relating to recreation, navigation or angling for Cantley Stream or Intwood Stream within the study area. The River Yare is used for recreation and angling purposes, however commercial traffic is rare.

13.7.85. There are 38 isolated ponds in the study area, however, these have not been identified as being used for angling or other recreational purposes.

13.7.86. Due to this, attributes associated with recreation and human health were not considered for surface water features other than the River Yare (see Table 13.7).

Events

13.7.87. The Greater Norwich SFRA (JBA, 2017) provides details on a number of flood events known to have affected the Greater Norwich area between 1273 and 2017. Coastal flooding events affected the Yare and Bure catchments in 1608, 1897, 1953, 1976, 1981, 1983, 1993, 2007 and 2013. A rainfall and snowmelt flood occurred in 1878. A number of these floods resulted in fatalities and damage to hundreds or thousands of properties.

13.7.88. A 1 in 1000-year rainfall event in 1968 caused fluvial flooding which affected the Yare catchment. Rainfall caused widespread inundation of the fluvial floodplains on the Yare river in 1981. In 1993, a rainfall event caused flooding in Norwich and part of the Broads and affected 33 properties. The River Yare was affected with some flooding due to surface water.

Climate change

13.7.89. The Meteorological Office regional climate summary for eastern England (Met Office, 2016) indicates the current climate baseline within the study area to be:

- Mean annual temperatures ranging from 9.5°C to around 10.5°C in the low-lying areas with mean daily minimum temperatures of 1°C in winter and mean daily temperatures of 20°C to 23°C in summer.
- Average annual sunshine durations over eastern England range from over 1,600 hours in Norfolk, Suffolk and Essex to less than 1,450 hours in East Yorkshire and Lincolnshire.
- Eastern England has a more even annual distribution of rainfall when compared with the rest of the UK with an average of 30 rain days in winter and less than 25 days in summer.
- The average number of days with snow falling is about 20 per year in low lying areas.
- Eastern England is one of the more sheltered parts of the UK in terms of wind.

13.7.90. Climate change predictions suggest that the future annual recharge volumes for groundwater are broadly stable although the groundwater recharge season is likely to condense into a shortened period, leading to more variable groundwater levels and a greater drought vulnerability (Environment Agency, 2021).

13.7.91. The associated online climate change allowance (Environment Agency, 2020a) states that to allow for residual uncertainty in assessing the impacts of climate change on future flood risk, fluvial flow rates should be increased by 65%. The climate change allowance to allow for residual uncertainty in assessing the impacts of climate change on future peak rainfall intensity is 40%. This refers to the ’Upper End’ categories for the Anglian Region and a time horizon of 2080s

(2070 to 2115), as the Proposed Scheme is classed as 'essential infrastructure' partly lying in Flood Zone 3. The lifetime of the development is assumed to be 100 years when considering flood risk.

Sensitivity of receptors

13.7.92. The following receptors or features have been identified that could potentially be affected by the construction and operation of the Proposed Scheme. In accordance with DMRB LA 113 guidance, the importance of these features in terms of their attributes are summarised in Table 13.7 below.

13.7.93. The Environment Agency designated main rivers, the River Yare and Intwood Stream, have been assessed individually. The ordinary watercourse Cantley Stream, which flows from west to east through the Proposed Scheme has also been assessed separately. The River Yare floodplain has not been assessed as it does not fall within the study area.

13.7.94. Unnamed ponds in the Intwood Stream WFD water body catchment have been considered together as they all lie within the same Operational Catchment.

13.7.95. The Broadland Rivers Chalk and Crag WFD groundwater body (representing the Chalk Principal aquifer) and overlying Secondary aquifer (representing the Sheringham Cliffs Formation) have been considered separately. Cantley Stream, the licensed and unlicensed abstractions and designated sites have been assessed as indirect receptors of the aquifers (direct receptors). These are considered attributes of the aquifers listed in the table below.

Table 13.7 Importance of water environment attributes in study area

Feature	Attribute	Importance	Reason for assigned value
Cantley Stream	Water supply and quality	Medium	Two known abstractions within the study area. Fail WFD chemical status within the water body catchment.
	Dilution and removal of waste products	Low	No known consented discharges
	Value to economy	Medium	Two known abstraction within the study area. Limited known usage of the watercourse.
	Conveyance of flow	High	Q_{95} is estimated to be 0.013 m^3/s (Low Flows 2).
	Biodiversity	High	Priority habitats within the study area
Intwood Stream	Water supply and quality	Low	WFD failure chemical status. No abstraction points within the study area.
	Dilution and removal of waste products	Low	No known consented discharges

Feature	Attribute	Importance	Reason for assigned value
	Value to economy	Low	No abstraction points within the study area. Limited know use of the water body.
	Conveyance of flow	High	Q_{95} unknown but assumed to be greater than 0.013 m^3/s and less than 1 m^3/s.
	Biodiversity	High	Priority habitats within the study area
River Yare	Water supply and quality	Low	WFD failure chemical status. No known abstraction within the study area.
	Dilution and removal of waste products	Low	One consented discharge of secondary treated sewage effluent to a tributary of the River Yare
	Recreation	Medium	Some commercial navigation, now used predominantly for recreational purposes. Some angling
	Value to economy	Medium	No known abstraction in the study area, some recreational use
	Conveyance of flow	High	Q_{95} upstream is 0.322 m^3/s of Intwood Stream confluence.
	Biodiversity	High	No designated sites within the study area, However, Priority Habitats 2km downstream of the study area
Ponds	Water supply and quality	Low	No abstraction points within the study area. WFD failure chemical status.
	Dilution and removal of waste products	Low	No known consented discharges
	Value to economy	Low	No abstraction points within the study area. Limited know use of the water body.
	Biodiversity	High	Priority habitats within the study area
Cantley Stream Floodplain	Conveyance of flow	Low to high	On 'more vulnerable' development is partially within the modelled floodplain (high importance). There are areas of agricultural land use classed as 'less vulnerable' (medium) and amenity land use classed as 'water compatible' land use (low) near to and within the floodplain.
Intwood Stream Floodplain	Conveyance of flow	High	Flood Zone 3a and 3b few areas local to this consist of 'more vulnerable' development but no development within the floodplain.
Broadland Rivers Chalk and Crag	Water supply and quality	High to very high	Principal aquifer, WFD objectives for good status by 2027. A number of licensed and unlicensed abstractions are located within the study area used for irrigation and potable supply. It is unknown what aquifer unlicensed abstractions take from.
	Soakaway	Low	No soakaways to discharging to Chalk in study area.

Feature	Attribute	Importance	Reason for assigned value
	Vulnerability	High	Combined aquifer groundwater vulnerability of medium risk with soluble rock risk associated with the Chalk (i.e. solution features may enable rapid movement of pollutants).
	Economic Value	Very high	Principal aquifer providing a regionally important resource including licensed abstractions in the study area.
	Conveyance of flow	High	Cantley Stream is a chalk fed stream in the study area, and therefore there are hydraulic pathways to surface waters via baseflow. In addition, priority habitats are likely supplied by baseflow: the Meadow Farm County Wildlife Site and Intwood Carr County Wildlife Site.
	Biodiversity	Medium	Groundwater dependent terrestrial ecosystems assessed to be moderate importance (see Volume 3, Appendix 13.3 Groundwater assessment) (TR010037/APP/6.3)
Secondary Superficial Aquifer	Water supply and quality	Medium	Secondary aquifers supporting local water supply. There is one confirmed licensed abstraction from the superficial deposits used for potable supply.
	Soakaway	High	Secondary aquifers received water from existing road drainage soakaways
	Vulnerability	Medium	Combined aquifer groundwater vulnerability of medium risk.
	Economic value	Medium	Supports at least one local abstraction.
	Conveyance of flow	High	In hydraulic continuity with the Chalk Principal aquifer and locally supports base flow to Cantley Stream.
	Biodiversity	Medium	Groundwater dependent terrestrial ecosystems assessed to be moderate importance (see Volume 3, Appendix 13.3 Groundwater assessment) (TR010037/APP/6.3)

13.8. Potential impacts

13.8.1. This section considers the potential impacts on surface water, groundwater and flood risk receptors, prior to the implementation of mitigation measures.

13.8.2. Where the effect of the Proposed Scheme on a receptor would result in potential impact, this has been assessed below. This assessment is based on the design elements provided in ES Chapter 2 The proposed scheme.

Construction

Surface water

13.8.3. Construction activities, including the demobilisation of site compounds, increase the risk of a pollution incident from accidental spillages or leakage of fuels, oils, chemicals, wastewater, concrete or cement admixtures used. Such accidental

spillages are potentially likely to impact on surface water features such as Cantley Stream, Intwood Stream and the ponds local to the Proposed Scheme and the River Yare catchment. There may also be an indirect impact on the River Yare as a downstream receptor. This, in turn, may have a negative impact on downstream aquatic environments, recreation, water supply, water quality and recreation.

13.8.4. Construction works would have the greatest potential to impact on the surface water environment when they take place within, adjacent, over or close to surface water features, including the fluvial floodplain. The placement of construction materials, washing of plant and vehicles, and cleaning areas of hardstanding, for example, increases the potential for mobilisation of sediment and contaminants from surface water runoff to watercourses and ponds. In addition, the Cantley Stream river realignment, the Cantley Stream Underpass extension, the new Cantley Lane South Culvert and the construction of six new outfalls along Cantley Stream would also increase the potential for mobilisation of sediment and contaminants. These activities could adversely impact on water quality, recreational users, value to the economy and the aquatic ecology aspects of surface water features including Cantley Stream where works are in close proximity. There may be an indirect impact on Intwood Stream, ponds and the River Yare as downstream receptors.

