



Ant Broads and Marshes SSSI

Nutrient Modelling Summary

Date: October 2026

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Introduction

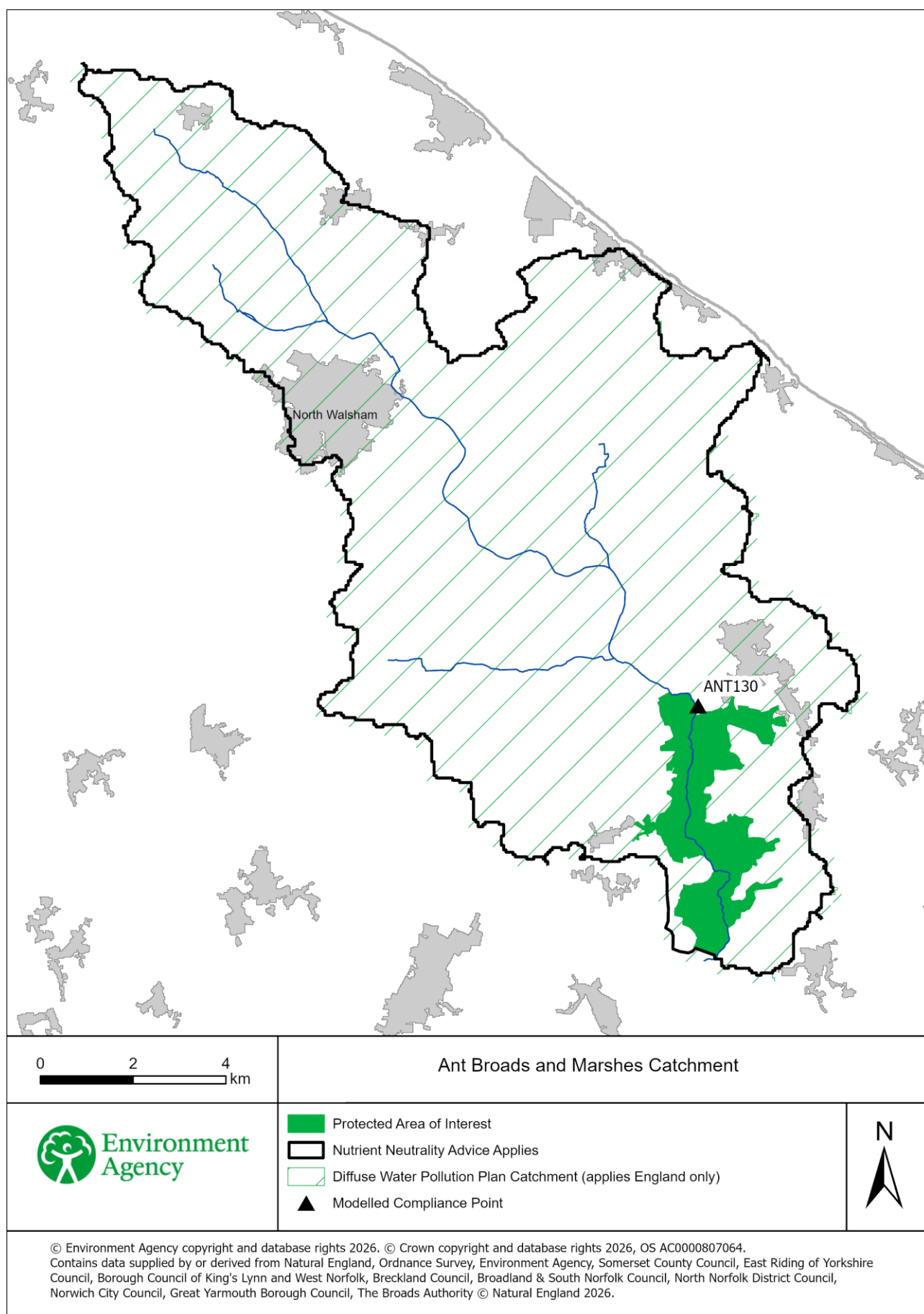
This document provides summary outputs from the Environment Agency's water quality modelling for the Ant Broads and Marshes Site of Special Scientific Interest (SSSI), part of the Broads Special Area of Conservation (SAC) (Map 1). We provide source apportionment information and data to show the scale of reductions needed to achieve protected area water quality targets. Our outputs will help those working on Diffuse Water Pollution Plans (DWPPs), designing or co-ordinating nutrient mitigation schemes, and working on site restoration. We aim to support a general understanding of the catchment rather than give the level of detail needed to inform specific on-the-ground measures. Our detailed methodology is described in the associated project overview document.

