



Nitrate Neutrality Study – Outline Planning Application One Horton Heath

DATE OF ISSUE: 4 DECEMBER 2020
ISSUE: 00
HM REFERENCE: 25709-RP-SU-001

PROJECT:
ONE HORTON HEATH
EASTLEIGH
HAMPSHIRE

CLIENT:
EASTLEIGH BOROUGH COUNCIL

PROJECT NAME: **ONE HORTON HEATH**

REPORT NAME: **Nitrate Neutrality Study – Outline Planning Application
One Horton Heath**

ISSUE STATUS: **FINAL**

HM REFERENCE: **25709-RP-SU-001**

DATE OF ISSUE: **4 DECEMBER 2020**

ISSUE: **00**

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DOCUMENT HISTORY:

ISSUE	DATE	DETAILS
00	4/12/2020	FINAL REPORT

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Executive Summary

Hilson Moran has been appointed by the One Horton Heath Project Team (HPPT) at Eastleigh Borough Council (EBC) to provide a Nitrate Neutrality Study for the development of its One Horton Heath site in Hampshire, centred approximately on National Grid Reference SU 48815 17105.

This report provides a summary of the evidence gathered to support the Nitrate Neutrality Study together with the final calculations and recommendations for appropriate mitigation measures for the scheme.

The calculations demonstrate that:

- 1) The total N-loss from agricultural uses from the whole pre-existing OPA site is **3,435.2 kg N/yr**. Spread over a farmed area of 123.1 ha, this equates to an average N-loss of **27.9 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE as an average N-loss for all farm types within the Solent catchment area;
- 2) It is assumed that all foul sewage generated by pre-existing dwellings and farmsteads is treated on-site by septic tanks and drainage fields, discharging leachate ultimately to local watercourses or groundwaters. N-losses from pre-existing foul sewage loadings have been calculated as **153.0 kg N/yr** from the whole site;
- 3) Consequently, total N-losses from the pre-existing site have been calculated as **3,588.2 kg N/yr**;
- 4) If the wastewater generated by the proposals is conveyed to Chickenhall WwTW it will be treated and discharged without any permit concentration limit for TN, with an estimated discharge concentration of 27 mg/l TN. Consequently, the annual mass discharge of N into the River Itchen SAC (assuming a 2 mg/l TN base concentration in the supplied potable water) would be **11,741.7 kg TN/yr**. In terms of mitigation, assuming all N can be removed from the runoff from the proposed development, the scheme would result in a net increase in N discharged to the local environment of c. **9,784.2 kg TN/yr**;
- 5) Should a water usage rate of 110 l/s be achieved in the operational development, then the scheme would result in a net increase in N discharged to the local environment of **2,372.4 kg TN/yr**;
- 6) If the wastewater generated by the proposals is conveyed to Peel Common WwTW it will be treated and discharged at a TN concentration of 5.49 mg/L (assuming the facility discharges at an average of 90 % of the consent limit). Consequently, the annual mass discharge of N into the Portsmouth Harbour SPA (assuming a 2 mg/L TN base concentration in the supplied potable water) would be **1,639.1 kg TN/yr**. In terms of mitigation, assuming all N can be removed from the runoff from the proposed development, the scheme would result in a net decrease in N discharged to the local environment of c. **1,949.2 kg TN/yr**;
- 7) Should a water usage rate of 110 l/person/day be achieved in the operational development, then the scheme would result in a net reduction in N discharged to the local environment of **2,811.3 kg TN/yr**.
- 8) As such, the total mass of N discharged to sensitive European Designated Sites would be reduced as a result of the proposed development discharging its sewage effluent to Peel Common WwTW. This would result in a net benefit to local biodiversity and the conservation status of the downstream European Designated Sites. Consequently, it has been assumed in this report that discharge to Peel Common WwTW will be progressed in preference to Chickenhall WwTW;

- 9) It is estimated that the proposed land uses within the new development will result in a total loss of **1,529.4 kg TN/yr** in runoff from the site;
- 10) As part of the proposals, it is intended to construct a network of SuDS features across the site comprising basins, swales, ponds and wetlands to sustainably manage runoff from the scheme. All proposed SuDS features will be planted and incorporate permanently wet areas around inlets, outlets and wetland areas within the base of the features;
- 11) Wetlands have been shown to remove N from runoff through processes such as denitrification and sedimentation. Assuming a mean removal rate of 181 g N/m²/yr can be achieved in the permanently wet areas of the proposed SuDS features, c. 49 % of the base of each SuDS feature will need to be provided as a permanently wetted area in order to treat all N in the runoff from the scheme. This percentage wetted area coverage will be achievable within the detailed design of the features;
- 12) Consequently, it is anticipated that the proposed SuDS network should be able to remove all of the additional N within the runoff resulting from the scheme. This will ensure that the scheme will confer a net reduction of at least **1,949.2 kg TN/yr** (with an aspiration to achieve a reduction of **2,811.3 kg TN/yr**) being discharged to the environment from the site, which would result in a significant net benefit to local biodiversity and the conservation status of the downstream European Designated Sites.

1. Introduction

Hilson Moran has been appointed by the One Horton Heath Project Team (HPPT) at Eastleigh Borough Council (EBC) to provide a Nitrate Neutrality Study for the development of its Horton Heath site in Hampshire, centred approximately on National Grid Reference SU 48815 17105 and identified in Figure 1.1.

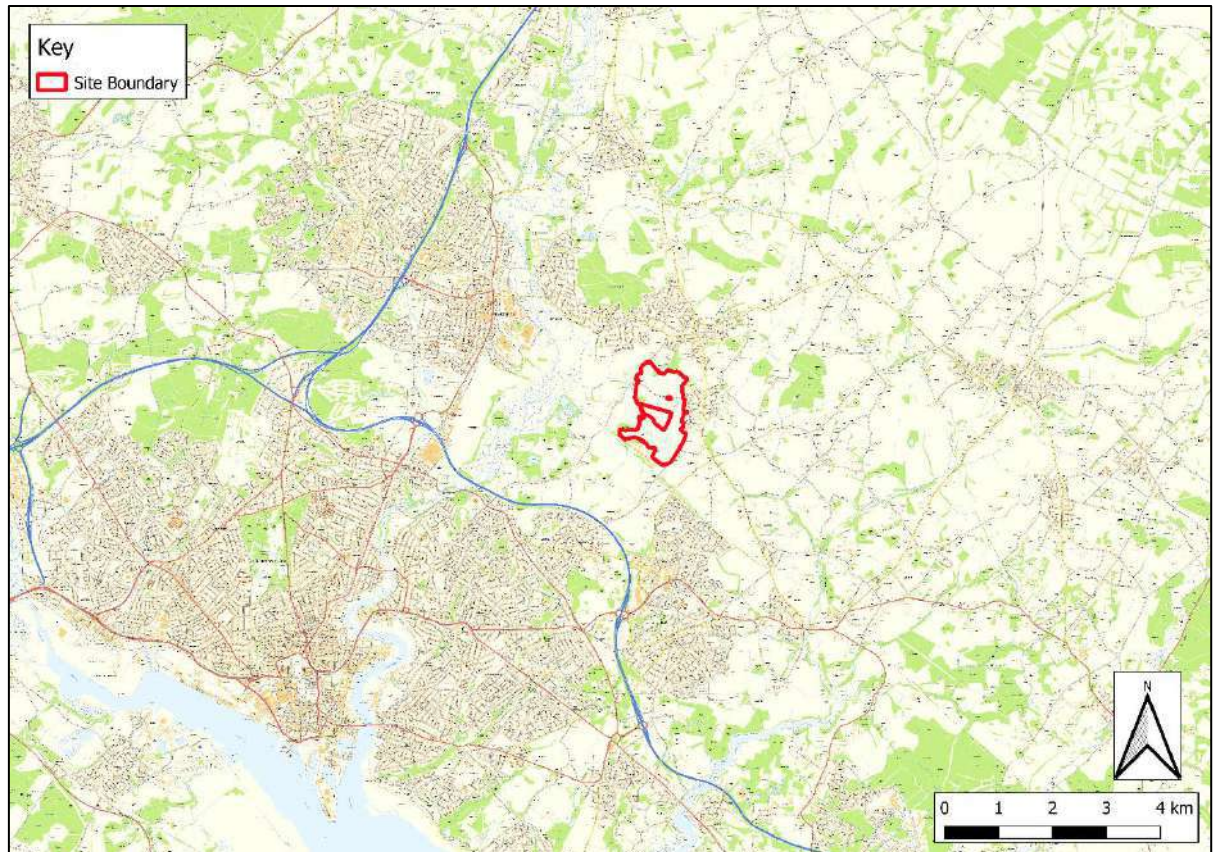


Figure 1.1 Site Location

1.1. Background

Residential and tourism development applications within the Hampshire area have been being delayed or not permitted for more than a year due to the impacts associated with nitrate concentrations reaching the Solent and influencing the qualifying features of internationally designated sites associated with the Solent. These designated sites are the Solent Maritime Special Area of Conservation (SAC), Portsmouth Harbour Special Protection Area (SPA), Chichester and Langstone Harbours SPA and Solent and Southampton Water SPA).

Additional nitrate loadings from new development, principally associated with increased wastewater generation, has been identified to be causing algal blooms within the Solent that influence dissolved oxygen levels within the marine waterbody as well as smothering food resources for birds and marine life.

Developments that can provide mitigation that delivers nitrogen neutrality are permissible, *i.e.* those that include mitigation to remove an equal volume of nitrate from the catchment as they

contribute can proceed as they demonstrate no impact upon the qualifying features of the designated sites.

1.2. Purpose

This Nitrate Neutrality Study has been produced to accompany the Outline Planning Application (OPA) for the scheme and to provide sufficient evidence to both EBC and Natural England (NE) that nitrate neutrality can be achieved in order to avoid any detrimental impacts on downstream European Designated Sites.

1.3. Structure

The following sections of the report provide an introduction to the study, followed by commentary on the approach and methodology adopted, followed by the final nitrate neutrality calculations for the OPA for the scheme. An overview of appropriate mitigation measures is also provided.

References are included at the end of the report with document control information included at the front.

1.4. Scope of the Assessment

This document comprises the Nitrate Neutrality Study for the OPA for the whole c. 125 ha One Horton Heath site.

1.5. Limitation and Copyright

This report has been prepared on behalf of and for the exclusive use of EBC and is subject to and issued in connection with the provisions of the agreement set out by Hilson Moran. Hilson Moran accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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1.6. Declaration of Competency

This assessment has been carried out by Dr Paul Bond PhD MSc BSc CEnv CSci MEnvSc MCIEEM. Paul possesses over 30 years' experience of environmental, civil engineering and industrial projects within commercial, public and academic sectors. He holds a doctorate in Sustainable Drainage Systems (SuDS), possesses post-doctoral experience in bacterial nitrogen transformations and is also a competent Ecologist, possessing 20 years environmental consultancy experience. As such, Dr Paul Bond is suitably qualified and experienced to conduct and direct the Horton Heath Nitrate Neutrality Study.

2. Approach

2.1. Background

There is currently uncertainty surrounding whether the condition of designated ecological areas located within the Solent Region will be detrimentally impacted by increases in discharges of treated sewage effluent from future housing growth in the area. This issue has been subject to ongoing detailed work commissioned by local planning authorities in association with NE, the EA and water companies. Until this work is complete, NE maintains the stance that the uncertainty remains and the potential for future housing developments across the Solent Region to exacerbate these impacts creates a risk to the potential future conservation status of designated sites. Consequently, NE has stated that one way to address this uncertainty is for new development to achieve nutrient neutrality by securing the required mitigation in compliance with the Habitats Regulations.

NE has developed a recommended methodology to determine the potential impact of new developments on local designated sites. Hilson Moran has been appointed by HHPT to provide a detailed Nitrate Neutrality Study for the development of its Horton Heath site in Hampshire. The aim of the study is to refine the NE approach, in order to provide a robust assessment of the impact of the development on downstream European Designated Sites and to inform the selection of appropriate mitigation measures for the scheme.

2.2. European Designated Sites

The Habitats Directive and Conservation of Habitats and Species Regulations 2017 (as amended) make reference to the consideration of likely significant effects of a project or plan on one or more European Sites, including Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).

However, national planning policy provided by the National Planning Policy Framework (NPPF)¹, also expects those sites under consideration for designation, *i.e.* potential SPAs (pSPAs) and candidate SACs (cSACs), Ramsar sites and areas identified to provide compensatory sites, to be considered through the Habitats Regulations Assessment (HRA) process. The legislation/agreement governing the designation of the sites are described further below:

- SPAs – classified under the European Council Directive 79/49/EEC ‘on the conservation of wild birds’ (also known as the ‘Birds Directive’) for the protection of wild birds and their habitats, including particularly rare and vulnerable species listed in Annex I of the Directive and migratory species;
- SACs – designated under European Council Directive 92/43/EEC ‘on the conservation of natural habitats and of wild fauna and flora’ (also known as the ‘Habitats Directive’), targeting particular habitats (listed on Annex I) and/or species (listed on Annex II) that are identified as being of European importance;
- Ramsar – listed under the Convention on Wetlands of International Importance (Ramsar Convention, 1971) as sites that support important wetland habitats and species, especially waterfowl habitat; and,
- Compensatory Sites – sites that have been identified to provide compensatory habitat for that impacted by plans or projects permitted through the ‘imperative reasons for overriding public interest’ (IROPI) assessment.

For ease of reference, these designations are collectively referred to within this Nitrate Neutrality Study report as 'European Designated Sites', despite Ramsar designations being made at the international level. SPAs and SACs are also referred to in guidance documents as 'Natura 2000' sites.

2.3. Methodology

The Nitrate Neutrality Study methodology is based on the NE approach (included in **Appendix 1**) with additional detail designed to increase the accuracy of the methodology and confidence in the results.

3. Assessment

3.1. Nitrate Baseline Study

The Nitrate Baseline Study comprised investigation into the following:

3.1.1. Initial Site Walkover and Interview with Farmers

Site visits and walkover surveys were conducted by Hilson Moran on the 4th February and 18th February 2020.

On the 4th February, the northern half of the site, largely lands known as the ‘Marsh’s Farm’, was surveyed and photographed. In addition, the current farmers of these lands, namely Robert and Adam Marsh, were interviewed on site during this visit with reference to current and historic farming practices over the last 10 years. This included ascertaining information relating to fertiliser and farm yard manure (FYM) additions, crops and livestock over this period.

On the 18th February the southern half of the site, largely lands known as the ‘Owton’s Farm’, was surveyed and photographed. In addition, the current farmer of these lands, namely Simon Owton, was interviewed on site during this visit and questioned as per above. This interview was followed up with subsequent additional queries by telephone.

Site observations of the Marsh’s and Owton’s Farms are presented as annotated plans with observations in **Appendix 2**, with interview notes and associated documentation presented as **Appendix 3**.

It is important to note that as Parcel 51, in the south-eastern corner of the masterplan, is covered by a separate planning application (Ref. X/19/86475) inclusion of this has been omitted from the nitrate neutrality calculations.

3.1.2. Locations of Nearby Designated Sites

The locations of nearby designated sites, including European Designated Sites and the nationally designated Sites of Special Scientific Interest (SSSIs), were identified with reference to Defra sources and presented within the selected GIS platform (QGIS). These included the Solent Maritime SAC, Solent & Southampton Water SPA/Ramsar, Solent & Dorset Coast pSPA and River Itchen SAC. A qualitative assessment of the sensitivity of designated sites to nitrogen (N) inputs was then made with reference to the UK Air Pollution Information System (APIS) website and site citations (from NE and JNCC websites). The locations of the nearby designated sites are and the results of this exercise are presented in **Appendix 4**.

In summary, habitats and species within the River Itchen SAC and SSSI, Solent Maritime SAC, Solent & Southampton Water SPA, Lee-on-the-Solent to Itchen Estuary SSSI and Hythe to Calshot Marshes SSSI were deemed susceptible to any increase in N-loadings associated with the proposed development (either from runoff or increased N in Wastewater Treatment Works (WwTW) discharges).

3.1.3. Site Catchment Characteristics

Site catchment characteristics such as rainfall, soils and geology were determined with reference to resources such as the Flood Estimation Handbook (FEH) webservice (refer to <https://fehweb.ceh.ac.uk/>), Soilscape (refer to <http://www.landis.org.uk/soilscapes/>) and British Geological Service (BGS) (refer to <https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/>) websites.

Geology

The majority of the site is underlain by the Eocene Wittering Formation, comprising interbedded sands, silts and clays. The south eastern corner of the site is underlain by Eocene Earnley Sand Formation. Superficial alluvial deposits comprising clay, silt, sand and gravel can be found adjacent to the small watercourses that flow through the site.

Soils

Soil type across the site largely comprises 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with impeded drainage draining to the local stream network. The main risks associated with these soils relate to overland flow from compacted or poached fields, with organic slurry, dirty water, fertiliser, pathogens and fine sediment all able to move in suspension or solution with overland flow or drain water. The soils of Parcels 33, 48 and 51 comprise '*Freely draining slightly acid sandy soils*' draining to groundwater. Such soils are particularly vulnerable to leaching of nitrate and pesticides to groundwater. They are highly erodible under arable and vegetable crops, where sloping, resulting in eutrophication and clogging of stream beds with sand. Further details are presented in **Appendix 5**.

Rainfall

The Standard Annual Average Rainfall (SAAR) for the site for the period 1961 to 1990 is 801 mm.

3.1.4. Wastewater Treatment Works Serving Development

With reference to Southern Water records, the site lies closest to the Chickenhall Eastleigh WwTW, which lies approximately 1.7 km to the west of the site and discharges treated effluent directly into the River Itchen SAC (refer to **Appendix 6**). The WwTW, which serves a population of approximately 100,000 residents, does not have a permit concentration limit for Total Nitrogen (TN). As such, as per NE guidance a discharge concentration of 27mg/L TN is assumed (a typical value derived by Southern Water from nitrogen effluent concentrations at two WwTWs in the Solent area). It should be noted that a 90 % correction factor cannot be used for this WwTW, due to the facility not being regulated by a TN consent limit.

Peel Common WwTW lies approximately 14.7 km to the SE of the site. This WwTW is one of Southern Water's largest operational sites serving extensive parts of south Hampshire, including parts or all of Eastleigh, Fareham and Gosport Boroughs, as well as small parts of Winchester. The WwTW is located on a c. 15 ha site and operates in accordance with an environmental permit set and monitored by the EA. This includes a permit concentration limit for TN of 6.1 mg/L. Treated effluent is discharged from a long sea outfall located at Browndon directly into the Portsmouth Harbour SPA.

3.1.5. Conceptual Site Model for N-Losses and Potential N-Inputs to Local Designated Sites

A Conceptual Site Model (CSM) of the site is presented in **Appendix 7**. It illustrates that the main N-inputs to the site comprise ammonium from agricultural fertiliser, organic nitrogen from applied FYM and from grazing livestock. Lesser inputs arise from atmospheric nitrogen oxides (NO_x), including nitrogen dioxide (NO₂) and ammonia (NH₃) from agricultural plant, cars and trains. The main N losses from the site that could impact on downstream European Designated Sites comprise nitrate (NO₃⁻) in runoff entering water courses and mobilisation in groundwaters (resulting from mineralisation and bacterial transformations), together with organic-N in sewage from pre-existing homesteads discharged to septic tanks and drainage fields, with effluent ultimately finding its way to local watercourses and groundwaters.

3.1.6. Use of ADAS Farmscoper Modelling to Estimate Agricultural N-Inputs to the Site

The site was split into suitably sized units of similar land use categories and input into GIS (QGIS) in order to manage the N-budget data, permitting the effective input, storage, retrieval and visualisation of the gathered spatial information. These land parcels are illustrated in **Appendix 8** and allow pre-development versus post-development N loading differentials and mitigation measures to be addressed on a parcel by parcel basis. A summary spreadsheet with a selection of GIS-held data for each parcel is presented as **Appendix 9**. As stated above, Parcel 51 in the south eastern corner of the masterplan is covered by a separate planning application (Ref. X/19/86475) and has, therefore, been omitted from the nitrate neutrality calculations.

Farming practices such as conventional tillage, chemical fertilisation and manure application to fields, high livestock stocking rates and overgrazing have all been identified as potential causes of diffuse agricultural nitrate pollution leading to pressures on water quality and European Designated Sites.

Farmscoper (Farm SScale Optimisation of Pollutant Emission Reductions) Decision Support Tool (v.4) is a decision support tool that can be used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants. The Farmscoper tool was developed by ADAS for Defra to enable the assessment of the cost and effect of diffuse pollution mitigation methods at the farm scale. The farm systems within the tool can be customised to reflect management and environmental conditions representative of farming across England and Wales. The tool estimates baseline emissions of a suite of different pollutants, including nitrate and predicts the mitigation potential against these pollutants and also quantifies potential benefits for biodiversity. The Farmscoper tool suite of spreadsheets have been used by Defra and the EA, as well as other public and private bodies with an interest in reducing agricultural pollution. The Farmscoper tool can be used at a range of scales from farm scale and small catchments to national coverage, and is the methodology recommended within the NE's '*Advice on Achieving Nutrient Neutrality for New Development in the Solent Region*' (refer to **Appendix 1**). Within the Farmscoper tool, the source models used to populate the pollutant loss database (*i.e.* to create the baseline) were applied at 1 km² resolution across England and Wales, using local data on soils, slopes, field connectivity, rainfall *etc.*, and the results aggregated for the 3 soil types and 6 climate zones available within Farmscoper. The predicted losses thus represent a typical environmental situation (for the soil type and climate zone selected).

The NE guidance, cited above and included in **Appendix 1**, provides average nitrate losses (in kg N/ha/yr) for a number of farm types within then Solent Region, with an average N-loss for the catchment area from all farm types of 26.9 kg N/ha/yr. The user is able to specify nitrogen (and phosphorus) fertiliser application rates, which can be input by crop type. Farmscoper also allows the user to enter livestock counts for 28 different categories of livestock and calculates typical excretion and manure quantities from the type of and number of livestock inputted into the model.

As such, the tool requires the input of livestock, cropping and management data and combines this with appropriate soil, drainage and climate parameters. Consequently, using site observations and information gained from interviewing farmers for typical farming practices on the pre-development site over the last 10 years, the Farmscoper 'CREATE' spreadsheet was utilised, being applied separately to the Marsh's Farm (located approximately north of the small unnamed watercourse that dissects the site and being largely an arable farm) and the Owton's Farm (located approximately south of the watercourse and being largely a cattle farm).

Summary spreadsheets illustrating input parameters for each parcel is presented as **Appendix 9**. Farmscoper input parameters and results (both numerical and graphical) for each farm are presented as **Appendix 10**.

With regard to the Marsh's Farm, of a total applied mass of 7,671 kg NO₃⁻ N/yr from fertiliser and 173.0 kg N/yr from FYM (7,844 kg N/yr in total), an annual total nitrate-N loss of **1,576 kg NO₃⁻ N/yr** has been calculated (20.5 % of total applied N). Of this, 1,265 kg NO₃⁻ N/yr (80.2 % of total loss) was from arable land uses, 304 kg NO₃⁻ N/yr (19.3 % of total loss) was from grassland uses and 7 kg NO₃⁻ N/yr (0.4 % of total loss) was from other uses, with an average concentration in runoff of 9.0 mg NO₃⁻ N/l.

With regard to the Owton's Farm, of a total applied mass of 3,742 kg NO₃⁻ N/yr from fertiliser and 3,987 kg N/yr from FYM (7729 kg N/yr in total), an annual total nitrate-N loss of **1,859 kg NO₃⁻ N/yr** has been calculated (24.1 % of total applied N). Of this, 137 kg NO₃⁻ N/yr (7.4 % of total loss) was from arable land uses, 1,480 kg NO₃⁻ N/yr (79.6 % of total loss) was from grassland uses and 154 kg NO₃⁻ N/yr (8.3 % of total loss) was from other uses, with an average concentration in runoff of 10.0 mg NO₃⁻ N/l.

Consequently, the total N-loss from agricultural uses from the whole OPA site was calculated as **3,435.2 kg N/yr**. Spread over a farmed area of 123.1 ha, this equates to an average N-loss of **27.9 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE above as an average N-loss for all farm types within the Solent catchment area.

3.1.7. Estimating Pre-existing Foul Sewage N Losses

Information on the foul network currently serving the site was obtained from Southern Water. This information demonstrated that none of the pre-existing dwellings and farmsteads are connected to the adopted foul sewage network, which is absent across most of the site. Consequently, it is assumed that all foul sewage generated by the above pre-existing uses is treated on-site by septic tanks and drainage fields, discharging leachate ultimately to local watercourses or groundwaters.

N-losses from pre-existing foul sewage loadings have, therefore, been calculated in the following way:

- i. Instead of relying on the national occupancy rate calculated by the Office for National Statistics (ONS) of 2.4 residents per dwelling, as suggested in the NE guidance to be used as a 'starting point' (refer to **Appendix 1**), the accuracy of the calculation was increased by using Nomis postcode headcounts and household estimates from the 2011 Census (refer to https://www.nomisweb.co.uk/census/2011/postcode_headcounts_and_household_estimates) combined with the Doogal.com postcode mapping site (refer to <https://www.doogal.co.uk/UKPostcodes.php>) to derive average household sizes depending on house size (based on number of bedrooms);
- ii. Local occupancy rates derived in this way and used within the calculation are presented in Table 3.1 below:

Table 3.1 Derived Eastleigh Borough Occupancy Rates Used in this Calculation

Number of Bedrooms in Dwelling	Eastleigh Borough Average Occupancy Rate
1	1
2	1.5
3	2.25
4	3
5	3.75
6	4.5

- iii. Water usage does not equate to wastewater output per household (as assumed in the standard NE methodology, presented as **Appendix 1**) as there are always losses to evaporation/metabolisation/irrigation etc. Consequently, reference was made to the Southern Water data presented in Table 3.2 below (and sourced from <https://www.southernwater.co.uk/account/water-usage-guide>) to provide wastewater outputs in m³/yr depending on the household size derived from Table 3.1 above.

Table 3.2 Southern Water Typical Wastewater Emissions per Size of Dwelling

Number of People in Property	1	2	3	4	5	6
Estimated use per year (cubic metres)	65	100	135	160	180	200
Estimated use (litres per day)	178	274	370	438	493	548
Wastewater (cubic metres)	60.1	92.5	124.87	148.0	166.5	185.0

- iv. From the literature^{2,3,4} (refer to Table 3.3 below) it is assumed that 65.5 % of the above wastewater output volumes comprise kitchen, bath and laundry outputs with minimal N concentration, other than the 2 mg/L TN base concentrations for local water supplies accepted by NE (refer to **Appendix 1**). Similarly, 34.5 % of the above wastewater output is assumed to consist of water closet (WC) waste, comprising urine, faeces and potable water with a 2 mg/L TN base concentration.

Table 3.3 Typical Sources for Household Wastewater Components (from Henze, 2008)

Parameter	Unit	Toilet		Kitchen	Bath/ Laundry	Total
		Total*	Urine			
Wastewater	m ³ /yr	19	11	18	18	55
Chemical Oxygen Demand	kg/yr	27.5	5.5	16	3.7	47.2
Biological Oxygen Demand	kg/yr	9.1	1.8	11	1.8	21.9
Nitrogen	kg/yr	4.4	4.0	0.3	0.4	5.1
Phosphorus	kg/yr	0.7	0.5	0.07	0.1	0.87
Potassium	kg/yr	1.3	0.9	0.15	0.15	1.6

* Including urine

- v. From the literature⁵, a median annual N emission rate per person from human waste (faeces and urine) of 4.5 kg N/person/year was then derived. This was used to provide the nitrate-N in wastewater per year for each of the pre-existing dwellings;

- vi. With reference to the literature⁶, it was assumed that 80 % of the nitrate-N in foul sewage from the pre-existing dwellings and farmsteads is discharged from the septic tanks to the drainage fields, whilst 20 % of it is retained as sludge in the tanks which is periodically removed and taken to the local WwTW. Consequently, a precautionary approach was taken for these nitrate budget calculations and only 80 % of the estimated sewage derived N was included, as it is unclear if the 20 % in the sludge tankered away is currently maintained within the catchment.

The results of this exercise are presented in **Appendix 11**. For Chalcroft Farm it should be noted that the calculation was conducted not only for the farmstead dwelling, but also separately for the business element of the farm. From discussions with Simon Owton, it has been estimated that around 100 people regularly work at the site during a normal day, including the meat processing team, drivers and operators of the Farm Shop. These all use the on-site toilets, so their N contribution has also been calculated as per points (iii) to (vi) above and using a water use volume of 50 l/day per person, which is accepted as an average value for commercial uses.

The results indicate a loss to local watercourses and groundwater of **153.0 kg N/yr** from pre-existing sewage emissions from the whole site.

Sewage losses from septic tanks and drainage fields will be removed from the post development conditions as all foul sewage will be conveyed to a suitable WwTW for treatment prior to discharge to the environment (see Section 3.3 below).

3.1.8. Estimating NO_x Inputs from Local Road and Rail Networks

The UK Air Information Resource (AIR) is operated by Defra and includes computer modelled predictions of background concentrations of air pollutants over the whole of the UK with a grid resolution of 1 km². The background information for NO_x for local road and rail contributions (*i.e.* diesel trains travelling along the Eastleigh to Fareham rail line to the south of the site) in the grid squares covering the Masterplan are presented in **Appendix 12** for the years 2010, 2025 and 2030.

For each 1 km² grid square across the site, the total NO_x arising from within the grid square and outside the grid square in the baseline year of 2020 were identified. As emissions of oxides of nitrogen convert to nitrogen dioxide over time, the NO_x concentration was converted to NO₂ using version 7.1 of the DEFRA 'NO_x to NO₂ Conversion Spreadsheet' and a conversion factor of 1 as per EA guidance for long-term timescales.

The NO₂ deposition flux for each grid square was then calculated using the product of the vertical deposition velocity above (*i.e.* V_d which is defined as the vertical speed of compounds directed downward toward a surface) and the ambient concentration using the following equation:

$$F_x = V_{d_x} \times C_x$$

where F_x is the dry deposition flux of compound X, V_{d_x} is the deposition velocity of compound X, and C_x is the concentration of compound X.

The results for pre-existing loadings from traffic and rail related NO₂ are presented in **Appendix 12**. These indicate an average NO₂ loading from traffic across the site of 0.014 kg/ha/yr, which equates to 0.0041 kg N/ha/yr. Similarly, the results indicate an average NO₂ loading from rail across the site of 0.00022 kg/ha/yr, which equates to 0.000064 kg N/ha/yr.

With a total average deposition from road and rail of 0.0042 kg N/ha/yr and a total site area of 124.0 ha, this equates to a total annual site loading of 0.5 kg N/yr.

Consequently, the impact of any increase in emissions arising from additional traffic generated by the development has been deemed to be negligible and has not been included in the final N-budget calculation for the scheme.

3.1.9. N-Contributions from Other Local and Regional Sources

A review of local industry did not highlight any other significant sources of N inputs nearby to the site.

3.1.10. Total N-Losses from the Pre-Existing Site

Consequently, total N-losses from the pre-existing site have been calculated as **3,435.2 kg N/yr** (agricultural losses) + **153.0 kg N/yr** (foul sewage losses) = **3,588.2 kg N/yr**.

3.2. Nitrate Losses from the Proposed Development

A plan of the proposed OPA development, together with an illustrative housing mix and non-residential uses indicative floorspace are presented in **Appendix 13**.

3.2.1. Estimating Post-Development Sewage N-Losses

As per the pre-development sewage losses, reference was made to the derived Eastleigh Borough occupancy rates based on local postcode headcount and census data, as described in Section 3.1.7 above, in order to improve the accuracy of the calculation. In addition, occupancy rates for non-residential uses were sourced from the literature, as presented in **Appendix 14**. This exercise demonstrated that the proposals will introduce approximately 4,677 new residents onto the site.

It should be noted that Chapter 6: Socio-Economics of the One Horton Heath OPA Environmental Statement (ES) estimates an increase in population associated with the OPA scheme of 5,775, derived from the Office for National Statistics (ONS) 2016-based household projections for local authorities and higher administrative areas in England of 2.31 persons per household in Eastleigh in 2031. As this blanket figure takes no account of differing household sizes associated with dwelling size and the proposed development includes a significant number of 1 and 2 bedroom dwellings that would typically accommodate 2 or less occupants, the above methodology described in Section 3.1.7 is deemed to provide a more accurate estimate of the additional population, based on house sizes and their respective average household sizes for the locale.

Table 3.4 presents the estimated precautionary wastewater emissions from the residential dwellings associated with the proposals, assuming current typical Southern Water wastewater emission rates based on household size presented in Table 3.2 above. This gives a total wastewater volume of **434,885.8 m³** for residential uses.

Table 3.4 Residential Wastewater Emissions using Southern Water Emissions Data

Type of Dwelling	Number of Occupants	Wastewater Emission (m ³ /yr)	Total Wastewater Emission (m ³ /yr)
1B2P Flat	372	60.1	22,357.2
2B4P Flat	902	76.3	68,822.6
2B4P House	1,194	92.5	110,445.0
3B6P House	1,760	100.6	177,056.0
4B8P House	450	124.9	56,205.0
Total			434,885.8

In addition, non-residential uses were assumed to generate 50 l/day per person, which is accepted as an average value for commercial uses. With c. 1,906 users of WCs within non-residential uses, this equates to $50 \times 365 \times 1,906/1,000 = 34,784.5 \text{ m}^3/\text{yr}$.

Consequently, it is estimated that residential and non-residential uses will generate **469,669.5 m³/yr** of wastewater (based on typical current usage).

It should be noted that EBC wish to deliver an exemplar scheme at One Horton Heath, achieving ambitious water efficiency targets well below those prescribed by Building Regulations. The aim is to minimise water use to no more than 110 l/person/day, but with an aspiration to achieve less than 90 l/d per capita consumption (PCC).

Consequently, if an average water usage rate of 110 l/person/day could be achieved in the post development situation, then the residential wastewater discharge volume could be reduced to $4678 \times 110/1000 \times 365 = 187,821.7 \text{ m}^3/\text{yr}$ (using the water usage volume as a proxy for wastewater output volume), resulting in a combined residential and non-residential wastewater volume of **222,606.2 m³/yr** of wastewater.

3.3. Final N Budget Calculations

3.3.1. Option 1 – Discharging Sewage to Chickenhall WwTW

With reference to Section 3.1.4 above, if the wastewater generated is conveyed to Chickenhall WwTW it will be treated and discharged without any permit concentration limit for TN, with an estimated discharge concentration of 27mg/L TN. Consequently, the precautionary annual mass discharge (in kg) of N into the River Itchen SAC (assuming a 2 mg/l TN base concentration in the supplied potable water) would be $469,669.5 \text{ m}^3 \times 1,000 \times (27 \text{ mg/L} - 2 \text{ mg/L})/1,000,000 = 11,741.7 \text{ kg TN/yr}$.

Consequently, in terms of mitigation, not only will the N in runoff from the proposed development need to be managed appropriately, the proposed development could result in a net increase in N discharged to the local environment of $11,741.7 - 3,588.2 \text{ kg N/yr}$ (refer to Section 3.1.10 above for the total pre-development N-loss) = $8,153.5 \text{ kg TN/yr}$. Adding a precautionary 20 % buffer as recommended by NE (refer to Appendix 1), this equates to a total net increase in N discharged to the local environment of $8,153.5 \times 1.2 = 9,784.2 \text{ kg TN/yr}$.

Should a water usage rate of 110 l/person/day be achieved in the operational development, then the scheme would result in a net increase in N discharged to the local environment of $(222,606.2 \text{ m}^3 \times 1,000 \times (27 \text{ mg/L} - 2 \text{ mg/L})/1,000,000) - 3,588.2 \text{ kg N/yr} = 1,977.0 \text{ kg TN/yr}$. Adding a precautionary 20 % buffer as recommended by NE, this equates to a total net increase in N discharged to the local environment of $1,977.0 \times 1.2 = 2,372.4 \text{ kg TN/yr}$.

3.3.2. Option 2 – Discharging Sewage to Peel Common WwTW

With reference to Section 3.1.4 above, if the wastewater generated is conveyed to Peel Common WwTW it will be treated and discharged at a TN concentration of 5.49 mg/L (assuming the facility discharges at an average of 90 % of the consent limit). Thus, the annual mass discharge (in kg) of N into the Portsmouth Harbour SPA (assuming a 2 mg/L TN base concentration in the supplied potable water) would be $469,669.5 \text{ m}^3 \times 1,000 \times (5.49 \text{ mg/L} - 2 \text{ mg/L})/1,000,000 = 1,639.1 \text{ kg TN/yr}$. Consequently, in terms of mitigation, assuming that the N in runoff from the proposed development would be managed appropriately (see below), the proposed development would result in a **net reduction** in N discharged to the local environment of $1,639.1 - 3,588.2 \text{ kg N/yr}$ (refer to Section 3.1.10 above for the total pre-development N-loss) = **1,949.2 kg TN/yr**.

Within the NE Methodology (refer to Appendix 1), it is not stated if a precautionary 20 % buffer should be applied to net gains in N-loss. Therefore, as a precautionary measure, the 20 % buffer has not been applied in this case.

Furthermore, should a water usage rate of 110 l/person/day be achieved in the operational development, then the scheme would result in a **net reduction** in N discharged to the local environment of $(222,606.2 \text{ m}^3 \times 1,000 \times (5.49 \text{ mg/L} - 2 \text{ mg/L}) / 1,000,000) - 3,588.2 \text{ kg N/yr} = \mathbf{2,811.3 \text{ kg TN/yr}}$.

As above, a 20 % buffer has not been applied to this betterment as a precautionary measure.

As such, the total mass of N discharged to sensitive European Designated Sites would be reduced as a result of the proposed development discharging its sewage effluent to Peel Common WwTW. This would result in a net benefit to local biodiversity and the conservation status of the downstream European Designated Sites.

Considering the significant benefit to downstream European Designated Sites afforded by Option 2, this option is deemed the most preferable. Consequently, it is assumed in this report that Option 2 will be progressed in preference to Option 1.

3.3.3. N-Losses Associated with Proposed Development Land Uses

The proposed development will comprise the following general land uses:

- 1) Circa 683,598 m² of 'urban' use, including buildings, highways, gardens, road verges and small areas of open space within the urban fabric. With reference to the NE Nitrate Neutrality Methodology presented in **Appendix 1**, such urban use can be assumed to exhibit a nitrogen leaching rate of 14.3 kg/ha/yr.

Consequently, it is estimated that the proposed urban use within the new development will result in a $684,261 / 10,000 \times 14.3 = \mathbf{978.5 \text{ kg TN/yr}}$ loss per year in urban runoff;

- 2) Circa 8,200 m² of land identified as potential allotments. With reference to the NE Nitrate Neutrality Methodology presented in **Appendix 1**, such community food growing use can be assumed to exhibit the same N-loss rate as that exhibited by the average farm type for the Solent catchment, *i.e.* 26.9 kg/ha/yr.

Consequently, it is estimated that the proposed allotments within the new development will result in an $8,200 / 10,000 \times 26.9 = \mathbf{22.1 \text{ kg TN/yr}}$ loss per year in runoff from the food growing areas;

- 3) Circa 547,707 m² of greenspace and soft landscaping. With reference to the NE Nitrate Neutrality Methodology presented in **Appendix 1**, such open space and green infrastructure can be assumed to exhibit a nitrogen leaching rate of 5 kg/ha/yr.

Consequently, it is estimated that the proposed greenspace and soft landscaping within the new development will result in a $547,707 / 10,000 \times 5 = \mathbf{273.9 \text{ kg TN/yr}}$ loss per year in runoff from these green areas.

It is estimated, therefore, that the proposed land uses within the new development will result in a total loss of $1,274.5 \times 1.2 \text{ (NE buffer)} = \mathbf{1,529.4 \text{ kg TN/yr}}$ in runoff from the site.

4. Mitigation Measures

4.1. General Mitigation Measures

As part of this Nitrate Neutrality Study, a high-level assessment of mitigation measures suitable for the proposed scheme was conducted early on in order to inform the design process and final mitigation measures, if required. The results of this assessment are presented as **Appendix 15**.

The report identified 4 main mitigation options that could have potential for the scheme. These comprised:

- 1) Addressing agricultural inputs within the catchment through the application of best practise measures, incorporating technology and providing intercepting wetlands. Although the success of these measures would be dependent upon identifying appropriate farmsteads within the River Itchen Fluvial Catchment and willing individuals to engage with the process, it was identified within the report that the provision of wetlands could be a valuable measure provided within the boundary of the post-development scheme, providing multifunctional water quality, flood prevention, biodiversity and amenity features;
- 2) The introduction of a suitable Reverse Auction Scheme for nitrogen reduction, in collaboration with Southern Water, which would offer funding to farmers in exchange for commitments that provide a reduction in the input of nitrogen in to the catchment. Whilst this mitigation option has significant and proven potential to reduce nitrogen inputs at a catchment level for the benefit of sensitive habitats downstream, it is currently unclear whether it is a realistic option for Horton Heath within the timeframe associated with the increase in residential occupancy resulting from the scheme;
- 3) On-site wastewater denitrification, either by providing a number of appropriate package treatment works across the proposed development or alternatively providing a single centralised on-site wastewater treatment plant. The report identified that this approach could wholly deliver the nitrate neutrality required and even result in a nitrate deficit, compared to the pre-existing agricultural uses of the site. However, as discussed in the NE Nitrate Neutrality Methodology (refer to **Appendix 1**), the EA has a presumption against private sewage treatment works in sewered areas and will always seek connection to the mains sewer where possible and practicable. A principle concern relates to the failure rates of package treatment plants (PTPs) and the lack of review and periodic upgrades via regulatory systems that apply to mains;
- 4) Offsetting, with the removal of low-grade agricultural land within the same catchment and returning it to unproductive green infrastructure with biodiversity and amenity value.

The calculations in Section 3 above demonstrate that if all foul sewage from the proposed development is conveyed to Peel Common WwTW for treatment and that the N in runoff from the proposals can be managed appropriately, the scheme would result in a net reduction in N discharged to the local environment of at least **1,949.2 kg TN/yr** with the potential to achieve a net reduction of **2,811.3 kg TN/yr** if a water usage of 110 l/person/day can be accomplished in the operational development.

Consequently, assuming treatment at Peel Common WwTW will be feasible, the majority of the above mitigation measures will not be necessary, with only the provision of wetlands identified as a necessary measure to remove nitrate in runoff from within the site, whilst providing multifunctional water quality, flood prevention, biodiversity and amenity features.

4.2. Provision of Sustainable Drainage Systems (SuDS)

As part of the proposals, it is intended to construct a network of SuDS features across the site comprising basins, swales, ponds and wetlands to sustainably manage runoff from the scheme as illustrated in **Appendix 15**.

It is intended that all the proposed SuDS features will be planted and incorporate permanently wet areas around inlets (sediment forebays), outlets (secondary sedimentation areas) and wetland areas within the base of the features, as illustrated in Figure 4.1 below.

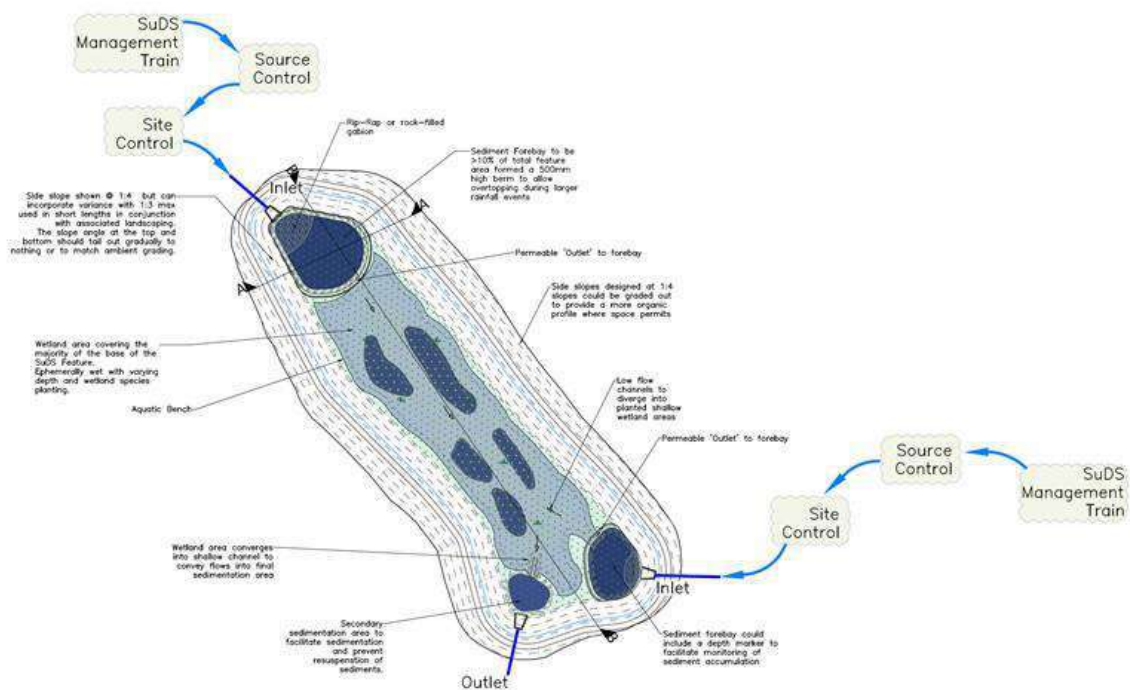


Figure 4.1 Schematic of Typical Proposed SuDS Feature

With reference to the NE Nitrate Neutrality Methodology (**Appendix 1**), the ability of wetlands to remove nitrogen from runoff through processes such as denitrification and sedimentation has been demonstrated in numerous studies. In particular, a recent systematic review of the effectiveness of wetlands for N (and P) removal conducted by Land *et al*, 2016⁷ used data from 203 wetlands worldwide. The average N removal rate for wetlands that were included in this review was 181 g N/m²/yr.

Assuming this removal rate can be achieved in the permanently wet areas of the proposed SuDS features, in order to remove the total 1,529.4 kg TN/yr in runoff from the site (refer to Section 3.3.3 above) a total $(1,529.4 \text{ kg TN/yr} \times 1,000) / 181 \text{ g N/m}^2/\text{yr} = 8,449.7 \text{ m}^2$ permanently wetted area would need to be provided.

With reference to **Appendix 15**, the total basal area of the proposed SuDS features equates to 17,246 m². Consequently, in order to provide the necessary treatment area within the bases of the SuDS would require a minimum of $(8,449.7 \text{ m}^2 / 17,246 \text{ m}^2) \times 100 = 49 \%$ of the base of each SuDS feature to be provided as a permanently wetted area.

With reference to Figure 4.1 above, this percentage wetted area coverage is achievable within the proposed design and thus will be targeted within the detailed design of the features.

Consequently, it is anticipated that the proposed SuDS network should be able to remove all of the additional N within the runoff resulting from the scheme. This will ensure that the scheme will confer a net reduction of at least **1,949.2 kg TN/yr** (with an aspiration to increase this to **2,811.3 kg TN/yr**, refer to Section 3.3.2 above) being discharged to the environment from the site, which would result in a significant net benefit to local biodiversity and the conservation status of the downstream European Designated Sites.

5. Summary and Conclusion

The aim of the study was to refine the NE approach, in order to provide a robust assessment of the impact of the development on downstream European Designated Sites and to inform the selection of appropriate mitigation measures for the scheme.

This report provides a summary of the evidence gathered to support the Nitrate Neutrality Study together with the final calculations and recommendations for appropriate mitigation measures for the scheme.

The calculations demonstrate that:

- 1) The total N-loss from agricultural uses from the whole pre-existing OPA site is **3,435.2 kg N/yr**. Spread over a farmed area of 123.1 ha, this equates to an average N-loss of **27.9 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE as an average N-loss for all farm types within the Solent catchment area;
- 2) It is assumed that all foul sewage generated by pre-existing dwellings and farmsteads is treated on-site by septic tanks and drainage fields, discharging leachate ultimately to local watercourses or groundwaters. N-losses from pre-existing foul sewage loadings have been calculated as **153.0 kg N/yr** from the whole site;
- 3) Consequently, total N-losses from the pre-existing site have been calculated as **3,588.2 kg N/yr**;
- 4) If the wastewater generated by the proposals is conveyed to Chickenhall WwTW it will be treated and discharged without any permit concentration limit for TN, with an estimated discharge concentration of 27 mg/l TN. Consequently, the annual mass discharge of N into the River Itchen SAC (assuming a 2 mg/l TN base concentration in the supplied potable water) would be **11,741.7 kg TN/yr**. In terms of mitigation, assuming all N can be removed from the runoff from the proposed development, the scheme would result in a net increase in N discharged to the local environment of c. **9,784.2 kg TN/yr**;
- 5) Should a water usage rate of 110 l/s be achieved in the operational development, then the scheme would result in a net increase in N discharged to the local environment of **2,372.4 kg TN/yr**.
- 6) If the wastewater generated by the proposals is conveyed to Peel Common WwTW it will be treated and discharged at a TN concentration of 5.49 mg/L (assuming the facility discharges at an average of 90 % of the consent limit). Consequently, the annual mass discharge of N into the Portsmouth Harbour SPA (assuming a 2 mg/L TN base concentration in the supplied potable water) would be **1,639.1 kg TN/yr**. In terms of mitigation, assuming all N can be removed from the runoff from the proposed development, the scheme would result in a net decrease in N discharged to the local environment of c. **1,949.2 kg TN/yr**;
- 7) Should a water usage rate of 110 l/person/day be achieved in the operational development, then the scheme would result in a net reduction in N discharged to the local environment of **2,811.3 kg TN/yr**.
- 8) As such, the total mass of N discharged to sensitive European Designated Sites would be reduced as a result of the proposed development discharging its sewage effluent to Peel Common WwTW. This would result in a net benefit to local biodiversity and the conservation status of the downstream European Designated Sites. Consequently, it has been assumed in this report that discharge to Peel Common WwTW will be progressed in preference to Chickenhall WwTW;

- 9) It is estimated that the proposed land uses within the new development will result in a total loss of **1,529.4 kg TN/yr** in runoff from the site;
- 10) As part of the proposals, it is intended to construct a network of SuDS features across the site comprising basins, swales, ponds and wetlands to sustainably manage runoff from the scheme. All proposed SuDS features will be planted and incorporate permanently wet areas around inlets, outlets and wetland areas within the base of the features;
- 11) Wetlands have been shown to remove N from runoff through processes such as denitrification and sedimentation. Assuming a mean removal rate of 181 g N/m²/yr can be achieved in the permanently wet areas of the proposed SuDS features, c. 49 % of the base of each SuDS feature will need to be provided as a permanently wetted area in order to treat all N in the runoff from the scheme. This percentage wetted area coverage will be achievable within the detailed design of the features;
- 12) Consequently, it is anticipated that the proposed SuDS network should be able to remove all of the additional N within the runoff resulting from the scheme. This will ensure that the scheme will confer a net reduction of at least **1,949.2 kg TN/yr** (with an aspiration to increase this to **2,811.3 kg TN/yr**) being discharged to the environment from the site, which would result in a significant net benefit to local biodiversity and the conservation status of the downstream European Designated Sites.



