River Wensum: Costessey Boreholes Permit

HRA - Stage 2 Appropriate Assessment

27 March 2020

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The preparation of Rev C and Rev D of this report includes the contribution of Atkins, who worked alongside Mott MacDonald to respond to feedback received on Rev B.

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Contents

Tables

Figures

Executive summary

The River Wensum is a Special Area of Conservation (SAC) from near its source downstream to Hellesdon Mill on the north-western outskirts of Norwich. Anglian Water currently abstract from the river at Heigham to supply Norwich. When required, the boreholes at Costessey are used to supplement water supply, via the Costessey Pits.

To maintain security of supply, Anglian Water have proposed a drought action for the Costessey boreholes that would allow a temporary increase in the maximum annual licensed abstraction rate from the boreholes. This increase in groundwater abstraction has the potential to impact groundwater dependent features within the study area as well as flows and river levels within the River Wensum.

The Costessey boreholes are adjacent to the SAC which is also a Site of Special Scientific Interest (SSSI). Qualifying features include the following habitats:

- Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
- White-clawed crayfish (*Austropotamobius pallipes*)
- Desmoulin's whorl snail (*Vertigo moulinsiana*)
- Brook lamprey (*Lampetra planneri*)
- Bullhead (*Cottus gobio*)

As part of the environmental assessment carried out for this drought permit, a Stage 1 Screening Assessment has been undertaken to assess the environmental effects of the proposed drought permit (Mott MacDonald 2018). The Stage I Screening concluded that there are mechanisms by which potential impacts arising from the proposed drought permit could result in Likely Significant Effects (LSE) on the qualifying features of the River Wensum SAC. This is with the exception of white clawed crayfish (*Austropotamobius pallipes*).

This report details Stage 2 of the Habitats Regulations Assessment (HRA), which is required to provide an assessment of the impacts of the proposed drought permit on the European designated sites within the Zone of Influence (ZoI).

Impacts have been identified that could affect the local distribution of designated species within the ZoI of the drought permit. Although these impacts are not expected to significantly affect the overall integrity of the SAC, monitoring and mitigation measures have been identified. Impacts include:

- River flows are expected to reduce by an average of 7.5% and up to 12.1% in the River Wensum SAC. This is within the acceptable range of deviation from natural flows in order to comply with Good status under the Water Framework Directive (WFD), but it is not in the range of acceptable deviation from natural flows to comply with the flow targets of the River Wensum SAC.
- Groundwater levels are expected to reduce as far as the SSSI units that have been identified as optimum habitat for Desmoulin's whorl snail (i.e. Units 38/39 and 40-44).

Monitoring and mitigation measures have been identified that are considered sufficient to mitigate against temporary periods of reduced flow and lowered groundwater levels. Mitigation and monitoring measures are presented in the Environmental Assessment Report (EAR).

Although there is no velocity data currently available for this assessment, we can make the assumption based on the previous modelling results (Mott MacDonald, 2014) that the expected velocity changes will only be minor (reduction of about 2%) and will not jeopardise the distribution and integrity of the River Wensum SAC qualifying features. The reduction in groundwater is likely to have a more significant effect on SSSI Units 38/39, but the spatial scale is relatively small and is offset by the monitoring and mitigation measures proposed in the EAR.

1 Introduction

1.1 Background

Anglian Water abstracts water from the River Wensum at Heigham via the Costessey pits to Heigham WTW. When required, the Costessey groundwater source is used to supplement water supply. In the event of a severe drought, it is proposed that the Costessey groundwater source could be used to support water supply. To achieve this, the drought permit would support a temporary increase in the maximum annual licensed abstraction rate at the Costessey groundwater source from 2000Ml/yr to 4800Ml/yr. The proposed drought permit would be triggered when flows at Heigham are approximately 80Ml/d. 80Ml/d is calculated as the Heigham HOF of 27Ml/d, plus a small operating margin, plus the annual average abstraction at Heigham of 41.8Ml/d. As per current guidance, the drought permit would cover a six month period and it is understood that reapplication for a further six months would be permissible[1]. Flow analysis of the worst historic (1991-93) and modelled 1 in 200 yr droughts suggest flows would not fall below 80Ml/d.

The Environment Agency's Water Company Drought Plan Guidance (Environment Agency, 2017) states that a water company must ensure that its plan meets the requirements of the Conservation of Habitats and Species Regulations (UK Government, 2017). As such, it must undertake a Habitats Regulations Assessment (HRA) on the effects of the drought permit on European sites, alone or in combination with other plans.

1.2 Habitats Regulation Assessment Framework

In accordance with Article 63 of the Habitats Directive, an Appropriate Assessment is required where a plan or project not directly connected with or necessary to the management of a Natura 2000 site(s), may give rise to significant effects upon a Natura 2000 site(s). The requirement for an Appropriate Assessment has been transposed into UK law under Regulation 61 of the Conservation of Habitats and Species Regulations 2017 ('Habitats Regulations') (S.I. 2017/1012) (as amended) and is commonly referred to as a 'Habitats Regulations Assessment' (HRA).

Natura 2000 sites form a network of European protected sites, designated for their rare, vulnerable and/or endangered species and habitats. Natura 2000 sites include Special Areas of Conservation (SAC) and Special Protection Areas (SPA). HRAs are also required, as a matter of UK Government policy, for potential SPAs (pSPA), candidate SACs (cSAC) and wetlands of international importance (Ramsar sites) for the purposes of considering plans and projects, which may affect them. Hereafter all of the above designated nature conservation sites are referred to as "European sites".

The HRA is undertaken in a series of steps, referred to as 'stages' in the case of the assessment of projects or 'tasks' in the case of the assessment of plans (Department for Communities and Local Government (DCLG, 2006). The series of stages correspond with the Assessments prescribed by the Habitats Regulations Assessment Handbook (Figure 1). This guidance has been followed for this assessment.

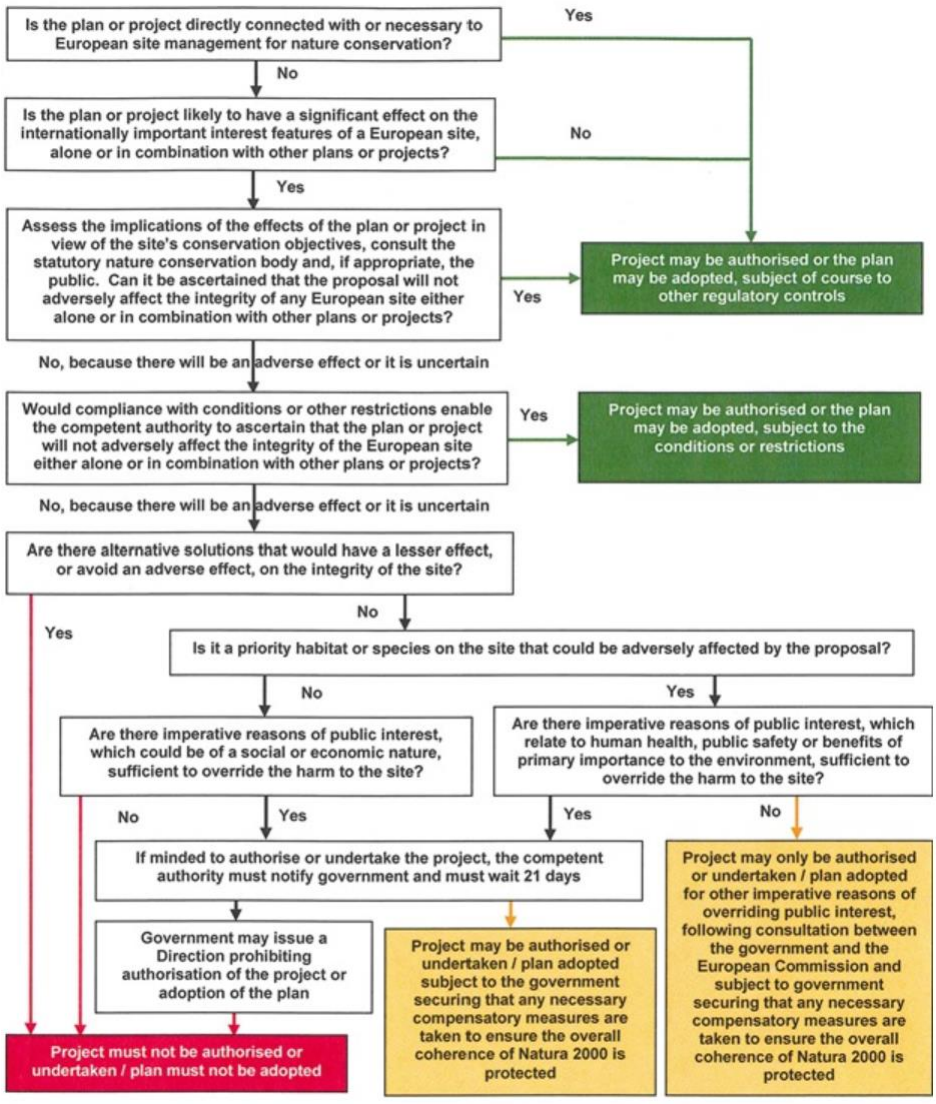
Each stage determines whether further stages in the process are required. The first stage identifies Likely Significant Effects (LSEs) by identifying the presence or absence of significant

[1] https://www.gov.uk/guidance/apply-for-a-drought-permit

indicators. If the conclusion of Stage 1 is that there will be no significant impacts on the European site(s), there is no requirement to undertake further stages.

