Scoping Natural Flood Management using SCALGO, SCIMAP and GIS

Malvern Hills National Landscape

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1.0 Introduction

This report provides a summary of the outputs created by Josie Lynch and Professor Ian Maddock from the University of Worcester for the Malvern Hills National Landscape (MHNL) for scoping and appraising water capture and storage options for Natural Flood Management (NFM) inside the MHNL plus a 1km buffer.

- Aim - To provide information that can be used to inform discussions with landowners and managers about future management of land and water, regarding both capturing and slowing flow during/after periods of heavy rain and storing water for agricultural use to reduce the need for abstraction during periods of dry weather and drought.

- Objective - To analyse and map opportunities for NFM in those parts of the Severn and Teme catchments that fall within the MHNL and within 1km of the Natural Landscape (NL) boundary.

- Methodology - This will be an entirely desk-based study using web-based applications including SCIMAP and SCALGO.

- Output - A report and associated mapping files which show the location of surface water run-off and identify provisional opportunities for slowing flows and for online and offline water storage. NB It is recognised that ground-truthing is not a component of this project and may need to be carried out at a later date.

NFM is an approach that uses natural processes to reduce flood risk by slowing flow, enhancing water retention, and improving ecological resilience (Thaler et al., 2023). NFM techniques include soil and land management, leaky dams, tree planting, wetland restoration, and creating buffer strips to slow and store water during heavy rainfall (CIRIA 2023). By working with natural hydrological cycles, NFM provides sustainable and cost-effective solutions for flood mitigation. Traditional flood risk management often relies on engineered structures such as concrete flood defences, embankments, and drainage channels. Whilst these methods can provide immediate and localised protection, they can be expensive to maintain and may disrupt natural watercourses. In contrast, NFM offers a more sustainable solution by restoring natural landscapes to absorb and slow water movement (CaBA 2025).

The MHNL presents significant opportunities for NFM implementation. The steep slopes, diverse habitats, and agricultural land create potential for flood mitigation strategies. Implementing NFM practices in this area can help manage water flow, reduce soil erosion, and enhance ecosystem services, contributing to a more sustainable and resilient NL.

Elevation data, soil erosion risk, hydrological connectivity, surface flow pathways and storage, runoff attenuation features, floodplain reconnection potential, floodplain woodland potential, and Flood Zone 2 data is used to provide opportunities for NFM at 25 locations within the MHNL. Four of these locations have been explored in greater detail as case studies.

It is important to note that this is an optioneering exercise and all designs presented are conceptual, serving as illustrative examples and not comprehensive, detailed engineering plans. The figures represent the volume associated with features e.g ponds of a specific size and shape (i.e. perimeter), without constituting detailed designs. These statistics are intended to offer a general understanding of potential interventions at the priority sites and should not be employed for design purposes alone.

Figure 1 and 2 (overleaf) display the location of the MHNL. The MHNL boundary was provided by Paul Esrich at MHNL and imported into GIS to define the area and add a 1 km buffer around the MHNL boundary using the buffer tool. This buffered area serves as the region within which all relevant spatial data will be examined, and outputs will be generated, as shown by the pink outline in all figures.

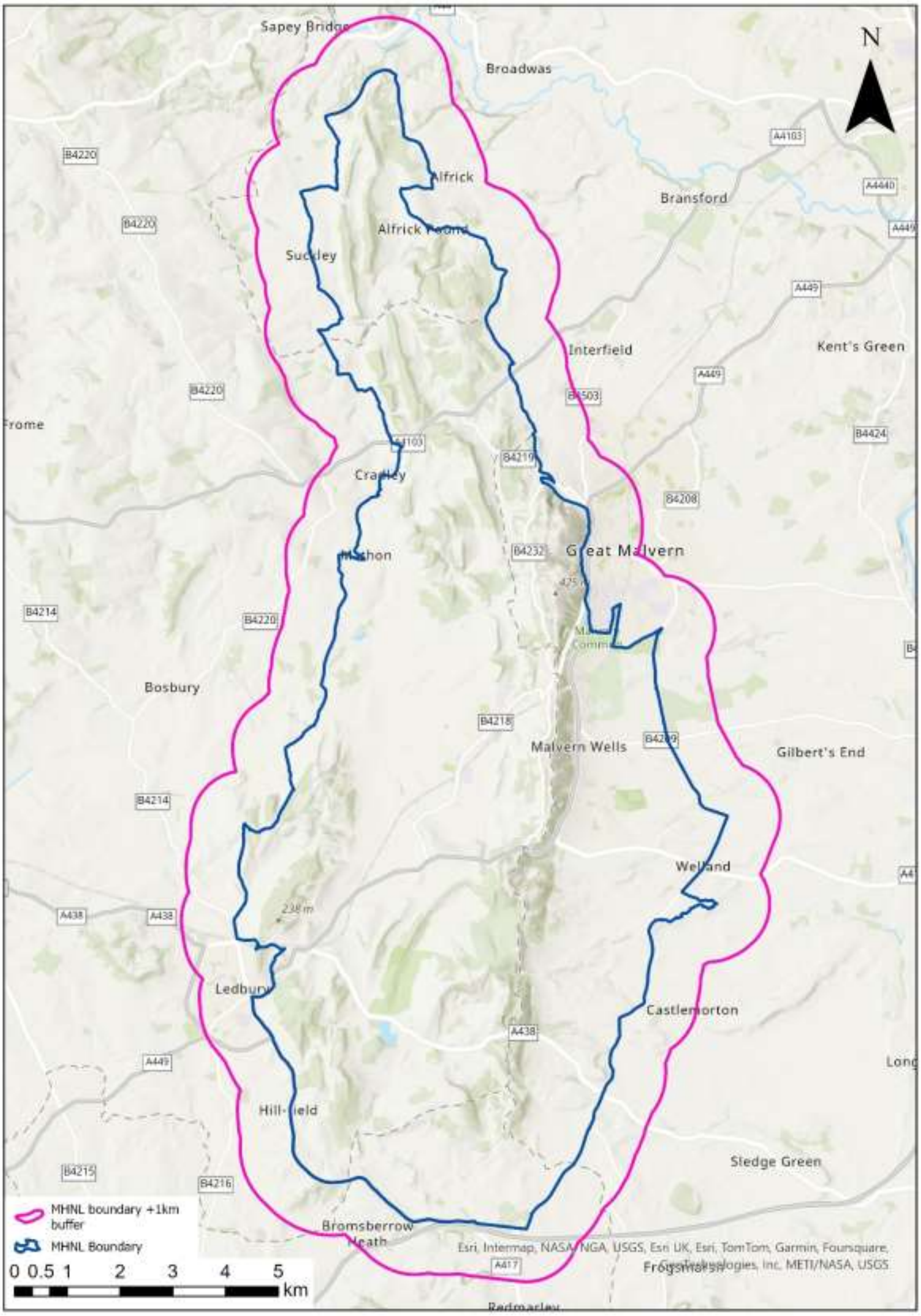

Figure 1 Location of the Malvern Hills National Landscape and MHNL + 1km buffer (ArcGIS 2025).

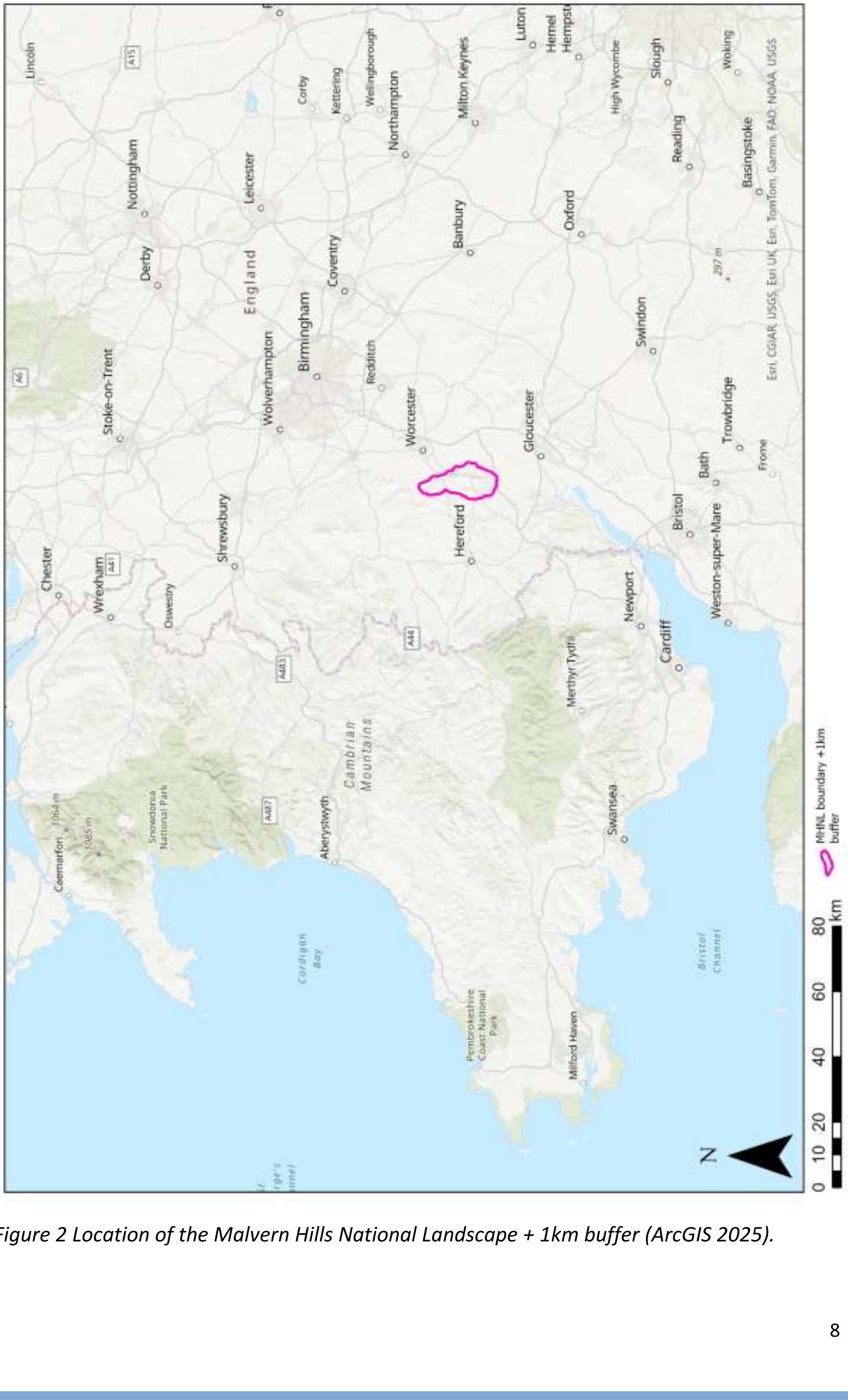

Figure 2 Location of the Malvern Hills National Landscape + 1km buffer (ArcGIS 2025).

1.1 Software

This work was carried out using three platforms, i.e., SCALGO, SCIMAP and a Geographical Information System (GIS):

SCALGO (2024) is an online national flood risk platform for rural and urban planning, climate adaptation, administration of watercourses and emergency planning. SCALGO provides rapid mapping of flood risk from watercourses, in depressions or from the sea and provides an overview of the combined flood risk to a single property, entire city or catchment. The software is a static hydrological model simulating the effect of a given amount of rainfall falling instantaneously onto the landscape and forecasting overland flow and location of water storage. The default topographic data for simulating water flow across the landscape in SCLAGO uses Environment Agency LiDAR 1m resolution data, i.e., there is a spot height for each 1m x 1m square from 2023.
SCALGO can be accessed here: https://scalgo.com/

SCIMAP (2024) is a tool created for identifying locations in a landscape which have a high risk of generating diffuse pollution particularly generate from agricultural sources i.e. runoff from fields. This software also assists with water quality management by modelling the origin of this pollution and how it might be transported into watercourses. SCIMAP uses spatial data on topography (at 5m resolution- i.e., there is a spot height for each 5m x 5m square), hydrology and land use to generate risk maps on hydrological connectivity, diffuse pollution and erosion risk potential. The software allows for the model to be customised with various inputs like land cover, soil type, and rainfall data to focus on specific areas of concern. By identifying high-risk zones, SCIMAP can guide targeted and cost-effective land management strategies, making it a valuable tool for environmental managers and policymakers aiming to reduce soil erosion and water pollution.
SCIMAP can be accessed here: https://scimap.org.uk/

Geographic Information Systems (GIS) integrate spatial data, maps, and analytical tools to capture, store, analyse, and visualise geographic information. Used in diverse fields such as urban planning, environmental management, and disaster response, GIS enhances decision-making by providing powerful tools to map, model, and interpret complex datasets.

1.2 Overview of a selection of potential water capture and storage measures

1.2.1 Ponds

Ponds are an effective water storage measure and they minimise downstream flood risk by capturing and temporarily storing excess water during heavy rainfall, preventing rapid runoff and reducing flood peaks. Ponds also enhance water quality by trapping sediments and retaining excess nutrients. They can improve biodiversity, water quality, and offer habitats for various species. These artificial reservoirs serve as water sources for irrigation during dry periods and contribute to sustainable farming practices by reducing dependence on abstraction from streams and rivers during low flow and on external water supplies. The effectiveness of ponds in addressing flooding depends on factors like location, vegetation, slope, flow path, geology, and soil saturation.

1.2.2 Earth bunds

A bund is an earth bank created for run off interception and/or storage either on the contour or for run off diversion by creating a bund at an angle to the contour to redirect run off away from high-risk areas. By impeding the flow of water, they also facilitate sediment deposition, enhancing water quality, while reducing flood risk downstream. As well as flood mitigation, bunds can create temporary wetland habitats, benefiting species like wading birds.

1.2.3 Leaky dams

Typically constructed with locally sourced cut timber, leaky dams vary from basic wood pieces to more intricately stacked logs placed or anchored in the stream channel. Their purpose is to mitigate downstream flood peaks by temporarily slowing or storing water within the channel or redirecting it onto banks. These structures provide hydraulic resistance and improved connectivity with the floodplain by intercepting moderate to high flows without impeding low flows and allow for fish to pass upstream.

1.2.4 Soil management

Soil management can reduce flood risk by improving soil structure and increasing infiltration to increase water storage capacity. This also helps mitigate soil erosion and limit the transfer of sediment and pollutants into rivers. Farming practices such as high stocking densities, heavy machinery use, and leaving soils bare in winter can heighten erosion, compaction risk and reduce infiltration. Implementing cover crops, relieving compaction, soil aeration, altering machinery practices and runoff control features (e.g in-field buffer strips, hedges) are effective methods for mitigating soil erosion.

1.2.5 Floodplain reconnection

Floodplain reconnection involves restoring natural connections between rivers and their floodplains, allowing water to flood historically inundated areas during high flows. This process enhances flood risk management by dissipating floodwaters over a wider area, reducing peak flows downstream. It also promotes natural ecosystem functions, improving biodiversity and supporting habitat restoration.

1.2.6 Woodland

Floodplain and riparian woodland absorb surplus water in heavy rainfall, slowing downstream flow and reducing flood peaks. These woodlands provide benefits including stabilising riverbanks, intercepting runoff pollutants, reducing sediment in streams, and reducing flooding through enhanced water absorption as well as contributing to a healthy soil structure and biodiversity.

1.2.7 Buffer strips

Typically planted along watercourses or between agricultural fields and water bodies, these strips consist of dense grass vegetation and their primary function is to reduce soil erosion effects by preventing sediment runoff into waterways. Grass buffer strips effectively filter pollutants from runoff, improving water quality. Beyond erosion control, they provide habitats for diverse plant and animal species, contributing to biodiversity.

1.2.8 Beetle bank

A beetle bank is a raised strip of land (0.4 - 0.6m high, 2m wide) within/along arable fields, planted with tussocky grasses and wildflowers. Beetle banks help slow surface water flow, reducing soil erosion and increasing infiltration. Their deep-rooted vegetation enhances water retention and drainage, minimising runoff reaching nearby watercourses. By breaking up long slopes and dispersing water, they reduce flood risk downstream by slowing the rate at which water enters rivers and streams. Beyond their flood management benefits, they also support biodiversity by providing habitat for beneficial insects that naturally control crop pests.

2.0 Malvern Hills National Landscape maps

2.1 LiDAR 1m Elevation Data

Overleaf, elevation maps for the MHNL have been produced using SCALGO with 1m resolution Environment Agency (EA) Light Detection and Ranging (LiDAR) data. Figures 3 to 6 show the entire NL as well as sections from the north to south of the NL.

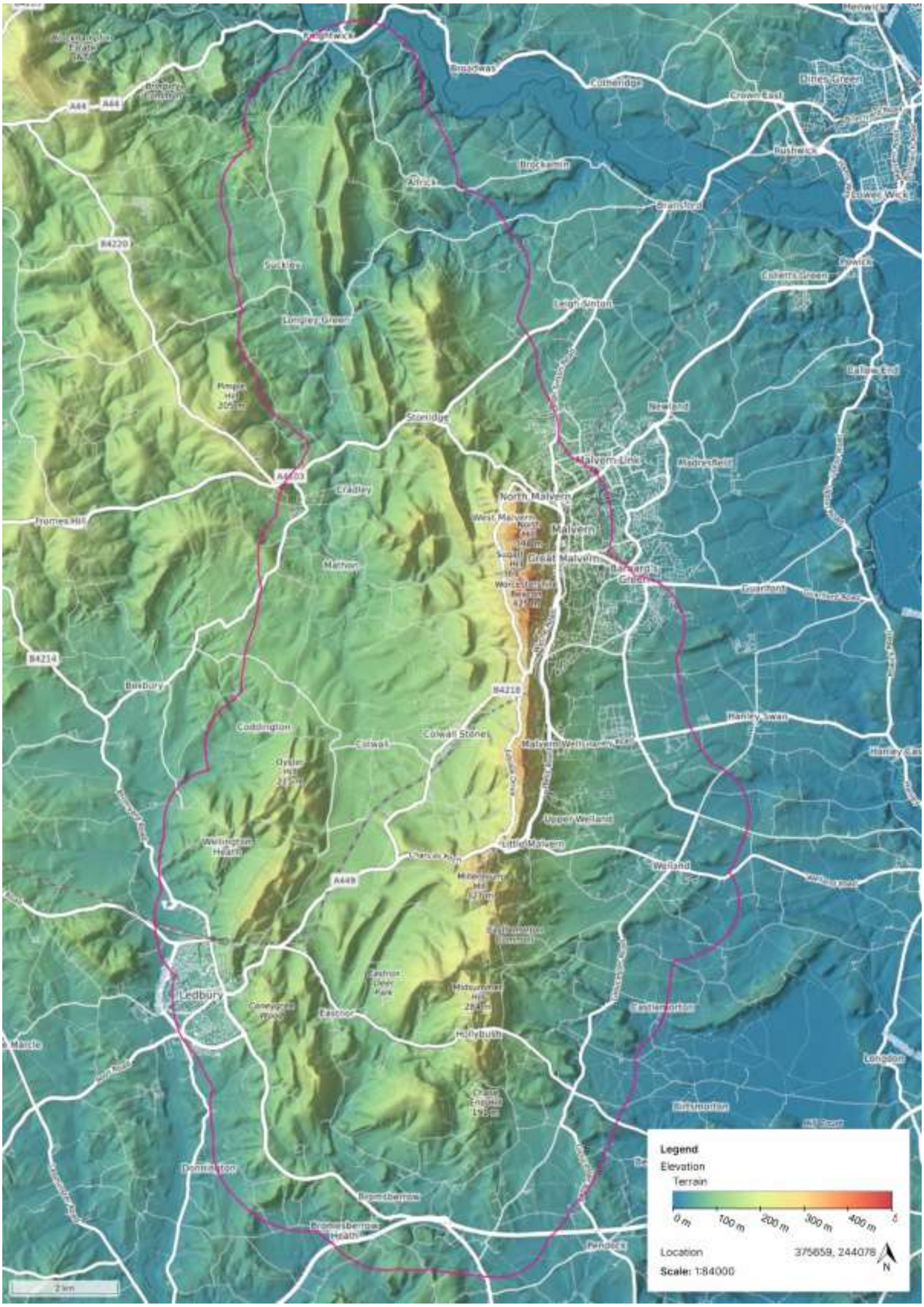

Figure 3 MHNL elevation map (SCALGO 2025)

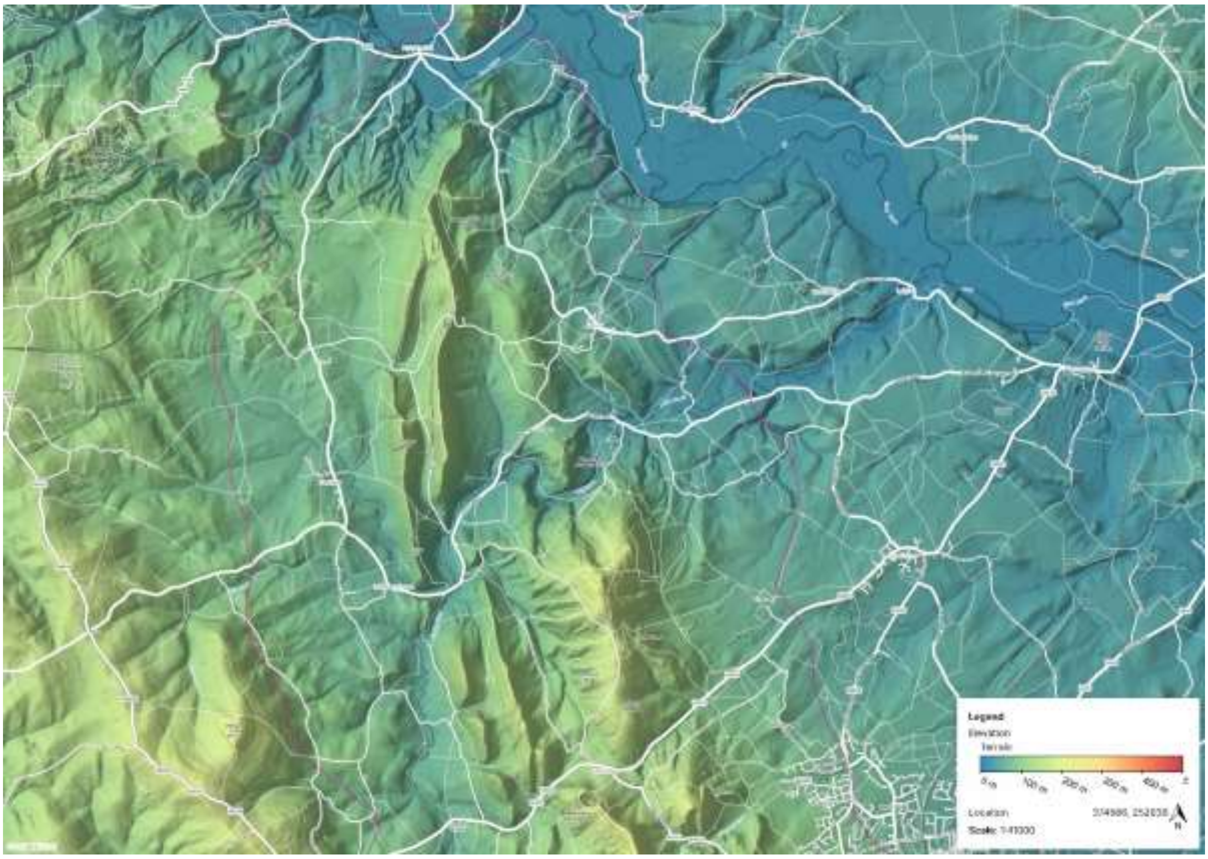

Figure 4 MHNL elevation map (north) (SCALGO 2025)

Figure 5 MHNL elevation map (central) (SCALGO 2025)

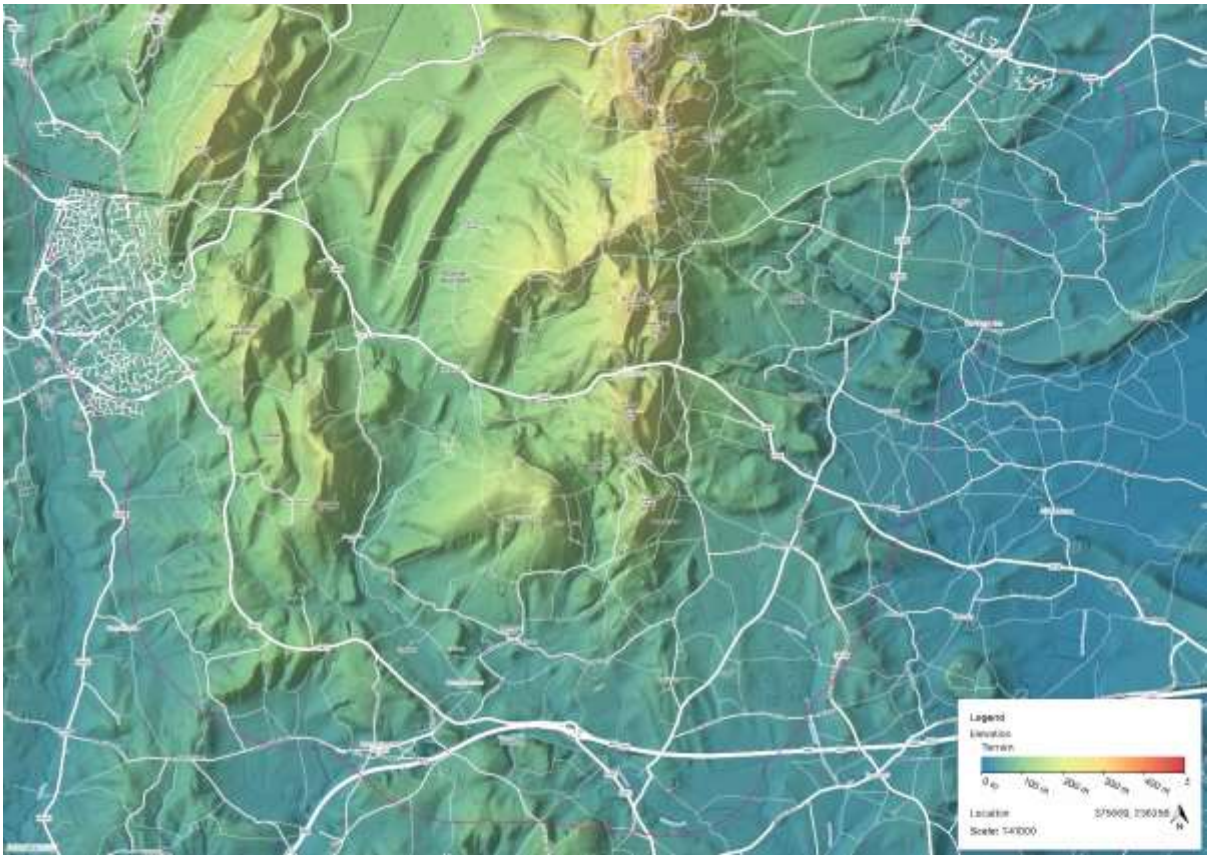

Figure 6 MHNL elevation map (south) (SCALGO 2025)

2.2 Erosion risk potential

Soil erosion is the displacement of soil by wind, water, or human activity, leading to the loss of fertile topsoil. Eroded soil can enter rivers, increasing sedimentation, decreasing water quality, and disrupting ecosystems. Sediment smothers fish spawning grounds, degrades habitats, and reduces river capacity, increasing flood risks. Reducing soil erosion maintains good soil fertility, can improve water retention and prevents land degradation. Eroded soil depletes nutrients which can reduce crop yields and increase the need for more fertiliser, impacting farm profits and harm the environment.

In MHNL the steep slopes and heavy rainfall can accelerate erosion which can put farmland and water quality at risk. Soil erosion modelling helps identify priority areas for intervention. NFM techniques e.g cover cropping and buffer strips enhance flood resilience and support sustainable farming.