13.8.5. Water quality impacts are likely to be short term during the construction period. However, some potential construction impacts, such as the deposition of sediments in watercourses, can have longer term consequences. Especially with respect to aquatic ecology, where increased sediment loading of streams and changes to turbidity can have a negative impact. The geomorphological assessment (ES Appendix 13.5 (**TR010037/APP/6.3**)) notes Cantley Stream appears to have limited capacity for sediment conveyance which is likely due to having relatively low stream power. Therefore, any increase in sedimentation caused by construction would have a disproportionate impact on the channel due to the residence time in a particular channel reach. The WFD ecological quality elements that could be impacted include:

- physicochemical quality elements (ammonia, dissolved oxygen, pH, and phosphate)
- biological quality elements (invertebrates and macrophytes and phytobenthos, and fish for the Yare (Tiffey to Wensum) only)

13.8.6. There will be a requirement to work within Cantley Stream and its floodplain in order to complete the construction of new outfalls in Cantley Stream, Cantley Lane South Culvert, the Cantley Lane Link Road, the extension of the A11 Cantley Stream Underpass and the stream realignment. This may cause an increase in risk of fluvial flooding to the Proposed Scheme or others due to

obstruction or changes in the flows within the channels and on the floodplain. Additionally, this could adversely impact upon downstream flood-sensitive receptors, aquatic environments, value to economy, water quality and recreational users of surface water features including Cantley Stream, Intwood Stream (and their floodplains), the River Yare and ponds located downstream.

13.8.7. The construction of the Cantley Stream river realignment, the Cantley Stream Underpass extension, the new Cantley Lane South Culvert and the six new outfalls along Cantley Stream would impact on the riparian and channel morphology, habitat and ecology, including existing water vole habitat, of the stream through the disturbance (bank destabilisation) and / or removal of stream banks and channel. This would negatively impact upon the existing channel morphology, water quality and biodiversity of Cantley Stream and its downstream receptors, including Intwood Stream, the River Yare and the ponds. The WFD ecological quality elements that could be impacted include:

- physicochemical quality elements (ammonia, dissolved oxygen, pH, phosphate)
- biological quality elements (invertebrates and macrophytes and phytobenthos, and fish for the Yare (Tiffey to Wensum) only)
- hydromorphological quality elements (hydrological regime and morphological conditions)

13.8.8. During construction, there is an increased risk of flooding during and following extreme rainfall events, including those areas identified as at risk of surface water flooding. Works may lead to temporary changes in the surface water runoff regime by the alteration of ground elevations and overland flow pathways or the construction of above ground structures acting as a barrier to flow.

13.8.9. Most notably, the construction of the embankments associated with the Cantley Lane South link road, the A11-A47 connector road, the earthwork bunds located south of the junction and to the west of the A11 would alter the surface water regime local to Cantley Stream. This could cause localised flooding to the Proposed Scheme and nearby receptors due to changes in surface water flood flow pathways. Indirectly, overloading of the temporary drainage system could adversely impact on surface water features including the Cantley Stream, Intwood Stream (and their floodplains), the River Yare and ponds. This, in turn, may have a negative impact on downstream flood-sensitive receptors, aquatic environments, value to economy, water quality and recreational users.

13.8.10. During construction there will be an increase in new hardstanding areas, including the compounds and temporary stockpile locations, which, if not mitigated, would increase the volume and flow rate of runoff from the construction areas. This could result in the increased localised flooding to the

Proposed Scheme and other flood-sensitive downstream receptors. Additionally, this could adversely impact upon downstream aquatic environments, value to economy, water quality and recreational users of surface water features including Cantley Stream, Intwood Stream, the River Yare and ponds.

13.8.11. There would be a requirement to divert an Anglian Water water main and there is likely to be a requirement to divert an Anglian Water foul sewer under Cantley Stream and its floodplain, downstream of Cantley Lane South. It is proposed that the utilities diversions would be installed using directional drilling methods. However, there is the potential for the associated construction works to cause an increase in risk of fluvial flooding to the Proposed Scheme or others due to obstruction or changes in the flows within the channel and floodplain. Additionally, these activities could adversely impact upon downstream flood-sensitive, water quality, recreational users, value to the economy and the aquatic ecology aspects of surface water features including Cantley Stream. There may be an indirect impact on Intwood Stream and the River Yare as downstream receptors.

Groundwater

13.8.12. Drainage of construction areas where topsoil has been removed may result in surface water contaminated by construction materials (primarily as a result of accidental spillages and leakages) discharging to groundwater. This is also a risk within site compounds, where temporary drainage is collected in unlined drainage ditches. The greatest risk is likely to occur where infiltration from site drainage occurs directly into the Sheringham Cliffs Formation superficial aquifer, and where there is potential for migration into the Chalk Principal aquifer and its associated indirect receptors (Cantley Stream, down-gradient abstractions and designated sites).

13.8.13. The removal of topsoil, and also significant thicknesses of the unsaturated zone within excavations, has the potential to increase the vulnerability of underlying aquifers, and therefore increases the risk of any contaminated surface water entering the Chalk Principal aquifer. The cutting for the A11-A47 connector road removes a significant thickness of Sheringham Cliffs Formation, and in places exposes the Chalk Principal aquifer. Underpasses adjacent to the Cantley Stream, where the Chalk is close to existing ground level, may also expose the Chalk Principal aquifer during construction. In this location construction of utilities diversions is also a risk. In these areas there is therefore an increased risk of contamination as a result of accidental spillages and leakages during construction.

13.8.14. Excavations required for the construction of underpasses may also result in contamination of groundwater through direct contact with construction materials.

The Ward's Wood Underpass and utilities diversions constructed through directional drilling may be constructed using slurries and grouts, which have the potential to contaminate both direct and indirect receptors, especially if fractures are present within the exposed Chalk aquifer as these can act as preferential pathways for contaminants. This poses a significant risk to down-gradient receptors, such as Cantley Stream, the unlicensed abstractions and the designated sites.

13.8.15. Groundwater control activities such as dewatering may be required for underpass construction or utilities diversions. Such activities have the potential to result in a reduction in local groundwater levels and therefore a loss of groundwater to any indirect receptors within the construction dewatering area of influence. This is of particular concern for any nearby unlicensed abstractions. Cantley Stream may also experience losses in baseflow as a result of dewatering activities required for adjacent excavations.

13.8.16. Discharge water from construction dewatering activities are likely to contain suspended solids and may therefore result in contamination of a receiving water body. Although not confirmed, this is likely to be either returned to ground via infiltration galleries, or discharged directly to Cantley Stream.

13.8.17. The placement of piled foundations has the potential for contamination of groundwater through smearing of contaminants from the surface, the creation of preferential pathways between different aquifer units and / or direct contact with construction materials. Adjacent to Cantley Stream, where the Sheringham Cliffs Formation is saturated, any piled foundations have the potential to directly impact both the secondary superficial aquifer and the Principal Chalk aquifer. Further from the Cantley Stream, piled foundations for structures such as the Cantley Lane Footbridge and the Ward's Wood Underpass (if the construction method requires foundations) are likely to impact the saturated Chalk aquifer only.

Operational

Surface water

13.8.18. There is a risk of pollution to surface water features resulting from accidental spillage or pollution incidents. This risk would increase with the increase in the volume of traffic. Such accidental spillages could result in short term adverse impacts on water quality, recreational users, value to the economy and aquatic ecology of surface water features, including Cantley Stream, Intwood Stream and ponds. The River Yare may also be adversely affected, as an indirect receptor.

13.8.19. The Proposed Scheme would result in an increase in the highway drainage area. This coupled with the associated increase in traffic volumes would result in an

increase in pollutant loads in highway runoff. This could result in a long-term increase in diffuse pollution, adversely impacting on water quality, recreational users, value to the economy and aquatic ecology of surface water features, including Cantley Stream, Intwood Stream and ponds. The River Yare may also be adversely affected, as an indirect downstream receptor. The WFD ecological quality elements that could be impacted from accidental spillage or increases in pollutant loads in highway runoff include:

- physicochemical quality elements (ammonia, dissolved oxygen, pH, phosphate and temperature)
- biological quality elements (invertebrates and macrophytes and phytobenthos, and fish for the Yare (Tiffey to Wensum) only)
- Specific pollutants (copper and zinc)

13.8.20. The Proposed Scheme could lead to a change in the surface water runoff regime by the alteration of ground elevations or overland flow pathways. This could result in the diversion of flood flow pathways, increased localised flooding next to the scheme with potential increased flood risk to the Proposed Scheme and to others. Indirectly, this would potentially affect downstream aquatic environments, recreational users and value to economy associated with surface water features including the ponds, Cantley Stream and floodplain and Intwood Stream and floodplain. The River Yare may also be adversely affected, as an indirect downstream receptor.

13.8.21. The Proposed Scheme, through creation of the new carriageway hardstanding areas, would result in an increase in impermeable area which, if not mitigated, would increase the peak flow rate of runoff as well as the volume from the carriageway. This could result in increased localised flooding to the Proposed Scheme and others downstream. Additionally, this would potentially adversely impact upon downstream aquatic environments, recreational users and value to economy associated with surface water features including the ponds, Cantley Stream and floodplain and Intwood Stream and floodplain. The River Yare may also be adversely affected, as an indirect downstream receptor.

