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Ellon Natural Flood Management and River Basin Management Plan Report

Final Report

September 2018

Aberdeenshire Council

Aberdeenshire COUNCIL

JBA Project Manager

Caroline Anderton
JBA Consulting
Unit 2.1 Quantum Court
Research Avenue South
Heriot Watt Research Park
Edinburgh
EH14 4AP

Revision History

Revision Ref / Date Issued	Amendments	Issued to
P01 / 19 June 2018	-	Alistair Scotland and Lee Watson, Aberdeenshire Council
P03 / 21 Sept 2018	SEPA and Aberdeenshire Council comments addressed.	Alistair Scotland and Lee Watson, Aberdeenshire Council
C01 / 03 April 2019	Published.	Alistair Scotland and Lee Watson, Aberdeenshire Council

Contract

This report describes work commissioned by Gavin Penman, on behalf of Aberdeenshire Council on 10 October 2017 by Purchase Order Number 1095192. Dougall Baillie's representative for the contract was Scott Macphail and Aberdeenshire Council's representative for the contract was Alistair Scotland. Hannah Otton, Briony McIntosh and Caroline Anderton of JBA Consulting carried out this work.

Prepared by ..... Briony McIntosh MEarthSci
Assistant Analyst

Hannah Otton BSc
Assistant Analyst

Reviewed by ..... Caroline Anderton BSc MSc CEnv CSci MCIWEM C.WEM
Technical Director

Purpose

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Acknowledgements

JBA wishes to thank SEPA for supplying the natural flood management, morphological pressures and river basin management plan datasets. JBA also thanks Aberdeenshire Council for the supply of data.

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Executive Summary

Context

Under the Flood Risk Management (Scotland) Act 2009, this report forms part of the appraisal study for Ellon commissioned by Aberdeenshire Council. The purpose of this report is to assess the current condition of watercourses within the River Ythan catchment, based on parameters set out in the River Basin Management Plan (RBMP) for catchments with status less than good, and identify potential opportunities for Natural Flood Management (NFM).

This has been achieved through an initial desktop study of the catchment, determining the hydrological conditions and characteristics of the catchment, alongside SEPA's Section 20 screening data. The catchment comprises several smaller sub-catchments, the greatest contribution in terms of peak flows is from the upper Ythan northwest of Fyvie (18% to the overall catchment discharge) followed by the Little Water (14%) and Fordoun Burn (13%, also in the headwaters region of the Ythan). In addition to the River Ythan, four small tributaries flow through Ellon discharging into the River Ythan presenting additional flood risk to the town; these are therefore important in their own right in terms of NFM opportunities.

Natural Flood Management Summary

A long list of the relevance of a range of NFM options was created for each of the key areas in the catchment. A screening exercise was then undertaken using the collated GIS data to derive key locations for site inspection, with site walkovers resulting in a short list of suitable opportunities for each of the prioritised catchments.

NFM opportunities are numerous across the wider River Ythan catchment. Particular focus has been given to the short-listed sub-catchments identified as having multiple opportunities, and which were used to inform recommendations for the wider catchment. Within the flood scheme extent the key sub-catchments where NFM would be of greatest benefit to flood risk at Ellon are the Modley Burn and Broomie's Burn catchments. Outwith the scheme, NFM opportunities are high in the Youlie-Bronie Burn sub-catchment. This catchment contributes a relatively high proportional flow to the River Ythan and NFM in this region would therefore benefit the downstream community of Ellon, as well as the smaller communities of Pitmedden and Tarves within the sub-catchment. Overall the Ythan catchment is dominated by pastural land which has resulted in straightened watercourses, drainage channels and a high potential for runoff. Good land management practices such as along contour ploughing, hedgerow and buffer strip planting at field boundaries, use of cover crops to reduce runoff and creation of new river corridors are key NFM recommendations.

A summary of suitable NFM measures for the key Ythan sub-catchments assessed as part of this study are provided in Table 1, with specific locations and additional NFM measures recommended for the wider catchment as a whole mapped in Figure 1. It should be noted the opportunities mapped in Figure 1 are primarily based on the areas visited during the catchment walkovers and are not exhaustive, with similar measures applicable across the River Ythan catchment.

River Basin Management Plan Summary

Within the flood scheme extent the River Ythan is classified as being in 'Good' physical condition according to the 2016 RBMP classifications. With the exception of rock armour along the banks of the Ythan in the Meadows area, no other significant morphological pressures within the scheme extent were identified in the SEPA dataset or during the site investigations. It is therefore recommended the existing condition of the River Ythan in this reach is maintained, ensuring any future flood prevention measures do not impact the 'Good' morphological status.

The tributary watercourses within the scheme extent have catchment areas less than 10 km^2 and are not therefore classified within the RBMP. The physical condition of these watercourses was assessed during the catchment walkovers. In contrast to the Ythan these were found to be in poor physical condition. The Modley Burn was sediment and debris laden at its source, straightened through agricultural land and increasingly constrained as it flowed south through Ellon. Opportunities to improve the physical condition of the burn include improving in-channel morphological diversity within the incised sections of channel in the upper catchment e.g. spits, bars and two-stage channels, and restoration of sinuosity in the golf course. In the urban extent of the catchment repairs to the degrading walls and channel banks parallel to Modley Place are recommended to prevent erosion and further undercutting. The Broomie's Burn is much less

constrained with fewer pressures, the primary recommendation being removal or setting back of embankments in the lower reaches by The Meadows to improve floodplain connectivity. Both catchments would benefit from bank stabilisation, sediment traps and buffer strips to manage sedimentation which would also improve water quality.

The Hillhead and Fortree Burns are highly straightened field drainage channels which have incised into the land. No additional significant morphological pressures were identified other than being culverted beneath Ellon to their confluence with the Ythan. Incision is a constraint on improving floodplain connectivity and meandering. The physical condition of these watercourses could be improved within the confines of the incised channel by creating two-stage channels, bars and spits. It may be possible to meander in areas or alternatively encourage wetland development where the slope of the watercourse is minimal. Increasing buffer strip areas ideally to 6 m in width at field boundaries, and stabilising excessively eroding sections of bank would also improve water quality in-line with RBMP objectives.

Outwith the scheme extent a number of the River Ythan tributaries are classified as being in 'Moderate' physical condition. The Youlie-Bronie Burn and Ebrie Burn catchments were chosen for further investigation. The greatest pressure impacting channel capacity percentage used is high impact realignment. Meandering and increasing sinuosity would therefore have the greatest release of capacity and improvement in RBMP status. Embankments are the second greatest pressure which at the locations visited and have the potential to be removed or set-back also allowing greater floodplain connectivity. A weir located along the Bronie Burn approximately 900 m upstream of its confluence with the River Ythan is a significant physical pressure impacting fish migration. Redesign or removal of the weir would greatly improve the RBMP status of this watercourse.

Implementation Approach

The approach to implementing the above recommendations will depend on a number of factors, not least landowner involvement and the availability of funding for this type of measure. However, the recommended methodology for the delivery of river restoration and NFM within the catchments is suggested as follows:

- Incorporation of NFM within a proposed FPS either as a separate option or to supplement other more structural options to provide future adaptation against climate change.
- Inclusion within any wider Aberdeenshire Council NFM funding mechanism to deliver NFM and river restoration when specific funds become available on an ad-hoc basis.
- Delivery of measures via an FPS as a percentage uplift included within the total FPS costs set aside for local NFM and RBMP measures.

The following are considered key areas for NFM/ RBMP improvements and specifically we recommend:

- **Broomie's Burn:** upper catchment floodplain storage and sediment management potential in the vicinity of Niree Farm. Recommended NFM measures include storage ponds, wetlands, sediment traps, floodplain woodland planting and leaky bunds. Additionally, there is floodplain storage potential downstream of Balmacassie Bridge with potential to meander the burn and create a floodplain storage pond and/ or wetland.
- **Modley Burn:** improve in-channel morphological diversity in the incised upper catchment channel and limit sediment and surface water runoff from the agricultural land through good land management practices. Re-design the river corridor through Ellon Golf Course to increase sinuosity, remove morphological constraints and increase floodplain storage potential. This will require stakeholder engagement with the golf course. Repair the degrading walls and stabilise the eroding banks of the Modley Burn adjacent to Modley Place.
- **Bronie Burn:** Floodplain storage potential along the Bronie Burn in the form of ponds and/ or wetland upstream of Hillhead of Ardlethen.
- **Ebrie Burn:** undertake a separate catchment study of the Ebrie Burn which contributes a proportionally high flow to the River Ythan, the physical condition is classified in the 2016 RBMP as being 'Poor' and where NFM opportunities are high. NFM opportunities were particularly high at The Sidings where buffer strip planting, hedgerows and leaky bunds would reduce runoff and improve floodplain storage. Additionally, there is potential to set-back or remove the constraining embankments improving floodplain connectivity.

Table 1: Summary of NFM options within the key sub-catchments assessed during the walkover

Summary of proposed NFM interventions				
Catchment	**Increased vegetation cover**	**Working within/ on the banks**	**Land management**	**Runoff Management**
River Ythan	Riparian woodland. Along contour woodland planting.	Buffer strips at field boundaries. Meander straightened tributaries. Remove/set back embankments.	Sediment traps Along contour ploughing. Limit livestock poaching of the bank.	Leaky bunds. Wetlands. Storage ponds.
Broomie's Burn	Floodplain woodland planting.	In-stream debris dams. Buffer strips. Re-meander straightened sections. Remove embankments.	Sediment traps. Limit livestock poaching of the bank.	Leaky bunds. Wetland. Offline storage ponds.
Modley Burn	Riparian planting.	Restore morphology. Buffer strips at field boundaries. Re-meander straightened sections.	Fence off watercourse to limit livestock poaching.	Leaky bunds. Storage ponds.
Hillhead and Fortree Burns	Hedgerow planting. Riparian woodland.	In-stream debris dams. Buffer strips at field boundaries. Increase channel roughness.	Along contour ploughing. Remove debris piles from river bank.	Leaky bunds.
Youlie Bronie Burn	Riparian and floodplain woodland planting.	In-stream debris dams. Storage ponds. Buffer strip. Remove/set back embankments.	Cover crops. Along contour ploughing.	Leaky bunds. Offline storage ponds. Wetlands.
Ebrie Burn	Riparian woodland planting. Floodplain woodland.	Debris dams. Buffer strips. Remove/set back embankments.	Along contour ploughing. Hedgerows.	Leaky bunds. Wetland or wet-woodland.

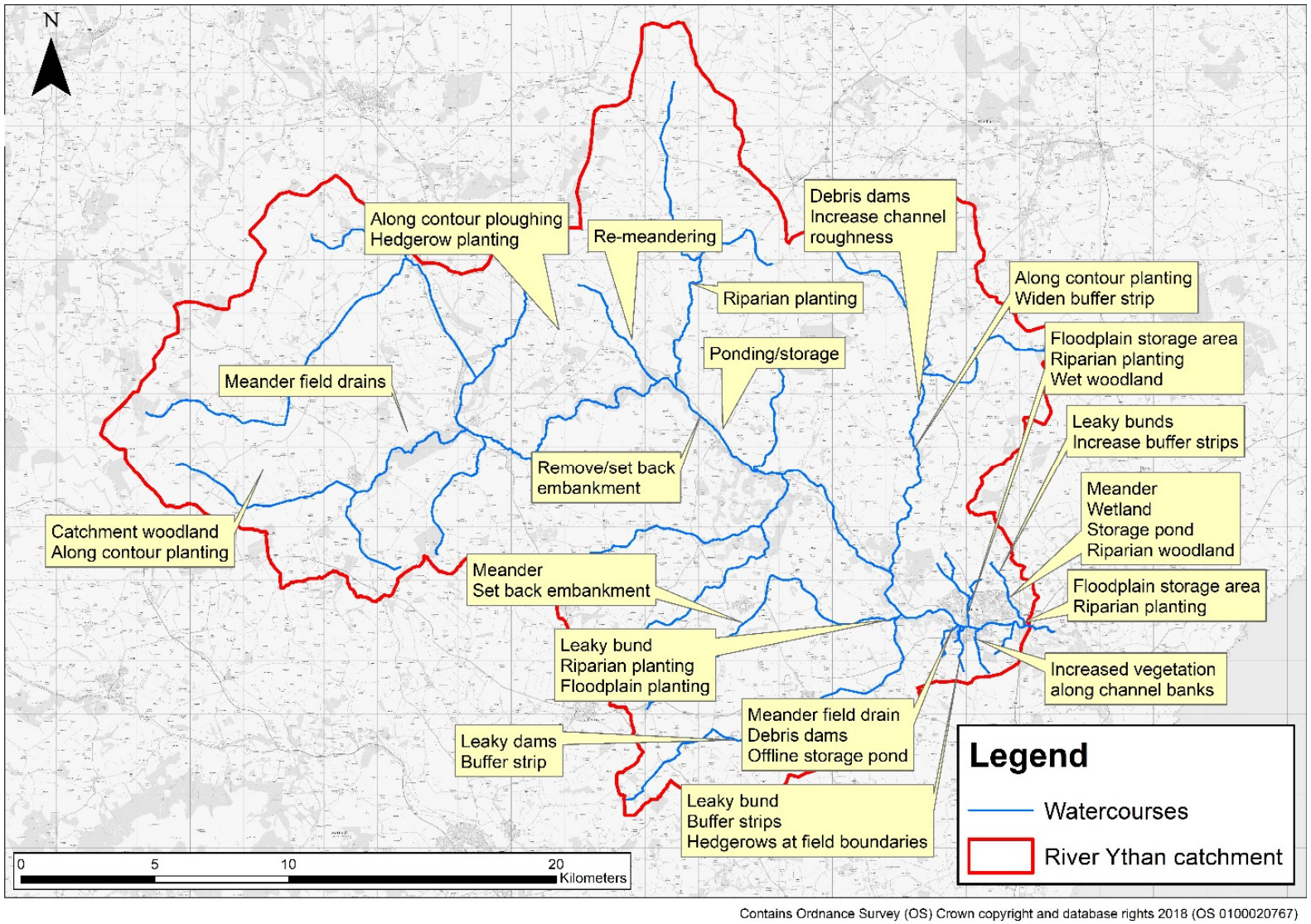

Figure 1: Summary of NFM options within the River Ythan catchment.

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Abbreviations

BFIHOST	Base Flow Index estimated from soil type
BGS	British Geological Survey
CAR	Controlled Activity Regulations (2010)
DTM	Digital Terrain Model
FPS	Flood Protection Scheme
FRM	Flood Risk Mapping
GIS	Geographical Information System
LiDAR	Light Detection And Ranging
mAOD	metres Above Ordnance Datum
NGR	National Grid Reference
OS	Ordnance Survey
OS NGR	Ordnance Survey National Grid Reference
PFRA	Preliminary Flood Risk Assessment
QMED	Median Annual Flood (with return period 2 years)
RBMP	River Basin Management Plan
SAC	Special Area of Conservation, protected under the EU Habitats Directive
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area for birds, protected under the EU Habitats Directive
SPRHOST	Standard percentage runoff estimated from soil type
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive

1 Introduction

The purpose of this report is to assess the current condition of watercourses within the River Ythan catchment based on parameters set out in the River Basin Management Plan (RBMP) and identify potential opportunities for Natural Flood Management (NFM). A desk-based review of the catchment was used to identify areas to be investigated further through site walkovers. The results of these are presented in the following chapters.

1.1 RBMP

1.1.1 Legislation

The River Basin Management Plan forms part of the European Water Framework Directive (WFD) 2000. The WFD is currently in its second cycle (2015 - 2027) and sets out the objectives for protecting and improving the water environment, balancing the environmental, societal and economic costs and benefits. The Scottish Environmental Protection Agency (SEPA) are responsible for managing this within Scotland.

The RBMP defines and classifies the environmental condition of water bodies, with the overall condition graded from bad to high based on a number of categories including: access for fish migration; water flows and levels; freedom from invasive species; water quality; ecology and physical condition.

1.1.2 Aim

The aim of this RBMP assessment was to consider the current (2016) overall status of each watercourse within the catchment and in particular identify those classified as less than good based on their physical condition. Focus is given to the physical condition of the watercourse as this has a direct impact on flood risk from the river. Additionally, improvements to the morphology are likely to also improve the status of other RBMP categories. Multiple RBMP criteria will be considered in the optioneering stage.

For those considered less than good or within the modelled reaches (i) a desk-based review of the current significant morphological pressures along each watercourse was undertaken; (ii) the percentage capacity of the river used by these pressures was calculated using a methodology in keeping with SEPA's Morphological Impact Assessment System (MImAS) and (iii) a catchment walkover to review the constraints and identify opportunities to improve physical condition undertaken. The results of these are discussed in further detail in the following chapters.

1.2 NFM

1.2.1 Legislation

The Flood Risk Management (Scotland) Act 2009 requires SEPA and Responsible Authorities to consider sustainable approaches to managing flood risk. This includes considering the role that NFM has in reducing flood risk, where NFM was defined by SAIFF (2011)[1] as follows:

'Natural Flood Management can be defined as those techniques that aim to work with natural hydrological and morphological processes, features and characteristics to manage the sources and pathways of flood waters. These techniques include the restoration, enhancement and alteration of natural features and characteristics, but exclude traditional flood defence engineering that works against or disrupts these natural processes.'

1.2.2 Aim of the assessments

In the past, flood management has typically focused on traditional methods of mitigating flood risk, such as the use of flood walls and embankments, although such methods are not considered to be sustainable, particularly in the face of the increased frequency and severity of flooding predicted to impact Scotland as a result of climate change.

In contrast, NFM measures work together with the natural characteristics and processes of the landscape to help manage the sources and pathways of flooding as part of a catchment-wide

1 Scottish Advisory and Implementation Forum for Flooding (SAIFF, 2011)

approach and are generally considered to be more sustainable. Traditional measures do however, still have a role in terms of protection and cost benefit analysis with respect to large magnitude floods, as NFM measures may be more effective for smaller scale events.

NFM measures vary in scale and type depending on local conditions. The SEPA Natural Flood Management Handbook[2], Chapter 2, provides guidance on river- and catchment-based NFM measures. The ultimate goals of such measures are as follows:

- Reduce the rate or amount of runoff;
- Improve the ability of rivers and their floodplains to manage flood water.

These aims are largely achieved by storing more water within the catchment and slowing the flow of water overland or instream. The types of NFM measures considered for suitability within the catchment include those in Table 1-1.

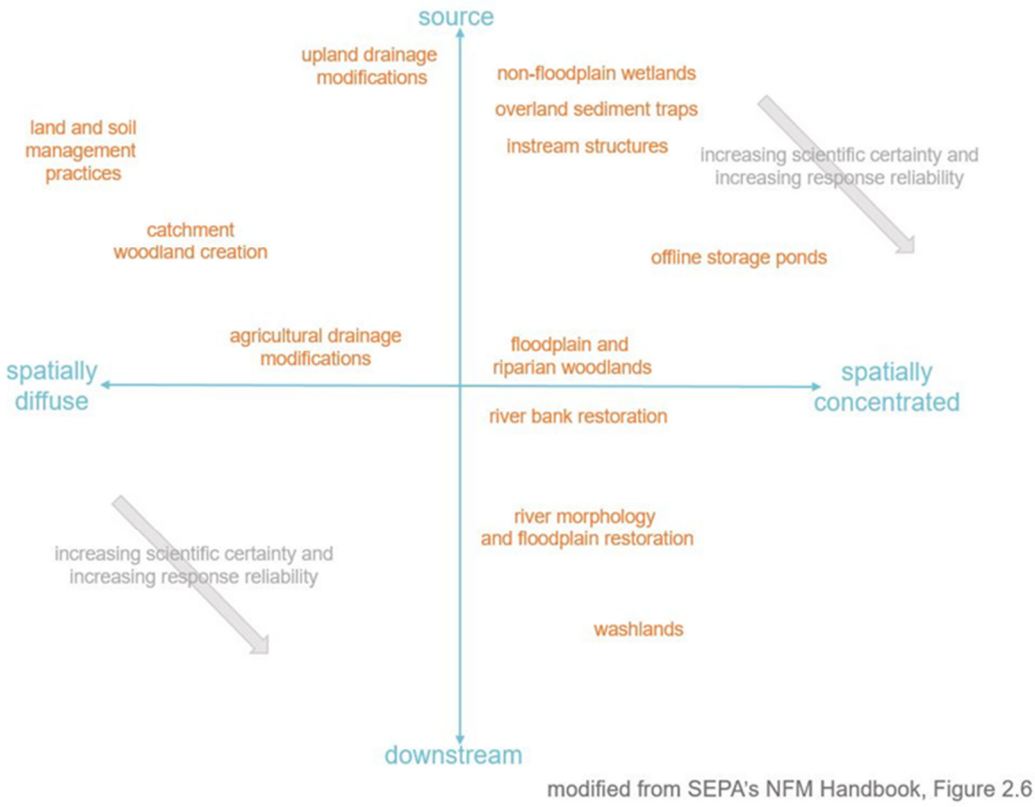
Table 1-1: Examples of types of NFM measures suitable for application across catchments

Type of NFM measure	Examples
Increased vegetation cover	Woodland planting (conifer, native and broadleaf) Gully woodland planting Creation of cross-slope tree shelter belts Riverbank woodland
Working within and on the banks of the channel	Placing of large woody debris and boulders In-channel barriers Bank restoration/erosion protection Managing channel instabilities (e.g. fencing) Reach restoration and floodplain reconnection Removal of obstacles to river flow
Land management	Soil and bare earth improvements Changing agricultural field drainage Blocking of upland drains
Runoff management	Overland flow interception Offline ponds Farm wetlands Sediment traps

NFM measures often offer a number of multiple benefits (such as improvements in water quality or increased access to nature) and can be used in conjunction with traditional engineering approaches to flood risk management where appropriate. The effectiveness of NFM measures is generally dependent on their location within the catchment (Figure 1-1).

2 https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf [Chapter 2. Page 14].

Figure 1-1: Spatial distribution of NFM measures within a catchment



modified from SEPA's NFM Handbook, Figure 2.6

The aim of this NFM assessment was to consider the current state of the catchment and identify locations where NFM may be appropriate. Potential opportunities for NFM within the catchment are discussed in further detail in the following chapters.

2 Catchment characteristics

The catchment draining to Ellon covers a total area of approximately 550 km^2 and is traversed by a number of watercourses. The River Ythan is the primary watercourse which originates at Ythanwells approximately 30 km northwest of Ellon. The river flows initially north from its source at the northern boundary of the Grampian Mountains, then southeast towards Ellon. It discharges into the North Sea approximately 10 km downstream of Ellon and is tidally influenced downstream of the town. A number of tributaries discharge into the River Ythan with the Meiklemill Burn, Modley Burn and Broomie's Burn tributaries flowing through Ellon itself.

2.1 Catchment geology, soils and topography

According to the British Geological Survey (BGS) 1:625,000 scale geological map of Britain[3], the catchment is underlain predominantly by metamorphic psammite and pelites, with areas of igneous intrusions. A band of sedimentary bedrock is present in the Steinmanhill area in the northeast of the catchment (Figure 2-1). The catchment is overlain by superficial glacial deposits, alluvium and small areas of peat.

The James Hutton Institute's 1:250,000 scale Soils of Scotland map[4], indicates the catchment is dominated by podzols in the northwest and brown soils and gleys in the southeast (Figure 2-2). Podzols are widespread throughout Scotland and are associated with acid parent material and semi-natural heath or coarse grassland vegetation and coniferous woodland[5]. Water is able to percolate through the top section of the soil profile.

The catchment is therefore dominated by relatively impervious bedrock, mixed permeability superficial deposits with relatively permeable soils. The catchment BFIHOST (baseflow index estimated from soil type) of 0.62 and SPRHOST (Standard percentage runoff estimated from soil type) of 27.83% indicate the catchment as a whole is moderately permeable and would therefore not be expected to show a particularly flashy response to rainfall events.

3 British Geological Survey http://mapapps.bgs.ac.uk/geologyofbritain/home.html [Accessed: November 2017]

4 http://www.hutton.ac.uk/learning/natural-resource-datasets/soilshutton/soils-maps-scotland/download#soilmapdata

5 https://www.hutton.ac.uk/learning/exploringscotland/soils/podzols

Figure 2-1: Geology

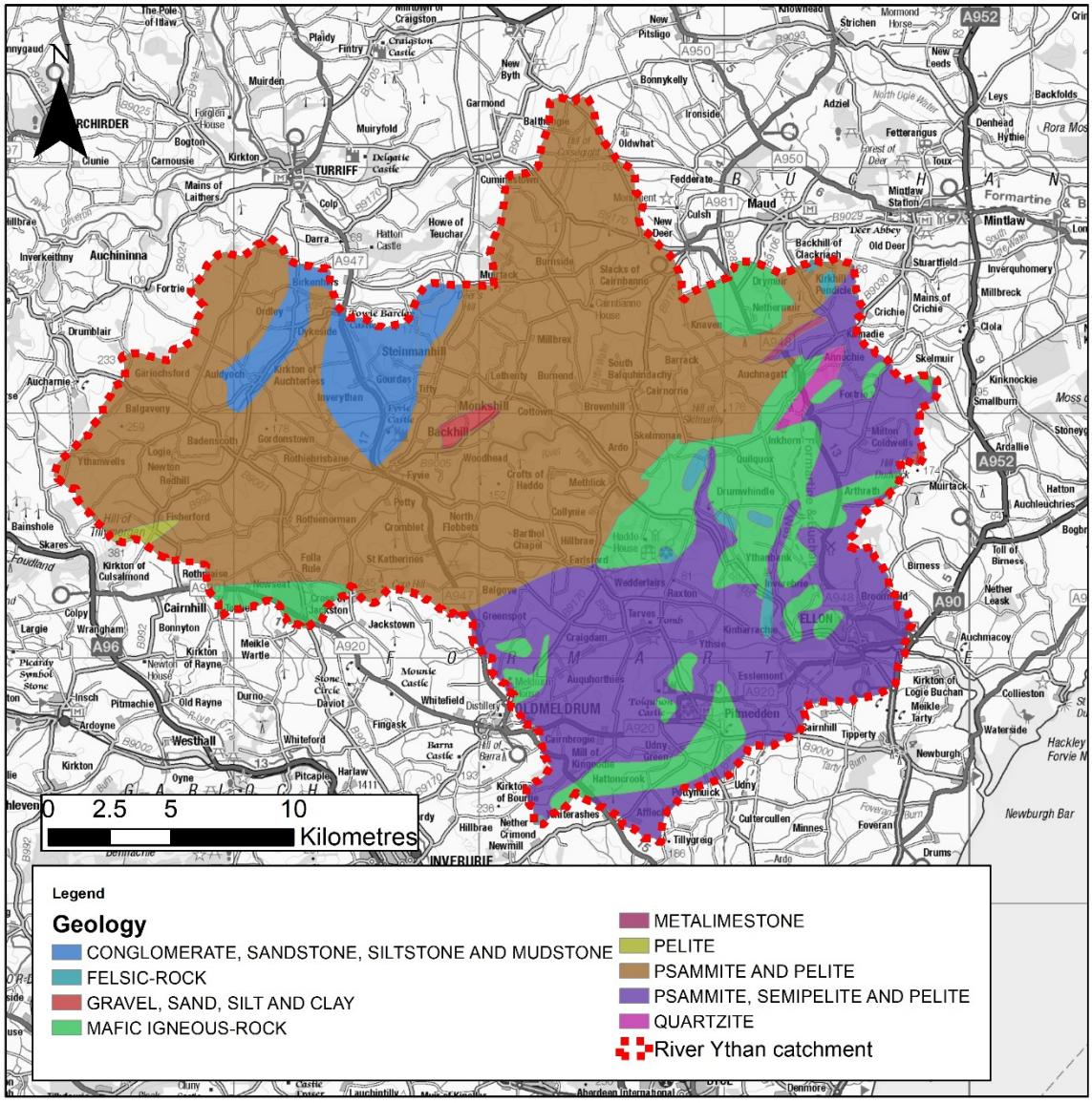
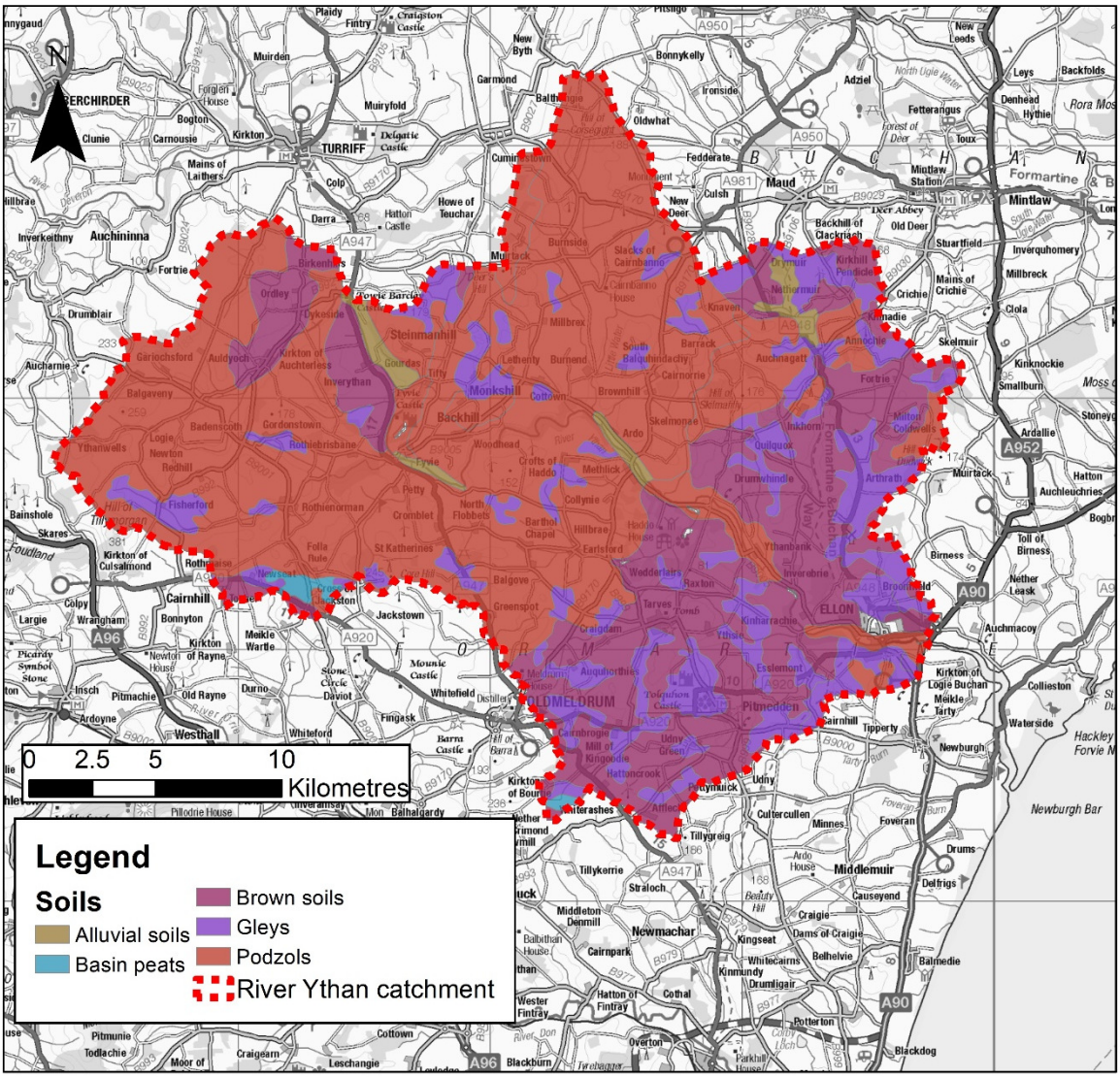


Figure 2-2: Soils



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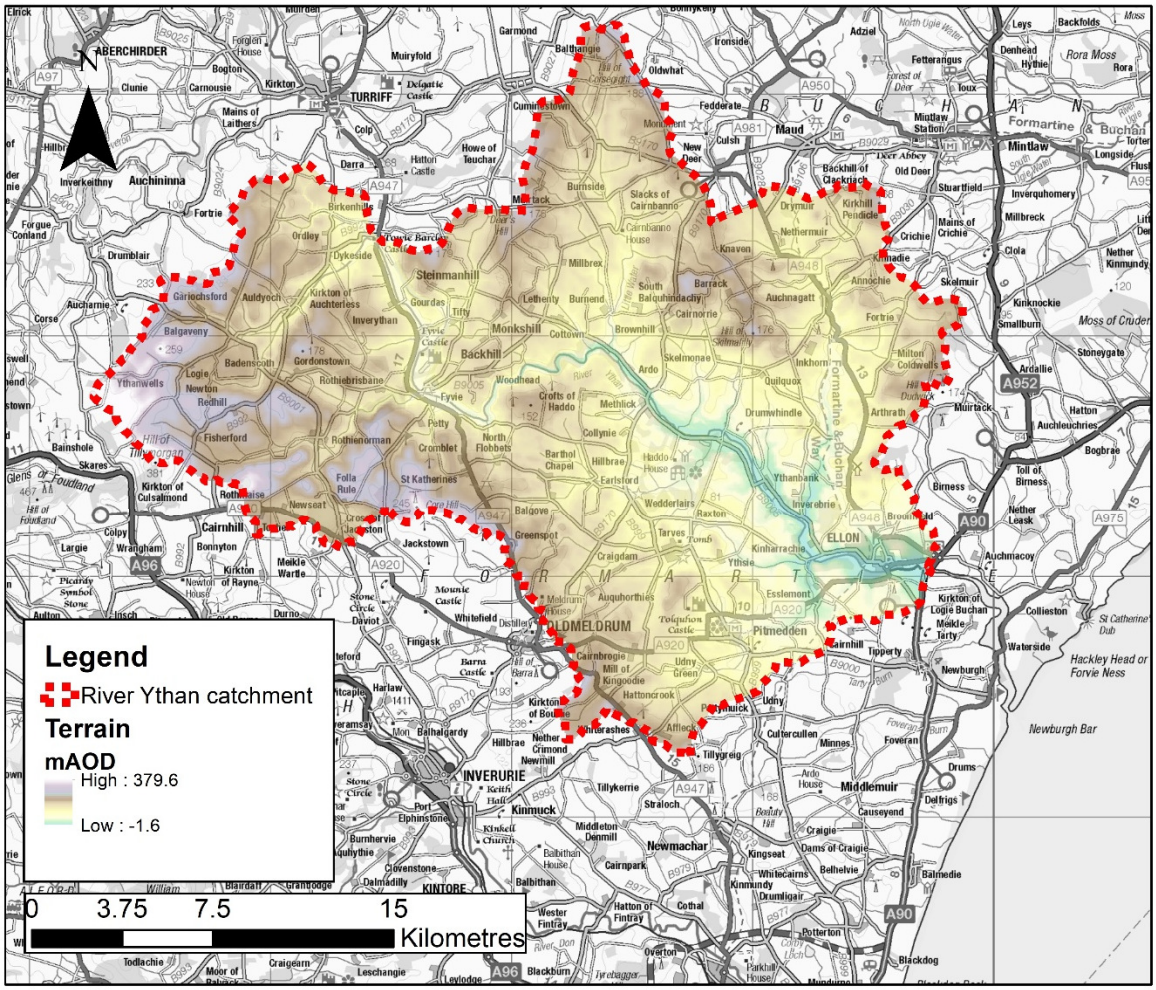
The geomorphology of the catchment as a whole reflects the complex glacial history of the region. During the last Ice Age the Buchan region was covered by a number of ice sheets which intersected near Ellon. One ice sheet flowed east toward the North Sea but a secondary Ice Sheet flowed south from the Moray Firth[6]. As the Ice Sheets melted the catchment was crossed by a number of meltwater channels, including the Ythan. Ice damming at the North Sea[6] during de-glaciation resulted in the River Ythan flowing inland and forming the over-deepened Fyvie Gorge[7], west of Ellon, while the remainder of the catchment exhibits an undulating topography as a result of the glacio-fluvial history.

Elevations within the catchment are greatest in the west reaching approximately 380 metres above Ordnance Datum (mAOD) near the headwaters of the River Ythan, decreasing to approximately 5 mAOD at Ellon. A Digital Terrain Model (DTM) of the catchment is illustrated in Figure 2-3.

6 Merritt, J. and Leslie, G. 2009. Scottish Natural Heritage. Northeast Scotland. A Landscape Fashioned by Geology. http://www.snh.org.uk/pdfs/publications/geology/northeastscotland.pdf [Accessed: November 2017].

Figure 2-3: Catchment topography



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2.2 Catchment hydrology and watercourse characteristics

The River Ythan originates in farmland near Ythanwells and flows north towards the Mains of Towie in a narrow, highly straightened channel through agricultural land. At the Mains of Towie a tributary flowing from the north (Burn of Kingsford) discharges into the River Ythan along the left bank. The Ythan itself changes course sharply at this location to flow southeast toward Fyvie, still within a narrow, straightened channel with little riparian vegetation through agricultural fields. East of Fyvie the River Ythan flows through the narrow Fyvie Gorge[7] before subsequently flowing in a much wider, more sinuous channel to Ellon.

