The Sizewell C Project

6.3 Volume 2 Main Development Site

Chapter 19 Groundwater and Surface Water

Appendices 19C - 19F

Revision: 1.0

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Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

VOLUME 2, CHAPTER 19, APPENDIX 19C : SIZEWELL DRAIN DIVERSION OUTLINE DESIGN

Contents

Tables

None provided.

Plates

None provided.

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Appendices

None provided.

19C SIZEWELL DRAIN DIVERSION OUTLINE DESIGN

19C.1 Realignment works upstream of IDB DRN163G0201

19C.1.1 For realignment works (**Figure 19C.1** of this volume) upstream of Internal Drainage Board (IDB) DRN163G0201, as shown on **Figure 19E.2** of this volume, construction would take place solely from the main platform. The only exceptions to this would be:

- where vegetation clearance is required to provide adequate clearance for plant;
- for the supervision of construction works; and
- where new/repositioned structures are required to maintain water levels within the fen meadow habitat.

19C.1.2 The drain would be realigned immediately following construction of the sheet piling. This would better enable construction of a stable bank for the realigned drain closest to the piling to take place.

19C.1.3 Water levels would be monitored during piling and an allowance made for pumping of land drainage where required to ensure that temporary construction effects are controlled to within acceptable limits.

19C.2 Realignment works downstream of IDB DRN163G0201

19C.2.1 For realignment works (**Figure 19C.1** of this volume) downstream of IDB DRN163G0201, as shown on **Figure 19E.2** of this volume, realignment of the drain would again immediately follow the installation of sheet piling. Access arrangements would be directly from the main platform. Construction on the outer (west) bank would generally be avoided where reasonably practicable, allowing the western fringe of the reedbed to remain in place and form the outer bank of the realigned drain. However, due to the topography and water levels, a new structure is likely to be required on the outer (west) bank to aid water level management in the adjacent wetland area and therefore some construction is likely to be required on this part of the bank.

19C.2.2 Construction access, and therefore any associated compaction of the underlying peat and any further temporary works, would be focused on the inner (east) bank to help protect the Sizewell Marshes Site of Special Scientific Interest (SSSI). A temporary crossing point may be required on

IDB DRN163G0201 to provide access to Goodram's Fen whilst maintaining existing land drainage, until the realigned drain is in place.

19C.3 Realignment works at Leiston Drain

19C.3.1 Construction works will aim to minimise disturbance to Leiston Drain and would generally be limited to:

- the new confluence of the Sizewell Drain and Leiston Drain;
- a further drain connection on the south bank of Leiston Drain to a relic drain; and
- small-scale works (as necessary) to modify the form and function of Leiston Drain.

19C.3.2 Construction is likely to take place from the outer (north) bank of the channel where ground conditions are typically more stable and potentially allowing this aspect of the drain diversion to take place independently of land raising and piling installation. Where practicable, realignment works would take place concurrently with construction works to the SSSI crossing to minimise disturbance.

19C.4 Water level control structures

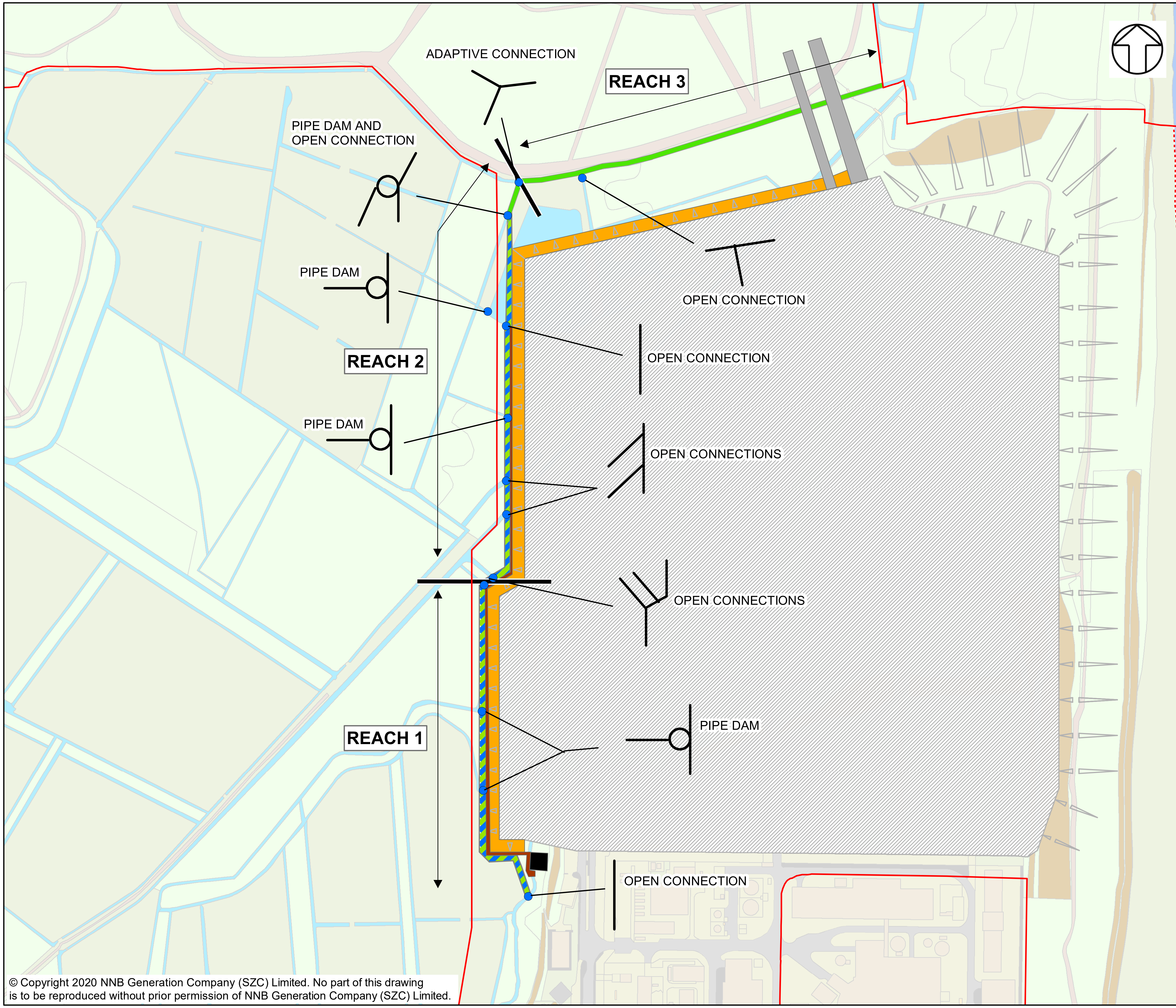
19C.4.1 There are currently many confluences between the Sizewell Drain and other tributary drains in the Sizewell Marshes SSSI, as its drainage network is generally artificially controlled. This includes the use of water level control structures, including sluices and simple piped connections. Monitoring shows them to be effective in contributing to the conservation of biodiversity interests in this SSSI.

19C.4.2 As part of the realignment works, additional means of permanently manipulating water levels within the Sizewell Marshes SSSI are proposed. This would ensure water levels that would otherwise have changed as a result of the proposed development can be mitigated, where this is necessary to conserve biodiversity interests. Such control structures would include passage for fish, including eels.

19C.4.3 IDB DRN163G0201 would incorporate temporary measures to provide pollution control, which would ultimately be removed to form an open connection with Sizewell Drain. It is also proposed that an area of deeper water is created here by excavating the channel bed to a greater depth in a stepped profile. Pipe dams would also be installed as necessary within the site boundary at the confluences with other minor ditches that would adjoin the realigned drain.

19C.4.4 A water control structure would be installed in the realigned Sizewell Drain, approximately 5 -10m south of the confluence with Leiston Drain. Due to the capacity of Sizewell Drain, a tilting weir is likely to be necessary to provide an adaptive water management regime across the eastern areas of Sizewell Marshes, unless evidence shows that a pipe dam is sufficient at the detailed design stage.

19C.4.5 Whilst the realignment works are taking place, short-term temporary blind bunds are likely to be necessary to restrict water flow. Blind bunds are currently present within parts of the SSSI.



NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- NEW DRAIN CONNECTION
- REACH MARKERS
- PROPOSED LOCATION OF PYLON
- PROPOSED CROSSING
- SMALL SCALE WORKS
- 2M WIDE BANK
- REALIGNED DRAIN
- EDGE OF PROPOSED EMBANKMENT
- PROPOSED LOCATION OF SIZEWELL C

NOT PROTECTIVELY MARKED

DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 19C
SIZEWELL DRAIN DIVERSION OUTLINE DESIGN

DRAWING TITLE:
SIZEWELL DRAIN REALIGNMENT AND CONNECTIONS

DRAWING NO:
FIGURE 19C.1

DATE:	DRAWN:	SCALE :
JAN 2020	S.C.H	1:3,500 @A3

SCALE BAR
0 40 80 120 160 200 M

VOLUME 2, CHAPTER 19, APPENDIX 19D : OFF-SITE DEVELOPMENTS ASSESSMENT

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Tables

Plates

None provided.

Figures

None provided.

Appendices

None provided.

1. Groundwater and Surface Water Off-Site Developments

1.1 Introduction

1.1.1 This appendix of **Volume 2, Chapter 19** of the **Environmental Statement** (**ES**) (Doc Ref. 6.2) presents an assessment of the groundwater and surface water effects arising from the construction and operation of the proposed off-site developments, off-site sports facilities at Leiston, fen meadow compensation sites south of Benhall and east of Halesworth and, if required, the marsh harrier habitat improvement area (Westleton). They are referred to throughout this appendix as the 'off-site developments' or 'the proposed development'.

1.1.2 Detailed descriptions of the proposed development sites (referred to throughout this volume as the 'site' as relevant to the location of the works), the proposed off-site development works and different construction and operational phases are provided in **Chapters 1-4** of this volume of the **ES**. A glossary of terms and list of abbreviations used in this chapter is provided in **Volume 1, Appendix 1A** of the **ES**.

1.2 Legislation, policy and guidance

1.2.1 **Volume 1, Appendix 6O** 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. There is no further legislation, policy and guidance over and above that described in **Volume 1**, **Appendix 6O** that is deemed relevant to the assessment of effects associated with the off-site development works.

1.3 Methodology

a) Scope of the assessment

1.3.1 The generic Environmental Impact Assessment (EIA) methodology is detailed in **Volume 1**, **Chapter 6**. The full method of assessment for groundwater and surface water that has been applied for the Sizewell C Project is outlined in **Volume 1**, **Appendix 6O**.

1.3.2 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 PINS in 2014, with an updated request issued in 2019. 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**.

1.3.3 This section provides specific details of the groundwater and surface water screening exercise, the methodology applied to the assessment of the proposed off-site development works screened in, and a summary of the general approach to provide appropriate context for the assessment that follows.

1.3.4 Where the proposed off-site development works are considered to have the potential for likely significant effects, these have been screened in for further assessment. The scope of assessment considers the impacts of the construction and operational use of the proposed off-site developments.

b) Consultation

1.3.5 The scope of the assessment has also been informed by ongoing consultation and engagement with statutory consultees throughout the design and assessment process as outlined in **Volume 1, Appendix 6O**. No consultation with statutory consultees has been undertaken with specific regards to the off-site developments.

c) Environmental screening

1.3.6 An environmental screening exercise was undertaken to identify which of the off-site development works may give rise to environmental effects that could potentially be significant. This concluded that the two fen meadow compensation sites should be taken forward to the assessment of likely effects on groundwater and surface water.

1.3.7 Two of the off-site development works (off-site sports facilities at Leiston and the marsh harrier improvement area west of Westleton) have been screened out of the groundwater and surface water assessment as they are not likely to give rise to significant environmental effects.

1.3.8 **Table 1.1** provides a summary of the environmental screening exercise.

Table 1.1: Summary of environmental screening exercise.

Proposed Off-Site Developments.	Summary Of Potential Effects.	Screened In Or Out Of The Assessment.
Sports facilities at Leiston.	All works will be within the site's boundary and will not impact on any groundwater and surface water receptors. Based on the proposed construction and operational activities, and the absence of potential surface water receptors in the vicinity of the site, no significant effects are predicted.	Screened out.

<table>
<tr><th>Proposed Off-Site Developments.</th><th>Summary Of Potential Effects.</th><th>Screened In Or Out Of The Assessment.</th></tr>
<tr><td></td><td>The limited scale of proposed earthworks and excavations means that no effects are predicted on the groundwater environment.</td><td></td></tr>
<tr><td>Fen meadow compensation site south of Benhall.</td><td rowspan="2">The limited scale of proposed earthworks and excavations means that no effects are predicted on the groundwater environment.
There will be a potential impact on surface water receptors within, and adjacent to the site during the construction and operational phases of the proposed fen meadow compensation areas.</td><td>The potential effects only relate to surface water receptors.
Screened in.</td></tr>
<tr><td>Fen meadow compensation site east of Halesworth.</td><td>The potential effects only relate to surface water receptors.
Screened in.</td></tr>
<tr><td>Marsh harrier habitat improvement area - west of Westleton.</td><td>There are no works associated with the marsh harrier habitat improvement area that will impact on any groundwater and surface water receptors.</td><td>Screened out.</td></tr>
</table>

d) Study area

1.3.9 The study area for the consideration of effects from contaminative sources on controlled waters is discussed in **Chapter 18** of this volume and includes the off-site development sites and land immediately beyond it to a distance of 500 metres (m). This is hereafter referred to as the inner study area.

1.3.10 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 identified.

1.3.11 The inner study area is extended for the consideration of effects on groundwater and surface water levels and flows, and water dependent receptors and includes the site and land immediately beyond it to a distance of 1 kilometre (km). This is hereafter referred to as the outer study area.

1.3.12 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.

1.3.13 The inner and outer study areas were defined using professional judgement following review of ground conditions, the local hydrogeological and hydrological regime, and the scope of proposed works.

e) Assessment scenarios

1.3.14 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 peak years.

f) Assessment criteria

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

i. Assessment of physical impacts

1.3.16 Physical impacts include:

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

1.3.17 The assessment criteria of physical impacts on groundwater and surface water resources and receptors are based on the methodology provided in **Volume 1, Appendix 6O**.

ii. Assessment of contamination to controlled waters

1.3.18 The assessment of potential impacts from existing and new contamination sources on controlled waters have been considered as part of the geology and land quality assessment in the development of the preliminary conceptual site model to determine and classify potential effects.

1.3.19 Further details on the methodology applied is provided in **Volume 1, Appendix 6N**, and summarised in **Chapter 18** of this volume.

iii. Water Framework Directive compliance

1.3.20 The significance of impacts on Water Framework Directive (WFD) status relates only to compliance or non-compliance. Non-compliance will only occur because of non-temporary 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. The **WFD Compliance Assessment** (Doc Ref. 8.14) has been provided as a separate document submitted alongside the Development Consent Order (DCO) application.

iv. Flood risk assessment

1.3.21 The **Flood Risk Assessment** (Doc Ref. 5.2) has been provided as a separate document submitted alongside the DCO application. The main conclusions with relevance to the activities considered as part of the EIA are summarised in this appendix.

g) Assessment methodology

1.3.22 **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

1.3.23 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 resources and receptors from the construction and operation phases of the proposed development.
- Assessment of the significance of likely effects from the proposed development including the consideration of mitigation measures.
- Identification of any residual effects and secondary mitigation, where required.

1.3.24 The assessment also considers the findings of the **WFD compliance assessment** and **Flood Risk Assessment**.

ii. Establishing baseline

1.3.25 Due to the discrete nature of the works the current and future baseline assessment has been based on a review of readily available web-based information.

iii. Assessment

1.3.26 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 would be required to determine the magnitude and extent of potential changes.

h) Assumptions and limitations

1.3.27 The following assumptions have been made in this assessment:

- Surface water discharge will be managed so it does not exceed the predetermined greenfield run-off rates in accordance with relevant guidance.
- Environmental Quality Standards prescribed for downstream designated WFD water bodies have been adopted for upstream watercourses for the purposes of this assessment.

1.3.28 The following limitations have been identified:

- No ground investigation has been carried out at the off-site developments at the time of writing. Therefore, no observed information about the ground conditions at the sites or encountered groundwater was available for the production of this assessment. It is anticipated ground investigations will be carried out prior to detailed design.
- No groundwater quality data is available for the off-site developments.

1.4 Assessment of effects

1.4.1 As identified in **section 1.3c**, the two fen meadow compensation sites are considered to have the potential to result in significant environmental effects and have therefore been assessed in further detail. The off-site sports facilities at Leiston and marsh harrier habitat improvement area (Westleton) are considered not likely to result in significant environmental effects during their construction or operation.

1.4.2 **Table 1.2** summarises the outcome of the assessment of the likely effects of the off-site development works screened into the assessment. For each site the baseline environment is described and any environmental design and embedded mitigation is outlined, and a summary of the likely effects, before and after any additional mitigation and monitoring (if required) is provide.

Table 1.2: Summary of the assessment of effects for off-site developments.

Baseline Environment.	Environmental Design And Embedded Mitigation.	Assessment Of Effects.	Additional Mitigation And Monitoring.	Residual Effect.
Fen meadow compensation site south of Benhall.				
Current baseline The proposed fen meadow site is immediately adjacent to the River Fromus, which is classified as a Main River by the Environment Agency and is a reportable reach under the Water Framework Directive (WFD) (GB105035045980) (Ref. 1.1.). The site lies within the functional floodplain of the River Fromus. Whilst the morphology of the River Fromus has the potential to 'support Good' ecological status, the ecological status of the waterbody has been classified as 'Poor' under WFD reporting. Physico-chemical water quality also fails to support Good status. The River Fromus is classified as a medium sensitivity receptor. The fen meadow site receives a consented discharge from the Benhall Sewage Treatment Works which is conveyed through the surface drainage network (very low sensitivity receptor) through the floodplain to the River Fromus.	**Construction** Engineering works would be designed to avoid disturbance to the water environment. Ground investigation and risk assessment undertaken prior to commencement of construction. All site activities are carried out in accordance with the Code of Construction Practice (CoCP). **Operation** The design will create a mosaic of habitats, with small-scale water management controls operated to maximise the area of fen meadow created within the site.	**Construction** A minor adverse, short-term impact is predicted. Physical effects including erosion and sediment transport associated with stripping of topsoil, vegetation clearance, stockpiling, earthworks and associated machine movements is anticipated to be minimal. The impact would be **not significant**. **Operation** A potentially moderate adverse, long-term impact is predicted to affect the conveyance of flows through the surface drainage network within the floodplain. The effect would be **not significant**. A potentially moderate beneficial effect is predicted. It is anticipated that the design will complement the existing floodplain and riverine habitats and, consequently, should give rise to beneficial	**Construction** Not required. **Operation** Once operational, ongoing monitoring and management will be required to deliver and maintain the target habitats.	**Construction** Minor adverse (**not significant**). **Operation** Moderate adverse (**not significant**). Moderate beneficial (**not significant**).

Baseline Environment.	Environmental Design And Embedded Mitigation.	Assessment Of Effects.	Additional Mitigation And Monitoring.	Residual Effect.
Future baseline There are no committed development(s) or forecasted changes that would materially alter the baseline conditions during the construction and operation phases of the proposed fen meadow compensation site.		**significant** effects for surface waters.		
Fen meadow compensation site east of Halesworth				
Current baseline The proposed site is immediately adjacent to the River Blyth, which is classified as a Main River be by the Environment Agency and is a reportable reach under the WFD (GB105035046030) (Ref. 1.2) The site lies within the functional floodplain of the River Blyth. The river is designated as a heavily modified waterbody. As a result of changes to the hydrological regime it does not support Good status under WFD reporting. However, the physico-chemical water quality is classified as Good and biological quality is of High Status. The River Blyth is classified as a medium sensitivity receptor. The site receives a consented discharge from the Halesworth Sewage Treatment Works which is conveyed through the surface drainage network (very low	**Construction** Engineering works would be designed to avoid disturbance to the water environment. Ground investigation and risk assessment undertaken prior to commencement of construction. Ensuring all site activities are carried out in accordance with the CoCP. **Operation** The design will create a mosaic of habitats, with small-scale water management controls operated to maximise the area of fen meadow created within the site.	**Construction** A minor adverse, short-term impact is predicted. Physical effects including erosion and sediment transport associated with stripping of topsoil, vegetation clearance, stockpiling, earthworks and associated machine movements is anticipated to be minimal. The impact would be **not significant**. **Operation** A potentially moderate adverse, long-term impact is predicted to affect the conveyance of flows through the surface drainage network within the floodplain. The effect would be **not significant.** A potentially moderate beneficial effect is predicted. It is anticipated	**Construction** Not required. **Operation** Once operational, ongoing monitoring and management will be required to deliver and maintain the target habitats.	**Construction** Minor adverse (**not significant**). **Operation** Moderate adverse (**not significant**). Moderate beneficial (**not significant**).

Baseline Environment.	Environmental Design And Embedded Mitigation.	Assessment Of Effects.	Additional Mitigation And Monitoring.	Residual Effect.
sensitivity receptor) through the floodplain to the River Blyth. **Future baseline** There are no committed development(s) or forecasted changes that would materially alter the baseline conditions during the construction and operation phases of the proposed fen meadow compensation site.		that the design will complement the existing floodplain and riverine habitats and, consequently, should give rise to beneficial **significant** effects for surface waters.		

References

1.1 Catchment Data Explorer: River Fromus Water Body (Online) Available from https://environment.data.gov.uk/catchment-planning/WaterBody/GB105035045980 (Accessed September 2019).

1.2 Catchment Data Explorer: River Blyth Water Body (Online) Available from https://environment.data.gov.uk/catchment-planning/WaterBody/GB105035046030 (Accessed September 2019).

VOLUME 2, CHAPTER 19, APPENDIX 19E : SURFACE WATER CONCEPTUALISATION MODEL

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None provided.

Executive summary

Surface water drainage network

Surface water drainage in the Sizewell C study area comprises two lowland, low energy river systems that both discharge to the sea at Minsmere Sluice; Leiston Drain and the Minsmere River. Estimates suggest that the Minsmere River contributes approx. 79% flows into the study area, compared to approximately 14% from Leiston Drain. Flows in Leiston Drain are heavily influenced by the consented discharge of treated effluent from Leiston sewage treatment works (STW).

The low, flat valleys of each river system are naturally wet, and both systems have been extensively modified by human activities including the enlargement and diversion of the main river channels, and the construction of a complex network of interconnecting drains throughout the floodplain on the valley floor. As a result of these modifications, the watercourses have uniform, trapezoidal channels with steep banks and very little geomorphological diversity. The dominant geomorphological processes are sediment deposition and, when flows have sufficient energy, sediment transport.

Water levels in the surface drainage network are controlled and regulated by the operation of control structures such as sluiced pipes, syphons, stop boards, and the tidal sluice at Minsmere. Water levels are managed so that they stay within a relatively narrow range, although there are variations between the spring-summer and autumn-winter seasons.

Minsmere Sluice

The most important control structure for the surface water drainage system is the Minsmere Sluice, which is located at the downstream end of the Minsmere New Cut. The sluice is divided into two chambers, each with its own gravity-outlet culvert to the sea. The northern chamber receives flows from the Minsmere New Cut, while the southern chamber receives flows from the Leiston Drain and Scott's Hall Drain.

Until recently, the sluice was in a poor state of repair, but the culverts and flap valves were refurbished in 2013/14. Prior to the remedial works, the poor condition and configuration of the outfalls (which lacked operational non-return valves) allowed uncontrolled ingress of water via overtopping of the central wall (from the other watercourses or from high tide levels) into the rest of the drainage system.

After completion of the remedial works to the sluice, Suffolk Wildlife Trust (SWT) noted that winter water levels (2014-15) in Sizewell Marshes were higher than they have previously been. This had been attributed by the Environment Agency to the presence of several blockages on Leiston Drain. Some blockages were removed by the Environment Agency at the start of week commencing 30 March 2015, resulting in a gradual reduction in water levels observed in monitoring data from the site. The refurbished sluice prevents the ingress of water from the Leiston Drain system into the

Minsmere New Cut and Scott's Hall Drain and vice versa. Although it is possible that water could move upstream through the syphon into Scott's Hall Drain if the penstock was open, this is very unlikely to occur under normal flow conditions.

Surface water-groundwater connectivity

As a result of the hydrology of the peat and crag deposits which underlie the site, the surface waters are strongly influenced by water levels and flows within the groundwater system. The surface and groundwater systems both respond rapidly to rainfall, and there is strong hydraulic connectivity between the two systems. The surface water contributes to groundwater in the upstream parts of the Sizewell Marshes Site of Special Scientific Interest (SSSI), and groundwater contributes to surface waters in the downstream parts of the SSSI. This means that any activities which affect surface or groundwater hydrology have the potential to affect the entire hydrological system, which should therefore be considered as a whole.

Water quality

Water quality in the drainage catchments is generally good. However, parts of Leiston Beck/Drain are affected by consented discharges from the Leiston STW (which includes combined storm overflows from Leiston) and display elevated concentrations of ammonia, nitrate, nitrite and phosphate. In addition, the upstream end of Sizewell Drain is affected by road run-off, displaying elevated concentrations of total petroleum hydrocarbons (TPH) and several specific pollutants or Water Framework Directive (WFD) Priority Substances.