13.8.22. The construction of seven new outfalls, the extension of the A11 Cantley Stream Underpass by 15m including the associated minor watercourse realignment, the new Cantley Lane South Culvert (which is 40m in length) and the realignment of Cantley Stream for approximately 390m would result in the loss or deterioration of channel and riparian habitat and the reduction of morphological complexity of Cantley Stream. The location of the outfalls can be found in ES Appendix 13.4 Water quality assessment (**TR010037/APP/6.3**). This can lead to degradation of the watercourse habitat and supporting ecological features (including water vole) and thus adversely impact on the following WFD ecological and

hydromorphological elements of the Intwood and Yare (Tiffey to Wensum) water bodies:

- biological quality elements (invertebrates and macrophytes and phytobenthos, and fish for the Yare (Tiffey to Wensum) only)
- hydromorphological quality elements (hydrological regime and morphological conditions)

13.8.23. The Proposed Scheme would lead to a change in fluvial floodplain conveyance of Cantley Stream due to the presence of embankments, the Cantley Lane South Culvert, the extension of the A11 Cantley Stream Underpass and the proposed outfalls (if they are not set into the river bank), acting as a barrier to flow. The design of the Proposed Scheme would result in a loss of floodplain storage with a potential increase in flood risk to the Proposed Scheme and to others. In addition, this could adversely affect downstream aquatic environments, recreational users and value to economy for surface water features including the ponds, Cantley Stream and its floodplain, Intwood Stream and its floodplain. The River Yare may also be adversely affected, as an indirect downstream receptor.

13.8.24. Seven proposed outfalls would discharge natural catchment and highway drainage from the Proposed Scheme with the potential to cause erosion within Cantley Stream. The outfall structure itself, if not set back into the river bank, can create localised turbulent flows which could lead to erosion of the bed and bank. In turn this can impact on channel stability, structural damage and an increase sediment in downstream reaches leading to degradation of the watercourse habitat. Utilities diversions installed by directional drilling under Cantley Stream have the potential to result in channel instability installed should they be drilled at shallow depths. These aspects could adversely affect Cantley Stream which has been identified as being sediment sensitive. Intwood Stream and the River Yare may also be adversely affected, as indirect downstream receptors.

Groundwater

13.8.25. Structures extending below the water table, such as underpasses and foundations, have the potential to create a barrier to groundwater flow, especially within superficial aquifers that have limited spatial extents. This may result in groundwater mounding up-gradient of the structure and redirection of groundwater away from receptors directly down-gradient. Where structures are close to Cantley Stream and intercept both the saturated Sheringham Cliffs Formation and Chalk aquifers, however, any groundwater mounding may result in a reversal of the hydraulic gradient between the aquifer units which subsequently could impact upon baseflow to Cantley Stream.

13.8.26. Road drainage design incorporates unlined road drainage in the form of filter drains. Routine road runoff has the potential to impact on the water quality of the receiving groundwater body, and indirect groundwater receptors such as Cantley Stream and downgradient unlicensed abstractions. In the vicinity of the A11 – A47 connector road, there is potential that the top of the Chalk bedrock will be intercepted and road drainage may discharge direct into the Principal Aquifer. A water quality assessment has been completed based on the HEWRAT assessment tool and results are contained in ES Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**).

13.9. Design, mitigation and enhancement measures

13.9.1. This section provides details of the following measures:

- 'Essential mitigation' measures – these are required for the delivery of the Proposed Scheme and that can be acquired through statutory powers. They are generally incorporated into construction activities, through the appropriate selection of construction methods and materials, adoption of best practice measures and monitoring, and also long term maintenance.
- 'Embedded mitigation' measures – these are incorporated into the project design in order to avoid or prevent adverse environmental effects. They are generally incorporated into operation of the Proposed Scheme, as part of the design.

Construction

13.9.2. During construction, best practice methods for pollution prevention and water management would be implemented as part of the overall Environmental Management Plan (EMP) (**TR010037/APP/7.4**). Guidance on best practice in relation to pollution prevention and water management is set out in CIRIA guidelines (C741 Charles and Edward, 2015; C648 Murnane *et al*., 2006) and the Environment Agency's approach to groundwater protection (Environment Agency, 2018a) and groundwater protection guides (Environment Agency, 2017a, 2017b). Best practice methods specific to the identified potential impacts are discussed further below.

Surface water

13.9.3. The design and construction of all above ground structures shall aim to minimise the potential to impact on surface water features and flood risk. Specific mitigation measures to achieve this include both embedded and essential mitigation and are described below.

13.9.4. The potential for impacts to occur as a result of contamination from accidental spillages shall be minimised by the following measures:

- Appropriate storage of construction materials, including bunding of storage tanks, use of silt fencing and covering stockpiles.
- Spill kits should be located on sites near to ordinary watercourses and within the works compounds and staff should be trained in their use.
- Emergency response procedures included in the EMP (**TR010037/APP/7.4**) to handle any leakages or spillages of potentially contaminating substances.

13.9.5. No pollution pathways shall be created between the construction sites, including material lay down areas, and ordinary watercourses. Measures shall be implemented to prevent surface water runoff containing suspended sediment reaching watercourses through overland flow during rainfall events. This shall include an appropriate treatment train to prevent accidental spillages reaching groundwater, remove sediment and other contaminants as well as attenuating runoff. This must be specified as part of a temporary works water drainage strategy within the EMP (**TR010037/APP/7.4**).

13.9.6. Intwood Stream and the River Yare is designated as a Nitrate Vulnerable Zone for surface water and for groundwater. In addition, the ecological classification of the Intwood Stream WFD water body is limited to moderate due to the presence of phosphate. Where construction activities have the potential to mobilise nitrate and phosphate during, for example, earthworks in areas of agriculture, there is a potential to increase nitrate and phosphate concentrations within Intwood Stream, the River Yare or to groundwater (nitrate only). The risk of nitrate and phosphate mobilisation will be managed by the implementation of best practice construction measures through the EMP (**TR010037/APP/7.4**).

13.9.7. The above measures will mitigate impacts to WFD physicochemical and biological quality elements of Intwood Stream and Yare (Tiffey to DS Norwich) caused by construction activities and spillages.

13.9.8. There are construction activities planned within Cantley Stream and its floodplain including the construction of the extension to the A11 Cantley Lane Underpass and associated minor watercourse alignment, the Cantley Lane South Culvert and the Cantley Stream realignment. Approval must be sought for an ordinary watercourse consent from Norfolk County Council before any construction works are undertaken. There are no works proposed within 8m of a designated main river and as such, no consent (in the form of a Flood Risk Activity Permit) would be required from the Environment Agency. In addition to this, there are no works proposed immediately adjacent to a watercourse managed by Norfolk Rivers Internal Drainage Board, and therefore no consent is required from the Internal Drainage Board. The potential increase in flood risk and negative impacts on surface water receptors shall be managed by the implementation of a construction-phase drainage system, where the construction will take place

offline. This must be specified as part of the temporary works drainage strategy and implemented through the EMP (**TR010037/APP/7.4**).

13.9.9. The realignment of Cantley Stream and the construction of the proposed outfalls, culvert, underpass extension and natural catchment drainage shall be constructed at the first phases of the phased construction plan. The new river channel and Cantley Lane South culvert shall be constructed off-line and shall be designed to minimise impacts on water quality and ensure there is a minimal loss of habitat or biodiversity, meeting the requirements of water vole. In-river sediment controls (for example, straw matting) during the connection of the stream diversion with the existing stream shall be used. Reconnection of the new alignment with the existing stream shall be undertaken during low flows to minimise sediment transport. Mitigation of the ecological features of Cantley Stream during the realignment works is described further in ES Chapter 8 (Biodiversity). Due to the extension of the A11 Cantley Stream underpass and the extended length of culvert under Cantley Lane South, it is deemed there will be impacts of minor adverse significance on the biodiversity of Cantley Stream as a result. However, the Proposed Scheme has been designed to minimise impacts on the water environment:

- The new culvert at Cantley Lane South must maximise freeboard, include a soft sediment bed and a mammal shelf to maintain habitat connectivity.
- The A11 Cantley Stream underpass extension must be extended using a similar aperture and should incorporate a soft sediment at the base of the watercourse similar to that in the existing culvert.
- The realignment of Cantley Stream and the new culvert at Cantley Lane South must retain a similar length, gradient and water depth (for water vole) as the existing stream.

13.9.10. These measures will also mitigate impacts to WFD physicochemical and biological quality elements of Intwood Stream and Yare (Tiffey to DS Norwich). The minor impacts noted above are not considered to have an impact on the overall WFD status of the waterbodies.

13.9.11. Works would lead to temporary changes in overland flow and volume by the alterations of ground elevations due to re-profiling, alterations of overland flow pathways and construction of above ground structures acting as a barrier to flow. This includes the construction of the embankments associated with the A11-A47 connector road and Cantley Lane South link road, and the earthwork bunds located south of the interchange and west of the A11. This increased flood risk and negative impacts on surface water receptors shall be managed by the implementation of a construction-phase drainage system. This shall also include the construction of ‘dry culverts’ or cross drains to maintain natural flood flow pathways where they are intercepted by the Proposed Scheme; the natural

catchment drainage shall be constructed at the start of the phased construction plan. A temporary works water drainage strategy shall be incorporated into the EMP (**TR010037/APP/7.4**) to prevent increased flood risk to people and property elsewhere, and to manage pollution risks most commonly associated with increased sediment loading.

13.9.12. Construction activities, such as the extension of A11 Cantley Stream underpass, the Cantley Lane South culvert and the Cantley Stream realignment, occur within the fluvial floodplain of Cantley Stream, shall be constructed in a phased manner to avoid an increase in flood risk, over and above that stated in the FRA (ES Appendix 13.1) (**TR010037/APP/6.3**). The construction of Cantley Lane South culvert and the stream realignment, prior to Cantley Lane link road would mitigate against potential impacts to nearby receptors. The significance of effect is assumed to be the same as for the operation of the Proposed Scheme described in paragraphs 13.9.40 to 13.9.42.