We converted the total phosphorus Common Standards Monitoring Guidance (CSMG) target applicable to the Ant Broads and Marshes SSSI to a phosphate target to assess the modelled river phosphate at the modelled assessment point (Map 1). Natural England and the Environment Agency agree these targets for water dependent protected areas and publish them on the [Catchment Data Explorer](#). We used the total nitrogen lake Water Framework Directive target when assessing the river nitrate modelled results. The Water Framework Directive total nitrogen target is tighter than the CSMG target.

Alongside Simcat SAGIS models, we used the Farmscoper v5 decision support tool and applied the revised polluter pays principle methodology (v0.17) used during PR24 planning to define the sector share of the targets for the point and diffuse sectors.

Our outputs highlight the dominant nutrient sources under a range of scenarios, including future estimates based on planned water company investment up to 31 March 2030 (AMP8) and the wider implementation of rural land use measures.

We have not incorporated additional nutrient contributions from any future development and growth including housing. Any additional future nutrient load will be assessed through the planning process led by the Local Planning Authority or through our permitting process.



Map 1. Ant Broads and Marshes SSSI and catchment with protected area highlighted and catchment where Natural England nutrient neutrality advice applies shown. Modelled assessment point highlighted.

Models used

We used the PR19 and PR24 Simcat SAGIS models for this work alongside Farmscoper v5. Simcat SAGIS (Source Apportionment Geographical Information System) integrates ArcGIS-based digital information management and visualisation with SIMCAT (Simulated Catchment), the Environment Agency's water quality model. Farmscoper is a decision support tool that can be used to assess diffuse agricultural pollutant loads and quantify the impacts of farm mitigation methods on these pollutants.

The PR19 Simcat SAGIS model is calibrated to 2010 to 2012 data, following nationally agreed model build and calibration standards across UKWIR (UK Water Industry Research). Outputs from this model are used to establish the sector share of the protected site target under the revised polluter pays principle. Similarly, the PR24 Simcat SAGIS model is calibrated to 2014 to 2020 data, following UKWIR agreed model build and calibration standards.

The calibration process optimises the agreement between measured and simulated values through reasonable and systematic adjustments to model parameters and input data. We adjust the inputs where there is least confidence, those representing diffuse sources of pollution. The associated project overview document details the datasets included in the models. To assess confidence in the models, we compare the measured and simulated values. While Simcat SAGIS provides a robust framework for decision-making in wastewater investment, we have less certainty in the diffuse load estimates. As a result, we have lower confidence when using the models to assess the outcomes of measures that target diffuse sources, including those used here and in the DWPPs.

Farmscoper has undergone external peer review (Gooday et al., 2014), and the component models and methods used within Farmscoper have been published in the external literature. The assumptions, methods and resulting conclusions are therefore based on sound scientific principles. Farmscoper was developed as an advisory tool to aid policy makers. Farmscoper is now used more extensively and for a wider range of purposes than originally intended, therefore the consequences of assumptions and other uncertainties in Farmscoper outputs need to be considered when decision-making and users need to understand the assumptions, uncertainty, and limitations at the relevant scale of interest.

We used Farmscoper v5 to assess diffuse agricultural pollutant loads and to quantify the impacts of farm scale mitigation methods for a range of scenarios. This applies the agricultural planning assumptions for RBMP cycle 3 for land management measures (Environment Agency, 2022), as well as information from Defra project WT1594 (Defra, 2019a). We present outputs for two Farmscoper scenarios in this report to provide estimates of the reduction in nutrient losses from 'full regulation' and 'theoretical maximum' uptake rates in agricultural mitigation measures (Table 2).

Scenarios

The modelling scenarios (Table 1) evaluate the effectiveness of nutrient reductions in point and diffuse sources to meet protected site targets and the diffuse sector share of those targets. In the 2030 Full Regulation and 2030 Theoretical Maximum scenario we have applied the Farmscoper v5 reductions (Tables 2 and 3) to the rural land use sector inputs. We have based the point sector measures on the AMP8 water industry national environment programme agreed in December 2024 ([PR24 WINEP](#)).

