Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Evidence based targeting of agricultural measures to reduce nitrogen in catchments to achieve water quality objectives

August 2025

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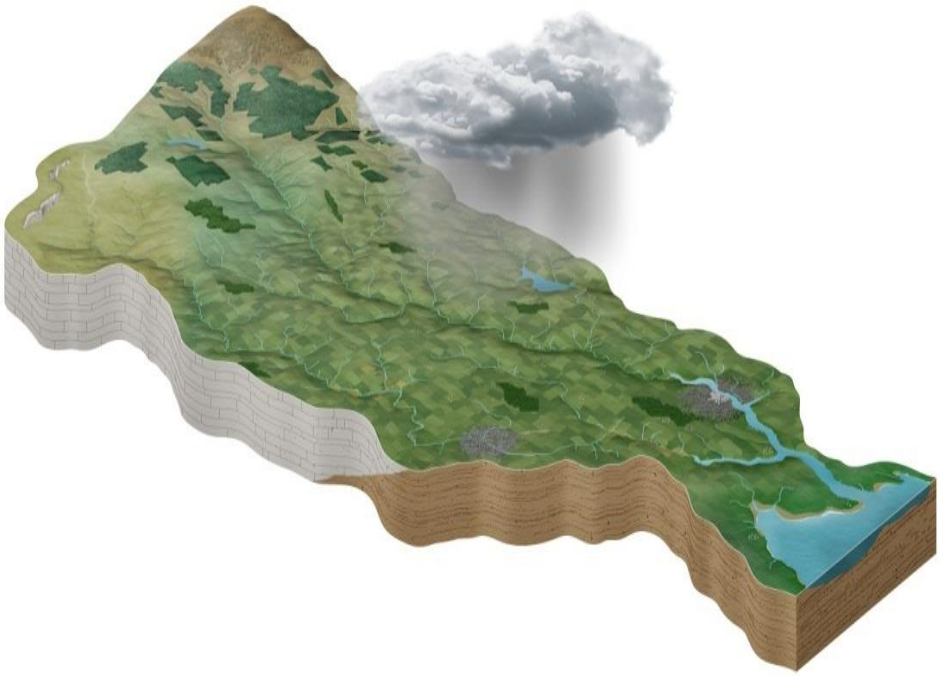

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Environmental Protection Agency
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Summary

While progress is being made, water quality in Ireland is not on track to meet the objectives of the EU Water Framework Directive (WFD) by 2027. All sectors have a role to play, but nutrient pollution from agriculture remains the most widespread pressure impacting on water quality. Ongoing targeted actions, by all farmers, are needed to protect and restore water quality to deliver the environmental outcomes that are required. In recent years, the EPA has improved the evidence base for targeting agricultural measures and has increased the frequency of publishing reports, indicators, and data to support evidence-based actions by all stakeholders. This includes the twice-yearly update of the early insights indicator for nitrogen and the on-line mapping tool for the Farm and Landscape measures for Agriculture (FLAG) map (previously the Targeting Agricultural Measures map).

This report outlines three updates to the evidence base to support targeting the right measures in the right place to improve water quality. The first update is the assessment of the catchments that need nitrogen load reductions to support good estuarine ecological conditions which incorporates more recent monitoring data since first reported by the EPA in 2021, and some improvements to the assessment methodology. The second update follows the same methodology to look back at changes in the reductions required over a 35-year period since 1990 at representative monitoring stations. Thirdly, the FLAG map has also been updated with monitoring data up to 2024, along with the other multiple lines of evidence used to indicate where agricultural measures are needed to restore water quality.

The results of the load reduction assessment indicate that nitrogen losses in our catchments have decreased in recent years. Consequently, the amount of nitrogen that must be reduced to meet ecological targets has also declined across all but one location (the Blackwater catchment) compared to the previous assessment which was based on the 2017–2019 reporting period.

Nitrogen load reductions were assessed at 20 representative downstream catchment monitoring stations on major rivers across Ireland. These stations provide an estimate of the average distance to target for their respective upstream catchment areas. Based on data from 2022–2024, seven of the 20 stations still require nitrogen reductions, ranging from 2% to 38%. The highest annual reductions are needed at the Barrow station (~2,100 tonnes), followed by the Slaney station (~1,100 tonnes). The five other catchment stations needing nitrogen reductions are the Bandon, Blackwater, Boyne, Nore and Suir catchments.

The remaining 13 stations have met their nitrogen targets: the Avoca, Corrib, Deel, Dodder, Erne, Fergus, Garavogue, Lee, Liffey, Maigue, Moy, Shannon and Tolka catchments. This marks an improvement since the previous reporting period - both the number of catchment stations requiring reductions and the scale of those reductions have decreased: 10 stations needed an average reduction of 18% for the 2017-2019 period, which has now decreased to 7 stations with an average required reduction of 16% based on data for 2022-2024. However, the current results still fall short of the levels observed between 2008 and 2011, which remains the period when nitrogen levels were closest to meeting ecological targets over the past 35 years.

Ongoing action will be needed in freely draining agricultural areas to keep nitrogen at a sustainable level in catchments where the levels are close to the threshold. These include the Maigue/Deel, Liffey, and Tolka catchments. In the case of the Lee catchment, while the nitrogen targets have been met at the representative downstream river monitoring point, nitrogen levels

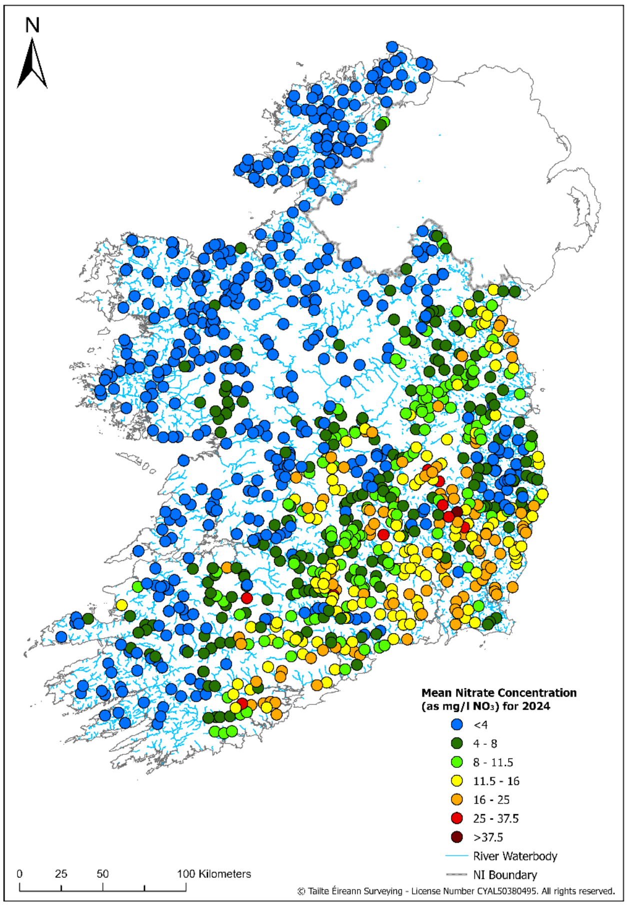
are still elevated in some sub-catchments above the monitoring station, and most sub-catchments below the river monitoring station. These areas are still contributing nitrate to the estuary that is in unsatisfactory ecological condition. These subcatchment areas are therefore highlighted in the FLAG map.

To support the on-going targeting of all types of agricultural issues that require measures, the FLAG map was updated with the most recent information available for each water body. Orange areas on the map indicate areas to reduce nitrate losses, navy areas are for measures to reduce phosphorus/sediment losses, and red areas indicate that there is a potential farm point source issue. Within each water body, the relevant Pollution Impact Potential (PIP) map can be used for further targeting within the critical source areas for either nitrogen or phosphorus.

These tools and assessments demonstrate how combining load reduction calculations and mapping tools can support efforts to target measures to reduce nitrate losses to water. In the areas with excess nitrogen, measures should include full compliance with the GAP Regulations, and significant improvements in nitrogen use efficiency to reduce the nitrogen surplus and therefore the amount of nitrogen that is available for leaching. An overall reduction in nitrogen loads may also be required in those catchments and subcatchments where nitrates levels are substantially in excess of the levels needed to support good water quality.

1. Introduction

The primary water quality issue of concern in Ireland is elevated concentrations of nutrients, i.e. nitrogen and phosphorus. Excess nutrients in waters leads to eutrophication when an overgrowth of algae causes unsatisfactory oxygen conditions, that in turn impacts on the health of our aquatic ecosystems. Nitrogen losses to transitional waters are of particular concern as these waters are sensitive to excess nitrogen and they are in the poorest ecological condition of all waterbody types – 36% of transitional waters were in satisfactory condition in the most recent assessment (2016-2021)[1]. The river monitoring data (Map 1) shows the mean nitrate concentrations for river monitoring stations in 2024, with elevated concentrations in rivers in the south-east.



Map 1: Average nitrate concentrations in rivers (2024)[2]. Concentrations >11.5 mg/l as NO_3 (equivalent to 2.6 mg/l as N) are elevated and need to be reduced to support Good ecological status in the estuaries and coastal waterbodies.

The EPA continues to improve the evidence base for targeting agricultural measures, and has increased the frequency of publishing reports, indicators, and data to support evidence-based actions by all stakeholders (Table 1).

[1] WaterQuality_SummaryReport.pdf
[2] https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/water-quality-monitoring-report-on-nitrogen-and-phosphorus-concentrations-in-irish-waters-2024.php

Table 1. EPA evidence to support targeting agricultural measures.