Water quality in the surface watercourses is influenced by the input of saline water from Minsmere Sluice, which results in elevated salinity and sulphate levels in the surface waters. The refurbished sluice is deliberately operated to allow some saline intrusion into Leiston Drain and Scott's Hall Drain at high tide.

Ecology

The surface water system supports important assemblages of invertebrates and rare vascular plants, as well as providing habitats for birds such as marsh harrier and bittern. The drainage system has been designated for its nature conservation value as a result of these features. The southern parts of the surface drainage network (including the Leiston Drain and surrounding drainage units) comprise the nationally designated Sizewell Marshes SSSI, and the northern parts (including the drainage units that connect to the Minsmere New Cut) form part of the nationally and internationally designated Minsmere to Walberswick Heaths and Marshes SSSI, Special Protection Area (SPA), Special Area of Conservation (SAC), and Ramsar site.

The distribution of the sensitive invertebrate and plant species is closely connected to shading and is also likely to be influenced by water quality and quantity. The habitats that support the important bird species are also sensitive to changes in surface water. For example, bittern forage at the interface between reed beds and open water, and cannot forage if water levels are too deep, or if the water quality degrades significantly, leading to a reduction in the amount of fish species available as prey.

Potential impacts

During its construction and operation stages, the proposed (unmitigated) development has the potential to cause changes in surface water quality, quantity and distribution, as well as hydrogeological and geomorphological changes which might affect ecology and impact upon designated habitats.

Specifically, the proposed development has the potential to change water levels and impact upon the surface water environment in the drainage units that are located to the south of the Minsmere New Cut, namely Leiston Beck and Leiston Drain, Sizewell Drain, IDB Drain No.7, Sizewell Marshes, Sizewell Belts and the Minsmere South Levels. There are mechanisms for the proposed development to impact upon Minsmere New Cut itself, but it is expected that these impacts would not be significant. If the surface water study shows that these changes will not be minimal, then the surface water study area will be extended to include other impacted surface water units.

The configuration and operation of the Minsmere Sluice means that, under normal conditions, there is no mechanism for the proposed development to impact upon the surface water receptors that are located to the north of Minsmere New Cut, namely the Minsmere Old River, Dowleys and North Levels, Island Meer Old Reed Beds, Lowered Reed Beds, The Scrape and Eastbridge Meadow. **Volume 2, Appendix 19B** of the **ES** states that, although a hydrological link between the two watercourses cannot be categorically dismissed, "*the potential for measurable hydrological impact on either side of the sluice is minimal*". Furthermore, small changes to baseflow volumes of the magnitude currently predicted are "*extremely unlikely*" to result in any measurable changes to the operation of the sluice (Ref. 1.1).

The scheme will include in-built control measures, such as construction phase water management zones (WMZ), an operational phase drainage system and a foul water management strategy for the construction and operational phases, designed to minimise the potential for impact on the surface water environment, in terms of both flow and chemical quality.

1. Surface Water Conceptualisation Model

1.1 Introduction

1.1.1 This report, which presents an overview of the surface freshwater receptors that potentially could be affected by the Sizewell C main development site, is based on the Royal Haskoning 2015 report (Ref. 1.2), with some updates where required due to more recent legislation or data availability.

a) Project context

1.1.2 The development of the Sizewell C power station has the potential to cause a range of direct and indirect changes to the surface water environment. The proposed development would require extensive earthworks and ground disturbance and changes to land use. In addition, the proposed development may require changes to the way surface water drainage and groundwater are managed, in an area that is currently heavily managed by an intricate system of sluices and drains. These changes could impact upon surface water hydrology, water quality, geomorphology and hydroecology (both aquatic and terrestrial).

1.1.3 The surface water environment surrounding the proposed Sizewell C site (**Figure 19E.1**) supports sensitive water-dependent habitats that are of national and international importance. The area to the south and west of the site is located within the Sizewell Marshes SSSI, while the area to the north is located within the Minsmere to Walberswick Heaths and Marshes SSSI, SPA, SAC, and Ramsar site.

1.1.4 Any changes to the freshwater environment and the habitats it supports therefore need to be investigated in detail and, where necessary, measures to mitigate potential impacts considered. This report represents a conceptual understanding of the baseline environment and the potential changes the proposed development may have and is intended to inform the impact assessment studies (Environmental Impact Assessment (EIA), Habitats Regulations Assessment (HRA), and WFD Compliance Assessment).

b) Purpose of this report

1.1.5 This report presents an overview of the surface freshwater receptors that potentially could be affected by the Sizewell C main development site. It includes a description of the baseline hydrology, geomorphology, water quality and ecology, and a conceptualisation of how the site functions, and to what extent, if any, it can be impacted by the proposed development.

1.1.6 This report also includes a description of the main activities during the construction and operational phases that potentially could result in impacts to surface waters and defines the geographical extent of the surface water environment that could be affected by these impacts.

1.1.7 The final section of this report considers the potential issues (impacts) and provides an initial discussion regarding the way in which these issues will be assessed. In addition to analysis undertaken specifically for this topic, this report also references relevant outputs from the groundwater and ecology topic areas.

1.1.8 Various consents, permits and licences may be required from the Environment Agency, Natural England and the Internal Drainage Board (IDB) prior to and during the proposed development. This report will form part of the evidence base to obtain them.

c) Report structure

1.1.9 The report is divided into six sections:

- **Section 2** (this section) provides a description of the purpose of this report.
- **Section 3** provides a summary of the sources of information used to inform the development of this report.
- **Section 4** provides a summary of the baseline environment, including hydrology, geomorphology, water quality and ecology.
- **Section 5** considers mechanisms for potential impact from the Sizewell C development on surface waters and defines the receptors that may be affected by the proposed development.
- **Section 6** presents a conceptual model of how the surface water system functions and how it could be impacted by the proposed development.
- **Section 7** provides an overview of the proposed approach to assessing potential impacts on surface water receptors.

1.2 Sources of information

a) Purpose of this section

1.2.1 This section presents a summary of the sources of data that are referenced in this report.

b) Previous studies

1.2.2 The baseline characteristics of the surface water receptors presented in this section were identified using the key data sources listed in **Table 1.1**. In addition to these data, information available from other Sizewell C Project topic work streams, including the Flood Risk Assessment, ecology and groundwater topics, was used. References to individual studies are provided throughout the text where necessary.

Table 1.1: Sources of data used to inform this report.

Data Set / Type.	Data Source.
Field survey.	Walkover survey of the Sizewell Belts and Marshes undertaken on 10 July 2014. Walkover survey of the Minsmere site undertaken on 22 October 2014.
Mapping	District level surface water maps for Suffolk Coastal and Ipswich areas. Ordnance Survey base mapping (MasterMap vector mapping and 1:10,000 and 1:25,000 raster mapping). Cranfield Soil and AgriFood Institute soil maps (Ref. 1.3). British Geological Survey (BGS) solid and superficial geology mapping (Ref. 1.4). Environment Agency LiDAR data. Environment Agency "What's in my backyard?" website (Ref. 1.5). Environment Agency Catchment Data Explorer (Ref. 1.6).
Hydrological data.	Surface water logger monitoring results and site visits reports for January to July 2014 (Ref. 1.7, Ref. 1.8, Ref. 1.9, Ref. 1.10, Ref. 1.11 and Ref. 1.12). Surface water flow gauge installation reports (Ref. 1.13, Ref. 1.14, Ref. 1.15, Ref. 1.16, Ref. 1.17 and Ref. 1.18). Aldhurst Farm Habitat Creation Scheme Feasibility and Conceptual Design Report (Ref. 1.19). Minsmere Sluice Analysis of Outfall Capacity (Ref. 1.20). Flood Risk Assessment (FRA) Scoping Report: Sizewell C Nuclear New Build (Ref. 1.21). Environment Agency flow data from the Middleton gauging station. Aldhurst Farm Habitat Creation Scheme Planning Application (December 2014). Sluice Inspections: Minsmere (Ref. 1.22).
Hydrogeological data.	Groundwater level monitoring data collected between April 2011 and March 2012 (Ref. 1.23). EIA Scoping Report (Ref. 1.24). Envirocheck Datasheet for SSSI habitat replacement feasibility study (Ref. 1.25). Updating, Extension and recalibration of groundwater and surface water models in the vicinity of Sizewell power station, Suffolk (Ref. 1.26). AMEC 2012 Summary of Groundwater Quality data (Ref. 1.27).

Data Set / Type.	Data Source.
	Aldhurst Farm Habitat Creation Scheme Planning Application (December 2014). Atkins Conceptual Site Model of the Hydrogeological Regime (Revision 5). East Suffolk Abstraction Licensing Strategy (Ref. 1.28).
Geomorphological data.	Sizewell Watercourse and Floodplain survey (Ref. 1.29).
Water quality data.	Terrestrial surface water quality monitoring campaigns carried out in 2012-2013. AMEC Spreadsheets summarising the quality control checks and corrections AMEC for December 2013, and January and February 2014. AMEC Spreadsheets containing raw data downloaded during monthly monitoring visits in January February and March 2014.
Consultation	Consultation with land managers (Ref. 1.30): • SWT 28 January 2014,18 June 2014, 24 April 2015 and 20 June2015 (consultation is still ongoing). • Royal Society for the Protection of Birds (RSPB) 22 of October 2014, and 21 June 2015 (consultation is still ongoing). • Stakeholder workshop held on 25 March 2015 to discuss the initial conceptualisation presented in the first draft of this document. Correspondence: • Letter 'Sizewell C – Surface Water EIA/HRA Workshop' – Environment Agency 14 April 2015. • Letter 'Sizewell C Evidence Plan Surface Water Topic Group' – RSPB 15 May 2015. • Email 'SZC Surface Water Conceptualisation Workshop - NE response' – Natural England 15 May 2015. • Letter 'Sizewell C: Defra single voice – surface water workshop responses' - Environment Agency 14 August 2015.

1.3 Surface water baseline environment

a) Purpose of this section

1.3.1 This section provides a description of the terrestrial surface water environment within the wider study area around the Sizewell C Project. This includes a description of the baseline hydrology, geomorphology, water quality and ecology.

b) Definitions

1.3.2 The Environment Agency divides surface waters into two broad categories:

- Main rivers are larger watercourses that have been identified as being important by the Department for Environment, Food and Rural Affairs

(Defra). Although main rivers are usually larger streams and rivers, smaller watercourses of local significance may also be assigned this status. Main rivers are managed by the Environment Agency and are marked on an official document called the main river map which can be found at Environment Agency local offices. Main rivers can include any structure that controls or regulates the flow of water in, into or out of the channel. There are two main rivers in the study area: Leiston Drain and Minsmere River.

- Ordinary watercourses are every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows, but which does not form part of a Main river. The local authority or IDB has powers on ordinary watercourses are similar to the Environment Agency's powers on main rivers. The surface drainage channels in the study area are ordinary watercourses, with the exception of the two Main rivers.

1.3.3 These definitions are used in the subsequent descriptions of the surface water network and the definition of surface water receptors later in this section.

c) Study area

1.3.4 For the purposes of this report, the study area has been initially defined as the surface water drainage network that surrounds the proposed development site (**Figure 19E.1**). All the surface water receptors that potentially could be impacted by the development (either directly as a result of changes to surface hydrology, geomorphology or water quality, or indirectly as a result of changes to groundwater) have been included at this initial stage. The remainder of this section summarises the baseline conditions observed in the study area.

d) Physical controls

1.3.5 The form and behaviour of a river catchment is determined by the complex interaction of water with physical controls such as topography, solid and superficial geology, and soils. It is important that the physical baseline of a river catchment is well understood so that the functionality of the system can be characterised and a conceptual model developed.

i. Topography

1.3.6 The topography of the area surrounding the Sizewell C development site is that of a low lying coastal plain. Elevation is highest in the west of the area (c.15 metres Above Ordnance Datum (m AOD)), and gently declines in an easterly direction towards the coast (less than 5m AOD).

1.3.7 A large proportion of the coastal plain consists of the low, flat valleys of Leiston Drain and the Minsmere River, which are divided by a promontory of higher ground that extends close to the sea (Goose Hill). The valley of Leiston Drain and a historic tributary (now an IDB-maintained drain) contain Sizewell Marshes to the south and Sizewell Belts to the north (both of which form part of Sizewell Marshes SSSI; see **section 1.4h** of this chapter for details), divided by slightly higher ground at Leiston Common. The marshes are separated from the sea by an area of higher ground along the coast, occupied by the existing Sizewell A and B stations.

ii. Solid and superficial geology

1.3.8 The solid geology of the area is dominated by Quaternary rocks of the Crag Group, which consist of a series of marine and estuarine sands, gravels, silts and clays. This is underlain by a layer of Palaeogene deposits from the Harwich and Lambeth Groups, below which the chalk is located. The bedrock dips towards the south east.

1.3.9 The solid bedrock is overlain by the Quaternary Lowestoft Formation, which consists of sands, gravels, and, on higher ground, glacial diamicton. The river valleys are infilled with Quaternary peat deposits, and the lower reaches are underlain by fine grained (dominated by silts and clays) tidal flat deposits that fringe the coast. Finally, a layer of coarse beach deposits (dominated by sands and gravels) is exposed along the coastline.

1.3.10 The peat that underlies Sizewell Marshes has an average thickness of between 3m and 4m, and contains a variable proportion of clay, silt and sand in a matrix of highly organic soil. The thickest deposits of approximately 8m to 10m are located directly adjacent to the proposed Sizewell C site and become thinner towards the west. The peat deposits have become locally compacted as a result of the emplacement of made ground during the development of the Sizewell A and B stations.

iii. Soils

1.3.11 The England and Wales Soil Map shows that the soil across the site is Newport 3 (551f). This soil is described as generally deep well drained sandy and coarse loamy soil. However, in some areas the soils are coarse and fine loamy soils with slowly permeable sub-soils and slight seasonal waterlogging.

e) Hydrology

i. Overview of surface drainage

1.3.12 The hydrology of the study area, or its response to rainfall events, is governed by the physical controls described in **section 1.4d** of this chapter. Catchment topography is frequently the primary control. Depending on catchment gradient, hydrology may be categorised as either ‘upland’ or ‘lowland’.

1.3.13 The upland hydrology describes the response of the catchment to rain falling on steeper ground, where rainfall typically drains to streams and channels, before discharging to larger watercourses or main rivers.

1.3.14 The lowland hydrology describes the response of the catchment to rain falling on the low lying, virtually flat areas of the catchment, such as the Sizewell Belts and Minsmere Levels. These areas are drained by a network of interconnecting drains, manually controlled and regulated by the operation of over 100 control structures, such as sluiced pipes, syphons and stop boards. Lowland drainage may be sub-divided into smaller flood cells or drainage units. Drainage units receive water either in the form of baseflow as a result of high groundwater levels, direct rainfall, run-off from adjacent higher ground, or overspill from water exceeding the capacity of the drains that flow through them.

1.3.15 Due to the hydrogeology of the area, surface waters are strongly influenced by the water level and flow within the groundwater system, provided in **section 1.4iii** of this chapter. Monitoring of groundwater levels within the study area shows that the groundwater system responds quickly to rainfall and that there is a strong hydraulic connectivity between the groundwater and surface water systems.

1.3.16 Surface water drainage in the area is dominated by two main river systems that both discharge to the sea at Minsmere Sluice, to the north of the proposed Sizewell C development (**Figure 19E.2**):

- The Leiston Drain system, which is located to the west of the Sizewell C site. Leiston Drain rises near Abbey Road in Leiston, from where it flows in an easterly direction until it reaches Lover’s Lane (note that this reach is also referred to as Aldhurst Valley Stream, to denote the section upstream of its confluence with discharge from Leiston STW). The drain continues to flow east through Sizewell Belts and Marshes. From here, it flows in a northerly direction in an artificial channel along the coast until it discharges into the sea at Minsmere Sluice. The natural outlet for the watercourse is likely to have been considerably further south, although this is not shown on the First Edition Ordnance Survey mapping of the areas (dated 1884).
- The Minsmere River system, which is located to the north of the Sizewell C site. The Minsmere River rises as the River Yox, to the north west of Saxmundham. From here, it flows in an easterly direction towards Yoxford, downstream of which it is renamed the Minsmere River. It continues to flow in a south easterly direction through

Middleton and Eastbridge, where it enters the extensive Minsmere wetland system. Flow becomes divided between the Minsmere New Cut, an engineered channel which drains into the sea at Minsmere Sluice, and the Minsmere Old River, the remnant of the natural channel which joins the New Cut just upstream of the sluice.

ii. Water level and flow monitoring

1.3.17 There is a gauge on the Minsmere River at Middleton (upstream of the study area), which has provided recorded level data since 1977. Up until 1993, data were recorded at hourly intervals and since 1993 levels have been recorded at 15-minute intervals. The level data record is converted to a flow record using a rating curve; however, the Environment Agency advises that this is only applicable for lower flow conditions. The Environment Agency, which operates and maintains the gauge, has also stated that due to bypassing at higher flows and uncertainties in the levelling of the gauge datum, data recorded at the Middleton gauge should be used with caution. The gauge data does, however, provide useful information about the response of the catchment to rainfall events, such as the timing and shape of the responding flood hydrograph.

1.3.18 In order to provide further understanding of the water levels and flows within the Sizewell Marshes SSSI, a programme of flow monitoring at six locations has been in place since December 2013 (**Figure 19E.3**). The monitoring locations and initial results are presented by AMEC (**Table 1.2**). The rationale for the location of gauges was agreed in advance with the Environment Agency and is taken from **Volume 2, Appendix 19B** of the **ES** as follows:

- G5: Upstream location to monitor surface water flows in the Sizewell Marshes SSSI through the Leiston Drain.
- G3 and G4: Flows are then monitored at control structures (weirs) that determine the partitioning of flow between the north arm of the Leiston Drain (G4) and the southern arm of the Leiston Drain (G3).
- G6a and G7a: Flows are monitored downstream in the Leiston Drain north arm (G6a) and in the Leiston Drain southern arm downstream of the confluence with Sizewell Drain (G7a).
- G1: The total outflow from the Sizewell Marshes SSSI.
- G8: A new monitoring point was installed during the week commencing 2 March 2015 on the downstream reaches of Leiston Drain. The position of this monitoring point was also agreed in advance with the Environment Agency.

1.3.19 Gauges G3 and G4 are fixed weirs, recording water levels which are subsequently converted to flows through use of a rating equation. The other gauges record channel velocity and water level, enabling a direct calculation of flows.

1.3.20 Groundwater levels for Sizewell C and the surrounding area were initially monitored by AMEC in 2010 to 2011. The monitoring network was significantly expanded in 2012 and 2013 to incorporate piezometers in the peat within the Sizewell Marshes SSSI and four paired boreholes to monitor groundwater levels in the shallow and deeper parts of the crag.

1.3.21 From October 2013 groundwater levels have been monitored at 61 locations within the Sizewell C site and surrounding area. Piezometers that record data at 15-minute intervals are installed at 43 of these locations. In August 2014, five monitoring locations were added to the groundwater monitoring network in order to provide coverage of the area to the north of the Sizewell Marshes SSSI. Monitoring is scheduled to continue through the rest of 2015.

1.3.22 Initial analysis of the data obtained from the monitoring network outlined above has been used in determining the hydrological baseline. This is particularly of use in generating an understanding of the groundwater system and its interaction with the surface water drainage system.

iii. Surface water receptors

1.3.23 This section describes each component of the surface water baseline in the study area. A discussion of the potential mechanisms for impact and the spatial extent of potential impact are provided in **section 1.5** of this chapter.

1.3.24 The surface water receptors are listed below and shown in **Figure 19E.2**:

- Leiston Drain.
- Minsmere New Cut.
- Minsmere Old River.
- IDB Drain No.7 (IDB Drain DRN163G0101).
- Sizewell Drain (IDB Drain DRN163G0202).
- IDB Drain DRN163G0201.
- Scott’s Hall Drain.
- Sizewell Marshes.
- Sizewell Belts.

- Minsmere South Levels.
- Island Meer Old Reed Beds.
- Dowleys and North Levels.
- Lowered Reed Beds.
- The Scrape.
- Eastbridge Meadow.

1.3.25 The baseline characteristics of each of the watercourses and drainage units identified above are outlined below. The hydrological data that were used to establish these baseline conditions are listed in **Table 1.2** (Hydrological Data).

f) Leiston Drain

1.3.26 Leiston Drain drains a total catchment area of approximately 12 kilometres squared (km^2). The higher ground that surrounds Sizewell Belts, including the urban area of Leiston, accounts for $10.5km^2$ of this area. The remaining $1.5km^2$ of the catchment consists of a lowland drainage system, which makes up the Sizewell Belts drainage unit.

1.3.27 The Leiston Drain system provides a relatively small hydrological input to the study area. According to estimations made by Flood Study of River Minsmere and Leiston Drain, Suffolk (Ref. 1.31) as part of flood risk study the Leiston Drain system represents approximately 4.4% of the total contributing catchment identified by (**Table 1.2**). It should be noted that the figures quoted in **Table 1.2** were derived for the 1 in 10-year flood rather than non-flood flows, and that they are representative of inflows to the study area rather than flows at the downstream limit of each sub-catchment.

1.3.28 Estimates of flow and relative contribution using the Low Flows Enterprise package are presented in **Table 1.2** and **Table 1.3** below. These provide an improved indication for non-flood flows. However, the Low Flows Enterprise package assumes a net balance of groundwater contribution across the catchment, which can introduce significant errors in small catchments especially where groundwater influence is significant. These estimates are for natural flows (i.e. those derived from rainfall and groundwater inputs) and do not include contributions from the STW. According to these estimations the Leiston Drain system represents approximately 14% of the total contributing catchment.

Table 1.2: Estimates of flow into the study area.

Watercourse	Minsmere River.	Leiston Drain.	Sizewell Drain.	Scott's Hall Drain.
Catchment area (km^2)	65.2	7.71	3.77	2.1
Baseflow index	0.45	0.81	0.88	0.89
Min flow (m^3/s)	0.05	0.015	0.005	0.003
Q95 (m^3/s)	0.065	0.017	0.008	0.004
Q70 (m^3/s)	0.112	0.038	0.012	0.007
Mean flow (m^3/s)	0.31	0.056	0.018	0.01
Q10 (m^3/s)	0.67	0.087	0.031	0.015

Table 1.3: Estimates of relative contribution from different sub-catchments.

Watercourse	Minsmere River.	Leiston Drain.	Sizewell Drain.	Scott's Hall Drain.
Catchment area (%)	83	10	5	3
Min flow (%)	68	21	7	4
Q95 (%)	69	18	9	4
Q70 (%)	66	22	7	4
Mean flow (%)	79	14	5	3
Q10 (%)	83	11	4	2
Catchment area (%)	83	10	5	3

1.3.29 The Leiston Drain rises at Aldhurst Farm and drains the rural catchment to the north of Leiston. It is joined by a tributary which drains the urban area of Leiston to the south. This tributary receives the consented discharge from Leiston STW, which contributes a significant percentage of the total flow in normal conditions. Monthly spot flow was recorded at 16.5l/s to 62.5l/s. Measurement of daily total volume of final effluent at Leiston STW for the months March 2011 to December 2011 records between 13.7l/s and 33.4l/s. It is estimated that, during the gauged period, the percentage contribution of the final effluent to the total flow upstream of Lover's Lane over a 24-hour period ranged from 35% to 58%, with an average of 40%.

1.3.30 Based on information received from Environment Agency for the period from January 2005 to December 2011, the daily mean discharge from the Leiston STW was 1112 metres cubed (m^3), following a typical diurnal flow pattern. The maximum daily discharge from the facility noted during this period was 3497m^3 and minimum daily discharge was 0m^3. Periods with no discharge occurred on 10 occasions between 2005 and 2011 (1 – 7 April 2005, 14 May 2005 and 9 -10 June 2006) and may be attributable to maintenance at the

STW facility. If these values are removed, the minimum daily discharge recorded was 440m^3. There are also a number of combined storm overflows that surcharge through the STW and into Leiston Drain during periods of heavy rain. Both the STW and the combined storm overflows discharge via the surface drainage system into Leiston Drain at the same location. This is augmented by surface run-off from Leiston, which produces a peak in discharge during rainfall events.

