The Sizewell C Project

6.6 Volume 5 Two Village Bypass

Chapter 12 Groundwater and Surface Water

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12 Groundwater and Surface Water

12.1 Introduction

12.1.1 This chapter of **Volume 5** of the **Environmental Statement** (**ES**) presents an assessment of the potential groundwater and surface water effects arising from the construction and operation of the two village bypass (referred to throughout this volume as the 'proposed development'). This includes an assessment of potential impacts, the significance of effects, the requirements for mitigation, and the residual effects.

12.1.2 Detailed descriptions of the two village bypass site (referred to throughout this volume as the 'site'), the proposed development, and the different phases of development are provided in **Chapters 1** and **2** of this volume. A glossary of terms and list of abbreviations used in this chapter is provided in **Volume 1**, **Appendix 1A** of the **ES**.

12.1.3 The Government's Good Practice Guide for Environmental Impact Assessment (EIA)[1] (Ref. 12.1) outlines the potential environmental effects that should be considered for groundwater and surface water, for example physical effects of the development and effects on groundwater etc. Further information on these topics and those which have been scoped into the assessment can be found in **section 12.3** of this chapter.

12.1.4 This assessment has been informed by data from other assessments as following:

- **Appendix 11A** of this volume: Two Village Bypass: Phase 1 Desk Study Report 2020.
- **Appendix 11B** of this volume: conceptual site models.
- **Appendix 11C** of this volume: impact assessment tables.
- **Two Village Bypass Flood Risk Assessment** (FRA) (Doc Ref. 5.5).
- **Water Framework Directive** (WFD) **Compliance Assessment Report** (Doc Ref. 8.14).

[1] This document has been withdrawn but still constitutes good advice and should be referred to in the absence of alternative guidance.

12.2 Legislation, policy and guidance

12.2.1 **Volume 1, Appendix 6O** of the **ES**, identifies and describes legislation, policy and guidance of relevance to the assessment of the potential groundwater and surface water impacts associated with the Sizewell C Project across all **ES** volumes.

12.2.2 This section provides an overview of the specific legislation, policy and guidance specific to the assessment of the proposed development.

a) International

12.2.3 International legislation relevant to the groundwater and surface water assessment includes:

- WFD 2000/60/EC (Ref. 12.2).
- Groundwater Daughter Directive 2006/118/EC (Ref. 12.3).
- The Discharge of Dangerous Substances into the Aquatic Environmental Directive 2006/11/EC (Ref. 12.4).

12.2.4 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the **ES**.

b) National

i. Legislation

12.2.5 National legislation relevant to the groundwater and surface water assessment includes:

- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (Ref. 12.5).
- WFD (Standards and Classification) Directions (England and Wales) 2015 (Ref. 12.6).
- Environmental Permitting Regulations (England and Wales) 2016 (Ref. 12.7).
- Water Resources Act 1991 (Ref. 12.8).
- Water Act 2003 (Ref. 12.9).

- Flood and Water Management Act 2010 (Ref. 12.10).

12.2.6 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the **ES.**

ii. Planning policies

12.2.7 The National Policy Statements (NPS) set out national policy for energy infrastructure. The overarching NPS for Energy (EN-1) (Ref. 12.11) and NPS for Nuclear Power Generation (EN-6) (Ref. 12.12) provide the primary policy framework within which the development will be considered. A summary of the relevant planning policy, together with consideration of how these have been taken into account, is provided in **Volume 1, Appendix 6O** of the **ES**.

12.2.8 Other national policies relevant to the groundwater and surface water assessment include the National Planning Policy Framework (NPPF) (Ref. 12.13).

12.2.9 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the **ES**.

c) Regional

12.2.10 Regional policies relevant to the groundwater and surface water assessment include:

- Environment Agency Anglian River Basin Management Plan (RBMP) (Ref. 12.14).
- The East Suffolk Abstraction Licensing Strategy 2017 (Ref. 12.15).
- Environment Agency East Suffolk Catchment Flood Management Plan 2009 (Ref. 12.16).

12.2.11 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the **ES**.

d) Local

12.2.12 Local policies relevant to the groundwater and surface water assessment includes:

- Suffolk Flood Risk Management Strategy (Ref. 12.17).
- Strategic Flood Risk Assessment (Ref. 12.18).

- Strategic Coastal District Council (SCDC) Local Plan Core Strategy and Development Management Policies (Ref. 12.19).
- SCDC Final Draft Local Plan (Ref. 12.20).

12.2.13 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the ES.

e) Guidance

12.2.14 Guidance relevant to the groundwater and surface water assessment includes:

- Planning Practice Guidance (Ref. 12.21).
- Government's 25 Year Environment Plan (Ref. 12.22).
- The Government's Good Practice Guide (Ref. 12.23) for EIAs.
- The Groundwater Protection Position Statements Guidance (Ref. 12.24).
- Control of water pollution from construction sites: A guide to good practice, Construction Industry Research and Information Association (2001) (Ref. 12.25).
- Environment Agency's Pollution Prevention Guidelines: Working on construction sites (Ref. 12.26).
- The Design Manual for Roads and Bridges (DMRB) (2008) Volume 11, Section 2, Part 5 Assessment and Management of Environmental Effects (Ref. 12.27).
- DMRB (2009) Volume 11, Section 3, Environmental Assessment Techniques (Ref. 12.28).

12.2.15 The requirements of these, as relevant to the groundwater and surface water assessment, are described in **Volume 1, Appendix 6O** of the **ES**.

12.3 Methodology

a) Scope of the assessment

12.3.1 The generic EIA methodology is detailed in **Volume 1**, **Chapter 6** of the **ES**.

12.3.2 The full method of assessment for groundwater and surface water that has been applied for the Sizewell C Project is included in **Volume 1**, **Appendix 6O** of the **ES**.

12.3.3 This section provides specific details of the groundwater and surface water methodology applied to the assessment of the proposed development, and a summary of the general approach to provide appropriate context for the assessment that follows. The scope of assessment considers the impacts of the construction and operational phases of the proposed development.

12.3.4 The scope of this assessment has been established through a formal EIA scoping process undertaken with the Planning Inspectorate (PINS). A request for an EIA scoping opinion was initially issued to the PINS in 2014, with an updated request issued in 2019, see **Volume 1, Appendix 6A** of the **ES**.

12.3.5 Comments raised in the EIA scoping opinion received in 2014 and 2019 have been taken into account in the development of the assessment methodology. These are detailed in **Volume 1, Appendices 6A** to **6C** of the **ES.**

12.3.6 The Government's Good Practice Guide for EIA states that the following potential environmental effects should be considered for the water environment:

- levels and effects of emissions to water from the development;
- abstractions of/effects on surface or groundwater resources;
- effects of development on drainage or run-off pattern in the area;
- changes to groundwater level, watercourses and flow of underground water;
- crossings of watercourses; and
- effects of pollutants on water quality.

12.3.7 Additionally, consideration should be given to flood risk as well as WFD compliance, and their interactions with other assessments such as geology and land quality, and terrestrial ecology and ornithology assessments.

12.3.8 Potential impacts from existing and new contamination sources on controlled waters have been considered as part of the geology and land quality assessment in **Chapter 11** of this volume, to determine and classify potential effects associated with ground contamination. Further assessment of identified effects from contamination to groundwater and surface waters is reported in this chapter.

b) Consultation

12.3.9 The scope of the assessment has also been informed by ongoing consultation and engagement with statutory consultees (**Table 12.1**) throughout the design and assessment process as outlined in **Volume 1 Appendix 6O** of the **ES**.

Table 12.1 Summary of consultation responses that have informed the scope and methodology of the assessment and design, relevant to groundwater and surface water.

Date	Consultees	Summary of discussion/ comments
9 July 2019	Environment Agency; Natural England	Telephone call held to talk through the design principles, potential requirement for compensatory flood storage and potential ecological impacts. Particular discussion on the development of the design to limit constraint to flood flows through the floodplain and be recognisant of habitat connectivity. Principle of providing flood relief culverts in addition to the main crossing discussed, in order to reduce afflux below a threshold value of 30mm.
10 September 2019	Environment Agency; Suffolk County Council (SCC)	Meeting held to share further information on design principles and option selection including routes, alignment and levels. Meeting focused on potential for ecological impacts and enabling mammal passage during flood events.
23 October 2019	Environment Agency; SCC	Interim hydraulic modelling results shared.
25 November 2019	Environment Agency; SCC; East Suffolk Council (ESC)	Telephone call held to share details on how consultation feedback has been adopted in the design with respect to habitat connectivity and afflux. Modifications described following discussion with SCC who are expected to adopt

Date	Consultees	Summary of discussion/ comments
		the bypass. Further information presented on hydraulic performance of culvert crossings.

c) Study area

12.3.10 The study area for the consideration of effects from contaminative sources on controlled waters is discussed in **Chapter 11** of this volume and includes the site and land immediately beyond it to a distance of 500 metres (m) from the site boundary. This is hereafter referred to as the inner study area.

12.3.11 The size of the inner study area takes into account the transport of potential contaminants of concern in the environment, and the connectivity of these contaminants via pathways of migration or exposure to the receptors and resources identified.

12.3.12 The general methodology adopted for the consideration of effects on groundwater and surface water levels and flows, and water dependent receptors and resources extends beyond this inner study area to a distance of 1 kilometre (km) from the site boundary. This is termed the outer study area.

12.3.13 The size of the outer study area allows for any potential physical changes resulting from the proposed development that may propagate through the water environment and beyond the inner study area to be assessed.

12.3.14 The site boundary and study areas are presented in **Figure 12.1** of this volume.

d) Assessment scenarios

12.3.15 The assessment of effects on the water environment includes the assessment of both the construction phase and operational phase of the proposed development rather than the assessment of any specific years.

e) Assessment criteria

12.3.16 As described in **Volume 1**, **Chapter 6** of the **ES**, the EIA methodology considers whether impacts of the proposed development would have an effect on any receptors or resources. Assessments broadly consider the magnitude of impacts and value/sensitivity of receptors/resources that could be affected in order to classify effects.

i. Assessment of physical impacts

12.3.17 Physical impacts include:

- changes or alterations to water levels and flow regimes of groundwater and surface water receptors and resources; and
- changes to water dependent groundwater and surface water receptors and resources.

12.3.18 The assessment criteria of physical impacts on groundwater and surface water receptors and resources are based on the methodology provided in **Volume 1, Appendix 6O** of the **ES** and summarised in the following sub-sections.

Sensitivity

12.3.19 The approach to assigning levels of sensitivity to receptors and resources is set out in **Table 12.2**.

Table 12.2: Assessment of the value or sensitivity of receptors and resources for groundwater and surface water.