EPA report / indicator / data	Content	Key evidence / insights
Farm and Landscape measures for Agriculture (FLAG) map (formerly the Targeting Agricultural Measures map)	Types of agricultural issues that require targeted measures in each water body.	Mapping tool to support targeting of measures by all stakeholders.
Early insights indicator for nitrogen concentrations	Nitrogen concentrations in representative downstream monitoring stations of 20 major rivers. Updated twice per year.	Indicates the trajectory of nitrate concentrations at national and regional levels.
Nitrogen load reduction indicator (see Section 2 below)	Nitrogen load reduction estimates in the same downstream monitoring station of 20 major rivers, based on 3 years data.	Indicator of the distance to target for major catchments to support good estuarine water quality.
Water quality monitoring report on nitrogen and phosphorous concentrations in Irish waters	Phosphorus and nitrate data from the national water quality monitoring programme for groundwater, rivers, lakes, estuarine and coastal waters. Reported annually.	Spatial overview and regional assessment of data from monitoring stations from all waterbody types that are representative of the impact of agriculture on water quality.
Water Quality Indicator Report	Annual updates of key water quality indicators including nutrients and biology. Published in the first two of every three year monitoring period, and included in the Water Quality in Ireland report every three years.	Progress with key biological and nutrient water quality indicators in all catchments.
Water Quality in Ireland Report	Three-yearly integrated assessment of the health of Irelands rivers, lakes, canals, estuaries, coastal waters and groundwaters.	Full assessment of water quality as required under the Water Framework Directive. Includes results for water quality indicators and overall ecological status
Source Load Apportionment Model (SLAM)	Assessment of nitrogen load contributions to water by sector.	Agriculture is the dominant source of nitrogen in the areas highlighted as requiring measures.
Nitrate concentration data	Nitrate concentration data for all monitored stations available on catchments.ie	Publicly accessible data to support evidence-based targeting of measures, and tracking progress with outcomes, by all stakeholders.
Pollution Impact Potential Maps (PIP maps)	Maps that highlight the highest risk areas in the landscape for losses of nitrogen and phosphorus to waters	Maps for targeting the right measure in the right place to address local risks to water quality
Significant pressure assessments: Agriculture	Report on agriculture as a significant pressure impacting water quality. One of a series of reports on each pressure type.	Describes the evidence base underpinning the waterbody level assessments of the impacts of agriculture on water quality. Includes links to find out more about local areas

These reports highlight that the most frequent issue impacting water quality from agricultural activities are loss of excess nutrients from diffuse sources such as spreading of fertilisers and manures, or from point sources such as farmyards. Excess nitrogen is the main issue for estuaries and coastal waters with nitrogen losses particularly associated with free draining soils in the south-eastern half of the country. Measures to reduce nitrogen leaching are needed in these areas. Excess phosphorus and sediment are the main issues for our rivers and lakes and are more typically associated with areas where the soils are poorly draining, such as in Cavan, Monaghan and parts of Limerick for example. Pathway interception measures that interrupt the connections between the land and watercourses, such as buffer zones, are needed in these areas.

This report provides three inter-related updates to the evidence-base:

(1) the assessment of the catchments that need nitrogen reductions to support good estuarine and coastal ecological conditions which incorporates more recent monitoring data since first reported by the EPA in 2021,
(2) the changes in the nitrate distance-to-targets over a 35-year period since 1990 for these representative catchments as outlined above, and
(3) the Farm and Landscape measures for Agriculture (FLAG) map (formerly the Targeting Agricultural Measures map) has also been updated with monitoring data up to 2024, along with the other multiple lines of evidence used to indicate where agricultural measures are needed to restore water quality.

2. Nitrogen load reduction indicator (update 1)

2.1 Overview of nitrogen load reductions to-date

In June 2021, the EPA published an assessment on the nitrogen reductions that were needed in major catchments to support healthy aquatic ecosystems, i.e. to achieve at least Good Ecological Status under the Water Framework Directive[3]. The assessment was based on monitoring data up to and including 2019. The assessment found that there were several Catchments of Concern in the south-eastern half of the country where nitrogen concentrations exceeded the standard needed to protect the ecology of our estuarine and coastal waters[4]. The report highlighted the scale of the nitrogen loads discharging to sea from these catchments, and that needed to be reduced to levels that support good ecological condition.

This report provides an update to that assessment using monitoring data for the period up to and including 2024. Both reports use the same representative river monitoring sites used in the recently published Early Insights Nitrogen Indicator[5] report which highlighted that nitrogen levels in rivers in 2024 have reduced compared to recent years. However, the levels remain too high in the south-eastern catchments. The results presented here build on chemistry results previously reported and indicate the magnitude of the nitrate load reductions that remains for the Catchments of Concern. Some improvements to the assessment methodology have also been applied which are explained throughout.

2.2 Assessment Methodology

The steps in the assessment, along with the changes and updates to the methodology, are as follows:

Step 1: Annual Mean Concentrations

The flow weighted mean Total Oxidised Nitrogen (TON) concentrations are calculated for each catchment (Table A1, Appendix 1). Flow weighted concentrations place more weight on measurements taken during higher flows as these periods contribute the greater volume in a given year.

The form of nitrogen used in the original assessment was Total Nitrogen (TN), which includes both the organic and inorganic fractions. This assessment was updated to use Total Oxidised Nitrogen (TON) as this is the most bioavailable fraction of TN. This also facilitates an integrated assessment of fresh and marine waters as the EPA's national freshwater monitoring network monitors for TON at most sites. For some estuaries, longer residency times means that organic nitrogen forms can be converted to the bioavailable inorganic forms and can contribute to biological impacts and hence the TN values are being kept under a watching brief. For this reason and to facilitate comparison with the previous report, the results tables for TN are presented in Appendix 2.

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[3] https://www.catchments.ie/assessment-of-the-catchments-that-need-reductions-in-nitrogen-concentrations-to-achieve-water-quality-objectives/

[4] The dissolved inorganic nitrogen (DIN) standard for low salinity waters is 2.6 mg/L as N (or 11.5 mg/l as NO_3)

[5] Early insights indicator for nitrogen concentrations

Step 2: Annual Nitrogen Loads

The total annual load (tonnes) of nitrogen being discharged from each catchment is estimated based on the flow weighted mean concentrations and the river flows at each of the most downstream monitoring points of each catchment (Table A2, Appendix 1).

In the previous assessment, the loads for the total catchment were estimated based on the data at the most downstream monitoring point, but scaled up to whole catchment level, with the assumption that the rate of losses (i.e. kg/ha) were the same upstream and downstream of the monitoring station. This was done to include an estimate, based on extrapolation, of the additional contributions to the receiving transitional water from the unmonitored areas downstream of the monitoring point and via small coastal streams. In recent years, the evidence base has evolved, and the EPA FLAG map was developed using multiple lines of evidence to identify the waterbodies that require nitrogen measures based on local waterbody specific information. The simple catchment extrapolation is therefore no longer required. The catchment scaling factors used previously are however, included in Table A2 for comparison. The removal of the extrapolation means that the indicative nitrogen loads in this assessment are lower than was reported previously. The catchment areas are also revised to indicate the areas draining to each catchment's monitoring point (Table 2 and Table A1). Areas downstream of the monitoring point are nevertheless included in the FLAG map and measures continue to be targeted in areas where the evidence shows that nitrogen losses are too high (see Section 4).

Step 3: Annual Nitrogen Reductions

The nitrogen load reductions (tonnes) needed to achieve the nitrogen standard in the estuaries to protect ecological health (2.6 mg/l as N, or 11.5 mg/l as NO_3) are estimated for each catchment (Table A3, Appendix 1). As outlined in Step 2, the load reduction estimates are based on the data at the monitoring point and are not extrapolated to the total catchment area as per the previous report. Hence, the values in tonnes reported are lower in this update than reported previously. The results for the previous reporting period (2017-2019) are recalculated and presented alongside the updated results in Table 2. The catchment scaling factors used previously are included in Table A2 for reference. These stations provide an estimate of the average distance to target for their respective upstream catchment areas and contribute one line of evidence to the total catchment assessment of nitrate issues (see Appendix 2).

2.3 Results

Annual Nitrogen Concentration Variability

Figure 1 shows the distributions of the flow weighted mean concentrations for the major catchments in the south-eastern half of the country. The Barrow and Slaney have the highest concentrations which are much higher than the standard of 2.6 mg/l as N (green dashed line). The Nore, Boyne, Bandon, Blackwater, and Suir exceed the standard most of the time but are lower than the Barrow and the Slaney. The Liffey, Lee, Deel, Tolka and Maigue, catchments typically have mean concentrations below the standard. The flow weighted mean TON concentrations for the catchments are in Table A1, Appendix 1. No new catchments have shown exceedances of the standard in the five years since the previous report.