Table 1: Summary description of the point and diffuse measures represented in the Simcat SAGIS Scenarios modelled.

Scenario	Point Sector Measures	Diffuse Sector Measures	Model
Actual (2014 to 2020)*	Observed discharge flow and quality (2014 to 2019). Where not available, defaults used.	Current activities as represented post model calibration.	PR24 Calibration
2030 Optimistic	Water company AMP8 quality permit limits incorporated where applicable**	Current activities as represented post model calibration.	PR24 Calibration
2030 At Permit	All discharges represented at permitted flow and quality values up to and including AMP8**	Current activities as represented post model calibration.	PR24 At Permit
2030 Full Regulation	All discharges represented at permitted flow and quality values up to and including AMP8**	Rural land use inputs reduced by Full Regulation values from Farmscoper v5 (Table 2).	PR24 At Permit
2030 Theoretical Maximum	All discharges represented at permitted flow and quality values up to and including AMP8**	Rural land use inputs reduced by Theoretical Maximum values from Farmscoper v5 (Table 2).	PR24 At Permit

*Previously referred to as the 'recent' scenario.

**Does not include any discharge flow increases that may be required to support growth.

Table 2: Phosphate and nitrate percentage reductions applied to the rural land use sector in the Simcat SAGIS scenarios, values produced through Farmscoper v5 modelling.

Scenario	Description	Phosphate	Nitrate
Full Regulation	100% uptake of Regulatory measures, 25% uptake of Farming Rules for Water 'reasonable' Regulatory measures and 'current' uptake of voluntary measures.	9%	2%
Theoretical Maximum	100% uptake of all measures in Farmscoper v5.	38%	15%

Ant Broads and Marshes modelled outputs

We estimate the phosphate catchment input load source apportionment to be 64% point source and 36% diffuse source in the Actual (2014 to 2020) scenario. Urban sources (23%) dominate the diffuse sector (Table 3). The source apportionment changes incrementally under the subsequent scenarios. When we apply the Full Regulation and Theoretical Maximum reductions to the rural land use sector, the contribution from the rural land use sector falls from 8% in the 2030 At Permit scenario to 7% and 3% respectively.

For the nitrate catchment input load source apportionment, we estimate point sources to be 21% and diffuse sources 79% in the Actual (2014 to 2020) scenario. Rural land use sources (74%) dominate the diffuse sector (Table 4). The source apportionment changes incrementally under the subsequent scenarios. When we apply the Theoretical Maximum reductions to the rural land use sector, the contribution from the rural land use sector falls from 78% in the 2030 At Permit scenario to 75%.

We estimate the baseline (2009) sector share of the phosphate protected site target to be 50% diffuse and 50% point. This gives a sector share of 0.008mg/l for both the diffuse and point sectors (Table 5). The estimated phosphate concentrations at modelled assessment point ANT130 in the Actual (2014 to 2020) scenario exceed the sector share of the targets (Table 5). For the sector share to be met, the diffuse sector concentrations need to reduce by an estimated 26% and point sector concentrations by 76%. With both the Full Regulation and Theoretical Maximum reductions applied to the rural land use sector, the residual reductions needed to meet the diffuse sector share are 20% and 8% respectively (Table 5).

We estimate the baseline (2009) sector share of the protected site total nitrogen target to be 91% diffuse and 9% point (based on nitrate concentrations). This gives a diffuse sector share of 0.974mg/l and a point sector share of 0.096mg/l (Table 6). Both sector shares are estimated to be exceeded in the Actual (2014 to 2020) scenario (Table 6). The diffuse sector concentrations need to reduce by an estimated 37% and point sector concentrations by 92%. With both the Full Regulation and Theoretical Maximum reductions applied to the rural land use sector, the residual reductions needed to meet the diffuse sector share are 34% and 24% respectively (Table 6).

Input load source apportionment

Tables 3 and 4 show the estimated catchment input load source apportionment figures for each scenario modelled for both phosphate and nitrate. We have greatest confidence in the point sector loads where monitoring data is available. Confidence reduces where the contribution from the sector is based on estimates rather than observed data, such as the diffuse sectors. Apportioning the input loads gives an indication of which sector is the dominant nutrient source.