Value or Sensitivity.	Description
High	An attribute with high quality/rarity, international or national significance that has a low capacity to accommodate disturbance or change.
Medium	An attribute with high quality/rarity, at a national scale, and has some resilience to disturbance or change. An attribute with high quality/rarity, at a regional scale that has a low capacity to accommodate disturbance or change. An attribute with medium quality/rarity, at a national scale that has a low capacity to accommodate disturbance or change.
Low	An attribute with medium quality/rarity, at a national or regional scale and some resilience to disturbance or change. An attribute with low quality/rarity, at a national or regional scale and some resilience to disturbance or change.
Very Low	An attribute with low quality/rarity, at a regional and local scale and resilience to disturbance or change.

Magnitude

12.3.20 The magnitude of a potential impact is estimated based on the likely level of change and is independent of the importance of the feature. The definitions of magnitude classifications are provided in **Table 12.3**.

Table 12.3: Assessment of magnitude of impact on groundwater and surface water.

Magnitude	Criteria
High	Large-scale permanent/irreversible, or long-term temporary, changes over the whole development area and potentially beyond (i.e. off-site), to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Medium	Medium-scale permanent/irreversible, or medium-term temporary, changes over the majority of the development area, and potentially beyond, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Low	Noticeable but small-scale change, permanent or temporary changes over a partial area, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Very Low	Noticeable, but very small-scale change, or barely discernible changes for any length of time over a small area, to key characteristics or features of the particular environmental aspect's character or distinctiveness.

12.3.21 Where the assessment of potential impact concludes that through careful design and the application of appropriate mitigation, there will be no discernible change (no impact) to a receptor or resource, then a conclusion of no effect will be drawn.

12.3.22 Given the timescales of the Sizewell C Project, the nature of potential changes to the water environment from the proposed development and their reversibility, the definitions of temporary impacts are categorised as follows:

- short-term = less than six months;
- medium-term = between six months and six years; and
- long-term = more than six years.

Effect definition

12.3.23 The classification of the likely effect for groundwater and surface water are determined using the matrix presented in **Table 12.4.**

Table 12.4: Classification of effects.

		Value/Sensitivity of Receptor.			
		Very Low.	Low	Medium	High
Magnitude	Very Low.	Negligible	Negligible	Minor	Minor
	Low	Negligible	Minor	Minor	Moderate
	Medium	Minor	Minor	Moderate	Major
	High	Minor	Moderate	Major	Major

12.3.24 An effect can be 'adverse' or 'beneficial' depending on the nature of impact on the quality and integrity on the receptor or resource. For example, an adverse effect would be where there would be a loss or damage to the quality or integrity of an attribute, whereas a beneficial effect would arise from the creation of a new or an improvement to an attribute.

12.3.25 Following the classification of an effect as presented in **Table 12.4**, a clear statement is made as to whether the effect is 'significant' or 'not significant'. As a general rule, major and moderate effects are considered to be significant, and minor and negligible effects are considered to be not significant. However, professional judgement is also applied where appropriate.

ii. Assessment of contamination to controlled waters

12.3.26 The assessment of potential impacts from existing and new contamination sources on controlled waters has been considered as part of the geology and land quality assessment in the production of the Preliminary Conceptual Site Model (PCSM) to determine and classify potential effects.

12.3.27 Further details on the methodology applied is provided in **Volume 1, Appendix 6N** of the **ES**, and summarised in **Chapter 11** of this volume.

iii. Water Framework Directive compliance

12.3.28 WFD impacts are assessed differently to the approach conventionally used within the EIA process, and require an assessment of whether a project (or an element of a project) is compliant or non-compliant with the environmental objectives outlined in Article 4 of the WFD.

12.3.29 The significance of effects on WFD status relates only to compliance or non-compliance. Non-compliance will only occur because of permanent impacts that cannot be mitigated, irrespective of the degree of vulnerability to change of the receptor. The assessment in this context will be restricted to either compliance or non-compliance.

12.3.30 The **WFD Compliance Assessment Report** (Doc Ref. 8.14) has been provided as a separate document as part of this application for development consent. The main conclusions with relevance to the activities considered as part of the EIA are summarised in this chapter.

iv. Flood risk assessment

12.3.31 The **Two Village Bypass FRA** (Doc Ref. 5.5) has been provided as a separate document as part of this application for development consent. The main conclusions from the FRA with relevance to the potential flood sources affecting the site, and the impacts that the proposed development would have on altering the flood risk levels relating to the surrounding surface water receptors are summarised in this chapter.

f) Assessment methodology

12.3.32 **Volume 1**, **Chapter 6** sets out the broad approach to impact assessment employed within the overall **ES**. This section details the approach to the assessment of impacts specifically relating to groundwater and surface water.

i. General approach

12.3.33 The approach to the groundwater and surface water assessment comprises:

- establishing the baseline conditions for the study area with respect to geology, hydrology, hydrogeology, and water dependent resources and receptors;
- identification of potential impacts on identified water dependent resources and receptors from the construction and operational phases of the proposed development;
- assessment of the significance of likely effects from the proposed development including the consideration of primary and tertiary mitigation measures; and
- identification of any residual effects and secondary mitigation where required.

12.3.34 The assessment also considers the findings of the **WFD Compliance Assessment Report** (Doc Ref. 8.14), and **Two Village Bypass FRA** (Doc Ref 5.5).

ii. Existing baseline

12.3.35 Existing baseline conditions are defined based on available published and site-specific information.

12.3.36 The baseline assessment has relied on existing data, previous desk study and Ground Investigation (GI) reports, groundwater monitoring data and historical records. The following sources have been reviewed:

- publicly available information from the British Geological Survey (BGS) online mapping resource (Ref. 12.29);
- publicly available information from the Environment Agency (Ref. 12.30, and Ref. 12.31);
- publicly available information from the Defra's Multi-Agency Geographic Information for the Countryside (MAGIC) website (Ref. 12.32);
- **Appendix 12A** of this volume: Two Village Bypass: River Corridor Survey;
- **Appendix 11A** of this volume: Two Village Bypass: Phase 1 Desk Study Report, which includes the Landmark Envirocheck Report for the site and study area, and details of the site walkover.

iii. Future baseline

12.3.37 The future baseline is typically established upon extrapolating the current baseline using technical knowledge of changes (for example changes in rainfall), and future climate forecasts to predict the environmental conditions at a future point in time. This assessment considers future baseline conditions solely in the context of known future developments and predictable changes in the quality of receptors (for example forecast improvements in the status of WFD water bodies).

iv. Assessment

12.3.38 Potential changes to the water environment in terms of water levels, flow and quality are considered qualitatively against baseline conditions. Should a significant effect be identified at the end of the qualitative assessment, a more detailed quantitative appraisal of potential impacts on water levels and flow has been undertaken to determine the magnitude and extent of potential changes.

g) Assumptions and limitations

12.3.39 The following assumptions have been made in this assessment:

- The assessment considers development within the site parameters as set out in the description of development at **section 2.3** of **Chapter 2** of this volume of the **ES** and as illustrated on the **Works Plans** (Doc Ref. 2.3) reproduced in **Appendix 2A** of this volume. This is secured by the **Draft DCO** (Doc Ref. 3.1).

- Surface water discharge will be managed so it does not exceed the predetermined Greenfield run-off rates in accordance with the **Outline Drainage Strategy** in **Volume 2, Appendix 2A** of the **ES**. This is secured by a requirement included in Schedule 2 of the **Draft DCO** (Doc Ref. 3.1).

- Environmental Quality Standards prescribed for downstream designated WFD water bodies have been adopted for upstream, non-designated watercourses for the purposes of this assessment, in order to consider the worst case scenario.

12.3.40 The following limitations have been identified:

- GI has not been carried out at the site at the time of writing, but will be undertaken prior to the commencement of construction. Therefore, no observed information about the ground conditions at the site or encountered groundwater was available for the production of this assessment. Publicly available information from the BGS such as historical borehole logs has been used to inform the assessment.

- No groundwater quality data is available for the site, however given the site setting and historical land use there is a low risk of poor quality groundwater. Potential sources of contamination have been considered in **Chapter 11** of this volume and this has informed the assessment.

12.4 Baseline environment

12.4.1 This section presents a description of the baseline environmental characteristics within the site and study area.

a) Current baseline

i. Site walkover

12.4.2 Site walkovers of the River Alde floodplain, and from public roads and tracks, were undertaken in March 2019 and May 2019 to gain further information on the site setting, to consider the context of the proposed development, and to confirm the current desk study mapping and aerial photographs. Additionally, these walkovers provided opportunities to identify potential visual or olfactory contamination present at the site at the time of the walkover. Alongside the second walkover survey, the river corridor survey methodology was used to characterise the River Alde and the floodplain drainage network. Details of the dominant riparian vegetation and physical structures of the watercourses were recorded in the form of a map using a set of standard symbols and abbreviations – see **Appendix 12A** of this volume).

12.4.3 The site comprises agricultural land with associated access tracks and local roads. The western and eastern site boundaries are formed by the existing A12. The site's northern and southern boundaries are formed by agricultural land.

ii. Topography

12.4.4 The site is located on the floodplain of the River Alde before rising onto the watershed between the Rivers Alde and Fromus. Light Detection and Ranging data show that the highest ground levels, slightly above 26m Above Ordnance Datum (AoD), are located in the central section (Pond Wood to north of Farnham Hall) of the site. The lowest ground levels, slightly below 4m AoD are located in the western end (River Alde floodplain) of the western section (A12/Tinker Brook to Pond Wood) of the site.

iii. Geology

12.4.5 There is potential for Made Ground to be encountered in the areas associated with the construction of the A12 and other minor roads. In addition, there is potential for fly tipping in the area, as well as farmers tips, the contents of which will be unknown.

12.4.6 Available BGS records indicate that the superficial geology underlying the site comprises Lowestoft Formation (diamicton) described as poorly-sorted matrix-supported deposits in the western and eastern sections of the site, in the vicinity of the junctions with the A12. The River Alde and the associated network of drains that intersect the site are underlain by alluvium. Superficial deposits are recorded absent in some areas in the east of the site.

12.4.7 The bedrock geology beneath the site comprises of three different bedrock strata. The Chillesford Church Sand Member underlies the majority of the site. This is described as shallow-water marine and estuarine sands, gravels, silts and clay. The Red Crag Formation outcrops in the west of the site, underlying the River Alde and comprises sands. The Crag Group underlies the north-east of the site and is described as shallow water marine and estuarine sands, gravel, silts and clays.

12.4.8 BGS borehole scans and trials pits within 1km of the site boundary are limited in number and located sporadically. Borehole reference TM36SE84 is located to the north of the site at national grid reference (NGR) 636390 260750 and shows that sand and gravel of either the Lowestoft Formation or Crag Group extends at least 30m below ground level (mbgl). Borehole records TM35NE53 and TM35NE32 are located within the western part of the site at NGR 636230 259910 and 635430 259740, respectively. These describe shallow deposits and also indicate that the shallow geology of the site comprises predominately poorly sorted sands interbedded with gravel, clays and silts.