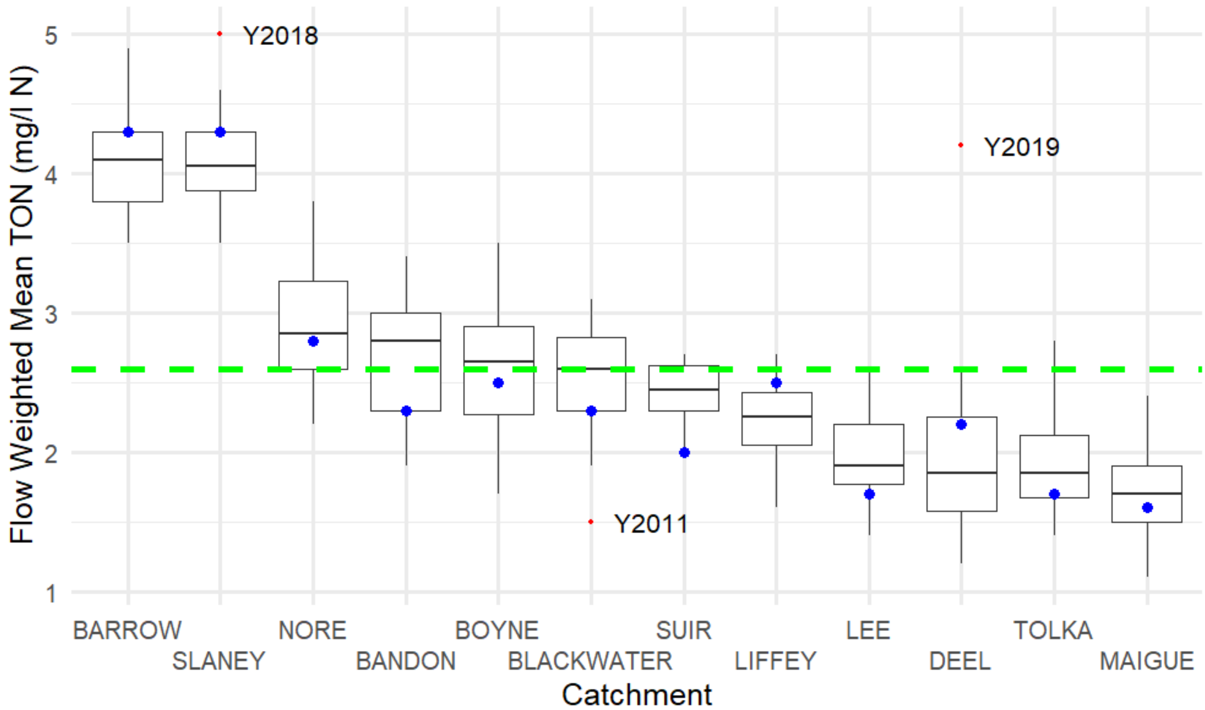


Figure 1. Distribution of total oxidised nitrogen (TON) flow weighted mean concentrations for Catchments of Concern 2009-2024. This chart is called a box plot. The boxes represent the spread in concentrations for the middle 50% of the data (between the 25th and 75th percentiles), for each catchment for all years. The line in the middle of each box is the median concentration for each catchment, for all years. The blue dots represent the most recent concentration (2024). The red dots and associated year are outliers (unusual data). The green dashed line is the environmental quality standard for nitrogen to support good ecological status (2.6 mg/l as N, or 11.5 mg/l as NO_3).

Catchment Based Nitrogen Load Reductions

This assessment using data up to 2024 found that the nitrogen load reductions required to support good ecological condition has decreased in recent years compared with the previous assessment (Table 2). Both the number of stations requiring reductions, and the scale of those reductions have decreased: 10 stations needed reductions of up to 43% for the 2017-2019 period[6], which has now decreased down to 7 stations with a maximum required reduction of 38% based on data for 2022-2024. This improvement reflects the reduction from peak nitrate emissions observed in 2018/2019 following the 2018 drought. The greatest level of reductions is needed at the Barrow catchment monitoring station (approximately 2,100 tonnes, or 38%), followed by the Slaney catchment monitoring station (approximately 1,100 tonnes, or 31%).

Table 2: Nitrogen (N) load emissions and the nitrogen load reduction required (%) calculated at downstream monitoring stations of major rivers.

Catchment	Area (km^2)	Agricultural Area (km^2)	High PIP-N Area (km^2)	N load 2017-2019 (tonnes)	N Reduction required 2017-2019	N load 2022-2024 (tonnes)	N Reduction required 2022-2024
Bandon	514	414	237	1932	18%	1870	8%
Barrow	2820	2020	689	5572	42%	5521	38%
Blackwater	2440	1870	630	4780	6%	5591	11%
Boyne	2630	2010	447	4145	19%	4311	7%
Deel	515	440	101	1059	20%	671	0%
Lee	1150	883	454	3091	0%	2206	0%
Liffey	1120	688	94.3	1381	2%	1014	0%
Maigue	807	696	187	967	0%	687	0%
Nore	2420	1900	631	4155	24%	4224	16%
Slaney	1320	1040	434	4399	43%	3602	31%
Suir	2640	2060	717	4686	1%	4739	2%
Tolka	164	67	67	119	5%	137	0%

Of the seven catchments identified as requiring targeted nitrate measures, the average load reduction is now 16% to reach the maximum levels acceptable for good estuarine health. The distance to target has reduced across all locations except for the Blackwater catchment (Figure 2). In the case of the Maigue/Deel, Liffey, and Tolka, no further TON load reductions are required for their respective upstream catchment areas based on measurements at the monitoring station to achieve the nitrogen threshold in their estuaries. Ongoing implementation of measures to protect water quality and to address localised nitrate issues will however be required. Section 4.3 provides further details on how this evidence contributes to the catchment assessments of nitrate issues.

[6] The reductions reported here for the 2017-2019 period are lower compared with the values from the 2021 assessment due to changes in the methodology outlined in Section 2.2.

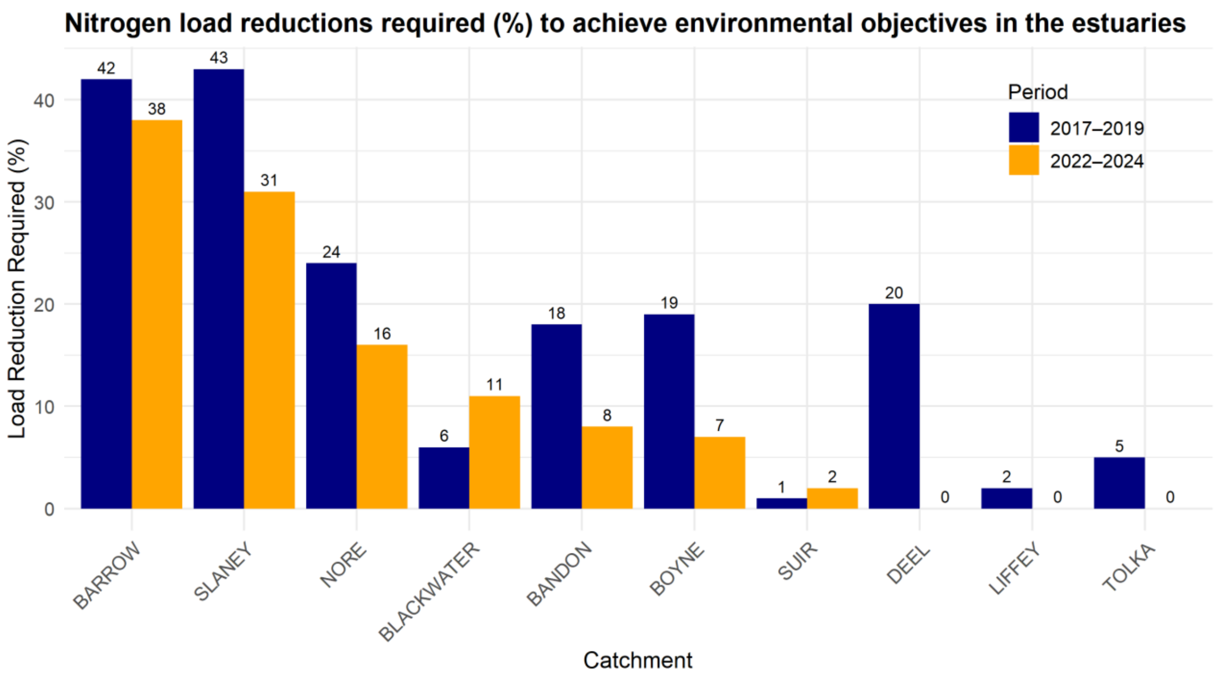


Figure 2: Comparison of Total Oxidised Nitrogen load reductions (%) at the representative monitoring stations for 2017-2019 and 2022-2024. The results are in order of the reductions required for 2022-2024. Stations with no reductions required in either period are not shown.

The load reductions presented provide an indication of the relative scale of effort needed in different catchments to achieve water quality targets. These reductions relate to the nitrate that enters water after the attenuation and denitrification in the landscape, and they average out the variations and influences of different soil types and farm practices in the upstream catchments.

3. Long-term trends in catchment nitrogen data (update 2)

3.1 Catchment nitrogen loads and required reductions since 1990

The percentage load reductions from 1990 to 2024 (Figure 3) reveals significant temporal variability in the required reductions in nitrate emissions across the representative river catchments to meet the levels needed for good estuarine water quality. These values provide an indication of the relative scale of effort needed in different catchments, highlighting where the most significant interventions are necessary to improve water quality. The variability in required reductions over time is influenced by multiple factors, including weather patterns and agricultural practices.

The year 1996 recorded the highest total nitrogen load emissions from these stations of 73,859 tonnes, and 2008 showed the lowest total nitrogen load emissions from the stations of 31,953 tonnes. The average required nitrogen load reductions were at the lowest in 2008 and 2011. In 2008, 2009 and 2011, there were only two catchments with mean annual TON concentrations greater than 2.6 mg/l as N, and therefore that needed load reductions (Figure 4). The tables of annual concentration data, total nitrogen loads and the calculated required load reductions for each station are available for download: https://gis.epa.ie/GetData/Download.

