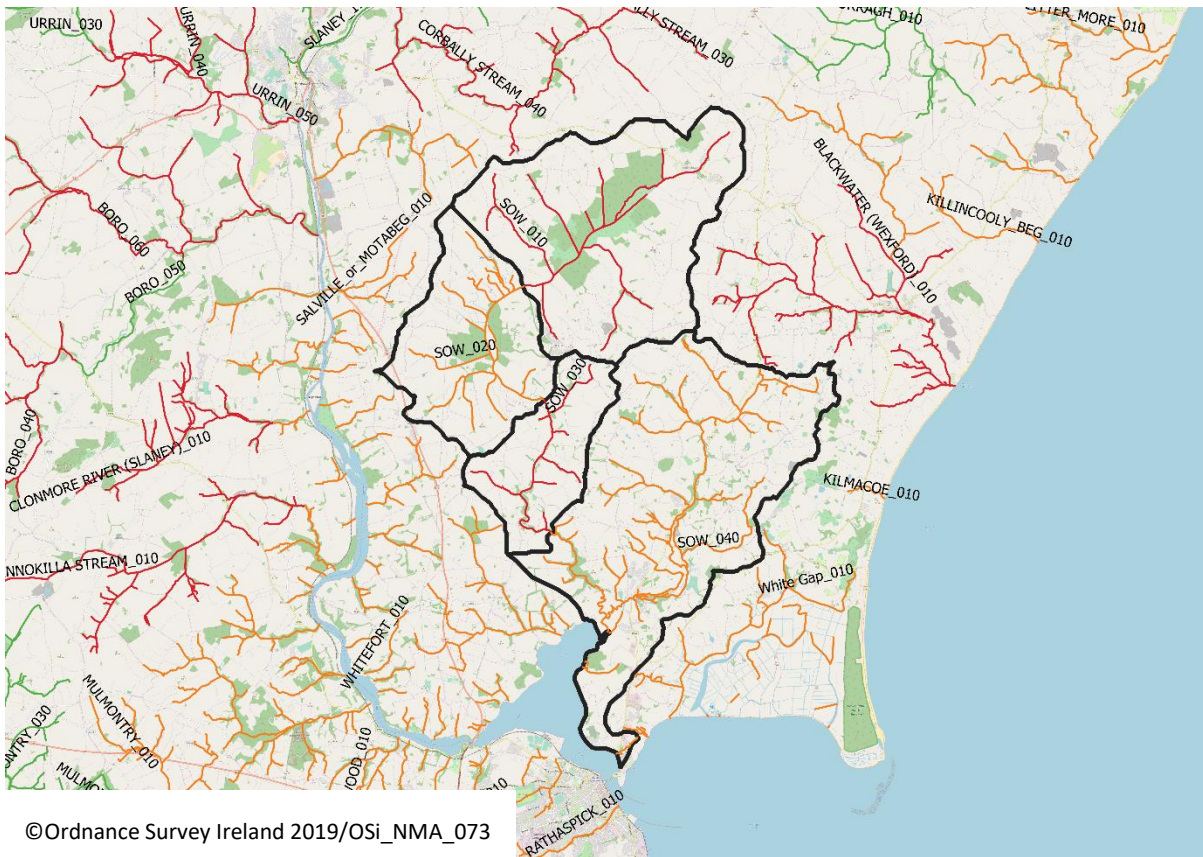


Sow Priority Area for Action

Desk Study

AFA0167



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Acknowledgements

The authors would like to acknowledge the contributions of Wexford County Council who have carried out a significant amount of work in the Sow catchment in recent years and their support of the Local Authority Waters Programme.

Data attribution

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

WFD App – EPA characterisation data

Annual Environmental Reports for Ballymurn and Ballaghkeen UWWTPs

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 (2015)

IFS Soils: EPA (2006)

Susceptibility and Pollution Impact Potential Maps: EPA (2018)

WFD waterbody status: EPA (2018)

SAC and NHA boundaries: NPWS (2018)

1 Background

The Sow Prioritised Area for Action (PAA) is located in county Wexford to the north of Wexford town. It consists of four waterbodies; Sow_010, Sow_020, Sow_030 and Sow_040.

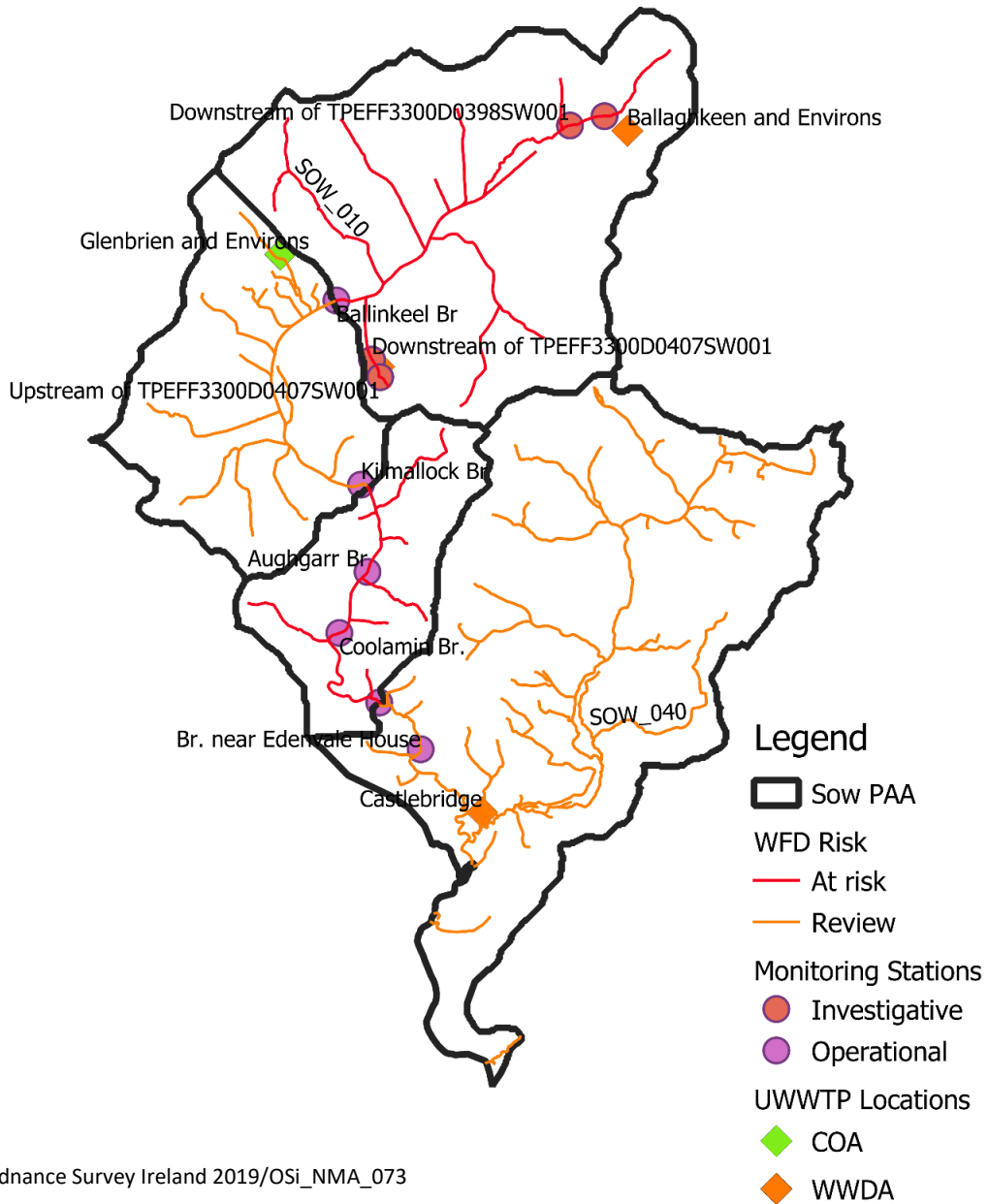
Regional workshops were held in Roscrea on 6-9 June 2017 and were attended by representatives of local authorities (Kilkenny, Tipperary, Waterford City and County, Kildare, Laois, Offaly, Carlow, Wexford & Wicklow), and other agencies (Bord Iascaigh Mhara, DHPCLG, EPA, National Dairy Sustainability Forum, National Federation for Group Water Schemes, Sea Fisheries Protection Authority, Waterways Ireland, LAWCO, Irish Water, IFI, Forest Service, Coillte, NPWS, Teagasc, GSI, DAFM, Marine Institute and EPA). Based on the draft River Basin Management Plan priorities, a set of agreed principles and the priorities of the workshop attendees, 34 areas were recommended for action in the South East region, the Sow was chosen for the following reasons:

- Potential to utilise County Council involvement in local drainage schemes.
- Important water abstraction - Wexford town and area north of Wexford.
- Woodlands for water scheme is being developed in the area.
- Important amenity area.
- Opportunity to work with demonstration farm project.
- Important heritage areas, such as Edenvale, in the area.
- Active community groups in the area.
- One deteriorated water body.
- Drinking water protected area objective not met.

Table 1. Summary table of water bodies within the Sow PAA.

WB Name	WFD Risk	Status Obj.	2009	2012	2015	2016	Pressure Cat.	Pressure Subcat.	Sig. Pressure
SOW_010	At Risk	Good	M	M	M	M	Urban waste water	Ballymurn UWWTP (PE 500-1000)	Yes
							Urban waste water	Ballaghkeen UWWTP (PE 500-1000)	Yes
							Forestry	Forestry	Yes
							Hydromorphology	Channelisation	Yes
							Domestic waste water	Waste water discharge	Yes
Sow_020	Review	Good	G	U	U	U	Agriculture	Agriculture	Yes
Sow_030	At Risk	Good	G	M	M	M	Agriculture	Pasture	Yes
Sow_040	Review	Good	U	U	U	U	Urban runoff	Diffuse sources runoff	Yes

2 Receptor Information and Assessment



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Figure 1. Monitoring stations located in the Sow PAA.

2.1 Sow_010

- Sow_010 is monitored at Ballinkeel Bridge and is currently in moderate ecological status and is classified as *At Risk* of failing to meet its objectives under the WFD. It has consistently been at moderate status since 2004.
- Ammonia levels in the Sow_010 are below the good Environmental Quality Standard (EQS) threshold of 0.065 mg/l with a 2014 baseline concentration of 0.053 mg/l.
- Ortho-phosphate baseline concentrations in 2014 were 0.031 mg/l which is below the 0.035 mg/l EQS for good ecological status but is still relatively high. Concentrations are trending downwards and expected to be at 0.010 mg/l by 2021 which would be indicative of high status.
- Total oxidised nitrogen baseline concentrations were 4.92 mg/l in 2014 and are predicted to remain fairly static to 2021. These are levels which are likely to affect water quality and therefore nitrate is considered to be the significant issue in the Sow_010, although phosphate and ammonia may also be significant.
- Phosphate and ammonia concentrations increase sharply downstream of Ballymurn UWWTP and greatly exceed their respective EQS.
- Concentration of ammonia, phosphate and nitrate are also high in the upper reaches of the catchment at Lower Br Ballaghkeen with ammonia and phosphate exceeding their respective EQS.

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Table 2. Receptor information for the Sow_010.

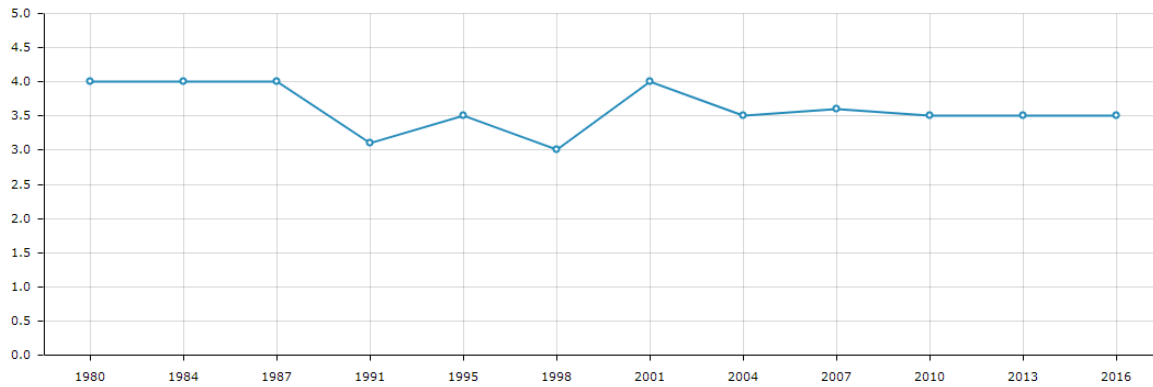
Factor	Ballinkeel Br	Upstream of TPEFF3300D0407SW001	Downstream of TPEFF3300D0407SW001	Lower Br Ballaghkeen
MP Type	WFD Operational MP	Investigative MP upstream of Ballymurn WWTP Primary discharge	Investigative MP downstream of Ballymurn WWTP Primary discharge	PreWFD site
Risk Category	<i>At Risk</i>	<i>At Risk</i>	<i>At Risk</i>	<i>At Risk</i>
Biological Status				
Monitoring Station(s) with Q-values	Ballinkeel Bridge			
2016-2018 Q-value data	Moderate			
2014 Q-value data	Moderate			
2011 Q-value data	Moderate			
Trends in Q-value since 2009	No change			
Hydrochemistry Data				
Monitoring Station(s) with data	Ballinkeel Bridge	Upstream of TPEFF3300D0407SW001	Downstream of TPEFF3300D0407SW001	Lower Bridge Ballaghkeen
Existing	NH ₄ , PO ₄ , TON BOD	NH ₄ , PO ₄ , TON, COD, SS, TN, TP	NH ₄ , PO ₄ , TON, COD, SS, TN, TP	NH ₄ , PO ₄ , TON, COD, SS, TN, TP
New				
Trends in PO₄, NH₃ and NO₃				
In App (until 2015)	NH ₄ : Upwards			
	PO ₄ : Downwards			
	TON: Downwards			
All available data				
Other water quality data				
BOD	Max 2.6 mg/l (August 2014)			
COD		Max 60 mg/l (November 2016)	Max 36 mg/l (November 2015)	Max 11 mg/l (November 2016)
SS		Max 135 mg/l (November 2016)	Max 71 mg/l (November 2015)	Max 20 mg/l (April 2016)