Where a project or plan is likely to give rise to significant effects upon a European site(s), an assessment must be made of the implications on the integrity of that site in view of that site's structure, function and conservation objectives (Stage 2), either alone or in-combination. Furthermore, where there are adverse impacts, an assessment of potential mitigation measures will also be required in Stage 2. If it is concluded that adverse impacts are likely to remain after mitigation, there must be an examination of alternative ways to complete the project that avoids adverse impacts on the integrity of the site (Stage 3). Where alternatives exist, these should be subjected to Stage 1 and/or Stage 2 assessments. Where no alternatives exist, it is necessary under Regulation 64 of the Habitats Regulations to identify if there are or are not Imperative Reasons for Overriding Public Interest (IROPI). If there are IROPI then compensatory measures must be assessed (Stage 4) under Regulation 68 of the Habitats Regulations.

Figure 1: Assessment process



1.3 Scope of the Stage 2 Appropriate Assessment

Under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) ("Habitat Regulations"), a competent authority must make an appropriate assessment of the implications of the plan or project.

As part of this project, a Stage 1 Screening for the assessment of LSE was already undertaken to assess the environmental effects of the proposed drought plan (included in Mott MacDonald, 2018). The Stage 1 Screening concluded that the project will have LSE on the River Wensum SAC, with all the qualifying habitats and features therefore requiring an Appropriate Assessment. This is with the exception of white clawed (or Atlantic stream) crayfish (*Austropotamobius pallipes*) which is not considered in this assessment.

This report therefore details Stage 2 of the HRA which is required to:

- Consider the impact of the project on the integrity of the Natura 2000 site, either alone or in combination with other projects and plans, with respect to the conservation objectives of the site and its structure and function; and
- Assess potential mitigation strategies where adverse impacts are identified, including setting out a timescale and identifying mechanisms through which the mitigation measures will be secured, implemented and monitored.

Potential impacts may be direct or indirect and are dependent on the relationship between the action (implementation of the drought permit) and the receptor (the qualifying features of the European site). The significance of an impact is relative to the sensitivity, existing condition and conservation status of the qualifying features of the site and the scale of the impact in space and time.

Potential impacts on the qualifying features of the European site are evaluated with respect to the scale, extent and nature of the impact, for example the area of habitat affected, changes in hydrodynamics, potential changes in species distribution, and the duration of the impact. The sensitivities of each of the qualifying features are also assessed.

This report will be sent for consultation with relevant nature conservation authorities and the public. Following consultation, if it is considered that residual adverse effects remain, the next stage of HRA (Assessment of Alternative Solutions) would be required.

1.4 Methodology

This Stage 2 assessment has been formulated using the following approach:

- Detailed assessment of the potential impacts of the proposed drought permit (Costessey boreholes) for the River Wensum;
- Assessment of the European sites' characteristics and identification of their conservation objectives;
- Review of existing baseline data collected in relation to drought permits on the River Wensum, including Environment Agency catch data for all years.
- Identification of the aspects of the proposed drought permit that could significantly impact the conservation objectives of the European sites; and
- Review of all formal and informal consultation responses.

This assessment has been undertaken in accordance with the following guidance:

- EC (2000) *Managing Natura 2000 Sites*. The provisions of Article 6 of the Habitats Directive 92/43/EEC;
- EC (2001) *Assessment of plans and projects significantly affecting Natura 2000 sites.* Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. Brussels (November 2001);
- Environment Agency (2017). *Drought plan guideline extra information. Environmental Assessments for Water Company Drought Plans;*
- 12/WR/02/7 Strategic Environmental Assessment and Habitats Regulations Assessment-Guidance for Water Resources Management Plans and Drought Plan; and
- Tyldesley & Chapman (2013). *The Habitats Regulations Assessment Handbook.*

The River Wensum SAC is within the area of the proposed works.

1.5 Structure of the report

The structure of this report follows the recommended guidance for undertaking Appropriate Assessments as follows:

- **Section 2** presents a description of the proposed drought permit and a summary of the HRA Stage I Screening Assessment;
- **Section 3** presents a description of the River Wensum SAC, its qualifying features, conservation objectives and the sensitivity of these features;
- **Section 4** presents the predicted impacts of the proposed drought permit on features of the European designated sites;
- **Section 5** presents monitoring requirements and proposed mitigation measures; and
- **Section 6** includes recommendations and presents conclusions of the assessment

2 River Wensum: Costessey boreholes abstraction

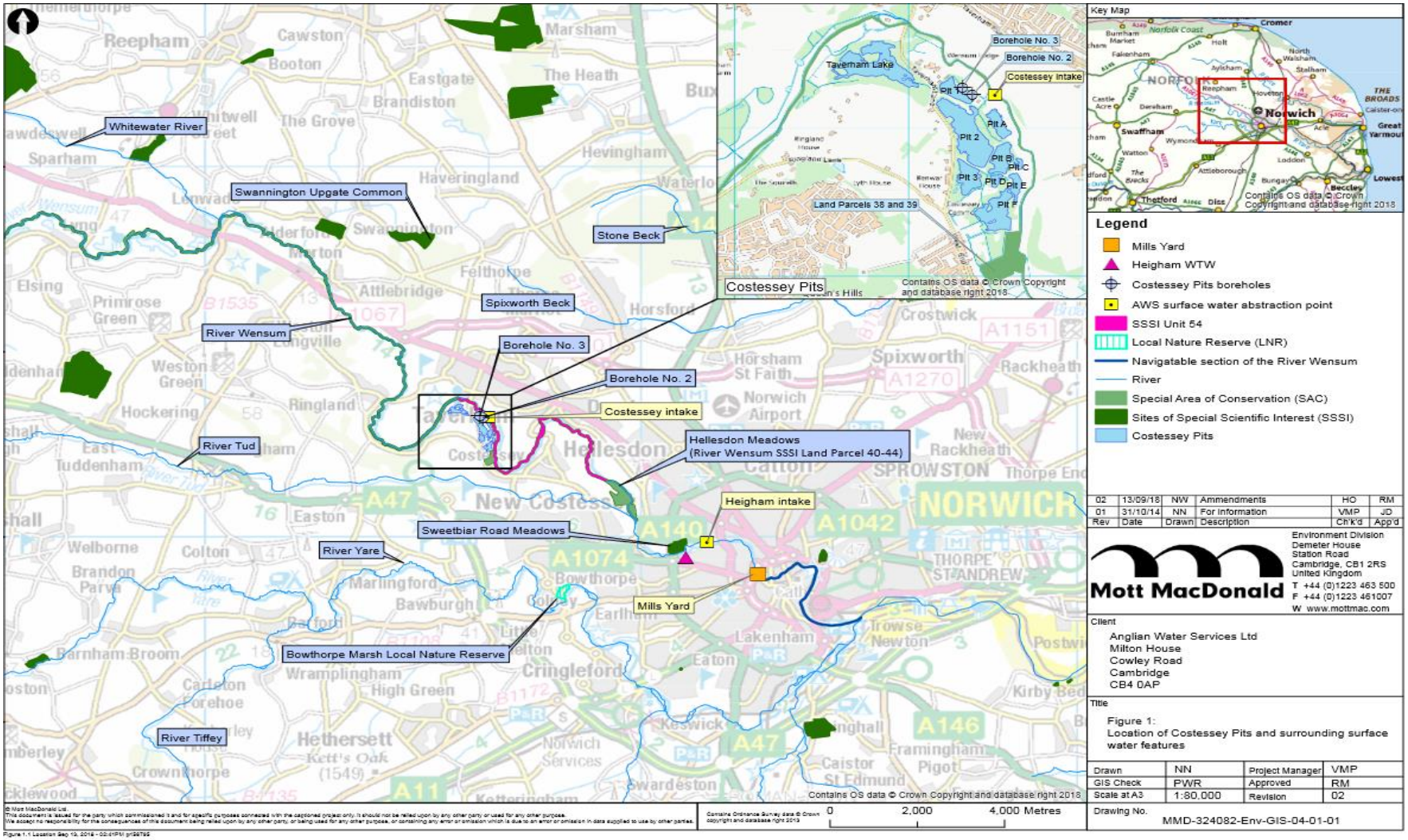
2.1 Overview of existing abstraction licence

Prior to March 2019, Anglian Water abstracted water from the River Wensum at Costessey via the Costessey pits to Heigham WTW. When required, the Costessey boreholes were used to supplement water supply.