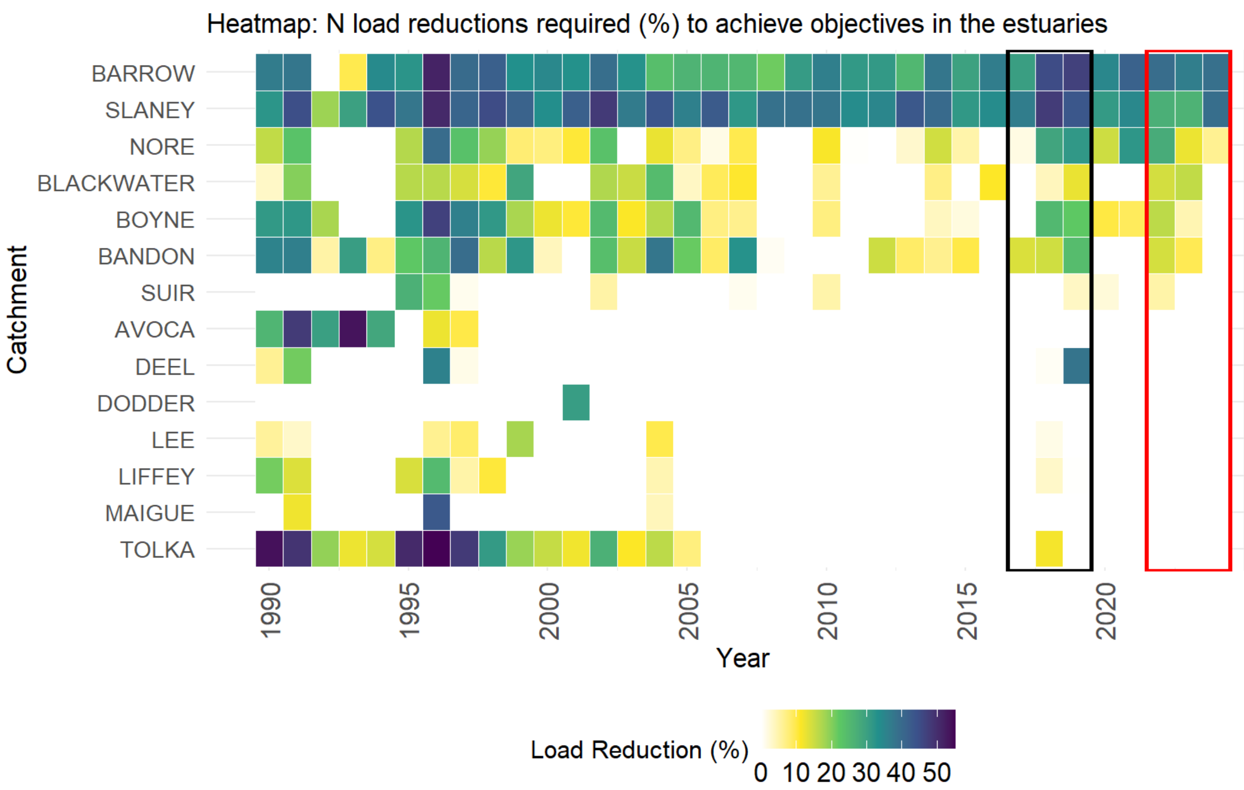


Figure 3. Heatmap of the percentage annual nitrogen load reductions needed from 1990-2024 to achieve environmental objectives in the estuaries. Recent data for 2022-2024 (red box) and previously reported data for 2017-2019 (black box), in the context of the past 35 years. The darker the colour, the greater the load reductions needed in that year to achieve the environmental objectives. White indicates that no reductions were needed.

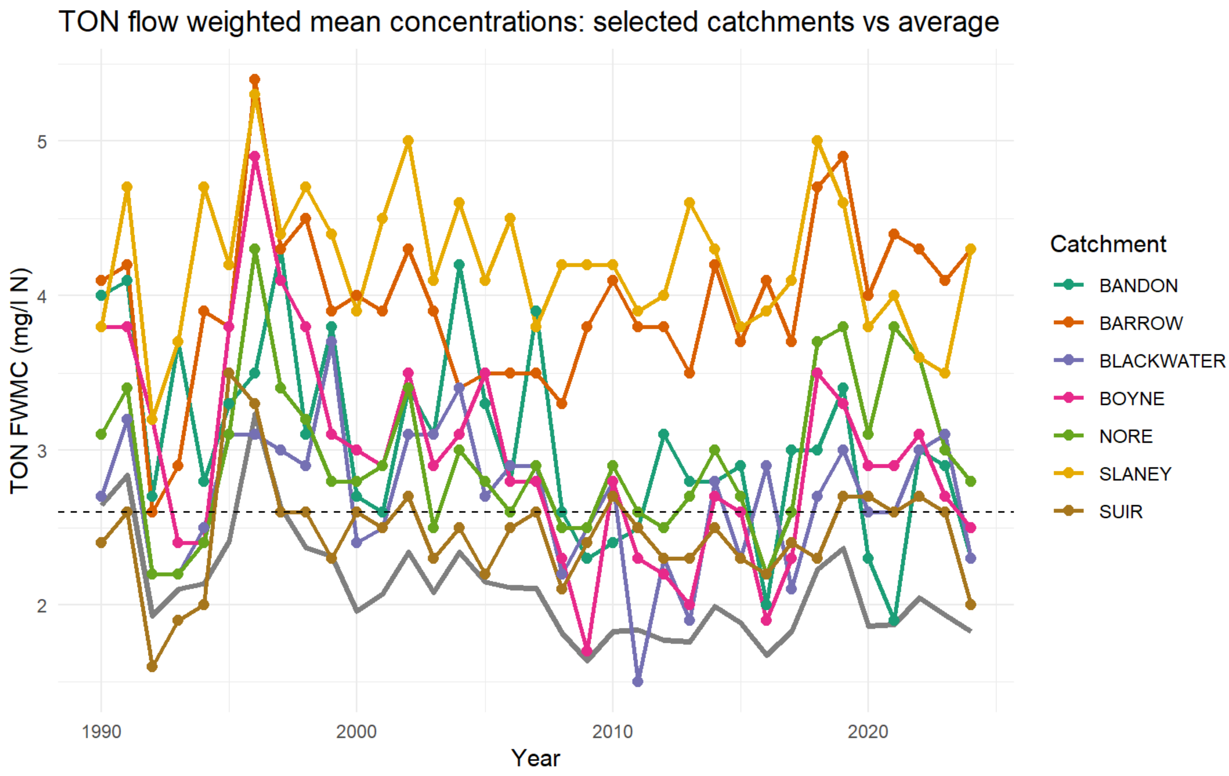


Figure 4. TON flow-weighted mean concentrations (FWMC) for 7 catchments that currently require load reductions to achieve the estuary water quality threshold of 2.6 mg/l N (dashed line) compared with the average annual TON FWMC of all representative river monitoring stations (grey line).

The Barrow and Slaney stand out, both in terms of their historical nitrate load contributions and the consistently high percentage reductions required, reflecting the large agricultural footprint and nutrient pressures present in combination with freely draining soils, and lower annual effective rainfall[7]. The Slaney catchment shows the highest average reduction required across the dataset, at approximately 35%, indicating a sustained need for substantial mitigation efforts. The Barrow catchment, while slightly lower in average reduction required (32%), shows a greater variability over the 35-year period.

The data highlights major improvements in nitrogen emissions in catchments such as the Tolka and Avoca since the 1990s. Catchments such as the Boyne, Blackwater, and Nore show some improvements since the mid-1990s peak, however varying levels of reductions are still required in most years, highlighting on-going water quality challenges.

The long-term dataset underscores the importance of targeted, catchment-specific strategies to achieve water quality targets. The consistently high required reductions in catchments like Slaney and Barrow highlight the need for sustained and targeted efforts to reduce nitrogen emissions to water. Understanding where and when these reductions are needed is essential for effective water policy and environmental protection.

[7] Effective rainfall is the fraction of annual rainfall that is available for infiltration (or recharge) into the ground, depending on rainfall characteristics, hydrogeological conditions and land cover.

3.2 Ecological recovery in Irish catchments

Of the 7 catchment monitoring stations that currently require nitrogen load reductions, the Blackwater catchment in Co. Cork is mid-table at 11% and is an example of an intensively farmed catchment where ecological recovery has occurred in the recent past. Nutrient losses from the catchment decreased substantially in the period up to 2012, from relatively high levels in the 1990s and 2000s when animal numbers and fertiliser use were at their highest. This resulted in a significant improvement in the ecology of the downstream estuary, to a satisfactory condition in the mid-2010s (Ni Longphuirt, et al., 2015[8]). Unfortunately, subsequent increases in nutrient losses occurred up until the late 2010s, which resulted in unsatisfactory ecological conditions returning in the early 2020s. This highlights two points, firstly, that Ireland's heterogenous landscape influences nutrient loss – the shallow geological systems with relatively high rainfall flush nutrients quickly enabling ecological recovery within a decade. Secondly, the experience in the Blackwater catchment is a reminder of the importance of maintaining improvements once they are achieved.

The scale of effort required is greater for the two catchments with the highest identified nitrate load reductions: the Barrow and the Slaney. Despite consistently elevated nitrate levels over the 35-year monitoring period - particularly for the Slaney - evidence suggests that the nutrient levels were within acceptable limits in the 1970s. Notably, surveys conducted by An Foras Forbartha in the early 1970s indicated that the Slaney estuary was in good health at that time (1972 Survey of the Slaney estuary[9]). Following several decades of nutrient enrichment, the current challenge is to achieve nitrate load reductions of over 30% to restore and protect water quality.

