

Nutrient Neutrality Generic Methodology

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Nutrient Neutrality Generic Methodology

Ricardo and Natural England



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Further information

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

1. Introduction

Special Areas of Conservation (SAC), Special Protection Areas (SPA), and Ramsar sites are some of the most important areas for wildlife in the United Kingdom. They are internationally important for their habitats and wildlife and are protected under the Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations). At some of these sites, there are high levels of nitrogen and phosphorus input to the protected 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 effects on ecology from an excessive presence of nutrients are impacting on protected habitats and species.

There is uncertainty as to whether new growth will further deteriorate designated sites, and/or make them appreciably more difficult to restore. The potential for future housing developments to exacerbate these impacts creates a risk to their potential future conservation status.

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 Habitats Regulations.

This practical methodology sets out an approach 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 becomes available. 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.

The information accompanying this methodology includes a brief summary of the environmental context for this nutrient neutral approach, a nutrient budget calculator, and advice on mitigation.

Key Principles

The principles underpinning Habitats Regulations assessments are well established¹. At the screening stage, plans and projects should only be granted consent where it is

¹ See, amongst others Case C-127/02 Waddenervereniging and Vogelsbeschermingvereniging (Waddenzee); R (Champion) v North Norfolk DC [2015] EKC 52 (Champion); C-323/17 People Over Wind, Peter Sweetman v Coillte Teoranta (People Over Wind); C-461/17 Brian Holohan and Others v An Bord Pleanála (Holohan); Joined Cases C-293/17 and C-294/17 Coöperatie Mobilisation for the Environment UA and Others v College van gedeputeerde staten van Limburg and Other (the Dutch Nitrogen cases);

possible to exclude, on the basis of objective information, that the plan or project will have significant effects on the sites concerned². Where it is not possible to rule out likely significant effects, plans and projects should be subject to an appropriate assessment. That appropriate assessment must contain complete, precise and definitive findings which are capable of removing all reasonable scientific doubt as to the absence of adverse effects on the integrity of the site³.

Natural England has been reviewing the available evidence on Habitats sites which are in unfavourable condition due to elevated nutrient levels. Where plans or projects will contribute additional nutrients to Habitats sites which are close to or already in unfavourable condition for nutrients, then a robust approach to the Habitats Regulations assessment of the effects of plans and projects is required.

Where sites are close to or already in unfavourable condition for nutrients, it may be difficult to grant consent for new plans and projects that will increase nutrient levels at the Habitats site. Nutrient neutrality provides a means of effectively mitigating the adverse effects associated with increased nutrients from new plans and projects, by counterbalancing any additional nutrient inputs to ensure that there is no net change in the amount of nutrients reaching the features which led to a Habitats site being designated.

Where new residential development is proposed, the additional nutrient load from the increase in wastewater and/or the change in the land use of the development land created by a new residential development can create an impact pathway for potential adverse effects on Habitats sites that are already suffering from problems related to nutrient loading. This impact pathway is shown diagrammatically in Figure 1. Habitats Regulations Assessments (HRAs) of new residential developments therefore need to consider whether nutrient loading will result in 'Likely Significant Effects' (LSE) on a Habitats site. If an HRA cannot exclude a LSE due to nutrient loading, the Appropriate Assessment will need to consider whether this nutrient load needs to be mitigated in order to remove adverse effects on the Habitats site.

For those developments that wish to pursue neutrality, Natural England advises that a nutrient budget is calculated for new developments that have the potential to result in increases of nitrogen/phosphorus entering the Habitats 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 Habitats sites. This approach must be tested through the 'appropriate assessment' stage of the Habitats

² Case C-127/02 Waddervereniging and Vogelsbeschermingvereniging (Waddenzee)

³ Case 164/17 Grace & Sweetman v An Bord Pleanála (Grace & Sweetman)

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 Habitats sites in question.

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.

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 buffer to the Total Nitrogen/Total Phosphorus figure 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.

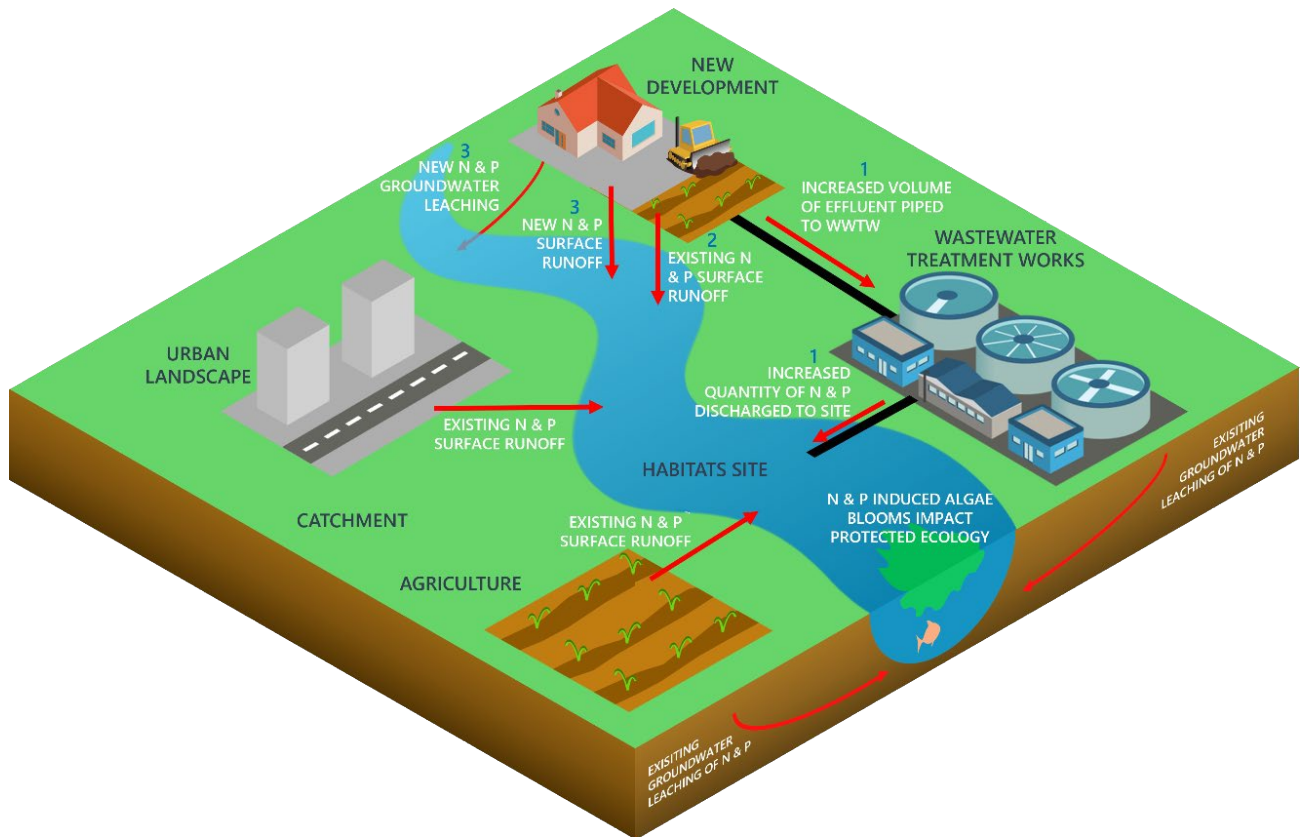
By applying the nutrient neutrality methodology, with the buffer, to new development, the competent authority may be satisfied that, while margins of error will inevitably vary for each development, this approach will ensure that new development in combination will avoid significant increases of nitrogen/phosphorus load from entering the Habitats sites⁴.

A Habitats Regulations assessment must be capable of removing all reasonable scientific doubt as to the absence of adverse effects on a Habitats site. Absolute certainty is not required, but the methodology used to evaluate potential adverse effects (and the measures intended to mitigate them) must effectively address any reasonable scientific doubt to achieve the required degree of certainty.

Note: A Nutrient Budget Calculator has been issued alongside this methodology. This calculator has been pre-populated with catchment data and undertakes the calculations for each of the stages set out in this methodology on the user's behalf. It is recommended that the calculator is used to generate nutrient budgets for new development.

⁴ This approach was expressly endorsed in R (Wyatt) v Fareham BC [2021] EWHC 1434 (Admin)

Figure 1: Schematic of a water catchment system (river or coastal) showing the pathway for impact (black line) from new residential development, as well as the current sources of nutrient pollution within catchments



Overview of the stages of the generic nutrient budget methodology

A nutrient budget is calculated in 4 stages:

1. The increase in nutrient loading to a Habitats site that results from the increase in wastewater from a new development.
2. The nutrient loading from the past/present land use of the development site.
3. The nutrient loading from the future mix of land use on the development site.
4. Calculation of the net change in nutrient loading to a Habitats site with the addition of a buffer. The net change in nutrient loading + the buffer is the nutrient budget.

