Runoff Management Plan: Haltwhistle Burn Catchment (Version 0.3)

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1. Introduction

The Haltwhistle Burn catchment is a 42km^2 predominantly rural catchment located in Northumberland. The Burn and its tributaries suffer from multiple pressures and many properties in and around the town of Haltwhistle have been affected by flash flood events, historically and also more recently.

Learning from best practice demonstrated within the Belford Burn catchment in Northumberland, Tyne Rivers Trust is promoting the use of Natural Flood Management (NFM) within the Haltwhistle Burn catchment. NFM involves alteration, restoration or use of landscape features which work with natural processes (rather than against) in order to reduce issues of flood risk and degradation of sediment, water quality and habitats. Newcastle University has developed this runoff management plan highlighting two key zones within the catchment which will be used as NFM demonstration sites and it also presents a selection of features that are proposed.

2. Characterising the Haltwhistle Burn Catchment

2.1. Topography

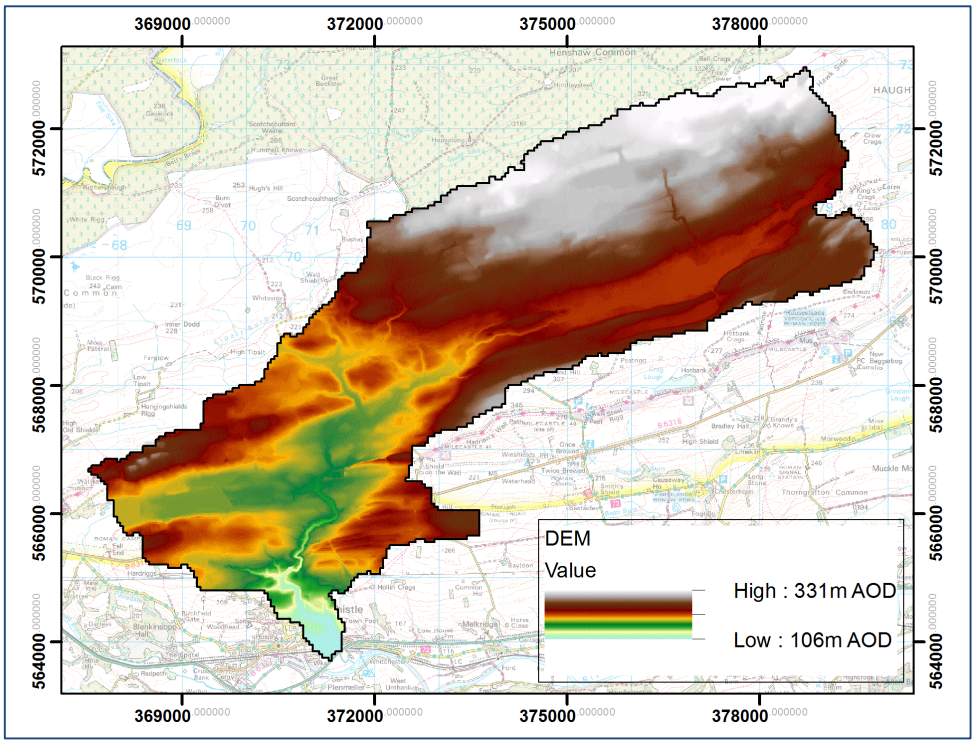

***Figure 1** – DEM of the Haltwhistle Burn Catchment*

Due to the surrounding topography and the Whin Sill outcrops, the Haltwhistle Burn catchment is elongated in shape, giving it a 'flashy' response during heavy rainfall events. In the upper catchment, the land falls north and south towards Greenlee Lough which is situated within a subdued valley. The

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topography remains fairly flat for a few kilometres west, before it then starts to fall towards the south west. Once below the B6318 Military Road in the lower part of the catchment, it becomes steep and narrow (gorge area), before reaching Haltwhistle itself. The Digital Elevation Model (DEM) in Figure 1 (or view an interactive map online here: http://bit.ly/1l9YC6a) illustrates the catchment's topography and also the 'squeeze' at the point where the Haltwhistle Burn meets the River South Tyne, which can have the effect of exacerbating flooding issues.