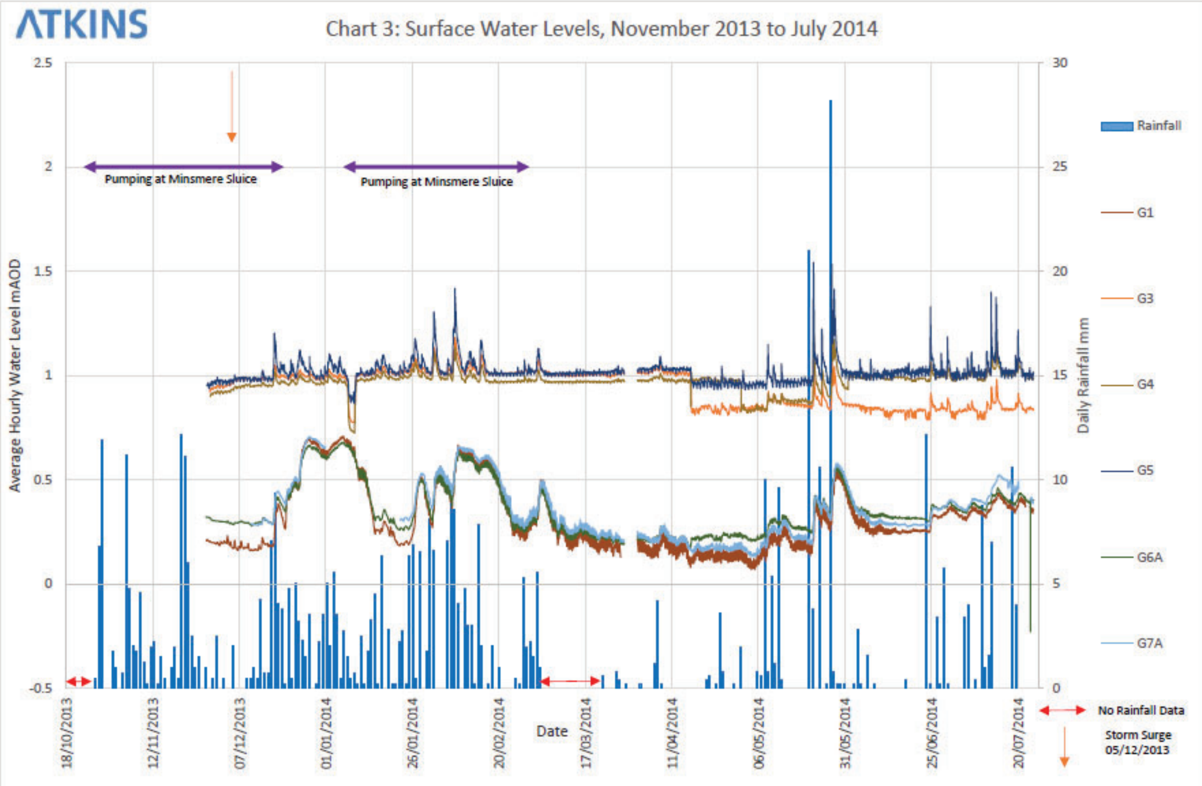
1.3.31 The discharge data above is based upon unvalidated data from the Environment Agency, for which the treated effluent component has not been separated. Higher frequency, validated data has been requested from Anglian Water Services who operate the STW, but at the time of writing these data have not been made available.

1.3.32 Leiston Drain has been subject to extensive modification and is classified by the Environment Agency as a main river downstream of Lover's Lane (note that the reach upstream of Lover's Lane is not classified as a main river). The channel can be described as uniform and trapezoidal in terms of profile and with very little differential gradient.

1.3.33 The consented discharge from Leiston STW contains higher levels of nutrients (including phosphates) than the rest of the drainage system. In order to reduce the ingress of nutrients into the wider drainage network, SWT have attempted to reduce connectivity between Leiston Drain and the drainage network on either side (Sizewell Belts and Sizewell Marshes) via the use of flow regulating structures.

1.3.34 Surface water monitoring at six gauging locations on the Leiston Drain and coincident rainfall data, for the period November 2013 to July 2014, are shown in **Plate 1.1**.

Plate 1.1: Temporary gauge surface water levels and daily rainfall.



1.3.35 **Plate 1.1** demonstrates that water level behaviour clusters into two groups:

- G5, G3 and G4: Gauges in the western (upstream) section of the Marshes, with a water level range of 0.9-1.2m AOD; and
- G6a, G7a and G1: Gauges in the eastern (downstream) section of the Marshes, with a water level range of 0.2-0.7m AOD.

1.3.36 **Plate 1.1** also shows that all six of the gauges respond quickly to rainfall. The influence of the cessation of temporary pumping at Minsmere Sluice during its refurbishment is evident in the three downstream gauges, but not the upstream gauges. This reflects the fact that groundwater inputs contribute more to surface water flows in the upstream part of the system, further details are provided in **section 1.4iii** of this chapter.

1.3.37 The Leiston Drain flows to the north to join the Minsmere New Cut at Minsmere Sluice. Further details about the operation of the sluice are provided in **section 1.4iii** of this chapter.

g) Minsmere new cut

1.3.38 The largest hydrological input to the study area (representing approximately 79%) is from the Minsmere River system (**Table 1.3**). The Minsmere River rises as the River Yox, to the north west of Saxmundham. From here, it flows in an easterly direction towards Yoxford, downstream of which it is renamed the Minsmere River. The Minsmere New Cut starts immediately downstream of the village of Middleton (upstream of the study area). The Minsmere New Cut, constructed in 1812, is a man-made, straight and highly uniform channel.

1.3.39 Between Reckford Bridge and Dam Bridge inflows enter the Minsmere New Cut from the north through a series of flapped sluices. These inflows include the catchment draining the area around Westleton, as well as the Eastbridge Meadow Drainage Unit. To the south of the Minsmere New Cut the lowland area is drained by the Minsmere Old River, which discharges to the Minsmere New Cut via a flapped sluice, 10m upstream of Dam Bridge.

1.3.40 Downstream of Dam Bridge, the embankments of the Minsmere New Cut are more pronounced, which contains flows within the channel downstream to its outfall at the Minsmere Sluice. There is a small triangular area of approximately 3ha of washland between the Minsmere New Cut and its southern embankment. The recent remedial bank reinstatement works on the Minsmere New Cut have included a number of changes including 996m of capping of existing asbestos piles, 220m of bank raising (typically between 1.24 and 1.41m AOD) and a combined 143m of erosion protection and reinstatement of collapsed piles to an elevation of 1.33m AOD. Approximately 100m upstream of Minsmere Sluice, the Minsmere New Cut is joined from the north by the Minsmere Old River, via a flapped sluice.

1.3.41 The Minsmere New Cut discharges to the North Sea via Minsmere Sluice. Further detail about the function, operation and impact of the Minsmere Sluice is provided in **section 1.4iii** of this chapter.

1.3.42 Level data from the Environment Agency's Middleton gauge (located approximately 3km upstream of the study area, near the village of Middleton) shows that during low flow conditions, water levels are approximately 1.6m AOD; 200 millimetres (mm) above the weir crest. Based on the Environment Agency's flow rating, this equates to a flow of 0.3m^3/s. Based on the 38-year record, the mean annual average water level is approximately 2.5m AOD, equivalent to a flow within the region of 6-9m^3/s.

1.3.43 The highest water level, 2.9m AOD, was recorded in February 2009, with an equivalent flow of approximately 19m^3/s. Anecdotal evidence from the RSPB suggests that flooding from the Minsmere New Cut occurs on an annual basis. This is currently being investigated further as part of the Flood Risk Assessment (FRA) for the Sizewell C development.

h) Minsmere Old River

1.3.44 The Minsmere Old River is the remnant of the course of the original Minsmere River, prior to construction of the Minsmere New Cut. Between Reckford Bridge and Dam Bridge, (to the south of the Minsmere New Cut) the Minsmere Old River is the main receiving watercourse of a complex lowland drainage system. As well as a natural groundwater fed baseflow, the Minsmere Old River receives water from tributaries entering the system from the south west, including two main IDB drains (DRN163G0401 and DRN163G0301) which drain the catchments surrounding Theberton.

1.3.45 The Minsmere Old River discharges to the Minsmere New Cut, via a flapped sluice, 50m upstream of Dam Bridge. Water is also able to pass beneath the road between Dam Bridge and the village of Eastbridge to the south via two culverts approximately 20m and 240m to the south of Minsmere New Cut, connecting the Minsmere Old River to the IDB Drain No. 7. Downstream of Dam Bridge, the course of the Minsmere Old River runs to the north of the Minsmere New Cut. The Minsmere Old River forms the boundary between the Dowleys and North Levels and Lowered Reed Beds drainage units, before ultimately discharging to the Minsmere New Cut, approximately 100m upstream of Minsmere Sluice. The Minsmere Old River receives water via flapped sluice outfalls from the Lowered Reed Beds and The Scrape drainage units.

1.3.46 The Minsmere Old River is fed via groundwater as well as direct rainfall. In flood conditions the Minsmere Old River is also fed by water spilling from the Minsmere New Cut to Eastbridge Meadow, from where it can pass through pipe openings under Dam Bridge to the north of Minsmere New Cut.

i) IDB Drain No. 7

1.3.47 IDB Drain No. 7 (also known as IDB Drain DRN163G0101) drains the Minsmere South Levels drainage unit to the south of Minsmere New Cut. IDB Drain No. 7 starts to the west of Eastbridge, upstream of Dam Bridge.

1.3.48 For most of its length the drain flows to the east, to where it joins the Leiston Drain 200m upstream of Minsmere Sluice. However, under normal conditions, the first 400m of the drain to the east of Dam Bridge flows westward, beneath Dam Bridge Road and empties into the Minsmere New Cut via the sluice just to the west of Dam Bridge ([redacted], SWT, pers. comm.; verified during a site visit in June 2015).

1.3.49 IDB Drain No. 7 is joined by Tank Drain, which drains the wide lowland area to the north of Goose Hill.

j) Sizewell Drain

1.3.50 Sizewell Drain (IDB Drain DRN163G0202) is the primary watercourse draining the Sizewell Marshes drainage unit. The drain originates at Sizewell village, immediately south of Sizewell A power station. The drain flows in a northerly direction along the landward toe of the power station platform, before joining the Leiston Drain to the north of the site of the proposed Sizewell C power station. The drain has a small catchment and contributes a very small proportion (5%) of flows to the study area (**Table 1.3**).

k) IDB Drain DRN163G0201

1.3.51 IDB Drain DRN163G0201 is a small watercourse that drains from the downstream (eastern) end of the small reservoir that is located in Sizewell Marshes. This is itself fed by flows from Leiston Drain. The drain flows in an easterly and north easterly direction until it joins Sizewell Drain.

l) Scott's Hall Drain

1.3.52 Scott's Hall Drain is located close to the coast, to the north of the Minsmere New Cut. The watercourse flows in a southerly direction before discharging into the sea via Minsmere Sluice, see **section 1.4iii** of this chapter for more detail. The drain has a catchment area of approximately 2km^2, and accounts for 3% of the contribution of discharge at Minsmere Sluice during mean flows (**Table 1.3**). This reduces to 0.3% during the 1 in 10-year flood.

m) Sizewell Marshes

1.3.53 The Sizewell Marshes drainage unit covers the network of drains (including Sizewell Drain) to the west of the Sizewell power station platform. The Sizewell Marshes receives water from the catchment draining the higher ground to the south and south-west, to the east of Leiston.

1.3.54 Water in the Sizewell Marshes drains under gravity to the Leiston Drain. The rate of discharge is therefore controlled by water levels in the Leiston Drain, which in turn is governed by tide-locking and the capacity of the Minsmere Sluice. Flows are generally very low, and changes to water levels occur in synchronicity with changes in groundwater levels.

1.3.55 Water levels in the Sizewell Marshes are managed via a series of sluices in the surface water channels. Between October/November and May, marsh ditches are filled with water and most of the fields are waterlogged. At other times the ditches have variable levels of water in them but generally are half to two thirds full and the fields, although no longer waterlogged, are near field capacity. They can also be dry around the southern margin of the marsh. Within the marshes there are large numbers of drainage channels which can be described as artificial trapezoidal channels with high water levels and no discernible flow.

n) Sizewell Belts

1.3.56 The Sizewell Belts drainage unit receives water from run-off from the catchment draining to the Leiston Beck and higher ground to the west of Kenton Hills and Leiston Common. The Sizewell Belts are also fed by direct rainfall and baseflow from groundwater. Groundwater-surface water interactions are important within this drainage unit, with surface waters contributing to groundwater in upstream parts of the unit and groundwater contributing to surface waters downstream, for futher details see **section 1.4iii** of this chapter.

1.3.57 Water levels in the Sizewell Belts are controlled by a series of interconnecting drains, which ultimately discharge to the Leiston Drain. During periods of heavy rainfall, drainage from the Sizewell Belts is reliant upon the capacity of the drainage system to store additional water, as well as water levels in the Leiston Drain. Water levels across the site are heavily managed.

o) Minsmere South Levels

1.3.58 The Minsmere South Levels drainage unit represents the large area to the south of the Minsmere New Cut. Water enters the drainage unit either in the form of direct rainfall or baseflow from high groundwater levels. Run-off from the higher ground to the west and southwest is intercepted by a toe drain on the western fringe of the drainage unit, from where it is discharged to the IDB Drain No. 7. Water is drained from the Minsmere South Levels via a network of interconnected drains, which also lead to IBD Drain No. 7. The western side drains to IDB Drain No. 7 via Tank Drain and the eastern side drains to IDB Drain No. 7 via an RSPB boundary ditch. IDB Drain No. 7 ultimately discharges through gravity into the Leiston Drain. The rate of discharge is therefore largely dependent upon water levels in the Leiston Drain.

1.3.59 When flooded, the Minsmere South Levels create additional habitats for bird species. This area is managed to create a balance of habitat diversity that provide both valuable wet and flooded habitat types.

p) Dowleys and North Levels

1.3.60 The Dowleys and North Levels drainage unit is bounded to the north by the Minsmere Old River and to the south by the Minsmere New Cut. The drainage unit is effectively a closed system, with inflows mainly entering the drainage unit from direct rainfall. Water can also enter the drainage unit during flood events, via overtopping of the Minsmere New Cut or Minsmere Old River. Overtopping from the Minsmere New Cut is now less likely, following bank reinstatement work undertaken by the Environment Agency.

Topographic survey of the new bank height is planned for October 2015. Until that is completed, it is assumed that the lowest levels are 1.21m AOD (taken from as-built drawings of the refurbishment ref 019417-0031AB).

q) Island Meer Old Reed Beds

1.3.61 The Island Mere Old Reed Beds is located downstream of Dam Bridge, to the north of the Minsmere Old River. The Island Mere Old Reed Beds are separated from the Minsmere Old River by a narrow swathe of land which forms part of the Lowered Reed Beds. An embankment along the southern boundary separates the two drainage units; this was formed during the excavation of the Lowered Reed Beds by the RSPB.

1.3.62 As well as direct rainfall, the Island Meer Old Reed Beds drainage unit receives water from run-off from the higher ground to the north, draining areas such as Saunders Hill, Vault Hill and the area around Scott's Hall Farm to the south of Sheepwash Lane. The interconnected network of ditches drains water to the east, where it passes through a series of sluices into the Lowered Reed Beds drainage unit.

1.3.63 The RSPB manage water levels within an approximate 0.4m range between spring and winter. Bitterns nest just above the 'normal' (i.e. non-flood) water level. Prior to the onset of flooding, water levels are lowered, in order to provide flood storage capacity. Water levels are held high in the breeding season to prevent nesting at low levels, in order to reduce the risk of nests being destroyed in flood events.

r) Lowered Reed Beds

1.3.64 The Lowered Reed Beds drainage unit is situated immediately north of, and is in hydraulic connectivity with, the Minsmere Old River. The Lowered Reed Beds are separated from higher ground by other drainage units, with the exception of a short length to the south of the RSPB Visitor Centre. The drainage unit receives water in the form of direct rainfall, baseflow from high groundwater levels, or from overtopping of adjacent drains. Drains within the Lowered Reed Beds direct flow to the east to the Minsmere Old River via sluices at the eastern boundary of the drainage unit.

s) The Scrape

1.3.65 The Scrape is located immediately to the north of Minsmere Sluice and is fed by groundwater and direct rainfall. Water can both drain out of and be received via the Scott's Hall Drain, which discharges into Minsmere Sluice. Opening the penstock on Scott's Hall Drain at the Minsmere Sluice complex allows saline intrusion at high tide, in order to create brackish water in The Scrape (when separate sluices into the Scrape are also opened).

1.3.66 Whilst considered as one drainage unit, The Scrape is actually formed of four individual ponds, (North Girder, East Scrape, West Scrape and East Waltons). The RSPB can manage water levels in these ponds independently of each other. However, under normal flow conditions there is little or no change in the water level throughout spring – summer and autumn – winter (although there are differences between the two). Water levels are held higher in the winter than in the summer in order to benefit wintering wildfowl.

t) Eastbridge Meadow

1.3.67 Eastbridge Meadow drainage unit is a cell to the north of the Minsmere New Cut, immediately upstream of Dam Bridge. Eastbridge Meadow receives run-off from higher ground to the north. Eastbridge is one of the first locations to flood from the Minsmere New Cut. During flood events water can pass beneath Dam Bridge and join the Minsmere Old River. Under normal conditions water discharges to the Minsmere New Cut via a flapped sluice structure, known as Mulberry Sluice No. 2.

u) Minsmere Sluice

i. Overview

1.3.68 The Minsmere Sluice is located at the downstream end of the Minsmere New Cut, where it forms the interface between the freshwater drainage system and the sea. The structure is the gravity outlet for all of the surface drainage from the Minsmere river system, the Leiston Drain system, and Scott's Hall Drain system (**Figure 19E.4**). It becomes tide locked during periods of high tide.

1.3.69 The sluice comprises a chamber fed by a total of four inlets and two outlets with a central divide wall as shown in **Figure 19E.4**. The chamber receives water from three watercourses:

- The Minsmere New Cut from the west (from which there are two openings).
- Leiston Drain from the south.
- Scott's Hall Drain from the north.

1.3.70 The sluice was constructed in the 19th Century and has been modified on a number of occasions in order to manage drainage within the catchment. The most recent of these changes occurred as part of the remedial work undertaken by Black and Veatch on behalf of the Environment Agency in 2013/14, in order to improve the durability and operation of the structure.

1.3.71 The nature of this remedial work has been investigated through consultation with the Environment Agency and a review of design drawings which is ongoing. It is important to understand how the sluice operates and how the operation has been affected by the remedial works, because it is fundamental to understanding the hydrology of the catchment. It is also key to assess the extent to which changes in the Leiston Drain and Sizewell Drain may affect the hydrology of Minsmere New Cut and Scott's Hall Drain.

ii. Functionality of Minsmere Sluice

1.3.72 The sluice chamber is divided into two sub-chambers by a central wall (**Plate 19.1**) at an elevation of 1.19m AOD, which has been designed to keep flows separate during low flows (although overtopping can occur during flood flows and high tides).

1.3.73 The northern chamber receives flows from the northern culvert of the Minsmere New Cut. The southern chamber is also connected to the Minsmere New Cut through its southern culvert, which includes a penstock at its upstream face and a newly fitted flapped outlet into the chamber (shown in the foreground on **Plate 1.2**). Anecdotal evidence (Ref. 1.32) suggests that the penstock on the southern culvert was not opened frequently for a number of years prior to the refurbishment of the sluice. In the winter of 2014/2015, it was opened for a period of several weeks to alleviate high water levels in the catchment. Flows from the Minsmere New Cut discharge into the northern chamber unless they are sufficiently high to overtop the central wall and enter the southern chamber, i.e. within the range of normal conditions Minsmere New Cut does not discharge into the southern chamber.

1.3.74 The southern chamber receives flow from the flapped Leiston Drain culvert (**Plate 1.3**) and a syphon draining the Scott's Hall Drain (from the north) under the northern chamber.

Plate 1.2: Minsmere New Cut tidal flap values and chamber dividing wall.

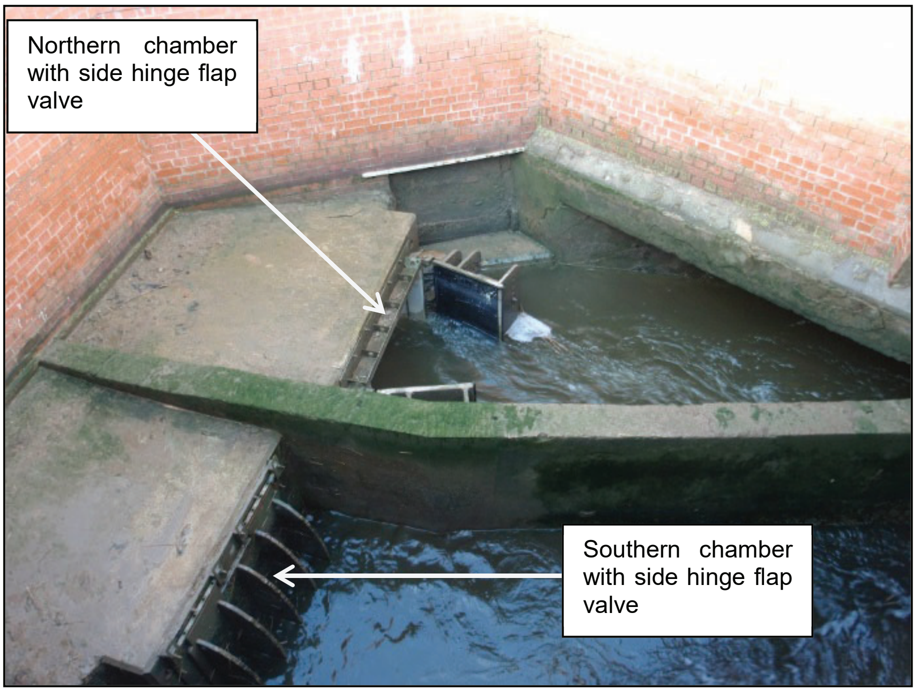
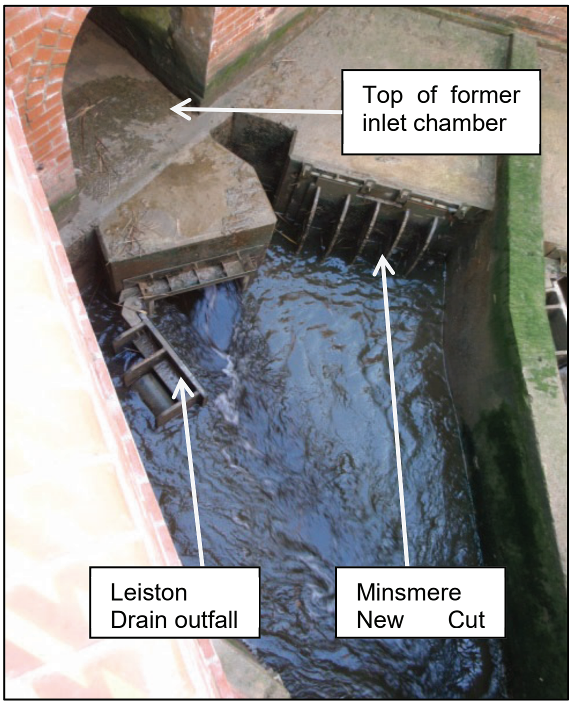


Plate 1.3: Leiston Drain and southern Minsmere New Cut flapped outfalls.



1.3.75 Under non-flood flow conditions (i.e. when flows are contained within the channel), the northern chamber of the Minsmere Sluice drains through a 1500mm diameter outlet, and the southern chamber discharges through a

1200mm diameter outlet. Both outlets 'dog-leg' approximately 50m to the outfall into the North Sea.

1.3.76 During flood conditions in any one or more of the catchments, water is able to overtop the central dividing wall between the chambers (**Plate 1.4**) and discharge via both outlets, which effectively increases the drainage capacity of the sluice. This increases water levels in the southern chamber, which allows the flaps on both the Leiston and Scott's Hall drains to close more easily. Depending on the scale and duration of a flood event in the Minsmere catchment, drainage of the Leiston and Scott's Hall systems may take several days.

iii. Operation pre-remedial works

1.3.77 Prior to the remedial works undertaken in 2013/14, the structure was in poor condition (**Plate 1.3**). The gates and penstock did not seal properly, and access into the confined space made maintenance difficult.

1.3.78 The poor condition and arrangement of the Leiston outfall previously allowed uncontrolled ingress of water overtopping the central wall from the Minsmere New Cut or from high tide levels due to the omission of an operational non-return valve.

Plate 1.4: Leiston Drain flapped outfall, prior to remedial work (JBA, 2013).

iv. Remedial works

1.3.79 The completed works at the sluice are recorded in a number of Environment Agency drawings (Drawing number 109417- 0015).

In addition to structural changes to make the structure more durable, the old top hinged flap valves were replaced with more modern side hinged flap valves. Although there is no significant hydrological difference between these two flap types, side hinge flap valves are often favoured as damper systems can be installed to reduce their rate of closure, allowing them to stay open longer to allow fish or water to pass through. The closure rates of the flap valves could potentially be adjusted (with dampers or by tightening hinges) and fine-tuned by adding more weight to the gate.

1.3.80 The new Leiston Drain flapped outlet has been designed to allow for a slow rate of closure that can allow a short period of saline intrusion at high tide; however, the flap can be adjusted to manage the rate and volume of ingress. It is understood from the RSPB that this arrangement of the Leiston outfall is designed to maintain the important brackish-freshwater transition in the Minsmere South Levels drainage unit. This is a key objective of the drain arrangement, as saline intrusion into the watercourses must be controlled to preserve the important designated habitats. In addition, the Scott's Hall Drain syphon includes an eel-friendly flap valve and penstock that can be lifted to allow sea water into the RSPB reserve so that salinity levels and brackish water can be managed effectively.

1.3.81 **Table 1.4** shows the key dimensions of the sluice both before and after completion of the remedial works. The pre-remedial work geometries have been taken from the existing Environment Agency model which is based on two previous sets of drawings. It is understood that the dimensions of the Scott's Hall Drain culvert in the model were taken from the upstream culvert, rather than the smaller syphon component of the structure.

v. How changes have affected the Leiston Drain and the Sizewell Drain

1.3.82 The information contained in **Table 1.4** indicates that the geometry of the various components of Minsmere Sluice have changed due to the remedial work. The Minsmere New Cut northern culvert invert has been raised by approximately 100mm with the bore area of the culvert has been reduced by over 30% of its former capacity. The Leiston Drain culvert geometry has been modified with the invert level being raised by 200mm and the bore area has been reduced by over 40%. The differences in the geometry shown for the Scott's Hall Drain culvert are due to the current Environment Agency model utilising the dimension of the culvert upstream of the penstock, the post remedial levels are those of the downstream section of the culvert. The upstream invert level is now 1m lower because a part of the former structure no longer exists.