In March 2019, the water abstraction moved from Costessey to Heigham, driven by the need to protect the River Wensum SAC. A HOF value of 27Ml/d applies for the water abstraction at Heigham, lower than that previously applicable to abstraction at Costessey. The Costessey boreholes continue to be used to supplement water supply when required.

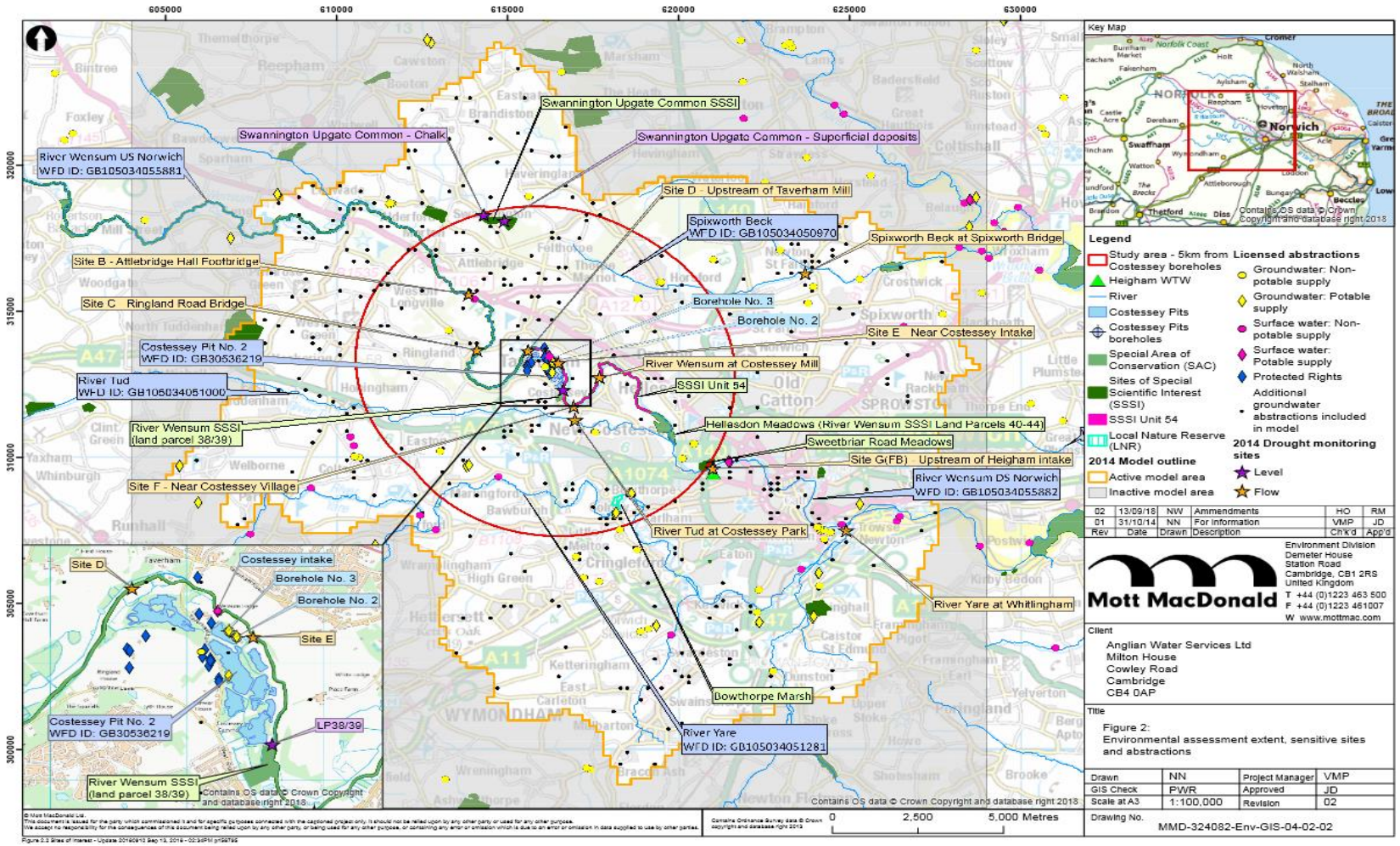
A map showing the key points of reference for this Stage 2 Appropriate Assessment is shown in Figure 2 below. In line with the previous environmental assessments, the study area is defined as being up to 5km from the Costessey boreholes (Figure 3). A slightly larger area, comprising the area of the Costessey sub-model, was considered in brief in the Stage 1 Screening Assessment to reflect the uncertainty in the operation of the boreholes during a drought.

Figure 2: Location of the River Wensum SAC, SSSI Units 38-39 and 40-44 and Costessey abstraction boreholes



Source: Mott MacDonald 2014

Figure 3: 5km buffer defined as the study area for the Appropriate Assessment



Source: Mott MacDonald 2014

2.2 Overview of proposed drought permit

It is possible that during a severe drought, flows in the River Wensum may be reduced, such that use of the Heigham intake is compromised (though in the historic record the flow has never reached such a low level). In the event of a severe drought, it is proposed that the Costessey boreholes could be used to support water supply to Norwich. To achieve this, the drought permit would support a temporary increase in the maximum annual licensed abstraction rate at the Costessey groundwater source from 2000Ml/yr to 4800Ml/yr. The proposed drought permit would be triggered when flows at Heigham are approximately 80Ml/d. 80Ml/d is calculated as the Heigham HOF of 27Ml/d, plus a small operating margin, plus the annual average abstraction at Heigham of 41.8Ml/d. As per current guidance, the drought permit would cover a six month period, and it is understood that reapplication for a further six months would be permissible[2]. Flow analysis of the worst historic (1991-93) and modelled 1 in 200 yr droughts suggest flows would not fall below 80Ml/d.

The current and future abstraction and transfer licences for Costessey boreholes and Heigham intake are given in Table 1.

Table 1: Costessey boreholes and Heigham abstraction and transfer licences

Licence number	Description	Daily quantity (Ml/day)	Annual quantity (Ml/year)	Combined Annual			Comments
7/34/11/*G/0399	Costessey Pits PWS	57.7	17,000		NORPWS: 57.7Ml/d; 17000Ml/y	HEICOS: 57.7Ml/d; 17000Ml/y	Level restriction <5.6mAOD
7/34/11/S/399	Heigham intake PWS	57.7		COSHIM: 120Ml/d 17000Ml/y			Residual flow of 27Ml/d required downstream of abstraction
	Heigham intake transfer to Pits	57.7					Residual flow of 49Ml/d require downstream of abstraction
	Costessey intake transfer to Pits	120					Subject to stepped residual flow at Costessey Mill gauging station and 5.3 mod level covenant at Costessey Mill.
7/34/11/G/486	Costessey boreholes PWS	30	2000				Daily reduces to 20Ml/d and annual to 1000Ml/y on 31/03/24
	Costessey boreholes PWS				NORPWS (see above)		

2.3 Summary of HRA Stage I Screening Assessment

The Stage I Screening Assessment determined that there are mechanisms by which potential impacts arising from the proposed drought permit could result in LSE on the River Wensum SAC.