2.2. Geology, soil and land cover

The catchment's bedrock geology is characterised by alternating bands of limestone, sandstone and a combination of limestone, sandstone, siltstone and mudstone. The area is also known for its ridges that form the Whin Sill. Recent and unconsolidated deposits (superficial geology) are typically peat and glacial till. An interactive geology map of the catchment can be viewed here: http://bit.ly/1nYnVwd.

Peaty soils dominate the upper Haltwhistle Burn catchment and loamy / clayey soils predominate in the lower catchment (view an interactive map online here: http://bit.ly/1kkSsp9).

According to the CEH 2007 land cover map (view an interactive map online here: http://bit.ly/1epeq6c), coniferous woodland, acid grassland and heather grassland dominate the upper catchment. Apart from a small urbanised area of Haltwhistle, the lower catchment is generally improved acid grassland.

Impeded soil drainage, over-grazing and other farming activities accelerate run-off and erosion in this catchment, particularly during winter months.

2.3. Stream network and impact zone

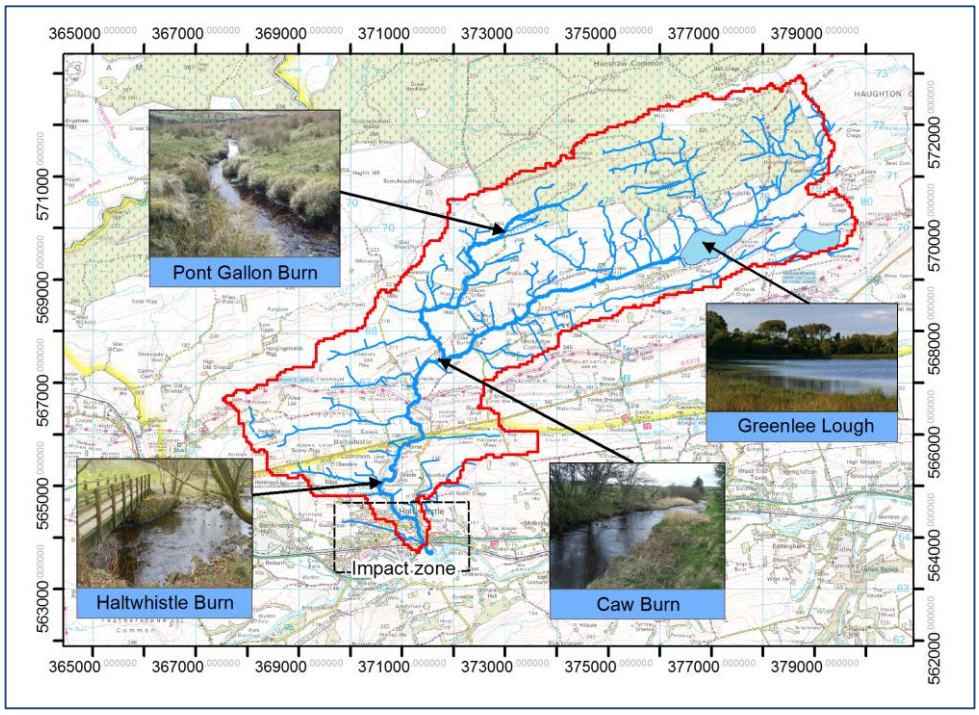

***Figure 2** – River network within the Haltwhistle Burn Catchment*

As the river network converges south towards its confluence with the River South Tyne, it passes through the eastern edge of the town of Haltwhistle. This is regarded as the main 'impact zone' which typically experiences high velocities and volumes of water and sediment during flash flood events.

The catchment comprises of a long linear and complex network of ditches, drains, streams and small burns which drain into the River South Tyne. Although the Haltwhistle Burn, Caw Burn and Pont Gallon Burn are the 'backbone' watercourses, the majority of the network is made up of smaller ditches, drains and streams. Figure 2 (for an interactive map online visit: http://bit.ly/1kkSEoo) locates the Haltwhistle Burn and its tributaries.

2.4. Strahler stream order

Stream order is used to define stream size in a drainage basin based on the hierarchy of tributaries. The principle of the Strahler ordering system is that two 1st order streams (the smaller, typically headwater watercourses) form a 2nd order stream, two 2nd order streams then join to form a 3rd order stream and so on. A Strahler stream network map has been created using the ArcGIS spatial analyst (hydrology) tools for the catchment (see Figure 3 or view an interactive Strahler map online here: http://bit.ly/ULmgig).