Erosion risk potential maps, generated by SCIMAP for the MHNL, are shown overleaf. These maps display the relative erosion potential as a result of the water volume flowing over a point in the landscape and the local slope to determine the potential speed of flow. The model considers factors such as slope steepness, land cover type, and connectivity to water bodies. Higher erosion risk areas are those with exposed soils, steep slopes, and strong hydrological connectivity, while vegetated or flat areas typically have lower erosion risk. Areas highlighted in red are the highest erosion risk, followed by orange and then yellow. The lowest areas of erosion risk are highlighted in blue. These maps are added to SCALGO, as displayed in figures 7 to 13.

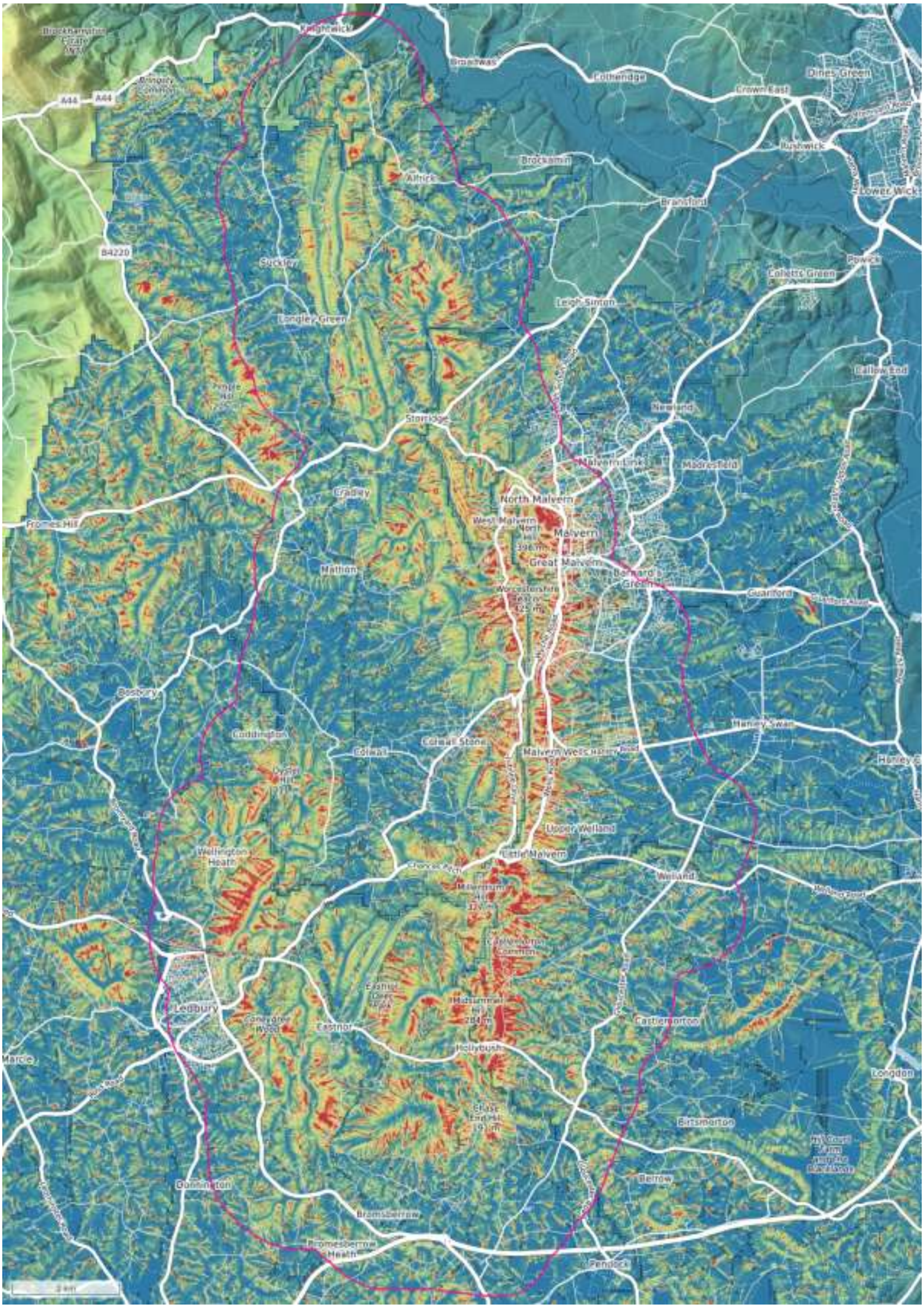

Figure 7 MHNL soil erosion (SCIMAP 2024).

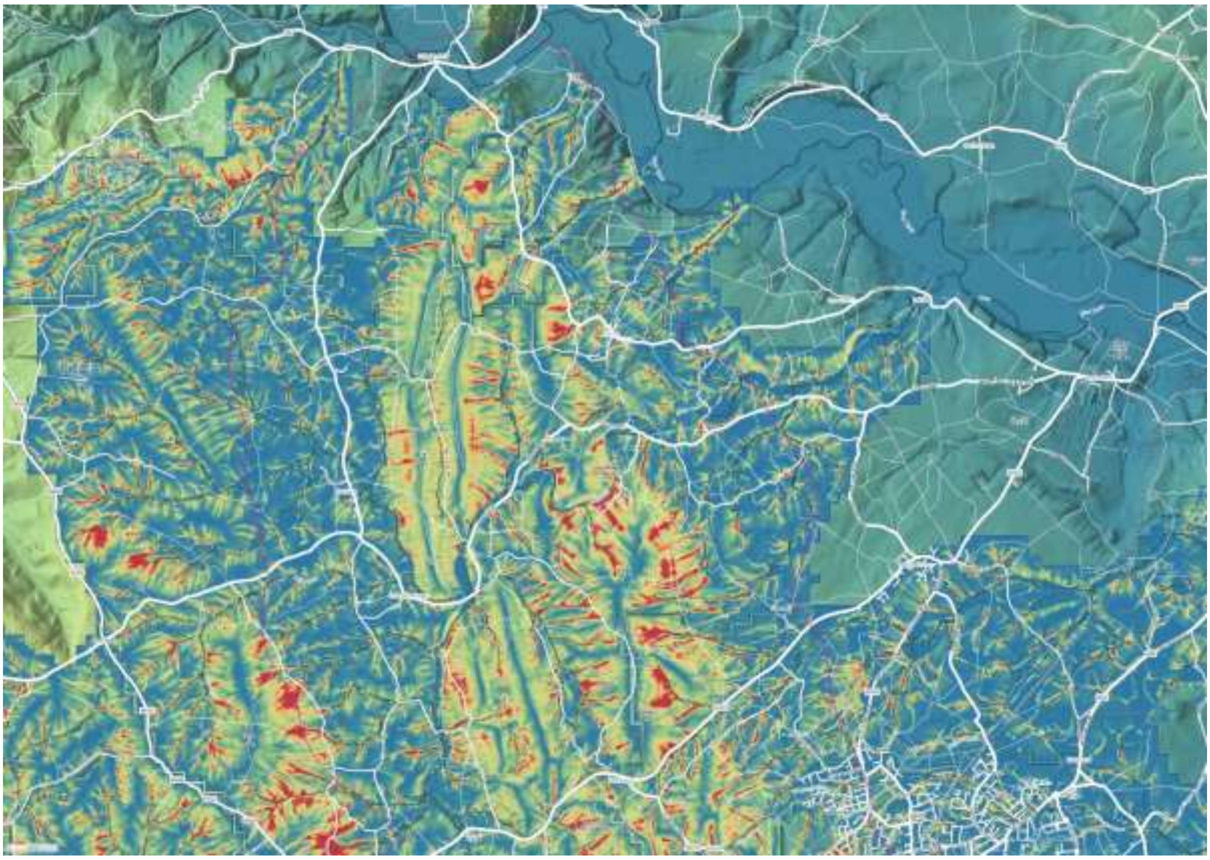

Figure 8 MHNL soil erosion risk (north) (SCIMAP 2024; SCALGO 2025)

Figure 9 MHNL soil erosion risk (north) aerial photography (SCIMAP 2024; SCALGO 2025)

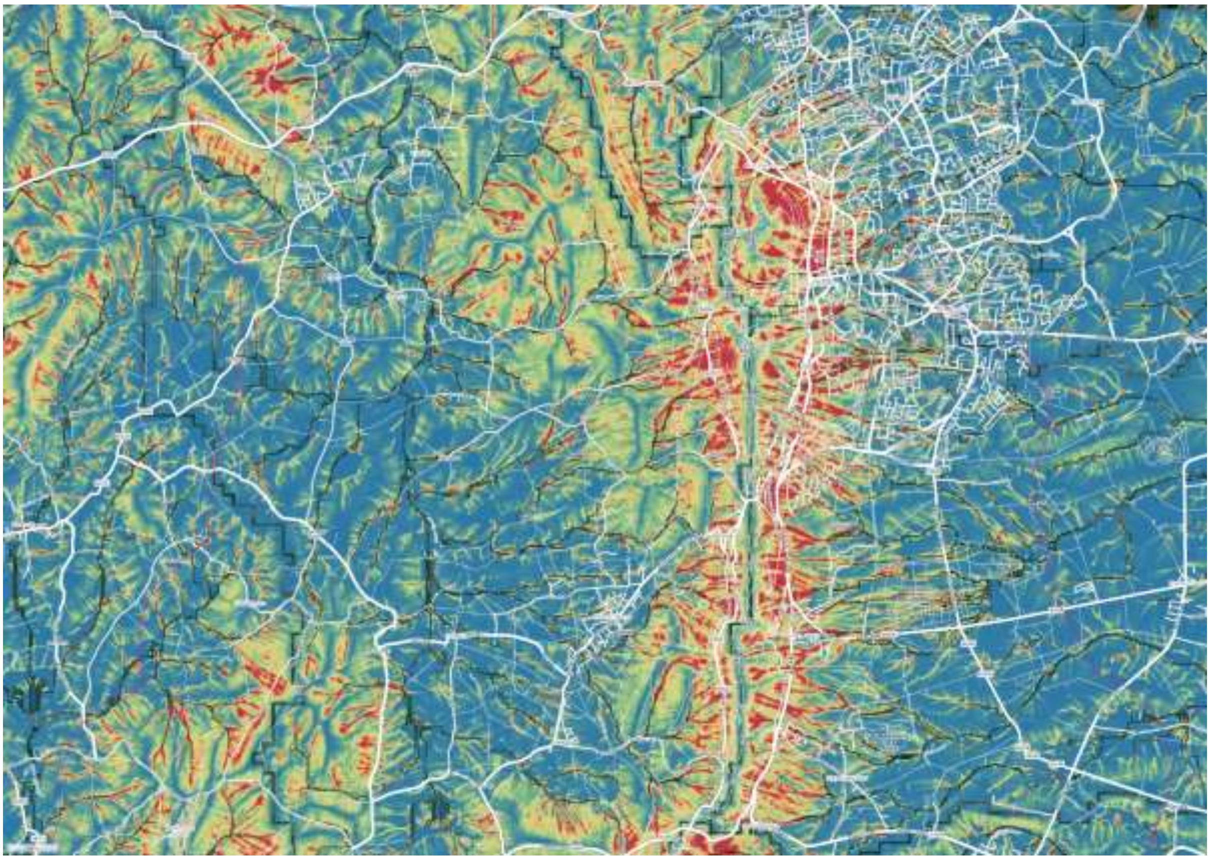

Figure 10 MHNL soil erosion risk (central) (SCIMAP 2024; SCALGO 2025)

Figure 11 MHNL soil erosion risk (central) aerial photography (SCIMAP 2024; SCALGO 2025)

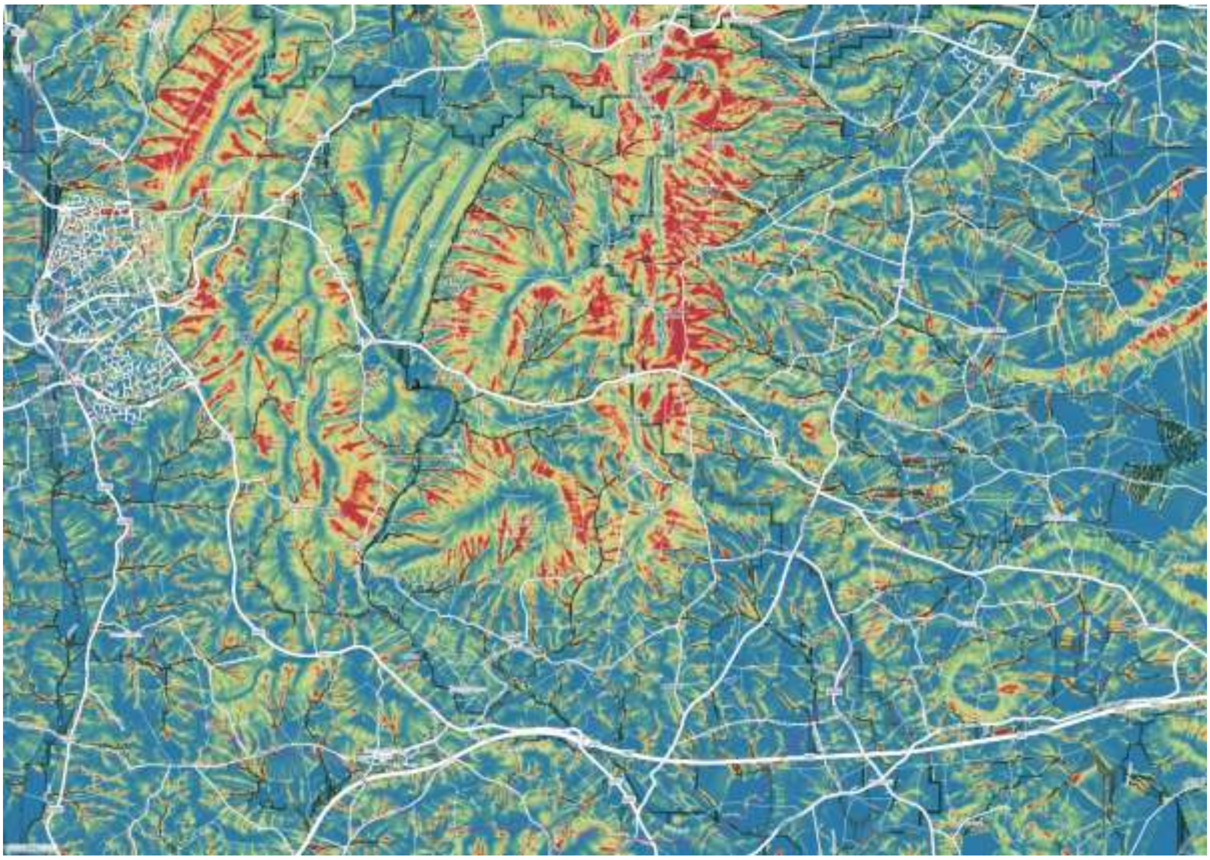

Figure 12 MHNL soil erosion risk (south) (SCIMAP 2024; SCALGO 2025)

Figure 13 MHNL soil erosion risk (south) aerial photography (SCIMAP 2024; SCALGO 2025)

2.3 Hydrological connectivity

Hydrological connectivity is the movement of water, sediments, and nutrients across a landscape, linking the environment to watercourses through surface and subsurface flow pathways. It plays a crucial role in shaping river systems, influencing flood dynamics, and affecting water quality. Effective management of hydrological connectivity can improve river health by reducing sediment and nutrient loading, which in turn supports biodiversity and aquatic ecosystems. On farm, maintaining good connectivity management prevents soil loss, retains moisture for crops, and minimises runoff that could carry valuable nutrients away from fields.

The hydrological connectivity maps, generated by SCIMAP for the MHNL, are shown overleaf. These maps display the surface hydrological connectivity with the river channel and its floodplain. Areas highlighted in red show where, during higher flow conditions, the channel connects to its floodplain most frequently, followed by orange then yellow. Blue areas connect least frequently. These maps displayed in figures 14 to 20 are exported from SCIMAP and imported into SCALGO. Areas where the channel connects most frequently with its floodplain are locations for further consideration for the creation of online and offline storage ponds, for example.

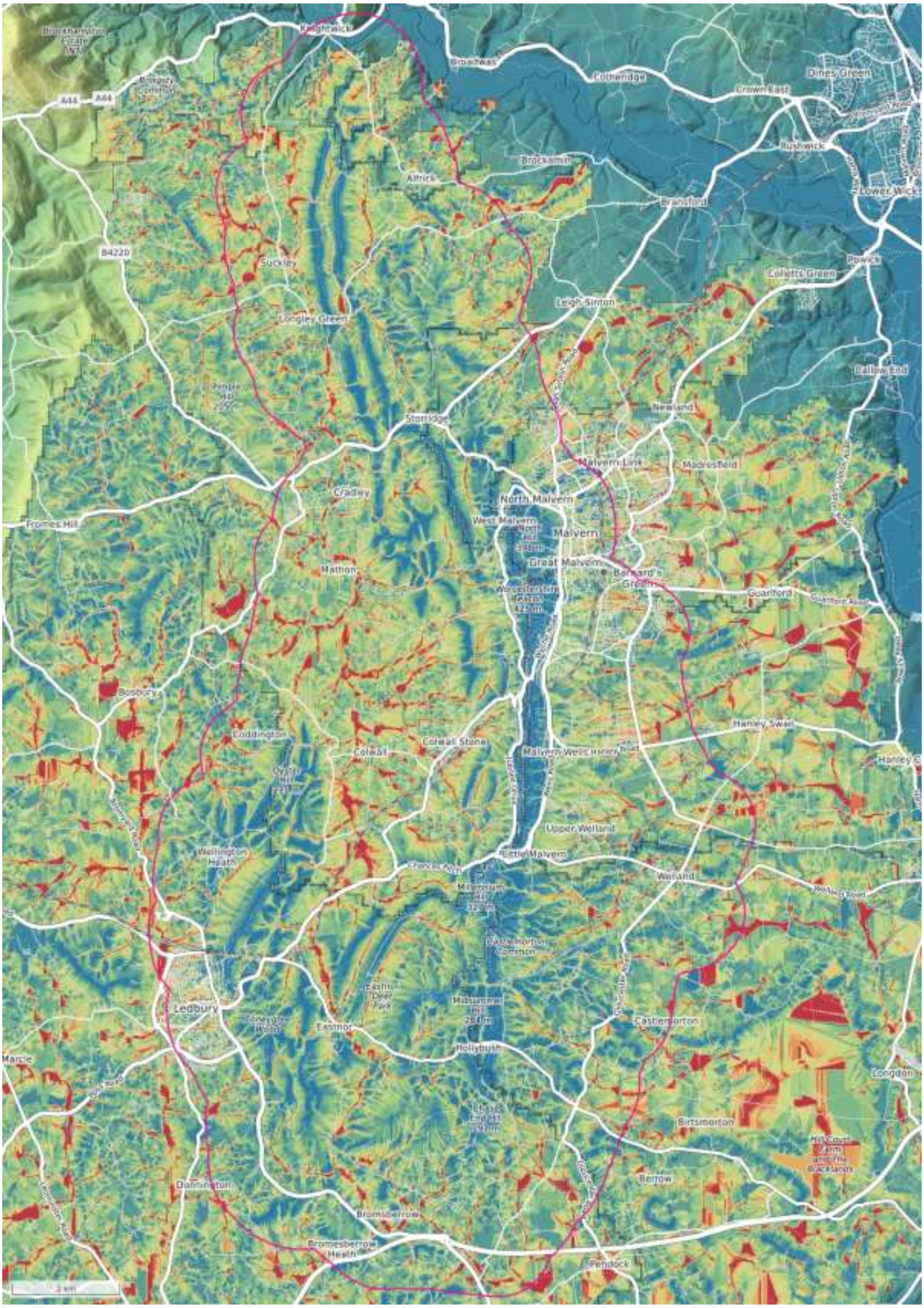

Figure 14 MHNL hydrological connectivity (SCIMAP 2024; SCALGO 2025)

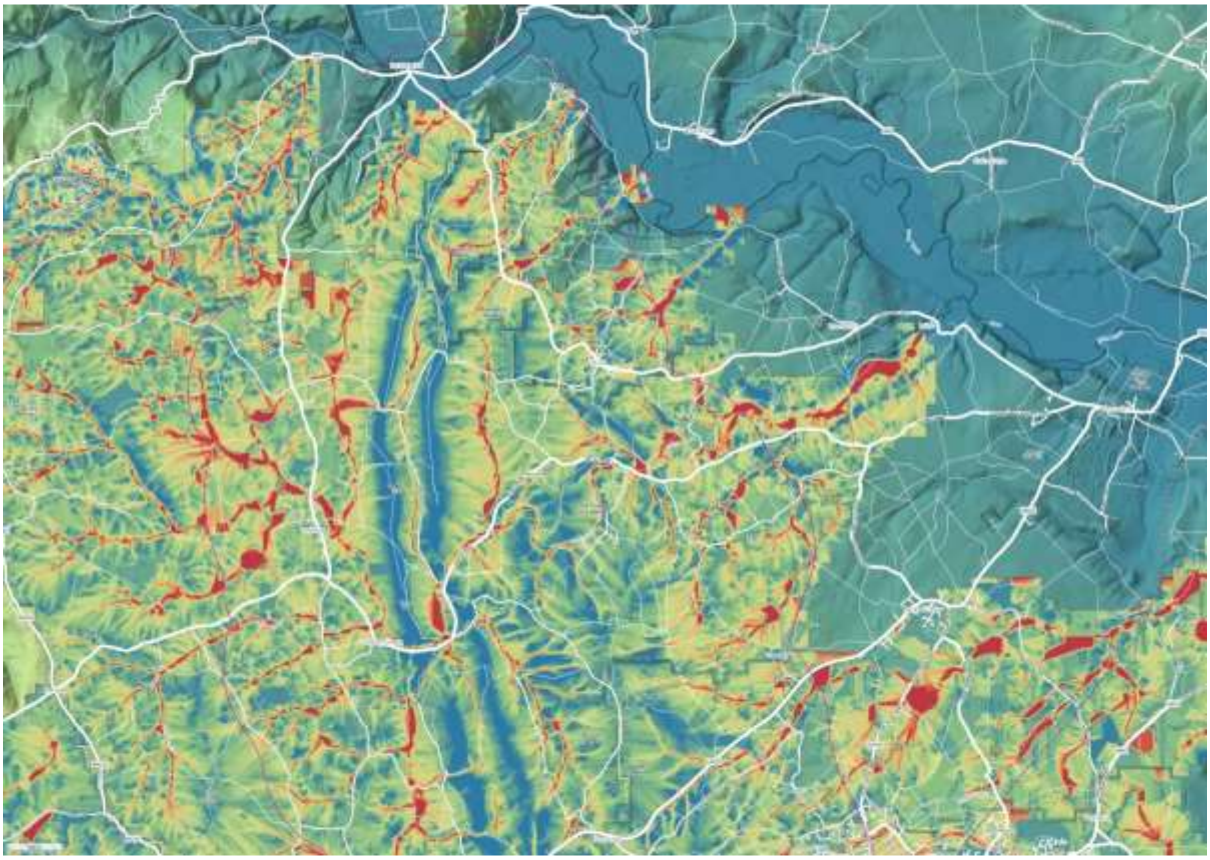

Figure 15 MHNL hydrological connectivity (north) (SCIMAP 2024; SCALGO 2025)

Figure 16 MHNL hydrological connectivity (north) aerial photography (SCIMAP 2024; SCALGO 2025)

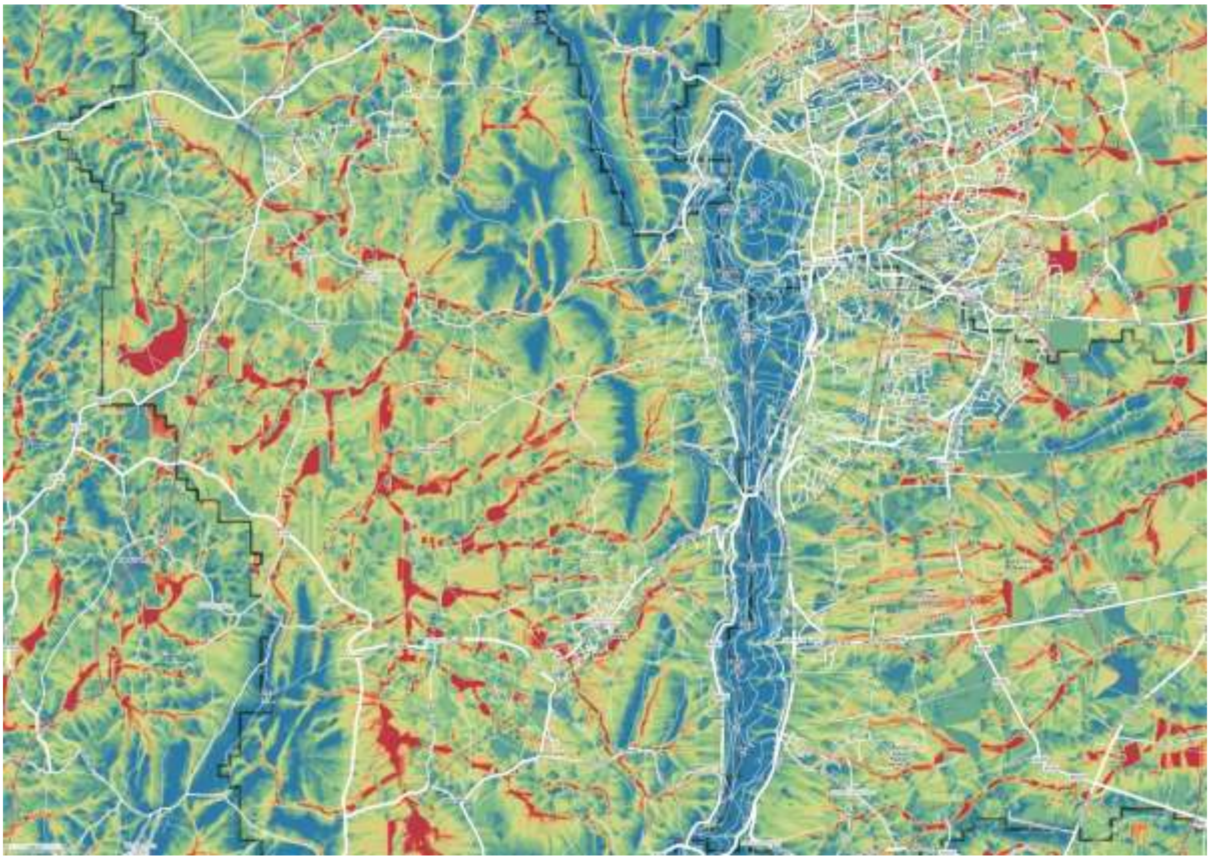

Figure 17 MHNL hydrological connectivity (central) (SCIMAP 2024; SCALGO 2025)

Figure 18 MHNL hydrological connectivity (central) aerial photography (SCIMAP 2024; SCALGO 2025)