13.9.13. Increased flood risk and negative impacts on surface water receptors caused by an increase in hardstanding area and alteration of ground levels leading to an increase in the peak flow rate, volume or change in the direction of surface water runoff shall be managed by the implementation of a temporary surface water drainage strategy. The strategy shall adopt SuDS principles to attenuate runoff to existing rates as well as provide water treatment; this must be incorporated into the EMP (**TR010037/APP/7.4**). This would prevent increased flood risk to people and property elsewhere and manage any impacts on consented discharges and the aquatic environment.

13.9.14. Temporary drainage from the main construction compound would typically be collected within a ditch surrounding the compound and redirected to settlement ponds before being discharged to either a surface watercourse or ground. Discharges to groundwater (or sewer and surface water) must only be made with the appropriate consents or permits in place. Any non-compliant discharges would be collected and disposed of off-site at a licensed facility.

13.9.15. The diversion of Anglian Water main water pipe is currently proposed to be directionally drilled at a depth of 1.4m from the highway verge and carriageway, and 1.7m from arable land. Should the foul sewer diversion be required, it is currently proposed this will be directionally drilled at a depth of 2m across the Proposed Scheme. Where the diversion goes under Cantley Stream, a phased construction shall be implemented, where the construction shall be undertaken offline. The diversion shall be undertaken before the new realigned Cantley Stream is constructed. Once this is complete the diversion can be constructed under the existing stream once that is offline. This would minimise any to increase in flood risk to sensitive receptors elsewhere and manage pollution risks.

13.9.16. Inspections and audits, along with general monitoring and reporting of effectiveness of control measures to be carried out throughout the construction programme, would be incorporated into the EMP (**TR010037/APP/7.4)**. The mitigation strategies implemented will be reviewed regularly to best suit the practices being undertaken on site.

13.9.17. Monitoring of Cantley Stream must be carried out prior to and during the construction phase. This includes visual assessments for oil and silt, as well as watercourse monitoring using portable field indicator equipment. Whilst construction is in progress, Cantley Stream must be monitored at locations up and downstream of the works within and adjacent to the watercourse, including the installation of continuous turbidity or total suspended solids monitor probes. Monitoring requirements shall be discussed with the Environment Agency and Norfolk County Council prior to construction and these requirements shall be outlined in the water monitoring and management plan in the EMP (**TR010038/APP/7.4**).

Groundwater

13.9.18. The potential for impacts to occur as a result of contamination from accidental spillages and leakages within areas where topsoil has been removed or within excavated areas must be minimised by the following measures:

- Appropriate storage of construction materials, including bunding of storage tanks, use of silt fencing and covering stockpiles.
- Spill kits located on sites near to ordinary watercourses or drainage ditches and within the works compounds and staff should be trained in their use.
- Emergency response procedures included in the EMP (**TR010037/APP/7.4**) to handle any leakages or spillages of potentially contaminating substances.

13.9.19. The EMP (**TR010037/APP/7.4**) must highlight high risk areas, such as the A11-A47 connector road cutting, which significantly increases the vulnerability of the Chalk aquifer, and infiltration to ground must be avoided in this area.

13.9.20. The design and construction of all below ground structures must aim to minimise the potential to impact on groundwater quality during construction. Specific mitigation measures to achieve this include both embedded and essential mitigation and these are discussed in further detail below.

13.9.21. Construction method statements and risk assessments must require approval from the Environment Agency where construction activities are likely to intercept the Chalk saturated aquifer, especially adjacent to Cantley Stream. The construction method statements must include the use of best practice methods to minimise creation of contamination pathways and generation of suspended

solids. Monitoring of down-gradient receptors must also be undertaken before, during and after construction. As location information on unlicensed abstractions is limited, a water features survey must be undertaken to identify these. In addition, the use of any additives within grouts (such as for the Ward's Wood Underpass) must be approved by the Environment Agency as part of a permit application.

13.9.22. Where groundwater control is required, isolation techniques shall be considered in preference to dewatering, if feasible, in order to limit impacts to stream baseflow and subsequently downstream designated sites. Any dewatering activities will be subject to approval from the Environment Agency and obtaining the relevant licences and permits. Further investigations and impact assessments will be required as part of the licensing process to confirm rates of abstraction and area of influence and identify potential receptors within the area of influence.

13.9.23. Groundwater monitoring (levels and quality) between the dewatering locations and down-gradient receptors is likely to be a condition of the dewatering licence. Careful consideration of the dewatering discharge points will be required to minimise both the resource impacts on the groundwater catchment and quality impacts on the receiving water body. Discharges must only be made with the appropriate consents or permits in place and any non-compliant discharges would be collected and disposed of off-site at a licensed facility.

13.9.24. The design and construction of piled foundations shall minimise the potential to impact on groundwater supply or groundwater quality by adoption of the following mitigation measures:

- The piling design shall be selected to appropriately minimise disturbance to groundwater flows and thus supply to indirect receptors.
- The piling method shall minimise the generation of suspended solids that may impact nearby indirect receptors.
- The piling method shall minimise creation of preferential pathways between aquifer units, where more than one saturated aquifer unit is likely to be encountered.
- A piling risk assessment shall be undertaken prior to commencement of the works. Environment Agency guidance on minimising pollution risk due to piling should be adhered to (Environment Agency, 2002; 2017a; and Westcott *et al.*, 2001).
- Construction materials shall be chosen appropriately to minimise groundwater contamination via direct contact.

13.9.25. Inspections and audits, along with general monitoring and reporting of effectiveness of control measures to be carried out throughout the construction programme, shall be incorporated into the EMP (**TR010037/APP/7.4)**. The

mitigation strategies implemented will be reviewed regularly to best suit the practices being undertaken on site.

13.9.26. Monitoring of groundwater features at risk from pollution shall be carried out prior to and during the construction phase, subject to confirmation with the Environment Agency and these requirements outlined in the EMP (**TR010037/APP/7.4)**. This would comprise groundwater level and quality monitoring at suitable points between activities on site that may result in groundwater impacts and the down-gradient receptors identified that are at risk of these impacts. Activities likely to require groundwater monitoring include any construction activities intercepting the Chalk aquifer, especially those identified as having the potential to intercept baseflow to Cantley Stream, those identified as having the potential to impact on groundwater quality at down-gradient receptors, and dewatering activities.

Operation

Surface water

13.9.27. The potential effects of the operation of the Proposed Scheme on the water environment have been assessed and mitigated through design (embedded mitigation), as described below.

13.9.28. The Drainage strategy report (ES Appendix 13.2) (**TR010037/APP/6.3**) confirms that highway drainage would discharge to surface water via detention basins and swales and to ground via filter drains. The use of filter drains and swales / grassed ditches, which are not required as mitigation, shall be confirmed by the supplementary ground investigation to commence in Spring 2021. The proposed highway drainage is split into ten catchments, utilising an assumed three existing outfalls and five new outfalls. The location of the existing outfalls require verification through a drainage survey. However, the assumed locations can be found in ES Appendix 13.4 (Water quality assessment) (**TR010037/APP/6.3**).

13.9.29. The potential associated increase in the volume of traffic would result in an increase in pollutant loads in highway runoff, resulting in long-term increase in pollution and subsequent deterioration in water quality. Prior to discharging to Cantley Stream or ground, there is an intention to provide filter drains and swales to provide water quality treatment, except for areas considered sensitive to groundwater pollution where carrier drains must be used. However, this is subject to further supplementary ground investigation. Vegetated attenuation ponds will be constructed north of the A11 and to the south of the A47/A11 Thickthorn Junction to provide water quality treatment for mitigation and enhancement purposes, respectively. A vegetated detention basin is required north of the A11 to mitigate against elevated copper pollution risk, the detention basin will be grassed and dry except at times of heavy rainfall (ES Appendix 13.4 ,Water

quality assessment (**TR010037/APP/6.3**)). The detention basin, immediately west of the A47, will be planted with suitable local species to provide further water quality and biodiversity enhancements. Details of the drainage design can be found in ES Appendix 13.2 (Drainage strategy report) (**TR010037/APP/6.3**).

13.9.30. The potential water quality impacts of accidental spillages on surface water bodies were assessed using HEWRAT spillage assessment, as described in Appendix D of DMRB LA113. With the inclusion of additional measures proposed in the drainage design all outfalls passed this assessment. The results indicated all drainage areas would have <0.5% annual risk of pollution, the output from these assessments can be found in ES Appendix 13.4 (Water quality assessment) (**TR010037/APP/6.3**). No further mitigation is required following the spillage assessment in HEWRAT, however, pollution control devices such as penstocks shall be provided in order to reduce any pollution that may occur in the event of a spillage, as noted in ES Appendix 13.2 (Drainage strategy report) (**TR010037/APP/6.3**).

13.9.31. The potential water quality impacts of routine runoff on surface water receptors has also been assessed using DMRB LA113 HEWRAT assessment (assessment of pollution impacts from routine runoff to surface waters). The assessment shows the outfalls pass the HEWRAT assessment and that there is a negligible impact following dilution in the channel for both soluble and sediment-bound pollutants when the additional measures from the drainage design have been included. The output from the assessment can be found in ES Appendix 13.4 (Water quality assessment) (**TR010037/APP/6.3**).