Stream order is taken into account when managing watercourses and building an understanding of which tributaries have a higher risk of flooding or contribute to the flood risk downstream. The majority of watercourses feeding into the Haltwhistle Burn (which enters the impact zone downstream) are 1st and 2nd order streams. Managing these 'headwater' streams using NFM will assist with attenuating flood peaks and slowing the flow during heavy rainfall events.

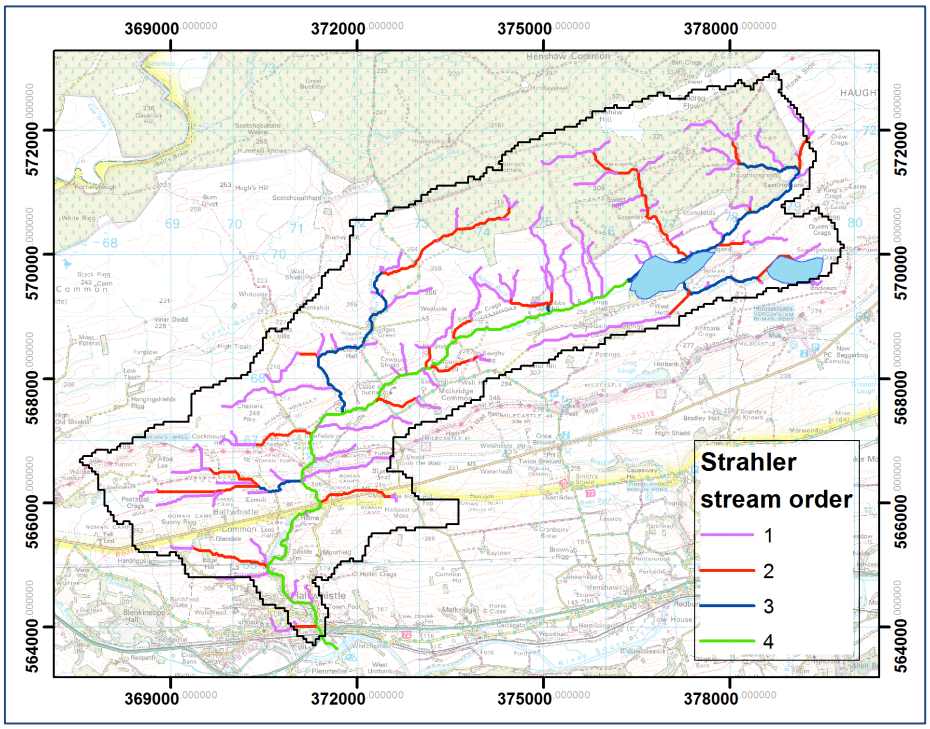

Figure 3 – *Strahler stream order within the Haltwhistle Burn Catchment*

3. Historical and recent catchment issues: sharing local knowledge and catchment monitoring

The Haltwhistle Burn catchment has been historically affected by flooding, from both surface water and fluvial (river) sources. More recently, the Burn and its tributaries burst their banks during extreme rainfall events in 2007, 2012, 2013 and 2014. The recent flood events which occurred on Wednesday 30th April and Sunday 11th May 2014 highlight how flashy and localised rainfall and subsequent flood events are within this catchment. On both occasions there were no weather warnings issued by the Met Office and rainfall totals took locals by surprise. On each occasion, the storm lasted approximately 40 minutes resulting in properties being flooded, culverts becoming blocked by sediment and drains surcharged. A local resident commented that "*the floods had been and gone within a few hours*". This flooding mechanism is common to the catchment so it is very difficult to warn and prepare residents for flooding. Due to the flashy nature of the catchment, the Environment Agency has classified it as a 'rapid response catchment'. Typical of a rural catchment, storm discharge is also usually contaminated by sediment and agricultural runoff which in turn adversely affects species living within the water environment.

