

# Norfolk Vanguard Offshore Wind Farm

## Appendix 9.1 Botanical Survey

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*Photo: Kentish Flats Offshore Wind Farm*



# Information for the Habitats Regulations Assessment

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For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean and Rebecca Sherwood

Signed: 

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## Norfolk Vanguard Botanical survey

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Report prepared by Norfolk Wildlife Services Ltd.  
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## 2. Executive Summary

2.1. Following consultation on The Extended Phase 1 Habitat Survey (Royal HaskoningDHV, 2017a), a detailed survey of the River Wensum and its floodplain were recommended to be carried out to understand any potential effects of horizontal directional drilling on the designated and notifiable features of River Wensum Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI).

2.2. The survey had four aims:

1. To identify the National Vegetation Classification (NVC) communities within the River Wensum SAC and SSSI.
2. To note if the following plants are growing within the River Wensum or grazing marsh ditches:
  - pond water-crowfoot *Ranunculus peltatus*;
  - stream water-crowfoot *Ranunculus penicillatus ssp. pseudofluitans*;
  - river water-crowfoot *Ranunculus fluitans*.
3. To identify the NVC communities within the semi-improved grassland found adjacent to the River Wensum.
4. To look for presence of calcareous groundwater springs/seepage within the semi-improved grassland.

2.3. Methodologies were developed using guidance documents from Rodwell (2006) and Doarks and Leach (1990).

2.4. The semi-improved grassland adjacent to the River Wensum consisted of two main NVC communities, which were often transitional to each other:

- MG6 – *Lolium perenne-Cynosurus cristatus* grassland
- MG10 – *Holco-Juncetum effusi* rush pasture

2.5. The River Wensum consisted of two main NVC communities:

- A8a - *Nuphar lutea* community, “species-poor” sub community (aquatic zone)
- S5 - *Glycerietum maximae* swamp, *Alisma plantago-aquatica-Sparganium erectum* sub community (marginal edge)

2.6. Communities associated with the ditches varied depending on location and land management. They were classified according to Doarks and Leach (1990) as being:

- Aquatic End Group A5b – *Lemna minor-Lemna trisulca*-filamentous algae
- Aquatic End Group A6 - *Callitriche stagnalis/platycarpa*
- Aquatic End Group A7b - *Potamogeton pectinatus-Myriophyllum spicatum*
- Emergent End Group E1 – *Carex riparia/acutiformis-Phragmites australis*
- Emergent End Group E2 – *Glyceria Maxima-Berula erecta*
- Emergent End Group E3 - *Juncus effusus*

2.7. None of the following species, associated with the River Wensum SAC habitat were recorded during the botanical survey within the River Wensum or its floodplain: *R. peltatus*, *R. penicillatus ssp. pseudofluitans* or *R. fluitans*

2.8. There was no evidence of calcareous ground water spring or seepage activity with the study area.



## **3. Introduction**

### **3.1. Project background**

3.1.1. Norfolk Vanguard is a proposed offshore wind farm being developed by Vattenfall Wind Power Limited (or an affiliate company), with a capacity of 1800MW, enough to power 1.3 million UK households. The offshore wind farm comprises two distinct areas, Norfolk Vanguard East (NV East) and Norfolk Vanguard West (NV West) and will be connected to the shore by offshore export cables installed within the provisional offshore cable corridor. The project will also require onshore infrastructure in order to connect the offshore wind farm to the National Grid at the existing National Grid substation at Necton, which in summary will comprise the following:

- Landfall;
- Cable relay station (if required);
- Underground cables;
- Onshore substation; and
- Extension to the existing Necton National Grid substation.

3.1.2. The location of the onshore electrical infrastructure is shown on Figure 1, Appendix A: of the Extended Phase 1 Habitat Survey Report (Royal HaskoningDHV, 2017a). Collectively the onshore electrical infrastructure is herein referred to as the 'onshore project area'.

3.1.3. During the development of the project, the onshore Scoping Area that was initially defined has been refined, to include three landfall options, associated cable relay search zones, as well as an onshore substation search zone in proximity to the Necton National Grid substation. A 200m wide cable corridor has been identified within which the buried cable will be located, and Horizontal Directional Drilling (HDD) zones and mobilisation zones have been identified along the cable corridor.

3.1.4. The surveys described within this report were designed and based on the onshore project area which was in use when the project Extended Phase 1 Habitat Survey was undertaken (February 2017). As the project design is further refined, these search zones will decrease in size, and the final options for the siting of infrastructure (i.e. one cable relay station, one landfall, one onshore substation) will be taken forward for the final Development Consent Order (DCO) application in June 2018.

### **3.2. Aim of report**

3.2.1. As Norfolk Vanguard is a Nationally Significant Infrastructure Project (NSIP) an Environmental Impact Assessment (EIA) is required as part of a DCO application under the Planning Act 2008.

3.2.2. Norfolk Wildlife Services were appointed in late April 2017 to undertake additional ecological surveys to support this application as set out within the Survey Scope (Royal HaskoningDHV, 2017b).

3.2.3. The Extended Phase 1 Habitat Survey (Royal HaskoningDHV, 2017a) identified the potential for legally protected species located within the project area plus a 50m buffer surrounding the project area, and provided recommendations for further surveys required to characterise the ecological baseline for the project area.

### **3.3. Survey objective**

3.3.1. The botanical survey had four objectives:

1. To identify the NVC communities within the River Wensum SAC and SSSI;

2. To note if the following plants are growing within the River Wensum or grazing marsh ditches:
  - pond water-crowfoot *R. peltatus*;
  - stream water-crowfoot *R. penicillatus* ssp. *pseudofluitans*;
  - river water-crowfoot *R. fluitans*.
3. To identify the NVC communities within the semi-improved grassland found adjacent to the River Wensum.
4. To look for presence of calcareous groundwater springs/seepage within the semi-improved grassland.

### **3.4. Survey scope**

#### **3.4.1. Development of survey scope**

3.4.1.1. A Scoping Report for the EIA (Royal HaskoningDHV, 2016) was submitted to the Secretary of State on 3 October 2016 and the response in the form of a Scoping Opinion (PINS, 2016) published on 11 November 2016. That Scoping Opinion included the consultation responses of Natural England and Norfolk County Council.

3.4.1.2. An Extended Phase 1 Habitat Survey of the onshore project area was undertaken during February 2017 (Royal HaskoningDHV, 2017a). The Extended Phase 1 Habitat Survey identified the potential for legally protected species located within the project area plus a 50m buffer surrounding the project area, and provided recommendations for further surveys required to characterise the ecological baseline for the project area. These recommendations were issued to stakeholders on 17 March 2017 for comment, as part of the project Evidence Plan Process. Feedback was received from Norfolk County Council and Natural England on the 23 March 2017 and 3 April 2017 respectively that the methodologies were appropriate and acceptable.

3.4.1.3. A Survey Scope detailing the surveys required in order to deliver the Extended Phase 1 Habitat Survey Report recommendations (Royal HaskoningDHV, 2017b) was produced in March 2017. The Survey Scope (set out in Section 3.4.2) was used to tender for delivery of ecological surveys required for the project. Norfolk Wildlife Services based the methodology on this Survey Scope in consultation with the client.

#### **3.4.2. Survey Scope**

##### *Survey area*

3.4.2.1. Following consultation with Natural England conducted as part of the Evidence Plan Process, the need for a detailed assessment of the habitat associated with the River Wensum was recommended to ensure that the potential effects of proposed horizontal directional drilling under the River Wensum upon the quantifying features of the River Wensum SAC and the notified features of the River Wensum SSSI were fully understood. As a consequence a botanical survey will be undertaken to characterise the habitats of the semi-improved grassland found adjacent to the River Wensum during the field survey. This botanical survey will also involve a systematic search of the site in order to check the wet grassland habitats for the presence of springs and seepages, in order to characterise the water environment within the River Wensum floodplain.

3.4.2.2. The locations of the habitats scoped into the botanical survey are shown on Figure 1 (Appendix 1 of this report).

##### *Methodology*

3.4.2.3. The botanical survey will follow the methodology set out in *National Vegetation Classification: Users' handbook* (Rodwell, 2006). The survey will cover all semi-improved and wet grassland areas adjacent to the River Wensum within the survey area (as shown on Figure 1). Quadrat sampling will be used within delineated sub-communities, and those species found within each quadrat identified. An NVC communities map will be drawn up following the results of the survey, and the precise location of all notable species recorded.

The following aquatic plant species, for which the habitat is given its SAC status, will be given particular attention:

- pond water-crowfoot *Ranunculus peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*.

3.4.2.4. The optimal surveying window for the botanical survey is between April and June.

3.4.2.5. The survey should be undertaken by experienced NVC surveyors, preferably members of the CIEEM. No species licences are required for this survey.

### **3.5. Scoping of survey locations**

3.5.1. Natural England recommended the need for a detailed assessment of the habitat associated with the River Wensum to ensure that the potential effects of proposed horizontal directional drilling under the River Wensum upon the qualifying features of the River Wensum SAC and the notified features of the River Wensum SSSI were fully understood.

### **3.6. Conservation Status of the River Wensum SAC**

3.6.1. The whole length of the River Wensum is a designated Site of Special Scientific Interest (1993) and Special Area of Conservation (2005). The site is listed under Annex I for habitat 3260 "Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitriche-Batrachion* vegetation".

3.6.2. The River 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.

### **3.7. Presence of springs and seepages**

3.7.1. Soligenous water movement through the soil discharging from rocks can be at a point (spring) or over a wide area (seepage). A pre-requisite for this type of groundwater discharge is an underlying or adjacent aquifer, such as the Cretaceous chalk aquifer underlying the soils of the River Wensum.

3.7.2. Evidence of spring activity is usually characterised by surface wetness and/or a change in vegetation community within a site.

## 4. Methodology

4.1. Section 4.1 sets out the proposed survey protocol as agreed between Royal HaskoningDHV and Norfolk Wildlife Services prior to any field work commencing, and Section 4.2 sets out how the surveys were delivered in relation to the protocol and identifies any deviations or modifications that took place during the delivery phase.

### 4.1. Survey protocol

4.1.1. This Section details the proposed survey protocol as agreed between Royal HaskoningDHV and Norfolk Wildlife Services prior to any field work commencing.

