Waters of LIFE

Local Authority Waters Programme

vibrant communities | catchment assessment | healthy waters

Shournagh Demonstration Catchment

Desk Study

May 2022

www.watersoflife.ie

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

Co-funded by the European Union

Date	Version No	Status	Change	Author name	Reviewer name
26/05/22	D01	Draft		LAWPRO	Cormac Mc Conigley
21/2/23	F01	Final		Maeve Ryan	Anne Goggin Cormac McConigley

Acknowledgements

This report was prepared by LAWPRO catchment scientists on behalf of the Waters of LIFE Integrated Project. The authors would like to acknowledge the contribution of Cork County Council, Forest Service - DAFM, Environmental Protection Agency, Geological Survey Ireland and National Parks and Wildlife Service to this report and thank them for their support of the Local Authority Waters Programme.

Data Sources

The following data sources were consulted in the preparation of this report:

- Catchment boundaries, waterbodies, and areas for action: EPA (2018).
- Bedrock Unit: GSI (2008).
- Aquifer Category: GSI (2015).
- Groundwater body: EPA Catchments Unit (2018).
- Soils & Subsoils Maps: Teagasc-EPA (2015).
- Pollution Impact Potential Maps: EPA (2021).
- Assessment of the catchments that need reductions in nitrogen concentrations to achieve water quality objectives, WFD River Basin Management Plan-3rd Cycle (June 2021).
- Mellander, P. E., Jordan, P., Shore, M., McDonald, N. T., Wall, D. P., Shortle, G., & Daly, K. (2016). Identifying contrasting influences and surface water signals for specific groundwater phosphorus vulnerability. *Science of the Total Environment*, *541*, 292-30
- Fresne, M., Jordan, P., Daly, K., Fenton, O., & Mellander, P. E. (2022). The role of colloids and other fractions in the below-ground delivery of phosphorus from agricultural hillslopes to streams. *Catena*, *208*, 10573
- Fresne, M., Jordan, P., Fenton, O., Mellander, P. E., & Daly, K. (2021). Soil chemical and fertilizer influences on soluble and medium-sized colloidal phosphorus in agricultural soils. *Science of the total environment*, *754*, 142112.
- Report on Salmon Monitoring Programmes 2018 funded under the Salmon Conservation fund (2020/1-4512), Aquest Environmental and Inland Fisheries Ireland.
- Teagasc sectoral roadmap dairy (https://www.teagasc.ie/media/website/publications/2020/Road-Map-2027-Dairy-201120.pdf)
- Shore, Mairead, et al. "Influence of stormflow and baseflow phosphorus pressures on stream ecology in agricultural catchments." *Science of the Total Environment* 590 (2017): 469-483.
- Lee CFRAMS, 2014.

Disclaimer

Although every effort has been made to ensure the accuracy of the material contained in this publication, complete accuracy cannot be guaranteed. Neither the Local Authority Waters Programme (LAWPRO), Waters of LIFE nor the author(s) accept any responsibility whatsoever for loss or damage occasioned, or claimed to have been occasioned, in part or in full as a consequence of any person acting or refraining from acting, as a result of a matter contained in this publication.

Contents

Table of Figures

List of Tables

Summary

The Shournagh Demonstration Catchment is one of six catchments selected by the Waters of Life Project. The Waters of LIFE is an EU LIFE Integrated Project which aims to help reverse the deterioration of Ireland's most pristine waters.

The Shournagh is located in County Cork with the river rising in the foothills of the Boggeragh Mountains *ca.* 25 km northwest of Cork city. Flowing in a south easterly direction towards Blarney where it confluences with the river Lee.

The Shournagh Demonstration Catchment comprises five river waterbodies, Rathcoola_010, Shournagh_010, Shournagh_020, Shournagh_030 and Shouragh_040. The latter three are Blue Dot waterbodies, meaning that their Water Framework Directive (WFD) environmental objective is to achieve High ecological status. (High-status objective). All five waterbodies discharge to the Lee (Cork)_90 just west of Cork city.

Rathcoola_010 and the Shournagh_010 are currently at Good status and although *Not at Risk* of failing to meet their WFD objective, will be considered for protection measures by the Waters of Life. The Shournagh_020 was at Good status in the most recent WFD reporting period (2013 – 2018) due to a 'Good' RHAT score in 2017. It was therefore *at Risk* of not achieving its High status objective. However, the most recent biological and RHAT data in 2020 were both at High status indicating a return to High status. It is therefore considered to be currently *Not at Risk* and will be considered for protection measures by the Waters of Life Programme. Shournagh_030 and _040 are currently at Moderate status and are therefore *At Risk* of not meeting their WFD High status objectives. These two rivers will be considered for restoration measures by the Waters of Life Programme.

Elevated ortho-phosphate and nitrate levels are driving the overall Moderate ecological status in Shournagh_030 and 040. Accounting for the influence of the Manin_SC_010 subcatchment and the Blarney WWTP (discharges to the Shournagh_030 just west of Blarney town), approximately 42% of the phosphate loads and 53% of the nitrate loads at Bannow Br on the Shournagh_040 are arising from the Shournagh Demonstration Catchment (i.e. Rathcoola_010, Shournagh_010, _020 _030 and _040).

The soils in this catchment are brown earths over old red sandstone geology. They are well drained with the exception of small areas of gleyic brown alluvial soils neighbouring the stream in the lower catchment. These soils are generally well suited to the grassland dairy production that dominates in this catchment. Based on the free draining nature of the soils, nitrogen is considered the main nutrient at risk of loss via subsurface pathways. However, the iron-rich old red sandstones which underlie this catchment tend to have a weak ability to retain ortho-phosphate in the soil and are prone to leaching of phosphate via subsurface pathways. Therefore diffuse losses of nitrate and phosphate from agricultural soils is the main pressure in the Shournagh Demonstration Catchment. Subsurface pathways are the main route for losses of both of these nutrients and therefore mitigation measures which focus on source control options are likely to be most effective. These measures broadly include

reducing nutrient inputs, improved soil nutrient management and improving nutrient use efficiencies. Soil phosphorus (and pH) data should be gathered where possible to identify the riskiest index 4 soils.

The initial local catchment assessment aims to gather baseline data on macroinvertebrate health and water chemistry at the outlet of each subbasin and also in the headwaters of each subbasin where access is possible via the road. A total of 24 potential sample sites have been identified at this desk-study stage for this purpose. It is recommended to conduct the biological surveys within the same season and the water chemistry sampling on the same/consecutive days where possible to facilitate robust comparisons between sites.

1 Introduction

1.1 Background to Catchment

The Waters of LIFE is an EU LIFE Integrated Project (IP) which aims to help reverse the deterioration of Ireland's most pristine waters. The Project will operate in five demonstration catchments nationally to test measures for the protection and restoration of High Status in Blue Dot rivers. The five demonstration catchments were selected from WFD sub-catchments defined by the EPA. The selection process considered a number of criteria, including number and extent of significant pressures, status history and Q value amongst others. The project also includes one control catchment (the Sheen), which was selected on the basis that it consistently demonstrated High Status in the past and is currently *Not at Risk* of failing to meet its WFD objectives. See Demonstration Catchment Selection Report for further information on the catchment selection process.

The Shournagh Demonstration Catchment comprises five river waterbodies within the larger Lee[Cork]_SC_060 subcatchment: Rathcoola_010, Shournagh_010, Shournagh_020, Shournagh_030 and Shournagh_040. The adjacent Manin_SC_010 subcatchment discharges to the Shournagh_030 just west of Blarney town and is considered in some sections of this desk study in terms of its contributing nutrient loads but **where reference in this report is made to the 'native Shournagh', this excludes the contribution of Manin_SC_010. Both Lee {Cork}_SC_060 and Manin_SC_010 form part of the Lee, Cork Harbour and Youghal Bay catchment.**

The river Shournagh rises in the foothills of the Boggeragh Mountains *ca.* 25 km northwest of Cork city, flowing generally in a southerly direction to discharge to the Lee (Cork)_90 to the west of Cork city.

Shournagh Valley pNHA spans sections of the Shournagh_030 and Shournagh_040 subbasins (see Appendix 1). Shournagh valley pNHA comprises areas of wet woodland, scrub, scrub woodland and old estate mixed woodland. Dippers (Cinclus hibernicus) and Grey wagtail (Motacilla cinerea) are known to feed along and around the river channel.

The river Shournagh supports salmonid species and other fisheries but is not designated as a salmonid river under the WFD. A catchment-wide electro-fishing survey was conducted in 2018 by Inland

Fisheries Ireland along the Martin and Shournagh Rivers. The results showed that these two rivers together had a mean catch of 17.97 salmon fry/5min in 2018. High abundances of salmon fry were observed at sites along all the main rivers.

The lower sections of the Shournagh River are prone to flooding and a flood embankment has been constructed along the right bank of the Shournagh_030 in Tower which protects a number of residential properties and the Blarney WWTP at St. Anne's Hill. Hydraulic computer modelling indicates that this flood embankment provides protection to these properties and assets up to the 1% AEP flood event. For areas not protected by this embankment, hydraulic computer modelling indicates that there is limited flood risk with 11 residential properties within the flood extent of the estimated 1% AEP event. (Lee CFRAMS, 2014)

1.2 Summary Information

Figure 1 shows location of the Shournagh Demonstration Catchment, waterbodies within, monitoring locations and the latest ecological status. A schematic layout of the catchment, with current WFD status and risk, is provided in **Figure 2**. Summary information on risk, ecological status, known pressures and associated significance for the waterbodies in catchment is presented in **Table 1**. This is further summarised in the 'Receptor information and assessment' section.

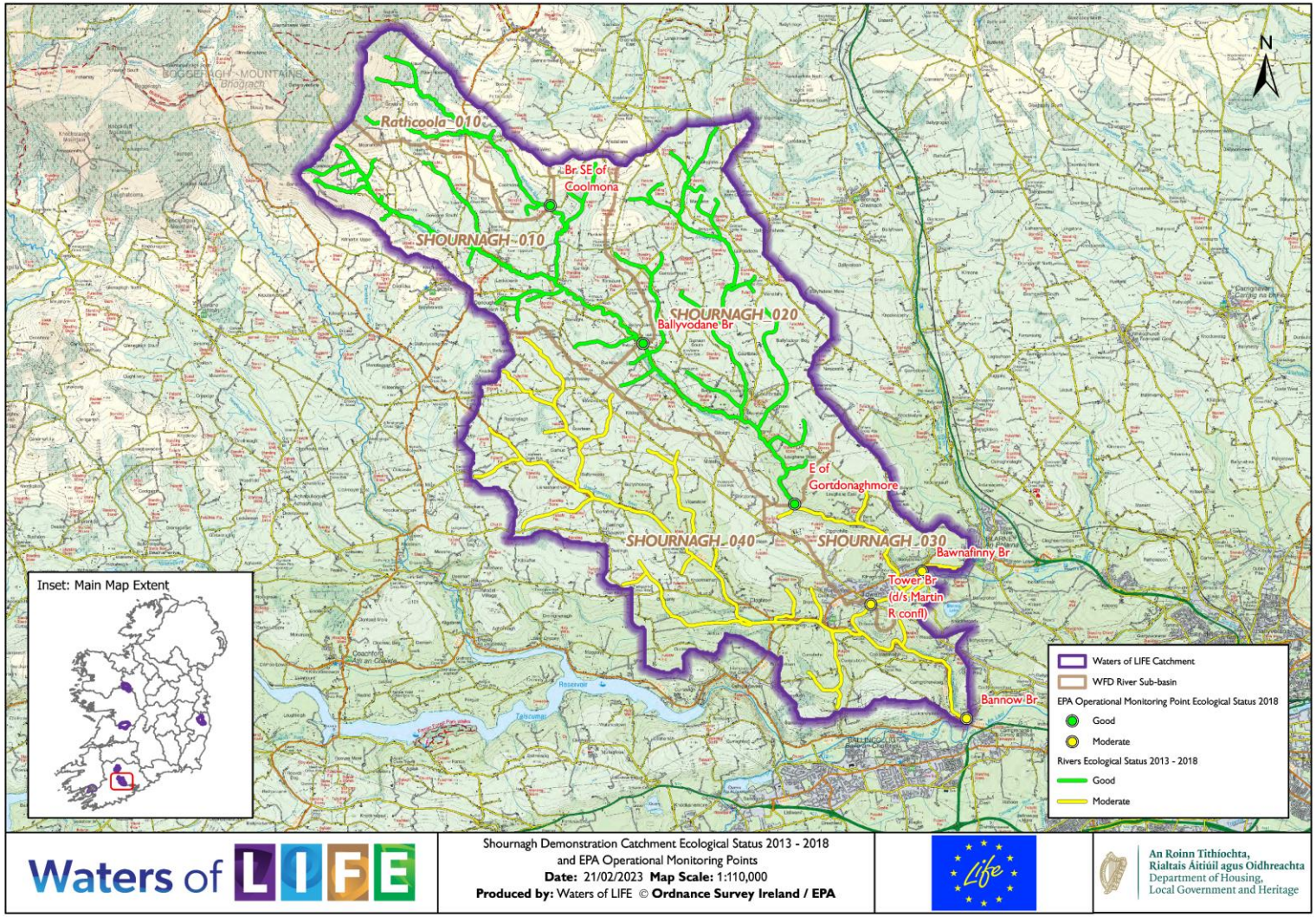


Figure 1: Overview of Shournagh Demonstration Catchment waterbodies and WFD monitoring sites.

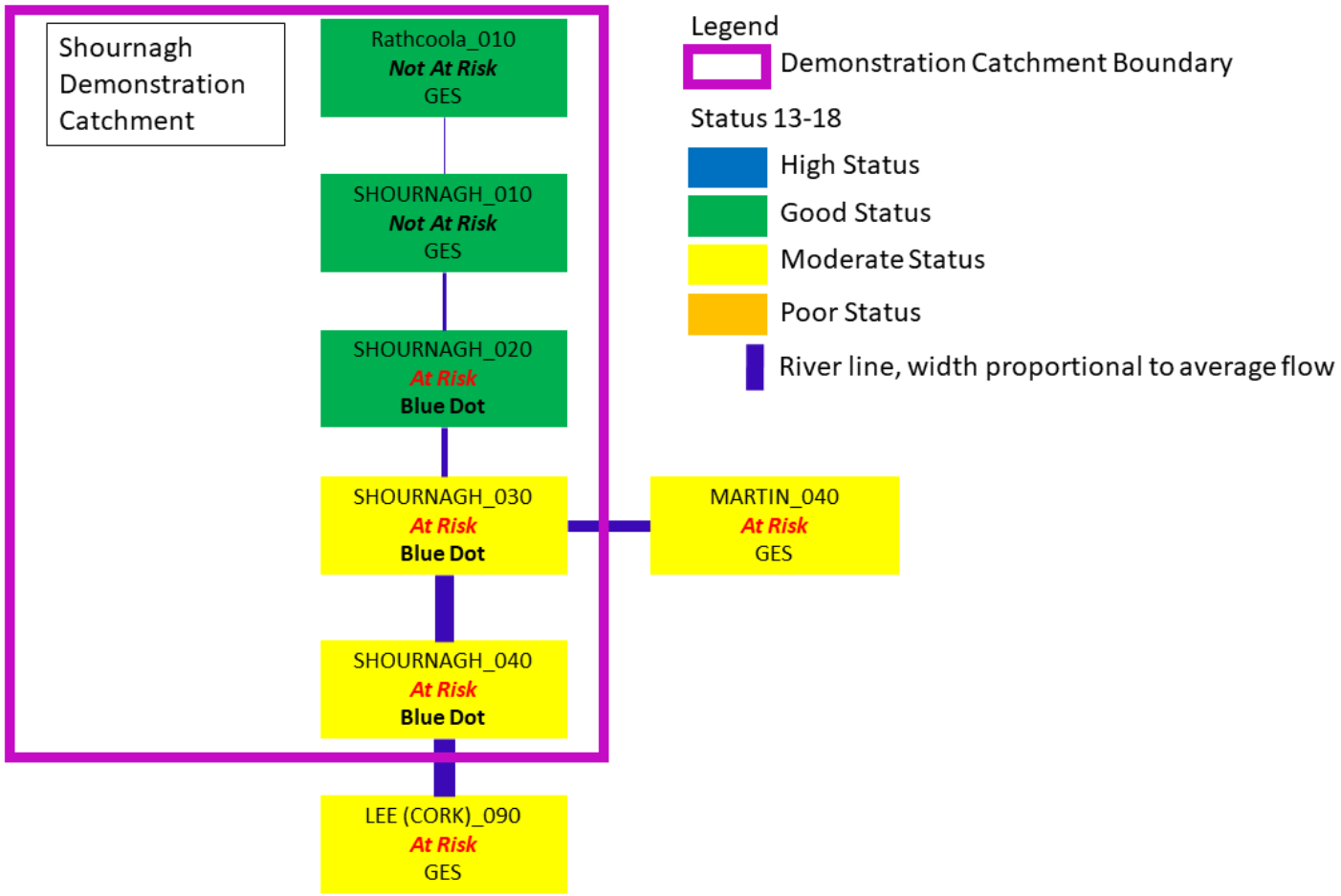


Figure 2: Schematic layout of the Shournagh Demonstration Catchment showing 2013-2018 WFD status and cycle 3 risk

Table 1: Summary of ecological status and pressures for the demonstration catchment

Waterbody				Status Objective	Ecological Status				Pressures		
Name	**Code**	**Type**	**Risk**		2007-09	2010-12	2010-15	2013-18	**Category**	**Sub-Category**	**Significant ?**
Rathcoola_010	IE_SW_19R450050	River	*Not at Risk*	Good	G	P	M	G	Agriculture	Agriculture	Yes
Shournagh_010	IE_SW_19S010100	River	*Not at Risk*	Good	H	M	G	G	No pressure impacts data available		
Shournagh_020	IE_SW_19S010200	River	*At Risk*	High	H	H	H	G	Hydromorphology	Embankments	Yes
Shournagh_030	IE_SW_19S010300	River	*At Risk*	High	G	H	H	M	Urban wastewater	Agglomeration PE>10,000	Yes
									Urban Run-off	Diffuse sources runoff	Yes
									Domestic wastewater	Single house discharges	No
Shournagh_040	IE_SW_19S010500	River	*At risk*	High	G	H	H	M	Agriculture	Agriculture	Yes
									Urban Run-off	Diffuse sources runoff	Yes
									Domestic wastewater	Single house discharges	Yes

H= High, G = Good....

