NORTH SPROWSTON AND OLD CATTON

BEESTON, NORWICH

NUTRIENT NEUTRALITY ASSESSMENT AND MITIGATION STRATEGY

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Authorisation and Version Control

This Nutrient Neutrality Assessment was commissioned to investigate and mitigate against the concerns raised by NE regarding the nutrient neutrality of the proposed development at Beeston, Norwich and the potential adverse effects on downstream designated sites.

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EXECUTIVE SUMMARY

In 2018, the European Court of Justice refined the definition of plans and projects and ruled that mitigation needs to be in place to ensure that there will be no likely significant effect on the conservation status of designated sites. Additional nutrient loading to designated sites already in an unfavourable conservation status is not permissible unless mitigation is in place. This ruling has come to be known as 'The Dutch Case'.

The development lies within the catchment of the River Bure. The River Bure leads to the Broads, which is a Special Area of Conservation, comprises many different Sites of Special Scientific Interest and is designated under the Ramsar Convention under the name 'The Broadland'.

Five of the units of the Broads are in unfavourable condition due to water quality, therefore ruling of the Dutch Case applies. All developments in the catchment have to demonstrate 'nutrient neutrality' in order to ensure no adverse effect on the integrity of the designated site, meaning that the nutrients generated by the development must be less than or equal to the nutrients generated by the existing land use.

The application site consists of 207.4 ha of land under the ownership of a landowner consortium comprising the Beeston Estate, Morley Agricultural Foundation, Alderman Norman Trust, Norfolk County Council and the Howard family. It lies within the Old Catton, Sprowston, Rackheath and Thorpe St. Andrew 'Growth Triangle'.

The proposal is the construction of 3,520 homes, and their associated greenspace and infrastructure.

It was shown through this assessment that the development would not be nutrient neutral, and a mitigation strategy is therefore required. A mitigation strategy to achieve nutrient neutrality has been devised and comprises four key components.

Domestic wastewater from the site will be treated onsite to a much higher standard than is currently achieved at the municipal wastewater treatment plant. This will allow the wastewater load from the site to be significantly reduced.

Sustainable Drainage Systems will be used within the site to reduce nutrient pollution from surface water runoff. These systems will be optimised to remove nutrients and will likely include elements of bioretention.

Several existing septic tanks, currently serving single houses, will be upgraded to a more modern package treatment plant that will be optimised to remove nutrients.

An offsite wetland has been proposed at Dobb's Beck to the northwest of the site. This will remove sufficient nutrients from the Beck to offset the residual nutrient budget after the previous mitigation measures are applied.

Through this mitigation strategy, it has been demonstrated that the site will achieve nutrient neutrality.

ABBREVIATIONS

Acronym	Definition
AA	Appropriate Assessment
EMC	Event Mean Concentration
HRA	Habitats Regulations Assessment
NE	Natural England
NEGM	Natural England Generic Methodology
NNBC	Norfolk Nutrient Budget Calculator
SAAR	Standard Average Annual Rainfall
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage System
TN	Total Nitrogen
TP	Total Phosphorus
WwTW	Wastewater Treatment Works

1 INTRODUCTION

1.1 The application site consists of 207.4 ha of land under the ownership of a landowner consortium comprising the Beeston Estate, Morley Agricultural Foundation, Alderman Norman Trust, Norfolk County Council and the Howard family. It lies within the Old Catton, Sprowston, Rackheath and Thorpe St. Andrew 'Growth Triangle' originally designated by the adopted Greater Norwich Development Partnership Joint Core Strategy as a location for the development of 7,000 homes by 2026, rising to 10,000 after 2026, to help meet rising demand for housing in Norwich and Norfolk.

1.2 As the site lies within the catchment of a European and internationally designated site – The Broads – a Habitats Regulations Assessment (HRA) is required.

Background

1.3 A HRA refers to the several distinct stages of assessment which must be undertaken in accordance with the Conservation of Habitats and Species Regulations 2017 (as amended) to determine if a plan or project may affect the protected features of a habitats site (any site which would be included within the definition at Regulation 8 of the Conservation of Habitats and Species Regulations 2017) before deciding whether to undertake, permit or authorise it.

1.4 A significant effect should be considered likely if it cannot be excluded on the basis of objective information and it might undermine a site's conservation objectives. A risk or a possibility of such an effect is enough to warrant the need for an Appropriate Assessment (AA) to be carried out by the competent authority. 'Appropriate' is not a technical term. It indicates that an assessment needs to be proportionate and sufficient to support the task of the competent authority in determining whether the plan or project will adversely affect the integrity of the habitats site. An AA must contain complete, precise, and definitive findings and conclusions to ensure that there is no reasonable scientific doubt as to the effects of the proposed plan or project.[1]

1.5 In 2018, the European Court of Justice refined the definition of plans and projects in the so-called 'Dutch case' ruling that mitigation needs to be certain at the time of assessment to ensure that there will be no adverse effect on the conservation status of European designated sites which already exceed compliance limits[2].

1.6 Nutrient neutrality is a means of ensuring that a plan or project does not add to existing nutrient burdens. Where nutrient neutrality is properly applied and the existing land does not undermine the conservation objectives, Natural England (NE) considers that an adverse effect on integrity alone and in combination can be ruled out[3].

1.7 In the Broadland Rivers management catchment, developments could adversely affect the Broads, which is a Special Area of Conservation (SAC), comprises many different Sites of Special Scientific Interest (SSSI) and is designated under the Ramsar Convention under the name 'The Broadland'. In particular, development in this area may have an impact on the Bure Broads and Marshes SSSI.

[1] Guidance on the use of Habitats Regulations Assessment – https://www.gov.uk/guidance/appropriate-assessment – accessed 11/2022
[2] Joined Cases C-293/17 and C-294/17 of the European Court of Justice
[3] Wood, A., Wake, H., and McKendrick-Smith, K. (2022) *Nutrient Neutrality Principles* Natural England Technical Information Note, TIN186

1.8 Recent water quality data shows that the Ant, Bure, Trinity, Upper Thurne, and Yare Broads and Marshes SSSIs are overall exceeding their water quality targets for nitrogen and phosphorus and are considered to be in 'unfavourable' condition[4]. Therefore the ruling of the Dutch Case applies.

1.9 The practical implication of the Dutch Case across England is the necessity to mitigate increases in nutrient loading from new development including nutrients contained in surface water runoff and an increase in wastewater flows to any of the Wastewater Treatment Works (WwTW) in the relevant catchment.

Scope of Study

1.10 The main objectives of this study are to:

- Provide an overview of NE's position in respect to water quality within the designated site;
- Present calculations, based on the absence of any mitigation measures, to outline the potential increase in nutrient loading as a result of the proposed development; and
- Outline the mitigation strategy proposed to manage surface and wastewater from the proposed development and present supporting calculations in order to ensure that, from first occupation of the dwellings, the proposed development is nutrient neutral.

[4] Wood, A., Wake, H. and McKendrick-Smith, K (2022), *The Broads Special Area of Conservation/Broadland Ramsar – Evidence Pack.* Natural England Technical Information Note TIN205 Natural England.