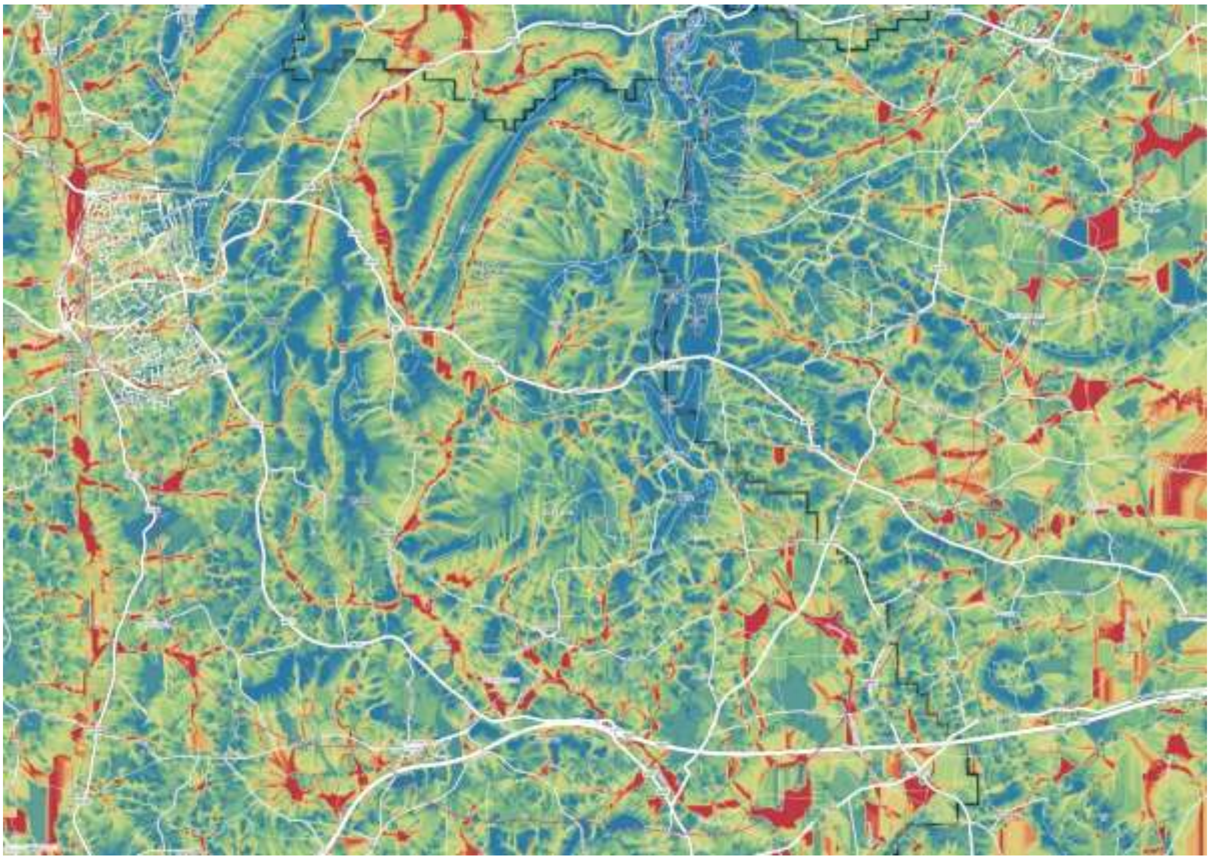

Figure 19 MHNL hydrological connectivity (south) (SCIMAP 2024; SCALGO 2025)

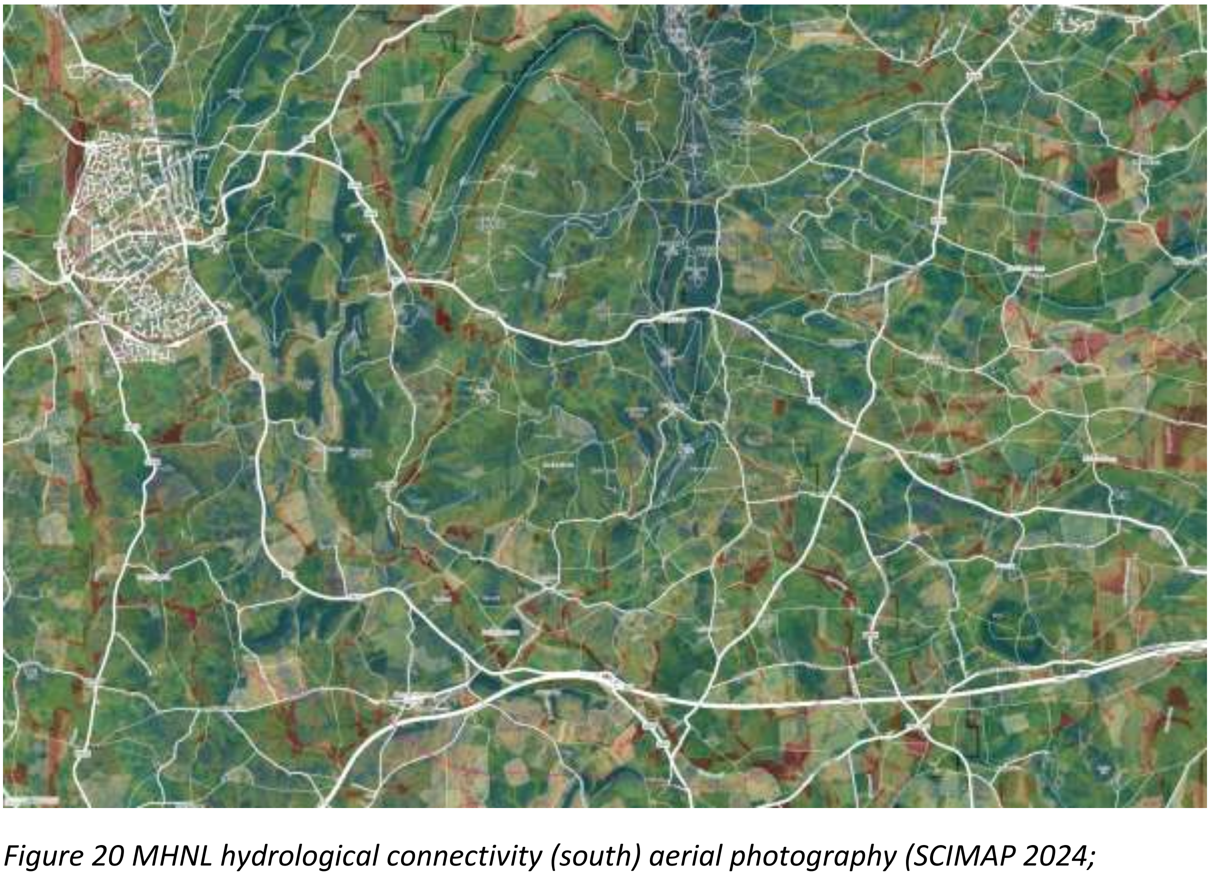

Figure 20 MHNL hydrological connectivity (south) aerial photography (SCIMAP 2024; SCALGO 2025)

2.4 Overland flow (OLF) paths and surface water storage

Overland flow pathway modelling tracks surface water movement during rainfall, influenced by topography, soil type, and land use. Water ponding occurs in land depressions, creating storage areas. Managing these processes is crucial for NFM, as controlled overland flow reduces downstream flood risks, improves soil infiltration, and enhances water retention. Surface water storage helps slow runoff, reduces peak river flows, and mitigates soil erosion. For farmers, managing overland flow and ponding prevents soil degradation, waterlogging, and crop losses.

Overleaf, maps have been produced using SCALGO with 1m resolution EA LiDAR data. Figures 21 to 24 display natural depressions (depressions in the terrain with no natural outlet, enabling water to gather during rainfall) and flow accumulation (directions of flow paths and show how the surface water accumulates).

SCALGO is a static hydrological model simulating the effect of a given amount of rainfall falling instantaneously onto the landscape and forecasting the flow paths that will follow and where the water will be retained. Figure 21 displays overland flow pathways (blue lines) of the entire MHNL at a scale of 1:84000 over aerial photography using a simulation of 20mm of rainfall and a flow network detail of an area of 3.00 ha (i.e. showing only flow lines with an upstream area larger than the threshold).

Figures 22, 23, and 24 display both overland flow pathways (blue lines) and surface water flooding (blue areas) for the north, central, and south of the MHNL using a scale of 1:38000. This uses a simulation of 20mm of rainfall showing a water depth of at least 20mm. A simulation with 20mm of rainfall was chosen as this represents a heavy rainfall event that could cause localised flooding, but not to the extent that this would be an extremely rare occurrence. These maps highlight areas where water gathers during a rainfall event which are potential locations for water storage on farm. This data can be used to identify areas for leaky dams or grass bunds, for example.

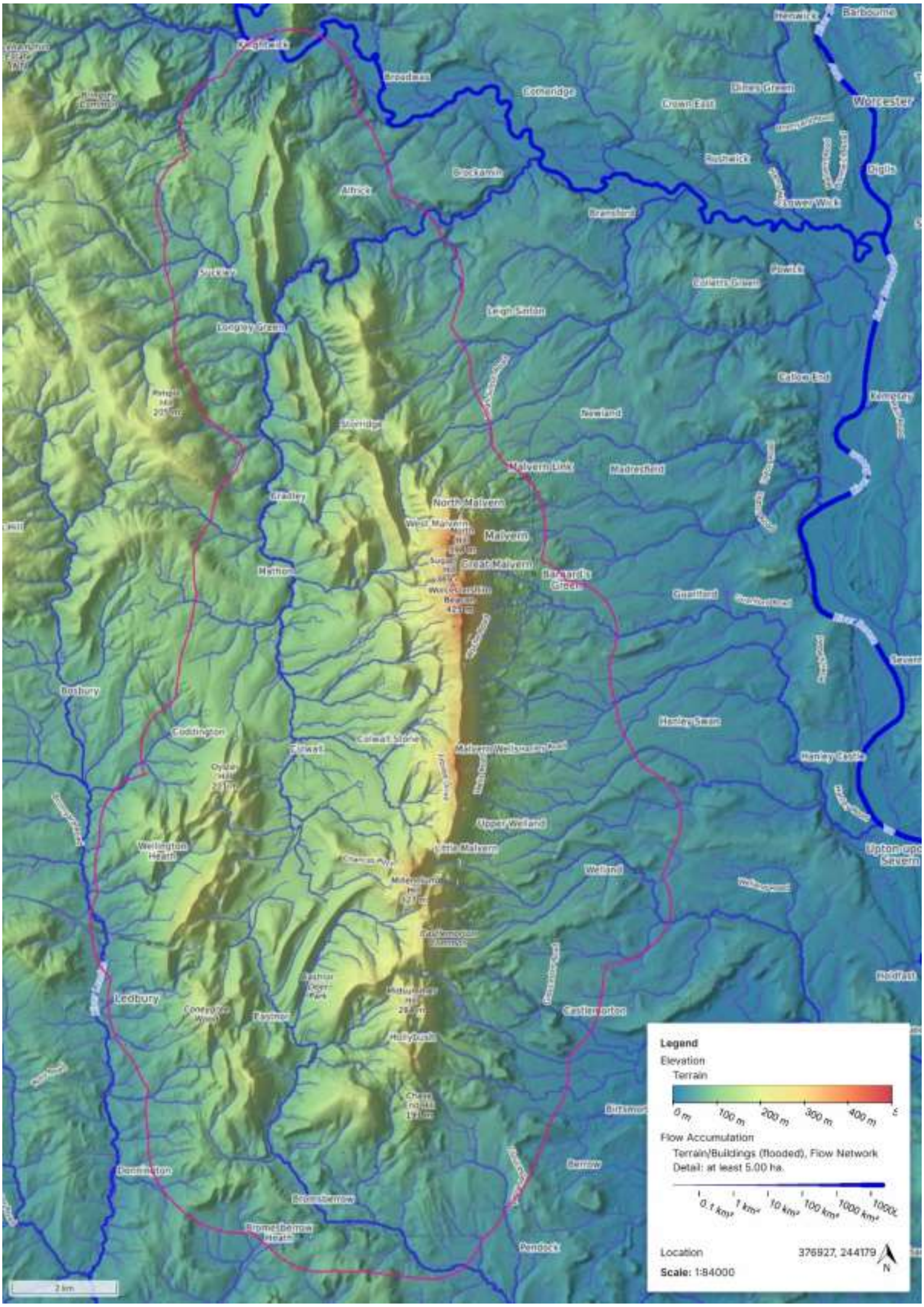

Figure 21 MHNL overland flow pathways (SCALGO)

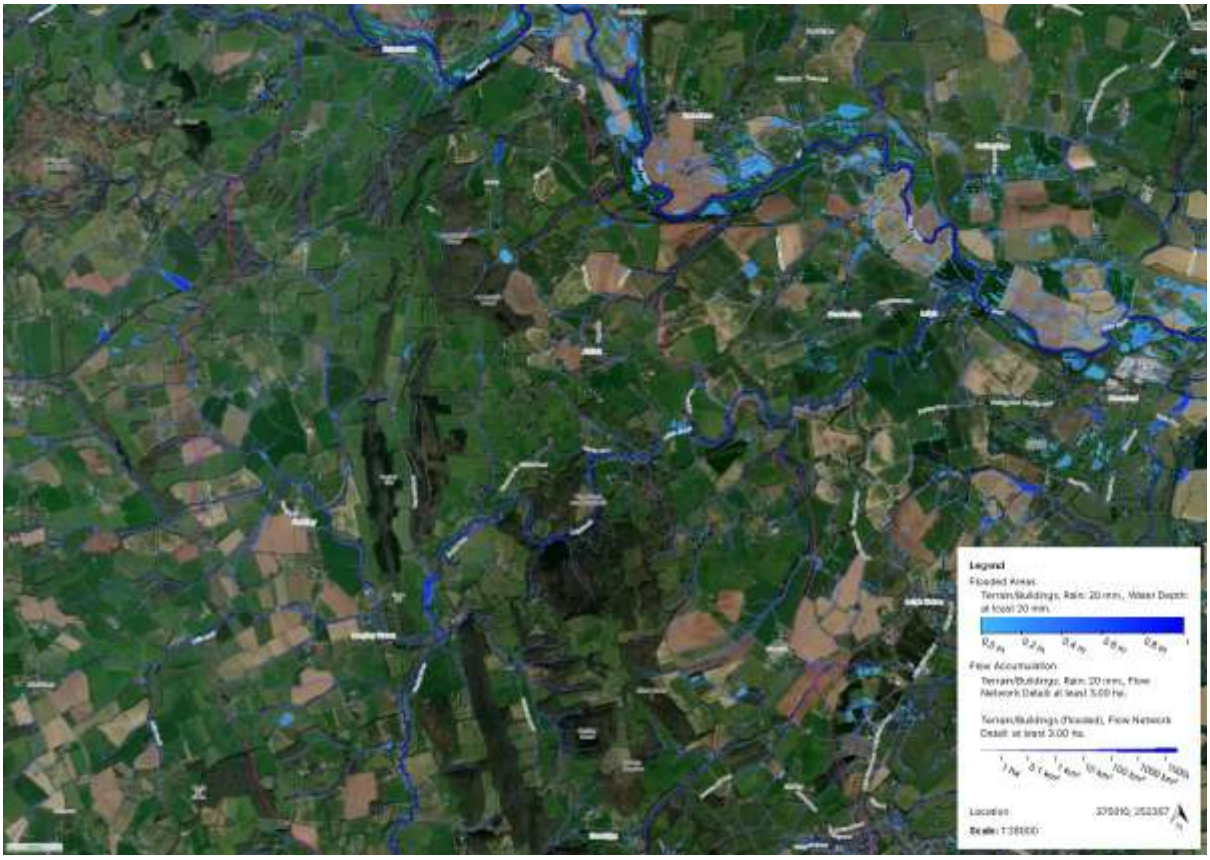

Figure 22 MHNL overland flow pathways and water ponding (north) (SCALGO)

Figure 23 MHNL overland flow pathways and water ponding (central) (SCALGO)

Figure 24 MHNL overland flow pathways and water ponding (south) (SCALGO)

3.0 Additional GIS data layers

The data generated from SCALGO and SCIMAP, along with the additional data presented in this chapter, has been incorporated into GIS and shared with the MHNL as e.g. Shapefiles and TIFFs.

The following three datasets have been produced as part of the Mapping Potential for Working with Natural Processes research project (SC150005). The project developed a toolbox of mapped data and methods to pinpoint potential locations for Working with Natural Processes (WWNP) interventions (DEFRA 2017).

3.1 Runoff attenuation features 3.3% AEP

Runoff Attenuation Features Potential are best estimates of locations of high flow accumulation across the land surface or in smaller channels, where it may be possible to temporarily store water and attenuate flooding during high flows. The dataset is designed to support signposting of areas to target enhanced storage. It is based upon the Risk of Flooding from Surface Water datasets and identifies areas of high flow accumulations for the 3.3% Annual Exceedance Probability surface water maps. The areas of ponding or accumulation are between 100m^2 and 5000m^2. All the potential areas have been constrained so that they are not in urban areas or on roads, rails or canals. These areas are highlighted in red in figures 25, 26 and 27.

Figure 25 WWNP Runoff attenuation feature 3.3% AEP (red) (north) (WWNP 2017)

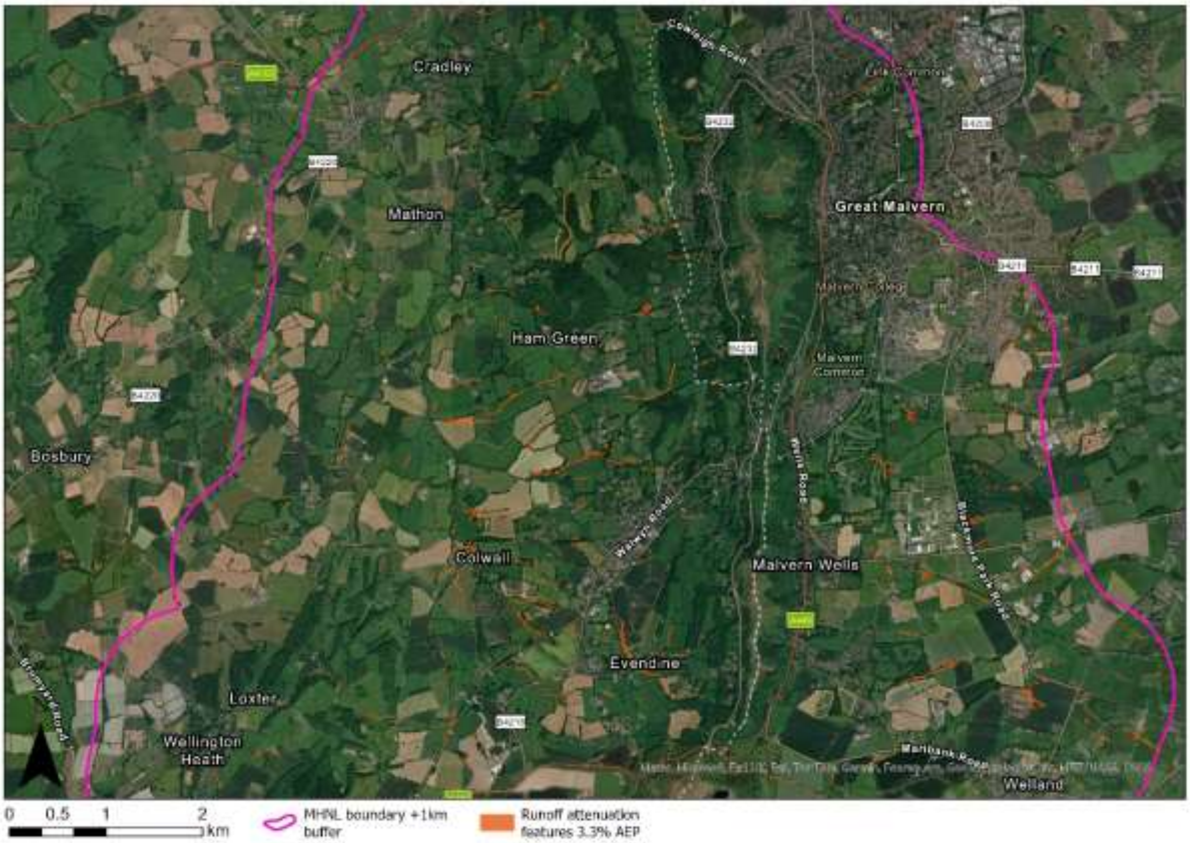

Figure 26 WWNP Runoff attenuation feature 3.3% AEP (red) (central) (WWNP 2017)

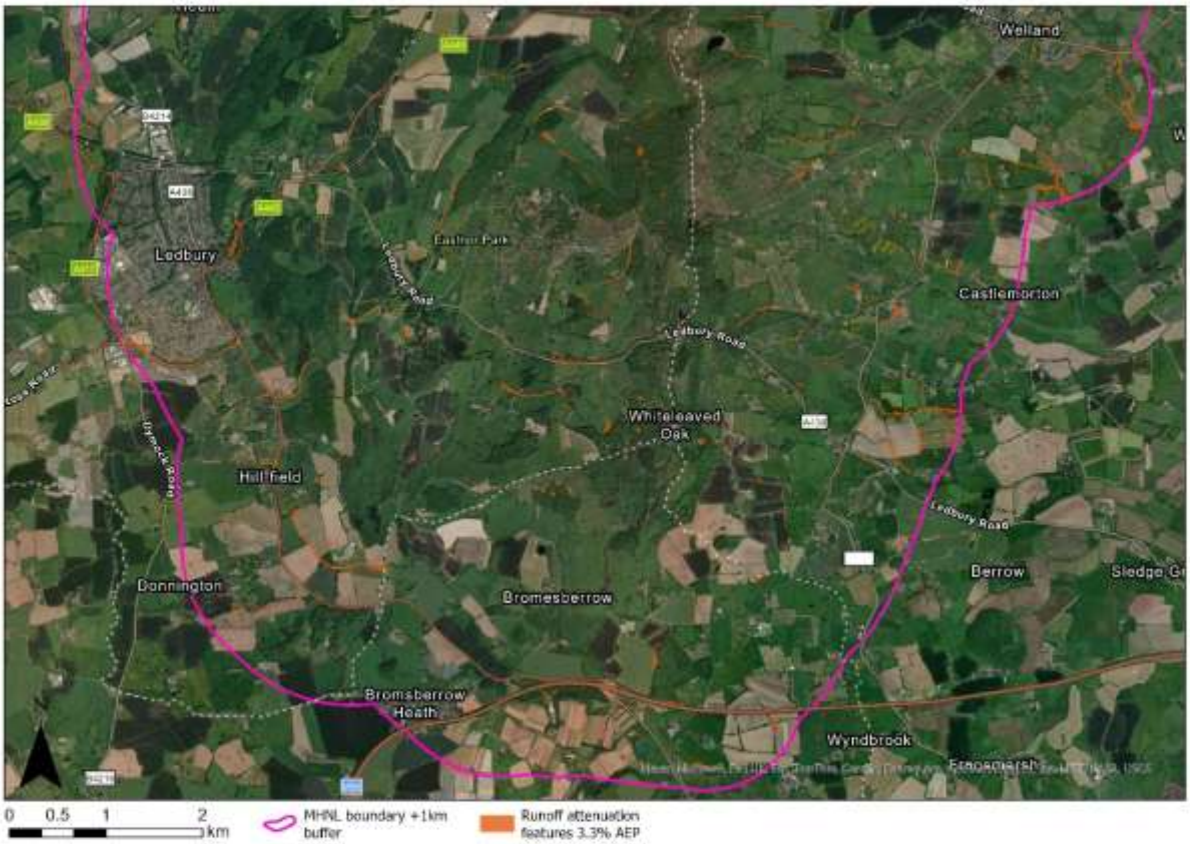

Figure 27 WWNP Runoff attenuation feature 3.3% AEP (red) (south) (WWNP 2017)

3.2 Floodplain reconnection potential

WWNP Floodplain Reconnection Potential shows best estimates of locations where it may be possible to establish reconnection between a watercourse and its natural floodplain, especially during high flows. The dataset is based upon the Risk of Flooding from Rivers and Sea probability maps and identifies areas of low and very low probability that are close to a watercourse, but which do not contain residential property or key services.

In the Risk of Flooding from Rivers and Sea maps, low probability means a 0.1% to 1% annual chance of flooding (1 in 1,000 to 1 in 100 years), while very low probability means less than 0.1% (less than 1 in 1,000 years). These areas in the WWNP Floodplain Reconnection Potential layer rarely flood but are close to the waterbody so offer potential for reconnection. This is displayed in figures 28, 29 and 30.

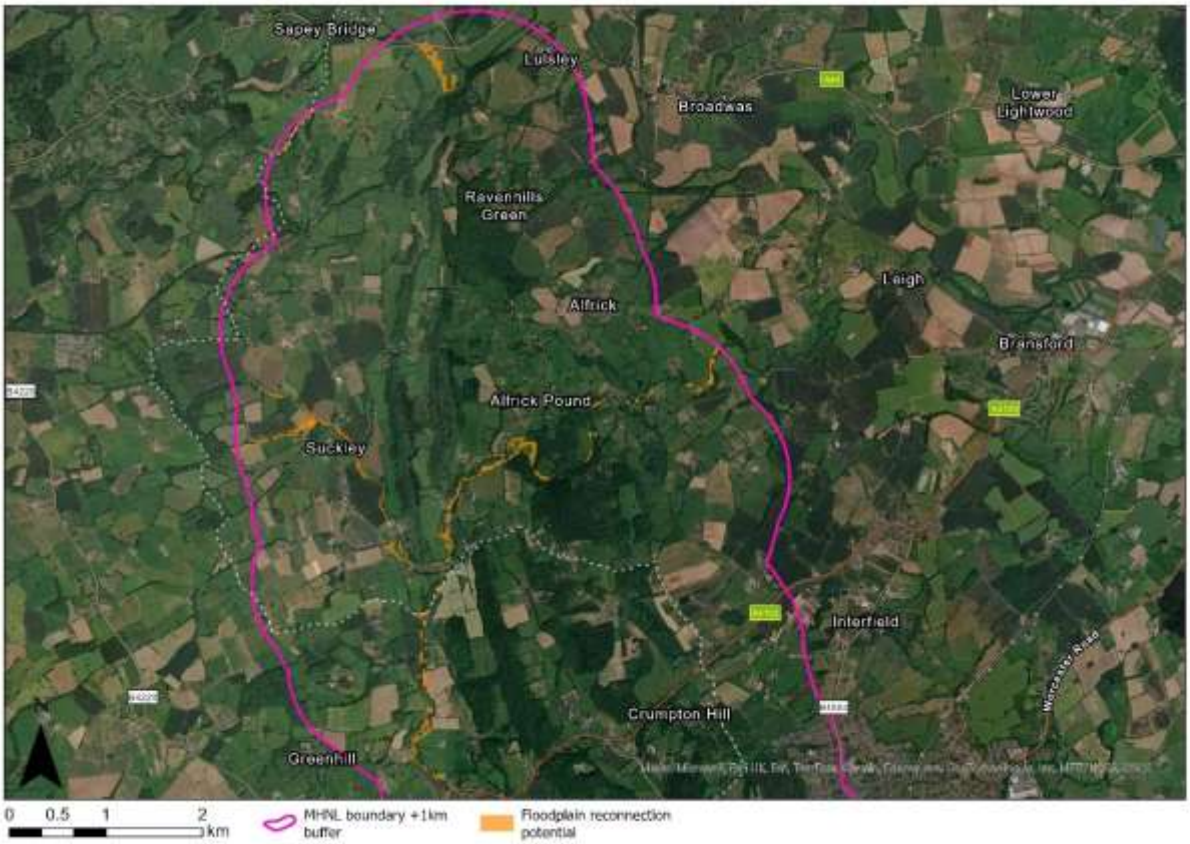

Figure 28 WWNP Floodplain Reconnection Potential (orange) (north) (WWNP 2017)