Over the past 12 months, members of the local community have shared their local knowledge, observations, anecdotes, photographs and videos, providing valuable evidence of catchment behaviour and issues (of which can be viewed here: http://bit.ly/1prc0XC). Figure 4 contains a few examples of this 'crowd-sourced' information. Data has also been obtained from a network of automatic rainfall gauges and water level recorders which have been used to characterise the catchment and again confirm how flashy the watercourses are. Examples of data downloaded from these devices can be viewed online, including an interactive graph and map here: http://bit.ly/1rWG5Sq.

Haltwhistle Burn at peak flow (and heavily contaminated with sediment) during 30th April 2014 flash flood event (NY 71378 63981)

Excessive algal growth shows signs of nutrient enrichment and possible eutrophication across the catchment.

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Slaty Sike morphologically active behind Broomshaw Hill Farm after 12th May 2014 flood event (NY 70482 64987)	Cleughfoot Farm following July 2007 flash floods adjacent to Caw Burn (NY 71490 67456)
 Widespread flooding and river bank erosion during 22nd to 23rd December 2014 event, including the Caw Burn (downstream of Cawfields Quarry - NY 71303 66447).	 Debris and sediment blocks culvert causing deep and fast flowing surface water flooding along Willia Road (NY 70561 65006)
 Haltwhistle Burn rising rapidly 23rd December 2014 following heavy rain. Photograph taken from behind Shepherd Hill (NY 71465 64338).	 On-going sediment build-up under Townfoot bridge (Haltwhistle) reducing capacity during flood events over time (NY 71353 64020).

Figure 4 – *Evidence of catchment issues in the Haltwhistle Burn catchment*

4. Proposed NFM demonstration sites within the Haltwhistle Burn Catchment

Natural Flood Management (NFM) involves alteration, restoration or use of landscape features which work with natural processes (rather than against) in order to reduce issues of flood risk and degradation of sediment, water quality and habitats. These types of features significantly contrast traditional ('hard') defences, such as flood walls and barriers, which tend to work against natural processes and are expensive to construct, maintain and monitor. Newcastle University has researched catchment management and a NFM approach for many years now, with the Belford Burn catchment in Northumberland being the main research pilot site which has been referred to as 'best practice' across the UK:

"Research has proven that flow intervention structures, both in the watercourse and on the surrounding farmland, can have a significant impact on the flood levels downstream by slowing and storing floodwater. At the same time, Newcastle University were able to demonstrate the beneficial impact such features have on water quality, leading to an understanding of the multiple benefits that changes in land use and construction of small interventions can have" Newcastle University and Environment Agency (2011).

"*A Runoff Attenuation Feature is defined as a man-made landscape intervention that intercepts and attenuates a hydrological flow pathway to provide multiple benefits, including flood management and improving water quality. Simply, the design philosophy is to create features that 'slow, store and filter' runoff in the rural landscape*" Quinn *et al*. (2013).

This runoff management plan highlights two key demonstration zones which are proposed for the Haltwhistle Burn catchment. These demonstration zones will be used to test the performance of a range of NFM features and physically act as demonstration sites for local members of the community, including land owners and the local River Watch Group. Demonstration sites will ensure that members of the local community are included within the catchment management process and will also assist with increasing their awareness and understanding of catchment processes, catchment connectivity and NFM itself. Demonstration sites can also be used to assist with scaling up benefits of NFM across the wider catchment.

The location of the two demonstration sub-catchments have been based on the following selection criteria:

- Strahler stream order: 1st and 2nd order streams are likely to provide the most benefits from NFM;
- General topography, geology, land cover and soil type which favour attenuation of flood water;
- Size and shape of the sub-catchment: small (~1km) and elongated;
- There are known catchment related issues within the sub-catchment;
- Willingness of land owners to be involved in this initial demonstration phase;
- Proximity to the town of Haltwhistle itself;
- Feasibility and suitability for a range of different NFM features;
- Must complement existing or proposed runoff management work (primarily by Tyne Rivers Trust and Northumberland County Council);
- Are within an area where local Haltwhistle River Watch volunteers have already expressed an interest in community-based monitoring activities.