[8] Ni Longphuirt, et al. 2015. https://doi.org/10.1016/j.scitotenv.2015.03.076

[9] An Foras Forbartha 1980, Dispersion and Water Quality in Wexford Harbour and the Slaney Estuary, Vol 1: C_51_Wexford-Harbour_1980.pdf

4. Farm and Landscape measures for Agriculture: FLAG map (update 3)

4.1 Map development to-date

To assist in targeting agricultural actions, the EPA has developed the FLAG map to help inform the agricultural sector about where, and what kinds of supplementary actions are needed to improve water quality in addition to the basic measures[10].

The FLAG map draws together multiple lines of evidence to highlight spatially where the agricultural sector is a pressure impacting on water quality, what the specific water quality issue is (whether nitrogen, phosphorus/sediment or ammonia), and therefore what kind of measures are needed (whether source control, pathway interception or farmyard management). The lines of evidence include ecological status, water quality issues, nutrient trends and risk for each waterbody; landscape characteristics including soils and nutrient attenuation; assessments of all pressures impacting on waterbodies including source apportionment assessments; and measures being implemented. A catchment-based approach has been taken in the development of the map which means that the whole upstream catchment, or the areas draining to waterbodies that need reductions in nutrients have been included in the areas to be targeted for measures. Monitoring data and modelling outputs have both been used in the development of the map to ensure that it is based on the best available science.

The map is being used to target measures to achieve the specific water outcomes that need to be delivered in each waterbody by the agricultural sector. Four kinds of actions are identified:

- **Orange flag**: areas with nitrogen issues, where measures to reduce nitrogen leaching from agriculture are needed. Source control measures are likely to be the most effective.
- **Navy flag**: areas with phosphorus and sediment issues, where measures to prevent surface runoff from agricultural lands are needed. Pathway interception measures, such as buffer strips, are likely to be the most effective.
- **Red flag**: areas with high ammonium concentrations, where measures to prevent sources of manures and ammonium fertilisers entering water courses are needed. Compliance with the Good Agricultural Practice Regulations, especially around the farmyard, is likely to be the most effective.
- **White flag**: areas where either the environmental objectives have been met, or there are water quality issues but they are being caused by another pressure other than agriculture. Ongoing implementation of the basic measures, ensuring high rates of compliance is likely to be the most effective.

The FLAG map is currently being used by Local Authorities to target agricultural inspections[11], to guide discussions at farm scale between farmers and their advisors about what voluntary measures should be taken, and to support the implementation of the Better Farming for Water

[10] https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/water-quality-monitoring-report-on-nitrogen-and-phosphorous-concentrations-in-irish-waters-2022.php
[11] National Agricultural Inspection Programme (NAIP) | Environmental Protection Agency

Campaign, the Farming for Water EIP, agri-environment schemes, results-based payments programmes and various other water quality improvement projects.

4.2 FLAG map update 2025

The 2025 FLAG map update (Map 2) incorporates chemistry monitoring data from 2022 to 2024 and includes minor revisions to the assessment of significant agricultural pressures and local authority investigations.

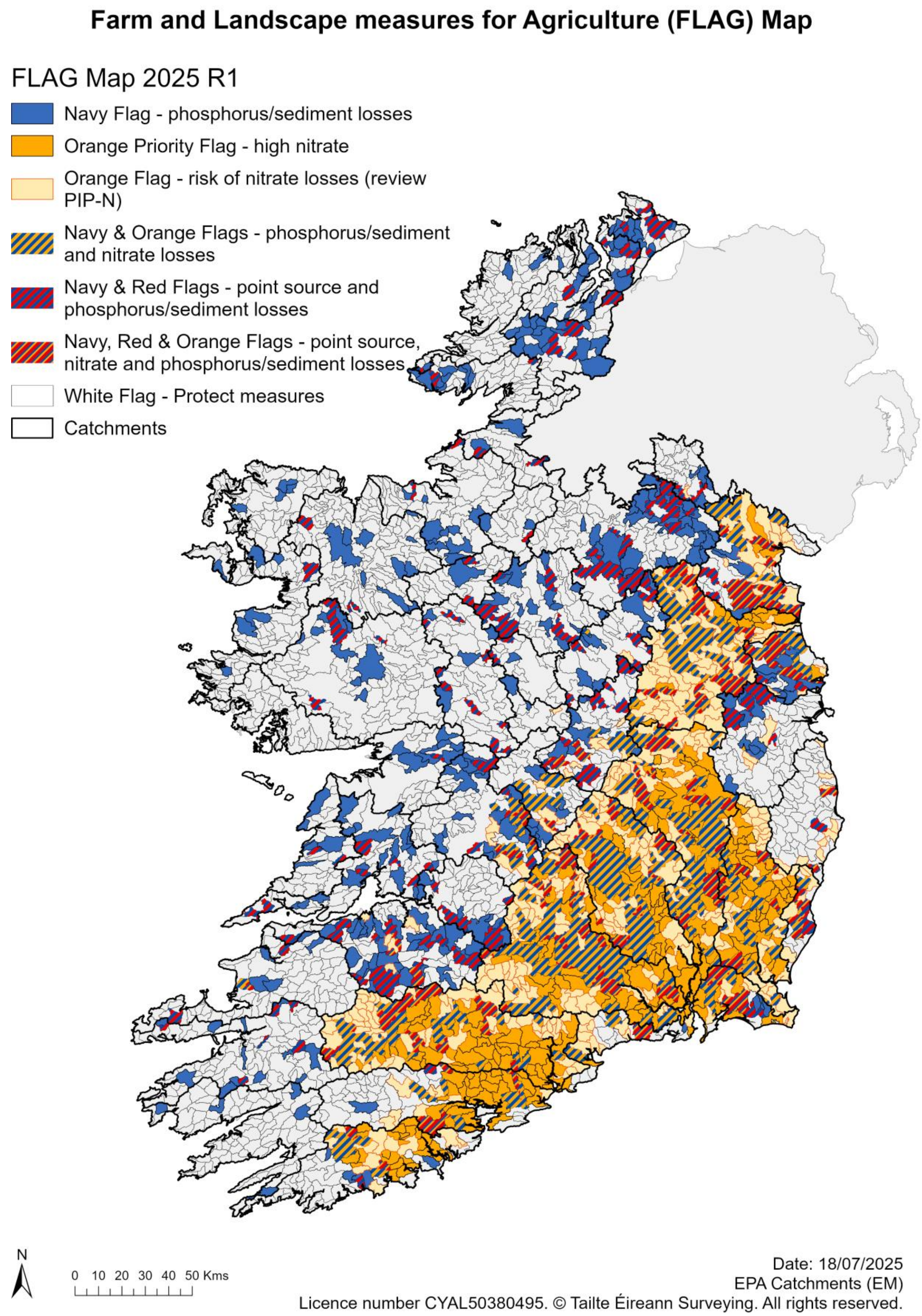
The areas with phosphorus and sediment issues (blue flags) are consistent with the previous map release, as these are driven primarily by the assessment of agriculture as a significant pressure. This is based on the most recent characterisation assessments available, which has not been substantially updated since the previous version of the map from 2023. A comprehensive assessment of water quality in Ireland is due for completion later in 2025 and this will be used to complete an updated assessment of the significant pressures in 2026. The changes in significant agricultural pressures will be reflected in the next update of the FLAG map.

The methodology to identify areas for ammonium/farmyard measures (red flags) in the map was updated in the current release – the ammonia threshold was increased from 0.04 to 0.065 mg/l in line with the Good Status boundary (S.I. No. 77/2019), and increasing trends are considered, along with spikes in biological oxygen demand (BOD) in the recent 3-year period. The number of waterbodies flagged has slightly increased from the previous map, based on these updates and an increase in information provided by the local authorities. All of these waterbodies are also identified as having phosphorus and sediment issues (blue flags). See Appendix 3 for an overview of the process to identify the waterbodies with farmyard organic pollution issues (red) and phosphorus/sediment issues (Navy) for the FLAG map.

