



Nutrient Neutrality Study – Ageas Bowl, West End, Eastleigh

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Executive Summary

Hilson Moran has been appointed by Land & Development Advisory Ltd to provide a Nutrient Neutrality Study for the mixed-use development of the Ageas Bowl, Botley Rd, West End, Hampshire SO30 3XH, centred approximately on National Grid Reference SU 477 140.

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

The calculations demonstrate that:

- The total nitrogen (TN) and total phosphorous (TP) losses from pre-existing uses of the site have been derived using site visits and liaison with land managers, together with appropriate modelling;
- Pre-existing losses have been calculated as **205.1 Kg/TN/yr** and **12.71 Kg/TP/yr**;
- The wastewater generated by the proposals will be conveyed to Portswood Wastewater Treatment Works (WwTW) where it will be treated and discharged without any permit concentration limit for TN or TP, with estimated discharge concentrations of 27 mg/l TN and 5 mg/l TP;
- For nitrogen (N) losses, a standard Natural England (NE) Methodology has been used. For phosphorus (P) losses a modified version of the Herefordshire Council Phosphate Budget Calculator Tool has been used;
- The results identify that a total of **872.2 Kg/TN/yr** will need to be neutralised in order to mitigate against the proposed development;
- Although there is currently no obligation for the scheme to demonstrate P neutrality, the results identify that a total of **162.78 Kg TP/yr** would need to be targeted in order to achieve P neutrality for the proposed development;
- The use of "soft SuDS", such as swales, detention basins and the de-culverting of the existing Telegraph Brook to provide a two-stage channel, with restored floodplain and the potential for new wetland habitats, have been identified as surface water flooding mitigation measures. Although not quantified at this stage, these new stormwater attenuation/conveyance features and floodplain habitats will help to remove N and P from site runoff, and in terms of the de-culverted Telegraph Brook, could be used to reduce nutrient existing nutrient loadings in the brook itself;
- Eastleigh Borough Council (EBC) are currently putting in place a land assembly project that will provide a permanent Borough wide N (and P) mitigation approach. Consequently, it is anticipated that the **872.2 Kg/TN/yr** loss associated with the development will be fully mitigated by EBCs Strategic Land Parcels offsetting scheme (or similar scheme, such as that run by Hampshire & Isle of Wight Wildlife Trust);
- EBC currently state that they possess 3,633 N credits (1 credit = 1 kilogram of nitrates per year) across 78.5 ha of council-owned land. The cost per credit is £3,000 + VAT and they will also require an undertaking for their legal and administrative costs. As such, to fully mitigate the N-loss associated with this scheme, will require a financial contribution in the order of £3,000 x 872.2 Kg/TN/yr = **£2,616,600**;

- This financial contribution may be reduced if on-site reduction in N and P loss can be demonstrated through the sympathetic design of on-site SuDS and other wetland features highlighted in this report;
- Furthermore, there will be opportunities to minimise N & P inputs associated with the land management of both the golf course, soft landscaping and potentially the cricket grounds, through the application of best practise measures;
- A range of land management best practise recommendations have been presented to minimise N and P loadings during the construction and operational phases of the scheme;
- Consequently, the N impacts of the proposals will be fully mitigated and P losses minimised in order to ensure that they do not detrimentally affect local biodiversity or the conservation status of the downstream European Designated Sites.

1. Introduction

Hilson Moran has been appointed by Land & Development Advisory Ltd to provide a Nutrient Neutrality Study for the mixed use development of the Ageas Bowl, Botley Rd, West End, Hampshire SO30 3XH, centred approximately on National Grid Reference SU477140 and identified in Figure 1.1.

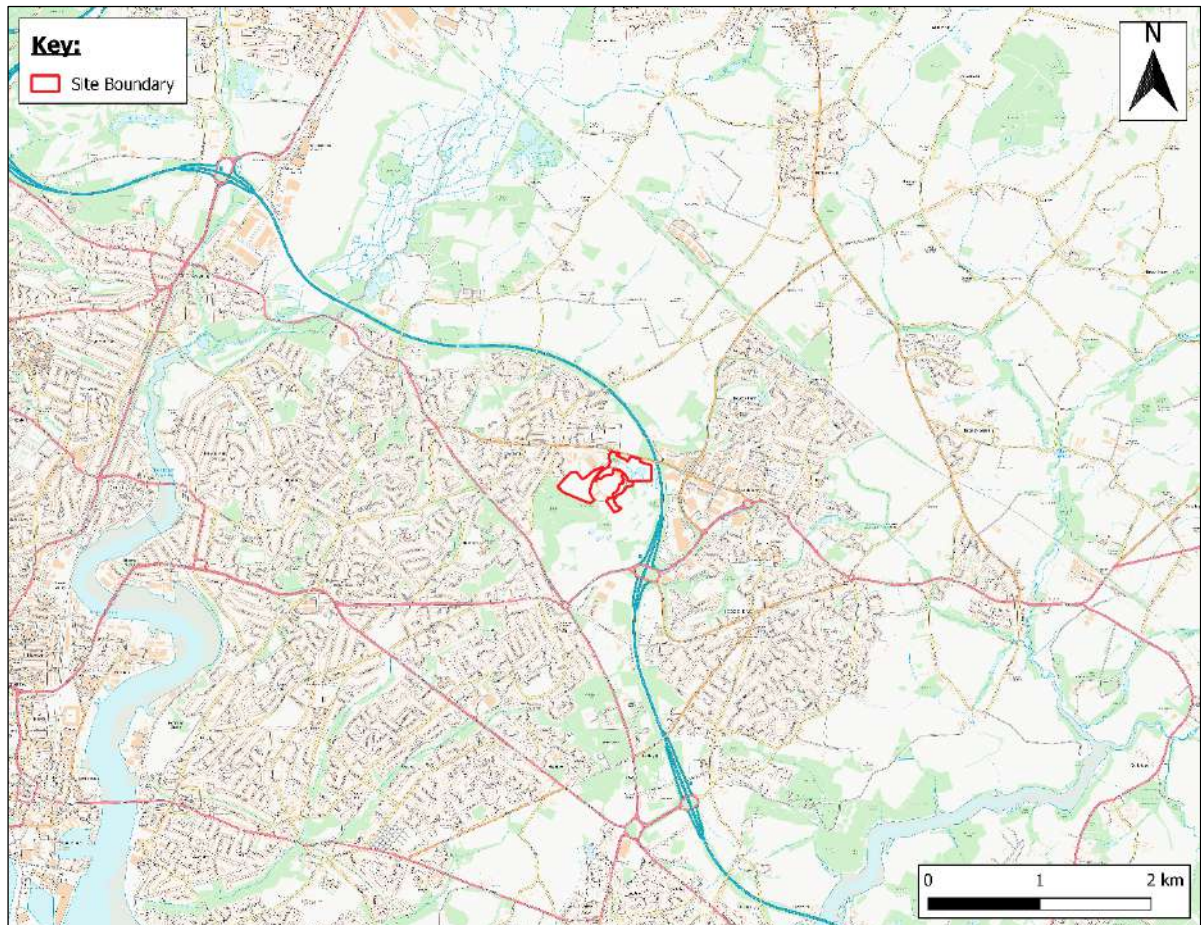


Figure 1.1 *Site Location* (Contains Ordnance Survey data © Crown copyright and database right 2022)

1.1. Background

Since 2019, residential and tourism development applications within the Hampshire area have been delayed due to 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.

Following a test case heard in the European court, Natural England (NE) advised that no planning consents should be granted within the region unless they can demonstrate nitrate neutrality.

More recently, there has also been an interest in reducing phosphorus (P) loadings to downstream European protected areas. Although there is no obligation for developments in the Solent area to demonstrate P neutrality, and neither has a standard methodology for the calculation of P budgets been devised, Land & Development Advisory Ltd have expressed their desire to aim for P outputs associated with the scheme to be minimised.

1.2. Purpose

This Nutrient Neutrality Study has been produced to accompany the planning application for the scheme and to provide sufficient evidence to both EBC and 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 and then by the final nitrate neutrality and phosphorous budget calculations for the Ageas Bowl 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 Nutrient Neutrality Study for the Ageas Bowl redevelopment.

1.5. Limitation and Copyright

This report has been prepared on behalf of and for the exclusive use of Land & Development Advisory Ltd 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 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 Ageas Bowl Nutrient Neutrality Study.

2. Approach

2.1. 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 SPAs and 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), along with Ramsar sites and areas identified to provide compensatory sites to these 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.

2.2. Methodology

2.2.1. Nitrogen Neutrality

The nitrogen (N) neutrality methodology is based on the standard NE approach (included in **Appendix 1**).

2.2.2. Phosphorus Budget

Within the UK, there have been at least two other catchment scale studies on the potential impacts of development related phosphate loadings on European protected areas endorsed by NE. These comprise:

- i. Advice on Nutrient Neutrality for New Development in the Stour Catchment in Relation to Stodmarsh Designated Sites (2020)² which has been prepared by NE in order to ensure that both nitrate and P impacts from local development on the Stodmarsh SPA/SAC/SSSI lakes are minimised;

The methodology constitutes a 4 stage empirical approach, comprising:

- Stage 1 Calculate Total Nitrogen (TN) and Total Phosphorus (TP) in kilograms per annum derived from the development that would exit the Wastewater Treatment Works (WwTW) after treatment;
- Stage 2 Adjust N / P load to offset existing nitrogen from current land use;
- Stage 3 Adjust N / P load to account for land uses with the proposed development;
- Stage 4 Calculate the net change in the TN and TP load that would result from the development.

The NE methodology states that:

“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.”

- ii. The Herefordshire Council Interim Phosphate Delivery Plan (2021)³ has been designed to minimise the impact of new developments on the River Wye SAC, which supports a diverse and rare ecology currently under pressure from P pollution from point and diffuse sources. The Delivery Plan includes a spreadsheet based methodology based on the above NE Stodmarsh approach (Herefordshire Council Phosphate Budget Calculator Tool)⁴.

As with the Stodmarsh approach, the Herefordshire phosphate budget is calculated in four stages as the balance between:

1. The increase in P loading to national sites that result from the increase in wastewater from a new development, which is based on population increase, water use and nutrient concentrations in discharges from WwTW and package treatment plants;
2. The P export from the past and present land use of the development site;
3. The P export from the future mix of land use on the development site *e.g.* urban land and greenspace;
4. Calculation of the net change in P loading to a designated site using the outputs from Stages 1-3, *i.e.* the P budget, which includes the addition of a 20% precautionary buffer.

As with the Stodmarsh approach, inputs to the various components of each of these four stages were determined using scientific literature, best practice industry guidelines, secondary data and modelling. Where estimates for an input were subject to uncertainty, the precautionary principle was applied in order to determine a suitable value.

It should be noted that the NE guidance, on which this methodology is based, only covers nutrient budget calculations for residential developments. Agricultural and industrial development that may be subject to an HRA due to increased nutrient loading is subject to ongoing guidance development.

As the Herefordshire Council Phosphate Budget Calculator Tool post-dates the Stodmarsh study, a modified version of this tool has been used for the Ageas Bowl scheme. In particular, the Herefordshire Tool relies on a WwTW catchment-based approach specific to the WwTWs serving the River Wye SAC catchment. The Ageas Bowl redevelopment will discharge its foul water to Portswood WwTW for treatment, which currently does not possess a discharge limit neither for TP nor TN.

With regard to TN, as per NE guidance, a discharge concentration of 27.0 mg/l TN is assumed (a typical value derived by Southern Water from nitrogen effluent concentrations at other non-consented 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.

With regard to TP, for WwTWs without P permits, the concentration of P in the treated effluent from the works will depend on the P concentration in the influent. Natural England advises that the WwTW effluent P concentration value for WwTWs with no P permit should be determined from best available evidence². Neither Southern Water nor the EA routinely monitor P in the effluent from WwTWs without P permits. Research and consultation with NE supporting the Herefordshire Council Phosphate Budget Calculator Tool concluded that a value of 5 mg TP/l in the effluent from non-permit limited WwTWs is likely to provide a suitably precautionary input for this step of the P budget methodology⁵.

As a check for the precautionary nature of this value, an approximation of the anticipated TP effluent concentration was performed using the methodology used by Hydes and Wright (1999)⁶ and Xiong (2000)⁷ for Southampton Water, whereby a coefficient of 0.4 kg TP per person per year is multiplied by the served inhabitant population of the sewage outfall, assuming 30 % removal of TP at the WwTW to make the estimation.

With regard to Portswood WwTW, the projected served inhabitant population for 2025/2026 is stated to be 81,033 Population Equivalent (PE)⁸. Therefore, 81,033 PE x 0.4 kg TP/person/yr x 30 % TP removal = 22,689.2 kg TP/yr. With a consented dry weather flow (DWF) of 27,700 m³/day, this equates to a mean discharge concentration of $22,689.2/365 = 62.2 \text{ kg}/27,700 \times 1000 = 2.25 \text{ mg TP/l}$. Consequently, the use of a **5 mg/l TP** discharge concentration is assumed to be suitably precautionary.

As with the non-permitted TN discharge concentration, a 90 % correction factor cannot be used for this WwTW due to the facility not being regulated by a TP consent limit.

Consequently, following consultation with NEⁱ, a modified Herefordshire Tool has been used which:

1. Uses a residential development occupancy rate of 2.4 for Eastleigh Borough, rather than the default 2.3 occupancy rate included in the Herefordshire Tool;
2. Using a residential per capita potable water usage of 110 l/day, as advised by NE in their 2020 Nutrient Neutrality guidance⁹, rather than the default 120 l/day included in the Herefordshire Tool tool;
3. Selecting the “No permit” (5 mg/l TP) Herefordshire WwTW option within the tool;

ⁱ Consultation with Rebecca Aziz, Senior Advisor Sustainable Development, Thames Solent Area Team – email communication: DAS 13695/261385 NE response - One Horton Heath Provision Phosphorus Budget, 04 October 2021 10:30

4. With regard to the derivation of Itchen Catchment specific P export values, it is deemed unreasonable for any single applicant to be expected to create the vast amount of background regional data and a suitable method of assessment for an issue that neither EBC nor NE have any published data or guidance. As such, it is felt that the derivation and approval of Solent Region P export values would be inappropriate until NE and the EBC Planning Department confirm their policy position and provide suitable working data/assumptions and an assessment tool to be used by applicants.

With this in mind, Hilson Moran have collated a comparison of P export values used in both the Stodmarsh and Herefordshire studies. A summary of these values are presented in Table 2.2 below.