Appendix 1 Natural England Nitrate Neutrality Methodology

ADVICE ON ACHIEVING NUTRIENT NEUTRALITY FOR NEW DEVELOPMENT IN THE SOLENT REGION

SECTION 1 INTRODUCTION

- 1.1 The water environment within the Solent region is one of the most important for wildlife in the United Kingdom. It is internationally important for its wildlife and is protected under the Water Environment Regulationsⁱ and the Conservation of Habitats and Species Regulationsⁱⁱ as well as national protection for many parts of the coastline and their sea.ⁱⁱⁱ There are high levels of nitrogen and phosphorus input to this water environment with sound evidence that these nutrients are causing eutrophication at these designated sites. These nutrient inputs currently mostly come either from agricultural sources or from wastewater from existing housing and other development. The resulting dense mats of green algae and other effects on the marine ecology from an excessive presence of nutrients are impacting on the Solent's protected habitats and bird species.
- 1.2 There is uncertainty as to whether new growth will further deteriorate designated sites. This issue has been subject to detailed work commissioned by local planning authorities (LPAs) in association with Natural England, Environment Agency and water companies. This strategic work, which updates early studies, is on-going. Until this work is complete, the uncertainty remains and the potential for future housing developments across the Solent region to exacerbate these impacts creates a risk to their potential future conservation status.
- 1.3 One way to address this uncertainty is for new development to achieve nutrient neutrality. Nutrient neutrality is a means of ensuring that development does not add to existing nutrient burdens and this provides certainty that the whole of the scheme is deliverable in line with the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended).
- 1.4 This report sets out a practical methodology to calculating how nutrient neutrality can be achieved. This methodology is based on best available scientific knowledge, and will be subject to revision as further evidence is obtained. It is our advice to local planning authorities to take a precautionary approach in line with existing legislation and case-law when addressing uncertainty and calculating nutrient budgets.
- 1.5 This report includes a brief summary of the planning and environmental context for this nutrient neutral approach, the detailed methodology and advice on mitigation. Further information and guidance is included in the annexes.

SECTION 2 PLANNING CONTEXT

- 2.1 The Partnership for Urban South Hampshire (PUSH), Natural England (NE), and Environment Agency (EA) have been jointly working to develop an Integrated Water Management Strategy (IWMS) since before 2008. This work examines the potential for the PUSH region to accommodate future housing growth without having a detrimental effect upon the water environment. A Water Quality Working Group has been set up to identify and analyse the existing evidence gaps and evaluate the need for strategic mitigation measures. A Water Quality Group including Natural England, Environment Agency and Chichester District Council have been working to identify solutions to water quality concerns in Chichester Harbour for at least 10 years. However, there is currently uncertainty as to whether there is sufficient capacity to accommodate the new housing growth.
- 2.2 Since March 2018, Natural England has been advising that one means of addressing this uncertainty for larger development (in excess of 200-300 houses), including all EIA development, is to calculate a nutrient budget and achieve nutrient neutrality.
- 2.3 During the summer of 2018, a review of the condition of designated sites water environment in the Solent harbours was undertaken (see next section). The best available up-to-date evidence has identified that some interest features at the designated sites, such as intertidal mudflat habitat and the wildlife they support are widely in unfavourable condition due to existing levels of nutrients and are therefore at risk from additional nutrient inputs.
- 2.4 It is Natural England's view that there is a likely significant effect on several internationally designated sites (Special Protection Areas, Special Areas of Conservation and Ramsar sites) due to the increase in wastewater from the new developments coming forward.
- 2.5 The uncertainty about the impact of new development on designated sites needs to be recognised for all development proposals that are subject to new planning permissions and have inevitable wastewater implications. These implications, and all other matters capable of having a significant effect on designated sites in the Solent, must be addressed in line with Regulation 63 of the Conservation of Habitats and Species Regulations 2017.
- 2.6 LPAs and applicants will be aware of CJEU decisions regarding the assessment of elements of a proposal aimed toward mitigating adverse effects on designated sites and the need for certainty that mitigating measures will achieve their aims. The achievement of nutrient neutrality, if scientifically and practically effective, is a means of ensuring that development does not add to existing nutrient burdens.
- 2.7 The Water Quality Working Groups draw together expertise from local planning authorities, Environment Agency, Natural England and the water companies to examine this uncertainty further and develop an approach that ensures that

development can progress in a timely manner whilst ensuring the requirements of the Habitats Regulations are met. Further information is included in Annex 1.

SECTION 3 ENVIRONMENTAL CONTEXT

- 3.1 In 2018 and 2019 Natural England undertook a number of condition assessments of the features of the designated international sites around the Solent (the Solent Maritime SAC, Chichester and Langstone Harbours SPA, Portsmouth Harbour SPA, Solent and Southampton Water SPA) as well as the nationally designated SSSIs that underpin these international designations. An account of the outcome of these assessments, together the evidence used to support the conclusions, is given in Annex 2 with a brief summary below. Annex 2 also includes information on the Solent and Dorset Coast SPA and the Solent and Isle of Wight Lagoons SAC.

Solent Maritime SAC

- 3.2 For the Solent Maritime SAC the condition assessments completed considered the SAC features across the site as a whole and found the condition of these features - estuary, mudflat & sandflats, sandbanks – to be unfavourable. The unfavourable assessment is based on a number of attributes failing, including the nutrient water quality attribute. Other attributes were also found to be failing, such as, for seagrasses, their extent, distribution, rhizome structure and reproduction as well as biomass, and for the intertidal mud and sand features their infaunal quality. These failures are considered to be in part due to impacts from elevated nutrients.
- 3.3 Currently the site condition assessment does not include the saltmarsh feature which has not yet been assessed. However preliminary analysis of data shows that there was a loss of extent of saltmarsh across the Solent between 2008 and 2016.

Special Protection Areas and Ramsar sites (Solent and Southampton Water, Portsmouth Harbour and Chichester and Langstone Harbours)

- 3.4 Condition assessment for the SPAs and Ramsar sites have yet to be undertaken, but a number of bird features are declining as highlighted by recent Wetland Bird Survey alerts. A comparison with regional and national trends indicates that several of the declines are likely to be due to site specific reasons rather than reflecting wider national or regional population trends. While the cause of these site specific declines in the Solent area are largely unknown there are possible links to the elevated nutrient loading.

Sites of Special Scientific Interest (SSSI)

- 3.5 During 2018 and 2019, Natural England revised and updated the SSSI assessments in the greater Solent area in relation to the influence of the water environment on the condition of estuarine SSSI interest features that underpin the SAC and SPAs. These assessments especially included littoral sediment habitat (mudflat and other tidally

exposed sediment flats). The review of parts of the greater Solent area and some SSSI interest features is ongoing.

- 3.6 The SSSI interest feature assessments completed consider the concentrations of inorganic nitrogen status in each harbour and estuary, and evidence for ecological responses. Particular attention was given to records on phytoplankton abundance and the presence and abundance of opportunistic green macroalgae.
- 3.7 These SSSI assessments give a spatially more specific account of the condition of protected sites and details are given in Annex 2 with condition varying across different parts of the Solent. Overall some 81% of the total area assessed is in unfavourable condition. Breaking down this unfavourable area, 40% if it is classed as recovering condition, most of this being in Langstone Harbour but these units are considered 'at risk' of not recovering to a favourable situation as it is unclear whether the nutrient status will become adequate to substantially prevent the growth of dense macroalgae mats in parts of the Harbour.
- 3.8 In 2019 and 2020, a more detailed review of Chichester Harbour's intertidal features was undertaken of all the overlapping national and internationally designated features including saltmarsh, wintering and nesting birds. More than 3000 hectares of the harbour is in unfavourable declining condition. Reasons for feature declines are complex with many factors acting together, but water quality is one of the contributing causes to the observed declines.

SECTION 4 NUTRIENT NEUTRALITY APPROACH FOR NEW DEVELOPMENT

Introduction

- 4.1 Achieving nutrient neutrality is one way to address the existing uncertainty surrounding the impact of new development on designated sites. This practical methodology provides advice on how to calculate nutrient budgets and options for mitigation, should this be necessary.
- 4.2 There is evidence that inputs of both phosphorus and nitrogen influence eutrophication of the water environment. However, the principal nutrient that tends to drive eutrophication in the marine environment is nitrogen and this is supported by modelling and evidence. Please see Annex 2 for further details.
- 4.3 The best available evidence is for focus in the Solent harbours to be on nitrogen reduction, and reduction in both nitrogen and phosphorus in the Medina catchment. However, this approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.
- 4.4 The nutrient budget in this report calculates quantities of nitrogen (N) generated by development. This N comes in different forms and measured N concentrations vary according to exactly what is measured. These differences need to be recognised when calculating nutrient budgets. The key measurement is Total Nitrogen (TN), i.e. both organic and inorganic forms of nitrogen, because this is what is available for

plant growth. TN is the sum of the inorganic forms - nitrate-nitrogen ($\text{NO}_3\text{-N}$), nitrite-nitrogen ($\text{NO}_2\text{-N}$), ammoniacal - N - and organically bonded nitrogen.

- 4.5 For developments on the Isle of Wight that are impacting on the Medina estuary, both a phosphorus and nitrogen budget may be required. Natural England will work closely with the Isle of Wight Council and applicants to provide advice on a bespoke case-by-case basis.

Approach to calculating nutrient budgets

- 4.6 For those developments that wish to pursue neutrality, Natural England advises that a nitrogen budget is calculated for new developments that have the potential to result in increases of nitrogen entering the international sites. A nutrient budget calculated according to this methodology and demonstrating nutrient neutrality is, in our view, able to provide sufficient and reasonable certainty that the development does not adversely affect the integrity, by means of impacts from nutrients, on the relevant internationally designated sites. This approach must be tested through the 'appropriate assessment' stage of the Habitats Regulations Assessment. The information provided by the applicant on the nutrient budget and any mitigation proposed will be used by the local planning authority, as competent authority, to make an appropriate assessment of the implications of the plan or project on the designated sites in question. Further information of this process is available [here](#).
- 4.7 The nutrient neutrality calculation includes key inputs and assumptions that are based on the best-available scientific evidence and research. It has been developed as a pragmatic tool. However, for each input there is a degree of uncertainty. For example, there is uncertainty associated with predicting occupancy levels and water use for each household in perpetuity. Also, identifying current land / farm types and the associated nutrient inputs is based on best-available evidence, research and professional judgement and is again subject to a degree of uncertainty.
- 4.8 It is our advice to local planning authorities to take a precautionary approach in line with existing legislation and case-law when addressing uncertainty and calculating nutrient budgets. This should be achieved by ensuring nutrient budget calculations apply precautionary rates to variables and adding a precautionary buffer to the TN calculated for developments. A precautionary approach to the calculations and solutions helps the local planning authority and applicants to demonstrate the certainty needed for their assessments.
- 4.9 By applying the nutrient neutrality methodology, with the precautionary buffer, to new development, the competent authority may be satisfied that, while margins of error will inevitably vary for each development, this approach will ensure that new development in combination will avoid significant increases of nitrogen load to enter the internationally designated sites.

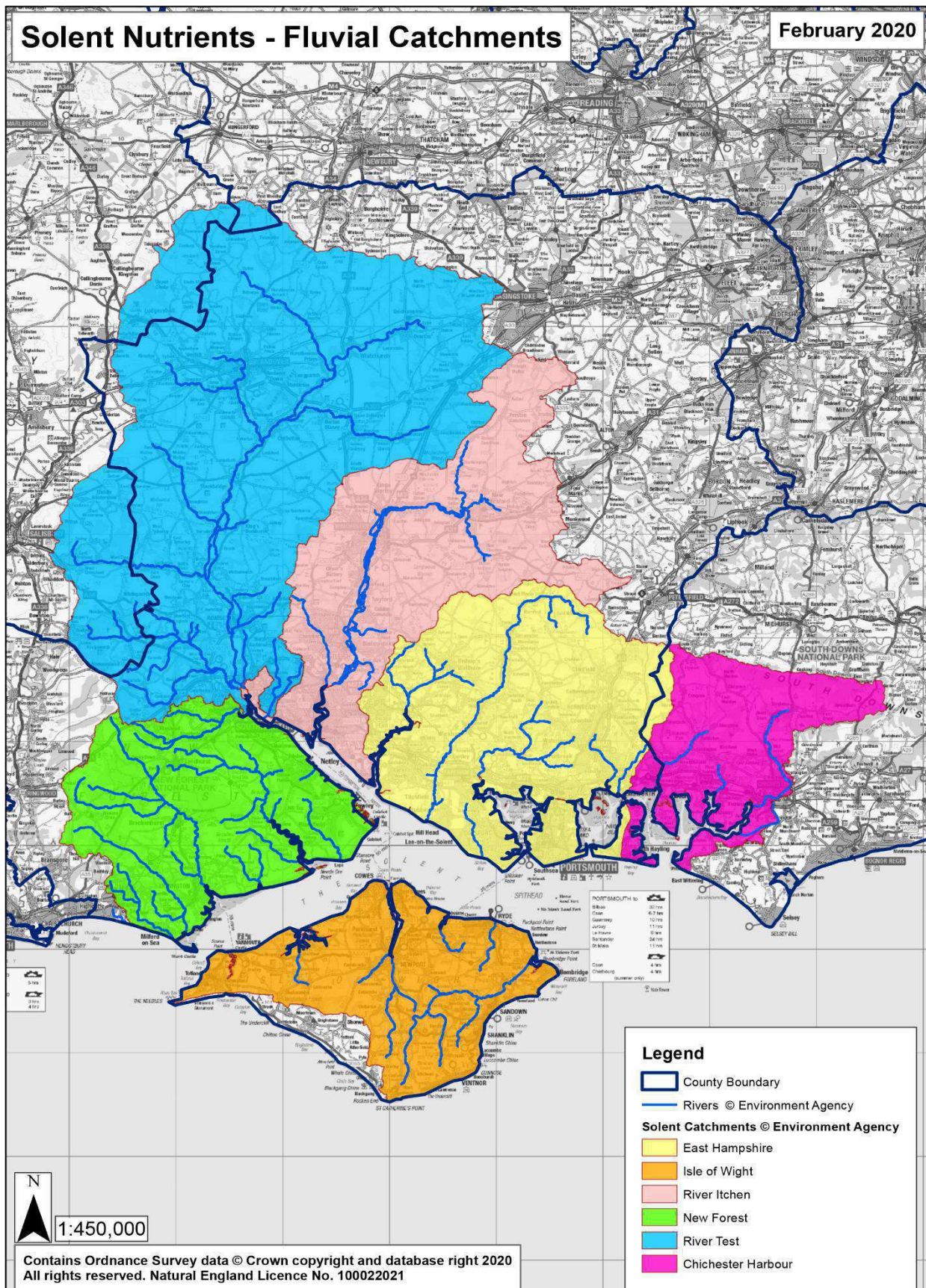
Location of development

- 4.10 The nutrient neutrality approach only applies to developments where the treated effluent discharges into any Solent international sites (Solent Maritime SAC, Solent and Southampton Water SPA and Ramsar, Portsmouth Harbour SPA and Ramsar, Chichester and Langstone Harbours SPA and Ramsar), or any water body (surface or groundwater) that subsequently discharges into such a site. The catchment area is shown on Figure 1.
- 4.11 This approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.

Type of development

- 4.12 This methodology is for all types of development that would result in a net increase in population served by a wastewater system, including new homes, student accommodation, tourism attractions and tourist accommodation. This development will have inevitable wastewater implications.
- 4.13 Other commercial development not involving overnight accommodation will generally not be included. It is assumed that anyone living in the catchment also works and uses facilities in the catchment, and therefore wastewater generated by that person can be calculated using the population increase from new homes and other accommodation. This removes the potential for double counting of human wastewater arising from different planning uses.
- 4.14 Tourism attractions and tourism accommodation are exceptions, as these land uses attract people into the catchment and generate additional wastewater and consequential nitrogen loading on the Solent. This includes self-service and serviced tourist accommodation such as hotels, guest houses, bed and breakfasts and self-catering holiday chalets and static caravan sites. Other applications will be considered on their individual merits, for example new cruise ship facilities etc.
- 4.15 There may be cases where planning applications for new commercial or industrial development or changes in agricultural practices could result in the release of additional nitrogen into the system. In these situations, a case-by-case approach will be adopted. Early discussions with Natural England via our chargeable services (DAS) are recommended.

Figure 1 Solent Catchment Area Contains public sector information licensed under the Open Government Licence v3.0



Methodology for nutrient budgets

- 4.16 The initial stage is to determine whether the development will drain to the mains network or to a non-mains facility e.g. an on-site package treatment works.
- 4.17 The methodology for development that drains to the mains network is in Section A. Please go to Section B if the new development is not on the mains network.

Section A

Stage 1 Calculate Total Nitrogen (TN) in kilograms per annum derived from the development that would exit the Wastewater Treatment Works (WwTW) after treatment

Stage1 Step 1 Calculate additional population

- 4.18 New housing and overnight accommodation can increase the population as well as the housing stock within the catchment. This can cause an increase in nitrogen discharges. To determine the additional population that could arise from the proposed development, it is necessary that sufficiently evidenced occupancy rates are used. Natural England recommends that, as a starting point, local planning authorities should consider using the average national occupancy rate of 2.4, as calculated by the Office for National Statistics (ONS), as this can be consistently applied across all affected areas.
- 4.19 However competent authorities may choose to adopt bespoke calculations tailored to the area or scheme, rather than using national population or occupancy assumptions, where they are satisfied that there is sufficient evidence to support this approach. Conclusions that inform the use of a bespoke calculation need to be capable of removing all reasonable scientific doubt as to the effect of the proposed development on the international sites concerned, based on complete, precise and definitive findings. The competent authority will need to explain clearly why the approach taken is considered to be appropriate. Calculations for occupancy rates will need to be consistent with others used in relation to the scheme (e.g. for calculating open space requirements), unless there is a clear justification for them to differ.

Stage 1 Step 2 Confirm water use

- 4.20 Determine the water use / efficiency standard for the proposed development to be defined in the planning application and, where relevant, the Environmental Statement. The nitrogen load is calculated from the scale of water use and thus the highest water efficiency standards under the building regulations will minimise the increase in nitrogen from the development.
- 4.21 It is recommended that each Local Planning Authority impose a planning condition on all planning permissions for one or more net additional new dwellings requiring construction to the optional requirement^{iv} under G2 of the Building Regulations 2010.

- 4.22 A model condition is set out below:

“The dwellings shall not be occupied until the Building Regulations Optional requirement of a maximum water use of 110 litres per person per day has been complied with.”

- 4.23 The water use figure is a proxy for the amount of wastewater that is generated by a household. New residential development may be able to achieve tighter water use figures, with or without grey water recycling systems, and this approach is supported from a water resource perspective (for example in support of Southern Water’s Target 100 litres per person per day). However, the key measurement is the amount of wastewater generated by the development that flows to the wastewater treatment works.
- 4.24 If tighter water use restrictions are used in the nutrient calculation – with or without grey water recycling systems – these restrictions should reflect the wastewater expected to be generated over the lifetime of the development. There is a risk that when kitchen and bathroom fittings are changed by occupants over the years, less water-efficient models could be installed. It is Natural England’s view that it would be difficult to evidence and secure delivery of tighter restrictions at this time. However, if sound evidence can be provided, this will be considered on a case-by-case basis.
- 4.25 It is Natural England’s view that while new developments should be required to meet the 100 litres per person a day standard, the risk of standards slipping over time and the uncertainty inherent in the relationship between water use and sewage volume should be addressed by the use in the calculation of 110 litres per person per day figure.

Stage 1 Step 3 Confirm WwTW and permit level

- 4.26 Identify the Wastewater treatment works (WwTW) that the development will drain to and whether it has a TN permit.
- 4.27 For most planning applications, the WwTW provider is not confirmed until after planning permission is granted. The nutrient calculation should be based on the permit levels of the most likely WwTW. In any cases where the WwTW changes, a reassessment of the nutrient calculation will be required to ensure the development is nutrient neutral.

WwTWs with TN permit

- 4.28 Identify the permit concentration limit for Total Nitrogen at the proposed WwTW. If the WwTW will have a tightened permit concentration limit for Total Nitrogen under the company’s Water Industry Asset Management Plan by 2024 then use this tightened value. If a new WwTW is proposed, obtain a determination from the

Environment Agency on the permit limit for Total Nitrogen that would apply to the works and when they are likely to be built.

- 4.29 Where there is a permit limit for Total Nitrogen, the load calculation will use a worst case scenario that the WwTW operates at 90% of its permitted limit. A water company has the option of operating the works as close to the consent limit as practicable without breaching the consent limit. Natural England and the Environment Agency have agreed to take 90% of the consent concentration limit as the closest the water company can reasonably operate the works without risk of breaching the consent limit.

WwTWs without a TN permit

- 4.30 For developments that discharge to WwTWs with no TN permit limit, best available evidence must be used for the calculation. In the first instance, Southern Water or other wastewater provider should be contacted for details of the nitrogen effluent levels for the specific WwTW. Robust evidence may be available to derive a value for nitrogen in the wastewater stream based on the type of wastewater treatment at the works.
- 4.31 However, if this data is not available, a figure of 27mg/l can be used. This figure has been derived by Southern Water from nitrogen effluent concentrations at two WwTWs in the Solent area and this average figure may change if new evidence becomes available.
- 4.32 It is not possible to apply the 90% correction in these cases as these WwTWs are not regulated by a Total Nitrogen consent limit.

Relationship between TN and water use

- 4.33 For WwTWs with TN consents there is a direct relationship between TN and water use. For example, for WwTWs with a permit of 9 mg /l, it can be calculated that for each litre of water that passes through the works, 8.1mg (90% of 9 mg/l) of nitrogen could be released into the water environment. If a household uses 150 litres, this equates to 1215 mg of TN; if this is reduced to 100 litres, 810 mg of TN is released.
- 4.34 For WwTWs without a TN consent level, the relationship between water use and TN in the effluent is more complex, but applying the same methodology for nutrient neutrality is considered appropriate.
- 4.35 For these WwTWs, there is no guarantee that reductions in water use will lower TN discharges. These WwTWs are not regulated by the concentration of TN in each litre of effluent. Instead, the TN concentration could vary depending on the flow volume and concentration of TN coming into the WwTW. Growth in area will lead to more people which will increase the amount of nitrogen reaching a WwTWs and this could then change TN levels in the effluent. However, there is currently no clear correlation

between the TN concentration of the WwTW discharge and size of population served. It is therefore not considered necessary to correct for this factor. The processes at WwTWs and how nitrogen changes its form during treatment are complex, especially the interaction between different levels of nitrogen and carbon in the wastewater. Any error due to marginal increases in TN concentration with increases in population served by a particular WwTW will be covered by the precautionary 20% buffer.

- 4.36 Please note that due to this uncertainty the use of measures designed to reduce water consumption as a means of reducing TN are not appropriate in areas served by WwTWs without an N permit. This is likely to affect authorities with WwTWs that drain into rivers, as many of these WwTWs do not have TN permit limits currently.

Stage 1 Step 4 Calculate Total Nitrogen (TN) in Kg per annum that would exit the WwTW after treatment derived from the proposed development

- 4.37 The TN load is calculated by multiplying the water use of the proposed development by the appropriate concentration of TN after treatment at the WwTW.
- 4.38 An element of the TN within the wastewater coming from a household is from the drinking water supplied to that household. However, this forms a relatively small proportion (<10%) of this total. This has been calculated by using a nitrate-N concentration in drinking water of 8mg/l and a TN generated per person of 3.5kg/yr.
- 4.39 Moreover, in order for favourable condition for the Solent sites to be achieved it is necessary for there to be substantial reductions in ground and river water nitrogen concentrations. Since drinking water comes from these same sources these reductions will in turn affect TN concentrations in drinking water. It is therefore not appropriate to calculate TN budgets over the lifetime of the development based on the current elevated TN levels in drinking water. To do so would lock in a higher TN discharge from development that would offset the required improvements in TN levels in drinking water from changes in agricultural practice over time.
- 4.40 Notwithstanding the above, it is our advice that it is appropriate to discount an amount of N that would be present in groundwater and river water if they were in a more natural condition. Peer review research indicates that the mean natural river concentration would have been below 0.45 mg/l nitrate-nitrogen^v. Evidence also suggests that a nitrate concentration in rivers of c2 mg/l equates to the average concentrations in rivers before the 1960s, prior to the dramatic increase in N concentrations during the subsequent decades^{vi}. This nitrate concentrations corresponds well with emerging evidence from the Poole Harbour catchment where it is considered that restoration to a favourable conservation status would require a nitrogen load below 1000 tonnes of TN per year landward input. To achieve this, average TN levels in river water in the Poole Harbour catchment would need to be <c2.75 mg/l TN.

- 4.41 The total annual nitrogen load reductions necessary to achieve a favourable conservation status for the international sites within the greater Solent area have yet to be determined. However, for the purpose of the methodology, a river and groundwater TN concentration of 2 mg/l is considered at this stage to be likely to meet the restoration objectives for the Solent international sites. We therefore recommend that a discounted figure of 2 mg/l is used to reflect the amount of N that would otherwise be present in river and groundwater.
- 4.42 Natural reductions in nitrogen concentrations, mainly through de-nitrification processes, also occur within watercourses. The scale of de-nitrification is complex and dependent on a number of variables, including the characteristics of the water channels, season, water flows, N concentrations, and uptake by plant communities, etc. Insufficient evidence is currently available to properly evaluate de-nitrification rates within the greater Solent catchments and therefore this factor has not been included within the current methodology. Nevertheless natural de-nitrification processes, particularly for discharges in the upper Solent catchment, provide an additional precautionary factor for the methodology.

Worked example of a nutrient budget calculation for discharge to a WwTW using methodology.

- 4.43 The following worked example calculates the Total Nitrogen load of a development of 1000 dwellings based on a WwTW with a consent limit for Total Nitrogen of 9 mg/l.
- 4.44 Where residential developments also include other overnight accommodation such as tourist accommodation and attractions, the associated water use from these additional land uses will need to be included in the calculation. These rates should be based on empirical evidence from similar developments or published literature and will be assessed on a case by case basis.

Table 1 – Calculating wastewater Total Nitrogen load from proposed development

STAGE 1 - WORKED EXAMPLE TO CALCULATE TOTAL NITROGEN (TN) LOAD FROM DEVELOPMENT WASTEWATER				
Step	Measurement	Value	Unit	Explanation
Development proposal	Development types that would increase the population served by a wastewater system	1000	Residential dwellings	
Step 1	Additional population	2400	Persons	Uses an average household size of 2.4 x 1000 dwgs (greenfield site).
Step 2	Wastewater volume generated by development	264,000	litres/day	2400 persons (step 1) x 110 litres. Where relevant, deduct wastewater volume of population displaced by the proposed development.
Step 3	Receiving WwTW environmental TN permit limit. Assume discharge to be at 90% of consent limit.	8.1	mg/l TN	90% of the consent limit = 8.1 mg/l TN.
Step 4	Deduct acceptable TN loading (@ 2 mg/l TN) (as defined in paragraph 4.40)	6.1	mg/l TN	8.1 (step 3) – 2 mg/l TN
Step 5	TN discharged after WwTW treatment	1,610,400	mg/TN/day	264000 (step 2) x 6.1 (step 4) =1,610,400
Step 6	Convert mg/TN to kg/TN per day	1.6104	Kg/TN/day	Divide by 1,000,000
Step 7	Convert kg/TN per day to kg/TN per year	587.8	Kg/TN/yr	1.6104 x 365 days
Wastewater total nitrogen load	587.8 kg/TN/yr			

Stage 2 *Adjust nitrogen load to account for existing nitrogen from current land use*

- 4.45 This next stage is to calculate the existing nitrogen losses from the current land use within the redline boundary of the scheme. The nitrogen loss from the current land use will be removed and replaced by that from the proposed development land use. The net change in land use will need to be subtracted from or added to the wastewater Total Nitrogen load.
- 4.46 Nitrogen–nitrate loss from agricultural land can be modelled using the Farmscoper model. A study commissioned by Natural England from ADAS modelled this loss for different farm types across the river catchments that drain to the Solent (ADAS UK Ltd. 2015. Solent Harbours Nitrogen Management Investigation).
- 4.47 If the development area covers agricultural land that clearly falls within a particular farm type used by the Farmscoper model then the modelled average nitrate-nitrogen loss from this farm type should be used. The farm types used in the ADAS model are set out in Table 2, with the nitrate-nitrogen loss. Further details on farm classification are included in Appendix 1.

Table 2 Farm types and average nitrogen-nitrate loss

AVERAGE NITRATE-NITROGEN LOSS PER FARM TYPE IN THE SOLENT CATCHMENT AREA (kg/ha)	
Cereals	31.2
Dairy	36.2
General Cropping	25.4
Horticulture	29.2
Pig	70.4
Lowland Grazing	13.0
Mixed	28.3
Poultry	70.7
Average for catchment area	26.9

- 4.48 If the proposed development area covers several or indeterminate farm types then the average nitrate-nitrogen loss across all farmland may be more appropriate to use. The average figure is also included in Table 2.
- 4.49 The figures in the ADAS report are based on 2010 land use data and may be updated from time-to-time as land use and agricultural practice to control nitrate loss changes.
- 4.50 For maize farms, it is recommended that the general cropping nitrogen leaching rate is used in the calculation. For sites that are in use as allotments, it is recommended

that the most appropriate farm type for allotments is the average rate of 26.9 kg/ha/yr. For sites that are currently in use as horse paddocks, it is recommended that the lowland grazing figure should be used in the calculation.

- 4.51 It is important that farm type classification is appropriately precautionary. It is recommended that evidence is provided of the farm type for the last 10 years and professional judgement is used as to what the land would revert to in the absence of a planning application. In many cases, the local planning authority, as competent authority, will have appropriate knowledge of existing land uses to help inform this process.
- 4.52 There may be areas of a greenfield development site that are not currently in agricultural use and have not been used as such for the last 10 years. In these areas as there is no agricultural input into the land a baseline nitrogen leaching value of 5 mg/l should be used. This figure covers nitrogen loading from atmospheric deposition, pet waste and nitrogen fixing legumes.
- 4.53 Where development sites include wildlife areas, woodlands, hedgerows, ponds and lakes that are to be retained, these areas can either be excluded from the calculation as there will be no change in nitrogen input onto this land, or included with the same nitrogen leaching rate in stage 2 and 3. This approach assumes that if they are adopted as green infrastructure or a wildlife area in the new development, appropriate management can be secured with any planning permission (see next section) to restrict nitrogen loading.
- 4.54 A similar approach can also be taken for the redevelopment of urban land as the nitrogen leaching rate would be 14.3 kg/ha in stage 2 and 14.3 kg/ha in stage 3. If there is no change in site area, these areas can be excluded from the calculation.
- 4.55 For sites, where existing land use is not confirmed, it is Natural England's advice to local planning authorities and applicants to take a precautionary approach in line with existing legislation and case-law.
- 4.56 Please note if evidence can be provided to support an alternative nitrogen figures for any existing land use, then this information will be reviewed by the local planning authority and Natural England.
- 4.57 A worked example to calculate the nitrogen load from existing land use is set out in Table 3.

Table 3 Calculating nitrogen load from current land use

STAGE 2 - WORKED EXAMPLE TO CALCULATE NITROGEN LOAD FROM CURRENT LAND USE				
Step	Measurement	Value	Unit	Explanation
1	Total area of existing agricultural land	40	Hectares	This is the area of agricultural land that will be lost due to development
2	Identify farm type and confirm nitrate loss.	26.9	Kg/ha/yr	The developable area covers several farm types therefore an average has been used. Reference Appendix 1 and Table 2
3	Multiply area by nitrate loss	1,076	Kg/N/yr	40 ha x 26.9 kg/N/yr
Nitrogen load from current land use	1,076 Kg/N/yr			

Stage 3 *Adjust nitrogen load to account for land uses with the proposed development*

- 4.58 The last stage is to add in the nitrogen load that will result from the new development that is not received by a WwTW. This includes the nitrogen load from the new urban development and from the new open space including any Suitable Alternative Natural Greenspace (SANG), Nature Reserves, or Bird Refuge Areas as identified within the redline boundary of the scheme.
- 4.59 The calculation only includes the areas of the site where there will be a change in land use, for example from agricultural land to new urban development or agricultural land to Suitable Alternative Natural Greenspace (SANG) / open space. Where there is no proposed change to land use, this land should be excluded from the nitrogen budget as there will be no change to the nitrogen load from this area.

Urban development

- 4.60 The nitrogen load from the new urban development results from sewer overflows and from drainage that picks up nitrogen sources on the urban land. Urban development includes the built form, gardens, road verges and small areas of open space within the urban fabric. These nitrogen sources include atmospheric deposition, pet waste, fertilisation of lawns and gardens and inputs to surface water sewers. The nitrogen leaching from urban land equates to 14.3 kg/ha/yr^{vii}. Appendix 2 sets out the scientific research and literature in relation to this figure.

Open Space and Green Infrastructure

- 4.61 Nitrogen loss draining from new designated open space or Suitable Alternative Natural Greenspace (SANG) should also be included. The nitrogen leaching from this land is likely to equate to 5 kg/ha/yr. Appendix 3 sets out the scientific research and literature in relation to this figure. This figure can also be used where new nature reserves or bird refuge areas are created and for new woodland planting areas.
- 4.62 The competent authority will need to be assured for that this open space will be managed as such and there will be no additional inputs of nutrients or fertilisers onto this land for the duration of the development. Appropriate conditions or other legal measures may be necessary to ensure it will not revert back to agricultural use, or change to alternative uses that affect nutrient inputs in the long term. It is therefore recommended that the 5 kg/ha/yr rate applies to areas of designated open space on-site of around 0.5 hectares and above. These sites will also need long term management to ensure the provision of dog bins and that these are regularly emptied.
- 4.63 Small areas of open space within the urban fabric, such as road verges, gardens, children's play areas and other small amenity areas, should not be included within this category. The urban development figure is appropriate for these land uses.

Community food growing provision

- 4.64 For any areas of the site that are proposed for community food growing provision such as allotments, it is recommended that the average farm type rate is used (26.9 kg/ha/yr).
- 4.65 A worked example is shown in the table below. This is based on a developable area of 38 hectares covering land in a mix of farm types with the removal of 2 hectares of agricultural land to create SANG.

Table 4 – Adjust nitrogen load to account for future land uses

STAGE 3 - WORKED EXAMPLE TO CALCULATE NITROGEN LOAD FROM FUTURE LAND USES				
Step	Measurement	Value	Unit	Explanation
1	New urban area	38	Hectares	Area of development that will change from agricultural land to urban land use
2	Nitrogen load from future urban area	543.4	Kg/N/yr	38 ha x 14.3 Kg/N/yr
3	New SANG / open space	2	Hectares	Area of development that will change from agricultural land to SANG / open space
4	Nitrogen load from SANG / open space	10	Kg/N/yr	2 ha x 5.0 Kg/N/yr
5	Combine nitrogen load from future land uses	553.4	Kg/N/yr	543.4 Kg/N/yr + 10 Kg/N/yr
Nitrogen load - future land uses	553.4 Kg/N/yr			

Stage 4 ***Calculate the net change in the Total Nitrogen load that would result from the development***

- 4.66 The last stage is to calculate the net change in the Total Nitrogen load to the Solent catchment with the proposed development. This is derived by calculating the difference between the Total Nitrogen load calculated for the proposed development (wastewater, urban area, open space etc) and that for the existing land uses.
- 4.67 It is necessary to recognise that all the figures used in the calculation are based on scientific research, evidence and modelled catchments. These figures are the best available evidence but it is important that a precautionary buffer is used that recognises the uncertainty with these figures and in our view ensures the approach prevents, with reasonable certainty, that there will be no adverse effect on site integrity. Natural England therefore recommends that a 20% precautionary buffer is built into the calculation.
- 4.68 There may be instances where it is the view of the competent authority that an alternative precautionary buffer should be used on a site-specific basis where sufficient evidence allows the legal tests to be met.

4.69 Table 5 sets out a worked example.

Table 5 Nitrogen Load Budget

STAGE 4 - WORKED EXAMPLE TO CALCULATE THE NET CHANGE IN NITROGEN LOAD FROM THE DEVELOPMENT				
Step	Measurement	Value	Unit	Explanation
1	Identify nitrogen load from wastewater (stage 1)	587.8	Kg/TN/yr	See Table 1
2	Calculate the net change in nitrogen from land use change - subtract existing land uses nitrogen load (stage 2) from future land uses nitrogen load (stage 3)	-522.6	Kg/TN/yr	553.4 (stage 2) - 1076 (stage 3) = -522.6 Kg/TN/yr
3	Determine nitrogen budget – the Total Nitrogen wastewater load for the proposed development plus the change in nitrogen load from land use change (the latter figure may be positive i.e. the change in land use will generate more nitrogen, or negative i.e. the change in land use will generate less Nitrogen)	64.8	Kg/TN/yr	587.4 (step 1) + - 522.6 (step 2) = 64.8 Kg/TN/yr
4	Where TN budget is positive add 20% precautionary buffer	77.8	Kg/TN /yr	64.8 + 20% = 77.8.
Total Nitrogen that needs to be neutralised	77.8 Kg/TN /yr			

Section B

Methodology for calculating TN budgets for package treatment works (PTPs)

- 4.70 The Environment Agency has a presumption against private sewage treatment works in sewered areas and will always seek connection to the mains sewer where possible and practicable. A principle concern relates to the failure rates of PTPs and the lack of review and periodic upgrades via regulatory systems that apply to mains. There will be site specific factors (e.g. in proximity to watercourses, soil saturation levels, etc.) that would need to be considered when evaluating this risk.
- 4.71 Further advice from the Environmental Agency on the use of PTP may be found at:
<https://www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits>
- 4.72 Where development are proposing to use package treatment works, or similar, it is recommended that the TN level is calculated on a per person basis. On average each person produces sewage containing 0.0035 tonnes of nitrogen per year (3.5 kilograms)^{viii}. The TN prior to treatment = number of additional pollution x 3.5 Kg = Kg/TN/yr.
- 4.73 The percentage reduction of TN that may be applied as result of treatment will depend on the efficiency of the treatment processes employed and must be assessed on a case by case basis. NB The evidence supporting the efficiency of PTPs should include the test result documents from the lab (in English) and/or measured effluent concentrations from real world applications, not just the covering certificate. Information will also need to be provided on the long term monitoring and management of these installations and this will need to be secured.
- 4.74 Bespoke calculations of the TN load may be possible for larger PTPs in instances where robust evidence of the performance of the system in removing nitrogen is provided. In addition to the above, the evidence will need to include, as a minimum, a full year of operation and supporting information to ensure that the concentration of total nitrogen within the effluent can be reliably predicted. In these cases, early consultation with Natural England, through our charged advice service, and the competent authority is recommended.
- 4.75 Table 6 sets out a worked example for Stage 1. Stages 2, 3 and 4 of the above methodology can then be applied.

Table 6 Alternative Stage 1 methodology for package treatment works (PTPs)

STAGE 1 - WORKED EXAMPLE TO CALCULATE TOTAL NITROGEN (TN) LOAD FROM DEVELOPMENT WASTEWATER WITH AN ONSITE PTP (prior to treatment)				
Step	Measurement	Value	Unit	Explanation
Development proposal	Development types that would increase the population served by a wastewater system	100	Residential dwellings	
Step 1	Additional population	240	Persons	Based on average household size of 2.4
Step 2	TN prior to treatment Based on 3.5 Kg TN per person per year	840	Kg TN /yr	240 (step 1) x 3.5 Kg TN per person per yr
Step 3	Receiving PTP TN reduction efficiency	70	%	Efficiency of PTP used must be evidenced.
Step 4	TN discharged after PTP treatment	252	Kg TN /yr	30% of 840
Step 5	Acceptable N loading (as defined in paragraph 4.40) Based on 110 l per day per person	52,800	mg TN /day	Total waste water from development (110l x 240 persons) x Acceptable N loading of 2 mg/l
Step 6	Convert acceptable TN loading to TN Kg / Yr	19.3	Kg TN / Yr	Divide by 1000000 x by 365 days
Step 7	TN discharged - acceptable N loading (@ 2 mg/l)	232.7	Kg TN / Yr	252 (step 4) – 19.3 (step 6)
PTP Total Nitrogen Load	279.2 Kg TN / Yr			

SECTION 5 MITIGATION

Introduction

- 5.1 If there is a nitrogen surplus from the WwTW discharge (a positive figure), then mitigation is required to achieve nitrogen neutrality. If the calculation identifies a deficit (a negative figure), no mitigation is required. In the worked example set out in Table 5, the nitrogen budget with 20% buffer is 77.8 Kg/TN/yr. Nitrogen neutrality would therefore require appropriate mitigation measures that would remove a minimum of 77.8 Kg/TN/yr.
- 5.2 Mitigation can be 'direct' through upgrading sewage treatment works and through alternative measures, e.g. interceptor wetlands; or 'indirect' by taking land out of high nitrogen uses, e.g. crops or intensive livestock systems that result in an excess of nitrogen lost to the water environment.
- 5.3 The purpose of the mitigation measures is to avoid impacts to the designated sites, rather than compensating for the impacts once they have occurred. Avoiding impacts is achieved by neutralising the additional nutrient burden that will arise from the proposed development, achieving a net zero change at the designated sites in a timely manner.
- 5.4 To ensure it is effective mitigation, any scheme for neutralising nitrogen must be certain at the time of appropriate assessment so that no reasonable scientific doubt remains as to the effects of the development on the international sites. This will need consideration of the delivery of mitigation, its enforceability and the need for securing the adopted measures for the duration of the development's effects, generally 80-125 years.
- 5.5 Schemes that are being delivered by other sectors (for example water industry and agricultural sector) for the purpose of meeting the necessary conservation measures designed for the international sites and to take appropriate steps to avoid the deterioration of the international sites should not also be used as mitigation for plans and projects, as this would compromise the original purpose and would be unlikely to meet the legal tests of the Habitats Regulations.
- 5.6 Further information has been included in this section on recommended mitigation measures. Each mitigation scheme will be assessed on its own merits and on a case by case basis, based on the submitted evidence. We recommend applicants to discuss options with local planning authorities and Natural England through our [charged advice service](#), at the earliest opportunity. However, it is ultimately the decision of the local planning authorities, as competent authorities, to determine the suitability of the proposed mitigation scheme in line with the legal tests in the Habitats Regulations.

Types of mitigation

Conversion of agricultural land for community and wildlife benefits

- 5.7 Permanent land use change by converting agricultural land with higher nitrogen loading to alternative uses with lower nitrogen loading, such as for local communities, wildlife, and under schemes for flood management or to deliver the UK Government's Net Zero greenhouse gas emissions target by 2050^{ix}, is one way of neutralising nutrient burdens from development. It is important to retain the best and most versatile agricultural land in food production, particularly food crop production. However, there are a number of reasons to support conversion of agricultural land where the land is less economic to farm. There may also be a wide range of incidental benefits for the local community and wildlife from this change, as well as delivery of wider planning policy objectives and climate emergency pledges.

On-site options

- 5.8 One option is to increase the size of the SANGs and Open Space provision for the development on agricultural land that reduces the nitrogen loss from this source. This can be secured as designated open space or by other legal mechanisms.

Off-site options

- 5.9 Another option is to acquire, or support others in acquiring, agricultural land elsewhere within an appropriate river catchment area. By changing the land use in perpetuity (e.g. to woodland, heathland, saltmarsh, wetland or conservation grassland), this reduces the nitrogen loss from this source.
- 5.10 Mitigation land should be appropriately secured to ensure that at the time of appropriate assessment it is certain that the benefits will be delivered in the long term. Natural England advises that this can be achieved through an appropriate change of ownership to a local planning authority or non-government organisation. However, it is recognised that there may be other legal mechanisms available to the competent authority to ensure deliverability and enforceability of a mitigation proposal. These can be considered on a case by case basis.
- 5.11 Small scale developments are encouraged to consider opportunities for providing local small scale mitigation measures that deliver multiple benefits. Possible options include the creation of local ponds, wetlands, local nature reserves, community orchards (without nitrogen inputs), or copse. Another example is to turn a strip (in excess of 10m width) of agricultural land immediately adjacent to a public footpath into a greenway. This could be demarcated by hedges or woodland planting for both public and wildlife benefits.

Woodland planting

- 5.12 Woodland planting on agricultural land is a means of securing permanent land use change without necessitating land purchase. It can be evidenced easily by aerial photography and site visits. The level of woodland planting required to achieve nutrient neutrality is 20% canopy cover at maturity. In very broad terms, this equates to 100 trees per hectare, although this is dependent on the type of trees planted and there are also options that this can be achieved by natural regeneration, especially if adjacent to existing native woodland. It is our preference that native broadleaf species are selected where possible, to secure wider biodiversity gains.
- 5.13 In a relatively short time, the woodland planting would require a felling licence and woodland removal would also be covered by the EIA Regulations where woodland is planted as mitigation for internationally designated sites. There are therefore a number of layers of security for the competent authorities to ensure this mitigation is being delivered effectively. Planted woodland does require management for the first decade in terms of plug fencing and maintenance until the canopy has reached above browsing height, thereafter management is relatively minimal though some thinning is preferable to enable mature trees to develop.
- 5.14 Woodland planting would secure carbon capture, biodiversity and recreational benefits. The established woodlands could also be used for wood fuel production or coppice timber production.

Wetlands

- 5.15 Wetlands receiving nitrogen-rich water can remove a proportion of this nitrogen through processes such as denitrification and sedimentation. Wetlands can be designed as part of a sustainable urban drainage (SUDs) system, taking urban runoff/stormwater; discharges from STWs can be routed through wetlands; or the flow, or part of the flow, of existing streams or rivers can be diverted through wetlands. Wetlands deliver incidental wildlife and biodiversity benefits, with possible drainage and flood defence benefits (by reducing risk of harm from natural hazards).
- 5.16 It is essential that wetlands and SUDs are maintained to provide ongoing nutrient removal. Provisions for resourcing the ongoing maintenance of SUDs will need to be secured with any planning permission. Further information on the potential for nitrogen mitigation using wetlands is included in Appendix 4.

Wastewater Treatment Work Upgrades

- 5.17 Mitigation options at WwTWs include the agreement with the wastewater treatment provider that they will maintain an increase in nitrogen removal at the WwTW. This may include either upgrades to infrastructure (long term), or where the existing WwTW infrastructure has capacity an agreement to operate the WwTW at a higher standard than required by the discharge consent. Natural England, Environment Agency, Local Planning Authorities and water companies are working together to explore these options.

- 5.18 There may also be opportunities to progress a wetland at a WwTWs, at the final stage of the process, once the permit consents have been met. It is possible to discharge the WwTWs outfall through wetlands, prior to release into the wider environment. Further details of this option is included in Appendix 4.

Size of mitigation land

- 5.19 The mitigation land must be sufficient to ensure the legal tests in the Habitats Regulations can be met.
- 5.20 Larger schemes create more opportunities for other sources of funding. Land that is taken out of agriculture for nutrient mitigation could also qualify for additional funding for future management to meet other legislative and policy requirements. For example, with additional management and infrastructure, this land may qualify as Suitable Alternative Natural Greenspace to relieve recreational pressure on international designated sites or, alternatively, to deliver a strategic bird reserves in line with Solent Waders and Brent Goose Strategy. Furthermore, larger schemes have the potential to deliver wider community and biodiversity benefits and these options should be encouraged where possible.
- 5.21 Smaller schemes will also be acceptable where the legal tests in the Habitats Regulations are met so there is certainty around these measures, for example, their deliverability, enforceability and long term use

Location of mitigation

- 5.22 The location of the mitigation site will also influence the effectiveness of the measure. The appropriate location for mitigation land firstly depends on the catchment of the development and location of the WwTWs outfall. Consideration then needs to be given to site specific factors such as geology, hydrology and topography.

Identifying the catchment for mitigation land

- 5.23 The fluvial catchment for the Solent internationally designated sites is shown on Figure 1. Figures 2 – 7 show the catchment area at a larger scale^x.
- 5.24 A key objective is to ensure mitigation land is situated in the most effective location. In order to achieve this, it may be appropriate to establish mitigation land in a number of locations or catchments. For example, for some of the coastal WwTWs, there is a widespread distribution of output to a number of designated sites within the Solent. Therefore a number of catchments would be appropriate locations for mitigation land. This view is based on modelling that has been undertaken by the Environment Agency and analysed by water quality specialists within Natural England in relation to the internationally designated sites. The modelling identifies the relative contributions of all nitrogen sources within the harbours and estuaries of the Solent and is the best available scientific evidence available^{xi}.

- 5.25 The following recommendations can generally be applied to determine the suitability of the mitigation location. These recommendations are based on spatial principles and temporal principles

Spatial principles

- 5.26 It is Natural England's view that mitigation land within the same catchment as the development location is appropriate.

River catchments

- 5.27 For WwTWs that drain into the rivers, it is appropriate for the mitigation land to be within the same river catchment as the outfall location. This is the preferred solution in all cases. If this is not possible, mitigation in close alternative catchments would be appropriate in the following cases.

River Test and River Itchen

- 5.28 It is appropriate for the River Test and River Itchen catchment to be considered as one catchment. Therefore development located in the River Test catchment could be mitigated in the River Itchen catchment and *vice versa*.

Bartley Water

- 5.29 It is also appropriate for development within the Bartley Water catchment (New Forest) to be included with the Test and Itchen catchment. This is due to the close proximity of the outfalls within Southampton Water and the tidal flows between these estuaries.

New Forest Rivers

- 5.30 It is appropriate for the New Forest rivers that outfall to the southern coast of the New Forest to be considered as one catchment – River Beaulieu, River Lymington, Danes Stream, Dark Water, Sowley Stream and the coastal areas.

River Meon

- 5.31 For development that outfalls to the River Meon, it would be appropriate to mitigate within the River Hamble catchment and within the Portsmouth Harbour catchment.

River Hamble

- 5.32 For development that drains to ground within the River Hamble catchment or to a WwTWs that drains to the River Hamble, eg Bishops Waltham WwTW, mitigation land is limited to within the River Hamble catchment.

Isle of Wight Rivers

- 5.33 For development that drains to ground within the catchment of or direct to the each of the Isle of Wight rivers, eg Eastern Yar, mitigation land is limited to within the same river catchment.

Portsmouth Harbour, Langstone Harbour and Chichester Harbour

- 5.34 For the WwTWs that drains to each harbour (Portsmouth Harbour, Langstone Harbour and Chichester Harbour), priority locations for mitigation are the same river catchment as the WwTW outfall.
- 5.35 For example, the Bosham WwTW outfalls at the base of Bosham and Fishbourne Channels within Chichester Harbour. The most effective location for mitigation is within the same catchment as these arms of Chichester Harbour.
- 5.36 In some cases there may be opportunities to mitigate within other river catchments within the harbours. These will be examined on a case by case basis and we advise early consultation with Natural England and the local planning authority.