4.3 Recognising local nitrogen issues in the FLAG map

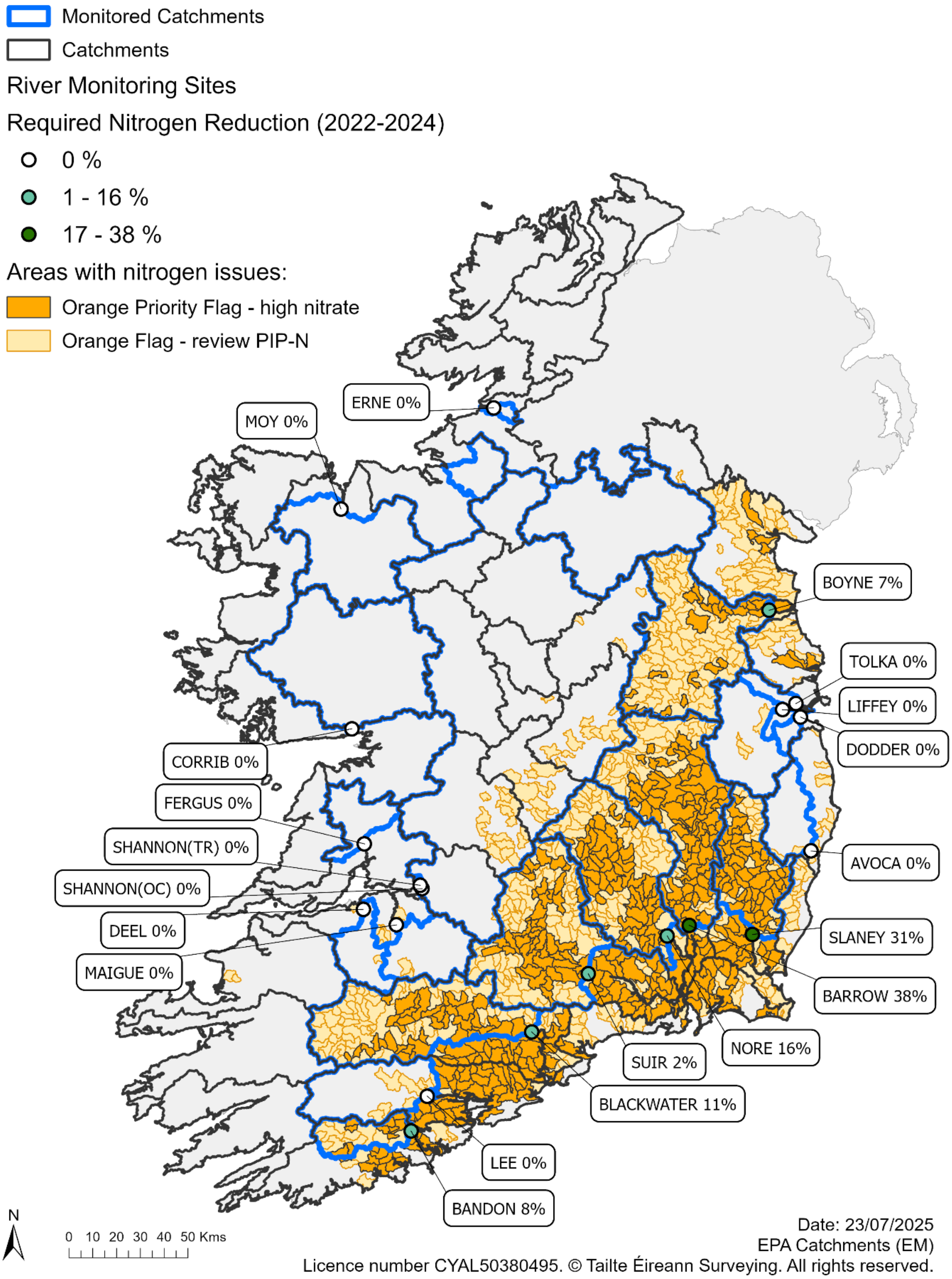
The areas with nitrogen issues (orange flags) are identified from a combination of the water quality in the downstream transitional and coastal water bodies and the river waterbody nitrate levels for 2022 to 2024. As with the red and navy flags, the changes in the waterbodies flagged with nitrate issues is relatively small, primarily due to changes in nitrate concentrations across the river monitoring network. See Appendix 3 for an overview of the process to identify the waterbodies with nitrate issues for the FLAG map.

The catchment-scale load reduction provided in Section 2 (Table 2) provides an indication of the relative level of effort required in the areas draining to each monitoring station. Comparing these monitored areas with the nitrate issues identified in the FLAG map reveals that, along the south coast, significant nitrate-impacted areas lie downstream of the river monitoring stations (Map 3). Therefore, the nitrate load reduction indicator should be interpreted in conjunction with the FLAG map to identify areas that need action to improve estuarine water quality.



Map 2: Farm and Landscape measures for Agriculture (FLAG) Map.

Nitrogen Load Reductions and Waterbodies with Nitrate Issues from the Farm and Landscape measures for Agriculture (FLAG) Map



Map 3. Catchment nitrogen load reductions required (%) based on data for 2022-2024, and waterbodies with nitrate issues from the 2025 Farm and Landscape measures for Agriculture (FLAG) Map. The monitored catchments areas (blue lines) are the areas draining to the catchment monitoring points used in this assessment.

Some catchments, such as the Maigue/Deel and Shannon, do not require nitrate reductions to meet estuarine water quality objectives. However, they do contain waterbodies with localised nitrate issues. Excess nitrate in rivers also causes impacts to the local riverine ecology and reductions are therefore also needed in these areas[12]. These are highlighted in the FLAG map, along with other areas where reductions in runoff carrying phosphorus, sediment and organic nitrogen are necessary.

In contrast, the Lee catchment presents the opposite scenario. While nitrogen load reductions are needed to achieve estuarine environmental objectives, the river station at Leemount Bridge records average nitrogen concentrations below the threshold of 2.6 mg/l as N – indicating that the average nitrogen losses at this point in the catchment are within acceptable limits (Section 2, Table 2). This reflects the hydrogeology of the catchment – poorly draining soils in the headwaters do not easily lose nitrate to water and the nitrate losses are occurring downstream of the monitoring station, closer to the coast. Based on these multiple lines of evidence, the headwater areas are not flagged as having nitrate issues. In the catchment nitrogen assessment, a few sub-catchments upstream of the station have elevated nitrogen levels and most of the sub-catchments downstream are contributing significantly to nitrate loads in the estuary. These areas are marked with orange flags in the FLAG map.

The analysis underscores the importance of spatial targeting. It demonstrates how combining load reduction estimates with spatially explicit data from the FLAG map can enhance efforts to identify and prioritise areas for nitrogen reduction measures, ultimately supporting improvements in estuarine water quality, while at the same time contributing to the protection of upstream river waterbodies.

[12] Rivers need on average slightly lower nitrogen levels than estuaries to support good ecological status. However, rivers are not as directly sensitive or responsive to excess nitrogen as they are to excess phosphorus, which is why there is typically a greater focus on reducing excess phosphorus to protect rivers. In lieu of a regulatory nitrate standard for rivers, the estuarine standard of 2.6 mg/l as N is used as a screening value in this methodology.

5. Factors Influencing Changes in Water Quality

5.1 Changes in nitrate concentrations

In the predominantly rural catchments, more than 85% of the sources of nitrogen in the catchment are from chemical and organic fertilisers associated with agriculture [13]. The range of agricultural measures implemented over the last 4-5 years have likely contributed to the improvement in nitrate concentrations across many catchments, particularly in 2023 and 2024, and the decrease in the nitrogen load reductions required (Table 2). In contrast to the other catchments, nitrate concentrations rose significantly in the Slaney and Barrow catchments between 2023 and 2024.

The National Farm Survey data indicates there has been an increase in Nitrogen Use Efficiency (NUE) on farm by over 5% from 2013 to 2023, highlighting improved nitrogen management practices. Greater awareness is being encouraged through the Teagasc Better Farming for Water campaign and the Farming for Water EIP[14], through the use of AgNAV and PastureBase to calculate farm level nitrogen surpluses and NUE values. Notable reductions in nitrogen inputs in recent years include the following:

- There has been a substantial decrease in nitrogen chemical fertiliser sales predominantly influenced by market forces (32% reduction in 2022 and 2023). This reduction in nitrogen input has likely contributed to the decrease in nitrate leaching. The reported increases in fertilizer sales in 2024 however, has potential to result in a future increase in nitrate concentrations in waters if nitrogen use is not managed efficiently on farm.
- A reduction in the national dairy herd since 2022[15] has led to decreased nitrogen inputs, particularly from urine, which is a significant source of nitrate in water.
- A slight decrease in feed concentrate usage in 2023 also contributed to reduced nitrogen inputs.
- Regulations limiting crude protein content in feed and reducing the maximum chemical nitrogen allowances for grassland since 2022 have contributed to reduced nitrogen inputs.
- Several other relevant measures have been strengthened and added to the Nitrates Action Programme including the introduction of three new excretion rate bands for dairy cows[16].

In summary, the decline of nitrate concentrations in water is likely due to a combination of increased Nitrogen Use Efficiency, reduced chemical fertiliser usage, reduced inputs from feed, reductions in animal numbers, regulatory measures, and changes in agricultural practices. While progress has been made, further reductions are needed in the highlighted catchments to achieve water quality objectives.

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[13] Source Load Apportionment Model (SLAM)
[14] https://farmingforwater.ie/app/uploads/2025/01/Measures-Booklet-Single-sheet.pdf
[15] https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2024.php
[16] https://www.gov.ie/en/department-of-housing-local-government-and-heritage/publications/fifth-nitrates-action-programme-2022-2025/

In these areas, measures might include full compliance with the GAP Regulations, further improvements in nitrogen use efficiency to reduce the nitrogen surplus, and an overall reduction in nitrogen loads in those catchments where nitrates levels are substantially in excess of the levels needed to support good water quality. Pollution Impact Potential maps have been developed to identify the critical source areas for nitrogen[17]. The critical source areas are the highest risk areas in the landscape for nitrogen leaching, and they occur where the nitrogen loads are relatively high and the soils are freely draining. Measures to reduce leaching should be targeted in the critical source areas, particularly in the catchments flagged for nitrate reductions, to deliver maximum environmental benefits.

5.2 Targeting agricultural measures going forward

It is important that the sector builds on the momentum in recent years and continues to implement actions to reduce nutrient losses in a targeted way. Ireland's Water Action Plan 2024 advocates the need for 'the right measure in the right place'. For agriculture, this requires measures to be targeted, depending on the soil, landscape and catchment characteristics. In some areas, nitrogen reduction measures are needed. In other areas, phosphorus pathway interception measures are needed. The types of measures needed in each area are indicated on the EPA FLAG and Pollution Impact Potential (PIP) maps.