Table 1.4: Minsmere Sluice geometry: pre and post remedial works.

Chamber	Structure.	Pre-Remedial Work Dimension	Post Remedial Work Dimension	Post Remedial Work Source of Information.
North	**Minsmere (North) – North chamber outlet**			
	Width	1.645m	1.290m	Drawing 109417 - 017AB
	Height	1.524m	1.290m	Drawing 109417 - 017AB
	US Invert	-0.767m AOD	-0.650m AOD	Drawing 109417 - 017AB
	Throat Invert	-0.768m AOD	-0.650m AOD	Drawing 109417 - 017AB
	DS Invert	-0.881m AOD	-0.650m AOD	Drawing 109417 - 017AB
Dividing wall.	**Chamber wall**			
	Length	5.610m	5.610m	Same as previous model as no length given on drawings
	Level	1.073m AOD	1.190m AOD	1907417-0017AB Minsmere sluice sections of new cut culverts 1 of 2
South	**Minsmere (South) – South chamber (not operated – penstock)**			
	Width	1.393m	0.990 m	Drawing 109417 - 017AB
	Height	1.523m	1.290 m	Drawing 109417 - 017AB
	US Invert	-0.695m AOD	-0.650 m AOD	Drawing 109417 - 017AB
	Throat Invert	-0.697m AOD	-0.650 m AOD	Drawing 109417 - 017AB
	DS Invert	-0.799m AOD	-0.650 m AOD	Drawing 109417 - 017AB
	Leiston Drain – South chamber			
	Width	0.919m	0.695 m	Drawing 109417 - 0015AB
	Height	1.285m	1.000 m	Drawing 109417 - 0015AB
	US Invert	-0.740m AOD	-0.550 m AOD	Drawing 10941 - 0019AB
	Throat Invert	-0.741m AOD	-0.550 m AOD	Drawing 10941 - 0019AB
	DS Invert.	-0.822m AOD	-0.550 m AOD	Drawing 10941 - 0019AB.
	Scott's Hall Drain – South chamber (syphon)			
	Width	1.128m	0.840 m	Drawing 122211.030.
	Height	1.113m	0.700 m	Drawing 122211.030.
	US Invert.	0.980m AOD	-0.110 m AOD	Current 1D model upstream cross section invert elevation as old structure (stop boards/weir) no longer exists.
	Throat Invert.	-2.088m AOD	-1.810 m AOD	Drawing 109417-0024AB.
	DS Invert.	-0.970m AOD	-0.910 m AOD	Drawing 10941 - 0019°.

1.3.83 After completion of the remedial works to the sluice, SWT noted that winter water levels (2014-15) in Sizewell Marshes were higher than they have previously been. This had been attributed by the Environment Agency to the presence of several blockages on Leiston Beck. Some blockages were removed by the Environment Agency at the start of week commencing 30 March 2015. Afterwards a gradual reduction in water levels was observed in monitoring data from the site. It should be noted that woody debris was observed in parts of the channel during the geomorphological walkover survey, further details provided in **section 1.4f** of this chapter, and it is therefore possible that similar blockages could occur again in the future as part of the natural functioning of the system.

1.3.84 The refurbished sluice, with fully operational non-return valves, prevents the ingress of water from the Leiston Drain system into the Minsmere New Cut and Scott's Hall Drain and vice versa. According to the Environment Agency (Ref. 1.33) it is possible that water could move upstream through the syphon into Scott's Hall Drain if the penstock was open, although this could only occur if the seaward end of the culvert was to become jammed open. Water from the Minsmere New Cut and Scott's Hall Drain could also potentially enter the Leiston Drain if the seaward outfall was blocked.

1.3.85 However, water levels would have to be considerably higher in one system than those in the other for a transfer of water between the systems to occur (i.e. this transfer would require very high levels in the Leiston system and very low levels in the Minsmere system). This is extremely unlikely to occur under normal conditions. In addition, this pathway would also require the penstock on Scott's Hall Drain to be open to allow water from Leiston Drain to pass upstream into the drainage units north of the Minsmere New Cut. This means that although there is a potential mechanism for water that enters the sluice chamber to pass upstream into the Scott's Hall Drain, this mechanism is reliant on head differences that are unlikely to occur under normal flow conditions. Even under such extreme conditions, which would occur rarely, if at all, there would be no passage of water from Leiston Drain to Scott's Hall Drain unless the penstock to Scott's Hall Drain is open. If it were to be open, it could be closed to prevent this occurring.

v) Groundwater

i. Groundwater units

1.3.86 As discussed previously in **section 1.4e** of this chapter, groundwater and surface water levels are closely related in parts of the catchment, with groundwater contributing to surface water flows and surface waters recharging groundwater. In their report, provided in **Volume 2, Appendix 19B** of the **ES**, Atkins has undertaken analysis of data from boreholes and piezometers within the study area. Groundwater has been identified in the following strata:

- Made ground, formed during the construction of Sizewell A and B, comprises a mixture of granular and cohesive material. Due to the variability in the lithological composition of the strata, it is considered that the groundwater in the made ground is in partial continuity with the underlying natural strata, and that the layers of cohesive material will act to delay the recharge to the underlying aquifers.
- Peat deposits are not classified as an aquifer by the Environment Agency. However, they are of significant importance to the hydrological regime of the study area, as they store and transmit water originating from groundwater, precipitation or surface water. Analysis of piezometer data shows that groundwater levels in the peat are within an average of 200mm of ground level. Groundwater levels in the peat appear to be laterally continuous and well connected across the Sizewell Marshes SSSI. The hydrographs produced for the peat piezometers show that the groundwater levels are highly responsive to rainfall, with peak groundwater levels corresponding with peak rainfall (Appendix C in Atkins, 2015). The groundwater levels in the peat were strongly influenced by the operation of the temporary pumps during the construction phase of the Minsmere Sluice refurbishment programme. All peat boreholes showed a gradual decline in groundwater level during the operation of the pumps and a rapid recovery in water levels following cessation of pumping. The piezometers closest to the Sizewell Drain (P1, P, P7, P10 and P11) responded greatest to the effects of the pumping, suggesting a high degree of connectivity between the surface water and peat groundwater system.
- Lowestoft Sand and Gravel is found on the higher ground to the west of the site and overlies the Red Crag strata. Based on the available data, it was not possible to differentiate groundwater trends in the Lowestoft sand and gravel from the Red Crag Formation, due to its similar lithology.
- The Red Crag Formation (crag) is designated by the Environment Agency as a principal aquifer, behaving as a storage medium for the chalk in the west of the study area. Towards the coast and in the vicinity of Sizewell C, Sizewell Marshes and Minsmere South Levels, the crag is confined / semi confined by Superficial Deposits. This confinement of the crag potentially restricts the upward flow of the groundwater into the upper shallow aquifers such as the peat. Analysis of borehole levels shows a degree of connectivity between the groundwater regime and the North Sea, dissipating with distance from the coast.

- The chalk is a principal aquifer and is hydraulically separated from the crag aquifer in the east of the study area by the presence of Paleogene deposits.

ii. Surface – groundwater interaction

1.3.87 The surface water levels were compared with the peat groundwater levels, and found to be in the same range, (varying between 0.2 and 1.2m AOD). Both surface water and groundwater levels are influenced by rainfall and vary together. This shows that there is good hydraulic continuity between water in the peat and the surface water drainage system.

1.3.88 Groundwater contours within the peat show a general flow direction towards the east, with localised interaction with the surface water network, including apparent discharge to and recharge from, surface watercourses. In the upstream part of the Sizewell Marshes, groundwater levels are slightly lower than the surface water levels (G3 and G4) throughout the monitoring period. This would suggest that surface water contributes to the groundwater in the upstream part of the marshes. In the downstream part of the marshes, the opposite is observed, with surface water levels being slightly lower than the groundwater levels, suggesting that the surface water system is fed by the groundwater.

1.3.89 The observed connectivity between groundwater and surface water means that the two systems should not be treated in isolation. Rather, it should be recognised that any potential impact to one system as a result of the development, could also potentially affect the other. For example, if unmitigated, interruptions to the groundwater flow regime, such as those arising from the construction of a groundwater cut-off wall, would also have an impact on the surface water system.

w) Abstractions

1.3.90 The crag and superficial aquifers support a number of licensed and private water supplies. Information on licenced abstractions is summarised below in **Table 1.5**, **Table 1.6** and **Table 1.7** and was taken from the Environment Agency's 'What's In My Back Yard' online database (**Figure 19E.5**). The details below are limited to abstractions large enough to require an abstraction licence (more than $20m^3$ day^{-1}). There may be other, smaller non-licenced abstractions within the study area.

i. Surface water abstractions

1.3.91 There are four licenced surface water abstractions with the Leiston Beck and lower Minsmere River systems (**Table 1.5**).

Table 1.5: Surface water abstractions.

Abstraction Licence Number.	Approximate Location.	Abstraction Purpose.	Licenced Volume (TCMA).	Abstraction Period.
7/35/03/**/0049	645150 263495 Stream / irrigation pond.	General Agriculture: Spray Irrigation – Direct.	300	Unknown
7/35/03/*S/0075	646000 263800 Reservoir at Leiston-cum-Sizewell.	General Agriculture: Spray Irrigation – Direct.	49.4	01 May to 31 October.
7/35/03/*S/0051	645600 263770 Unnamed spring fed watercourse east of Lover's Lane.	General Agriculture: Spray.Irrigation – Direct.	22.7	01 May to 30 September.
7/35/03/S/0047	646002 266227 Two Penny Bridge – Minsmere New Cut.	General Agriculture: Spray Irrigation – Direct.	31.0	01 April to 31 October.

1.3.92 The East Suffolk Catchment Abstraction Management Strategy states that the Environment Agency would consider application for new surface abstraction on the lower Minsmere system and may consider application for new abstraction on the Leiston Beck system at high flows only. Therefore, it is possible that additional surface water abstractions may be licenced in the study area in the future, although this is considered to be unlikely.

ii. Groundwater abstractions

1.3.93 The two largest groundwater abstractions in the study area are public water supply abstractions operated by Essex and Suffolk Water. These are Coldfair Green public water supply and Leiston public water supply (**Table 1.6**).

1.3.94 Both abstractions have associated compensation discharges; the Leiston public water supply requires Essex and Suffolk Water to discharge up to 570m^3/d to Leiston Beck immediately upstream of Lover's Lane (NGR TM454635) when directed by the Environment Agency (such directions may be received between May and October). Abstraction returns data for 2005 – 2013 indicate that the Leiston public water supply abstracts at a relatively constant average of 1.5Ml/d (approximately 65% of annual licensed quantity). No returns data for the compensation discharge have been provided, but it is understood that this has not been used since the 1990s.

1.3.95 Abstraction from Coldfair Green is subject to a licence constraint with discharge to the Hundred River (outside this study area), abstraction returns for this license indicate that the compensation discharge has been operated for short periods in each year between 2005 and 2013. Abstraction has occurred at an average rate of 1.1Ml/d since 2008 (50% of annual licensed quantity).

1.3.96 There are numerous smaller abstractions within the study area (**Table 1.7**).

Table 1.6: Groundwater abstractions.

Abstraction Licence Number.	Approximate Location.	Abstraction Purpose.	Licenced Volume (TCMA).	Abstraction Period.
7/35/03/*G/0072	644140 261760 Leiston public water supply Goldings Lane, Leiston.	Public Water Supply.	830 000 (including compensation discharge on request from Environment Agency).	No restriction. Compensation flow may be required May to October.
7/35/03/*g/044	643700 260820 Coldfair Green public water supply, Leiston.	Public Water Supply.	830 (including 25 for compensation discharge on request from Environment Agency).	No restriction. Compensation flow may be required July to October.

Table 1.7: Smaller abstractions within the study area.

Abstraction Licence Number.	Approximate Location.	Abstraction Purpose.	Licenced Volume (TCMA).	Aquifer.	Abstraction Period.
7/35/03/*G/0049	645100 263500 15 well points NE of Brickworks Farm.	General Agriculture: Spray Irrigation – Direct.	27	Sands and gravels.	April to September.
7/35/03/*g/025	644060 263120	Spray irrigation.	11.3	Crag Group	No restriction.
7/35/03/*G/0045	645320 264570 Well at Upper Abbey Farm.	General Farming and Domestic (including potable).	Unknown	Unknown	Unknown
7/35/03/**/0051	645190 263765	Spray irrigation.	Unknown	Unknown	Unknown
7/35/03/*G/0065	644200 263200 10 Wellpoints North of Westward House.	General Agriculture: Spray Irrigation – Direct.	Unknown	Crag Group.	Unknown
7/35/03/*G/0051	645050 264250 Near Leiston Abbey.	General Farming And Domestic.	24.9	Sands and gravels.	No restriction.
7/35/03/*G/0025	644000 263100 West End Nurseries.	General Agriculture: Spray Irrigation – Direct.	205	Unknown	Unknown

1.3.97 The Environment Agency (Ref. 1.34) may consider application for groundwater abstraction in the area depending on the scale and potential impact of the abstraction on the surface water resources. Therefore, it is possible that additional groundwater abstractions may be licenced in the study area.

x) Geomorphology

i. Overall description

1.3.98 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). This section presents a description of the main geomorphological features of the drainage system based on a desk-based assessment of archive data (**Table 1.2**) and a detailed geomorphological walkover survey undertaken for this study in June 2015.

1.3.99 Historical planform change throughout the area of the Sizewell drainage network has been very limited over the last century. Analysis of historical Ordnance Survey mapping (e.g. 1884 and 1928) has indicated no significant changes associated with realignment or straightening of the channel (**Plate 1.5**). Although there is very little evidence of significant changes to the drainage networks planform between 1884 and the present day, the channel has been modified through the construction of artificial land drains and channel enlargement in parts of the network. These have helped to increase the connectivity between the drainage network and the surrounding floodplains.

1.3.100 As a result of these modifications, the watercourses typically have uniform, trapezoidal channels with steep to near-vertical banks, and very low energy flows (**Plates 1.6** and **Plate 1.7**). The banks and riparian zone are generally heavily vegetated, with extensive emergent vegetation communities and floating vegetation found in large parts of the drainage network (**Plate 1.8**). The substrate is largely obscured, but typically consists of fine sediments (silts and clays) when they flow over the peat, and fine sediments overly a coarser matrix (gravels) when the watercourses flow over the crag.

1.3.101 Sediment deposition and, when flows have sufficient energy, transport are likely to be the dominant fluvial processes which operate in the main rivers. The behaviour of the fluvial system is largely dominated by artificial modifications, principally the operation of the Minsmere Sluice, which prevents free drainage during high tide or increased water levels in the Minsmere New Cut, and discharges from the Leiston STW operated by Anglian Water. The management of the systems by SWT and the RSPB is also likely to affect the geomorphology of the drainage system.

Plate 1.5: Historical Ordnance Survey mapping of the Sizewell area.

i) 1884

ii) 1928

Plate 1.6: Leiston Drain in the Minsmere South Levels.

Plate 1.7: Typical artificial drainage channel in Sizewell Marshes.

Plate 1.8: Extensive vegetation growth in the drainage network in Sizewell Marshes.

1.3.102 Despite the extent of historical channel modifications and the highly managed nature of the drainage system, there are no in-channel structures that influence the flow of water in the main channels of Leiston Drain, Sizewell Drain and IDB Drain No. 7. Several in-channel structures have been identified:

- Leiston Drain: A culvert underneath the Lover's Lane road bridge, several weirs (now used as part of the gauging network for this Sizewell C Project, see **section 1.4e** of this chapter) and Minsmere Sluice (note that this is described in detail later in this section).
- IDB Drain No.7: A culvert underneath a footbridge.

1.3.103 It should be noted that many of the smaller drains feeding into the main watercourses are regulated by sluiced pipes, syphons and stop boards.

1.3.104 Hard (artificial) bank reinforcement is present for approximately 20m of the length of the Sizewell Drain. This represents less than 1% of total channel length and is located in the vicinity of an electricity pylon (NGR TM 46918 63094). This hard bank reinforcement is unlikely to represent a significant control over the geomorphology of the watercourse.

1.3.105 The drainage system can be divided into several reaches, which are described in the subsequent sections, as shown on **Figure 19E.2**. The figure also shows the locations of channel cross sections mentioned in the subsequent sections.

ii. Leiston Drain (Aldhurst Valley Stream)

1.3.106 The upstream reach of Leiston Drain is also known as Aldhurst Valley Stream. This reach starts at Abbey Road and runs downstream to Lover's Lane. Bankfull channel width increases with distance from Abbey Road, from approximately 1m (cross section 01_3832) to nearly 7m upstream of Lover's Lane (cross-section 01_2863). This wider section of the watercourse is shallow with large vegetated sandy berms present. The maximum depth of the channel is 2.5m.

1.3.107 The channel in the upstream section of the reach is asymmetrical, with one of the banks visibly steeper than the other. The channel in the downstream section is trapezoidal and the banks are very steep.

1.3.108 Throughout the whole reach, channel bed material consists of fine sediment (predominantly silt). The downstream parts of the reach are characterised by a thicker silt layer with a maximum depth of 90 centimetres (cm), which is likely to have accumulated as a result of the impounding effect of the culvert underneath the road bridge at Lover's Lane.

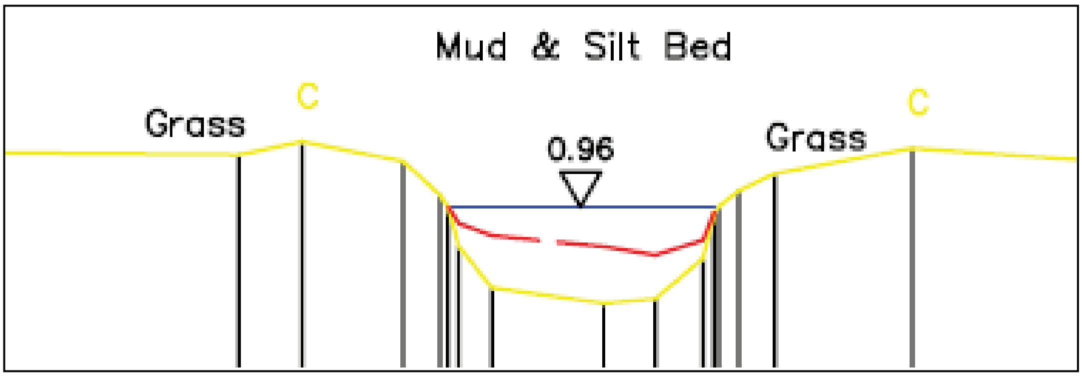
1.3.109 During the July 2015 geomorphological walkover, the most upstream reach of the watercourse (upstream of the discharge from Leiston STW) was found to be dry. This reach was also dry during the topographic survey conducted by Storm Geomatics in 2013. It is therefore assumed that this part of the channel only contains flow during periods of high rainfall events. According to the channel topographic survey undertaken in December 2013 (**Table 1.2**), water levels varied from approximately 0.4m-1.5m downstream of the STW discharge point.

1.3.110 It is planned to create 6ha of a wetland habitat adjacent to the stream between Valley Road and Abbey Road, which would include wet reed bed, open-water and perimeter ditches within groundwater basins, together with drier marginal reed habitat and 60ha of grassland and heathland (planning application DC/14/4224/FUL). The scheme is designed to avoid impact on surface and groundwater levels downstream, with the existing groundwater abstraction point relocated so its discharge can be used to retain a minimum flow of 11l/s in Leiston Beck (Ref. 1.35).

iii. Leiston Drain

1.3.111 This reach starts downstream of Lover's Lane and ends at the footbridge. The upstream section of the reach channel is trapezoidal with nearly vertical banks (**Plate 1.9**). In the downstream section of the reach, the banks are less steep and slightly asymmetrical. Some cross-sections show sediment built-up at one side of the channel. The channel is wide and the bankfull width usually varies from around 3-5.5 m. The channel bed and banks consist of fine silt material but were largely obscured by vegetation growth at the time of the walkover survey. However, in the downstream section the bed material comprises sand as well as silt.

Plate 1.9: Leiston Drain downstream of Lover's Lane (Storm Geomatics, 2013).



1.3.112 The reach immediately downstream of Lover's Lane is ponded with some areas of the channel overgrown by reeds and duckweed. In some areas signs of recent maintenance works were identified during the July 2015 walkover survey, with vegetation being partially removed. Vegetation clearance was also recently undertaken in the area of the temporary gauging weir. Upstream of the reservoir offtake (see below), bank failure was noted, possibly due to a tree falling. The tree was removed and vegetation established itself on eroded faces indicating that this site is no longer active.

1.3.113 Once the channel reaches the woodland on the edge of Sizewell Belts (Leiston Carr, Nursery Covert and Grimseyes) it widens again up to approximately 6m and is much shallower than in upstream reaches, with vegetated mid-channel bars noted in some locations. Some limited flow diversity was noted in this section of the watercourse during the 2015 geomorphological walkover survey, in locations where fallen trees and large woody debris were present in the channel. Signs of trampling by grazing livestock were also noted along this part of the watercourse.

1.3.114 The section of the watercourse that flows along the southern edge of Goose Hill was ponded with no visible flow during the 2015 geomorphological survey. Both banks of the channel are less steep than in upstream reaches (**Plate 1.10**). Upstream of the footbridge (TM 47345 64521), the channel is open with no in-channel vegetation and no tree cover. Downstream of the footbridge the channel becomes wider (up to 7m) and shallower (**Plate 1.11**). This section of the channel has been recently maintained (shortly before June 2015), with in channel vegetation partially removed. Signs of livestock trampling were found along this section of the watercourse.

Plate 1.10: Leiston Drain to the south of Goose Hill (Storm Geomatics, 2013).

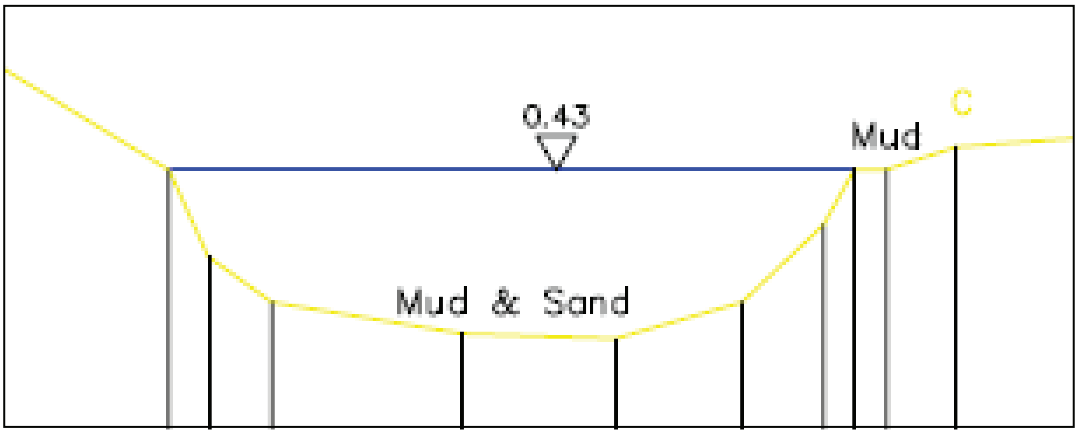
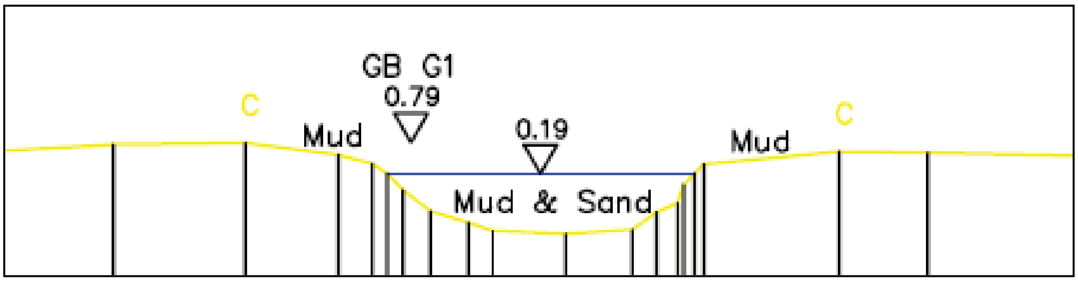


Plate 1.11: Leiston Drain to the east of Minsmere South Levels (Storm Geomatics, 2013).



1.3.115 The water levels at the time of the 2013 survey were high and nearly overtopping the channel banks. The water depths measured from the bottom of the channel in this reach varied from around 0.9m to 2.1m depending on the channel depth. There was sediment built up immediately upstream of the control structures, and the water levels measured in these locations are much lower than in the other sections. The water levels measured downstream from the temporary gauging weir located at cross-section 01-2253 are approximately 0.3m lower than water levels measured upstream of the structure (November 2013).

1.3.116 Water depths were much lower during the geomorphological walkover undertaken in June 2015, ranging from approximately 0.2m in upstream reaches to approximately 0.5m in downstream reaches. This is likely to reflect a seasonal change in the hydrology of the system.