The potential impacts identified are as a result of:

- Changes to surface water flows which are outside the acceptable range of flow targets for the SAC, thus with potential risks to the qualifying vegetative features and fish species;

[2] https://www.gov.uk/guidance/apply-for-a-drought-permit

- Increased phosphorous concentrations in combination with reduced flows on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation types. A separate study into water quality impacts is being undertaken by Atkins and any findings will be fed into this assessment when available.
- Changes in DO on white-clawed crayfish. A separate study into water quality impacts is being undertaken by Atkins and any findings will be fed into this assessment when available; and
- Potential for reduction in groundwater levels in SSSI Land Parcels 38/19 and 40-44 to affect Desmoulin's whorl snail.

A Stage 2 Appropriate Assessment has therefore been undertaken.

3 River Wensum SAC

3.1 Site overview

The extent of this assessment is largely defined by the presence of the River Wensum SAC, which is adjacent to, and in direct hydrological continuity with, the Costessey boreholes. The River Wensum is a SAC for 71km of its 73km length, and is considered to be one of the best examples in the UK of a naturally enriched calcareous lowland river, with over 100 species of plants, a rich invertebrate fauna and a relatively natural corridor. The upper reaches of the river are fed by springs that rise from the chalk and by run-off from calcareous soils rich in plant nutrients, which gives rise to dense beds of submerged and emergent vegetation characteristic of a chalk stream. Further downstream, the chalk is overlain with boulder clay and river gravels.

The River Wensum SAC supports one Annex I habitat and four Annex II species (JNCC, 2015), listed below:

- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation,
- White-clawed crayfish (*Austropotamobius pallipes*),
- Desmoulin's whorl snail (*Vertigo moulinsiana*),
- Brook lamprey (*Lampetra planneri*),
- Bullhead (*Cottus gobio*).

In addition to the qualifying species present in the SAC, the river supports abundant brown trout (*Salmo trutta fario*), which form the major component of the fish community of the upper Wensum, whilst the middle and lower reaches are dominated by chub (*Leuciscus cephalus*), pike (*Esox Lucius*), eel (*Anguilla anguilla*) and barbel (*Barbus barbus*). Kingfisher (*Alcedo attthis*) and little grebe (*Tachybaptus ruficollis*) breed along the river (JNCC, 2015). These species are not considered for this assessment as they are not part of the qualifying features of the SAC.

3.2 River Wensum SAC qualifying features

3.2.1 Annex I Habitats that are the primary reason for selection of this site

3260 Water courses of plain to montane levels with the *Ranunculin fluitantis* and *Callitricho-Batrachion* vegetation

The Wensum represents sub-type 1 in lowland eastern England. Although the river is extensively regulated by weirs, *Ranunculus* vegetation occurs sporadically throughout much of the river's length. Stream water-crowfoot *R. penicillatus* ssp. *pseudofluitans* is the dominant *Ranunculus* species but thread-leaved water-crowfoot *R. trichophyllus* and fan-leaved water-crowfoot *R. circinatus* also occur.

3.2.2 Annex II Species that are a primary reason for selection for this site

1092 White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*

The Wensum is a chalk-fed river in eastern England and is an eastern example of riverine white-clawed crayfish *Austropotamobius pallipes* populations. As with most of the remaining crayfish populations in the south and east of England, the threats from non-native crayfish

species and crayfish plague are severe. Designation of the river as a SAC provides as much protection as can be afforded to such vulnerable populations.

3.2.3 Annex II Species present as a qualifying feature, but not a primary reason for site selection.

1016 Desmoulin's whorl snail *Vertigo moulinsiana* - Desmoulin's whorl snail is scheduled on Annex II of the European Habitats Directive, listed in the British Red Data Book as a rare species, and included on Section 41 of the NERC Act 2006 as a priority species in England. Its Annex II status makes it a primary driver for the designation of the Wensum SAC.

1096 Brook lamprey *Lampetra planeri* - Brook lamprey is the most common of the three lamprey species (Maitland, 2003) and have historically been recorded in the River Wensum; confirmed in the Environment Agency catch data in the Wensum waterbodies pre and post 2013. This species is listed on Annex II and V of the Habitats Directive and is a Species of Principal Importance in the UK (NERC Act 2006, Section 41).

1163 Bullhead *Cottus gobio* - Bullhead is listed on Annex II of the European Habitats Directive (1992) as a non-priority species and in Appendix III of the Bern Convention. It is a qualifying species of the River Wensum SAC, although not a primary driver for its selection. It is a relatively common species in the rivers of Norfolk (Norfolk & Norwich Naturalists' Society, 2009) although more likely to be encountered in the headwaters of Norfolk rivers (Perrow et al, 1997).

3.3 River Wensum SAC conservation objectives and improvement plan

The conservation objectives for the River Wensum SAC are outlined in '*European Site Conservation Objectives for River Wensum Special Area of Conservation site code: UK0012647'* (Natural England, 2014a). With regard to the SAC and the natural habitats and/or species for which the site has been designated and subject to natural change, the conservation objectives are to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the favourable conservation status of its qualifying features, by maintaining or restoring:

- The extent and distribution or qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

3.3.1 Site improvement plan

Site Improvement Plans (SIPs) have been developed for the River Wensum SAC as part of the Improvement Programme for England's Natura 2000 site (IPENS) (Natural England, 2014b). The SIPs for the River Wensum SAC have identified the following features as existing pressures or threats affecting the condition of the site and requiring improvement:

- **Physical modification** – Much of the river channel has been modified by artificial enlargement (over deepening, over widening and straightening). The extent of modification has been identified as part of the river restoration strategy.

- **Inappropriate weirs dams and other structures –** In-channel structures are adversely impacting flow by creating impoundment on the river reducing hydromorphological and ecological connectivity.
- **Invasive species** – Presence of signal crayfish (*Pacifastacus leniusculus*) is a threat to the white-clawed crayfish and native fish species. Signal crayfish also impact on in-stream macrophytes and damage river banks. Invasive plant species compete with native species and reduce biodiversity, they can also exacerbate erosion and sediment regimes.
- **Water pollution** – Water quality issues affect all SAC features. There are adverse impacts on water quality from discharge, pesticides and nutrients entering the river from the catchment.
- **Water abstraction** – Abstraction is adversely impacting the flow regime of the river. Changes to abstraction licences to relieve pressure on the river were identified through review of consents and were implemented in April 2019.
- **Siltation** – Major sediment ingress points have been identified on the upper and lower reaches of the river. Sediment often has nutrients attached, which has detrimental effects on water quality. It also directly affects the habitats of species. Sediment sources in the Wensum are derived from catchment runoff and are linked to field drainage systems/ditch maintenance, erosion, tributary inputs and road drainage.

3.4 Sensitivities and conservation status of the qualifying features

The main sensitivities of the qualifying features of the River Wensum SAC are outlined below. The conservation status as well as the principal existing threats to the achievement or maintenance of favourable conservation status are also outlined.

3.4.1 Ranunculion fluitantis and Callitricho-Batrachion vegetation

Description

There are several variants of this habitat in the UK, with the River Wensum representing sub-type 1. *Ranunculus* vegetation occurs sporadically throughout much of the river's length. Stream water-crowfoot *R. penicillatus* ssp. *pseudofluitans* is the dominant *Ranunculus* species but thread-leaved water-crowfoot *R. trichophyllus* and fan-leaved water-crowfoot *R. circinatus* also occur.

Sensitivities

This habitat is sensitive to pollution and changes in hydrology which can affect the population dynamics. Flow velocity is thought to be the single most important control on the condition of *Ranunculus* (Hatton-Ellis and Grieve, 2003).

Threats

- Arterial drainage of rivers and changes in flow regime are significant threats.
- Nutrient enrichment and sedimentation of rivers can lead to changes in dissolved oxygen (DO) and light and ultimately changes in plant populations.
- Eutrophication is the most significant threat.

3.4.2 White-clawed crayfish (Austropotamobius pallipes)

Description

White-clawed crayfish occur in relatively hard, mineral-rich waters on calcareous and rapidly weathering rocks. Flowing water habitats in which they have been found often have

undermined, overhanging banks, with sections with heterogeneous flow patterns, as well as cobbles and rock riffles, roots and woody vegetation, and under water-saturated logs or weirs and boulders that provide suitable refuges (Environment Agency, 2014b). They tend to inhabit watercourses with a depth between 0.75m and 1.25m, with low water levels increasing their vulnerability to predation (Environment Agency, 2014b). Flow conditions that affect bankside vegetation and submerged plant communities in which crayfish use for refuge, may have indirect consequences to white-clawed crayfish (Environment Agency, 2014b). Further, increased silt loads (and turbidity) caused by flow changes (natural or induced) can clog the gills of crayfish (Environment Agency, 2014b).