2 Receptor information & assessment

2.1 Context and Setting

The Shournagh Demonstration Catchment comprises five river waterbodies, Rathcoola_010, Shournagh_010, Shournagh_020, Shournagh_030 and Shouragh_040. The four Shournagh river waterbodies have been proposed as WFD areas for action under the third cycle of the River Basin Management plan. Rathcoola_010 and the Shournagh_010 are currently at Good status and although they are currently *Not at Risk* of meeting their WFD objective, will be considered for protection measures by Waters of Life.

Shournagh_020, _030 and _040 are blue dot waterbodies which means they have a high-status objective under the WFD. The Shournagh_020 was at Good status in the most recent WFD reporting period (2013 – 2018) due to a 'Good' RHAT score in 2017. It was therefore *at Risk* of not achieving its High status objective. However, the most recent biological and RHAT data in 2020 were both at High status for the Shournagh_020 indicating a return to High status for this waterbody. It is therefore considered to be currently *Not at Risk* and will be considered for protection measures by the Waters of Life Programme. Shournagh_030 and _040 are currently at Moderate status and are therefore *At Risk* of not meeting their WFD High status objectives. Elevated ortho-phosphate and nitrate levels are driving the overall Moderate ecological status in Shournagh_030 and 040. These two rivers will be considered for restoration measures by the Waters of Life Programme.

All five waterbodies discharge to the Lee (Cork)_090 (just west of Cork city). The Lee (Cork)_090 was at Moderate status in the last reporting period (2013 – 2018) and a moderate fish status was driving the overall ecological status.

2.2 WFD Information

Water quality information has been reviewed and summary of ecological status, biological conditions, and nutrient chemistry for the Shournagh catchment waterbodies are summarised in **Table 2** and **Table 3**.

Table 2 Receptor information for river waterbodies in Demonstration Catchment.

Waterbody Name		**Shournagh_020**	**Shournagh_030**	**Shournagh_040**	**Rathcoola_010**	**Shournagh_010**
Monitoring Station		E of Gortdonaghmore	Tower Br (d/s Martin R confl)	Bannow Br	Br SE of Coolmona	Ballyvodane Br
Waterbody Code		IE_SW_19S010200	IE_SW_19S010300	IE_SW_19S010500	IE_SW_19R450050	IE_SW_19S010100
Risk Category		*At risk*	*At risk*	*At risk*	*Not at Risk*	*Not at Risk*
WFD objective		High	High	High	Good	Good
Ecological status	2010-2015	High	High	High	Moderate	Good
	2013-2018	Good	Moderate	Moderate	Good	Good
	Element driving status	Hydromorphology	Nutrients (nitrate and phosphate)	Nutrients (nitrate and phosphate)	Invertebrates	Invertebrates
Biological Status (Inverts)	2011	High	High	High	Poor	Moderate
	2014	High	High	Good	Moderate	Good
	2017	High	High	High	Good	Good
	2019		Good			
	2020	High	High	High	Good	Good
Hydromorphology	2017	Good (RHAT)	High			
	2020	High (RHAT)	High			
Supporting chemistry	2013-2018	No data available	Fail	Fail	No data available	No data available
Ortho-P	Baseline 2017	No data available	0.057	0.060		
	Indicative quality		Moderate	Moderate		
Nitrate	Baseline		4.987	5.347		
	Indicative quality		Moderate	Moderate		
Ammonium	Baseline		0.041	0.032		
	Indicative quality		High	High		
Protected areas		Shournagh Valley pHNA				
Significant issue for receptor[1]		Hydromorphology[1]	nitrate and phosphate	nitrate and phosphate		

2.3 Biological data

Table 3: Biological Q data available on the WFD app for the monitoring stations in the Shournagh Demonstration Catchment

Waterbody name	WFD monitoring station	1981	1986	1990	1994	1997	1999	2002	2005	2008	2011	2014	2017	2019	2020
Rathcoola_010	Br SE of Coolmona					4-5	4	4	4	4	3	3.5	4		4
Shournagh_010	Ballyvodane Br	5	4-5	4-5	4	4-5	4	4	4	4-5	3.5	4	4		4
Shournagh_020	E of Gortdonaghmore	5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5		4-5
Shournagh_030	Tower Br (d/s Martin R confl)	5	4-5	4	4-5	4	3.5	3.5	3.5	4	4-5	4-5	4-5		4-5
Shournagh_040	Bannow Br				4-5	4-5	4-5	4-5	4	4	4-5	4-5	4	4.5	4-5

2.4 Hydrochemistry

Hydrochemistry monitoring data are only available for Shournagh_030 and 040.

Shournagh_030

Annual average ortho-P concentrations exceeded the mean High status EQS (0.025mg/L) every year from 2012 to 2021 (**Figure 3**) at Tower Br. during this period, the mean High status EQS was exceeded approximately 87% of the time and the 95th %ile High status EQS (0.045mg P/l) was exceeded 52% of the time. The annual average orthoP concentration was highest in 2018 when Ireland experienced a summer drought. The three highest concentrations in that year occurred during the very dry summer months (July, August and September) which may suggest the presence of point sources.

Annual average nitrate-N concentrations were well in excess of the mean High-status EQS of 0.9mg/l used in WFD status classification. Annual average nitrate-N concentrations increased steadily from 2013 – 2019 but followed a downward trajectory in recent years. Nitrate-N concentrations nearly always exceeded the mean and 95th %ile (1.4mg/l) High-status EQS's with the exception of two occasions in 2014 and one in 2015 (**Figure 4**).

Annual average ammonium concentrations were generally close to the mean High status EQS of 0.04mg/l, exceeding it in some years. There were occasional spikes in excess of the 95th%ile High-status EQS (0.09mg/l) most years (**Figure 5**). These spikes could be indicative of emissions from a point source(s) likely in close proximity to the monitoring station.

BOD concentrations exceeded the mean High-status EQS of 1.3mg/L 33% of the time over the 9-year monitoring period indicating the presence of an intermittent point source of organic effluent.

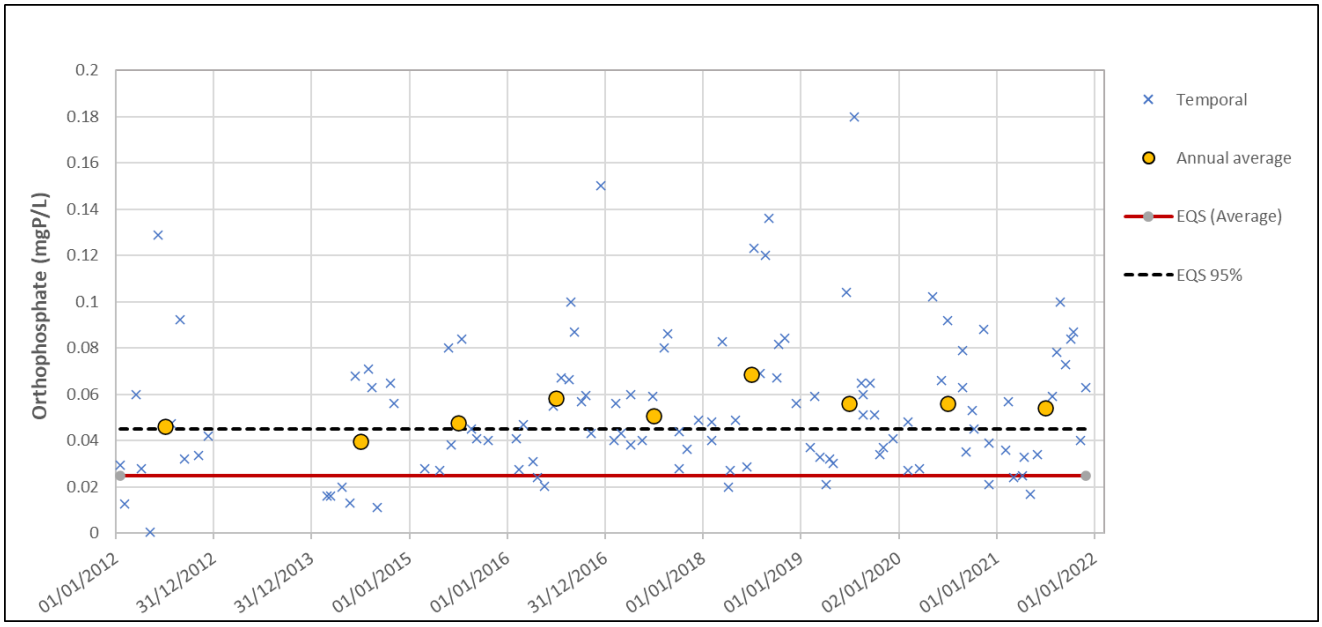


Figure 3: Orthophosphate concentrations measured at Tower Br on the Shournagh_030 from 2012-2022

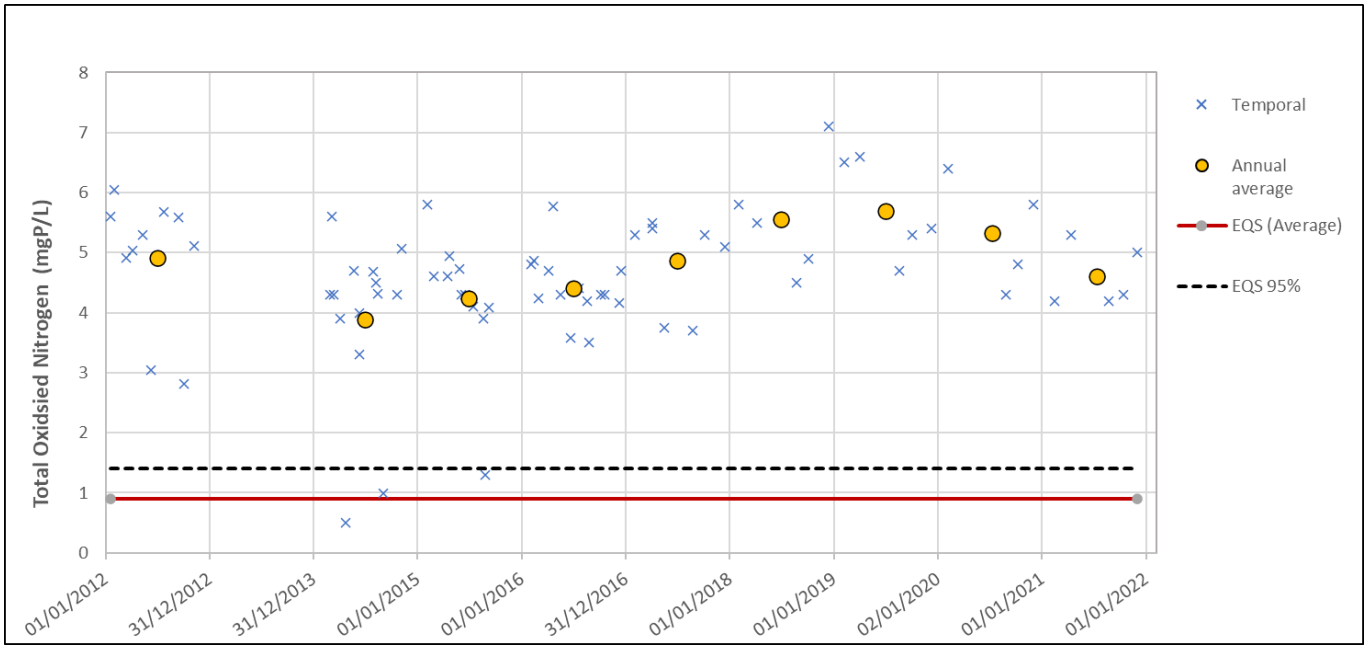


Figure 4: Total oxidised nitrogen concentrations measured at Tower Br on the Shournagh_030 from 2012-2022.

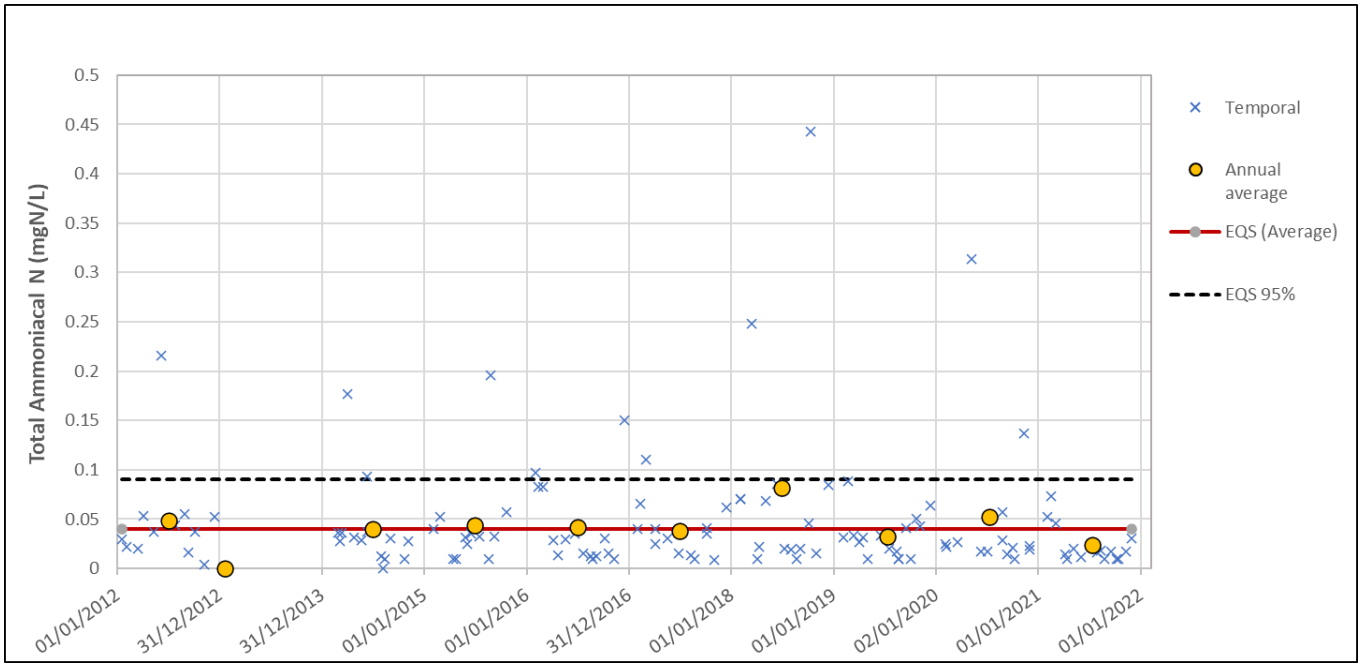


Figure 5:' Total ammoniacal N concentrations measured at Tower Br on the Shournagh_030 from 2012-2022.

