

Keel Foherish
Priority Area for Action Desk Study
AFA 0096
South-West Region



Photograph of WFD operational monitoring point at Keel Br, taken on 26th of August 2020.

Disclaimer:

Although every effort has been made to ensure the accuracy of the material contained in this publication, complete accuracy cannot be guaranteed. The Local Authority Waters Programme (LAWPRO) 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.

Copyright ©LAWPRO, February 2021

This report cannot be reproduced without the prior written consent of LAWPRO.

Table of Contents

Acknowledgements.....	3
Summary	4
1 Background	5
1.1 Location of Keel Foherish Priority Area for Action and Reasons for Selection.....	5
1.2 Waterbody information	9
2 Receptor Assessment.....	11
2.1 Overview table	12
2.2 Q values.....	14
2.3 Hydrochemistry.....	18
2.4 Hydromorphology	20
2.5 Summary of Issues	22
3 Significant pressures	24
3.1 Initial EPA characterisation	24
3.2 Conclusions on the Significant Pressures.....	25
4 Pathways Information (diffuse pollution).....	26
4.1 Conceptual Model Development.....	26
5 Interim conclusions on the PAA.....	31
6 Workplan.....	32
6.1 EPA further characterisation actions	32
6.2 Additional Information Requirements.....	32
6.3 Local Catchment Assessment.....	32
7 Review of possible mitigation options.....	37
8 Communications	37
9 Appendices.....	38

List of Figures

Figure 1-1: Keel Foherish PAA.....	6
Figure 1-2: Keel Foherish Priority Area for Action WFD Risk	7
Figure 1-3: Keel Foherish Priority Area for Action Ecological status	8
Figure 2-1: WFD monitoring stations.....	11
Figure 2-2: Q value, at Keel Br, Keel_010.....	14
Figure 2-3: Q value, at Br N of Curraleigh, Foherish_010	14
Figure 2-4: Q value, at Br u/s Foherish River, Garrane (Lee)_010	15
Figure 2-5: Q value, at Foherish – Foherish Br, Foherish_020.....	15
Figure 2-6: Q value, at Foherish – W of Caherbirrane, Foherish_020	16
Figure 2-7: Orthophosphate results at Keel Bridge, Keel_010	18
Figure 2-8: Ammonia results at Keel Bridge, Keel_010.....	18
Figure 2-9: Orthophosphate results at Foherish – Foherish Br, Foherish_020.....	19
Figure 2-10: Ammonia results at Foherish – Foherish Br, Foherish_020.....	19
Figure 4-1: Conceptual Model	27
Figure 7-1: Sample locations for Keel_010	35
Figure 7-2: Sample locations for Foherish_020	36
Figure 9-1: Pollution impact potential: surface water receptor nitrate PIP Map.....	38
Figure 9-2: Pollution impact potential: surface water receptor phosphate PIP Map.....	39

Figure 9-3: Near Surface Phosphate Susceptibility	40
Figure 9-4: Soils Wet/Dry	41
Figure 9-5: Soil Type	42
Figure 9-6: Land Use	43
Figure 9-7: Natural sediment accumulation	44

List of Tables

Table 1-1: Background information on the Keel Foherish Priority Area for Action.....	5
Table 1-2: Summary table of individual waterbodies within the Keel Foherish Priority Area for Action, including headwaters.....	9
Table 1-3: Monitoring point locations	10
Table 2-1: Receptor information for Keel_010 and Foherish_020	12
Table 2-2: Receptor information for Foherish_010 and Garrane (Lee)_010, headwaters to PAA waterbodies	13
Table 2-3: Table of Q values.....	17
Table 2-4: Foherish_020 (Foherish – Foherish Br, RS19F020200) hydromorphological assessment (RHAT) score.....	20
Table 2-5: Foherish_020 (Foherish – W of Caherbirrane, RS19F020300) hydromorphological assessment (RHAT) score.....	21
Table 3-1: Initial EPA characterisation	24
Table 4-1: Conceptual model	29
Table 6-1: EPA further characterisation actions	32

Acknowledgements

The authors would like to acknowledge the contribution of Cork County Council staff to this report and thank them for their support of the Local Authority Waters Programme. The Council has carried out a significant amount of work in the Keel Foherish catchment in recent years.

Summary

The Keel Foherish Priority Area for Action (PAA) consists of two river waterbodies: Keel_010 and Foherish_020. The PAA lies within the Foherish_SC_010 subcatchment (id: 19_4) within catchment area Lee, Cork Harbour and Youghal Bay (19). The geology is Devonian Old Red Sandstone and it overlies an LI aquifer (Ballinhassig West groundwater body).

The river was selected as a PAA for a multi-agency approach between Forest Service, Coillte and Cork County Council. It was also selected for the potential to examine impacts from wind farms. Both waterbodies were failing to meet their Water Framework Objective status and both were *At Risk* at the time of selection. Also, one of the deteriorated waterbodies (Foherish_020) is a high ecological status objective waterbody.

Keel_010 is 9.97 km in length. The water quality in Keel_010 dropped from good status in 2008 to poor status in 2011-2014. It returned to good status (its WFD objective) in 2017 but further assessment needs to be undertaken to determine the cause of the 2011 deterioration.

Foherish_020 is 13.78 km in length. This is a high status objective waterbody with two WFD operational monitoring stations. Water quality at the upstream station has been consistently high biological status but the downstream station deteriorated from high to good biological status in 2011. It improved back to high status in 2017 but the overall ecological status of Foherish_020 remains at Good, driven by hydromorphological conditions at both monitoring stations.

The significant issue which drove the 2011 biological status deterioration in both waterbodies is likely to be sediment but associated nutrients may also be an issue.

The significant pressures which contributed to the 2011 deterioration may be forestry and anthropogenic activities (windfarm development). Surface pathways therefore need to be the focus for assessment. The windfarm development itself is located in the Foherish_020 sub-basin but the access roadway is situated in Keel_010, 1km upstream of the WFD monitoring point. The possible contribution of sediment from roadway construction may have contributed to the deterioration in water quality here. Construction activity associated with the windfarm itself may potentially have impacted on water quality downstream in Foherish_020.

Recommended Actions:

- Limited local catchment assessment on Keel_010 to confirm whether the EPA monitoring point (Keel Br) is still at good status and to try to determine the cause of the 2011 deterioration here.
- Local catchment assessment on Foherish_020 has three purposes: to confirm whether the RHAT scores for both monitoring stations are still at less than high, to confirm whether biological status remains high at both monitoring stations and if not, to identify the reasons for the current deterioration and to try to identify the reasons for the earlier (2011 to 2014) biological status deterioration here.
- Catchment assessment in Foherish_020 will consist of a stream walk starting at the EPA monitoring point (Foherish-W of Caherbirrane) working upstream towards to the confluence with Keel_010.

Information from this first local catchment assessment will inform the extent of additional assessment and stream walks needed.

1 Background

1.1 Location of Keel Foherish Priority Area for Action and Reasons for Selection

The Keel/Foherish Rivers are tributaries of the Sullane. The PAA comprises two waterbodies (Keel_010 and Foherish_020).

The Keel/Foherish Rivers were selected as a PAA for a multi-agency approach between Forestry Service, Coillte and Cork County Council. They were also selected for; the potential to examine impacts from wind farms. Both waterbodies were failing to meet their WFD status objective and both were *At Risk*. Also, one of the deteriorated waterbodies (Foherish_020) is a high ecological status objective waterbody.

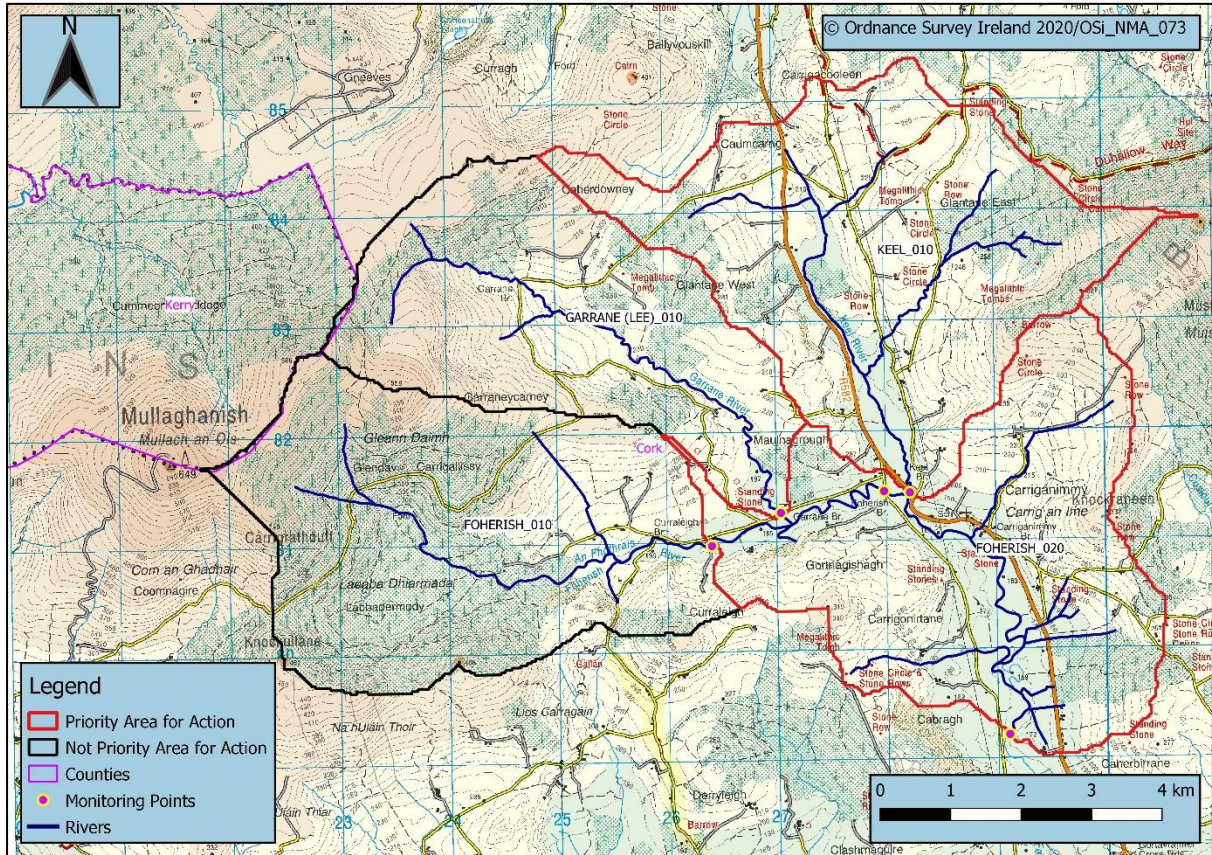
Table 1-1: Background information on the Keel Foherish Priority Area for Action

Priority Area for Action	Catchment No.	Catchment Name	Sub catchment	Region	Local Authority
Keel Foherish	19	Lee, Cork Harbour and Youghal Bay	19_4 Foherish_SC_010	Southwest	Cork

Priority Area for Action	No. of <i>At Risk</i> WBs	No. of <i>Review</i> WBs	No. of dRBMP Prioritised WBs	No. of WBs for Status Improvement		
				2021	2027	Beyond 2027
Keel Foherish	1	1	2	0	2	0

Keel Foherish Priority Area for Action Desk Study

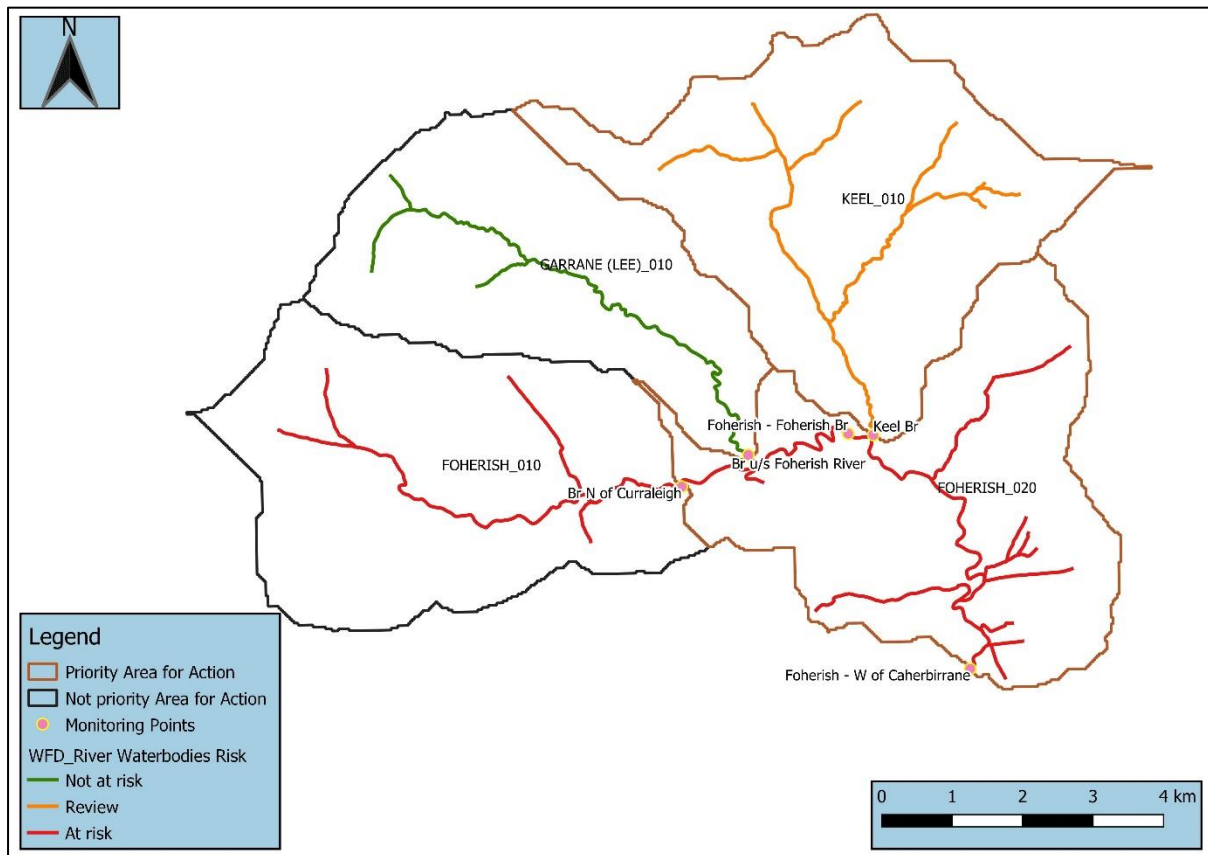
A map of the Keel Foherish PAA is presented in figure 1.1 below:



Source: EPA

Figure 1-1: Keel Foherish PAA

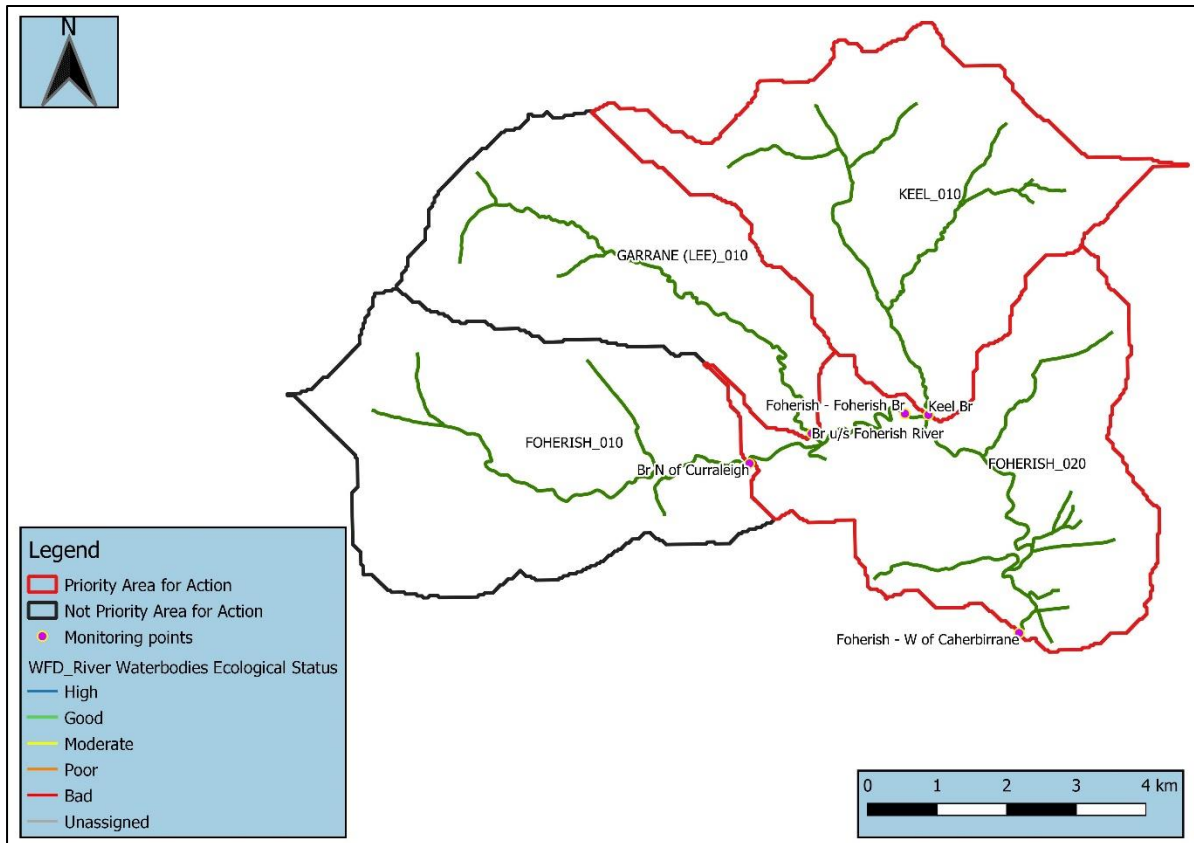
The Keel Foherish PAA risk and status maps are shown on figures 1.2 and 1.3 respectively, with monitoring point locations.



Source: EPA 2020

Figure 1-2: Keel Foherish Priority Area for Action WFD Risk

Keel Foherish Priority Area for Action Desk Study



Source: EPA 2020

Figure 1-3: Keel Foherish Priority Area for Action Ecological status

1.2 Waterbody information

Table 1.2 outlines summary status and pressure information for each waterbody. Details of monitoring points are provided in table 1.3 and shown on the map in figure 1.1 above.

Table 1-2: Summary table of individual waterbodies within the Keel Foherish Priority Area for Action, including headwaters

Water body Code	Water body Name	Water body Type Name	Date to meet Environmental Objective	Risk	Status Objective	Ecological Status				Pressures		
						07-09	10-12	10-15	13-18	Category	Sub Category	Significant
IE_SW_19K020200	KEEL_010	River	2027	Review	Good	Good	Poor	Poor	Good	Forestry	Forestry	Yes
										Anthropogenic Pressures	Unknown	Yes
IE_SW_19F020100	Foherish_010 (Upstream of PAA)	River	-	At risk	High	High	High	High	Good	Hydromorphology	Overgrazing	Yes
IE_SW_19G030200	Garrane (Lee)_010 (Upstream of PAA)	River	-	Not at risk	Good	High	Good	Good	Good	-	-	-
IE_SW_19F020300	Foherish_020	River	2027	At risk	High	High	Good	Good	Good	Forestry	Forestry	Yes
										Anthropogenic Pressures	Unknown	Yes

Source: EPA 2020

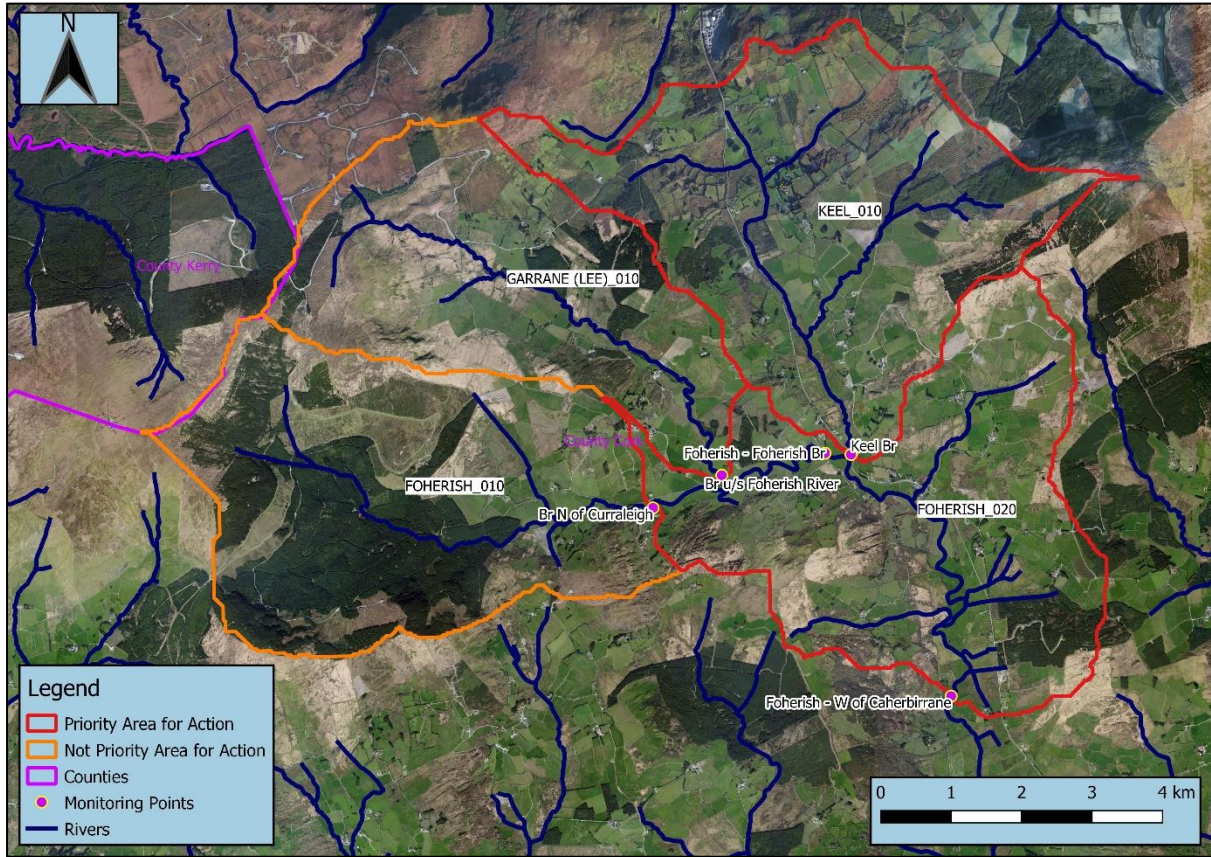
Table 1-3: Monitoring point locations

Waterbody	Monitoring Point Code	Name	Type	Comments
Keel_010	RS19K020200	Keel Br	Operational	Q data and limited supporting chemistry
Foherish_010 (Upstream of PAA)	RS19F020100	Br N of Curraleigh	Operational	Includes Q data only
Garrane (Lee)_010 (Upstream of PAA)	RS19G030200	Br u/s Foherish River	Operational	Includes Q data only
Foherish_020	RS19F020200	Foherish - Foherish Br	Operational	Q data and limited supporting chemistry
	RS19F020300	Foherish - W of Caherbirrane	Operational	Includes Q data only

Source: EPA 2020

2 Receptor Assessment

Monitoring stations are shown on the map below:



Source: EPA

Figure 2-1: WFD monitoring stations

2.1 Overview table

Information on the PAA waterbodies, including summary results for each operational monitoring point, is provided in table 2.1 and table 2.2:

Table 2-1: Receptor information for Keel_010 and Foherish_020

		Figures Tables	Keel_010	Foherish_020	
Risk Category		Y	Review	At risk	
Monitoring station		Y	RS19K020200	RS19F020200	RS19F020300
Station Type			Operational	Operational	Operational
Biological Status (Inverts)	2010-2015	Y	Poor (3)	High (Q4/5)	Good (4)
	2013-2018	y	Good (4)	High (Q4/5)	High (Q4/5)
	Trends in Q values		2017 Q data indicate a return to good status here	Q results for the monitoring station consistently high since 1990.	2017 Q data indicate a return to high status here
Biological Status (fish)			No data	No data	
Hydrochemistry Data					
Ortho-P (mg/l P)	Baseline		No data	No data	No data
	Indicative quality		No data	No data	No data
	Trends - significant?		No data	No data	No data
	Distance to threshold		No data	No data	No data
NH4-N (mg/l N)	Baseline		No data	No data	No data
	Indicative quality		No data	No data	No data
	Trends - significant?		No data	No data	No data
	Distance to threshold		No data	No data	No data
TON (mg/l N)	Baseline		No data	No data	No data
	Indicative quality		No data	No data	No data
	Trends - significant?		No data	No data	No data
	Distance to threshold		No data	No data	No data
Other nutrient monitoring data			Results of monitoring undertaken in 2019 and 2020 indicate that nutrients and BOD are not currently an issue in this waterbody	Results of monitoring undertaken in 2019 and 2020 indicate that nutrients and BOD are not currently an issue in this waterbody	No data
RHAT score			No data	Good	
Evidence of Arterial drainage			No	No	
Ecological Status (2010–2015)			Poor	Good	
Ecological Status (2013–2018)			Good	Good	
Trends			Poor status from 2011 to 2014. Returned to good in 2017.	2017 Q data indicates a return to high status here. However, hydromorphological conditions are good.	
Protected Areas			Ballinhassig West (Drinking Water)	Ballinhassig West (Drinking Water)	
WFD Objective			Good	High	
EPA biologist notes (if any)			Biologist's comment: 2014 survey-moderate siltation. No livestock access at site. Nothing else of note.	Biologist's comment: Substrate clean. Nothing else of note.	
Significant issue/impact for receptor			-See section 2.4	-See section 2.4	

Keel Foherish Priority Area for Action Desk Study

Table 2-2: Receptor information for Foherish _010 and Garrane (Lee)_010, headwaters to PAA waterbodies

	Figures Tables	Foherish _010	Garrane (Lee)_010
Risk Category	Y	At risk	Not at risk
Monitoring station	Y	RS19F020100	RS19G030200
Station Type		Operational	Operational
Biological Status (Inverts)	2010-2015	High (Q4/5)	Good (4)
	2013-2018	High (Q4/5)	High (Q4/5)
	Trends in Q values	Q results for the monitoring station consistently high since 1994.	2017 Q data indicate a return to high status here
Biological Status (fish)		No data	No data
Hydrochemistry Data			
Ortho-P (mg/l P)	Baseline	No data	No data
	Indicative quality	No data	No data
	Trends - significant?	No data	No data
	Distance to threshold	No data	No data
NH4-N (mg/l N)	Baseline	No data	No data
	Indicative quality	No data	No data
	Trends - significant?	No data	No data
	Distance to threshold	No data	No data
TON (mg/l N)	Baseline	No data	No data
	Indicative quality	No data	No data
	Trends - significant?	No data	No data
	Distance to threshold	No data	No data
RHAT score		Good	Good
Evidence of Arterial drainage		No	No
Ecological Status (2010–2015)		High	Good
Ecological Status (2013–2018)		Good	Good
Trends		Q results for the monitoring station consistently high since 1994. However, hydromorphological conditions are good.	2017 Q data indicate a return to high status here. However, hydromorphological conditions are good.
Protected Areas		Ballinhassig West (Drinking Water)	Ballinhassig West (Drinking Water)
WFD Objective		High	Good
EPA biologist notes (if any)			
Significant issue/impact for receptor		-See section 2.4	-See section 2.4

Keel Fotherish Priority Area for Action Desk Study

2.2 Q values

Keel_010 (Review) (PAA waterbody)

There is one operational station on Keel_010 the Keel Br, RS19K020200. There are no chemistry data available for Keel Br. Biological monitoring results at this location deteriorated from good (Q4) in 2008 to poor (Q3) in 2011 to 2014. 2017 Q data indicates a return to good status. Q values are graphed in figure 2.2 and summarised in table 2-3.