2 WATER QUALITY IN THE BROADS

The Broads Designated Sites[5]

2.1 The Broads comprises several different SSSIs, but only the Bure Broads and Marshes SSSI is of concern for this development. The Bure Broads and Marshes SSSI is designated by NE for the following features of interest:

- Assemblages of breeding birds – Lowland fen without open water
- Eutrophic Lakes
- Floodplain fen (lowland)
- Invertebrate assemblage W126 seepage
- Invertebrate assemblage W211 open water on disturbed sediments
- Invertebrate assemblage W313 moss & tussock fen
- Invertebrate assemblage W314 reed-fen & pools
- Lowland mire grassland and rush pasture
- Vascular plant assemblage
- Wet woodland

2.2 The Broads SAC is designated by NE for the following qualifying features:

- Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.
- Natural eutrophic lakes with Magnopotamion or Hydrochariton
- Molinia meadows on calcareous, peat or clay-silt soil
- Transition mires and quaking bogs
- Calcareous fens with *C. Mariscus* and species of *C. Davallianae*
- Alkaline fens
- Alluvial woods with *A. Glutinosa, F. Excelsior*
- Desmoulin's whorl snail, *Vertigo moulinsiana*
- Otter, *Lutra lutra*
- Fen orchid, *Liparis loeselii*
- Little ram's-horn whirlpool snail, *Anisus vorticulus*

2.3 The Broadland Ramsar site is designated for the following features:

- Bewicks's swan, *Cygnus columbianus bewickii* – Wintering
- Floodplain alder woodland
- Floodplain fen

[5] Available at: designatedsites.naturalengland.org.uk [Accessed 11/2022]

- Gadwall, *Anas strepera* – Wintering
- Shoveler, *Anas clypeata* – Wintering
- Wetland invertebrate assemblage
- Wigeon, *Mareca Penelope* – Wintering

2.4 The focus of this letter is on the evidence of degrading water quality in the Broads designated sites, henceforth referred to as the 'Habitats Sites'.

Total Nitrogen and Total Phosphorus

2.5 It has been found that the nutrients of highest significance in terms of water quality in Habitats Sites are Total Nitrogen (TN) and Total Phosphorus (TP).

2.6 TN includes organic and inorganic forms of nitrogen, both of which are available for plant growth and can contribute to algal blooming. TN is the sum of inorganic forms of nitrogen – nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N) and ammoniacal nitrogen (NH_3-N and NH_4-N) – and organically bonded nitrogen.

2.7 TP includes all phosphorus components – phosphate phosphorus (PO_4-P), dissolved organic phosphorus and particulate phosphorus in algal and bacterial cells – and also includes mineral particles such as clay.

Water Quality

2.8 The focus of this letter is on the evidence of degrading water quality in the Broads designated sites, henceforth referred to as the 'Habitats Sites'.

2.9 The condition of the Habitats Sites which supports the designated features is in part dependent on the water quality within them. The occurrence of excessive nutrients in the Habitats Site can impact the competitive interactions between high plant species, and between higher plant species and algae, which can result in dominance in attached forms of algae, and a loss of characteristic plant species.

2.10 Elevated concentrations of both TP and TN have led to poor water quality within the Habitats Sites, leading to the occurrence of eutrophication, which impacts on aquatic macrophyte flora and leads to changes in water chemistry. Recent data shows that the following SSSIs which underpin the SAC are failing to meet TN and TP water quality targets:

- Ant Broads and Marshes
- Bure Broads and Marshes
- Trinity Broads
- Upper Thurne Broads and Marshes
- Yare Broads and Marshes.

2.11 The occurrence of elevated nutrients in a waterbody can impact the competitive interactions between high plant species and between higher plant species and algae, which can result in a loss of characteristic plant species. Changes in plant growth and community composition and structure can have implications for the wider food web and the species present. Eutrophication can also increase dissolved oxygen levels in a waterbody and affect the substrate condition, which could in turn negatively impact the local biota.

Strategic Approach

2.12 Where sites are already in unfavourable condition due to elevated nutrient levels, NE considers that competent authorities will need to carefully justify how further inputs from new plans and projects, either alone or in combination, will not adversely affect the integrity of the site given the conservation objectives.[6]

2.13 To address the uncertainty and the subsequent risk to the Habitats Sites, the mitigation strategy outlined in this report will ensure that the proposed development does not add to existing nutrient burdens and provides certainty that the whole of the scheme is deliverable in line with the requirements of the Conservation of Habitats and Species Regulations 2017[7] and in light of relevant case law[8].

2.14 The latest NE methodology and the Norfolk methodology have been followed to ensure that the proposed development will be nutrient neutral (i.e. will not increase the flux of nutrients to the designated site).

2.15 In this report we implement the following staged approach. In Part 1, it is calculated, in the absence of any mitigation measures, the potential increase in nutrient loading from the proposed development. In Part 2, a mitigation strategy is proposed and supporting calculations are presented which provide sufficient and reasonable certainty that the development will not contribute to an increase in nutrient loading.

2.16 The Nutrient Neutrality calculations in this report are based on key inputs and assumptions based on the best available scientific evidence and research. To accommodate for the necessary level of uncertainty in these key assumptions, a buffer is used when calculating the nutrient budget. This buffer ensures that a precautionary approach is followed throughout.

[6] Natural England (16 March 2022) Letter to LPA Chief Executives and heads of planning 'Advice for development proposals with the potential to affect water quality resulting in adverse nutrient impacts on Habitats Site.'

[7] Conservation of Habitats and Species Regulations (England and Wales) Regulations 2017

[8] Including Wildlife and Countryside Act 1981, Countryside and Rights of Way Act 2000 and Rural Communities Act 2006

3 SITE DESCRIPTION

Location

3.1 The application site consists of 207.4 ha of land under the ownership of a landowner consortium comprising the Beeston Estate, Morley Agricultural Foundation, Alderman Norman Trust, Norfolk County Council and the Howard family. It lies within the Old Catton, Sprowston, Rackheath and Thorpe St. Andrew 'Growth Triangle' originally designated by the adopted Greater Norwich Development Partnership Joint Core Strategy as a location for the development of 7,000 homes by 2026, rising to 10,000 after 2026, to help meet rising demand for housing in Norwich and Norfolk.

3.2 The application site is bounded to the south by the established communities of Old Catton and Sprowston, to the east by Sprowston Manor Golf Club and to the West by St. Faith's Lane. It is bounded on the north by the recently built Broadland Northway A1270, beyond which lies the village of Spixworth.

3.3 The site is located on the watershed between the Bure Operational Catchment and the Yare Operational Catchment, while the majority of the site is located within the Bure Operational Catchment. This is shown in Figure 1, along with the site context within the wider Broadland Rivers Management Catchment.