1.3.117 Woody debris, consisting of fallen branches and, in some instances, entire trees, was observed in the watercourse as it flows through woodland areas during the survey. This debris locally increased flow diversity but did not cause significant impoundment due to the position of the debris within the channel.

iv. Leiston Common Reservoir

1.3.118 Leiston Drain also feeds a small online reservoir with a weir at the downstream limit. The channel downstream of the reservoir, which feeds into Sizewell Drain, is largely dry during low flow (i.e. non-flood) conditions.

1.3.119 The width of the reservoir varies from around 5-7.5m. The banks of the reservoir are gently sloping and the bed consists of silty material. At the time of the topographic survey in 2013, water levels measured from the bottom of the reservoir were more than 1m deep. Downstream from the control structure located at the east end of the reservoir, water levels were around 0.4m lower than upstream. The weir plates can be operated to stop water flowing into the downstream of the weir; this channel is frequently dry.

1.3.120 The watercourse downstream from the reservoir is trapezoidal, with steep banks present throughout the whole reach. Leiston Drain is wide and bankfull width varies from 3-7.5m (at the reservoir). The channel bed consists of fine silt material. In some locations the silt layer is up to 50cm thick. The maximum depth of the channel varies from 1-2 m. The water levels at the time of the survey were high and close to bankfull, ranging from 1-2m.

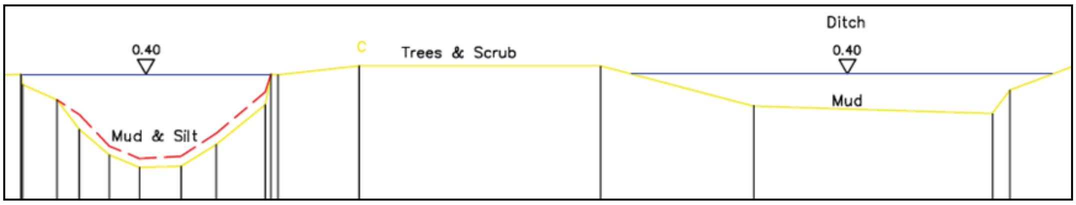
1.3.121 Downstream of its confluence with Sizewell Drain, Leiston Drain runs along the eastern edge of the Minsmere South Levels drainage unit. The channel is trapezoidal but less steep than in other reaches. The bankfull channel width is approximately 7m and maximum channel depth is approximately 1m. The water levels at the time of the 2013 survey were high and nearly overtopping the channel banks. The bed material consists of silt and fine sand.

v. Sizewell Drain

1.3.122 Sizewell Drain runs in a northerly direction between the Sizewell Marshes and the Sizewell A and B stations. In some locations, the drain consists of a wide-open channel, but in others it is divided into two parallel interconnected channels (**Plate 1.12**). The channel is trapezoidal with relatively steep banks along much of its length, although parts of the channel are poorly defined (e.g. adjacent to the northern end of the existing Sizewell B station). The presence of the raised platforms for the existing Sizewell A and B power stations close to the right bank severely constrain the floodplain, and in places this bank is more than 1m higher than the left bank. Large amounts of woody debris were noted in the channel during the geomorphological survey in June 2015.

1.3.123 The bankfull width of the channel varies from around 2m to almost 20m. The channel bed consists of fine silt material. In some locations the silt sediment layer reaches 50cm in thickness. The channel depth varies from approximately 1-1.5m. The water levels at the time of the survey in December 2013 were high and nearly overtopping the channel banks.

Plate 1.12: Sizewell Drain adjacent to the Sizewell B power station (Storm Geomatics, 2013).



vi. IDB Drain No.7

1.3.124 IDB Drain No. 7 is located south of the Minsmere New Cut and runs in easterly direction until it joins the Leiston Drain. The channel is trapezoidal with relatively steep banks. Throughout most of the channel high manmade levees were noted on both banks of the channel. The channel width varies from 4-6m and the bed and banks of the watercourse consist mostly of sand and silt.

1.3.125 All surveyed reaches are heavily impounded, with no perceptible flow observed during the June 2015 geomorphological survey. The water levels were very low (approximately 20cm deep) at the time of the survey. Some sections of the channel run on the edge of an area of woodland, and overhanging trees and woody debris were noted in these areas.

y) Water quality

i. Water Framework Directive standards

1.3.126 The WFD is a major piece of European legislation that obligates Member States to achieve minimum standards in terms of condition of all bodies of surface water and groundwater. It is therefore of considerable importance in the assessment of chemical water quality.

1.3.127 The River Basin Districts Typology, Standards and Groundwater threshold values (WFD) (England and Wales) Directions 2010 sets out standards for the main water quality parameters (physico-chemical quality, specific pollutants and priority substances) that are included in the WFD. This section assesses the quality of the surface drainage system in the context of these standards.

ii. Water quality sampling

1.3.128 Water quality in the drainage systems surrounding the Sizewell C development site has been monitored over several years, with samples being collected on an approximately monthly basis between 28 January 2010 and 30 January 2013 (AMEC, 2013) (**Figure 19E.3**). The water samples were analysed for a variety of substances, including:

- Basic water quality parameters (**Table 1.8**): Temperature, pH, dissolved oxygen, biochemical oxygen demand (BOD), salinity and suspended solids.
- Nutrients (**Table 1.9**): Total ammonia and ammonium, nitrate, nitrite, sulphate, sodium, chloride, and soluble reactive phosphorus.
- Total Petroleum Hydrocarbons (TPH) (**Table 1.10**).
- WFD Specific Pollutants (**Table 1.11**) : Dissolved iron, total zinc, cadmium, dissolved mercury, Di(2-ethylhexyl)-phthalate (DEHP), Nonylphenol(4-Nonylphenol), Octylphenol((4-(1,1',3,3'-tetramethylbutyl)-phenol), Polyaromatic hydrocarbons, and Tributyltin-cation.

iii. Baseline water quality

1.3.129 The results of the water quality sampling undertaken by AMEC have been compared to the standards set out in the River Basin Districts Typology, Standards and Groundwater threshold values (WFD) (England and Wales) Directions 2015 (where applicable) (Ref. 1.43). **Table 1.8** (basic water quality parameters) indicates that:

- All sites meet the standard for WFD 'High' status for temperature (25°C) and pH (pH 6 as a 5th percentile and pH 9 as 95th percentile) set out in the River Basin Districts Directions 2015.
- No sites achieved compliance with the 60% dissolved oxygen saturation WFD 'Good' standard or for BOD (threshold value 5mg/l, 90th percentile) WFD 'good' quality standard as specified in the River Basin Districts Directions 2015.
- Salinity at the majority of sites is close to the boundary between fresh and brackish water (0.5 PSS), reflecting the ingress of saline water through Minsmere Sluice. Highest average salinities (3.6 PSS) were observed at the downstream (coastal) end of Leiston Drain
- Mean annual concentrations of suspended solids exceeding the cyprinid fish guideline threshold value from the now-revoked Freshwater Fish Directive (2006/44/EC) were recorded in twelve locations.

1.3.130 **Table 1.9** (nutrients) indicates that:

- Five sites (SW8, SW13, SW4, SW6 and SW14) failed to achieve a 'moderate' or higher level of total ammonia as defined in the River Basin Districts Directions 2015. The majority of affected sites are located downstream of Leiston STW.
- At seven monitoring sites (SW1, SW2, SW4, SW6, SW12, SW13 and SW15) maximum nitrate concentrations were recorded in excess of the Water Supply (Water Quality) Regulations 2016 (Ref. 1.36) (50mg/l), whilst at nine monitoring sites 95th percentile concentrations of nitrite exceeded the 0.03mg/l guideline threshold value for cyprinid fish from the Freshwater Fish Directive (Ref. 1.37) (now revoked).
- All locations, with exception of monitoring sites SW6 and SW11, displayed mean sodium concentrations below the non-statutory threshold value of 170mg/l during the monitoring period (Environment Agency's EPR H1 guidance, which was withdrawn in 2016).
- The mean non-statutory freshwater Environmental Quality Standard (EQS) was exceeded by mean chloride concentration values of 250mg/l (Environment Agency's EPR H1 guidance, which was withdrawn in 2016) at sites SW5, SW6, SW11 and SW16.
- Elevated phosphorus concentrations were observed at most monitoring sites. Sites SW1, SW2, SW3 and SW10 were found to have the highest concentration.
- TPH are presented in **Table 1.10**. This indicates that all sampling locations recorded the presence of TPHs in excess of 50mg/l on at least one occasion, with site SW6 exhibiting the highest concentrations (3,170mg/l).

1.3.131 **Table 1.11** (WFD specific pollutants) indicates that:

- Mean values of dissolved iron in excess of the WFD 'Good' standard (1mg/l) set out in the River Basin Districts Directions 2015 were recorded at three monitoring locations (SW6, SW13 and SW14).
- Mean total zinc concentrations did not exceed the 'Good' standard at any of the sites, based on the River Basin Districts Directions 2010 (note 2015 Directions only include dissolved zinc and therefore are not able to be applied to this monitoring data).
- A single exceedance of the annual average threshold for cadmium of 0.25µg/l specified in the River Basin Districts Directions 2015 was recorded at SW2 (0.27µg/l).

- Six samples recorded dissolved mercury at concentrations greater than the 0.05μg/l annual average EQS threshold set out in the River Basin Districts Directions 2010 (note mercury in freshwater is not included in the 2015 River Basin Districts Directions). Of these, SW3, SW15 and SW16 were greater than the maximum acceptable concentration EQS (0.07μg/l).
- Di(2-ethylhexyl)-phthalate (DEHP), Nonylphenol(4-Nonylphenol), Octylphenol ((4-(1,1’,3,3’-tetramethylbutyl)-phenol) and Tributyltin-cation all exceeded average annual EQS from the River Basin Districts Directions 2015 during the campaign. Benzo(a)pyrene exceeded annual average EQS from the River Basin Districts Directions 2010; however, this EQS has tightened in the 2015 River Basin Districts Directions (now at 1.7 x 10-4ug/l) and without the original data cannot be compared.

1.3.132 Priority substances and other indicators of pollution are therefore largely absent from surface waters throughout the site. However, there are indications that parts of Leiston Drain have been affected by discharges from Leiston STW, and the upstream end of the Sizewell Drain is impacted by road run-off and other discharges from Sizewell village.

1.3.133 Currently Atkins is undertaking a further programme of water quality monitoring. The locations have been selected to be representative of each reach based upon the results of the original baseline monitoring, and to ensure ongoing accessibility. These locations have been agreed with the Environment Agency. In the summer of 2015, one round of sampling from both the new locations and the baseline locations was undertaken to ensure consistency, and no issues were observed (Atkins, pers. comm.).

Table 1.8: Basic water quality parameters.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
Temperature (°C)	10.6	0.4	23.5	The overall mean water temperature over the 37 month monitoring period was 11°C for all sites, with the mean range of temperature differences recorded as 4.5°C (AMEC, 2013). A slightly higher mean temperature was recorded at Sites SW1, SW2 and SW3. The highest recorded temperature was 23.5°C (site SW9, June 2010). The minimum recorded temperature was 0.4°C (site SW11, January 2012. Overall, the in-situ temperature results are typical for lowland shallow watercourses. The influence of the Leiston STW on the water temperature is most visible during the winter months. Leiston Drain mean water temperatures are 0.8°C higher than records for the same time for the Sizewell Drain. All sites meet the standard for WFD 'High' status (25°C) set out in the River Basin Districts Directions 2015.
pH (pH unit)	7.3	5.3	8.7	The overall mean pH value recorded in surface waters was 7.3, with the majority of values between 6 and 9 (AMEC, 2013). The lowest mean pH value was recorded at sites SW1, SW6, SW7 and SW9. The mean pH data for all monitoring sites were broadly consistent from 2010 to 2012. All sites meet the WFD 'high' status for pH (pH 6 as a 5th percentile and pH 9 as 95th percentile) set out in the River Basin Districts Directions 2015.
Dissolved oxygen	45.9	2.3	159.3	In-situ measurements of dissolved oxygen were compared with the standards set out in the RBMP Directions 2015. Data for the second River Basin Management Plan (RBMP2), published on the Environment Agency's Catchment Data Explorer (Ref. 1.6), suggests that dissolved oxygen concentrations are currently at 'good' status for Minsmere Old River water

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				body (2016 status), but currently at 'bad' for Leiston Beck water body (2016 status). Dissolved oxygen was at 'good' status until 2015 in Leiston Beck, and the deterioration is attributed to continuous sewage discharges (Ref. 1.6). The calculated 10th percentile value of each monitoring site indicates that the 60% dissolved oxygen saturation WFD 'good' standard specified in the River Basin Districts Directions 2015 was not achieved at any of the sites. All monitoring sites would fail even if the 'poor' WFD classification was adopted as the appropriate standard (10th percentile of 45% saturation). None of the monitoring sites show compliance with the now-revoked Freshwater Fish Directive threshold value of 7mg/l (50th percentile). High dissolved oxygen values were occasionally recorded at monitoring sites as a result of daytime photosynthesis by higher aquatic plants or algae. Shallow watercourses with an abundance of water plants are often subject to wide fluctuations of dissolved oxygen.
BOD (mg O2 per l)	7.6	0	130	None of the monitoring sites achieved compliance with the WFD 'good' quality standard (threshold value 5mg/l, 90th percentile) for type 5 (less than 80m altitude, $CaCO_3$ 100-200mg/l) and 7 ($CaCO_3$ less than 200mg/l) watercourses specified in the River Basin Districts Directions 2015 in the 37 month monitoring period. All sites failed to meet any of the WFD classification ranges (90th percentile BOD concentrations). An increase of BOD was noted throughout all sites in autumn and early spring. When using the new proposed WFD standards, sites SW4, SW7 and SW12 would achieve "poor" status. SW6, SW14 and SW15 failed to meet 2015 standards and the new proposed WFD standard every year between 2010 and 2012 (SW6 is located at Sizewell Drain and SW14 and SW15 are located in Minsmere South Levels).

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
Salinity	-	-	-	The majority of sites showed to be at the salinity boundary between freshwater and slightly brackish conditions (0.5 Practical Salinity Scale, PPS). Salinity greater than 0.5 PPS was recorded at sites SW5, SW6, SW8, SW11, SW15 and SW16. All the surface watercourses within the monitored area are within approximately 2km of the shoreline and are influenced by the inputs of salt via marine aerosol deposition and, potentially, by saline ground water intrusion (although the groundwater saline interface is approximately 15m below ground level). Sea water can also enter the Leiston Drain via Minsmere Sluice, and this is potentially the main input of salinity to the freshwater system. Notably higher salinity than at the other sites was recorded at site SW11 (average salinity 3.6 PPS), which is located on the Leiston Drain close to its downstream limit at the sluice. Sites SW15 and SW16 are located on the drain approximately 1.6km from the Minsmere Sluice, however on occasions the influence of seawater may be recorded at this distance upstream from the coast.
Suspended solids	106.7	5	6378	Mean annual concentrations of suspended solids exceeding the cyprinid fish guideline threshold value of 25mg/l from the now-revoked Freshwater Fish Directive (2006/44/EC) were recorded in twelve locations. Site SW1, SW3, SW9 and SW10 showed concentration above the threshold. The elevated concentrations of suspended solids are typical for shallow, lowland, slow flowing watercourses. The highest mean concentrations of the suspended solids were noted at site SW5 (646mg/l) and SW6 (374mg/l) (AMEC, 2013). Both sides are characterised by the very shallow water depths.

Table 1.9: Nutrients

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
Total ammonia and ammonium (mg/l).	0.9	Less than 0.1	39.5	Total ammonia results were compared to the 'high' quality status threshold value of 0.3mg/l (90th percentile) for river types 3, 5 and 7 (rivers with an altitude of less than 80m AOD, and alkalinity of greater than 50mg/l $CaCO_3$) from the RBMP Directions 2015. Only site SW12 achieved a 'high' quality status, five monitoring sites achieved a 'good' quality status (SW2, SW4, SW9, SW10 and SW15), five sites achieved a 'moderate' quality status (SW1, SW3, SW7, SW11 and SW16), and sites SW8 and SW13 recorded a 'poor' quality status. Sites SW5, SW6 and SW14 failed to achieve the 'poor' quality status as defined in the WFD Directions. The current (2016) status for total ammonia for Leiston Beck is 'good', although this was 'high' until 2016 in the draft RBMP2 information presented on the Environment Agency's Catchment Data Explorer (Ref. 1.6). Using the new proposed WFD standards, only site SW12 achieved a 'high' quality status, three monitoring sites achieved a 'good' quality status (SW9, SW10 and SW11 upstream), five sites achieved a 'moderate' quality status (SW1, SW2, SW7, SW11 downstream, SW15), and five sites recorded a 'poor' quality status (SW3, SW4, SW5, SW13 and SW16). Comparison of mean total ammonia as N, mean ammonium as NH_4 and mean unionised ammonia as NH_3 data from monitoring site SW12 confirms that the Leiston STW contributes a large proportion of the ammonia recorded in Leiston Beck. A substantial increase of ammonia species was noted from 2010 to 2011 at sites located in the Sizewell Drain. The annual mean concentration of total ammonia (as N) in the Sizewell Drain is 2.01mg/l, which is much higher than 0.25mg/l result for Leiston Beck.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				There has been a general increase in the ammonia species at the northern monitoring sites between 2010 and 2012 for example an annual mean of unionised ammonia (as NH_3) increased from 0.006mg/l-0.017mg/l. All monitoring sites except SW2, SW9, SW10 and SW12 were recorded having exceeded the ammonium annual standard of 1mg/l (95^{th} percentile) from the now-revoked Freshwater Fish Directive.
Nitrate (mg/l)	18.3	Less than 1	94	At seven monitoring sites (SW1, SW2, SW4, SW6, SW12, SW13 and SW15) maximum nitrate concentrations were recorded in excess of Water Supply (Water Quality) Regulations 2016 (50mg/l). The highest nitrate concentrations of 94mg/l were recorded at monitoring site SW15. Lower nitrate concentrations were recorded at sites located at Sizewell Marshes (SW4, SW5 and SW9). Mean nitrate concentrations in the Sizewell Drain show an increase with downstream distance (SW6, SW7 and SW9). The northern sites showed a general increase of mean inter-annual nitrate concentrations between 2010 (8.66mg/l) and 2012 (13.45mg/l). An increase in nitrate concentrations of a similar proportion was noted within the SSSI ditches during same period.
Nitrite (mg/l)	0.10	Less than 1	3.85	At nine monitoring sites during the 37 months monitoring period, 95^{th} percentile concentrations of nitrite exceeded the 0.03mg/l guideline threshold value for cyprinid fish from the now revoked Freshwater Fish Directive (2006/44/EC). The mean nitrite interannual data recorded in Leiston Beck shows a decrease with time from 2010 (0.35mg/l) to 2012 (0.18mg/l) which corresponds with a 38% reduction of dissolved oxygen.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
Sulphate (mg/l)	77	Less than 1	2,357	The elevated value at site SW11, which is located near the Minsmere Sluice, is caused by intrusion of sea water through the sluice. The concentrations of sulphate recorded at site SW11 are typical sea water concentrations. Elevated concentrations at sites SW15 and SW16, which are both on a ditch parallel to the Minsmere New Cut, coincide with spring tide periods when saline intrusion is likely to be at its greatest.
Sodium (mg/l)	127.2	3.1	7,693	All locations, with exception of monitoring sites SW6 and SW11, displayed mean sodium concentrations below the non-statutory threshold value of 170mg/l during the monitoring period (Environment Agency's EPR H1 guidance, withdrawn in 2016) (AMEC, 2013). Sodium concentrations at site SW16 were close to this threshold, with mean concentrations of 162mg/l.
Chloride (mg/l)	238.9	9.3	15,655	The mean non-statutory freshwater EQS was exceeded by mean chloride concentration value of 250mg/l (Environment Agency's EPR H1 guidance, withdrawn in 2016) at sites SW5, SW6, SW11 and SW16. The highest chloride concentration of 15,655mg/l was recorded at site SW11 in June 2010. The mean chloride concentration for this site is 1,675mg/l. Site SW16 showed elevated mean chloride concentrations during spring tide periods.
Soluble reactive phosphorus (mg/l)	0.4	Less than 0.02	4.3	The River Basin Districts Directions 2015 set an environmental standard for mean soluble reactive phosphorus of 0.12mg/l for a 'good' status class. Elevated phosphorus concentrations were observed at most monitoring sites. Monitoring results are consistent with the Leiston Beck WFD water body description included in the Anglian River Basin Management Plan, which describes its current status (2016) for phosphate as 'poor', having been 'good' in 2015 and 'bad' previously (sites SW1, SW2, SW3 and SW10 were found to have the highest concentration) (Ref. 1.6). The pressure

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				affected the phosphate status is point source continuous sewage discharges. The draft proposal for new phosphorus standards for rivers under the WFD (Defra and Welsh Government, 2014) would reduce site specific standard for phosphorus from 0.12mg/l-0.069mg/l, resulting in an additional site (SW15) failing to meet WFD 'good' status. 'Good' status would still be achieved at SW7 and SW9 under this proposal. A mean soluble reactive phosphorus value of 0.71mg/l was recorded for one site (SW5). This represents hyper-eutrophic status, which applies for a mean value of more than 0.1mg/l. This area of standing water falls outside of the WFD lake protocols since its surface area is less than 50ha. Monitoring site SW12 and the internal SSSI ditches have the lowest mean soluble reactive phosphorus concentrations. The other systems such as Leiston Beck and the Sizewell Drain have a greater degree of nutrient enrichment. The decrease in soluble reactive phosphorus concentrations every year at the northern sites was noted, although these sites recorded increases in ammonia and nitrite levels during the same period. The mean concentrations of soluble reactive phosphorus increased at sites located at the Sizewell Drain between 2010 and 2012. Phosphate removal was implemented at Leiston STW during the spring of 2015, and so baseline concentrations downstream of the discharge should be expected to fall.

Table 1.10: Total Petroleum Hydrocarbons.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
TPH (µg/l).	44	Less than 10	3,170	All sampling locations recorded the presence of TPHs on at least seven occasions and concentrations in excess of 50mg/l on at least one occasion. Site SW6, which receives road run-off drainage from Sizewell Gap, recorded TPH most frequently, and displayed the highest concentrations (3,170mg/l).

Table 1.11: WFD Specific pollutants.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
Dissolved iron (µg/l)	871	<10	31,740	Mean values of dissolved iron in excess of the WFD 'good' standard (1mg/l) set out in the River Basin Districts Directions 2015 were recorded at three monitoring locations (SW6, SW13 and SW14). Elevated iron concentrations at these sites correspond with low concentrations of dissolved oxygen. Dissolved iron concentrations at sites located on the Leiston Beck were relatively constant between 2010 and 2012 (average value 18.3µg/l) and achieved WFD 'Good' status. The ditches within the Sizewell Marshes SSSI (sites SW4, SW5 and SW9) show a much higher average of 178µg/l. The Sizewell Drain and the northern sites also show higher dissolved iron concentrations. It should be noted that analysis of the dissolved iron concentration began in April 2010 and the mean values used were based on a smaller number

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				of monthly samples than many of the other determinants.
Total zinc (µg/l)	421.4	<1	318.6	The WFD 'good' standard for total zinc specified in the River Basin Districts Directions 2010 is dependent upon water hardness. It is therefore 0.125mg/l ($CaCO_3$ greater than 250mg/l) for all sites with the exception of SW2, SW7, SW9, SW13 and SW14, where it is 0.075mg/l ($CaCO_3$ between 100-250mg/l). Mean total zinc concentrations did not exceed the 'good' standard at any of the sites. However, individual samples at several monitoring locations were found to be in exceedance of this value (AMEC, 2013). Furthermore, data from monitoring sites located at Leiston Beck and the Sizewell Drain show increasing mean zinc concentrations between 2010 and 2012. All monitoring sites met the new proposed WFD standard for the bioavailable zinc (µg/l plus ambient background concentration). The long-term average bioavailable zinc concentrations didn't exceed 6µg/l at all sites. Concentrations of the bioavailable zinc were calculated using UK Technical Advisory Group Metal Bioavailability Tool. Predicted No Effect Concentration and calcium concentrations were obtained from the Atkins water quality report from November 2014.
Cadmium (µg/l)	N/A*	<0.01	0.270	A single exceedance of the annual average threshold for cadmium of 0.25µg/l specified in the River Basin Districts Directions 2015 was recorded at SW2 (0.27µg/l). However, if the threshold is compared against an average of the measurements made at the site in 2012 to give a true annual average, the data do not exceed the threshold. On nine occasions dissolved cadmium was detected at concentrations greater than 0.1µg/l at monitoring sites directly downstream of Leiston

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				STW (SW2, SW3, SW10 and SW11).
Dissolved mercury. (µg/l)	N/A*	<0.01	33.1	Six samples recorded dissolved mercury at concentrations greater than the 0.05µg/l annual average EQS threshold set out in the River Basin Districts Directions 2010. Of these, SW3, SW15 and SW16 were greater than the maximum acceptable concentration EQS (0.07µg/l).
Di(2-ethylhexyl)-phthalate (DEHP). (µg/l)	N/A*	<0.2	9.21	Multiple occurrences of DEHP were recorded across the monitoring area (AMEC, 2013). 38 samples recorded concentrations greater than the minimum reporting value for the laboratory used to analyse these samples (more than 0.2µg/l), of which 13 were greater than the 1.3µg/l annual average EQS threshold defined in the River Basin Districts Directions 2015. The monitoring locations associated with the exceedances do not show any distinct spatial relationship (AMEC, 2013). The occurrences of DEHP are not atypical of freshwater systems.
Nonylphenol(4-Nonylphenol) (µg/l)	N/A*	<0.125	1.44	The results show sixteen exceedances of average annual EQS from the River Basin Districts Directions 2015 of 0.3µg/l.
Octylphenol((4-(1,1',3,3'-tetramethylbutyl)-phenol) (µg/l)	N/A*	<0.05	<0.250	Four exceedances of the River Basin Districts Directions 2015 annual average EQS of 0.1µg/l were recorded during campaign 26 in 2012.
Polyaromatic hydrocarbons	N/A*	N/A*	N/A*	In order to achieve overall compliance with the WFD (as specified in the River Basin Districts Directions 2015), polyaromatic hydrocarbon concentrations must comply with individual EQS for benzo(a)pyrene, the sum of benzo(b)fluoranthene and benzo(k)fluoranthene, the sum of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.