A brief description of the steps required within each stage of the nutrient budget follows:

Overview of the steps in Stage 1

Table 1: Stage 1 steps (including calculation and output for each step)

Step	Description	Calculation	Output
<u>Step 1: Calculate increase in population due to the development</u>	Calculates the additional population that will result from the development.	No. of new dwellings/units x residents per dwelling value (number of people)	Total additional population (number of people)
<u>Step 2: Calculate the increase in wastewater production due to the development.</u>	The additional population results in additional water usage and therefore additional production of wastewater with its associated nutrient load.	Additional population (number of people) x daily per person water usage (litres/person/day)	Total daily water use (litres/day)
<u>Step 3: Determine the concentration of nutrients in wastewater and calculate additional wastewater nutrient load</u>	Combine the daily rate of additional wastewater by the development with the concentration of nutrients (nitrogen or phosphorus) after wastewater treatment to get the additional nutrient load that will discharge to the Habitats site.	Daily water use (litres/day) x wastewater nutrient concentration (mg/l)	Nutrient load (kg/day)

Overview of the steps in Stage 2

Table 2: Stage 2 steps (including calculation and output for each step)

Step	Description	Calculation	Output
<u>Step 1: Obtain nutrient export values from current land use(s)</u>	The current land use or land uses on a development site have associated levels of nutrient export that will	Various calculations depending on the land uses	Nutrient export coefficient (kg/ha/year)

Step	Description	Calculation	Output
	currently impact the Habitats site. This step provides details on how to obtain nutrient export coefficients to calculate the level of nutrient export from a development site pre-development.		
<u>Step 2: Calculate the annual nutrient export from the current land use(s) on your development site</u>	The nutrient export coefficients obtained in Step 1 of Stage 2 are used along with areas of land under each land use to calculate the total export of nutrients from the development site pre-development.	Nutrient export coefficient (kg/ha/year) x area of land (ha)	Nutrient load (kg/year)

Overview of the steps in Stage 3

Table 3: Stage 3 steps (including calculation and output for each step)

Step	Description	Calculation	Output
<u>Step 1: Calculate the annual export from future land use(s)</u>	This step accounts for the nutrient export from land use on the development site after the development has been built. It uses nutrient export coefficient for land uses that were determined in Stage 2.	Nutrient export coefficient (kg/ha/year) x area of land (ha)	Nutrient load (kg/year)

Overview of the steps in Stage 4

Table 4: Stage 4 steps (including calculation and output for each step)

Step	Description	Calculation	Output
<u>Stage 4: Calculating the nutrient budget</u>	The outputs from Stages 1-3 are combined to calculate the nutrient budget for the development.	Final Stage 1 output - Final Stage 2 output + Final Stage 3 output	Nutrient load (kg/yr) – this is the nutrient budget
<u>Stage 4: Add the buffer to the nutrient budget</u>	The nutrient budget calculated in Step 1 of Stage 4 is increased by a 20% “buffer”. to account for any residual uncertainties in the methods used to derive the various inputs to Stages 1-4 of the nutrient budget.	Nutrient budget (kg/yr) x 1.2	Nutrient load (kg/yr) – this is the final output of the methodology

Note: the following sections contain the stages and associated methodology required to calculate the nutrient budget.

2. Stage 1: Calculate nutrient loading from additional wastewater

Step 1: Calculate increase in population due to the development

What:

This input determines the additional population that will result from a new residential development.

Why:

The people living in a new residential development will generate waste-water. Wastewater is enriched in nutrients and, following treatment, if the additional wastewater discharges to a Habitats site it will increase nutrient loadings, posing risks to the ecology of the site.

How: (Selecting a robust occupancy figure)

The increase in population is calculated using a residents per dwelling/unit value that is multiplied by the number of dwellings within the development.

Competent authorities must satisfy themselves that the residents per dwelling/unit value used in this step of the calculation reflects local conditions in their area. The residents per dwelling value can be derived from national data providing it reflects local conditions. However, if national data does not yield a residents per dwelling/unit value that reflects local occupancy levels then locally relevant data should be used instead. Whichever figure is used, it is important to ensure it is sufficiently robust and appropriate for the project being assessed. It is therefore recommended that project level Appropriate Assessments specifically include justification for why the competent authority has decided upon the occupancy rate that has been used.

Further guidance is provided below.

National occupancy data

When using national occupancy data, the Office of National Statistics (ONS) national average value for the number of residents per dwelling of 2.4 is recommended. This value is derived from 2011 census data and is subject to change when the 2021 Census becomes available. This value can be used if the Local Planning Authority is satisfied that:

- It is appropriate for the level and type of housing development that is expected to come forward in the Local Planning Authority's area (a strategic assessment should be made of the development anticipated to come forward over the Local Plan

period to ensure the use of average figures will not under/over estimate the level of impact)

- It corresponds to the local average in the area (it is not likely to overestimate or underestimate occupancy)
- It is based on data that is robust and doesn't underestimate the level of impact over time.

It may not be appropriate to use the national average occupancy rate for development types which are not included in the ONS data, such as student accommodation or houses in multiple occupation. For such developments, the Local Planning Authority should specify an appropriate occupancy rate in the project level Appropriate Assessment and explain how this figure was derived.

Locally relevant occupancy data

If the national average occupancy rate does not correspond with local conditions, then a locally relevant average residents per dwelling value may be more appropriate. If a Local Planning Authority decides to use a locally relevant value, that value needs to be supported by robust and sufficient evidence which should be included in the project level Appropriate Assessment. Key sources of evidence include:

- The average occupancy rate from the census for the relevant local administrative area, e.g. the county.
- The average occupation figures used by the Local Planning Authority to calculate population growth due to Local Plan development.
- The average occupation figures used by the local water company to plan for population growth and the impact on water resources and sewage treatment.

A local / regional average occupancy rate can be used provided that it is from a robust source which can show trends over a protracted period of time— such as from ONS derived data or from the annual English Housing Survey. Figures derived from data collected over short periods of time will not be acceptable as short-term data is unlikely to provide the required degree of certainty. The Local Planning Authority should ensure that any trend in occupancy rates or estimates of the average number of persons per household used will continue for perpetuity and would not underestimate the level of impact over time. A local / regional average occupancy rate would therefore need to be based on figures over at least a 5-year period⁵.

⁵ The figure of 5 years has been chosen as the minimum period of time over which occupancy rates can be calculated from as local plans and WRMPs are reviewed every 5 years, so represents a long enough period of time to capture any trends or changes

Local Planning Authorities will also need to satisfy themselves that a locally derived occupancy figure is appropriate for the level and type of housing development that is expected (a strategic assessment should be made of the development anticipated to come forward over the Local Plan period to ensure the use of average figures will not under/overestimate the level of impact).

Occupancy rates based on dwelling type

Should the nature or scale of development associated with a particular project proposal suggest that the use of an average occupancy rate is not appropriate, then the Local Planning Authority may decide to adopt an occupancy rate based on the dwelling types proposed for that particular project, provided it meets the criteria outlined above. This may be appropriate where a project proposer seeks consent for a development comprising certain dwelling types (e.g. flats and small 1 and 2 bed dwellings). If the Local Planning Authority decides to adopt a local approach based on determining occupancy rate by dwelling type, that approach should be used for all planning applications, rather than reverting back to the use of an average occupancy rate. This will ensure that the Local Planning Authority doesn't inadvertently underestimate total occupancy levels (and consequently water quality impacts) across its area by applying a lower residents per dwelling/unit value for developments comprising smaller units but failing to adopt a higher residents per dwelling/unit value for developments comprising larger units or a mix of units.

Consistency in applying occupancy rates

The same occupancy rate should be used where there are several different impacts on Habitats sites which require strategic mitigation. The strategic approaches developed with local planning authorities to deal with in combination impacts on international sites elsewhere typically calculate mitigation requirements and contribution requirements based on current national average occupancy rates. Local Planning Authorities may decide to use a locally derived average occupancy rate instead, but this local occupancy rate must be used consistently across each type of impact and each Habitats site affected. Local Planning Authorities should not use different occupancy rates in their HRAs for the same dwelling types / size of units. Whilst the impacts will be different, occupancy rates will have been used to estimate the scale of impact and subsequently the scale of mitigation required on the protected sites. The types of impact will typically last in perpetuity. Care is therefore needed to ensure the adoption of an alternative occupancy rate based on an assessment of net population additions to a locality for nutrient budgeting does not undermine other existing strategic approaches, particularly where there are overlapping impacts within the locality.

Advice on occupancy rates applied at Plan level

It is not recommended to base occupancy rates on the dwelling type for strategic HRAs of plans or for identifying mitigation at a strategic scale unless the Local Planning Authority can be sufficiently certain about the exact dwelling types that will come forward for each

allocation. A more precautionary approach is required which considers the overall average occupancy rate which effectively smooths out any discrepancies which are based on dwelling type.