7 Gunn, A., Mendum, J., and Thomas, C. 2015. Geology of the Huntly and Turriff Districts. http://nora.nerc.ac.uk/512185/1/Huntly_JRMedit_15-Mar-2015%20FINAL.pdf [Accessed: November 2017]

Figure 2-4: Key watercourses

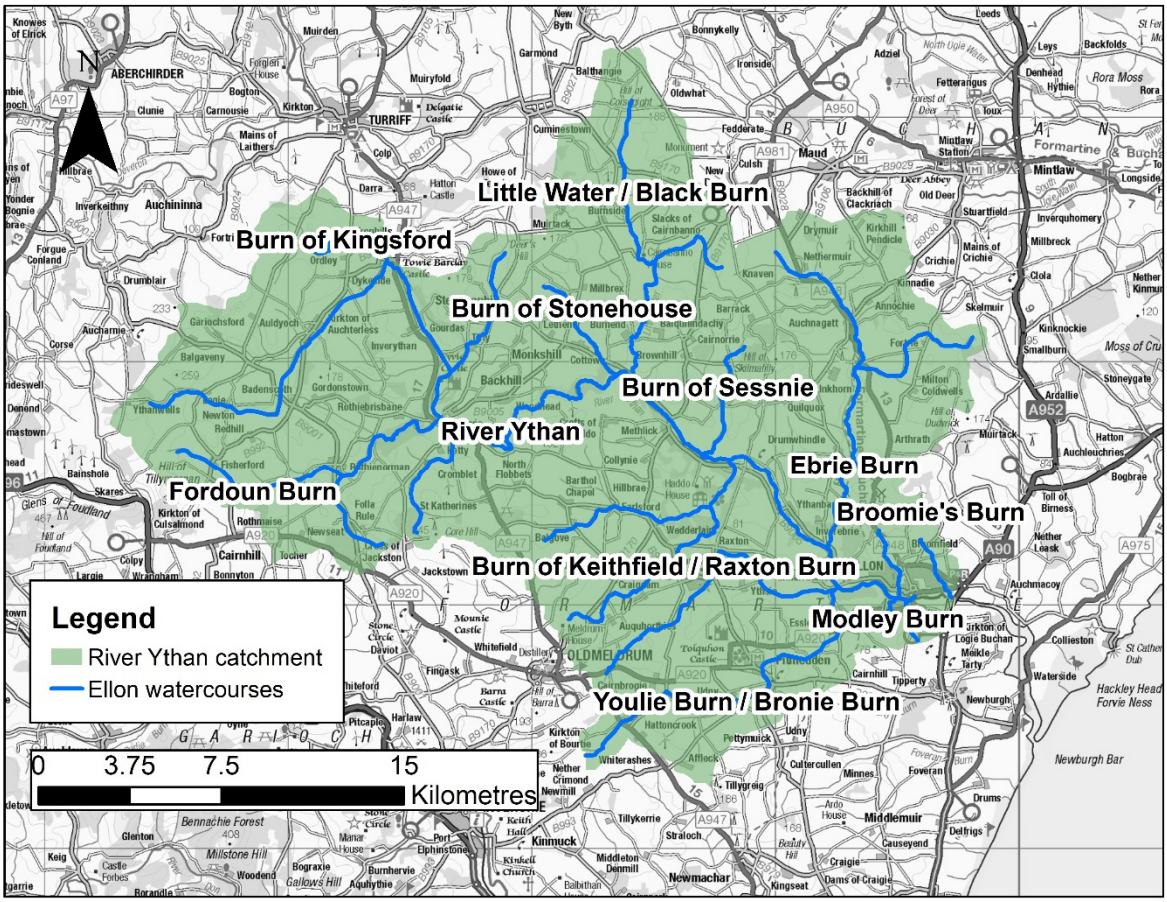
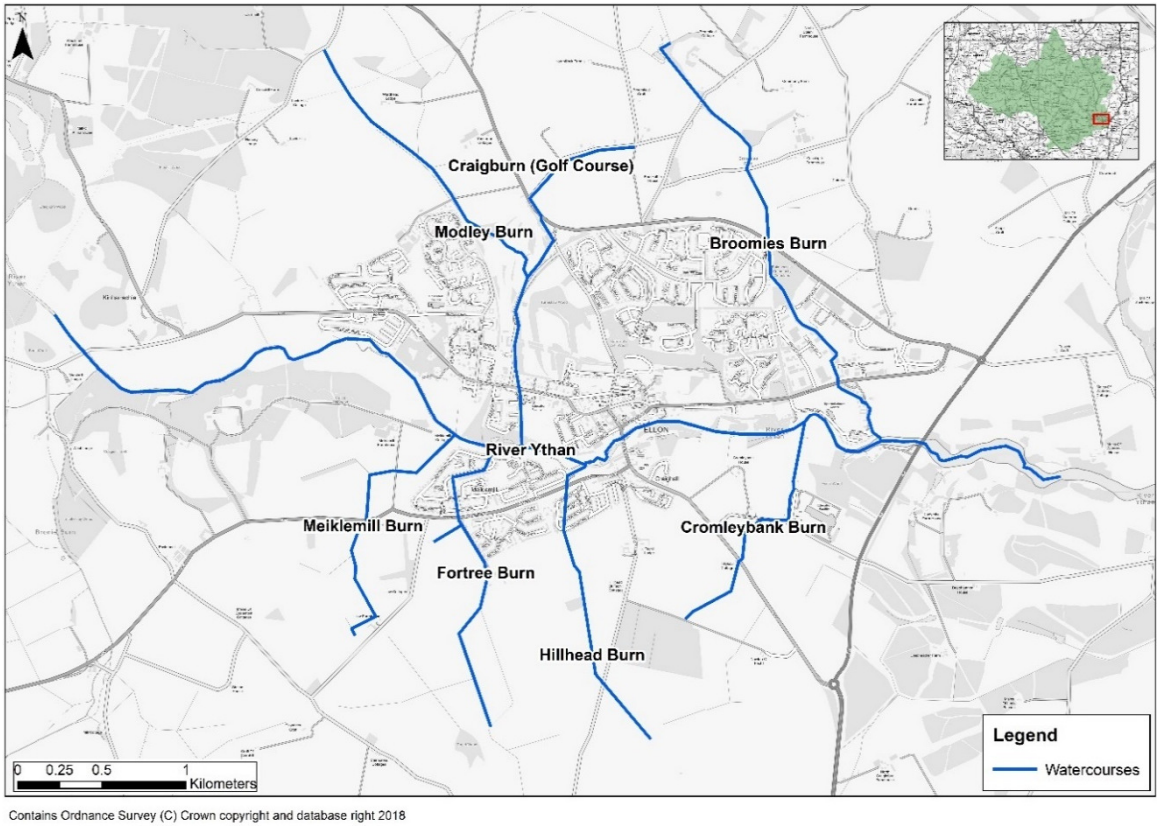


Figure 2-5: Ellon tributaries

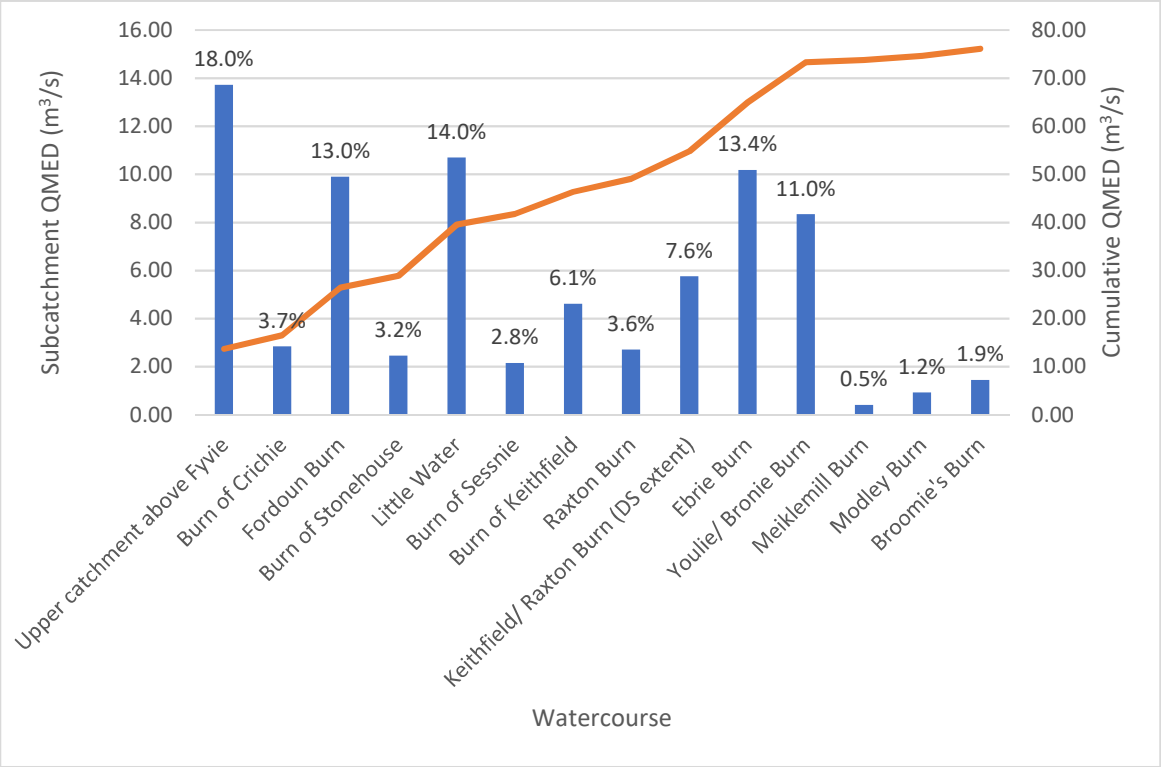


A number of tributaries discharge into the River Ythan along both banks from its source to Ellon. Figure 2-6 gives the median annual maximum flow (QMED)[8] of the key watercourses within the catchment and the percentage this represents of the cumulative QMED at the downstream extent of the tributaries at Ellon. It shows the greatest contribution is from the headwaters of the River Ythan which contributes approximately 18% to the overall catchment discharge. The Little Water, Ebrie Burn and Fordoun Burn respectively contribute the next greatest proportions. Average annual rainfall is approximately 826 mm at Ellon.

Whilst the Meiklemill, Modley and Broomie's Burn's represent just 0.5%, 1.2% and 1.9% respectively of the total catchment flow, they are important minor tributaries which present a flood risk to Ellon. The Modley Burn and Broomie's Burn originate to the north of Ellon and flow through the town discharging into the River Ythan on the left bank, to the west and east of the town respectively. The Meiklemill Burn is located on the right bank of the Ythan and flows through the southern portion of Ellon.

8 QMED was calculated at the downstream point of each major tributary based on the catchment descriptors with no adjustments. This was deemed to be sufficient for providing high level analysis to indicate relative proportional contributions only.

Figure 2-6: QMED contributions



A review of historical OS mapping[9] of the watercourses highlighted in Figure 2-4, indicated they have had a relatively similar planform to present since the 1880's. A review of historical military maps[9] dating from the 18th century however, indicates the River Ythan once flowed in a less constrained, highly sinuous channel. As this mapping dates from the 1700's accurate identification of paleochannels is limited. Evidence of paleochannels along the River Ythan in aerial photography[10] is limited due to the land being agricultural and thus highly modified over the centuries. Additionally, a review of LiDAR data[11] in the Ellon region also did not reveal any significant paleochannels.

9 National Library of Scotland http://maps.nls.uk/geo/find/# Ordnance Survey (OS) One-inch Scotland, 1885-1900 to present maps. Roy Military Survey of Scotland, 1747-1755, Maps of Scotland (18th century), Highlands.

10 Bing maps aerial photography.

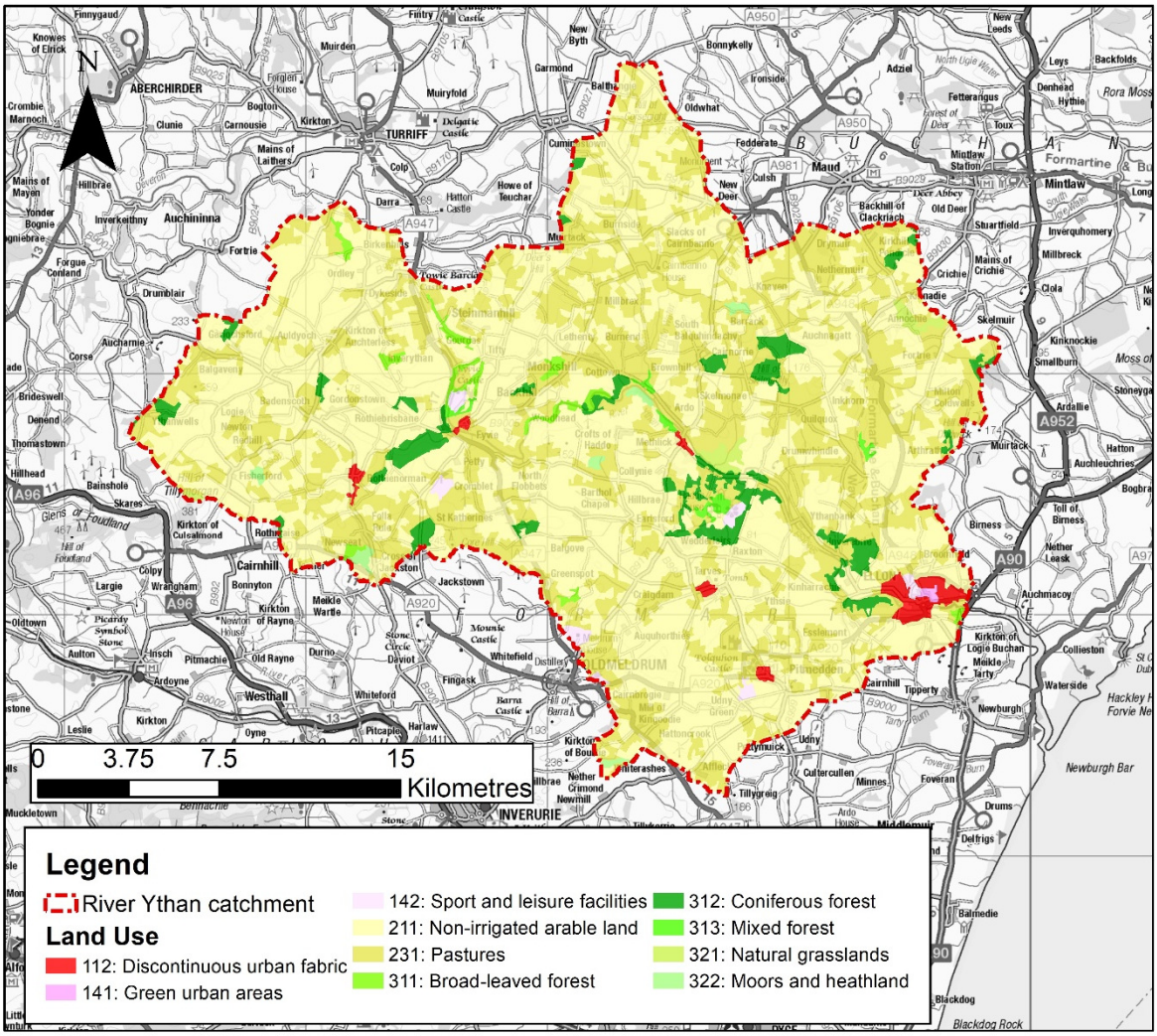
11 Scottish Government, Phase 1 (2011) 1 m resolution LiDAR and 2016 0.25 m resolution LiDAR.

2.3 Land management

2.3.1 Land Use

Figure 2-7 illustrates the land cover types in the catchment based on the Land Cover Map 2012[12]. Land use within the catchment is predominantly arable land and pasture. There are small areas of forestry predominantly along the banks of the River Ythan and in the headwaters of the Burn of Sessnie. Ellon is the main urban area within the catchment however, there are several smaller urban areas namely Methlick and Fyvie along the River Ythan, Rothienorman near the headwaters of the Fordoun Burn and Pitmedden along the Bronie Burn.

Figure 2-7: Land Use



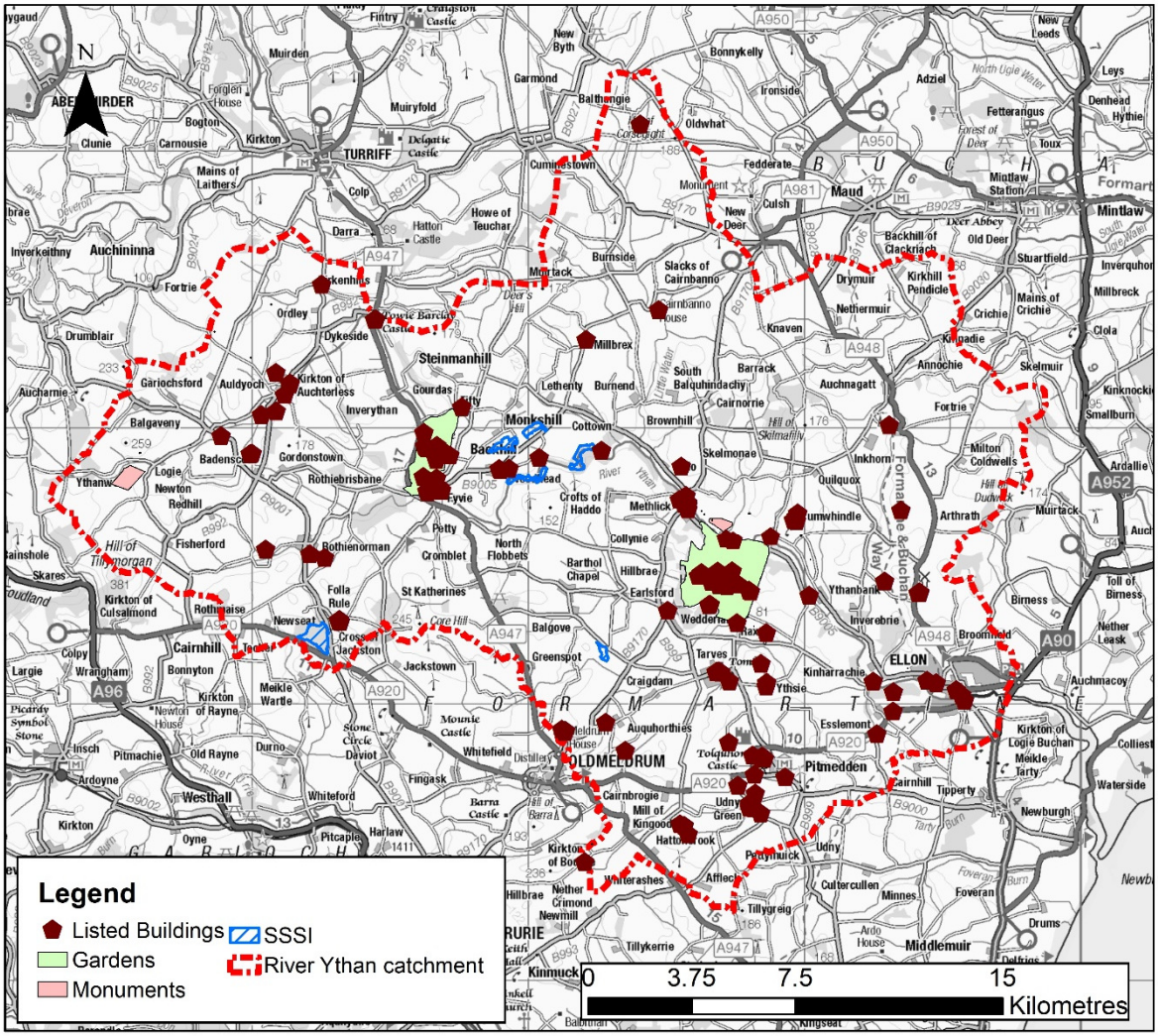
2.3.2 Protected areas

Scottish Natural Heritage[13] datasets indicate within the River Ythan catchment there are a number of Sites of Special Scientific Interest (SSSI) which include the: Wartle Moss (wetlands) near Newseat; Red Moss (wetlands) at Oldtown and the Windy Hills (earth sciences), and Gight Woods (woodland) near Fyvie. The catchment contains a number of Historic Scotland scheduled monuments, listed buildings as well as gardens and designed landscape (GDL) areas. A list of the listed buildings is included in Appendix C.

12 Corine Land Cover European seamless vector database. Release v18_5 (02/2016) http://land.copernicus.eu/pan-european/corine-land-cover

13 Scottish Natural Heritage http://gateway.snh.gov.uk/sitelink/searchmap.jsp [Accessed: November 2017]

Figure 2-8: Scottish Natural Heritage designated areas

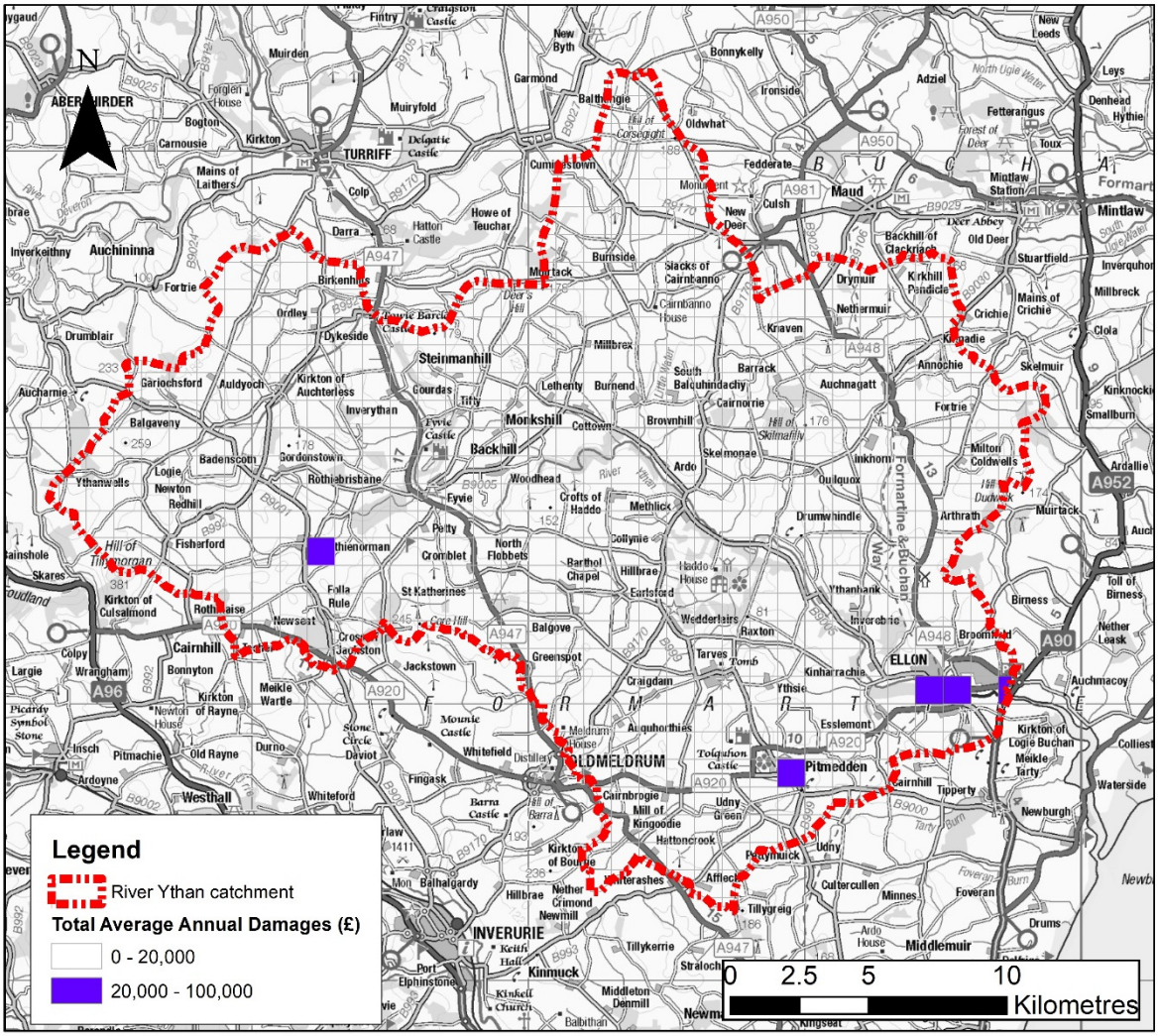


Outwith the catchment but at the downstream extent of the River Ythan, the Ythan Estuary and coastline is an area of special interest and has a number of designations with the Sands of Forvie and Meikle Loch being Special Protected Areas (SPA), Special Areas of Conservation (SAC) and SSSI. The coastline also forms the Forvie Nature Reserve.

2.4 Flood damages and areas at risk

SEPA supplied their Preliminary Flood Risk Assessment (PFRA) analysis of flood damages. Figure 2-9 shows total average annual damages (AAD) within the Ellon catchment indicating key areas affected by fluvial flooding. The dataset indicates estimated damages are generally high where the catchment is urbanised i.e. at Ellon, Pitmedden and Rothienorman which is to be expected.

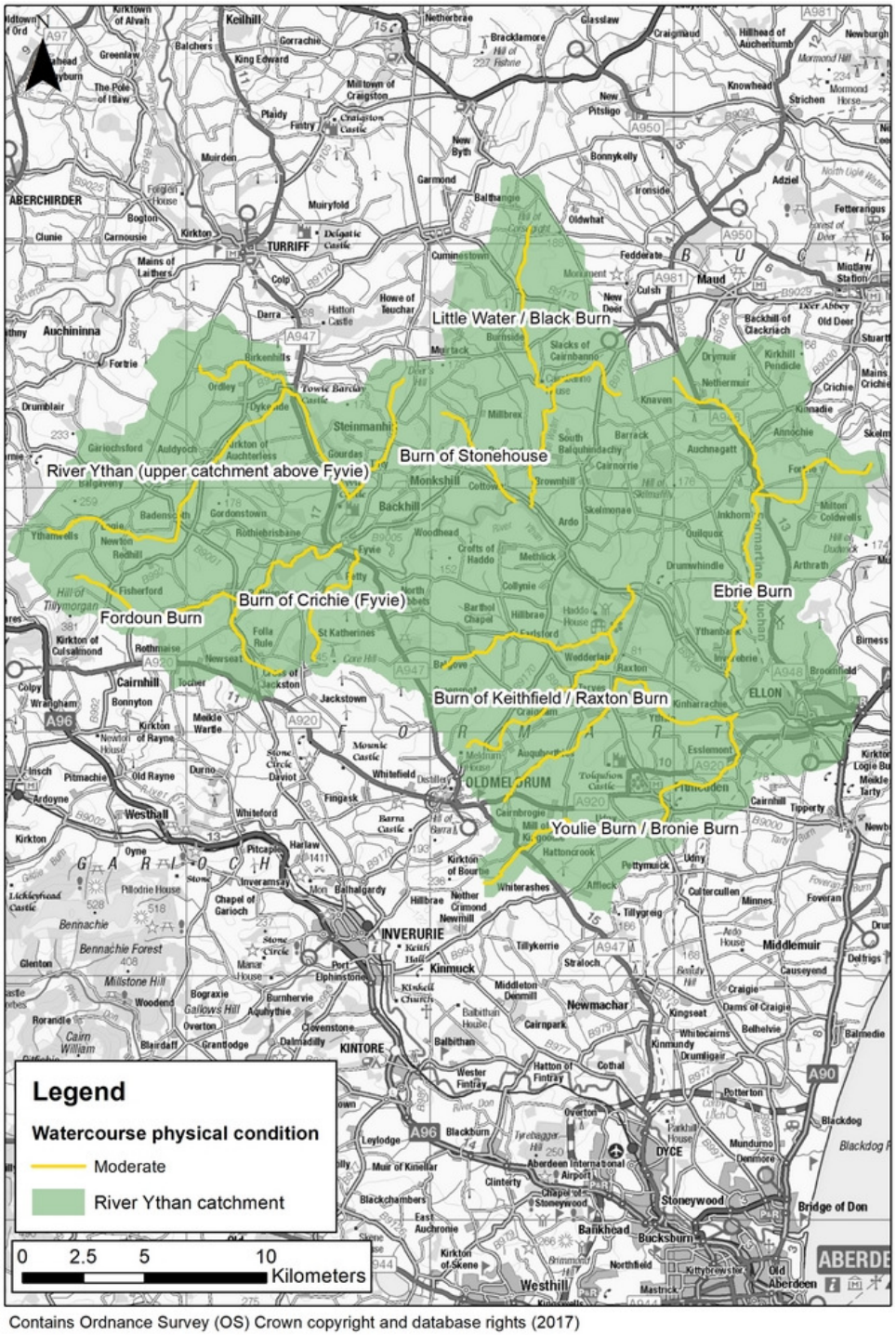
Figure 2-9: Fluvial Average Annual Damages



3 RBMP - review of physical pressures

RBMP data were examined using the Water Environment Hub[14] and RBMP datasets supplied by SEPA. Within the River Ythan catchment three watercourses are classified as having 'Poor' overall condition based on the 2016 waterbody classifications (Appendix A) and the remaining eight watercourses are classified as being in 'Moderate' condition. All watercourses with the exception of the River Ythan between Fyvie and Ellon and the Burn of Sessnie, are classified as 'Moderate' on the basis of their physical condition (Figure 3-1). The Burn of Keithfield/Raxton Burn, Ebrie Burn and Youlie/Bronie Burn are classified as 'Poor' on the basis of their ecological condition.

Figure 3-1: Current waterbody classification based on physical condition



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14 SEPA Water Environment Hub https://www.sepa.org.uk/data-visualisation/water-environment-hub/ [Accessed: November 2017]

For each of the watercourses identified above as having less than 'Good' physical condition, the significant morphological pressures along each watercourse were identified using the SEPA morphological pressures dataset[15]. Significant pressures were defined as:

- Impoundments.
- Set back embankments.
- Embankments with and without reinforcement.
- Green and grey bank reinforcement.
- High and low impact realignment.
- Culverts.

These are shown in the following figures, it should be noted that the SEPA mapping does not necessarily follow the watercourses, as they are plotted as straight lines based on their start and end point.

15 SEPA is currently reviewing and revising the morphological pressures dataset, as such pressures indicated may have since been removed. It was outwith the scope of this contract for JBA to survey physical pressures along the watercourses .

Figure 3-2: Significant morphological pressures in the upper catchment

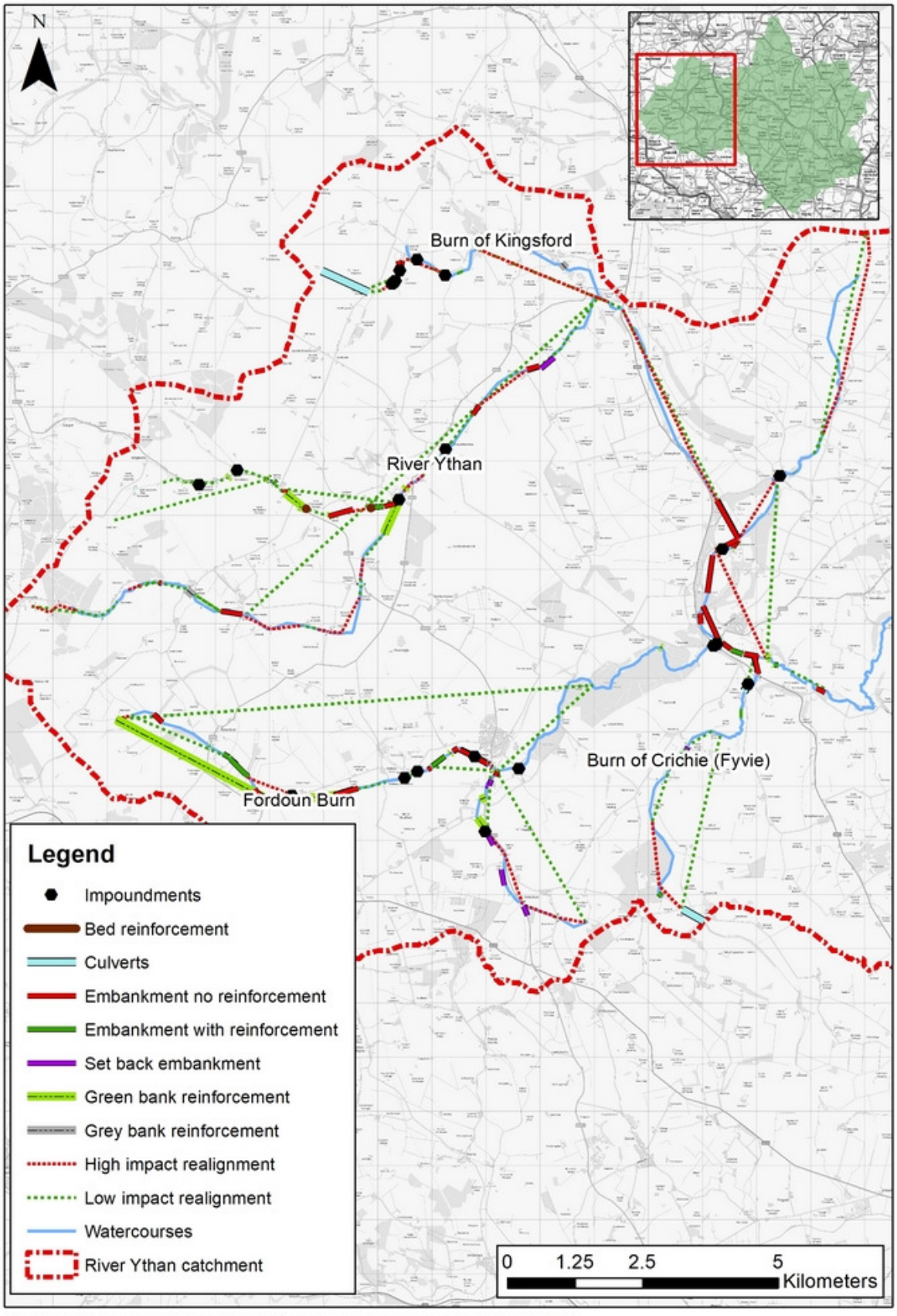


Figure 3-3: Significant morphological pressures along the Little Water/ Black Burn and Burn of Stonehouse

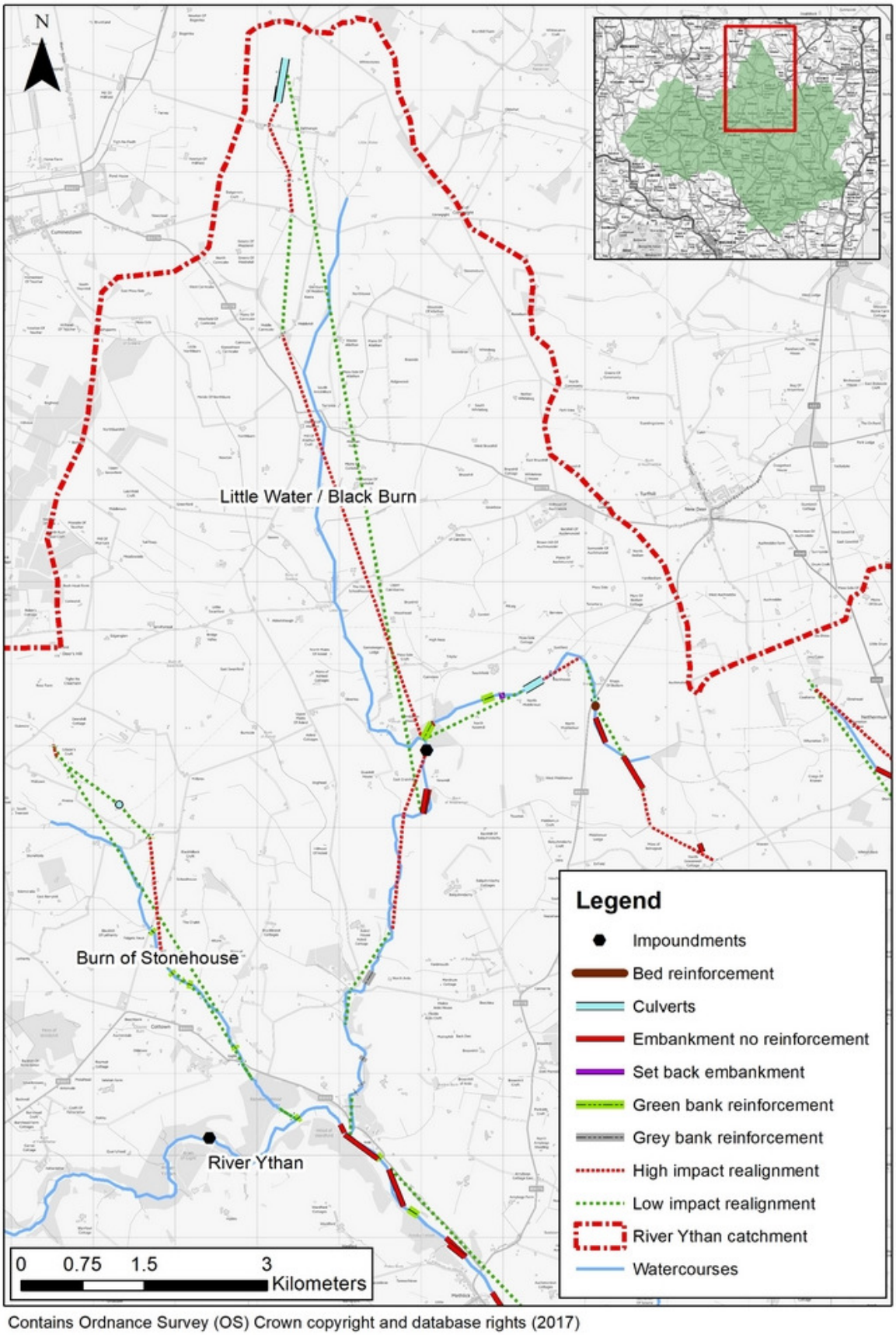


Figure 3-4: Significant morphological pressures along the Burn of Keithfield/ Raxton Burn and Youlie/ Bronie Burn