Table 3: Estimated catchment input load phosphate source apportionment at ANT130.

Scenario	Point Sources	Rural Land Use	Urban	Septic Tanks	Other
Actual (2014 to 2020)	64.4%	8.4%	22.9%	4.3%	0.0%
2030 Optimistic	60.0%	9.5%	25.7%	4.8%	0.0%
2030 At Permit	65.7%	8.1%	22.0%	4.1%	0.0%
2030 Full Regulation	66.5%	7.0%	22.3%	4.1%	0.0%
2030 Theoretical Maximum	69.1%	3.4%	23.2%	4.3%	0.0%

Table 4: Estimated catchment input load nitrate source apportionment at ANT130.

Scenario	Point Sources	Rural Land Use	Urban	Septic Tanks	Other
Actual (2014 to 2020)	21.1%	73.8%	0.7%	0.1%	4.3%
2030 Optimistic	10.3%	83.9%	0.8%	0.1%	4.9%
2030 At Permit	16.2%	78.4%	0.7%	0.1%	4.5%
2030 Full Regulation	16.4%	78.1%	0.7%	0.1%	4.6%
2030 Theoretical Maximum	18.4%	75.5%	0.8%	0.1%	5.2%

Input concentrations and reductions

The in-river modelled concentrations arise from the input loads, after the influence of river dilution and natural decay processes in the river have been simulated. Tables 5 and 6 show the in-river concentration at modelled assessment point ANT130 (Map 1) to be consistent with the revised polluter pays principle methodology (v.0.17) used in the PR24 water company price reviews.

Apportionment by concentration and by load can be different because inputs from different sources tend to occur under different river flow conditions. Inputs from treatment works occur continuously while diffuse source inputs tend to occur under higher river flow conditions where there is greater dilution available in the receiving water. As a result, a kilogram of phosphorus discharged from a treatment works will have a relatively greater impact on in-river concentrations than the equivalent input from diffuse sources.

Table 5: Phosphate sector share (converted from total phosphorus) alongside modelled concentrations (mg/l) and estimated percentage reductions needed across all scenarios at modelled assessment point ANT130.

Scenario and Assessment Metric	Diffuse	Point	Total
Baseline (2009) sector share of the target at ANT130	50%	50%	
Sector share of the target (mg/l)	0.008	0.008	0.015
Actual (2014 to 2020) - modelled sector concentration (mg/l)	0.010	0.031	0.041
Actual (2014 to 2020) - reduction to meet sector share	26%	76%	64%
2030 Optimistic – modelled sector concentration (mg/l)	0.010	0.023	0.033
2030 Optimistic – reduction to meet sector share	26%	67%	55%
2030 At Permit – modelled sector concentration (mg/l)	0.010	0.031	0.041
2030 At Permit – reduction to meet sector share	26%	76%	64%
2030 Full Regulation – modelled sector concentration (mg/l)	0.009	0.031	0.040
2030 Full Regulation – reduction to meet sector share	20%	76%	63%
2030 Theoretical Maximum – modelled sector concentration (mg/l)	0.008	0.031	0.039
2030 Theoretical Maximum – reduction to meet sector share	8%	76%	62%

Table 62: Total nitrogen sector share alongside modelled nitrate concentrations (mg/l) and estimated percentage reductions needed across all scenarios.

	Diffuse	Point	Total
Baseline (2009) sector share of the target at ANT130	91%	9%	
Sector share of the target (mg/l)	0.974	0.096	1.07
Actual (2014 to 2020) - modelled sector concentration (mg/l)	1.546	1.216	2.762
Actual (2014 to 2020) - reduction to meet sector share	37%	92%	61%
2030 Optimistic – modelled sector concentration (mg/l)	1.544	0.459	2.003
2030 Optimistic – reduction to meet sector share	37%	79%	47%
2030 At Permit – modelled sector concentration (mg/l)	1.489	0.793	2.282
2030 At Permit – reduction to meet sector share	35%	88%	53%
2030 Full Regulation – modelled sector concentration (mg/l)	1.465	0.793	2.258
2030 Full Regulation – reduction to meet sector share	34%	88%	53%
2030 Theoretical Maximum – modelled sector concentration (mg/l)	1.287	0.793	2.079
2030 Theoretical Maximum – reduction to meet sector share	24%	88%	49%

Input load figures used to calculate source apportionment

Table 7: Estimated phosphate catchment input loads (kg/d) and input load source apportionment after calibration, before in-river processes. These are estimates of total catchment loads and not estimates of loads entering the Ant Broads and Marshes protected area because loads enter the site under high river flow and/ or pumped conditions.