Whichever value a Local Planning Authority ultimately decides to use for 'residents per dwelling/unit value', the Local Planning Authority must be satisfied that it:

- The average occupancy rate from the census for the relevant local administrative area, e.g. the county. Reflects local circumstances and conditions, both across its local authority area and within the catchment of the particular Habitats site that may be adversely affected by the plan or project under consideration.
- Is based on robust data.
- Reflects trends in occupancy rates in its area over the long-term.
- Does not underestimate the scale of impact and subsequently the scale of mitigation required.

Ultimately, this can only be determined through the Local Planning Authority's appropriate assessment of the specific plan or project for which consent is sought. It is for Competent authorities to satisfy themselves that the residents per dwelling/unit value used reflects the local conditions in their area.

Note: When 2021 Census data is available, the 2.4 value will be updated.

Input values into Stage 1, Step 1

The input value:

- A locally relevant persons per dwelling figure
Or
- 2.4 persons per dwelling

Example – calculating additional population:

The required calculation:

Number of dwellings x relevant persons per dwelling figure = *additional population*

Example scenario: A new development of 500 new homes is being constructed that contains a mix of:

- 100 one-bedroom flats
- 200 two-bedroom flats
- 100 three-bedroom semidetached houses
- 50 three-bedroom terraced affordable homes
- 50 four-bedroom detached houses

Calculate additional population due to the development:

500 dwellings x 2.4 persons per dwelling = 1200 persons

Note: the above example assumes robust strategic assessment of likely housing delivery has been undertaken, therefore given the mix of housing types an average occupancy rate has been applied

Step 2: Calculate the increase in wastewater production due to the development

What:

The increase in wastewater production is determined using the estimated average water use per additional head of population due to the development. The average daily water use per person is determined in accordance with water efficiency standards that are stipulated in building regulations and, subsequently, in planning permission.

Why:

The water use per person is used to calculate the additional annual wastewater production due to the new development. Wastewater contains nutrients and when it is discharged from a wastewater treatment system, these nutrients are released into the environment. This release of nutrients to the environment within the catchment of a Habitats site creates a pathway for new residential development to impact the Habitats site.

How:

Water efficiency standards detailed in the Buildings Regulations provide a water efficiency standard for maximum water consumption per person that needs to be achieved for a new residential development. The Building Regulations also state an optional higher water efficiency standard. This higher optional standard needs to be adopted through a Local Plan policy, which in turn requires this higher water efficiency standard to be secured through a planning condition. Some local authorities have gone further than the optional higher efficiency standard in the Building Regulations by committing an even higher water efficiency standard to Local Plan policy. This means there are three potential categories of water efficiency standard from which the water use per person can be determined depending on what planning conditions are imposed:

- The Building Regulations legal maximum water use per person standard of 125 litres/person/day should be used where no higher standard is secured through a planning condition
- The optional higher Building Regulations water use per person standard of 110 litres/person/day should be used where this is secured through a planning condition.
- A water use per person standard that is even higher than the optional higher Building Regulations water efficiency standard where this is secured through a planning condition.

Whichever water efficiency standard is selected, water usage is increased by an additional 10 litres per person per day to account for changes to less water efficient fittings throughout the lifetime of the development.

This water usage value in litres per person per day is multiplied by 365.25 in order to calculate the annual water use per person. The annual water use per person can then be multiplied by the additional population as calculated in Step 1.

Input values into Stage 1, Step 2

The input value:

- Building Regulations minimum standard: 125 litres/person/day (l/p/d) + 10 l/p/d = 135 l/p/d
Or
- Building Regulations optional higher standard: 110 l/p/d + 10 l/p/d = 120 l/p/d
Or
- Local Plan policy secured higher water efficiency standard < 110 l/p/d = water efficiency standard in Local Plan policy + 10 l/p/d = TBC
- Days in a year: 365.25 (this accounts for a leap year every four years).
- Total population: *input from Step 1*.

Example – calculating additional water use:

The required calculations:

Water efficiency standard (l/p/d) x days in a year = annual water use per person (l/person/year)
Additional population x annual water use per person (l/person/year) = increase in water use (l/year)

Example scenario:

- Planning permission has been granted with a condition that the development uses the Building Regulations optional higher water efficiency standard. Therefore, the water usage to be used in the budget calculations is 120 litres/person/day (110 + 10 litres/person/day = 120 litres/person/day).
- A new development results in an increase of 1200 persons.
- 120 litres/person/day x 365.25 days = 43,830 litres/person/year

1200 persons x 43,830 litres/person/year = 52,596,000 litres/year

Step 3: Determine the concentration of nutrients in wastewater and calculate additional wastewater nutrient load

What:

This input is the estimated nutrient concentration in the treated wastewater generated by the new development. It is used to calculate the total annual loading of nutrients to a designated site.

Wastewater from a new development is preferably discharged to a mains sewer for subsequent treatment at a wastewater treatment works (WwTWs). In a WwTWs, nutrients are removed by treatment processes. For some WwTWs, the removal of nutrients from wastewater is achieved by a dedicated process to comply with a permitted concentration of nitrogen or phosphorus in the treated wastewater that leaves a WwTW, ensuring that the nutrient levels will not exceed the permit limit. Other WwTWs will not have permitted limits on the concentration of nutrients in their final discharges and thus the nutrient concentrations in their discharges can be variable and may increase.

New developments in rural areas that cannot reasonably be expected to connect to a mains sewer will need to be connected to an onsite wastewater treatment system, e.g. a package treatment plant (PTP) or septic tank. The concentration of nutrients in the treated wastewater discharged from an onsite system is variable and dependent on the type of system.

Whatever the type of sewage treatment system a new development connects to, the concentration of nitrogen or phosphorus in its treated wastewater discharge is required as the input for this step of the nutrient budget calculations.

Why:

The higher the concentration of nutrients in the treated wastewater discharging to a Habitats site, the greater the increase in nutrient loading and, subsequently, the greater the eutrophication risk.

How:

Note: This depends on the treatment facility being used to treat the wastewater from the new development.

What water treatment facility is being used?

Wastewater discharge to a WwTW:

If the new development is connecting to mains sewerage, there is a need to first determine which WwTW the development is going to discharge to. This information can be obtained on request from the local sewerage undertaker.

The WwTW that a development is connecting to may or may not have a permit limiting the concentration of nitrogen or phosphorus in its discharge. There are four WwTWs permit scenarios that will determine the concentration of nitrogen and/or phosphorus in a WwTW discharge:

1. The WwTW has a permit controlling the concentration of nitrogen and/or phosphorus in its discharge
2. The WwTW has a permit controlling the concentration of nitrogen and/or phosphorus in its discharge and this is being tightened, e.g. its allowable nitrogen and/or phosphorus concentration is being lowered between now and 2025.
3. The WwTW does not have a permit which controls the concentration of nitrogen and/or phosphorus in its discharge.
4. The WwTW does not have a permit which controls the concentration of nitrogen and/or phosphorus in its discharge but it is getting a permit on the allowable nitrogen and/or phosphorus concentration in its discharge between now and 2025.

Note: the accompanying nutrient budget calculator is pre-populated with WwTW permit values. If you are completing this methodology to determine the inputs for the site-specific nutrient budget methodology for a Habitats site without a nutrient budget calculator, you will need to engage with the water company or companies within the Habitats site catchment to obtain details of WwTWs with permits, that have permits that are being tightened or that do not have permits but are getting them by 2025.

Table 5: Lookup table for current and future nitrogen and phosphorus WwTW permit limits to use as input to Step 3 of Stage 1. This table should be completed when the nutrient budget methodology for a Habitats site is set up. Note: Cells in this table have been left deliberately blank

Name of WwTW	Current permit limit for total nitrogen (mg TN/l)	Current permit limit for total phosphorus (mg TP/l)	Future (2025) permit limit for total nitrogen (mg TN/l)	Future (2025) permit limit for total phosphorus (mg TP/l)

To determine the input value required for this step:

- If the WwTW that your development site is connecting to has only a current nitrogen/phosphorus concentration permit, go to [Part 1.3.A](#).
- If the WwTW that your development site is connecting to has a current and a future nitrogen/phosphorus concentration permit, go to [Part 1.3.B](#).
- If the WwTW that your development site is connecting to has no current nitrogen/phosphorus concentration permit, go to [Part 1.3.C](#).
- If the WwTW that your development site is connecting to has no current nitrogen/phosphorus concentration permit but does have a future nitrogen/phosphorus concentration permit, go to [Part 1.3.D](#).

Wastewater discharge to onsite wastewater treatment

If the new development cannot connect to a WwTW and is therefore using an onsite wastewater treatment system, go to [Part 1.3.E](#).