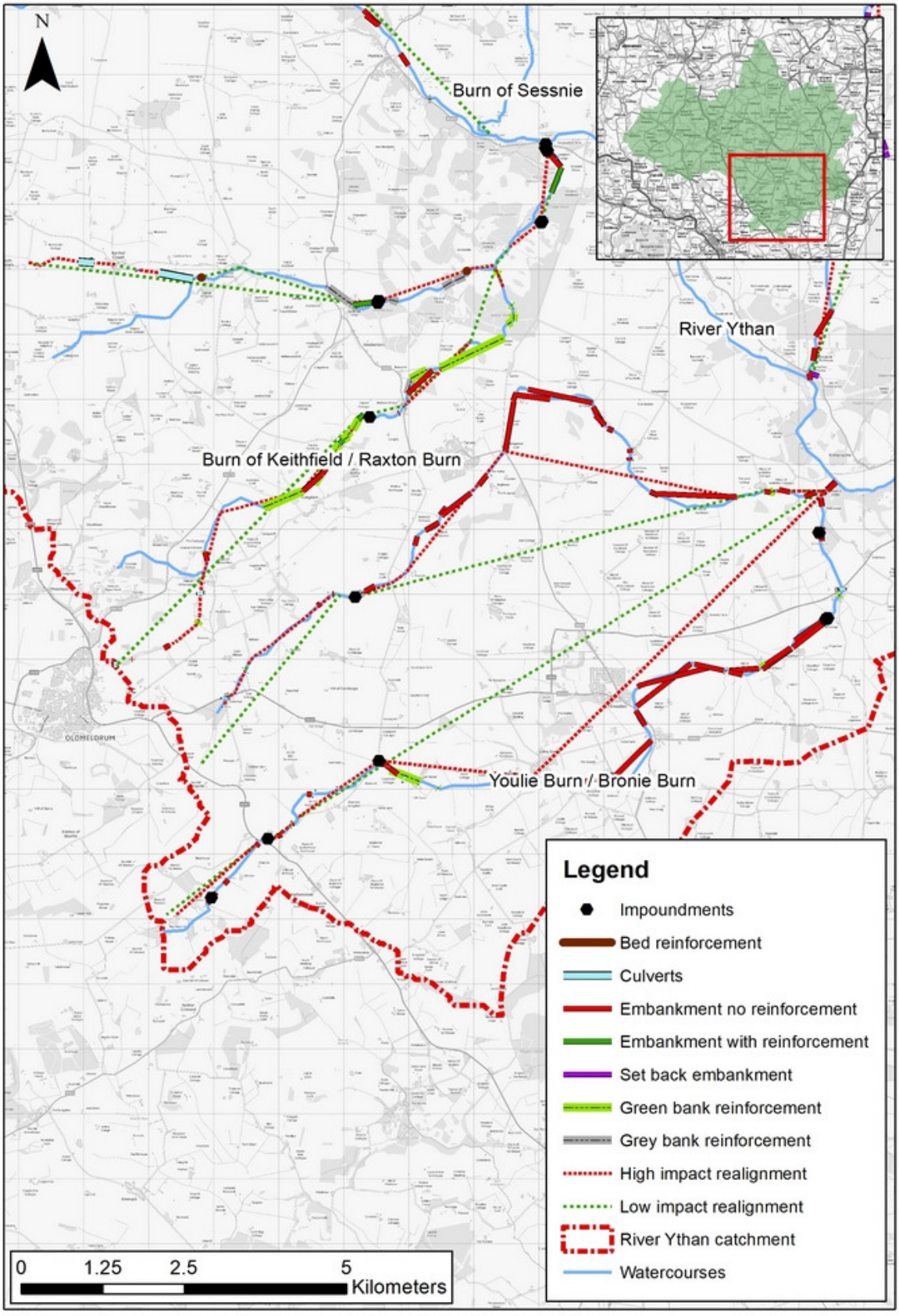
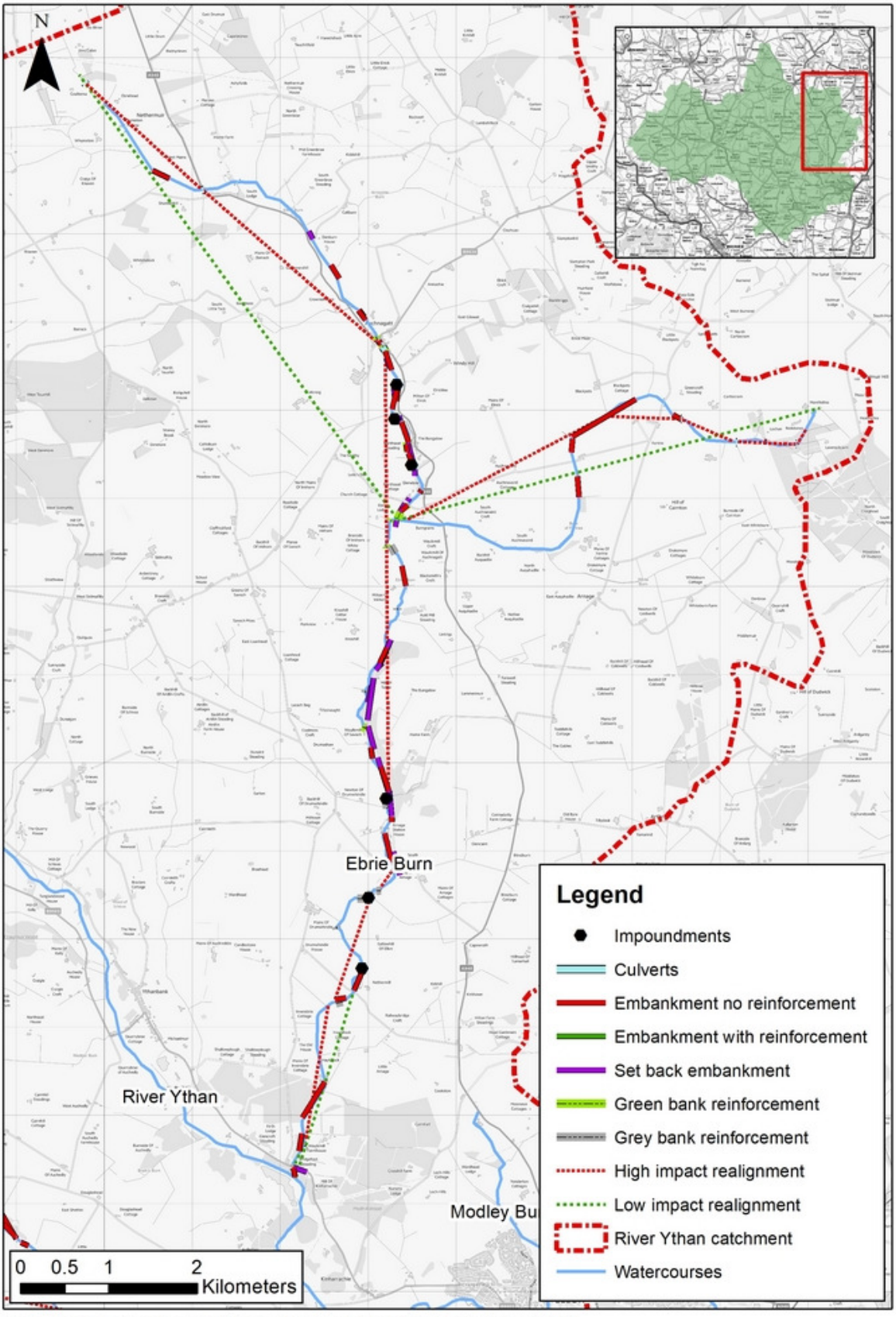


Figure 3-5: Significant morphological pressures along the Ebrie Burn



3.1 Morphological Impact Assessment Results

Morphological impact assessments were undertaken for each of the watercourses identified above as being of less than good physical condition. The Modley, Broomie's Hillhead and Fortree burns are not within the SEPA morphological pressures dataset as their catchment areas are less than 10 km^2 however, physical constraints were assessed during the site walkovers and are discussed in further details in the relevant chapters.

3.1.1 Methodology

The physical condition status of a waterbody is defined according to (i) the relative impact of a pressure on the river bank and channel (Impact Rating[16]), which varies according to river typology; (ii) the length of the channel or bank taken up by the physical pressure (Pressure Footprint) and (iii) the total waterbody length. The capacity of the river used by a pressure is calculated for both the channel and banks according to the following equation and summed to obtain the total percentage:

$$Capacity\ Used = \frac{Impact\ Rating\ x\ Pressure\ Footprint}{Total\ Waterbody\ Length}$$

The watercourses are subsequently classified[17] as follows:

Table 3-1: Waterbody classification bands

Status	Total Capacity Used (%)
High	5
Good	25
Moderate	50
Poor	75
Bad	>75

3.1.2 Results

The MiMAS methodology is presently being updated and revised. The above methodology was applied to all watercourses within the Ythan catchment of less than good physical condition. This resulted in considerably different classification results to those defined above, therefore the results have been used to determine the relative improvement that could be made (discussed in the relevant chapters) and are not indicative of present waterbody conditions. Further information on pressure lengths and capacities are given in Appendix A.

Table 3-2: Morphological condition results

Watercourse	Physical condition status	Length (km)	Majority typology	Total capacity used (%)
River Ythan (upper catchment above Fyvie)	Moderate	40.49	C	188.19%
Fordoun Burn	Moderate	18.25	C	124.31%
Little Water / Black Burn	Moderate	21.03	C	186.64%
Burn of Keithfield / Raxton Burn	Moderate	20.87	C	204.33%
Ebrie Burn	Moderate	22.74	C	279.59%
Youlie Burn / Bronie Burn	Moderate	30.22	C	316.02%
Burn of Crichie (Fyvie)	Moderate	6.89	B	128.28%
Burn of Stonehouse	Moderate	5.94	B	157.39%

16 The Scotland River Basin Directives 2009 http://www.gov.scot/Publications/2010/01/06141049/4
17 http://www.gov.scot/Resource/0045/00457867.pdf

4 Opportunities for Natural Flood Management

SEPA, as part of the FRM Act Section 20 screening process, has undertaken a high-level strategic analysis of Scotland to determine the areas in which NFM measures could be most effective[18]. In particular, for the River Ythan at Ellon this broad-scale analysis has demonstrated where opportunities exist for the following:

- Runoff reduction.
- Floodplain storage.
- Sediment management.

4.1 Runoff Reduction

To identify the areas with the greatest potential for runoff reduction, SEPA has produced a map showing which areas make the greatest contribution to overland flows, based on factors including land cover, soil type, slope and rainfall.

Areas with medium to high potential for runoff reduction within the catchment are illustrated in Figure 4-1. The dataset suggests there are limited opportunities for runoff reduction within the catchment as a whole. There are no areas of high potential, but areas of medium potential are indicated primarily in the western headwaters and Fyvie Gorge regions. Key catchments of interest may therefore include the following sub-catchments:

- Upper River Ythan near the Mains of Towie.
- Fordoun Burn.
- Fyvie Gorge region.
- Ebrie Burn.
- Broomie's Burn.

4.2 Floodplain Storage

SEPA has also produced a map to identify areas with potential for floodplain storage, considering factors such as floodplain slope and land cover (in particular, the potential to increase surface roughness). Areas with medium and high potential for floodplain storage within the catchment are illustrated in Figure 4-2. It should be noted that SEPA's floodplain storage mapping was carried out only for areas of floodplain with an annual probability of flooding at least every 200 years.

The dataset suggests there is high potential along the majority of the River Ythan between the mains of Towie and Ellon where the topography is generally flatter and open. Unsurprisingly there is limited opportunity for floodplain storage in the headwater region. A number of tributaries in the eastern catchment also have indicative potential for floodplain storage. Key areas to focus on with respect to floodplain storage are therefore:

- River Ythan between the Mains of Towie and Fyvie.
- Raxton Burn.
- Ebrie Burn.
- Modley Burn.

4.3 Sediment Management

SEPA has produced a map identifying areas of erosion, deposition and transport within Scottish rivers, thus identifying where sediment management measures may be appropriate for implementation to decrease flood risk. This was achieved using a model to estimate the amount of sediment entering and leaving a given reach and calculating the overall sediment balance. Sediment is naturally eroded and transported downstream in a river however activities such as straightening of the channel and land management practices can disturb natural processes causing excessive erosion or deposition.

18 Nutt, N. 2012. Flood Risk Management (Scotland) Act 2009. Methods to screen and quantify natural flood management effects. Report commissioned by SEPA and Forestry Commission Scotland, May 2012.

A sediment management potential map for the catchment is illustrated in Figure 4-3. The sediment management mapping indicates many of the tributaries west of Ythanbank, as well as the headwaters of the Ythan, are highly to moderately eroding, generally where the topography is steeper. The remaining reach of the Ythan is indicated to be depositing material, as are the easternmost tributaries.

Ellon falls within the North East Flood Risk Management Strategy (FRMS) and is classified as Potentially Vulnerable Area (PVA) 06/12 in the North East Local Plan District (LPD). The LPD highlights sediment management along the Modley and Broomie's Burns to be of importance in the area.

Figure 4-1: Areas with medium potential for runoff reduction

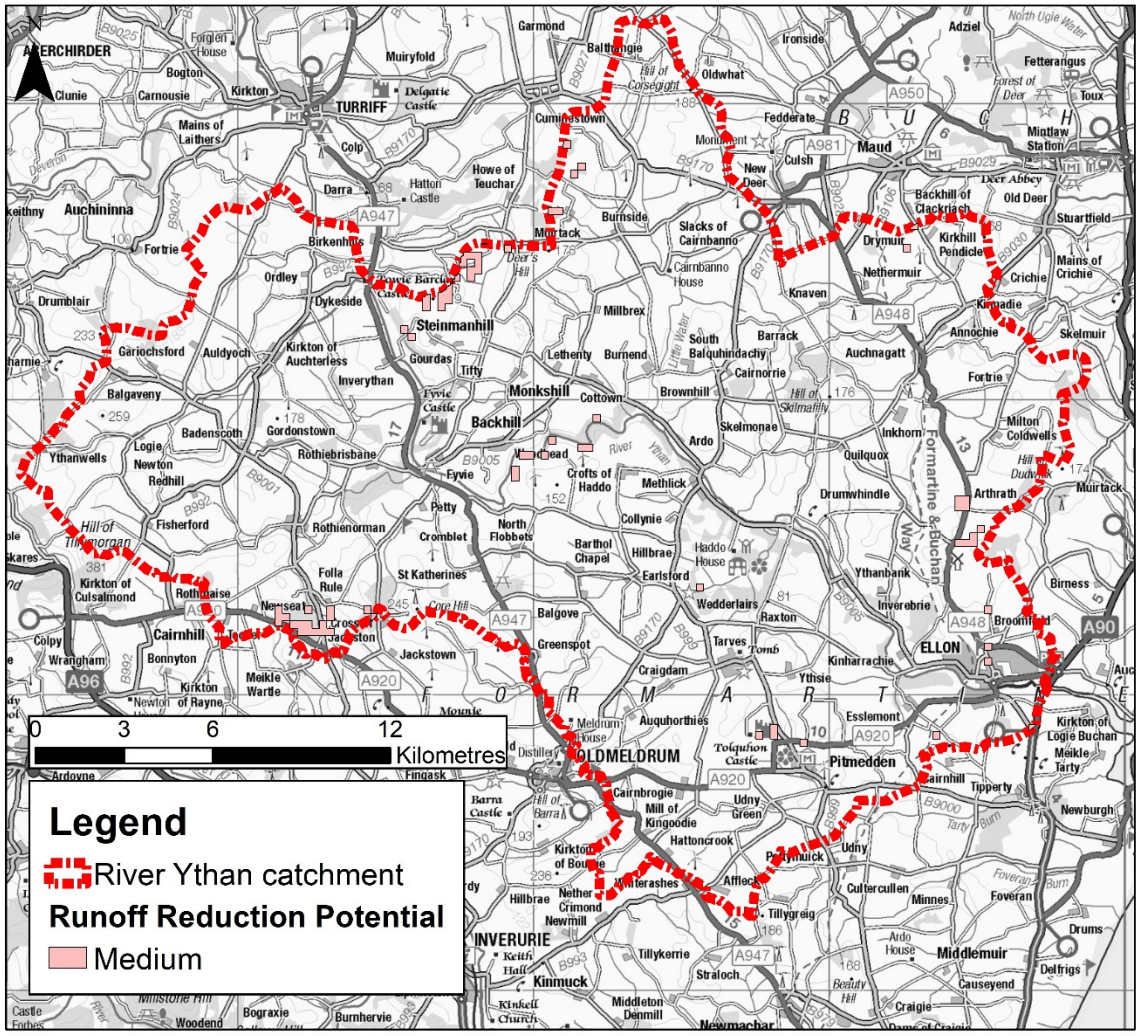


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Figure 4-2: Areas with medium to high potential for floodplain storage

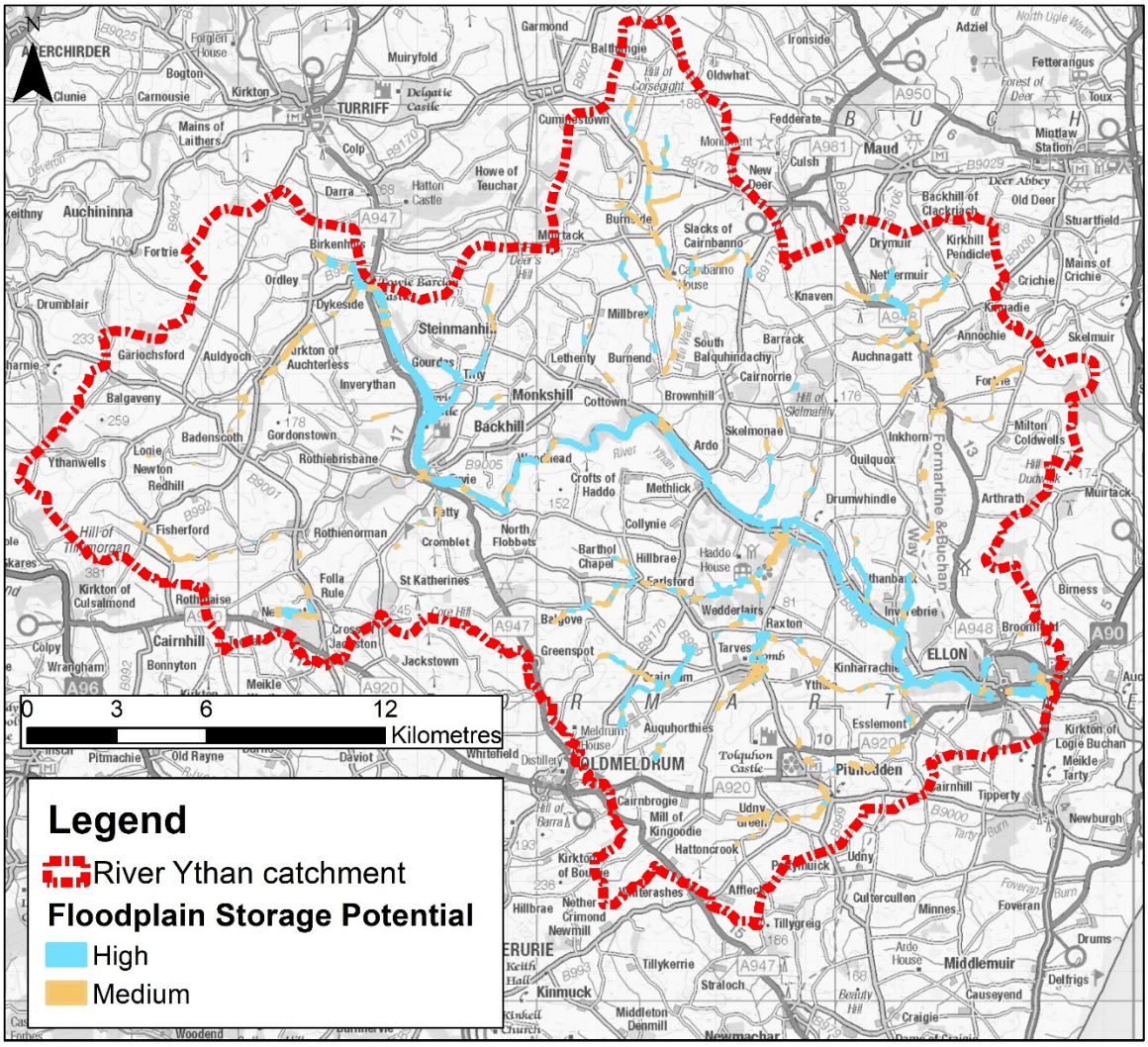
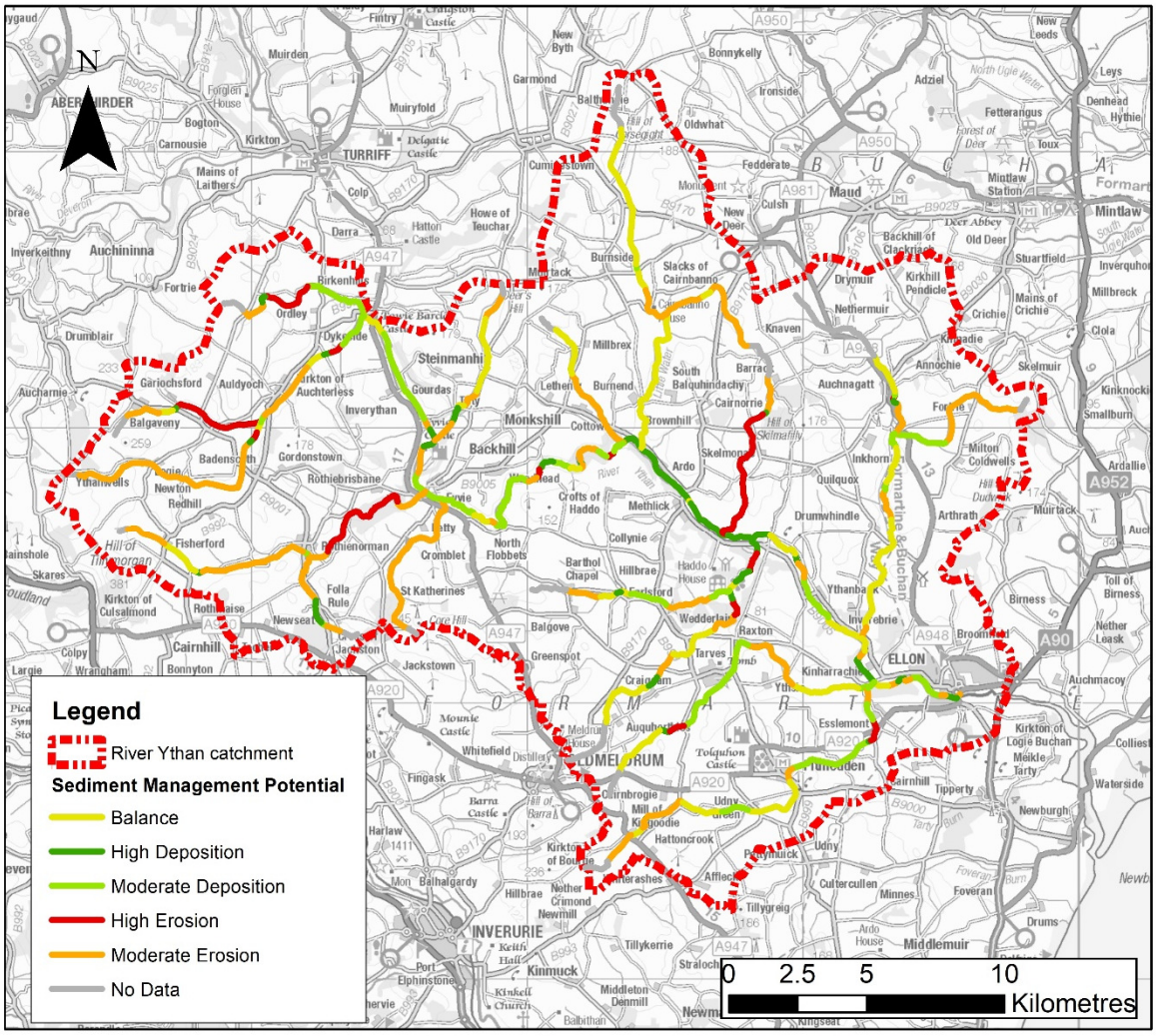


Figure 4-3: Potential for sediment management



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4.4 Long list of options

Based on the SEPA mapping datasets and additional information in the preceding chapters, a long list of NFM options within key sub-catchments of the River Ythan are provided below. One to three ticks are used to indicate from a desk-based review the likelihood of being able to implement that NFM measure.

Table 4-1: Long list of NFM options

Category	Type of NFM measure	Western catchment (River Ythan headwaters & Fordoun Burn)	Northern sub-catchments (Little Water/ Black Burn, Ebrie Burn & Burn of Sessnie)	Southern sub-catchments (Raxton, Bronie and Youlie Burn's)	Ellon sub-catchments (Modley, Broomie's. Hillhead and Fortree Burn)
Increased vegetation cover	Woodland planting (conifer, native and broadleaf)	✓✓✓	✓✓✓	✓✓✓	✓✓
	Gully woodland planting	✓	✓		
	Creation of cross-slope tree shelter belts	✓	✓	✓✓	✓
	Riverbank woodland	✓✓✓	✓✓✓	✓✓✓	✓✓
Working within and on the banks of the channel	Placing of large woody debris and boulders				
	In-channel barriers	✓✓	✓✓	✓✓	✓
	Bank restoration/erosion protection	✓	✓	✓	✓
	Managing channel instabilities (e.g. fencing)	✓		✓	✓
	Reach restoration and floodplain reconnection	✓✓✓	✓✓	✓✓	✓
	Removal of obstacles to river flow				✓
Land management	Soil and bare earth improvements	✓	✓✓	✓	✓
	Changing agricultural field drainage	✓✓✓	✓✓	✓✓✓	✓✓
	Blocking of upland drains		✓		
Runoff management	Overland flow interception	✓✓	✓✓	✓	✓
	Offline ponds	✓✓	✓✓	✓✓	✓
	Farm wetlands	✓	✓	✓	✓
	Sediment traps				✓

5 Screening process

The information highlighted in the preceding chapters is summarised in Table 5-1. This has been used to inform where to focus site visits within the River Ythan catchment.

Table 5-1: Summary of desk based NFM and RBMP findings

Sub-catchment	Key flood risk sub-catchment	Watercourses have a high number of significant morphological pressures	Potential for runoff reduction	Potential for floodplain storage	Immediate area incurs major damages	High proportional contribution to River Ythan flow
Ythan headwaters (above Fyvie)	No	**Yes**	**Yes**	**Yes**	No	**Yes**
Ythan (Fyvie - Methlick)	No	No	**Yes**	**Yes**	No	-
Ythan (Methlick to Ellon)	**Yes**	No	No	**Yes**	**Yes**	-
Fordoun Burn	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Burn of Crichie	No	No	No	**Yes**	No	No
Burn of Stonehouse	No	No	No	**Yes**	No	No
Little/ Black Burn	No	No	**Yes**	**Yes**	No	**Yes**
Burn of Sessnie	No	No	No	**Yes**	No	No
Burn of Kiethfield/ Raxton Burn	No	**Yes**	**Yes**	**Yes**	No	**Yes**
Youlie/ Bronie Burn	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Ebrie Burn	No	**Yes**	**Yes**	**Yes**	No	**Yes**
Modley Burn	**Yes**	No	**Yes**	**Yes**	**Yes**	No
Broomie's Burn	**Yes**	No	**Yes**	**Yes**	**Yes**	No
Hillhead and Fortree Burn's	**Yes**	No	No	No	**Yes**	No

Note: Sub-catchments highlighted in bold were selected as locations for the site visit

The priority based on the above table is for areas of greatest influence on the flood risk communities, where there are multiple NFM opportunities and existing RBMP constraints. Sites have been selected on the basis that they are key areas of flood risk and there were multiple opportunities to both assess improving the physical condition of the watercourses and implement NFM measures. The following areas were selected for further investigation:

- The Modley Burn and Broomie's Burn sub-catchments which directly affect Ellon to assess NFM opportunities.
- The two small unnamed tributaries on the right bank of the Ythan to the south of Ellon (the Fortree and Hillhead Burns) to assess NFM opportunities.

- The Ebrie Burn which contributes a high proportional flow, has a number of significant morphological pressures along its reach and can be used as an example to inform NFM opportunities in the wider Ythan catchment as whole.
- The Youlie/ Bronie Burn which contributes a high proportional flow and has a number of significant morphological pressures. Additionally, Pitmedden along the Bronie Burn is indicated to be an area of high AAD's.
- The River Ythan between the Fyvie Gorge and Ellon to assess NFM opportunities e.g. runoff reduction and floodplain storage and assess RBMP constraints in the vicinity of Methlick.

6 River Ythan

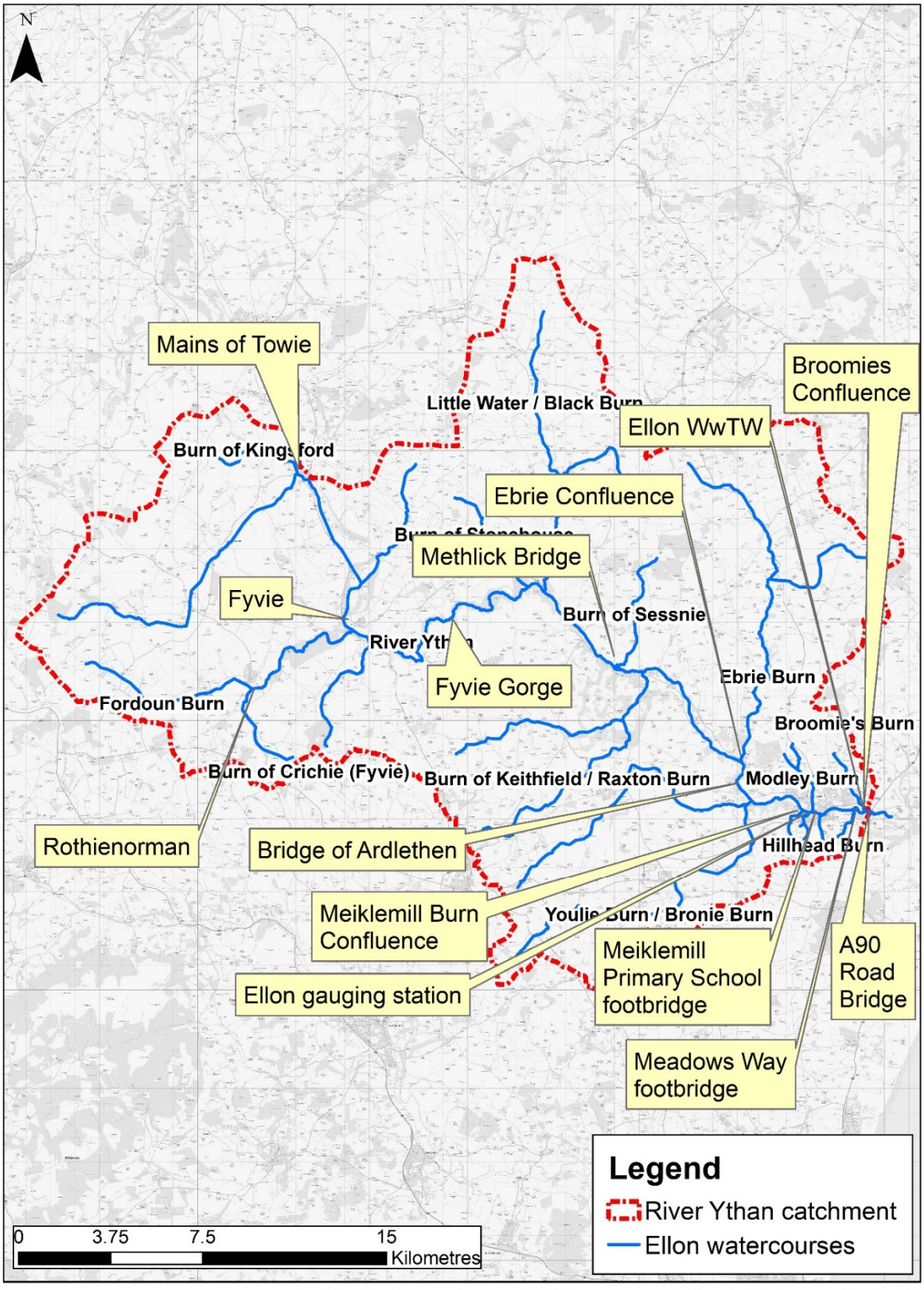
The River Ythan is the primary source of flood risk to Ellon, it has a large catchment area with many sub-catchments, therefore the initial screening process (Sections 2-4) was used to identify key areas to investigate further. These areas/ catchments were selected on the basis they had the greatest NFM and RBMP opportunities based on the SEPA datasets and/ or they were key sub-catchments of direct flood risk to the urbanised areas. These are discussed in further detail in the proceeding chapters. This chapter will focus specifically on the River Ythan and in particular the RBMP and NFM findings and opportunities within the scheme extent, as well as suggested NFM opportunities for the wider catchment as a whole.

6.1 Catchment summary

The River Ythan catchment is large and rural with land use dominated by pasture. According to the SEPA RBMP datatset, between Methlick and Ellon the River Ythan is classified as being in overall 'Moderate' condition based on its ecological status (Appendix A). It is however, classified as being in 'Good' physical condition with the SEPA morphological pressures dataset indicating no significant pressures within the scheme extent. The headwaters of the Ythan (above Fyvie) in contrast are classified as being in moderate physical condition and have undergone historical realignment with the watercourse being relatively straightened through the agricultural fields.

The SEPA NFM datasets indicated high to moderate floodplain storage potential along the entire reach of the Ythan within the scheme extent, and that the river is predominantly depositing sediment. Runoff reduction potential within the scheme extent is limited, primarily being indicated within the Modley and Broomie's burns sub-catchments. For the wider Ythan catchment medium runoff reduction potential is primarily indicated in the upper catchment west of Methlick but high floodplain storage potential is indicated along almost the whole river between Ellon and the Mains of Towie.

Figure 6-1: River Ythan catchment key locations



6.2 NFM and RBMP Site Walkover Findings

The site visit for the Ythan catchment took place over the 16 and 17 April 2018. Weather conditions on the day of the walkovers were bright, clear and dry. Conditions in the week prior to the visit had been mixed, with periods of rain and localised areas of pooled water were present at the time of the visit. River levels were within their normal range at the time of the walkovers. A map showing the location of photos taken in the Ythan catchment is included in Appendix B.1.

6.2.1 River Ythan at Ellon

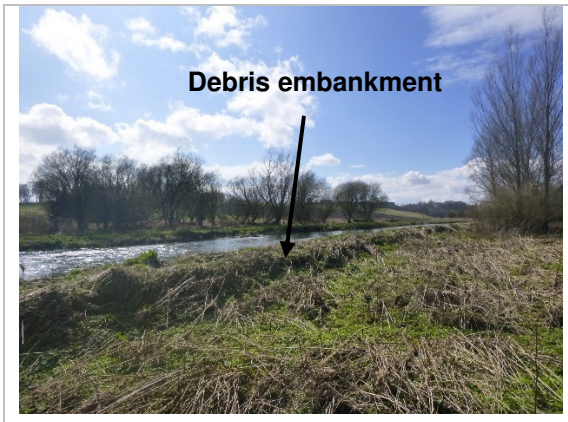
Between approximate Ordnance Survey National Grid Reference (OS NGR) NJ 961 303 and the A90 road bridge, the River Ythan flows in a wide, semi-meandering channel. There are no constraints on the watercourse and the banks are eroding allowing for channel migration and thus a continued 'Good' physical condition. Floodplain vegetation along the right bank is predominantly grassland (Figure 6-2, A) but areas of woodland and rougher vegetation are present on the left bank. The rougher vegetated regions of the left bank floodplain are actively storing water within the floodplain, with ponding and marshy areas were visible at the time of the walkover (Figure 6-2, D). Debris and vegetation have formed small, localised embankment like features along the left bank upstream of The Meadows (Figure 6-2, C). Along the right bank there is localised woodland planting upstream of the Meadows Way footbridge and a narrow buffer strip at the base of the agricultural fields that slope toward the Ythan. However, further riparian woodland and/or vegetation planting would encourage greater infiltration, as well as buffering runoff and sediment input from adjacent agricultural fields (Figure 6-2, B).

On the right bank between the Meadows Way footbridge and the A90 road bridge the floodplain is open grassland with low roughness to slow out-of-bank flow across the floodplain. Floodplain woodland planting is therefore an option in this area to increase roughness and infiltration upstream of the Meadows. The floodplain is already active however it may be possible to enhance its storage potential by creating an offline storage pond or a secondary channel through which water could be diverted during times of high flow. This would reduce the volume of water flowing towards the Meadows and Broomie's Burn confluence where a number of properties are located. Power lines (Figure 6-2, A) in this area of floodplain are however, a constraint that will need to be considered. It is highly recommended this area of wide, connected, active floodplain is maintained and protected from future development to maintain its flood storage potential.

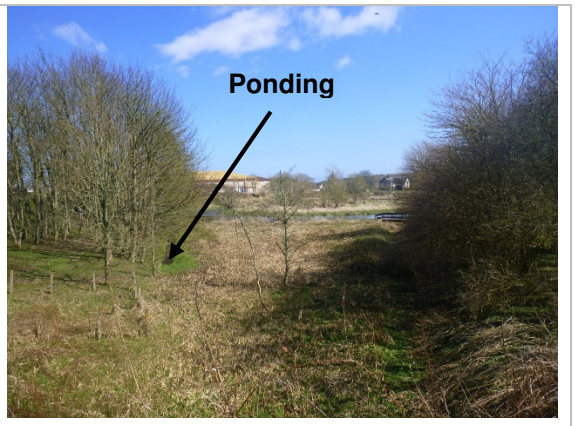
Figure 6-2: River Ythan near the Meadows

A: Potential right bank floodplain storage area. Note electricity pylon. Floodplain woodland planting is also an option. (OS NGR NJ 96764 30442)

B: Further planting in the right bank riparian zone recommended to reduce runoff. The river is flowing right to left. (OS NGR NJ 96570 30359)



C: Looking upstream. Right bank riparian woodland is buffering runoff from the adjacent fields. Greater vegetation and roughness present on the left bank which is storing water. Small debris embankments have formed along the right bank. (OS NGR NJ 96570 30359)



D: Dip in the left bank floodplain upstream of the Meadows footbridge and sports centre. Evidence of ponding and floodplain storage which should be maximised, and similar wetland type areas encouraged elsewhere in the floodplain. (OS NGR NJ 96745 30459)

Further upstream between the Ellon gauging station bridge and downstream of the Old Bridge of Ellon, the River Ythan continues in a relatively unconstrained, moderately eroding channel (Figure 6-3, B, C). Upstream and downstream of the Old Bridge of Ellon the right bank is forested and well vegetated which will act to slow and store water within this reach of the floodplain. By Meiklemill Primary School, the right bank slopes steeply down from the path that runs along the length of the river towards the Ellon gauging station bridge. Areas of riparian woodland are present as well as new planting, some of which hasn't taken (Figure 6-3, A). Floodplain storage on the right bank as indicated in the SEPA mapping is not likely due to the steep and narrow nature of the bank/ floodplain and proximity to properties. Continued riparian planting is however recommended to reduced fluvial and sediment runoff from the urbanised right bank. The left bank is less steep, more open and already well vegetated with natural woodland features such as small debris dams, developing to buffer runoff from the left bank urban areas (Figure 6-3, E).