#### *Relevant guidance*

4.1.2. The following guidance documents were used to inform development of the survey methodology:

- Rodwell, J.S. (2006) National Vegetation Classification: Users' handbook. JNCC
- Doarks, C., & Leach, S. J. (1990). A classification of grazing marsh dyke vegetation in Broadland. Nature Conservancy Council.

#### *Methodology*

4.1.3. Three different methodologies will be undertaken for different aspects of the Norfolk Vanguard botanical survey.

- An NVC survey of grassland within the wider floodplain (Rodwell 2006) including identification of any springs and seepages.
- For the Norfolk Vanguard River Wensum SAC/SSSI Survey, an adapted NVC river survey on a point-sampling basis, supplemented by visual examination.
- A vegetation survey of the ditches using the methodology of Doarks and Leach (1990).

4.1.4. The three methodologies are described below.

#### **Grassland NVC survey**

4.1.5. Sampling of the site will be undertaken in accordance with the approach set out in Rodwell (2006). An initial walkover will be conducted to identify the broad vegetation communities present within the site. Following this, sampling quadrats will be randomly selected within each broad vegetation community. A full species list will be noted for each quadrat, with species abundances quantified in accordance with the Domin scale and vegetation height will be recorded.

Table 1 : Domin cover values

Domin	Cover (%)
10	91-100
9	76-90
8	54-75
7	34-50
6	26-33
5	11-25
4	4-10
3	<4% (many individuals)
2	<4% (several individuals)

1	<4% (few individuals)
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4.1.6. Any potential calcareous groundwater seepage/spring activity within the site will be noted.

4.1.7. A NVC community type will be attributed to the sampling locations. A map showing the NVC communities will be drawn up following the results of the survey, and the precise location of all notable species recorded.

4.1.8. Quadrat sampling will be used within delineated sub-communities, and those species found within each quadrat identified.

***Analysis to NVC Communities***

4.1.9. The NVC community type for each sampling location will be on Rodwell (2006) and surveyor experience from comparable sites with those identified communities. Floristic tables will be generated for each community type that summarises the abundance and constancy values of constituent species among the samples. Constancy values will be allocated as per the following table:

*Table 2 : Constancy tables as defined in Rodwell (2006)*

Constancy	Frequency (5%)	Description
I	1-20 (i.e. 1 stand in 5)	scarce
II	21-40	occasional
III	41-60	frequent
IV	61-80	constant
V	81-100	constant

4.1.10. Keys of British Plant Communities Volume 3: Grasslands and Montane Communities, British Plant Communities Volume 4: Aquatic communities, swamps and tall herb fen and British Plant Communities Volume 1: Woodlands and scrub will be used to assign NVC community types.

***River Wensum SAC/SSSI Survey***

4.1.11. The total length of the River Wensum survey reach (a distance of 360m) will be split into 10 equal parts, so sampling will occur approximately every 35m.

4.1.12. A canoe will be anchored in the approximate centre of the river at the identified sampling locations (Figure 2). Photographs will be taken and grid references noted at each sampling location.

4.1.13. A rope with a 3 headed grapnel will be thrown 5m south west and north east of each anchored sampling location. The grapnel will be allowed to sink to the river bed before being slowly pulled along the river bed and into the canoe.

4.1.14. At each sampling location any plants collected on the grapnel will be noted by the field surveyor and scored according to a percentage scale (0-100%).

4.1.15. A bathascope will be used at and between sampling locations to look through the water column at vegetation towards the river bed. A visual assessment will be made through the water column regarding species, abundances and vegetation height. Shallower vegetation will be incorporated within the sampling regime.

4.1.16. Particular attention will be paid to identify those species listed within the specification document.

4.1.17. The following aquatic plant species, associated with the River Wensum SAC habitat, will be given particular attention:

- pond water-crowfoot *R. peltatus* .
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans* .
- river water-crowfoot *R. fluitans*.

4.1.18. An NVC community will be attributed to each of the sampling locations, based on a combination of the grapnel sampling and bathascope assessment.

4.1.19. An NVC community will be attributed to the marginal vegetation.

### **Ditch Survey**

4.1.20. Four distinct ditch systems were identified within the River Wensum floodplain survey area and were labelled Ditch 1-4 (see Figure 3).

4.1.21. Within each ditch system, 20m sections will be chosen per ditch that appears to contain homogenous or representative vegetation for both aquatic and emergent communities. Photographs will be taken and grid references noted at each sampling location.

4.1.22. All species within the aquatic zone will be noted with abundances (quantified within DAFOR) and general notes about the ditch recorded. Local cover values will also be noted, where relevant. Emergent species are defined as those within the aquatic zone, which for most of the summer have the majority of their biomass above the water surface.

Table 3 : DAFOR and local cover values

DAFOR	Cover (%)	Local cover vales
Dominant (D)	70-100	A-LD
Abundant (A)	30-70	F-LD, FLA
Frequent (F)	10-30	O-LD, OLA
Occasional (O)	3-10	R-LD, R-LA, O-LF
Rare (R)	<3	R-LF, R-LO

4.1.23. The following aquatic plant species, associated with The River Wensum SAC habitat, will be given particular attention:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

### **Analysis to Endgroups**

4.1.24. Aquatic and emergent species for each sampling location will be attributed an End Group. Species and abundances will be hand sorted through the key in Doarks and Leach (1990) to identify an aquatic and emergent End Group for each sampling location. These groups are set out in the Tables below.

Table 4 : Aquatic vegetation communities, as defined in Doarks and Leach (1990)

Communi ty	Binomial Names	Common names
A1	<i>Scirpus fluitans-Potamogeton natans</i>	Floating club rush-broad leaved pondweed

A2	<i>Potamogeton natans</i> - <i>Hottonia palustris</i> - <i>Myriophyllum verticillatum</i>	Broad leaved pondweed-Water violet-Whorled water milfoil
A3a	<i>Potamogeton natans</i>	Broad leaved pondweed
A3b	<i>Stratiotes aloides</i> - <i>Hydrocharis morsus-ranae</i>	Water soldier-Frogbit
A4	<i>Ceratophyllum demersum</i>	Rigid hornwort
A5a	<i>Elodea Canadensis</i> - <i>Ceratophyllum demersum</i>	Canadian pondweed-Rigid hornwort
A5b	<i>Lemna minor</i> - <i>Lemna trisulca</i> -Filamentous algae	Common duckweed-Ivy leaved duckweed-Filamentous algae
A6	<i>Callitriche stagnalis/platycarpa</i>	Common/Variou leaved water starwort
A7a	Filamentous algae- <i>Enteromorpha</i>	Filamentous algae-Gutweed
A7b	<i>Potamogeton pectinatus</i> – <i>Myriophyllum spicatum</i>	Fennel pondweed-Spiked water milfoil

Table 5 : Emergent vegetation communities, as defined in Doarks and Leach (1990)

Community	Binomial Names	Common names
E1	<i>Carex riparia/acuteformis</i> - <i>Phragmites australis</i>	Greater/Lesser pond sedge-Common reed
E2	<i>Glyceria maxima</i> - <i>Berula erecta</i>	Reed canary grass/Lesser water parsnip
E3	<i>Juncus effusus</i>	Soft rush
E4	<i>Phragmites australis</i>	Common reed
E5	<i>Scirpus maritimus</i> - <i>Scirpus lacustris</i> subsp. <i>tabernaemontani</i> - <i>Eleocharis uniglumis</i>	Saltmarsh bulrush-Common club rush-Slender spike rush
E6	<i>Scirpus maritimus</i> - <i>Juncus gerardii</i>	Saltmarsh bulrush-Saltmarsh rush

### Personnel

4.1.25. All surveys will be undertaken by suitably experienced NVC surveyors, who are either members of CIEEM or act according to its code of conduct.

### Survey timing, equipment and weather conditions

4.1.26. Although the optimal surveying window for the botanical survey was identified by the ITT as being between April and June, given the survey required identification of sedges and rushes the optimal period is May to late July / early August.

### Additional information

4.1.27. A permit to survey within The River Wensum SAC will be required from Natural England.

4.1.28. Any locally scarce species will be noted with reference to A Flora of Norfolk (Beckett and Bull, 1999).

4.1.29. Any nationally scarce species will be noted with reference to The Vascular Plant Red Data List for Great Britain (Cheffings and Farrell (Eds), 2005).

## 4.2. Survey delivery

4.2.1. This Section details how the surveys were delivered in relation to the agreed protocol, identifies any deviations or modifications that took place during the delivery phase and highlights survey limitations.

### 4.2.1. Survey methodology as delivered

#### *Access to survey sites*

4.2.1.1. Access permission to the northern half of the River Wensum was not granted.

4.2.1.2. There were no other access restrictions.

#### *Survey effort*

4.2.1.3. There appeared to be two distinct grassland NVC community types identified during the walkover of the site. 14 quadrats of 2m x 2m, specified in accordance with Rodwell (2006) for short herbaceous vegetation, were randomly selected within these two areas (Figure 1).

4.2.1.4. Due to the depth of the river being too deep to wade in, and too wide to sample from the southern bank, the survey of the River Wensum was undertaken by canoe.

4.2.1.5. Due to the dangers of sampling the marginal vegetation of the River Wensum from the bank next to deep water and silt or from a canoe, the marginal vegetation was attributed a NVC community based on visual impression of the species present.

#### *Dates of surveys*

Table 6 : Dates, personnel and weather for vegetation surveys

Location	Visit Date	Time	Weather	Personnel
NVC Grassland	05/07/2017	10:00-17:00	2/8 cloud cover, BWS 1, dry, hot 27°C	Sally McColl Chris Smith
NVC Grassland	24/08/2017	08:00-15:00	2/8 cloud cover, BWS 1, dry with sunny spells, hot 24°C	Sally McColl Carolyn Smith
NVC River Wensum	28/07/2017	08:30-14:00	7/8 cloud cover, BWS 3, dry, cool with sunny spells	Sally McColl James Allitt
NVC Ditches	23/08/2017	08:00-15:00	2/8 cloud cover, BWS 1, dry, with sunny spells, hot 22°	Sally McColl Ben Moore
NVC Ditches	24/08/2017	08:00-15:00	2/8 cloud cover, BWS 1, dry with sunny spells, hot 24°C	Sally McColl Carolyn Smith

#### *Personnel*

4.2.1.6. All surveys were undertaken by suitably experienced NVC surveyors, who are listed in the table below. Other personnel mentioned in Table 6 were safety workers.