Shournagh_040

Annual average ortho-P concentrations exceeded the mean High-status EQS (0.025mg/L) every year from 2014 to 2021 (**Figure 6**) at Bannow Br with no apparent trends in the data. During this period, ortho-P concentrations exceeded the mean and 95%ile (0.045mg/l) High status EQS's, 95% and 55% of the time respectively.

Annual average nitrate-N concentrations were always well in excess of the mean High-status EQS of 0.9mg/l used in WFD status classification (**Figure 7**) from 2014 – 2021. Annual average nitrate-N concentrations increased steadily from 2013 – 2019 but decreased in recent years. During the monitoring period 2014 – 2021, nitrate-N concentrations always exceeded both the mean and 95th%ile (1.4mg/l) High-status EQS's.

Annual average ammonium concentrations exceeded the mean High-status EQS (0.04mg/l) in 2014 and 2015 but haven't exceeded it since 2015. There were occasional spikes in ammonium concentrations in excess of the mean High-status EQS but there have been none in excess of the 95th %ile High status EQS since 2017, indicating that a point source has since been resolved (**Figure 8**).

BOD concentrations exceeded the EQS of 1.3mg/L six times over the nine-year monitoring period, two of which were since 2017.

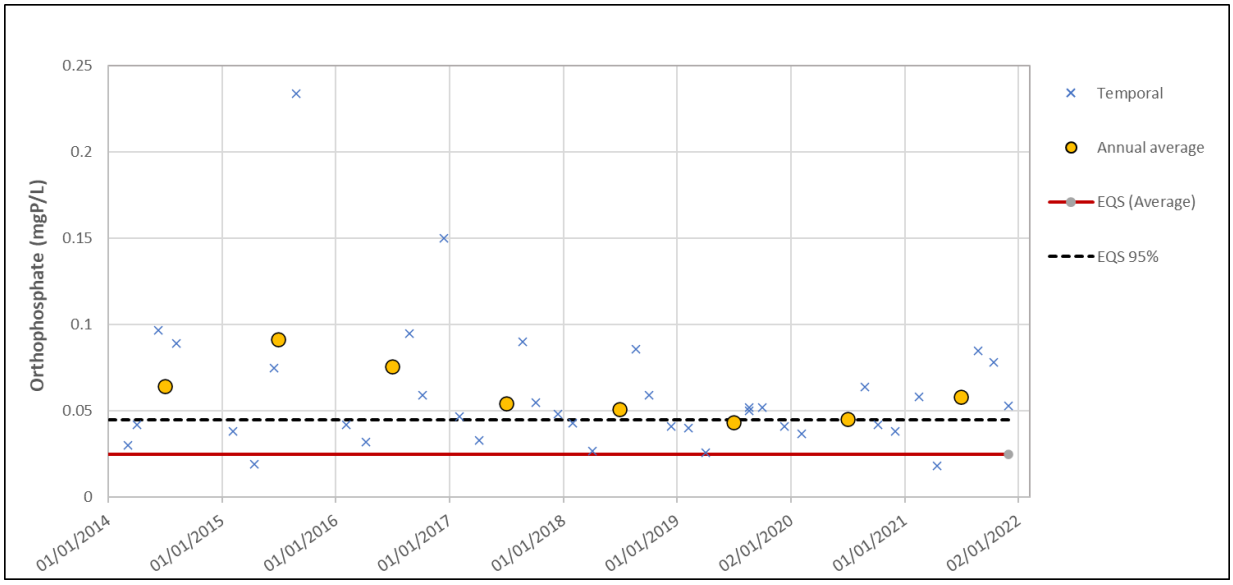


Figure 6: Orthophosphate concentrations measured at Bannow Br on the Shournagh_040 from 2012-2022.

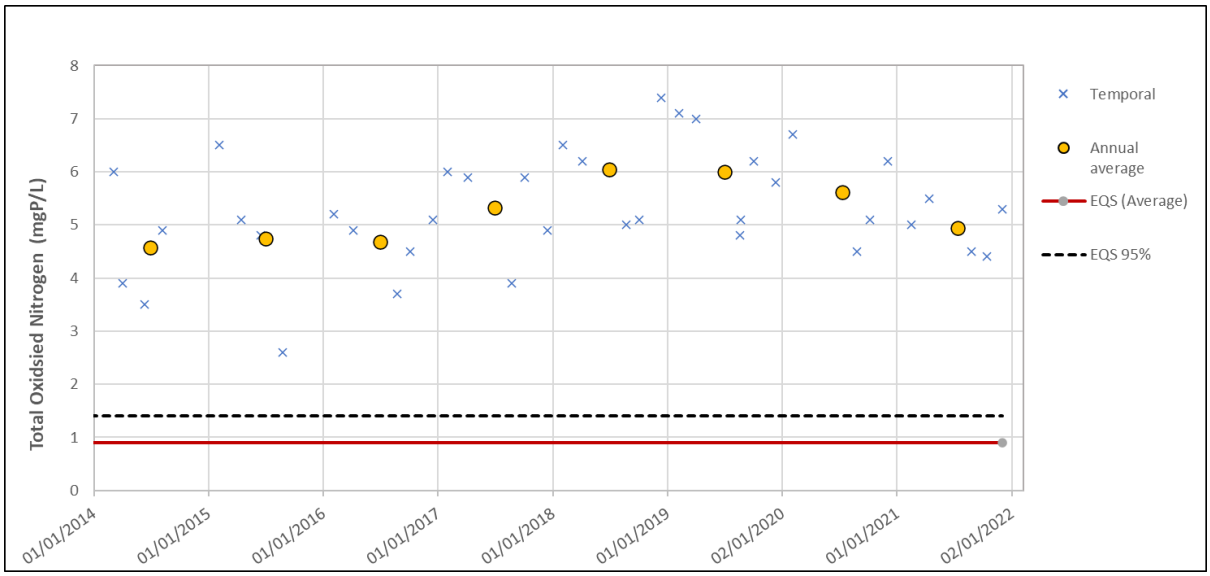


Figure 7: Total oxidised nitrogen concentrations measured at Bannow Br on the Shournagh_040 from 2012-2022.

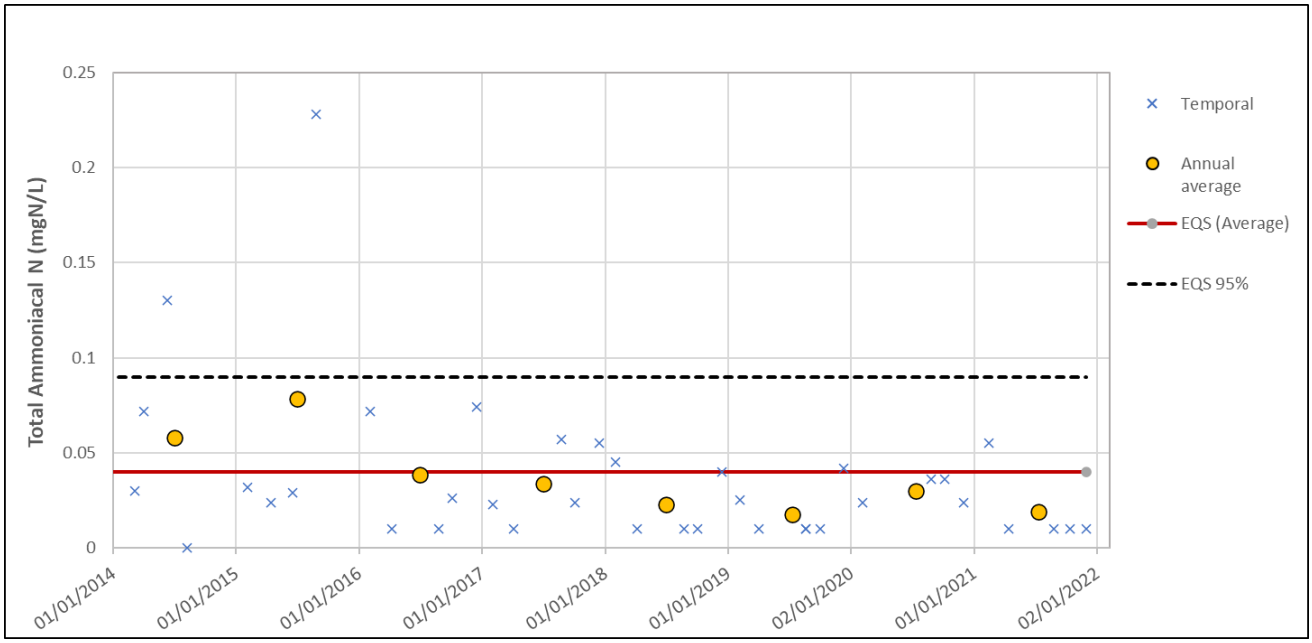


Figure 8: Total ammoniacal N concentrations measured at Bannow Br on the Shournagh_040 from 2012-2022.

2.5 Summary of the issues

Rathcoola_010

Rathcoola_010 is currently meeting its WFD objective of Good status. However, it is important to prevent any deterioration of water quality in the future, particularly considering this waterbody dropped to Poor status in 2011 and Moderate status in 2014. From the data available in the WFD app it appears that **sediment** issues from land reclamation may have been responsible for the historical deterioration. As routine chemistry monitoring is not conducted on this waterbody it is difficult to conclude if nutrients are likely to become a significant issue for this waterbody in the future. However, nitrate and phosphate are significant issues in the downstream waterbodies which have similar soil types and land-uses as Rathcoola_010, therefore it seems likely that both **nitrate** and **phosphate** may be significant issues for this waterbody.

Shournagh_010

Shournagh_010 is currently meeting its WFD objective of Good status. However, this waterbody dropped to Moderate status in 2011 and there has been a general decline in conditions from High status to Good status over the last 40 years. There is no characterisation data available in the WFD app for this waterbody however, nitrate and phosphate are significant issues in the downstream

waterbodies which have similar soil types and land-uses as the Shournagh_010, therefore it seems likely that both **nitrate** and **phosphate** may become significant issues for this waterbody in the future.

Shournagh_020

Hydromorphology was driving the overall Good ecological status in Shournagh_020 during the last monitoring period (2013 – 2018). The 2017 RHAT survey highlighted below optimal bank structure, vegetation, riparian conditions and floodplain connectivity all in relation to the left-hand bank due to the presence of a major road and associated infrastructure (i.e. road embankment). However, these features improved in the 2020 survey and the overall hydromorphology status was High. Biological status was also High in 2020 therefore this waterbody is currently achieving its High ecological status objective.

Routine chemistry monitoring is not conducted on this waterbody. However, nitrate and phosphate are significant issues in the downstream waterbodies which have similar soil types and land-uses as the Shournagh_020, therefore it seems likely that both **nitrate** and **phosphate** may become significant issues for this waterbody in the future.

Shournagh_030

Both ortho-phosphate and nitrate-N were at moderate status in the last monitoring period (2013-2018) resulting in an overall fail for the supporting chemistry conditions in this waterbody. Therefore, **nitrate** and **phosphate** are the significant issues for this waterbody. Concentrations of both of these nutrients are persistently elevated, with annual averages exceeding the mean EQS each year since 2012. These persistently elevated concentrations indicate that transfer is occurring via diffuse pathways for both nutrients. Very elevated ortho-P concentrations during the very dry summer months (July, August and September) of 2018 suggest the presence of point sources. Annual average ammonium concentrations were generally below the EQS, however occasional spikes in ammonium and BOD are indicative of emissions from an organic point source, likely in close proximity to the monitoring station.

Shournagh_040

Both ortho-phosphate and Nitrate-N were at Moderate status in the last monitoring period (2013-2018) resulting in an overall fail for the supporting chemistry conditions at this site. Therefore, **nitrate** and **phosphate** are the significant issues for this waterbody. Concentrations are both of these nutrients are persistently elevated, with annual averages exceeding the mean EQS each year since 2014. These persistently elevated concentrations indicate that transfer is occurring via diffuse pathways for both nutrients. Annual average ammonium concentrations were generally below the EQS. There were occasional spikes in ammonium prior to 2017. However, since 2017, ammonium concentrations have always been below the Good status EQS indicating that a point source has since been resolved. BOD concentrations exceeded the mean Good status EQS of 1.5mg/L twice since 2017, indicating a possible intermittent organic point source.

3 Significant pressure information

3.1 Initial EPA Characterisation

The information in the following table was extracted from the WFD app on 25/03/2022. However, the agricultural pressure described for Rathcoola_010 and the hydromorphology pressure described for Shournagh_020 are no longer preventing these two waterbodies from achieving their WFD objectives of Good and High status respectively and therefore are now unlikely to be significant.

Table 4: Initial EPA characterisation

Waterbody		Pressures				
Name	**Code**	**Category**	**Sub-Category**	**Name**	**Significant ?**	**Pressure & impact details**
Rathcoola_010	IE_SW_19R450050	Agriculture	Agriculture		Yes	Altered habitat due to morphological changes
Shournagh_010	IE_SW_19S010100	No pressure impacts data available				
Shournagh_020	IE_SW_19S010200	Hydro-morphology	Embank-ments		Yes	Altered habitat due to morphological changes
Shournagh_030	IE_SW_19S010300	Urban wastewater	Agglomer-ation PE>10,000	Blarney	Yes	Nutrient pollution
		Urban Run-off	Diffuse sources runoff		Yes	Nutrient pollution
		Domestic wastewater	Single house discharges		No	Nutrient pollution
Shournagh_040	IE_SW_19S010500	Agriculture	Agriculture		Yes	Nutrient pollution
		Urban Run-off	Diffuse sources runoff		Yes	Nutrient pollution
		Domestic wastewater	Single house discharges		Yes	Nutrient pollution

3.2 Agricultural nutrient pressures

The Shournagh catchment is *ca.* 121 km2 in area. Approximately 75% of the land is in pasture-based agriculture (see Corine Land use map Appendix 2). The balance is mainly comprised of cereal crops, with riparian woodlands along the main Shournagh River and some forestry in the uplands, mostly in Rathcoola_010. Blarney golf course and a small urban centre (Tower village) also occupy a substantial area of Shournagh_030. There is another golf course, Muskerry, in Shournagh_040. Dairying is the predominant land use in the Shournagh catchment, and the stocking rate is among the highest in the country. Approximately 40% of the land is being farmed at a stocking rate greater than 170 kgN/ha. Considering this and the persistently elevated nitrate and phosphate concentrations in the Shournagh_030 and Shournagh_040, it seems very likely that diffuse nutrient losses from agriculture are a significant issue throughout this catchment.

The soils in this catchment are brown earths over old red sandstone geology. They are well drained with the exception of small areas of gleyic brown alluvial soils neighbouring the stream in the Shournagh_030 and _040 (Appendix 3). The aquifer is Locally Important - bedrock which is moderately productive only in local zones. Groundwater recharge is low and groundwater vulnerability is mostly high, rising to extreme along the river channels where there is exposed bedrock (Appendix 5). The well-drained soils support a long growing season, early livestock turnout and the grassland dairy production that dominates in this catchment. Based on the free draining nature of the soils, nitrogen is considered the main nutrient at risk and the main loss pathway is leaching through the soils to groundwater. Well drained soils are not typically associated with diffuse P losses; however, the iron-rich old red sandstones tend to have a weak ability to retain ortho-phosphate in the soil compare to other well drained sols in ireland and are prone to leaching of phosphate to shallow groundwater (Mellander et al. 2016, Fresne et al. 2021, 2022). Therefore, the Shournagh catchment is risky for both nitrate and phosphate loss via diffuse subsurface pathways.