Table 2.1 Comparison of Herefordshire Tool and Stodmarsh Study P Export Rates

Land use	P export value (kg P/ha/yr)	
	Herefordshire	Stodmarsh
Cereals	0.56	0.36
Dairy	0.48	0.49
General Cropping	0.53	0.28
Horticulture	0.27	0.18
Pig	0.28	0.34
Lowland Grazing	0.38	0.24
Mixed	0.51	0.27
Poultry	0.73	0.34
Average farming for area	0.47	0.28
Community food growing	0.47	0.28
Greenspace	0.02	0.14
Woodland	0.02	0.14
Shrub	0.02	0.14
Water	0.00	0.14
Residential urban land	1.69	0.83
Commercial/industrial urban land	1.21	0.83
Open urban land	0.89	0.83

As can be seen, all P export values are generally of the same magnitude, with the highest loss rates associated with urban uses, the lowest rates associated with greenspace/natural land use and agricultural uses falling between these two limits. In general, other than the greenspace/natural land use values (which have been sourced from the literature for the two studies, rather than being derived from catchment specific Farmscoper modelling), the Herefordshire P export values are all generally greater than the Stodmarsh values.

The underlying geology of Herefordshire, including the catchments of the Arrow, Wye OC and Monnow, consists mostly of sandstones and mudstones of the Old Red Sandstone sequence, belonging to the Devonian Period. Locally, small pockets of superficial glacial sand and gravel are present. The overlying soils reflect the relatively granular nature of the underlying strata, mainly comprising either freely draining slightly acid loamy soils with lesser areas of slightly acid loamy and clayey soils with slightly impeded drainage or locally, slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage.

The underlying geology of the Stour catchment in Kent, lying upstream from the Stodmarsh SPA/SAC/SSSI lakes, consists mostly of permeable chalk, with other Cretaceous sediments including mudstones, sandstones and limestones of the Gault, Upper and Lower Greensand Formations, together with mudstones, siltstones and sandstones of the Wealden Group to the south. Superficial deposits of brickearth and clay-with-flints are found locally. The overlying soils reflect the largely permeable strata below, largely comprising freely draining slightly acid/lime-rich loamy soils. Locally, soils are slightly acid loamy and clayey with slightly impeded drainage associated with finer grained superficial deposits, with slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage associated with the mudstones and siltstones of the Wealden Group to the south.

P exported from terrestrial systems is a combination of dissolved P and P that is bound to soil as particulate P. Most P in the soil is in the particulate form, as precipitates of iron, aluminum or calcium phosphates, bound to soil minerals (clay, calcite, aluminium hydroxides, etc.), or occluded within soil granules¹⁰. Dissolved P is predominantly phosphate ions (PO_4^{3-}), but it can also contain P sorbed to colloidal particles, organic P compounds and non-reactive mineral forms including polyphosphates and phosphonates. In agricultural watersheds, phosphorus entering wetlands is typically present in both organic and inorganic forms that are either dissolved (<0.45 mm) or particulate (>0.45 mm). In most agricultural soils, 50–75% of P is inorganic, with 60–90% of P transported from cultivated fields in the particulate form¹¹.

Within catchments, Johnston and Dawson (2005)¹² have identified three distinct processes that facilitate the transport of P from soil to receiving waters, comprising:

1. Incidental P transfers which can occur when large amounts of manure or fertiliser are applied and these are combined with large, preferential water flows across the surface of the landscape. Frequent rainfall in parts of the UK increases the potential for such rapid, direct (incidental) transfers of P, especially when rainfall interacts directly with animal manures, animal excreta or fertilisers soon after their application to the soil surface;
2. Soil erosion in the form of the detachment of soil particles from the main mass of soil when intense rainfall or the flow of water over the soil surface provides sufficient energy to do this. Soil particles can be transported over the soil surface or down through the soil profile depending on the direction in which the water flows. From both arable and grassland, the amount of P lost will increase with increasing P enrichment of the exposed soil surface. Water can move to a ditch by overland or surface flow or by interflow or “through flow”, e.g. at the interface of the plough layer and subsoil, or at an impermeable layer, such as bedrock. Significant amounts of P can be transported by overland flow, especially in eroded material;
3. Irrespective of the source, transport of P in solution occurs only if the P is soluble in water, i.e. the soil solution or surface water. This is a biochemical process and the water with its entrained P can move laterally as surface runoff or vertically down the soil profile. When moving down the profile, P is likely to be adsorbed onto sites in the subsoil. Consequently, it is unlikely that this will be more than a very minor pathway for the movement of P from soil to a water body because the solubility of most P compounds in water is so small. Even in fertilisers with a large percent of water-soluble P, all of the P is rapidly adsorbed onto soil particles from which it must go into the soil solution before there is any risk to movement in drainage water. This is perhaps the only method of P transport from soil that might be considered as a diffuse loss but the contribution to the total P load in a water body is very small.

With reference to Section 3.1.3.2 below, the central and northern areas of the Ageas Bowl site are underlain by the Eocene Marsh Farm Formation, comprising *“Laminated clay; wavy to lenticular-bedded sand interbedded with clay in equal proportions”*, whilst the remainder of the site is underlain by the Eocene Earnley Sand Formation, comprising *“Glaucconitic silty sands and sandy silts”*.

Soil type across the site reflects the predominance of underlying fine-grained strata and high water table, largely comprising *“Naturally wet very acid sandy and loamy soils”* draining to shallow groundwater with the golf course areas comprising *“Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils”* with impeded drainage draining to the local stream network.

Consequently, as the primary drainage routes across the site would be via overland or shallow sub-surface flow, it is anticipated that P loss would be dominated by particulate bound species and the rates from the site would therefore generally be greater than those derived for the Herefordshire study (where freely draining soils are more prevalent). These in turn would be anticipated to be greater than those derived for the Stodmarsh study, where the predominantly freely draining soils and permeable geology would encourage infiltration and adsorption of soluble P onto soil particles at depth within the soil column. As such, it is anticipated that the P export values presented in the Herefordshire Tool will typically be greater than those exhibited by the Ageas Bowl site and the use of Herefordshire P export values will provide suitably precautionary baseline values at this stage, in the absence of more robust site-specific values.

3. Assessment

3.1. Nitrogen and Phosphorus Baseline Studies

The N and P Baseline Studies comprised investigation into the following:

3.1.1. Initial Site Walkover and Interview with Farmers

A walkover survey of the site was conducted by Hilson Moran on the 3rd December 2021. The survey confirmed that the site comprised 5 main “Character Areas”, as indicated in **Appendix 2**.

3.1.1.1. Character Area 1 – Northern Part of Boundary Lakes Golf Course

This c. 6.34 ha area comprised the northern extent of the Boundary Lakes Golf Course. At its western end it comprises amenity turfed bank with street trees and hardstanding within the interior of the Ageas Bowl Stadium. In addition, it includes mixed (largely pine) woodland, with bramble, ivy and bracken dominated understorey, surrounding the golf course car park constructed from compacted crushed stone and tarmac. North of the car park lies a small watercourse within a channel constructed from wooden sleepers (Telegraph Brook), which flows eastwards towards a series of three large ornamental lakes. North of the brook lies the woodland fringed Tee 1 and fairway. Stone chip car parking is present in the northern corner of the area, next to Botley Road. The majority of the site comprises Tees 2 & 3, Greens 1, 2, 18 and a Practise Green, the three ornamental lakes, fairways, “rough” grass, woodland and associated golf course infrastructure (refer to Figure 3.1). The lakes were observed to be largely devoid of submergent or emergent vegetation, with the substrate covered in blanket weed even though the middle pond was being aerated by an ornamental fountain, indicating high nutrient levels in runoff.



Figure 3.1 *Character Area 1 – Boundary Lakes Golf Course – Green 1 looking southwards across lake*

3.1.1.2. Character Areas 2 & 3 – Northern Part of Boundary Lakes Golf Course

This relatively small c. 0.63 ha area largely comprises an amenity turfed bank topped with a timber palisade fence, with street trees and hardstanding within the interior of the Ageas Bowl Stadium, above the stands (refer to Figure 3.2). At its southern end the bank is supported by a concrete revetment wall, providing a staff and officials pedestrian access to the undercroft areas of the stands.



Figure 3.2 *Character Areas 2 & 3 – Staff access, stands and turfed bank viewed from the south east*

3.1.1.3. Character Area 4 – Hampshire Wellbeing Centre, Compound and Woodland

The eastern side of this c. 1.48 ha area comprises the buildings and tarmac car parking areas of the Hampshire Wellbeing Centre. The buildings are single storey, low-rise and timber clad, surrounded by amenity turf with associated shipping container temporary offices (refer to Figure 3.3)

To the west above the buildings lies an earthworks compound located on a plateau cut into the slope, fringed by amenity turf and mixed woodland. The compound is used for storage of landscaping materials such as turf, aggregate, compost and the like.

The area also includes a small section of amenity turfed bank, highway, hardstanding and entrance to the Colin Ingelby-Mackenzie Stand of the Ageas Bowl Stadium.



Figure 3.3 *Character Area 4 – Hampshire Wellbeing Centre and temporary offices with woodland and earthworks compound beyond, viewed from south east*

3.1.1.4. Character Area 5 – Main Stadium Coach and Car Parks and Landscaping

The majority of this c. 5.88 ha area comprises the main coach and car parking areas for the Ageas Bowl Stadium. The vehicle parking areas are constructed with crushed stone. The larger upper vehicle park is flat and lies within a large cutting, surrounded by amenity turfed slopes, natural grassland banks and tree planting (refer to Figure 3.4). To the south lies the Woodland Trust managed Telegraph Woods and to the west and industrial estate and residential areas of West End.

The lower car parking areas are also constructed from crushed stoned and slope north eastwards towards the main access to Ageas Bowl site. To the west of the car parking area there is a relatively steep amenity turfed bank sloping down to the relatively natural, tree and shrub lined channel of the Telegraph Brook, which issues from a culvert and brick headwall to the north of the upper vehicle parking area, flowing north eastwards along the western boundary of the site. Beyond this lies the David Lloyd Gym and Hampshire Tennis and Health Club. Along the turfed bank, various small diameter land drain outfalls were noted issuing from the slope towards the brook, draining the parking areas above. At the northern end of the car park, the brook enters another culvert, taking it beneath the access highway and roundabout, issuing into the timber sleeper lined channel on the golf course beyond (refer to Character Area 1 above).



Figure 3.4: *Character Area 5 – Main Coach and Car Parking Areas, viewed from the south west*

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. The locations of the nearby designated sites (and associated watercourses) are presented in **Appendix 3**.

3.1.3. Site Catchment Characteristics

Site catchment characteristics, such as local watercourses, 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/soilscales/>) and British Geological Service (BGS) (refer to <https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/>) websites.

3.1.3.1. Local watercourses

With reference to the associated 2022 Andy Clay Consulting “*Flood Risk Assessment: HCC Strategic*” report:

“The site is in the overall catchment of the River Hamble, located ~4.3km to the east of the site. This watercourse then drains south-west into Southampton Water near Hamble-le-Rice ~8.4km to the south of the site. The River Hamble is tidal for approximately half of its length, and navigable in its lower reaches. The drainage of water from the site into the River Hamble is achieved through a tributary of Pudbrook Lake. This flows within a culverted section to the east of the M27 motorway, adjacent to the eastern boundary of the overall site.”

With regard to the local Telegraph Brook, which dissects the site, the above FRA highlights that:

“The site is within the local catchment of Telegraph Brook, which is a small watercourse that drains from the central part of Telegraph Wood....Water would ordinarily be conveyed into an inlet within Telegraph Wood that is just outside of the site and then through a culverted section of the watercourse that is situated beneath the western part of the site. There is a culvert outlet at the downstream-end of the culvert which drains into an open section of channel located along the northern site boundary and adjacent to the David Lloyd Gym and Tennis Centre....This section of watercourse is semi-natural in that it is a simple trapezoidal channel aligned with trees and hedges. It then flows into a culverted section that passes beneath Marshall Road roundabout. The lower section of Telegraph Brook flows within a less natural channel. It has a very shallow gradient with the channel banks formed by wooden sleepers. This drains through the eastern part of the site. The watercourse then drains into an upper and lower lake separated by a weir at the edge of the site. The upper lake is connected to the lower lake via a weir, on the eastern side of the upper lake and which is on the western side of the lower lake....The lower lake then drains via another lake to the south-east, with this located outside of the site extent. It then drains to another culverted section under the M27 motorway. This culverted section is understood to continue under the retail estate to the east of the site, eventually draining into the River Hamble.”

3.1.3.2. Geology

As illustrated in Figure 3.5, the central and northern areas of the Ageas Bowl site are underlain by the Eocene Marsh Farm Formation, comprising “*Laminated clay; wavy to lenticular-bedded sand interbedded with clay in equal proportions*”, whilst the remainder of the site is underlain by the Eocene Earnley Sand Formation, comprising “*Glauconitic silty sands and sandy silts*”.