Part 1.3.A: Where a development is discharging to a WwTW with a permit

WwTWs with permits on their nitrogen and/or phosphorus discharge concentrations are operated so that there is some headroom between the concentration in the discharge and the level that has to be met for compliance with the permit, to ensure that there will be compliance with the permit. Where there is a permit limit for Total Nitrogen or Total Phosphorus, 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 that 90% of the consent concentration limit is the closest the water company can reasonably operate the works without risk of breaching the consent limit.

Therefore, the input value for this step is the permit level multiplied by a factor of 0.9. This input value is multiplied by the annual volume of wastewater produced by the development (see [Step 2](#) in Stage 1) to determine the additional nutrient load from the new development's wastewater, which is the final output from Stage 1 of the nutrient budget methodology.

Input values into Stage 1, Step 3A

The input value:

- Find the value of the permit limit concentration for the relevant WwTW detailed in Note: the accompanying nutrient budget calculator is pre-populated with WwTW permit values. If you are completing this methodology to determine the inputs for the site-specific nutrient budget methodology for a Habitats site without a nutrient budget calculator, you will need to engage with the water company or companies within the Habitats site catchment to obtain details of WwTWs with permits, that have permits that are being tightened or that do not have permits but are getting them by 2025.
- Table 1
- Multiply this value by 0.9 to get the input value
- Multiply the input value by the output from [Step 2](#) to determine the final output from Stage 1

Example – nutrient loading from a WwTW with a permit

The required calculations:

$$\begin{aligned} \text{Permit limit (mg/l)} \times 0.9 &= \text{permit limit with headroom (mg/l)} \\ \text{Permit limit with headroom (mg/l)} \times \text{annual water use from development (l/year)} &= \\ \text{nutrient load (mg/year)} & \\ \text{Nutrient load (mg per year)} / 1,000,000 &= \text{nutrient load (kg/year)} \end{aligned}$$

Example scenario:

- A new development will discharge to a WwTW with a permit limit of 8 mg TN/l.
- The additional total annual wastewater associated with this new development is 52,596,000 litres/year (see example in [Step 2](#)).

Calculate the annual nitrogen load from the new development:

- Reduce the permit limit to 90% of 8 mg TN/l = $8 \text{ mg TN/l} \times 0.9 = 7.2 \text{ mg TN/l}$
- Multiply the reduced permit limit by the annual wastewater produced by the development: $52,596,000 \text{ litres/year} \times 7.2 \text{ mg TN/l} = 378,691,200 \text{ mg TN/year}$
- Divide by 1,000,000 to convert to kg per year: $378,691,200 \text{ mg TN/year} / 1,000,000 =$

378.7 kg TN/year

Part 1.3.B: Where a development is being discharged to a WwTW with a changing permit level

Some WwTWs are scheduled for upgrades to nitrogen and/or phosphorus treatment capacity. For Water Company discharges, the upgrades are secured through the Water Companies Price Review (PR) process and set out within the Water Industry National Environment Programme (WINEP). The WINEP for PR19 requires these upgrades to be completed by 2025, although they may be programmed to be completed sooner.

Therefore, there is a potential scenario where a new development begins discharging to a WwTW before the date when upgrade will be completed (which could be between now and 2025). This will generate a certain amount of additional nutrient loading to a Habitats site for a short period, followed by long period after the WwTW has been upgraded when the new development's additional nutrient load from wastewater will be lower. In this scenario, two nutrient budgets are required as follows:

1. Calculate a nutrient budget based on the wastewater nutrient loading per year over the lifetime⁶ of the development using the future nitrogen and/or phosphorus permit limit.
2. Calculate a nutrient budget based on the wastewater nutrient loading per year for the period up to and including 2025 (or when the upgrade will come online) using the current nitrogen and/or phosphorus permit limit).

The output from the first nutrient budget can be used as the basis for the amount of nutrients that need to be removed using long-term mitigation measures. The difference between the output for the first nutrient budget per year and the higher output for the second nutrient budget per year is the amount of additional nutrients per year that need to be mitigated in the short-term, until the WwTW upgrade comes online, which can be achieved using temporary mitigation measures.

WwTWs with permits on their nitrogen and/or phosphorus discharge concentrations are operated so that there is some headroom between the concentration in the discharge and the level that has to be met for compliance with the permit, to ensure that there will be compliance with the permit. It is assumed in the calculation that the nitrogen and/or phosphorus concentration of the final effluent being discharged from a WwTW is at 90% of the permitted limit for both the current and future permit limits. Therefore, the input values for this step are the permit limits multiplied by a factor of 0.9. These input values are multiplied by the annual volume of wastewater produced by the development (see [Step 2](#)

⁶ For practical purposes, development's lifetime is treated as 80-125 years. The exact period of time within this window that a nutrient budget is required for will be set by the local authority

in Stage 1) to determine the additional nutrient load from the new development's wastewater, which is the final output from Stage 1 of the nutrient budget methodology.

Input values into Stage 1, Step 3B

The input value:

- Find the current and future values of the permit limit concentrations for the relevant WwTW.
- Multiply these values by 0.9 to get the input values.
- Multiply the input values by the output from Step 2 to determine the wastewater nutrient loads for the current and future permit limits at the relevant WwTW.
- Use the wastewater nutrient loads for current and future permit limits to determine the long-term nutrient budget for mitigation and the additional nutrient load that will require short-term mitigation.

Example – nutrient loading from a WwTW with changing permit limits

The required calculations:

$$\begin{aligned}\text{Permit limit (mg/l)} \times 0.9 &= \text{permit limit with headroom (mg/l)} \\ \text{Permit limit with headroom (mg/l)} \times \text{annual water use from development (l/year)} &= \\ &\text{nutrient load (mg/year)} \\ \text{Nutrient load (mg per year)} / 1,000,000 &= \text{nutrient load (kg/year)}\end{aligned}$$

Example scenario:

A new development is completed on the 01/01/2022 and will discharge to a WwTW with a current permit limit of 8 mg TN/l.

- This permit limit is changing to 5 mg TN/l in 2025.
- The additional total annual wastewater produced by the new development is 52,596,000 litres/year.

Two nutrient budgets are completed:

1. A budget for the lifetime of a development using the lower limit of 5 mg TN/l, with long-term mitigation measures applied to achieve nutrient neutrality for this nutrient load in perpetuity.
2. A 4-year nutrient budget covering 2022-2025 using the N permit of 8 mg TN/l. Short-term measures can be used to mitigate the additional nutrient load created whilst the WwTW has a higher permit limit.

A worked example of this scenario is as follows:

1. Long-term annual load:

Reduce the future permit limit to 90% of 5 mg TN/l = $5 \text{ mg TN/l} \times 0.9 = 4.5 \text{ mg TN/l}$

$$\begin{aligned}4.5 \text{ mg TN/l} \times 52,596,000 \text{ litres/year} &= 236,682,000 \text{ mg TN/year} \\ 236,682,000 \text{ mg TN/year} / 1,000,000 &= 236.7 \text{ kg TN/year}\end{aligned}$$

2. 4-year annual load:

Reduce the current permit limit to 90% of 8 mg TN/l = $8 \text{ mg TN/l} \times 0.9 = 7.2 \text{ mg TN/l}$

$7.2 \text{ mg TN/l} \times 52,596,000 \text{ litres/year} = 378,691,200 \text{ mg TN/year}$
 $378,691,200 \text{ mg TN/year} / 1,000,000 = 378.7 \text{ kg TN/year}$

3. Calculate the difference between the 4-year annual load the long-term annual load

$378.7 \text{ kg TN/year} - 236.7 \text{ kg TN/year} = 142 \text{ kg TN/year}$

Note: The outputs from the long-term annual load (1.) and the difference between the short-term(4-years in this example) annual load (3.) will be needed in [Stage 4](#) of this methodology.

Part 1.3.C: Where a development is being discharged to a WwTW without a permit

The sewerage undertaker should have been consulted in order to try and obtain an estimate for nutrient concentrations in WwTW discharges that not controlled by permit limits. These estimates should be ideally based on monitoring of the final effluent.

If a reliable estimate of the nutrient concentration in the final effluent cannot be provided, the following values should be used for total nitrogen and total phosphorus:

- Total nitrogen: 27 mg TN/l
- Total phosphorus: 8 mg TP/l

Where local WwTW data exists for a specific catchment which would suggest a lower default value, then this can be used to justify and set a more locally relevant default value.

These values should be multiplied by the total annual wastewater volume produced by the new development as identified in [Step 2](#).

Input values into Stage 1, Step 3C

The input values:

- If values are available for the specific WwTW effluent concentration, these should be used.
- If there is no data on the WwTW effluent concentration, use standard default of 27 mg TN/l or nitrogen and/or 8 mg TP/l for phosphorus or a local catchment default if there is the evidence to support one.

Example – nutrient loading from a WwTW with no permit limit

The required calculations:

Default nutrient concentration value (mg/l) x annual water use from development (l/year) =

nutrient load (mg/year)

Nutrient load (mg per year) / 1,000,000 = nutrient load (kg/year)

Example scenario:

- A new development will discharge to a WwTW with no permit limit and there is no data on the WwTW effluent concentration.
- The additional total annual wastewater produced by the new development is 52,596,000 litres/year.