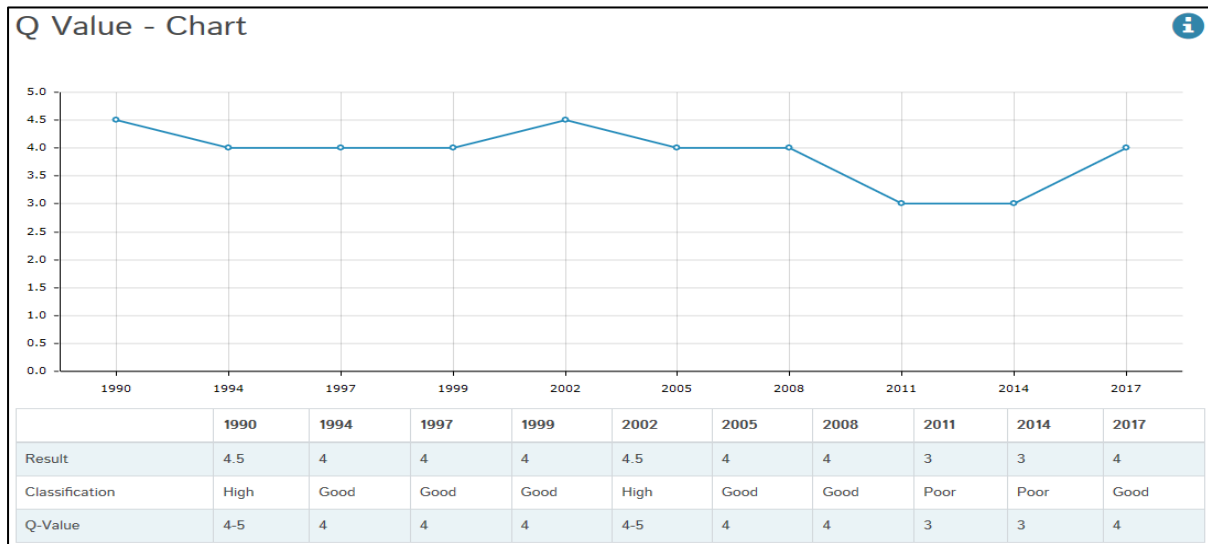


Figure 2-2: Q value, at Keel Br, Keel_010

Fotherish_010 (At Risk) (upstream of PAA waterbody Fotherish_020)

There is one operational station on Fotherish_010 the Br N of Curraleigh, RS19F020100. There are no chemistry data available for this station. Q results for the monitoring point at Br N of Curraleigh have been consistently high since 1994 (see below figure 2.3 and summarised in table 2-3).

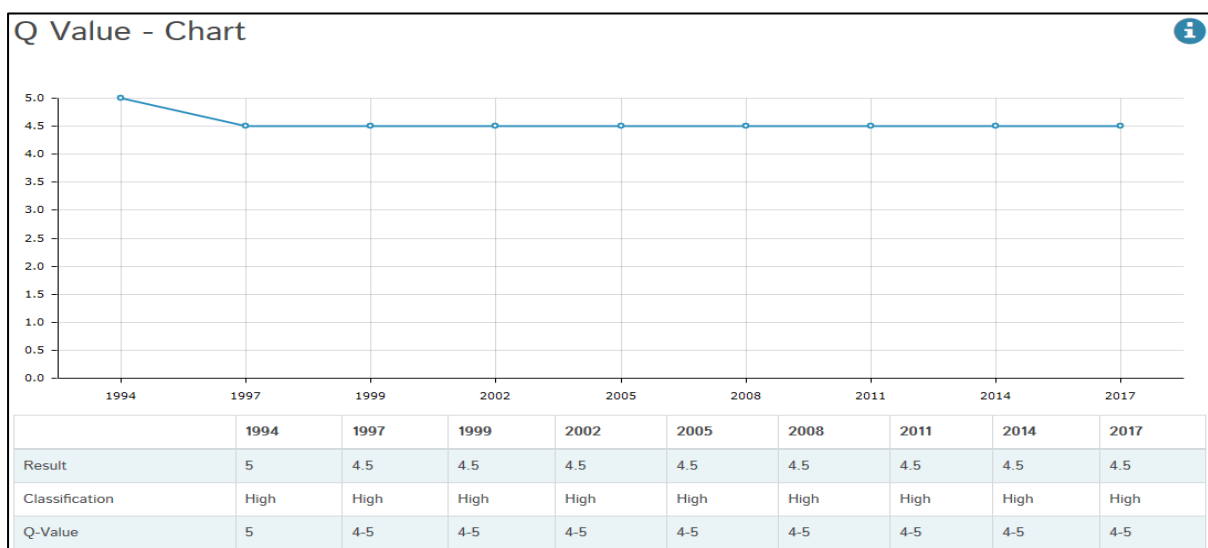


Figure 2-3: Q value, at Br N of Curraleigh, Fotherish_010

Garrane (Lee)_010 (*Not at risk*) (upstream of PAA waterbody Foherish_020)

There is one WFD operational monitoring station on Garrane (Lee)_010: Br u/s Foherish River, RS19G030200. There are no chemistry data available for this station. Biological results for the monitoring point have been consistently dropping from high to good since 1990. 2017 Q data indicates a return to high status. Q values are graphed in figure 2.4 and summarised in table 2-3.

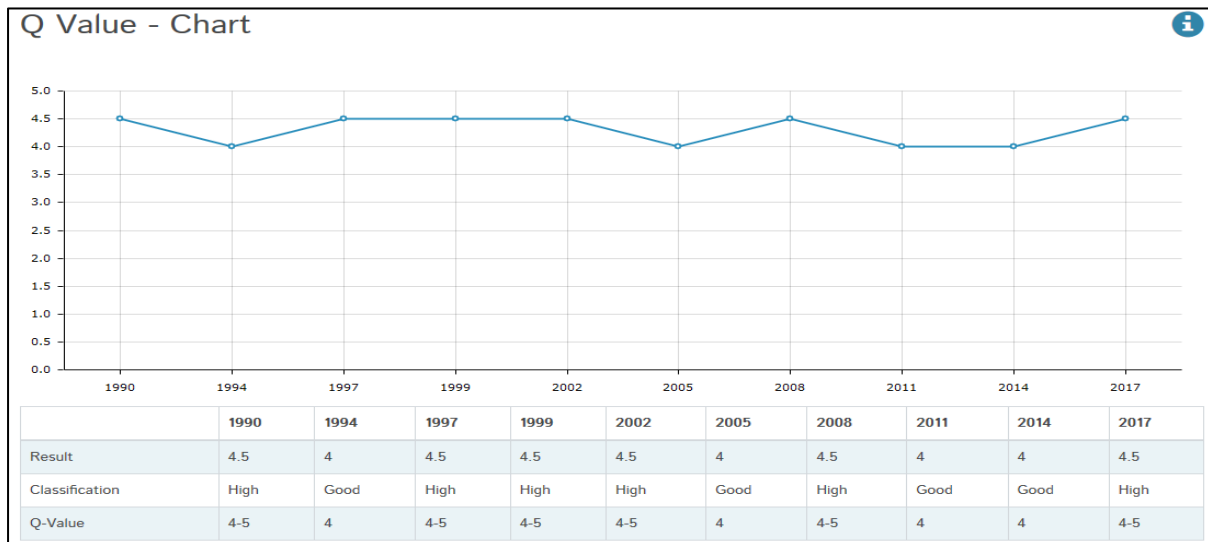


Figure 2-4: Q value, at Br u/s Foherish River, Garrane (Lee)_010

Foherish_020 (*At Risk*) (PAA waterbody)

There are two operational stations on Foherish_020: Foherish – Foherish Br, RS19F020200 and Foherish – W of Caherbirrane, RS19F020300. There are no chemistry data available for either station. Q results for the monitoring point at Foherish Br have been consistently high since 1990 (see below figure 2.5 and summarised in table 2-3).

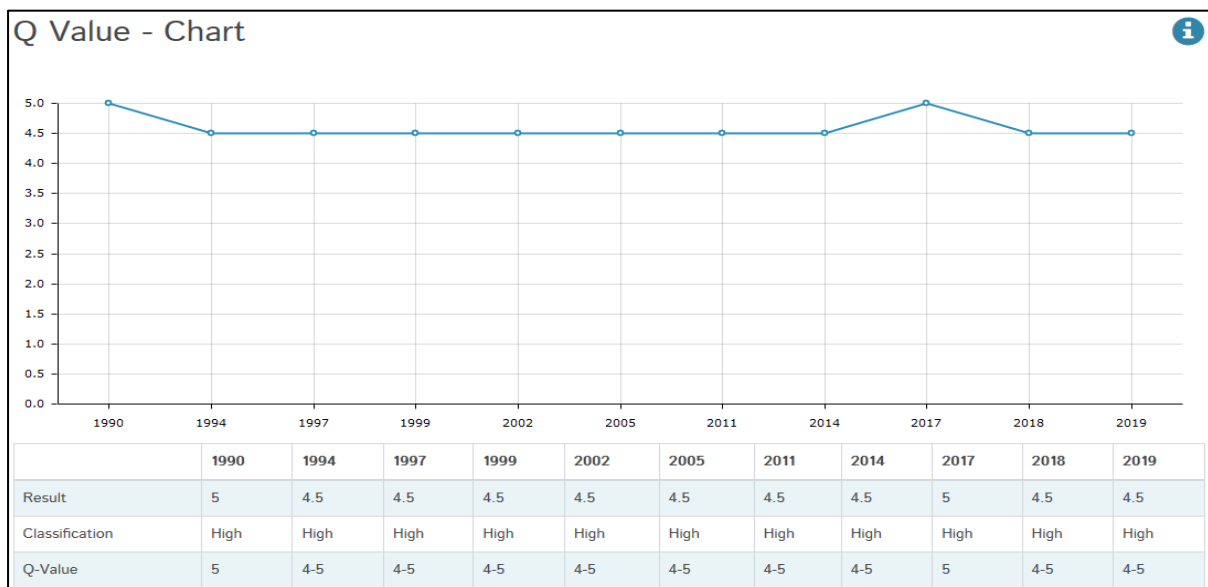


Figure 2-5: Q value, at Foherish – Foherish Br, Foherish_020

Biological monitoring results at Foherish-W of Caherbirrane deteriorated from high (Q4/5) in 2008 to good (Q4) in 2011 to 2014. 2017 and 2018 Q data indicate a return to high status. This monitoring point is located 4kms downstream of the Foherish bridge station, where no status deterioration occurred in 2011 to 2014, suggesting that the pressure responsible for the 2011-2014 deterioration did not originate in Foherish_010 or Garrane (Lee)_010 headwaters to Foherish_020. It is also possible that if the significant issue here is sediment, the sediment may have arisen in either of these headwaters but did not deposit on the river bed here due to higher flows/steeper gradient. Q values are graphed below in figure 2.6 and summarised in table 2-3.