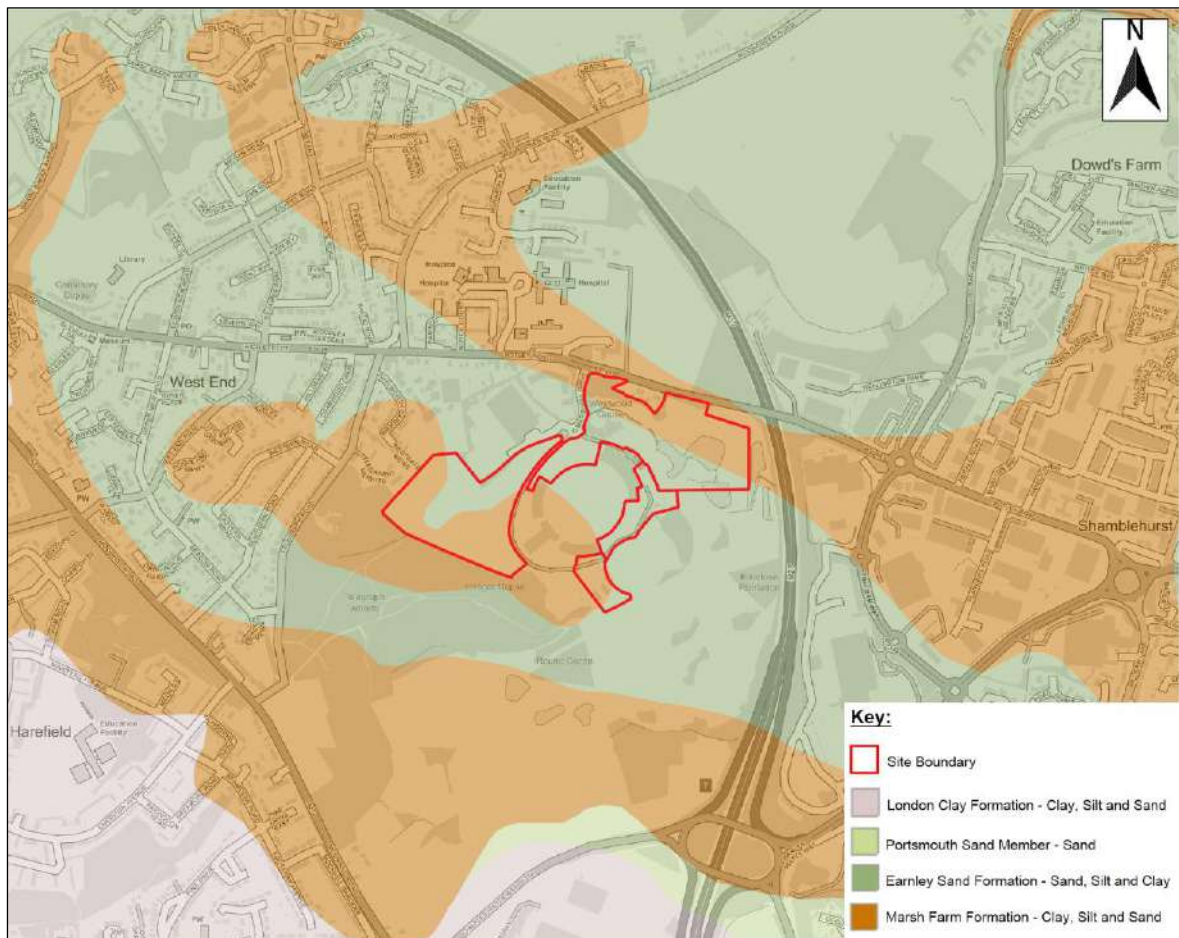


Figure 3.5 *Bedrock Geology on and around the Site (BGS, 2021) (not to scale)*

3.1.3.3. Soils

Soil type across the site reflects the predominance of underlying fine grained strata and high water table. With reference to Figure 3.6, soils across the majority of the site comprise “*Naturally wet very acid sandy and loamy soils*” draining to shallow groundwater. These soils are of very low fertility and “*where cropped, vulnerable to leaching of nitrate and pesticides to groundwater... lime and fertilisers are rapidly leached.*”.

Soils across the north eastern gold course area are described as “*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.

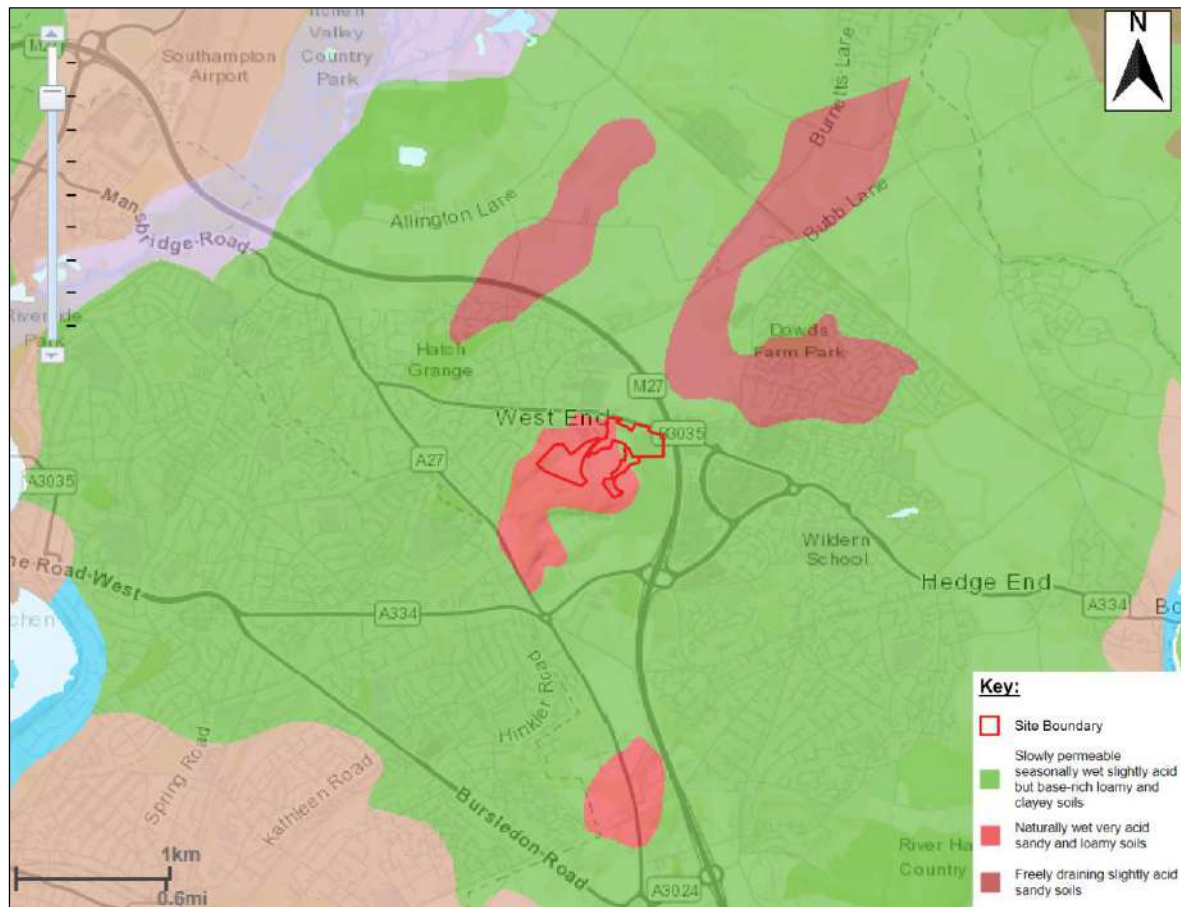


Figure 3.6 Soil Classification on and around the Site (Soilscapes, 2021)

3.1.3.4. Rainfall

The Standard Annual Average Rainfall (SAAR) for the site for the period 1961 to 1990 is 805 mm.

3.1.4. Wastewater Treatment Works Serving Development

Environmental permits for discharges from WWTWs are determined based on statutory water quality standards and objectives. These standards and objectives differ depending on whether the receiving watercourse is inland or coastal and also depending on its quality, amenity and whether there are any protected sites located nearby.

For inland receiving water, the assessment will take into account the immediate receiving water and main receiving river. In general, P is believed to be the primary limiting nutrient for UK inland waters, hence for inland waters discharges, only P removal is required. There are exceptional cases, but these will be linked to specific factors.

With reference to Southern Water records, foul sewage from the site is currently conveyed to Portswood WwTW, which lies approximately 3.8 km to the west of the site and discharges treated effluent directly into the tidal reach of the River Itchen (refer to **Appendix 4**). The WwTW, which is projected to serve an inhabitant population for 2025/2026 of 81,033 PE⁸ and has a consented DWF of 27,700 m³/day, does not have a permit concentration limit for either TN or TP.

As such, as per NE guidance, a discharge concentration of 27.0 mg/l TN is assumed (a typical value derived by Southern Water from nitrogen effluent concentrations at other non-consented 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.

As described in Section 2.2.2 above, research and consultation with NE supporting the Herefordshire Council Phosphate Budget Calculator Tool has concluded that a value of 5 mg TP/l in the effluent from non-permit limited WwTWs is likely to provide a suitably precautionary value. As with the non-permitted TN discharge concentration, a 90 % correction factor cannot be used for this WwTW, due to the facility not being regulated by a TP consent limit.

3.2. Nutrient Losses Associated with Golf Course Fertiliser Applications

Periodic nutrient applications are an integral and essential part of establishing and maintaining high quality golf turf. Consequently, golf course turf can be one of the most intensively managed land uses in the urban landscape. As with agricultural use, these fertiliser applications increase the potential for nutrients to be transported off site in surface runoff or through subsurface drainage features exiting to surface water. In reviewing a number of watershed and plot-scale studies, Bock and Easton (2019)¹³ determined typical total N and P losses from golf courses at around 2-20 kg ha⁻¹ yr⁻¹ and 1.5-5 kg ha⁻¹ yr⁻¹. These typical N loss rates from golf courses compare well with the NE default loss rate of 14.3 kg ha⁻¹ yr⁻¹ (whilst the typical P loss rate range is higher than the NR default loss rate of 0.83 kg ha⁻¹ yr⁻¹).

Information provided by Simon Lee, the Head Groundsman for the Ageas Bowl, revealed that NPK fertiliser was applied regularly to the golf course tees, greens and fairways (refer to **Appendix 5**). Nevertheless, given the urban location of the site and the relatively small areas receiving fertiliser applications as a percentage of the site area (c. 4.5%), together with the assumed parity of golf course N-loss rates with typical urban N-loss rates, it was deemed unnecessary to separately model the golf course losses (e.g. with Farmscoper), which comfortably sit within the NE definition of urban development (which includes “the built form, gardens, road verges and small areas of open space within the urban fabric”, where nitrogen sources include the “fertilisation of lawns and gardens”)⁹.

Consequently, in line with NE guidance the entire pre-existing site area of 14.34 ha will be assumed to have an existing N-loss rate of 14.3 kg ha⁻¹ yr⁻¹.

3.3. Nitrate Losses from the Proposed Development

The proposed development will comprise:

Mixed-use development comprising; 183 x 1,2,3 & 4 bedroom dwellings, 81-x bedroom independent living facility (Use Class C2), 136 x-bedroom hotel (Use Class C1), well-being centre (Use Class E / F2), new pavilion building and improvements to existing stadium, vehicular access, car parking, pedestrian circulation and processional ramp, together with tree planting, landscaping, SuDS and biodiversity enhancements.

A plan of the proposed redevelopment, together with the proposed housing/hotel/care home mix are presented in **Appendix 6**.

3.3.1. Estimating Post-Development Sewage N-Losses

A figure of 2.4 residents per dwelling, a projected water use of no more than 110 l/person/day and a precautionary 100 % 'Return to Sewer' (RTS) was used in the calculations, as recommended by NE.

The hotel will be modelled on the 3-star Hampton by Hilton type of hotel. With reference to the The Institute of Plumbing (2002) "*Plumbing Engineering Services Design Guide*"¹⁹ and UK daily water demand design data presented in The College of Estate Management document "*Grey Water for UK Housing*" (2013)²⁰, a 3-star hotel would be anticipated to exhibit a daily potable water use of 150 l/bedroom/day.

Similarly, referencing the same document, an elderly care home would be anticipated to exhibit a daily potable water use of 135 l/bed space/day.

Table 3.1 presents the estimated wastewater emissions from the proposals, giving a total annual wastewater emission of **79,647 l/day** for the proposed residential, hotel and care home uses of the scheme.

Table 3.1 Residential, Hotel and Care Home Wastewater Emissions

Type of Use	No. of dwellings	Occupancy Rate	Daily water usage (l/person)	Total Wastewater Emission (l/day)
Dwellings	183	2.4	110	48,312
Hotel	136	N/A	150	20,400
Care Home	81	N/A	135	10,935
Total				79,647

3.4. Final N Budget Calculations

3.4.1. Discharging Sewage to Chickenhall WwTW

With reference to Section 3.1.4 above, the wastewater generated by the residential element of the proposals will be conveyed to Portswood WwTW and will be treated and discharged without any permit concentration limit for TN (or TP), with an estimated discharge concentration of 27.0 mg/l TN.

3.4.2. Nitrogen-Losses Associated with Proposed Development Land Uses

It is assumed that the entire post-development 14.34 ha site will have an N-loss rate of 14.3 kg ha⁻¹ yr⁻¹.

3.4.3. NE Methodology Calculation

The following calculations set out the above steps using the NE Methodology (refer to **Appendix 1**) and ensuring the incorporation of an appropriate precautionary buffer:

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

STAGE 1 – CALCULATION OF 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	183	Residential dwellings	Refer to Appendix 6 and Table 3.1 above
		136	3-star hotel bedrooms	
		81	Care home bed spaces	
Step 1	Development residential population	439.2	Persons	Refer to Section 3.3.1 and Table 3.1 above for derivation of development residential population.
Step 2	Wastewater volume generated by development	79,647	litres/day	Refer to Section 3.3.1 and Table 3.1 above.
Step 3	Receiving WwTW environmental TN permit limit.	27.0	mg/l TN	No consent limit for Portswood WwTW, so assumed to be a discharge concentration of 27.0 mg/l as per NE Methodology.
Step 4	Deduct acceptable TN loading (@ 2 mg/l TN) as per NE Methodology.	25.0	mg/l TN	27.0 (step 3) – 2.0 mg/l TN (accounting for baseline TN concentration in potable water).
Step 5	TN discharged after WwTW treatment	1,991,175	mg/TN/day	79,647 (step 2) x 25.0 (step 4) = 1,991,175
Step 6	Convert mg/TN to kg/TN per day	1.99	Kg/TN/day	Divide by 1,000,000
Step 7	Convert kg/TN per day to kg/TN per year	726.8	Kg/TN/yr	16.51 x 365 days
Step 8	Calculate pre-existing foul sewage N loss	0.0	Kg/TN/yr	No residential or overnight stay present within red line boundary
Step 9	Calculate wastewater total nitrogen load by subtracting pre-existing load from post-development load	726.8	Kg/TN/yr	726.8 (step 7) – 0.0 (step 8)
Wastewater total nitrogen load	726.8 Kg/TN/yr			

3.4.3.2. Stage 2 - Adjust nitrogen load to account for existing nitrogen from current land use

STAGE 2 – CALCULATION OF NITROGEN LOAD FROM CURRENT LAND USE				
Step	Measurement	Value	Unit	Explanation
Step 1	Total area of existing urban development	14.34	Hectares	This is the net area of existing urban development land that will remain unchanged with regard to land use classification as a result of the development comprising the entire site area.
Step 2	Identify nitrate loss rate for land use	14.3	Kg/ha/yr	As per NE guidance, for urban development land uses.
Step 3	Multiply area by nitrate loss	205.1	Kg/N/yr	14.34 ha (step 1) x 14.3 kg/N/yr (step 2)
Nitrogen load from current land use	205.1 Kg/TN/yr			

3.4.3.3. Stage 3 - Adjust nitrogen load to account for land uses with the proposed development

STAGE 3 – CALCULATION OF NITROGEN LOAD FROM FUTURE LAND USES				
Step	Measurement	Value	Unit	Explanation
Step 1	New urban area	14.34	Hectares	Site footprint, which will continue to be used for “urban development”
Step 2	Nitrogen load from future urban area	205.1	Kg/N/yr	14.34 ha x 14.3 Kg/N/yr
Step 3	New open space (greenspace and soft landscaping) and/or other uses	N/A	Hectares	
Step 4	Nitrogen load from open space and/or other uses.	N/A	Kg/N/yr	
Step 5	Combine nitrogen load from future land uses	205.1	Kg/N/yr	
Nitrogen load - future land uses	205.1 Kg/TN/yr			

3.4.3.4. Stage 4 - Calculate the net change in the Total Nitrogen load that would result from the development

STAGE 4 – CALCULATION OF THE NET CHANGE IN NITROGEN LOAD FROM THE DEVELOPMENT				
Step	Measurement	Value	Unit	Explanation
Step 1	Identify nitrogen load from wastewater (Stage 1)	726.8	Kg/TN/yr	Refer to Stage 1 above
Step 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)	0.0	Kg/TN/yr	205.1 (Stage 3) – 205.1 (Stage 2) = 0.0 Kg/TN/yr
Step 3	Determine nitrogen budget – the Total Nitrogen wastewater load for the proposed development plus the change in nitrogen load from land use change	726.8	Kg/TN/yr	726.8 (step 1) + 0.0 (step 2) = 726.8 Kg/TN/yr
Step 4	Where TN budget is positive add 20% precautionary buffer	872.2	Kg/TN /yr	726.8 + 20% = 872.2 Kg/TN /yr
Total Nitrogen that needs to be neutralised	872.2 Kg/TN /yr			

3.5. Final P Budget Calculations

3.5.1. Tool Inputs and Outputs

The inputs and outputs of for the Herefordshire Council Phosphate Budget Calculator Tool based on the information provided above and in the associated Appendices are presented in **Appendix 7**.