Sensitivities

White-clawed crayfish prefer well aerated waters with a DO of greater than 60% saturated (i.e. the 90th percentile) (Peay, 2002).

Threats

Signal crayfish out-compete white-clawed crayfish and also carry crayfish plague (*Aphanomyces astaci*) a fungal disease that wipes out white-clawed crayfish populations.

Conservation status

This species is listed on Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and included on Section 41 of the NERC Act 2006 making it a priority species in England. The white-clawed crayfish is also an Annex II species under the European Habitats Directive (1992) making it a primary driver in the selection of the Wensum SAC.

3.4.3 Desmoulin's whorl snail (*Vertigo moulinsiana*)

Description

Desmoulin's whorl snail (*Vertigo moulinsiana*) is the largest *Vertigo* species, with a shell height of up to approximately 2.6mm. The distribution of Desmoulin's whorl snail in the UK is mainly confined to the south east of England, stretching from east Dorset to north – west Norfolk (Killen, 2003). The snail lives on reed grasses and sedges, such as reed sweet-grass (*Glyceria maxima*), and tussocks of greater pond-sedge (*Carex riparia*) and lesser pond-sedge (*C. acutiformis*), where it feeds on the microflora. In autumn it may ascend taller reeds and scrub (JNCC, 2015).

Sensitivities

Desmoulin's whorl snail is considered a terrestrial gastropod but is associated with permanently wet habitats, including calcareous swamps, fens and marshes, and riparian margins. It lives on living and dead stems and leaves of tall plants (Killeen et al, 2012) and grazes on fungi, micro-algae and bacteria growing on marsh plants, and decaying higher plants (Killeen, 2003).

The hydrological regime associated with these environments is essential for this species to survive. The snail is dependent on the maintenance of high water levels and standing water (House et al, 2016) and is susceptible to extreme fluctuations in groundwater levels, potentially inducing intolerable hydrological conditions.

Consequently, a stable hydrogeology with highly humid conditions is required, which is met by a high water table below the stands of vegetation (Wade, 2013). This must be close to the surface so that the ground never dries out and even in high summer water will rise when the ground is trodden (Rees et al, 2010, cited in Wade, 2013). There is evidence that there is hydrological connectivity between the River Wensum levels and SSSI units. For this reason, changes to the

water level in the river may affect unit moisture levels and consequently impact Desmoulin's whorl snail habitat conditions.

Tattersfield & McInnes (2002) conducted a comprehensive study detailing the relationship between the hydrological regime and densities of Desmoulin's whorl snail within the Norfolk Valley Fens (SAC) and Kennet and Lambourn floodplains in Berkshire. Maximum snail densities were recorded at sites where water levels were consistently above the ground surface throughout the year (mean annual level 0.25m). Using this data, the authors calculated the critical minimum summer water level threshold to be 0.5mbgl, i.e. below surface groundwater, inferring that snails would be able to survive but in relatively small numbers for a finite period.

Threats

- Changes in hydrology, such as water abstraction and general drainage of wetlands leading to reduced water tables and loss of periodic flushes;
- Channelisation of rivers, deepening of drainage channels and creation of vertical profiles to riverbanks, eliminating wetland and marginal marsh habitat;
- Regular cutting of riparian margins of rivers and tidying of riverside paths.

Conservation status

Desmoulin's whorl snail (*Vertigo moulinsiana*) is listed under Annex II of the European Union Habitat and Species Habitat Directive and is considered a priority species in the UK Biodiversity Action Plan (BAP). The International Union for Conservation of Nature (IUCN) consider this species to be vulnerable.

3.4.4 Brook lamprey (*Lampetra planeri*)

Description

The lampreys belong to the Agnatha group, being amongst the most primitive living vertebrates. Most lamprey species have a similar lifecycle, with suitable spawning grounds comprising clean gravel beds with areas of soft marginal silt/sand in shallow waters with moderate current. The adults breed in reeds constructed from the gravel and the juveniles live buried in silt beds. In the UK spawning of brook lamprey (Lampetra planeri) in British rivers starts when the water temperature reaches 10–11ºC, usually in March and April.

Sensitivities

Lampreys are susceptible to disturbance and pollution at any stage during their life cycle. Brook lamprey are sensitive to pentachlorophenol, and of average sensitivity to copper. Due to their low fecundity and dispersal rates it is postulated that lampreys are sensitive to rapid changes in environmental variables.

Threats

- Physical obstruction such as weirs impact on lamprey distribution.
- River cleaning and channel maintenance have the potential to significantly impact on lamprey through disruption of reed structures. Also, the removal and disturbance to areas of fine silt material, which may be used as habitat for juvenile lamprey or ammocoetes, can directly impact on lamprey populations. The highest sensitivity for Brook lamprey is from March to April during the spawning period and the subsequent hatching. Pollution may cause loss of lamprey populations directly and through smothering of spawning gravels and nursery silts by algae and bacteria.

Conservation status

Brook lamprey is the most abundant and widespread of the British lampreys and have been assessed as having favourable overall conservation status.

3.4.5 Bullhead (Cottus gobio)

Description

Bullhead is the only freshwater cottid found in the UK. It is a bottom-living fish that inhabits a variety of rivers, streams and stony lakes. It requires good water quality, a stony substrate free from excessive siltation and sufficient cover from overhanging vegetation or woody debris.

Bullheads spawn from February to June; typically once for females in upland streams, and up to four times in warmer lowland streams (Tomlinson and Perrow, 2003).

Sensitivities

Bullheads are susceptible to changes in oxygen saturation and temperature, with critical thermal limits of -4.2 and 27.7ºC (Tomlinson and Perrow, 2003).

Threats

- Siltation over hard, coarse substrate reduces the necessary habitat.
- Introduction of other fish species for fisheries and the presence of invasive crayfish species have been shown to impact populations through competition.
- Physical obstructions fragment populations, while channel management may reduce the habitat available to bullhead through the removal of hard substrate during dredging operations and excessive management of riparian trees and clearance of wood debris/leaf litter (Tomlinson and Perrow, 2003).

Conservation status

Range conservation status is favourable.

3.5 Qualifying features within the Zone of Influence

This report assesses the potential environmental impacts of implementing such a drought action, considering the river in the vicinity of the boreholes, within a 5km radius.

A desk-based study of existing data has been carried out to determine the presence of qualifying features within the ZoI. Details of these findings are outlined below.

Ranunculion fluitantis and *Callitricho-Batrachion* vegetation

The River Wensum is extensively regulated by weirs, but *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation occurs sporadically throughout much of the river's length, although not present along the whole river (Wade,2013). A rapid macrophyte assessment undertaken in 2013 by Mott MacDonald confirmed the presence of *Ranunculion fluitantis* and *Callitricho-Batrachion* both upstream and downstream of the Costessey and its presence is likely to extend throughout the River Wensum, from its source at Colkirk and Whissonsett to its confluence with the Rivers Tud and Yare (Wade, 2013). Surveys were undertaken in 500m stretches between the six ecological survey locations in July, August and September 2013.

Bullhead (*Cottus gobio*)

Bullhead is listed on Annex II of the European Habitats Directive (1992) as a non-priority species and is listed in Appendix III of the BERN Convention. It is a qualifying species of the

River Wensum SAC, but not a primary driver for its selection. Bullhead are relatively common through the Wensum and have been recorded in the Environment Agencies catch data upstream and downstream of the Costessey.

Brook lamprey (*Lampetra planeri*)

Brook lamprey are the most numerous of the three lamprey species (Maitland, 2003) and have historically been recorded in the River Wensum, confirmed in the Environment Agency catch data pre and post 2013. This species is listed on Annex II and V of the Habitats Directive and is a species of Principal Importance in the UK (NERC Act 2006, Section 41).