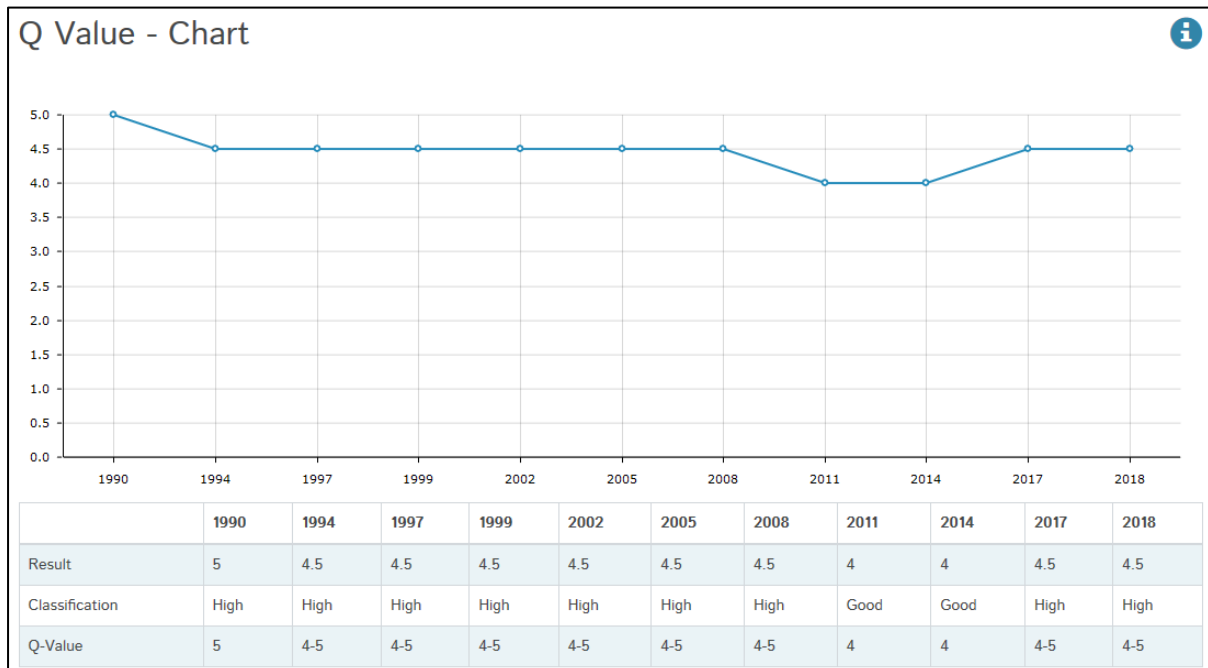


Figure 2-6: Q value, at Foherish – W of Caherbirrane, Foherish _020

Keel Foherish Priority Area for Action Desk Study

Table 2-3: Table of Q values

Water body Name	Monitoring Point	1990	1994	1997	1999	2002	2005	2008	2011	2014	2017	2018	2019
Keel_010	Keel Br	High	Good	Good	Good	High	Good	Good	Poor	Poor	Good	-	-
Foherish_010	Br N of Curraleigh	-	High	High	High	High	High	High	High	High	High	-	-
Garrane (Lee)_010	Br u/s Foherish River	High	Good	High	High	High	Good	High	Good	Good	High	-	-
Foherish_020	Foherish – Foherish Br	High	High	High	High	High	High	High	High	High	High	High	High
	Foherish – W of Caherbirrane	High	High	High	High	High	High	High	Good	Good	High	High	-

Source: EPA 2018

2.3 Hydrochemistry

Keel_010 and Foherish_020 are monitored under WFD for biology only. However the EPA undertook monitoring on both waterbodies between February 2019 and February 2020. BOD results have been generally satisfactory with all results below the good status EQS of 1.5 mg/l (annual average). Orthophosphate and ammonia levels are below the good status for both the mean and 95%ile Environmental Quality Standard (EQS) from the European Communities Environmental Objectives (surface Waters) Regulations. Results are graphed in figures 2.7 and 2.8.

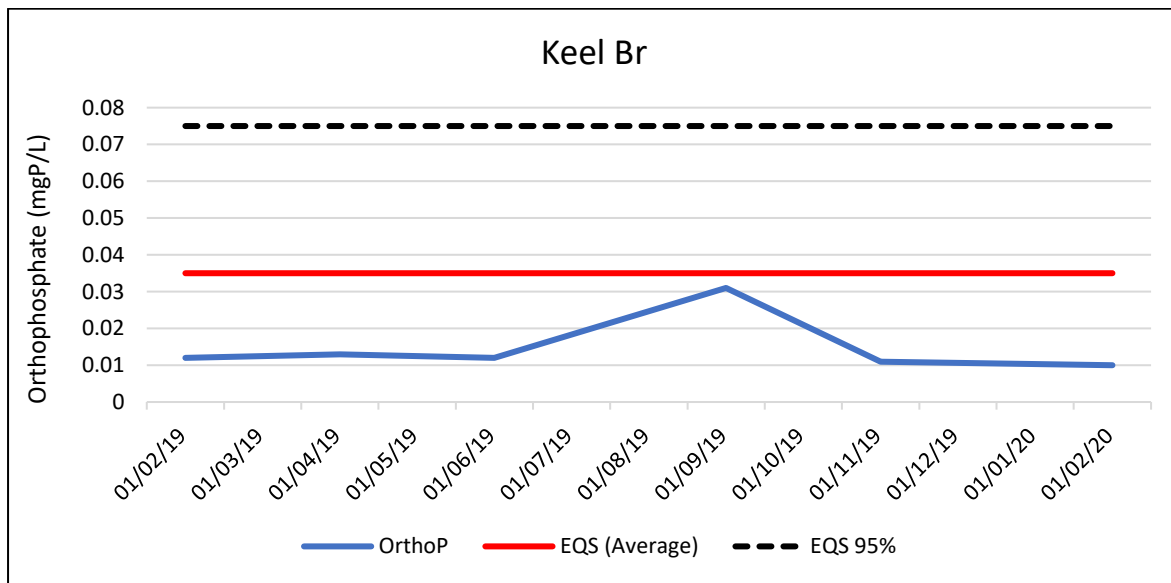


Figure 2-7: Orthophosphate results at Keel Bridge, Keel_010

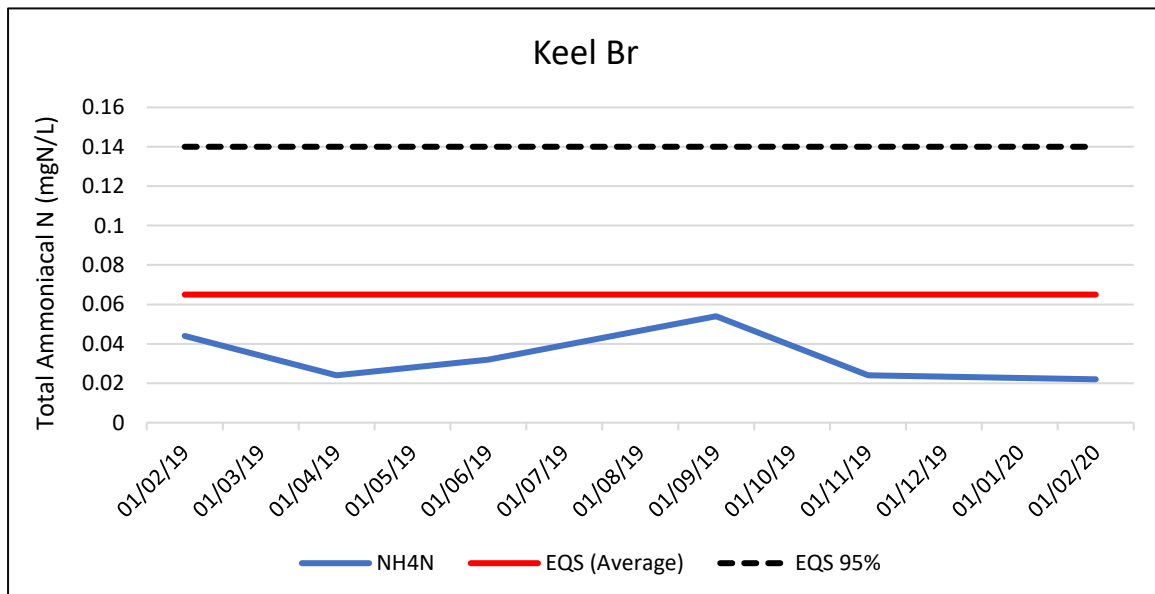


Figure 2-8: Ammonia results at Keel Bridge, Keel_010

BOD results were satisfactory, with all results below the high status EQS of 1.3 mg/l (annual average). Orthophosphate and ammonia results were also within the relevant mean EQS. Results are graphed in figures 2.9 and 2.10.

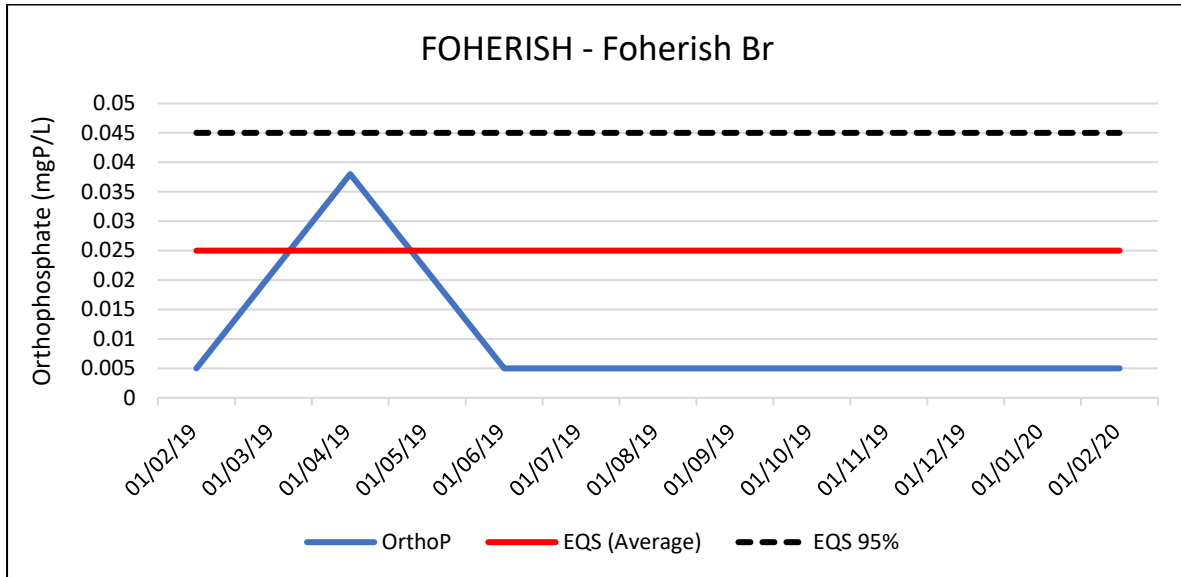


Figure 2-9: Orthophosphate results at Foherish – Foherish Br, Foherish_020

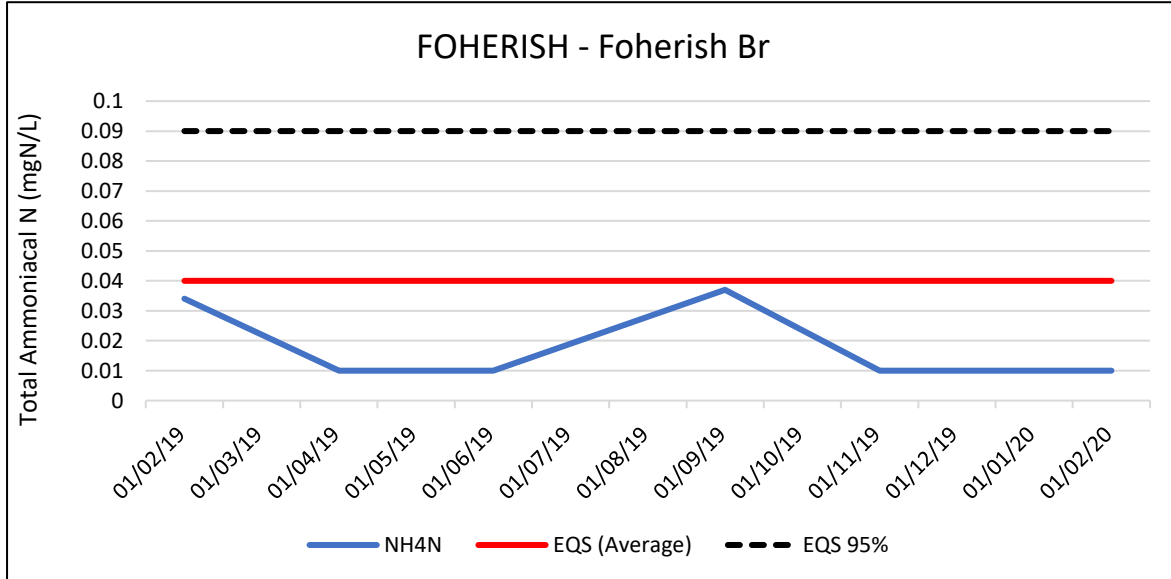


Figure 2-10: Ammonia results at Foherish – Foherish Br, Foherish_020

2.4 Hydromorphology

Table 2-4: Foherish_020 (Foherish – Foherish Br, RS19F020200) hydromorphological assessment (RHAT) score