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Factor	Ballinkeel Br	Upstream of TPEFF3300D0407SW001	Downstream of TPEFF3300D0407SW001	Lower Br Ballaghkeen
TN		Max 41.3 mg/l (February 2014)	Max 13.9 mg/l (November 2015)	Max 8.5 mg/l (April 2016 & December 2015)
TP		Max 13 mg/l (November 2016)	Max 2.3 mg/l (August 2015)	Max 1.1 mg/l (November 2014)
2014 Baseline Concentration (mg/l)				
Ammonia	0.053 mg/l	0.045 mg/l	4.786 mg/l	0.235 mg/l
Phosphate	0.031 mg/l	0.031 mg/l	0.779 mg/l	0.096 mg/l
TON	4.917 mg/l	5.989 mg/l	3.705 mg/l	5.576 mg/l
Distance to threshold				
Ammonia	Far	Far	Far	Far
Phosphate	Far	Far	Far	Near
TON	Far	Far	Far	Far
Supporting Conditions				
Chemistry Conditions	Pass			
Oxygenation Conditions	Pass			
Acidification Conditions	Pass			
Hydromorphology				
RHAT Score	N/A			
Evidence of arterial drainage	None			
Ecological Status (2017)	Moderate			
Trends 2010-2017	No change			
Protected Areas	None			
WFD Objective	Good			
EPA biologist notes (if any)	As was the case in 2013, Moderate ecological conditions were recorded at all three sites assessed			

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Factor	Ballinkeel Br	Upstream of TPEFF3300D0407SW001	Downstream of TPEFF3300D0407SW001	Lower Br Ballaghkeen
Significant issue/impact for receptor	Nitrate and possibly ammonia and phosphate			



	1980	1984	1987	1991	1995	1998	2001	2004	2007	2010	2013	2016
Result	4	4	4	3.1	3.5	3	4	3.5	3.6	3.5	3.5	3.5
Classification	Good	Good	Good	Poor	Moderate	Poor	Good	Moderate	Moderate	Moderate	Moderate	Moderate
Q-Value	4	4	4	3*	3-4	3	4	3-4	3-4*	3-4	3-4	3-4

Figure 2. Q-value data for Ballinkeel Br on Sow_010.

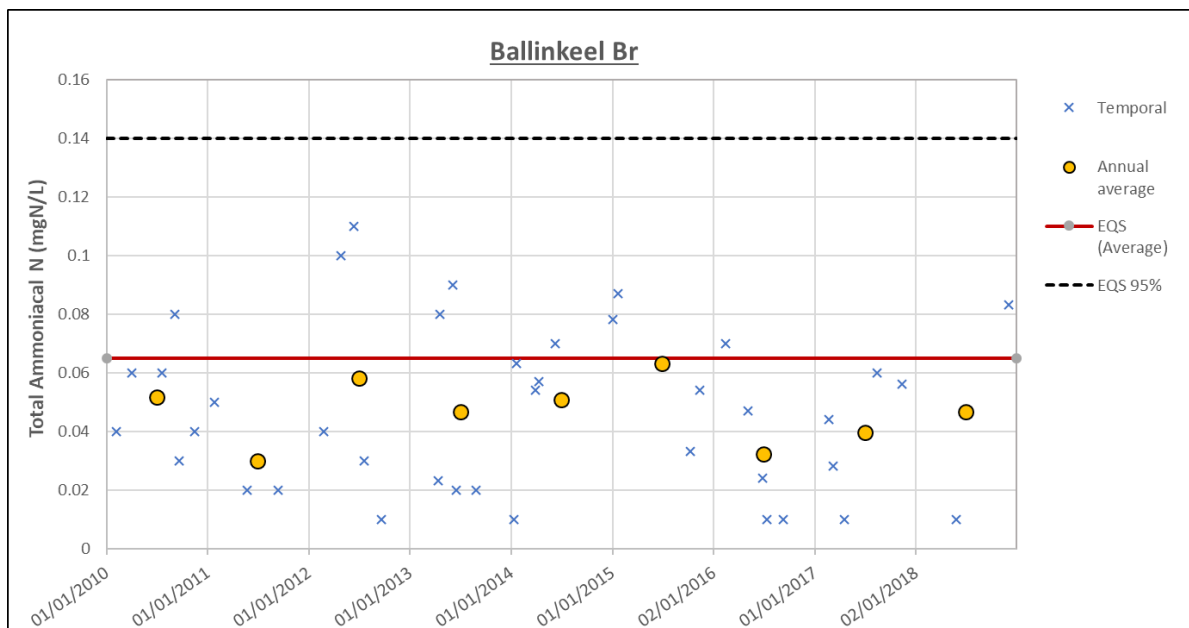


Figure 3. Mean annual ammonia concentrations at Ballinkeel Br on Sow_010.

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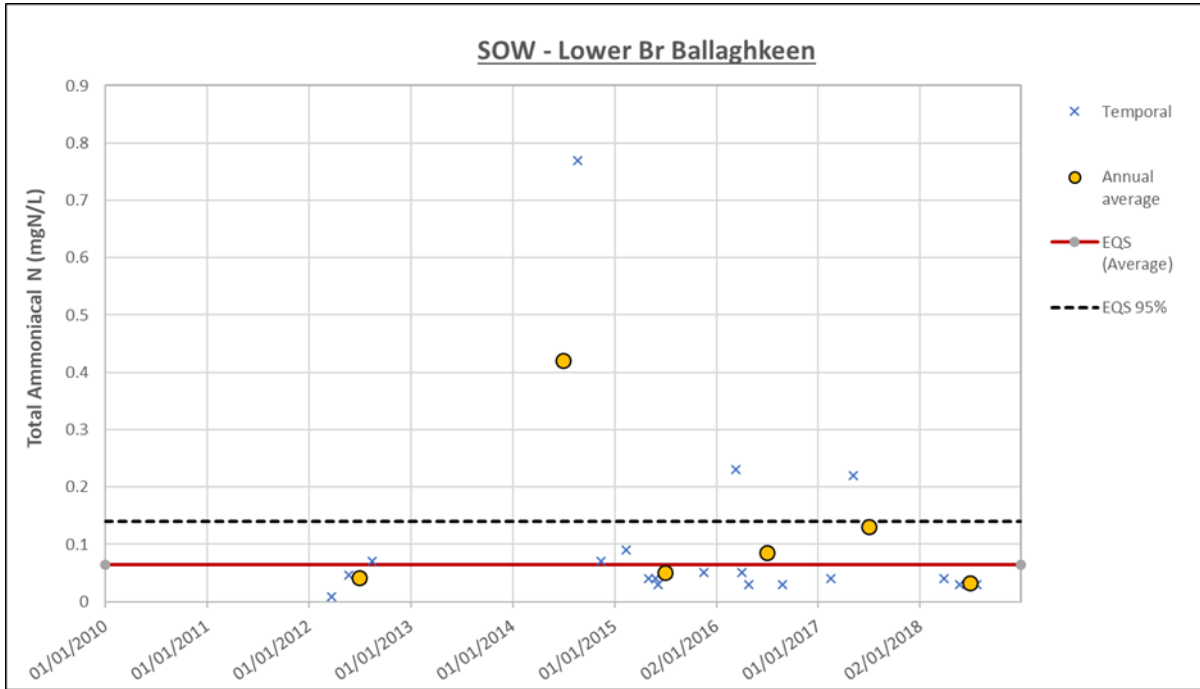


Figure 6. Ammonia concentrations at Lower Br Ballaghkeen.

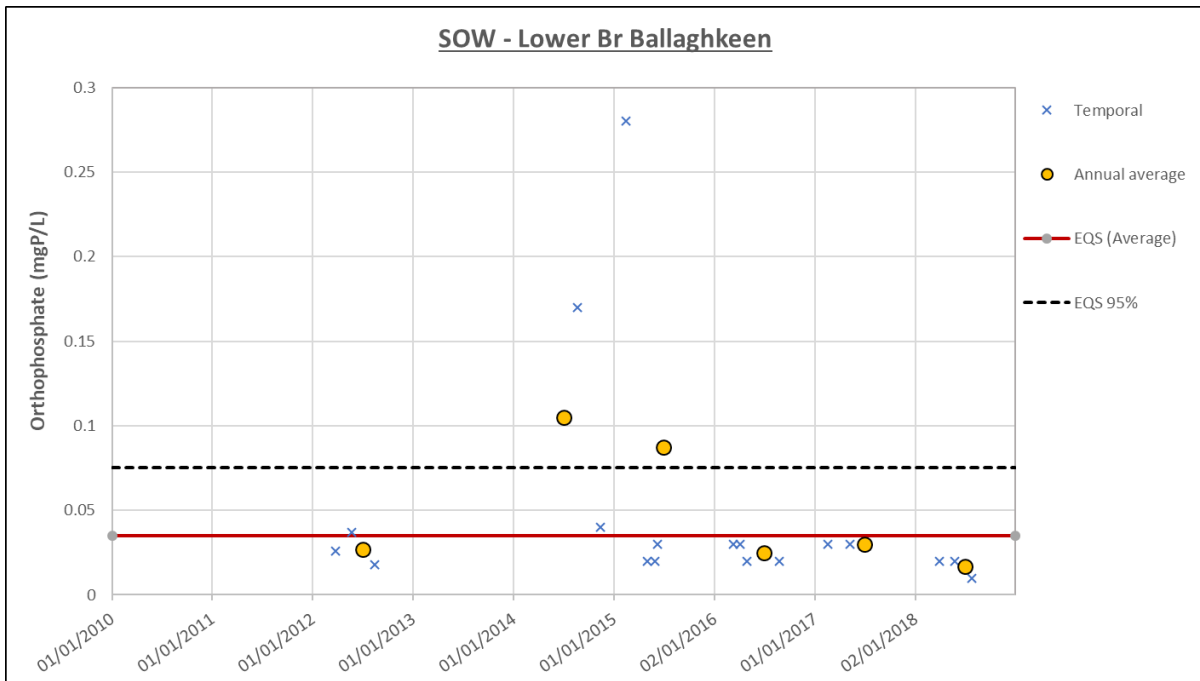


Figure 7. Ortho-phosphate concentrations at Lower Br Ballaghkeen on Sow_010.

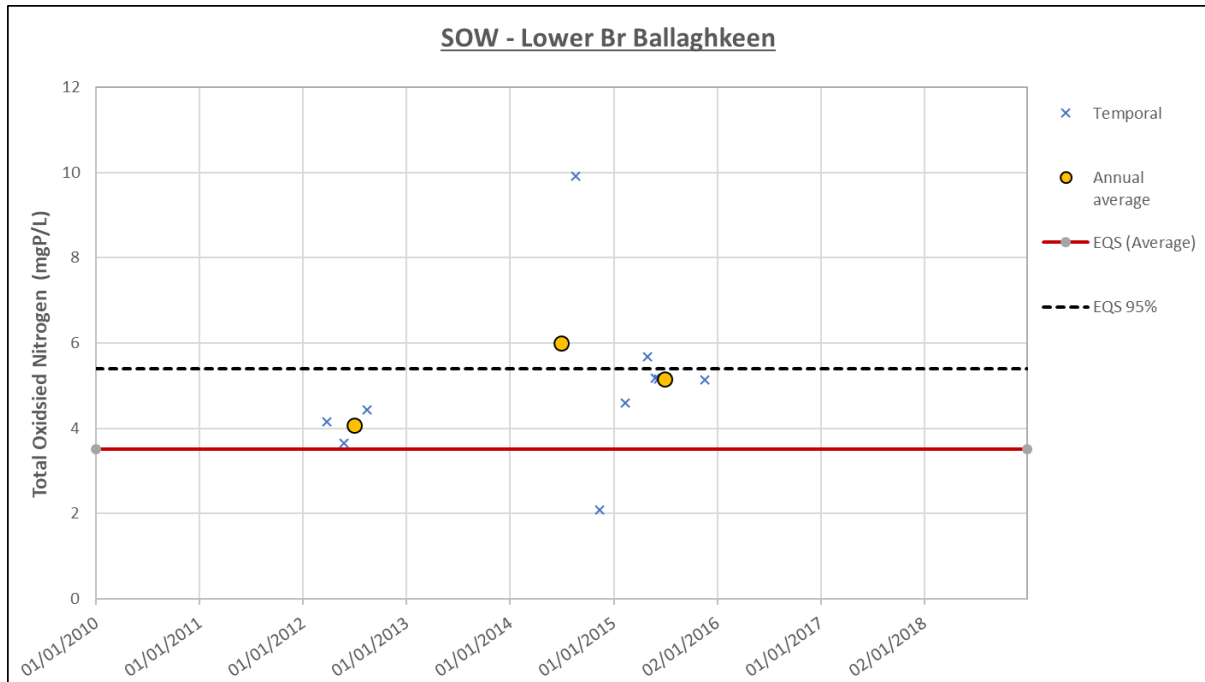


Figure 8. Total oxidised nitrogen concentrations at Lower Br Ballaghkeen on Sow_010.