Desmoulins whorl snail (*Vertigo moulinsiana*)

Based on the conclusions outlined in the Stage 1 Screening assessment (Mott MacDonald, 2018), the following SSSI units which are incorporated in the River Wensum SAC have been defined as the ZoI for Desmoulin's whorl snail based on their susceptibility to change in groundwater levels:

- Costessey common south Foster and Mann (Unit 38)
- Costessey Common South Costessey parochial trust (Unit 39)
- Rogers Farm Joyhold Ltd (Unit 40)
- Rogers Farm the Great Hospital (Unit 41)
- Rogers Farm NRA (Unit 42)
- Rogers Farm Mallett (Unit 43)
- Riverside Close Hellesdon Jefferys (Unit 44)

Unit 38 and 39 comprise approximately 4ha of lowland neutral grassland adjacent to the Wensum directly downstream of the Costessey Pits. The condition of these units was last assessed in 2014 and was considered to be 'unfavourable-no change', with concerns over appropriate land management understood to contribute to its condition. Appropriate management is not in place on this unit and the condition assessment notes that the landowner would like to lightly graze the unit with ponies, which could be compatible with the nature conservation interests (Natural England, 2018).

Units 40 – 44 (Hellesdon Meadows) of the River Wensum SSSI comprise approximately 13ha of lowland neutral grassland immediately adjacent to the River Wensum at Hellesdon where the river is embanked and impounded. The grassland units are hydrologically disconnected from the river and are drained through a network of ditches. The vegetation structure is semi-natural and dominated by floodplain and grazing marsh habitats and Units 40-43 are subject to low-level grazing in the summer. There is currently no grazing regime implemented at Unit 44 and the presence of Himalayan balsam (*Impatiens glandulifera*) has been noted on the margins of the river and possibly in the drains (Natural England, 2018).

Hellesdon Meadows are considered favourable for Desmoulin's whorl snail, but the condition assessment notes that if the hydrological regime between the river and the floodplain was restored in this area (a river restoration strategy is in place), then there may be opportunities to make conditions in these units even more appropriate for the snail.

The known distribution of Desmoulin's whorl snail across Norfolk is within fen sites in the Yare, Ant and Bure valleys in the Broads Natural sites. The snail is also known at sites within the River Nar valley (West Acre, Castle Acre and nearby East Walton and Adcocks Common), Glanford on the River Glaven and the Upper Wensum (Shereford, Hempton and Guist) within

the North Norfolk Natural Area and Thompson Common in the Brecks Natural Area (Norfolk Biodiversity Action Plan).

In 2001, a survey of the River Wensum found Desmoulin's whorl snail in two sections of the river, with largest populations at Fakenham and from Ringland to Hellesdon Mill (Killeen, 2001). The reach from Ringland to Hellesdon Mill covers the study area. Within this area, there are two known locations (17 in the whole of the river), where Desmoulin's whorl snail are found: Costessey Fens and Meadows (River Wensum SSSI Units 38/39) and Hellesdon Meadows (River Wensum SSSI Units 40-44).

More recently surveys were undertaken by Abrehart Ecology (2017) at Costessey and Drayton. These surveys have found no Desmoulin's whorl snails at either of the sites, with this species only being recorded in upstream reaches of the River Wensum. At Costessey, the site was found to be no longer suitable to support this species. It was deemed that without significant intervention to remove all invasive species in the lower Wensum this site is unlikely to recover (Abrehart Ecology, 2017). Therefore, future prospects for the site were considered 'unfavourable'.

In Drayton, no Desmoulin's whorl snail were recorded and the site was deemed to be too dry to support the species. An increase in site mister would be required for the site to be able to support this species. Future prospects for the site were considered 'unfavourable'.

4 Impact Assessment

4.1 Impact Significance

4.1.1 Overview

Under the plans of the proposed drought permit flows within the boundaries of the SAC could be reduced by up to 14% (site upstream of the Heigham intake) with an average reduction in flows across the simulated monitoring sites of 7.5%. Equally the modelling results from previous assessment suggested that groundwater levels could drop substantially in SSSI Units 38-44 and river base levels could be reduced on average by 1.3%.

The aforementioned impacts arising from the proposed drought permit have been identified in the HRA Stage 1 Screening assessment as potentially impacting negatively on the qualifying features of the River Wensum SAC. Each qualifying feature identified in the screening assessment as susceptible to changes in the hydrological regime has been discussed in detail in the following sections.

4.1.2 *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

The dynamic nature of riverine environments means that that there is constant adaptation to fluctuations in flow regime and sediment load, leading to changes in fluvial processes and associated habitats (Hatton-Ellis & N Grieve). Consequently, some macrophyte species can adapt to a range of flow regimes. The optimum range for *Ranunculion fluitantis* and *Callitricho-Batrachion* types is between 0.3 and 0.5m/s (Environment Agency, 2004).

Based on the previous modelled conditions during the pump test in 2013 (Mott MacDonald, 2014a-b), the average estimated velocity in the River Wensum in baseline modelled conditions for 1991 was 0.22m/s, and over the whole modelled period was 0.24m/s, ie below the optimum range. Therefore, under severe drought conditions, there is an argument that the Wensum would not support *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation types at this location, regardless of further reductions in flow (or velocity) as a result of a drought action, as flow conditions would be below the minimum flow required for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation types.

Increased phosphorous concentrations in combination with reduced flows gives the potential for vegetation growth to become excessive and detrimental to the functioning of the river and the integrity of the SAC. As flows in the river are not predicted to reduce significantly, the dilution capability of the river should be maintained. Phosphate contaminants from sewage treatment works will therefore not increase significantly. Temperatures and BOD may increase in summer months, but given the temporary nature and winter focus of any drought action, impacts on water quality are considered negligible. A cessation clause on the drought action will be included in the event that impacts are observed. Proposed mitigation (e.g. aeration) could also be implemented in the event that impacts are observed. A separate study into water quality impacts is being undertaken by Atkins and any findings will be fed into this assessment when available.

The relationship between the volumetric flow and velocity has not been quantified for the purpose of this study, so the associated impact on macrophytes under drought conditions is difficult to quantify. Macrophytes communities were surveyed during the summer of 2013 and

results suggested that the macrophyte communities recorded from July to November 2013 showed no response to reduced flow conditions.

No information has been obtained on the relationship between *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and water depth. However, effects of the predicted reduction in water depth of 1.4% in the event of implementation of a drought permit are likely to be negligible. No adverse effects on the qualifying feature are anticipated.

4.1.3 White-clawed crayfish

White-clawed crayfish are sensitive to low oxygen levels. Temperatures and BOD may increase in summer months. Warm temperatures, coupled with shortening day length and autumn turnover, mean low DO events could also occur in late summer, autumn or early winter. A cessation clause on the drought action will be included in the event that impacts are observed. Proposed mitigation (e.g. aeration) could also be implemented in the event that impacts are observed. A separate study into water quality impacts is being undertaken by Atkins and any findings will be fed into this assessment when available.

4.1.4 Desmoulin's whorl snail

Desmoulin's whorl snail distribution and abundance are closely linked to the hydrological regime in a given environment (see section 3.4). Killen (2003) defined population levels against a hydrological gradient outlined in Table 2. High populations occurred where water levels were always above ground level. In contrast where water levels dropped below 0.4mbgl the snail occurred only at very low abundances.

Table 2: Summary of the hydrological requirements of Desmoulin's whorl snail

V. moulinsiana	Associated water level
High population	Mean annual water level over +0.25m, with fluctuations from 0m to +0.6m Water level never/very rarely falls below ground level
Medium population	Water level fluctuates between -0.2m and +0.2m during the year
Low population	Mean annual water level less than 0m, with fluctuations from -0.4m to 0m
Critical population	Minimum: Summer -0.5m below ground level Winter -0.4m below ground level

Source: Mott MacDonald (adapted from Kileen, (2003))

SSSI Units 38 -39

The proposed drought permit at Costessey boreholes was conceptualised using the Costessey sub-model, which is based on the Environment Agency's North East Anglian Chalk regional model constructed by Wood PLC (previously Amec Foster Wheeler) for SSSI Units 38 and 39 respectively.