Coastal WwTWs

- 5.37 For development that drains to coastal WwTW (Portswood WwTW, Woolston WwTW, Millbrook WwTW) within the northern part of Southampton Water, mitigation is appropriate in the following catchments – River Test, River Itchen, Bartley Water.
- 5.38 For development that drains to other coastal WwTWs in Southampton Water eg Ashlett Creek WwTW, mitigation is appropriate in the following catchments - River Test, River Itchen, River Meon, River Hamble, eastern catchments of the New Forest.
- 5.39 For development that drains to Peel Common WwTW, mitigation is appropriate in the following catchments – River Meon, Portsmouth Harbour, Medina Estuary, Wootton Creek, Langstone Harbour.
- 5.40 For development that drains to Budds Farm WwTW, mitigation is appropriate in the following catchments – River Meon, Portsmouth Harbour, Langstone Harbour, Chichester Harbour, Wootton Creek, Medina Estuary (and the estuaries in between).
- 5.41 For development that drains to Pennington WwTW, mitigation is appropriate in the following catchments, south coast of New Forest, Western Yar, Newton Harbour

Drain to ground

- 5.42 For developments that drain to ground via a package treatment plant (PTP) or mains WwTWs, it is appropriate for mitigation land to be within the same catchment as the outfall location of the PTP or WwTW.

Temporal principles

- 5.43 Within chalk geology where the nitrogen discharge is to ground and remote from watercourses there is likely to be a considerable delay (it may take up to 1 year for ground water discharges to percolate through a meter of chalk) before the nitrogen discharged reaches the international designated sites. In such circumstances mitigation measures that take effect quickly may not need to be implemented immediately. We advise that these issues are examined on a case by case basis in consultation with the relevant local planning authority or authorities and Natural England.

Identifying optimal locations for mitigation

- 5.44 Any discharge from a development that is directed to a WwTW that outfalls to the estuaries and harbours has the potential to reach the designated sites in a matter of hours or tide cycle. It is therefore important for any mitigation sites to be located in the most optimal locations. Sites that are downstream of the WwTWs and upstream of the designated sites are ideally located to reduce the nutrient load reaching the designated sites.
- 5.45 It is our preference that mitigation sites are prioritised within the lower fluvial catchment and in close proximity to water courses that drain into the Solent estuaries and harbours. Sites that are located on tertiary geology or clay are preferred or sites that are located on the break of slope onto chalk bedrock. These sites reduce the time lag between the nutrient benefits of changes to land use within the catchment and the benefits to the designated sites.
- 5.46 For sites located on the upper fluvial catchment of the Solent on the chalk bedrock, without any water course in close proximity, there may be a time lag for consideration. It is our advice that the depth of the chalk groundwater is considered. For sites where the groundwater is more than 5m below ground level, then this land is unlikely to be appropriate for mitigation for short term development. Although it may be appropriate for development that is phased over more than 5 years, provided the mitigation land is delivered straightaway.
- 5.47 There may be sites where there is evidence of a short time lag between nutrient reduction at the mitigation site and the designated sites, or where the mitigation site is located on a geology or in an area that will result in additional benefits for nutrient removal, over and above the change in land use at the site itself. These options will be considered on a case by case basis.

Strategic Solutions

- 5.48 It is appreciated that achieving nutrient neutrality may be difficult for smaller developments, developments on brownfield land, or developments that are well-progressed in the planning system. Natural England is working closely with local planning authorities to progress Borough /District/ City wide and more strategic

options that achieve nutrient neutrality and enable this scale of development to come forward.

- 5.49 A number of options are coming forward. It is recommended that discussions are held with the relevant local planning authorities with regard to these options. Further information will be available on the [Partnership for South Hampshire website and Chichester District Council website](#) in due course.
- 5.50 Natural England can provide further advice on the methodology and mitigation options through our [chargeable services](#) (DAS).

ⁱ The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

ⁱⁱ Conservation of Habitats and Species Regulations (England and Wales) Regulations 2017 (as amended)

ⁱⁱⁱ Including Wildlife and countryside Act 1981 as amended, Countryside and Rights of Way Act 2000, Marine and Coastal Access Act 2009, Natural Environment and Rural Communities Act 2006

^{iv} The optional requirement referred to in G2 requires installation and fittings and fixed appliances for the consumption of water at 110 litres per person per day.

^v Desmit, X., Thieu, V., Billen, G., Campuzano, F., Dulière, V., Garnier, J., Lassaletta, L., Ménesguen, A., Neves, R., Pinto, L., Silvestre, M., Sobrinho, J.L., Lacroix, G., 2018. Reducing Marine Eutrophication May Require a Paradigmatic Change. *Science of the Total Environment* 635 (2018) 1444–1466

^{vi} Crossley, Laura Helen (2019) Palaeoenvironmental reconstruction of Poole Harbour water quality and the implications for estuary management. *University of Southampton, Doctoral Thesis*, 331pp,

Howden, N.J.K., Burt, T.P., 2009. Statistical analysis of nitrate concentrations from the Rivers Frome and Piddle (Dorset, UK) for the period 1965–2007. *Ecohydrology* 2, 55–65. doi:[10.1002/eco.39](https://doi.org/10.1002/eco.39),

Howden, N. J. K., Burt, T. P., Worrall, F., Whelan, M. J., & Bierzoza, M. (2010). Nitrate concentrations and fluxes in the River Thames over 140 years (1868-2008): Are increases irreversible? *Hydrological Processes*, **24**, 2657– 2662. <https://doi.org/10.1002/hyp.7835>

^{vii} Supplementary Planning Document – Achieving Nitrogen Neutrality in Poole Harbour. 2017

^{viii} Supplementary Planning Document – Achieving Nitrogen Neutrality in Poole Harbour, 2017

^{ix} <https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/>

^x These plans contain public sector information licensed under the Open Government Licence v3.0

^{xi} Environment Agency – CPM modelling, SAGIS/SIMCAT and Telemac modelling for Water Framework Directive DIN and Ecological Impact Investigations, 2014

Figure 2

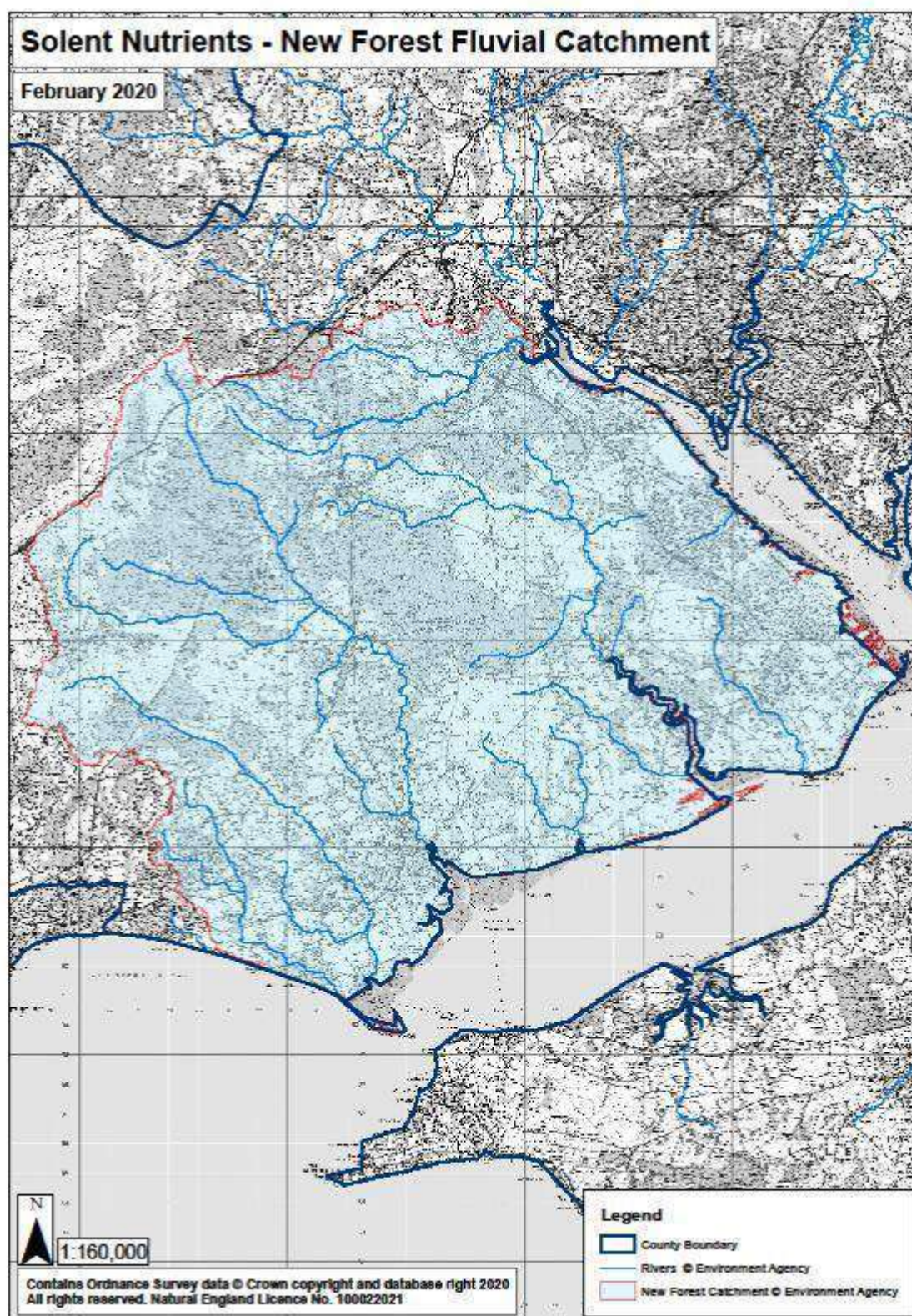


Figure 3

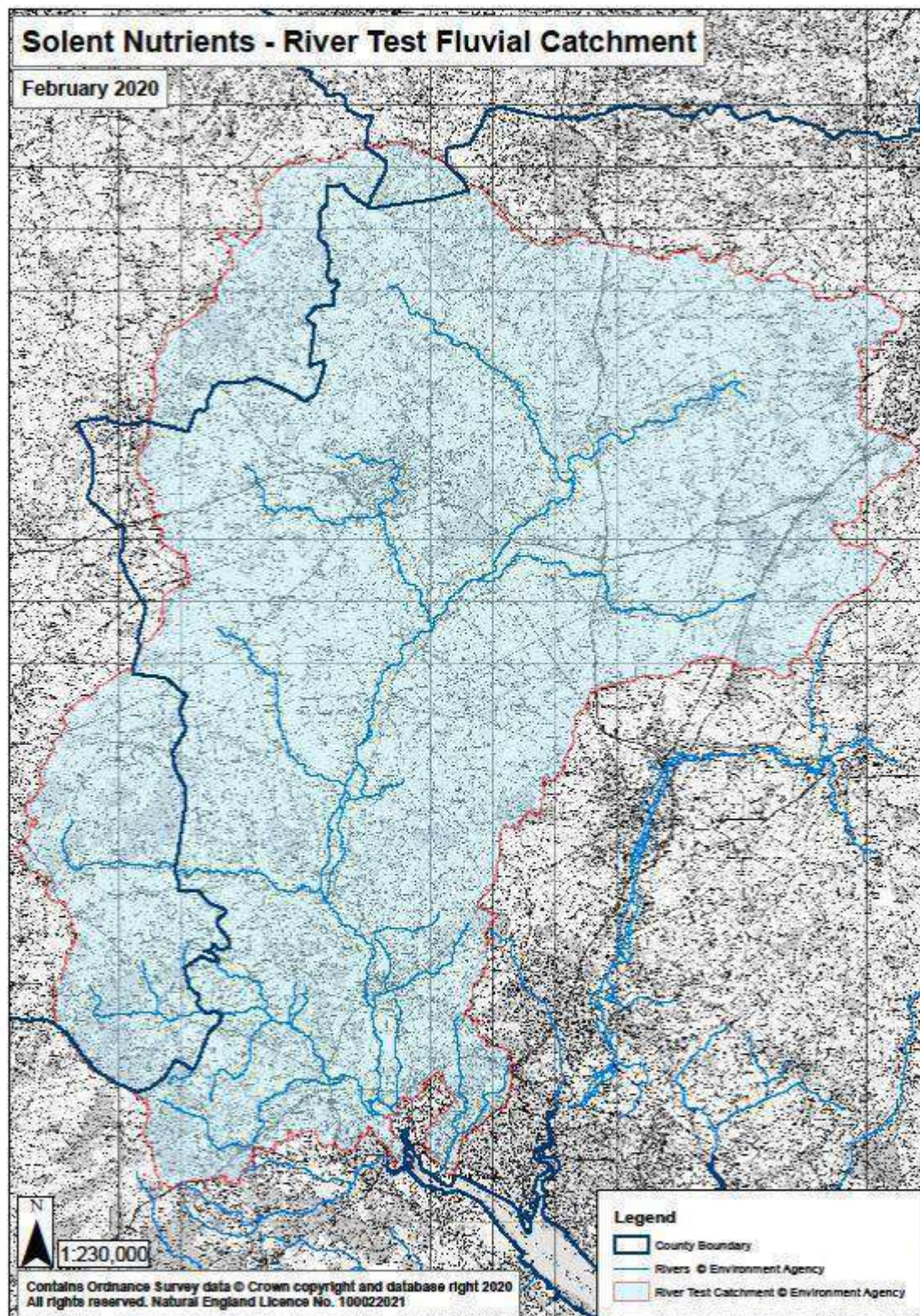


Figure 4

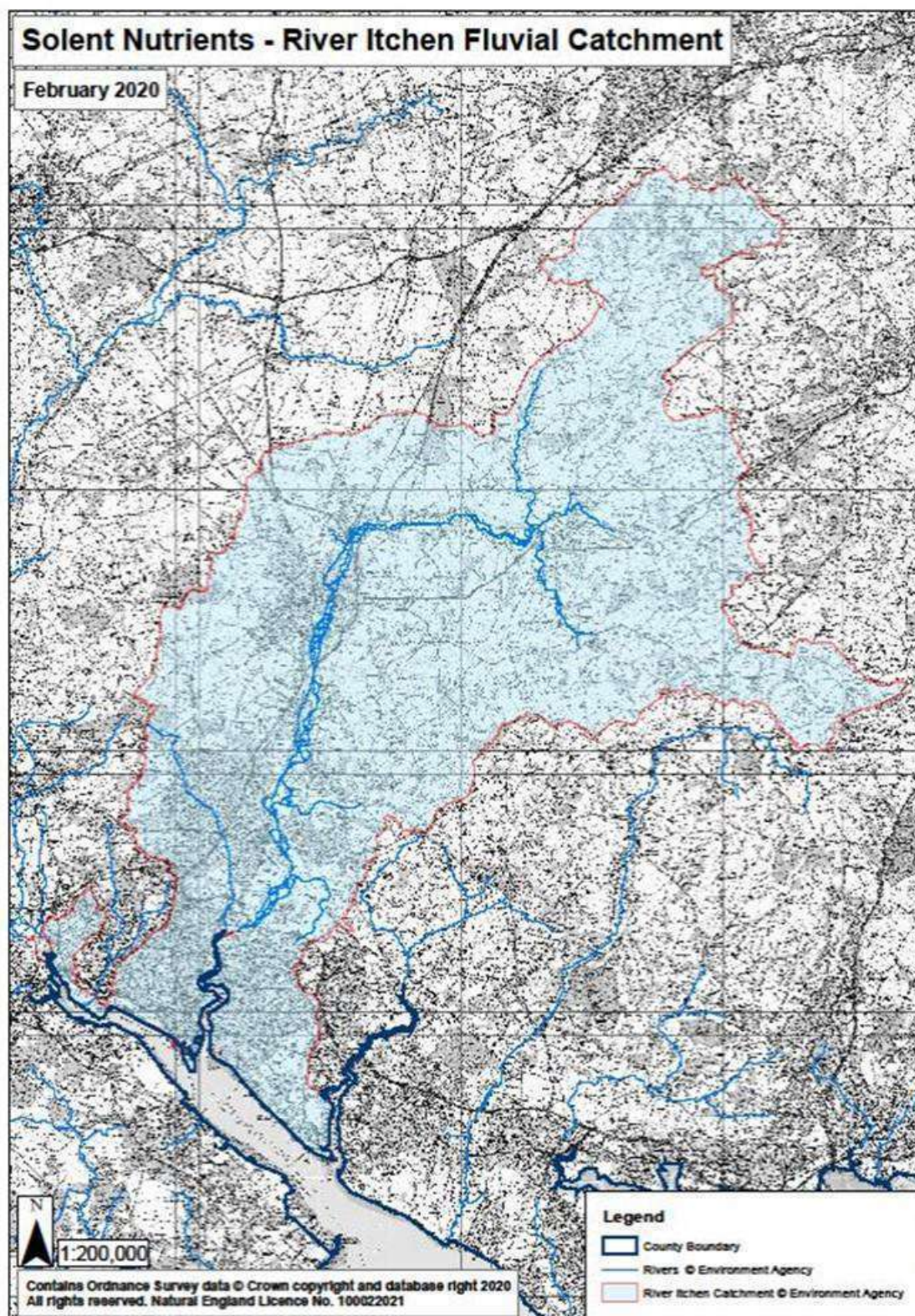


Figure 5

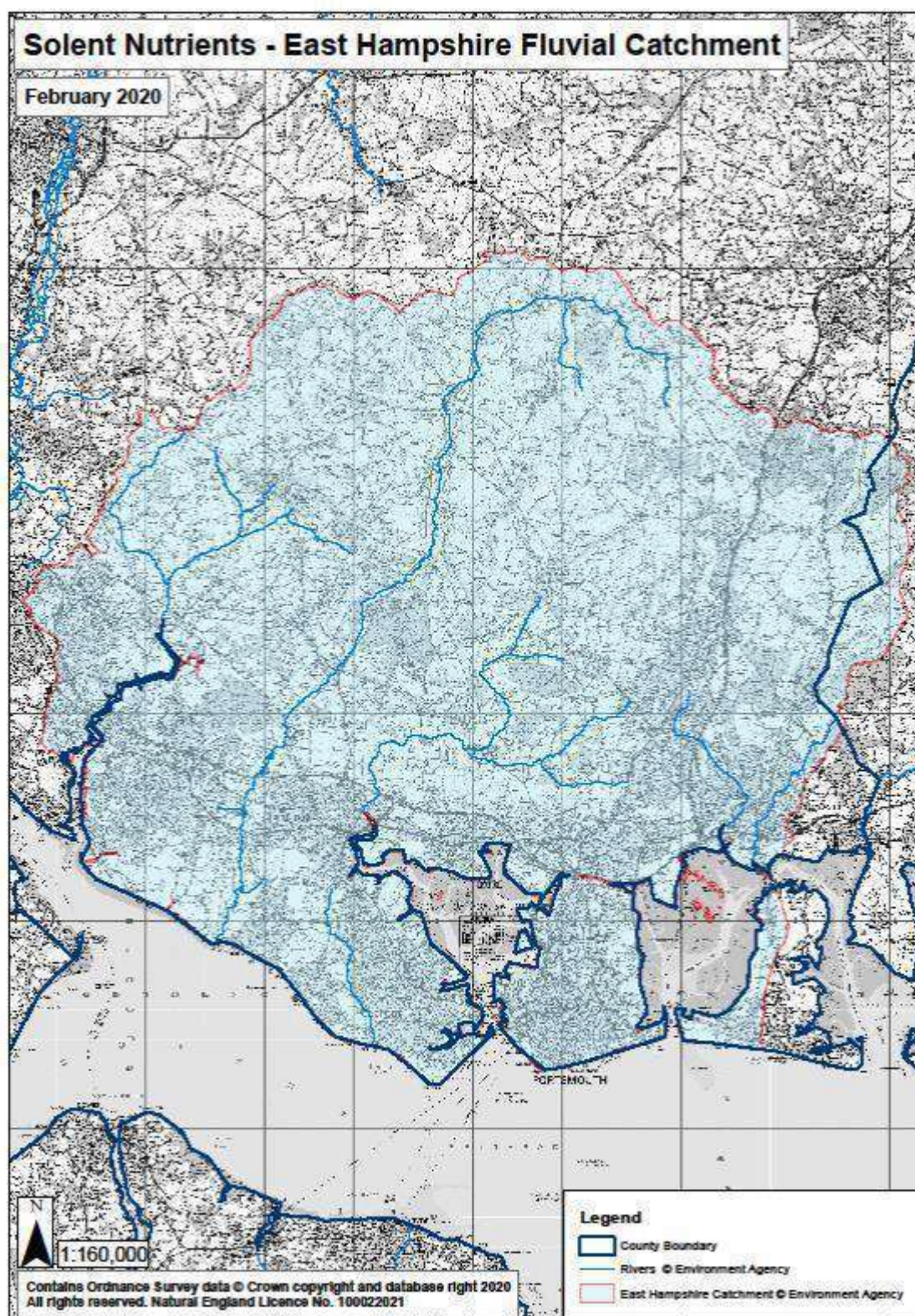


Figure 6

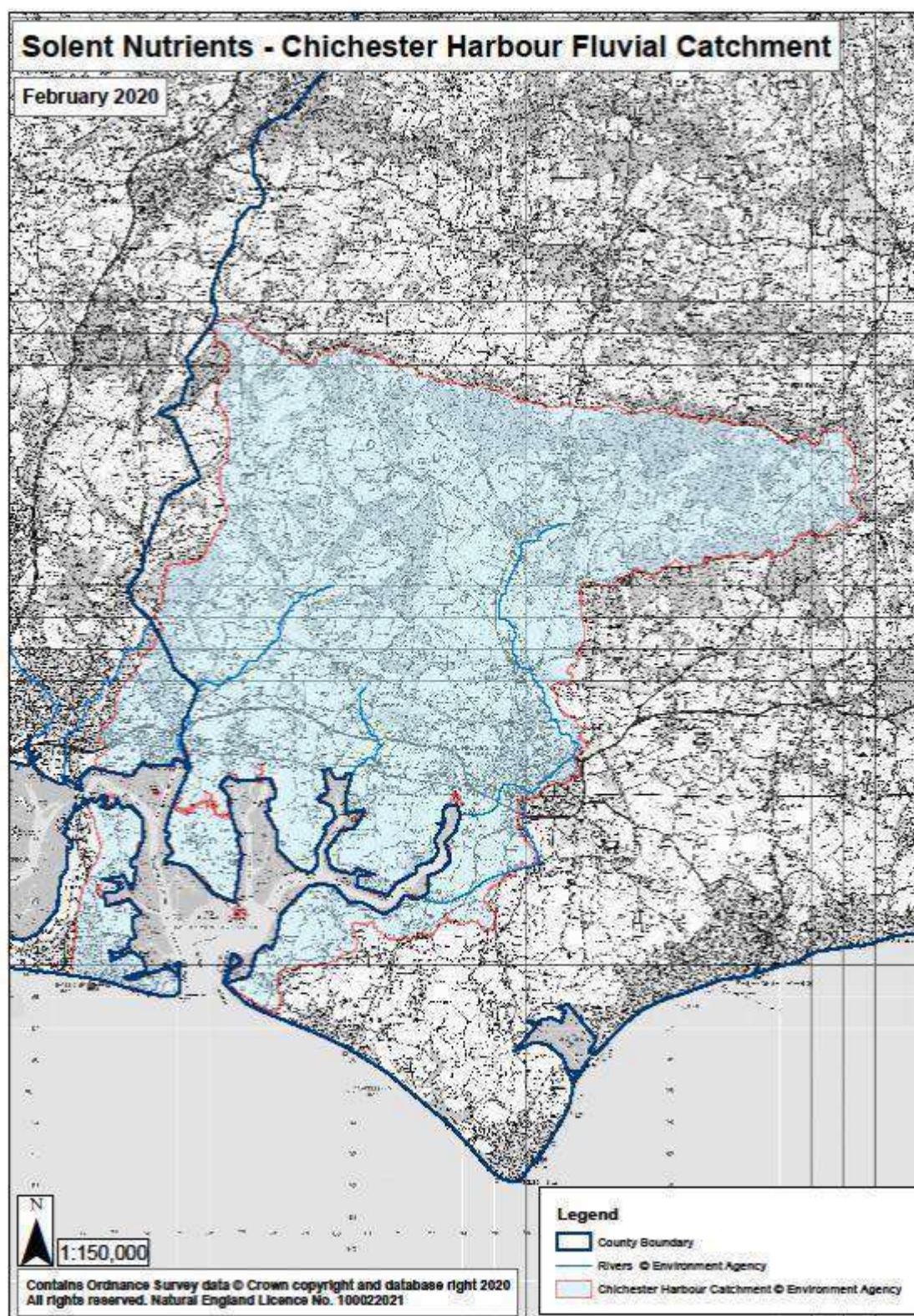
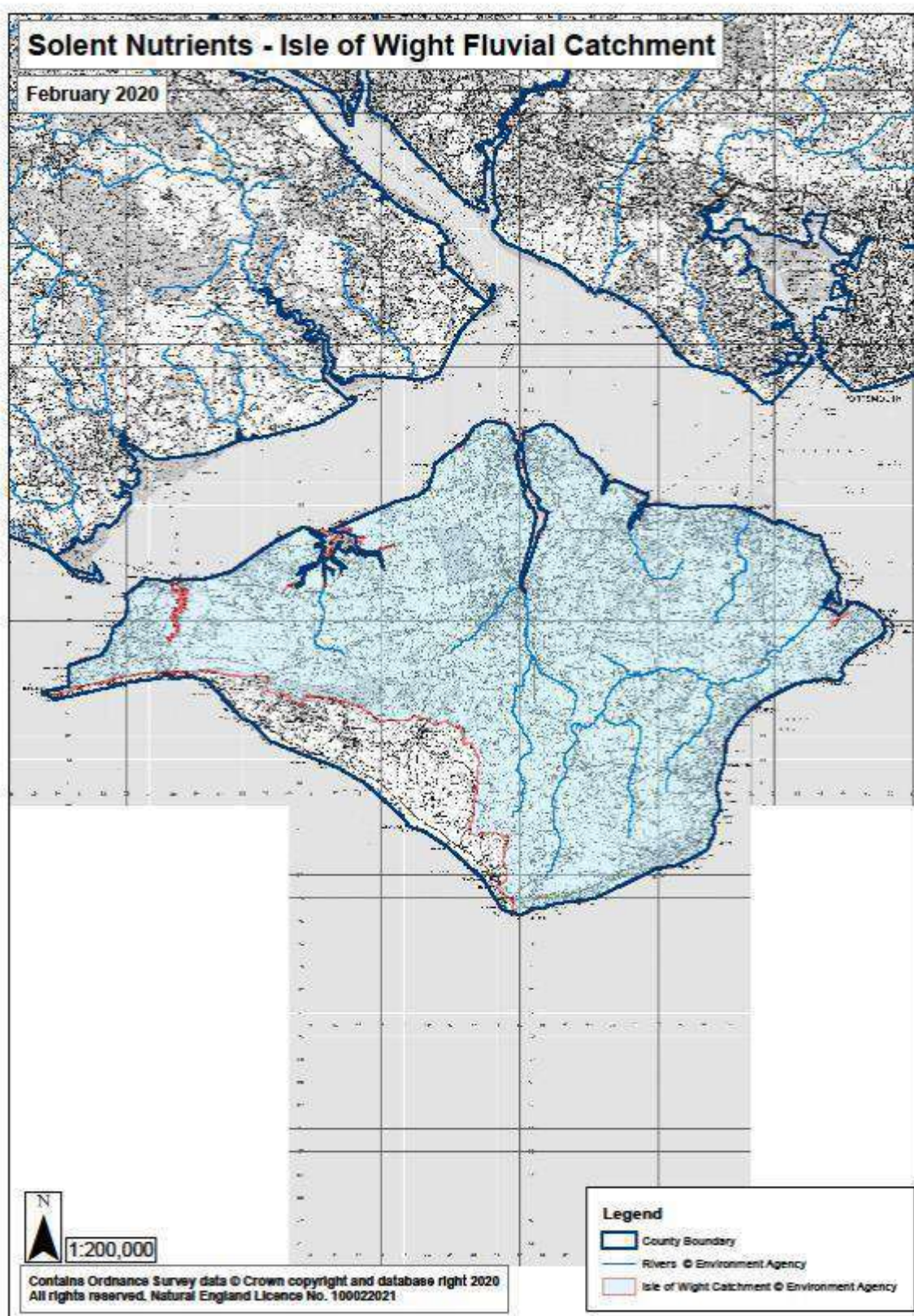


Figure 7



ANNEX 1 PLANNING CONTEXT

- A1.1 In 2016, an Integrated Water Management Study (IWMS) for South Hampshire was commissioned by the Partnership for Urban South Hampshire (PUSH) Authorities, with the Environment Agency and Natural England. This examined the delivery of development growth in relation to legislative and government policy requirements for designated sites and wider biodiversity. It updated an earlier study in 2008. Similar studies have also been undertaken for Chichester Harbour and growth in Sussex (2018) though this study was largely for Water Framework Directive assessments.
- A1.2 The IWMS for South Hampshire was completed in March 2018 and identified that there is currently uncertainty as to whether new housing growth can be accommodated without having a detrimental effect upon the water environment.
- A1.3 The updated IWMS report in March 2018 concluded that there is uncertainty about the impact of local plan growth on the designated sites, especially after 2020. There was uncertainty about the efficacy of catchment measures to deliver the required reductions in nitrogen levels, and/or whether the upgrades to wastewater treatment works will be sufficient to accommodate the quantity of new housing proposed.
- A1.4 To examine this issue further, local planning authorities set up a Water Quality Working Group in South Hampshire to add to the one already in existence for Chichester with the Environment Agency, Natural England and water companies. The objectives of these groups include identifying and analysing the existing evidence gaps and evaluating the need for strategic mitigation measures. The primary focus of this work is to address the uncertainty associated with strategic local plan growth.
- A1.5 Natural England is working closely with local planning authorities to address this wider issue and progress options that achieve nutrient neutrality. It is appreciated that this may be difficult for smaller developments, developments on brownfield land or developments that are well-progressed in the planning system.
- A1.6 Natural England has advised affected local planning authorities to set up Borough-wide, or strategic approaches that developments can contribute to thereby ensuring that this uncertainty is fully addressed by all applications and is working closely with affected local planning authorities to help address this issue.

ANNEX 2 ENVIRONMENTAL CONTEXT

Designated sites review

Solent Maritime SAC and SPAs

- A2.1 In 2018, condition assessments of the estuary, mudflat & sandflats, and sandbanks features of the Solent Maritime SAC were undertaken. The condition assessments completed considered the SAC features across the site as a whole and found the condition of these features assessed to be unfavourable. The unfavourable assessment is based on a number of attributes failing, including the nutrient water quality attribute. Other attributes were also found to be failing, such as the extent, distribution, rhizome structure and reproduction, and biomass of seagrasses, as well as the infaunal quality of the intertidal mud and sand features. These failures are likely to be in part due to impacts from nutrients. Currently the site condition assessment does not include the saltmarsh feature which has not yet been assessed. However preliminary analysis of data shows that there was a loss of extent of saltmarsh across the Solent between 2008 and 2016. The cause of this loss it is not known but elevated nutrients can contribute towards the susceptibility of saltmarsh to erosion through effects on plant root growth and the cohesion of mud around the roots. In 2019/20 the intertidal areas of the Chichester Harbour estuary were examined in detail including the saltmarsh feature. The saltmarsh feature of this part of the SAC is in unfavourable declining condition due to the poor quality of the remaining marsh and ongoing net loss. Chichester Harbour contained half the saltmarsh feature area at designation of the SAC. Water quality impacts (macroalgal mats rotting and living) were recorded on all the saltmarsh surveyed.
- A2.2 A full SPA condition assessment has yet to be undertaken, however the 2019/20 assessment of Chichester Harbour included assessment of the Chichester and Langstone Harbours SPA as well as the SSSI birds. This showed that shelduck populations on the SSSI and the SPA are showing a 71% decline in the long term that appears to be tracking that of the region although not the British trend. The declining proportion of the regional numbers supported by this site suggest that site-specific pressures are affecting this species. While the cause of these site specific declines in Chichester Harbour and the Solent area more widely are yet to be confirmed, research has found that the foraging ability of shelduck can be affected by algal mats. The wintering bird assemblage in general across Chichester Harbour is in unfavourable no change condition.

Solent and Dorset Coast Special Protection Area

- A2.3 The Solent and Dorset Coast Special Protection Area (SPA) protects important foraging areas at sea used by qualifying interest features from colonies within adjacent SPAs, namely the Solent and Southampton Water SPA and the Chichester and Langstone Harbours SPA. These qualifying interest features are the foraging and nesting of three species of tern: common tern, Sandwich tern and little tern. This

site was designated in 2020. Given the relationship between the designated sites for the foraging areas and the colonies, the threats and condition of each these interrelated designated sites should be considered in combination as part of the Habitat Regulations Assessment. The SPA has not yet been fully condition assessed but the Chichester Harbour review of 2020 looked at not only breeding numbers of the three tern species in but also the productivity (how many chicks survived). The terns in Chichester Harbour, which are also a feature of the SSSI, are considered to be overall in unfavourable declining condition. The relationship of the tern breeding and foraging populations to water quality impacts in the Solent is not currently known, although it is not thought to be the primary reason for declining numbers of poor productivity in Chichester Harbour.

Solent and Isle of Wight Lagoons Special Area of Conservation

- A2.4 The Solent encompasses a series of coastal lagoons, including percolation, isolated and sluiced lagoons. The site includes a number of lagoons in the marshes in the Keyhaven – Pennington area, at Farlington Marshes in Langstone Harbour, behind the sea-wall at Bembridge Harbour and at Gilkicker, near Gosport.
- A2.5 The water quality target for the coastal lagoon features is to maintain nutrient levels at which biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. Surveys in 2013, noted several lagoons had high pH levels likely due to photosynthetic activity, however there were no records of opportunistic macroalgae or phytoplankton blooms and most lagoons (except for Butts Lagoon and Shut Lake) continue to support good lagoonal communities. The sediment in Butts Lagoon has remained anoxic in surveys in 2013, although this represents similar conditions to that present in baseline surveys. Therefore, available evidence does not indicate that eutrophication is affecting site integrity at any of the lagoons within the SAC, except for Butts Lagoon.

SSSI

- A2.6 During 2018 and 2019, Natural England revised and updated the SSSI assessments in the greater Solent area in relation to the influence of the water environment on the condition of estuarine SSSI interest features that underpin the SAC and SPAs. These assessments especially included littoral sediment habitat (mudflat and other tidally exposed sediment flats). The review of parts of the greater Solent area and some SSSI interest features is ongoing.
- A2.7 The SSSI interest feature assessments completed consider the concentrations of inorganic nitrogen status in each harbour and estuary, and evidence for ecological responses. Particular attention was given to records on phytoplankton abundance and the presence and abundance of opportunistic green macroalgae. Other responses to elevated nutrients may also occur, such as effects on phytoplankton composition and seagrass and saltmarsh extent and composition. These have not yet been assessed.

- A2.8 Where there is sufficient information to show that the water environment causes interest features to be in unfavourable condition, this has been recorded within the completed assessments. In addition, in cases where there is significant uncertainty that elevated nutrient levels are affecting the condition of interest features, a provisional assessment of borderline favourable condition is recorded, along with a potential threat that unfavourable condition may become apparent with more evidence. In cases where there is currently inadequate information to come to a conclusion the SSSI assessment has remained unchanged. Some parts of the greater Solent area are also recorded to be in unfavourable condition for SSSI interest features for reasons other than the water environment, such as coastal squeeze and disturbance. A brief summary of the condition classes in relation to the water environment for interest feature condition follows.

Unfavourable Declining Condition

- A2.9 The 2018 assessment did not assign units to this condition as this condition requires demonstration of significant deterioration or declines in populations above threshold numbers for birds or loss of habitat for features or demonstrable and consistent worsening of attributes over time.
- A2.10 The more detailed, follow-on assessment, to review trends in the interest features of Chichester Harbour in 2019/20 has determined that the Chichester Harbour condition is declining due to the continued net loss of the saltmarsh feature, poor condition of the remaining marsh, declining numbers of some species of terns and low or zero productivity of nesting terns in the Harbour. Overall the wintering bird assemblage was unfavourable no change not because the birds populations were stable but because on average the declines in populations were not sufficient to trigger a declining status. Trends varied with species, with those species that can switch to other foraging methods and habitats away from the intertidal in general showing lesser declines or even increases. The other features assessed (littoral sediment, eelgrass were all given unfavourable status but with low confidence and Natural England were unable to discern a trend due to insufficient data. The units were assigned to the features in the worst condition where the data was of high confidence so overall the intertidal habitats in Chichester Harbour in unfavourable declining condition.

Unfavourable no change

- A2.11 This work identified that there are sections of the designated sites in the Solent that are unfavourable for the interest features on the weight of evidence of elevated levels of inorganic nitrogen and biological indication of eutrophication shown by the abundance of macroalgae. Where sites are recorded as unfavourable, opportunistic green macroalgae is recorded to reach >75% cover, or a biomass of 1kg/m² or more. In these cases there is also little or no evidence of any reduction in nutrient status that would be adequate to substantially prevent the growth of dense macroalgae mats.

- A2.12 There are unfavourable (no change) assessment on units within the following estuaries and harbours in Hampshire: Southampton Water, Hamble estuary, Portsmouth Harbour, Chichester Harbour and on the Isle of Wight: Yar estuary, Newtown Harbour, Medina estuary, Wootton Creek and Bembridge Harbour.

Unfavourable recovering (at risk)

- A2.13 The review identified that there are parts of Langstone Harbour where the water environment of a unit is assessed as unfavourable for the interest features on the weight of evidence on inorganic nitrogen concentrations and biological indications of eutrophication, shown by the abundance of macroalgae (>75% cover density or a biomass of $\geq 1\text{kg/m}^2$), but recovering on the basis of a large reduction in nutrient inputs through diversion of wastewater. These units are considered 'at risk' of not recovering to a favourable situation on the water environment as it is unclear whether the nutrient status will become adequate to substantially prevent the growth of dense macroalgae mats in parts of the Harbour. Also other potential ecological responses to elevated nutrient concentrations that could affect the condition of the designated features, such as impacts on saltmarsh and seagrass, have not been assessed.
- A2.14 The 2018 assessments did not identify any Unfavourable (recovering) units where there is a littoral sediment feature in any of the other estuaries and harbours.

Favourable – high threat

- A2.15 Some sections of the designated sites in the Solent are provisionally assessed as borderline favourable for the interest features. Here there is elevated levels of inorganic nitrogen but, at a local unit scale, the data that is available only demonstrates slight biological indication of eutrophication shown by some presence of macroalgae (<75% cover density, or a biomass of $<1\text{kg/m}^2$). These are provisional assessments with a high threat that the nutrient status is inadequate to substantially prevent detrimental ecological effects on designated features, particularly if there is change in environmental conditions. The high threat assessment also reflects the fact that other potential ecological responses to elevated nutrient concentrations that could affect the condition of the designated features, such as impacts on saltmarsh and seagrass, have not yet been assessed.
- A2.16 There are favourable (high threat) units within the following estuaries and harbours in Hampshire: Lymington estuary, Solent and Itchen Estuary, Test Estuary, Southampton Water, Portsmouth Harbour, Chichester Harbour, Langstone Harbour, and on the Isle of Wight: Newtown Harbour and Bay and Bembridge Harbour.

Catchment work

- A2.17 The high levels of nitrogen and phosphorus input to the water environment is currently caused by agricultural sources and wastewater from existing housing.

There are a number of mechanisms already in place to reduce the amount of nutrient inputs within our rivers and coastal waterbodies.

- A2.18 Within the river catchments; Defra's Catchment Sensitive Farming (CSF) programme works with agriculture to reduce diffuse sources of pollution such as fertiliser and slurry run-off. One of the aims of this work is to deliver environmental benefits from reducing diffuse water pollution. To achieve these goals CSF delivers practical solutions and targeted support which should enable farmers and land managers to take voluntary action to reduce diffuse water pollution from agriculture to protect water bodies and the environment.
- A2.19 In addition, Southern Water is upgrading their wastewater treatment works to reduce the amount of phosphorus inputs from human sewage. There are agreed improvements to phosphorus permits on four Southern Water Services on the River Test and phosphorus upgrades at two wastewater treatment works on the River Itchen.
- A2.20 Natural England has recently published a review of the effectiveness of catchment sensitive farming approaches in the report "Catchment Sensitive Farming Evaluation Report – Water Quality Phases 1 to 4 (2006-2018) (NE731)". Work is on-going to evaluate the effectiveness of such work in reducing existing inputs into the Solent's water environment. Nationally, the results in this report state that water quality is estimated to have improved, due to reduced pollutant loadings, by between 1.2 and 6.5 per cent across water bodies associated with Phase 1 CSF Target Areas.

Type of nutrient inputs to designated sites

- A2.21 There is evidence that inputs of both phosphorus and nitrogen influence eutrophication of the water environment. However, the principal nutrient that tends to drive eutrophication in the marine environment is nitrogen and this is supported by modelling and evidence.
- A2.22 A modelling assessment has been undertaken by the Environment Agency to understand the importance of nitrogen in causing the growth of macroalgae and phytoplankton within estuaries in the Solent. This work used the Combined Phytoplankton and Macroalgae model developed by Cefas and was assessed at a water body scale. This scale provides an overview and may mask conditions that are unfavourable for designated interest features at a more local scale. The modelling suggests that in one estuary, the Medina, both nitrogen and phosphorus availability may control macroalgae growth (e.g. Rees-Jones et al 2014 and Udal *et al* 2014).
- A2.23 The best available evidence is for focus in the Solent harbours to be on nitrogen reduction, and reduction in both nitrogen and phosphorus in the Medina catchment. However, this approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.

- A2.24 The nutrient budget in this report calculates quantities of nitrogen (N) generated by development. This N comes in different forms and measured N concentrations vary according to exactly what is measured. These differences need to be recognised when calculating nutrient budgets. The key measurement is Total Nitrogen (TN), i.e. both organic and inorganic forms of nitrogen, because this is what is available for plant growth. TN is the sum of the inorganic forms - nitrate-nitrogen (NO₃-N), nitrite-nitrogen (NO₂-N), ammoniacal-N - and organically bonded nitrogen.
- A2.25 Total Nitrogen is measured by WwTW where there is a permit with a TN limit consent. However, for WwTWs without permits, measurements could be inorganic nitrogen (nitrate + nitrite + ammoniacal N) or TN or a mix. Most river quality monitoring by EA only records the inorganic N forms. The Farmscoper report measures nitrate-nitrogen not TN. Nitrate is normally the largest component of TN but quantities of organic N are significant. In the Test catchment dissolved organic nitrogen has been found to comprise 7% of the potential biologically available nitrogen in the river and 13% of that in the estuary (Purdie, 2005). Thus, the land use change element of this methodology will underestimate TN leaching. We therefore advise that this uncertainty is recognised as one of the several factors taken into account by the recommended precautionary buffer approach adopted by this methodology.
- A2.26 For developments on the Isle of Wight that are impacting on the Medina estuary, both a phosphorus and nitrogen budget may be required. Natural England will work closely with the Isle of Wight Council and applicants to provide advice on a bespoke case-by-case basis.
- A2.27 This approach is also supported by scientific literature which confirms that whilst both nitrogen and phosphorus should be reduced to tackle estuarine eutrophication, primarily the focus should be on nitrogen. Phosphorus reduction alone does not address the mechanisms caused by elevated nitrogen that affect sea-grass health and the structural stability, extent and plant species diversity of saltmarsh. In addition, most land use measures to reduce nitrogen are also likely to reduce phosphorus concurrently.

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Appendix 1 – Farm Types

The UK system is based on weighting the contributions of each enterprise in terms of their associated outputs. The weights used (known as ‘Standard Outputs’ or SOs) are calculated per hectare of crops and per head of livestock and used to calculate the total standard output associated with each part of the Farm Business.

Cereals

Holdings on which cereals, combinable crops and set-aside account for more than two thirds of the total SO and (pre-2007) where set-aside alone did not account for more than two thirds of the total SO. (Holdings where set-aside accounted for more than two thirds of total SO were classified as specialist set aside and were included in “other” below.)

General cropping

Holdings on which arable crops (including field scale vegetables) account for more than two thirds of the total SO, excluding holdings classified as *cereals*; holdings on which a mixture of arable and horticultural crops account for more than two thirds of their total SO excluding holdings classified as *horticulture* and holdings on which arable crops account for more than one third of their total SO and no other grouping accounts for more than one third.

Horticulture

Holdings on which fruit (including vineyards), hardy nursery stock, glasshouse flowers and vegetables, market garden scale vegetables, outdoor bulbs and flowers, and mushrooms account for more than two thirds of their total SO.

Specialist Pigs

Holdings on which pigs account for more than two thirds of their total SO.

Specialist Poultry

Holdings on which Poultry account for more than two thirds of their total SO.

Dairy

Holdings on which dairy cows account for more than two thirds of their total SO.

Lowland Grazing Livestock

Holdings on which cattle, sheep and other grazing livestock account for more than two thirds of their total SO except holdings classified as *dairy*. A holding is classified as lowland if less than 50 per cent of its total area is in the Less Favoured Area (LFA).

Mixed

Holdings for which none of the above categories accounts for more than 2/3 of total SO. This category includes mixed pigs and poultry farms as well as farms with a mixture of crops and livestock (where neither accounts for more than 2/3 of SOs).

http://farmbusinesssurvey.co.uk/DataBuilder/UK_Farm_Classification_2014_Final.pdf

Appendix 2 – Leaching of nitrogen from urban areas

The average total nitrogen leaching rate from an urban area (14.3kg/ha/yr) comes from values for hydrologically effective rainfall (478mm - precipitation minus losses from evapo-transpiration) and the nitrogen concentration of leachate (3mg/l) given in Bryan et al (2013) the latter figure derived from an AMEC report. The value for nitrogen concentration is similar to one quoted in House et al (1993) who give a mean event concentration of 3.2mg/l for total nitrogen (with this value derived from other sources) with a range of 0.4-20mg/l. Thus although it is not specified by Bryan et al (2013), it is probably reasonable to take the 3mg/l to be total nitrogen especially since the organic component of N from urban areas is likely to be relatively small.

Mitchell (2001) gives the following event mean concentrations in mg/l total N from urban areas; Urban Open 1.68; Ind/Comm 1.52; Residential 2.85; Main roads 2.37. It is recognised that the datasets that produced these figures are not large (n = 14 in this case), a good deal of uncertainty remains and that further sampling is needed to validate models of pollutant effects from urban runoff (Leverett et al 2013).

Typical nutrient concentrations in urban stormwater runoff in the U.S. are 2.0 mg/l for total N (TN) (Schueler 2003). Population densities seem to be less in the most studied urban catchments (eg Groffman et al 2004 in Baltimore, Hobbie et al 2017 in Minnesota) than those in the UK but this does not necessarily lead to an increase in the rate of nitrogen leaching from the catchment for the factors affecting this value are complex. Thus although there will clearly be variation between different urban areas, there is insufficient knowledge to be able to predict N leaching from the different characteristics of these areas. And for practical purposes an overall N leaching figure is needed; nothing found in the literature indicates that another value would be more representative than 3mg/l.

An N leaching figure can also be derived by using the relationship between mean stream and river flow rate and catchment area. The ratio for the gauging station on the River Meon at Mislingford is 0.014m³/sec/km² and, with a TN concentration of 3mg/l, this equates to a TN leaching rate of 13.2mg/l, similar to the value obtained when hydrologically effective rainfall is used.

Comparison can also be made with direct measurements of TN urban outputs from studies in the USA (Hobbie et al 2017, Groffman 2004). The values in the Hobbie paper for urban catchments in Minnesota varied from 12.5-27.2 kg/ha/yr with a mean of 17.3 kg/ha/yr. The outputs measured by Groffman (2004) were smaller (between 5.5 and 8.6kg/ha/yr) but these were less urbanised catchments, several including areas of old growth forest where nitrogen retention was very high. Thus these values are broadly of the same order as the 14.3 kg/ha/yr leaching figure initially calculated.

Nitrogen inputs in these studies come predominantly from three sources - atmospheric deposition, pet waste and lawn fertilisation. N deposition was slightly lower in both Baltimore and Minnesota than values from APIS in the around the Solent (23.8kg/ha/yr for hedgerows

or woodland, 14.7kg/ha/yr for grassland). No UK studies have been found to compare with the US ones for N inputs in urban areas from pet waste or from lawn fertilisation.

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Appendix 3 - Estimating the leaching of total nitrogen (TN) from natural greenspace (SANG).

A number of assumptions must be made about the management of the SANG to allow an estimate of TN leaching to be made. These are as follows:

- The vegetation of the SANG would be predominantly permanent grassland but with an element of tree and scrub cover (this will of course vary for different SANGS but a 20% average figure is used here). The degree of tree and scrub cover will not greatly affect the result as both permanent grassland and woodland/scrub exhibit a high degree of N retention. It matters most because of the differences in the rate of atmospheric N deposition between the two habitats.
- The grassland would be permanent (ploughing will release large amounts of N) and is not fertilised either with artificial fertiliser or manures. It may be ungrazed or grazed very lightly (<0.1LU/ha/yr) with no supplementary feeding (even without supplementary feeding, grazing can increase N leaching because N retention is lower when N is delivered in the form of cattle urine and dung [Wachendorf et al 2005]).
- The grassland may be cut with the cutting regime dependent on other factors. Cuttings may be left or removed from site as the case may be but should not be gathered and composted in heaps on site. Any gorse within the scrub should be controlled so it is no more than rare across the mitigation area since a significant amount of nitrogen fixation occurs within gorse stands.

A generic leaching value for N concentration from AMEC for 'rough grazing', quoted in Bryan et al (2013), is 2mg/l. Using this concentration together with a value of 478mm for the hydrologically effective rainfall (HER) gives a leaching value for N of 9.6 kg/ha/yr. A similar value (8.8kg/ha/yr) is obtained if the relationship between mean stream flow and catchment area (0.014 cumecs/km² which is the ratio for the gauging station on the nearby River Meon at Mislingford) is used instead, keeping the same N concentration of 2mg/l. It is not clear whether these AMEC concentrations are for total nitrogen or for inorganic nitrogen.

The particular grassland management regime for which the 2mg/l N concentration applied is not known. However, even though studies of N leaching from natural unfertilised grasslands are rare in the literature (most are of agricultural grasslands with fertiliser inputs of some sort) it seems likely that this value is higher than might be expected from a natural grassland with no fertiliser inputs such as a SANG. Thus for example TN leachate concentrations were between 0.44 and 0.67 mg/l in an extensively managed montane grassland (that still had one slurry application per year) and the equivalent mean TN loss was 1.0, 2.6 and 3.1 kg/ha/yr for three different areas (Fu et al 2017).

Adjusting for a SANG with 20% woodland/scrub, using the AMEC woodland generic leaching value of 0.5mg/l (Bryan et al 2013) for the woodland/scrub component, results in an N output of 8.1 kg/ha/yr.

The 0.5mg/l value is also much higher than the very low nitrate concentrations in streams from purely forested catchments (Groffman 2004) and from those reported by for a large sample of forested streams by Mulholland et al 2008 where the mean nitrate-N concentrations were <0.1mg/l. All but a few of the samples from an unfertilised suburban lawn had nitrate-N concentrations below the detectable limit of 0.2mg/l (Gold et al 1990). The same was true for a forest plot and the average nitrate-N losses from both home lawn and the forest plots averaged 1.35 kg/ha/yr over 2 years. These studies of both grassland and woodland nutrient cycling suggest that the AMEC generic leachate concentration of 3mg/l, resulting in an N output of 9.6kg/ha/yr, is too high when applied to a SANG.

Despite there being no direct N fertiliser inputs on a SANG, N inputs will still occur from three main sources. These are atmospheric deposition, pet waste and N fixation from legumes and estimating the contribution of each of these sources, together with the proportion of N retained, is an alternative method of working out the N contribution from a SANG.