HA	19
Station Code	RS19F020200
Local Authority	Cork County Council
WFD River Waterbody Code	IE_SW_19F020300
WFD River Waterbody Name	Foherish_020
Station Name	Foherish – Foherish Br
Easting	127983
Northing	81444
Assessment Year	2017
Fieldsheet Date	08/06/2017 09:30 AM
Visibility Upstream	50
Visibility Downstream	50
Hydromorphology Class	Good
Hydromorphology Score	0.78125
Sum Attribute Score	25/32
Channel Form Score	4 (high)
Channel Form Comments	Appears natural
Channel Vegetation Score	3 (good)
Channel Vegetation Comments	Woody habitat not optimal
Channel Substrate Condition Score	4 (high)
Channel Substrate Condition Comments	As expected, free from oil and sediment
Channel Barriers To Continuity Score	4 (high)
Channel Barriers To Continuity Comments	None visible
Bank Structure Left Score	1.5 (good)
Bank Structure Right Score	2 (high)
Bank Structure Comments	LHS DS and US poaching
Bank Vegetation Left Score	0.5 (poor)
Bank Vegetation Right Score	1 (moderate)
Bank Vegetation Comments	LHS US and DS no trees RHS US and DS trees semicontinuous
Riparian Landcover Left Score	0.5 (poor)
Riparian Landcover Right Score	0.5 (poor)
Riparian Landcover Comments	Improved grassland LHS US AND DS Improved grassland RHS US
Floodplain Connectivity Left Score	2 (high)
Floodplain Connectivity Right Score	2 (high)
Floodplain Connectivity Comments	Looks okay

Source: EPA 2018

Table 2-5: Foherish _020 (Foherish – W of Caherbirrane, RS19F020300) hydromorphological assessment (RHAT) score

HA	19
Station Code	RS19F020300
Local Authority	Cork County Council
WFD River Waterbody Code	IE_SW_19F020300
WFD River Waterbody Name	Foherish _020
Station Name	FOHERISH – W of Caherbirrane
Easting	129103
Northing	79216
Assessment Year	2017
Fieldsheet Date	08/06/2017 12:00 PM
Visibility Upstream	100
Visibility Downstream	100
Hydromorphology Class	Good
Hydromorphology Score	0.796875
Sum Attribute Score	25.5
Channel Form Score	4 (high)
Channel Form Comments	Appears natural
Channel Vegetation Score	3 (good)
Channel Vegetation Comments	Good instream vegetation though woody habitat not optimal
Channel Substrate Condition Score	4 (high)
Channel Substrate Condition Comments	No excess sediment
Channel Barriers To Continuity Score	4 (high)
Channel Barriers To Continuity Comments	None visible
Bank Structure Left Score	2 (high)
Bank Structure Right Score	1.5 (good)
Bank Structure Comments	LHS good and natural RHS minor poaching
Bank Vegetation Left Score	0.5 (poor)
Bank Vegetation Right Score	0.5 (poor)
Bank Vegetation Comments	Isolated or clumps of trees only. No canopy layers
Riparian Landcover Left Score	1 (moderate)
Riparian Landcover Right Score	1 (moderate)
Riparian Landcover Comments	Grazing, rough pasture LHS and RHS
Floodplain Connectivity Left Score	2 (high)
Floodplain Connectivity Right Score	2 (high)
Floodplain Connectivity Comments	

Source: EPA 2018

2.5 Summary of Issues

Keel_010 (*Review*)

Biological monitoring results for the operational monitoring point on Keel_010 deteriorated from good (Q4) in 2008 to poor (Q3) in 2011 to 2014. 2017 Q data indicate that it has recovered back to good (Q4) status but the cause of the deterioration between 2011 and 2014 needs to be established if possible in order to ensure that the waterbody is not at risk of deteriorating again. EPA biologists noted siltation issues in 2014 and to a lesser extent in 2017, indicating that sediment was the significant issue causing the deterioration to poor status here in 2011. There are limited chemistry data available for this waterbody. Recent results indicate that nutrients are not currently an issue; phosphate and ammonia results were below the relevant EQS's when assessed in 2019 and 2020. However no data are available on nutrient levels prior to the 2011 deterioration here.

Foherish_010 (*At Risk*, inputting waterbody, not part of the PAA)

Foherish_010 is a high status objective waterbody. Biological status has been consistently high here since monitoring commenced but ecological status is currently good due to hydromorphological condition.

Garrane (Lee)_010 (*Not at risk*, inputting waterbody, not part of the PAA)

Garrane (Lee)_010 is a good ecological status objective waterbody (*Not at risk*) but discharging to a high status objective waterbody (Foherish_020). Biological results for the monitoring point have varied between high and good from 2002 to 2017, with 2017 results at high (Q4/5). Note that good hydromorphological conditions are preventing the waterbody from achieving its high ecological status objective. There are no chemistry data available for this waterbody.

Foherish_020 (*At Risk*)

Foherish_020 is a high status objective waterbody with two WFD operational monitoring stations, Foherish – Foherish Br and Foherish – W of Caherbirrane. The Foherish Br station has been consistently at high biological status since monitoring commenced. Foherish-W of Caherbirrane was at high biological status until 2011 when it dropped to good. 2017 and 2018 Q data indicate that it has recovered back to high (Q4/5) but ecological status here is good, failing on hydromorphological condition. The RHAT assessment score for both monitoring points is poor for bank vegetation and moderate for riparian land cover. Land use in the vicinity of both stations is under agriculture. The hydromorphological issues need to be addressed in order for the waterbody to achieve its high status objective.

The cause of the deterioration in biological status between 2011 and 2014 also needs to be investigated to ensure that the waterbody is not at risk of deteriorating again. Given that biological monitoring results at the upstream station 'Foherish Bridge' have been consistently high (and Q5 in

2017), it is likely that the pressure driving the 2011 deterioration at 'Foherish-W of Caherbirrane' originated either in Keel_010 or in Foherish_020, between the confluence with Keel_010 and the lower (Foherish-W of Caherbirrane) station. Limited chemistry data for the monitoring station at Foherish Br indicate that nutrients are not currently an issue at this location. However no data are available for the downstream station 'Foherish-W of Caherbirrane' where the water quality deterioration occurred. Biologists noted moderate siltation at Foherish-W of Caherbirrane in 2014, suggesting that sediment was the significant issue driving the status deterioration. If this is the case, the possibility of sediment arising upstream of Foherish Bridge can't be ruled out at desk study stage as it is possible that sediment doesn't settle out of the water column until downstream of Foherish Bridge. The catchment sediment accumulation maps indicate variable sediment accumulation upstream of Foherish br (see figure 9.7). It is more likely though that 2011 sediment issues in Foherish_020 would have been associated with upstream forestry activities, possibly from Keel_010 and/or from the windfarm development. There are areas of pasture on peat in the catchment, which may also have caused sediment and possibly nutrient (ammonia and phosphate) loss to surface waters in the past. The surface phosphate PIP map indicates some very high/high areas for risk of diffuse sources of phosphate along the main river channel (see figure 9.2) although these are very small in terms of the overall sub-basin area.

3 Significant pressures

3.1 Initial EPA characterisation

Table 3-1: Initial EPA characterisation

Waterbody Name	Id	Category	Sub Category	Name	Significant	Pressure & Impact details	Impact Assessment
Keel_010	WBP0004294	Forestry	Forestry	n/a	Yes	Altered habitat due to Morphological changes	SLAMv2.04 P Forestry 43%. Forestry is planted on poorly drained soils. Moderate siltation was recorded during the 2014 survey for biological status. Aerial photography indicates recent felling.
	WBP0005749	Anthropogenic Pressures	Unknown	n/a	Yes	Altered habitat due to Morphological changes	Cork County Council reported that a windfarm was developed in the Keel_010 subbasin. Moderate siltation was recorded during the 2014 ecological survey. Comments on risk associated with forestry felling and construction in the development phase and road drainage, maintenance of silt traps and changes to hydrology post construction.
Foherish_010	WBP0008202	Hydromorphology	Overgrazing	n/a	Yes	Altered habitat due to Morphological changes	Not a true decline in conditions, as hydromorphology wasn't surveyed in previous cycle. Recent information indicates hydromorphology is preventing the WB from achieving its HESO. The 2017 RHAT survey highlighted bank vegetation and riparian conditions (no continuous canopy and improved grassland right up to the bank top on pastures) are keeping the WB from achieving high status.
Garrane (Lee)_010	-	-	-	-	-	-	-
Foherish_020	WBP0005391	Forestry	Forestry	n/a	Yes	Altered habitat due to Morphological changes	Pressure from inputting RWB, Keel_010. Station 19F020300 driving status (good). STATION~200 is High - Q values SLAMv2.04 P Forestry 43%. Forestry is planted on poorly drained soils. Moderate siltation was recorded during the 2014 survey for biological status. Aerial photography indicates recent felling.
	WBP0005649	Anthropogenic Pressures	Unknown	n/a	Yes	Altered habitat due to Morphological changes	Cork County Council reported that a windfarm was developed in the Keel_010 subbasin. Moderate siltation was recorded during the 2014 ecological survey. Comments on risk associated with forestry felling and construction in the development phase and road drainage, maintenance of silt traps and changes to hydrology post construction. Station 19F020300 driving status (good). STATION~200 is high - Q values.

3.2 Conclusions on the Significant Pressures

Keel_010 (*Review*)

The WFD initial characterisation identified forestry and anthropogenic pressures (windfarm development) as the significant pressures on Keel_010, driving the deterioration from good status (Q4) in 2008 to poor (Q3) in 2011 to 2014. Cork County Council staff have advised LAWPRO that the windfarm is located in Foherish_020 but the access road is in Keel_010 approximately 1km upstream of the WFD monitoring point. If there is direct connectivity between the access road and the river (via road drains on the L7442) then it is possible that sediment may have been lost to the river during the windfarm road construction. The extent of forested areas in Keel_010 is quite small and most of the land use is under agriculture (pasture) (see figure 9.6). There are small areas of pasture on peat in the catchment, carrying the risk of sediment and possibly nutrient (ammonia and phosphate) loss to surface waters. There is a PIP rank 1 area for surface P loss just upstream of the WFD monitoring point. Land use and land management, including forestry, agriculture and the windfarm access road must be investigated to try to identify the reason for the 2011 deterioration here.

Foherish_020 (*At Risk*)

The WFD App lists the significant pressures on Foherish_020 as forestry and anthropogenic pressures. The waterbody's good hydromorphological condition is preventing it achieving high ecological status (biological status is high). The hydromorphological issues appear to be related to agricultural land use.

It is difficult to conclude on the significant pressure/s causing the earlier status deterioration in this waterbody. Forested areas are small here. Land use maps show that the bulk of Foherish_020 is under agriculture. There are areas of pasture on peat in the catchment, carrying the risk of ammonia, phosphate and sediment loss to surface waters. The surface phosphate PIP map indicates very high/high areas for risk of diffuse sources of phosphate along the main river channel (see figure 9.2) although these areas are small, associated with the river alluvium. It is also possible that sediment loss associated with windfarm construction may have contributed to or been responsible for the 2011 deterioration in Foherish_020.

4 Pathways Information (diffuse pollution)

4.1 Conceptual Model Development

The conceptual model is based largely on a combination of land use, soil type, PIP maps (and susceptibility maps). The inputs from larger point sources (such as the forestry and the windfarm development) also need to be assessed in the local catchment assessment process. Available results indicate that sediment (possibly also associated with orthophosphate and/or ammonium) are the significant issue(s) in the PAA. Land use and management must be investigated. This should include agriculture, land drainage and forestry activities which may be causing the sediment issues here. Flow paths for pollutant transfer are likely to be via diffuse overland flow and land drains with contribution from point sources (forestry and the windfarm development). The surface Phosphate PIP map (see figure 9.2) has areas of very high/high PIP rank which are along channels in agricultural use in this PAA and these areas should be the focus for stream walks in assessing phosphate loadings. Sediment (possibly also associated with orthophosphate and/or ammonium) from forestry and agriculture is the likely significant issue as the corine land usage map (see figure 9.6) indicates pastures/forestry on peaty soils. Pathways will be via diffuse and land drains. Note that there are a few areas of well-draining soil (AminDW, AminSW) and this corresponds with the surface NO3 PIP map. The phosphate contribution via this pathway is likely to be insignificant.

In terms of the critical source areas and pathways for diffuse pollution, the PAA has been divided into three compartments based on soil type. Soils in compartment 1 are poorly draining, compartment 2 are peat and compartment 3 are well draining. The conceptual model is shown in figure 4.1 with details provided in table 4.1.