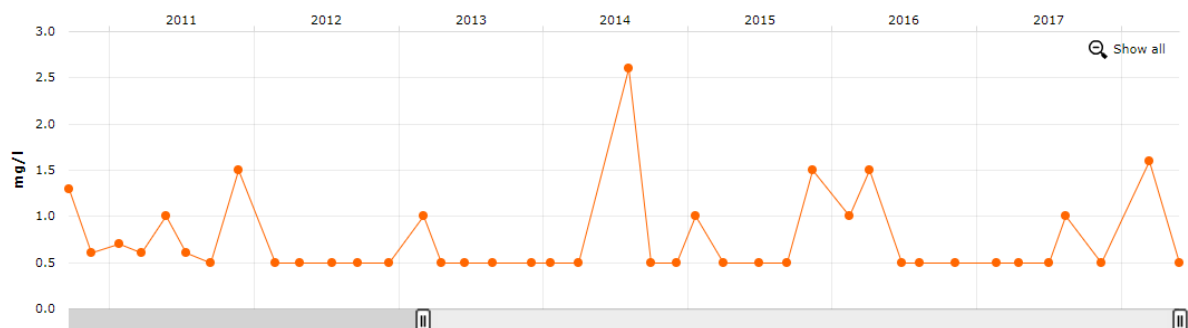


Figure 9. BOD concentrations at Ballinkeel Br on Sow_010.

2.2 Sow_020

- Sow_020 is not currently monitored and its current status is unknown. The most recent Q-value assessment was in 2007 at Kilmallock Bridge and it was found to be in good ecological status.
- Baseline ammonia concentrations in 2014 were indicative of good quality at 0.047 mg/l.
- Baseline ortho-phosphate concentrations were also indicative of good quality at 0.031 mg/l. However, these concentrations are still relatively high and may be a significant issue.

- Baseline TON concentrations in 2014 were 4.34 mg/l which is a level that is likely to affect ecological quality. Therefore, nitrate is considered to be the significant issue in the Sow_020.
- The characterisation process has also highlighted chemical pollution caused by pesticides as a significant pressure in this catchment. This likely reflects the drinking water abstraction in this catchment and it is unclear whether this would have an effect on ecological status at the monitoring point but should be investigated in order to protect the drinking water source.

Table 3. Receptor information for Sow_020.

Factor	
Risk Category	<i>Review</i>
Biological Status	
Monitoring Station(s) with Q-values	None
2016-2018 Q-value data	N/A
2014 Q-value data	N/A
2011 Q-value data	N/A
Trends in Q-value since 2009	N/A
Hydrochemistry Data	
Monitoring Station(s) with data	Kilmallock Br
Existing	NH4, PO4, TON
New	
Trends in PO4, NH3 and NO3 (In App (until 2015))	
Ammonia	Downwards
Phosphate	Upwards
TON	None
All available data	
Other water quality data	
BOD	Max 3.1 mg/l (July 2012)
2014 Baseline Concentration (mg/l)	
Ammonia	0.047 mg/l
Phosphate	0.031 mg/l
TON	4.344 mg/l
Distance to threshold	
Ammonia	Far
Phosphate	Far
TON	Far
Supporting Conditions	
Chemistry Conditions	Unassigned
Oxygenation Conditions	Unassigned
Acidification Conditions	Unassigned
Hydromorphology	
RHAT Score	N/A
Evidence of arterial drainage	None
Ecological Status (2017)	N/A

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Trends 2010-2017	N/A
Protected Areas	Sow Drinking Water Protected Area
WFD Objective	Good
EPA biologist notes (if any)	
Significant issue/impact for receptor	Nitrate and possibly ammonia and phosphate

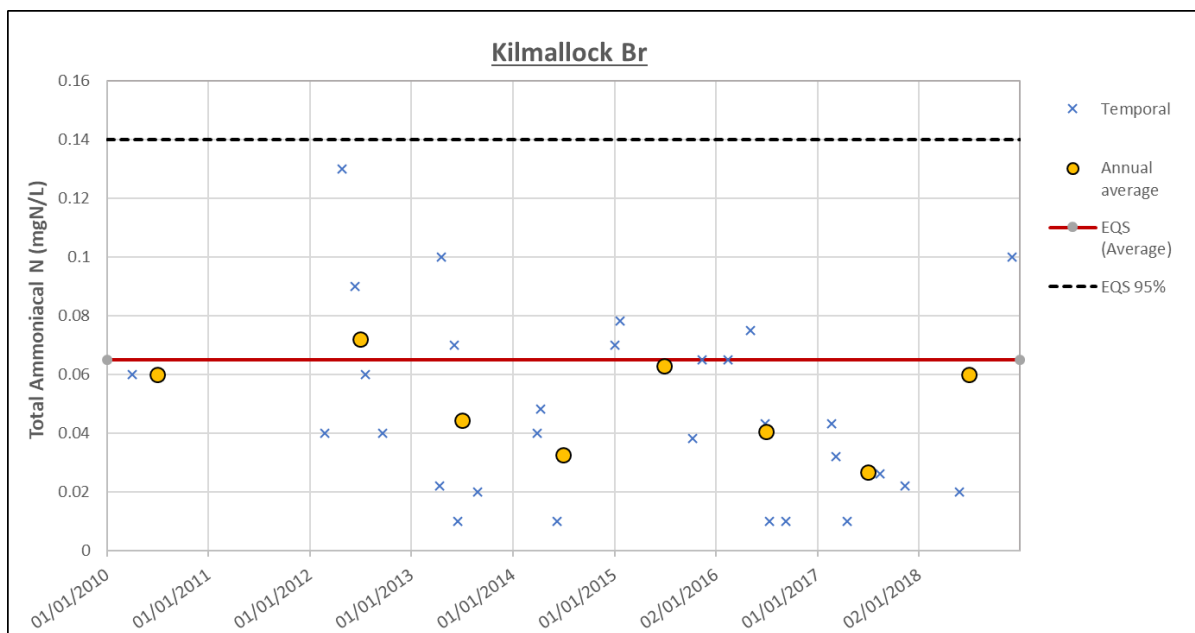


Figure 10. Mean annual ammonia concentrations at Kilmallock Br on Sow_020.

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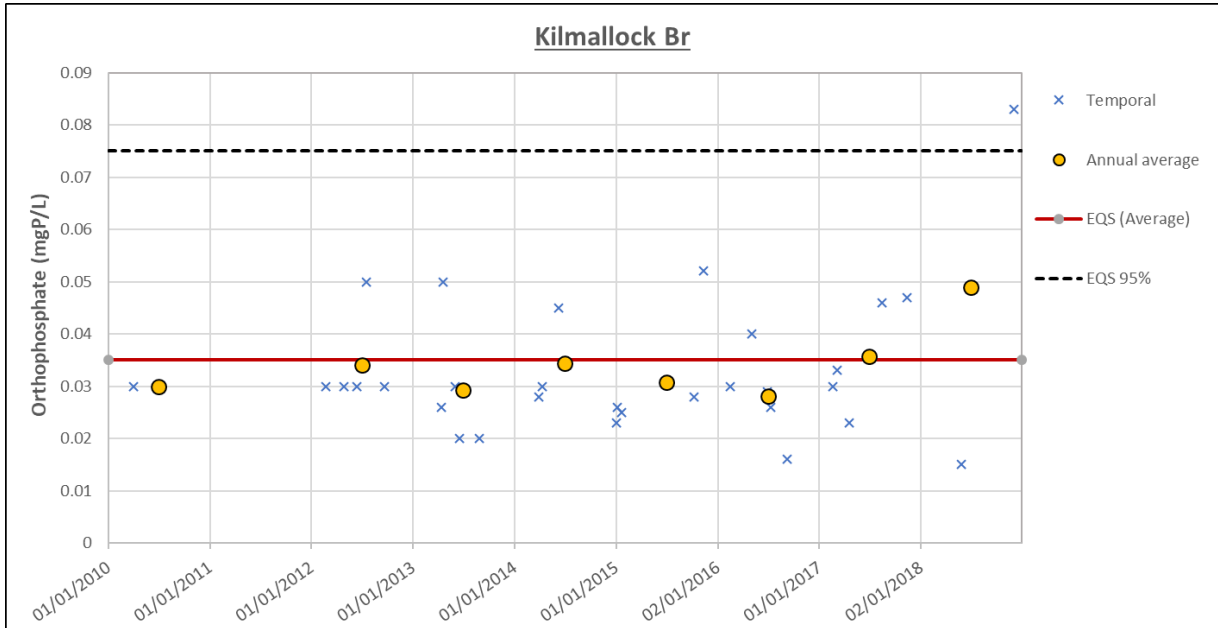


Figure 11. Mean annual ortho-phosphate concentrations at Killmallock Br on Sow_020.

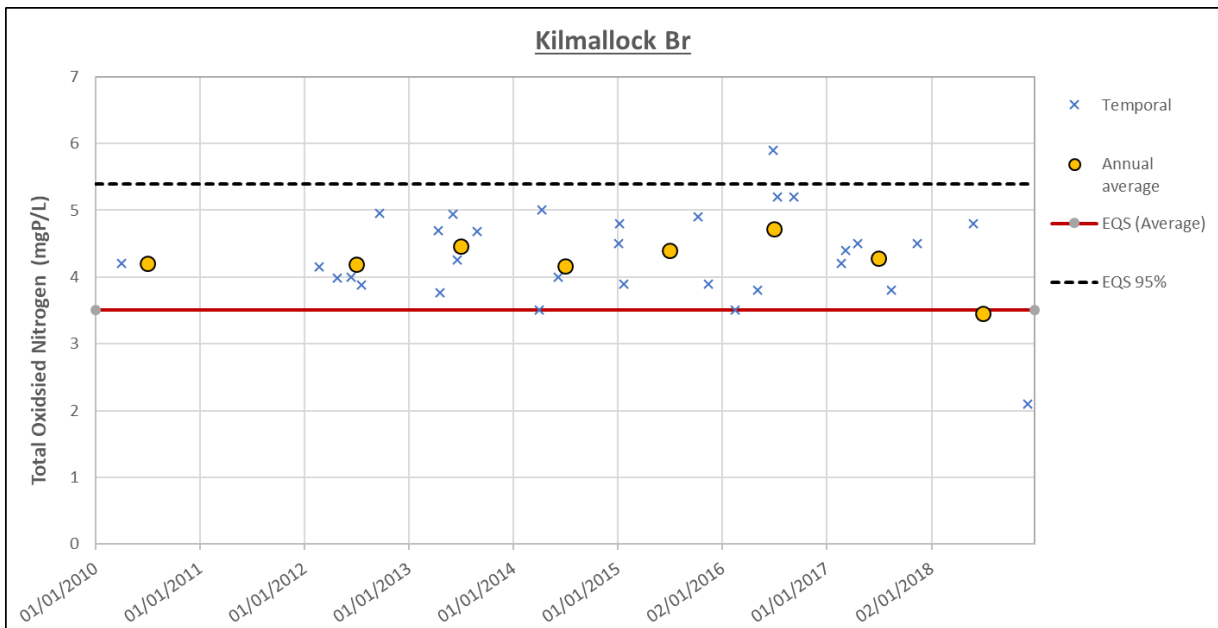


Figure 12. Mean annual TON concentrations at Killmallock Br on Sow_020.

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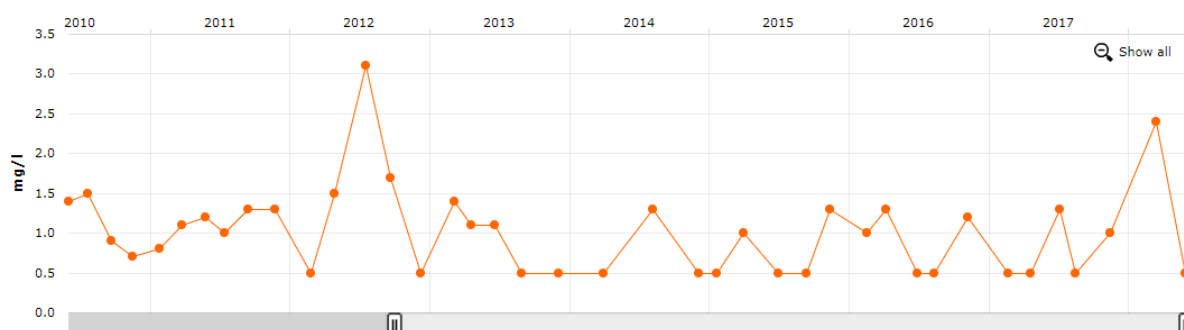


Figure 13. BOD concentrations at Kilmallock Br on Sow_020.

2.3 Sow_030

- Ecology on the Sow_030 is monitored at both the Augharr Bridge and the Randalsmill Bridge. Both sites were monitored in 2016 and were both found to be in moderate status (i.e. Q-value of 3-4). Water chemistry in the Sow_030 is monitored at Coolamin Bridge (Fig. 1).
- Baseline ammonia concentrations in 2014 were 0.044 mg/l which is indicative of good quality.
- Baseline ortho-phosphate concentrations in 2014 were 0.029 mg/l which, although under the EQS, is relatively high and could be causing an issue.
- Baseline TON concentrations in 2014 were 4.259 mg/l. These concentrations are likely to impact on water quality and as such nitrate is likely to be the significant issue in this catchment and is likely coming from agricultural activities.

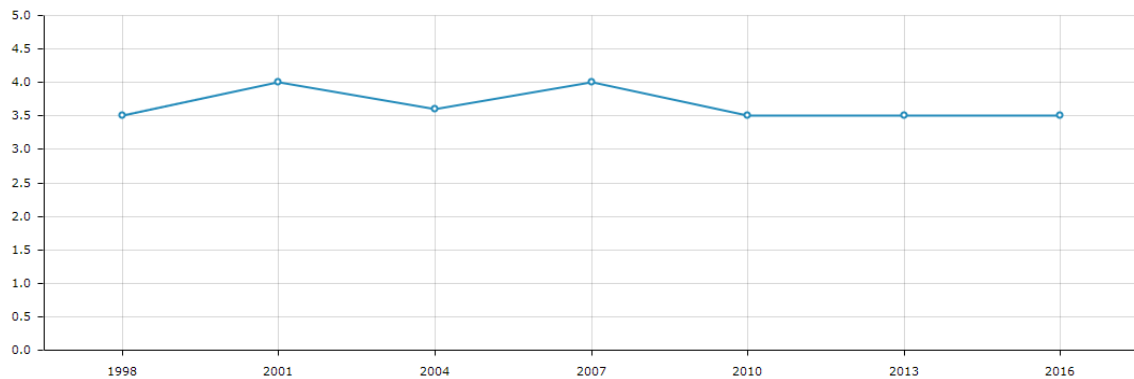
Table 4. Receptor information for Sow_030.