Annual load of nitrogen:

27 mg N/l x 52,596,000 litres/year = 1,420,092,000 mg N/year or 1,420,092,000 mg N/year / 1,000,000 = 1420.1 kg N/year

Annual load of phosphorus:

8 mg P/l x 52,596,000 litres/year = 420,768,000 mg P/year

420,768,000 mg P/year / 1,000,000 = 420.8 kg P/year

Part 1.3.D: Where a development is being discharged to a WwTW that is currently without a permit limit but that is being upgraded to have a permit limit in the future

In this situation the approach set out under [Part 1.3.B](#) should be followed. To determine the current WwTW effluent concentration to use for the second, short-term nutrient budget (until the WwTW permit limit comes into force), the approach set out in [Part 1.3.C](#) for discharges without a current permit limit should be followed.

Input values into Stage 1, Step 3D

The input value:

For the period up to 2025 (or when the permit will come into force if this is earlier than 2025):

- If a value is available for the specific WwTW effluent nitrogen or phosphorus concentration, this should be used.
- If there is no data on the WwTW effluent concentration, use the standard default of 27 mg TN/l for nitrogen and/or 8 mg TP/l for phosphorus, or a local catchment default if there is the evidence to support one.

For the period after 2025 (or when the permit will come into force if this is earlier than 2025):

- Use the permit limit concentration nitrogen and/or phosphorus for the relevant WwTW.
- Multiply this value by 0.9 to get the input value.

Example – nutrient loading from a WwTW with no current permit limit but that is getting a permit limit in the future

The required calculations:

For the period before the permit comes into force:

Default nutrient concentration value (mg/l) x annual water use from development (l/year) =

nutrient load (mg/year)

Nutrient load (mg per year) / 1,000,000 = nutrient load (kg/year)

For the period after the permit comes into force:

Permit limit x 0.9 = permit limit with headroom

Permit limit with headroom x annual water use from development = nutrient load (mg/year)

Nutrient load (mg per year) / 1,000,000 = nutrient load (kg/year)

Example scenario:

- A new development is completed on the 01/01/2022 and will discharge to a WwTW with no current permit.
- There is no data on the WwTW effluent concentration and so the default value of 27 mg TN/l is used.
- The WwTW is getting a permit limit of 8 mg N/l in 2025.
- The additional total annual wastewater produced by the new development is 52,596,000 litres/year.

Two nutrient budgets are completed:

1. A long-term budget using the lower limit of 8 mg TN/l should be calculated, with long-term mitigation measures applied to achieve nutrient neutrality for this nutrient load in perpetuity
2. A 4-year nutrient budget covering 2022-2025 using the default “No permit concentration” for nitrogen of 27 mg TN/l is calculated and short-term measures can be used to mitigate the additional nutrient load created whilst the WwTW has no permit limit.

A worked example of this scenario is as follows:

1. long-term annual load:

Reduce the future permit limit to 90% of 8 mg TN/l = $8 \text{ mg TN/l} \times 0.9 = 7.2 \text{ mg TN/l}$

$7.2 \text{ mg TN/l} \times 52,596,000 \text{ litres/year} = 378,691,200 \text{ mg TN/year}$

$378,691,200 \text{ mg TN/year} / 1,000,000 = 378.7 \text{ kg TN/year}$

2. 4-year annual load:

$27 \text{ mg TN/l} \times 52,596,000 \text{ litres/year} = 1,420,092,000 \text{ mg TN/year}$

$1,420,092,000 \text{ mg TN/year} / 1,000,000 = 1,420.1 \text{ kg TN/year}$

3. Calculate the difference between the 4-year annual load the long-term

$\text{Annual load } 1,420.1 \text{ kg TN/year} - 378.7 \text{ kg TN/year} = 1041.4 \text{ kg TN/year}$

Note: The outputs from the long-term annual load (1.) and the difference between the short-term (4-years in this example) annual load (3.) will be needed in Stage 4 of this methodology.

Part 1.3.E: Where the development is connecting to an onsite wastewater treatment system

The nutrient concentration in the final effluent should be identified through the manufacturer of the wastewater treatment technology being used.

If data on the phosphorus concentration in effluent from a treatment system is not available, a value of 9.7 mg P/l should be used for PTPs and 11.6 mg P/l for septic tanks. These figures are derived from the available literature (May *et al.*, 2016; O’Keeffe, *et al.*, 2015) and represent the average of reported mean TP values stated.

If data on the nitrogen concentration in effluent from a treatment system is not available, a value of 72.9 mg TN/l should be used for PTPs and 96.3 mg TN/l for septic tanks. These figures are derived from the available literature (Lusk, *et al.*, 2017; Gill & Mockler, 2016; Richards *et al.*, 2016; Humphrey Jr, *et al.*, 2013; Withers, *et al.*, 2011), and represent the average of reported mean TN values stated.

The relevant nutrient concentration value should be multiplied by the total annual wastewater volume associated with the new development as identified in [Step 2](#).

For sustained and adequate nutrient removal, on-site treatment technology needs to be regularly maintained. The LPA should therefore take steps to secure maintenance of the technology in perpetuity to ensure that the nutrient levels used in this step of the calculation are achieved. The treatment technology used should be appropriately sized in order to account for the wastewater arising from the new development and should follow the relevant building regulation standards and any EA permitting requirements.

PTPs or septic tanks that discharge to ground may be able to achieve further reductions in phosphorus export from a development as a large proportion of phosphorus is retained in

soil. If evidence can be provided that shows the reductions in phosphorus that are likely to be achieved by a drainage field, along with a suitable maintenance plan to ensure phosphorus reductions are maintained for the lifetime of a development, it is likely that mitigation requirements could be reduced significantly. The level of phosphorus reductions that a drainage field can achieve will be dealt with on a case-by-case basis as it depends on local soil conditions and the choice of filter media if one is used.

Input values into Stage 1, Step 3E

The input values:

- This input should ideally be a verified concentration of total phosphorus or total nitrogen as detailed in manufacturer specifications for a septic tank or package treatment plant.
- If a verified total phosphorus or total nitrogen concentration is not provided, the following default values should be used.
- Septic tanks:
 - Total Phosphorus = 11.6 mg TP/l
 - Total Nitrogen = 96.3 mg TN/l
- Package treatment plants:
 - Total Phosphorus = 9.7 mg TP/l
 - Total Nitrogen = 72.9 mg TN/l

Example – nitrogen loading from a PTP The required calculations:

PTP effluent nutrient concentration value (mg/l) x annual water use from development (l/year) =

nutrient load (mg/year)

Nutrient load (mg per year) / 1,000,000 = nutrient load (kg/year)

Example scenario:

- A new development of two houses will discharge to a PTP.
- The houses are built to a water efficiency standard of 120 l/person/day (see [Step 2](#)).
- The PTP has a verified TN concentration in its final effluent of 25 mg TN/l.
- The concentration of phosphorus is not provided and so the default value of 9.7 mg TP/l is used.
- The additional total annual wastewater associated with this new development is 4.8 ([the additional population](#)) x 120 l/person/day x 365.25 (days in a year) = 210,384 l/year.

Annual load of nitrogen:

$25 \text{ mg TN/l} \times 210,384 \text{ litres/year} = 5,259,600 \text{ mg N/year}$
 $5,259,600 \text{ mg N/year} = 5.3 \text{ kg N/year}$

Annual load of phosphorus:

$9.7 \text{ mg TP/l} \times 210,384 \text{ l/year} = 2,040,725 \text{ mg P/year}$
 $2,040,725 \text{ mg P/year} / 1,000,000 = 2.04 \text{ kg P/year}$

Full worked example of Stage 1 calculations

Table 6 presents a full worked example of the steps required for the Stage 1 nutrient budget calculations. The example presented in this table shows how the Stage 1 output is generated when a development connects to WwTW with a permit limit that is not changing, with the numbers in the table taken from the examples shown above. For Step 4, the inputs and calculations are taken from the example in [Part 1.3.A](#). For developments where the calculations detailed in one of Parts 1.3.B-E apply, those calculations would substitute the calculations shown in Step 4 of Table 2.

Table 6: Full worked example of the calculations required to determine the output from Stage 1 of a nutrient budget. In this example, the nutrient budget is being calculated for nitrogen.