12.4.9 Further detail on the geology of the site is presented in **Chapter 11** of this volume**.**

iv. Hydrogeology

12.4.10 The Environment Agency classifies the alluvium and the sand and gravel of the Lowestoft Formation as a Secondary A Aquifers[2], and the Lowestoft Formation (diamicton) as a Secondary Aquifer (undifferentiated)[3].

12.4.11 The Environment Agency classifies the Crag Group, Red Crag Formation and the Chillesford Church Sand Member underlying the site as Principal Aquifers[4].

[2] Secondary A Aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
[3] A Secondary (Undifferentiated) Aquifer is designated in cases where it has not been possible to attribute either category Secondary A or Secondary B to a rock type.
[4] Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

12.4.12 The site does not lie within or adjacent to a groundwater Source Protection Zone[5] (SPZ). A Total Catchment Zone (Zone 3)[6] of a groundwater SPZ is located approximately 720m north of the western boundary of the proposed development. The SPZs are presented on **Figure 12.1** of this volume.

12.4.13 Current groundwater levels at the site are unknown. Contours shown on BGS hydrogeological mapping (Ref. 12.29) suggest that groundwater levels within the Crag Group are around 5m AoD (approximately 0-15 mbgl across the site). These contours are based on data from 1976, and are only indicative of current levels, however the hydrogeological regime is considered unlikely to have changed significantly in the intervening years. Further GI would establish current groundwater levels at the site.

12.4.14 The site is located on the Waveney and East Suffolk Chalk and Crag WFD groundwater body (groundwater body ID GB40501G400600). The Environment Agency catchment data explorer 2016 classification shows this groundwater body as being of Poor quantitative and Poor chemical status, with an objective to being of good quantitative and good chemical status by 2027. The Poor chemical status is attributed to impact from agriculture as evidenced by elevated nitrate concentrations in groundwater. The proposed development falls within a groundwater Nitrate Vulnerable Zone.

v. Surface water features

12.4.15 The site is located within the River Alde (water body ID GB105035046060) (Ref. 12.33) and the River Fromus (water body ID GB105035045980) (Ref. 12.34) catchments.

12.4.16 The western end of the site crosses the River Alde and floodplain. The study area includes a network of drains on the River Alde floodplain. There are also 25 ponds within the inner study area. Several ponds are located on the northern side of the A12 and are considered hydrologically isolated from the site.

12.4.17 Although the site falls within the River Fromus catchment, it is very unlikely that contaminative sources or potential physical effects from the site would

[5] Groundwater Source Protection Zones are areas defined around groundwater sources used for public drinking water supply. The SPZ shows the risk of contamination from activities that might cause pollution in the area. The closer the activity, the greater the risk.

[6] Total catchments (Zone 3) are defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. There is still the need to define individual source protection areas to assist operators in catchment management.

impact the River Fromus. The East Suffolk line which falls within both the inner and outer study area and separates the site from the River Fromus limiting potential overland run-off impacts to the River Fromus. The watercourses are presented on **Figure 12.1** of this volume.

12.4.18 The Environment Agency catchment data explorer 2016 classification shows that both water bodies have received an overall classification of Poor ecological potential.

vi. Water quality

12.4.19 The 2016 physico-chemical and chemical data presented on catchment data explorer have been reviewed for the River Alde and River Fromus to characterise the catchments. The chemical status for both rivers is Good.

12.4.20 Physico-chemical data for the River Alde indicate that it is at High status for ammonia, pH and temperature, with the exception of phosphate, which is at Good status, and dissolved oxygen, which is at Poor status. The Moderate physico-chemical status is likely to be the result of the Poor status of dissolved oxygen.

12.4.21 Physico-chemical data for the River Fromus indicate that it is at High status for all quality elements, with the exception of phosphate, which is at Poor status, and dissolved oxygen, which is at Bad status. This is likely to be due to high nutrient loadings from agricultural run-off, and/or treated sewage effluent and eutrophication processes. The Moderate physico-chemical status is likely to be the result of the Poor phosphate status and Bad status of dissolved oxygen.

12.4.22 No groundwater quality data is available for the site.

vii. Groundwater and surface water interaction

12.4.23 Groundwater will likely exist in beds and lenses of more granular material within the alluvium. It is possible this water may be in hydraulic continuity with surface waters, however, it is likely to be constrained to the extent of the alluvium where in contact with low permeability strata.

12.4.24 The Lowestoft Formation at the site is expected to be of relatively low permeability. Therefore, hydraulic continuity between the Lowestoft Formation and local surface water is likely to be limited.

12.4.25 Due to the likely granular and permeable nature of the Crag Group, it is likely that groundwater within the Chillesford Church Sand Member and Red Crag Formation aquifers will be in hydraulic continuity with each other. Due to the anticipated depth to groundwater within the Crag Group, it is possible that

the principal bedrock aquifers are in hydraulic continuity with the River Alde where low permeability superficial deposits are absent and where the Crag is present at shallow depth below ground.

viii. Water Abstractions

Groundwater

12.4.26 Ten licenced groundwater abstractions were identified within the outer study area. These are detailed in **Table 12.5**.

Table 12.5: Licensed groundwater abstractions within the outer study area.

Licence Number.	Location Including NGR.	Source	Purpose	Maximum Annual Abstraction (m^3).
7/35/04/*g/0076	637160, 259550 (10m south of the site) Walk Farm, Farnham.	Glacial Sand and Gravel.	Agriculture (General).	9,100
7/35/04/*G/0043	635360, 259530 (45m west of the site). Parkgate Farm, Stratford St Andrew.	Glacial Sand and Gravel.	General farming and domestic.	Unknown
7/35/04/*G/0094	637410, 260200 (65m south of the site) Friday St, Farnham.	Glacial Sand and Gravel.	General Agriculture: Spray Irrigation-Direct. Seasonal-Abstraction only 01 April to 30 Sep.	Unknown
7/35/04/*G/0056	636450, 258995 (360m south of the site). Hill Farm, Farnham.	Crag	General farming and domestic.	Unknown
7/35/04/*G/0095	637910, 260360 (410m east of the site) Manor Farm, Benhall.	Groundwater	General Agriculture: Spray Irrigation-Direct. Seasonal-Abstraction only 01 Mar to 30 Nov.	Unknown

Licence Number.	Location Including NGR.	Source	Purpose	Maximum Annual Abstraction (m^3).
7/35/04/*G/0056	636220, 258810 (420m south of the site). Hill Farm, Farnham.	Crag	General farming and domestic.	Unknown
7/35/04/*G/0103	636390, 260750 (540m north of the site) Butchers Hole, Benhall.	Crag	General Agriculture: Spray Irrigation-Direct. Seasonal-Abstraction only 01 Mar to 30 Nov.	Unknown
7/35/04/*G/0057	636217, 258647 (600m south of the site). Hill Farm, Farnham.	Groundwater	General Agriculture: Spray Irrigation – Direct.	Unknown
7/35/04/*G/0001	638250, 259870 (780m south-west of the site) Well points at Croft Farm, Snape, Farnham.	Glacial Sands and Gravels.	Spray Irrigation.	455,000
7/35/04/*G/0034	636950, 261340 (835m north of the site) Walnut Tree Farm, Benhall.	Groundwater	General Farming and Domestic.	Unknown

12.4.27 There is potential for unknown Private Water Supplies (PWS) to be in use within the groundwater study area. Should any PWS exist, they would likely be associated with the isolated farm buildings and residential properties in the study area.

Surface water

12.4.28 One licenced surface water abstraction has been identified within the outer study area. This is detailed in **Table 12.6**.

Table 12.6: Licensed surface water abstraction within the outer study area.

Licence Number.	Location Including NGR.	Source	Purpose	Maximum Annual Abstraction (m^3).
7/35/04/*S/0057	636000, 258620 (500m south of the site). River Alde, Hill Farm, L. Glemham.	Surface water.	General Agriculture: Spray Irrigation-Direct. Seasonal-Abstraction only 01 April to 30 Sep.	Unknown

ix. Fluvial geomorphology

12.4.29 The surface watercourses in the area are typical of lowland, low energy drainage systems. Many of the channels are entirely artificial, and the natural channels have been extensively modified (probably to facilitate drainage and use of the surrounding marshland as grazing marsh).

12.4.30 Geomorphology and hydromorphology are key factors contributing to whether a water body can achieve or maintain Good ecological status.

12.4.31 Neither the River Alde nor the River Fromus are designated Artificial or Heavily Modified Water Bodies. The morphology of the River Alde is of sufficient quality to support Good status. However, the hydrological regime does not support Good status. The morphology and hydrological regime of the River Fromus is sufficient to support Good status.

12.4.32 Sediment deposition and, when flows have sufficient energy, transport are likely to be the dominant fluvial processes which operate in the Alde River and its floodplain.

x. Flood risk

12.4.33 The ESC Strategic FRA maps identify that at the eastern extent of the site, on the A1094 at Friday Street Farm, there is one case each of highways and groundwater flooding recorded.

12.4.34 The Environment Agency's Flood Map for Planning indicates that the site is located in Flood Zones 1, 2 and 3 and has a low risk of flooding from tidal or coastal sources, as shown on **Figure 12.1** of this volume. Flood Zones 2

and 3 extents are associated with flood risk from the River Alde, which is not a tidally influenced watercourse. The risk of flooding from fluvial sources in the vicinity of the River Alde is considered to be high, as the proposed development crosses the River Alde.

12.4.35 The Environment Agency's long-term flood risk mapping shows that the majority of the site is at very low risk of flooding from surface water. However, towards the west of the site there is a complex array of surface water flow paths associated with the River Alde floodplain. The majority of these areas are of high and medium surface water flood risk flow in a southerly direction. These flow paths drain into the River Alde to the south of the proposed bypass. There are also small areas of low surface water flood risk crossed by the proposed highway near the River Alde. At the eastern extent of the site at Friday Street Farm there is an area of high surface water flood risk immediately north of the A1094.

12.4.36 The BGS susceptibility to groundwater flooding map identifies there is potential for groundwater flooding to occur at the surface in parts of the site that cross the River Alde and the floodplain. Due to the proximity of some areas of the proposed development to the River Alde, the risk of groundwater flooding to the site is high due to the possibility of groundwater emergence.

12.4.37 Further information on flood risk at the site is provided in the **Two Village Bypass FRA** (Doc Ref. 5.5) which has been submitted as part of this application for development consent.

xi. Historic and environmentally sensitive sites

12.4.38 Further consideration of historic and ecological designated sites, both statutory and non-statutory is given in **Chapters 7** and **9** of this volume. A review of the MAGIC website has confirmed that there are no internationally or nationally designated water dependent sites within the outer study area. Refer to **Figure 7.1** of this volume.

xii. Existing buildings

12.4.39 Changes in groundwater level have the potential to affect building foundations. There are no existing buildings present on-site (**Figure 9.1** of this volume), however, there are several residential properties, farms and associated buildings within the outer study area, including the villages of Stratford St Andrew and Farnham. There are a number of buildings located adjacent to site including, the Old Police House, The Red House, and Parkgate Farm. Pond Barn is also located within 100m of the site boundary.