Factor	Augharr Br	Randalsmill Br	Coolamin Br
Risk Category	At Risk		
Biological Status			
Monitoring Station(s) with Q-values	Augharr Br	Randalsmill Br	
2016-2018 Q-value data	Moderate	Moderate	
2013 Q-value data	Moderate	Moderate	
2010 Q-value data	Moderate	Good	
Trends in Q-value since 2009	No change	Decline	
Hydrochemistry Data			
Monitoring Station(s) with data			Coolamin Br

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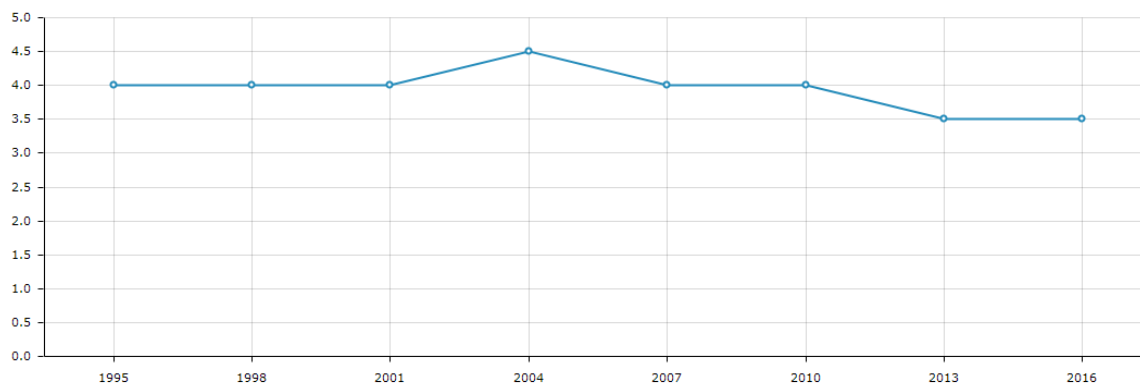
Factor	Augharr Br	Randalsmill Br	Coolamin Br
Existing			NH4, PO4, TON, BOD
New			
Trends in PO4, NH3 and NO3 (In App (until 2015))			
Ammonia			Upwards
Phosphate			Downwards
TON			Downwards
All available data			
Other water quality data			
BOD			Spikes: 2.8 mg/l (September 2015); 2.4 mg/l (May 2018)
2014 Baseline Concentration (mg/l)			
Ammonia			0.044 mg/l
Phosphate			0.029 mg/l
TON			4.259 mg/l
Distance to threshold			
Ammonia			Far
Phosphate			Far
TON			Far
Supporting Conditions			
Chemistry Conditions			Pass
Oxygenation Conditions			Pass
Acidification Conditions			Pass
Hydromorphology			
RHAT Score	N/A		
Evidence of arterial drainage	None		
Ecological Status (2017)			Moderate
Trends 2010-2017			Decline
Protected Areas	None		
WFD Objective	Good		
EPA biologist notes (if any)			As was the case in 2013, Moderate ecological conditions were recorded at all three sites assessed
Significant issue/impact for receptor	Nitrate and possibly phosphate		

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	1998	2001	2004	2007	2010	2013	2016
Result	3.5	4	3.6	4	3.5	3.5	3.5
Classification	Moderate	Good	Moderate	Good	Moderate	Moderate	Moderate
Q-Value	3-4	4	3-4*	4	3-4	3-4	3-4

Figure 14. Q-value data for Augharr Br on Sow_030.



	1995	1998	2001	2004	2007	2010	2013	2016
Result	4	4	4	4.5	4	4	3.5	3.5
Classification	Good	Good	Good	High	Good	Good	Moderate	Moderate
Q-Value	4	4	4	4-5	4	4	3-4	3-4

Figure 15. Q-value data for Randallsmill Br on Sow_030.

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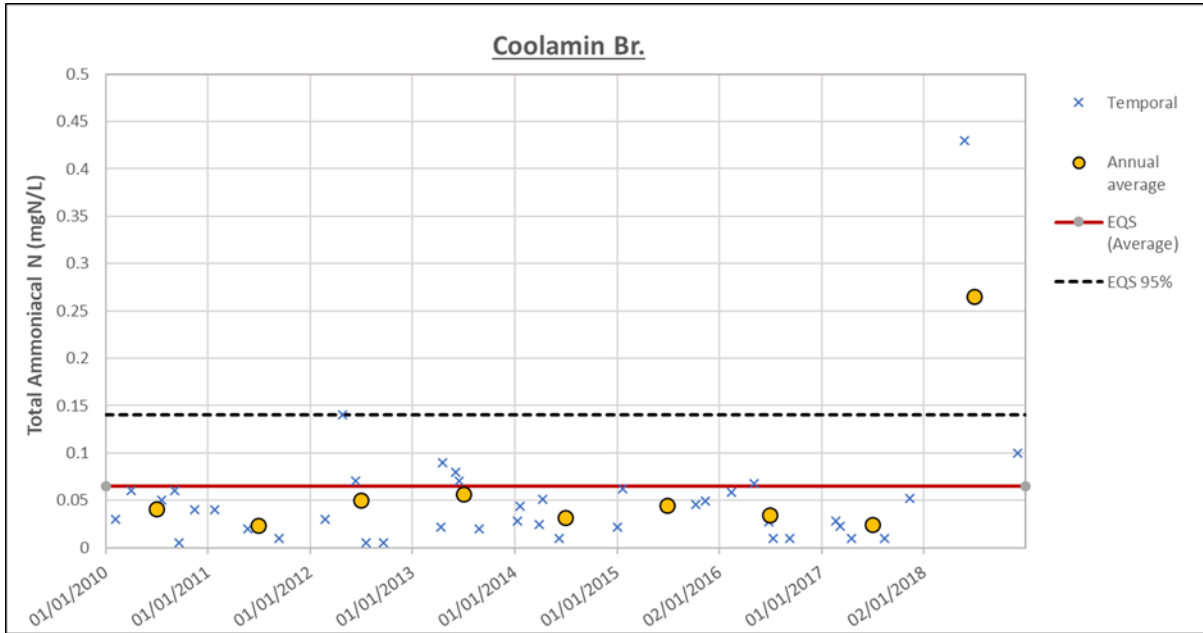


Figure 16. Mean annual ammonia concentrations at Coolamin Br on Sow_030.

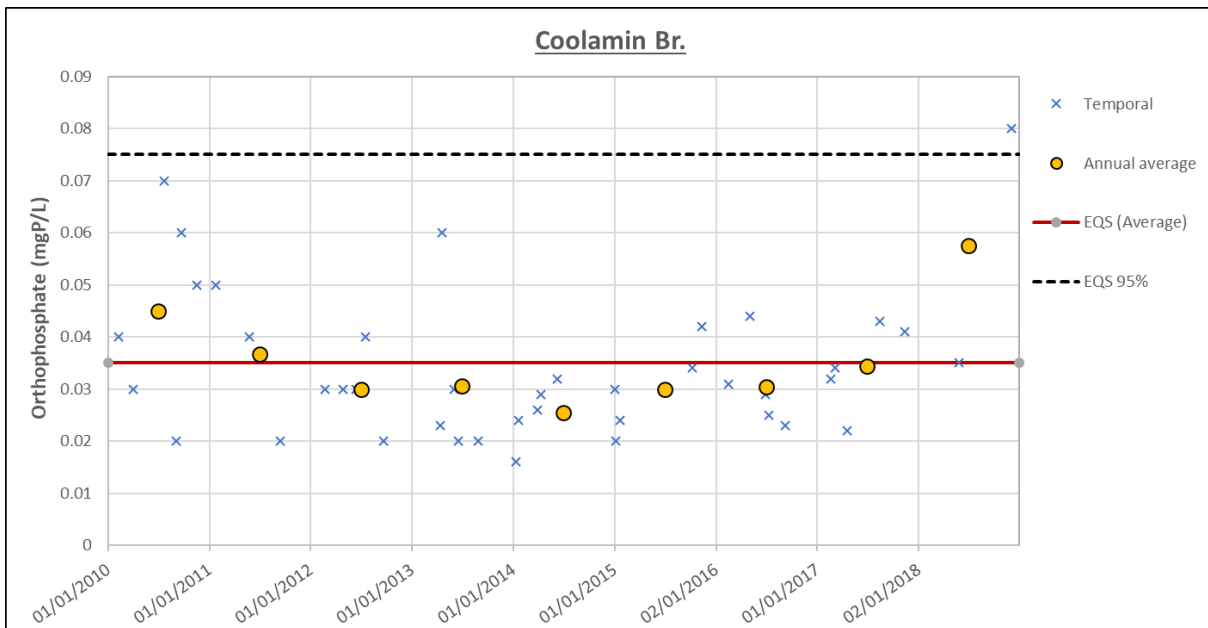


Figure 17. Mean annual ortho-phosphate concentrations at Coolamin Br on Sow_030.

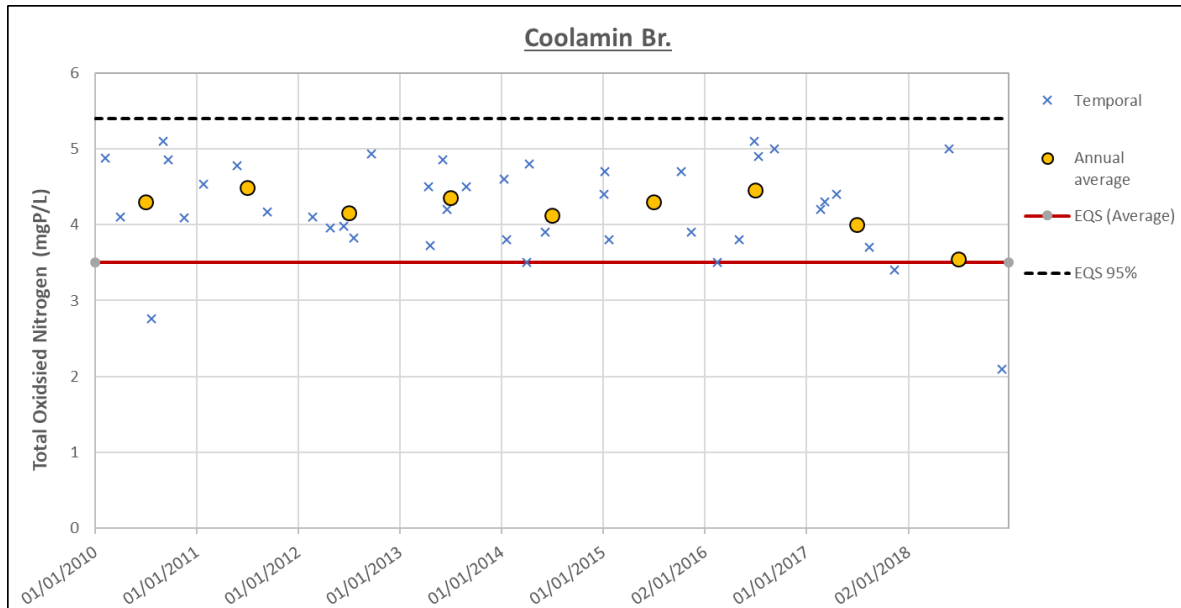


Figure 18. Mean annual TON concentrations at Coolamin Br on Sow_030.

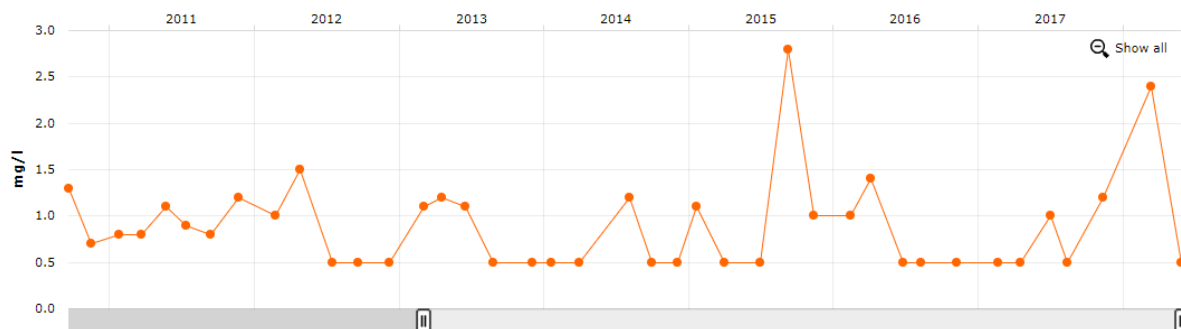


Figure 19. BOD concentrations at Coolamin Br on Sow_030.

2.4 Sow_040

- The status of Sow_040 is under review and no ecological data are available. Water chemistry is monitored at Br near Edenvale House.
- Baseline ammonia concentrations in 2014 were 0.021 mg/l which is well below the EQS.
- Baseline ortho-phosphate concentrations in 2014 were indicative of good quality at 0.027 mg/l but are still slightly elevated.
- Baseline TON concentrations in 2014 were 4.316 mg/l which is a level that is likely to impact on ecological quality. Therefore, nitrate is considered to be the significant issue in this waterbody.

Table 5. Receptor information for Sow_040.