Table 7 : Personnel and relevant experience

Team Member	Experience
Chris Smith	20 years' experience within ecological consultancy and 25 years' experience of ecological surveying including NVC plant surveys.
Sally McColl	10 years' experience of ecological surveying, including aquatic plant surveys, condition monitoring and NVC plant surveys.
Carolyn Smith	4 years' experience of ecological surveying including NVC plant surveys.



## Consent

4.2.1.7. A permit to survey within the SAC was received from Natural England on 24<sup>th</sup> July 2017 (Appendix 3).

### 4.2.2. Limitations

4.2.2.1. The NVC approach was not felt applicable to ditch vegetation within the site, due to the limitations of that classification for artificial dykes (Mountford, 2006). However the alternative use of Doarks and Leach (1990) is felt to be more robust and applicable in this instance and gives no significant limitations.

4.2.2.2. Limitations for each survey type are outlined in the Table below.

*Table 8: Limitations and suggested impacts*

Survey Type	Limitation	Impact of Limitation
Grassland Survey	No limitations	N/A
River Survey	Access to the northern half of the river was not given by the landowner, so the survey was carried out on the southern half;  The marginal edge was too dangerous to sample from the bank or by canoe.	Not significant – the emergent vegetation was visible from the southern half of the river, and the aquatic vegetation was fairly uniform.  Not significant – the marginal edge consisted of a single species swamp community and was easily assessed by eye.
Ditch Survey	No limitations	N/A

## 5. Results

5.1. Maps showing sampling locations are shown in Appendix 1 (Figures 1-3).

5.2. Photographs taken at sampling locations are included in Appendix 2 (Figures 4-38).

5.3. Raw data tables and endgroup descriptions (Doarks and Leach, 1990) are attached as separate documents.

5.4. A map showing field names is attached in Appendix 6 and NVC map is attached in Appendix 7.

### 5.1. Grassland NVC survey

#### Overview

5.1.1. The site consists of a relatively flat floodplain, which nevertheless contains some variation in levels and drainage patterns. Areas closest to the river appear to have the highest water tables, and include areas with peaty soils (Fields 4, 7, 8 and 9) whereas the more southerly and westerly sections are drier and loamy (Fields 6 and 1). The site is roughly grazed throughout to varying degrees by cattle.

5.1.2. The site slopes down from the upland in the north easterly direction although the majority of the fields are undulating, with some lower wetter patches having impeded drainage. Penny Spot Beck and the River Wensum were embanked, whilst all other ditches graded into the surrounding grassland.

5.1.3. On the back of the floodbank, Field 9, there was a distinct patch of wetter vegetation. This is thought to be caused by seepage of water through the floodbank due to proximity to the river rather than soligenous water flow. Another distinct wetter area was on the edge of the survey area in Field 7, which is likely caused by natural undulation of the field. The remaining fields, although showing undulation with lower areas, appeared much drier.

5.1.4. The aquatic and marginal communities of the ditches are a prominent feature, but are dealt with in the subsequent sections.

5.1.5. The grassland appears to consist of the following vegetation communities:

- MG6 – *Lolium perenne*-*Cynosurus cristatus* grassland
- MG10 – *Holco-Juncetum effusi* rush pasture

5.1.6. MG6 is present throughout the southern and easterly parts of the site, whilst MG10 is confined to a small area at the back of the floodbank and the north western and north eastern (part of) marshes. These habitats are intrinsically linked with ground conditions, with MG6 located on free draining soil and on areas of higher ground, and MG10 being located on impeded soils and in lower areas.

5.1.7. There are overgrown hedgerows and scattered scrub throughout the site with species such as hawthorn *Crataegus monogyna* (which is classified as W21 – *Crataegus monogyna*-*Helix hederia* scrub (Target notes 1 and 3)), and sallow *Salix cinerea* with a bramble *Rubus fruticosus* understorey (which is classified as W2a *Salix cinerea*-*Betula pubescens*-*Phragmites australis*, *Alnus glutinosa*-*Filipendula ulmaria* sub community).

5.1.8. A line of oaks *Quercus robur* (Target note 4) and poplars *Populus spp.* (Target note 2) were recorded.

5.1.9. Field 10 was excluded from classification under NVC as it appeared to be in a cropping regime, and not grassland.

## **MG6 *Lolium perenne*-*Cynosuretum cristati* grassland**

### *Description*

5.1.10. The sampling locations were grass-dominant with species such as *Agrostis stolonifera*, *Holcus lanatus* and *L. perenne* having the highest constancy values as well as *Ranunculus repens*, which typically persists in grazed areas.

5.1.11. Herbs present with the highest constancy values are small creeping species such as *Potentilla repens*, *Trifolium repens*, and *Trifolium pratense* with taller herbs present at some sampling locations.

5.1.12. The MG6 grassland sampling locations were labelled as D1-D6.

5.1.13. On average between 10 and 20 species were recorded per sampling location, with over half of those recorded being grasses.

5.1.14. No nationally or locally scarce species were noted at any of the sampling locations.

### *Variation within community*

5.1.15. There is variation between the fields within the site, as shown by the sample data.

5.1.16. At the south-east of the site, there was a lush, tussocky sward which had approximately four coarse grass species of equal abundance including *A. stolonifera* and *Festuca arundinacea* and appeared to have been grazed earlier in the season (Field 5).

5.1.17. At the back of the floodbank adjacent to the wetter MG10 community (Field 9), the vegetation here was less species rich and had coarse grasses such as *A. stolonifera*, *H. lanatus* and *F. arundinacea* in higher abundances.

5.1.18. Throughout the site, but especially on the eastern side the community was often transitional to the MG10 community and examples of samples within these areas had higher occurrence of *J. effusus*, *H. lanatus* and *R. repens* (Field 8).

5.1.19. As the ground rose towards the west the sward became drier (Field 6), and became a more closely grazed sward with more fine grasses evident. A lot of ruderal species such as *Cirsium arvense* and *Rumex obtusifolius* were evident.

5.1.20. At the south-west (Field 1) the sward was lush, and lightly grazed with a higher proportion of herbs and *Juncus inflexus* present. However, the southern and eastern areas of this field appeared higher and drier. This location is very clearly transitional in places towards the *J. inflexus* variation of MG10 (Target note 5).

5.1.21. Fields 2, 3 and 4 were ungrazed at the time of survey and vegetation was very tall and had *Arrhenatherum elatioris* evident.

5.1.22. The back of the floodbank (Field 9) and Field 5 had a much more tussocky sward, consistent with a lighter grazing regime.

### *Goodness of fit to community*

5.1.23. MG6 is described as “a short, tight sward which is grass-dominated. *Lolium Perenne* is usually the most abundant grass with varying amounts of *Cynosurus cristatus*. *Festuca Rubra* and *Agrostis capillaris* are frequent throughout and, in long-established pasture, they may be abundant. *Holcus lanatus* and *Dactylis glomerata* are also frequent but of somewhat patchy distribution. They may become more prominent as coarse tussocks if pasture is under-grazed and *H. lanatus* is often abundant and vigorous around cattle dung which the animals avoid.” (Rodwell, 1992).

5.1.24. It is not an exact fit with MG6, as *C. cristatus* is only present at one of the quadrats, and *T. repens* is in a lower value. However this may be because many of the areas are

transitional to MG10 and are located within damper areas which are less favourable for *C. cristatus*.

5.1.25. MG6 is typical of grazed lowland pasture in Britain on moist freely draining soils, which is consistent with the site.

5.1.26. Ungrazed Fields 2 and 5 could potentially fit better with MG1-A. *elatioris* as it grades to the arable upland (Target notes 6 and 7)), where under grazing has allowed this grass to appear more dominant, or it could just be that a lighter grazing regime has led to this appearance of change.

### Constancy table

5.1.27. The constancy table is shown below.

Table 9: Constancy table for MG6 *Lolium perenne*-*Cynosuretum cristati*

Species	Average for stand (DOMIN)	Constancy
<i>Agrostis stolonifera</i> (creeping bent)	4	V
<i>Holcus lanatus</i> (Yorkshire fog)	5	V
<i>Lolium perenne</i> (perennial ryegrass)	2	V
<i>Ranunculus repens</i> (creeping buttercup)	3	V
<i>Taraxacum</i> agg. (dandelion)	2	V
<i>Festuca rubra</i> (red fescue)	2	IV
<i>Phleum pratensis</i> (timothy)	3	IV
<i>Arrhenatherum elatius</i> (false oat grass)	2	III
<i>Cerastium fontanum</i> (common mouse ear)	1	III
<i>Poa trivialis</i> (rough meadow grass)	1	III
<i>Bromus mollis</i> (soft brome)	1	II
<i>Carex hirta</i> (hairy sedge)	1	II
<i>Dactylis glomerata</i> (cocks foot)	1	II
<i>Festuca arundinacea</i> (tall fescue)	2	II
<i>Juncus inflexus</i> (hard rush)	2	II
<i>Plantago lanceolata</i> (ribwort plantain)	1	II
<i>Poa pratensis</i> (smooth stalked meadow grass)	1	II
<i>Potentilla repens</i> (creeping cinquefoil)	1	II
<i>Trifolium pratense</i> (red clover)	1	II
<i>Trifolium repens</i> (white clover)	1	II
<i>Agrostis capillaris</i> (common bent)	1	I
<i>Alopecurus geniculatus</i> (marsh foxtail)	1	I
<i>Brachythecium rutabulum</i> (rough stalked feather moss)	0	I
<i>Cynosurus cristatus</i> (crested dogs tail)	0	I
<i>Deschampsia cespitosa</i> (tufted hair grass)	1	I
<i>Glechoma hederacea</i> (ground ivy)	0	I
<i>Juncus effusus</i> (soft rush)	1	I
<i>Lathyrus pratensis</i> (meadow vetchling)	1	I
<i>Lotus corniculatus</i> (bird's foot trefoil)	1	I
<i>Potentilla anserina</i> (silverweed)	1	I
<i>Pulicaria dysenterica</i> (common fleabane)	1	I
<i>Rumex crispus</i> (curled dock)	<1	I
<i>Rumex obtusifolius</i> (broad leaved dock)	1	I
<i>Senecio jacobaea</i> (ragwort)	<1	I
<i>Urtica dioica</i> (nettle)	<1	I
<i>Vicia cracca</i> (tufted vetch)	<1	I

## MG10 – *Holco-Juncetum effusi* rush pasture

### Description

5.1.28. These wetter grasslands were on peaty soils, located within the lowest areas within the site and are numbered W1-W7.