Aerial imagery indicates that large sections of the Shournagh River are protected by woodlands along the riverbank. These riparian woodlands essentially provide a buffer for nutrient losses in overland flow to the Shournagh river from the adjacent farmland, for example from high P pollution impact potential zones. However, these wooded riparian margins are unlikely to afford much attenuation of diffuse nutrient losses via subsurface pathways.

Given the intensity of agriculture in the Shournagh catchment, there may also be nutrient losses from agricultural point sources such as farmyard effluents. Point sources from agriculture are likely to be more prevalent in poorly-drained agricultural catchments due to the high density of drainage ditches in these settings which can provide a direct vector between farmyards and receiving waterbodies. Nevertheless point sources have also been linked to elevated phosphorus concentrations in summer baseflows in the nearby Timoleague study catchment which has similar soils and bedrock to the Shournagh Demonstration Catchment (Shore et al., 2017). Therefore, potential point sources should be assessed where possible during rivers walks and farm visits in the demonstration catchment.

Figure 9 and **Figure 10** below show the livestock organic nitrogen and phosphorus inputs in each subbasin. These figures are based on the 2019 LPIS data from DAFM and show (i) the total organic nutrient inputs in each subbasin and (ii) the organic nutrient inputs per hectare in each subbasin. As can be seen in the figures below, Shournagh_010, 020 and 040 have the highest total nutrient inputs as well as the highest inputs per hectare. This indicates that these three subbasins are likely delivering the greatest diffuse nutrient loads to the stream.

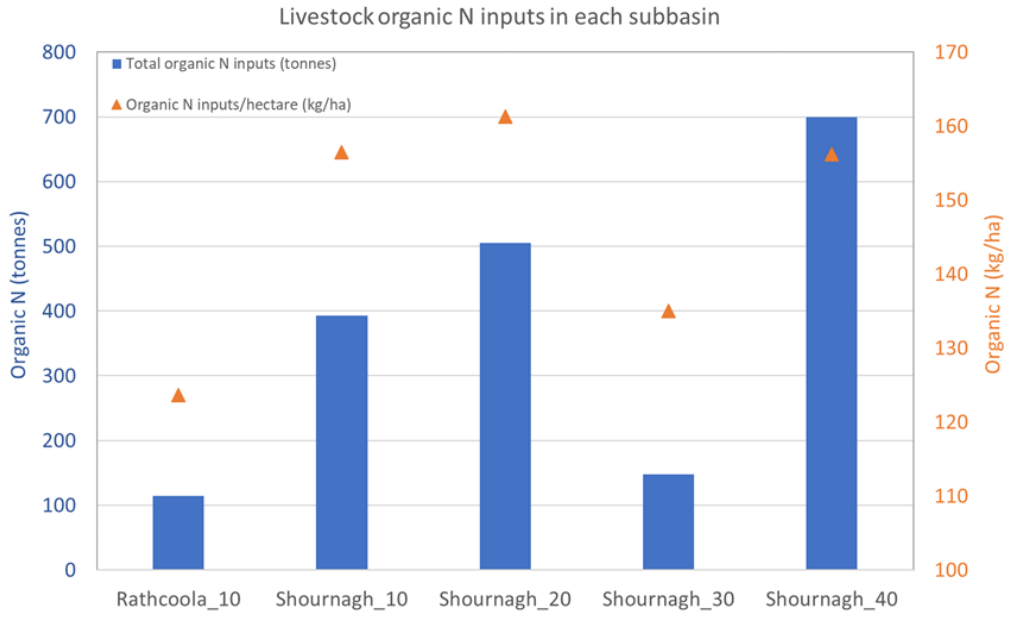


Figure 9: Livestock organic N inputs in each subbasin

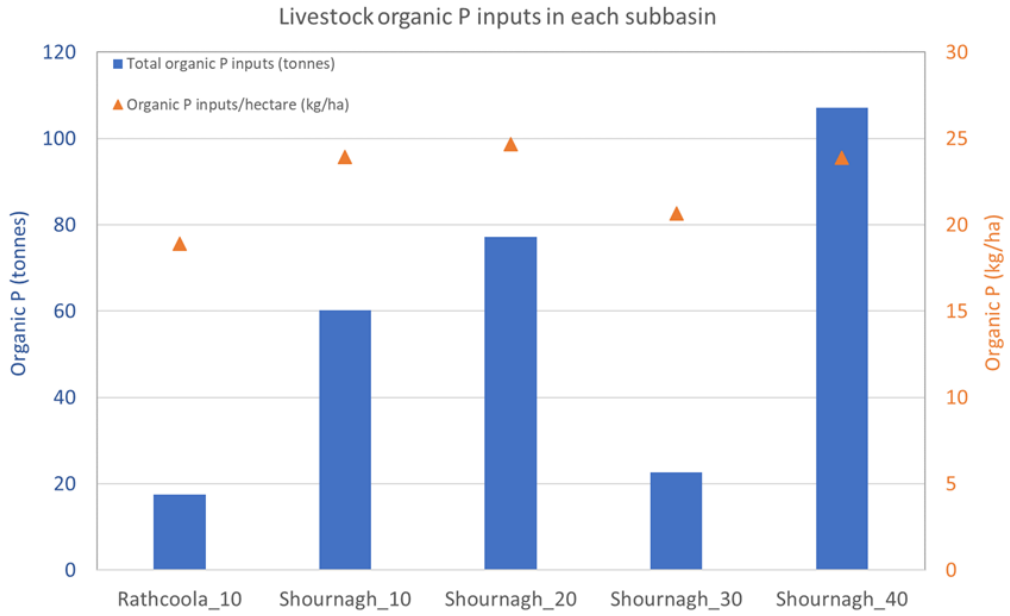


Figure 10: Livestock organic P inputs in each subbasin

Pollution impact potential maps for both phosphate (**Figure 11**) and nitrate (**Figure 12**) were developed for the Shournagh Demonstration Catchment as illustrated below to highlight the riskiest areas for nutrient losses in each subbasin.

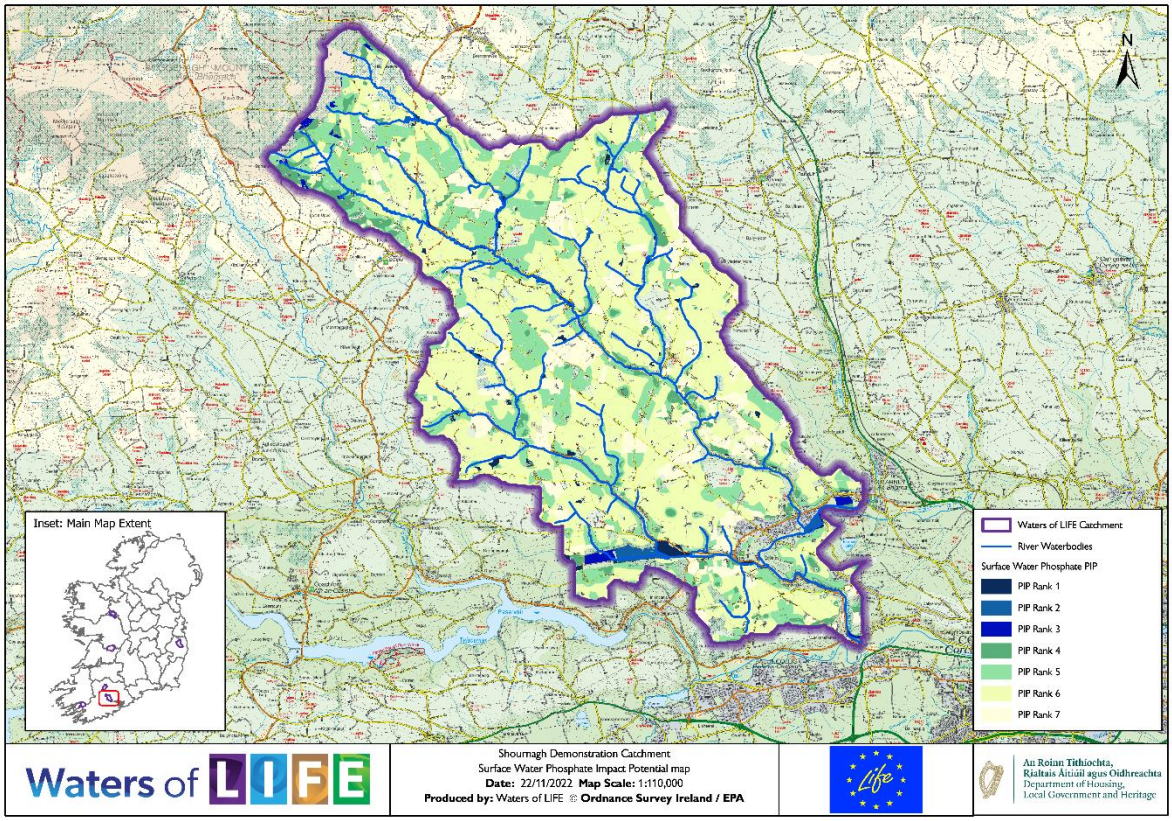


Figure 11: Pollution impact potential (PIP) map of phosphate loss to surface water in the Shournagh Demonstration Catchment, illustrating ranks 1-5 only

Figure 11 above shows the areas where there is likely to be the highest risk of diffuse P losses from agricultural areas. The risky areas are ranked here from 1 – 5 with 1 being the highest risk of P losses and 5 being the lowest. Usually ranks 1 – 3 only are considered to be at 'High' risk, typically due to the presence of poorly draining soils and moderate/high livestock intensity. However, there are very few areas here ranked 1-3 yet we know there are very high P losses further downstream in the Shournagh_030 and Shournagh_040. Therefore ranks 4 and 5 were also included. Rank 4 in this map is typically due to the presence of extreme vulnerability due to rock at or near the surface and little potential for attenuation via the soil matrix. Rank 5 here is typically due to moderate/high livestock intensity on well-drained soil. Rank 5 is not usually considered risky for P loss due to the well-drained nature of the soil. However, the Shournagh catchment is underlain by Old Devonian Red Sandstones which have been linked to elevated P loss to groundwater due to the formation of Iron-phosphate complexes (Mellander et al. 2016, Fresne et al. 2021, 2022). This is still a poorly understood process at catchment scale but presuming uniformity in soil geochemistry across the well-drained soils is likely to be greatest in areas with the highest P loadings as captured in the Rank 5 areas above. Therefore

for the purposes of this project it is advised that all areas Ranked 1 – 5 above be considered as high risk for P loss in the Shournagh catchment.

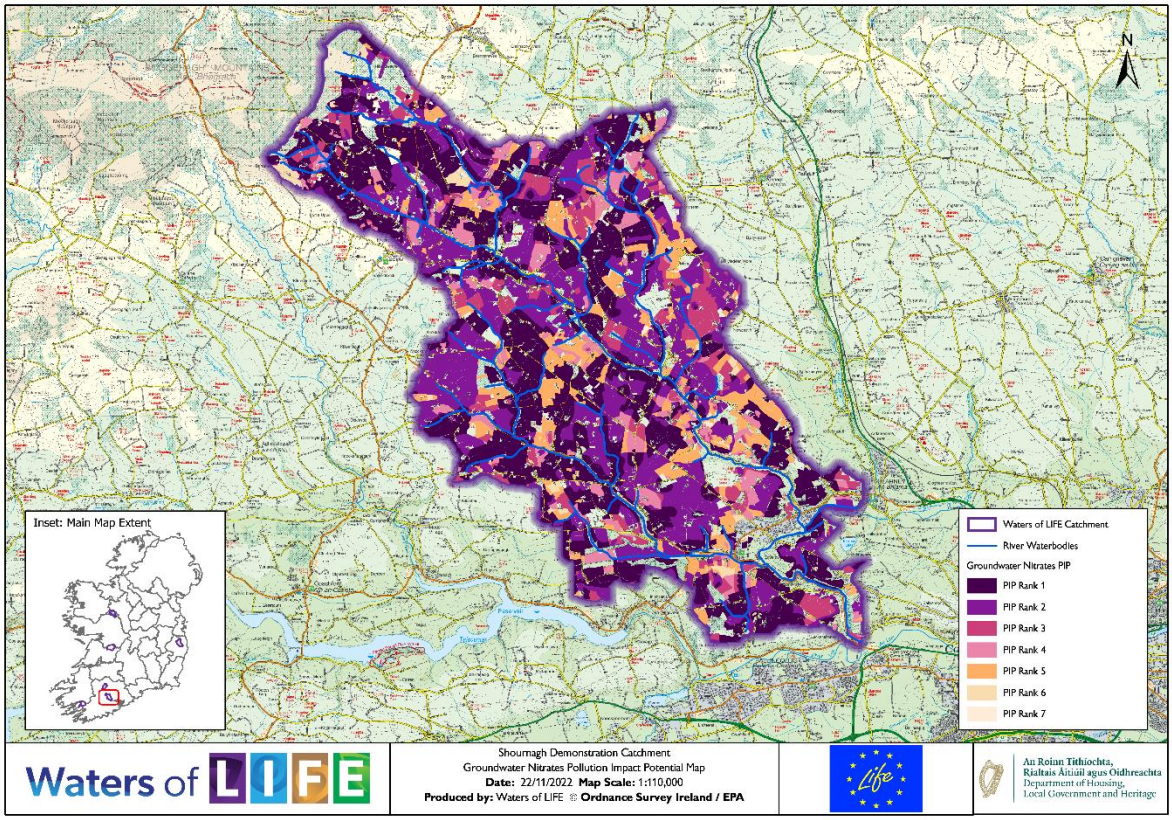


Figure 12: Pollution impact potential map of nitrate loss to surface water in the Shournagh Demonstration Catchment illustrating ranks 1-3 only

Figure 12 above shows the areas where there is likely to be the highest risk of diffuse N losses from agriculture. The high risk areas are ranked here from 1 – 3 (with 1 being the highest risk of N losses), typically due to the presence of well-drained soils and moderate moderate/high livestock intensity. As can be seen in the figure, the majority of the Shournagh Demonstration Catchment has a high risk of diffuse N loss. For the purposes of the Waters of Life demonstration catchment, it may be useful to target the rank 1 and 2 areas to provide a focus for mitigation measures.

Table 5: The percent of each subbasin at the PIP ranks 1 – 5 for P and ranks 1 – 2 for N.

		PIP P risky target areas					PIP N risky target areas		
	basin size (km^2)	Rank 1 (%)	Rank 2 (%)	Rank 3(%)	Rank 4(%)	Rank 5(%)	Rank 1(%)	Rank 2(%)	Rank 3(%)
Rathcoola_10	9.23	2	0	4	6	19	26	23	7
Shournagh_10	25.13	2	0	1	4	29	31	22	29
Shournagh_20	31.31	2	1	0	3	16	16	18	34
Shournagh_30	10.94	1	1	1	4	14	18	13	21
Shournagh_40	44.81	2	1	1	5	25	22	28	24

3.3 Section 4 discharges

There are a number of section 4 discharges in the Shournagh catchment as shown in Appendix 7. One at the Courtbrack WWTP in Shournagh_020. One associated with Blarney Golf Course in Shournagh_030. Another associated Muskerry Golf Course in Shournagh_040 and an additional one associated with the hospitality industry on a tributary of Shournagh_040. The details and potential risks posed by these discharges to water-quality in the Shournagh catchment should be discussed with relevant staff in Cork County Council as part of the Waters of Life project. Based on the High Biological status in the Shournagh_020, _030 and _040, it seems likely that these discharges are not posing a significant risk to water-quality.

3.4 Rathcoola_010

Agriculture

From the data available in the WFD app it appears that sediment issues from land reclamation may have been responsible for the historical deterioration in biological quality from Good status in 2008 to Poor in 2011 and Moderate in 2014. However, this waterbody was Good status in 2017 and 2020, therefore land reclamation is unlikely to still be a significant pressure. But, it may be susceptible to land reclamation pressures in the future.