Figure 6-3: River Ythan near the Meiklemill Primary School

A: Looking upstream from the Meiklemill Primary School bridge. River banks are eroding. New plating on steeper right bank and already wooded and vegetated left bank. (OS NGR NJ 95079 30274)

B: Looking downstream from the Meiklemill Primary School footbridge. Channel is moderately sinuous with eroding banks in-keeping with the 'Good' RBMP physical condition status. Riparian woodland is already present along both banks. (OS NGR NJ 95079 30274)

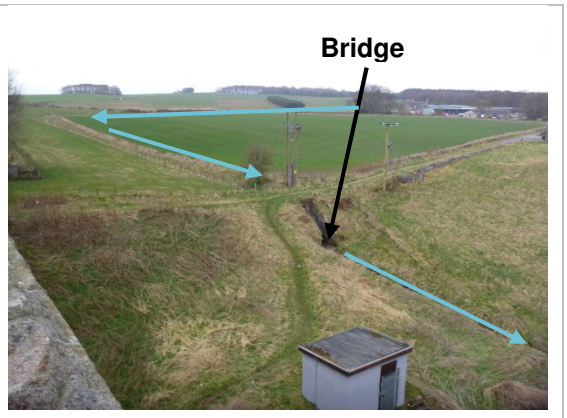
	
C: Right bank erosion along the River Ythan near Mieklemill Primary School. (OS NGR NJ 94869 30287)	D: Looking towards the wooded left bank where storage and woody debris dam features are already developing. (OS NGR NJ 94989 30253)
	
E: Drainage channel through the left bank floodplain with woody debris collecting in runoff channels. (OS NGR NJ 94975 30311)	

Upstream of the Ellon gauging station bridge, floodplain storage potential is again indicated along both banks. The left bank is wide, flat, open grassland which is forested as it slopes up towards the town reducing runoff, however a highly straightened drainage ditch runs across the floodplain discharging directly into the Ythan (Figure 6-4, A). It is recommended the drainage channel be meandered to slow flow towards the Ythan, as well as small debris dams emplaced to encourage out-of-bank flow and greater floodplain connection. This will work towards improving RBMP morphological and habitat status but will have limited overall impact on flood risk at Ellon due the proportionally small catchment, and therefore fluvial, contribution of the field drain. A storage pond, wetland or wet-woodland area could be created in this region to encourage greater floodplain storage and infiltration, increase floodplain roughness to slow flow and would have additional ecological and recreational benefits. Meiklemill Primary School is also located 10 mins walk downstream and an NFM project in this area would provide educational opportunities. However, any potential creation of a storage pond would require careful consideration and consultation with SEPA due to the presence of the gauging station, as modification to the floodplain characteristics and flow would impact upon the rating at the station. The right bank is also indicated to have floodplain storage potential however it is already an active floodplain and is more steeply sloped and narrow so no further recommendations have been made.

Similarly, to the drainage ditch on the left bank, the Meiklemill Burn flows into the Ythan from the east along the right bank in a highly straightened channel through agricultural land (Figure 6-4, B). It is recommended this too be meandered where possible, and a larger buffer strip planted to encourage greater infiltration of runoff from adjacent agricultural fields. In-stream debris dams may

be an option but careful consideration would need to be made of their potential to block the small bridge near its confluence with the Ythan (Figure 6-4, B).

Figure 6-4: River Ythan near Ellon gauging station

	
A: Left bank of the Ythan with highly straightened drainage ditch. Potential area of floodplain storage and/ or increased planting e.g. floodplain woodland. (OS NGR NJ 94714 30328)	B: Highly straightened Meiklemill Burn through agricultural land. Limited buffer strip and channel is relatively incised. From road to the gauging station in foreground the land is steeply sloped. (OS NGR NJ 94714 30328)

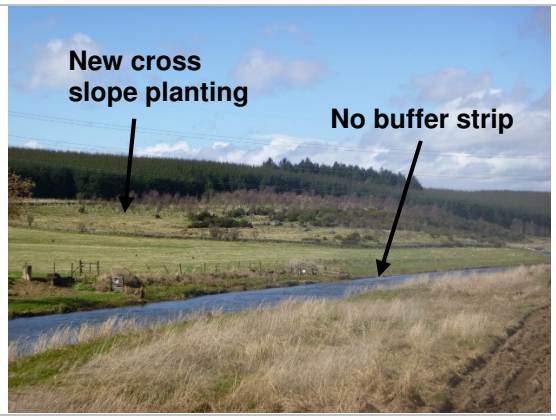
6.2.2 River Ythan near the Bridge of Ardlethen

Toward the western extent of the scheme in the vicinity of Bridge of Ardelthen (and Youlie/Bronie Burn confluence) the Ythan continues in a wide, unconstrained channel. Significant erosion was noted at the Youlie/ Bronie Burn confluence (Figure 6-6, C). Upstream of the bridge along the left bank there is a moderately large buffer strip from the agriculturally ploughed fields which is around 12 m wide and runs along the edge of the field for over 150 m (Figure 6-6, A). Further vegetation or riparian woodland could be planted which would increase infiltration, stabilise the banks and aid sediment trapping along a reach of the Ythan already indicated to be undergoing high deposition. The right bank in contrast slopes gently towards the river. A large area has been newly planted and a small dry-stone wall is also buffering hillside runoff (Figure 6-6, B) but no buffer strip is present along the bank edge and there is grazing to the bank edge which increases the potential for pollution from livestock and animal waste, and promotes potential waterborne diseases.

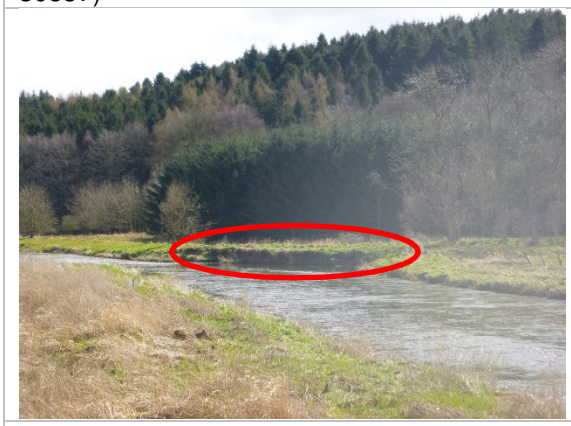
Approximately 2 km further upstream of the Bridge of Ardlethen, near the Ebrie Burn confluence (OS NGR NJ 921 324) a large pond is located on the right bank of the River Ythan. It could not be determined onsite whether the pond is directly connected to the Ythan at its upstream point. From aerial photography and OS mapping it would appear it is related to the quarry on the right bank and outflows into the Ythan downstream of the Ebrie confluence. The left bank of the Ythan near the confluence the floodplain has been planted with new woodland which will aid infiltration, storage and runoff reduction (Figure 6-6, D and E). A leaky dam could be created below the area of ponding (Figure 6-5, D) to increase floodplain storage further. Similar techniques could be applied elsewhere along the Ythan.

Figure 6-5: River Ythan between the Ebrie Burn and Youlie Burn confluence

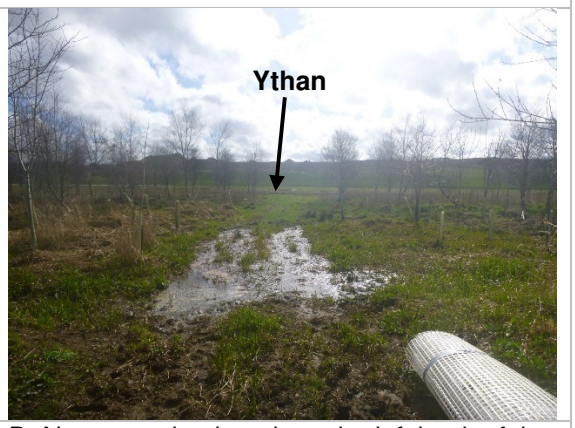
A: Looking upstream from the Bridge of Ardlethen. Further planting in the left bank buffer strip to increase roughness and infiltration recommended. (OS NGR NJ 92497 30837)



B: Looking toward the right bank with cross-slope planting but there is a lack of buffer strip along the margins of the Ythan. (OS NGR NJ 92497 30837)



C: Bank erosion at the Youlie Burn confluence. (OS NGR NJ 92497 30837)



D: New tree planting along the left bank of the Ythan, and ponding where a leaky dam could be created. (OS NGR NJ 92089 32375)

E: Young trees on the left bank and Ythan visible in the background. (OS NGR NJ 92089 32375)

6.2.3 River Ythan at Methlick

The Ythan was then observed at Methlick east of Fyvie Gorge where the SEPA NFM dataset indicates high potential for floodplain storage. The river flows in a wide, straight channel having undergone low impact realignment and is constrained by embankments at several locations. The floodplain is predominantly grazed grassland or ploughed fields, typical of the upper Ythan (Figure 6-6, B). Upstream of Methlick Bridge a large proportion of the upper slopes of the right bank are

forested however, the bank edges are grazed and no buffer strips present (Figure 6-6, A). There is less forestry along the left bank and it is similarly grazed with no buffer strip. A large pond is present (Figure 6-6, A) which is not linked to the Ythan, but is acting as a storage feature within the floodplain. Removal or setting back of the embankments would be recommended as well as buffer strip planting in the riparian zone. Downstream of Methlick Bridge floodplain storage potential was also indicated in the SEPA datasets. There is an area of rough ground adjacent to the playing field which could be used for wetland or a storage pond (Figure 6-6, C).

Figure 6-6: River Ythan at Methlick

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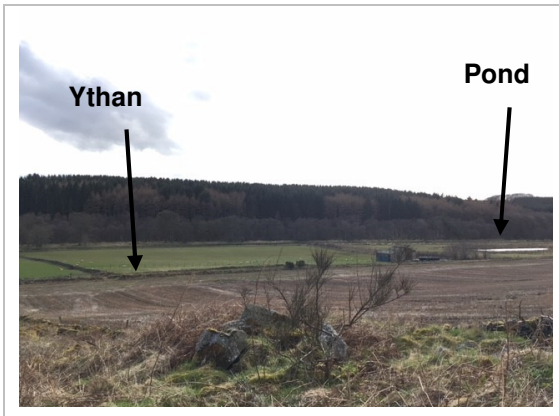
<tr><td> 
</td><td>  </td></tr>
<tr><td>A: Forested right bank and pond on left bank. The Ythan flows in a very straightened channel. Similar storage pond features on the left bank would buffer runoff from the low roughness agricultural land. (OS NGR NJ 85360 38165)</td><td>B: Looking downstream towards Methlick Bridge. The left bank is grazed with no buffer strip. Buffer strips and riparian woodland planting are recommended along this reach. Meandering the straightened river into these areas would involve loss of agricultural land. (OS NGR NJ 85354 38090)</td></tr>
<tr><td>  </td><td></td></tr>
<tr><td>C: Looking downstream from Methlick Bridge. Area of land adjacent to the playing fields with wetland and/ or floodplain storage pond potential. (OS NGR NJ 85701 37554)</td><td></td></tr>
</table>

6.3 Summary and recommendations

Within the scheme reach there are no significant morphological pressures and the River Ythan is already in 'Good' physical condition. This was confirmed during the site walkover and recommendations would therefore be to ensure any flood protection works do not add significant constraints to the watercourse in order to ensure its continued 'Good' status.

The SEPA NFM dataset indicated high floodplain storage potential along the majority of the scheme extent. Much of the floodplain is already well vegetated with a high proportion of floodplain woodland planting encouraging infiltration and storage and buffering runoff from the town. Further potential for increased floodplain storage as indicated in the SEPA dataset was identified, namely on the right bank of the Ythan near the Meadows Way footbridge and on the left bank at Ellon gauging station

where a storage pond/ wetland/ wet-woodland area could be created. By the Meadows this would slow and reduce out-of-bank flow towards the Meadows properties, however by the gauging station any storage would require careful consideration on the potential impact on gauging station flows. Medium runoff reduction potential is indicated in the SEPA datasets predominantly to the north of Ellon. Runoff reduction measures were identified during the site visit but are discussed in further detail in the following chapters as they fall within the Modley and Broomie's Burn sub-catchments.

Outwith the scheme extent, the River Ythan is classified as being in 'Moderate' physical condition upstream of Fyvie but physical constraints affect the watercourse from upstream of Methlick. At Methlick the Ythan has undergone low impact realignment and there are embankments along both banks. Meandering of this reach to increase sinuosity would involve loss of agricultural land, however potential to remove or set-back embankments was identified to encourage greater floodplain connectivity. NFM opportunities indicated in the SEPA datasets included high to medium floodplain storage potential along the majority of the Ythan, as well as medium runoff reduction potential particularly through the Fyvie Gorge region. Similarly to improving the RBMP status, NFM opportunities are constrained in the upper catchment by the agricultural nature of the land. Areas for floodplain storage are generally grazed pasture and would require significant landowner engagement.

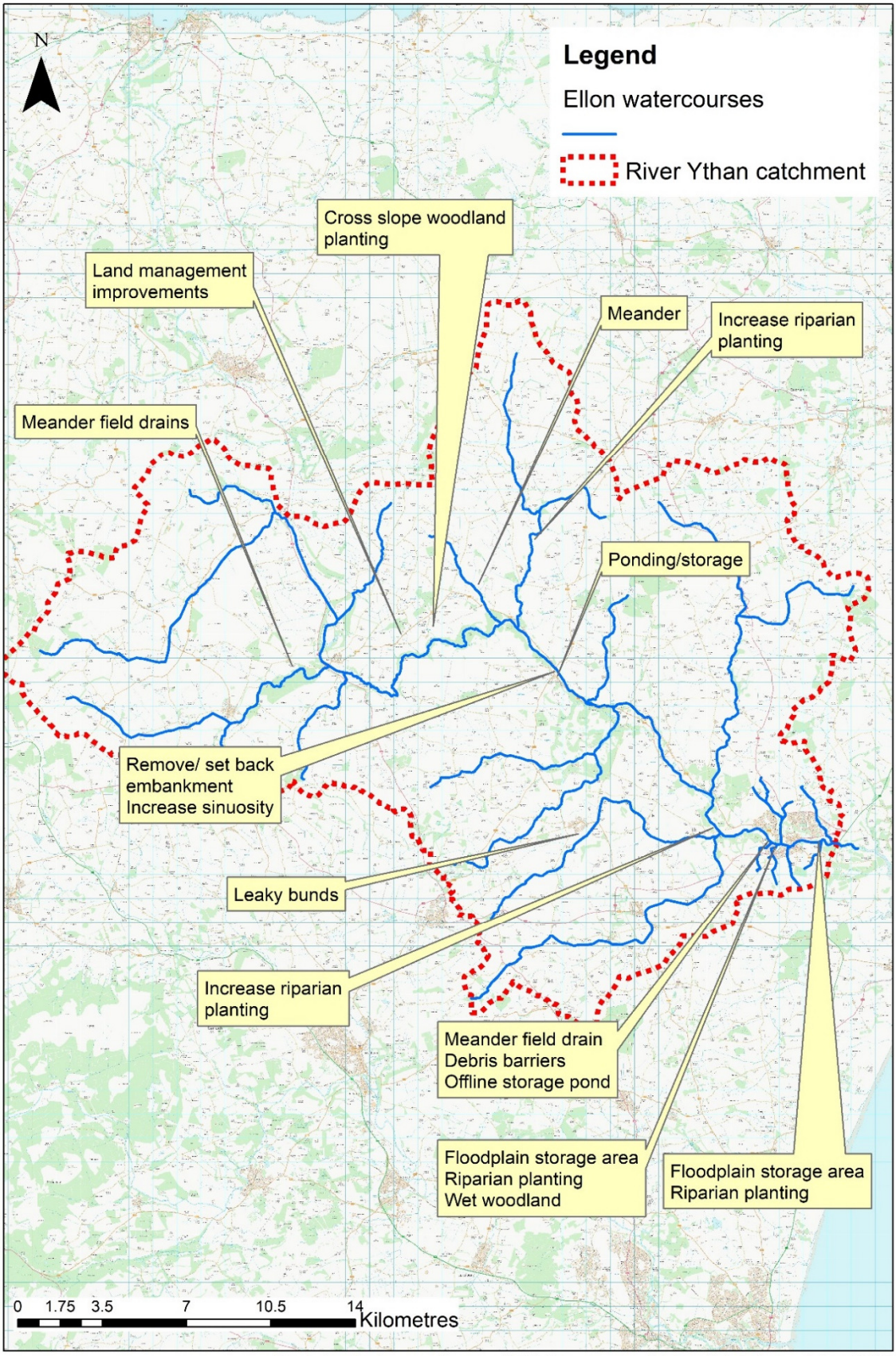
Overall, land management improvements such as meandering of straightened drainage ditches; in-stream debris dams; buffer strips and hedgerow planting are the key NFM recommendations for such an agriculturally dominated catchment. This will limit runoff, sediment input and improve floodplain connectivity to reduce flow from the upper catchment towards the urbanised areas further downstream. This will also benefit the RBMP status through reduction of sediment and pollutants into the River Ythan. The majority of the tributaries are also classified as being in 'Moderate' physical condition predominantly due to channel capacity being taken up by embankments and realignment. Capacity release and improvement in status is therefore high where these are able to be removed or set back and sinuosity restored. Additionally, improved floodplain connectivity and increasing channel length along the tributaries will reduce flow to the main Ythan.

Key recommendations based on the site visits and applicable to the wider catchment are as follows:

- Meander straightened field drains, particularly in the upper catchment, to slow flow to the main Ythan. For example, in the Rothienorman (Fordoun Burn) region.
- Increase the area of buffer strip to at least 6 m at field boundaries (as per Aberdeenshire Council guidelines[19]) and plant a variety of vegetation e.g. gorse, which will increase roughness, encourage infiltration and trap sediment and pollutants.
- Bunds at key locations along field boundaries to reduce runoff.
- Maximise and encourage areas of storage and ponding along the Ythan floodplain e.g. through riparian woodland planting, floodplain storage ponds and wetlands.
- Remove or set-back embankments at key locations to increase the capacity of the channel and encourage greater floodplain connectivity e.g. near Methlick, which has both NFM and RBMP benefits.
- Potential for large floodplain storage features such as a storage pond or wetland in key locations e.g. upstream of the Meadows (Figure 6-2, A) and by Methlick Bridge (Figure 6-6, C).
- Land management improvements to reduce bare earth and therefore runoff through the Fyvie Gorge. Cross slope woodland planting within the gorge is recommended.
- Along contour ploughing to act as natural management for reducing sediment and water runoff.
- Riparian woodland planting along watercourses similar to that along the Ebrie catchment (Chapter 11).
- Meander straightened watercourses e.g. the Burn of Stonehouse, to delay runoff to the main River Ythan.

19 Aberdeenshire Council. Planning Advice: Buffer Strip Guidance [Accessed 24/08/18] https://www.aberdeenshire.gov.uk/media/21345/2015_09-buffer-strips-planning-advice.pdf

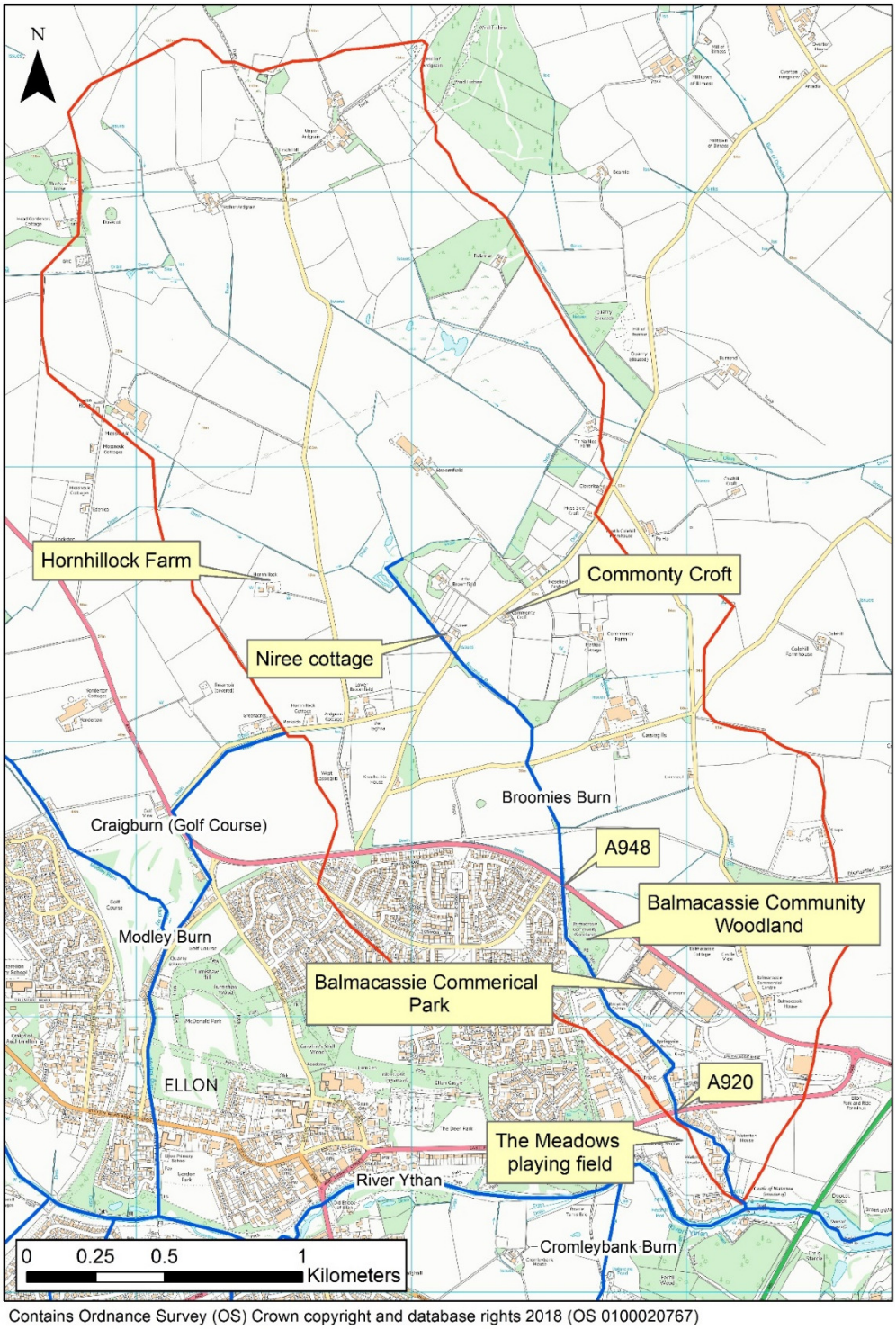
Figure 6-7: Ythan catchment NFM opportunities



7 Broomie's Burn

The Broomie's Burn is a small tributary of the River Ythan with a catchment area of approximately 6 km^2. The burn originates as a series of field drains to the north of Ellon in rural, agricultural land. It flows south towards Ellon where is passes beneath the A948, flows through Balmacassie Community Woodland becoming relatively more constrained in its lower urbanised reaches. As the catchment is less than 10 km^2 the watercourse has not been classified within the RBMP or morphological pressures datasets. The SEPA NFM dataset indicates runoff reduction potential in the upper, rural area of the catchment and floodplain storage along the middle reaches of the burn between the Balmacassie Woodland and the A920.

Figure 7-1: Broomie's Burn key locations



7.1 Site walkover findings

The site visit for the Broomie's Burn catchment took place over the 16 and 17 April 2018. Weather conditions on the day of the walkovers were bright, clear and dry. Conditions in the week prior to the visit had been mixed with periods of rain throughout the week. A map showing the location of photos taken in the Broomies catchment is included in Appendix B.2.

7.1.1 Upper catchment

The upper catchment is defined as the area north of the A948. The burn was observed approximately 1.5 km north of the A948 in the vicinity of Hornhillock Farm and Commonty Croft. The burn originates as a series of small channels and drainage ditches that cross the agricultural fields. To the west of the minor road near Hornhillock Farm the watercourse runs in a highly straightened channel between two fields. A small buffer strip is present along both banks and is fenced along the left bank to prevent livestock grazing to the bank edge. A straightened roadside drainage ditch flows south into the burn just before it is culverted beneath the road toward Niree Cottage (Figure 7-2, A). To the east side of the minor road the burn fans into a series of smaller, meandering channels across an area of less cultivated land where small ponds have formed (Figure 7-2, D). Proposed NFM measures in this area include: planting further vegetation e.g. gorse in the buffer strips upstream of the culvert to limit runoff from the fields; leaky bund along the right bank field boundary where surface water ponding was visible (Figure 7-2, B); in-stream debris dams to encourage greater floodplain connectivity in the less cultivated land to the east of the culvert and maximising storage in the ponds by building small bunds or debris dams to enlarge the areas of ponding.

Downstream of the ponds the Broomie's Burn flows into a more confined and straightened channel. The left bank is higher and forested parallel to Niree Farm (Figure 7-2, E) while the right bank is open ploughed land. This section of channel was much more polluted and sluggish (Figure 7-2, F and G) with sediment input high from the adjacent right bank field and through erosion of the left bank. Suggested NFM measures include: meandering into the uncultivated floodplain on the right bank, install small debris dams to encourage out-of-bank floodplain connection, sediment trap(s) along the right bank (Figure 7-2, E) and/ or buffer strip planting to actively achieve the North East LPD goal of sediment management (Section 4.3) within the Broomie's Burn. The burn then flows beneath the minor road to the south of Niree Cottage (Figure 7-2, H) where the SEPA NFM dataset indicates medium floodplain storage potential. Ponding on the left bank at the base of the field was visible at the time of the visit and a leaky bund would aid runoff retention. The right bank is already wooded and contributing woody debris within the channel creating natural dam-like features to slow flow (Figure 7-2, I) and the woodland may act as storage at times of peak flow.

Further downstream the burn is straightened through agricultural fields (Figure 7-2, J) flowing toward a culvert beneath the A948. At this point the channel is relatively incised and the adjacent land slopes toward the main channel. At the upstream face of the A948 culvert a large volume of sediment is input to the burn via a straightened field drainage ditch from the west (Figure 7-2, K). It is recommended increasing the buffer strip along both banks and installing leaky bunds at the field boundaries which slope toward the incised channel to reduce runoff and sediment input. Meandering is unlikely due to channel incision and debris dams pose a risk of blockage to the road culvert.

Figure 7-2: Upper Broomie's Burn catchment

A: Looking upstream toward Hornhillock Farm. Highly straightened Broomie's channel with roadside drainage entering from the north. Increasing vegetation within the buffer strips recommended. (OS NGR NJ 95667 32616)

B: Surface water ponding on the right bank (watercourse is to right of image). Leaky bund could be built at the field boundary to limit runoff to the main channel. (OS NGR NJ 95667 32616)

C: Culvert beneath minor road at which point the burn fans out across less cultivated land. Water pooling at the culvert outlet. (OS NGR NJ 95667 32616)

D: Ponds in the uncultivated land between the minor road and Niree Cottage. Bunds and woody debris dams could be installed to maximise storage. (OS NGR NJ 95999 32486)

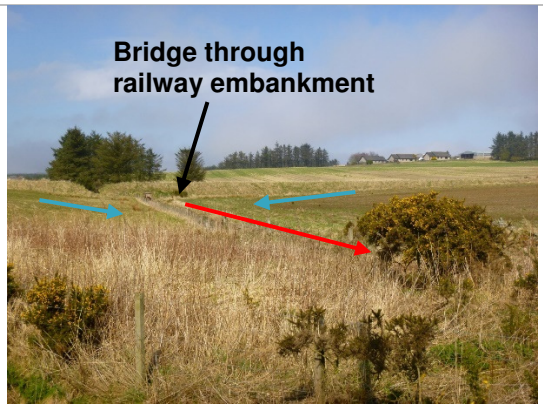
E: Looking downstream along the Broomie's Burn by Niree cottage. Meandering, debris dams and sediment traps on the right bank recommended. (OS NGR NJ 95975 32546)

F: Polluted, sediment rich runoff from the cultivated fields entering along the right bank. Steep, eroding left bank is also contributing sediment. (OS NGR NJ 96139 32343)

G: Flow pathway and polluted waters entering the Broomie's Burn. (OS NGR NJ 96139 32343)

H: Small bridge beneath the minor road by Commonty Croft with brick wingwalls. (OS NGR NJ 96149 32318)

I: Area indicated as having floodplain storage potential in the SEPA NFM datasets. A leaky bund in the field corner would aid runoff and sediment reduction to the main channel. Limited buffer strip on the left bank but forested right bank. (OS NGR NJ 96149 32318)



J: Highly straightened Broomie's Burn north of the A948. Land slopes towards burn where there is a minimal buffer strip. Channel moderately incised. Increasing area of buffer strip recommended. (OS NGR NJ 96553 31498)

K: Upstream face of the A948 culvert. Drainage ditch inputting sediment and runoff. (OS NGR NJ 96553 31498)

7.1.2 Lower catchment

The lower catchment is defined as the area south of the A948 to the Broomie's Burn confluence with the River Ythan near the Meadows. The Broomie's Burn exits the A948 culvert and flows in a relatively straightened channel parallel to Portsoy Crescent (Figure 7-3, C). The right bank is steep and the channel morphology is constrained by the properties, with sections of the channel lined by brick wall. The left bank in contrast is less constrained and well vegetated (Figure 7-3, B), although there is a section of grey-bank rip rap by the culvert outlet (Figure 7-3, A) and further downstream a line of boulders is acting as a constraint (Figure 7-3, E). Set-back or removal of these would allow for greater floodplain connectivity. Downstream of the Balmacassie woodland the burn is much less constrained. Several runoff pathways were visible from the woodland trail (Figure 7-3, F) and at the edge of footbridges (Figure 7-3, G) toward the Broomie's channel, which is contributing sediment to the watercourse. Ensuring the buffer strip is maintained and erosion channels minimised will reduce sediment influx and work towards the LPD aim of controlling sediment within the channel.

Upstream of the Balmacassie Way bridge by the Balmacassie Commercial Park the land slopes steeply towards the watercourse (Figure 7-3, H and I). The bank is currently vegetated but riparian woodland and vegetation planting is suggested to encourage continued infiltration as well as slow runoff and reduce pollutants from the industrial area. A leaky bund would also reduce sediment and pollutant runoff into the watercourse (Figure 7-3, I). Downstream of the footbridge the right bank is steeply sloped but already planted with riparian woodland. The left bank in contrast opens out and there is a large, open area of floodplain (Figure 7-3, J). This area is ideal for re-meandering, storage pond(s) and floodplain woodland planting, additionally in-stream debris dams to encourage out-of-bank flow onto the floodplain is recommended. These measures would increase storage upstream of the urbanised Meadows area of the catchment. A short distance downstream the burn meanders past industrial properties where both banks are vegetated and eroding (Figure 7-3, K) but floodplain storage potential as indicated in the SEPA mapping is limited due to the banks being urbanised. Woodland along the banks is already contributing woody debris to the channel.

Figure 7-3: Broomie's Burn catchment between Balmacassie woodland and the A920

A: Grey bank rip-rap along the Broomie's Burn at the outlet of the A948 culvert. (OS NGR NJ 96554 31470)

B: Looking downstream from the top of the Balmacassie Woodland. Steep but vegetated right bank which back onto a number of properties. Left bank is less constrained and well vegetated. (OS NGR NJ 96554 31470)

C: Straightened and relatively more confined Broomie's Burn with properties backing onto the right bank through the Balmacassie Woodland. (OS NGR NJ 96560 31392)

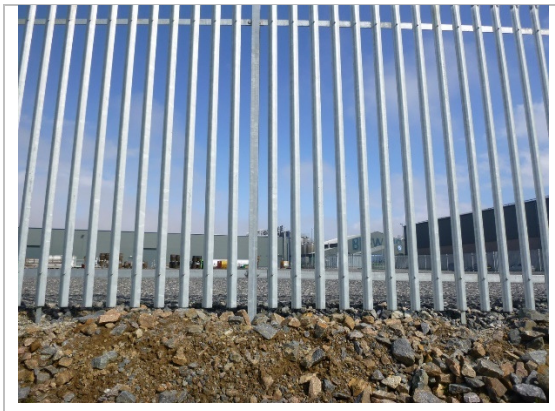
D: Left bank footpath and floodplain. Broomie's Burn highlighted in blue. (OS NGR NJ 96560 31392)

E: Channel constrained on right bank by Portsoy Crescent properties. The line of boulders on the left bank are also constraining it and it is recommended they be removed. (OS NGR NJ 96562 31293)

F: Runoff and sediment input from the footpath to the Broomie's Burn should be minimised. (OS NGR NJ 96562 31293)

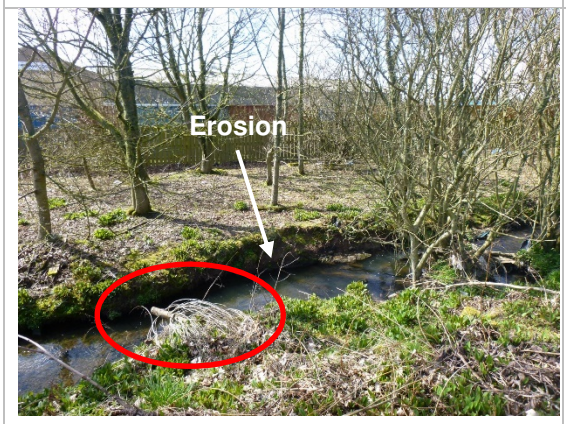
G: Scour and sediment input at the edge of a new footbridge through the Balmacassie woodland. (OS NGR NJ 96663 31152)

H: Looking downstream from the community woodland towards the Balmacassie bridge. BrewDog factory to the right with runoff directed downslope towards the burn. Riparian woodland planting recommended. (OS NGR NJ 96663 31152)



I: Balmacassie Commerical Park where runoff, sediment and pollutants are originating. Leaky bund and floodplain planting recommended to reduce pollutant influx to the Broomie's. (OS NGR NJ 96777 31051)

J: Looking downstream from the Balmacassie bridge. Open, flat, unused left bank floodplain where the Broomie's Burn could be meandered, storage ponds and wetland area created. (OS NGR NJ 96688 31094)



K: Upstream of the A920 road bridge, erosion along the right bank. Riparian woodland planting is contributing woody debris to the channel which acts to slow flow. (OS NGR NJ 96961 30695)

L: Upstream face of the A920 road culvert. Minimising upstream sediment input reduces the potential for culvert blockage and therefore flood risk. (OS NGR NJ 96956 30664)

Downstream of the A920 the Broomie's Burn flows along the margin of the Meadows playing fields and parallel to a number of properties (Figure 7-4, B) A large embankment runs along the length of the right bank (Figure 7-4, B) limiting floodplain connection to the playing fields. The left bank is also steep and abuts onto a number of properties and is also therefore not suitable for floodplain storage as indicated in the SEPA mapping. Setting back and/ or lowering the right bank embankment to encourage out-of-bank flow onto the margins of the playing fields would reduce rapid conveyance toward the Ythan by improving the Broomie's floodplain connectivity. Surface runoff from the playing fields is also known to be a flood risk to the Meadows properties at its southern margin, therefore the storage potential of the playing fields could be further enhanced through creation of a leaky bund north of the properties.

The Broomie's is further constrained and canalised east of the Meadows where is flows through a number of back gardens (Figure 7-4, F) with grey bank protection on both banks. The final few hundred metres are less constrained where the burn flows through a small area of woodland (Figure 7-4, C). Debris at the Ythan confluence was noted and it appeared runoff is directed from the adjacent agricultural field and road (Figure 7-4, D). The bank protection is also crumbling into the Broomie's Burn near the confluence which has the potential to become a blockage back up the Broomie's Burn towards the properties (Figure 7-4, E).