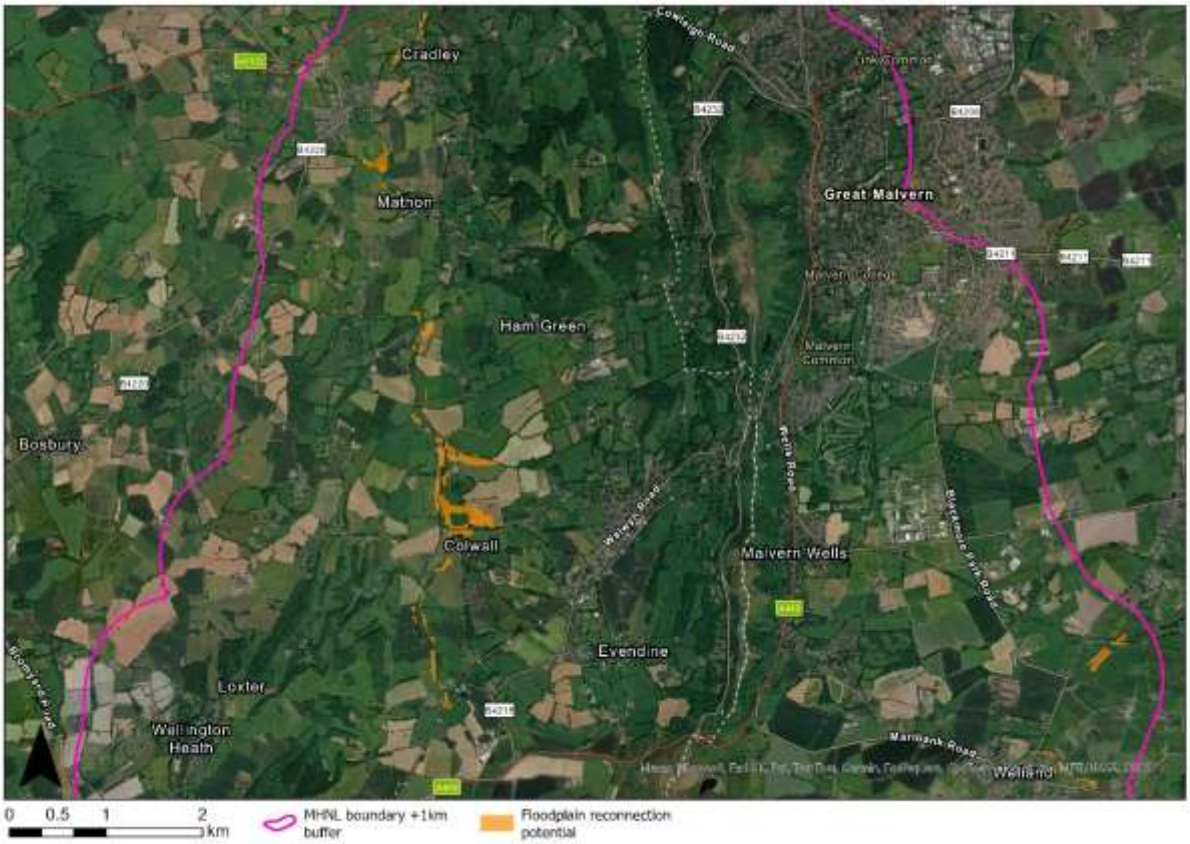

Figure 29 WWNP Floodplain Reconnection Potential (orange) (central) (WWNP 2017)

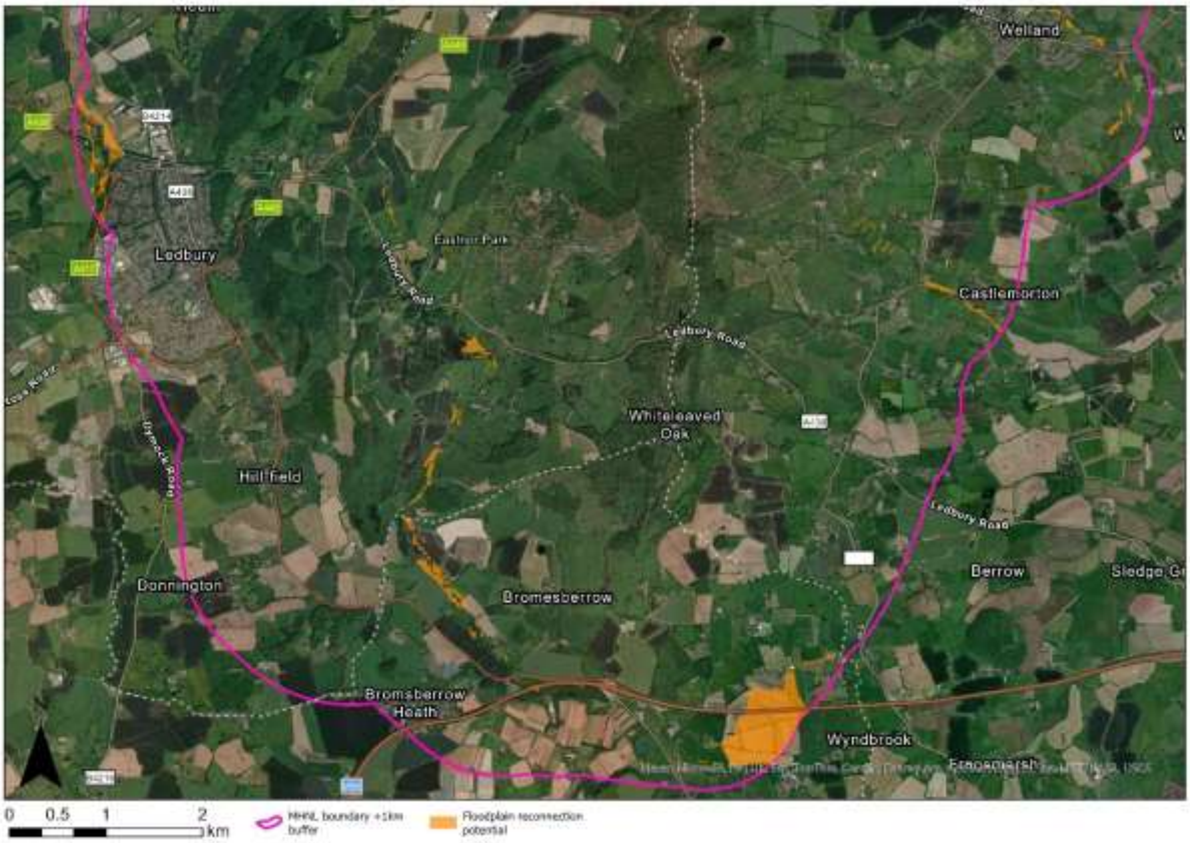

Figure 30 WWNP Floodplain Reconnection Potential (orange) (south) (WWNP 2017)

3.3 Floodplain woodland potential

WWNP Floodplain Woodland Planting Potential is best estimates of locations where tree planting on the floodplain may be possible, and effective to attenuate flooding. The dataset is designed to support signposting of areas of floodplain not already wooded. The dataset is based upon fluvial Flood Zone 2 of the Flood Map for Planning. A set of open access constraints data was used to erase areas which contained existing woodland, watercourses, peat, roads, rail and urban locations. This data is displayed in figures 31, 32, and 33.

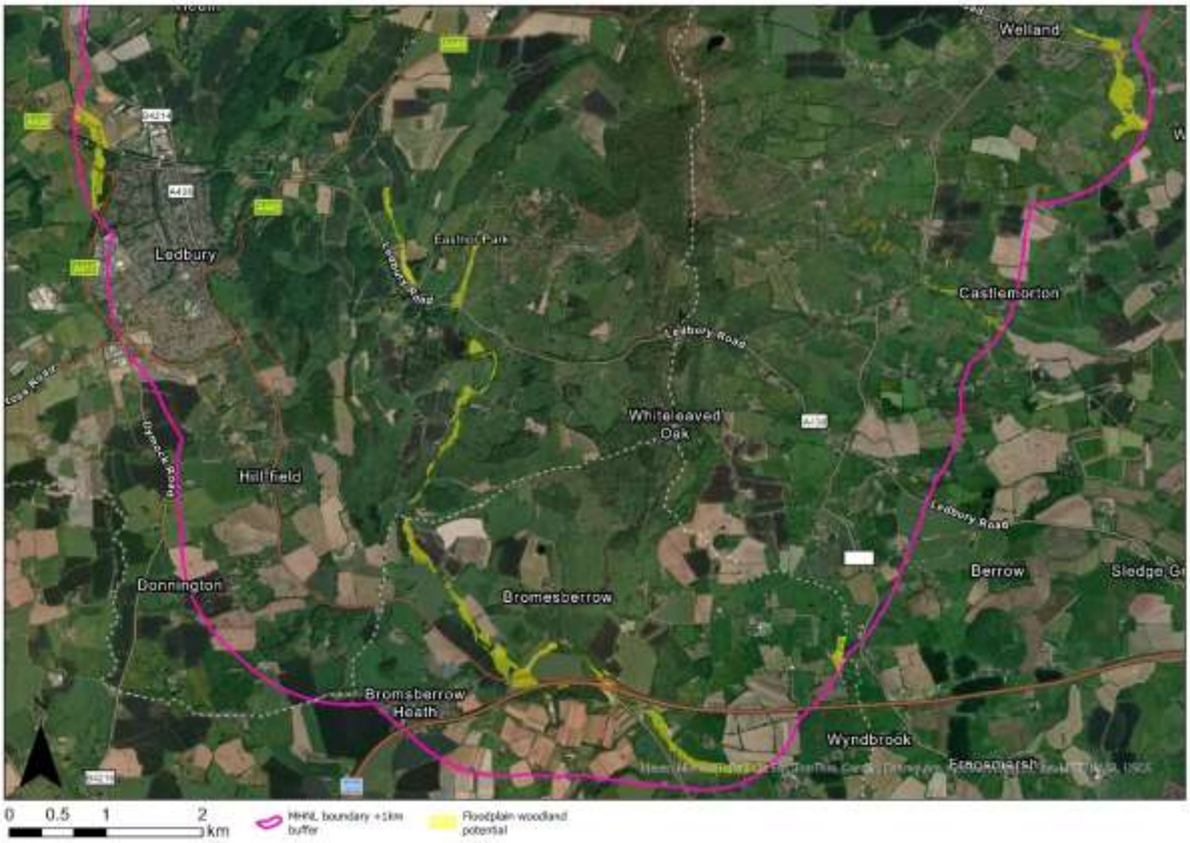

Figure 31 WWNP Floodplain Woodland Planting Potential (yellow) (north) (WWNP 2017)

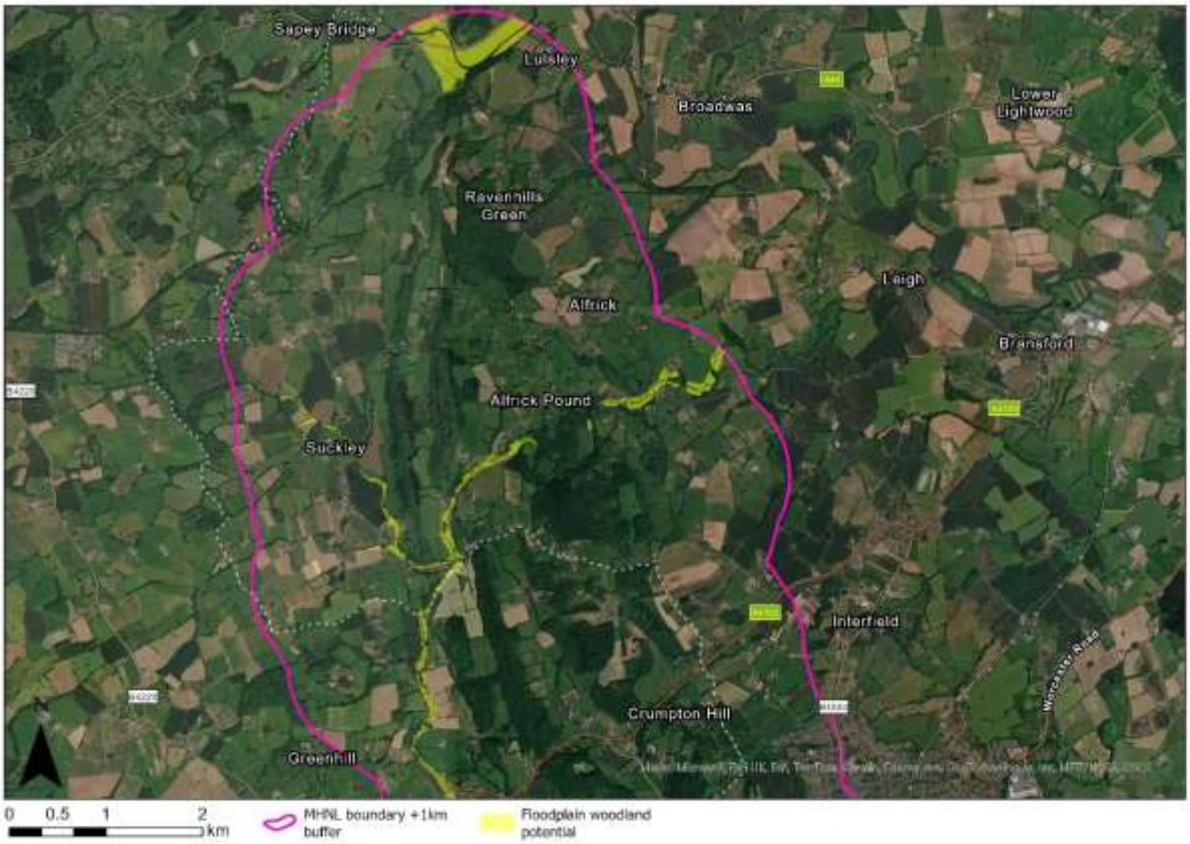

Figure 32 WWNP Floodplain Woodland Planting Potential (yellow) (central) (WWNP 2017)

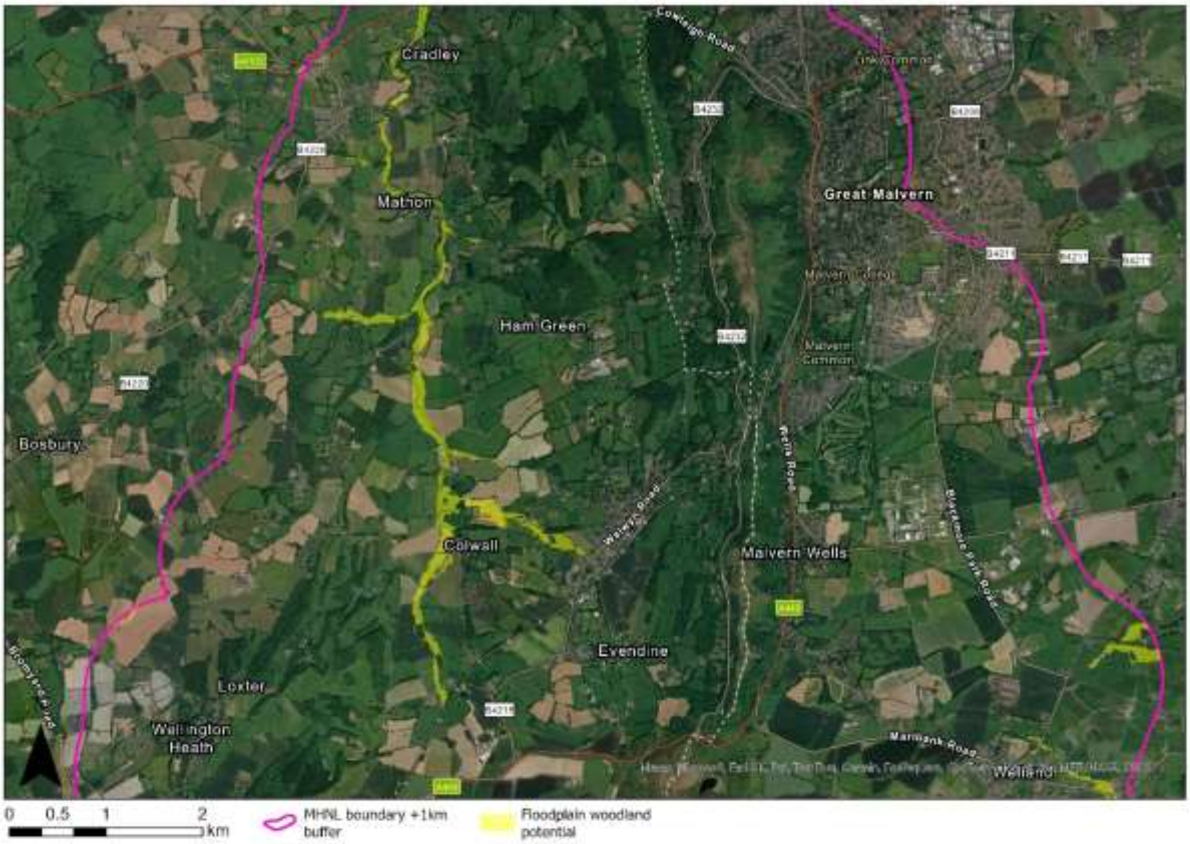

Figure 33 WWNP Floodplain Woodland Planting Potential (yellow) (south) (WWNP 2017)

3.4 Flood Zone 2 and Flood Zone 3

Flood Zone 2 and Flood Zone 3 maps are crucial tools in identifying areas at risk of flooding. Both Flood Zone 2 and Flood Zone 3 are the best estimate of the areas of land at risk of flooding, when the presence of flood defences are ignored (figure 34). Flood Zone 2 represents areas that have a medium probability of flooding, with a risk of flooding between 1% and 3.3% annually. Flood Zone 3, on the other hand, indicates areas with a higher probability of flooding, with a risk greater than 3.3% annually. Both zones are essential for NFM planning, as they highlight regions where interventions can have significant benefits in reducing flood risk. These maps can guide decisions on where to implement flood attenuation features, such as floodplain reconnection, wetland restoration, and tree planting.

Figure 34 Flood Zone 2 and Flood Zone 3 (EA 2024; ArcPro 2025)

4.0 Recommendations for NFM locations

4.1 Overview of priority sites

The information and data presented in this report has been used in the comprehensive identification of 25 high-priority areas within the MHNL for NFM interventions which are displayed in figure 35.

Overleaf, table 1 and 2 summarises the NFM measures assigned to each priority area, including potential interventions such as soil management, pond and wetland creation, leaky dams, floodplain woodland, floodplain reconnection, grass buffer strips, and bunds. The table further provides details including coordinates, nearest place names, sources of information, current land use, and a succinct description of the identified opportunities.

The appendix corresponds to table 1 and 2 which provides a detailed view of each priority location described.

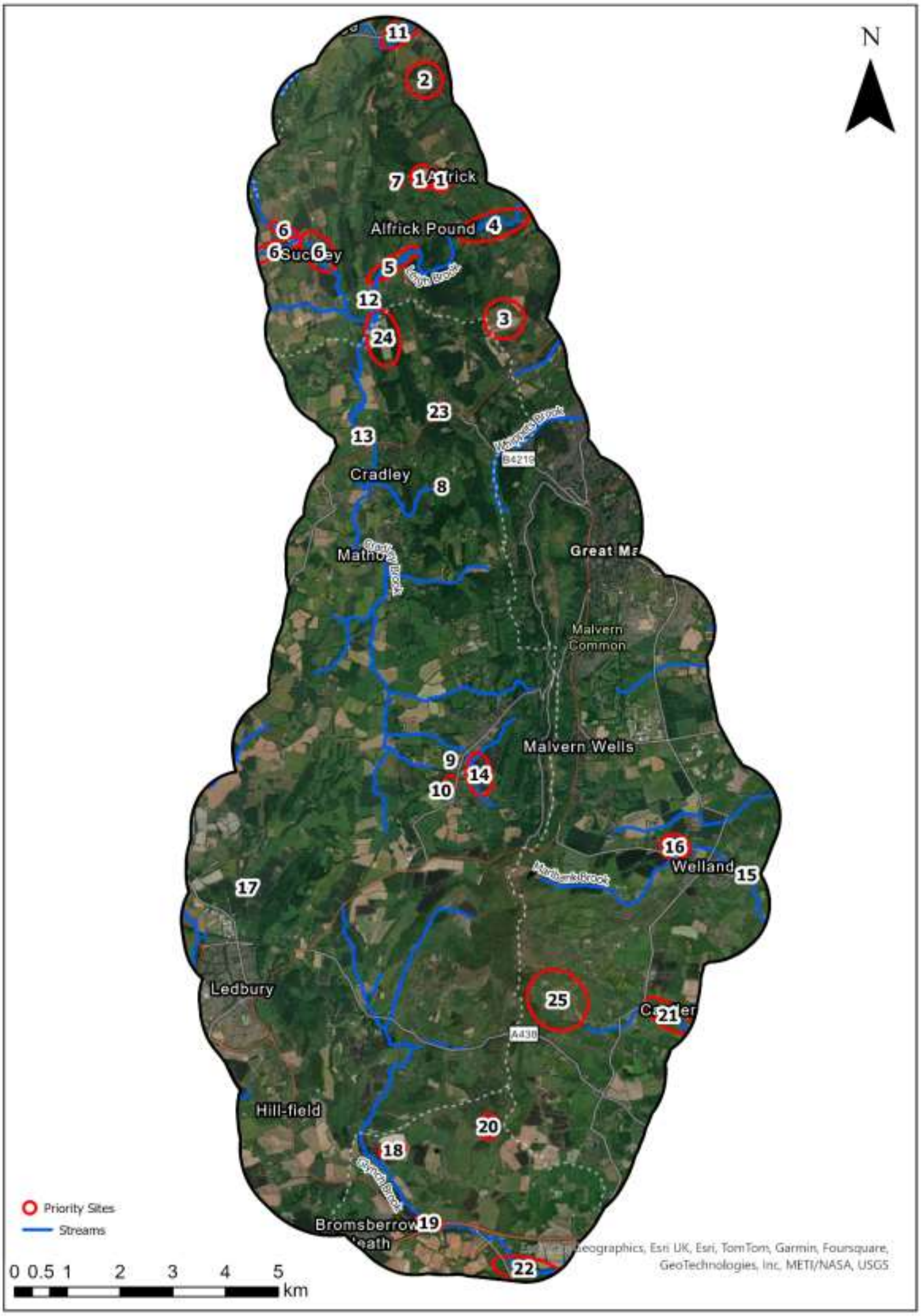

Figure 35 25 priority locations for NFM in MHNL (ArcPro 2025)

Table 1 Priority table 1-13 for NFM interventions

Site number	Lat / long	Nearest place	Information sources	Land use	Possible NFM opportunity					Notes / description
1	52.17615, -2.37546	Alfrick Village	SCIMAP soil erosion SCALGO Google Earth	Non-irrigated arable land	Soil management	Grass buffer strips				SCIMAP analysis highlights the area as a red zone for high erosion risk, indicating significant sediment/nutrient loss. As arable land, it is more vulnerable to erosion during heavy rainfall. Additionally, SCALGO shows a major overland flow path where runoff is concentrated, increasing erosion and downstream flood risk. Also visible rills/gullies in aerial imagery from 2013. NFM measures could reduce sediment transport and improve water infiltration through e.g buffer strips or soil improvements.
2	52.19271, -2.37572	Hill Road	SCIMAP soil erosion SCIMAP hydrological connectivity SCALGO Google Earth	Non-irrigated arable land	Soil management	Leaky dams	Pond	Floodplain tree planting		SCIMAP highlights it as a red erosion zone, and as arable land, it is highly vulnerable during heavy rainfall. Close to a watercourse and Flood Zone 2 of the River Teme, it has high connectivity, meaning eroded soil is likely to reach the stream. SCALGO reveals a major overland flow path, and 2013 aerial imagery shows visible rills/gullies. The site is well-suited for soil/land management interventions, with a small stream offering potential for leaky barriers or a pond with floodplain tree planting to slow flow and trap sediment.
3	52.15283, -2.35436	Crowcroft Farm	SCIMAP soil erosion SCALGO Google Earth	Non-irrigated arable land	Soil management	Grass buffer strips				SCIMAP highlights it as a red erosion zone, and as arable land, it is highly vulnerable during heavy rainfall. SCALGO shows a major overland flow path linked to surface water, increasing sediment transport risk. Aerial imagery (2013) reveals rills and gullies, indicating past erosion. With high connectivity between risk areas and flow paths, the site is well-suited for land management interventions, such as buffer strips or soil improvements, to reduce sediment loss and improve water retention.
4	52.16864, -2.35528	Stocks Road	SCALGO Google Earth WWNP Floodplain Woodland Potential	Pastures	Leaky dams	Floodplain tree planting				Located along Leigh Brook and predominantly pasture fields, it is ideally situated for riparian/floodplain woodland intervention. The site lies within the Working with Natural Processes (WWNP) layer for suggested floodplain woodland, offering an opportunity to introduce floodplain or riparian woodland upstream of Leigh Sinton. Leaky dams are also a possibility here. This would help enhance water retention, improve water quality and enhance ecological benefits.
5	52.15968, -2.38650	Stocks Road 2	SCALGO Google Earth WWNP Floodplain Woodland Potential	Pastures	Leaky dams	Floodplain tree planting				As with site 4, this site also sits within the WWNP layer for floodplain woodland upstream of Leigh Sinton. This area also provides an option for leaky dams. The benefits would be as described above.
6	52.16229, -2.40467	Suckley	WWNP Floodplain reconnection WWNP Floodplain Woodland Potential	Arable and pastures	Floodplain tree planting	Floodplain reconnection				Floodplain tree planting and floodplain reconnection are suitable at this location because both arable and pasture land fall within the WWNP floodplain reconnection and WWNP floodplain woodland layers. The presence of both land types provides opportunities for habitat creation, soil stabilisation, and increased carbon sequestration while maintaining agricultural productivity in appropriate areas.
7	52.17496, -2.38344	West of Alfrick Village	WWNP Runoff attenuation features 3.3% AEP	Pastures	Pond					A pond can be constructed at this location because it falls within the WWNP Runoff Attenuation Features 3.3% AEP layer, indicating suitability for water management. Additionally, its presence in pasture land ensures minimal disruption to arable farming while enhancing flood resilience, biodiversity, and water retention in the landscape.
8	52.12269, -2.37088	East of Cradley	WWNP Runoff attenuation features 3.3% AEP SCALGO	Pastures	Pond					As with above, a pond can be constructed at this location because it falls within the WWNP Runoff Attenuation Features 3.3% AEP layer. SCALGO has also modelled a flowpath here too.
9/10	52.07181, -2.36947	Walwyn Road	WWNP Runoff attenuation features 3.3% AEP Google Earth	Arable	Pond					As with above, a pond can be constructed at this location because it falls within the WWNP Runoff Attenuation Features 3.3% AEP layer. Woodland at site number 10 is a possible location for a pond.
11	52.20221, -2.38045	Knightwick	SCALGO	Pastures	Pond					A pond can be constructed at this location as it lies on the floodplain of the River Teme, with SCALGO models indicating water naturally ponds here. The SCALGO flooded areas layer, confirms persistent wetness, further supported by aerial photography. Given its low productivity, a large pond would enhance flood resilience and biodiversity.
12	52.15576, -2.39060	Stocks Road	SCALGO Flood Zone 2	Pastures	Pond	Wetland				A pond could be constructed at this location due to its strong hydro connectivity, low erosion risk, and in the floodplain reconnection layer. The existing 120m x 50m pond demonstrates feasibility, with potential for a larger storage area or multiple ponds to enhance flood mitigation in his location. Situated in Flood Zone 2, the site naturally supports water retention, reducing downstream flood risk. Proximity to Leigh Brook further strengthens its suitability for increased flood storage capacity.
13	52.13157, -2.39247	Stifford's Bridge	SCALGO SCIMAP soil erosion Google Earth	Arable and pastures	Grass buffer strips	Pond	Leaky dams	Bunds	Soil management	Case study 1 - the area is prone to erosion and surface runoff, making it suitable for buffer strips, ponds, leaky dams, grass bunds, and soil management. These interventions will reduce flood risk, trap sediment, enhance water quality, and improve soil stability, aligning with SCALGO modeling and aerial observations of erosion pathways.