Factor	
Risk Category	<i>Review</i>
Biological Status	
Monitoring Station(s) with Q-values	None
2016-2018 Q-value data	N/A
2013 Q-value data	N/A
2010 Q-value data	N/A
Trends in Q-value since 2009	N/A
Hydrochemistry Data	
Monitoring Station(s) with data	Br near Edenvale House
Existing	NH4, PO4, TON, BOD, chromium, copper, zinc, lead, nickel, cadmium
New	
Trends in PO4, NH3 and NO3 (In App (until 2015))	
Ammonia	Upwards
Phosphate	Downwards
TON	Downwards
All available data	
Other water quality data	
BOD	Small spikes to 2 mg/l (August 2017) and 2.6 mg/l (March 2018). Generally <1 mg/l
2014 Baseline Concentration (mg/l)	
Ammonia	0.021 mg/l
Phosphate	0.027 mg/l
TON	4.316 mg/l
Distance to threshold	
Ammonia	Far
Phosphate	Far
TON	Far
Supporting Conditions	
Chemistry Conditions	N/A
Oxygenation Conditions	N/A
Acidification Conditions	N/A
Hydromorphology	
RHAT Score	N/A

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Factor	
Evidence of arterial drainage	None
Ecological Status (2017)	N/A
Trends 2010-2017	N/A
Protected Areas	River Slaney Vally SAC, Wexford Harbour and Slobs SPA, Slaney Estuary (Lower) Nutrient Sensitive Area
WFD Objective	Good
EPA biologist notes (if any)	N/A
Significant issue/impact for receptor	Nitrate

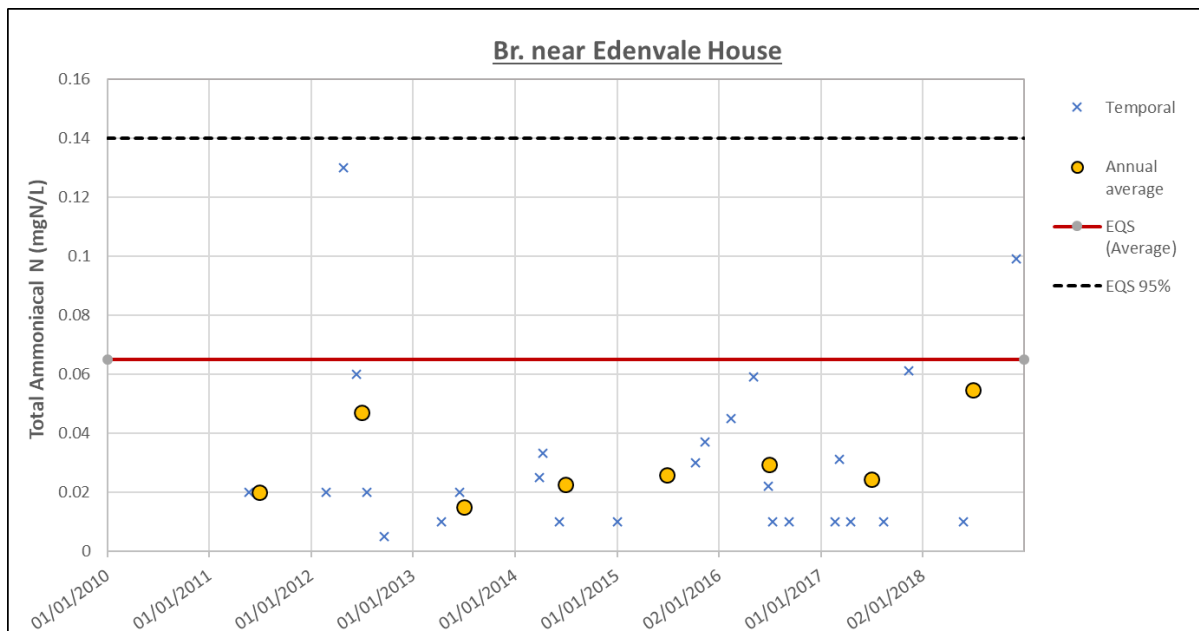


Figure 20. Mean annual ammonia concentrations at Bridge near Edenvale House on Sow_040.

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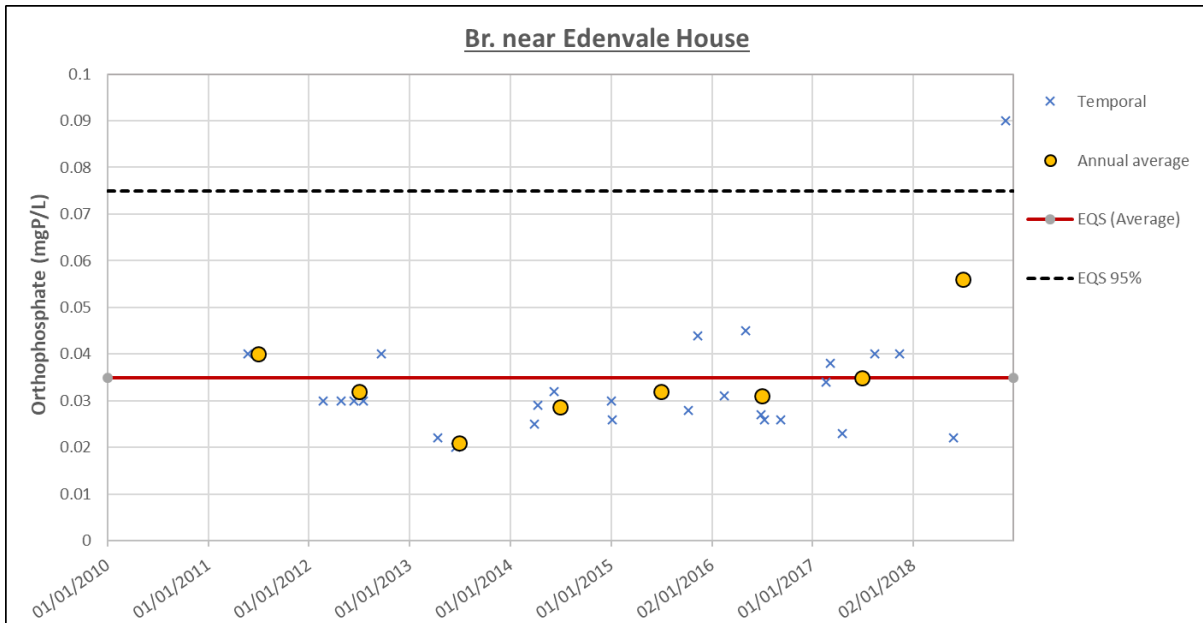


Figure 21. Mean annual ortho-phosphate concentrations at Bridge near Edenvale House on Sow_040.

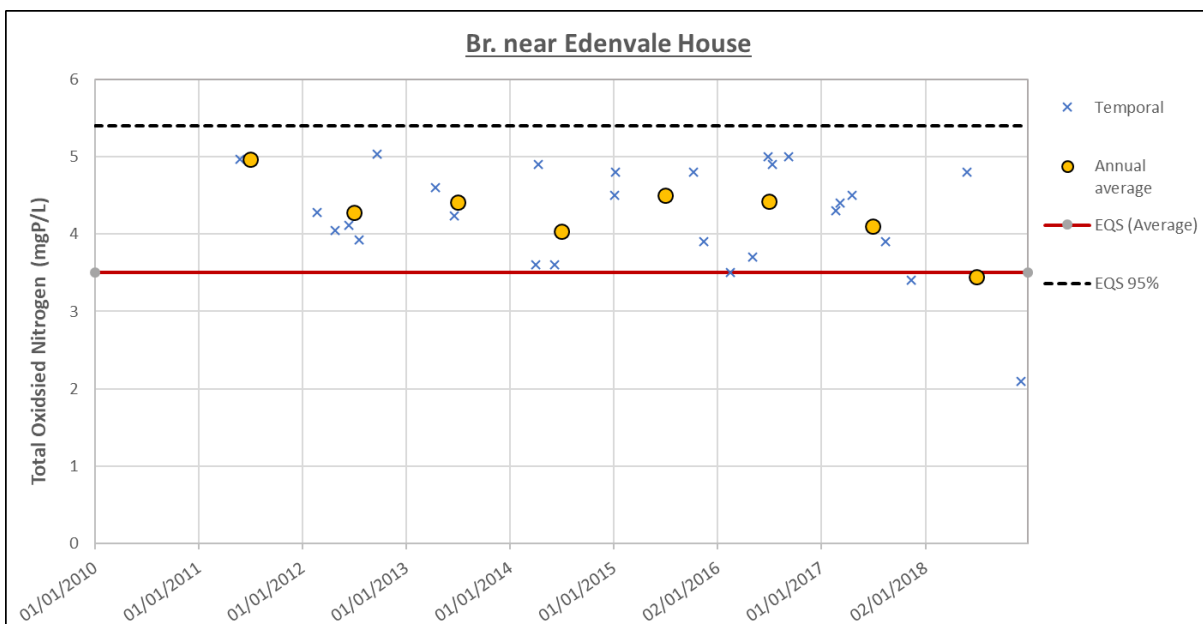


Figure 22. Mean annual TON concentrations at Bridge near Edenvale House on Sow_040.

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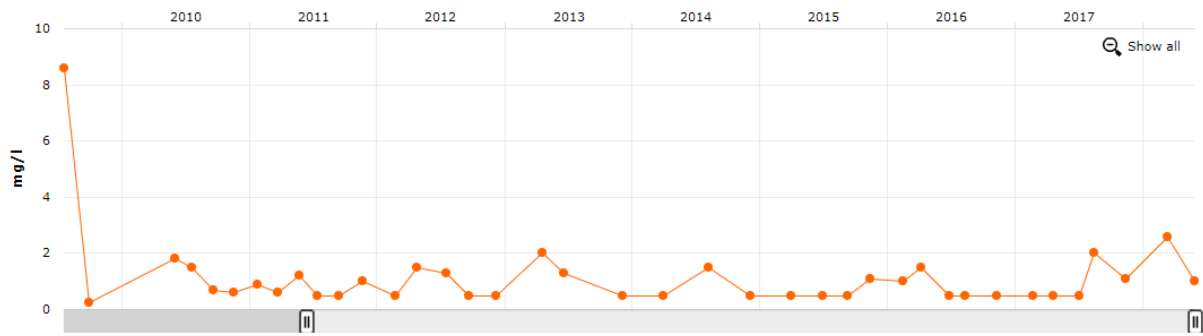


Figure 23. BOD concentrations at Bridge near Edenvale House on Sow_040.

3 Significant Pressures

Table 6. Significant Pressures identified for the Sow PAA by the Initial Characterisation process.

Waterbody	Pressure Category	Sub-category	Significant Pressure	Impact
Sow_010	Urban waste water (Ballymurn UWWTP)	PE 500-1000	Yes	Nutrient pollution
	Urban waste water (Ballaghkeen UWWTP)	PE 500-1000	Yes	Nutrient pollution
	Forestry		Yes	Altered habitat due to morphological changes
	Hydromorphology	Channelisation	Yes	Altered habitat due to morphological changes
	Domestic waste water	Waste water discharge	Yes	Nutrient pollution
Sow_020	Agriculture	Agriculture	Yes	Chemical pollution (pesticides)
Sow_030	Agriculture	Pasture	Yes	Nutrient pollution
Sow_040	Urban runoff	Diffuse sources runoff	Yes	Nutrient pollution

3.1 Sow_010

- There are two UWWTPs in the Sow_010, Ballaghkeen Urban Waste Water Treatment Plant (UWWTP) and Ballymurn UWWTP. Chemical monitoring results are available upstream and downstream of Ballymurn UWWTP (Fig. 20-23).
- Ballymurn UWWTP appears to be contributing significant amounts of total phosphorus and chemical oxygen demand immediately downstream and is in close proximity to the Ballinkeel Br monitoring point.
- Additionally, ammonia and phosphate concentrations are elevated in the upper reaches of Sow_010 downstream of Ballaghkeen UWWTP.

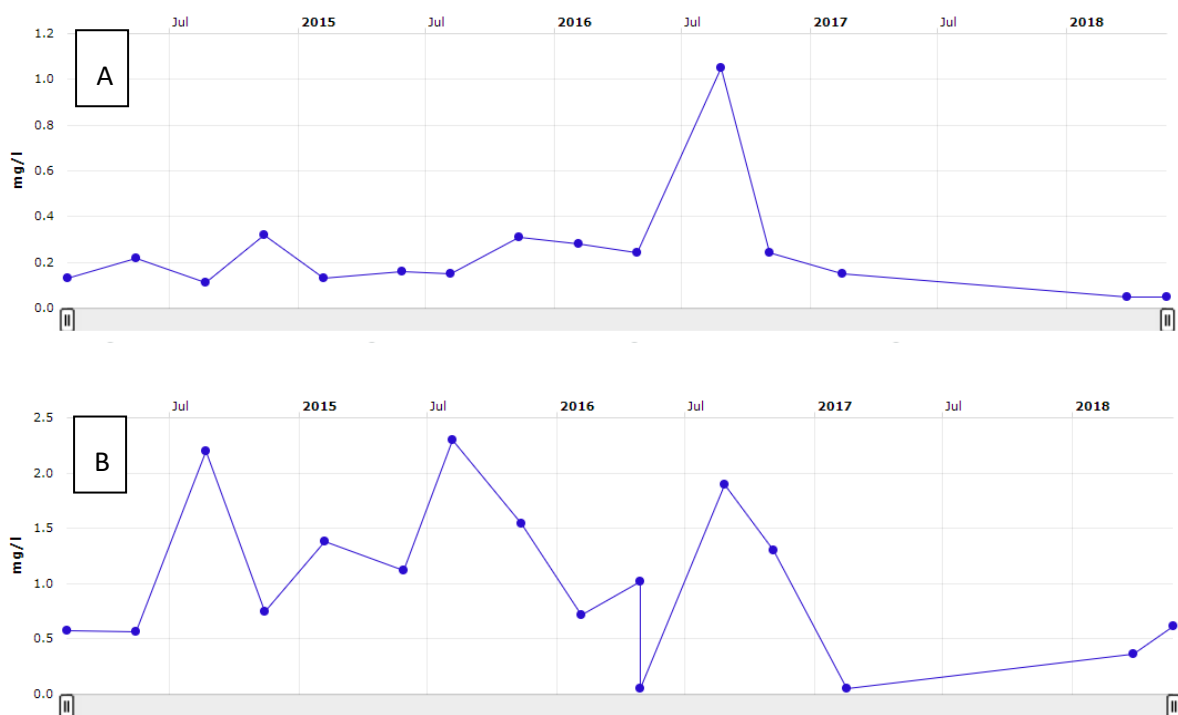


Figure 24. Total phosphorus concentration A) U/S of Ballymurn UWWTP (Upstream of TPEFF3300D0407SW001) and B) D/S of Ballymurn UWWTP (Downstream of TPEFF3300D0407SW001).