3.5.2. Total P Mitigation Target

Including a 20 % precautionary buffer as recommended by NE, it is estimated using the Herefordshire Council Phosphate Budget Calculator Tool as described above that the total amount of P associated with the proposals to aim to mitigate = **162.78 kg TP/year**.

4. Mitigation Measures

4.1. General Mitigation Measures

As part of this study, a high-level assessment of mitigation measures suitable for the proposed scheme has been conducted.

Currently, although N neutrality must be demonstrated for all new residential developments and those that include overnight stay uses, there is no obligation yet to demonstrate P-neutrality. Nevertheless, there will be an aspiration to reduce P loadings associated with then proposed development, wherever possible.

Potential mitigation measures suitable for the scheme include:

- 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 or Hamble Fluvial Catchments and willing individuals to engage with the process, the provision of wetlands, both as Sustainable Drainage Systems (SuDS) or as “polishing” wetlands to remove N and P from pre-existing waterbodies, could also be a valuable measure provided within the boundary of the post-development scheme or on nearby lands owned or in the control of the applicant, providing multifunctional water quality, flood prevention, biodiversity and amenity features (refer to Section 4.2);
- 2) The introduction of a suitable Reverse Auction Scheme for N and P reduction, in collaboration with Southern Water, which would offer funding to farmers in exchange for commitments that provide a reduction in the input of P in to the catchment. This mitigation option has been used successfully elsewhere to achieve N reductions (*e.g.* Wessex Water working with EnTrade in Poole Harbour – refer to <https://www.catchments.ie/using-reverse-auctions-to-support-delivery-of-catchment-off-sets-in-wessex-uk/>) where its significant and proven potential to reduce N inputs at a catchment level for the benefit of sensitive habitats downstream has been demonstrated.

Wessex Water and EnTrade have also worked together in the Vale of Pewsey with Wiltshire Council, Black Sheep Countryside Management and Catchment Sensitive Farming (CSF) (farmer engagement). The objective of the scheme is to enable planning permissions for new housing to be granted by offsetting additional P pollution caused by growth, in line with permanence requirements of the Habitats Regulations

The scheme is still being established, but outcomes so far include:

- Contracts for 25kg of long-term P reductions agreed in first phase, sufficient to meet initial offset requirements;
- P reduction models validated with regulators;
- Contracting and funding model to assure permanent delivery close to finalisation with NE; and
- Novel form of P reduction (Minimum Tillage system) bought by Wessex Water, with a connected Carbon Offset.

Although a similar scheme for the Solent Region is a possibility, it is currently unclear whether it is a realistic option for the Ageas Bowl within the timeframe associated with the increase in residential occupancy resulting from the scheme;

- 3) On-site wastewater treatment, by providing a number of appropriate package treatment works across the proposed development. Although denitrification can be achieved within development scale package treatment works, Bunce *et al* (2018) have concluded that most P-removal technologies have been developed for use at larger wastewater treatment plants that have economies-of-scale, rigorous monitoring and in-house operating expertise. Smaller treatment plants often do not have these. Although significant progress has been made in developing some technologies for small-scale application, namely sorptive media, there is a shortage of treatment technologies for P-removal at smaller scales, particularly sustainable and reliable options that demand minimal operating and maintenance expertise or are suited to northern latitudes.

Furthermore, the Environment Agency (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.

Consequently, the use of on-site wastewater treatment by means of package treatment works across the proposed development is not currently considered to be a viable option for the scheme;

- 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.

EBC are currently putting in place a land assembly project that will provide a permanent Borough wide nitrate mitigation approach. Consequently, it is anticipated that this scheme will be used to wholly offset the remaining increase in N-loss to the Solent associated with the Ageas scheme.

With regard to the mitigation measures listed above:

- 1) The Ageas Bowl and its environs already lie within a Nitrate Vulnerable Zone (NVZ), which has been designated by the Department for Environment, Food and Rural Affairs (Defra) to protect water quality from nitrates from agricultural sources. As such, all farmers within the Itchen and Hamble catchments are obliged to follow an Action Programme and follow a series of measures on fertilizer application to minimise the risk of nitrates polluting ground or surface water. Those who do not comply can be fined by the Government. Consequently, as the regulation of NVZs and the encouragement of farmers to adopt nutrient reduction measures lie largely with the government bodies such as the EA, Defra, the Rural Payments Agency and NE, the ability of the applicant to influence farmers further may well be limited.

Nevertheless, the use of “soft SuDS”, such as swales, detention basins and the deculverting of the existing Telegraph Brook to provide a two-stage channel, with restored floodplain and the potential for new wetland habitats have been identified as surface water flooding mitigation measures within the associated 2022 Andy Clay Consulting “*Flood Risk Assessment: HCC Strategic*” report. These new stormwater attenuation/conveyance features and floodplain habitats will also serve to remove N and P from site runoff, and in terms of the deculverted Telegraph Brook, could be used to reduce nutrient existing nutrient loadings in the brook itself.

Furthermore, there will be opportunities to minimise N & P inputs associated with the land management of both the golf course, soft landscaping and potentially the cricket grounds, through the application of best practice measures;

- 2) It is understood that the UK Government is planning to establish an online ‘nitrate trading’ auction platform in the medium term, where developers will be able to buy credits from landowners looking to create new and less ‘nitrogen intensive’ habitats. The platform is expected to be rolled out over the next two years and will be delivered jointly between Defra, Ministry of Housing, Communities & Local Government, NE and the EA. However, it is unlikely that this initiative will be up and running in time to provide mitigation for the Ageas Bowl scheme;
- 3) As discussed above and also 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 principal 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. Consequently, there may be some regulatory inertia against the adoption of development-scale package treatment plants, at least for the foreseeable future.
- 4) EBC are currently putting in place a land assembly project that will provide a permanent Borough wide nitrate mitigation approach (refer to <https://www.eastleigh.gov.uk/planning-and-building/nutrient-neutrality-offset-scheme>). Consequently, it is anticipated that this scheme will be used to wholly offset the increase in N-loss to the Solent associated with the Ageas Bowl scheme, by means of an appropriate financial contribution. EBC currently state that they possess 3,633 N credits (1 credit = 1 kilogram of nitrates per year) across 78.5 hectares of council-owned land. The cost per credit is £3,000 + VAT and they will also require an undertaking for their legal and administrative costs. As such, to fully mitigate the N-loss associated with this scheme, will require a financial contribution in the order of £3,000 x 872.2 (Kg/TN/yr) = **£2,616,600**.

Those interested in securing credits are requested to fill out the Expression of Interest form (available at <https://www.eastleigh.gov.uk/media/10142/nutrient-neutrality-scheme-enquiry-form.pdf>) and return to nutrientoffset@eastleigh.gov.uk. Once an Expression of Interest form has been received, EBC will confirm whether credits are available to meet the anticipated need, so that the process below can be followed:

1. Developer & Local Planning Authority go through planning process as usual;
2. Local Planning Authority confirms offset requirement and suitability of EBC scheme to Developer;
3. EBC confirms credits are still available;
4. Local Planning Authority grants consent (probably with a pre-start or Grampian condition relating to nitrate mitigation;
5. Developer buys credits from EBC;
6. EBC issues vesting certificate to developer; and
7. Developer applies to Local Planning Authority for discharge of condition.

Alternatively, the Hampshire & Isle of Wight Wildlife Trust (HIWWT) has initiated a similar “Nitrate Reduction Programme” through the creation of new nature reserves on formerly intensively managed farmland and returning it to natural habitats, such as traditionally grazed meadows, wetlands or woodlands (refer to <https://www.hiwwt.org.uk/reducing-nitrates-solent>). The scheme works in a similar way to the EBC scheme, with nitrate credits being sold to developers either through a conditional contract for larger developments contingent on the granting of planning permission, with payment due shortly after planning permission has been granted, or by a simple sale for smaller developments, usually those below 5kg.

A deposit of 10% is paid upon issuing of the contract. The length of time between paying the deposit and paying the balance could be several months for some larger developments due to the subsequent processes that need to happen prior to planning permission being granted.

The cost of a nitrate credit within this scheme is currently unknown, but further information can be gained by contacting HIWWT at nitrates@hiwwt.org.uk or filling out an Expression of Interest form at <https://www.hiwwt.org.uk/Nutrient-Reduction-Expression-Interest-Format>.

4.2. Provision of Sustainable Drainage Systems (SuDS)

With reference to the 2022 Andy Clay Consulting “*Flood Risk Assessment: HCC Strategic*” report, the provision of the following stormwater control measures will be explored, including:

1. Sections of swale could be included in the scheme, to provide a drainage feature for both the conveyance and attenuation of surface water runoff;
2. De-culverting of the Telegraph Brook in Character Area 5 and replacing it with a realigned two-stage channel providing an additional storage volume to accommodate high flows (refer to Figure 4.1). The new channel profile will be suited to both, low and high flow conditions. The low flow will occupy the lower stage of the channel, and promote a flowing watercourse and the associated benefits. Whereas the upper stage will provide a storage volume to accommodate high flows. The floodplain areas created to accommodate high flows, could also provide opportunities for wetland creation and the N and P reducing capabilities of these environments.
3. In addition, the FRA states that along the route of the watercourse, there may also be opportunities to include detention basins.

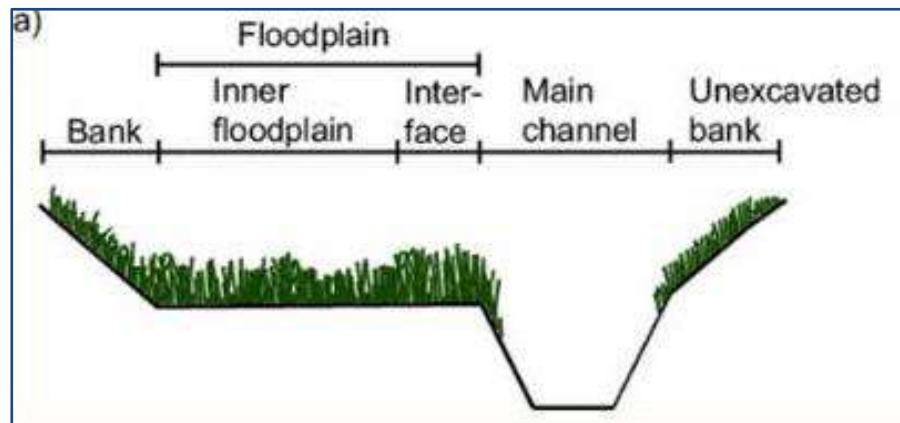


Figure 4.1 *Cross-section of Proposed Two-Stage Channel of De-culverted Telegraph Brook (from Andy Clay Consulting, 2022)*

With reference to the NE Nitrate Neutrality Methodology (**Appendix 1**), the ability of wetlands to remove N and P from runoff through processes such as denitrification and sedimentation has been demonstrated in numerous studies.

In particular, NE cites a recent systematic review of the effectiveness of wetlands for N (and P) removal conducted by Land *et al*, 2016²¹ which used data from 203 wetlands worldwide. The median N removal rate for wetlands that were included in this review was 93 g/m²/yr, which equates to a median N removal efficiency of 37%. The median P removal rate for wetlands that were included in this review was 1.2 g/m²/yr, which equates to a median P removal efficiency of 50%.

Alternatively, a similar, yet more relevant review has been conducted by Koch *et al* (2014)²² which is restricted to 701 papers on drainage features only receiving stormwater, such as urban stormwater ponds, wetlands, and swales. The paper demonstrates that wet ponds exhibited a median N-removal rate of 40 %, wetlands 61 % and swales 50 %. The paper also highlights the importance of utilising a SuDS treatment train in maximizing N removal, with associated peak flow and sediment reduction. N removal efficiency increased not only cumulatively but also for individual SuDS features further along a treatment train.

Another paper by the US EPA (2000)²³, encompasses a review of 153 separate studies of stormwater SuDS features, including dry and wet ponds, wetlands, filtering and infiltration practices and water quality swales, in which influent total P concentrations ranged from 0.03 to 3.0 mg/l, with an average of 0.43 mg/l and a median of 0.25 mg/l. Median total P removal efficiencies were found to be:

- 19 % for stormwater dry ponds (including dry extended detention ponds and quantity control ponds);
- 51 % for stormwater wet ponds (including wet ponds, wet extended detention ponds and multiple pond systems);
- 49 % for stormwater wetlands (including pond/wetland system, extended detention wetlands, submerged gravel wetlands and shallow marsh);
- 50 % for filtering practices (including organic filters, perimeter sand filters; surface sand filters, vertical sand filters and bioretention);
- 70 % for infiltration practices (including porous pavements and infiltration trenches) ; and

- 34 % for water quality swales (including wet swales, dry swales, grass channels and ditches).