12.4.40 Further consideration of existing buildings within the study area is given in **Chapter 9** of this volume.

xiii. Potential for existing contamination

12.4.41 The following potential existing contamination sources are discussed in **Chapter 11** of this volume:

- historical site usage;
- waste management sites;
- service stations;
- industrial and other potentially contaminative land uses; and
- potential for Unexploded Ordnance.

12.4.42 The potential sources of contamination at the site are presented in the PCSM in **Chapter 11** of this volume.

xiv. Summary of key receptors

12.4.43 The key receptors for potential effects are summarised in **Table 12.7.**

Table 12.7: Key receptors within the study area.

Receptor	Receptor Sensitivity to Physical Effects.	Receptor Sensitivity to Contaminative Effects.
Chillesford Church Sand Member groundwater (Principal Aquifer).	Medium	Medium
The Red Crag Formation groundwater (Principal Aquifer).	Medium	Medium
The Crag Group groundwater (Principal Aquifer).	Medium	Medium
Alluvium (Secondary A Aquifer).	Low	Medium
Lowestoft Formation groundwater- sand and gravel (Secondary A Aquifer).	Low	Medium
Lowestoft Formation groundwater (Secondary Aquifer (undifferentiated)).	Very low.	Medium
Groundwater abstractions.	Medium	Medium
Potential PWS.	Medium	Medium
Existing buildings.	Medium	Medium
River Alde (main river).	Medium	Medium

Receptor	Receptor Sensitivity to Physical Effects.	Receptor Sensitivity to Contaminative Effects.
River Alde floodplain.	Medium	Medium
Surface drainage network.	Very low.	Medium
Surface water abstraction.	Medium	Low
Existing ponds.	Very low.	Medium

b) Future baseline

12.4.44 Committed developments have been considered as future receptors in the assessment of ground and surface water impacts during the construction and operation phases of the proposed development. The two committed developments which have been identified within the study area are summarised in **Table 12.8.**

Table 12.8: Committed developments.

Planning Application Ref.	Site Address.	Description of development.	Date of Approval.	Status	Distance (m).
DC/17/1331/FUL	Pond Farm Hill Farm Road Farnham Suffolk.	Full planning application for the conversion of three existing agricultural barns to form two dwellings.	09/01/2018	Construction not commenced.	58
DC/18/0322/FUL	Glemham Estate Reservoir Land north of Hill Farm Road Farnham IP17 1LU.	To construct an 80,000m^3 reservoir covering an area of approximately 3.5 hectares. The reservoir will be used to store and supply water to the in-hand farming business for the irrigation of crops during the Summer months.	25/06/2018	Construction not commenced.	153

12.4.45 The construction timeline for these committed developments is unconfirmed. However, planning permissions generally require construction to commence within three years of the grant of planning permission or reserved matters

approval before the planning permission lapses. As such, and for the purposes of this assessment, it has been assumed that the developments will have been constructed prior to 2022. These committed developments have therefore been considered as future receptors as part of the baseline for the groundwater and surface water assessments.

12.4.46 Climate change will be taken into account in the detailed drainage design through the application of the appropriate rainfall intensity allowances.

12.4.47 There is not anticipated to be any change to aquifer classification as a result of any stage of the two village bypass development.

12.4.48 As the length of the construction and operational phases of the proposed development will cover a period of more than ten years, changes to the WFD status of the River Alde and River Fromus water bodies could be realised, relating to the default 'good status' been achieved by 2027 and beyond. Although WFD status is only relevant to the **WFD Compliance Assessment Report** (Doc Ref. 8.14), improved water quality, geomorphology or biology as a result of WFD implementation are considered within the evolution of the future baseline.

12.4.49 The future baseline of the River Alde water body is not predicted to change. This judgement is based on the following factors:

- the hydromorpholoical supporting elements quality is already meeting required standards (supports Good), so will not be improved through the implementation of the Anglian RBMP;
- physico-chemical quality elements will remain Moderate due to the disproportionate burdens to improve the status of dissolved oxygen, which is currently Poor. This is due to the discharge of domestic drainage flows;
- biological quality elements will remain Poor due to the cause of adverse impacts which is unknown for Macrophytes and Phytobenthos Combined fish. This is due to hard barriers, poor land management and diffuse rural road pollution; and
- the Poor biological status and Moderate physico-chemical status, which are not anticipated to improve so the ecological status will remain as Poor for River Alde water body throughout the construction and operational phases of the proposed development.

12.4.50 The future baseline of the River Fromus water body is not predicted to change. This judgement is based on the following factors:

- physico-chemical quality status will remain as Moderate as there are no technical solutions to improve the dissolved oxygen and phosphate elements. This is due to poor soil management and the consented discharge from the Benhall sewage treatment works;
- the hydrological regime for the River Fromus already supports good, so will not be improved through the implementation of the Anglian RBMP;
- biological quality elements will remain Poor due to the disproportionate burdens to improve the status of fish within the system. This is due to physical modifications such as hard barriers, land drainage for agriculture and rural land management and the consented discharge from the Benhall sewage treatment works; and
- moderate physico-chemical status and Poor biological status is not anticipated to improve so the ecological status will remain as Poor throughout the construction and operational phases of the proposed development, due to the consented discharge from the Benhall sewage treatment works.

12.5 Environmental design and mitigation

12.5.1 As detailed in **Volume 1**, **Chapter 6** of the **ES**, a number of primary mitigation measures have been identified through the iterative EIA process and have been incorporated into the design and construction planning of the proposed development. Tertiary mitigation measures are legal requirements or are standard practices that will be implemented as part of the proposed development.

12.5.2 The assessment of likely significant effects of the proposed development assumes that primary and tertiary mitigation measures are in place. For groundwater and surface water, these measures are identified in the following section, with a summary provided on how the measures contribute to the mitigation and management of potentially significant environmental effects.

a) Primary mitigation

12.5.3 Primary mitigation is often referred to as embedded mitigation and includes modifications to the location or design to mitigate impacts; these measures become an inherent part of the proposed development.

i. Construction phase

12.5.4 The route of the proposed two village bypass road would cross the River Alde via a multi-span overbridge, allowing for the river to flow under the bypass beneath the proposed bridge. The overbridge would be 60m in length and have two intermediate concrete piers set on each side of the River Alde.

12.5.5 Existing local drainage from the adjacent fields would be culverted so that their use would continue unchanged. Field drains located at the western end of the bypass, either side of the proposed River Alde embankment, would be diverted along the base of the embankment to the River Alde where possible.

12.5.6 Excess water on the floodplains would be culverted through the embankments via flood arch culverts. These culverts would be approximately 5.4 by 3m in dimension and eight in number. The flood arches minimise the afflux at the location of the bypass, to below the threshold of 30 millimetres (mm).

12.5.7 Parkgate Farm Drain would be crossed using portal culverts with a width of 5.4m and a height of 3m. Whin Covert Drain would be culverted through one of the flood arch culverts.

ii. Operational phase

12.5.8 Water draining from the road infrastructure would pass through appropriate drainage, including the incorporation of sustainable drainage system (SuDS) measures as set out in the **Outline Drainage Strategy** in **Volume 2, Appendix 2A** of the **ES,** such as swales and petrol/oil interceptors as necessary (following a Highways England Water Risk Assessment Tool assessment as part of detailed design). This would allow infiltration to the superficial aquifer, whilst also protecting the underlying groundwater from hydrocarbon contamination.

12.5.9 Infiltration basins would be located along the length of the site and would be designed to cater for a 100 years flood event plus allowance for climate change. Swales would be provided along the length of the route of the two village bypass, except where it crosses over the River Alde floodplain on embankment and overbridge. The swales would attenuate and convey surface water run-off at a rate not exceeding existing Greenfield run-off rates.

b) Tertiary mitigation

12.5.10 Tertiary mitigation will be required regardless of any EIA assessment, as it is imposed, for example, as a result of legislative requirements and/or standard sectoral practices.

12.5.11 Groundwater management during the construction phase may be required to dewater the area immediately adjacent to the cuttings, should groundwater be locally present. These groundwater control measures will be developed at detailed design stage following ground investigation.

12.5.12 Tertiary mitigation measures to be incorporated into the proposed development during enabling works, construction and operation, as set out in the **Code of Construction Practice (CoCP)** (Doc Ref. 8.11) include:

- Temporary SuDS to be implemented early in the construction phase. Construction phase water management zones to intercept surface run-off, sediment and contaminants from the construction compound and laydown areas, and incorporate sustainable drainage measures such as swales, filter drains, infiltration ponds and soakaways to promote infiltration.

- Construction drainage to be contained within the site, with infiltration to ground. A low bund is proposed to be constructed to achieve this with an external toe drain to intercept off-site run-off that may otherwise be impeded by the presence of the proposed bund. Only if full infiltration is not possible, would these systems discharge into existing surface drainage networks at greenfield run-off rates to minimise the potential for impact.

- Hardstanding to be constructed within the construction compounds where required to mitigate potential spills and leaks. Water falling onto impermeable surfaces to pass through a bypass separator.

- Construction drainage to take account of the area at risk from surface water flooding in the south-west of the site.

- Foul sewage arising from the construction compound to be tankered off-site.

- Implementation of working methods during construction to ensure there would be no surface water run-off from the works, or any stockpiles, into adjacent surface watercourses/leaching into underlying groundwater in accordance with best practice.

- Implementation of a contamination watching brief by suitably qualified and experienced personnel would be completed when excavating areas of potential contamination risk to groundwater and surface waters.

- Implementation of appropriate pollution incident control e.g. plant drip trays and spill kits. Spill kits would be available on-site at all times. Sand bags or stop logs would also be available for deployment on the outlets from the site drainage system in case of emergency spillages.

- Implementation of appropriate and safe storage of fuel, oils and equipment during construction. For example, all fuels, oils, lubricants and other chemicals would be stored in an impermeable bund with at least 110% of the stored capacity. All refuelling would take place in a dedicated impermeable area, using a bunded bowser. Biodegradable oils should be used where possible.

- The wheels of all vehicles would be free of contamination before arriving at site. All vehicles would be inspected prior to leaving site and should contaminative substances be identified suitable measures (e.g. wheel washing) would be implemented.

- Concrete and cement mixing and washing areas would be situated at least 10m away from surface water receptors. These would incorporate settlement and recirculation systems to allow water to be re-used. All washing out of equipment would be undertaken in a contained area, and all water would be collected for off-site disposal.

- Stockpiles would be located a minimum of 10m from the nearest watercourse.