Scenario	STW (kg/d)	Intermittents (kg/d)	Industrial (kg/d)	Rural Land Use (kg/d)	Urban (kg/d)	Septic Tanks (kg/d)	Highways (kg/d)	Point (%)	Rural Land Use (%)	Urban (%)	Septic Tanks (%)	Other (%)
Actual (2014 to 2020)	1.860	0.051	0.000	0.250	0.678	0.126	0.000	64.4%	8.4%	22.9%	4.3%	0.0%
2030 Optimistic	1.532	0.051	0.000	0.250	0.678	0.126	0.000	60.0%	9.5%	25.7%	4.8%	0.0%
2030 At Permit	1.971	0.051	0.000	0.250	0.678	0.126	0.000	65.7%	8.1%	22.0%	4.1%	0.0%
2030 Full Regulation	1.971	0.051	0.000	0.214	0.678	0.126	0.678	66.5%	7.0%	22.3%	4.1%	0.0%
2030 Theoretical Maximum	1.971	0.051	0.000	0.101	0.678	0.126	0.000	69.1%	3.4%	23.2%	4.3%	0.0%

Table 8: Estimated nitrate catchment input loads (kg/d) and input load source apportionment after calibration, before in-river processes. These are estimates of total catchment loads and not estimates of loads entering the Ant Broads and Marshes protected area because loads enter the site under high river flow and/ or pumped conditions.

Scenario	STW (kg/d)	Intermittents (kg/d)	Industrial (kg/d)	Rural Land Use (kg/d)	Urban (kg/d)	Septic Tanks (kg/d)	Highways (kg/d)	Atmospheric Deposition (kg/d)	Point (%)	Rural Land Use (%)	Urban (%)	Septic Tanks (%)	Other (%)
Actual (2014 to 2020)	58.340	0.302	0.000	205.050	1.851	0.326	0.000	11.880	21.1%	73.8%	0.7%	0.1%	4.3%
2030 Optimistic	24.980	0.302	0.000	205.050	1.851	0.326	0.000	11.880	10.3%	83.9%	0.8%	0.1%	4.9%
2030 At Permit	42.020	0.302	0.000	205.050	1.851	0.326	0.000	11.880	16.2%	78.4%	0.7%	0.1%	4.5%
2030 Full Regulation	42.020	0.302	0.000	201.200	1.851	0.326	0.000	11.880	16.4%	78.1%	0.7%	0.1%	4.6%
2030 Theoretical Maximum	42.020	0.302	0.000	173.410	1.851	0.326	0.000	11.880	18.4%	75.5%	0.8%	0.1%	5.2%

References

Defra (2019a). A national scale assessment of current and future actions to reduce diffuse pollution of water by agriculture. Report by ADAS for Defra project WT1594: 1-47.

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List of abbreviations

ADAS – UK-based independent agricultural and environmental consultancy, previously National Agricultural Advisory Service (NAAS).

AMP8 WINEP – Asset Management Plan 8 (2025 – 2030) Water Industry National Environment Programme - [Water industry national environment programme \(WINEP\) methodology - GOV.UK](#)

CSMG – Common Standards Monitoring Guidance – includes guidance on the appropriate standards and targets for designated sites [Common Standards Monitoring Guidance for Freshwater Habitats | JNCC Resource Hub](#)

DWPP – Diffuse Water Pollution Plan

NEAP-N – ADAS model providing annual 1 km grid loadings of nitrate.

PR – [Price Review https://www.ofwat.gov.uk/regulated-companies/price-review/](https://www.ofwat.gov.uk/regulated-companies/price-review/)

PSYCHIC – ADAS model providing annual 1 km grid loadings of Phosphate.

SAC – Special Area of Conservation

SAGIS – Source Apportionment Geographical Information System

SPA – Special Protection Area

SSSI – Site of Special Scientific Interest

UKWIR – United Kingdom Water Industry Research

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