The Slaty Sike and Great Chesters Burn sub-catchment are therefore proposed as demonstration sites, as detailed below within Section 4.1 and 4.2. In both demonstration zones, the primary aim is not to reduce overall volumes of water; rather it is to store and attenuate high flows following heavy rainfall events. This will slow down the flow, lower the peak of the hydrograph within the impact zone and reduce the watercourses ability to transport sediment and debris. Water will be released slowly once the peak event has passed. Within each zone a network of features are proposed which will collectively manage runoff, rather than relying on one large feature. It is also important to note that NFM features installed within the two sub-catchments will compliment any existing or proposed runoff management techniques adopted by Tyne Rivers Trust or other catchment stakeholders.

It is anticipated that interested River Watch (and wider community) volunteers will assist during the construction phase of NFM features. Monitoring of NFM features will be required once constructed to confirm that they are performing as expected and to provide the local community and land owners with confidence that they are having a positive impact on their water environment. Although some automatic sensors may be required initially, members of the local Haltwhistle River Watch Group have already expressed an interest in monitoring the effects of NFM, including before, during and after heavy rainfall events. This latter approach is expected to support long-term monitoring and maintenance activities.

As part of the Catchment Restoration Funds (CRF) project, Tyne Rivers Trust has already introduce some runoff management measures within the Haltwhistle Burn catchment. Existing ( ) and proposed ( ) measures are mapped online here: http://bit.do/catchmentmanagement and are expected to compliment the network of features described below.

4.1. Zone 1: Slaty Sike sub-catchment

Zone 1 comprises of the Slaty Sike sub-catchment which is located within the lower region of the Haltwhistle Burn catchment. This sub-catchment is summarised in Table 1 below.

Given the nature of the Slaty Sike sub-catchment, a series of NFM features are proposed. These features are described in Table 2 and also mapped in Figure 5.

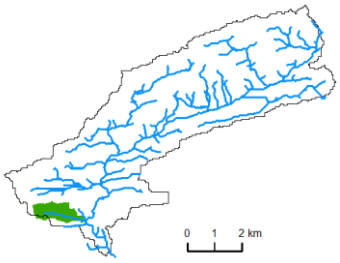
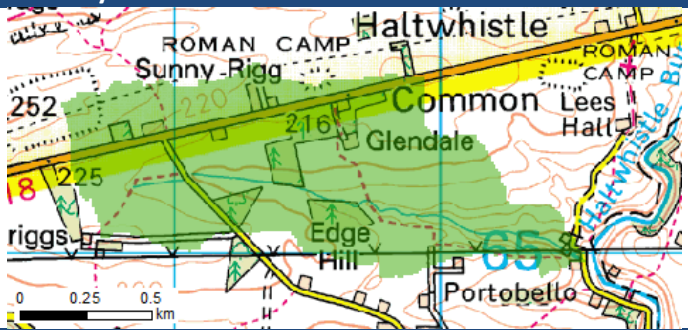
Zone 1 – Slaty Sike sub-catchment	
Location: 	
Name of watercourse	Slaty Sike
Watercourse length:	1.8km
Flow direction:	West to east
Sub-catchment area:	1.00 km^2
Topography:	241m AOD (west) to 135m AOD (east).
Bedrock geology:	Mudstone, sandstone and limestone
Soil:	Loamy and clayey (slowly permeable, seasonally wet)
Dominant land cover / use:	Improved grassland (agricultural use)
Strahler stream order:	1 and 2
Known issues:	Flashy response. Has flooded Broomshaw Hill Farm buildings, including recent 11th May 2014 event. Due to morphological activity, it acts as a sediment source which blocks culverts and contributes to flooding issues along Willia Road. It also contributes to the flood peak and 'murky water' in the Townfoot area of Haltwhistle. Visual inspections over the past year also confirm that bank erosion and collapse has accelerated in some locations along the Slaty Sike.