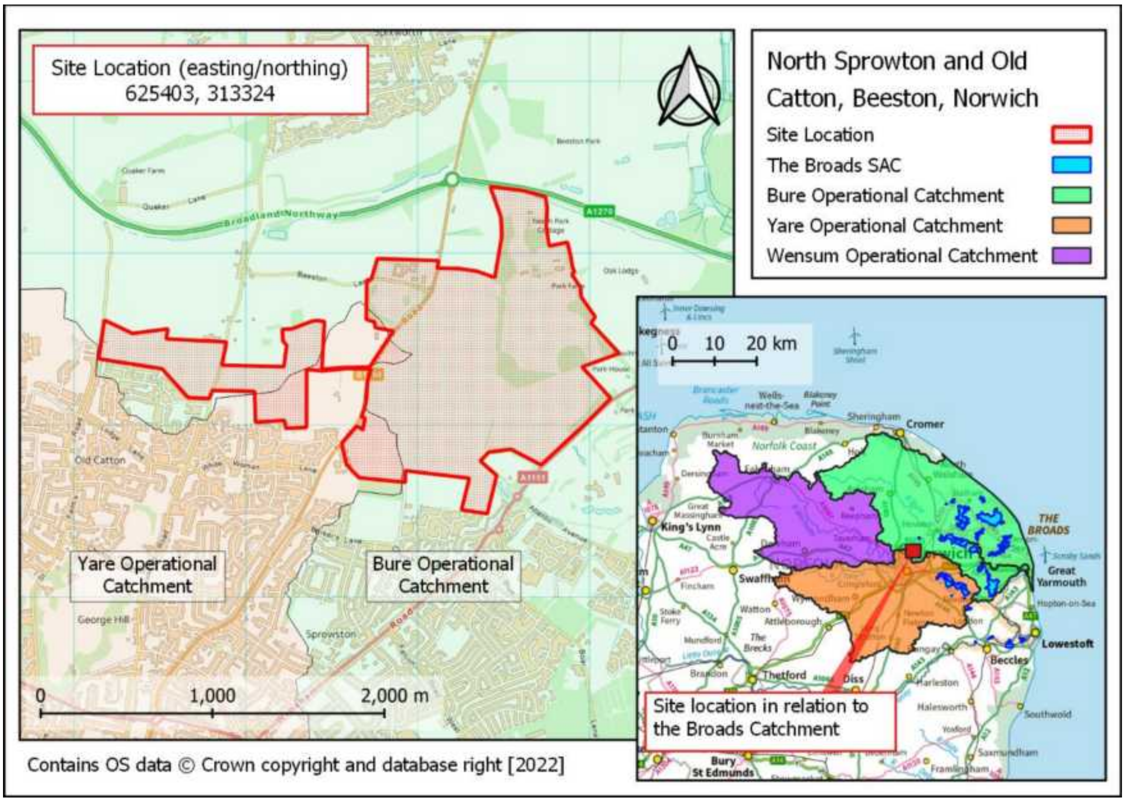


Figure 1: Location and Context of Site

Proposed Development

3.4 The proposal includes up to 3,520 new residential dwellings, associated greenspace and space for allotments and food production – as well as the various associated commercial and infrastructural developments. Drawings showing the plans can be found in Appendix A.

4 PART 1: CALCULATING THE NUTRIENT BUDGET

Natural England Methodology

4.1 The latest version of the Natural England Generic Methodology (NEGM) for determining whether a site achieves nutrient neutrality was issued in March 2022[9]. This guidance lays out the process of calculating the nutrient budget and provides worked examples.

Stage 1 – Total Wastewater Load

4.2 Stage 1 of the calculation is to calculate the nutrient load from the additional wastewater that will be generated by the development. This stage specifically only includes new overnight stays in the development, as it is assumed that any additional wastewater generated by diurnal use would be accounted for elsewhere.

4.3 This is done by multiplying the total amount of wastewater by the expected concentration of treated effluent from the WwTW serving the development. The WwTW can be determined through an enquiry from the wastewater service provider in the development location.

4.4 Where a licence limit on either TN or TP exists, the NEGM advises that the limit is multiplied by 90% as a proxy for the effluent concentration. This is because water companies will operate with a 'headroom' below their licence limit to reduce the risk of exceedance. Where no licence limit exists, the NEGM advises the use of values of 27 mgN/l and 8 mgP/l for the effluent concentrations of TN and TP respectively.

4.5 NE guidance recommends using water use as a proxy for total wastewater amount, excluding any garden use. NE's advice is to use the Building Regulations to determine the average water use per person, and then to add 10 litres/person/day (l/p/d) to the value to account for uncertainty in any future changes to fittings.

4.6 The increase in the number of people from a development can be determined through the use of census data from the Office for National Statistics (ONS). This gives the average occupancy of a dwelling type, and NE recommends the use of the national average occupancy rate to determine the expected population.

Stage 2 and Stage 3 – Existing and Future Surface Water Loads

4.7 Stage 2 of the calculation is to consider the existing land use on the site, and Stage 3 is to consider the future land-use onsite. Using the ADAS Farmscoper tool, loading factors can be determined for all different agriculture uses within the catchment. These loading factors are further separated by the underlying soil drainage conditions and average rainfall and are measured in kg/ha/year.

4.8 In the NEGM, evidence suggested that non-agricultural, non-urban land uses do not leach TP. It was therefore conservatively assumed that woodland, greenspace, and similar land uses would leach TP at the limit of detection which, in some studies, was 0.02 kgP/ha/year.

4.9 In the NEGM, urban loading factors were modelled using assumed[10] 'event mean concentrations' (EMC) of nutrients for rainfall events. The average runoff for a site can be calculated using the Modified Rational Method and multiplying the runoff by the EMC will give the nutrient load. This

[9] Ricardo and Natural England (February 2022) Nutrient Neutrality Generic Methodology
[10] The latest NE methodology quotes 'Mitchell, G., 2005. Mapping hazard from urban non-point pollution: A screening model to support sustainable urban drainage planning. Journal of Environmental Management, 74(1), pp. 1-9' in the definition of the so-called 'event mean concentrations'. However, the paper does not disclose how the event mean concentrations listed were calculated.

has been standardised for a 1 ha site so that a loading factor can be obtained in the same units of measurement as for agriculture and greenspace.

4.10 Using these loading factors, and the area of various land uses on the site, the existing and future nutrient load from diffuse sources can be calculated.

Stage 4 – Final Unmitigated Nutrient Budget

4.11 Stage 4 of the calculation is the final stage. At this point, the totals from Stage 1 and Stage 3 are added together, and the total from Stage 2 is subtracted. If there is a surplus (i.e., the proposed total is higher than the existing total), a buffer (factor of safety) of 20% is added to the total, and this is then referred to as 'the nutrient budget'. If the nutrient budget comes out as less than or equal to zero, then the development has achieved nutrient neutrality.

4.12 All the calculations set out in this section can be seen in full in Appendix B of this report.

Norfolk Nutrient Budget Calculator

4.13 In September 2022, the Norfolk Combined Authorities commissioned Royal Haskoning DHV to prepare a report[11], based on the NEGM, that was more region-specific to Norfolk in terms of the rates used. This gave rise to the Norfolk Nutrient Budget Calculator (NNBC).

4.14 The NNBC is largely the same as the NEGM, with a few key differences. These are explored below.

Occupancy Rate

4.15 The NNBC used raw census data from 2021 to determine the average household occupancy in Norfolk. Where the NEGM advises the use of the national average household occupancy from the 2011 census of 2.4, the NNBC used a proprietary method to determine a specific occupancy rate of 1.876.

Water Usage per Person

4.16 The NNBC uses a default value of 110 l/p/d (Building Regulations Optional Standard) within the calculator and does not apply an additional 10 l/p/d as per the NEGM.

4.17 This has been justified by the use of a number of studies indicating that future trends for water use are more likely to decrease, rather than increase, and that currently, the average water use in houses designed to meet the Building Regulations Minimum Standard (125 l/p/d) is actually 113.7 l/p/d.

4.18 Furthermore, the water efficiency requirements can be secured through the use of a planning condition by the LPA.

4.19 The NNBC therefore considers the use of the Optional Standard without the 10 l/p/d buffer to be sufficiently precautionary.

Relationship between Effluent Discharge Concentration and Permit Limits

4.20 Where the NEGM takes a generalised approach of assuming that WwTWs will operate at 90% of the licence limit, the NNBC takes a more bespoke approach. It looked at each WwTW (called Water Recycling Centres or WRCs within the NNBC) and analysed the measured discharge concentrations.

4.21 It then applied certain assumptions to each WwTW, based on the size of the WwTW and the expected population growth, and published a table within the report listing what the effluent

[11] Royal Haskoning DHV (September 2022) 'Norfolk Nutrient Budget Calculator' Reference: PC3719-RHD-ZZ-XX-RP-Z-0001

discharge concentration should be for each of the WwTWs with a TP limit within the catchment (no WwTW had a licence limit for TN).

4.22 For WwTWs without licence limits, the NNBC advised the use of 25 mgN/l and 6 mgP/l for TN and TP respectively. These values were used in the Environment Agency (EA) modelling of nutrient inputs from WwTWs in Norfolk and the NNBC therefore considered them to represent the most locally relevant default values.

Agricultural Runoff Coefficients

4.23 The only noticeable change is that the NNBC has rounded off all the runoff coefficients to two decimal places – e.g. where the NEGM gives a runoff coefficient of 0.061424… kgP/ha/year, the NNBC gives a runoff coefficient of 0.06 kgP/ha/year. This results in a slight calculation difference between the two methods.