Figure 7-4: Broomie's Burn catchment south of the A920

	
A: Downstream face of A920 road culvert. Steep left and right bank. Woody debris in the channel. Channel banks are eroding. (OS NGR NJ 96944 30642)	B: Looking upstream from the Meadows. The right bank is constrained by the embankment and the left bank by properties. (OS NGR NJ 97054 30580)
	
C: Lower reach of the Broomie's Burn where the floodplain opens out through a small woodland. (OS NGR NJ 97140 30453)	D: Debris wrack mark on left bank. Agricultural field in the background and road to the left of the image are flow pathways. (OS NGR NJ 97140 30453)
	
E: Crumbling bank protection at the outlet of the Broomie's to the Ythan. If left this may cause a blockage at the downstream boundary of the Broomie's. (OS NGR NJ 97173 30355)	F: Constrained canalised Broomie's Burn through the properties to the east of the Meadows. (OS NGR NJ 97054 30580)

7.2 Summary and Recommendations

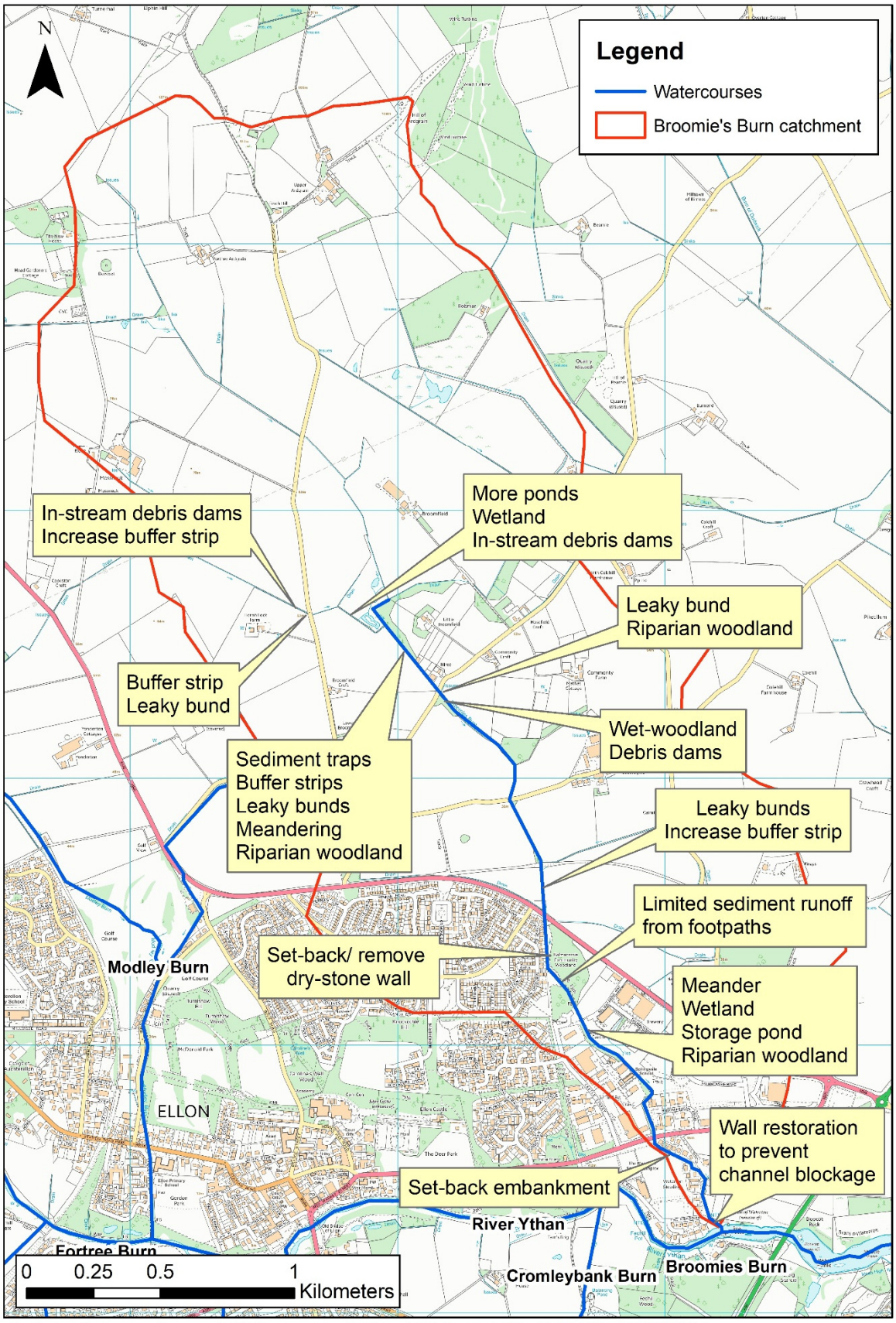
The Broomie's Burn has a small, gently sloping, predominantly agricultural catchment. Overall many NFM and RBMP opportunities were identified during the site visits which would reduce the risk of flooding to Ellon.

In its upper region (north of Commonty Croft) the burn is relatively unconstrained but sediment input and runoff to the channel is high. A number of opportunities to reduce runoff, manage sediment and pollutant input and increase upland storage were identified. South of Commonty Croft and in the lower region of the catchment (south of the A948) the Broomie's Burn becomes relatively more constrained however, a number of NFM and opportunities for reducing morphological pressures were identified.

Key recommendations based on the site visits are as follows:

- Re-meander over straightened field drains in the upper catchment.
- Increase the area of buffer strip at field boundaries, ideally 6 m[19], and plant a variety of vegetation e.g. gorse to increase roughness, encourage infiltration and trap sediment e.g. by Hornhillock Farm.
- Install bunds at key locations at field boundaries to reduce runoff directly to the burn.
- Maximise ponding and upper catchment storage already occurring by Niree Cottage by building small bunds and debris dams. This land is currently uncultivated and would not therefore involve loss of productive land.
- Sediment traps in the upper catchment e.g. along the right bank of the Broomie's near Niree cottage to reduce sediment and pollutant runoff to the Broomie's.
- Remove or set-back embankments at key locations to increase the capacity of the channel and encourage greater floodplain connection e.g. removal of the left bank dry-stone wall through Balmacassie woodland and the right bank embankment at the Meadows playing field.
- Create a wetland or floodplain storage areas along the left bank of the Broomie's Burn downstream of the Balmacassie Woodland to store and reduce flow upstream of the Meadows properties. This has added ecological and amenity multi-benefits.
- Minimise sediment runoff pathways from tracks and bridges as well as potential blockages e.g. wall collapse, within the Broomie's Burn.

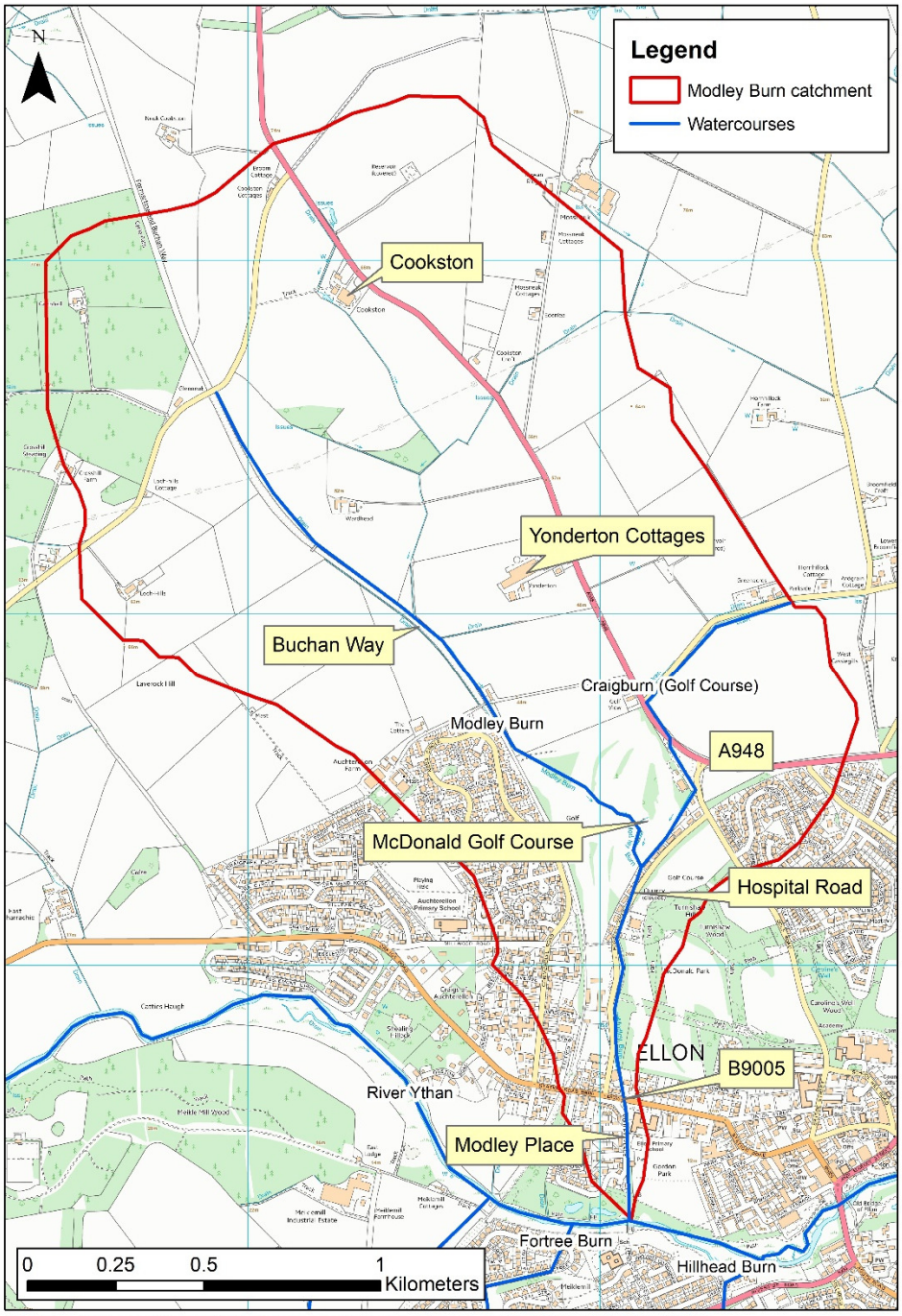
Figure 7-5: Broomie's catchment NFM opportunities



8 Modley Burn

The Modley Burn is a small tributary of the River Ythan with a catchment area of approximately 4 km^2. The burn originates near Cookston Farm to the north of Ellon in rural, agricultural land where a number of drainage channels discharge into it. As the burn approaches Ellon it changes course to flow east through the golf course where another small tributary joins from the northeast. The burn is culverted beneath, and then flows adjacent to, Hospital Road south of McDonald Golf Course, becoming increasingly constrained and straightened through Ellon due to urbanisation. As the catchment is less than 10 km^2 the watercourse has not been classified within the RBMP or SEPA morphological pressures datasets. The SEPA NFM datasets indicates medium runoff reduction potential in the lower catchment near the golf course, as well as floodplain storage through the golf course north of Hospital Road.

Figure 8-1: Modley Burn key locations



8.1 Site walkover findings

The site visit for the Modley Burn catchment took place over the 16 and 17 April 2018. Weather conditions on the day of the walkovers were bright, clear and dry. Conditions in the week prior to the visit had been mixed with periods of rain throughout the week. A map showing the location of photos taken in the Modley catchment is included in Appendix B.3.

8.1.1 Source at Cookston Farm and the upper catchment

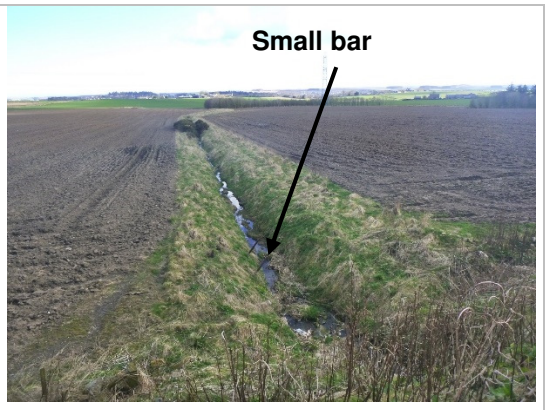
The upper catchment is defined as the area north of Ellon golf course. At Cookston Farm, where the burn originates, the watercourse was found to be highly straightened and in poor condition. The channel banks were well vegetated; the channel itself overgrown and sluggish (Figure 8-2, A); bank erosion is contributing large volumes of sediment (Figure 8-2, B) and additional debris e.g. large concrete blocks had almost completely blocked the culvert beneath Cookston Farm (Figure 8-2, C). Downstream of the farm towards the golf course the Modley Burn is highly straightened bound by very steep, vegetated banks (Figure 8-2, D) and a large volume of sediment and debris was still present in the channel. It is recommended the condition of the watercourse be improved, particularly in relation to sediment volumes which is also highlighted as a key action in the North East LPD (Section 3.4). Due to the steep banks, meandering of the Modley Burn downstream of Cookston Farm is limited but maintaining varied geomorphological features such as the small bars as seen at the time of the site visit should be beneficial. Additional planting e.g. of gorse along the banks within this reach would also be recommended to increase channel roughness. Further downstream by Yonderton Cottages the Modley Burn still flows in a highly over-straightened channel with a straightened field drainage ditch discharging into it from the north, as is typical in this upper region of the catchment (Figure 8-2, E). Meandering of the Modley Burn through the right bank floodplain which was uncultivated and in-stream debris dams to encourage out-of-bank flow in this region are recommended.

Figure 8-2: Modley Burn at Cookston Farm

A: Upper Modley Burn by Cookston Farm. Straightened channel with steep sided banks and overgrown channel. (OS NGR NJ 94203 32919)

B: Significant erosion and sediment input at Cookston Farm on the inside of the left bank meander. (OS NGR NJ 94203 32919)

C: Large concrete block and sediment accumulation blocking the culvert entrance and causing pooling upstream. (OS NGR NJ 94236 32889)



D: Looking downstream of Cookston toward the golf course. Highly straightened channel with steep banks of either side. Increasing the area of buffer strip recommended. (OS NGR NJ 94289 32849)

E: Straightened tributary drainage channel and Modley Burn with uncultivated right bank floodplain which could be used for meandering or storage. (OS NGR NJ 94473 31995)

8.1.2 Modley Burn at Ellon Golf Course

From Yonderton Cottage the Modley Burn runs adjacent to the Buchan Way where a secondary channel merges into the main Modley Burn west of the golf course. The channel at this point is relatively unconstrained (Figure 8-3, A and B) and recommended NFM measures include riparian woodland, hedgerows, buffer strips and leaky bunds to buffer runoff from the adjacent agricultural field. As the Modley Burn initially enters the golf course it maintains a semi-meandering nature and flows through a small woodland where the banks are eroding and woody debris is accumulating in the channel (Figure 8-3, D).

However, further downstream the watercourse has been highly modified: the channel is narrow, shallow and been lined with brick preventing natural erosion and channel migration across the golf course (Figure 8-3, F). There are also a series of culverts and bridges along the watercourse (Figure 8-3, G). Any modifications to the burn in this area would require considerable engagement with the golf course. However, it may be possible to integrate NFM features within the golf course while maintaining and adding to its recreational value. For example, the woodland could be made into a wet-woodland with greater floodplain storage capacity and this would not involve loss of the green. Small storage ponds or wetland areas may also be able to be integrated into the landscape which has additional ecological value.

Figure 8-3: Modley Burn at the Golf Course

	
A: Looking downstream from the Buchan Way toward the golf course. Recommended NFM includes riparian woodland or hedgerow planting at the field boundary or leaky bunds to reduce runoff to the main burn. (OS NGR NJ 94741 31625)	B: Straightened channel as the burn initially enters the golf course. (OS NGR NJ 94741 31625)
	
C: Looking downstream in the golf course toward the woodland. (OS NGR NJ 94810 31587)	D: Modley Burn through the wooded area of the golf course. This area could be made into a wet woodland with instream debris-dams to encourage greater floodplain connection and storage. This would have minimal disruption to the golf course green. (OS NGR NJ 94852 31563)
	
E: Straightened section of channel through the woodland. Meandering recommended. (OS NGR NJ 94916 31529)	F: Looking upstream towards the woodland. The Modley Burn is very straightened, runoff is high from the golf green and minor erosion of

	the channel was observed. (OS NGR NJ 94956 31506)
	
G: Canalised Modley Burn with bricked channel edges inhibiting channel migration. Culverts and bridges are also a common feature thought the golf course. (OS NGR NJ 94994 31469)	H: Modley Burn in the area of golf course south of Hospital Road. Channel is wider but incised and bound by steep banks. Sediment input is high from eroding banks. (OS NGR NJ 95058 31042)

8.1.3 The Modley Burn tributary at Hospital Road

A tributary originating north of the A948 flows southwest into the Modley Burn on the eastern side of Hospital Road. Flooding has been known to occur in this area. The watercourse emerges on the south side of the A948 from one culvert, entering another with a trash screen approximately 3 m later. The trash screen at the time of the visit was half full (Figure 8-4, A) and the water in the channel stagnant. Leaf litter and other debris is washed round the wingwall of the culvert from the road. It is suggested a water retention feature in the fenced area to the south of the road be installed to slow and reduce runoff into the culverted channel which ultimately discharges into the Modley Burn.

Downstream the tributary channel exits the second culvert into a very straightened channel that flows parallel to the Hospital Road properties (Figure 8-4, B). The right bank is wooded and it is suggested that the burn be meandered into the area. The burn has incised at this point however, and therefore linking the watercourse with the floodplain may be difficult and require excavation. The left bank is constrained by the Hospital Road properties.

Figure 8-4: Modley Burn tributary

	
A: Trash screen half blocked with trash. Red arrows indicate runoff and debris flowpath. Potential storage pond area to the north of the culverted channel. (OS NGR NJ 95262 31492)	B: Straightened channel west of Hospital Road. Left bank is constrained by properties, but land on right bank could be excavated to allow for meandering. (OS NGR NJ 95233 31446)

8.1.4 The Modley Burn through Ellon

The Modley Burn flows through the southern portion of the golf course adjacent to Hospital Road in a wider channel but is constrained by deep, steep banks, erosion of which is inputting large volumes of sediment (Figure 8-3, H). South of the golf course, downstream of the B9005 the burn becomes increasingly constrained and incised and is walled on both sides through the lower urban areas of Ellon (Figure 8-5, A). Adjacent to Modley Place and Ellon Primary School the left bank wall is in very poor condition: it has collapsed in some areas and bank erosion and undercutting is occurring (Figure 8-5, E) contributing large sediment fractions to the watercourse. The right bank wall collapsed during previous flooding events causing water to flow out of the watercourse and flood the garages adjacent to it, and it is therefore recommended that the wall is repaired to reduce flood risk. Runoff from pathways was also observed (Figure 8-5, C). Opportunities to meander the watercourse or connect to the floodplain are limited due to the urbanised nature of the banks, however it is recommended the condition of the restraining walls be improved to prevent the high degree of erosion and large debris input into the channel, which has potential to cause blockages and takes up channel capacity increasing the potential for flooding. The very final few metres of the Modley Burn to the Ythan confluence are unconstrained where it meets the Ythan floodplain (Figure 8-5, F). The ground has undergone poaching from dogs and other animals, and there is an abundance of fine sediments that have the potential to enter the watercourse. It is recommended that this area of land is fenced to reduce soil compaction, allow re-vegetation of the floodplain and a leaky bund would reduce the inflow of fine sediments into the watercourse.

Figure 8-5: Lower Modley Burn

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>A: Looking upstream from the B9005 road bridge. Channel is constrained by walls and the floodplain is developed on both banks. (OS NGR NJ 95069 30619)</td><td>B: Downstream of the B9005 road bridge the burn is constrained on both sides walls. Modley Place road and properties are to the right of the image. (OS NGR NJ 95069 30619)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>C: Flow pathway and sediment input to the Modley Burn by Ellon Primary School. (OS NGR NJ 95078 30568)</td><td>D: Grey bank gabion baskets along the Modley Burn near Ellon Primary School. (OS NGR NJ 95078 30568)</td></tr>
</table>

E: Eroding left and right bank, wall failure and high sediment input. (OS NGR NJ 95081 30454)

F: Unconstrained final reach of the Modley Burn with open floodplain. Poaching has occurred and fencing off this area would reduce soil compaction and allow re-vegetation of the floodplain. (OS NGR NJ 95085 30330)

8.2 Summary and Recommendations

The Modley Burn catchment is small and land use varied for such a small catchment. The burn is significantly more constrained and modified than the Broomie's Burn and opportunities to improve the watercourse condition in line with the RBMP objectives are limited due to the nature of the surrounding land use: the burn flows through Ellon golf course and is then highly urbanised for it final few hundred metres.

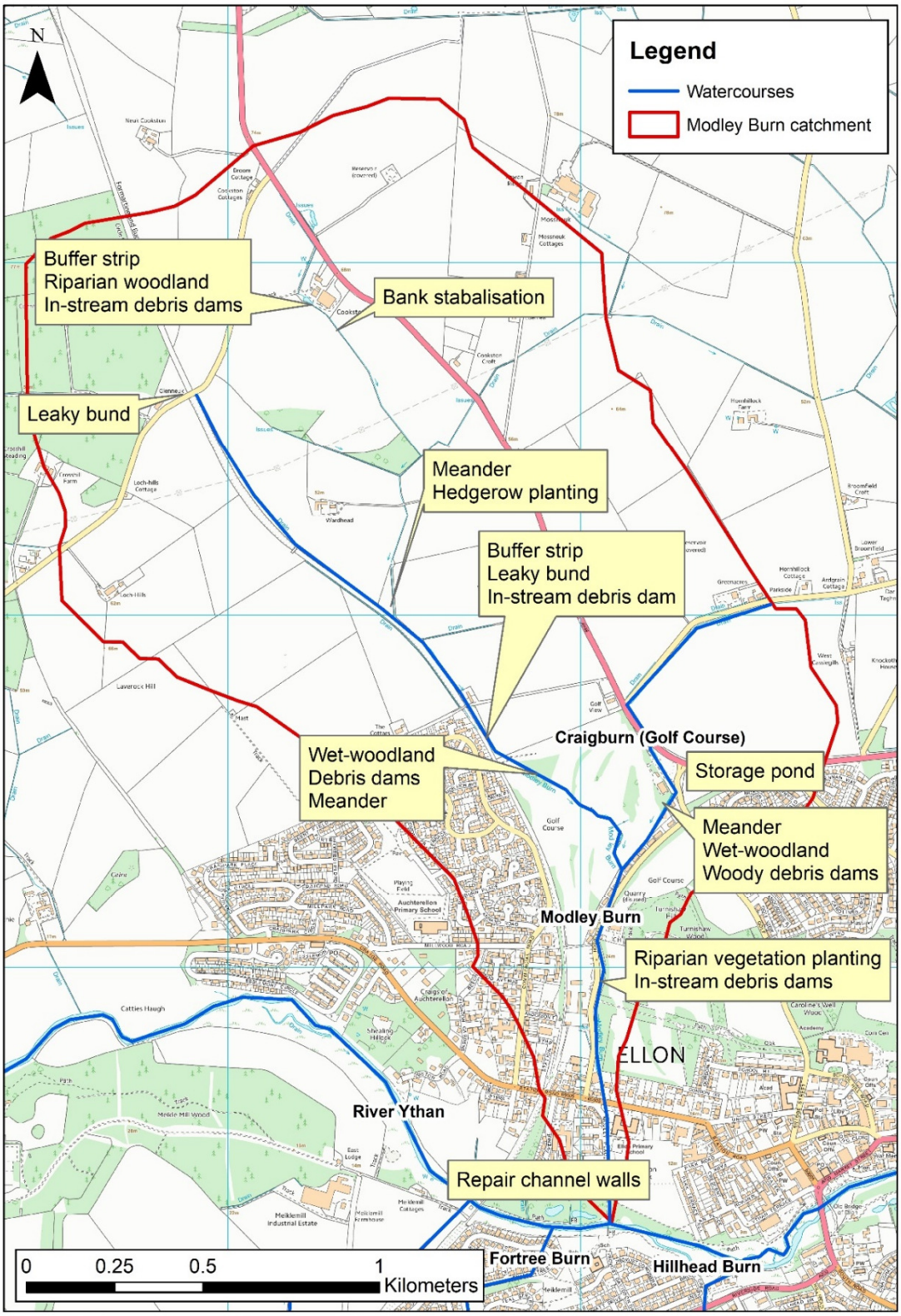
NFM opportunities across the catchment are high but particularly in the northern upper region. Here land use is predominantly agricultural, the watercourse is relatively unconstrained but straightened and there are a number of opportunities for sediment management and runoff reduction. As the burn flows through Ellon golf course it has undergone significant anthropogenic modification. There is potential to improve the physical condition and implement NFM measures which would require considerable stakeholder engagement but has the opportunity for educational, amenity and ecological multi-benefits. The final 300 m from the B9005 to its confluence with the River Ythan the Modley Burn is highly constrained with limited NFM and RBMP opportunities. The key recommendation being repairs to the channel walls to prevent large debris input, undercutting and erosion of the banks.

Key recommendations based on the site visits are as follows:

- Improve the physical and hydrological condition of the Modley Burn, particularly at its source by Cookston Farm, to minimise sediment and debris input. This also addresses the North East LPD objective of sediment management along the Modley Burn.
- Where possible re-meander over straightened field drains in the upper catchment.
- Increase the area of buffer strip ideally to 6 m[19] at field boundaries and plant a variety of vegetation e.g. gorse to increase channel roughness, encourage infiltration and trap sediment.
- Install bunds at key locations at field boundaries to reduce runoff directly to the burn.
- Encourage wet woodland to develop in the forested area of Ellon golf course, this should cause minimal disruption to the green within the golf course.
- Restore a natural morphology to the burn through the golf course where the channel has been brick lined, and consider if storage pond features or runoff reduction measures such as planting could be incorporated into the golf course.
- Reduce flood risk from the Modley Burn tributary. A storage pond/ wetland to buffer roadside runoff is suggested at the A948/ Hospital Road junction, and meandering of the straightened channel into the right bank woodland parallel to the Hospital Road properties is suggested.

- Riparian planting along the main Modley Burn at the margins of the golf course at Hospital Road to stabilise the banks, reduce runoff from the golf course, increase infiltration and reduce sediment input.
- Improve the condition of the Modley Place channel walls to prevent undercutting and debris input.

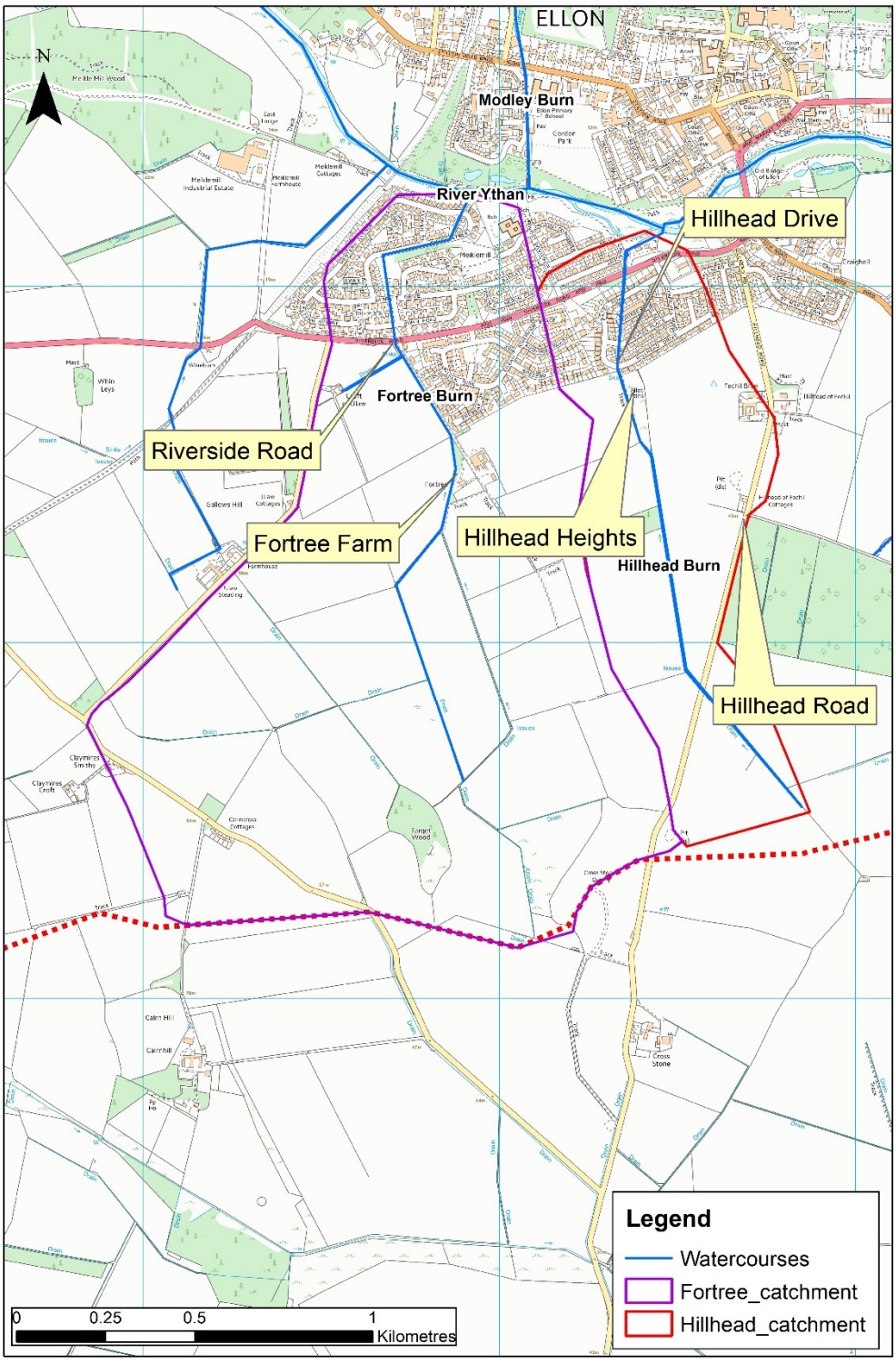
Figure 8-6: Modley Burn catchment NFM opportunities



9 Hillhead and Fortree Burns

The Hillhead and Fortree Burns are small right bank tributaries of the River Ythan with catchment areas of just 0.7 km^2 and 2 km^2 respectively. The burns originate in the agricultural land south of Ellon and are primarily highly straightened field drainage ditches which are then culverted beneath the town. As the catchments are less than 10 km^2 the watercourses have not been classified within the RBMP, NFM or SEPA morphological pressures datasets.

Figure 9-1: Hillhead and Fortree Burn catchments key locations



9.1 Site walkover findings

The site visit for both tributaries took place on the 17 April 2018. Weather conditions on the day of the walkover were windy and overcast with light showers. Conditions in the week prior to the visit had been mixed with periods of rain throughout the week. A map showing the location of photos taken in the Hillhead and Fortree catchment is included in Appendix B.4.

9.1.1 Hillhead Burn

The Hillhead Burn originates south of Hillhead Road and flows almost due north in a very straightened, moderately incised channel through agricultural land toward the Hillhead Drive culvert (Figure 9-2, C). Buffer strips are present along its entire reach but sediment and debris input to the burn from the agricultural land is high based on observations on the day of the walkover, therefore it is recommended greater riparian planting e.g. of gorse bushes and/or hedgerows at field boundaries be undertaken to reduce fluvial runoff and trap sediment from the ploughed fields. A small area of woodland is located on the right bank (Figure 9-2, A) but it was higher up than the channel and so would not be suitable to turn into a wet woodland. Additional riparian woodland planting or increasing connectivity of the Hillhead Burn to the existing woodland is suggested.

A new housing development is being constructed south of Hillhead Drive (Hillhead Heights) and has resulted in large volumes of sediment being moved and stored on the right bank (Figure 9-2, B). This will result in a temporary short term significant increase in volume and size of sediment within the channel, which contained a large volume of sediment including cobbles and boulders at the time of the site visit. The left bank adjacent to the development site is also less vegetated and eroding contributing further sediment (Figure 9-2, E). Reducing sediment input to the channel e.g. through bank stabilisation or sediment capture measures, is recommended as over time this will silt up the culvert and increase the risk of flooding.

Meandering of the watercourse may be limited due to the steep banks constraining the channel, particularly on the left bank. However, as construction is already occurring on the right bank due to the housing development, this may provide an opportunity for excavation and meandering of the burn and/ or other NFM measures in conjunction with the development. This would have the multiple benefit of improving the aesthetic and ecological value of the area and providing greater amenity value to the properties being developed.

The burn enters a large culvert with trash screen at Hillhead Drive where a secondary large brick headwall has been built (Figure 9-2, G). Considerable volumes of large debris were evident around the culvert inlet and bank erosion and scour round the headwalls (as it is not connected to high ground) was evident (Figure 9-2, F). To minimise the risk of blockage within the culvert from debris, as well as reduce fluvial runoff volumes it is recommended features such as leaky bunds at the field boundary be installed. Culvert blocking results in flood waters entering the main road and flooding properties just downstream of the culvert on the steep hill. It is noted that the soil in this area has a high clay fraction[20], therefore infiltration may be lower, so careful planning of potential storage areas is required. Hedgerow planting to stabilise the banks is also recommended and has additional infiltration benefits.

20 Drainage Assessment. Proposed development at Hillhead Drive, Ellon, Aberdeenshire. March 2014. Issue 2. Fairhurst. https://upa.aberdeenshire.gov.uk/online-applications/files/C8E0A646DD6AACB3BE869C7F49B24134/pdf/APP_2014_2761-REFUSED_-_DRAINAGE_ASSESSMENT_-_99737-6864402.pdf

Figure 9-2: Hillhead Burn

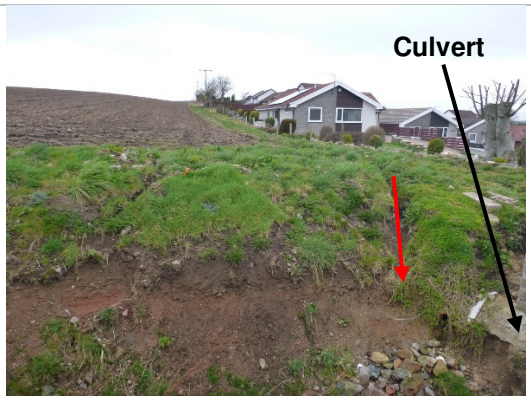
A: Looking upstream towards the upper catchment. Further riparian woodland planting and/ or encouraging wet-woodland storage is recommended. (OS NGR NJ 95416 29564)

B: Secondary channel drainage channel adjacent to the west of the Hillhead Burn and large pile of unconsolidated sediment from the construction site. (OS NGR NJ 95416 29564)

C: Looking downstream toward Hillhead Drive. Straightened channel with buffer strip. Further riparian and hedgerow planting recommended hedgerow to, increase infiltration, reduce runoff and trap sediment. (OS NGR NJ 95416 29564)

D: Looking east at another straightened tributary flowing into the Hillhead Burn. (OS NGR NJ 95416 29564)

E: Looking upstream from the development site. Eroding banks with large sediment fractions within the channel. A trash screen within the channel is highlighted. Hedgerow planting at field boundary and on banks to stabilise and increase channel roughness recommended. (OS NGR NJ 95357 29697)



F: Eroding bank, runoff channel and sediment accumulation at the culvert inlet. A leaky bund to limit runoff at the culvert headwall recommended. (OS NGR NJ 95336 29756)

	
G: Culvert inlet with debris accumulation and newly constructed wingwall. (OS NGR NJ 95336 29756)	

9.1.2 Fortree Burn

The Fortree Burn similarly originates in the agricultural land to the south of Ellon as a series of straightened drainage channels which converge into a single channel near Fortree Farm, before entering a culvert at Riverside Road. North of Fortree Farm. The watercourse is relatively incised with eroding banks (Figure 9-3, A). The sediment fraction was much less coarse than was observed in the Hillhead Burn and the banks vegetated, however, runoff and sediment/ debris input to the burn is still high, particularly at field boundaries and access points which are also culverted (Figure 9-3, C). As the burn approaches the track leading to Riverside Road, the channel narrows and the sediment fraction increases in coarseness with areas of significant erosion (Figure 9-3, D, E and G). In the upper reach increasing the area of buffer strip, bunds at field boundaries and hedgerows to minimise runoff is recommended. Similarly, hedgerows and riparian woodland to stabilise the banks and reduce runoff in the lower reach of the burn are recommended. Small debris dams in the Fortree tributary (Figure 9-3, H) are suggested to slow flow and encourage out-of-bank flow to the floodplain. At the time of the visit the trash screen at the culvert inlet was covered in debris (Figure 9-3, I) and sediment and surface water runoff from the track is easily able to enter the channel (Figure 9-3, F and I).

Figure 9-3: Fortree Burn

	
A: Looking upstream south of Fortree Farm. Incised channel with small buffer strip. Recommended increasing buffer strip area and planting additional vegetation types to increase channel roughness and infiltration. (OS NGR NJ 94838 29312)	B: Tributary of the Fortree Burn with small stone wall on right bank constraining the channel. (OS NGR NJ 94838 29312)

C: Ponding, land compaction and sediment input in area of field access. Bunds at field boundary recommended. (OS NGR NJ 94862 29386)

D: Narrower channel and larger sediment fraction input. Debris dams along this reach to encourage out-of-bank flow into the wooded area recommended. (OS NGR NJ 94871 29580)

E: Looking downstream to Riverside Road. Channel narrower and constrained but riparian planting along full reach. (OS NGR NJ 94871 29580)

F: Roadside drainage channel which ultimately discharges to the culvert entrance (photo I). (OS NGR NJ 94871 29580)

G: Bank erosion. Limited buffer strip. (OS NGR NJ 94806 29691)

H: Fortree Burn tributary. Debris-dams suggested to encourage out-of-bank flow into the vegetated banks. Hedgerow on left bank, similar planting recommended upstream. (OS NGR NJ 94732 29805)

	
I: Riverside Road culvert with debris covered trash screen. Gravel at downstream point of the roadside flow pathway highlighted in photo F. (OS NGR NJ 94710 29842)	

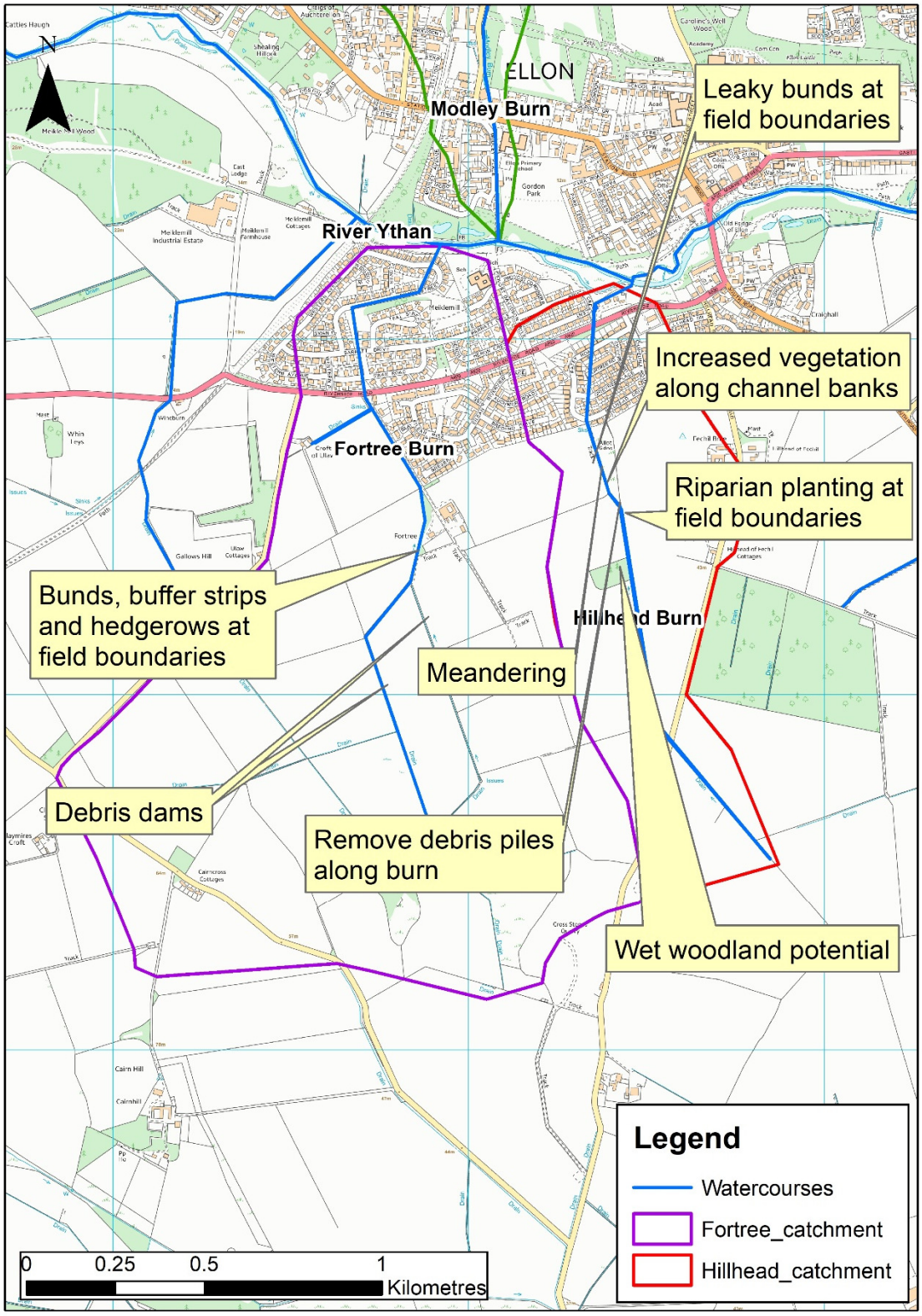
9.2 Summary and Recommendations

Both catchments are relatively flat and land use is dominated by agriculture. The watercourses are highly straightened, moderately incised field drainage channels but with few additional morphological constraints. RBMP improvements are limited other than improving water quality through sediment influx management, as meandering is unlikely due to the channels being relatively incised with steep banks. NFM opportunities identified are primarily runoff reduction measures which include buffer strip and hedgerow planting, riparian woodland planting and leaky bunds at field boundaries.