Considering the intensive dairying in the Rathcoola_010 subbasin and the elevated nitrate and phosphate concentrations further downstream, diffuse nutrient losses from agriculture may adversely affect the invertebrate fauna in this subbasin in the future. Total organic N and P inputs for Rathcoola_010 are estimated to be 114 and 17 tonnes respectively, with an approximate rate of 124kgN/ha and 19kgP/ha (**Figure 9** and **Figure 10** above). Given the intensity of agriculture in this subbasin, agricultural point sources and associated nutrient and organic pollution may also pose a risk to the water quality of Rathcoola_010 in the future.

As shown in **Table 5** above, 31% of Rathcoola_010 is considered to be at high risk of diffuse P loss, the majority of which (*ca.* 19%) is likely to be via subsurface leaching with iron complexes (rank 5). Forty nine percent of Rathcoola_010 is at rank 1 and 2 for diffuse N loss via subsurface leaching. Addressing the pathways for these diffuse losses would be very challenging due to the subsurface nature of these losses. Therefore, either reducing nutrient inputs or improving nutrient use efficiency will be important to prevent any deterioration from Good status in this waterbody.

Forestry

There are pockets of forestry throughout the Shournagh catchment, much of which is privately owned riparian forestry in the Shournagh_030 and the lower sections of Shournagh_040. However, there is more extensive state owned and private forestry in Rathcoola_010, occupying 26% of the catchment area, 17% of which is owned by Coillte and the remained privately owned (Appendix 6). Forestry land-use has been frequently linked to excess sediment release to watercourses which can be detrimental to aquatic fauna. Typical sources of sediment from forestry activities include thinning and clear-felling, pathways created by machine rutting on clear-fell sites, site preparation for afforestation, road construction associated with forestry activities and inappropriate forest drainage. Although Rathcoola_010 is currently meeting its WFD objective of Good status, this waterbody dropped to Poor status in 2011 and Moderate status in 2014. From the data available in the WFD app it appears that sediment issues from land reclamation may have been responsible for the historical deterioration, however it is possible that some of this sediment could also have arisen from forestry activities mentioned above. Therefore, sediment assessments along the river channel will be particularly important in the Rathcool_010 and observations of forestry operations and drainage management over the course of the Water of Life project.

3.5 Shournagh_010

Agriculture

There is no pressure information in the WFD app for Shournagh_010. However, considering the land-use, water-quality and pollution impact potential data shown above, diffuse nutrient losses from agriculture are likely to be the main pressure in the subbasin. Total organic N and P inputs for Shournagh_010 are estimated to be 393 and 60 tonnes respectively, with an approximate rate of 157kgN/ha and 24kgP/ha (**Figure 9** and **Figure 10** above). Considering the intensity of agriculture in this subbasin, agricultural point sources and associated nutrient and organic pollution may also pose a risk to the water quality of Shournagh_010 in the future.

Thirty six percent of Shournagh_010 is considered to be at high risk of diffuse P loss (**Table 5**), the majority of which (*ca.* 29%) is likely to be via subsurface leaching with iron complexes (rank 5). Fifty three percent of Shournagh_010 is at rank 1 and 2 for diffuse N loss via subsurface leaching. This subbasin has the largest proportion of risky areas for both diffuse N and P loss. Therefore, mitigation measures for diffuse nutrient losses should focus in this headwater subbasin in tandem with those in the adjacent Rathcoola_010 which has the second highest proportion of areas ranked 1 and 2 for nitrate loss.

3.6 Shournagh_020

Hydromorphology

Hydromorphology was driving the overall Good ecological status in Shournagh_020 during the last monitoring period (2013 – 2018). The 2017 RHAT survey highlighted below optimal bank structure, vegetation, riparian conditions and floodplain connectivity all in relation to the left-hand bank.). However, these features improved in the 2020 survey and the overall hydromorphology status was High. Biological status was also High in 2020 therefore this waterbody is currently achieving its High ecological status objective. Hydromorphology can be removed as a significant pressure from the WFD app.

Agriculture

Whilst agriculture is not listed as a significant pressure for the Shournagh_020 in the WFD App, considering the data presented in section 3.2, it is likely to delivering elevated nitrogen and phosphorus levels to the stream. Total organic N and P inputs for Shournagh_020 are estimated to be 505 and 77 tonnes respectively, with an approximate rate of 161kgN/ha and 25kgP/ha (**Figure 9** and **Figure 10** above). Twenty two percent of Shournagh_020 is considered to be at high risk of diffuse P loss (**Table 5**), 16% of which is likely to be via subsurface leaching with iron complexes (rank 5). Thirty four percent of Shournagh_020 is at rank 1 and 2 for diffuse N loss via subsurface leaching. Considering the intensity of agriculture in this subbasin, agricultural point sources and associated nutrient and organic pollution may also pose a risk to the water quality of Shournagh_010 in the future.

Urban wastewater

There is a sewage treatment plant at Courtbrack (COA no. A0437_01), discharging to a tributary of the Shournagh_020 approximately 2.7 km upstream of the EPA station 'E of Gortdonaghmore' at the catchment outlet. The wastewater treatment plant (WWTP) has a PE of 250 and provides tertiary treatment, consisting of aeration, sand filtration and phosphorus removal. The plant discharge is not a significant pressure on Shournagh_020, considering the consistent High biological status at the downstream WFD monitoring point. It is assessed here only in terms of its contribution to the elevated phosphorus and nitrogen levels measured further downstream.

The PE load recorded by Irish Water in 2020 was 151. LAWPRO's urban wastewater assessment methodology was used to estimate effluent phosphate load for a COA with tertiary treatment. This gave a figure of 33 grammes P per day discharging to the river, for a PE of 151. At design loading, the estimate is 54.5 grammes per day. COA estimates for nitrate are not provided in the LAWPRO methodology but a worst case approach is taken here, assuming that the nitrogen load is 8 grammes per person per day. This equates to 1.21kg nitrogen for a PE of 151 and 2kg nitrogen at the design PE loading of 250.

The nearest downstream monitoring station is Tower Br on the Shournagh_030. Estimated nutrient loadings at Tower Br, minus the contribution from the Martin_040 River, are 11.1 kgP/day and 1033 kgN/day (**Table 6** below). Therefore, even at design loading rates, the Courtbrack CoA would

contribute less than 0.5% of the P loading to the Shournagh_030 and less than 0.2% of the N load at Tower Bridge.

There are no nutrient concentration or loading data available for the Shournagh_020. However, a very basic area-weighted approach was used to broadly estimate nutrient loadings in the Shournagh_020. The results gave indicative values of 8.48 kgP/day and 837 kgN/day. These calculations were based on the size and nutrient loadings recorded for the 'native' Shournagh_030 catchment and accounted for the nutrient loadings from the Blarney WWTP in Shournagh_030. Using these estimated figures, Courtbrack CoA contributes approximately 0.7% of the P loadings and less than 0.3% of the N loadings in the Shournagh_020. These data indicate that the Courtbrack CoA does not significantly contribute to nutrient loads in the Shournagh_020 or the Shournagh_030.

3.7 Shournagh_030

Concentrations of both nitrogen and phosphorus are persistently elevated in the Shournagh_030, with annual averages exceeding the mean EQS each year since 2012. The initial EPA characterisation identified two significant pressures on Shournagh_030, Urban Wastewater (Blarney UWWTP) and Urban Runoff (Blarney town). Domestic wastewater was also listed as a pressure but was not considered to be significant. Diffuse nutrient losses from agriculture may also be a significant pressure in this subbasin. These pressures are explored in sections below. However, the adjacent Manin_SC_010 subcatchment is approximately 88 km^2 and delivers significant nutrient loads into the Shournagh_030 at Bawnafinny Bridge, affecting the water quality at both Tower Br (Shournagh_030) and Bannow Br (Shournagh_040), so first of all the inputting loads from the adjacent Manin_SC_10 subcatchment need to be considered and explored.

Influence of adjacent Manin_SC_010 subcatchment

The water quality characteristics relating to the Bawnafinny Br and Tower Br monitoring sites are shown in **Table 6** below.

Table 6: Water quality characteristics relating to Bannow Br and Bawnafinny Br.

Waterbody name EPA station name	Martin_040 Bawnafinny Br	Shournagh_030 Tower Br
Contributing catchment area (km^2)	88.5	161.8
No. of contributing waterbodies	5	8
30^{th} percentile flow (m^3/s)	3.209	5.568
Annual avg P concentration (mg/l)	0.057	0.056
Annual avg P load (kg/day)	15.8	26.9
Annual avg N concentration (mg/l)	5.3	5.2
Annual avg N load (kg/day)	1469	2502
Annual avg NH_4 concentration (mg/l)	0.038	0.036
Annual avg NH_4 Ammonium load (kg/day)	10.54	17.32
% P load from Bawnafinny Br		59%
% N load from Bawnafinny Br		59%
% NH_4 load from Bawnafinny Br		61%

As shown in **Table 6**, annual average phosphate and nitrate concentrations are very similar between the two monitoring sites. This implies a consistency in pressures as the river flows from the Martin_040 into the Shournagh_030 with neither significant dilution nor concentration of nutrients occurring.

Based on the data shown in **Table 6** above, the Manin_SC_10 subcatchment (as measured at Bawnafinny Br) delivers approx. 59% of the phosphate and nitrate loads and 61% of the ammonium loads measured at Tower Br on the Shournagh_030. The Manin_SC_10 subcatchment comprises approx. 55% of the total catchment area contributing to Tower Br and is therefore delivering a slightly higher proportion of the phosphate, nitrate and ammonium loads.

Table 7: Nutrient loading calculations relating to Tower Br.

Waterbody name EPA station name	Shournagh_030 Tower Br
P reduction rqd for WFD target 0.025 (kg/day)	16.1
N reduction rqd for WFD target 0.9 (kg/day)	2463
N reduction rqd for WFD target 1.8 (kg/day)	1722
N reduction rqd for WFD target 3.5 (kg/day)	986
P Load from 'native' Shournagh (-load from Martin) (kg/day)	11.1
N Load from 'native' Shournagh (-load from Martin) (kg/day)	1033

In order to achieve a High-status P concentration of 0.0225mg/l at Tower Br on the Shournagh_030, a P load reduction of 16.1kg/day is required (**Table 7**). The 'native' Shournagh_030 catchment (i.e. minus the contribution from Manin_SC_010) delivers *ca.* 11.1kg P/day to Tower Br, therefore even if

all the P is removed from the 'native' Shournagh_030 catchment, the High-status EQS would still not be met at Tower Br.

In order to achieve a High-status N concentration of 0.81mg/l at Tower Br, a N load reduction of 2463kg/day is required. The 'native' Shournagh_030 catchment delivers *ca.* 1033kg N/day to Tower Br, therefore even if all the N is removed from the 'native' Shournagh_030 catchment, the high-status EQS would still not be met at Tower Br.

It is important to develop realistic targets for the project and what is considered a desirable nutrient concentration at the outlet of Shournagh_030.

For this purpose, three nutrient concentration scenarios are considered for the 'native' Shournagh_030 catchment in isolation, with the nutrient loads from the Manin_SC_010 subcatchment subsequently accounted for (**Table 8** below).

(i) A notional clean value whereby nutrient concentrations in the 'native' Shournagh_030 catchment are hypothetically at 1/5th the high-status EQS. Accounting for the additional loads from the Manin_SC_010, phosphate and nitrate concentrations at the outlet of Shournagh_030 would be 0.03mg/l and 2.7mg/l respectively.

(ii) A High-status scenario whereby nutrient concentrations in the 'native' Shournagh_030 catchment are hypothetically at 0.9 times the high-status EQS. Accounting for the additional loads from the Manin_SC_010, phosphate and nitrate concentrations at the outlet of Shournagh_040 would be 0.037mg/l and 2.93mg/l respectively.

(iii) A Good-status scenario whereby nutrient concentrations in the 'native' Shournagh_030 catchment are hypothetically at 0.9 times the Good-status EQS. Accounting for the additional loads from the Manin_SC_010, phosphate and nitrate concentrations at the outlet of Shournagh_040 would be 0.039mg/l and 3.22mg/l respectively.

Table 8: Three nutrient concentration scenarios for the 'native' Shournagh_030 catchment

	Native Shournagh_030		Shournagh_030 Plus Main_SC_010	
	Notional clean conc	**Notional clean Load**	**Notional clean total load**	**Notional clean resultant conc**
	mg/l	*kg/day*	*kg/day*	*mg/l*
Phosphate	0.005	1.019	16.8	0.03
Nitrate-N	0.18	36.7	1505.7	2.7
	High status conc	**High status load**	**High status total load**	**High status resultant conc**
	mg/l	kg/day	kg/day	mg/l
Phosphate	0.0225	4.59	20.4	0.037
Nitrate-N	0.81	165.1	1634.1	2.93
	Good status conc	**Good status load**	**Good status total load**	**Good status resultant conc**
	mg/l	*kg/day*	*kg/day*	*mg/l*
Phosphate	0.03	6.115	21.9	0.039
Nitrate-N[1]	1.62	330	1799	3.22
Nitrate-N[2]	3.15	642	2111	3.78

[1]There is no N Good status EQS for rivers therefore the threshold of 1.8mg/l used in the status classification is used here.

[2] Here a threshold of 3.5 mg/l is used which is used by the EPA as a guide in characterisation to point towards riverine impact that needs restoration.

Urban runoff

Nitrate and orthophosphate are the significant issues impacting on Shournagh_030. Urban runoff can contribute nutrients to a watercourse, but they are unlikely to be delivered alone. The constituents of urban runoff can include sediment, organic pollutants and toxic components in addition to nutrients. Considering that Shournagh_030 has consistently achieved high biological status since 2011, it seems unlikely that urban runoff is a significant pressure on this waterbody. However, the impact of urban runoff can only be assessed via the local catchment assessment process and should not be excluded at desk study stage. Issues to look out for include evidence of pollution (sewage fungus, debris, anoxic sediment) immediately downstream of pipes and drains.

Urban wastewater

The potential impact of the Blarney WWTP is assessed below following the LAWPRO methodology as shown in steps (i)-(iv) below. This desk-based approach is used by LAWPRO to assess likely pollution risk associated with an urban wastewater discharge and to determine the extent of fieldwork required to confirm. Blarney WWTP operates under EPA wastewater discharge licence number D0043_01. The plant comprises a 3NP – Tertiary N and P removal system. Plant capacity is 13000PE. Nutrient load data for this assessment are based on annual average values provided in the 2020 AER.

i) Is Blarney WWTP a significant pressure from initial characterisation?

Yes. The following is an extract from the WFD App characterisation information 'the WWTP appears to be well run and has Tertiary N & P treatment in place, however, a number of Ortho P exceedances were noted. A significant proportion of the Ortho P load is likely to be coming from the WWTP, however, there doesn't appear to be enough evidence to link the Moderate N result to be WWTP'.

ii) Assessment of UWW contribution to the total load (and required reduction) at the WFD monitoring point.

Nitrate and orthophosphate are the significant issues impacting on Shournagh_030. The total load of each parameter at the waterbody outlet was calculated by multiplying the 2020 baseline values by the estimated mean flow (Q30). The load from the UWW discharge was calculated from the 2020 AER, multiplying average nutrient concentration by mean effluent flow. Results (presented in **Table 9** below) indicate that the licensed UWW discharge is not a significant pressure on Shournagh_030. Contribution to the total MRP and TON loads and required reduction is significantly below 20% for both parameters.

Table 9: Blarney UWW discharge contribution to mean daily load and required reduction at Tower Br on the Shournagh_030

	Est. mean daily load at WFD mon. pt (Shournagh_030 and Martin_040 combined)	Daily load from Blarney WWTP (fom 2020 AER)	WWTP contribution to daily load at WFD mon pt
	kg/day	kg/day	%
MRP	26.94	1.21	4.5
NH4N	17.32	0.38	2.2
TON	2502	56.4	2.3

Considering that the work of the Waters of Life project in the Shournagh catchment will not include any measures in the inputting Martin River system, step (ii) was repeated using the nutrient loads and required reduction associated with the Shournagh_030 system alone (i.e. minus the contribution from Martin_040) (**Table 10**). The conclusion remains the same; while the contribution of the UWW discharge to the required MRP reduction at Tower Bridge monitoring station is higher in this scenario, it is still well below 20%.