13.9.32. The detention basin, immediately west of the A47, will be planted with suitable local species to provide further water quality and biodiversity enhancements. Vegetated detention basins would also reduce nitrate and phosphate concentrations through biological uptake.

13.9.33. The above mentioned measures will also mitigate impacts to WFD physicochemical, biological and specific pollutant quality elements of Intwood Stream and Yare (Tiffey to DS Norwich).

13.9.34. As the Proposed Scheme lies within Flood Zones 2 and 3, a flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**) has been prepared to assess the flood risk arising from the Proposed Scheme.

13.9.35. Any increase in runoff associated with the alteration of ground elevation due to the earthwork bunds located south of the A47/A11 Thickthorn Junction will be intercepted using appropriately designed collection drains at the base of the bund. Existing surface water pathways for overland flows are to be maintained or facilitated through interception using appropriately designed collection drains and

cross-drains. Cross-drains must be designed to convey a 1 in 100-year flow including an additional 40% climate change allowance in order to maintain connectivity of surface water flooding pathways and to mitigate against any increase in flood risk. Further details can be found in the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.36. Assessment of the surface water flood risk from the Proposed Scheme was carried out using the hydraulic model where there is a potential impact on a flood-sensitive receptor located to the north of Cantley Lane link road. The outcome of the hydraulic concluded there is no increase in flood risk as a result of the Proposed Scheme. Further details can be found in the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.37. The proposed increase in areas of impermeable highway and alteration of ground elevations due to re-profiling would result in an increase in peak flow rates discharging to Cantley Stream. Any increase in surface water runoff shall be attenuated using oversized pipes and attenuation ponds. The drainage is designed to attenuate new drainage systems to the greenfield runoff rate up to a 1 in 100-year rainfall event including a 40% climate change allowance. For existing drainage systems that are modified as part of the Proposed Scheme, there must be no increase in existing runoff rate; these standards are in accordance with DMRB CG501. This will ensure there is no increase in surface water runoff peak flow rate resulting from the Proposed Scheme.

13.9.38. Hydraulic modelling was undertaken, where the runoff discharging from outfalls was incorporated into the Cantley Stream model in order to look at the impact of new drainage systems on structures and flooding. The addition of drainage inflows has a negligible impact on the A11 Cantley Stream Underpass, and the Cantley Lane South Culvert. This indicates the attenuated runoff discharging from the Proposed Scheme has negligible impact on the flood risk. Further details can be found in the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.39. The alteration of grounds levels and the presence of embankments, the culverts and outfalls have the potential to alter the conveyance of flow in the floodplain. The flood risk impact of the Proposed Scheme has been fully assessed in the FRA using hydraulic modelling and the details of the assessment and impacts are presented in the ES Appendix 13.1 (Flood risk assessment) (**TR010037/APP/6.3**). Flood depth difference maps showing the magnitude of impacts in the Cantley Stream floodplain are provided in the flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.40. There are no flood risk impacts to receptors (for example, residential properties) classed as ‘more vulnerable’ under the NPPF flood risk vulnerability

classification. Within the vicinity of the residential receptor adjacent to Intwood Road, changes in flood depth were predicted to be below 5mm and the receptor was not predicted to be flooded above threshold level. Due to this, mitigation is not required.

13.9.41. The extension of the A11 underpass, the alteration of ground levels, removal of the throttle on flood flows caused by existing Cantley Lane South culvert, and the realignment of Cantley Stream, result in changes in the pattern of flood risk within Cantley Stream floodplain. For the 1 in 100-year including 65% climate change, a reduction in floodplain depth of up to 100mm with isolated instances of increased levels of up to 500mm (associated with ground elevation model changes) upstream of the A11 were predicted. For the 1 in 100-year flood event, with the inclusion of 65% climate change allowance, the Proposed Scheme resulted in an overall reduction in predicted maximum flood depth between the A11 and Cantley Lane South culvert of up to 1m compared to the baseline scenario, as the design of the new culvert removes the existing flood flow throttle.

13.9.42. Between the A11 and the A47 changes in the floodplain level ranged from a reduction of up to 250mm and an increase of up to 100mm. This is principally due to the stream realignment changing the patterns of flooding but also discrepancies in the LiDAR data. At the most downstream extent, upstream of Intwood Road, an increase of up to 5mm was predicted. The flood depth difference map (Figure C-17 of Appendix C) in the flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**) shows the areas of major and moderate adverse and beneficial magnitude change for the 1 in 100 year event (with a 65% climate change as defined by Table 3.71 in DMRB guidance LA 113. The magnitude of impact ranges from major adverse to major beneficial. The receptors within the affected areas are classified as ‘less vulnerable’ (agricultural land) and ‘water compatible’ (amenity) under the NPPF. This results in a significance of effect ranging from moderate adverse to moderate beneficial for the conveyance of flow for Cantley Stream floodplain. Overall, given the scale of the change and the importance of the receptor it is considered the significance of effect is classed as moderate rather than major under DMRB LA104. No ‘more vulnerable’ receptors, as defined under the NPPF flood risk vulnerability classification, are predicted to be adversely affected. The indirect impacts to Intwood Stream further downstream and its floodplain and the River Yare are assumed to be negligible.

13.9.43. The extension of the existing A11 Cantley Stream Underpass contains Cantley Stream and a realigned farm access track and must be extended using the same aperture as the existing structure. The new Cantley Lane South Culvert must be designed to a 1 in 100-year flood event including an additional 65% climate change allowance. During consultation with Norfolk County Council and the Environment Agency a 600mm freeboard, soft bed and mammal ledge was

requested for the new culvert. However, due to constraints to maintain similar stream gradient to existing, the need to provide suitable water depth for water vole, and the constraints in the road geometry meaning the soffit of the culvert could not be raised, the required freeboard could not be met (a minimum freeboard of 428mm achieved). Further details can be found in Annex A of the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.44. The realigned reach of Cantley Stream (including the new culvert at Cantley Lane South and the A11 Cantley Stream Underpass) must retain a similar channel length and gradient to the existing stream. In addition, the realigned reach must provide replacement water vole habitat and maximise freeboard at the new culvert. To provide a preferred water depth of at least 30cm throughout the full length of the diverted reach of Cantley Stream, riffle and pool structures must be provided within the channel. This will maintain the preferred water depths (at low flows) and morphological characteristics of the stream that support the existing aquatic ecology including the known water vole population and mitigate against any impacts. The design of the measures would be undertaken at detailed design stage in consultation with the Environment Agency, Norfolk County Council and other stakeholders. Further details can be found in the Geomorphology assessment (report ES Appendix 13.5) (**TR010037/APP/6.3**) and the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**).

13.9.45. The A11 Cantley Stream Underpass and the Cantley Lane South Culvert will result in the loss of riparian banks and channel bed including associated habitat. To mitigate against the impacts, the structures must be constructed to maintain a natural sediment bed at the base of the culvert and a mammal ledge should be provided above the design flood level. This will maintain connectivity of the habitat and allow mammal passage. Initial consultation with the Environment Agency, discussed the concept of restoring the realigned section of Cantley Stream to a chalk stream which would have involved constructing a wider but shallower channel. However, surveys for water voles had identified the presence of the species in the existing reach to be realigned as well as upstream of the A11 and downstream of the existing Cantley Lane South culvert. The requirement to retain suitable habitat for water vole, which would need deeper water depths and steeper banks than a typical chalk stream cross-section, conflicted with the aspiration of chalk stream restoration. In addition, the opportunities for river habitat restoration, such as meandering of the existing straightened stream, within the Proposed Scheme DCO boundary were limited by the presence of water vole.

13.9.46. Riparian planting along Cantley Stream shall provide mitigation for the loss or deterioration of riparian habitat due to additional culverting. In addition, where the realigned stream meets the existing stream to the east of Cantley Lane South, a section (approximately 38m) of the existing stream will be restored to

provide backwater habitat for water vole and other species. However, due to the additional culverting it is considered there will be impacts of minor adverse magnitude on the biodiversity of Cantley Lane Stream as a result. Further details can be found in the Geomorphology assessment report (ES Appendix 13.5) (**TR010037/APP/6.3**). The location of water vole habitat creation and riparian planting can be seen in the Environmental masterplan (**TR010037/APP/6.8)**.

13.9.47. To minimise the risk of channel instability and subsequent erosion of the watercourse banks and bed due to the discharge from the proposed outfalls, flow rates and velocities must be kept to a minimum. Scour protection downstream of the outfall must be provided to ensure the risk of erosion is minimised. The proposed outfalls must be set back into the bank to minimise the impact on flow conveyance and minimise the impact of erosion and scouring of river bed and banks. Utilities diversions should be installed, by directional drilling, at a depth to avoid any risk of bed and channel destabilisation.

13.9.48. These measures noted above relating to the culverts and river realignment will also mitigate impacts to WFD physicochemical, biological and hydromorphological quality elements of Intwood Stream and Yare (Tiffey to DS Norwich). The impact of minor adverse magnitude due to the extension of the A11 Cantley Stream Underpass and the additional culverting resulting from the Cantley Lane South Culvert is considered to have no impact on the WFD status of either water bodies.

Groundwater

13.9.49. The potential for below ground structures such as underpasses, overbridge piled foundations and utilities diversions to impact on groundwater levels and flows within the underlying aquifer has been mitigated against through embedded mitigation. For example, individual concrete piles must be spaced so as not to impede groundwater flow. Groundwater mounding impacts associated with underpasses must be mitigated against through the inclusion of subsurface drainage in the design.