N deposition

The following are typical values taken from APIS for TN deposition in the Solent area. .

Improved grassland 14.7 kgN/ha/yr; Arable horticultural 14.7 kgN/ha/yr; Neutral grassland 14.7 kgN/ha/yr

Hedgerows 23.8 Kg N/ha/year; Broadleaved, Mixed and Yew Woodland 23.8 Kg N/ha/year

Using the value for hedgerows and woodland for the 20% scrub component of the hypothetical SANG and the neutral grassland value for the rest results in a deposition rate of $11.76 + 4.76 = 16.5$ kg/ha/yr.

Pet waste

SANGs are specifically designed to attract increased levels of public access particularly dog walkers so the potential inputs of N from dog waste are likely to be significant.

Hobbie et al (2017) give a figures for TN inputs from this source for entire urban areas and these vary between 3.56 and 21.2kg/ha/yr for 7 urban catchments with a median of 6.9kg/ha/yr. A figure of 17kg/ha/yr can be gleaned from Baker 2001 which was worked out using information on pet numbers, nutritional needs, pet weights etc; 76% of this was from dogs.

The heavy use of SANGS by dogs suggests that N inputs would most likely be higher than these figures averaged over the whole urban area. Nevertheless, inputs to the SANG from this waste means that it is not deposited elsewhere in the urban area where N may anyway end up in the same receiving water.

TN retention in grasslands will also be higher than the average over other parts of the urban area but the characteristics of the inputs from dogs is likely to lower the amount of TN

retained because the concentrated patchy nature of the input will reduce the proportion of TN retained compared with more evenly spread inputs, as mentioned above.

Picking up dog faeces will obviously reduce the input from but not remove inputs from urine. Dog urine has a high N content.

In these circumstances there is clearly uncertainty about the level of input from this source the highest figure from Hobbie et al (21.2kg/ha/yr) has been used but adjusted downwards because not all of this will be from dogs resulting in an overall value of 16.1 kg/ha/yr.

This has also been done on the basis that funding, together with a binding commitment, is provided for in perpetuity collection of dog waste and enforcement of pick up rather than relying on direct LA resources which could stop at any time.

TN fixation

Hobbie et al (2017) give a value for this of 17.5kg/ha/yr from direct investigation of unfertilised urban parks and this is the value used. Fixation would only be in the grassland part of the SANG which reduces the figure to 14 kg/ha/yr.

TN retention

A number of studies have shown high TN retention in urban areas (eg 80% Hobbie et al 2017) thought to be mainly attributable to TN retention in urban grasslands and lawns which may be in turn related to high carbon within organic matter in the soils. The release of large quantities of N when permanent grassland is ploughed illustrates the capacity of these grassland for N storage (eg Howden et al 2011).

Direct measurements of total N outputs from urban grasslands in the Groffman et al (2009) studies in Baltimore also show high N retention in urban grassland but there are difficulties in applying these results directly to SANGs partly because the plots were either quite heavily fertilised or may have had unmeasured N inputs from neighbouring land. Nitrate-N losses from an unfertilised home lawn averaged 1.35 kg/ha/yr over 2 years (Gold et al 1990). Generally the complex processes and uncertainties about how the management of these grasslands might affect the degree of TN retention and TN output makes estimation of the proportion retained difficult. Nevertheless a value of 90% given in Groffman et al (2009), and supported by a number of references given there, would seem reasonable considering also that overwatering and over fertilising, neither of which would happen on a SANG, seem to be factors that lead to more leaching.

Woodland and scrub. N retention measured in forest plots in Baltimore was very high (95%) Groffman (2004). N percolation losses measured by Gold et al 1990 in forest plots were low and similar to those in unfertilised lawn. However, it is probably not valid to equate a scrub/woodland part of a SANG with the forest plots measured in the Groffman studies in Baltimore for these were old growth well established forests. Nevertheless there is still likely to be high N retention in these areas even if not as much as 95%.

Given all of the above, a 90% TN retention rate over the SANG as a whole has been used in the calculation below

Inputs

N Deposition (APIS) = 16.5 kg/ha/yr

Pet waste 16.1 kg/ha/yr

N fixation 14 kg/ha/yr

Total = 46.6 kg/yr

Watershed retention of TN 90%

Total TN output = 4.66 kgN/ha/yr

Conclusion

The question of estimating TN outputs from a SANG has been approached from different angles. These investigations all indicate that the value used so far – 13 kg/ha/yr is too high. Instead an TN output of 5 kg/ha/yr is considered to be close to the true value but still sufficiently precautionary.

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Appendix 4 – Potential for N mitigation using wetlands

Where N budget calculations indicate that N outputs from proposed developments are greater than pre development conditions, the use of new constructed wetlands to retain some of the N output is one mitigation option.

There are a number of possibilities for different types of constructed wetland. Wetlands can be designed as part of a sustainable urban drainage (SUDs) system, taking urban runoff/stormwater; discharges from STWs can be routed through wetlands; or the flow, or part of the flow, of existing streams or rivers can be diverted through wetlands.

Wetlands receiving nitrogen-rich water can remove a proportion of this nitrogen through processes such as denitrification and sedimentation. This has been demonstrated in numerous studies; a recent systematic review of the effectiveness of wetlands for N (and P) removal (Land et al 2016) used data from 203 wetlands worldwide of which the majority were free water surface (FWS) wetlands (similar in appearance and function to natural marshes with areas of open water, floating vegetation and emergent plants). The median removal rate for wetlands that were included in this review was 93g/m²/yr (or just under a tonne/ha/year). The proportion of N removed is termed the efficiency and the median efficiency of wetlands included in the Land review was 37%.

Many factors influence the rate of N removal in a wetland the most important being hydraulic loading (HLR - a function of the inlet flow rate and the wetland size), inlet N concentration and temperature. Together inlet N concentration and flow rate determine the amount of N that flows through the wetland which ultimately limits the amount of N saving that can be achieved.

The rate of removal can also be expressed in terms of the amount of N removed per unit wetland area. This removal rate will typically increase as the inlet N concentration increases, at least within the normal range of inlet N concentrations. Thus wetlands that treat the N rich discharges, for example from STWs, or water in rivers where the N concentrations are high, will remove more N per unit area than say, wetlands treating water in a stream where water quality is very good and the N concentration is low. Thus if space is at a premium, and the goal is to remove as much N as possible, it makes sense to site wetlands where N concentrations are high.

For wetlands to work well, specialist design input based on sound environmental information will be necessary. There will be a need for consultation with relevant statutory bodies. These processes are likely to be easier where wetlands are an integral part of a larger development. Wetlands do offer additional benefits above offering neutrality but will also require ongoing monitoring, maintenance and adjustments beyond any particular developments completion. Consideration of the long term security of facilities and their adoption at an early stage is advisable.

There are a number of publications which advise about constructed wetlands. For example, Kadlec and Wallace (2009) is a comprehensive source of information covering all stages related to the implementation of different types of constructed wetland. The many papers relating the results from detailed monitoring over many years of the performance of two constructed wetlands in Ohio, USA are also instructive (eg Mitsch et al 2005, 2006, 2014).

Stormwater wetlands

These are what is termed event-driven precipitation wetlands with intermittent flows. There will normally be baseflow and stormwater components to the inputs.

For such wetlands Kadlec and Wallace state that:-

‘A typical configuration consists of a sedimentation basin as a forebay followed by some combination of marshes and deeper pools’

However, ponds are usually less effective at removing N (Newman et al 2015) than shallow FWS wetlands so the emphasis here should be on the latter although a small initial sedimentation basin is desirable since is likely to reduce the maintenance requirement for sediment removal in the FWS wetland. One advantage of this type of wetland is that it can be designed as an integral part of SUDs for the development and therefore is subject to fewer constraints.

Some wetlands with intermittent flows are prone to drying out and may need provisions for a supplemental water source. In some circumstances, this may be possible through positioning the wetland bottom so that there is some connection to groundwater. However many varieties of wetland vegetation can withstand drying out although there may be a small reduction in water quality improvement (Kadlec and Wallace 2009). Nevertheless base and stormwater flows to each wetland should be worked out to ensure that it is viable.

Wetlands need to be appropriately sized taking into account the HLR and N loading rates. To give a general idea of the areas involved, a wetland 1ha in area would serve a development area of about 50ha.

Calculating the potential N retention in such wetlands involves first determining the proportion of the HER that will pass through the wetland because a percentage of the water carrying N will go directly into groundwater, bypassing storm drains and SUDs and the constructed wetlands. This percentage will depend on such factors as the proportion of hard surface within the development and the geology. Then, assuming the inlet TN concentration is 3mg/l, a proportionate reduction of 37% can be used to work out the amount of N retained.

Provision is needed to control tree and scrub invasion, for wetlands with emergent vegetation medium height such as Typha and reed had higher rates of denitrification than those dominated by trees and woody shrubs (Alldred and Baines 2016).

Other critical aspects of design are the water control structures - inflow and outflow arrangements with water level control – and the need or otherwise for a liner. This last issue is related to soil permeability. A variety of emergent wetland plants, not only reed, can be effective within wetlands. Wetlands with a number of different plant species, rather than monocultures, are desirable both for biodiversity reasons and because they are more resilient against changes in environmental conditions; different species will have different tolerances. Guidance concerning planting can be found in Kadlec and Wallace (2009); allowance should be made in planting ratios and densities for different rates of expansion of different species. Another approach is to use material containing wetland plant seeds from a nearby wetland with a species composition similar to the one preferred. However, unless the donor site is carefully monitored, this would obviously increase the risk of importing unwanted alien plants.

Sedimentation will eventually compromise some aspects of the wetland's function and rejuvenation measures will be necessary (Kadlec and Wallace 2009). The same authors indicate a sediment accretion rate in the order of 1 or 2cm/yr and give examples of rejuvenation after 15 and 18 years but other wetlands have not needed any significant restoration in similar timespans. Various different options for the management of sediment accumulation are given by Qualls and Heyvaert (2017). There of course needs to be provisions to ensure that appropriate maintenance and restoration measures, guided by monitoring, are periodically carried out.

Other sources of information about stormwater wetlands include Wong et al (1999, available on line). The papers about a stormwater wetland in the Lake Tahoe Basin in California are also useful (Heyvaert et al 2006, Qualls and Heyvaert 2017).

Constructed wetlands taking discharges from STW

Many of the considerations discussed above for stormwater wetlands apply equally here. There will obviously be constraints on the location and size of such a wetland because of land availability in the area of the STW. The flow from the STW together with the N concentration in the discharge are needed to determine the approximate size of a wetland. We would recommend a wetland area that gives an N loading of about 500 g/m²/yr or lower. Because many of the discharges from STW have a high N concentration the potential for N retention in such wetlands is also high. The concentration of N in the outflow will be variable but the purpose of such wetlands is to retain N overall rather than to provide a specific constant standard of water quality in the outflow.

Wetlands associated with streams and rivers

Diverting part of the flow of a stream or river through a wetland, with the outflow returning to the watercourse, provides another opportunity for N saving. For obvious reasons such wetlands would mostly need to be located on the river floodplain. The inlet flow rate can be controlled so it is appropriate for the size of the wetland created and so that the ecology of the watercourse is not compromised in the section affected.

There can be other concerns in relation to the potential effects on the stream or river. An abstraction licence will almost certainly be required.

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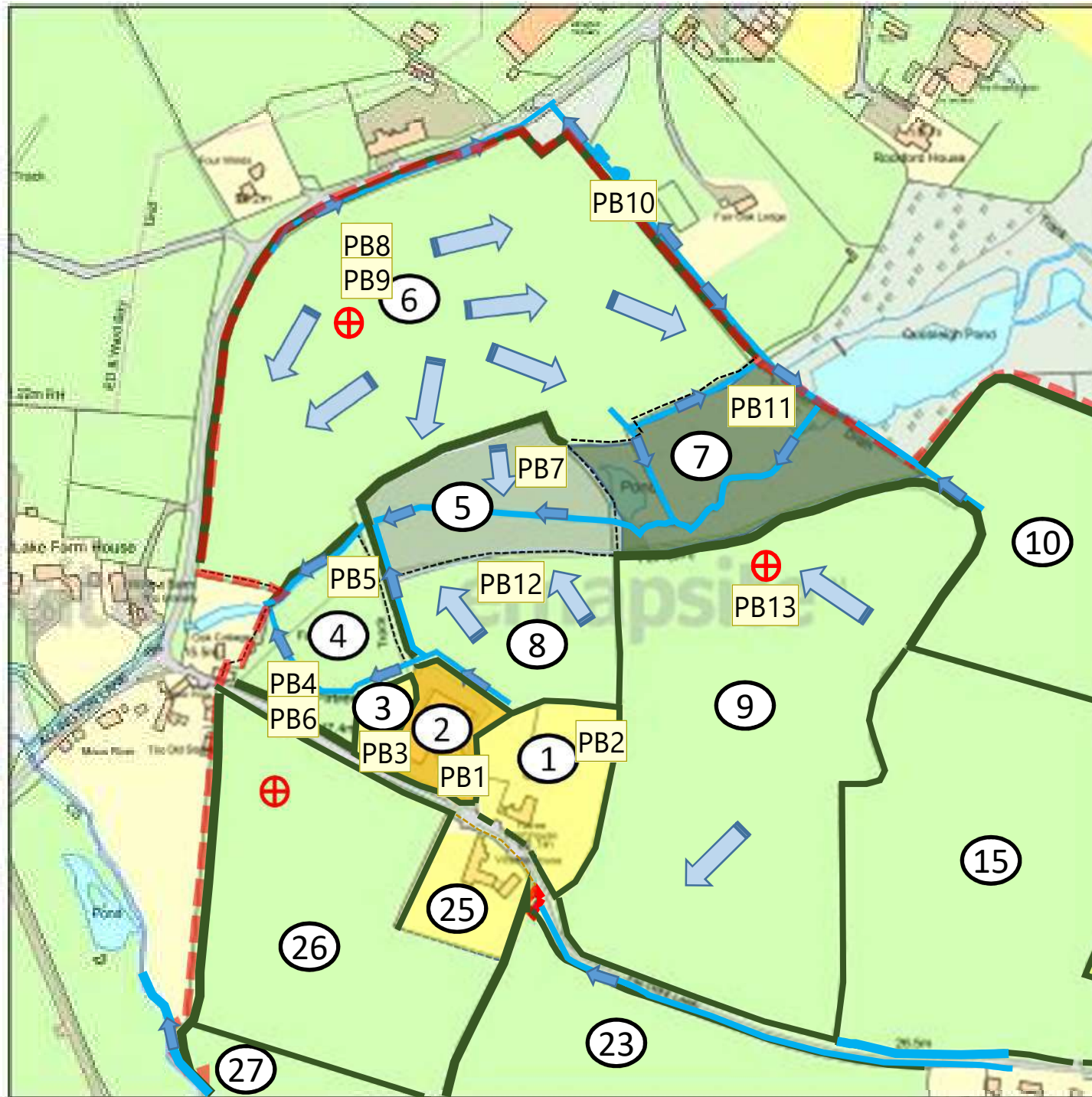
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Appendix 2 Field Observations



Slide 1

- PB1** Parcel 1 - Residential dwelling with private gardens and swimming pool. Surrounded by 3 m wide hedge
Paul Bond, 17/02/2020
- PB2** Parcel 2 - Area of bare muddy compacted ground with demolition debris throughout. Surrounded by 2 m wide hedge. Small drainage ditch with running water along northern boundary, approx 100 mm deep flowing westwards.
Paul Bond, 17/02/2020
- PB3** Parcel 3 - Derelict residential dwelling, with derelict private gardens and disused swimming pool. Plot surrounded by 2 m wide hedge. Small drainage ditch with running water along northern boundary, approx 100 mm deep flowing westwards.
Paul Bond, 17/02/2020
- PB4** Parcel 4 - Permanent pasture (hay cut). Small watercourse meanders across this field with shallow open channel/wetland area with rushes established along course. Deep ruts formed where vehicles have tracked across this very wet field exposing orange silty/clayey soils. Free oil contamination exposed on standing water within ruts. From plant?
Paul Bond, 17/02/2020
- PB6** 2 m wide hedge along southern and eastern boundary. NE boundary is fenced (barbed wire) with vehicle track beyond. South western boundary currently comprises temporary fence to adjacent residential dwelling beyond red-line boundary.
Paul Bond, 17/02/2020
- PB5** North western boundary comprises small watercourse flowing southwestwards towards pool in residential property. Water muddy and up to 0.5 m deep. Some poaching evident adjacent to watercourse (by sheep and/or cattle, although not present at the time). Free oil evident on standing water in this poached area. Molehills indicate soils pass to sandy/gravelly loam adjacent to watercourse (alluvium?).
Paul Bond, 17/02/2020
- PB7** Parcel 5 - Wet rough unimproved grassland with rushes. Small watercourse, the banks lined with small trees and shrubs, flows through centre of plot, approx 0.4 m deep, flowing westwards. Southern boundary fenced, northern boundary 2 m wide hedge.
Paul Bond, 17/02/2020
- PB8** Parcel 6 - Permanent pasture - grass with buttercups, very little clover. Rutting by vehicles in western half of field indicates a clayey loam soil. Ground very wet with standing water in ruts. Majority of field enclosed by 2 m wide hedge.
Paul Bond, 17/02/2020
- PB9** Archaeological dig in northern half of the field at the time of the survey indicated ~300 mm chestnut brown silty clayey loam overlying orange clay bedrock. Wide drainage channel running along northern boundary adjacent to road. Approx 200 mm depth of water flowing north eastwards. Piezometer with blue wellhead in western centre of field. Free oil contamination observed on standing water in north eastern corner of field, adjacent to spoil heap of sandy clay.
Paul Bond, 17/02/2020
- PB10** Beyond eastern boundary hedge lies a series of small ponds with bullrushes. Residential development progressing beyond. Amphibian fencing around ponds. Ponds interconnected by drainage channel flowing north along northern half of boundary towards highway drainage and south

Slide 1 (Continued)

along southern half of boundary towards woodland and Quobleigh Pond.

Paul Bond, 17/02/2020

- PB11** Parcel 7 - Wet broadleaved woodland, with grass and bramble understorey. Wide vegetated wetland through centre, flowing westwards towards large pond. Dry channel running eastwards along fenced northern boundary.

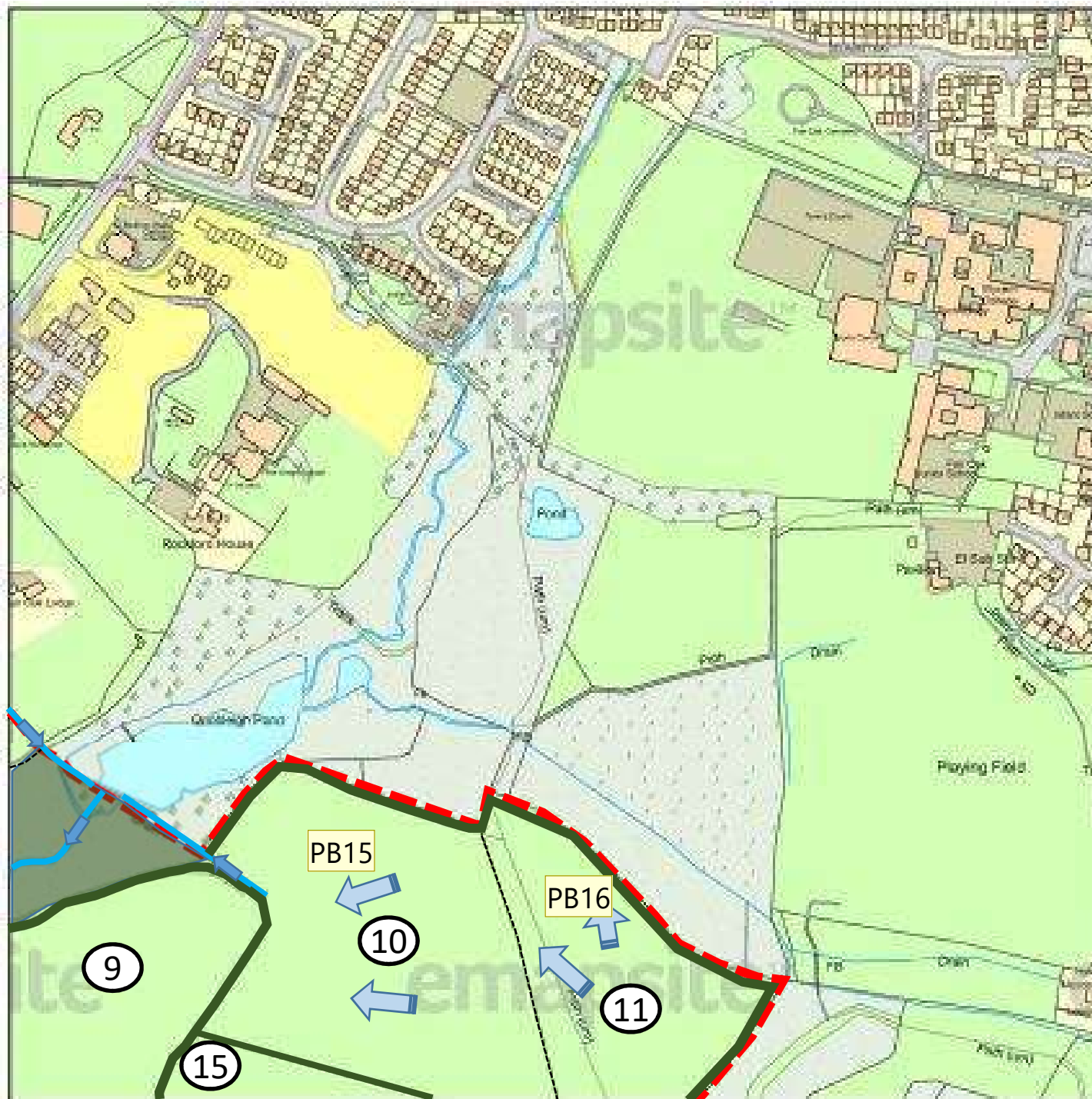
Paul Bond, 17/02/2020

- PB12** Parcel 8 - Permanent pasture. Sloping gently north-westwards towards Parcel 5 and adjacent watercourse. Fenced along northern boundary. Aprox 2 m wide hedges forming remaining boundaries with flowing drainage ditches along south western and western boundaries, flowing westerly and northerly, respectively. Footpath along northern boundary. Molehills indicate soil is a medium brown silty loam.

Paul Bond, 18/02/2020

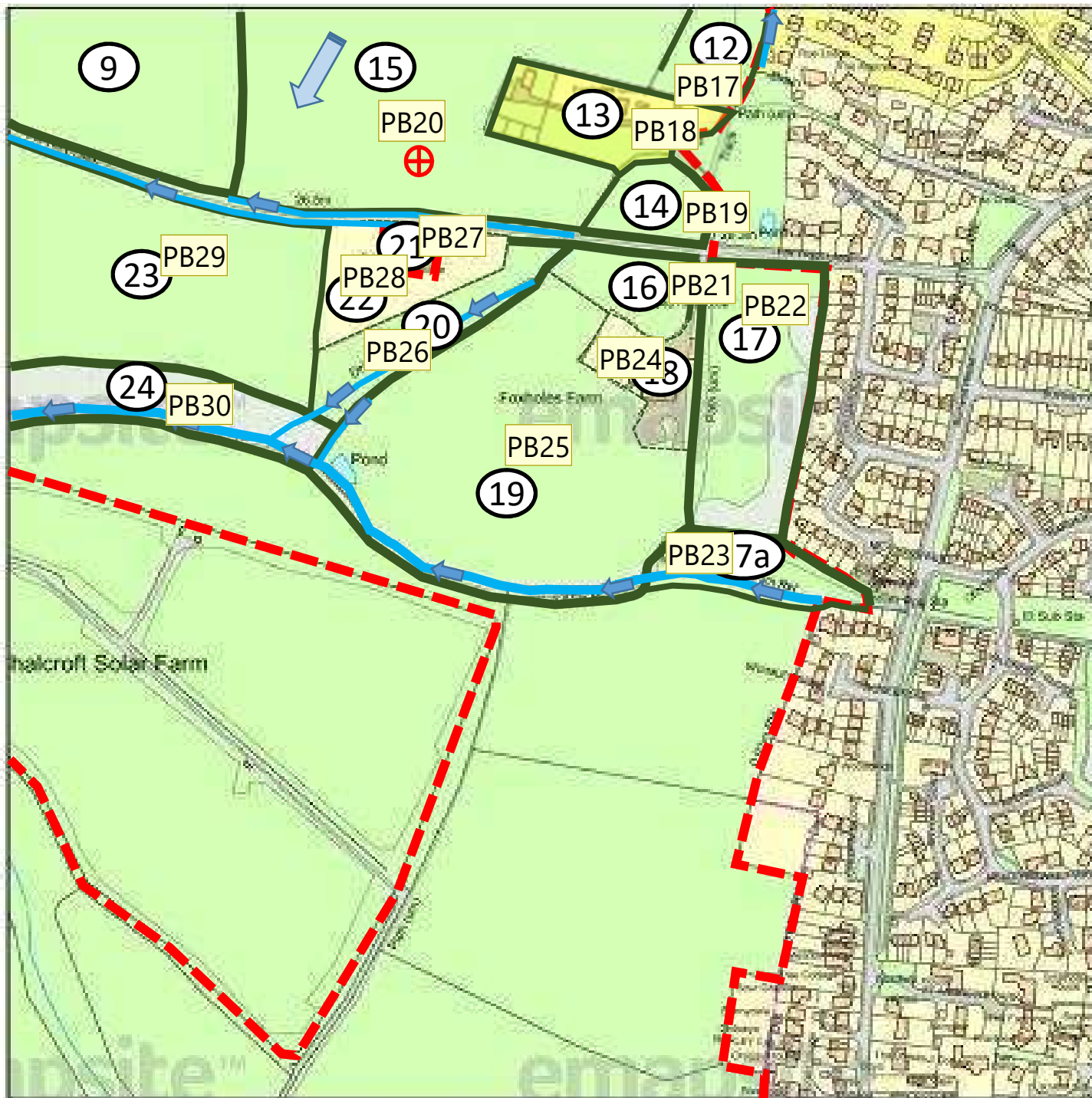
- PB13** Parcel 9 - Permanent pasture. Southern, western and south eastern boundaries ~2 m thick hedgerow. Northern boundary fenced, with woodland beyond. Scrub and woodland understorey encroaches approx 3 m into field along this boundary. Hedgerow approx 3 m wide in north eastern corner adjacent to Parcel 10. Footpath also along northern boundary. Northern half of field drains north-westerly towards Parcel 7 and associated watercourse. Southern half of field drains south-westerly towards Fir Tree Lane. Piezometer close to northern boundary - metal cover badly damaged by machinery with head of well open to the elements - needs repairing.

Paul Bond, 18/02/2020



Slide 2

- PB15** Parcel 10 - Arable (wheat?) crop. Known as "10 acre field". Northern boundary fenced, with flailed woodland understorey/set aside encroaching approx 5 m into field (including footpath which is also along this boundary). Field generally drains westwards. Small wet drainage ditch along north western boundary flowing towards the watercourse in Parcel 7. Relic hedge along eastern boundary although mainly just fence with scattered shrubs. 2 m wide hedge along southern boundary, with 3 m wide hedge along western boundary. Occasional free oil contamination on standing water along northern boundary and in north east corner.
Paul Bond, 18/02/2020
- PB16** Parcel 11- Permanent pasture. Northern and eastern boundary fenced, with flailed woodland understorey/set aside encroaching approx 3 m into field. Western boundary fenced with relic hedge, comprising occasional scattered shrubs. Footpath through centre of field. Field generally drains northwards. Occasional free oil contamination on standing water along northern and western boundaries.
Paul Bond, 18/02/2020



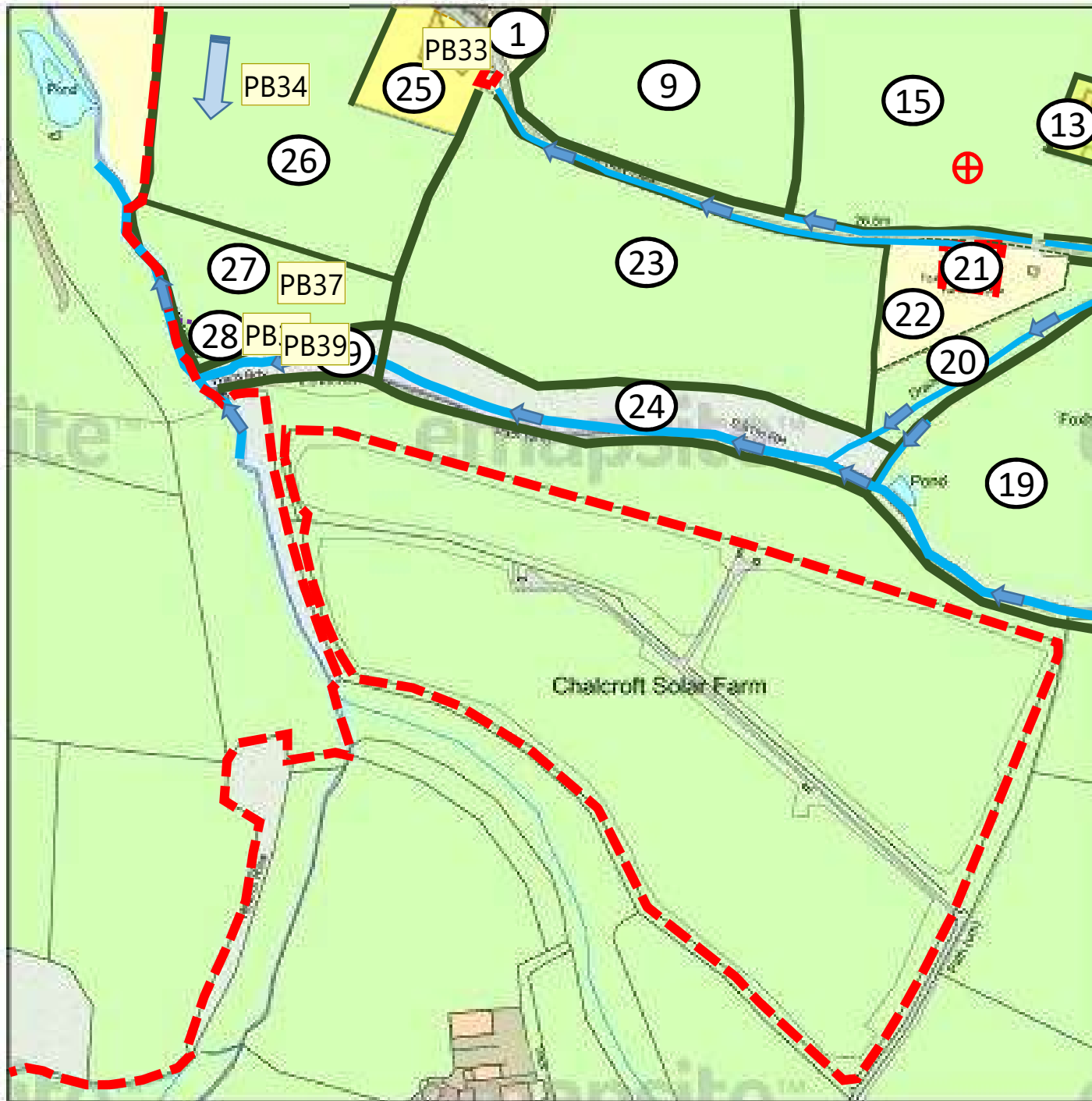
Slide 3

- PB17** Parcel 12 - Pasture. Some waterlogging at northern end with localised oil contamination. New housing development currently being built beyond site boundary to the east. Ditch running northwards and new trash screen constructed just beyond hedge along eastern boundary, as part of new development. Public footpath runs through middle of field. Large well rotted manure heap, comprising straw and cattle waste at northern end of field adjacent to northern boundary. Low percentage of clover with docks and chickweed in sward. 2 m wide hedge with scattered trees along eastern boundary. Gappy 2 m wide hedge along western boundary, incomplete at northern end.
Paul Bond, 18/02/2020
- PB18** Parcel 13 - Foxhole Cottages - residential dwellings, buildings and associated gardens. Surrounded by thick 2 m wide hedge with scattered trees.
Paul Bond, 18/03/2020
- PB19** Parcel 14 - wet and scrubby fallow land with rushes. 3 m wide hedge with scattered trees along northern, eastern and southern boundaries with scrub encroaching into field. More formal 2 m wide hedge along western boundary.
Paul Bond, 18/03/2020
- PB20** Parcel 15 - Winter wheat. Field gently sloping towards Fir Tree Lane. 2 m wide hedges along northern, eastern and southern boundaries. Thicker 3 m hedge with shrubs and small trees along western boundary. Piezometer located at southern end opposite residential dwelling/flower retailer. Large ditch along southern boundary fronting onto Fir Tree Lane full of standing water and overtopping onto highway.
Paul Bond, 19/03/2020
- PB21** Parcel 16 - set aside. Rough grassland with tall ruderals. Thick informal hedge along northern and western boundaries. Remnant hedge along eastern boundary and fencing along southern boundary.
Paul Bond, 19/03/2020
- PB22** Parcel 17 - Playing fields with relatively long amenity turf surrounded by thick hedges with areas of woodland and shrubs along eastern and southern boundaries. Waterlogging of soils at southern end and associated poaching by human footfall at the southern access point to the fields.
Paul Bond, 19/03/2020
- PB23** Parcel 17a - Small strip of coppiced woodland with muddy public footpath and small stream running through it (flowing westwards).
Paul Bond, 19/03/2020
- PB24** Parcel 18 - Highly disturbed area - former Foxholes Farmhouse, comprising heaps of demolition rubble, comprising bricks, soil, steel supports, corrugated iron sheeting, paint and chemical cans and a number of large gas cylinders. Enclosed by temporary construction fencing. Standing water in wheel ruts and puddles exhibiting significant algal growth, with large patches of black of oil stained soils in places.
Paul Bond, 19/03/2020
- PB25** Parcel 19 - Rough grassland with tall sward and ruderals (set aside). 3 m wide thick hedgerows along western and eastern boundaries. Thick area of woodland and shrubs along southern boundary with 200 mm deep fast flowing stream - flowing eastwards dissipating in places into diffuse wetland, particularly at eastern end. Channel becomes more defined westwards. Also wet ditch flowing southwards at southern end of western boundary. Large overgrown pond in SW corner, with emergent vegetation and surrounded by brambles. Small island in middle. Small stand of Japanese Knotweed in centre of southern boundary on the northern side of the stream (stand approximately 4 x 3 m).

Slide 3 (Continued)

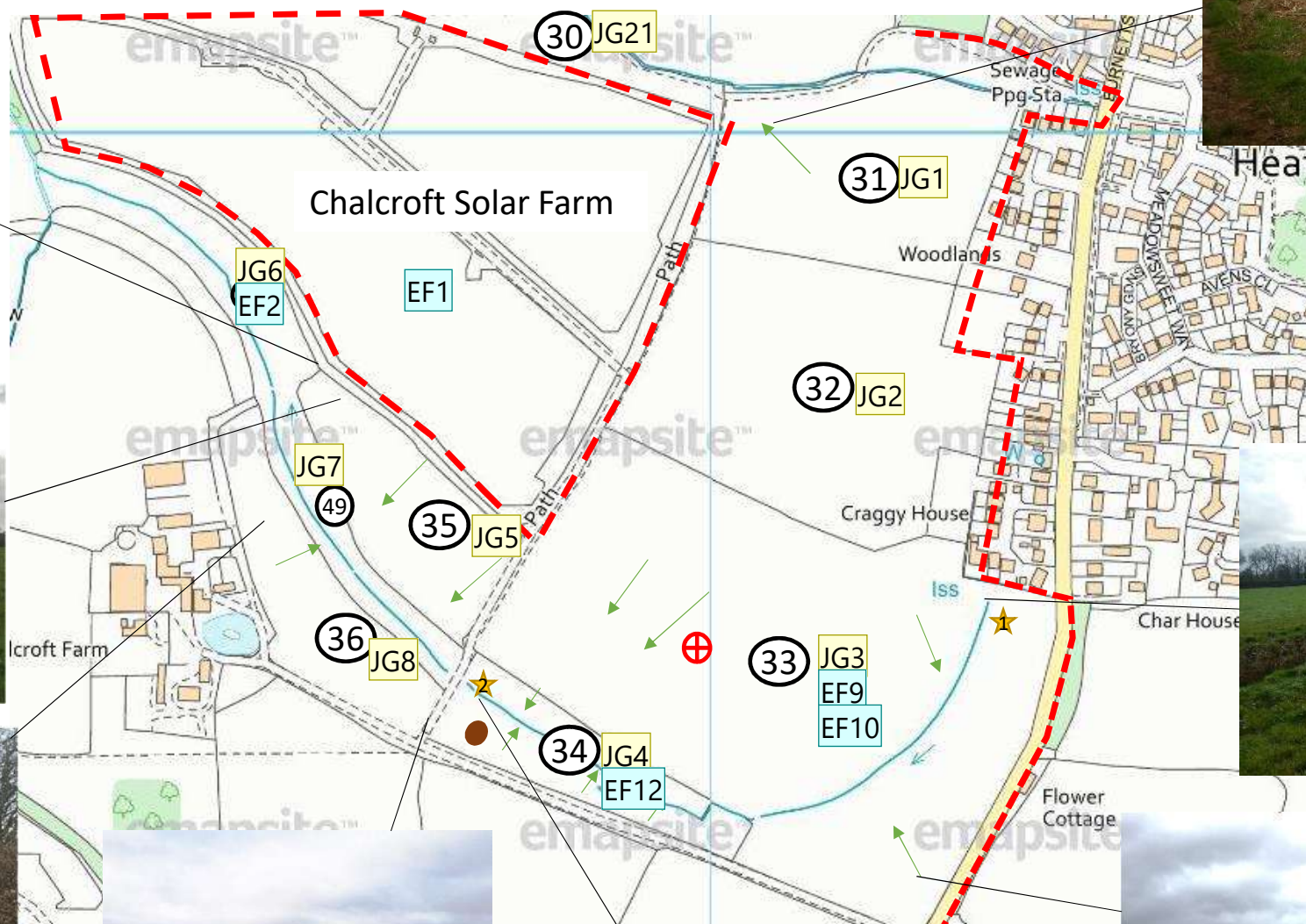
Paul Bond, 19/03/2020

- PB26** Parcel 20 - rough grassland with clumps of tall ruderals. Small watercourse flowing through middle of parcel towards stream to the south. All hedgerow boundaries other than fenced boundary with Foxholes Garage to north and west.
Paul Bond, 19/03/2020
- PB27** Parcel 21 - Outside of site - residential dwelling and outbuildings including Foxholes Garage and flower retailer. Small wet ditch with standing water along frontage onto Fir Tree Lane.
Paul Bond, 19/03/2020
- PB28** Parcel 22 - Outside of Site - grassland/ lawn surrounding Foxholes Garage and associated outbuildings.
Paul Bond, 19/03/2020
- PB29** Parcel 23 - "12 Acres" field. Winter wheat. 2 m wide hedge along eastern and northern boundaries. Wet shallow ditch full of litter along Fir Tree Lane frontage. Little evidence of flow, but slope westwards. 3 m wide hedge along western boundary with scattered trees. To the south lies a strip of woodland with stream (see Parcel 24).
Paul Bond, 19/03/2020
- PB30** Parcel 24 - Strip of woodland and shrubs with small stream running westwards through it.
Paul Bond, 19/03/2020



Slide 4

- PB33** Parcel 25 - Victoria House - residential dwelling with associated gardens and out buildings. Walled along frontage to Fir Tree Lane, with hedges along western and eastern boundaries and fenced along southern boundary.
Paul Bond, 19/03/2020
- PB34** Parcel 26 - Pasture. 3 m wide hedges with scattered trees along western and eastern boundary. 2 m wide hedge along Fir Tree Lane frontage. Piezometer in NW corner. Field slopes southwards with gappy 2 m wide hedge along southern boundary. Molehills indicate that soil is a light brown silty loam.
Paul Bond, 19/03/2020
- PB37** Parcel 27 - Pasture - grading into wetter conditions southwards. 3 m wide hedge along western boundary with scattered trees and small watercourse flowing northwards. 3 m wide hedge with scattered trees along eastern boundary, with woodland bordering small watercourse flowing westwards along SE boundary.
Paul Bond, 19/03/2020
- PB38** Parcel 28 - to the south of Parcel 27 lies a triangle of wet tall ruderals. Vegetation recently cut and left on ground. In places standing water exhibited bright orange staining and free oil contamination. To the west lies 3 m wide hedge and associated watercourse (up to 500 mm deep in places) flowing northwards. To the south lies scrubby/woodland area of Parcel 29 with watercourse flowing westwards.
Paul Bond, 19/03/2020
- PB39** Parcel 29 - wet scrubby and woodland area with small watercourse (approx 300 mm deep) flowing westwards forming confluence with boundary watercourse to the west, which then flows northwards.
Paul Bond, 19/03/2020



Slide 1

- JG1** Parcel 31 - Maize (grown every other year). 2.75 ha.
James Gibson, 19/02/2020
- JG2** Parcel 32 - Pasture/silage. 4.64ha.
James Gibson, 19/02/2020
- JG3** Parcel 33 - Pasture/silage. Land gently slopes towards stream. Gravel clay at far south west corner. Fence on boundary with Parcel 2, 3m hedge all along eastern flank and boundary with parcel 4. Borehole location indicated by red cross. Water sample location 1 at star. 9.67ha.
James Gibson, 19/02/2020
- EF9** Water sample taken as stream enters site boundary shows Nitrite levels 0 ppm, ammonia levels between 0.25 and 0.5 ppm and Nitrate levels around 5 ppm.
Emma Flower, 26/02/2020
- EF10** Hedge also runs along farm track. North boundary of this field is a barbed wire fence between this field and Parcel 32.
Emma Flower, 26/02/2020
- JG4** Parcel 34 - Narrow strip of boggy marsh land with land sloping gently towards a stream cutting through the middle of the field. Path divides Parcel 4 and 6. Large manure heap in south east corner of parcel to the right of the path just as you enter the field (brown circle). Water sample location 2 indicated by yellow star. 3 m hedge borders parcel. 1.24 ha.
James Gibson, 19/02/2020
- EF12** Results of the water test at this site show nitrate and nitrite levels very similar to that of the other test site, nitrite around 0 ppm and nitrate around 5 ppm. The levels of ammonia at this site were noticeably higher, around 2 ppm, this was noticeably higher than the test site 1.
Emma Flower, 26/02/2020
- JG5** Parcel 35 - Pasture. Gently sloping south east towards stream. Field surrounded with 3 m hedge. 1.56 ha.
James Gibson, 19/02/2020
- JG6** Parcel 50 - Narrow strip of marshy land surrounding stream. Gentle slope in direction of stream. Bordered by 3 m hedge. 1.04 ha.
James Gibson, 19/02/2020
- EF2** Does not appear to be grazed as longer sedges and grasses in this area, barbed wire fence between this strip of land and the solar farm.
Emma Flower, 26/02/2020
- JG7** Parcel 49 - Narrow strip of marshy land surrounding stream. Gentle slope in direction of stream. Bordered by 3 m hedge. 0.8 ha.
James Gibson, 19/02/2020

Slide 1 (Continued)

- JG8** Parcel 36 - Pasture. Gently sloping towards stream. Flatter in south eastern corner. Low 3 m wide hedge on boundary with Parcel 39, high 3 m hedge on western flank closer to farm buildings. 1.44 ha.
James Gibson, 19/02/2020
- JG21** Parcel 30 - Pasture. Narrow strip of land north of the solar farm. Gentle slope to the north towards the stream. Bordered to the north by trees. 1.52 ha.
James Gibson, 20/02/2020
- EF1** While the solar farm is outside the site boundary, Simon Owton mentioned that he owned the land and leased it to the solar farm. He cuts the grass around the solar panels 3 times a year, the grass is left on site.
Emma Flower, 25/02/2020



Slide 2

- JG9** Parcel 37 - Steeply sloping towards stream. Ditch running along east and south east boundary of parcel filled with polluted water. Manure left in piles. Water run off from farm building runs through here via ditch towards stream in Parcel 20. 0.08 ha.
James Gibson, 19/02/2020
- EF6** Contents of the ditch were more like sludge than water despite the recent heavy rain.
Emma Flower, 26/02/2020
- JG10** Parcel 38 - Pasture. Land quickly falls away towards the streams on the western and northern boundaries of the field as shown by the green lines and arrows. Slope is particularly steep on boundary with Parcel 39 (see image). Tall, wide hedgerow boundary with Parcel 39. 3.72 ha.
James Gibson, 19/02/2020
- EF4** Despite the slope, the field is very waterlogged in places with a mainly clay soil.
Emma Flower, 26/02/2020
- JG11** Parcel 39 - Narrow strip of land accessible by a small rickety bridge. Very waterlogged, parts were knee deep with water at time of site visit. Long grasses and reed species were established here. A small wood on a steep slope is located to the north east of the field. 1.27 ha.
James Gibson, 19/02/2020
- EF3** A ditch slowly flowing north was located at the boundary of the waterlogged field and the wooded area. Cut branches were piled around the field.
Emma Flower, 26/02/2020
- JG12** Parcel 40 - Pasture, but at time of visit very boggy waterlogged marsh-land. Land flat. Small watercourses found running through the middle of the field and in water ditches along all the edges of the field, all flowing in a north-easterly direction. Two large clumps of frogspawn were found in the stream in the middle of the field. A small wooden footbridge allows access via the footpath through the field over the stream ditches. Woodland on either side. 3.3 ha.
James Gibson, 19/02/2020
- JG13** Parcel 41 - Pasture. Land is separated from Parcel 10 by a small hedgerow within which was located a drainage ditch. Land is flat and enclosed by woodland to the north and south. 0.9 ha.
James Gibson, 19/02/2020
- JG14** Parcel 42 - Pasture. Flat marsh-land. 3 m wide hedge on northern flank, woodland on southern. Two mounds of earth mixed with rubble and gravel were found close to the woodland side of the field halfway along the length of the field. A ditch runs along the southern boundary closest to the woodland transporting water in a westerly direction. A medium sized stream to the north west separates Parcels 42 and 40. 0.66 ha.
James Gibson, 19/02/2020
- JG15** Parcel 43 - Pasture. Gently sloping to the west. Waterlogged ground to the west and south-west. Drainage ditch running alongside hedge on the north west flank. Two streams converge in the northern corner of the field and at the time of site visit

Slide 2 (Continued)

the stream was flowing fast. The car park for the farm buildings (capacity approx 50 cars) is adjacent to the eastern flank of the field. 2.42 ha.

James Gibson, 19/02/2020

EF11 Small manure pile in western corner of the field indicated by brown circle.

Emma Flower, 26/02/2020

JG16 Parcel 44 - Buildings to the south of the pond are mostly derelict with a dumping ground behind. Waste is well organised and is mostly scrap metal, broken pallets and cardboard. 0.36 ha.

James Gibson, 19/02/2020

JG17 Parcel 45 - Flat field with collection of trees in the middle. Used for pasture. Bound by hedge to the east and thin line of tree to south in front of which is a drainage ditch with water flowing west. Clay soils to the south east, gravel/clay soils to the west. 1.82 ha.

James Gibson, 19/02/2020

EF8 Slopes at the edge of the field towards the drainage ditch which contains vegetation.

Emma Flower, 26/02/2020

EF5 Car park has space for around 50 cars, with about 40-45 parked at the time of visit. Some butchery occurs in the buildings in the farm yard and there was regular pressure hosing of vehicles and other equipment on this site.

Emma Flower, 26/02/2020

EF7 Streams join here and flow north.

Emma Flower, 26/02/2020



Slide 3

- JG18** Parcel 46 - Pasture. Flat field with 3 m wide hedge on west side, woodland on south side and a mixture of fence and hedgerow on east side. 2.93 ha.
James Gibson, 19/02/2020
- EF13** Clay soils, slight slope towards Parcel 47 in SE corner of field.
Emma Flower, 26/02/2020
- JG19** Parcel 47 - Pasture. Mostly flat field with a gentle slope towards the south west. The south west and southern boundary is marked with trees and fence. Eastern boundary is marked with a mixture of hedgerow and fences. Large puddles had formed in front of the fence in places. Clayey soils. There was a borehole in the field shown on the map by the red cross. 6.5 ha.
James Gibson, 19/02/2020
- JG20** Parcel 48 - Pasture/silage. Similar to Parcel 47 except for aspect - here land is highest on the side by Burnetts Lane halfway up the field. There is a small ditch transporting water northwards in the hedgerow separating Parcels 47 and 48. At the time of our visit there was evidence of hedgerow removing on the western flank exposing fence and there were large ruts where vehicles had tracked across the wet field. 7.85 ha.
James Gibson, 19/02/2020



Slide 4

EF14

Parcel 51 - Grass field sloping steeply towards Burnetts Lane to the NW, and less steeply towards the SE & Bubb Lane. Site is owned by Queens College, so its exact use is not clear. Archaeologists were on site digging trenches. Soil appeared less clayey and more loamy. Trees border the field at the southern boundary with the train line, and a hedge 3 m, to the NE of the field. All hedges had been removed along both boundaries with the roads and heras fencing was in its place. 4.84 ha.

Emma Flower, 26/02/2020

Appendix 3 Farmer Interview Notes

Interview with Rob and Adam Marsh 04/02/20

Management of each parcel (refer to walkover plans for parcel locations)

- Nitrogen Fertiliser Application Field Record Sheets supplied for the following fields:
 - Parcel 10 ("10 acre" field); 4.64 ha (11.5 acres)
 - Parcel 15 ("18 acre" field); and 7.39 ha (18.3 acres)
 - Parcel 23 ("12 acre" field. 4.96 ha (12.3 acres)

These fields above were wheat last year, but alternate between wheat and maize. Figures in the table from the nitrate ordering sheet for Foxholes WW were used for amounts of Nitrate applied to these areas per ha.

- Parcel 6 – Previously grazed by a flock of sheep (~50 head) from the Davies farmstead. Treated as rotational grassland in Farmscoper. 6.12 ha (15.1 acres) within OPA.
- Parcel 9 – Pasture with hay cut. 7.37 ha (18.2 acres), parcels 9 and 26 (11.52 ha total) are classed as Victor's hay on the fertiliser sheets, classed as rotational grassland on Farmscoper
- Parcel 11 – pasture/fodder. 2.86 ha (7.1 acres).
- Parcel 17 – playing field – no applications. Treated as set aside in the calculations. 1.53 ha 3.8 acres.
- Parcels 14 and 16 are fallow with one cut per year. – Treated as fodder in the calculations. Total area 1.0 ha (2.5 acres).
- Parcel 19 with no applications. Treated as set aside in the calculations. Total area 3.73 ha (9.2 acres).
- Parcels 20 and 24 wet and scrubby with no applications and perhaps only one cut per year (1st cut) and perhaps a flail in summer. Treated as set aside in the calculations. Total area 2.03 ha (3.7 acres).