Table 10: Blarney UWW discharge contribution to mean daily load and required reduction associated with the Shournagh_030 system alone (i.e. minus the contribution from Martin_040).

	Est. mean daily load at WFD mon. pt (Shournagh_030	Required Reduction at WFD mon.pt	Daily loading from Blarney WWTP *(from 2020 AER)*	WWTP contribution to daily load at WFD mon pt	WWTP contribution to required load reduction
	kg/day	kg/d	kg/day	%	%
MRP	11.14	6.55	1.21	10.9	18.5
NH4N	6.78	NA	0.38	5.6	NA
TON	1032	867	56.4	5.5	6.5

iii) Assessment of pollution risk posed by the UWW discharge in river 95%ile flow conditions.

Headroom utilisation calculations indicate that the licensed UWW discharge does not pose a pollution risk at Tower Bridge monitoring station in low flow (Q95) conditions. Percentage headroom utilised for all parameters is well below the LAWPRO recommended limit of 50% (**Table 11**). Key parameters in terms of immediate pollution risk are BOD and ammonium. Headroom utilisation for these is less than 5%.

Table 11: Headroom utilisation (Q95 river flow) for Blarney UWW discharge

	Upstream conc (notional clean)	Final D/S Conc	Headroom utilised
	(mg/l)	mg/l	%
BOD	0.26	0.301	2
MRP	0.005	0.012	18
NO_3N	0.18	0.511	27
NH_4N	0.008	0.01	3

iv) Consideration of proximity of the discharge to the monitoring point

Treated effluent from Blarney UWWTP discharges to the Shournagh_030 main channel approximately 700m upstream of the Tower Br WFD monitoring point. There are no tributaries flowing into the main channel between the two points. Therefore, there is a proximity issue here i.e. a risk of water quality deterioration at the WFD monitoring point resulting from one-off or occasional environmental incidents associated with the plant. This risk is best assessed by biological monitoring. There is no impact on downstream biology however as biological monitoring results at the Tower Bridge monitoring station have been at Q4/5 since 2011 (and Q4 in 2008).

Conclusion on UWW as a potential point source pressure on Shournagh_030

Desktop calculations indicate that the licensed effluent discharge from the Blarney wastewater treatment plant is unlikely to be a significant pressure on Shournagh_030. The discharge is not a significant contributor to the total MRP or TON loadings at Tower Bridge monitoring station. While it contributes close to 20% of the required P reduction for the native Shournagh_030 catchment, the plant is compliant with its licence and has tertiary P removal in place so it is unlikely to be able to achieve significant further P reduction. The pollution risk in low flow conditions is below the recommended limit of 50% headroom utilisation. While the location of the discharge is indicative of a potential proximity issue, biological monitoring results at Tower Bridge station from 2008 to 2020 do not indicate a problem here. There is a storm water overflow located at the head of the works, which could potentially cause downstream spikes in MRP when it activates. These spikes would also be associated with elevated BOD. Data from 2014 to 2021 were examined to determine whether this is

the case but of the 57 MRP results which exceeded the high-status 95%ile EQS in that period, only seven results were also associated with BOD levels above the EQS.

Domestic wastewater

The following information was provided in the WFD app for domestic wastewater 'WWTS clusters upstream of Blarney agglomeration and situated on low near surface P susceptibility and PIP SW-P. Cork CoCo - Noted only a few houses on septic tanks near the river channel, river is contained in wooded glen for much of its length which provides buffering. Remove as significant pressure'.

Agriculture

In summary, approx. 59% of the nitrate and phosphate load at Tower bridge are from the Manin_SC_10 subcatchment and 4.5% and 2.3% of the phosphate and nitrate loads respectively at Tower Bridge come from the Blarney WWTP (**Table 9**). Therefore, approximately 37% of the phosphate loads and 39% of the nitrate loads at Tower bridge are arising from the 'native' Shournagh_030 catchment (i.e. Rathcoola_010, Shournagh_010, Shournagh_020 and Shournagh_030). The risk maps for diffuse N and P loss (**Figure 11**and **Figure 12**) show substantial areas of the Shournagh_030 are risky for diffuse P (14% of the area in rank 5) and N (31% of the area in rank 1 and 2) loss from agricultural areas via subsurface pathways. A relatively small area close to Tower village are also risky for P loss in overland flow (i.e. ranks 1-3). Considering the intensity of agriculture in this subbasin, agricultural point sources and associated nutrient and organic pollution may also be contributing the elevated nutrient concentrations in this waterbody and may pose a risk to the health of the macroinvertebrate fauna in the future. Reducing nutrient inputs and/or improving nutrient use efficiency will be important to improving water quality in this waterbody.

3.8 Shournagh_040

Influence of adjacent Manin_SC_10 subcatchment.

The Manin_SC_010 subcatchment delivers significant nutrient loads to the Bannow Br monitoring on the Shournagh_040. The water quality characteristics relating to the Bawnafinny Br (Representing the Manin_SC_010 subcatchment) and Tower Br monitoring sites are shown in **Table 12** below. Water quality characteristics for Shournagh_030 are also shown for comparative purposes.

Table 12:Water quality characteristics relating to Bawnafinny Br, Bannow Br and Tower Br (See Figure 1)

Waterbody name EPA station name	Martin_040 Bawnafinny Br	Shournagh_040 Bannow Br	Shournagh_030 Tower Br
Contributing catchment area (km^2)	88.5	211.9	161.8
No. of contributing waterbodies	5	9	8
30^{th} percentile flow (m^3/s)	3.209	6.459	5.568
Annual avg P concentration (mg/l)	0.057	0.049	0.056
Annual avg P load (kg/day)	15.8	27.4	26.9
Annual avg N concentration (mg/l)	5.3	5.55	5.2
Annual avg N load (kg/day)	1469	3097	2502
Annual avg Ammonium concentration (mg/l)	0.038	0.021	0.036
Annual avg Ammonium load (kg/day)	10.54	11.72	17.32
% P load from Bawnafinny Br		58%	
% N load from Bawnafinny Br		47%	
% NH_4 load from Bawnafinny Br		90%	

Based on the data shown in **Table 12** above, the Manin_SC_010 subcatchment (as measured at Bawnafinny Br) delivers *ca.* 58% of the phosphate load and 47% of the nitrate load measured at Bannow Br on the Shournagh_040. The Manin_SC_010 subcatchment (88.5 km^2) comprises approx. 42% of the total area of both catchments (Manin subcatchment and Shournagh Demonstration Catchment) (212km^2), therefore it is delivering a relatively higher proportion of the phosphate and nitrate loads.

Table 13: Nutrient loading calculations relating to Bannow Br.

Waterbody name EPA station name	Shournagh_040 Bannow Br
P reduction rqd for WFD target 0.025 (kg/day)	14.8
N reduction rqd for WFD target 0.9 (kg/day)	3052
N reduction rqd for WFD target 1.8 (kg/day)	2193
N reduction rqd for WFD target 3.5 (kg/day)	1339
P Load from 'native' Shournagh (-load from Martin) (kg/day)	11.6
N Load from 'native' Shournagh (-load from Martin) (kg/day)	1628

In order to achieve a High-status P concentration of 0.0225mg/l at Bannow Br on the Shournagh_040, a P load reduction of 14.8kg/day is required. The 'native' Shournagh_040 catchment (i.e minus the contribution at Bawnafinny Br) delivers *ca.* 11.6kg P/day, therefore even if all the P is removed from the 'native' Shournagh_040 catchment, the High-status EQS would still not be met at the outlet of the Shournagh_040.

In order to achieve a High-status N concentration of 0.81mg/l (90% of the Nitrate target for High Status) at the outlet of Shournagh_040, a N load reduction of 3052kg/day is required. The native' Shournagh_040 catchment (i.e minus the contribution at Bawnafinny Br) delivers 1628kg N/day, therefore even if all the N is removed from the 'native' Shournagh_040 catchment, the High-status EQS would still not be met at the outlet of the Shournagh_040.

In order to develop realistic nutrient concentration targets for the Bannow Br monitoring site on the Shournagh_040, three nutrient concentration scenarios are considered below (Table 3.7.1.3) as per the Shournagh_030.

(i) A notional clean whereby nutrient concentrations in the 'native' Shournagh_040 catchment are hypothetically at 1/5th the high-status EQS. Accounting for the additional loads from the Manin_SC_10, phosphate and nitrate concentrations at the outlet of Shournagh_040 would be 0.031mg/l and 2.72mg/l respectively.

(ii) A High-status scenario whereby nutrient concentrations in the 'native' Shournagh_040 catchment are hypothetically at 0.9 times the high-status EQS. Accounting for the additional loads from the Manin_SC_010, phosphate and nitrate concentrations at the outlet of Shournagh_040 would be 0.04mg/l and 3.04mg/l respectively.

(iii) A Good-status scenario whereby nutrient concentrations in the 'native' Shournagh_040 catchment are hypothetically at 0.9 times the Good-status EQS. Accounting for the additional loads from the Manin_SC_010, phosphate and nitrate concentrations at the outlet of Shournagh_0 40 would be 0.043mg/l and 3.45mg/l respectively.

Table 14: Three nutrient concentration scenarios for the 'native' Shournagh_040 catchment

	Native Shournagh_040		Shournagh_040 Plus Main_SC_010	
	Notional clean conc	**Notional clean load**	**Notional clean total load**	**Notional clean resultant conc**
	mg/l	*kg/day*	*kg/day*	*mg/l*
Phosphate	0.005	1.40	17.2	0.031
Nitrate-N	0.18	51	1520	2.72
	High status conc	**High status load**	**High status total load**	**High status resultant conc**
	mg/l	kg/day	kg/day	mg/l
Phosphate	0.0225	6.32	22.1	0.04
Nitrate-N	0.81	227	1696	3.04
	Good status conc	**Good status load**	**Good status total load**	**Good status resultant conc**
	mg/l	*kg/day*	*kg/day*	*mg/l*
Phosphate	0.03	8.42	24.2	0.043
Nitrate-N[1]	1.62	455	1924	3.45
Nitrate-N[2]	3.15	885	2354	4.22

[1]There is no N Good status EQS for rivers therefore the threshold of 1.8mg/l used in the status classification is used here.

[2] Here a threshold of 3.5 mg/l is used which is used by the EPA as a guide in characterisation to point towards riverine impact that needs restoration.

Domestic wastewater

Domestic wastewater is listed as a significant pressure for Shournagh_040 in the WFD app (Cycle 3 characterisation information). EPA initial characterisation notes that the SLAM P V2.06 (12-14) indicates septic tanks as a potential source of nutrients, with higher N risk systems near the river channel. A 3% increase in dwellings in the sub basin (+29 no. between 2015 and 2019) is also noted.

EPA SANICOSE model (2018) output identifies a number of domestic wastewater treatment systems in the Shournagh catchment with high or very high phosphorus / nitrogen pollution impact potential, including some systems along the main channel close to the Bannow Bridge monitoring point. This pressure should be investigated in the local catchment assessment for this waterbody.

Agriculture

Accounting for the influence of the Manin_SC_010 subcatchment, approximately 42% of the phosphate loads and 53% of the nitrate loads at Bannow Br are arising from the 'native' Shournagh_040 catchment (i.e. Rathcoola_010, Shournagh_010, _020 _030 and _040). The risk maps for diffuse N and P loss (Figures in section 3.2) show substantial areas of the Shournagh_040 are risky for diffuse P (25% of the area in rank 5) and N (50% of the area in rank 1 and 2) loss from agricultural

areas via subsurface pathways. A relatively small area to the west of Tower village is also risky for P loss in overland flow (i.e. ranks 1-3). Considering the intensity of agriculture in this subbasin, agricultural point sources and associated nutrient and organic pollution may also be contributing the elevated nutrient concentrations in this waterbody and may pose a risk to the health of the macroinvertebrate fauna in the future. Reducing nutrient inputs and/or improving nutrient use efficiency will be important to improving water quality in this waterbody.

Urban wastewater

A stormwater overflow associated with the Blarney WWTP discharges to the Shournagh_040 just upstream of Muskerry golf course. Whilst there may be some local impacts from this overflow from time to time, the chemistry data further downstream at Bannow Br shows little evidence of point source issues – there have been no spikes in ammonium concentrations in excess of the 95th %ile High-status EQS (0.9mg/l) since 2017 and just two breaches of the mean High-status EQS for BOD (1.3 mg/l) since 2017. Nevertheless, it should be taken into consideration in the local catchment assessment.

Water abstractions

There are three water abstractions on the Shournagh_040. One is for the Muskerry golf club and is abstracted from the river at a rate of ca. 1800 m3/annum. The other two are for drinking water supplies (Vicarstown and Ballyshoneen) and are groundwater abstractions. The abstraction rate for these is 9125 m3/annum. These abstractions are too minor to have any discernible influence of the water quality of the Shournagh_040 which has an estimated Q30 flow of 6.459 m3/s.

4 Pathway information & analysis

The soils in this catchment are well-drained brown earths over old red sandstone geology. They are well drained with the exception of small areas of gleyic brown alluvial soils neighbouring the stream in the lower catchment. Based on the free draining nature of the soils, nitrogen is considered the main nutrient at risk of loss via subsurface pathways. However, the iron-rich old red sandstones which underlie this catchment tend to have a weak ability to retain ortho-phosphate in the soil and are prone to leaching of phosphate via subsurface pathways. Therefore, diffuse losses of nitrate and phosphate from agricultural soils is the main pressure in the Shournagh Demonstration Catchment.

Given the consistency of setting, the catchment is a single compartment where similar sub surface pathways exist throughout.

5 Interim story of Shournagh Demonstration Catchment

The Shournagh Demonstration Catchment comprises five waterbodies. Three of these are blue dot waterbodies, i.e. with High status objectives.

Rathcoola_010

- Currently *Not at Risk* and at Good ecological status (2013-2018 cycle).
- Macroinvertebrates driving status. No routine chemistry monitoring
- WFD objective: Protect
- Potential significant issues under protect function: sediment, nitrate and phosphate
- Likely pressures:
    - Agriculture – mostly diffuse nutrient losses but may also could include point sources and sediment losses associated with land reclamation.

Shournagh_010

- Currently *Not at Risk* and at Good ecological status (2013 – 2018)
- Macroinvertebrates driving status. No routine chemistry monitoring
- WFD objective: Protect
- Potential significant issues under protect function: nitrate and phosphate
- Likely significant pressures
    - Agriculture – mostly diffuse nutrient losses but may also could include point sources

Shournagh_020

- Currently *Not at Risk* and at High ecological status (2013 – 2018)
- A High ecological status objective waterbody
- Macroinvertebrates driving status. No routine chemistry monitoring
- WFD objective: Protect
- Potential significant issues under protect function: nitrate and phosphate
- Likely significant pressures
    - Agriculture – mostly diffuse nutrient losses but may also could include point sources

Shournagh_030

- Currently *At Risk* and at Moderate ecological status (2013 – 2018)
- A High ecological status objective waterbody
- Macroinvertebrates currently High status
- WFD objective: Restore
- Failing on nitrate and phosphate (both Moderate status)

- Significant issues for restore function: nitrate and phosphate
- Likely significant pressures
    - Agriculture – mostly diffuse nutrient losses but may also could include point sources

Shournagh_040

- Currently *At Risk* and at Moderate ecological status (2013 – 2018)
- A High ecological status objective waterbody
- Macroinvertebrates currently High status
- WFD objective: Restore
- Failing on nitrate and phosphate (both Moderate status)
- Likely significant issues for restore function: nitrate and phosphate
- Likely significant pressures
    - Agriculture – mostly diffuse nutrient losses but may also could include point sources

6 Work plan

There are no further characterisation actions listed in the WFD app for the Shournagh Demonstration Catchment waterbodies. Biological status is currently meeting WFD objectives in each of the five subbasins. However, more spatially extensive invertebrate sampling in each subbasin would be useful to identify any impacted tributaries which may pose a risk to achieving WFD objectives in the future. Therefore, it is recommended to initially conduct SSIS surveys along the main tributaries in each subbasin where access is possible via the roadway. Suggested sites that may be suitable for initial SSIS sampling are shown in **Figure 13** below. These are numbered according to the waterbody initials and start from _1 beginning at the subbasin outlet and increase consecutively moving up the waterbody. Figure 13 shows four potential sample sites in Rathcoola_010 (R10_1 - R10_4), six in Shournagh_010 (S10_1 – S10_6), four in Shournagh_020 (S20_1 – S20_4), three in Shournagh_030 (S30_1 – S30_3) and seven in Shournagh_040 (S40_1 – S40_7). Where impacts are found, more detailed investigations can ensue once access to private lands has been agreed with landowners and resources are in place. It is recommended to undertake the biological surveys within the same season where possible to ensure homogeneity in conditions between sites. Assessment of sedimentation levels (for example the shuffle index) would also be useful at each of the sample sites, especially in Rathcoola_010, in order to determine whether sedimentation is or could become a potential issue in this catchment.