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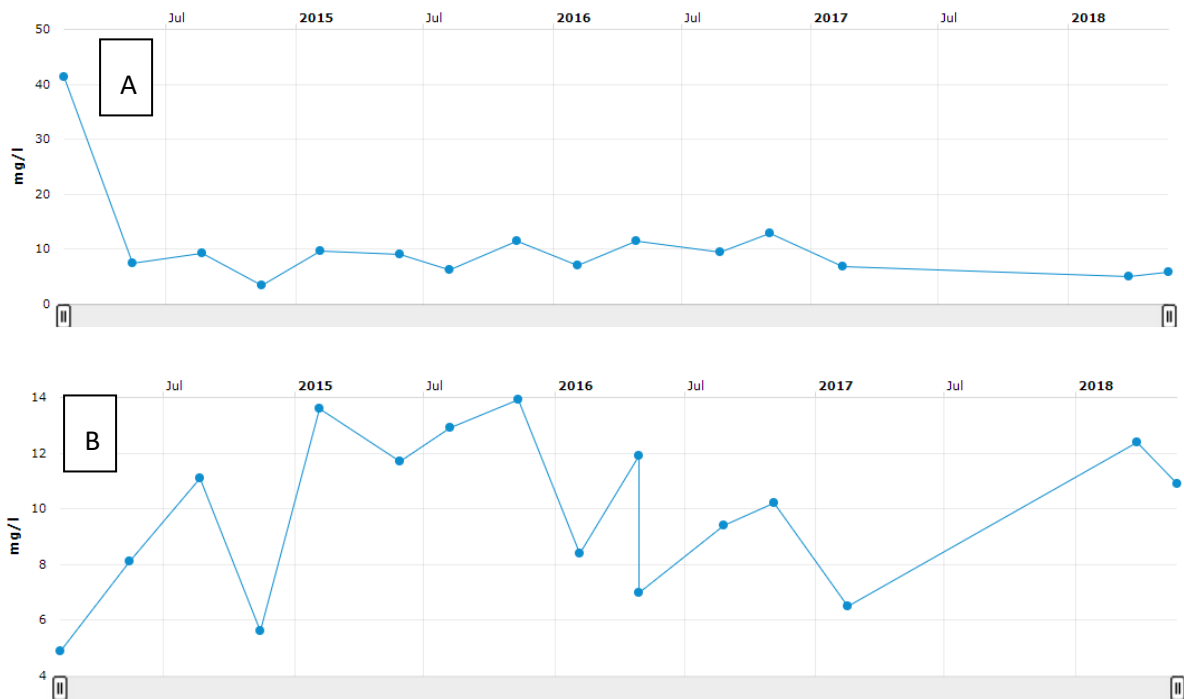


Figure 25. Total nitrogen concentration A) U/S of Ballymurn UWWTP (Upstream of TPEFF3300D0407SW001) and B) D/S of Ballymurn UWWTP (Downstream of TPEFF3300D0407SW001).

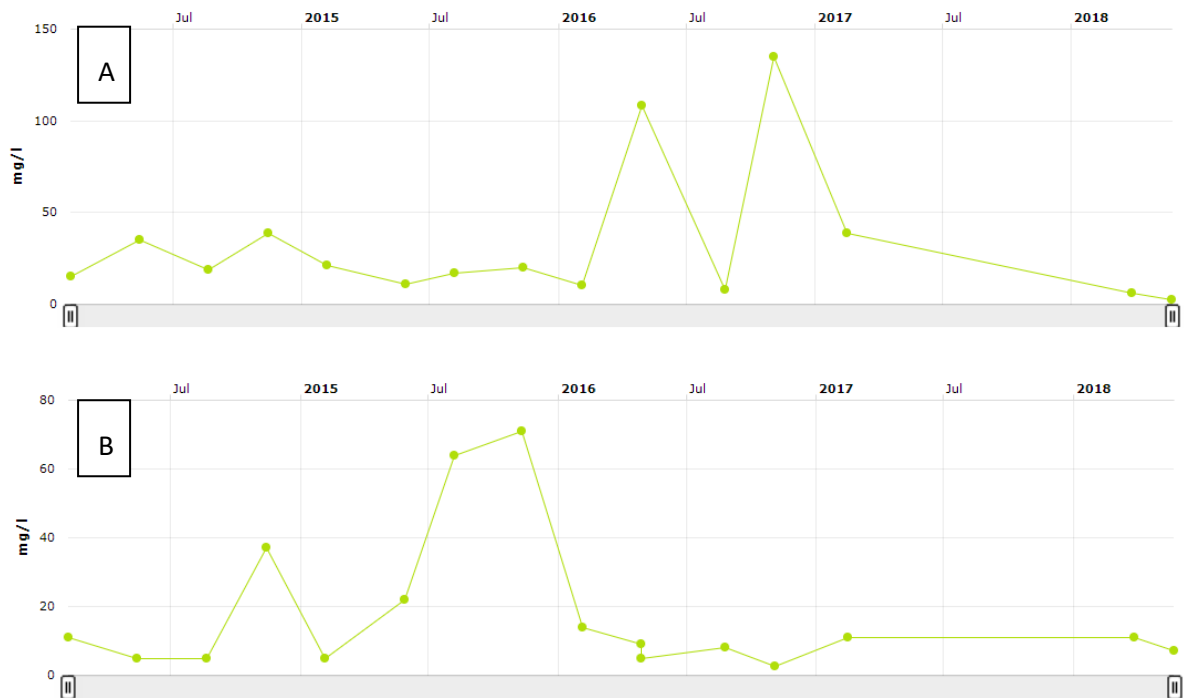


Figure 26. Suspended solids concentration A) U/S of Ballymurn UWWTP (Upstream of TPEFF3300D0407SW001) and B) D/S of Ballymurn UWWTP (Downstream of TPEFF3300D0407SW001).

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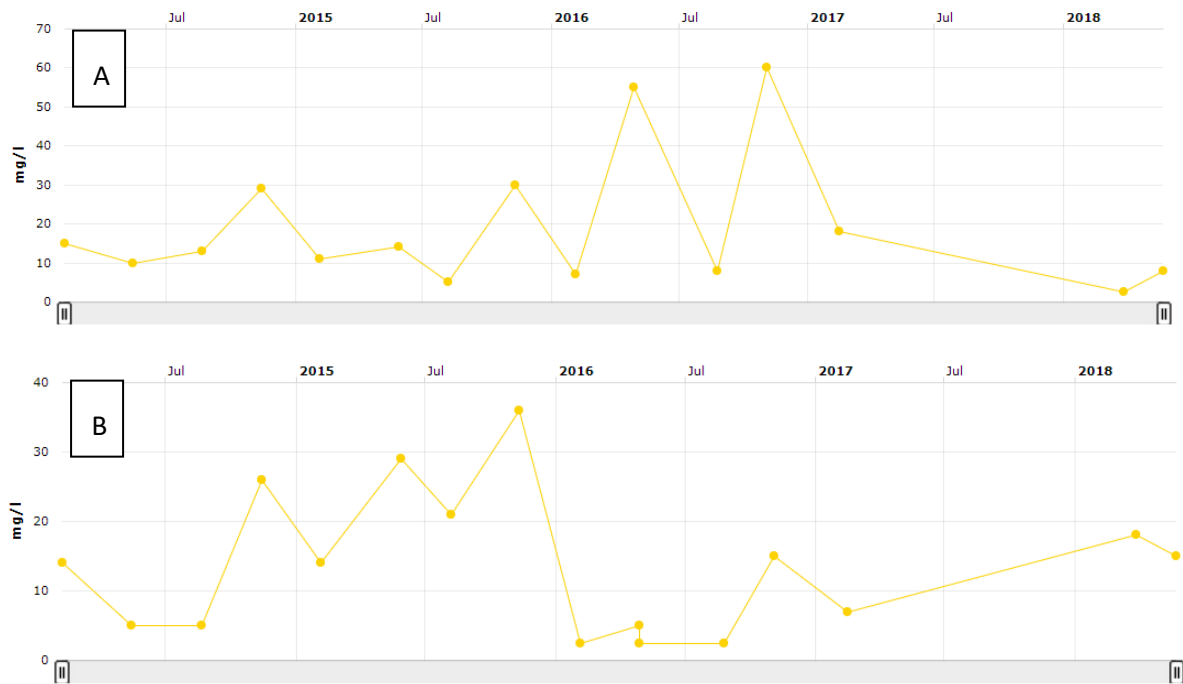


Figure 27. Chemical Oxygen Demand (COD) A) U/S of Ballymurn UWWTP (Upstream of TPEFF3300D0407SW001) and B). D/S of Ballymurn UWWTP (Downstream of TPEFF3300D0407SW001).

3.2 Sow_020

- Pesticide pollution has been identified as a significant issue in the Sow_020. This appears to be primarily in relation to levels in drinking water. The main abstraction for Wexford Town is located at Kilmallock Bridge and pesticide limits were breached in 2015. There have been no pesticide exceedances since.
- Areas of high P PIP should be targeted for measures to ensure that pesticide is not being lost to water. This includes much of the upper and mid catchment (Fig. 28).
- Nitrate is the significant issue in this waterbody. However, the nitrate PIP maps show that there is very little potential for diffuse nitrate loss from agricultural land (Fig. 29).
- Therefore, a more likely source of nitrate are the two UWWTPs in the Sow_010.

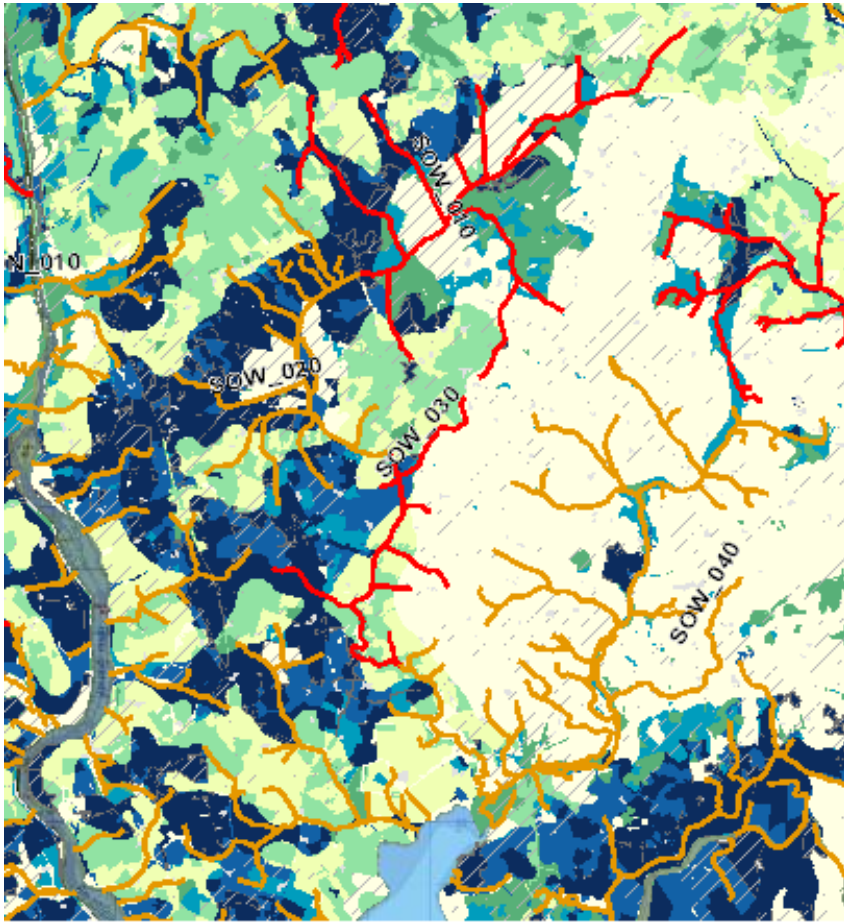


Figure 28. Surface water phosphate pollution impact potential (PIP) map.