Annual variability due to weather and changing management practices are apparent in the data in recent decades (Figure 1). In the context of changing weather patterns, annual variabilities are likely to increase in future with climate change, as temperatures increase, rainfall becomes more intense and seasonal patterns change. Sufficient resilience needs to be built into mitigation measures to maintain nitrogen concentrations within sustainable limits for good ecosystem health.

[17] https://www.catchments.ie/next-generation-pollution-impact-potential-maps-launched/

Appendix 1: Results Tables for Total Oxidised Nitrogen (TON)

Based on the methodology described in this report, the flow weighted mean Total Oxidised Nitrogen concentrations, estimated loads (tonnes) of nitrate (as N) and the estimated catchment load reductions required, are provided in Table A1, Table A2 and Table A3, respectively. The equivalent tables for Total Nitrogen (TN) are provided in Appendix 2.

TON is the sum of nitrate and nitrite without the organic fraction. Total Nitrogen (TN) and TON results are highly correlated: in catchments in the east and south-east, 90-100% of the total nitrogen load is comprised of TON. This is because the TON fractions of nitrogen move more readily with recharge down through the freely draining soils into groundwater and into watercourses in the SE, than the organic fractions which are often associated with sediment, overland flow and poorly draining soils. In catchments in the West, the proportion of TN that is TON is lower at ≤50% (Erne, Fergus, Moy) and 60-80% for the Maigue, Shannon, Corrib and Deel. This means the catchments in the west have proportionally higher levels of organic nitrogen in their waters than in the south-east where the form is almost all TON[18]. As the estuaries in the south and south-east have the greatest reductions needed, the focus in this report is therefore on reducing TON. TON is also measured in rivers which facilitates an integrated catchment assessment. The nitrogen data in the previous Catchment Load Reductions report were presented as TN, so TN data are also presented here for direct comparison.

The tables below show data since 2016 for annual concentration data, total nitrogen loads and the calculated required load reductions for each of the selected catchment monitoring stations. The 35-year datasets with annual results since 1990 are available for download: https://gis.epa.ie/GetData/Download - on the menu on the left, click on "Water/ Water Framework Directive", scroll down to “Published Water Quality Data” and select the file "Load Reduction Indicator Data And Results 2025 (Excel)".

[18] As the concentrations of nitrite in Irish freshwaters is very small, TON is considered to be approximately equivalent to nitrate. The nitrogen standard used for estuaries is for Dissolved Inorganic Nitrogen (DIN) which is comprised of the sum of nitrate, nitrite and ammonium (as N). As Nitrite and ammonium concentrations are proportionately relatively low in Irish estuarine waters, the Dissolved Inorganic Nitrogen concentrations are also considered to be approximately equal to nitrate concentrations.

Table A1: Annual flow weighted Total Oxidised Nitrogen (TON) concentrations (mg/l N) in major catchments. Shaded results indicate years where the 2.6 mg/l N dissolved inorganic nitrogen standard was exceeded.

	Area (km2)	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2022-2024**
AVOCA	639	1.2	1.2	1.6	1.4	1.4	1.1	1.9	1.6	1.4	1.6
BANDON	511	2	3	3	3.4	2.3	1.9	3	2.9	2.3	2.7
BARROW	2921	4.1	3.7	4.7	4.9	4	4.4	4.3	4.1	4.3	4.2
BLACKWATER	2426	2.9	2.1	2.7	3	2.6	2.6	3	3.1	2.3	2.8
BOYNE	2567	1.9	2.3	3.5	3.3	2.9	2.9	3.1	2.7	2.5	2.8
CORRIB	3138	0.4	0.5	0.5	0.7	0.5	0.7	0.5	0.6	0.5	0.5
DEEL	485	1.5	2.4	2.6	4.2	1.6	1.8	1.5	1.9	2.2	1.9
DODDER	109	1.3	1.2	1.4	1.4	1.1	1	1.2	1.6	1.2	1.3
ERNE	3982	0.5	0.3	0.4	0.6	0.5	0.5	0.6	0.7	0.4	0.6
FERGUS	650	0.3	0.5	0.5	0.6	0.4	0.5	0.6	0.4	0.5	0.5
LEE	930	1.4	2.2	2.6	2.5	1.8	1.8	2.2	2	1.7	2.0
LIFFEY	1121	1.8	2.1	2.7	2.6	2.2	2.3	2.4	2.4	2.5	2.4
MAIGUE	806	1.5	2	1.9	2.4	1.5	1.9	1.6	1.1	1.6	1.4
MOY	1910	0.3	0.4	0.5	0.5	0.4	0.3	0.4	0.4	0.4	0.4
NORE	2410	2.2	2.6	3.7	3.8	3.1	3.8	3.6	3	2.8	3.1
SHANNON(OC)	11628	1.1	0.9	1.2	1.3	1.3	0.9	1	1	1	1.0
SHANNON(TR)		1.1	0.8	1	1.7	1.1	0.8	1.2	0.9	0.9	1.0
SLANEY	1355	3.9	4.1	5	4.6	3.8	4	3.6	3.5	4.3	3.8
SUIR	2637	2.2	2.4	2.3	2.7	2.7	2.6	2.7	2.6	2	2.4
TOLKA	141	1.9	1.8	2.8	1.7	2.1	1.7	2.5	2.2	1.7	2.1

Table A2: Estimated annual loads (tonnes) of Total Oxidised Nitrogen (TON) discharging from a selection of large river catchments. To estimate loads for the whole catchment as per the previous assessment, multiply the loads by the scaling factor (SF).

	SF	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	2022-2024
AVOCA	1.02	733	664	1205	995	959	750	1163	1218	898	1093
BANDON	1.19	1145	1651	2052	2094	1784	1160	1733	2213	1665	1870
BARROW	1.05	5026	3753	6699	6263	5840	5954	5109	6144	5311	5521
BLACKWATER	1.37	5743	3259	5591	5490	5445	4198	5915	6593	4266	5591
BOYNE	1.05	2538	2364	4106	5965	5357	3599	4216	5512	3205	4311
CORRIB	1	1132	1298	1523	2520	2156	2059	1433	2246	1581	1753
DEEL	1	305	670	864	1643	682	488	538	779	696	671
DODDER	1.04	90	70	113	113	95	69	75	158	96	110
ERNE	1.10	1559	944	1228	2005	2082	1482	1856	2742	1380	1993
FERGUS	1.60	164	308	276	362	321	203	213	247	231	230
LEE	1.35	3030	3461	3119	2692	2289	1815	2402	2577	1639	2206
LIFFEY	1.12	1124	696	2329	1119	1087	974	861	1235	945	1014
MAIGUE	1.31	528	784	859	1258	921	673	749	653	658	687
MOY	1.09	456	761	915	996	943	564	603	822	805	743
NORE	1.05	2424	2789	5028	4649	4161	4160	4610	4853	3210	4224
SHANNON(OC)	1.00	2593	1008	1738	1738	2883	1025	1223	1603	1108	1311
SHANNON(TR)	1.00	6038	4046	4896	13496	9698	4452	5512	6311	5287	5703
SLANEY	1.30	3256	3435	5711	4050	3721	4311	3268	3705	3833	3602
SUIR	1.37	3724	3881	4789	5387	5857	4455	5540	5397	3280	4739
TOLKA	1.03	94	81	146	118	130	86	123	185	91	133

Table A3: Estimated annual load reductions (tonnes) of Total Oxidised Nitrogen (TON) needed to achieve 2.6 mg/l N at the catchment monitoring station.

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2022-2024
AVOCA	0	0	0	0	0	0	0	0	0	0
BANDON	0	228	302	508	0	0	247	209	0	152
BARROW	1834	1132	3020	2943	2229	2460	2010	2234	2066	2103
BLACKWATER	630	0	211	689	0	0	853	1038	0	630
BOYNE	0	0	1035	1319	541	326	681	242	0	308
CORRIB	0	0	0	0	0	0	0	0	0	0
DEEL	0	0	0	626	0	0	0	0	0	0
DODDER	0	0	0	0	0	0	0	0	0	0
ERNE	0	0	0	0	0	0	0	0	0	0
FERGUS	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0	0	0
LIFFEY	0	0	71	0	0	0	0	0	0	0
MAIGUE	0	0	0	0	0	0	0	0	0	0
MOY	0	0	0	0	0	0	0	0	0	0
NORE	0	0	1458	1463	614	1323	1273	600	199	691
SHANNON(OC)	0	0	0	0	0	0	0	0	0	0
SHANNON(TR)	0	0	0	0	0	0	0	0	0	0
SLANEY	1101	1255	2732	1750	1153	1490	878	973	1501	1117
SUIR	0	0	0	183	128	0	279	0	0	93
TOLKA	0	0	13	0	0	0	0	0	0	0

Appendix 2: Results Tables for Total Nitrogen (TN)

Table A4: Annual flow weighted Total Nitrogen concentrations (mg/l N) in major catchments. Shaded results indicate years where the 2.6 mg/l N dissolved inorganic nitrogen standard was exceeded.