Three abstraction scenarios were modelled for a period of severe drought (1991, which was the third of three years of below average summer flows in the River Wensum) and compared with a no abstraction baseline scenario (Figure 4). The groundwater abstraction scenarios were:

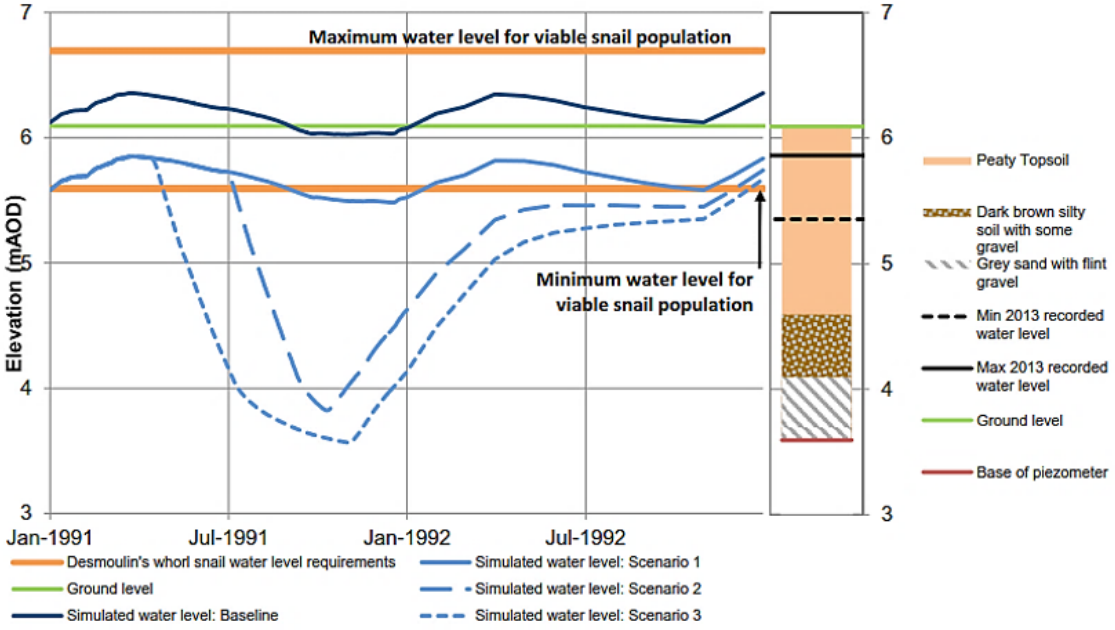
- Scenario 1: groundwater abstraction from borehole No. 3 at a continuous rate of 3.5Ml/day;
- Scenario 2: continuous groundwater abstraction of 3.5Ml/day from borehole No. 3 and 100 days of abstraction between July and October 1991 at 20.5Ml/day from borehole No. 2; and

- Scenario 3: a continuous groundwater abstraction of 3.5Ml/day from borehole No. 3 and 200 days of abstraction between April and November 1991 at 20.5Ml/day from borehole No. 2.

The three scenarios represent annual abstraction figures of 1278, 3328 and 5378Ml respectively. Scenario 3 is a little more severe than the proposed drought permit which would involve annual abstraction of up to 4800Ml.

Examination of the simulated scenarios against the baseline groundwater levels for SSSI Units 38 and 39 suggest that water levels are below the requirements of Desmoulin's whorl snail. Under Scenario 3 the water levels drop to a minimum of approximately 2.5m below baseline conditions in the summer, with waters under Scenario 2 following a similar trend. Groundwater fluctuations simulated under Scenario 1 are far less extreme, with water levels staying in the tolerable range of the snail for the majority of the cycle with the exception of a small period a small period in the summer 1991. Scenario 1 does not relate to the current proposed drought permit.

Figure 4: Range of simulated and observed water levels compared with the requirements of Desmoulin's whorl snail

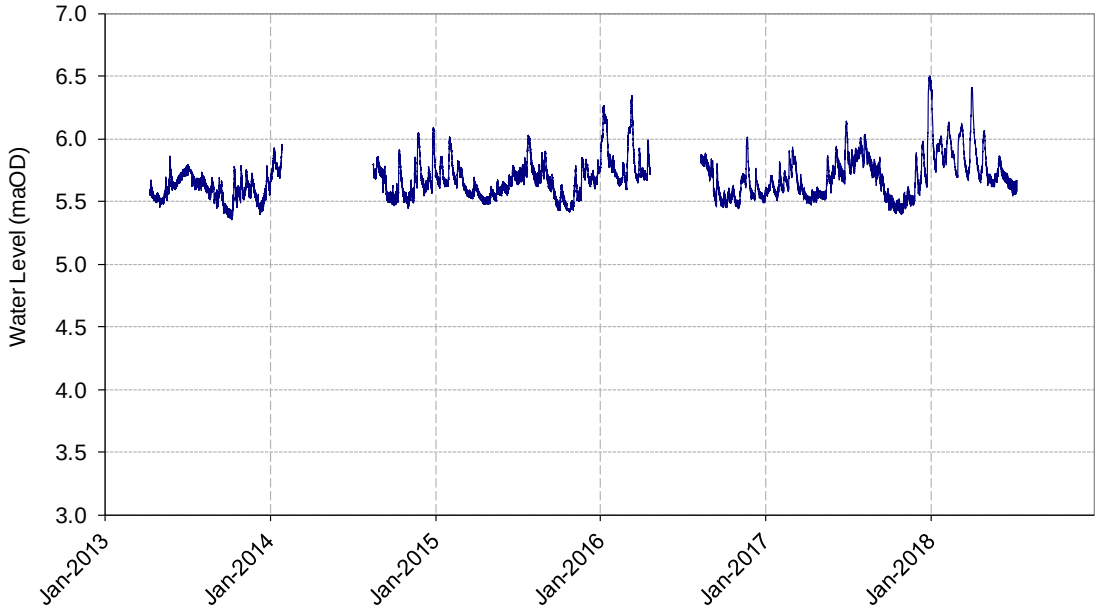


Source: Mott MacDonald 2014

It must be noted that the regional model had to be used to estimate the groundwater levels at SSSI Units 38 and 39 and information regarding the local hydrodynamics have not been incorporated into the model due to a lack of data.

Piezometer data covering most of the period since 2013 (Figure 5) shows that the level dropped below 5.5m in every year and was therefore below the minimum water level for a viable snail population. This was in a period without particularly notable drought conditions, and no drought action such as the proposed drought permit abstraction. This further suggests that this site is no longer viable for the snail which is in line with the most recent condition assessment for these land parcels which found the condition of the site unfavourable and found no presence of the snail.

Figure 5: Piezometer data for land parcel 38/39



SSSI Units 40-44 (Hellesdon Meadows)

The area of Units 40-44 (Hellesdon Meadows) has also been identified as suitable habitat for Desmoulin's whorl snail. Although these units are hydrologically disconnected from the river, direct observation shows river water levels have an influence on the water levels within the units (Natural England, 2018). However, it is considered that the predicted change in river flows or groundwater levels will not result in adverse effects on these land parcels. This may however change if proposed restoration at this location restores connection with the floodplain. This action would potentially enhance habitat suitability of the snail.

The groundwater predictions in response to the 2013 pump test (Figure 4) suggested a potential decrease in groundwater levels of 0.1-0.5m at Land Parcel 40-44 (Hellesdon Meadows), but similar to the conflict for Land Parcel 38/39 above, Anglian Water (2018) suggest that there should be no change in groundwater level predicted at Hellesdon Meadows.

This assessment suggests that the relationship between groundwater abstraction and groundwater levels at the land parcels is not yet fully understood, and that there is enough evidence to suggest that the land parcels could at least become temporarily unsuitable for the species, and could result in habitat deterioration to some degree. Therefore, it is suggested that further examination of the impact of the proposed drought permit on Desmoulin's whorl snail is required.

4.1.5 Bullhead

As recognised in section 3.5, Bullheads have been identified both upstream and downstream of the Costessey abstraction point, but these areas are unlikely to be spawning grounds for this species. Bullheads utilise a variety of habitats with variable flow regimes. Juveniles are associated with shallow water and higher velocities and the adults shallow to moderate depth 5-40cm and fast flows (0.10 to 0.40m/s) (Mott MacDonald, 2018). The small reduction in depth predicted as a result of the implementation of a drought permit will therefore not have a

significant effect on this species. However, a potential reduction in water velocity could have implications for adults downstream of the abstraction point. In the 2014 Mott MacDonald report, the estimated maximum reduction in velocity in 1991 is 0.003m/s, reducing from 0.157m/s in the baseline simulation to 0.154m/s in Scenario 3 (reduction of 2% from the baseline), and therefore reported as minimal. The relationship between velocity and flow for the current proposed drought permit is not fully understood however, therefore low flow velocity must be considered in this assessment. Lower flow velocity can result in a reduction in DO concentrations which can in turn unsuitable conditions for bullhead. In the absence of DO requirements for bullhead in the literature requirements for brown trout are referenced here. This is considered appropriate as the two species occur sympatrically and minimum DO conditions are likely to be at the same level. Brown trout require a minimum dissolved oxygen concentration of 40% saturation (Tomlinson & Perrow, 2003). No adverse effects on the qualifying feature are anticipated as long as DO saturation is above 60% (Tomlinson & Perrow, 2003).