Table 2 Priority table 14-25 for NFM interventions

Site number	Lat / long	Nearest place	Information sources	Land use	Possible NFM opportunity						Notes / description
14	52.07454, -2.36066	Evendine	SCALGO Google Earth	Arable	Soil management	Grass buffer strips					Aerial imagery from 2024, 2021, 2017, and 2013 shows evidence of soil erosion and bare crop areas indicating the need for soil management here. Grass buffer strips could be added on field margins.
15	52.05689, -2.28527	East of Welland	SCALGO Flood Zone 2	Pastures	Pond	Wetland	Floodplain tree planting	Bunds			The significant surface water shown on SCALGO and a depression in the field identified by LIDAR indicates natural water retention potential. By implementing NFM here, upstream water flow can be slowed before reaching residential areas. Additionally, its location in Flood Zone 2 reinforces the need for flood resilience measures. Grass bunds could be implemented on the flow path and a pond/wetland/tree planting would assist in holding back surface water.
16	52.06142, -2.30578	West of Welland	SCALGO SCIMAP soil erosion SCIMAP hydrological connectivity Google Earth	Arable	Soil management	Grass buffer strips					Soil erosion, as indicated by SCIMAP, and high hydro connectivity, which suggests soil and sediments could enter Marlbank Brook. Aerial photography and SCALGO flow paths confirm runoff patterns aligning with mapped data. This site is upstream of Marlbank Brook and Welland houses, making interventions crucial for reducing sediment transport, improving water quality, and mitigating flood risks for downstream communities.
17	52.05424, -2.42380	South of Wellington Heath	SCALGO	Pastures	Pond	Wetland					Very wet conditions shown in SCALGO, a depression in LIDAR data, and the absence of an existing pond in aerial photography or OS maps. The site's proximity to the channel as well as being pasture are good for interventions such as pond or wetland creation.
18	52.00986, -2.38442	West of Bronsdsberrow	SCALGO SCIMAP hydrological connectivity	Arable	Pond	Wetland					Potential for a pond, as indicated by a 100m x 50m flooded area on SCALGO. The site is already within a buffer strip, with flow pathways converging into this natural depression. No existing pond is recorded on OS maps, and its slightly upstream position aligns with SCIMAP hydro connectivity, making it a good spot for water retention/sediment capture.
19	51.99736, -2.37392	A417/M50	SCALGO SCIMAP hydrological connectivity Flood Zone 2	Pastures	Pond	Wetland					This 350 x 100m area is well-suited for NFM with potential for a pond, multiple ponds, or a larger wetland. SCALGO shows flooding, and the site is fed by Glynch Brook, allowing water retention potential. Located in Flood Zone 2 so interventions here would help slow flow, store floodwater, and reduce downstream risk.
20	52.01245, -2.35722	South of Whiteleaved Oak	SCALGO	Pastures	Pond	Leaky dams	Bunds				Potential ponds are indicated by flooded areas and flow paths in SCALGO, yet no ponds currently exist on the OS map - only a stream/ditch, which could feed new ponds. Leaky dams or bunds in the flow path within tree cover could help slow runoff and enhance water retention. However, a site visit is needed to ground truth flow.
21	52.03232, -2.30541	Castlemorton	SCALGO Flood Zone 2 WWNP layers	Pastures	Floodplain reconnection	Floodplain tree planting	Leaky dams				Inside the WWNP floodplain reconnection and floodplain woodland layers. Being in Flood Zone 2, it offers strong potential for floodplain reconnection, allowing the channel to reconnect naturally with its floodplain. Additionally, the stream provides opportunities for leaky dams to slow water flow, though ground truthing is needed to confirm flow.
22	51.99926, -2.34664	Glynch Brook M50	SCALGO Flood Zone 2 WWNP Runoff attenuation features 3.3% AEP	Pastures	Pond	Floodplain tree planting	Leaky dams				Glynch Brook and location in flood zone 2. The WWNP runoff attenuation features 3.3% AEP layer support the feasibility of ponds on pasture land. Additionally, the area allows for riparian tree planting and the potential for leaky dams in the stream (with ground truthing for flow).
23	52.13581, -2.37210	New Storridge	SCALGO	Pastures	Bunds						Pilot study 1 case study - Visible overland flow pathway on the pasture field that is subtly noticeable in aerial imagery but clearly defined in LIDAR data. The flow path runs above properties, making it a good location for NFM.
24	52.14950, -2.38853	Longley Green	SCALGO WWNP layers		Bunds	Pond	Leaky dams	Soil management			Pilot study 2 case study - Flow pathways identified in Areas 1 and 2 show potential for grass bunds to slow and store water during heavy rainfall. These areas, along with identified depressions and hydrological connectivity maps, suggest suitable locations for floodplain storage ponds. Additionally, leaky dams could be implemented, pending site assessment to ensure flow conditions are suitable. These interventions align with reducing erosion risk and improving floodplain storage.
25	52.03548, -2.33813	Chase End Road	SCALGO	Arable and pasture	Grass buffer strips	Pond	Leaky dams	Bunds	Beetle Bank	Soil management	Case study 4 - Widening grass buffer strips, adding more, and slowing water flow before the pond will reduce silt buildup. Introducing wetland areas in low-lying fields enhances biodiversity while storing water. Leaky dams, grass bunds, and beetle banks further reduce runoff and enhance soil stability. Transitioning to permanent cover crops and diverse leys promotes better infiltration, erosion control, and more resilient soil, significantly improving the site's flood management capacity.

5.0 Case studies

Four of the high-priority locations have been explored in greater detail as case studies which are presented in this section. As outlined in the introduction of this report, it is important to note that this is an optioneering exercise and all designs presented are conceptual, serving as illustrative examples and not comprehensive, detailed engineering plans.

5.1 Case study 1

Case Study 1, located in the MHNL, sits on sedimentary bedrock made up of sandstone, mudstone and limestone. This area comprises of a mixture of slowly permeable seasonally wet acid loamy and clayey soils, slightly acid loamy and clayey soils with impeded drainage and freely draining slightly acid loamy soils. There is grassland with some arable and forest with a wide range of pasture and woodland types and the fertility ranges from low, moderate, and high across the area.

Figures 36 and 37 display SCALGO output of modelled overland flow pathways. This simulation uses 20mm of rain with a flow network detail of at least 500m^2 and the water ponding in depressions is visible if deeper than 20cm. Figure 38 displays the erosion risk output from SCIMAP. Red being the highest risk, followed by orange, then yellow etc. Figure 39 displays the hydrological connectivity output from SCIMAP. Red being areas of land which are connected to the channel most frequently, followed by orange, then yellow etc. This data can be used to highlight areas for floodplain reconnection and flood plain storage as well as areas where runoff could be problematic.

5.1.1 Potential NFM interventions – Case Study 1

In figure 40 and 41, six bunds are proposed to slow the flow and temporarily store water on this main flow pathway. The proposed bunds have a consistent height and depth, while the cross-sectional width varies along the slope to accommodate the depression. This design allows for flexibility in adjusting the size of the bunds as needed. Although these bunds may not retain as much water as a pond, their advantage lies in their minimal impact on farming practices. The volume of water stored is in table 3. The cross section of modelled earth bunds displaying modelled water which will pool behind during heavy rainfall events (blue).

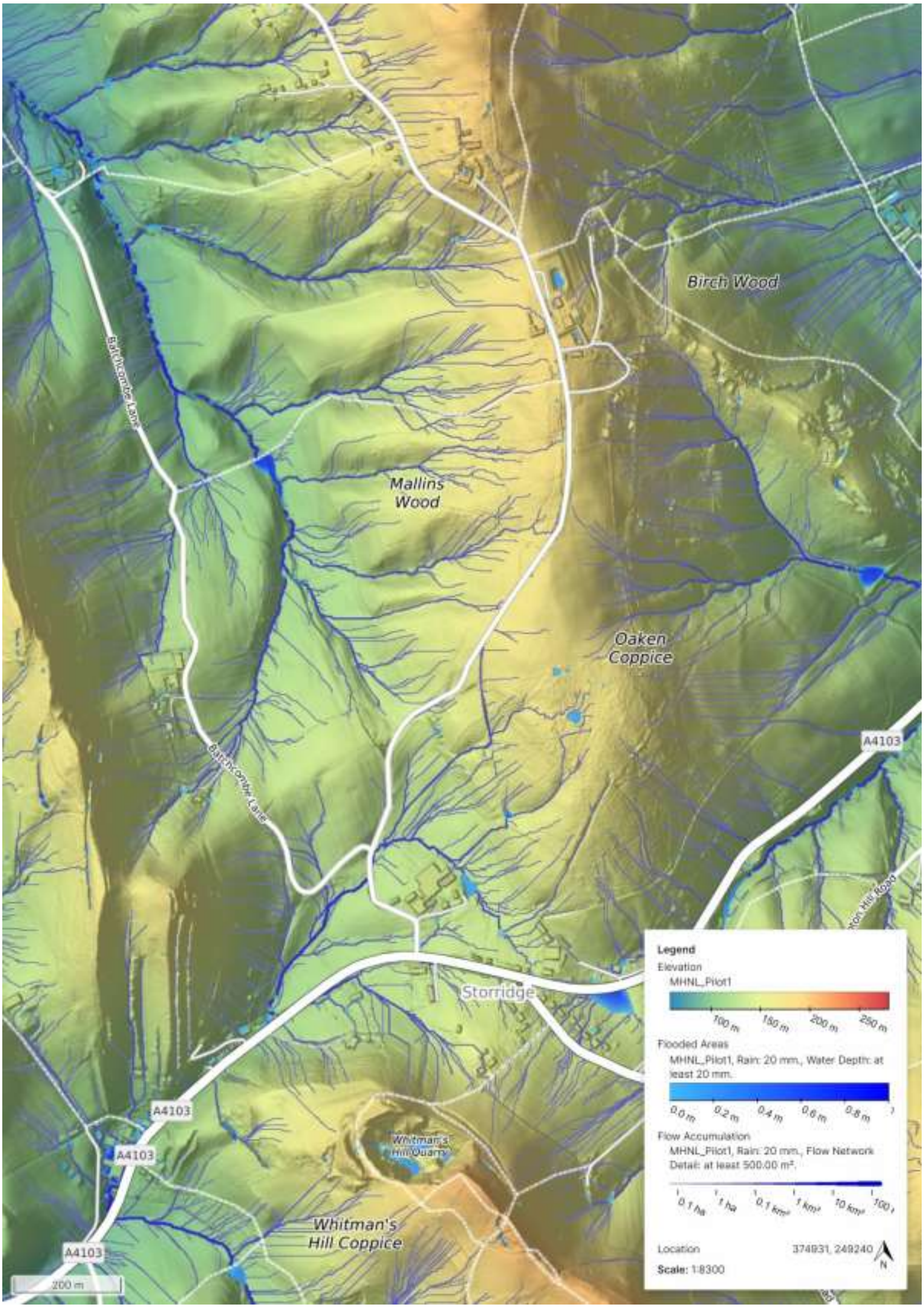

Figure 36 Overland flow pathways on 1m LiDAR data for Case Study 1 (SCALGO 2025)

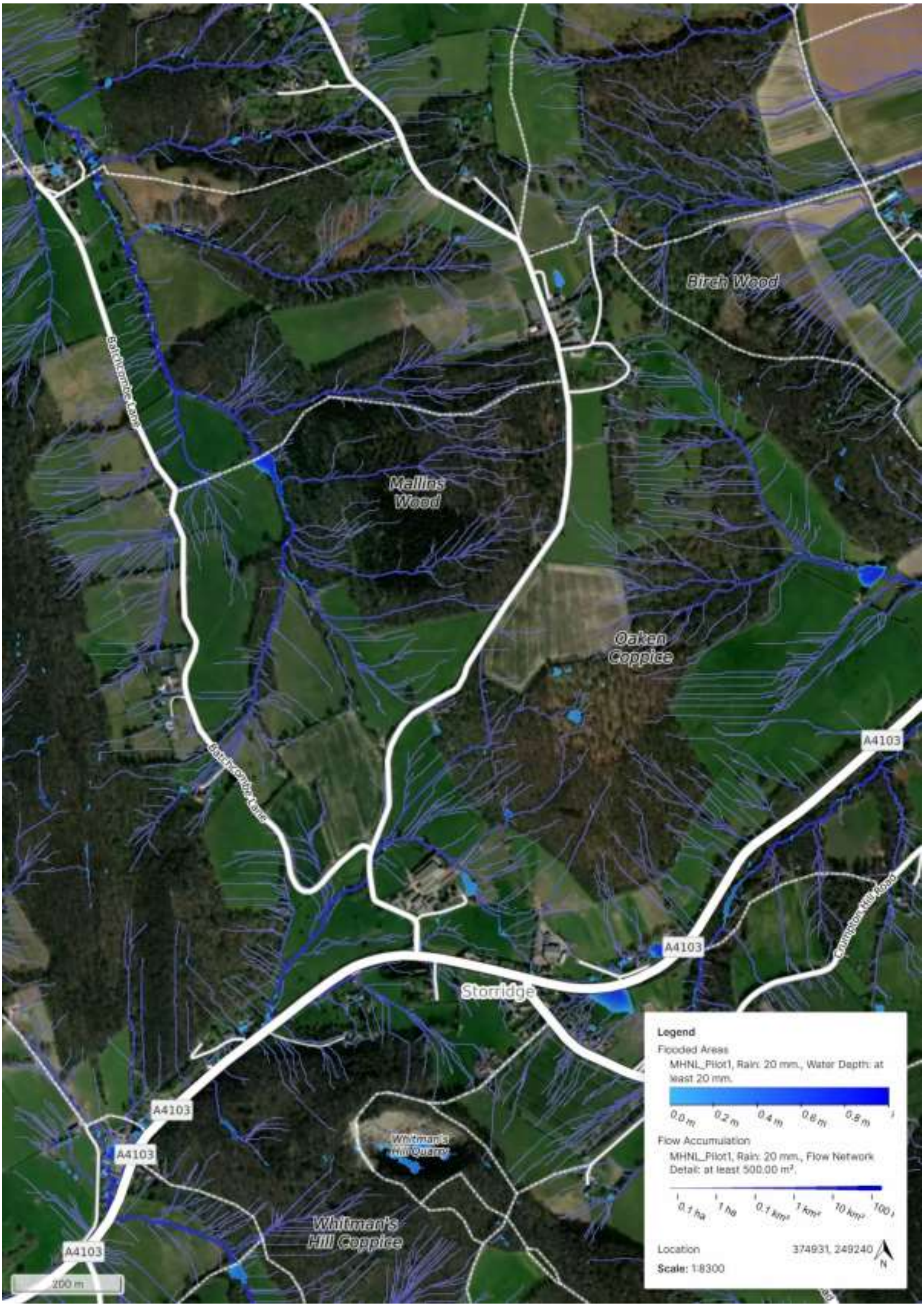

Figure 37 Overland flow pathways on aerial photography for Case Study 1 (SCALGO 2025)

Figure 38 Erosion risk on aerial photography for Case Study 1 (SCIMAP; SCALGO 2025)

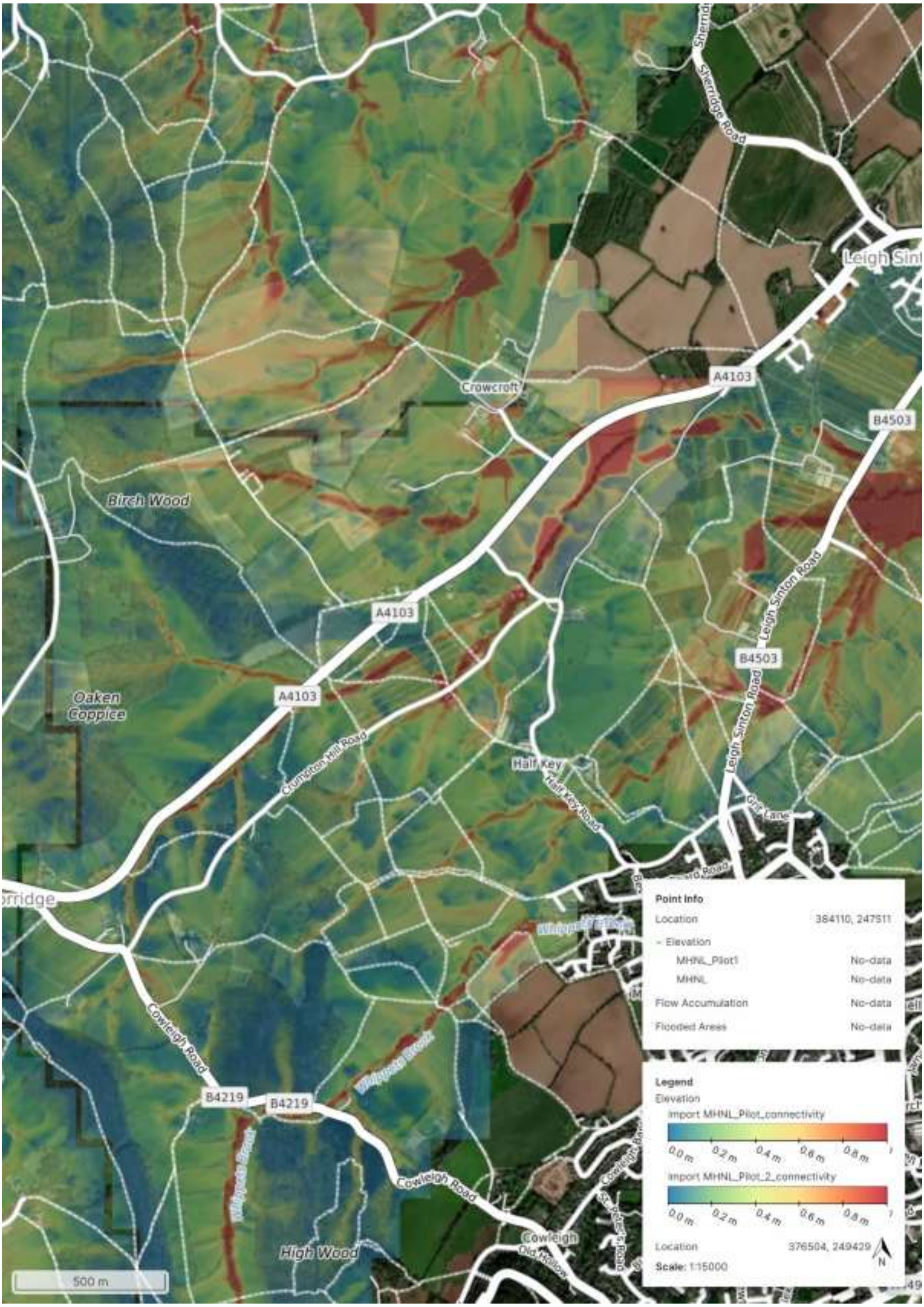

Figure 39 Hydrological connectivity on aerial photography for Case Study 1 (SCIMAP; SCALGO 2025)

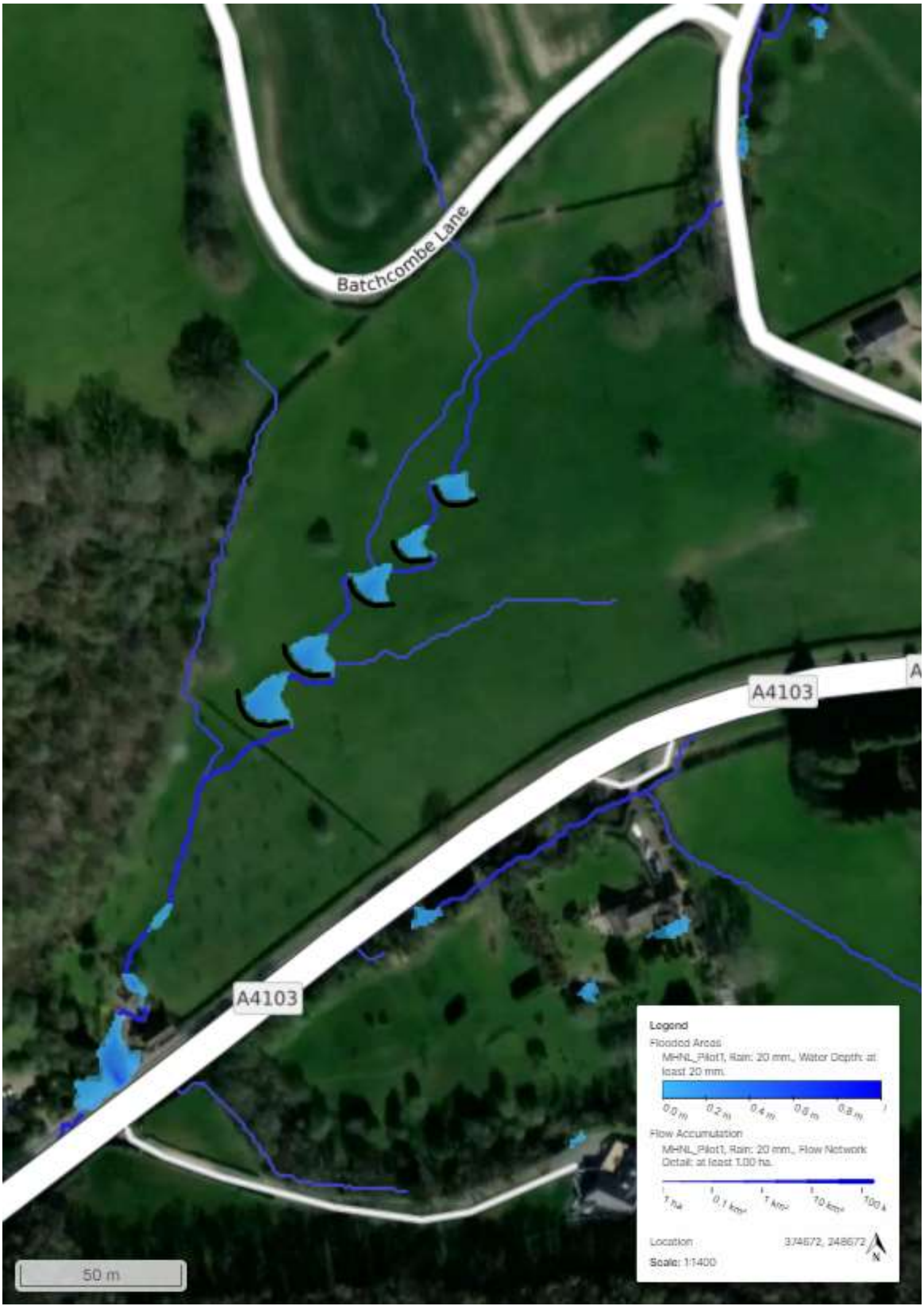

Figure 40 Modelled grass bunds on aerial photography at Case Study 1 (SCALGO 2025)

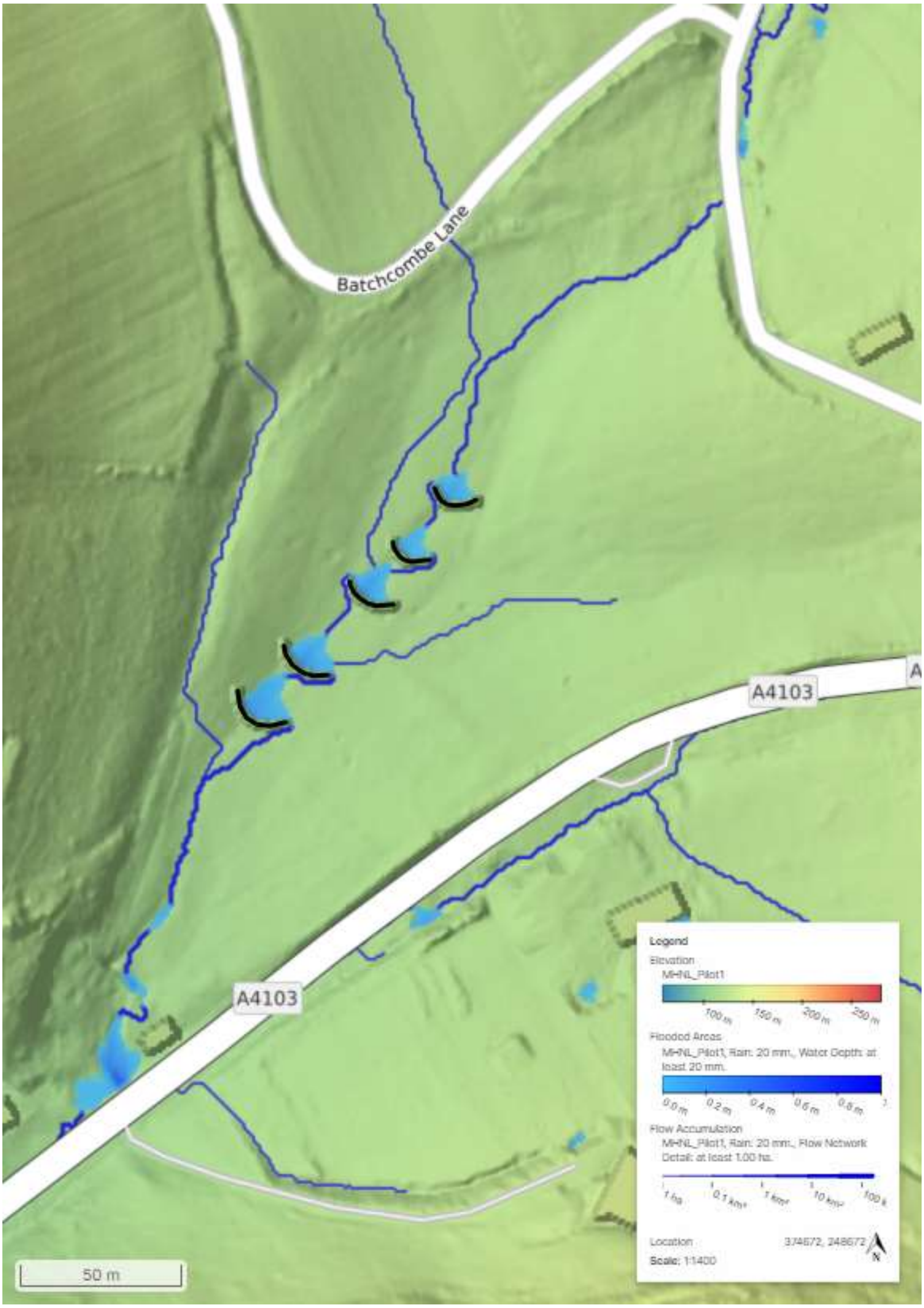

Figure 41 Modelled grass bunds on LiDAR data at Case Study 1 (SCALGO 2025)

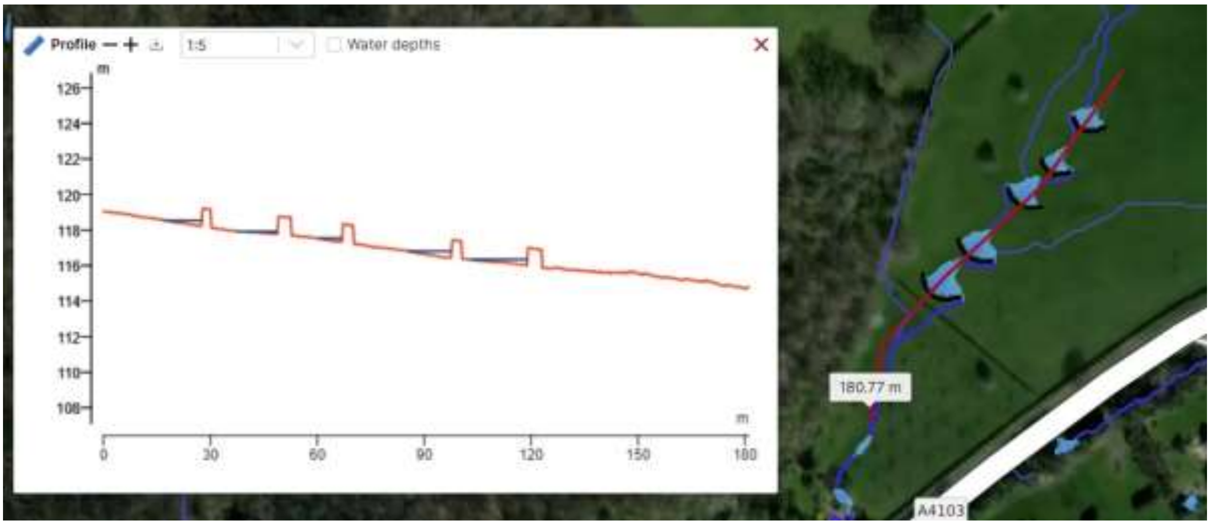

Figure 42 Cross section of grass bunds on aerial photography at Case Study 1 (SCALGO 2025)

Table 3 Statistics for modelled grass bunds (SCALGO 2025)

Bund number (up slope to down slope)	Depth (m)	Height (m)	CS width (m)	Volume held (m^3)	Water depth (max.) (cm)
1	1.5	1	20	7.5	31
2	1.5	1	17	5	11
3	1.5	1	21	11	33
4	1.5	1	22	16	36
5	1.5	1	25	20	35

5.2 Case study 2

Case Study 2 sits on sedimentary bedrock made up of siltstone, mudstone and limestone. This area comprises predominantly of slightly acid loamy and clayey soils with impeded drainage. They are loamy some clayey in texture and there is predominantly arable and grassland landcover with the fertility being moderate to high.