4.2.1. Detention basins

With reference to the above studies, it is proposed that the following general enhancements for N, P and sediment removal will be included in any detention basins constructed as part of the scheme:

1. They possess a sediment forebay to enhance the removal of particulate N and P, together with sediment;
2. The area of wetland within the remaining basal areas of the basins is maximised (*e.g.* by excavating below the outfall invert) in order to maximise the extent of the saturated zone and encourage denitrification in anoxic areas below the water surface;
3. Detention basins will be linked in series, wherever possible, to maximise the cascading nature of the SuDS train;
4. The basin bases are planted up with suitable vegetation to slow flow rates, maximise residence time, encourage denitrification around root areas and also uptake of P;
5. The basin maintenance schedule will include periodic dredging of forebays, which will permit removal of sediment/particulate P/ Particulate Organic Nitrogen (PON) from the catchment; and,
6. Basin maintenance will also include rotational harvesting of vegetation to remove P loads from the catchment.

Consequently, the adoption of the above principles within all basins across the scheme will enable the 61 % median N removal rate and 51 % median P removal rate for stormwater wetlands to be targeted for the lifetime of the scheme.

4.2.2. Swales

As with detention basins, where practical, the provision of a permanently saturated zone within the swale is desirable to maximise N removal through denitrification, as described by Ekka *et al* (2021)²⁴. Koch *et al* (2014)¹¹ cites a median N removal efficiency of 50 % for ‘dry’ swales (*i.e.* comprising “grass channels, grass swales, and dry swales without underdrains, and do not include bioswales”), although wet swales are not specifically identified (being included in wetlands with a median N removal efficiency of 61 %). Alternatively, the EPA *National Pollutant Removal Performance Database for Stormwater Treatment Practices* (2000)²⁵, specifically provides median removal efficiencies for “Water Quality Swales” of 31 % for nitrogen oxides (NO_x) (nitrate and nitrite), 84 % for TN, 38 % for soluble P, 34 % for TP and 81 % for Total Suspended Solids (TSS).

This generally agrees with other studies, including:

- 35% total P mean removal efficiency for a vegetated swale and several filter strips in North Carolina, USA²⁶; and,
- 33 % total P mean removal efficiency for roadside swales serving secondary roads in the USA²⁷.

Consequently, the provision of swales across the site as part of the SuDS strategy, will serve to contribute to N, P and sediment reduction in surface water runoff from the scheme.

4.3. Best Practise Land Management Measures

In addition, if not already in use, there are a number of best practise measures that can be adopted by the Head Groundsman and/or landscape management contractors to ensure that N and P loadings associated with the construction and post-development phases of the scheme are minimised. These include:

- Fertiliser application rates should be as low as possible (in accordance with manufacturers specifications for timing of application *e.g.* avoid rainfall events);
- Fertility management plans for golf course and cricket ground turf, together with other soft landscaped areas, should aim to balance the nutritional requirements of the plant with the potential for offsite nutrient transport;
- Fertility plans and subsequent fertiliser applications should focus equally on N and P requirements;
- Post application irrigation places the nutrients in the thatch and surface soil layer. This practice can reduce P losses by more than 10%²⁸;
- Maintaining a healthy dense turf promotes drainage and infiltration and can reduce runoff 15-fold^{29, 30}. All else remaining equal, less runoff water results in less surface nutrient loss;
- During golf course construction and modification works (which will be required as part of this scheme), it is common practice to apply large amounts of P for root development and establishment. Care should be taken to adjust the amount of applied P once the grass is established, thereby avoiding P-saturated soils, as the residual P in the soil is readily available for transport within surface runoff, and additional P applications will only serve to further enhance the potential for runoff losses;
- Periodic soil and plant tissue testing of levels of N, P (and potassium (K)) may be of value to determine the amount of nutrients required based on current soil conditions as well as plant needs; and,
- Introducing grass buffers around streams helps to intercept flow, slow down runoff, increase infiltration, and significantly reduce nutrient losses.

5. Summary and Conclusion

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

The calculations demonstrate that:

- The TN and TP losses from pre-existing uses of the site have been derived using site visits and liaison with land managers, together with appropriate modelling;
- Pre-existing losses have been calculated as **205.1 Kg/TN/yr** and **12.71 Kg/TP/yr**;
- The wastewater generated by the proposals will be conveyed to Portswood Wastewater Treatment Works (WwTW) where it will be treated and discharged without any permit concentration limit for TN or TP, with estimated discharge concentrations of 27 mg/l TN and 5 mg/l TP;
- For N losses, a standard NE Methodology has been used. For P losses a modified version of the Herefordshire Council Phosphate Budget Calculator Tool has been used;
- The results identify that a total of **872.2 Kg/TN/yr** will need to be neutralised in order to mitigate against the proposed development;
- Although there is currently no obligation for the scheme to demonstrate P neutrality, the results identify that a total of **162.78 kg TP/yr** would need to be targeted in order to achieve P neutrality for the proposed development;
- The use of "soft SuDS", such as swales, detention basins and the de-culverting of the existing Telegraph Brook to provide a two-stage channel, with restored floodplain and the potential for new wetland habitats, have been identified as surface water flooding mitigation measures. Although not quantified at this stage, these new stormwater attenuation/conveyance features and floodplain habitats will help to remove N and P from site runoff, and in terms of the de-culverted Telegraph Brook, could be used to reduce nutrient existing nutrient loadings in the brook itself;
- EBC are currently putting in place a land assembly project that will provide a permanent Borough wide N (and P) mitigation approach. Consequently, it is anticipated that the **872.2 Kg/TN/yr** loss associated with the development will be fully mitigated by EBCs Strategic Land Parcels offsetting scheme (or similar scheme, such as that run by Hampshire & Isle of Wight Wildlife Trust);
- EBC currently state that they possess 3,633 N credits (1 credit = 1 kilogram of nitrates per year) across 78.5 hectares of council-owned land. The cost per credit is £3,000 + VAT and they will also require an undertaking for their legal and administrative costs. As such, to fully mitigate the N-loss associated with this scheme, will require a financial contribution in the order of £3,000 x 872.2 Kg/TN/yr = **£2,616,600**;
- This financial contribution may be reduced if on-site reduction in N and P loss can be demonstrated through the sympathetic design of on-site SuDS and other wetland features highlighted in this report;
- Furthermore, there will be opportunities to minimise N & P inputs associated with the land management of both the golf course, soft landscaping and potentially the cricket grounds, through the application of best practise measures;

-
- A range of land management best practise recommendations have been presented to minimise N and P loadings during the construction and operational phases of the scheme;
 - Consequently, the N impacts of the proposals will be fully mitigated and P losses minimised in order to ensure that they do not detrimentally affect local biodiversity or 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.

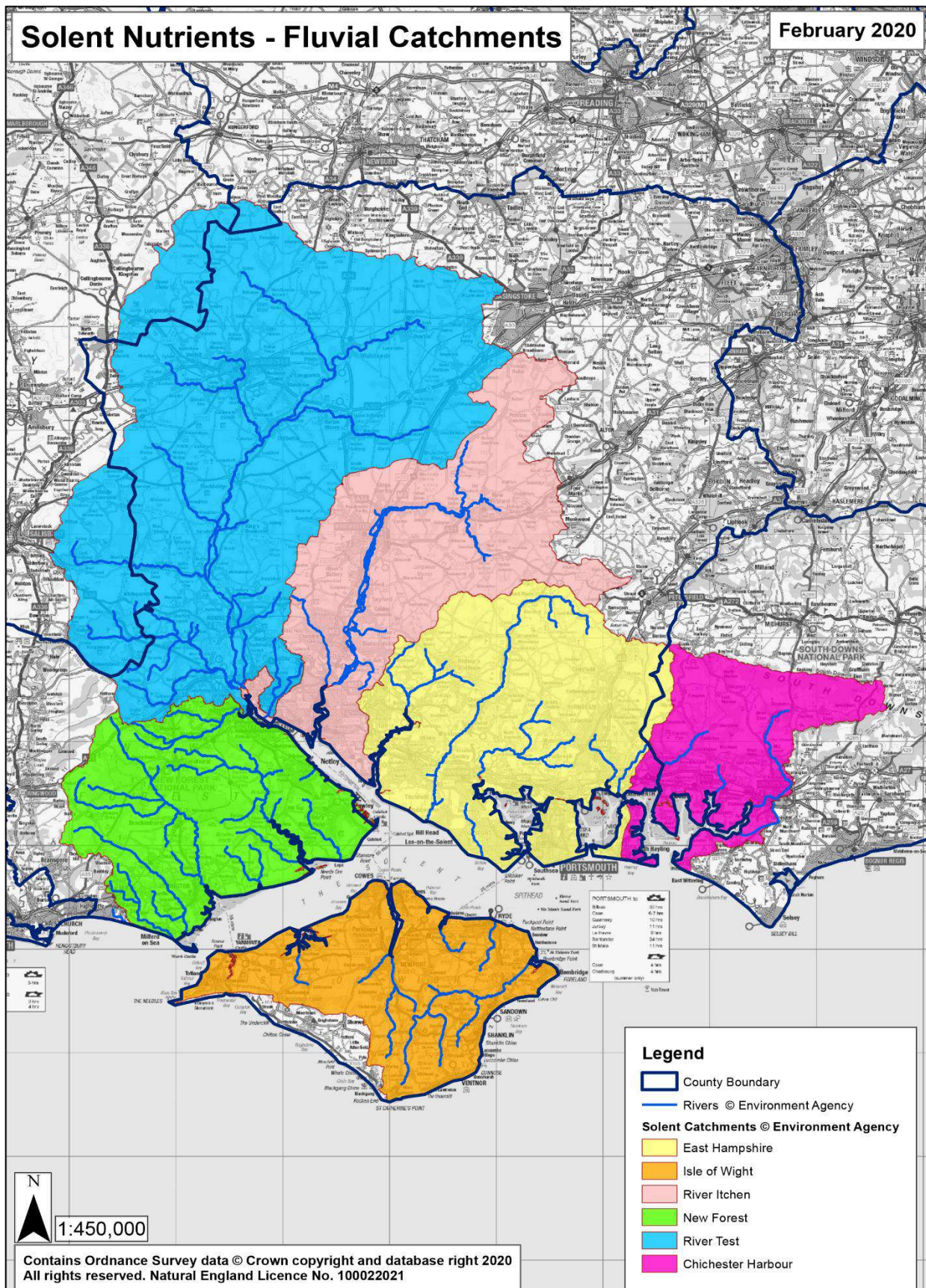
Location of development

- 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., & Bieroza, 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