General

- Between 150 to 200 tonne of farmyard manure (FYM) imported into their land within red line boundary. This is applied to the maize crop which is grown alternate years. Consequently, in Farmscoper this is represented as 87.5 tonnes per year on the maize crop i.e. $(150+200)/2/2$.
- Most hay cuts for home (local) trade.
- No boundary walls – all hedges and fences.
- Maize crops require very low nitrogen – typically alternate between maize and wheat.
- Typical annual field operations comprise a machine till, drill, roll, fertiliser application and then harvest. All machinery tractor toed other than a combine for harvesting.
- On-site machinery comprises 1, perhaps 2 tractors, a 4-wheel drive (although most daily access is on foot), a quad which is only used in summer and a combine for harvesting.
- For hay, first cut end of May/beginning of June, 2nd cut in August.
- The areas which are developed buildings or demolished buildings are not included in Farmscoper.

NVZ Field Record Sheet

Main Business: R & A Marsh Farms Ltd
Year: 2019
Area: ha

Crop Management Partners LLP
Rhys Evans
Tel: E-Mail: rhys@cropmanagement.co.uk



10 Acre

Holding name: Main Holding
Field reference:
Map / NG Number: SU4917 / 0167
Postcode:
Crop: Wheat Winter

Holding reference:
Working area (ha): 4.54
Soil type: Medium (Eng)
NVZ Region: England and Wales NVZ (2009 or earlier)
Variety: KWS Zyatt

Field Cropping History

Cropping Year	Part Field Ref	Crop Name	Crop Sequence
2018	Whole field	Maize Forage	1

Nitrogen Fertiliser Applications

Application		Manure Type	Quantity	Rate/ha	Units	Available N		Total Organic N	
Date	Product					%	kg/ha	%	kg/ha
07/02/2019	38N 19so3	Mineral Fertiliser	1194.020	263.000	kg	38.000	99.94		
16/03/2019	34.5% AN	Mineral Fertiliser	1316.600	290.000	kg	34.500	100.05		
10/05/2019	34.5% AN	Mineral Fertiliser	1293.900	285.000	kg	34.500	98.33		
						298.32		0.00	

Date Comment

12 Acre

Holding name: Main Holding
Field reference:
Map / NG Number: SU4817 / 4.95
Postcode:
Crop: Wheat Winter

Holding reference:
Working area (ha): 4.95
Soil type: Medium (Eng)
NVZ Region: England and Wales NVZ (2009 or earlier)
Variety: KWS Zyatt

Field Cropping History

Cropping Year	Part Field Ref	Crop Name	Crop Sequence
2018	Whole field	Maize Forage	1

Nitrogen Fertiliser Applications

Application		Manure Type	Quantity	Rate/ha	Units	Available N		Total Organic N	
Date	Product					%	kg/ha	%	kg/ha
07/02/2019	38N 19so3	Mineral Fertiliser	1301.850	263.000	kg	38.000	99.94		
16/03/2019	34.5% AN	Mineral Fertiliser	1435.500	290.000	kg	34.500	100.05		
10/05/2019	34.5% AN	Mineral Fertiliser	1410.750	285.000	kg	34.500	98.33		
						298.32		0.00	

Date Comment

NVZ Field Record Sheet

Main Business: R & A Marsh Farms Ltd
Year: 2019
Area: ha

Crop Management Partners LLP

Rhys Evans
Tel: E-Mail: rhys@cropmanagement.co.uk

CROP
MANAGEMENT
PARTNERS

18 Acre

Holding name: Main Holding

Field reference:

Map / NG Number: SU4817 / 9946

Postcode:

Crop: Wheat Winter

Holding reference:

Working area (ha): 7.46

Soil type: Medium (Eng)

NVZ Region: England and Wales NVZ (2009 or earlier)

Variety: KWS Zyatt

Field Cropping History

<u>Cropping Year</u>	<u>Part Field Ref</u>	<u>Crop Name</u>	<u>Crop Sequence</u>
2018	Whole field	Maize Forage	1

Nitrogen Fertiliser Applications

<u>Application</u>	<u>Product</u>	<u>Manure Type</u>	<u>Quantity</u>	<u>Rate/ha</u>	<u>Units</u>	<u>Available N</u>	<u>Total Organic N</u>
<u>Date</u>						% kg/ha	% kg/ha
? 07/02/2019	38N 19so3	Mineral Fertiliser	1961.980	263.000	kg	38.000 99.94	
? 16/03/2019	34.5% AN	Mineral Fertiliser	2163.400	290.000	kg	34.500 100.05	
? 10/05/2019	34.5% AN	Mineral Fertiliser	2126.100	285.000	kg	34.500 98.33	
						298.32	0.00

Date

Comment

Owton Farm Interview Notes

Focussing on last year's activities/crops it would be useful to know:

6. The percentage of your fields directly adjacent to watercourses; **approx. 60%**
7. The types of field boundaries and the approximate percentage of these types (i.e. hedges, walls, fences or other); **hedges (80%), fences (5%) and trees (15%)**
8. The area (in hectares) of each type of land use, including types of crops, pasture, rough grazing, grassland, orchards, bare fallow, woodland and set aside;
 - **60ha total**
 - **Pasture 50ha**
 - **Maize 6.75ha (2.75ha and 4ha parcels alternating every two years) I had 4 ha maize**
 - **Silage 22.16ha I had 60 acres/ 24ha silage**
 - **3.25ha other**
9. Fertiliser (N and P₂O₅) additions in kg/ha for each type of land use. Typical application rates for some crops are included on the spreadsheet, but these can be modified to suit your own applications;
 - **Maize – 20/10/10 fertiliser applied 150kg per acre (or 370kg per ha) = 2497kg total on maize fields.**
 - **Silage – 25/15 fertiliser 75kg per acre (or 185kg per ha) I had it as after silage cut 25/5/15 applied (75kg)**
 - **Pasture – 34.5% N fertiliser 200kg in 3 doses**
10. Manure applications - including tonnage and type of manure received on site and the percentage application to the respective land uses.
 - **Maize – 24 tons per ha (10 tons per acre)**
 - **Silage – the same as maize? I had the farm yard manure as 10 tonnes overall applied to silage & maize fields (not per acre) applied in 1 dose in April and then ploughed in after 1 week, or sometimes a couple of days between application and ploughing**
 - **No manure imports**
 - **All farm yard manure (FYM) only applied on fields used for maize and silage**
 - **No dirty water store / slurry store on site. No manure exported.**

For each type of land use, we would also be interested in the respective field operations, including:

6. Length of ley; 2 years
7. The number of times each year the land is ploughed, cultivated, harrowed, subsoiled, disced, rolled, sprayed, fertilised etc. Land chain harrowed once in spring, they use a slot drill to overseed the grass
8. Type of equipment used for planting; One JCB and one tractor
9. Any irrigation (mm/ha); None
10. Number of cuts per year and type of harvesting equipment used. Contractors brought in to harvest who use the tractor. (For the maize field).
For hay /

Finally, we would also be interested in what type of vehicles/plant you regularly use on the farm e.g. tractors, pick-ups, quad bikes etc. JCB and tractor only.

Animal stock:

1 bull

70 cows < 1 year old

50 cows 1-2 years old

20 cows 2+ years old

Typically 220 cows start the winter diminishing to 160 in spring.

Simon confirmed that he farmed all of the fields to the south of Fir Tree Lane, apart from the field across Burnetts Lane in the far south east corner of the development site, this is owned by Queens College. He owns the land which the solar farm is and leases it to the solar farm. He cuts the grass around the solar farm 3 times a year and leaves the grass in situ.

24ha/56.8 acres silage but when the silage fields are measured on GIS they are around 29ha so this higher figure is used in Farmscoper. Silage fields receive part of the 10 tonne manure along with 100kg / acre 20/10/10. Also there is an after cut application of 25/5/15 at 75kg/acre

Fields around 72.15 acre total for silage so 7215kg 20/10/10 fertiliser of which 20% is Nitrate, so 1443kg N total, /29.2ha = 49.42 kg N/ha.

Plus 5411 kg of 25/5/15 of which 25% is N, 1352 kgN / 29.2ha = 46.33 kg N/ha

Both Fertiliser applications total 120 kg/n/yr/ha. The silage production at the Marshes Farm (out of the site) uses 100kgN / yr I don't know whether this is also grazed, so the Owton's figure doesn't seem too far out.

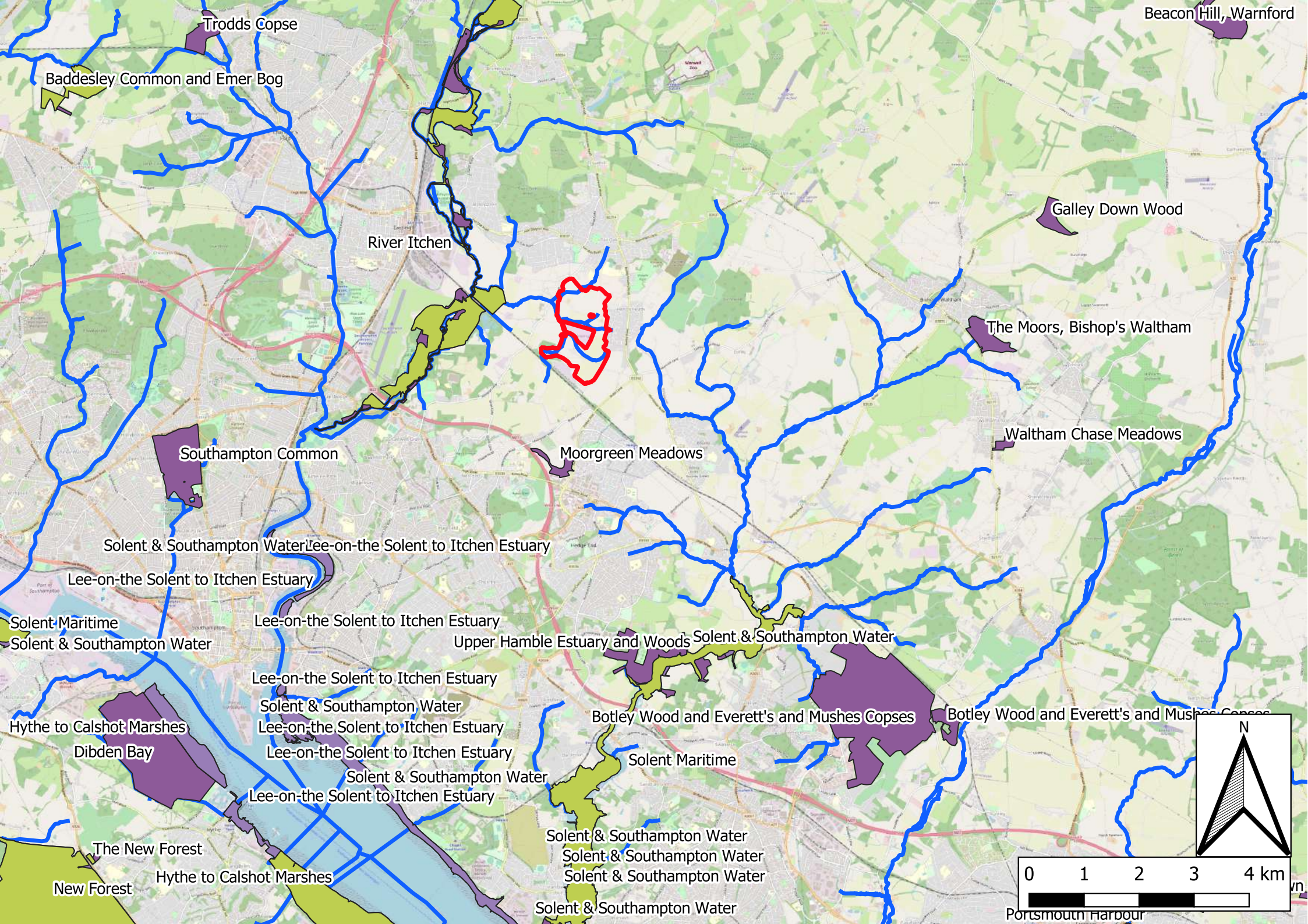
40ha/98.8 acres pasture, around 25 ha of this is permanent pasture (during grazing season) and the remainder is grown for silage in the spring & then grazed afterwards. Fields 32, 33, 47, and 48 are classed as silage fields, these are cut in May and then cattle graze them from June until early November.

4ha maize grown for cattle feed & used on site. Fertilised with manure and 20/10/10

Field 51 classed as set aside as owned by Queens College, grass field possibly grazed but no info on this, if information is obtained then this can be added in.

The fields to the west of the site are not cut for silage and are only grazed, these are grazed from mid-March, cattle are housed in the barn during the winter – early Nov to mid-March depending on how wet the ground is this can vary. Grazing fields receive 34.5N 200kg ammonium nitrate 3 times a year, this is 200kg total throughout the year, not each time. So 34.5%N which equates to around 3kg N/ha applied per year, (this seems low but I did check this figure with him today).

Appendix 4 Nearby European Designated Sites and SSSIs



Nitrogen Sensitivity in Designated Sites

River Itchen SAC and SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
SAC and SSSI						
Watercourses of plain to montane levels with the <i>Ranunculus fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation	Yes	No comparable habitat with established critical load estimate available	No Critical Load assigned. Systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should be given to other sources of N, <i>i.e.</i> discharges to water, diffuse agricultural pollution <i>etc.</i>			Potential for development to affect the habitat as a result of changes to N discharges (reduced from farmland, increased from STW).
Southern Damsel fly (<i>Coenagrion mercurial</i>)						
Dwarf shrub heath	Yes	Northern wet heath: <i>Erica tetralix</i> dominated wet heath	10 – 20 N/ha/yr	Potential negative impact on species due to impacts on the species broad habitat		Development is not considered likely to affect the species as impacts on habitats will be limited.
Southern Damsel fly (<i>Coenagrion mercurial</i>); White-clawed Crayfish (<i>Austropotamobius pallipes</i>); Brook Lamprey (<i>Lampetra planeri</i>); Atlantic Salmon (<i>Salmo salar</i>); Bullhead (<i>Cottus gobio</i>); Otter (<i>Lutra lutra</i>)						
Rivers and Streams	Yes	No comparable habitat with established critical load estimate available	No Critical Load assigned. Systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should be given to other sources of N, <i>i.e.</i> discharges to water, diffuse agricultural pollution <i>etc.</i>	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
SSSI						
Broad-leaved, mixed and yew woodland: (<i>Alnus glutinosa</i> – <i>Carex paniculata</i>); (<i>Alnus glutinosa</i> – <i>Urtica dioica</i>); (<i>Salix cinerea</i> – <i>Galium palustre</i>)						
Broad-leaved, mixed and yew woodland	Yes	Broadleaved deciduous woodland 10 – 20 kg N/ha/yr			Changes in soil processes, nutrient imbalance, altered composition mycorrhiza and ground vegetation	Development is not considered likely to have a significant influence on the terrestrial habitat.
Fen, marsh and swamp (<i>Juncus subnodulosus</i> – <i>Cirsium palustre</i> fen meadow); (<i>Phragmites australis</i> – <i>Eupatorium cannabinum</i> tall-herb fen); (<i>Phragmites australis</i> swamp and reed-beds)						
Fen, marsh and swamp	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease in bryophytes	Majority of the habitat falls upstream in the catchment, with only Unit 100 falling downstream. Unfavourable recovering condition, indicates that appropriate grazing required to recover unit to favourable status. So development is unlikely to influence the feature.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Neutral grassland (<i>Cynosurus cristatus</i> – <i>Caltha palustris</i> grassland); (<i>Cynosurus cristatus</i> – <i>Centaurea nigra</i> grassland)						
Neutral grassland	Yes	Low and medium altitude hay meadows			Increase in tall grasses, decrease in diversity	Development is not considered likely to have a significant influence on the terrestrial habitat.
Fen, marsh and swamp: (<i>Carex acutiformis</i> swamp); (<i>Glyceria maxima</i> swamp); (<i>Phragmites australis</i> – <i>Urtica dioica</i> tall-herb fen)						
Fen, marsh and swamp	No	-	-	-	-	Feature not sensitive to N.
Water vole (<i>Arvicola amphibious</i>)		No broad habitat assigned		Seek site specific advice.		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Invertebrate assemblage	Yes	No comparable habitat with established critical load estimate available	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no nitrogen EUNIS class, for which a critical load has been set, which is comparable to the broad habitat in which the feature occurs	Decision to be taken at a site specific level		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Lowland open waters and their margins		No broad habitat assigned		Seek site specific advice.		Associated with supporting breeding birds, no affect expected as a result of changes to N discharges from the site or associated STW.

Solent Maritime SAC

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Perennial Vegetation of Stony Banks	Yes	Coastal stable dune grasslands 8 – 15 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no exact or close match between the EUNIS classes for which critical loads are set and this Annex 1 habitat feature. Therefore, taking account of the typical species present and the likely sensitivity of the ecosystem to atmospheric nitrogen deposition the habitat feature is matched to EUNIS critical loads class based on expert judgement.		Increase tall grasses, decrease prostrate plants, increased N leaching, soil acidification, loss of typical lichen species.	Main areas of habitat located on Calshot Spit (distant side of Southampton Water to the South of Fawley) and Chichester Harbour. Unlikely to be significantly influenced by nutrient nitrogen in waterbody.
Shifting dunes along the shoreline with <i>Ammophila arenaria</i> ('white dunes')	Yes	Shifting coastal dunes 10 – 20 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained with the Annex 1 habitat feature and represents the most equivalent EUNIS class for which a critical load is set.		Biomass increase, increase N leaching	The extensive sand dunes at East Head at the mouth of Chichester Harbour are dominated by marram grass <i>Ammophila arenaria</i> . There are also accreting sand dunes found at Pilsey Island in Chichester Harbour. Therefore, unlikely to be affected by changes in N in the River Itchen catchment.
Estuaries	Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained with the Annex 1 habitat feature and represents the most equivalent EUNIS class for which a critical load is set.		Increase late successional species, increase productivity increase in dominance of graminoids	Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Coastal Lagoons	Yes					
Salicornia and other annuals colonizing mud and sand	Yes					
Spartina swards (<i>Spartinion maritimae</i>)	Yes					
Atlantic salt meadows	Yes					
Sandbanks which are slightly covered by sea water all the time	No	-	-	-	-	Feature not sensitive to N.
Mudflats and sandflats not covered by seawater at low tide	Yes	No comparable habitat with established critical load estimate available	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no nitrogen EUNIS class, for which a critical load has been set, which is comparable to the habitat feature			Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Annual vegetation of drift lines	No	-	-	-	-	Feature not sensitive
Desmoulin's Whorl Snail (<i>Vertigo moulinsiana</i>)						
<i>Rivers and Streams</i>	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation		Desmoulin's whorl snail <i>Vertigo moulinsiana</i> , which is rare in Great Britain and usually occurs within base-rich wetlands where there are long established

			other sources of N, i.e.discharges to water, diffuse agricultural pollution etc.			swamps, fens and marshes, is found in the reedbeds at the top of Fishbourne channel in Chichester Harbour. Therefore, unlikely to be affected by the project and changes in N in the River Itchen catchment.
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Solent & Southampton Water SPA

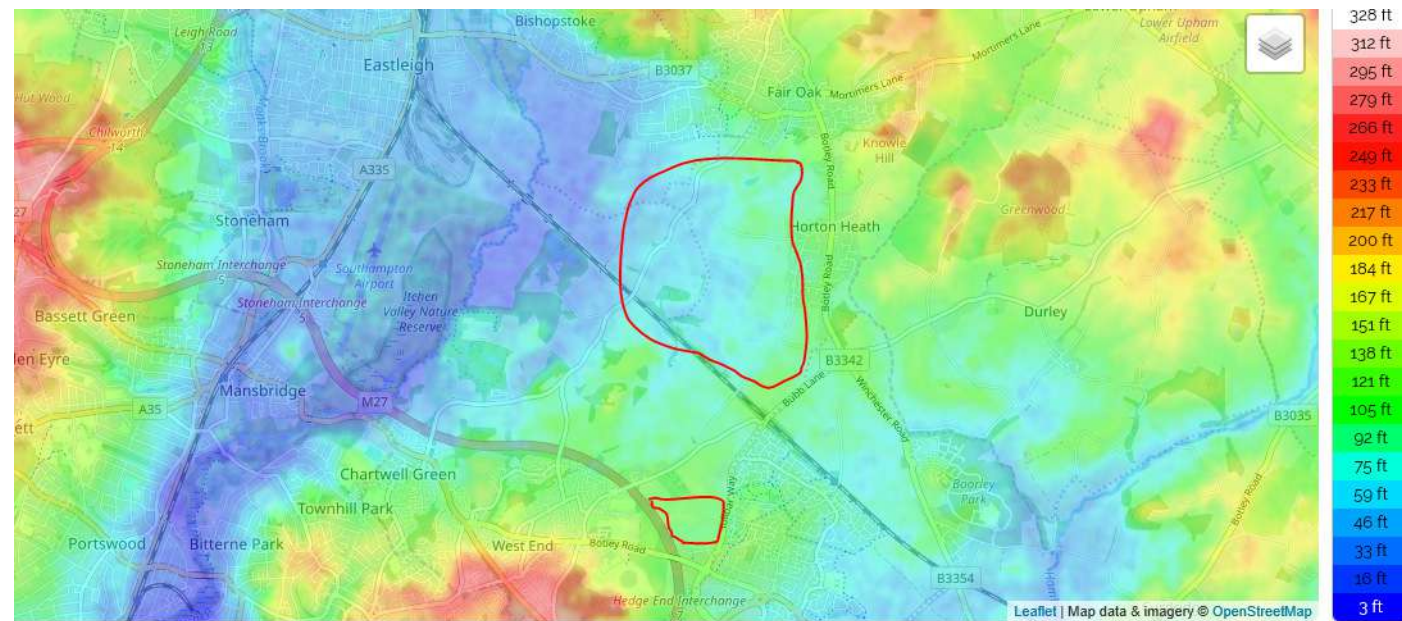
Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Sandwich Tern (<i>Sterna sandvicensis</i>); Roseate Tern (<i>Sterna dougallii</i>); Common Tern (<i>Sterna hirundo</i>); Little Tern (<i>Sterna albifrons</i>)						
<i>Supralittoral sediment (acid type)</i>	Habitat: Yes	Coastal stable dune grasslands – acid type	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase tall grasses, decrease prostrate plants, increased N leaching, soil acidification, loss of typical lichen species	Habitats are all supralittoral and therefore unlikely to be significantly influenced by the project and changes in N in the River Itchen catchment.
<i>Supralittoral sediment (calcareous type)</i>	Species: Yes	Coastal stable dune grasslands - calcareous type 10 – 15 kg N/ha/yr			Biomass increase, increase N leaching	
<i>Supralittoral sediment</i>		Shifting coastal dunes 10 – 20 kg N/ha/yr				
Common Tern (<i>Sterna hirundo</i>); Eurasian teal (<i>Anas crecca</i>)						
<i>Standing open water and canals</i>	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to other sources of N, i.e. discharges to water, diffuse agricultural pollution etc	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation		The standing open water is listed as being associated with oligotrophic and dystrophic lakes, ponds, mesotrophic lakes, eutrophic standing waters and aquifer fed waterbodies. The habitat supporting the species are not anticipated to be influenced by changes in N discharges within the River Itchen catchment.
Eurasian teal (<i>Anas crecca</i>); Ringed plover (<i>Charadrius hiaticula</i>)						
<i>Littoral sediment</i>	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Mediterranean gull (<i>Larus melanocephalus</i>); Black-tailed godwit (<i>Limosa limosa islandica</i>)						
<i>Littoral sediment</i>	Habitat: Yes Species: Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	Potential negative impact on species due to impacts on the species' broad habitat	Increase late successional species, increase productivity increase in dominance of graminoids	Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).

Moorgreen Meadows SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Broadleaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Urtica dioica</i>)	Yes	Broadleaved deciduous woodland 10 – 20 kg N/ha/yr			Changes in soil processes, nutrient imbalance, altered composition mycorrhiza and ground vegetation	Moorgreen Meadows SSSI sits at a higher elevation to the development site, therefore changes in nitrogen as a result of the development is very unlikely to influence the site.
Fen, marsh and swamp (<i>Juncus effuses/acutiflorus</i> – <i>Galium palustre</i> rush pasture)	Yes	Moist and wet oligotrophic grasslands: <i>Molinia caerulea</i> meadows 15 – 25 kg N/ha/yr			Increase in tall graminoids, decreased diversity, decrease of bryophytes	
Fen, marsh and swamp (<i>Molinia caerulea</i> – <i>Cirsium dissectum</i> fen meadow)	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease of bryophytes	
Neutral Grassland (<i>Cynosurus cristatus</i> – <i>Centraurea nigra</i> grassland)	Yes	Low and medium altitude hay meadows 20 – 30 kg N/ha/yr			Increase in tall grasses, decrease in diversity	Moorgreen Meadows SSSI sits at a higher elevation to the development site, therefore changes in nitrogen as a result of the development is very unlikely to influence the site.
Broadleaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Fraxinus excelsior</i> – <i>Lysimachia nemorum</i> woodland)	No	-	-	-	-	
Northern Marsh Orchid (<i>Dactylorhiza purpurella</i>)		No broad habitat assigned		Seek site specific advice.		

<https://en-gb.topographic-map.com/maps/b9/England/>



Lee-on-the-Solent to Itchen Estuary SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Vascular plant assemblage	Yes	No comparable habitat with established critical load estimate available	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no nitrogen EUNIS class, for which a critical load has been set, which is comparable to the broad habitat in which the feature occurs			Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Teal (<i>Anas crecca</i>); Brent Goose (<i>Branta bernicla bernicla</i>); Dunlin (<i>Calidris alpina alpina</i>); Ringed Plover (<i>Charadrius hiaticula</i>); Grey Plover (<i>Pluvialis squatarola</i>); Redshank (<i>Tringa totanus</i>)						
Littoral sediment	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids.	No adverse effect on species as a result of N changes.
Wigeon (<i>Anas penelope</i>); Black-Tailed Godwit (<i>Limosa limosa islandica</i>); Great Crested Grebe (<i>Podiceps cristatus</i>)						
Littoral sediment	Habitat: Yes Species: Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	Potential negative impact on species due to impacts on the species' broad habitat	Increase late successional species, increase productivity increase in dominance of graminoids.	Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Teal (<i>Anas crecca</i>); Wigeon (<i>Anas penelope</i>); Great Crested Grebe (<i>Podiceps cristatus</i>)						
Standing Open Water and Canals	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to other sources of N, i.e. discharges to water, diffuse agricultural pollution etc	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Brent Goose (<i>Branta bernicla bernicla</i>)						
Improved Grassland	No	-	-	-	-	Feature not sensitive to N.

Upper Hamble Estuary and Woods SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Broadleaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Urtica dioica</i> woodland); (<i>Betula pubescens</i> – <i>Molinia caerulea</i> woodland); (<i>Salix cinerea</i> – <i>Betula pubescens</i> – <i>Phragmites australis</i> woodland); (<i>Salix cinerea</i> – <i>Galium palustre</i> workload); (<i>Salix pentandra</i> – <i>Carex rostrata</i> woodland)						
Broadleaved, mixed and yew woodland	Yes	Broadleaved deciduous woodland 10 – 20 kg N/ha/yr			Changes in soil processes, nutrient imbalance, altered composition mycorrhiza and ground vegetation	Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW
Broadleaved, mixed and yew woodland (<i>Fraxinus excelsior</i> – <i>Acer campestre</i> – <i>mercurualis perennis</i> woodland)	Yes	Meso- and eutrophic <i>Quercus</i> woodland 15 – 20 kg N/ha/yr			Changes in ground vegetation	
Fen, marsh and swamp (<i>Phragmites australis</i> swamp and reed-beds)	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease in bryophytes	
Littoral sediment (Annual <i>Salicornia</i> Saltmarsh); (<i>Artemisia maritima</i> saltmarsh); (<i>Atriplex portulacoides</i> – <i>Frakenia laevis</i> saltmarsh); (<i>Atriplex portulacoides</i> saltmarsh); (<i>Blysmus rufus</i> saltmarsh); (<i>Eleocharis uniglumis</i> saltmarsh); (<i>Elytrigia atherica</i> saltmarsh); (<i>Juncus maritimus</i> – <i>Triglochin maritima</i> saltmarsh); (<i>Juncus maritimus</i> saltmarsh); (<i>Spartina anglica</i> saltmarsh); (<i>Suaeda maritima</i> saltmarsh)						
Littoral sediment	Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr			Increase late successional species, increased productivity, increase in dominance of graminoids	Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW
Neutral grassland (<i>Cynosurus cristatus</i> – <i>Centaurea nigra</i> grassland)	Yes	Low and medium altitude hay meadows 20 – 30 kg N/ha/yr			Increase in tall grasses, decrease in diversity.	
Broad-leaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Fraxinus excelsior</i> – <i>Lysimachia nemorum</i> woodland)	No	-	-	-	-	Feature not sensitive to N.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Littoral sediment (<i>Festuca rubra</i> saltmarsh <i>Puccinellia maritima</i> sub-community)	?	No broad habitat assigned		Seek site specific advice.		Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW
Fen, marsh and swamp (<i>Glyceria maxima</i>)	No	-	-	-	-	Feature not sensitive to N.
Littoral sediment (<i>Scirpus maritimus</i> swamp)	No	-	-	-	-	Feature not sensitive to N.
Littoral sediment (<i>Spergularia marina</i> – <i>Puccinellia distans</i> saltmarsh)	No	No broad habitat assigned	-	Seek site specific advice.	-	Feature not sensitive to N.
Littoral sediment (<i>Suaeda vera</i> – <i>Limonium bibervosum</i> saltmarsh)	No	No broad habitat assigned	-	Seek site specific advice.	-	Feature not sensitive to N.
Purple Emperor (<i>Apatura iris</i>)	?	No broad habitat assigned	-	Seek site specific advice.		Found in large blocks of broadleaved woodland or clusters of smaller woods and/or dense scrub with a good supply of willow. Flies high in the tree-tops of well-wooded landscapes in central-southern England where it feeds on aphid honeydew and tree sap. The adults are extremely elusive and occur at low densities over large areas. The males occasionally descend to the ground, usually in mid-morning, where they probe for salts either from road surfaces or from animal dung. Unlikely to be influenced by changes in N associated with the site.

Lincegrove and Hackett's Marshes SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Fen, marsh and swamp (<i>Phragmites australis</i> swamp and reed-beds)	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease in bryophytes	Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW
Neutral grassland (<i>Agrostis stolonifera</i> – <i>Alopecurus geniculatus</i> grassland); (<i>Festuca rubra</i> – <i>Agrostis stolonifera</i> – <i>Potentilla anserine</i> grassland) <i>Neutral grassland</i>	Yes	Low and medium altitude hay meadows 20 – 30 kg N/ha/yr			Increase in tall grasses, decrease in diversity	Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW
Littoral sediment (Annual <i>Salicornia</i> Saltmarsh); (<i>Artemisia maritima</i> saltmarsh); (<i>Atriplex portulacoides</i> – <i>Frankenia laevis</i> saltmarsh); (<i>Atriplex portulacoides</i> saltmarsh); (<i>Blysmus rufus</i> saltmarsh); (<i>Eleocharis uniglumis</i> saltmarsh); (<i>Elytrigia atherica</i> saltmarsh); (<i>Juncus maritimus</i> – <i>Trilochin maritima</i> saltmarsh); (<i>Juncus maritimus</i> saltmarsh); (<i>Puccinellia maritima</i> saltmarsh, <i>Puccinellia maritima</i> dominant sub-community); (<i>Spartina anglica</i> saltmarsh); (<i>Suaeda maritima</i> saltmarsh) <i>Littoral sediment</i>	Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr			Increase late successional species, increase productivity, increase in dominance of graminoids	Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Littoral sediment (<i>Festuca rubra</i> saltmarsh, <i>Juncus gerardii</i> sub-community); (<i>Festuca rubra</i> saltmarsh, <i>Puccinellia maritima</i> sub-community); (<i>Spergularia marina</i> – <i>Puccinellia distans</i> saltmarsh); (<i>Suaeda vera</i> – <i>Limonium binervosum</i> saltmarsh)						
<i>Littoral sediment</i>	?	No broad habitat assigned	-	Seek site specific advice.		Only a small proportion of the site falls within this catchment, therefore change in agricultural practice from development will see a reduction in nitrogen associated with run-off, although negligible effect on site. Outside of the influence of the Chickenhall STW

Hythe to Calshot Marshes SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Littoral sediment (Annual <i>Salicornia</i> saltmarsh); (<i>Puccinellia maritima</i> saltmarsh, <i>Puccinellia maritima</i> dominant sub-community); (<i>Spartina anglica</i> saltmarsh); (<i>Suaeda maritima</i> saltmarsh);						
Littoral sediment	Yes	Pioneer, low-mid, mid-upper saltmarshes			Increase late successional species, increase productivity, increase in dominance of graminoids	Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Littoral sediment (<i>Festuca rubra</i> saltmarsh <i>Puccinellia maritima</i> sub-community)	?	No broad habitat assigned	-	Seek site specific advice.		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Teal (<i>Anas crecca</i>); Brent Goose (<i>Branta bernicla bernicla</i>); Dunlin (<i>Calidris alpina alpina</i>); Ringed Plover (<i>Charadrius hiaticula</i>); Grey Plover (<i>Pluvialis squatarola</i>); Redshank (<i>Tringa totanus</i>)						
Littoral sediment	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.
Wigeon (<i>Anas Penelope</i>); Black-tailed godwit (<i>Limosa limosa islandica</i>)						
Littoral sediment	Habitat: Yes Species: Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase late successional species, increase productivity increase in dominance of graminoids	Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Teal (<i>Anas crecca</i>); Wigeon (<i>Anas Penelope</i>)						
Standing open water and canals	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to other sources of N, i.e. discharges to water, diffuse agricultural pollution etc	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.		Potential for development to affect supporting habitat as a result of changes to N discharges in the Itchen catchment (reduced from farmland, increased from STW).
Brent Goose (<i>Branta bernicla bernicla</i>)						
Improved grassland	No	-	-	-	-	Feature not sensitive to N.

Dibden Bay SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Lapwing (<i>Vanellus vanellus</i>): <i>Littoral sediment</i>	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.
<i>Arable and horticulture</i>	No	-	-	-	-	Habitat not sensitive to N changes.
Invertebrate Assemblage	Habitat: Yes Species: Site Specific	No comparable habitat with established critical load estimate available	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no nitrogen EUNIS class, for which a critical load has been set, which is comparable to the broad habitat in which the feature occurs	Decision to be taken at a site specific level		Site is affronted by Hythe and Calshot Marshes SSSI, assemblage typically wetland and saline wetland instead of marine. Therefore, not considered likely to be affected by changes in N from the River Itchen catchment.

Eling and Bury Marshes SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Broad-leaved, mixed and yew woodland (<i>Fraxinus excelsior</i> – <i>Acer campestre</i> – <i>Mercurialis perennis</i> woodland)	Yes	Meso- and eutrophic <i>Quercus</i> woodland 15 – 20 kg N/ha/yr			Changes in ground vegetation.	Development is not considered likely to have a significant influence on the terrestrial habitat.
Littoral sediment (Annual <i>Salicornia</i> Saltmarsh); (<i>Atriplex portulacoides</i> saltmarsh); (<i>Puccinellia maritima</i> saltmarsh, <i>Puccinellia maritima</i> dominant sub-community); (<i>Spartina anglica</i> Saltmarsh); (<i>Suaeda maritima</i> Saltmarsh)						
Littoral sediment	Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr			Increase late successional species, increase productivity increase in dominance of graminoids	Although potential exists, the site is located upstream in Southampton Water and therefore influence will only occur at high tide, with greater dilution of inputs, therefore unlikely to have a significant influence on the site.
Teal (<i>Anas crecca</i>); Brent Goose (<i>Branta bernicla bernicla</i>); Ringed Plover (<i>Charadrius hiaticula</i>)						
Littoral sediment	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.
Black-tailed godwit (<i>Limosa limosa islandica</i>)						
Littoral sediment	Habitat: Yes Species: Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase late successional species, increase productivity increase in dominance of graminoids	Although potential exists, the site is located upstream in Southampton Water and therefore influence will only occur at high tide, with greater dilution of inputs, therefore unlikely to have a significant influence on the site.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Teal (<i>Anas crecca</i>)						
<i>Standing open water and canals</i>	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to other sources of N, i.e. discharges to water, diffuse agricultural pollution etc	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.		Although potential exists, the site is located upstream in Southampton Water and therefore influence will only occur at high tide, with greater dilution of inputs, therefore unlikely to have a significant influence on the site.
Brent Goose (<i>Branta bernicla bernicla</i>)						
<i>Improved grassland</i>	No	-	-	-	-	Feature not sensitive to N.

Lower Test Valley SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Fen, marsh and swamp (<i>Filipendula ulmaria</i> – <i>Angelica sylvestris</i> mire); (<i>Juncus subnodulosus</i> - <i>Cirsium palustre</i> fen meadow); (<i>Phragmites australis</i> swamp and reed-beds)						
Fen, marsh and swamp	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease in bryophytes	Upstream of Southampton Water, typically outside of the influence of tidal water (above MHW) therefore changes in N in the River Itchen catchment unlikely to influence the habitat.
Fen, marsh and swamp (<i>Carex acutiformis</i> swamp); (<i>Carex riparia</i> swamp); (<i>Glyceria fluitans</i> water-margin vegetation); (<i>Glyceria maxima</i> swamp); (Other water-margin vegetation); (<i>Phalaris arundinacea</i> tall-herb fen); (<i>Phragmites australis</i> - <i>Urtica dioica</i> tall-herb fen); (<i>Scirpus lacustris</i> ssp. <i>tabernaemontani</i> swamp); (<i>Sparganium erectum</i> swamp)						
Fen, marsh and swamp	No	-	-	-	-	Feature not sensitive to N.
Neutral grassland (<i>Agrostis stolonifera</i> - <i>Alopecurus geniculatus</i> grassland); (<i>Cynosurus cristatus</i> - <i>Caltha palustris</i> grassland); (<i>Cynosurus cristatus</i> - <i>Centaurea nigra</i> grassland); (<i>Festuca rubra</i> - <i>Agrostis stolonifera</i> - <i>Potentilla anserina</i> grassland);						
Neutral grassland	Yes	Low and medium altitude hay meadows 20 – 30 kg N/ha/yr			Increase in tall grasses, decrease in diversity	Development is not considered likely to have a significant influence on the terrestrial habitat.
Littoral sediment (Annual <i>Salicornia</i> Saltmarsh); (<i>Atriplex portulacoides</i> saltmarsh); (<i>Eleocharis uniglumis</i> saltmarsh); (<i>Elytrigia atherica</i> saltmarsh); (<i>Puccinellia maritima</i> saltmarsh, <i>Puccinellia maritima</i> dominant sub-community); (<i>Spartina anglica</i> Saltmarsh); (<i>Suaeda maritima</i> Saltmarsh);						
Littoral sediment	Yes	Pioneer, low- mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr			Increase late successional species, increase productivity increase in dominance of graminoids	Although potential exists, the site is located upstream in Southampton Water and therefore influence will only occur at high tide, with greater dilution of inputs, therefore unlikely to have a significant influence on the site.
Littoral sediment (<i>Festuca rubra</i> saltmarsh <i>Festuca rubra</i> - <i>Glaux maritima</i> sub-community); (<i>Festuca rubra</i> saltmarsh <i>Juncus gerardii</i> sub-community); (<i>Festuca rubra</i> saltmarsh <i>Leontodon autumnalis</i> sub-community); (<i>Festuca rubra</i> saltmarsh tall <i>Festuca rubra</i> sub-community)						
Littoral sediment	?	No broad habitat assigned	-	Seek site specific advice.		Although potential exists, the site is located upstream in Southampton Water and therefore influence will only occur at high tide, with greater dilution of inputs, therefore unlikely to have a significant influence on the site.
Littoral sediment (<i>Scirpus maritimus</i> swamp)	No	-	-	-	-	Feature not sensitive to N.

North Solent SSSI

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Acid grassland (<i>Festuca ovina</i> – <i>Agrostis capillaris</i> – <i>Rumex acetosella</i> grassland)	Yes	Inland dune siliceous grasslands 8 – 15 kg N/ha/yr			Decrease in lichens, increase biomass, increased succession.	Development is not considered likely to have a significant influence on the terrestrial habitat.
Neutral grassland (<i>Cynosurus cristatus</i> - <i>Caltha palustris</i> grassland); (<i>Cynosurus cristatus</i> - <i>Centaurea nigra</i> grassland); (<i>Festuca rubra</i> - <i>Agrostis stolonifera</i> - <i>Potentilla anserina</i> grassland); (<i>Lolium perenne</i> - <i>Cynosurus cristatus</i> grassland);						
Neutral grassland	Yes	Low and medium altitude hay meadows 20 – 30 kg N/ha/yr			Increase in tall grasses, decrease in diversity	Development is not considered likely to have a significant influence on the terrestrial habitat.
Littoral sediment (Annual <i>Salicornia</i> Saltmarsh); (<i>Atriplex portulacoides</i> saltmarsh); (<i>Elytrigia atherica</i> saltmarsh); (<i>Juncus maritimus</i> - <i>Triglochin maritima</i> saltmarsh); (<i>Juncus maritimus</i> saltmarsh); (<i>Spartina anglica</i> Saltmarsh); (<i>Suaeda maritima</i> Saltmarsh); (<i>Suaeda vera</i> drift-line); (Transitional low marsh vegetation with <i>Puccinellia maritima</i> , annual <i>Salicornia</i> species and <i>Suaeda maritima</i>);						
Littoral sediment	Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr			Increase late successional species, increase productivity increase in dominance of graminoids	Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Littoral sediment (<i>Festuca rubra</i> saltmarsh <i>Puccinellia maritima</i> sub-community); (<i>Zostera communities</i>)						
Littoral sediment	?	No broad habitat assigned	-	Seek site specific advice.		Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Littoral sediment (<i>Scirpus maritimus</i> swamp); (<i>Spergularia marina</i> - <i>Puccinellia distans</i> saltmarsh);						
Littoral sediment	No	-	-	-	-	Feature not sensitive to N.
Supralittoral sediment (<i>Festuca rubra</i> – <i>Galium verum</i> fixed dune grassland)	Yes	Coastal stable dune grasslands 8 – 15 kg N/ha/yr			Increase tall grasses, decrease prostrate plants, increased N leaching, soil acidification, loss of typical lichen species	Habitats are all supralittoral and therefore unlikely to be significantly influenced by the project and changes in N in the River Itchen catchment.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Supralittoral sediment (<i>Matricaria maritima</i> - <i>Galium aparine</i> strandline community); (<i>Rumex crispus</i> - <i>Glaucium flavum</i> shingle community)						
Supralittoral sediment	?	No broad habitat assigned	-	Seek site specific advice.		Habitats are all supralittoral and therefore unlikely to be significantly influenced by the project and changes in N in the River Itchen catchment.
Broad-leaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Carex paniculata</i> woodland); (<i>Betula pubescens</i> - <i>Molinia caerulea</i> woodland); (<i>Crataegus monogyna</i> - <i>Hedra helix</i> scrub); (<i>Salix cinerea</i> - <i>Betula pubescens</i> - <i>Phragmites australis</i> woodland);						
Broad-leaved, mixed and yew woodland	Yes	Broadleaved deciduous woodland 10 – 20 kg N/ha/yr			Changes in soil processes, nutrient imbalance, altered composition mycorrhiza and ground vegetation	Development is not considered likely to have a significant influence on the terrestrial habitat.
Broad-leaved, mixed and yew woodland (<i>Fraxinus excelsior</i> – <i>Acer campestre</i> – <i>Mercurialis perennis</i> woodland); (<i>Quercus robur</i> - <i>Pteridium aquilinum</i> - <i>Rubus fruticosus</i> woodland);						
Broad-leaved, mixed and yew woodland	Yes	Meso- and eutrophic <i>Quercus</i> woodland 15 – 20 kg N/ha/yr			Changes in ground vegetation	Development is not considered likely to have a significant influence on the terrestrial habitat.
Broad-leaved, mixed and yew woodland (<i>Alnus glutinosa</i> – <i>Fraxinus excelsior</i> <i>Lysimachia nemorum</i> woodland)	No	-	-	-	-	Feature not sensitive to N.
Dwarf shrub heath (<i>Calluna vulgaris</i> – <i>Ulex minor</i> heath); (<i>Ulex minor</i> - <i>Agrostis curtisii</i> heath)						
Dwarf shrub heath	Yes	Dry heaths 10 – 20 kg N/ha/yr			Transition from heather to grass dominance, decline in lichens, changes in plant biochemistry, increased sensitivity to abiotic stress	Development is not considered likely to have a significant influence on the terrestrial habitat.
Dwarf shrub heath (<i>Ulex minor</i> - <i>Agrostis curtisii</i> heath)	Yes	Northern wet heath: <i>Erica tetralix</i> dominated wet heath 10 – 20 kg N/ha/yr			Transition heather to grass. Ericaceous species susceptible to frost and drought.	

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Fen, marsh and swamp (<i>Juncus effusus</i> / <i>acutiflorus</i> - <i>Galium palustre</i> rush pasture); (<i>Molinia caerulea</i> – <i>Potentilla erecta</i> mire)						
Fen, marsh and swamp	Yes	Moist and wet oligotrophic grasslands: <i>Molinia caerulea</i> meadows 15 – 25 kg N/ha/yr			Increase in tall graminoids, decreased diversity, decrease of bryophytes	Units indicating this as the main habitat are all located on the distant side of Southampton Water and around the shoreline to the west (Calshot, Lepe, Thorns Beach and Beaulieu). Therefore very unlikely to be influenced by changes in N in the River Itchen catchment.
Fen, marsh and swamp (<i>Carex paniculata</i> swamp); (<i>Juncus subnodulosus</i> - <i>Cirsium palustre</i> fen meadow); (<i>Phragmites australis</i> swamp and reed-beds)						
Fen, marsh and swamp	Yes	Rich fens 15 – 30 kg N/ha/yr			Increase in tall graminoids, decrease in bryophytes	As above
Vascular plant assemblage	Yes	No comparable habitat with established critical load estimate available			Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no nitrogen EUNIS class, for which a critical load has been set, which is comparable to the broad habitat in which the feature occurs	Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Little Tern (<i>Sterna albifrons</i>); Common Tern (<i>Sterna hirundo</i>); Sandwich Tern (<i>Sterna sandvicensis</i>);						
<i>Supralittoral sediment (acidic type)</i>	Habitat: Yes Species: Yes	Coastal stable dune grasslands - acid type 8 – 10 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set.	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase tall grasses, decrease prostrate plants, increased N leaching, soil acidification, loss of typical lichen species	Habitats are all supralittoral and therefore unlikely to be significantly influenced by the project and changes in N in the River Itchen catchment.
<i>Supralittoral sediment</i>		Shifting coastal dunes 10 – 20 kg N/ha/yr			Biomass increase, increase N leaching	
<i>Supralittoral sediment (calcareous type)</i>		Coastal stable dune grasslands - calcareous type 10 – 15 kg N/ha/yr			Increase tall grasses, decrease prostrate plants, increased N leaching, soil acidification, loss of typical lichen species	
Common Tern (<i>Sterna hirundo</i>); Teal (<i>Anas crecca</i>);						
<i>Standing Open Water and Canals</i>	Yes	No comparable habitat with established critical load estimate available	No Critical Load has been assigned to the EUNIS classes for meso/eutrophic systems. These systems are often P limited (or N/P co-limiting), therefore decisions should be taken at a site specific level. Furthermore, consideration should also be given to other sources of N, i.e.discharges to water, diffuse agricultural pollution etc	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.		Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Teal (<i>Anas crecca</i>); Brent Goose (<i>Branta bernicla bernicla</i>); Dunlin (<i>Calidris alpina alpina</i>); Ringed Plover (<i>Charadrius hiaticula</i>); Oystercatcher (<i>Haematopus ostralegus</i>); Grey Plover (<i>Pluvialis squatarola</i>);						
<i>Littoral Sediment</i>	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.

Habitat/Species	Sensitive to N?	Relevant N Critical Load Class	Justification for linking habitat to Critical Load Class	Reason for sensitivity to nutrient nitrogen impacts on broad habitat	Exceedance Impacts	Comments on Sensitivity to Changes in N on Development Site
Black-tailed godwit (<i>Limosa limosa islandica</i>)						
<i>Littoral Sediment</i>	Habitat: Yes Species: Yes	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) this EUNIS class contains, overlaps with or is contained within the Broad Habitat, or component of the broad habitat, in which the feature occurs, and represents the most equivalent EUNIS class for which a critical load is set	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.	Increase late successional species, increase productivity increase in dominance of graminoids	Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Turnstone (<i>Arenaria interpres</i>)						
<i>Littoral rock</i>	Habitat: Yes Species: No	Pioneer, low-mid, mid-upper saltmarshes 20 – 30 kg N/ha/yr	Based on the NBN Habitats Dictionary (http://www.nbn.org.uk/habitats) there is no exact or close match between the EUNIS classes for which critical loads are set and the broad habitat in which the feature occurs. Therefore, taking account of the likely sensitivity of the ecosystem to atmospheric nitrogen deposition, the broad habitat, in which the feature occurs, is matched to a EUNIS critical loads class based on expert judgement	1. No expected negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply	Increase late successional species, increase productivity increase in dominance of graminoids	No adverse effect on species as a result of N changes.
Brent Goose (<i>Branta bernicla bernicla</i>)						
<i>Improved grassland</i>	No	-	-	-	-	Feature not sensitive to N.
Spotted Redshank (<i>Tringa erythropus</i>)						
<i>No broad habitat assigned</i>	?	No broad habitat assigned	-	Seek site specific advice.		Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Invertebrate Assemblage	Yes	No broad habitat assigned	-	Seek site specific advice.		
Lowland damp grasslands	?	No broad habitat assigned	-	Seek site specific advice.		No effect anticipated on the terrestrial habitat from the development site.
Lowland open waters and their margins	?	No broad habitat assigned	-	Seek site specific advice.		Although potential exists, the site is located in the Solent where there is a greater volume of water that will provide dilution effects. Influence will, therefore, be minimal.
Sand-dunes and saltmarshes	?	No broad habitat assigned	-	Seek site specific advice.		