12.5.13 The following measures would be incorporated into the construction works to minimise flood-related health and safety risks:

- Construction phasing to minimise or prevent constraint in floodplain (beyond that within the final design).

- Constructing embankment with culvert in place and not afterwards, so no more restriction than final design.

- Providing temporary pumping to mitigate impact of any temporary flood plain loss.

- Link to Environment Agency/Met office weather information and an associated emergency flood action plan to manage effects of out of bank flows.

12.5.14 Additional tertiary mitigation that would be anticipated and referenced in the **CoCP** (Doc Ref. 8.11) includes:

- Excavation and handling of materials and stockpiling and construction waste would be managed by good working practice in accordance with the materials management measures, soil management measures and waste management measures set out in the **CoCP**.

- Plan and design piling activities in compliance with Environment Agency guidance. This guidance may highlight the need for a piling risk assessment to ensure that piling techniques deemed appropriate are implemented at the site (by identifying and managing potential risks as a result of creating pathways to groundwater).

12.6 Assessment

a) Introduction

12.6.1 This section presents the findings of the groundwater and surface water assessment for the construction and operation of the proposed development.

12.6.2 This section identifies any likely significant effects that are predicted to occur and **section 12.7** of this chapter then highlights any secondary mitigation and monitoring measures that are proposed to minimise any adverse significant effects (if required).

b) Construction

i. Groundwater level and flow regime

12.6.3 The removal of on-site vegetation and the compaction of soils due to construction vehicles and materials storage may locally reduce the rate at which rainfall makes its way into the groundwater for a short duration, however, the overall volume of water discharging to ground is unlikely to change. The impact to groundwater from these activities would be very low, resulting in a negligible effect for the very low and low value superficial aquifers, and a minor adverse effect for the medium value bedrock aquifers. The effects would be **not significant**.

12.6.4 Current groundwater levels at the site have not been established, however, available BGS hydrogeological mapping suggests that Crag groundwater levels at the site may be around 5m AoD (0-15 mbgl). The construction includes a cutting of up to 4.5mbgl (+1m/-1m as per the parameters), however based on the information available at the time of writing, it is anticipated that this cutting will be wholly within the Lowestoft Formation

(diamicton), and so it is considered unlikely that the groundwater of the sands and gravels of the Lowestoft Formation, alluvium and the bedrock groundwater will be encountered during the proposed works. Due to the anticipated limited lateral extent of groundwater within the Lowestoft Formation (diamicton) and its low permeability, it is likely that any groundwater control measures required to dewater the superficial aquifer during the construction of the cuttings would be localised and of short duration. The impact to the very low value Lowestoft Formation (diamicton) aquifer would be low and the effect classified as negligible. The effect would be **not significant**.

12.6.5 It is unlikely that the base of the cutting will extend beyond the base of the Lowestoft Formation (diamicton) aquifer. Therefore, no groundwater control measures are anticipated to be required within the Lowestoft Formation sand and gravels aquifer, the alluvium or the bedrock aquifers and therefore there would be no effect on these aquifers with respect to dewatering activities. Geological horizons and groundwater levels will need to be established during the GI, with the impact of the cuttings on the aquifers to be reassessed once the data is made available.

12.6.6 The River Alde is located on-site and is considered to have the potential to receive baseflow from the underlying aquifers. With the implementation of the primary and tertiary mitigation measures identified, the river is unlikely to be affected by the localised changes to the hydrogeological environment identified. It is concluded that there would be no effect on the river with respect to groundwater level and flow.

12.6.7 Whilst some of the licensed groundwater abstractions within the outer study area are in close proximity to the site boundary, they are at some distance from the construction activities which may decrease groundwater availability. Groundwater control measures are anticipated to be confined to the Lowestoft Formation (diamicton) aquifer, from which it is unlikely that the groundwater abstractions would take water. With the implementation of the primary and tertiary mitigation measures identified, the groundwater abstractions identified are unlikely to be affected by any local changes to the hydrogeological environment. It is concluded that there would be no effect on the abstractions with respect to water level and flow.

12.6.8 There are no known PWS in the outer study area, however, groundwater control measures are anticipated to be confined to the Lowestoft Formation (diamicton) aquifer, from which it is unlikely that PWS would abstract water. It is concluded that there would be no effect on PWS in the outer study area with respect to groundwater level and flow.

12.6.9 As only localised and short-term groundwater control requirements are anticipated at the site, it is concluded that there would be no effect on the medium value existing buildings in terms of subsidence risk.

ii. Contamination of groundwater

12.6.10 As presented in **Chapter 11** of this volume, the construction phase would potentially introduce new sources of contamination to the site through spills or leaks of contaminants used during construction. Construction works, such as excavation and stockpiling, can pose a risk to groundwater receptors through leaching and run-off of contaminants. Intrusive activities and removal of low permeability material can pose a risk to groundwater by creating new contaminant pathways or mobilising existing contamination through exposure of contaminated soil or remobilisation of contaminants through soil disturbance. The potential contaminant linkages assessed in **Chapter 11** of this volume which have been carried forward into this assessment are:

- The potential for mobilising contaminants by excavation and stockpiling of material, increasing the risk to controlled water receptors through leaching and run-off. Earthworks could provide opportunities for run-off to contain suspended solids if not carried out in line with required management procedure.

- The potential for introducing new sources of contamination such as from spillages and leaks from construction activity.

- The potential for creation of new pathways to groundwater during groundworks, through opening up ground temporarily and construction activities, such as earthworks, piling, installation of drainage and other below-ground services and foundations.

12.6.11 Earthworks activities such as construction of embankments or excavation of cutting during the construction process create a potential pathway for existing on-site contamination to reach groundwater. It is unlikely that the cutting would extend beyond the base of the low permeability Lowestoft Formation (diamicton) aquifer and into the underlying sand and gravel Lowestoft Formation, alluvium and bedrock aquifers. Should contamination be introduced it would likely be confined to the Lowestoft Formation (diamicton) aquifer and is therefore unlikely to intercept the bedrock water table.

12.6.12 Piling activities would be localised and of short-term duration and undertaken in compliance with Environment Agency guidance, which may require a piling risk assessment.

12.6.13 As presented in **Chapter 11** of this volume, there is also the potential for existing contamination at the site, as well as the introduction of new contaminants and preferential pathways through construction activities. The implementation of the primary and tertiary mitigation measures identified in **section 12.5** of this chapter and in **Chapter 11** of this volume, including implementation of pollution incident control and safe storage of fuel, oils and equipment, would reduce this risk.

12.6.14 The principal bedrock aquifers would be protected from any spills or leaks where overlain by low permeability superficial deposits. However, in areas where the superficial deposits are absent, there is a potential pathway for contamination to reach the bedrock groundwater.

12.6.15 Where a spill or leak does occur, given the relatively low volumes of potentially contaminative material and the primary and tertiary mitigation measures employed, the scale of the spill or leak is likely to be small and captured before loss to ground.

12.6.16 Compared to the existing baseline, the level of risk to groundwater in the underlying superficial and bedrock aquifers, from the leaching/migration of contaminants through the soil is slightly increased during the construction phase and the effect is classified as minor adverse. The effects would be **not significant**.

12.6.17 Compared to the existing baseline, the level of risk to groundwater in the underlying superficial and bedrock aquifers from the migration of contaminants through preferential pathways created by the construction activities is slightly increased during the construction phase and the effect is classified as minor adverse. The effects would be **not significant**.

12.6.18 The River Alde is considered to have the potential to receive baseflow from the underlying aquifers and therefore there is a potential pathway for groundwater contamination to reach the watercourse. The assessment of the impact to the River Alde with respect to quality is presented in **section 12.6** of this chapter.

12.6.19 The abstraction boreholes located at Walk Farm, Parkgate Farm and at Friday Street are all located within 100m of the site boundary. Due to their proximity to the site, it is considered that there is the potential for contamination from the site activities to migrate to the abstractions, through leaching through the soil or via the creation of preferential pathways. With the implementation of the primary and tertiary mitigation measures, it is anticipated that the risk to the abstraction is the same as for the aquifer from which they abstract groundwater. This is an increase from the existing baseline during the construction activities and the effect is classified as minor adverse. The effect would be **not significant**.

12.6.20 The other groundwater abstractions identified are located over 350m from the site. Due to their distance from the site, and with the implementation of the primary and tertiary mitigation measures identified, it is concluded that there would be no effect on the abstractions with respect to water quality.

12.6.21 There are no known PWS in the inner study area, however there is the potential for as yet unidentified PWS to be within the inner study area. With the implementation of the primary and tertiary mitigation measures identified, the impact to potential PWS with respect to water quality beyond the site itself would be the same as for the groundwater from which they would abstract, and therefore classified as minor adverse. The effect would be **not significant**.

12.6.22 It is considered that there is no pathway for contaminative sources from the construction activities to impact groundwater receptors beyond the inner study area of 500m. Groundwater receptors identified in the baseline environment **section 12.4** of this chapter which are situated outside of the inner study area are therefore not assessed for the effects from contaminative sources during the construction phase.

iii. Alteration of the surface water flow regime

12.6.23 Any changes to the flow regime have the potential to increase existing pressures and adversely affect the hydromorphology of the River Alde, functional floodplain of the River Alde, surface drainage network, existing ponds, Glemham reservoir (once constructed), and the surface water abstraction.

12.6.24 Where construction increases the extent of bare and compacted ground for a prolonged period, there is the potential for an increase in surface run-off, and an increase in flood peaks in the nearest receptor. The proposed development would create new areas of bare ground for prolonged periods during the construction phase.

12.6.25 Construction phase water management is embedded in the design, with on-site surface water run-off being infiltrated or discharged at Greenfield run-off rates until the SuDS infrastructure is operational. This will result in a very low magnitude impact on the River Alde, functional floodplain of the River Alde, surface drainage network, existing ponds, Glemham reservoir (once constructed), and the surface water abstraction. This effect is classified as negligible and considered to be **not significant**. Once the drainage infrastructure is operational, there will be no effect on the receptors from increased surface run-off from the proposed development for the remainder of the construction phase.

12.6.26 The flow regime of the River Alde, functional floodplain and surface drainage network during construction will however be altered by the embankment across the floodplain during periods of higher (out of bank) flow. Even though flood relief culverts through the embankment will be present, it is anticipated that there will be some back-flooding on the floodplain and potentially within the surface drainage network during high flow periods. The effect is classified as minor adverse and considered to be **not significant**.

iv. Disruption of fluvial processes

12.6.27 Disruption of the fluvial processes have the potential to affect the River Alde, surface drainage network and the functional floodplain of the River Alde.

12.6.28 Construction of the proposed development would require the construction of a single span overbridge across the River Alde, an embankment with eight flood relief culverts across the floodplain and culverts across a surface drain at Parkgate Farm, and a mammal passage culvert at Whin Covert.