Key recommendations based on the site visits are as follows:

- Increase the area of buffer strip at field boundaries and plant a variety of vegetation e.g. gorse, to increase infiltration, buffer runoff and trap sediment.
- Hedgerow planting to stabilise banks and increase infiltration.
- Land management techniques such as along-contour ploughing of fields to limit sediment and runoff
- Encourage woodland connectivity and storage along the Hillhead Burn and additional riparian woodland planting.
- Install bunds at key locations at field boundaries to reduce runoff directly to the burn e.g. at the field access point along the Fortree Burn.
- Remove large debris piles stored on the river banks as observed along both burns to reduce sediment input to the main channel. This has the multi-benefit of improving both water quality and preventing siltation of the culvert.
- Increase channel roughness within the incised channels to slow in-channel flow.
- In-stream debris dams within smaller tributary field drains to slow flow toward the main Hillhead and Fortree Burns. Careful consideration of placement required to ensure no risk of blockage to the culverts.

Figure 9-4: Hillhead and Fortree Burn catchments NFM opportunities

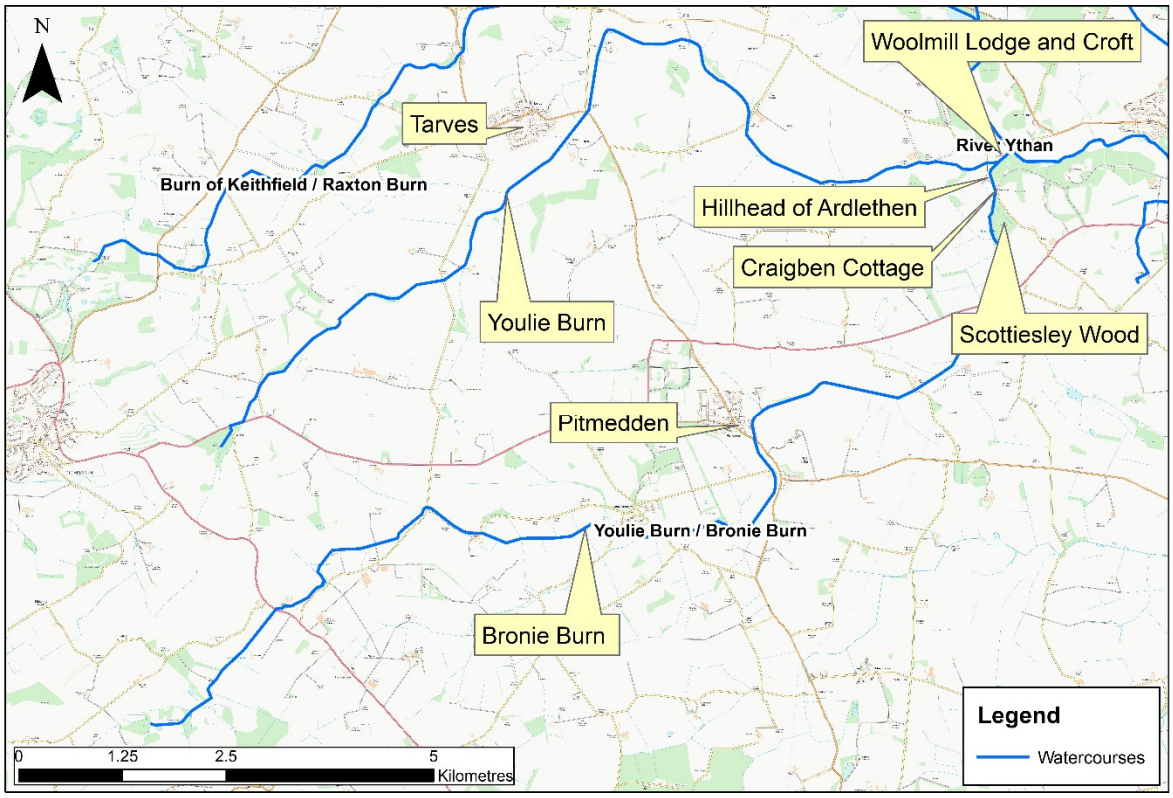


10 Youlie-Bronie Burn

The Youlie-Bronie Burn is a large right bank tributary of the River Ythan with a catchment area of approximately 75 km^2. The Youlie Burn originates approximately 6 km southwest of Tarves and the Bronie Burn approximately 8 km west of Pitmedden. Both burns converge near Woolmill Farm a short distance upstream of the Ythan confluence. The catchment is rural with small urban communities at Tarves and Pitmedden, which are indicated to suffer damages in the SEPA AAD dataset.

The Youlie-Bronie Burn is classified as being in overall 'Poor' condition, based on ecological and biological elements (Appendix A) but is also classified as being in 'Moderate' physical condition. The SEPA morphological pressures dataset indicates there are a number of significant morphological pressures along the entire extent of each watercourse particularly a number of embankments and each has undergone significant realignment. The NFM datasets indicate high to moderate floodplain storage potential along the Youlie Burn near Tarves and the Bronie Burn at Pitmedden, as well as near their confluence. Medium runoff reduction potential is indicated to the north of Pitmedden. Both rivers are primarily undergoing moderate deposition or are in balance.

Figure 10-1: Youlie and Bronie Burn catchments key locations



10.1 Site walkover findings

The site visit took place on the 17 April 2018. Weather conditions on the day of the walkover were bright and clear. Conditions in the week prior to the visit had been mixed with periods of rain throughout the week. A map showing the location of photos taken in the Youlie and Bronie catchment is included in Appendix B.5.

10.1.1 Youlie Burn

A short distance upstream of the Youlie/ Bronie confluence near Woolmill Lodge, the SEPA NFM dataset indicates the Youlie Burn is moderately depositing material and there is high floodplain storage potential to the east of the minor road. The watercourse has undergone high impact realignment and is highly straightened through the agricultural fields. Potential for large floodplain storage features and further meandering is at present restricted to the south of Woolmill Lodge as

the land is currently farmed, however discussions with the farmers could lead to opportunities arising along the entire watercourse. Additionally, to the east of the lodge is private garden also unsuited to storage and re-meandering. Riparian woodland planting could however, be an option in this area which would encourage natural woody debris accumulation within the channel. A highly straightened drainage ditch flows into the Youlie Burn from the south which, like the Youlie Burn, has a narrow buffer strip, contains a number of large boulders (Figure 10-2, B) and right bank collapse is occurring. In-stream woody debris dams and riparian planting to stabilise the banks of the tributary are recommended.

The SEPA morphological pressures dataset also indicates the Youlie Burn is constrained by a right bank embankment upstream of the minor road bridge. The embankment is not providing direct protection to any properties and it is suggested this feature could be removed to release channel capacity and encourage greater floodplain connectivity. Both banks slope relatively steeply towards the main channel. A small buffer strip was present along the length of the left bank and ponding was evident in the southwest corner of the field (Figure 10-2, A). It is recommended a leaky bund could be installed in this area to encourage runoff retention within the floodplain, increase the area of buffer strip and undertake riparian woodland planting along the left bank.

Figure 10-2: Youlie Burn near the Bronie confluence

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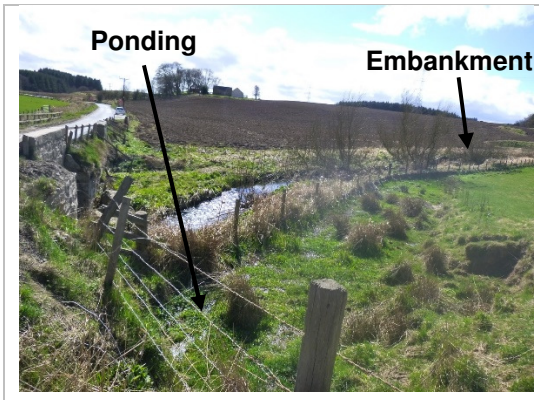
<tr><td> 
</td><td>  </td></tr>
<tr><td>A: Ponding at the base of the slope on the left bank. Leaky bund, increasing the buffer strip area and riparian planting recommended. In addition, removal of the right bank embankment would release channel capacity improving the RBMP status. (OS NGR NJ 92350 30337)</td><td>B: Straightened drainage tributary channel. Small in-stream debris dams and increasing the buffer strip area along the right bank recommended. (OS NGR NJ 92268 30540)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>C: Erosion, bank collapse and large debris input to the drainage channel. Riparian planting could be used to stabilise the banks. (OS NGR NJ 92267 30590)</td><td>D: Looking downstream from the minor road bridge. Floodplain storage potential indicated in the SEPA mapping along the right bank . Drainage ditch flows in from the south (right). Riparian woodland planting and increasing the area of buffer strip recommended. (OS NGR NJ 92267 30590)</td></tr>
</table>

The Youlie Burn was assessed further upstream near Tarves where high floodplain storage potential is indicated in the SEPA NFM dataset. The watercourse has undergone high impact realignment and is highly straightened through the pastural land, along with a number of field drains in the area (Figure 10-3, A). The banks of the Youlie Burn were vegetated with limited riparian trees and minimal buffer strip. Recommended NFM measures identified on site include increasing the area of buffer strip along both the main Youlie Burn and tributary field drains; leaky bunds in key locations at field boundaries to reduce direct runoff to the channel e.g. Figure 10-3, A and C; where possible meandering channels however, this may result in the loss of agricultural land; increasing channel roughness particularly along field drains (Figure 10-3, A) as well as in-stream debris dams to promote out-of-bank flow into the floodplain and thus floodplain storage as indicated in the SEPA mapping. Re-meandering of the main Youlie Burn is limited in this region of the catchment as the channel is moderately incised and would result in loss of productive land. An embankment is indicated to run along the length of the right bank downstream of the road bridge which could be removed or set-back to increase channel capacity.

Figure 10-3: Youlie Burn near Tarves

	
A: Field drainage ditch with ponding and runoff from adjacent field. In-stream debris dams to promote floodplain connectivity, increase buffer strip area and in-channel roughness also recommended. (OS NGR NJ 87268 31175)	B: Looking upstream from the road bridge. Highly realigned Youlie Burn. Runoff from adjacent grassland. Banks are vegetated but increasing the top of bank buffer strip area and further riparian woodland planting recommended. (OS NGR NJ 87451 31186)
	
C: Runoff and sediment easily able to enter burn. Buffer strips, hedgerows and bunds at field boundaries recommended to reduce runoff. (OS NGR NJ 87451 31186)	

10.1.2 Bronie Burn

The SEPA NFM and RBMP datasets indicate the Bronie Burn near its confluence with the Youlie has undergone high impact realignment and is bound on the right bank by embankments. Floodplain storage potential along the both banks is also indicated, and the channel is indicated to be undergoing moderate erosion upstream of the confluence.

South of Craigben Cottage the Bronie Burn flows in a relatively unconstrained channel and left bank erosion was clearly visible (Figure 10-4, C) thus allowing for channel migration across the left floodplain. The floodplain was open uncultivated land with potential to be used for a wetland/ wet-woodland to encourage floodplain storage and increase infiltration, a large in-stream debris dam would also encourage out-of-bank flow into this area reducing flow toward Woolmill Lodge and River Ythan. Alternatively, a floodplain storage pond could be created. The right bank is already forested (Scottiesley Wood) and buffering runoff from the pastural land to the east of the road as was evident at the time of the visit (Figure 10-4, B). A small dry-stone wall to the east of the minor road is also acting as a runoff barrier but is crumbling in places (Figure 10-4, A). To the west of Craigben by Hillhead of Ardlethen Cottage, the land slopes toward the left bank of the Bronie Burn where runoff is directed downslope, across the road and into the Bronie. Cross slope woodland planting and a wetland storage feature at the base of the field would help reduce runoff (Figure 10-4, D).

Downstream of the Craigben road bridge the Bronie Burn flows in an open channel with eroding banks but is constrained along the entire right bank by an embankment approximately 2 m in height and is wooded (Figure 10-4, E and F). A trash line was evident approximately 1 m up the embankment opposite Woolmill Lodge as well as a considerable distance up the garden of the croft. The residents of Woolmill Croft believe the woodland has reduced the capacity of the right bank floodplain but this may also be in part due to the embankment. Removal or setting back the embankment would be tricky due to the number of trees along its length but an option could be breaching the embankment at several sections. This would have RMBP benefits through releasing channel capacity, as well as NFM benefits if the Bronie Burn could be meandered through and its connectivity with the forest floodplain improved.

Figure 10-4: Bronie Burn near Woolmill Croft

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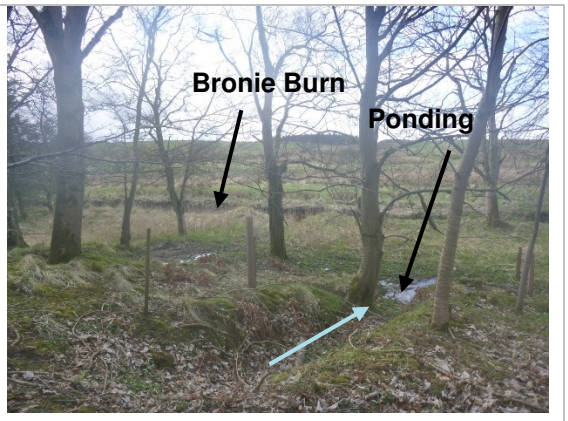
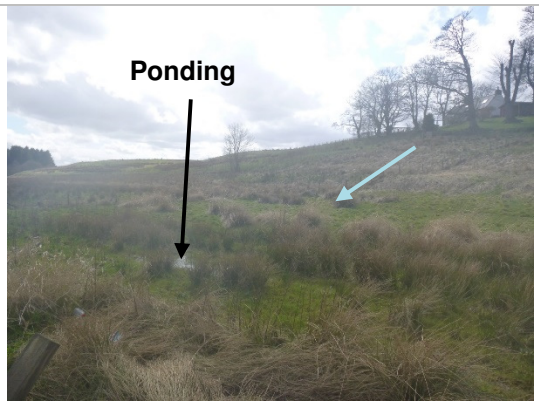
<td> 
</td>
</tr>
<tr>
<td>A: Grassland on right bank of Bronie Burn by Craigben cottage. Runoff is directed across the road and through the right bank woodland. (OS NGR NJ 92374 30256)</td>
<td>B: Right bank woodland with runoff channel. Woody debris is encouraging ponding and storage. Woodland planting on the left bank could have similar runoff and storage benefits.(OS NGR NJ 92374 30256)</td>
</tr>
</table>

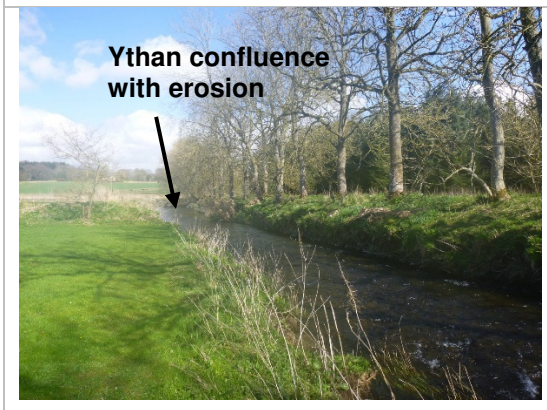
C: Eroding unconstrained Bronie channel south of Craigben cottage. Open left bank floodplain which could be developed into a wetland or a storage pond created. (OS NGR NJ 92387 30151)



D: Hillhead of Ardlethen cottage. Cross-slope woodland planting and wetland creation at base of slope suggested to reduce runoff toward Bronie burn to left of image. (OS NGR NJ 92280 30401)

E: Bronie Burn downstream of the Craigben road bridge. Left bank is open field while the right bank is bound by an embankment that is wooded. (OS NGR NJ 92350 30337)

F: Sediment and debris input from the roadside at Craigben bridge. (OS NGR NJ 92350 30337)



G: Downstream of the Youlie-Bronie confluence. Highly straightened channel with wooded right bank embankment and Woolmill Croft garden. (OS NGR NJ 92350 30337)

H: Trash line on right bank embankment. (OS NGR NJ 92478 30652)

I: Trash line in Woolmill Croft garden. (OS NGR NJ 92427 30621)

The Bronie Burn was assessed further upstream near Pitmedden where a number of embankments, as well as floodplain storage potential is indicated in the SEPA datasets. The Pitmedden community is also highlighted in the SEPA datasets to suffer from high AAD's. The Bronie Burn was found to be very straightened and constrained through the town, with high sediment input, factors which contribute to the downgrade in RBMP status. New development was taking place at the southeast margin of Pitmedden which is likely to result in short term increases in sediment to the watercourse (Figure 10-5, C). Controlling and reducing this sediment input will have benefits on water quality and ecology. An embankment is indicated in the morphological pressures dataset to run along the length of the right bank upstream of the B999 road bridge but was not particularly visible onsite and may not be acting as a high constraint (Figure 10-5, A). The adjacent land is agricultural and runoff likely to be high therefore riparian woodland planting and increasing the area of buffer strip is recommended. Downstream of the B999 road bridge the Bronie Burn continues in a highly straightened channel but there are limited options to meander with both banks being urbanised (Figure 10-5, B). A number of drains discharge into the Bronie Burn which are also highly straightened and canalised through the town (Figure 10-5, D). Meandering of these field drains where possible is recommended as well as ensuring adequate buffer strips in the agricultural areas.

Figure 10-5: Bronie Burn at Pitmedden

A: Looking upstream from the B999 road bridge. Right bank embankment is indicated in the SEPA datasets but was not particularly evident onsite. Further riparian woodland planting recommended and increasing buffer strip along both banks. (OS NGR NJ 89470 27255)

B: Looking downstream from the B999 road bridge. Channel straightened but constrained along both banks. (OS NGR NJ 89470 27255)

C: Large sediment input from the housing development site as no erosion protection practices in place. (OS NGR NJ 89470 27255)

D: Canalised drain flowing toward the Bronie Burn on the south of the B999. (OS NGR NJ 89451 27256)

10.2 Summary and Recommendations

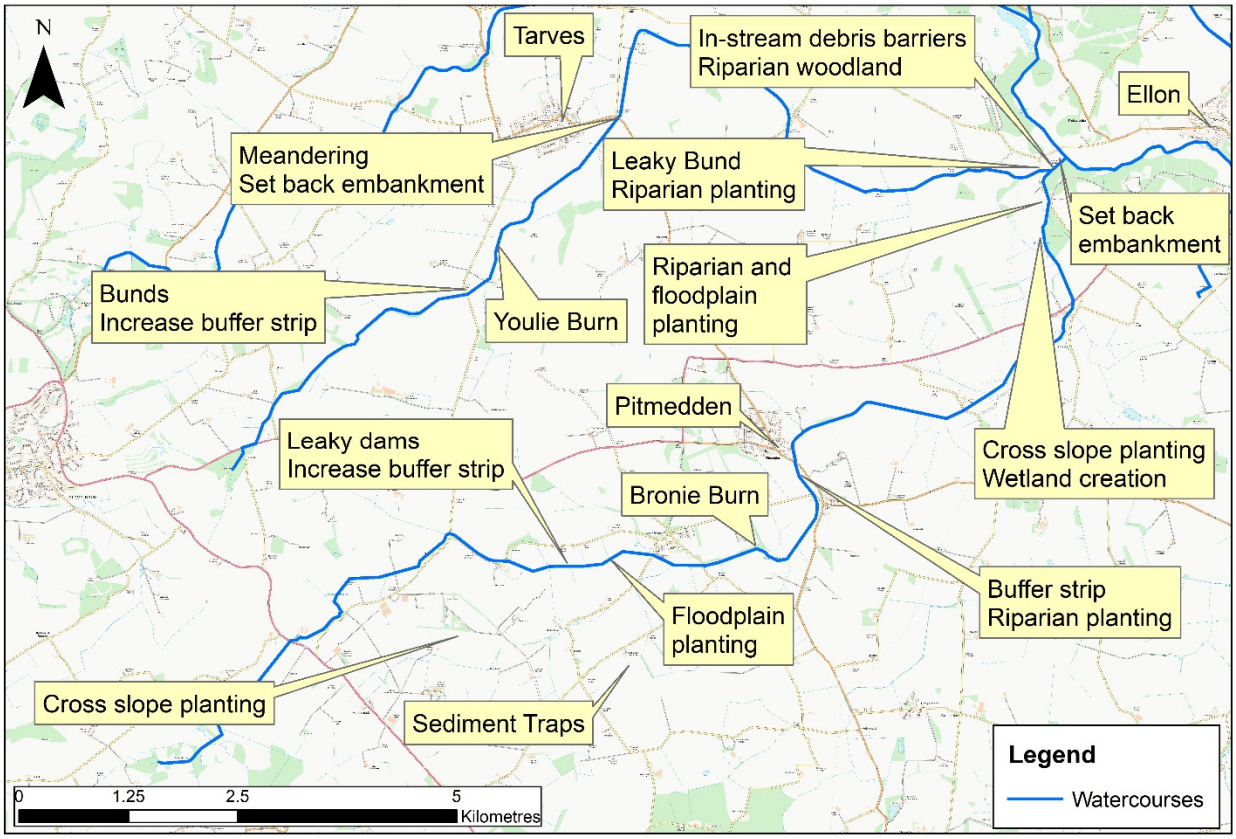
The Youlie-Bronie catchment is a large rural catchment with land use dominated by pasture. This means runoff is likely to be high and directed toward highly straightened watercourses, which at many of the locations visited had minimal buffer strips. Increasing buffer zones will work toward the RBMP objective of improving water quality, through limiting sediment and pollutant discharge but also has NFM benefits by increasing infiltration and reducing runoff volumes. Opportunities to improve the physical condition of the watercourse in line with the RBMP objectives is more limited. Re-meandering is recommended but would require careful consideration of location, as the watercourses have incised in areas, and would require considerable landowner engagement as it is likely to result in loss of productive land. The Bronie Burn is constrained for much of its reach by a series of embankments which in the areas visited have potential to be removed or set-back which in the areas visited alone could release up to 20% capacity thus also improving the RBMP status.

NFM opportunities are varied with areas suitable for floodplain storage and runoff reduction identified during the site visits but similarly to improving the physical condition these opportunities would require considerable land owner engagement due to the high proportion of the catchment that is farmed and the potential impact floodplain storage may have on productive land.

Key recommendations based on the site visits are as follows:

- Minimise field runoff through strategically places bunds at field boundaries (Figure 10-3, A) and hedgerow planting which will also increase infiltration.
- Increase the area of buffer strip along field drains and the main watercourses to minimise runoff and buffer pollutants entering the watercourse.
- Increase channel roughness through riparian planting particularly on realigned, highly straightened watercourses, to slow flow.
- Small in-stream debris dams e.g. along field drains (Figure 10-2, B) to encourage out-of-bank flow onto the floodplain.
- Remove or set-back embankments to increase channel capacity and floodplain connectivity e.g. along the Youlie Burn near the Bronie confluence (Figure 10-2, A).
- Riparian and floodplain woodland planting to encourage wet-woodland storage e.g. near Craigben Cottage (Figure 10-4, B).
- Maximise areas of uncultivated land for meandering, storage and planting potential.
- Potential for storage ponds also in less cultivated areas of the floodplain.

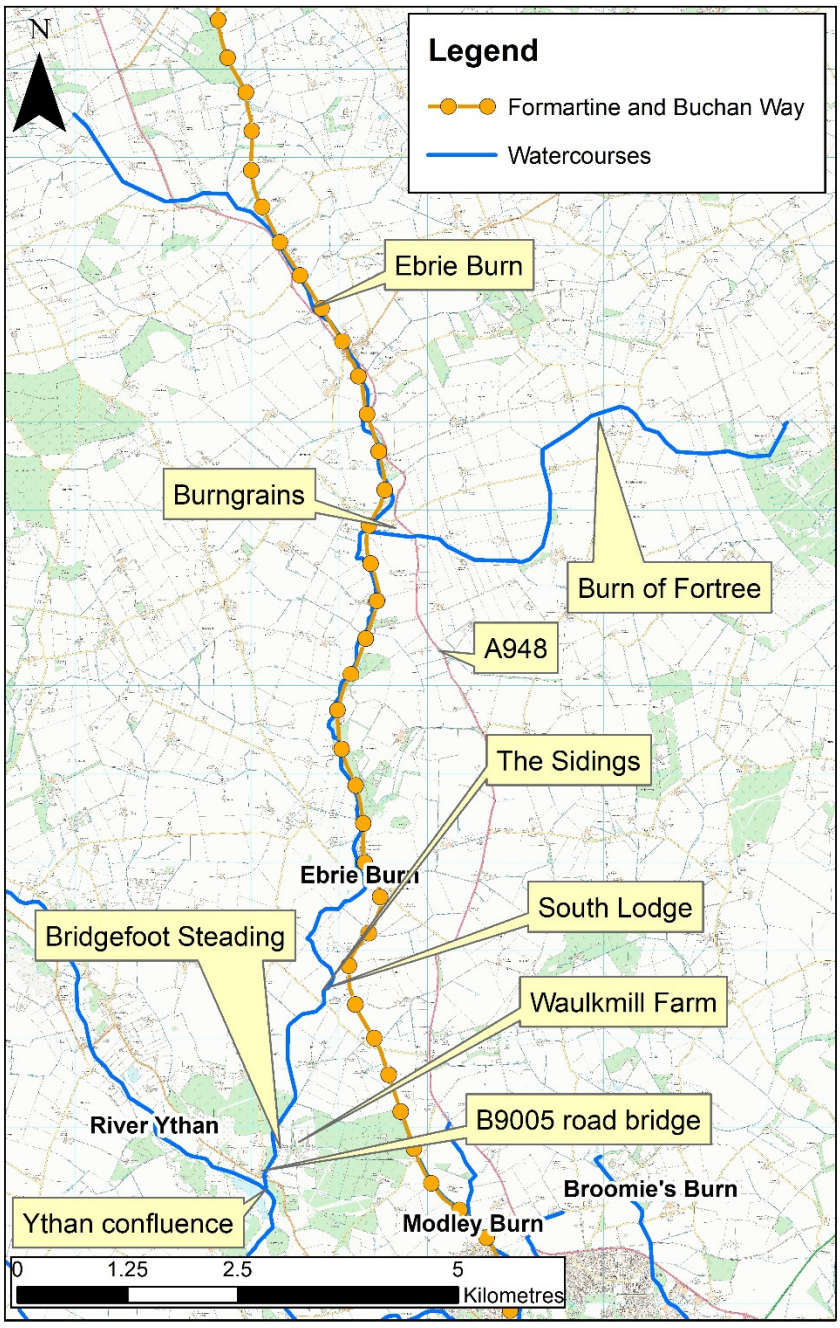
Figure 10-6: Youlie and Bronie burn catchment NFM opportunities



11 Ebrie Burn

The Ebrie Burn is a large left bank tributary of the River Ythan with a catchment area of approximately 77 km^2. The river originates approximately 15 km northwest of Ellon and flows due south to its confluence with the River Ythan. The catchment is rural pastural land with small areas of woodland and forestry. The Ebrie Burn is classified as being in overall 'Poor' condition based on its ecological and biological elements (Appendix A) and is classified as being in 'Moderate' physical condition. The SEPA morphological pressures dataset indicates there are a number of significant morphological pressures along the entire extent of the watercourse but in particular the key pressure is high impact realignment and a number of embankments. The NFM datasets indicate high to moderate floodplain storage potential along the lower reach of the river by Waulkmill Farm as well as in the headwaters south of Nethermuir. Medium runoff reduction potential is indicated in the southeast of the catchment and the river overall is in balance or undergoing moderate erosion.

Figure 11-1: Ebrie catchment key locations



11.1 Site walkover findings

The site visit took place on the 17 April 2018. Weather conditions on the day of the walkover were bright and clear. Conditions in the week prior to the visit had been mixed with periods of rain throughout the week. A map showing the location of photos taken in the Ebrie catchment is included in Appendix B.6.

At its confluence with the Ythan the Ebrie Burn flows in a straightened but unconstrained channel with open floodplain along both banks. The channel is eroding and woodland has been planted extensively along the right bank with additional riparian trees on the left bank (Figure 11-2, A). Upstream of the B9005 road bridge the channel is similarly straightened but the banks are eroding as it tries to restore sinuosity. There is a small area of riparian planting on the right bank while the left bank is open grassland (Figure 11-2, B). The left bank is indicated in the SEPA mapping as having high potential for floodplain storage and it is suggested a wet-woodland or wetland area could be created in the uncultivated land immediately north of the B9005 road which would reduce runoff and sediment trap from the adjacent sloping agricultural land having additional water quality benefits. Upstream of Bridgefoot Steading extensive new riparian woodland planting has been undertaken (Figure 11-2, C) which will increase infiltration, buffer runoff from the paddocks on the sloping left bank and encourage woody debris barrier to form within the channel. It is recommended similar NFM measures be adopted elsewhere along the watercourse. It was not possible to access the watercourse to assess the degree of incision but meandering may be possible but may require excavation if incision has occurred.

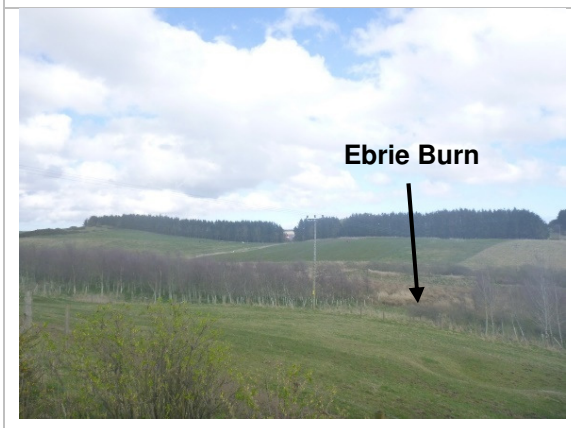
Further upstream by South Lodge the Ebrie Burn has undergone high impact realignment but is unconstrained downstream of the minor road bridge (Figure 11-2, D). The set-back embankment indicated in the morphological pressures dataset is a large former railway embankment which is not acting as a direct constraint (Figure 11-2, F). The large area of grey bank protection was also not evident other than the bridge itself. Floodplain storage potential is indicated along the right bank where the land flattens at the base of the field. This land appeared to be used for grazing thus a large scale floodplain storage features such as a wetland or storage pond is less suited and runoff reduction measures such as increasing the buffer zone, leaky bunds at the field boundary and cross woodland planting along the upper reaches of the slope are suggested as more suitable NFM options (Figure 11-2, E and G). The left bank has a wider buffer strip, but additional planting of different vegetation and/ or riparian woodland is suggested to further increase infiltration and roughness.

Upstream of the minor road bridge the right bank of the Ebrie Burn is unconstrained and the banks eroding (Figure 11-2, I). The ploughed fields slope toward the channel and a small buffer strip was present but increasing the width of this and riparian woodland planting is recommended. Along the left bank the river is constrained by an embankment which is protecting a number of properties and gardens (Figure 11-2, H). Therefore, complete removal is not recommended however, the embankment could be set back to increase channel capacity. By the upstream face of the road bridge where the embankment ends the left bank floodplain has potential for a storage pond to be integrated into the floodplain or to implement a washland, an area of land which would periodically get flooded.

Figure 11-2: Ebrie Burn

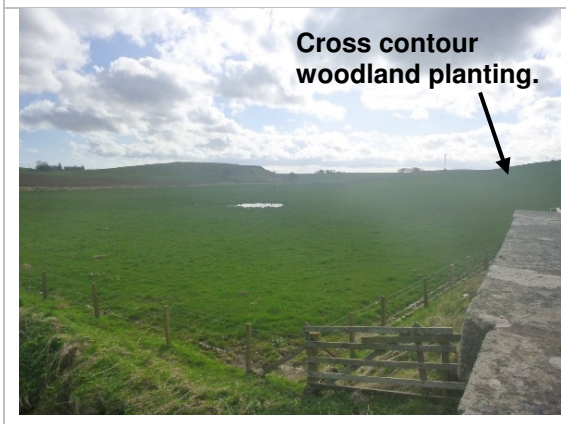
A: Ebrie Burn at the River Ythan confluence. Straightened but unconstrained channel with floodplain woodland planting along both banks. (OS NGR NJ 92154 32412)

B: Looking upstream from the B9005 road bridge. Area of floodplain storage potential on left bank. (OS NGR NJ 92154 32412)



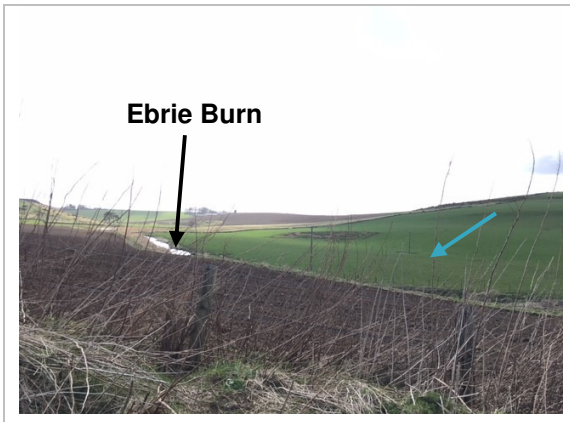
C: Recent riparian woodland planting along both banks upstream of Bridgefoot Steading, as well as top of slope woodland planting to reduce runoff from the paddocks. Similar NFM measures recommended for elsewhere in the catchment. (OS NGR NJ 92109 32582)

D: Looking downstream from South Lodge. Recommended increasing the roughness of the left bank buffer strip and enlarging the right bank buffer strip. (OS NGR NJ 93284 35819)



E: Right bank indicated as having floodplain storage potential. Cross slope woodland planting at the top of the hill and leaky bunds at field boundary recommended. (OS NGR NJ 93284 35819)

F: Former railway embankment indicated in the SEPA pressures dataset. (OS NGR NJ 93284 35819)



G: The Ebrie catchment is predominantly agricultural land with high runoff from pastural land as shown above. Buffer strips, hedgerows and leaky bunds at field boundaries are therefore recommended across the catchment to limit fluvial and sediment runoff to the Ebrie Burn and drainage channels. (OS NGR NJ 93367 35698)

H: Embankment by The Sidings. Embankment is protecting a number of properties on the floodplain but it could be set back a short distance to increase channel capacity. (OS NGR NJ 93217 36060)

I: Right bank erosion and sediment input from the ploughed field. Limited buffer strip therefore recommended increasing area. (OS NGR NJ 93217 36060)

J: Looking upstream at the straightened channel. Buffer strip on right bank is larger than further downstream and the left bank embankment is lower. (OS NGR NJ 93217 36060)

11.2 Summary and Recommendations

The Ebrie Burn catchment is large and rural with land use dominated by pasture and limited areas of woodland. The watercourse has undergone historical realignment which accounts for the greatest percentage capacity of the watercourse used (Appendix A). Of the reaches visited the watercourse was highly straightened with limited evidence of natural erosion restoring sinuosity and morphological diversity therefore intervention to re-meander reaches is recommended to have the greatest improvement on physical condition. Embankments are the next greatest pressure on the watercourse; the series of set-back embankments north of South Lodge cannot be removed as these are a former railway and from part of the Formartine and Buchan Way but are having limited impact on morphology in many areas. Several embankments with no reinforcement are located along the Ebrie also upstream of South Lodge and again have potential to be removed or set-back to release channel capacity and improve RBMP status. Of the areas visited alone, removal or set-back of embankments and restoring sinuosity could release up to 10% total capacity.