5.1.29. The species with highest constancy values are *J. effusus*, *A. stolonifera*, and *H. lanatus* with *R. repens* a constant but at a low abundance.

5.1.30. Sampling locations W1, W2, W6-W8 were taken along the back of the river bank to north/north-east of the site.

5.1.31. Sampling locations W3-W5 were taken in the northern marsh, although this habitat continued slightly to the south (Field 8).

5.1.32. No nationally or locally scarce species were noted at any of the sampling locations.

### Variation within community

5.1.33. W5 (Field 7) was distinctly wetter and *Persicaria amphibia* was evident within the *J. effusus*.

5.1.34. W7 (Field 9) had *Glyceria maxima* present instead of *J. effusus*. These sampling locations were generally lightly or not grazed, although the grass sward between the tussocks were well grazed.

### Goodness of fit to community

5.1.35. MG10 *Holco-Juncetum effusi* – “a sward with prominent tussocks of *Juncus effusus* up to 80cm tall in a generally species poor and shorter grassy ground. *Holcus lanatus* and *Juncus effusus* are the only constant grasses and each or both may be abundant” (Rodwell, 1992).

5.1.36. This community is characteristic of permanently moist sites, which is widely distributed in pastures and are usually grazed.

5.1.37. It is a good fit with this community type as *A. stolonifera*, *H. lanatus* and *J. effusus* are present at high constancies, although *R. repens* is at a lower occurrence.

### Constancy table

5.1.38. The constancy table is below.

Table 10: Constancy table for MG10

Species	Average for stand (DOMIN)	Constancy
<i>Agrostis stolonifera</i> (creeping bent)	4	V
<i>Holcus lanatus</i> (Yorkshire fog)	5	V
<i>Juncus effusus</i> (soft rush)	5	V
<i>Alopecurus pratensis</i> (meadow foxtail)	2	IV
<i>Arrhenatherum elatius</i> (false oat grass)	2	IV
<i>Festuca arundinacea</i> (tall fescue)	2	IV
<i>Filipendula ulmaria</i> (meadow sweet)	2	IV
<i>Stellaria graminea</i> (lesser stitchwort)	1	IV
<i>Potentilla anserina</i> (silverweed)	2	III
<i>Ranunculus repens</i> (creeping buttercup)	1	III
<i>Rumex acetosa</i> (common sorrel)	1	III
<i>Cerastium fontanum</i> (common mouse ear)	1	III
<i>Juncus articulatus</i> (jointed rush)	1	II

<i>Lathyrus pratensis</i> (meadow vetchling)	1	II
<i>Lotus pedunculatus</i> (greater bird's-foot-trefoil)	1	II
<i>Poa trivialis</i> (rough meadow grass)	1	II
<i>Taraxacum</i> agg. (dandelion)	1	II
<i>Carex acutiformis</i> (lesser pond sedge)	1	II
<i>Dactylis glomerata</i> (cock's-foot)	1	II
<i>Glechoma hederacea</i> (ground ivy)	1	II
<i>Glyceria maxima</i> (reed sweet-grass)	1	II
<i>Carex riparia</i> (greater pond sedge)	1	II
<i>Trifolium pratense</i> (red clover)	<1	II
<i>Carex hirta</i> (hairy sedge)	<1	I
<i>Cirsium arvense</i> (creeping thistle)	<1	I
<i>Lolium perenne</i> (perennial ryegrass)	<1	I
<i>Myosotis secunda</i> (creeping forget me not)	<1	I
<i>Persicaria amphibia</i> (amphibious bistort)	1	I
<i>Phalaris arundinacea</i> (reed canary grass)	1	I
<i>Urtica dioica</i> (common nettle)	<1	I
<i>Cirsium dissectum</i> (meadow thistle)	<1	I
<i>Equisetum palustre</i> (marsh horsetail)	<1	I
<i>Quercus</i> spp. (oak sapling)	<1	I
<i>Rumex conglomeratus</i> (clustered dock)	<1	I
<i>Rumex obtusifolius</i> (broad leaved dock)	<1	I
<i>Senecio aquaticus</i> (marsh ragwort)	<1	I
<i>Senecio jacobea</i> (common ragwort)	<1	I
<i>Trifolium repens</i> (white clover)	<1	I

5.1.39. Full data tables are provided as an excel table in Appendix 4.

## 5.2. River Wensum SAC/SSSI survey

### Description

5.2.1. The river was approximately 2m deep and 20m wide, with good marginal vegetation, often in floating and inaccessible mats.

5.2.2. There were no trees along the river banks of the southern stretch of the survey area. There were a few white willows *Salix alba*, along the southern banks between sampling locations 6 and 8, and some oaks *Quercus robur*, and alders *Alnus glutinosa* along the northern bank.

5.2.3. Two main vegetation communities were identified:

- A8a-*Nuphar lutea* community, species-poor sub community.
- S5-*Glycerietum maximae* swamp, *Alisma plantago-aquatica*-*Sparganium erectum* sub community.

### S5-*Glycerietum maximae* swamp

5.2.4. There was a good marginal vegetation dominated by *G. maxima* with large mats of *Apium nodiflorum* stretching out into the river, narrowing the open water by up to 10m in certain areas. There were some floating mats of *P. arundinacea* and *Veronica catenata* throughout the sampled area. *Sparganium erectum* with some *Myosotis scorpioides* was present at sampling location 10. This emergent community was assessed as NVC S5-*Glycerietum maximae* swamp, *Alisma plantago-aquatica*-*Sparganium erectum* sub community.

### A8a-*Nuphar lutea* community, species-poor sub community

5.2.5. The majority of the open water was generally covered by *N. lutea*, which persisted throughout the water column. The amount to which the *N. lutea* persisted through the water column varied along the length. It was estimated that *N. lutea* was present over 25% of the water column growing from the bed to 50cm below the surface at sampling locations 4 and 5, whereas at most other sampling locations *N. lutea* was evident on the water surface and was estimated to occupy an average of 25%-50% of the water column.

5.2.6. *N. lutea*, dominated the water column, with occasional species such as *Callitriche spp.*, and *Elodea nuttalli* being recorded. The occasional strand of *M. spicatum* was noted floating on the water surface, but not picked up during the survey. Beds of this plant were noted upstream from the survey area.

5.2.7. The NVC community assigned to the aquatic communities is A8a-*Nuphar lutea* community, species-poor sub community.

### Variation within community

5.2.8. This stretch of river was fairly uniform in terms of aquatic macrophyte diversity.

5.2.9. None of the following species listed within the Norfolk Vanguard Phase 2 Ecological Surveys Scope associated with the River Wensum SAC habitat were noted:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

5.2.10. No locally or nationally scarce species were noted during the survey.

### Goodness of fit to community

5.2.11. A8 is described in Rodwell (1995) "...Much of the vegetation is species poor, consisting of little else apart from *N. lutea*..."

5.2.12. The species-poor sub community is described in Rodwell (1995) as "*N. lutea* is sometimes the only plant here, with just very occasional *L. minor* on the surface, *Elodea canadensis*, *Callitriche stagnalis*, *Zannichellia* or *Ceratophyllum demersum* beneath and a few shoots or clumps of *Sagittaria*, *Apium*, *V. beccabunga* or *Mentha aquatica*."

5.2.13. The sampling locations fit well with the description of this community type.

### Results table

5.2.14. Species and abundances of aquatic plants noted at each sampling location are listed in Table 10 below.

Table 11 : Species and abundances of aquatic plants at river sampling locations

Point	Sampling direction	Species			
		<i>Nuphar lutea</i>	<i>Callitriche spp.</i>	<i>Elodea nuttalli</i>	<i>Myosotis scorpioides</i>
		% cover	% cover	% cover	% cover
1	NE	25	-	5	-
1	SW	25	-	-	-
2	NE	10	5	25	-
2	SW	-	5	20	-
3	NE	10	-	5	-
3	SW	50	-	-	-
4	NE	30	-	1	-
4	SW	10	-	15	-
5	NE	25	-	-	-
5	SW	10	-	5	-
6	NE	25	-	-	-
6	SW	30	-	-	-
7	NE	15	-	-	-
7	SW	20	-	-	-
8	NE	5	-	-	-
8	SW	-	-	-	-
9	NE	30	-	-	-
9	SW	30	-	-	-
10	NE	75	-	-	1
10	SW	75	-	-	-



## 5.3. Ditch survey

### Ditch 1

#### Description

5.3.1. This was an agricultural field drain of approximately 2.5m wide and was fairly uniform along its length, with water being very shallow (10-30cm) and abundant vegetation cover.

#### Aquatic vegetation

5.3.2. *Polygonum amphibium* was locally dominant, at three of the sampling locations (1A, 1B, 1D) with *Potamogeton berchtoldii* being abundant at 1C.

5.3.3. The species recorded along this ditch length key out to three different End Groups. Species recorded at sampling locations 1A correspond to the End Group A6-*Callitriche stagnalis/platycarpa* which is a good fit with this group with both *C. spp.* and *L. minor* being present.

5.3.4. Species recorded at sampling location 1B key out to the End Group A7b-*Potamogeton pectinatus-Myriophyllum spicatum*, which doesn't fit well as none of the constant species for this group were recorded, and only keyed to this group due to the presence of *L. minor*.

5.3.5. Species recorded at sampling locations 1C and 1D key out to End Group A5b-*Lemna minor/Lemna trisulca*/filamentous algae. Despite two of the constant species not being recorded with only *L. minor* being present, it is a good fit to this group as it represents ditches with low species diversity with some *C. spp.* and *P. pusilus/berchtoldii* present. End Group A5b is the best fit with sampling locations 1B-1D.

Table 12 : Ditch 1 – Species and abundances of aquatic vegetation

Species	Sampling Location			
	1A	1B	1C	1D
<i>Polygonum amphibium</i>	A - LD	F	-	F - LD
<i>Potamogeton bertoldii</i>	O	A	A	R
<i>Callitriche spp.</i>	O - LD	-	R	-
<i>Lemna minor</i>	R	R	R	O
<b>Aquatic End Group</b>	<b>A6</b>	<b>A7b</b>	<b>A5b</b>	<b>A5b</b>

#### Emergent vegetation

5.3.6. Emergent vegetation was in general low growing with species such as *B. erecta*, frequently occurring. Other species such as *Mentha aquatica* were of rare occurrence. There were no dominant species at any of the points except at 1A where pendulous sedge *Carex pendula*, was locally dominant.