12.6.29 The construction of the bridge, culvert crossings and the embankment have the potential to adversely impact the fluvial geomorphology of these receptors. The impeding features confine surface flows and geomorphic activity to localised areas of the receptors and therefore reduces the area, frequency and rate of erosion and deposition.

12.6.30 The offset between the banks of the River Alde and the proposed bridge abutments means that there would be no direct interaction between the bridge and the current river channel. Furthermore, there would be considerable space for natural channel adjustments to occur in the future. No effect is therefore predicted for the River Alde.

12.6.31 A disruption to natural floodplain geomorphology processes (sediment movement) is anticipated, however the results of these effects would be largely felt during the operational phase of the proposed development. As such, the effect is classified as negligible for the functional floodplain of the River Alde during construction and considered to be **not significant**.

12.6.32 The installation of culverts on surface drains would directly disturb the bed and banks of the drains and result in the direct loss of natural geomorphological features within the footprint of the structure. Temporary works during culvert installation could result in reduced flow and sediment conveyance and create upstream impoundments. The impacts would be confined to the construction area and, as such, the effect is classified as negligible for the surface drainage network and considered to be **not significant**.

v. Contamination of surface waters

12.6.33 Contamination of surface waters arising from construction activities through the disturbance/mobilisation of existing sources of contamination or the introduction of new sources/contaminants have the potential to adversely affect the water quality of the River Alde, surface drainage network, existing ponds, Glemham reservoir (once constructed) and the surface water abstraction at Cobbold Farms, increasing existing pressures on these receptors.

12.6.34 Where excavations and the introduction of contaminants to a site take place, there is the potential for an increase in the risk of contaminating the nearest receptor. The proposed development would involve excavations and has the potential to introduce contaminants during the construction phase.

12.6.35 Construction phase water management is embedded in the design, with on-site surface water run-off being infiltrated or discharged at Greenfield run-off rates until the SuDS infrastructure is operational. Implementation of appropriate pollution incident control in accordance with the **CoCP** (Doc Ref. 8.11) would further minimise the impacts of site construction activities on the surface drainage network.

12.6.36 As detailed in **Appendices 11B** and **11C** of this volume, the risk on the receptors from both lateral migration of existing contamination and discharge of contaminants from construction activities are considered to slightly increase compared to the baseline risk. The effects from both impacts on these surface water receptors are classified as minor adverse, and considered to be **not significant**.

12.6.37 It is considered that there is a pathway for contaminative sources from the construction activities to impact surface water receptors beyond the inner study area of 500m. Surface water receptors identified in the baseline environment **section 12.4** of this chapter which are situated in the outer study area (surface water abstraction) are, therefore, assessed for the effects from contaminative sources during the construction phase.

12.6.38 Contamination of surface waters arising from construction activities also have the potential to affect the existing surface water abstraction (Cobbold Farm, Glemham) from the River Alde. Based on the primary and tertiary mitigation measures embedded in the design, the effect is classified as minor adverse, and considered to be **not significant** for the surface water abstraction.

vi. Flood risk

12.6.39 The proposed development would be served by a sustainable drainage for the lifetime of the site to manage any additional surface water run-off. The

surface water run-off is proposed to infiltrate to ground, with controlled discharge to a local watercourse as a secondary option if required. The controlled discharge would be limited to the Greenfield run-off rate to the local ordinary watercourses. The majority of the proposed development is in Flood Zone 1. However, it does cross Flood Zone 2 and 3 on the River Alde floodplain. Site-specific hydraulic model demonstrates that the proposed development will be safe and not significantly increase flood risk. No effect is predicted.

12.6.40 Further information on flood risk at the site is provided in the **Two Village Bypass FRA** (Doc Ref. 5.5) which has been submitted as part of this application for development consent.

vii. Water Framework Directive compliance

12.6.41 The site is located within the River Alde and River Fromus WFD water body catchments, and on the Waveney and East Suffolk Chalk and Crag groundwater body.

12.6.42 The preliminary (Stage 2) WFD assessment demonstrates that the majority of the proposed construction activities would not have direct or indirect effects on the River Alde, River Fromus and Waveney & East Suffolk Chalk and Crag water bodies that would be sufficient to cause deterioration in the status of the water body or protected areas located within the water bodies.

12.6.43 However, the construction of the watercourse crossings has the potential to affect the hydromorphology of the River Alde and counteract or otherwise affect the delivery of three RBMP improvement measures (removal or easement of barriers to fish migration, increase in-channel morphological diversity, and habitat improvements) identified for the water body. The potential impacts of these activities were therefore considered in a more detailed assessment (Stage 3).

12.6.44 The detailed assessment demonstrates that, although the proposed construction of the watercourse crossings could result in highly localised effects on hydromorphology, the changes are not predicted to be sufficient to result in deterioration of the status of any quality elements in the River Alde (within or between status classes).

12.6.45 Furthermore, any effects would not prevent the implementation or counteract the effects of the mitigation measures identified in the RBMP. As the proposed construction stage activities will not lead to a change in the overall status of the water bodies, the proposed construction activities are deemed compliant with the WFD.

12.6.46 Further information on the WFD compliance is provided in the **WFD Compliance Assessment Report** (Doc Ref. 8.14) as part of this application for development consent.

viii. Inter-relationship effects

12.6.47 This section provides a description of the identified inter-relationship effects that are anticipated to occur on groundwater and surface water receptors between the individual environmental effects arising from construction of the proposed development.

12.6.48 There are anticipated to be inter-relationship effects between groundwater and surface water (i.e. groundwater providing baseflow to surface watercourses); geology and land quality (i.e. naturally elevated concentration of contaminants in certain geologies); and terrestrial ecology and ornithology (i.e. groundwater dependent ecosystems). This is in relation to potential receptors which could be impacted during the construction of the proposed development.

12.6.49 The assessment of groundwater and surface water flows and levels is considered in this chapter, and there are no further combined effects beyond those stated in the preceding section.

12.6.50 The assessment of contamination in groundwater and surface water is considered inherently within the geology and land quality assessment, and no further combined effects are anticipated.

12.6.51 The assessment of terrestrial ecology is considered in **Chapter 7** of this volume.

c) Operation

12.6.52 This section assesses the potential impacts of the operational phase of the proposed development on groundwater and surface water hydrology, geomorphology and water quality.

i. Groundwater level and flow regime

12.6.53 Instances where cuttings intercept the water table could have an impact on the groundwater flow and flow direction, although long-term groundwater dewatering is unlikely to be required given the limited lateral extent of groundwater within the Lowestoft Formation (diamicton), and the depth to the sand and gravel Lowestoft Formation, alluvium and bedrock aquifers which are unlikely to be intercepted by the cutting. The potential impact to groundwater levels in the aquifers and to existing buildings from the proposed

development with respect to subsidence risk therefore does not require assessment.

12.6.54 The drainage design for the site has not been finalised, however, it is anticipated that the proposed works would increase the impermeable area of ground cover at the site. The drainage design would intercept run-off from adjacent areas, avoiding flooding lengths of the road that are in a cutting and preventing increased run-off to adjacent areas where the road is embanked. The use of SuDS infrastructure would allow infiltration to the superficial aquifer and would mean that although the spatial distribution of infiltration would be changed by the development, the total volume of infiltration entering the ground would not be significantly changed. The design would avoid, or minimise, impact to groundwater receptors. The impact to the very low and low value superficial aquifers would therefore be of low magnitude, and the effect classified as negligible for the diamicton deposits and minor adverse for the alluvium and the sand and gravels of the Lowestoft Formation. The effect would be **not significant**.

12.6.55 Variable permeability of the superficial deposits overlaying the Principal bedrock aquifers, and changes to the distribution of recharge over the site area may affect the flow regime of the bedrock groundwater under the site. The impact on the medium value bedrock aquifers would therefore be low, and the effect on the flow regime of the bedrock aquifers is classified as minor adverse. The effect would be **not significant**.

12.6.56 The abstraction boreholes located at Walk Farm, Parkgate Farm and at Friday Street are all located within 100m of the site boundary. Due to the relatively small changes in the groundwater flow and level regime, in combination with the implementation of the primary and tertiary mitigation measures identified, the impact on these groundwater abstractions with respect to groundwater level and flow would be very low and the effect classified as minor adverse. The effect would be **not significant**.

12.6.57 The other groundwater abstractions identified are located over 350m from the site. Due to their distance from the site and with the implementation of the primary and tertiary mitigation measures identified, they are unlikely to be affected by any local changes to the hydrogeological environment. It is concluded that there would be no effect on the abstractions with respect to groundwater level and flow.

12.6.58 Whilst there are no known PWS in the inner study area, the superficial and bedrock aquifers are anticipated to experience no discernible change resulting from the proposed development. The impact on any medium value PWS would be very low and the effect would be classified as minor adverse. The effect would be **not significant**.

ii. Contamination of groundwater

12.6.59 As presented in **Chapter 11** of this volume, the operation of the proposed development could introduce new sources of contamination to the site and create additional potential pathways for the migration of potential contamination. The implementation of the primary and tertiary mitigation measures identified in **section 12.5** of this chapter, and in **Chapter 11** of this volume, would reduce this risk.

12.6.60 During operation the main risks from contamination are fuel spills or leaks from the vehicles using the bypass. It is not anticipated that significant spills or leaks will occur from vehicles used for commuting purposes. It is understood that contamination from these sources would be of limited magnitude and longevity and would be mitigated through tertiary mitigation methods. The presence of silt traps and hydrocarbon bypass separators within the drainage design would prevent the supply of sediment, and other contamination to the drainage network. The provision of infiltration basins would protect the underlying groundwater from hydrocarbon contamination.

12.6.61 Compared to the existing baseline, the level of risk to groundwater in the underlying superficial and bedrock aquifers from the leaching/migration of contaminants through the soil is decreased during the operation phase and the effect is classified as minor beneficial. The effects would be **not significant**.

12.6.62 Compared to the existing baseline, the level of risk to groundwater in the underlying superficial and bedrock aquifers from the migration of contaminants through preferential pathways created by the operational activities is decreased during the operation phase, and the effect is classified as minor beneficial. The effects would be **not significant**.

12.6.63 The abstraction boreholes located at Walk Farm, Parkgate Farm, and at Friday Street are all located within 100m of the site boundary. Due to their proximity to the site, it is considered that there is the potential for contamination from the site activities to migrate to the abstractions, through leaching through the soil or via the creation of preferential pathways. With the implementation of the primary and tertiary mitigation measures, it is anticipated that the risk to the abstractions is the same as for the aquifer from which it abstracts groundwater. This is a decrease from the existing baseline during the operational activities and the effect is classified as minor beneficial. The effect would be **not significant**.

12.6.64 The other groundwater abstractions identified are located over 350m from the site. Due to their distance from the site and with the implementation of the primary and tertiary mitigation measures identified, it is concluded that there would be **no effect** on the abstractions with respect to water quality.