Step	Calculations	Explanation
Step 1	$500 \text{ dwellings} \times 2.4 \text{ persons per dwelling} = 1200 \text{ persons}$	Calculate additional population
Step 2	$120 \text{ litres/person/day} \times 365.25 \text{ days} = 43,830 \text{ litres/person/year}$	Calculate the increase in wastewater production
	$1200 \text{ persons} \times 43,830 \text{ litres/person/year} = 52,596,000 \text{ litres/year}$	
Step 3	$8 \text{ mg TN/l} \times 0.9 = 7.2 \text{ mg TN/l}$	Reduce the adjusted permit limit to 90% of 6 mg TN/l
	$52,596,000 \text{ litres/year} \times 7.2 \text{ mg TN/l} = 378,691,200 \text{ mg TN/year}$	Multiply the reduced adjusted permit limit by the annual wastewater

Step	Calculations	Explanation
		produced by the development
	$\frac{378,691,200 \text{ mg TN/year}}{1,000,000} = 378.7 \text{ kg TN/year}$	Divide by 1,000,000 to convert to kg per year – this is the final output from Stage 1.

3. Stage 2: Nutrient loading from current land use(s)

Step 1: Obtain nutrient export values from current land use(s)

What:

This input determines the amount of nutrients that are currently exported from your development site. These nutrients will be offset against the new nutrient load generated by your development in wastewater.

Why:

Not accounting for the current export of nutrients from your site would result in double counting of nutrients that were generated by previous land use and nutrients that will be generated by land use post-development. This will result in the nutrient budget output being an overestimate.

How:

Note: This depends on the current land use on your development site.

What is the land use on your development site?

Development in non-urban areas:

If your development site is on agricultural land, go to [Part 2.1.A](#).

If your development site is on greenfield, greenspace or community food growing (e.g. allotments) land use(s), go to [Part 2.1.B](#).

Development in urban areas:

If your development is in an urban area and the mix of land uses is changing, go to [Part 2.1.C](#).

Note: If your development site is in an urban area and the ratio of land uses is not changing, both Stage 2 and Stage 3 of the methodology can be skipped. This is because the only net increase in nutrients comes from the new wastewater generated by the development.

Example of Stage 2

Example – no change in ratio of urban land use

Your development site is 10 ha.

The mix of current land uses pre-development are:

- 8 ha urban, e.g. houses, roads etc.
- 2 ha greenspace.

The post-development mix of land uses is:

- 8 ha urban, e.g. houses, roads etc.
- 2 ha greenspace.

The ratio of land uses remains unchanged and thus the associated nutrient export from the site also does not change.

Hence, this stage as outlined in Part 2.1.C is not required and the subsequent calculations in Stage 3 can also be omitted.

Part 2.1.A: Obtaining nutrient export values for agricultural land use

Estimates of the nitrogen and phosphorus export from agricultural land have been derived using Farmscoper, an industry standard tool for assessing the pollution risks posed by agriculture. Farmscoper outputs values for kilograms of nitrate and total phosphorus export per hectare of farmland. These values are termed export coefficients. Using an add-on to Farmscoper called the Farmscoper Upscale tool, nitrate and total phosphorus export coefficients can be generated without requiring additional data.

Note: The Farmscoper export coefficients are pre-populated in the accompanying nutrient budget calculator. If a nutrient budget is being undertaken without a calculator, then Farmscoper export coefficients will need to be generated for river catchments at a specific scale termed the “Operational Catchment” scale. Guidance on running Farmscoper to generate export coefficients can be provided by Natural England upon request.

To select an export coefficient or coefficients for the agricultural land uses on your development site, you will need to collate the following information:

1. The farm type or farm types that are currently on your development site.
2. The area of the farm in hectares that is used by each farm type.
3. The Operational Catchment that your development site is located in.
4. The soil characteristics for your development site.
5. The average annual rainfall for your development site.

6. Whether your development site is in Nitrate Vulnerable Zone (NVZ).

With the exception of farm type and area for each farm type, the above information can be found online. Please see the instructions below for how to find the information listed in points 3-5. For farm type(s) and area(s), you will need to ascertain this information from the current farmer.

For farm types, Farmscoper has set categories. You need to select the farm type(s) that most accurately represents the type(s) of farming on your development site from the following list:

- Cereals
- General
- Horticulture
- Pig
- Poultry
- Dairy
- Mixed
- Less Favoured Area (LFA) Grazing
- Lowland Grazing

Finding your Operational Catchment:

- Go to: [England | Catchment Data Explorer](#)
- Change the “Search by” option to “Postcode” or “Coordinates” and search your sites postcode or coordinates.
- The map will show a regional view with highlighted areas.
- On the left of the page, various names will be listed under the headings “River Basin District”, “Management Catchment”, “Operational Catchment” and “Water Body”. You need to ascertain your development site’s Operational Catchment.
- If there is more than one name under the Operational Catchment heading, zoom in on the
- map to your development site’s location, which should be shaded blue.
- Hover the cursor over the map at your development site’s location. A name should be shown that will match one of the Operational Catchments on listed on the left of the screen. Make a note of this Operational Catchment name.

Finding the soil characteristics for your site:

- Go to: [Soilscapes soil types viewer - Cranfield Environment Centre. Cranfield University \(landis.org.uk\)](#)
- Select the “Search” tab to the right of the map.
- Search using postcode or coordinates.
- Click on the “Soil information” tab beneath “Search”.
- Make a note of the Soilscape number and description.

- Look up the farmscoper soil drainage type using the soilscape number in [Table 20](#) in Appendix 1.

Finding the average rainfall for your site:

- Go to: [Search Data | National River Flow Archive \(ceh.ac.uk\)](https://ceh.ac.uk/research/river-flow-archives/)
- Click on any number in the “Station number” column. This will open a new tab in your browser.
- On this page, click the “Catchment info” tab.
- Change the “Select spatial data type to view” drop down to “Rainfall”.
- On the tabs beneath this drop down, select “Legend”.
- Use the interactive map to locate your development site.
- Record the annual rainfall band for your development site by comparing the colour on the map with the legend.
- Look up the farmscoper equivalent rainfall band using the site specific annual average rainfall band number in [Table 21](#) in Appendix 1.

Finding out whether your development is within an NVZ:

- Go to: [Magic Map Application \(defra.gov.uk\)](https://magic.defra.gov.uk/)
- In the “Table of Contents” on the left of the screen, expand the entry called “Designations” by clicking on the “+” icon.
- Scroll to the bottom of the list that will appear when you expand “Designations”, “Land-Based designations” and “statutory” and check the box next to “Nitrate Vulnerable Zones”. This should colour various areas of the map.
- Using the search bar next to the “MAGIC” label, search for your development site location. You can search by postcode, or by clicking on the black arrow in the search bar, you can change to searching by grid reference or coordinates.
- If your development site is within the coloured area on the map, it is in an NVZ.

Use the information above to find your nitrate or total phosphorus export coefficients in [Table 22](#) in appendix 1.

If there is good evidence, such as the output from farm-specific Farmscoper modelling or a detailed monitoring exercise, this can be used to support a different export efficient.

Part 2.1.B: Obtaining nutrient export values from non-agricultural greenfield, greenspace and community food growing land uses

If your development site is on land that is currently under non-agricultural greenfield or greenspace land use, default values for nitrogen and phosphorus export from these land uses are provided in Table 3. Greenfield or greenspace should be interpreted as more natural greenspace, i.e. semi-natural habitats where fertilisers will not be applied and dog waste is managed. It does not include sports fields/pitches or parks where fertiliser is likely

to be applied and thus should be classed as urban. As such, the values for greenspace represent the estimated background export of nitrogen and phosphorus from areas of land that do not have additional inputs of nitrogen or phosphorus from sources such as agriculture, use of fertilisers and/or pet waste. You will also need to know the area of land in hectares that is covered by greenfield or greenspace land uses.

Table 7: Use the values in this table as the export coefficients for nitrogen and phosphorus if your development site is currently under greenfield or greenspace land use.

Default export coefficients for nitrogen and phosphorus from greenfield or greenspace	
Nitrogen	3.00 kg/ha/year
Phosphorus	0.02 kg/ha/year

If there are areas of community food growing land, e.g. allotments or similar land uses, that are being removed by the development, then an agricultural land export coefficient has been determined as the most representative input to represent the nitrogen or phosphorus export from this land use. To determine this value, you need to follow the instructions in [Part 2.1.A](#) to find the Operational Catchment and annual average rainfall for your site. Then go to [Appendix 1](#) and use the Operational Catchment and annual average rainfall value to find the nitrogen or phosphorus export coefficient for the:

- “FreeDrain” (freely draining) soil characteristic
- The “General” farm type

You will also need to know the area of your development site that is covered by community food growing land use.

Part 2.1.C: Obtaining nutrient export values from urban land uses

If your development site is on brownfield land, you will need to obtain nitrogen or phosphorus export coefficients for the types of pre-existing urban land use on the site. In this methodology, export coefficients have been defined for the three types of urban land use:

- Residential – urban land used for housing. This includes gardens, roadside verges, and small areas of greenspace (<0.1 hectares), as well as driveways, roads and any other hardstanding.
- Open urban – urban land that is primarily hardstanding but is not primarily used for housing or industry. This may include but, not limited to, roads, small greenspace areas, and buildings

- Commercial/industrial – an area of land developed as a site for office space, retail parks, factories, and other industrial businesses

You will need to classify the urban land use(s) on your development site into one of these three types and also determine the area in hectares that is covered by each type of urban land use.