Conceptual Model Map

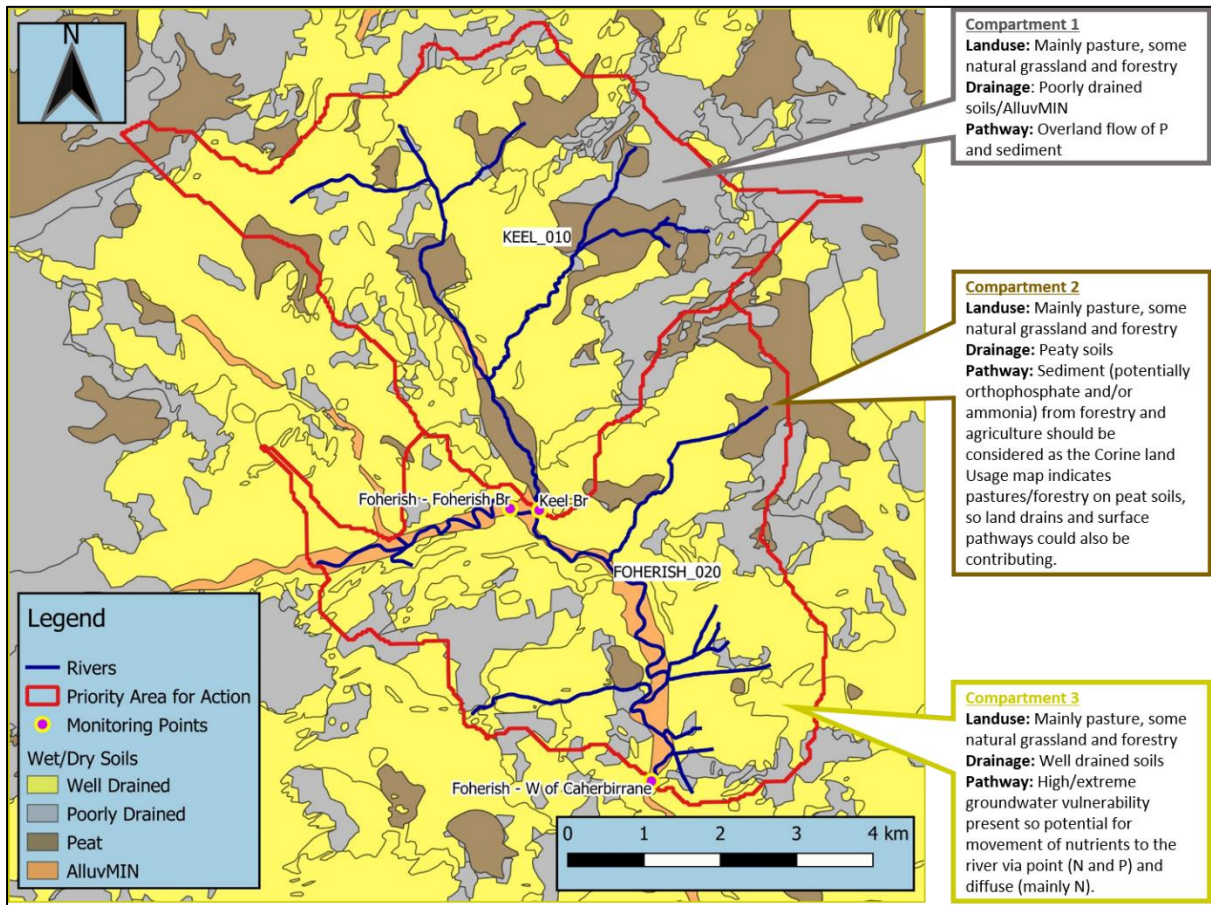


Figure 4-1: Conceptual Model

Compartment 1 corresponds to the poorly draining soil and there are areas of alluvium soil as can be seen in figure 4.1. The main flow paths including drains are diffuse overland flow for surface phosphate (and potentially sediment). The surface phosphate susceptibility map has moderate/high ranking in this PAA and these areas should be the focus for stream walks in assessing phosphate (and potentially sediment) loadings (see figure 9.3).

Compartment 2 corresponds to the peaty soils. Sediment (possibly also associated with orthophosphate and/or ammonium) from forestry and agriculture is the likely significant issue as the corine land usage map (see figure 9.6) indicates pastures/forestry on peat soils. Pathways will be via diffuse and land drains. There is also increased possibility of orthophosphate from point sources connected by drains/pipes to streams. Felling records would be useful to establish the timeframe extent of forestry for this waterbody to assist in determining whether forestry is a significant pressure here. This indicates sediment (possibly also associated with orthophosphate and/or ammonium). The surface Phosphate PIP map (see figure 9.2) has areas of high PIP Rank in this compartment and these areas should be the focus for stream walks in assessing phosphate loadings upstream.

Compartment 3 (well-draining soil) covers more than two-thirds of the PAA. This compartment corresponds to the well-drained soil and this corresponds with the surface nitrate PIP map (see figure 9.1). The main flowpaths in these areas are near surface recharge via outcrops. There may be limited phosphate contribution via this pathway but it is likely to be insignificant in comparison to the overall loadings on the catchment.

In summary, considering that sediment (potentially phosphate and/or ammonia) are the significant issue(s) in this PAA, compartments 1 and 2 are of most significance in terms of pollutant pathways, with overland flow and land drains being the most likely pathways for sediment (and phosphate). Most of the losses are expected during/after periods of heavy rainfall.

Table 4-1: Conceptual model

Factor	Map Y/N	Description and relevance		
		Compartment 1	Compartment 2	Compartment 3
Location	y	This compartment corresponds to poorly drained soil and alluvium	This compartment corresponds to peat	This compartment corresponds to well drained soil
Topography		Very rugged		
Soil type	y	AminDW (deep well drained soils), AlluvMIN (mineral alluvium), AminPDPT (Poorly drained soils with peaty topsoil), AminSP (shallow poorly drained soils), AminSRPT (shallow, lithosolic-podzolic type soils potentially with peaty topsoil)	BktPt (blanket peats)	AminDW (deep well drained soils), AminSW (shallow well drained soils)
Subsoil type		TDSs (sandstone till devonian), RckNCa (bedrock at surface-non calcareous), A (alluvium undifferentiated)	BktPt (blanket peats)	TDSs (sandstone till devonian), RckNCa (bedrock at surface-non calcareous)
Subsoil permeability		Mostly subsoil less than 3 metres and some moderate	Moderate and subsoil less than 3 metres	Mostly subsoil less than 3 metres and some moderate
Soil drainage	y	Poorly drained soil	Peaty soil	Well drained soil
Gwb		Ballinhassig		
Gwb flowpath		Flow occurs along fractures, joints and faults. Flows in the aquifer are generally concentrated in a thin zone at the top of the rock, although deeper groundwater flows along faults and major fractures. Diffuse recharge occurs across the groundwater body through the subsoils and rock outcrops. The water table can vary from a few metres up to more than 10 m below ground surface, depending upon topography. Groundwater is generally unconfined. Flow path lengths are generally short, ranging from 30-300 m. Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps.		
Bedrock unit		Devonian Old Red Sandstones		
Aquifer type		LI (Locally important aquifer which is moderately productive only in local zones)		
Groundwater vulnerability		Mostly X and extreme; some areas of high and moderate	Mostly extreme and high; some areas of moderate	Mostly extreme, some areas of high and X, localised areas of moderate

Keel Foherish Priority Area for Action Desk Study

Factor	Map Y/N	Description and relevance		
		Compartment 1	Compartment 2	Compartment 3
PO4 susceptibility (surface)	y	Mainly moderate on the poorly drained soil and high on the alluvium.	Moderate/high	Low
NO3 susceptibility (sub surface)		Very low	Very low	Mostly low
NO3 susceptibility (surface)		Low on the poorly drained soil and high/moderate along alluvial river channel	Low	Moderate/high on the well drained soil. Locally very high on the outcrops.
Po4 PIP (Surface water)	y	Mainly moderate (rank 4 and 5) on the poorly drained soil and high (rank 2 and 3) along alluvial river channel. Some low as there is forestry.	Very high/ high (rank 1 and 3) in agriculture use, some low as there is forestry.	Mainly very low/low (rank 6 and 7) as well drained in agriculture.
NO3 PIP (ground water)		Mainly very low (rank 7)	Mainly very low (rank 7)	Mainly very low (rank 6 and 7)
NO3 PIP (Surface water)	y	Very low (rank 6 and 7) on the poorly drained soil and high/moderate (rank 3, 4 and 5) along alluvial river channel	Mainly very low (rank 7)	Mainly high/very high (rank 1, 2 and 3) on the well drained soil
Likely main pathway(s)		Overland flow (including land drains) of P and sediment	Overland flow (including land drains) of orthophosphate, ammonia and sediment	Near surface and shallow groundwater flow. Some recharge via outcrops.

5 Interim conclusions on the PAA

Keel_010

- Keel_010 is a good status objective waterbody, currently at good ecological status and categorised as at *Review*.
- Biological status deteriorated from good (Q4) in 2008 to poor (Q3) in 2011 - 2014 but returned to good status (Q4) in 2017 EPA monitoring survey.
- The reason for the 2011 deterioration needs to be established if possible in order to ensure that the waterbody is not at risk of deteriorating again.
- Keel_010 is not monitored for chemistry under WFD but six monitoring rounds were undertaken by the EPA in 2019 and 2020. Results indicate that nutrients are not currently an issue here.
- Sediment is likely be the significant issue which drove the 2011 deterioration in this waterbody, from biologists' observations at the time.
- The WFD App characterises the significant pressures for Keel_010 as forestry and anthropogenic pressures (windfarm access road). Sediment loss to the waterbody may have arisen due to forestry (clearfelling) and/or to windfarm road construction.
- Agriculture may also possibly have contributed to the 2011 water quality deterioration here; corine land use and soil maps show areas of pastures on poorly draining soils and surface P PIP maps indicate high rank areas upstream of the WFD monitoring point.

Foherish_020

- Foherish_020 is at good ecological status but is a high ecological status objective waterbody and is currently categorised as *At Risk*.
- There are two WFD monitoring stations on the waterbody: Foherish Bridge which is located approximately 250m upstream of the confluence with Keel_010 and Foherish-W of Caherbirrane, located close to the waterbody outlet. Biological status at Foherish Bridge has been consistently high since 1990. Biological status at Foherish-W of Caherbirrane deteriorated from high (Q4/5) in 2008 to good (Q4) in 2011 and 2014 but had returned to high (Q4/5) in 2017.
- Foherish_020 is not monitored for chemistry under WFD but six monitoring rounds were undertaken by the EPA in 2019 and 2020, at Foherish Bridge. Results indicate that nutrients are not currently an issue here. No data are available for Foherish-W of Caherbirrane where the 2011- 2014 deterioration occurred.
- Hydromorphology condition (surveyed at both monitoring stations in 2017) is preventing the waterbody from achieving high ecological status. RHAT scores for the waterbody were 'good' in 2017 and it is therefore still categorised as *At Risk*.
- Agriculture is currently a significant pressure here; landuse pressures associated with improved pasture are contributing to the less than high RHAT scores for both WFD monitoring sites.
- The reason for the 2011 deterioration in biological status needs to be established if possible, to protect against future deterioration.
- The WFD App lists forestry and anthropogenic pressures (windfarm development) as the significant pressures on the waterbody driving the 2011-2014 deterioration here.
- Sediment is likely to be the significant issue which drove the biological status deterioration in this waterbody between 2011 and 2014.

- Sediment loss to the waterbody may have arisen due to forestry activities in Keel_010 or Foherish_020. Windfarm construction may also have contributed to sediment loss to Foherish_020.
- Flow paths for sediment transfer are via diffuse overland flow and land drains.

6 Workplan

6.1 EPA further characterisation actions

Table 6-1: EPA further characterisation actions

WB Name	Id	Action	Responsible Organisation	Further Characterisation Action details
Keel_010	FC002741	IA7 Multiple Sources in Multiple Areas	Local Authority Waters Programme (LAWPRO)	Local catchment assessment on sources of sediment from forestry and windfarm development. To include, drainage from forested area, road drainage associated with wind farm development, maintenance of silt traps and changes to the hydrology of the area.
Foherish_010	-	-	-	-
Garrane (Lee)_010	-	-	-	-
Foherish_020	FC002742	IA1 Provision of Information	Local Authority Waters Programme (LAWPRO)	Monitor for an improvement in biological status following local catchment assessment and implementation of measures in Keel_010.

The estimated resource for this local catchment assessment (from the EPA's initial estimates) is 48 days.

6.2 Additional Information Requirements

- Contact local forest service advisor regarding felling history in the catchment. Felling records from 2011 and earlier would be useful.

6.3 Local Catchment Assessment

Field investigations to be undertaken at the following locations as outlined below and as shown on figures 7.1 and 7.2. The assessment will commence in the Keel_010 headwaters as the 2011 deterioration on Foherish_020 may have been driven by pressures impacting on Keel_010.

Keel_010

Keel_010 dropped from good to poor status in the 2011 monitoring round. It returned to good status (its WFD objective) in 2017. However, limited assessment is needed to i) confirm whether the site is still at good status and if not, to identify the pressures currently impacting on water quality here and ii) to try to determine the cause of the 2011 deterioration.

- i) SSIS or rapid assessment and field parameter assessments should be undertaken at the WFD monitoring station, Keel Br on the Keel_010 to determine whether any change has occurred since the 2017 EPA monitoring round. If biological status at the monitoring station is less than good, take note of sediment extent and type both upstream and downstream of the monitoring point. Continue with SSIS/rapid assessment and measurement of field parameters to assess individual inflow tributaries. These assessments will help rule tributaries in or out in terms of potential for downstream impact. Assess stream bed sediment extent and type and look for evidence of nutrient issues. There is pasture directly along the main river channel and this is a high/very high phosphate PIP area due to the peaty soils. If LCA results are indicative of sediment impact, walk upstream on each tributary to assess potential sediment sources, focussing on lands downstream of forested areas and downstream of the windfarm site. Take note of recently felled or replanted areas in the waterbody. If nutrients appear to be an issue, nutrient sampling will be required to identify those tributaries which are contributing elevated nutrients to the monitoring point. Undertake three rounds of nutrient sampling at the WFD monitoring point in low, high and moderate flow conditions. Take note of hydromorphological changes and sources of sediment. Assess potential sediment runoff from forest clearfelling areas. Felling records are also important. Otherwise focus on diffuse runoff from high/very high phosphate PIP areas.
- ii) Walk upstream along the public road, from the WFD monitoring point on Keel_010 to the windfarm access road, looking for connectivity between the road and the river (i.e. road drains which might have provided a pathway for runoff of sediment-laden stormwater to the river when the windfarm road was originally constructed).

Foherish_020

The purpose of the local catchment assessment on Foherish_020 is three-fold: i) to confirm whether the RHAT scores for both monitoring stations are still at less than high, ii) to confirm whether biological status remains high at both monitoring stations and if not to identify the reasons for the current deterioration, iii) to try to identify the reasons for the earlier (2011 to 2014) biological status deterioration here.