	Area (km2)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2022-2024
AVOCA	639	1.3	1.4	1.9	1.7	1.6	1.4	1.7	1.6	1.4	1.6
BANDON	511	2.8	3.3	3.3	3.4	2.9	2.5	3.1	2.9	2.2	2.7
BARROW	2921	4	5.4	8.1	5.5	4.9	4.8	5.3	4.7	5.3	5.1
BLACKWATER	2426	3.5	3	3.2	3.2	2.9	3.3	3.3	3.3	2.6	3.1
BOYNE	2567	2.7	2.9	4.1	3.8	3.4	3.4	3.2	3.1	2.7	3
CORRIB	3138	0.7	0.9	0.8	1	0.8	1.1	1	0.9	0.7	0.9
DEEL	485	2	3.1	4.2	3.5	2.4	2.5	2.3	2.5	2.7	2.5
DODDER	109	1.4	3.4	1.5	1.7	2.5	1.5	1.2	1.4	1.4	1.3
ERNE	3982	1	1.2	1.6	1.8	1.8	1.7	1.4	1.5	1	1.3
FERGUS	650	0.7	1	0.9	1.1	0.9	1	1	1	0.8	0.9
LEE	930	2	2.6	2.6	2.7	2.1	2.1	2.4	2.1	1.7	2.1
LIFFEY	1121	2.3	2.4	3.8	2.9	2.6	2.6	2.4	2.5	2.8	2.6
MAIGUE	806	2.2	2.6	2.9	3.2	2.6	2.6	2.2	1.9	2.2	2.1
MOY	1910	0.7	1	1	1.2	0.9	0.9	0.8	0.8	0.8	0.8
NORE	2410	3	3.2	4	4.3	3.7	4	3.9	3.3	3	3.4
SHANNON(OC)	11628	1.8	1.4	1.6	1.8	2.1	1.4	1.5	1.5	1.4	1.5
SHANNON(TR)		1.7	1.3	1.5	1.9	1.7	1.3	1.6	1.4	1.3	1.4
SLANEY	1355	4.5	4.8	6.6	5.5	4	4.2	4	3.8	4.5	4.1
SUIR	2637	2.7	2.8	2.9	2.8	2.9	3	3	2.7	2.2	2.6
TOLKA	141	2.5	2.1	3	3.2	2.7	2.7	2.5	2.1	1.9	2.2

Table A5: Estimated total annual loads (tonnes) of Total Nitrogen (TN) discharging from major catchments at their most downstream river monitoring station. To estimate loads for the whole catchment as per the previous assessment, multiply the loads by the scaling factor (SF).

	SF	2016	2017	2018	2019	2020	2021	2022	2023	2024	2022-2024
AVOCA	1.02	838	769	1371	1228	1126	930	1055	1274	898	1076
BANDON	1.19	1600	1779	2237	2104	2202	1511	1758	2244	1597	1866
BARROW	1.05	4970	5410	11407	6972	7176	6429	6275	7009	6623	6636
BLACKWATER	1.37	6893	4615	6576	5990	6182	5292	6354	6962	4890	6069
BOYNE	1.05	3617	3018	4830	6846	6228	4320	4408	6347	3504	4753
CORRIB	1	2140	2337	2696	3697	3729	3251	2609	3380	2388	2792
DEEL	1	426	877	1394	1378	1015	690	787	1024	845	885
DODDER	1.04	101	205	126	135	210	99	75	140	106	107
ERNE	1.10	3133	3499	4847	6614	7435	5518	4044	6264	3009	4439
FERGUS	1.60	385	574	481	637	649	416	363	558	371	431
LEE	1.35	4330	4138	3065	2930	2726	2160	2651	2725	1647	2341
LIFFEY	1.12	1431	782	3260	1239	1267	1091	864	1263	1026	1051
MAIGUE	1.31	796	1010	1284	1698	1582	925	1059	1081	867	1002
MOY	1.09	1292	1746	1825	2495	2203	1713	1332	1766	1605	1568
NORE	1.05	3309	3402	5527	5251	5053	4356	5069	5337	3520	4642
SHANNON(OC)	1.00	4262	1537	2448	2363	4545	1601	1826	2489	1552	1956
SHANNON(TR)	1.00	8861	6453	7137	15820	15418	7166	7536	10519	7816	8624
SLANEY	1.30	3761	4001	7590	4831	3978	4551	3642	4013	4053	3903
SUIR	1.37	4538	4466	5947	5602	6337	5224	6032	5677	3568	5092
TOLKA	1.03	125	93	155	221	168	133	123	181	101	135

Table A6: Estimated annual load reductions (tonnes) of Total Nitrogen (TN) needed to achieve 2.6 mg/l N at the catchment station.

	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2022-2024**
AVOCA	0	0	0	0	0	0	0	0	0	0
BANDON	104	356	487	518	211	0	272	240	0	171
BARROW	1778	2789	7728	3652	3364	2667	3176	3099	3378	3218
BLACKWATER	1780	629	1196	1189	706	1076	1292	1407	0	900
BOYNE	136	334	1759	2200	1412	1047	873	1077	109	686
CORRIB	0	0	0	0	0	0	0	0	0	0
DEEL	0	135	536	361	0	0	0	0	26	9
DODDER	0	48	0	0	0	0	0	0	0	0
ERNE	0	0	0	0	0	0	0	0	0	0
FERGUS	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	124	0	0	0	0	0	0
LIFFEY	0	0	1002	120	0	0	0	0	60	20
MAIGUE	0	0	122	335	0	0	0	0	0	0
MOY	0	0	0	0	0	0	0	0	0	0
NORE	448	658	1957	2065	1506	1519	1732	1084	509	1108
SHANNON(OC)	0	0	0	0	0	0	0	0	0	0
SHANNON(TR)	0	0	0	0	0	0	0	0	0	0
SLANEY	1606	1821	4611	2531	1410	1730	1252	1281	1721	1418
SUIR	158	324	542	398	608	746	771	265	0	345
TOLKA	0	0	22	42	5	4	0	0	0	0

Appendix 3: Farm and Landscape measures for Agriculture (FLAG) Map diagrams.

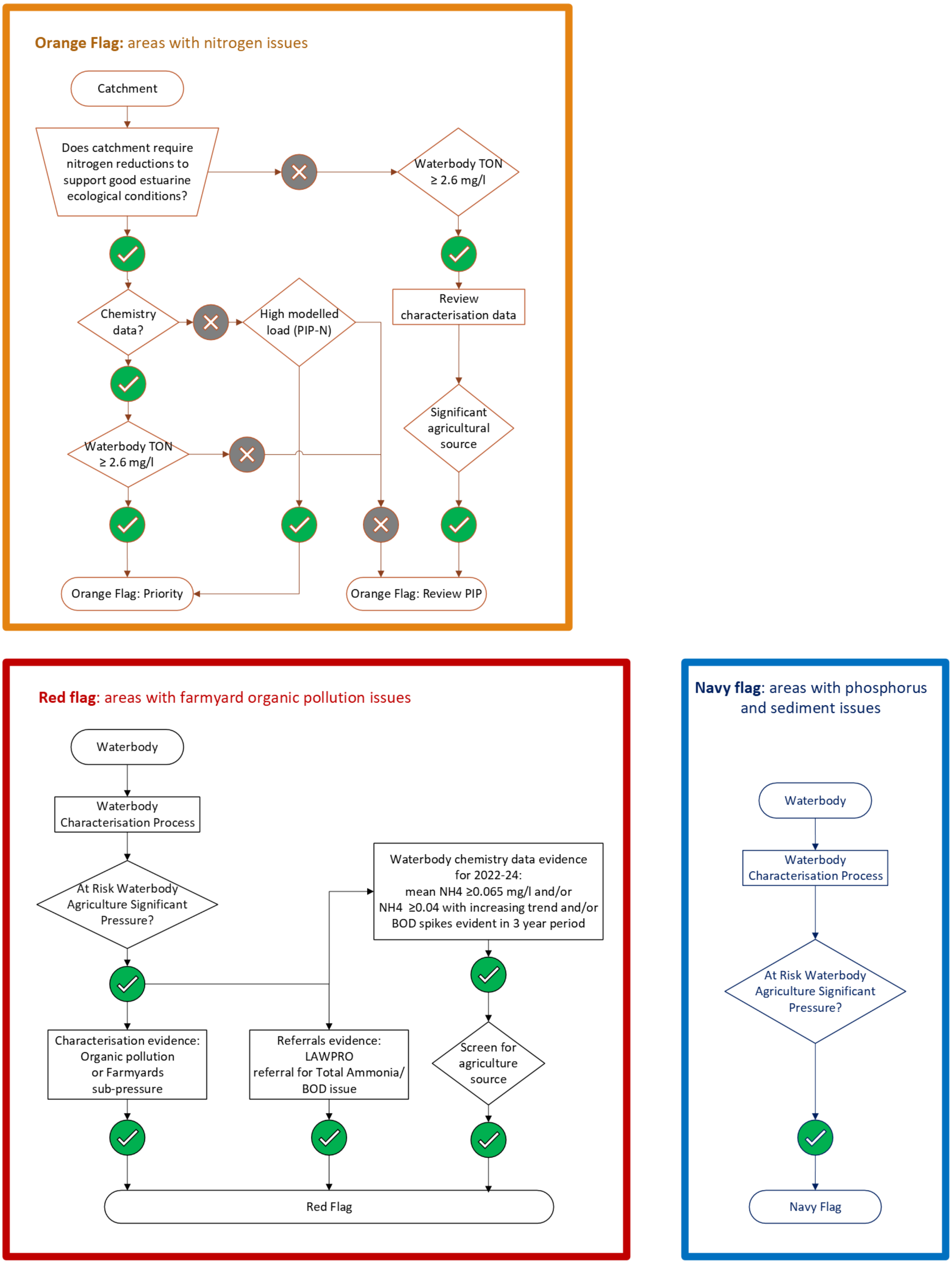

Figure A1. Overview of the process to assign the measures flags in the FLAG map.

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