Once you know the different types of urban land use on your site, the nitrogen and phosphorus export coefficients for each land use type can be obtained. To obtain these coefficients, you will need to look up the average annual rainfall for your development site. This can be found by following the instructions under the “Finding the average annual rainfall for your site” heading in [Part 2.1A](#). Once you have the urban land use type(s) and average annual rainfall for your site, look up the corresponding urban nitrogen or phosphorus export coefficient(s) in Table 16.

Note: an explanation of how these coefficients were calculated is provided in [Appendix 2](#).

Where specific measures are incorporated in a development (such as permeable paving in the urban realm) with sufficient evidence to support a different nutrient event mean concentration and/or percentage of land that is impervious, then the approach set out in appendix 2 can be used to calculate a more locally specific urban export coefficient.

Table 8: Nitrogen and Phosphorus export coefficients for urban land use types.

Average annual rainfall band (mm)	Residential N export coefficient (kg/ha/yr)	Commercial / industrial N export coefficient (kg/ha/yr)	Open urban N export coefficient (kg/ha/yr)	Residential P export coefficient (kg/ha/yr)	Commercial / industrial P export coefficient (kg/ha/yr)	Open urban P export coefficient (kg/ha/yr)
508 - 525	9.41	5.02	5.55	1.00	0.73	0.54
525.1 - 550	9.83	5.24	5.80	1.05	0.77	0.56
550.1 - 575	10.33	5.51	6.09	1.10	0.81	0.59

Average annual rainfall band (mm)	Residential N export coefficient (kg/ha/yr)	Commercial / industrial N export coefficient (kg/ha/yr)	Open urban N export coefficient (kg/ha/yr)	Residential P export coefficient (kg/ha/yr)	Commercial / industrial P export coefficient (kg/ha/yr)	Open urban P export coefficient (kg/ha/yr)
575.1 - 600	10.83	5.77	6.38	1.16	0.85	0.62
600.1 - 625	11.32	6.04	6.67	1.21	0.89	0.65
625.1 - 650	11.82	6.30	6.97	1.27	0.93	0.68
650.1 - 675	12.30	6.56	7.25	1.32	0.97	0.71
675.1 - 700	12.79	6.82	7.54	1.37	1.00	0.74
700.1 - 750	13.51	7.20	7.96	1.45	1.06	0.78
750.1 - 800	14.44	7.70	8.51	1.55	1.14	0.83
800.1 - 850	15.38	8.20	9.06	1.65	1.21	0.89
850.1 - 900	16.31	8.70	9.61	1.75	1.28	0.94
900.1 - 950	17.24	9.19	10.16	1.85	1.35	0.99
950.1 - 1,000	18.17	9.69	10.71	1.95	1.43	1.05

Average annual rainfall band (mm)	Residential N export coefficient (kg/ha/yr)	Commercial / industrial N export coefficient (kg/ha/yr)	Open urban N export coefficient (kg/ha/yr)	Residential P export coefficient (kg/ha/yr)	Commercial / industrial P export coefficient (kg/ha/yr)	Open urban P export coefficient (kg/ha/yr)
1,000.1 - 1,100	19.57	10.44	11.54	2.10	1.54	1.13
1,100.1 - 1,200	21.43	11.43	12.63	2.30	1.68	1.24
1,200.1 - 1,400	24.23	12.92	14.28	2.60	1.90	1.40
1,400.1 - 1,600	27.96	14.91	16.48	3.00	2.20	1.61
1,600.1 - 2,000	33.55	17.89	19.78	3.60	2.64	1.93
2,000.1 - 2,400	41.00	21.87	24.17	4.40	3.22	2.36
2,400.1 - 3,000	50.32	26.84	29.66	5.40	3.95	2.90
3,000.1 - 4,000	65.23	34.79	38.45	7.01	5.13	3.76
4,000.1 - 5,500	88.53	47.22	52.19	9.51	6.96	5.10

Step 2: Calculate the annual nutrient export from the current land use(s) on your development site

What:

The total annual nutrient loading from pre-existing land uses on your development site is calculated using the nutrient export coefficients determined in [Stage 2, Step 1](#).

Why:

As stated above, not accounting for the current export of nutrients from your site would result in double counting of nutrients that were generated by previous land use and nutrients that will be generated by land use post-development.

How:

The export coefficients identified in [Stage 2, Step 1](#) are multiplied by the corresponding land area (in hectares) for each land use. This will provide annual nutrient loading values in kg per year for each land types found within the site's boundary. If there is more than one land use within your site's boundary, the sum of these values will give the total current site's land use annual nutrient loading.

Input values into Stage 1, Step 2

The input value:

- The export coefficient(s) obtained for each land use in Parts 2.1.A-C.
- The area in hectares of each land use an export coefficient has been obtained for

Example – annual nutrient export from current land use(s) on your development site

The required calculation:

Land use area (ha) x land use nutrient export coefficient (kg/ha/yr) = nutrient export (kg/yr)

Example scenario:

A new development is to be constructed on a 10-ha site that contains:

- 2 ha of dairy farming with a nitrogen export coefficient of 25 kg/ha/yr and a phosphorus export coefficient of 0.42 kg/ha/yr
- 4 ha of cereal farming with a nitrogen export coefficient of 20 kg/ha/yr and a phosphorus export coefficient of 0.32 kg/ha/yr
- 4 ha of urban open urban land with a nitrogen export coefficient of 6.67 kg/ha/yr and a phosphorus export coefficient of 0.89 kg/ha/yr

To calculate the annual nutrient export from the area of dairy farming:

- $2 \text{ ha} \times 25 \text{ kg N/ha/year} = 50 \text{ kg N/year}$
- $2 \text{ ha} \times 0.42 \text{ kg P/ha/year} = 0.84 \text{ kg P/year}$

To calculate the annual nutrient export from the area of cereals farming:

- $4 \text{ ha} \times 20 \text{ kg N/ha/year} = 80 \text{ kg N/year}$
- $4 \text{ ha} \times 0.32 \text{ kg P/ha/year} = 1.28 \text{ kg P/year}$

Four hectares of open urban land:

- $4 \text{ ha} \times 6.67 \text{ kg N/ha/year} = 26.68 \text{ kg N/year}$
- $4 \text{ ha} \times 0.89 \text{ kg P/ha/year} = 3.56 \text{ kg P/year}$

Total annual nutrient loading from current land uses:

Nitrogen:

- $50 \text{ kg N/year} + 80 \text{ kg N/year} + 26.68 \text{ kg N/year} = 156.68 \text{ kg N/year}$

Phosphorus:

$0.84 \text{ kg P/year} + 1.28 \text{ kg P/year} + 3.56 \text{ kg P/year} = 5.68 \text{ kg P/year}$

4. Stage 3: Nutrient loading from future land use(s)

Step 1: Calculate the annual export from future land use(s)

What:

Once a development site has been built, the land uses on the site will have an associated nutrient export. Stage 3 of the nutrient budget accounts for the export of nutrients from the new land use(s) on your development site.

Why:

If you were to only account for the nutrients that were exported by the previous land use(s) on your development site (using the steps in [Stage 2](#)), the final nutrient budget would be an underestimate of the total nutrient export from the development site and as shown in [Stage 2](#), different land uses have different associated export of nutrients. This means the final mix of land uses on a development site needs to be accounted for to provide the most accurate estimate of future nutrient export once the development is built.

How:

The same approaches shown in [Stage 2](#) are applied in [Stage 3](#). Each land use on the post-development site will need to be categorised to find the relevant nitrogen or phosphorus export coefficient. As in [Stage 2](#), these export coefficients are then multiplied by the area for each land use to get an annual nutrient export for that land use. The sum of the nutrient exports for each land use is the total nutrient export from land uses on your development site. This total is the output from [Stage 3](#) that is used in the nutrient budget calculations in [Stage 4](#).

If your development site is incorporating greenspace or community food growing areas, please see [Part 2.1.B](#) to determine the export coefficients required for these land uses.

For the urban land uses on your development site, please see [Part 2.1.C](#) to determine the export coefficients for the relevant types of urban land use.

Input values into Stage 3, Step 1

The input value:

- The export coefficient(s) for each land use.
- The area in hectares of each land use an export coefficient has been obtained for.