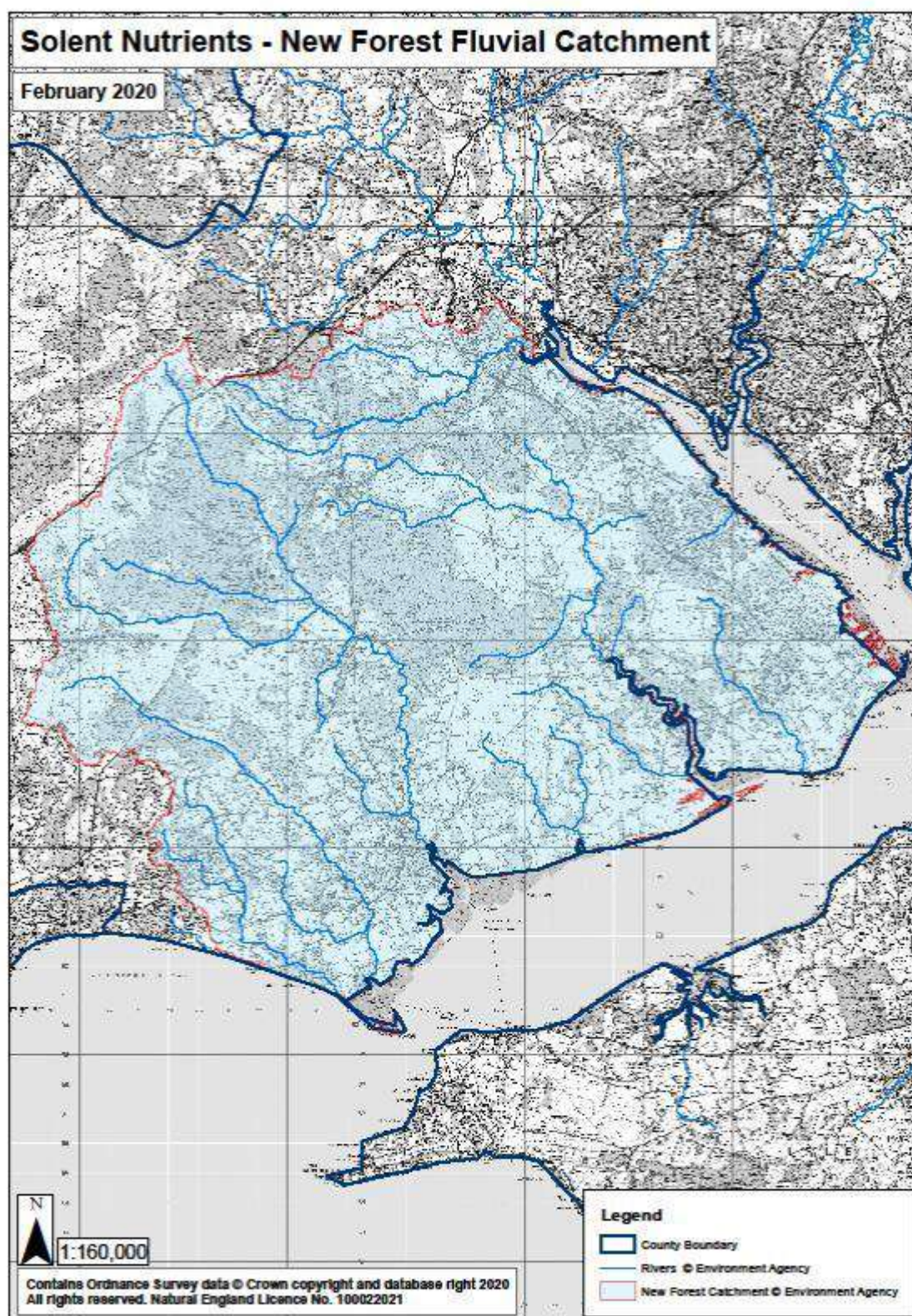


Figure 3

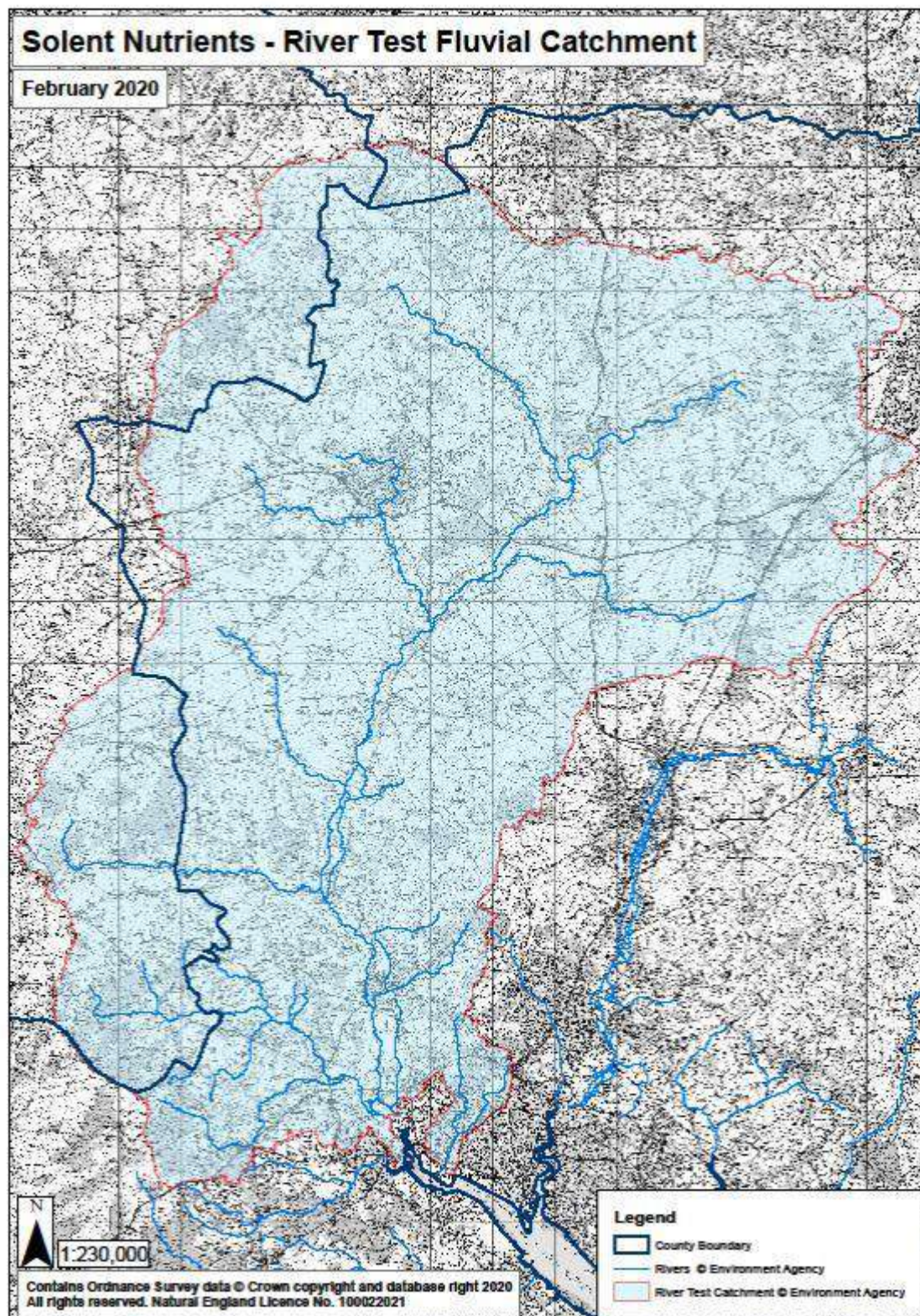


Figure 4

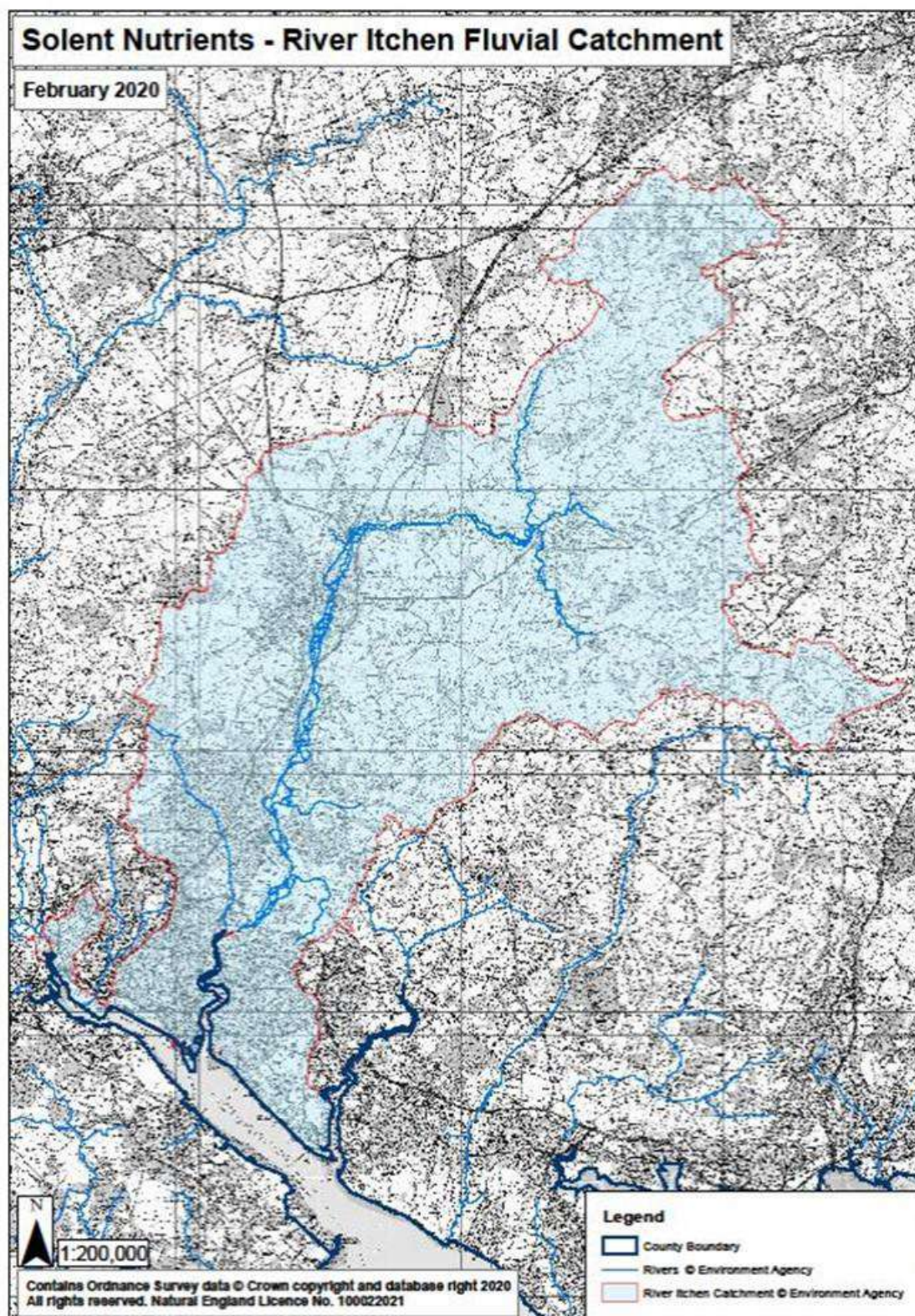


Figure 5

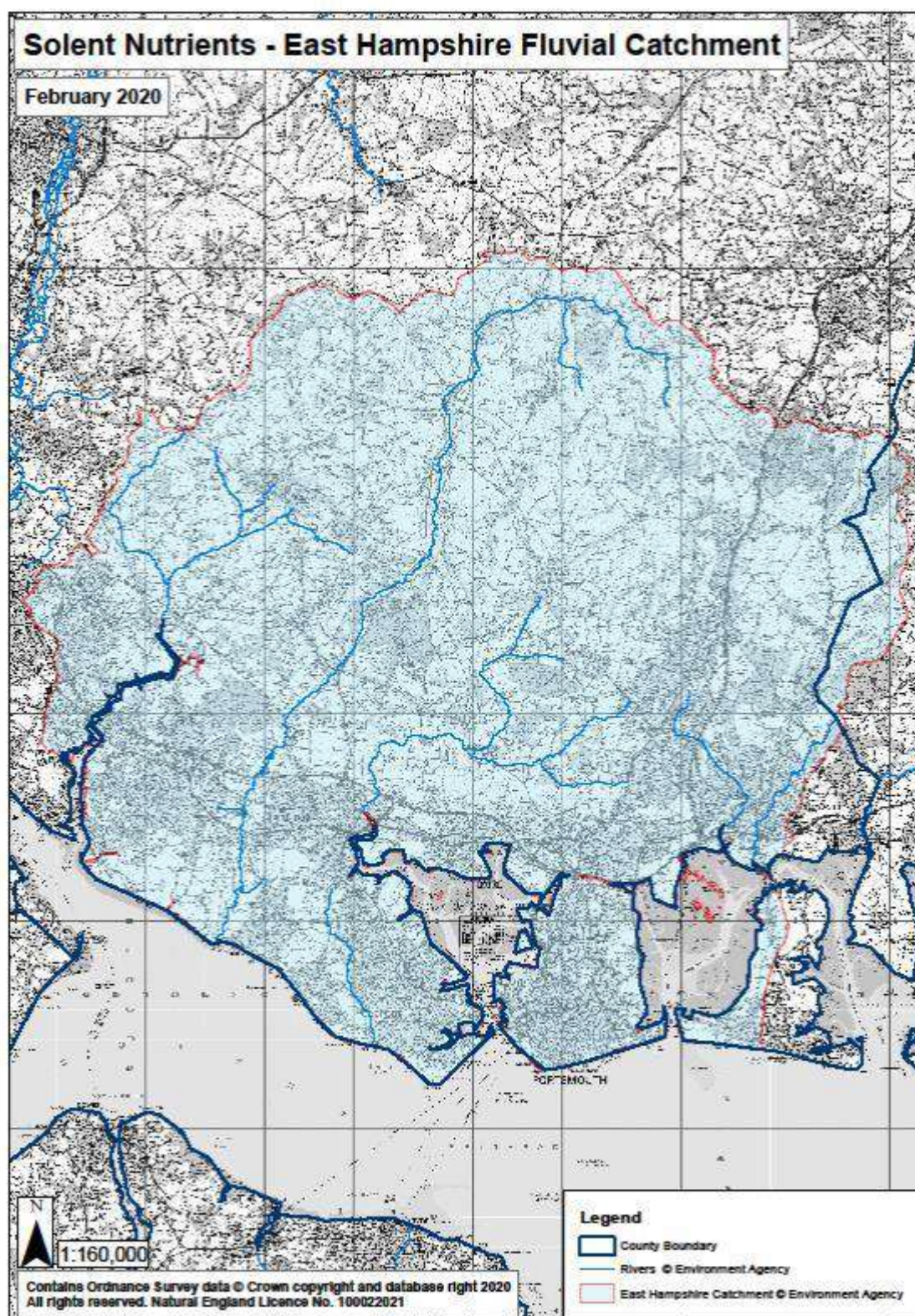


Figure 6

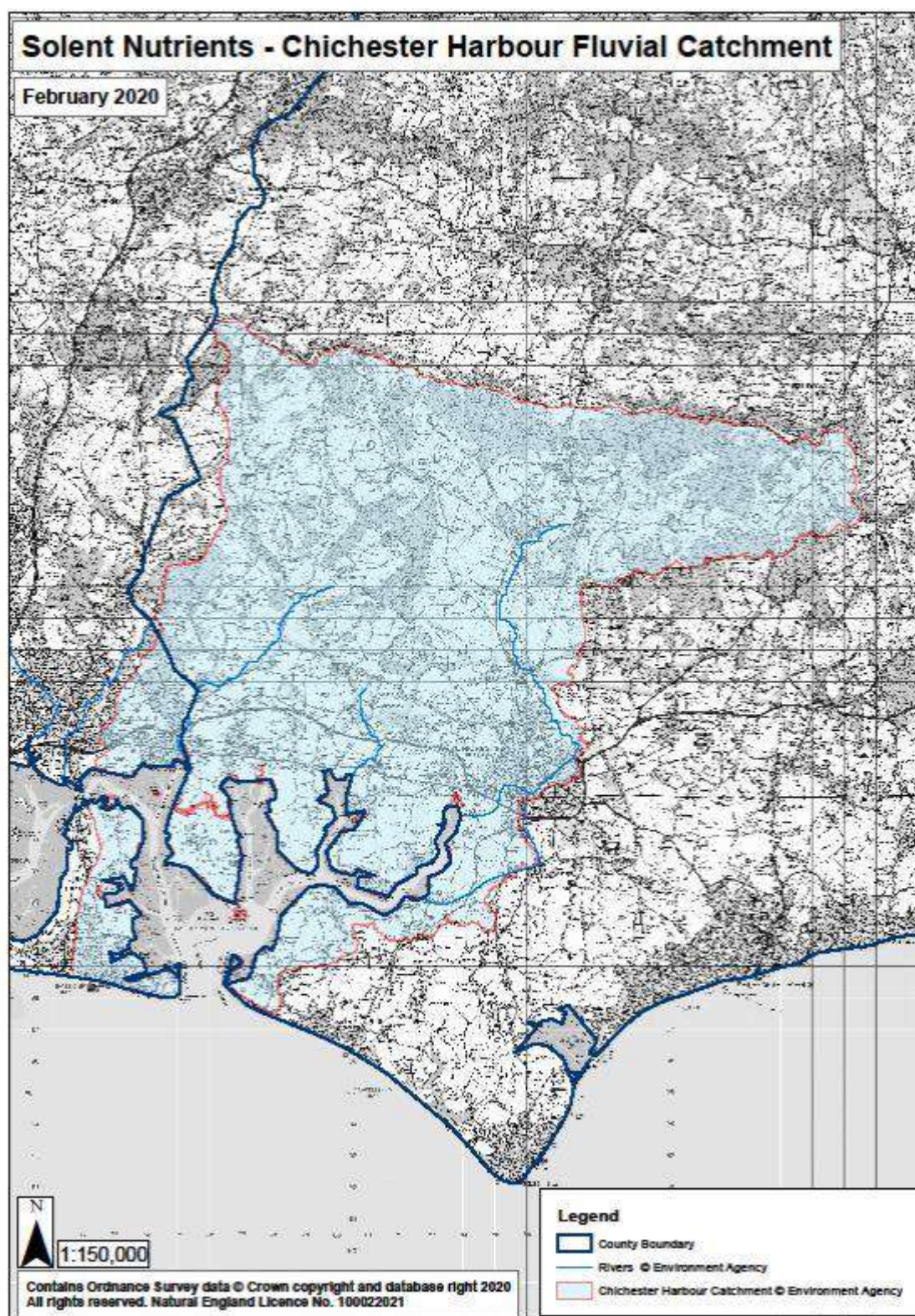
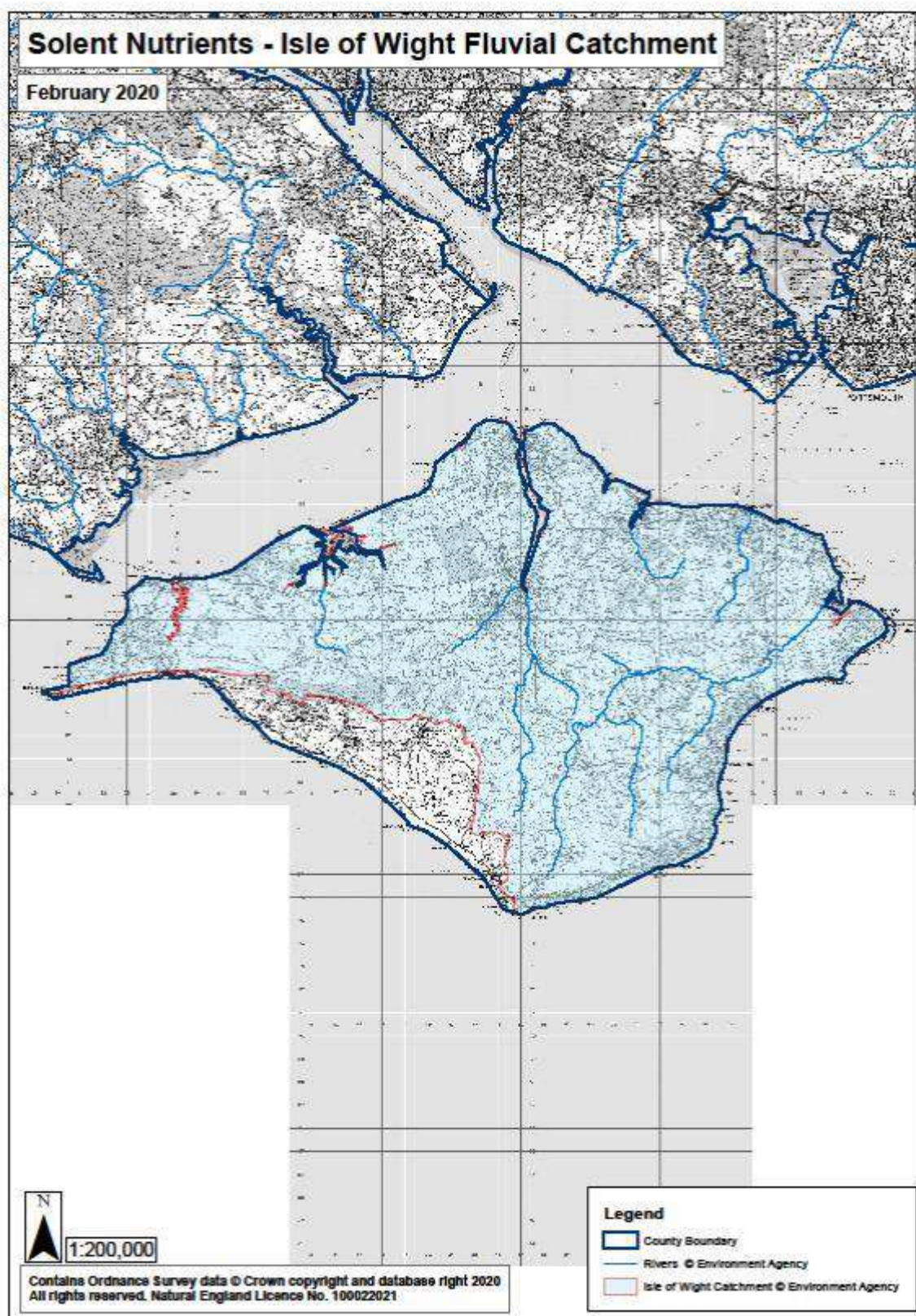


Figure 7



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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Appendix 2 Existing Site and Character Areas



Figure A.1 *Aerial Image of the Ageas Bowl Site*

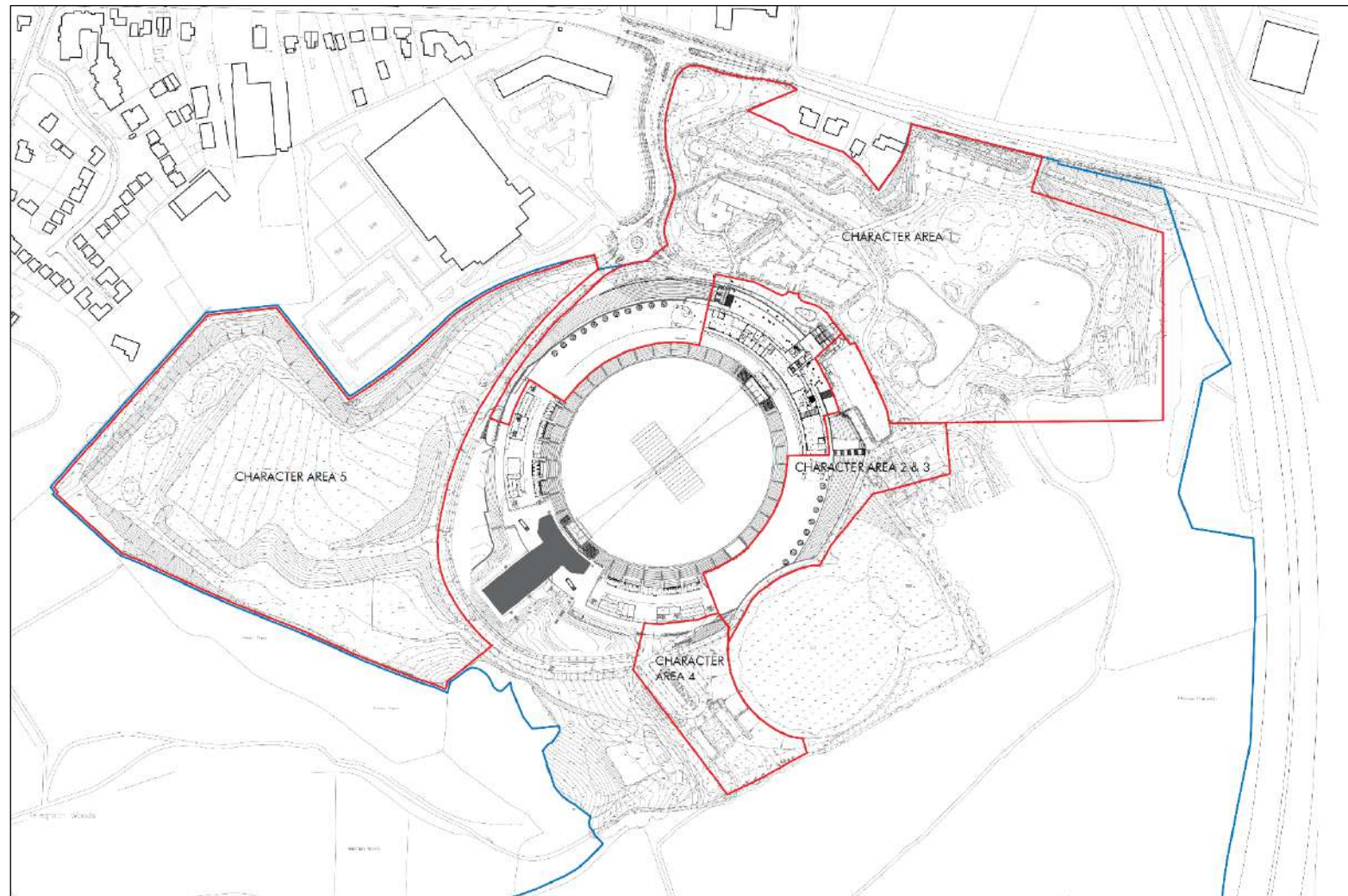
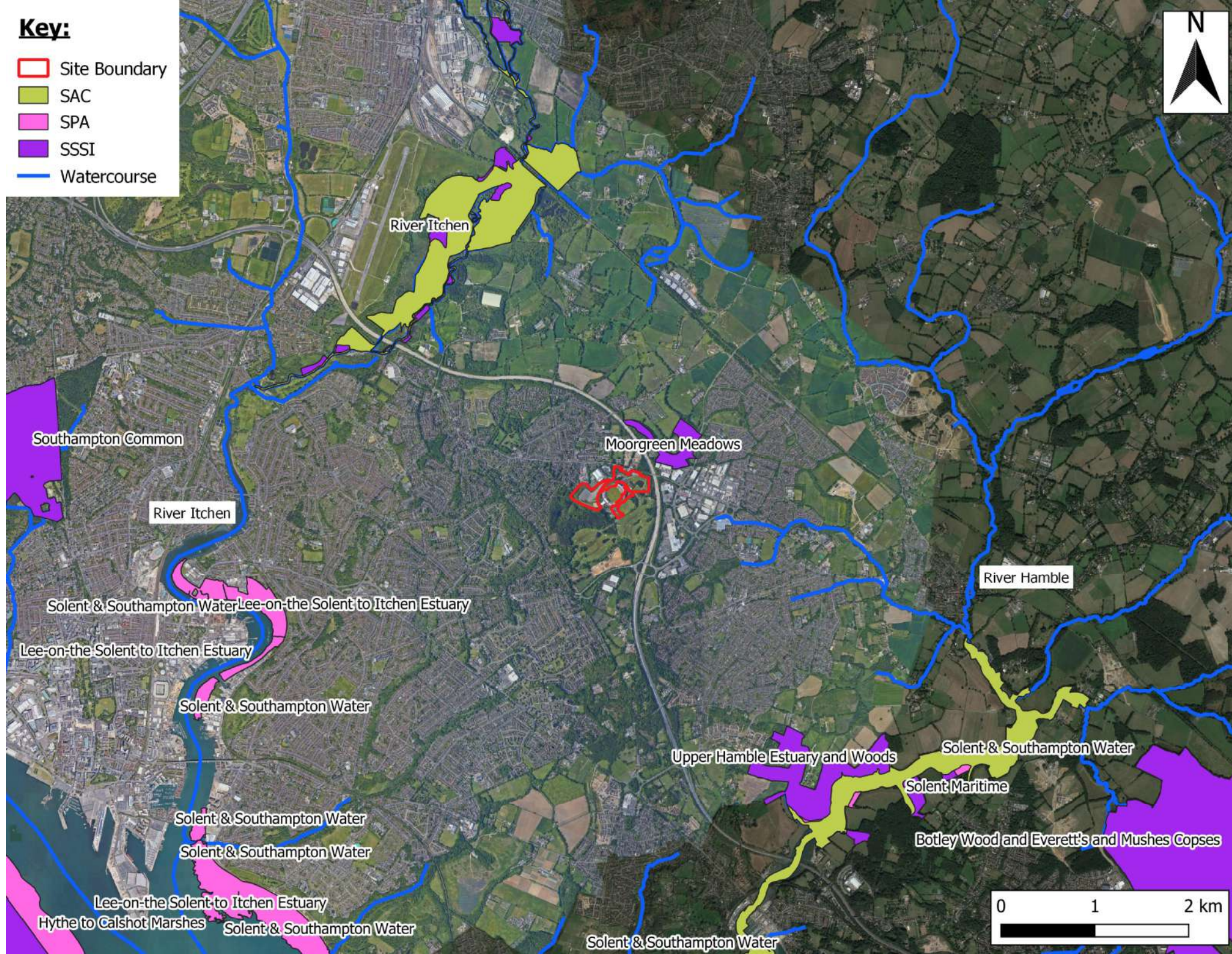


Figure A.2 *Topographical Survey of the Ageas Bowl Site (not to scale)*

Appendix 3 **Nearby European Designated Sites and SSSIs**

Key:

- Site Boundary
- SAC
- SPA
- SSSI
- Watercourse

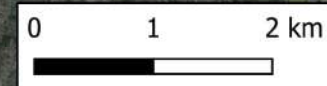


Appendix 4 Nearby WwTWs



Key:

-  Site Boundary
-  Wastewater Treatment Works



Appendix 5 Boundary Lakes Golf Course Fertiliser Applications

Granular Nutrition inputs to Golf Course areas marked on Character Area 1 map.

From 2016- present these applications have been mirrored each year following a nutrition program-
T1,T2,T3- 2x 25 kg bags covers these three sets of Tees.

February- Evolution 5-5-10

April-Marathon sport 16-4-8

June-Marathon sport 10-0-15

August- Marathon Sport 10-0-15

October- Marathon Sport 7-0-21

December- Marathon Sport 7-0-21

From 2016- present these applications have been mirrored each year following a nutrition program-
Fairway 1- 6x 25kg bags covers this area.

April- Marathon Sport 16-4-8

August- Marathon Sport 10-0-15

From 2016- present these applications have been mirrored each year following a nutrition program-
PG,G1,G2,G18 1x 20 kg bag on each Green.