13.9.50. The road drainage design shall consider groundwater levels to ensure no discharges via infiltration features or unlined road drainage occur directly into the saturated aquifer or in areas where there is less than one metre between the base of the infiltration feature and the groundwater table. Where this may occur, separate sealed carrier drain systems with road gully collection shall be used instead of unlined drainage systems.

13.9.51. Baseline water quality monitoring shall be undertaken to ensure no impacts arise from the proposed drainage design to groundwater receptors including GWDTE sites and Cantley Steam, a sensitive chalk stream.

13.10. Assessment of likely significant effects

13.10.1. Potential effects on surface water and groundwater receptors during construction are summarised in Table 13.8, together with residual impacts after mitigation. The mitigation measures described in Table 13.8 are discussed in detail in Section 13.9.

13.10.2. Potential effects on surface water and groundwater receptors during operation are summarised in Table 13.9, together with residual impacts after mitigation. The mitigation measures described in Table 13.9 are discussed in detail in Section 13.9.

13.10.3. The impact on surface water receptors is based on the outcome of the Flood risk assessment (ES Appendix 13.1) (**TR010037/APP/6.3**), Water quality assessment (ES Appendix 13.4) (**TR010037/APP/6.3**) and Geomorphology assessment report (ES Appendix 13.5) (**TR010037/APP/6.3**). These impact assessments include potential receptors identified in the assessments for groundwater levels and flow and groundwater dependent terrestrial ecosystems detailed in ES Appendix 13.3 Groundwater assessment (**TR010037/APP/6.3**).

13.10.4. The impact of the Proposed Scheme on the Water Framework Directive status of the affected water bodies is also considered in this section and is based on the assessments noted above.

13.10.5. Where potential impacts have multiple groundwater receptors (direct and indirect) the highest importance value has been listed in the table and used for the assessment. This adopts a source – pathway – receptor approach and by using the highest importance value provides a conservative outcome.

13.10.6. The Proposed Scheme results in a significant effect on the conveyance of flow in Cantley Stream floodplain, principally as a result of removing the throttle on flood flows with the proposed Cantley Lane South culvert and the stream realignment. The effects range from moderate beneficial to moderate adverse significance depending on the location within the floodplain. The effects would be present during both construction and operation.

13.10.7. No other significant residual effects on surface water and groundwater receptors are anticipated during construction or operation of the Proposed Scheme.

Table 13.8 Potential effects on groundwater and surface water receptors during construction of the Proposed Scheme

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
Accidental leakage or spillages	Pollution of surface water features due to accidental spillage or leakage of fuel and oils, or due to placement of construction materials, washing of plant, cleaning areas of hardstanding etc. (suspended solids and dissolved contaminants) Deterioration of downstream aquatic environments and abstraction water quality.	Cantley Stream	Water supply and quality	Medium	Mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (pollution prevention measures in the construction drainage design, emergency response procedures and provision of spill kits). Adhere to CIRIA guidelines on control of water pollution on linear construction sites (C648) and environmental best practice on site (C741) Monitoring plan must include water quality monitoring prior to, during and after construction (to be discussed with the Environment Agency).	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low	No direct discharge. Mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (pollution prevention measures in the construction drainage design, emergency	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
		River Yare	Water supply and quality	Low	response procedures and provision of spill kits). Adhere to CIRIA guidelines on control of water pollution on linear construction sites (C648) and environmental best practice on site (C741)	Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Works within, adjacent, over or close to water bodies, watercourses, ponds or the fluvial floodplain	Pollution of surface water bodies due to placement of construction materials, washing of plant, cleaning areas of hardstanding etc. (suspended solids and dissolved contaminants) Deterioration of downstream aquatic environments.	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4).** Adhere to CIRIA guidelines on control of water pollution on linear construction sites (C648) and environmental best practice on site (C741). An ordinary watercourse consent is required from Norfolk County Council	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
					prior to start of construction works. Monitoring plan to include water quality sampling prior to, during and after construction (to be discussed with the Environment Agency).		
		Intwood Stream	Water supply and quality	Low	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (pollution prevention measures in the construction drainage design, emergency response procedures and provision of spill kits).	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Works within, adjacent, over or close to water bodies, watercourses, ponds or the fluvial floodplain	Increased localised flooding to the Proposed Scheme. Increased or redirected flood risk to other and risk to flood-sensitive receptors near to overloaded system and downstream.	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (including temporary drainage strategy employing SuDS where appropriate). An ordinary watercourse consent is required from Norfolk County Council prior to start of construction works.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Cantley Stream floodplain	Conveyance of flow	Medium		Major adverse to major beneficial (based on impact under Proposed Scheme operation)	Moderate adverse to moderate beneficial (rather than major as moderate magnitude impacts are predominant)
		Intwood Stream	Water supply and quality	Low	Construction design and EMP (**TR010037/APP/7.4**) (including temporary drainage strategy	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Conveyance of flow	High	employing SuDS where appropriate).	Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Intwood stream floodplain	Conveyance of flow	High		Negligible	Slight adverse
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Cantley Stream realignment, construction of A11 culvert extension and replacement of	Deterioration or loss of the aquatic environments and deterioration in water quality.	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**).	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
Cantley Lane South culvert.	Deterioration of downstream aquatic environment of indirect receptors.		Biodiversity	High	Adhere to CIRIA guidelines on control of water pollution on linear construction sites (C648) and environmental best practice on site (C741). Construction of Cantley Stream river realignment and Cantley Lane South Culvert off-line at start of construction programme An ordinary watercourse consent is required from Norfolk County Council prior to start of construction works. Monitoring plan to include water quality sampling prior to, during and after construction (to be discussed with the Environment Agency).	Minor adverse	Slight adverse (impact minimised due to proposed mitigation)
		Intwood Stream	Water supply and quality	Low	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**). Monitoring plan to include water quality sampling prior to, during and after construction (to be discussed with	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Recreation	Medium	the Environment Agency).	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Alteration of ground elevations and overland flow pathways and construction of above ground structures acting as a barrier to flow.	Changes in surface water flow pathways resulting in overloading of drainage systems and surface watercourses. Increased or redirected flood risk to other and risk to flood-sensitive receptors near to overloaded system and downstream. Deterioration of downstream aquatic environments.	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (including a temporary surface water drainage strategy). Adhere to CIRIA guidelines on control of water pollution on linear construction sites (C648) and environmental best practice on site (C741). Construction of drainage and culverts at to maintain flow pathways before earthworks construction.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Cantley Stream Floodplain	Conveyance of flow	Medium		Negligible	Neutral
		Intwood Stream Floodplain	Conveyance of flow	High		Negligible	Slight adverse
Drainage of additional hardstanding areas (closed drainage system that discharges to surface water outfall).	Increase in the rate and volume of surface water runoff to water features and increased localised flooding to the Proposed Scheme. Increased or redirected flood risk to other and risk to flood-sensitive	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (including a temporary surface water drainage strategy). Adhere to CIRIA guidelines on control of water pollution on linear	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
	receptors near to overloaded system and downstream. Deterioration of downstream aquatic environments. Increase in rate and volume impacting downstream consented discharges.	Intwood Stream	Water supply and quality	Low	construction sites (C648) and environmental best practice on site (C741). An ordinary watercourse consent is required from Norfolk County Council prior to start of construction works.	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Cantley Stream Floodplain	Conveyance of flow	Medium		Negligible	Neutral
		Intwood Stream Floodplain	Conveyance of flow	High		Negligible	Slight adverse
Utilities diversions	Increased or redirected flood risk	Cantley Stream	Water supply and quality	Medium	Construction design and mitigation measures	Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
	to other and risk to flood-sensitive receptors downstream. Pollution of surface water features, including an increase in sediment load. Deterioration of downstream aquatic environments		Value to economy	Medium	implemented as part of the EMP (**TR010037/APP/7.4**). Depth of utilities diversions shall avoid instabilities to stream channel and bed. Phased construction where the diversion will be undertaken offline before Cantley Stream is realigned, in the realigned reach, and after realignment in the location of the existing stream once it is offline.	Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Drainage of construction areas including excavations, cuttings, utilities diversions and site compounds	Discharge of surface water contaminated by construction materials and surface contaminants to groundwater (including accidental spillages and leakages).	<u>Direct receptors:</u> Secondary superficial aquifer <u>Indirect receptors:</u> Principal aquifer Cantley Stream	Water supply and quality	Medium	Mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) (pollution prevention measures in the construction drainage design, emergency response procedures	Negligible	Neutral
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	Medium		Negligible	Neutral
			Economic Value	Medium		Negligible	Neutral

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
	Removal of topsoil and excavations removing a significant thickness of the unsaturated zone increases the vulnerability of underlying aquifers.	down-gradient abstractions Designated sites	Conveyance of flow	High	and provision of spill kits). Mitigation measures implemented as part of the EMP (**TR010037/APP/7.4**) should also highlight high risk areas and satellite compounds in high risk areas to avoid infiltration to ground.	Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse
Excavations, including construction of underpasses and utilities diversions	Contamination of groundwater through direct contact with construction materials	<u>Direct receptors:</u> Secondary superficial aquifer Principal aquifer <u>Indirect receptors:</u> Cantley Stream down-gradient abstractions Designated sites	Water supply and quality	Very high	Construction method statements and risk assessments to be discussed with the EA where construction activities likely to intercept the Chalk. Water quality monitoring before, during and after construction. Best practice methods to minimise contamination pathways and generation of suspended solids	Negligible	Slight adverse
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	High		Negligible	Slight adverse
			Economic Value	Very high		Negligible	Slight adverse
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse
Groundwater control requirements associated with construction of underpasses, utilities	Reduction in local groundwater levels and therefore a loss of groundwater flow / resource to nearby receptors	<u>Direct receptors</u> Secondary superficial aquifer Principal aquifer	Water supply and quality	Very high	Isolation techniques to be considered in preference to dewatering, if feasible. Dewatering activities will be subject to approval	Negligible	Slight adverse
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	High		Negligible	Slight adverse