Parameter	Results Of Testing (AMEC, 2013).			Description
	Long Term Average 2010-2013.	Min.	Max.	
				A single exceedance of the average annual EQS for benzo(a)pyrene of 0.05µg/l was recorded at location SW6 (0.054µg/l). The combined annual average EQS for benzo(b)fluoranthene and benzo(k)fluoranthene of 0.03µg/l) was only exceeded at site SW6 during two monitoring campaigns (AMEC, 2013). The sum of their concentration was 0.118µg/l. The combined annual average EQS for benzo(g,h,i)-perylene and indeno(1.2.3-cd)-pyrene is 0.002µg/l. The minimum reporting value of the testing laboratory used by AMEC (2013) (less than 0.01µg/l in each instance) is not sufficiently low to allow direct comparison with the annual average EQS. However, there was only one occurrence each of these polyaromatic hydrocarbons across to campaigns and both were recorded at SW6 (0.082mg/l).
Tributyltin-cation. (µg/l)	N/A*	0.0005	0.02	The minimum reporting value of the testing laboratory used to inform AMEC (2013) is less than 0.0005µg/l. This is greater than the annual average EQS of 0.0002µg/l that is included in the River Basin Districts Directions 2015. However, there were four occurrences of Tributyltin-cation concentrations greater than the minimum reporting value during the monitoring period, all at site SW6. The results from Campaigns 27, 34 and 35 were all above the maximum acceptable concentration of 0.0015µg/l (0.00015µg/l, 0.02µg/l and 0.0174µg/l, respectively).

**Not calculated, as most concentrations were below the minimum reporting value.*

z) Ecology

i. Environmental designations

1.3.134 The wider Sizewell C study area contains a number of sites that have been designated for their nature conservation importance; much of the ecological value relates to wetland habitat and other features closely connected with surface water quality and quantity. These sites include both statutory and non-statutory designations, as follows:

- Sizewell Marshes SSSI: This site comprises unimproved wet meadows, areas of wet woodland, reed bed and an extensive ditch system, which collectively support important assemblages of invertebrates and rare vascular plants (as well as some of the water bird interest features of the Minsmere to Walberswick Heaths and Marshes SPA and Ramsar site, e.g. marsh harriers and bittern). The citation for the site itself identifies an important breeding bird assemblage characteristic of wet grassland and associated habitats. However, the site's breeding bird assemblage has declined, in line with a national decline, and species such as snipe and lapwing are no longer present.
- Minsmere to Walberswick Heaths and Marshes SSSI, SAC, SPA and Ramsar: The cited interest features of the different elements of this large site are summarised in **Table 1.12**.
- Non-statutory designated sites: In addition to the above statutory designated sites, there is a small area forming part of the Minsmere South Levels County Wildlife Site (CWS), a non-statutory designation which has been designated for the coastal grazing marsh and associated species present. Other non-statutory designated sites in the wider study area include Leiston Common CWS, Reckham Pits Wood CWS and Suffolk Shingle Beaches CWS.

Table 1.12: Minsmere to Walberswick Heaths and Marshes cited interest features.

Designation	Interest Feature.
SAC	Supports the following **Annex 1** habitats as a primary reason for selection: Annual vegetation of drift lines. European dry heaths. Habitat present as a qualifying feature, but not primary reason for selection: Perennial vegetation of stony banks.
SPA	Supports populations of European importance of the following species: During the breeding season (avocet, bittern, little tern, marsh harrier, nightjar and woodlark). During the winter (avocet, bittern and hen harrier).

Designation	Interest Feature.
	In addition, the SPA also supports an important assemblage of breeding and wintering wildfowl including gadwall, teal, shoveler and white-fronted geese.
Ramsar	Contains a mosaic of marine, freshwater, marshland and associated habitats, complete with transition areas in between. Contains the largest continuous stand of reed bed in England and Wales, and rare transition in grazing marsh ditch plants from brackish to fresh water. The Ramsar site also supports nine nationally scarce plants and at least 26 red data book invertebrates, as well as an important assemblage of rare breeding birds associated with marshland.
SSSI	The SSSI supports a diverse series of habitat types, most notably mudflats, shingle beach, reed beds, heathland and grazing marsh. These habitats provide sheltered feeding grounds for wildfowl and shorebirds, and also support important flora and invertebrate assemblages.

ii. Ecological features

1.3.135 This section describes the ecological features that are present within the surface water study area, both within and outside the designated sites (**Figure 19E.6**).

1.3.136 It is acknowledged that there is considerable overlap between groundwater and surface water, and that ecological receptors are likely to be influenced by changes in both parameters. The development of the groundwater Conceptual Site Model suggested that there is likely to be a strong interaction with surface water features, with some groundwater discharge to, and recharge from, surface waters. The extent to which groundwater, surface water, or a combination of both, influences the ecological receptors identified will be fully determined as the two work streams are brought together and the assessment process develops.

1.3.137 A suite of hydrologically-dependent ecological features have previously been identified as part of the development of the groundwater work stream. This work has been developed into a detailed hydroecological review of the wetland vegetation present within both Sizewell Marshes and the Minsmere South Levels; the results of this review will be reported separately, so it is not intended to repeat this here. Instead, this report will focus on those ecological features of Sizewell Marshes and the Minsmere South Levels that have a clear relationship with surface water.

aa) Ditches

1.3.138 Sizewell Marshes and the Minsmere South Levels comprise a network of drainage ditches that support diverse aquatic plant communities, including the nationally-scarce soft hornwort (*Ceratophyllum submersum*), fen pondweed (*Potamogeton coloratus*) and whorled water-milfoil (*Myriophyllum* *verticillatum*). A noticeable gradient, from freshwater to slightly brackish communities, exists within the study area, particularly in the vicinity of the Minsmere Sluice. The most diverse aquatic vegetation is found in those stretches of ditch that do not receive shading from tree and shrub species, the long-term management of the ditches being important in maintaining open full light conditions.

1.3.139 Riparian vegetation adjacent to each ditch often supports tall emergent species including common reed (*Phragmites australis*), lesser pond-sedge (*Carex acutiformis*) and lesser water-parsnip (*Berula erecta*). The ditch network also supports an important invertebrate assemblage (including the Norfolk hawker dragonfly *Aeshna isosceles*) as well as water voles (*Arvicola amphibius*) and otters (*Lutra lutra*). Whilst these species are considered to be relatively robust to moderate changes in the quantity of surface water, provided the available bank and transition habitats are not significantly affected, they are potentially sensitive to changes in water quality.

bb) Wetland vegetation

1.3.140 In addition to ditches, Sizewell Marshes supports important species-rich fen meadow, reed bed and wet woodland vegetation, whilst the Minsmere South Levels also support coastal floodplain grassland. Of these habitats, species-rich fen meadow is considered to be the most sensitive to changes in the surface water regime, because it requires a relatively constant water table. Fen meadow is able to tolerate small seasonal fluctuations (several centimetres) but is vulnerable to periods of extended inundation or a lowering of the water table.

cc) SPA bird species

1.3.141 Minsmere South Levels support populations of bird species that are cited as interest features of the Minsmere to Walberswick SPA (the boundary of which is further north); thus, the birds present would be regarded as functionally linked to the SPA populations. SPA species that could potentially be affected by changes in the quality and quantity of surface water include marsh harrier (*Circus aeruginosus*), bittern (*Botaurus stellaris*), avocet (*Recurvirostra avosetta*) and breeding and wintering wildfowl species such as gadwall (*Anas strepera*), teal (*Anas crecca*), shoveler (*Anas clypeata*) and white-fronted goose (*Anser albifrons*).

1.3.142 In addition, marsh harrier forage regularly over Sizewell Marshes, and bittern have been recorded occasionally during the winter and spring, whilst wildfowl species such as shoveler and gadwall are present during the winter months.

1.3.143 As well as the SPA bird species present within the study area, the habitat features that support these bird features could also potentially be sensitive to changes in surface water. For example, bittern forage at the interface between reed bed and open water, and cannot forage if water levels are too deep, or if the water quality degrades significantly, leading to a reduction in the amount of fish species available as prey.

dd) Non-SPA breeding and wintering waders and wildfowl

1.3.144 The coastal floodplain grazing marsh within the Minsmere South Levels supports breeding waders, such as redshank and snipe, and breeding wildfowl.

1.3.145 Wading bird species depend upon soft ground and ditch edges during the breeding season (April to June) with areas of shallow surface water flooding. They require a specific vegetation structure to the fields in which they nest; if fields are too wet during the breeding season, the growth of species such as rush and sedge can increase, creating a dense tussocky sward structure unsuitable for nesting.

1.3.146 In contrast, breeding wildfowl require aquatic vegetation to feed on and emergent vegetation along ditch edges in which to nest. During the winter months, shallow surface water flooding of the grazing marsh is important to maintain populations of wintering wildfowl.

1.3.147 Surface water levels within the coastal floodplain grazing marsh are carefully managed during both the winter and the breeding season to provide optimal conditions for wintering and breeding waders and wildfowl.

1.3.148 Sizewell Marshes no longer supports populations of breeding wader species but does support some wildfowl during both the winter months and the breeding season. These receptors are potentially sensitive to changes in the surface water regime, in particular the quantity of surface water inputs. The Sizewell Marshes SSSI also provides supporting habitat for the European designated species associated with the Minsmere to Walberswick Heaths and Marshes SPA, including bittern and marsh harrier.

ee) Water Framework Directive water bodies

1.3.149 The indicative study area boundary (**Figure 19E.1**) covers two river water bodies, one groundwater water body and one coastal water body. These are summarised below and in **Table 1.13** and **Table 1.14**.

1.3.150 All three of the surface water bodies are designated as heavily modified water bodies (HMWB), which means that they are substantially altered. They are all currently assessed as achieving 'moderate' overall potential (2016), with 'moderate' Ecological status and 'good' chemical status. The Ecological status is being affected by the supporting elements (both), biological quality elements (Minsmere Old River) and physico-chemical quality elements (Leiston Beck and Suffolk Coastal).

Table 1.13: WFD surface water bodies within the study area (2016 status).

Waterbody	Leiston Beck.	Minsmere Old River.	Suffolk Coastal.
Type	River	River	Coastal
ID	GB105035046271	GB105035046270	GB650503520002
Overall water body status/potential.	Moderate (2016).	Moderate (2016).	Moderate (2016).
Overall water body objective.	Good (2027) Disproportionate burdens.	Good (2027) Unfavourable balance of costs and benefits. Disproportionate burdens.	Moderate (2015) Unfavourable balance of costs and benefits.
Heavily modified/Artificial water body?	HMWB	HMWB	HMWB
Ecological	Moderate	Moderate	Moderate
Supporting elements (surface water).	Moderate	Moderate	Good
Biological quality elements.	Good	Poor	Good
Hydromorphological supporting elements.	Supports Good	Supports Good	-
Physico-chemical quality elements.	Moderate	Good	Moderate
Specific pollutants.	-	-	-
Chemical	Good	Good	Good
Priority substances.	Does not require assessment.	Does not require assessment.	Does not require assessment.
Other pollutants.	Does not require assessment.	Does not require assessment.	Does not require assessment.
Priority hazardous substances.	Does not require assessment.	Does not require assessment.	Does not require assessment.

1.3.151 The groundwater water body is currently assessed as achieving 'poor' overall status, with similarly both the quantitative and chemical status being at 'poor'.

Table 1.14: WFD groundwater water body within the study area (2016 status).

Waterbody	Waveney and East Suffolk Chalk and Crag.
Type	Groundwater
ID	GB40501G400600
Overall water body status/potential.	Poor (2016)
Overall water body objective.	Poor (2015)

	Disproportionate burdens. Groundwater status recovery time.
Quantitative	Poor
Quantitative status element.	Poor
Chemical (GW)	Poor
Chemical status element.	Poor

ff) Summary of baseline environment

1.3.152 The previous sections have described the physical controls, hydrology, geomorphology, water quality and ecology of the surface drainage system that surrounds the Sizewell C development site. The main findings of the baseline analysis, with respect to the functionality of the surface water system, presented in this section are summarised below:

- The drainage system is that of a low-lying coastal plain which largely consist of the low, flat valleys of Leiston Drain and the Minsmere River.
- Surface water drainage in the area comprises two main river systems that both discharge to the sea at Minsmere Sluice, Leiston Drain and the Minsmere River. Both systems are lowland catchments drained by a network of interconnecting drains, manually controlled and regulated by the operation of control structures.
- The Minsmere River is the larger of the two systems, contributing 79% flows into the study area, compared to approximately 14% from Leiston Drain. Flows in Leiston Drain are heavily influenced by the consented discharge of treated effluent from Leiston STW, which, on average, accounts for approximately 40%.
- The most important structure in the drainage system is the Minsmere Sluice. This structure is a coastal outlet which ultimately controls water levels in the Leiston Drain and Minsmere River systems (including Scott's Hall Drain). The sluice, which was refurbished in 2013/14, is designed to prevent flows from one freshwater system entering the other.
- 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 and are uniform and trapezoidal. Flows are generally very low.
- There is strong evidence that there is good hydraulic continuity between groundwater levels in the peat and water levels in the surface water drainage system. Surface water contributes to groundwater in the

upstream (western) parts of the drainage system, while groundwater contributes to surface waters in the downstream (eastern) parts of the drainage system.

- Water quality in the drainage catchments is generally good, although parts of the Leiston Drain are affected by consented discharges from the Leiston STW (which includes combined storm overflows from Leiston). Water quality in the downstream reaches of the watercourse is greatly influenced by the input of saline water from Minsmere Sluice, which results in elevated salinity and sulphate levels.
- The surface water drainage system supports a range of sensitive plants, invertebrates and birds. The distribution of these species is influenced by water quality and quantity.

1.4 Potentially Impacted Environment

a) Purpose of this section

1.4.1 This section identifies the Sizewell C development scheme activities that have the potential to impact upon surface water receptors and explains the mechanisms through which impacts could be realised. It also identifies those parts of the surface water environment described in **section 1.4** of this chapter that potentially could be affected by the development.

i. Scheme activities with potential to impact upon surface waters

1.4.2 The proposed Sizewell C development would comprise a wide variety of different components during the construction and operation phases. Initial analysis has been undertaken to identify which of these components has the potential to impact upon surface waters. The results of this process are presented in **Table 1.15** and **Table 1.16**.

1.4.3 However, it is important to acknowledge that the potential impacts of the proposed development on surface waters would be minimised (i.e. the mechanisms by which some of the activities currently identified in **Table 1.15** and **Table 1.16** could impact on surface waters would be reduced or removed) by the inclusion of in-built control measures within the scheme design. These measures are still in development, but are likely to include:

- Construction phase WMZs. These zones would intercept surface run-off, sediment and contaminants from the construction compound and laydown areas, and incorporate sustainable drainage measures such as swales, filter drains, detention basins and soakaways to promote infiltration. If full infiltration is not possible, these systems will also be designed to discharge into the surface drainage network at greenfield run-off rates to minimise the potential for impact.

- Design of watercourse modifications (including channel diversions and permanent and temporary bridge crossings) to minimise potential adverse impacts on flows, water levels, geomorphology and ecology.
- A foul water management strategy during the construction and operational phases to prevent the contamination of surface waters through release of effluent.
- An operational phase drainage system which would include sustainable drainage measures to intercept water, sediment and contaminants. The current preferred option is for the discharge from the operational drainage system up to the 1 in 100-year flood event to be routed out to sea via the cooling water outfall, thus avoiding the potential for adverse impacts on freshwater receptors.

1.4.4 **Table 1.15** and **Table 1.16** also provide an initial indication of the impacts that are expected to be designed out by the incorporation of control measures in the scheme design and are therefore would not result in changes to the surface water environment. These assumptions will be examined in detail in the assessment process, which will assume that these control measures are in place. Where full design details are not available during the assessment, appropriately conservative assumptions will be made and stated as such. Further details of the assessment process are provided in **section 1.7** of this chapter.

1.4.5 It should be noted that additional measures may be required to mitigate the impacts of different scheme elements on surface water receptors. These will be identified and evaluated during the assessment process.

Table 1.15: List of activities and associated potential impact mechanisms during construction.

Activity	Potential Mechanisms For Impact On Surface Waters.	Control Measures In Design (Section 19.4k).
Initial site preparation: construction of new access road, temporary construction areas, and bridges, excavation of borrow pit, stockpiling of materials, construction of the green rail route, installation of surface water drainage	Changes in surface water quality, quantity and distribution associated with land use change from natural vegetated surface to hard standing, sediment laden run-off, changes in surface water chemistry due to changes in the proportion of water received from different sources and changes in water quality associated with leakage or accidental spills of fuels, oils, lubricants and construction materials. Hydrological, geomorphological and water quality changes could have direct effects on	Construction phase WMZs. Dust control measures.

Activity	Potential Mechanisms For Impact On Surface Waters.	Control Measures In Design (Section 19.4k).
system, rerouting of ditches.	ecology and impact upon designated habitats (SSSIs and other designated sites). Increase in sediment from wind-blown dust derived from disturbed ground.	
Earthworks for platform development (this would involve the excavation of large amount of spoil comprising soil, made ground, peat, alluvium and crag sand to reach the foundation depths for the buildings and other structures) and pumping and discharge of groundwater during construction of platform and cut off wall.	Changes in surface water quality, quantity and distribution associated with land use change from natural vegetated surface to hard standing, sediment laden run-off, changes in surface water chemistry due to changes in the proportion of water received from different sources and changes in water quality associated with leakage or accidental spills of fuels, oils, lubricants and construction materials. Direct changes to groundwater flow patterns and volumes could result in impacts on surface waters (depending on where the water is discharged), including increased surface water flows, potential for geomorphological adjustment and changes to water chemistry as a result of an increased proportion of groundwater. Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites).	Construction phase WMZs. Any discharges would be a permitted activity, which would be agreed and consented by the Environment Agency.
Winning and placement of additional material to make up platform height (this extra material would either be won from within the temporary construction area, or sourced from off-site).	Changes in surface water quality, quantity and distribution associated with land use change, sediment laden run-off, and changes in water quality associated with leakage or accidental spills of fuels, oils and lubricants. Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites).	Construction phase WMZs.
Surface water drainage (construction site, laydown area and road infrastructure).	Changes in surface water quality, quantity and distribution associated with discharge of site run-off into the surface drainage network. Changes in surface water chemistry due to changes in the proportion of water received from different sources and changes in water quality associated with road run-off and leakage or accidental spills of fuels, oils, lubricants and other potential contaminants. Hydrological, geomorphological and water quality changes could have direct effects on	Construction phase WMZs.

Activity	Potential Mechanisms For Impact On Surface Waters.	Control Measures In Design (Section 19.4k).
	ecology and impact upon designated habitats (SSSIs and other designated sites).	
Discharge of foul water.	Discharge of treated effluent, impacting upon water quality and flow volumes. Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites).	Foul water management strategy. Any discharges would be a permitted activity, which would be agreed and consented by the Environment Agency.

Table 1.16: List of activities and associated potential impact mechanisms during operation

Activity	Potential Mechanisms For Impact On Surface Waters.	Control Measures In Design (Section 19.4k).
Presence of power station platform and cut-off wall.	Direct changes to groundwater flow patterns and volumes could result in impacts on surface waters (depending on where the water is discharged), including increased surface water flows, potential for geomorphological adjustment and changes to water chemistry as a result of an increased proportion of groundwater. Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites).	Operational phase drainage system Any discharges will be a permitted activity, which would be agreed and consented by the Environment Agency.
Surface water drainage (station and road infrastructure, changes to topography).	Changes in surface water quality, quantity and distribution associated with discharge of site run-off into the surface drainage network. Changes in surface water chemistry due to changes in the proportion of water received from surface and groundwater sources, and changes in water quality associated with road run-off and leakage or accidental spills of fuels, oils, lubricants and other potential contaminants.	Operational phase drainage system.

Activity	Potential Mechanisms For Impact On Surface Waters.	Control Measures In Design (Section 19.4k).
	Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites). Surface water drainage for the site (up to 1 in 100+ climate change) would be diverted to the sea via the fore bay.	
Presence of permanent SSSI crossing	Direct changes to bed and bank habitats could impact upon natural geomorphology. Changes to the volume and distribution of surface water flows, with the potential for geomorphological adjustment. Hydrological, geomorphological and water quality changes could have direct effects on ecology and impact upon designated habitats (SSSIs and other designated sites).	Watercourse modifications to minimise adverse impacts.

b) Potentially affected receptors

1.4.6 The control measures that would be implemented with the objective of preventing any changes in surface water (and groundwater) would be located as close as possible to the development so that the potential impacts of changes are likely to reduce with distance from the development site.

c) Sizewell Belts drainage unit and Leiston Drain

1.4.7 The Sizewell Belts drainage unit has the greatest potential to be affected by the development. The raising of the platform level and the rerouting of the Sizewell Drain and the construction of a cut-off wall have the potential to impact groundwater levels. This affect will be assessed as part of a groundwater modelling programme.

1.4.8 The Sizewell Belts drainage unit receives water draining from the high ground at Dunwich Forest and also land to the west. Topographic survey data identifies that the redline boundary of the development site bisects two small unnamed 'valleys' draining to the north of the Sizewell Belts drainage unit. The larger of the two originates to the south of Hilltop Covert. As with all elements of the development, unless adequately mitigated, the surface water run-off from the main construction and laydown areas could increase, leading to increased drainage to and higher water levels in the Sizewell Belts drainage unit. This impact would be mitigated through the use of a series of WMZs, designed specifically to limit outflows to the greenfield run-off rate. Furthermore, the WMZs would be designed to ensure that they do not affect water levels downstream.

1.4.9 It should also be noted that, in the current baseline condition, the land occupying the site of the Sizewell C platform drains directly to the Sizewell Drain, and also to the Leiston Drain downstream of its confluence with Sizewell Drain. In the developed scenario, surface water on the platform site would be managed through on-site systems (potentially including underground drainage networks and surface channels). It is expected that this water would be discharged through the fore bay to the North Sea for flood events up to the 1 in 100 years, with an allowance for climate change. Sizewell Marshes drainage unit and Sizewell Drain.

1.4.10 The Sizewell Marshes drainage unit drains to the Sizewell Drain, which discharges into the Leiston Drain immediately west of the proposed Sizewell C platform site. Any changes in the Sizewell Belts, and hence Leiston Drain, have the potential to be affected by water levels in the Sizewell Belts drainage unit. If water levels are lower in the Leiston Drain, more water will be drawn from the groundwater within the Sizewell Marshes. If levels in the Leiston Drain are elevated, water levels in the Marshes drainage system will also be higher.

d) Minsmere South Levels drainage unit and IDB Drain No.7

1.4.11 The Minsmere South Levels drainage unit, to the south of the Minsmere New Cut, is drained by IBD Drain No.7 and Tank Drain (which connects to IDB Drain No. 7 at National Grid Reference (NGR) TM471658). If unmitigated, the construction and laydown areas on Goose Hill and Dunwich Forest, as well as land to the west, could increase surface water run-off to the Minsmere South drainage unit. Water levels in the Minsmere South drainage unit could potentially also be affected by changes in the Sizewell Belts and Sizewell Marshes drainage units, which supply water to Minsmere South via the Leiston Drain.

e) Minsmere New Cut

1.4.12 All elements of the development are situated to the south of the Minsmere New Cut. The only way in which the development could impact water levels in the Minsmere New Cut would be via changes upstream of Dam Bridge. The Minsmere Old River receives water from IDB drain DRN163G0301, which drains the catchment between The berton and Eastbridge. The Minsmere Old River enters the Minsmere New Cut via a flapped outfall, immediately upstream of Dam Bridge. Run-off rates from the catchment draining to IDB drain DRN163G0301 could, if unmitigated, be increased as a result of the laydown areas to the north of the proposed campus.

1.4.13 The Minsmere Old River discharges into the Minsmere New Cut approximately 100m upstream of Minsmere Sluice. In addition, a short length of IDB Drain No. 7 flows from east to west and discharges into Minsmere

New Cut at the outfall immediately upstream of Dam Bridge. It is theoretically possible that large impacts on IDB Drain No. 7 or the Minsmere South Levels drainage units could have resulting impacts on Minsmere New Cut.