Figures 43 and 44 display SCALGO outputs of modelled overland flow pathways using 1m resolution LiDAR data and aerial photography. This simulation uses 20mm of rain with a flow network detail of at least 1ha. The water ponding in depressions is visible if deeper than 20mm. This map scale is 1:6000. Figures 45 and 46 also display SCALGO outputs of modelled overland flow pathways but using a flow network detail of at least 500m^2. The water ponding in depressions is visible if deeper than 20mm. This map scale is also 1:6000.

Figure 47 displays the erosion risk output from SCIMAP. Red being the highest risk, followed by orange, then yellow etc. This data is used to highlight areas which soil management could take place. Figure 48 displays the hydrological connectivity output from SCIMAP. Red being areas of land which are connected to the channel most frequently, followed by orange, then yellow etc. This data can be used to highlight areas for floodplain reconnection and flood plain storage as well as areas where runoff could be problematic.

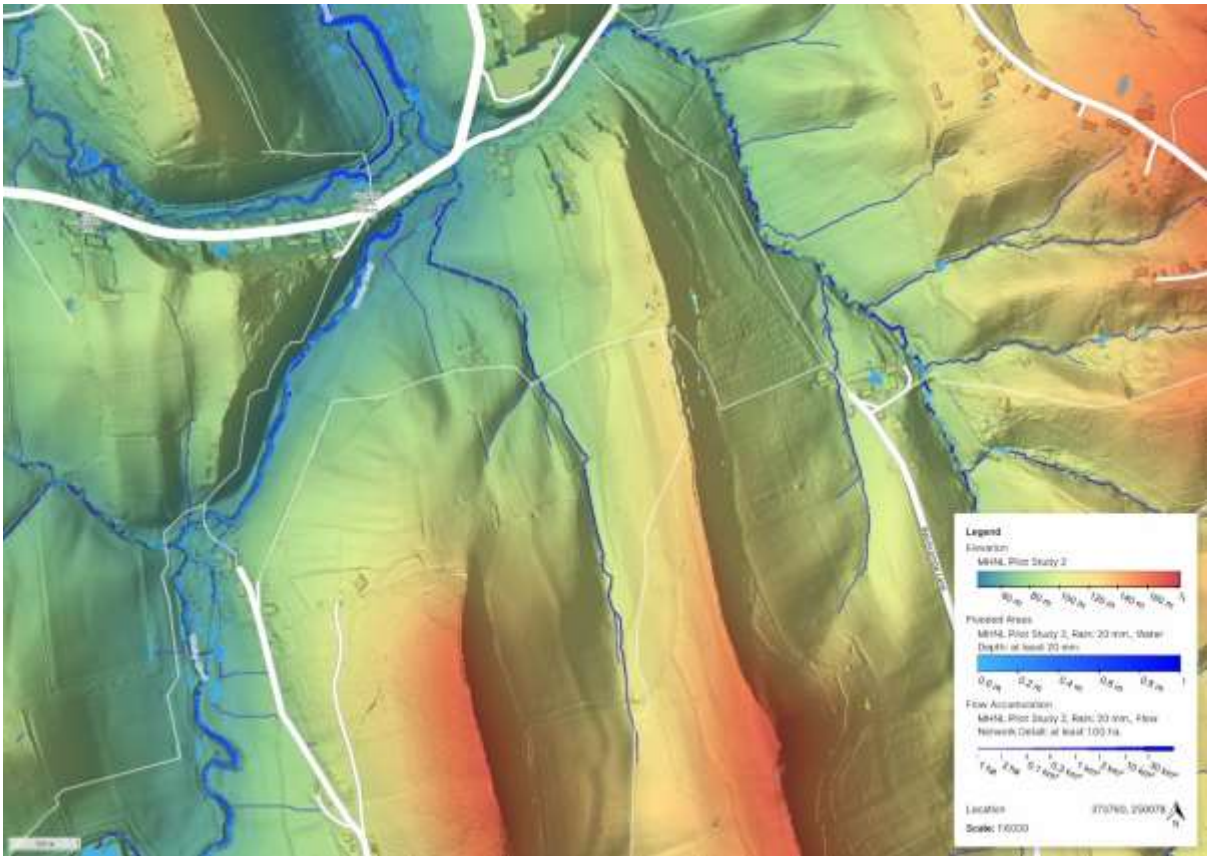

Figure 43 Overland flow pathways on 1m LiDAR data for Case Study 2 (SCALGO 2025)

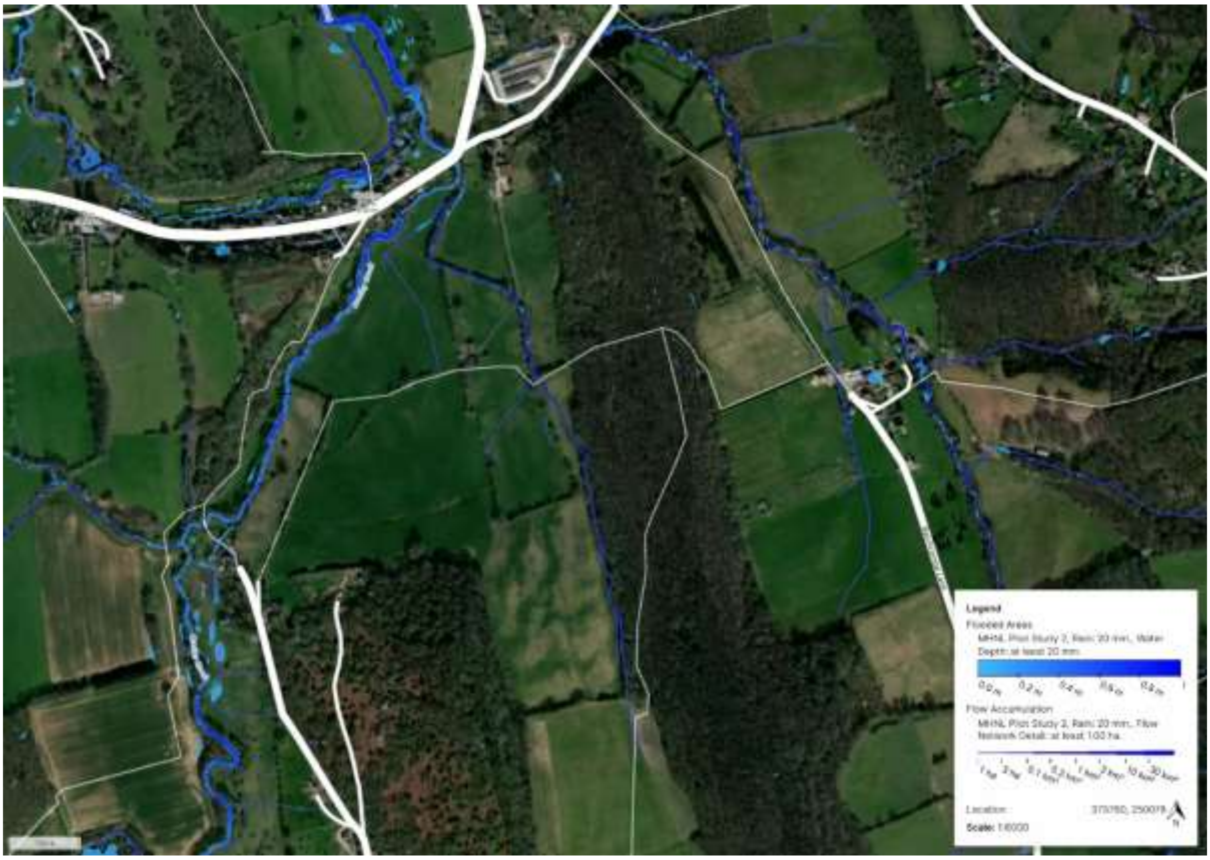

Figure 44 Overland flow pathways on aerial photography for Case Study 2 (SCALGO 2025)

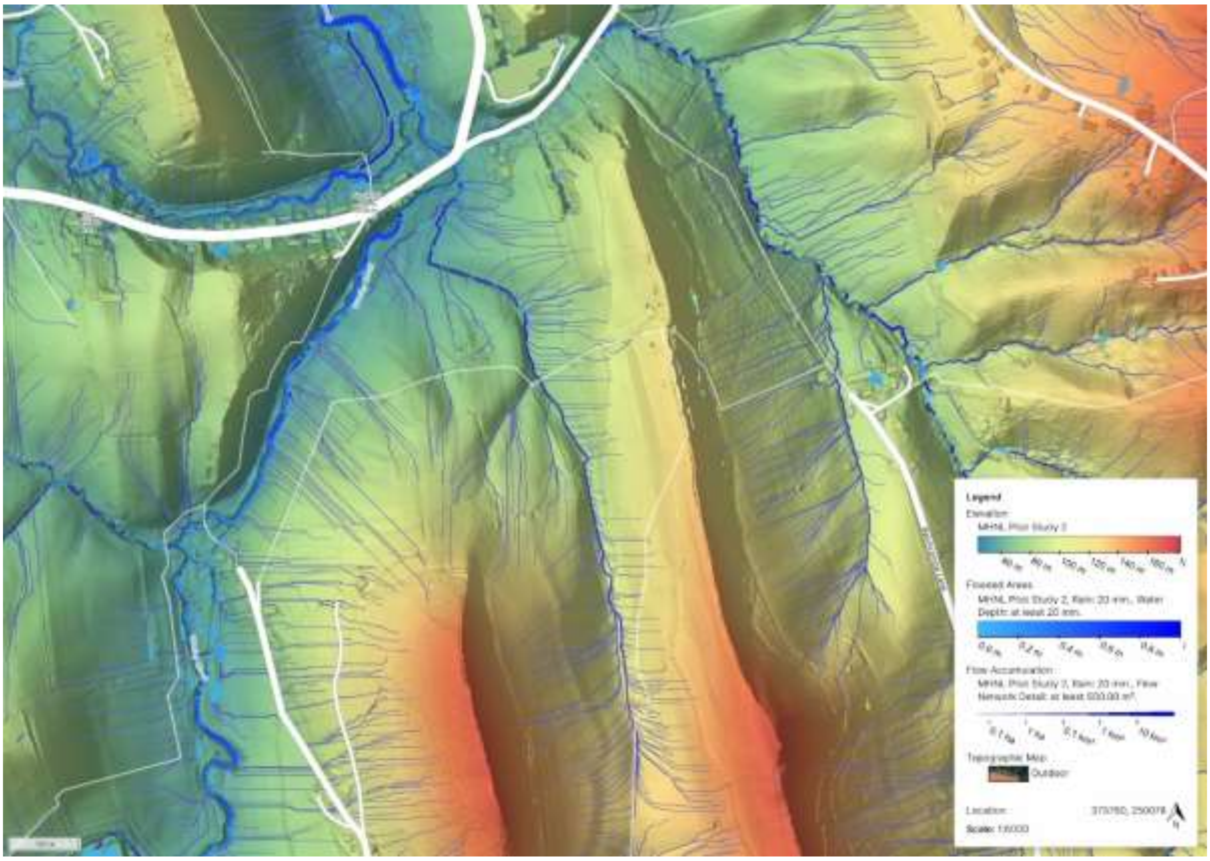

Figure 45 Overland flow pathways on 1m LiDAR data for Case Study 2 (SCALGO 2025)

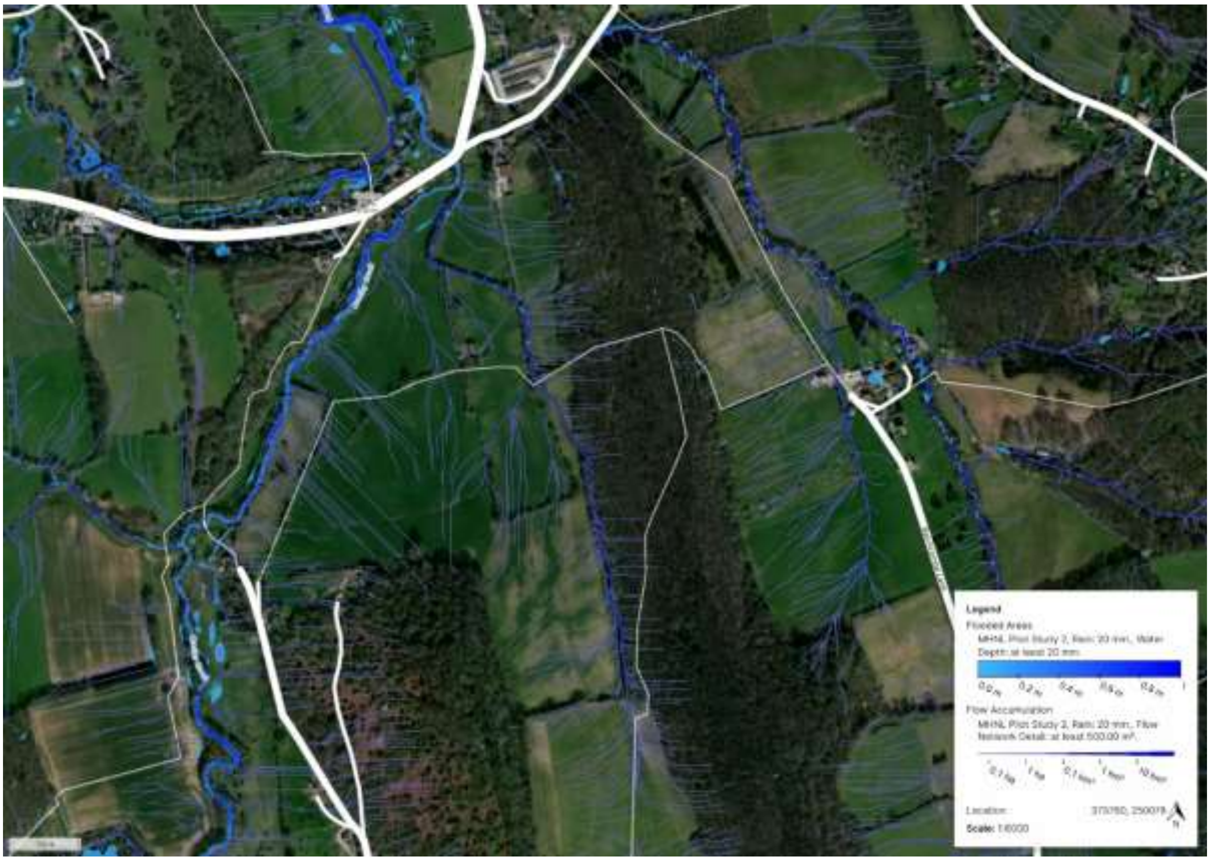

Figure 46 Overland flow pathways on aerial photography for Case Study 2 (SCALGO 2025)

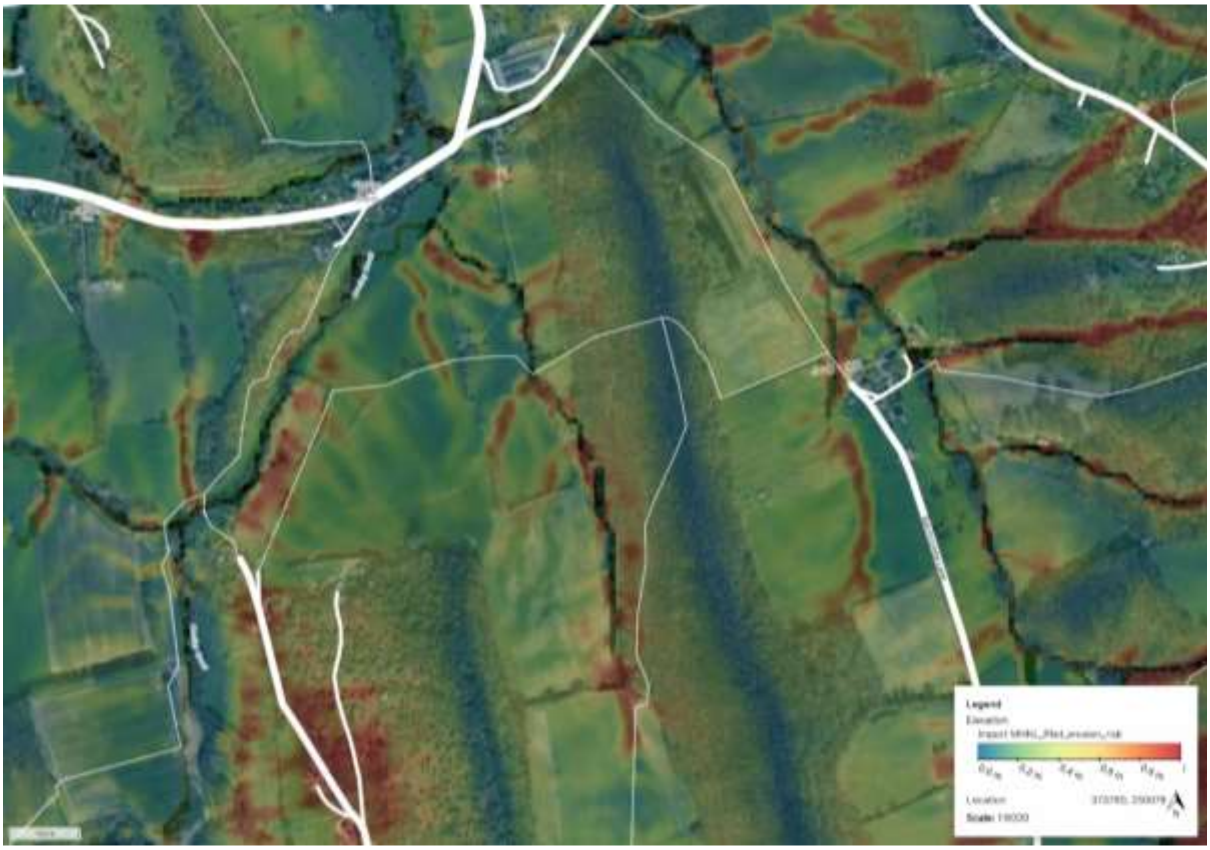

Figure 47 Erosion risk on aerial photography for Case Study 2 (SCIMAP; SCALGO 2025)

Figure 48 Hydrological connectivity on aerial photography for Case Study 2 (SCIMAP; SCALGO 2025)

5.2.1 Potential NFM interventions – Case Study 2

Area 1 - The flow path marked in red indicates a potential site for grass bunds (similar to the example shared in Pilot Study 1) to temporarily slow/store water along this primary overland flow route. The yellow circle highlights an area identified by SCALGO as potential water storage locations on the floodplain. This area, along with its surroundings, is also emphasised in the hydrological connectivity map. This could be a suitable location for a storage pond on the floodplain, connected to the overland flow path.

Area 2 - Like Area 1, two flow pathways (circled in red) in pasture fields are identified as promising locations for a series of grass bunds to slow and temporarily store overland flow during heavy rainfall events. At the confluence where these two flow paths join to form a primary flow route, a storage pond (yellow circle) could be constructed (ensuring the footpath is not obstructed).

Green box - This area shows potential for leaky dams. However, further discussions with the landowner and/or a site visit will be necessary to ground truth flow conditions and determine suitability. The stream in this location should not be too large for leaky dams, but instead it's important to confirm that there is enough flow during rainfall events to make these leaky dams effective. Similarly, there is potential for leaky dams along the Cradley Brook, although as at this location it is so near its confluence with the Leigh Brook the flows may be too high. This, too, should be assessed during a site visit.

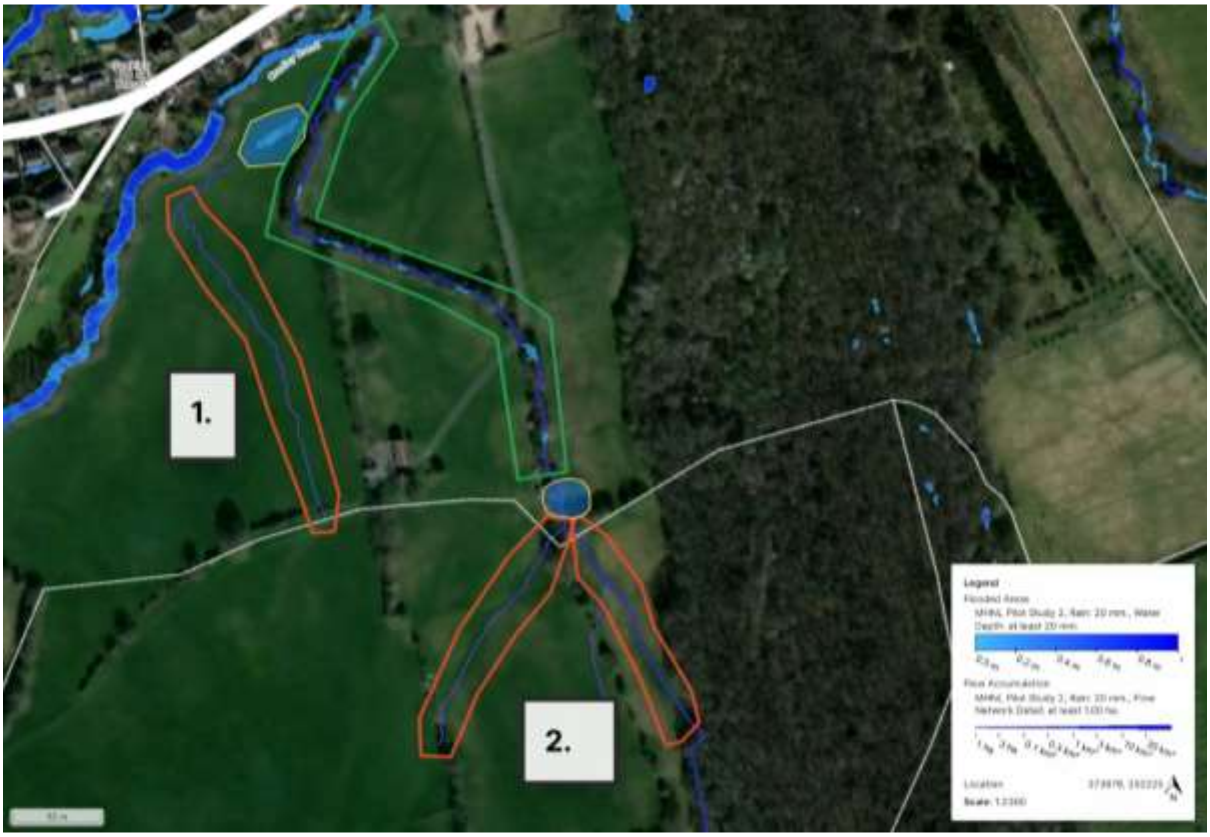

Figure 49 Locations for NFM interventions at Case Study 2 (SCALGO 2025)

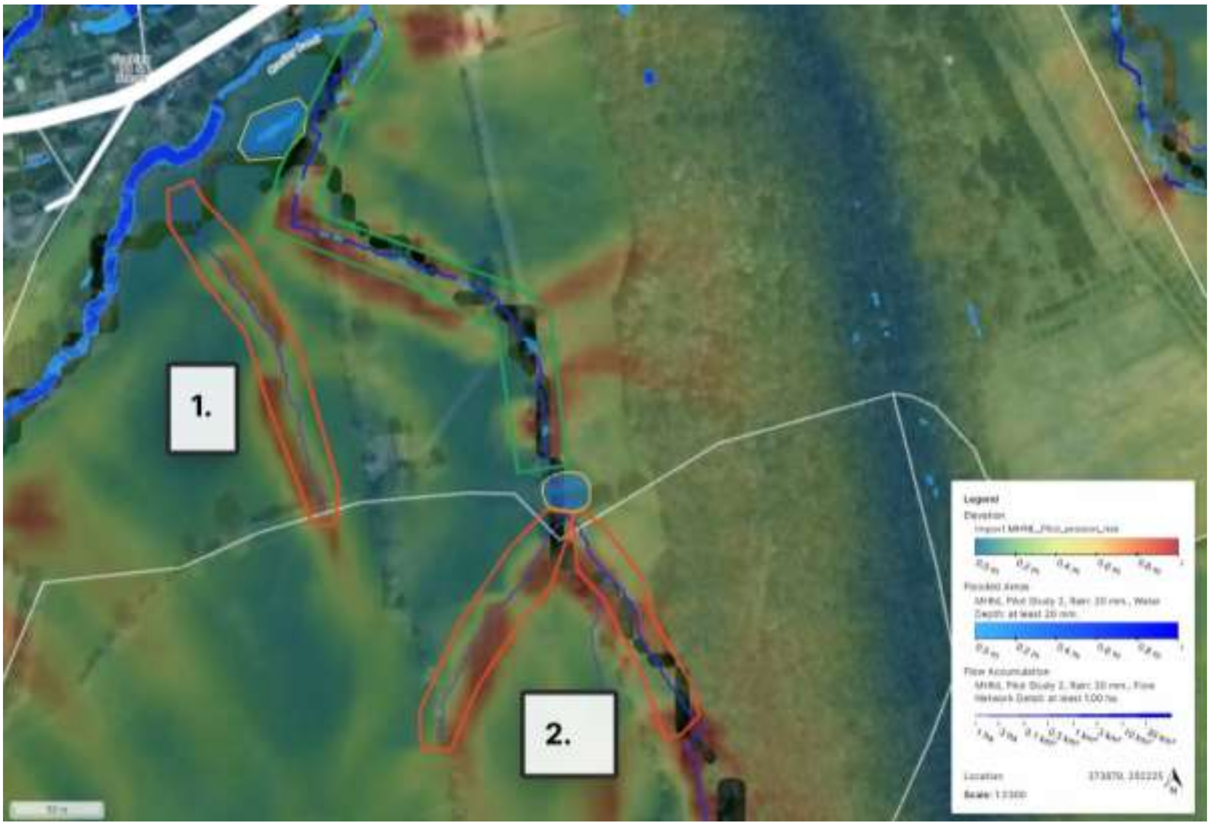

Figure 50 Locations for NFM interventions at Case Study 2 with erosion risk potential (SCIMAP 2025; SCALGO 2025)

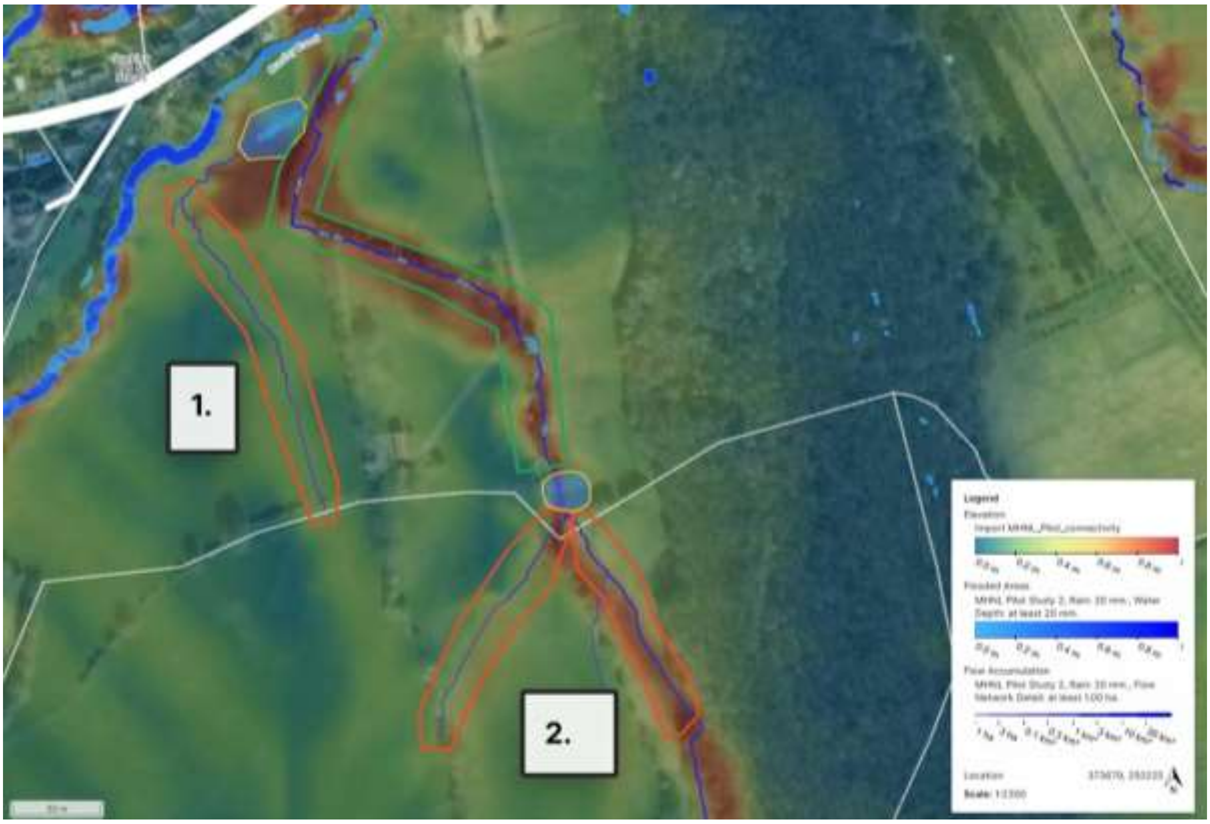

Figure 51 Locations for NFM interventions at Case Study 2 with hydrological connectivity (SCIMAP 2025)

5.3 Case study 3 – Stifford's Bridge

Land near Stifford's Bridge (52.13157, -2.39247) sits on sedimentary bedrock comprising of siltstone, mudstone and limestone. This area comprises predominantly of slightly acid loamy and clayey soils with impeded drainage. The land cover is both arable and grassland landcover with moderate to high fertility. At this location, a buffer strip, four ponds, leaky dams, grass bunds and soil management is proposed which is shown in figures 52, 53 and 54.