Construction Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
diversions and foundations		Indirect receptors Cantley Stream Nearby abstractions Designated sites	Economic Value	Very High	from EA. Further investigations and assessments will be required as part of the licensing process, and likely to include monitoring before, during and after construction, and treatment of discharge water.	Negligible	Slight adverse
			Conveyance of flow	Very High		Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse
Placement of piled foundations and utilities diversions	Potential for contamination of groundwater through smearing of contaminants from surface / creation of pathway for migration of groundwater between different aquifer units / direct contact with construction materials	Direct receptors Secondary superficial aquifer Principal aquifer Indirect receptors Cantley Stream Nearby abstractions Designated sites	Water supply and quality	Very high	Piling / construction risk assessment and design (incorporating best practice methods) to minimise contamination pathways and generation of suspended solids	Negligible	Slight adverse
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	High		Negligible	Slight adverse
			Economic Value	Very high		Negligible	Slight adverse
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse

Table 13.9 Potential effects on groundwater and surface water receptors during operation of the Proposed Scheme

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
Accidental leakage or spillages	Pollution of surface water features due to accidental spillage or leakage. Deterioration of downstream aquatic environments and abstraction water quality.	Cantley Stream	Water supply and quality	Medium	Proposed drainage design. No additional measures required due to spillages assessment results indicating all drainage areas would have <0.5% annual risk of pollution. Penstocks should be provided as best practice.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low	No direct discharge. Proposed drainage design. No additional measures required due to spillages assessment results indicating all drainage areas would have <0.5% annual risk of pollution. Penstocks should be provided as best practice.	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Biodiversity	High		Negligible	Slight adverse
Increase in pollutants from routine road runoff	Pollution of surface water features, including an increase in sediment load. Deterioration of downstream aquatic environments	Cantley Stream	Water supply and quality	Medium	Proposed drainage design. One vegetated detention pond (basin 1 - grass lined north of the A11) must be provided to treat highway drainage. Enhancement measures including vegetated detention basin (basin 2 – west of A47) and swales shall be provided but are not required to mitigate environmental impact.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low	No direct discharge Proposed drainage design. One vegetated detention pond (grass lined north of the A11). Enhancement measures including vegetated detention basin (basin 2 – west of A47) and swales shall be provided but are not required to mitigate environmental impact.	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Alteration of overland flow pathways due to road alignment and alteration of ground levels.	Changes in surface water flow pathways resulting in overloading of drainage systems and surface watercourses. Increased or redirected flood risk to others and risk to flood-sensitive receptors. Deterioration of downstream aquatic environments.	Cantley Stream	Water supply and quality	Medium	Proposed Scheme design - surface water flooding flow pathways maintained through interceptor drains designed to convey 1 in 100-year event including 40% climate change allowance in order to maintain connectivity of surface water flooding pathways. Collector drains will be located around the base of the earthwork bunds to intercept and collect any additional runoff.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Neutral
		Ponds	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Cantley Stream Floodplain	Conveyance of flow	Medium		Negligible	Neutral
		Intwood Stream Floodplain	Conveyance of flow	High		Negligible	Slight adverse
Drainage of additional areas of hardstanding and alteration of ground elevations due to re-profiling	Increase in the rate and volume of surface water runoff to water bodies and watercourses and increased localised flooding to the Proposed Scheme. Increased or redirected flood risk to others and risk to flood-sensitive receptors near to	Cantley Stream	Water supply and quality	Medium	Proposed drainage designed to attenuate 1 in 100-year event including 40% climate change allowance to greenfield runoff rate	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
	overloaded system and downstream. Deterioration of downstream aquatic environments	Intwood Stream	Water supply and quality	Low	No direct discharge. Proposed drainage designed to attenuate 1 in 100-year event including 40% climate change allowance to greenfield runoff rate	Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Cantley Stream Floodplain	Conveyance of flow	Medium	Proposed drainage designed to attenuate 1 in 100-year event including 40% climate change allowance to greenfield runoff rate	Negligible	Neutral
		Intwood Stream Floodplain	Conveyance of flow	High	No direct discharge. Proposed drainage designed to attenuate 1 in 100-year event including 40% climate	Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
					change allowance to greenfield runoff rate		
Extension of A11 Cantley Stream Underpass, new Cantley Lane South Culvert, realignment of Cantley Stream, proposed new outfalls and embankments	Loss or deterioration in channel morphology and reduction in hydromorphological complexity. Deterioration or loss of the aquatic environments and deterioration in water quality. Deterioration of downstream aquatic environment of indirect receptors.	Cantley Stream	Water supply and quality	Medium	Proposed Scheme design. A11 Cantley Lane Underpass to be extended using a similar aperture to the existing including provision of a sediment bed to match existing. Cantley Lane South culvert to be designed with soft bed, mammal ledges and an agreed minimum freeboard for a 1 in 100-year fluvial event (including a 65% climate change allowance). Realigned stream channel retains length and similar gradient to existing stream. Realigned stream to include pools and riffles to support the required depth for water vole habitat. An ordinary watercourse consent is required from Norfolk County Council prior to start of construction. Construction method statement and detailed design drawings of the stream realignment require discussion with the Environment Agency and Norfolk County Council.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Minor adverse	Slight adverse (proposed mitigation minimises effect)
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
Extension of A11 Cantley Stream Underpass, new Cantley Lane South Culvert, realignment of Cantley Stream, proposed new outfalls and embankments	Potential changes to the conveyance of flow in the fluvial floodplain and loss of fluvial floodplain, restriction or redirection of the water body and watercourses causing increased localised flooding to the Proposed Scheme. Increased or redirected flood risk to other and risk to flood-sensitive receptors near to overloaded system and downstream. Deterioration or loss of aquatic environments.	Cantley Stream	Water supply and quality	Medium	Proposed Scheme design. A11 Cantley Lane Underpass to be extended using a similar aperture to the existing. Cantley Lane South culvert to be designed with soft bed, mammal ledges and an agreed minimum freeboard for a 1 in 100-year fluvial event (including a 65% climate change allowance). Realigned stream channel retains length and similar gradient to existing stream. Realigned stream to include pools and riffles to support the minimum depth (30cm) for water vole habitat. An ordinary watercourse consent is required from Norfolk County Council prior to start of construction.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Conveyance of flow	High		Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Biodiversity	High		Negligible	Slight beneficial
		Cantley Stream Floodplain	Conveyance of flow	Medium		Major adverse to major beneficial	Moderate adverse to moderate beneficial (rather than major as moderate magnitude impacts are predominant)
		Intwood Stream Floodplain	Conveyance of flow	High		Negligible	Slight adverse
Discharge from proposed outfalls	Potential risk of erosion impacting on channel stability, causing structural damage and an increase sediment in downstream reaches. Deterioration of downstream aquatic environments.	Cantley Stream	Water supply and quality	Medium	Surface water runoff will be attenuated to greenfield rates at source Proposed outfall design to include erosion protection measures. Adherence to C786 – Culvert, Screen and Outfall Manual guidelines. An ordinary watercourse consent is required from Norfolk County Council prior to start of construction.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
Utilities diversions	Potential risk of adverse bed and channel stability impacts, causing structural damage and an increase sediment in downstream reaches. Pollution of surface water features, including an increase in sediment load. Deterioration of downstream aquatic environments	Cantley Stream	Water supply and quality	Medium	Depth of utilities diversions shall avoid instabilities to stream channel and bed. An ordinary watercourse consent is required from Norfolk County Council prior to start of construction.	Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		Intwood Stream	Water supply and quality	Low		Negligible	Neutral
			Value to economy	Low		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse
		River Yare	Water supply and quality	Low		Negligible	Neutral
			Recreation	Medium		Negligible	Neutral
			Value to economy	Medium		Negligible	Neutral
			Biodiversity	High		Negligible	Slight adverse

Operational Activity	Potential effects on direct and indirect receptors	Feature	Relevant attributes	Importance (value)	Mitigation	Magnitude of impact after mitigation	Significance of effect after mitigation
Permanent placement of below-ground structures, i.e. piles, underpasses and associated utilities diversions	Redirection of flows around permanent underground structures potentially resulting in groundwater mounding and groundwater flooding Reversal of hydraulic gradient between the Sheringham Cliffs Formation and the Chalk which subsequently could impact upon baseflow to Cantley Stream and designated sites.	Direct receptors Secondary superficial aquifer Principal aquifer Indirect receptors Cantley Stream Nearby licensed / unlicensed abstractions Designated sites	Water supply and quality	Very High	Piling / structure design to ensure no impedance of groundwater flow (through inclusion of subsurface drainage) or creation of pathways for surface contamination.	Negligible	Slight adverse
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	High		Negligible	Slight adverse
			Economic Value	Very High		Negligible	Slight adverse
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse
Routine road runoff and accidental spillages discharging to filter drains	Routine road drainage may result in contamination of receiving aquifer Accidental spillages collected by road drainage may result in contamination of receiving aquifer	Direct receptors Secondary superficial aquifer Principal aquifer Indirect receptors Cantley Stream Nearby abstractions Designated sites	Water supply and quality	Very High	Road drainage design to consider groundwater levels to ensure no direct discharges via infiltration features or unlined road drainage into the saturated aquifer. Additional baseline water quality monitoring.	Negligible	Slight adverse
			Soakaway	High		Negligible	Slight adverse
			Vulnerability	High		Negligible	Slight adverse
			Economic Value	Very High		Negligible	Slight adverse
			Conveyance of flow	High		Negligible	Slight adverse
			Biodiversity	Medium		Negligible	Neutral or Slight adverse

Water Framework Directive assessment

13.10.8. This section outlines the assessment of potential construction and operation related impacts on each of the water bodies' quantity and quality elements. It assessed whether these impacts could lead to non-compliance of the WFD and the ability of the relevant WFD water bodies to meet their current objectives.