- i) Undertake RHAT assessment at both WFD monitoring stations. Check if the condition of the riparian structure and riparian vegetation has improved at both stations. Record all relevant details and take photographs so that a detailed referral can be prepared if score is less than high.
- ii) Undertake SSIS assessments at both monitoring stations to determine whether any change has occurred since the last EPA monitoring round in 2018/2019. If results are indicative of less than high status or sediment appears to be an issue, continue with SSIS/rapid assessment and field parameters to assess individual inflow tributaries. These assessments will help rule tributaries in or out in terms of potential for downstream impact. Also assess stream bed sediment extent and type at all sites. There is pasture directly along the main river channel and this is a high/very high phosphate PIP area due to the peaty soils. If LCA results are indicative of sediment impact, walk upstream on each tributary to assess potential sediment sources, focussing on lands downstream of forested areas and downstream of the windfarm site. Felling records are also important. Take note of recently felled or replanted areas in the waterbody. If the local catchment assessment results are indicative of nutrient impact, undertake nutrient monitoring (orthophosphate and ammonium in particular) on all impacted

tributaries and at the WFD monitoring points. Otherwise plan to undertake three rounds of nutrient sampling at the WFD monitoring points in low, high and moderate flow conditions.

iii) If results at both monitoring stations on Foherish_020 indicate that biological status remains high here, the LCA focus will be to try to determine the reason for the 2011-2014 deterioration. It may not be possible to conclude on this because water quality improvements occurred as far back as 2017. However, Foherish_020 is a high status objective waterbody so it is important to try to identify the pressure driving this earlier deterioration to ensure that the waterbody is not at risk. Undertake a stream walk on the main channel upstream of monitoring point 'Foherish - W of Caherbirrane' to the confluence with Keel_010. Carry out SSIS/RA and note field parameters at all locations. Record sediment extent and type. Focus first on the main channel because the 2011-2014 deterioration on Foherish_020 may be linked to the upstream deterioration on Keel -010 which occurred in the same time period. If no issues are identified between these locations, extend the catchment walk upstream of Foherish bridge to look for evidence of any sediment issues in this part of the sub-basin. Also look for connectivity between the wind farm site and the river (ie drains/streams).

The initial information gathered by the local catchment assessment team will inform further, more targeted, assessments where required. Where significant pressures are identified, appropriate mitigation measures will be discussed and referred to the relevant agency.



Figure 7-1: Sample locations for Keel_010



Figure 7-2: Sample locations for Foherish_020

7 Review of possible mitigation options

The EPA initial characterisation information and desk study findings identified forestry and windfarm development as the likely significant pressures in this PAA. Sediment is the most likely significant issue but nutrients may also be an issue. The aim of the local catchment assessment process is to confirm the significant pressure(s) and issue(s) and help to inform the nature of the mitigation measures required.

If forestry is confirmed as a significant pressure, improved management will be required e.g. silt traps/drain blocking/carefully managed felling to reduce sediment (and nutrient) loss via surface pathways. If agriculture is identified as a significant pressure in this catchment, LA Waters staff will work with the relevant ASSAP advisors to identify appropriate mitigation measures.

8 Communications

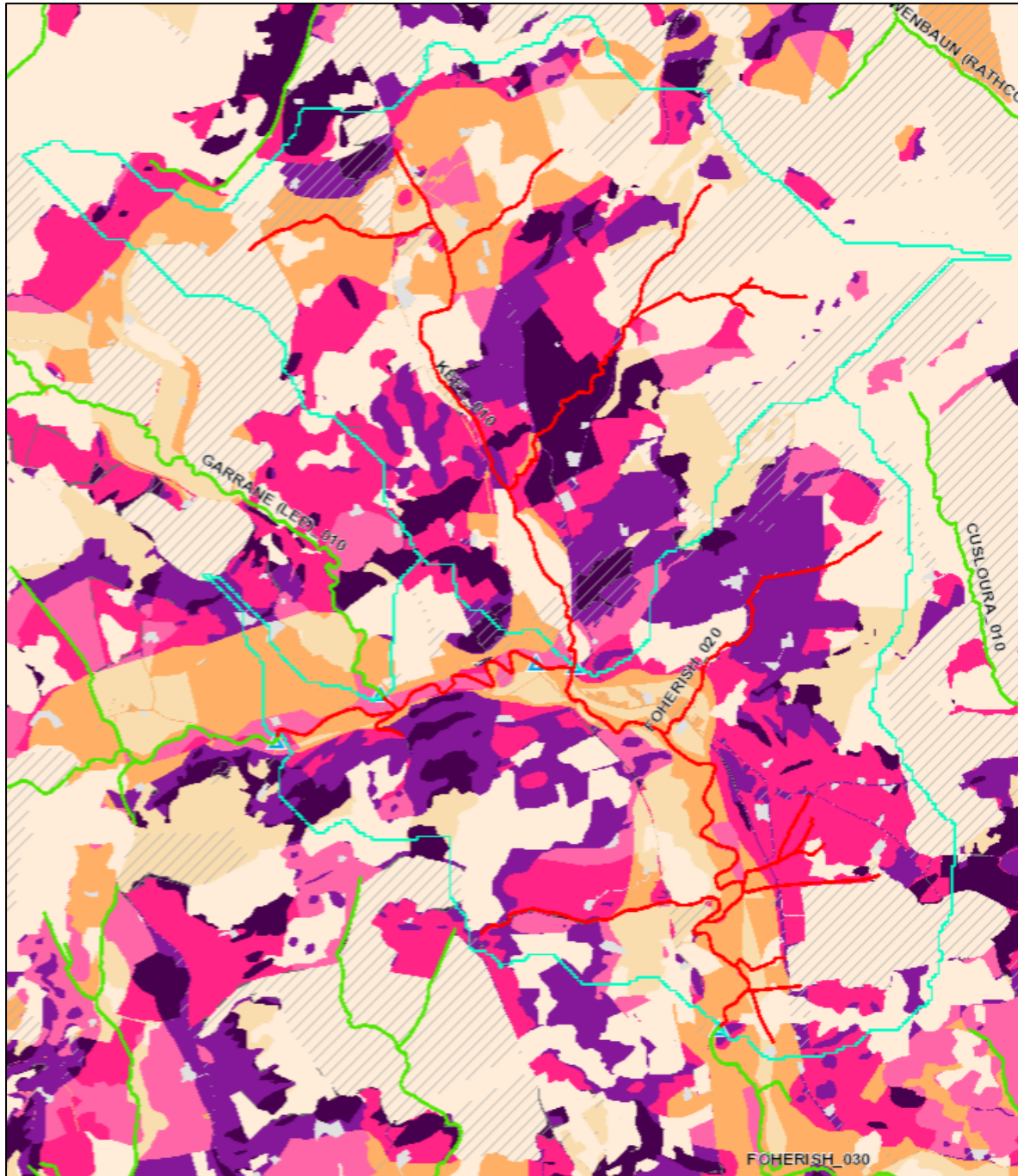
- A public meeting was held via Zoom on the 27th of October 2020.
- The normal LAWPRO approach of public meetings in the local community was not an option due to Covid 19 concerns. Instead a virtual meeting for this PAA was held, supported by newspaper notice and public information leaflets which were distributed in the local community in advance of the meeting.
- The meeting was attended by members of Cork County Council and Agricultural Sustainability Support and Advisory Programme (ASSAP). There were no attendees from the public but the meeting was recorded and the meeting link is now available on the waters and communities website.
- According to the EPA initial characterisation, significant pressures include forestry and the windfarm development. Agriculture also needs to be assessed as a potential significant pressure in Foherish_020 due to the RHAT scores.

Key messages for this PAA

- The Keel Foherish Priority Area for Action comprises the river waterbodies Keel_010 and Foherish_020.
- Both waterbodies deteriorated from their WFD objectives in 2011.
- Water quality in Keel_010 improved in 2017 and it is now meeting its WFD objective.
- Foherish_020 is also now meeting its WFD objective in terms of biological status but hydromorphological pressures are preventing it from achieving high ecological status.
- Forestry and anthropogenic pressures may have caused the 2011 deterioration in both waterbodies.
- LAWPRO focus will try to confirm the reasons for the earlier deterioration (if possible) and will identify and assess the current hydromorphological impacts in Foherish_020.
- The LAWPRO team will work with the relevant stakeholders to address any issues identified.

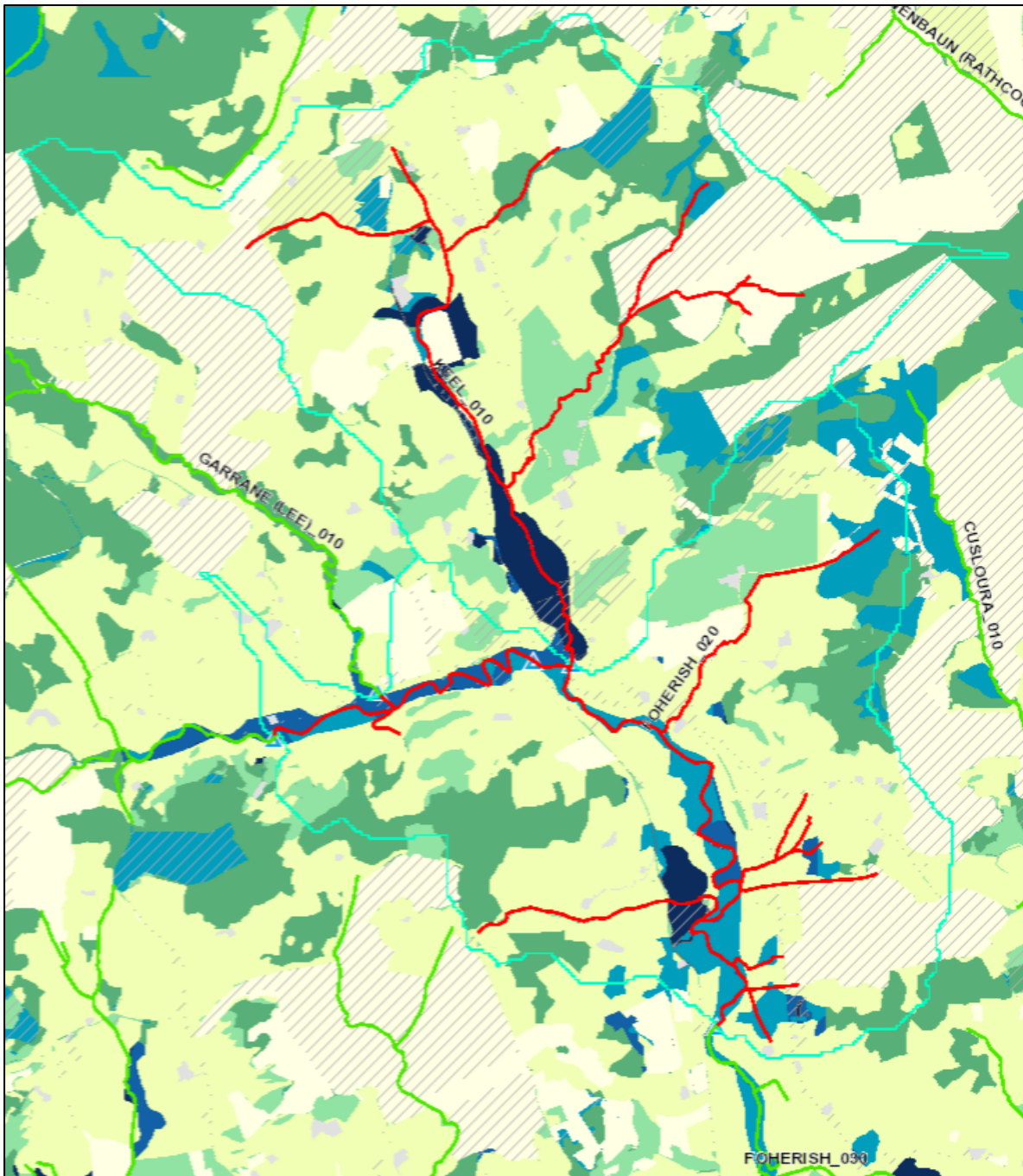
Date of completion of the desk study: 11th of February 2021