Appendix 5 Soil Types

Soil types

Soilscape 10: (Parcels 51, 48, 33)

Freely draining slightly acid sandy soils

- Texture:
Sandy
- Drainage:
Freely draining
- Fertility:
Low
- Landcover:
Arable
- Carbon:
Low
- Drains to:
Groundwater
- Water protection:
Particularly vulnerable to leaching of nitrate and pesticides to groundwater; Highly erodible under arable and vegetable crops, where sloping, resulting in eutrophication and clogging of stream bed with sand.
- General cropping:
Suitable for wide range of spring and autumn sown crops including irrigated roots, potatoes and field vegetables; lime and fertiliser rapidly leached; shortage of soil moisture will limit yield without irrigation



Soilscape 18: (all other parcels)

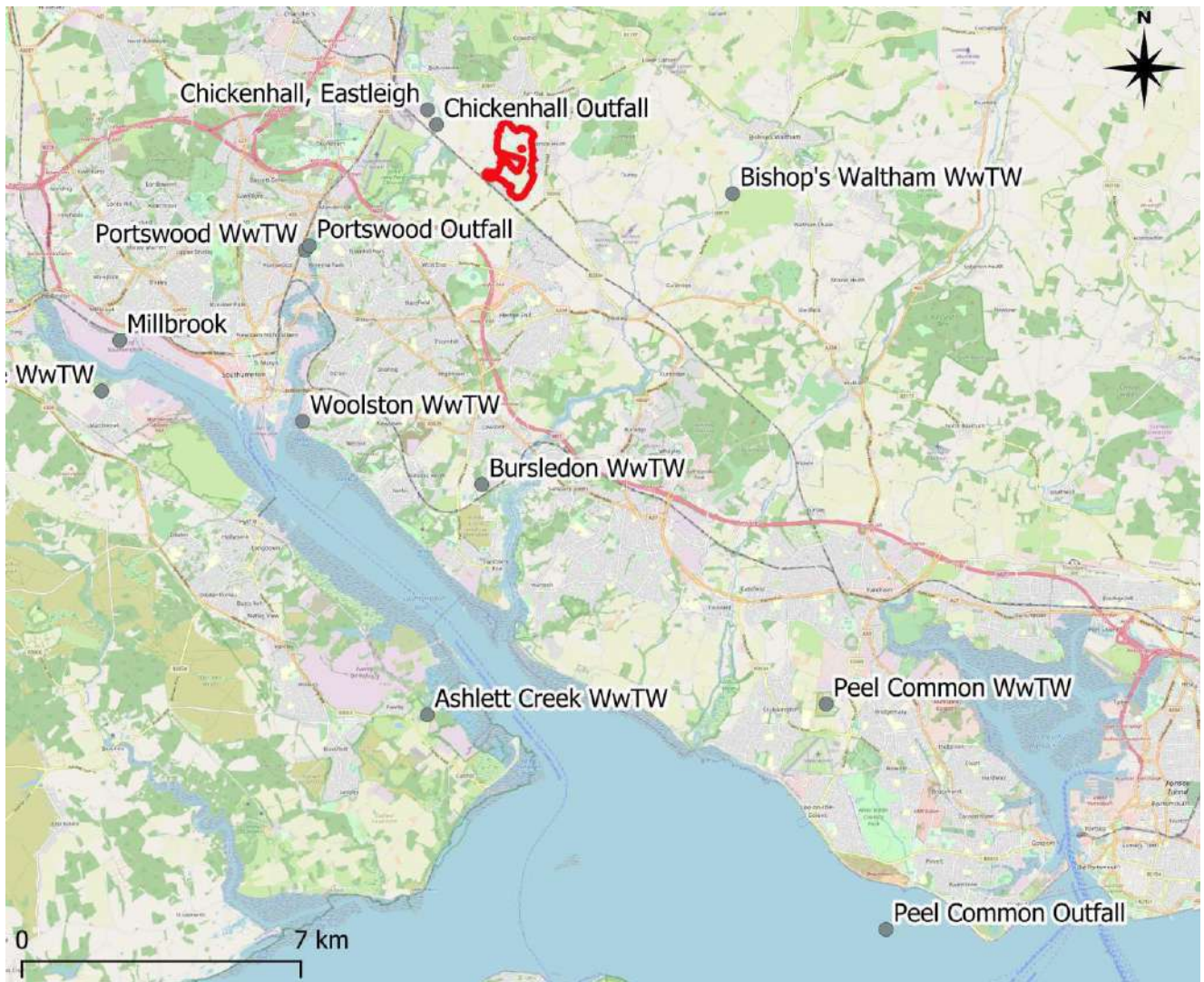
Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils

- Texture:
Loamy and clayey
- Drainage:
Impeded. Drains to stream network
- Fertility:
Moderate
- Habitats:
Seasonally wet pastures and woodlands
- Landcover:
Grassland and arable some woodland
- Carbon:
Low
- Drains to:
Stream network
- Water protection:
Main risks are associated with overland flow from compacted or poached fields. Organic slurry, dirty water, fertiliser, pathogens and fine sediment can all move in suspension or solution with overland flow or drain water
- General cropping:
Mostly suited to grass production for dairying or beef; some cereal production often for feed. Timeliness of stocking and fieldwork is important, and wet ground conditions should be avoided at the beginning and end of the growing season to avoid damage to soil structure. Land is tile drained and periodic moling or subsoiling will assist drainage.

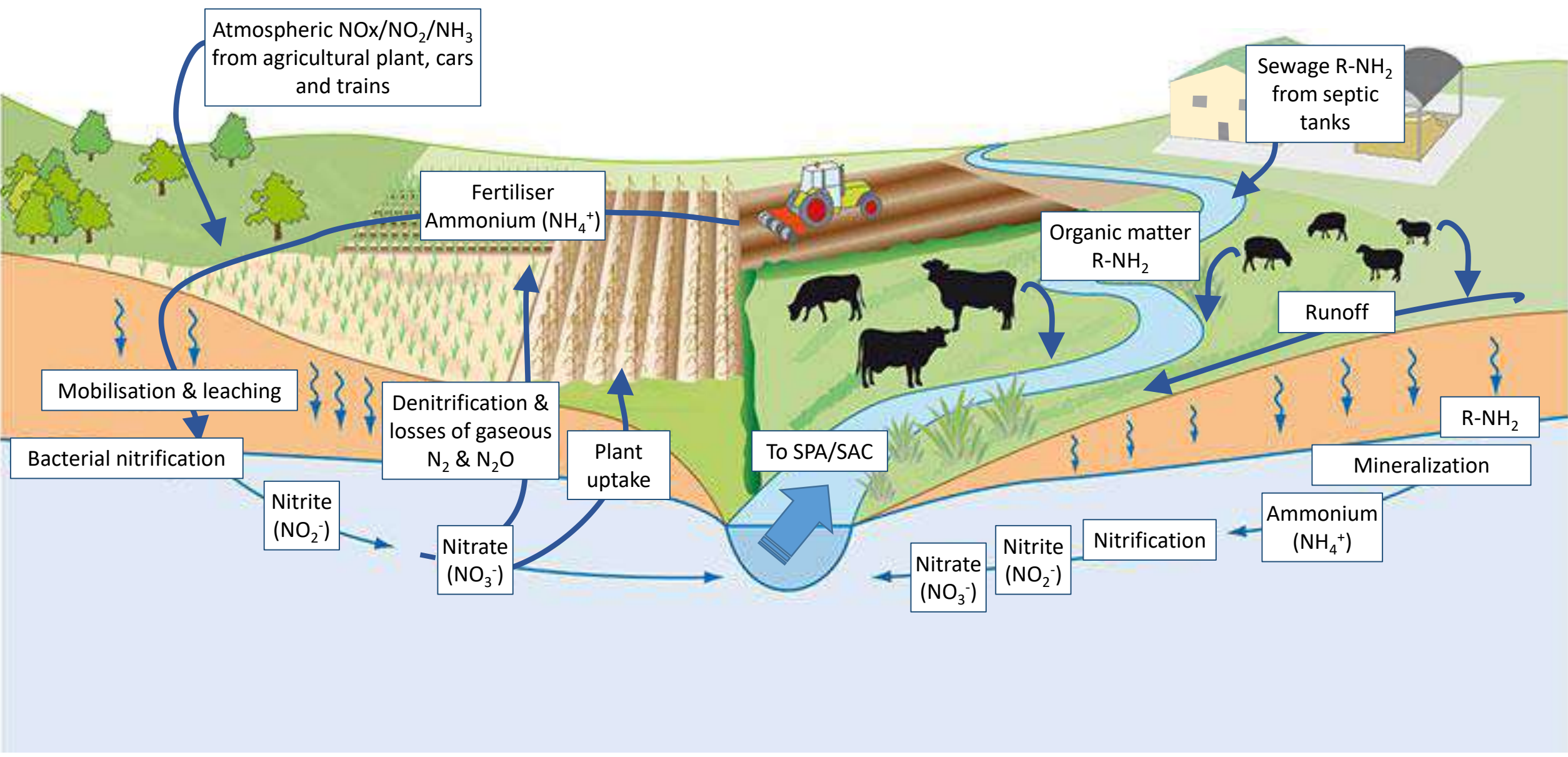


Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water
Superficial – Secondary A
Bedrock – Secondary A

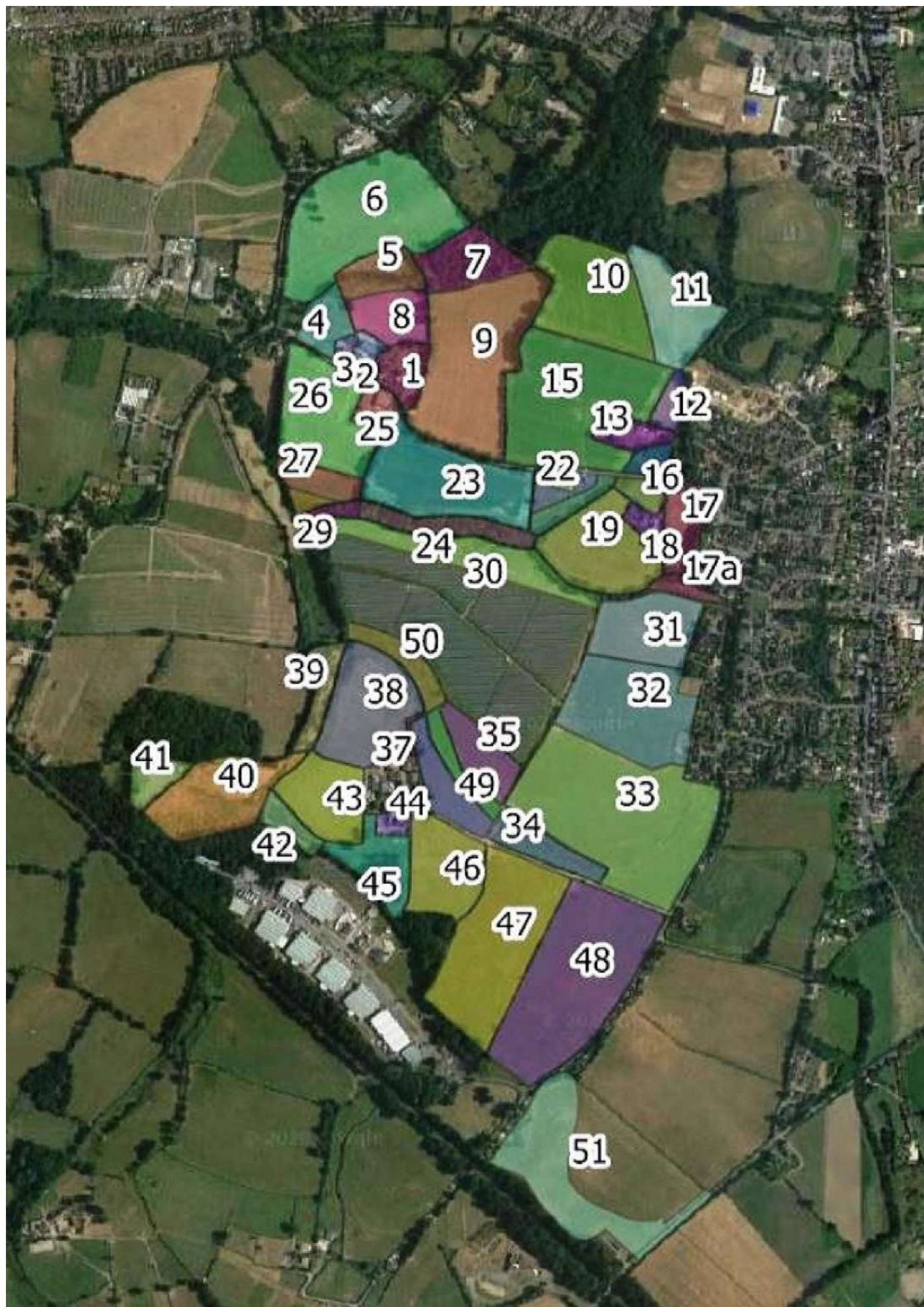
Appendix 6 Nearby WwTWs



Appendix 7 Conceptual Site Model



Appendix 8 GIS Parcels



Appendix 9 Summary GIS Data

Parcel No.	Land Use		Soil Type	Texture	Aquifer	Drainage	Hazard	Fertiliser Application (kg N/ha)	Manure Application (kg N/ha)	Total Fertiliser N (kg)	Total FYM N (kg)	Field Notes	Use
1	Residential house with gardens	1.11	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Residential dwelling with private gardens and swimming pool. Surrounded by 3 m wide hedge (PB1).	B
2	Demolished buildings.	0.52	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Area of bare muddy compacted ground with demolition debris throughout. Surounded by 2 m wide hedge. Small drainage ditch with running water along northern boundary, approx 100 mm deep flowing westwards (PB2).	U
3	Boarded up house with derelict pool and gardens.	0.23	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Derelict residential dwelling, with derelict private gardens and disused swimming pool. Plot surrounded by 2 m wide hedge. Small drainage ditch with running water along northern boundary, approx 100 mm deep flowing westwards (PB3)	U
4	Fallow grass field. Cut only, not grazed.	1.13	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	113.43	0.00	Permanent pasture (hay cut). Small watercourse meanders across this field with shallow open channel/wetland area with rushes established along course. Deep ruts formed where vehicles have tracked across this very wet field exposing orange silty/clayey soils. Free oil contamination exposed on standing water within ruts. From plant? 2 m wide hedge along southern and eastern boundary. NE boundary is fenced (barbed wire) with vehicle track beyond. South western boundary currently comprises temporary fence to adjacent residential dwelling beyond red-line boundary. North western boundary comprises small watercourse flowing south-westwards towards pool in residential property. Water muddy and up to 0.5 m deep. Some poaching evident adjacent to watercourse (by sheep and/or cattle, although not present at the time). Free oil evident on standing water in this poached area. Molehills indicate soils pass to sandy/gravelly loam adjacent to watercourse (alluvium?) (PB4, PB5 & PB6).	F
5	Fallow grass field. Cut only, not grazed, marshy.	1.45	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	145.11	0.00	Wet rough unimproved grassland with rushes. Small watercourse, the banks lined with small trees and shrubs, flows through centre of plot, approx 0.4 m deep, flowing westwards. Southern boundary fenced, north-rn boundary 2 m wide hedge (PB7).	F
6	Grazed by sheep.	6.12	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	90	2.2	550.95	13.47	Permanent pasture - grass with buttercups, very little clover. Rutting by vehicles in western half of field indicates a clayey loam soil. Ground very wet with standing water in ruts. Majority of field enclosed by 2 m wide hedge. Archaeological dig in northern half of the field at the time of the survey indicated ~300 mm chestnut brown silty clayey loam overlying orange clay bedrock. Wide drainage channel running along northern boundary adjacent to road. Approx 200 mm depth of water flowing north eastwards. Piezometer with blue wellhead in western centre of field. Free oil contamination observed on standing water in north eastern corner of field, adjacent to spoil heap of sandy clay. Beyond eastern boundary hedge lies a series of small ponds with bullrushes. Residential development progressing beyond. Amphibian fencing around ponds. Ponds interconnected by drainage channel flowing north along northern half of boundary towards highway drainage and south along southern half of boundary towards woodland and Quoibleigh Pond (PB8, PB9 & PB10).	RG
7	Wet woodland area.	2.08	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Wet broadleaved woodland, with grass and bramble understorey. Wide vegetated wetland through centre, flowing westwards towards large pond. Dry channel running eastwards along fenced northern boundary (PB11).	W
8	Fallow grass field. Cut only, not grazed, marshy.	1.64	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	164.31	0.00	Permanent pasture. Sloping gently north-westwards towards Parcel 5 and adjacent watercourse. Fenced along northern boundary. Aprox 2 m wide hedges forming remaining boundaries with flowing drainage ditches along south western and western boundaries, flowing westerly and northerly, respectively. Footpath along northern boundary. Molehills indicate soil is a medium brown silty loam (PB12).	F
9	Pasture with hay cut.	7.37	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	90	0	663.68	0.00	Permanent pasture. Southern, western and south eastern boundaries ~2 m thick hedgerow. Northern boundary fenced, with woodland beyond. Scrub and woodland understorey encroaches approx 3 m into field along this boundary. Hedgerow approx 3 m wide in north eastern corner adjacent to Parcel 10. Footpath also along northern boundary. Northern half of field drains north-westerly towards Parcel 7 and associated watercourse. Southern half of field drains south-westerly towards Fir Tree Lane. Piezometer close to northern boundary - metal cover badly damaged by machinery with head of well open to the elements - needs repairing (PB13).	RG
10	Wheat.	4.64	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	300	0	1391.44	0.00	Arable (wheat?) crop. Known as "10 acre field". Northern boundary fenced, with flailed woodland understorey/set aside encroaching approx 5 m into field (including footpath which is also along this boundary). Field generally drains westwards. Small wet drainage ditch along north western boundary flowing towards the watercourse in Parcel 7. Relic hedge along eastern boundary although mainly just fence with scattered shrubs. 2 m wide hedge along southern boundary, with 3 m wide hedge along western boundary. Occasional free oil contamination on standing water along northern boundary and in north east corner (PB15).	M/W
11	Fallow grass field. Cut only, not grazed.	2.86	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	285.92	0.00	Permanent pasture. Northern and eastern boundary fenced, with flailed woodland understorey/set aside encroaching approx 3 m into field. Western boundary fenced with relic hedge, comprising occasional scattered shrubs. Footpath through centre of field. Field generally drains northwards. Occasional free oil contamination on standing water along northern and western boundarie (PB16).	F
12	Fallow grass field. Cut only, containing old manure pile.	0.62	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	61.85	0.00	Pasture. Some waterlogging at northern end with localised oil contamination. New housing development currently being built beyond site boundary to the east. Ditch running northwards and new trash screen constructed just beyond hedge along eastern boundary, as part of new development. Public footpath runs through middle of field. Large well rotted manure heap, comprising straw and cattle waste at northern end of field adjacent to northern boundary. Low percentage of clover with docks and chickweed in ward. 2 m wide hedge with scatted trees along eastern boundary. Gappy 2 m wide hedge along western boundary, incomplete at northern end (PB17).	F
13	Dwelling and surrounding grounds.	0.86	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Foxhole Cottages - residential dwellings, buildings and associated gardens. Surrounded by thick 2 m wide hedge with scattered trees (PB18).	U
14	Fallow grass field. Cut only.	0.49	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	48.81	0.00	Wet and scrubby fallow land with rushes. 3 m wide hedge with scattered trees along northern, eastern and southern boundaries with scrub encroaching into field. More formal 2 m wide hedge along western boundary (PB19).	F
14a	Small wooded area to east of footpath.	0.67	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Small area of woodland to east of footpath with public access.	W
15	Wheat.	7.39	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	300	0	2216.44	0.00	Winter wheat. Field gently sloping towards Fir Tree Lane. 2 m wide hedges along northern, eastern and southern boundaries. Thicker 3 m hedge with shrubs and small trees along western boundary. Piezometer located at southern end opposite residential dwelling/flower retailer. Large ditch along southern boundary fronting onto Fir Tree Lane full of standing water and overtopping onto highway (PB20).	M/W

16	Fallow grass field. Cut only.	0.53	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	100	0	52.78	0.00	Set aside. Rough grassland with tall ruderals. Thick informal hedge along northern and western boundaries. Remnant hedge along eastern boundary and fencing along southern boundary (PB21).	F
17	Playing field.	1.53	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Playing fields with relatively long amenity turf surrounded by thick hedges with areas of woodland and shrubs along eastern and southern boundaries. Waterlogging of soils at southern end and associated poaching by human footfall at the southern access point to the fields (PB22).	SA
17a	Small wooded area beside watercourse.	0.46	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Small strip of coppiced woodland with muddy public footpath and small stream running through it (flowing westwards) (PB23).	W
18	Demolished farmhouse and surrounding garden (now rubble and scrub).	0.53	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Highly disturbed area - former Foxholes Farmhouse, comprising heaps of demolition rubble, comprising bricks, soil, steel supports, corrugated iron sheeting, paint and chemical cans and a number of large gas cylinders. Enclosed by temporary construction fencing. Standing water in wheel ruts and puddles exhibiting significant algal growth, with large patches of black of oil stained soils in places (PB24).	SA
19	Fallow scrubby field.	3.73	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Rough grassland with tall sward and ruderals (set aside). 3 m wide thick hedgerows along western and eastern boundaries. Thick area of woodland and shrubs along southern boundary with 200 mm deep fast flowing stream - flowing eastwards dissipating in places into diffuse wetland, particularly at eastern end. Channel becomes more defined westwards. Also wet ditch flowing southwards at southern end of western boundary. Large overgrown pond in SW corner, with emergent vegetation and surrounded by brambles. Small island in middle. Small stand of Japanese Knotweed in centre of southern boundary on the northern side of the stream (stand approximately 4 x 3 m) (PB25).	SA
20	Wet scrubland area.	0.68	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Rough grassland with clumps of tall ruderals. Small watercourse flowing through middle of parcel towards stream to the south. All hedgerow boundaries other than fenced boundary with Foxholes Garage to north and west (PB26).	SA
21	Residential dwelling and flower sales - not part of site.	0.18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Outside of site - residential dwelling and outbuildings including Foxholes Garage and flower retailer. Small wet ditch with standing water along frontage onto Fir Tree Lane (PB27).	U
22	Private grassed field - not part of the site.	0.59	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Outside of Site - grassland/ lawn surrounding Foxholes Garage and associated outbuildings (PB28).	U
23	Wheat.	4.96	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	300	0	1487.33	0.00	"12 Acres" field. Winter wheat. 2 m wide hedge along eastern and northern boundaries. Wet shallow ditch full of litter along Fir Tree Lane frontage. Little evidence of flow, but slope westwards. 3 m wide hedge along western boundary with scattered trees. To the south lies a strip of woodland with stream (see Parcel 24) (PB29).	M/W
24	Wet scrub and woodland.	1.35	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Strip of woodland and shrubs with small stream running westwards through it (PB30).	SA
25	Victoria Farmhouse.	0.67	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Victoria House - residential dwelling with associated gardens and out buildings. Walled along frontage to Fir Tree Lane, with hedges along western and eastern boundaries and fenced along southern boundary (PB33).	U
25a	Fir Tree Lane	0.86	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Highway with grass verges	U
26	Hay field.	4.15	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	90	38.4	373.94	159.55	Pasture. 3 m wide hedges with scattered trees along western and eastern boundary. 2 m wide hedge along Fir Tree Lane frontage. Piezometer in NW corner. Field slopes southwards with gappy 2 m wide hedge along southern boundary. Molehills indicate that soil is a light brown silty loam (PB34).	RG
27	Fallow field, only cut.	0.99	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	90	0	89.35	0.00	Pasture - grading into wetter conditions southwards. 3 m wide hedge along western boundary with scattered trees and small watercourse flowing northwards. 3 m wide hedge with scattered trees along eastern boundary, with woodland bordering small watercourse flowing westwards along SE boundary (PB37).	F
28	Fallow field, only cut.	0.28	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	90	0	25.56	0.00	To the south of Parcel 27 lies a triangle of wet tall ruderals. Vegetation recently cut and left on ground. In places standing water exhibited bright orange staining and free oil contamination. To the west lies 3 m wide hedge and associated watercourse (up to 500 mm deep in places) flowing northwards. To the south lies scrubby/woodland area of Parcel 29 with watercourse flowing westwards (PB38).	F
29	Wet scrubland.	0.29	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Wet scrubby and woodland area with small watercourse (approx 300 mm deep) flowing westwards forming confluence with boundary watercourse to the west, which then flows northwards (PB39).	SA
30	Grazed by cattle.	3.13	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	9.38	302.25	Pasture. Narrow strip of land north of the solar farm. Gentle slope to the north towards the stream. Bordered to the north by trees. While the solar farm is outside the site boundary, Simon Owton mentioned that he owned the land and leased it to the solar farm. He cuts the grass around the solar panels 3 times a year, the grass is left on site (JG21).	PP
31	Alternates annually between maize and silage.	2.95	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	49	66.8	144.70	197.26	Maize (grown every other year) (JG1).	M
32	Silage cut in May, than grazed by cattle June - Nov.	5.03	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	120	38.2	603.34	192.06	Pasture/silage (JG2).	RG
33	Silage cut in May, than grazed by cattle June - Nov.	10.24	Freely draining slightly acid sandy soils	Sandy	Bedrock - Secondary A	Freely draining. Drains to groundwater.	Vulnerable to leaching of nitrate and pesticides to groundwater; Highly erodible under arable and vegetable crops, where sloping, resulting in eutrophication and clogging of stream bed with sand.	120	38.2	1228.50	391.07	Pasture/silage. Land gently slopes towards stream. Gravel clay at far south west corner. Fence on boundary with Parcel 2, 3 m hedge all along eastern flank and boundary with parcel 4. Borehole location indicated by red cross. Water sample location 3 at star. Water sample taken as stream enters site boundary shows nitrate levels 0 ppm, ammonia levels between 0.25 and 0.5 ppm and nitrate levels around 5 ppm. Hedge also runs along farm track. North boundary of this field is a barbed wire fence between this field and Parcel 32 (JG3, EP9 & EF10).	RG

34	Marshy land, grazed by cattle who have access to watercourse - very large manure pile in this field.	1.35	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	4.06	130.80	Narrow strip of boggy marsh land with land sloping gently towards a stream cutting through the middle of the field. Path divides Parcel 4 and 6. Large manure heap in south east corner of parcel to the right of the path just as you enter the field (brown circle). Water sample location 2 indicated by yellow star. 3 m hedge borders parcel (JG4 & EF12).	PP
35	Grazed by cattle.	1.71	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	5.12	164.85	Pasture. Gently sloping south east towards stream. Field surrounded with 3 m hedge (JG5).	PP
36	Grazed by cattle.	1.59	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	4.78	154.18	Pasture. Gently sloping towards stream. Flatter in south eastern corner. Low 3 m wide hedge on boundary with Parcel 39, high 3 m hedge on western flank closer to farm buildings (JG8).	pp
37	Ditch full of slurry.	0.10	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	96.68	0.00	9.39	Steeply sloping towards stream. Ditch running along east and south east boundary of parcel filled with polluted water. Manure left in piles. Water run off from farm building and yard runs through here via ditch towards stream in Parcel 20. Contents of the ditch were more like sludge than water despite the recent heavy rain (JG9 & EF6).	PP
38	Grazed by cattle.	3.93	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	11.78	379.75	Pasture. Land quickly falls away towards the streams on the western and northern boundaries of the field as shown by the green lines and arrows. Slope is particularly steep on boundary with Parcel 39 (see image). Tall, wide hedgerow boundary with Parcel 39. Despite the slope, the field is very waterlogged in placed with a mainly clay soil (JG10 & EF4).	PP
39	Grazed by cattle.	1.00	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	3.00	96.82	Narrow strip of land accessible by a small rickety bridge. Very waterlogged, parts were knee deep with water at time of site visit. Long grasses and reed species were established here. A small wood on a steep slope is located to the north east of the field. A ditch slowly flowing north was located at the boundary of the waterlogged field and the wooded area. Cut branches were piled around the field (J11 & EF3).	pp
40	Marshy grazing for cattle.	3.68	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	11.05	356.17	Pasture, but at time of visit very boggy waterlogged marsh-land. Land flat. Small watercourses found running through the middle of the field and in water ditches along all the edges of the field, all flowing in a north-easterly direction. Two large clumps of frogspawn were found in the stream in the middle of the field. A small wooden footbridge allows access via the footpath through the field over the stream ditches. Woodland on either side (JG12).	pp
41	Marshy grazing for cattle.	0.96	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	2.89	93.09	Pasture. Land is separated from Parcel 10 by a small hedgerow within which was located a drainage ditch. Land is flat and enclosed by woodland to the north and south (JG13).	pp
42	Marshy grazing for cattle.	0.74	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	2.23	71.85	Pasture. Flat marsh-land. 3 m wide hedge on northern flank, woodland on southern. Two mounds of earth mixed with rubble and gravel were found close to the woodland side of the field halfway along the length of the field. A ditch runs along the southern boundary closest to the woodland transporting water in a westerly direction. A medium sized stream to the north west separates Parcels 42 and 40 (JG14).	PP
43	Grazed by cattle, small manure pile on slope.	2.66	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	7.97	256.97	Pasture. Gently sloping to the west. Waterlogged ground to the west and south-west. Drainage ditch running alongside hedge on the north west flank. Two streams converge in the northern corner of the field and at the time of site visit the stream was flowing fast. The car park for the farm buildings (capacity approx 50 cars) is adjacent to the eastern flank of the field. Small manure pile in western corner of the field indicated by brown circle (JG15 & EF11).	pp
44	Used as a waste store - mainly hardstanding.	0.35	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Buildings to the south of the pond are mostly derelict with a dumping ground behind. Waste is well organised and is mostly scrap metal, broken pallets and cardboard. Car park has space for around 50 cars, with about 40-45 parked at the time of visit. Some butchery occurs in the buildings in the farm yard and there was regular pressure hosing of vehicles and other equipment on this site (JG16 & EF5).	U
45	Grazed by cattle.	1.87	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	5.62	181.12	Flat field with collection of trees in the middle. Used for pasture. Bound by hedge to the east and thin line of tree to south in front of which is a drainage ditch with water flowing west. Clay soils to the south east, gravel/clay soils to the west. Slopes at the edge of the field towards the drainage ditch which contains vegetation (JG17 & EF8).	PP
46	Grazed by cattle.	2.98	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to steam network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	8.94	288.19	Pasture. Flat field with 3 m wide hedge on west side, woodland on south side and a mixture of fence and hedgerow on east side. Clay soils, slight slope towards Parcel 47 in SE corner of field (JG18 & RF13).	pp
47	Silage cut in May, then grazed by cattle until early Nov.	6.26	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	120	38.2	751.73	239.30	Pasture. Mostly flat field with a gentle slope towards the south west. The south west and southern boundary is marked with trees and fence. Eastern boundary is marked with a mixture of hedgerow and fences. Large puddles had formed in front of the fence in places. Clayey soils. There was a borehole in the field shown on the map by the red cross (JG19).	RG
48	Silage cut in May, then grazed by cattle until early Nov.	7.76	Freely draining slightly acid sandy soils	Sandy	Bedrock - Secondary A	Freely draining. Drains to groundwater.	Vulnerable to leaching of nitrate and pesticides to groundwater; Highly erodible under arable and vegetable crops, where sloping, resulting in eutrophication and clogging of stream bed with sand.	120	38.2	931.56	296.55	Pasture/silage. Similar to Parcel 47 except for aspect - here land is highest on the side by Burnett's Lane halfway up the field. There is a small ditch transporting water northwards in the hedgerow separating Parcels 47 and 48. At the time of our visit there was evidence of hedgerow removing on the western flank exposing fence and there were large ruts where vehicles had tracked across the wet field (JG20).	RG
49	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	0.82	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	2.45	79.09	Narrow strip of marshy land surrounding stream. Gentle slope in direction of stream. Bordered by 3 m hedge (JG7).	PP
50	Marshy land, grazed by cattle who have access to watercourse.	1.09	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Superficial - Secondary A/ Bedrock - Secondary A	Impeded. Drains to stream.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	3	96.68	3.28	105.75	Narrow strip of marshy land surrounding stream. Gentle slope in direction of stream. Bordered by 3 m hedge. Does not appear to be grazed as longer sedges and grasses in this area, barbed wire fence between this strip of land and the solar farm. Streams join here and flow north (JG6 & EF2).	PP
50a	Chalcroft Farmstead	2.08	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Loamy and clayey	Bedrock - Secondary A	Impeded. Drains to stream network.	Overland flow of organic slurry, dirty water, fertiliser, pathogens and fine sediment with drain water.	0	0	0.00	0.00	Buildings to the south of the pond are mostly derelict with a dumping ground behind. Waste is well organised and is mostly scrap metal, broken pallets and cardboard. Car park has space for around 50 cars, with about 40-45 parked at the time of visit. Some butchery occurs in the buildings in the farm yard and there was regular pressure hosing of vehicles and other equipment on this site (JG16 & EF5).	U
123.10								Total Applied N (kg) - Marsh's Farm		7671		173	
								Total Applied N (kg) - Owton's Farm		3742		3987	
								Total Applied N (kg) - Entire Site		11413		4160	

Appendix 10 Farmscoper Inputs & Results

Input

[illegible]



Farmscoper Create

03/11/2020



File Information	
Create File:	201105 PB Revision
Climate:	700 - 900 mm
Soil Type:	Impermeable - Drained for Arable
Farm Area:	56.11 ha

	Nitrate (kg)	Phosphorus (kg)	Sediment (kg)	Ammonia (kg)	Methane (kg)	Nitrous Oxide (kg)	Pesticides (units)	FIOs (10 ⁹ cfu)	Soil Carbon (t)	Energy Use (kg CO ₂)	Production (£)
Arable	1,265	23.15	17,676	430.3	0	266.3	1.28	15	4,748	39,896	-
Grass	304	2.57	707	187.6	1,966	210.6	0.00	1,477	2,505	15,768	-
Rough	0	0.00	0	0.0	0	0.0	0.00	0	0	0	-
Other	7	0.70	1	32.5	82	3.3	0.61	106	0	11,399	-
Total	1,576	26.42	18,384	650.3	2,047	480.1	1.89	1,598	7,254	67,063	66,147

Report Units
☒ Total Loss
☐ Loss Per ha

Compact
or Expand
Report

Arable Cropping	ha
Winter Wheat	8
Winter Barley	0
Spring Barley	0
Winter OSR	0
Maize	8
Potatoes	0
Sugar Beet	0
Peas	0
Beans	0
Fodder Crops	10
Other Crops	0
Vegetables (Brassicas)	0
Vegetables (Other)	0
Orchards	0
Soft Fruit	0
Bare Fallow	0
Set Aside	8
Woodland	3

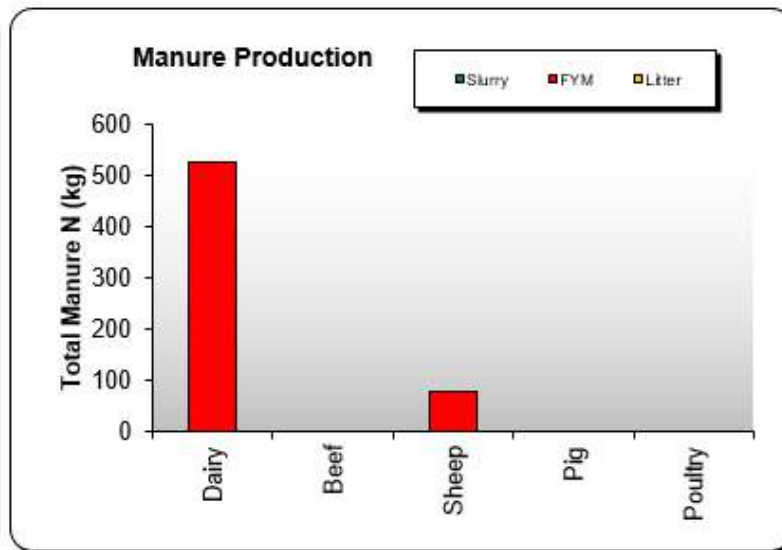
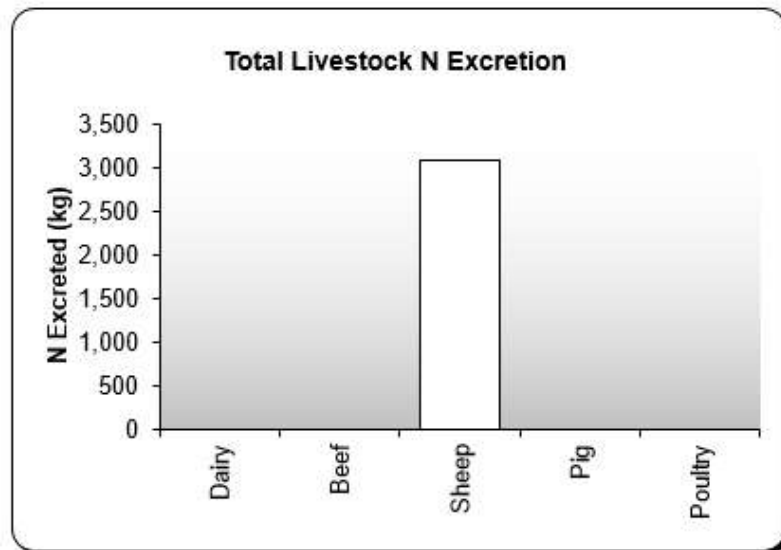
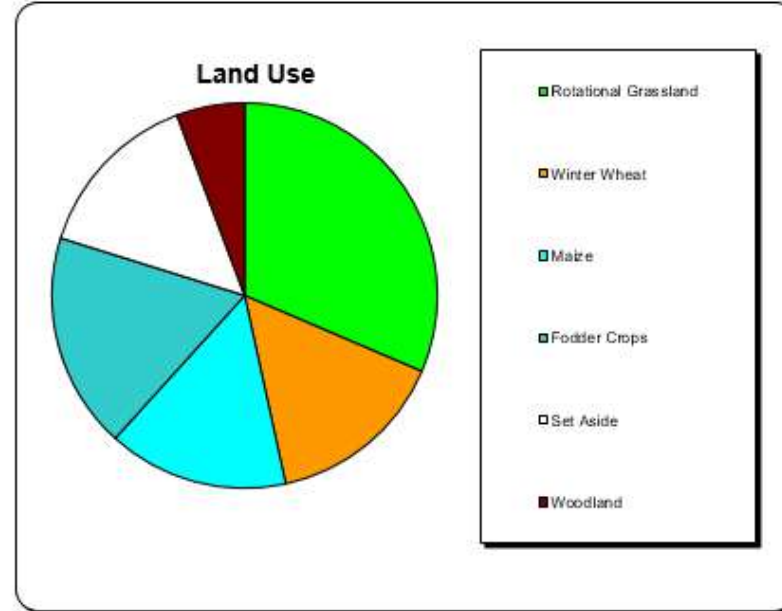
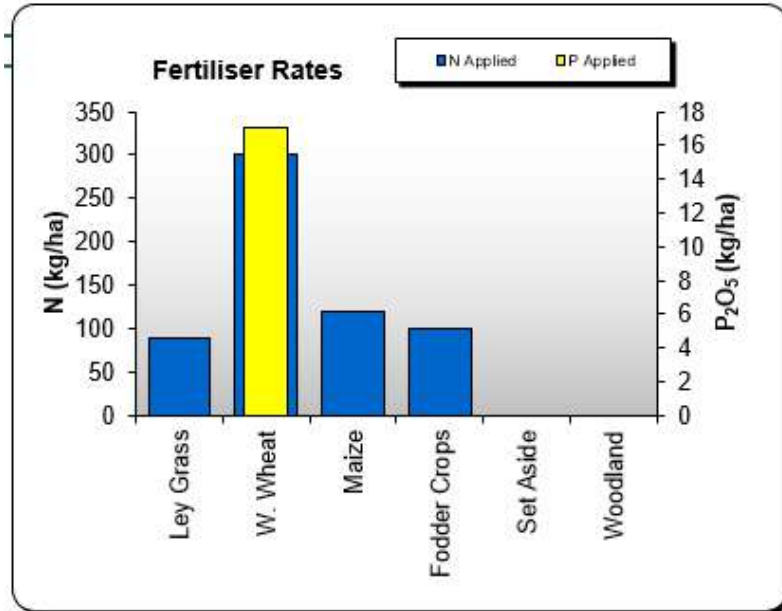
Grassland	ha
Permanent Pasture	0
Rotational Grassland	18
Rough Grazing	0

Livestock	Count
Dairy	
Cows and Heifers	0
Heifers in Calf (2 years +)	0
Heifers in Calf (< 2 years)	0
Beef	
Cows and Heifers	0
Heifers in Calf (2 years +)	0
Heifers in Calf (< 2 years)	0
Other Cattle	
Bulls (2 years +)	0
Cattle (2 years +)	0
Cattle (1 - 2 years)	0
Cattle (< 1 year) & Calves	0
Sheep	
Sheep	250
Lambs (< 1 year)	0

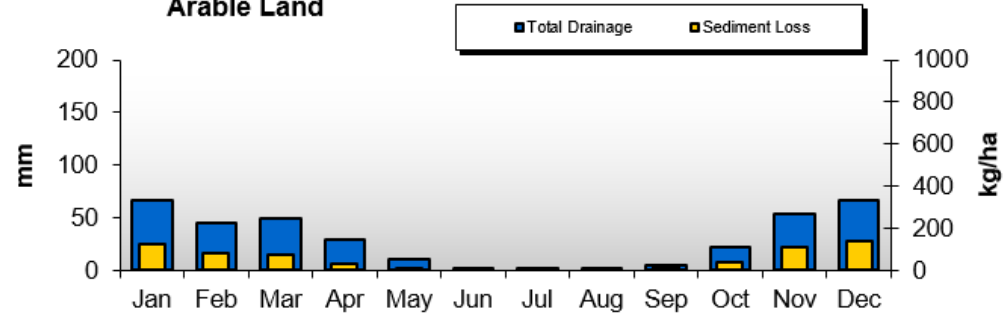
Livestock	Count
Indoor Pigs	
Sows in Pig & Other Sows	0
Gilts in Pig & Barren Sows	0
Gilts Not Yet in Pig	0
Boars	0
Other Pigs (> 110kg)	0
Other Pigs (80 - 110kg)	0
Other Pigs (50 - 80kg)	0
Other Pigs (20 - 50kg)	0
Other Pigs (< 20kg)	0
Outdoor Pigs	
Sows in Pig & Other Sows	0
Gilts in Pig & Barren Sows	0
Gilts Not Yet in Pig	0
Boars	0
Other Pigs (> 110kg)	0
Other Pigs (80 - 110kg)	0
Other Pigs (50 - 80kg)	0
Other Pigs (20 - 50kg)	0
Other Pigs (< 20kg)	0

Livestock	Count
Poultry	
Layers	0
Layers (Free range)	0
Pullet	0
Broilers	0
Turkeys	0
Breeding Birds	0
Other Poultry	0

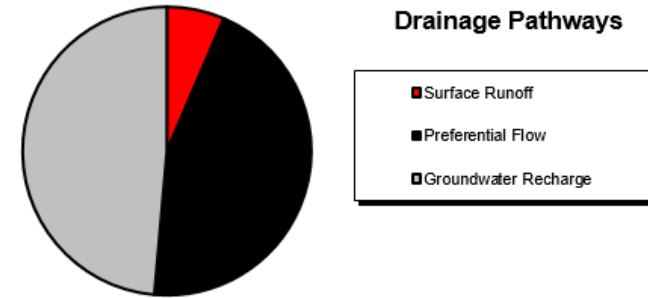
Manure Values	kg N
Dairy FYM	528
Dairy Slurry	0
Beef FYM	0
Beef Slurry	0
Sheep FYM	78
Pig FYM	0
Pig Slurry	0
Poultry Muck	0



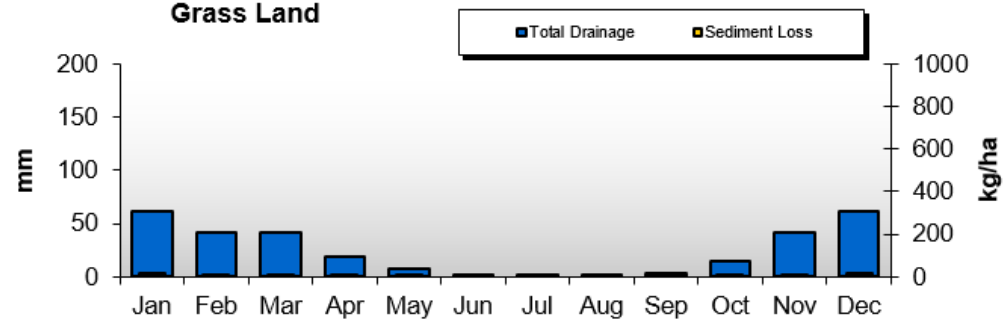
Arable Land



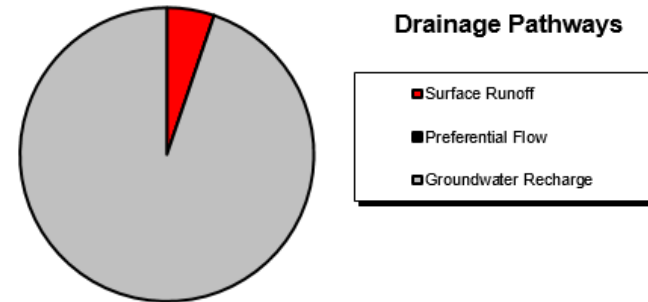
Drainage Pathways

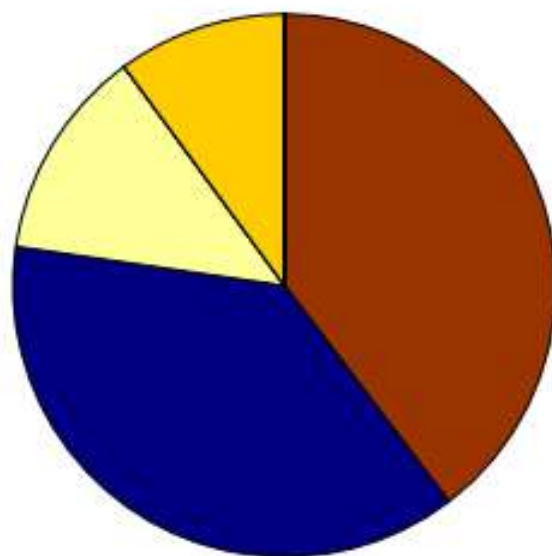
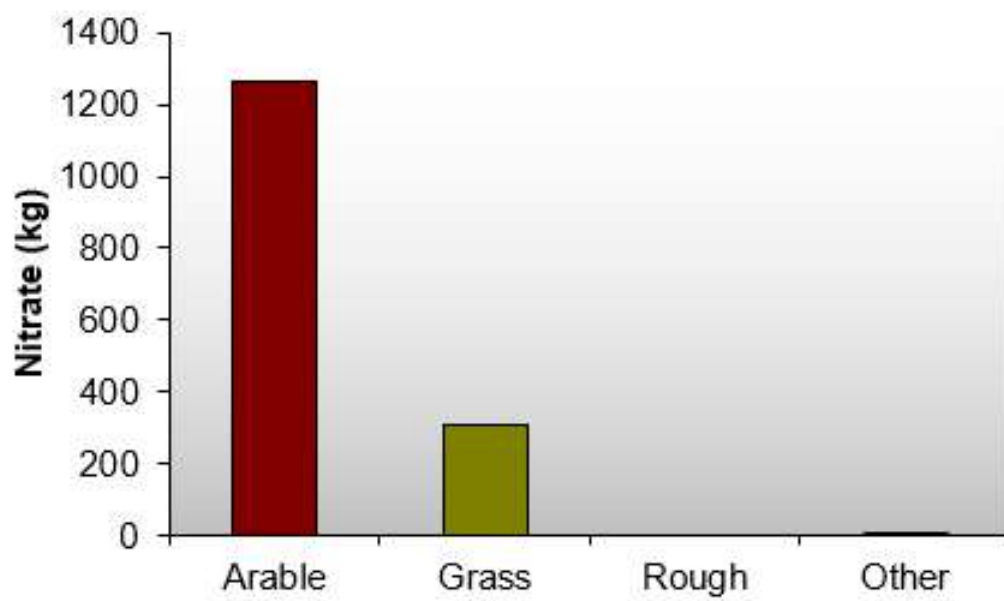


Grass Land



Drainage Pathways





Apportionment

- Soil & Residues
- Fertiliser
- FYM
- Slurry
- Litter
- Voided
- Enteric
- Dirty Water
- PPPs
- Biomass
- Other (Crops)
- Other (Livestock)

Results Summary

Farmed area = 53.46 ha (including set aside and woodland)

Annual total applied fertiliser-N = 7670.9 kg NO₃-N

Annual total applied FYM-N = 173.0 kg N

Annual total agricultural applied N = 7843.9 kg N

Annual total Nitrate-N loss = **1576.4 kg NO₃-N**

Percentage Nitrate-N loss of agricultural N input = 20.1 %

Nitrate-N loss from arable land uses = 1265 kg NO₃-N (80.2 % of total loss)

Nitrate-N loss from grassland uses = 304 kg NO₃-N (19.3 % of total loss)

Nitrate-N loss from other uses = 7 kg NO₃-N (0.4 % of total loss)

Average concentration in runoff = 8.96 mg NO₃-N/l

Annual total Ammonia (gaseous) loss = 650.3 kg NH₃-N

Annual total Nitrous Oxide (gaseous) loss = 480.2 kg N₂O

Input

Cropping	Area (ha)	Fertilisers Applied		PPPs [% Typical]	Manure Received						Manure Details						Pesticide Details					
		N (kg/ha)	P ₂ O ₅ (kg/ha)		Cattle Slurry [%]	Cattle & Sheep FYM [%]	Pig Slurry [%]	Pig FYM [%]	Poultry Muck [%]	Dirty Water [%]	Slurry (t/ha)	FYM (t/ha)	Litter (t/ha)	Dirty Water (t/ha)	Manure Total N (kg/ha)	Manure P (kg/ha)	Fungicide [% PPPs]	Herbicide [% PPPs]	Insecticide [% PPPs]	Regulator [% PPPs]	Molluscicide [% PPPs]	Spray Trips
Permanent Pasture	27.6	3		100	65				70	0.0	20.2	0.0	0.3	86.6	19.1	0	100	0	0	0	0	1.4
Rotational Grassland	29.3	120		100	30				30	0.0	8.8	0.0	0.1	37.7	8.3	0	100	0	0	0	0	1.4
Rough Grazing				100												0	100	0	0	0	0	1.1
Winter Wheat	3.0	49		100	5					0.0	14.6	0.0	0.0	62.3	13.7	0	100	0	0	0	0	16
Winter Barley																						
Spring Barley																						
Winter OSR																						
Maize																						
Potatoes																						
Sugar Beet																						
Peas																						
Beans																						
Fodder Crops																						
Other Crops																						
Vegetables (Brassica)																						
Vegetables (Other)																						
Orchards																						
Soft Fruit																						
Bare Fallow																						
Set Aside																						
Woodland																						
Manure remaining for export off farm																						
Manure Use Warnings																						



Farmscoper Create

03/11/2020

Report Units

☒ Total Loss

☐ Loss Per ha

Compact
or Expand
Report

File Information	
Create File:	Copy of 201105 PB Revision
Climate:	700 - 900 mm
Soil Type:	Impermeable - Drained for Arable
Farm Area:	59.85 ha

	Nitrate (kg)	Phosphorus (kg)	Sediment (kg)	Ammonia (kg)	Methane (kg)	Nitrous Oxide (kg)	Pesticides (units)	FIOs (10 ⁹ cfu)	Soil Carbon (t)	Energy Use (kg CO ₂)	Production (£)
Arable	137	2.81	2,139	27	0	29.8	0.06	4	377	1,924	-
Grass	1,480	12.82	2,238	511	4,394	658.0	0.01	4,317	7,397	38,054	-
Rough	0	0.00	0	0	0	0.0	0.00	0	0	0	-
Other	154	10.12	0	1,230	4,010	22.4	0.06	2,428	1	25,618	-
Total	1,771	25.74	4,378	1,768	8,405	710.3	0.13	6,749	7,775	65,596	83,450

Arable Cropping	ha
Winter Wheat	0
Winter Barley	0
Spring Barley	0
Winter OSR	0
Maize	3
Potatoes	0
Sugar Beet	0
Peas	0
Beans	0
Fodder Crops	0
Other Crops	0
Vegetables (Brassicas)	0
Vegetables (Other)	0
Orchards	0
Soft Fruit	0
Bare Fallow	0
Set Aside	0
Woodland	0