Table 1 – *Summary of Zone 1 demonstration site: Slaty Sike sub-catchment*

Feature	Description / Purpose
A series of online runoff attenuation features (RAFs) 	Online RAFs are ponds with a bund placed across the stream. These features work by storing water when the flow is high and releases it slowly back into the river downstream once the peak has passed. 'Online' means that these features are located within the drainage channel. An outlet pipe will also be required to let water pass through the bund.
A series of online log jams 	Wooden structures are placed perpendicular to (across) small drains, ditches and streams to encourage sediment trapping, reduce local erosion and create/improve ecological habitats. They act as a flow restrictor, blend easily into the landscape and sediment collected behind the feature can be re-used by the farmer. Flow is expected to stay in the ditch.
Large woody debris (LWD)	Simple wood dams (usually timber sourced from the same area) are placed across the watercourse. LWD can slow and divert flood flow onto

	the woodland floor. This means that water has to pass over a rougher surface (increases hydraulic roughness) and around obstacles which will attenuate the flow during a flood, therefore reduce flood risk downstream. It also helps to filter murky flood water, allowing sediment to settle out. Woodland areas where a stream passes through are ideal locations for LWD as they are usually less productive zones for farmers and also provide a local source of material. Naturally fallen trees are often found in these areas and can be utilised.

Table 2 – *Features proposed in Zone 1: Slaty Sike sub-catchment*

Figure 5 – *Map illustrating the location of features proposed in Zone 1: Slaty Sike sub-catchment*

An interactive map can also be viewed online here: http://bit.do/catchmentmanagement. **Once the map has loaded, click on the polygons, arrows and dots; a window will pop up describing what the features are and also contain images of what they may look like once constructed. Click on the image to view a larger copy. Please note that the shape and size of features proposed are indicative at this stage and need to be approved by all relevant stakeholders before specific details can be determined.**

Consultations and site visits with relevant land owners are currently underway at the time of revising this report (January 2015 – see Figure 6). So far local land owners and land agents have shown a positive attitude towards the NFM features proposed in the Slaty Sike sub-catchment. This includes *"I think it is just lovely working with nature like this. It is a great compromise"* (local land owner, January 2015). The plan has been tweaked (see Version 0.2 of this report) following land owner requests and preferences for NFM on their land, along with their local knowledge.

Figure 6 – *Walking the Slaty Sike catchment with local land owners and agents*

4.2. Zone 2: Great Chesters Burn sub-catchment

Zone 2 comprises of an unnamed watercourse (for the purpose of this runoff management plan it has been named 'Great Chesters Burn' sub-catchment) which is located within the middle region of the Haltwhistle Burn catchment. This sub-catchment is summarised in Table 3 below. Features proposed within the Great Chesters Burn are described in Table 4 and also mapped in Figure 6.

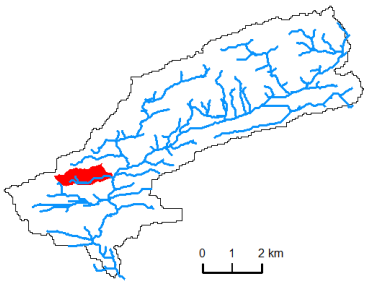
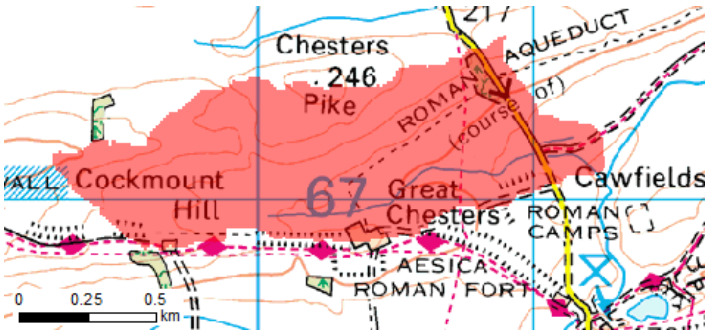
Zone 3 – Great Chesters Burn sub-catchment	
Location: 	
Name of watercourse	Unnamed (assigned "Great Chesters Burn")
Watercourse length:	1.8 km
Flow direction:	West to east
Sub-catchment area:	0.89km^2
Topography:	251m AOD (west) to 178m AOD (east).
Bedrock geology:	Alternating bands of limestone and limestone, sandstone, siltstone and mudstone.
Soil:	A mixture of peaty soils and slowly permeable loamy and clayey soils.
Dominant land cover / use:	Improved grassland (agricultural use)
Strahler stream order:	1 and 2
Known issues:	Flashy response. Contributes to flooding on the adjacent road and Cleughfoot Farm land, including the recent 30th April 2014 event. Contributes to the flood peak in the Townfoot area of Haltwhistle.