February- Agronomic Services 12-0-15

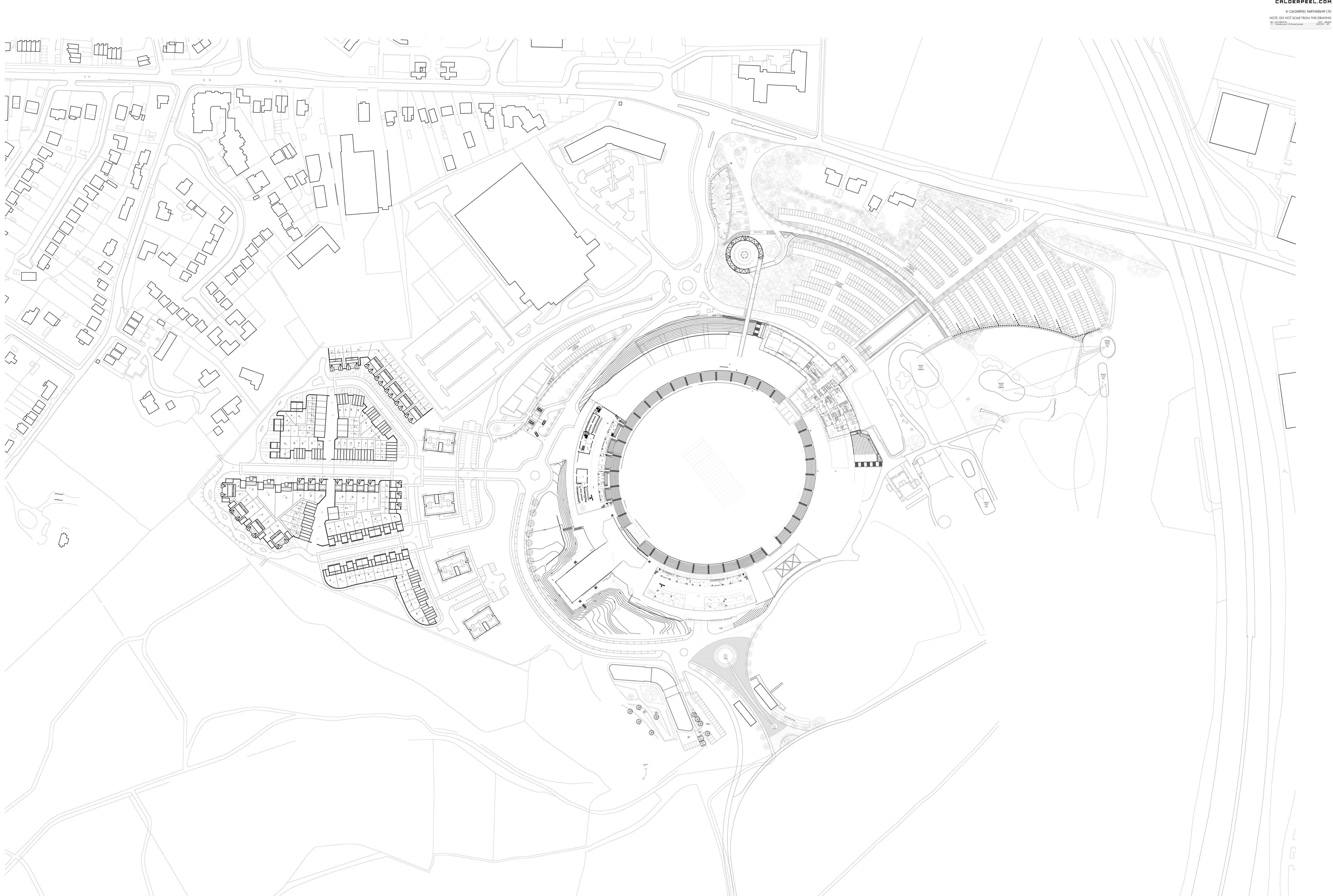
April- Agronomic Services 16-2-10

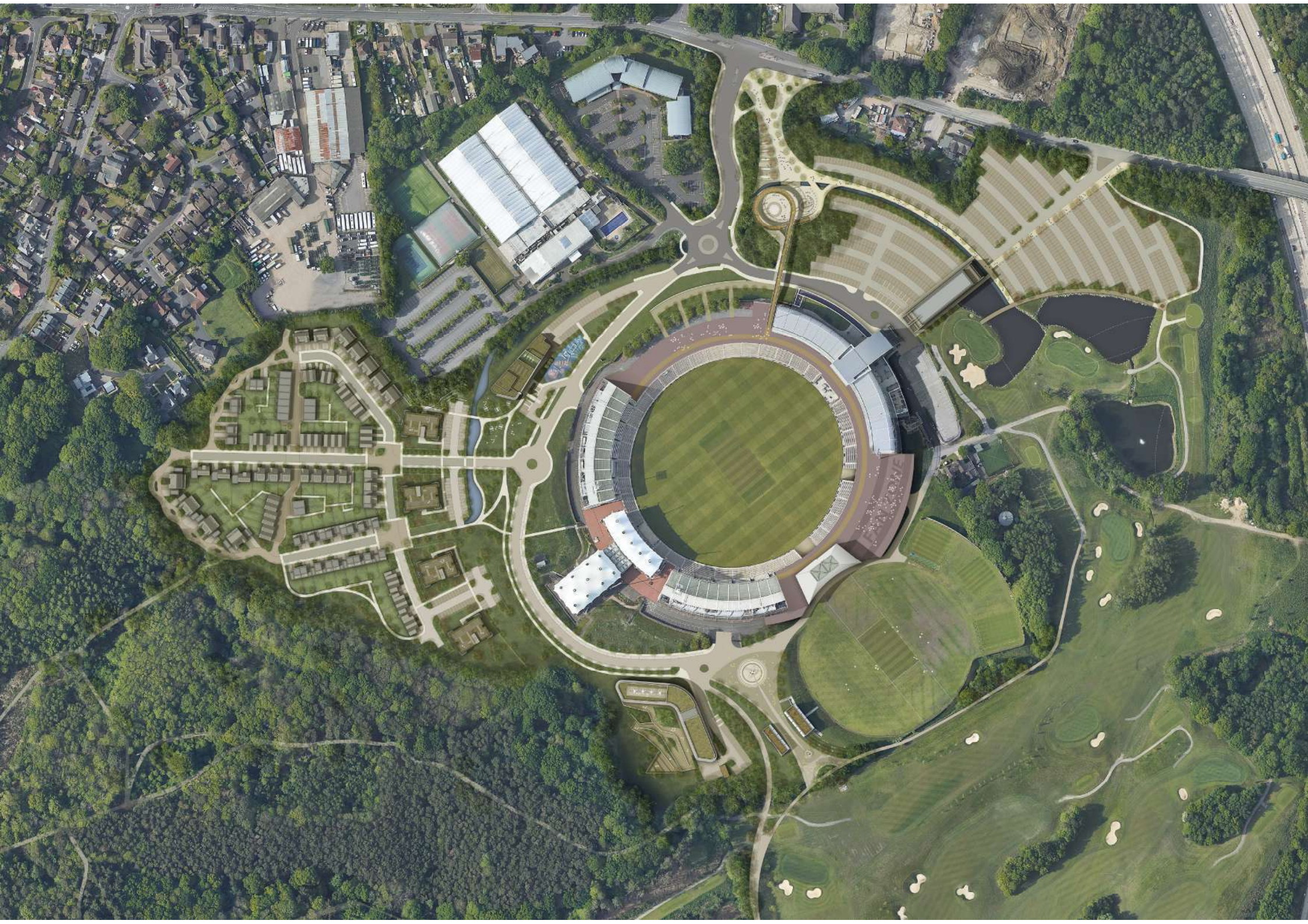
June- Agronomic Services 4-0-4 + 9%FE

October- Agronomic services 11-5-11



Appendix 6 Proposed Development





CALDERPEEL

A R C H I T E C T S

29.11.2021

Car Park, Spectator Ramp & Hotel

[illegible]

CHARACTER AREA 3 - AREAS SCHEDULE

CALDERPEEL

ARCHITECTS

		DATE:	29.11.2021			
Pavilion & Maintenance						
Notes	Accommodation Type	Sq.m	Sq.ft	Build Type		
Areas are over 3 Storeys	Maintenance Stores	2136	22989.8	New Build/Refurb		
	Cricket Nets	500	5381.5	New Build/Refurb		
	WC/Changing	149	1603.7	New Build/Refurb		
	Wicket Cover St.	463	4983.3	New Build/Refurb		
	Pavilion	392	4219.1	New Build/Refurb		
Total:		3640	39177.32			
			Total GIA:	3844.9 Sq.m 41,383.3 Sq.ft		
			Total NIA:	3640 Sq.m 39,177.3 Sq.ft		
please note that all areas are approximate and should not be relied upon for any contractual purposes						
GIA's						
LG	548.1 Sq.m					
GF	1423.9 Sq.m					
Free to Roam level	519.6 Sq.m					

ARCHITECTS

DATE:	29.11.2021
--------------	------------

Care Home

Net Internal Areas							Gross Internal Areas		
Floor Level	Accommodation Type	Quantity	Sq.m	Sq.ft	Build Type			Sq.m	Sq.ft
Gf	Concierge	1	390	4197.6	New Build		Gf	489.2	5265.3
1st	En-suite + Bedrooms (@ circa 20sq.m)	19	380	4089.9	New Build		1st	1192	12829.5
1st	En-suite + Bedrooms (@ circa 24sq.m)	5	120	1291.6	New Build		2nd	1192	12829.5
1st	En-suite + Bedrooms (@ circa 26sq.m)	3	78	839.5	New Build		3rd	753	8104.5
2nd	En-suite + Bedrooms (@ circa 20sq.m)	19	380	4089.9	New Build		Total:	3626.2	39028.8
2nd	En-suite + Bedrooms (@ circa 24sq.m)	5	120	1291.6	New Build				
2nd	En-suite + Bedrooms (@ circa 26sq.m)	3	78	839.5	New Build				
3rd	En-suite + Bedrooms (@ circa 20sq.m)	19	380	4089.9	New Build				
3rd	En-suite + Bedrooms (@ circa 24sq.m)	5	120	1291.6	New Build				
3rd	En-suite + Bedrooms (@ circa 26sq.m)	3	78	839.5	New Build				
	(Staff rooms, BOH, breakout spaces included in gia)								
Total:			2124	22860.6					

Total:

(Staff rooms, BOH, breakout spaces included in gia)

Total GIA:	39028.8
------------	---------

sq.ft

(Staff rooms, BOH, breakout spaces included in gia)

Total NIA:	22860.6
------------	---------

sq.ft

please note that all areas are approximate and should not be relied upon for any contractual purposes

CHARACTER AREA 5 - AREAS SCHEDULE

CALDERPEEL

ARCHITECTS

			DATE:	29.11.2021			
Well-Being Centre							
Floor Level	Accommodation Type	Sq.m	Sq.ft	Build Type			
1st	Leisure	623.4	6709.7	New Build			
2nd	Leisure	445	4789.5	New Build			
Total:		1068.4	11499.2				
			Total GIA:	11499.2	sq.ft		
please note that all areas are approximate and should not be relied upon for any contractual purposes							

Appendix 7 Herefordshire Council Phosphate Budget Calculator Tool Inputs & Results

Stage 1: Calculate the additional phosphorus loading (kg/year) associated with the increased wastewater generation in the new development

This stage calculates the phosphorous loading associated with the increased household water usage within the development. The user should enter values in Table 1.1 only. When the user selects a WwTW that the development drains to, the adjacent cell finds the relevant phosphorous value in the 'WwTW look up' worksheet. For unpermitted WwTWs a value of 5 mg P/L has been assumed, though this may be edited in the future if Dwr Cymru provide further monitoring data. If the WwTW that the development drains to is not in the drop down list, select "No permit".

If a package treatment plant (PTP) or septic tank is being used, select this option from the dropdown list. If the manufacturer has provided a phosphorus concentration in the final effluent then enter this into G19. If a value has not been provided, do not edit cell G19 and leave the default values.

Is this being completed for the period before or after 2025? Answer:

Table 1.1:

Development specific inputs			
Inputs	Value	Unit	Notes
Occupancy rate	2.4	persons/dwelling	Keep as 2.3 unless exact value is known
Water use	110	litres/day	Keep as 120 unless other efficiency measures are used. Although this is 10 litres above the Local Plan value, it accounts for any potential changes.
Development Proposal	183	dwelling	Enter in G13 the number of dwellings being built
No permit	5	mg P/l	Select a WwTW to which wastewater is being discharged using dropdown in G14.

Table 1.2:

Stage 1 wastewater load		
Variable	Value	Unit
Additional population	439.2	People
Wastewater by development	79647	litres/day
TP discharge from WwTW	358411.5	mg TP/day
Convert to kg/TP/d	0.358412	kg TP/day
Convert to kg/TP/yr	130.91	kg TP/yr
Total wastewater TP load	130.91	kg TP/yr

Includes hotel & care home

Stage 2: Calculate existing P load from current land use

This stage calculates the phosphorous loading from the current land use on the development site. The user should enter values for the type of land use and the area of each type of land use in Table 2.1.

Table 2.1:

Phosphate loading from existing land use			
Type	Area (ha)	Annual P export (kg/ha)	Notes
Lowland	0	0.00	Select existing land use type in drop down list in E11:E20, starting with E11. Enter the area of the selected land type in corresponding cell in column F If results are saying #N/A, check that the correct values have been entered in Table 1 (Introduction) If they are still #N/A double check you have the right area on the maps you used to enter the values in Table 1 (introduction) If still #N/A then manually look up the most similar combination of land type to the values entered in Table 1 and the Farm Type in Table 2.1 in 'Stage 2 and 3 lookups'
General	0	0.00	
Cereals	0	0.00	
Greenspace	0	0.00	
Woodland	0	0.00	
Residential urban land	0	0.00	
Open urban land	14.34	12.71	
Total	14.34	12.71	

Stage 3: Adjust load to account for land uses within the proposed development

This stage calculates the phosphorous loading associated with the new land uses within the development's redline boundary. The user should select relevant land uses and their areas within the development in Table 3.1.

Table 3.1:

Phosphorus losses from new land uses			
Type	Area (ha)	Phosphorus loading (kg/ha)	Notes
Community food growing	0	0.00	Select new land use type in drop down list in D10:19, starting with D10. Enter the area of the selected land type in corresponding cell in column E
Residential urban land	5.88	9.95	
Open urban land	8.46	7.50	
Greenspace	0	0.00	
Total	14.34	17.44	

Stage 4: Net Change and calculation of the budget

This stage calculates the total amount of phosphorus to mitigate for a development to be nutrient neutral. No values should be entered in Table 4.1. Provided all other steps are fully complete, this will be calculated automatically.

Table 4.1:

Input	Value (kg TP/year)
New P to WwTW	130.91
Net land use P change	4.74
P budget	135.65
P budget + 20% buffer	162.78

The total amount of phosphorus to mitigate is:

162.78 kg/year

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