Grassland	ha
Permanent Pasture	28
Rotational Grassland	29
Rough Grazing	0

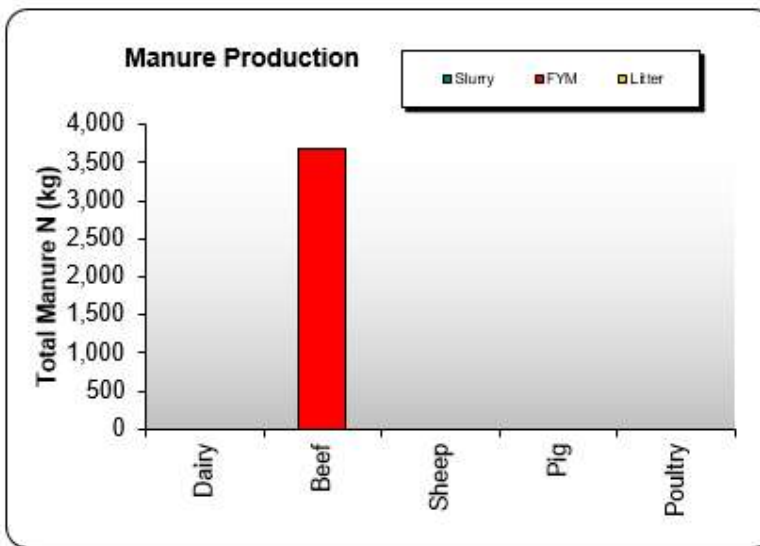
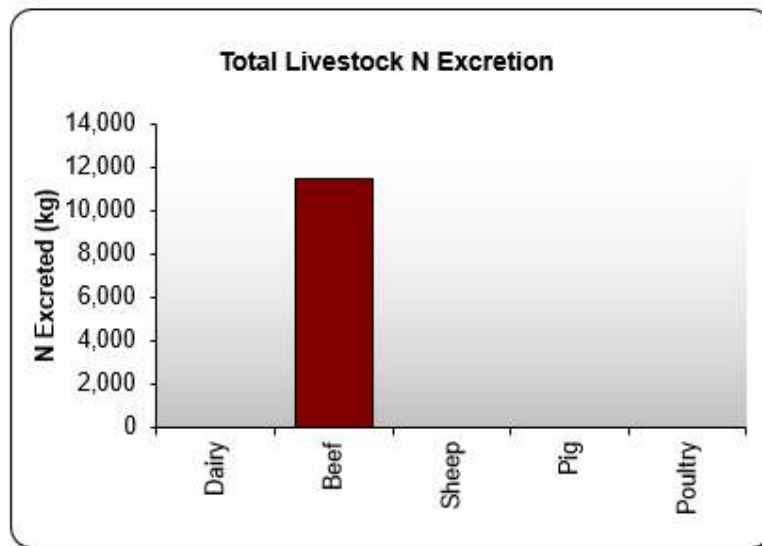
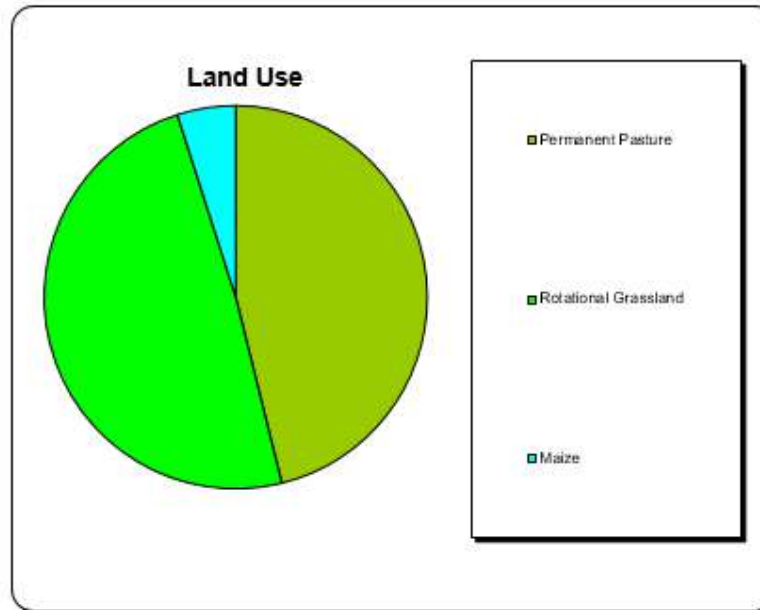
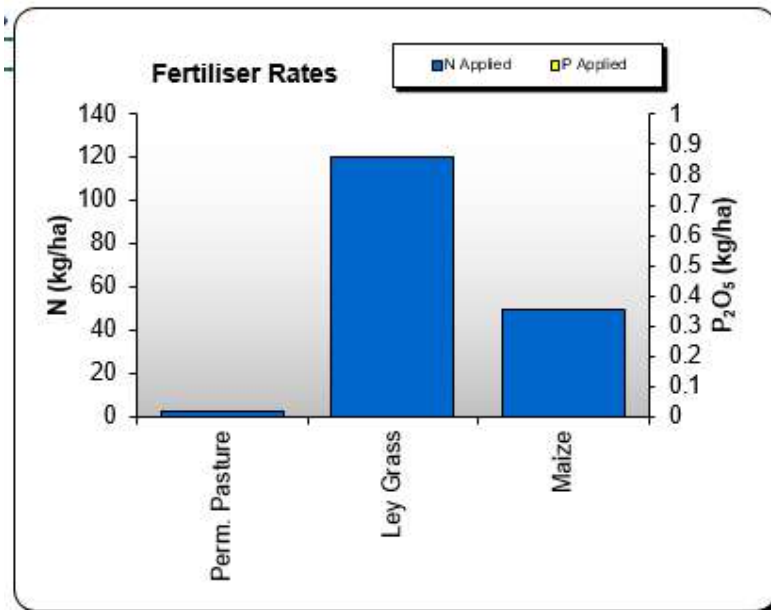
Livestock	Count
Dairy	
Cows and Heifers	0
Heifers in Calf (2 years +)	0
Heifers in Calf (< 2 years)	0
Beef	
Cows and Heifers	70
Heifers in Calf (2 years +)	0
Heifers in Calf (< 2 years)	0
Other Cattle	
Bulls (2 years +)	1
Cattle (2 years +)	20
Cattle (1 - 2 years)	50
Cattle (< 1 year) & Calves	40
Sheep	
Sheep	0
Lambs (< 1 year)	0

Livestock	Count
Indoor Pigs	
Sows in Pig & Other Sows	0
Gilts in Pig & Barren Sows	0
Gilts Not Yet in Pig	0
Boars	0
Other Pigs (> 110kg)	0
Other Pigs (80 - 110kg)	0
Other Pigs (50 - 80kg)	0
Other Pigs (20 - 50kg)	0
Other Pigs (< 20kg)	0
Outdoor Pigs	
Sows in Pig & Other Sows	0
Gilts in Pig & Barren Sows	0
Gilts Not Yet in Pig	0
Boars	0
Other Pigs (> 110kg)	0
Other Pigs (80 - 110kg)	0
Other Pigs (50 - 80kg)	0
Other Pigs (20 - 50kg)	0
Other Pigs (< 20kg)	0

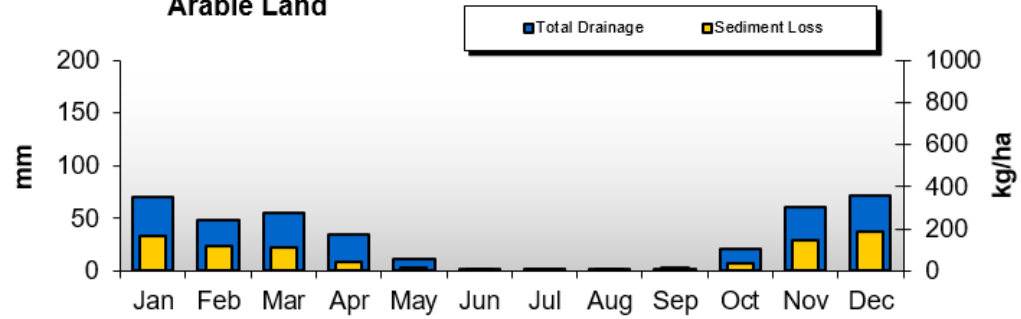
Livestock	Count
Poultry	
Layers	0
Layers (Free range)	0
Pullet	0
Broilers	0
Turkeys	0
Breeding Birds	0
Other Poultry	0

Manure Values	kg N
Dairy FYM	0
Dairy Slurry	0
Beef FYM	3,674
Beef Slurry	0
Sheep FYM	0
Pig FYM	0
Pig Slurry	0
Poultry Muck	0

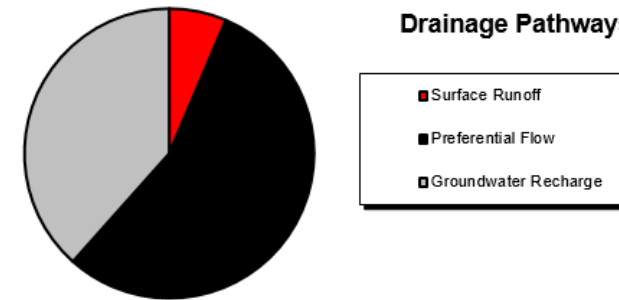




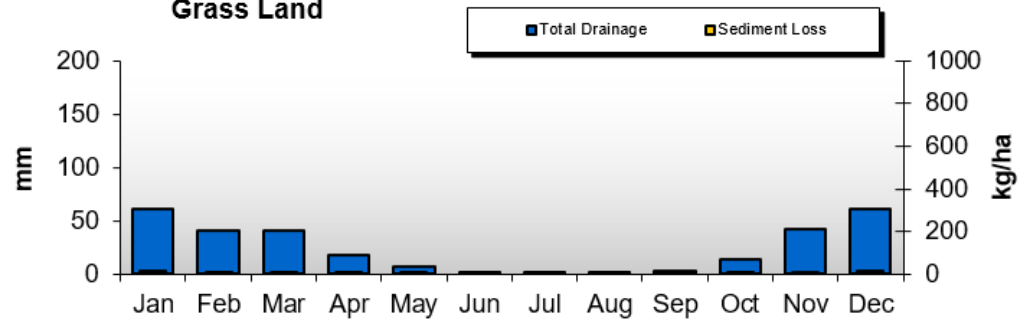
Arable Land



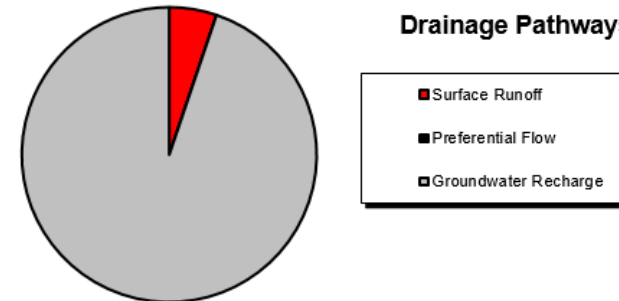
Drainage Pathways

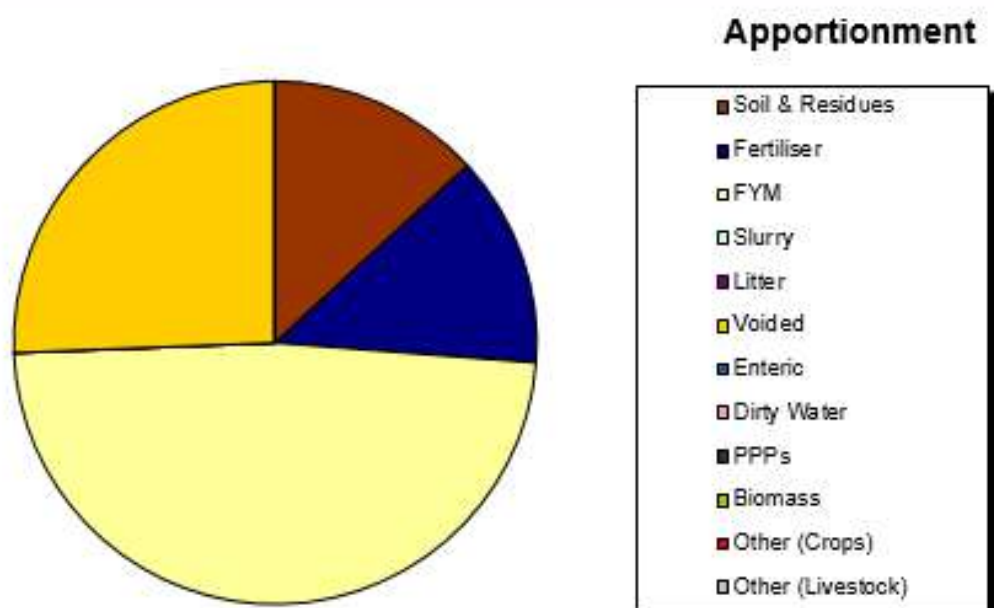
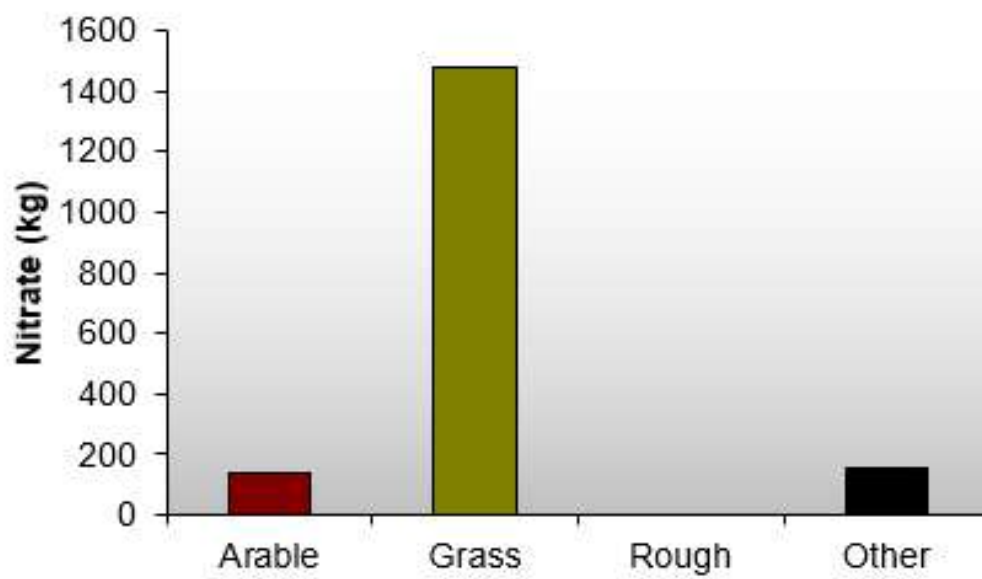


Grass Land



Drainage Pathways





Results Summary

Farmed area = 61.0 ha

Annual total applied fertiliser-N = 3742.4 kg NO₃-N

Annual total applied FYM-N = 3986.5 kg N

Annual total agricultural applied N = 7728.9 kg N

Annual total Nitrate-N loss = **1858.8 kg NO₃-N**

Percentage Nitrate-N loss of agricultural N input = 24.0 %

Nitrate-N loss from arable land uses = 137 kg NO₃-N (7.4 % of total loss)

Nitrate-N loss from grassland uses = 1480 kg NO₃-N (79.6 % of total loss)

Nitrate-N loss from other uses = 154 kg NO₃-N (8.3 % of total loss)

Average concentration in runoff = 9.97 mg NO₃-N/l

Annual total Ammonia (gaseous) loss = 1768.5 kg NH₃-N

Annual total Nitrous Oxide (gaseous) loss = 710.3 kg N₂O

Appendix 11 Transport Related N Loadings

1.1. Defra 2017 Background Maps

The UK Air Information Resource (AIR) is operated by Defra and includes computer modelled predictions of background concentrations of air pollutants over the whole of the UK with a grid resolution of 1 km². Background concentrations are those levels that would be expected to be observed away from specific sources of air pollutants, such as roads and industrial installations. The background information for relevant pollutants in the grid squares covering the masterplan are provided in Table 1 below.

Table 1 *Background NO_x and NO₂ Concentrations from 2017 Defra Background Maps*

NGR Grid Square	Year	NO _x (µg/m ³)				
		Total	Road (In)	Road (Out)	Rail (In)	Rail (Out)
447500 118500	2020	20.53	1.25	4.76	0.00	0.20
	2025	17.17	0.88	3.30	0.00	0.20
	2030	15.47	0.62	2.37	0.00	0.19
448500 118500	2020	19.79	1.35	4.40	0.00	0.15
	2025	16.54	0.95	3.05	0.00	0.14
	2030	14.91	0.67	2.19	0.00	0.14
449500 118500	2020	20.49	1.55	4.66	0.00	0.13
	2025	17.12	1.11	3.24	0.00	0.13
	2030	15.42	0.81	2.32	0.00	0.12
447500 117500	2020	19.36	0.03	5.15	0.03	0.17
	2025	16.24	0.02	3.57	0.03	0.16
	2030	14.69	0.01	2.57	0.03	0.16
448500 117500	2020	19.63	0.14	5.34	0.00	0.15
	2025	16.44	0.10	3.70	0.00	0.15
	2030	14.85	0.07	2.66	0.00	0.15
449500 117500	2020	20.02	0.96	4.89	0.00	0.13
	2025	16.73	0.68	3.40	0.00	0.12
	2030	15.09	0.49	2.44	0.00	0.12
447500 116500	2020	22.83	0.13	7.78	0.03	0.15
	2025	18.86	0.09	5.39	0.03	0.15

NGR Grid Square	Year	NO _x (µg/m ³)				
		Total	Road (In)	Road (Out)	Rail (In)	Rail (Out)
448500 116500	2030	16.78	0.07	3.88	0.03	0.14
	2020	21.29	0.10	6.61	0.03	0.13
	2025	17.71	0.07	4.59	0.03	0.13
	2030	15.89	0.06	3.30	0.03	0.14
449500 116500	2020	21.03	1.08	5.53	0.00	0.13
	2025	17.51	0.76	3.84	0.00	0.12
	2030	15.71	0.55	2.76	0.00	0.12
447500 115500	2020	31.78	7.56	8.69	0.00	0.13
	2025	25.23	5.23	6.03	0.00	0.12
	2030	21.56	3.77	4.33	0.00	0.12
448500 115500	2020	24.59	0.69	8.57	0.03	0.11
	2025	20.24	0.49	5.94	0.03	0.11
	2030	17.95	0.36	4.27	0.02	0.11
449500 115500	2020	22.84	0.89	6.81	0.04	0.11
	2025	18.97	0.63	4.73	0.04	0.10
	2030	16.96	0.45	3.40	0.04	0.10

1.2. Deposition Velocities

Deposition velocities are taken from the Air Quality Technical Advice Group (AQTAG)¹ and recommended by the Institute for Air Quality Management's (IAQM's) guidance document on air quality impacts on nature sites². The NO₂ deposition velocity varies according to the habitat present, with the following presented:

- Grassland: Deposition velocity of 0.0015 m/s;
- Woodland: Deposition velocity of 0.003 m/s.

¹ Air Quality Advisory Group, 2014, AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.

² Holman et al (2019). A guide to the assessment of air quality impacts on designated nature conservation sites – version 1.0, Institute of Air Quality Management, London

As the pre-existing sites comprises only around 2.6 % woodland, with the majority of the remainder (apart from buildings, roads, watercourses etc) comprising either grassland or crops (which would anticipated to provided similar depositional environments to grasslands), the grassland deposition velocity was adopted for the whole site.

The IAQM Guidance identifies that the deposition velocity for NO is extremely small and assuming that all NO_x is in the form of NO₂ is therefore highly conservative. Whilst deposition concentrations may decrease over time, the 2007 Design Manual for Roads and Bridges guidance for ecological assessment suggesting a reduction in background deposition rates by 2% each year is no longer considered to be appropriate as it is not supported by monitoring data. Therefore, by assuming no change in the deposition rates should be seen as a worst-case approach.

1.3. General Methodology

For each 1 km² grid square across the site, the total NO_x arising from within the grid square and outside the grid square in the baseline year of 2020 were obtained for roads and rail from the table above. As emissions of oxides of nitrogen convert to nitrogen dioxide over time, the NO_x concentration was converted to NO₂ using version 7.1 of the DEFRA “NO_x to NO₂ Conversion Spreadsheet” and a conversion factor of 1 as per EA guidance for long-term timescales.

The NO₂ deposition flux for each grid square was then calculated using the product of the vertical deposition velocity (Vd) above and the ambient concentration using the following equation:

$$F_x = Vd_x \times C_x$$

where F_x is the dry deposition flux of compound X, Vd_x is the deposition velocity of compound X, and C_x is the concentration of compound X.

The results for pre-existing loadings from traffic and rail related NO₂ are presented in Tables 2 and 3 below.

These indicate an average NO₂ loading from traffic across the site of 0.014 kg/ha/yr, which equates to 0.0041 kg N/ha/yr.

Similarly, the results indicate an average NO₂ loading from rail across the site of 0.00022 kg/ha/yr, which equates to 0.000064 kg N/ha/yr.

With a total average deposition from road and rail of 0.0042 kg N/ha/yr and a total site area of 124.2 ha, this equates to a total annual site loading of **0.5 kg N/yr**.

Consequently, the impact of any increase in emissions arising from additional traffic generated by the development has been deemed to be negligible and has not been included in the final N-budget calculation for the scheme.

Table 2 – NO₂ deposition from pre-existing road traffic

Receptor ID	X	Y		Grid Square Total Road Nox PC (ug/m3)	TOTAL NO2 PC Concs (ug/m3)	PC Dry Dep. Rate (kgN/ha/yr)
				2020	2020 Base	2020 Base
1	447	118	447500_118500	6.01	8.30	0.012
2	448	118	448500_118500	5.75	8.15	0.012
3	449	118	449500_118500	6.21	8.40	0.013
4	447	117	447500_117500	5.18	7.84	0.012
5	448	117	448500_117500	5.48	8.01	0.012
6	449	117	449500_117500	5.85	8.21	0.012
7	447	116	447500_116500	7.9	9.32	0.014
8	448	116	448500_116500	6.7	8.67	0.013
9	449	116	449500_116500	6.6	8.62	0.013
10	447	115	447500_115500	16.3	13.72	0.021
11	448	115	448500_115500	9.3	10.04	0.015
12	449	115	449500_115500	7.7	9.21	0.014
						AVERAGE
						0.014
						MIN
						0.012
						MAX
						0.021

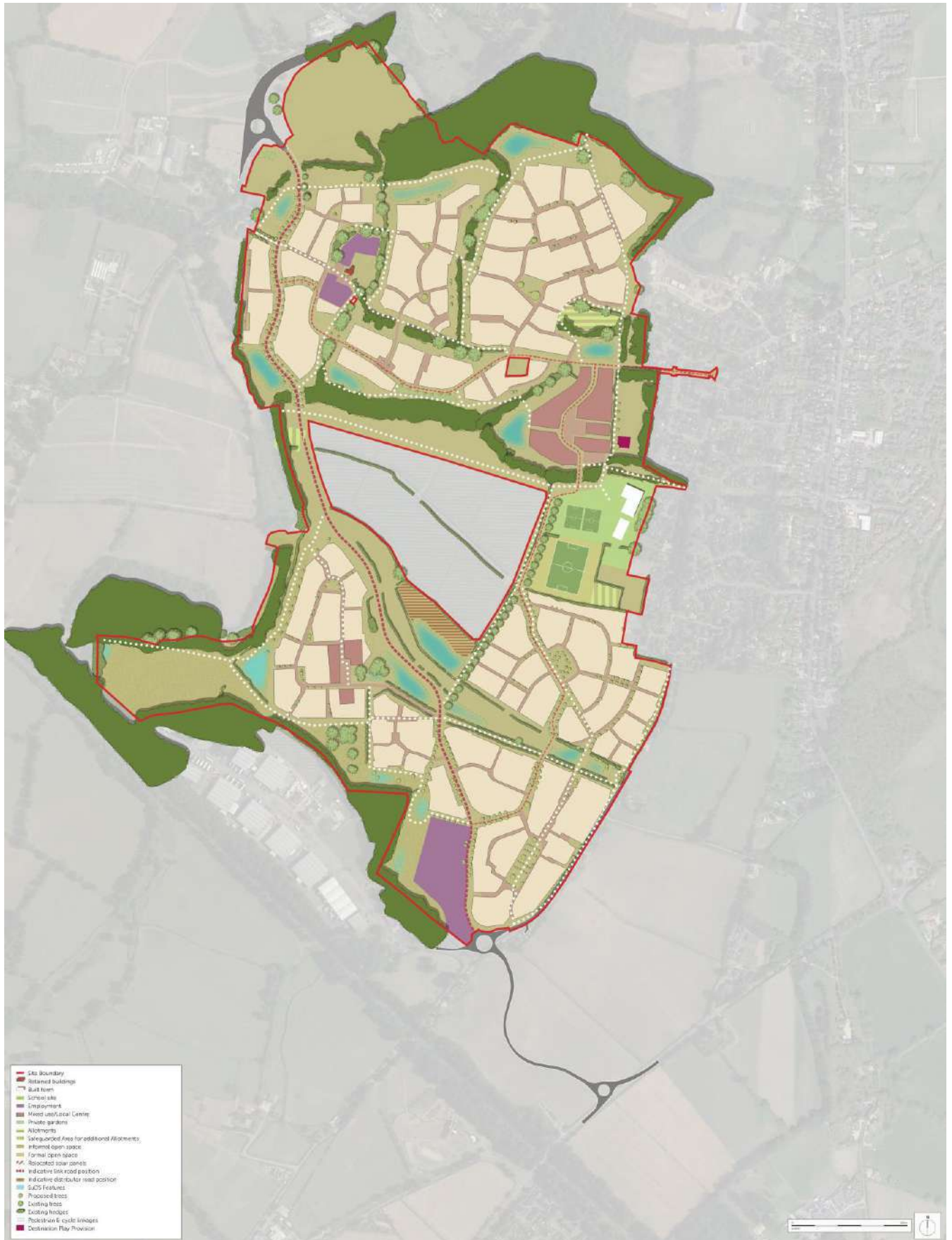
Table 3 – NO₂ deposition from pre-existing rail traffic

Receptor ID	X	Y		Grid Square Total Rail Nox PC (ug/m3)	Assumed 100% conversion as per EA Guidance	
					TOTAL NO2 PC Concs (ug/m3)	PC Dry Dep. Rate (kgN/ha/yr)
				2020	2020 Base	2020 Base
1	447	118	447500_118500	0.2	0.2000	0.00030
2	448	118	448500_118500	0.15	0.1500	0.00023
3	449	118	449500_118500	0.13	0.1300	0.00020
4	447	117	447500_117500	0.2	0.2000	0.00030
5	448	117	448500_117500	0.15	0.1500	0.00023
6	449	117	449500_117500	0.13	0.1300	0.00020
7	447	116	447500_116500	0.2	0.1800	0.00027
8	448	116	448500_116500	0.2	0.1600	0.00024
9	449	116	449500_116500	0.1	0.1300	0.00020
10	447	115	447500_115500	0.1	0.1300	0.00020
11	448	115	448500_115500	0.1	0.1100	0.00017
12	449	115	449500_115500	0.1	0.1100	0.00017
						AVERAGE
						0.00022
						MIN
						0.00017
						MAX
						0.00030

Appendix 12 Pre-existing Sewage N Losses

On-Site Dwellings/businesses										
Dwelling	Address	OS Grid Ref	Bedrooms	Residents	Wastewater volume (m ³ /yr)	Potable water 65.5% (kg/N/yr)	Toilet waste 34.5% (kg/N/yr)	Nitrate-N in wastewater (kg/yr)	Nitrate-N in effluent discharged to ground (kg/yr)	Nitrate-N in sludge tankered to WwTW (kg/yr)
Fir Tree Farmhouse	Fir Tree Lane, SO50 7DF	448582, 117490	6	4.5	157.25	0.02	20.26	7.00	5.60	1.40
Fir Tree Farm	Fir Tree Lane, SO50 7DF	448477, 117558	3	2.25	100.59	0.01	10.13	3.50	2.80	0.70
Victoria House	Fir Tree Lane, SO50 7DF	448546, 117444	5	3.75	142.22	0.02	16.88	5.83	4.67	1.17
Foxholes Farmhouse	Fir Tree Lane, SO50 7DF	449124, 117203	4	3	124.87	0.02	13.51	4.67	3.74	0.93
Foxholes Farm Cottage	Fir Tree Lane, SO50 7DF	448927, 117282	2	1.5	76.30	0.01	6.76	2.34	1.87	0.47
Foxholes Farm Cottage Annexe 1	Fir Tree Lane, SO50 7DF	448953, 117286	1	1	60.10	0.01	4.50	1.56	1.25	0.31
Foxholes Farm Cottage Annexe 2	Fir Tree Lane, SO50 7DF	448955, 117275	1	1	60.10	0.01	4.50	1.56	1.25	0.31
Pond Cottage 1	Burnetts Lane, SO30 2HU	448617, 116646	2	1.5	76.30	0.01	6.76	2.34	1.87	0.47
Pond Cottage 2	Burnetts Lane, SO30 2HU	448626, 116649	2	1.5	76.30	0.01	6.76	2.34	1.87	0.47
Chalcroft Farm homestead	Burnetts Lane, SO30 2HU	448556, 116614	4	3	124.87	0.02	13.51	4.67	3.74	0.93
Chalcroft Farm (business)	Burnetts Lane, SO30 2HU	448548, 116643	N/A	100	1825.00	0.24	450.13	155.45	124.36	31.09
Total								191.26	153.01	38.25

Appendix 13 Proposed Development



Illustrative Housing Mix

	Percentage	Number	Open Market	Private Rented	Affordable	Retirement (Affordable)
1B2P Flat	14.87	372	100	125	77	69
2B4P Flat	24.02	601	100	125	169	206
2B4P House	23.86	597	300	125	172	-
3B6P House	31.25	782	350	250	182	-
4B8P House	6.00	150	150	-	-	-
Total		2,500	1,000	625	600	275
			40%	25%	35%	

Non-residential Uses Indicative Floorspace

Use	Use Class	Illustrative Floorspace (m ²)
Community building	F.2	500
Early Years Nursery	E(f)	500
Retail/Shops/ Supermarket	E	2499
Offices	B1	9500
General industrial/ Storage or distribution	B2/B8	9500

Appendix 14 Estimated Occupancy of Proposed Development

Type of dwelling	Local Occupancy Rate	Number of dwellings	No. of Residents using 2.4 National Average	No. of Residents using 2.31 2030 EBC Average	No. of Residents using Local Occupancy Rates
1B2P Flat	1	372	893	859	372
2B4P Flat	1.5	601	1442	1388	901.5
2B4P House	2*	597	1433	1379	1194
3B6P House	2.25	782	1877	1806	1759.5
4B8P House	3	150	360	347	450
TOTAL		2502	6005	5780	4677
*As a precautionary local approach occupancy rate raised from 1.5 to 2, to reflect additional dwelling space within house compared to flat					
Use	Use Class	Illustrative Floorspace	Occupants /m ²	Number of Occupants/Employees	Number of Occupants using WC
Community building ¹	F.2	500	1	500	500
Early Years Nursery ²	E(f)	500	2.9	172	172
Retail/Shops/ Supermarket	E	2499	7	357	179*
Offices ³	B1	9500	12	792	792
General industrial/ Storage or distribution	B2/B8	9500	36	264	264
TOTAL					1906
¹ Peak occupant densities from the Buildings Regulations 2010, Fire Safety - Volume 2: Buildings other than Dwellinghouses					
² Average indoor space ratio from the Statutory Framework for the Early Years Foundation Stage, 2017					
³ Employee densities from OffPAT Employment Densities Guide, 2 nd Edition, 2010					
*Assumes 50 % of occupants (including shoppers) use WC					



Appendix 15 Horton Heath N Mitigation Report



Horton Heath Nitrate Neutrality Study Mitigation Options Review

DATE OF ISSUE: 08 JUNE 2020
ISSUE: 0.2
HM REFERENCE: 10000-RP-CS-001

PROJECT:
HORTON HEATH MASTERPLAN
HEDGE END
HANTS

CLIENT:
EASTLEIGH BOROUGH COUNCIL
EASTLEIGH HOUSE
UPPER MARKET STREET
EASTLEIGH SO50 9FD



PROJECT NAME: **HORTON HEATH MASTERPLAN**
REPORT NAME: **Horton Heath Nitrate Neutrality Study
Mitigation Options Review**
ISSUE STATUS: **DRAFT**
HM REFERENCE: **10000-RP-CS-001**

DATE OF ISSUE: **08 JUNE 2020**
ISSUE: **0.2**

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DOCUMENT HISTORY:

ISSUE	DATE	DETAILS
0.1	12/5/2020	DRAFT FOR REVIEW
0.2	08/06/2020	DRAFT FOR CLIENT COMMENT

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1. Introduction

Hilson Moran has been commissioned by Eastleigh Borough Council (EBC) to identify suitable mitigation measures that could be incorporated into the Horton Heath masterplan scheme in order to achieve nitrate neutrality. Nitrate neutrality is a significant consideration in the Solent region, required for residential or tourism related developments that would see an increase in the resident population, with the aim of avoiding additional nitrogen inputs into the Solent.

The Solent is a significant environment for a wide range of habitats and species, receiving international designations of Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar along with national designations of Sites of Special Scientific Interest (SSSI).

The Solent environment currently receives a high level of nutrient input, primarily nitrogen and phosphorus, which are causing adverse effects on the designated sites as a result of eutrophication, with dense mats of algal growth caused by excessive nutrients affecting the marine environment. A Natural England (NE) advice document identifies principle sources in the catchment as agricultural or wastewater¹.

The following sections identify the various mitigation measures available to achieve, or assist in achieving, nitrate neutrality associated with development of the Horton Heath site, and discusses whether they are appropriate for the scheme. The masterplan scheme is still being determined and the design worked upon, and as a result the application of mitigation measures will be refined and determined once the exact magnitude of nitrate loading has been quantified.

The NE advice document identifies that there are two types of mitigation that could be applied, which are:

- Direct: removing nitrate concentrations from wastewater generated by the site through upgrading of sewage treatment works and alternative measures, *e.g.* interceptor wetlands; or,
- Indirect: addressing nitrate concentrations by reducing inputs elsewhere in the catchment through taking land out of high nitrogen uses, *e.g.* crops or intensive livestock systems that result in an excess of nitrogen lost to the water environment.

Although the Horton Heath development will result in the conversion of agricultural land for urban development, consideration of the benefits of the removal of pre-existing on-site agricultural uses is accounted for in the calculation of the net change in nitrogen load from the development and is not, therefore, considered in the development of mitigation.

2. Addressing Agricultural Inputs

With agricultural inputs identified by NE as one of the principal sources of excess nutrient loading of the Solent, options that address nitrogen input from agricultural practices has significant potential as ‘indirect’ mitigation to address the increase associated with the Horton Heath development.

Addressing agricultural inputs can be achieved in one of three ways:

- Revising practices to follow best practice in relation to farming methods;
- Incorporating technology to target fertiliser application; and,
- Establishing intercepting wetlands on farmland to reduce nitrate input.

2.1. Best Practice Methods

Agricultural methods, in both arable and pastoral farming, can have a significant influence on the nutrient loading of the receiving environment, and changes in practice can alter the discharge of nutrients.

Nutrient application, primarily nitrogen, phosphorus and potassium, is an essential process in arable production, improving crop yield through nourishment and increase soil productivity. However, nutrients that are not taken up by crops will be lost to the receiving environment, with run-off and leachate causing excess nutrients to reach the riverine environment.

With regard to pastoral farming, the density of livestock kept can influence the nutrient loading from a farm. Increasing densities of livestock will increase the production of manure on a site, with subsequent effects on nitrogen emissions from a site.

Defra’s “*Protecting our Water, Soil and Air: A Code of Good Agricultural Practice*”² for farmers, growers and land managers, known widely as the ‘CoGAP’, consolidates and updates three separate former codes for water, soil and air. The publication offers practical interpretation of legislation and provides good advice on best practice aimed at minimising agricultural pollution while protecting natural resources and allowing economically sound agriculture to continue. It includes advice specifically on managing nitrogen. Furthermore, as ammonia can be readily converted to nitrite and then nitrate by means of nitrification in soils (see Figure 4.1 below), much of the advice presented for reducing ammonia emissions will serve also to reduce nitrate emissions from farms. Key recommendations consider the storage and spreading of organic and manufactured fertilisers and diets and housing of livestock. In particular, farmers should:

- Establish a nutrient management plan which identifies the suitable timings and rates of application of nitrogen fertiliser and organic manure to meet crop requirements, aiming to use the right amount in the right place at the right time.
- Maintain green cover on the land for as much of the year as possible.
- Match the nitrogen content of livestock feed to the particular requirements of the stock.
- In order to reduce both run-off risk and ammonia loss, when applying livestock manures to bare land or stubble:
 - Farmers should incorporate into the soil any slurry that has been surface broadcast (spread by splash plate). This should be done immediately and at the latest within 6 hours.

- o They should incorporate solid manures into the soil as soon as possible and at the latest within 24 hours.

In addition, the UK 'Nitrate Regulations'³, which implement the European Community's Nitrates Directive, help reduce nitrogen losses from agriculture to water. They designate areas where nitrate pollution is a problem, known as Nitrate Vulnerable Zones (NVZs), and set rules for certain farming practices, which must be followed within these zones.

The rules promote best practice in the use and storage of fertiliser and manure, and build on the guidelines set out in the CoGAP. The Horton Heath site and the River Itchen Fluvial Catchment, in which the site lies, are located entirely within a formally designated NVZ. As such, the farms that fall within the site boundary should currently be complying with the Regulations and applying best practice in the use and storage of fertiliser and manure.

A Fertiliser Manual⁴ has been published by Defra to complement the CoGAP NVZ guidelines, designed to help farmers and land managers better assess the fertiliser required for the range of crops they plan to grow, by suggesting what level of nutrients are required to provide the best financial return for the farm business. The Manual addresses the application of both mineral fertilisers and other sources of nutrients such as manures and slurries.

The associated PLANET 3 software (refer to <http://www.planet4farmers.co.uk/>) generates recommendations based on the Fertiliser Manual, and can generate records of nutrient use on the farm. It takes account of the crop nutrient requirement, the nutrients supplied from the soil and applications of organic manures and manufactured fertilisers. Defra also make available the PLANET Dynamic Link Library, which performs the calculations to generate nutrient management recommendations, for incorporation into commercial software programmes to help with good nutrient management.

The Fertiliser Manual also sits alongside the National Farmers Union's (NFU) "*Tried and Tested*" advice (refer to <http://www.nutrientmanagement.org/>), such as the Nutrient Management Plan guidance document⁵, which presents a plan that can be used by farmers to manage their nutrients efficiently in order to save money, reduce environmental risks and help meet the Nitrate Regulations in a step-by-step, manageable way.

Defra and the EA have produced a number of leaflets and guidance documents to help farmers in NVZs understand the requirements, and implement and comply with the Action Programme measures. These are available on the UK Gov website (refer to <https://www.gov.uk/government/collections/nitrate-vulnerable-zones>) or via the Farming Advice Service (FAS) helpline on 03000 200 301.

As the entire River Itchen Fluvial Catchment lies within a NVZ, it is anticipated that the encouragement of farmers beyond the site boundary, but within the same catchment, to adopt the measures in CoGAP, may have limited impact on nitrate losses to the Solent as these farms should already be complying with the Regulations. Nevertheless, the European Commission (EC) have highlighted good practices in relation to nutrient loss in agriculture associated with the Wielkopolskie region in Poland, which go above and beyond the Nitrate Regulations requirements. These measures can be considered a model of best practise and should be championed by EBC wherever possible.

The associated document of examples⁸, which is presented in the Appendix to this report, identifies the measures used, including the planting of catch/cover crops to address nutrient losses from run-off and leaching. This involves using catch crops in the crop rotation process, reducing nutrient leaching and run-off and, thereby, reducing the need to add organic or artificial fertilisers. Incorporating crop residues is highlighted as a method of improving soil structure and water

retention capacity, reducing the risk of leaching, and, in the case of straw, fixing nitrogen into the soil that is slowly released.

The document also identifies the use of sediment ponds, which we consider separately below.

In terms of livestock farming, the main recommendations comprise:

- The use of professionally formulated diets that match the nutrient content of the feed to the requirements of the animal at the different production stages; and
- Maintenance of housing by regular cleaning and removal of waste, separation of waste types and appropriate storage.

The EC document also identifies the composting of generated manure as a good opportunity to reduce the volume of organic material and transform nitrogen into ammonia, improving storage practices and reducing run-off and leaching through a higher content of ammonia and storage in organic matter.

Covering of manure stores is recommended in both the CoGAP and EC documents, although if this is not possible the EC document identifies increasing the height of stockpiles to increase compaction as a cheaper and easier method to implement, although less effective than covering and requiring appropriate equipment.

Further to these, advice on improving water quality, including measures to manage fertiliser use and reduce nitrate losses, is currently available in 50 priority catchments in England (including the Water Framework Directive (WFD) Test & Itchen Water Management Catchment, in which the proposed development lies) through the England Catchment Sensitive Farming Delivery Initiative, (ECSFDI). This joint Defra/NE/Environment Agency (EA) project uses a network of Catchment Sensitive Farming Officers (CSFOs) to engage with farmers and encourage them to make changes in practice and infrastructure to improve water quality and help meet Water Framework Directive targets. The ECSFDI also operates a small but very popular Capital Grants Scheme to part fund infrastructure improvements on farms to help reduce diffuse water pollution. More information on this initiative is available at the “*Catchment Based Approach*” (CBA) website (refer to <https://catchmentbasedapproach.org>) which provide an online community platform and knowledge hub for all organisations and individuals interested in participating in collaborative and cross-sector management of the water environment.

The site includes an online discussion forum, training and knowledge resources, calendar of upcoming events, examples of best practice, tools and delivery case studies encompassing a broad range of policy and practitioner interests.

As such, it is recommended that EBC should make every effort to inform their tenant farmers and other farmers and land managers within their borough of the above good practise documents, websites, software and other resources.

2.2. Incorporating Technology

The emergence of cloud-based information technology has helped transform opportunities for the agricultural industry, with ‘Smart Agriculture’ helping farmers to target their resources to maximise crop yield through appropriate interventions. Figure 2.1 identifies the general hierarchy of possible applications, services and sensors for Smart Agriculture.

This approach ensures the appropriate application of fertilisers within crop production, using the data produced to identify where and when fertilisers may be required, instead of their widespread application across the entire crop at pre-determined intervals. This targeted application reduces

the quantity of fertiliser used and, through direct application, ensures that it is delivered to the places most needed at the time it is needed, thereby reducing the risk of nitrogen losses through run-off and leaching.

Maybe less obvious, is the benefits associated with the targeted irrigation of crops, ensuring water is applied at appropriate times and locations based on the data. This should reduce the amount of water applied to crops, and therefore contribution to run-off and leaching of excess nutrients.

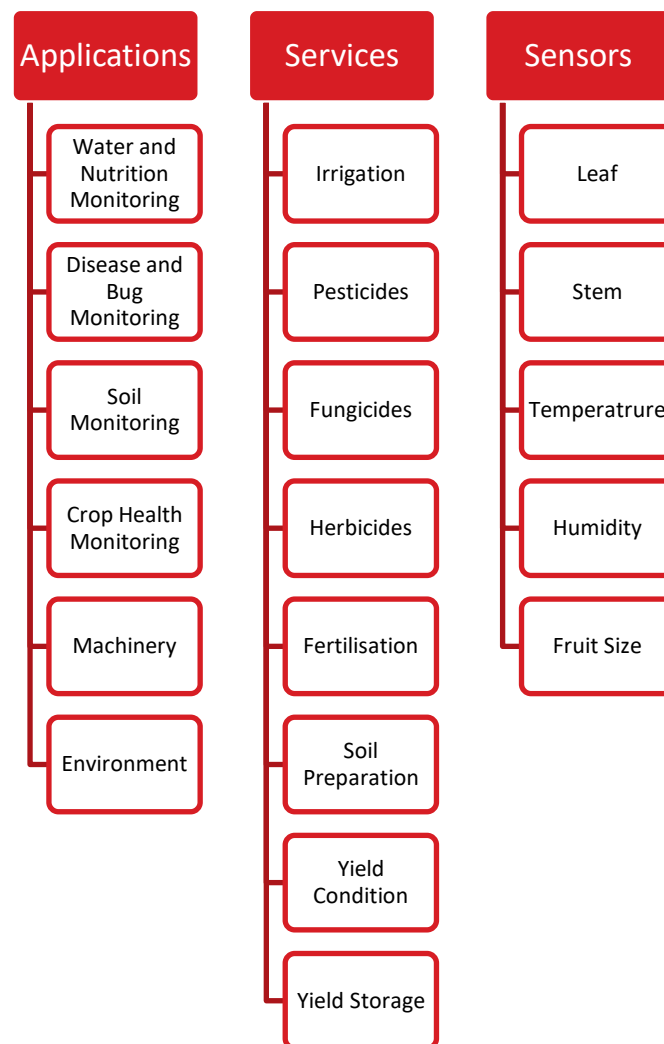


Figure 2.1 *General Hierarchy of Possible Applications, Services and Sensors for Smart Agriculture⁹*

2.3. Intercepting Wetlands

The establishment of wetland habitats within farmland to intercept run-off and, to some degree, nutrients leached through the soil is an alternative, or complimentary, measure to reduce the discharge of nutrients from farmland into our riverine systems. The EC document of examples in the Wielkopolskie region provides a good example of what these wetland habitats comprise: *i.e.* a 'shallow sediment basin and wetland covered with typical wetland plants, which act as a filter'. These could comprise network of drainage channels or a basin area in the appropriate location

based on the natural drainage of the area (*i.e.* at the lowest point in the farmland), and may require some engineering solutions to block the pathway and slow the water or, on steeply sloping areas, a series of wetlands may be required.

The wetland habitats retain nutrients in the sediments as the run-off is slowed down and soil particles are retained through sedimentation. This significantly reduces the nutrients discharged from farmland, and when dredged to increase capacity the soils can be reapplied to the soil as a fertiliser to recycle the nutrients. Similar habitat types, predominantly settling basins with common reeds, are widely employed alongside major roads to control pollutants and sediments from road run-off from entering riverine catchments.

Although the mitigation is highly effective and proven, wetland habitats within agricultural areas will inevitably reduce the productive areas within farms which may be less favourable to farmers – particularly where slope or soil conditions result in more extensive wetland features. However, once established, the features do not require significant maintenance (other than periodic dredging) for the benefit to be continued.

2.4. Application of Agricultural Best Practise Measures

The encouragement of all of the above agricultural measures may well have the potential to deliver the mitigation required to achieve nitrate neutrality for the Horton scheme, however, their success is dependent upon identifying appropriate farmsteads and willing individuals to engage with the process.

Appropriate farmsteads to mitigate the proposed development will be restricted to those within the same catchment, *i.e.* the River Itchen, to ensure the development does not effectively increase nitrate inputs in one area and reduce them in another. As already discussed above, as the entire River Itchen Fluvial Catchment lies within a NVZ, measures above and beyond those required to meet the Nitrate Regulations, should be championed, as farms within the catchment should already be complying with the Regulations. Furthermore, some of the measures, such as the construction of wetlands, would also be dependent upon identifying suitable farms/individuals that would be willing to set aside potential productive farmland. This would also, likely, require some level of contractual agreement for retention and maintenance of the feature.

Nevertheless, the provision of wetlands could be a valuable measure provided within the boundary of the post-development scheme. It is anticipated that Public Open Spaces (POS) and other soft landscaped areas within the development, will be subject to their own Nutrient Management Plans, with the aim of avoiding the use of nutrient applications wherever possible. The use of wetlands within the site boundary could then be used to both intercept runoff from adjacent agricultural areas entering the site and also to “polish” surface water runoff from both the developed areas and POS within the scheme, providing multifunctional water quality, flood prevention, biodiversity and amenity features. Opportunities for the provision of such wetland areas will be identified as the masterplan evolves.

3. Reverse Auction Nitrate Reduction Scheme

A Reverse Auction Scheme for nitrogen reduction effectively offers funding in exchange for commitments that provide a reduction in the input of nitrogen in to the catchment. This mitigation is linked to the options relating to agricultural best practice, however, it is applied at a much greater scale.

Wessex Water have trialled this type of scheme with the online environmental trading platform, EnTrade, establishing the Fundspreader scheme. In this scheme, farmers within the catchment influencing Poole Harbour, who have agreed to carry out environmentally friendly farming measures, are all paid the same rate, in £/kg N, for doing so and the reward they receive is based on the amount of nitrogen (kg N) that they save. The scheme has been seen as a success, with farmers financially incentivised to be considerate in the application of nitrogen and in 2015 the scheme offset 40 tonnes of nitrogen from entering Poole Harbour.

Such schemes are typically best co-ordinated by the local water utilities company as they can operate the reverse auction schemes over appropriate catchment areas influencing key environments, with the present case of nitrate inputs to the Solent affected by a range of Wastewater Treatment Works (WwTW) across the Hampshire region. However, there needs to be a financial driver behind the utilities company, in this case Southern Water, progressing such scheme.

Although such financial drivers are likely to emerge as a result of the Solent nitrate issue, with regard to the Horton Heath development, it is understood that Chickenhall WwTW (to which it is anticipated the foul sewage generated by the operational scheme will ultimately be conveyed to), does not currently have a nitrate discharge limit. As such, the fiscal benefit to Southern Water is currently not evident. However, due to the Solent nutrient issue, it is anticipated that this may change in the near future, with an obvious onus to curb nutrient loadings from all WwTWs discharging directly to or upstream from the designated international sites around the Solent.

Therefore, whilst this mitigation option has significant and proven potential to reduce nitrogen inputs at a catchment level for the benefit of sensitive habitats downstream, it is currently unclear whether it is a realistic option for Horton Heath within the timeframe associated with the increase in residential occupancy resulting from the scheme.

4. Wastewater Denitrification

With wastewater comprising the principal source of nitrogen generated from the developed site (*i.e.* in the form of nitrates that enter the Solent via the conventional WwTW), control of the nitrogen associated with the exported wastewater is one of the mitigation options under consideration to achieve nitrogen neutrality for the site.

With reference to Figure 4.1 below, denitrification is an important step in wastewater treatment, converting a potentially significant contaminant to a benign gas that can be released without environmental consequence. The denitrification process is achieved in a series of sequential steps; the first comprising the conversion of organic nitrogen and ammonia into nitrate through a series of aerobic processes, which can be achieved through treatment devices such as aerobic treatment units or sand and gravel filters. The second step is carried out in anaerobic conditions, where bacteria oxidise the organic nitrogen using the oxygen formed in the first step to convert the nitrate to nitrogen gas, principally in the form of di-nitrogen (N_2).