13.10.9. Groundwater bodies have been considered during the screening and scoping for this assessment.

WFD background and approach

13.10.10. The key objectives of the WFD, provided for in the area River Basin Management Plan (RBMP) (Environment Agency, 2018b), are as follows:

- To prevent deterioration of the status of surface waters and groundwater.
- To achieve objectives and standards for protected areas.
- To aim to achieve good status for all water bodies or, for heavily modified water bodies and artificial water bodies, good ecological potential and good surface water chemical status.
- To reverse any significant and sustained upward trends in pollutant concentrations in groundwater.
- The cessation of discharges, emissions and losses of priority hazardous substances into surface waters.
- Progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants.

13.10.11. The assessment complies with section 3.50 of DMRB LA113 and was carried out with due regard to the Planning Inspectorate Water Framework Directive Guidance (Planning Inspectorate, 2017). The assessment process is as follows:

- identification of water bodies that are potentially affected (directly or indirectly) or could be at risk as a result of the Proposed Development
- the baseline characteristics of the water bodies concerned
- a description of the Proposed Development and the aspects of the development considered within the scope of the WFD assessment
- the methods used to determine and quantify the scale of WFD impacts
- an assessment of the risk of deterioration, as Article 4.7 may apply where is a there is a risk the Proposed Development will prevent the achievement of good status or result in deterioration in status
- an explanation of any mitigation required and how its delivery is secured
- an explanation of any enhancements and/or positive contributions to the RBMP objectives proposed and how their delivery would be secured.

13.10.12. The Planning Inspectorate Advice Note 18 recommends that applicants seek the views of appropriate agencies early in the application process to agree: a) the need for a WFD assessment; and b) the method, scope and screening criteria to be employed when undertaking that assessment.

13.10.13. The Environmnent Agency and Norfolk County Council (as the Lead Local Flood Authority) were consulted on issues related to flood risk, Water Framework Directive and geomorphology at meetings in May 2018, June 2020, August 2020 and November 2020 where discussions focused on the assessments for the Cantley Lane south culvert and diversion of Cantley Stream. Outcomes from these consultations have helped inform the WFD assessment and mitigation. However, consultation is ongoing.

13.10.14. A screening assessment was undertaken to determine WFD water bodies that should be included in this assessment as part of the EIA Scoping Report (February 2018) (**TR010037/APP/6.5**). Following this, a scoping assessment was undertaken for the receptors that are potentially at risk from the Proposed Scheme. This was outlined in the Scoping Report (February, 2018) and has been discussed in detail above. All surface water WFD and chemical quality elements are scoped in to the WFD compliance assessment.

Proposed Scheme WFD assessment

13.10.15. Baseline information detailing surface water features, groundwater features and aquatic ecology can be found in in section 13.7.

13.10.16. A summary of the WFD surface water and groundwater bodies within the study area, including their targets and objectives was obtained from the current Anglian RBMP, as shown by the Environment Agency's Catchment Data Explorer (Environment Agency, 2020b). This information was based on the 2019 status. The baseline condition of the various WFD elements are provided in section 13.7 and Tables 13-3 and 13-4.

13.10.17. The surface water WFD catchments are within the Anglian River Basin District and their locations are identified in ES Figure 13.2 (WFD and Internal Drainage Board surface water bodies) (**TR010037/APP/6.2**) and ES Figure 13.4 (WFD groundwater bodies) (**TR010037/APP/6.2**).

13.10.18. Geomorphological site walkovers were carried out in March 2018 and May 2020. The walkover surveys were undertaken to ground truth evidence of geomorphic change and/or instability that may be impacted by the Proposed Scheme, and to identify the dominant geomorphic processes occurring on each river reach to ensure baseline conditions are adhered to, or improved upon, as far as possible. Water quality sampling was also undertaken to inform the water quality impact assessment.

Effects of works

13.10.19. The assessment of the compliance of the Proposed Scheme with the WFD has been split into two sections: assessment of the effects and required mitigation during construction (temporary works) and during operation on the WFD water bodies. These impacts have been in identified from section 13.8 and mitigation measures considered within the design of the Proposed Scheme have been discussed in section 13.9.

13.10.20. The location of water vole habitat creation and riparian planting can be seen in the Environmental masterplan (**TR010037/APP/6.8)**.

13.10.21. The assessment of impacts can be seen in Tables 13-8 and 13-9 for construction and operation, respectively. These tables indicate that there will not be any significant impacts caused to the water environment from the Proposed Scheme when the mitigation mentioned in section 13.9 is in place. Due to this, this WFD assessment concludes that the construction and operational activities affecting the Intwood Stream and indirectly Yare (Tiffey to Wensum) will be compliant with the requirements of the WFD. This assumes the mitigation is implemented and limits the overall effect of the Proposed Scheme to slight adverse and is localised. Due to this, construction and operational activities affecting the Intwood Stream and indirectly Yare (Tiffey to Wensum) are not considered to cause deterioration and should not prevent future attainment of good ecological status.

13.10.22. Table 13-10 provides a summary of the WFD assessment during the construction and operation of the Proposed Scheme.

Table 13.10 Summary of WFD water body assessment

Water body name ID	WFD aspect		Impacts on status or ability to meet target	Reference
Intwood Stream (GB105034051240)	Ecological	Supporting elements (surface water)	Slight short term construction impact due to spillage or works close to the water features, however, pollution prevention measures in the EMP and large degree of dilution in the river means this would not cause deterioration. Slight short term construction and operational impact due to the construction of culvert, underpass extension, outfalls and river realignment.	See Table 13.8 and 13.9
		Biological		
		Hydromorphological supporting elements		
		Physico-chemical quality		
		Specific pollutants (including copper and zinc)		

Water body name ID	WFD aspect		Impacts on status or ability to meet target	Reference
			No other construction related impact due to mitigation outlined in EMP (**TR010037/APP/7.4**). Slight operational impact.	
	Chemical	Priority substances Other pollutants Priority hazard substances	No construction related impact due to mitigation outlined in EMP (**TR010037/APP/7.4**). No operational impact.	See Table 13.8 and 13.9
Yare (Tiffey to Wensum) (GB105034051281)	Ecological	Supporting elements (surface water) Biological Hydromorphological supporting elements Physico-chemical quality Specific pollutants (including copper and zinc)	Not a direct receptor. Slight short term construction impact due to spillage or works close to the water features, however, pollution prevention measures in the EMP and large degree of dilution in the river suggests this would not cause deterioration. Slight short term construction and operational impact due to the construction of culvert, underpass extension, outfalls and river realignment. No other construction related impact due to mitigation outlined in EMP (**TR010037/APP/7.4**). Slight operational impact.	See Table 13.8 and 13.9
	Chemical	Priority substances Other pollutants Priority hazard substances Other pollutants Priority hazard substances	Not a direct receptor. No construction related impact due to mitigation outlined in EMP (**TR010037/APP/7.4**). No operational impact.	See Table 13.8 and 13.9
Broadland Rivers Chalk and Crag groundwater body	Quantitative	Quantitative saline intrusion Quantitative water balance Quantitative GWDTEs test Quantitative dependent surface water body status	No construction related impact due to best practice mitigation measures outlined in construction method statements, risk assessments, and the EMP and obtaining all relevant licences and permits. Negligible operational impact due to mitigation	See Table 13.8 and 13.9

Water body name ID	WFD aspect		Impacts on status or ability to meet target	Reference
			included in Scheme design	
	Chemical	Chemical drinking water protected area	No construction related impact due to best practice mitigation measures outlined in construction method statements, risk assessments and the EMP (**TR010037/APP/7.4**) and obtaining all relevant licences and permits. Negligible operational impact due to mitigation included in Scheme design	See Table 13.8 and 13.9
		General chemical test		
		Chemical GWDTEs test		
		Chemical dependent surface water body status		
		Chemical saline intrusion		

13.11. Monitoring

13.11.1. Although a likely significant effect on the conveyance of flow in Cantley Stream floodplain has been identified as a result of the Proposed Scheme, monitoring is not considered appropriate for such an effect.

13.11.2. There are no significant effects (moderate or above) identified within the assessment in respect to ground water or any other aspect of surface water. However, monitoring of groundwater is part of the essential mitigation required to ensure construction works such as the excavations do not have a significant effect. Monitoring of surface water quality is also part of the essential mitigation for the construction activities such as the Cantley Stream realignment and the extension to the A11 Cantley Stream underpass. This has been discussed in section 13.9.

13.12. Summary

13.12.1. The Proposed Scheme results in a significant effect on the conveyance of flow in Cantley Stream floodplain, principally as a result of removing the throttle on flood flows with the proposed Cantley Lane South culvert and the stream realignment. The effects range from moderate beneficial to moderate adverse significance depending on the location within the floodplain.

13.12.2. With mitigation, the Proposed Scheme is not predicted to give rise to any further significant residual effects (identified as moderate or major adverse) during either the construction or operational phases.

13.12.3. The outcome of this assessment is based on the mitigation measures described in this chapter which shall be secured through measures embedded in the design

and the implementation of the Environmental Management Plan (**TR010037/APP/7.4**).

13.13. References

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