Urban Runoff Coefficients

4.24 The NNBC largely used the same method as the NEGM to calculate urban runoff coefficients, however, it challenged the assumptions regarding impermeable area.

4.25 The NEGM subdivided the original 'urban' designation from previous guidance into 'residential urban', 'commercial/industrial' and 'open urban'. The NNBC further subdivides the 'residential urban' category into 'high', 'medium', and 'low' density residential. These divisions were made on the basis of differing impermeable areas as found in the literature.

4.26 In the NEGM it was assumed that the impermeable area in urban areas was 80%, in part to account for urban creep. The NNBC conducted a literature review and found that the impermeable area was generally significantly lower in a number of studies, especially for residential.

4.27 The NNBC collated the data from the various studies, using the upper value where a range was provided, and took the average value of all the data. For TN, to account for the fact that it is more readily transported in the environment, and additional 20% was added to the impermeability values.

4.28 These impermeability values for each of the urban land uses are listed in Table 6 of the NNBC, and Table 7 of the NNBC provides leaching rates for the various rainfall bands.

Calculation of the Nutrient Budget for the Site

4.29 The approach used in calculation of the nutrient budget follows the NNBC.

Nutrient Load from Additional Wastewater

4.30 The primary source of nutrients from residential development is usually domestic wastewater. Typically, wastewater is conveyed from development to the public sewerage and onto the WwTW for treatment before discharge to surface waters.

4.31 Wastewater from the site would normally be conveyed to Whitlingham WwTW, which has no limit for TN and a TP licence limit of 1 mgP/l. In line with the NNBC, the effluent concentration is therefore taken as 25 mgN/l and 0.9 mgP/l.

4.32 In line with NNBC, the national average occupancy of 1.876 people per house was used in the calculations and the site will meet the Building Regulations' optional requirement for water use of 110 l/p/d.

4.33 Using the information above, a wastewater nutrient load of 6,628.28 kgN/year and 238.62 kgP/year has been calculated for the proposed development scheme.

Nutrient Load from Land Use Change

4.34 The site is within the Bure Operational Catchment and lies partially within the Bure Broads Eutrophic Lake Nitrate Vulnerable Zone (NVZ) and wholly within the Norwich Crag and Gravels NVZ[12]. The HR Wallingford Greenfield Runoff Tool gives a standard average annual rainfall (SAAR) of 616 mm, and Cranfield University's SoilScapes tool indicates that the soil onsite is classed as 'Freely Draining'.

4.35 The vast majority of the site is used for the growing of cereal crop, with only a few hedgerows and footpaths making up the difference. It has therefore been designated as 'cereals'. With a total area of 207.40 ha, this gives an existing nutrient load of 5,340.55 kgN/year and 12.44 kgP/year.

4.36 The future land use will predominantly be medium density residential urban. There are 97.50 ha set aside for greenspace, and 5 ha set aside for allotments, leaving 104.90 ha for residential. Using rates derived from the NNBC, the future nutrient load is therefore 981.79 kgN/year and 37.68 kgP/year.

The Nutrient Budget

4.37 The future nutrient load, including loads from both wastewater and surface water, exceeds the existing nutrient load by 2,269.52 kgN/year for TN and 263.86 kgP/year for TP.

4.38 The total nutrient budget, including the 20% buffer applied on positive values, therefore comes to 2,723.43 kgN/year and 316.63 kgP/year.

4.39 The completed NNBC has also been attached to this document, although it differs due to an error in the loading rate for allotments.

[12] https://mapapps2.bgs.ac.uk/ukso/home.html?layers=NVZEng [accessed 11/2021]

5 PART 2: MITIGATION STRATEGY

5.1 As the development will result in an increase in nutrient load, mitigation will be required to achieve nutrient neutrality. The mitigation strategy presented in this section has been designed to reduce the nutrient budget to zero.

5.2 All calculations for the proposed mitigation strategy are included in full in Appendix B of this report.

Reduction in Nutrient Load through Onsite Treatment of Wastewater

5.3 The core of the mitigation strategy is to treat wastewater onsite using a wastewater treatment works designed and operated by Severn Trent Connect (STC), who are an Ofwat-licenced water company.

5.4 It is proposed that a licence will be sought from the EA to discharge to surface waters at limits of 10 mg/l for TN and at 0.15 mg/l for TP.

5.5 In line with the NEGM (Section 1.3 A), for sewage to a WwTW operated by a water company with a licence limit, the effluent concentration will be taken as 90% of the licence limit.

5.6 Using the licence limits mentioned above and multiplying by 90%, the future wastewater load has been reduced to 2,387.77 kgN/year and 35.82 kgP/year from the unmitigated values of 6,632.69 kgN/year and 238.78 kgP/year.

Offsetting through upgrades to existing septic tanks

5.7 Another mitigation option that has been considered is the upgrade of septic tanks to a better package treatment plant (PTP), or if appropriate, connecting the properties served by the septic tank to the new STC WwTW.

5.8 The NNBC provides rates for expected effluent concentrations, and they are given as 96.30 kgN/year and 11.60 kgP/year. By upgrading these to high efficiency levels, a significant reduction in nutrient load can be achieved.

5.9 The upgrade would be secured through a planning agreement between the developer, the Beeston Estate who own the properties that include the septic tanks, and the relevant local planning authority.

5.10 At this point, draft Heads of Terms have been agreed with the Beeston Estate, who own the 10 houses served by septic tanks. Upgrading these septic tanks would provide a nutrient benefit of 64.45 kgN/year and 8.56 kgP/year, which can be offset against the nutrient budget.

Reduction in Nutrient Load through Constructed Wetland

5.11 It is proposed to construct a wetland of approximately 3.9 ha in size just downstream of Rackheath WwTW, which lies just northwest of the site boundary.

5.12 This wetland will take sewage effluent discharge, including storm overflows, directly from Rackheath WwTW, and will additionally take water from Dobb's Beck, where Rackheath WwTW discharges. Furthermore, treated effluent from the onsite WwTW will be discharged into this wetland.

5.13 The removal rates were calculated in the Basis of Design by Water Design Engineers, which can be found in Appendix B. This sets the removal rates for the wetland at 2,133.55 kgN/year and 43.83 kgP/year.

Reduction in Nutrient Load through use of Sustainable Drainage Systems

5.14 The use of Sustainable Drainage Systems (SuDS) will reduce the leaching rates from the future urban land uses of the site.

5.15 By reducing the future TP load from the urban portions of the site by 50%, nutrient neutrality can be achieved.

5.16 In line with the recently released CIRIA Guidance of TP removal from SuDS (C808), infiltration is assumed to remove 100% of TP for all infiltrated. It is noted that the western portion of this site will be infiltrated to ground, and the geology of the site is generally conducive towards infiltration.

5.17 It is likely that infiltration will play a large role in the drainage strategy for this site, however this has not been looked at in detail at this point.

5.18 Assuming that the site is designed to infiltrate the 100-year event, then 1% of flows would exceed the design event, so a reduction of 99% is achievable through infiltration.

5.19 Additionally, if reductions due to infiltration are not achievable, then it is still possible to achieve the required nutrient rate through the use of filtration elements and phosphate-adsorbing material. This combination will allow a total TP reduction of 84.5%. CIRIA Guidance (C609) provides TN reduction rates from 30% to 70%, but no TN reduction is necessary to achieve neutrality.

5.20 The calculations have been completed using a reduction rate of 80% for TP and 50% for TN. However, it is likely that a higher removal rate will be achieved, as this is clearly achievable under the latest CIRIA Guidance.