5.3.7. The emergent vegetation does not fill well with the End Groups due to the lack of dominant species resulting from shading.

Table 13: Ditch 1 – Species and abundances of emergent vegetation

Species	Sampling Location			
	1A	1B	1C	1D
<i>Agrostis stolonifera</i>	R	O	R	
<i>Alisma aquatica</i>			R	
<i>Berula erecta</i>		F	R	

Species	Sampling Location			
<i>Cardamine pratensis</i>		R	R	
<i>Carex pendula</i>	LD			
<i>Carex spp.</i>			O	
<i>Epilobium hirsutum</i>	R	R	R	
<i>Equisetum palustris</i>	R			
<i>Juncus articulatus</i>			O	
<i>Juncus inflexus</i>	R	R	A	
<i>Mentha aquatica</i>	O	O	F	R
<i>Polygonum amphibium</i>		F		
<i>Ranunculus repens</i>	R	R	R	
<i>Salix cinerea</i>		O	O	O
<i>Solanum dulcamara</i>	R			
<i>Tussilago farfara</i>			R	
<i>Typha latifolia</i>	O	O	O	
<b>Emergent End Group</b>	<b>E2</b>	<b>E3</b>	<b>E3</b>	<b>E2</b>

### Summary

5.3.8. End Group A6-*Callitriche stagnalis/platycarpa* is typically found in ditches that border between the uplands and grazing marsh, which can dry out for periods in the summer. Land to the north of the ditch does slope downwards, and due to the woodland fringe on the south side it is thought likely that the ditch does dry out at times in the shallower areas. This group is most closely associated with emergent End Group E2-*Glyceria maxima-Berula erecta*.

5.3.9. End Group A5b-*Lemna minor/Lemna trisulca*/filamentous algae is species poor, typically found in water depths of <20cm, and is associated with moderately eutrophic conditions.

5.3.10. None of the following species listed within the Norfolk Vanguard Phase 2 Ecological Surveys Scope associated with the River Wensum SAC habitat were noted:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

## Ditch 2

### Description

5.3.11. This was an agricultural field drain of approximately 2.5m wide, 5-30cm water depth and was variable along its length in terms of vegetation cover.

### Aquatic vegetation

5.3.12. Sampling locations 2C to 2E keyed out to End Group A5b – *Lemna minor*-*Lemna trisulca*-filamentous algae where species such as *C. spp.* and *P. berchtoldii* are often typical.

5.3.13. Sampling locations 2A and 2B could not be assigned aquatic End Groups due to the lack of water plants. These points were heavily overshadowed by dense hedgerow to the west and tall ruderal vegetation to the east. The water level was very low at these points, with the sandy substrate at the bottom of the ditch evident. However, the ditch is quite uniform along its length, and the End Groups are thought likely to follow the same community, if shading was reduced.

Table 14: Ditch 2 - Species and abundances of aquatic vegetation

Species	Sampling Locations				
	2A	2B	2C	2D	2E
<i>Lemna trisulca</i>	-	-	R	A	-
<i>Lemna minor</i>	R	-	R	O	R
<i>Callitriche spp.</i>	-	-	O-LD	R	R
Filamentous algae	-	-	F-LD	O	O
<i>Hottonia palustre</i>	-	-	F	O	-
<i>Potamogeton bertoldii</i>	-	-	F-LD	-	-
<i>Elodea nuttalli</i>	-	-	-	R	-
<b>Aquatic End Group</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>

### Emergent vegetation

5.3.14. Emergent vegetation was generally low growing with species such as *B. erecta*, and *M. aquatica*, occurring with the highest scores at each sampling location. *P. arundinacea*, and *G. maxima* were locally dominant at sampling locations 2C and 2D.

5.3.15. Sampling location 2A was closest to emergent End Group E3-*Juncus effusus*, due to the presence of *Juncus effusus*, however this was only at rare occurrence and therefore sampling location 2A fits better with E2-*Glyceria maxima*-*Berula erecta* to which sampling locations 2B-2E also key out. However, only sampling location 2E has *G. maxima* present, whilst sampling locations 2A and 2D have *B. erecta* present as abundant to dominant and sampling locations 2B and 2C have it occurring occasionally.

Table 15: Ditch 2 – Species and abundances of emergent vegetation

Species	Point				
	2A	2B	2C	2D	2E
<i>Agrostis stolonifera</i>	R	R			
<i>Apium nodiflorum</i>					R
<i>Berula erecta</i>	D	O	O	A	
<i>Cardamine pratensis</i>	R				R
<i>Cerastium fontanum</i>					R
<i>Epilobium hirsutum</i>	R	R			

<i>Equisetum palustris</i>					O
<i>Eupatorium cannabinum</i>	R				
<i>Filipendula ulmaria</i>				R	
<i>Galium palustre</i>					R
<i>Glyceria maxima</i>					A/LD
<i>Holcus lanatus</i>				R	
<i>Iris pseudoacorus</i>					O
<i>Juncus effusus</i>	R				
<i>Juncus inflexus</i>		R			
<i>Mentha aquatica</i>	F	F		F	R
<i>Myosotis scorpidium</i>			O	O	O
<i>Phalaris arundinacea</i>	O		A/LD	O	
<i>Ranunculus repens</i>	O			R	
<i>Ranunculus scleratus</i>					R
<i>Salix cinerea</i>	O				
<i>Scrophularia auriculatum</i>					R
<i>Solanum dulcamara</i>		R	R	R	R
<i>Urtica dioica</i>	R	O			
<i>Valeriana officinalis</i>	R	R			
<b>Emergent End Group</b>	<b>E3</b>	<b>E2</b>	<b>E2</b>	<b>E2</b>	<b>E2</b>

### Summary

5.3.16. Ditch 2 was consistently classified as this End Group A5b-*Lemna minor/Lemna trisulca*/filamentous algae along its length.

5.3.17. End Group A5b-*Lemna minor/Lemna trisulca*/filamentous algae is a species poor community typically found in water depths of <20cm, and is associated with eutrophic conditions.

5.3.18. This aquatic community is often associated with the emergent vegetation End Group E2-*Glyceria maxima-Berula erecta* which is typical of eutrophic freshwater conditions with a high base status.

5.3.19. None of the following species listed within the Norfolk Vanguard Phase 2 Ecological Surveys Scope associated with the River Wensum SAC habitat were noted:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

### Ditch 3

5.3.20. This was an Internal Drainage Board (IDB) drain running along the back of the floodbank, which looked to have been cleared out within the last few years. This ditch was 2.5m wide and approximately 45-60cm deep.

#### Aquatic vegetation

5.3.21. Beds of *C. spp.*, dominated under the water surface with *Lemna minuta* dominating at the water surface. *E. nuttalli* was also recorded at all 5 sampling locations. This was the most diverse of the four ditches sampled, with an average of 5-6 species per sampling location.

5.3.22. The End Group assigned to the aquatic vegetation in this ditch is A5b – *Lemna minor-Lemna trisulca*-filamentous algae.

Table 16: Ditch 3 – Species and abundances of aquatic vegetation

Species	Sampling Locations				
	3A	3B	3C	3D	3E
<i>Lemna minuta</i>	A	A	A	F	O
<i>Callitriche spp.</i>	A	A	F	O	O
Filamentous algae	F	F	F	O	-
<i>Ceratophyllum demersum</i>	-	-	O	R	-
<i>Elodea nuttalli</i>	R	R	F	O	O
<i>Hottonia palustre</i>	-	F	O	R	-
Hydrodictyon algae	-	-	R	-	-
<i>Polygonum amphibium</i>	-	R	R	-	-
<i>Potamogeton pusillus</i>	R	R	-	-	-
<b>Aquatic End Group A6</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>

#### Emergent vegetation

5.3.23. Emergent vegetation had a good mix of species with *Sparganium erectum*, and *G. maxima* occurring abundantly within the sampling locations. Other typical swamp species such as *Filipendula ulmaria*, and *Galium palustre* were recorded at low abundances.

5.3.24. The End Group assigned to the emergent vegetation in this ditch is E2 – *Glyceria Maxima-Berula erecta*. It is a good fit with E2, as *G. maxima* was present at four of the sampling locations, and *A. stolonifera* and *A. nodiflorum/B. erecta* were present at the majority of sampling locations.

Table 17: Ditch 3 – Species and abundances of emergent vegetation

Species	Sampling Locations				
	3A	3B	3C	3D	3E
<i>Agrostis stolonifera</i>	R		R		
<i>Apium nodiflorum</i>	R	R	F	R	R
<i>Berula erecta</i>			R		R
<i>Carex riparia</i>		R			
<i>Cerastium fontanum</i>			R	R	
<i>Equisetum palustris</i>			R		
Filamentous algae			F		
<i>Filipendula ulmaria</i>		R	R	R	R

Species	Sampling Locations				
<i>Galium palustre</i>			O	R	R
<i>Glyceria maxima</i>	O	F		O	
<i>Hippuris vulgaris</i>			F		
<i>Holcus lanatus</i>		R			R
<i>Juncus articulatus</i>		R			
<i>Juncus effusus</i>		R	R	R	
<i>Mentha aquatica</i>	R		O		
<i>Phalaris arundinacea</i>	R	R	R		O
<i>Polygonum amphibium</i>		R			
<i>Ranunculus repens</i>	R	R	R	R	R
<i>Rumex conglomeratus</i>			R		
<i>Salix cinerea</i>		O	O	R	
<i>Scrophularia auriculatum</i>		R			R
<i>Solanum dulcamara</i>					O
<i>Sparganium emerum</i>	F				
<i>Sparganium erectum</i>	F	O		O	F
<i>Stachys palustris</i>	R		O		
<i>Urtica dioica</i>	R		R	R	R
<i>Veronica beccabunga</i>			O		
<b>Emergent End Group</b>	<b>E2</b>	<b>E2</b>	<b>E2</b>	<b>E2</b>	<b>E2</b>

### Summary

5.3.25. Ditch 3 was consistently classified along its length as aquatic End Group A5b – *Lemna minor-Lemna trisulca*-filamentous algae. It is associated with the emergent End Group is E2 – *Glyceria Maxima-Berula erecta*, typical of high nutrient conditions.