9 Appendices



Source: EPA 2016

Figure 9-1: Pollution impact potential: surface water receptor nitrate PIP Map

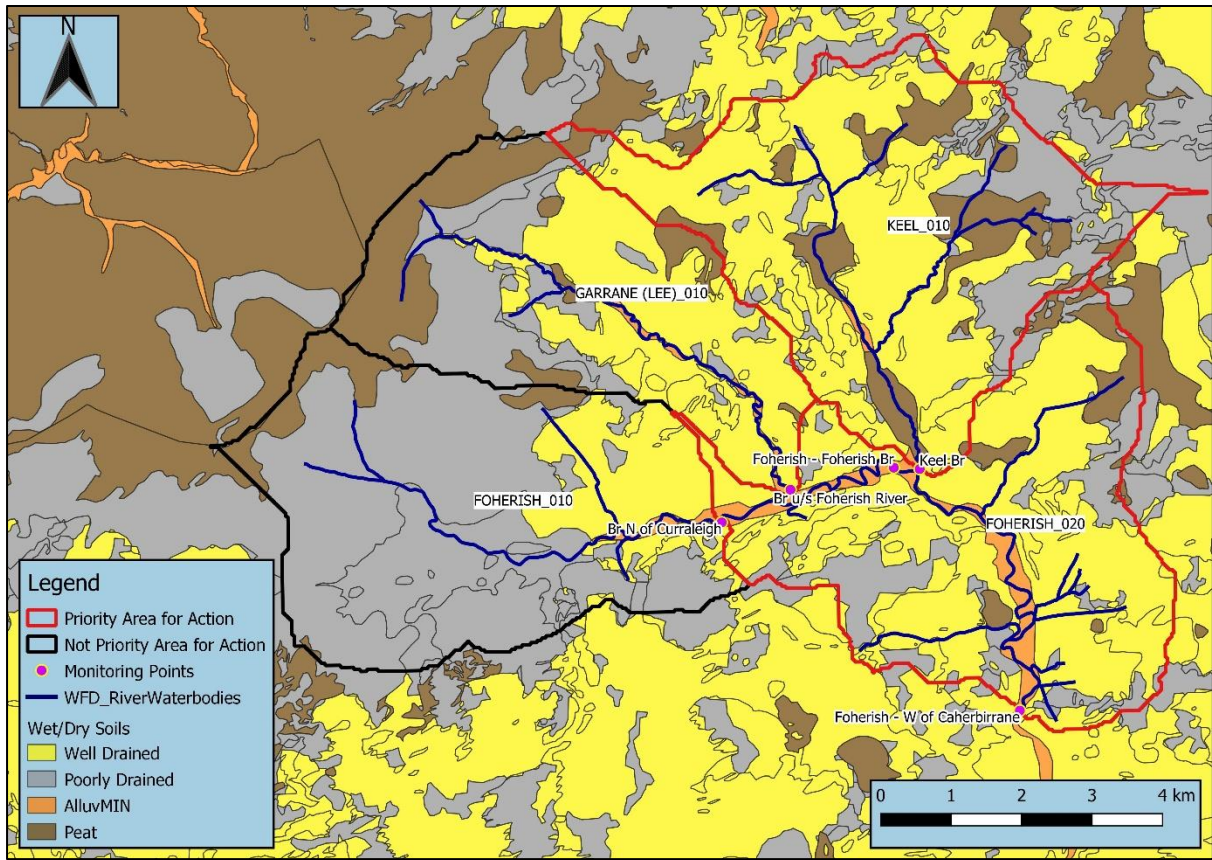


Source: EPA 2016

Figure 9-2: Pollution impact potential: surface water receptor phosphate PIP Map

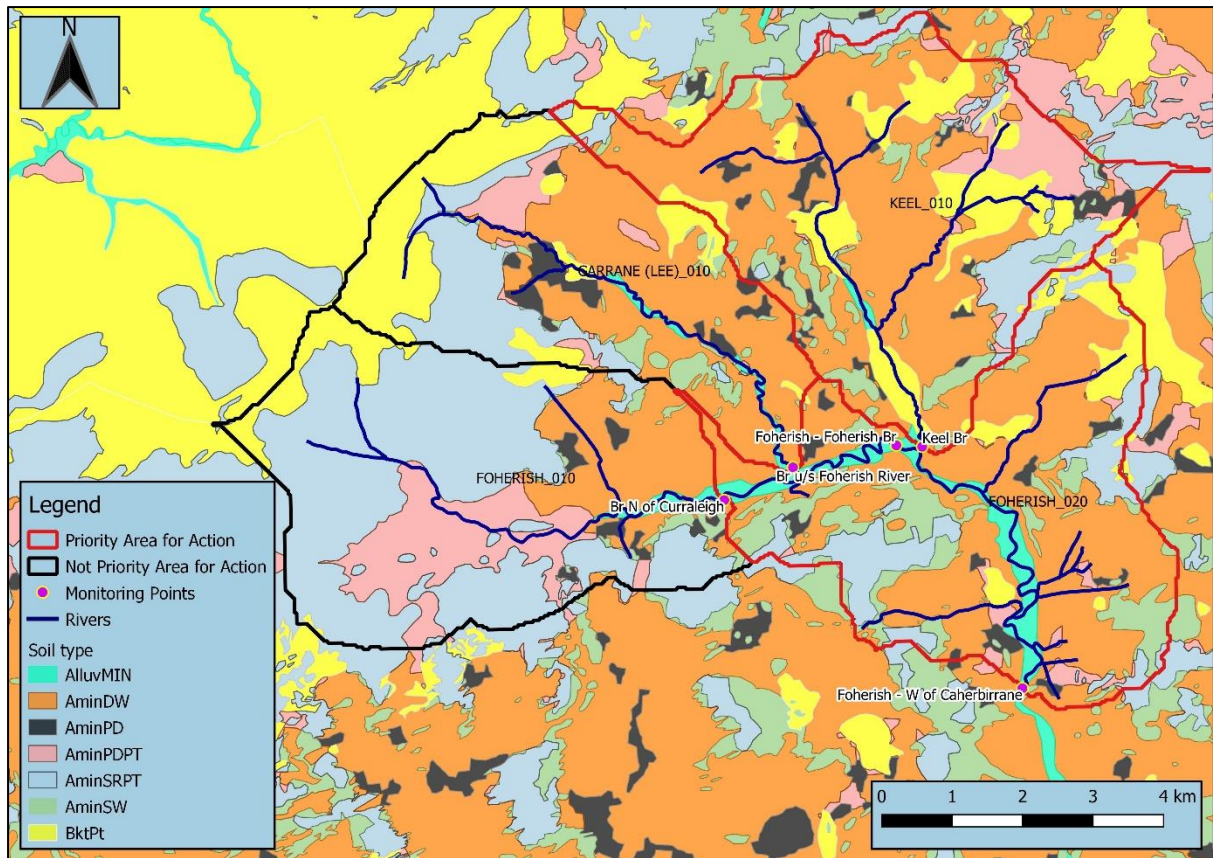


Figure 9-3: Near Surface Phosphate Susceptibility



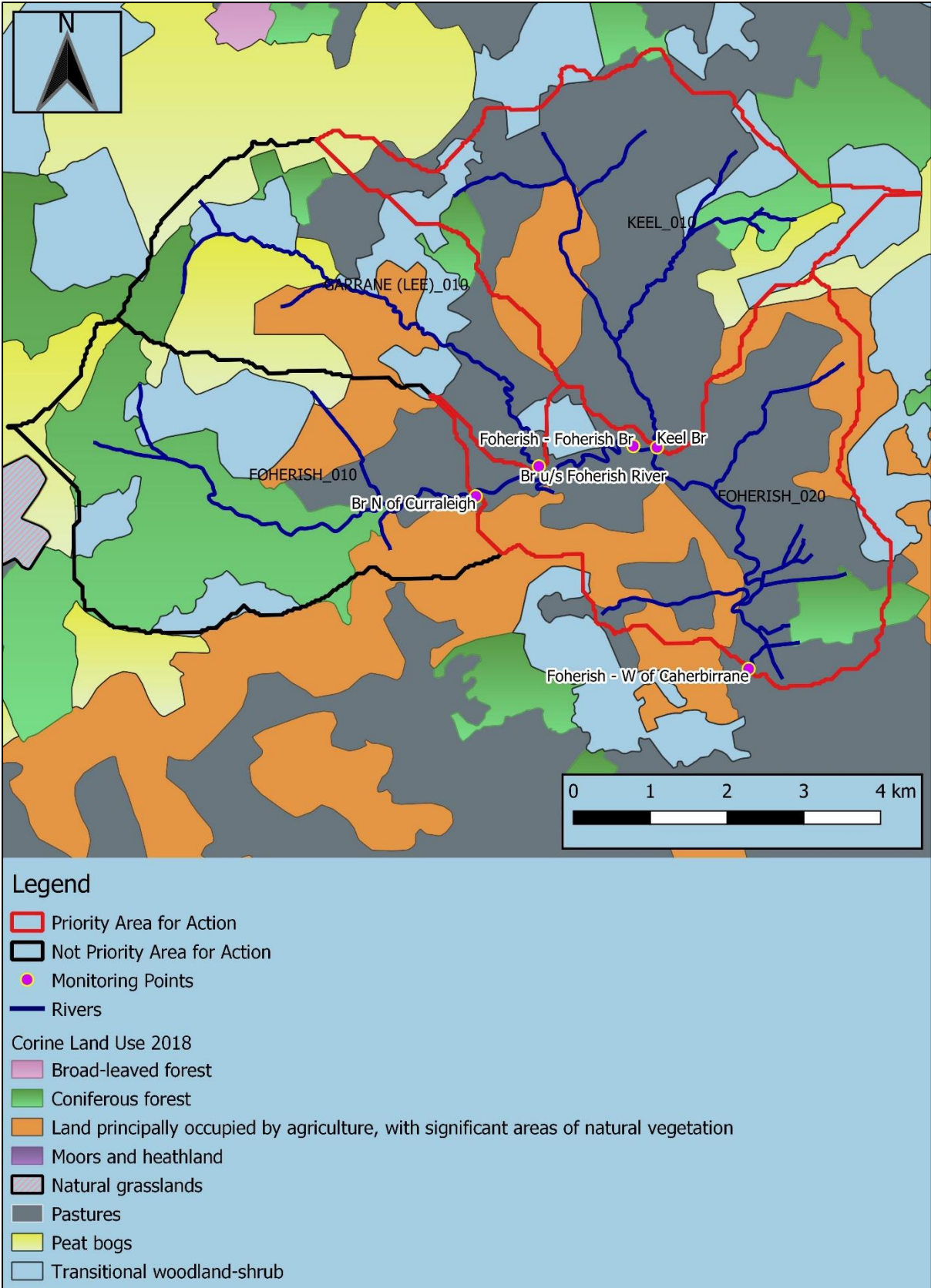
Source: Teagasc-EPA

Figure 9-4: Soils Wet/Dry



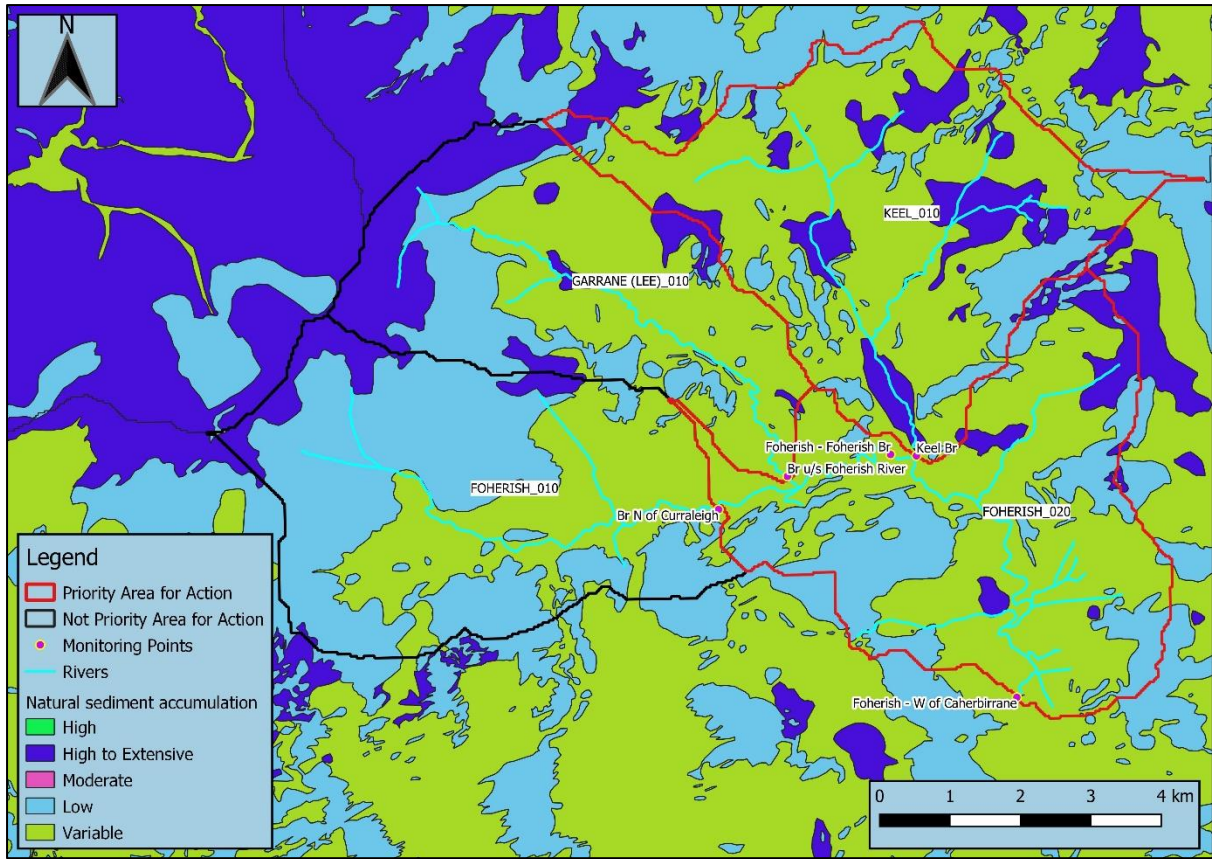
Source: EPA

Figure 9-5: Soil Type



Source: EPA (2018)

Figure 9-6: Land Use



Source: EPA (2020)

Figure 9-7: Natural sediment accumulation