Table 3 – *Summary of Zone 2 demonstration site: Great Chesters Burn sub-catchment*

Feature	Description / Purpose
A series of offline runoff attenuation features (RAFs)	Offline RAFs are ponds adjacent to the watercourse which divert and store water during high flow. They reduce the flood peak downstream by storing water until high flows have passed. A bund is required to hold the water back within the pond. This approach also encourages sediment to be removed from the flow which improves water quality. Water is then released slowly back into the stream network via an outlet point.
Swales	Swales are used to connect flow to back to old palaeochannels. Swales are broad, shallow channels covered with grass or other vegetation that are designed to store runoff and remove pollutants *via* filtration or sedimentation.
One large online runoff attenuation feature (RAF)	This online RAF involves using the road as a bund to attenuate high flows and trap sediment. A spill may also be required. The water will be released at a slower rate once the peak has passed.

Table 4 – *Features proposed in Zone 2: Great Chesters Burn sub-catchment*

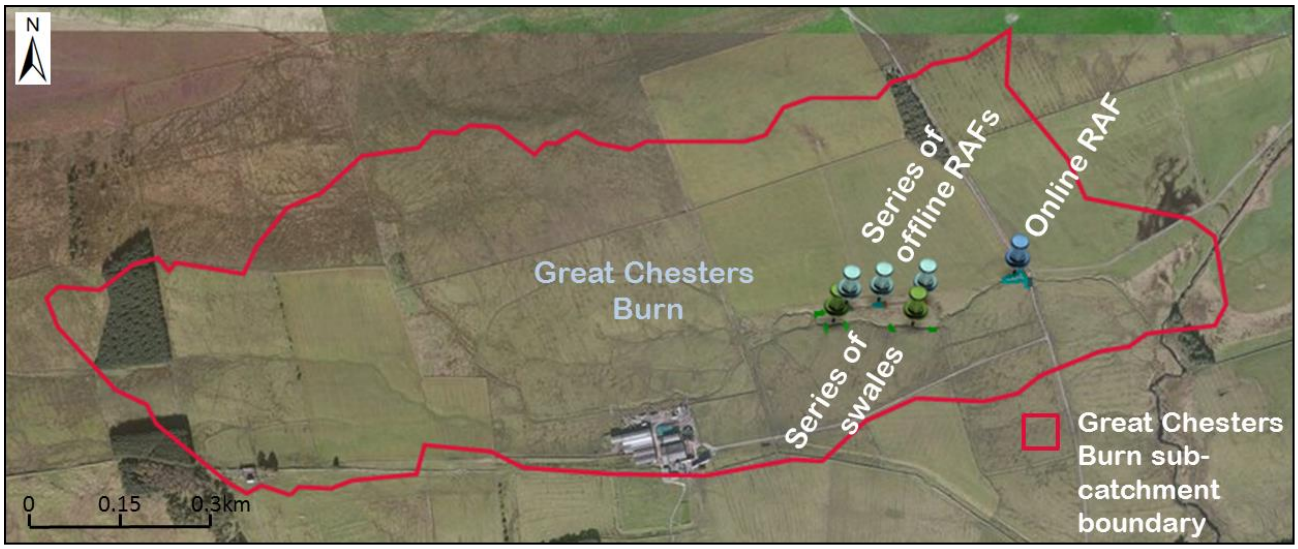


Figure 6 – *Map illustrating the location of features proposed in Zone 2: Great Chesters Burn sub-catchment*

An interactive map can also be viewed online here: http://bit.do/catchmentmanagement. Once the map has loaded, click on the polygons, arrows and dots; a window will pop up describing what the features are and also contain images of what they may look like once constructed. Click on the image to view a larger copy. Please note that the shape and size of features proposed are indicative at this stage and need to be approved by all relevant stakeholders before specific details can be determined.

5. Further sources of information

CIRIA (2013) *Land use management effects on flood flows and sediments – guidance on prediction*, CIRIA Report C179. London: CIRIA.

Newcastle University (2014) 'Haltwhistle Burn Project: Know Your catchment'. Available at: http://research.ncl.ac.uk/haltwhistleburn/communityhub/knowyourcatchment/ (Accessed: 28th July 2014).

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