12.6.65 Whilst there are no known PWS in the inner study area, with the implementation of the primary and tertiary mitigation measures identified, the impact to potential PWS with respect to water quality would be the same as for the groundwater from which they would abstract. Therefore the effect would be classified as minor beneficial. The effect would be **not significant**.

12.6.66 It is considered that there is no pathway for contaminative sources from the operational activities to impact groundwater receptors beyond the inner study area of 500m. Groundwater receptors identified in the baseline environment **section 12.4** of this chapter which are situated outside of the inner study area are therefore not assessed for the effects from contaminative sources during the operation phase.

iii. Alteration of the surface water flow regime

12.6.67 Any changes to the flow regime have the potential to increase existing pressures, and adversely affect the hydromorphology of the River Alde, the functional floodplain of the River Alde, surface drainage network, existing ponds, Glemham reservoir (once constructed) and the surface water abstraction.

12.6.68 An increase in the extent of hardened surfaces will lower the infiltration rate and could increase surface run-off in receiving watercourses. Although the proposed development will have areas of impermeable surfaces, an operational drainage system is embedded in the design, with on-site surface water run-off being infiltrated or discharged at Greenfield run-off rates. No effect is predicted for the River Alde, the functional floodplain of the River Alde, surface drainage network, existing ponds, Glemham reservoir (once constructed), and the surface water abstraction from the increased run-off from the proposed development. The effect would be **not significant**.

12.6.69 The flow regime of the River Alde, functional floodplain and surface drainage network during the operational phase would however be altered by the embankment across the floodplain during periods of higher (out of bank) flow. Existing natural flow paths would be disrupted, with water movement restricted to within the bridge aperture, and the flood relief culverts on the floodplain, which could cause temporary back-flooding on the floodplain and potentially within the surface drainage network during high flow periods. The effect is classified as minor adverse and considered to be **not significant**.

iv. Disruption of fluvial processes

12.6.70 Disruption of the fluvial processes have the potential to affect the River Alde, surface drainage network and the functional floodplain of the River Alde.

12.6.71 The presence of the bridge, culverts and embankments has the potential to adversely impact the fluvial geomorphology of these receptors. The impeding features confine surface flows and geomorphic activity to localised areas of the receptors, and therefore reduces the area, frequency and rate of erosion and deposition.

12.6.72 The proposed operational overbridge would require two intermediate piers, however these would be located outside of the river with no direct interaction with the River Alde. There would be sufficient space for natural channel adjustments to occur in the future between the bridge abutments. As such, **no effect** is predicted for the River Alde. The effect would be **not significant**.

12.6.73 The permanent presence of the embankment across the floodplain of the River Alde would act as a barrier to the free movement of water during periods of high flow. A disruption to natural floodplain geomorphology processes (sediment movement) is anticipated. Where temporary back-flooding occurs, excess sediments would be deposited on the floodplain. The effect is classified as minor adverse for the functional floodplain of the River Alde and considered to be **not significant**.

12.6.74 The operational presence of culverts on surface drains could result in reduced flow and sediment conveyance and could create upstream impoundments that affect patterns of erosion and sedimentation. The culverts would be designed to ensure that any impacts on continuity of the drains are minimised meaning that the operational culverts would not result in any significant changes to the hydromorphology of the surface drains. The effect is classified as negligible for the surface drainage network and considered to be **not significant**.

v. Contamination of surface waters

12.6.75 Contamination of surface waters may arise from the operation of the proposed development due to the introduction of new sources of contaminants through leaks and spills that may occur along the proposed development. If this occurs, these have the potential to adversely affect the biology and water quality of the River Alde, surface drainage network, existing ponds, Glemham reservoir and the surface water abstraction at Cobbold Farms, increasing existing pressures on these receptors.

12.6.76 As presented in the DMRB Sustainability and Environmental Appraisal (Ref. 12.35) the risk of contaminants reaching a surface water receptor is lower for newly constructed roads as opposed to existing roads due to an improvement in drainage system solutions.

12.6.77 Water draining from the proposed development would pass through bypass separators before discharging to the swales. Implementation of appropriate

pollution incident control will further reduce the risks of run-off from chemical spills or leaks and prevent water contamination.

12.6.78 As detailed in **Appendices 11B** and **11C** of this volume, on the basis of the primary and tertiary mitigation measures, the risk on surface waters would remain the same as the baseline risk. The effects from discharge of contaminants on these surface water receptors are classified as negligible and considered to be **not significant**.

12.6.79 It is considered that there is a pathway for contaminative sources from the operational activities to impact surface water receptors beyond the inner study area of 500m. Surface water receptors identified in the baseline environment **section 12.4** of this chapter which are situated in the outer study area (surface water abstraction) are, therefore, assessed for the effects from contaminative sources during the operational phase. Specifically, contamination of surface waters arising from operational activities has the potential to affect the existing surface water abstraction (Cobbold Farms, Glemham) from the River Alde. Based on the protection afforded by the design, the effect is classified as negligible and considered to be **not significant** for the surface water abstraction.

vi. Flood risk

12.6.80 The existing site is currently greenfield with no impermeable surfaces and small localised areas of surface water flood risk. Therefore, the proposed highway development would significantly increase the impermeable area on the site. Without effective measures, this increase in impermeable area has the potential to increase the surface water run-off and the associated flood risk both on and off site.

12.6.81 Flood risk from fluvial sources are high where the bypass is required to cross the River Alde. Hydraulic modelling has been undertaken to assess the potential impact of the proposed development on flood risk. For the design scenario (100-year event with 35% allowance for climate change) in channel afflux was limited to 14 millimetres (mm).

12.6.82 Flood depths in small localised areas on the floodplain increased by a maximum of 254mm. These areas comprise arable land used for agriculture and would be inundated under the baseline scenario.

12.6.83 The proposed development is classed as being ‘Essential Infrastructure’ under the NPPF and is located in Flood Zones 1, 2 and 3. As per the Flood Risk Vulnerability and Flood Zone Compatibility (Ref. 12.36), the development was considered as being required to pass the Exception Test.

12.6.84 The Exception Test is judged to be passed as it is demonstrated in the **Two Village Bypass FRA** (Doc Ref. 5.5) that the impact of the two village bypass as mitigated by the embedded design is not significant, is overweighed by the benefit of the crossing, will be safe for the users and does not result in any significant off site increase in flood risk.

12.6.85 The increase in impermeable area associated with the proposed development will require sustainable management of surface water run-off. This is being addressed by sustainable drainage through the **Outline Drainage Strategy** in **Volume 2, Appendix 2A** of the **ES**.

12.6.86 Based on the information presented, the proposed mitigation measures and in line with NPPF guidance, it is considered that the development site is appropriate in terms of flood risk. No effect is predicted.

12.6.87 Further information on flood risk at the site is provided in the **Two Village Bypass FRA** (Doc Ref. 5.5) which has been submitted as part of this application for development consent.

vii. Water Framework Directive compliance

12.6.88 The site is located within the River Alde and River Fromus WFD water body catchments and on the Waveney and East Suffolk Chalk and Crag groundwater body.

12.6.89 The operational two village bypass would require the permanent presence of a single span overbridge across the River Alde, an earth embankment across the floodplain, and culverts across on two smaller watercourses (Parkgate Farm Drain and Whin Covert Drain).

12.6.90 The preliminary (Stage 2) WFD assessment demonstrates that the majority of the proposed operation activities would not have direct or indirect effects on the River Alde, River Fromus, and Waveney & East Suffolk Chalk and Crag water bodies, that would be sufficient to cause deterioration in the status of the water body or protected areas located within the water bodies.

12.6.91 However, the presence of the watercourse crossings has the potential to affect the hydromorphology of the River Alde and counteract or otherwise affect the delivery of three improvement measures (removal or easement of barriers to fish migration, increase in-channel morphological diversity, and habitat improvements) identified for the water body. The potential impacts of these activities were therefore considered in a more detailed assessment (Stage 3).

12.6.92 The detailed assessment demonstrates that, although the presence of the watercourse crossings could result in highly localised effects on

hydromorphology, the changes are not predicted to be sufficient to result in deterioration of the status of any quality elements in the River Alde (within or between status classes).

12.6.93 Furthermore, any effects would not prevent the implementation or counteract the effects of the mitigation measures identified in the RBMP.

12.6.94 As the proposed operational phase activities will not lead to a change in the overall status of the water bodies; the proposed operational activities are deemed compliant with the WFD.

12.6.95 Further information on the WFD compliance is provided in the **WFD Compliance Assessment Report** (Doc Ref. 8.14) as part of this application for development consent.

viii. Inter-relationship effects

12.6.96 This section provides a description of the identified inter-relationship effects that are anticipated to occur on groundwater and surface water receptors between the individual environmental effects arising from operation of the proposed development.

12.6.97 There are anticipated to be inter-relationship effects between groundwater and surface water (i.e. groundwater providing baseflow to surface watercourses); geology and land quality (i.e. naturally elevated concentration of contaminants in certain geologies) and terrestrial ecology and ornithology (i.e. groundwater dependent ecosystems). This is in relation to potential receptors which could be impacted during the operation of the proposed development.

12.6.98 The assessment of contamination on groundwater and surface water is considered inherently within the geology and land quality assessment – **Chapter 11** of this volume, and no further combined effects are anticipated.

12.6.99 The assessment of groundwater and surface water flows and levels is considered in this chapter, and there are no further combined effects beyond those stated in the preceding section.

12.6.100 The assessment of terrestrial ecology is considered in **Chapter 7** of this volume.

12.7 Mitigation and monitoring

a) Introduction

12.7.1 Primary and tertiary mitigation measures which have already been accounted for as part of the assessment are summarised in **section 12.5** of this chapter. Where further mitigation is required this is referred to as secondary mitigation, and where reasonably practicable, secondary mitigation measures have been proposed.

12.7.2 This section describes the proposed secondary mitigation measures for groundwater and surface water as well as describing any monitoring required of specific receptors/resources or for the effectiveness of a mitigation measure.

b) Mitigation

12.7.3 A ground investigation would be undertaken to confirm ground conditions, contamination status and other ground related risks prior to commencement of construction works. Where the ground investigation and subsequent generic risk assessments identifies unacceptable levels of contamination and ground related risks, further detailed quantitative risk assessment followed by, where necessary, the remediation of soil and groundwater contamination prior to construction may be required.

12.7.4 Active management and maintenance of the drainage infrastructure would be required to ensure the continued efficacy of the surface water drainage system.