1.4.14 As discussed above there are theoretical mechanisms by which the Minsmere New Cut itself could by impacted by the proposed development. However, within the range of normal conditions, the mechanisms for further propagation of these impacts into adjacent drainage units (which are protected by flapped valves) are unlikely to result in measurable changes. These are discussed further in the section below.

f) Drainage units to the north of the Minsmere New Cut

1.4.15 As described in **section 1.4** of this chapter, the Minsmere Sluice incorporates a number of flapped outfalls. Any change in surface water conditions in the Leiston Drain would be prevented from directly impacting the Minsmere New Cut or drainage units to the north as a result of the flap valves on the Scott's Hall Drain and the Minsmere New Cut.

1.4.16 Scott's Hall Drain and Leiston Drain meet within the southern chamber of Minsmere Sluice, however the relative elevations of the two watercourses are such that with the normal range of conditions, changes to level within the Leiston Drain would not impede flow from Scott's Hall Drain. **Volume 2, Appendix 19B** of the **ES** states that, although a hydrological link between the two watercourses cannot be categorically dismissed, the potential for measurable hydrological impact on either side of the sluice is minimal.

1.4.17 There is a possibility of direct connectivity from the drainage units to the south of Minsmere New Cut to those to the north, but only during extreme events; according to **Volume 2, Appendix 19B** of the **ES** the southern sluice chamber is isolated from the New Cut and connected drainage units unless overtopping of the dividing wall occurs during flood conditions. It would therefore be expected that during flood events, the majority of flow would be derived from the Minsmere system rather than the Leiston system (cf. **Table 1.2**, **Table 1.3** and **Table 1.4**) and initial modelling suggests flow from north to south during 1000-year flood events. In any case these events are outside of the range of normal conditions that are considered as part of the EIA process, further details provided in **section 1.2c** and **section 1.7c** of this chapter.

1.4.18 **Volume 2, Appendix 19B** of the **ES** states that, given that surface water drainage from the proposed development would need to be limited to greenfield run-off rates, the potential impacts to the surface water regime are *"restricted to alterations in baseflow"*. It is also acknowledged that the construction of the groundwater cut-off wall is also likely to increase groundwater baseflow. However, provisional modelling outlined in the groundwater conceptual site model indicates that any potential increase in baseflow falls within the seasonal range of groundwater discharge into Leiston Drain, and that this "*impact is likely to be lower than the current level of flow depletion resulting from local water abstraction*". Small changes to baseflow volumes of the magnitude currently predicted are therefore "*extremely unlikely*" to result in and measurable changes to the operation of the sluice, provided in **Volume 2, Appendix 19B** of the **ES**. It is therefore concluded that all areas to the north of the Minsmere New Cut would remain unaffected by the proposed development.

g) Summary of potentially impacted environment

1.4.19 This section demonstrates that there are potential mechanisms for the proposed development (unmitigated) to impact upon the surface water system to the south of the Minsmere New Cut (**Figure 19E.2**), which includes the following drainage units:

- Leiston Drain.
- Sizewell Drain.
- IDB Drain No.7.
- IDB Drain DRN163G0201.
- Sizewell Marshes.
- Sizewell Belts.
- Minsmere New Cut.
- Minsmere South Levels.

1.4.20 This section also demonstrates that there are no mechanisms for the proposed scheme to impact upon the drainage system to the north of Minsmere New Cut (**Figure 19E.2**), which includes the following drainage units:

- Minsmere Old River.
- Dowleys & North Levels.
- Island Meer Old Reed Beds.
- Lowered Reed Beds.
- The Scrape.

- Eastbridge Meadow.

1.4.21 It is therefore proposed that the assessment of the potential impacts of the proposed development focusses on the surface water receptors that are situated to the south of the Minsmere New Cut, and that the receptors to the north are excluded from further assessment.

1.5 Surface water conceptual model

a) Purpose of this section

1.5.1 This section draws on the baseline information provided in **section 19.4** of this chapter and the discussion of potential scheme impacts in **section 1.5** of this chapter to develop a conceptual model of the surface water system within which the Sizewell C development site is located. This conceptual model defines how the different factors that control surface drainage interact across the study area and how the proposed development could affect the surface water system.

b) Surface water conceptual model

i. Surface water drainage network

1.5.2 Surface water drainage in the Sizewell C study area comprises two lowland, low energy river systems that both discharge to the sea at Minsmere Sluice; Leiston Drain and the Minsmere River. The Minsmere River is the larger of the two systems, contributing 79% flows into the study area, compared to approximately 14% from Leiston Drain. Flows in Leiston Drain are heavily influenced by the consented discharge of treated effluent from Leiston STW, which, on average, accounts for approximately 40%. The low, flat valleys of each river system are naturally wet, and both systems have been extensively modified by human activities.

1.5.3 This modification includes the enlargement and diversion of the main river channels, and the construction of a complex network of interconnecting drains throughout the floodplain on the valley floor. As a result of these modifications, the watercourses have uniform, trapezoidal channels with steep banks and very little geomorphological diversity. The dominant geomorphological processes are sediment deposition and, when flows have sufficient energy, sediment transport.

1.5.4 Water levels in the surface drainage network are controlled and regulated by the operation of control structures such as sluiced pipes, syphons, stop boards, and the tidal sluice at Minsmere. Water levels are managed so that they stay within a relatively narrow range, although there are variations between the spring-summer and autumn-winter seasons.

ii. Minsmere sluice

1.5.5 The most important control structure for the surface water drainage system in the Sizewell area is the Minsmere Sluice; a tidal sluice that is located at the downstream end of the Minsmere New Cut. The sluice is divided into two chambers, each with its own gravity-outlet culvert to the sea. The northern chamber receives flows from the Minsmere New Cut, while the southern chamber receives flows from the Leiston Drain and Scott's Hall Drain.

1.5.6 The sluice was previously in a poor state of repair, and the culverts and flap valves were refurbished in 2013/14. Prior to the remedial works, the poor condition and configuration of the outfalls (which lacked operational non-return valves) allowed uncontrolled ingress of water via overtopping of the central wall (from the other watercourses or from high tide levels) into the rest of the drainage system. It is important to note that this overtopping only occurred during high flows, and not during lower flows.

1.5.7 After completion of the remedial works to the sluice, SWT noted that winter water levels (2014-15) in Sizewell Marshes were higher than they have previously been. This had been attributed by the Environment Agency to the presence of several blockages on Leiston Beck. Some blockages were removed by the Environment Agency at the start of week commencing 30 March 2015, and afterwards a gradual reduction in water levels was observed in monitoring data from the site.

1.5.8 The refurbished sluice prevents the ingress of water from the Leiston Drain system into the Minsmere New Cut and Scott's Hall Drain and vice versa. Although it is possible that water could move upstream through the syphon into Scott's Hall Drain if the penstock was open, this could only occur if the seaward end of the culverts was to become blocked and the penstock on Scott's Hall Drain was opened. This means that although there is a potential mechanism for water that enters the sluice chamber to pass upstream into the Scott's Hall Drain, this mechanism is reliant on head differences that are unlikely to occur under normal flow conditions. Even under such extreme conditions, which would occur rarely, if at all, there would be no passage of water from Leiston Drain to Scott's Hall Drain unless the penstock to Scott's Hall Drain is open. If it were to be open, it could be closed to prevent this occurring. This means that the potential for measurable hydrological impact on either side of the sluice is minimal.

iii. Surface water-groundwater connectivity

1.5.9 As a result of the hydrology of the peat and crag deposits which underlie the site, the surface waters are strongly influenced by water levels and flows within the groundwater system. The surface and groundwater systems both respond rapidly to rainfall, and there is strong hydraulic connectivity between the two systems. Analysis of surface and groundwater levels demonstrates that surface water contributes to groundwater in the upstream parts of the Sizewell Marshes SSSI, and groundwater contributes to surface waters in the downstream parts of the SSSI. This means that any activities which affect surface or groundwater hydrology have the potential to affect the entire hydrological system, which should therefore be considered as a whole.

iv. Water quality

1.5.10 Water quality in the drainage catchments is generally good. However, parts of Leiston Beck/Drain are affected by consented discharges from the Leiston STW (which includes combined storm overflows from Leiston) and display elevated concentrations of ammonia, nitrate, nitrite and phosphate. In addition, the upstream end of Sizewell Drain is affected by road run-off, displaying elevated concentrations of TPH and several specific pollutants or WFD Priority Substances.

1.5.11 Water quality in the surface watercourses is influenced by the input of saline water from Minsmere Sluice, which results in elevated salinity and sulphate levels in the surface waters. The refurbished sluice is deliberately operated to allow some saline intrusion into Leiston Drain and Scott's Hall Drain at high tide.

v. Ecology

1.5.12 The surface water system supports important assemblages of invertebrates and rare vascular plants, as well as providing habitats for birds such as marsh harrier and bittern. The drainage system has been designated for its nature conservation value as a result of these features. The southern parts of the surface drainage network (including the Leiston Drain and surrounding drainage units) comprise the nationally designated Sizewell Marshes SSSI, and the northern parts (including the drainage units that connect to the Minsmere New Cut) form part of the nationally and internationally designated Minsmere to Walberswick Heaths and Marshes SSSI, SAC, SPA and Ramsar site.

1.5.13 The distribution of the sensitive invertebrate and plant species is closely connected to shading and is also likely to be influenced by water quality and quantity. The habitats that support the important bird species are also sensitive to changes in surface water. For example, bittern forage at the interface between reed beds and open water, and cannot forage if water levels are too deep, or if the water quality degrades significantly, leading to a reduction in the amount of fish species available as prey.

vi. Potential impacts

1.5.14 During its construction and operation stages, the proposed (unmitigated) development has the potential to cause changes in surface water quality, quantity and distribution, as well as hydrogeological and geomorphological changes which might affect ecology and impact upon designated habitats.

1.5.15 Specifically, the proposed development has the potential to change water levels and impact upon the surface water environment in the drainage units that are located to the south of the Minsmere New Cut, namely Leiston Beck and Leiston Drain, Sizewell Drain, IDB Drain No.7, Sizewell Marshes. Sizewell Belts and the Minsmere South Levels.

1.5.16 There are mechanisms for the proposed development to impact upon Minsmere New Cut. According to the Environment Agency (**Table 1.3**) the catchment of Minsmere New Cut (at Minsmere Sluice) is 65.2km^2. The area of land within the Minsmere South Levels drainage unit which drains westward and into Minsmere New Cut is estimated to be 0.37km^2, or around 0.6% of the total. With the flow and quality overwhelmingly controlled by the catchment upstream of Dam Bridge it is considered that any impact on Minsmere New Cut would be minimal.

1.5.17 The configuration and operation of the Minsmere Sluice means that, under normal conditions, there is no mechanism for the proposed development to impact upon the surface water receptors that are located to the north of Minsmere New Cut, namely the Minsmere Old River, Dowleys and North Levels, Island Meer Old Reed Beds, Lowered Reed Beds, The Scrape and Eastbridge Meadow.

1.5.18 The scheme will include in-built control measures, such as construction phase WMZs, an operational phase drainage system and a foul water management strategy for the construction and operational phases, designed to minimise the potential for impact on the surface water environment, in terms of both flow and chemical quality.

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NOTES

KEY

SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY

DEMARCATION LINE

NOT PROTECTIVELY MARKED

SZC
EDF ENERGY
CGN

DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 19E
SURFACE WATER CONCEPTUALISATION MODEL

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SITE LOCATION

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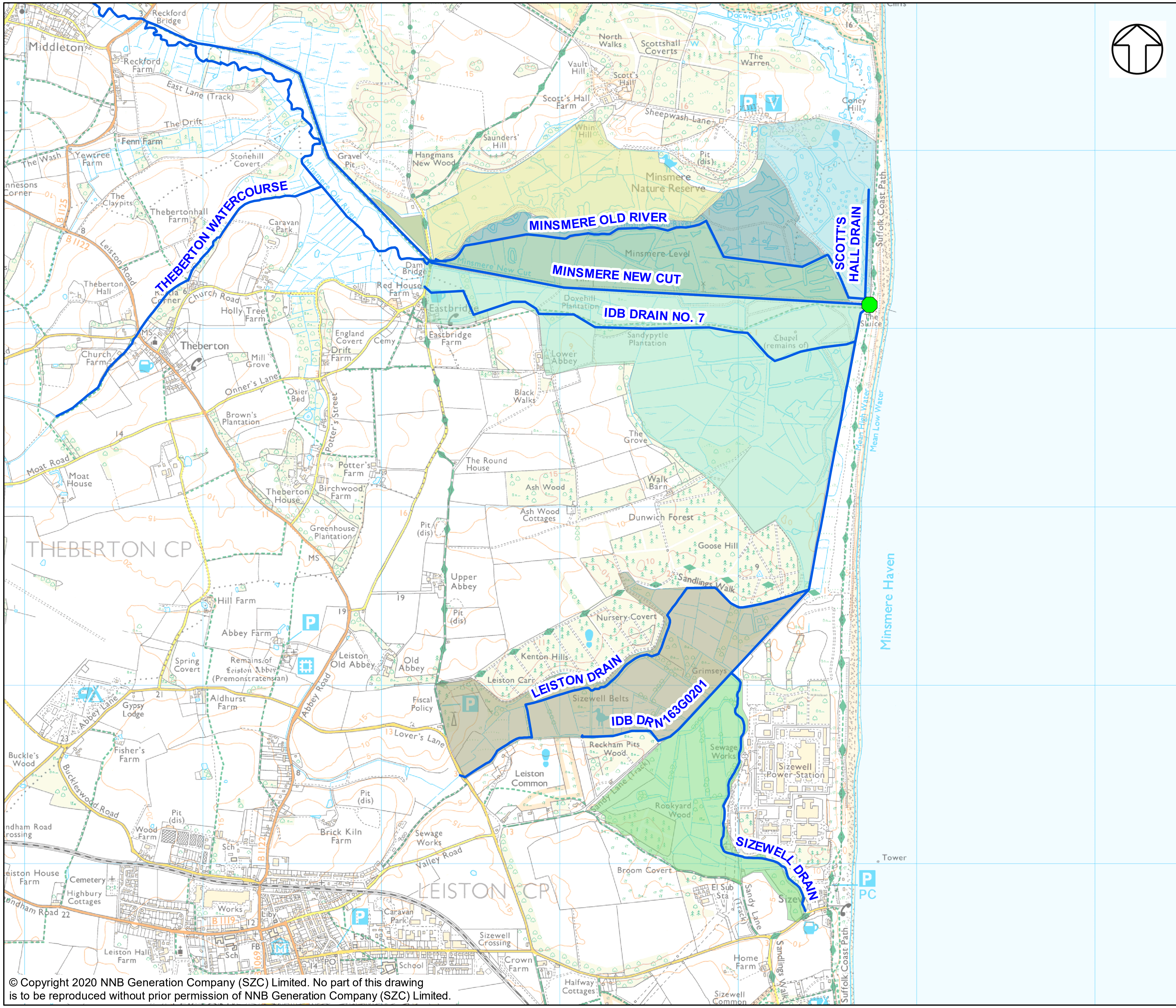

NOTES

KEY

- WATERCOURSES
- MINSMERE SLUICE

DRAINAGE UNITS

- SIZEWELL BELTS
- DOWLEYS AND NORTH LEVELS
- EASTBRIDGE MEADOW
- ISLAND MEER OLD REED BEDS
- LOWERED REED BEDS
- MINSMERE SOUTH LEVELS
- SIZEWELL BELTS
- THE SCRAPE

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EDF ENERGY SZC CGN

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SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 19E
SURFACE WATER CONCEPTUALISATION MODEL

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SURFACE WATER DRAINAGE UNITS

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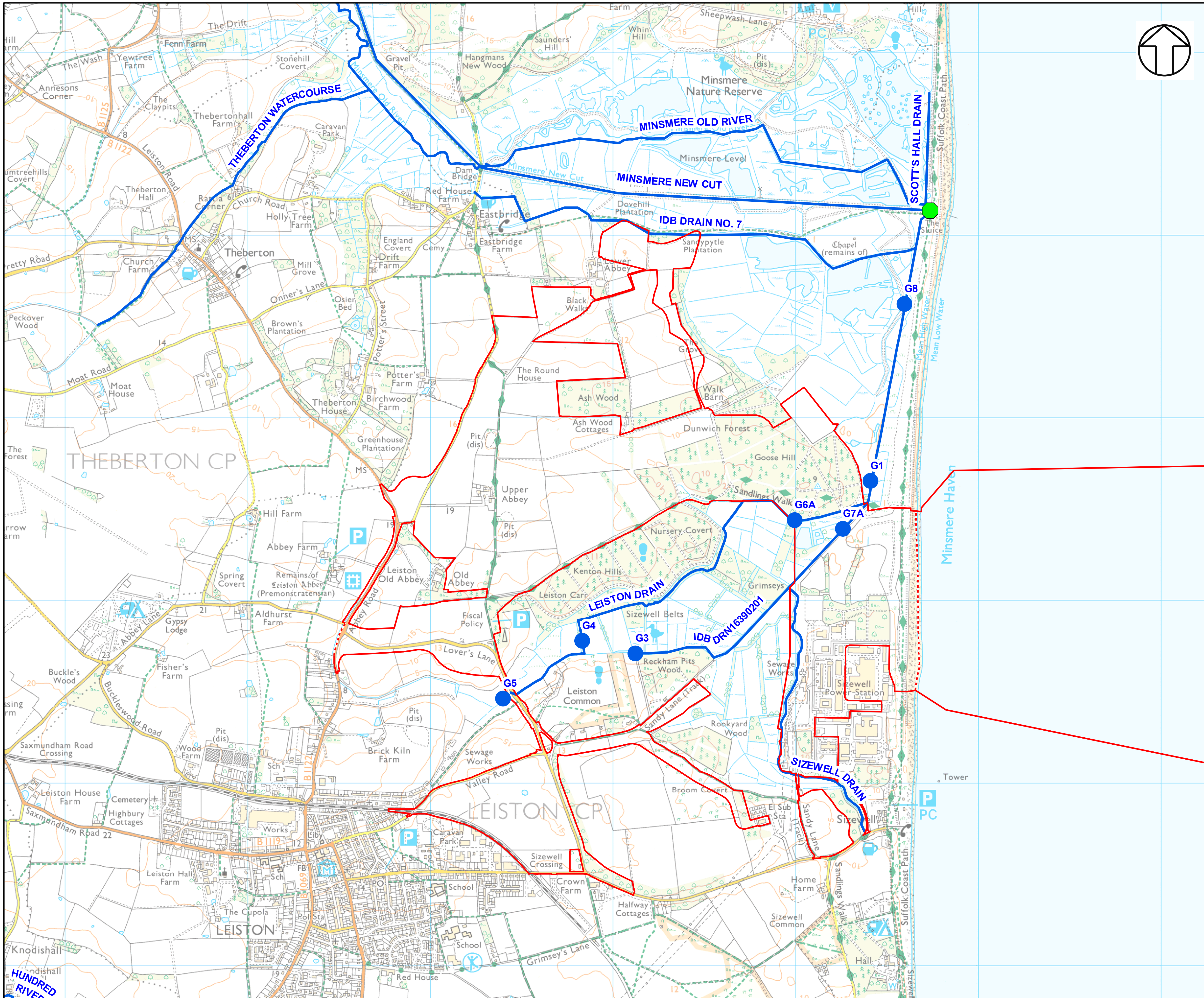

NOTES

KEY

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- DEMARCATION LINE
- WATERCOURSES
- SURFACE WATER MONITORING LOCATIONS
- MINSMERE SLUICE

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VOLUME 2
APPENDIX 19E
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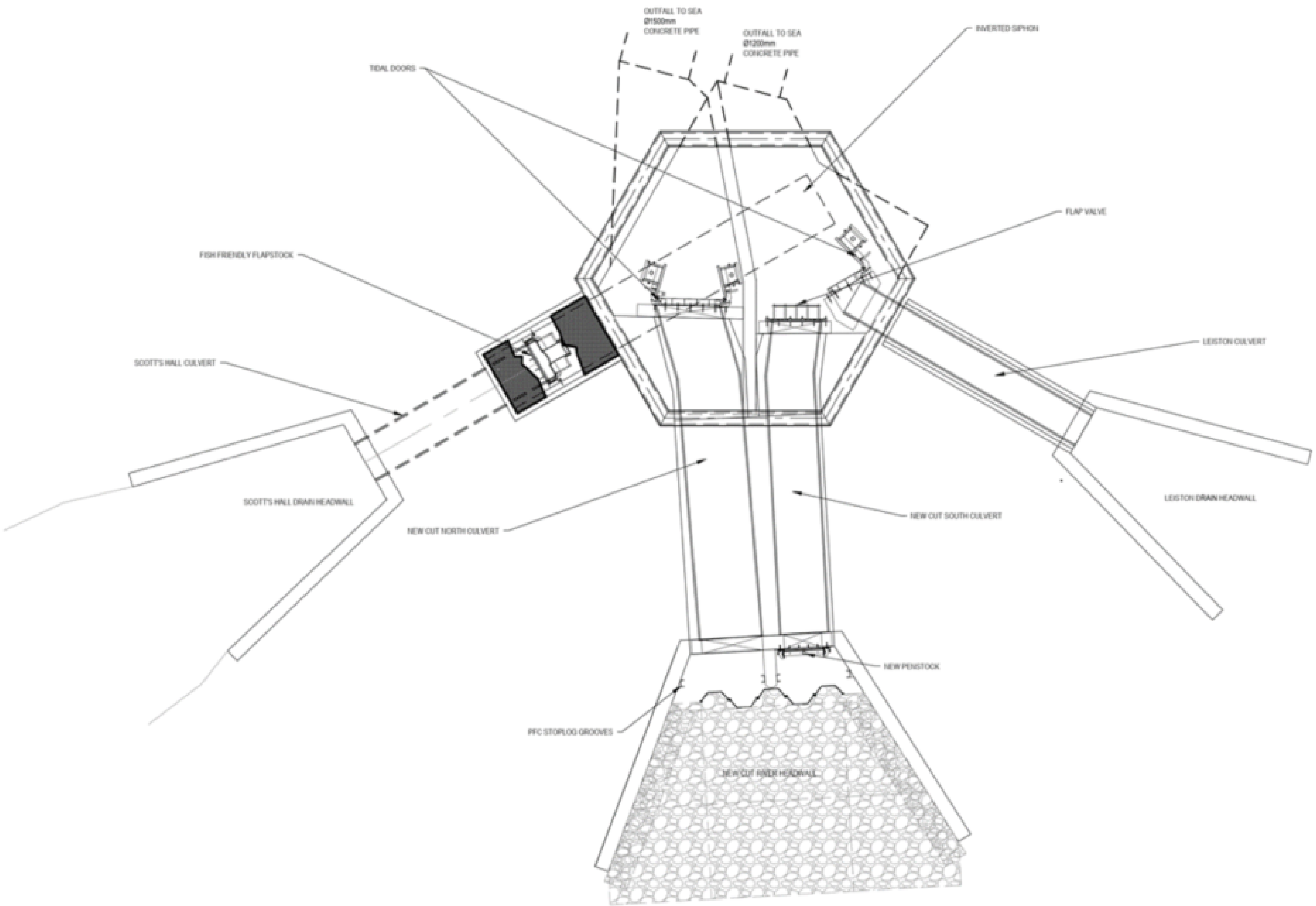

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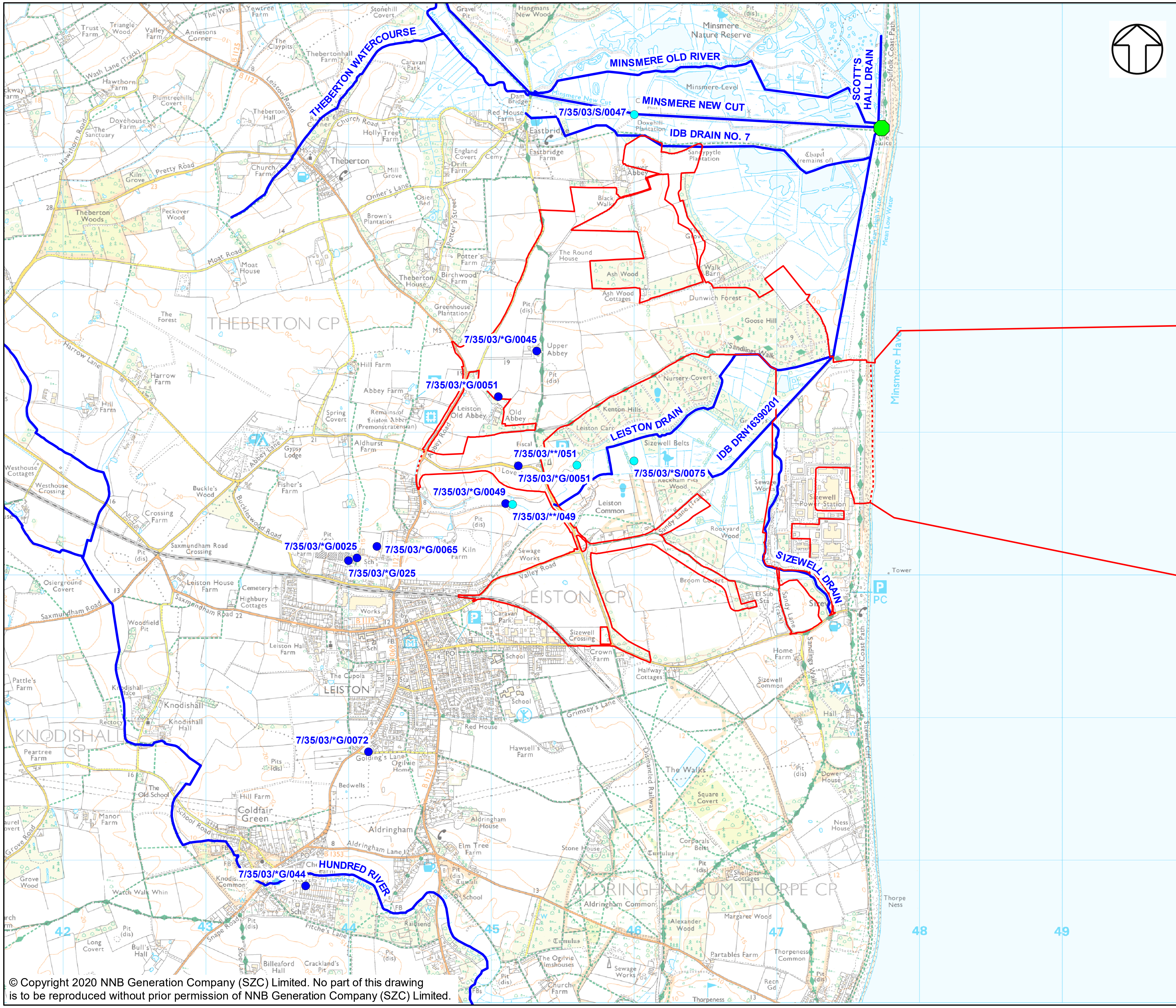