Nitrate and phosphate are driving the moderate ecological status in Shournagh_030 and Shournagh_040 and may also be elevated in the subbasins upstream. Initially, it is recommended to sample all the sites shown in Figure 13 and analyse them for nutrients and physico-chemical parameters. Water sampling will be particularly important at the outlets of the Rathcoola_010, Shournagh_010 and Shournagh_020 to establish indicative concentrations of nutrients in these subbasins. Nutrient sampling of the smaller tributaries in each subbasin would be useful to identify which tributaries are delivering the greatest nutrient loads to the subbasin outlets. For the water-quality sampling it is recommended to undertake sampling at all sites across the five basins on the same day/on consecutive days where possible to ensure that comparisons of nutrient levels between sites are conducted during (i) similar flow conditions and (ii) similar land management practices (e.g. open period for slurry spreading).

For the initial local catchment assessments in the five subbasins, rather than spending time trying to measure flow directly in these subbasins, an area weighted approach (in conjunction with the EPA HydroTool where possible) is recommended to estimate flows and subsequent nutrient loads in these subbasins. More detailed flow assessments could be conducted as needed throughout the course of the project.

Consideration should also be given to conducting SSIS assessments above and below known point sources such as stormwater overflows, WWTP discharge points and section 4 discharges shown in Appendix 7. Whilst these point sources do not seem to be impacting the biology at the subbasin outlets, the possibility of local impacts needs to be investigated. These assessments should be undertaken during low river flows. Due to the large scale of this catchment and in the interest of

resource efficiency, it is advised to focus on the sites outlined in Figure 13 initially. Site S30_1 is just 700m downstream of Blarney WWTP and should detect any significant issues with the plant. Site S40_2 is just 800m downstream of the stormwater overflow associated with Blarney WWTP. Site S40_3 is just 250m downstream of a Section 4 licensed discharge. Site S20_3 is just below the discharge point for Courtbrack WWTP, and care should be taken to make sure a sample is taken below the mixing zone (i.e. 10 times the stream width). The sample may need to be taken on the main channel below the confluence in order to avoid the mixing zone here. Similarly, site S40_4 is just below a section 4 discharge and care should be taken to avoid the mixing zone here.

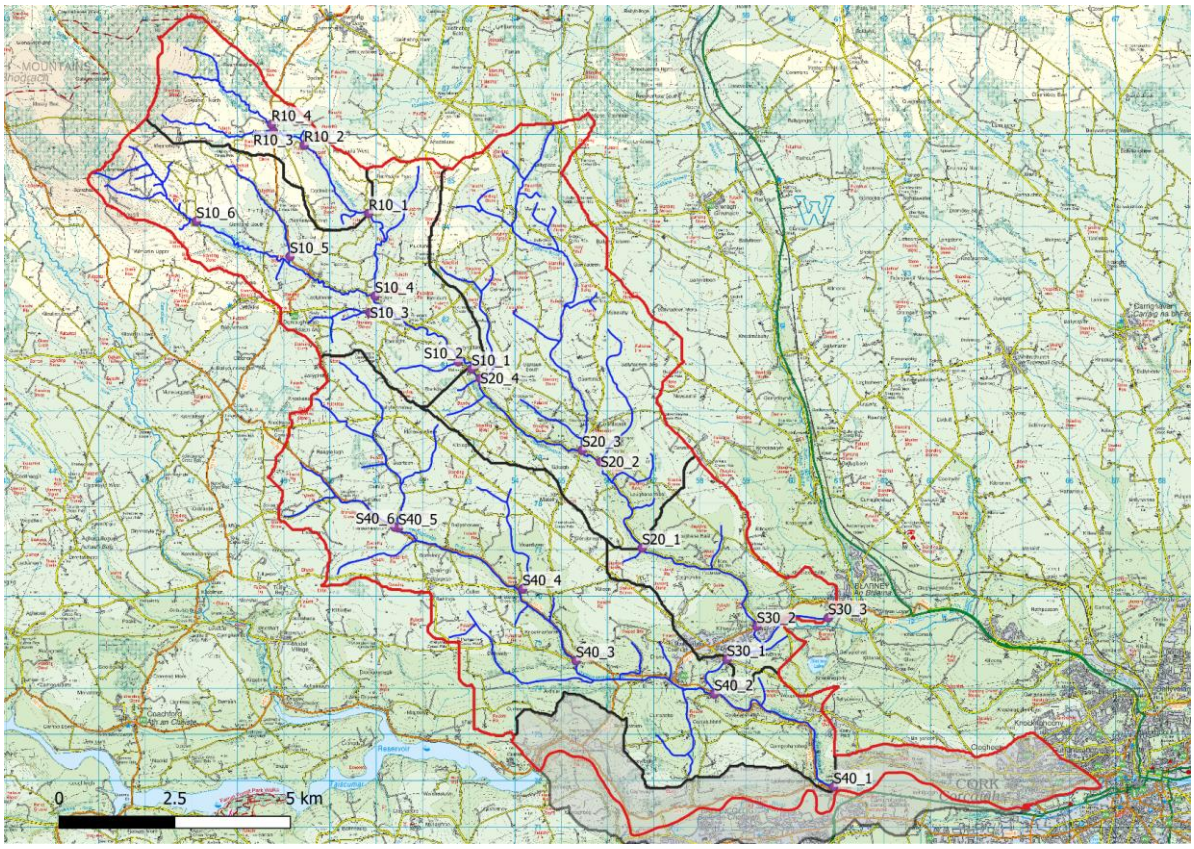


Figure 13 Suggested sample sites in the Shournagh Demonstration Catchment for initial SSIS/RA surveys, sediment assessments and water chemistry analysis

7 Review of possible mitigation options

Mitigation actions which focus on diffuse nitrate and phosphate losses from agriculture are likely to be the most effective for achieving WFD targets in the Shournagh Demonstration Catchment.

Mitigation measures for nitrate are particularly important in this catchment because the Shournagh Demonstration Catchment is part of the Lee, Cork Harbour and Youghal Bay catchment which is one of the EPA's catchments of concern for nitrate loss. The proportion of the critical source areas for nitrate loss within the Shournagh Demonstration Catchment is relatively large. As a result, a relatively small effort in terms of improvements or measures could be spread thinly over a relatively large area. Source control options are generally accepted as being the most effective for nitrate. These could include either reduction of nitrogen inputs, improved soil nutrient management and improving nutrient use efficiencies. The Teagasc National Farm Survey Sustainability report shows that average nitrogen use efficiencies in Ireland's predominantly grass based farming systems are of the order of 25%, indicating great scope for improvements in this area. Over the next 10 years, the Ag Climatise roadmap has set a target of an absolute reduction in the overall level of nitrogen fertiliser being used on Irish farms from a high of 408,000 tonnes in 2018 to 325,000 tonnes in 2030, with an interim target of 350,000 tonnes in 2025. The Teagasc dairy roadmap lists a range of such measures to reduce chemical N usage on average which could be used to help achieve this target.

There is scope to maximise the value of slurry on dairy farms to get the most from its P and K content as well as N. This can be achieved by making sure that it goes to the right place at the right time at the right rate.

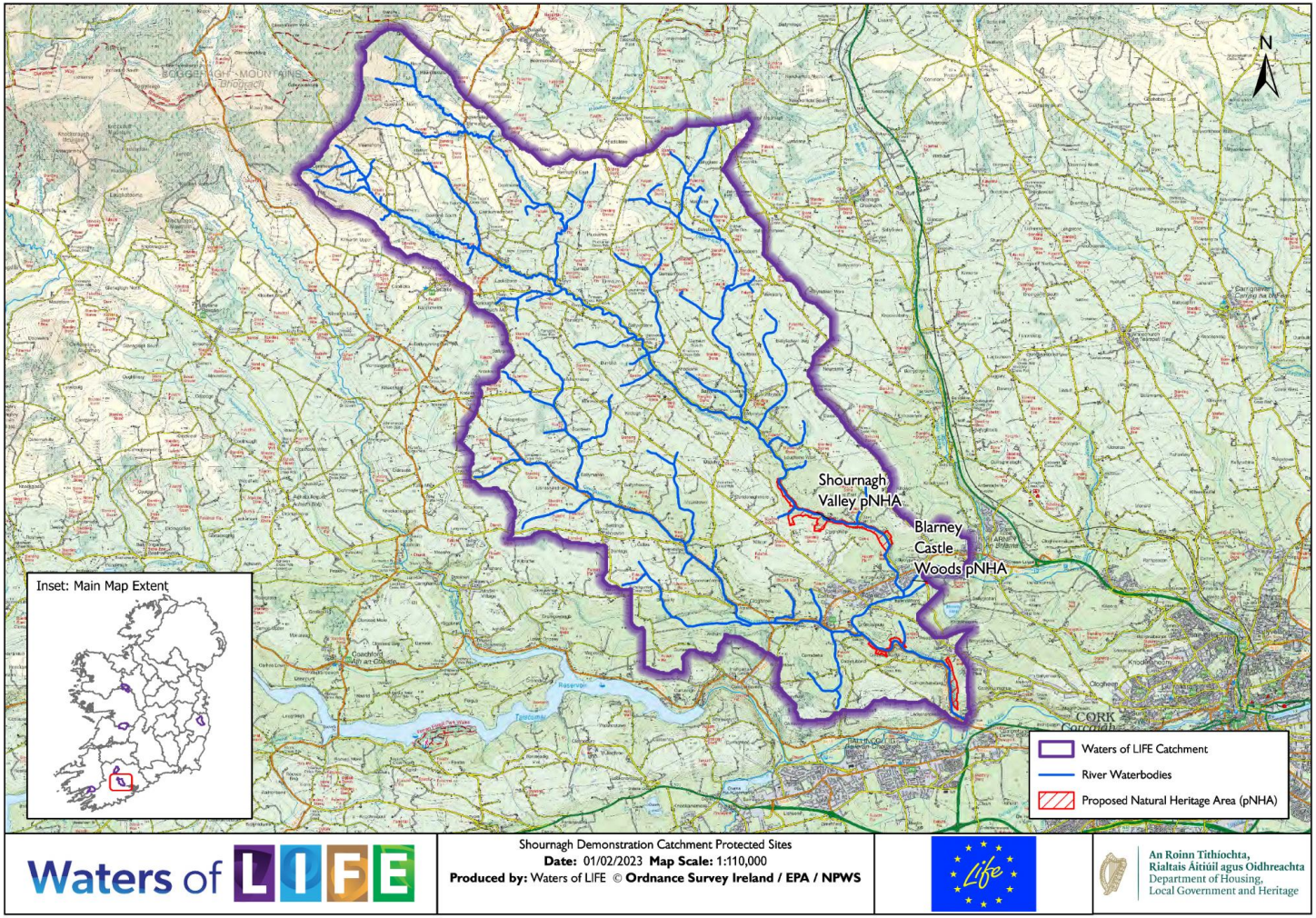
- **P & K – Right Place** – Spread on fields/paddocks where fertility is low and where the nutrient demand is highest (e.g. silage field), avoiding critical sources areas where possible.
- **N – Right Time** – Spread when potential N losses are low and the potential for uptake by a growing crop is high (February to April)
- Method – Use a Low Emission Slurry Spreader

Mitigation measures for phosphorus loss typically focus on breaking the pathways for P loss and critical source area maps tend to be weighted heavily towards the presence of poorly draining soils prone to overland flow. In the P PIP ranks 1 – 3, measures should focus on breaking the pathway, for example by planting buffer strips or creating bunds along the flow delivery points. However, in the case of the Shournagh Demonstration Catchment where diffuse P losses are likely to predominantly be occurring by leaching to shallow groundwater, it seems more prudent to target high source (soil P) pressures rather than surface pathways. In terms of the P PIP maps, these areas are ranked 4 (extreme vulnerability to groundwater) and 5 (appears to reflect lands with high organic P loadings). In these

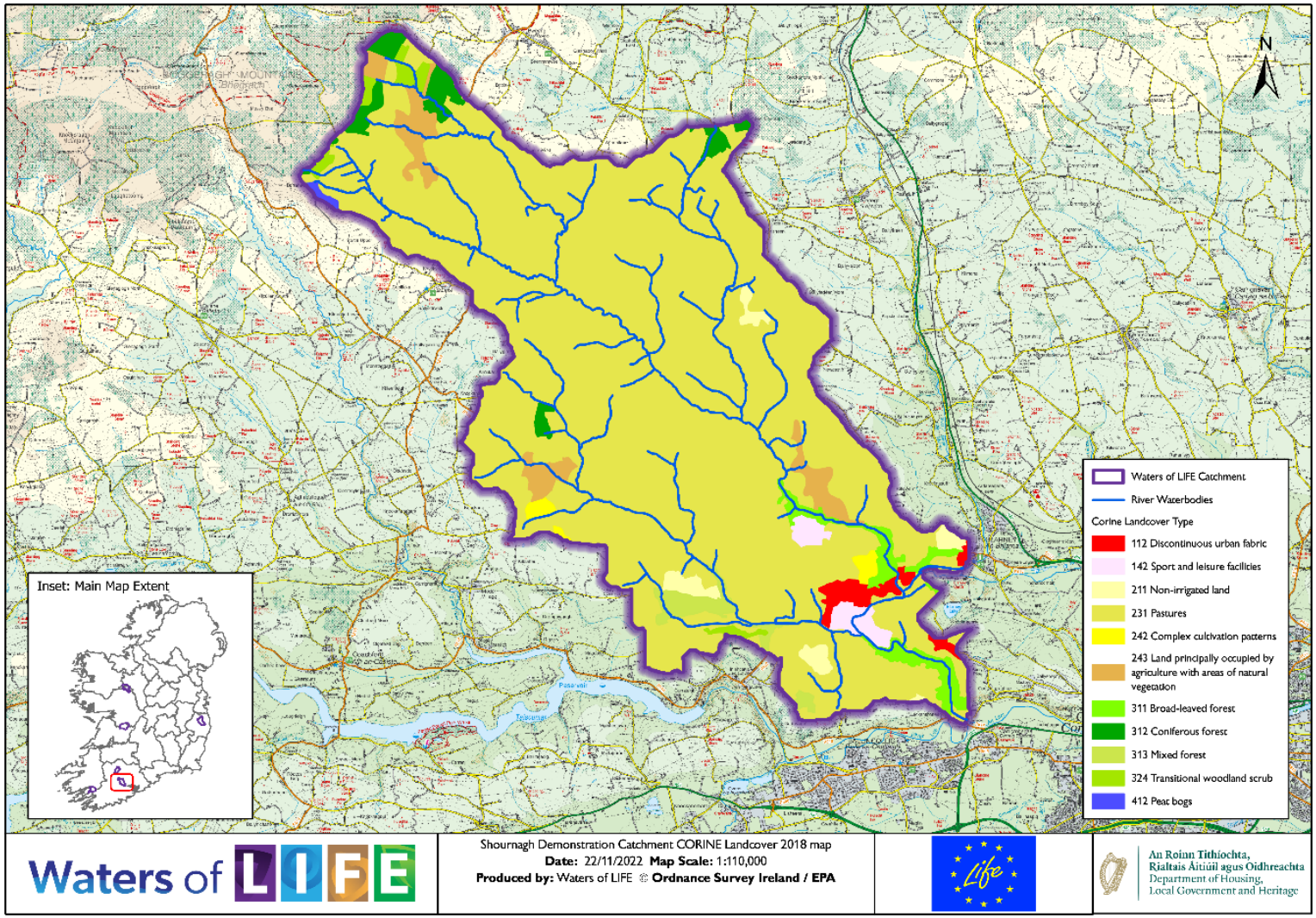
areas, source control options are likely to be most effective such as reducing phosphorus inputs, improved soil nutrient management and improving nutrient use efficiencies.