12.7.5 The hydraulic modelling in the **Two Village Bypass FRA** (Doc Ref. 5.5) has shown there is an increase in water levels in localised areas to the north of the proposed overbridge over the River Alde during a 1 in 100 year event (with 35% allowance for climate change). The land affected comprises agricultural fields and is already inundated under the baseline scenario (without the proposed development in place). As set out in the assessment (section 12.6) it is considered that the development site is appropriate in terms of flood risk and no effect is predicted. However, in response to consultation the Environment Agency has stated that written consent from the landowner must be obtained for the increased flood depth, hazard and velocity in these localised areas. SZC Co. will continue to engage with the land owner with the view to reaching such an agreement. However, as this agreement has not been obtained at the time of submission of the application, the proposed development includes areas within the site to the north of the proposed bridge that could provide flood compensation. It is not considered that this flood compensation land is required for the proposed development. It is nevertheless being put forward as part of the DCO

application in case the Secretary of State disagrees with this position and takes the view that it is in fact required.

12.7.6 A flood risk emergency plan would be developed to identify safe access and escape routes, demonstrate free and safe movement of people during a design flood and set out the potential for evacuation before a more extreme event.

c) Monitoring

12.7.7 A programme of gas, groundwater and surface water monitoring would be designed as part of the ground investigation and would be required prior to construction works commencing. The results of this short-term monitoring would determine whether further long-term gas, groundwater and surface water monitoring is required during the construction and operational phases.

12.8 Residual effects

12.8.1 **Tables 12.9** and **Table 12.10** present a summary of the groundwater and surface water assessment. They identify the receptor/s likely to be impacted, the level of effect and, where the effect is deemed to be significant, the tables include the mitigation proposed and the resulting residual effect.

Table 12.9: Summary of effects for the construction phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
Crag Groundwater (Principal Aquifer).	Reduction in the rate/volume of water discharging to ground.	Appropriate drainage design. Temporary SuDS and water management zones. Ensuring all site activities are carried out in accordance with the **CoCP** (Doc Ref. 8.11).	Minor adverse.	Ground investigation and relevant risk assessments completed prior to detailed design and construction works. Remediation of soil and groundwater if necessary. Longer term gas and groundwater and	Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
Chilesford Church Sand Member Groundwater (Principal Aquifer).	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.
	Leaching/migration of contamination in		Minor adverse.		Minor beneficial

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
	soils to groundwater.			monitoring if necessary.	**(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
The Red Crag Formation Groundwater (Principal Aquifer).	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
Lowestoft Formation sands and gravels groundwater (Secondary A Aquifer).	Reduction in the rate/volume of water discharging to ground.		Negligible		Negligible **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
Lowestoft Formation sands and gravels groundwater (Secondary A Aquifer).	Reduction in the rate/volume of water discharging to ground.		Negligible		Negligible **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential		Minor adverse.		Minor beneficial

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
	pathways to groundwater.				**(not significant)**.
Lowestoft Formation diamicton groundwater (Secondary Aquifer (undifferentiated)).	Reduction in the rate/volume of water discharging to ground.		Negligible		Negligible **(not significant)**.
	Lowering of groundwater levels.		Negligible		Negligible **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor adverse.		Minor beneficial **(not significant)**.
Groundwater abstractions <350m from the site.	Reduction in groundwater availability to the abstraction.		No effect.		No effect **(not significant)**.
	Contamination mobilised during construction migrating to the abstraction.		Minor adverse.		Minor beneficial **(not significant)**.
Groundwater abstractions greater than 350m from the site boundary.	Reduction in groundwater availability to the abstraction.		No effect.		No effect **(not significant)**.
	Contamination mobilised during construction migrating to the abstraction.		No effect.		No effect **(not significant)**.
Potential PWS.	Reduction in groundwater availability to the PWS.		No effect.		No effect **(not significant)**.
	Contamination mobilised during construction		Minor adverse.		Minor adverse **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
	migrating to the PWS.				
Existing buildings.	Groundwater control measures attributing to subsidence risk.		No effect.		No effect **(not significant)**.
River Alde (Main River).	Alteration of surface water flow regime from impeding embankment across the floodplain.	A single span bridge will be constructed where the route crosses the River Alde flood relief culverts through embankment .	Minor adverse.	Not required.	Minor adverse **(not significant)**.
	Alteration of surface water flow regime from increased run-off.	Isolation of the site from the wider environment to prevent off-site effects, with drainage to ground.	No effect.	Not required.	No effect **(not significant)**.
	Disruption of fluvial processes.	Single span bridge.	No effect.	Not required.	No effect **(not significant)**.
	Contamination of the river.	Isolation of the site from the wider environment to prevent off-site effects, with drainage to ground. Adoption of pollution prevention measures.	Minor adverse.	Ground investigation and relevant risk assessments completed prior to detailed design and construction works. Remediation of soil and groundwater if necessary. Longer term surface water	Negligible **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
				monitoring if necessary.	
Surface Drainage Network.	Alteration of surface water flow regime from impeding flows.	Flood relief culverts through embankment .	Minor adverse.	Not required.	Minor adverse **(not significant)**.
	Alteration of surface water flow regime from increased run-off.	Isolation of the site from the wider environment to prevent off-site effects, with drainage to ground.	No effect.	Not required.	No effect **(not significant)**.
	Disruption of fluvial processes.	None	Negligible	Not required.	Negligible **(not significant)**.
	Contamination of the receptor.	Isolation of the site from the wider environment to prevent off-site effects, with drainage to ground. Adoption of pollution prevention measures.	Minor adverse.	Ground investigation and relevant risk assessments completed prior to detailed design and construction works. Remediation of soil and groundwater if necessary. Longer term surface water monitoring if necessary.	Negligible **(not significant)**.
Functional floodplain.	Alteration of surface water flow regime from impeding embankment across the floodplain.	Flood relief culverts.	Minor adverse.	Not required.	Minor adverse **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Mitigation.	Residual Effects.
	Disruption of fluvial processes.	Flood relief culverts.	Negligible	Not required.	Negligible **(not significant)**.
Surface water abstraction.	Alteration of surface water flow regime.	Isolation of the site from the wider environment to prevent off-site effects, with drainage to ground. Adoption of pollution prevention measures.	No effect.	Not required.	No effect **(not significant)**.
	Contamination of the source.		Minor adverse.	Ground investigation and risk assessment. Longer term surface water monitoring if necessary.	Negligible **(not significant)**.
Existing ponds and Glemham Reservoir (once constructed).	Alteration of surface water flow regime.		No effect.		No effect **(not significant)**.
	Contamination of the receptor.		Minor adverse.		Negligible **(not significant)**.
Flood risk to surrounding areas.	Loss of functional floodplain storage or displacement of sea or river water.	Landscaping to ensure no net loss of floodplain storage.	No effect.	Not required.	No effect **(not significant)**.

Table 12.10: Summary of effects for the operational phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
Crag Groundwater (Principal Aquifer).	Reduction in the rate/volume of water discharging to ground.	Water draining from the road structure will pass through appropriate drainage including the incorporation of SuDS and bypass separators where necessary. This will allow infiltration to the superficial	Minor adverse.	Longer term gas and groundwater monitoring if necessary. Management and maintenance of the SuDS.	Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
Chilesford Church Sand Member Groundwater	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
(Principal Aquifer).	Leaching/migration of contamination in soils to groundwater.	aquifer, whilst also protecting the underlying groundwater from hydrocarbon contaminatio n.	Minor beneficial.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
The Red Crag Formation Groundwater (Principal Aquifer).	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
Alluvium (Secondary A aquifer).	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
Lowestoft Formation sands and gravels groundwater (Secondary A Aquifer).	Reduction in the rate/volume of water discharging to ground.		Minor adverse.		Minor adverse **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
Lowestoft Formation diamicton groundwater (Secondary Aquifer (undifferentiated)).	Reduction in the rate/volume of water discharging to ground.		Negligible		Negligible **(not significant)**.
	Leaching/migration of contamination in soils to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
	Migration of contamination through preferential pathways to groundwater.		Minor beneficial.		Minor beneficial **(not significant)**.
Groundwater abstraction < 350m from the site boundary.	Reduction in groundwater availability to the abstraction.		Minor adverse.		Minor adverse **(not significant)**.
	Contamination mobilised during construction migrating to the abstraction.		Minor beneficial.		Minor beneficial **(not significant)**.
Groundwater abstraction greater than 350m from the site boundary.	Reduction in groundwater availability to the abstraction.		No effect.		No effect **(not significant)**.
	Contamination mobilised during construction migrating to the abstraction.		No effect.		No effect **(not significant)**.
Potential PWS.	Reduction in groundwater availability to the PWS.		Minor adverse.		Minor adverse **(not significant)**.
	Contamination mobilised during construction migrating to the PWS.		Minor beneficial.		Minor beneficial **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
River Alde (Main River).	Alteration of surface water flow regime from impeding embankment across the floodplain.	Flood relief culverts through embankment .	Minor adverse.	Not required.	Minor adverse **(not significant)**.
	Alteration of surface water flow regime from increased run-off.	The operational drainage system is embedded in the design.	No effect.	Not required.	No effect **(not significant)**.
	Disruption of fluvial processes.	A single span bridge will be constructed where the route crosses the River Alde. Flood relief culverts through embankment .	No effect.	Not required.	No effect **(not significant)**.
	Contamination of surface waters.	Water draining from the site will pass through bypass separators where necessary. Implementation of appropriate pollution incident control.	Negligible	Longer term surface water monitoring if necessary. Management and maintenance of the SuDS.	Negligible **(not significant)**.
Surface drainage network.	Alteration of surface water flow regime from impeding embankment across the floodplain.	Flood relief culverts through embankment .	Minor adverse.	Not required.	Minor adverse **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
	Alteration of surface water flow regime from increased run-off.	The operational drainage system is embedded in the design.	No effect.	Management and maintenance of the SuDS. Longer term surface water monitoring if necessary.	No effect **(not significant)**.
	Disruption of fluvial processes.	None	Negligible	Not required.	Negligible **(not significant)**.
	Contamination of surface waters.	Water draining from the site will pass through bypass separators where necessary. Implementation of appropriate pollution incident control.	Negligible	Management and maintenance of the SuDS. Longer term surface water monitoring if necessary.	Negligible **(not significant)**.
River Alde floodplain.	Alteration of surface water flow regime from impeding embankment across the floodplain.	Flood relief culverts.	Minor adverse.	Not required.	Minor adverse **(not significant)**.
	Disruption of fluvial processes.	Flood relief culverts.	Minor adverse.	Not required.	Minor adverse **(not significant)**.
Surface water abstraction.	Alteration of the flow regime.	The operational drainage system is embedded in the design.	No effect.	Management and maintenance of the SuDS. Longer term surface water monitoring if necessary.	No effect **(not significant)**.
	Contamination of the source.		Negligible		Negligible **(not significant)**.
Existing ponds and Glemham Reservoir.	Alteration of the flow regime.		No effect.		No effect **(not significant)**.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Mitigation.	Residual Effects.
	Contamination of surface waters.		Negligible		Negligible **(not significant)**.
Flood risk to surrounding areas.	Loss of functional floodplain storage or displacement of sea or river water.	Landscaping to ensure no net loss of floodplain storage.	No effect.	Not required.	No effect **(not significant)**.

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