Figure 52 Aerial photography of land near Stifford's Bridge (Google Earth 2025)

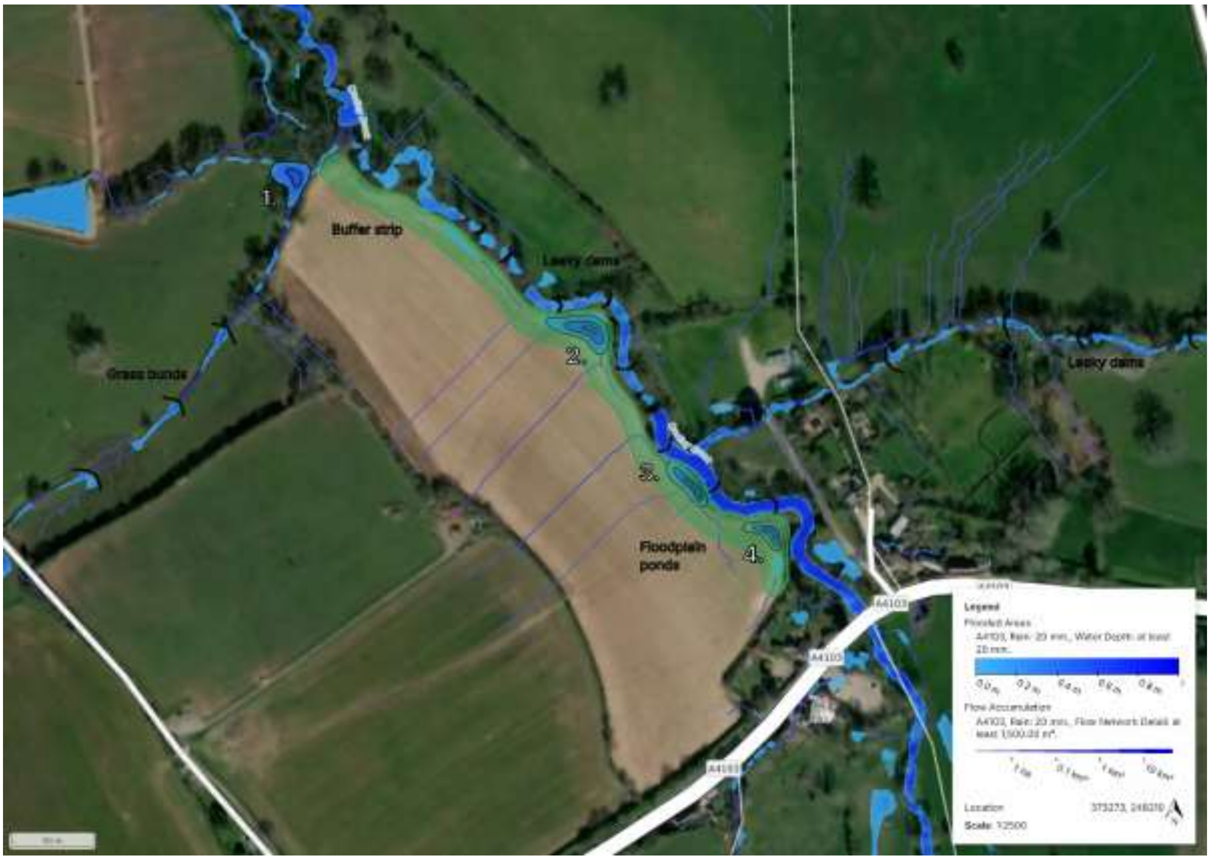

Figure 53 Proposed NFM interventions on aerial photography with flow paths (SCALGO 2025)

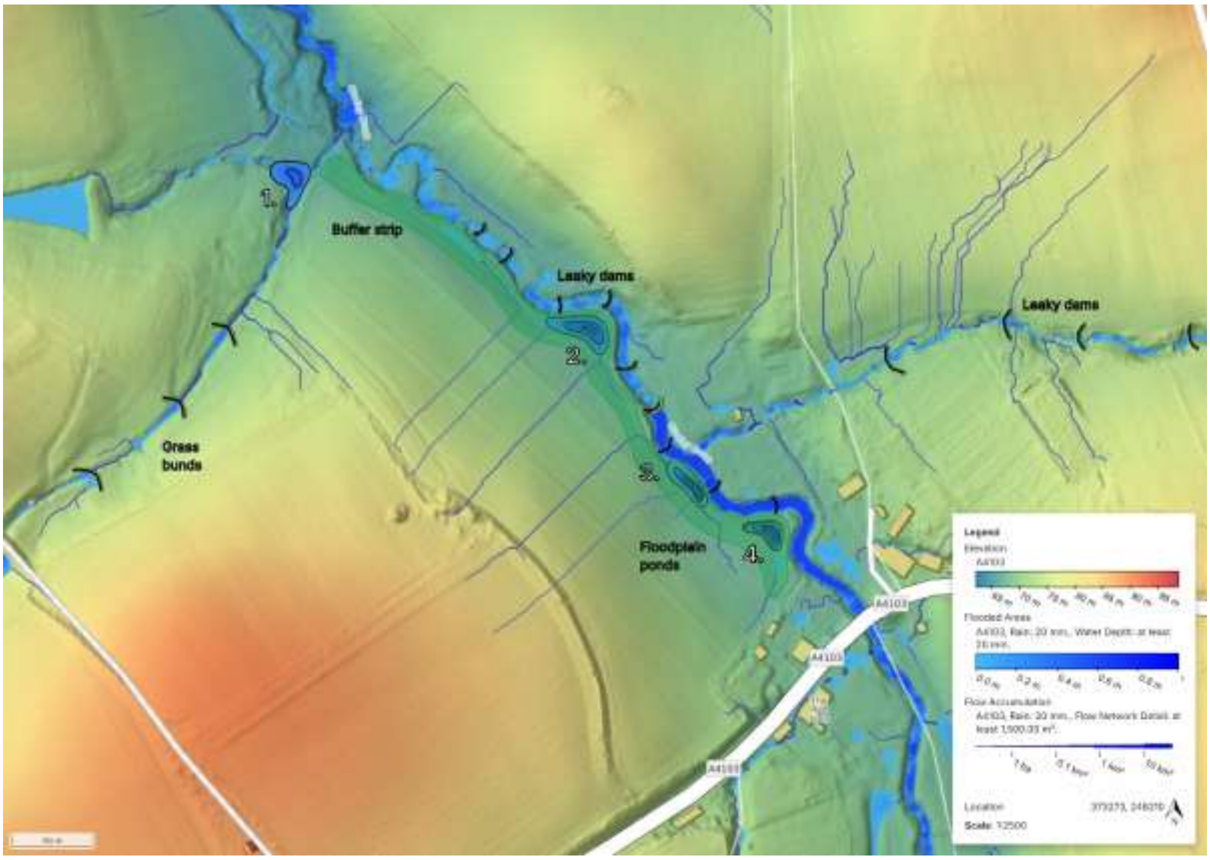

Figure 54 Proposed NFM interventions on LiDAR data with flow paths (SCALGO 2025)

5.3.1 Grass buffer strip

Firstly, a grass buffer strip has been recommended at this location to help mitigate soil erosion and improve water quality. Positioned at the bottom of a sloping field prone to erosion and adjacent to a watercourse, the buffer strip will act as a protective barrier, reducing surface runoff and trapping sediment before it reaches the watercourse. It will also help filter out nutrients, pesticides, and other pollutants, preventing them from entering the stream.

For buffer strips adjacent to watercourses, the recommended width typically ranges from 12m to 24m. Under the Sustainable Farming Incentive (SFI) scheme, the required width for payment eligibility varies based on the specific action and land type. The proposed buffer strip, shown in Figure 53 and 54, extends along the 400m length of the field with an approximate width of 15m, offering a balance between effective runoff control and farmland productivity.

5.3.2 Ponds

As seen in figures 53 and 54, three ponds are proposed at the bottom of a sloping field prone to soil erosion. As they are near a watercourse in Flood Zone 2 they can provide multiple benefits. They help trap sediment and nutrients, preventing them from washing into the watercourse and improving water quality. Additionally, they slow surface runoff, reducing peak flows and lowering flood risk downstream. A fourth pond is proposed on the significant flow path. The presence of a pond here can further enhance flood attenuation by storing water temporarily, slowing its movement, and allowing infiltration, which reduces soil loss and enhances groundwater recharge.

Table 4 presents current statistics for the pond, highlighting its maximum water depth and volume based on modelling in SCALGO.

Table 4 Statistics of the four ponds presented at Stifford's Bridge (SCALGO 2025).

	Pond 1	Pond 2	Pond 3	Pond 4
Water depth (max.)	1.25 m	1.5m	1.4 m	1 m
Volume m^3	351 m^3	352 m^3	228 m^3	103 m^3
Perimeter (approx.)	88 m	105 m	80 m	71 m

Figure 55 Location for proposed ponds at Stifford's Bridge (SCALGO 2025)

Figure 56 Land at Stifford's Bridge in Flood Zone 2 (EA 2024; SCALGO 2025)

5.3.3 Erosion control

Soil erosion control has been recommended at this location due to the presence of a sloping field prone to erosion, situated adjacent to a watercourse. Implementing erosion control measures in this area offers multiple benefits, including reducing sediment runoff into the watercourse, improving soil health, and enhancing water retention within the field. By minimising soil loss, these measures also contribute to maintaining agricultural productivity and preventing the degradation of valuable topsoil. There are several effective methods for controlling soil erosion in this setting. Options include, contour ploughing to slow surface runoff, and planting cover crops to increase soil stability and organic matter.

Historic aerial photography (2021, 2017 and 2013) as well as current aerial photography reveal the presence of rills and gullies in the same locations where SCALGO has modelled flow pathways, demonstrating a strong correlation between observed erosion features and the modelled data. This alignment indicates that SCALGO is a reliable tool for predicting water flow and erosion risks, reinforcing the need for targeted erosion control interventions in this area.

Figure 57 Historic aerial photography from 2017 showing rills/gullies in the field (Google Earth 2025)

5.3.4 Leaky dams

Leaky dams have been recommended for this location in the Cradley Brook and a small stream flowing into it upstream of Stifford's Bridge to slow flow. The recommended requirements for leaky dam design is, at a minimum, installation should occur in a sequence of three dams, the spacing between each dam is recommended to be approximately seven times the channel width and width of each dam should be at least 1.5 times the channel width, and the structure positioned ~300mm above the base flow level (Yorkshire Dales Rivers Trust 2021).

5.3.5 Grass bunds

Despite the landcover being pasture and typically less prone to soil erosion compared to, for example, a bare arable field, there is a significant flow path flowing overland here. Therefore, intercepting, slowing and temporarily/permanently storing water, along with providing opportunities for infiltration and evaporation during storm events will help to reduce the flow peak and therefore the effects of soil erosion, diffuse pollution, and improve conveyance of water within the watercourse with reduced soil erosion. The proposed bunds have a consistent height and depth, while the cross-sectional width varies along the slope to accommodate the depression. This option involves only a temporary reduction in grass coverage and once revegetated the field can be grazed or driven over as normal. This design allows for flexibility in adjusting the size of the bunds as needed and unlike other measures, this approach does not require materials to be transported to the area and instead only a small amount of ground excavation is required. Although these bunds may not retain as much water as a pond, their advantage lies in their minimal impact on farming practices.

5.4 Case study 4 – Chase End Road

Land near Chase End Road (52.03501, -2.33969) sits on sedimentary bedrock comprising of mudstone. This area comprises of a mix of freely draining acid loamy soils and slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage. The land use is a mix of arable, grassland, rough grazing and some woodland with low to moderate fertility. At this location, a buffer strip, four ponds, leaky dams, grass bunds, a beetle bank, and soil management are proposed which is shown in figures 61 and 62.

5.4.1 Grass buffer strip

Expanding the grass buffer strip and adding an additional strip in the adjacent field will help slow surface water flow before it reaches the proposed pond 1 (figures 61 and 62). This can reduce the risk of sediment deposition, preventing the pond from silting up and maintaining its effectiveness for water storage and flood mitigation. The buffer strips will also enhance soil stability, improve water infiltration, and reduce nutrient runoff, supporting both flood management and environmental benefits.

5.4.2 Ponds

Creating a pond or small wetland area in the lowest, wettest fields can provide natural water storage, helping to slow floodwaters and reduce downstream flood risk while also enhancing biodiversity. As shown in figures 61 and 62, Pond 1 could be strategically placed in the corner of a pasture field to intercept and break up the overland flow pathway from the adjacent arable land. Pond 2 would offer additional on-farm water storage, potentially supporting future abstraction. Pond 3, currently situated within a grass buffer zone, presents an ideal location for a new pond that would complement existing land management practices while enhancing flood resilience, as with Pond 4.

5.4.3 Grass bunds / Leaky dams

Grass bunds could be installed in the pasture field near Field 1 to slow surface runoff before it reaches Pond 1, helping increase water infiltration. Additionally, grass bunds or leaky dams in the main overland flow path in the wooded area adjacent to the pasture field would help retain water, slow flow velocity, and promote gradual infiltration. Putting grass bunds in the woodland area above Pond 4 would have the same benefits.

5.4.4 Beetle bank

A beetle bank could be implemented in the arable field (indicated by the pink line in figures 61 and 62) to help slow overland flow and reduce soil erosion. By creating a raised strip of vegetation, the beetle bank would act as a natural barrier, disrupting surface water movement and encouraging water infiltration into the soil. As seen in the historical imagery in figure 60, this larger field was previous split with hedges which would help slow surface water flow and therefore reduce erosion. A beetle bank could help to reduce the speed and volume of runoff, decreasing the risk of soil loss and nutrient depletion from erosion. Additionally, the beetle bank would enhance biodiversity by providing habitat for predatory insects, which can contribute to natural pest control in the surrounding farmland.

5.4.5 Erosion control

Transitioning from maize e.g. diverse herbal leys on farmland can significantly improve soil structure, enhance water infiltration, and reduce runoff. Deep-rooted species like clover, chicory, and ryegrass help manage waterlogged soils and improve overall soil health. E.g converting the wettest arable fields into species-rich grassland not only increases water infiltration but also reduces erosion risks, creating a more resilient landscape.

Figure 58 Overland flow pathways on aerial photography (SCALGO 2025)

Figure 59 LiDAR data at Chase End Road (SCALGO 2025)

Figure 60 Historical aerial photography of Chase End Road from 1945 (Google Earth 2025)

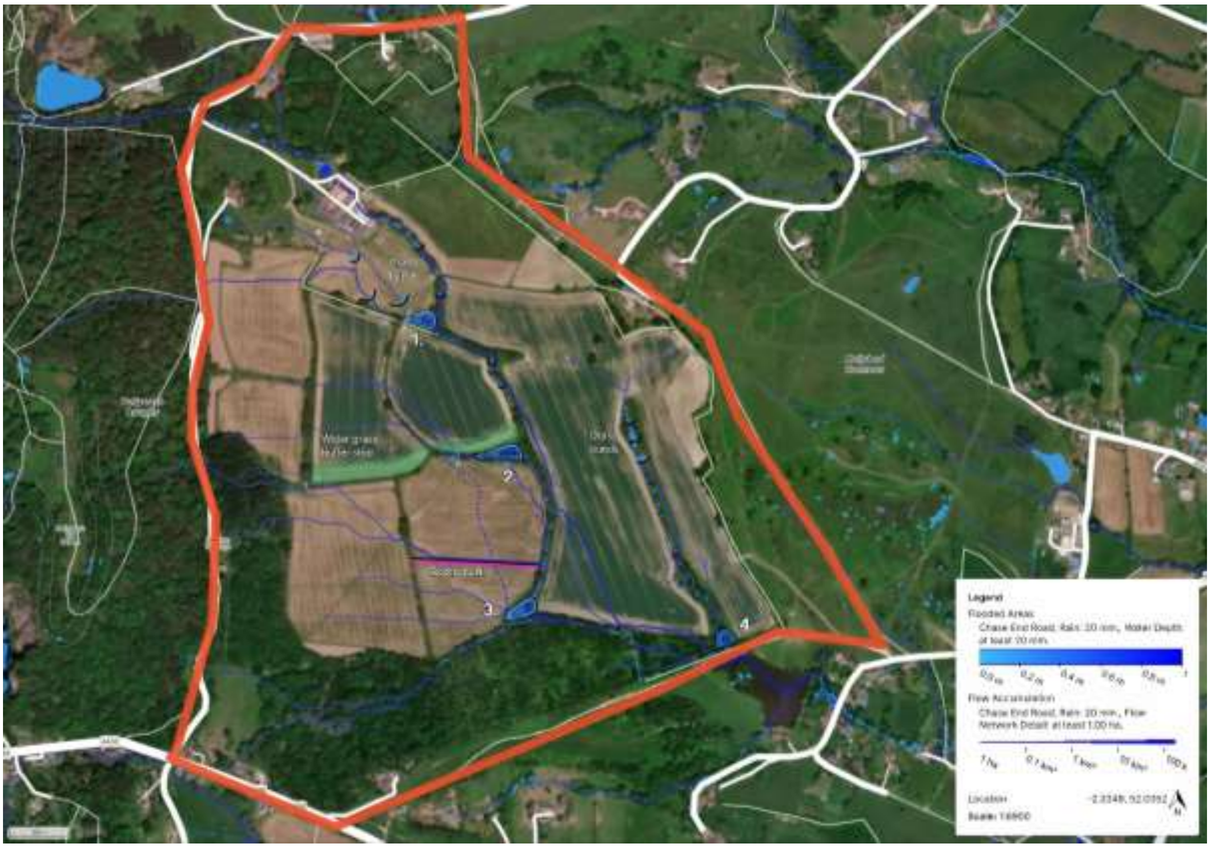

Figure 61 Proposed NFM interventions at Chase End Road (SCALGO 2025)

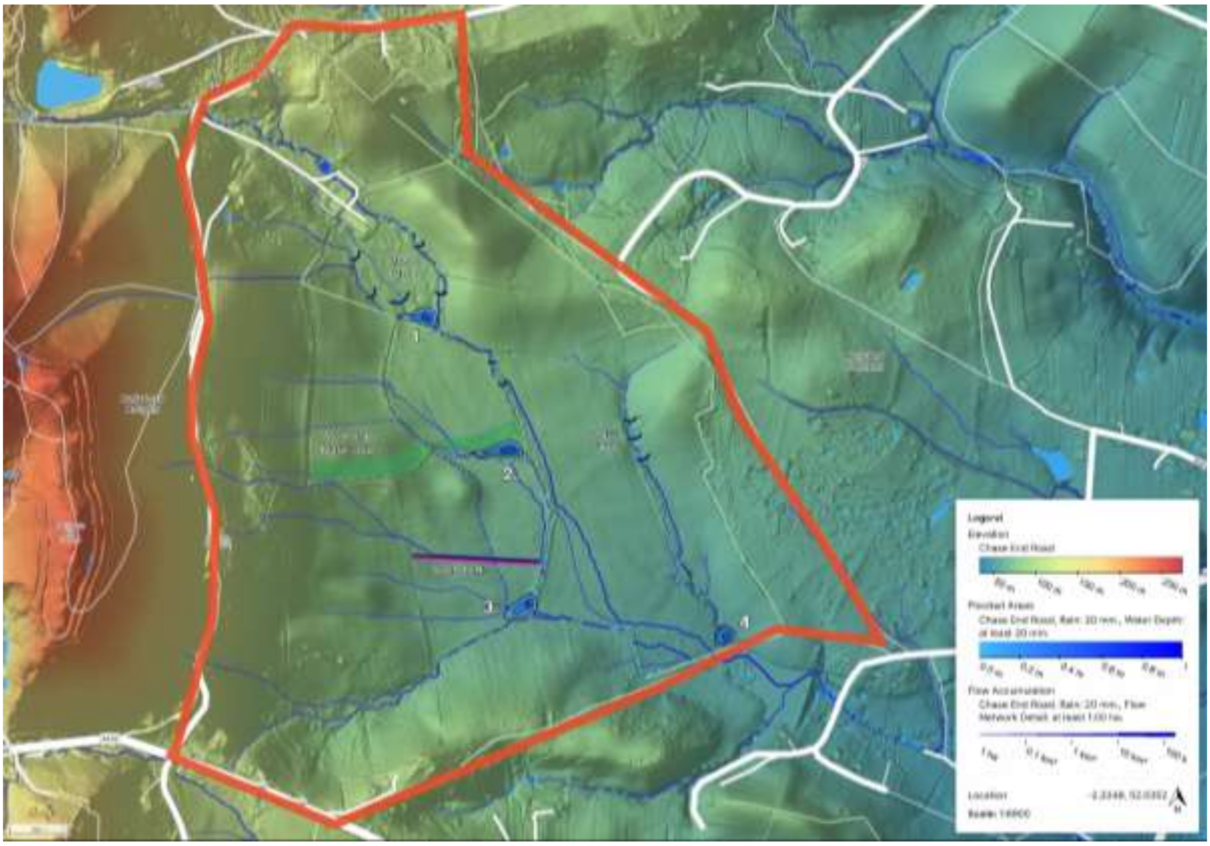

Figure 62 Proposed NFM interventions at Chase End Road (SCALGO 2025)

6.0 Summary

This report summarises the work from the University of Worcester, focusing on scoping and appraising water capture and storage options for NFM within the MHNL and a 1km buffer. The aim is to inform discussions with landowners and managers about capturing and slowing flow during heavy rainfall and storing water for agricultural use, reducing the need for abstraction during dry periods. The study uses web-based tools like SCIMAP and SCALGO to map NFM opportunities in the Severn and Teme catchments. The output includes mapping of surface water runoff and opportunities for slowing flows and water storage, though ground-truthing may be needed later. NFM techniques, such as soil management, leaky dams, and wetland restoration, offer sustainable flood mitigation by working with natural hydrological processes. The MHNL diverse habitats and agricultural land provide significant opportunities for NFM to reduce soil erosion, manage water flow, and enhance ecosystem services. The study identifies 25 potential NFM sites, with four explored as detailed case studies.

7.0 Reference List

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8.0 Appendix

The appendix supports the information in table 1 and 2 in section 4.0 with the titles of each sub-section referring to column 3 these tables. Site 13, 23, 24 and 25 are not included in the appendix as they are described in section 7.0 above.