NOTES

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- DEMARCATION LINE
- WATERCOURSES
- MINSMERE SLUICE
- GROUNDWATER ABSTRACTION
- SURFACE WATER ABSTRACTION

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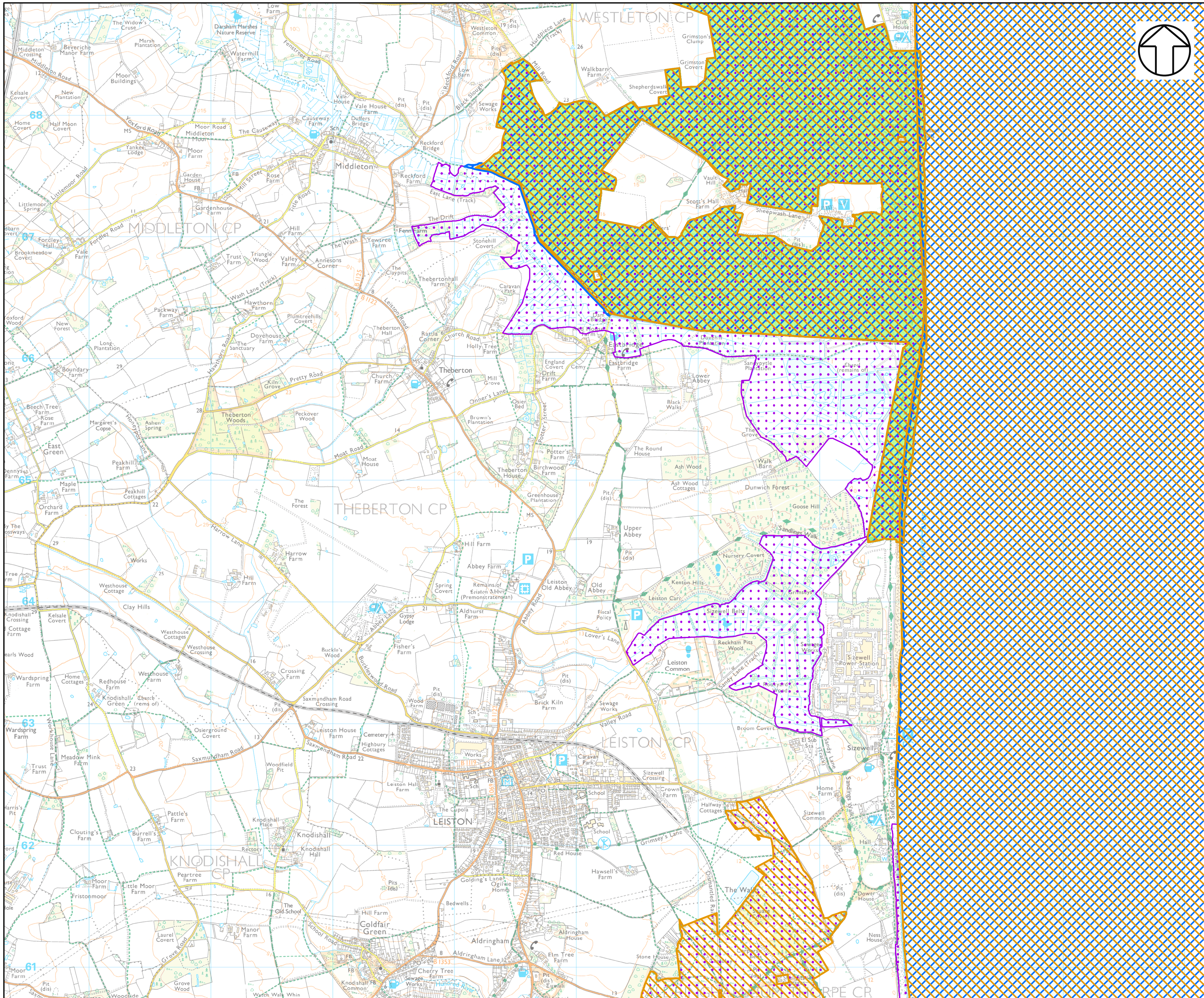

NOTES

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- SPECIAL AREA OF CONSERVATION
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR

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VOLUME 2
APPENDIX 19E
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VOLUME 2, CHAPTER 19, APPENDIX 19F : MONITORING AND RESPONSE STRATEGY

Contents

Tables

None provided.

Plates

None provided.

Figures

None provided.

Annexes

1. Monitoring and Response Strategy

1.1 Introduction

1.1.1 As part of the development of the Sizewell C power station there is the potential for changes to occur to the groundwater flow regime at the site and in the surrounding area. In order to establish an understanding of the groundwater and surface water regime at the site, an ongoing adaptive monitoring programme has been in place since 2013. The monitoring network has frequently been reviewed and updated during that time to incorporate new boreholes installed as part of the various Ground Investigations (GIs) undertaken. Monitoring data underpins the groundwater assessment, including the numerical model, and provides confidence to stakeholders that the conceptual understanding of the groundwater and surface water system is well developed.

1.1.2 The environmental impact assessment, particularly in relation to sensitive groundwater dependent ecological receptors, relies on the outputs of predictive numerical modelling scenarios. In order to demonstrate the anticipated change in the water environment used to inform the assessment is in line with that which actually occurs, a specific programme of monitoring is proposed. This strategy sets out the principles of the monitoring, and the mitigation approach should an unacceptable degree of change be observed.

1.2 Current monitoring network

a) Groundwater

1.2.1 The current monitoring network includes 86 No. borehole locations for monitoring groundwater within the Sizewell C site and surrounding area. Locations are shown on **Figure 19.3** of this volume and listed in **Annex 19F.1**.

1.2.2 Data loggers are installed at 49 No. of the locations, providing a continuous record of groundwater levels across the site, with readings taken at 15-minute intervals. Of these loggers, 17 No. are Conductivity, Temperature and Depth Sensor (CTD) loggers, recording electrical conductivity and temperature as well as groundwater level. Manual water level measurements are taken monthly at all monitoring locations. As well as providing an instantaneous groundwater level record, these manual readings are used to ensure that the logger data is compensated correctly and that the loggers are fully functioning and recording accurate data.

1.2.3 Manual temperature level and conductivity reading profiling is carried out monthly at five crag boreholes (C1D, C2D, C3D, C4D, GW3). These temperature level and conductivity reading profiles provide an indication as to the depth of the saline interface at the site.

1.2.4 Low flow groundwater sampling is undertaken across the site as appropriate to provide a baseline water quality and hydrochemistry dataset and to inform ongoing assessments.

b) Surface water

1.2.5 The Sizewell Marshes Site of Special Scientific Interest (SSSI) contains a series of interconnected drainage ditch systems. In order to provide further understanding of the flows and surface water levels within the SSSI, a programme of velocity and stage monitoring at seven locations is currently implemented. The rationale for the location of the gauges, shown on **Figure 19.3** of this volume, is as follows:

- G5 – upstream location to monitor surface water inflows to the Sizewell Marshes SSSI through the Leiston drain, within the extent of the Aldhurst Farm Habitat Creation Scheme;
- G3 and G4 – control structures (weirs) located to determine the partitioning of flow between Leiston drain (G4) and Sizewell drain (G3) at the upstream end of the Sizewell Marshes SSSI;
- G6a and G7a – downstream locations in the Leiston drain (G6a) and Sizewell drain (G7a);
- G1 – downstream location to monitor total outflow from the Sizewell Marshes SSSI (downstream of the Leiston beck/Sizewell drain confluence) in the Leiston drain; and
- G8 – installed approximately 500m south of Minsmere Sluice in 2015 in order to monitor changes in flow and level in the Leiston drain downstream of G1.

1.2.6 Monitoring locations G1, G5, G6a, G7a and G8 all comprise a bed mounted echo-correlation sensor (Nivus) which records both velocity and stage. The velocity is output to the timeview telemetry system, however as only one parameter can be output using this method, separate impress pressure transmitters were installed to allow for stage data to also be received by telemetry. The telemetry system outputs the data to the timeview website once every 24 hours, allowing for swift, remote view of the telemetered parameters. Additionally, the loggers can be manually downloaded on site for review as required.

1.2.7 During each monthly site visit, vegetation and silt clearance is undertaken to reduce the chance of the velocity sensor becoming blocked. The two batteries that power each Nivus are replaced with recharged ones to ensure that data collection continues with minimal risk of disruption. The batteries are replaced at least once every 6 weeks in order to ensure that there is sufficient charge to power the instruments.

1.2.8 G3 and G4 do not use a Nivus sensor to estimate velocity rates – these instead use a v-notch weir-based system, with separate impress pressure transmitters installed to allow for stage data to be received by telemetry. These sites do not have batteries that require changing and operate from an internal power source. As with the other gauging stations, vegetation and silt clearance is carried out on a monthly basis to maintain the operation of the weir.

c) Weather station

1.2.9 A weather station is currently in place at the site which monitors multiple parameters, including rainfall. The data from the weather station is downloaded as part of the monthly site visit and the batteries replaced every 6 months.

1.3 Future monitoring strategy

a) Introduction

1.3.1 The assessment of potential changes to the water environment shows that the predicted changes are limited in extent, magnitude and duration such that **no significant** environmental impacts should occur. However, it is recognised that reassurance monitoring is required to demonstrate that the predicted change is realised, and not exceeded, as the project progresses.

1.3.2 The future monitoring strategy presented within this document pertains to the monitoring recommended to understand the effect of the proposed development on the site in comparison to baseline conditions and to validate the effectiveness of the mitigation measures implemented. Detailed monitoring arrangements for the Sizewell Marshes SSSI will be captured within a monitoring plan, to be developed collaboratively with appropriate stakeholders. This monitoring plan could also be used inform a revised Water Level Management Plan for the SSSI. Sentinel boreholes will be used to identify any potential changes that may extend to the Minsmere Walberswick Heaths and Marshes SSSI.

1.3.3 All of the monitoring requirements will be captured in a monitoring plan, to be agreed prior to the commencement of works. The monitoring plan will initially be based on the continuation of baseline monitoring, however, it will be regularly reviewed and proactively managed such that additional monitoring points will be incorporated as necessary to ensure adequate coverage is maintained throughout all phases of the proposed development.

b) Monitoring approach

1.3.4 In the first instance the monitoring strategy is to continue the baseline monitoring programme in terms of frequency, locations, and collection of the same data type.

1.3.5 The aims of the monitoring strategy are as follows:

- to collect appropriate monitoring data to facilitate comparison with the long-term baseline dataset;
- be adaptive such that as the proposed development evolves, suitable monitoring is in place throughout e.g. installation of additional monitoring infrastructure to validate the performance of the cut-off wall prior to commencement of dewatering;
- to provide sufficient reassurance monitoring data to allow comparison between actual and predicted water levels;
- provide sentinel boreholes to test that there is no change extending to other sensitive receptors such as the Minsmere Walberswick Heaths and Marshes SSSI;
- to facilitate ongoing engagement with Suffolk Wildlife Trust; and
- a framework of 'trigger' and 'action' levels to determine when management actions are required will be agreed with stakeholders. These may be captured in an updated Water Level Management Plan for the Sizewell Marshes SSSI, or implemented as a standalone control measure. The monitoring plan will provide the mechanism to assess whether these actions are needed.

1.3.6 In addition to ongoing groundwater and surface water monitoring, there will be continued monitoring of vegetation to establish ecological changes. Should ecological change be identified and be attributed to hydrological change, this would lead to a review of the previously agreed trigger levels and corrective action being taken accordingly.

c) Proposed monitoring principles

1.3.7 The existing monitoring network is appropriate for the site in its present state and is likely to continue to be so during early stages of construction such as site clearance. However, as construction progresses, and the site moves into subsequent phases, the monitoring requirements will change.

1.3.8 The monitoring plan will be kept as a live document and revised regularly to ensure it remains fit for purpose for the activities being undertaken at the site. Appropriate stakeholders, such as the Environment Agency, Natural England and Suffolk Wildlife Trust will be appraised of proposed changes to the monitoring plan in line with changing activities on site.

1.3.9 Updates to the monitoring plan will be undertaken in line with the following principles:

- the monitoring undertaken should be proportionate to risk;
- the monitoring requirements should be informed by the outcome of assessment;
- the monitoring should take into consideration the extensive baseline monitoring dataset;
- the monitoring should make use of the existing monitoring infrastructure where possible;
- the monitoring will focus on the impact of the proposed development on the Sizewell Marshes SSSI and Minsmere Walberswick Heaths and Marshes SSSI; and
- the monitoring network will be adaptive and dependent on the project phase and the data/assessment requirements. The network will incorporate additional monitoring points introduced during future GIs as appropriate.

d) Mitigation approach

1.3.10 An adaptive trigger level approach will be taken, in line with the following principles:

- change from baseline conditions identified;
- plan to prepare for pre-determined action; and
- the implementation of mitigation.

1.3.11 This would be implemented as a standalone control measure but could be captured in an updated Water Level Management Plan for Sizewell Marshes SSSI.

1.3.12 Trigger levels would be defined, which would relate to the degree of change observed such as change in level or flow, and duration of the change. Each trigger level would involve suitable intervention to mitigate the unacceptable change. For example, this may require altering the control structures within the Sizewell Marshes SSSI to modify the movement of water through the wetland.

1.3.13 The trigger levels would be developed to be cognisant of the sensitivity of the receptor to the potential impact identified. A mitigation toolkit would be developed from which the appropriate mitigation can be drawn, based on the trigger level that has been reached.

1.3.14 It is envisaged that the principal mitigation options would relate to the new control structure to be installed at the northern end of the realigned Sizewell drain and operational practice within the Sizewell Marshes SSSI. Consequently, this approach is consistent with the existing operational management regime within the system.

1.3.15 The entire process would have continued oversight by appropriate technical specialists, in conjunction with key stakeholders, who would provide advice on the trigger levels reached, the levels of intervention and the subsequent mitigation requirements.

1.4 Summary

1.4.1 A comprehensive monitoring network is currently in place at the site, the locations of which are presented on **Figure 19.3** of this volume and listed in **Annex 19F.1**. The network includes 86 No. groundwater monitoring locations, seven surface water monitoring locations and a weather station.

1.4.2 The assessment of potential changes to the water environment shows that the predicted changes are limited in extent, magnitude and duration such that no significant environmental impacts should occur. However, it is recognised that reassurance monitoring is required to demonstrate that the predicted change is realised, and not exceeded, as the Sizewell C Project progresses. All of the monitoring requirements will be captured in a monitoring plan which shall be agreed prior to the commencement of works.

1.4.3 The monitoring plan will initially be based on the continuation of the baseline monitoring programme. The plan will be regularly reviewed and proactively managed to ensure that adequate coverage is maintained throughout all phases of the proposed development.

1.4.4 The monitoring will be focused in the areas where the assessment modelling showed potential change to occur, e.g. Sizewell Marshes SSSI, however sentinel boreholes will be incorporated to demonstrate that the change doesn't extend to other sensitive receptors.

1.4.5 A framework of 'trigger' and 'action' levels to determine when management actions are required will be agreed with stakeholders. This would be implemented as a standalone control measure but could be captured in an updated Water Level Management Plan for Sizewell Marshes SSSI. The monitoring plan will provide the mechanism to assess whether and when these actions are implemented.

1. Annex 19F.1 Monitoring Location List

Table 1.1: Monitoring location list.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
P1	-	646986	263819	0.484	1.99	Peat	Manual dip and WL logger download.
P2	-	646855	263748	0.609	1.99	Peat	Manual dip and WL logger download.
P3	-	646478	263761	0.951	1.97	Peat	Manual dip and WL logger download.
P4	-	646935	264023	0.526	1.99	Peat	Manual dip and WL logger download.
P5	-	646724	263987	0.776	1.99	Peat	Manual dip and WL logger download.
P6	-	646525	264105	0.813	1.94	Peat	Manual dip and WL logger download.
P7	-	647029	264188	0.704	1.98	Peat	Manual dip and WL logger download.
P8	-	646809	264246	0.654	1.98	Peat	Manual dip and WL logger download.
P9	-	646665	264287	0.762	1.95	Peat	Manual dip and WL logger download.
P10	-	647323	264466	0.544	1.99	Peat	Manual dip and WL logger download.
P11	-	647189	264376	0.435	1.98	Peat	Manual dip and WL logger download.
P12	-	646923	264427	0.766	1.97	Peat	Manual dip and WL logger download.
P13	-	647426	264795	0.516	1.85	Peat	Manual dip and WL logger download.
P14	-	646742	263648	0.746	1.98	Peat	Manual dip and WL logger download.
P15	-	646520	263856	0.684	1.97	Peat	Manual dip and WL logger download.
PZ2009_2	MPM2009_7A	647346	264112	1.760	46.80	Crag	Manual dip and WL logger download.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
PZ2009_3	MPM2009_4A	647352	264218	1.560	47.95	Crag	Manual dip and WL logger download.
PZ2009_5	DBH2009_5	647305	264094	1.414	21.32	Sand	Manual dip and WL logger download.
PZ2009_6	DBH2009_6	647249	264095	1.513	21.61	Sand	Manual dip and WL logger download.
PZ2009_7	DBH2009_7	647088	264094	1.694	20.90	Sand	Manual dip and CTD logger download.
PZ2009_8	DBH2009_8	647339	264095	1.674	35.82	Sand	Manual dip and WL logger download.
PZ2009_10	DBH2009_10	647411	264095	1.784	35.98	Sand	Manual dip and CTD logger download.
PZ2009_11	DBH2009_11	647560	264095	3.253	20.50	Sand	Manual dip and CTD logger download.
PZ2009_13	DBH2009_13	647330	263969	2.052	20.64	Sand	Manual dip and CTD logger download.
PZ2009_14	DBH2009_14	647330	263846	6.270	20.63	Sand	Manual dip and CTD logger download.
PZ2009_15	CBH2009_5	647191	264181	1.281	40.38	Crag	Manual dip and CTD logger download.
PZ2009_16	CBH2009_7	647059	263872	3.583	56.50	Crag	Manual dip and CTD logger download.
PZ2009_17	DBH2009_15	647156	264674	6.036	21.35	Sand	Manual dip and CTD logger download.
PZ2009_18	GW6D	647289	264397	0.710	14.24	Crag	Manual dip and CTD logger download.
PZ2009_19	GW5	646846	264688	6.996	12.38	Crag	Manual dip and WL logger download.
PZ2009_20	GW4	646262	264492	7.171	11.66	Crag	Manual dip and CTD logger download.
PZ2009_21	GW19	647074	263591	6.387	10.15	Sand and Gravel.	Manual dip and CTD logger download.
C1 S	-	646559	263657	1.366	6.26	Crag	Manual dip and WL logger download.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
C1 D	-	646560	263657	1.297	20.15	Crag	Manual dip, CTD logger download and temperature level and conductivity reading profile.
C2 S	-	646525	264203	1.793	6.21	Crag	Manual dip and WL logger download.
C2 D	-	646527	264204	1.772	19.80	Crag	Manual dip, CTD logger download and temperature level and conductivity reading profile.
C3 S	-	647319	264638	2.801	7.04	Crag	Manual dip and WL logger download.
C3 D	-	647320	264639	2.769	20.83	Crag	Manual dip, CTD logger download and temperature level and conductivity reading profile.
C4 S	-	647002	264442	1.423	6.35	Crag	Manual dip and WL logger download.
C4 D	-	647001	264442	1.421	23.06	Crag	Manual dip, CTD logger download and temperature level and conductivity reading profile.
GW3	-	645662	264140	10.510	15.15	Crag	Manual dip, CTD logger download and temperature level and conductivity reading profile.
GW6S	-	647288	264395	0.704	5.82	Made ground	Manual dip and WL logger download.
GW7	-	647245	264293	1.894	7.64	Made ground	Manual dip.
GW8	-	647468	264354	7.270	11.06	Made ground	Manual dip.
GW9S	-	647592	264455	3.049	6.73	Gravel	Manual dip.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
GW9D	-	647592	264456	3.063	17.83	Crag	Manual dip.
GW10	-	647394	264178	1.763	6.49	Made ground	Manual dip.
GW11S	-	647150	264095	1.480	9.48	Peat	Manual dip.
GW11D	-	647149	264095	1.482	19.35	Crag	Manual dip.
GW11S1	-	647152	264095	1.502	5.56	Made ground.	Manual dip.
GW12	-	647509	264092	8.580	13.85	Made ground (clay) and Crag Sand.	Manual dip.
GW13	-	647575	264085	3.192	7.27	Gravel	Manual dip.
GW15	-	647317	264004	1.578	5.54	Made ground.	Manual dip.
GW16D	-	647439	263800	6.481	10.90	Made ground.	Manual dip.
GW20	-	647079	262945	2.724	7.90	Crag	Manual dip and WL logger download.
GW21	-	647056	262797	8.734	13.20	Made ground (clay) and Sand.	Manual dip.
GW24S	-	647158	264256	1.523	5.27	Sand	Manual dip and WL logger download.
GW24D	-	647157	264254	1.441	16.16	Crag	Manual dip.
BP12	-	645713	264789	12.010	20.32	Crag	Manual dip.
BP23	-	646544	265007	8.650	12.24	Crag	Manual dip and WL logger download.
BP27	-	645577	265683	11.920	20.48	Crag	Manual dip.
BDG1	-	647324	264544	1.680	15.54	Crag	Manual dip and WL logger download.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
C7	-	645315	265287	15.730	20.10	Crag	Manual dip.
BP6	-	645450	265231	16.440	20.56	Crag	Manual dip.
BP7	-	645701	265224	16.410	20.85	Crag	Manual dip.
BP9	-	645542	265361	13.630	20.37	Crag	Manual dip.
BP28	-	645608	265523	10.310	20.05	Crag	Manual dip and WL logger download.
BR15	-	645337	264757	15.250	12.32	Crag	Manual dip.
CPB_BP_11	-	645574	265148	17.370	19.69	Crag	Manual dip and CTD logger download.
CPB_BP_13	-	646009	265384	12.070	20.10	Crag	Manual dip.
CPB_BP_14	-	646038	265267	13.930	19.36	Crag	Manual dip.
SD_BP_3	-	645574	265405	12.390	45.19	Crag	Manual dip.
SD_BP_5	-	645586	265286	15.470	25.26	Crag	Manual dip.
SD_BP_6	-	645929	265296	14.140	25.38	Crag	Manual dip.
SD_BP_7	-	645326	265151	17.230	23.50	Crag	Manual dip.
SD_BP_8	-	645580	265036	15.660	25.00	Crag	Manual dip.
Piez 1A	-	645457.5	263523.4	1.980	2.37	Peat	Manual dip.
Piez 1B	-	645458.7	263523.9	1.940	2.70	Peat	Manual dip.
Piez 2A	-	645439.7	263551.1	2.120	1.53	Peat	Manual dip.
Piez 2B	-	645440.7	263551.8	2.100	1.01	Peat	Manual dip.
Piez 3A	-	645542.7	263621.8	1.630	3.97	Peat	Manual dip.

Location.	Previous Borehole ID.	Easting.	Northing.	Ground Level (mAOD).	Base of Borehole (mbgl).	Response Zone.	Monitoring Undertaken.
Piez 3B	-	645543.5	263622.6	1.650	0.43	Peat	Manual dip.
GR09	-	644733.9	263725.8	14.830	15.30	Sand	Manual dip.
GR11	-	644538.3	263797.9	10.840	11.82	Sand	Manual dip and CTD logger download.
AF6	-	645327.2	263322.1	6.040	11.00	Sand	Manual dip.
BH1	-	645431	263516	2.430	5.00	No BH Log.	Manual dip.
RR7	-	645343.5	264041.9	9.030	-	Sand	Manual dip.