5.21 Using these removal rates, the future surface water nutrient loads would be reduced from 981.79 kgN/year and 37.68 kgP/year to 706.64 kgN/year and 9.30 kgP/year.

The Mitigated Nutrient Budget

5.22 In Part 1 of this report the nutrient budget for the proposed development was calculated as 2,728.71 kgN/year and 316.82 kgP/year.

5.23 Through the use of onsite treatment of wastewater, the upgrading of existing septic tanks, an offsite wetland, and the use of SuDS to treat surface water, the site has achieved nutrient neutrality, and provides a reduction in nutrient load to the Habitats Sites of 4,443.94 kgN/year and 13.19 kgP/year.

6 PHASING STRATEGY

6.1 It is necessary to consider the timeline of when houses can be built and when each different mitigation solution will become active.

6.2 It is particularly important to consider how wastewater will be dealt with for the initial dwellings, as the STC onsite WwTW will not be able to treat wastewater until approximately 150 houses are occupied.

6.3 This section will look to answer two questions: how the wastewater will be dealt with before the onsite WwTW becomes active, and how many houses can be built before the wetland is required.

6.4 In each phase, the nutrient removal capacity due to SuDS has been taken as 50% for TN and 80% for TP.

6.5 The calculation sheets for this section can be found in Appendix B.

Phase 1: Initial Wastewater Strategy

6.6 There are two main options to deal with wastewater before the onsite WwTW becomes active: firstly, it can be tankered to a WwTW outside of the Broads Catchment (and any other nutrient neutrality catchments); secondly, it can be discharged to the municipal sewer to Whitlingham WwTW, and then re-routed to the onsite WwTW once the quantity of wastewater becomes sufficient.

6.7 There are advantages and disadvantages to both strategies, however this document will only examine their effects on the nutrient budget.

6.8 If wastewater is tankered outside of the catchment, then the site will be neutral through provision of bioretention SuDS, even up to the full 3,520 houses. However, tankering is not a long-term solution, and this only demonstrates that there is no limiting factor on the number of houses that can be built through tankering. The long-term solution of connecting to the onsite WwTW is not superseded. This can be considered Phase 1 Option A.

6.9 If wastewater is conveyed through the sewerage to Whitlingham WwTW, then 220 units can be built before the site is no longer nutrient-neutral. This is dependent on both fallowing the entire site, and on upgrading 10 septic tanks. In addition, bioretention SuDS will be implemented across the entire development. 220 units is sufficient to meet the requirements to start operating the onsite WwTW. This can be considered Phase 1 Option B.

6.10 It has been assumed that the residential urban area scales linearly with the number of houses, and that the remainder of the site, excluding the 5 ha of community food growing, will be left as greenspace.

6.11 Tankering is likely the preferred solution, however, should that not be acceptable, temporary conveyance of wastewater to Whitlingham WwTW is a possible solution.

Phase 2: Total number of houses that can be built without wetland offsetting

6.12 This phase will be split into two options, which are distinct from each other. They have been grouped together into one phase, as they are not dependent on each other, and can be performed simultaneously, or sequentially, with either coming first. They have termed Phase 2a and Phase 2b. In both cases, this is under the assumptions that wastewater is being treated onsite and that bioretention SuDS will be provided.

Phase 2a: Total number of houses that can be offset through fallowing of entire site

6.13 By taking the entire site out of production, sufficient nutrient credits are created to offset a total of 702 houses.

6.14 It has been assumed that the residential urban area scales linearly with the number of houses, and that the remainder of the site, excluding the 5 ha of community food growing, will be left as greenspace.

Phase 2b: Additionally upgrading septic tanks

6.15 By upgrading 10 septic tanks, 64.45 kgN/year and 8.56 kgP/year of further nutrient benefit is created.

6.16 This will allow for an additional 616 house to be built, for a total of 1,318. This reduced effect is due to the way residential urban area has been assumed to scale.

Summary

6.17 The final element is the delivery of the offsite wetland, which will unlock the entire scheme and create an additional surplus of at least 4,168.80 kgN/year and 13.19 kgP/year, which can be used to offset other schemes.

6.18 Table 1 below summarises the phasing strategy.

Table 1: Summary of Mitigation Phasing

Mitigation	Occupation
Phase 1a: Tankering outside catchment with bioretention SuDS	No restriction
Phase 1b: Discharge to Whitlingham WwTW, with fallowing of entire site and septic tank upgrades with bioretention SuDS	220 Units
Phase 2a: Onsite WwTW, bioretention SuDS and fallow land	702 Units
Phase 2b: Onsite WwTW, bioretention SuDS, fallow land, and septic tank upgrades	1,318 Units
Phase 3: Delivery of offsite wetland, onsite WwTW, bioretention SuDS, fallow land and septic tank upgrades	3,520 Units + Additional Surplus

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Following the procedure outlined in the NNBC it has been demonstrated, through the implementation of the proposed mitigation strategy, that the proposed development will be nutrient neutral.

7.2 This has been achieved through a compound strategy, involving the treatment of domestic wastewater onsite to a high standard, the upgrading of existing septic tanks, the construction of an engineered wetland at Dobb's Beck and the use of SuDS to treat surface water runoff from the site.

7.3 The onsite WwTW will be adopted, maintained, and operated in the long-term by STC in their capacity as the local statutory wastewater undertaker.

7.4 The upgrades to the septic tanks will be agreed with all affected parties, and a maintenance and operations plan will form part of this agreement.

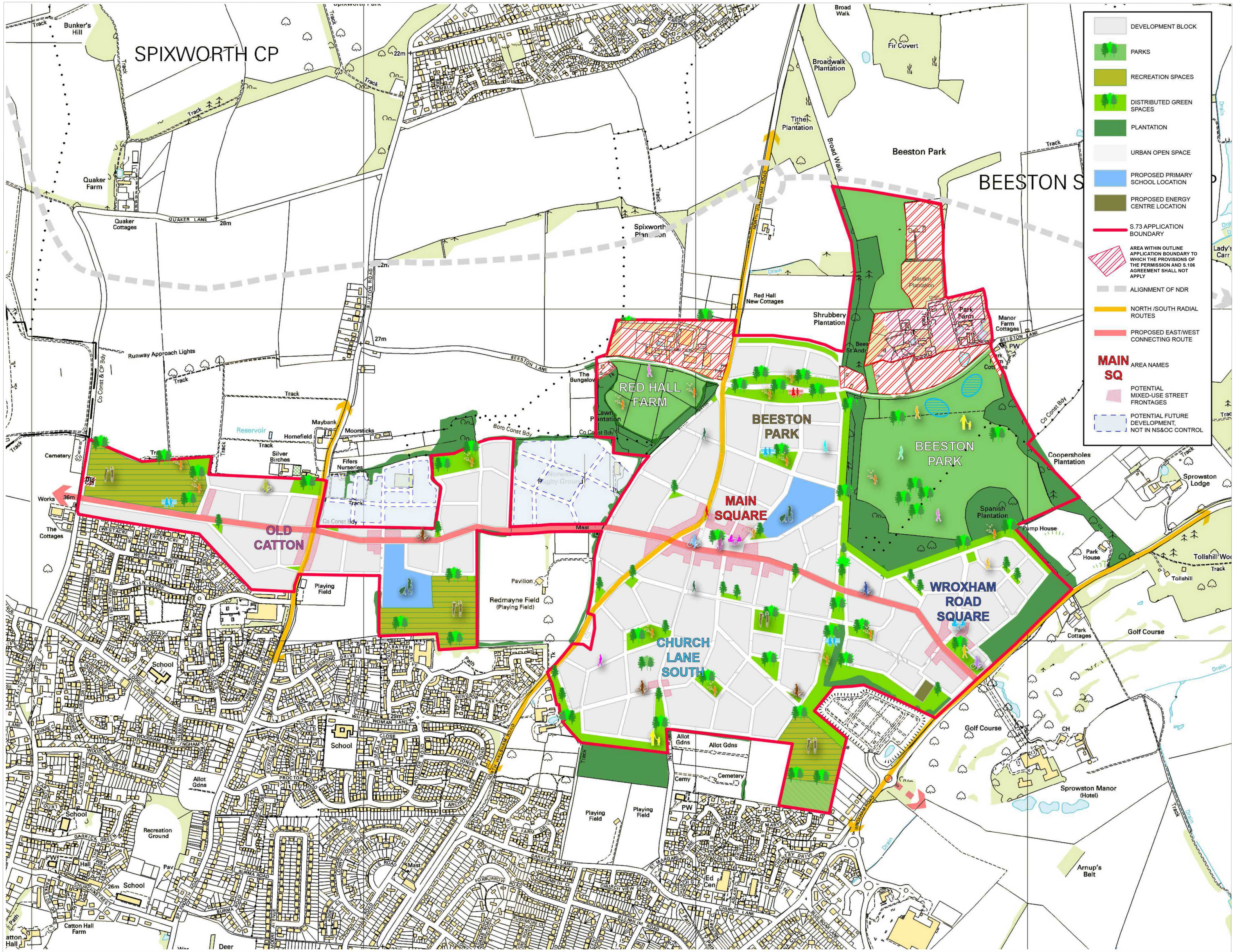
7.5 Management and maintenance of the SuDS will be the responsibility of the maintenance company to ensure performance in perpetuity.