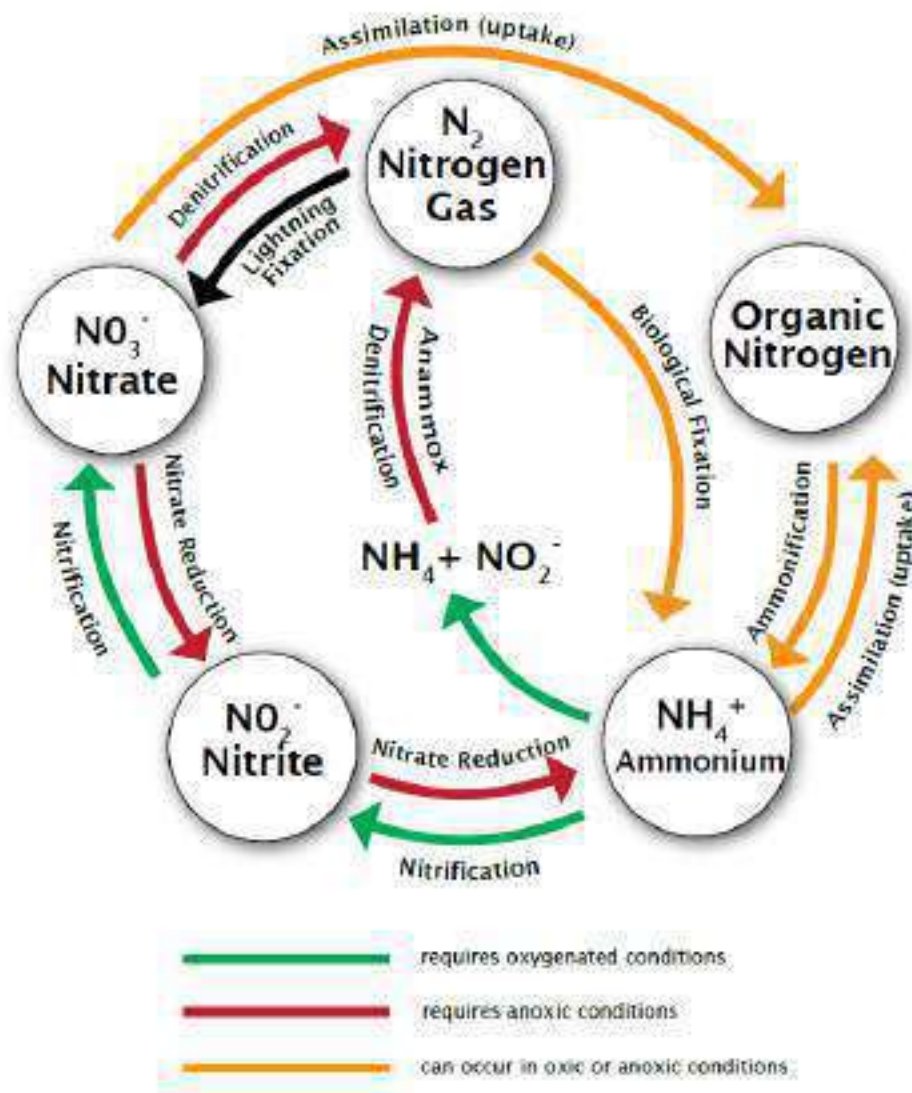


Figure 4.1 Simplified Nitrogen Cycle¹⁰

However, it should be noted that the removal of nitrogen from wastewater is not necessarily a simple process, even for a conventional WwTW, as it relies upon environmental conditions to support the bacteria required for the important second step of the process.

One of the obvious solutions would be to address nitrate concentrations at WwTWs, increasing the capacity for removal prior to discharge into the river network. However, many of the sites are likely to require an upgrade to their infrastructure, which is an expensive solution that is unlikely to be deliverable within the required timescales for the project. Some WwTWs may already have capacity to operate at a higher standard than required by their discharge consent, however, it is likely this will be required to improve conditions and may not be available to offset development increases.

Consequently, consideration of on-site solutions as a direct mitigation to the increase in nutrient loading is a more realistic option for the Horton Heath masterplan development. Although not currently widely used in the UK, there are a number of package treatment plants which have been developed to provide on-site solutions for the denitrification of wastewater. Appropriate systems currently available in the UK include::

- The Graf Klaro range with denitrification module offering treatment capabilities from 16 to 1,000 people equivalents (PE), or 2,400 to 150,000 litres/day capacity (refer to Figure 4.1 below);
- The Kee NuDisc range offering treatment capabilities from 7 to 467 PE, or 1,000 to 70,000 litres/day capacity; and,
- The Premier Tech Aqua DSAF range offering treatment capabilities from 30 to 600 PE, or 4,500 to 90,000 litres/day capacity.



Figure 4.2 *Graf Klaro XL package treatment plant with denitrification module*

There are further systems available, but the above systems demonstrate that options are available for all sizes of development, with multiple systems providing capacity for developments greater than the Graf Klaro 1,000 PE system. Inclusion of on-site solutions, such as these, across the proposed development will result in the discharge of low nitrate concentration wastewater, either to the foul water system for further treatment at the Chickenhall WwTW, or alternatively could be

allowed to infiltrate to ground if local ground conditions allow and is acceptable to the planning and environmental regulatory authorities.

Alternatively, a centralised on-site wastewater treatment plant could be considered within the masterplan to treat the wastewater generated by the scheme, for discharge to the local watercourse network, which drains through the Itchen catchment. Any such plant can be sized appropriately to treat the wastewater generated on the site and include the latest technology to remove a significant proportion of the nitrate element prior to discharge. This can be included as part of a water recycling strategy for the site, with tertiary treatment allowing for part of the water to be recycled for non-potable uses.

With this in mind, the Hilson Moran Infrastructure and Environment Team have already had a number of meetings with Southern Water and two separate New Appointment or Variation companies (NAVs) (Albion Water and Icosa Water), to discuss potential options. One such option could be the appointment of a NAV to provide a 'Full Service' solution, incorporating both onsite treatment and water recycling. Consequently, it would appear feasible to install an on-site wastewater plant serving the whole development and capable of achieving 9 mg/l N discharge from the site or better, with additional non-potable treatment, storage and pumping facilities provided to serve WC flushing and garden watering.

It is anticipated that excess effluent, not treated for reuse, would discharge to an on-site watercourse. Outfall from the plant to the public sewer has also been considered, however Natural England's current position is that all effluent discharged to sewer would be considered to enter the environment at 27 mg/l N from Chickenhall WTW, regardless of any pre-treatment. Furthermore, the full service NAV model is not compatible with such an arrangement, whereby, the appointed company would effectively be paying to treat wastewater on-site but also paying Southern Water for a bulk discharge. Because the NAV cannot charge any more than the incumbent water company for sewerage services, this option would not be commercially viable.

The precise footprint of an on-site treatment works will depend on a number of factors but it is estimated that a maximum footprint of up to 50 x 50 m should be appropriate. There are significant areas of both formal and informal open space planned for the north-west and south-east parts of the site which could potentially accommodate such an installation. Either area should be convenient for providing an outfall and would not negatively affect the on-site drainage strategy.

The developer would additionally need to pay for the on-site treatment plant, non-potable treatment, storage and pumping but would avoid sewerage Infrastructure Charges (and also conversely Infrastructure Credits) by not connecting to the Southern Water sewer. They would, however, likely benefit from some investment by the chosen NAV. A NAV would also potentially offer further additional benefits including adoption and maintenance of SuDS features and marginally lower water bills for residents (and certainly no more than Southern Water).

Provisional calculations have indicated that such an approach could wholly deliver the nitrate neutrality required and even result in a nitrate deficit, compared to the pre-existing agricultural uses of the site. Alternatively, the provision of smaller scale units distributed throughout the development, as also described above, could form an effective part of a suite of mitigation measures designed to achieve neutrality or betterment.

5. Offsetting

Offsetting the increases in nitrogen inputs associated with residential development is, in some aspects, somewhat of a controversial proposal as it involves the removal of productive agricultural land as a means of reducing nitrogen inputs within a catchment. The land could be turned over to green infrastructure, as a Suitable Alternative Natural Greenspace (SANG) and managed for public amenity and biodiversity enhancement purposes.

Whilst removal of productive agricultural land with catchments draining to the Solent will evidently reduce the nitrate input, the purchasing of such farmland by developers as an offset could be seen in a bad light by the general public – particularly in a time when food security and how much food we can produce in the UK is rising to the top of the agenda. The NFU in the South-East has released a position statement¹¹ identifying that the loss of productive land is not the most sustainable option and should only be considered as a last resort, with options to work alongside productive farmland more favourable and cost effective.

However, the Hampshire and Isle of Wight Wildlife Trust (HIWWT) have put forward proposals for offsetting that would provide the benefits associated with the loss of intensive agricultural production whilst maintaining public perception. The HIWWT offsetting scheme will look to remove lower-grade agricultural land from intensive production, thereby removing nutrient application, and creation of suitable alternative uses for the land – such as traditionally grazed meadows, wetlands or woodlands. HIWWT identify that over 70% of Hampshire is farmed, and therefore, the scheme can utilise the lowest grade farmland without significant impacts on farmers, whilst establishing opportunities for housing to progress. However, it is expected that developments would need to meet certain criteria through planning – notably biodiversity protection and enhancement. As a not-for-profit charity, the Wildlife Trust could only establish such schemes funded through the developments.

Offsetting, as part of an established scheme such as that proposed by the HIWWT, presents a significant opportunity to offset increases in nitrate discharge as a result of the development. However, this is likely to be a costly process, and therefore should probably be employed in combination with the reduction measures discussed above.

6. Summary & Conclusions

Hilson Moran has been commissioned by EBC to identify suitable mitigation measures that could be incorporated into the Horton Heath masterplan scheme in order to achieve nitrate neutrality.

The following main measures have been identified as having potential for the scheme:

- Addressing agricultural inputs through the application of best practise measures, incorporating technology and providing intercepting wetlands. The encouragement of these agricultural measures may well have the potential to deliver the mitigation required to achieve nitrate neutrality for the Horton scheme, however, their success is dependent upon identifying appropriate farmsteads within the River Itchen Fluvial Catchment and willing individuals to engage with the process.

Nevertheless, the provision of wetlands could be a valuable measure provided within the boundary of the post-development scheme, providing multifunctional water quality, flood prevention, biodiversity and amenity features.

- The introduction of a suitable Reverse Auction Scheme for nitrogen reduction, in collaboration with Southern Water, which would offer funding to farmers in exchange for commitments that provide a reduction in the input of nitrogen in to the catchment.

Whilst this mitigation option has significant and proven potential to reduce nitrogen inputs at a catchment level for the benefit of sensitive habitats downstream, it is currently unclear whether it is a realistic option for Horton Heath within the timeframe associated with the increase in residential occupancy resulting from the scheme.

- On-site wastewater denitrification, either by providing a number of appropriate package treatment works across the proposed development or alternatively providing a single centralised on-site wastewater treatment plant. Provisional calculations indicate the latter approach could wholly deliver the nitrate neutrality required and even result in a nitrate deficit, compared to the pre-existing agricultural uses of the site. Alternatively, the provision of smaller scale units distributed throughout the development, could form an effective part of a suite of mitigation measures designed to achieve neutrality or betterment.
- Offsetting, with the removal of low-grade agricultural land within the same catchment and returning it to unproductive green infrastructure with biodiversity and amenity value. Offsetting, as part of an established scheme such as that proposed by the local Wildlife Trust, presents a significant opportunity to offset increases in nitrate discharge as a result of the development. However, this is likely to be a costly process, and therefore should probably be employed in combination with the reduction measures discussed above.

The Horton Heath masterplan scheme is still being determined and the design worked upon. As a result, the application of the above mitigation measures will be refined and determined once the exact magnitude of nitrate loading resulting from the operational scheme has been quantified.



Appendix: Good Practices to Reduce Nutrient Loss in the Wielkopolskie Region (Poland)



Closing the mineral cycles
at farm level

Good practices
to reduce nutrient loss
in the **Wielkopolskie**
region (Poland)

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Nutrient loss – Why does it matter?

Nitrogen, phosphorus and potassium are essential for agricultural production as they nourish the crops and support soil productivity. However, if these nutrients are not taken up by plants, they run the risk of being lost in various ways (e.g., leaching, run-off, emissions) and causing unnecessary costs for the farming business. Finding the right amount required by the plants and optimising the timing and application of the nutrients to match these needs can result in an economic gain and a positive effect on human health and the environment, including soil health and fertility.

This leaflet was developed in the framework of the project “Resource Efficiency in Practice – Closing Mineral Cycles”. It aims at providing practical information to farmers on how the risk of nutrient loss can best be minimised or prevented. In particular, the leaflet addresses the effects of nutrient loss in Poland, with a specific focus on the Wielkopolskie region. The leaflet also provides practical information to farmers on how resource use efficiency can be maximised through good practices at farm level.



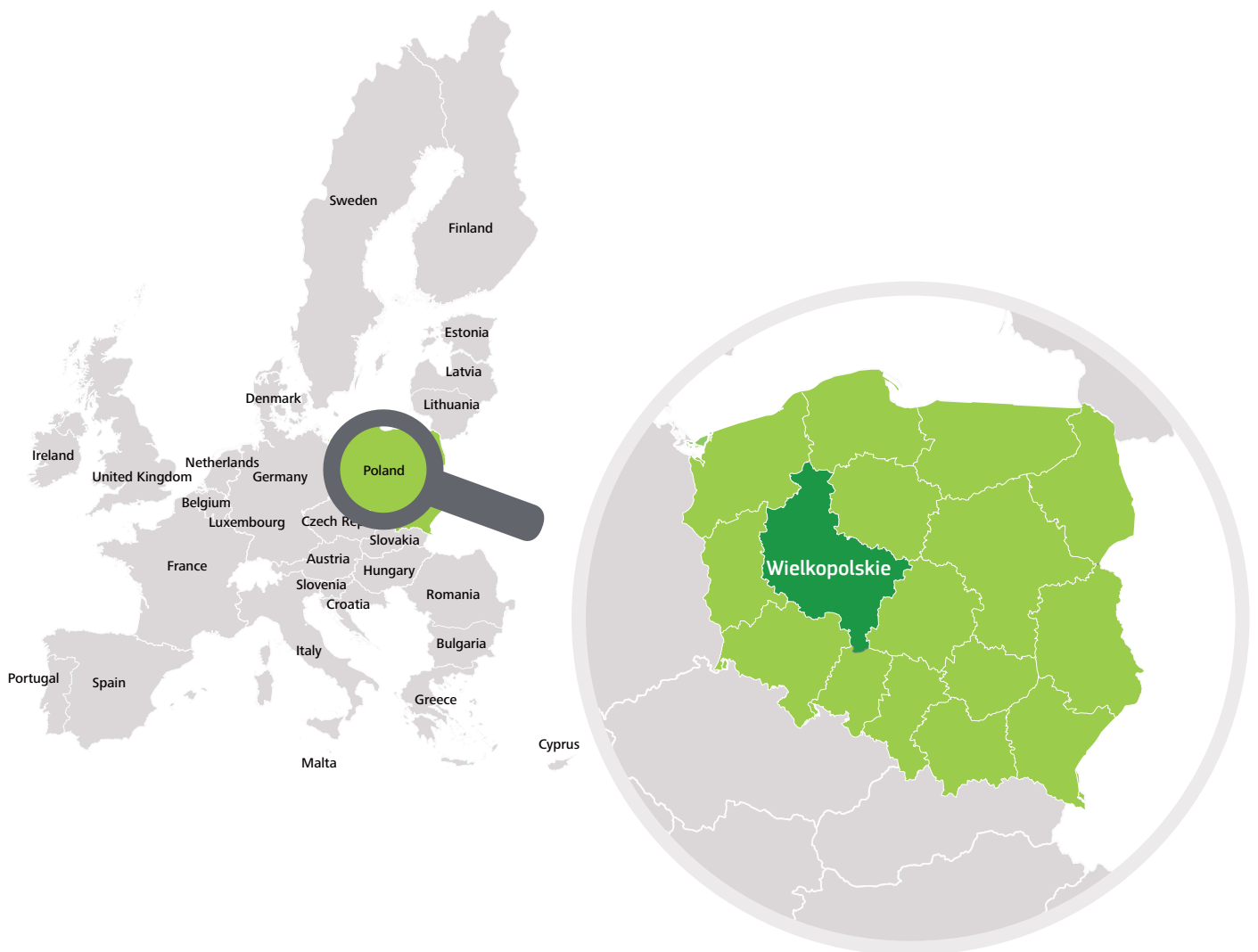
Strongly overfertilised mid-field pond

Agricultural structure in Wielkopolskie

Approximately 1.7 million hectares were dedicated to agriculture in Wielkopolskie in 2013, representing 57% of the total area. Arable land accounted for 81% of the total agricultural land in the region, with cereals, sugar beets and vegetables representing the dominant crops. Cereal production occurred on 73% of the arable land (mainly wheat and maize).

Livestock production includes pigs, poultry and cattle. The largest number of pigs in the country (3.9 million in 2013) is housed in Wielkopolskie. The region also holds the second highest number of cattle (860,000 in 2013) in Poland. The regional livestock density is relatively moderate, however, with an average of 0.7 livestock animals per ha in 2008-2011.

Figure 1 - Map of Europe (Poland in green) and map of Poland showing the Wielkopolskie region in dark green



How does nutrient loss affect farming business?

Nutrients are valuable and vital resources, which can nourish productive grazing lands and crops. From an economical point of view, it therefore makes sense to match the nutrient application to the grassland and crop requirements, thus limiting nutrient loss as much as possible. This in turn could limit the additional costs (e.g., tractor fuel, spreading equipment, labour, etc.) incurred when nutrients are applied beyond the crop and grass requirements. In addition, nutrient loss can create other costs for the farmer; for instance, in order to prevent soil acidification (which can increase with the application of fertilisers), farmers may have to lime their soils. Avoiding the impacts that may result from nutrient loss provides benefits to farming businesses, such as maintaining soil health and fertility and crop yields.

How does nutrient loss affect the Wielkopolskie region and what are the causes?

The Wielkopolskie region faces a number of pressures from nutrient surpluses, largely due to agricultural production as well as industrial and municipal waste. (1) Restructuring and intensification of farms, large and concentrated livestock production with poor farm infrastructure, lack of implementation and accuracy of fertilisation management plans, very few examples of collective action between farmers, and dense drainage networks have contributed to nutrient losses in the region. Wielkopolskie's light, acidic, and highly erodible soil also contributes to nutrient losses, causing regional as well as transboundary effects. Eutrophication of lakes, lagoons, and the Baltic Sea has partly resulted from N and P surpluses from agriculture in the region, which has impacted recreation and tourism opportunities as well as biodiversity due to the development of algae blooms. More than 80% of surface water sources frequently exceed the legal standards for drinking water, leading to high treatment costs.



Effects of crop rotation and monoculture at the Swojec Experimental Farm, Wrocław University of Environmental and Life Sciences



What has already been done to address the problem in the region?

Since 1996, the Polish government has issued policy guidelines to integrate environmental concerns into agricultural processes. The Polish Code of Agricultural Good Practices was developed in 2004, prioritising the “sustainable balance of mineral nutrients” and creating a monitoring programme to track the mineral nitrogen content in soil. The programme aimed to determine the right nutrient doses for crops and assess how to prevent nitrogen leaching from soil to water. Research has also been conducted on how to streamline fertiliser uptake in vegetable production through integrated and organic production methods.



Top and bottom : Unusual example of a buffer zone between arable land and a lake. Water flows from a stream into the ditch and then into the shore of the lake overgrown by reeds by a siphon system intended to filter out sedimentation and nutrient loads.

Poland has co-coordinated (along with Finland) the Priority Area “Nutri” of the EU Strategy for the Baltic Sea Region, aimed at reducing nutrient inputs to the Baltic Sea. (2) Three river basins in the Wielkopolskie Vovoidship developed water management plans to improve the surface water quality as well as reduce the nutrient load transported to the Baltic Sea. The Wielkopolska Agriculture Advisory Centre in Poznań offers trainings and workshops for farmers and advisors. It has also implemented a network of demonstration farms in the context of the Baltic Deal project. (3) Additionally, a project founded by BalticSea2020 on “Self-evaluation concerning nutrients by farmers in Poland” was also launched in 2013. The three-year project is aimed at training farm advisors and engaging with farmers in order to propose measures to reduce nutrient run-off based on their experiences. In 2013, the project led to the publication of a guide to improve nutrient management for both advisors and farmers. (4)

Set of region-specific good practices

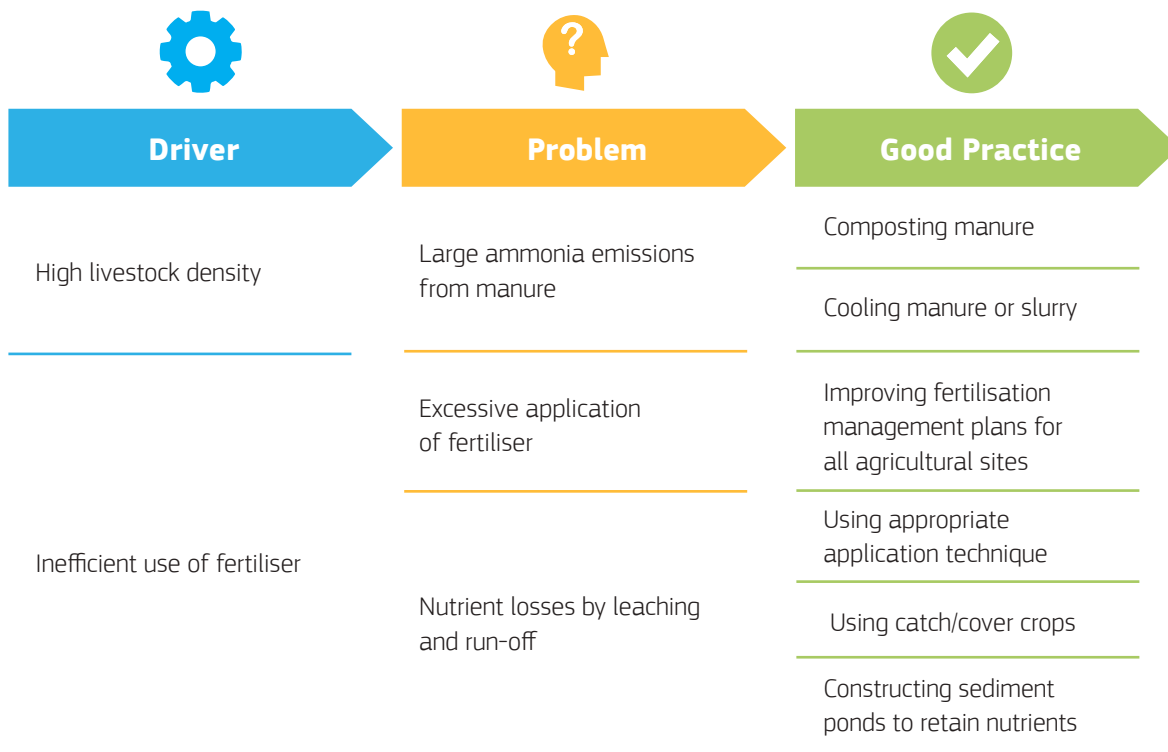
Several examples of 'good practice' measures to reduce nutrient loss and increase resource efficiency in the Wielkopolskie region have been identified (see Figure 2) and will be described in more detail in the following tables.

The measures were selected based on their impacts on the agro-ecosystem in terms of reduced losses through improved nutrient utilisation. Thus, the selected measures provide some economic advantages for the farmer and at the same time

reduce nutrient loss from the farming system, benefitting both the environment and society. Emphasis was placed on measures that have not yet been exploited to their full potential within the Wielkopolskie region. Further selection criteria were whether the measure might be feasibly implemented and whether the measure offers benefits which balance (or outweigh) the costs.

The graphic below highlights various drivers of nutrient loss which exist in the Wielkopolskie region and problems related to those drivers. The final column presents the good practices that were identified as ways to potentially solve the problems associated with nutrient loss.

Figure 2: Selection of good practice measures for the Wielkopolskie region



Composting manure



Definition of the measure	Composting solid manure transforms nitrogen into ammonia and reduces the volume of the original material. Composting can be easily implemented on-farm and generates a product that is easy to export off-farm.
Technical implementation	Manure can be composted in containers; It requires regular aeration by pushing or pulling air through the compost piles; The use of closed systems as well as modifying the C:N ratio helps reduce ammonia emissions (up to 40% of N losses are in ammonia form), but it can also enhance nitrous oxide emissions.
Technical requirements	Composting is preferably applied to solid pig/cattle manure and to pig/cattle/poultry deep litter; Regular aeration of the compost may require specific machinery; The quality of compost produced as well as the gaseous N lost due to denitrification during composting depend on: moisture content, porosity, C:N ratio of the raw manure, temperature, pH and forced aeration/ mechanical turning; Optimal composting occurs when there is a C:N ratio between 20 and 30. For pig manure, straw needs to be added to obtain the C:N ratio required for optimal microorganism activity.

Effects, benefits and costs

Benefits for farming business	Composting facilitates easier storage and use of manure. Using compost as a fertiliser also increases nutrient assimilation by crops, thereby reducing the need for chemical fertilisers.
Costs for farming business	The cost of an aerator for use in domestic production is estimated at 0.15 EUR/tonne of processed manure; thus, investment costs are around 7,200 EUR in Poland. (5)
Co-benefits and trade-offs	Composted manure can be stored or spread with little odour, pathogens and weed seeds. Additionally, increased availability of some N for plants (ammonium) may result in fewer losses to water or air after spreading. Rain or snow falling on uncovered compost piles results in water percolation through the piles that can transfer nutrients to water bodies by run-off or leaching. However, ammonia volatilisation, more than nitrate run-off and leaching losses, may reduce compost's potential as a plant nutrient source.
Environmental effects	Air: Decreased ammonia emissions (depending on the C:N ratio) leading to less particulate matter, odour, and ozone formation, which lowers risks to human health (e.g., aggravated asthma and respiratory problems). Water: Reduced leaching and run-off of nutrients (N, and P to a lesser extent) through higher content of ammonium and storage in soil organic matter, decreasing eutrophication and improving surface and groundwater quality, thereby lowering risks to human health and biodiversity. Biodiversity: Positive effects from reduced N deposition in natural ecosystems.



Cooling manure or slurry

Definition of the measure	Temperature control of the stored manure or slurry to decrease the volatilisation rate and thus ammonia emissions.
Technical implementation	Properly insulate the storage units to avoid temperature changes resulting from the exterior temperature; Install cooling plates and pipes; Regularly control the temperature.
Technical requirements	This measure requires slurry to be stored in a tank. It may require infrastructure changes at farm level, e.g. placing slurry tanks under the housing units may warm the manure by its proximity to the livestock. Cooling slurry could also be connected to a system of heat recovery.

Effects, benefits and costs

Benefits for farming business	Decrease in the amount of fertiliser purchased, as the manure contains more ammonium; cost-savings through less labour due to fewer applications; possible on-farm energy savings through installation of heat exchangers that allow for recuperation of energy to heat homes, livestock buildings, water, or to dry crops.
Costs for farming business	Installation and materials for slurry tanks; costs may vary depending on whether the farmer is able to construct or change the storage infrastructure independently or if a contractor needs to be hired.
Co-benefits and trade-offs	The N content of manure is higher as less is lost through volatilisation and may require less overall application with targeted matching of the nutrient content to the plants' needs. Thus, the nutrient content of the manure must be taken into account during application to avoid excess fertilisation that can lead to leaching and run-off.
Environmental effects	Air: Decreased ammonia emissions leading to less particulate matter, odour, and ozone formation, which lowers risks to human health (e.g. aggravated asthma and respiratory problems); Reduced greenhouse gas emissions (methane, nitrous oxide and carbon dioxide), thereby decreasing the impact on climate. Soil: Improved soil fertility and health through reduced potential for soil acidification. Biodiversity: Positive effects from reduced N deposition in natural ecosystems.

Improving fertilisation management plans for all agricultural sites



Definition of the measure

Preparation of basic fertiliser management plans could be expanded to cover the whole territory rather than just large farms (> 100 ha) in nitrate vulnerable zones (NVZs) and pig and poultry farms with more than 100 livestock units. Additionally, larger farms could include more detailed calculations in their plans than simply determining the basic nutrient balance. For instance, more detailed fertilisation management plans could be developed using specific tools (e.g., soil analysis) and accounting for all relevant inputs and outputs (e.g., deposition, fertilisation, crop residues), which would allow the amount of nutrients applied to be optimised to the specific plot conditions (soil type, crop demand, and remaining nutrients). Basing organic and inorganic fertiliser application rates on a calculated nutrient balance can considerably reduce nutrient losses.

Technical implementation

Calculate and interpret the site-specific nutrient balance:
Analyse the parcel-specific remaining nutrient content in the soil considering the soil type and mineralised crop residues;
Determine the crop nutrient requirements for the desired yield under the given environmental circumstances;
Analyse the nutrient content of organic fertilisers, establish the ratio to mineral fertilisers to fully satisfy crop needs, and consider the time lapse between the application and the assimilation of nutrients by crops.

Technical requirements

The measure involves the calculation of N, P and K leftover in the soil and adjustment of the amount of fertiliser to be applied in the next growth period. This is based on soil samples taken in the spring and autumn (N_{min}), which also serve as a monitoring element of this measure. Nutrient application is fine-tuned according to the crop type and the local conditions. Appropriate tools are required to calculate the necessary fertiliser levels, which may be accessible through advisory services.

Effects, benefits and costs

Benefits for farming business Cost-savings from reduced purchase and less application of additional fertiliser.

Costs for farming business Soil analyses, increased management efforts when applied to all sites, and potentially additional technical support to balance the N, P and K budget (e.g., consideration of remaining nutrient content).

Co-benefits and trade-offs The reduction of applied nutrients positively affects nutrient loss provided that the application takes place under suitable conditions (including weather conditions). A further benefit is the reduction of greenhouse gas emissions during the production of fertilisers if less additional inorganic fertiliser is applied.

Environmental effects

- Water:** Reduced leaching and run-off of nutrients (N, P, and K), decreasing eutrophication and improving surface and groundwater quality, thereby lowering risks to human health and biodiversity.
- Soil:** Improved soil fertility and health through reduced potential for acidification.
- Air:** Decreased ammonia emissions leading to less particulate matter, odour, and ozone formation, which lowers risks to human health (e.g., aggravated asthma and respiratory problems);
Reduced greenhouse gas emissions (nitrous oxide and carbon dioxide), thereby decreasing the impact on climate.
- Biodiversity:** Positive effects from reduced N deposition in natural ecosystems.



Using appropriate application techniques

Definition of the measure

The use of an appropriate manure application technique, such as band application or injection, can reduce the volatilisation of ammonia by decreasing the surface area of manure in contact with the air. Thereby, the potential for ammonia emissions decreases and consequently, the amount of nitrogen utilised by the crops is improved. Even distribution of manure can also improve the utilisation of nutrients. When manure is incorporated immediately after spreading or directly through injection, nutrient run-off can also be decreased.

Technical implementation

Immediately incorporate urea-containing fertiliser (e.g. via injection of slurry, ploughing in solids), which significantly reduces ammonia emissions;
Calibrate fertiliser spreaders to reduce N losses;
Broadcast spreading techniques should be replaced by more accurate ones, e.g., trailing hoses/shoes. (6)

Technical requirements

The appropriate application technique may vary according to soil type and crop. When the manure is applied before seeding, band spreaders (followed by incorporation) or injectors (open or closed slot) can be used. Band spreaders drag perforated hoses behind them, from which slurry is applied close to the ground. Injection systems slit the soil open and inject the fertiliser at different depths. On grassland, using a trailing shoe spreader helps provide uniformity of spreading and lowers emissions. Some band spreading or closed slot slurry injection machines for top dressing applications are also available. Distribution of slurries mixed with irrigation water can also be a suitable technique provided that the irrigation water does not leave the fields. Some of these types of equipment, like a band spreader or an injector connected to an umbilical system, can also improve the timing of application as well as lead to more efficient use of nutrients.

Effects, benefits and costs

Benefits for farming business Cost-savings from reduced purchase and application of additional fertilisers. Consistent and even application promotes better yields as all crops are fertilised.

Costs for farming business Purchase or rental costs of specific equipment and potential costs from reduced field capacity of the machinery (use of contractors could be a possible solution to reduce expenses); higher labour intensity. Collective action could be a way for smaller farms to invest in such techniques.

Co-benefits and trade-offs Accurate application avoids fertiliser waste, which in turn reduces the use of supplemental manufactured N fertilisers. Through application close to the soil, odour emissions are reduced, but in order to avoid an increase in the nitrate leaching potential, injection must be timed appropriately in terms of crop needs and climate conditions. Furthermore, shallow injection may increase the potential for nitrous oxide emissions; thus, deep injection is preferable. By incorporating or injecting manure, nutrient run-off is reduced. Trailing shoe equipment may increase the potential for soil compaction due to the weight of the attachment. Slurry is best applied in spring when soils are often wetter, thereby threatening compaction damage. Umbilical slurry handling systems can be used to alleviate this, but they are expensive.

Environmental effects

Air: Decreased ammonia emissions leading to less particulate matter, odour, and ozone formation, which lowers risks to human health (e.g., aggravated asthma and respiratory problems);
Reduced greenhouse gas emissions (carbon dioxide – reduced production of mineral fertiliser), thereby decreasing the impact on climate.

Water: Reduced run-off of nutrients (N and P), decreasing eutrophication and improving surface and groundwater quality, thereby lowering risks to human health and biodiversity.

Soil: Improved soil fertility and health through reduced potential for acidification.

Biodiversity: Positive effects from reduced N deposition in natural ecosystems.

Using catch/cover crops



Definition of the measure	Integrating catch crops into the crop rotation reduces nutrient leaching and run-off and decreases the need to add organic and mineral fertilisers. This is particularly relevant to farms in NVZs, where nitrogen leaching risk must be reduced by using catch/cover crops or other suitable measures included the Code of Good Agricultural Practice. (7)
Technical implementation	Crop rotation (with catch crops in winter) should account for the characteristics of each type of catch crop in order to maintain good soil structure and soil organic matter. Catch crops should be incorporated mechanically only to avoid additional chemical application and further pollution risks.
Technical requirements	Integrating catch crops is particularly suited to the region due to the soil type; catch crops are more effective on sandy soils than on clay soils, which is the case in Wielkopolskie. Consideration of the appropriate time for seeding and ploughing under the catch crop is required, but low technical and knowledge requirements are necessary. The choice of the catch crops should be adapted to the territory and the other crops of the rotation to optimise their nutrient catching function. Legumes mixed with cereals are already used by Polish farmers, which contribute to the N surplus in the region due to biological fixation.

Effects, benefits and costs

Benefits for farming business	Improved soil fertility and availability of nutrients after the crop has been ploughed in as the residues release nutrients which are available to nourish the following crop, thus reducing the need for additional fertiliser purchase and application costs.
Costs for farming business	Additional seeding and ploughing costs but overall, low implementation/running costs.
Co-benefits and trade-offs	Catch crops (and cover crops in general) are a means to combat weeds. Consider legumes for soils with poor nutrient content or which are subject to high nutrient losses due to their capacity for N-fixation. One drawback of legume-rich swards is the high risk of nitrate leaching and increased nitrous oxide emissions after ploughing.
Environmental effects	Soil: Improved soil fertility and structure through increased soil organic matter and reduced risk of soil erosion, contributing to carbon sequestration and storage in the soil. Water: Reduced risk of leaching and run-off of nutrients during fallow crop periods, decreasing eutrophication and improving surface and groundwater quality, thereby lowering risks to human health and biodiversity. Air: Reduced greenhouse gas emissions (nitrous oxide), thereby decreasing the impact on climate. Biodiversity: Positive effects due to the catch/cover crops providing additional wildlife and pollinator habitats.



Constructing sediment ponds to retain nutrients

Definition of the measure

Small shallow sediment basins retain soil particles and nutrients, especially P, from run-off water. This measure could help decrease the nutrient concentration in surface water.

Technical implementation

A sediment pond is composed of a shallow sediment basin and wetland covered with typical wetland plants, which act as a filter. Ponds can be constructed by widening a section of a ditch or assessing the most appropriate location to create a shallow basin based on the natural drainage of the area. The size of the drainage area and the soil type will influence the size of the sediment pond and the suitability of the measure (e.g., basins in sandy soils would not retain high structural integrity compared to other soil types). The flow of run-off may need to be slowed down by increasing soil heights along ponds to block the pathway of the water. If the area is highly sloping, a second wetland can be added to increase the sedimentation efficiency.

Technical requirements

The measure does not require significant investments or technical knowledge, but the measure does require some substantial planning before implementation and additional labour to create the pond. This measure can be combined with conservation tillage and buffer strips at the end of the field to reduce soil erosion and nutrient losses.

Effects, benefits and costs

Benefits for farming business Once established, sediment ponds require little maintenance and cleaning out the built-up sediment allows farmers to recover organic matter and nutrients to re-apply onto the field. This reduces the need to purchase and apply additional fertilisers. Additionally, farms practicing irrigation can create sediment ponds to catch the irrigation run-off and re-use it for increased water use efficiency.

Costs for farming business Costs for labour to implement technical requirements, such as increasing soil heights, creating shallow basins, or widening a section of a ditch. Costs may vary depending on the area taken out of production and the opportunity costs from not harvesting crops there.

Co-benefits and trade-offs Soil and water quality is improved by slowing floodwaters and rainwater run-off and retaining the nutrients in the sediment (mainly P), which are caught by the plants. Pesticides may be caught in addition to N, P, and K bound to soil particles. Possible risk of plant death and fungi development in the ponds if the ponds stay wet for a long period of time. As constructed wetlands, sedimentation ponds produce varying levels of N and methane emissions to air, which negatively impact climate change. However, wetlands can store large amounts of carbon, which has a positive impact on climate change. (8)

Environmental effects
Water: Reduced risk of eutrophication through storage and sedimentation of run-off water containing soil particles and nutrients (especially P as well as N and K) and improving surface water quality, thereby lowering risks to human health and biodiversity.
Biodiversity: Benefits from creation or restoration of semi-natural habitats.

Further good practices to reduce nutrient losses

Increasing the height of manure heaps to increase manure compaction

Increasing the height of temporary manure heaps is a simple measure that reduces ammonia emissions through compaction of the manure under its own weight. Increasing heap height to 4-6 m would require proper equipment, such as a telescopic loader. This method is a less effective alternative to manure cover, but it is easier and cheaper to implement.

Using an impermeable floor for manure storage

Since a significant share of the manure is stored in heaps, using an impermeable floor (e.g., concrete) would avoid nutrient losses by run-off and leaching. Programmes have been implemented to help increase the use of impermeable floors for the temporary storage of solid manure and tanks for liquid manure and slurry. In particular, the Polish Rural Development Programme 2014-2020 under the EU Common Agricultural Policy provides subsidies for the modernisation of buildings and storage facilities.

Conservation tillage techniques

Wielkopolskie is affected by tillage-induced erosion, both from water and wind. Tillage-induced erosion is responsible for soil loss (> 20 t/ha) and thereby nutrient loss, in particular P. Favouring conservation tillage or no-till would help reduce the loss of nutrients due to tillage. Conservation tillage also decreases the decomposition of residues and thus increases the available nitrogen for crops. However, due to the type of soil in Wielkopolskie, which is mostly sandy, tillage would likely have only a limited effect on nutrient losses from leaching or emissions. This technique is mostly appropriate for large or intensive farms and holdings with few or no livestock. No-till can only be

implemented in holdings with livestock production if the slurry is injected into the soil as slurry needs to be incorporated. While implementation may result in some labour cost-savings, both reduced till and no-till may require significant investments for the purchase of specialist machinery and/or result in an increased use of herbicides and pesticides. Yield loss may also potentially result due to weeds, leading to further costs.

Incorporating crop residues

Incorporating crop residues or mulching enriches soil organic matter and has a positive impact on soil structure and water retention capacity, which in turn reduces the risk of nutrient leaching. Residues such as straw have a high carbon to nitrogen ratio and help fix nitrogen that is slowly released. Combining fertilisers with straw and liming increases soil organic matter content. This measure can have a high effect on the overall regional nutrient loss since 84% of the land in the region is arable land. In Poland, ploughing under is the most common solution for utilising harvest residues. Farmers apply this type of practice in order to enrich their soils and due to a lack of alternative uses for the straw (e.g., insufficient quantities compared to the size of the cattle and breeding systems, or since a high quantity of pig operations do not use straw for bedding).



Aberdeen Angus and Simmental heifers in organic farm in Pyzdry, région of Wielkopolskie



Further relevant links

Further information (links) on the issue of reducing nutrient losses in agriculture which are relevant for the Wielkopolskie region can be found below. This information entails links to legal documents, programmes, initiatives, institutions and studies.

EU level

DG Environment - Nitrates Directive:

http://ec.europa.eu/environment/water/water-nitrates/index_en.html

The study "Resource Efficiency in Practice - Closing Mineral Cycles" is available at the following link:

<http://ec.europa.eu/environment/water/water-nitrates/studies.html>

DG Environment - Sustainable use of phosphorus:

<http://ec.europa.eu/environment/natres/phosphorus.htm>

EU Strategy for the Baltic Sea Region:

<http://www.balticsea-region-strategy.eu/>

Contacts:

ENV-NITRATES@ec.europa.eu;

ENV-USE-OF-PHOSPHORUS@ec.europa.eu

National and regional level

Ministry of Agriculture and Rural Development:

<http://www.minrol.gov.pl/eng/>

Rural Development Programme for 2014-2020:

<http://www.minrol.gov.pl/Wsparcie-rolnictwa-i-rybolowstwa/PROW-2014-2020>

Ministry of the Environment:

http://www.mos.gov.pl/kategoria/4945_green_investment_scheme/?j=en

Agency for Restructuring and Modernisation of Agriculture (ARMA):

<http://www.arimr.gov.pl/o-arimr/information-about-the-agency.html>

Agricultural Market Agency (ARR):

http://www.arr.gov.pl/index.php?option=com_content&view=article&id=687&Itemid=528

Agricultural Social Insurance Fund:

<http://www.krus.gov.pl/en/>

Agricultural Property Agency

<http://www.anr.gov.pl/web/guest>

Nitsch, H. (2003) Cross Compliance National Report: Poland:

<http://www.ieep.eu/assets/74/seminar1countryreportpoland.pdf>

Wielkopolskie Region:

<http://regiony.poland.gov.pl/wielkopolskie/Wielkopolskie,Region,116.html>

Statistical Office in Poznań:

<http://poznan.stat.gov.pl/en/publications/agriculture-forestry/agriculture-in-wielkopolskie-voivodship-in-2013,1,8.html>

Studies and projects

Korczyńska, A. et al. (2013) Incentives and Support Mechanisms Stimulating Innovation within Manure Management in Poland:

http://www.balticmanure.eu/download/Reports/Country_reports/conutry_specific_incentives_poland_web.pdf

The Baltic Manure project – Business Opportunities:

<http://www.balticmanure.eu/>

Baltic Deal:

[http://www.balticdeal.eu/\(links for buffer strips and compost from solid manure\)](http://www.balticdeal.eu/(links%20for%20buffer%20strips%20and%20compost%20from%20solid%20manure))

HELCOM (Baltic Marine Environment Protection Commission – Helsinki Commission) (2014) Eutrophication status of the Baltic Sea 2007-2011 - A concise thematic assessment. Baltic Sea Environment Proceedings No. 143:

<http://helcom.fi/Lists/Publications/BSEP143.pdf>

Polish Ministry of Environment (2010) Initial National Implementation Programme for the Baltic Sea Action Plan:

http://helcom.fi/Documents/Baltic%20sea%20action%20plan/National%20follow-up/NIP_Poland.pdf

Skorupski, J. (2012) Industrial Animal Farming in Poland as a major threat to the natural environment of the Baltic Sea:

http://databases.eucc-d.de/files/documents/00001134_CR20_pp_45-53_Skorupski.pdf

Agro Business Park (2011) Inventory of Manure Processing Activities in Europe:

http://agro-technology-atlas.eu/docs/21010_technical_report_I_inventory.pdf

Pietrzak, S. (2012) Priority measures for reducing nitrogen and phosphorus losses from agriculture and water protection, Institute of Technology and Life Sciences in Falenty (ITP), Poland:

www.balticdeal.eu/measure/adapted-feeding?aid=4507&sa=1

Ministerstwo Rolnictwa i Rozwoju Wsi & Ministerstwo Środowiska (2004) Kodeks dobrej praktyki rolniczej (Ministry of Agriculture and Rural Development & Ministry of Environment - Code of Good Agricultural Practice):

http://www.kzgw.gov.pl/files/file/Materialy_i_Informacje/Dyrektywy_Unijne/Azotowa/kodeks_dobrej_praktyki_rolniczej.pdf

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Image sources:

Cover page: Field crops in Raszków in the region of Wielkopolskie where cereal production occurred on 73% of the arable land (mainly wheat and maize) © Jacek Halicki - P3: Strongly overfertilised mid-field pond © Aneta Kozłowska - P5: Effects of crop rotation and monoculture at the Swojec Experimental Farm, Wrocław University of Environmental and Life Sciences © Lesław Zimny - P6 top & bottom: unusual example of a buffer zone between arable land and a lake. Water flows from a stream into the ditch and then into the shore of the lake overgrown by reeds by a siphon system intended to filter out sedimentation and nutrient loads © Zygmunt Miatkowski - P8: Composting is a natural process that transforms manure into a valuable organic fertiliser which is easier to handle and transport than fresh manure © Marek Krysztoforowski - P9: Slurry cooling © Frank-Bondgaard - P10: Farmer taking soil samples out of ploughed field. Matching crop requirements and nutrient content of soil and fertilisers can minimize nutrients losses and reduce expenses © Wayne Hutchinson / Alamy - P11: Equipment that allows direct incorporation of slurry and a uniform distribution of nutrients © Giorgio Provolo - P12: White mustard grown as catch crop in Poland © Lesław Zimny - P13: This sedimentation pond was established by widening a section of a ditch. In the foreground, right after the inlet, is the deeper sedimentation basin © S. Owenius, Water Revival Systems Uppsala (WRS) - P15: Aberdeen Angus and Simmental heifers in organic farm in Pyzdry, région of Wielkopolskie © Edyta and Janina Saacke.

Project:

Resource Efficiency in Practice - Closing Mineral Cycles

Funded by the European Commission | No. 070372/2013/665122/ETU/B.1

Project partners:

BIO by Deloitte, Ecologic Institute, AMEC Foster Wheeler Environment & Infrastructure, Technical University of Denmark, University of Milan and LEI Wageningen UR

Appendix 16 Proposed SuDS Network



Stratton Park House, Wanborough Road
Swindon, SN3 4HG

Telephone
01793 828000

Website
www.pfapl.com

Preliminary
This drawing is produced for initial discussion and illustrative purposes only, and should not be relied upon for tender or pricing purposes.

NOTES

1. This drawing is based on the Topographical Survey undertaken by Mayer Brown Limited, Drawing No:R/SAV.1.21.1, Rev E, dated 05 May 2014.
2. This site layout is based on Thrive's Concept Masterplan, Drawing number: EAST200403 CMP 01 Rev P1, dated 28.08.20
3. Main River designation based on Flood Map for Planning.
4. The swale/conveyance features shown indicatively in this drawing are subject to detailed design levels to assess their feasibility.

Key

- Risk of Flooding from Surface Water Outline
- Basin Catchment Allocation
- Flood Zone 2
- Flood Zone 3
- Indicative Location of Southern Foul Water Sewage Pumping Station
- 5m offset from Watercourse
- 8m offset from Main Rivers
- Opportunity for swale conveyance feature

Rev	Date	Description	Drawn	Check
#	24/08/20	First Issue	DAB	MWS
A	10/09/20	Addition of Basin 8 and revision of Basin South	DAB	MWS
B	14/09/20	Client details updated. Catchment numbers added	BF	

Status
PRELIMINARY

Client
Eastleigh Borough Council

Project
One Horton Heath, Hampshire

Drawing Title
Indicative Location of Strategic SuDS Features

Drawing No. **G277/12** REV B
Date: September 2020 Scale: 1:2500 @ A1
E-Mail: DBuciak@pfapl.com

Basin 5B
Catchment: 5B
Gross Area: 2.21 HA
Gross Estimated Impermeable area: 1.528HA
Q_{dep}: 17.6/s
Basin Attenuation Volume: 848m³

Basin 4A
Catchment: 4A
Gross Area: 3.839 HA
Gross Estimated Impermeable area: 2.495HA
Q_{dep}: 30.7/s
Basin Attenuation Volume: 1351m³

Basin 4B.1
Catchment: 4B.1
Gross Area: 6.122 HA
Gross Estimated Impermeable area: 3.979HA
Q_{dep}: 48.9/s
Basin Attenuation Volume: 2180m³

Basin 4B.2
Catchment: 4B.2
Gross Area: 3.546 HA
Gross Estimated Impermeable area: 2.304HA
Q_{dep}: 28.3/s
Basin Attenuation Volume: 1255m³

Basin 3A
Catchment: 3A & 3A-S
Gross Area: 3.759 HA
Gross Estimated Impermeable area: 2.724HA
Q_{dep}: 30.0/s
Basin Attenuation Volume: 1525m³

Basin 4C Not Required
storage now provided in
Basin 4D

Basin 5A
Catchment: 5A
Gross Area: 4.538 HA
Gross Estimated Impermeable area: 3.225HA
Q_{dep}: 36.3/s
Basin Attenuation Volume: 1807m³

Basin 4D
Gross Area: 3.513HA
Gross Estimated Impermeable area: 2.2831HA
Q_{dep}: 28.1/s
Basin Attenuation Volume: 1236m³

Basin 4E
Basin/swale conveyance
feature

Swale
Opportunity for swale feature to provide
attenuation for part of the link road and
reduce sediment transportation to
downstream surface water network.

Proposed Layout does not respect existing
drainage ditch.
This may result in the need for culverting
existing ditch and assessing discharge from
upstream catchments

Basin South
Catchment: 1
Gross Area: 5.05 HA
Gross Estimated Impermeable area: 3.66HA
Q_{dep}: 40.39/s
Basin Attenuation Volume: 2078m³

Basin Central
Catchment: 9 & 9S
Gross Area: 7.878 HA
Gross Estimated Impermeable area: 5.472 HA
Q_{dep}: 63.0/s
Basin Attenuation Volume: 3012m³

Basin 8
Catchment: 8
Gross Area: 1.660 HA
Gross Estimated Impermeable area: 1.079 HA
Q_{dep}: 13.28/s
Basin Attenuation Volume: 618m³

Basin 7A & 7B
Catchment: 7B & 7B
Gross Area: 4.138 HA
Gross Estimated Impermeable area: 2.690 HA
Q_{dep}: 33.1/s
Basin Attenuation Volume:
1076m³ (Basin 7A) + 394m³ (Basin 7B)

Basin 6A
Catchment: 6A
Gross Area: 6.685 HA
Gross Estimated Impermeable area: 4.345 HA
Q_{dep}: 53.4/s
Basin Attenuation Volume: 2368m³

Revised Basin 6B Odlessey
Catchment: 6B
Gross Area: 2.5616 HA
Gross Estimated Impermeable area: 1.665 HA
Q_{dep}: 20.4/s
Basin Attenuation Volume: 916m³

Basin 1
Ruby & Stag Ltds Basin
Conflicts with Concept Masterplan
Drawing number CMP 01 Rev P2
Dated 28.07.20

Employment Area Basin
Catchment: Employment
Gross Area: 1.883 HA
Gross Estimated Impermeable area:
1.601 HA
Q_{dep}: 15.0/s
Basin Attenuation Volume: 971m³

0m 100m 200m
Scale 1:2500

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