Example – annual nutrient export from future land use(s) on your development site

The required calculation:

Land use area (ha) x land use nutrient export coefficient (kg/ha/yr) = nutrient export (kg/yr)

Example scenario:

A new development is to be constructed on a 10-ha site that contains:

- 8 ha of residential land with nitrogen export coefficient of 11.32 kg/ha/yr and a phosphorus export coefficient of 1.21 kg/ha/yr
- 2 ha of greenspace with a nitrogen export coefficient of 3 kg/ha/yr and a phosphorus export coefficient of 0.02 kg/ha/yr

To calculate the annual nutrient export from the residential area:

- 8 ha x 11.32 kg N/ha/year = 90.56 kg N/year
- 8 ha x 1.21 kg P/ha/year = 9.68 kg P/year

To calculate the annual nutrient export from the area of greenspace:

- 2 ha x 3 kg N/ha/year = 6 kg N/year
- 2 ha x 0.02 kg P/ha/year = 0.04 kg P/year

Total annual nutrient loading from current land uses:

Nitrogen:

- 90.56 kg N/year + 6 kg N/year = 96.56 kg N/year

5. Stage 4: Calculating the nutrient budget, including the buffer

What:

Stage 1-3 have calculated the nutrient export from the different sources of nutrients from your development, both pre- and post-development and occupation. Each of Stages 1-3 has output an amount of nitrogen or phosphorus in kg per year. The balance, or net change, in the amount of nitrogen or phosphorus that will come from your development once built and occupied is the nutrient budget for your development.

The methodology adopts a precautionary approach to the nutrient budget calculation. To ensure robustness an additional 20% buffer is added to the final figure.

Why:

This final Stage of the nutrient budget methodology calculates whether your new development will result in a surplus of nitrogen or phosphorus being exported to a Habitats site. If the output of the nutrient budget calculations, including the 20% buffer, shows that the development will result in a surplus of nutrients being exported to a Habitats site, this is the amount of nutrient mitigation needed for the development to be “nutrient neutral”.

How:

The development's nutrient budget = Stage 1 output - Stage 2 output + Stage 3 output.

The addition of the 20% buffer = nutrient budget x 1.2

If the outcome of the nutrient budget is zero or a negative figure, there is no need to add the precautionary buffer and no nutrient mitigation is needed.

Input values into Stage 4

The input value:

- The outputs from stages 1-3

Example – Calculation of the nutrient budget and addition of the buffer.

This example calculates a nitrogen budget using the outputs from the examples in:

- [Stage 1, Part 1.3.A](#) – 378.7 kg N/year
- [Stage 2, Step 2](#) – 156.68 kg N/year
- [Stage 3, Step 1](#) – 96.56 kg N/year

The nutrient budget calculated is:

- $378.7 \text{ kg TN/year} - 156.68 \text{ kg N/year} + 96.56 \text{ kg N/year} = 318.58 \text{ kg N/year}$

The addition of the precautionary buffer is calculated as:

- $341.5 \text{ kg N/year} \times 1.2 = 382.3 \text{ kg N/year}$

The final output from the nutrient budget and the amount of nitrogen to be mitigated in this example is:

- 382.3 kg N/year

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Appendices

Appendix 1: Lookup tables for selecting Farmscoper nitrogen or phosphorus export coefficients

The following three lookup tables should be used to determine the export coefficient for the farm type or farm types on your development site.

First, use the information for “soil characteristics” as outlined in [Part 2.1.A](#) to select the Farmscoper soil drainage type from Table 9.

Table 9: Determine the Farmscoper equivalent soil drainage type by finding the development specific Soilscape number in the table below.

Farmscoper soil drainage type				
Soilscape number	Drainage	Free draining (FreeDrain)	Drained arable (DrainedAR)	Drained for arable and grazing (DrainedArGr)
1	Naturally wet	-	-	X
2	Variable	-	-	X
3	Freely draining	X	-	-
4	Freely draining	X	-	-
5	Freely draining	X	-	-
6	Freely draining	X	-	-
7	Freely draining	X	-	-
8	Slightly impeded drainage	-	X	-
9	Slightly impeded drainage	-	X	-
10	Freely draining	X	-	-

Farmscoper soil drainage type				
Soilscape number	Drainage	Free draining (FreeDrain)	Drained arable (DrainedAR)	for Drained for arable and grazing (DrainedArGr)
11	Freely draining	X	-	-
12	Freely draining	X	-	-
13	Freely draining	X	-	-
14	Freely draining	X	-	-
15	Naturally wet	-	-	X
16	Surface wetness	-	-	X
17	Impeded drainage	-	-	X
18	Impeded drainage	-	-	X
19	Impeded drainage	-	-	X
20	Naturally wet	-	-	X
21	Naturally wet	-	-	X
22	Naturally wet	-	-	X
23	Naturally wet	-	-	X
24	Variable	-	-	X
25	Naturally wet	-	-	X
26	Naturally wet	-	-	X
27	Naturally wet	-	-	X

Using the information collated for “average annual rainfall” as outlined in [Part 2.1.A](#), select the relevant “Farmscoper rainfall volume equivalent” value from Table 10.

Table 10: Determine the Farmscoper equivalent soil drainage type by finding the development specific Soilscape number in the table below.

Average annual rainfall (mm)	Farmscoper rainfall volume equivalent (mm)
508 - 525	Under600
525.1 - 550	Under600
550.1 - 575	Under600
575.1 - 600	Under600
600.1 - 625	600to700
625.1 - 650	600to700
650.1 - 675	600to700
675.1 - 700	600to700
700.1 - 750	700to900
750.1 - 800	700to900
800.1 - 850	700to900
850.1 - 900	700to900
900.1 - 950	900to1200
950.1 - 1,000	900to1200
1,000.1 - 1,100	900to1200
1,100.1 - 1,200	900to1200
1,200.1 - 1,400	1200to1500
1,400.1 - 1,600	1200to1500

Average annual rainfall (mm)	Farmscoper rainfall volume equivalent (mm)
1,600.1 - 2,000	Over1500
2,000.1 - 2,400	Over1500
2,400.1 - 3,000	Over1500
3,000.1 - 4,000	Over1500
4,000.1 - 5,500	Over1500

Using the Farmscoper soil drainage type and the Farmscoper rainfall volume equivalent, along with other values as outlined in [Part 2.1.A](#), select relevant export coefficient values from Table 11.

Table 11: Determine the Farmscoper equivalent soil drainage type by finding the development specific Soilscape number in the table below. Note, cells in this table have been left deliberately blank.

Catchment	Farmscoper Farm Type	NVZ	Climate	Farmscoper Soil Drainage Term	Nitrogen export coefficient	Phosphorus export coefficient

Appendix 2: Derivation of urban nitrogen and phosphorus runoff coefficients

Research into diffuse pollution in urban environments has produced values called event mean concentrations (EMCs) that describe the average concentration of nitrogen and phosphorus in urban runoff during rainfall events. For the purposes of this methodology, the EMCs (Mitchell, G., (2005))⁷ detailed in Table 22 were used. See [Part 2.1.C](#) for a definition of the land use types in Table 12.

Table 12: EMC's for nitrogen and phosphorus for three key types of urban land use

Land use	Nitrogen event mean concentration (mg N/l)	Phosphorus event mean concentration (mg N/l)
Residential	2.85	0.41
Commercial/industrial	1.52	0.30
Open urban land	1.68	0.22

The EMCs were combined with a standard method for calculating urban runoff which requires only rainfall as an input. The HR Wallingford Modified Rational Method was used, as shown in equation 1.

Equation 1

$$L = R * Pr$$

Where:

L = annual average runoff (mm)

R = annual average rainfall (mm)

Pr = percentage runoff (%)

$$Pr = 0.829 * PIMP + 0.078 * U - 20.7$$

$PIMP$ = the percentage of land that is impervious (whole number)

⁷ Mitchell, G., 2005. Mapping hazard from urban non-point pollution: A screening model to support sustainable urban drainage planning. *Journal of Environmental Management*, 74(1), pp. 1-9.

U = catchment wetness index. Calculated by (use 41 if rainfall over 760 mm):

$$U = -129.5 + (0.424 * R) - (2.28 * 10^{-4} * R^2) - (4.56 * 10^{-8} * R^3)$$

For phosphorus, the value for PIMP was set as 80%, as this has been suggested as the proportion of impervious surfaces once urban creep (the paving over of pervious surfaces) reaches a maximum. The use of an 80% PIMP value, while high, accounts for the potential increases in impervious surfaces that may occur over the lifetime of a development.

Research has also suggested that non-paved gardens account for between 19-27% of the entire urban area. As gardens are the primary type of permeable surface within residential areas, the use of an 80% PIMP value is considered to be precautionary as an area with 19% coverage by non-paved gardens would indicate that around 80% of the remaining urban residential area would be impermeable surfaces.

For nitrogen, a value of 100% was used for PIMP. Whilst this is an unrealistic assumption in most urban environments, the use 100% for PIMP was deemed appropriate as a notable proportion of the nitrogen from pervious land within an urban environment may still leach to a Habitats site via subsurface or groundwater pathways. This is because nitrogen is much more readily transported than phosphorus, especially in dissolved form. A 100% value is deemed to be a precautionary input given the uncertainties surrounding the amount of nitrogen that is likely to leach from an urban environment via subsurface and groundwater pathways.

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