7.6 The wetlands will be secured through a planning agreement, and a company will be contracted for their long-term monitoring and maintenance of the wetlands.

7.7 The proposed mitigation strategy is subject to detailed design of each of the strategy components to ensure that the required levels of nutrient removal are achieved.

APPENDIX A: SITE PLAN AND FURTHER INFORMATION

Landscape Layout: **Urbed Proposed Key Areas Plan, Dwg No: NS&OC 104**



Rev:	Notes:	Date:	Dr by	Ap by
D	D_301121_amendments	30-11-21	KW	LC
C	C_221121_amendments	22-11-21	KW	LC
B	B_210621_amendments	21-06-21	KW	LC
A	A_010415_amendments	01-04-15	BGD	-

Original By: BGD | Date: 07.09.2012 | Ap by: -

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Drawing Title: PROPOSED KEY AREAS PLAN

Project Title: NORTH SPROWSTON & OLD CATTON

Client: TOWN

Project Number: 1094 | Issue Status: OPA

Drawing Number: NS&OC 104

Scale: 1:5000@A1/1:10000@A3 | Date: 30.11.2021 | Revision: D

APPENDIX B: CALCULATIONS

Water Design Engineers:

Basis of Design for Wetland

Water Environment Ltd:

Unmitigated Nutrient Neutrality Calculations

Phase 1a Calculations

Phase 1b Calculations

Phase 2a Calculations

Phase 2b Calculations

Mitigated Nutrient Neutrality Calculations (2 Pages)

Basis of Design for Nutrient Mitigation Wetland

WATER DESIGN ENGINEERS
Pioneering

Site:	Dobbs Beck, Rackheath
Client:	
Date:	21/03/2023 **Rev**

Proposed Wetland Scheme

Free Water Surface (FWS) Interceptor Wetland
Event Driven - Gravity flow from catchment
Interception of surface water runoff form Dobbs Beck Lake
plus final effluent transferred from Beeston Park STW
Treatment of all flows up to and including the 1 in 1 yr event
Safe passage of 1 in 100 yr event without increasing flood risk

1. Total Nutrient Loads to be Mitigated

Total Nitrogen	**2130.00**	**kgTN/yr**
Total Phosphorus	**43.80**	**kgTP/yr**

*From assessment agreed with Natural England

2. Flow & Load Characteristics

Total Catchment Area	1063.00	ha	*Catchment area of Dobbs Beck Lake, from FEH website*
TN Leaching from Catchment	3667.71	kgTN/yr	*25% of estimated load from catchment + 50% load from Rackheath WwTW effluent*
TP Leaching from Catchment	76.19	kgTP/yr	*25% of estimated load from catchment + 50% load from Rackheath WwTW effluent*
SAAR	614.00	mm	*Standard average annual rainfall - From UKSUDS*
SPR	0.10		*Standard percentage runoff coefficient - From UKSUDS*
Average annual runoff	685940.8	m^3/yr	*Including effluent flow from Rackheath WwTW*
Average TN conc of runoff	5.35	mgTN/l	*TBC by sampling and analysis*
Average TP conc of runoff	0.111	mgTP/l	*TBC by sampling and analysis*
Beeston STW Effluent Flow	265130.53	m^3/yr	*From WEL NN report*
Beeston STW Effluent TN conc	10.00	mgTN/l	*From WEL NN report*
Beeston STW Effluent TP conc	0.15	mgTP/l	*From WEL NN report*
Combined total annual flow	951071.33	m^3/yr	
Combined TN load	6319.02	kgTN/yr	
Combined TP load	115.96	kgTP/yr	
Combined TN conc	6.64	mgTN/l	
Combined TP conc	0.122	mgTP/l	

Greenfield Runoff Rates for Catchment (from UKSUDS)

1 in 1 year	95.22	l/s
Qbar	109.44	l/s
1 in 30 years	268.14	l/s
1 in 100 years	389.62	l/s

2a. Flow Regime for Normal Operation (Mid Feb - Mid Jan)

100% of wetland area in use

Percentage runoff treated	90%		*Treating all runoff events up to and including the 1 in 1 year event*
Average daily flow treated	2345.1	m^3/d	
No. of months	11		
Total influent load of TN	5213.19	kgTN/yr	
Total influent load of TP	95.67	kgTP/yr	

2b. Flow Regime During Wetland Maintenance (Mid Jan - Mid Feb)

75% of wetland area in use

Percentage runoff treated	90%		*Treating all runoff events up to and including the 1 in 1 year event*
Average daily flow treated	2345.1	m^3/d	
No. of months	1		
Total influent load of TN	473.93	kgTN/yr	
Total influent load of TP	8.70	kgTP/yr	

3. Wetland Design Characteristics

Designed using the P-k-C* model (Kadlec & Wallace 2009)

Area of treatment wetland	3.900	ha	*Initial estimate - TBC following topo survey and layout design*
Apparent Tanks in Series (*P* TIS)	4.0		*Applicable for FWS wetland with at least one flow path with demonstrable sinuosity*
Rate constant for TN (k_{TN})	11.2	m/yr	*Applicable for FWS wetland gravity fed from perennial stream*
Rate constant for TP (k_{TP})	13.1	m/yr	*Applicable for FWS wetland gravity fed from perennial stream*
Background conc TN (C^*_{TN})	1.50	mgTN/l	
Background conc TN (C^*_{TP})	0.0220	mgTP/l	

CONSTRUCTED WETLAND ASSOCIATION

Basis of Design for Nutrient Mitigation Wetland

WATER DESIGN ENGINEERS
Pioneering

Site:	Dobbs Beck, Rackheath
Client:	
Date:	21/03/2023 **Rev**

Proposed Wetland Scheme

Free Water Surface (FWS) Interceptor Wetland
Event Driven - Gravity flow from catchment
Interception of surface water runoff form Dobbs Beck Lake
plus final effluent transferred from Beeston Park STW
Treatment of all flows up to and including the 1 in 1 yr event
Safe passage of 1 in 100 yr event without increasing flood risk

1. Total Nutrient Loads to be Mitigated

Total Nitrogen	**2130.00**	**kgTN/yr**
Total Phosphorus	**43.80**	**kgTP/yr**

*From assessment agreed with Natural England

4. Wetland Performance Characteristics

4a. Performance for Normal Operation (Mid Feb - Mid Jan)