5.3.26. None of the following species listed within the Norfolk Vanguard Phase 2 Ecological Surveys Scope associated with the River Wensum SAC habitat were noted:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

### Ditch 4 (Penny Spot Beck)

5.3.27. Penny Spot Beck meanders through the site where it flows out into the River Wensum. The ditch has steeply sloping sides, well vegetated with emergent vegetation, which encroach into the ditch significantly along the majority of its length causing significant shading. It is different from the other ditches sampled by having a slow flow, whereas other ditches were static.

#### Aquatic vegetation

5.3.28. This ditch had no aquatic plants at any of the sampling locations, except for filamentous algae at one point. The ditch had macrophytes present during the July grassland visit (pers. obs. Chris Smith 05/07/17).

5.3.29. At sampling location 4C, the ditch is approximately 5cm deep and is adjacent to a cattle drinking point. The substrate is gravelly and flowing with water with the odd piece of filamentous algae, caught on the stone. At sampling location 4B the ditch deepens to 30cm, the stony bottom is replaced by silt and there is encroachment from marginal vegetation. At sampling location 4C, the water is deeper to 45cm and becomes more turbid.

5.3.30. It is not clear why there were no plants growing within the ditch in the sample area, where the ditch is more open and not subject to significant shading. There was no sign of the ditch being recently cleared out, or any treatment by herbicides. It is unlikely that the cattle are the issue, as there is significant poaching by cattle on the other ditches surveyed. It is thought possible run-off from the arable land to the north may be responsible, although there were no blooms of algae present which are consistent with nutrient enrichment.

5.3.31. It is thought likely that if aquatic vegetation was present, it would be consistent with a species poor community A5b – *Lemna minor*-*Lemna trisulca*-filamentous algae as environmental conditions within Penny Spot Beck appear similar to that of neighbouring ditches within the site. The A5b End Group was most frequently associated with E2 (Doarks and Leach, 1990), and were most frequently recorded together across the survey area.

Table 18: Ditch 4 - Species and abundances of aquatic vegetation

Species	Sampling Locations		
	4A	4B	4C
<i>Filamentous algae</i>	R	-	-
<b>Aquatic End Group A6</b>	<b>A5b</b>	<b>A5b</b>	<b>A5b</b>

#### Emergent vegetation

5.3.32. Emergent vegetation was dominated by single-species stands of reeds and grasses with limited associated species recorded at each point. *G. maxima*, *P. arundinacea*, and *C. riparia* were recorded as the most abundant species.

5.3.33. Sampling locations D2 and D3 keyed out to emergent End Group E2, whilst D1 keyed out to group E1 – *Carex riparia/acuteformis*-*Phragmites australis* due to the presence of *C. riparia* at the water line. Although all sampling locations seem more consistent with E2 it is however a poor fit as two of the constant species, *B. erecta* and *A. stolonifera* were not present.

Table 19: Ditch 4 – Species and abundances of emergent vegetation

Species	Sampling Locations		
	4A	4B	4C
<i>Agrostis stolonifera</i>			

Species	Sampling Locations		
<i>Apium nodiflorum</i>			R
<i>Berula erecta</i>			
<i>Carex riparia</i>	O		
<i>Cerastium fontanum</i>			
<i>Equisetum palustris</i>			
Filamentous algae			
<i>Filipendula ulmaria</i>			
<i>Galium palustre</i>			
<i>Glyceria maxima</i>	F	A	
<i>Hippuris vulgaris</i>			
<i>Holcus lanatus</i>			
<i>Juncus articulatus</i>			
<i>Juncus effusus</i>			
<i>Mentha aquatica</i>			
<i>Phalaris arundinacea</i>	O	O	F
<i>Polygonum amphibium</i>			
<i>Ranunculus repens</i>		R	R
<i>Rumex conglomeratus</i>			
<i>Salix cinerea</i>			
<i>Scrophularia auriculatum</i>			
<i>Sparganium emerum</i>			
<i>Sparganium erectum</i>			
<i>Stachys palustris</i>			
<i>Urtica dioica</i>			
<i>Veronica catenata</i>			R
<b>Emergent End Group</b>	<b>E1</b>	<b>E2</b>	<b>E2</b>

### Summary

5.3.34. No aquatic species were evident along the beck within the survey area. The majority of the beck is very narrow, with steep banks and very tall emergent vegetation which is shading the ditch. It is thought likely that if vegetation were to be present it would be consistent with A5b – *Lemna minor-Lemna trisulca*-filamentous algae. The majority of emergent vegetation along the beck is classified as emergent End Group E2 – *Glyceria maxima-Berula erecta* which is consistent with the lack of grazing along this ditch length.

5.3.35. None of the following species listed within the Norfolk Vanguard Phase 2 Ecological Surveys Scope associated with the River Wensum SAC habitat were noted:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus ssp. pseudofluitans*
- river water-crowfoot *R. fluitans*

### 5.4. Incidental observations

5.4.1. A number of signal crayfish *Pacifastacus leniusculus*, were seen whilst carrying out the survey of the River Wensum.



## 6. Conclusions

### **Grassland NVC Survey**

6.1. The semi-improved grassland found adjacent to the River Wensum consisted of two main NVC communities, which were often transitional to each other:

- MG6 – *Lolium perenne*-*Cynosurus cristatus* grassland
- MG10 – *Holco-Juncetum effusi* rush pasture

6.2. MG10 is a species poor community and characteristic of permanently moist sites, which are widely distributed in grazed pastures. It is a good fit with this community type.

6.3. MG6 is typical of short, tight grass-dominated swards found on free draining soil within grazed lowland pastures, which is consistent with the study area. It is not an exact fit with MG6 because many of the areas are transitional to MG10 and are located within damper areas, and some ungrazed areas could fit better with MG1.

### **River Wensum SAC/SSSI Survey**

6.4. The section of the River Wensum within the study area is dominated by beds of *N. lutea* and is classified as NVC community A8a-*Nuphar lutea* community, “species-poor” sub community. Marginal vegetation consists of NVC community S5-*Glycerietum maximae* swamp, *Alisma plantago-aquatica*-*Sparganium erectum* sub community.

### **Ditch Survey**

6.5. The ditches varied depending on location and land management. They were classified according to Doarks and Leach (1990) as being:

- Aquatic End Group A5b – *Lemna minor*-*Lemna trisulca*-filamentous algae
- Aquatic End Group A6 - *Callitriche stagnalis*/*platycarpa*
- Aquatic End Group A7b - *Potamogeton pectinatus*-*Myriophyllum spicatum*
- Emergent End Group E1 – *Carex riparia/acutiformis*-*Phragmites australis*
- Emergent End Group E2 – *Glyceria Maxima*-*Berula erecta*
- Emergent End Group E3 - *Juncus effusus*

6.6. Some ditches were very shaded or for other reasons lacked aquatic vegetation.

6.7. Despite the variation in appearance of vegetation communities the best fit End Groups across the study area appeared to be species poor End Groups A5b – *Lemna minor*-*Lemna trisulca*-filamentous algae and E2 – *Glyceria Maxima*-*Berula erecta* associated with eutrophic conditions.

### **Ranunculecae floating beds**

6.8. None of the following species, associated with the River Wensum SAC habitat were recorded during the botanical survey within the River Wensum or its floodplain:

- pond water-crowfoot *R. peltatus*
- stream water-crowfoot *R. penicillatus* ssp. *pseudofluitans*
- river water-crowfoot *R. fluitans*

### **Presence of springs and seepage**

6.9. There was no evidence of calcareous ground water spring or seepage activity with the study area. The MG10 community at the back of the flood bank is likely to be a result of river

water seepage through the flood bank, as this area is isolated, not extensive and is in close proximity to the river. Other wetter communities on the site, such as MG10, and dyke vegetation such as A5b are more consistent with lateral water flows or impeded drainage rather than soligenous water movement.

## 7. References

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## 8. Appendix 1 – Map of sampling points