8.1 NFM site 1 – Alfrick village

Figure 63 High soil erosion risk at site 1 (SCIMAP 2024)

Figure 64 Evidence of soil erosion (rills/gullies present) in historical aerial photography from 2013 (Google Earth 2025)

8.2 NFM site 2 – Hill Road

Figure 65 High soil erosion risk at site 2 (SCIMAP 2024)

Figure 66 Predominant flow pathways connected to stream with high hydrological connectivity (turquoise) at site 2 (SCIMAP 2024)

Figure 67 Evidence of soil erosion (rills/gullies present) in historical aerial photography from 2013 (Google Earth 2025)

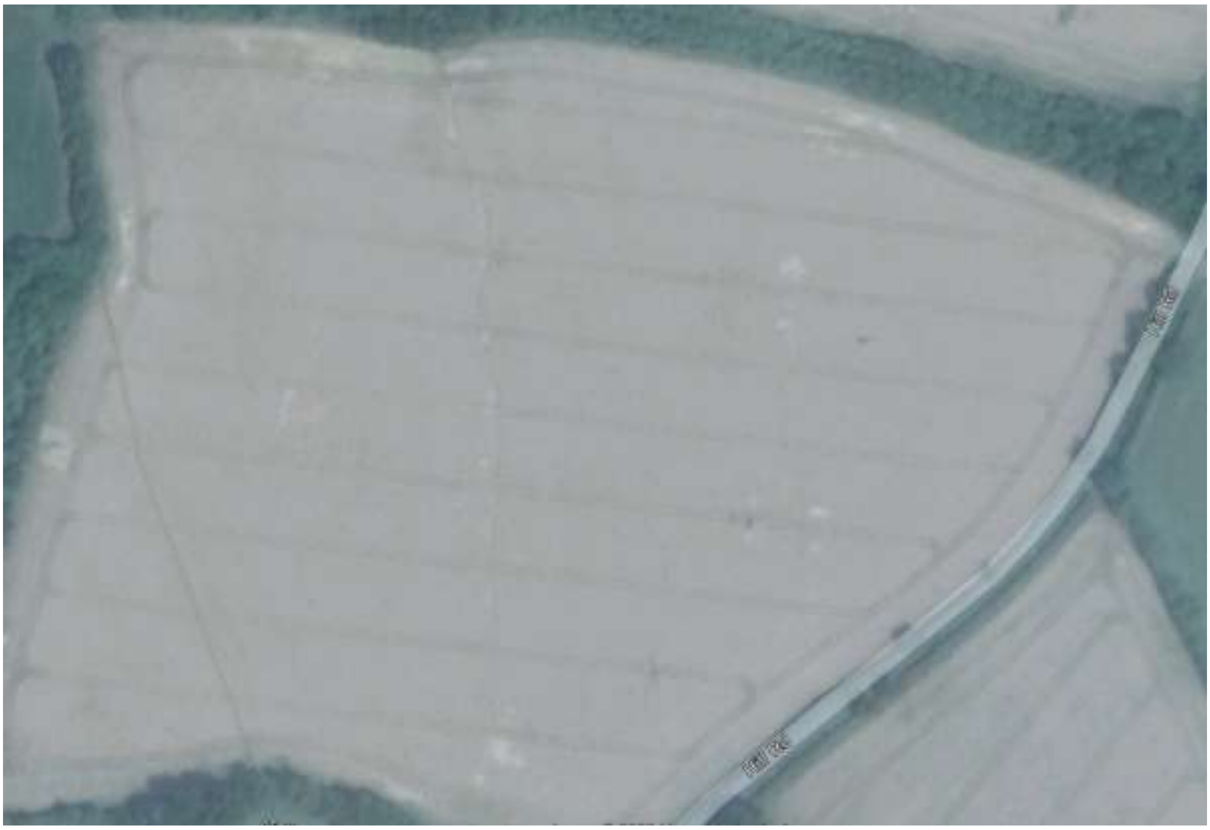

Figure 68 Evidence of soil erosion (rills/gullies present) in historical aerial photography from 2017 (Google Earth 2025)

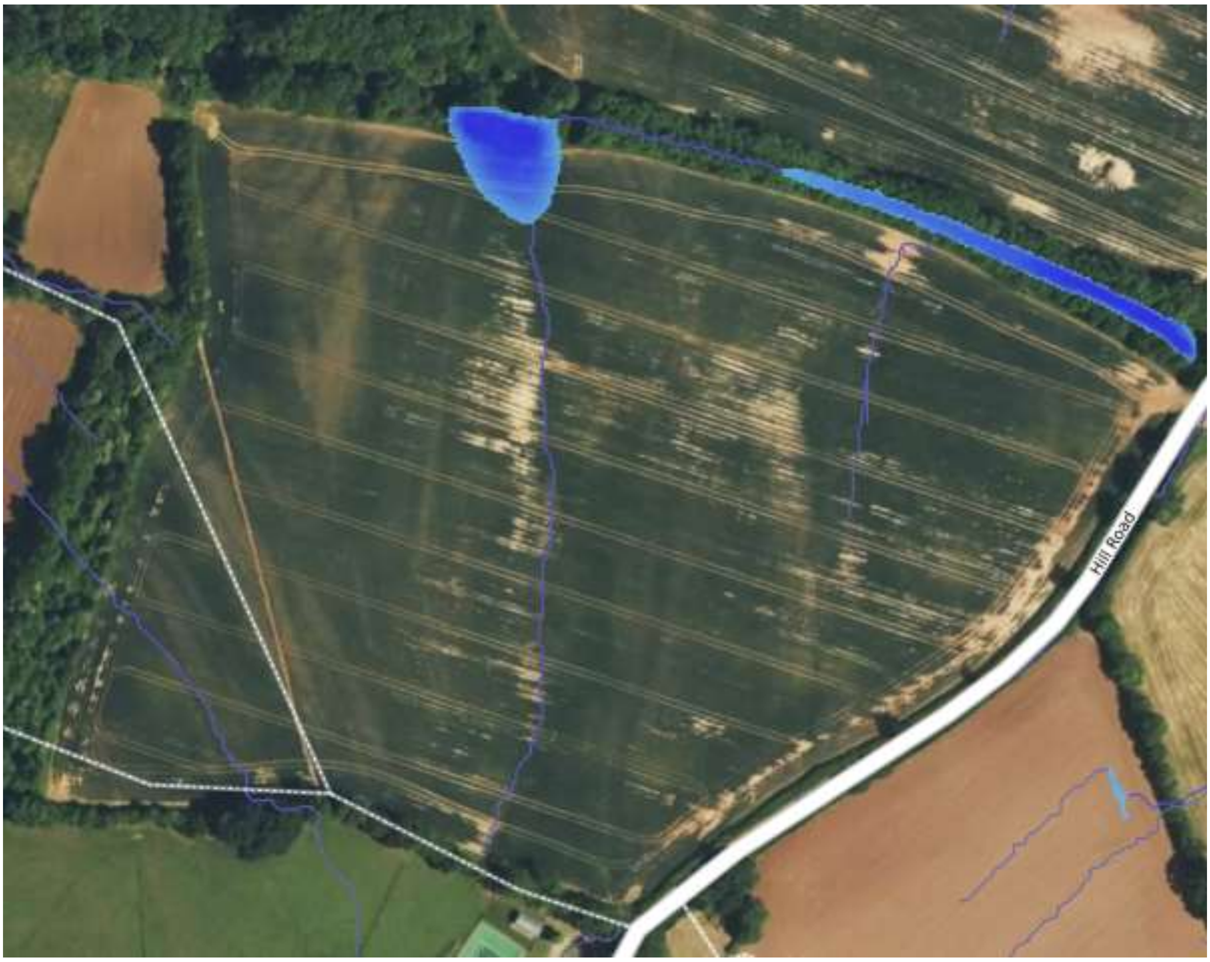

Figure 69 Significant overland flow pathways modelled using SCALGO are in the same location as the rills/gullies seen in 2013 and 2017 (SCALGO 2025)

8.3 NFM site 3 – Crowcroft Farm

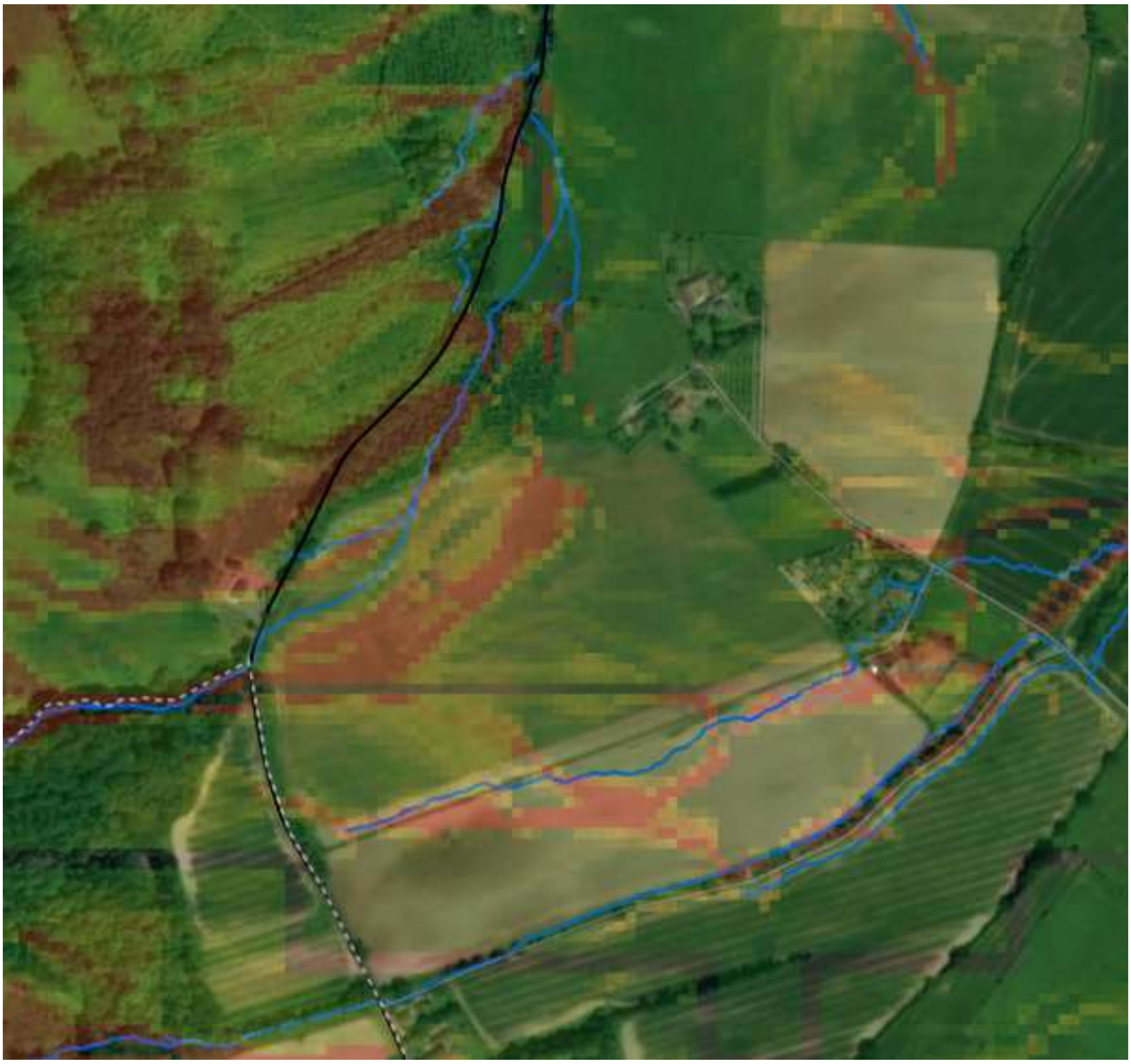

Figure 70 High soil erosion risk at NFM site 3 (SCIMAP 2024)

Figure 71 Evidence of soil erosion (rills/gullies present) in aerial photography (Google Earth 2025)

8.4 NFM site 4 – Stocks Road

Figure 72 WWNP floodplain woodland potential at this location along the Leigh Brook site 4 (ArcGIS 2025)

8.5 NFM site 5 - Stocks Road 2

Figure 73 WWNP floodplain woodland potential at this location along the Leigh Brook site 5 (ArcGIS 2025)

8.6 NFM site 6 – Suckley

Figure 74 WWNP Floodplain reconnection and WWNP Floodplain woodland potential at site 6 (WWNP 20217)

8.7 NFM site 7 – West of Alfrick Village

Figure 75 WWNP Runoff attenuation features 3.3% AEP for potential pond at site 7 (WWNP 2017)

8.8 NFM site 8 – east of Cradley

Figure 76 WWNP Runoff attenuation features 3.3% AEP for potential pond at site 8 (WWNP 2017)

8.9 NFM site 9 and 10 – Walwyn Road

Figure 77 WWNP Runoff attenuation features 3.3% AEP for potential pond at site 9 and 10 (WWNP 2017)

8.10 NFM site 11 – Knightwick

Figure 78 Evidence of standing water at land near Knightwick (SCALGO 2025)

Figure 79 Modelled standing water at land near Knightwick (SCALGO 2025)

8.11 NFM site 12 – Stocks Road

Figure 80 Modelled standing water at land near Stocks Road (SCALGO 2025)

Figure 81 Aerial photography at land near Stocks Road (SCALGO 2025)

Figure 82 OS map at land near Stocks Road (SCALGO 2025)

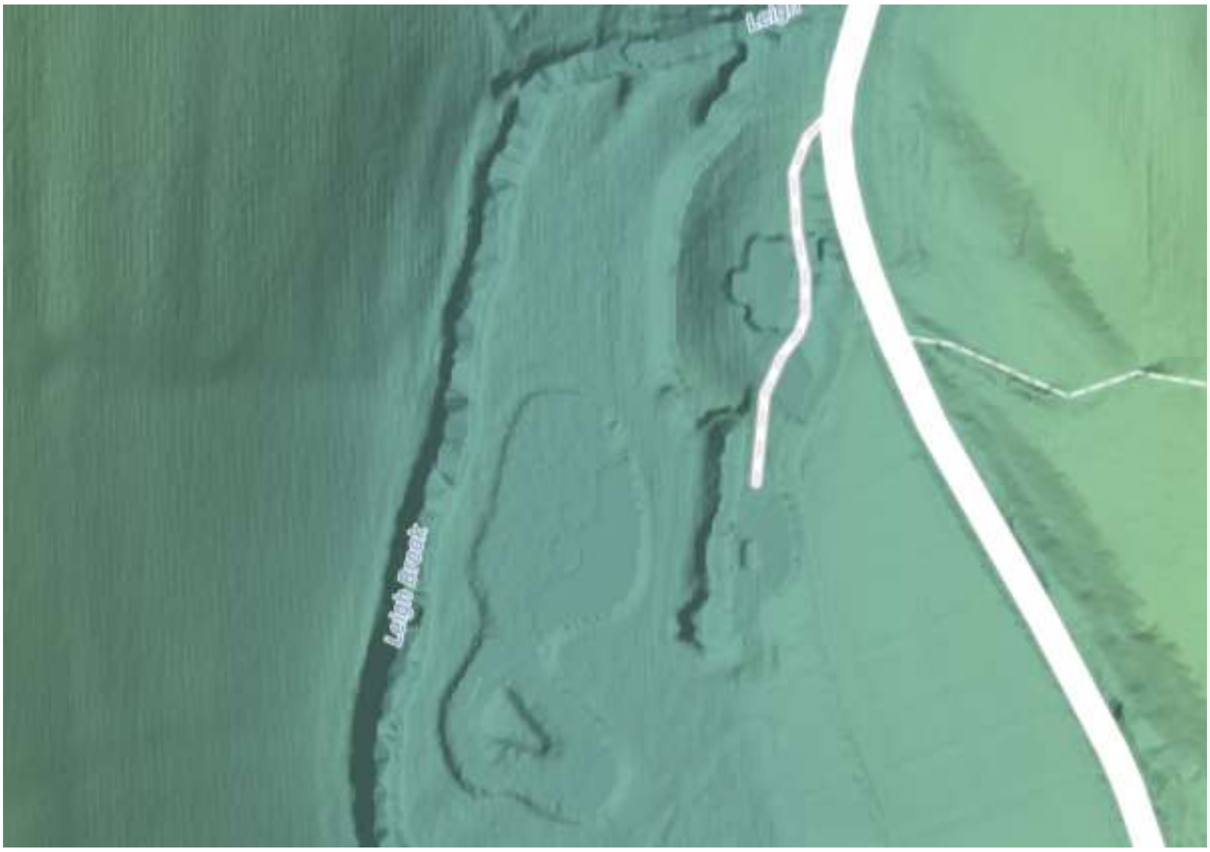

Figure 83 LiDAR data at land near Stocks Road (SCALGO 2025)

Figure 84 Flood zone 2 at land near Stocks Road (EA 2024)

Figure 85 Hydrological connectivity at land near Stocks Road (SCIMAP 2025)

Figure 86 Floodplain reconnection potential at land near Stocks Road (WWNP 2017)

8.12 NFM site 14 – Evendine

Figure 87 Modelled overland flow over aerial photography (SCALGO 2025)

Figure 88 Aerial photography in 2021 (Google Earth 2025)

Figure 89 Aerial photography in 2017 (Google Earth 2025)

Figure 90 Aerial photography in 2013 (Google Earth 2025)

8.13 NFM site 15 – East of Welland

Figure 91 Flooded areas at site 15 (SCALGO 2025)

Figure 92 LiDAR data at site 15 (SCALGO 2025)

Figure 93 OS map at site 15 (SCALGO 2025)

Figure 94 Flood Zone 2 at site 15 (SCALGO 2025)

8.14 NFM site 16 – West of Welland

Figure 95 Modelled overland flow and flooded areas over areal photography at site 16 (SCALGO 2025)

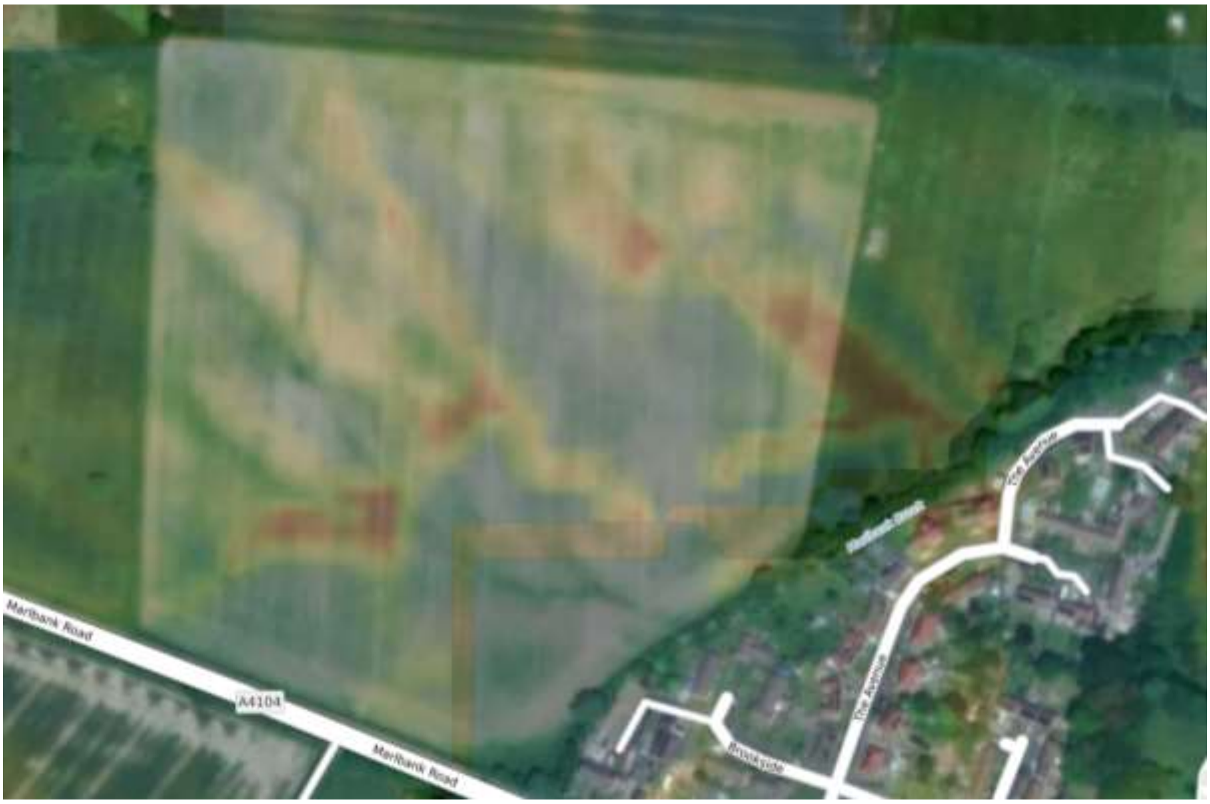

Figure 96 Soil erosion at site 15 (SCIMAP 2025)

Figure 97 Hydrological connectivity at site 15 (SCIMAP 2025)

8.15 NFM site 17 – South of Wellington Heath

Figure 98 Modelled flooded areas at site 17 (SCALGO 2025)

Figure 99 OS map at site 17 (SCALGO 2025)

8.16 NFM site 18 – West of Bromesberrow

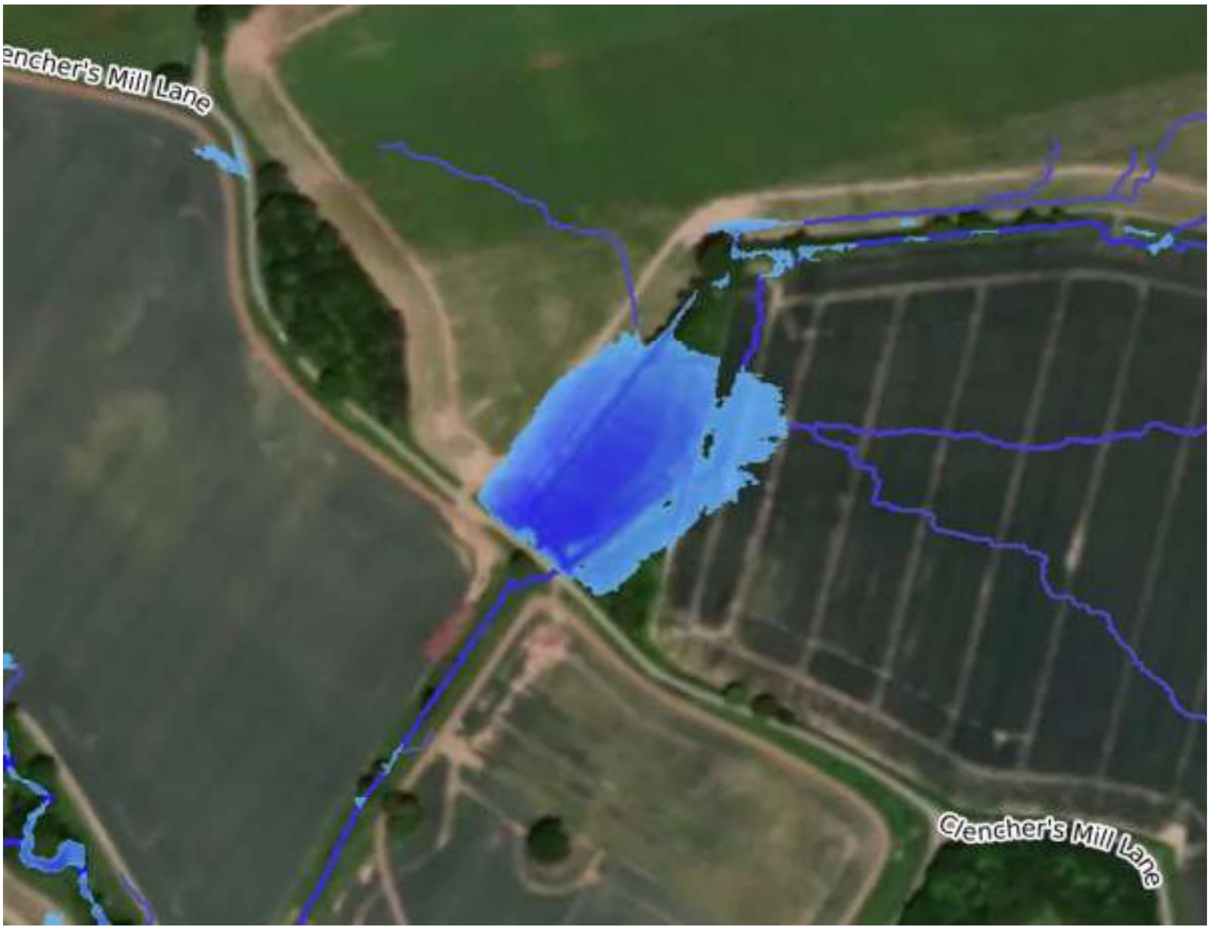

Figure 100 Modelled flooded areas at site 18 (SCALGO 2025)

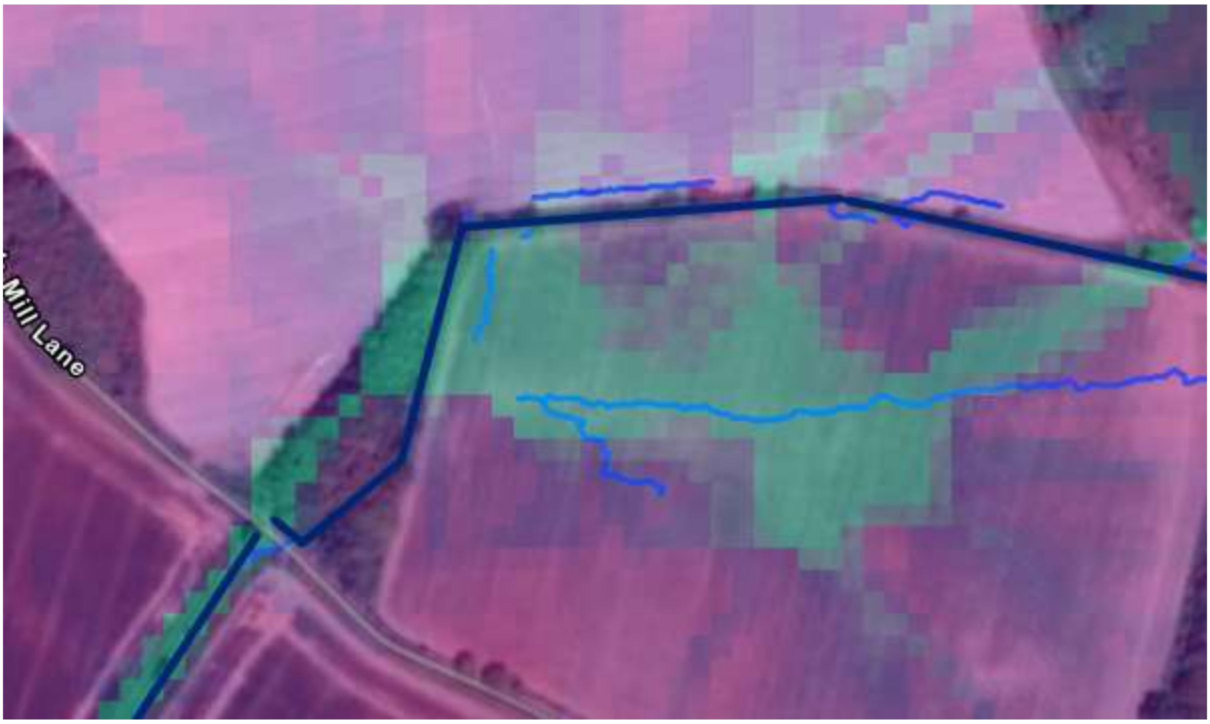

Figure 101 Hydrological connectivity at site 18 (SCALGO 2025)

8.17 NFM site 19 – A417 / M50

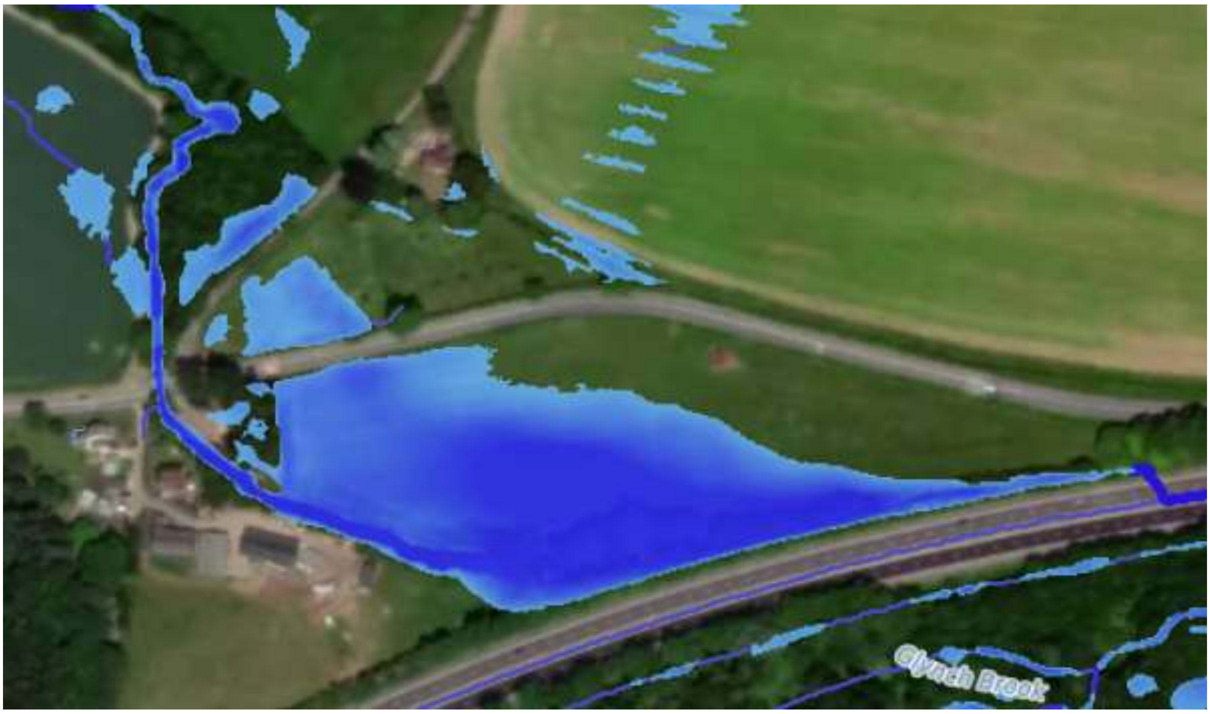

Figure 102 Modelled flooded areas at site 19 (SCALGO 2025)

Figure 103 Modelled flood zone 2 areas at site 19 (SCALGO 2025)

8.18 NFM site 20 – South of Whiteleaved Oak

Figure 104 Modelled overland flow and flooded areas at site 20 (SCALGO 2025)

Figure 105 OS map at site 20 (SCALGO 2025)

8.19 NFM site 21 – Castlemorton

Figure 106 WWNP floodplain woodland potential at site 21 (WWNP 2017)

Figure 107 Flood Zone 2 at site 21 (EA 2024)

Figure 108 WWNP Floodplain reconnection potential at site 21 (WWNP 2017)

8.20 NFM site 22 – Glynch Brook M50

Figure 109 WWNP floodplain woodland potential at site 22 (WWNP 2017)

Figure 110 WWNP Runoff attenuation features 3.3% AEP for potential pond at site 22 (WWNP 2017)

Figure 111 WWNP Runoff attenuation features 3.3% AEP for potential pond at site 22 and Flood Zone 2 (WWNP 2017)

8.21 NFM site 22 – Glynch Brook M50

Figure 112 Overland flow over aerial photography at site 22 (SCALGO 2025)

Scoping Natural Flood Management using SCALGO, SCIMAP and GIS

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February 2025

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Malvern Hills National Landscape