100% of wetland area in use

Hydraulic Loading Rate (HLR)	6.01	cm/d	
q	21.9	m/yr	
Treatment efficiency for TN	38%		*Calculated from P-k-C* model (Kadlec & Wallace 2009)*
Treatment efficiency for TP	43%		*Calculated from P-k-C* model (Kadlec & Wallace 2009)*
TN Load Removed	1988.25	kg	
TP Load Removed	40.82	kg	
Nominal effluent conc of TN	3.31	mgTN/l	
Nominal effluent conc of TP	0.0637	mgTP/l	

4b. Performance During Wetland Maintenance (Mid Jan - Mid Feb)

75% of wetland area in use

Hydraulic Loading Rate (HLR)	8.02	cm/d	
q	29.3	m/yr	
Treatment efficiency for TN	31%		*Calculated from P-k-C* model (Kadlec & Wallace 2009)*
Treatment efficiency for TP	35%		*Calculated from P-k-C* model (Kadlec & Wallace 2009)*
TN Load Removed	145.09	kg	
TP Load Removed	3.01	kg	
Nominal effluent conc of TN	3.71	mgTN/l	
Nominal effluent conc of TP	0.0727	mgTP/l	

5. Total Annual Nutrient Mitigation

Total Nitrogen	**2133.35**	**kgTN/yr**	*100% of requirement*
Total Phosphorus	**43.83**	**kgTP/yr**	*100% of requirement*
TN Removal Rate	547.01	kgTN/ha/yr	
TP Removal Rate	11.24	kgTP/ha/yr	
Treatment efficiency for TN	38%		
Treatment efficiency for TP	42%		
Nominal effluent conc of TN	3.34	mgTN/l	
Nominal effluent conc of TP	0.0644	mgTP/l	

CONSTRUCTED WETLAND ASSOCIATION

Nutrient Neutrality Calculations
Unmitigated Budget

WATER | ENVIRONMENT
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Job No.	22061	
Job Name	Sprowston and Old Catton	
Engineer	Christopher Garrard	CMG
Checked by	Gareth Snyman	GS
Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
New Dwellings	3,520	Unit	Occupancy of 1.876 used in line with the NNBC
Average Occupancy	1.876	persons/unit	
Future Population	6,603.5	Persons	
Water Use	110	litres/person/day	Building Regs Optional Requirement
Effluent TN Concentration	25.00	mg/l	Foul Sewage to Whitlingham WwTW. The effluent concentration is taken as 90% of the licence limit, where one exists
TP Licence Limit	1.00	mg/l	
Future Wastewater Nutrient Load	**6,628.28**	**kgN/yr**	
	238.62	**kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55**	**kgN/yr**	
		12.44	**kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Urban Land Uses				
Residential Urban	104.90	5.25	0.34	
Reduction Factor due to SuDS		0%	0%	
Urban Nutrient Load (kg/year)		550.29	35.48	
Non-Urban Land Uses				
Greenspace	97.50	3.00	0.02	
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		431.50	2.20	
Future Surface Water Nutrient Loads		**981.79**	**kgN/yr**	
		37.68	**kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	7,610.07	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	276.30	kgP/yr	
TN Budget	2,269.52	kgN/yr	Total net increase after development
TP Budget	263.86	kgP/yr	
Nutrient Budget with 20% Buffer	**2,723.43**	**kgN/yr**	
	316.63	**kgP/yr**	

Nutrient Neutrality Calculations
Phase 1a Tankering

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Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
Wastewater is tankered out of the catchment, so there is no wastewater load to the site.			
Future Wastewater Nutrient Load	**0.00**	**kgN/yr**	
	0.00	**kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55**	**kgN/yr**	
		12.44	**kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Urban Land Uses				
Residential Urban	104.90	5.25	0.34	All drained areas will pass through bioretention SuDS
Reduction Factor due to SuDS		50%	80%	
Urban Nutrient Load (kg/year)		275.14	7.10	
Non-Urban Land Uses				
Greenspace	97.50	3.00	0.02	
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		431.50	2.20	
Future Surface Water Nutrient Loads		**706.64**	**kgN/yr**	
		9.30	**kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	706.64	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	9.30	kgP/yr	
TN Budget	-4,633.91	kgN/yr	Total net increase after development
TP Budget	-3.15	kgP/yr	
Nutrient Budget with 20% Buffer	**-4,633.91**	**kgN/yr**	
	-3.15	**kgP/yr**	

Nutrient Neutrality Calculations
Phase 1b Wastewater to Sewer

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Job No.	22061	
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Engineer	Christopher Garrard	CMG
Checked by	Gareth Snyman	GS
Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
New Dwellings	220	Unit	Total number of houses that can be built, before site is no longer nutrient neutral.
Average Occupancy	1.876	persons/unit	
Future Population	412.7	Persons	
Water Use	110	litres/person/day	Building Regs Optional Requirement
Effluent TN Concentration	25.00	mg/l	Foul Sewage to Whitlingham WwTW. The effluent concentration is taken as 90% of the licence limit, where one exists
TP Licence Limit	1.00	mg/l	
Future Wastewater Nutrient Load	**414.27** **14.91**	**kgN/yr** **kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year) TN	Leaching Rates (kg/ha/year) TP	Explanation
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55** **12.44**	**kgN/yr** **kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year) TN	Leaching Rates (kg/ha/year) TP	Explanation
Urban Land Uses				
Residential Urban	6.56	5.25	0.34	Residential Urban assumed to scale linearly with number of houses. All drained areas will pass through bioretention SuDS
Reduction Factor due to SuDS		50%	80%	
Urban Nutrient Load (kg/year)		17.20	0.44	
Non-Urban Land Uses				
Greenspace	195.84	3.00	0.02	Remainder of site assigned to Greenspace
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		726.53	4.17	
Future Surface Water Nutrient Loads		**743.73** **4.61**	**kgN/yr** **kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	1,158.00	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	19.52	kgP/yr	
TN Budget	-4,182.55	kgN/yr	Total net increase after development
TP Budget	7.08	kgP/yr	
Nutrient Budget with 20% Buffer	**-4,182.55 kgN/yr** **8.50 kgP/yr**		

Offsetting through Upgrade of Septic Tanks

Measurement	Value	Unit	Explanation
Existing Dwellings Connected to Septic Tanks	10	Unit	Occupancy of 1.876 used in line with the NNBC
Average Occupancy	1.876	persons/unit	
Existing Population	18.8	Persons	
Water Use	125	litres/person/day	Building Regs Minimum Requirement
Septic Tank TN Effluent Concentration	96.30	mg/l	Default Septic Tank Concentrations in NNBC
Septic Tank TP Effluent Concnetration	11.60	mg/l	
PTP TN Effluent Concentration	21.00	mg/l	Achievable effluent concentrations without chemical dosing (Graf One2Clean)
PTP TP Effluent Concentration	1.60	mg/l	
Nutrient Benefit from Upgrading Septic Tanks	**64.45** **8.56**	**kgN/yr** **kgP/yr**	
Mitigated Nutrient Budget	**-4,247.01 kgN/yr** **-0.06 kgP/yr**		