Figure 1: Grassland sampling point map

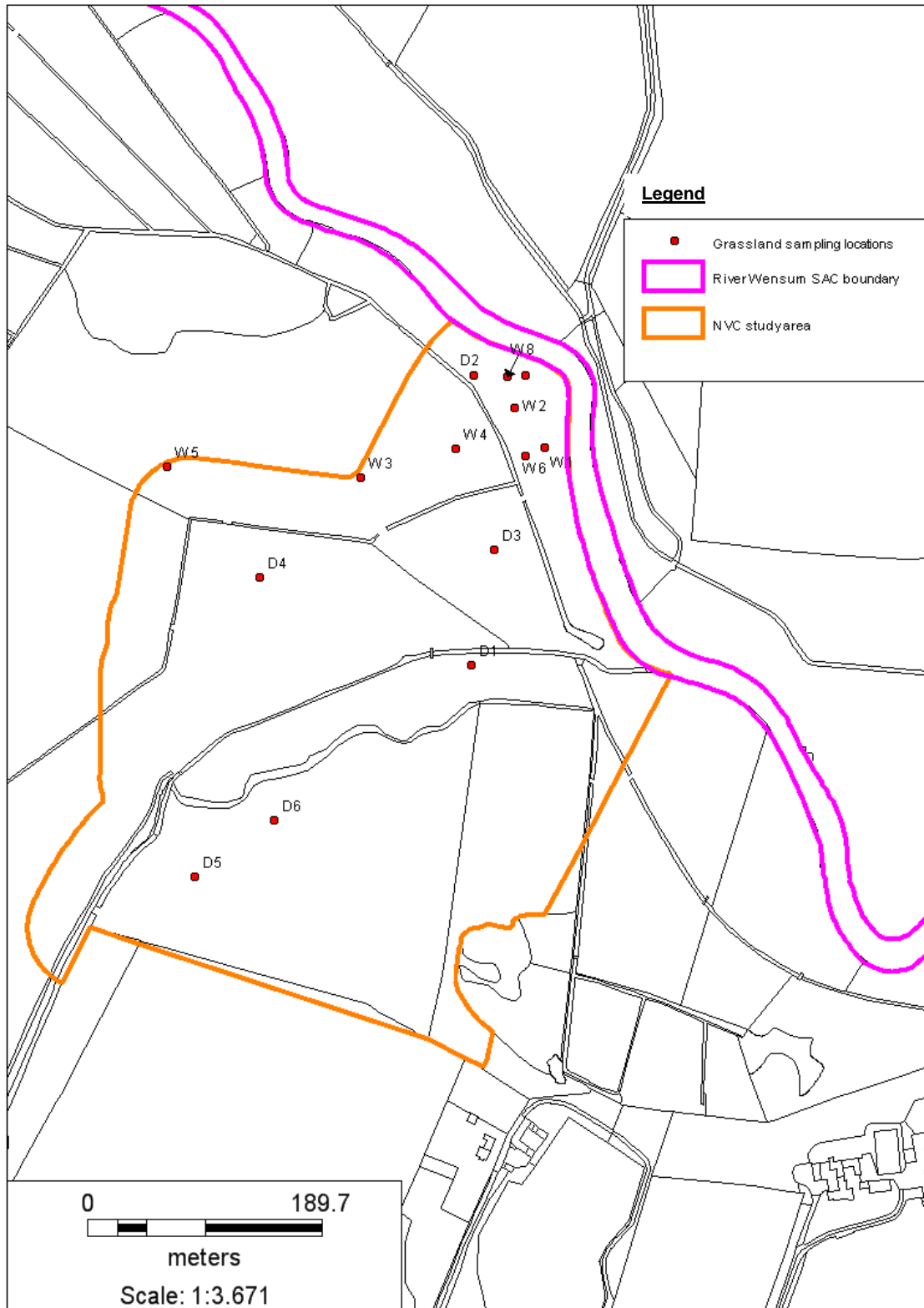


Figure 2: River survey sampling point map

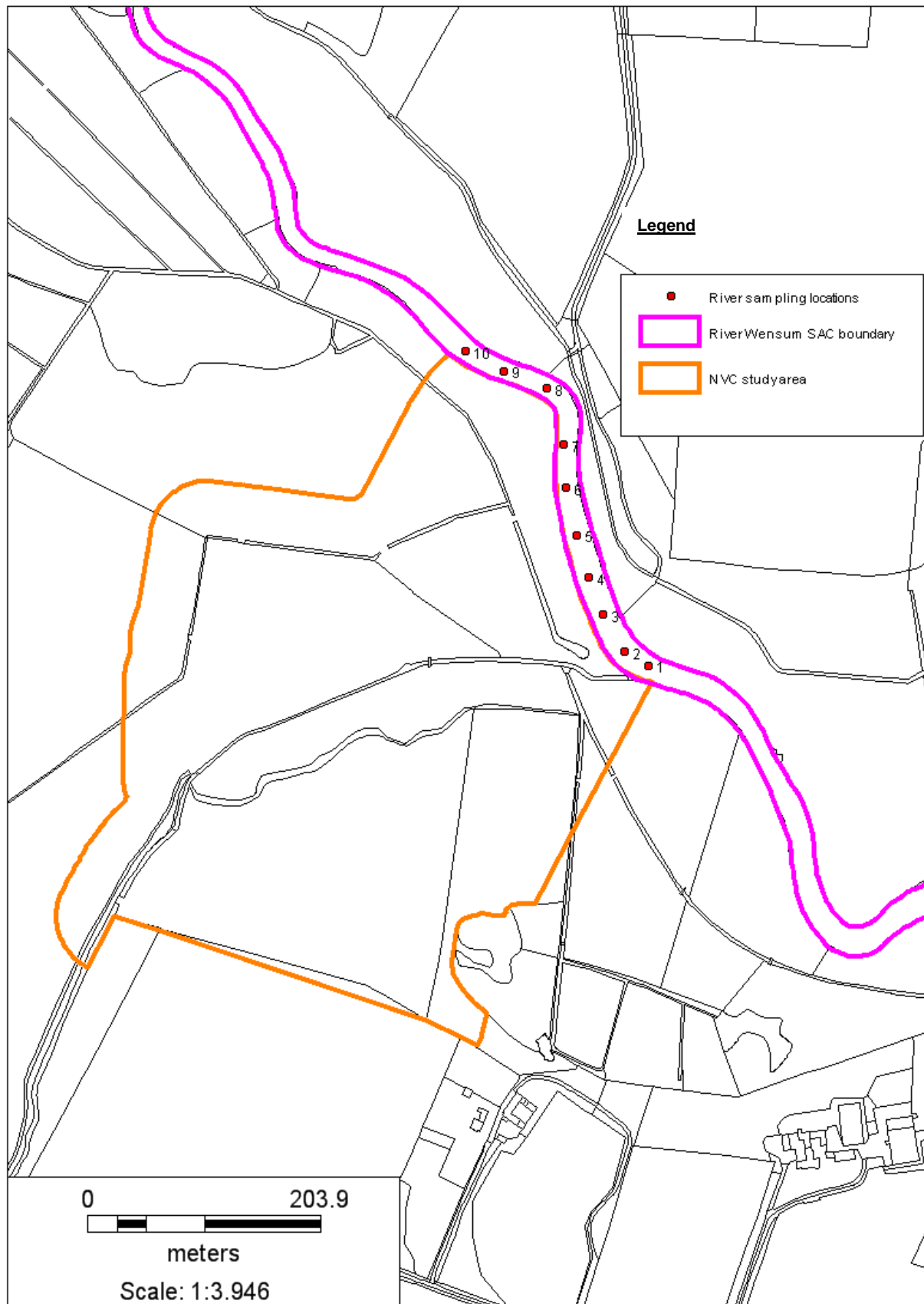
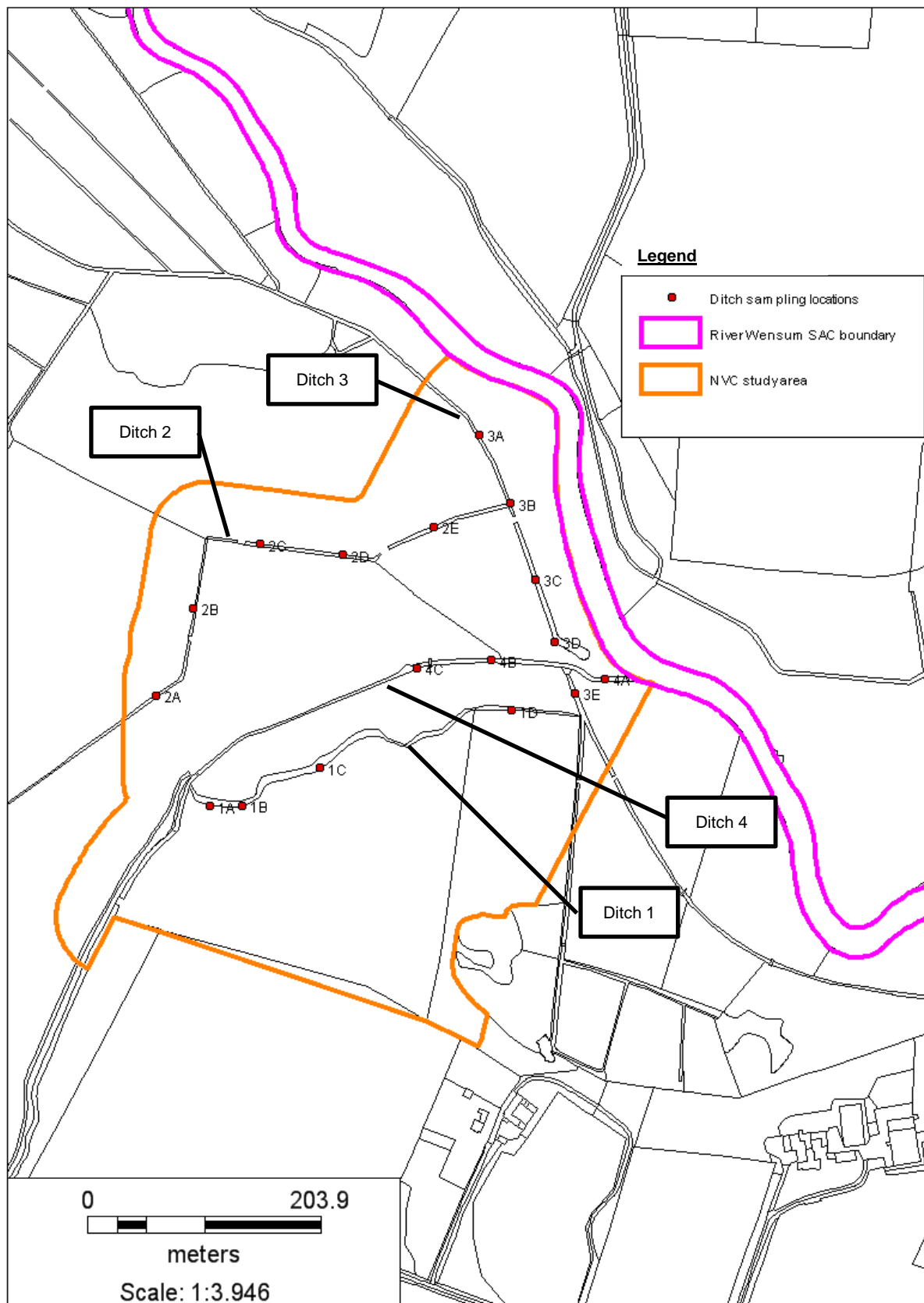


Figure 3: Ditch survey sampling point map



## 9. Appendix 2 – Photographs



*Figure 4 : Grassland survey sampling point W1 – MG10*



*Figure 5 : Grassland survey sampling point W2 – MG10*



*Figure 6 : Grassland survey sampling point W3 – MG10*



*Figure 7 : Grassland survey sampling point W4 – MG10*



*Figure 8 : Grassland survey sampling point W5 – MG10*



*Figure 8 : Grassland survey sampling point W7 – MG10*



*Figure 10 : Grassland survey sampling point W8 – MG10*



*Figure 11 : Grassland survey sampling point D1 - MG6*



*Figure 12 : Grassland survey sampling point D2 - MG6*



*Figure 13 : Grassland survey sampling point D3 - MG6*



*Figure 14 : Grassland survey sampling point D4 - MG6 on driest part of site with many ruderals*