Data on soil phosphorus and pH levels would be particularly useful in the Shournagh Demonstration catchment and should be collated and obtained where possible to identify Index 4 soils in particular where soil P levels are in excess of crop requirement and highly prone to leaching.

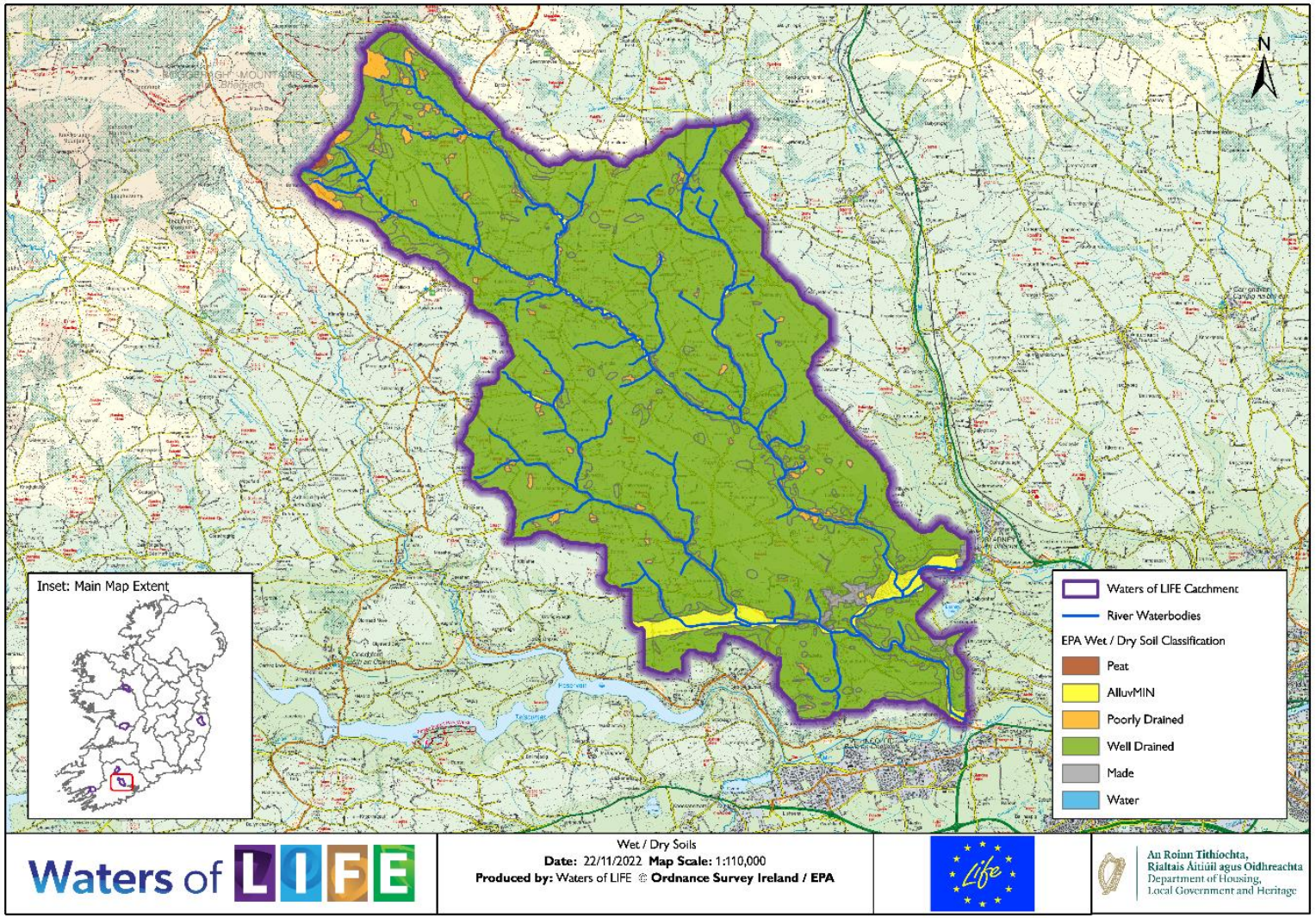
Appendix 1. Location of the Shournagh Valley pNHA in the Demonstration Catchment



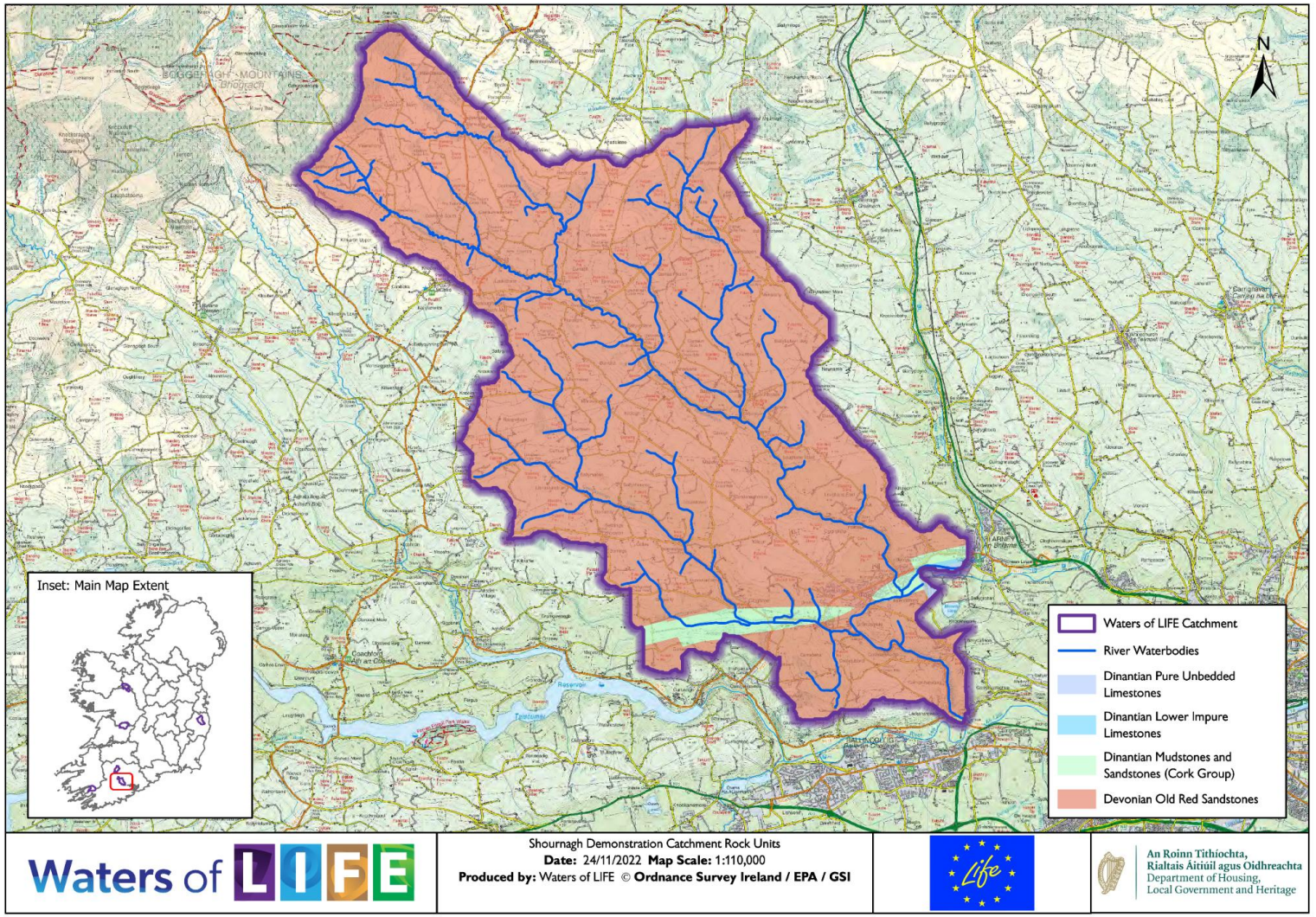
Appendix 2. Corine land use data (2018) for the Shournagh Demonstration Catchment



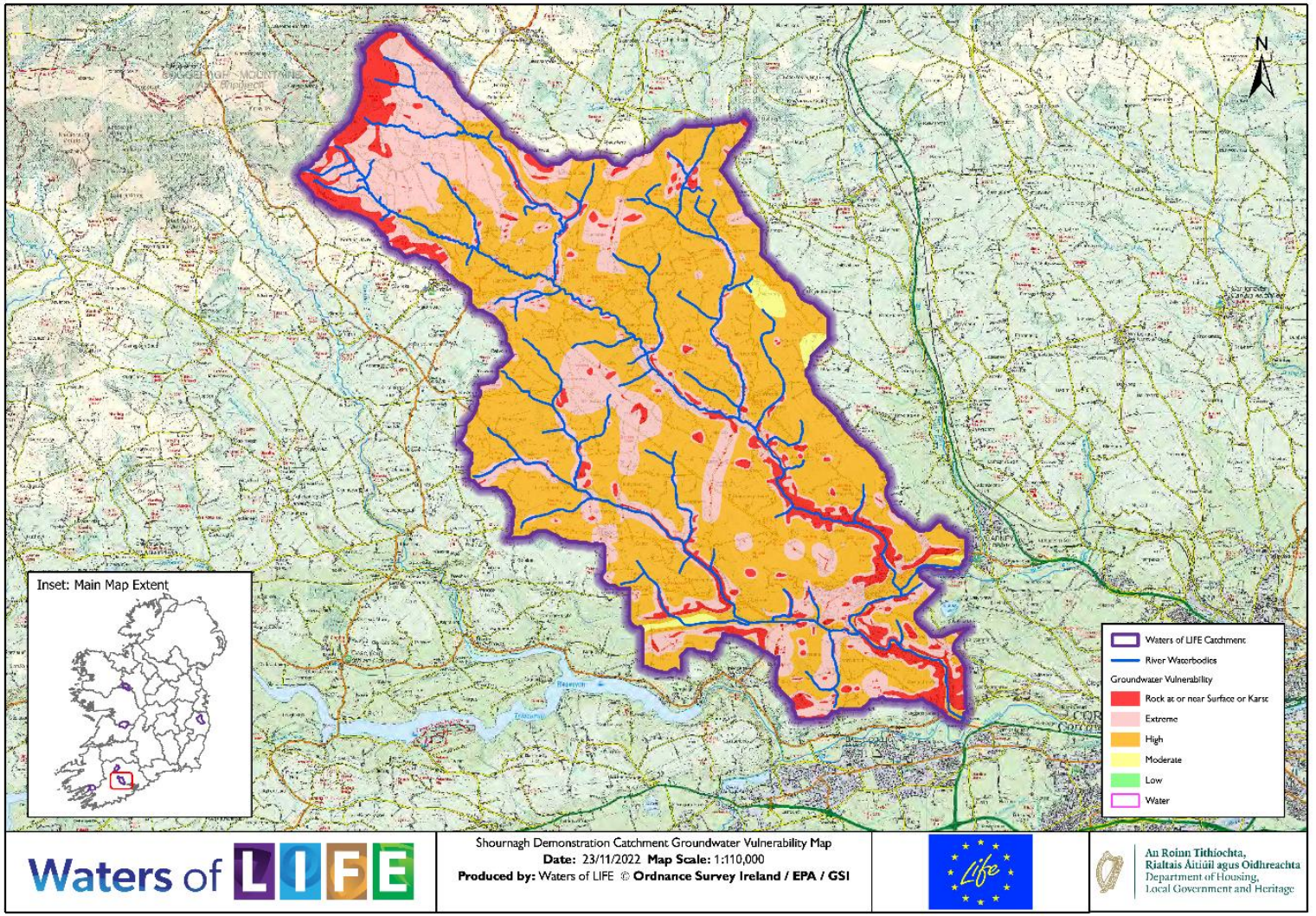
Appendix 3. Soil drainage class map for the Shournagh Demonstration Catchment



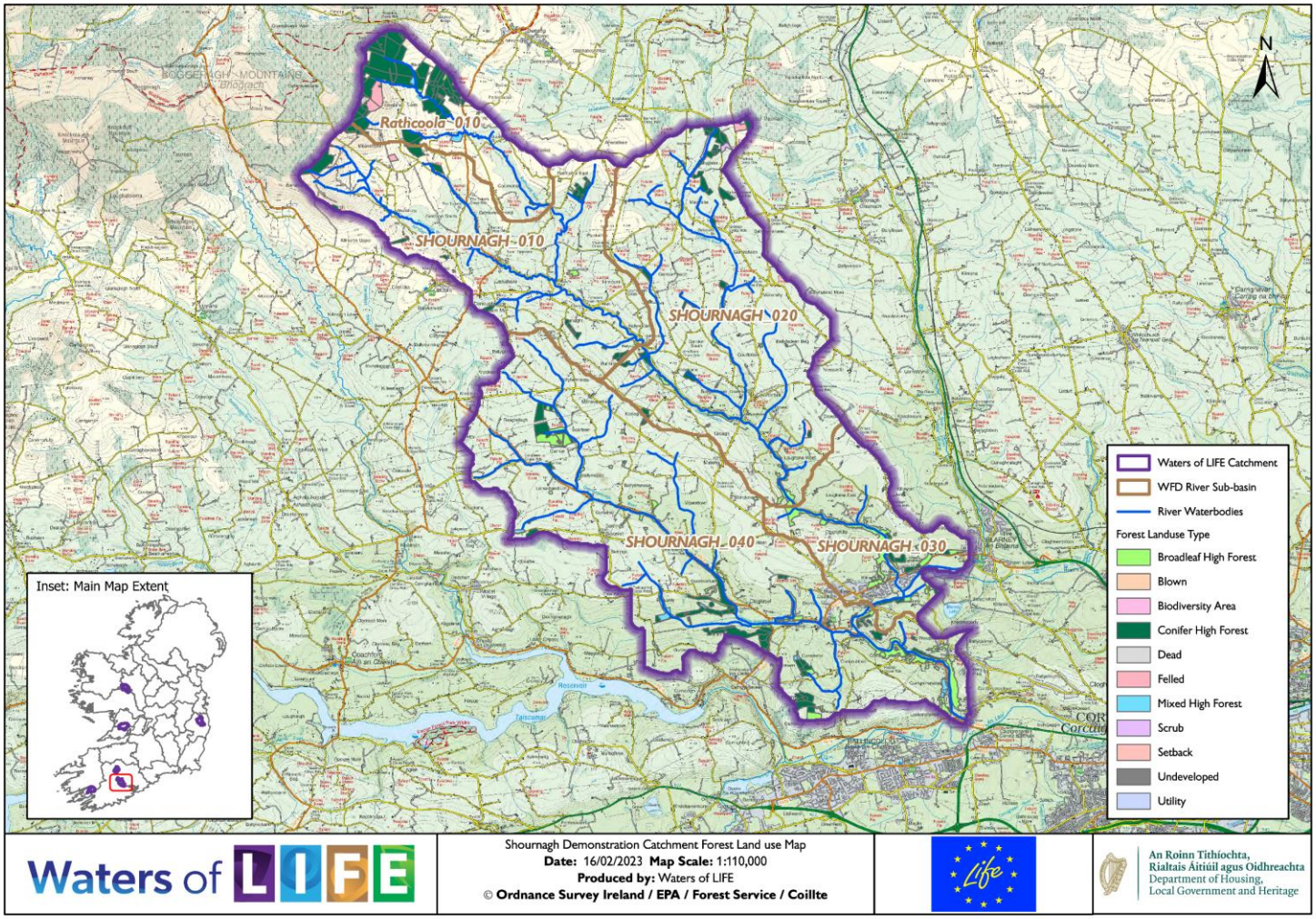
Appendix 4. Bedrock unit map for the Shournagh Demonstration Catchment



Appendix 5. Groundwater vulnerability map for the Shournagh Demonstration Catchment



Appendix 6 Forestry cover in the Shournagh Demonstration Catchment



Appendix 7. Locations of licensed discharges in the Shournagh Demonstration Catchment.