Nutrient Neutrality Calculations
Phase 2a

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Checked by	Gareth Snyman	GS
Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
New Dwellings	702	Unit	Total number of houses that can be built, before site is no longer nutrient neutral.
Average Occupancy	1.876	persons/unit	
Future Population	1,317.0	Persons	
Water Use	110	litres/person/day	Building Regs Optional Requirement
TN Licence Limit	10.00	mg/l	Foul Sewage to onsite STC WwTW. The effluent concentration is taken as 90% of the licence limit, where one exists
TP Licence Limit	0.15	mg/l	
Future Wastewater Nutrient Load	**475.88**	**kgN/yr**	
	7.14	**kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year) TN	Leaching Rates (kg/ha/year) TP	Explanation
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55**	**kgN/yr**	
		12.44	**kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year) TN	Leaching Rates (kg/ha/year) TP	Explanation
Urban Land Uses				
Residential Urban	20.92	5.25	0.34	Residential Urban assumed to scale linearly with number of houses. All drained areas will pass through bioretention SuDS
Reduction Factor due to SuDS		50%	80%	
Urban Nutrient Load (kg/year)		54.87	1.42	
Non-Urban Land Uses				
Greenspace	181.48	3.00	0.02	Remainder of site assigned to Greenspace
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		683.44	3.88	
Future Surface Water Nutrient Loads		**738.31**	**kgN/yr**	
		5.29	**kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	1,214.19	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	12.43	kgP/yr	
TN Budget	-4,126.36	kgN/yr	Total net increase after development
TP Budget	-0.01	kgP/yr	
Nutrient Budget with 20% Buffer	**-4,126.36**	**kgN/yr**	
	-0.01	**kgP/yr**	

Nutrient Neutrality Calculations
Phase 2b

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Job No.	22061	
Job Name	Sprowston and Old Catton	
Engineer	Christopher Garrard	CMG
Checked by	Gareth Snyman	GS
Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
New Dwellings	1,318	Unit	Total number of houses that can be built, before site is no longer nutrient neutral.
Average Occupancy	1.876	persons/unit	
Future Population	2,472.6	Persons	
Water Use	110	litres/person/day	Building Regs Optional Requirement
TN Licence Limit	10.00	mg/l	Foul Sewage to onsite STC WwTW. The effluent concentration is taken as 90% of the licence limit, where one exists
TP Licence Limit	0.15	mg/l	
Future Wastewater Nutrient Load	**893.46**	**kgN/yr**	
	13.40	**kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55**	**kgN/yr**	
		12.44	**kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Urban Land Uses				
Residential Urban	39.28	5.25	0.34	Residential Urban assumed to scale linearly with number of houses. All drained areas will pass through bioretention SuDS
Reduction Factor due to SuDS		50%	80%	
Urban Nutrient Load (kg/year)		103.02	2.66	
Non-Urban Land Uses				
Greenspace	163.12	3.00	0.02	Remainder of site assigned to Greenspace
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		628.37	3.51	
Future Surface Water Nutrient Loads		**731.39**	**kgN/yr**	
		6.17	**kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	1,624.85	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	19.57	kgP/yr	
TN Budget	-3,715.70	kgN/yr	Total net increase after development
TP Budget	7.13	kgP/yr	
Nutrient Budget with 20% Buffer	**-3,715.70**	**kgN/yr**	
	8.55	**kgP/yr**	

Offsetting through Upgrade of Septic Tanks

Measurement	Value	Unit	Explanation
Existing Dwellings Connected to Septic Tanks	10	Unit	Occupancy of 1.876 used in line with the NNBC
Average Occupancy	1.876	persons/unit	
Existing Population	18.8	Persons	
Water Use	125	litres/person/day	Building Regs Minimum Requirement
Septic Tank TN Effluent Concentration	96.30	mg/l	Default Septic Tank Concentrations in NNBC
Septic Tank TP Effluent Concnetration	11.60	mg/l	
PTP TN Effluent Concentration	21.00	mg/l	Achievable effluent concentrations without chemical dosing (Graf One2Clean)
PTP TP Effluent Concentration	1.60	mg/l	
Nutrient Benefit from Upgrading Septic Tanks	**64.45**	**kgN/yr**	
	8.56	**kgP/yr**	
Mitigated Nutrient Budget	**-3,780.15**	**kgN/yr**	
	-0.01	**kgP/yr**	

Nutrient Neutrality Calculations Mitigated

WATER | ENVIRONMENT

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Tel: 020 8545 9720 • Email: admin@waterenvironment.co.uk

Job No.	22061	
Job Name	Sprowston and Old Catton	
Engineer	Christopher Garrard	CMG
Checked by	Gareth Snyman	GS
Date	24/03/2023	

Standard Average Annual Rainfall (mm)	616	Soil Type	Freely Draining
Nitrate Vulnerable Zone	TRUE	Catchment	Bure

Stage 1 - Total Nitrogen (TN) and Total Phosphorus (TP) Load from Development Wastewater

Measurement	Value	Unit	Explanation
New Dwellings	3,520	Unit	Average occupancy of 2.4 as recommended by NE
Average Occupancy	1.876	persons/unit	
Future Population	6,603.5	Persons	
Water Use	110	litres/person/day	Building Regs Optional Requirement +10 l/p/d
TN Licence Limit	10.00	mg/l	Foul Sewage to onsite STC WwTW. The effluent concentration is taken as 90% of the licence limit, where one exists
TP Licence Limit	0.15	mg/l	
Future Wastewater Nutrient Load	**2,387.77**	**kgN/yr**	
	35.82	**kgP/yr**	

Stage 2 - Calculation of Existing Nutrient Load from Surface Water

Existing Land Use	Existing Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Cereals	207.40	25.75	0.06	
Existing Surface Water Nutrient Loads		**5,340.55**	**kgN/yr**	
		12.44	**kgP/yr**	

Stage 3 - Calculation of Future Nutrient Load from Surface Water

Future Land Use	Proposed Area (ha)	Leaching Rates (kg/ha/year)		Explanation
		TN	TP	
Urban Land Uses				
Residential Urban	104.90	5.25	0.34	All drained areas will pass through bioretention SuDS
Reduction Factor due to SuDS		50%	80%	
Urban Nutrient Load (kg/year)		275.14	7.10	
Non-Urban Land Uses				
Greenspace	97.50	3.00	0.02	
Community food growing	5.00	27.80	0.05	
Non-Urban Nutrient Load (kg/year)		431.50	2.20	
Future Surface Water Nutrient Loads		**706.64**	**kgN/yr**	
		9.30	**kgP/yr**	

Stage 4 - Calculation of TN andTP Budgets

Measurement	Value	Unit	Explanation
Total Future TN	3,094.41	kgN/yr	Sum of Wastewater and Future Surface Water Loads
Total Future TP	45.11	kgP/yr	
TN Budget	-2,246.14	kgN/yr	Total net increase in nutrient load after development
TP Budget	32.67	kgP/yr	
Nutrient Budget with 20% Buffer	**-2,246.14**	**kgN/yr**	
	39.20	**kgP/yr**	

Nutrient Neutrality Calculations Mitigated

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Date	24/03/2023	

Offsetting through Upgrade of Septic Tanks

Measurement	Value	Unit	Explanation
Existing Dwellings Connected to Septic Tanks	10	Unit	Occupancy of 1.876 used in line with the NNBC
Average Occupancy	1.876	persons/unit	
Existing Population	18.8	Persons	
Water Use	125	litres/person/day	Building Regs Minimum Requirement
Septic Tank TN Effluent Concentration	96.30	mg/l	Default Septic Tank Concentrations in NNBC
Septic Tank TP Effluent Concnetration	11.60	mg/l	
PTP TN Effluent Concentration	21.00	mg/l	Achievable effluent concentrations without chemical dosing (Graf One2Clean)
PTP TP Effluent Concentration	1.60	mg/l	
Nutrient Benefit from Upgrading Septic Tanks	**64.45**	**kgN/yr**	
	8.56	**kgP/yr**	

Mitigation through construction of wetland at Dobb's Beck

Description	Removal rate (kg/ha/year)		
Active Wetland Area (ha)	3.90		Based on Basis of Design from Water Design Engineers Dated 21/03/2023
Wetland TN Removal	2,133.35	kgTN/year	
Wetland TP Removal	43.83	kgTP/year	
Mitigated Nutrient Budget	**-4,443.94**	**kgN/yr**	
	-13.19	**kgP/yr**	