*Figure 15 : Grassland survey sampling point D5 - MG6*





Figure 16 : Grassland survey sampling point D6 - MG6



Figure 17 : Ditch survey sampling point 1A – A6 / E2



Figure 18 : Ditch survey sampling point 1B – A7b / E3



Figure 19 : Ditch survey sampling point 1C – A5b / E3



Figure 20 : Ditch survey sampling point 1D – A5b / E2



Figure 21 : Ditch survey sampling point 2A – A5b / E3



Figure 22 : Ditch survey sampling point 2C – A5b / E2



Figure 23 : Ditch survey sampling point 2D – A5b / E2



Figure 24 : Ditch survey sampling point 3A – A5b / E2



Figure 25 : Ditch survey sampling point 3B – A5b / E2



Figure 26 : Ditch survey sampling point 3C – A5b / E2



Figure 27 : Ditch survey sampling point 3D – A5b / E2



*Figure 28 : Ditch survey sampling point 3E – A5b / E2*



*Figure 29 : Ditch survey sampling point 4A – E1*



*Figure 30 : Ditch survey sampling point 4B – E1*



*Figure 31 : River survey sampling point 2 – A8a*



*Figure 32 : River survey sampling point 3 – A8a*



*Figure 33 : River survey sampling point 4 – A8a*



Figure 34 : River survey sampling point 5 – A8a



Figure 35 : River survey sampling point 6 – A8a



Figure 36 : River survey sampling point 8 – A8a



Figure 37 : River survey sampling point 9 – A8a



Figure 38 : River survey sampling point 10 – A8a

## 10. Appendix 3 – Consent



River Wensum Site of Special Scientific Interest Norfolk  
("the SSSI")  
River Wensum Special Area of Conservation (SAC)

### CONSENT OF NATURAL ENGLAND

Section 28E(3)(a) of the Wildlife and Countryside Act 1981  
(as amended and inserted by section 75 and Schedule 9 of  
the Countryside and Rights of Way Act 2000)  
Regulation 21 of the Conservation of Habitats and Species  
Regulations 2010

To:

Mr Carrick.....

Of:

Castle Farm, Swanton Morley, Dereham, NR20 4JT.....

You have Natural England's consent to carry out, cause or permit to be carried out the operations specified below, on the land specified below.

This consent covers the period to 31<sup>st</sup> August 2017.

The specified operations:

Aquatic plant and Desmoulin whorl snail surveys.....  
.....

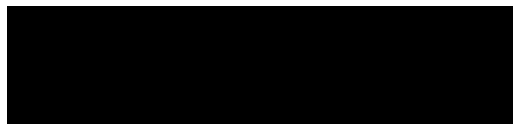
Timing of the operations:

24<sup>th</sup> July 2017 to 31<sup>st</sup> August 2017.....

Land on which the operations are to be carried out:

The River Wensum and adjacent land and ditches as shown on the attached maps.

Signed for Natural England:



Date:

24/07/2017.....

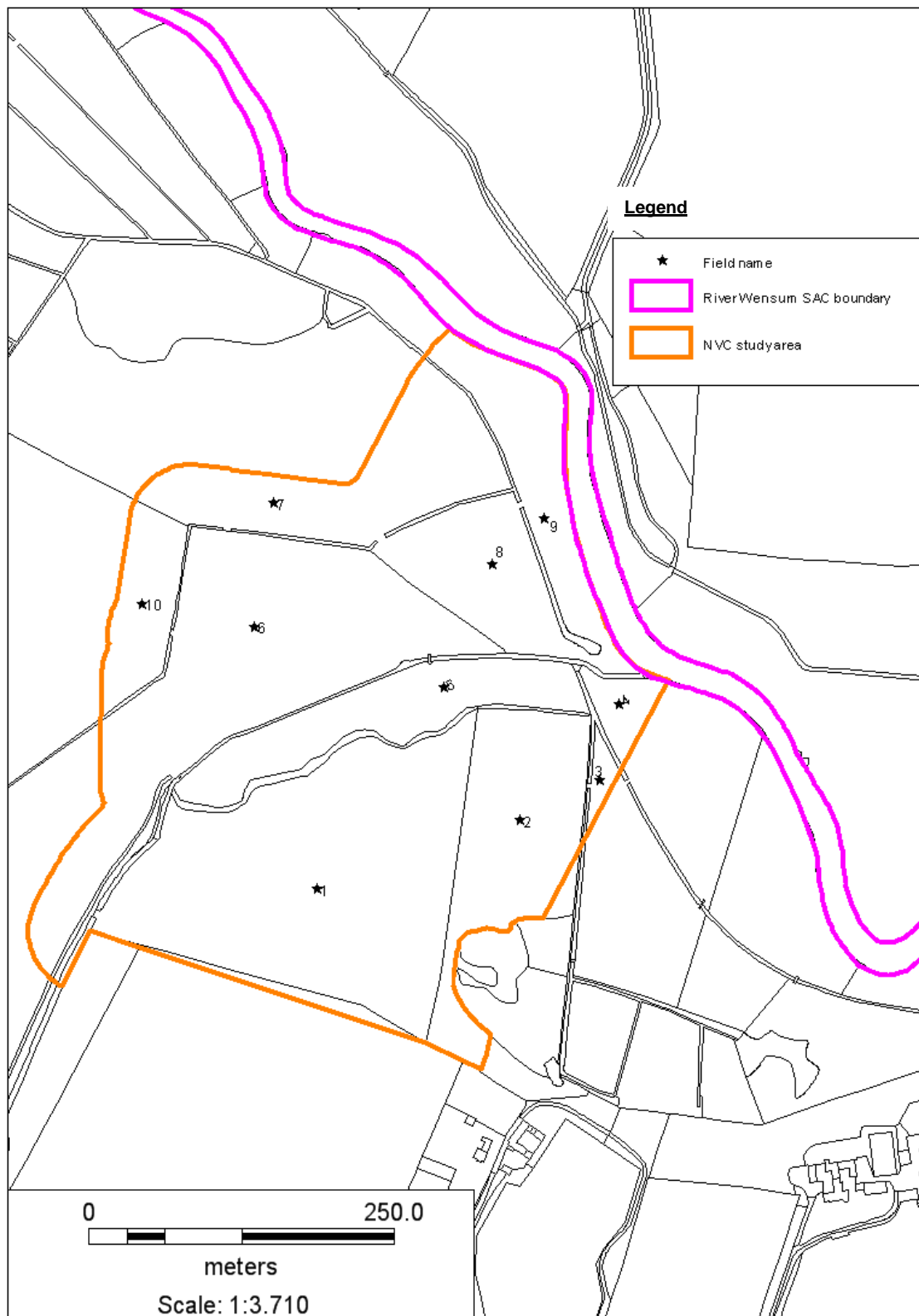
## 11. Appendix 4 – Raw data tables

Attached as excel files

## 12. Appendix 5 – Endgroup descriptions

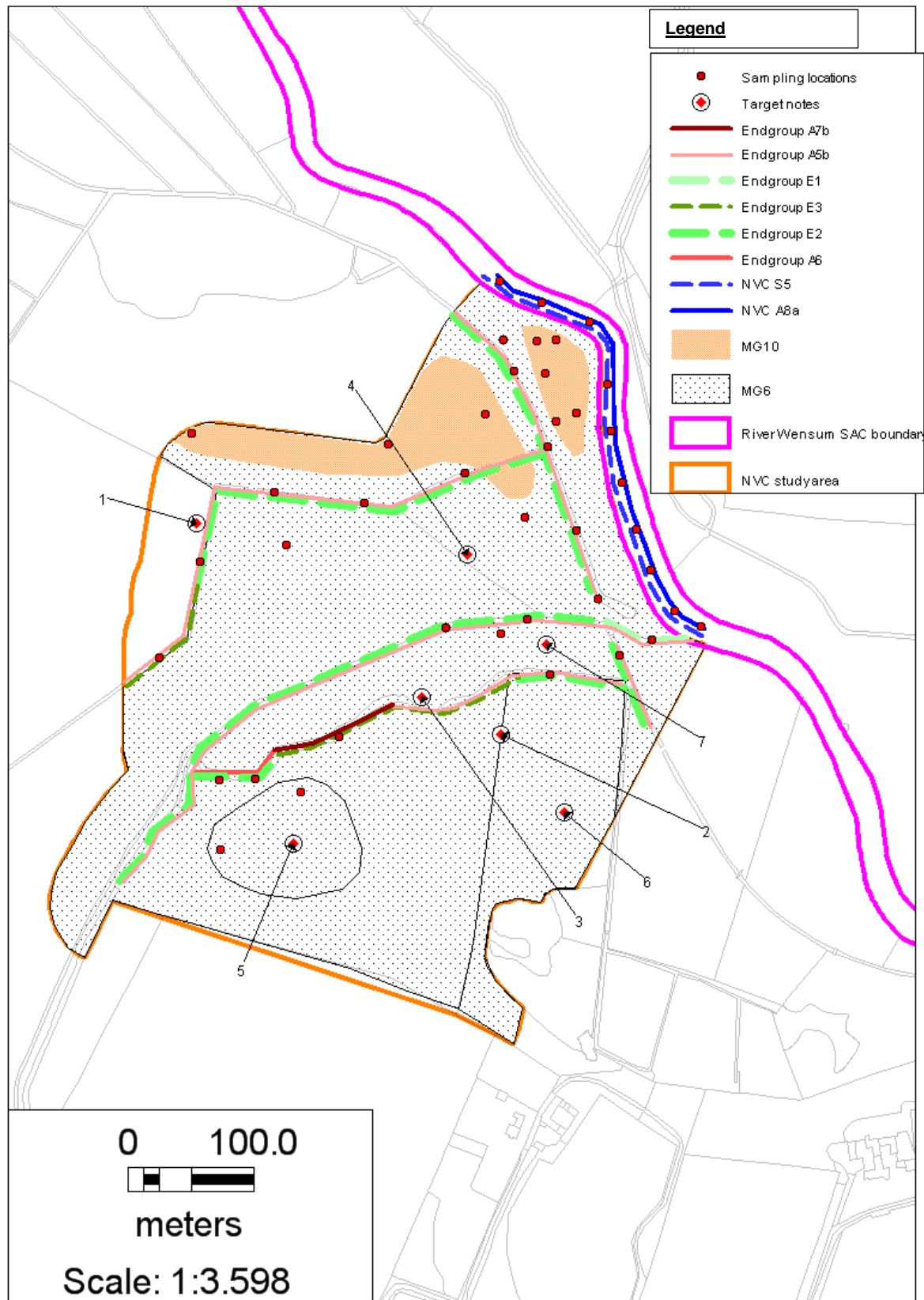
Attached as pdf files

### 13. Appendix 6 – Field Name Map





## 14. Appendix 7 – NVC/End Group Map



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