4.1.6 Brook Lamprey

Brook lamprey spawn in late spring/early summer, when temperatures reach between 10-11°C. Typically adults require flow velocities in the region of 0.2-0.3m/s and water depth of 3-30cm. Once the eggs hatch, ammocoete larvae drift downstream, settling in depositing substrates such as silt at river and stream margins. These nursery grounds not only have slow flow rates but are actually backwaters with flow in reverse compared to the main current (Maitland, 2000). Cowx et al (2004) also provides some optimum depths and velocities that correlate with the above flow rates: larvae <50cm, 0.08-0.10m/s; spawning 3-150cm, 0.3-0.5m/s (Table 3).

Table 3: Summary of the hydrological requirements of brook lamprey

European feature	Optimum depth (m)	Optimum velocity (m/s)
Brook lamprey (Lampetra planeri)	Larval nursery beds: 0.25m Larvae: <0.5m Spawning 0.03-1.5m	Larval nursery beds: 0.4m/s Burrows: 0.08-0.1m/s Larvae: 0.08-0.1m/s Spawning: 0.3-0.5m/s

Source: Cowx et al (2004)

The stretch of river in the area of impact is generally not synonymous with brook lamprey spawning habitat due the depth of the water column (>5m). As such the proposed reduction of 0.02m does not affect brook lamprey given the unsuitability of the habitat. Conceptual flow velocities have not been modelled for these works so it's difficult to ascertain how a reduction in flow will positively or negatively impact on this species. However, the slight reduction in water flow and reduction in base levels will likely reduce water velocity on a small scale but cannot be quantified in this case, so the precautionary principle is adopted, and an impact is assumed for the purpose of this assessment.

4.2 In-combination effects

Article 6(3) of the Habitats Directive requires that "*any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives*".

The likely impacts on the integrity of the River Wensum SAC arising from the combination of the proposed drought permit with other plans and projects relevant to the area must therefore be assessed.

4.3 Local planning applications

A search of the Breckland, South Norfolk, Norwich and Broadland councils identified the following planning permission granted in the ZoI.

- Application No: 20171035: Proposed development, Conversion of existing barn into 1 no: dwelling (including demolition works); (2) Demolition of existing bungalow, hardstanding, outbuildings (including sports hall, swimming pool, greenhouses, workshops and aircraft hangar) and erection of 7 no. dwellings.

Due to the temporary nature of the proposed works it is not expected that significant in-combination effects will occur.

4.3.1 Environment Agency drought plans

4.3.1.1 East Anglia Area

There is no overlap in European Sites considered for the Costessey Boreholes and East Anglia Area Environment Agency drought plan.

4.3.1.2 Lincolnshire and Northampton

There is no overlap in European Sites considered for the Costessey Boreholes and Lincolnshire and Northampton Environment Agency drought plan.

4.3.1.3 East Anglia (East)

There is no overlap in European Sites considered for the Costessey Boreholes and East Anglia (East) Environment Agency drought plan.

4.3.2 Other Water Company drought plans

4.3.2.1 Cambridge Water

There is no overlap in European Sites considered for the Costessey Boreholes and Cambridge Water's drought plan.

4.3.2.2 Affinity Water

There is no overlap in European Sites considered for the Costessey Boreholes and Affinity Water's drought plan.

4.3.2.3 Yorkshire Water

There is no overlap in European Sites considered for the Costessey Boreholes and Yorkshire Water's drought plan.

4.3.2.4 Severn Trent Water

The updated Severn Trent Water Drought Plan is not currently available. There is no expectation of any overlap in European sites considered for the Wensum and Severn Trent drought plans.

4.3.2.5 Essex and Suffolk Water

A screening exercise to determine if a SEA was required was undertaken and concluded that the supply-side actions would not have a significant effect on the environment. As a result, no

in-combination likely significant effects are anticipated between Costessey Boreholes and the Essex and Suffolk Water drought plan.

4.3.3 Water Company Water Resource Management Plans (WRMP)

4.3.3.1 Anglian Water WRMP19

Anglian Water's final WRMP 2019 includes HRA screening assessment for three plans; the Best Value Plan (BVP), the Least Cost Plan (LCP) and the adaptive strategy. Six options across the three plans were identified as having a Likely Significant Effects on European sites and taken forward to Stage 2 appropriate assessment. These were: ESU1 Felixstowe Desalination, ESU2 Ipswich Water Reuse, NFN1 Kings Lynn Desalination, SHB2 Pyewipe Water Reuse for non-potable use, NFN2 Kings Lynn Water Reuse and NFN3 Fenland Reservoir. There is no overlap in European Sites considered between any of these options and Costessey Boreholes.

4.3.3.2 Affinity Water WRMP19

There is no overlap in European Sites considered for the Costessey Boreholes and Affinity Water's WRMP.

4.3.3.3 Severn Trent Water WRMP19

There is no overlap in European Sites considered for the Costessey Boreholes and Severn Trent Water's WRMP.

4.3.3.4 Yorkshire Water WRMP19

There is no overlap in European Sites considered for the Costessey Boreholes and Yorkshire Water's WRMP.

4.3.3.5 Cambridge Water WRMP19

There is no overlap in European Sites considered for the Costessey Boreholes and Cambridge Water's WRMP.

4.3.3.6 Essex and Suffolk Water WRMP19

There were no supply schemes in Essex and Suffolk Water's WRMP19 so no in combination LSE's are anticipated.

4.3.4 Other plans and projects

4.3.4.1 Water Resources East (WRE)

The WRE programme is not due to start until 2045 as it is part on longer term planning and is an entirely non-statutory plan, whereas Anglian Water's Drought Plan is only active for another year. There is currently no Habitat Regulations Assessment for the WRE plan therefore any in-combination effects cannot be assessed as this time.

4.3.4.2 Anglian River Basin Management Plan (RBMP)

The level of detail in the plan does not allow consideration of the effect on individual European Sites, but the HRA determines that the RBMP is not likely to have any significant effects on any European sites, alone or in-combination with other plans and projects. Therefore, no in-combinations LSEs with Costessey Boreholes are anticipated.

4.3.4.3 National Policy Statement – Sizewell C

There is no overlap in European Sites considered for Costessey Boreholes and Sizewell C construction or operation.

4.3.4.4 A14 upgrade

There is no overlap in European Sites considered for Costessey Boreholes and the A14 upgrade.

4.3.4.5 Cam-MK-Ox corridor

No further details are available on this scheme at present.

4.3.4.6 East West Rail

There is no HRA for East West Rail as the are no European Sites that could be impacts by the scheme.

5 Mitigation and Enhancement Measures

Anglian Water are committed to minimising any potential downstream impacts that could occur as a result of implementation of the drought permit. When considering river flow, the impact of predicted changes on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, brook lamprey and bullheads cannot be ruled out entirely given the uncertainty around the relationship between flow rate (m^3/day) and water velocity (m/s). In the 2014 Mott MacDonald report, the estimated maximum reduction in velocity in 1991 is 0.003m/s, reducing from 0.157m/s in the baseline simulation to 0.154m/s in Scenario 3 (reduction of 2% from the baseline), and therefore reported as minimal. Mitigation measures are however still proposed to further minimise potential impacts on these qualifying species, as well as monitoring.

Detailed information of the monitoring requirements and proposed mitigation measures are provided in the Environmental Assessment Report. Measures to understand the impacts on groundwater with respect to Desmoulin's whorl snail are also included.

6 Conclusions

Potential impacts arising from the proposed drought permit have been identified that could have a LSE on the integrity of the River Wensum SAC. The predicted reduction in groundwater levels has the potential to impact on Desmoulin's whorl snail at SSSI Units 38/39 and 40-44. Water quality impacts on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and white-clawed crayfish have also been identified. It is considered that the potential adverse effects on the integrity of the River Wensum SAC can be managed through the implementation of the monitoring and mitigation prescribed in the EAR. However, a separate study into water quality impacts is being undertaken by Atkins and any findings will be fed into this assessment when available.

Provided that proposed monitoring and mitigation measures are implemented no further stage in the appropriate assessment process is considered necessary.

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