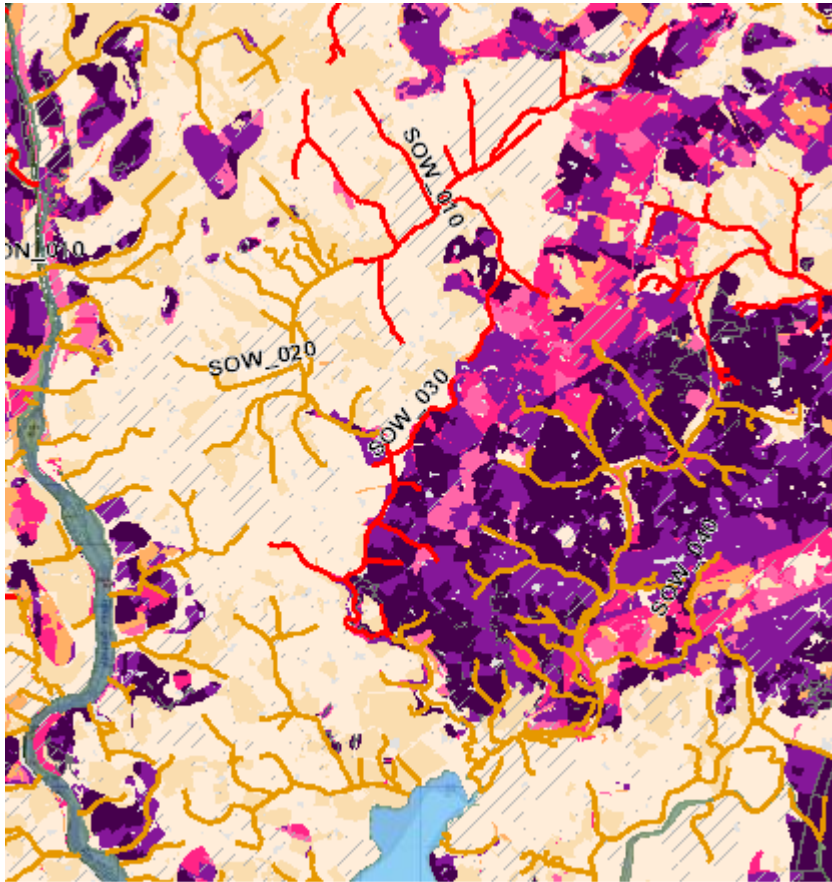


Figure 29. Surface water nitrate pollution impact potential (PIP) map.

3.3 Sow_030

- Agricultural pollution, mainly from pasture enterprises, has been identified as the significant pressure in the Sow_030.
- Nitrate is the significant issue in this waterbody. The nitrate PIP maps show much of the east of the catchment has the potential to contribute nitrate (Fig. 25). This is mainly from the area underlain by sand and gravel aquifer.

3.4 Sow_040

- The significant pressure identified in the characterisation process in Sow_040 was urban diffuse runoff. The main town in the catchment is Castlebridge at the outlet of the waterbody. Wastewater from Castlebridge is treated in the Wexford Town wastewater treatment plant which is not located in this water body. However, there are a number of storm overflows from the Castlebridge sewage collection system in Sow_040; these and other urban discharges are considered potential pressures requiring further assessment.

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- However, there is a significant agricultural area upstream of this, including a mixture of grassland and tillage enterprises which should not be discounted.

4 Pathway Information and Analysis

4.1 Overview of Pathways in the PAA

- Two main compartments and two subcompartments have been identified for the Sow PAA.
- Compartment 1 consists of a regionally productive karstified aquifer with high transmissivity. There is also a subcompartment of sand and gravel aquifer in this compartment.
- Compartment 2 consists of a poorly productive aquifer with a low transmissivity. There are two subcompartments, one consists of poorly draining soils and the other is sand and gravel aquifer.
- As nitrate is the main issue in the PAA diffuse losses of nitrate from agricultural lands in the areas underlain by the sand and gravel aquifer pose the greatest risk.

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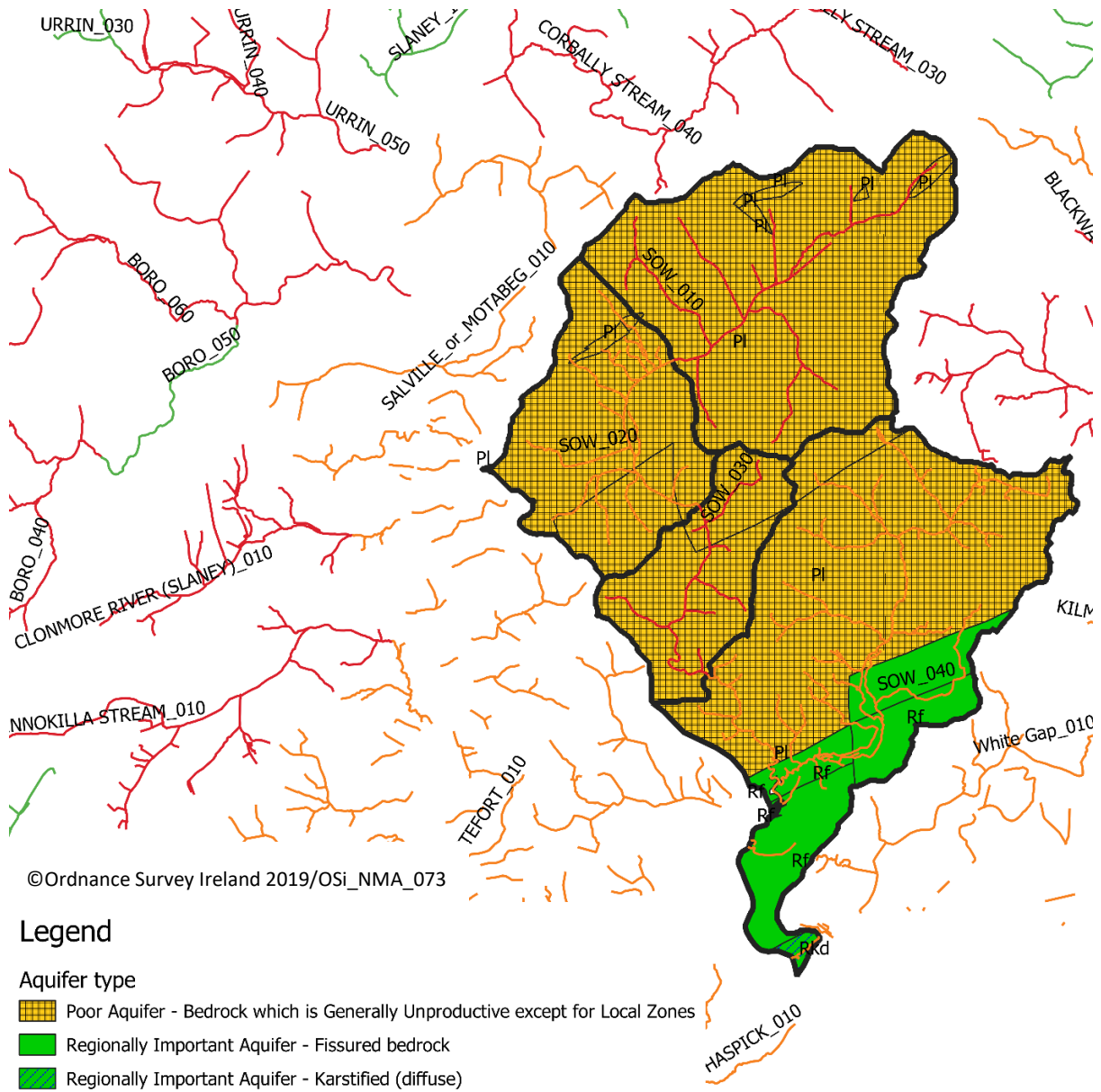


Figure 30. Aquifer type in the Sow PAA.

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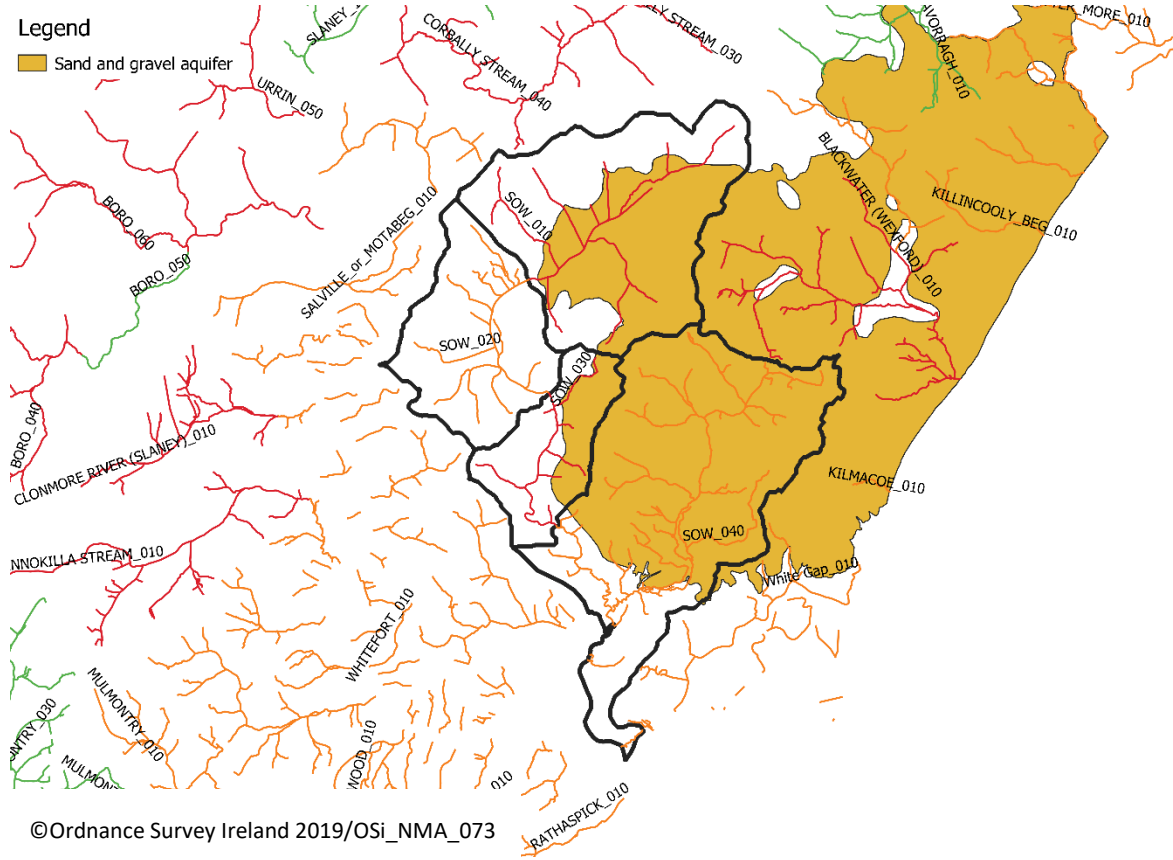


Figure 31. Area of sand and gravel aquifer in the Sow PAA.

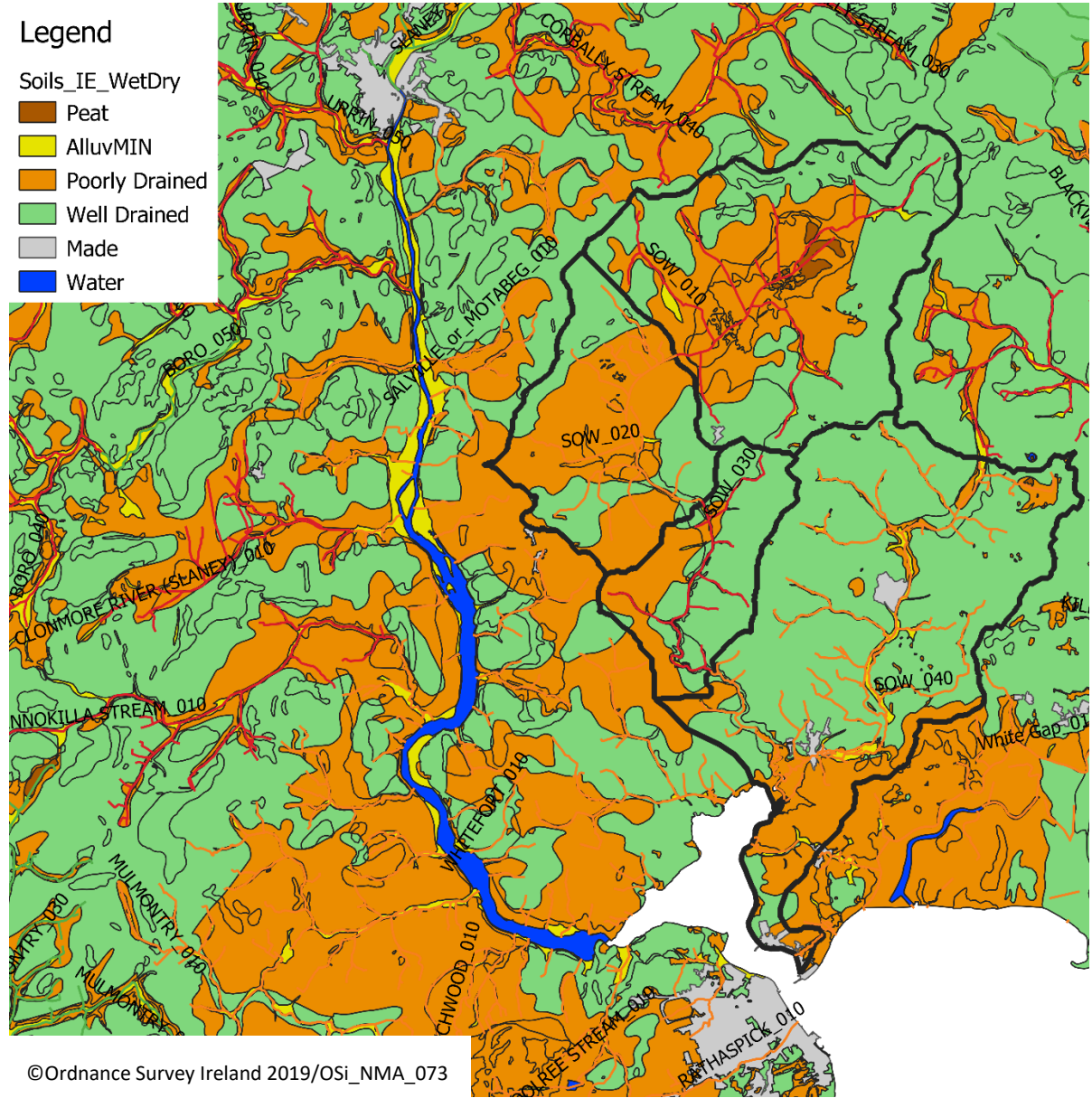


Figure 32. Soil drainage type in the Sow PAA.