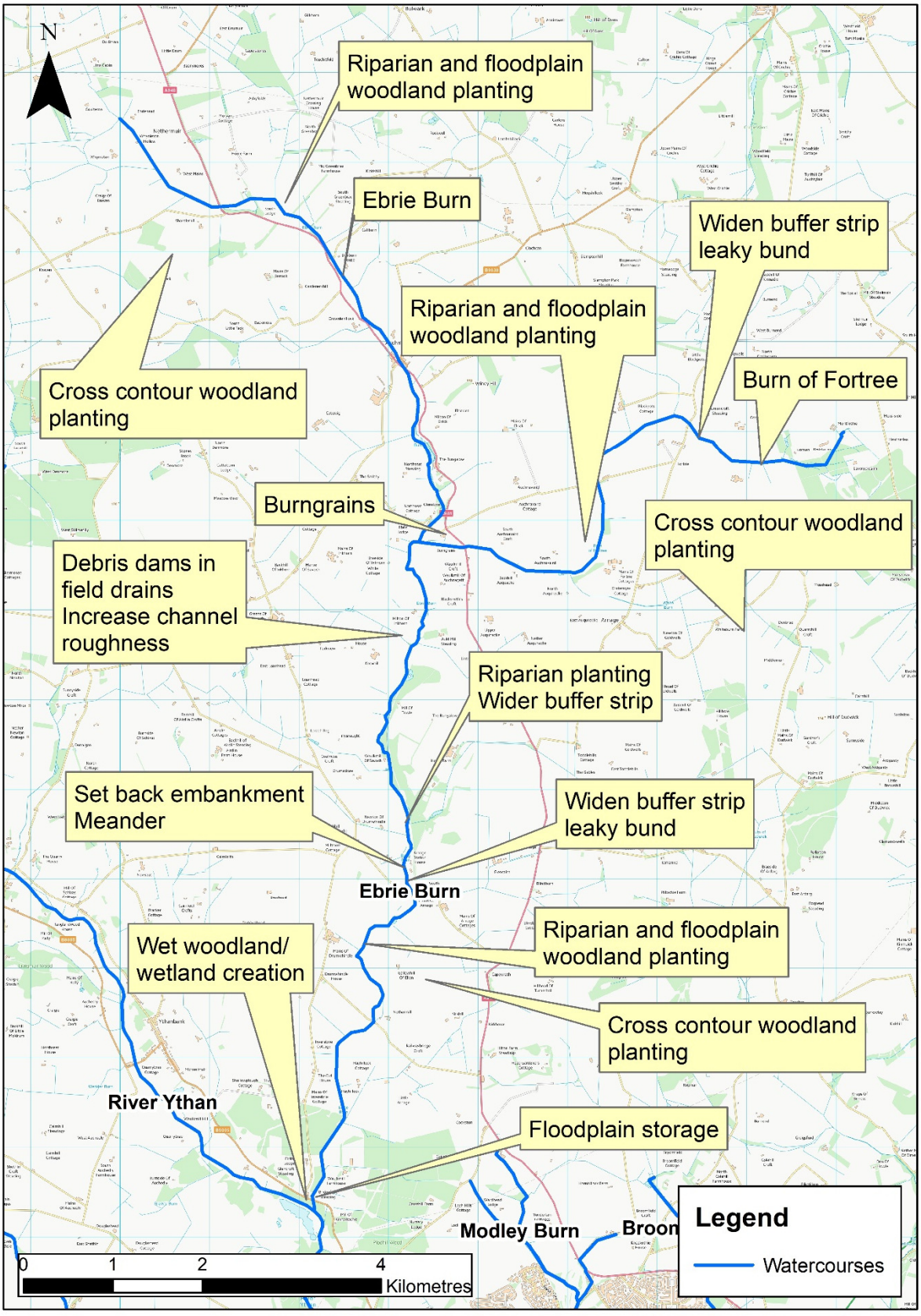
The SEPA NFM datasets indicate floodplain storage along the majority of the final reach of the Ebrie Burn and by South Lodge. Potential for a wetland and wet-woodland floodplain storage was identified during the site visits along the lower Ebrie however, storage potential by South Lodge is

more limited due to land use. Runoff reduction measures such as buffer strips, cross woodland planting, leaky bunds and riparian woodland planting (as seen upstream of Bridgefoot Steading) are instead recommended.

Key recommendations based on the site visits are as follows:

- Minimise field runoff through strategically placed bunds at field boundaries (Figure 11-2, E) and hedgerow planting which will also increase infiltration.
- Increase the area of buffer strip ideally to 6 m[19] along field boundaries to minimise runoff and buffer pollutants entering the watercourse (Figure 11-2, I).
- Increase channel roughness and install debris dams along straightened field drainage channels discharging into the Ebrie Burn to slow and encourage out-of-bank flow onto the floodplain.
- Remove or set-back embankments to increase channel capacity and floodplain connectivity e.g. set back the embankment at The Sidings (Figure 11-2, H).
- Riparian woodland planting to buffer hillslope runoff e.g. similar to that by Waulkmill Farm (Figure 11-2, C).
- Floodplain woodland planting to encourage wet-woodland storage like that at the Ythan confluence.
- Wetland or wet-woodland creation in areas of uncultivated land e.g. (Figure 11-2, B).

Figure 11-3: Ebrie Burn catchment NFM opportunities



12 Conclusions

12.1 RBMP

Within the River Ythan catchment 3 watercourses are classified as being in overall 'Poor' condition and 8 in 'Moderate' condition based on SEPA's 2016 classifications. Of these, 8 are downgraded on the basis of their physical condition. The River Ythan within the scheme extents is in good physical condition. No significant morphological pressures were indicated in the SEPA datasets and no significant pressures, or additional aspects which would downgrade the status of river were observed during the site visit. Any works in the area should therefore seek to maintain the present physical condition.

The Ythan tributaries within the scheme extent (Broomie's, Modley, Hillhead and Fortree Burns) are not included in the RBMP and SEPA morphological pressures datasets due to their catchment areas being < 10 km^2. A number of pressures along each were however, noted during the site walkovers. The Modley Burn in particular was found to be in very poor physical condition with the watercourse being sediment and debris laden at its source; very straightened through the agricultural land north of Ellon; highly modified through the golf course and from the B9005 south constrained and canalised for its final 300 m. Opportunities to improve the watercourse condition in-line with the RBMP strategies within its lower reaches is limited due to significant urbanisation of the floodplain. Upstream of Hospital Road and into the rural upper catchment there are greater opportunities to improve the watercourse through sediment management and morphological improvements. The Broomie's Burn in contrast is much less constrained with fewer pressures, the primary recommendations being removal or setting back of embankments in the lower reaches. The Hillhead and Fortree Burns are highly straightened field drainage channels but with no additional significant morphological pressures other than being culverted beneath Ellon to their confluence with the Ythan. Incision is a constraint on improving floodplain connectivity and meandering but the physical condition of these watercourses could be improved within the confines of the channel by creating two-stage channels, bars and spits and it may be possible to meander in areas to minimise further incision. Increasing buffer strip areas ideally to 6 m in width at field boundaries would also improve water quality in-line with RBMP objectives. Meandering and buffer strips would require landowner consent due to the potential loss of agricultural land.

Outwith the scheme extent a number of additional tributaries are classified as being in 'Moderate' physical condition. The Youlie-Bronie Burn and Ebrie Burn catchments were chosen for further investigation. The greatest pressure impacting channel capacity percentage used is high impact realignment. Meandering and increasing sinuosity would therefore have the greatest release of capacity and improvement in RBMP status. Embankments are the second greatest pressure which at the locations visited along both watercourses have the potential to be removed or set-back also allowing greater floodplain connectivity.

12.2 NFM

NFM opportunities across the Ythan catchment are numerous. Within the scheme extents the NFM opportunities are greatest within the Modley and Broomie's Burn sub-catchments where recommendations include: storage ponds, sediment traps, wetlands, leaky bunds and in-stream debris dams within the upper catchments to reduce and slow flow to the lower urbanised, at risk communities. Options also exist within the lower catchment of both burns and include floodplain storage ponds, floodplain woodland planting and wetland opportunities.

Land use across the Ythan catchment as a whole is dominated by agriculture with minimal areas of forest and in general a gently sloping topography. Due to the agricultural nature of the catchment many of the main watercourses have been straightened and the land is crossed by numerous straightened field drains. Land management practices to reduce runoff, minimise sediment influx and restore sinuosity to watercourses are therefore the key NFM measures to adopt. Key recommendations across the Ythan catchment as a whole based on observations made in the Ebrie and Youlie-Bronie catchments include widening buffer strips, ideally to 6 m, at field boundaries, hedgerow planting, riparian woodland planting, leaky bunds, in-stream debris dams and meandering of watercourses to slow runoff towards both the tributary and in turn the main River Ythan.

12.3 Economic, social and environmental benefits and disbenefits

A high-level consideration of the economic, social and environmental benefits and disbenefits have been considered in the table below.

Table 12-1: Economic, social and environmental assessment

Criteria	Ellon tributaries (Broomie's, Modley, Hillhead and Fortree Burns)	Youlie-Bronie Burn	Ebrie Burn	River Ythan
Interventions	Storage ponds, buffer strips, hedgerows, sediment traps, leaky bunds and meandering.	Leaky bunds, set-back embankments, riparian woodland and buffer strips.	Cross lope, riparian and floodplain woodland planting, set-back embankments, wetlands, buffer strips.	Floodplain wetland and woodland, storage ponds, buffer strips, riparian woodland planting.
Morphology (including WFD objectives)	Benefit: Increased sinuosity slows flow. Disbenefit: For Modley Burn potential impact on golf course.	Benefit: Sinuosity restored to slow flow to the Ythan. Disbenefit: Limited areas suitable for meandering.	Benefit: Increase channel capacity and improve floodplain connectivity through embankment removal. Disbenefit: Potential loss of productive agricultural land.	Benefit: Bank stabilisation provided through riparian planting. Disbenefit: Potential loss of agricultural land.
Water quality (including WFD objectives)	Benefit: Improve runoff water quality from farmland. Disbenefit: Loss of productive land for buffer strips.	Benefit: Improve runoff water quality from farmland. Disbenefit: Impact on productive agricultural land.	Benefit: Greater bank-side vegetation to improve runoff water quality. Disbenefit: Impact on productive agricultural land.	Benefit: Buffer strips catch sediment and pollutants. Disbenefit: Impact on productive agricultural land.
Natural processes (soils, geomorphology, geology)	Benefit: Improve soil loss from farmland and natural riparian processes. Disbenefit: Potential loss of productive agricultural land.	Benefit: Reduce soil loss from farmland and natural riparian processes. Disbenefit: Potential loss of productive agricultural land.	Benefit: Embankment removal restores morphology by allowing sinuosity. Disbenefit: Not possible to remove all embankments.	Benefit: Meandering will improve upstream morphology. Disbenefit: Potentially impermeable soils within the catchment limiting infiltration.
Climate change impact	Benefit: Woodland and wetlands have carbon sequestration benefits. Disbenefit: Limited ability to future proof.	Benefit: Woodland planting has carbon sequestration benefits. Disbenefit: Limited ability to future proof.	Benefit: Carbon sequestration benefits of hedgerow and woodland planting. Disbenefit: Limited ability to future proof.	Benefit: Carbon sequestration benefits of woodland plating. Disbenefit: Time taken for trees to reach maturity.

Habitats and species	Benefit: Opportunities to create new habitats. Disbenefit: Effect of sediment trapping on habitats.	Benefit: Reducing sediment influx will improve water quality ecological status. Disbenefit: Effect of sediment trapping on existing habitats.	Benefit: Reducing sediment influx will improve water quality and ecological status Disbenefit: Fishing pond at Mill of Elrick in along the upper Ebrie which could be impacted by changes in flow due to NFM.	Benefit: Wetlands create new habitats. Disbenefit: Ythan is designated salmonid waters.
Recreation, tourism and education	Benefit: Opportunities to engage school children from the local primary schools. Disbenefit: Potential recreational impacts in the golf course.	Benefit: Bowling green and tennis court in Pitmedden known to have flooded. Potential to prevent this with upper catchment NFM. Disbenefit: Impact of works on public tracks.	Benefit: Visual improvements in the catchment where the Buchan Way cycle/ walkway runs. Disbenefit: Potential impact of embankment set-back/ removal on The Sidings properties.	Benefit: Primary schools in Ellon and Methlick provide educational opportunities. Disbenefit: Recreational areas such as the walkways on the banks of the Ythan may be affected by works.
Landscape	Benefit: Essentially rural catchment, but potential for visual improvements through the urban areas e.g. by the Balmacassie Commercial Park. Disbenefit: Elements are limited by urban infrastructure.	Benefit: Essentially rural catchment but visual improvements in urban communities. Disbenefit: Elements are limited by urban infrastructure and development.	Benefit: Improved morphology has visual benefits. Disbenefit: Buchan Way embankment not an easily removed feature/ constraint.	Benefit: Bare earth improvements through the Fyvie Gorge. Disbenefit: Agricultural nature of the land limits opportunities.
Perceived multiple benefits	Improved morphology, water quality, biodiversity and visual benefits.	Improved morphology, water quality, biodiversity and visual benefits.	Climate change adaptation, water quality, biodiversity.	Habitat creation, educational opportunities and improved water quality.

12.4 Recommendations and proposed mechanisms to develop NFM and RBMP

Without detailed modelling the interventions discussed within this report have not been quantified in terms of economic, social or environmental benefits. The way in which the council may wish to take the recommendations for environmental improvement forward will depend on a number of factors including the scale of opportunities, the funding available and whether a FPS is likely to go ahead. We propose that the recommendations could be undertaken as follows:

- **Incorporation of NFM within a proposed FPS either as a separate option** (particularly for the Broomie's Burn sub-catchment for example), or to supplement other more structural options to provide future adaptation against climate change. Additional modelling may help to quantify the benefits of such measures and facilitate inclusion within the wider appraisal studies.
- **Inclusion within any wider Aberdeenshire NFM funding mechanism to deliver NFM** and river restoration when specific funds become available on an ad-hoc basis (e.g. a pick list of measures to implement with land owner consent, but without further appraisal). This would lend itself to a separate catchment or sub-catchment study and would suit the recommendations made for the Youlie-Bronie Burn as these would benefit both Ellon and the wider risk communities including Pitmedden. This catchment is also ranked poorly under RBMP categories which could be tackled alongside the NFM options. Such studies may present many multiple benefits including environmental improvements by reviewing opportunities and success would rely on favourable landowners.
- **Delivery of measures via an FPS as a percentage uplift included within the total FPS costs set aside for local NFM and RBMP measures**. For example, 10% of the total FPS costs could be set aside for wider environmental improvements and NFM delivery. Once again, this could help to achieve the adaptation and wider environmental benefits without the need for wider appraisal and modelling. This would be suited to the Broomie's and Modley Burn catchments, where a number of NFM measures have been recommend and would reduce flood risk to Ellon. Early discussions with landowner and legal department may also be beneficial.

12.5 Future works

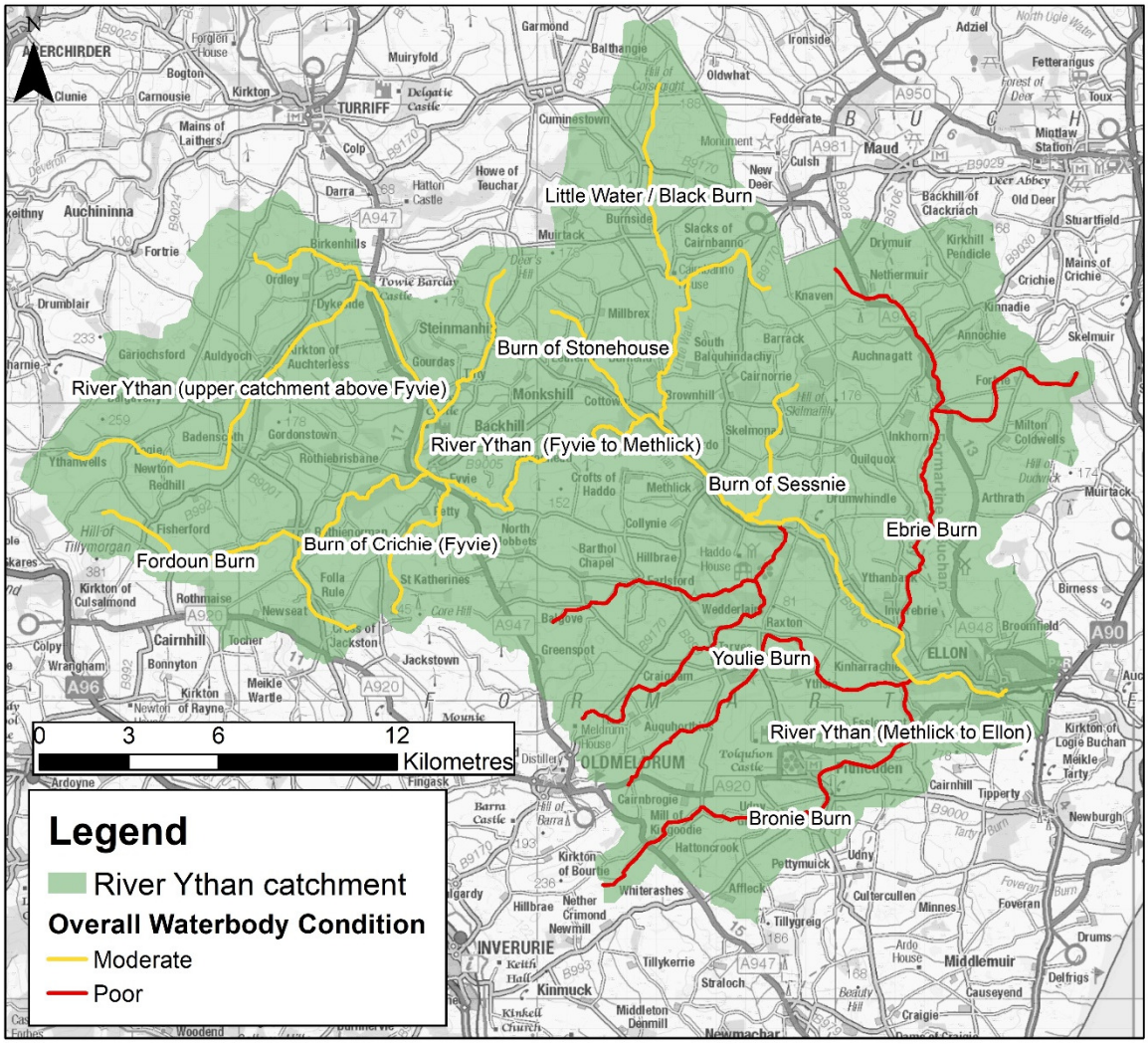
To enable future implementation of RBMP improvements and NFM interventions, the following may be required:

- Raise awareness
- Early landowner awareness and consultation
- Public awareness raising event
- Further investigation
- Ground investigations (including infiltration testing and contamination testing)
- Utilities search and review
- Detailed topographic survey
- Ecological survey
- Detailed hydraulic modelling
- Set up pre-works monitoring
- Outline design
- Early contractor involvement
- Public engagement
- Detailed design
- Produce bill of quantities and contract documents
- Tender for contractor
- Planning application including CAR licence
- Construction
- Post-works monitoring.

Appendices

A RBMP Watercourse Classifications

A.1 Map of overall waterbody conditions within the Ythan catchment



A.2 Table of current overall waterbody status

			Reason for Downgrade (2016)				
Watercourse	**RBMP ID**	**Present Overall Condition (2016)**	**Overall ecology**	**Physico-chem**	**Biological elements**	**Specific pollutants**	**Hydromorphology**
ELLON							
River Ythan (upper catchment above Fyvie)	23233	Moderate	Moderate	Moderate	Moderate	Pass	Moderate
River Ythan (Fyvie to Methlick)	23232	Moderate	Moderate	Good	Moderate	Pass	Good
River Ythan (Methlick to Ellon)	23231	Moderate	Moderate	Good	Moderate	Pass	Good
Fordoun Burn	23234	Moderate	Moderate	Moderate	Moderate	Pass	Moderate
Burn of Crichie (Fyvie)	23235	Moderate	Moderate	Good	Moderate	Pass	Moderate
Burn of Stonehouse	23236	Moderate	Moderate	High	Moderate	Pass	Moderate
Little Water / Black Burn	23237	Moderate	Moderate	Good	Moderate	Pass	Moderate
Burn of Sessnie	23238	Moderate	Moderate	High	Moderate	Pass	Good
Burn of Keithfield / Raxton Burn	23239	Poor	Poor	Good	Poor	Pass	Moderate
Ebrie Burn	23240	Poor	Poor	Good	Poor	Pass	Moderate
Youlie Burn / Bronie Burn	23241	Poor	Poor	Moderate	Poor	Pass	Moderate

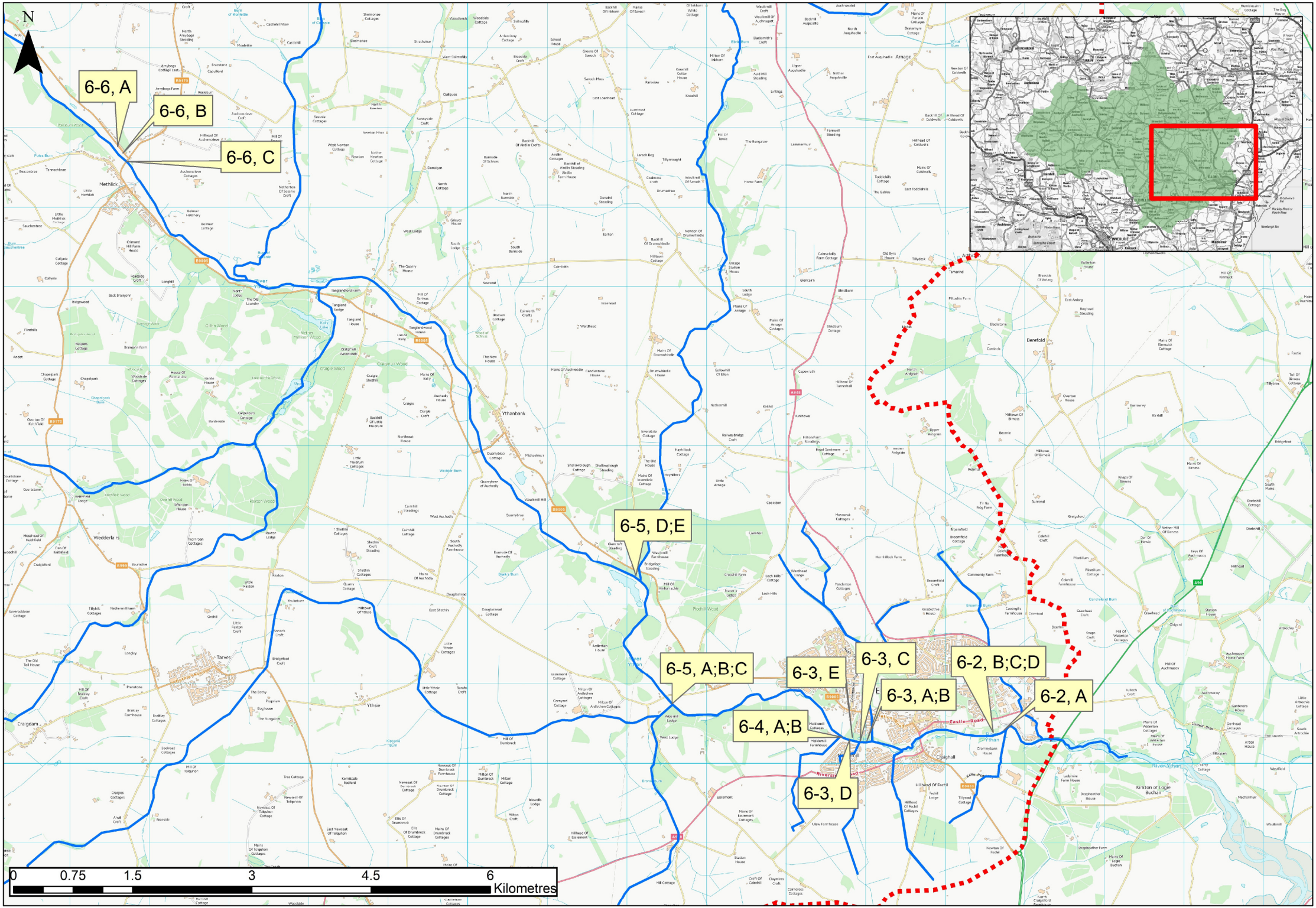
A.3 Morphological Impact Assessment

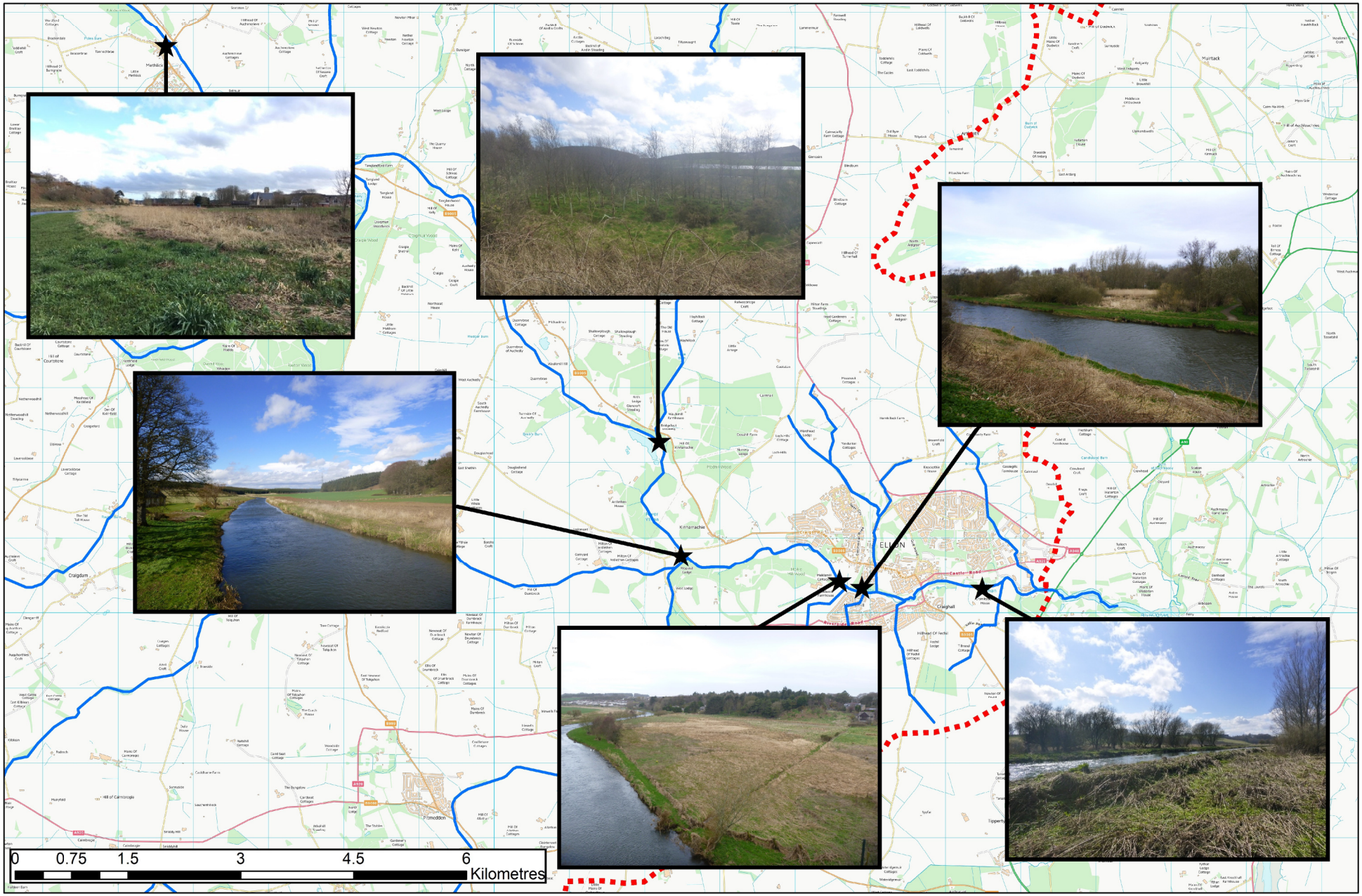
Pressure	Impoundments	Set Back Embankments	Embankments with no Reinforcements	Embankment Bank Reinforcement	Green Bank Reinforcement	Grey Bank Reinforcement	High Impact Realignment	Low Impact Realignment	Culverts
	River Ythan (Upper catchment above Fyvie)								
Pressure Length (m)	199	294	4346	343	2098	347	22956	10089	1220
Channel Capacity Used (%)	0.82	0.05	8.96	0.06	0.09	0.32	94.67	7.72	5.57
Bank Capacity Used (%)	0.33	0.00	4.02	0.00	0.80	0.32	56.69	4.73	3.01
Total Capacity Used (%)	1.15	0.05	12.99	0.06	0.90	0.64	151.37	12.46	8.59
	Ebrie Burn								
Pressure Length (m)	50	1037	5891	0	365	837	20605	333	110
Channel Capacity Used (%)	0.37	0.30	21.63	0.00	0.40	1.38	151.31	0.45	0.89
Bank Capacity Used (%)	0.15	0.00	9.71	0.00	0.25	1.38	90.60	0.28	0.48
Total Capacity Used (%)	0.51	0.30	31.34	0.00	0.65	2.76	241.91	0.73	1.38
	Youlie Burn / Bronie Burn								

Pressure Length (m)	291	0	17154	0	732	371	27576	0	0
Channel Capacity Used (%)	1.61	0.00	47.40	0.00	0.14	0.46	152.39	0.00	0.00
Bank Capacity Used (%)	0.65	0.00	21.29	0.00	0.38	0.46	91.25	0.00	0.00
Total Capacity Used (%)	2.25	0.00	68.69	0.00	0.51	0.92	243.65	0.00	0.00

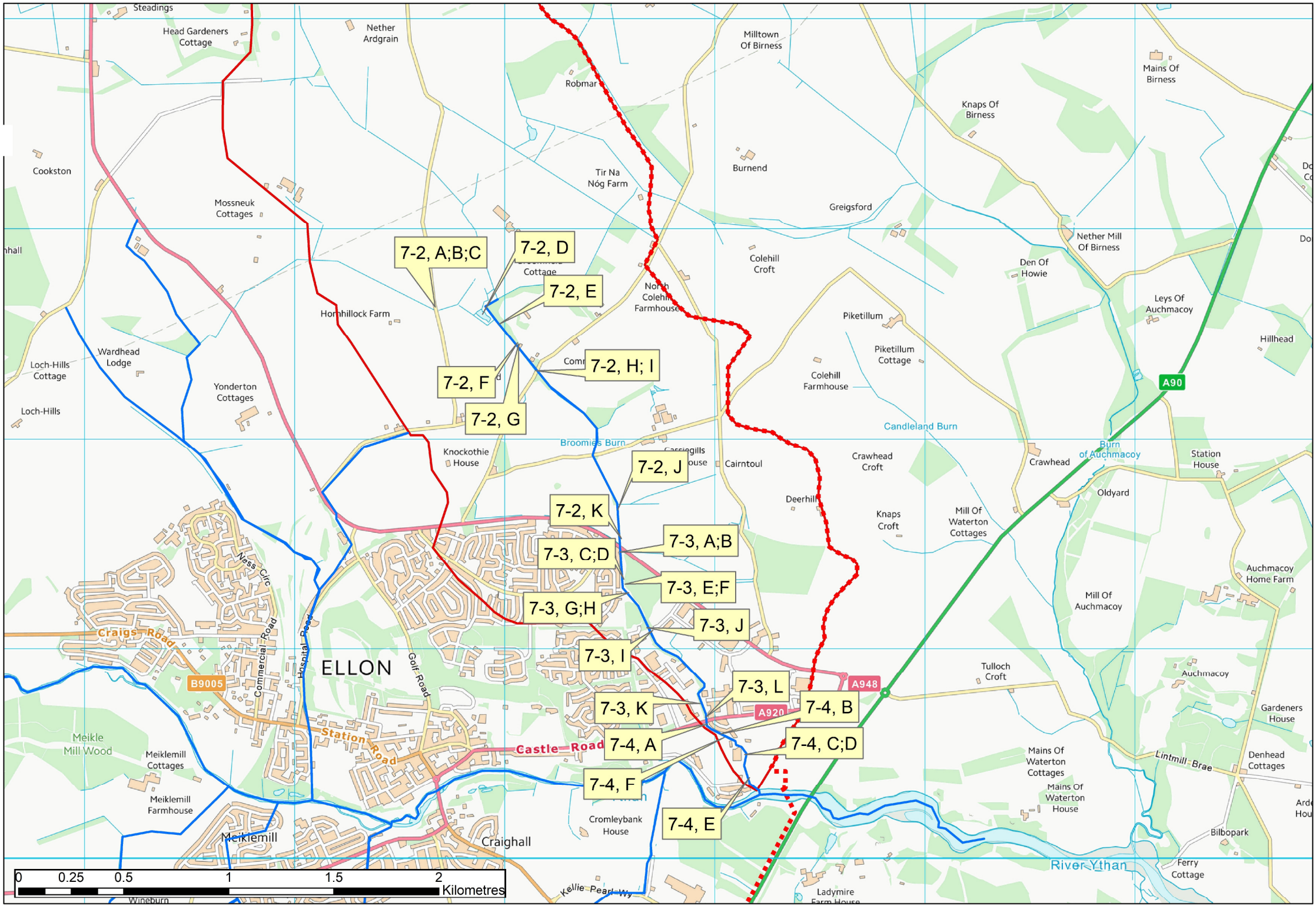
B Site Visit Photo Maps

B.1 River Ythan

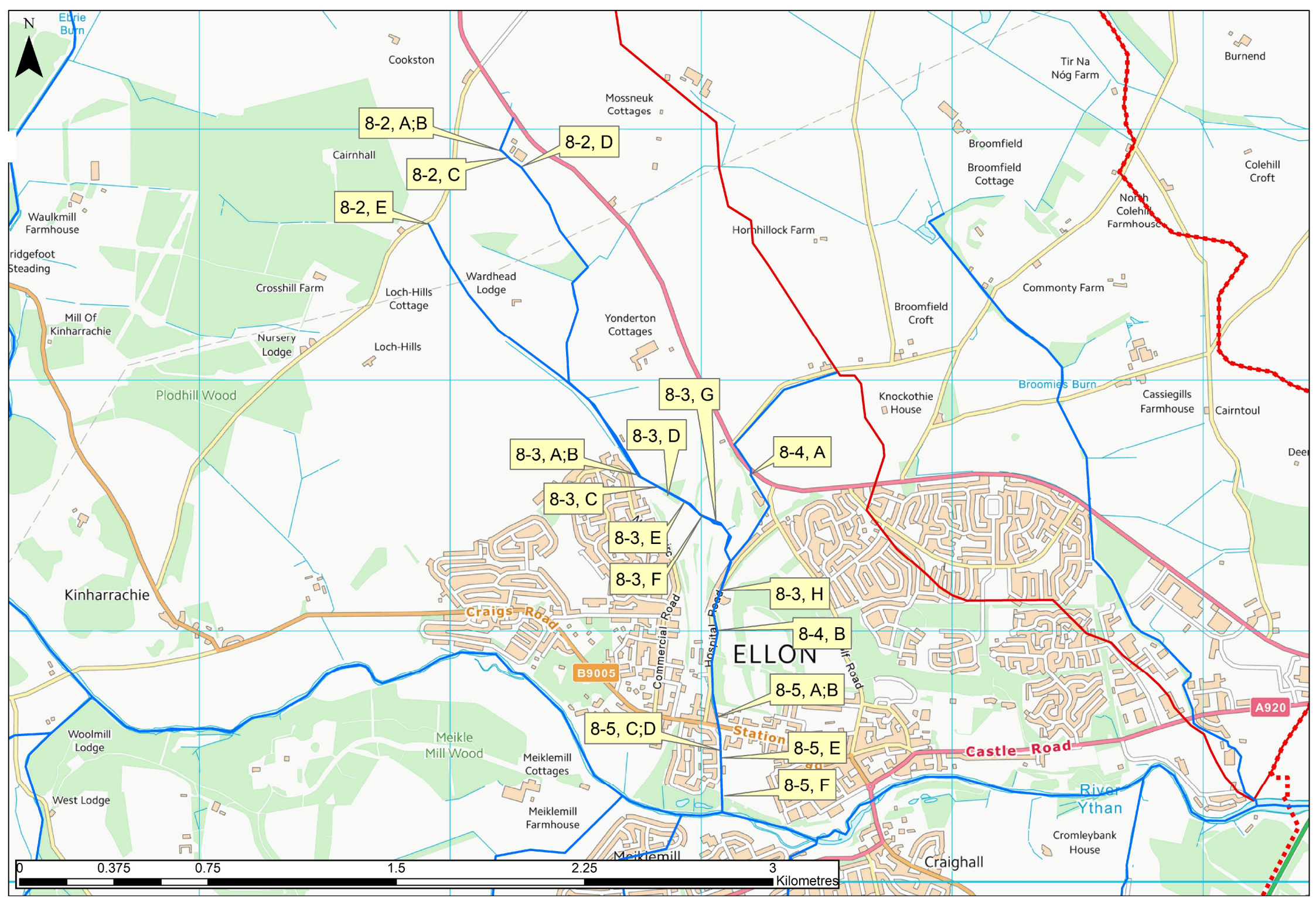


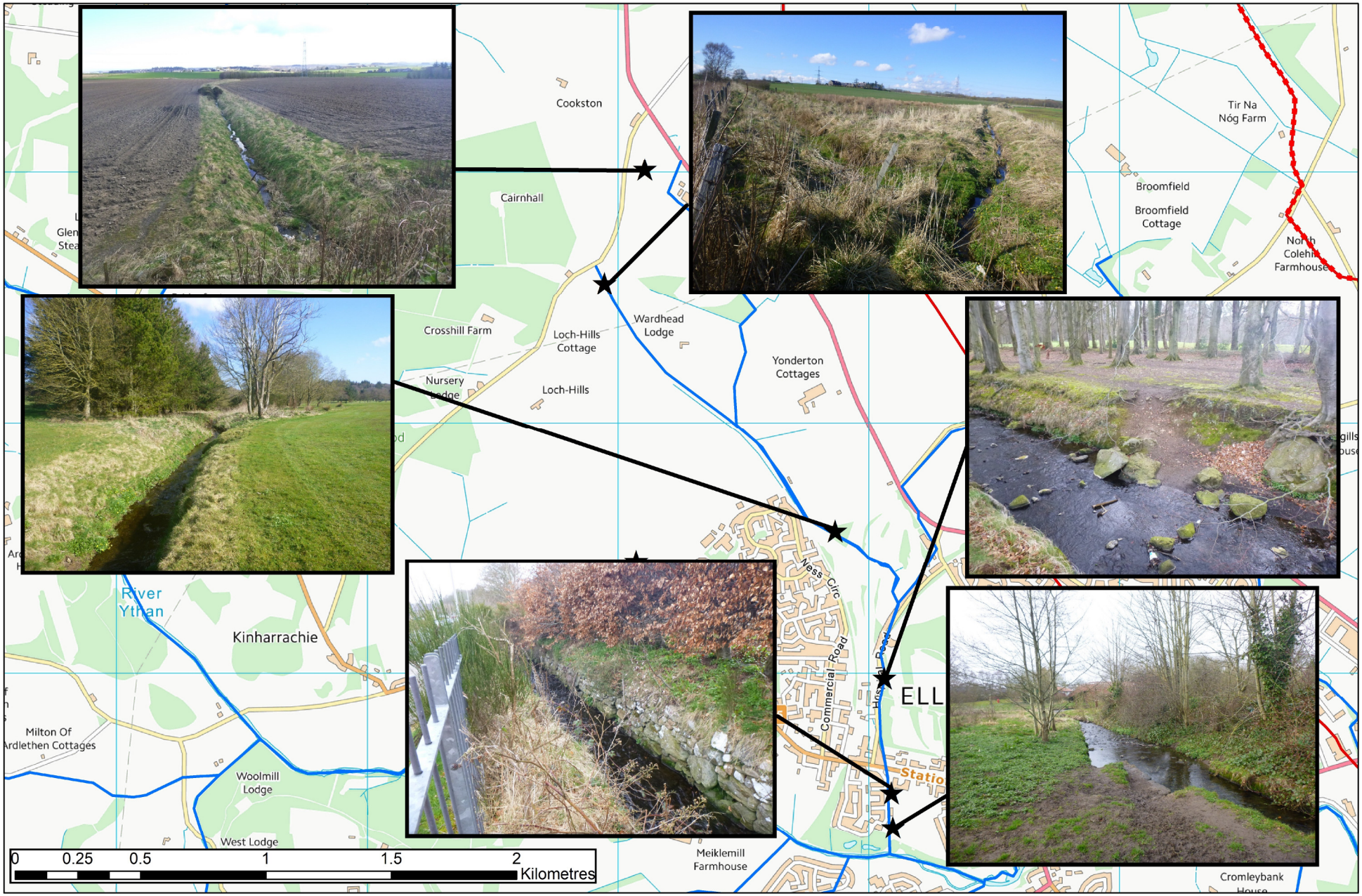


B.2 Broomie's Burn

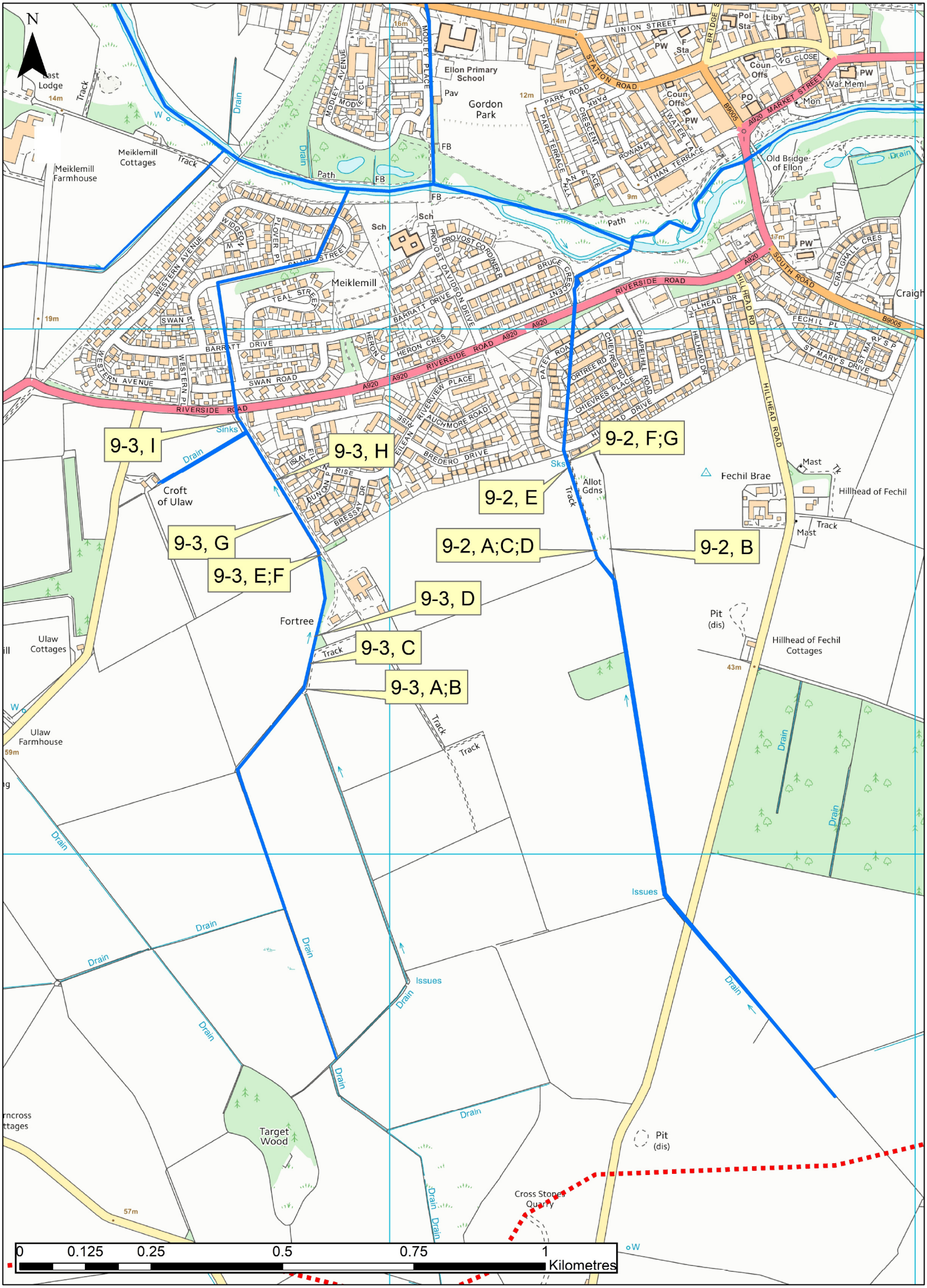


B.3 Modley Burn

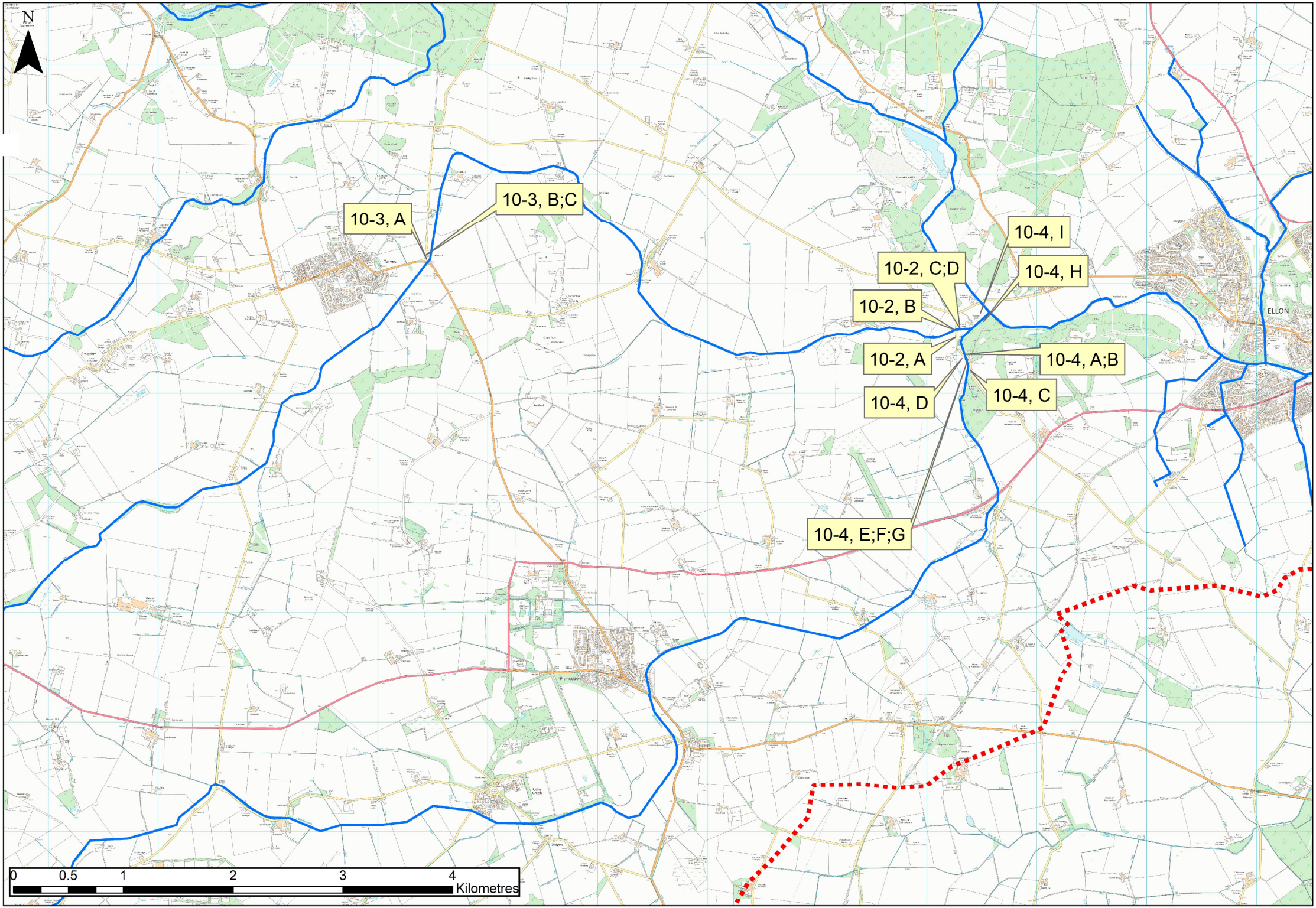


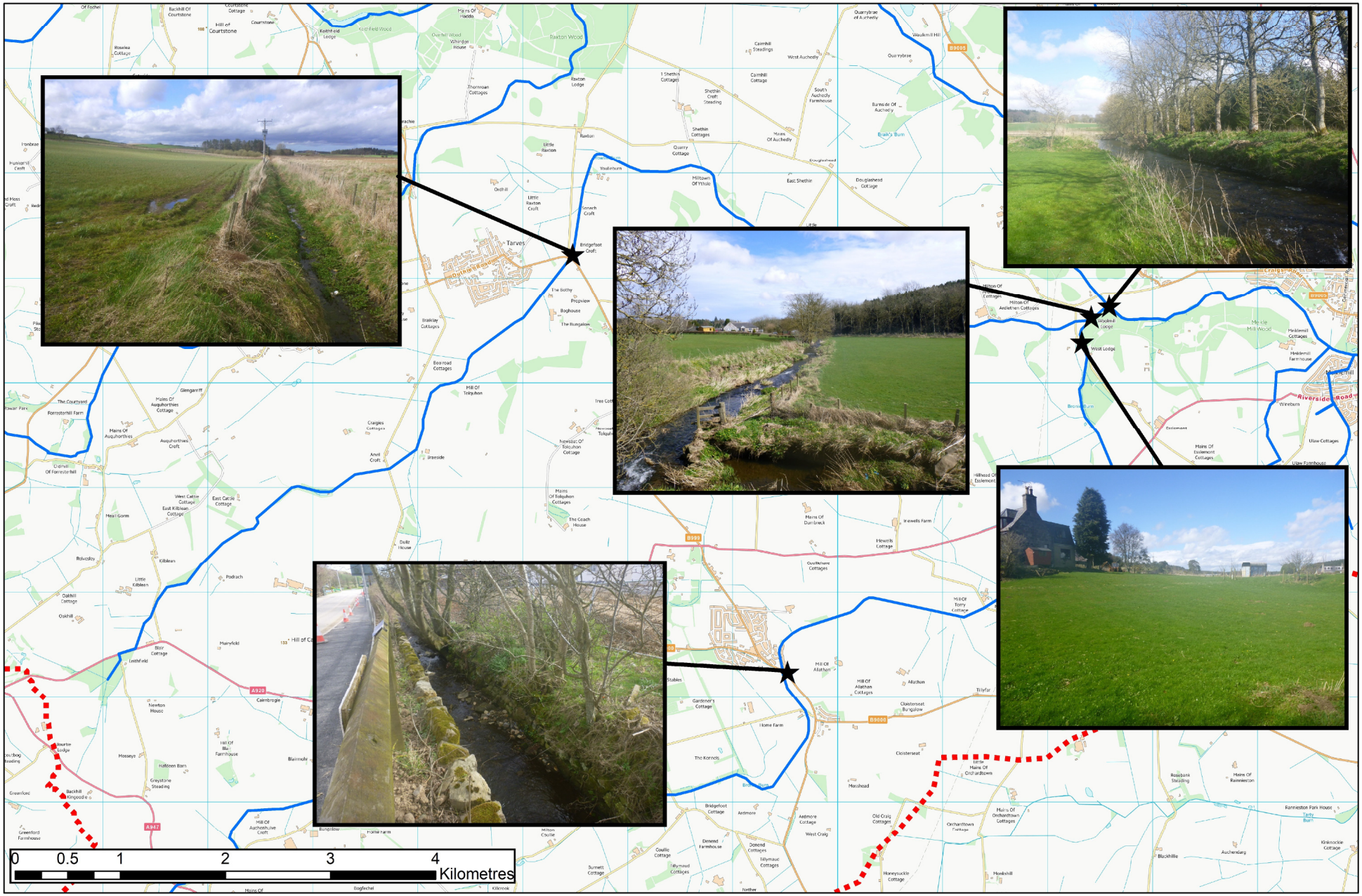


B.4 Hillhead and Fortree Burns

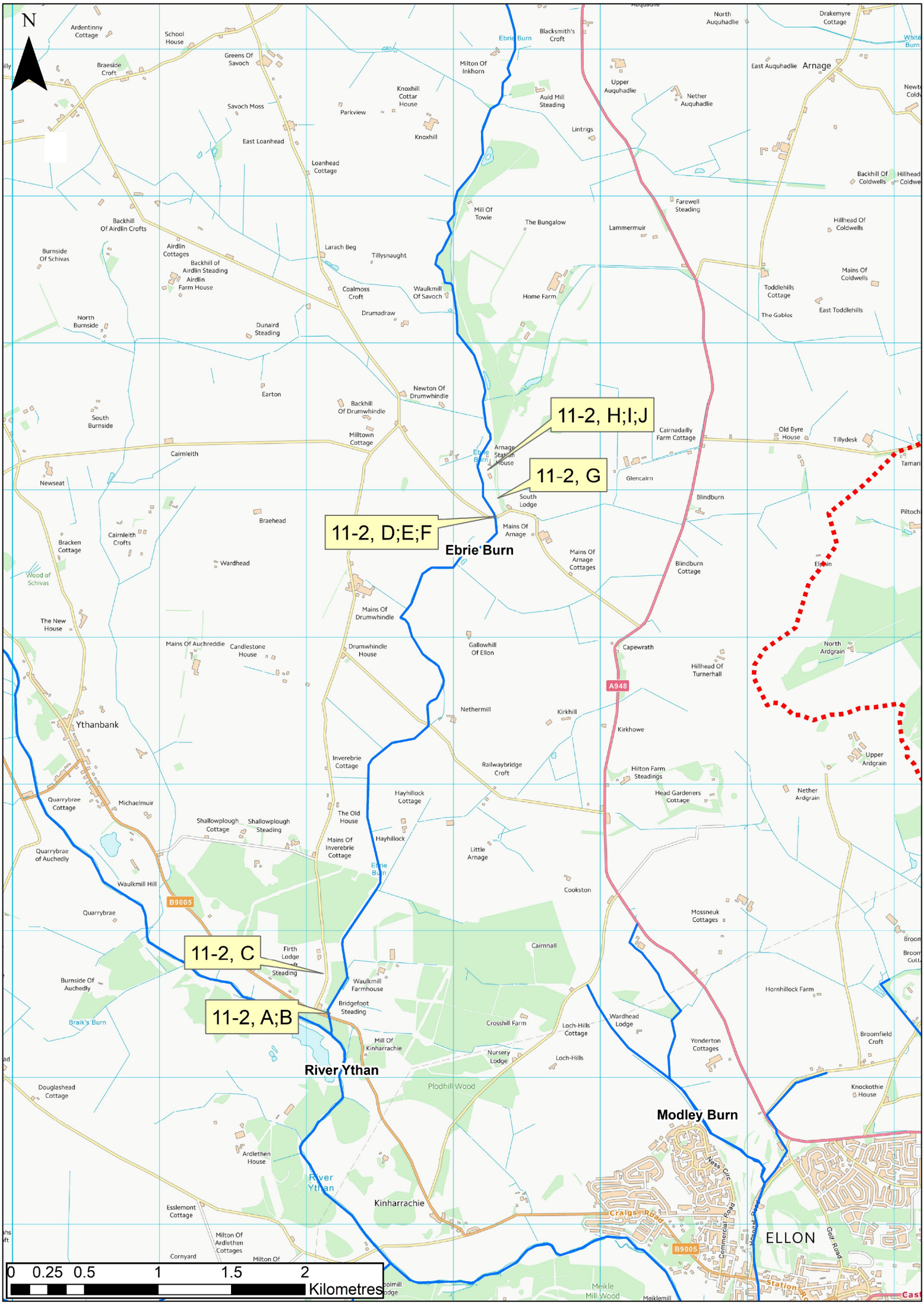


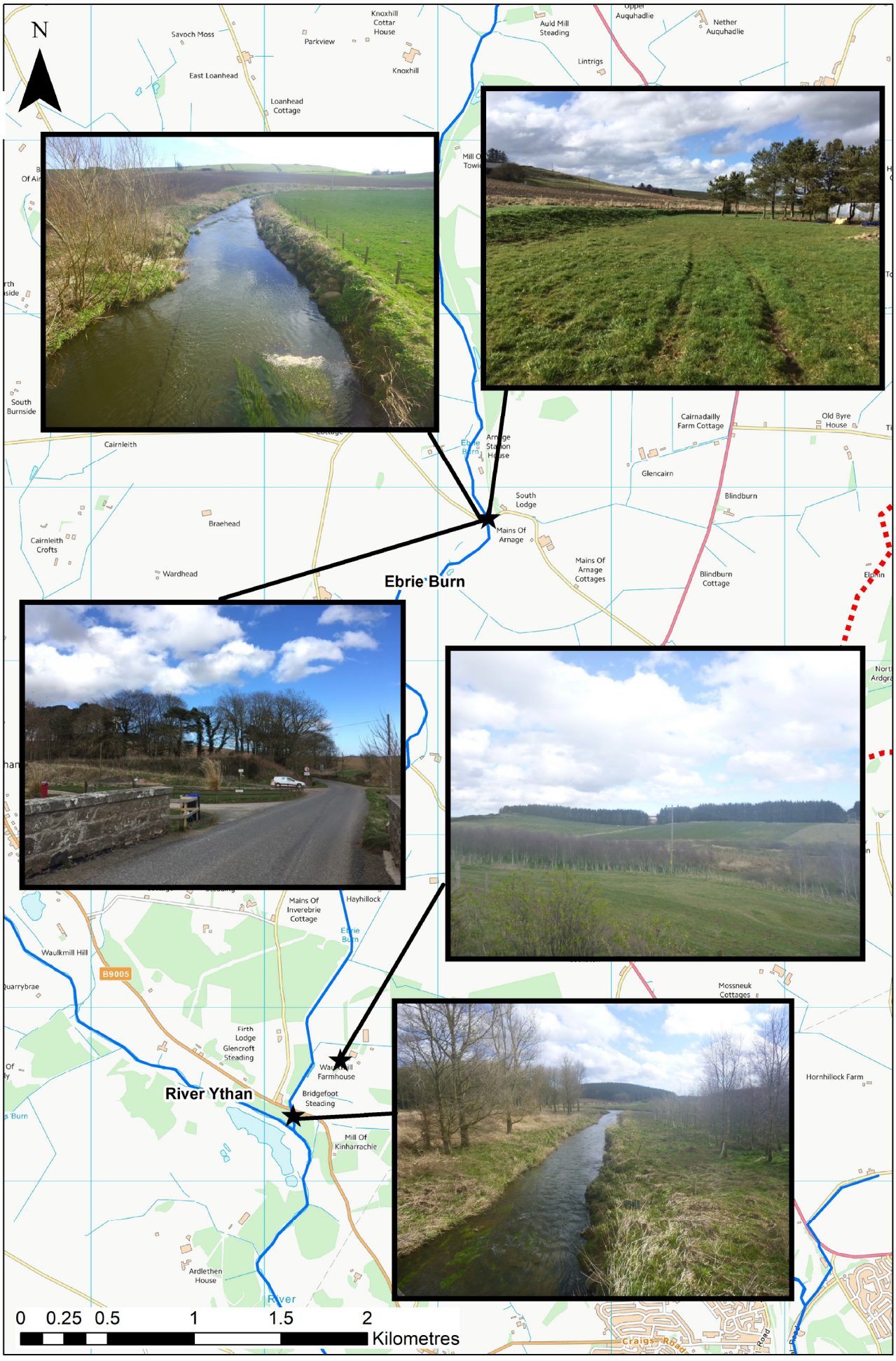
B.5 Youlie-Bronie Burn





B.6 Ebrie Burn





C Listed Buildings

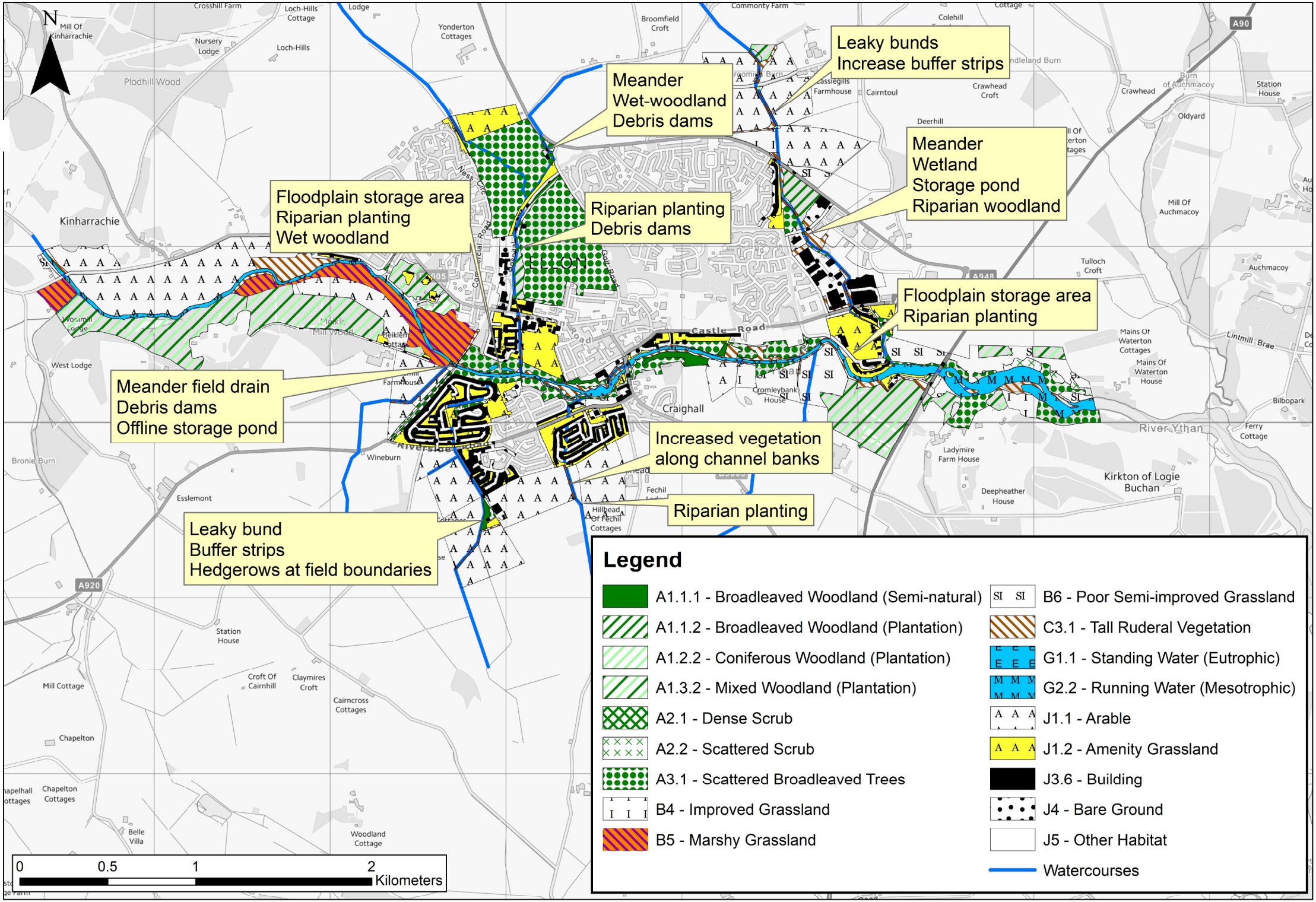
Address	Date Listed
RAMORNIE CRAIGS ROAD	1984-09-11
HADDO HOUSE BURIAL ENCLOSURE	1984-09-11
METHLICK OLD PARISH CHURCH (ST. DEAVANACH)	1971-04-16
LITTLE ARDO FARMHOUSE, S. SECTION ONLY	1984-09-11
HADDO HOUSE FOUNTAIN	1971-04-16
HADDO HOUSE, MONUMENT TO COL. SIR ALEXANDER GORDON	1971-04-16
PITMEDDEN HOUSE	1971-04-16
UDNY SCHOOLHOUSE UDNY GREEN (WEST SIDE)	1984-09-11
GATES ON AVENUE ("THE GOLDEN GATES") E.S.E. OF HADDO HOUSE	1971-04-16
FYVIE CASTLE, RACQUETS COURT	1993-08-31
ESSLEMONT HOUSE	1971-04-16
HOME FARM OF BLACKFORD, DOVECOT.	1971-04-16
COMMERCIAL ROAD AUCHTERCRAG WITH GARDEN URNS AND GATEPIERS	1988-12-20
METHLICK OLD PARISH CHURCH CHURCHYARD	1971-04-16
IVY COTTAGE METHLICK VILLAGE	1984-09-11
HADDO HOUSE, WALLED GARDEN	1971-04-16
HADDO HOUSE GARDENS COTTAGE	1971-04-16
TOWIE BARCLAY CASTLE	1972-11-24
WOODHEAD HOUSE (FORMERLY WOODHEAD HOUSE HOTEL)	1982-02-15
MELDRUM HOUSE	1971-04-16
PITTRICHIE SOUTH LODGE	1984-09-11
UDNY CHURCHYARD	1984-09-11
HOWFF OF SCHIVAS	1984-04-16
SCHIVAS WALLED GARDEN	1971-04-16
ABERDEEN ARMS HOTEL	1984-09-11
SHETHIN FARMHOUSE	1971-04-16
MAINS OF HADDO, FARMHOUSE AND OFFICE	1984-09-11
SOUTH LODGE, ROTHIE-NORMAN	1982-02-15
FASTERN'S EEN CROSS, FYVIE.	1982-02-15
CLYDESDALE BANK, FYVIE.	1982-02-15
FYVIE CASTLE	1971-04-16
LAUNDRY HOUSE, FYVIE CASTLE.	1971-04-16
HADDO ESTATE, THE PHEASANTRY	1999-05-04
FOLLA RULE VILLAGE HALL	2000-11-30
TANGLANDFORD, TANGLANDFORD BRIDGE	1996-01-19
MANSE OF METHLICK	1984-09-11
BRIDGEND, METHLICK VILLAGE	1984-09-11
HOUSE OF SCHIVAS	1971-04-16
MARYFIELD	1982-02-15
PRIORY CROSS, FYVIE.	1982-02-15
HILTON OF TURNERHALL, FARMHOUSE	1971-04-16
MAINS OF BADENSCOTH, FRAGMENT OF OLD HOUSE, OUTBUILDINGS, WALLED GARDEN WITH BARN ON E. WITH GATEPIERS	1982-02-15
PITMEDDEN GARDEN AND ESTATE, FARMHOUSE (FORMER LAUNDRY), STABLE, OPEN SHED, STEADING AND BOTHY	2006-09-28
OLD BRIDGE OF ELLON	1971-04-16
PITTRICHIE HOME FARM	1984-09-11
HADDO HOUSE STABLE AND COACHHOUSE BLOCK S. OF HOUSE	1971-04-16
MILL OF FORESTERHILL	1971-04-16

KILBLEAN, HOUSE AND GARDEN WALLS	1971-04-16
PRIMROSE COTTAGE UDNY GREEN (SOUTH SIDE)	1984-09-11
PITMEDDEN GREAT GARDEN	1971-04-16
WEST BLOCK OF FARM STEADING SCHIVAS	1971-04-16
TARVES MANSE	1971-04-16
BOAT OF ARDLETHEN BRIDGE OVER RIVER YTHAN	1984-09-11
MANSE OF FYVIE, GARDEN WALLS.	1982-02-15
IVY BRIDGE OVER RIVER YTHAN W.N.W. OF FYVIE CASTLE	1971-04-16
EAST GATE AND LODGE FYVIE CASTLE	1971-04-16
HILTON STEADING (EXCLUDING LATER, BUILDINGS IN COURT)	1971-04-16
CASTLE OF ESSLEMONT	1971-04-16
MAINS OF BADENSCOTH, FRAGMENT OF OLD HOUSE, OUTBUILDINGS, WALLED GARDEN WITH BARN ON E. WITH GATEPIERS	1982-02-15
OLD PARISH CHURCH OF AUCHTERLESS (ST. DONAN)	1971-04-16
TOLQUHON MONUMENT, TARVES CHURCHYARD	1971-04-16
THE LAUNDRY, HADDO	1984-09-11
HADDO HOUSE SUNDIAL S.E. OF FOUNTAIN	1971-04-16
MANSE OF UDNY	1984-09-11
UDNY BRIDGE	1984-09-11
MONUMENT TERMINATING AVENUE E.S.E. OF HADDO HOUSE	1971-04-16
HOUSE OF SCHIVAS	1971-04-16
OLD INN, S.E. CORNER OF TARVES SQUARE.	1984-09-11
NORTH YTHSIE FARMHOUSE	1984-09-11
KEITHFIELD LODGE, GATES AND GATEPIERS HADDO HOUSE	1984-09-11
ST. GEORGE'S RECTORY FOLLA RULE.	1971-04-16
MASONIC LODGE, LEWES, FYVIE.	1982-02-15
OLD HOME FARM, FYVIE CASTLE	1971-04-16
ALL SAINTS EPISCOPAL CHURCH, WOODHEAD.	1971-04-16
MANSE (FORMERLY WOODHEAD MANSE).	1982-02-15
FYVIE PARISH CHURCH.	1971-04-16
ARNAGE CASTLE	1971-04-16
DUFF OF HATTON MAUSOLEUM, AUCHTERLESS CHURCHYARD	1982-02-15
AUCHTERLESS CHURCHYARD	1982-02-15
AUCHTERLESS PARISH CHURCH	1982-02-15
OLRIG (FORMER FREE MANSE) STATION ROAD.	1971-04-16
ST. MARY ON THE ROCK EPISCOPAL CHURCH, ELLON	1971-04-16
MELDRUM HOUSE PAIR OF GARDEN HOUSES AT S.E. OF HOUSE	1971-04-16
MELDRUM HOUSE PAIR OF GARDEN HOUSES AT S.E. OF HOUSE	1971-04-16
METHLICK NEW PARISH CHURCH	1971-04-16
HADDO HOUSE BALUSTRADES FLANKING S.E. AVENUE	1971-04-16
MELDRUM HOUSE OUTER GATE AND STABLE AND COACHHOUSE BLOCK	1971-04-16
SAVOCH OF DEER CHURCH.	1982-02-15
SMIDDY COTTAGE UDNY GREEN (SOUTH SIDE)	1984-09-11
UDNY CASTLE	1971-04-16
PITMEDDEN LIME-KILN	1971-04-16
ATHOLHILL FARMHOUSE	1984-09-11
HOUSE OF SCHIVAS, LARGE SUNDIAL	1984-04-16
PARISH CHURCH OF TARVES (ST. ENGLAT)	1971-04-16
BEDE HOUSE, BOGHOUSE, TARVES	1984-09-11
SOUTH LODGE, HADDO HOUSE.	1984-09-11

TIFTY, WATERWHEELHOUSE.	1982-02-15
MANSE OF FYVIE, SUNDIAL.	1982-02-15
FYVIE CASTLE SOUTH GATES	1982-02-15
FYVIE CASTLE BOATHOUSE	1971-04-16
WALLED GARDEN, FYVIE CASTLE.	1971-04-16
FYVIE, MAIN STREET, OLD SCHOOL BUILDING	1982-02-15
FYVIE CASTLE, DISUSED PRIVY BETWEEN CASTLE AND IVY BRIDGE	1971-04-16
TEMPLAND, FARMHOUSE.	1982-02-15
MAINS OF THORNTON	1971-04-16
PITMEDDEN GARDEN AND ESTATE, FARMHOUSE (FORMER LAUNDRY), STABLE, OPEN SHED, STEADING AND BOTHY	2006-09-28
PITMEDDEN FORMER FREE CHURCH	1993-04-08
HADDO HOUSE, BUTLER'S HOUSE	1984-09-11
HADDO HOUSE SUNDIAL ON S. LAWN	1971-04-16
HADDO HOUSE ICE-HOUSE	1984-09-11
CAIRNBANNO HOUSE (NOW FARMHOUSE).	1971-04-16
UDNY CASTLE LODGE AND GATES	1971-04-16
UDNY MORT-HOUSE	1971-04-16
BRIDGE OF AUCHEDLY OVER RIVER YTHAN	1984-09-11
NORTH LODGE, KINBROON, BY ROTHIENORMAN	1982-02-15
ST. GEORGE'S EPISCOPAL CHURCH, FOLLA RULE.	1971-04-16
ARDLOGIE HOUSE (FORMER MANSE OF FYVIE)	1982-02-15
OLDWOOD COTTAGE, FYVIE CASTLE.	1971-04-16
WOODHEAD TOLBOOTH (OLD FARM HOUSE, WOODHEAD)	1971-04-16
MILLBREX CHURCH	1971-04-16
FYVIE PARISH CHURCH, OLD CHURCHYARD, (EXCLUDING MODERN CEMETERY).	1971-04-16
NETHERMILL, FORMER GRAIN MILL	1984-09-11
NEW MILL, MILL.	1982-02-15
NETHERTHIRD FARMHOUSE.	1982-02-15
PAIR OF STAGS, FLANKING AVENUE E.S.E. OF HADDO HOUSE	1971-04-16
METHLICK BRIDGE OVER RIVER YTHAN	1971-04-16
NORTH LODGE	1984-09-11
HADDO HOUSE	1971-04-16
HADDO HOUSE	1971-04-16
HADDO HOUSE STABLE AND COACHHOUSE BLOCK S. OF HOUSE	1971-04-16
TOWIE BARCLAY STEADING EAST OF CASTLE	1976-07-02
BALTHANGIE COTTAGE.	1982-02-15
PITTRICHIE DOVECOT	1971-04-16
UDNY PARISH CHURCH (CHRIST CHURCH)	1971-04-16
UDNY ARMS HOTEL UDNY GREEN (SOUTH SIDE)	1984-09-11
TOLQUHON CASTLE	1971-04-16
TARVES CHURCHYARD	1984-09-11
SOUTH YTHSIE FARMHOUSE	1984-09-11
MAINS OF HADDO, NORTH FRONT OF STEADING	1984-09-11
HILL OF YSTHIE, MONUMENT TO PRIME MINISTER THE 4TH EARL OF ABERDEEN	1984-09-11
STATUE, S. OF WALLED GARDEN FYVIE CASTLE	1971-04-16
NORTH LODGE, FYVIE CASTLE.	1971-04-16
FETTERLETTER, TWIN CIRCULAR STRUCTURES N.W. OF FARMHOUSE	1982-02-15

GIGHT CASTLE	1971-04-16
HILTON WINDMILL	1971-04-16
LITTLEMILL OF ESSLEMONT	1971-04-16
HATTON MANOR, FARMHOUSE	1971-04-16
KNOCKLEITH HOUSE.	1982-02-15
MAINS OF BADENSCOTH, FRAGMENT OF OLD HOUSE, OUTBUILDINGS, WALLED GARDEN WITH BARN ON E. WITH GATEPIERS	1982-02-15
BIRSE WAR MEMORIAL	1980-11-25
PITMEDDEN GARDEN AND ESTATE, FARMHOUSE (FORMER LAUNDRY), STABLE, OPEN SHED, STEADING AND BOTHY	2006-09-28
HADDO HOUSE HALL	2009-12-14

D Ecology within Scheme Extent



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Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

t:+44(0)1756 799919
e:info@jbaconsulting.com

Jeremy Benn Associates Ltd
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