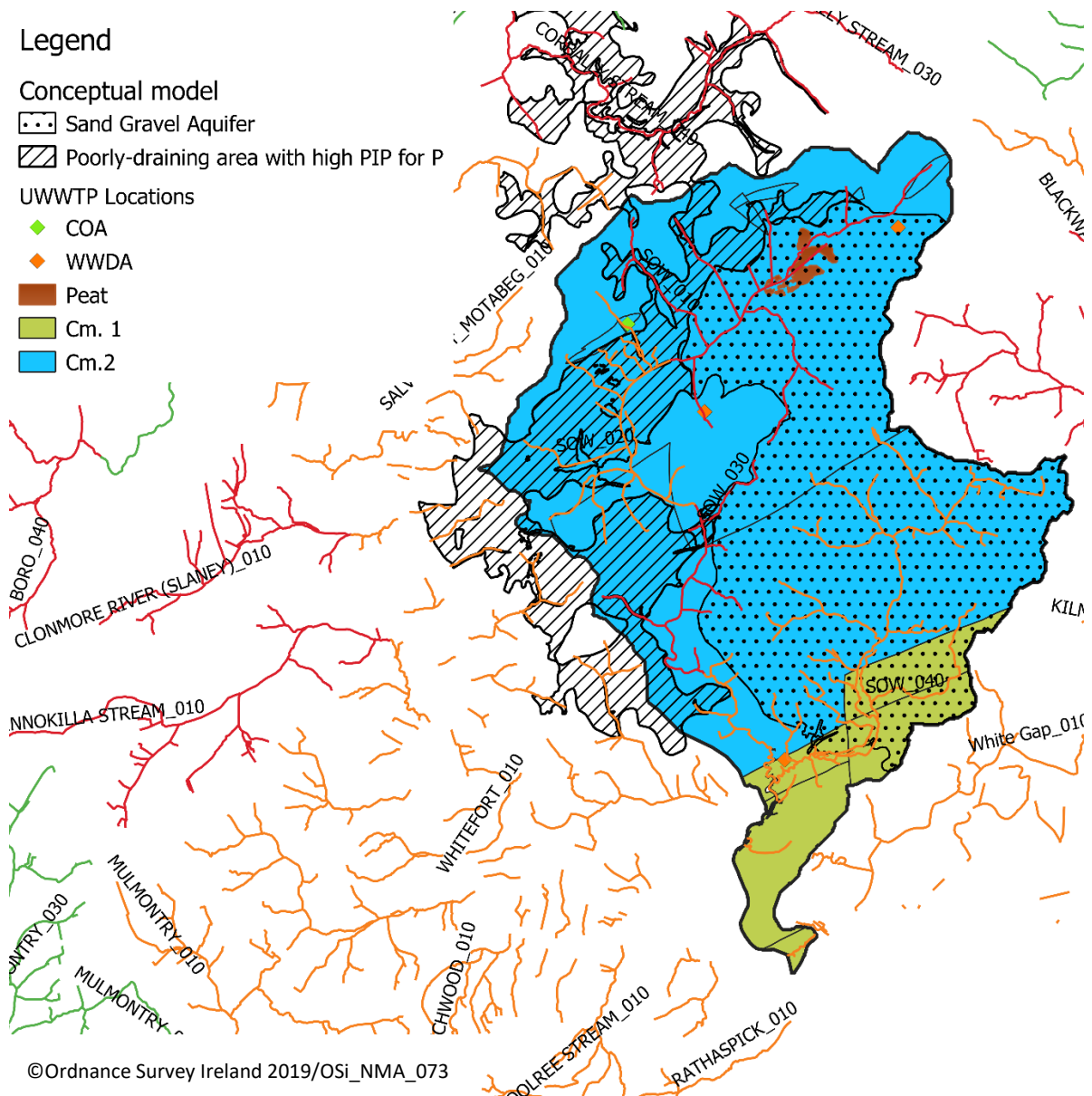


Figure 33. Conceptual model of main pathways in the Sow PAA.

4.2 Sow_010

- Significant issue: Nitrate
- Significant pressure: Ballymurn UWWTP and Ballaghkeen UWWTP
- Relevant pathways: Direct discharge. Also possibly diffuse losses via the sand and gravel aquifer.
- Two UWWTPs discharging directly to the Sow_010.

4.3 Sow_020

- Significant issue: Pesticides and nitrate
- Significant pressure: Agriculture and UWWTPs
- Relevant pathways: Nitrate – direct discharge from UWWTPs; pesticide – poorly drained soils
- High nitrate concentrations in this waterbody are likely as a result of pollution from the Ballymurn and Ballaghkeen UWWTPs upstream of the waterbody in Sow_010.
- Pesticide losses will be from areas of poorly draining soils. They are more likely to be applied in higher quantities in these areas in order to control the growth of rushes. Additionally, loss is most commonly via overland flow. Therefore, areas of high phosphate PIP are the most likely sources.

4.4 Sow_030

- Significant issue: Nitrate
- Significant pressure: Agriculture
- Relevant pathways: Areas of sand and gravel aquifer
- Nitrate loss is most likely on the areas of sand and gravel aquifer. Due to the poorly productive bedrock aquifer underlying this catchment the main pathway will be via the sand and gravel aquifer itself or via the upper fractured zone with little groundwater flow through the bedrock. This is reflected in the nitrate PIP maps which show high pollution impact potential on all areas underlain by sand and gravel aquifer.

4.5 Sow_040

- Significant issue: Nitrate
- Significant pressure: Agriculture
- Relevant pathways: Areas of sand and gravel aquifer and productive aquifer in the lower part of the catchment
- Nitrate loss is most likely on the areas of sand and gravel aquifer. Due to the poorly productive bedrock aquifer underlying most of this catchment the main pathway will be via the sand and gravel aquifer itself or via the upper fractured zone with little groundwater flow through the poor aquifer. This is reflected in the nitrate PIP maps which show high pollution impact potential on all areas underlain by sand and gravel aquifer.
- However, nitrate will also be transported via groundwater flow in the relatively small area of productive bedrock aquifer near the catchment outlet.

4.6 Pathways Conceptual Model and Likely Critical Source Areas

- For Sow_010 the most significant pathway for nitrate is likely direct as a result of point sources from the two UWWTPs in the catchment.
- Nitrate pollution in Sow_020 is also likely from the two UWWTPs in the Sow_010 as no pathway for diffuse nitrate loss exists. Therefore, dealing with nitrate in the Sow_10 may also lead to improvements in the Sow_020.

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- For pesticide pollution in the Sow_020 the poorly draining areas and particularly the areas in the upper reaches, above the drinking water abstraction with a high P PIP should be targeted for pesticide losses.
- In the Sow_030 nitrate loss is likely from anywhere on the sand and gravel aquifer. Stream walk should focus on identifying “problem” tributaries.
- In Sow_040 most of the catchment has potential to contribute nitrate as it is on sand and gravel aquifer and a small area near the outlet is also underlain by a productive aquifer. Areas of PIP rank 1 for nitrate should be focussed on by ASSAP.

Table 7. Main pathways identified in each compartment.

	Compartment 1		Compartment 2
Direct	Ballymurn and Ballaghkeen UWWTP		
Aquifer	PI		Rf, Rkd
Rock Units	Ordovician metasediments, Cambrian metasediments		Dinantian lower impure limestones, Dinantian pure bedded limestones
	Sub-Compartment 1A	Sub-Compartment 1B	
Soil type	Poorly-drained	Well-drained	Well-drained
Subsoil		Sand and gravel aquifer	Sand and gravel aquifer
Groundwater Vulnerability	L	H	H
PO ₄ PIP	Rank 1-2	Rank 7	Rank 7
NO ₄ PIP	Rank 6-7	Rank 1-3	Rank 1-3
Main Flow Paths	Overland	Subsurface via the sand and gravel aquifer	Groundwater

5 Interim Story of the Sow PAA

5.1 Sow_010

- Sow_010 is currently at moderate status with a 2016 Q-value of 3-4 at the Ballinkeel Bridge monitoring station.
- Nitrate is the main issue in this waterbody with concentrations of 4.9 mg/l recorded at Ballinkeel Bridge.
- Nitrate PIP maps show few areas with potential for significant nitrate loss.
- Therefore, the main significant pressure appears to be the two UWWTPs in the catchment; Ballaghkeen and Ballymurn. Both plants have continuously breached their ELVs.
- There is also a significant area of forestry in this catchment on poorly draining soils adjacent to the waterbody. From aerial photography, buffer strips do not appear to be present in a number of areas.
- Channelisation was also noted in the EPA characterisation process along with DWWTS as potentially significant pressures.
- Although phosphate and ammonia are below the EQS both are still relatively high and are also considered significant as concentrations are sufficiently elevated to impact on water quality.

5.2 Sow_020

- The current status of Sow_020 is unknown as it has not been monitored since 2009, when it was in good status.
- There is a drinking water abstraction in the Sow_020. There have been high concentrations of pesticides identified in the waterbody which could impact on this drinking water source. Areas of poorly draining soils and particularly areas of high phosphate PIP upstream of the abstraction should be targeted as sources of pesticide.
- Nitrate also appears to be the significant issue in the catchment with a baseline concentration of 4.3 mg/l at Kilmallock Bridge.
- Similarly to Sow_010, phosphate and ammonia concentrations, although below the EQS, are relatively high and reducing them may lead to improvements in water quality.
- The likely significant pressure in the Sow_020 are the two UWWTPs in the Sow_010. Dealing with them may lead to reductions in nutrient concentrations in the Sow_020 as well.

5.3 Sow_030

- Sow_030 is monitored at Augharr Bridge and Randalsmill Bridge and both sites were found to be in moderate status in 2016 with a Q-value of 3-4.
- The significant issue in the catchment is nitrate with a baseline concentration of 4.3 mg/l at Coolamin Bridge.
- Most of the catchment has well drained soils and part of the catchment is underlain by sand and gravel aquifer and the land use is predominantly pastoral farming. Therefore, most of the catchment has the potential to contribute nitrate via the upper fractured zone or via the sand and gravel aquifer.

- Areas of high nitrate PIP should be targeted. These areas are mainly on the sand and gravel aquifer.

5.4 Sow_040

- The status of Sow_040 is unknown as it has not been monitored since 1991.
- Nitrate is the significant issue with a 2014 baseline concentration of 4.3 mg/l.
- Most of the catchment has the potential to contribute nitrate as a large area is underlain by sand and gravel aquifer. This is reflected in the nitrate PIP maps. Due to the mainly pastoral land use in the catchment it will likely prove difficult to reduce nitrate concentrations in the waterbody.

5.5 Overview

- The most significant issue in the Sow PAA appears to be the two UWWTPs in the Sow_010. These may also prove to be the easiest to deal with.
- Pesticide use in the Sow_010 and Sow_020 should be investigated with ASSAP, with a particular focus on high phosphate PIP areas.
- Agriculture may be contributing to high nitrate concentrations, particularly in the Sow_030 and Sow_040. It may prove very difficult to deal with nitrate inputs in the PAA as the large area of sand and gravel aquifer means that much of the PAA has the potential for nitrate loss. Therefore, reducing inputs of phosphate and ammonia may be a more viable option for achieving water quality improvements.

6 Work Plan

Focus first on Sow_010 as there are a range of potential issues which may be affecting receiving waterbodies.

- Inquire if Wexford Co Co have any information relating to the location of DWWTS and any “problem areas”.
- SSIS up and down stream of the Ballymurn and Ballaghkeen UWWTPs. If they are deemed to be an issue then refer back to Irish Water. Carry out a mass balance for the two treatment plants.
- If no difference above and below the two UWWTPs on Sow_010 a full catchment walk taking field parameters (conductivity, DO, pH etc.) will be required with forestry, domestic waste water and hydromorphology all identified as significant pressures. As nitrate appears to be the issue (~5 mg/l N) the areas of sand and gravel aquifer should be targeted.
- Contact Wexford Co Co/ Irish Water for information on the abstraction in Sow_020 and for clarification on the concentrations of pesticides present. ASSAP should focus on areas of high phosphate PIP upstream of the abstraction to reduce pesticide loss to water.
- SSIS on Sow_020 near catchment outlet to determine risk status.
- If Sow_020 is *at risk* then try to determine if pesticide use is an issue for water quality or just drinking water quality. Water samples may be required during low and high flows. Rapid assessments should be carried out at the confluence of the larger tributaries to narrow down issues.
- Catchment walk in Sow_030 needed to identify effects from agriculture. Particularly focus on the area of sand and gravel aquifer to the east of the waterbody as N is the issue.
- SSIS on Sow_040 on both the branch that comes from the Sow_030 and the main channel in the catchment upstream of Castlebridge. If possible SSIS should also be carried out below Castlebridge after the confluence of these two branches of the river to determine the effect of the urban area as this is listed as the significant pressure. This area may be tidal however, so this may not be possible.
- If Sow_040 is *at risk* below Castlebridge then catchment should be walked in the vicinity of Castlebridge to identify urban pressures (pipes) and potential diffuse urban pathways.
- If at risk upstream of Castlebridge then full catchment walk is needed to identify pressure from agriculture. Areas of high PIP for N should be targeted. However, this is most of the catchment.

7 Possible Mitigation Options

- Upgrades needed on Ballymurn and Ballaghkeen UWWTPs by Irish Water.
- Possible upgrades of DWWTS in Sow_010.
- Increased buffer strips in forested areas.
- Discuss mitigation strategies with ASSAP advisor in relation to nitrates pollution from agriculture, particularly in Sow_030 and Sow_040.